Chapter 1　Name and Business Address or Office Address of The Developer

I. Name of Developer

Greater Changhua Offshore Wind Farm Southeast Company Preparatory Office

II. Business Address

Rm. 1, 14F., No.36, Songren Rd., Xinyi Dist., Taipei City 110, Taiwan (R.O.C.)

Table 1-1 Name and Business Address or Office Address of the Developer and Name of Responsible Person

Developer	Greater Changhua Offshore Wind Farm Southeast Company Preparatory Office
Business or Office Address	Rm. 1, 14F., No.36, Songren Rd., Xinyi Dist., Taipei City 110, Taiwan (R.O.C.)
Name of Responsible Person	Matthias Bausenwein

Remarks: 1. Developer indicates natural person with capacity, name of natural person shall be listed.
2. If a supervisor of higher authority is the person in charge of the development unit, it is mandatory to obtain his/her consent in advance.
3. While submitting to government planned project or construction institute for reviewing, the task shall be listed in EIS report or EIA report and attach its organization chart.
4. If the developer is an investment consortium, cooperation or joint venture, their responsibility shall be described in EIS report or EIA report and attach relevant supporting documents.
5. Person in charge shall be liable for Article 20- Article 23 of Environmental Impact Assessment Ordinance.

Chapter 2 Name of Responsible Person

I. Name of Responsible Person

Matthias Bausenwein

Table 2-1 Name and Business Address or Office Address of Developer, Name of Responsible Person

Developer	Greater Changhua Offshore Wind Farm Southeast Company Preparatory Office
Business or Office Address	Rm. 1, 14F., No.36, Songren Rd., Xinyi Dist., Taipei City 110, Taiwan (R.O.C.)
Name of Responsible Person	Matthias Bausenwein

Remarks: 1. Developer indicates natural person with capacity, name of natural person shall be listed.
2. If a supervisor of higher authority is the person in charge of the development unit, it is mandatory to obtain his/her consent in advance.
3. While submitting to government planned project or construction institute for reviewing, the task shall be listed in EIS report or EIA report and attach its organization chart.
4. If the developer is an investment consortium, cooperation or joint venture, their responsibility shall be described in EIS report or EIA report and attach relevant supporting documents.
5. Person in charge shall be liable for Article 20- Article 23 of Environmental Impact Assessment Ordinance.

Chapter 3 Signatures of EIS General Assessor and Project Planners

Table 3-1 Signatures of EIS General Assessor and Project Planners (6 pages)

General Assessor	Name	Tu, Ming-Lin	Signature	
	Service Unit	Unitech Engineering CO., LTD		
	Academic Background	M.S in Civil Engineering, National Central University		
	Related Experience and Certifications	19 years of experience in consultant company. Traffic engineering technician, Certificate Number: 010988		
General Assessor	Name	Liu, Jai-Kun	Signature	
	Service Unit	Unitech Engineering CO., LTD		
	Academic Background	M.S in Civil Engineering, National Taiwan University		
	Related Experience and Certifications	19 years of experience in consultant company.		
Meteorology	Name	Chen, Li-Ping	Signature	
	Service Unit	Unitech Engineering CO., LTD		
	Academic Background	M.S in School of Forestry & Resource Conservation, National Taiwan University		
	Related Experience and Certifications	6 years of experience in consultant company. VCS/ISO 14064:2006 Greenhouse Gas Inventory and Reduction Director Inspector PAS 2050 Gas Emission of Carbon Footprint and Life Cycle Inspector		
Air Quality	Name	Lin, Yi-Shiou	Signature	
	Service Unit	Unitech Engineering CO., LTD		
	Academic Background	M.S in Environmental Engineering, National Taiwan University		
	Related Experience and Certifications	3 years of experience in consultant company. Training of Environment Impact Assessment (104) Certificate Number E0030082 (Completion of course after 49 hours) Level B Qualified Certificate for Exclusive Personnel of Air Pollution Prevention (2014)Certificate Number of EPA FB020102 Occupational Safety and Hygiene Officer Certificate Number of Taipei City Labor Inspection Office 103305076, (2014) 0211-25709 Occupational Safety and Health Affair Managers (Labor Affairs Department, New Taipei City Government 1043069686)		

Table 3-1 Signatures of EIS General Assessor and Project Planners (Cont. 1)

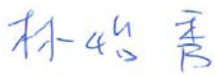
<table>
<tr><td rowspan="4">Noise Vibration</td><td>Name</td><td>George Hsieh</td><td>Signature</td><td>謝智超</td></tr>
<tr><td>Service Unit</td><td colspan="3">Unitech Engineering CO., LTD</td></tr>
<tr><td>Academic Background</td><td colspan="3">M.S in Environmental Engineering, NCKU</td></tr>
<tr><td>Related Experience and Certifications</td><td colspan="3">1 year of experience in consultant company.
Environmental Impact Assessment Training Course (2016) Central Training Course NUMBER E0030074
Level A Qualified certificate for Exclusive Personnel of Waste Water Treatment (2014) (Certificate Number of EPA GA250097)
Class A Dedicated Air Pollution Control Specialist (2013) (Certificate Number of EPA FA 300189)
Class A Waste Disposal Technician (2013) (Certificate Number of EPA HA190640)</td></tr>
<tr><td rowspan="4">Underwater Noise</td><td>Name</td><td>Chen, Chi-Fang</td><td>Signature</td><td></td></tr>
<tr><td>Service Unit</td><td colspan="3">Department of Engineering Science and Ocean Engineering, National Taiwan University</td></tr>
<tr><td>Academic Background</td><td colspan="3">PhD in Ocean Engineering, Massachusetts Institute of Technology (MIT)</td></tr>
<tr><td>Related Experience and Certifications</td><td colspan="3">Professor of Department of Engineering Science and Ocean Engineering (Current Position)
Defense Technology Research of Underwater Acoustics for 19 years (1991.3- Present)
Research Results for 5 years: Industrial Exclusive Port for Changhua Dacheng Program- Survey of Sound Source Underwater
Forestry Development Plan of Council of Agriculture
Executive Yuan, R.O.C.- Planned Project of Chinese White Dolphins and Important Habitats
Survey of Underwater Noise Program Mai Liao The No. 6 Naphtha Cracker Navigation Channel</td></tr>
<tr><td rowspan="4">Hydrology and Water Quality (Ground)</td><td>Name</td><td>Lin, Yi-Shiou</td><td>Signature</td><td></td></tr>
<tr><td>Service Unit</td><td colspan="3">Unitech Engineering CO., LTD</td></tr>
<tr><td>Academic Background</td><td colspan="3">M.S in Environmental Engineering, NTU</td></tr>
<tr><td>Related Experience and Certifications</td><td colspan="3">3 years of experience in consultant company.
Training of Environment Impact Assessment (104) Certificate Number E0030082 (Completion of course after 49 hours)
Occupational Safety and Hygiene Officer (Certificate Number of Taipei City Labor Inspection Office 1033050765, Training course 0211-25709 (2014))
Class A Occupational Safety and Health Affair Managers (Certificate Number of Taipei City Labor Inspection Office 1043069686)</td></tr>
</table>

Table 3-1 Signatures of EIS General Assessor and Project Planners (Cont. 2)

Hydrology and Water Quality (Underground)	Name	Chiu, Ching Ming	Signature	邱景明
	Service Unit	Unitech Engineering CO., LTD		
	Academic Background	M.S in Dept. Harbor & River Engineering, NTOU		
	Related Experience and Certifications	19 years of experience in consultant company.		
Hydrology and Water Quality (Maritime)	Name	Yang, Tai-Chiang	Signature	楊代強
	Service Unit	Huan Hai Engineering CO., LTD.		
	Academic Background	M.S in Civil Engineering, NTU and Hydraulic Engineering.		
	Related Experience and Certifications	15 years of experience in consultant company Certificate of Hydraulic Engineer: (1994): certificate number 1006		
Soil	Name	Wood Chang	Signature	
	Service Unit	Unitech Engineering CO., LTD		
	Academic Background	M.S in Environmental Engineering, National Chiao Tong University		
	Academic Background	9 years of experience in consultant company		
Geology and Topography	Name	Chang, Chen-Lin	Signature	張鎮麟
	Service Unit	CECI Engineering Consultants, Inc., Taiwan		
	Academic Background	Constructive Engineering (Geotechnical Engineering), National Taiwan University of Science and Technology		
	Related Experience and Certifications	1. Relevant Experience: CECI Engineering Consultants, Inc., Taiwan (2013.08- Present) 2. Certificate: Level C Engineering Measurement (No.042-006356)		
Waste	Name	Chu Ling, Hsu	Signature	許林綾
	Service Unit	Unitech Engineering CO., LTD		
	Academic Background	M.S in Harbor & River Engineering, NTOU		
	Related Experience and Certifications	9 years of experience in consultant company. Class A Dedicated Air Pollution Control Specialist (2013) (Certificate Number of EPA FA 010157)		

Table 3-1 Signatures of EIS General Assessor and Project Planners (Cont. 3)

Terrestrial Ecology (Plant)	Name	Bao-Yuan, Chen	Signature	陳保元
	Service Unit	Institute of Ecology and Evolutionary Biology, NTU		
	Academic Background	M.S in Ecology and Evolutionary Biology, NTU		
	Related Experience and Certifications	First Phase EIS of Offshore Wind Farm EIS of Penghu Low Carbon Wind Farm		
Terrestrial Ecology (Anima;)	Name	Lian, Yu-Yi	Signature	連裕益
	Service Unit	Formosa Natural History Corporation		
	Academic Background	M.S in Plant Pathology and Microbiology, NTU		
	Related Experience and Certifications	First Phase EIS of Offshore Wind Farm EIS of Penghu Low Carbon Wind Farm		
Marine Ecology	Name	Kwang-Tsao Shao	Signature	邵廣昭
	Service Unit	Ke Hai Ecological Consultant Co., Ltd.		
	Academic Background	PhD in Ecology and Evolution, State University of New York at Stony Brook.		
	Related Experience and Certifications	Chief Executive and research fellow of Biodiversity Research Center Academia Sinica, Director and Research Fellow of Institute of Cellular and Organismic Biology Academia Sinica, Professor of Continuing Education in Biology Research Institute of National Taiwan Normal University Director and Associate Professor of Institute Marine Biology, National Taiwan Ocean University Professor of Department of Entomology, National Chung Hing University Professor of Research Center of Fishery Science, National Taiwan Ocean University Professor of Institute of Oceanography, National Taiwan University Expertise in marine ecology, marine life, fish ecology, biodiversity of marine life, fishery biology, database and etc.		

Table 3-1 Signatures of EIS General Assessor and Project Planners (Cont. 4)

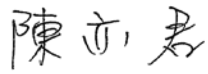
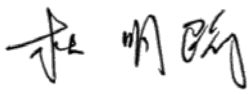
Landscape for Recreation	Name	Lin, Yi-Xuan	Signature	
	Service Unit	Dian Liang Landscape Design Co., Ltd		
	Academic Background	M.A in Landscape Architecture of Ohio State University- Columbus		
	Related Experience and Certifications	13 years of experience of landscape for recreation Lecturer of Department of Landscape Architecture of Chung Hua University and MingDao University		
Social Economy	Name	Lilian Chen	Signature	
	Service Unit	Unitech Engineering CO., LTD		
	Academic Background	M.S in Natural Resources and Environmental Studies, National Dong Hwa University		
	Related Experience and Certifications	11 years of experience in consultant company		
Transportation	Name	Tu, Ming-Lin	Signature	
	Service Unit	Unitech Engineering CO., LTD		
	Academic Background	M.S in Civil Engineering, National Central University (NCUCE)		
	Related Experience and Certifications	19 years of experience in consultant company Transportation Engineering Technician, Certificate Number 010988		
Culture	Name	Lu, Tai-Long	Signature	
	Service Unit	Long Men CO., LTD		
	Academic Background	Master in Anthropology, National Taiwan University		
	Related Experience and Certifications	Over 10 years of experience of industrial heritage survey assessment		

Table 3-1 Signatures of EIS General Assessor and Project Planners (Cont. 5)

Electromagnetic Wave	Name	Chi-Jui Wu	Signature	
	Service Unit	Deputy Chairman of Electrical Engineering, National Taiwan University of Science and Technology		
	Academic Background	PhD in Electrical Engineering, NTU		
	Related Experience and Certifications	Conducted 50 projects assessment of electromagnetic field in power system, Transient Analysis of Submarine Cable Transmission System (2008), Research of Computation Program and Suppression Technique in Transmission Line 3D Magnetic Field, Measurement Project of Magnetic Field Intensity Taipower Substation (2005), Impact on Magnetic Field of Underground Transmission Line Phase Sequence, Monthly Journal of Taipower Engineering (2008)		
Public Opinion Poll	Name	Cheng, Yu-Ting	Signature	
	Service Unit	Department of Statistics of NCCU		
	Academic Background	Ph.D. in Statistics, University of Minnesota, USA		
	Related Experience and Certifications	Associate Professor, Department of Statistics of National Chengchi University, Chief of Data Mining Center of NCCU		

Remarks:1. Project planners shall comply with Article 9 of Environmental Impact Assessment Act Enforcement Rules and attach copies of related documents; If possesses any technician qualifications and related certificates, the number of certificates can be listed.

2. Project planners shall be liable to Article 20 of Environmental Impact Assessment Act Enforcement Rules.

3. If the project planners and on-field surveyor are not the same person, it shall be signed respectively; If the field survey is conducted by inspection body, the name, representative, permit document of the body and permit document of test category shall be listed. Outsource academic institution, professors, researcher or non-commercial group shall be listed in field survey.

4. Project planners shall be the technician environmental impact assessment, staff of architectural firm and advisory service research group. Assigned institution shall sign at Table 3-1 and be liable.

5. Supervisor of Environmental Impact Assessment of developer shall fill out Table 3-2.

Table 3-2 Environmental Impact Assessment Department of Developer and Assigned Institution for Environmental Impact Assessment

<table>
<tr><td rowspan="6">Environmental Impact Assessment Department in Developer</td><td colspan="2">Business Development</td><td colspan="4">Greater Changhua Offshore Southeast Company Preparatory Office</td></tr>
<tr><td colspan="2">Address</td><td colspan="4">Rm. 1, 14F., No.36, Songren Rd., Xinyi Dist., Taipei City 11073, Taiwan (R.O.C.)</td></tr>
<tr><td rowspan="2">Supervisor of Developer</td><td>Position</td><td>Chairman</td><td>Telephone</td><td colspan="2">02-2722-1617</td></tr>
<tr><td>Name</td><td>Matthias Bausenwein</td><td>Fax</td><td colspan="2">02-2722-0226</td></tr>
<tr><td rowspan="2">Project Manager</td><td>Position</td><td>Permit and Consent Business</td><td>Telephone</td><td colspan="2">02-2722-1617</td></tr>
<tr><td>Name</td><td>Kao, Chuan-Sheng</td><td>Fax</td><td colspan="2">02-2722-0226</td></tr>
</table>

<table>
<tr><td rowspan="10">Assigned Institution for Environmental Impact Assessment</td><td colspan="2">Name of Institution</td><td colspan="3">Unitech Engineering CO., LTD</td><td colspan="2">License Number</td><td colspan="2">Certificate of Engineering Consultant: 000153</td></tr>
<tr><td colspan="2">Address</td><td colspan="7">17F.-7, No.77, Sec 1, Xintai 5th Rd., Xizhi Dist., New Taipei City 221, Taiwan (R.O.C)</td></tr>
<tr><td colspan="2">Legal Representative</td><td>Position</td><td>Person in Charge</td><td>Name</td><td>Lo, Kuang Mei</td><td>Telephone</td><td colspan="2">(02) 2698-1277</td></tr>
<tr><td colspan="2">Assigned Task</td><td colspan="7">Technical Consultant of Environmental Impact Assessment</td></tr>
<tr><td colspan="2">Development Unit</td><td colspan="4">Department of Environmental Impact Assessment</td><td colspan="3" rowspan="6">
Seal of Institute</td></tr>
<tr><td colspan="2">Business Address</td><td colspan="4">17F.-7, No.77, Sec 1, Xintai 5th Rd., Xizhi Dist., New Taipei City 221, Taiwan (R.O.C)</td></tr>
<tr><td rowspan="2">Person in Charge</td><td>Position</td><td>General Manager</td><td>Telephone</td><td colspan="2">(02)2698-1277</td></tr>
<tr><td>Name</td><td>Tu, Ming-Lin</td><td>Fax</td><td colspan="2">(02)2698-1284</td></tr>
<tr><td rowspan="2">Project Manager</td><td>Position</td><td>Project Engineer</td><td>Telephone</td><td colspan="2">(02)2698-1277</td></tr>
<tr><td>Name</td><td>George Hsieh</td><td>Fax</td><td colspan="2">(02)2698-1277</td></tr>
</table>

Remarks: This table is filled out by Environmental Impact Assessment Department of developer and assigned institution for Environmental Impact Assessment for the purposes of reviewing by competent authority, tracking and supervising.

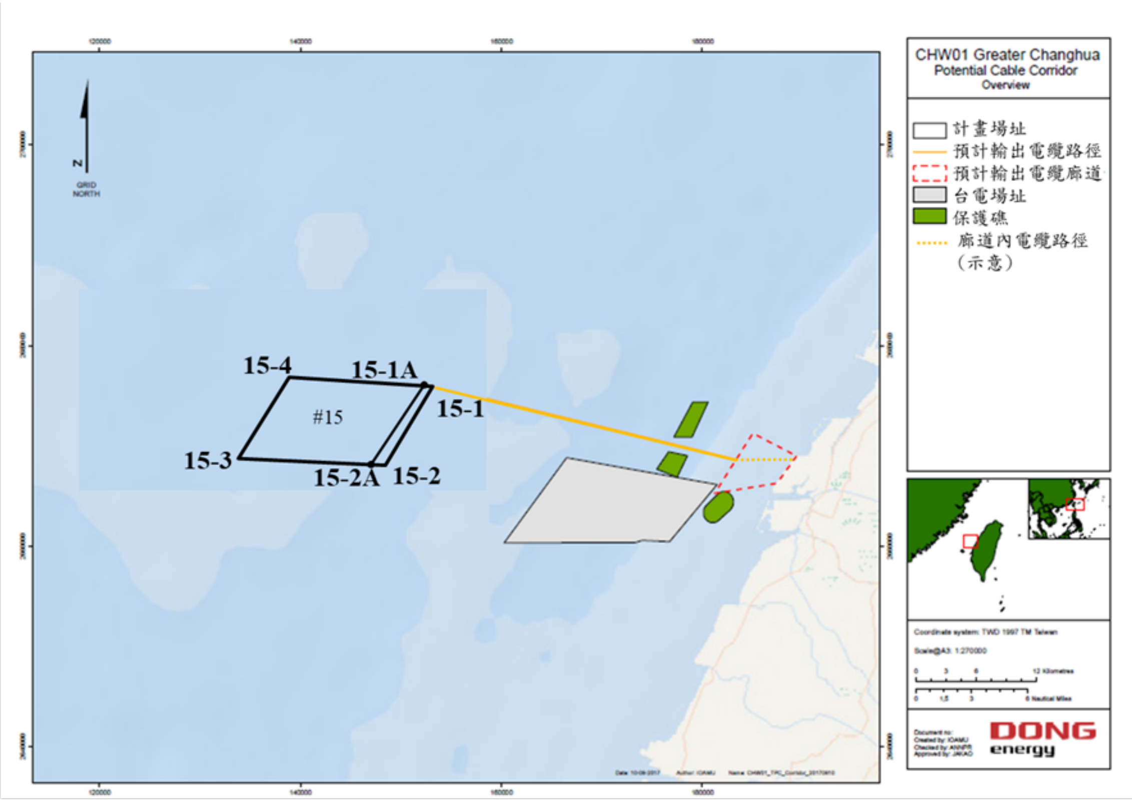
Chapter 4 Name of Development and Development Site

4.1 Name of Development

Greater Changhua Southeast Offshore Wind Farm Project

4.2 Development Site

Greater Changhua Southeast Offshore Wind Farm Project is located at offshore area of Xianxi Township and Lukang Township, Changhua County, the nearest distance of wind farm and shore is approx. 35.7km. The land cable is expected to set up at Xianxi Township or Lukang Township, the development site is shown as Figure 4.2-1. The future location of submarine cable for common corridor of Taiwan Power Company is shown as Figure 4.2-2.



註1：依台電公司於106年8月14日公告之共同廊道進行規劃
註2：15-1及15-2為原風場邊界點，15-1A及15-2A為依交通部航港局預公告之航道範圍縮減後之風場邊界點

Figure 4.2-1 Schematic Diagram of Greater Changhua Southeast Offshore Wind Farm Project

Table 4.2-1 Name and Development Site of Development

1.Development	Greater Changhua Southeast Offshore Wind Farm Project
Regulations or Organic Act of Development	1.□Name of Laws and Content (Including Articles, Paragraph, Subparagraph and Item): 2.■Other: Operation Directions Governing Offshore Wind Farm Applications
Regulations of environmental impact assessment document ■EIS □Preliminary Draft of EIA □Others:	1.■The development shall implement Article 29 Item 1 Subparagraph 5 of Standards for Determining Specific Items and Scope of Environmental Impact Assessments for Development Activities: Set Up Wind Farm Offshore System 2.□Others （Please specify）
3.Scale of Project	1. Waters Area of Offshore Wind Farm: The original area of this offshore wind farm is 120.4km^2. According to Maritime and Port Bureau, MOTC, after revision of navigation channel on August 11th, 2017, the area is 108.7km^2. The depth of water ranges between 34.4 and 44.1m. The installed capacity of wind turbine ranges between 8MW and 11MW. If the wind turbine with minimum installed capacity (8MW) is selected, 76 wind turbines will be erected. If the wind turbine with maximum installed capacity (11MW), 55 wind turbines will be erected. The total installed capacity is not exceeded 613MW. 2. Transmission and Distribution Lines: This project is planned in accordance with Taiwan Power Company. The landing point is located at north corridor. It is then linked to booster station and grid connection point of Taiwan Power Company through roads.
4.Location of Development, Administration Area and Land Use District (Schematic Map of Development)	1.Location of Development: This project is located at offshore area of Xianxi Township, Changhua County. The nearest distance with shore is approx. 35.7km. Overland cable is mainly set at Xianxi Township or Lukang Township. The geographical location of project is shown as Figure 4.2-1. 2.Administration Area: Xianxi Township and Lukang Township 3.Land Use District: (1) Offshore Wind Farm: The configuration area of wind turbine is waters. (2) Overland cable is located at existing roads; the roads of this project are located at Changhua Coastal Industrial Park under jurisdiction of Changhua Coastal Park Service Center.

4.3 Environmentally Sensitive Areas and Sites of Special Scientific Interest’s Limitation Survey

Environmentally sensitive area, sites of specia

l scientific interest limitation survey results, items and regulatory restrictions are shown in Table 4.3-1 and 4.3-2:

Table 4.3-1 Table of Environmentally Sensitive Areas and Sites of Special Scientific Interest’s Limitation Survey

	Development Location	Yes Unknown No	Supporting Information and Documents	Remarks
1	Is it located at nature reserve area or protected area issued by Taiwan Coastal Nature Environment Protection Plan?	☐ ☐ ■	Official Letter 1050004457, issued by Urban and Rural Development Branch, Construction and Planning Agency, MOI on 17th Oct. 2016. Official Letter 1050005878 issued by Urban and Rural Development Branch, Construction and Planning Agency, MOI on 30th Dec. 2016. Official Letter 1050813949 issued by Urban and Rural Development Branch, Construction and Planning Agency, MOI on 13th Oct. 2016.	Refer to Appendix 1: 1-10 to 1-14, 1-41 to 1-43 and 1-49 to 1-60.
2	Is it located at National Important Wetland?	☐ ☐ ■	Official Letter 1050004457 issued by Urban and Rural Development Branch, Construction and Planning Agency, MOI on 17th Oct. 2016. Official Letter 1050005878 issued by Urban and Rural Development Branch, Construction and Planning Agency, MOI on 30th Dec. 2016.	Refer to Appendix 1: 1-10 to 1-14. Wind farm area, submarine cable route, landing points and etc. are not located within “National Important Wetland”. Official Letter 1040800278 issued by Ministry of Interior, R.O.C on 28th Jan. 2015 (Appendix 1:1-44 to 1-48). The terrestrial facility of this project is not located within “National Important Wetland”.

Table 4.3-1 Table of Environmentally Sensitive Areas and Sites of Special Scientific Interest's Limitation Survey (Cont. 1)

	Development Location	Yes Unknown No	Supporting Information and Documents	Remarks
3	Is it located at estuary, lagoon, mangrove swamp, marsh, sand dune, sand bar, coral reef or another wetland?	☐ ☐ ■	On-site Survey Results, Orthophoto Map and 1:25,000 Topographic Map	Refer to Appendix 1: 1-1 to 1-6.
4	Is it located at Tap Water Quality Protection Area?	☐ ☐ ■	Official Letter 1050054098 issued by 11th Branch Water Corporation on 7th Oct. 2016 Official Letter 1050057089 issued by 11th Branch Water Corporation on 28th Dec. 2016. Official Letter 10551151410 issued by Water Resources Agency, Ministry of Economic Affairs on 19th Oct. 2016. Official Letter 10551197340 issued by Water Resources Agency, Ministry of Economic Affairs on 4th Jan. 2017.	Refer to Appendix 1:1-15, 1-61, 1-17 to 1-18 and 1-65 to 1-66.
5	Is it located at a certain distance with Water Quality and Quantity Protection Are or Intake of Drinking Water?	☐ ☐ ■	Official Letter 1050050175 issued by Environmental Protection Bureau Changhua County on 6th Oct. 2016. Official Letter 1050069097 issued by Environmental Protection Bureau Changhua County on 26th Dec. 2016.	Refer to Appendix 1: 1-16 and 1-80 to 1-81.
6	From effluent to estuary, if the water body of wastewater is accessed via tap water intake on the surface? Within 20km of estimated industrial wastewater effluent, if the irrigation associations use it as intake of irrigation water?	☐ ☐ ■	Official Letter 1050054098 issued by 11th Branch Taiwan Water Corporation on 7th Oct. 2016. Official Letter 1050057089 issued by 11th Branch Taiwan on 28th Dec. 2016.	Refer to Appendix 1:1-15 and 1-61. This project is located at offshore of Changhua County instead of land area; Estimated area of terrestrial electrical and mechanical facility is within Changhua Coastal Industrial Park. Land use district is divided into industrial zone and irrigation area of non-irrigation association; Thus, intake of irrigation association is not involved.

Table 4.3-1 Table of Environmentally Sensitive Areas and Sites of Special Scientific Interest's Limitation Survey (Cont. 2)

	Development Location	Yes	Unknown	No	Supporting Information and Documents	Remarks
7	Is it located at reservoir catchment area, reservoir storage range or constructing commercial center?	□	□	■	Official Letter 10551151410 issued by Water Resources Agency, Ministry of Economic Affairs on 19th Oct. 2016. Official Letter 10551197340 issued by Water Resources Agency, Ministry of Economic Affairs on 4th Jan. 2017.	Refer to Appendix 1: 1-17 to 1-18 and 1-65 to 1-66.
8	Is it located at Designated Soil and Water Conservation Area?	□	□	■	Official Letter 1050397706 issued by Changhua County Government on 24th Nov. 2016. Official Letter 1050459605 issued by Changhua County Government on 5th Jan. 2017. Official Letter 1050341428 issued by Changhua County Government on 12th Oct. 2016.	Refer to Appendix 1:1-19 to 1-21 and 1-74 to 1-75. Changhua County has not announced any designated soil and water conservation area.
9	Is it located at wildlife refuge or wildlife habitat?	■	□	□	Official Letter 1051613712 issued by Forestry Bureau, COA, Executive Yuan on 7th Nov. 2016. Official Letter 1051617765 issued by Forestry Bureau, COA, Executive Yuan on 26th Dec. 2016. Official Letter 1050357557 issued by Changhua County Government on 18th Oct. 2016. Official Letter 1060004257 issued by Changhua County Government on 5th Jan. 2017.	Refer to Appendix 1:1-22 to 1-23, 1-68 to 1-69 and 1-78 to 1-79. This project is not within the area of "Chinese White Dolphin Major Wildlife Habitat". The submarine cable has passed the area. To avoid wildlife of that area affects by noise, vibration, wind turbine and other disturbance, in the stages of construction, operation and decommission, EIA is conducted to determine blade sweeping, noise and foundation of wind turbine have caused any impacts on wildlife of that area (such as cetacean. Birds and bats). Thus, specific mitigation impacts and ecological compensation measures are proposed.

Table 4.3-1 Table of Environmentally Sensitive Areas and Sites of Special Scientific Interest's Limitation Survey (Cont. 3)

	Development Location	Yes	Unknown	No	Supporting Information and Documents	Remarks
10	Is it located at hunting area or fishing area?	☐	☐	■	Official Letter 1050357557 issued by Changhua County Government on 18th Oct. 2016. Official Letter 1051617765 issued by Forestry Bureau, COA, Executive Yuan on 26th Dec. 2016.	Refer to Appendix 1:1-24 to 1-26 and 1-68 to 1-69. Hunting Area and Fishing Area are not announced by Changhua County yet.
11	Are there any protected wildlife animal or rare and valuable plant or animal?	■	☐	☐	Ecological Survey Results of This Project. Directory of Survey Results is enclosed at Appendix 4.2 and 4.3.	Directories of survey results are listed in Appendix 4.2 and 4.3. Based on ecological survey results, 4 protected species are discovered in terrestrial survey, including eurasian kestrel and black-winged kite (rare and valuable species). Other conversation-deserving wildlife such as oriental pratincole and brown shrike are listed. 3 protected species are listed in marine survey, such as bridled tern and greater crested tern of rare and valuable species. 7 protected species are documented in coastal survey, such as black-faced spoonbill of endangered species, black-winged kite, osprey, eurasian kestrel and little tern of rare and valuable species, eurasian curlew and oriental pratincole of other conservation-deserving wildlife are documented as well. A protected species, bottlenose dolphin is discovered in marine survey. 2 groups and 2 individuals of bottlenose dolphins are discovered.

Table 4.3-1 Table of Environmentally Sensitive Areas and Sites of Special Scientific Interest's Limitation Survey (Cont. 4)

	Development Location	Yes Unknown No	Supporting Information and Documents	Remarks
12	Is it located at location, heritage area or neighboring area of cultural heritage (including underwater cultural heritage) which mentioned in Article 3 of Cultural Heritage Act?	□ □ ■	Official Letter 1050008604 issued by Changhua County Cultural Affairs Bureau on 4th Oct. 2016. Official Letter 1050011438 issued by Changhua County Cultural Affairs Bureau on 23rd Dec. 2016. Cultural Heritage Survey Report of this Project Website of Cultural Heritage Survey Report http://www.boch.gov.tw/culturacasesearch_177.html Official Letter 1063006424 issued by Bureau of Cultural Heritage, Ministry of Culture on 20th Jun. 2017 Official Letter 1063013677 issued by Bureau of Cultural Heritage, Ministry of Culture on 30th Nov. 2017.	Refer to Appendix 1:1-27 to 1-28 and 1-72 to 1-73. Survey results are described in Appendix 8. According to cultural heritage survey report, terrestrial land involved within Changhua Coastal Industrial Park has no National Historic Sites or relics. There are 6 National Historic Sites but 0 National Relics at Changhua County, not within the area of Changhua Coastal Industrial Park. The nearest National Historic Sites is approximately 5km away. Refer to Appendix 8:8-1 to 8-13. Refer to Appendix 1:1-90 to 1-91.
13	Is it located at National Park, National Scenic Area or other Scenic Area?	□ □ ■	Official Letter 1050013489 issued by Tourism Bureau, Ministry of Transportation and Communications on 5th Oct. 2016. Official Letter 1050020401 issued by Tourism Bureau, Ministry of Transportation and Communications on 21st Dec. 2016.	Refer to Appendix 1:1-29 and 1-63.
14	Is there any rare and valuable geographical landscape?	□ □ ■	After on-site survey, existing roads and sea dikes on the terrestrial region of offshore wind farm have no rare and special geographic landscape.	Refer to Appendix 1:1-1 to 1-5.

Table 4.3-1 Table of Environmentally Sensitive Areas and Sites of Special Scientific Interest's Limitation Survey (Cont. 5)

	Development Location	Yes Unknown No	Supporting Information and Documents	Remarks
15	Is it located at protective forest, national forest, forest reserve or forest recreation area?	□ □ ■	Official Letter 1051613712 issued by Forestry Bureau, COA, Executive Yuan on 07th Nov. 2016. Official Letter 1051617765 issued by Forestry Bureau, COA, Executive Yuan on 26th Dec. 2016. Official Letter 1066071686 issued by Changhua Coastal Park Service Center on 25th Apr. 2017.	Refer to Appendix 1:1-22 to 1-23 and 1-68 to 1-69. A total of 60 plots of land from Lugong Section 1 to 59 and Section 88 is considered as second phase developing land of Lugang West Section 1, it is conducted according to actual progress. It is estimated to finish the development at November of 2017. During that time, related units will set land use zoning and types of land use, details is shown in 1-88.
16	Is it located at mine ground or mine underground registered under Mineral Rights?	■ □ □	Official Letter 10500096780 issued by Bureau of Mines, MOEA on 4th Oct. 2016. Official Letter 10500126630 issued by Bureau of Mines, MOEA on 22nd Dec. 2016. Official Letter 10510468863 issued by Exploration and Production Business Div., CPC Corporation, Taiwan on 23rd Aug. 2016.	Refer to Appendix 1: 1-30 to 1-31 and 1-67. The site of this wind farm is located at area of Mineral Rights Official #5638 (No. 3399 Mining Claim). After intussusception with current oil gas exploration of CPC Corporation Taiwan potential site, they are not overlapped, the safety of marine exploration and production are unaffected.
17	Is it located at breeding conservation area of aquatic plants and animal, fishing fights zone, closed fishing area of fish shelter and net gear or important using area of fisheries?	■ □ □	Official Letter 1051216778 issued by Fisheries Agency, Council of Agriculture on 12th Oct. 2016. Official Letter 1051222093 issued by Fisheries Agency, Council of Agriculture on 30th Dec. 2016. Officials Words 1060126968 issued by Changhua County Government on 14th Apr. 2017.	Refer to Appendix 1:1-32 to 1-33 and 1-70 to 1-71. Part of submarine cable passes through Exclusive Fishing Right of Changhua Fishermen's Association. Refer to Appendix 1:1-87. Changhua County has no fixed net fishery right zones and demarcated fishery right zone. Terrestrial electrical and mechanical facility is estimated locate at Changhua County, not at fixed net fishery right zones and demarcated fishery right zones.

Table 4.3-1 Table of Environmentally Sensitive Areas and Sites of Special Scientific Interest's Limitation Survey (Cont. 6)

	Development Location	Yes Unknown No	Supporting Information and Documents	Remarks
18	Is it located at river area, groundwater control area, flood plain control zones, land for waterway management or area of drainage facilities?	■ □ □	Official Letter 10551151410 issued by Water Resources Agency, Ministry of Economic Affairs on 19th Oct. 2016. Official Letter 10551197340 issued by Water Resources Agency, Ministry of Economic Affairs on 4th Jan. 2017. Official Letter 1050397706 issued by Changhua County Government on 24th Nov. 2016. Official Letter 1050459605 issued by Changhua County Government on 5th Jan. 2017.	Refer to Appendix 1:1-17 to 1-18, 1-20 to 1-21, 1-65 to 1-66 and 1-74 to 1-75. Land cable of this project is located within the groundwater control zone. No prefecture-administered river at Changhua County.
19	Is it located at geologic structure unstable area (active fault, geological disaster zone) , river bank or coastal erosion zone?	□ □ ■	Official Letter 10500055550 issued by Central Geological Survey, MOEA on 6th Oct. 2016. Enquiry from Central Geological Survey, MOEA, active fault observation system is used for citizen to inquire. (Website: http://fault.moeacgs.gov.tw/MgFault/Home/pageMap?LFun=1) Website data from the 4th River Management Office, WRA.(http://www.wra04.gov.tw/ct.asp?xItem=60104&ctNode=29712&mp=99)。	Refer to Appendix 1:1-34 to 1-35. Refer to Appendix 1:1-118 to 1-145. The site of wind farm is located at Changhua Offshore. It is 35.7km away from shore. The landing point is within Changhua Coastal Industrial Park, no active fault is discovered within 10km perimeter of this site. This project has no unstable geological structure (active fault, environmental-geological disaster area). Refer to Appendix 1:1-9. According to interpretation survey data of topography migration at Changhua Coast, Changhua Coastal Industrial Park is not located at river bank and coastal erosion area.

Table 4.3-1 Table of Environmentally Sensitive Areas and Sites of Special Scientific Interest's Limitation Survey (Cont. 7)

	Development Location	Yes Unknown No	Supporting Information and Documents	Remarks
20	Is it located at Geologically Sensitive Area announced by Geology Act?	□ □ ■	Official Letter 10500055550 issued by Central Geological Survey, MOEA on 6th Oct. 2016. Power transmission lines is inquired by Environmentally Sensitive Area Inquiry Ssytem of Central Geological Survey, MOEA (website): http://gis.moeacgs.gov.tw/gwh/gsb97-1/sys_2014b/	Refer to Appendix 1:1-34 to 1-35 and 1-118 to 1-145.
21	Is it located at Class III Air Pollution Control Zone?	■ □ □	Official Letter 1050050175 issued by Changhua County Government on 6th Oct. 2016. Official Letter 1050069097 issued by Environmental Protection Bureau Changhua County on 26th Dec. 2016.	Refer to Appendix 1: 1-16 and 1-80 to 1-81. Since 1st Jan. 2017, Changhua County is classified as Class 3 Control Region.
22	Is it located Class I and Class II Noise Control Area?	□ □ ■	Official Letter 1050050175 issued by Environmental Protection Bureau Changhua County on 6th Oct. 2016. Official Letter 1050069097 issued by Environmental Protection Bureau Changhua County on 26th Dec. 2016.	Refer to Appendix 1:1-16 and 1-80 to 1-81.
23	Is it located at water pollution control zone?	□ □ ■	Official Letter 1050050175 issued by Environmental Protection Bureau Changhua County on 6th Oct. 2016. Official Letter 1050069097 issued by Environmental Protection Bureau Changhua County on 26th Dec. 2016.	Refer to Appendix 1:1-16 and 1-80 to 1-81.
24	Is it located coast, mountain, military control zone, vital area, air traffic control zone or affected facilities of military radar, communication, telecommunications or radio waves?	□ □ ■	Official Letter 1050013290 issued by the 5th Army Command on 25th Oct. 2016. Official Letter 1060000026 issued by the 5th Army Command on 3rd Jan. 2017.	Refer to Appendix 1:1-36 and 1-64. This project does not cover military control zone, ban and restrictions area or vital area.

Table 4.3-1 Table of Environmentally Sensitive Areas and Sites of Special Scientific Interest's Limitation Survey (Cont. 8)

	Development Location	Yes	Unknown	No	Supporting Information and Documents	Remarks
25	Is it located at designated restricted development area (Non-development or Condition Development Zone)?	■	□	□	Official Letter 1050004457 issued by Urban and Rural Development Branch, Construction and Planning Agency, MOI on 17th Oct. 2016. Official Letter 1050005878 issued by Urban and Rural Development Branch, Construction and Planning Agency, MOI on 30th Dec. 2016.	Refer to Appendix 1:1-10 to 1-14 and 1-41 to 1-60. This area of this project is considered as restricted development area and conditional development area.
26	Is it located at air traffic control zone?	□	□	■	Official Letter 1050023472 issued by Civil Aeronautics Administration on 4th Oct. 2016. Official Letter 1050030497 issued by Civil Aeronautics Administration on 23rd Dec. 2016.	Refer to Appendix 1:1-37 and 1-62.
27	Is it located at hillside or lands reserved for aboriginal people?	□	□	■	Official Letter 1050341428 issued by Changhua County Government on 12th Oct. 2016. Official Letter 1050245824 issued by Changhua County Government on 20th Jul. 2016. Power transmission line is inquired by Changhua Hillside Geographical Information System. (http://sw.chcg.gov.tw/chcgsw/)	Refer to Appendix 1:1-19. Refer to Appendix 1:1-89. This project is referred to survey results of lands reserved for aboriginal people at Xidao Offshore Wind Farm Project and North Changhua Offshore Wind Farm; Changhua County has not allocated lands reserved for aboriginal people. Refer to Appendix 1:1-7. In Changhua County, hillside is observed at Changhua City, Huatan Township, Fenyuan Township, Yuanlin Township, Shetou Township, Tianzhong Township and Erlin Township. Landing point of submarine cable and terrestrial electrical and mechanical facility are located within the area of Shenggang Township, Xianxi Township and Lugang Township, no hillside in the area.

Table 4.3-1 Table of Environmentally Sensitive Areas and Sites of Special Scientific Interest's Limitation Survey (Cont. 9)

	Development Location	Yes Unknown No	Supporting Information and Documents	Remarks
28	Is area of development site located at above 50% or above 40% of slope?	☐ ☐ ■	On-site Survey Results, Orthophoto Map and 1:25,000 Topographic Map	Refer to Appendix 1:1-1 and 1-5. This project is within the area of offshore wind farm.
29	Is it located at forest range or forestry land?	☐ ☐ ■	Official Letter 1050352924 issued by Changhua County Government on 13th Oct. 2016. Official Letter 1050357557 issued by Changhua County Government on 18th Oct. 2016. Cadastral Map Land Number Transcription Official Letter 1066071686 issued by Changhua Coastal Park Service Center on 25th Apr. 2017.	Refer to Appendix 1:1-38. Refer to Appendix 1:1-24 to 1-26. Refer to Appendix 1:1-90 to 1-119. A total of 60 plots of land from Lugong Section 1 to 59 and Section 88 is considered as second phase developing land of Lugang West Section 1, it is conducted according to actual progress. It is estimated to finish the development at November of 2017. During that time, related units will set land use zoning and types of land use, details is shown in 1-88.
30	Is it located at special agricultural area, hillside conservation zones, archeology reserve, ecological conservation area or security land?	☐ ☐ ■	Official Letter 1050357557 issued by Changhua County Government on 18th Oct. 2016. Cadastral Map Land Number Transcription Official Letter 1066071686 issued by Changhua Coastal Park Service Center on 25th Apr. 2017.	Refer to Appendix 1:1-24 to1-26. Refer to Appendix 1:1-90 to 1-119. A total of 60 plots of land from Lugong Section 1 to 59 and Section 88 is considered as second phase developing land of Lugang West Section 1, it is conducted according to actual progress. It is estimated to finish the development at November of 2017. During that time, related units will set land use zoning and types of land use, details is shown in 1-88.
31	Is it located at special agricultural area consolidated to be agricultural land?	☐ ☐ ■	Official Letter 1050397706 issued by Changhua County Government on 24th Nov. 2016. Official Letter 1050343826 issued by Changhua County Government on 6th Oct. 2016. Official Letter 1050446187 issued by Changhua County Government issued on 23rd Dec. 2016.	Refer to Appendix 1: 1-20 to 1-21, 1-39 and 1-76.

Table 4.3-1 Table of Environmentally Sensitive Areas and Sites of Special Scientific Interest's Limitation Survey (Cont. 10)

	Development Location	Yes	Unknown	No	Supporting Information and Documents	Remarks
32	Is it located at conservation area of Urban Planning Division?	☐	☐	■	Official Letter 1050343481 issued by Changhua County Government on 20th Oct. 2016. National Land Surveying and Mapping Center (http://maps.nlsc.gov.tw/) Inquired by National Land Surveying and Mapping Center: (http://maps.nlsc.gov.tw/) and Survey System of National Land Use Zoning: (http://luz.tcd.gov.tw/WEB/) Cadastral Map Land Number Transcription Official Letter 1066071686 issued by Changhua Coastal Park Service Center on 25th Apr. 2017.	Refer to Appendix 1:1-40. Refer to Appendix 1:1-8 This project is not within Xianxi Township, Shenggang Township and Lukang Township of Changhua County, the site is non-urban land. Refer to Appendix 1:1-107 to 1-136. This site is considered as industrial zone of non-urban land. A total of 60 plots of land from Lugong Section 1 to 59 and Section 88 is considered as second phase developing land of Lugang West Section 1, it is conducted according to actual progress. It is estimated to finish the development at November of 2017. During that time, related units will set land use zoning and types of land use, details is shown in 1-88.
33	Is it located at exclusion area around nuclear facility and low population zone?	☐	☐	■		This project is not within area of New Taipei City and Pingtung County, no review is needed.
34	Is it located at 1500m above sea level altitude?	☐	☐	■	On-site Survey Results, Orthophoto Map and 1:25,000 Topographic Map	Refer to Appendix 1:1-1 and 1-5.
35	Is there other Environmentally Sensitive Area or Special District Area?	☐	☐	■	Based on EPA local environmental database and on-site survey, the site is not located at other environmentally sensitive area or special district.	

Remarks:1. Sites where are clearly not located in aforementioned locations may be exempted to attach supporting document. Reasons shall be stated in the columns of remarks.
2.Sites where are located at aforementioned environmentally sensitive area or district with specific purpose shall be compliance with regulations of Civil Code and constituted related measures.

Table 4.3-2 Table of Environmentally Sensitive Areas and Sites of Special Scientific Interest's Limitation Survey

No.	Items at Environmental Sensitive Area	Relevant Regulations	By Content	Mitigation Measures
1.	Submarine cable passes through the estimated area of Important Habitat of Chinese White Dolphin.	Wildlife Conservation Act	Article 18 of Wildlife Conservation Act: Protected Wildlife should be conserved and shall not be disturbed, abused, hunted, killed or otherwise utilized.	The area of this wind farm project has avoided reserved area of "Chinese White Dolphin Major Wildlife Habitat". Thus, it is minimum 30km away of west part boundary. Submarine cable passes through reserved area of "Chinese White Dolphin Major Wildlife Habitat". Construction of submarine cable will not produce great noise; Thus, it will not cause any affect to Chinese White Dolphin. Cetaceans might be affected during pilling stage. The protection measures of cetacean during pilling stage is drafted in Chapter 8.
2.	Protected birds and cetaceans which are recorded within site of project.	Wildlife Conservation Act	Article 18 of Wildlife Conservation Act: Protected Wildlife should be conserved and shall not be disturbed, abused, hunted, killed or otherwise utilized.	Mitigation measures of birds' and cetaceans' ecology are drafted, details are described in Chapter 8.
3.	It is located at mine ground or mine underground registered under Mineral Rights.	Article 8 of Mining Law	Mining Law is considered to real right. Except for special regulations, the regulations of real estate real rights are in accordance with Civil Code.	According to Official Letter 10510468863 issued by Chinese Petroleum Corporation on 23rd August 2016, the area of wind farm and submarine cable is overlapped with CPC Corporation, Taiwan Official #5638 Mineral Rights (First Mining Claim of Taiwan Strait). After overlaying with current oil gas exploration of CPC Corporation Taiwan potential site, they are not overlapped, the safety of exploration and production of CPC Corporation, Taiwan are unaffected.
4.	It is located at Fishing Fights	Fisheries Act	Fishing Fights mentioned in Article 15 of Fisheries Act	It is handled according to Fisheries Act.

No.	Items at Environmental Sensitive Area	Relevant Regulations	By Content	Mitigation Measures
	Zone of Changhua Fishermen's Association		is described as follows: • Fixed Net Fishery Right: It defines the rights to catch aquatic animals via setting fish barrier or fishing gear at waters and artificial bank. • Demarcated Fishery Right: It defines the right to cultivate fish at certain area. • Exclusive Fishing Right: It defines the fishery rights to construct fishing ground via certain waters to provide fishery right holders to access fishery. ✓ Fishery to catch aquatic animals. ✓ Fishery to cultivate aquatic animals. ✓ Fishery to catch aquatic animal within water depth of 25m via fixed fishing gear. Article 29 of Fisheries Act: The competent authority may alter or revoke its approval to fishing right or suspend the operation of any fishing right, if any of the following circumstances occurs: • Requirements of national defense. • Economic utilization of land. • Conservation of aquatic resources. • Requirements of environmental protection. • Navigation and anchorage of any vessel. • Laying of underwater pipelines and cables.	

No.	Items at Environmental Sensitive Area	Relevant Regulations	By Content	Mitigation Measures
			• Exploration and exploitation of minerals. • Requirements of other public interests. Before rendering any administrative disposition as referred to in the preceding paragraph, the competent authority shall publicize such disposition in advance and notify all fishery operators concerned. Where the administrative disposition as referred to in paragraph 1, cause any loss to the fishery operator, the relevant competent authority or the party claiming alteration, revocation, or termination shall reconcile the operator to make appropriate compensation for the losses. Should the reconciliation fail, the central competent authority shall decide the content of the compensation.	
5	Terrestrial cable is located at Groundwater Control Area.	Regulations on Groundwater Conservation	Rigging and drawing water within controlled area shall be compliance with Article 5 of “Regulations on Groundwater Conservation”: Rigging and drawing water within controlled zone shall comply with one of the following regulations: • Water system has not reached or provided in household water supply or public water supply. • Due to war, natural disaster, significant changes or long-term natural wear and tear,	Development does not extract groundwater. Thus, it does not involve regulations of rigging and drawing water.

No.	Items at Environmental Sensitive Area	Relevant Regulations	By Content	Mitigation Measures
			well which obtained water rights are depleted or allocated by government are unable to use. The original water right holder is necessary to continue using the water. • Recharge and recycle of groundwater are conducted upon consent of supervisors. • Coping with policies of National Competent Authorities for Business Objectives, central authorities agree to reallocate underwater rights. • Within announced exclusive cultivating fishery zone of agriculture central authorities, rigging and drawing of water shall be duly conducted upon the consent of central authorities. • Within the hot spring area announced by Hot Spring Act, the management of hot spring area is planned to be water supply of public pipelines upon the consent of central authorities. • Risk of water shortage might occur in facility or campsite of national defense, international airport, international commercial port, fire bureau, medical center or local hospital. Thus, backup water source	

No.	Items at Environmental Sensitive Area	Relevant Regulations	By Content	Mitigation Measures
			must be prepared. • To prevent war, natural disasters or other major changes which lead to major changes in public interests, central governing authority or National Competent Authorities for Business Objectives shall prepare back-up water supply upon the consent of central governing authority. Those who fulfill one of the aforementioned regulations, the competent authority shall grant required amount of water with water right and issue certificate of water right. Certificate of water right shall indicate recorded items shall meet the requirement of rigging and drawing of water. Back-up water supply shall be indicated as well.	
6.	Class III Control Region of Air Pollution	Air Pollution Control Act	Existing stationary pollution sources within Class 3 control regions shall reduce pollutant emissions. Newly installed or modified stationary pollution sources within Class 3 control regions in which pollutant emissions reach a certain scale shall employ best feasible control technology. Modelling and simulation shall be performed to verify pollutant emissions from newly installed or modified stationary pollution sources within Class 3 control regions	This project is development plan of wind farm, no air pollutant and stationary source are emitted.

No.	Items at Environmental Sensitive Area	Relevant Regulations	By Content	Mitigation Measures
			will not exceed allowable pollutant increase limits and allowable pollutant increase limits of air quality shall not affect by neighboring control zone. The central competent authority shall determine the allowable pollutant increase limits, air quality modeling, simulation standards and the best feasible control technology.	
7.	It is located at Designated Restricted Development Zone (Non-Development Zone and Conditional Development Zone)	Amendment of Regional Planning at north, middle, south and east region of Taiwan. First Overall Review	It is divided into Designated Development Zone and Conditional Development Zone. Designated development zone refers to sensitive area in natural environment. Except for national defense, national public works and quality and safety of living environment, development without conservation purpose is prohibited, they are controlled by business regulatory for conservation and development purpose in order to use national land effectively. Thus, it restricts that variety and intensity of land use variety and intensity by conditions.	It is divided into "Designated Restricted Development Zone" and "Conditional Development Zone", water is considered as conditional development zone. According to Regional Planning Law, land of waters can be provided as multi purposes and facilities users. This project is offshore wind farm project, it is considered as a marine development plan.
		National Regional Planning	Environmentally Sensitive Area is divided into Class I Environmentally Sensitive Area and Class II Environmentally Sensitive Area. Class I Environmentally Sensitive Area: Strengthen resources conservation and environmental protection, do not damage environment	Based on "National Regional Planning", it is divided into Class I Environmentally Sensitive Area and Class II Sensitive Area, waters is considered as Class II Environmentally Sensitive Area. Waters Zoning Principle of National: Utilization of waters

No.	Items at Environmental Sensitive Area	Relevant Regulations	By Content	Mitigation Measures
			and landscape resource in principle. Class II Sensitive Environmentally Area: Limited development capacity of environmentally sensitive area is taking into consideration to cover address on conservation and development, strengthen regulatory conditions and regulate land development.	shall base on ecological conservation. Before the constitution of water allowance and permit mechanism, it shall comply with the business regulations. This is an offshore wind farm project; related proposals shall be raised in accordance with “Guidelines of Application for Offshore Wind Farm Site” issued by Bureau of Energy on 2nd July 2015 in order to fulfill the requirements of waters region zoning by “National Regional Planning”.

Chapter 5 Developmental Objective and Content

Table 5-1 Developmental Objective and Content

I. Developmental Objective

The Bureau of Energy, Ministry of Economic Affairs, has announced on July 2, 2015 the "Offshore Wind Farm Site Application Regulations" in line with government policies to endorse the early offshore wind energy development preparations of the developers. Greater Changhua Offshore Wind Farm SE Ltd. Preparatory Office (hereinafter referred to as "the Preparatory Office") has proposed the " Greater Changhua SE Offshore Wind Power Project" (hereinafter referred to as "the Project") for the development of offshore wind farms in response to government's renewable energy policies to promote nuclear-free homeland by the year 2025. We hope that through profound exchange and interaction, we can bring international experiences into Taiwan's wind power industry and join hands with Taiwan's various resources from political and academical fields to invest in offshore wind farm development and jointly promote future energy development so that Taiwan will have a better chance in leading Asia-Pacific's development of energy industry cluster and set the regional green energy study case.

II. Developmental Content

(1) Territorial Waters Of The Offshore Wind Farm: Wind farm of the Project is located off the coast of Xianxi Township of Changhua County. It belongs to the 15^{th} Zone of Potential announced by the "Offshore Wind Farm Site Application Regulations". This Zone of Potential is approximately35.7km from main island of Taiwan whereof the area is approximately $120.4km^2$. Water depth is approximately 34.4~44.1m with average water depth of 40.9m. The Zone of Potential does not include restricted areas such as fishing port ranges, wetlands, protected reef area, coastal nature conservation area, important habitat for wild bird, important Baluga dolphin habitat, etc.

(2) Single wind turbine unit of the Project has capacity of approximately 8~11MW, with the maximum capacity of not exceeding 613MW. If wind turbine with single unit capacity of 8MW is chosen, the maximum number of wind turbines in the layout will be 76 units.

(3) Submarine cable engineering: the Project adopts two 220kV submarine cables in 33kV or 66kV array to interconnect wind turbines, which will be intergrated in the territorial waters, which the landing will be planned based on the common corridor. The submarine cables will connect with the offshore substation and be connected to the northern part of the common corridor to reach land.

(4) Onshore electricity transmission and distribution facilities engineering: future planning will follow Taiwan Power Company, connecting to land via Changhua offshore common corridor northern corridor. It will then be connected to land cables along the road to reach the land booster (step-down) station, and then connect to the Changkong grid connection point..

construction phase	1. Project content	Offshore wind turbine foundation construction, tower assembly, blade cabin assembly, mechanical and electrical equipment installation, connection station engineering, transmission line engineering (including submarine cable and land cable) and other relevant facilities.
	2. Construction procedure	Geological prospecting, pile planting, submarine cable and land cable line engineering, wind turbine tower assembly, blade assembly, and mechanical and electrical equipment installation / commercial operation.
	3. Construction period	Onshore facilities are scheduled to be constructed since year 2019. All construction works are expected to be completed by year 2025.
	4. Environmental protection measures	Adverse impact reduction countermeasures and monitoring operations on environmental factors such as air pollution control, noise control, runoff water pollution reduction, sewage treatment, construction management, environmental monitoring, etc.

	5. Earthwork management	excavation amount (m^3)	amount of fill (m^3)	volume of spoil (m^3)	spoil dumping ground
		Maximum 261,800 (soil Volume)	Maximum 66,700 (soil Volume)	Maximum 195,100 (soil Volume) Maximum 234,120 (loose volume)	According to the relevant provisions of Changhua Coastal Industrial Park; the principle is to carry out in-situ leveling or land fill within the industrial park
Operational phase	1. General facilities	Offshore wind turbines generator set, submarine cable facilities, onshore substation, land cable facilities.			
	2. Environmental protection facilities	Green landscaping, safety measures, environmental monitoring, etc.			
	3. Amounts of Various emission commitment	None			

5.1 Developmental Objective

5.1.1 Project Origin

DONG Energy Group, an energy giant in Northern Europe, was once one of Europe's most powerful coal-fired power companies; with the idea of promoting energy transformation in Europe and its abundant technical resources, it is now a global leader in off-shore wind power generation. Since DONG Energy Wind Power, a subsidiary of the DONG Energy Group, built its first wind farm in 1991, it has been putting the efforts in transforming conventional energy systems into sustainable renewable energy sources to create higher economic value from energy source for the local people at the wind farm. As an offshore wind power industry leader, DONG Energy Wind Power has 25 years of experiences in the development, construction and operation of offshore wind farms. It has built more than a quarter of the world's offshore wind power capacity. DONG Energy Wind Power has successfully installed the 1000th wind turbine in 2016. It is the first wind farm developer in the world who has reached this milestone. It has a 3GW capacity in operating device and a 4.4GW capacity in constructing device, which demonstrate its industrial strength in offshore wind power business.

The west coast of Taiwan has strong southwesterly airstream during summer and northeast monsoon winds during winter, coupled with strong wind speed empowered by mountain gap along the two sides of the strait, it is abundant in natural wind power resource. The seabed is also a gently sloped continental shelf, thus is very suitable for setting up offshore wind turbines. According to the survey conducted by the international engineering consulting firm 4C Offshore, there are 20 observatory sites with best wind condition in the world16 out of, whereof 16 of them are situated in the Taiwan Strait. In addition, according to the study conducted by Industrial Technology Research Institute of Taiwan in 2013, Taiwan has an area of 5,640 km^2 for offshore wind power installation, which is29 billion watts in total capacity, or equivalent to annual electricity consumption of approximately 20 million households.

In view of the wind power requires lower development costs comparing to other renewable energies and is mature in technology, coupled with strong concentrated wind at the western coast of Taiwan, it is thus very suitable for the development of wind power. Therefore, the government has demonstrated its determination in developing offshore wind power by listing offshore wind power as the second item on the list of top ten carbon emissions reduction goals during Executive Yuan’s Carbon Emissions Reduction Conference held in May, 2011. Offshore wind power has become the core of policy development—during the Energy Conference held in 2015, a 600MW offshore wind farm establishment off western coast of Taiwan was proposed to be completed by the year of 2020; furthermore, the Bureau of Energy, Ministry of Economic Affairs, had made announcement in May, 2015 expecting to complete the expansion of total targeted capacity of 4,000MW from renewable energy device by the year of 2030. The “Offshore Wind Farm Site Application Regulations” was also announced on July 2, 2015 to promote the development of offshore wind power.

DONG Energy Wind Power is optimistic about the offshore wind market potential in Asia and Taiwan's explosive power in wind farms and determination in sustainable energy development. Therefore, in 2016, it has chosen Taiwan as a base for cultivating the Asian market where it has set up the “Greater Changhua Offshore Wind Farm SE Ltd. Preparatory Office” (hereinafter referred to as the “Preparatory Office”) and proposed the “Greater Changhua Offshore Wind Farm SE Da-Chang-Hua (Great Changhua) Offshore Wind Farm Changhua 1-5 – Development Zone” (hereinafter referred to as “the Project”) in response to the relevant policies promoted by the Bureau of Energy, Ministry of Economic Affairs. We hope that through the development of Changhua's territorial waters and planning of offshore wind farm site, we can help Taiwan reduce dependence on imported energy, reduce energy supply risks, and ensure the sustainable development of our domestic energy and environment. Based on our more than twenty-five years of practical experiences and global industrial resources, we wish to inject new international vision and resources into the developmental blue-print of Taiwan's offshore wind power industry to assist the key domestic manufacturers in establishing a solid foundation to start the rapid growth of offshore wind power.

5.1.2 Project Objective

The Bureau of Energy, Ministry of Economic Affairs, has announced on July 2, 2015 the "Offshore Wind Farm Site Application Regulations" in line with government policies to endorse the early offshore wind energy development preparations of the developers. The Preparatory Office") has proposed the Project in response to government's renewable energy policies to promote nuclear-free homeland by the year 2025. We hope that through profound exchange and interaction, we can bring international experiences into Taiwan's wind power industry and join hands with Taiwan's various resources from political and academical fields to invest in offshore wind farm development and jointly promote future energy development so that Taiwan will achieve its goal of nuclear-free homeland by the year 2025. And we also hope to build a regional green energy ecosystem with Taiwan being the starting point, in order to give Taiwan a better chance in leading Asia-Pacific's development of energy industry cluster and setting the regional green energy study case, as well as to assist the government in enhancing its national competitiveness.

5.2 Developmental Content

5.2.1 Project Site Overview

I. Wind farm boundary

The Project has chosen the 15th Zone of Potential in Changhua County according to the "Offshore Wind Farm Site Application Regulations" announced by the Bureau of Energy, Ministry of Economic Affairs on July 2, 2015. The site is located off the coast of Xianxi Township of Changhua County. Area of the site is approximately 120.4km^2 and is approximately 35.7km from the shore. Water depth is approximately 34.4~44.1m. The wind farm appears roughly in trapezoidal shape (see Figure 5.2.1-1).

This Zone of Potential does not include restricted areas such as fishing port ranges, wetlands, protected reef area, coastal nature conservation area, important habitat for wild bird, important Baluga dolphin habitat, etc.

Future planning will follow Taiwan Power Company, connecting to land via Changhua offshore common corridor northern corridor. It will then be connected to land cables along the road to reach the land booster (step-down) station, and then connect to the Changkong grid connection point.

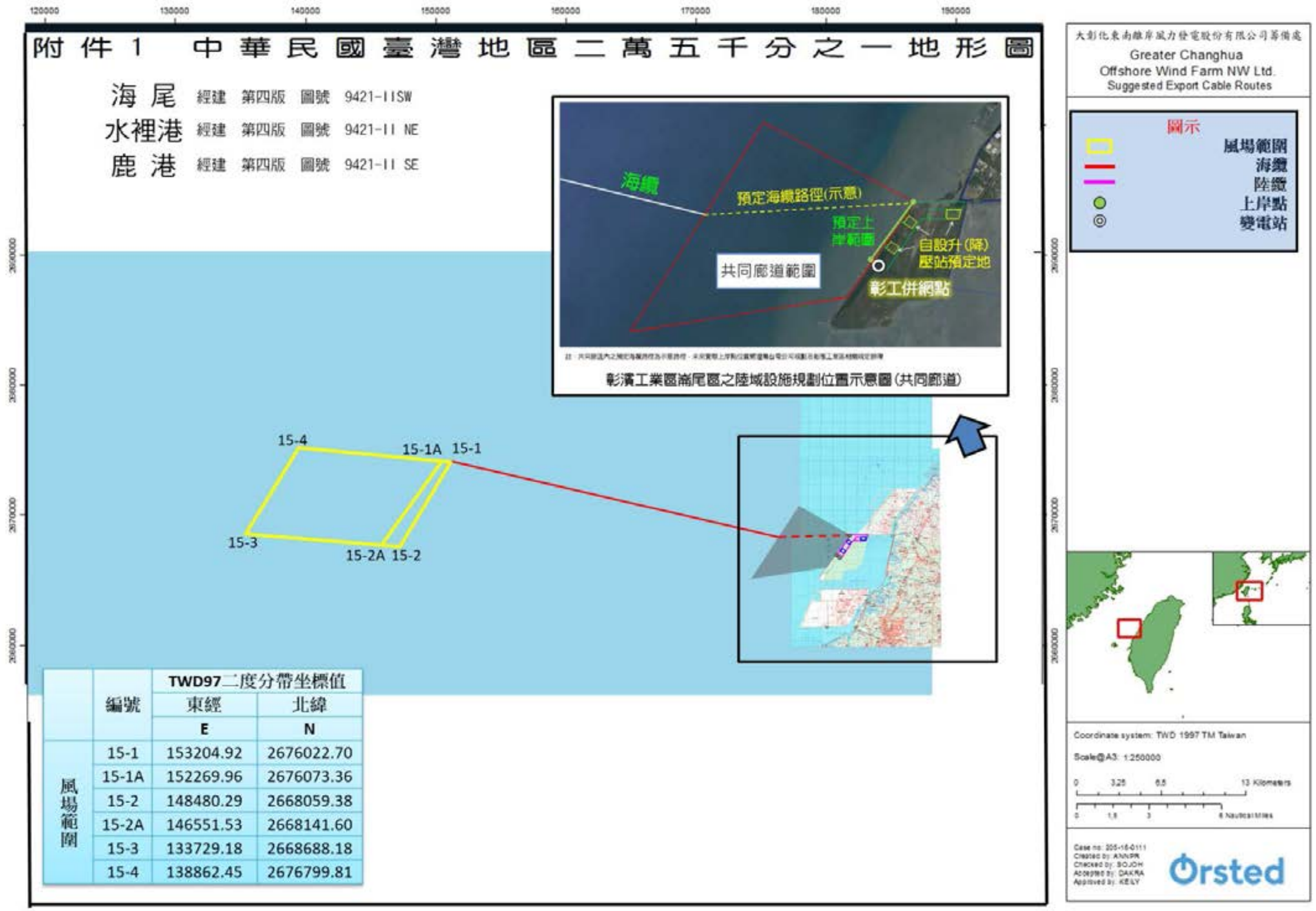


Figure 5.2.1-1 Map of the Project’s Wind Farm Site and Cable Location (1/2)

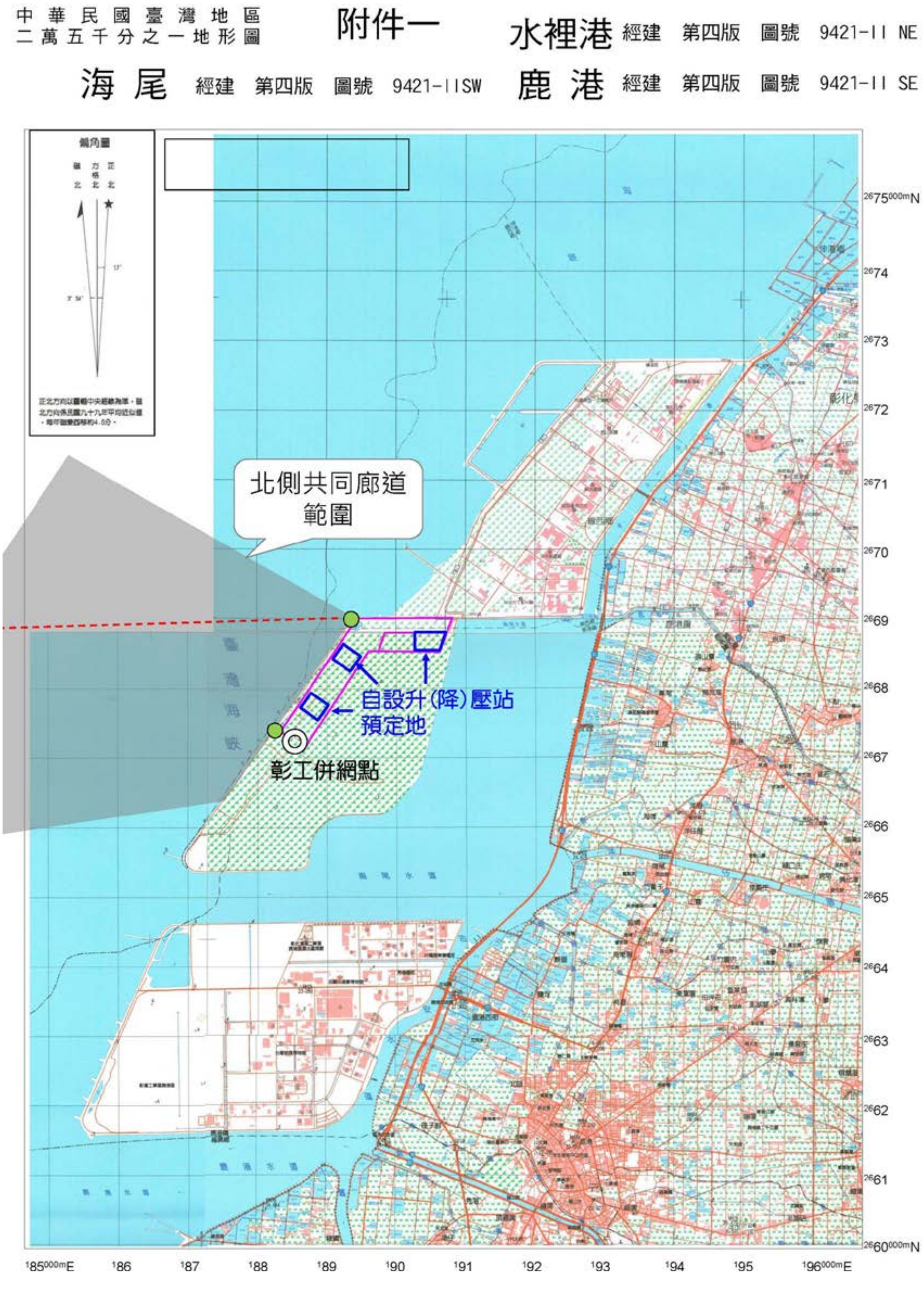


Figure 5.2.1-1 Map of the Project’s Wind Farm Site and Cable Location (2/2)

II. Unit Layout Plan

(1) Wind Turbine Capacity and Quantity

The maximum planned total capacity of the Project will not exceed 613MW. The capacity of a single wind turbine unit is planned to be 8.0~11.0MW. If wind turbine with single unit capacity of 8MW is chosen, the number of wind turbine in the layout will be at its maximum which is 76units; and if wind turbine with single unit capacity of 11MW, the number of wind turbine in the layout will be at its minimum which is 55 units.

(2) Wind Turbine Size

The altitude of the wind turbine hub in the Project is approximately 153~160m and the rotor diameter is approximately 195~210m; therefore, the altitude of the blade's topmost tip is approximately (total height) 250~265m. The final wind turbine selected for construction will be chosen from within the stated size ranges. The turbine design envelope including site capacity is given in Table 5.2.1-1 and the elevations are defined in Figure 5.2.1-2.

Table 5.2.1-1 WTG design envelope

Element	Smallest Turbine		Largest turbine	
	Minimum	Maximum	Minimum	Maximum
Number of WTGs (#)	76		55	
WTG capacity (MW)	4.0		11.0	
Rotor Diameter (m)	-	195	-	210
Lower Tip height, LAT (m)	27.9(LAT) 25.0(MSL)	55	27.9(LAT) 25.0(MSL)	55
Total height / Upper tip height, LAT (m)	-	250	-	265
Hub height, LAT (m)	-	153	-	160
Maximum rotor rotational speed (RPM)	-	11	-	8
Approximate Distance between Turbine, W-E, (m)	500~722			
Approximate Distance between Turbine, N-S, (m)	2,925~4,215			

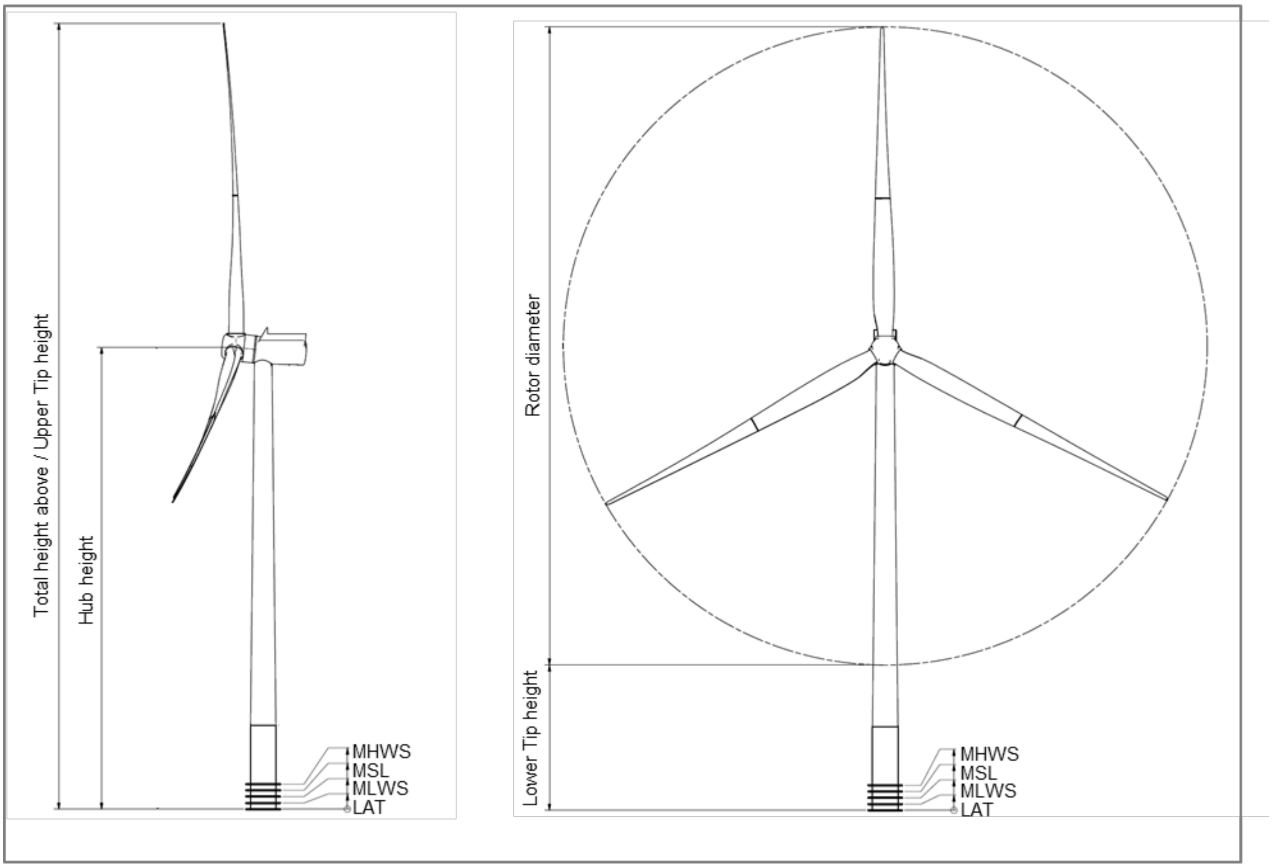


Figure 5.2.1-1 WTG elevation drawing stating main parameters.

(3) Wind Turbine Layout

Taking into account the prevailing wind directions are the north wind and the northeast wind, the principle of wind turbines layout for the Project is to adopt east-west direction as the main layout direction in order to optimize power generation capacity. The spacing between wind turbines along the east-west wind direction is between 500~722m, and the spacing between wind turbines along the north-south wind direction is between 2,925~4,215m. The maximum and minimum quantity of wind turbines in the layout are shown in Figure 5.2.1-3.

Since the east side of the wind farm are channels, and taking into account the wind-sweep area does not exceed the scope of the wind farm, the Project retains the largest rotor diameter of 210m divided by half plus 2m, as a buffer zone, that is, all wind turbines are at least 107m away from the wind farm’s north and east border.

South side, north side and west side of this wind farm is adjacent to the other wind farms. There is a 1,260m buffer zone between this wind farm and the adjacent wind farm (6 times the maximum rotor diameter). The wind farm center closest to the nearest wind farm will be situated at the buffer zone boundary.

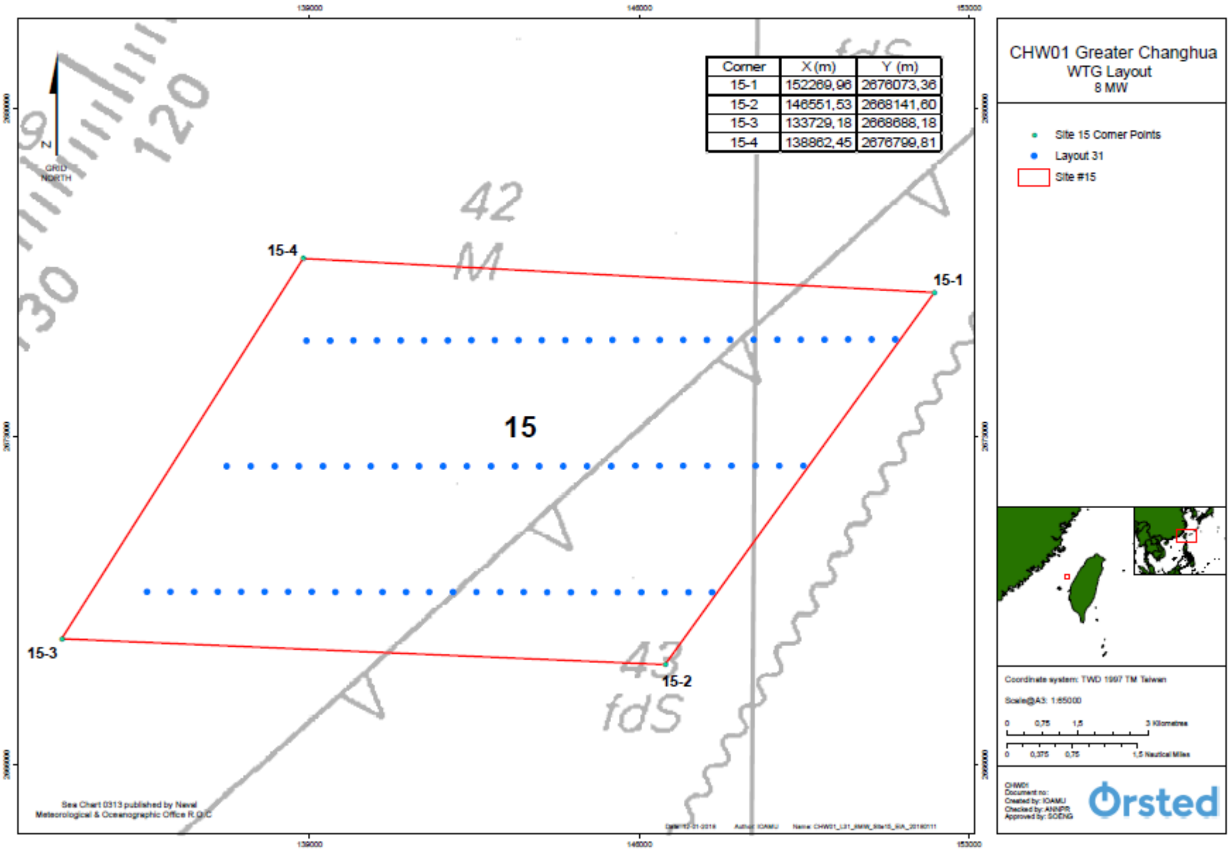


Figure 5.2.1-3 Schematic diagram of the scope of the Project’s wind turbines layout (1/2)

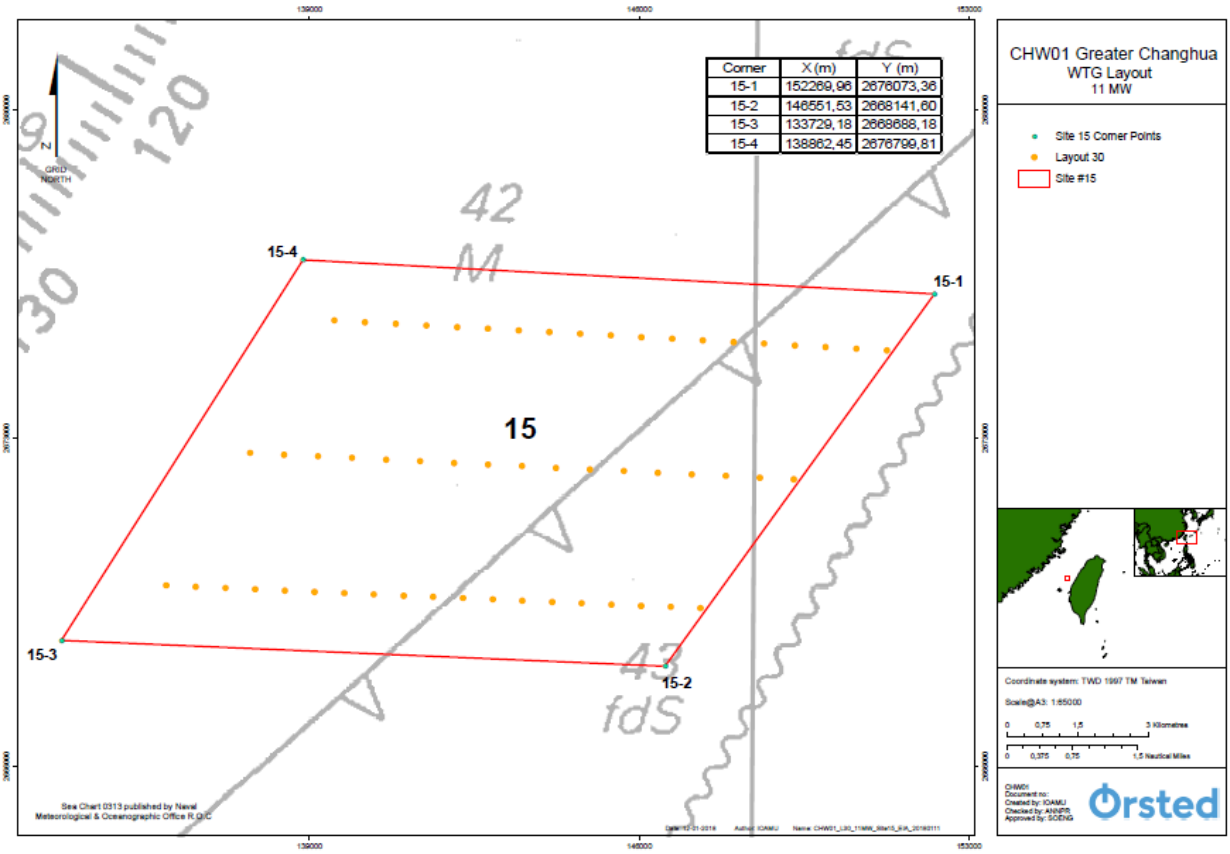


Figure 5.2.1-3 Schematic diagram of the scope of the Project’s wind turbines layout (2/2)

III. Power Generation

Wind farm of the Project estimated net Annual Energy Production(AEP) of 2,400 GWh/yr after considering all the losses and availabilities such as the wake loss, wind turbine availability, output cable loss, and distribution substation loss. The estimated net AEP is based on a combination of following data sources:

(1) Re-analysis data

ERA-Interim global atmospheric reanalysis data from the European Centre for Medium-Range Weather Forecasts (ECMWF), obtained through the wind analysis software "WindPRO".

(2) High-level mesoscale modelling

High level – Coarse mesoscale map available from Vortex.

(3) Available mean wind speeds reported for coastal wind farms in the region.

Penghu (8m/s) & Taichung (8.4m/s)

The process for estimating the onsite wind climate is as follows:

(1) The mean wind speed at the two coastal wind farms in the region is scaled to the site using the Vortex mesoscale model, giving a mean wind speed of at the site of 9.8 m/s at 100m.

(2) In order to apply the wind climate (wind rose and wind distribution) from ERA-Interim the data requires scaling such that the mean wind speed of ERAI data set is the same as the expected mean for the site. The scaling factor is determined from the ratio of the mean of the ERAI data and the expected mean wind speed at the site.

(3) The indicative output estimation is presented in Table 5.2.1-2. The final output estimation will depend on the exact chosen wind turbine, layout etc.

Table 5.2.1-2 Indicative output estimation for site 13

Indicative output assessment, site 15	Value
Installed capacity [MW]	602 – 613
Mean wind speed @ 100m [m/s]	9.81
Internal wake loss [%]	~ 6
Net AEP [GWh/year]	2400
Full load hours [Hours/year]	4000
Capacity factor	0.45

5.2.2 Project Planning

I. Type of Foundation

The Project preliminarily planned to adopt Jacket with driven piles as the pre-selected type of wind turbine foundation struction. However, more detailed analysis, including laboratory tests, shall be conducted in the future to select the best type and size of foundation that yields the best performance and to reduce uncertainty.

The jacket foundation(driven piles) is generally consist of two main parts, namely the driven piles (3 or 4 piles) and jacket structure. The piles are cylindrical tubes. The length and weight of the pile varies by different water depth and soil conditions. Vertical piling or angled piling method can be chosen according to the soil conditions. For vertical piling, the piles can adopt pre-piling method, then use grouting or forging to fix the pile and pipe rack in place. If angled piling is required to obtain sufficient rigidity or load bearing capacity, the pipe rack must first be placed on seabed layed with mud-mats, and then install the piles by slipping through a sleeves or legs of jacket, then apply grouting or forging to fix the same piles and pipe racks in place.

The jacket is a three or four legged steel tube lattice structure with a transition piece on top designed to bridge the interface between the three or four legs and the tubular wind turbine tower. It will be equipped with boat landing, access ladder, davit crane, external and internal platforms and various railings (secondary structures). On top of the transition piece is a flange for bolt connection to the turbine tower, and inside the transition piece are array cable related items such as cable hang-offs and switchgear. The piled jacket is illustrated in Figure 5.2.2-1. The pilled jacket design envelope is presented in Table 5.2.2-1.

Table 5.2.2-1 Piled Jacket design envelope.

Element	Maximum for 4 MW WTG	Maximum for 11 MW WTG	Comments
Number of piles/legs	4	4	
Leg Spacing (m)	38	40	
Outer Pile Diameter (m)	3.5	4	
Pile Penetration Depth (m)	80	85	
Indicative weight of Jacket (t)	1000	1200	
Indicative weight of Pile (t)	120	160	per pile
Scour protection – seabed area (m^2)	800	800	per foundation

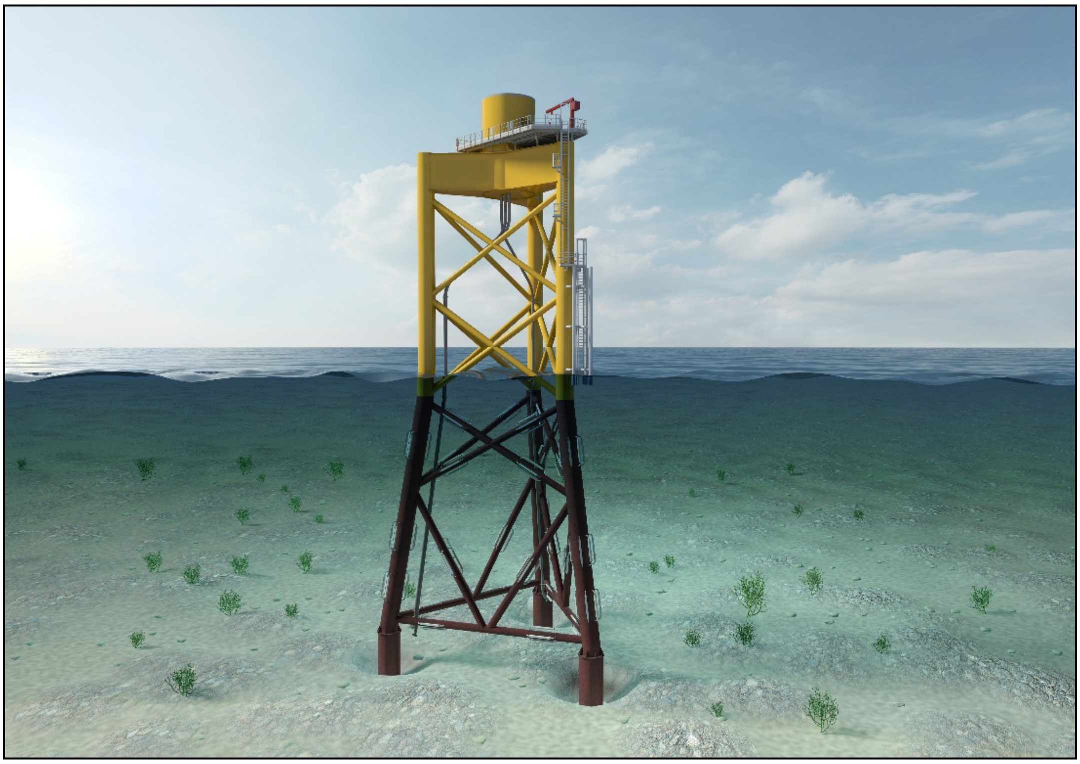


Figure 5.2.2-1 Pilled jacket conceptual drawing (pre-installed vertical piles).

(1) Jacket Foundations (driven piles)

The jacket foundation(driven piles) is generally consist of two main parts, namely the driven piles (3 or 4 piles) and jacket structure. The piles are cylindrical tubes. The length and weight of the pile varies by different water depth and soil conditions. Vertical piling or angled piling method can be chosen according to the soil conditions. For vertical piling, the piles can adopt pre-piling method, then use grouting or forging to fix the pile and pipe rack in place. If angled piling is required to obtain sufficient rigidity or load bearing capacity, the pipe rack must first be placed on seabed layed with mud-mats, and then install the piles by slipping through a sleeves or legs of jacket, then apply grouting or forging to fix the same piles and pipe racks in place.

The jacket is a three or four legged steel tube lattice structure with a transition piece on top designed to bridge the interface between the three or four legs and the tubular wind turbine tower. It will be equipped with boat landing, access ladder, davit crane, external and internal platforms and various railings (secondary structures). On top of the transition piece is a flange for bolt connection to the turbine tower, and inside the transition piece are array cable related items such as cable hang-offs and switchgear. The piled jacket is illustrated in Figure 5.2.2-2. The pilled jacket design envelope is presented in Table 5.2.2-2.

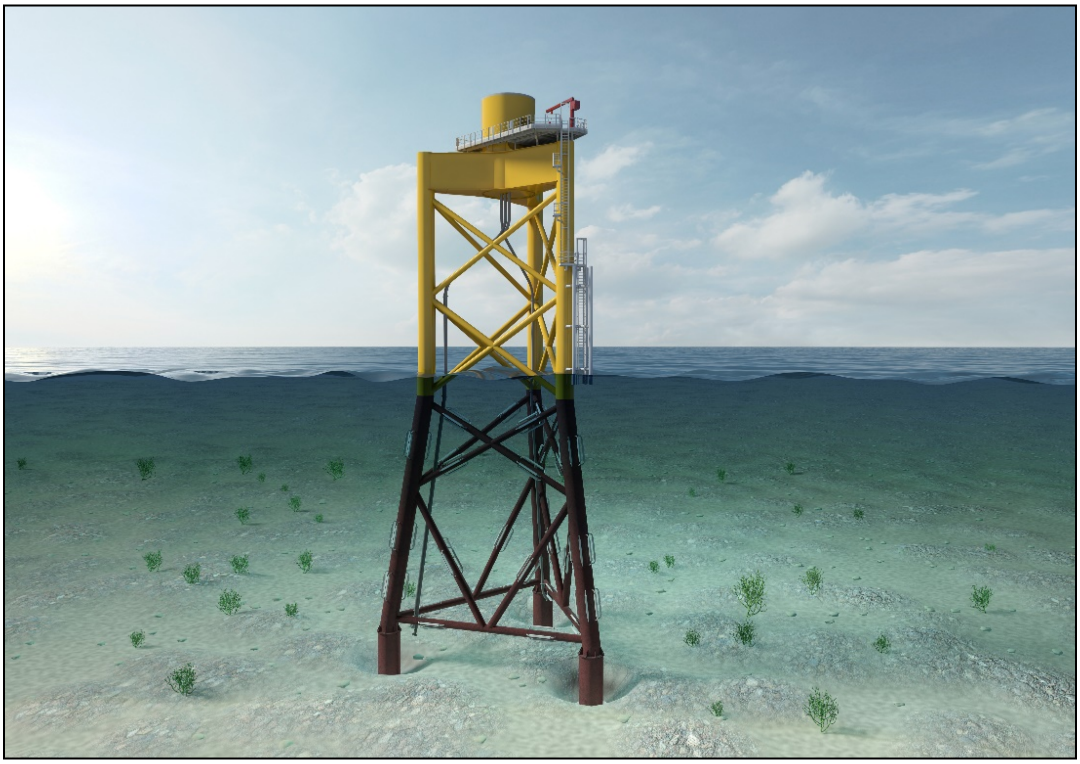


Figure 5.2.2-2 Piled jacket conceptual drawing (pre-installed vertical piles).

Table 5.2.2-2 Pilled Jacket design envelope.

Element	Maximum for 4 MW WTG	Maximum for 11 MW WTG	Comments
Number of piles/legs	4	4	
Leg Spacing (m)	38	40	
Outer Pile Diameter (m)	3,5	4	
Pile Penetration Depth (m)	80	85	
Indicative weight of Jacket (t)	1000	1200	
Indicative weight of Pile (t)	120	160	per pile
Scour protection – seabed area (m^2)	800	800	per foundation

II. Scour design

The scour protection design defines the type of scour protection and its geometry. Various types of scour protection exist and can be applied depending on the actual physical conditions. The most widely applied type of scour protection is the rock berm type of a rock pad making up the scour protection.

Jacket legs and piles have typical diameter of 2-4 m primarily depending on the seabed conditions. The scour potential of a jacket is smaller than that of a monopile. Scour protection can sometimes feasibly be omitted, if the structural design can demonstrate stability even if scour occurs.

Seabed footprint of traditional rock berm scour protection for jacket typically extends is in the range of 5 to 15 m from the jacket leg, depending on size and type of piling arrangement.

III. Electricity Transmission and Distribution System

(1) Array Cables

The array cables will connect the individual wind turbines with the offshore substation. The array cables will be layouted in strings connecting the wind turbines in series before reducing the amount of cables connected to the offshore substation. The array cable layout is highly depending on the actual wind turbine layout and choice of cable dimensions.

The voltage transmission between turbines will be either 33kV or 66kV, depending on the finalized turbine capacity and layout, currently the 66kV design is preferred.

(2) Interlink Cables

The purpose of the interlink cable is to ensure back-up power supply to the turbines in case the grid connection is lost for longer periods.

There are two options for interlinking the site with neighboring sites:

1. WTG to WTG interlink: voltage will either be 33kV or 66kV, based on voltage transmitted between turbines.

2. OSS to OSS interlink: voltage will either be 33kV, 66kV or 220kV

The length of array cables and (1) voltage level (2) turbine power capacity are closely related. The choice of solution will be taken during the project design phase.

Table 5.2.2-2 Preliminary Cable Length Planning

Turbine power capacity	Length of array cables	Voltage level
8MW	100-115 km	33kV
11MW	65-80 km	66kV

(3) Offshore Export Cable

The power generated from wind turbines will be connected to array cables of 33kV or 66kV connecting to offshore substations to increase voltage, then be transferred via 2 220kV offshore export cables, and following the planning of the common corridors, to reach shore at the northern part of the common corridor, then connect to to the Changkong grid connection point. The maximum offshore export cable length is given in Table 5.2.2-3. The indicative offshore export cable route and landing points are illustrated Figure 5.2.2-2.

Table 5.2.2-3. Offshore Export cable length

Maximum route length, OSS to Landing points	No. of Export Cables	Total maximum export cable length, OSS to landing points
55 km	2	110 km

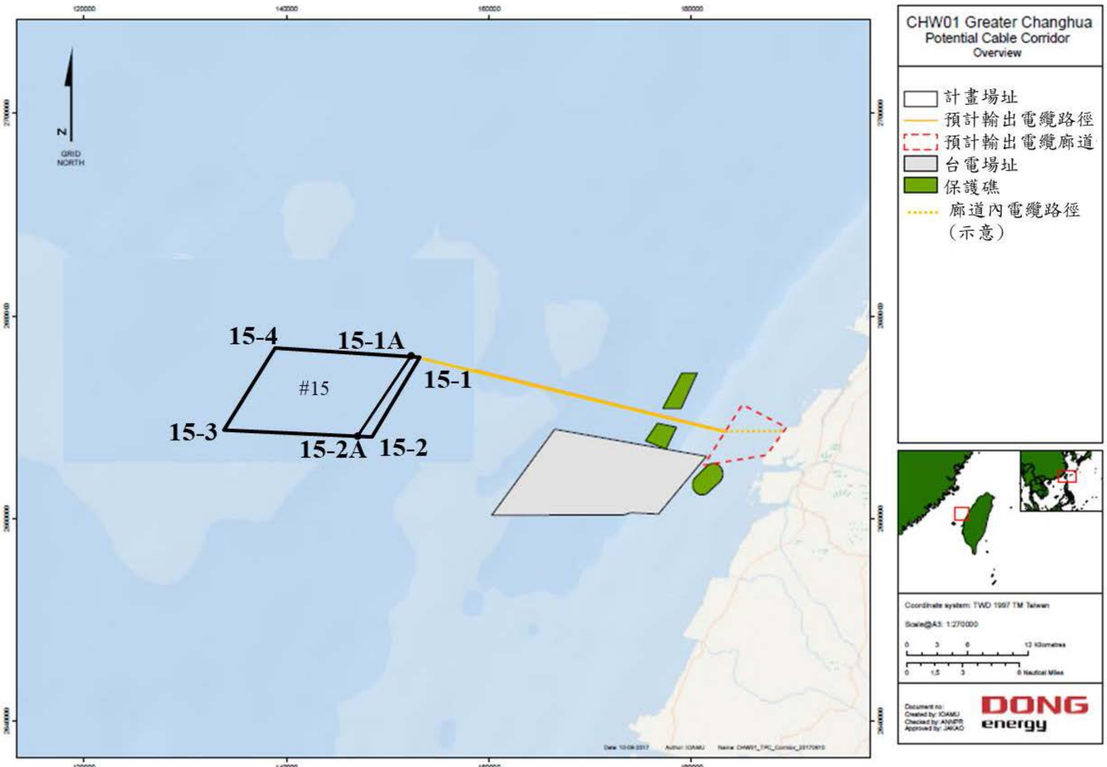


Figure 5.2.2-4. Indicative Offshore Export cable route and landing points.

(4) Offshore Substation

A Heating Ventilation and air conditioning (HVAC) offshore substation (OSS) is required in order to collect the individual array cable strings and transforming this to higher voltage before exporting this to shore.

The offshore substation's location will be based on the turbine layout. However, it should be located in the center of the wind farm, hence it will be planned inside the wind farm borders. The maximum sizes is stated in Table 5.2.2-4. A sketch of the OSS is given in Figure 5.2.2-3.

Table 5.2.2-4 Design plan of the Project's offshore distribution substation and accommodation module

	OSS
Amount [#]	1
Base structure	4 legged jacket
Maximum Seabed footprint [m]	40m x 40m
Maximum topside size (LxWxH)	50m x 40m x 30m*
Maximum Helideck overhang	20m

Piles (jacket)	12 in total (4 legs, 3 piles per leg) Max. diameter of pile is 3.5m. Length of pile is depending on the geotechnical details at OSS location.
Pile penetration depth	85 m

Note：”*” **Including helideck but excluding crane and antenna mast**

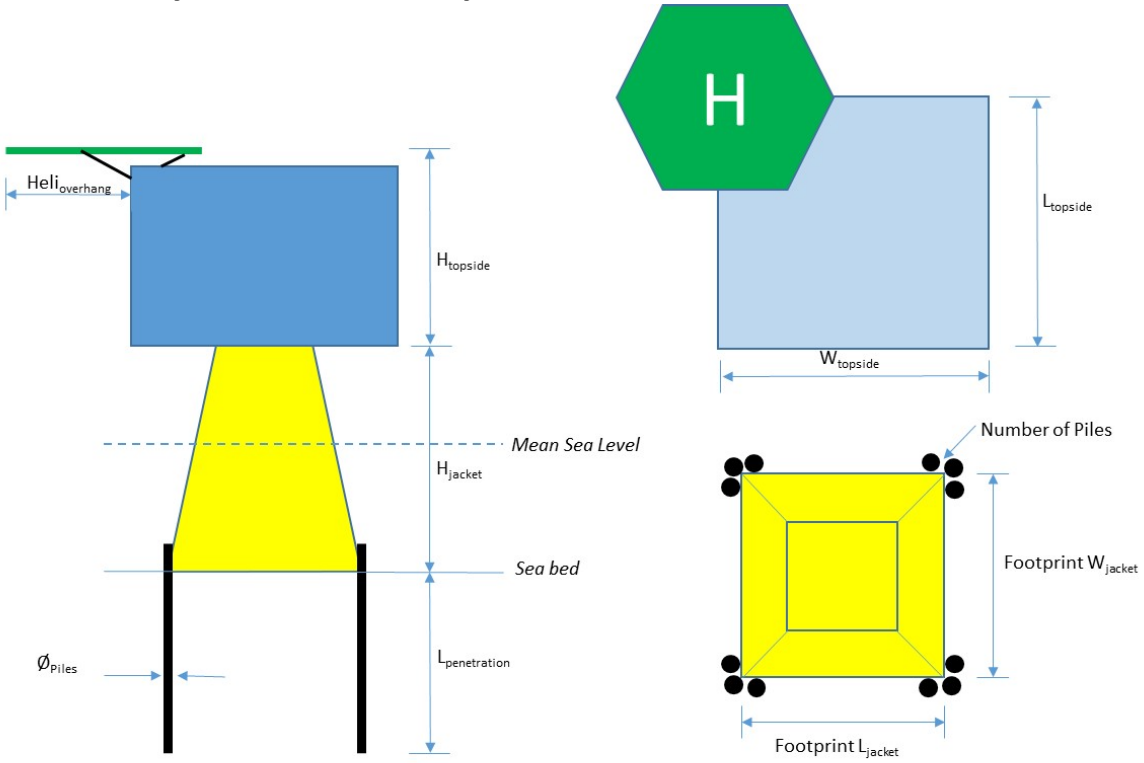


Figure 5.2.2-3 Schematic diagram of the Project’s offshore distribution substation

1. Safety policy

   The safety philosophy for the OSS is to provide a safe working environment for personnel as well as secure adequate protection of the environment and the asset itself. The OSS will be designed as an unmanned platform if it is the stand-alone solution and as a manned installation if accommodation is integrated.

2. Unmanned installations

   The intention is, by a combination of active and passive systems, to provide protection for visiting personnel during an event of emergency/fire and means for escape, drain environmentally hazardous substances to a safe vessel (tank) from where it can be handled accordingly, and as to the extent possible prevent escalation of any event.

   The platform will be design for the local environmental conditions i.e. wind, wave load, earthquake etc. For typhoons, the platform will not be manned as these can be seen on the weather forecast whereas earthquake occurs without warning so the platform may be manned in such situation. The platforms must therefore be designed to sustain the conditions e.g. earthquake and a 10.000 year wave.

3. Manned installations

   If the platform is designed as a manned installation, personnel will be trained to handle accidents as e.g. a fire. The platform will in this case contain firewater so personnel can be kept safe to a large extend on only evacuate personnel in severe cases. In case of typhoons it should also be considered to evacuate the personnel as no work anyway will be performed on the WTGs under these conditions.

4. Pollution prevention system

   A pollution prevention system will be installed on the topside. The system collects liquids from drip trays located under oil filled equipment, fuels storage and water/foam units and connects to the oil/water separator as well as connects main drip trays below main transformers to sump tank on cable deck. No water with a pollution above 10 Parts Per Million (PPM) will be discharged to sea. . The holding tank has a capacity of around 120m^3 and is equipped with oil-water separation system, under normal operating conditions, the tank has no need to be cleaned regularly, it only needs to be cleaned when the oil-water separation system is not working properly.

   For manned installations, a system for waste water will be installed and collected. The waste water will then be brought to shore for disposal.

   In general all waste on the platforms will be collected, sorted and brought to shore for disposal.

(5) Transition Joint Bays

A Transition Joint Bay (TJB) is required on each system in the immediate vicinity of the landfall Horizontal Directional Drilling (HDD) launch point to connect the offshore export cables to the onshore export cables. The HDD concept is illustrated in Figure 5.2.2-4.

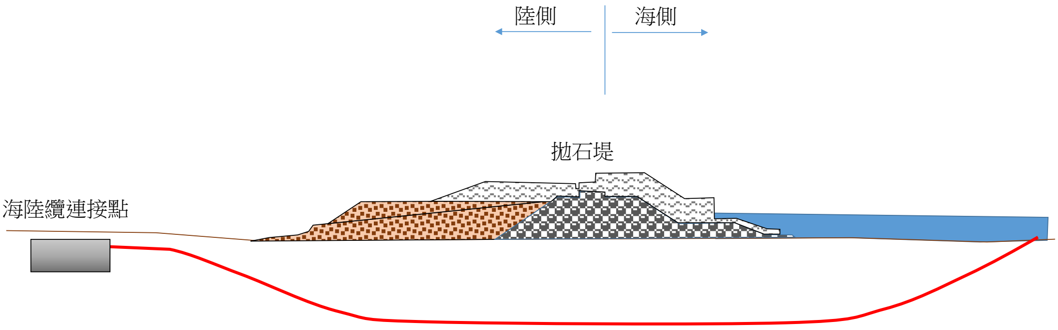


Figure 5.2.2-4 Concept of Landfall HDD's and Transition Joint Bays

(6) Land Cable Route

After land cable of the Project is connected to the onshore substation from the TJB, it will be connected with the existing distribution substation of Taiwan Power Company. It is currently planned with four connectable distribution substations, which are: Xianxi D/S substation, Luxi D/S substation, Changbin E/S substation, or grid connection point Changkong. Landing points and onshore fractures are shown as Figure 5.2.2-5. One distribution substation of Taiwan Power Company will be selected to connect with the Project's own onshore substation after negotiation with Taiwan Power Company in the future.

Connect to grid connection point Changkong：It will be connected by 220kV cable from the TJB to onshore substation; the cable length is expected to not exceed 3.7 km. It will be connected by 161kV cable from onshore substation to grid connection point Changkong; the cable length is expected to not exceed 4.35km.

The land cable of the Project will all be embedded within the Changhua Coastal Industrial Park. There are no densely populated areas along the route, and there are no houses, schools and hospitals. Total length of the land cable will not exceed 8km.：

(7) Land Cable trench

The sizes required for the three types of land cable trench are shown in Table 5.2.2-5 and Figure 5.2.2-6. The cable trench dimension has been designed by software calculations in accordance with IEC60287 (Cymcap Version 7.1 Rev. 1). The method considered was based on the following assumptions:

1. 161kV
   a. Conductor material: Aluminum
   b. Conductor cross area: 1600 mm^2
   c. Electric line: three single circuit line
2. 220kV
   a. Conductor material: Aluminum
   b. Conductor cross area: 1800 mm^2
   c. Electric line: two single circuit line
3. 345kV
   a. Conductor material: Aluminum
   b. Conductor cross area: 2500 mm^2
   c. Electric line: two single circuit line
4. Common parameters
   a. Cables buried in ducts
   b. Parallel systems side by side.
   c. Soil temperature 25^{o}C
   d. Soil thermal resistivity 1.2 Km/W

e. Backfill thermal resistivity 1.0Km/W
f. Soil drying temperature: 50ºC (Trench dimensions (width and depth) were based on dimensions of 50ºC isotherm within which the soil could dry out requiring special backfill)

The different dimensions of cable trenches are due to differences in the heat losses, because of the various cable loads, conductor cross sections, number of systems and system separations considered and required for each voltage level.

It cannot be compared by linear calculation. The software calculations are required to ensure correct cable designs for the load and installation conditions.

Table 5.2.2-5 sizes required for the land cable trench of the Project

Land cable	Depth (m)	Width (m)
220kV	3.25	3.0
345kV	3.0	4.5
161kV	4.2	5.8

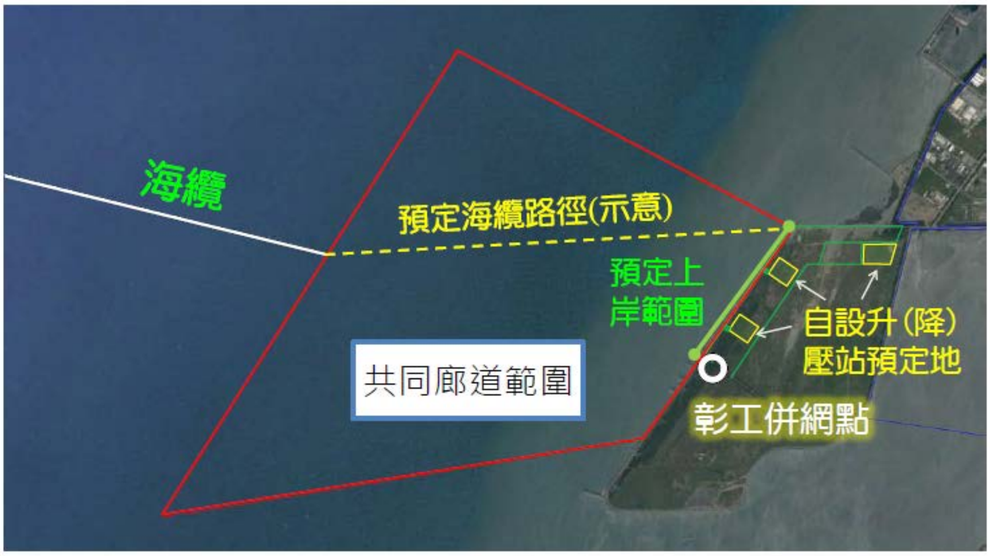
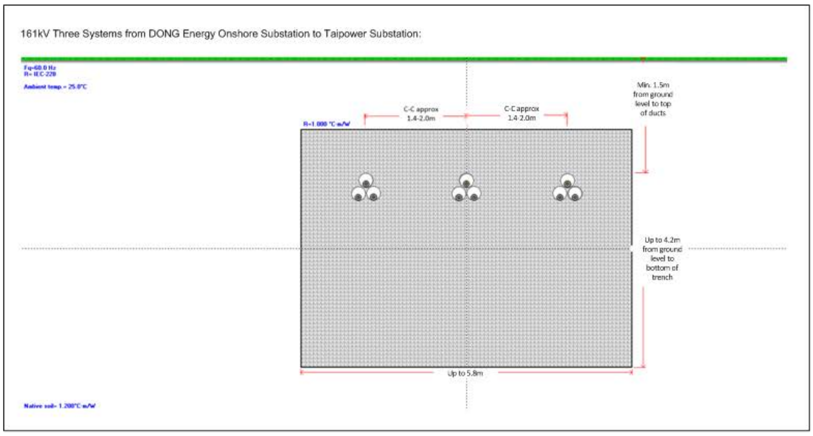
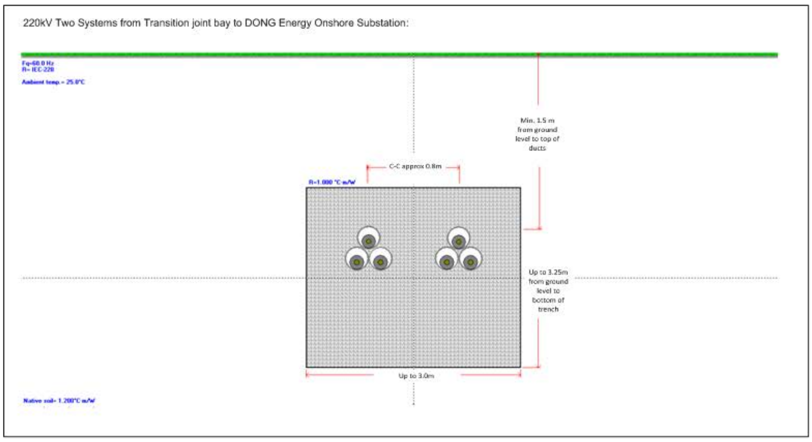


Figure 5.2.2-5 The Landing Point and Land Cable Planning

161kV



220kV



345kV

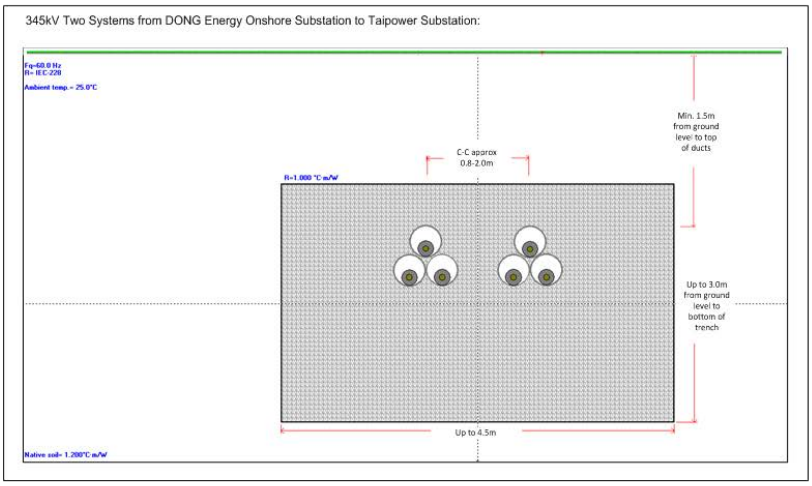


Figure 5.2.2-6 Schematic diagram of possible-use land cable trench embedment

(8) Onshore Substation Plan

The Project will set up onshore substation near the intended distribution substation of Taiwan Power Company. It is preliminarily planned that the onshore substation building, control room, gas-insulated switchgear (GIS) and related electromechanical facilities will require a total area of approximately 23,800m^2.

IV. Spoil Disposal Plan

According to the “Land Lease Guidelines of Changhua Coastal Industrial Park in Lukang Township or Xianxi Township”, Changhua Coastal Industrial Park is a state-owned land; therefore, the spoils from construction works within this area shall be handled by in-situ leveling in lieu of moving out from the Changhua Coastal Industrial Park. In addition, this project has inquired the Changhua Coastal Industrial Park's service center regarding the future soil backfilling location. However the service center mentions that the backfilling work will depend on the future construction progress inside the industrial park. Therefore it will only be necessary to apply, following relevant regulations, before the start of project construction. In addition, the Industrial Development Bureau (IDB)has an overall site planning regarding land use, this project will be sure to follow relevant plans stipulated by the IDB.

The engineering in the Project that would incur spoils are the Onshore Electricity Transmission and Distribution System Engineering and the Onshore Substation Engineering. After preliminary estimation, the maximum total spoils volume from the Project's onshore substation and land cable engineerings will be approximately 234,000m3 (loose volume). the spoils from excavation will be handled by in-situ land fill and leveling within Changhua Coastal Industrial Park according to regulations of the industrial park, therefore, there will be no outward transport of spoils. Calculations of the spoils from the Project are described as follows:

(1) Onshore Substation Engineering
  1. Excavation area of non-fundation area：6,800m^2
  2. Excavation area of foundation area：17,000 m^2
  3. Excavation depth of non-foundation area：1.00m
  4. Excavation depth of foundation area：：3.00m
  5. Estimated spoils：6,800×1+17,000×3=57,800m^3 (soil volume)

(2) Onshore Electricity Transmission and Distribution System Engineering
  1. Option 1：connect to Xianxi D/S substation
    (i) Length：approximately 2.7km for 220kV; approximately 1.8km for 161kv cable
    (ii) Trench width：3.0m for 220kV; 5.8m for 161kv cable
    (iii) Trench excavation depth： 3.25m for 220kV; 4.2m for 161kv cable
    (iv) Trench land fill depth：1.275m for 220kV; 1.3m for 161kv cable
    (v) Transition Joint Bays：approximately 600m^3 in total
    (vi) Joint Bays：approximately 300m^3/ea; approximately 19 points are required; total 5,700m^3
    (vii) Excavation volume：
    2,700×3.0×3.25+1,800×5.8×4.2+600+5,700=76,473m^3
    (viii) Land fill volume：2,700×3.0×1.275+1,800×5.8×1.3=23,900 m^3
    (ix) Spoil volume：76,473 – 23,900 = 52,573 m^3 (soil volume)
  2. Option 2：connect to Changbin E/S substation
    (i) Length：approximately 2.1km for 220kV; approximately 3.2km for 345kv cable
    (ii) Trench width：3.0m for 220kV; 4.5m for 345kv cable
    (iii) Trench excavation depth： 3.25m for 220kV; 3.0m for 345kv cable
    (iv) Trench land fill depth：1.275m for 220kV; 1.325m for 345kv cable
    (v) Transition Joint Bays：approximately 600m^3 in total
    (vi) Joint Bays：approximately 300m^3/ea; approximately 20 points are required; total 6,000m^3
    (vii) Excavation volume：
    2,100×3.0×3.25+3,200×4.5×3.0+600+6,000=70,275m^3
    (viii) Land fill volume：2,100×3.0×1.275+3,200×4.5×1.325=27,113 m^3
    (ix) Spoil volume：70,275 – 27,113 = 43,162 m^3(soil volume)
  3. Option 3：connect to Luxi D/S substation

(i) Length：approximately 3.0km for 220kV; approximately 2.8km for 161kv cable
(ii) Trench width：3.0m for 220kV; 5.8m for 161kv cable
(iii) Trench excavation depth：3.25m for 220kV; 4.2m for 161kv cable
(iv) Trench land fill depth：1.275m for 220kV; 1.3m for 161kv cable
(v) Transition Joint Bays：approximately 600m^3 in total
(vi) Joint Bays：approximately 300m^3/ea; approximately 25 points are required; total 7,500m^3
(vii) Excavation volume：
$3{,}000\times3.0\times3.25+2{,}800\times5.8\times4.2+600+7{,}500=105{,}558m^3$
(viii) Land fill volume：$3{,}000\times3.0\times1.275+2{,}800\times5.8\times1.3=32{,}587\ m^3$
(ix) Spoil volume：105,558 – 32,587 = 72,971 m^3 (soil volume)

4. Option 4：connect to grid connection point Changkong
(i) Length：approximately 3.7km for frontward-section; approximately 4.35km for backward-section
(ii) Trench width：3.0m for frontward-section; 5.8m for backward-section
(iii) Trench excavation depth：3.25m for frontward-section; 4.2m for backward-section
(iv) Trench land fill depth：1.275m for frontward-section; 1.3m for backward-section
(v) Transition Joint Bays：approximately 600m3 in total
(vi) Joint Bays：approximately 60,650m3 in total
(vii) Excavation volume：approximately 204,000m3 in total
(viii) Land fill volume：approximately 66,700m3 in total
(ix) Spoil volume：204,000 – 66,700 = 137,300 m3 (soil volume)

(3) Maximum Spoil volume Estimation
1. Soil volume：57,800+137,300＝195,100 m^3
2. Loose volume：$195{,}100\times1.2 \fallingdotseq 234{,}120\ m^3$

5.2.3 Construction Planning

I. Working Docks

The wind farm site of the Project is located off the coast of Xianxi Township and Lukang Township of Changhua County. The offshore wind turbine will be constructed on the sea. These are all large piece heavy materials, which include foundation components, supporting tower, wind turbine structural unit, etc. Mechanic vessel will be required to load, unload, transport and assembly all the equipment. Taking into account the transportation, storage and assembly of the wind turbine components, sufficient harbor facilities space shall be provided to accommodate the wind turbine components without impact on normal operation of the harbor and traffic convenience on the harbor’s internal and external roads. According to the preliminary investigation, it is known that this type of port is very rare in Taiwan, and there are no domestic harbor facility specially designed to support offshore wind power The Project has preferably planned to use Taichung Harbor, which is nearest to the site, as the port for construction, loading, unloading, transporting works and docking port according to the domestic policy objectives in offshore wind power plan loading condition of each port. An onshore assembly site will be set up within the harbor. See Figure 5.2.3-1 Schematic diagram showing the status of Taichung Harbor’s terminal configuration.

In response to the developmental trend of offshore wind power, the renewable energy policy of the Bureau of Energy, Ministry of Economic Affairs, has clearly designated Taichung Harbor as the port for offshore wind power development. It has coordinated with Taichung branch of Taiwan international Ports Corporation in releasing land space from Taichung Harbor and conducted maritime engineering base layout plan based on usable land space in year 2018-2020. The terminal configuration for offshore wind power will be conducted in two phases: the first phase (in year 2018) will provide logistics sites of approximately13.8 hectares for terminal #4C, #5A, #5B and #5 (the second line behind the terminal) and a 400m in length for terminal #5A and #5B; the final stage (in year 2020) will provide logistics sites of approximately 27.1 hectares for terminal #5~#8 (from the first line behind the terminal to the second line behind the terminal) and an approximately 800m in length for terminal #5～#8.

The Bureau of Energy plans to use terminal #5A and #5B of Taichung Harbor and the logistics sites (including the logistics sites of terminal #5A and #4C) as the assembly base for offshore wind turbines by the year 2018; the plan is to complete 60 wind turbine assembly operations annually in order to be used in the demonstration wind farm. The year 2020 target is to use terminal #5~#8 and their logistics sites; the plan is to complete 100 wind turbine assembly annually in order to be used by the Potential Zones developers.

At present, there are some space left at terminal #2, #4, #4B, #4C, #5A and #5B in the northern pier and the northern jetty area only; the rest of the logistics sites are committed to long-term leases and are set with relevant facilities. The plane position are shown in Figure 5.2.3-1, whereof Taichung Harbour Warehousing & Stevedoring Co., Ltd. has leased the land behind the first line and the second line of terminal #5～#8 with the lease coming due at the end of year 2016. Taichung branch of Taiwan international Ports Corporation intends to lease these areas on short-term bases by then. On the other hand, terminal #4B~#4C and part of the logistics sites have been designated and approved by the Executive Yuan as the appropriated wharf for sea patrol base.

Since the wind turbine components and the underwater supporting structure are all large piece heavy components, the existing terminals can not meet the usage demand of the heavy wind turbine components; new construction and renovation works of the wharf are required. At present stage, Taichung branch of Taiwan international Ports Corporation has made renovation plan for terminal #5A and new construction design plan for terminal #5B in line with domestic energy development needs as the subsequent heavy-duty wind power wharfs. The wharf shall be 400m in length; the design is expected to be completed in year 2016 and operational by the end of year 2018.

In order to avoid interference between the production or assembly of the wind turbine unit and the underwater support structure, Taichung branch of Taiwan international Ports Corporation originally envisioned to convert approximately 74.2 of power zone (Ⅱ) and approximately 183 hectares of industrial zone (Ⅱ) to be offshore wind power industry area; however, it is subject to subsequent negotiations according to actual land lease situation of the domestic companies. At present stage, Taichung branch of Taiwan international Ports Corporation intends to allow domestic companies to lease and develop terminal #38 and #39 of Taichung Harbor as the construction base for underwater structures. Terminal #38 and #39 are located in the Central-South jetty area. According to the overall development plan of the Taichung Harbor, length of terminal #38 is approximately330m and length of terminal #39 is approximately 357m. total length of both terminals are approximately 687m. Status quo of both terminals are revetments with its logistics sites remain prime for companies to store steel stacked by short-term lease. Area of the logistics sites is approximately 24 hectares. The plane position are shown in Figure 5.2.3-1. Based on the study conducted by the Bureau of Energy, Ministry of Economic Affairs, and Denmark, both terminal #38 and #39 and its logistics sites can be used for assemble operations of approximately 30 jacket-type underwater supporting structures.

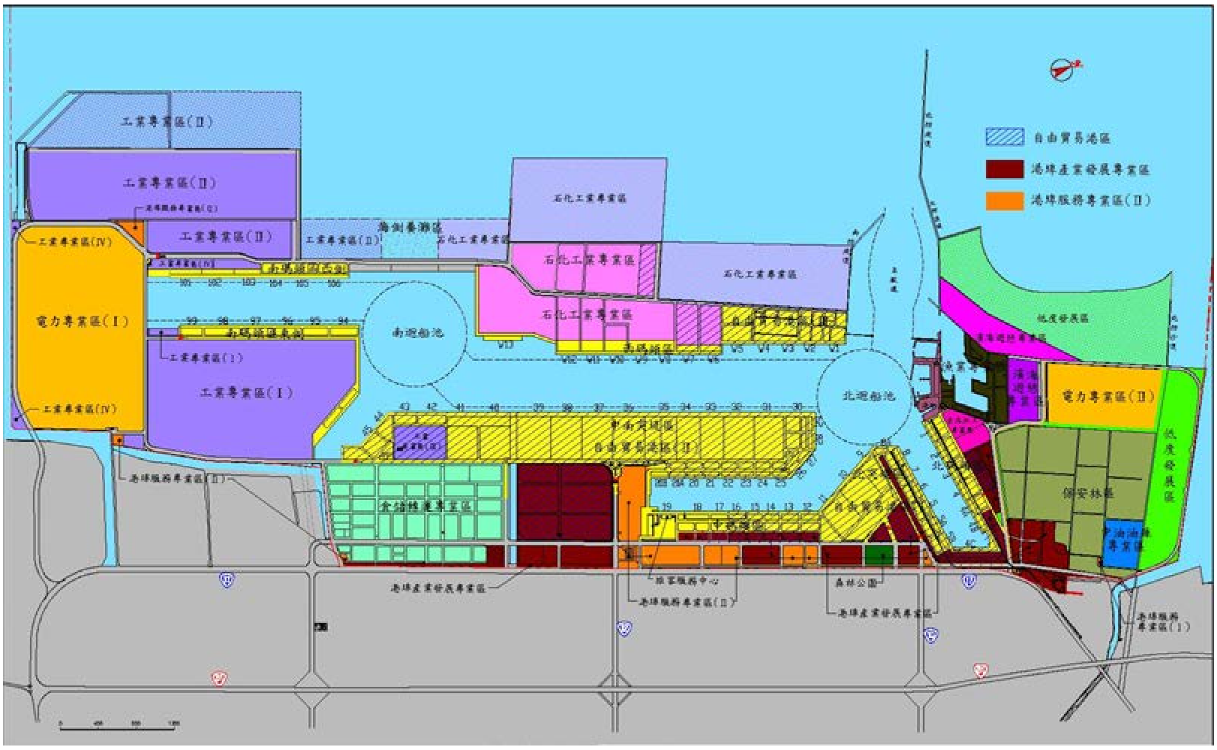
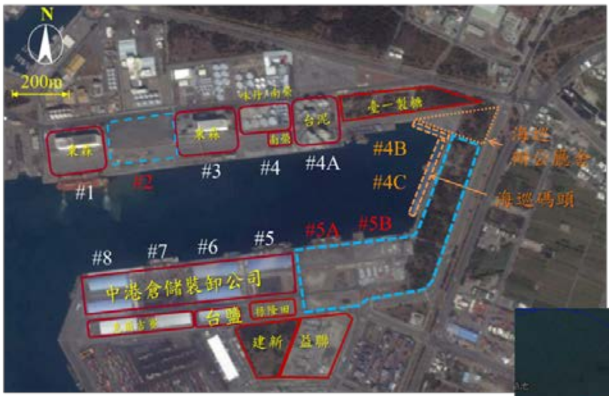
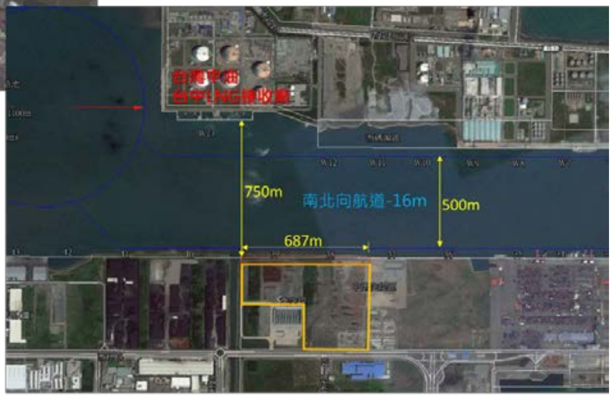


Figure 5.2.3-1 Schematic diagram showing the status of Taichung Harbor’s terminal configuration (1/2)



北碼頭及北突堤區使用現況圖



資料來源：底圖為Google Earth，本計畫彙編。

中南突堤區使用現況圖

Figure 5.2.3-1 Schematic diagram showing the status of Taichung Harbor’s terminal configuration (2/2)

II. WTG Foundation Installation

(1) Transport

The WTG foundations are transported from manufacturer directly to offshore site or to an Installation Harbour and stockpiled.

(2) Installation

1. A rock berm scour protection is installed around a position if required using fall pipe or side dumbing vessels.
2. Foundations are loaded from the manufacturer/Installation Harbour to Installation Vessel in batches of 2-5 depending of vessel and foundation type. Transported to the predetermined offshore position. For installation of Piled Jackets please see Section 5.2.2.

III. Wind Turbine Installation

(1) Transport

1. The installation vessel will be prepared for load out during the mobilisation phase in the mobilisation harbour. Sea fastenings for the components are manufactured and installed on the installation vessel ready to receive wind turbines.
2. Wind turbines will be delivered from the factory in parts to the pre-assembly/load out harbour. There they will be pre-assembled into larger components, quality checked for any transport damages and prepared for load out.

(2) Installation

1. Wind Turbines, in sections 1) Towers 2) Nacelle and hub 3) Blades (3x single), are loaded from the Installation Harbour to the Installation Vessel in batches of 4-6. This can be done with shore based mobile cranes and sometimes also in combination with the installation vessel crane.
2. The installation vessel then transports the wind turbines to the given offshore position and elevates to the correct safe height using the jack-up system. The sections are lifted carefully to the foundation and fastened together with bolts.
3. Then the Installation vessel will lower back down to sea level and move onto the next position.

(3) Commissioning

1. The final Completion /commissioning works will take place with mechanical and electrical teams on each position.
2. The teams are transported in Crew Transfer Vessels. The commissioning teams may stay offshore in an accommodation vessel to reduce the number of journeys to and from site. The accommodation vessel can be either a jack up vessel similar to the installation vessel or a dynamic positioning (DP) vessel.

(4) Energisation

Energisation is managed in accordance with DONG Energy Electrical Safety rules. Switching will only be operated by competent and skilled Senior Authorised Persons in accordance to switching procedures.

(5) Test

1. Each turbine will be individually tested.
2. The entire wind farm will go through a final test.

風力機組安裝示意圖

海上打樁作業示意圖

海纜安裝作業示意圖

風機設置完成示意圖

Figure 5.2.3-2 Schematic diagram of wind turbine construction operations

IV. Array Cable Installation

(1) Installation

1. The export cables are loaded into an installation vessel and transported to offshore location
2. First end pulled inside offshore substation/wind turbine
3. Installation vessel lays cable to next wind turbine
4. Second end pulled up next wind turbine
5. Array cables will be buried by jetting or cutting trencher (burial vessel).

(2) Termination

Termination of Array Cables at the Offshore Substation and WTG.

(3) Test

Test of the cable before being energised.

(4) Energisation

Energisation will happen in accordance to DONG Energy Electrical Safe rules. Switching of Medium and High Voltage equipment will only be operated by competent and skilled Senior Authorised Persons in accordance to switching procedures.

V. Export cable Installation

(1) Groundwork /Excavation – onshore

1. The planned cable route will be surveyed
2. Jointing bays will be excavated and the cable route will be excavated
3. Plastic pipes will be laid in the cable route trenches between jointing bays
4. Cable routes trenches will be filled in and the cable is pulled through plastic pipes between jointing bays
5. Cables jointed in jointing bays

(2) Horizontal Directional Drilling (HDD)

Potential Drilling under the sea defence wall in order to pull and protect the export cable.

(3) Offshore Installation
1. The export cable is loaded to the installation vessels and transported to offshore location.
2. The export cable will be surface laid and export cable sections will be joined on a barge
3. The cable will be buried by jetting or cutting trencher (burial vessel), then pulled under the sea defence wall through HDD pipes.
4. The Export cable jointed to onshore export cable at jointing pit
5. Export cable pulled inside the Offshore Substation.

(4) Termination Offshore Substation
Termination of Export Cable at the Onshore Substation and at the Offshore Substation.

(5) Test
Test of the cable before being energised.

VI. Onshore Substation

(1) Groundwork
1. Ground improvement including potential piling
2. Excavation for foundations
3. Filling-up with gravel around foundations
4. Finishing works on ground surface

(2) Construction
1. Foundations and buildings.
2. Installation of equipment.

(3) Commissioning
During the commissioning all equipment will be completed according to the specifications and awaiting terminations and energisation.

(4) Test
Equipment on the Offshore Substation will be tested according the Quality plan and specifications.

(5) Energisation
Energisation will happen in accordance to DONG Energy Electrical Safe rules. Switching of Medium and High Voltage equipment will only be operated by competent and skilled Senior Authorised Persons in accordance to switching procedure.

VII. Offshore Substation

(1) Installation of Offshore Substation Foundation & Topside
Foundation and Topside are loaded from the manufacturing site to transportation barge. Then transported by tug to the given offshore position. Foundation will be lifted in position by Installation Vessel on site, hereafter piled and grouted. After grout the Topside will be lifted in position on foundation by Installation Vessel and welded to the foundation.

(2) Test and Commissioning of Offshore Substation Topside
1. During the offshore test commissioning equipment on board will be re-tested to verify functionality after transport and installation. This will be done in accordance with test specifications and safety regulations
2. Purpose is to make Offshore Substation Topside is ready for pull in and termination of array and export cables and later energization.

(3) Energisation of Export cable and Offshore Substation

Energisation will happen in accordance to DONG Energy Electrical Safe rules. Switching of Medium and High Voltage equipment will only be operated by competent and skilled Senior Authorised Persons in accordance to switching procedures.

5.2.4 Operation & Maintenance Plan

Since 1991, with the inaguration of Vindeby Offshore Windfarm (DK), DONG Energy Wind Power has been gradually expanding its footprint and fleet as operator of offshore wind farms. As of today, DONG Energy Wind Power operates more than 900 offshore wind turbines with an overall capacity of over 3 GW. DONG Energy Wind Power strives to optimise its operations building upon its technical and asset management expertise, consolidating existing clusters and considering further expansion to harness synergies across its portfolio. This strategy comprises all elements of operating a wind farm, e.g. spare part management, logistic, site organization as well as back office support.

The Preparatory Office will be operating the wind farm during its operational lifetime. Usually the operation period is planned to be 20-25 years, in line with the permit requirements in a given market. The Preparatory Office will be responsible for the primary operation and maintenance works of the Project. The Project will provide a definite O & M plan, including routine work, investigation and survey works, prior to operation.

I. Health, Safety & Environment (HSE)

The Preparatory Office will ensure that all contractors' and sub-contractors' will comply with our Health, Safety & Environment (HSE) standards, requirements and HSE plan as well as with the relevant national reuqirements. Furthermore, all the parties working in the wind farm at any point in time will be required to undergo an HSE induction.

II. Operation and Maintenance Base

The Preparatory Office will set up a base for operation and maintenance. The base will be consist of office building, warehouses, cranes and pontoons, to ensure safe and effective mooring and transport of personnel. At the same time, consideration will be given in setting up a helicopter base and constructing related facilities to facilitate future helicopter operations.

III. Operation and Maintenance Items

(1) The foundation of the Project's wind farm includes internal and external components and submarine structures, which will undergo regular and non-scheduled inspections.

(2) The cable array, submarine cables and anti-scouring brush facilities of the Project's wind turbine will be subject to periodic inspections according to the seabed and soil conditions to determine if any non-scheduled maintenance is required.

(3) The facility structure and electromechanical system of the Project's offshore distribution substation and onshore booster station will be subject to periodic inspections. Non-scheduled inspection will be performed if necessary.

(4) Mechanical and electrical systems of the wind turbine will adopt planned maintenance; the main items include general inspection, testing, grease sampling and replacement of consumables and damaged components.

(5) Wind turbines of the Project will, in principle, undergo all-weather remote monitoring to allow close control of wind turbine performance and immediate fault response. In the event of a failure, the affected wind turbine will be handled by the troubleshooting team, which will then perform a corrective maintenance.

IV. Employment and job creation

A team consisting of technicians and onsite administration, will work to support the offshore wind farms operations through its lifetime. DONG Energy Wind Power foresees to employ a local based team which will be supported and trained during the pre-operational and early operational phase by experienced colleagues. This onboarding and training period has the purpose to transfer best practices and lesson learnt from the existing organization, enabling the alignment to the operating portfolio and reducing the learning period.

During the first years (approximately 5 years), DONG Energy Wind Power's Site Organization will be supported by the Turbine manufacturer Service Provider organization, which will also work out of the O&M Base together with DONG Energy Wind Power to ensure a smooth ramp-up of the operations. This is a preliminary assessment and could be adjusted depending on operational requirements and potential synergies with other wind farms in the area.

Furthermore, it is expected that the operations and maintenance of the foreseen offshore wind farms will generate a number of indirect jobs within the local community spanning to different sectors and industries, such as hospitality (e.g. accomodation, hotels, housing, etc.), transportation services, maintenance of the facilities, vessels and other equipment.

5.2.5 Decommissioning Plan

Wind farm is built based on the designed service life. When the designed service life is reached, the wind farms shall undergo decommissioning. Decommissioning is generally reverse-installation which requires low in precision; therefore, it will be conducted in the same controlled manner and in accordance with the risk management plan to ensure the same or a higher level of health and safety for individuals and the environment.

All components and objects resulting from the project's decommission shall be transported to a designated harbor to be handled in order to reuse, recycle or treated according to relevant law. Since the turbine equipment are mostly iron material, hence the wastes produced from decommissioning should be recyclable and reusable. The recycle of glass fiber blades is the only incomplete business, but the foreign wind farm currently under decommissioing (Videby wind farm) has proposed a preliminary recylce and reuse approach such as donating to technical institues, to experiment on the continuous use in the future. Or disassemble the blades and use them for special-designed noise curtains.

Prior to the decommision, this project will be in close communication with government authorities. Meanwhile this project will borrow experience from large-scale european wind farms entering the decommission stage. When suitable, the recycle and reuse of turbine components will be evaluated and planned, which involves upgrading, storage or reuse of components. Also, before decommissiong, this project will follow the decommisioning plan and will conduct EIA.

This chapter describes the current decommissioing technology adopted by this project, explained below：

I. Pre-Decommissioning：Site surveys and site specific assessments must be performed prior to any jack up activities to determine the appropriate method and vessel specifications in order to conduct work safely. In addition, appropriate ports should be identified as early as possible in order to plan for related operations, which include confirming the port length, water depth, and the permissible carrying capacity at the bottom of the seabed at the time of jacking. Finally, the pre-demolition preparatory work will include wind turbine, foundation, offshore distribution substation, etc., and the demolition work will include inspecting hook points, cutting cables, removing loose items, etc.

II. Wind Turbine Generators：The dismantling and removal of turbine components (blades, nacelle, tower etc.) will largely be a reversal of the installation process and subject to the same constraints. Using today's technology, dismantling of the turbines will require a jack-up vessel to ensure adequate control and to cope with the relatively high lifts and high crane hook loads. Following steps will take place:

1. Positioning and jack-up
2. Prepare lifting tools and sea fastenings
3. Remove rotor blades
4. Remove nacelle
5. Remove tower
6. All removed items will safely be placed on the deck and transported to harbour.

III. Wind Turbine Foundation：Foundations will be removed after the turbine has been removed. This will be carried out according to the best practise at the time of decommissioning, however the current assumption is to leave the buried part of the foundations from a certain level below the seabed ensuring this will not be uncovered. If it's is preferred to leave a visible part of the foundation structure in place e.g. if the structure is being used as marine habitat, this will be agreed with relevant stakeholders and regulators assessing the environmental impact and navigational safety.

For decommissioning of jacket foundations, it is anticipated that the pile will be cut below the seabed level to a depth that will ensure the remaining foundation is unlikely to become exposed. The exact depth will depend upon the sea-bed conditions, (i.e. dynamics, and site characteristics at the time of decommissioning.)

1. Mobilize suitable vessel (likely to be a jack-up vessel or heavy-lift vessel).
2. Deploy ROVs or divers to inspect the foundation and reinstate lifting attachment if needed.
3. Cut the legs of the jacket structure just above the piles.
4. Remove jacket by crane.
5. Excavate outside of piles
6. Cut the piles and remove by crane.
7. Lift foundation onto the decommissioning vessel or transport barge and transport to harbour.

IV. Anti-Scouring Brush Facility：The Scouring Brush Protection will be default to be left in-situ to preserve the marine habitat that may have established over the life of the wind farm. This will be agreed with relevant stakeholders and regulators assessing the environmental impact. If removal is deemed necessary, this will be done by the best practice at the time of removal.

V. Offshore substation：The decommissioning of the Offshore Substation will comprise the dismantling and removal of the topside and the foundation (substructure). The operation will follow a reversal installation process subjected to the same constraints as the installation operation. Both the surface and underwater preparation works can be performed using a suitable support vessel.

1. Mobilize suitable vessel (likely to be a heavy-lift vessel);
2. Remove / lift topside structure.
3. Backload Topside structure into the awaiting cargo barge or in the installation vessel deck;
4. Deploy specified cutting tool via work-class ROV;
5. Cut the foundation piles below the seabed.
6. Remove / lift jacket structure.

7. Backload Topside structure into the awaiting cargo barge or in the installation vessel deck;
8. Barge sails to harbour for dismantling.

VI. Offshore cables：The base assumption is that the offshore cables are removed. If total removal of the offshore cables is not possible relevant stakeholders and regulators will be consulted. If there are no issues with stakeholders/regulators and the risk of the cable becoming exposed is minimal, then the cable that cannot be removed will be left in situ. The cables will be cut as close as possible to the part of the cable that cannot be removed. The ends will be weighted down and buried (probably using an ROV) to ensure they do not interfere with vessels etc. At cable or pipeline crossings the cables are likely to remain in place to avoid unnecessary risk to the integrity of the third party cable or pipeline.

VII. Onshore substation：The onshore substation will be fully removed if reuse is not possible. All buildings and equipment will removed and processed for reuse, recycle or disposal. Potential hazards and pollutants to the environment will be identified and a risk mitigation plan put in place to ensure removal is carried out with minimal risk of damage to surrounding environment.

VIII. Onshore cables：The onshore cables will be handled in relation to the legislation at the time of decommissioning.

5.3 Scheduled Project Progress

The Preparatory Office is a subsidiary of DONG Energy Wind Power. DONG Energy Wind Power has applied for a total of four sites in Taiwan, which are zone #12, #13, #14 and #15 respectively, and it expects to develop at least one site per year. The currently planned offshore operations are expected to begin constructing in year 2021, while onshore operations are expected to begin in year 2019.

However, due to the ongoing investigations of each site, the development sequence of the site has thus not yet been confirmed. The priority development and construction site(s) is expected to be confirmed by year 2018.

The 4 Greater Changhua projects(NE, SE, NW, SW) belong to the same developer, even though the development order cannot be determined at this point, but later during the construction stage, through internal coordination, all offshore construction items including turbine implementation, turbine assembly, and cable laying…etc will be construction in order, meaning only 1 turbine piling work at a time as opposed to conducting the same construction work at the same time.

Chapter 6 Related Projects and Environmental Status of Development

In order to have better understanding of possible impacts at project site and adjacent area, related projects and environmental status, including wind turbine generator and power transmission lines are further detailed and used it as datum of evaluation. Possible affected scopes of master plan's related project and environmental status are further detailed, including physical and chemical environment, ecological environment, recreational landscape, social economy, transportation and cultural environment.

6.1 Related Projects

To understand the possible affect of adjacent area of development site, except for basic considerations of development bckground and resources' characteristic, projects and major construction plan (planning, constructing and completion of construction) of this project are taking into consideration, they are explained as follows:

6.1.1 Master Plan

II. National Master Plan on Energy Conservation and Carbon Reduction

(i) Competent Authority: Executive Yuan

(ii) Objective and Content

Due to global warning and depletion of conventional energy, the major countries in the world have to introduce "Conservation Energy and Carbon Reduction" in government policies. This is to conduct energy stargegy layout, implement green policies and devleop green industry to promote the society and economy of low-carbon. Based on Copenhagen Accord proposed by COP15 in May 2009, increase in glocal temperature shall be controlled within 2 degree Celius. Upon instruction from the President, "Promotion of Energy Conservation and Carbon Reduction by Executive Yuan" is established to consolidate the plans of all energy conservation and carbon reduction and incorparte with "National Master Plan on Energy Conservation and Carbon Reduction" which has set 10 benchmark projects and 35 benchmark plans, shown as Figure 6.1.1-1. This is to accelerate the implementation of energy conservation and carbon reduction measures and practice year objective. Policies comprehensively guide the low-carbon economic development and shape a society with consciousness of energy conservation and carbon reduction.

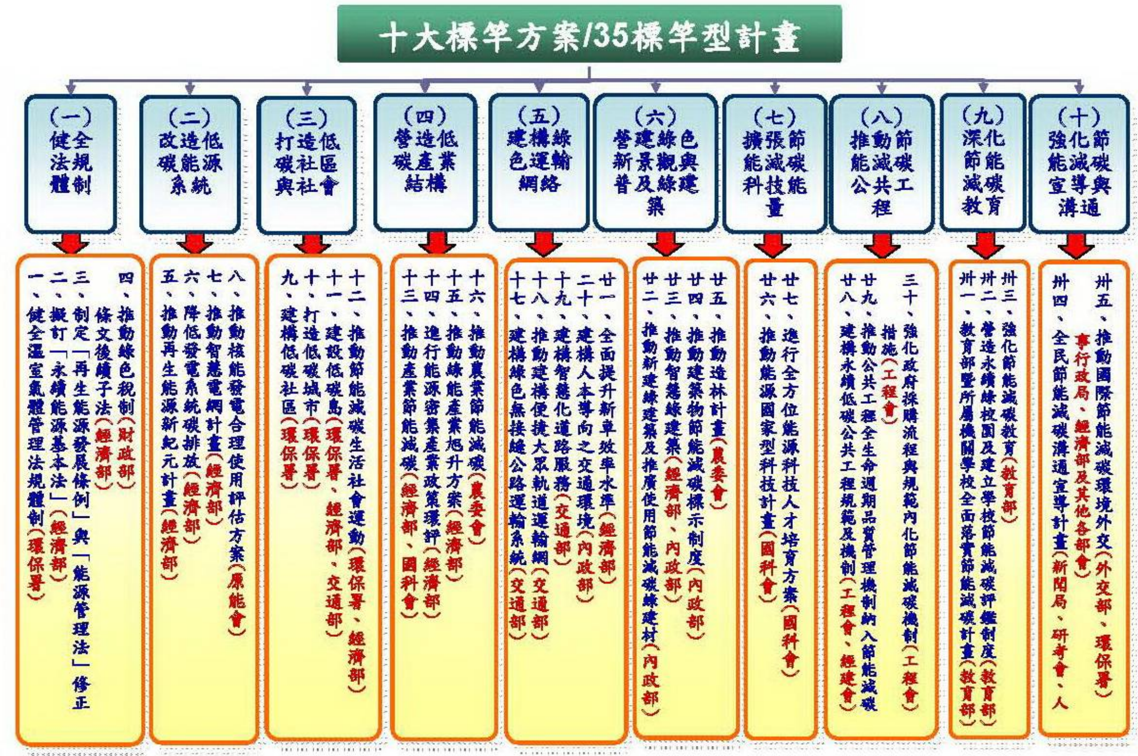
1. Goal of Energy Conservation: Since 2008, energy efficiency per year will increase more than 2% in the next 8 years which will reduce the energy intensity more than 20% in 2015, comparing with 2005; In 2025, it is hoped that energy intensity will reduce for more than 50% via technology

breakthrough and supplementary measures.

2. Goal of Carbon Reduction: National carbon dioxide emission of 2020 is maintained as 2005of which; National carbon dioxide emission of 2025 is maintain as 2000 of which.

(iii) Correlation With This Project

In order to have complete legal system, wind farm in “Advocacy Pragramme of Renewable Energy” of “Low-Carbon Energy System Transformation” and sub-law of “Renewable Energy Development Act” has become the main promotion project. “Promotion Development of Hotwheel (Wind, Biomass and Hydrogen Energy and Electric Car)” of Green Energy Rising Plan by creating low carbon industry structure is associated with this offshore wind farm. This project is in accordance with relevant regulations and policy direction. This will contribute in natuional goal of carbon reduction in the future after operation.



Source of Material: Energy Conservation and Carbon Reduction Promotion Program, ExecutiveYuan (National Master Plan on Energy Conservation and Carbon Reduction (Summary)) in May of 2010.

Figure 6.1.1-1 10 Benchmark Projects and 35 Benchmark Plans

III. Energy Continuity Guidelines

(i) Competent Authority: Executive Yuan

(ii) Objective and Content

It is proposed by Ministry of Economic Affairs in June of 2008, the details are describeds as follows:

1. Objective of Policy- Development of Sustainable Energy shall give consideration to “Safety of Energy”, “Development of Economy” and “Environment Protection” to fulfill the needs of future generation. Due to insufficient natural resources in Taiwan and limited environmental carrying capacity, policies of sustainable resources shall effectively utilize limited resources to create triple-win vision in aspects of energy, environmental protection and economy.
   (1) Increase Energy Efficiency: Increase more than 2% of energy efficiency per year in the next 8 years which makes energy intensity decrease more than 20% in 2015 comparing with 2005. In 2025, it is hoped that energy intensity will reduce for more than 50% via technology breakthrough and supplementary measures.
   (2) Development of Clean Energy: National carbon dioxide emission from 2016 to 2020 is maintained as 2008 of which; National carbon dioxide emission of 2025 is maintain as 2000 of which. In 2025, low-carbon energy in power generation system is increased from 40% to 55%.
   (3) Make sure energy supply is stable: Establish an energy safety supply system which can fulfill 6% of economic growth in the next 4 years and economic development goal with annual income per person up to 30,000 US Dollars.
2. Policies Principle- Constitue 2 high and 2 low energy consumption patterns and energy supply syustem including, “High Efficiency”, “High Value”, “Low Emission” and “Low Dependence”
   (1) High Efficiency: Increase energy usage and production efficiency.
   (2) High Value: Increase the adding value of energy utilization.
   (3) Low Emission: Energy supply and consumption way with low carbon and low pollution.
   (4) Low Dependence: Reduce the dependence of fossil fuels and imported energy.
3. Policy Guidelines- Promotion guidelines of sustainable energy policies will start with “clean energy” of energy supply and “energy saving” of energy demand.
   (1) In terms of “clean energy”, energy structure is transforemed and efficiency is improved.
   (2) In terms of energy saving, actual carbon reduction measures in all

departments are promoted.

(3) Constitute complete regulations and related mechanisms.

(iii) Correlation with This Project

This project is in accordance with government policy direction which increase utilization of renewable energy and commited to develop production low-carbon energy. After operation, it will contribute to national goal of carbon reduction.

IV. Central Part of Taiwan Regionnal Planning

(i) Competent Authority: Ministry of Interior

(ii) Duration of Project: 2021

(iii) Objective and Content

The central regions includes Miaoli County, Taichung County, Taichung City, Changhua County, Nantou County and Yunlin County. The local centers of Changhua urban system includes Changhua City, Yuanlin Township and Erlin Townhsip. Evaluating global impact, natural environment of central regionsactual condiction, development status and potential, the ultimate goal of central regional planning is “environment protection, developemnt of economy, emphasis of social justice and lead to sustainable development”. Guideline of land-use plan aims to promote the proper distribution of populations and economic activities in order to improve livelihood and working environment and to effectively utilize and conserve natural resources. Strategy of land use shall actively and effectively guide development and conservation of land, manage land use type and make orderly change in spatial structure.

(iv) Correlation With This Project

This offshore wind farm site is located ar Changhua Offshore, considered as green energy industry, in line with ultimate goal “environment protection, developemnt of economy, emphasis of social justice and lead to sustainable development”.

V. Offshore Wind Farm Region Development Policy Assessemnt

(i) Competent Authprity: Ministry of Economic Affairs, R.O.C.

(ii) Objective and Content

After the implementation of Regulations of Bulk Reward on 3rd July 2012, Bureau of Energy, Ministry of Economic Affairs considers proper distribution of national water resources, comprehensive planning of marine space, conservation of ecological resources and reduce the cost of development and etc. Offshore Wind Farm Region Development Policy is estimated to announce by the end of 2017 and implement at 2018. The second phase of offshore iwnd farm promotion is in acordance with Directions Governing Potential Site, free competition mechanism is adopted. Site is selected by developer for application and development, the space of marine and national resource are unable to comprehensively planned and consolidated. Problems of regulations invloved development site and job responsibilities are encountered. In the past year, Ministry of Economic Affairs had successfully dealt with issues of National Defense construction restriction. Bureau of Energy conducts regional planning through exclusion area. With initial study of professional institution, cross-department negotiation is performed focusing on boundaries and location of affected area. Through implementation of policy EIA and draft of promotion plan, Offshore Wind Farm Region Development Polict is successfully announced and implemented, the objectives are listed as follows:

1. In terms of overall planning of marine space, avoid using space to conduct competition and cooperation.
2. Intergate and utilize national resource to reduce overall investment cost.
3. Offshore wind farm develop year by year to drive the development of local industries.

(iii) Correlation With This Project

In line with offshore wind farm government policy, this project is considered as second stage of potential site. It is expected to promote and utilize renewable energy, protect environment and drive related industries.

VI. Renewable Energy Development Act

(i) Competent Authority: Ministry of Economic Affairs, R.O.C.

(ii) Objective and Content

Renewable Energy Development Act is the most important legal source to promote equipment utilizing renewable energy industry. Bureau of Energy, Ministry of Economic Affairs proposed preliminary draft in 2002 and sent it to Legislative Yuan for review in August. After legislators' 3 terms of office, Third Reading was conducted on 12th June of 2009 and it was promulgated on 8th July 2009, it had marked an important milestone in the development of renewable energy.

Economic cost of renewable enrgy is higher than conventional energy, countries in the world implement incentive measures to ensure the development of renewable energy. In terms of generating electricty, it is mostly adopted the most common Fixed Feed-in Tariffs and Renewable Portfolio Standard. Taiwan adopts Germany-led Fixed Feed-in Tariffs and other supplementary measures to encourage all walks of life to put in equipment utilizing renewable energy. Overall, Renewable Energy Development Act is focused on 2 legislative purposes:

1. Seek For Competition in Renewable Energy and Troubleshoot the Obstacles

(1) Electric undertaking which operates power network is obligated to grid connection and acquisition of renewable energy.

(2) Renewable energy is charged with Fixed Feed-in Tariffs, subsidy is

provided to increase economic incentive.

(3) Loose the restrictions of land use, requirements of self-usage power generation equipment and conditions.

2. The Internalization of Conventional Energy External Cost

(1) Electricty industry and power generation equipment with certain capacity which ar not utilizing renewable energy shall pay the foundation fee as the financial source of incentive.

(2) The paid funding fee can be reflected to eletrcity rate to meet the usage and fee principal of polluters.

Bureau of Energy denotes, types of renewable energy passed by Legislature Yuan include solar energy, biomass energy, geothermal energy, ocean energy, wind energy, non pumped storage plant, direct use of waste or generated energy after process. The legislation content is summarized as follows:

1. The total incentive total amount is 6.5-10.0 MW.
2. The approved renewable energy generation equipment is governed by regulations of parallel connection and feed-in.
3. Self-usage power generation equipment for renewable energy which less than 500W is not restricted to requirements of Electricity Act, application for approval, registration and wholesale of residual electricity.
4. Electricity undertaking and self-usage generation company with certain installed capacity shall pay certain amount of money to serve as fund, based on total non-renewable power generation. It is used as electricity subsidy, equipment subsidy, denmonstarted subsidy and promotion.
5. Electricity industry which operates power networks at local is connected to nearest rendezvous point of renewable energy, power generated by parallel connection and feed-in, under rational burden cost and economy.
6. Competent authority shall invite related departments, scholars and experts and committee constituted by association to accredit feed-in tariff of renewable energy and calculation method. Review the technology of renewable energy, change of cost, achievement of goals, review and amendment annually.
7. It is in early stage of devleopment, the equipment of renewable energy shall be gicen demonstated incentive; Utilization of solar energy, biomass energy and other renewable energy is subsidized by oil fund.
8. Government newly-built, reconstruction public engineering or public

building shall set up renewable energy generation facility in priority under required standards of engineering.

In the future, with the dual system of parallel connection of renewable energy development and protection of electricity price, the facility of renewable energy is rewarded to reach the goals of renewable enrgy promotion, environment protection and development of related industries.

(iii) Correlation with This Project

To cope with offshore wind farm policy, the equipment of renewable energy is erected to promote and utilize renewable energy, protect environment and drive the development of related industries.

VII. Guidelines of Application For Offshore Wind Farm Site

(i) Competent Authority: Ministry opf Economic Affairs, R.O.C.

(ii) Objective and Content

Taiwan is an island state, where is narrow and highly populated. Mountainous region is consisted two-third of the region. Due to increase of terrestrial wind turbine erection and limited land for wind farm site, the difficulty of terrestrial erection will be increased gradually. Comparing to land, wide range of waters with optimal wind power, stability, less turbulences provides a feasible path for Taiwan to develop wind power. Foreign manufactures provide terrestrial wind turbines, services of terrestrial wind turbines and share related patents and expertises. Taiwan Straits provides favorable conditions for offshore wind farm. The ways to develop offshore wind farm system in Taiwan is an important development objective in second phase of Taiwan and yet an important work to establish energy independence and safety for Taiwan. To encourage the development of offshore wind farm, Bureau of Energy, Ministry of Economic Affairs implemented Bulk Rewards of Offshore Wind Farm System on 3rd July 2012 and Guidelines of Application For Offshore Wind Farm Site on 2nd July 2015, published information about 36 potential sites and existing waters information. Total potential sites is up to 25 GW, it encourages developers who are interested in offshore wind farm to self-develop which allows developers prepare and handle procedure about offshore wind farm.

1. Requirements of Appliction of Offshore Wind Farm Site:

(1) Electricity undertakings which obtained license according to Electricty Act, the percentage of own fund shall account for 5% and above in overall investment.

(2) Application of establish electricty is restricted to limited company, it shall establish electricity preparatory office in the country. The own fund of preparatory office or promoter shall account for 5% or above in overall investment.

2. Related Regulations of Application:

(1) The configuration of single application shall not less than 100KW and shall not less than 5KW per km^2.

(2) Application site shall be based on potential sites listed in this attachment in pronciple. Those where are located outside potential site shall be further explained.

(3) After filing for reference or issue of consent letter, modification of wind farm site due to regulatory restrictions, results of environmental impact assessment or non-attributable reasons to applicants shall be consented competent authority. The modification of wind farm site which does not comply with 4th regulation, competent authority shall reject the modification applications.

(iii) Correlation With This Project

In line with offshore wind farm government policies, generating facilities of renewable energy is set to promote and utilize renewable energy, protect environment and drive development of related industries.

VIII. Challenge 2008 Six-Year National Development Plan

(i) Competent Authority: Council for Economic Planning and Development, Executive Yuan

(ii) Objective and Content

To face the global competition, the competitiveness of nation must be enhanced. “Challenge 2008 Six-Year National Development Plan” (Executive Yuan 31st May 2002 Offical #0910027098) proposed by Executive Yuan, is used as master plan of National Development Plan in the hope to accelerate the development of Taiwan and construct Taiwan as a Green Silicon Island. On the basis of government policies, focus the resources, promote National Development Plan in priority, invest in important construction to enhance development potential, break the limitations in the hope of entering rank of modernized countries by solid competitiveness.

This project is divided into 2 parts, Volume I and Volume II. Volume I is general information which indicates chanllenges and issues of globalization, path of Green Silicon, project content, economic efficiency and goal of challenge; Volume II indicates direction and principle of Ten Key Individual Plan. Ten Key Infividual Plans includes e-Generation Manpower Cultivation Plan, Cultural and Creative Industry Development Plan, International Innovation and R&D Base Plan, Industrial Value Heightening Plan, Doubling Tourist Arrivals Plan, e-Taiwan Construction Plan, Operations Headquarters Development Plan, Island-wide Trunk Transportation Construction Plan, Water and Green Construction Plan and New

Home Community Development Plan. This offshore wind farm project is under Water and Green Construction Plan.

(一) Correlation With Development

This development aims to accelerate government's green electricity policy, in response to development demand of global climate change framework and the awareness of environmental protection. This project discusses the ways of eliminating greenhouse gaseous which has become the issue concerns by the world, highlighting the importance of self-produced green energy. The utilization of green energy will lead to less pollution by fossil fuel. This project is compatible with "Water and Green Construction Plan".

VIII. National Development Plan (From 2013 to 2016)

(i) Competent Authority: National Development Council, Executive Yuan

(ii) Objective and Content

In the next 4 years, the government will begin the comprehensive construction, the key strategies including economic vitality, social justice, government intergrity, high quality cultural education, sustainable environment. Comprehensive construction, peace cross-strait and global friendly. In terms of economic vitality, the government will open up and deregulate to introduce Taiwan enterprises to the world. Accelerating the innovation of technology, optimising industry structure, strengthening competition of industry, promoting employment and stabilizing prices can result in economic growth which share by all. The implemented policies include signing of trade agreements, promotion of "free economic pilot zones", larger incentives for Taiwanese firms to list on the Taiwanese stock market, acceleration of industries' structural adjustments, strengthening innovation of technology, promotion essential force of enterprise, create more job opportunities and maintaining price stability. In terms of "social justice", the governments will narrow the wealth gap, implement 2nd Generation NHI, promote the reform og National Pension, create an favorable fertility environment, promote ethics intergration and eliminate sexual discrimination. In the aspect of government intergrity, the government will reform to have a stringent anti-corruption regimen, enhance the protection of human rights and accelerate the transformation of government struture. As for high quality cultural education, the goverment will facilitate cultural and creative industry, implement Directions Governing for the 12-Year Basic Education Curriculam and higher education. With respect of sustainable environment, the government will implement policies of energy saving and carbon reduction, construction to build sustainable ecological homeland and strengthen the disaster prevention. For comprehensive constrcution, the government will continuously promote basic construction, strengthen hub of marine and aviation, sound traffic network, equal regional development and sound finance and banking system. With respect of peace cross-strait, the government shrives to enhance cross-strait relationship and interaction, promote ECFA follow-up issues and agreement, strengthen national defense and build a solid natioanl security. Last but not least, the government will focus on global friendly to enhance foreign relationship, actively participate intergration of regional eonomy, participate in humanitarian aid, strengthen cultural exchanges and upgrade tourism industry.

Perform and implement “Drive Econmic Momentum Plan” to promote diversity and innovation of industry. The goals of the plan include, increasing the output of export and expanding market, strengthening manpower training, promoting investment and construction, boosting government’s efficiency, shoring up domestic confidence and middle- and long- term regulation of economy and industry struture.

(iii) Correlation With Development

This development is assisting government to accomplish the objectives of green energy policies to cope with the development demand of global climate change and growing environmental awareness. This project discusses the ways of eliminating greenhouse gaseous which has become the issue concerns by the world, highlighting the importance of self-produced green energy. The utilization of green energy will lead to less pollution by fossil fuel. This project is compatible with “Environmental Sustainability”.

IX. National Development Plan (From 2017 to 2020)

(i) Competent Authority: National Development Council, Executive Yuan

(ii) Duration of Project: From 2017 to 2020.

(iii) Objective and Content:

In the next four years, the promotion of policies emphaiszes on “Transformation on Economic Struture”, “Strengthen Social Safety Net”, “Equity and Justice of Society”, “Peaceful Development and Cross-strait Relationship” and “Diplomacy and Global Issues”. With respect of “Transformation on Economic Struture”, the government is enhancing the economic vitality, economic autonomy and economic landscape. Thus, the linking between industry and local is strengthened as well. Export and domestic demand are served as twin-engine which makes industry production and people’s livelihood are indispensable to each other and external trade and local economy complement one another. Strive to create an ecomic model with core value: innovation, employment and distribution which pursues sustainable development. In term of “ Strengthen Social Safety Net”, the government will fully implement 5 social programs, including safety housing, food security, community care, sustainable pension and security maintenance; To increase the employment rate of teenagers, elders and women, friendly child care and children support system are established. Long-term care plan and Sustainable National Pension System are established to take care the minority and set up a sound social safety net. With respect of “ Equity and Justice of Society”, public policies embody diversity, equity, liberalisation, transparency and value of human rights to deepen and evolve democracy mechanism of Taiwan. With regards to

“Peaceful Development and Cross-strait Relationship”, the government will build economic community consensus with Southeast Asia, India, New Zealand, Australia and etc. to create a win-win new cooperation model through New Southbound Policy; Enhance the layout and diversity of economy by strenthening the aliance of the world and local. At the same time, maintain the stability and prosperity of Taiwan by initiating a continuous cross-straits constructive dialogue without premises. 「On the subject of “Diplomacy and Global Issues”, the government holds the principle of “Steadfast Diplacy” and “Mutual Assiatnce for Mutual Benefits” and universal values of peace, liberal, democracy and human rights. Through the cooperation of all walks of life, improve the relationship between Taiwan and other countries by actively engaging in humanitarian work, medical assistance, disease prevention, anti-terrorist and combating crime etc. At the same time, in order to cope with climate change, national land conservation, prevention of disaster and measures to eliminate greenhouse gaseous, “low carbon lifestyle” has become the typical pattern of livelihood and production.

The next 4 years of key development is fully boost domestic economy. Through public policies and investment, the government will create new economy dynamic with brand-new economic layout; At the same time, 2 major development strategies: “maintain safety and justice of society” and “maintain peace and stability” are promoted to maintain social equity and environment stability and lay a long-term peace and stability of foundation.

(iv) Correlation With This Development

In response to “low carbon, high quality, stability and economic efficiency” energy system, this development assisst government to strengthen the safety of energy, develop green and innovative economy, promote sustainability of environment and increase the percentage of renewable energy to create safe, stable, effective and clean energy supply system and gradually implement the goal of 2025 Nuclear-Free Homeland. This project is compatible with “Low Carbon Sustainability”.

X. Medium-Term Plans of National Construction Comprehensive Assessment (2012 to 2017)

(i) Competent Authority: National Development Council, Executive Yuan

(ii) Duration of Project

From 2012 to 2017

(iii) Objective

1. Sustainable Development of Urban and Rural.
2. Innovation and Economic Growth.
3. Conservation of National Land and Security
4. Green Intelligence Transportation.

(iv) Correlation With This Development

This development is considered as development of clean energy in order to increase the stability of electricty supply at Changhua coastal area and strengthen the environmental quality and application of green development which is compliance with national development direction.

XI. Comprehensive Development Plan of Changhua County (First Amendment)

(i) Competent Authority: Changhua County Government

(ii) Duration of Project

From 2002 to 2013, 3 phases in total.

(iii) Objective

1. In line with the draft of Comprehensive National Plan Development Plan, “Comprehensive Development Plan of Changhua County (First Amendment)” is shaped into the pioneer pilot study of National Spatial and Urban Rural Plan.
2. Through scientific analysis procedure and appropriate participation method by citizens, the next 12 years of overall development layout plan of Changhua is regulated to improve the conservation and utilization of land and natural resources in Changhua County. This may lead to appropriate distribution of population and industry activities. The sound development of economy throughout the county is accelerated, livelihood of citizens in the county and public welfare are improved.
3. Keeping in line with efficiency of county policies, substantial project meachnism is established in county government policy. Passive control system is replaced with active control system. A long term and comprehensive development plan is selected to lead the construction of the county.
4. Conduct overall review on development plans on Changhua County. From perspective of overall devleopment in the county, provide intergrative development suggestion.
5. Through continuous communication and negotiation, the need of local development is responded to the monitoring unit to seek for assiatnce for governmetn units which can implement the comprehensive development plan and accelerate the sound devleopment.
6. According to development concept amd characteristics of all townships, the developmnt strategy of all township in Changhua County is separately

planned to coordinate the development pace and work to make the construction works more productive.

To cope with the draft of Government Middle- and Long-Term Infrastructure Projects by Council for Economic Planning and Development Executive Yuan, major infrastructure plan of Changhua County is proposed. With the way of short-term focus, the comprehensive transformation of Changhua County can be accelerated and drive the efficiency of growth.

(iv) Correlation With Development

This offshore wind farm is located at Fangyuan Township and offshore of Lukang Township, Changhua County. It is under Erlin District which encompasses Erlin Township, Fangyuan Township, Dacheng Township and Jutang Township. Erlin District is located at the remote southwest area of Changhua. It lies at border area, in addition to lack access of transportation, Erlin District is a district with slow development in Changhua County. This project is in line with govenrment’s offshore wind farm policy, develop clean energy via natural wind resource in Changhua County. During construction and operation phase, local employment opportunities are increased. Feedback of electricity and subsidy to fishery are offered to improve the environment.

XII. Amendment of National Regional Planning

(i) Competent Authority: Ministry of the Interior

(ii) Duration of Project

2026

(iii) Objective

1. Conservation and management of national land are put into practice.
2. Coping with Comprehensive Management Plan of River Basin to plan and review land use.
3. Strengthe the management of coastal area to cope with climate change and disaster prevention.
4. Maintain the total area of farmland and protect the environment of food production.
5. Intergrate the develop demand to increase the development competitiveness of industry.
6. Review land use plan to promote the industry of land vitalization and redevelopment.
7. Implement the intensive city idea to promote sustainable development at urban and rural regions.

8. Draft metropolitan area and special district plan to promote the integration of cross-domain resources.

(iv) Correlation with Development

本 None of the wind turbines in this project are in the preservation zones along the coast of Changhua, as mentioned in the chapter of utilization of ocean territories in National Regional Planning. After reviewing the zoning principle of administrative maritime boundaries for each municipal, county and city: “The administrative maritime boundaries of each municipality, county and city, is defined by the perpendicular method in combination with equidistant line method, extending outwards towards the boundary of territorial waters from the maritime end point of the land boundary.” Therefore, this project is located within Changhua county’s maritime jurisdiction.

Comparing with current using status of waters in Changhua regional plan, wind farm area is incorporated into related content. Thus, this wind farm area has avoided environmental sensitive area of Changhua Coastal Area including: important habitat area of Chiense White Dolphin, Wong Kung Prawn Breeding Consevation Area, demarcated fishery right of Changhua Fishermen’s association, protected reef area to mitigate the impact on waters.

XIII. National Sustainable Development Plan

(i) Competent Authority: Executive Yuan

(ii) Objective and Content

Establish vision of sustainable development which also serves as basic strategy and operational guidelines of Taiwan in response to international trend. To assess the foundation of sustainability of national development, develop sustainable devlopment indicator, build a sustainable indicator statistic, publish and review related systems.

(iii) Correlation With This Project

Wind energy is one of the renewable energy which in line with the goal of National Sustainable Development. After the erection of wind turbine, the power generation can increase the installed capacity of national renewable energy to reach the goals of National Sustainable Development.

XIV. Strategic Plan for National Spatial Development

(i) Competent Authority: Executive Yuan

(ii) Objective and Content

Cross-strait relationship, aging society with fewer children, climate change energy conservation and carbon reduction, financial crisis, the emerge of Asian countries, change in domestic and international and important issues facing by governance are taking into consideration. Based on the premises of sustainable economy, sustainable society and sustainable environment, goals of National Spatial Development is creating innovative environment to build a sustainable society with a vision creating Taiwan a safe and natural ecology, high quality lifestyle, operation of knowledge economy and energy conservation and carbon reduction and water saving.

(iii) Correlation With This Project

This development is generated via wind power which is a clean and green energy. Carbon emission of Taiwan can be reduced which compliance with the vision of energy conservation and carbon reduction and sustaianable social environment.

XV. Comprehensive Coastal Management Plan

(i) Competent Authority: Ministry of the Interior

(ii) Objective and Content

In order to achieve the goals such as maintaining natural system, ensuring zero loss on natural coast, responding to climate change, preventing coastal disaster and environmental destruction, protecting and rehabilitating coastal resource, promoting coastal integrated management, promoting sustainable development of society, economics, and environmental on coastal area, protecting, utilizing and managing land in coastal area, according to Articles 8 and 44 of Coastal Management Act, "Overall Coastal Management Plan" is researched and developed to manage the problems and countermeasures of comprehensive coastal management, to implement the principles of planning management on coastal areas, to coordinate the divisions of works between relevant authorities, to advise the related projects for revisions or changes, to effectively guide the use of coastal land, and to improve the sustainable management of coast.

(iii) Correlation With Development

This project is complied with the energy proportion of government's 2025 Nuclear Free Homeland Goal: 30% of buring coal, 50% of combustible gas and 20% of renewable energy and new energy policy to promote the energy efficiency. Facilitate the development of clean energy to drive the development national green industry in hoping of reaching the goal of 20% renewable energy by 2025. Construct offshore wind farm and related works. Overall ecological conservation, landscape and environmental factors are taking into consideration to implement coastal function and homeland security and create win-win situation in coastal management and energy transformation.

XVI. Sustainable Coastal Overall Development Project (Second Phase)

(i) Competent Authority: Ministry of Interior

(ii) Objective and Content

In response to the economic policy of the presidential political opinion on "The 12 Constructions of the Love Taiwan", and for "The Blueprint of Economic

Development” that is fully promoted by the government, among which, “The New Life of Coast” is a vision to create a symbiosis between nature and culture on coastal areas. By improving the overall environment of the fishing port and strengthening the management of the protection forest, the coastal landscape can be reconstructed to restore the beauty of the coast. The fishing port will be activated and managed towards the development between fishery industry and coastal recreational function and will protect the life and property of coastal resident and share the harbor resources.

(iii) Correlation With This Development

This wind energy is one of the renewable energy which compliance with vision and goals of National Devlopment Plan. Ecology conservation, landscape and environment and other facotrs, are taking into consoderation while building offshore wind turbine to reduce the possible impact on coastal area.

XVII. Promote Four-Year Wind Farm Project

(i) Competent Authority: Ministry of Economic Affairs

(ii) Objective and Content

The energy in Taiwan is highly dependent on imports, and the dependence on fossil energy is extremely high. Facing with the global trend of greenhouse gas reduction and the national consensus of nuclear-free homeland, the government's plan for new energy policy aims to increase the proportion of renewable energy power generation to 20% in 114 year. Towards the vision of a nuclear-free homeland in 2025, a safe, stable, efficient and clean energy supply and demand system can be built to take into account the balance of energy security, environmental sustainability and green economy development. According to the Ministry of Economic Affairs’ plan aiming to expand the capacity of various types of renewable energy and its power generation, the long-term goal of wind power generation is 4.2 GW in 114 year, including 1.2 GW of land-based wind power and 3 GW of offshore wind power.

In the case of offshore wind power, in 101 year, the Ministry of Economic Affairs announced the implementation of the Phase 1 “Wind Power Offshore Demonstration System Incentive Scheme”. Three demonstration business owners are expected to complete the demonstration wind farm in 109 year. In 104 year, the Energy Bureau of the Ministry of Economic Affairs continued to announce the Phase 2 “Offshore Wind Power Planning Site Application Highlights” and 36 potential sites available for industrial reference and self-input. For the Phase 3 area development policy, the Ministry of Economic Affairs conducted the “Policy EIA” on the basis of the potential sites and completed the procedures on May 1, 106 year. The follow-up plan has been gradually expanded to the deep-sea area by means of “block development”. The overall driving strategy of wind power will be based on the principle of “Short-term Standard Meeting, Medium- and Long-term Fundamental measures for governing the country”, and will first achieve the cumulative capacity of 1,334 MW in 109 year. At the same time, the administrative process will be accelerated, and the foundation will be promoted to achieve the cumulative capacity of 4.2 GW in 114 year, aiming for the vision of energy security, green economy and environmental sustainability.

(iii) Correlation With This Project

This project is complied with the energy proportion of government’s 2025 Nuclear Free Homeland Goal: 30% of buring coal, 50% of combustible gas and 20% of renewable energy and new energy policy to promote the energy efficiency. Facilitate the development of clean energy to drive the development national green industry in hoping of reaching the goal of 20% renewable energy by 2025. Construct offshore wind farm and related works to comply with visions and objectives of government. It is expected to achieve the development goal of offshore wind farm and make contribution to green energy development in consideration of factors such as national security, safety of navigation, visual landscape, coastal environment and humanity socio-economy and ecological conservation.

Table 6.1-1 All Correlated Projects that Could be Affected by the Development Behavior

Range	Project	Competent Authority	Completion Time	Correlation or Impacts
Master Plan	National Master Plan on Energy Conservation and Carbon Reduction	Executive Yuan	2025	Wind power is classified as low-carbon energy. This project is in accordance with related regulations and policies. It is contributable to carbon reduction objective after operation.
	Sustainable Energy Policy Guidelines	Ministry of Economic Affairs, R.O.C.	2025	This project aims to develop and produce energy with low carbon emission based on the direction of renewable energy utilization policy of the government, which will be beneficial to national carbon reduction target once it is up and running.
	Central Regional Planning (Second Overall Review)	Ministry of the Interior	2021	This offshore wind farm is located at Changhua Waters and it is considered as green energy industry. It is compliance with the goal "implementing environmental conservation, economic development and society justice and leading to sustainable development".
	Offshore Wind Farm Site Development Policy Assessment Statement	Ministry of Economic Affairs, R.O.C.	2018	This project complies with government offshore wind farm policy. It is considered as second phase operation potential site in the hopes of ultilization renewable energy, environmental protection and impetus to drive related industries.
	Renewable Energy Development Act	Ministry of Economic Affairs, R.O.C.	—	Under the guarantee of such act, the energy generated by this project will be merged into the electrical power grid of Taipower and the project will sign an agreement for the purchasing/selling of electricity according to the renewable power wholesale pricing announced by Ministry of Economic Affairs.
	Guidelines of Application For Offshore Wind Farm Site	Ministry of Economic Affairs, R.O.C.	2019	This project invests in the development of equipment that generates renewable energy based on the government's offshore wind power generation policies and applications will be submitted according to its regulations.
	Challenge 2008 National Development Plan	Council for Economic Planning And Development, Executive Yuan	2018	開 Development aims to achienve government green energy policy goal to cope with global development demand due to climate change and the raise of environmental concerns. "Control the emission of greenhouse gaseous" has become an important issue in the globe, making the self-generating and green energy is increasingly remarkable. Thus, this project is compatible with objectives of Water and Green Construction Plan.

Table 6.1-1 All Correlated Projects that Could be Affected by the Development Behavior(Cont. 1)

Range	Project	Competent Authority	Completion Time	Correlation or Impacts
Master Plan	National Development Plan (2013 to 2016)	National Development Council, Executive Yuan	2016	The development behavior will help the government to achieve its green electrical power policy while coping with requirements in the framework of global climate change development and executed with the awakening environmental protection awareness in mind. The topic of how to reduce green house gas emission has already become the priority issue for nations around the world and the importance of self-produced green energy has become more important every day. The application of renewable energy to prevent pollution from fossil fuels power generation are also being noticed more each day and therefore this project shares compatible goals with the idea of achieving a "Sustainable Environment".
	National Development Plan (2017 to 2020)	National Development Council, Executive Yuan	2020	In response to nergy system of "low carbon sustainability, stability with high quality and economy with efficiency", this project assists the government to enhance energy safety, create new green economy and facilitate sustainability of environment. Increase the proportion of renewable energy power generation to build safe, stable, efficient and clean energy supply demand system in order to implement 2025 Nuclear-Free Homeland. Thus, this project is compatible with environmental goal "low-carbon and sustainable".
	Overall National Development Planning Assessment Midway Plan (2012 to 2017)	National Development Council, Executive Yuan	2017	The development is considered as clean energy. The application of wind power can improve the stability of power supply in the coastal area of Changhua, environmental quality and green energy development which is in line with National Development Direction.
	Changhua Comprehensive Development Plan (First Revision)	Changhua County Government	Plan Target Year 2013	This project is cooperated with the government's offshore wind power generation policy, utilizing natural wind resources to develop clean energy. During construction and operation of the project, loca employment rate can be increased. Thus, generation feedback and compensation of fishery are provided to improve living environment.
	Revised National Regional Planning	Ministry of the Interior, R.O.C.	2026	None of the wind turbines in this project are in the preservation zones along the coast of Changhua, as mentioned in the chapter of utilization of ocean territories in National Regional Planning. After reviewing the zoning principle of administrative maritime boundaries for each municipal, county and city: "The administrative maritime boundaries of each municipality, county and city, is defined by the perpendicular method in combination with equidistant line method, extending outwards towards the boundary of territorial waters from the maritime end point of the land boundary." Therefore, this project is located within Changhua county's maritime jurisdiction.
	Sustainable Development Action Plan	Executive Yuan	2015	This wind farm project is generalized into one of the renewable energies which complies with goal of sustainability of National Sustainable Development Operation. Wind turbine generators which build after completion can increase the installed capacity of renewale energy to achieve the goals of national sustainable development.

Table 6.1-1 All Correlated Projects that Could be Affected by the Development Behavior (Cont. 2)

Range	Project	Competent Authority	Completion Time	Correlation or Impacts
Master Plan	Strategic Plan for National Spatial Development	Executive Yuan	—	This project is generated via natural wind power which is considered as natural and clean energy in the hope of reducing Taiwan carbon emission. It is complied with energy efficiency and achieved development goal of sustainable socio-environment.
	Overall Coast Management Plan	Executive Yuan	2036	This project is complied with the energy proportion of government's 2025 Nuclear Free Homeland Goal: 30% of buring coal, 50% of combustible gas and 20% of renewable energy and new energy policy to promote the energy efficiency. Facilitate the development of clean energy to drive the development national green industry in hoping of reaching the goal of 20% renewable energy by 2025. Constrcut offshore wind farm and related works. Overall ecological conservation, landscape and enviroenmntal factors are taking into consideration to implement coastal function and homeland security and create win-win situation in coastal management and energy transformation.
	Sustainable Coastal Overall Development Plan (Second Phase)	Executive Yuan	—	This offshore wind farm project is considered as one of the renewable energy which complies with visions and objectives of National development Plan. Ecolocial conservation, landscape and environmental factors are taking into consideration while building offshore winng turbines to reduce the possible impacts on coastal area.
	4-Year Plan of Wind Power Promotion	Ministry of Economic Affairs, R.O.C.	2025	This project is complied with the energy proportion of government's 2025 Nuclear Free Homeland Goal: 30% of buring coal, 50% of combustible gas and 20% of renewable energy and new energy policy to promote the energy efficiency. Facilitate the development of clean energy to drive the development national green industry in hoping of reaching the goal of 20% renewable energy by 2025. Construct offshore wind farm and related works to comply with visions and objectives of government. It is expected to achieve the development goal of offshore wind farm and make contribution to green energy development in consideration of factors such as national security, safety of navigation, visal landscape, coastal environment and humanity socio-economu and ecological conservation.

Table 6.1-1 All Correlated Projects that Could be Affected by the Development Behavior (Cont. 3)

Range	Project	Competent Authority	Completion Time	Correlation or Impacts
Development Within area of a few hundreds meter along the lines Development Within 10km of perimeter or Linear-Type Development	Fuhai Offshore Wind Farm Project (Phase I Project)	Bureau of Energy, Ministry of Economic Affairs	2020	This project is in maritime territory west of Fangyuan Township of Changhua County where two offshore wind turbines and a marine meteorological observation tower were installed 8 kilometers away from the shore. This project is generated via wind power which causes positive impact on Taiwan electricity system and stability.
	Fuhai Changhua Offshore Wind Farm	Bureau of Energy, Ministry of Economic Affairs	Planning	This project is in west waters of Fangyuan Township of Changhua County where 9 to 13km away from shore. The maximum total installed capacity is 120MW. This is adjacent to northeast wind farm. This project site has avoided the area of that wind farm site.
	Changhua Coastal Industrial Park Wind Farm Project	Bureau of Energy, Ministry of Economic Affairs	Operating	Offshore wind farm project of Changhua Coatsal Industrial and this project are generated by wind energy. Wind power is generated by natural wind, combustion of fuel is not involved. Thus, it is the cleanest renewable energy.
	Greater Changhua Northwest Offshore Wind Farm	Bureau of Energy, Ministry of Economic Affairs	Planning	This wind farm site is located at offshore area of Changhua County. It is No.12 potential site of Guidelines of Application For Offshore Wind Farm Site. It is generated by wind energy which has positive impact on Taiwan electricity supply and stability.
	Greater Changhua Northeast Offshore Wind Farm	Bureau of Energy, Ministry of Economic Affairs	Planning	This wind farm site is located at offshore area of Changhua County. It is No.13 potential site of Guidelines of Application For Offshore Wind Farm Site. It is generated by wind energy which has positive impact on Taiwan electricity supply and stability.
	Greater Changhua Southwest Offshore Wind Farm	Bureau of Energy, Ministry of Economic Affairs	Planning	This wind farm site is located at offshore area of Xianxi Township and Lukang Tonship. It is No.14 potential site of Guidelines of Application For Offshore Wind Farm Site. It is generated by wind energy which has positive impact on Taiwan electricity supply and stability.
	Hailong No.2 Offshore Wind Farm	Bureau of Energy, Ministry of Economic Affairs	Planning	This wind farm site and Hailong No.2 Offshore Wind Farm are generated by wind energy. The generated electricity is for Changhua Area. Offshroe wind farm is generated by natural wind power, no combustion of fuel is involved, it is the cleanest renewable energy.
	Hailong No.3 Offshore Wind Farm	Bureau of Energy, Ministry of Economic Affairs	Planning	This wind farm site and Hailong No.3 Offshore Wind Farm are generated by wind energy. The generated electricity is for Changhua Area. Offshroe wind farm is generated by natural wind power, no combustion of fuel is involved, it is the cleanest renewable energy.
	Formosa III (Haiding) No.1 Offshore Wind Farm	Bureau of Energy, Ministry of Economic Affairs	Planning	This wind farm site and Formosa III (Haiding) No.1 Offshore Wind Farm are generated by wind energy. The generated electricity is for Changhua Area. Offshroe wind farm is generated by natural wind power, no combustion of fuel is involved. It is the cleanest renewable energy.
	Formosa III (Haiding) No.2 Offshore Wind Farm	Bureau of Energy, Ministry of Economic Affairs	Planning	This wind farm and Formosa III (Haiding) No.2 Offshore Wind Farm are generated by wind energy. The generated electricity is for Changhua Area. Offshroe wind farm is generated by natural wind power, no combustion of fuel is involved. It is the cleanest renewable energy.

Table 6.1-1 All Correlated Projects that Could be Affected by the Development Behavior (Cont. 4)

Range	Project	Competent Authority	Completion Time	Correlation or Impacts
Development Within area of a few hundreds meter along the lines Development Within 10km of perimeter or Linear-Type Development	Formosa III (Haiding) No.3 Offshore Wind Farm	Bureau of Energy, Ministry of Economic Affairs	Planning	This wind farm and Formosa III (Haiding) No.3 Offshore Wind Farm are generated by wind energy. The generated electricity is for Changhua Area. Offshroe wind farm is generated by natural wind power, no combustion of fuel is involved. It is the cleanest renewable energy.
	OWF Project Phase I	Bureau of Energy, Ministry of Economic Affairs	Planning	30 wind turbines of the project are erected at about 5 kilometres away from west side of Fangyuan Township’s coastal area where is adjacent to east side of this project. This project has avoided the wind farm area during planning.
	OWF Project Phase II	Bureau of Energy, Ministry of Economic Affairs	Planning	This project is located at waters area where is about 9km away from Xianxi Township, Fuxing Township, Lukang Township and Fanfyuan Township of Changhua County. The maximum installed capacity is 720MW. It is adjacent to north side of this project. This project has avoided the wind farm area during planning.
	CSC Offshore Wind Farm Project	Bureau of Energy, Ministry of Economic Affairs	Planning	This project is located at west waters area 7km away from Dacheng Township and Fangyuan Township, Changhua County. The maximum total installed capacity is 707.2MW. It is adjacent to south part of this wind farm. This project has avoided the wind farm area during planning.
	Wong Gong and Yongsing Offshore Wind Farm	Bureau of Energy, Ministry of Economic Affairs	2010	This project and Wang Gong and Yongsing Wind Farm Project are generated by wind power. The generated electricity is for Changhua Area. Offshroe wind farm is generated by natural wind power, no combustion of fuel is involved. It is the cleanest renewable energy.
	Xidao Offshore Wind Farm Project	Bureau of Energy, Ministry of Economic Affairs	Planning	This project is located at west waters area of Fangyuan Township, Changhua County. It is 9-17km away from shore, the installed wind turbines are 23 to 53. It is adjacent to south part of this wind farm. This project has avoided the wind farm area during planning.
	Zhangfang Offshore Wind Farm Project	Bureau of Energy, Ministry of Economic Affairs	Planning	This project is located at west water area of Fangyuan Township, Changhua County. It is 14 to 25km away from the shore. The installed wind turbines range from 32 to 72. It is located at the south part of this project.
	)Haixia Offshore Wind Farm Project (#27 Wind Farm)	Bureau of Energy, Ministry of Economic Affairs	Planning	This project is located at offshore area of Fusing Township and Fanfyuan Township of Changhua County, the nearest distance away from shore is up to 14km. The erected wind turbines are not more than 75 wind turbines, it is located at south part of wind farm. This project has avoided the wind farm area during planning.
	Fufang Offshore Wind Farm Project	Bureau of Energy, Ministry of Economic Affairs	Planning	This project is located at west waters area of Fangyuan Township, the nearest distance away from shore ranges between 16.5km and 28km. The number of wind turbine is between 34 and 69. It is located at south part of this wind farm.
	Haixia Offshore Wind Farm Project (#28 Wind Farm)	Bureau of Energy, Ministry of Economic Affairs	Planning	This wind farm is located at offshore area of Fangyuan Township and Dacheng Township, more than 14km away from shore. No more than 75 wind turbines shall be erected. This project has avoided the wind farm area during planning.

Table 6.1-1 All Correlated Projects that Could be Affected by the Development Behavior (Cont. 5)

Range	Project	Competent Authority	Completion Time	Correlation or Impacts
Development Within area of a few hundreds meter along the lines Development Within 10km of perimeter or Linear-Type Development	Construction Plan of Offshore Plant at Fusing Township and Fangyuan Township	Bureau of Energy, Ministry of Economic Affairs	Terminate Development	This project has not registered for electricity industry innovation registration in Ministry Economic Affairs. It is terminated permanently for development. It has suspended EIA review conclusion on 28th January 2016.
	Types and Area of Chinese White Dolphin Important Habitat (Reserved Area)	Council of Agriculture, Executive Yuan, R.O.C.	—	During early stage of planning, this wind farm site has avoided Important Habitat of Chinese White Dolphine. Thus, wind turbines are erected away from Important Haibitat of Chinese White Dolphin. Appropriate measures are taken after survey and impact assessment of Chinese White Dolphin ro reduce the disturbance and limit the impact on Chinese White Dolphin.
	Existing Planned Offshore Wind Farm Project at Changhua Offshore	Bureau of Energy, Ministry of Economic Affairs	Planning	The wind farm site has not overlapped with other wind farm, this project has avoided the wind farm area.
	Development Plan for Changhua Coastal Industrial Park	Industrial Development Bureau, MOEA	Operating	Changhua Coastal Industrial Park is an industrial park in the vicinity of project, integrating with manufacturing, R&D, residency and recreation. With respect to land use, it was mainly constituted by factory sites (factory, testing and research), related industry land (wholesale, retail, F&B, industrial and commercial, transportation, warehouse, communication, service industry, financial industry, insurance and real estate), community, public facility, environmental protection sites and recreational land (riverside park, ocean park, yacht terminal). In the future, Changthua County coastal area is generated by wind power to increase the stability of power supply.

6.1.2 Related Projects

I. Fuhai Offshore Wind Farm Project (Phase I)

(i) Developer: Fuhai Wind Farm Corp. Preparatory Office

(ii) Developer: Fuhai Wind Farm Corp. Preparatory Office

(iii) Content:

2 offshore wind turbines and a weather (instrumentation) tower are constructed at 8km from west coast of Fangyuan Township, Changhua County.

(iv) Operation Phase

2020

(v) Correlation or Impact

These 2 projects rely on wind energy which cause positive impacts on Taiwan electric supply and stability.

II. Fuhai Changhua Offshore Wind Farm

(i) Organizer: Bureau of Energy, Ministry of Economic Affairs

(ii) Developer: Fuhai Wind Farm Corp.

(iii) Content: This project is located at offshore area of Fangyuan Township, Changhua County. The distance between shore and wind farm is approx 9-13km, maximum capacity is not more than 120MW. Wind turbine is connected via submarine cable in series. It is connected to overland cable after landing point and linked to Hanbao Substation of Taiwan Power Company.

(iv) Schedule: It is processing Environemntal Imapct Assessment, it is estimated to operate at 2020.

(v) Correlation or Impact:

It is located at southeast of this project; it has positive impact on Taiwan electricity supply and stability.

III. Development Plan for Changhua Coastal Industrial Park

(i) Competent Authority: Industrial Development Bureau, Ministry of Economic Affairs

(ii) Scope and Schedule of Project

Development approved by Executive Yuan encompasses Xianxi, Lunwei, Lukang and access roads. Development area is 3,643ha. in total. Among which, Xianxi Area takes up for 1,090ha., Lunwei Area take ups for 1,340 ha., Lugang Area takes up for 1,148ha and access roads take up for 65ha. Changhua Coastal Industrial Park is integrated with manucfacturing, R&D, residency and recreation. Its development is cooperated with economy and land sold, it is developed in zone. In 1992, this industrial park had passess review of EIA. It was planned to complete by the end of 2001. Overall economy was taking into consideration, it was adjusted to complete in 2010. With respect to land use, it was mainly constituted by factory sites (factory, testing and research), related industry land (wholesale, retail, F&B, industrial and commercial, transportation, warehouse, communication, service industry, financial industry, insurance and real estate), community, public facility, environmental protection sites and recreational land (riverside park, ocean park, yacht terminal), 3,643ha. in total.

(ii) Correlation or Impact

Part of windbreak forest of this project and Changhua Coastal Industrial Park is altered to construct wind turbines, it has positive impacts on Taiwan eletricty supply and stability. Offshroe wind farm is generated by natural wind power, no combustion of fuel is involved. It is the cleanest renewable energy.

IV. Development Plan of Offshore Plant at Changhua Industrial Park

(i) Organizer: Bureau of Energy, Ministry of Economic Affairs

(ii) Developer: infraVest

(iii) Content:

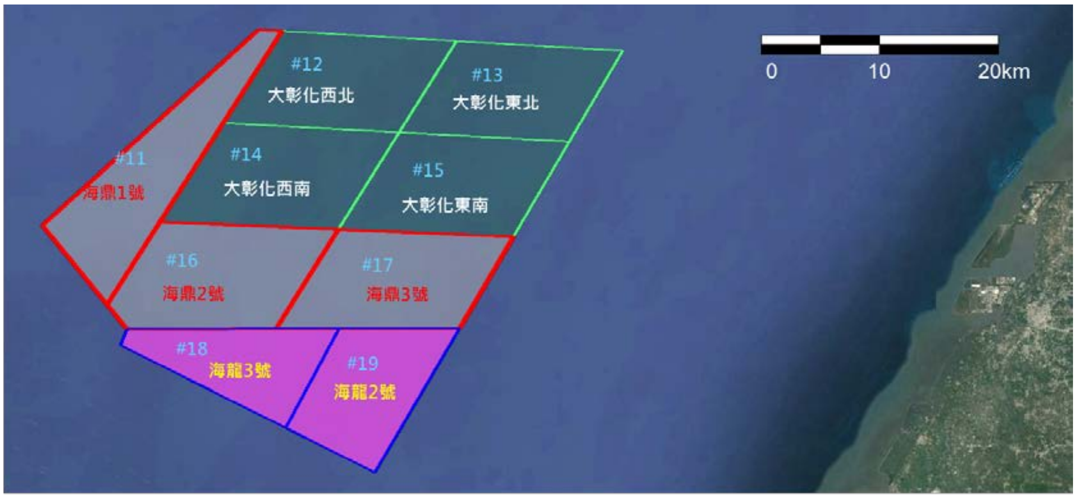
45 wind turbines are builts in Chnaghua Coastal Industrail Park (13 wind turbines are erecetd in Xianxi Area, 10 wind turbines are erected in Lunwei Area. Single unit capacity of wind turbine ranges from 2,000kW to 3,000kW, total capacity ranges from 90,000kW to 135,000kW.

(iv) Operation Phase

It started construction in January of 2006, it would be completed in June of 2006.

(v) Correlation or Impact

This project and Changhua Coastal Offshore Wind Farm project are generated by wind power which causes positive impact on Taiwan electricity supply and stability. It relies on natural wind as its energy, no fuels are burned, making it the cleanest renewable energy.



google影像攝影時間：2017年。

Figure 6.1.2-1 Schematic Diagram of Greater Changhua, Changhua, Hailong and Haiding Development Site

V. Greater Changhua Northwest Offshore Wind Farm

(i) Organizer: Bureau of Energy, Ministry of Economic Affairs

(ii) Developer: Greater Changhua Northwest Wind Farm Preparatory Office

(iii) Content:

The main location of the project is located at the No. 12 offshore wind power site announced by the Energy Bureau. The wind farm covers an area of 117.4 square kilometers. According to the "Offshore Wind Power Planning Sites Application Guidelines", the there shall not be less than 5,000 kW/square kilometer. The total installation capacity should be above 598 MW.

(iv) Operation Phase

Currently set in the plan.

(v) Mutual relationship or influence

Both this project and the Changhua Northwest offshore wind power generation project are based on wind power generation, which has a positive impact on Taiwan's power supply and stability. And because wind power is powered by natural wind, it does not burn any fuel and is the cleanest renewable energy.

VI. Greater Changhua Northeast Offshore Wind Farm

(i) Organizer: Energy Bureau of the Ministry of Economic Affairs

(ii) Developer: Greater Changhua Northeast Wind Farm Preparatory Office

(iii) Content:

The main location of the project is located at the No. 13 offshore wind power site announced by the Energy Bureau. The wind farm covers an area of 111.8 square kilometers. According to the "Offshore Wind Power Planning Sites Application Guidelines", the there shall not be less than 5,000 kW/square kilometer. The total installation capacity should be above 570 MW.

(iv) Operation Phase

Currently set in the plan

(v) Mutual relationship or influence

Both this project and the Changhua Northeast Offshore Wind Power Project are based on wind power generation, which has a positive impact on Taiwan's power supply and stability. And because wind power is powered by natural wind, it does not burn any fuel and is the cleanest renewable energy.

VII. Greater Changhua Southwest Offshore Wind Farm

(i) Organizer: Energy Bureau of the Ministry of Economic Affairs

(ii) Developer: Greater Changhua Southwest Wind Farm Preparatory Office

(iii) Content:

The main location of the project is located on the No. 14 offshore wind power site announced by the Energy Bureau. The wind farm has a range of 126.3 square kilometers. According to the "Application points for offshore wind power planning sites", there shall not be less than 5,000 kW/square kilometers. The total installation capacity should be above 624.5 MW.

(iv) Operation Phase

Currently set in the plan.

(v) Mutual relationship or influence

Both this project and the Greater Changhua Southwest Offshore Wind Power Project are based on wind power generation, which has a positive impact on Taiwan's power supply and stability. And because wind power is powered by natural wind, it does not burn any fuel and is the cleanest renewable energy.

VIII. Hailong No.2 Offshore Wind Farm

(i) Organizer: Energy Bureau of the Ministry of Economic Affairs

(ii) Developer： Hailong No. 2 Wind Power Co., Ltd. Preparation Office

(iii) Content:

The project site is located in Fuxing Township and Fangyuan Township, Changhua County. It belongs to the No. 19 potential site announced by the Energy Bureau. The site area is about 59.2 square kilometers, the offshore distance is about 40-55 kilometers, and the water depth is about 20 kilometers. ~55 meters, the potential site area has initially excluded the restricted areas such as fishing ports, wetlands, protected areas, fishery resources conservation areas, important wild bird habitats, important habitats of white dolphins.

The installation of the fan of this project shall not be less than 5,000 kW per square kilometer in the “Application Points for Offshore Wind Power Planning Sites”. The capacity of the single unit is between 6 and 9 MW. If the unit is arranged at 6 MW, the number of layouts is approximately For the 63 units, as the capacity of the single unit increases, the number of units is reduced, but the total unit capacity is increased. Therefore, the maximum number of fan units in this project is 63, and the maximum unit capacity is 532 MW (using 9.5 MW units). Future technology upgrades may also use units with larger stand-alone capacity.

This project adopts a 33kV submarine cable series fan (the 66kV submarine cable may be used depending on the actual situation in the future). After the sea substation is boosted to 245kV, it is expected to be on the seashore of the Zhangbin Industrial Zone in Xixiang or Lugang Town of Changhua County. . After landing on the seawall of Zhangbin Industrial Zone in Xixiang or Lugang Town of Changhua County, it will be connected to the adjacent land-based buck station and depressurized to 161kV, and then connected to the Zhangbin UHV Substation.

(iv) Mutual relationship or influence

Both the project and Hailong No. 2 offshore wind power generation project are based on wind power generation, which has a positive impact on Taiwan's power supply and stability. And because wind power is powered by natural wind, it does not burn any fuel and is the cleanest renewable energy.

IX. Hailong No.3 Offshore Wind Farm

(i) Organizer: Energy Bureau of the Ministry of Economic Affairs

(ii) Developer：Hailong No. 3 Wind Power Co., Ltd. Preparation Office

(iii) Content：

The project site is located in Fuxing Township and Fangyuan Township of Changhua County. It belongs to the No. 18 potential site announced by the Energy Bureau. The site area is about 85.2 square kilometers, the offshore distance is about 50~70 kilometers, and the water depth is about 25~50 meters, the potential site area has initially excluded the restricted areas such as fishing ports, wetlands, protected areas, fishery resources conservation areas, important wild bird habitats, important habitats of white dolphins.

The installation of the fan of this project shall not be less than 5,000 kW square kilometer in the “Application Points for Offshore Wind Power Planning Sites”, and the capacity of the single unit shall be between 6 and 9.5 MW. If the unit is arranged at 6 MW, the number of layouts shall be There are about 78 parts. As the capacity of the stand-alone unit increases, the number of units is reduced, but the total unit capacity is increased. Therefore, the maximum number of fan units in this project is 78 (detailed in Figure 5.2.2-2), and the maximum unit capacity. For 513 MW (using 9.5 MW units), it is also possible to use units with larger single capacity if future technology upgrades.

This project adopts a 33kV submarine cable series fan (the 66kV submarine cable may be used depending on the actual situation in the future). After the sea substation is boosted to 245kV, it is expected to be on the seashore of the Zhangbin Industrial Zone in Xixiang or Lugang Town of Changhua County. . After landing on the seawall of Zhangbin Industrial Zone in Xixiang or Lugang Town of Changhua County, it will be connected to the adjacent land-based buck station and depressurized to 161kV, and then connected to the Zhangbin UHV Substation.

(iv) Mutual relationship or influence

Both the project and Hailong No. 3 offshore wind power generation project are based on wind power generation, which has a positive impact on Taiwan's power supply and stability. And because wind power is powered by natural wind, it does not burn any fuel and is the cleanest renewable energy.

X. Formosa III (Haiding) No.1 Offshore Wind Farm

(i) Organizer: Energy Bureau of the Ministry of Economic Affairs

(ii) Developer：Haidingyi Wind Power Co., Ltd. Preparation Office

(iii) Content：

The project site is located in Shengang Township, Line Xixiang, Lugang Town, Changhua County, and Lusha Township, Penghu County. It belongs to the No. 11 potential site announced by the Energy Bureau. The site area is about 95 square kilometers. The site is located in Changhua. The county coast is about 62.1 kilometers recently. It is about 43.3 kilometers away from the coast of Penghu County. The water depth ranges from 21.9 to 50.7 meters. The potential site area has initially excluded fishing ports, wetlands, protected areas, fishery resources conservation areas, and important wild birds. Land, white dolphin important habitat area... and other restricted areas.

The layout of the fan of this project shall not be less than 5,000 square meters per square kilometer in the "Application Points for Offshore Wind Power Planning Sites". The capacity of the single unit is between 8 and 12 MW. If the unit is arranged at 8 MW, the number of layouts is approximately For 68 units, as the capacity of the single unit increases, the number of units is reduced, but the total unit capacity is increased. Therefore, the maximum number of fan units in this project is 68, and the maximum unit capacity is 552 MW (using 12 MW units), such as the future. Technical upgrades may also use units with larger stand-alone capacity.

This project adopts a 66kV submarine cable series fan, which is expected to be launched from the Zhangbin Industrial Zone of Xixiang, Changxiang County after the sea power substation is boosted to 161~245kV. After landing on the seawall of Zhangbin Industrial Zone in Xixiang, Changhua County, it will be connected to the adjacent onshore step-down station and connected to the Zhangbin UHV Substation along the existing road.

(iv) Mutual relationship or influence

Both the project and Haiding Offshore Wind Power Project No. 1 wind farms are based on wind power generation, which has a positive impact on Taiwan's power supply and stability. And because wind power is powered by natural wind, it does not burn any fuel and is the cleanest renewable energy.

XI. Formosa III (Haiding) No.2 Offshore Wind Farm

(i) Organizer: Energy Bureau of the Ministry of Economic Affairs

(ii) Developer：Haiding II Wind Power Co., Ltd. Preparation Office

(iii) Content:

The project site is located in the west of Changhua County, Xixiang, Lugang Town, Fuxing Township and Baisha Township of Wuhu County. It belongs to the No. 16 potential site announced by the Energy Bureau. The site area is about 111.7 square kilometers. The site is located at Changhua. The county coast is about 50.3

kilometers long, and the nearest distance to the coast of Wuhu County is about 41.6 kilometers. The water depth ranges from 19.1 to 48.8 meters. The potential site area has initially excluded fishing ports, wetlands, protected areas, fishery resources conservation areas, and important wild birds. Land, white dolphin important habitat area... and other restricted areas.

The layout of the fan of this project shall not be less than 5,000 kW per square kilometer in the “Application Points for Offshore Wind Power Planning Sites”. The capacity of the single unit is between 8 and 12 MW. If the unit is arranged at 8 MW, the number of layouts is approximately For the 82 units, as the capacity of the single unit increases, the number of units is reduced, but the total unit capacity is increased. Therefore, the maximum number of fan units in this project is 82, and the maximum unit capacity is 732 MW (using 12 MW units), such as the future. Technical upgrades may also use units with larger stand-alone capacity.

This project adopts a 66kV submarine cable series fan, which is expected to be launched from the Zhangbin Industrial Zone of Xixiang, Changxiang County after the sea power substation is boosted to 161~245kV. After landing on the seawall of Zhangbin Industrial Zone in Xixiang, Changhua County, it will be connected to the adjacent onshore step-down station and connected to the Zhangbin UHV Substation along the existing road.

(iv) Mutual relationship or influence

Both the project and Haiding Offshore Wind Power Project No. 2 wind farms are based on wind power generation, which has a positive impact on Taiwan's power supply and stability. And because wind power is powered by natural wind, it does not burn any fuel and is the cleanest renewable energy.

XII. Formosa III (Haiding) No.3 Offshore Wind Farm

(i) Organizer: Energy Bureau of the Ministry of Economic Affairs

(ii) Developer：Haiding III Wind Power Co., Ltd. Preparation Office

(iii) Content:

The project site is located in the outer seas of Xixiang, Lugang Town and Fuxing Township of Changhua County. It belongs to the No. 17 potential site announced by the Energy Bureau. The site area is about 103.4 square kilometers. The site is about 36.8 from the coast of Changhua County. Kilometers, the water depth range is about 34.0~44.9 meters, and the potential site area has initially excluded the restricted areas such as fishing ports, wetlands, protected areas, fishery resources conservation areas, important wild bird habitats, important habitats of white dolphins, etc.

The layout of the fan of this project shall not be less than 5,000 kW per square kilometer in the “Application Points for Offshore Wind Power Planning Sites”. The capacity of the single unit is between 8 and 12 MW. If the unit is arranged at 8 MW, the number of layouts is approximately For the 78 units, as the capacity of the single unit increases, the number of units is reduced, but the total unit capacity is increased. Therefore, the maximum number of fan units in this project is 78, and the maximum unit capacity is 720 MW (using 12 MW units), such as the future. Technical upgrades may also use units with larger stand-alone capacity.

This project adopts a 66kV submarine cable series fan, which is expected to be launched from the Zhangbin Industrial Zone of Xixiang, Changxiang County after the sea power substation is boosted to 161~245kV. After landing on the seawall of Zhangbin Industrial Zone in Xixiang, Changhua County, it will be connected to the adjacent onshore step-down station and connected to the Zhangbin UHV Substation along the existing road.

(iv) Mutual relationship or influence

Both the project and the Haiding Offshore Wind Power Project No. 3 wind farms are powered by wind power, which has a positive impact on Taiwan's power supply and stability. And because wind power is powered by natural wind, it does not burn any fuel and is the cleanest renewable energy.

XIII. OWF Project Phase I

(i) Organizer: Energy Bureau of the Ministry of Economic Affairs

(ii) Developer: Taiwan Electric Power Corporation

(iii) Content:

The project is to set up 30 offshore wind turbines about 2 kilometers from the shore of the west side of Fangyuan Township in Changhua County.

(iv) Operation Time:

3 years after obtaining the license.

(v) Mutual relationship or influence

Both the project and this project are based on wind power, which has a positive impact on Taiwan's power supply and stability. And because wind power is powered by natural wind, it does not burn any fuel and is the cleanest renewable energy.

XIV. OWF Project Phase II

(i) Organizer: Energy Bureau of the Ministry of Economic Affairs

(ii) Developer: Taiwan Electric Power Corporation

(iii) Content:

The project wind farm is located in the outer seas of Xixiang, Lugang Town, Fuxing Township and Fangyuan Township of Changhua County. The nearest distance to the coast is about 9.7 kilometers, and the water depth of the wind turbine is about 37~49 meters. It is planned to set up 5MW ~10 MW single-unit wind turbines with a maximum total capacity of 720 MW and a maximum of 108 wind turbines.

(iv) Mutual relationship or influence：

Both the project and this project are based on wind power, which has a positive impact on Taiwan's power supply and stability. And because wind power is powered by natural wind, it does not burn any fuel and is the cleanest renewable energy.

XV. CSC Offshore Wind Farm

(i) Organizer: Energy Bureau of the Ministry of Economic Affairs

(ii) Developer： Zhongneng Power Generation Co., Ltd. Preparation Office

(iii) Content:

The project is located in the outer sea of Dacheng Town and Fangyuan Township in Changhua County. The offshore distance is about 7~22 kilometers. It is estimated that 84 sets of 6.0MW wind turbines, or 72 units of 7.0MW or 8.0MW wind turbines, or 63 8.0MW or 9.5MW wind turbine solution. After connecting the wind turbines to the wind turbines, the land is connected to the land cable, and finally merged into the Taipower Substation of Taipower or other substation designated by the Taipower Company, or according to the letter of the Ministry of Economic Affairs on August 2, 2006, by the letter No. 10602611030 The “Changhua Offshore Wind Power Submarine Along the Common Corridor Range” was transferred to the Yongxing Port and other designated stations of the Yongxing Expressway after the landing on the south side of Changhua.

(iv) Project prograss：

The environmental impact assessment operation is being carried out and is scheduled to be completed in 2024.

(v) Mutual relationship or influence：

The same clean energy can increase the proportion of renewable energy supply in Taiwan and reduce greenhouse gas emissions.

XVI. Xidao Offshore Wind Farm Project

(i) Organizer: Energy Bureau of the Ministry of Economic Affairs

(ii) Developer： West Island Wind Power Co., Ltd. Preparation Office

(iii) Content:

The project is located in the outer sea of Fangyuan Township, Changhua County. The offshore distance is about 9~17 kilometers. It is estimated that 53 sets of 6.0MW wind turbines or 23 12MW wind turbines will be adopted. Connected to a marine substation. The 161 kV output cable connecting the offshore substation and the shore will be 13 kilometers long and will be landed in Xinyi Village, Fangyuan Township.

(iv) Project Prograss：

Engaged in environmental impact assessment.

(v) Mutual relationship or influence：

The same clean energy can increase the proportion of renewable energy supply in Taiwan and reduce greenhouse gas emissions.

XVII. Zhangfang Offshore Wind Farm Project

(i) Organizer: Energy Bureau of the Ministry of Economic Affairs

(ii) Developer： Zhangfang Wind Power Co., Ltd. Preparation Office

(iii) Content：The project is located in the west side of Fangyuan Township, Changhua County. The distance from the shore is about 14~25 kilometers. The water depth of the wind turbine is about 22~42 meters. The planned layout plan is 32~72 units of 6.0~12.0 MW wind turbines. After connecting the wind turbines in series, the landline is connected to the landline and finally merged into the Yongxing Open and Closed Station of Taipower Company or the Dacheng Substation.

(iv) Project progress: The environmental impact assessment operation is being carried out in an engraved manner. It is expected to be completed in 2~3 years from the scheduled construction to the start of the commercial transfer operation.

(v) Mutual relationship or influence： The same clean energy can increase the proportion of renewable energy supply in Taiwan and reduce greenhouse gas emissions. Located on the southeast side of the project wind farm, the plan has been set away from the site during planning.

XVIII. Haixia Offshore Wind Farm Project (#27 Wind Farm)

(i) Organizer: Energy Bureau of the Ministry of Economic Affairs

(ii) Developer：Strait Wind Power Co., Ltd. Preparation Office

(iii) Content：The project is located in Fuxing Township of Changhua County and the outer sea of Fangyuan Township. The nearest offshore site is about 14 kilometers or more. The planned layout plan does not exceed 75 wind turbine models of 8~12MW, and the stand-alone capacity is larger depending on the technical improvement considerations. The crew. After connecting the wind turbines to the wind turbines, the land is connected to the land cable, and finally merged into the West Substation of the Taipower Company (self-directing scheme) or the Taiping Plan of the Taipower Plan (the south/north side common corridor plan, tentatively designated as Yongxing Station Or Zhang Yi Kaishou / Zhanggong booster station, the actual lead point will be determined according to the project execution schedule, Taipower company planning results and parallel review results).

(iv) Project progress: The environmental impact assessment operation is being carried out in an engraved manner. It is expected that the construction, completion acceptance and handover will be completed in about 3 to 4 years.

(v) Mutual relationship or influence：The same clean energy can increase the proportion of renewable energy supply in Taiwan and reduce greenhouse gas emissions. Located on the southeast side of the project wind farm, the plan has been set away from the site during planning.

XIX. Fufang Offshore Wind Farm Project

(i) Organizer: Energy Bureau of the Ministry of Economic Affairs

(ii) Developer: Fufang Wind Power Co., Ltd. Preparation Office

(iii) Content: The project is located in the west side of Fangyuan Township, Changhua County. The distance from the shore is about 16.5~28 kilometers. The water depth of the wind turbine is about 22~40 meters. The planned layout plan is 34~69 units of 6.0~12.0 MW wind turbines. After connecting the wind turbines in series, the landline is connected to the landline and finally merged into the Yongxing Open and Closed Station of Taipower Company or the Dacheng Substation.

(iv) Project progress: The environmental impact assessment operation is being carried out in an engraved manner. It is expected to be completed in 2~3 years from the scheduled construction to the start of the commercial transfer operation.

(v) Mutual relationship or influence: The same clean energy can increase the proportion of renewable energy supply in Taiwan and reduce greenhouse gas emissions. It is located on the southeast side of the project wind farm. The plan has been set away from the site during planning

XX. Haxia Offshore Wind Farm Project (#28 Wind Farm)

(i) Organizer: Energy Bureau of the Ministry of Economic Affairs

(ii) Developer: Strait Wind Power Co., Ltd. Preparation Office

(iii) Content: The project is located in Fangyuan Township of Changhua County and the outer sea of Dacheng Township. The nearest offshore site is about 14 kilometers or more. The planned layout plan does not exceed 75 wind turbine models of 8~12MW, and the stand-alone capacity is larger depending on the future technical improvement considerations. unit. After connecting the wind turbines to the wind turbines, the landline is connected to the land cable, and finally merged into the Taicheng Substation of Taipower Company (self-directing scheme) or the lead-in point of the Taipower planning (the south/north side common corridor plan, tentatively designated as Yongxing Kaishang or Changyi Open and Closed/Changgong booster station, the actual lead-through point will depend on the execution schedule of the project, the planning results of Taipower Company and the results of the parallel review).

(iv) Project progress: The environmental impact assessment operation is being carried out in an engraved manner. It is expected that the construction, completion acceptance and handover will be completed in about 3 to 4 years.

(v) Mutual relationship or influence： The same clean energy can increase the proportion of renewable energy supply in Taiwan and reduce greenhouse gas emissions. Located on the southeast side of the project wind farm, the plan has been set away from the site during planning.

XXI. Construction Plan of Offshore Plant at Fusing Township and Fangyuan Township

(i) Organizer: Energy Bureau of the Ministry of Economic Affairs

(ii) Developer： Taiwan Electric Power Corporation

(iii) Content：

There are 18 wind turbines installed in Wanggong and Yongxing Haipu in Yufangyuan Township. The capacity of each unit is 2,000-3,000 kW. The 8 wind turbines installed in Yongxing District are currently not constructed.

The 10 wind turbines set up in Wanggong District have been in operation since the Republic of China in 1999. The 10 wind turbines are connected in series at the site location, and each is connected to the electric room by 22.8kV two-circuit underground cable. The voltage is boosted to 161kV, and then connected to the 161kV confluence of Hanbao D/S with 161kV underground cable. row.

(iv) Operational time

The 10 wind turbines set up in Wanggong District have been in operation since the year 99.

(v) Mutual relationship or influence

The project and Wanggong and Yongxing wind power generation projects are all based on wind power generation, and the power generated can be supplied to the Changhua area. And because wind power is powered by natural wind, it does not burn any fuel and is the cleanest renewable energy.

XXII. Construction of the wind power plant in Fuxing Township and Fangyuan Township of Changhua County

(i) Organizer: Energy Bureau of the Ministry of Economic Affairs

(ii) Developer： Hanwei Wind Power Co., Ltd. Preparation Office

(iii) Content：

Located in the coastal breeding ponds of Fuxing Township and Fangyuan Township in Changhua County, the development activities include 32 wind turbines, underground transmission lines, switchyards and extra-territorial roads.

(iv) Mutual relationship or influence

The plan failed to apply to the Ministry of Economic Affairs for the preparation of the registration of the electrical industry, and it will be discontinued for development. The environmental impact assessment review conclusion was abolished on January 28, 105.

XXIII. Chinese White Dolphi Chinese White Dolphin Types and scope of important habitats for wild animals (pre-determined)

(i) Organizer：Council of Agriculture

(ii) Content

1. Types：

A complex ecosystem of marine ecosystems and estuarine ecosystems.

2. Scope：

The north is the forest park beach north of Longfeng Port in Miaoli County; the south boundary line is the southwestern end of the outer umbrella top; the west boundary line is straight obliquely lined on the shoreline 1-3 nautical mile according to the different range of activities of Chinese White Dolphin; The eastern boundary line is 50 meters from the shoreline and includes the main estuary. This important habitat includes 98% Chinese White Dolphin sighting points, covering a total of four municipalities and counties (cities) such as Miaoli, Taichung, Changhua, and Yunlin. The detailed range is shown in Figure 6.1.2-2.

3. Area：

76,300 hectare.

(iii) Relevance to the plan

At the beginning of the planning, the project wind field has been considered to avoid the impact on the habitat of the conservation Chinese White Dolphin. Therefore, all units in the planned wind field have avoided the planning scope of their planned important habitat. After the investigation and impact assessment of Chinese White Dolphin, appropriate precautions were taken to minimize the interference of construction behavior on Chinese White Dolphin, and its impact should be limited.

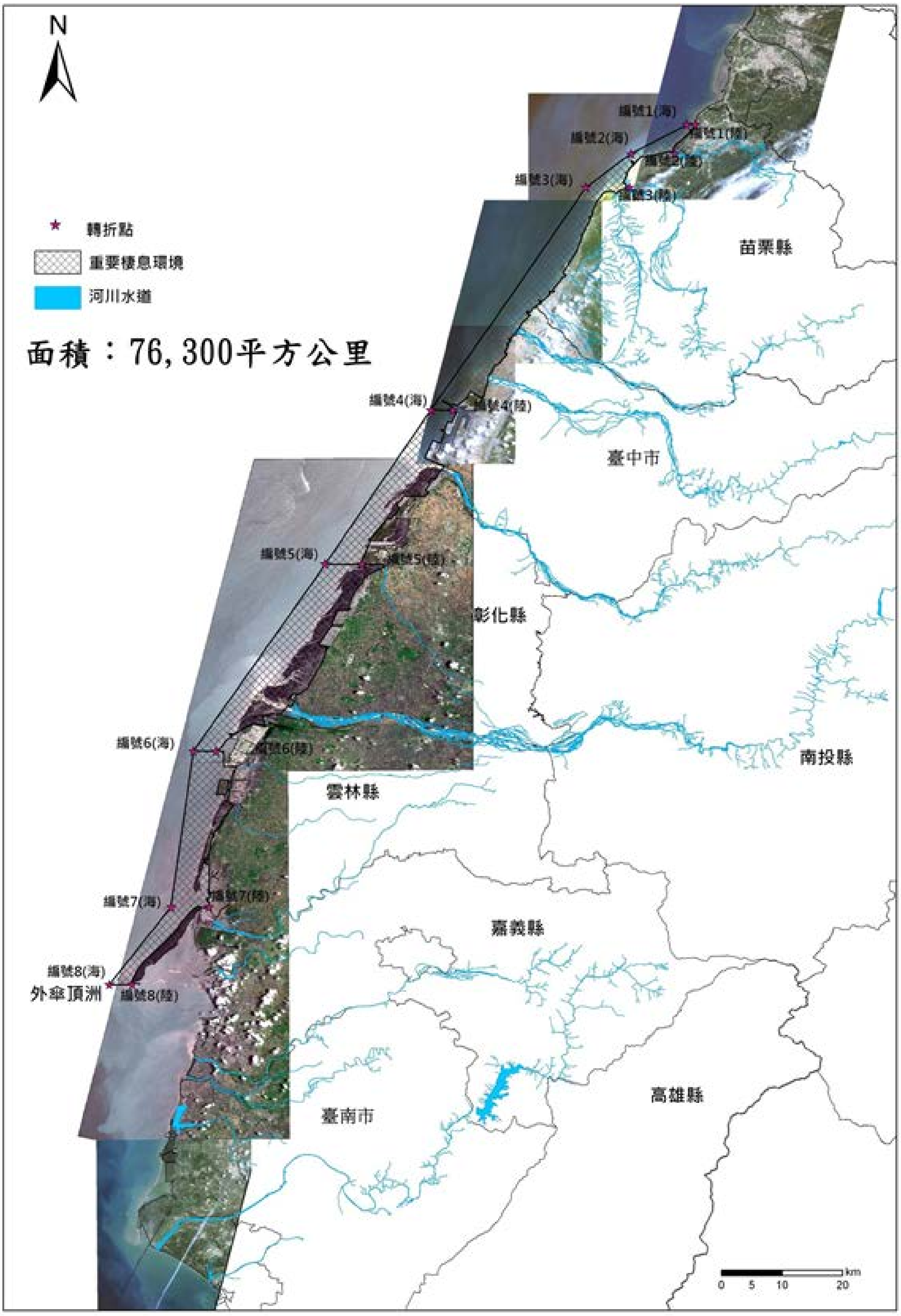


Figure 6.1.2-2Chinese White Dolphin wild animal important habitat environment map

XXIV. Existing Application of Offshore Wind Farm Project at Changhua Offshore

(i) Content

Bathymetry of Changhua County is slight subdeud and wind is stable. 16 offshore wind farm dealers and 19 offshore wind farm projects are planned in this waters, related location is shown as Figure 6.1.2-3 and summaries of projects are listed as Table 6.1.2-1.

(ii) Correlation with This Project

Area of this project is not overlapped with other wind farms to avoid to installation within wind farm site.

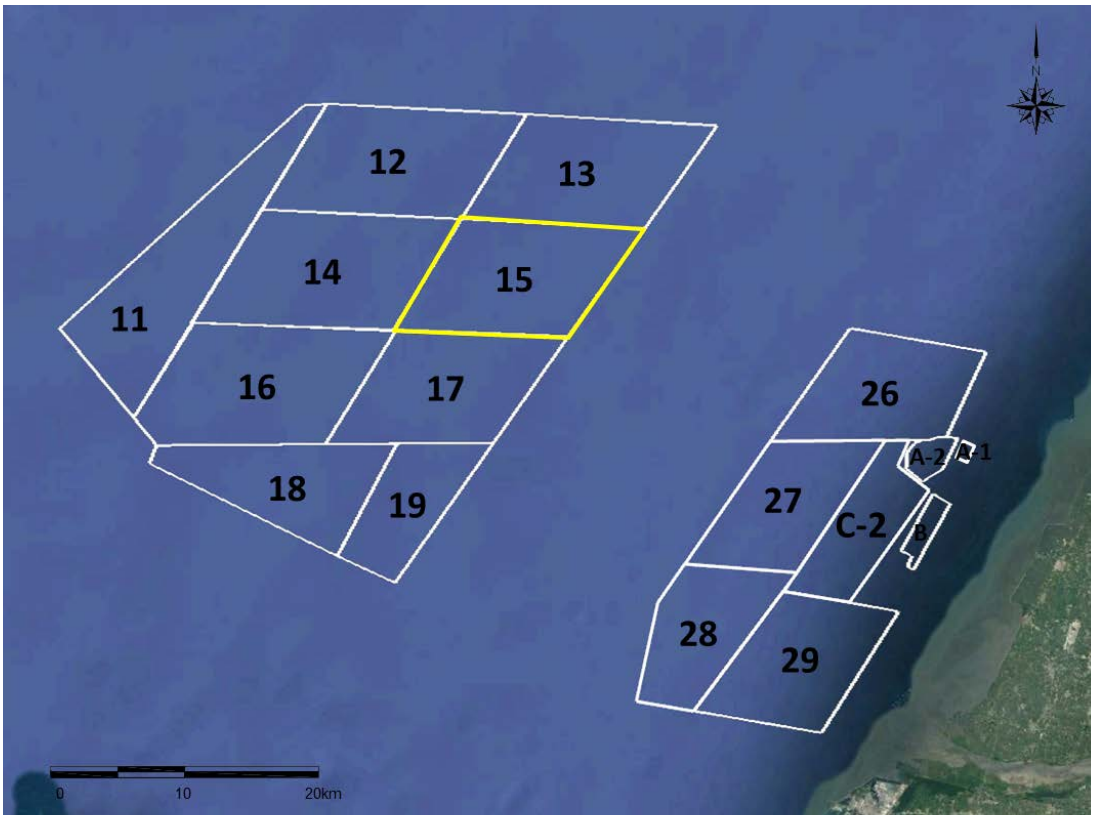


Figure 6.1.2-3 Schematic Diagram of Changhua County Offshore Wind Farm

Table 6.1.2-1 Table of Offshore Wind Farm Project at Changhua County

Regulatory		Code	Name of Project	Development Unit	Maximum Total Installed Capacity (MW)	Wind Farm Area
Ordinance on Investment Subsidy for Offshore Wind Power		A-1	Fuhai Offshore Wind Farm Project (Phase 1 Construction Plan)	Fuhai Wind Farm Corp.	8	—
		A-2	Fuhai Changhua Offshore Wind Farm Project	Fuhai Wind Farm Corp.	120	8.0
		B	Offshore Wind Farm Phase 1 Construction Plan	Taiwan Power Company	110	7.6
Guidelines of Application For Offshore Wind Farm Site	Site	Haiding No.1 Offshore Wind Farm	Formosa III (Haiding) No.1 Offshore Wind Farm Preparatory Office	552	95.0	95.0
		Greater Changhua Northwest Offshore Wind Farm Project	Greater Changhua Northwest Offshore Wind Farm Preparatory Office	598	117.4	117.4
		Greater Changhua Northeast Offshore Wind Farm Project	Greater Changhua Northeast Offshore Wind Farm Preparatory Office	570	108.2	108.2
		Greater Changhua Southwest Offshore Wind Farm Project	Greater Changhua Southwest Offshore Wind Farm Preparatory Office	642.5	126.3	126.3
		Greater Changhua Southeast Offshore Wind Farm Project	Greater Changhua Southeast Offshore Wind Farm Preparatory office	613	108.7	108.7
		Haiding No.2 Offshore Wind Farm Project	Formosa III (Haiding) No.2 Offshore Wind Farm Preparatory Office	732	111.7	111.7
		Haiding No.3 Offshore Wind Farm Project	Formosa III (Haiding) No.3 Offshore Wind Farm Preparatory Office	720	103.4	103.4
		Hailong No.3 Offshore Wind Farm Project	Hailong No.3 Wind Power Co., Ltd. Preparatory Office	512	85.2	85.2
		Hailong No.2 Offshore Wind Farm Project	Hailong No.2 Wind Power Co., Ltd. Preparatory Office	532	59.2	59.2
		Offshore Wind Farm Phase 2 Constrcution Plan	Taiwan Power Company	720	89.21	89.21
		Chnaghua Zhangfang Offshore Wind Farm Project	Zhangfang Offshore Wind Farm Preparatory Office	600	82.4	82.4
		Coastal No.27 Offshore Wind Farm Project	Coastal Offshore Wind Farm Preparatory Office	600	66.0	66.0
		Changhua Fufang Offshore Wind Farm Project				74.5
			Fufang Offshore Wind Farm Preparatory Office	600	74.5	52.0
		Coastal No.28 Offshore Wind Farm Project	Coastal Offshore Wind Farm Preparatory Office	600	52.0	39.0
	Not Within Site	CSC Offshore Wind Farm Project				50.7

6.2 Physicochemistry of Environment

Meteorology, noise vibration, hydrology and water quality, soil, physiography and geology, waste, ecology, recreational landscape, socio-economy, transportation and cultural relic and other environmental factors are summarized in the following sections.

To cope with the planing of common corridor, submarine cable route is added in July 2017 to conduct survey of marine water quality, water quality of intertidal zone, marine sediment, noise vibration, soil and transportation.

6.2.1 Meteorology

Surface meteorology of this project is in accordance with “Regulations of Air Quality Model”, the information is referred to Wuqi Weather Station, Central Weather Bureau. It has collected data from 2006 to 2016. The meteorogical data is shown as Table 6.2.1-1, the following meteorological factors are described as follows:

I. Temperature

The mean annual temperature is 23.1℃, the temperature is higher from May to October. July peaks at temperature 29.2℃, the temperature is at the lowest in January with 15.7℃. Seasonal change of temperature shows similar patterns with other districts of Taiwan. The highest mean month temperature peaks at 32.2℃ in July and has its lowest in January with 12.7℃.

II. Air Pressure

The annual mean air pressure is 1,009.7 millibar (MB). Air pressure shows higher value from November to April which peaks at 1,016.8 millibar (MB). Air pressure is lower from May to October and has its lowest at 1,002.8 millibar (MB) in August which indicates that it is affected by Siberian high. In summer, it displays subtropics climate which affected by Pacific high.

III. Wind Direction and Wind Speed

The annual prevailing wind is north wind. From June to August, the majority is south-south-east wind. The wind speed is slower. The frequency of calm wind is higher than other month; North wind constitutes the majority in other months. The annual mean wind speed is 4.5m/s. From October to the follwing February, wind speed is faster in fall and winter. The wind speed in January reaches the highest at 6.1m/s, and ay its lowest at 3.3m/s in August.

IV. Precipitation and Evaporation

The annual accumulative precipitation is 1,392.0mm and annual mean accumulative evaporation is 14466.2mm. Due to rainy season or typhoon, the rainfall season of the site is from April to September and peaks in August at 295.5mm. The preciopitaion is lowest in October with 32.4mm. It is dry as southern part of Taiwan in winter.

Data from 1985 to 2016 (32 years) is retrieved and shown as Table 6.2.1-2. The annual precipitation of Wuqi Weather Station reached the highest in the year of 2007 with 2,203.7mm. Day precipitation reached the highest on 13th July 2013 with 510mm.

Table 6.2.1-1 Statistical Data of Wuqi Weather Station

Month	Wind (m/sec)				Air Pressure (mb)	Wind Temperature (℃)			Relative Humidity (%)	Precipitation		Evaporation (mm)	Insolation Duration (hr)	Coverage of Cloud	Insolation (MJ/m²)
	Mean Wind Speed	Dominanat Wind Direction	Maximum			Mean	Mean			Total (mm)	Days of Precipitation ≧0.1mm				
			Mean	Dominant			Maximum	Minimum							
1	6.1	N	14.8	N	1016.8	15.7	18.8	12.7	79.7	39.6	6.8	79.5	139.3	6.0	281.5
2	5.4	N	14.5	N	1015.2	16.4	20.5	13.8	81.7	40.2	6.2	74.3	111.9	6.8	281.4
3	4.6	N	14.3	N	1013.6	18.6	22.5	15.6	78.7	73.9	9.4	102.2	141.9	6.4	377.5
4	3.9	N	13.7	N	1010.3	22.5	26.0	19.5	78.2	109.7	10.6	112.5	135.0	6.8	412.7
5	3.6	N	12.3	N	1006.9	25.7	29.1	22.7	79.2	208.8	11.8	133.2	167.0	6.4	490.5
6	3.7	SSE	11.7	N	1004.3	28.0	31.1	25.5	78.9	225.7	12.0	146.8	190.8	6.6	519.7
7	3.8	SSE	14.5	N	1003.6	29.2	32.2	26.4	75.8	177.1	19.0	179.3	253.0	5.5	612.3
8	3.3	SSE	16.4	NNW	1002.8	28.8	31.9	26.3	77.2	295.5	10.9	155.1	211.7	5.7	525.4
9	4.0	N	18.4	N	1005.1	27.7	31.1	26.2	76.4	103.8	7.4	144.3	210.5	4.7	486.5
10	5.4	N	16.2	N	1009.5	24.9	28.3	22.3	74.8	32.4	2.7	145.3	226.2	3.6	451.5
11	5.1	N	14.9	N	1013.0	21.9	25.1	19.2	77.3	52.4	6.0	101.1	163.3	5.2	312.0
12	5.7	N	14.9	N	1015.6	17.7	22.1	14.9	75.8	35.9	5.8	92.7	164.6	5.2	291.0
年	4.5	N	23.4	N	1009.7	23.1	26.5	20.3	77.9	1392.0*	98.6	1466.2*	1948.8*	5.7	5042.0*

Remarks: "*" indicates annual total amount.
Data Source: 1. Central Weather Bureau, Annual Report of Meteorology from 1985 to 2016.
2. CWB, Observation Data Inquire System, 2016 http://e-service.cwb.gov.tw/HistoryDataQuery/index.jsp

T6.2.1-2 Statistical Table of Annual Precipitation and Maximum Day Precipitaion at Wuqi Weather Station

Year	Precipitation (mm/Year)	Maximum Day Precipitation (mm)	Date	Year	Precipitation (mm/Year)	Maximum Day Precipitation (mm)	Date
1985	1658.0	281.0	23rd August	90	1949.1	455.0	30th July
1986	1421.3	197.0	22nd August	91	1080.0	105.5	23rd May
1987	1224.6	149.8	25th June	92	513.0	62.0	7th June
1988	1092.0	167.0	20th April	93	1325.0	185.5	25th August
1989	1043.8	163.0	12th September	94	1784.4	162.0	19th July
1990	1759.9	227.5	19th August	95	1372.6	123.5	14th July
1991	833.9	123.4	24th June	96	2203.7	249.5	8th June
1992	1276.6	89.5	30th August	97	1613.5	249.5	18th July
1993	995.3	145.4	2nd June	98	997.3	155.0	9th August
1994	1603.7	310.0	3rd May	99	1182.4	114.5	27th July
1995	895.4	112.5	9th June	100	605.0	65.0	9th November
1996	1357.2	234.1	1st August	101	1660.8	449.0	2nd August
1997	1596.3	245.5	17th May	102	1921.4	510.0	13th July
1998	1605.6	93.5	10th March	103	1154.2	158.0	23rd July
1999	973.0	95.0	8th July	104	1148.0	117.0	20th May
2000	1244.7	74.0	2nd August	105	1392.0	100.5	12th August

Data Source: 1. Central Weather Bureau, Annual Report of Meteorology from 1985 to 2016.

V. Coverage of Cloudage and Relative Humidity

Cloudage and relative humidity are slightly changed in months, annual relative humidity is 77.8%. Relative humidity of 82.2% is highest in February. On the other hand, relative humidity of 74.3% is the lowest in October, Like other monitoring stations on the plain, annual average cloudage is 5.7. Cloudage of 3.6 is the lowest in October; Cloudage of 6.8 is the highest in February and April.

VI. Duration of Insolidation and Global Radiation

Global radiation is approx. 1,948.8 hours in the area. Insolation duration is longer from July to October; Insolatiobn duration is shorter from December to February. Among which, July has the longest insolation durations, 253 hours. On the other hand, February has the shortest insolation duration, 111.9 hours. Annual global radiation is 5,042.0MJ/m2. It is higher from May to October and lower from November to April. Among which, July peaks the highest with 612.3MJ/m2. February has the lowest global radiation with 281.4MJ/m2.

VII. Typhoon

From 1958 to 2016, there were 164 typhoon warnings in Taiwan (including specific tracks). The tracks of typhoons can be generalized into 10 types (Figure 6.2.1-1). Among which, Track 3 has greater impact on Changhua County, where the site is. The probability of occurrence of Track 3 is 15%.

Figure 6.2.1-1   Track of Typhoon in Taiwan

6.2.2 Sea Conditions

I. Sea Conditions

(i) Tides

Statistical tidal data of neighboring waters is collected, related monitoring location is shown as Figure 6.2.2-1. Tidal station of water resources agency, MOEA (2012-2015) is listed as Table 6.2.2-1. Wanggong Tide Station set (98 year)at Guoguang Petrochemical Dacheng Industrial Zone, Lukang Station (September 95~June 97), Lugang Waterway Station (September 95 ~ December 96) and the Taichung Port Tide Station (84-104 years), the consolidation is shown in Table 6.2.2-2; Chengda Hydraulics Office carried out the survey data from the coastal area of Changhai to the north side of the Zhuoshuixikou from 2011 to 2013; the consolidation is shown in Table 6.2.2-3. The monitoring results show that the area is dominated by the half-day tidal, that is, there are two high and low tides in one day. The tidal level near the site is higher than the rest of the west coasts of the provinces, with an average tidal range of about 3.5 meters, which is one of the largest tidal ranges on the west coast of Taiwan. And monthly statistical results show that the average sea level in winter and spring is lower than that in summer and autumn. It is speculated that it is affected by the influence of typhoon and low pressure in summer and autumn and the offshore current caused by the northerly easterly wind in spring and winter.

According to study report of DHI on June of 2016, DTU 10 Tide Model is adopted to calculate H.A.T and L.A.T between P2 and P1, the locations are shown as Figure 6.2.2-2, calculated results are shown in Table 6.2.2-4. On-site measurement is in progressm, the detailed analysis results of tidal level will be added in design phase.

(ii) Waves

In order to understand the level of waves in neighboring maritime territory for the entire year and during monsoon season, the project collected wave observation data between September of 1999 - November of 2013 taken from Harbor and Marine Technology Center’s observation stakes (position shown in Figure 6.2.2-1) located 25m deep in the water and 150 meters outside of Taichung Harbor’s northern breakwater pier head. The data of neighboring maritime territory for each season, spring (March ~ May), summer (June ~ August), Fall (September ~ November) and Winter (December ~ February of following year), plus the wave height distribution for the entire year are summarized and shown in Figure 6.2.2-3 ~ 6.2.2-4. The joint probability distribution of wave height, direction and cycle period are shown in table 6.2.2-5 ~ 6.2.2-6. Based on the analysis results, in summer, wave height which lower than 1m accounts for 74.6%; Wave period lower than 8 seconds accounts for 92.4%. In winter, wave height lower than 2m is up to 42.5%; Wave period lower than 8 seconds accounts for 78.2%; Annual wave height which lower than 2m is up to 71.1%; Wave period lower than 8 seconds accounts for 87.5%.

Figure 6.2.2-1 Location of Monitoring Station Sea Conditions of this Project and Correlation Project

Figure 6.2.2-2 Location Between P2 and P1 Extimated by DTU10 Tidal Model

Table 6.2.2-1 Statistical Data of Miaoliao Tidal Station

Year	2012							2013						
Month	c	Mean High Water Level	Mean Low Water Level	Mean High Water Level of Spring Tide	Mean Low Water Level of Spring Tide	Mean High Water Level of Neap Tide	Mean Low Water Level of Neap Tide	Mean Tide Level	Mean High Water Level	Mean Low Water Level	Mean High Water Level of Spring Tide	ean Low Water Level of Spring Tide	Mean High Water Level of Neap Tide	Mean Low Water Level of Neap Tide
Jan.	12.8	160.4	-120.4	184.7	-175.6	157.8	-115.5	18.9	167.5	-117.3	201.1	-172.2	156.8	-106.9
Feb.	20.2	168.9	-114.4	199.1	-152.0	162.2	-109.6	27.8	172.4	-129.0	-	-	175.8	-138.5
Mar.	36.1	181.2	-101.2	214.4	-140.2	169.3	-97.0	27.3	174.0	-108.4	201.5	-141.1	139.5	-78.0
Apr.	38.0	176.8	-95.5	202.6	-133.8	163.1	-101.7	36.9	178.3	-96.8	202.1	-136.1	163.8	-97.8
May	43.4	183.1	-89.8	205.0	-142.7	168.8	-89.0	41.0	180.4	-90.9	198.1	-143.6	172.1	-87.2
Jun.	46.7	191.2	-91.5	215.3	-145.7	181.1	-92.5	39.3	179.2	-92.3	201.5	-148.9	170.0	-85.3
Jul.	45.1	191.1	-90.2	210.5	-148.3	185.9	-87.8	44.5	183.5	-87.9	207.9	-143.8	179.1	-91.9
Aug.	50.0	200.1	-90.2	231.2	-131.3	191.1	-94.1	51.5	192.9	-83.5	221.8	-125.6	189.6	-87.5
Sep.	45.8	194.0	-87.9	223.2	-126.6	177.4	-91.2	49.3	195.4	-85.4	228.6	-113.7	182.6	-98.1
Oct.	44.3	192.1	-89.1	225.5	-126.0	173.9	-93.2	48.1	200.9	-91.1	230.7	-127.0	186.9	-96.7
Nov.	31.6	174.7	-98.8	202.6	-154.5	162.7	-100.0	38.3	186.2	-98.0	211.5	-142.4	175.1	-102.8
Dec.	26.1	170.1	-107.6	197.3	-161.8	161.3	-103.3	29.3	176.2	-105.4	194.6	-155.2	169.9	-106.4
Mean	36.7	182.0	-98.1	209.3	-144.9	171.2	-97.9	37.7	182.2	-98.8	209.0	-140.9	171.8	-98.1
Year	2014							2015						
Month	Mean Tide Level	Mean High Water Level	Mean Low Water Level	Mean High Water Level of Spring Tide	Mean Low Water Level of Spring Tide	Mean High Water Level of Neap Tide	Mean Low Water Level of Neap Tide	Mean Tide Level	Mean High Water Level	Mean Low Water Level	Mean High Water Level of Spring Tide	ean Low Water Level of Spring Tide	Mean High Water Level of Neap Tide	Mean Low Water Level of Neap Tide
Jan.	31.6	180.7	-104.8	200.4	-155.5	173.4	-97.9	6.6	156.8	-122.2	184.4	-178.5	153.1	-116.5
Feb.	38.3	185.5	-96.6	214.0	-139.7	175.8	-88.5	9.4	159.6	-123.3	188.7	-168.3	144.9	-105.6
Mar.	39.4	186.8	-90.5	209.0	-131.2	171.0	-78.9	16.4	161.9	-117.2	193.1	-150.4	146.9	-119.5
Apr.	52.8	189.6	-62.8	214.2	-70.4	171.0	-63.5	20.7	164.2	-112.3	191.4	-146.9	145.8	-111.9
May	55.0	185.4	-66.4	205.7	-73.9	179.3	-62.9	27.0	164.9	-102.6	185.2	-150.9	154.7	-101.9
Jun.	38.2	175.8	-96.2	198.4	-154.2	169.1	-93.9	29.8	168.0	-99.2	184.7	-154.3	164.8	-102.7
Jul.	39.1	181.3	-94.3	198.9	-157.0	179.1	-90.8	39.9	186.7	-97.6	205.4	-148.4	188.0	-96.5
Aug.	37.4	182.2	-98.5	209.7	-143.4	174.2	-96.9	44.6	196.1	-94.1	205.1	-142.8	200.2	-83.3
Sep.	38.9	185.0	-97.6	209.0	-138.2	171.7	-94.7	39.4	187.3	-96.8	212.0	-122.6	171.4	-103.0
Oct.	34.9	190.8	-103.8	221.6	-138.8	168.5	-103.9	33.0	184.2	-103.9	200.7	-135.1	173.9	-105.4
Nov.	26.5	177.1	-109.5	203.6	-158.8	160.7	-109.8	22.0	170.1	-113.6	193.8	-158.6	154.9	-118.7
Dec.	15.6	164.3	-121.2	190.3	-174.0	153.1	-117.8	16.5	165.1	-117.3	188.9	-172.1	157.8	-113.6
Mean	37.3	182.0	-95.2	206.2	-136.3	170.6	-91.6	25.4	172.1	-108.3	194.5	-152.4	163.0	-106.6

Data Source: Taiwan Hydrological Year Book of Water Resources Agency, Ministry of Economic Affairs- 4th Section of Nearshore Hydrology
Unit: cm

Table 6.2.2-2 tatistical Table of Neighboring Marine Tidal Level

Name of Sampling Station and Data Collection Period / Tidal Level	Fangyuan		Wong Gong	Lukang	Taichung
	99	100	98	95.9~97.6	84~104
Highest High Water Level (H.H.W.L)	2.873 (99.9.9)	2.505 (100.7.1)	2.212	3.140 (95.9.10)	3.21
High Water of Ordinary Spring Tide (H.W.O.S.T)	2.255	1.938	1.912	2.630	—
Mean High Water Level (M.H.W.L)	1.948	1.670	1.636	2.146	2.08
High Water of Ordinary Neap Tide (H.W.O.N.T)	—	—	—	1.557	—
Mean Water Level (M.W.L)	—	—	-0.026	0.357	0.11
Low Water on Neap Tide (L.W.O.N.T)	—	—	—	-0.593	—
Mean Low Water Level (M.L.W.L)	—	—	-1.580	-1.336	-2.01
Low Water on Spring Tide (L.W.O.S.T)	—	—	-1.720	-1.849	—
Lowest Low Water Level (L.L.W.L)	—	—	-2.089	-2.280 (97.6.4)	-3.19
Mean Range	—	—	3.216	3.482	—

Remarks: Fangyuan is located at intertidal zone, low water is unable to obtain. Unit: m

Table 6.2.2-3Observational Data of Tidal Level at Tainan Hydraulics Laboratory, National Cheng Kung University, From 2011 to 2013

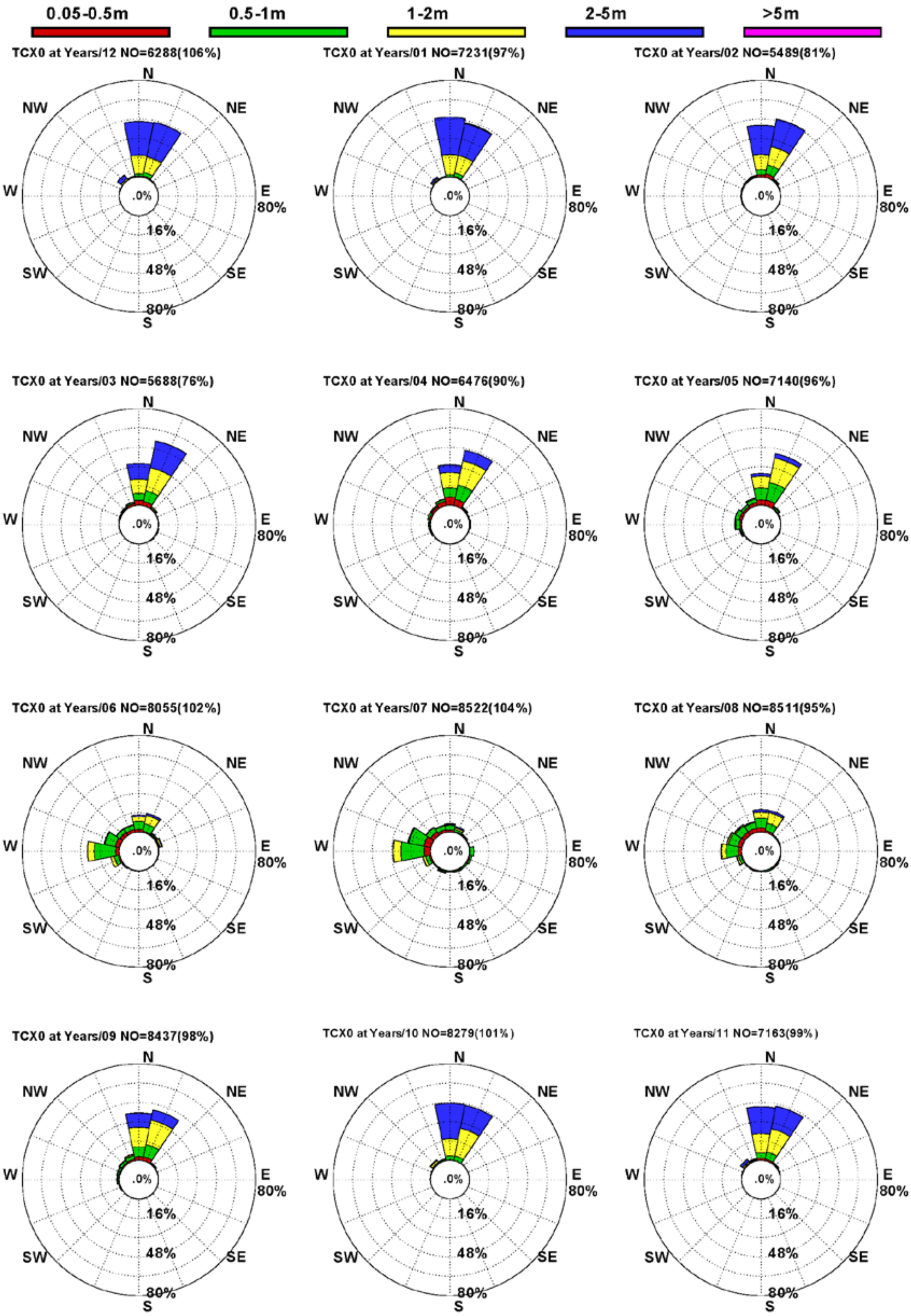
Name of Sampling Station and Data Collection Period / Tidal Level	FCW1	FCW2	CPW1	CPW2
	2012	2013	2011~2013	2011
Highest Tidal Level	2.28~2.55	2.27~2.98	2.37~2.82	2.01
Lowest Tidal Leve	-2.45~-2.73	-2.52~-3.54	-2.51~-3.03	-2.90
Maximum Tidal Range	5.18	6.52	5.59	4.91

Unit: m

Table 6.2.2-4 H.A.T and L.A.T Calculated by DTU10 Tide Model

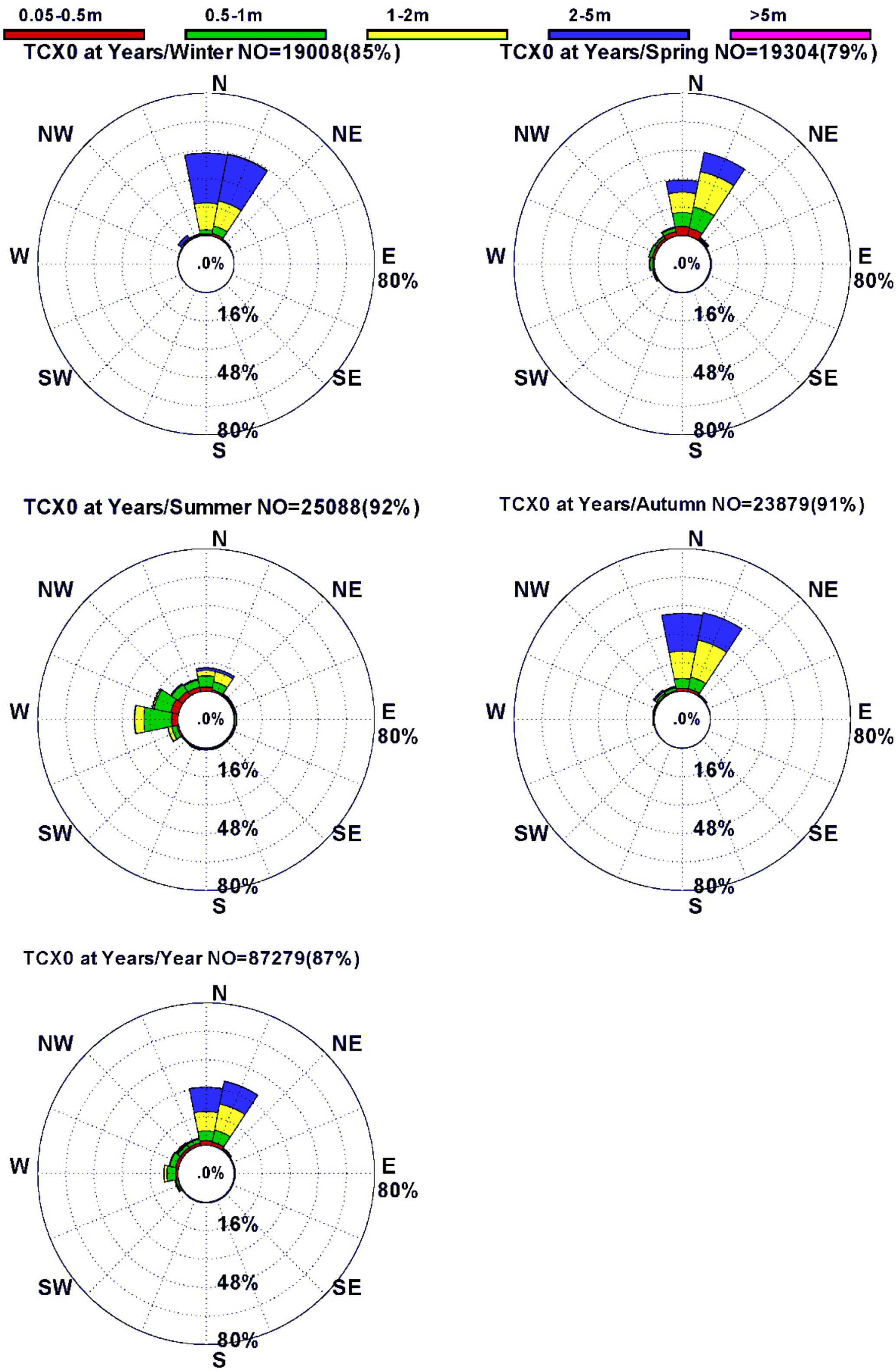
Datum Level	P2	P1
	DTU10(mMSL)	DTU10(mMSL)
H.A.T.	+2.77	+2.91
L.A.T.	-3.10	-3.25
H.A.T. – L.A.T.	5.87	6.16

Data Source: Metocean Data for Planning of Geophysical Survey and Design of Offshore Wind Farms, Taiwan
Remarks: Accuracy of DTU10 Tide Model is 0.125° (Cheng, Y., and O. B. Andersen (2011). Multimission empirical ocean tide modeling for shallow waters and polar seas.)



Data Source: Year book of port meteorological observational data of 2013 (Taichung Port), Harbor and Marine Technology Center

Figure 6.2.2-3 Monthly Wave Rose of Neighboring Waters Within Site



Data Source: Year book of port meteorological observational data of 2013 (Taichung Port), Harbor and Marine Technology Center

Figure 6.2.2-4 Monthly Wave Rose of Neighboring Waters Within Site

Table 6.2.2-5 Distribution of Annual Wave Height Period and Probability at Neighboring Waters

$T_{1/3}$ (Sec) / $H_{1/3}$	2 ~3	3 ~4	4 ~5	5 ~6	6 ~7	7 ~8	8 ~9	9 ~10	10 ~12	12 ~14	14 ~16	16 ~18	18 ~20	20 ~40	40 ~60	60 ~200	合計 (%)
.0m~.5m	.4	1.1	1.2	3.8	4.0	1.7	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	12.5
.5m~1.0m	.7	4.2	4.9	7.1	6.2	3.2	.9	.3	.2	.1	.0	.0	.0	.0	.0	.0	27.9
1.0m~1.5m	.1	.4	2.2	4.7	6.2	2.2	.4	.1	.2	.1	.0	.0	.0	.0	.0	.0	16.6
1.5m~2.0m	.1	.0	.4	2.4	5.5	4.6	.7	.1	.1	.0	.0	.0	.0	.0	.0	.0	14.0
2.0m~3.0m	.3	.0	.2	2.0	4.3	9.2	3.9	.5	.1	.0	.0	.0	.0	.0	.0	.0	20.5
3.0m~4.0m	.1	.0	.0	.6	.9	1.8	2.3	1.0	.1	.0	.0	.0	.0	.0	.0	.0	6.7
4.0m~5.0m	.0	.0	.0	.1	.2	.3	.4	.3	.1	.0	.0	.0	.0	.0	.0	.0	1.4
5.0m~6.0m	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.2
6.0m~8.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1
8.0m~10.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10.0m~12.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12.0m~14.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
14.0m~16.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
16.0m~18.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
18.0m~20.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20.0m~22.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
22.0m~24.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
24.0m~26.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26.0m~30.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
30.0m~50.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
合計	1.6	5.7	8.9	20.8	27.4	23.0	9.0	2.5	.8	.2	.0	.0	.0	.0	.0	.0	100.0

Data Source: Year book of port meteorological observational data of 2013 (Taichung Port), Harbor and Marine Technology Center, September of 1999 to November of 2013.

Table 6.2.2-6 Distribution of Annual Wave Height Period and Probability at Neighboring Waters

波向 $H_{1/3}$	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	合計
.0m–.5m	2.4	2.0	.3	.2	.2	.2	.1	.1	.1	.1	.2	.4	1.2	1.6	1.4	1.5	12.6
.5m–1.0m	5.4	6.7	.4	.2	.4	.3	.2	.2	.1	.2	.1	1.0	4.9	3.4	1.9	2.1	27.9
1.0m–1.5m	5.0	7.7	.2	.1	.0	.0	.0	.0	.0	.1	.0	.6	1.4	.3	.4	.4	16.6
1.5m–2.0m	5.6	7.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.1	.2	.1	.3	.1	14.0
2.0m–3.0m	9.4	9.5	.1	.1	.0	.0	.0	.0	.0	.1	.0	.1	.1	.0	.4	.1	20.5
3.0m–4.0m	3.3	2.7	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	.0	6.7
4.0m–5.0m	.7	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	1.4
5.0m–6.0m	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2
6.0m–8.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1
8.0m–10.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10.0m–12.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
12.0m–14.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
14.0m–16.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
16.0m–18.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
18.0m–20.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20.0m–22.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
22.0m–24.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
24.0m–26.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
26.0m–30.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
30.0m–50.0m	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
合計	31.9	36.1	1.4	.6	.6	.5	.4	.4	.4	.5	.4	2.2	7.9	5.4	4.7	4.3	100.0

Data Source: Year book of port meteorological observational data of 2013 (Taichung Port), Harbor and Marine Technology Center, September of 1999 to November of 2013.

Based on the research report conducted by DHI in 2016.06, the wind data collected (1979.01.01～2015.12.31, total of 37 years) from the National Centers for Environment Prediction (NCEP) through the Climate Forecast System Reanalysis (CFSR), plus the wave time series data estimated from DHI Global Wave Model (SWGWM), were used to analyze the extreme value of sea conditions for neighboring P2 and its detailed positions are shown in figure 6.2.2-2.

(1) Extreme Value of Significant Wave Height (Hm0) and Its Corresponding Peak interval (TP)

After using Gumbel distribution, least square method and maximum annual value, the estimate extreme value of wave height (Hm0), are shown in table 6.2.2-7. Within which, the predicted values of 500 years interval were based on the upper range values from the confidence interval and the corresponding peak intervals (TP) are shown in table 6.2.2-8.

(2) Extreme Values of Maximum Independent Wave Height (Hmax) and Its Corresponding Peak Interval (THmax)

The maximum extreme values of independent wave height (Hmax) estimated by using the Gumbel distribution are shown in table 6.2.2-9 and the peak intervals (THmax) that correspond to Hmax are shown in table 6.2.2-10.

(3) Maximum Extremely Value of Wave Crest Height(Cmax)

Use the largest wave crest height extremely value (Cmax, SWL) estimated by Gumbel distribution at location P2, as shown in table 6.2.2-11.

(4) Relationship between Extreme Value of Significant Wave Height (Hm0) and the Wind Velocity at a Height of 10 Meters (U10).

Take out the annual maximum values of significant wave height (Hm0) and 10 meters wind velocity (U10) from the data of year 37 (1979.01.01～2015.12.31), as shown in table 6.2.2-12.

Furthermore, in order to understand the characteristics of waves near the project zone, onsite monitoring were carried out from August 18, 2016 to March 18, 2017 (Observation of buoy 1 located 119.83°E, 24.20°N and buoy 2 located 119.59°E, 24.11°N, see figure 6.2.2-1 for details), through analysis and summarization, the wave height distribution of ocean area close by the project zone are shown in table 6.2.2-13 ～ table 6.2.2-16. Based on the results, during observation period, 92.22 % of waves observed at buoy 1 had wave heights less than 4.5m, where 96.49% of these had significant intervals less than 10 seconds and the highest frequency of wave direction was NNE; observation of buoy 2 reveals that 92.28% of waves observed were less than 4.5m, where 94.03% of these waves had significant intervals less than 10 seconds and the highest frequency of wave direction was also NNE.

Table 6.2.2-7 H_{m0} Extreme Value Under Each Regression Period (Position P2)

H_{m0} Estimation(m)	T_R(years)				
	1	10	50	100	500
Best Estination	5.6	8.5	10.5	11.4	(13.4/15.6)*
Range(Confidence interval 2.5-97.5%)	5.3 - 6	7.3 – 9.5	8.7 - 12	9.3 – 13.1	10.6 – 15.6

Data Source: Metocean Data for Planning of Geophysical Survey and Design of Offshore Wind Farms, Taiwan
Remark: 1. The results is based on the Gumbel distribution and the average sea condition of 3 hours
2. The number indicates mid-value/ upper limit value.

Table 6.2.2-8 T_P Extreme Value Under Each Regression Period (Position P2)

Estimation	T_R(years)				
	1	10	50	100	500*
Best Estination	10.0	11.3	12.0	12.3	(12.9/13.6)*
Range (Confidence interval 5-95%)	9.1 – 10.9	10.6 – 12.1	11.5 – 12.8	11.8 – 13.0	12.6 – 13.6

Data Source: Metocean Data for Planning of Geophysical Survey and Design of Offshore Wind Farms, Taiwan
Remark: 1. The results is based on the Gumbel distribution and the average sea condition of 3 hours
2. The number indicates mid-value/ upper limit value.

Table 6.2.2-9 H_{max} Extreme Value Under Each Regression Period (Position P2)

Short-term Estimation	T_R(years)				
	1	10	50	100	500
Forristall	10.3	15.5	19.1	20.6	(24.3/27.9)*
Rayleigh	11.4	17.1	21.1	22.9	(26.9/30.8)*

Data Source: Metocean Data for Planning of Geophysical Survey and Design of Offshore Wind Farms, Taiwan
Remark: 1. The results is based on the Gumbel distribution and the average sea condition of 3 hours
2. The number indicates mid-value/ upper limit value.

Table 6.2.2-10 TH_{max} Extreme Value Under Each Regression Period (Position P2)

Estimation	T_R(years)				
	1	10	50	100	500*
Best Estination	9.0	10.2	10.8	11.1	(11.6/12.2)*
Range(Confidence interval 5-95%)	8.2 – 9.8	9.6 – 10.9	10.3 – 11.5	10.6 – 11.7	11.3 – 12.2

Data Source: Metocean Data for Planning of Geophysical Survey and Design of Offshore Wind Farms, Taiwan
Remark: 1. The results is based on the Gumbel distribution and the average sea condition of 3 hours
2. The number indicates mid-value/ upper limit value.

Table 6.2.2-11 C_{max} Extreme Value Under Each Regression Period (Position P2)

預測	T_R(years)				
	1	10	50	100	500
Best Estination	6.3	9.6	11.9	12.9	(15.3/17.5)*

Data Source: Metocean Data for Planning of Geophysical Survey and Design of Offshore Wind Farms, Taiwan
Remark: 1. The results is based on the Gumbel distribution and the average sea condition of 3 hours
2. The number indicates mid-value/ upper limit value.

Table 6.2.2-12 The Maximum values for H_{m0} and U_{10} each year(1979 ~ 2015)

Year	Max wind speed (m/s)	Max H_{m0} (m)	Year	Max wind speed (m/s)	Max H_{m0} (m)
1979	21.5	5.1	1998	27.8	7.8
1980	21.1	5.5	1999	22.5	5.5
1981	22.0	5.6	2000	27.2	8.5
1982	25.0	6.2	2001	22.9	5.2
1983	21.7	5.2	2002	21.0	5.2
1984	21.9	5.3	2003	20.2	4.5
1985	23.2	5.9	2004	19.8	4.4
1986	32.5	10.6	2005	24.3	6.0
1987	28.3	8.5	2006	22.3	5.9
1988	21.2	4.8	2007	25.7	6.6
1989	22.1	5.0	2008	25.1	7.1
1990	22.0	5.1	2009	21.9	5.6
1991	25.5	7.0	2010	28.6	7.9
1992	21.8	5.2	2011	24.8	7.0
1993	22.2	5.3	2012	26.7	6.8
1994	24.5	5.8	2013	25.4	6.3
1995	20.6	5.8	2014	30.9	9.1
1996	25.2	7.2	2015	35.9	11.1
1997	20.5	4.8			

Data Source: Metocean Data for Planning of Geophysical Survey and Design of Offshore Wind Farms, Taiwan

Table 6.2.2-13 Table of Wave Height and Peak Period by Observation Buoy 1

	Peak Period (sec)																
Wave Height (m)	0~1	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	11~12	12~13	13~14	14~15	>15	Subtotal
0.0~0.5	-	-	0.05	0.20	0.31	0.82	1.04	0.44	0.29	0.30	0.08	0.12	-	-	-	-	3.65
0.5~1.0	-	-	0.07	1.24	2.26	2.74	3.59	2.45	0.93	0.69	0.18	0.01	-	-	-	-	14.15
1.0~1.5	-	-	-	0.17	1.68	2.53	3.39	1.90	0.65	0.40	0.21	0.05	-	-	-	-	10.99
1.5~2.0	-	-	-	-	0.16	1.51	3.92	3.22	0.80	0.23	0.14	0.07	-	-	0.03	-	10.08
2.0~2.5	-	-	-	-	-	0.31	3.57	5.97	1.21	0.25	0.08	0.03	0.03	0.01	-	0.01	11.47
2.5~3.0	-	-	-	-	-	0.04	1.04	6.61	3.96	0.23	0.04	-	-	-	-	0.01	11.94
3.0~3.5	-	-	-	-	-	-	0.20	3.68	7.68	0.90	-	-	-	-	-	-	12.45
3.5~4.0	-	-	-	-	-	-	-	0.74	7.31	2.06	0.09	-	-	-	-	-	10.21
4.0~4.5	-	-	-	-	-	-	-	0.14	3.47	3.35	0.30	-	-	-	-	0.01	7.28
4.5~5.0	-	-	-	-	-	-	-	-	1.20	2.69	0.63	0.03	-	-	-	-	4.54
> 5.0	-	-	-	-	-	-	-	-	0.29	1.62	1.15	0.09	-	-	-	0.10	3.25
Subtotal	-	-	0.12	1.60	4.41	7.95	16.75	25.16	27.78	12.72	2.89	0.39	0.03	0.01	0.03	0.14	100.00

Data Source: Observation buoy 1, observation from 2016.08.18 to 2017.03.18.

Table 6.2.2-14Wave Height and Wave Direction of Observation Buoy 1

	Wave Direction																
Wave Height (m)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Subtotal
0.0~0.5	0.6	1.6	0.5	0.3	0	0.1	0.1	0.1	0.1	0.1	0.1	0	0	0	-	0.1	3.7
0.5~1.0	1.9	6.9	1.7	0.1	0	0	0.1	0.2	0.1	0.4	1.3	0.6	0.2	0.1	0.2	0.4	14.2
1.0~1.5	1.1	7.4	0.9	0	-	0	0	0	0.2	0.6	0.5	0	-	0.1	0	0.1	10.9
1.5~2.0	1.2	7.7	0.7	0	-	-	-	0	0.2	0.2	0.1	-	-	-	-	0	10.1
2.0~2.5	1.3	9	1	-	0	-	-	-	0.1	0.1	-	-	-	-	-	0	11.5
2.5~3.0	0.4	10	1.4	-	-	-	-	-	0	0.1	-	-	-	-	-	-	11.9
3.0~3.5	0.1	10	2.2	-	-	-	-	-	0	0.2	0	-	-	-	-	-	12.5
3.5~4.0	0	7.4	2.7	-	-	-	-	0	0	0.1	0	-	-	-	-	-	10.2
4.0~4.5	-	4.4	2.7	0.1	-	-	0.1	0	0	0	0	-	-	-	-	0	7.3
4.5~5.0	-	2.5	1.8	0.1	0	0.1	0	-	0	0	-	-	-	-	-	-	4.5
> 5.0	-	1.4	1.6	0.1	0.1	0	0	-	0	-	0	-	-	0	0	-	3.2
Subtotal	6.6	68.3	17.2	0.7	0.1	0.2	0.3	0.3	0.7	1.8	2	0.6	0.2	0.2	0.2	0.6	100

Data Source: Observation buoy 1, observation from 2016.08.18 to 2017.03.18.

Table 6.2.2-15 Table of Wave Height and Peak Period by Observation Buoy 2

	Peak Period (sec)																
Wave Height (m)	0~1	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	11~12	12~13	13~14	14~15	>15	Subtotal
0.0~0.5	-	-	-	0.47	0.59	0.74	0.84	0.43	0.3	0.12	0.19	0.3	0.03	0.03	0.02	0.02	4.08
0.5~1.0	-	-	0.08	1.23	1.96	3.2	3.81	2.24	1.22	0.72	0.39	0.15	-	-	-	-	15
1.0~1.5	-	-	-	0.32	2.28	3.12	4.33	1.62	1.01	0.61	0.42	0.05	-	-	-	0.03	13.79
1.5~2.0	-	-	-	-	0.13	1.57	3.86	2.73	0.72	0.19	0.27	0.08	-	-	-	0.03	9.58
2.0~2.5	-	-	-	-	-	0.22	3.56	4.7	1.67	0.25	0.15	0.05	-	-	-	-	10.6
2.5~3.0	-	-	-	-	-	0.03	1.16	5.16	4.62	0.51	0.03	0.02	-	0.02	-	0.02	11.57
3.0~3.5	-	-	-	-	-	-	0.17	2.71	7.65	1.06	0.07	0.02	-	-	-	-	11.68
3.5~4.0	-	-	-	-	-	-	-	0.2	5.58	3.02	0.17	0.02	-	-	-	-	8.99
4.0~4.5	-	-	-	-	-	-	-	0.03	2.34	3.88	0.74	-	-	-	-	-	6.99
4.5~5.0	-	-	-	-	-	-	-	-	0.71	2.98	1.21	0.02	-	-	-	-	4.92
> 5.0	-	-	-	-	-	-	-	-	0.07	1.31	1.3	0.12	-	-	-	-	2.8
Subtotal	0	0	0.08	2.02	4.96	8.88	17.73	19.82	25.89	14.65	4.94	0.83	0.03	0.05	0.02	0.1	100

Data Source: Pbservation buoy 2, observation 2016.08.18～2017.03.18.

Table 6.2.2-16Wave Height and Wave Direction of Observation Buoy 2

	波向																
Wave Height (m)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Subtotal
0.0~0.5	0.4	1.9	0.7	0.2	0	0	0	0	-	0	0	0.2	0.2	0.2	0.2	0.1	4.1
0.5~1.0	1.1	7.1	2.4	0.1	0.1	0.1	0.1	0.1	0.1	0.4	0.8	1	0.4	0.4	0.3	0.5	15
1.0~1.5	0.6	8.1	3.2	0.1	0	0	0.1	0	0.2	0.7	0.5	0.2	0.1	-	0	0	13.8
1.5~2.0	0.5	7.1	1.7	-	0	0.1	-	-	0	0.3	0	-	-	-	-	-	9.7
2.0~2.5	0.1	7	3.3	0	0.1	0	-	-	-	0.1	0	-	-	-	-	-	10.6
2.5~3.0	0	6.6	4.7	-	0	-	-	-	0.1	0.1	0.1	-	-	-	-	-	11.6
3.0~3.5	-	4.9	6.6	-	-	-	-	-	0	0.1	0.1	-	-	-	-	-	11.7
3.5~4.0	0	3.2	5.6	0.1	-	-	-	-	0	-	0.1	-	0	-	-	-	9
4.0~4.5	-	1.3	5.7	-	-	-	-	-	0	0	0	-	-	-	-	-	7
4.5~5.0	-	0.8	4	0	-	-	-	0	-	0	-	-	-	-	-	-	4.8
> 5.0	-	0.2	2.5	-	-	-	-	-	-	0	-	-	-	-	-	-	2.7
Subtotal	2.7	48.2	40.4	0.5	0.2	0.2	0.2	0.1	0.4	1.7	1.6	1.4	0.7	0.6	0.5	0.6	100

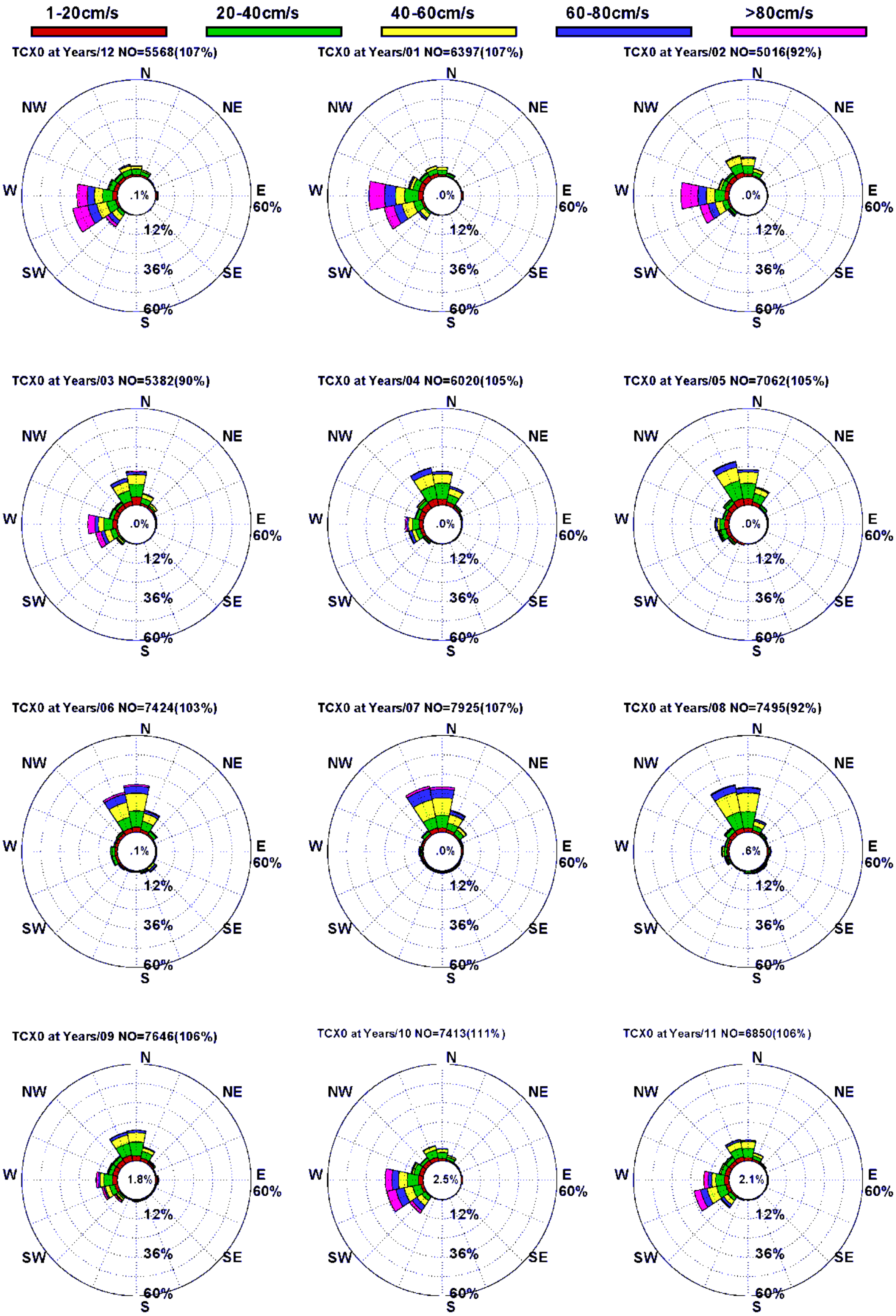
Data Source: Pbservation buoy 2, observation 2016.08.18～2017.03.18.

(iii) Ocean Current

In order to understand the annual and seasonal ocean current velocity in areas around the project zone, ocean current data observed between the period of 2003.08 ~ 2013.11 by observation pile (location as shown in figure 6.2.2-1) belonging to MOTC’s Harbor and Marine Technology Center of the Institute of Transportation, submerged at a depth of -25m under sea and 150 m off the coast of breakwater pier head north of Taichung Harbor were collected. The monthly, spring (March ~ May), summer (June ~ August), fall (September ~ November), winter (December ~ February) and annual current velocity distribution of ocean regions around the project zone are shown in figures 6.2.2-5 ~ 6.2.2-6 and the combined probability distribution of current velocity and direction for the entire year is depicted in table 6.2.2-17. Judging from results of the analysis, the main direction of current flow in the project zone for the entire year is NNW(19.3%), with an average current velocity of 41.7cm/sec and 248.3cm/sec of maximum current velocity observed.

According to the research conducted by DHI on June 2016, seasonal circulation currents commonly found in Taiwan Strait are shown in figure 6.2.2-7 and the currently velocities and directions of each month are depicted in figure 6.2.2-8. In addition, when referencing the 2010 document “Tide-surge interaction intensified by the Taiwan Strait” published by Wen-Zhou Zhang et al. in 2010, it explained that the maximum current velocity offshore of Taichung Harbor were usually less than 1m/s.

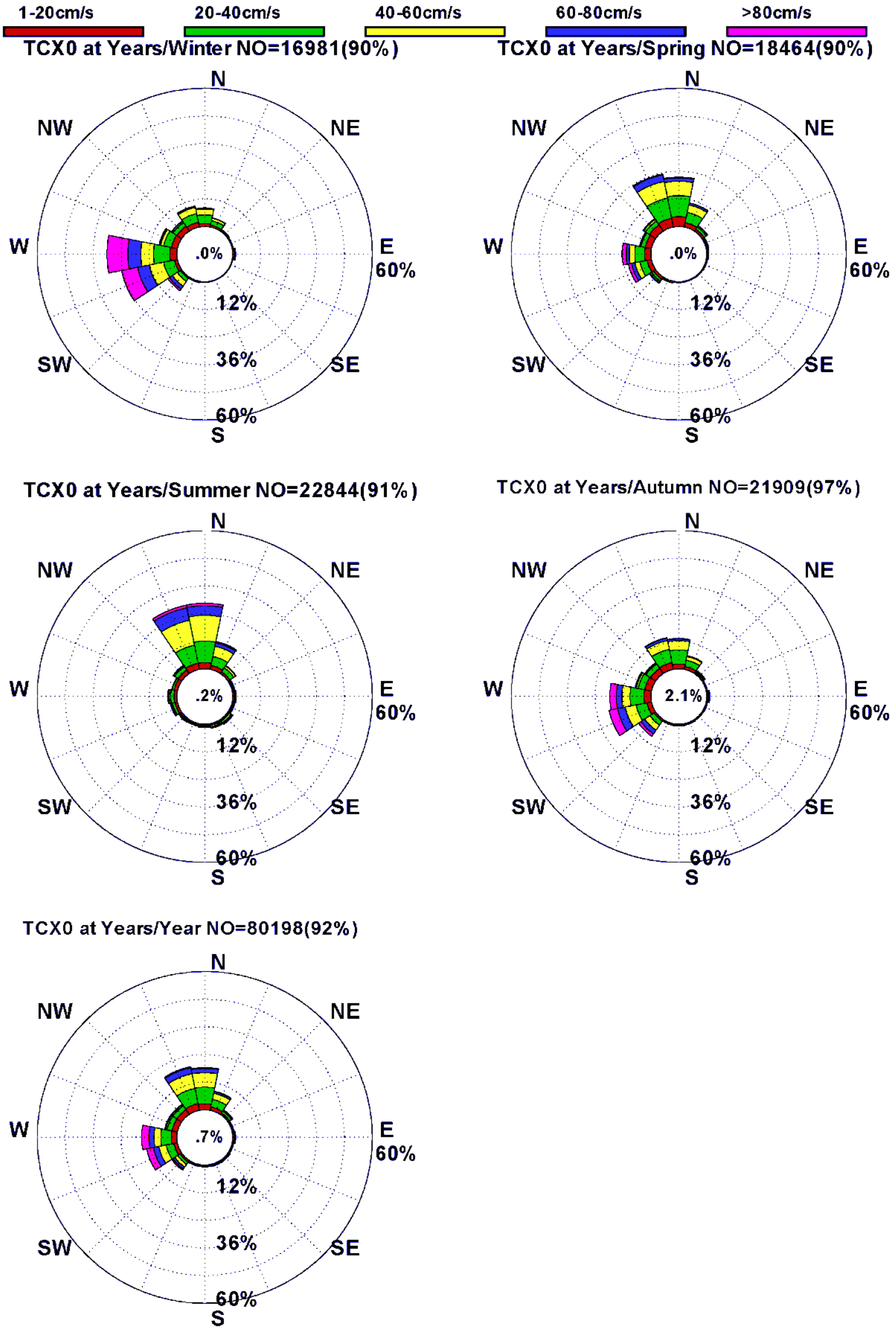
In order to understand the characteristics of ocean currents near the project zone, onsite investigations were carried out from August 18, 2016 to March 18, 2017 (location of observation shown in figure 6.2.2-1) and ocean current distribution of nearby regions were analyzed and summarized based on the data collected, as shown in figure 6.2.2-9. From the results, it is apparent that, during observation, the value of current velocity at buoy 1 gets smaller as the depth of water gets deeper and current direction were both NNE at the surface (water depth of -2 ~ -3m) and median layer (water depth of -20 ~ -21m). When the depth of water increases to -40 ~ -41m, the direction of ocean current changed to primarily SW; observation of the direction of ocean current at buoy 2 were both NNE at the surface (water depth of -5.5 ~ -6.5m) and median layer (water depth of -25.5 ~ -26.5m), but the direction turned to SSW at deeper water levels (water depth of -45.5 ~ 46.5m).



Data Source: 2013 Harbor Weather Observational Yearly Report, Harbor and Marine Technology Center, 2003.08-2013.11

Figure 6.2.2-5 Monthly Wind Rose of Waters in the Vicinity of Project

Site

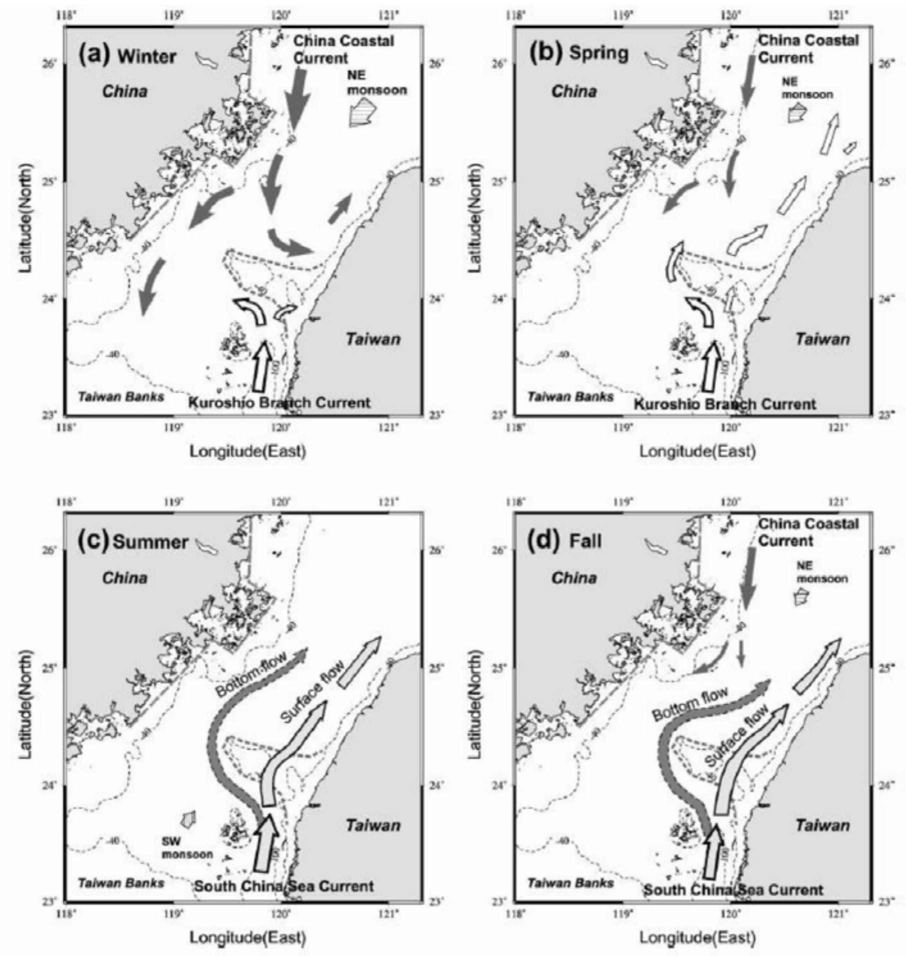


Data Source: 2013 Harbor Weather Observational Yearly Report, Harbor and Marine Technology Center, 2003.08-2013.11

Figure 6.2.2-6 Seasonal and Annual Wind Rose of Waters in the Vicinity of Site

Table 6.2.2-17 Joint Probability Distribution of Annual Flow Velocity and Flow Direction of Waters in the Adjacent Waters of Site

流向 流速	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	合計(%)
0cm/s	.8	.1	.1	.1	.1	.1	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	2.0
5cm/s	.5	.3	.2	.2	.2	.1	.1	.1	.1	.1	.2	.3	.5	.5	.5	.5	4.4
10cm/s	.8	.4	.2	.1	.2	.1	.1	.1	.1	.2	.3	.5	.7	.8	.9	1.0	6.4
15cm/s	1.2	.7	.3	.1	.1	.1	.1	.0	.0	.1	.3	.6	1.1	.9	1.0	1.3	7.8
20cm/s	1.5	.8	.3	.1	.1	.0	.1	.0	.0	.1	.3	.9	1.2	.8	.7	1.5	8.4
25cm/s	1.9	.9	.3	.1	.1	.0	.0	.0	.1	.1	.3	.9	1.3	.6	.5	1.7	8.7
30cm/s	1.8	.8	.3	.0	.1	.0	.0	.0	.0	.0	.3	.8	1.1	.4	.5	1.7	7.9
35cm/s	2.0	.9	.2	.0	.1	.0	.0	.1	.1	.0	.4	.8	1.0	.3	.3	1.8	8.0
40cm/s	2.0	.8	.2	.0	.1	.0	.1	.0	.0	.0	.4	.9	.8	.2	.2	1.8	7.6
45cm/s	1.7	.9	.2	.0	.1	.0	.1	.1	.0	.0	.4	.8	.8	.2	.2	1.7	7.1
50cm/s	2.6	1.0	.2	.0	.1	.1	.1	.1	.1	.0	.7	1.5	1.2	.2	.2	3.0	11.2
60cm/s	1.3	.5	.1	.0	.0	.1	.1	.1	.1	.0	.5	1.3	1.1	.1	.1	1.8	7.3
70cm/s	.6	.2	.0	.0	.0	.0	.1	.1	.0	.0	.4	1.1	1.1	.1	.0	.8	4.7
80cm/s	.2	.1	.0	.0	.0	.0	.0	.1	.0	.0	.3	.9	.9	.1	.0	.3	3.0
90cm/s	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.2	.7	.7	.0	.0	.1	2.0
100cm/s	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.8	.9	.0	.0	.0	2.0
120cm/s	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	.4	.0	.0	.0	.8
140cm/s	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.2	.0	.0	.0	.3
160cm/s	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.1
180cm/s	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
200cm/s	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
600cm/s																	
合計	18.9	8.5	2.5	.8	1.2	.7	1.0	.9	.8	.9	5.1	13.4	15.1	5.6	5.4	19.3	100.0



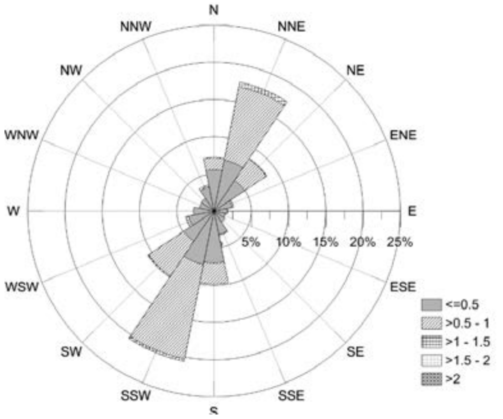
Data Source: Metocean Data for Planning of Geophysical Survey and Design of Offshore Wind Farms, Taiwan

Figure 6.2.2-7 Seasonal Change of Flow at Taiwan Straits

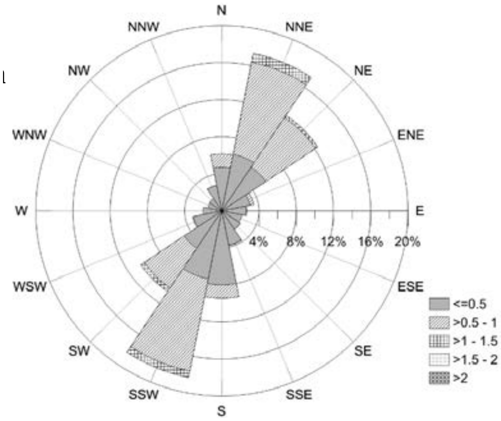
Month	direction	speed (knots)
Jan	SW	0.5-1.7
Feb	SW	0.4-0.6
Mar	SW turns to NE	0.4-0.9
Apr	NE	0.5-0.8
May	NE	0.4-1.0
June	NE	0.5-1.7
July	NE	0.5-1.5
Aug	NE	1.0-2.0
Sep	NE	0.5-1.0
Oct	W turns to SW	0.3-0.8
Nov	W turns to SW	0.2-0.5
Dec	SW	0.5-1.0

Data Source: Metocean Data for Planning of Geophysical Survey and Design of Offshore Wind Farms, Taiwan

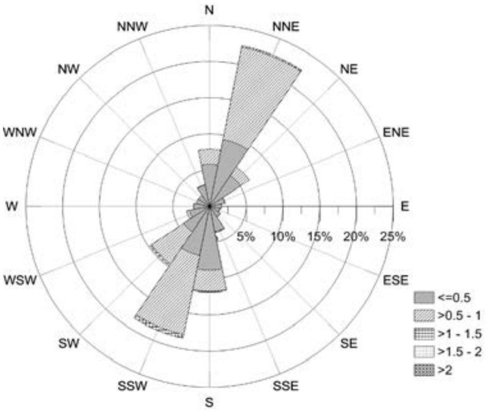
Figure 6.2.2-8 (Entering) Ocean Current of Taiwan Strait, its Flow Velocity and Seasonal Change



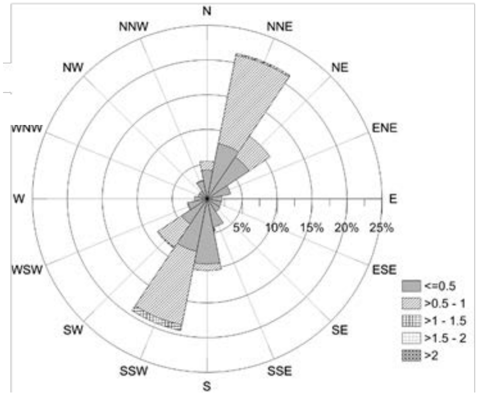
Water Depth-2～-3m



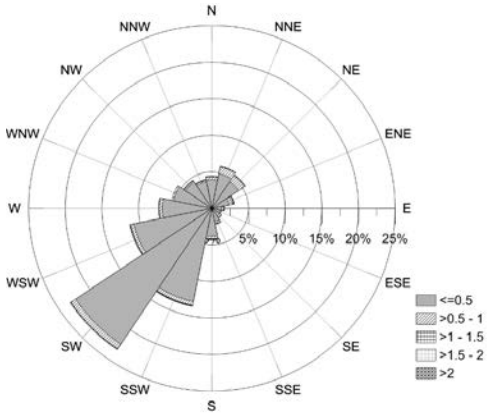
Water Depth -5.5～-6.5m



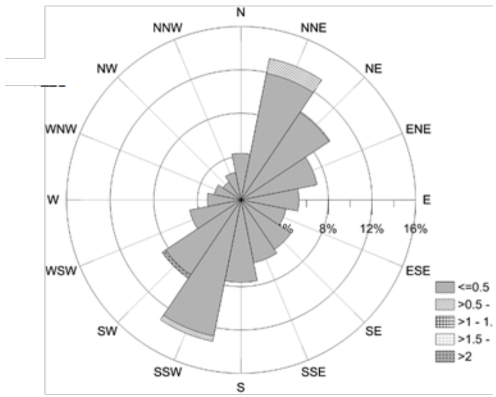
Water Depth -20～-21m



Water Depth -25.5～-26.5m



Water Depth -40～-41m



Water Depth -45.5～-46.5m

Observation Buoy 1, Observation Time 2016.08.18～2017.03.18	Observation Buoy 2, Observation Time 2016.08.18～2017.03.18

Figure 6.2.2-9 Wind Rose of Flow in the Vicinity of this Project

II. Marine Water Quality

This project is located at the offshore area of Xianxi Township, Changhua County. In accordance with “Marine Environment Classification and Marine Environmentla Quality Standards” (26th December 2001, Offical Words 0081750), waters of this project is classified as Class B Marine Water Body. As the results, the testing results of marine water quality is analyzed by Class B Marine Water Quality Standard.

(i) EPA and Marine Water Quality Monitoring Results of Correlated Projetcs

Data of neighboring EPA and related marine water quality monitoring data are shown as Table 6.2.2-18. Locations of monitoring stations are shown as Figure 6.2.2-10. Based on monitoring results from 2014 to second quarter of 2016, marine water quality in the vicinity is complied with Class B Marine Water Quality Statndards.

(ii) Monitoring Stations of On-Site Supplementary Survey

Wind farm site and 12 stations in the vicinity are in accordance with “Operational Rules of Environmental Impact Assessment for Development”. Monitoring locations are shown as Figure 6.2.2-10. From 2016 to 2017, 12 stations are selected for 3 marine water supplementary surveys. Monitoring results are shown as Table 6.2.2-19-21. On 8th July 2017, 3 stations within common corridor have conducted a supplementary survey in Lunwei Area, the location are shown as Figure 6.2.2-11 and results are shown as Table 6.2.2-22. Analyzed results are described as follows：

Based on results of 3 marine water surveys (Table 6.2.2-19 to 6.2.2-21), from October of 2016 to January of 2017, water temperature ranges between 24.5^{0}C and 28^{0}C; pH value ranges from 8.0 to 8.2; Suspended solid ranges from 2.9 to 10.3mg/L; Do ranges from 5.1 to 7.1mg/L; BOD is less than 2.0mg/L; Ammonia nitrogen ranges between 0.01 and 0.09mg/L; Coliform group is less than <10~340CPU/100m. Salinity ranges between 32.5 and 34.3psu. Grease is less than 0.5mg/L. Transparency ranges between 3.5m and 6.0m. Regarding analysis of nutrient, nitrate ranges between 0.03mg/L and 0.96mg/L; Nitrite ranges from ND to 0.16mg/L; Orthophosphate ranges between ND and 0.197PO_4^{3-}mg/L; Silicate ranges between 0.082 and 0.583mg SiO_2/L. With respect to heavy metal, Chromium is less than 0.00025mg/L, Cadmium ranges between ND and 0.0003mg/L; Copper ranges between 0.0002 and 0.0023mg/L; Lead ranges from ND to 0.0012mg/L; Zinc ranges between 0.0014 and 0.0137mg/L; Nickel ranges between ND and 0026mg/L; Mercury is ND; Arsenic ranges from 0.0011 to 0.0031mg/L. Analysis results show testing items around offshore area of Changhua County normal waters range.

According to marine water quality survey results in the Lunwei Area supplementary survey for common corridor (Table 6.2.2-22), in July of 2017, water temperature ranges between 27.3 and 29.9℃; pH value ranges between 7.9 and 8.0; Suspended solid ranges between 10.7 and 15.2mg/L; DO ranges from 7.2 to 7.6mg/L; BOD is below 2.0mg/L; Ammonia nitrogen is lower than 2.0mg/L; Coliform group is less than 10CPU/100mL; Salinity ranges between 31.0psu and 32.7psu; Grease is lower than 0.5mg/L; Transparency ranges between 1.73m and 1.885m. Regarding nutrient, nitrate ranges between 1.37 and 1.68mg/L; Nitrite ranges between ND and 0.04mg/L; Orthophosphate is below 0.061 PO43-mg/L; Silicate is lower than 1.0 mgSiO2/L. With respect to heavy metal, Chromium is lower than 0.005mg/L; Cadmium ranges between ND and 0.005mg/L; Copper ranges from 0.0005mg/L to 0.0032mg/L; Lead ranges between 0.0005 and 0.0007; Zinc ranges between 0.0013 and 0.0046mg/L; Nickel ranges between 0.0005 and 0.0007mg/L; Mercury is ND; Arsenic ranges between 0.0012mg/L and 0.0014mg/L. Analysis result show that testing items are within normal range.

III. Water Quality in Intertidal Zone

From 2016 to 2017, 7 stations are selected to conduct 3 water quality supplementary surveys around impact area power transmission line at intertidal zone. Monitoring results is shown as Table 6.2.2-22 to Table 6.2.2-25. On 8th July 2017, 3 stations are selected to conduct a supplementary survey on common corridor. Monitoring results is shown as Table 6.2.2-26. According to “Marine Environmental Classification and Marine Environmental Quality Standards” (26th December of 2001, Official Words of EPA 0081750), waters of this project is classified as Class B Marine Water Body. As the results, the testing results of marine water quality is analyzed by Class B Marine Water Quality Standard.

Based on water quality survey results in power transmission lines of intertidal zone (It is shown as Table 6.2.2-23 to 6.2.2-25), from September to November of 2016, water temperature ranges between 24.3℃ and 30.4℃; pH value ranges between 7.9 and 8.1; Suspended solid ranges between 20.4 to 183mg/L; DO ranges between 5.9 and 6.6 mg/L. BOD is less than 2.0mg/L; Ammonia nitrogen ranges between 0.02 and 0.15mg/L; Coliform group ranges between 10 and 350CPU/100mL. Salinity ranges between 31.3 and 34.1psu. Grease is less than 0.5mg/L. Transparency ranges between 0.2 and 1.2m. With respect to nutrient, nitrate ranges between 0.15 and 0.66mg/L; Nitrite ranges between ND and 0.3mg/L; Orthophosphate ranges between 0.02 and 0.176PO43-mg/L. Silicate ranges between 0.128 and 0.378mgSiO2/L. With respect to heavy metal, Chromium is less than 0.00025mg/L; Cadmium ranges between ND and 0.0001mg/L; Copper ranges between 0.0004 and 0.0023mg/L; Lead ranges between ND and 0.0005mg/L; Zinc ranges between 0.0008 and 0.0086mg/L; Nickel ranges between 0.0002 and 0.0011mg/L; Mercury is ND; Arsenic ranges between 0.0011 and

0.0029mg/L. Analysis results show testing items are within normal range.

Based on survey results of 3 intertidal water quality survey station at Lunwei Area (Table 6.2.2-26), water temperature of all monitoring stations from October of 2016 to January of 2017 ranges between 24.1 and 29℃. pH value ranges between 8.0 and 8.2. Suspended solid ranges between 3.1 and 12.6mg/L. DO ranges from 5.0 to 7.8mg/L. BOD is less than 2.0mg/L. Ammonia nitrogen ranges between 0.01 and 0.09mg/L. Coliform group is between 10 and 90CPU/100mL. Salinity ranges between 32.6 and 34.7psu. Oil is less than 0.5mg/L. Transparency is between 3 and 10.5m. According to analysis of nutrient, nitrate ranges between 0.06 and 0.99mg/L. Nitrigte ranges between ND and 0.14mg/L. Orthophosphate ranges from ND to 0.53PO_4^{3-}mg/L. Orthosilicate ranges from 0.092 to 0.552mgSiO_2/L. Based on heavy metal analysis, it shows that chromium is less than 0.005mg/L. Cadmium is between ND and <0.0005mg/L. Copper ranges between 0.0006 nad 0.0032mg/L. Lead ranges between 0.0005 and 0.0007mg/L. Zinc ranges between 0.0013 and 0.0046mg/L. Nickel ranges between 0.0005 and 0.0007mg/L. Mercury is ND. Arsenic ranges between 0.0013 and 0.0046mg/L. The analysis results shows monitoring items of all sampling station are within normal range.

Figure 6.2.2-10 Location Map of EPA, Marine Water Quality, Intertidal Water Quality and Marine Sediment Survey

Figure 6.2.2-11 Marine Water Quality, Intertidal Zone Water Quality and Location Map of Supplemenatry Survey of Marine Sediment of Common Corridor

Table 6.2.2-18 Monitoring Data of Marine Water Quality, EPA

Sampling Station	Sampling Date		Water Temperature	Salinity	pH Value	Dissolved Oxygen	Suspended Solid	Chlorophyll a	Ammonia Nitrogen	Nitrate	Orthophosphate	Nitrite	Silicate	Cadmium	Chromium	Copper	Zinc	Lead	Mercury
	Year	Month	℃	psu		mg/L	mg/L	μg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Coastal Area of Changhua Coastal Industrial Park 1	105	11	26.4	32.5	8.2	6.6	7.2	—	—	—	—	—	—	0.00004	—	0.0006	0.0025	0.0002	<0.0003
	105	7	29.4	32.5	8.2	6.7	8.2	—	—	—	—	—	—	0.00002	—	0.0003	0.0016	0.0002	<0.0003
	105	5	27.8	34.6	8.2	6.4	12.7	—	—	—	—	—	—	0.00004	—	0.0005	0.0017	0.0002	<0.0003
	105	1	19.2	33.3	8.2	7.5	16.6	0.9	0.01	0.12	0.061	0.008	0.526	0.00003	<0.001	0.0003	0.0019	0.0001	<0.0003
	104	11	26.5	34	8.1	6.6	10.7	—	—	—	—	—	—	0.00002	—	0.0004	0.0014	0.0002	<0.0003
	104	7	29.7	33.1	8	6.1	7.2	—	—	—	—	—	—	0.00003	—	0.0003	0.0017	0.0001	<0.0003
	104	4	24.8	34.2	8.2	6.9	8.6	—	—	—	—	—	—	0.00002	—	0.0005	0.0053	0.0002	<0.0003
	104	1	17.9	33	8.2	7.9	8.4	2.6	0.06	0.09	0.067	0.018	0.52	0.00005	<0.001	0.0006	0.001	0.0001	<0.0003
	103	10	25.6	32.7	8.2	6.9	4	—	—	—	—	—	—	0.00002	—	0.0005	0.0023	0.0001	<0.0003
	103	8	30.2	33	8.1	6.7	4.4	—	—	—	—	—	—	0.00002	—	0.0003	0.0017	0.0001	<0.0003
	103	5	26.4	33.3	8.1	6.2	7	—	—	—	—	—	—	0.00002	—	0.0003	0.0013	<0.0001	<0.0003
	103	1	21.2	33.7	8.1	6.9	5.6	0.7	0.03	0.12	0.03	0.019	0.588	0.00003	<0.001	0.0003	0.0006	<0.0001	<0.0003
Coastal Area of Changhua Coastal Industrial Park 2	105	11	26.7	32.3	8.2	6.7	6.8	—	—	—	—	—	—	0.00007	—	0.0005	0.0017	0.0002	<0.0003
	105	7	29.6	30.8	8.2	6.5	10.1	—	—	—	—	—	—	0.00004	—	0.0003	0.0014	0.0001	<0.0003
	105	5	27.9	34.5	8.2	6.4	15.3	—	—	—	—	—	—	0.00003	—	0.0005	0.0018	0.0002	<0.0003
	105	1	18.3	33.1	8.2	7.6	23.2	1.5	0.01	0.15	0.072	0.01	0.64	0.00002	<0.001	0.0005	0.0036	0.0001	<0.0003
	104	11	26.2	33.6	8.1	6.7	16.2	—	—	—	—	—	—	0.00004	—	0.0005	0.0016	0.0001	<0.0003
	104	7	29.5	33.3	8	6.1	8.2	—	—	—	—	—	—	0.00002	—	0.0003	0.0023	0.0003	<0.0003
	104	4	24.5	34.3	8.2	6.9	11.2	—	—	—	—	—	—	0.00002	—	0.0004	0.0013	0.0002	<0.0003
	104	1	17.6	33	8.2	7.9	23.4	2.1	0.08	0.09	0.081	0.021	0.668	0.00003	<0.001	0.0005	0.001	0.0001	<0.0003
	103	10	25.3	33.1	8.2	6.8	6	—	—	—	—	—	—	0.00002	—	0.0005	0.0042	0.0002	<0.0003
	103	8	30.3	31.9	8.1	6.7	3.9	—	—	—	—	—	—	0.00002	—	0.0003	0.0022	0.0001	<0.0003
	103	5	26.4	33.7	8.1	6.3	7.9	—	—	—	—	—	—	0.00002	—	0.0003	0.0011	0.0001	<0.0003
	103	1	20.8	33.7	8.1	6.7	6.7	0.6	0.05	0.1	0.067	0.019	0.548	0.00004	<0.001	0.0003	0.0014	<0.0001	<0.0003
Coastal Area of Changhua Coastal Industrial Park 3	105	11	26.6	32.8	8.2	6.6	12.8	—	—	—	—	—	—	0.00004	—	0.0005	0.0018	0.0002	<0.0003
	105	7	29.4	32.4	8.2	6.7	11.9	—	—	—	—	—	—	0.00005	—	0.0004	0.0018	0.0001	<0.0003
	105	5	27.8	34.3	8.2	6.4	18.3	—	—	—	—	—	—	0.00003	—	0.0005	0.0023	0.0002	<0.0003
	105	1	18.7	33.1	8.2	7.6	24.6	1.1	0.05	0.15	0.088	0.009	0.525	0.00002	<0.001	0.0005	0.004	0.0001	<0.0003
	104	11	25.7	33.1	8.1	6.8	10.7	—	—	—	—	—	—	0.00003	—	0.0004	0.0014	0.0001	<0.0003
	104	7	29.4	33.8	8.1	6.2	12.4	—	—	—	—	—	—	0.00002	—	0.0004	0.0026	0.0002	<0.0003
	104	4	24.1	33.7	8.1	7.1	16.4	—	—	—	—	—	—	0.00003	—	0.0006	0.0028	0.0001	<0.0003
	104	1	17.7	33.2	8.2	7.9	13.8	2.5	0.06	0.08	0.075	0.019	0.532	0.00002	<0.001	0.0005	0.001	0.0001	<0.0003
	103	10	25.2	32.4	8.1	6.8	13.2	—	—	—	—	—	—	0.00004	—	0.001	0.0058	0.0001	<0.0003
	103	8	30.8	31.9	8.1	6.7	3.8	—	—	—	—	—	—	0.00006	—	0.001	0.0006	<0.0001	<0.0003
	103	5	26.1	33.8	8.1	6.2	14.7	—	—	—	—	—	—	0.00002	—	0.0004	0.0013	0.0001	<0.0003
	103	1	21.1	33.9	8.1	7.3	4.5	0.5	0.02	0.12	0.07	0.018	0.572	0.00006	<0.001	0.0002	0.0009	0.0001	<0.0003
Class B Marine Water Body Quality Standard			—	—	7.5~8.5	—	—	—	—	—	—	—	—	0.01	0.05	0.03	0.5	0.1	0.002

Data Source: Environmental Protection Agency, Executive Yuan, Environmental Water Quality Information.

Table 6.2.2-19First Marine Water Quality Monitoring Results of This Site

Sampling Station	Coliform Bacteria	Transparency	Suspended Solid	Water Temperature	Chromium	Cadmium	Copper	Lead	Zinc	Nickel	Mercury	pH	Arsenic	Nitrate	Nitrite	Ammonia Nitrogen	Orthophosphate	Salinity	Silicate	DO	Oil	BOD
	CPU/100mL	m	mg/L	℃	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	—	mg/L	mg/L	mg/L	mg/L	PO_4^{3-}mg/L	psu	$mgSiO_2/L$	mg/L	mg/L	mg/L
12-1 Up	<10	5	5.2	27.6	<0.00025	ND	0.0007	ND	0.0025	0.0006	ND	8.1	0.0009	0.10	0.02	0.03	0.013	32.8	0.120	6.3	<0.5	<2.0
12-1 Mid	<10	—	7.4	27.6	<0.00025	0.0001	0.0005	ND	0.0043	0.0005	ND	8.1	0.0009	0.13	ND	0.03	ND	32.8	0.206	6.1	<0.5	<2.0
12-1 Low	<10	—	8.0	27.4	<0.00025	0.0001	0.0004	ND	0.0041	0.0005	ND	8.2	0.0010	0.12	0.02	0.04	0.017	32.9	0.110	6.2	<0.5	<2.0
12-2 Up	<10	5	9.2	27.6	<0.00025	0.0001	0.0003	ND	0.0035	0.0004	ND	8.1	0.0007	0.09	0.02	0.03	ND	33.1	0.241	5.4	<0.5	<2.0
12-2 Mid	<10	—	5.6	27.6	<0.00025	ND	0.0001	ND	0.0018	0.0003	ND	8.1	0.0007	0.11	0.02	0.02	0.018	33.2	0.213	5.4	<0.5	<2.0
12-2 Low	<10	—	7.0	27.6	<0.00025	0.0001	0.0004	ND	0.0030	0.0005	ND	8.2	0.0010	0.06	0.02	0.04	0.013	33.2	0.144	5.1	<0.5	<2.0
12-3 Up	<10	10.5	4.2	28.5	<0.00025	ND	0.0003	0.0005	0.0020	ND	ND	8.2	0.0014	0.11	ND	0.03	0.050	34.4	0.141	6.6	<0.5	<2.0
12-3 Mid	<10	—	3.4	28.3	<0.00025	ND	0.0009	ND	0.0017	ND	ND	8.2	0.0012	0.15	ND	0.04	0.054	34.5	0.114	6.6	<0.5	<2.0
12-3 Low	<10	—	4.2	28.2	<0.00025	ND	0.0003	0.0004	0.0031	0.0003	ND	8.2	0.0011	0.22	ND	0.03	0.062	34.7	0.155	6.5	<0.5	<2.0
12-4 Up	<10	10.2	3.7	28.5	<0.00025	ND	0.0003	0.0004	0.0036	0.0002	ND	8.2	0.0009	0.12	ND	0.02	0.057	34.4	0.096	6.4	<0.5	<2.0
12-4 Mid	10	—	4.6	28.4	<0.00025	ND	0.0004	ND	0.0032	0.0003	ND	8.2	0.0012	0.19	ND	0.05	0.056	34.6	0.100	6.6	<0.5	<2.0
12-4 Low	<10	—	3.7	28.4	<0.00025	ND	0.0003	ND	0.0037	0.0002	ND	8.2	0.0011	0.32	ND	0.04	0.056	34.6	0.152	6.6	<0.5	<2.0
12-5 Up	<10	5.0	8	28.0	<0.00025	0.0001	0.0007	0.0005	0.0036	0.0004	ND	8.1	0.0017	0.11	ND	0.03	0.018	33.7	0.227	5.7	<0.5	<2.0
12-5 Mid	<10		6.2	27.8	<0.00025	0.0001	0.0008	0.0003	0.0040	0.0005	ND	8.1	0.0017	0.09	0.02	0.04	ND	33.7	0.307	5.6	<0.5	<2.0
12-5 Low	<10		5.8	27.7	<0.00025	0.0001	0.0006	0.0003	0.0032	0.0004	ND	8.1	0.0016	0.11	ND	0.03	ND	33.8	0.310	5.6	<0.5	<2.0
12-6 Up	25	5.0	7.4	29.0	<0.00025	ND	0.0006	ND	0.0044	0.0004	ND	8.1	0.0021	0.05	ND	0.04	0.033	32.7	0.103	5.8	<0.5	<2.0
12-6 Mid	30	—	6.5	28.9	<0.00025	0.0001	0.0009	ND	0.0037	0.0006	ND	8.1	0.0017	0.16	ND	0.03	0.010	32.8	0.110	5.8	<0.5	<2.0
12-6 Low	30	—	6.8	28.9	<0.00025	ND	0.0006	ND	0.0011	0.0002	ND	8.1	0.0016	0.16	ND	0.02	0.013	32.8	0.248	5.6	<0.5	<2.0
12-7 Up	<10	7.0	5.2	28.8	<0.00025	ND	0.003	0.0003	0.0026	0.0002	ND	8.1	0.0012	0.08	ND	0.03	0.054	34.4	0.100	6.5	<0.5	<2.0
12-7 Mid	<10	—	5.1	28.3	<0.00025	ND	0.0011	0.0003	0.0061	0.0002	ND	8.2	0.0010	0.41	ND	0.01	0.45	34.5	0.107	6.5	<0.5	<2.0
12-7 Low	20	—	5.4	28.1	<0.00025	ND	0.0005	ND	0.0033	ND	ND	8.1	0.0010	0.18	ND	0.02	0.53	34.4	0.141	6.5	<0.5	<2.0
12-8 Up	<10	5.0	5.4	28.9	<0.00025	ND	0.0012	0.0004	0.0035	0.0009	ND	8.1	0.0024	0.08	ND	0.04	ND	32.9	0.110	5.1	<0.5	<2.0
12-8 Mid	<10	—	4.3	28.9	<0.00025	ND	0.0009	ND	0.0040	0.0004	ND	8.1	0.0020	0.05	ND	0.08	0.019	32.9	0.313	5.1	<0.5	<2.0

Sampling Station	Coliform Bacteria	Transparency	Suspended Solid	Water Temperature	Chromium	Cadmium	Copper	Lead	Zinc	Nickel	Mercury	pH	Arsenic	Nitrate	Nitrite	Ammonia Nitrogen	Orthophosphate	Salinity	Silicate	DO	Oil	BOD
	CPU/100mL	m	mg/L	℃	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	—	mg/L	mg/L	mg/L	mg/L	PO_4^{3-}mg/L	psu	$mgSiO_2/L$	mg/L	mg/L	mg/L
12-8 Low	<10	—	7.6	28.8	<0.00025	ND	0.0008	ND	0.0031	0.0004	ND	8.1	0.0018	0.05	ND	0.05	ND	32.9	0.338	5.1	<0.5	<2.0
12-9 Up	<10	5.0	5.4	28.3	<0.00025	ND	0.0007	ND	0.0075	0.0004	ND	8.0	0.0022	0.21	ND	0.05	ND	33.5	0.307	6.0	<0.5	<2.0
12-9 Mid	<10	—	7.0	28.2	<0.00025	ND	0.0007	0.0003	0.0049	0.0006	ND	8.0	0.0017	0.13	ND	0.09	0.012	33.5	0.313	5.9	<0.5	<2.0
12-9 Low	<10	—	5.3	28.1	<0.00025	0.0002	0.0006	0.0010	0.0055	0.0006	ND	8.1	0.0014	0.14	0.02	0.03	ND	33.6	0.535	5.7	<0.5	<2.0
12-10 Up	10	4.0	5.8	27.6	<0.00025	0.0001	0.0005	ND	0.0015	0.0005	ND	8.1	0.0016	0.23	0.14	0.03	0.019	33.4	0.092	5.1	<0.5	<2.0
12-10 Mid	<10	—	7.0	27.5	<0.00025	0.0001	0.0006	0.0003	0.0025	0.0008	ND	8.1	0.0014	0.35	0.13	0.04	0.130	33.4	0.103	5.1	<0.5	<2.0
12-10 Low	<10	—	7.6	27.4	<0.00025	0.0001	0.0006	ND	0.0048	0.0009	ND	8.1	0.0016	0.28	0.13	0.03	0.115	33.5	0.248	5.0	<0.5	<2.0
12-11 Up	15	5.0	7.1	27.6	<0.00025	ND	0.0009	0.0004	0.0038	0.0012	ND	8.1	0.0018	0.29	0.13	0.02	0.039	33.3	0.286	5.8	<0.5	<2.0
12-11 Mid	<10	—	7.0	27.5	<0.00025	0.0001	0.0008	0.0003	0.0039	0.0009	ND	8.1	0.0016	0.38	0.13	0.03	0.129	33.5	0.303	5.1	<0.5	<2.0
12-11 Low	15	—	6.8	27.4	<0.00025	0.0003	0.0010	0.0011	0.0074	0.0011	ND	8.1	0.0017	0.50	0.14	0.04	0.136	33.5	0.300	5.1	<0.5	<2.0
12-12 Up	<10	3.0	10.8	28.8	<0.00025	0.0001	0.0009	ND	0.0013	0.0009	ND	8.1	0.0008	0.014	0.02	0.03	ND	33.6	0.300	5.6	<0.5	<2.0
12-12 Mid	<10	—	6.4	28.6	<0.00025	0.0001	0.0006	0.0004	0.0060	0.0004	ND	8.1	0.0016	0.018	0.02	0.03	ND	33.7	0.535	5.3	<0.5	<2.0
12-12 Low	<10	—	12.6	28.6	<0.00025	0.0001	0.0004	0.0005	0.0052	0.0005	ND	8.1	0.0019	0.07	0.02	0.03	ND	33.7	0.552	5.4	<0.5	<2.0
Class B Marine Water Body Quality Standard	—	—	—	—	—	0.01	0.03	0.1	0.5	—	0.002	7.5~8.5	0.05	—	—	—	—	—	—	5.0	—	3.0

Data Source: Based on statistical survey results of this project, Asia Environmental Technical Corporation is assigned by on-site survey (Accreditation Number by EPA: 003), the survey is conducted on 20th Oct. 2016.

Table 6.2.2-20 Second Marine Water Quality Monitoring Results of This Site

Sampling Station	Coliform Bacteria	Transparency	Suspended Solid	Water Temperature	Chromium	Cadmium	Copper	Lead	Zinc	Nickel	Mercury	pH	Arsenic	Nitrate	Nitrite	Ammonia Nitrogen	Orthophosphate	Salinity	Silicate	DO	Oil	BOD
	CPU/100mL	m	mg/L	℃	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	—	mg/L	mg/L	mg/L	mg/L	PO_4^{3-}mg/L	psu	mgSiO_2/L	mg/L	mg/L	mg/L
12-1 Up	25	5.0	5.1	27.1	<0.00025	ND	0.0008	ND	0.0034	0.0019	ND	8.1	0.0018	0.44	0.02	0.02	0.149	33.4	0.231	6.2	<0.5	<2.0
12-1 Mid	<10	—	6.2	27.0	<0.00025	ND	0.0008	ND	0.0039	0.0018	ND	8.1	0.0013	0.44	0.02	0.02	0.146	33.5	0.349	6.0	<0.5	<2.0
12-1 Low	<10	—	5.3	27.0	<0.00025	ND	0.0008	ND	0.0039	0.0018	ND	8.1	0.0015	0.42	0.02	0.03	0.147	33.5	0.328	6.1	<0.5	<2.0
12-2 Up	15	5.0	5.5	27.1	<0.00025	ND	0.0007	ND	0.0050	0.0011	ND	8.1	0.0016	0.50	0.02	0.02	0.142	33.6	0.168	6.1	<0.5	<2.0
12-2 Mid	<10	—	5.6	26.9	<0.00025	ND	0.0007	ND	0.0047	0.0010	ND	8.1	0.0016	0.55	0.02	0.03	0.146	33.7	0.300	5.8	<0.5	<2.0
12-2 Low	<10	—	4.4	26.8	<0.00025	ND	0.0007	ND	0.0048	0.0010	ND	8.1	0.0015	0.46	0.02	0.04	0.150	33.6	0.248	5.8	<0.5	<2.0
12-3 Up	35	4.0	5.8	24.4	<0.00025	ND	0.0004	ND	0.034	0.0005	ND	8.2	0.0013	0.22	0.04	0.02	0.131	33.6	0.085	7.4	<0.5	<2.0
12-3 Mid	1.1E+02	—	4.8	24.5	<0.00025	ND	0.0003	ND	0.027	0.0004	ND	8.2	0.0012	0.17	0.03	0.04	0.041	33.6	0.167	7.4	<0.5	<2.0
12-3 Low	25	—	4.3	24.4	0.0004	ND	0.0004	ND	0.031	0.0004	ND	8.1	0.0012	0.20	0.04	0.02	0.134	33.7	0.089	7.2	<0.5	<2.0
12-4 Up	3.1E+02	4.0	5.3	24.5	<0.00025	ND	0.0005	ND	0.0034	0.0004	ND	8.1	0.0013	0.22	0.03	0.02	0.128	33.7	0.109	7.6	<0.5	<2.0
12-4 Mid	4.1E+02	—	6.3	24.4	<0.00025	ND	0.0004	ND	0.0034	0.0004	ND	8.2	0.0013	0.20	0.03	0.02	0.135	33.6	0.143	7.5	<0.5	<2.0
12-4 Low	2.9E+02	—	5.2	24.3	<0.00025	ND	0.0003	ND	0.0026	0.0003	ND	8.2	0.0013	0.10	0.04	0.04	0.053	33.7	0.201	7.7	<0.5	<2.0
12-5 Up	2.9E+02	4.0	8.3	24.5	<0.00025	ND	0.0004	0.0004	0.0065	0.0006	ND	8.1	0.0011	0.17	0.02	0.03	0.136	33.7	0.150	7.8	<0.5	<2.0
12-5 Mid	3.3E+02	—	6.1	24.5	<0.00025	ND	0.0003	ND	0.0038	0.0004	ND	8.1	0.0011	0.17	0.02	0.03	0.137	33.7	0.099	7.4	<0.5	<2.0
12-5 Low	1.0E+02	—	9.4	24.4	<0.00025	ND	0.0004	0.0003	0.0055	0.0006	ND	8.1	0.0010	0.17	0.02	0.03	ND	33.7	0.177	7.4	<0.5	<2.0
12-6 Up	2.4E+02	4.0	6.2	24.6	<0.00025	ND	0.0004	0.0003	0.0055	0.0006	ND	8.1	0.0011	0.16	0.03	0.02	0.130	33.6	0.099	7.6	<0.5	<2.0
12-6 Mid	4.2E+02	—	6.7	24.4	<0.00025	ND	0.0004	ND	0.0050	0.0004	ND	8.1	0.0011	0.06	0.02	0.02	0.139	33.7	0.146	7.6	<0.5	<2.0
12-6 Low	1.6E+02	—	8.4	24.3	<0.00025	ND	0.0006	0.0003	0.0050	0.0005	ND	8.1	0.0011	0.07	0.02	0.03	0.136	33.8	0.146	7.4	<0.5	<2.0
12-7 Up	1.9E+02	4.0	7.8	24.2	<0.00025	ND	0.0004	ND	0.0034	0.0003	ND	8.1	0.0013	0.19	0.03	0.02	0.052	33.6	0.133	7.8	<0.5	<2.0
12-7 Mid	20	—	8.2	24.1	<0.00025	0.0001	0.0009	ND	0.0074	0.0041	ND	8.1	0.0012	0.21	0.04	0.03	0.128	33.7	0.133	7.7	<0.5	<2.0
12-7 Low	15	—	11.0	24.1	<0.00025	0.0001	0.0005	0.0003	0.0055	0.0004	ND	8.1	0.0012	0.22	0.04	0.04	0.134	33.7	0.150	7.6	<0.5	<2.0
12-8 Up	3.0E+02	4.0	6.5	24.4	<0.00025	ND	0.0004	ND	0.0053	0.0007	ND	8.1	0.0011	0.27	0.02	0.05	0.138	33.7	0.156	7.8	<0.5	<2.0
12-8 Mid	4.3E+02	—	8.2	24.3	0.0004	ND	0.0002	0.0003	0.0055	0.0005	ND	8.1	0.0011	0.26	0.02	0.03	0.037	33.8	0.099	7.5	<0.5	<2.0
12-8 Low	4.1E+02	—	7.7	24.3	<0.00025	ND	0.0003	0.0006	0.0049	0.0004	ND	8.1	0.0011	0.21	0.02	0.04	0.138	33.8	0.133	7.4	<0.5	<2.0
12-9 Up	1.7E+02	3.5	7.4	24.7	<0.00025	ND	0.0004	0.0003	0.0060	0.0004	ND	8.1	0.0011	0.17	0.04	0.04	0.129	33.6	0.201	7.4	<0.5	<2.0
12-9 Mid	2.3E+02	—	6.1	24.7	<0.00025	ND	0.0004	ND	0.0097	0.0007	ND	8.1	0.0012	0.18	0.04	0.02	0.132	33.6	0.150	7.2	<0.5	<2.0
12-9 Low	1.9E+02	—	5.9	24.6	<0.00025	ND	0.0004	0.0003	0.0064	0.0006	ND	8.1	0.0012	0.17	0.04	0.05	0.123	33.7	0.099	7.2	<0.5	<2.0
12-10 Up	30	3.5	6.2	24.8	<0.00025	ND	0.0005	ND	0.0086	0.0007	ND	8.1	0.0012	0.21	0.04	0.04	0.119	33.1	0.190	7.2	<0.5	<2.0
12-10 Mid	30	—	7.3	24.7	<0.00025	ND	0.0004	ND	0.0039	0.0004	ND	8.1	0.0012	0.25	0.04	0.03	0.137	33.2	0.217	7.1	<0.5	<2.0
12-10 Low	2.5E+02	—	4.6	24.7	<0.00025	ND	0.0004	ND	0.0046	0.0004	ND	8.1	0.0008	0.04	0.02	0.02	0.140	33.2	0.123	7.0	<0.5	<2.0
12-11 Up	2.5E+02	4.0	5.1	24.6	0.0003	ND	0.0005	0.0004	0.0097	0.0006	ND	8.2	0.0011	0.28	0.03	0.05	0.129	33.6	0.146	7.8	<0.5	<2.0
12-11 Mid	2.8E+02	—	8.8	24.5	0.0004	ND	0.0005	ND	0.0081	0.0005	ND	8.2	0.0010	0.28	0.03	0.05	0.133	33.6	0.146	7.7	<0.5	<2.0
12-11 Low	3.4E+02	—	6.8	24.4	<0.00025	ND	0.0005	ND	0.0086	0.0007	ND	8.2	0.0012	0.32	0.03	0.04	0.131	33.7	0.170	7.7	<0.5	<2.0
12-12 Up	90	3.5	8.2	24.9	<0.00025	ND	0.0008	ND	0.0045	0.0007	ND	8.1	0.0011	0.19	0.04	0.06	0.128	32.6	0.123	6.9	<0.5	<2.0
12-12 Mid	1.8E+02	—	6.8	24.8	<0.00025	ND	0.0004	ND	0.0049	0.0008	ND	8.1	0.0011	0.23	0.02	0.06	ND	32.7	0.190	6.8	<0.5	<2.0
12-12 Low	4.7E+02	—	8.5	24.7	<0.00025	ND	0.0003	ND	0.0052	0.0004	ND	8.1	0.0011	ND	ND	0.04	ND	32.6	0.201	6.8	<0.5	<2.0
Class B Marine Water Body Quality Standard	—	—	—	—	—	0.01	0.03	0.1	0.5	—	0.002	7.5~8.5	0.05	—	—	—	—	—	—	5.0	—	3.0

Data Source: Based on statistical survey results of this project, Asia Environmental Technical Corporation is assigned by on-site survey (Accreditation Number by EPA: 003), sampling stations 12-5 and 12-11 are conducted on 15th November 2016, the remaining are conducted on 11th December 2016.

Table 6.2.2-21 Second Marine Water Quality Monitoring Results of This Site

Sampling Station	Coliform Bacteria	Transparency	Suspended Solid	Water Temperature	Chromium	Cadmium	Copper	Lead	Zinc	Nickel	Mercury	pH	Arsenic	Nitrate	Nitrite	Ammonia Nitrogen	Orthophosphate	Salinity	Silicate	DO	Oil	BOD
	CPU/100mL	m	mg/L	℃	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	—	mg/L	mg/L	mg/L	mg/L	PO_4^{3-}mg/L	psu	$mgSiO_2/L$	mg/L	mg/L	mg/L
12-1 Up	15	5.0	5.1	27.2	<0.00025	ND	0.0012	ND	0.0106	0.0003	ND	8.2	0.0014	0.98	0.07	0.07	0.136	33.6	0.238	6.1	<0.5	<2.0
12-1 Mid	<10	—	3.1	27.2	<0.00025	ND	0.0009	ND	0.0098	0.0003	ND	8.2	0.0014	0.99	0.08	0.04	0.143	33.8	0.278	5.8	<0.5	<2.0
12-1 Low	15	—	6.4	26.8	<0.00025	ND	0.0009	ND	0.0096	0.0003	ND	8.2	0.0014	0.81	0.08	0.03	0.126	33.8	0.150	5.4	<0.5	<2.0
12-2 Up	10	5.5	4.4	27.0	<0.00025	ND	0.0013	0.0005	0.0124	0.0004	ND	8.2	0.0015	0.81	0.08	0.08	0.131	33.8	0.217	5.9	<0.5	<2.0
12-2 Mid	10	—	6.4	27.0	<0.00025	0.0006	0.0017	0.0008	0.0094	0.0008	ND	8.2	0.0015	0.84	0.08	0.08	0.129	34.0	0.238	5.7	<0.5	<2.0
12-2 Low	20	—	5.0	26.9	<0.00025	0.0002	0.0013	0.0004	0.0104	0.0005	ND	8.2	0.0013	0.87	0.08	0.07	0.134	33.9	0.201	5.4	<0.5	<2.0
12-3 Up	<10	6.5	4.4	26.9	<0.00025	ND	0.0013	ND	0.0004	ND	ND	8.2	0.0027	0.52	0.02	0.02	0.135	34.5	0.347	6.1	<0.5	<2.0
12-3 Mid	<10	—	4.8	26.9	<0.00025	ND	0.0008	0.0004	0.0005	ND	ND	8.2	0.0024	0.53	0.02	0.02	0.141	34.5	0.272	6.1	<0.5	<2.0
12-3 Low	<10	—	4.6	26.8	<0.00025	ND	0.0006	0.0003	0.0003	ND	ND	8.2	0.0025	0.53	0.02	0.02	0.129	34.6	0.206	5.7	<0.5	<2.0
12-4 Up	<10	6.5	8.0	26.7	<0.00025	ND	0.0005	ND	0.0039	0.0005	ND	8.2	0.0024	0.55	0.01	0.03	0.134	34.4	0.320	6.0	<0.5	<2.0
12-4 Mid	10	—	6.3	26.7	<0.00025	ND	0.0008	0.0003	0.0058	0.0005	ND	8.2	0.0025	0.55	0.01	0.02	0.133	34.4	0.268	5.9	<0.5	<2.0
12-4 Low	10	—	7.1	26.6	<0.00025	ND	0.0005	0.0003	0.0029	0.0005	ND	8.2	0.0034	0.60	0.01	0.02	0.141	34.4	0.285	5.8	<0.5	<2.0
12-5 Up	10	5.0	5.7	27.4	<0.00025	ND	0.0005	ND	0.0031	0.0003	ND	8.1	0.0020	0.56	0.01	0.02	0.135	33.6	0.189	5.7	<0.5	<2.0
12-5 Mid	20	—	6.2	27.3	<0.00025	ND	0.0004	ND	0.0028	0.0003	ND	8.1	0.0023	0.57	0.01	0.02	0.137	33.7	0.251	5.4	<0.5	<2.0
12-5 Low	<10	—	6.1	27.3	<0.00025	0.0001	0.0005	ND	0.0030	0.0003	ND	8.1	0.0021	0.58	0.01	0.02	0.135	33.7	0.303	5.4	<0.5	<2.0
12-6 Up	<10	5.5	3.7	27.2	<0.00025	ND	0.0006	ND	0.0027	0.0004	ND	8.1	0.0019	0.54	0.01	0.02	0.134	33.0	0.285	5.6	<0.5	<2.0
12-6 Mid	20	—	5.0	27.2	<0.00025	ND	0.0016	ND	0.0029	0.0004	ND	8.1	0.0020	0.59	0.02	0.02	0.135	33.1	0.272	5.5	<0.5	<2.0
12-6 Low	25	—	5.4	27.2	<0.00025	ND	0.0005	ND	0.0057	0.0004	ND	8.1	0.0020	0.58	0.02	0.02	0.134	33.2	0.320	5.3	<0.5	<2.0
12-7 Up	<10	6.0	6.0	26.7	<0.00025	ND	0.0005	ND	0.0024	0.0003	ND	8.1	0.0027	0.55	0.02	0.02	0.141	34.5	0.220	6.0	<0.5	<2.0
12-7 Mid	20	—	5.4	26.7	<0.00025	ND	0.0004	ND	0.0032	0.0004	ND	8.1	0.0025	0.53	0.01	0.03	0.137	34.5	0.175	5.9	<0.5	<2.0
12-7 Low	<10	—	7.4	26.6	<0.00025	ND	0.0004	ND	0.0032	0.0004	ND	8.2	0.0026	0.52	0.01	0.02	0.133	34.6	0.137	5.8	<0.5	<2.0
12-8 Up	10	5.0	4.3	27.3	0.0003	ND	0.0005	ND	0.0029	0.0003	ND	8.1	0.0025	0.52	0.01	0.02	0.130	33.1	0.175	5.5	<0.5	<2.0

Sampling Station	Coliform Bacteria	Transparency	Suspended Solid	Water Temperature	Chromium	Cadmium	Copper	Lead	Zinc	Nickel	Mercury	pH	Arsenic	Nitrate	Nitrite	Ammonia Nitrogen	Orthophosphate	Salinity	Silicate	DO	Oil	BOD
	CPU/100mL	m	mg/L	℃	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	—	mg/L	mg/L	mg/L	mg/L	PO_4^{3-}mg/L	psu	$mgSiO_2$/L	mg/L	mg/L	mg/L
12-8 Mid	<10	—	6.2	27.2	<0.00025	ND	0.0007	0.0006	0.0039	0.0008	ND	8.1	0.0020	0.66	0.01	0.02	0.137	33.0	0.285	5.3	<0.5	<2.0
12-8 Low	<10	—	5.5	27.1	<0.00025	0.0001	0.0006	0.0004	0.0040	0.0008	ND	8.1	0.0020	0.61	0.01	0.02	0.135	33.2	0.292	5.2	<0.5	<2.0
12-9 Up	20	5.5	4.2	27.1	<0.00025	ND	0.0006	ND	0.0026	0.0003	ND	8.1	0.0021	0.56	0.01	0.02	0.139	33.3	0.230	6.0	<0.5	<2.0
12-9 Mid	<10	—	6.2	27.1	<0.00025	ND	0.0007	ND	0.0030	0.0004	ND	8.1	0.0021	0.64	0.01	0.02	0.129	33.3	0.268	6.0	<0.5	<2.0
12-9 Low	<10	—	6.6	26.9	<0.00025	ND	0.0006	ND	0.0028	0.0004	ND	8.1	0.0021	0.55	0.02	0.03	0.138	33.3	0.285	5.8	<0.5	<2.0
12-10 Up	35	5.0	5.7	27.2	<0.00025	ND	0.0006	ND	0.0028	0.0004	ND	8.1	0.0022	0.52	0.01	0.02	0.134	33.5	0.175	5.3	<0.5	<2.0
12-10 Mid	<10	—	5.8	27.1	<0.00025	ND	0.0006	ND	0.0029	0.0004	ND	8.1	0.0022	0.53	0.01	0.02	0.135	33.5	0.268	5.2	<0.5	<2.0
12-10 Low	20	—	5.1	27.0	0.0003	<0.0001	0.0006	ND	0.0019	0.0003	ND	8.1	0.0024	0.51	0.02	0.02	0.135	33.6	0.137	5.1	<0.5	<2.0
12-11 Up	20	5.0	4.9	27.2	<0.00025	ND	0.0007	0.0013	0.0062	0.0011	ND	8.1	0.0020	0.54	0.01	0.02	0.128	33.4	0.320	5.9	<0.5	<2.0
12-11 Mid	15	—	5.8	27.1	<0.00025	ND	0.0010	0.0003	0.0066	0.0006	ND	8.1	0.0019	0.59	0.01	0.02	0.124	33.5	0.175	5.9	<0.5	<2.0
12-11 Low	10	—	4.0	27.0	<0.00025	ND	0.0010	ND	0.0057	0.0005	ND	8.1	0.0021	0.52	0.01	0.02	0.127	33.7	0.175	5.6	<0.5	<2.0
12-12 Up	20	4.0	3.6	27.4	<0.00025	ND	0.0006	0.0005	0.0039	0.0005	ND	8.1	0.0025	0.55	0.02	0.02	0.128	33.4	0.216	5.6	<0.5	<2.0
12-12 Mid	20	—	4.8	27.3	<0.00025	ND	0.0008	0.0005	0.0050	0.0007	ND	8.1	0.0021	0.59	0.02	0.02	0.137	33.5	0.282	5.4	<0.5	<2.0
12-12 Low	<10	—	3.6	27.2	<0.00025	ND	0.0007	0.0004	0.0078	0.0005	ND	8.1	0.0021	0.52	0.02	0.02	0.134	33.5	0.258	5.3	<0.5	<2.0
Class B Marine Water Body Quality Standard	—	—	—	—	—	0.01	0.03	0.1	0.5	—	0.002	7.5~8.5	0.05	—	—	—	—	—	—	5.0	—	3.0

Data Source: Based on statistical survey results of this project, Asia Environmental Technical Corporation is assigned by on-site survey (Accreditation Number by EPA: 003), sampling stations 12-5 and 12-11 are conducted on 15th November 2016, the remaining are conducted on 11th December 2016.

Table 6.2.2-22 Supplementary Marine Water Monitoring Results on Common Corridor in Lunwei Area

Sampling Station	Coliform Bacteria	Transparency	Suspended Solid	Water Temperature	Chromium	Cadmium	Coper	Lead	Zinc	Nickel	Mercury	pH	Arsenic	Nitrate	Nitrite	Ammonia				Arsenic	Nitrate	Nitrite
	CPU/100mL	m	mg/L	℃	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	—	mg/L	mg/L	mg/L	mg/L	PO_4^{3-}mg/L	psu	mgSiO_2/L	mg/L	mg/L	mg/L
M-N1(Surface)	<10	1.85	10.7	29.4	<0.005	ND	0.0006	<0.0005	0.0027	<0.0005	ND	8.0	0.0014	1.37	ND	<0.1	<0.061	32.7	<1.0	7.6	<0.5	<2.0
M-N1(Middle Layer)	<10	—	14.1	28.1	<0.005	<0.0005	0.0006	0.0007	0.0042	<0.0005	ND	8.0	0.0014	1.43	<0.03	<0.1	<0.061	32.7	<1.0	7.6	<0.5	<2.0
M-N1(Bottom)	<10	—	12.2	27.3	<0.005	ND	0.0012	<0.0005	0.0036	0.0006	ND	8.0	0.0014	1.54	<0.03	<0.1	<0.061	32.7	<1.0	7.5	<0.5	<2.0
M-N2(Surface)	<10	1.78	13.1	29.3	<0.005	ND	0.0032	<0.0005	0.0023	0.0005	ND	7.9	0.0013	1.54	<0.03	<0.1	<0.061	31.4	<1.0	7.3	<0.5	<2.0
M-N2(Middle Layer)	<10	—	11.2	29.3	<0.005	ND	0.0006	<0.0005	0.0026	<0.0005	ND	7.9	0.0013	1.63	<0.03	<0.1	<0.061	31.4	<1.0	7.3	<0.5	<2.0
M-N2(Bottom)	<10	—	12.9	28.9	<0.005	ND	0.0005	<0.0005	0.0013	0.0006	ND	7.9	0.0014	1.49	<0.03	<0.1	<0.061	31.4	<1.0	7.3	<0.5	<2.0
M-N3(Surface)	<10	1.73	15.2	29.9	<0.005	ND	0.0010	<0.0005	0.0036	0.0007	ND	7.9	0.0013	1.56	<0.03	<0.1	<0.061	31.0	<1.0	7.2	<0.5	<2.0
M-N3(Middle Layer)	<10	—	12.7	29.7	<0.005	ND	0.0015	0.0006	0.0042	<0.0005	ND	7.9	0.0012	1.58	<0.03	<0.1	<0.061	31.0	<1.0	7.2	<0.5	<2.0
M-N3(Bottom)	<10	—	14.2	29.4	<0.005	ND	0.0010	<0.0005	0.0046	<0.0005	ND	7.9	0.0014	1.68	0.04	<0.1	<0.061	31.1	<1.0	7.2	<0.5	<2.0
Class B Marine Water Body Quality Standard	—	—	—	—	—	0.01	0.03	0.1	0.5	—	0.002	7.5~8.5	0.05	—	—	—	—	—	—	5.0	—	3.0

Data Source: Based on statistical survey results of this project, Asia Environmental Technical Corporation is assigned by on-site survey (Accreditation Number by EPA: 164).

Table 6.2.2-23 First Intertidal Zone Water Quality Monitoring Results

Sampling Station	Coliform Bacteria	Transparency	Suspended Solid	Water Temperature	Chromium	Cadmium	Copper	Lead	Zinc	Nickel	Mercury	pH	Arsenic	Nitrate	Nitrite	Ammonia Nitrogen	Orthophosphate	Salinity	Silicate	DO	Oil	BOD
	CPU/100mL	m	mg/L	℃	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	—	mg/L	mg/L	mg/L	mg/L	PO_4^{3-}mg/L	psu	$mgSiO_2/L$	mg/L	mg/L	mg/L
Intertidal Zone -1-Up	100	1.2	33.6	29.6	<0.00025	ND	0.0004	0.0003	0.0013	0.0003	ND	8.1	0.0012	0.18	0.01	0.14	0.049	33.9	0.284	6.3	<0.5	<2.0
Intertidal Zone -1-Low	150	—	20.4	29.6	<0.00025	ND	0.0004	ND	0.0016	0.0003	ND	8.1	0.0012	0.18	0.02	0.09	0.042	33.9	0.249	6.4	<0.5	<2.0
Intertidal Zone -2-Up	95	1.0	21.6	29.6	<0.00025	0.0001	0.0007	0.0003	0.0012	0.0003	ND	8.1	0.0021	0.21	ND	0.08	0.044	34.0	0.228	6.3	<0.5	<2.0
Intertidal Zone -2-Low	90	—	23.9	29.5	<0.00025	0.0001	0.0005	0.0003	0.0014	0.0002	ND	8.1	0.0011	0.15	ND	0.08	0.071	34.0	0.312	6.6	<0.5	<2.0
Intertidal Zone -3-Up	55	1	54.8	30.3	<0.00025	0.0001	0.0004	ND	0.0021	0.0006	ND	8.1	0.0021	0.36	0.01	0.11	0.050	34.1	0.346	6.4	<0.5	<2.0
Intertidal Zone -3-Low	55	—	28.8	30.1	<0.00025	0.0001	0.0005	0.0003	0.0012	0.0007	ND	8.1	0.0013	0.20	0.01	0.11	0.073	34.0	0.218	6.2	<0.5	<2.0
Intertidal Zone -4-Up	35	0.7	106.0	30.0	<0.00025	ND	0.0006	ND	0.0011	0.0007	ND	8.1	0.0021	0.26	ND	0.08	0.055	34.1	0.259	6.5	<0.5	<2.0
Intertidal Zone -4-Low	35	—	83.6	30.1	<0.00025	ND	0.0005	0.0004	0.0011	0.0003	ND	8.1	0.0013	0.28	0.01	0.11	0.028	34.0	0.200	6.3	<0.5	<2.0
Intertidal Zone -5-Up	35	0.5	183.0	30.0	<0.00025	ND	0.0006	ND	0.0011	0.0003	ND	8.1	0.0021	0.34	0.01	0.10	0.051	33.8	0.190	6.1	<0.5	<2.0
Intertidal Zone -5-Low	55	—	174.0	30.4	<0.00025	ND	0.0005	0.0003	0.0009	0.0003	ND	8.1	0.0029	0.27	0.01	0.11	0.092	33.8	0.246	6.3	<0.5	<2.0
Intertidal Zone -6-Up	75	0.5	120.0	29.9	<0.00025	0.0001	0.0012	ND	0.0008	0.0003	ND	8.0	0.0022	0.29	0.02	0.10	0.067	33.5	0.253	6.2	<0.5	<2.0
Intertidal Zone -6-Low	350	—	139.0	29.8	<0.00025	0.0001	0.0006	0.0002	0.0010	0.0004	ND	8.0	0.0013	0.36	0.01	0.13	0.064	33.6	0.218	6.1	<0.5	<2.0
Intertidal Zone -7-Up	250	0.5	145.0	29.6	<0.00025	0.0001	0.0006	0.0003	0.0019	0.0006	ND	8.1	0.0012	0.44	0.01	0.10	0.076	33.2	0.190	6.3	<0.5	<2.0
Intertidal Zone -7-Low	90	—	143.0	29.6	<0.00025	0.0001	0.0013	ND	0.0028	0.0007	ND	8.1	0.0018	0.47	0.02	0.15	0.061	32.9	0.128	5.9	<0.5	<2.0
Class B Marine Water Body Quality Standard	—	—	—	—	—	0.01	0.03	0.1	0.5	—	0.002	7.5~8.5	0.05	—	—	—	—	—	—	5.0	—	3.0

Data Source: Based on statistical survey results, Asia Environmental Technical Corporation is assigned by on-site survey (Accreditation Number by EPA: 003). It is conducted on 5th September 2016.

Table 6.2.2-24 Second Intertidal Zone Water Quality Monitoring Results

Sampling Station	Coliform Bacteria	Transparency	Suspended	Water Temperature	Chromium	Cadmium	Copper	Lead	Zinc	Nickel	Mercury	pH	Arsenic	Nitrate	Nitrite	Ammonia Nitrogen	Orthophosphate	Salinity	Silicate	DO	Oil	BOD
	CPU/100mL	m	mg/L	℃	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	—	mg/L	mg/L	mg/L	mg/L	PO_4^{3-}mg/L	psu	$mgSiO_2/L$	mg/L	mg/L	mg/L
Intertidal Zone -1-Up	35	0.9	62.2	28.3	<0.00025	ND	0.0005	ND	0.0049	0.0002	ND	8.0	0.0019	0.53	0.30	0.05	0.107	31.9	0.298	6.2	<0.5	<2.0
Intertidal Zone -1-Low	10	—	60.0	28.6	<0.00025	ND	0.0008	0.0003	0.0086	0.0004	ND	8.0	0.0017	0.66	0.29	0.03	0.093	31.9	0.264	6.1	<0.5	<2.0
Intertidal Zone -2-Up	20	0.8	25.0	28.5	<0.00025	0.0001	0.0007	0.0003	0.0043	0.0003	ND	8.0	0.0017	0.56	0.25	0.05	0.118	32.0	0.281	6.2	<0.5	<2.0
Intertidal Zone -2-Low	45	—	24.7	28.4	<0.00025	ND	0.0007	ND	0.0074	0.0004	ND	8.0	0.0018	0.57	0.24	0.05	0.121	31.9	0.250	6.2	<0.5	<2.0
Intertidal Zone -3-Up	130	0.8	29.8	28.1	<0.00025	0.0001	0.0008	0.0005	0.0054	0.0004	ND	7.9	0.0019	0.54	0.28	0.05	0.124	31.3	0.233	6.3	<0.5	<2.0
Intertidal Zone -3-Low	50	—	22.9	28.0	<0.00025	0.0001	0.0007	0.0004	0.0047	0.0005	ND	8.0	0.0019	0.58	0.28	0.03	0.120	31.8	0.129	6.2	<0.5	<2.0
Intertidal Zone -4-Up	<10	0.6	50.6	28.2	<0.00025	0.0001	0.0007	0.0003	0.0034	0.0003	ND	8.0	0.0018	0.63	0.28	0.05	0.097	31.8	0.271	6.2	<0.5	<2.0
Intertidal Zone -4-Low	10	—	63.3	28.2	<0.00025	0.0001	0.0005	0.0003	0.0016	0.0004	ND	8.0	0.0019	0.63	0.27	0.04	0.159	31.8	0.378	6.2	<0.5	<2.0
Intertidal Zone -5-Up	<10	0.5	40.7	28.3	<0.00025	0.0001	0.0006	0.0004	0.0022	0.0005	ND	8.0	0.0016	0.56	0.27	0.05	0.096	31.9	0.298	6.2	<0.5	<2.0
Intertidal Zone -5-Low	20	—	34.7	28.1	<0.00025	0.0001	0.0007	0.0005	0.0058	0.0003	ND	8.0	0.0018	0.55	0.25	0.05	0.102	31.8	0.271	6.3	<0.5	<2.0
Intertidal Zone -6-Up	65	0.5	40.9	28.6	<0.00025	ND	0.0006	ND	0.0057	0.0003	ND	8.0	0.0019	0.54	0.27	0.04	0.097	31.8	0.215	6.2	<0.5	<2.0
Intertidal Zone -6-Low	15	—	37.9	28.4	<000025	0.0001	0.0009	0.0004	0.0058	0.0003	ND	8.0	0.0019	0.59	0.28	0.03	0.122	31.8	0.236	6.1	<0.5	<2.0
Intertidal Zone -7-Up	<10	0.5	61.5	28.5	<0.00025	ND	0.0009	0.0004	0.0026	0.0005	ND	8.0	0.0017	0.54	0.28	0.05	0.111	32.0	0.354	6.1	<0.5	<2.0
Intertidal Zone -7-:Low	20	-	59.0	28.2	<0.00025	0.0001	0.0014	0.0003	0.0045	0.0005	ND	8.0	0.0017	0.64	0.27	0.03	0.110	31.9	0.195	6.1	<0.5	<2.0
Class B Marine Water Body Quality Standard	—	—	—	—	—	0.01	0.03	0.1	0.5	—	0.002	7.5~8.5	0.05	—	—	—	—	—	—	5.0	—	3.0

Data Source: Based on statistical survey results, Asia Environmental Technical Corporation is assigned by on-site survey (Accreditation Number by EPA: 003). It is conducted on 6th November 2016.

Table 6.2.2-25 Third Intertidal Zone Water Quality Monitoring Results

Sampling Station	Coliform Bacteria	Transparency	Suspended Solid	Water Temperature	Chromium	Cadmium	Copper	Lead	Zinc	Nickel	Mercury	pH	Arsenic	Nitrate	Nitrite	Ammonia Nitrogen	Orthophosphate	Salinity	Silicate	DO	Oil	BOD
	CPU/100mL	m	mg/L	℃	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	—	mg/L	mg/L	mg/L	mg/L	PO_4^{3-}mg/L	psu	$mgSiO_2$/L	mg/L	mg/L	mg/L
Intertidal Zone -1-Up	120	0.2	88.0	24.5	<0.00025	ND	0.0023	ND	0.0012	0.0011	ND	8.0	0.0013	0.30	0.09	0.04	0.176	33.3	0.247	6.0	<0.5	<2.0
Intertidal Zone -1-Low	45	—	92.7	24.4	<0.00025	ND	0.0010	ND	0.0015	0.0010	ND	8.0	0.0013	0.32	0.10	0.04	0.160	33.2	0.257	6.0	<0.5	<2.0
Intertidal Zone -2-Up	40	0.2	62.0	24.7	<0.00025	ND	0.0008	ND	0.0011	0.0011	ND	8.1	0.0013	0.37	0.11	0.03	0.129	33.4	0.321	5.9	<0.5	<2.0
Intertidal Zone -2-Low	35	—	76.8	24.5	<0.00025	ND	0.0007	ND	0.0010	0.0009	ND	8.0	0.0013	0.36	0.11	0.06	0.116	33.5	0.291	6.0	<0.5	<2.0
Intertidal Zone -3-Up	240	0.3	51.7	24.5	<0.00025	ND	0.0007	ND	0.0009	0.0010	ND	8.0	0.0013	0.37	0.11	0.05	0.131	33.2	0.260	6.1	<0.5	<2.0
Intertidal Zone -3-Low	190	—	63.7	24.6	<0.00025	ND	0.0006	ND	0.0015	0.0010	ND	8.0	0.0014	0.37	0.10	0.07	0.145	33.1	0.233	6.0	<0.5	<2.0
Intertidal Zone -4-Up	110	0.2	37.2	24.5	<0.00025	ND	0.0008	ND	0.0014	0.0009	ND	8.0	0.0017	0.41	0.10	0.05	0.134	33.2	0.253	6.1	<0.5	<2.0
Intertidal Zone -4-Low	140	—	73.4	24.3	<0.00025	ND	0.0007	ND	0.0014	0.0009	ND	8.0	0.0014	0.41	0.09	0.02	0.141	33.3	0.335	6.1	<0.5	<2.0
Intertidal Zone -5-Up	65	0.3	36.3	24.6	<0.00025	0.0001	0.0007	ND	0.0015	0.0010	ND	8.1	0.0014	0.44	0.10	0.09	0.139	33.0	0.297	6.0	<0.5	<2.0
Intertidal Zone -5-Low	170	—	30.2	24.7	<0.00025	ND	0.0006	ND	0.0012	0.0009	ND	8.0	0.0016	0.42	0.09	0.06	0.118	33.1	0.193	6.1	<0.5	<2.0
Intertidal Zone -6-Up	25	0.3	64.7	24.8	<0.00025	ND	0.0006	ND	0.0021	0.0009	ND	8.0	0.0014	0.30	0.08	0.06	0.120	33.5	0.297	6.4	<0.5	<2.0
Intertidal Zone -6-Low	55	—	41.6	24.9	<0.00025	ND	0.0007	ND	0.0013	0.0009	ND	8.0	0.0015	0.42	0.08	0.05	0.163	33.5	0.341	6.4	<0.5	<2.0
Intertidal Zone -7-Up	140	0.2	47.2	25.1	<0.00025	ND	0.0006	ND	0.0011	0.0008	ND	8.1	0.0013	0.41	0.09	0.02	0.128	33.4	0.233	5.9	<0.5	<2.0
Intertidal Zone -7-:Low	70	—	52.9	25.3	<0.00025	ND	0.0006	ND	0.0011	0.0009	ND	8.1	0.0014	0.49	0.13	0.05	0.153	33.5	0.260	5.9	<0.5	<2.0
Class B Marine Water Body Quality Standard	—	—	—	—	—	0.01	0.03	0.1	0.5	—	0.002	7.5~8.5	0.05	—	—	—	—	—	—	5.0	—	3.0

Data Source: Based on statistical survey results of this project, Asia Environmental Technical Corporation is assigned by on-site survey (Accreditation Number by EPA: 164).

Tabvle 6.2.2-26 Supplementary Marine Water Monitoring Results on Common Corridor in Lunwei Area

Sampling Station	Coliform Bacteria	Transparency	Suspended Solid	Water Temperature	Chromium	Cadmium	Copper	Lead	Zinc	Nickel	Mercury	pH	Arsenic	Nitrate	Nitrite	Ammonia Nitrogen	Orthophosphate	Salinity	Silicate	DO	Oil	BOD
	CPU/100mL	m	mg/L	℃	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	—	mg/L	mg/L	mg/L	mg/L	PO_4^{3-}mg/L	psu	$mgSiO_2$/L	mg/L	mg/L	mg/L
IT-N1(Surface)	$1.4x10^3$	0.32	37.5	31.7	<0.005	ND	0.0047	<0.0005	0.0235	<0.0005	ND	7.7	0.0022	2.42	0.35	0.12	0.064	18.4	<1.0	5.8	<0.5	<2.0
IT-N1(Bottom)	$8.5x10^2$	—	33.7	31.3	<0.005	ND	0.0039	<0.0005	0.0282	0.0005	ND	7.7	0.0019	2.24	0.34	0.13	0.061	18.4	<1.0	5.8	<0.5	<2.0
IT-N2(Surface)	$2.2x10^3$	0.33	36.6	31.6	<0.005	ND	0.0049	<0.0005	0.0259	<0.0005	ND	7.7	0.0019	2.30	0.34	0.14	0.086	18.4	<1.0	5.8	<0.5	<2.0
IT-N2(Bottom)	$1.5x10^3$	—	35.4	31.5	<0.005	ND	0.0057	<0.0005	0.0204	<0.0005	ND	7.7	0.0021	2.35	0.36	0.14	0.068	18.4	<1.0	5.8	<0.5	<2.0
IT-N3(Surface)	$9.5x10^2$	0.37	31.5	31.5	<0.005	ND	0.0051	<0.0005	0.0165	<0.0005	ND	7.7	0.0022	2.48	0.34	0.12	0.074	18.5	<1.0	5.8	<0.5	<2.0
IT-N3(Bottom)	$6.5x10^2$	—	33.0	31.4	<0.005	ND	0.0058	0.0006	0.0395	0.0005	ND	7.7	0.0020	2.42	0.34	0.12	0.080	18.5	<1.0	5.8	<0.5	<2.0
Class B Marine Water Body Quality Standard	—	—	—	—	—	0.01	0.03	0.1	0.5	—	0.002	7.5~8.5	0.05	—	—	—	—	—	—	5.0	—	3.0

Data Source: Based on statistical survey results of this project, Asia Environmental Technical Corporation is assigned by on-site survey (Accreditation Number by EPA: 164).

IV. Marine Sediment

According to wind farm and 12 stations in the vicinity of Operational Rules of Environmental Impact Assessment for Development, monitoring locatiosn are shown as Figure 6.2.2-10. Supplementary surveys of marine sediment are conducted at October and November of 2016. As environmental standards of marine sediment is yet to be established, it is referred to marine sediment standards of National Ocean and Atmosphere Administration,NOAA, it is listed in Table 6.2.2-27. As TEL indicates chemical substances is less than this value, it will not cause any harm to creatures.

From survey results of 2 sediment surveys, heavy metal content of bottom mud is shown as Table 6.2.2-28 and 6.2.2-29. There are no special high values for all heavy metal, and PEL are not exceeded.

3 supplementary surveys were conducted on 8th July 2017 regarding common corridor of Lunwei Area, heavy metal of sediment is shown as Table 6.2.2-30. Based on survey results, heavy metal content of monitoring stations M-N1, M-N2 and M-N3 do not exceed PEL.

Table 6.2.2-27 Marine Sediment Regulations of National Oceanic and Atmospheric Administration (NOAA)

Item	Threshold Effect Level (TEL)	Effect Range-Low (ERL)	Probable Effect Level (PEL)	Effect Range-Median (ERM)
Arsenic	7.24	8.2	41.6	70
Cadmium	0.7	1.2	4.2	9.6
Chromium	52.3	81	160	370
Copper	18.7	34	108	270
Lead	30.2	46.7	112	218
Mercury	0.13	0.15	0.7	0.71
Nickel	15.9	20.9	42.8	51.6
Zinc	124	150	271	410

Remarks: Unit: mg/kg Dry Weight
Data Source: National Ocean and Atmosphere Administration,NOAA

Table 6.2.2-28 First Marine Sediment Monitoring Results (20th October 2016)

Sampling Station	Cadmium	Chromium	Copper	Nickel	Lead	Zinc	Mercurty	Arsenic
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
15-1	ND	17.5	5.18	19.2	9.40	56.7	ND	12.4
15-2	ND	18.6	5.11	21.5	11.0	62.8	ND	13.0
15-3	ND	26.4	3.12	25.9	29.2	79.5	ND	84.6
15-4	ND	25.8	3.68	25.3	24.2	80.2	ND	62.5
15-5	ND	25.5	10.0	23.7	14.1	71.5	ND	9.43
15-6	ND	26.5	10.1	24.5	14.1	73.6	ND	9.71
15-7	ND	26.2	4.14	24.8	20.1	80.1	ND	48.4
15-8	ND	23.7	12.9	27.1	17.4	82.6	ND	10.6
15-9	ND	18.7	5.71	20.9	10.1	62.4	ND	10.1
15-10	ND	28.5	10.4	26.4	15.4	80.0	ND	9.21
15-11	ND	17.3	5.74	18.8	9.49	58.1	ND	9.77
15-12	ND	20.3	5.56	24.0	11.4	70.8	ND	9.15

Remarks: Sampling dates of 15-3, 15-4 and 15-7 is 1st of September 2016. Date of other sampling station is 15th November 2016.

Data Source: Based on statistical survey results of this project, Asia Environmental Technical Corporation is assigned by on-site survey (Accreditation Number by EPA: 003).

Table 6.2.2-29 Second Marine Sediment Monitoring Results

Sampling Station	Cadmium	Chromium	Copper	Nickel	Lead	Zinc	Mercurty	Arsenic
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
15-1	ND	25.9	8.36	21.2	25.4	73.3	ND	16.7
15-2	ND	24.6	9.44	19.7	25.9	76.5	ND	18.2
15-3	ND	25.2	12.5	26.0	17.6	82.6	ND	81.0
15-4	ND	21.3	8.94	15.8	19.1	99.0	ND	59.4
15-5	ND	15.9	6.87	11.9	14.2	73.7	ND	9.18
15-6	ND	19.6	9.76	20.3	13.3	63.0	ND	10.6
15-7	ND	26.1	8.85	21.0	14.2	83.7	ND	41.1
15-8	ND	19.0	6.96	15.4	9.71	63.9	ND	9.13
15-9	ND	19.2	11.5	18.9	13.5	70.5	ND	10.6
15-10	ND	13.4	6.06	10.1	12.1	61.6	ND	7.03
15-11	ND	15.8	6.91	12.0	14.0	73.5	ND	8.73
15-12	ND	10.4	5.16	8.00	9.53	47.5	ND	6.99

Remarks: Sampling dates of 15-3-15-2 is 15th November 2016; Sampling dates of 15-1 and 15-2 is 11th December 2016.

Data Source: Based on statistical survey results of this project, Asia Environmental Technical Corporation is assigned by on-site survey (Accreditation Number by EPA: 003).

Table 6.2.2-30 Supplementary Marine Sediment Monitoring Results on Common Corridor in Lunwei Area

Sampling Station	Cadmium	Chromium	Copper	Nickel	Lead	Zinc	Mercurty	Arsenic
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
M-N1	<0.505	21.1	10.5	18.0	18.3	78.8	ND	12.0
M-N2	<0.505	19.7	8.01	19.1	15.9	67.2	ND	10.5
M-N3	<0.505	21.5	8.23	16.2	18.7	64.8	ND	10.6

Data Source: Based on statistical survey results of this project, Asia Environmental Technical Corporation is assigned by on-site survey (Accreditation Number by EPA: 164).

6.2.3 Air Quality

Terrestrial facility of this project includes construction roads and power transmission line, encompassing Xianxi Township and Lukang Township. According to "Air Pollution Control Zone of Municipal and County (City)" promulgated by Environmental Protection Administration, Executive Yuan and results of Environmental Protection Bureau Changhua County, air pollution sources including particulate maters (PM10), Ozone (O3), sulphur dioxide (SO2), nitrogen dioxide (NO2) and carbon monoxide (CO) are complaince with Class II Air Pollution Control Region; Based on Official Letter 1050061014 promulgated by Environmental Protection Administration, since 1st January 2017, particulate matters (PM2.5) is designated as Class III Air Pollution Control Zone. Shalu, Xianxi and Erlin monitoring stations and on-site supplementary monitoring stations are located in the vicinity of site, the statistical results is shown as follows:

V. Monitoring Results of EPA

The locations of Changhua City, Xianxi and Erlin monitoirng stations which constructed by Environmental Protection Administration are shown as Figure 6.2.3-1. The monitoring statistical analysis from 2014 to 2016 is shown as Table 6.2.3-1:

(i) Particulate Matter (PM_{10})

It is defined as particulate matter with diameter below 10μm, it is also known as floating dust. Fugitive dust, waste gas emitted by cars, open buring and construction are the major sources of these particulate matters. The average of Shalu Station ranges between 25 and 74 μg/m3; Xianxi Station ranges between 25 and 80 μg/m3; Erlin Station ranges between 28 and 88 μg/m3.

(ii) Particulate Matter (PM2.5)

It is defined as particulate matter with diameter below 2.5μm. Buring is the major source of these substances, such as fossil fuels and industrial emission, exhaust gas of mobile source. The value of Shalu Staion ranges between 8 and 42 μg/m3. Xianxi Station ranges from 11μg/m3 to 46 μg/m3 and Erlin Station ranges from 11 to 49 μg/m3.

(iii) Suphur Dioxide (SO_2)

Sulphur dioxide is an colorless gas with irritaing ordour. The mean monthly value of Shalu Station ranges from 2.3ppb to 4.2ppb. For Xianxi Station, it ranges from 2.3ppb to 4.8ppb.

(iv) Nitrogen Dioxide (NO_2)

Nitrogen dioxide is an brown irritating gaseous. The major source is burning fuels, manufacture emission and emission of transporation, The mean value per month of Shalu Station is from 9.61 to 19.50ppb. Xianxi Station ranges from 5.26 to

18.11ppb. For Erlin Station, it ranges between 5.16 and 15.26ppb.

(v) Carbon Monoxide (CO)

Carbon monoxide is an asphyxiating, colorless and ordourless gas. It is mainly attributable to burning of fuels, process emissions and wastegas emission of transporation vehicle. Value per month of Shalu ranges from 0.22ppm to 0.48ppm. For Xianxi Station, it ranges from 0.18ppm to 0.47ppm. The value of Erlin Station per month ranges between 0.14 and 0.43ppm.

(vi) Ozone (O_3)

Ozone is existed in nature. It protects from the excessive ultralight entering atmosphere. During manucfacturing and using process of fixed pollution source and mobile pollution source, emission of Nox and Volatile Organic Compounds (VOC) will form ozone after phtochemical reaction by sunlight. This artificial ozone has strong oxidizing power which has stimulating and siccation effect on eyes, nose and membrane of throat. Thus, it has negative impact on plants as well. In summer and fall (from June to August), Taiwan is affected by Pacific subtropical high, southwesterly flow and typhoon. Southwesterly flow and typhoon are followed with high wind speed and covective airwave which will speed up the dispersion and cleansing of pollutants. Pacific subtropical high is followed with downstream air, thus, wind speed is slower and stabler. This results in photochemical reaction which causes deterioration of ozone air quality. Monthly value of Shalu Station ranges between 19.2ppb and 43.2ppb; Xianxi Stationranges between 18.1ppb and 42.8ppb; Erlin Station ranges between 17.5ppb and 42.7ppb.

VI. On-Site Supplementary Monitoring Station

In the light of “ Operational Rules of Environmental Impact Assessment for Development”, air quality survey shall be conducted in the vicinity of terrestrial development site. From Ausgut to November of 2016, 3 on-site supplemnetary air quality surveys were conducted in total. The location of surveys includes Tianbao Temple, Wuqi Fishery Harbor, Lukang Industrial Park, Putian Temple, Fushun Temple and housing of Fubao Village. The monitoring stations are shown as FIgure 6.2.3-1; Survey results is shown as Table 6.2.3-2 to 5. With respect to some monitoring stations, except for TSP, PM10 and PM2.5, other air quality monitoring results are compliance with air quality standards which indicates air quality around site is in good conditions.

Figure 6.2.3-1 Location Map of Air Quality Monitoring Station of EPA and This Project

Table 6.2.3-1 Actual Statistical Table of Air Quality, EPA (1/3)

Sampling Station	Year	Month	Sulphur Dioxide (SO_2) ppb	Nitrogen Dioxide (NO_2) ppb	Ozone (O_3) ppb	Carbon Monoxide (CO) ppb	Particulate Matter (PM_{10}) $\mu g/m^3$	Fine Particulate Matter ($PM_{2.5}$) $\mu g/m^3$
Shalu Station	2014	1	4.2	18.88	30.7	0.48	72	42
		2	2.5	14.36	31.9	0.38	50	30
		3	3.8	18.38	35.1	0.47	74	42
		4	3.4	15.49	41.5	0.39	64	37
		5	3.1	14.28	26.8	0.35	39	24
		6	3.0	11.65	23.5	0.27	34	18
		7	3.7	10.11	24.3	0.22	35	20
		8	3.4	10.36	24.7	0.23	32	16
		9	3.7	13.14	27.6	0.31	47	24
		10	2.8	14.82	43.2	0.35	69	32
		11	2.7	15.98	32.8	0.41	67	32
		12	3.1	16.02	28.8	0.42	60	26
	2015	1	3.0	16.73	31.9	0.45	65	29
		2	2.6	15.21	32.0	0.44	64	27
		3	2.8	16.33	30.8	0.42	55	25
		4	3.1	13.45	36.1	0.33	51	19
		5	2.9	13.46	25.9	0.32	42	15
		6	2.9	9.93	19.2	0.23	31	8
		7	2.9	9.61	27.3	0.25	42	13
		8	3.3	11.60	25.2	0.29	38	13
		9	3.1	14.61	35.0	0.37	48	19
		10	2.8	15.18	37.3	0.39	59	23
		11	3.2	19.09	30.8	0.47	61	24
		12	2.9	15.62	28.1	0.43	52	20
	2016	1	2.3	15.18	26.7	0.44	44	21
		2	2.3	13.32	32.5	0.41	48	24
		3	2.5	19.50	32.3	0.45	58	32
		4	2.8	15.23	32.9	0.41	59	31
		5	3.0	13.87	29.1	0.35	40	17
		6	2.8	10.35	21.9	0.23	25	9
		7	2.7	9.85	23.3	0.22	29	12
		8	3.2	12.24	32.2	0.29	42	20
		9	2.5	12.24	26.4	0.28	39	17
		10	3.4	16.07	30.9	0.39	59	26
		11	3.0	18.08	29.8	0.40	54	24
		12	2.1	13.62	35.3	0.36	48	23

Data Source: Taiwan Air Quality Monitoring Network, http://taqm.epa.gov.tw/taqm/tw/default.aspx.

Table 6.2.3-1 Actual Statistical Table of Air Quality, EPA (2/3)

Sampling Station	Year	Month	Sulphur Dioxide (SO_2) ppb	Nitrogen Dioxide (NO_2) ppb	Ozone (O_3) ppb	Carbon Monoxide (CO) ppb	Particulate Matter (PM_{10}) μg/m^3	Fine Particulate Matter ($PM_{2.5}$) μg/m^3
Xianxi Station	2014	1	6.1	17.53	29.8	0.46	80	46
		2	4.2	13.51	29.4	0.39	50	30
		3	4.9	13.87	35.8	0.43	68	40
		4	4.7	13.83	42.2	0.40	58	31
		5	3.7	11.00	28.4	0.33	36	19
		6	3.4	7.85	24.6	0.23	33	14
		7	3.4	5.48	25.6	0.19	30	14
		8	3.2	5.26	26.9	0.18	25	13
		9	4.0	9.24	27.9	0.27	40	20
		10	4.6	13.46	42.8	0.37	68	33
		11	4.4	15.50	32.1	0.40	60	31
		12	4.7	16.23	29.3	0.43	64	33
	2015	1	4.8	16.26	32.2	0.47	67	35
		2	4.5	14.38	32.6	0.44	66	36
		3	4.4	14.75	33.2	0.40	57	32
		4	4.1	11.01	36.1	0.32	49	23
		5	3.5	10.23	26.1	0.29	39	20
		6	2.7	6.33	18.1	0.21	30	11
		7	2.8	5.73	29.3	0.21	36	16
		8	3.0	7.49	25.5	0.23	31	13
		9	4.5	12.12	36.0	0.34	44	21
		10	4.7	14.13	37.6	0.38	59	27
		11	4.8	16.49	31.3	0.43	60	30
		12	4.7	16.44	27.7	0.44	55	28
	2016	1	4.1	16.03	28.6	0.42	48	27
		2	3.9	13.83	34.6	0.39	52	30
		3	4.5	18.11	34.8	0.41	61	37
		4	4.1	12.10	35.7	0.37	58	37
		5	3.8	10.40	30.2	0.31	40	23
		6	2.3	7.06	22.6	0.20	28	13
		7	2.8	6.51	24.4	0.18	32	16
		8	3.5	7.64	34.9	0.26	37	20
		9	3.9	10.14	27.6	0.28	40	18
		10	4.6	12.97	30.5	0.34	53	31
		11	5.0	16.59	31.5	0.38	56	32
		12	4.1	14.36	36.5	0.41	62	31

Data Source: Taiwan Air Quality Monitoring Network,http://taqm.epa.gov.tw/taqm/tw/default.aspx

Table 6.2.3-1 Actual Statistical Table of Air Quality, EPA (3/3)

Sampling Station	Year	Month	Sulphur Dioxide (SO_2) ppb	Nitrogen Dioxide (NO_2) ppb	Ozone (O_3) ppb	Carbon Monoxide (CO) ppb	Particulate Matter (PM_{10}) μg/m^3	Fine Particulate Matter ($PM_{2.5}$) μg/m^3
Erlin Station	2014	1	4.8	15.26	32.1	0.42	88	49
		2	3.6	11.97	30.9	0.37	67	30
		3	3.9	12.32	37.3	0.39	81	46
		4	4.5	12.07	42.2	0.38	70	33
		5	2.6	8.54	26.1	0.25	44	19
		6	2.8	6.26	23.4	0.19	32	24
		7	3.0	6.22	24.3	0.15	37	26
		8	2.3	5.45	24.7	0.14	28	23
		9	3.3	8.01	26.4	0.22	44	32
		10	3.8	11.23	42.7	0.33	69	44
		11	4.1	13.05	31.8	0.37	64	43
		12	4.2	14.64	28.3	0.41	66	43
		1	4.8	15.26	32.1	0.42	88	49
	2015	1	4.1	14.29	31.9	0.43	74	43
		2	4.3	12.62	32.2	0.41	69	39
		3	4.4	13.00	32.8	0.40	62	35
		4	3.8	10.39	33.9	0.28	48	26
		5	2.6	8.23	25.3	0.22	38	21
		6	2.6	6.50	17.5	0.15	37	18
		7	2.9	5.16	27.9	0.16	41	19
		8	2.9	5.73	23.2	0.16	34	16
		9	3.9	8.98	34.7	0.29	43	24
		10	4.2	10.34	36.5	0.34	55	29
		11	4.7	12.85	30.5	0.40	65	35
		12	4.4	13.55	28.2	0.41	54	31
	2016	1	3.6	12.41	28.1	0.41	48	26
		2	3.7	11.79	34.1	0.38	54	29
		3	3.9	13.35	35.0	0.40	61	35
		4	4.0	9.27	33.6	0.34	57	32
		5	3.4	8.96	27.8	0.27	39	21
		6	2.7	6.17	20.2	0.15	28	14
		7	3.2	5.88	22.6	0.14	30	15
		8	3.5	6.36	30.8	0.19	38	15
		9	3.5	9.10	26.4	0.25	34	11
		10	4.1	10.34	28.8	0.30	62	24
		11	4.0	12.55	30.8	0.35	64	23
		12	4.0	12.05	35.1	0.36	64	23

Data Source: Taiwan Air Quality Monitoring Network,http://taqm.epa.gov.tw/taqm/tw/default.aspx.

Table 6.2.3-2 Supplementary Survey Results of On-Site Air Quality (August)

Location of Smapling Station / Monitorting Date (Y/M/D) / Pollutant / Item		Tianbao Temple	Wuqi Fishery Harbor	Lukang Industrial Park	Putian Temple	Fushun Temple	Housing of Fubao Village	Air Quality Standard
		7th-8th of August 2016	11th-12th August 2016	10th -11th August 2016	6th- 7th August 2016	12th -13th August 2016	8th- 9th August 2016	
Sulphur Dioxide SO_2 (ppm)	Maximum Per Hour	0.007	0.011	0.015	0.010	0.014	0.008	0.250
	Average Per Day	0.004	0.006	0.008	0.006	0.007	0.006	0.100
Nitrogen Oxide NOx (ppm)	Maximum Per Hour	0.020	0.029	0.020	0.022	0.022	0.017	—
	Average Per Day	0.009	0.013	0.009	0.006	0.013	0.008	—
Nitrogen Dioxide NO_2 (ppm)	Maximum Per Hour	0.015	0.018	0.018	0.013	0.019	0.013	0.250
	Average Per Day	0.006	0.005	0.005	0.004	0.010	0.006	—
Nitric Oxide NO (ppm)	Maximum Per Hour	0.006	0.016	0.011	0.009	0.011	0.008	—
	Average Per Day	0.003	0.007	0.003	0.002	0.002	0.002	—
Carbon Monoxide CO (ppm)	Maximum Per Hour	0.5	1.0	0.7	0.6	0.6	0.7	35
	Average Maximum Value of 8 hrs.	0.3	0.5	0.4	0.4	0.4	0.3	9
Ozone (ppm)	Maximum	0.041	0.017	0.080	0.073	0.048	0.041	0.120
	Average Maximum Value of 8 hrs.	0.027	0.008	0.032	0.040	0.021	0.023	0.060
TSP (μg/m^3)	Value of 24 hours	30	60	89	58	42	47	250
PM_{10} (μg/m^3)	Average Per Day	17	52	105	65	39	40	125
$PM_{2.5}$ (μg/m^3)	Value of 24 hours	8	31	48	36	24	25	35
Lead (μg/m^3)	Value of 24 hours	ND (<0.0452)	ND (<0.0452)	ND (<0.0452)	ND (<0.0452)	ND (<0.0452)	ND (<0.0452)	1.0 (月Average值)
Wind Speed (m/s)	Average Per Day	1.3	0.4	0.2	0.1	0.5	1.4	—
Wind Direction (Deg)	Most Frequent Wind Direction	349.4	264.5	272.0	325.7	178.0	302.7	—
Temperature (℃)	Average Per Day	29.3	29.3	29.0	30.3	26.4	29.7	—
Relative Humidity (%)	Average Per Day	82.7	82.7	82.4	76.1	89.9	77.2	—

Data Source: Based on statistical survey results of this project, Asia Environmental Technical Corporation is assigned by on-site survey (Accreditation Number by EPA: 003).
Control Standards: Official Letter 1010038913 "Air Quality Standards" issued by EPA on 14th May 2012.

Table 6.2.3-3 Supplementary Survey Results of On-Site Air Quality (September)

Pollutant	Item \ Location of Smapling Station / Monitorting Date (Y/M/D)	Tianbao Temple 18th -19th September 2016	Wuqi Fishery Harbor 20th -21st September 2016	Lukang Industrial Park 12th 13th September 2016	Putian Temple 17th -18th September 2016	Fushun Temple 13th -14th September 2016	Housing of Fubao Village 16th -17th September 2016	Air Quality Standard
Sulphur Dioxide SO2 (ppm)	Maximum Per Hour	0.009	0.002	0.015	0.003	0.007	0.004	0.250
	Average Per Day	0.005	0.002	0.004	0.002	0.004	0.002	0.100
Nitrogen Oxide NOx (ppm)	Maximum Per Hour	0.020	0.013	0.031	0.019	0.049	0.020	—
	Average Per Day	0.009	0.007	0.015	0.011	0.022	0.007	—
Nitrogen Dioxide NO2 (ppm)	Maximum Per Hour	0.018	0.011	0.021	0.014	0.022	0.008	0.250
	Average Per Day	0.007	0.005	0.009	0.008	0.012	0.003	—
Nitric Oxide NO (ppm)	Maximum Per Hour	0.005	0.005	0.018	0.006	0.038	0.017	—
	Average Per Day	0.002	0.002	0.006	0.003	0.010	0.003	—
Carbon Monoxide CO (ppm)	Maximum Per Hour	1.0	0.2	0.7	0.5	0.7	3.2	35
	Average Maximum Value of 8 hrs.	0.6	0.1	0.4	0.3	0.5	0.3	9
Ozone (ppm)	Maximum Per Hour	0.087	0.064	0.049	0.052	0.043	0.045	0.120
	Average Maximum Value of 8 hrs.	0.049	0.042	0.040	0.027	0.015	0.024	0.060
TSP (μg/m^3)	Value of 24 hours	81	114	379	42	111	82	250
PM_{10} (μg/m^3)	Average Per Day	53	64	157	26	68	50	125
$PM_{2.5}$ (μg/m^3)	Value of 24 hours	22	18	18	10	18	9	35
Lead (μg/m3)	Value of 24 hours	ND (<0.0452)	ND (<0.0452)	ND (<0.0452)	ND (<0.0452)	ND (<0.0452)	ND (<0.0452)	1.0 (月 Average 值)
Wind Speed (m/s)	Average Per Day	3.3	0.1	2.0	0.3	0.9	2.0	—
Wind Direction (Deg)	Most Frequent Wind Direction	34.5	119.1	13.8	251.5	36.2	330.6	—
Temperature (℃)	Average Per Day	27.3	25.7	27.7	26.9	28.0	28.3	—
Relative Humidity (%)	Average Per Day	67.8	74.5	79.4	83.0	80.9	80.7	—

Data Source: Based on statistical survey results of this project, Asia Environmental Technical Corporation is assigned by on-site survey (Accreditation Number by EPA: 003).
Control Standards: Official Letter 1010038913 “Air Quality Standards” issued by EPA on 14th May 2012.

Table 6.2.3-4 Supplementary Survey Results of On-Site Air Quality (October)

Location of Sampling Station / Monitoring Date (Y/M/D) / Pollutant / Item		Tianbao Temple	Wuqi Fishery Harbor	Lukang Industrial Park	Putian Temple	Fushun Temple	Housing of Fubao Village	Air Quality Standard
		20th -21st October 2016	23rd -24th October 2016	17th -18th October 2016	21st -22nd October 2016	16th -17th October 2016	18th -19th October 2016	
Sulphur Dioxide SO2 (ppm)	Maximum Per Hour	0.007	0.002	0.006	0.006	0.008	0.006	0.250
	Average Per Day	0.002	0.001	0.003	0.003	0.004	0.003	0.100
Nitrogen Oxide	Maximum Per Hour	0.028	0.013	0.019	0.013	0.030	0.049	—
	Average Per Day	0.009	0.004	0.009	0.005	0.015	0.015	—
NOx (ppm)	Maximum Per Hour	0.012	0.012	0.015	0.012	0.020	0.029	0.250
	Average Per Day	0.006	0.004	0.006	0.004	0.011	0.011	—
Nitrogen Dioxide NO2 (ppm)	Maximum Per Hour	0.016	0.001	0.005	0.004	0.018	0.020	—
	Average Per Day	0.003	0.0002	0.003	0.001	0.005	0.004	—
Nitric Oxide	Maximum Per Hour	1.2	0.6	0.9	0.5	0.4	1.7	35
	Average Maximum Value of 8 hrs.	0.7	0.5	0.6	0.3	0.3	0.6	9
NO (ppm)	Maximum Per Hour	0.048	0.039	0.019	0.042	0.043	0.076	0.120
	Average Maximum Value of 8 hrs.	0.017	0.017	0.007	0.007	0.020	0.053	0.060
Carbon Monoxide	Value of 24 hours	152	54	162	60	95	82	250
CO (ppm)	Average Per Day	92	33	74	46	67	61	125
	Value of 24 hours	52	16	42	13	57	32	35
Ozone	Value of 24 hours	ND (<0.0452)	ND (<0.0452)	ND (<0.0452)	ND (<0.0452)	ND (<0.0452)	ND (<0.0452)	1.0 (月 Average 值)
(ppm)	Average Per Day	0.0	0.2	0.0	0.3	0.7	0.1	—
	Most Frequent Wind Direction	245.9	125.0	150.4	185.3	52.4	302.6	—
TSP (μg/m3)	Average Per Day	28.6	27.4	28.8	28.7	28.1	27.6	—
PM10 (μg/m3)	Average Per Day	82.8	81.9	79.1	82.4	79.3	85.5	—

Data Source: Based on statistical survey results of this project, Asia Environmental Technical Corporation is assigned by on-site survey (Accreditation Number by EPA: 003).
Control Standards: Official Letter 1010038913 "Air Quality Standards" issued by EPA on 14th May 2012.

Table 6.2.3-5   Supplementary Survey Results of Fallout Level

Sampling Station	Unit	11th August -12th September 2016	16th September-17th October 2016	17th October - 19th November 2016
Wuqi Fishery Harbor	g/m^2/month	14.0	3.5	3.3
Fushun Temple	g/m^2/month	17.2	5.2	2.8
Lukang Industrial Park	g/m^2/month	40.6	3.0	1.2
Housing of Fubao Village	g/m^2/month	38.4	1.9	2.3
Tianbao Temple	g/m^2/month	19.9	1.3	1.8
Putian Temple	g/m^2/mnth	15.6	4.1	2.8

6.2.4 Noise and Vibration

This site is located at offshore area of Xianxi Township, Changhua County. The main noise vibration around wind farm is produced by vessel. Noise vibration sources around overland route, transporting road and substation are mainly produced by traffic flow. Underwater environment, route of cable and vicinity of terrestrial booster station are classified as sensitive receivers.

In order to understand underwater background value and ambient noise background level, underwater noise measurement is conducted within offshore wind farm area. In the future, assess noise potential affected area during construction and operation of wind turbines by obtaining the characteristic of local underwater background noise. With respect to weekday and weekend 24 hours continuously noise measuring and supplementary vibration survey, vicinity of wind farm, power transmission line or constrcution roads will be selected for terrestrial part. The description of ambient background noise in the vicinity of wind farm and vibration status are described as follows:

VII. Underwater Noise

(i) Measurement of Underwater Background Noise

Underwater acoustic recorder is deployed at 4 locations within wind farm and waters in the vicinity in August of 2016. Underwater acounstic measurement is conducted prior to development. The measurement shall encompass at half hour before and after full tide and low tide to obatin underwater background noise characteristics and underwater noise level. The locations of measurement are shown in Figure 6.2.4-1, related information of sampling station is shown as Table 6.2.4-1. The analysis of noise is generally conducted by 1 Hz Spectrogram and bandwidth 1/3 Octave Band.

Table 6.2.4-1Coordinates and Water Depth of Underwater Noise Measuring Points

Measuring Point	Longitude	Latitude	Water Depth (m)
P1	119.906	24.192	35.5
P2	119.016	24.188	36.5
P3	119.979	24.131	44.6
P4	119.868	24.137	31.6

1. Measuring Equipment and Deployment

Underwater background measurement is conducetd by shipborne acoustic measurement via SM2M of Wildlife Acoustic. The measuring information is storaged within built-in stoarge device. Data is captured after retrieving, the specifications is shown as Table 6.2.4-2, the exterior appearwance is shown as Figure 6.2.4-2. The schematic diagram of 6.2.4-3 is the deployment of SM2M.

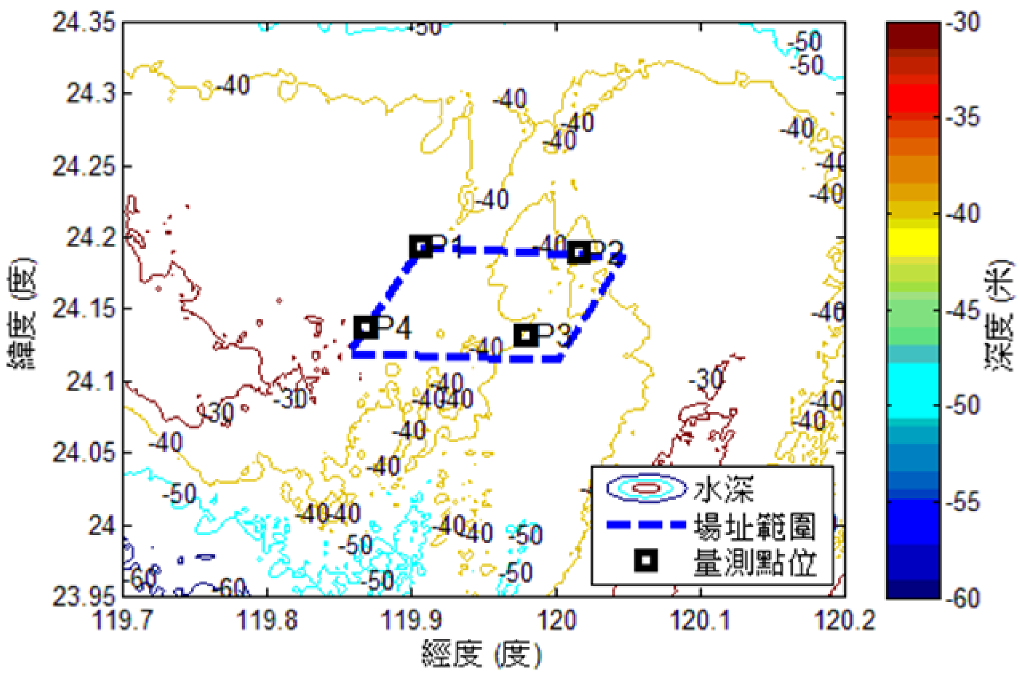


Figure 6.2.4-1 Schematic Diagram of Underwater Noise Measuring Location

Table 6.2.4-2 Model and Specification of SM2M

Name	Specifications	Setting
Exterior Dimension	Diameter: 16.5cm Height: 79.4cm Weight: Approx. 9.5kg	
Battery	32 pcs of AAA Battery, 4 batteries each group	
Sound Channel	Support 1, 2 (channel)	MONO
Highest Sampling Frequency	96kHz	44.1kHz
Data Storage Type	Memory Card:8GB~128 GBSDHC or 512GBSDXC, 16bit	Memory Card: 128GB SDXC x1
Log Period	It can be recording for maximum 36 days (2 channels, the sampling frequency is 9765.625 Hz).	Recording is started for 59 minutes on the hour, it will stop for a minute to split the file.
Maximum Depth	150 m	
Sensitivity of Microphone	-165dB re 1 µPa	-165 dB re 1 µPa
Gain	+0 dB 至+12 dB	+0 dB
File Format	Wav format, a record file is set as 59 minutes according to setting.	

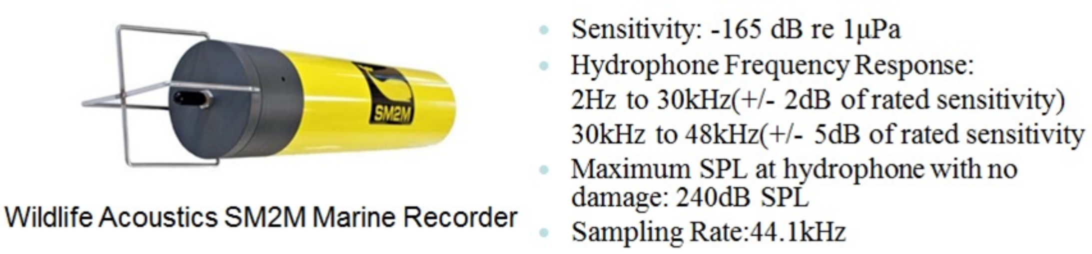


Figure 6.2.4-2 Exterior Appearance and Specification of SM2M

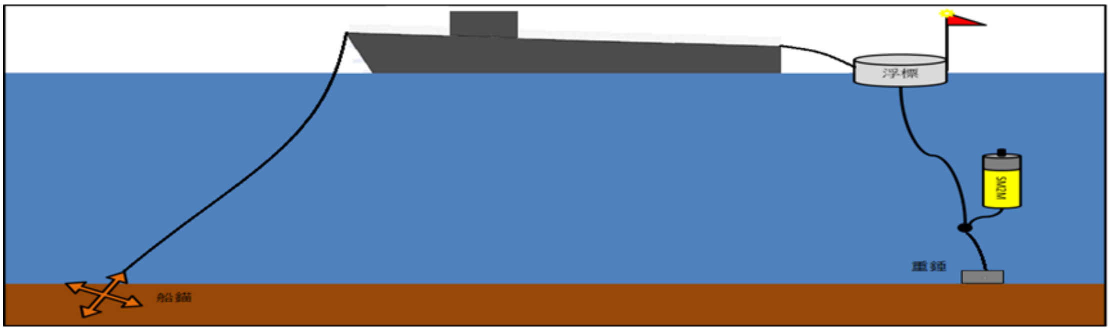


Figure 6.2.4-3 Schematic Diagram of Placement of Underwater Noise Measuring Instrument

2. Data Analysis

Since background noise requires the elimination of definite and identifiable source of noise (such as noise from a boat…etc.), therefore with the use of Matlab, data measured and collected onsite will go through Fast Fourier Transform, or FFT, where sound pressure level at 1 Hz bandwidth will be calculated first, then the normal distribution's upper and lower limit values of sound pressure level under each frequency will be used to eliminate the source of noises that does not belong to that particular ocean background, the screened data will then be averaged out to acquire the sound pressure level at 1 Hz bandwidth and transformed into 1/3 octave band spectrum level; on the other hand, because the reference sound pressure value was 1μPa, which differs from the reference sound pressure value of 20μPa used in the air, therefore, under the same receiving sound pressure, the sound pressure level (unit: dB re 1μPa) in the water will be 26 dB higher than the sound pressure level (unit: dB re 20μPa), this is the part where underwater acoustic related studies must be special attention to. In addition, the bandwidth 1Hz is more commonly used for underwater acoustic studies, unlike octave band used or 1/3 octave band used in air, because the level of octave band is the sum of all energy within a specific frequency interval, therefore the sound pressure level of octave band will be much higher than the 1Hz bandwidth used in underwater acoustic studies.

There are two types of sound pressure levels used in this project, spectrum level and 1/3 octave band level. The bandwidth of spectrum level is 1Hz and the bandwidth of 1/3 octave band varies depending on different center frequency. Even though most underwater acoustic studies use 1-Hz bandwidth but most documents shows it as 1/3 octave band due to convenience. The center frequency of 1/3 octave band is shown in table 6.2.4-3, for example, a 1/3 octave band level with center frequency of 25 Hz is the sum of energy from 22 to 28 Hz; a 1/3 octave band level with center frequency of 50 Hz is the sum of energy from 44 to 57.

Table 6.2.4-3 Center Frequency of 1/3 Octave Band

Lower Band Limit(Hz)	22.4	35.5	44.7	70.8	89.1	112	141	178	224
Center Frequency(Hz)	25	40	50	80	100	125	160	200	250
Upper Band Limit(Hz)	28.2	44.7	56.2	89.1	112	141	178	224	282

(ii) Analysis of Underwater Noise

It is measureed in August of 2016. The followings show analysis results of underwater noise from P1 to P4 during low tide and full tide. Table 6.2.4-4 displays the schedule of full tide and low tide of all measuring points. Table 6.2.4-5 to Table 6.2.4-12 display 1/3 Octave Level table during low tide and full tide from P1 to P4. Table 6.2.4-4 demonstrates spectrogram during full tide and low tide, 1-Hz frequency spectrum level diagram and 1/3 Octave level diagram. According to the results, the changes between full tide and low tide show a trivial change.

Table 6.2.4-4 Schedule of P1 to P4 during Full Tide and Low Tide

Measuring Points	Time of Full atide and Low Tide
P1	Low tide at 06:03 on 4th August 2016 – Full tide at 11:54 on 04th August 2016
P2	Low tide at 05:40 on 19th August 2016 – Full tide at 23:38 on 18th August 2016
P3	Low tide at 17:20 on 4th August 2016 – Full tide at 10:56 on 18th August 2016
P4	Low tide at 17:57 on 19th August 2016 – Full tide at 11:36 on 19th August 2016

(iii) Conclusion of Underwater Noise Measurement

Underwater background noise data is obtained via 4 measuring points. The duration of measuring shall at least encompass half hour before and after low tide and full tide to obtain the underwater background noise characteristics and underwater noise level.

The results collected this time at measurement location P1, shown as 1-Hz spectrum level, were similar to that of a Wenz Curve. During low and full tides at locations P2 and P3, results of spectrogram showed activities of ships passing by during these time, as shown by the results of 1-Hz spectrum level, the affected frequency range were between 10 ~ 500Hz, and the affected noise level were between 85 ~ 118 dB. Based on the results of 1-Hz spectrum level at P2 during full tide and at P4 during both low and full tide, part of biological noise from 400Hz ~ 2kHz were between 90 ~ 115dB. Because the location of this particular short measurement was close to the navigation channel of ships, it is likely that the results for low frequency were affected by operating noises from distant ships;

biological noises were detected during measurement intervals at some of the location, meaning that there are fishes or sea creatures inhibiting at these locations near the wind farm.

Background noise of low tide and full tide is used for measurement. Measurement process may have continuous, intermittent or one-time noise source effects instead of the local marine background noise.

Table 6.2.4-5 1/3 Octave Level at P1 Measuring Point During Full Tide

Center Frequency (Hz)	40	50	63	80	100	125	160	200	250
Band Level (dB)	105.0	111.4	112.0	106.1	104.0	102.7	103.2	100.5	99.9
Center Frequency (Hz)	315	400	500	630	800	1000	1250	1600	2000
Band Level (dB)	99.3	98.7	99.0	99.1	98.1	96.7	102.0	98.3	92.7
Center Frequency (Hz)	2500	3150	4000	5000	6300	8000	10000	12500	16000
Band Level (dB)	91.9	89.8	88.1	87.4	85.9	82.9	79.1	77.2	77.9

Table 6.2.4-6 1/3 Octave Level at P1 Measuring Point During Low Tide

Center Frequency (Hz)	40	50	63	80	100	125	160	200	250
Band Level (dB)	106.1	105.5	106.2	105.6	104.5	102.4	101.4	99.4	97.6
Center Frequency (Hz)	315	400	500	630	800	1000	1250	1600	2000
Band Level (dB)	94.9	94.8	93.1	92.4	92.0	91.4	98.8	94.7	89.9
Center Frequency (Hz)	2500	3150	4000	5000	6300	8000	10000	12500	16000
Band Level (dB)	88.5	87.0	85.1	83.6	81.4	78.6	76.5	76.7	78.0

Table 6.2.4-7 1/3 Octave Level at P2 Measuring Point During Full Tide

Center Frequency (Hz)	40	50	63	80	100	125	160	200	250
Band Level (dB)	106.6	106.2	108.1	108.9	110.1	106.7	106.5	106.5	104.4
Center Frequency (Hz)	315	400	500	630	800	1000	1250	1600	2000
Band Level (dB)	104.2	103.3	102.6	106.1	104.0	106.3	111.8	110.2	106.7
Center Frequency (Hz)	2500	3150	4000	5000	6300	8000	10000	12500	16000
Band Level (dB)	103.6	99.4	100.0	97.7	95.5	89.2	83.7	81.9	82.7

Table 6.2.4-8 1/3 Octave Level at P2 Measuring Point During Low Tide

Center Frequency (Hz)	40	50	63	80	100	125	160	200	250
Band Level (dB)	108.4	110.2	112.4	111.5	107.8	106.2	104.7	102.6	101.9
Center Frequency (Hz)	315	400	500	630	800	1000	1250	1600	2000
Band Level (dB)	100.8	101.7	101.0	100.9	99.2	97.1	97.2	100.0	94.4
Center Frequency (Hz)	2500	3150	4000	5000	6300	8000	10000	12500	16000
Band Level (dB)	93.2	90.8	89.8	89.3	87.7	84.1	80.7	78.7	79.3

Table 6.2.4-9 1/3 Octave Level at P3 Measuring Point During Full Tide

Center Frequency (Hz)	40	50	63	80	100	125	160	200	250
Band Level (dB)	108.1	111.0	110.4	109.6	123.5	109.1	107.7	117.5	108.3
Center Frequency (Hz)	315	400	500	630	800	1000	1250	1600	2000
Band Level (dB)	107.5	105.3	104.2	103.7	103.1	101.4	102.6	102.9	96.1
Center Frequency (Hz)	2500	3150	4000	5000	6300	8000	10000	12500	16000
Band Level (dB)	94.0	92.9	91.2	90.2	89.5	87.7	85.3	82.8	81.5

Table 6.2.4-10 1/3 Octave Level at P3 Measuring Point During Low Tide

Center Frequency (Hz)	40	50	63	80	100	125	160	200	250
Band Level (dB)	107.9	107.9	108.0	107.6	109.6	106.6	105.5	102.0	100.0
Center Frequency (Hz)	315	400	500	630	800	1000	1250	1600	2000
Band Level (dB)	99.3	99.9	98.8	98.6	97.3	95.8	97.4	99.8	91.3
Center Frequency (Hz)	2500	3150	4000	5000	6300	8000	10000	12500	16000
Band Level (dB)	91.3	89.6	89.2	88.8	88.3	86.9	84.5	82.1	80.2

Table 6.2.4-11   1/3 Octave Level at P4 Measuring Point During Full Tide

Center Frequency (Hz)	40	50	63	80	100	125	160	200	250
Band Level (dB)	101.7	102.7	102.1	101.1	99.5	95.1	92.0	88.7	88.6
Center Frequency (Hz)	315	400	500	630	800	1000	1250	1600	2000
Band Level (dB)	92.2	100.4	106.1	109.6	114.4	113.9	107.2	107.0	99.2
Center Frequency (Hz)	2500	3150	4000	5000	6300	8000	10000	12500	16000
Band Level (dB)	96.1	94.4	92.8	90.9	88.2	82.4	77.8	76.8	77.5

Table 6.2.4-12 1/3 Octave Level at P3 Measuring Point During Low Tide

Center Frequency (Hz)	40	50	63	80	100	125	160	200	250
Band Level (dB)	103.5	102.8	102.7	100.8	98.3	93.2	91.0	88.4	89.0
Center Frequency (Hz)	315	400	500	630	800	1000	1250	1600	2000
Band Level (dB)	89.9	89.1	89.1	91.3	91.8	93.9	104.6	94.1	83.5
Center Frequency (Hz)	2500	3150	4000	5000	6300	8000	10000	12500	16000
Band Level (dB)	83.2	82.2	80.9	80.6	79.4	77.4	75.8	75.9	77.3

Figure 6.2.4-4 Underwater Noise Spectrogram and Frequency Spectrum of P2

Figure 6.2.4-5 Underwater Noise Spectrogram and Frequency Spectrum of P2

Figure 6.2.4-6 Underwater Noise Spectrogram and Frequency Spectrum of P3

Figure 6.2.4-7 Underwater Noise Spectrogram and Frequency Spectrum of P4

VIII. Terrestrial Noise

Changhua County has completed 26 noise control notice in township, city and council. Based on the location, they are delineated into Class II Control Zone, Class III Control Zone and Class IV Control Zone. This project is located at Xianxi Township and Lukang Township, the school and Show Chwan Memorial Hospital are classified into Class II Control Zone; Changhua Coastal Industrial Park is classified into Class IV Control Zone, other places are classified into Class III Control Zone, it is shown as Figure 6.2.4-10 and Figure 6.2.4-11.

(ii) Noise Vibration

In order to understand the current conditions of environmental volume and vibration backgrounds of areas around the project base and along the paths of vehicle travel, a total of 9 monitoring stations were selected by this project according to the "Environmental Impact Evaluation Operation Standards", including the intersection of Beiti Road and Yugang Road outside of Taichung Harbor, potential paths of construction vehicle and affected sensitive spots in the future. Figure 6.2.4-8 depicts the locations of monitoring, where one 24 hours full day continuous environmental noise and vibration monitoring were performed on the weekends and during the week days between the months of August, September and October in 2016. Additionally, a supplementary investigation was performed at station 1 of Lun Wei Changhua Coastal Park Service Center located on An Xi Road on July 9 and 10, 2017, the location of monitoring can be viewed in figure 6.2.4-9 and the results are shown in table 6.2.4-13 ~ 14.

The results of supplementary noise monitoring for the sensitive spots and roadside traffics around the project base (table 6.2.4-13) showed that during the nights of August 22, 27 and October 6, 8 of 2016 data collected near Show Chwan Memorial Hospital exceeded noise control zone standards, while data collected from all other monitoring stations were within the standards of noise control zones and this could be the results of parking lot traffics and human conversation. Supplementary monitoring results from the rest of the project shows that the current status of surrounding area is consistent with the volume standards of control area at each measuring point.

According to the results of onsite vibration investigation conducted by this project (table 6.2.4-14), the data vibration data collected from the 9 monitoring stations during the day and night by the project's supplementary investigation all conforms to the standard values specified in the Tokyo Public Hazard and Vibration Control Standards of Japan.

(ii) Low-Frequency Noise

On 5th August of 2013, Environmental Protection Administration, Executive Yuan issued Official Letter 1020065143 to revise noise control standards. According Article 8, site and facility noise control standard issued by competent authority shall include low-frequency noise f wind turbines.

Low frequency noise monitoring stations are built in Datong Elementary School, Wenhua North Road of Shuili Harbor, Haipu Elementary School, Wuqi Elementary School, Lugang Industrial Park, Putioan Temple, Changhua Coastal Industrial Park, Hanbao Community Activity Center and Residences of Fubao Village to understand the low-frequency noise background value of neighboring housing area. Locations of monitoring station are shown as Figure 6.2.4-8. From August to October of 2016, 24-hour continuous low-frequency ambient noise monitoring was conducted on weekend and weekday. Monitoring results is shown as Table 6.2.4-15. Among which, daytime noise value of Wuqi Elementary School has exceeded Class II of Wind Turbine Low-Frequency Noise Control Standards. On 18th August 2016 and 22nd September 2016, it has exceeded control standards in daytime and nighttime. Noise value of Changhua Coastal Industrial Park in daytime has exceeded Class II Wind Turbine Low-Frequency Noise Control Standard. On 13th August and 3rd of November of 2016, it has exceeded Class III Low-Frequency Noise Control Standards of Wind Turbines during daytime and nighttime. On 5th of November 2016, it has exceeded control standards during nighttime.

Figure 6.2.4-8 Schematic Diagram of Noise Vibration and Low Frequency Moise Monitoring Station

Figure 6.2.4-9 Supplementary Survey Locationsof Common Corridor

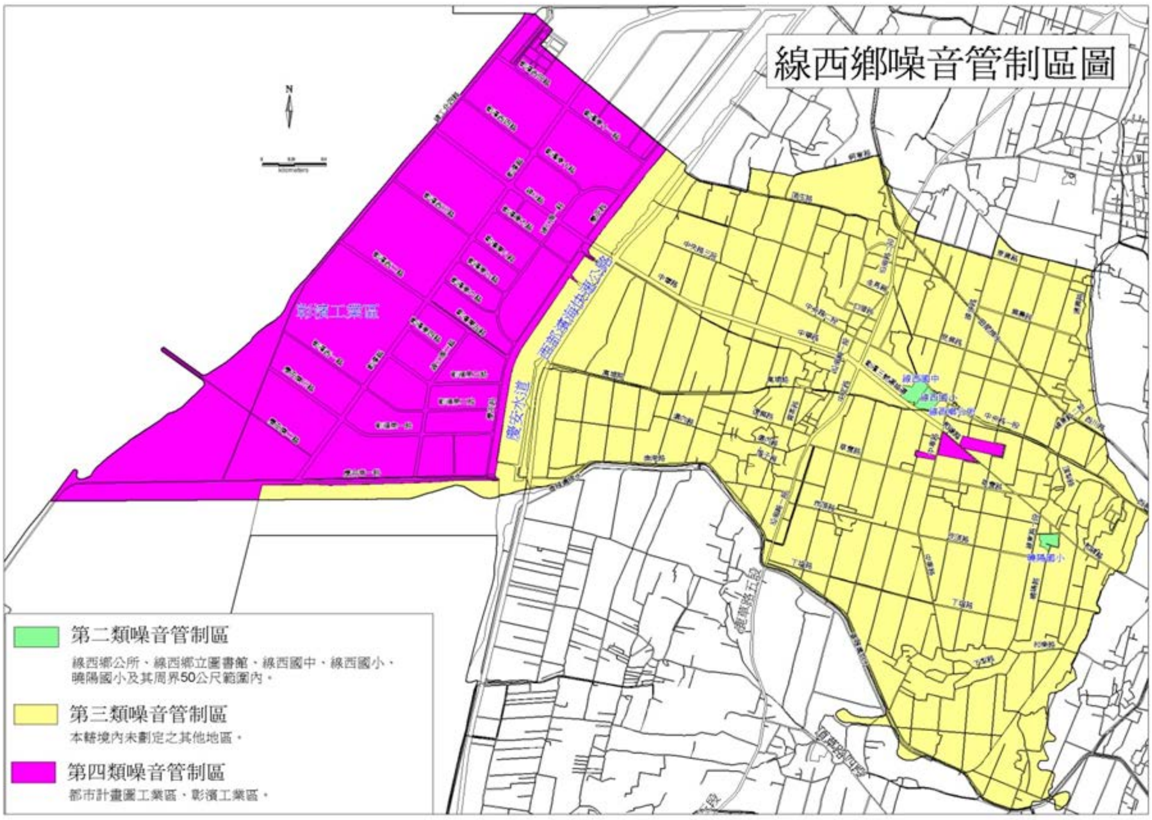


Figure 6.2.4-10 Noise Control Zones of Xianxi Township

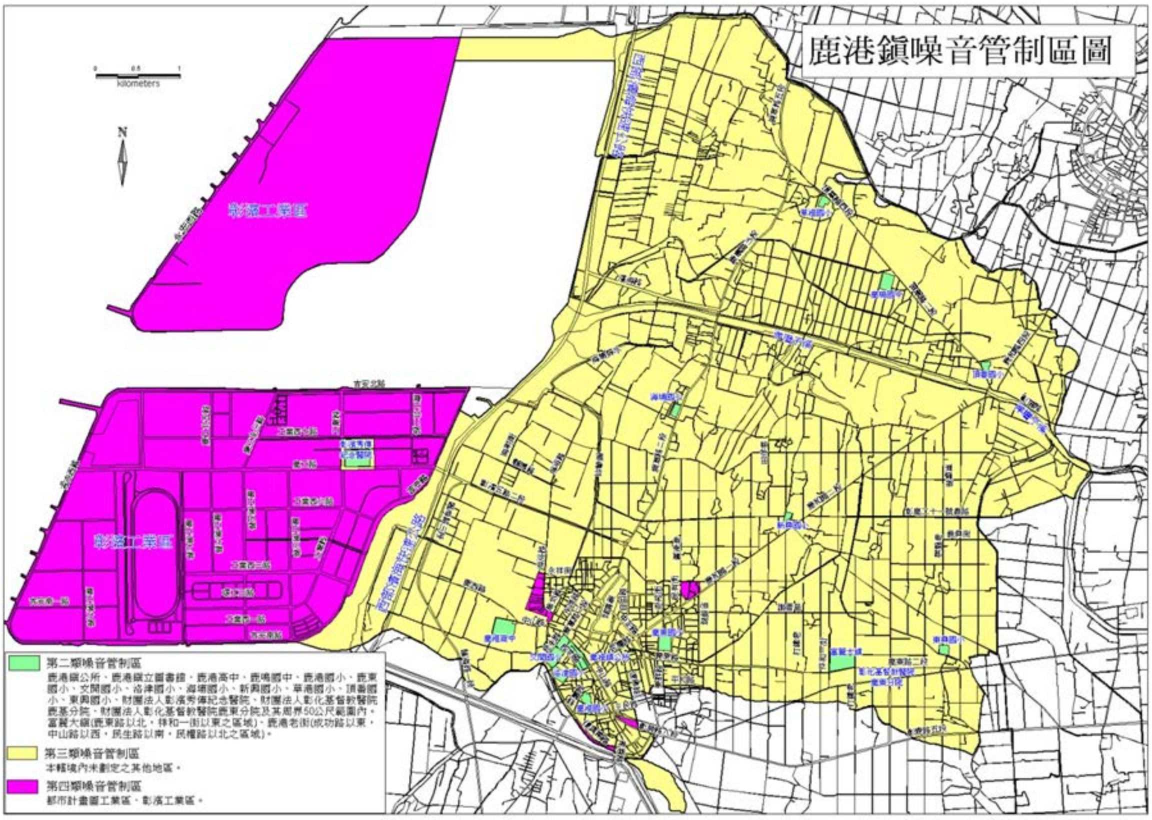


Figure 6.2.4-11 Noise Control Zone of Lukang Township

Table 6.2.4-13 Noise Measuring Results of This Project

Unit: dB(A)

Measuring Station	Measuring Time	L_{Day}	L_{Night}	$L_{Midnight}$
Intersection of Beiti Road and Fishing Harbor	18th August 2016 (Weekday)	72.0	64.3	61.1
	20th August 2016 (Weekend)	69.6	64.1	61.8
	22nd September 2016 (Weekday)	71.9	66.0	63.0
	24th September 2016 (Weekend)	70.8	65.7	63.2
Western Coast Express Highway, Changhua Coastal Industrial Park Access Road and Access roads of Changhua Coastal Industrial Park and Intersection of Changhua Coastal Indyustrial Park	18th August 2016 (Weekday)	69.8	59.8	62.9
	20th August 2016 (Weekend)	66.4	62.1	59.9
	22nd September 2016 (Weekday)	69.0	59.6	59.4
	24th September 2016 (Weekend)	64.7	56.5	56.6
Western Coast Express Highway, Xiangong Road and Zhonghua Road Intersection	18th August 2016 (Weekday)	68.4	63.0	58.6
	20th August 2016 (Weekend)	65.7	61.9	59.7
	22nd September 2016 (Weekday)	70.0	66.6	59.3
	24th September 2016 (Weekend)	66.9	60.9	57.9
Western Coast Express Highway and Lugong Intersection	22nd August 2016 (Weekday)	73.5	69.0	63.9
	27th August 2016 (Weekend)	70.5	66.8	64.6
	6th October 2016 (Weekday)	72.6	68.6	63.6
	8th October 2016 (Weekend)	70.9	66.1	63.4
Lukang Industrial Park (Lugong Road and Lugong South 7th Road)	22nd August 2016 (Weekday)	59.3	48.8	56.8
	27th August 2016 (Weekend)	54.3	48.9	52.3
	6th October 2016 (Weekday)	57.4	48.8	49.2
	8th October 2016 (Weekend)	54.6	47.7	52.3
Changhua Coastal Industrial Park (Changhua OCastal Road and Xiangong Road)	18th August 2016 (Weekday)	66.3	57.3	53.7
	20th August 2016 (Weekend)	63.0	53.8	51.4
	22nd September 2016 (Weekday)	65.8	57.4	53.7
	24th September 2016 (Weekend)	65.1	53.1	52.5
Haipu Elementary School	22nd August 2016 (Weekday)	69.8	66.7	61.3
	27th August 2016 (Weekday)	68.8	66.6	61.2
	6th October 2016	70.4	66.8	62.4
	(Weekday)	70.5	68.8	62.8
Anxi Road of Changhua Coastal Industrial Park	8th October 2016 (Weekend)	60.2	57.5	55.3
	9th July 2017 (Weekend)	62.8	55.9	54.1
Within Class III or Class IV Control Zone 8m of the roads		76	75	72
Show Chwan Memorial Hospital	22nd August 2016 (Weekday)	55.9	54.2	51.0
	27th August 2016 (Weekend)	55.0	55.1	60.1
	6th October 2016 (Weekday)	57.5	54.6	52.0
	8th October 2016 (Weekend)	56.0	51.9	52.1
Class II Control Zone		60	55	50

Remarks: According to Official Letter 0990006225D issued by Environmental Protection Agency on 21st January of 2000, time division mentioned in Article 2 Section 5, day starts from 6.00a.m to 8.00p.m, night starts from 8.00p.m to 10.00p.m and midnight starts from 10.00p.m to next day of 6.00a.m.

Data Source: Asia Environmental Technology Co., Ltd is assigned to conduct this project (Official Letter 003). Earthcare Environmental Technology Co., Ltd is assigned to conduct supplementary survey. (Official Letter 164)

Table 6.2.4-14 Vibration Measurement Results of this Project

Unit dB

Measuring Station	Measuring Time	L_{vday}	Lv night
Beiti Road and Intersection of Fishery Harbor	18th August 2016 (Weekday)	50.1	41.4
	20th August 2016 (Weekend)	47.7	41.9
	22nd September 2016 (Weekday)	50.2	44.1
	24th September 2016 (Weekend)	48.4	43.5
Western Coast Express Highway, Connecting Road of Changhua Coastal Industrial Park and Intersection of Changhua Coastal Road	18th August 2016 (Weekday)	47.2	38.1
	20th August 2016 (Weekend)	44..4	36.3
	22nd September 2016 (Weekday)	47.0	38.2
	24th September 2016 (Weekend)	43.7	34.4
Western Coast Express Highway, Xiangong Road and Zhonghua Road Intersection	18th August 2016 (Weekday)	44.0	37.3
	20th August 2016 (Weekend)	41.7	34.7
	22nd September 2016 (Weekday)	45.0	38.7
	24th September 2016 (Weekend)	41.2	33.8
Western Coast Express Highway and Lugong Road Intersection	22nd August 2016 (Weekday)	40.9	34.4
	27th August 2016 (Weekend)	37.8	31.1
	6th October 2016 (Weekday)	40.8	35.3
	8th October 2016 (Weekend)	38.2	31.8
Lukang Industrial Park (Lugong Road and Lugong South 7th Road)	22nd August 2016 (Weekday)	38.4	30.0
	27th August 2016 (Weekend)	30.2	30.0
	6th October 2016 (Weekday)	36.3	30.0
	8th October 2016 (Weekend)	32.1	30.0
Changhua Coastal Industrial Park (Changhua Coastal Roads and Xiangong Road Intersection)	18th August 2016 (Weekday)	41.4	33.5
	20th August 2016 (Weekend)	37.5	30.6
	22nd September 2016 (Weekday)	42.8	33.2
	24th September 2016 (Weekend)	37.6	30.5
Haipu Elementary School	22nd August 2016 (Weekday)	41.3	33.9
	27th August 2016 (Weekend)	38.1	33.3
	6th October 2016 (Weekday)	42.8	34.4
	8th October 2016 (Weekend)	42.3	34.2
Show Chwan Memorial Hospital	22nd August 2016 (Weekday)	41.7	33.6
	27th August 2016 (Weekend)	38.4	30.2
	6th October 2016 (Weekday)	41.9	33.9
	8th October 2016 (Weekend)	38.4	31.3
Anxi Road of Changhua Coastal Industrail Park	9th July 2017 (Weekend)	28.8	25.7
	10th July 2017 (Weekday)	29.6	25.2
Vibration Control Standards of Tokyo Datum Value of Class Zone		70	65

Remarks: 1. Tokyo Vibration Control Datum Value is adopted. Class I Zone: Quiet area for residency; Class II Zone:Industrial land use for residents.
2. Daytime starts from 7.00a.m to 9.00p.m, nighttime starts from 9.00p.m to next day of 7.00a.m.

Data Source: Asia Environmental Technology Co., Ltd is assigned to conduct this project (Official Letter 003). Earthcare Environmental Technology Co., Ltd is assigned to conduct supplementary survey. (Official Letter 164).

Table 6.2.4-15 Low-Frequency Noise Measurement Results of this Project

Unit: dB(A)

Measuring Station	Measuring Time	$L_{Day,LF}$	$L_{Night,LF}$	$L_{Night,LF}$
Datong Elementary School	18th August 2016 (Weekday)	34.0	27.6	24.7
	20th August 2016 (Weekend)	27.4	25.8	22.7
	3rd November 2016 (Weekday)	36.1	25.9	23.5
	5th November 2016 (Weekend)	27.9	25.7	21.8
Haipu Elementary School	22nd August 2016 (Weekday)	36.7	32.3	27.8
	27th August 2016 (Weekend)	38.0	32.1	27.5
	3rd November 2016 (Weekday)	36.7	33.6	28.6
	5th November 2016 (Weekend)	34.9	31.0	28.5
Wuqi Elementary School	18th August 2016 (Weekday)	44.7	40.3	35.1
	20th August 2016 (Weekend)	40.3	38.9	33.3
	22nd September 2016 (Weekday)	41.2	39.2	34.6
	24th September 2016 (Weekend)	39.5	39.0	33.1
Low-FrequencyNoise Control Standard for Wind Turbine Class II Control Zone		39	39	36
Wenhua Road of Shuili Harbor	10th August 2016 (Weekday)	27.1	26.2	23.6
	13th August 2016 (Weekend)	28.0	28.3	22.4
	22nd September 2016 (Weekday)	29.9	29.2	21.7
	24th September 2016 (Weekend)	33.2	25.4	22.1
Putian Temple	1st September 2016 (Weekday)	33.1	21.7	22.2
	3rd September 2016 (Weekend)	27.6	17.2	18.4
	31st October 2016 (Weekday)	31.2	22.9	20.9
	29th October 2016 (Weekend)	30.7	22.3	22.1
Hanbao Community Activity Center	1st September 2016 (Weekday)	26.5	45.6	21.1
	3rd September 2016 (Weekend)	24.9	29.8	17.4
	31st October 2016 (Weekday)	29.2	24.2	23.2
	29th October 2016 (Weekend)	38.3	38.5	24.6
Fubao Villoage Residency	20th August 2016 (Weekend)	31.6	30.5	29.9
	22nd August 2016 (Weekday)	28.8	28.4	26.5
	6th October 2016 (Weekday)	32.2	30.7	30.8
	8th October 2016 (Weekend)	29.1	28.2	26.6
True Jesus Church Lunwei Church	6th October 2016 (Weekday)	27.4	19.5	17.7
	8th October 2016 (Weekend)	20.6	18.5	17.4
	10th August 2016 (Weekday)	21.8	18.4	19.0
	13th August 2016 (Weekend)	21.3	18.9	22.6
Low-FrequencyNoise Control Standard for Wind Turbine Class III Control Zone		44	44	41
Changhua Coastal Industrial Park	10th August 2016 (Weekday)	50.7	39.9	43.0
	13th August 2016 (Weekend)	50.7	51.7	52.8
	3rd November 2016 (Weekday)	52.9	49.6	46.9
	5th November 2016 (Weekend)	51.2	41.5	45.8
Lukang Industrial Park	22nd August 2016 (Weekday)	36.9	36.6	31.7
	27th August 2016 (Weekend)	35.4	34.6	28.2
	31st October 2016 (Weekday)	37.2	33.5	33.0
	29th October 2016 (Weekend)	34.0	34.6	32.5

Remarks: "Noise Control Standards", it is implementaed on 5th August of 2013.
Data Source: Asia Environmental Technology Co., Ltd is assigned to conduct this project (Official Letter 003).

6.2.5 Hydrology and Water Quality

I. Hydrology and Water Quality of River

(i) Hydrology of River

This base is located between Wu River and Zhuoshui River, in the vicinity of Changhua Plain. These 2 river are originated from Central Mountain. Due to wide catchment area, it has great water volume. Due to high mountain and steep landscape, water storage ability is poor. During rainy season or torrential rain, water will flow to plain of downstream and result in flood. In dry season, it is insufficient for irrigation.

Based on 2015 Hydrological Year Book of Taiwan, the statistical data of the two rivers show that Zhuoshui River has a total length of 186.60 kilometers with an average slope of 1:190 and a basin area of 3156.90 square kilometers; the length of Black River’s (or Dadu River) main stream is 119.13 kilometers with an average slope of 1:92 and a basin area of 2025.60 square kilometers. Other smaller independent streams on the plain includes Tianwei drainage ditch, Fanya furrow, Yangzi Tun River, Lugang Drainage, Lugang Creek, Yuanlin Drainage, old Zhuoshui River (Maiyu Tun River), Hanbao River, Wanxing Drainage Ditch, Erlin River and Yu Liao River, as shown in figure 6.2.5-1. Wangxing Drainage Ditch and Erlin River are both irrigation and drainage systems that originated from independent small streams that flows into the ocean in plain areas downstream and diversions of Zhuoshuir River in early days. But ever since the rectification of Zhuoshui River where embankments were constructed, the rivers entered the ocean independently. Besides local rain falls, the volume of water it collects include good portions of the region’s drainages, regenerated water and subsurface water from Zhuoshui River, which shares close relation with the irrigation water from the main stream of Zhuoshui River, creating repeated layers of re-use and cycles.

Other irrigation drainage system were originally split-flow of Wu River and Zhuishui River. Other constructions of dikes of Wu River and Zhuoshui River, it flows into ocean independently. The water of catchment area is not only from local precipitation, a considerabvle amount of water is drained via sink patch.

(ii) Hydrology of Earth Surface

In order to understand the current situation of neigbouring water body’s hydrology. The reference data of neigboring rivers’ hydrology from 2013 to 2016 is shown as Table 6.2.5-2. The locations of monitoring stations are shown as Figure 6.2.5-2. The river pollution index is listed as Table 6.2.5-1. The neighboring water body Yang Zai Cuo Bridge is classified as moderate-serious polluted; Fubao Bridge is also moderate-serious polluted.

3 supplementary surveys of surface water and water quality on neigbhboring water body were conducted in July, September and November of 2016, river pollution index was analyzed as well. (Table 6.2.5-1). The survey locations are described in Figure 6.2.5-2. The examination results of earth surface's water quality and other examined items are described in Table 6.2.5-3.

One of the neighboring water bodies of this project, Qing An Waterway is mildly-slightly polluted. Yang Zai Cuo is mildly polluted; Xianxi Waterway is mildly-slightly polluted; Yuanlin is mildly polluted; Old Zhuo Shui Rier is mildly-serious polluted.

Figure 6.2.5-1 Drainage Map of Changhua County

Figure 6.2.5-1 Datum Value of River Pollution Index

Water Quality/Item	Mild Pollution	Slight Pollution	Moderate Pollution	Serious Pollution
Dissolved Oxygen (DO) mg/L	Below 6.5	4.6~6.5	2.0~4.5	Below 2.0
Biochemical Oxygen Demand (BOD_5) g/L	Below 3.0	3.0~4.9	5.0~15.0	Above 15.0
Suspended Solid(SS) mg/L	Below 20.0	20.0~49.9	50.0~100	Above 100
Ammonia Nitrogen (NH3-N) mg/L	Below 0.50	0.50~0.99	1.00~3.00	Above 3.00
Index	1	3	6	10
Pollution Index Accumulative Value	Below 2.0	2.0~3.0	3.1~6.0	Above 6.0

Data Source: National Environmental Water Quality Information Network , Environmental Protection Agency, Executive Yuan, http://wq.epa.gov.tw/Code/Business/Standard.aspx.

Remarks: Based on resolution of Rivised Datum Value and Calculation Method of River Pollution Index (Official Letter 1020045468 on 30th May 2013), RPI calculation metod is adjusted by referring to Environmnetal Analysis Laboratory since 2013.

Table 6.2.5-2 Water Quality Examination Results of Surface Water

Drainage System	Sampling Station	Sampling Dates		Water Temperature	pH Value	Electrical Conductivity	Suspended Solid	Dissolved Oxygen	Biochemical Oxygen Demand	Chemical Oxygen Demand	Ammonia Nitrogen	RPI	Pollution Index
		Year	Month	℃	—	μmho/cm25℃	mg/L						
Yang Zai Cuo River	Yang Zai Cuo Bridge	2016	12	21.4	7.20	14,200.00	110	4.63	4.1	25.5	13.1	6.5	Serious Pollution
			9	28.40	7.60	23,300.00	85.20	3.90	3.30	23.60	2.20	5.3	Moderate Pollution
			6	18.70	7.10	20,000.00	38.80	3.06	3.70	12.20	2.22	4.5	Moderate Pollution
			3	18.70	7.10	1,520.00	18.50	3.06	17.00	17.60	4.69	6.8	Serious Pollution
		2015	10	29.80	7.30	2,410.00	72.50	1.79	5.30	24.90	<0.01	8.0	Serious Pollution
			8	30.10	7.70	671.00	50.50	4.03	3.60	21.90	2.83	5.3	Moderate Pollution
			5	30.30	7.50	28,600.00	80.50	4.30	11.90	53.80	20.00	7.0	Serious Pollution
			3	18.50	7.40	11,200.00	35.30	5.46	6.80	6.80	13.50	5.5	Moderate Pollution
		2014	12	21.20	6.80	8,770.00	22.50	3.56	10.20	25.90	14.40	6.3	Serious Pollution
			9	31.10	7.40	12,600.00	26.60	3.17	11.90	32.10	1.44	5.3	Moderate Pollution
			6	31.10	7.12	13,800.00	46.00	1.01	9.00	30.80	1.18	6.3	Serious Pollution
			3	20.60	7.50	9,680.00	37.50	1.30	5.60	25.80	3.54	7.3	Serious Pollution
Zhuo Shui River	Fubao Bridge	2016	12	22.5	7.7	17,500.00	12.8	5.95	2.2	16.6	2.76	2.8	Slight Pollution
			11	25.30	7.80	11,200.00	31.80	4.38	24.10	3.80	1.03	6.3	Serious Pollution
			10	28.00	7.70	768.00	90.80	3.45	4.50	25.80	5.50	6.3	Serious Pollution
			9	27.60	7.90	18,600.00	105.00	4.58	3.00	18.30	2.21	5.8	Moderate Pollution
			8	32.90	7.30	1,700.00	43.50	2.92	5.30	24.40	1.72	5.3	Moderate Pollution
			7	30.30	8.40	1,640.00	24.20	4.82	3.20	18.40	15.70	4.8	Moderate Pollution
			6	24.90	7.30	9,500.00	18.00	2.21	4.40	17.20	9.63	5.0	Moderate Pollution
			5	30.30	8.40	660.00	56.00	4.82	4.90	21.10	6.34	5.5	Moderate Pollution
			4	24.90	7.30	2,010.00	23.50	2.21	4.00	18.60	5.80	5.5	Moderate Pollution
			3	23.80	7.20	1,310.00	26.00	2.45	3.70	15.70	7.74	5.5	Moderate Pollution
			2	17.10	7.40	38,000.00	44.50	3.71	3.30	36.80	2.11	4.5	Moderate Pollution
			1	19.40	7.70	1,270.00	44.20	2.30	19.80	84.50	1.13	6.3	Serious Pollution

Table 6.2.5-2 Water Quality Examination Results of Surface Water

Drainage System	Sampling Station	Sampling Dates		Water Temperature	pH Value	Electrical Conductivity	Suspended Solid	Dissolved Oxygen	Biochemical Oxygen Demand	Chemical Oxygen Demand	Ammonia Nitrogen	RPI	Pollution Index
		Year	Month	℃	—	μmho/cm25℃	mg/L						
Zhuo Shui River	Fubao Bridge	2015	12	24.90	7.40	4,910.00	31.80	3.39	7.20	42.20	13.90	6.3	Serious Pollution
			11	26.00	7.50	2,070.00	56.20	4.47	9.80	56.70	<0.01	7.0	Serious Pollution
			10	32.00	7.40	1,360.00	63.50	3.91	4.60	17.90	3.44	6.3	Serious Pollution
			9	29.70	7.20	27,500.00	41.70	3.10	3.70	129.00	1.32	4.5	Moderate Pollution
			8	27.30	7.50	643.00	67.00	4.90	6.00	39.70	3.05	6.3	Serious Pollution
			7	31.80	7.40	2,740.00	52.20	4.13	7.30	44.90	10.90	7.0	Serious Pollution
			6	33.80	7.80	1,640.00	27.00	5.80	10.50	28.70	52.80	5.5	Moderate Pollution
			5	33.80	7.90	3,620.00	47.80	7.78	30.50	80.60	829.00	6.0	Moderate Pollution
			4	27.40	7.70	7,830.00	47.80	2.98	23.40	69.40	25.90	7.3	Serious Pollution
			3	19.80	7.90	19,800.00	98.00	8.38	28.50	78.00	6.03	6.8	Serious Pollution
			2	17.30	7.70	43,100.00	34.60	3.31	3.80	16.50	1.29	4.5	Moderate Pollution
			1	21.00	7.40	2,200.00	23.50	2.54	13.10	53.00	28.50	6.3	Serious Pollution
		2014	12	17.40	7.80	4,000.00	70.00	2.08	53.20	144.00	47.70	8.0	Serious Pollution
			11	23.60	7.76	11,900.00	42.80	5.39	7.30	20.80	2.90	4.5	Moderate Pollution
			10	24.50	7.50	22,000.00	128.00	4.67	18.10	20.70	3.00	7.3	Serious Pollution
			9	34.10	7.60	985.00	18.50	2.81	8.40	13.30	1.22	4.8	Moderate Pollution
			8	33.10	7.70	7,370.00	18.00	5.85	4.90	18.00	1.08	3.3	Moderate Pollution
			7	33.30	7.77	37,800.00	53.80	3.76	8.80	14.50	0.04	4.8	Moderate Pollution
			6	29.60	7.78	33,100.00	61.00	3.79	11.00	19.60	0.17	4.8	Moderate Pollution
			5	30.80	7.67	870.00	42.20	3.60	7.40	20.20	0.95	4.5	Moderate Pollution
			4	26.40	7.85	3,810.00	172.00	4.57	2.20	157.00	0.09	4.5	Moderate Pollution
			3	18.80	7.77	5,570.00	64.00	5.49	7.10	17.40	3.56	6.3	Serious Pollution
			2	18.30	7.50	17,000.00	184.00	7.80	8.30	29.40	3.24	6.8	Serious Pollution

Data Source: National Environmental Water Quality Information Network , Environmental Protection Agency, Executive Yuan, http://wq.epa.gov.tw/Code/Business/Standard.aspx.

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Figure 6.2.5-2 Schematic Diagram of Earth Surface Water Quality, Earth Surface Water Quality Monitoring Stations of Changhua County Government and Underwater Water Quality Monitoring Stations of EPA

Table 6.2.5-3 Examination Results of Surface Water Quality

Examination Location	Date of Examination	Coliform Group (CFU/100ml)	Suspended Solid (mg/L)	Water Temperature (oC)	PH Value	Nitrate (mg/L)	Ammonia Nitrogen (mg/L)	Total Phosphorus (Mg P/L)	Dissolved Oxygen (mg/L)	Biochemical Oxygen Demand (mg/L)	Eletrical Conductivity (μmho/cm)	RPI	Pollution Index
Qing An Waterway	105.09.09	20000	7.4	26.9	7.9	0.48	0.15	0.296	9.2	3.4	2570	1.5	Mild Pollution
	105.10.11	1100	6.6	26.7	7.8	0.45	1.31	0.253	7.2	<2.0	33900	2.25	輕度污染
	105.11.14	7000	5.8	25.8	7.9	0.63	0.76	0.246	8	<2.0	32800	1.5	Mild Pollution
Yang Zai Cuo	105.09.09	100000	16.6	28.9	7.6	0.11	6.65	1.98	5.3	3.5	1640	4.25	Moderate Pollution
	105.10.11	160000	37.6	27.6	7.7	0.3	7.15	1.63	6.2	2.9	1770	4.25	Moderate Pollution
	105.11.14	43000	58.8	25.7	7.9	0.43	3.71	0.911	5.8	2.6	16200	5	Moderate Pollution
Xianxi Waterway	105.09.09	2000	35.3	28.4	8.1	0.45	0.45	0.121	8.3	<2.0	45500	1.5	Mild Pollution
	105.10.11	2300	45.4	26.6	8.1	0.51	1.21	0.425	7.5	8	38000	4	Moderate Pollution
	105.11.14	1400	269	25.8	7.9	0.21	0.6	0.162	7.3	<2.0	46800	3.75	Moderate Pollution
Yuanlin	105.09.09	140000	35.2	29.1	7.7	0.13	5	0.659	3.7	3.5	24200	5.5	Moderate Pollution
	105.10.11	85000	202	27.6	8.1	0.43	5.05	0.757	6.7	4.9	6800	6	Moderate Pollution
	105.11.14	63000	188	25.9	7.8	0.25	2.05	0.471	6	4.8	24500	5.5	Moderate Pollution
Old Zhuo Shui River	105.09.09	600000	20.2	30.2	7.7	0.04	9.29	1.44	3	9.7	6840	6.25	Serious Pollution
	105.10.11	28000	80.2	28	8.1	0.69	4.66	0.653	6.9	<2.0	1080	4.5	Moderate Pollution
	105.11.14	37000	150	26.1	7.8	0.31	4.05	0.567	5.1	2.7	14100	6	Moderate Pollution

Data Source: Asia Environmental Technology Co., Ltd. Is assigned to conduct surveys of this project (Official Letter 003 issued by Environmental Protection Agency).

II. Groundwater Hydrology and Water Quality

(i) Hydrology of Ground water

The ground water level in the Hsien Hsi region of Changhua is about 2.2 meters to 3.8 meters below ground surface, which is affected by tidal intrusions. The water quality is influenced by the intrusion of sea water that makes it unsuitable for irrigation and industrial use. According to the results of hydrological and geological investigation and research conducted by the Central Geological Survey MOEA, the base of this particular development project is located within the alluvial fan ground water region of Zhuoshui River, and based on the outcomes stated in the "Groundwater Monitoring Network Plan of Taiwan" published by the Water Resource Agency, the strata of Zhuoshui River's alluvial fan can be divided from the top to the bottom, into 4 water bearing stratums (aquifer) and 3 water resisting layers (aquitard), where water bearing stratums 2 and 3 are most significant and water bearing stratum 2 can be further divided into water bearing stratums 2-1 and 2-2 based on the water resisting layers of the sub-regions. Within which, water bearing stratum 1 has the least range of distribution and thickness, whereas stratums 2 and 3 has more wide spread distribution coverage and larger thickness; as for water bearing stratum 4, due to current limitations of drilling depths, its thickness is still undetermined. For the ease of analysis, Zhuoshui River's alluvial fan can be categorized into the following according to topography, geology and strata materials:

1. Fan Apex: East of Yuanlin, Xizhou, Xiluo, Huxi and Donghe links, no obvious existence of water resisting layers between each water bearing layers and water from ground surface goes straight to deeper layers, meaning that the apex of alluvial fan of Zhuoshui River is not limited to the existence of only water bearing layers.

2. Fan Center: The center of the fan covers the area west of unconstrained water bearing stratum zones to the east of Hao Xiu, Zhao Jia, Tan Yi, Tian Yang and Beigang links, where water resisting layers 1 lays on top of water bearing stratum 1 and significant water resisting layer exists between each water bearing stratum so water from the ground surface are unable to fill each water bearing stratums directly. In terms of strata materials, gravel occupies a large percentage of its composition.

3. Fan Tail: From the fan center all the west to the coast, where water bearing stratum 1 is covered by water resisting layer and there are

obvious water resisting layers between each water bearing stratum. However, the proportion of gravel within its stratum material is small and powder sand, mud and clay accounts for a larger proportion.

The water bearing stratum of ground water for this development project is located in the fan tail region.

(ii) Underground Water Quality

Referring to the nearby underground water inspection stations released by the Environmental Protection Administration, Xianxi Elementary School Inspection Station was selected. Its location is shown in Figure 6.2.5-2. Table 6.3.5-4 summarizes the underground water quality results for 2014-2015. This project is not located at water quality protected area. According to groundwater pollution monitoring datum value issued by EPA, ammonia nitrogen and mangenese of Xianxi Elementary School have exceeded groundwater monitoring datum value, the remaining items are complaince with standards. Due to fertility, domestic wastewater and excreta of animal, ammonia nitrogen has exceeded groundwater monitoring datum value. The existence of ammonia nitrogen indicates that the polluted duration is short.

Table 6.2.5-4 Annual groundwater quality inspection results at Xianxi Elementary School

Sampling Station	SamplingTime		Depth from water surface to well opening	Water Temperature	Electric Conductivity	pH Value	Dissolved Oxygen	Total Hardness	Total Dissolved SOlids	Chloride	Ammonia Nitrogen	Nitrate	Sulfate	Total Organic Carbon	Total Phenol	Villiaumite	Total Alkalinity
	Y	M	m	℃	µmho/cm25℃		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sian Ci Elementary School	2014	4	1.633	26.4	745	6.7	—	338	542	35.6	1.82	0.02	122	1.99	<0.0060	—	281
		7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		8	1.365	27.6	809	6.8	—	356	505	37.8	0.72	<0.01	132	3.18	<0.0060	—	—
		10	1.55	28.4	710	6.8	—	350	550	36.1	1.74	<0.01	120	3.20	<0.0060	—	280
	2015	1	2.52	27.3	700	6.7	—	253	524	37.3	2.38	<0.01	137	2.14	<0.0060	0.25	—
		4	1.212	26.6	814	6.8	—	310	495	37.1	2.40	0.01	121	3.06	<0.0060	0.27	239
		4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		7	1.566	27.2	811	6.7	—	322	573	37.8	1.52	<0.01	120	2.64	<0.0060	0.25	—
		10	1.455	28.7	981	6.8	—	347	666	49.7	1.40	<0.01	146	3.17	<0.0060	0.22	243
	2016	1	1.655	27.6	847	6.7	0.2	355	521	47.9	0.74	0.01	120	3.05	<0.0060	0.27	—
		4	1.348	26.1	1180	6.8	0.1	409	738	48.8	0.87	0.11	148	3.59	<0.0060	0.27	311
		7	1.927	27.3	1040	6.8	0.1	396	674	47.7	1.21	<0.01	110	2.76	<0.0060	0.29	—
		10	1.479	28.5	688	6.8	0.6	266	455	37	2.08	<0.01	78.6	2.3	<0.0060	0.31	224
	2nd Type of Monitoring Datum		—	—	—	—	—	750	1250	625	0.25	25	625	10	—	—	—

Sampling Station	Sampling Time		Arsenic	Cadmium	Chromium	Copper	Lead	Zinc	Iron	Manganese	Mercury	Nickel	Sodium	Potassium	Calcium	Magnesium
	Y	M	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sian Ci Elementary School	2014	4	0.004	<0.001	<0.001	<0.001	<0.003	0.008	1.070	0.704	<0.0003	0.011	56.7	7.68	92.5	27.6
		7	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		8	0.0025	<0.001	<0.001	0.002	<0.003	0.011	0.017	0.168	<0.0003	0.007	—	—	—	—
		10	0.0025	<0.001	<0.001	0.001	<0.003	0.010	0.079	0.799	<0.0003	0.006	54.3	9.37	93.2	28.5
	2015	1	0.0054	<0.001	<0.001	<0.001	<0.003	0.004	0.197	0.692	<0.0003	0.009	—	—	—	—
		4	0.0052	<0.001	<0.001	<0.001	<0.003	0.006	0.414	0.774	<0.0003	0.012	54.4	4.66	95.2	15.8
		4	—	—	—	—	—	—	—	—	—	—	—	—	—	—
		7	0.0035	<0.001	<0.001	0.001	<0.003	0.005	0.087	0.674	<0.0003	0.005	—	—	—	—
		10	0.0027	<0.001	<0.001	0.001	<0.003	0.012	0.012	0.663	<0.0003	0.011	62.4	7.67	100	25.1
	2016	1	0.0026	<0.001	<0.001	0.001	<0.003	0.013	0.066	0.284	<0.0003	0.007	—	—	—	—
		4	0.0036	<0.001	<0.001	0.001	<0.003	0.007	0.010	0.064	<0.0003	0.012	65.9	8.91	121	30.4
		7	0.0009	<0.001	<0.001	0.001	<0.003	0.013	0.155	1.130	<0.0003	0.006	—	—	—	—
		10	0.004	<0.001	<0.001	0.001	<0.003	0.007	0.698	1.100	<0.0003	0.006	37.6	4.88	73.5	21
	2nd Type of Monitoring Datum		0.25	0.025	0.25	5	0.25	25	1.5	0.25	—	—	—	—	—	—

Remarks: 1.Bold font indicates the estimated value is higher than underwater 2nd type of monitoring datum.
2.“ND” indicates it is unable to examine, “<” indicates it is lower than limiting value.
3.Data Source: Soil and groundwater pollution information network (http://ww2.epa.gov.tw/SoilGW/), National Environmental Water Quality Monitoring Information Network of EPA, EY (http://wq.epa.gov.tw/Code/Report/DownloadList.aspx) and compiled results of this project.

6.2.6 Soil

Heavy metal is examined via 7 sampling stations where located in the terrestrial vicinity of substation facility. Sampling survey is conducted in November of 2016 (Figure 6.2.6-1). 3 monitoring stations were conducted regarding common corridor on July of 2017 (Locations is shown in Figure 6.2.6-+1). Testing value of pH value and content of copper, mercury, lead, zinc, nickel, cadmium, chromium and arsenic of surface soil (0-15cm) and soil (15-30cm) is shown as Table 6.2.6-1 to Table 6.2.6-2.

Based on "Soil Pollution Monitoring Standards", "Soil Pollution Control Standards', general mornitoring standards and control standard, heavy metal content of soil is lower than soil pollution monitoring standards and control standard. This indicates tham soil in the vicinity of terrestrial substation is not pollution by heavy metal.

Table 6.2.6-1 Examination Analysis Results of Soil

Sampling Location / Item	pH	Zinc (mg/kg)	Cadmium (mg/kg)	Lead (mg/kg)	Copper (mg/kg)	Chromium (mg/kg)	Nickel (mg/kg)	Arsenic (mg/kg)	Mercury (mg/kg)
Beside Lusi Substation (Surface Soil)	7.6	58.3	ND	15.2	6.04	16.2	19.2	11.6	ND
Beside Lusi Substation (Soil)	7.7	59.7	ND	15.6	5.95	18.0	19.3	10.4	ND
Vacant Land of Lugong Road (Surface Soil)	7.7	86.1	ND	15.8	8.57	19.4	17.8	7.80	ND
Vacant Land of Lugong Road (Soil)	8.6	74.5	ND	14.6	8.24	19.2	19.1	8.31	ND
Changhua Coastal Industrial Park Substation (Surface Soil)	5.5	78.6	ND	15.8	9.76	15.1	15.3	7.08	ND
Beside Changhua Coastal Industrial Park Substation (Soil)	5.6	63.6	ND	13.0	7.09	15.3	16.0	7.84	ND
Vacant Land of Xi Er Road (Surface Soil)	6.9	69.7	ND	15.0	7.29	17.8	19.4	8.57	ND
Vacant Land of Xi Er Road (Soil)	7.6	60.5	ND	15.6	6.71	18.0	19.1	9.38	ND
Vacant Land of Xiangong North 4th Road (Surface Soil)	8.8	160	ND	23.0	16.6	23.8	20.9	4.55	ND
Vacant Land of Xiangong North 4th Road (Soil)	8.4	165	ND	23.2	16.4	24.1	20.5	5.64	ND
Beside Xianxi Substation (Surface Soil)	6.9	60.7	ND	13.4	7.35	16.7	18.2	6.22	ND
Beside Xianxi Substation (Soil)	6.8	60.2	ND	13.2	6.46	17.0	18.8	6.22	ND
Vacant Land of Qingan North Road (Surface Soil)	7.8	55.7	ND	14.5	6.43	16.3	17.8	8.43	ND
Vacant Land of Qingan North Road (Soil)	8.2	51.4	ND	13.9	4.58	14.4	16.3	8.70	ND
Soil Pollution Monitoring Standards	—	1000	10	1000	220	175	130	30	10
Soil Pollution Control Standards	—	2000	20	2000	400	250	200	60	20

註：1.資料來源：本計畫調查，委託亞太環境科技股份有限公司(環署檢字第 003 號)。
2."<"表該項測值低於方法偵測極限值。

Table 6.2.6-2 Analysis Results of Soil Supplementary Survey

Sampling Station / Item	pH	Zinc (mg/kg)	Cadmium (mg/kg)	Lead (mg/kg)	Copper (mg/kg)	Chromium (mg/kg)	Nickel (mg/kg)	Arsenic (mg/kg)	Mercury (mg/kg)
S-N1(Surface Soil)	6.9	64.7	ND	12.9	18.3	21.3	19.8	8.52	ND
S-N1 (Soil)	7.5	89.9	ND	12.3	13.9	18.3	18.4	8.01	ND
S-N2 (Surface Soil)	7.0	90.6	ND	16.8	24.7	22.7	19.1	7.70	ND
S-N2 (Soil)	7.1	110	ND	15.5	17.2	22.1	23.4	7.73	ND
S-N3 (Surface Soil)	6.5	41.4	ND	11.1	5.25	10.9	11.7	8.27	ND
S-N3 (Soil)	8.2	37.4	ND	10.1	5.94	12.4	12.2	8.33	ND
Monitoring Standard of Soil Pollution	—	1000	10	1000	220	175	130	30	10
Control Standards of Soil Pollution	—	2000	20	2000	400	250	200	60	20

註：1.資料來源：本計畫調查，委託廣大地環境科技股份有限公司(環署檢字第 164 號)。
2."<"表該項測值低於方法偵測極限值。

Figure 6.2.6-1 Schematic Diagram of Soil Sampling Locations

6.2.7 Physiography and Geology

I. Topography

(i) Terrestrial Topography

Changhua County is mainly constituted by plain, known as Changhua Coastal Plain, 94,240 ha. in total, accounting for 87.71%. Land where ranges from 100m to 1,000m or hill county and middle hills under 100m with 5% of slope is classified as hillside, 10,020 ha. in total, accounting for 9.33%. It is mainly distributed at Pagua Mountain where is east part of Changhua County.

Alpine forest is 3,180ha., accounting for 2.96% in Changhua County, It is mainly distributed in Shetou Township, Tianzhong Township, Ershui Township, Yuanlin Township, Huatan Township and Changhua City where are located at east part. It is high and precipitous and not suitable for production of agriculture. Thus, it is designated as protective forest. The topography of Changhua County is shown as Figure 6.2.7-1. Terrestrial utility of this projectis located at Xianxi Township and Lukang Township. Sea level of Xianxi Township and Lukang Township is 20m and below 10m respectively. Changhua Coastal Industrial Park where located at home base is classified as reclamation land, it is below 10m with flat terrain.

(ii) Marine Topography

Water depth measurement is measured by multibeam echo sounder which is mounted under vessel. The measuremen results is converted with tidal information of Taichung Harbor with datum of mean sea level. The water depth of this site ranges from -27.8m to -38.5m. The topography of seabed is shown in Figure 6.2.7-2 and Figure 6.2.7-3. The overall topography of this site shows that it is higher in southwest parr and lower in northeast part. Southwest pat and border of southern part is distributed with the form of dune which ranges from 1m to 4m with slope up to 20oC. Northeast part shows even landform and the average slope of seabed is less than 1o.

The formation of sand wave bed form on sandy seabed is a response to general fluid dynamics. Uneven sand waves were discovered within the regions of Greater Changhua Offshore Wind Power Plant and its shape represented that of a common north to east direction of flow. In the shallower south west regions, the shape of sand waves discovered were more complex due to the effects of different current flow and the sand waves observed closer to the north were all very even. The wavelength of these sand waves is about 150 ~ 200 meters apart and few can reach up to 250 meters. The amplitude of its shape at the bottom usually lies within an interval of 2 ~ 5 meters and the largest amplitude can be up to 8 ~ 9 meters. The largest pre-slope range is around 20°~30°.

Figure 6.2.7-1 Distribution Graph of Changhua County Topography

Figure 6.2.7-2 Topographical Map of Overall Sea Floor

Figure 6.2.7-3 Topographical Map of Sea Floor(1/2)

Figure 6.2.7-3 Topographical Map of Sea Floor (2/2)

According to the " Textural, mineralogical and chemical characteristics of surface marine sediments around Taiwan" (Page 67 – 81 of issue 39, Journal of Marine Science and Technology, June 2001), published by Chih-Yi Li and Ju-Chin Chen, this particular wind farm is part of the Chang Yuan Sand Ridge that is classified as a late Pleistocene residual sediment without any modern sedimentation. Under chemical analysis, the contents of cerium oxide, aluminum oxide, total iron contents and magnesium oxide in this area lies between the sediments observed in the surface layers of water regions near Taiwan and the estuary sediments (and suspended matters of river water) in mainland China. Furthermore, based on the hydrological flow field, the coastal water from mainland China invades the eastern part of the Taiwan Strait every winter, accumulating in the region north of Chang Yuan Sand Ridge in Taiwan Strait then makes a turn here to return north. It is possible for terrigenous materials from mainland China to be transmitted here and settle as it slows down to turn around. Based on the analysis above, which shows that the primary source of sediments in this area is most likely the sediments of Yangtze River brought here by the coastal currents in mainland China. The main minerals found in the shallow soil layers of this region are listed below in order of distribution: 67.57% of Si02, 10.49% of A1O3, 4.25% of ΣFeO, 1.50% of MgO, 5.43% of CaO, 0.07% of MnO, 2.03% of K2O and 1.24% of Na2O.

The results of mineral analysis did not indicate the presence of any metallic minerals with commercial value and precious metallic minerals such as rutile, ilmenite and zircon were all below testing standards.

II. Geology

(i) Regional Geology

This project is located at alluvium. Alluvium is sedimentary stratum accumulated on alluvial plain. Some is distributed at hill county or plain topography of hillside. It is composed by clay, silt, sand and gravelstone and it is poorly cemented. The most upper part is weathering to form soil which is widely used in agricuture. Littoral area and sand dune of caostal area which is in grey, light greyish black and light greyish yellow color are encompassed within alluvum. The composition is mainly constituted by quartz, slate and other debris and a little magnetic sand or minera figneous rock.

(ii) Site Geology

Based on the data of Central Geological Survey, MOEA, terrestrial geology in the vicinity of designated site is holocene alluvium which is consisted by gravelstone, sandy soil and clay, it is shown as Figure 6.2.7-4.

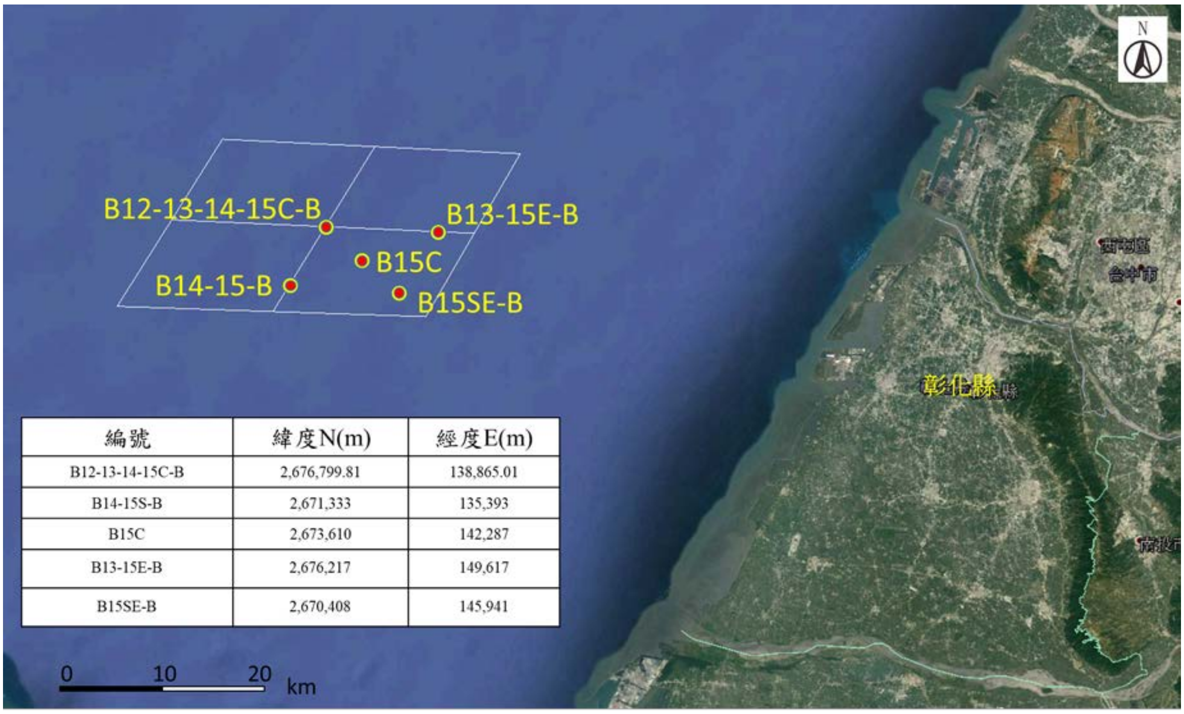
The project wind farm is located in Lugang Town and the outer sea of Xixiang, about 35.7 kilometers offshore. The sea area is mainly composed of sediments from the Xuoshui River and sediments on the Taiwan Strait. About 64 million tons/year, the sediments brought about by the interaction between the sediments and the Changhua sand ridge movement, the sediments on the Taiwan Strait are mainly from the sediments of the Yangtze River to the south of China, and the sediments are mainly Sandy soil is dominant.

1. Seismic Survey and Drilling

The geological distribution of this area is shown by the CPT histogram which displays the sand layer, silt layer and clay interlayer 50m below seabed, and results of seismic reflection were used as reference which categorizes the stratum into 5 layers from A ~ E, where the description of each layer is shown in table 6.2.7-1. The drilling positions of this project are shown in figure 6.2.7-5, where results of seismic prospecting at shallow layers are compared to drill hole column diagrams, as shown in figures 6.2.7-6 ~ figure 6.2.7-8. The depths of stratum depicted in the figure were based on the results of seismic reflection testing compared with drill hole data and the actual formation properties of each stratum was based on drill hole data. Results of geological drilling were taken into consideration when the geological model of this particular wind farm was established and it is represented by two diagonal cross-sections, with its location shown in figure 6.2.7-9 and cross-section of the stratum is shown in figures 6.2.7-10 and figures 6.2.7-11.

Table 6.2.7-1 Characteristics of each sub-layer of the seabed under investigation

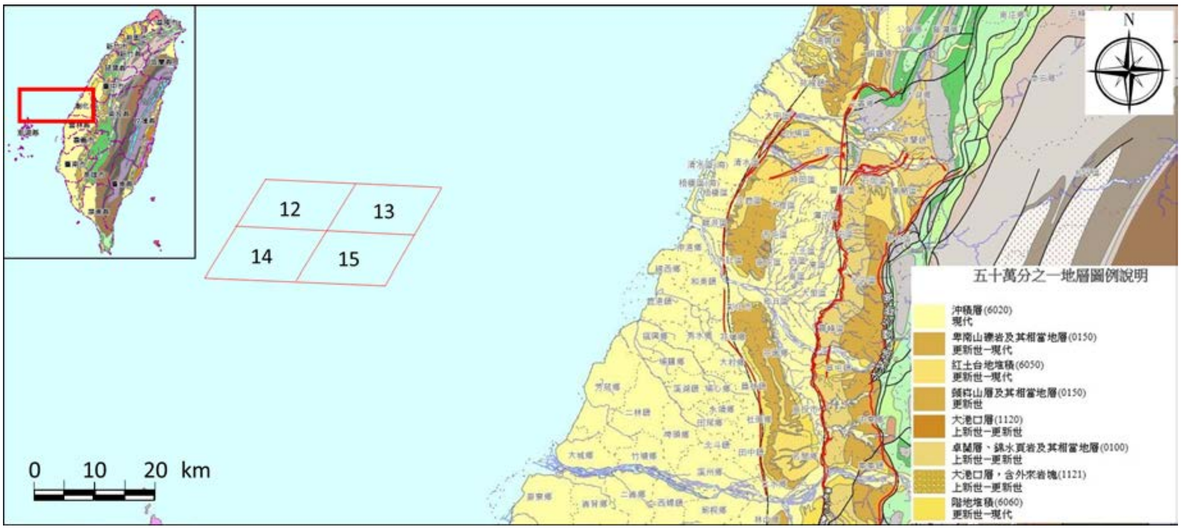
Layer	Characteristics Discription
Layer A	Loose to dense dark gray silty sand with shell debris and mica minerals. (SM)
Layer B	Dark gray sandy silt or silty sand and fine sand, with mica minerals. (ML/SM)
Layer C	Dark gray loose to medium compact silty sand and fine sand, with shell debris and mica minerals. (SM)
Layer D	Dark gray sandy silt or silt with shell entrapped mica minerals and clay grains. (ML)
Layer E	Solid to hard clay layer and interbedded layer of sandy silt and compact silt (CL/ML and SM interlayer)



編號	緯度N(m)	經度E(m)
B12-13-14-15C-B	2,676,799.81	138,865.01
B14-15S-B	2,671,333	135,393
B15C	2,673,610	142,287
B13-15E-B	2,676,217	149,617
B15SE-B	2,670,408	145,941

Photography time of google: 2016

Figure 6.2.7-4 Location Map of Drilling



Photography time of google: 2016

Figure 6.2.7-5 A geological map of the planned site adjacent to the continental area

Data Source: Central Geological Survey http://gis.moeacgs.gov.tw/gwh/gsb97-1/sys8/index.cfm

Figure 6.2.7-5 A geological map of the planned site adjacent to the continental area (continued)

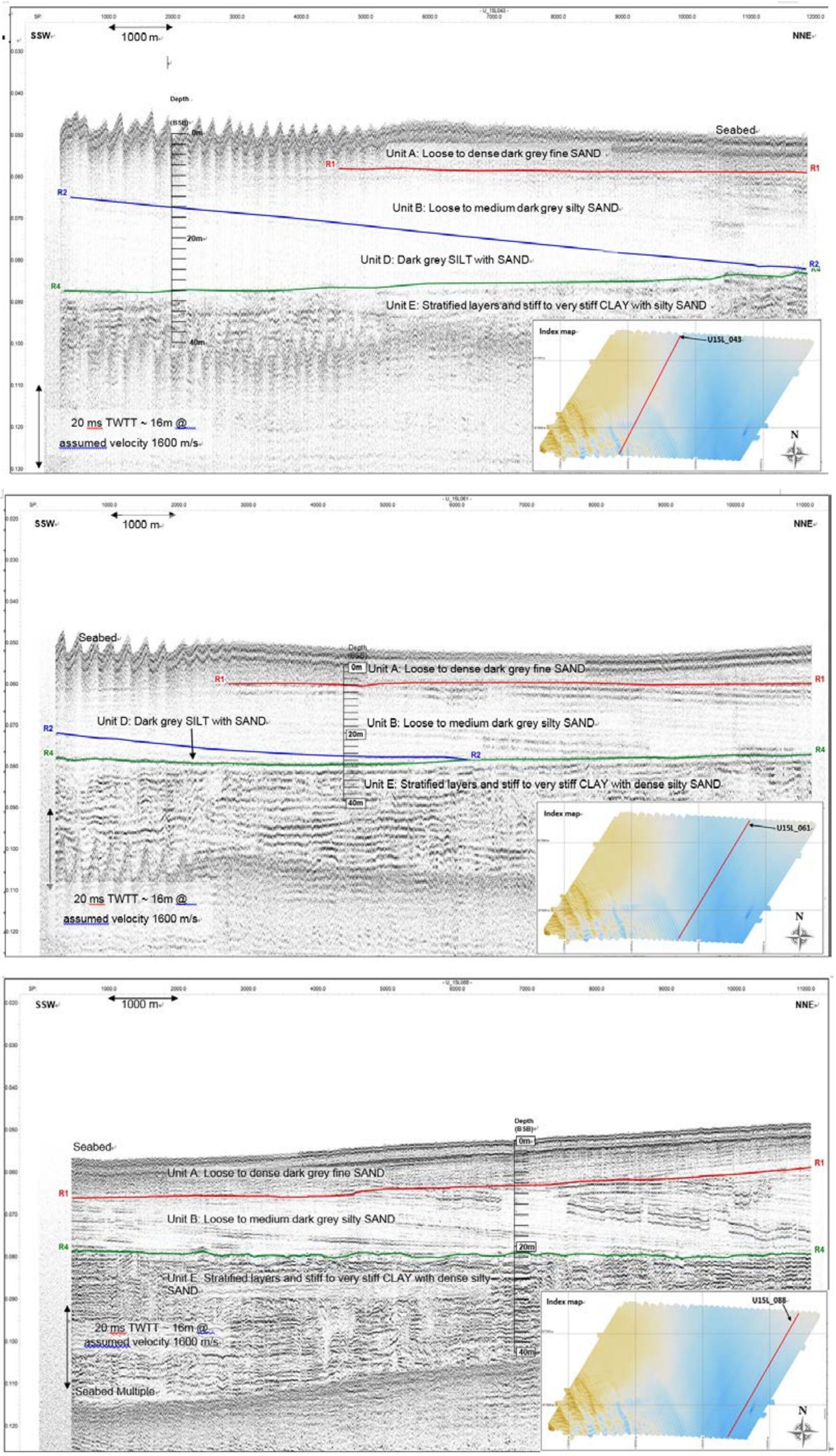


Figure 6.2.7-6   Shallow seismic map

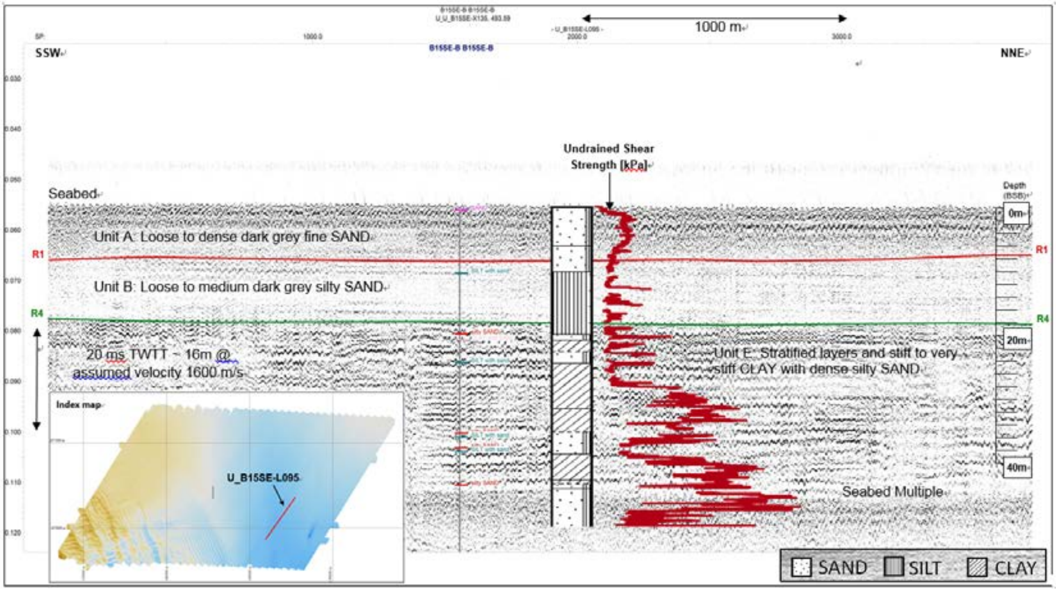


Figure 6.2.7-7 Comparison of shallow seismic data with B15SE-B borehole data

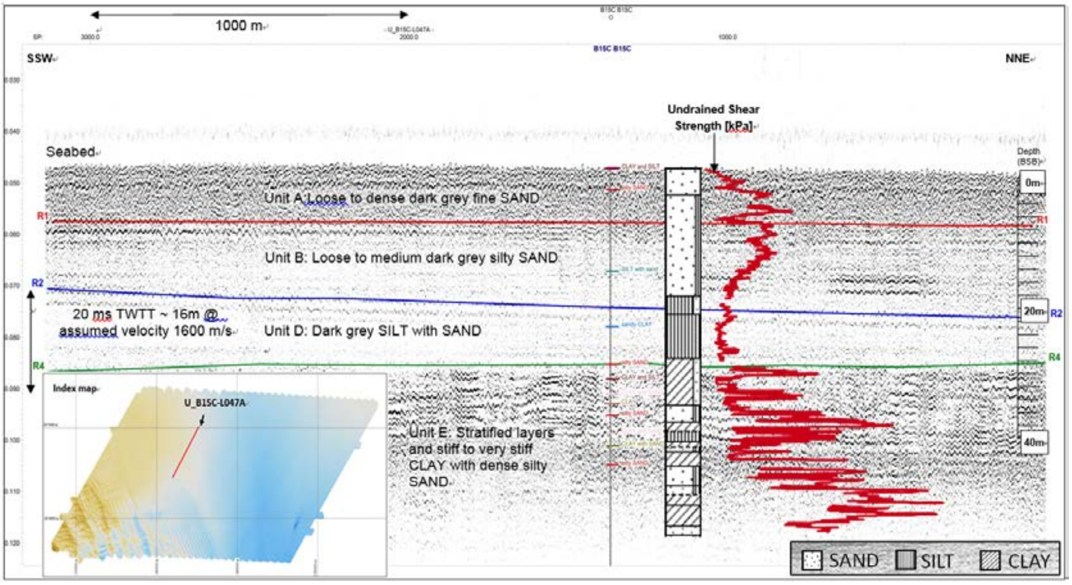


Figure 6.2.7-8 Comparison diagram of shallow seismic data and B15C borehole data

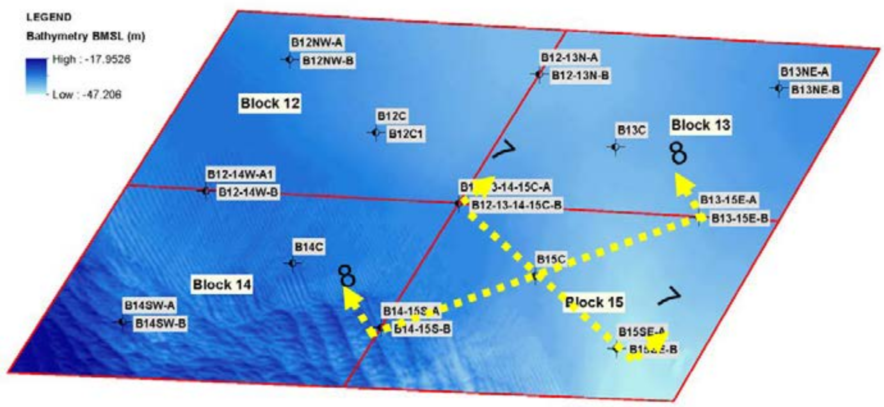


Figure 6.2.7-9 Schematic diagram of section position of formation model

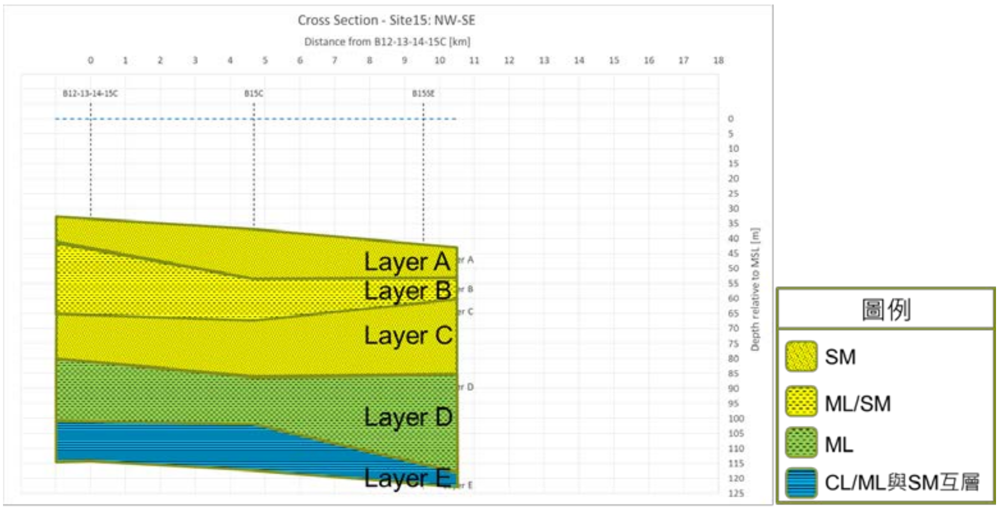


Figure 6.2.7-10 Stratigraphic model profile (Section 7-7)

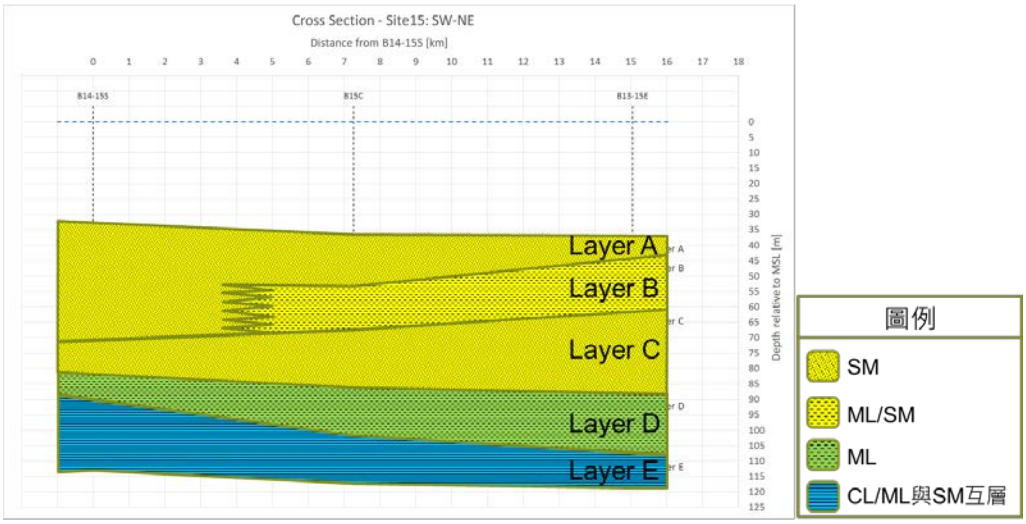


Figure 6.2.7-11 Stratigraphic model profile (Section 8-8)

2. Description Sea-bed Surface Sediment

The position of Zhuoshui River water system changes constantly with time, and the influence of ocean bottom stratum movements and currents, causes sediments to accumulate on the Changhua sand ridges, forming sandbanks and large surface of sand waves.

Results of side scan sonar (figure 6.2.7-12) shows that the sediments on top of seabed's surface are dominated by silty sand and the corn to the North West and south west are mostly medium density fine sand and medium to dense sandy mud.

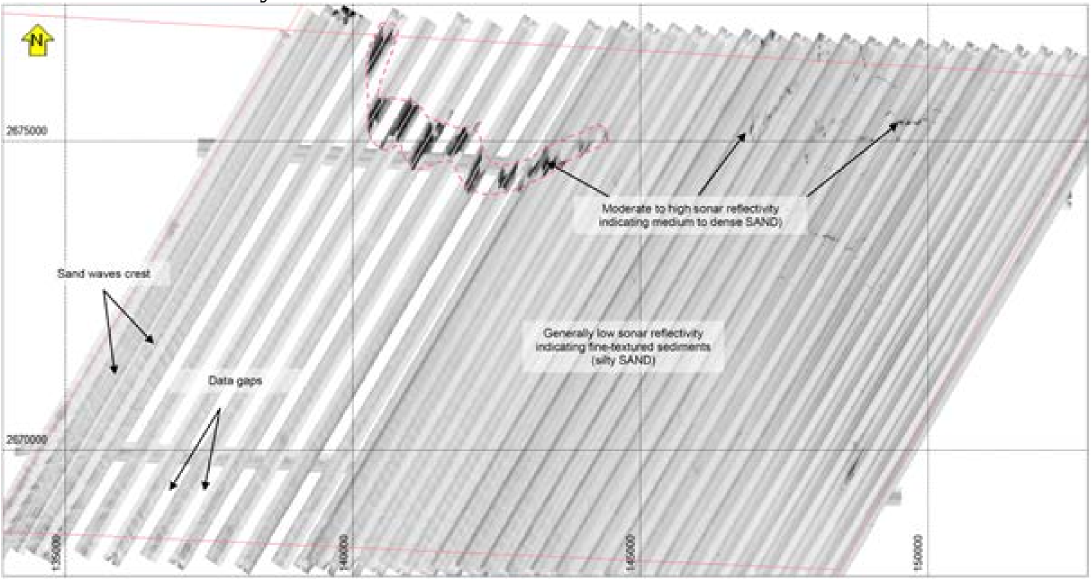


Figure 6.2.7-12 Results of Side-Scan Sonar

3. Grain Diameter Analysis

Statistics of grain diameter relating to the project's drill hole position can be found in table 6.2.7-2, where analytical data of surface layer grain diameter at each hole position were used for analysis and achieve the medium grain diameter (D50). Figure 6.2.7-13 is the medium grain distribution chart of this project wind farm, the medium grain distribution of the surface layer is approximately 0.099 ~ 0.200mm and the hole position B12 – 13 ~ 14-15C B located to the bottom right of the wind farm has a medium grain diameter of approximately 0.200mm.

Table 6.2.7-2 Particle Diameter of Borehole

Hole Site	E	N	Analysis of Particle Diameter(mm)				Median Diameter D50 (mm)
			D100	D60	D30	D10	
B12-13-14-15C B	138865.0	2676799.8	0.425	0.22	0.149	0.115	0.200
B14-15S B	135395.8	2671332.7	0.85	0.299	0.198	0.123	0.280
B13-15E B	149619.5	2676217.2	0.425	0.133			0.099
B15SE B	145943.5	2670407.7	0.425	0.176	0.132	0.109	0.160

Remarks: Analysis of particle diameter of hole site where located at surface layer is adopted. Median diameter is estimated by trend line of particle diamter analysis index (Abnormal value of calculation is filtered at certail hole sites).

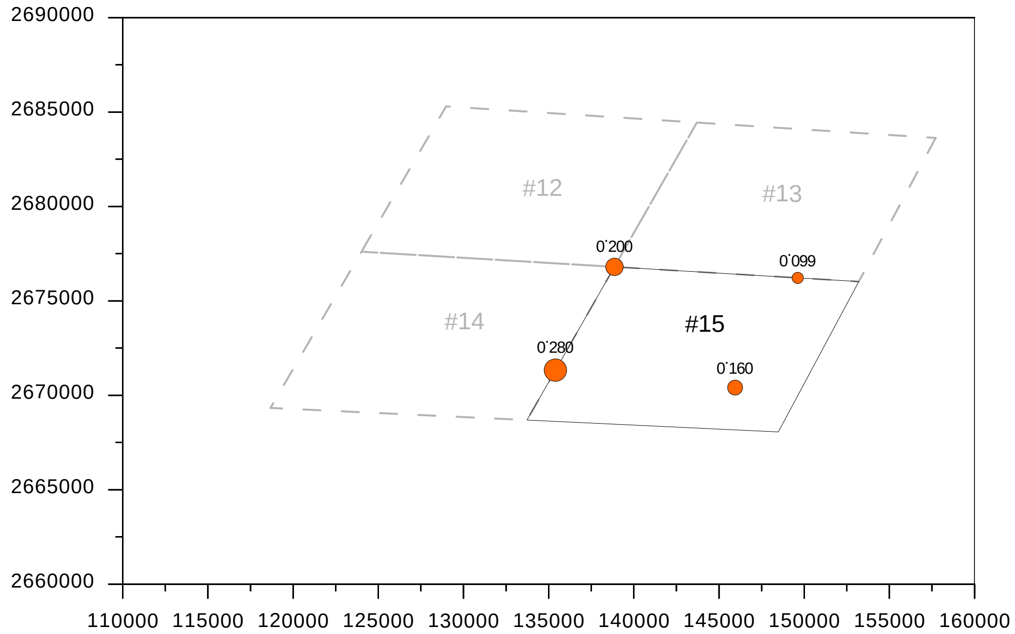


Figure 6.2.7-13 Distribution of Median Diameter at Surface Layer

III. Fault

In terms of plate tectonics, Taiwan is located on the junction of the Eurasia Plate and the Philippine Sea Plate (figure 6.2.7-14). During the extrusion and Collison process between these two plates, the orogenic zone of Taiwan was formed and effects created due to the fact that its load is directly on the plate, such as plate flexure and settlement, created the structural lowland found in the western region of Taiwan. At the same time, it adapted sediments delivered from nearby orogenic zone, forming the unique basin system that is known as the Foreland Basin (Yu and Chou, 2001). The area surveyed by the Greater Changhua Offshore Wind Power Generation Project is located in this particular basin system within the tectonic setting.

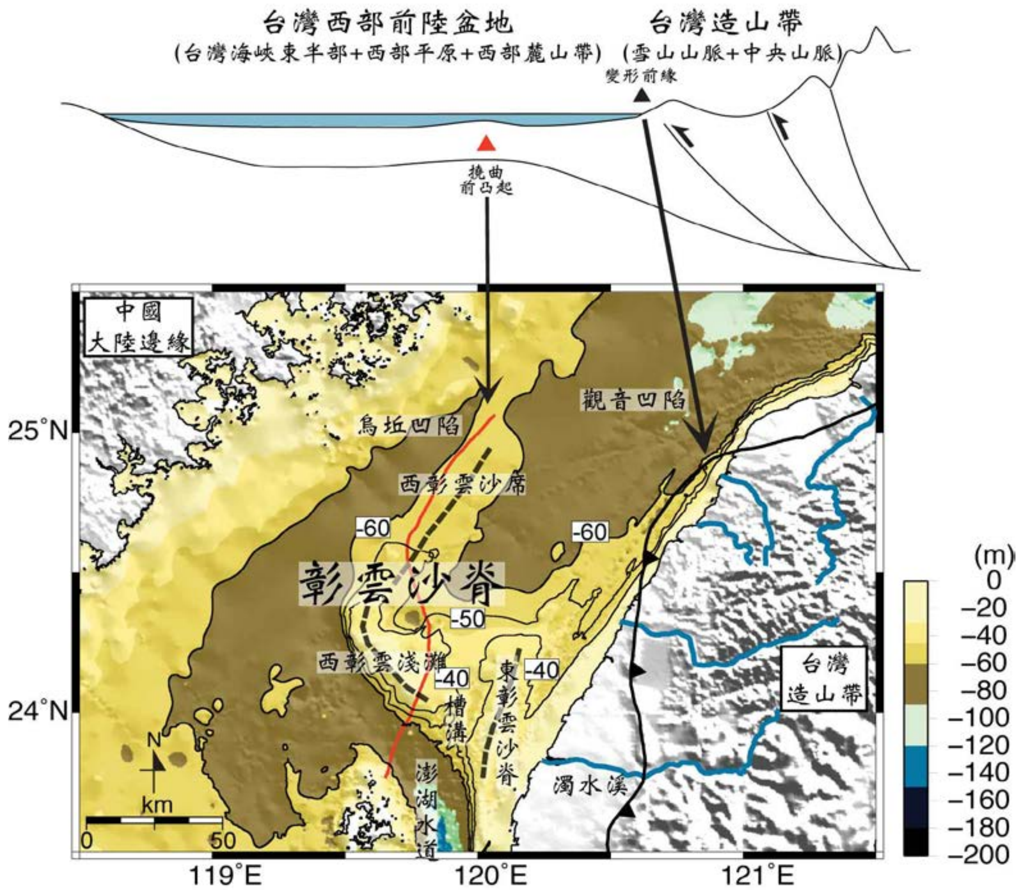
The foreland basin system extends from the west to the east, including the Taiwan Strait, the coastal plain and foothill zone of the west (figure 6.2.7-15). The structure of Taiwan's western foreland basin can be divided into the plate structure flexure zone – the front bulge (fore bulge) and the main accumulation zone of sediments on the east of the front bulge – fore deep. The survey area of this project is located around the Chang Yuan Sand Ridges of Taiwan Strait, which is part of the front bulge accumulation area within the foreland basin system (Chang et al., 2012; 2015), other plate tectonics are located on the flexure front bulge belt of the foreland basin in the western region of Taiwan (Yu and Chou, 2001; Chang et al., 2015; figure 6.2.7-15).

Under the plate tectonic framework mentioned above, according to researchers conducted by those before us, the fault in the ocean region of this project can be divided into two phases, before and after the development of the foreland basin system. Before the development of this basin system, the region was primarily affected by the tension fissure activities of continental margin, mainly the ancient normal fault with tension fissure from east to west (Chou and Yu, 2002); with the development of the basin system that followed, the fore bulge was effected by plate flexure and it formed a flexure type normal fault created by the fissure environment (figure 6.2.7-16). The flexure type normal fault was formed in earlier years and it is capable of piercing through the foreland basin stratum layer order formed as of late Miocene. The fault strikes mainly in the north to south direction and its fault displacement is generally less than 100 meters. Under the effect of orogenic load effect, the fore bulge region of Taiwan Strait moves gradually to the west and as it moves closer towards the coast of mainland China, the age of fault development gets younger, it is believed to be the syn-orogenic normal fault caused by the flexure of foreland plate (Chou and Yu, 2002; Chang et al., 2015).

In addition, Yang et al. (2006) was able to observe the normal fault located in the deep regions of Taiwan and Taiwan Strait in cross-section then summarize and graph it, with the use of multi-channel reflection seismograph. But the cross-section it used and the analysis results did not overlap directly with the regions of this project (figure 6.2.7-17).

Data Source: Modified by Angelier et al. (1986)

Figure 6.2.7-14 Structural Diagram of Taiwan and Neighboring Area



Base Map Source: Modified Chang et al. (2015).

Remarks: Eastern part of Taiwan Strait is part of Taiwan West Part foreland basin. Red line indicates bulge part.

Figure 6.2.7-15 Distribution Graph of Neighboring Faults

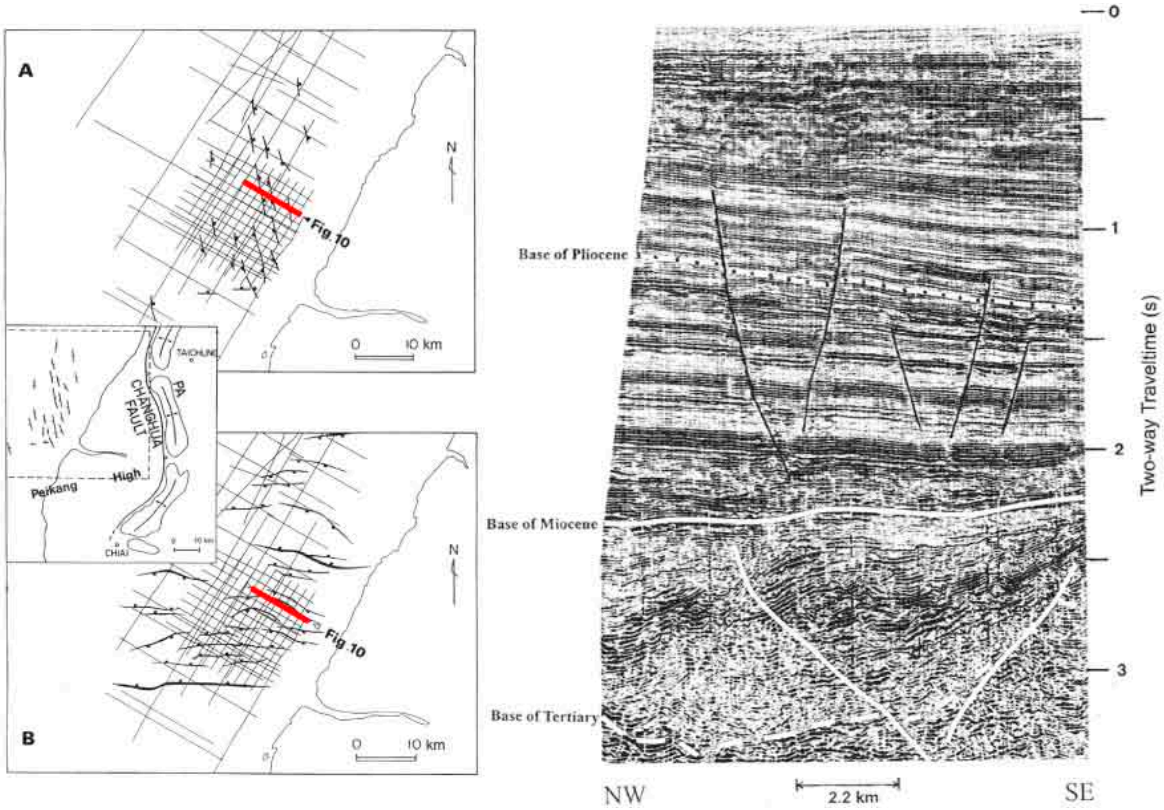


Figure 6.2.7-16 Deflected Normal Fault of Taiwan Western Part Foreland Basin

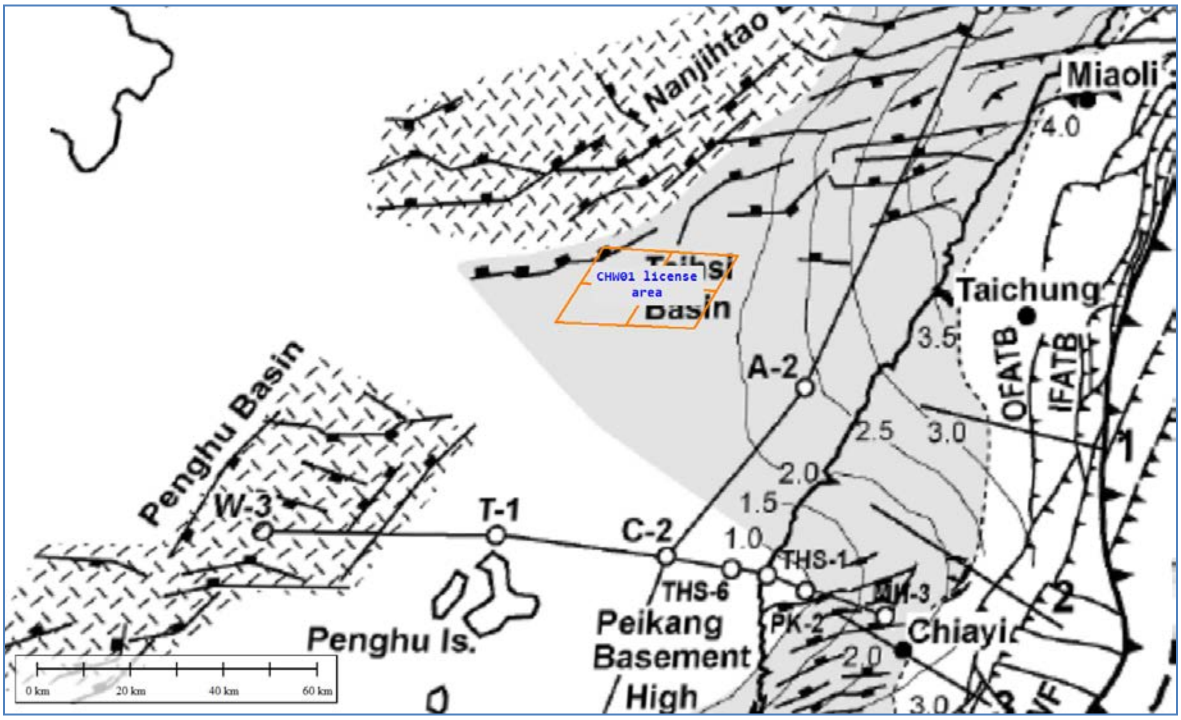
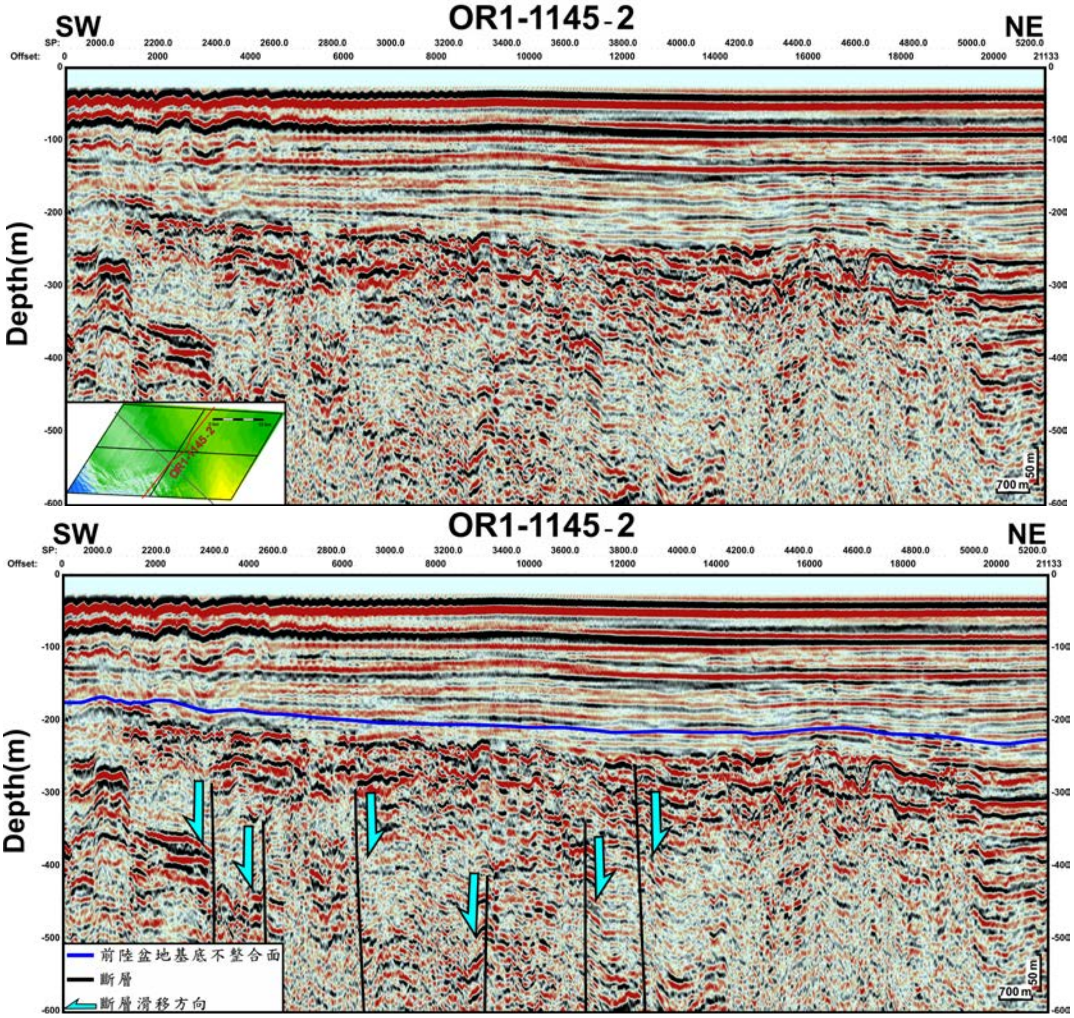
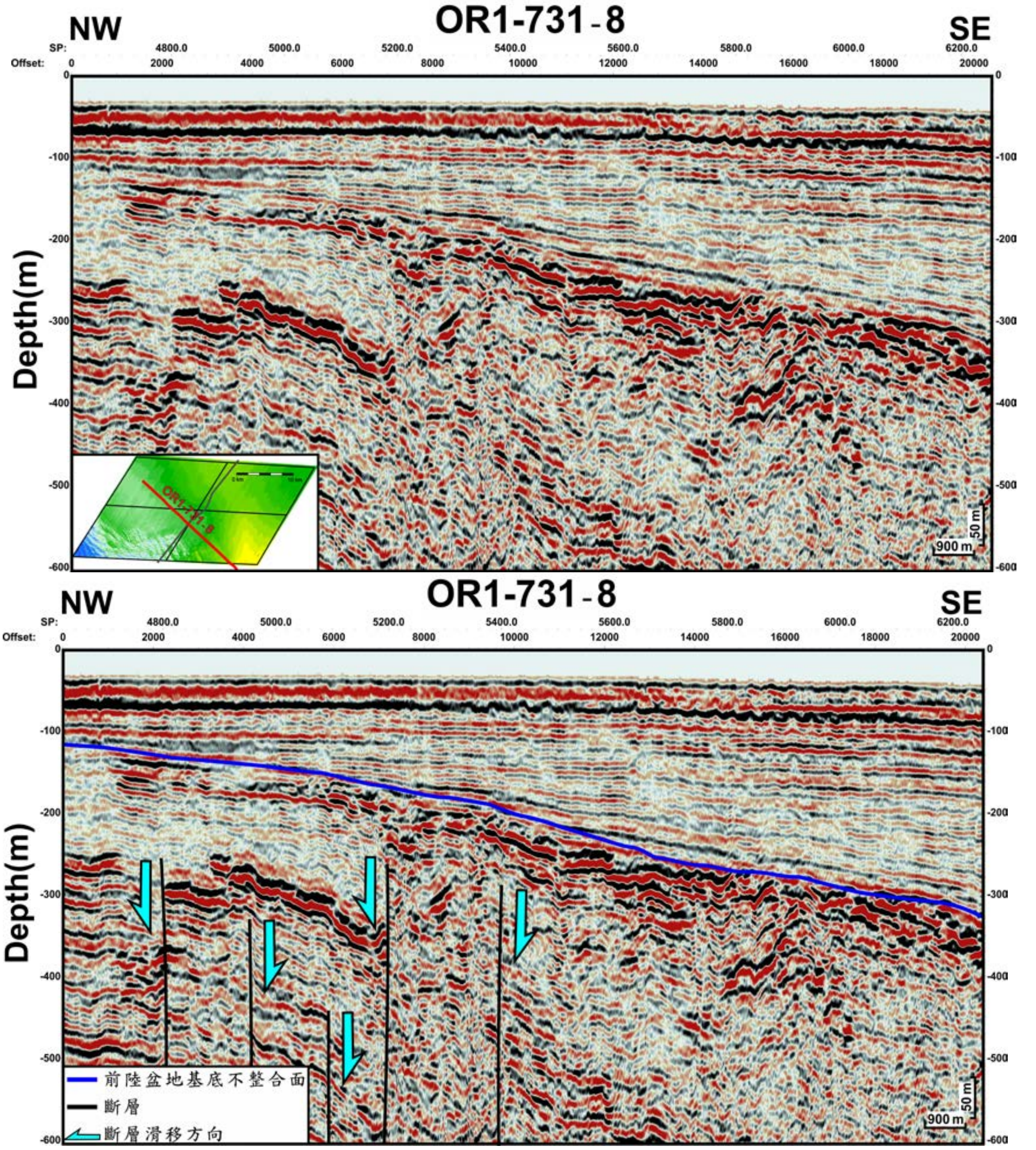


Figure 6.2.7-17 Deflected Normal Fault of Taiwan Western Part Foreland Basin



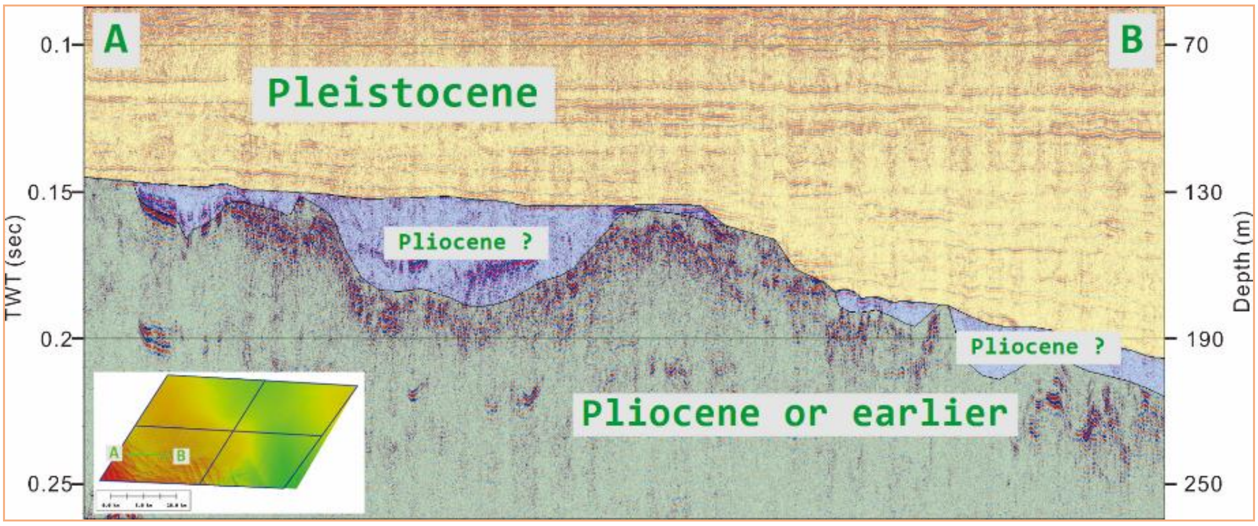
Note: The figure above shows the original section, and the figure below is the interpretation section. In the small figure of the original section, the red line is the location of the seismic section in the planned area, while the blue line in the interpretation section is the unconformity surface of the former continental base. The black line indicates the location of the fault, and the light blue arrow indicates the direction of fault dislocation.

Figure 6.2.7-18 Through the OR1-1145-2 multichannel reflection seismic section of the planned area



Note: The figure above shows the original section, and the figure below is the interpretation section. In the small figure of the original section, the red line is the location of the seismic section in the planned area, while the blue line in the interpretation section is the unconformity surface of the former continental base. The black line indicates the location of the fault, and the light blue arrow indicates the direction of fault dislocation.

Figure 6.2.7-19 Through the OR1-731-8 multichannel reflection seismic section of the planned area



Note: The section shows that the undisturbed sediments from the pleistocene covered the sediments from the pliocene or older. No fault was observed in this section.

Figure 6.2.7-20 Through the shallow stratigraphic section of the planned area

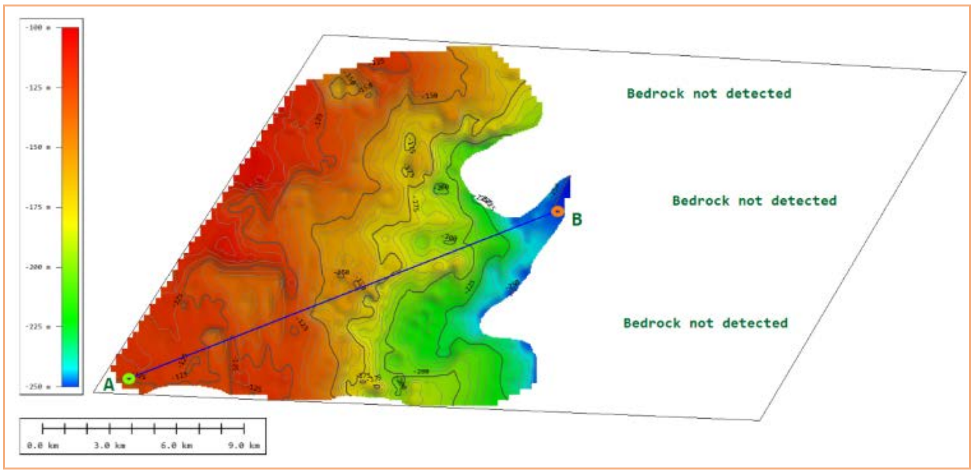


Figure 6.2.7-21 Depth Map of Bedrock

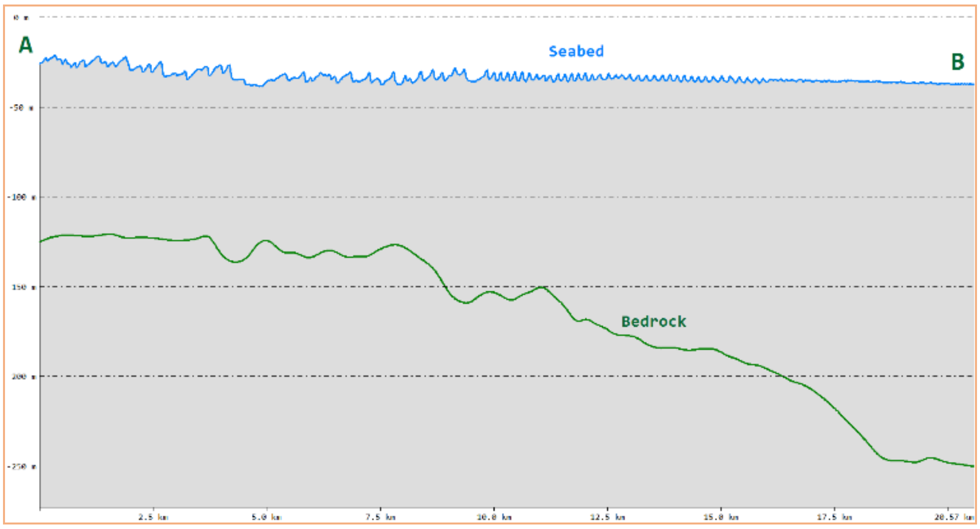
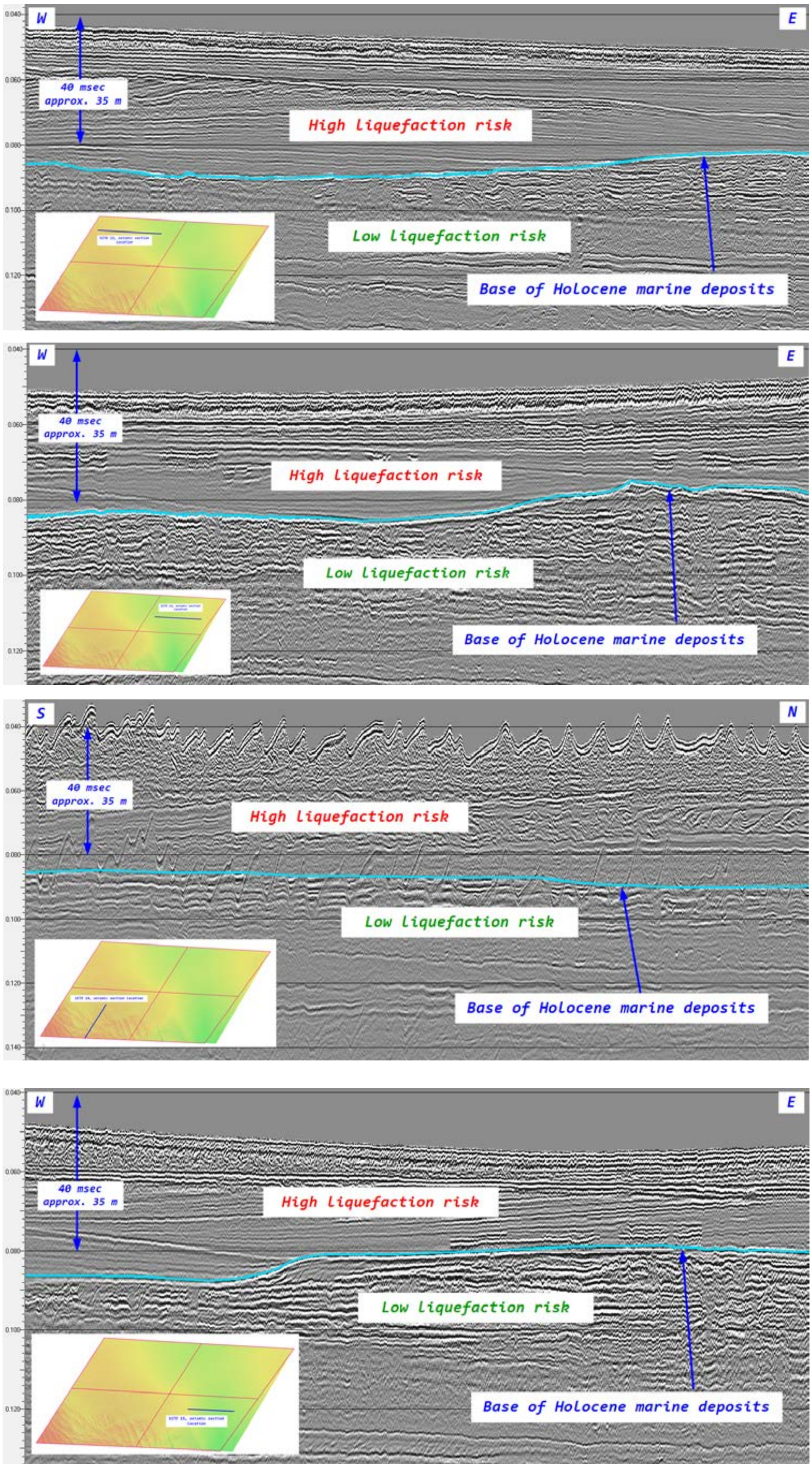


Figure 6.2.7-22 Cross Section of Bedrock



Note: The section position is shown in the lower left panel of the section. No fault dislocation was observed in the section.

Figure 6.2.7-23 Through the shallow stratigraphic profiles of each block of the project

底圖來源：經濟部中央地質調查所，臺灣活動斷層觀測系統及便民查詢服務
(網址：http://fault.moeacgs.gov.tw/MgFault/Home/pageMap?LFun=1)

Figure 6.2.7-24 Diagram of Fault Distribution around Study Areas

Aside from that, after taking the earthquake history of the area and other public resources into consideration, it is shown that historical events do not effectively and consistently represent the risk studies. Ørsted A/S is currently conducting a risk study on earthquakes at the Greater Changhua Offshore Wind Farm. The consultant is also conducting a research on the earthquake history.

The first large earthquake in Taiwan was recorded in 1604 while the earliest seismometer was set up in 1896. Based on research on past earthquake history, Taiwan is said to have had 33 incidents of catastrophic earthquakes in the absence of any seismographic records. The epicenter and scale of the earthquakes were found through estimations (Ng et al., 2009). Historical records and seismographic data have pointed out that in every century, there happens to be at least two earthquakes with the magnitude of 7.0 or greater.

Although observations of the deep and superficial stratigraphic sections in this study do not show obvious signs of fault lines propagating into the foreland basement unconformities affecting the superficial strata,but judging from the geological framework of the Wind Farm (the west rim of the study area is situated in the raised front area of the foreland basin) and the earthquake records of the areas along the Taiwan Strait, possibility of fault activities should still be considered.

IV. Geological Hazard

According to published reports by the Central Geological Survey, there are only two types of geologically sensitive areas found in the Changhua County, i.e. ‘groundwater recharge geologically sensitive areas' and 'landslide-landslip geologically sensitive areas'. The studied areas which are situated in the Xianxi and Lukang Townships are all out of the parameters of the reported geologically sensitive areas.

Besides that, this study also referred to the Geologically Sensitive Areas Inquiry System set up by the Ministry of Economic Affairs-Central Geological Survey (Access via: http://gis.moeacgs.gov.tw/gwh/gsb97-1/sys_2014b/).

All areas involved in this study are not within the parameters of the geologically sensitive areas. Further details, please refer to Appendix 1.3.

6.2.8 Waste

V. Waste Production

(i) Waste Cleaning

According to statistical data published by Environmental Protetcion Agency, Executive Yuan, the annual domestic waste in 2005 for Changhua County was 385,32 tons. The daily waste production per capita was 0.818kg and it is shown in Table 6.2.8-1.

(ii) Waste Characteristics

The results of waste charaxteristic analysis for Changhua County is the recent 5 years (2011 to 2015) performed by Environmental Protection Agnecy are summarized in Table 6.2.8-2. Physical composition and chemical analysis are included and described as follows:

1. Physical Composition

Physical composition (wet assay)of general waste is generalized into combustible and non-combustible. According to Table 6.2.8-2, the proportion of physical composition waste production of Changhua County in recent 5 years ranges from 96.23% to 98.72%. Among which, paper, kitchen waste and plastic account for higher proportion; Non-combustible accounts for 1.28 to 3.77%.

2. Chemical Analysis

Chemical analysis includes water, ashes, combustible component and higer and lower heating value . From Table 6.2.8-2, the moisture content of Changhua County in recent 5 years maintains at 55.21% to 57.14%. Ashes account for 3.36 to 6.81% and combustible components account for 36.27% to 39.64%. Higher heating value ranges between 2,252.40 and 2,513.78 Kcal/kg. Lower heating value ranges between 1,742.16 and 1,982.86, it is suitable to treat by incineration.

II. Waste Treatment Method

Most of the household garbage cleaning methods in Changhua County are entrusted to the cleaning team of the township and municipal government offices for clearing and transportation. For the year 104, after the garbage collection excluding the recycle materials, the remaining 99.86% are incinerated, and 0.14% are buried in sanitary. The incineration facility includes a small waste incinerator of 30 metric ton/day, and a waste recycling incineration plant in Xizhou, which was operated at the end of the year 89. The daily processing capacity is 900 metric tons, which can serve 13 townships such as Hsichou, Erhshui, Pitou, Shetou, Xihu, Beidou, Tianwei, Zhutang, Yongjing, Puxin, Yuanlin, Tanzhong and Erlin. Most of the sanitary landfills in Changhua County have been closed and rehabilitated. Therefore, the garbage disposal in the county is mainly incineration.

Table 6.2.8-1 Annual waste cleaning status in Changhua County

Year	Annual waste production volume (tons)	Categorized by treatment method (tons)							Daily waste production volume per capita (kg)	Rate of complete treatment (%)	Rate of recycling (%)
		Regular waste incineration	Large waste incineration	Sanitary landfill	Regular sanitary landfill	Large sanitary landfill	Landfill	Incineration			
2015	385,328	201,972	5,159	283	-	283	283	207,131	0.818	99.99	42.32
2014	391,688	204,044	4,277	18		18	18	208,321	0.829	100	41.34
2013	430,625	205,750	3,896	58	-	58	58	209,645	0.909	100	38.86
2012	429,744	210,744	2,543	43	-	43	43	213,287	0.902	100	35.66
2011	440,453	246,058	3,543	139	-	139	139	249,601	0.925	100	30.63
2010	443,471	256,743	3,910	280	-	280	280	260,653	0.928	100	28.17
2009	424,950	251,988	3,437	378	-	378	378	255,425	0.887	100	27.29

Source: "Environmental Resources Databank" (http://erdb.epa.gov.tw/), the Environmental Protection Administration, Executive Yuan.

Table 6.2.8-2 Physical and chemical composition of wastes in Changhua County

Sample Characteristics			2011	2012	2013	2014	2015
Physical composition (Wet component)	Combustible	Paper (%)	33.26	33.06	46.4	37.32	31.82
		Fabric Cloth (%)	2.78	2.18	2.2	0.91	4.64
		Woods, straws and leaves (%)	1.33	1.36	1.22	1.14	1.17
		Kitchen Waste (%)	39.56	42.26	31.78	41.21	38.12
		Plastic (%)	19.66	17.95	16.76	16.94	20.33
		Leather, Rubber (%)	0.31	0.24	0.17	0.1	0.04
		Others (include miscellaneous waste under 5mm) (%)	0.3	0.4	0.2	0.26	0.11
		Total (%)	97.2	97.45	98.72	97.87	96.23
	Non-Combustible	Metals (%)	0.43	0.14	0.21	0.12	0.47
		Non-metals (%)	0.33	0.18	0.2	0.62	0.05
		Glass (%)	1.44	1.52	0.73	1.24	1.15
		Other non-combustibles (%)	0.61	0.72	0.15	0.16	2.1
		Total (%)	2.81	2.55	1.28	2.13	3.77
Chemical composition	Three-Component	Water (%)	56.18	55.59	57.01	57.14	55.21
		Ash (%)	4.51	5.09	3.36	6.59	6.81
		Combustible Component (%)	39.32	39.32	39.64	36.27	37.98
	Element Analysis	Carbon (%)	22.41	21.57	20.67	21.19	23.86
		Hydrogen (%)	3.59	3.31	3.13	3.1	3.49
		Oxygen (%)	12.75	13.84	15.33	11.4	10.09
		Nitrogen (%)	0.37	0.41	0.33	0.38	0.34
		Sulphur (%)	0.12	0.12	0.13	0.15	0.13
		Chlorine (%)	0.08	0.08	0.05	0.06	0.07
	Calorifi Value	Dry component calorific value (kcal/Kg)	5,738.95	5,299.54	5,794.15	5,255.03	5,352.00
		Wet component maximum calorific value (kcal/Kg)	2,513.78	2,360.64	2,455.77	2,252.40	2,397.16
		Wet component minimum calorific value (kcal/Kg)	1,982.86	1,848.48	1,944.72	1,742.16	1,877.44

Source： “Environmental Resources Databank” (http://erdb.epa.gov.tw/), the Environmental Protection Administration, Executive Yuan.

6.2.9 Spoil Disposal

18 soil and gravel resource stacking sites are located in central region. Among which, 4 soil and gravel resource stacking sites are located on Changhua County and its annual processing capacity is 1.75million m3; 11 soil and gravel resource stacking sites are located in Taichung City, its annual processing capacity is 4.91million m3; 3 soil and gravel resource stacking istes are located in Yunlin County, the annual processing capacity is 2.796 million m3. Details is listed in Table 6.2.9-1.

Table 6.2.9-1 Operating soil and gravel resource stacking sites in Central Taiwan

County/ City	Site Name	Function	Licensed landfill volume (m^3)	Licensed treatment volume (m^3)	Acceptable Soil Quality
Taichung City	Paowen construction residual soil and gravel resource stacking site	Processing, transferring	0	360000	B1, B2-1, B2-2, B2-3, B3, B4
	Tungfa construction residual soil and gravel resource stacking site	Transferring	0	360000	B1, B2-1, B2-2, B2-3, B3, B4, B5
	Xitun District Tsungmao environmental protection soil and gravel resource stacking and processing site	Transferring	0	1080000	B1, B2-1, B2-2, B2-3, B3, B4, B5
	Paojen construction residual soil and gravel resource stacking site (Paojen Soil Development Co., Ltd.)	Processing, transferring	0	360000	B1, B2-1, B2-2, B2-3, B3, B4, B5
	Chianglin Environmental Protection Engineering Co., Ltd.	Transferring	0	360000	B1, B2-1, B2-2, B2-3, B3, B4, B5
	Tungyi Kuanlien soil and gravel resource stacking site	Transferring	5736	352800	B1, B2-1, B2-2, B2-3、B3, B4, B5
	Lucheng Premix Concrete Co., Ltd. Soil resource site	Processing	0	266688	B1, B2-1, B2-2, B2-3, B3, B4. B5
	Tsaishih Gravel Co., Ltd	Processing	0	355698	B1, B2-1, B2-2, B2-3, B3, B4, B5
	Taichung City Fengchou Seawall Public soil and gravel resource stacking site	Processing, transferring	0	720000	B1, B2-1, B2-2, B2-3, B3, B4, B5
	Tasheng soil and gravel resource stacking site	Processing, transferring	0	352800	B1, B2-1, B2-2, B2-3, B3, B4, B5
	Yingchuan Industrial Co., Ltd.	Processing	0	341568	B1, B2-1, B2-2, B2-3, B3, B4, B5
Changhua County	Tahsuan Environmental Protection Co., Ltd.	Processing	0	397800	B1, B2-1, B2-2, B2-3, B3, B4, B5, B6, B7
	Taichang Co., Ltd. soil and gravel resource stacking site	Processing	0	315000	B1, B2-1, B2-2, B2-3, B3, B4, B5, B6, B7
	Yunglin Development Industrial Co., Ltd.	Processing	0	403200	B1, B2-1, B2-2, B2-3, B3, B4, B5, B6
	Shengyao Environmental Protection Technology Co., Ltd.	Processing, transferring	0	633600	B1, B2-1, B2-2, B2-3, B3, B4, B5
Yunlin County	Sihhu Township Yingtung soil and gravel resource stacking site	Transferring	0	600000	B1, B2-1, B2-2, B2-3, B3, B4, B5, B6
	Holifa Soil Resource Technology Co. Ltd. soil and gravel resource stacking site	Processing, transferring	0	1080000	B1, B2-1, B2-2, B2-3, B3, B4, B5, B6
	Shihchuan Development Co., Ltd. soil and gravel resource stacking and transferring site	Transferring	0	1116000	B1, B2-1, B2-2, B2-3, B3, B4, B5, B6, B7

Source:http://www.soilmove.tw/Dump/DumpList.aspx

Note：Soil quality code: B1: rock, gravel, crushed stone or sand; B2-1: mixture of soil, gravel and sand (soil<30% by volume); B2-2: mixture of soil, gravel and sand (30%<soil<50% by volume); B2-3: mixture of soil, gravel and sand (soil>50% by volume); B3: silty soil (sludge); B4: clay soil; B5: bricks or concrete; B6: sludge or soil with water content >30%; B7: bentonite produced from diaphragm wall

6.2.10 Electromagnetic Field

In order to understand the magnetic field values generated by the project's shore connection station, electrical room and areas along the power transmission cable, the Department of Electrical Engineering from the National Taiwan University of Science and Technology was commissioned to perform tests for the magnetic field test plan proposed by this project. Table 6.2.10-1 and figure 6.2.10-1~2 shows the location of each inspection and testing location. The measurement of the project's current environmental electromagnetic field was performed in November 2016 and methods used for the inspection was in accordance to the "Electric Field and Magnetic Field Inspection Method in the Environment (Overhead High Voltage Line, Substation, Floor Type Transformer)". Announced by the Environmental Protection Administration on April 4, 2003. Subsequent supplementary investigation will be carried out in accordance with the newly announced "Radio Frequency Electromagnetic Field Wave Detection Method in the Environment (NIEA P203.92B)" by the Environmental Analysis Laboratory on January 17, 2017 and recommended values from domestic and foreign sources are shown in table 6.2.10-3. Description of the inspection and test results are as follows:

According to investigation (table 6.2.10-4), the first investigation of areas along the project's power transmission cable path showed background values between 0.0 ~ 7.3 milligauss and the maximum value of 7.3 milligauss was detected beside Changbin ES; according to the results of the second investigation (table 6.2.10-5), the background value of areas along the power transmission cable of this project showed values from 0.0 ~ 1.7 milligauss and the maximum value of 1.7 milligauss was recorded beside substation C. Both investigations showed values that were significantly lower than related domestic and foreign recommended values.

Table 6.2.10-1 Location of Electroagnetic Field Measuring Stations

Measuring Location	Measuring Location Code
Xianxi Landing Point	T1
Xianxi turning point 1	T2
Xianxi turning point 2	T3
Xianxi Substation	T4
Changhua Coastal intersection 1	T5
Changhua Coastal intersection 2	T6
Changhua Coastal Landing Point	T7
Measuring Point	T8
Shenglun	T9
Changhua Coastal ES	T10
Luhsi Landing Point	T11
Luhsi Intersection	T12
Luhsi Factory	T13
Luhsi Substation	T14

Table 6.2.10-2 Measuring Location of Supplementary Electromagnetic Survey

Measuring Location	Measuring Location Code
LandingPoint	T1
In the Vicinity of Substation C	T2
In the Vicinity of Substation B	T3
Changhua Coastal Substation	T4

Table 6.2.10-3 Standard Value of 50/60 Hz Magnetic Field Limit Recommended by Advanced Countries

Country	Limit value (mG)		
	Working Personnel		General Public
International Radiation Protection Association (IRPA)	All Days	5,000	1,000
	Few Hours	50,000	10,000
Japan	Continuous Exposure	50,000	2,000
	Exposure for Short Time	100,000	10,000
National Radiological Protection Board (NRPB)	20,000		20,000
Taiwan, ROC	—		833

note：1 mG＝0.1 micro Tesla

Figure 6.2.10-1 Electromagnetic Field Measuring Locations

Figure 6.2.10-2 Supplementary Electromagnetic Field Measuring Locations

Table 6.2.10-4 Magnetic Field Background Value of Power Transmission Line

Monitoring Location	Code of Monitoring Station	11th November 2016 (Weekday) Measured Value of Magnetic Field (Milligauss)			12th November 2015 (Weekend) Measured Value of Magnetic Field (Milligauss)		
		Maximum	Minimum	Average	Maximum	Minimum	Average
Xianxi Landing Point	T1-1	0	0	0	0	0	0
	T1-2	0	0	0	0	0	0
	T1-3	0	0	0	0	0	0
	T1-4	0	0	0	0	0	0
	T1-5	0	0	0	0	0	0
Xianxi Street Corner 1	T2-1	0	0	0	0	0	0
	T2-2	0	0	0	0	0	0
	T2-3	0	0	0	0	0	0
	T2-4	0	0	0	0	0	0
	T2-5	0	0	0	0	0	0
Xianxi Street Corner 2	T3-1	0.14	0.14	0.14	0.1	0.1	0.1
	T3-2	0.3	0.22	0.2305	0.25	0.14	0.221667
	T3-3	0.3	0.29	0.299667	0.3	0.29	0.290167
	T3-4	0.17	0.14	0.1405	0.22	0.14	0.149333
	T3-5	0.45	0.22	0.244	0.25	0.14	0.157833
Xianxi Substation	T4-1	0.14	0.14	0.14	0.3	0.17	0.228333
	T4-2	0.1	0	0.09	0.14	0.14	0.14
	T4-3	0.17	0	0.0275	0.17	0.14	0.153
	T4-4	0.1	0	0.001667	0.22	0.14	0.208
	T4-5	0.1	0	0.02333	0.34	0.1	0.143167
Changhua Coastal Industrial Park Intersection 1	T5-1	0.66	0	0.0435	0	0	0
	T5-2	0.4	0	0.0185	0	0	0
	T5-3	0.38	0	0.025333	0	0	0
	T5-4	0.71	0	0.064667	0	0	0
	T5-5	0.2	0	0.007333	0	0	0
Changhua Coastal Industrial Park Intersection 2	T6-1	0.25	0	0.0255	0	0	0
	T6-2	0.22	0	0.048667	0	0	0
	T6-3	0.34	0	0.072167	0	0	0
	T6-4	0.31	0	0.036167	0	0	0
	T6-5	0.8	0	0.041833	0	0	0
Landing Point of Changhua Coastal Industrial Park	T7-1	0.34	0	0.025667	0	0	0
	T7-2	0.5	0	0.039833	0	0	0
	T7-3	0.14	0	0.013667	0	0	0
	T7-4	0.5	0	0.028833	0	0	0
	T7-5	0.81	0	0.0675	0	0	0
Measuring Point	T8-1	0.95	0.82	0.8855	1.38	1.27	1.281
	T8-2	0.74	0.64	0.727667	1.36	1.21	1.2785
	T8-3	0.95	0.74	0.860667	2.13	1.85	1.973167
	T8-4	0.95	0.82	0.9205	2.19	1.92	2.091
	T8-5	0.82	0.74	0.818667	1.76	1.52	1.654667

Table 6.2.10-4 Magnetic Field Background Value of Power Transmission Line (Cont.)

Monitoring Location	Code of Monitoring Station	11th November 2016 (Weekday) Measured Value of Magnetic Field (Milligauss)			12th November 2015 (Weekend) Measured Value of Magnetic Field (Milligauss)		
		Maximum	Minimum	Average	Maximum	Minimum	Average
Shenglun	T9-1	2.39	1.76	2.068667	0.52	0.43	0.486333
	T9-2	2.89	2.17	2.634333	0.65	0.5	0.51
	T9-3	0.41	0.31	0.381667	0.29	0.29	0.29
	T9-4	0.76	0.31	0.3175	0.29	0.22	0.239833
	T9-5	0.68	0.41	0.502167	0.5	0.43	0.432667
Changhua CoastalIndustrialPark ES	T10-1	7.3	6.04	6.785833	2.45	2.15	2.3155
	T10-2	6.51	5.26	5.917167	2.42	2.29	2.348833
	T10-3	3.49	3.17	3.3325	2.46	2.38	2.395333
	T10-4	3.51	3.22	3.374833	2.47	2.39	2.458
	T10-5	4.82	3.7	4.05	2.44	2.29	2.359667
Lusi Landing Point	T11-1	0.71	0	0.130667	0	0	0
	T11-2	0.91	0	0.187667	0	0	0
	T11-3	0.34	0.1	0.185167	0	0	0
	T11-4	0.51	0.1	0.1565	0	0	0
	T11-5	0.34	0.1	0.125167	0	0	0
Lusi Intersection	T12-1	0.52	0.25	0.426667	0.31	0.22	0.243833
	T12-2	0.76	0.34	0.402167	0.38	0.34	0.342667
	T12-3	0.91	0.14	0.216833	0.14	0.14	0.14
	T12-4	0.64	0.14	0.210167	0.17	0.14	0.141
	T12-5	0.82	0.22	0.283	0.17	0.14	0.1425
Lusi Factory	T13-1	1.99	0.41	0.5775	0.68	0.55	0.567333
	T13-2	0.71	0.38	0.4635	0.49	0.35	0.4215
	T13-3	0.3	0.22	0.2475	0.14	0.14	0.14
	T13-4	0.81	0.25	0.312833	0.34	0.22	0.2425
	T13-5	0.38	0.22	0.282	0.29	0.29	0.29
Lusi Substation	T14-1	0.74	0.22	0.367	0.22	0.1	0.187667
	T14-2	0.75	0.22	0.325667	0.25	0.1	0.17833
	T14-3	1.31	1.16	1.237333	0.54	0.41	0.477167
	T14-4	0.8	0.52	0.652833	0.59	0.45	0.521833
	T14-5	0.73	0.45	0.494	0.3	0.3	0.3

Tabkle 6.2.10-5 Supplementary Survey on Magnetic Field Background Value of Power Transmission Line

Monitoring Location	Code of Monitoring Station	14th July 2017 (weekday) Measured Value of Magnetic Field (Milligauss)			15th July 2015 (weekend) Measured Value of Magnetic Field (Milligauss)		
		Maximum	Minimum	Average	Maximum	Minimum	Average
Landing Point	T1-1	0.1	0	0.001667	0.1	0	0.005
	T1-2	0	0	0	0.2	0	0.003333
	T1-3	0.14	0	0.004	0.1	0	0.00667
	T1-4	0	0	0	0.14	0	0.005667
	T1-5	0	0	0	0	0	0
Vicinity of Substation C	T2-1	0.22	0.14	0.143667	0.44	0.29	0.408
	T2-2	0.36	0.22	0.307167	1.48	0.54	1.2605
	T2-3	0.25	0.22	0.2205	1	0.77	0.83667
	T2-4	0.36	0.29	0.3425	1.7	1.42	1.5405
	T2-5	0.22	0.14	0.210667	0.77	0.5	0.6515
Vicinity of Substation B	T3-1	0	0	0	0.22	0	0.017
	T3-2	0.2	0	0.0123333	0.22	0	0.034
	T3-3	0	0	0	0.14	0	0.0023333
	T3-4	0	0	0	0	0	0
	T3-5	0.1	0	0.001667	0.1	0	0.005
Substation of Changhua Coastal Industrial Park	T4-1	0.22	0	0.016	0.38	0	0.077833
	T4-2	0.1	0.1	0.1	0.22	0.1	0.106833
	T4-3	0.17	0.1	0.101833	0.1	0.1	0.1
	T4-4	0.1	0	0.003333	0.14	0	0.070667
	T4-5	0.14	0	0.090333	0.14	0.1	0.100667

6.3 Ecology Environment

6.3.1 Terrestrial Ecology

2 quarters of terrestrial ecological surveys (including terrestrial birds) were conducted on 21st August and 10th October. In July of 2017, a quarter of supplementary survey on common corridor of Lunwei Area was conducted. Transmission and distribution system construction are built on terrestrial facility. It has passed coastal area, windbreak forest and roads, ecological survey was conducted on the area of terrestrial facility.

I. Current Environmental Condition

(i) Geographic Location

Coastal bird survey was conducted at Changhua north coastal area (east longitude 120 22.6 ~120 29.5 , northern latitude 24 03.4 ~24 12.0 , east longitude 186611.44~198364.53 and northern latitude 2661443.07~2677266.73), including wetland at southern coast of Dadu Estuary and Changhua Coastal Industrial Park. The administrative zone was across Lukang Township, Xianxi Township and LukangTownship, Changhua Couty.

Wu River (also known as Dadu River) is one of the most important rivers in Taiwan. It is originated from Xiqiao, Hehuan Mountain, Central Range. It is then flown into Taiwan Strait between Longjing District of Taichung City and Shenggang Township of Changhua County. It is 116.8km long and 3,062km2 wide. Dadu River Estuary is gently sloped which encompsses waters, intertidal zone, river, sand bank, reclaimed land, cultivated land, fish farm and etc. Due to wide variety and high naturalness, the number and species of bird are relatively high. Argillaceous intertidal zone with 4km width is formed by alluviation and drifting. Abundant benthic organisms is fertilized into it which are also the major food source of Scolopacidae and Charadriidae and waterbirds. Every year, many waterbirds stop can this site during migration or winter at this site.

5km south of Dadu Estuary is the area of Changhua Coastal Industrial Park. Changhua Coastal Industrial Park was originally an intertidal zone mud flat. Since 1970, it is tranfromed from a sea reclamation land to an industrial park. From north to south, it is divided into Xianxi Area, Lunwei Area and Lukang Area, with total area 3,643ha. Waterway is isolated between 3 area, industrial zoen and original coastal line. There is waterway between the three blocks and the industrial area and the original coastline, and the side facing the ocean is surrounded by seawalls.

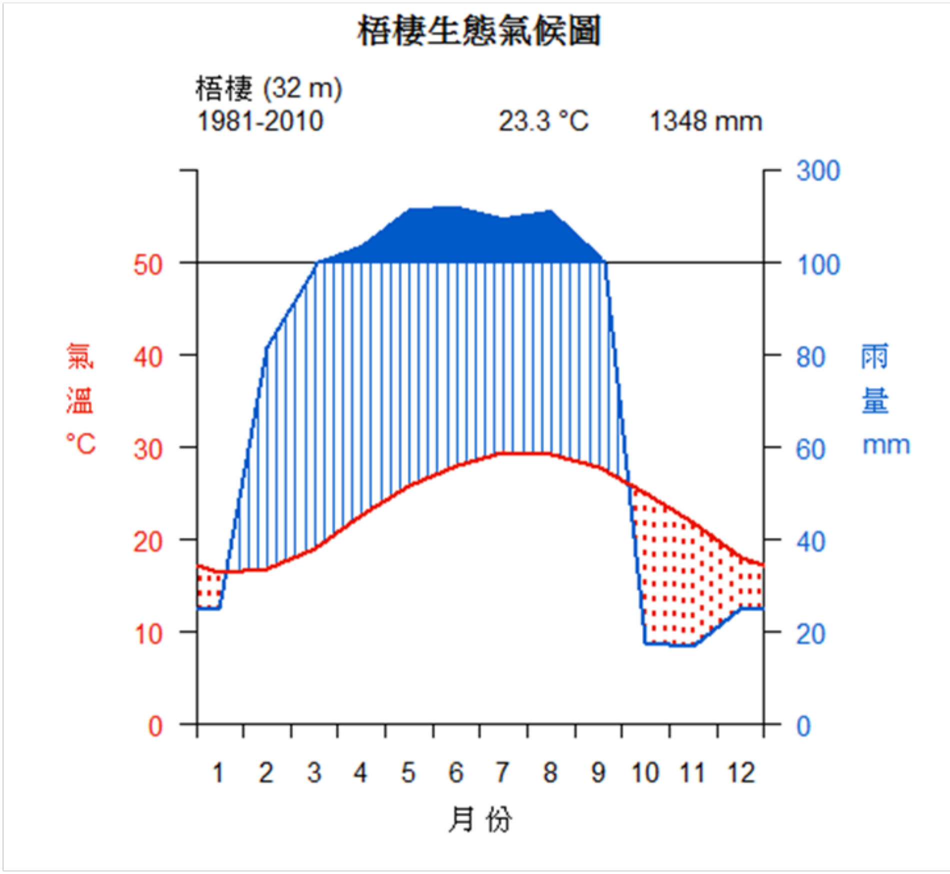
(ii) Climate

The nearest weather station of Central Weather Bureau is Wuqi Weather Station where is 6km north of site. It is also surrounded with waters, thus the weather of Wuqi Weather Station is used.

Wuqi is in the vicinity of Taichung Harbor. It has a tropical and monsoon climate. According to statistical data of Wuqi Weather Station for 30 years (1981-210), the annual precipitation is 1348m. As it is in the plain, the weather is dry. Annual raing days is approximately 90 dayas, it usually rains in February to September. The average temperature of Wuqi is 23℃. The warmest temperature reaches 29℃ in July and the coolest temperature falls at 16℃ in January. Mean monthly temperature is 5℃ higher than limited temperature of plant growth, With respect to temperature, there't no quarter to limit the growth of plants.

Strong wind is the characteristic of Wuqi The wind speed of Wuqi peaks in the results of Central Weather Bureau. Due to sea-land breeze in summer, the average wind speed is above3.5m/s. Due to north-easterly monsoon in winter, the average widn speed from November to December ranges from 6.4m/s to 6.9m/s, the maximum average wind speed is up to 20m/s (7-8 Degree); Maximum instatntaneous wind speed is up to 30m/s (10-11 Degree).

Ecological climate of Wuqi Area is shown as Figure 6.3.1-1. Ecolgical climate figure clearly shows major climate factor of local growth of vegetation- the relationship of temperature and precipitation; It is known as wet season when temperature line is lower than isohyet, and it is suitable for growth of plant; It is considered as dry season when temperature line is higher than isohyet. From this figure, relative dry season of Wuqi is from October to January. Remaining 8 months are relative wet season which is suitable for the growth of plants. This site is located at seashore, growth of plant is susceptible to strong wind and salt damage.



資料來源：中央氣象局梧棲測站，1981-2010。

Figure 6.3.1-1 Climate condition of Wuqi

(iii) Vegetation and land utilization

The types of land use of Dadu River Estuary include wasted fish farm, wasteland, riverside, and park land. The primary vegetation is grassland, and the abundant species is the exotic Pilose Beggarticks, followed by the summer abundant species of panicum repens. In winter the panicum repens will be withered, so the more significant species will be Bermuda Grass. They can form the scene of signal vegetation in different seasons. There is Seashore Dropseedgrass in near shore intertidal zone, and the primary species at the riverbank are Seahore Vine Morning Glory and Sea Purslane. And there are Common Cerberus Tree and Sea Lettuce along the in-land roads, which are the characteristic species of this region. You can also find Broomjute Sida, White Woodrose, and Rhodes Grass at the edge of waste fish farm, and Suaeda maritime, Dodder, Fragrant Pittosporum, and Seaside clerodendrum at the riverbank beach.

Changhua Coastal Industrial Park was formed by sea reclamation. Besides the land for industrial use, it also contains various habitats including natural grass land, inner seawall salt land, uncultivated grass land, man-made forest, and secondary forest. The two most advantageous habitats that cover the largest areas are man-made forest and uncultivated grass land. Different vegetations will grow in different habitats. There is no vegetation at the outer seawall due to the substantial amount of armor blocks. The natural grass land is mainly located on the sand hills near Xianxi Dumpling Corner and is suitable for the growth of Spinifex littoreus, Ipomoea pes-caprae, and Simpleleaf Shrub Chastetree. The inner seawall salty land is suitable for the growth of Simpleleaf Shrub Chastetree, Ipomoea pes-caprae, Fimbristylis cymosa, Trianthemum portulacastrum, Paspalum vaginatum, Digitaria ciliaris, and Bidens pilosa radiate. The vegetation on the uncultivated grass land will depend on the dryness of the land. Man-made forest is mainly distributed in Xianxi district and Lukang district and contains mostly costal wind-protection plantation. Man-made advantageous plantation includes coast oak and Hibiscus tiliaceus. There is not much plantation in the secondary forest mostly because it is not suitable for the growth of man-made plantation.

II. Ecological survey method

(i) Terrestrial Plants

1. Species and Distribution of Plants

Two investigators will conduct the survey on species of vascular plant along the accessible roads within the selected scope of survey, including the native, naturalized, and planted species. If any rare plant is found, or any species of special ecological, commercial, historical (such as old trees), aesthetic, scientific, and educational value is found, the distribution location should be marked, and its importance should be specified.

According to the regulations of environmental assessment, the survey of terrestrial plants must be conducted for at least two quarters, and a quarter of supplementary survey has been conducted with respect to the common corridor Lunwei Region in July 2017. Based on the analysis of ecological diagram, we know that in the project area the relative wet season is from February to September, and the relative dry season is from October to January; considering the possible difference in plants clusters during wet season and dry season, the two surveys have been scheduled in August and November to cover the situations of dry season and wet season.

2. Determine Naturalness

The survey of vegetation and naturalness will be interpreted according to the aerial photo, and the naturalness of the project area can be divided into class 0~5 according to the current status of land use and the plant society composition distribution.

(1) Naturalness 5a – natural forest land; including unspoiled forest, and once-spoiled forest which has been restored to its natural state; it has a rather stable composition of plant landscape and composition of plant society, and there will not be any major change of composition and structure in the future if it is not disturbed.

(2) Naturalness 5b – secondary forest land: the vegetation gradually recovered from human disturbance. They could be afforestation, grass shrub, or deserted orchard previously, and now the primary vegetation is mostly the naturally evolved secondary forest after the disturbance, and the forest form has been gradually restored to the structure of Ficus-Machilius forest.

(3) Naturalness 4 – original grassland: it could have been developed into a forest under the local atmospheric condition, yet the evolution stopped at the stage of grassland due to the restrictions of the factors of soil, moisture, nutrients, and repeated disturbances. So it has been kept at the form of grassland for a long time.

(4) Naturalness 3 – afforestation land: it includes afforestation land with post-logging land, grassland, post-fire afforestation land, and bamboo forest land. Even though the vegetation is formed by artificial planting, its constancy is rather high due to the long harvest period unlike the farmland with frequently changed crops.

(5) Naturalness 2 – farmland: the vegetation is artificially planted crops, include fruits, rice, multigrain, and special crops. And there is also the grassland with suspended farming, and the crops could be changed at any time.

(6) Naturalness 1 – bare land: the vegetation-free are resulted from natural factors, such as the bare lands resulted from river basin, reef, and natural collapse.

(7) Naturalness 0 – the vegetation-free are resulted from human activities,

such as cities, houses, roads, and airports.

3. Identification and Production of List

According to the four literatures of: (1) Taiwan Rare Plants Directory in the "Technical Specifications of Plant Ecological Assessment" (EPA of the Executive Yuan 2002); (2) The assessment of rare and endangered plant species conducted by Council of Agriculture according to the 1994 Edition of The World Conservation Union (IUCN); (3) "Flora of Taiwan" (Huang et al. 1993-2003); and (4)"Insights of the Latest Naturalized Flora of Taiwan" (Wu et al. 2010), the plant directory has been composed based on the two categories of rarity and endemicity, and the style, nativity, and richness of plant are specified in accordance with Tashan Plant Directory System. With the references of "Database of Rare and Endangered Plants in Taiwan" of Council of Agriculture (http://econgis.forest.gov.tw/rareplant/index.htm) and Population Distribution of Initial Review Directory of Taiwan Vascular Plant Red Paper (Wang Z. Z. et al. 2012), the species marked as rare species in the richness category of the directory have been assessed via the scope and method of development project to see if they will affect the wild population of rare plants, and to provide countermeasures. The attribute statistics table has been composed according to the style, nativity, and richness of this plant directory in order to calculate the species composition. The types of nativities of the four major types of plants (rare, endemic, native, and planted) in the survey area are provided. The ratios of these types and the types of vegetation recorded by the onsite survey can allow us to further understand the current status of human disturbance in the survey area, such that the impacts on the development project and the countermeasures can be assessed.

4. Setting and Survey of Sample Plot

Sample areas must be set up in the vegetation survey by selecting the type of representative vegetation, and the survey method must be determined according to the type of vegetation, such that the results can reveal the feature of each type of vegetation, and the survey can be conducted efficiently.

After the interpretation based on aerial photo of the project area and onsite survey, the abundant vegetation of forest and grassland have been selected for the survey. The sample area of grassland is a deserted grass land, and the sample area of forest is an artificial forest. There are different survey methods for different plant life styles:

(1) The forest sample area is based on the sampling unit of 10x10 m. The sample trees in the forest in the survey area are not tall, and there are many branches at the bottom, so the conventional diameter at breast height method will lead to underestimated biomass. Therefore, the coverage estimation method has been used to survey the tree species in the sample area and the types and coverage of plants in the forest floor layer (5x5 m).

(2) The grassland area is based on the sampling unit of 5x5 m. The sample area is randomly selected in a chosen typical area for the survey of all types of herbs and their percentage coverages in the sample area.

(ii) Terrestrial Mammal Survey

The scope of terrestrial survey of this project is as shown in Figure 6.3.1-2. The survey of terrestrial mammals has been conducted for two quarters, and a quarter of supplementary survey has been conducted in July 2017 with respect to the common corridor Lunwei Region at the survey site as shown in Figure 6.3.1-3. This survey was conducted via the three methods of crossing line survey method, trapping method, and Anabat system investigation.

1. Transect Line Survey Method

In this method one will move slowly forward along the planned sample line and randomly record any sign of activity of mammal found during the process of daytime and night-time survey, including individual siting, heard voice, or findings of excreta, traces, or dead bodies. It can be assisted by the interviews of local residents in order to understand the current status of composition of mammals in this region.

2. Trapping Method

This method is suitable for small mammals which are active on the ground, such as rodent (rats) and insectivore (soricidae). Large trap cages and H.B. Sherman traps have been installed at every monitoring sample site near grass, shrub, boulder or fallen wood, or at the area with rich ground cover plant in the forest. The trapping of 4-day-3-night has been conducted for each survey with the baits of pieces of sweet potato with peanut butter. The trap installation was completed by dusk every day, and it was reviewed in the next morning while replacing the baits to keep the smell. The old baits were taken out and placed at the cage door as the external bats to enhance the capture rate. If there is any animal captures, the survey personnel will place it in the bag for observation to determine its species and gender, measure its shape, and take photograph. The coordinates of the site of capture will also be recorded. After the recording is completed, the animal will be released at the original habitat, and a new trap will be installed to prevent the residual animal odor from affecting the subsequent capturing.

3. Anabat system investigation

This method is suitable for investigating the nocturnal flying chiroptera mammal (bat). A flying bat will emit ultrasonic signals, and there will be specific acoustic frequencies and waveforms for different species. The ultrasonic waves emitted by bats can be recorded by AnaBat II Bat Detector (Titley Electronics, Australia). In addition to confirm the existence of bat in the environment, the waveform and frequency of recorded ultrasonic signal can be compared with the reference acoustic frequency database in order to understand the diversity of types of local bats.

The peak of bat activities is in the evening, so the Anabat system investigation will begin 30 minutes before sunset and end by 8 pm. The voice recording will be conducted for 10 minutes at each sampling site, and it will be conducted at least once every quarter.

(iii) Terrestrial Bird Survey

The terrestrial birds survey can be divided into daytime survey and night-time survey, and it has been conducted for two quarters at the sites as shown in Figure 6.3.1-4. And a quarter of supplementary survey has been conducted in July 2017 with respect to the common corridor of Lunwei Region at the sites as shown in Figure 6.3.1-5.

1. Daytime survey: it is conducted via point counts method (Buckland et al. 1993). The survey personnel will stay at each selected sampling spot for 6 minutes to record all detected species and quantity of birds. For a comprehensive understanding of avian fauna in this region, all birds found during the movement between survey spots must also be recorded. Most terrestrial birds are active early in the morning, so the survey must be conducted with 3.5 hours after sunrise; it should be conducted in a sunny weather, and it should be stopped during rainy days.

2. Night-time survey: It is conducted via crossing line survey method, and the species and quantity of nocturnal birds heard or saw along the path of all survey spots must be recorded. The survey must be conducted within 3.5 hours after sunset in good weather condition without any wind.

(iv) Terrestrial Amphibians and Reptiles Survey

The terrestrial amphibians and reptiles survey has been conducted for two quarters at the sites as shown in Figure 6.3.1-4, and a quarter of supplementary survey has been conducted in July 2017 with respect to the common corridor of Lunwei Region. A daytime survey and night-time survey have been conducted once; the daytime survey was conducted from 10 am to 12 noon, and the night-time survey was conducted from 7 pm to 9 pm. The daytime survey and night-time survey were conducted via visual detection method, while the daytime observation has been assisted by manual stone-flipping method. The items to be recorded include the types, quantity, gender, behaviors, micro-habitat, and coordinate location of amphibians.

1. Visual detection method: the survey personnel is moving forward at a walking pace slower than 2 km/hour along the crossing line while observing and recording all targets on both sides. In addition to observing all types of possible habitats during the survey period, the observation emphasis should be put on regions with frequent appearance of reptiles, such as ditch, stone seam, shrub, and arbor. The night-time survey should be assisted by flashlight.

2. Manual stone flipping method: Based on the habits of some amphibians and

reptiles hiding beneath stones, stones with diameter from 10 to 50 cm which can be manually flipped will be randomly selected to be flipped over from one side to examine whether or not there is any amphibian and reptile hiding there. And then the stone will be put back to its original position.

In addition to the aforementioned fixed survey methods, there will also be random observations conducted via other animal survey methods with additional records. Only the species directory will be provided, and it will not be included in the analysis of relative quantity. Interview survey will be conducted with respect to local residents if possible, and the obtained information can serve as the reference for the species directory.

(v) Terrestrial Butterflies and Dragonflies Survey

Various insects could be distributed everywhere in the natural environment from the 30~40 meter high tree crown to underground, and they all have different habits. So it is rather difficult to survey all types of insects. Therefore, the terrestrial insect ecological survey of this project was focused of large insects, including butterflies and dragonflies, and it has been conducted via the following survey methods in the two forms of setting sampling area and along the crossing line:

1. Net capturing method: This is the most frequently used survey method. Various insect nets are used for capturing flying or resting insects in different habitats. When this method is used for population and richness surveys, it is usually used in coordination with crossing line or sampling area based on fixed number of net capturing, subjects, and sites.
2. Witness method: It is about recording all witnessed types and quantity of insects along the crossing line. This is the most frequently used method for butterflies ecological survey, and it can be used for other large insects.

Figure 6.3.1-2 Schematic Diagram of Terrestrial Survey

Figure 6.3.1-3 Traps Location of Mammal

Figure 6.3.1-3 Traps Location of Mammal (Cont.)

Figure 6.3.1-4 Sample Plot of Survey of Terrestrial Birds,Reptile, Amphabian, Butterfly and Dragonfly

Figure 6.3.1-5 Fixed Point Sample Plot of Terrestrial Birds and Survey Routes

III. Data Analysis

Different analytical methods should be adopted in response to different survey methods. The analytical methods for woody plant data, plant data of all sampling areas, and animal data are as described below.

(i) Data of Woody Plant

1. The names and scientific names of all plants in early surveys and this survey should be re-organized according to the Second Edition of Flora of Taiwan.

2. The diameter at breast height (DBH) of all plants should be converted to the basal area (BA). If there are multiple branches of this plant, the sum of basal area of every branch will become the basal area of this plant in this sampling area:

$$BA = \sum_{i=1}^{n} \pi \left(\frac{DBH_i}{2}\right)^2$$

Whereas, BA is the basal area of this plant by the unit of cm2, n is the number of branches of this plant, and DBHi is the diameter at breast height of the ith branch by the unit of cm.

3. All data should be keyed into the Microsoft Excel according to the data format of sampling area-tree species-basal area. The pivot table should be used to convert the data into a matrix of sampling area versus plant species. And the basal are of every tree species of every sampling area is multiplied by 100 and divided by the total basal area of that sampling area to obtain the percentage accounted for by the plant species in the sampling area.

4. The data is imported to Pcord to be analyzed via cluster analysis method. During the analysis, the distance calculation is done by Sorensen (Bray-Curtis) method, and the Flexible Beta method is used for linkage among all clusters.

(一) Plant data of all sampling areas

1. Scope and description of data selection

This part of data is collected from all sampling areas, yet it only includes the plant species in all sampling areas, and the grass plants in woody plant sampling areas and the species with diameter at breast height less than 2 cm are also included in the directory. Since the data is about the existence of species without any amount, so the analytical method is slightly different from the previous one.

2. Data analytical method and adopted software

Species diversity includes species richness and species evenness. In this study the species diversity is calculated based on coverage, and it is expressed by the three indicators (N0, N1, N2) defined by Hill (1973) and the E5 evenness indicator of Alatalo (1981).

(1) The total number of species of sample (N_0)

$N_0 = S$

S is the total number of species in the sample

(2) The number of abundant species in the sample (N_1)

$N_1 = e^{H'}$

$H' = -\sum_{i=1}^{S}[p_i \ln p_i]$ Pi：the ratio of total sample coverage accounted for by the coverage of the ith species

H' is Shannon's index, indicating the uncertainty of a certain species when an individual is encountered in the forest; this index is affected by the number of species and the number of individuals. The more the number of species, the higher the evenness of individual distribution among species will be.

(3) The number of very abundant species (N2) in the sample (N_2)

$N_2 = 1/\lambda$

$\lambda = \sum_{i=1}^{S} p_i^2$

λ Simpson's index, indicating the probability of any two individuals in the sampling area belonging to the same species, and its value is between 0 and 1. If the abundance is focused on a small number of species, λ value will be higher. If the λ value is 1, it means this society is formed by a single species.

(4) Evenness: it is expressed by the E5 evenness indicator of Alatalo (1981)

$E_5 = (N_2-1) / (N_1-1)$

When E5 approaches 0, it means higher abundance of a certain species in the sampling area.

(ii) Data of Animal

The biological data record of the survey has been summarized by Microsoft Excel, and the SYSTAT11 statistical software has been used for calculation of richness, density, and similarity of species. The analysis of diversity and evenness has been done via Shannon's function.

In this survey the population density D analysis has been conducted only for the birds, and the calculation program is as shown below:

$D = n\ 104/\pi\gamma^2$

Where n is the total number of birds recorded in a specific radius, and γ is the specific basic radius of a certain bird species (Xu, 2003).

The diversity and evenness estimation have been conducted according to the recorded directory of animal species. In this report the estimation has been done based on Shannon-Wiener's diversity index (H') and Shannon-Wiener's evenness index (E). The calculation formula (Magurran 1988, Krebs 1999) is as shown below:

$$H' = -\sum_{i=1}^{S} P_i \log_{10} P_i$$

$$E = H'/H_{max} = H'/\log_{10} S$$

S：the number of animal species recorded in each cluster

Pi：the amount percentage accounted for by the ith species in each cluster

H' is the Shannon-Wiener diversity index, and its value is usually between 1.5~3.5. The greater index indicates richer species in this area and a greater amount of more even individual species, thus leading to higher degree of cluster diversity. If the biological cluster in this area is formed by only one species, H' will be 0. Usually a matured and stable ecological system will have a higher degree of diversity, which will benefit the balance of ecological system. Therefore, the analysis of diversity index can be used to determine whether or not the survey area is a stable and matured ecological system.

E is Shannon-Wiener's evenness index. This index represents the distribution of number of all individual species in a cluster, which is also the evenness of distribution of the number of individual species. When this index approaches 1, it indicates that the number of individual species in this survey environment is more even, and the abundant species is less obvious.

IV. Survey Results

(i) Terrestrial Plant Survey

1. Plantation type and statistics

In the survey project area of the first quarter, a total of 33 families 90 genera and 107 species of plants are recorded (Table 6.3.1-1), where fern and gymnosperm are not investigated. There are 28 families 68 genuses and 80 species of Dicotyledons and 5 families 22 genuses and 27 species of Monocotyledons. Based on the plant type analysis, there are 10 species of arbors (accounting for 9.35%), 13 species of shrubs (accounting for 12.15%), 18 species of vines (accounting for 16.82%), and 66 species of herbs (accounting for 61.68%); based on the growth environment analysis, there are 3 endemic species (accounting for 2.80%), 55 native species (accounting for 51.40%), 46 naturalized species (accounting for 42.99%), and 3 planted species (accounting for 2.80%). The vegetation found by this survey was dominated by the native species of 51.40% followed by the 42.99% of naturalized species. The amount of planted species was the same as the endemic species. The total amount of exotic species was still less than the native species.

In the survey project area of the second quarter, a total of 34 families 95 genuses and 112 species of plants are recorded (Table 6.3.1-1), where fern and gymnosperm are not investigated. There are 29 families 72 genuses and 84 species of Dicotyledons and 5 families 23 genuses and 28 species of Monocotyledons. Based on the plant type analysis, there are 11 species of arbors (accounting for 9.82%), 13 species of shrubs (accounting for 11.61%), 19 species of vines (accounting for 16.96%), and 69 species of herbs (accounting for 61.61%); based on the growth environment analysis, there are 3 endemic species (accounting for 2.68%), 57 native species (accounting for 50.89%), 49 naturalized species (accounting for 43.75%), and 3 planted species (accounting for 2.68%). Most plants were not ideally grown due to strong wind. The vegetation found by this survey was dominated by the native species of 50.89% followed by the 43.75% of naturalized species. The amount of planted species was the same as the endemic species. The total amount of exotic species was still less than the native species.

By looking at data from two combined seasons, Gramineae is the most dominant in plant types (22 types), followed by Asteraceae (14 types), Legume (10 types), Euphorbiaceae (5 types), Malvaceae (5 types) and Convolvulaceae (5 types). Since the habitats along the selected region are mostly natural grass land, and uncultivated grass land as well as some open spaces near the road side, and there is not much forest around, the plants therefore are mainly light-demanding plants and no fern or gymnosperm type plants were observed. Table 6.3.1-1 shows the plantation characteristic table.

As for the quarter of supplementary survey on the common corridor Lunwei Region, In the survey project area a total of 47 families 114 genuses and 142 species of plants are recorded, and there are no fern and only 2 gymnosperm species. There are 39 families 86 genuses and 106 species of Dicotyledons and 6 families 26 genuses and 34 species of Monocotyledons. Based on the plant type analysis, there are 29 species of arbors (accounting for 20.42%), 17 species of shrubs (accounting for 11.97%), 19 species of vines (accounting for 13.38%), and 77 species of herbs (accounting for 54.23%); based on the growth environment analysis, there are 4 endemic species (accounting for 2.82%), 75 native species (accounting for 52.82%), 52 naturalized species (accounting for 36.62%), and 11 planted species (accounting for 7.75%). Most plants were not ideally grown due to strong wind. The vegetation found by this survey was dominated by the native species of 52.82% followed by the 36.62% of naturalized species. The ratio of planted species is not high. The total amount of exotic species was still less than the native species.

In terms of plants family, Gramineae has the most species (26) followed by Compositae (14), Leguminosae (10), Verbenaceae (6),and Malvaceae (6). This indicates that the environment was filled with natural grassland, deserted grassland, and roadside land, and there was less forests. So there were more destructive plant species with strong need for light, and there was not any fern.

For the plant directory please refer to Appendix 01, and for the plant attributes statistics please refer to Table 6.3.1-2.

Table 6.3.1-1 Characteristics Table of Offshore Plant at Changhua Coastal Industrial Park

Characteristics		Pteridophyta		Gymnosperms		Dicotyledonae		Monocotyledon		Total	
		First Quarter	Second Quarter	First Quarter	Second Quarter	First Quarter	Second Quarter	First Quarter	Second Quarter	First Quarter	Second Quarter
Types	No. of Family	0	0	0	0	28	29	5	5	33	34
	No. of Genus	0	0	0	0	68	72	22	23	90	95
	No. of Species	0	0	0	0	80	84	27	28	107	112
Living Form	Arbor	0	0	0	0	10	11	0	0	10	11
	Shrub	0	0	0	0	11	11	2	2	13	13
	Vine	0	0	0	0	18	19	0	0	18	19
	Herb	0	0	0	0	41	43	25	26	66	69
Attribute	Endemic	0	0	0	0	1	1	2	2	3	3
	Indigenous	0	0	0	0	38	40	17	17	55	57
	Naturalized	0	0	0	0	38	40	8	9	46	49
	Cultivated	0	0	0	0	3	3	0	0	3	3
Number	Common	0	0	0	0	72	76	24	25	96	101
	Normal	0	0	0	0	7	7	3	3	10	10
	Rare	0	0	0	0	1	1	0	0	1	1

Table 6.3.1-2 Characteristics Table of Offshore Plant at Changhua Coastal Industrial Park

Characteristics		Pteridophyta	Gymnosperms	Dicotyledonae	Monocotyledon	Total
Types	No. of Family	0	2	39	6	47
	No. of Genus	0	2	86	26	114
	No. of Species	0	2	106	34	142
Living Form	Arbor	0	2	27	0	29
	Shrub	0	0	15	2	17
	Vine	0	0	19	0	19
	Herb	0	0	45	32	77
Atribute	Endemic	0	0	2	2	4
	Indigenous	0	1	51	23	75
	Naturalized	0	0	43	9	52
	Cultivated	0	1	10	0	11
Number	Common	0	1	89	31	121
	Normal	0	0	15	3	18
	Rare	0	1	2	0	3

2. Rare Endemic Plants

The endemic plants in this project include Taiwan Golden-rain Tree, Chloris formosana (Honda) Keng and Phoenix hanceana. There is only one rare plant, Thespesia populnea, which is a man-made plant. It is not included in the Taiwan rare endemic plant directory from the "Plant Ecosystem Assessment Technology Standard". It is a species from the Taiwan vascular plant red paper preliminary assessment directory.

As the unique plant in Hengchun Peninsula, the appearance of Bhendi Tree is similar to Linden Hibiscus, so it is also known as Hengchun Linden Hibiscus. Its flower bud is woody, cup-shaped, and truncate-shaped, so it is also known as thespesia populnea. It actually belongs to a different genus as the Linden Hibiscus. It is speculated that it was generated among seedlings of Linden Hibiscus during afforestation. The plant found in this product is the one accidentally introduced along with the afforestation of wind-break forest, so it is an artificial plant rather than a natural plant. It is not included in the Directory of Rare and Endemic Plant Species in Taiwan listed in the "Technical Specifications of Plant Ecological Assessment"; it is a species included in the Initial Review Directory of Taiwan Vascular Plant Red Paper. The found distribution location is X: 190875 Y: 2669037.

The endemic species found during the supplementary survey with respect to the common corridor Lunwei Region are Tashiro Indian Hawthorn, Taiwan Golden-rain Tree, Formosan peacock-plume, and Formosan Date Palm. None of them are rare plants. The rare plants are Lanyu Podocarp, Common Garcinia, and Bhendi Tree, which are all artificial plants not included in the Directory of Rare and Endemic Plant Species in Taiwan listed in the "Technical Specifications of Plant Ecological Assessment"; it is a species included in the Initial Review Directory of Taiwan Vascular Plant Red Paper.

3. Vegetation type and plant naturalness (e.g. Figure 6.3.1-6~7)

(1) Natural forest (naturalness 5a)

The land under investigation is from sea reclamation, therefore, no natural forest.

(2) Secondary forest (naturalness 5b)

The land under investigation is from sea reclamation. Since the area is under strong wind and it is salty land, no secondary forest was yet formed.

(3) Natural grass land (naturalness 4)

There is no vegetation at the outer seawall due to the substantial amount of armor blocks. The natural grass land is mainly located on the sand hills near Xianxi Dumpling Corner and is suitable for the growth of Spinifex littoreus, Ipomoea pes-caprae, and Simpleleaf Shrub Chastetree. The rest of the natural grass land is the inner seawall salty land, which is suitable for the growth of Simpleleaf Shrub Chastetree, Ipomoea pes-caprae, Fimbristylis cymosa, Trianthemum portulacastrum, Paspalum vaginatum, Digitaria ciliaris, and Bidens pilosa radiate.

(4) Man-made forest (naturalness 3)

Man-made forest is mainly distributed as costal wind-protection plantation and was planted purposely by man. Man-made advantageous plantation includes coast oak and Hibiscus tiliaceus. Most of the man-made forest is uncultivated or destroyed by wind. Only few autochthonous or naturalized species grown naturally and moved towards secondary forest.

(5) Fish-farm side and road side grass land (naturalness 2)

Uncultivated land accounted for most of the area of the region under investigation. Different vegetations will grow in different habitats. Only few plants, such as Creeping Rhynchelytrum, Bidens pilosa radiate, Guinea grass, and Digitaria ciliaris, with strong growing power can survive on the road side. Secondary heliophilous species are rarely seen. The vegetation on the road side is mainly composed of weeds, mostly from Gramineae and Asteraceae, suggesting that this area is largely impacted by human. If human impact were removed, the uncultivated land may gradually transform into secondary forest. A naturalness of 2 was determined.

(6) Bare land (naturalness 1)

The area under investigation is mainly composed of sandbank and fish farm. Due to the nature of these lands, no vegetation was found.

(7) Man-made structure (naturalness 0)

The area of investigation is mainly comprised of seawalls and barely any building, sidewalk trees, garden landscape, etc. were seen. Plants such as Bidens pilosa radiate, Rhynchelytrum repens, goose grass and bermuda grass were observed on the road side. However, due to the strong human interference, the vegetation is not stable, giving a naturalness of zero.

Figure 6.3.1-6 Figure of Naturalness

Figure 6.3.1-7 Figure of Naturalness at Supplementary Survey

4. Setting of Plant Sample Plot

(1) Analysis of species composition and dominance in the sample areas of first and second seasons

A. A total of 9 sample areas were established in first and second investigations, which can be divided into 4 woody sample areas, and 5 grass land sample areas. All 4 woody sample areas contain wind-protection plantation. Among 5 grass land sample areas, 3 of them are sand dune natural grass land and the rest of them are inner seawall uncultivated grass land.

◆ Woody sample area 1: This sample area is located in the east-west wind-proof forest in the middle section of the western line, and there is an abandoned military camp on the west side. The coordinates are 190875 and 2669037. It is a coastal windbreak and the canopy is about 6-8 meters high. The main afforestation species is Casuarina equisetifolia. In the first season, the coverage of the ground cover plants was about 96%. The largest coverage area was Bidens pilosa var. radiata (65%). The other species were covered by large to large areas. , hanging melons and so on. In the second season, the coverage of ground cover plants was about 64%, and the largest coverage area was the large flower and salty grass (30%). Other occurrences of species depend on the degree of coverage, such as Megathyrsus maximus, Achyranthes aspera, squash fruit, Passiflora suberosa, Japanese Snail Seed, Balsampear.

◆ Woody sample area 2: This sample area is located next to the north wind turbine of the north-south windbreak forest in the west line of the line, with coordinates 192887 and 2672476. For coastal windbreaks, the canopy is about 3 meters high. The main afforestation species are Casuarina equisetifolia and Hibiscus tiliaceus. In the first season, the coverage of ground cover plants was about 53%, and the largest coverage area was Megathyrsus maximus, which accounted for about 25%. The coverage of other emerging species was Basella alba (10%) and Bidens pilosa var. radiata (8%), Passiflora suberosa (8%), Stephania japonica, Hibiscus tiliaceus, Lantana camara, Solanum diphyllum, and Japanese Snail Seed. Unmarked coverage is not high. In the second season, the coverage of ground cover plants is about 40%, and the largest coverage area is Datun, which accounts for about 25%. The coverage of other species depends on the degree of coverage (10%), large flowers and salty grasses. The leaves of Passiflora, the golden vine, the wood, the short-horned bitter gourd, the scutellaria, and the agate are not covered. In the second season, the Balsampear was added, and the Lantana camara L was removed from the sample area. The coverage of Pilose Beggarticks and the Passiflora suberosa was reduced from 8% to 1%.

- Woody sample area 3: This sample area is located in the south of the line west area, coordinates 187090, 2665719. For coastal windbreaks, the canopy is about 2 meters high. The main afforestation species are Casuarina equisetifolia and Hibiscus tiliaceus. In the first season, the coverage of ground cover plants was about 20%, and the largest coverage area was Tetragonia tetragonioides, accounting for about 12%. Other species were Solanum americanum, Parthenium hysterophorusand so on. In the second season, the coverage of ground cover plants was less than 2%, and there were only two species of Tetragonia tetragonioides and Phyla nodiflora.

- Woody sample area 4: This sample area is located at the southern edge of the survey area of Lukang District, with coordinates 186224 and 2663426. For coastal windbreaks, the canopy is about 3-4 meters high. The main afforestation species are Casuarina equisetifolia and Hibiscus tiliaceus. In the first season, the coverage of ground cover plants is only about 17%, and the species are at least in sequence: Basella alba, Bidens pilosa var. radiata, Lactuca indica, Coccinia grandis, Balsampear, and the like. The largest area covered is the Basella alba, which accounts for only 8%. In the second season, there was only 11% coverage of ground cover plants, and only species of Basella alba, Bidens pilosa var. radiata and Coccinia grandis were found. The largest coverage area is still the Basella alba, accounting for 8%.

- Herb sample area 1: This sample area is located in the northern sand dune of the west-west road of the east-west road of the meat-roasting corner of the line west. It is a natural grass-like land sample area with coordinates 189385 and 2668980. In the first season, the plant coverage was about 80%, the highest value was 60% for the Spinifex littoreus (Burm. f.) Merr., and 20% for Ipomoea pes-caprae. The other species were Oenothera laciniata and Digitaria ciliaris, and the coverage was not high. In the second season, only 73% of the plant coverage was left, 70% of the t Spinifex littoreus (Burm. f.) Merr. was the highest, and 3% of Ipomoea pes-caprae were in the second place. Oenothera laciniata and Digitaria ciliaris were covered by the sand and sand, then disappeared.

- Herb sample area 2: This sample area is located in the northern sand dune of the east-east road of the east-west road of the meat-nosed corner of the line west. It is a natural grass-like area, with coordinates 190498 and 2669040. In the first season, the plant coverage was about 84%, and the most covered ones were Vitex rotundifolia (40%), Ipomoea pes-caprae (25%), and Spinifex littoreus (Burm. f.) Merr. (18%). Other species were Shengmatang and Agaricus. The coverage is not high. Perhaps the accumulation of sand and sand brought by the typhoon, the plant coverage in the second season is only 4%, and the coverage is Vitex rotundifolia (20%), littoreus (Burm. f.) Merr. (15%), and Ipomoea pes-caprae (5%). The species that appeared Digitaria ciliaris, and the Dactyloctenium aegyptium were not seen.

- Herb sampler area 3: This sample area is located in the north sand dune of the east-west road of the north side of the meat horn in the west line of the line. It is a natural grass-like land sample area with coordinates 190742 and 2669625. In the first season, the plant coverage was over 70%, with 40% of the Spinifex littoreus (Burm. f.) Merr. and the Ipomoea pes-caprae (30%). The other species were only Dactyloctenium aegyptium, accounting for only 0.5%. In the second season, the plant coverage was 60%, with 40% of theSpinifex littoreus (Burm. f.) Merr. and the second of the Ipomoea pes-caprae (20%). The scorpionfish that appeared in the last season has disappeared.
- Herb sample area 4: This sample area is located on the southern edge of the line west area, which is a waste-like grass-like land sample area on the roadside of stone pavement, with coordinates 187380 and 2665383. The first season plant coverage exceeded 99%. The Melinis repens is the highest 60%, and other species with large coverage are Bidens pilosa var. radiata (20%); other species appear in order of Alyce Clover, Ipomoea pes-caprae, South African Hoarypea, Gomphrena celosioides, and Erigeron bonariensis. Portulaca pilosa, Parthenium Peacock-plume Grass, Indian Sesbania., Erigeron canadensis, etc. The second season plant coverage was nearly 47%. The Melinis repens is the highest 20%, and other species with large coverage are Bidens pilosa var. radiata (15%); other species appear in order of r Alyce Clover, Ipomoea pes-caprae, South African Hoarypea, Gomphrena celosioides, and Erigeron bonariensis. Portulaca pilosa, Parthenium Peacock-plume Grass. Indian Sesbania, who appeared in the last season, and Erigeron canadensis, have disappeared because of the dryness.
- Herb sample area 5: This sample area is located in the south of

Lugang District. It is a deserted grassland sample area close to the power plant, with coordinates 186762 and 2663658. In the first season, the plant coverage was over 90%. The dominant species were 40% of the Bidens pilosa var. radiata, 25% of Brachiaria subquadripara (Trin.) Hitchc., 12% of the Erigeron bonariensis, and 6% of the Purple Flower Bean, and other species appeared in Phyla nodiflora and Digitaria ciliaris, Alyce Clover, Indian Sesbania.., Megathyrsus maximus, Peacock-plume Grass.., Chloris formosana, Melinis repens, etc., coverage is not high. In the second season, the plant coverage is less than 65%. The dominant species are 25% of the Brachiaria subquadripara (Trin.) Hitchc., 20% of the Bidens pilosa var. radiata, 10% of the Purple Flower Bean, and 5% of the Megathyrsus maximus. Other species have the peas and Digitaria ciliaris. Peacock-plume Grass., Oenothera laciniata, Chloris formosana , Melinis repensetc., coverage is not high. The Oenothera laciniata is added this season. The Erigeron bonariensis, the Phyla nodiflora and the Indian Sesbania. that appeared in the last season have disappeared.

a. Analysis of the composition of woody plants

The forests in the project area are almost all windbreaks. Because the forest samples in the survey area are generally not high, and the base is mostly branched, the general chest height diameter measurement method will cause the biomass to be underestimated. Therefore, the tree species in the survey sample are estimated by the coverage. Four woody species were found in the four woody plots (Table 6.3.1-3), which were Casuarina, Astragalus, Qiliuli and Umbellifera. The most widely covered Casuarina and Astragalus membranaceus are common species of planted coastal windbreaks in Taiwan. The shape of the umbrella Yang is very similar to that of the yellow pheasant. It is a unique plant of the Hengchun Peninsula, commonly known as Hengchun Huangqi. This species of flower buds is lignified, cup-shaped, truncate, also known as paraplegia, which is actually different from Astragalus membranaceus. It should be planted in the seedlings of Astragalus membranaceus. Casuarina is the most important afforestation species here, with the highest coverage. Qilixiang is a self-generated shrub under the forest, and its important value is not high. The typhoon crossing in September swept away many leaves, but in the second quarter, the canopy coverage has been back to the first quarter, so it is only represented by the first.

Table 6.3.1-3 Coverage of Tree Strata at Xylophyta Sample Plot

Chinese Name	Coverage
Horsetail-tree	265
Rose wood	96
Orange-jessamine	1
Bhendi Tree	0.5
Total	362.5

b. Dominance of Herb

There are 9 plots in the ground cover, which can be divided into two categories; one is a total of 5 plots in the grass-like area, and the other is 4 in the lower layer of the wood-like plot. The Changhua seaside has poor soil, high salinity and rapid water loss, which is quite unfavorable for plant growth. Therefore, the species that can grow are rare and the biodiversity is not high. The first season sample survey only recorded 36 kinds of ground cover plants, among which trees Plant seedlings only have one species of scutellaria. In view of the combination of all the plots, the herbaceous layer is dominated by the Bidens pilosa var. radiata (22.35%) (Table 6.3.1-4), and the other order is the Spinifex littoreus (Burm. f.) Merr., Ipomoea pes-caprae, Melinis repens, Megathyrsus maximus, Basella alba, Vitex rotundifolia, Brachiaria subquadripara (Trin.) Hitchc. Basella alba, Achyranthes aspera and Erigeron bonariensis. There are many types of common invasive alien species. Among the top ten species, there are five species of naturalized species: Bidens pilosa var. radiata, Melinis repens Megathyrsus maximus, Basella alba and Erigeron bonariensis. The relative coverage is about 44.02% (the total relative coverage of the top ten species is 89.22%), and the dominance is about equal to the native species. There is a big difference between the grass-like ground sample area and the wood-like sample area in the superior composition ranking. The dominant herbaceous plants in the grass-like plot area are 1 to 5 in order, namely, the thorny wheat, the saddle vine, the red cedar, the large flower, the salty grass, and the Haipu ginger; and the stratified layer in the woody area is ranked 1 to 5 The order is Bidens pilosa var. radiata Megathyrsus maximus, Basella alba, Achyranthes aspera, and Tetragonia tetragonioides. The main constituent species are completely different except for the Bidens pilosa var. radiata. In the second season sample survey, only 30 kinds of ground cover plants were recorded, of which only one species of scutellaria was found in the arbor plant seedlings. Judging from the combination of all the plots, the herb layer is the most dominant by the thorny wheat (31.13%), and the others are the Bidens pilosa var. radiata, Megathyrsus maximus, Ipomoea pes-caprae, Brachiaria subquadripara (Trin.) Hitchc., Melinis repens, Vitex rotundifolia, Basella alba, Achyranthes aspera, and Purple Flower Bean. Among the top ten species, there are 5 species of naturalized invasive species, such as Bidens pilosa var. radiata, Melinis repens, Megathyrsus maximus, Basella alba, and Macroptilium atropurpureum. The relative coverage is about 39.87% (the total relative coverage of the top ten species is 93.9%), and the dominance is less than that of the native species. There is a big difference between the grass-like ground sample area and the wood-like sample area in the superior composition ranking. The dominant herbaceous plants in the grass-like plot area are 1 to 5 in order, namely, the Spinifex littoreus (Burm. f.) Merr, Bidens pilosa var. radiata, Ipomoea pes-caprae, Brachiaria subquadripara, Melinis repens; and the quilt in the woody area is ranked 1 to 5. The order of the name is Megathyrsus maximus, Bidens pilosa var. radiata, Basella alba, Achyranthes aspera, and Passiflora suberosa. The main constituent species are completely different except for the large flower and salty grass. It shows that the plant composition is very different due to different illuminance.

B. Diversity Analysis

Species disparity includes species richness and species eveness. This study calculates species dissimilarity by coverage. It is represented by the three indices (N0, N1, N2) defined by Hill (1973) and the E5 uniformity index of Alatalo (1981).

a. Diversity in woody sample areas (Table 6.3.1-5)

Due to the constant number of arbor trees in the two seasons, the first season data is representative. The degree of dissimilarity in the woody plot shows that the number of species in all plots is similar, ranging from 2 to 4 species, with the highest number of species in the plot 3 (4 species) and the lowest in all other dissimilarity indices. There are only two species in the sample area 1, 4, but several other differences in performance are good, especially E5.

Table 6.3.1-4 Relative Coverage List of Herb Sample Plot

Relative Coverage of Xylophyte Sample Plot(%)		Relative Covergae of Herb Sample Plot(%)		Relative Coverage of All Sample Plot (%)	
First Quarter	Second Quarter	First Quarter	Second Quarter	First Quarter	Second Quarter
Spanish Needle (41.22)	Guinea Grass (34.10)	Littoral Spinegrass (27.69)	Littoral Spinegrass (43.97)	Spanish Needle (22.35)	Littoral Spinegrass (31.13)
Guinea Grass (21.41)	Spanish Needle (27.28)	Seahore Vine Morning Glory (18.54)	Spanish Needle (12.31)	Littoral Spinegrass (19.25)	Spanish Needle (16.68)
Ceylon Spinach (9.64)	Ceylon Spinach (15.35)	Natal Grass (14.15)	Seahore Vine Morning Glory (11.26)	Seahore Vine Morning Glory (12.89)	Guinea Grass (11.21)
Common Achyranthes (8.03)	Common Achyranthes (12.79)	Spanish Needle (14.08)	Four Armgrass (8.79)	Natal Grass (9.84)	Seahore Vine Morning Glory (7.97)
New Zealand Spinach (6.42)	Grandular Petioluled Passiflora (1.71)	Simpleleaf Shrub Chaste Tree (9.39)	Natal Grass (7.07)	Guinea Grass (6.61)	Four Armgrass (6.23)
Grandular Petioluled Passiflora (4.28)	Japanese Snail Seed (1.71)	Four Armgrass (5.87)	Simpleleaf Shrub Chaste Tree (7.03)	Simpleleaf Shrub Chaste Tree (6.53)	Natal Grass (5.00)
American Black Nightshade (4.28)	Ivy Gourd (1.71)	Tall Fleabane (3.29)	Tall Fleabane (3.52)	Four Armgrass (4.08)	Simpleleaf Shrub Chaste Tree (4.98)
Ivy Gourd (1.07)	Bitter Gourd (1.71)	Tall Fleabane (1.41)	Buffalo Clover (2.46)	Ceylon Spinach (2.94)	Ceylon Spinach (4.48)
Indian Lettuce (1.07)	Japanese Stephania (0.85)	Buffalo Clover (1.17)	Guinea Grass (1.76)	Common Achyranthes (2.45)	Common Achyranthes (3.74)
Japanese Stephania (0.54)	Guadeloupe Cucumber (0.85)	South African Hoarypea (0.94)	South African Hoarypea (0.70)	Tall Fleabane (2.28)	Tall Fleabane (2.49)

Table 6.3.1-5 Diversity of Xylophyta Sample Plot

	Number of Species	λ (simpson)	H' (shannon)	N1	N2	E5
Sample Plot 1	2	0.52	0.67	1.95	1.91	0.95
Sample Plot 2	2	0.68	0.50	1.65	1.47	0.72
Sample Plot 3	4	0.93	0.19	1.20	1.07	0.35
Sample Plot 4	2	0.52	0.67	1.96	1.92	0.96
All Sample Plot	4	0.60	0.61	1.83	1.65	0.78

b. Diversity in GroundCovered Sample Plot (Table 6.3.1-6)

With regards to the ground cover sample area, the Q1 average coverage of herbaceous sample area is higher than that of woody sample area. Other than the number of species, herbaceous sample area showed worse performance than woody sample area in terms of other deviation indexes. Nevertheless, the differences in deviation indexes are not huge. From the single district, the number of species in the woody plot 3 and the herbaceous plot 3 was the lowest (3 species), but the other heterogeneous indexes were better than the herbaceous plots 1 (4 species), especially the herbs. In sample area 3, the uniformity E5 performed best. The highest number of species is herbaceous area 4, 5 (12 species), and the herbaceous area 5 has the highest dissimilarity index except for E5.

For Q2, the average coverage of herbaceous sample area is still higher than that of woody sample area. In terms of ground cover layer, herbaceous sample area and woody sample area showed similar performances and variation in each index is not significant. From the same area, the herbaceous area 1 has the lowest degree of dissimilarity, while the same species has only 2 kinds of woody sample area 3, herbaceous sample area 3, and the uniformity E5 performance is the highest. The highest number of species is herbaceous area 4, 5 (10 species), and the herbaceous area 5 has the highest performance except for E5.

Table 6.3.1-6 Diversity Table of Ground Cover Sample Plot

	Number of Species		λ (simpson)		H' (shannon)		N1		N2		E5	
	First Quarter	Second Quarter	First Quarter	Second Quarter	First Quarter	Second Quarter	First Quarter	Second Quarter	First Quarter	Second Quarter	First Quarter	Second Quarter
Xylophyta Sample Plot 1	4	7	0. 51	0 .33	0.89	1.30	2.44	3.65	1.97	3.03	0.67	0.76
Xylophyta Sample Plot 2	9	9	0.30	0.44	1.43	1.19	4.19	3.28	3.32	2.28	0.73	0.56
Xylophyta Sample Plot 3	3	2	0.50	0.56	0.77	0.64	2.16	1.89	2.02	1.80	0.88	0.90
Xylophyta Sample Plot 4	5	3	0.31	0.57	1.37	0.76	3.92	2.14	3.25	1.75	0.77	0.66
Herb Sample Plot 1	4	2	0.62	0.92	0.61	0.17	1.83	1.19	1.62	1.09	0.75	0.46
Herb Sample Plot 2	5	3	0.36	0.41	1.10	0.97	3.02	2.65	2.77	2.46	0.88	0.89
Herb Sample Plot 3	3	2	0.50	0.56	0.72	0.64	2.05	1.89	1.99	1.80	0.94	0.90
Herb Sample Plot 4	12	10	0.41	0.30	1.33	1.41	3.77	4.10	2.42	3.28	0.51	0.73
Herb Sample Plot 5	12	10	0.29	0.28	1.56	1.50	4.75	4.49	3.48	3.59	0.66	0.74
All Sample Plot	36	30	0.13	0.16	2.45	2.26	11.55	9.56	7.90	6.37	0.65	0.63

(2) Additional studies on species composition and their respective ecological dominance in sample areas.

A. 13 sample areas are set up in this study: 4 woodland sample areas and 9 grassland sample areas. All 4 woodland sample areas are made up of windbreak forests; whereas 3 out of 9 grassland sample areas are natural grass-covered land areas with sand dune formations, and the other 6 being grassy barrens enclosed by levees. Respective description are as follows:

◆ Woodland sample area 1: This sample area is located in the east-westward windbreak forest at the middle part of the Xianxi region. On its west, there is an abandoned military barrack with the coordinates 190875, 2669037. It is a coastal windbreak forest with its canopy reaching 6-8 feet tall. The forest is mainly made up of Casuarina equisetifolia. Approximately 76% of the land is covered by plants, with the Bidens pilosa var.radiata having the largest coverage (35%). Other plant species present are as follows (in descending order based on area of coverage): Panicum maximum (15%), Achyranthes aspera var. indica (10%), Passiflora suberosa (10%), Cocculus orbiculatus (3%), Broussonetia papyrifera (3%) etc.

- Woodland sample area 2: This sample area is situated at the south of the Xianxi region, having the coordinates 187090, 2665719. A coastal windbreak forest with the canopy at around 2 feet in height, the main afforestation species found are Casuarina equisetifolia and Hibiscus tiliaceus. Approximately 17% of the land is covered by plants, with the largest coverage achieved by Tetragonia tetragonoides with 15%. Other species present include Parthenium hysterophorus, Solanum americanum, Phyla nodiflora, Coccinia grandis etc., all with little coverage.

- Woodland sample area 3: This sample area is in the north-southward windbreak forest situated slightly further on shore.with the coordinates 188006, 2666953. The height of the canopy is around 2 feet. The main afforestation species found are Casuarina equisetifolia and Hibiscus tiliaceus. Coverage by plants is about 50% with the largest coverage achieved by Bidens pilosa var.radiata with 35%. Other plant species present are as follows (in descending order based on area of coverage): Brachiaria subquadripara (6%), Tetragonia tetragonoides (5%), Chenopodium acuminatum virgatum (3%) and Coccinia grandis (1%).

- Woodland sample area 4: This sample area is slightly to the east of an east-westward windbreak forest on coordinates 192618, 2669101. A coastal windbreak forest, the canopy of this sample area is around 8 feet in height. The area is afforested with only the Casuarina equisetifolia. Panicum maximum is the only species covering the land and has a coverage of 65%.

- Grassland sample area 1: This sample area is situated at the north sand dune, slight west to the east-westward road in the Xianxi Township and is a natural grass-covered land. The coordinates are 189385, 2668980. The land has 86% of plant coverage with the highest being Spinifex littoreus with 85%. Only one other species was found to be present in the sample area which is Ipomoea pes-caprae (1%).

- Grassland sample area 2: This sample area is situated at the north sand dune, slight east to the east-westward road in the Xianxi Township and is a natural grass-covered land. The coordinates are 190498, 2669040. The land has 83% of plant coverage with the highest being Spinifex littoreus with 60%. Other species found are Vitex rotundifolia L. f. (15%) and Ipomoea pes-caprae (8%).

- Grassland sample area 3: This sample area is situated at the north sand dune, to then north of the east-westward road in the Xianxi

Township and is a natural grass-covered land. The coordinates are 190742, 2669625. Approximately 70% of the land is covered by plants with the largest coverage achieved by Spinifex littoreus (60%). There was only one other species found in the sample area, which is Ipomoea pes-caprae (10%).

- ◆Grassland sample area 4: This sample area is situated at the south rim of the Xianxi region and is a grass-covered barren right at the side of a stone-paved road. The coordinates are 187380, 2665383. The land has a plant coverage of 83% with the largest coverage by Rhynchelytrum repens (40%), followed by Bidens pilosa var.radiata (30%). Other species present are as follows (in descending order in terms of quantity present): Alysicarpus vaginalis (4%), Ipomoea pes-caprae (4%), Tephrosia noctiflora (3%), Conyza sumatrensis (1%), Chloris barbata, Gomphrena celosioides Mart., Parthenium hysterophorus and Portulaca pilosa etc.

- ◆Grassland sample area 5: This sample area is a grass-covered barren at the side of a stone-paved road with the coordinates 190471, 2667622. The plant coverage in this area is approximately 80% with the largest coverage being Artemisia capillaris (60%). Other species found in this area are Bidens pilosa var.radiata (10%), Panicum maximum (5%), Rhynchelytrum repens (3%), Mimosa pudica (1%), Tephrosia noctiflora and Alysicarpus vaginalis etc.

- ◆Grassland sample area 6: This sample area is located at the northeast side of the on shore point and is a grass-covered barren at the side of a stone-paved road. The coordinates are 188294, 6667103. Total plant coverage is approximately 66% by Artemisia capillaris (45%), Rhynchelytrum repens (18%), Macroptilium atropurpureus (3%) and Oenothera laciniata respectively.

- ◆Grassland sample area 7: This sample area is situated at the northward and northeastward direction from grassland sample area 6. It is a wetland sample area amidst a grass-covered barren. The coordinates are 188739, 2667446. The plant coverage in the area is 72% with the Paspalum orbiculare (65%) being the more dominant species. Other species present include Saccharum spontaneum (4%), Indigofera spicata (1%), Pycreus polystachyos (1%), Phyla nodiflora and Imperata cylindrica etc.

- ◆Grassland sample area 8: This sample area is situated at the northeast corner of Xianxi Township and is a grass-covered barren area with the coordinates 190739, 2668760. Approximately 84% of the land is covered by plants, namely Rhynchelytrum repens (50%), Bothriochloa glabra (10%), Ipomoea pes-caprae (10%), Stachytarpheta jamaicensis (6%), Bidens pilosa var.radiata (5%), Praxelis clematidea (2%), Chloris barbata (1%) and Gomphrena celosioides Mart. etc.

- ◆ Grassland sample area 9: This sample area is located at 200 feet westward, slight south of Wind Farm No.16 . It is a grass-covered barren area with the coordinates 189353, 2668273. Plant coverage is approximately 85% with Praxelis clematidea (35%), Vitex rotundifolia (30%), Saccharum spontaneum (5%), Ipomoea pes-caprae (5%) and sesbania aegytica (5%) being the dominant species. Other species present include Portulaca pilosa, Chloris barbata, Fimbristylis dichotoma, Conyza canadensis, Lepidium apetalum, Digitaria violascens, Conyza sumatrensis, Suaeda maritima and Eragrostis tenella etc., all with limited coverage.

a. Analysis on the woody species composition (Table 6.3.1-7)

Almost all of the forests found in the study areas are windbreak forests. As the tree samples of the forests within the study area are mostly short in height with numerous branches at the base, the normal diameter at breast height method would result in an underestimation of the quantity of species present. Therefore, this study has adopted the plant coverage estimation method as the mean to study the number of present species in the study area. Investigation of the 4 woodland sample areas has revealed only 4 types of woody species, namely Casuarina equisetifolia, Hibiscus tiliaceus, Murraya paniculata and Thespesia populnea. Casuarina equisetifolia and Hibiscus tiliaceus are common species of coastal windbreak forests in Taiwan. The Thespesia populnea has similar appearance as the Hibiscus tiliaceus and is a plant of the Hengchun Peninsula, commonly known as the Hengchun Portia Tree. The calyx of the Thespesia populnea is lignified, having a cyathiform shape and truncate, hence is also known as the truncated-calyx-Portia Tree. Although the Thespesia populnea is not congeneric with the Hibiscus tiliaceus, its appearance might be due to being mixed and planted together with the Hibiscus tiliaceus during afforestation. Casuarina equisetifolia is the most important species in the afforestation of these areas and also having the largest coverage. Murraya paniculata is an archebiotic shrub in the understory of the forest with not much importance.

b. Ecological dominance of herbaceous species.

There are 13 groundcover sample areas which can then be divided into two main types: The grassland sample areas (9 in total) and the understory level of woodland sample areas (4 in total). The land alongside Changhua beach is infertile with high levels of sodium and rate of water loss. This results in an environment unsuitable for plant growth with little diversity as very few are able to thrive there. Studies on the sample areas found only 42 species of land-covering plants and the shoot of only one species of magaphanerophytes which is the Broussonetia papyrifera. Looking at all the groundcover sample areas as a whole, the species in the herbaceous group with the largest quantity is Spinifex littoreus (22.35%)(Table 6.3.1-8), followed by Bidens pilosa var.radiata, Rhynchelytrum repens, Artemisia capillaris, Panicum maximum, Paspalum orbiculare, Vitex rotundifolia, Ipomoea pes-caprae, Praxelis clematidea and Tetragonia tetragonoides etc. (from most to least). Among the top ten species, the Bidens pilosa var.radiata, Rhynchelytrum repens, Panicum maximum and Panicum maximum are naturalized species with the sum of relative coverage of approximately 37.94% (total relative coverage of the top ten species is 90.06%). Within the top ten, introduced species are shown to have much lower dominance as compared to the native species in terms of number of species and coverage. There is a vast difference in the order of dominance of the understory layer between the grassland and woodland sample areas. The dominant herbaceous species found in the grassland sample area are: (in descending order of dominance) Spinifex littoreus, Rhynchelytrum repens, Artemisia capillaris, Paspalum orbiculare and Bidens pilosa var.radiata; Whereas in the woodland sample areas, the dominant species in the groundcover layer are: (in descending order of dominance) Panicum maximum, Bidens pilosa var.radiata, Tetragonia tetragonoides, Passiflora suberosa and Achyranthes aspera var. indica. Aside from Bidens pilosa var.radiata, the main species composition of both types of sample areas are completely different. This shows that different degrees of light availability can result in different plant compositions in an area.

Table 6.3.1-7 Supplemenatry Survey of Tree Layer Coverage at Xylophyta Sample Plot

Chines Name	Coverage
Horsetail-tree	230
Rose wood	71
Orange-jessamine	1
Bhendi Tree	0.5
Total	302.5

Table 6.3.1-8 Supplementary Survey of Relative Coverage of Herb Sample Plot

Chinese Name	Ground Coverof Xylophyta Sample Plot Relative Coverage	Chinese Name	Herb Sample Plot Relative Coverage	Chinese Name	Total Relative Coverage
Guinea Grass	38.42%	Littoral Spinegrass	28.91%	Littoral Spinegrass	22.35%
Spanish Needle	33.62%	Natal Grass	15.66%	Spanish Needle	12.54%
New Zealand Spinach	9.61%	Mosquito Wormwood	14.81%	Natal Grass	12.10%
Grandular Petioluled Passiflora	4.80%	Ditch Millet	9.17%	Mosquito Wormwood	11.45%
Common Achyranthes	4.80%	Spanish Needle	6.35%	Guinea Grass	9.27%
Four Armgrass	2.88%	Simpleleaf Shrub Chaste Tree	6.35%	Ditch Millet	7.09%
Japanese Snail Seed	1.44%	Seahore Vine Morning Glory	5.36%	Simpleleaf Shrub Chaste Tree	4.91%
Paper Mulberry	1.44%	Stinky Cat Grass	5.22%	Seahore Vine Morning Glory	4.14%
Round-leaved goosefoot	1.44%	Paniculate bluestem	1.41%	Stinky Cat Grass	4.03%
Ivy Gourd	0.58%	Wild Sugracane	1.27%	New Zealand Spinach	2.18%
Common Parthenium	0.48%	Jamaica False-valerian	0.85%	Grandular Petioluled Passiflora	1.09%
American Black Nightshade	0.24%	Guinea Grass	0.71%	Common Achyranthes	1.09%
Turkey Tangle Fogfruit	0.24%	Indian Sesbania	0.71%	Paniculate bluestem	1.09%
Shaggy Purslane	0.00%	Buffalo Clover	0.58%	Wild Sugracane	0.98%
Jamaica False-valerian	0.00%	South African Hoarypea	0.49%	Jamaica False-valerian	0.65%
Butterweed	0.00%	Tall Fleabane	0.42%	Four Armgrass	0.65%
Indian Sesbania	0.00%	Peacock-plume Grass	0.35%	Indian Sesbania	0.55%
White Cogongrass	0.00%	Shaggy Purslane	0.30%	Buffalo Clover	0.45%
Numerous-branched flat-sedge	0.00%	Tall Fleabane	0.17%	South African Hoarypea	0.38%
Fimbristylis dichotoma (L.) Vahl.	0.00%	Numerous-branched flat-sedge	0.14%	Japanese Snail Seed	0.33%
Humble Plant	0.00%	Fimbristylis dichotoma (L.) Vahl.	0.14%	Paper Mulberry	0.33%
Paniculate bluestem	0.00%	Humble Plant	0.14%	Tall Fleabane	0.33%
Peacock-plume Grass	0.00%	Creeping Indigo	0.14%	Round-leaved goosefoot	0.33%

Table 6.3.1-8 Supplementary Survey of Relative Coverage of Herb Sample Plot (Continued)

Chinese Name	Ground Coverof Xylophyta Sample Plot Relative Coverage	Chinese Name	Herb Sample Plot Relative Coverage	Chinese Name	Total Relative Coverage
Natal Grass	0.00%	White Cogongrass	0.07%	Peacock-plume Grass	0.27%
Simpleleaf Shrub Chaste Tree	0.00%	Turkey Tangle Fogfruit	0.07%	Shaggy Purslane	0.23%
Mosquito Wormwood	0.00%	Silverflower Globeamaranth	0.04%	Ivy Gourd	0.13%
Seahore Vine Morning Glory	0.00%	Butterweed	0.04%	Tall Fleabane	0.13%
Silverflower Globeamaranth	0.00%	Violet Crab Grass	0.03%	Common Parthenium	0.13%
Wild Sugracane	0.00%	Suaeda maritima	0.03%	Numerous-branched flat-sedge	0.11%
Tall Fleabane	0.00%	Common Parthenium	0.03%	Fimbristylis dichotoma (L.) Vahl.	0.11%
Violet Crab Grass	0.00%	Garden Cress	0.03%	Humble Plant	0.11%
Evening Primrose	0.00%	Evening Primrose	0.01%	Turkey Tangle Fogfruit	0.11%
South African Hoarypea	0.00%	Feather Lovegrass	0.01%	Creeping Indigo	0.11%
Ditch Millet	0.00%	Grandular Petioluled Passiflora	0.00%	White Cogongrass	0.05%
Buffalo Clover	0.00%	Common Achyranthes	0.00%	American Black Nightshade	0.05%
Suaeda maritima	0.00%	Japanese Snail Seed	0.00%	Silverflower Globeamaranth	0.03%
Garden Cress	0.00%	Four Armgrass	0.00%	Butterweed	0.03%
Stinky Cat Grass	0.00%	American Black Nightshade	0.00%	Violet Crab Grass	0.02%
Littoral Spinegrass	0.00%	Ivy Gourd	0.00%	Suaeda maritima	0.02%
Creeping Indigo	0.00%	New Zealand Spinach	0.00%	Garden Cress	0.02%
Tall Fleabane	0.00%	Paper Mulberry	0.00%	Evening Primrose	0.01%
Feather Lovegrass	0.00%	Round-leaved goosefoot	0.00%	Feather Lovegrass	0.01%
Total	100.00%	Total	100.00%	Total	100.00%

B. Species Diversity Analysis

Species diversity includes species richness and species evenness. This study uses coverage to measure species diversity. Data is represented using the Hill Diversity Indices (1973), i.e. N0, N1, N2 and the Alatalo Evenness Index (1981), i.e. E5.

a. Diversity in Woodland Sample Areas. (Table 6.3.1-9)

The diversity in the woodland sample areas shows that there is no big difference in the number of species between all sample areas, generally having between 1-4 species. Sample area 4 has the lowest number of species (1 species) while also scoring the lowest for other diversity indices. Sample area 1 has the most number of species (4 species) but has a rather lackluster performance in the other diversity indices, being only better than sample area 4 that has only one species.

b. Diversity in groundcover sample areas. (Table 6.3.1-10)

As for groundcover sample areas, on average, grassland sample areas have a larger coverage than woodland sample areas, as well as generally scoring much superior results in diversity indices when compared to the groundcover layer of woodland sample areas, though with only minor difference between each index.

Viewing at the sample areas respectively, woodland sample area 4 shows the lowest number of species (1 species) and has the worst performance in all other diversity indices. Woodland sample area 1 and grassland sample area 6 have the best scores in the Evenness Index (E5). Grassland sample area 9 has the highest number of species (14 species) as well as good performance in other diversity indices, although when seen together with woodland sample area 1 (number of species: 6 species), each has leading scores against the other.

Table 6.3.1-9 Supplementary Survey of Diversity at Xylophyte Sample Plot

	Number of Species	λ (simpson)	H' (shannon)	N1	N2	E5
Sample Plot1	4	0.93	0.19	1.20	1.07	0.35
Sample Plot 2	2	0.52	0.67	1.95	1.91	0.95
Sample Plot 3	2	0.50	0.69	2.00	2.00	1.00
Sample Plot 4	1	1.00	0.00	1.00	1.00	0.00
All Sample Plot	4	0.63	0.58	1.78	1.58	0.74

Table 6.3.1-10 Supplementary Survey of Diversity at Ground Cover Sample Plot =

	Number of Species	λ(simpson)	H'(shannon)	N1	N2	E5
Xylophyta Sample Plot 1	6	0.29	1.47	4.33	3.46	0.74
Xylophyta Sample Plot 2	5	0.77	0.54	1.72	1.31	0.42
Xylophyta Sample Plot 3	5	0.52	0.98	2.67	1.93	0.56
Xylophyta Sample Plot 4	1	1.00	0.00	1.00	1.00	0.00
Herb Sample Plot 1	2	0.98	0.06	1.07	1.02	0.36
Herb Sample Plot 2	3	0.56	0.77	2.16	1.77	0.67
Herb Sample Plot 3	2	0.76	0.41	1.51	1.32	0.64
Herb Sample Plot 4	10	0.37	1.25	3.50	2.71	0.68
Herb Sample Plot 5	7	0.59	0.87	2.38	1.70	0.51
Herb Sample Plot 6	4	0.54	0.77	2.15	1.85	0.74
Herb Sample Plot 7	6	0.82	0.44	1.55	1.22	0.40
Herb Sample Plot 8	8	0.39	1.32	3.75	2.56	0.57
Herb Sample Plot 9	14	0.30	1.51	4.52	3.29	0.65
All Sample PloTable	42	0.11	2.52	12.45	8.78	0.68

(ii) Investigation on Land Mammals.

Investigation in 7 sample spots in the span of two rounds records 3 orders, 4 families, 13 species and 43 number of land mammals (not including the number of bats). No protected species present. In terms of the species endemism, there are 4 endemic species observed, namely the Rattus losea, Mus caroli, Myotis secundus, Murina puta and 1 endemic subspecies, the Eptesicus serotinus horikawai.

On the other hand, one round of additional investigation is carried out in Lunwei area, focusing on the common corridor. 9 sample spot investigations and line transect surveys are carried out, recording 3 orders, 3 families, 9 species and 9 number of mammals (including the types of bats). No protected species present. Species endemic to Taiwan observed are Rattus losea, Myotis secundus and those of the genus Murina. Suncus murinus (66.7%) is the species that showed most dominance in quantity in that area, being commonly seen on open lands and along the seacoasts. 2 Rattus losea and 1 Bandicota indica nemorivaga are recorded. Due to the hot weather in this round, rodents are inactive. Most of the mammals present are commonly seen species on the ground.

1. Trapping and Line Transect Survey.

   Investigations on a total of 225 traps in the span of two rounds record 2 orders, 2 families, 6 species and 43 number of small mammals (Table 6.3.1-11). First round of investigation spanned from 18th August 2016 to 21st August 2016; Second round of investigation was carried out from 7th November 2016 to 10th November 2016. Species captured include Suncus murinus of the order Soricomorpha and the Soricidae family, and Rattus losea, Rattus rattus, Mus musculus, Mus caroli and Rattus norvegicus of the order Rodentia and the Muridae family. The Rattus losea and Mus caroli are endemic species.

   Out of all species, the number of Mus caroli captured was the highest, commonly captured at sample spots that have good naturalness; The second most captured species is the commonly seen Suncus murinus of the Soricidae family, being captured mostly at locations that are close to human dwellings, with less naturalness.

   Out of all species, the Rattus losea and Mus caroli are commonly caught in areas that have more naturalness; Whereas the Rattus norvegicus and Rattus rattus are generally caught regardless of the area’s naturalness.

   One round of additional investigation is carried out in Lunwei area, focusing on the common corridor: 9 attempts of trappings at the sample spots; 2 families, 3 species and 9 number of epigaeic small mammals are caught in total (Table 6.3.1-11); Overall capture rate is 6.7%; No protected or exotic species present.

Table 6.3.1-11 Number of Trapped Animal in 2 Quarters

Order	Family	Species	Endemism	First Quarter	Second Quarter	Percentage
Insectivora	Soricidae	House Shrew			9	20%
Rodentia	Muridae	Brown Country Rat	Endemic	4	3	15%
		Black Rate		1	7	17%
		Formosan Mouse	Endemic	2	14	35%
		Mus Musculus		1		2%
		Rattus Norvegicus		2		4%
Total						43
Number of SPecies						6
Diversity H'(Shannon)						0.65
Evenness E(Shannon)						0.84

Table 6.3.1-12 Supplementary Record of Mouse Trap

Order	Family	Chinese Name	Scientific Name	Endemism	7/18	7/19	7/20	Total	Percenatge
Rodentia	Muridae	Brown Country Rat	*Rattus losea*	Taiwan Endemic Species	1		1	2	22.22%
		Bandicoot Rat	*Bandicota indica*			1		1	11.11%
Soricomorpha	Soricidae	House Shrew	*Suncus murinus*		3	2	1	6	66.67%
Total					4	3	2	9	
Number of Species					2.96%	2.22%	1.48%	6.67%	

2. Bat sonic wave detector investigation

From the investigation of bat sonic wave detectors, bats from 3 Families and 8 Species were found (Table 6.3.1-13). Myotis was the most widely spread species, which was found in every detecting point. The next commonly found species were Japanese house bat and Pipistrellus abamus, followed by Subspecies Miniopterus schreibersii fuliginosus and Tadarida insignis which were only found in one detecting point.

For the common corridor of the Lunwei District supplementary survey, the four stations conducted a three-day sound wave detector survey, taking the maximum value of each plot in each season, and a total of 6 species of bats were detected (including unidentifiable species). Tube-nose bats) (Table 6.3.1-14), no conservation, exotic species, etc., endemic species of long-toed bats and tube-nose bats in Taiwan. The number of long-toed rat ear bats is the most advantageous, and the only one recorded is the tube-nose bat

The coastal environment records East Asian bats, high-headed bats, East Asian-winged bats, long-toed bats, velvet bats, and unknown tube-nose bats. The distribution area is surrounded by land-based wind turbines and coastal forests, and is a potential affected species.

Table 6.3.1-13 Sampling of ANABAT System

Family	Scientific Name	Chinese Name	Endemism	Aug.	Nov.	Subtotal
Molossidae	*Tadarida insignis*	游離尾蝠		*		*
VESPERTILIONIDAE	*Miniopterus schreibersii fuliginosus*	東亞摺翅蝠		*		*
VESPERTILIONIDAE	*Pipistrellus abramus*	東亞家蝠		****		****
VESPERTILIONIDAE	*Scotophilus kuhlii*	高頭蝠		***	*	***
VESPERTILIONIDAE	*Eptesicus serotinus horikawai*	崛川氏棕蝠	Endemic Subspecies	*		*
VESPERTILIONIDAE	*Myotis secundus*	長趾鼠耳蝠	Endemic Species	****	**	****
VESPERTILIONIDAE	*Murina puta*	臺灣管鼻蝠	Endemic Species	**		**
Rhinolophidae	*Rhinolophus formosae*	臺灣大蹄鼻蝠	Endemic Species		*	*

Table 6.3.1-14 Supplementary Records of ANABAT System

Family	Chinese Name	Scientific Name	Endemism	Maximum
VESPERTILIONIDAE	東亞摺翅蝠	*Miniopterus schreibersii fuliginosus*		2
VESPERTILIONIDAE	東亞家蝠	*Pipistrellus abramus*		44
VESPERTILIONIDAE	高頭蝠	*Scotophilus kuhlii*		12
VESPERTILIONIDAE	長趾鼠耳蝠	*Myotis secundus*	Endemic Species	63
VESPERTILIONIDAE	管鼻蝠類	*Murina puta*	Endemic Species	1
VESPERTILIONIDAE	絨山蝠	*Nyctalus plancyi velutinus*		25

(iii) Terrestrial Bird Survey

From the investigation of 7 sampling points for land birds in two seasons, a total of 48 bird species from 11 Orders and 31 Families were found. By their characteristics, they are categorized into 25 Resident Birds, 16 winter birds, 5 Exotic birds and 2 summer birds. Three consecutive surveys were conducted every season. The number of each species was counted as the maximum value of the season, and the species with only 5% or more of the total number were the dominant species. The most abundant species were Jiayan (14.0%). The order was sparrow (13.1%), green eyes (12.6%), white-tailed starling (9.3%), little egret (7.9%) and Pulsatilla (5.4%). There are 10 kinds of uncommon species that only record 1 time, namely, small water duck, crested duck, Chinese egret, red dragonfly, kingfisher, big tail, pole north willow, blue sandpiper, ash and black-headed bird.

There are 4 protected species including the rare Eurasian Kestrel, Elanus caeruleus, Glareola maldivarus, and Brown Shrike (Figure 6.3.1-8). Eurasian Kestrel is a winter bird. It was found one time in November during its food hunting near the coastal region of the Changhua Coastal Industrial Park in Lukang District. Elanus caeruleus is a resident bird. It appeared in two consecutive seasons near the coastal region of the Changhua Coastal Industrial Park in Lukang and Xianxi District. Glareola maldivarus is a summer bird. A small flock of them were observed in August while they were flying pass the coastal region of Lukang District during their migration. Brown Shrike is a common winter bird. It was widely found in the region of investigation and can adapt the environment easily. Among south part of the investigation region in Lukang District, 4 protected species were all observed.

The endemic bird species found in the sampling areas include Barred Button Quail, Savanna Nightjar, House Swift, Black Drongo, Chinese Bulbul, Tawny-flanked Prinia, and Vinous-throated Parrotbill, 7 in total. There are five species of exotic species such as Egyptian sacred pheasant, wild pigeon, lynx, family starling and white-tailed starling, all of which are suitable for artificial environment and human interference. Among them, the white-tailed starling has the largest number, and its trails are visible in the whole region; the other few have only sporadic records.

A total of 23 species from 20 families and 9 orders of birds were recorded in the Lunwei District supplementary survey for the common corridor. Among the 23 species of birds, there are 20 species of resident birds, 2 species of summer migratory birds, and 1 species of exotic species. In terms of specificity, it includes four endemic subspecies. Three species of conservation birds were recorded in the plot.

The survey was conducted in the summer. In addition to the breeding season of the resident birds in this season, the summer migratory birds have arrived in Taiwan and began to breed, so they have the opportunity to observe the resident and summer migratory birds in the breeding. This season, the largest number of palm-tailed hawksbills (17.7%), followed by Jiayan and Pulsatilla (9.7%), followed by the white-tailed starling and the small skylark (8.1%), and the night survey was dominated by the Taiwan Nighthawk (6.5%). On the whole, the birds are mainly composed of resident birds, which are common bird species in developed areas. Migratory birds have a large number of summer migratory birds and swallows. In particular, Jiayan has arrived in Taiwan and began to nest and breed. In the plot, the swallows that fly in the air can often be observed. Yan Yan only had one individual record on the first day. It is speculated that due to the construction, the ethnic group that originally propagated within the scope.

n terms of endemism, the four unique subspecies recorded are the brown three-toed pheasant, the white-headed pheasant, the yellow-headed pheasant, and the black-necked blue pheasant. Pulsatilla belongs to the surrounding areas and forested birds. It is a common bird species in the hilly areas of the plains. As long as there are forests in the environment, there is a chance to distribute them. The yellow-headed fantail and the brown toe are occasionally visible in the grassland. The black-necked blue dragonfly belongs to the forest-like bird. This time, there is a record in the wind-proof forest in the center of the sample area, which may be a breeding individual.

The three conservation birds surveyed this season include two secondary conservation classes and one tertiary conservation category. The two secondary conservation classes are black-winged pheasants and small terns. The black-winged pheasant prefers to be active in the wilderness area. The wild voles in the plain area are the main food source. The black-winged pheasants observed in this area are flying back and forth over the farmland, and the prey in the field is searched. The young tern should be an individual who occasionally passes through the area. There are many ethnic groups in the surrounding sea area. In the past, there were breeding groups in this area, which may be disturbed today, so as to no breeding. One type of tertiary conservation is Yanling, which is a common summer migratory bird in Taiwan. Individuals observed this season should belong to the ethnic group that occasionally passes

The exotic species in the sample area are only white-tailed starlings, and the white-tailed starlings are mostly observed in the vicinity of artificial structures such as houses and telephone poles, and the number is not large.

Figure 6.3.1-8 Distribution Graph of Terrestrial Protected Bird Species

Figure 6.3.1-9 Distribution of Protected Bird Species in Supplementary Survey

Figure 6.3.1-10 Distribution of Exotic Bird Species in Supplementary Survey

(iv) Investigation of land amphibians and reptiles

1. Amphibians

The survey time for the two seasons was August and November 2016 respectively. In August, the temperature is high and it is the peak of amphibious reproduction. Therefore, it is more likely to investigate the complete species. The species surveyed this season are mostly frogs in the still waters. In the plot, there are sporadic drought-tolerant and salt-tolerant species. Rain frog and frog. The second quarter survey was conducted in November, the temperature dropped and the amphibians were not active.

A total of 13 amphibians from 1 Order 3 Families and 3 Species were recorded in 2 seasons. No protected species, endemic species and exotic species were found. Since the number of species found is low, there is no point of taking 5% of the total species as the advantageous species. Therefore, the sample areas under investigation lack advantageous species.

The survey area is adjacent to the coast. The environment is single, dry and low in nature. There is no stable fresh water environment such as ponds or freshwater ditches. Only the relatively dry and salinity-resistant small frogs, Gonder's red frogs and frogs are recorded. This environment does not benefit the habitat of amphibians. The data was analyzed for dissimilarity and the overall amphibian Shannon-Wiener’s dissimilarity index was 0.44.

here was no amphibious record in this season for the supplementary survey of the Lunwei District for the common corridor.

2. Reptiles

A total of 176 reptiles from 1 Order 3 Families and 3 Species were recorded in 2 seasons (August and November). No protected species and exotic species were found. There is one endemic species found, Stejneger's grass lizard.

The survey area is adjacent to the coast, with a single environment and low naturalness. Therefore, the species appearing are mainly grassy and artificially adapted species. On the whole, this environment is only suitable for the habitat of a few reptiles. The three species of the scorpion tiger, the scorpion tiger and the Penglai grass lizard are all common low-altitude species in western Taiwan.

Combining the two seasons of data for analysis, the most dominant species is the Hemidactylus frenatus (50.57%), mostly in the artificial or mixed forest environment; followed by the Takydromus stejnegeri Van Denburgh (48.86%), which appears in the grassland and continuous shrubs. environment of. No snakes were found in the second quarter survey. The data was analyzed for dissimilarity, and the overall reptilian Shannon-Wiener’s dissimilarity index was 0.31

For the common corridor of the Lunwei District supplementary survey, a total of 2 species from 1 order and 2 families, and 15 times were recorded. There were no conservation, exotic species and endemic species. The dominant species was 5%. The most dominant species was the Hemidactylus frenatus (93%), Elaphe carinata only recorded one time, the species are mostly low-altitude common species in western Taiwan.

(一) Investigation of Terrestrial butterfly

A total of 94 butterflies from 4 Families and 10 Species were recorded. No protected species and exotic species were found. There two Taiwan endemic species found, namely Striped policeman and Polygonia c-aureum lunulata.

Taking the majority of the total number of 5% or more as the dominant species, the most dominant species is the Okinawa small gray butterfly (44.7%), and the other order is Taiwan Yellow Butterfly (33%0, corrugated small gray butterfly (11.7%0, both of which are western Taiwan) It is common to the species. There are 4 species (40%) of rare species, including Burara jaina , Pieris rapae, Catopsilia pomona, Hypolimnas bolina, and etc, which are uncommon species in the area. The range of land cables is an industrial area for land reclamation. The land use types are mostly developed factories, waste cultivated land, coastal forests, intercropping trees, flower beds, horticultural landscapes, etc. The rare species mentioned above may come from the adjacent inland forest environment. A species that is sporadic.

In the second season, the degree of heterogeneity and uniformity were not high, 0.62 and 0.62 respectively; 6 species in the first season, 0.61 in heterogeneity, 0.78 in uniformity, 7 species in the second season, 0.56 in heterogeneity, and 0.66 in uniformity; And the number is slightly higher than the first season. The species composition is different from the dominant species Okinawa small gray butterfly, corrugated small gray butterfly and Taiwan yellow butterfly. The other types are different, and the conversion rate reaches 70%, indicating that the butterfly diversity in this region is not high. Seasonal variation is also large.

According to the butterfly composition, the dominant species mainly inhabits the species within the construction area, and there are many similar habitats in or around the vicinity. In addition, the butterfly has strong flight ability, although the ethnic group may be affected, but the impact is very small; other species are mostly incidental in the adjacent area. Sex through or diffuse ethnic groups, the impact of future land cable construction is small.

In the first season of the Lunwei District supplementary survey for the common corridor, a total of 338 sects were recorded in 3 families and 9 families. There was no conservation, and the exotic species was white butterfly. Taiwan's endemic subspecies are white corrugated small gray butterflies, which are only recorded once. The majority of his species are common types on the west coast of Taiwan.

The most dominant species is the white butterfly (29.6%), followed by the corrugated small gray butterfly (11%), followed by the yellow butterfly (9.2%) and the Taiwan yellow butterfly (66.3%), followed by the white butterfly (16.9%) and the peacock. Vanessa (10.1%) is the most common species in this.

The land cable of this project is mainly constructed along existing roads, except that the shoreline of the submarine cable is coastal sand, and the vegetation in most areas has been cleared or the maintenance of existing land wind turbines has little impact.

(v) Waters Dragonfly Survey

A total of 33 dragonflies from 1 Families and 5 Species were recorded. No protected species and endemic species were found. The advantageous species is Pantala flavescens (75.8%). Other species include Crimson Darter (3), Tramea virginia (2), Orthetrum Sabina (2), and Brachythemis contaminate (1). Most of the species found were common species.

Although there are some ponds, wetlands and ditches in the survey area, the ditches are also more artificial due to the proximity of the coast. The species inhabiting this area are mostly common types on the coast, including scarlet, Dahua, brown trout, etc. The species and the number of species in the second season are still much lower. The first season's disparity was 0.49, the uniformity was 0.81, and the second season was 0.1 and 0.3, both of which were significantly lower, indicating a relatively low diversity.

Due to the dragonfly analysis of the target composition, the area of the cable excavation area has been artificially disturbed. In the future, the affected species will be quite limited, and the flying capacity of dragonfly is strong, and the future construction impact is small. The divergence of the second season was 0.38 and the uniformity was 0.54.

In the first quarter of the Lunwei District Supplementary Survey for the Common Corridor, there was no record of dragonfly in this season.

6.3.2 Marine Ecosystem

V. Scope of Ecological Survey and Sampling Locations

The no. 15 wind site selected for this project in accordance with the Neng-Zi no. 10404015571 Directions of Application for Offshore Wind Site Selection announced by the MOEA Bureau of Energy on July 2, 2015 was chosen as the evaluation region. Previously, the no. 21 wind site had been selected as the first survey site. The location was then changed to the no. 15 wind site due to navigation problems. The potential wind sites zones are located in the seas on the north side of the mouth of the Dadu River offshore of the Xianxi and Lugang Townships in Changhua County. The locations of the marine ecological survey points were determined based on the Technical Guidelines for Ocean Ecology Assessments (Huan-shu-zong no. 0960058664A announced on August 2, 2007). The test station layout method should be able to cover the project site area and the surrounding potentially affected sea areas. Control stations shall also be set up outside of the affected area. The ocean ecology survey zone includes potentially affected areas including surrounding waters, offshore waters and the cable laying route. A total of 12 sampling stations were set up. During the second survey at the no. 15 wind site, some of the testing sites were moved in conjunction with cable route planning. Testing station 15-5 was changed to N15-5, 15-9 was changed to N15-9, 15-10 was changed to N15-10 and 15-12 was changed to N15-12. For the intertidal zone survey, the survey site was determined based on the area that may be affected by the landing section of the submarine cable. The landing sites for this project are all located inside the Changbin Industrial Park. Four intertidal zone surveys have already been completed for the Changbin Industrial Park. A total of 6 sites were set up for the first survey (March 9 – 11, 2016). The number of sites were then increased to 18 for the second, third and fourth surveys (survey site coordinates as shown in Table 6.3.2-1 and the positions are shown in Fig 6.3.2-1). For the project's joint corridor, a supplementary survey (Table 6.3.2-1, position shown in Fig 6.3.2-1) was conducted at 3 ocean ecology survey sites at the Lunwei area and 3 survey sites at the intertidal zone in July 2017.

VI. Regulations of Ecological Survey

Scope of ecological survey, methodologies and report writing are in accordance with Technical Guidance for Marine Ecological Assessment issued by Environmental Protection Agency, Executive Yuan (hereinafter referred to as EPA) (Official Letter 0960058664A issued by EPA on 2nd August 1996).

Table 6.3.2-1 Coordinates of Marine Survey Sampling Stations

Code of Sampling Stations		Coordinates of GPS		Code of Sampling Stations		Depth of Water Layer (m)	Water Layer of Phytoplankton Sampling	Coordinates of GPS	
		Longitude	Latitude					Longitude	Latitude
Intertidal Zone of Waters	Intertidal Zone 1-1	191919.85	2672715.55	Waters	15-1	39.1	5	147743.86	2675901.28
	Intertidal Zone 1-2	190944.08	2671184.20		15-2	36.5	5	142303.15	2677329.86
	Intertidal Zone 1-3	189375.14	2669079.47		15-3	33	5	139648.47	2675716.29
	Intertidal Zone 1-4	186871.23	2665695.78		15-4	33.3	4	135686.38	2673420.23
	Intertidal Zone 1-5	186537.37	2664490.02		15-5	40.2	5	142598.12	2670643.75
	Intertidal Zone 1-6	185445.24	2661772.67		N15-5	38.2	5	142351.79	2672521.74
	Intertidal Zone 1	193039.18	2672719.25		15-6	41.3	5	148358.19	2672253.33
	Intertidal Zone -2	192204.07	2672711.03		15-7	34.1	5	135898.71	2670309.92
	Intertidal Zone -3	191900.83	2672511.03		15-8	45.6	5	145634.88	2667792.09
	Intertidal Zone -4	191795.70	2672370.33		15-9	42.1	5	152246.01	2673065.66
	Intertidal Zone -5	191535.69	2672007.76		N15-9	36.8	5	158659.54	2673812.12
	Intertidal Zone -6	191364.39	2671758.50		15-10	42.0	5	153927.57	2671597.58
	Intertidal Zone -7	187751.38	2665370.50		N15-10	45.6	5	171949.45	2672741.05
	Intertidal Zone -8	187476.29	2665348.01		15-11	33	5	137230.91	2668250.72
	Intertidal Zone -9	187042.50	2665383.79		15-12	33.5	5	140208.56	2673386.23
	Intertidal Zone -10	187291.61	2664612.23		N15-12	12	3	181725.55	2661103.93
	Intertidal Zone -11	187020.47	2664612.44	Submarine Cable	MN-1	40	5	169359	2668236
	Intertidal Zone -12	186789.55	2664606.82		MN-2	40	5	175178	2668788
	Intertidal Zone -13	186574.04	2664407.90		MN-2	17	4	178613	2665031
	Intertidal Zone -14	186467.68	2664128.57						
	Intertidal Zone -15	186332.74	2663846.96						
	Intertidal Zone -16	186241.37	2663646.40						
	Intertidal Zone -17	186150.91	2663414.33						
	Intertidal Zone -18	185954.30	2662983.20						
	IT-N1	189055	2668952						
	IT-N2	188091	2667470						
	IT-N3	186902	2665739						

Remarks 1: Coordinates system is TWD97 (Torpdedoman Second Class)
Remarks 2: Sampling stations of first survey include Intertidal Zone 1-1 to 1-6. Sampling stations from second to fourth survey include Intertidal Zone 1 to 18.

Figure 6.3.2-1 Sampling Locations of Marine and Intertidal Zone Surveys

Figure 6.3.2-1 Sampling Locations of Marine and Intertidal Zone Surveys (Cont.)

I. Survey Dates

Dates of marine ecological survey are listed in Table 6.3.2-2.

Table 6.3.2-2 Survey Dates of Marine Ecological Survey

Survey Time / Quarter	Zooplankton Phytoplankton Marine Benthic Organism	Intertidal Zone	Fish Eggs and Juvenile Fish
First	13th February 2016 (No.21 Wind Farm)	9th to 11th March 2016	13th February 2016 (No.21 Wind Farm)
Seond	7th June 2016	30th May to 1st of June 2016	7th June 2016
Third	18th August 2016	24th to 26th August 2016	18th August 2016
Fourth	26th November 2016	22nd to 24th November 2016	26th November 2016
Fifth	13th March 2017	6th to 8th February 2017	13th March 2017
Sixth	7th July 2017	16th July 2017	7th July 2017

II. Current Status of Environment

(i) Meteorological State

North-northeast directional winds make up a relatively large proportion on the winds at the Changhua coastal wind field from October to March due to the effects of the northeast monsoon. The winds are quite strong mainly ranging between 5 – 15 m/s and reaching speeds up to 25 m/s or above. Winds from April to September are relatively unstable and wind speeds tend to be low, mostly between 0 – 5 m/s. During the typhoon season, winds can reach 15m/s or more when under the effects of typhoons. As for rainfall, precipitation is highest from May to August due to the effects of the plum rains and typhoons. Average precipitation in June is 236.7mm. Precipitation is lower in the winter due to the effects of the northeast monsoon. Rainfall averages just 11.2mm in October and annual cumulative precipitation can reach 1187.6mm.

Tides in the Changhua sea area is mainly twice daily rise and fall tidal movements. The flow is mostly in a northeasterly direction when the tide is rising and mostly in a southeasterly direction when the tide is falling. There is not much change over the seasons. Monsoon waves are highest in December reaching 2 meters and lowest in July reaching just 0.2m. According to 50-year recurrence interval estimates of typhoon waves, the highest waves at a depth of 20m are northernly 7.15m waves with an interval of 10.69 secs.

Ocean surface currents on Taiwan's west coast flow in a south to north direction due to south to north direction flow of the Kuroshio branch current conveyance. However, due to the effects of the Changyun ridge nearby Changhua, the current first flows west and then in a northerly or northeasterly direction. This is the most unique area for the ocean surface current on the west coast of Taiwan. Different seasons have an effect on the sea surface temperature (SST) around Taiwan. The

SST on the west coast averages 24℃ in the summer. Due to the effects of the northeast monsoon in the winter, mainland coastal currents bring cold water masses to central region seas in Taiwan. Sea surface salinity (SSS) varies from season to season in the waters around Taiwan. The SSS on the west coast ranges from 28 – 33 in the summer just like the sea temperature. Due to the effects of the northeast monsoon in the winter, mainland coastal currents bring cold water masses to central region seas in Taiwan. Due to the Changyun ridge offshore of Taiwan, this area forms a temperature and salinity gradient change. This is the most unique area for SSS on Taiwan's west coast.

(ii) Intertidal Zone

The surface of the Changhua wetlands intertidal zone is made up mostly of silt. These sources of silt flow into the mouth of the Zhuoshui River. Upstream gravel cutting causes erosion creating silt which flows to the river mouth. When the tide recedes, the entire silt bank is exposed. The silt dries out in the sun and it loses its adhesion. The northeasterly winds then blow the silt around. So, piles of sand can be seen all over the coastline. When the southwest air currents are strongest in the summer, the southwesterly winds blow the sand northward. Each year, this sand is blown back and forth. This north and south movement creates sediment which has settled but is still unstable. Local residents near the Changhua wetland harvest clams from the clam beds. The tides create obstacles and carve out many tidal creeks so newly born organisms are not easily carried out to sea by the tide. Therefore, fish and bottom feeders can find shelter in this area. The Changhua wetlands also have a broad intertidal zone. The current is slow so when the tide recedes, plankton, organic matter and algae in the water can easily get caught on the surface of the silt banks providing food for crabs, oysters and other organisms living there which makes the Changhua wetlands home to a rich variety of wildlife.

III. Survey Methods

(i) Survey Items

Phytoplankton, zooplankton, benthos and fixative marine plants. The various survey items and methods are described below:

1. Phytoplankton

(1) Species composition and abundance

A. In Situ Sampling

The Phytoplankton Sampling Method – Water Collection Method (NIEA E505.50C) announced by the Environmental Protection Administration (EPS) was used for this item. A standard water collector was used for the sampling. Based on the Technical Guidelines for Ocean Ecology Assessments (Huan-shu-zong no. 0960058664A), water samples were collected from different water levels at the assigned sampling point depths as shown in Table 6.3.2-3. One liter was collected and put into a wide-mouth PE plastic bottle and a final concentration of 5% formalin was added for preservation. The sample was kept away from sunlight, stored in ice and taken back to the lab for species identification and counting.

B. Identification and Sampling

After the sample was brought back to the lab, the water sample was mixed uniformly. 100 ml (amount may be changed based on the water conditions) was then taken and strained with a 0.2 µm diameter transparent filter membrane. The filter member was then picked up with tweezers after straining and a slide was made. Species identification and counting was done with an optical microscope and the data was converted into cells /L.

Table 6.3.2-3 Water Depth and Depth

Range of Water Depth	Sampling Horizon	Minimum Distance Between Bottom and Adjacent Layer
<5m	Surface Layer, 3m Underwater (Bottom)	-
<10m	Surface Layer, 3m Underwater, Bottom	3 m
<25m	Surface Level, 3m Underwater, 10m Underwater, Bottom	5 m
<50m	Surface Level, 3m Underwater, 10m Underwater, 25m Underwater, Bottom	10 m
<100m	Surface Level, 3m Underwater, 10m Underwater, 25m Underwater, 50m Underwater, Bottom	10 m

Remarks: Bottom is 2-5m off the seabed.

(2) Chlorophyll a

A. On-Site Sampling

This sampling is in accordance with Sampling Method of Phytoplankton- Sampling Water Method (NIEA E505.50C), announced by EPA. Systematic Water Sampler is utilized during sampling and the configuration of sampling depth to sample water at different aquifer is accordance with Regulations of Marine Ecology Assessment Technique (EPA, Official Words 0960058664A).

1 liter of water is sampled and poured into PE wide-mouthed plastic bottle. Then, it is filtered and extracted via 0.7 µm of Whatman GF/F

(glass fibre filter). The filtered filter shall avoid light, storage in cold and deliver to laboratory for testing.

B. Analysis of Chlorophyll a

This item is conducted in line with Test Methods of Chlorophyll a in Water- Ethanol Extraction (NIEA E508.00B). First, cut the filter into pieces with scissors, place into centrifuge tube and pour 10ml of ethanol. Put into 60oC incubator in dark for 30 minutes and place into cold water until it reaches room temperature and place into centrifuge (3000-5000g) for 10-15mins. Take out the centrifuge tube carefully and take 3ml of supernatant via micro pipette and move to the tube of photometer with diameter 1cm. Test the light absorption value 665 nm and 750nm via spectrophotometer, add 0.03ml of 1M HCL into tube of photometer to undergo acidification and re-measure the light absorption value of 665 and 750nm. At last, use the acquired light absorption value to calculate the content of chlorophyll a in water.

(3) Primary Productivity

The dissolved oxygen method (Garside et al. 1927) is used for this method. A standard water collector is used for sampling. Based on the technical guidelines for ocean ecology assessments (Huan-shu-zong no. 0960058664A), water samples were collected from different water levels at the assigned sampling point depths. After the water is collected, it is placed in cultivation BOD bottles (one clear and one dark bottles). Try to avoid producing any air bubbles when putting the water samples into the bottles. Then, put the samples into a transparent incubator and cultivate for 24 hours at a constant temperature using circulating water. Use the pre and post-cultivation dissolved oxygen measurements to calculate the primary productivity (μgC/L/d).

Measure by Light and Dark Bottle Method, the formulae to calculate the primary productivity is described as follows:

Respiration= Initial Oxygen Value of Dark Bottle- Final Oxygen Value of Dark Bottle)/ Total Time Taken

Net Primary Production (NPP)= (Final Oxygen Value of Light Bottle- Initial Oxygen Value of Light Bottle)/ Total Time Taken

Gross Primary Production (GPP)= Net Primary Production (NPP)+ Respiration

2. Zooplankton

(1) On-Site Sampling

This item meets the standard of Test Methods of Zooplankton announced by EPA and conducts with NORPAC net in sampling station (NORPAC net; mesh size 0.33mm x 0.33mm, conical net length 180cm, mouth diameter 45cm). Flow meter (HYDRO-BIOS Germany made machine digital flow meter) is attached at mouth diameter to measure the filtered water volume.

The survey of zooplankton is further detailed into surface horizontal sampling and vertical sampling method. Vertical sampling method is mainly conducted. When the water depth is lower than 7m, horizontal sampling is conducted. Vertical sampling method is conducted by NORPAC net and counterweight. Place the NORPAC net 1m away from bottom layer and pull upwards to sea surface in slow speed vertically (not exceed 3m per second).

Horizontal trawling is conducted by dragging the stern when water depth is below 7m and with speed below 3NM. Use washed bottle to pour the zooplankton into sampling bottle at the tail net by filtered sea water. Add 5% Millonig's Modified Phosphate Buffered Formalin, preserve in cold and deliver to laboratory to conduct analysis.

(2) Identification of Species and Calculation

After delivering back to laboratory, separate the water sample into 1/2, 1/4, 1/8 or 1/16 via riffler. Then, species identification and calculation are conducted via stereomicroscope. Lastly, convert into unit inds./1,000 m3 according to anemometer.

3. Benthic Organism

(1) Marine Benthic Organism

Sampling Standards of Benthic Organisms in Soft Sediment (NIEA E103.20C) is served as reference. Vessels of sampling stations are travelled with speed below 2NM, adopts Naturalist's rectangular dredge (mesh size: 5x 5mm, mouth diameter: 45cm, conical net length: 18cm). Use sifting screen to wash the mud, record the sample to identify and release on the spot. Storage in cold 5% Millonig's Modified Phosphate Buffered Formalin then deliver back to laboratory to undergo identification and calculation.

(2) Benthic Organisms in Intertidal Zone

This item is in accordance with Sampling Standards of Benthic Organisms in Hard Sediment (NIEA E104.20C) and Sampling Standards of Benthic Organisms in Soft Sediment (NIEA E103.20C).

Survey of benthic organisms with high mobility (such as prawn, crab and etc.) is conducted via Road Sampling Method. Fixed length of survey line is placed at the upper supratidal zone to lower supratidal zone, record the species at the 1m of right side and left side of survey line. If it can be identified, it shall be taken photo to identify and storage in cold. After delivering back to laboratory, it will undergo identification.

Survey of benthic organisms with low mobility (such as conch, mussel and etc.) is conducted via Fixed Frame Method. Survey line with fixed length is placed from upper supratidal zone to lower supratidal zone; certain number of sampling frame is placed at the left and right side of survey line (the sampling area is adjusted according to the environment). Epifauna such as conch and mussel is observed and sampled under this frame; some are excavated for 30cm for sampling. Identify and calculate after capture and return on the spot. Those cannot be identified, record the characteristics by taking photo, preserve in cold and identify after delivering to laboratory.

4. Maritime Plant

This item is accordance with Sampling Standards of Benthic Organisms in Hard Sediment (NIEA E104.20C) announced by EPA. A sampling area (1m x 1m) is set at upper supratidal zone, middle supratidal zone and lower supratidal zone (the sampling area is adjusted according to environment situation). Thus, the species and coverage of large fixed algae within the sample area are recorded by taking photo. After taking photo, scrap some algae and storage in cold. It will be identified after delivering back to laboratory. The coverage of large fixed algae (%) will be estimated when the video is delivered back to laboratory.

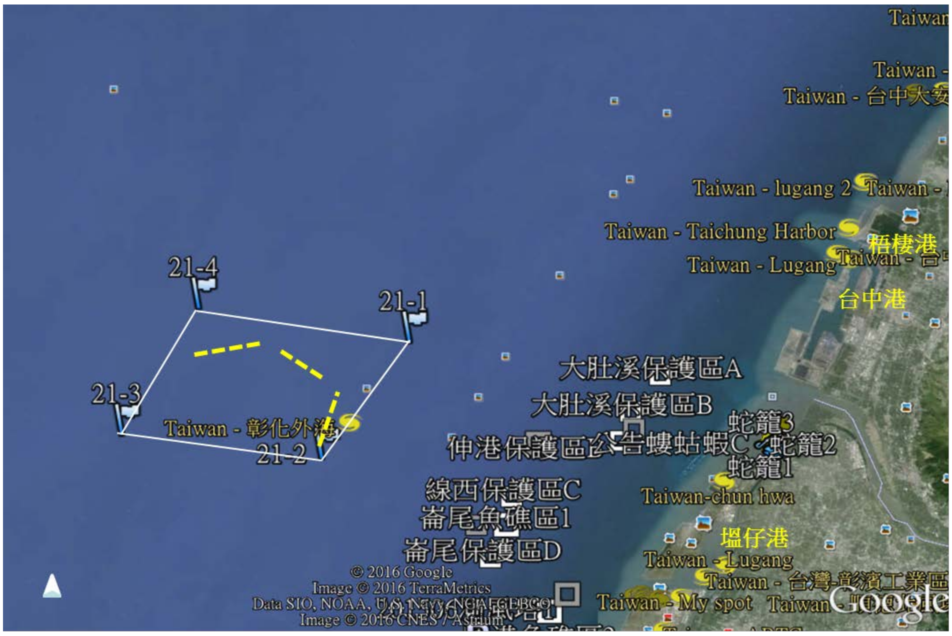
5. Fish Survey

(1) Adult Survey

Surveys analysis of fish species and economical fish species are conducted at waters around Changhua Coastal Industrial Park during operation of No.10 Wind Farm. Sampling locations are shown as Figure 6.3.2-2. Survey is conducted once per quarter in every sampling station. In March of 2016, a trip of bottom trawling sampling is conducted in order to understand the current situation of fish in that area. The description of marine ecological monitoring items and monitoring methodologies are described as follows:

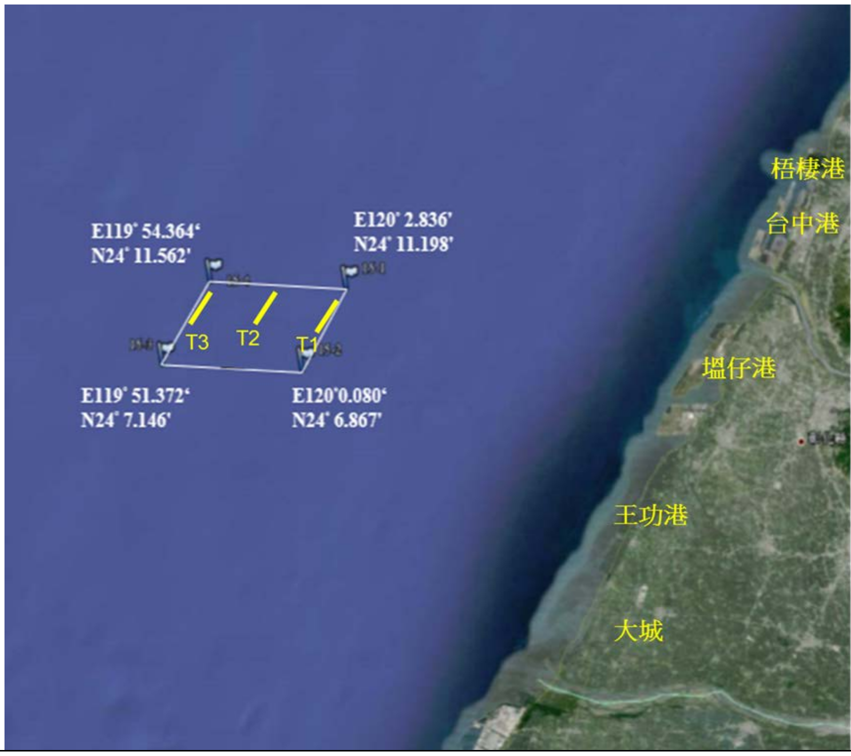
Surveys analysis of fish species and economical fish species are conducted at waters around Changhua Coastal Industrial Park during operation of No.15 Wind Farm from 2016 to 2017. Sampling locations of survey are shown as Figure 6.3.2-2. Survey is conducted once per quarter at every sampling station. In May, July, October of 2016 and January of 2017, a trip of bottom trawling samplings is conducted to understand current situation of fish. The description of marine ecological monitoring items and monitoring methodologies are described as follows.

The Wind Farm is located in the sea waters off the coast of Changhua Coastal Industrial Park. The local sea waters are relatively flat with slightly undulating sandy mud sediment; therefore, bottom trawling was adopted as the primary mode of operation. Since the bottom trawling fishing gear is non-selective, thus enable a more detailed understanding of the local fishery resources. In addition, based on past literature and survey data and local environmental characteristics, the local bottom trawling catch may also include surface fish species, and since the location of offshore wind turbines have now been moved to 3 nautical miles offshore where trawling is forbidden, sampling for the Project was thus conducted primarily by gillnetting. The experiment was conducted by renting gillnetting vessels around the sea water of wind farm (i.e. near the designated wind turbine site). No.21 Wind Farm conducted gillnet sampling at T1 (water depth: approximately 38.7m), T2 (water depth: approximately 36.6m), T3 (water depth: approximately 39.1m) (Figure 6.3.2-2), respectively, while No.15 Wind Farm conducted gillnet sampling at T1 (water depth: approximately 35~36m), T2 (water depth: approximately 36~37m), T3 (water depth: approximately 31~34m) (Figure 6.3.2-2), respectively. Gill nets were approximately 4m in height and approximately 6m in width with 7.5cm primary mesh and 2cm bottom mesh. Each gillnet survey line operated for about 30 minutes. The operative survey station was located by satellite positioning (GPS) and each latitude and longitude coordinates of the gillnetting operations were recorded (Table 6.3.2-4 and Table 6.3.2-5). The samples were frozen or refrigerated before fast delivered back to the laboratory for species identification and recording of body length range, quantity and weight. The analysis of fish community structure was carried out by Primer 6 software package, which include diversity index (H') and evenness index (J'), in order as to understand the status of fish in those sea waters. In addition, the fish specimens and relevant information obtained via other fishing methods would also be verified by visiting fish markets or survey subjects at each Changhuo port from time to time in order to further assess the potential impact by wind power generation on fish in those sea waters. Furthermore, the foundation of wind farm will be standing on the sea with sandy mud sediment, which may create similar effects of artificial reefs; therefore, the economic effect and impact upon fishery brought by the future wind farm foundations were explored based on the survey data of artificial reefs in the nearby cities of Changhua.



(圖片來源:google earth)

Sampling Locations of No.21 Wind Farm



Sampling Locations of No.15 Wind Farm

Taken by google in 2016.

Remarks 1: Dotted line indicates fish sampling station (T1-T3); Remarks 2: Source from google earth

Figure 6.3.2-2 Sampling Location of Fish Survey and No.21 and 15 Wind Farm (Bottom Trawling)

(2) Fish Egg and Juvenile Fish

This project was carried out by based on the “Marine zooplankton detection method” (NIEA E701.20C) announced by EPA. Each station carried out sampling by North Pacific Standard net (NORPAC net; mesh size: 0.33 mm × 0.33 mm; mesh length: 180 cm, mesh diameter: 45 cm) with flow meter (HYDRO-BIOS, Germany-made machinery-type digital flow meter) attached to detect the amount of filtered water.

Horizontal trawling refers to the tail trawling carried out at a low speed of below 3 nautical miles at the water depth of less than 7 meters with the trawl net mouth kept below water surface during the trawling process. After sampling, samples were cleaned in bottles to filter the seawater; and after the plankton was washed into the sample jar, a final concentration of 95% alcohol was immediately added into the sample jar and refrigerated prior to be carried back to the laboratory for analysis.

Table 6.3.2-4 Sampling Station, Methods, Water Depths, GPS and Dates of No.21 Wind Farm

測線	採樣深度	TWD97座標(下網)	TWD97座標(起網)	採樣日期
拖網測線T1	38.7m	2673539.593 167181.415	2677127.608 169540.719	2016.3.3
拖網測線T2	36.6m	2677314.441 168502.130	2680850.069 164346.229	2016.3.3
拖網測線T3	39.1m	2680958.857 164673.602	2680921.915 159902.954	2016.3.3

Table 6.3.2-5 Sampling Station, Methods, Water Depths, GPS and Dates of No.15 Wind Farm

測線	採樣深度	TWD97 (下網)	TWD97 (起網)	採樣距離	採樣日期	採樣日期	採樣日期
拖網測線T1	35-36m	2675583.334 152326.163	2671060.698 149110.231	4KM	2016.5.27	2016.7.20	2016.10.1
拖網測線T2	36-37m	2675963.266 144626.697	2672292.657 142717.484	4KM	2016.5.27	2016.7.20	2016.10.1
拖網測線T3	31-33m	2676215.894 139087.376	2672231.444 136103.610	4KM	2016.5.27	2016.7.20	2016.10.1

Biological samples collected at each station were sent to the laboratory, and the roe and fish larvae were manually picked out and placed under dissecting microscope (model no.: Carl Zeiss stereo Discovery V8) for morphological identification, classification, counting and photographing in order to identify as far as possible down to the lowest classification level. Morphological classification of roe mainly referenced to the literatures written by Muneo Okiyama (1988), Ahlstrom and Moser (1980) and Mito (1961) to classify based on shape of the egg, egg diameter, characteristics of the egg membrane, embryo characteristics (existence of embryo body, embryo shape, head shape and distribution pattern of chromosomes) and the distribution of oil globules. Morphological classification of fish larvae mainly referenced to the literatures written by Wong (1987), Muneo Okiyama (1988) and Chiu (1999) to classify based on body shape, body proportions, anal position, the intestinal form, gill cover spine and supraorbital spine, special surface structure (existence of Illuminator or hard bone plate), and the distribution location and distribution pattern of pigment cell. After the external morphological classification, one sample was randomly selected from each morphological form to identify barcode of life. If the quantity of this type is a lot or rather difficult to identify, one or two samples would be selected for DNA extraction, polymerase chain reaction (PCR) and sequencing. The Project selected approximately 650 base pairs of the COI gene from the mitochondrion DNA as the bases for comparison and followed the procedures and cell identification methods specified by Ko et al (2013). After the species was identified, the number of roe and fish larvae was divided by the drainage volume of the corresponding netting to convert into standardized data of abundance (number of individuals / 100 m3).

6. Fishery Resources

The main purpose of the Project is to understand the fishery production activities of fishermen in Changhua area and to conduct economic analysis on the fishing community, fishing culture and fishermen livelihood activities. Various data of Changhua sea waters such as fishing period, fishing ground, types of catches and sailing condition of the fishing vessels, plus data from in-situ testing, questionnaire surveys, fishing vessel entry/exit record of the fishing port security checkpoint, coupled with Fisheries Statistical Yearbook data and local fish catches statistics were all collected, aggregated and analyzed. The survey data were analyzed statistically according to the fish species, month and year; and the fishery types and value of the catches of the survey subjects were statistically recorded each month for the purposes of comprehensive analysis. Random visits to the two major fish markets (Changhua Fish Market and Puxin Fish Market) in Changhua County were carried out to understand the situation and to collect data of fish species; the types, yield and output value of cultivated species within Changhua County and coastal areas were collected to analyze and compare the potential impact on cultivated species by this development and application.

(ii) Index Analysis

1. Shannon-Wiener's Diversity Index

H'The higher the value means the higher the degree of species diversity.

$H' = -\Sigma P_i \times \ln P_i \quad = -\Sigma\ (ni/N) \times \ln\ (ni/N)$

P_i：Proportion of species 'i' in the total number of species in the community.

Ni：The number of individuals in species 'i'.

N：The total number of individuals in the community.

2. Pielou evenness index J

J' The higher the value means the more evenly distributed the species and individual quantity

$J' = H'/\ln S$

S: the number of species recorded in each community

IV. Survey Results

(i) Phytoplankton

1. Composition of Species

From No.21 wind field investigation, phytoplankton from 6 Phylum, 46 Genus and 51 Species were found (Table 6.3.2-6 and Figure 6.3.2-3), The recorded species included 1 species of Cyanobacteria from 1 genus; 2 species of Euglenozoa from 2 genera; 7 species of Dinoflagellata from 7 genera; 1 species of Haptophyta from 1 genus; 14 species of Heterokontophyta from 13 Genera; and 26 species of Phaeophyceae from 22 genera.

The number of species between different sampling points varied from 26 to 41, with the degree of abundance ranging from 148,403~392,760 cells/L, Station #21-5 yield the most number of species. The water depth and abundance of each survey station ranged from 21,465~109,080 cells/L, of which survey station #21-5 yield the highest in abundance under surface water. The abundance of each water layer ranged from 685,817~776,853 cells/L, of which the bottom layer yield the highest in abundance.

From Q1 No.15 wind field investigation, phytoplankton from 5 Phylum, 40 Genus and 52 Species were found (Table 6.3.2-7 and Figure 6.3.2-4), The recorded species included 3 species of Cyanobacteria from 2 genera; 9 species of Dinoflagellata from 5 genera; 1 species of Haptophyta from 1 genus; 13 species of Heterokontophyta from 13 Genera; and 26 species of Phaeophyceae from 19 genera.

The number of species between different sampling points and water depths varied from 7 to 32. Sampling point 15-11, with water depth of 3 meters obtained the most number of species. The degree of abundance for different water sampling points and sampling layer depths ranged from 42,840 ~ 188,676 cells/L, 3 meters under water at survey station #15-5 yield the highest in abundance.

From Q2 No.15 wind field investigation, phytoplankton from 6 Phylum, 51 Genus and 68 Species were found (Table 6.3.2-8 and Figure 6.3.2-5), The recorded species included 1 species of Cyanobacteria from 1 genus; 1 species of Euglenozoa from 1 genus; 10 species of Dinoflagellata from 6 genera; 1 species of Haptophyta from 1 genus; 27 species of Heterokontophyta from 21 Genera; and 28 species of Phaeophyceae from 21 genera.

The number of species between different sampling points and water depths varied from 9 to 27. Sampling point N15-5, with water depth of 10 meters obtained the most number of species. The degree of abundance for different water sampling points and sampling layer depths ranged from 12,540 ~ 117,000 cells/L. Sampling point N15-12 (bottom water layer) exhibited the highest degree of abundance.

From Q3 No.15 wind field investigation, phytoplankton from 5 Phylum, 52 Genus and 71 Species were found (Table 6.3.2-9 and Figure 6.3.2-5), The recorded species included 2 species of Cyanobacteria from 1 genus; 11 species of Dinoflagellata from 7 genera; 1 species of Haptophyta from 1 genus; 28 species of Heterokontophyta from 21 Genera; and 29 species of Phaeophyceae from 22 genera.

The number of species between different sampling points and water depths varied from 9 to 18. Sampling point 15-11 (top water layer) obtained the most number of species. The degree of abundance for different water sampling points and sampling layer depths ranged from 8,100 ~ 18,144 cells/L. Sampling point 15-1 (top water layer) exhibited the highest degree of abundance.

A total of 49 species of phytoplankton from 42 genera under 5 phyla were found at survey station #15 from 4th quarter survey result. The recorded species included 3 species of Cyanobacteria from 2 genera; 8 species of Dinoflagellata from 7 genera; 1 species of Haptophyta from 1 genus; 12 species of Heterokontophyta from 11 Genera; and 25 species of Phaeophyceae from 21 genera.

8~28 species were dwelling in various water layers at each survey station, of which surface water at survey station N15-9 yield the most number of species. The abundance at various water layers at each survey station ranged from 4,572 ~ 34,200 cells/L, of which 3 meters under water at survey station #15-3 yield the highest in abundance.

A total of 49 species of phytoplankton from 36 genera under 4 phyla (Table

6.3.2-11) were found from supplement survey result conducted at Lunwei District for the common corridor of Great Changhua offshore wind power generation.The recorded species included 3 species of Cyanobacteria from 2 genera; 5 species of Dinoflagellata from 3 genera; 21 species of Heterokontophyta from 17 Genera; and 20 species of Phaeophyceae from 14 genera.

8~24 species were dwelling in various water layers at each survey station, of which 10 meters under water at survey station M-N2 yield the most number of species. The abundance at various water layers at each survey station ranged from 9,524 ~ 154,404 cells/L, of which 10 meters under water at survey station M-N2 yield the highest in abundance.

2. Dominance Analysis

This quarter's survey records of No.21 Wind Farm showed that Campylosira sp. of Chaetoceros genus was relatively highest in abundance (25.85%), followed by Thalassiosira spp. of Coscinodiscus genus (13.64%), followed by Trichodesmium erythraeum of Trichodesmium genus (10.95%), which indicated that these 3 species were relatively highest in abundance in the Project. In addition, Thalassiosira spp. of Coscinodiscus genus showed the highest frequency of occurrence (100.00%), which indicated that this species was relatively common in the Project.

The 1st quarter survey records of No.15 Wind Farm showed that Trichodesmium spp. of Trichodesmium genus was relatively highest in abundance (44.15%), followed by Campylosira spp. of Chaetoceros genus (23.39%), followed by Trichodesmium erythraeum of Trichodesmium genus (6.20%), which indicated that these 3 species were relatively highest in abundance in the Project. In addition, Trichodesmium erythraeum of Trichodesmium genus and Campylosira spp. of Chaetoceros genus showed the highest frequency of occurrence (100.00%), which indicated that these two species were relatively common in the Project.

The 2nd quarter survey records of No.15 Wind Farm showed that Chaetoceros spp. of Chaetoceros genus was relatively highest in abundance (39.73%), followed by Chaetoceros curvisetus of Chaetoceros genus (11.95%), while the remaining all yield abundance of less than 10%, which indicated that these 2 species were relatively highest in abundance in the Project. In addition, Chaetoceros spp. of Chaetoceros genus showed the highest frequency of occurrence in every water layer at every survey station, which indicated that this species was relatively common in this survey.

The 3rd quarter survey records of No.15 Wind Farm showed that Chaetoceros spp. of Chaetoceros genus was relatively highest in abundance (29.18%), followed by Chaetoceros curvisetus of Chaetoceros genus (18.75%), while the remaining all yield abundance of less than 10%, which indicated that these 2 species were relatively highest in abundance in the Project. In addition, Chaetoceros spp. and Chaetoceros curvisetus of Chaetoceros genus showed the highest frequency of occurrence in every water layer at every survey station, which indicated that these two species were relatively common in this survey.

The 4th quarter survey records of No.15 Wind Farm showed that Nitzschia spp. of Nitzschia genus was relatively highest in abundance (29.78%), followed by Thalassiosira spp. of Coscinodiscus genus (19.69%), followed by Chaetoceros spp. of Chaetoceros genus (18.82%), which indicated that these 3 species were relatively highest in abundance in the Project. In addition, Nitzschia spp.of Nitzschia genus and Chaetoceros spp. of Chaetoceros genus showed the highest frequency of occurrence in every water layer at every survey station, which indicated that these two species were relatively common in this survey.

The supplement survey result conducted at Lunwei District for the common corridor of Great Changhua offshore wind power generation showed that Trichodesmium erythraeum of Trichodesmium genus was relatively highest in abundance (25.79%), followed by Nitzschia spp. of Nitzschia genus (25.01%), followed by Trichodesmium spp. of Trichodesmium genus (11.33%), which indicated that these 3 species were relatively highest in abundance in the Project. In addition, Thalassionema nitzschioides of Thalassionema genus and Thalassiosira spp. of Coscinodiscus genus showed the highest frequency of occurrence in every water layer at every survey station, which indicated that these two species were relatively common in this survey.

3. Diversity Index Analysis

The diversity index of phytoplankton observed from sampling points of No. 21 wind field ranged from 0.94 to 2.87. The uniformity index ranged from 0.45 to 0.87, The result showed that, the evenness index was relatively low at the surface layer of survey station #21-2, because Thalassiosira spp. of Coscinodiscus genus was high in abundance (see Figure 6.3.2-3).

The diversity index of phytoplankton observed from sampling points of No. 15 wind field in Q1 ranged from 0.69 to 2.40. The uniformity index ranged from 0.27 to 0.74, The result showed that, the evenness index was relatively low at some of the survey stations, because Trichodesmium erythraeum and Trichodesmium spp. of Trichodesmium genus or Chaetoceros spp. of Chaetoceros genus were high in abundance (see Figure 6.3.2-4).

The diversity index of phytoplankton observed from sampling points of No. 15 wind field in Q2 ranged from 1.01 to 2.29. The uniformity index ranged from 0.46 to 0.80, The result showed that, the evenness index was relatively low at some of the survey stations, because Chaetoceros spp. and Chaetoceros curvisetus of Chaetoceros genus were high in abundance (see Figure 6.3.2-5).

The diversity index of phytoplankton observed from sampling points of No. 15 wind field in Q3 ranged from 1.24 to 2.44. The uniformity index ranged from 0.52 to 0.91, The result showed that, the evenness index was relatively low at some of the survey stations, because Chaetoceros spp. and Chaetoceros curvisetus of Chaetoceros genus were high in abundance (see Figure 6.3.2-5).

The 4th quarter survey of No.15 Wind Farm showed that the diversity of phytoplankton species at each survey station was between 1.32~2.49, and the evenness was between 0.57~0.91. The result showed that species recorded in some of the water layer of 25 meters below water at station #15-1 was relatively less than that of the other survey station, thus, the diversity index was relatively low.

The supplementary survey result conducted at Lunwei District for the common corridor of Great Changhua offshore wind power generation showed that the diversity of phytoplankton species at each survey station was between 0.92~2.15, and the evenness was between 0.33~0.85. The result showed that, the evenness index was relatively low, because Trichodesmium erythraeum of of Trichodesmium genus was high in abundance at surface water layer of survey station M-N2 (see Figure 6.3.2-9).

4. Chlorophyll a concentration

The No.21 Wind Farm survey result showed that the chlorophyll ‘a’ concentration in every water layer at every survey station was between 0.10~0.69 μg/L. The results showed that the water layer of 10 meters below water at survey station #21-1 and the water layer of 10 meters below water at survey station #21-7 yield the lowest chlorophyll ‘a’ concentration, while the water layer of 10 meters below water at survey station #21-2 yield the highest concentration in chlorophyll ‘a’ concentration (see Figure 6.3.2-6).

The 1st quarter survey of No.15 Wind Farm showed that the chlorophyll ‘a’ concentration in every water layer at every survey station was between 0.02~0.47 μg/L. The results showed that the water layer of 3 meters below water and bottom layer at survey station #15-1, the water layer of 25 meters below water at survey station #15-2, the water layer of 10 meters below water at survey station #15-3, and the water layer of 3 meters below water at survey station #15-12 yield the lowest chlorophyll ‘a’ concentration, while the water layer of 25 meters below water at survey station #15-5 yield the highest concentration in chlorophyll ‘a’ concentration (see Figure 6.3.2-7).

The 2nd quarter survey of No.15 Wind Farm showed that the chlorophyll ‘a’ concentration in every water layer at every survey station was between 0.09~1.03 μg/L. The results showed that the surface water layer at survey station N15-10 yield the lowest chlorophyll ‘a’ concentration, while the bottom water layer at survey station N15-12 yield the highest concentration in chlorophyll ‘a’ concentration (see Figure 6.3.2-8).

The 3rd quarter survey of No.15 Wind Farm showed that the chlorophyll ‘a’ concentration in every water layer at every survey station was between 0.06~0.14 μg/L. The results showed that the water layer of 3 meters below water at survey station #15-3, the water layer of 10 meters below water at survey station #15-3, the surface water layer at survey station #15-6, the water layer of 3 meters below water at survey station #15-7, the bottom water layer at survey station N15-9 and the bottom water layer at survey station N15-10 yield the lowest chlorophyll ‘a’ concentration, while the surface water layer at survey station N15-9 yield the highest concentration in chlorophyll ‘a’ concentration (see Figure 6.3.2-8).

The 4th quarter survey of No.15 Wind Farm showed that the chlorophyll ‘a’ concentration in every water layer at every survey station was between 0.04~0.36 μg/L. The results showed that the water layer of 3 meters below water at survey station N15-10 yield the lowest chlorophyll ‘a’ concentration, while the water layer of 3 meters below water at survey station #15-2 yield the highest concentration in chlorophyll ‘a’ concentration.

The supplement survey result conducted at Lunwei District for the common corridor of Great Changhua offshore wind power generation showed that the chlorophyll ‘a’ concentration in every water layer at every survey station was between 0.04~0.14 μg/L. The results showed that the bottom water layer at survey station M-N1 and the surface water layer at survey station M-N2 yield the lowest chlorophyll ‘a’ concentration, while the bottom water layer at survey station M-N3 yield the highest concentration in chlorophyll ‘a’ concentration (see Figure 6.3.2-9).

5. Primary Productivity

The No.21 Wind Farm survey result showed that primary productivity in every water layer at every survey station was between 0.75~34.40 μgC/L/d. The results showed that the water layer of 10 meters below water at survey station #21-1 yield the highest primary productivity, while the water layer of 10 meters below water at survey station #21-2 yield the in lowest primary productivity (see Figure 6.3.2-6).

The 1st quarter survey of No.15 Wind Farm showed that primary productivity in every water layer was between 0.37~26.07 μgC/L/d. The results showed that the water layer of 3 meters below water at survey station #15-1, the water layer of 25 meters below water at survey station #15-2, the water layer of 10 meters below water at survey station #15-3, the water layer of 3 meters below water and bottom layer at survey station #15-12 yield the lowest primary productivity, while the water layer of 25 meters below water at survey station #15-5 yield the in highest primary productivity.

The 2nd quarter survey of No.15 Wind Farm showed that primary productivity in every water layer was between 3.03~70.28 μgC/L/d. The results showed that the surface water layer at survey station N15-10 yield the lowest primary productivity, while the bottom water layer at survey station N15-12 yield the in highest primary productivity.

The 3rd quarter survey of No.15 Wind Farm showed that primary productivity in every water layer was between 1.89~5.36 μgC/L/d. The results showed that the water layer of 3 meters below water at survey station #15-3, the water layer of 10 meters below water at survey station #15-3, the surface water layer at survey station #15-6, the water layer of 3 meters below water at survey station #15-7, the bottom layer at survey station N15-9 and the bottom layer at survey station N15-10 yield the lowest primary productivity, while the surface water layer at survey station N15-9 yield the in highest primary productivity.

The 4th quarter survey of No.15 Wind Farm showed that primary productivity in every water layer at every survey station was between 1.24~18.31 μgC/L/d. The results showed that the water layer of 3 meters below water at survey station N15-10 yield the lowest primary productivity, while the water layer of 3 meters below water at survey station #15-2 yield the in highest primary productivity.

In the Changhua Offshore Wind Power Generation, the supplementary survey records of the Lunwei District for the common corridors showed that the basic productivity of each station and each water layer is between 1.19 and 5.74 μgC/L/d. This result indicates that the base productivity of the bottom layer of the M-N1 is the highest, and the base productivity of the bottom layer of the M-N1 is the lowest (Fig. 6.3.2-9).

Table 6.3.2-6 Resources Table of Marine Plankton and Algae at No.21 Wind Farm (1/2)

Phylum	Genus	Scientifc Name	21-1					21-2					21-3					21-4					21-5					21-6				
			0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom
Cyanophyta	Trichodesmium	*Trichodesmium erythraeum*	12,960	17,280	1,440	9,720	16,200	25,715					9,000	15,480	7,200	4,680	1,080	7,560	15,480	9,360	12,240	17,280	15,480	11,160	4,680	13,320	720	3,960	13,680	2,160	8,280	16,200
Euglenophyta	Euglena	*Euglena* sp.																														
	Dinoflagellate	*Eutreptia* sp.	360	360	360		360							360		360	360	360	360	360			360			360		360			360	
Dinophyta	Peridiniales	*Peridinium* spp.	360	360		360			480			225								360		360		360	360	360	360					
	Oxytoxum challengeroides	*Oxytoxum scolopax*																														
	Ceratium	*Ceratium* sp.																														
	Pyrophacus horologicum	*Pyrophacus* sp.							48																							
	Prorocentrales	*Prorocentrum dentatum*		360	360	360			480				360		360	360	360	360			360	360		360		360	360			360	360	360
	Goniaulax	*Gonyaulax* sp.	360			360	360														360		360							360		360
	Gymnodinium	*Gyrodinium* sp.										90																				
Haptophyta	Chlorella	*Umbilicosphaera* sp.	360		360											360	360	360	360	360		360	360						360		360	360
Bacillariophyta	Achnanthes	*Achnanthes* sp.			360	360					515							360	360		360			360					360	360	360	
	Pinnularia	*Pinnularia interrupta*										225																				
	Navicula Pelagica	*Navicula* spp.	1,080		360	720		515	480		515	225	1,080		360		1,080	1,080	720	360	720	1,440		720	360	1,440	720	720		360	360	360
	Bacillariophyceae	*Bacillaria paradoxa*		1,440	1,080	360	1,080					1,800		360	360	1,080	720			360	1,440	720	1,080	1,080		720	720	720	360	360	360	360
	Asterionella	*Asterionella japonica*		360	360									360	360	360				360		360		360								360
	Thalassionema Nitzschioides	*Thalassionema nitzschioides*	1,080	720			1,080			515	515	900	1,440	1,080	1,440	1,080		720	1,440	1,080				720	1,440	360	1,440		720	720	1,440	720
	Fragilaria sp.	*Fragilaria* sp.	360	360												360		360			360	360		360	360	360	360				360	360
	Pleurosigma	*Pleurosigma* spp.	360	360			360			515	258	450						360	360	360		360		360	360	360				360		360
	Nitzschia	*Nitzschia panduriformis*		360	360		360							360							360		360	360			360	360		360	360	360
		Nitzschia spp.	12,600	5,040	2,880	11,520	13,680			1,029	1,543	225	5,040	13,320		3,600	11,880	11,520	1,440	360	4,680	7,200	12,240	7,560	4,320	11,880	13,680	10,800	12,240		6,120	6,840
	Cymbella	*Cymbella* sp.																														
	Pleurosigma	*Raphoneis amphiceros*	360		360	360						450	360	360		360	360			360			360	360	360			360		360	360	360
	Pleurosigma	*Diploneis bombus*							480					360	360	360	360		360				360	360		360		360	360	360		360
	Amphiprora	*Amphiprora alata*																														
Phaeophyceae	Dactyliosolen	*Dactyliosolen* sp.	1,440		5,760	5,760	3,600						3,240	360	5,400	720	2,880	3,600	3,960	5,400		5,040	5,400	3,600	2,520	3,960	4,680	4,320	360		5,040	3,240
	Dictyocha	*Dictyocha fibula*	360											360		360		360		360	360	360	360	360			360	360	360			
	Distephanus	*Distephanus speculum*		720	360	720	360								720	360	720	720	720	720	360	360					360			720	360	720
	Hemiaulus	*Hemiaulus* sp.	360	1,080	1,080	360	360						720	360	360	1,080		1,080	360	360	720		1,080	720	720	360	1,080	720	1,080	720	360	
	Lauderia	*Lauderia* sp.	360	2,520	720	720	720							720	2,160	2,160			360		720	360	2,160	2,520	1,800	1,080	2,160		1,800	2,520	2,160	2,520
	Paralia	*Paralia sulcata*	1,080	2,880		2,160	1,080	1,543	7,200	2,058		1,350	3,960	5,040	2,880	1,800	1,800	4,680	5,040	1,080	3,600	3,600	5,400	3,960	2,160		1,800	2,880	2,520	5,040	5,400	
	Microchaete	*Corethron hystrix*	360	360	360						515		720		720		360	720	360	360			360			360	720		720	720	720	360
	Coscinodiscus curvatulus	Thalassiosira *spp.*	2,520	14,040	10,800	9,360	9,720	20,058	9,600	18,000	14,915	12,150	13,680	5,760	6,840	4,680	4,680	5,040	1,440	4,680	12,240	4,320	13,680	6,480	8,280	2,520	7,560	360	9,000	9,720	6,840	11,520
	Chaetoceros	*Chaetoceros curvisetus*	2,160		720	360	2,520						3,600	3,240	2,160	1,080	2,520	3,240	720	360	3,240		3,240	2,880	2,880	720	360	1,440	2,520	1,440	2,160	3,240
		Chaetoceros spp.	8,280	30,600	31,320	11,160	10,080	3,600	2,880		2,058	1,800	6,840	22,680	9,000	24,120	28,800	29,520	16,200	23,040	27,720	16,200	26,640	20,520	27,000	32,040	10,440	2,880	13,680	15,480	8,640	3,960
	Melosira	*Melosira varians*	360										360			360						360	360	360	360		360	360			360	
	Stephanopyxis	*Stephanopyxis* sp.	360		360								360				360		360		360	360	360	360		360		360		360		360
	Rhizosolenia robusta	*Rhizosolenia* spp.		720	360	1,800	2,880			515	1,543		3,240	2,160	2,880	4,680	1,800	720	360	720	1,080	4,320	1,080	720	360	360	3,960	2,520	3,600	3,960	4,680	4,680
	Skeletonema	*Skeletonema costatum*	1,080	3,600	3,240	360		1,543	960		1,543		2,520	2,520	360	720	720	2,160			360	720	3,240	1,080	1,440	2,520	2,880	1,800	360	2,160		3,600
	Biddulphia biddulphiana	*Biddulphia longicruris*				360	360		240			450		360	360	360					360			360	360				360	360	360	360
		Biddulphia sinensis	360	360		360							360	360	360			360			360		360			360					360	360
		Biddulphia spp.								258																						
	Leptocylindrus	*Leptocylindrus* sp.		1,080	1,440	720	720						360		2,160	2,160	1,800	1,080	1,080			1,800	1,080	1,080	1,080	2,160		2,160	1,800	2,160		2,160
	Guinardia flaccida	*Guinardia* sp.	5,760	360	7,920	6,840	8,280						2,520	1,440	6,480	720	8,640	6,840	1,080	7,920	6,840	4,320	7,920	1,080	1,080	2,880	1,440	3,600	7,560	4,320	1,080	7,920
	Coscinodiscus	*Coscinodiscus* spp.	360		720	1,080	1,440	515	960		1,543	900	360	1,440			1,800	720	1,080	360	360		360		1,440	1,440	360	1,440	1,800	1,800	1,440	720
	bacteriastrum	*Bacteriastrum* spp.	360	2,520	1,800	1,080	720						1,080	2,880	1,800		2,160	360		2,880	2,160	1,080	2,520	720	360	360	1,800	1,800		1,800	360	2,160
	Actinocyclus	*Actinocyclus ehrenbergii*										225																				
	Actinoptychus capensis	*Actinoptychus* spp.			360	360				515				360	360		360	360		360	360		360				360					
	ditylum brightwellii	*Ditylum brightwellii*	360	720	1,080	1,080		258			515		360	720	360	720	720		1,080	1,080	360	360	720	360		720		360	720	720	1,080	360
	Eucampia	*Eucampia cornuta*	360		720		720							360		360	720		360					360	720	360		360		720	360	360
		Eucampia zoodiacus	360	1,800		1,440	1,440						1,800	1,440	1,080		1,080	360	1,800	1,800	1,440		1,440	1,800	1,800	1,080	360	360	1,800	360	360	1,440
Total			56,880	90,360	77,400	70,200	78,480	53,747	23,808	23,405	25,978	21,465	63,360	84,600	56,880	59,400	78,480	84,960	57,240	65,160	83,880	72,360	109,080	73,800	66,600	83,520	59,760	45,720	78,120	61,200	61,200	77,760
Chl a (μg/L)			0.24	0.19	0.10	0.16	0.24	0.69	0.47	0.69	0.27	0.33	0.50	0.39	0.39	0.45	0.39	0.53	0.53	0.19	0.33	0.63	0.39	0.33	0.39	0.41	0.33	0.33	0.25	0.41	0.35	0.12
Primary Productivity (μgC/L/d)			14.62	17.89	34.40	3.87	2.15	0.75	1.09	0.75	12.71	10.50	6.90	8.95	3.16	2.70	3.16	2.34	2.34	7.37	4.32	2.28	3.68	4.32	3.68	3.49	4.32	4.32	5.68	3.49	4.06	11.66
Diversity Index （*H'*）			2.45	2.20	2.24	2.55	2.43	1.22	1.62	0.94	1.62	1.68	2.61	2.39	2.69	2.36	2.33	2.36	2.31	2.27	2.29	2.39	2.51	2.59	2.29	2.21	2.56	2.72	2.47	2.67	2.76	2.72
Evenness Index（*J'*）			0.72	0.67	0.66	0.77	0.77	0.59	0.67	0.45	0.65	0.62	0.82	0.72	0.83	0.71	0.71	0.71	0.71	0.69	0.69	0.74	0.74	0.74	0.71	0.66	0.78	0.83	0.78	0.78	0.80	0.78

Table 6.3.2-6 Resources Table of Marine Plankton and Algae at No.21 Wind Farm (2/2)

Phylum	Genus	Scientific Name	21-7					21-8					21-9					21-10					21-11					21-12					RA(%)	OR(%)
			0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom		
Cyanophyta	Trichodesmium	*Trichodesmium erythraeum*	6,840	16,200	15,480	14,040	3,240						14,760	5,400	11,520	2,520	6,840											6,120	9,000	2,160	17,640	6,840	10.95	68.33
Euglenophyta	Euglena	*Euglena* sp.																			206												0.01	1.67
	Dinoflagellate	*Eutreptia* sp.	360						300	360			360		360		360													360			0.20	35.00
Dinophyta	Peridiniales	*Peridinium* spp.		360		360		180	300		240		360				360	360		515	515			328					360			360	0.23	40.00
	Oxytoxum challengeroides	*Oxytoxum scolopax*																	200														0.01	1.67
	Ceratium	*Ceratium* sp.																	80														0.00	1.67
	Pyrophacus horologicum	*Pyrophacus* sp.																															0.00	1.67
	Prorocentrales	*Prorocentrum dentatum*	360		360			360			300					360					412	655	600					360	360	360	360		0.30	48.33
	Goniaulax	*Gonyaulax* sp.	360									450	360	360		360	360											360		360			0.15	25.00
	Gymnodinium	*Gyrodinium* sp.									150											197											0.01	5.00
Haptophyta	Chlorella	*Umbilicosphaera* sp.				360							360				360			258				328				360	360				0.18	31.67
Bacillariophyta	Achnanthes	*Achnanthes* sp.	360	360	360	360	360		300				360	360			360												360		360	360	0.21	36.67
	Pinnularia	*Pinnularia interrupta*																															0.01	1.67
	Navicula Pelagica	*Navicula* spp.	720	1,440	1,440	1,440	1,440		150				720	1,440	1,080		360		800	515	2,058	655		655	655		600	720	1,440	1,080	720	720	0.98	75.00
	Bacillariophyceae	*Bacillaria paradoxa*			1,440	720	1,440						720	360	1,440	1,080	1,440												1,440	1,080	720	360	0.77	55.00
	Asterionella	*Asterionella japonica*		360	360	360								360	360		360							328		450		360		360	360	360	0.20	35.00
	Thalassionema Nitzschioides	*Thalassionema nitzschioides*	1,440		720		1,440	720	900	720	300	450	360	1,080	1,440	1,440		360	400	1,029			600	1,310	262	450	600	360	360	1,080	1,080	1,080	1.08	76.67
	Fragilaria sp.	*Fragilaria* sp.			360	360		288	300					360		360			120	52	515			328				360	360		360	360	0.23	43.33
	Pleurosigma	*Pleurosigma* spp.		360	360	360	360		300		300	360	360		360			360	80			655	600	262		450	600	360	360	360			0.34	56.67
	Nitzschia	*Nitzschia panduriformis*				360	360						360	360		360	360										600		360	360		360	0.22	36.67
		Nitzschia spp.	2,880	1,080	12,600	10,440	4,680	14,760	8,700	2,160	6,600	3,600	11,880	8,280	13,320	8,640	1,440	2,160	2,000	4,115	5,658	5,237	14,400	6,546	2,946	4,050	15,000	4,680	8,280	1,080	1,440	13,320	10.53	93.33
	Cymbella	*Cymbella* sp.																				328											0.01	1.67
	Pleurosigma	*Raphoneis amphiceros*					360									360					515	655						360	360	360			0.24	38.33
	Pleurosigma	*Diploneis bombus*	360				360						360	360							258					360		360		360			0.20	35.00
	Amphiprora	*Amphiprora alata*																				197											0.01	1.67
Phaeophyceae	Dactyliosolen	*Dactyliosolen* sp.	4,680	720	3,960	3,240	1,800	3,600	3,900	5,400	5,100	6,750	4,680	1,080	3,240	1,800	3,600											3,960	5,400	5,400	1,440	3,240	4.08	70.00
	Dictyocha	*Dictyocha fibula*		360							240					360					515								360	360	360	360	0.19	33.33
	Distephanus	*Distephanus speculum*		360	360	360	720		600							360			200	515					328		600		720	720	360	360	0.41	50.00
	Hemiaulus	*Hemiaulus* sp.		360	1,080	360	1,080	720	900	360			720	720	1,080	360			1,200	515			1,200	982	328	900	1,200	360		1,080	720	720	0.85	73.33
	Lauderia	*Lauderia* sp.	1,440		360	1,080	2,160		1,800	1,080	1,500	1,350		2,520	2,160	360	720	360			515	655		2,291		900	2,400			360			1.45	65.00
	Paralia	*Paralia sulcata*	360	3,600	4,320	360	4,680						2,880	2,880	1,080	720	5,400	5,400	800		2,058	2,291		655				3,960	4,680		3,960	2,160	3.58	75.00
	Microchaete	*Corethron hystrix*	360	360	360	720	360	360	300		600			720	720	360	360			258			600			225		720	360		720	360	0.47	60.00
	Coscinodiscus curvatulus	*Thalassiosira* spp.	4,320	9,000	11,160	2,880	11,880	7,920	2,700	6,120	2,400	7,650	2,880	7,920	2,520	3,240	11,520	10,800	3,600	7,715	6,686	14,400	17,400	4,255	8,182	13,500	10,800	12,960	11,520	13,320	13,680	8,280	13.64	100.00
	Chaetoceros	*Chaetoceros curvisetus*	1,800	2,880	3,240	2,880	720						2,880		1,080	3,240	3,240	1,440	800	1,543	2,572	1,310	4,200	3,273	1,637		1,800	720	3,600	1,080	360	1,800	2.53	76.67
		Chaetoceros spp.	3,600	28,440	20,160	23,400	5,760	15,840	17,100	12,600	15,000	27,450	5,400	4,680	18,360	29,520	12,600	11,160	16,000	8,743	21,600	15,710	30,000	29,128	15,382	10,800	30,000	1,800	20,880	6,840	22,680	22,320	25.85	98.33
	Melosira	*Melosira varians*	360	360			360	360							360	360	360												360	360	360	360	0.20	35.00
	Stephanopyxis	*Stephanopyxis* sp.												360	360						515							360	360	360	360		0.20	33.33
	Rhizosolenia robusta	*Rhizosolenia* spp.	3,600	4,680	4,680	1,080	1,080	1,440	300	360	300	225		1,080	720	3,960		3,600	800	515	2,572	4,582	7,800	2,291	328	450	600	2,160	3,960	4,680	1,440	1,080	3.09	90.00
	Skeletonema	*Skeletonema costatum*	2,880	1,440	1,800	3,240	3,600	1,440	900				1,080	1,080	2,880	3,600	1,800	1,800	800	2,058	1,543	6,546	4,800		2,619	1,350	1,200	1,080	1,800		720	1,080	2.52	81.67
	Biddulphia biddulphiana	*Biddulphia longicruris*	360		360		360	288		180	90		360		360	360	360												360	360	360	360	0.25	46.67
		Biddulphia sinensis	360	360			360				300	450	360			360				258				262								360	0.21	36.67
		Biddulphia spp.																	200		258	328											0.03	6.67
	Leptocylindrus	*Leptocylindrus* sp.	1,080	1,440	1,080	720	1,800	360				2,700	1,080	720	720	2,160	1,800						600	655	982			1,440	2,160	360	1,800	360	1.39	65.00
	Guinardia flaccida	*Guinardia* sp.	1,440	5,040	3,240	10,080	5,400	360			2,400		1,080	720	2,520	6,120	2,880	5,760	4,800	7,200			4,200	9,164	8,510	2,250	3,600	9,000	8,280	5,760	8,640	9,720	6.48	83.33
	Coscinodiscus	*Coscinodiscus* spp.	1,800	360		720		180	150	720			360	1,800		1,800	1,080	360	2,000	1,029	515	655	600	328	328	450		1,080		360	720	1,080	1.14	78.33
	bacteriastrum	*Bacteriastrum* spp.			1,800	1,800	1,440	720	300		300	1,350	2,160		1,800	1,440	1,440			4,115		5,237				2,250	600	1,800	2,160	1,800	2,520	360	1.82	70.00
	Actinocyclus	*Actinocyclus ehrenbergii*																															0.01	1.67
	Actinoptychus capensis	*Actinoptychus* spp.											360		360	360												360	360				0.16	26.67
	ditylum brightwellii	*Ditylum brightwellii*		1,080	1,080	360	360	360	240	720	300	450	1,080	360	720		1,080	360	400	1,029	515	1,310	600	982	328	450	600	720	1,080		360	360	0.86	83.33
	Eucampia	*Eucampia cornuta*	720	360	360	360	720	720	450				360		360		360		800									360	720				0.36	45.00
		Eucampia zoodiacus	1,080	360	720	1,440	1,440		150					1,440	1,440	1,800		1,800				1,310						1,440	720	720	720	1,440	1.19	63.33
Total			43,920	81,720	93,600	84,240	60,120	50,976	41,040	30,780	36,420	53,235	59,040	46,800	72,720	78,120	61,200	46,080	36,080	41,977	50,001	62,913	88,200	64,351	42,815	39,285	70,800	59,040	93,240	53,280	85,320	80,280		
Chl a (μg/L)			0.14	0.19	0.10	0.19	0.21	0.47	0.66	0.19	0.35	0.35	0.27	0.41	0.14	0.53	0.19	0.30	0.41	0.27	0.41	0.33	0.33	0.35	0.33	0.14	0.35	0.61	0.49	0.27	0.35	0.18		
Primary Productivity (μgC/L/d)			10.46	7.37	14.17	7.37	6.87	3.06	2.16	7.37	4.06	4.06	5.23	3.49	10.46	2.68	7.37	4.85	3.49	5.23	3.49	4.32	4.32	4.06	4.32	10.46	4.06	2.37	2.92	5.23	2.03	7.94		
Diversity Index （*H'*）			2.83	2.20	2.53	2.42	2.87	1.95	1.98	1.75	1.89	1.62	2.54	2.70	2.52	2.44	2.59	2.13	2.03	2.31	2.05	2.26	1.94	1.96	1.85	1.95	1.80	2.70	2.69	2.64	2.33	2.42		
Evenness Index（*J'*）			0.87	0.68	0.76	0.72	0.84	0.65	0.64	0.70	0.65	0.63	0.75	0.83	0.76	0.72	0.79	0.79	0.68	0.78	0.68	0.76	0.72	0.66	0.70	0.70	0.65	0.79	0.77	0.78	0.69	0.71		

Table 6.3.2-7 Resources Table of Marine Plankton and Algae at No.15 Wind Farm (1/2)

Phylum	Genus	Scientific Name	15-1					15-2					15-3					15-4				15-5					15-6				
			0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom
Cyanophyta	Trichodesmium	Trichodesmium erythraeum	2,000	10,800	6,000		3,600	3,858	4,000	6,546	6,000	3,000	6,667	3,858	15,429			5,539	12,375	3,600	7,500	23,226	25,200	10,800	12,000	3,600	9,360	3,600	7,560	6,480	7,920
		Trichodesmium spp.	36,000	54,000	42,000	32,000	32,400	28,286	34,000	36,000	28,800	39,000	32,000	30,858	41,143	10,286	12,858	30,462	63,000	30,600	60,000	104,517	126,000	115,200	111,000	37,800	51,120	43,920	51,120	45,720	44,280
	Richelia intracellularis	Richelia intracellularis						232			120	180							203	324							360			360	360
Dinophyta	Peridiniales	Peridinium spp.			600	400	720	515		328	240	600			258	515		277				465	1,440	1,440	1,500	1,080	720	1,800	360	720	360
	Oxytoxum challengeroides	Oxytoxum sp.									72												36							360	
	Ceratium	Ceratium furca																				47					360	360			360
		Ceratium fusus																													
		Ceratium sp.																				47					360				360
	Prorocentrales	Prorocentrum dentatum																				70						360		360	
		Prorocentrum micans																													
		Prorocentrum sp.			60			52	40																		360				
	Gymnodinium aerucyinosum Stein	Gymnodinium sp.	200																												
Haptophyta	Chlorella	Umbilicosphaera sp.				360																									
Bacillariophyta	Navicula Pelagica	Navicula spp.		360	900	1,200	1,800	772	800	328	960	1,500	800	1,029	1,029	1,543	1,029	1,108	450	1,440	900	930	720	1,080	150	720	1,800	360	1,080	720	360
	Rhabdonema adriaticum	Rhabdonema adriaticum														232		250												180	324
	Bacillariophyceae	Bacillaria paradoxa			600						1,200			772				1,108	450								1,080	720	720	360	360
	Asterionella	Asterionella japonica				4,000	2,880		800						772											1,440	360			360	
	Calothrix	Thalassiothrix sp.			300			258	400							258								360				360		360	360
	Thalassionema Nitzschioides	Thalassionema nitzschioides		360	1,800	1,200	360	1,029	3,600	2,946	1,440	600	534	772	515	2,315	1,029	554	1,800	360	300	930			1,500			360	360	1,080	720
	Fragilaria sp.	Fragilaria sp.																													
	Pleurosigma	Pleurosigma spp.		360		1,200	360									129	258	277	90	360									360	360	360
	Diatoma vulgare	Diatoma sp.																													
	Nitzschia	Nitzschia spp.	4,000	1,080	6,900	7,200	7,200	8,229	10,000	8,510	15,600	20,400	6,667	15,686	12,086	19,800	16,200	8,862	9,000	16,560	10,500	1,162	7,560	10,800	7,500	1,800	9,000	3,960	8,640	9,720	5,400
	Pleurosigma	Raphoneis amphiceros	200																23										108		180
	Pleurosigma	Diploneis bombus				200																									
	Amphiprora	Amphiprora alata																													
Phaeophyceae	Dictyocha	Dictyocha fibula			300								240								150			360	300		360		360		360
	Distephanus	Distephanus speculum							40	33																	360	360	360	360	360
	Hemiaulus	Hemiaulus sp.			300			515	400	1,637	720		267	515	258	258		277		360	900						360				360
	Lauderia	Lauderia sp.			600			515	7,200	1,964	960		800	258	2,058	3,600	2,572	1,662	3,600	4,320	2,100	1,626	3,960	1,800	1,800		1,800	1,800		2,160	1,800
	Microchaete	Corethron hystrix			60				800	328	24	300		258	772	258		831		360							360		360	360	
	Coscinodiscus curvatulus	Thalassiosira spp.	800	720			360	515	1,600	328	960		534	1,286	1,286	1,029		831	675	360	1,200	465		1,800	900	720			720	720	720
	Chaetoceros	Chaetoceros curvisetus			1,500			2,058	2,000	2,619	4,320	3,000	1,334	7,200	3,086	5,143	3,858	2,770	2,700		3,000		720				1,800	1,440	1,080	1,440	1,080
		Chaetoceros spp.	26,000	4,680	27,000	24,800	25,200	69,429	40,000	30,437	50,400	45,000	26,134	56,572	46,286	74,572	66,858	63,416	51,750	27,000	42,000	6,736	14,400	7,560	9,300	14,400	26,280	9,360	28,440	21,600	33,120
	Stephanopyxis	Stephanopyxis turris																						36			360	360			
	Asteromphalus	Asterolampra marylandica																													
	Rhizosolenia robusta	Rhizosolenia alata			300									258	258	515		277		720			360				360			360	360
		Rhizosolenia stolterfothii						1,029			1,440	600			515	2,058	772	2,216		2,880	900							720			1,080
		Rhizosolenia spp.	800	720	4,500	2,000	2,160	5,143	2,000	3,600	5,520	6,300	534	10,029	5,143	5,658	4,629	7,477	2,925	12,600	4,800	233	720	2,160	2,100	1,080	1,080	3,600	3,240	360	2,520
	Skeletonema	Skeletonema costatum	4,800	2,520	7,800	10,800	10,800	3,600		1,637	5,280			7,458	6,429	7,458	6,429	6,924	2,025	1,800	5,400	930		1,080		1,800	3,960	5,400	2,520	2,520	5,400
	Spirogyra	Climacodium biconcavum													26				45								360	360	360		360
		Climacodium frauenfeldianum													206				158											360	
	Biddulphia biddulphiana	Biddulphia mobiliensis																				117					360			360	
		Biddulphia rhombus																													
		Biddulphia spp.																							270			360	360	360	360
	Leptocylindrus	Leptocylindrus danicus				4,800	6,480							1,029	1,543	772	1,286	1,108	1,125	10,080	2,400	1,394		1,080			1,080	3,600	720	2,160	1,800
	Guinardia flaccida	Guinardia sp.																		360							360	360	360		
	Coscinodiscus	Coscinodiscus spp.											134				52							36		72		360	360		
	Campylosira cymbelliformis	Campylosira cymbelliformis			600																									360	360
	bacteriastrum	Bacteriastrum spp.	2,800	720	1,200			3,343	4,000	1,637	1,200	900	1,334	2,058	2,572	6,429	5,658	2,493	675	360	1,500	2,323	1,440		600	2,160	3,240	1,800	720	720	1,800
	Eucampia	Eucampia cornuta	2,400	720	5,700	7,600	5,400	6,429	8,000	4,255	6,000	7,800	800	5,143	7,715	9,000	6,686	12,185	6,750	7,920	6,000	2,555	5,400	3,240	1,800	3,600	4,680	360		4,320	2,520
		Eucampia zoodiacus				800		1,543	1,600		1,440			2,315	1,543	1,286	772	1,385	1,575	1,080	600	233	720				360	1,080			1,080
Total			80,000	77,040	109,020	98,560	99,720	137,350	121,280	103,133	132,696	129,180	78,779	147,354	150,928	153,114	130,946	152,289	161,394	123,444	150,150	148,006	188,676	158,832	150,720	70,272	122,400	87,120	110,268	105,660	117,144
Chl a (μg/L)			0.25	0.02	0.03	0.31	0.02	0.10	0.15	0.06	0.02	0.08	0.04	0.09	0.02	0.06	0.04	0.09	0.15	0.04	0.09	0.10	0.24	0.35	0.47	0.10	0.41	0.10	0.35	0.31	0.37
Primary Productivity (μgC/L/d)			14.00	212.94	106.47	1.99	31.31	4.98	3.51	8.60	212.94	45.87	80.59	40.30	75.16	20.63	28.44	14.22	8.42	33.19	16.59	13.95	6.02	4.08	3.05	13.95	3.49	13.95	4.08	4.65	3.90
Diversity Index （H'）			1.48	1.12	1.93	1.96	1.95	1.72	2.00	1.90	1.99	1.70	1.58	1.97	2.07	1.92	1.76	2.00	1.73	2.19	1.84	1.11	1.22	1.16	1.09	1.57	2.01	2.01	1.69	2.00	2.03
Evenness Index （J'）			0.62	0.45	0.63	0.72	0.74	0.57	0.68	0.67	0.65	0.64	0.58	0.67	0.66	0.62	0.64	0.64	0.57	0.72	0.64	0.38	0.46	0.42	0.41	0.61	0.60	0.62	0.54	0.59	0.59

Table 6.3.2-7 Resources Table of Marine Plankton and Algae at No.15 Wind Farm (2/2)

Phylum	Genus	Scientific Name	15-7					15-8					15-9					15-10					15-11					15-12					RA(%)	OR(%)
			0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom		
Cyanophyta	Trichodesmium	*Trichodesmium erythraeum*	13,847	19,800	3,600	6,924	3,600	21,334	3,600	5,334	5,400	1,800	9,000	3,600	4,680	11,520	1,800	9,000		5,400	12,600	3,600	2,520	2,520	3,600	8,640	8,640	360	3,240	3,960	360	1,440	6.20	96.67
		Trichodesmium spp.	105,231	72,000	34,200	36,000	46,800	120,000	63,000	72,000	43,200	31,320	46,800	32,040	29,160	30,240	52,560	72,000	30,858	55,800	54,000	79,200	23,040	23,760	29,160	41,760	29,880	30,960	18,000	29,520	28,440	29,520	44.15	100.00
	Richelia intracellularis	*Richelia intracellularis*		72								360			360	360	360							360	360	360	360				360		0.09	33.33
Dinophyta	Peridiniales	*Peridinium* spp.	277	1,440				1,600	1,080		1,800	720	720	360			720	772			360								720		720		0.40	60.00
	Oxytoxum challengeroides	*Oxytoxum* sp.			36			134		27		360				180				180		108	360	360	360	360							0.05	26.67
	Fucus vesiculosus	*Ceratium furca*													360	360	360									360							0.04	16.67
		Ceratium fusus		180																													0.00	3.33
		Ceratium sp.										360	360											360	360	360				360	360	360	0.06	20.00
	Prorocentrales	*Prorocentrum dentatum*										360								288													0.02	11.67
		Prorocentrum micans																			180			360	360			360		360	360	360	0.04	13.33
		Prorocentrum sp.		72	180						180			360		360				324	180		360										0.04	21.67
	Gymnodimium	*Gymnodinium* sp.																						360	360				360	360			0.03	11.67
Haptophyta	Chlorella	*Umbilicosphaera* sp.																												324			0.01	8.33
Bacillariophyta	Navicula Pelagica	*Navicula* spp.	831		1,080	554	540	800		1,067	1,440	360	1,080		360	360	720	1,286	1,029	1,800	1,440	1,800	720	360	360	720	720	1,080	360	720	360	720	0.77	96.67
	Rhabdonema adriaticum	*Rhabdonema adriaticum*										360											360					288					0.03	15.00
	Bacillariophyceae	*Bacillaria paradoxa*							360				720	360	720		720						360	360					360	360	360		0.19	36.67
	Asterionella	*Asterionella japonica*		720								360					360						360	360	1,080		360	720	360	1,080	1,440	720	0.29	35.00
	Microchaete	*Thalassiothrix* sp.		360			360			267			360	360	360				103		360		360	360			360	360			360		0.11	38.33
	Thalassionema Nitzschioides	*Thalassionema nitzschioides*			360	554			720	267			1,080	1,080		720	1,080	258		2,880		1,080	720	360		720	1,080	1,080	1,080		720	1,080	0.69	75.00
	Fragilaria sp.	*Fragilaria* sp.	56							27																							0.00	6.67
	Pleurosigma	*Pleurosigma* spp.	139	36	360											360							360		360	360		360	360		360		0.11	38.33
	Diatoma vulgare	*Diatoma* sp.						27																									0.00	5.00
	Nitzschia	*Nitzschia* spp.	831	2,160	7,560	5,816		1,334	5,760	5,867	7,200	6,480	2,520	6,840	3,960	5,040	9,000	2,572	1,029	3,240	2,880	5,400	8,640	2,160	2,520	7,920	2,520	1,800	2,160	2,160	2,880	2,880	6.18	100.00
	Raphoneis amphiceros	*Raphoneis amphiceros*			36							360		360		360							360	360	360		360	360	360			360	0.07	28.33
	Dunaliella salina.	*Diploneis bombus*																						360				180				180	0.01	10.00
	Amphipora alata (Her.) Kutzing	*Amphiprora alata*		36				134	324																								0.01	8.33
Phaeophyceae	Dictyocha	*Dictyocha fibula*									108						180	129									360			360			0.06	26.67
	Distephanus	*Distephanus speculum*										360			36											180				108			0.04	21.67
	Hemiaulus	*Hemiaulus* sp.		720							720	360	360	720		720	720						360	360	360	720	720		360			360	0.23	50.00
	Lauderia	*Lauderia* sp.	554	3,240	3,960	1,939	1,800	267				1,080	720	1,800		1,800	1,800			1,440			2,160	720	720	1,440	2,160	720	720		720		1.24	73.33
	Microchaete	*Corethron hystrix*				277							360			360	360						360	360			360		360		360	360	0.14	41.67
	Coscinodiscus	*Thalassiosira* spp.	277		720	554	1,080	1,334	1,080	267	1,080		360	360	1,080		720	1,543		1,080		720		360	360	360	720	360		360	360		0.53	76.67
	Chaetoceros	*Chaetoceros curvisetus*			2,160					1,334	1,800		1,800	1,080	2,520	3,600	2,880	1,286				720	2,160		360	1,800	3,240	720	360	360			1.27	65.00
		Chaetoceros spp.	4,154	17,640	36,000	15,785	16,200	3,200	18,720	14,934	20,160	38,880	29,160	34,920	30,960	32,040	37,440	15,429	8,229	3,240	6,480	22,320	14,760	6,480	3,600	22,680	21,600	9,000	7,560	7,920	5,760	6,840	23.39	100.00
	Stephanopyxis	*Stephanopyxis turris*											360	360		360	360									360	360						0.05	18.33
	Asteromphalus	*Asterolampra marylandica*																			36			360	360			360		360	360		0.03	13.33
	Rhizosolenia robusta	*Rhizosolenia alata*			360					267			360		360	360				360	360	360		360		360		360	360	360	360	360	0.14	45.00
		Rhizosolenia stolterfothii			720								1,080	720	720	720							720			1,080	360						0.32	33.33
		Rhizosolenia spp.	554	6,840	4,680	1,108	1,800	267	1,080	800	720	3,960	4,320	720	3,960	1,080	3,240	515		2,160	1,800	2,160	3,600	1,080	1,800	2,880	2,520	1,800	1,800	360	1,440	1,440	2.59	98.33
	Skeletonema	*Skeletonema costatum*			7,920	2,216	2,160		2,520	1,867	1,800	4,680	5,400	1,080		2,880	1,440	772	6,172		360	2,880	3,600	2,880			5,760	360	2,520	3,600	2,520	3,240	2.90	81.67
	Spirogyra	*Climacodium biconcavum*								240			360				288						360				360						0.05	21.67
		Climacodium frauenfeldianum										360											360	360	360	360	360						0.05	16.67
	Biddulphia biddulphiana	*Biddulphia mobiliensis*		288								360	216	360		360							360			360	360		360			360	0.07	25.00
		Biddulphia rhombus																		36				360	360						360	360	0.02	10.00
		Biddulphia spp.								267			360	180			360	258		144		360		360							360		0.07	25.00
	Leptocylindrus	*Leptocylindrus danicus*		7,560	2,160						1,800		2,160	2,880	1,440	3,600	3,600			1,440			1,080	2,160	2,160	1,080	3,600	720		720		1,080	1.29	60.00
	Guinardia flaccida	*Guinardia* sp.	277										360	360			360						360				360						0.06	20.00
	Coscinodiscus	*Coscinodiscus* spp.											72																				0.02	15.00
	Campylosira cymbelliformis	*Campylosira cymbelliformis*													360						360		360	360	360		360					360	0.06	20.00
	bacteriastrum	*Bacteriastrum* spp.		720	1,080	831	1,080	1,334		267		2,160	720	360	1,440	360	1,440	258			1,080	1,800	3,240	720	360	1,800	360	1,800	720	720	1,080	1,080	1.27	88.33
	Eucampia	*Eucampia cornuta*	277	6,480	7,200	2,493	3,600	3,200	4,320	6,934	5,400	5,040	5,040	4,320	1,800	5,400	1,440	5,143	5,143	5,400	6,840	5,400	1,800	2,160	2,160	3,960	2,160	2,160	360	1,800	720	1,440	4.02	100.00
		Eucampia zoodiacus		720	2,160		360			534			360	1,080	360	720	720	772			360	1,080	1,080	360		1,080	720	360		360	360		0.52	61.67
Total			**127,305**	**141,084**	**116,532**	**75,051**	**79,380**	**154,965**	**102,564**	**112,567**	**92,808**	**100,440**	**116,568**	**96,660**	**84,996**	**104,220**	**125,028**	**111,993**	**52,563**	**85,212**	**89,676**	**128,988**	**75,240**	**52,560**	**52,560**	**102,060**	**91,080**	**56,628**	**42,840**	**56,592**	**51,840**	**54,900**		
Chl a (μg/L)			0.06	0.09	0.04	0.09	0.10	0.21	0.10	0.27	0.35	0.25	0.31	0.06	0.10	0.18	0.37	0.31	0.08	0.11	0.12	0.41	0.10	0.04	0.04	0.21	0.16	0.06	0.02	0.06	0.03	0.02		
Primary Productivity (μgC/L/d)			24.07	16.59	33.19	16.59	13.95	6.98	13.95	5.41	4.08	5.76	4.65	24.07	13.95	8.02	3.90	4.65	18.89	13.20	12.04	3.49	13.95	33.19	33.19	6.98	8.83	24.07	87.68	24.07	21.92	87.68		
Diversity Index （*H'*）			0.69	1.68	2.05	1.65	1.39	0.86	1.33	1.35	1.73	1.81	2.00	1.89	1.81	2.08	1.84	1.33	1.25	1.45	1.44	1.42	2.40	2.26	1.90	2.00	2.24	1.82	2.10	1.85	1.92	1.86		
Evenness Index （*J'*）			0.27	0.56	0.67	0.64	0.56	0.33	0.54	0.46	0.64	0.59	0.59	0.59	0.60	0.64	0.56	0.48	0.64	0.51	0.51	0.51	0.71	0.65	0.59	0.61	0.66	0.57	0.68	0.59	0.59	0.60		

Remarks: RA represents (Relative Abundance,%), OR represents (Occurrence Rate, %).

Table 6.3.2-8 Resources Table of Marine Plankton and Algae at No.15 Wind Farm at Second Quarter of Survey (1/2)

Phylum	Genus	Scientific Name	15-1					15-2					15-3					15-4					N15-5					15-6				
			0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom
Cyanophyta	Trichodesmium	*Trichodesmium* spp.	7,200	1,500	3,000	5,400	3,600	1,800	3,000	9,000	3,600	1,080		600	6,000	2,572	3,858		3,300	655	3,600	2,520								9,000	5,400	3,240
Euglenophyta	Euglena	*Euglena* sp.							30	30																						
Dinophyta	Peridiniales	*Peridinium* spp.	360									360	300			258		300			360	360	300		300		360					
	Oxytoxum challengeroides	*Oxytoxum* sp.																														
	Ceratium	*Ceratium furca*																						30		36			30		36	
		Ceratium fusus																	30													
		Ceratium spp.		30			36			30	180	36		30	30	26						36		30		36	36					
	Prorocentrales	*Prorocentrum micans*																														
		Prorocentrum sp.																											30			36
	Peridiniales	*Protoperidinium* sp.																												30		36
	Pyrocystaceae	*Pyrocystis fusiformis*			30																											
		Pyrocystis noctiluca								30																						
Haptophyta	Chlorella	*Umbilicosphaera* sp.							30						30																	
Bacillariophyta	Achnanthes	*Achnanthes* sp.	36																													
	Pinnularia	*Pinnularia* sp.																														
	Navicula Pelagica	*Navicula cancellata*																														
		Navicula membranacea	216		300				150		180				300								300	450		144	180	150				
		Navicula spp.	144	300	600	720	360		750		720	360	300		300	515	258	300	300	328	180	360	300	750		720	360	750	300	300	540	360
	zonooidium	*Cocconeis* sp.																														
	Bacillariophyceae	*Bacillaria paradoxa*																														
	Asterionella	*Asterionella japonica*	360			720	360		3,000	3,000	1,440	720				258	772	1,500			720			900								
	Calothrix	*Thalassiothrix frauenfeldii*						36																								
		Thalassiothrix sp.	36			36			30																	360						
	Thalassionema Nitzschioides	*Thalassionema nitzschioides*	2,160	900	2,400	2,880	2,880	1,440	6,900	7,500	1,800	1,080		600	300	1,029	2,315	300	900				1,800	1,800	600	720	360	900	600		360	360
	Mastogloia	*Mastogloia* sp.			30																											
	Fragilaria sp.	*Fragilaria* sp.			30								30		30										30							
	Synedra	*Synedra ulna*			30																											
		Synedra sp.																										30				
	Pleurosigma	*Pleurosigma* spp.	360		150		360		30	300		360	30					30				36						30	300			360
	Campylodiscus brightwellii Grunow	*Striatella* sp.	36		30				150	120					30									60			36					
	Gomphonema parvulum (Kutz) Grum.	*Gomphonema* sp.											30										30	30								
	Nitzschia	*Nitzschia* spp.	8,640	3,000	9,600	5,400	5,040	720	8,400	6,600	5,760	5,040	5,100	7,500	8,400	3,858	4,115	3,900	2,700	1,637	3,240	2,880	4,500	2,700	1,200	2,520	3,960	1,500	5,400	300	360	1,080
	Gomphonema	*Licmophora abbreviata*	36		30				60																							
	Cymbella	*Cymbella affinis*																										30				
		Cymbella tumida		30																												
		Cymbella sp.																		33			30		30			30				
	Pleurosigma	*Raphoneis amphiceros*																														
	Amphora	*Amphora* sp.	36										30										30					30	30			
	Pleurosigma	*Diploneis bombus*											30																			
	Amphiprora	*Amphiprora alata*																	30													
Phaeophyceae	Cyclotella spp.	*Cyclotella* sp.																														

Phylum	Genus	Scientific Name	15-1					15-2					15-3					15-4					N15-5					15-6				
			0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom
	cosmarium	*Bellerochea* sp.			300	360				300		360											300									
	Microchaete	*Corethron hystrix*							30	30				30		26			30			36										
	Hemiaulus sinensis	*Hemiaulus indicus*											600		300			600	300		360	360										
		Hemiaulus sinensis																														
		Hemiaulus sp.	360	300		360			300	600		360	300	300	900	258			300		360		300	900		360						
	Coscinodiscus curvatulus	*Thalassiosira* spp.	2,880	600	3,000	2,520	1,440		8,100	1,200	5,760	5,400	1,500	1,500	1,200	3,086	2,315	900	600	328	2,160	1,080	3,900	3,900	600	1,440	1,800	1,800	900	900	720	1,080
	Chaetoceros	*Chaetoceros curvisetus*	7,200	1,500	4,200	3,600	2,880	5,400	13,500	6,900	3,600	4,320	1,500	4,500	1,500	1,543	1,286	2,100	2,400	1,637	1,800	720	2,400	1,800		2,160	1,080	1,500	2,700		2,520	1,080
		Chaetoceros spp.	29,880	10,500	21,000	13,680	15,120	17,280	33,600	36,000	20,880	16,560	9,000	13,500	6,600	6,686	5,143	8,400	9,000	6,546	7,920	6,120	18,000	14,400	10,800	9,360	7,200	11,400	15,000	9,600	8,640	7,200
	Melosira	*Melosira varians*																										30				
	Dactyliosolen fragilissima	*Dactyliosolen fragilissimus*		300			360	360		300		360					258	300	600										300			
	Asteromphalus	*Asterolampra* sp.			30							360																				
	Rhizosolenia robusta	*Rhizosolenia alata*		300					600						150						360	360		150								
		Rhizosolenia spp.	5,400	2,100	3,000	2,520	1,800	360	5,400	3,600	2,160	1,800	900	900	1,050	1,029	772	1,500	1,200	655	720	360	2,100	2,250	300	360	1,800		900	2,100	720	360
	Skeletonema	*Skeletonema costatum*			300				300			360					258										360			450	360	360
	Spirogyra	*Climacodium biconcavum*							150	30																						
	Biddulphia biddulphiana	*Biddulphia mobiliensis*		30	150	360	360																	30		360	360					
		Biddulphia spp.	36		30		360			30		360							30		360	360										
	Leptocylindrus	*Leptocylindrus danicus*					360		600				900			258	258				360											
	Lauderia borealis	*Lauderia* sp.	720				360				720	360						300	600		360			300			360	150	1,200		360	
	Guinardia flaccida	*Guinardia* sp.	36				36		30		360					258																
	Isochrysis	*Dictyocha fibula*	36			36				30	36				30		26				36											
	Coscinodiscus	*Coscinodiscus asteromphalus*		30		36									30					33		36										
		Coscinodiscus spp.	36		30	360		36	30	30														30		36	36		30		36	
	Campylosira cymbelliformis	*Campylosira cymbelliformis*																														
	bacteriastrum	*Bacteriastrum* spp.	720	300	900	720	360		2,700	1,500	720	360	5,700	1,500	2,400	1,286	258	1,800	1,200	655	360	1,080	2,100	600		720			900	300		
	Eucampia	*Eucampia cornuta*	5,040	4,200	6,300	1,440	2,520	720	9,000	3,600	4,320	3,600	600	600	3,000	2,058	258	2,400	3,600	982	1,440	1,080	1,500	3,900	600	2,160		900	5,400	600	720	1,440
		Eucampia zoodiacus			600	720			2,400	300	720	1,080			300	258	772				360	360					360					
Total			71,964	25,920	56,070	41,868	38,592	28,152	99,270	81,060	52,956	44,676	26,850	31,560	32,880	25,262	22,922	24,630	27,120	13,489	25,056	18,144	37,890	35,010	14,460	21,492	18,648	19,230	34,020	23,580	20,772	16,992
Chl a (μg/L)			0.51	0.22	0.39	0.25	0.22	0.22	0.74	0.57	0.39	0.35	0.19	0.22	0.19	0.15	0.13	0.18	0.21	0.10	0.19	0.12	0.25	0.25	0.12	0.18	0.14	0.16	0.13	0.13	0.15	0.10
Primary Productivity(μgC/L/d)			6.78	1.38	3.63	2.47	2.31	2.31	0.70	0.89	2.34	3.21	4.87	2.77	6.50	1.40	1.58	6.88	5.98	1.99	5.41	0.86	5.76	2.88	1.72	2.87	2.27	6.31	11.06	11.06	9.82	1.00
Species Diversity Index（*H'*）			1.96	1.94	2.03	2.20	2.09	1.26	2.20	1.93	2.07	2.20	1.92	1.66	2.14	2.29	2.22	2.12	2.16	1.70	2.27	2.16	1.82	2.04	1.01	1.94	1.93	1.48	1.77	1.42	1.72	1.85
Evenness Index（*J'*）			0.61	0.68	0.63	0.75	0.71	0.55	0.67	0.61	0.73	0.71	0.68	0.67	0.70	0.79	0.80	0.78	0.75	0.71	0.77	0.75	0.66	0.68	0.46	0.70	0.70	0.55	0.64	0.62	0.67	0.72

Table 6.3.2-8 Resources Table of Marine Plankton and Algae at No.15 Wind Farm at Second Quarter of Survey (2/2)

Phylum	Genus	Scientific Name	15-7					15-8					N15-9					N15-10					15-11					N15-12			RA(%)	OR(%)
			0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	Bottom		
Cyanophyta	Trichodesmium	*Trichodesmium* spp.	3,000				360	300	6,000		3,600	1,800			4,500	2,880	1,440			1,500	2,880	1,080		1,500	6,000	1,440			3,000		6.11	63.79
Euglenophyta	Euglena	*Euglena* sp.							30																						0.00	5.17
Dinophyta	Peridiniales	*Peridinium* spp.		150		180		300	300		360					360			150					300			360	300			0.30	34.48
	Oxytoxum challengeroides	*Oxytoxum* sp.																							30						0.00	1.72
	Ceratium	*Ceratium furca*				36									30	36	360														0.03	13.79
		Ceratium fusus																												40	0.00	3.45
		Ceratium spp.		30			36			30	36																				0.03	27.59
	Prorocentrales	*Prorocentrum micans*												150		360					360						360	300	300		0.09	10.34
		Prorocentrum sp.						300				360		150		360	360					360									0.10	13.79
	Peridiniales	*Protoperidinium* sp.																													0.00	3.45
	Pyrocystaceae	*Pyrocystis fusiformis*																													0.00	1.72
		Pyrocystis noctiluca																													0.00	1.72
Haptophyta	Chlorella	*Umbilicosphaera* sp.																													0.00	3.45
Bacillariophyta	Achnanthes	*Achnanthes* sp.																													0.00	1.72
	Pinnularia	*Pinnularia* sp.																		30								30			0.00	3.45
	Navicula Pelagica	*Navicula cancellata*																											150		0.01	1.72
		Navicula membranacea	300				360	150		150	360													30				150	300		0.21	31.03
		Navicula spp.	300	300		720	360	750	600	450	720	360	600	600	900	360		300	300	300	720	360	300			360	360	150	750		1.11	84.48
	zonooidium	*Cocconeis* sp.																											30		0.00	1.72
	Bacillariophyceae	*Bacillaria paradoxa*																						300							0.02	1.72
	Asterionella	*Asterionella japonica*																						900			1,440	900	4,800	8,400	1.52	29.31
	Calothrix	*Thalassiothrix frauenfeldii*																													0.00	1.72
		Thalassiothrix sp.																													0.02	6.90
	Thalassionema Nitzschioides	*Thalassionema nitzschioides*	300		300	360	720	300			1,080		300			360			300		1,080	360	600	600	1,200	360	1,440	4,200	5,400	2,000	3.23	75.86
	Mastogloia	*Mastogloia* sp.																													0.00	1.72
	Fragilaria sp.	*Fragilaria* sp.								30			30					30							30						0.01	13.79
	Synedra	*Synedra ulna*								30								30													0.00	5.17
		Synedra sp.													30																0.00	3.45
	Pleurosigma	*Pleurosigma* spp.																30	150									900	600	2,000	0.30	29.31
	Campylodiscus brightwellii Grunow	*Striatella* sp.								30				30					30										30		0.03	18.97
	Gomphonema parvulum (Kutz) Grum.	*Gomphonema* sp.						30										30													0.01	8.62
	Nitzschia	*Nitzschia* spp.	1,500	4,200	2,400	1,800	1,080	2,700	1,800	1,800	2,520	720	900	2,400	3,900	2,520	2,160	1,500		4,800	3,600	1,080	3,000	3,000	1,800	1,440	720	1,800	1,200	2,800	9.28	98.28
	Gomphonema	*Licmophora abbreviata*	30																30												0.01	8.62
	Cymbella	*Cymbella affinis*						60		30																					0.01	5.17
		Cymbella tumida						30																							0.00	3.45
		Cymbella sp.													30									30							0.01	10.34
	Pleurosigma	*Raphoneis amphiceros*												30				30	30									30	30		0.01	8.62
	Amphora	*Amphora* sp.			30			60										30											30	40	0.02	17.24
	Pleurosigma	*Diploneis bombus*																30	30												0.00	5.17
	Amphiprora	*Amphiprora alata*																											30		0.00	3.45
Phaeophyceae	Cyclotella spp.	*Cyclotella* sp.																										30		40	0.00	3.45

Phylum	Genus	Scientific Name	15-7					15-8					N15-9					N15-10					15-11					N15-12			RA(%)	OR(%)
			0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	Bottom		
	cosmarium	*Bellerochea* sp.						300			360																	300			0.13	13.79
	Microchaete	*Corethron hystrix*						30				36											30	30							0.02	17.24
	Hemiaulus sinensis	*Hemiaulus indicus*		600	600	360	360																								0.22	17.24
		Hemiaulus sinensis																							300		360				0.03	3.45
		Hemiaulus sp.		600			360													600				150	600	360					0.45	36.21
	Coscinodiscus curvatulus	*Thalassiosira* spp.	600	300		1,800	1,080	900	2,400	2,700	1,800	720	600	2,700	2,400	3,600	1,800	2,400	600	300	1,440	720		300	300	2,880	2,520	3,300	8,700	14,800	6.26	94.83
	Chaetoceros	*Chaetoceros curvisetus*	3,000	3,000	4,200	360		6,000	2,400	4,800	2,520	1,080	6,000	600	4,800	3,600	1,800		10,800	6,000	3,600	1,800	3,000	2,700	2,400	8,280	1,080	16,800	18,000	31,200	11.95	93.10
		Chaetoceros spp.	9,900	11,100	12,000	9,000	5,400	18,900	10,500	21,000	13,680	11,160	21,000	4,800	15,000	12,960	9,360	5,400	24,000	25,500	17,280	10,800	6,000	9,000	9,000	5,760	6,840	18,000	24,000	36,000	39.73	100.00
	Melosira	*Melosira varians*																													0.00	1.72
	Dactyliosolen fragilissima	*Dactyliosolen fragilissimus*																													0.16	15.52
	Asteromphalus	*Asterolampra* sp.																													0.02	3.45
	Rhizosolenia robusta	*Rhizosolenia alata*			150		360			300	360	360	300	150	300		360								900		360	1,500	600	400	0.42	34.48
		Rhizosolenia spp.	1,500	600	1,050	720	1,080	1,200	1,200	2,400	720	1,800	3,300	1,950	3,300	3,240	2,160	600	1,800	1,200	1,440	360	300	600	4,800	1,800	720	12,000	5,400	5,200	5.57	98.28
	Skeletonema	*Skeletonema costatum*			300	360	360																								0.19	18.97
	Spirogyra	*Climacodium biconcavum*																													0.01	3.45
	Biddulphia biddulphiana	*Biddulphia mobiliensis*																								360	180	300	300	800	0.18	20.69
		Biddulphia spp.																											300	400	0.11	17.24
	Leptocylindrus	*Leptocylindrus danicus*																										2,700	1,800		0.36	13.79
	Lauderia borealis	*Lauderia* sp.						1,500	600		720	720	300			360	360		600		360		600	600				1,800	1,200	2,400	0.90	44.83
	Guinardia flaccida	*Guinardia* sp.																												40	0.04	10.34
	Haptophyceae	*Dictyocha fibula*															36		30				30								0.02	17.24
	Coscinodiscus	*Coscinodiscus asteromphalus*		30	30																										0.01	12.07
		Coscinodiscus spp.					36		30	30						36		30				36			30			150		40	0.06	34.48
	Campylosira cymbelliformis	*Campylosira cymbelliformis*																												800	0.04	1.72
	bacteriastrum	*Bacteriastrum* spp.	1,200	4,500	1,500	1,080	1,440	1,200	1,800	1,500	720	360	1,800	900			720	600	1,800	1,800	1,080	720		1,200	300	1,440	1,080		4,500	4,800	3.39	82.76
	Eucampia	*Eucampia cornuta*	300	900	2,400	1,080	1,080	3,000	4,800	4,800	2,880	1,440	2,100	900	4,800	2,160	360	1,500	1,500	5,400	720	720	1,500	2,100	600		360	1,800	1,800	4,000	6.50	96.55
		Eucampia zoodiacus			300		360			900		360			900					600		360		300		360	360		300	800	0.71	41.38
Total			21,930	26,310	25,260	17,856	14,832	38,010	32,460	40,980	32,436	21,276	37,230	15,360	40,890	33,192	21,276	12,540	42,150	48,030	34,560	18,756	15,360	23,640	28,290	24,840	18,540	67,440	83,550	117,000		
Chl a (μg/L)			0.16	0.22	0.22	0.16	0.10	0.34	0.27	0.32	0.23	0.14	0.32	0.12	0.16	0.27	0.15	0.09	0.41	0.41	0.25	0.10	0.10	0.17	0.17	0.22	0.14	0.53	0.63	1.03		
Primary Productivity(μgC/L/d)			1.89	0.92	0.46	1.26	1.00	4.20	5.41	4.42	6.17	3.78	4.42	0.86	8.83	5.41	5.61	1.19	3.49	3.49	5.76	8.97	1.00	4.74	8.30	3.23	0.76	2.70	2.27	1.40		
Species Diversity Index（H'）			1.77	1.73	1.69	1.78	2.26	1.79	1.99	1.67	2.04	1.79	1.49	1.97	1.93	1.97	1.90	1.68	1.31	1.57	1.76	1.64	1.66	2.10	1.95	1.95	2.20	2.09	2.25	2.01		
Evenness Index（J'）			0.71	0.67	0.66	0.69	0.80	0.60	0.78	0.59	0.74	0.68	0.60	0.77	0.75	0.73	0.74	0.62	0.47	0.63	0.71	0.64	0.72	0.73	0.72	0.78	0.79	0.68	0.69	0.66		

Table 6.3.2-9 Resources Table of Marine Plankton and Algae at No.15 Wind Farm at Third Quarter of Survey (1/2)

Phylum	Genus	Scientific Name	15-1					15-2					15-3					15-4					N15-5					15-6				
			0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom
Cyanophyta	Trichodesmium	*Trichodesmium erythraeum*	720					360						900							1,440								360	300		
		Trichodesmium spp.	1,440	300	900		240	1,080	450	300		1,200		1,800	300	1,125	225	1,200			360	675	1,500	1,200		1,080	720	1,200	360	1,500	300	1,385
Dinophyta	Peridiniales	*Peridinium* spp.																									72					
	Oxytoxum challengeroides	*Oxytoxum* sp.																														
	Ceratium	*Ceratium furca*		30			24				30								45	33										30		
		Ceratium fusus															23								30							
		Ceratium spp.													30																	
	Prorocentrales	*Prorocentrum micans*																					60									
		Prorocentrum sp.						72																								
	Genus Protoperidinium	*Protoperidinium* sp.																										30				
	Pyrocystaceae	*Pyrocystis fusiformis*																														
	Dinophysis rotundata	*Dinophysis caudata*									30																					
		Dinophysis ovum																														
Haptophyta	Chlorella	*Umbilicosphaera* sp.																30														
Bacillariophyta	Achnanthes	*Achnanthes* sp.																														
	Pinnularia	*Pinnularia* sp.																														
	Navicula Pelagica	*Navicula cancellata*																								36						
		Navicula membranacea																									108					
		Navicula spp.	360					360				240			300	225	113					225								450		
	zonooidium	*Cocconeis* sp.								30																						
	Bacillariophyceae	*Bacillaria paradoxa*																														
	Asterionella	*Asterionella japonica*			600	360	240	720			900	840	900	900	600	675	450			655	1,080			300	300	1,080	360	900	360	600	900	
	Calothrix	*Thalassiothrix frauenfeldii*																														
		Thalassiothrix sp.																					60									
	Thalassionema Nitzschioides	*Thalassionema nitzschioides*	1,440	600	900	1,512	240	720	900		300		300	450	1,200	450	900	900	1,800	982	1,080	450	300	300		1,080	1,080	300	1,080	300	300	831
	Mastogloia	*Mastogloia* sp.																														
	Fragilaria sp.	*Fragilaria* sp.																														
	Synedra	*Synedra ulna*																													30	
		Synedra sp.																						30								
	Pleurosigma	*Pleurosigma* spp.																														
	Campylodiscus brightwellii Grunow	*Striatella* sp.											30																			
	Gomphonema parvulum (Kutz) Grum.	*Gomphonema* sp.																														28
	Nitzschia	*Nitzschia* spp.	1,800	1,200	600	360	960	1,800			1,200	960	600	1,800		675	450	1,590	1,800		1,080	450		600	600	1,800	1,800		1,800	900	900	554
	Gomphonema	*Licmophora abbreviata*																													30	
	Cymbella	*Cymbella affinis*																														
		Cymbella tumida																						30								
		Cymbella sp.																														
	Pleurosigma	*Raphoneis amphiceros*	36																													
	Amphora	*Amphora* sp.			30						30												30									
	Pleurosigma	*Diploneis bombus*																										30				
		Diploneis sp.					24											30														
	Amphiprora	*Amphiprora alata*								30																						
Phaeophyceae	Cyclotella spp.	*Cyclotella* sp.										24																				
	cosmarium	*Bellerochea* sp.																														

Phylum	Genus	Scientific Name	15-1					15-2					15-3					15-4					N15-5					15-6				
			0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom
	Microchaete	*Corethron hystrix*								30																	36					
	Hemiaulus sinensis	*Hemiaulus indicus*					24										68				36									30		
		Hemiaulus sinensis		60																				30								
		Hemiaulus sp.																														
	Coscinodiscus curvatulus	*Thalassiosira* spp.	720		1,500	360	720	2,160	1,350	900	900	720			900	675	225	1,800	900	328	1,440	675	300		600	720	1,080		1,800	1,200	300	1,662
	Chaetoceros	*Chaetoceros curvisetus*	3,240	1,800	1,500	3,240	3,120	2,880	1,800	300	1,800	2,880	1,800	2,250	2,700	2,700	2,475	1,500	3,150	2,946	720	2,250	2,100	2,400	2,400	2,520	1,440	2,700	4,680	3,900	2,400	831
		Chaetoceros spp.	4,680	5,100	6,000	3,600	4,320	3,960	4,500	6,000	6,000	4,080	6,000	900	600	1,575	1,575	1,500	1,800	4,910	4,680	3,375	1,800	4,200	5,100	2,160	2,520	900	1,800	3,600	3,000	4,154
	Melosira	*Melosira varians*				36																										
	Dactyliosolen fragilissima	*Dactyliosolen fragilissimus*																														
	Asteromphalus	*Asterolampra* sp.																														
	Rhizosolenia robusta	*Rhizosolenia alata*	36																									240				
		Rhizosolenia spp.	2,160	1,500	900				1,800	300	1,500	960	2,010	900	1,800	1,350	1,125	300	900	655	1,440	450	1,200	1,200	600	2,160	1,440		1,440	300	1,800	1,108
	Skeletonema	*Skeletonema costatum*																														
	Spirogyra	*Climacodium biconcavum*													30																	
	Biddulphia biddulphiana	*Biddulphia mobiliensis*																												90		
		Biddulphia spp.																														
	Leptocylindrus	*Leptocylindrus danicus*			300	360					300	240	300		300	225		300	450	164	360		300	300			360		360	300		277
	Lauderia borealis	*Lauderia* sp.	360						450	300		240					225					225	300	300		360	360		360	300		
	Guinardia flaccida	*Guinardia* sp.																														
	Haptophyceae	*Dictyocha fibula*						36					30	45							36					36					30	
	Coscinodiscus	*Coscinodiscus asteromphalus*																														
		Coscinodiscus spp.	72					36						45												36						
	Campylosira cymbelliformis	*Campylosira cymbelliformis*																														
	bacteriastrum	*Bacteriastrum* spp.	360	600	300	720		360	900	300	600	720	600	1,350		225	450	900	1,350	982	360				900	720	720	900			300	554
	Eucampia	*Eucampia cornuta*	360	1,500	300	1,800	960	1,800	900	300	1,200	960			300	675	1,125	300	1,350	982	720	900	900	300	1,200	1,800	1,080	900	720	900	1,500	831
		Eucampia zoodiacus	360	300	300	360		360							300		225		585			225	300	300	300		360		360			
	Heterochloridales	*Distephanus speculum*		30														30					30									
Total			18,144	13,020	14,130	12,708	10,872	16,704	13,050	8,790	14,790	14,064	12,570	11,340	9,360	10,575	9,654	10,380	14,130	12,637	14,832	9,900	9,180	11,490	12,030	15,588	13,536	8,100	15,480	14,700	11,790	12,215
Chl a (μg/L)			0.13	0.10	0.11	0.10	0.09	0.12	0.11	0.08	0.12	0.11	0.10	0.06	0.06	0.08	0.07	0.07	0.10	0.11	0.10	0.08	0.08	0.10	0.12	0.11	0.09	0.06	0.11	0.11	0.09	0.10
Primary Productivity(μgC/L/d)			26.86	2.99	13.20	5.98	5.93	4.30	4.71	6.75	7.74	10.37	8.97	10.32	20.63	2.70	3.13	18.79	11.96	1.89	9.97	1.35	18.89	6.98	1.72	4.71	3.56	17.20	13.20	13.20	16.59	1.00
Species Diversity Index（*H'*）			2.23	1.87	1.97	1.92	1.63	2.22	1.93	1.24	1.93	2.14	1.61	2.13	2.10	2.22	2.25	2.18	2.18	1.78	2.21	1.97	2.11	1.94	1.76	2.31	2.44	1.89	2.19	2.17	2.03	2.03
Evenness Index（*J'*）			0.81	0.75	0.77	0.80	0.68	0.82	0.88	0.52	0.75	0.83	0.70	0.89	0.82	0.89	0.83	0.85	0.91	0.77	0.84	0.82	0.80	0.73	0.76	0.87	0.88	0.82	0.85	0.78	0.79	0.85

Table 6.3.2-9 Resources Table of Marine Plankton and Algae at No.15 Wind Farm at Third Quarter of Survey (2/2)

Phylum	Genus	Scientific Name	15-7					15-8					N15-9					N15-10					15-11					N15-12			RA(%)	OR(%)
			0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	Bottom		
Cyanophyta	Trichodesmium	*Trichodesmium erythraeum*		900					900				300						900				554				360	300			1.15	22.41
		Trichodesmium spp.	1,500	900	1,200	360	258	1,500	900	900	360	1,310	1,500	600	900	720	1,200		900	1,500	1,800	360	554	1,200	900	300		1,500		1,440	6.32	84.48
Dinophyta	Peridiniales	*Peridinium* spp.																													0.01	1.72
	Oxytoxum challengeroides	*Oxytoxum* sp.					26																								0.00	1.72
	Ceratium	*Ceratium furca*						60									24						28					30			0.05	17.24
		Ceratium fusus																													0.01	3.45
		Ceratium spp.																													0.00	1.72
	Prorocentrales	*Prorocentrum micans*																									72				0.02	3.45
		Prorocentrum sp.																													0.01	1.72
	Genus Protoperidinium	*Protoperidinium* sp.																													0.00	1.72
	Pyrocystaceae	*Pyrocystis fusiformis*		30																											0.00	1.72
	Dinophysis rotundata	*Dinophysis caudata*																30													0.01	3.45
		Dinophysis ovum																							30						0.00	1.72
Haptophyta	Chlorella	*Umbilicosphaera* sp.																													0.00	1.72
Bacillariophyta	Achnanthes	*Achnanthes* sp.																30													0.00	1.72
	Pinnularia	*Pinnularia* sp.																	30											36	0.01	3.45
	Navicula Pelagica	*Navicula cancellata*																									36				0.01	3.45
		Navicula membranacea																													0.02	1.72
		Navicula spp.		150	150				300										150				277	300				300			0.54	25.86
	zonooidium	*Cocconeis* sp.																													0.00	1.72
	Bacillariophyceae	*Bacillaria paradoxa*																	60												0.01	1.72
	Asterionella	*Asterionella japonica*	300	600	300		772	300			1,080		300	300	300	360	480	900		900	360	720	277			300	360	900			3.27	68.97
	Calothrix	*Thalassiothrix frauenfeldii*							30																						0.00	1.72
		Thalassiothrix sp.																													0.01	1.72
	Thalassionema Nitzschioides	*Thalassionema nitzschioides*		300	900		515	300	1,200	600		328	900	900	300	1,440	960	1,200	1,200		360	1,080		900		1,200	1,080	900	900	360	5.36	84.48
	Mastogloia	*Mastogloia* sp.												30						30							36				0.01	5.17
	Fragilaria sp.	*Fragilaria* sp.															24														0.00	1.72
	Synedra	*Synedra ulna*																								30					0.01	3.45
		Synedra sp.																													0.00	1.72
	Pleurosigma	*Pleurosigma* spp.				288																									0.04	1.72
	Campylodiscus brightwellii Grunow	*Striatella* sp.							30																				30		0.01	5.17
	Gomphonema parvulum (Kutz) Grum.	*Gomphonema* sp.																													0.00	1.72
	Nitzschia	*Nitzschia* spp.	1,500	1,200	600		1,286	300	600	600	1,080	328	900	300	600	360	1,200	600	1,200	600	360	1,080	1,108	1,200	600		1,080	900		360	6.43	84.48
	Gomphonema	*Licmophora abbreviata*																					28								0.01	3.45
	Cymbella	*Cymbella affinis*									36													30							0.01	3.45
		Cymbella tumida																													0.00	1.72
		Cymbella sp.					26																								0.00	1.72
	Pleurosigma	*Raphoneis amphiceros*																													0.01	1.72
	Amphora	*Amphora* sp.																										30			0.02	6.90
	Pleurosigma	*Diploneis bombus*																						30							0.01	3.45
		Diploneis sp.																													0.01	3.45
	Amphiprora	*Amphiprora alata*																													0.00	1.72

Phylum	Genus	Scientific Name	15-7					15-8					N15-9					N15-10					15-11					N15-12			RA(%)	OR(%)
			0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	Bottom		
Phaeophyceae	Cyclotella spp.	*Cyclotella* sp.																													0.00	1.72
	cosmarium	*Bellerochea* sp.																	60												0.01	1.72
	Microchaete	*Corethron hystrix*																						30							0.01	5.17
	Hemiaulus sinensis	*Hemiaulus indicus*																					28						30		0.03	10.34
		Hemiaulus sinensis					26																				72				0.03	6.90
		Hemiaulus sp.										164											139								0.04	3.45
	Coscinodiscus curvatulus	*Thalassiosira* spp.			1,500	360	772	300	1,800	1,800	360	1,637	600	1,860	300	360	240	600	1,200	1,200	360	360	1,662	1,800	900	900		1,500	1,500		6.65	84.48
	Chaetoceros	*Chaetoceros curvisetus*	1,800	1,800	3,300	2,880	1,029	3,900	2,100	2,700	1,440	2,619	3,000	3,000	2,100	3,240	1,440	900	2,400	2,400	3,240	1,440	3,047	2,400	2,100	900	1,080	3,000	1,500	3,600	18.75	100.00
		Chaetoceros spp.	6,000	1,500	3,000	5,040	4,372	5,700	1,800	5,400	4,320	655	4,800	3,300	5,100	2,520	1,920	4,200	3,000	2,700	6,480	2,880	3,324	4,500	1,800	3,300	4,320	5,100	5,400	2,880	29.18	100.00
	Melosira	*Melosira varians*																													0.01	1.72
	Dactyliosolen fragilissima	*Dactyliosolen fragilissimus*												90																	0.01	1.72
	Asteromphalus	*Asterolampra* sp.																				72									0.01	1.72
	Rhizosolenia robusta	*Rhizosolenia alata*																	30												0.04	5.17
		Rhizosolenia spp.	1,500	1,800	300	360			1,800	1,200	1,440	1,637	1,500		1,800	720	1,200	1,500	1,200	900				300	1,200	1,200	2,160			2,160	7.96	79.31
	Skeletonema	*Skeletonema costatum*																90													0.01	1.72
	Spirogyra	*Climacodium biconcavum*																													0.00	1.72
	Biddulphia biddulphiana	*Biddulphia mobiliensis*																												108	0.03	3.45
		Biddulphia spp.		60																											0.01	1.72
	Leptocylindrus	*Leptocylindrus danicus*			300	360		300	300		360			300			240	300		300				300	300		360			360	1.29	51.72
	Lauderia borealis	*Lauderia* sp.	300		300				300		360			300					300				277		300	300		300		360	1.00	39.66
	Guinardia flaccida	*Guinardia* sp.										66																			0.01	1.72
	Haptophyceae	*Dictyocha fibula*				36	26									36					36		28		30			30			0.06	22.41
	Coscinodiscus	*Coscinodiscus asteromphalus*				36																									0.01	1.72
		Coscinodiscus spp.												30						30			28					30			0.04	13.79
	Campylosira cymbelliformis	*Campylosira cymbelliformis*														108															0.02	1.72
	bacteriastrum	*Bacteriastrum* spp.	300	900	600	720	772	900		300	720	655	960			720	720	300					277	300	960	300	720	900	300	1,080	3.98	75.86
	Eucampia	*Eucampia cornuta*	300		900	360			300	600	720	1,310	1,200	1,200	900	1,080	240	300		900	360	1,080	277	600	1,200	600		1,500	1,500		6.12	86.21
		Eucampia zoodiacus		300	300	360		300	300		360				300		240	300	300	300		360	277						300		1.24	48.28
	Heterochloridales	*Distephanus speculum*		30										30								36					36				0.03	12.07
	Total		13,500	10,470	13,650	11,160	9,880	13,860	12,660	14,100	12,636	10,709	15,960	12,240	12,600	11,664	10,128	11,250	12,930	11,760	13,356	9,468	12,190	13,890	10,320	9,330	11,772	17,220	11,460	12,744		
	Chl a (μg/L)		0.12	0.06	0.11	0.10	0.07	0.12	0.09	0.12	0.10	0.09	0.14	0.10	0.11	0.09	0.06	0.08	0.09	0.08	0.11	0.06	0.11	0.11	0.09	0.07	0.09	0.13	0.10	0.11		
	Primary Productivity(μgC/L/d)		2.58	3.44	0.94	1.99	1.57	12.04	16.59	12.04	13.95	5.93	10.58	1.00	13.20	16.59	13.76	1.35	16.59	18.89	13.20	15.48	0.94	7.54	16.59	10.96	1.19	11.06	13.95	13.20		
	Species Diversity Index（*H'*）		1.70	2.26	2.24	1.68	1.77	1.66	2.35	1.82	2.13	2.08	2.08	2.00	1.82	2.06	2.29	2.05	2.21	2.12	1.47	2.02	2.11	2.04	2.18	1.98	1.94	2.18	1.57	1.91		
	Evenness Index（*J'*）		0.77	0.85	0.85	0.68	0.71	0.69	0.87	0.83	0.83	0.87	0.87	0.76	0.79	0.83	0.87	0.78	0.82	0.85	0.67	0.84	0.73	0.77	0.88	0.83	0.74	0.78	0.72	0.80		

Table 6.3.2-10 Resources Table of Marine Plankton and Algae at No.15 Wind Farm at Fourth Quarter of Survey (1/2)

Phylum	Genus	Scientific Name	15-1					15-2					15-3					15-4					N15-5					15-6				
			0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom
Cyanophyta	Trichodesmium	Trichodesmium erythraeum	1,500		1,029			1,200			258	848	1,029			800	800		1,080	831			1,029		1,029		600	1,029	900			
		Trichodesmium spp.				300	212	2,100			258	848				1,400	1,000	1,029		1,662			258						600			
	Phytophthora	Richelia intracellularis																														
Dinophyta	Peridiniales	Peridinium spp.			155		170	210		78	52	191		144							100	100		206	103		210	206		206	52	
	Oxytoxum challengeroides	Oxytoxum sp.		26																		20				30						
	Ceratium	Ceratium furca					22	30	36		26		26		26			26	36	28			26							26		24
		Ceratium fusus														20										30						
	Prorocentrales	Prorocentrum micans	210		26	60			36	26	78		52	108	26	100			144		100		129		78	60	120	180		103		96
	Pyrocystaceae	Pyrocystis noctiluca																														
	Goniaulax	Gonyaulax sp.																									30					
	dimorphosiphon	Amphisolenia bidentata																														
Haptophyta	Chlorella	Umbilicosphaera sp.																														
Bacillariophyta	Navicula Pelagica	Navicula membranacea	60	78				60					103	180	129						20	40	26						60	52		
		Navicula spp.	600	772	515	240	424	600		258	515	212	258	360	772	140	400	129	288	554	400	600	26	515	258	900	600	772	60	129	515	240
	Bacillariophyceae	Bacillaria paradoxa									258				515					277				772					300			
	Thalassionema Nitzschioides	Thalassionema nitzschioides		515	180		424	270	360	155		64	180	324	232	200	200	258	360	554	160		258	258	515	600		232	300	515	515	216
	Fragilaria sp.	Fragilaria sp.		26		30	22			26	26		26	36	26				36		20	20	26		26				30			
	Pleurosigma	Pleurosigma spp.	300	772	772		212	900		772	129	191	772	720	515	200	400	772	144	194		600	232	515	772	300	150	772	300	103	52	72
	Nitzschia	Nitzschia spp.	4,800	6,943	1,286	10,200	2,118	6,300	11,160	9,515	5,915	5,295	7,200	13,320	10,543	2,200	800	7,715	9,360	9,139	3,400	6,400	1,543	9,000	5,143	3,300	10,800	3,343	9,600	6,429	9,258	2,160
	Pleurosigma	Raphoneis amphiceros						30										26		28							60					24
	Pleurosigma	Diploneis sp.					85			52							40			28		20								52		
	Amphiprora	Amphiprora alata																26									30					
	Trachyneis aspera	Trachyneis sp.	30										26																			
	Pleurotus	Tryblioptychus sp.																														
Phaeophyceae	Microchaete	Corethron hystrix		103			85			206		170		216	232						180			129	232	60				78	129	
	Hemiaulus sinensis	Hemiaulus sinensis		26			64				78			108			20	52	72	28	40	40		78					90			24
		Hemiaulus hauckii	120				191	150	180		26			720	258	200		52				100			103			258		103		240
	Coscinodiscus curvatulus	Thalassiosira spp.	7,200	6,172	5,915	2,700		7,500	8,640	4,629	5,143	2,118	1,543	6,840	5,400	1,800	2,400	4,886	6,840	3,600	2,000	1,000	3,858	4,372	52	7,800	6,000	4,629	7,500	2,829	3,343	4,800
	Chaetoceros	Chaetoceros curvisetus		772	772	900		900	1,080	515	772	636	515	1,080	772		600	772	1,080	554	600		515	772	515	300			600	258		480
		Chaetoceros spp.	6,000	1,800	5,400	1,500	5,083	7,500	5,040	5,915	3,086	4,659	2,058	4,320	1,800	4,400	1,000	1,286	1,800	2,493	4,400	3,200	5,143	5,658	6,686	3,300	7,800	2,058	7,500	3,858	2,572	5,520
	Rhizosolenia robusta	Rhizosolenia spp.	600	232		150	212		2,520	515	258	424	515	1,080			1,200	1,029	1,440	84		1,200	1,800	1,029	155	600	300	515	300	772	1,029	480
	Skeletonema	Skeletonema costatum		1,029	772			120	720	772	78		258			400			288		140				1,029	900		515				
	Spirogyra	Climacodium biconcavum		26		30	22													28												
	Biddulphia biddulphiana	Biddulphia mobiliensis		78																	100				52		180			129		72
		Biddulphia sinensis		155		120	128				78	22		180			140		36		20		52	129	78		120	155		129		
	Leptocylindrus	Leptocylindrus danicus	1,200		515	300		900	360	258	772		1,029	720	1,029	200	800	772	360		800	600	1,029		772	600	300	515	1,200	772	1,029	240
	Lauderia borealis	Lauderia annulata		515	1,029	600		900	360	1,029	1,029		772		772		400	1,029	1,080		600		515		515		1,200	258	1,200	515	772	
	Guinardia flaccida	Guinardia sp.																														
	Haptophyceae	Dictyocha fibula																	36													
	Coscinodiscus	Coscinodiscus spp.			155		106	30						360			140			28						600			150	180	155	120
	Campylosira cymbelliformis	Campylosira cymbelliformis	600	1,029				1,500	720	772	515	636	1,029	1,800	1,286			515	720	831	800	800	1,029	515	258		1,500	515	1,500	258	1,029	1,200
	bacteriastrum	Bacteriastrum spp.	300	258	155	900	848	210		1,029		636	515	1,440		400		772	288	277	200	800			1,029	300	1,200	258	900	1,286	1,029	480
	Eucampia	Eucampia cornuta		52	129					180									36													96
	Heterochloridales	Distephanus speculum						150				128	129		78	100	120			139	140			206	232			129	210	103	155	216
	ditylum brightwellii	Ditylum brightwellii	30							52		22	26			140	160		216		140	80		129		210				26	78	
		Ditylum sol				30																										
	Actinocyclus	Actinocyclus ehrenbergii			26		22													28	20						30					
	Actinoptychus capensis	Actinoptychus spp.												144			20				120						30		30			
	Planktoniella	Planktoniella blanda																26										26				
Total			23,550	21,379	18,831	18,060	10,450	31,560	31,212	26,754	19,350	17,100	18,061	34,200	24,411	12,700	10,640	21,172	25,740	21,385	14,500	15,620	17,494	24,283	19,632	19,890	31,260	16,365	33,330	18,911	21,712	16,800
Chl a (μg/L)			0.30	0.23	0.24	0.13	0.07	0.35	0.36	0.24	0.21	0.15	0.12	0.31	0.22	0.14	0.14	0.20	0.27	0.15	0.14	0.10	0.21	0.21	0.13	0.29	0.30	0.18	0.34	0.17	0.16	0.22
Primary Productivity(μgC/L/d)			13.38	10.78	10.48	4.85	2.33	16.93	18.31	11.49	9.17	6.30	4.90	13.94	9.95	5.76	5.06	8.33	11.65	5.48	4.91	3.50	8.43	8.71	4.75	14.66	14.85	8.14	16.34	7.88	6.96	10.63
Species Diversity Index（H'）			1.85	2.02	2.03	1.54	1.78	2.15	1.71	1.96	2.01	2.01	2.17	2.02	1.87	2.03	2.49	2.04	2.00	1.92	2.15	1.89	2.12	1.85	2.12	1.96	1.84	2.29	2.03	2.12	1.93	1.94
Evenness Index（J'）			0.68	0.66	0.72	0.57	0.60	0.71	0.67	0.65	0.66	0.71	0.71	0.66	0.65	0.73	0.85	0.69	0.65	0.63	0.69	0.67	0.73	0.67	0.69	0.69	0.61	0.78	0.67	0.67	0.70	0.65

Table 6.3.2-10 Resources Table of Marine Plankton and Algae at No.15 Wind Farm at Fourth Quarter of Survey (2/2)

Phylum	Genus	Scientific Name	15-7					15-8					N15-9					N15-10					15-11					N15-12			RA	OR
			0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	Bottom	(%)	(%)
Cyanophyta	Trichodesmium	Trichodesmium erythraeum	772	515		240					600	167				3,200								258	258				258		1.76	41.38
		Trichodesmium spp.										831													772				515		1.02	24.14
	Phytophthora	Richelia intracellularis																	36												0.00	1.72
Dinophyta	Peridiniales	Peridinium spp.	129	180				78		232			900	450	554					40	52						300	78		300	0.48	46.55
	Oxytoxum challengeroides	Oxytoxum sp.											30															26			0.01	8.62
	Ceratium	Ceratium furca	26		26					26					28					40						26	30			30	0.05	34.48
		Ceratium fusus	26								30											60		26							0.02	10.34
	Prorocentrales	Prorocentrum micans	26		103	90				180												300		26						30	0.22	44.83
	Pyrocystaceae	Pyrocystis noctiluca											30																		0.00	1.72
	Goniaulax	Gonyaulax sp.											30					36						26							0.01	6.90
	dimorphosiphon	Amphisolenia bidentata															72														0.01	1.72
Haptophyta	Chlorella	Umbilicosphaera sp.									30		30																		0.01	3.45
Bacillariophyta	Navicula Pelagica	Navicula membranacea		103		30	90					167	150		277					400	309	600	48	26	180		120		26		0.29	43.10
		Navicula spp.	180	772	129	600	675	206	515	515		554	750	450	554	400		360		800	206	1,800	216		52	772	600	258	103	600	2.10	91.38
	Bacillariophyceae	Bacillaria paradoxa			515			258	515			554				1,200				1,200					772				772		0.69	22.41
	Thalassionema Nitzschioides	Thalassionema nitzschioides	103	180	206	600	450	515	258	52	300	194	150	900	831	1,200	360	720			515	300				515	300		258	300	1.48	81.03
	Fragilaria sp.	Fragilaria sp.			26															40				26							0.04	29.31
	Pleurosigma	Pleurosigma spp.	772	206	515	600	225	515	206	515	900	222	150		277	2,000			360	400	515	600		772	258	772	900	258	515		2.09	86.21
	Nitzschia	Nitzschia spp.	2,572	2,315	9,772	8,400	5,400	9,000	2,829	4,629	11,400	9,970	4,200	6,750	2,493	2,000	7,200	3,600	720	4,000	4,115	4,200	5,040	10,286	9,258	1,543	900	8,229	515	6,900	29.78	100.00
	Pleurosigma	Raphoneis amphiceros								26												60						26		30	0.03	15.52
	Pleurosigma	Diploneis sp.					68				30	28												26						30	0.04	18.97
	Amphiprora	Amphiprora alata									30				28																0.01	6.90
	Trachyneis aspera	Trachyneis sp.						26												40									26		0.01	8.62
	Pleurotus	Tryblioptychus sp.																	36												0.00	1.72
Phaeophyceae	Microchaete	Corethron hystrix								52			30		28					40	52				52	78					0.19	32.76
	Hemiaulus sinensis	Hemiaulus sinensis		52	78	90		26			90	84	150											78	52	52	90				0.14	41.38
		Hemiaulus hauckii		258		240		52	515			222		225		200				200										60	0.41	39.66
	Coscinodiscus curvatulus	Thalassiosira spp.	1,029	3,600	5,658	4,200	4,050	4,372	2,315	6,172	1,800	1,108	3,900	3,600	1,108	1,200	6,480	2,520	720	1,200	5,143	2,400	3,600	6,686	1,029	5,915	3,900	3,600	6,429	1,200	19.69	98.28
	Chaetoceros	Chaetoceros curvisetus	772	515	772		675		772		600	831	1,500	450						800		600	480		515	515	900	772	258	900	2.47	70.69
		Chaetoceros spp.	6,429	3,086	3,600	5,700	4,500	2,315	4,372	1,286	3,300	1,108	4,500	9,900	1,662	1,200	3,600	2,880	720	2,400	2,572	3,000	4,560	2,058	515	515	6,900	2,829	5,658	2,400	18.82	100.00
	Rhizosolenia robusta	Rhizosolenia spp.	1,029	1,029			900	1,543				1,108	300	225	139	400	720			200	515	300	720			772	600	129		210	2.55	74.14
	Skeletonema	Skeletonema costatum	772		772	600		772		772	900	1,385			554		72				1,029	1,200	960	515		1,029	600		1,029	2,100	1.92	51.72
	Spirogyra	Climacodium biconcavum											30										24	26							0.02	12.07
	Biddulphia biddulphiana	Biddulphia mobiliensis		52		60	68						180		277				720	200	412	300					60			240	0.28	29.31
		Biddulphia sinensis		78	129		135				60	28	120								103		144	103		180	150		78	120	0.26	48.28
	Leptocylindrus	Leptocylindrus danicus	1,029	772	1,029	1,200	225	515	258		900	831	300	900	277					400			480	1,029	515	515		772	515	60	2.57	77.59
	Lauderia borealis	Lauderia annulata	515		515	600		1,029	772	515				450	277				180			300		515	1,029	772	600	1,029	1,029	1,200	2.30	63.79
	Guinardia flaccida	Guinardia sp.							26				30	45			72							26							0.02	8.62
	Haptophyceae	Dictyocha fibula				90						194	30										48		155	78	30				0.06	13.79
	Coscinodiscus	Coscinodiscus spp.		155	155		180	155					30							40	52				180			103		300	0.29	36.21
	Campylosira cymbelliformis	Campylosira cymbelliformis		1,029		600	675		515	1,029	900	554	900	900	831	3,200		720		2,800	1,543	3,600	1,200	1,286	258	1,286	1,200	1,286	515	600	4.24	81.03
	bacteriastrum	Bacteriastrum spp.	258	1,029	772	210	675	258	258	180	600	111	1,800	1,350		1,000			1,080	800		1,200		1,286	1,286	515	1,500		1,286	900	2.94	79.31
	Eucampia	Eucampia cornuta											60		139									129							0.07	13.79
	Heterochloridales	Distephanus speculum	155		103	150		52		206	210		60					180			52					26					0.30	43.10
	ditylum brightwellii	Ditylum brightwellii	155	103	52		180		78														216	155		129		232		180	0.24	39.66
		Ditylum sol												90																	0.01	3.45
	Actinocyclus	Actinocyclus ehrenbergii			78		45		26		30										52	60								90	0.04	20.69
	Actinoptychus capensis	Actinoptychus spp.																										52			0.03	10.34
	Planktoniella	Planktoniella blanda											30																		0.01	5.17
	Total		16,749	16,029	25,005	24,300	19,216	21,687	14,230	16,387	22,710	20,251	20,370	26,685	10,334	17,200	18,576	11,016	4,572	16,040	17,237	20,880	17,736	25,364	17,136	16,005	19,680	19,679	19,785	18,780		
	Chl a (μg/L)		0.16	0.14	0.24	0.22	0.20	0.19	0.15	0.22	0.12	0.12	0.22	0.32	0.09	0.13	0.24	0.12	0.04	0.11	0.20	0.21	0.18	0.28	0.08	0.21	0.25	0.23	0.31	0.15		
	Primary Productivity(μgC/L/d)		6.43	4.99	10.81	9.87	8.46	7.68	6.14	9.17	4.52	4.62	10.64	16.12	3.10	4.62	11.13	4.89	1.24	3.90	8.98	10.19	7.90	13.85	2.39	8.57	12.33	10.58	16.54	5.39		
	Species Diversity Index（H'）		2.14	2.37	1.91	1.96	2.03	1.89	2.11	1.84	1.81	2.03	2.25	1.87	2.40	2.26	1.32	1.61	1.91	2.30	2.02	2.35	1.88	1.82	1.84	2.29	2.16	1.82	2.05	2.22		
	Evenness Index（J'）		0.73	0.79	0.63	0.66	0.70	0.66	0.76	0.66	0.61	0.67	0.68	0.69	0.83	0.91	0.63	0.77	0.87	0.77	0.71	0.81	0.71	0.59	0.64	0.76	0.73	0.66	0.71	0.71		

Table 6.3.2-11 Resources Table of Supplementary Survey of Marine Plankton and Algae at Common Corridor at Lunwei Area

Phylum	Genus	Scientific Name	10607															RA(%)	OR(%)
			M-N1					M-N2					M-N3						
			0M	3M	10M	25M	Bottom	0M	3M	10M	25M	Bottom	0M	3M	10M	Bottom			
Cyanophyta	Trichodesmium	*Trichodesmium erythraeum*	2,216	2,880	400	6,000	6,750	54,000	8,100	12,000	4,236	13,500	4,500					25.79	78.57
		Trichodesmium sp.				2,000	2,250	18,000		4,000	2,118	4,500	9,000	4,236	4,236			11.33	64.29
	Phytophthora	*Richelia intracellularis*													5	5		0.00	14.29
Dinophyta	Ceratium	*Ceratium furca*											45					0.01	7.14
		Ceratium fusus							45									0.01	7.14
		Ceratium spp.	28		40		45											0.03	21.43
	Prorocentrales	*Prorocentrum micans*	28															0.01	7.14
	Pyrocystaceae	*Pyrocystis noctiluca*											45			43		0.02	14.29
Bacillariophyta	Achnanthes	*Achnanthes brevipes*								4,800								1.08	7.14
		Achnanthes sp.								2,800								0.63	7.14
	Pinnularia	*Pinnularia sp.*			4					4								0.00	14.29
	Navicula Pelagica	*Navicula spp.*	28	36				450	90	6,800	424			424	424			1.95	57.14
	zonooidium	*Cocconeis placentula*								800		45						0.19	14.29
	Streptotheca	*Streptotheca thamensis*	28			40												0.02	14.29
	Asterionella	*Asterionella japonica*				1,200						450	1,350					0.68	21.43
	Calothrix	*Thalassiothrix sp.*														424		0.10	7.14
	Thalassionema Nitzschioides	*Thalassionema frauenfeldii*	554	360				900		1,600			1,350	2,118	1,695	2,542		2.50	57.14
		Thalassionema nitzschioides	3,324	2,520	1,600	1,600	450	2,700	4,050	5,200	1,695	3,150	4,500	5,083	7,624	3,389		10.55	100.00
	Fragilaria sp.	*Fragilaria sp.*			40	40				40								0.03	21.43
	Pleurosigma	*Pleurosigma spp.*	28	360						800			45			212		0.33	35.71
	Trachyneis aspera	*Trachyneis sp.*						45						43				0.02	14.29
	Nitzschia	*Nitzschia panduriformis*								2,000								0.45	7.14
		Nitzschia spp.	1,108	360	400	400				108,400					424			25.01	42.86
	Gomphonema	*Licmophora abbreviata*													43			0.01	7.14
	Cymbella	*Cymbella affinis*						5		40								0.01	14.29
	Pleurosigma	*Raphoneis amphiceros*											45	43		43		0.03	21.43
		Raphoneis sp.		36														0.01	7.14
	Pleurosigma	*Diploneis bombus*	28							40								0.02	14.29
	Amphiprora	*Amphiprora alata*														43		0.01	7.14
Phaeophyceae	Cyclotella spp.	*Cyclotella meneghiniana*								40								0.01	7.14
		Cyclotella sp.						5										0.00	7.14
	cosmarium	*Bellerochea malleus*			200									212				0.09	14.29
	Coscinodiscus curvatulus	*Thalassiosira spp.*	554	1,080	400	1,200	450	900	2,250	400	848	450	1,800	5,506	1,271	5,506		5.09	100.00
	Chaetoceros	*Chaetoceros curvisetus*	1,108	540		2,000				1,200		2,250			1,695			1.98	42.86
		Chaetoceros messanensis		180														0.04	7.14
		Chaetoceros spp.	2,216	1,800	400	4,400	2,250	450	900	2,400	2,542	4,500	900		4,236			6.08	85.71
	Melosira	*Melosira moniliformis*								40								0.01	7.14
		Melosira sp.						5		160								0.04	14.29
	Rhizosolenia robusta	*Rhizosolenia alata*		36		400			450			225			424	424		0.44	42.86
		Rhizosolenia spp.	56			400		225	900	400		675	450	848	848	424		1.18	71.43
	Skeletonema	*Skeletonema costatum*	831						45									0.20	14.29
	Spirogyra	*Climacodium biconcavum*						45					45			43		0.03	21.43
	Biddulphia biddulphiana	*Biddulphia mobiliensis*			40	40	45	45		40								0.05	35.71
		Biddulphia sinensis				40												0.01	7.14
	Lauderia borealis	*Lauderia borealis*	28	360				225			424		450		424	1,695		0.81	50.00
	Guinardia flaccida	*Guinardia flaccida*						5										0.00	7.14
	Haptophyceae	*Dictyocha fibula*	28															0.01	7.14
	Coscinodiscus	*Coscinodiscus spp.*	28	36										43				0.02	21.43
	bacteriastrum	*Bacteriastrum spp.*	1,385	720	6,000	2,000	900		1,575	400	424				424			3.11	64.29
Total(cells/L)			13,604	11,304	9,524	21,760	13,140	78,005	18,405	154,404	12,711	29,745	24,525	18,556	23,773	14,793			
Chl a (μg/L)			0.06	0.06	0.07	0.12	0.04	0.04	0.09	0.05	0.05	0.08	0.07	0.13	0.11	0.14			
Primary Productivity(μgC/L/d)			1.91	1.75	2.32	4.46	1.19	1.29	3.05	1.56	1.52	2.77	2.26	5.14	4.04	5.74			
Species Diversity Index（*H'*）			2.15	2.10	1.28	2.11	1.40	0.92	1.60	1.30	1.78	1.62	1.83	1.62	2.00	1.69			
Evenness Index（*J'*）			0.73	0.78	0.53	0.78	0.67	0.33	0.70	0.41	0.85	0.70	0.69	0.70	0.76	0.66			

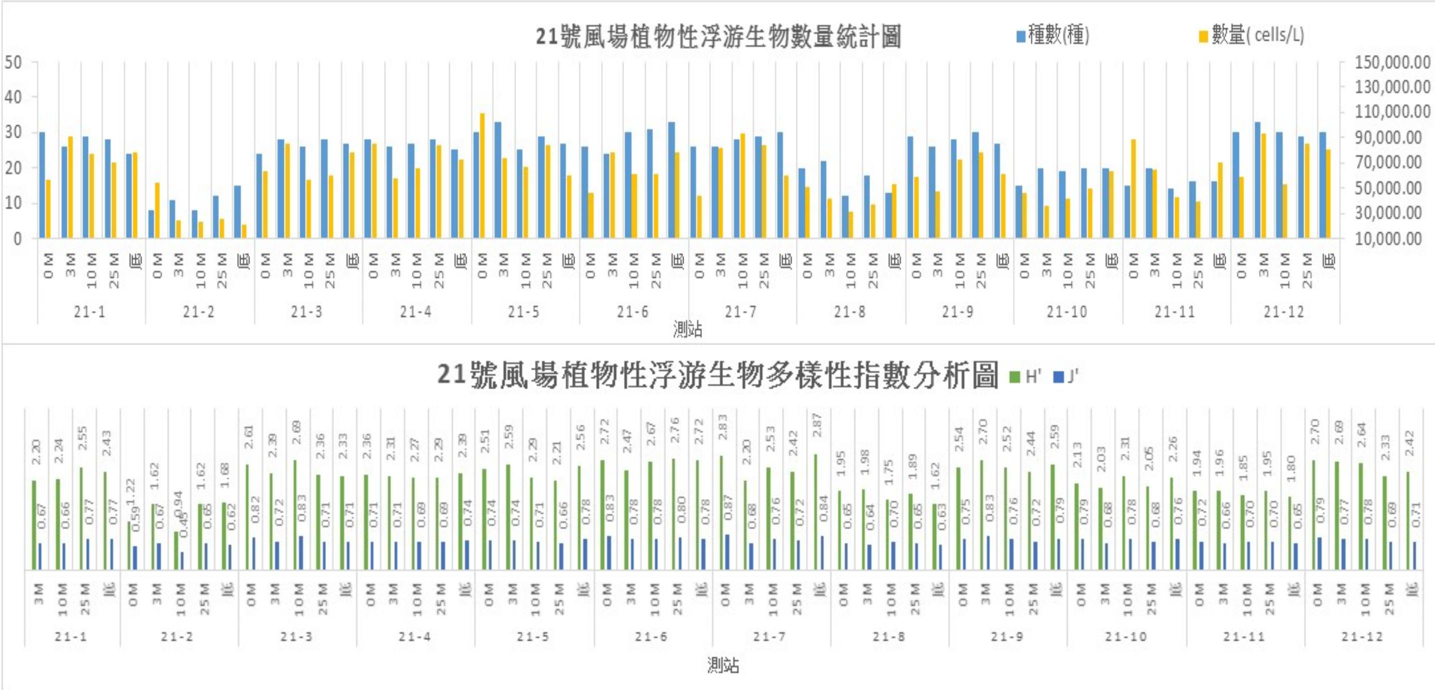


Figure 6.3.2-3 Statistical Diagram of Number and Diversity of Phytoplankton at No.21 Wind Farm, Changhua Waters

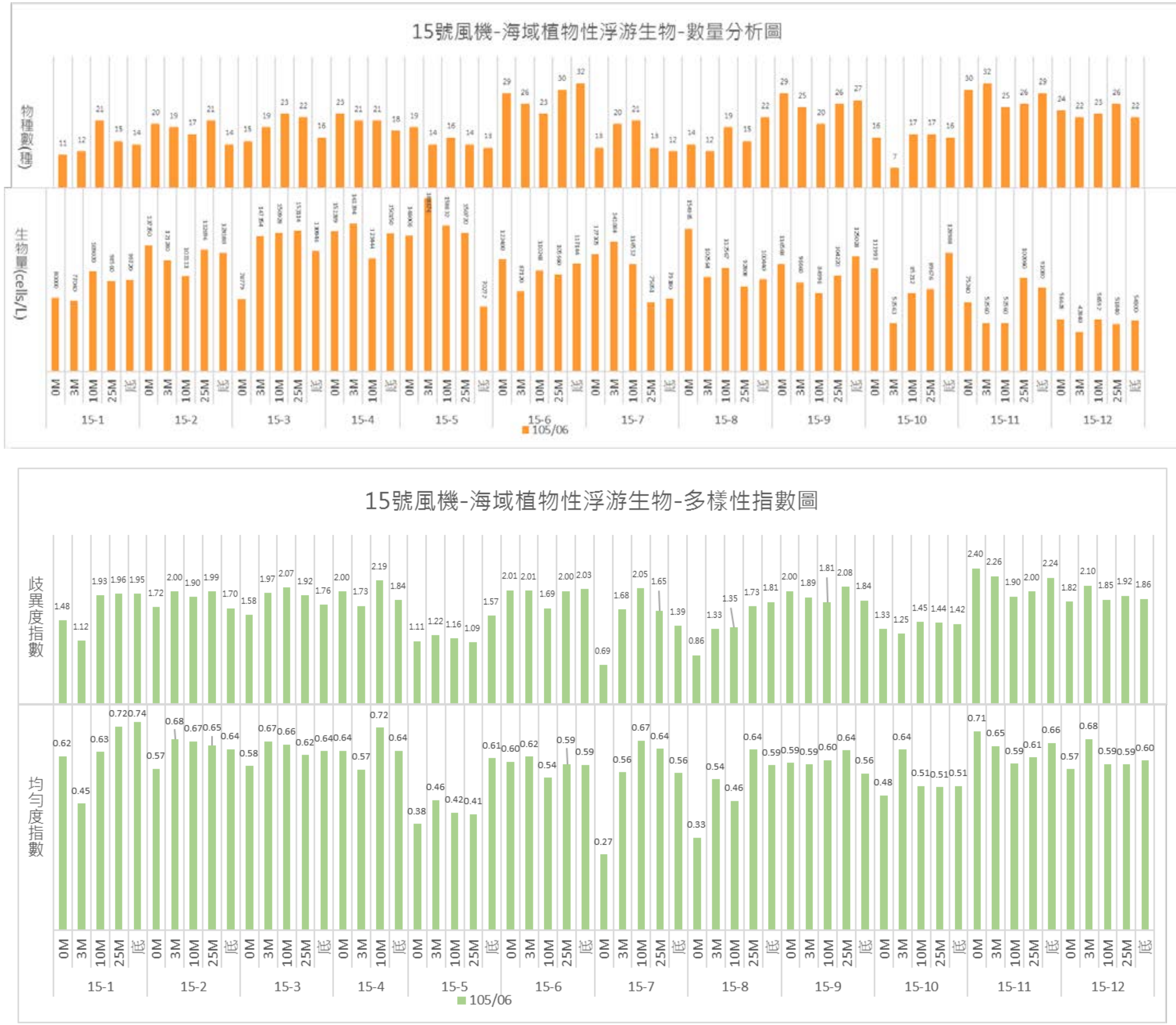


Figure 6.3.2-4 Statistical Diagram of Number and Diversity of Phytoplankton at No.15 Wind Farm, Changhua Waters at First Quarter

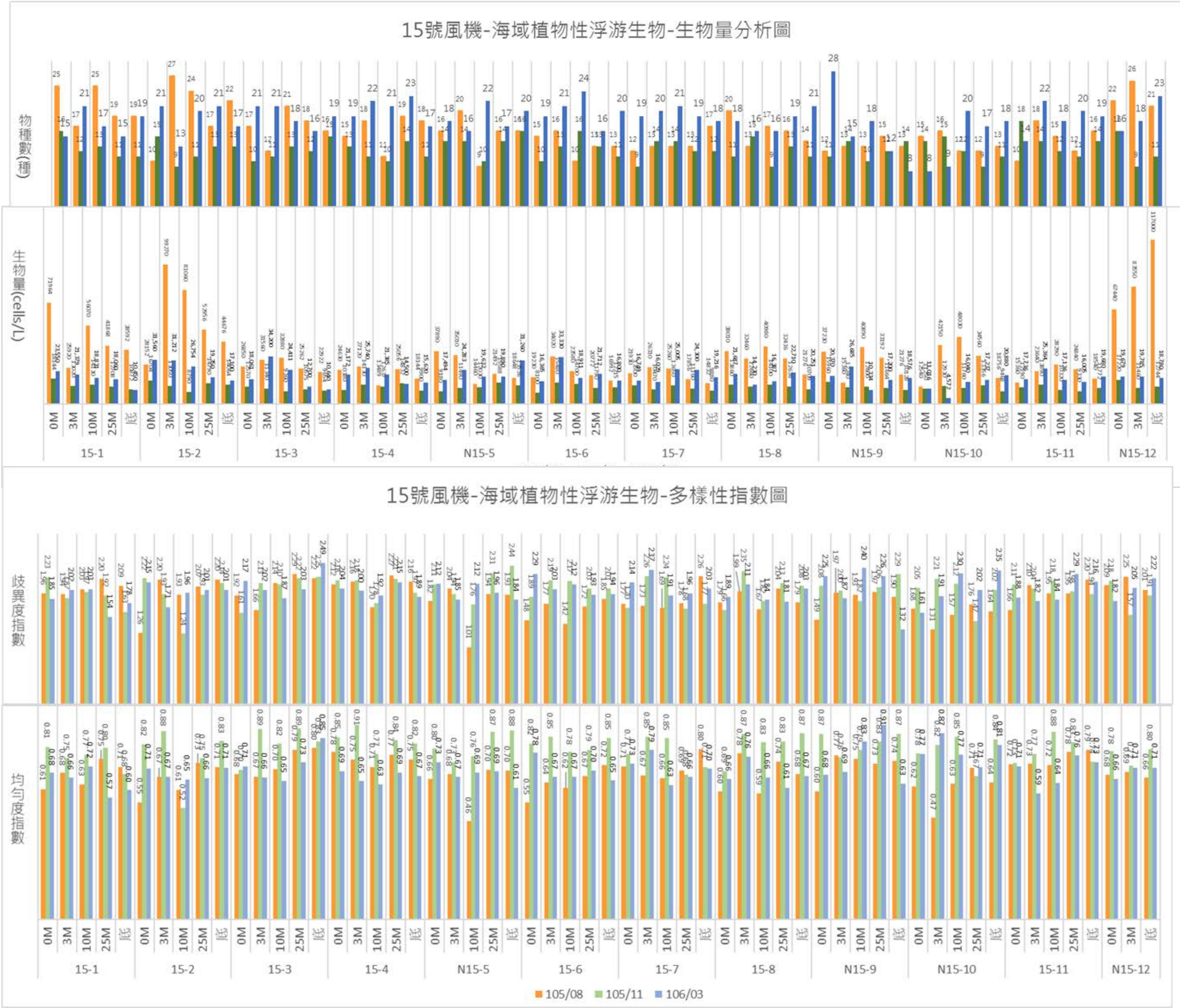


Figure 6.3.2-5 Statistical Diagram of Number and Diversity of Phytoplankton at No.15 Wind Farm, Changhua Waters at Second, Third and Fourth Quarter

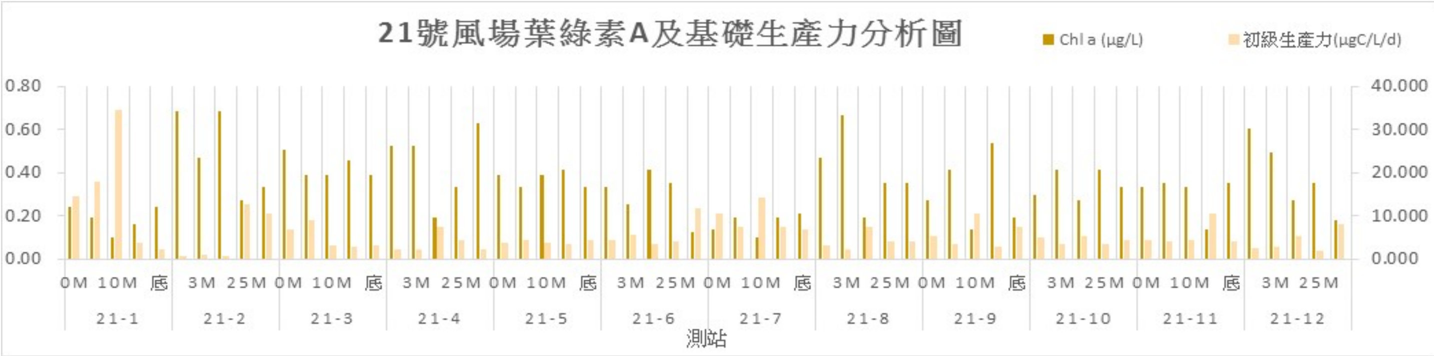


Figure 6.3.2-6 Analytical Diagram of Chlorophyll a and Primary Productivity of No.21 Wind Farm

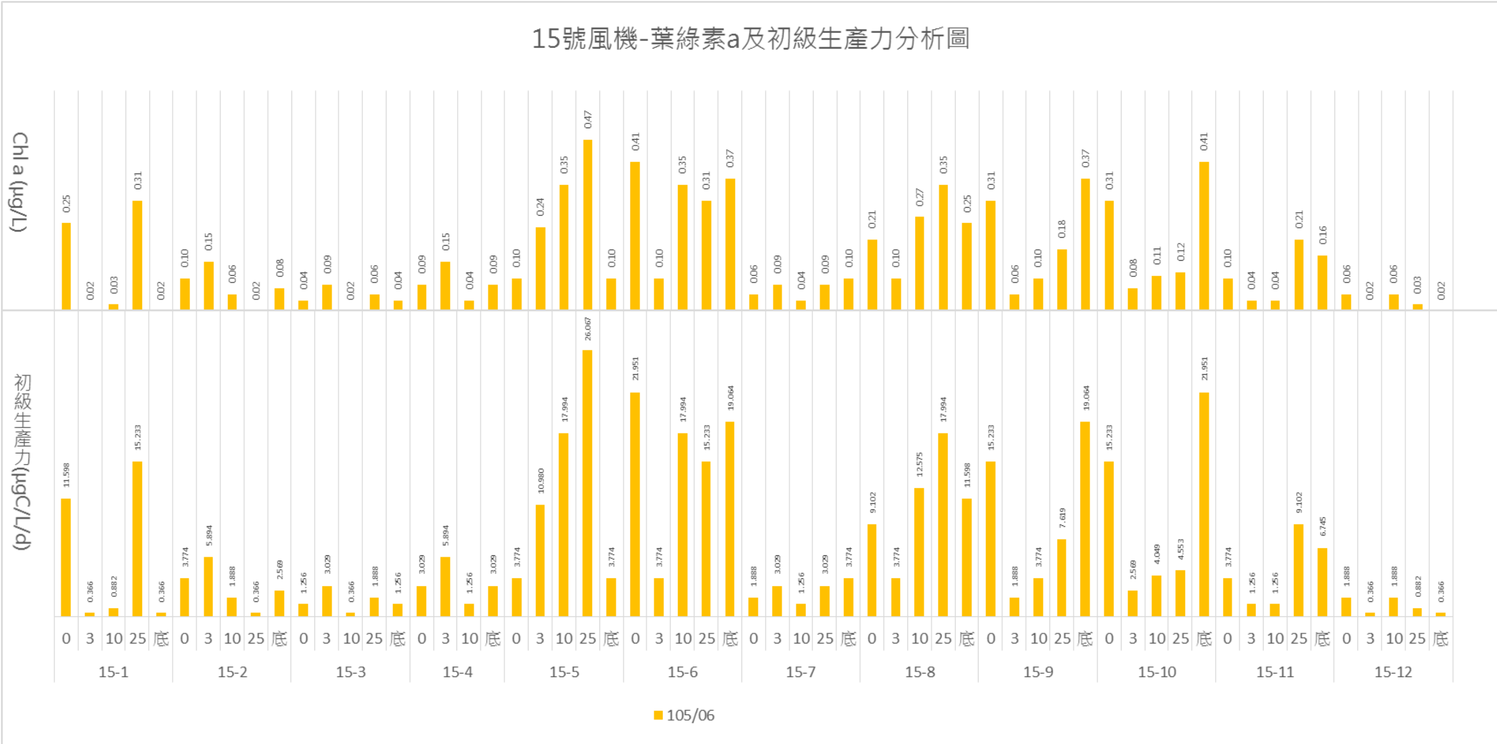


Figure 6.3.2-7 Analytical Diagram of Chlorophyll a and Primary Productivity of No.15 Wind Farm at First Quarter

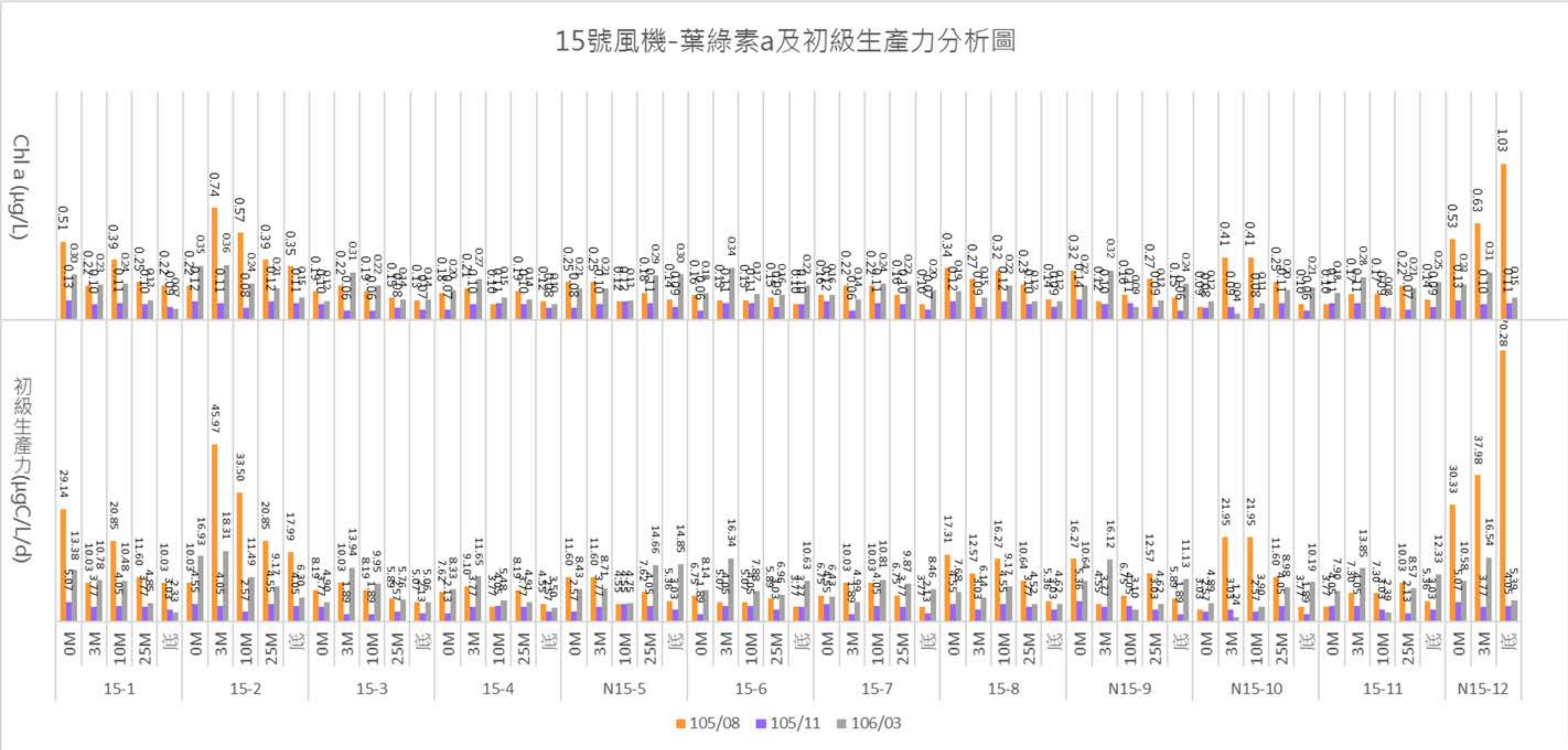
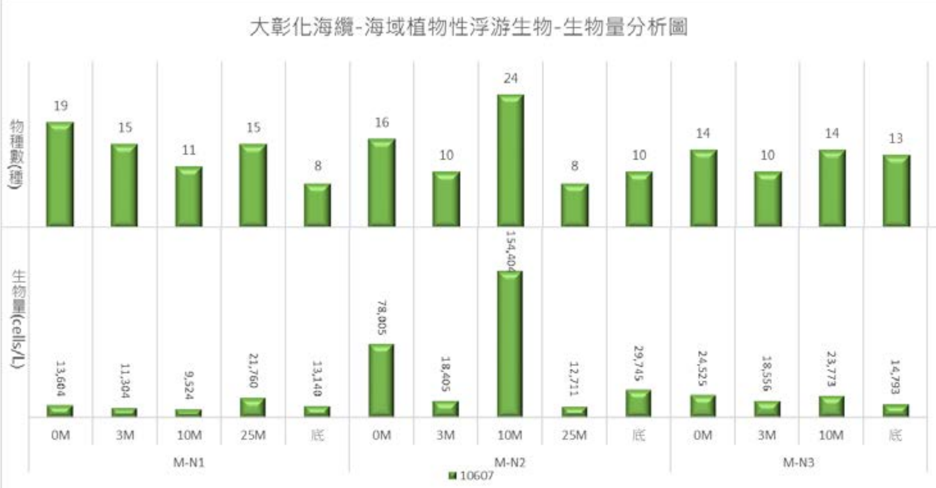
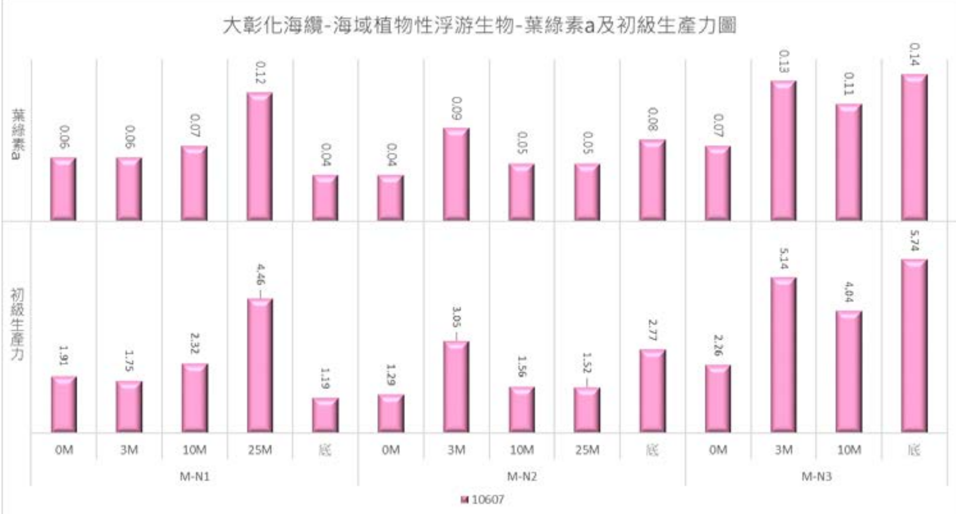


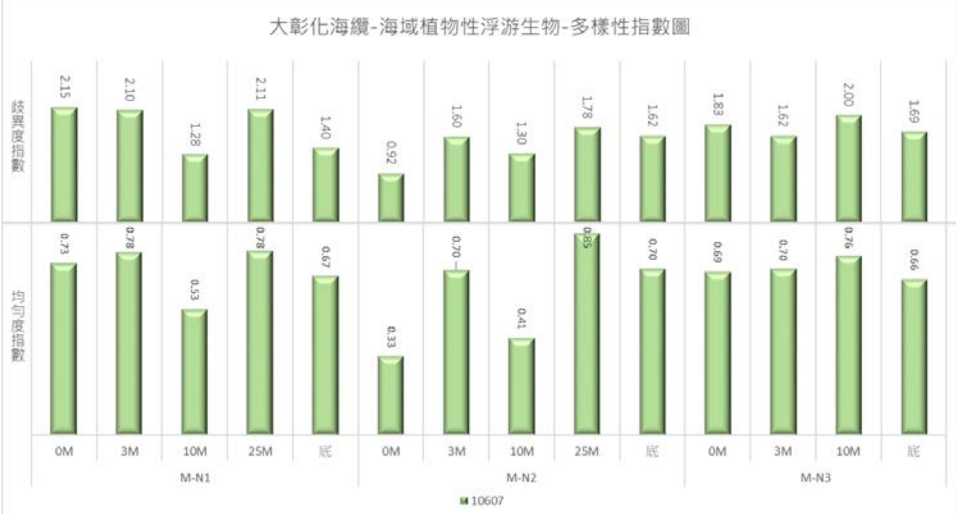
Figure 6.3.2-8 Analytical Diagram of Chlorophyll a and Primary Productivity of No.15 Wind Farm at Second, Third and Fourth Quarter



Statistical Diagram of Phytoplankton at Submarine Cable of Greater Changhua Offshore Wind Farm



Statistical Diagram of Cholorophyll a and Primary Productivity at Submarine Cable of Greater Changhua Offshore Wind Farm



Statistical Diagram of Diversity Index of Phytoplankton at Submarine Cable of Greater Changhua Offshore Wind Farm

Figure 6.3.2-9 Statistical Diagram of Marine Phytoplankton, Chlorophyll a, Primary Productivity and Diversity at Common Corridor of Lunwei Area

(ii) Zooplankton

1. Types of Composition

In the No. 21 wind farm survey result, total 8 phylum and 26 major taxa zooplankton were found (as shown in Table 6.3.2-12 and Fig. 6.3.2-10), Recording species include Chaetognatha of Chaetognatha, Siphonophore of Cnidaria, Meda of Prodzoa, Foraminifera of Protozoa, Noctiluca scintillans, Radioniaria, larvae and juveniles of Chordata, Caudata, Thaliacea, fish eggs, other mollusks of Mollusca, Heteropoda, Pteropoda, Echinoderm larva of Echinodermata, Arthropoda's Decapods larva, Ostracoda, Calanoid, Harpacticoida, Amphipoda, Cyclops, Copepod larva, Krill, Euphausiid, Mysis, Balanidae larva, Polychaeta of Annelida.

Species ranged from 13 to 18 in this season, with the most recorded species at stations 21-4, with abundances ranging from 262,369 to 9,506,827 inds./1,000 m3. The abundance recorded by station 21-12 is the highest.

In the No. 15 wind farm, the survey result of the 1st quarter shows total 8 phylums and 27 major categories zooplankton were found (as shown in Table 6.3.2-13 and Fig. 6.3.2-11), Recording species include Chaetognatha of Chaetognatha, Siphonophore of Cnidaria, Meda of Prodzoa, Foraminifera of Protozoa, Noctiluca scintillans, Radioniaria, larvae and juveniles of Chordata, Caudata, Thaliacea, fish eggs, other mollusks of Mollusca, Heteropoda, Pteropoda, Echinoderm larva of Echinodermata, Arthropoda's Decapods larva, Ostracoda, Cladocera, Calanoid, Harpacticoida, Amphipoda, Cyclops, Copepod larva, Krill, Euphausiid, Mysis, Balanidae larva, Polychaeta of Annelida.

This season, the species ranged from 18 to 26 categories, with the most recorded species at stations 15-12, with abundances ranging from 1,005,647 to 183,533,826 inds./1,000 m3, with the highest abundance recorded at station 15-1.

In the No. 15 wind farm, the survey result of the 2nd quarter shows total 8 phylum and 24 major categories zooplankton were found (as shown in Table 6.3.2-14 and Fig. 6.3.2-12), Recording species include Foraminifera of Protozoa, Mediusa of Cnidaria, Polychaeta of Annidida, Polychaeta of Annelida, Pteropoda of Mollusca, other mollusks, Ostracoda of Aphropoda, Amphipoda, Cladocera, Copepod larva, Calanoid, Cyclops, Harpacticoida, Krill, Mysis, Decapods larva , Balanidae larva, Echinoderm larva of Echinodermata, Chaetognatha of Chaetognatha, Thaliacea of Chordata, Caudata, fish eggs, larvae and juveniles.

This season, the species ranged from 11 to 19 categories, with the most recorded species at station N15-10, with abundances ranging from 995,546 to 71,804,432 inds./1,000 m3, with the highest abundance recorded at station N15-12.

In the No. 15 wind farm, the survey result of the 3rd quarter shows total 8 phylum and 26 major categories zooplankton were found (as shown in Table

6.3.2-15 and Fig. 6.3.2-12), Recording species include Foraminifera, Radiolaria of Protozoa, Medusa of Cnidaria, Polychaeta of Anelida, Pteropoda of Mollusca, Heteropoda, other mollusks, Ostracoda of Athropoda, Amphipoda, Cladocera, Copepod larva, Calanoid, Cyclops, Harpacticoida, Euphausiid, Krill, Mysis, Decapods larva, Balanidae larva, Echinoderm larva of Echinodermata, Chaetognatha of Chaetognatha, Thaliacea of Chordata, Caudata, fish eggs, larvae and juveniles.

This season, the species ranged from 14 to 21 categories, with the most recorded species at station 15-1, with abundances ranging from 1,176,413 to 18,777,576 inds./1,000 m3, with the highest abundance recorded at station N15-12.

In the fourth quarter of the 15th wind farm, 8 phylum, 25 major species of zooplankton (Table 6.3.2-16 and Figure 6.3.2-12) were found, and the recorded species included Foraminifera of Protozoa, Radiumaria, Medusa of Cnidaria, Siphonophore, Polychaeta of Annelida, Pteropoda, Heteropoda, other mollusks of Mollusca, Ostracoda of Arthropoda, Amphipoda, Copepod larva, Calanoid, Cyclops, Harpacticoida, Euphausiid, Krill, Mysis, Decapods larva, Balanidae larva, Echinoderm larva of Echinodermata, Chaetognatha Chaetognatha, Chordata's Thaliacea, Caudata, fish eggs, larvae and juveniles.

The fourth species records ranged from 12 to 19 categories, with the most recorded species at station N15-9, with abundances between 700,715 and 1,714,402 inds./1,000 m3, with the highest abundance recorded at station N15-12.

In the Changhua Offshore Wind Power Generation, the supplementary survey records of the Lunwei District for the common corridors found 8 phylum, 24 major types of zooplankton (Table 6.3.2-17). Recording species include Foraminifera of Protozoa, Mediusa of Cnidaria, Polyphona of Cnidaria, Polychaeta of Annelida, Pteropoda of Mollusca, Heteropoda, other mollusks, Ostracoda of Athropoda, Amphipoda, Cladocera, Copepod larva, Calanoid, Cyclops, Harpacticoida, Krill, Decapods larva , Balanidae larva, Chaetognatha of Chaetognatha, Thaliacea of Chordata, Caudata, fish eggs, larvae and juveniles and others.

The number of species surveyed this season ranges from 20 to 24 categories, with the most recorded species recorded at station M-N3. The abundance recorded by each station ranged from 127,158 to 421,142 inds./1,000 m3, with the highest abundance recorded at station M-N3 (Figure 6.3.2-13).

2. Analysis of Dominant Main Class

In the No. 21 wind farm survey record of various survey stations, the relative abundance of Cyclopoida accounts for the highest one (33.08 %), that of Calanoida accounts for the second one (25.31%), as that of Radiolaria accounts for the third one (13.64%), The results showed that the three species are the top three dominant species in the survey area. In addition, the frequency of three species of zooplankton, Calanoid, Cyclops and Copepod larva, was 100%, indicating that these three categories are common species of zooplankton in the sea area.

The survey result of the 1st quarter in the No. 15 wind farm of various survey stations shows the relative abundance of Calanoida accounts for the highest one (42.27 %), that of Cyclopoida accounts for the second one (20.62%), as that of Pteropoda accounts for the third one (10.64%), The results showed that the three species are the top three dominant species in the survey area. In addition, the frequency of fourteen major species of zooplankton, Chaetognatha, Medusa, Foraminifera, Radioniaria, Caudata, Thaliacea, other mollusks, Pteropoda, Echinoderm larva, Calanoid, Harpacticoida, Cyclops, Copepod larva, and Polychaeta, was 100%. . This result indicates that the fourteen categories are common species of zooplankton in the sea area of the case.

The survey result of the 2nd quarter in the No. 15 wind farm of various survey stations shows the relative abundance of Cyclopoida accounts for the highest one (36.52 %), as that of Calanoida accounts for the second one (33.78 %), The relative abundance of the rest is less than 10%. This result shows that the two species are the first two dominant species in the survey area. In addition, eight types of zooplankton, such as Foraminifera, Pteropoda, other mollusks, Copepod larva, Calanoid, Cyclops, Chaetognatha, and Caudata, have the highest frequency of occurrence, and all stations have appeared. This result indicates that these eight categories are common species of zooplankton in the planned sea area.

The survey result of the 3rd quarter in the No. 15 wind farm of various survey stations shows the relative abundance of Calanoida accounts for the highest one (42.89 %), as that of Cyclopoida accounts for the second one (29.45%), The relative abundance of the rest is less than 10%. The results showed that the two species are the first two dominant species in the survey area. In addition, nine types of zooplankton, such as Foraminifera, Pteropoda, other mollusks, Copepod larva, Calanoid, Cyclops, Decapods larva, Chaetognatha, and Caudata, have the highest frequency of occurrence, and all stations have appeared. This result indicates that the nine categories are common species of zooplankton in the planned sea area.

In the fourth quarter of the 15th wind farm, the results of each station were the highest relative abundance of Calanoid (40.96%), followed by Cyclops (36.50%), and the relative abundance of the others was less than 10%. The results showed that the two major species are the two dominant species in the survey area. In addition, six species of zooplankton, such as Siphonophore, other mollusks, Calanoid, Cyclops, Chaetognatha, and Caudata, have the highest frequency of occurrence, and all stations have appeared. This result indicates that these six categories are common species of zooplankton in the planned sea area.

In the Changhua Offshore Wind Power Generation, the supplementary survey records of the Lunwei District for the common corridors were the highest in Cyclops (43.19%) and the second in Calanoid (32.67%). The results showed that the two species are the top two dominant species in the survey area. In addition, the stations are Foraminifera, Radiumaria, Medusa, Siphonophore, Polychaeta, Pteropoda, Heteropoda, other mollusks, Amphipoda, Cladocera, Copepod larva, Calanoid, Cyclops, Harpacticoida, Decapods larva, Chaetognatha, Thaliacea, Caudata and larvae and juveniles19 Animal plankton has the highest frequency of occurrence, and each sample station appears. This result indicates that 19 categories are common species of zooplankton in the planned sea area

3. Diversity Index Analysis

The zooplankton diversity of various survey stations of No. 21 wind farm ranges between 1.51~1.91, while the Pielou's evenness (J') ranges between 0.57~0.72, The results showed that the abundance of Calanoid and Cyclops was higher than that of other species at each station, resulting in a low uniformity index of each station.

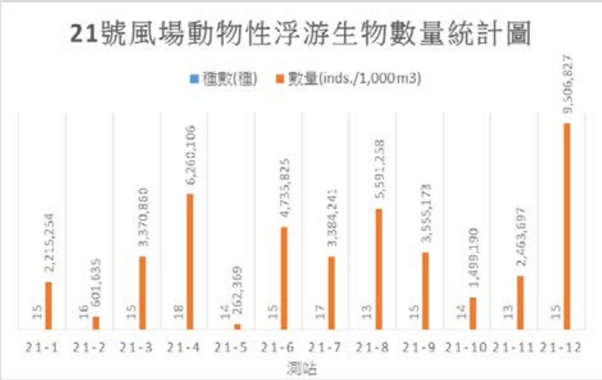
The survey result of the 1st quarter in the No. 15 wind farm of various survey stations shows the zooplankton diversity of various survey stations ranges between 1.74~2.32, while the Pielou's evenness (J') ranges between 0.55~0.77, The results showed that the stations 15-1, 15-2, 15-3, 15-4 and 15-12 had advantages over other species due to the abundance of Calanoid and Cyclops, resulting in a low uniformity index at each station.

The survey result of the 2nd quarter in the No. 15 wind farm of various survey stations shows the zooplankton diversity of various survey stations ranges between 1.48~1.92, while the Pielou's evenness (J') ranges between 0.52~0.75, The results showed that some stations were superior to other species by Calanoid and Cyclops abundance, resulting in a low partiality index for some stations.

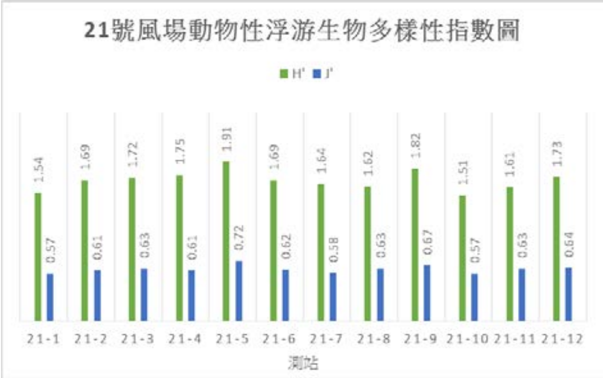
The survey result of the 3rd quarter in the No. 15 wind farm of various survey stations shows the zooplankton diversity of various survey stations ranges between 1.43~1.82, while the Pielou's evenness (J') ranges between 0.49~0.63, The results showed that the abundance of Calanoid and Cyclops was superior to other species in each station, resulting in a low uniformity index of each station.

In the fourth quarter of the 15th wind farm, the diversity index of the zooplankton species ranged from 0.94 to 1.75, and the uniformity ranged from 0.35 to 0.67, indicating that the abundance of Calanoid and Cyclops was superior to other species at each station. As a result, the uniformity index of each station is low.

In the Changhua Offshore Wind Power Generation, the supplementary survey records of the Lunwei District for the common corridors showed that the zooplankton's diversity index is between 1.52 and 1.82, and the uniformity is between 0.48 and 0.61. The stations were affected by Cyclops and Calanoid as dominant species, so that the uniformity index of each station in this survey was low (Fig. 6.3.2-13).

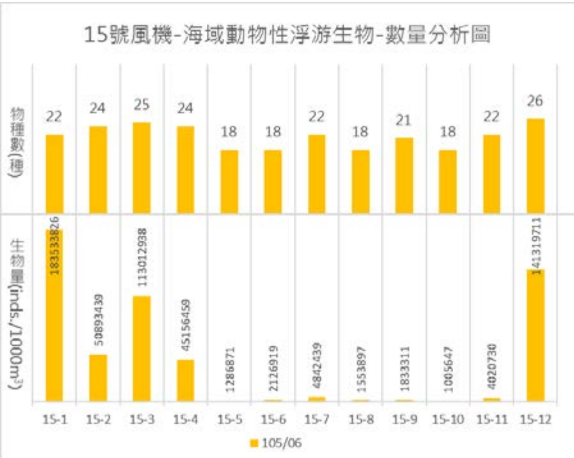


Statistical Diagram of Zooplankton at No.21 Wind Farm

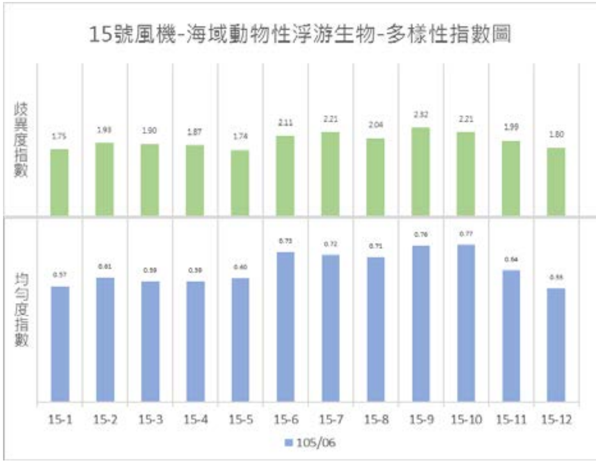


Diversity Index of Zooplankton at No.21 Wind Farm

Figure 6.3.2-10 Statistical Diagram and Diversity Index of Zooplankton at No.21 Wind Farm, Changhua Waters

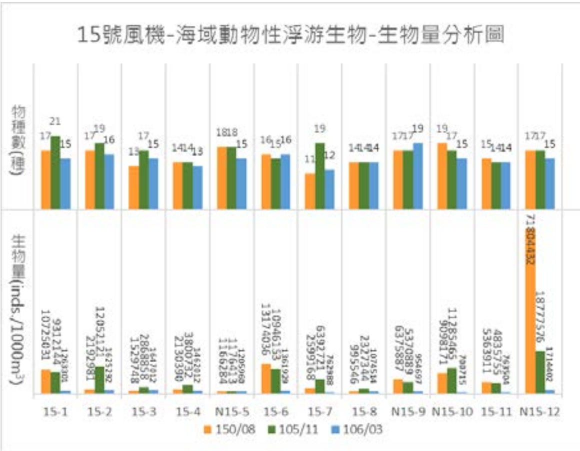


Statistical Diagram of Zooplankton at No.15 Wind Farm

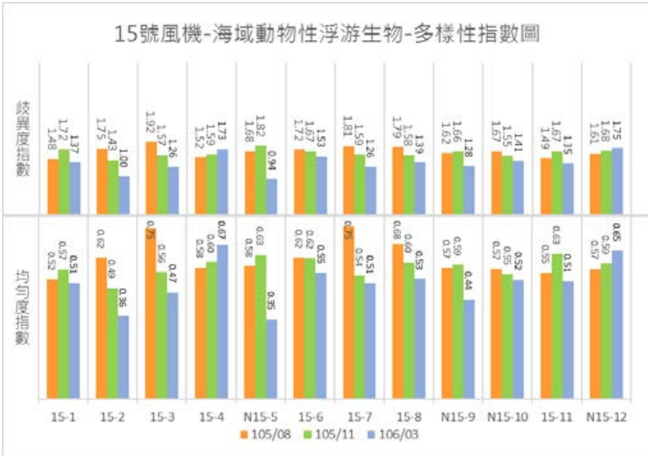


Diversity Index of Zooplankton at No.15 Wind Farm

Figure 6.3.2-11 Statistical Diagram and Diversity Index of Zooplankton at No.15 Wind Farm During First Quarter

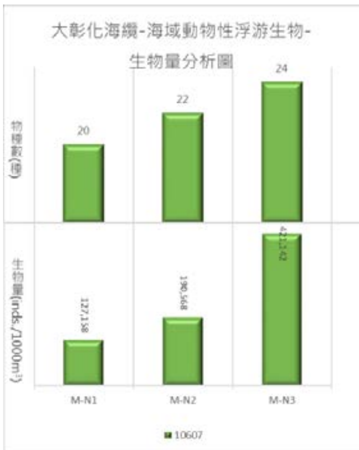


Statistical Diagram of Zooplankton at No.15 Wind Farm

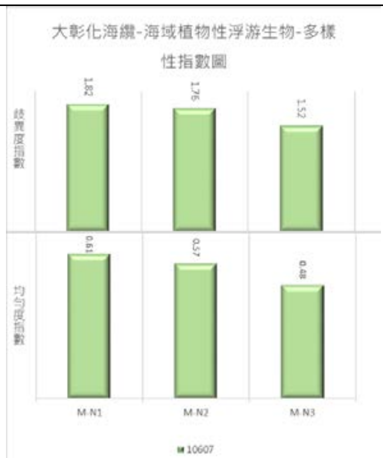


Diversity Index of Zookplankton at No.15 Wind Farm

Figure 6.3.2-12 Statistical Diagram and Diversity Index of Zooplankton at No.15 Wind Farm During Second, Third and Fourth Quarter



Statistical Diagram of Zooplankton at Submarine Cable of Greater Changhua Offshore Wind Farm



Diversity Index of Zooplankton at Submarine Cable of Greater Changhua Offshore Wind Farm

Figure 6.3.2-13 Statistics and Diversity of Zooplankton at Submarine Cable from Supplementary Survey at Common Corridor of Lunwei Area

Table 6.3.2-12 Resources Table of Marine Zooplankton at No.21 Wind Farm

Phylum	Main Class	Name	21-1	21-2	21-3	21-4	21-5	21-6	21-7	21-8	21-9	21-10	21-11	21-12	RA(%)	OR(%)
Chaetognatha	Amiskwia	Chaetognatha	1,417	8,124	41,096	58,219	110	67,609		104,794	20,548	128	131	224,558	1.21	91.67
Cnidaria	medusa	Medusa		122	206	29,110			23,817	34,932	20,548	12,780		37,427	0.37	66.67
	siphonophore	Siphonophora		122		292					206				0.00	25.00
Protozoa	foraminifera	Foraminifera	28,323		82,191	261,984	10,916	67,609	71,451	69,863	369,859	51,119	78,596	224,558	3.03	91.67
	Noctiluca scintillans	Noctiluca		8,124		146			1,191						0.02	25.00
	radiolaria	Radiolaria	481,484		349,312	698,623	21,832	676,087	762,134	209,587	1,006,839	792,341	366,777	561,394	13.64	91.67
Cephalochordata	Juvenile Fish	Fish larvae	142							524				188	0.00	25.00
	caudata	Appendicularia	1,983		20,548	145,547		135,218	166,717	279,450	143,835		26,199	486,541	3.24	75.00
	Doliolidae	Thaliacea												188	0.00	8.33
	Fish Egg	Fish eggs	1,841		103	583		339	23,817		20,548		52,397		0.23	58.33
Mollusca	Other Mollusca	Other Mollusca	284	138,100	41,096	146	32,748	339	120		20,548	51,119	393	74,853	0.83	91.67
	heterolobosea	Heteropoda		82		292		1,353		1,747			131	112,279	0.27	50.00
	Pteropoda	Pteropoda		8,124	20,548	29,110	55	339		69,863		128		37,427	0.38	66.67
Echinodermata	echinoderms	Echinodermata larva		40,618											0.09	8.33
Arthropoda	decapoda	Decapoda larvae	142	41	206	29,110	55		120			512			0.07	58.33
	Ostracoda	Ostracoda	142	8,124		146	10,916		120		103	639	131		0.05	66.67
	Calanoid	Calanoida	594,774	243,706	821,909	2,066,759	54,580	1,352,173	476,334	1,606,832	513,694	255,594	314,381	2,694,687	25.31	100.00
	Harpacticoida	Harpacticoida	141,613	40,618	328,764	582,186	10,916	304,239	214,351	104,794	102,739	25,560	419,174		5.24	91.67
	Amphipoda	Amphipoda		41			55	170	239				262		0.00	41.67
	Cyclopoida	Cyclopoida	793,031	89,359	1,253,412	1,950,322	87,328	1,385,977	1,405,184	2,165,730	1,006,839	127,797	1,074,133	3,031,523	33.08	100.00
	Copepodid	Copepoda nauplius	141,613	16,248	390,407	291,093	21,832	743,695	238,167	908,210	308,216	153,357	130,992	1,908,737	12.09	100.00
	Lucifer	Luciferidae							120						0.00	8.33
	euphausiid	Euphausiacea			514		110	339	120		103	2,556			0.01	50.00
	Mysidacea	Mysidacea												188	0.00	8.33
	Balanus	Barnacle nauplius	142												0.00	8.33
Annelida	Polychaeta	Polychaeta	28,323	82	20,548	116,438	10,916	339	239	34,932	20,548	25,560		112,279	0.85	91.67
Total(inds./1,000 m^3)			2,215,254	601,635	3,370,860	6,260,106	262,369	4,735,825	3,384,241	5,591,258	3,555,173	1,499,190	2,463,697	9,506,827		
Species Diversity Index（H'）			1.54	1.69	1.72	1.75	1.91	1.69	1.64	1.62	1.82	1.51	1.61	1.73		
Evenness Index（J'）			0.57	0.61	0.63	0.61	0.72	0.62	0.58	0.63	0.67	0.57	0.63	0.64		

Remarks: RA represents Relative Abundance, %, OR represents Occurrence Rate,%.

Table 6.3.2-13 Resources Table of Marine Zooplankton at No.15 Wind Farm Durinmg First Quarter of Survey

Phylum	Main Class	Name	15-1	15-2	15-3	15-4	15-5	15-6	15-7	15-8	15-9	15-10	15-11	15-12	RA(%)	OR(%)
Protozoa	noctiluca scintillans	Noctiluca								655					0.00	8.33
	foraminifera	Foraminifera	13,885,123	3,667,769	7,485,242	589,463	87,328	217,496	268,077	152,824	199,607	95,267	178,372	6,753,352	6.10	100.00
	radiolaria	Radiolaria	6,549,587	2,515,042	4,790,555	523,967	87,328	336,130	292,447	261,984	332,678	133,374	312,151	4,657,484	3.78	100.00
Cnidaria	medusa	Medusa	261,984	209,587	149,705	196,488	175	39,545	48,742	10,916	16,634	28,581	11,149	232,875	0.22	100.00
	Siphonophora	Siphonophora	392,976	209,587	299,410	328			24,371	6,550	8,317	19,054		349,312	0.24	75.00
Annelida	polychaeta	Polychaeta	2,095,868	733,554	2,095,868	785,951	17,466	19,773	121,853	2,184	16,634	3,811	44,593	1,862,994	1.42	100.00
Mollusca	Pteropods	Pteropoda	17,814,875	5,763,636	14,970,483	6,484,091	104,794	59,318	316,818	26,199	99,804	114,321	379,040	12,458,769	10.64	100.00
	heteropoda	Heteropoda		3,144	44,912	32,748			12,186				17,838	116,438	0.04	50.00
	Other mollusca	Other mollusca	392,976	419,174	748,525	1,178,926	17,466	29,659	146,224	21,832	24,951	19,054	33,445	1,862,994	0.89	100.00
Arthropoda	Ostracoda	Ostracoda		52,397	1,498									116,438	0.03	25.00
	Amphipoda	Amphipoda	2,620	1,048	1,498	32,748	874		1,219		84		2,230	116,438	0.03	75.00
	Cladocera	Cladocera			749	65,496	874		1,219		832		446	583	0.01	58.33
	copepod	Copepoda nauplius	7,859,504	1,991,075	4,042,031	1,899,381	17,466	98,862	438,670	65,496	66,536	22,865	200,669	4,890,358	3.92	100.00
	Calanoid	Calanoida	82,262,804	20,120,329	46,707,907	14,540,082	87,328	494,309	852,970	327,480	399,213	285,801	891,859	65,786,956	42.27	100.00
	Cyclopidae	Cyclopoida	38,249,584	9,955,372	19,162,219	13,295,661	663,692	514,081	1,437,863	349,312	216,241	152,427	1,471,567	28,061,339	20.62	100.00
	harpacticoida	Harpacticoida	785,951	104,794	1,497,049	327,480	8,733	39,545	146,224	21,832	66,536	19,054	111,483	1,513,683	0.84	100.00
	Euphausia	Euphausiacea	1,310	524	749	3,275							223	5,822	0.00	50.00
	Lucifer	Luciferidae	2,620	3,144	2,995	3,275								11,644	0.00	41.67
	Mysidacea	Mysidacea	5,240	2,096	4,492	3,275								3,494	0.00	41.67
	decapods	Decapoda larvae	261,984	104,794	149,705	98,244	874	198	1,219		832	19,054	4,460	349,312	0.18	91.67
	Balanus	Barnacle nauplius						198	122	219	16,634	5,717	2,230	1,165	0.00	58.33
Echinodermata	echinoderm	Echinodermata larvae	261,984	314,381	749	130,992	175	198	244	437	13,308	953	1,115	583	0.13	100.00
Chaetognatha	Amiskwia	Chaetognatha	5,763,636	1,991,075	3,892,326	1,964,876	104,794	118,635	438,670	174,656	166,339	19,054	133,779	4,541,047	3.51	100.00
Cephalochordata	Thaliacea	Thaliacea	2,095,868	733,554	1,497,049	261,984	17,466	98,862	73,112	110	33,268	9,527	111,483	2,561,616	1.36	100.00
	Caudata	Appendicularia	4,191,736	1,991,075	5,239,669	2,619,835	69,863	59,318	219,335	130,992	133,071	57,161	89,186	4,657,484	3.53	100.00
	Fish Egg	Fish eggs	2,620	1,048	2,995	98,244		594	732		21,625	572	22,297	116,438	0.05	83.33
	Juvenile Fish	Fish larvae	392,976	5,240	224,558	19,649	175	198	122	219	167		1,115	291,093	0.17	91.67
	Total(inds./1,000 m^3)		183,533,826	50,893,439	113,012,938	45,156,459	1,286,871	2,126,919	4,842,439	1,553,897	1,833,311	1,005,647	4,020,730	141,319,711		
	Species Diversity Index（H'）		1.75	1.93	1.90	1.87	1.74	2.11	2.21	2.04	2.32	2.21	1.99	1.80		
	Evenness Index（J'）		0.57	0.61	0.59	0.59	0.60	0.73	0.72	0.71	0.76	0.77	0.64	0.55		

Remarks: RA represents Relative Abundance, %, OR represents Occurrence Rate,%.

Table 6.3.2-14 Resources Table of Marine Zooplankton at No.15 Wind Farm Durinmg Second Quarter of Survey

Phylum	Main Class	Name	15-1	15-2	15-3	15-4	N15-5	15-6	15-7	15-8	N15-9	N15-10	15-11	N15-12	RA(%)	OR(%)
Protozoa	foraminifera	Foraminifera	314,381	153,826	204,769	78,596	46,724	860,803	172,264	45,563	209,587	377,257	165,464	1,006,017	2.86	100.00
	radiolaria	Radiolaria	151,369	38,457	84,317	78,596	60,073	224,558	129,198		75,452	279,450	193,041	586,843	1.50	91.67
Cnidaria	Medusa	Medusa		4,808	1,205		668	18,714	144	11,391		13,973			0.04	58.33
	siphonophore	Siphonophora	583	9,615	6,023		668	37,427				420		167,670	0.17	58.33
Annelida	Polychaeta	Polychaeta	34,932							3,418		41,918	13,789	586,843	0.54	41.67
Mollusca	Pteropods	Pteropoda	256,162	48,071	72,272	26,199	26,699	729,812	43,066	102,516	259,888	377,257	82,732	9,557,157	9.11	100.00
	Other mollusca	Other mollusca	151,369	67,299	84,317	45,848	26,699	261,984	86,132	34,172	142,519	251,505	82,732	1,173,686	1.89	100.00
Arthropoda	Ostracoda	Ostracoda				131	3,338				16,767		6,895	20,959	0.04	41.67
	Amphipoda	Amphipoda	583	4,808	1,205			18,714			8,384	13,973			0.04	50.00
	Cladocera	Cladocera					67					699	138	20,959	0.02	33.33
	copepod	Copepoda nauplius	582,186	163,440	96,362	170,290	66,748	580,107	358,882	22,782	310,189	307,394	634,276	2,515,042	4.57	100.00
	Calanoid	Calanoida	5,519,119	1,009,478	529,990	406,075	266,990	6,268,890	545,500	341,718	3,059,967	4,401,322	772,162	19,826,908	33.78	100.00
	Cyclopoida	Cyclopoida	2,841,065	432,634	313,176	1,126,529	560,678	2,638,548	933,092	318,937	1,542,559	2,053,951	3,033,493	30,641,585	36.52	100.00
	harpacticoida	Harpacticoida	69,863	9,615	3,614	1,310	6,675	205,845		45,563	108,986	125,753		3,982,149	3.59	83.33
	Lucifer	Luciferidae	5,822	4,808				18,714				140			0.02	33.33
	Mysidacea	Mysidacea	11,644			66					4,192	699			0.01	33.33
	Decapod	Decapoda larvae	23,288	14,422				37,427		5,696	16,767	27,945	27,578	167,670	0.25	66.67
	Balanidae	Barnacle nauplius												335,339	0.26	8.33
Echinodermata	Echinodermata	Echinodermata larvae		481			67			1,140					0.00	25.00
Chaetognatha	Amiskwia	Chaetognatha	477,393	105,755	84,317	65,496	40,049	879,516	71,777	22,782	477,858	489,036	55,155	754,513	2.77	100.00
Chordata	Doliolidae	Thaliacea		481		131	13,350		718		16,767		13,789		0.04	50.00
	Caudata	Appendicularia	279,450	124,983	48,181	130,992	40,049	374,263	258,395	34,172	125,753	335,339	261,984	377,257	1.88	100.00
	Fish Egg	Fish eggs				131	6,675			5,696	168		20,683	83,835	0.09	50.00
	Juvenile Fish	Fish larvae	5,822				67	18,714			84	140			0.02	41.67
Total(inds./1,000 m^3)			10,725,031	2,192,981	1,529,748	2,130,390	1,166,284	13,174,036	2,599,168	995,546	6,375,887	9,098,171	5,363,911	71,804,432		
Species Diversity Index（H'）			1.48	1.75	1.92	1.52	1.68	1.72	1.81	1.79	1.62	1.67	1.49	1.61		
Evenness Index（J'）			0.52	0.62	0.75	0.58	0.58	0.62	0.75	0.68	0.57	0.57	0.55	0.57		

Remarks: RA represents Relative Abundance, %, OR represents Occurrence Rate,%.

Table 6.3.2-15 Resources Table of Marine Zooplankton at No.15 Wind Farm Durinmg Third Quarter of Survey

Phylum	Main Class	Name	15-1	15-2	15-3	15-4	N15-5	15-6	15-7	15-8	N15-9	N15-10	15-11	N15-12	RA(%)	OR(%)
Protozoa	foraminifera	Foraminifera	137,887	74,853	148,193	78,596	47,276	419,174	63,512	46,233	157,191	341,188	145,915	312,817	2.21	100.00
	radiolaria	Radiolaria	82,732		84,682	91,695	55,155	228,641	79,389		78,596	243,706	145,915	234,613	1.49	83.33
Cnidaria	Medusa	Medusa	27,578	24,951	3,176	6,550	788	19,054	159			12,186		15,641	0.12	75.00
	siphonohore	Siphonophora	13,789	49,902				9,527		155		1,219		31,282	0.12	50.00
Annelida	Polychaeta	Polychaeta	137,887	74,853						15,411		24,371	13,265	156,409	0.47	50.00
Mollusca	Pteropoda	Pteropoda	165,464	49,902	52,926	52,397	39,397	209,587	79,389	107,876	130,992	402,115	106,120	516,147	2.15	100.00
	heteropoda	Heteropoda	138	250											0.00	16.67
	Other Mollusca	Other mollusca	330,927	249,509	84,682	91,695	47,276	342,961	285,801	184,930	244,518	182,780	132,650	860,245	3.41	100.00
Arthropoda	Ostracoda	Ostracoda	27,578	49,902	5,293	1,310	3,940	19,054	15,878	15,411			6,633	7,821	0.17	83.33
	Amphipoda	Amphipoda		500						15,411	4,367	12,186	13,265		0.05	41.67
	Cladocera	Cladocera									88	610			0.00	16.67
	copepod	Copepoda nauplius	193,041	249,509	105,852	196,488	70,913	419,174	698,623	46,233	192,122	402,115	663,250	1,219,983	5.00	100.00
	Calanoid	Calanoida	4,274,467	6,437,308	1,196,127	1,152,728	362,444	4,725,229	2,985,024	909,237	2,523,774	5,885,489	1,697,919	6,084,273	42.89	100.00
	Cyclop	Cyclopoida	1,820,096	3,068,949	973,838	1,611,199	417,598	3,220,015	1,556,023	832,183	1,257,521	2,619,835	1,591,799	7,288,615	29.45	100.00
	Aegisthus aculeatus	Harpacticoida	55,155	99,804	21,171	13,100	7,880	247,694	63,512		78,596	182,780		1,392,032	2.42	83.33
	euphausiid	Euphausiacea							159						0.00	8.33
	Lucifer	Luciferidae	2,758	24,951		655	394	19,054	7,939						0.06	50.00
	Mysidacea	Mysidacea	1,379		106				794		4,367	61			0.01	41.67
	Decapods	Decapoda larvae	110,309	174,656	1,059	6,550	788	57,161	15,878	15,411	17,466	24,371	13,265	46,923	0.54	100.00
	Balanus	Barnacle nauplius	27,578						477					93,845	0.14	25.00
Echinodermata	echinoderm	Echinodermata larvae	27,578	24,951	1,059		3,940								0.06	33.33
Chaetognatha	Amiskwia	Chaetognatha	1,323,706	1,022,983	116,438	130,992	63,034	666,867	254,045	61,644	384,243	548,338	106,120	344,098	5.63	100.00
Chordata	Doliolidae	Thaliacea					7,880		159		17,466				0.03	25.00
	caudata	Appendicularia	551,545	374,263	74,097	366,777	47,276	342,961	285,801	77,054	279,450	402,115	198,975	172,049	3.56	100.00
	Fish Eggs	Fish eggs			106		394		159	155	88		664	783	0.00	58.33
	Juvenile Fish	Fish larvae	552	125	53		40				44				0.00	41.67
Total(inds./1,000 m^3)			9,312,144	12,052,121	2,868,858	3,800,732	1,176,413	10,946,153	6,392,721	2,327,344	5,370,889	11,285,465	4,835,755	18,777,576		
Species Diversity Index（H'）			1.72	1.43	1.57	1.59	1.82	1.67	1.59	1.58	1.66	1.55	1.67	1.68		
Evenness Index（J'）			0.57	0.49	0.56	0.60	0.63	0.62	0.54	0.60	0.59	0.55	0.63	0.59		

Remarks: RA represents Relative Abundance, %, OR represents Occurrence Rate,%.

Table 6.3.2-16 Resources Table of Marine Zooplankton at No.15 Wind Farm Durinmg Fourth Quarter of Survey

Phylum	Main Class	Name	15-1	15-2	15-3	15-4	N15-5	15-6	15-7	15-8	N15-9	N15-10	15-11	N15-12	RA(%)	OR(%)
Protozoa	foraminifera	Foraminifera	428	19,773	170		12,780	56			54		341	25,560	0.41	66.67
	radiolaria	Radiolaria			57									128	0.00	16.67
Cnidaria	Medusa	Medusa	21,387	791		55,155	12,780	223		624		538		512	0.63	66.67
	siphonophore	Siphonophora	42,773	19,773	902	110,309	512	223	72	12,476	214	202	681	25,560	1.47	100.00
Annelida	polychaeta	Polychaeta	42,773		45,073	193,041	895	11,149	1,149	49,902	32,080	605	13,610	102,238	3.39	91.67
Mollusca	Pteropods	Pteropoda	535	396	11,269	27,578	320	279	503		214		205	25,560	0.46	83.33
	heteropoda	Heteropoda			57										0.00	8.33
	Other mollusca	Other mollusca	21,387	1,088	22,537	27,578	1,917	44,593	14,356	500	10,694	269	13,610	255,594	2.85	100.00
Arthropoda	Ostracoda	Ostracoda		99			512	56			214	26,871	69		0.19	50.00
	Amphipoda	Amphipoda					64								0.00	8.33
	copepodite	Copepoda nauplius	21,387	39,545	282	27,578	51,119	111,483		49,902	32,080		27,220	25,560	2.66	83.33
	Calanoid	Calanoida	598,820	1,107,251	507,065	386,081	779,561	312,151	373,237	424,164	256,637	147,786	421,896	638,985	40.96	100.00
	Cyclopoidae	Cyclopoida	449,115	336,130	856,377	551,545	332,272	635,450	200,974	436,640	545,354	362,747	190,534	408,950	36.50	100.00
	harpacticoida	Harpacticoida	21,387		113	138		44,593	72	12,476	21,387	26,871	13,610		0.97	75.00
	Euphausiacea	Euphausiacea		99		138		56			268				0.00	33.33
	Lucifer	Luciferidae				138						68			0.00	16.67
	Mysidacea	Mysidacea								63	107	68			0.00	25.00
	decapod	Decapoda larvae	321	198	282		64	892	14,356		1,177	13,436	13,610	639	0.31	83.33
	Balanus	Barnacle nauplius	107						144	63					0.00	25.00
Echinodermata	Echinodermata	Echinodermata larvae	107	198				56			107		69		0.00	41.67
Chaetognatha	Amiskwia	Chaetognatha	21,387	79,090	123,950	27,578	320	44,593	14,356	24,951	21,387	26,871	54,439	76,679	3.55	100.00
Chordata	Doliolidae	Thaliacea		989			64		216	250	321	269			0.01	50.00
	Urodelidea	Appendicularia	21,387	19,773	67,609	55,155	12,780	156,076	143,553	62,378	21,387	94,046	13,610	127,797	5.47	100.00
	Fish Eggs	Fish eggs		99	11,269					125	10,694	68		512	0.16	50.00
	Juvenile Fish	Fish larvae									321			128	0.00	16.67
	Total(inds./1,000 m3)		1,263,301	1,625,292	1,647,012	1,462,012	1,205,960	1,361,929	762,988	1,074,514	954,697	700,715	763,504	1,714,402		
	Species Diversity Index（H'）		1.37	1.00	1.26	1.73	0.94	1.53	1.26	1.39	1.28	1.41	1.35	1.75		
	Evenness Index（J'）		0.51	0.36	0.47	0.67	0.35	0.55	0.51	0.53	0.44	0.52	0.51	0.65		

Remarks: RA represents Relative Abundance, %, OR represents Occurrence Rate,%.

Table 6.3.2-17 Resources Table of Marine Zooplankton at Common Corridor of Lunwei Area During Supplmentary Survey

Pylum	Main Class	Name	10607			RA	OR
			M-N1	M-N2	M-N3	(%)	(%)
Protozoa	foraminifera	Foraminifera	4,658	6,619	5,869	2.32	100.00
	Radiolaria	Radiolaria	12,576	1,655	2,795	2.30	100.00
Cnidaria	Medusa	Medusa	1,398	1,104	280	0.38	100.00
	Siphonophora	Siphonophora	1,398	552	280	0.30	100.00
Annelida	polychaeta	Polychaeta	466	552	1,118	0.29	100.00
Mollusca	Pteropods	Pteropoda	1,863	828	6,987	1.31	100.00
	heteropoda	Heteropoda	932	276	839	0.28	100.00
	Other mollusca	Other mollusca	1,863	13,238	17,606	4.43	100.00
Arthropoda	Ostracoda	Ostracoda	466		1,118	0.21	66.67
	Amphipoda	Amphipoda	466	552	559	0.21	100.00
	Cladocera	Cladocera	2,795	17,374	8,105	3.83	100.00
	copepod	Copepoda nauplius	466	1,655	1,957	0.55	100.00
	Calanoid	Calanoida	36,795	62,325	142,240	32.67	100.00
	Cyclopoida	Cyclopoida	51,233	70,598	197,292	43.19	100.00
	harpacticoida	Harpacticoida	3,261	4,964	12,296	2.78	100.00
	decapod	Decapoda larvae	1,398	1,379	2,516	0.72	100.00
	Balanidae	Barnacle nauplius			280	0.04	33.33
	Lucifer	Luciferidae		552	280	0.11	66.67
Chaetognatha	Amiskwia	Chaetognatha	1,863	2,482	8,663	1.76	100.00
Chordata	Doliolidae	Thaliacea	466	1,104	559	0.29	100.00
	Caudata	Appendicularia	2,329	1,655	6,987	1.48	100.00
	Fish Eggs	Fish eggs		276	1,118	0.19	66.67
	Juvenile Fish	Fish larvae	466	552	559	0.21	100.00
Others	Others	Others		276	839	0.15	66.67
	Total(inds./1,000 m^3)		127,158	190,568	421,142		
	Species Diversity Index（H'）		1.82	1.76	1.52		
	Evenness Index（J'）		0.61	0.57	0.48		

Remarks: RA represents Relative Abundance, %, OR represents Occurrence Rate,%.

(iii) Benthic Organism

1. Composition of Species

Wind farm no. 21 records a total number of 6 orders, 12 families, and 15 species (as shown in table 6.3.2-18 and figure 6.3.2-14), recorded species include giant tun, Hemifusus colosseus, Babylonia areolata, Indian volute, Duplicaria badia, cone-shaped Nassa, Nudibranchs, neritic squid, spiny sand seastar, Portunus hastatoides, blood-spotted swimming crab, Parapenaeopsis hardwickii, Metapenaeopsis barbata, Calappa lophos, and Calappa philargius.

Wind farm no. 21 also records two types of corals, namely Cavernularia obesa and Pteroeides sparmanni Kölliker. The main research methodology for corals, as outlined by the Technical Guidance for Animal Ecological Assessment, is diving surveys, with coverage as its unit. The research methodologies and units used in this research varies on a case by case basis. The aforementioned research methodology only applies to this paragraph.

For the first quarter, the number of species in the first station is 2~5 species, with coverage of 6~16 organisms per trial, with the highest number of organisms in station 21-4.

The survey results of the first quarter on wind farm no. 15 records 4 orders, 7 families, and 10 species of benthos (table 6.3.2-19 and figure 6.3.2-15), recorded species include Babylonia areolata, Duplicaria badia, Terebra nebulosa, cone-shaped Nassa, Crenocrassatella foveolata, spiny sand seastar, Portunus hastatoides, blood-spotted swimming crab, Parapenaeopsis hardwickii, and Metapenaeopsis barbata.

The number of species in each station in the first quarter ranges from 2~4 species, with the ecological density of 2~9 ind, with the highest number in stations 15-5, 15-10, and 15-11.

The survey results for the second quarter on wind farm no. 15 records 6 orders, 11 families, and 13 species of benthos (table 6.3.2-20 and figure 6.3.2-16), recorded species include Cavernularia obesa, Babylonia areolata, Terebra nebulosa, Duplicaria badia, cone-shaped Nassa, Crenocrassatella foveolata, spiny sand seastar, Diogenidae, Portunus hastatoides, Parapenaeopsis hardwickii, Metapenaeopsis barbata, Matuta victor, and Nereis.

The survey results of the second quarter on wind farm no. 15 records 6 orders, 11 families, and 13 species of benthos (table 6.3.2-20 and figure 6.3.2-16), recorded species include Cavernularia obesa, Babylonia areolata, Terebra nebulosa, Duplicaria badia, cone-shaped Nassa, Crenocrassatella foveolata, spiny sand seastar, Diogenidae, Portunus hastatoides, Parapenaeopsis hardwickii, Metapenaeopsis barbata, Matuta victor, and Nereis.

The number of species found in each station in the second quarter is 2~4 species, with an ecology density of 3~8 ind/net, with the highest density in station 15-3.

The survey results of the third quarter records 5 orders, 11 families, and 14 species of benthos (table 6.3.2-21 and figure 6.3.2-16), and recorded species include Cavernularia obesa, Pteroeides sparmanni Kölliker, giant tun, Hemifusus colosseus, Babylonia areolata, Indian volute, cone-shaped Nassa, spiny sand seastar, Portunus hastatoides, blood-spotted swimming crab, Parapenaeopsis hardwickii, Metapenaeopsis barbata, Calappa lophos, and Calappa philargius.

The number of species in each station in the third quarter ranges from 0~5 species, with an ecological density of 0~13 ind/net, with the highest density in stations 15-6 and 15-8.

The survey results of the fourth quarter in wind farm no. 15 records 8 orders, 14 families, and 17 species of benthos (table 6.3.2-22 and figure 6.3.2-16), recorded species include Cavernularia obesa, Pteroeides sparmanni Kölliker, giant tun, Babylonia areolata, Terebra nebulosa, Duplicaria badia, cone-shaped Nassa, pencil squids, Crenocrassatella foveolata, spiny sand seastar, Diogenidae, Portunus hastatoides, blood-spotted swimming crab, Parapenaeopsis hardwickii, Metapenaeopsis barbata, Matuta victor, and Nereis.

The number of species in each station in the fourth quarter ranges from 2~5 species, with the highest number of species in stations 15-2 and N15-12. Ecological density is 4~12 ind/net, with the highest abundance in stations 15-4 and N15-12.

Supplementary surveys on the same topic are done by The Greater Changhua Offshore Wind Farm with results showing 3 orders, 4 families, and 4 species of benthos (table 6.3.2-23). Species recorded include Java turrid, Nassarius nodifer, Parapenaeopsis hardwickii, and Nereis.

Supplementary survey shows that each station has 0~3 species, with station M-N3 having the highest number of species. Ecological density ranges from 0~6 ind/net, with station M-N3 having the highest amount (figure 6.3.2-17)

2. Dominant species analysis

The survey record of wind farm no. 21 shows that the Parapenaeopsis hardwickii has the highest ecological density (26.19%), with spiny sand seastar placing second at 25.40%, followed by Metapenaeopsis barbata (8.73%). This shows that these three species have the highest ecological density among benthos in the territorial waters in this case. Among all species of benthos, Parapenaeopsis hardwickii is the most common species found in this territory at the appearance level of 58.33%.

In the first quarter, the survey record of wind farm no. 15 shows that the spiny sand seastar has the highest ecological density (16.67%), with cone-shaped Nassa placing second at 14.29%, followed by Metapenaeopsis barbata (13.10%). This shows that these three species have the highest ecological density among benthos in the territorial waters in this case. Among all the species of benthos, the spiny sand seastar is the most common species found in this territory at the appearance level of 66.67%.

In the second quarter, the survey record of wind farm no. 15 shows that the Metapenaeopsis barbata has the highest ecological density (21.88%), with Portunus hastatoides placing second at 15.63%, followed by cone-shaped Nassa (10.94%). This shows that these three species have the highest ecological density among benthos in the territorial waters in this research. Among all species of benthos, Parapenaeopsis hardwickii is the most common species found in this territory in this research with the highest level of appearance.

In the third quarter, the survey record of wind farm no. 15 shows that the spiny sand seastar has the highest ecological density (22.89%), with Parapenaeopsis hardwickii placing second at 14.46%, followed by Metapenaeopsis barbata (12.05%). This shows that these three species have the highest ecological density among benthos in the territorial waters in this research. Among all the species of benthos, the spiny sand seastar and Metapenaeopsis barbata is the most common species found in this territory in this research with the highest level of appearance.

In the fourth quarter, the survey record of wind farm no. 15 shows that cone-shaped Nassa has the highest ecological density (15.09%), with the spiny sand seastar and Portunus hastatoides placing second at 13.21%. This shows that these three species have the highest ecological density among benthos in the territorial waters in this research. Among all the species of benthos, the cone-shaped Nassa and spiny sand seastar are the most common species found in this territory in this research with the highest level of appearance.

Supplementary surveys on Changhua Lunwei District on the same topic are done by The Greater Changhua Offshore Wind Farm with results showing that Nassarius nodifer has the highest ecological density at 44.44%. This shows that this species has the highest ecological density among benthos in the territorial waters in this research. Among all the species of benthos, the Nassarius nodifer is the most common species found in this territory in this research with the highest level of appearance.

3. Analysis of Diversity Index

Survey results from wind farm no. 21 shows dissimilarity index between 0.64~1.49, uniformity index between 0.69~0.98, with station 21-6 recording the most numbers of species, therefore it has the highest level of dissimilarity index.

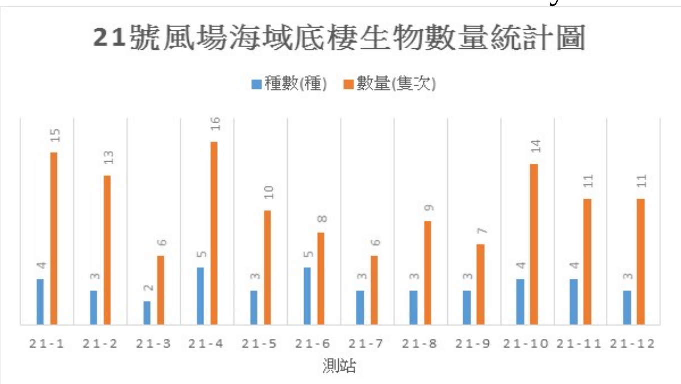
First quarter survey results from wind farm no. 15 shows a dissimilarity index between 0.69~1.37, uniformity index between 0.87~1.00, which shows that species population is evenly distributed and there are no dominant species.

Second quarter survey results from wind farm no. 15 shows a dissimilarity index between 0.64~1.33, uniformity index between 0.86~1.00, which shows that species population is evenly distributed and there are no dominant species.

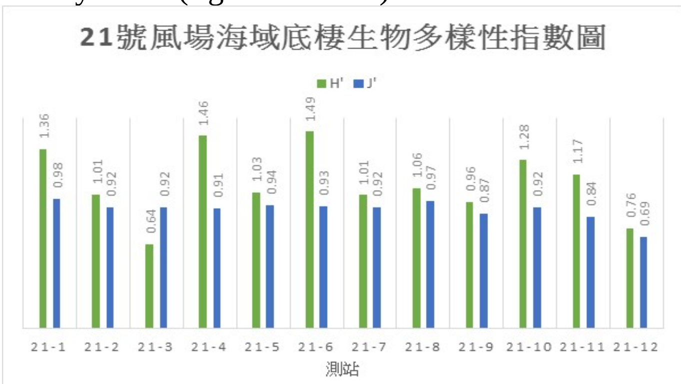
Third quarter survey results from wind farm no. 15 shows a dissimilarity index between 0.50~1.50, uniformity index between 0.72~1.00. Station N15-5 failed to record species, therefore it is difficult to calculate various indices, which shows that species population is evenly distributed and there are no dominant species.

Fourth quarter survey results from wind farm no. 15 shows a dissimilarity index between 0.56~1.56, uniformity index between 0.81~0.99. Station 15-3 showed a lower level of ecological density compared to other stations, therefore having comparably lower dissimilarity index and uniformity index.

Supplementary surveys on Changhua Lunwei District on the same topic are done by The Greater Changhua Offshore Wind Farm with results showing that each station has a dissimilarity index between 0.64~1.10, uniformity index between 0.92~1.00. Station M-N2 failed to record species, therefore impossible to calculate dissimilarity index and uniformity index (figure 6.3.2-17).

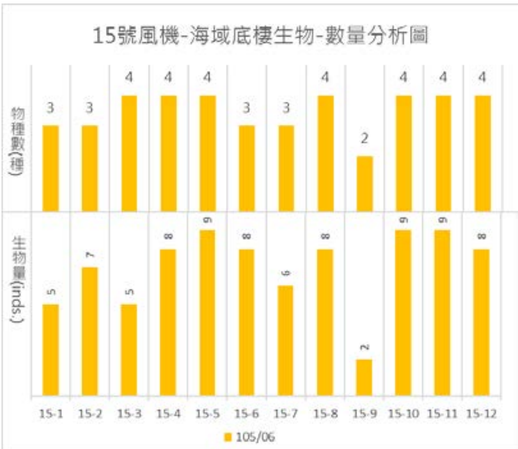


Statistical Diagram of Marine Benthic Organism at No.21 Wind Farm



Diversity of Marine Benthic at No.21 Wind Farm

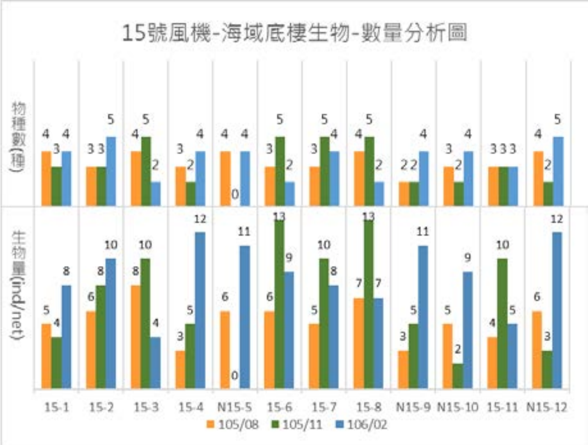
Figure 6.3.2-14 Statistics and Diversity of Benthic Organism at No.21 Wind Farm



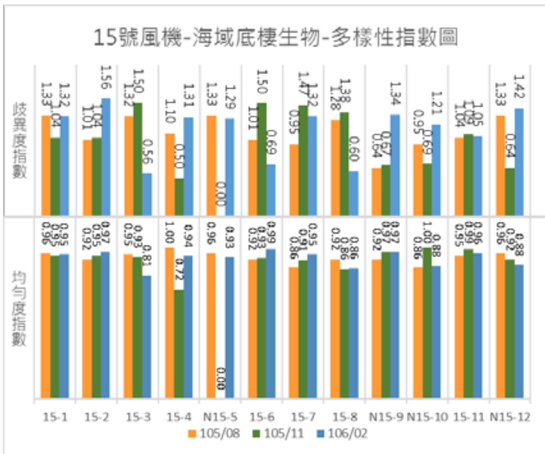
Statistical Diagram of Benthic Organism at No.15 Wind Farm

Diveristy of Benthic Organism at No.15 Wind Farm

Figure 6.3.2-15 Statistical Diagram and Diversity of Benthic Organism at No.15 Wind Farm During First Survey

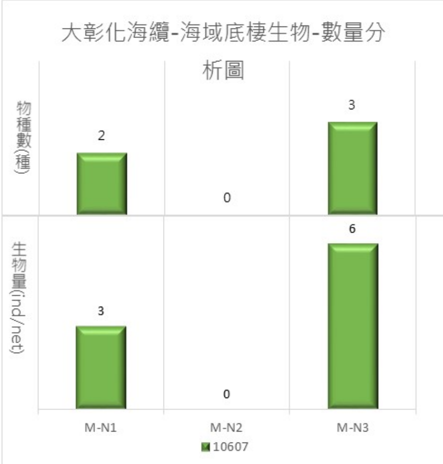


Statistical Diagram of Benthic Organism at No.15 Wind Farm

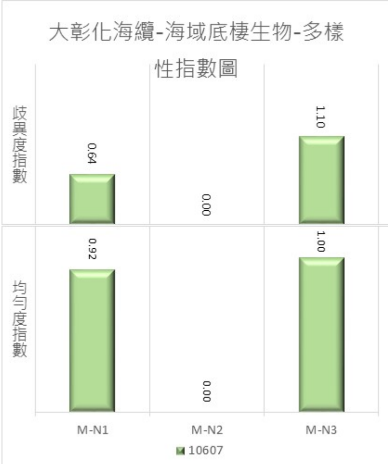


Diversity of Benthic Organsim at No.15 Wind Farm

Figure 6.3.2-16 Statistical Diagram and Diversity of Benthic Organism at No.15 Wind Farm During Secong, Third and Fourth Surveys



Statistical Diagram of Benthic Organism at Submarine Cable



Diversity of Benthic Organism at Submarine Cable

Figure 6.3.2-17 Statistical Diagram and Diversity of Benthic Organism at Common Corridor of Lunwei Area During Supplementary Survey

Table 6.3.2-18 Resource Table of Benthic Organism at No.21 Wind Farm

Order	Family	Chinese Name	Scientific Name	Endemism	Protected Level	21-1	21-2	21-3	21-4	21-5	21-6	21-7	21-8	21-9	21-10	21-11	21-12	RA(%)	OR(%)
Heteropoda	Tonnidae	栗色鶉螺	*Tonna olearium*						2									1.59	8.33
Neogastropoda	Melongenidae	長香螺	*Hemifusus colosseus*								1							0.79	8.33
	Buccinidae	象牙鳳螺	*Babylonia areolata*					2					3					3.97	16.67
	Volutacea	椰子渦螺	*Melo melo*						1			1					1	2.38	25.00
	TEREBRIDAE	顯眼櫛笥螺	*Duplicaria badia*											4	4			6.35	16.67
	NASSARUUDAE	球織紋螺	*Niotha conoidalis*			3						3		2	2			7.94	33.33
Nudibranchia		海蛞蝓	*Nudibranchia* sp.								1							0.79	8.33
Teuthida	Loliginidae	小管	*Loliginidae* spp.						6			2						6.35	16.67
Notomyotida	Luidiidae	砂海星	*Luidia quinaria*			4	6	4	4	5	2		4	1		2		25.40	75.00
Decapoda	Portunoidea	矛形梭子蟹	*Portunus hastatoides*												2		2	3.17	16.67
		紅星梭子蟹	*Portunus sanguinolentus*										2					1.59	8.33
	Penaeidae	哈氏仿對蝦	*Parapenaeopsis hardwickii*			5	2			3	3				6	6	8	26.19	58.33
		鬚赤蝦	*Metapenaeopsis barbata*				5		3	2						1		8.73	33.33
	Calappidae	卷折饅頭蟹	*Calappa lophos*													2		1.59	8.33
		逍遙饅頭蟹	*Calappa philargius*			3					1							3.17	16.67
Total						15	13	6	16	10	8	6	9	7	14	11	11		
Species Diversity Index（*H'*）						1.36	1.01	0.64	1.46	1.03	1.49	1.01	1.06	0.96	1.28	1.17	0.76		
Evenness Index（*J'*）						0.98	0.92	0.92	0.91	0.94	0.93	0.92	0.97	0.87	0.92	0.84	0.69		

Remarks:1. Unit: Individual
Remarks:2. RA represents Relative Abundance, %; OR represents Occurrence Rate,%.

Table 6.3.2-19 Resource Table of Benthic Organism at No.15 Wind Farm During First Quarter of Survey

Order	Family	Chinese Name	Scientific Name	Endemism	Protected Level	15-1	15-2	15-3	15-4	15-5	15-6	15-7	15-8	15-9	15-10	15-11	15-12	RA（%）	OR（%）
Neogastropoda	Buccinidae	象牙鳳螺	*Babylonia areolata*				2					1		1			2	7.14	33.33
	TEREBRIDAE	顯眼櫛筍螺	*Duplicaria badia*										3			3		7.14	16.67
		紅雲筍螺	*Terebra nebulosa*							3					2		1	7.14	25.00
	NASSARUUDAE	球織紋螺	*Niotha conoidalis*						3	1		3	2				3	14.29	41.67
VENEROIDA	Veneridae	厚蛤	*Bathytormus foveolatus*					1	1	3		2			3			11.90	41.67
Notomyotida	Luidiidae	砂海星	*Luidia quinaria*			1	1	1		2	3		2		2		2	16.67	66.67
Decapoda	Portunoidea	矛形梭子蟹	*Portunus hastatoides*			2		1							2	1		7.14	33.33
		紅星梭子蟹	*Portunus sanguinolentus*						1				1	1		2		5.95	33.33
	Penaeidae	哈氏仿對蝦	*Parapenaeopsis hardwickii*			2					3					3		9.52	25.00
		鬚赤蝦	*Metapenaeopsis barbata*				4	2	3		2							13.10	33.33
Total						5	7	5	8	9	8	6	8	2	9	9	8		
Species Diversity Index（*H'*）						1.05	0.96	1.33	1.26	1.31	1.08	1.01	1.32	0.69	1.37	1.31	1.32		
Evenness Index（*J'*）						0.96	0.87	0.96	0.91	0.95	0.99	0.92	0.95	1.00	0.99	0.95	0.95		

Remarks:1. Unit: Individual

Remarks:2. RA represents Relative Abundance, %; OR represents Occurrence Rate,%.

Table 6.3.2-20 Resource Table of Benthic Organism at No.15 Wind Farm During Second Quarter of Survey

Order	Family	Chinese Name	Scientific Name	Endemism	Protected Level	15-1	15-2	15-3	15-4	N15-5	15-6	15-7	15-8	N15-9	N15-10	15-11	N15-12	RA(%)	OR(%)
Pennatulacea	Cactaceae	海仙人掌	*Cavernularia* sp.														1	1.56	8.33
Neogastropoda	Buccinidae	象牙鳳螺	*Babylonia areolata*										3				2	7.81	16.67
	TEREBRIDAE	紅雲筍螺	*Terebra nebulosa*						1						1			3.13	16.67
		顆眼櫛筍螺	*Duplicaria badia*										2				1	4.69	16.67
	NASSARUUDAE	球織紋螺	*Niotha conoidalis*				2	1	1						3			10.94	33.33
VENEROIDA	Veneridae	厚蛤	*Bathytormus foveolatus*			1				2		1			1			7.81	33.33
Notomyotida	Luidiidae	砂海星	*Luidia quinaria*					2				1	1				2	9.38	33.33
Decapoda	Diogenidae	活額寄居蟹	*Diogenes* spp.							2								3.13	8.33
	Portunoidea	矛形梭子蟹	*Portunus hastatoides*			2	1	2			2			2		1		15.63	50.00
	Penaeidae	哈氏仿對蝦	*Parapenaeopsis hardwickii*			1		3		1			1					9.38	33.33
		鬚赤蝦	*Metapenaeopsis barbata*			1	3		1		3	3		1		2		21.88	58.33
	Matutidae	頑強黎明蟹	*Matuta victor*							1						1		3.13	16.67
Nereid	Nereididae	沙蠶	Gen. sp (Nereididae)								1							1.56	8.33
Total						5	6	8	3	6	6	5	7	3	5	4	6		
Species Diversity Index（*H'*）						1.33	1.01	1.32	1.10	1.33	1.01	0.95	1.28	0.64	0.95	1.04	1.33		
Evenness Index（*J'*）						0.96	0.92	0.95	1.00	0.96	0.92	0.86	0.92	0.92	0.86	0.95	0.96		

Remarks:1. Unit: Individual

Remarks:2. RA represents Relative Abundance, %; OR represents Occurrence Rate,%.

Table 6.3.2-21 Resource Table of Benthic Organism at No.15 Wind Farm During Third Quarter of Survey

Order	Family	Chinese Name	Scientific Name	Endemism	Protected Level	15-1	15-2	15-3	15-4	N15-5	15-6	15-7	15-8	N15-9	N15-10	15-11	N15-12	RA(%)	OR(%)
Pennatulacea	Cactaceae	海仙人掌	*Cavernularia* sp.				4					1		2				8.43	25.00
	Pennatulidae	斯氏棘海腮	*Pteroeides sparmanni*					1					3	3				8.43	25.00
Heteropoda	Tonnidae	栗色鶉螺	*Tonna olearium*								2							2.41	8.33
Neogastropoda	Melongenidae	長香螺	*Hemifusus colosseus*									1						1.20	8.33
	Buccinidae	象牙鳳螺	*Babylonia areolata*					1										1.20	8.33
	Volutacea	椰子渦螺	*Melo melo*						1				1		1			3.61	25.00
	NASSARUUDAE	球織紋螺	*Niotha conoidalis*				2						1					3.61	16.67
Notomyotida	Luidiidae	砂海星	*Luidia quinaria*			1		3			4	4	6		1			22.89	50.00
Decapoda	Portunoidea	矛形梭子蟹	*Portunus hastatoides*					3			4					3		12.05	25.00
		紅星梭子蟹	*Portunus sanguinolentus*										2					2.41	8.33
	Penaeidae	哈氏仿對蝦	*Parapenaeopsis hardwickii*			1	2				2	2				4	1	14.46	50.00
		鬚赤蝦	*Metapenaeopsis barbata*					2	4		1					3		12.05	33.33
	Calappidae	卷折饅頭蟹	*Calappa lophos*														2	2.41	8.33
		逍遙饅頭蟹	*Calappa philargius*			2						2						4.82	16.67
Total						4	8	10	5	0	13	10	13	5	2	10	3		
Species Diversity Index（*H'*）						1.04	1.04	1.50	0.50	-	1.50	1.47	1.38	0.67	0.69	1.09	0.64		
Evenness Index（*J'*）						0.95	0.95	0.93	0.72	-	0.93	0.91	0.86	0.97	1.00	0.99	0.92		

Remarks:1. Unit: Individual

Remarks:2. RA represents Relative Abundance, %; OR represents Occurrence Rate,%.

Table 6.3.2-22 Resource Table of Benthic Organism at No.15 Wind Farm During Fourth Quarter of Survey

Order	Family	Chinese Name	Scientific Name	Endemism	Protected Level	15-1	15-2	15-3	15-4	N15-5	15-6	15-7	15-8	N15-9	N15-10	15-11	N15-12	RA(%)	OR(%)
Pennatulacea	Cactaceae	海仙人掌	Cavernularia sp.					1		3						2	1	6.60	33.33
	Pennatulidae	斯氏棘海腮	Pteroeides sparmanni						2									1.89	8.33
Heteropoda	Tonnidae	栗色鶉螺	Tonna olearium												1			0.94	8.33
Neogastropoda	Buccinidae	象牙鳳螺	Babylonia areolata														2	1.89	8.33
	TEREBRIDAE	紅雲筍螺	Terebra nebulosa								4			2				5.66	16.67
		顯眼櫛筍螺	Duplicaria badia						3									2.83	8.33
	NASSARUUDAE	球織紋螺	Niotha conoidalis			2	2		2		5	3				2		15.09	50.00
Teuthida	Loliginidae	Loliginidae	(Gen. spp) Loliginidae													1		0.94	8.33
VENEROIDA	Veneridae	厚蛤	Bathytormus foveolatus			3						1		4	1			8.49	33.33
Notomyotida	Luidiidae	砂海星	Luidia quinaria			1	1	3		1				3			5	13.21	50.00
Decapoda	Diogenidae	活額寄居蟹	Diogenes spp.												3			2.83	8.33
	Portunoidea	矛形梭子蟹	Portunus hastatoides			2	3			4				2			3	13.21	41.67
		紅星梭子蟹	Portunus sanguinolentus				2		5			2						8.49	25.00
	Penaeidae	哈氏仿對蝦	Parapenaeopsis hardwickii				2											1.89	8.33
		鬚赤蝦	Metapenaeopsis barbata							3		2	5					9.43	25.00
	Matutidae	頑強黎明蟹	Matuta victor										2				1	2.83	16.67
Nereid	Nereididae	沙蠶	Gen. sp (Nereididae)												4			3.77	8.33
Total						8	10	4	12	11	9	8	7	11	9	5	12		
Species Diversity Index（H’）						1.32	1.56	0.56	1.31	1.29	0.69	1.32	0.60	1.34	1.21	1.05	1.42		
Evenness Index（J’）						0.95	0.97	0.81	0.94	0.93	0.99	0.95	0.86	0.97	0.88	0.96	0.88		

Table 6.3.2-23 Resource Table of Benthic Organism at Common Corridor at Lunwei Area During Supplementary Survey

Order	Family	Chinese Name	Scientific Name	Endemism Protected Level	10607			RA(%)	OR(%)
					M-N1	M-N2	M-N3		
Neogastropoda	Turridae	臺灣捲管螺	*Turricula javana*		1			11.11	33.33
	NASSARUUDAE	粗肋織紋螺	*Nassarius nodifer*		2		2	44.44	66.67
Decapoda	Penaeidae	哈氏仿對蝦	*Parapenaeopsis hardwickii*				2	22.22	33.33
Nereid	Nereididae	沙蠶	(Gen. sp) Nereididae				2	22.22	33.33
Total(inds./net)					3	0	6		
Species Diversity Index（*H'*）					0.64	0.00	1.10		
Evenness Index（*J'*）					0.92	-	1.00		

(iv) Ecology of Benthic organisms at Intertidal Zone

1. Types of Composition

First result of the research discovers 10 order, 13 families and 26 species of Benthos (Table 6.3.2-24, Figure 6.3.2-18), being recorded species including Pacific Crab(Hemigrapsus sanguineus), Grapsus albolineatus, Mictyris brevidactylus, the Robust Shell (Littoraria undulata),Granulilittorina exigua, Pyramid Periwinkle(Nodilittorina pyramidalis), Nerita polita, The Blotched Nerite (Nerita albicilla), Nerita plicata, Schrenck's limpet (nipponacmea schrenckii), Nipponacmea concinna, Patelloida striata, Thick-lipped monodont (Monodonta labio), Chaetopterus sp., Haliplanella luciae, Fistulobalanus albicostatus, Amphitrite's rock barnacle (Amphibalanus amphitrite), Thais clavigera, Manila clam (Venerupis philippinarum) , Korean cyclina clam (Cyclina sinensis), saccostrea kegaki, Ostrea denselamellosa, the Pacific oyster (Crassostrea gigas), Natal Rock Oyster (Saccostrea mordax), Crassostrea echinata and Siphonaria laciniosa.

Research results of each station shows the number of recording species are between 6 to 14 types, abundance is between 81 ~ 303 inds./m2, the station which records the highest abundance and the highest number of species is with tide 1 to 2.

Second result of the research discovers 15 orders, 26 families and 54 species of Benthos (Table 6.3.2-25, Figure 6.3.2-18), being recorded species including Pacific Crab (Hemigrapsus sanguineus), Penicillate shore crab (Hemigrapsus penicillatus) , Estuarine crab (Helice formosensis), Helicana doerjesi, Red-Clawed Crab(Perisesarma bidens), Mudflat crab (Parasesarma pictum), Uca arcuata, Uca lactea, Sentinel Crab(Macrophthalmus banzai), Horn-Eyed Ghost crab (Ocypode ceratophthalmus), Northern Calling Fiddler Crab (Uca borealis), Stimpson's ghost crab (Ocypode stimpsoni), Sand bubbler crab (Scopimera bitympana), Mictyris brevidactylus, Diogenes edwardsii, Portunidae, Hermit crabs (Paguroidea), Ghost Shrimp (Austinogebia edulis), the Robust Shell (Littoraria undulata) , the mangrove periwinkle(Littorina scabra), Granulilittorina exigua, Pyramid Periwinkle(Nodilittorina pyramidalis), Nereis, Sipunculus nudus, Nerita polita, The Blotched Nerite (Nerita albicilla), Nerita ocellata, Nerita chamaeleon, Schrenck's limpet (nipponacmea schrenckii), Nipponacmea concinna, Thick-lipped monodont (Monodonta labio), solid pheasant (Phasianella solida), Chaetopterus, Fistulobalanus albicostatus, Amphitrite's rock barnacle (Amphibalanus amphitrite), Thais clavigera, the pimpled nassa (Nassarius papillosus), Plicarcularia pullus, the channeled nassa (Nassarius dorsatus), Manila clam (Venerupis philippinarum), Korean cyclina clam (Cyclina sinensis), Asian hard clam (Meretrix lusoria), Mactra veneriformis, Saccostrea kegaki, Ostrea denselamellosa, the Pacific oyster (Crassostrea gigas), Scartelaos histophorus, Periophthalmini, Sea Roach (Ligia exotica), Natica gualteriana, Tiger Moon Snail (Notocochlis tigrina), Duck

Lantern Clam(Laternula anatina), Lingula anatina.

Research results of each station shows the number of recording species are between 3 to 22 types, the highest number of the species recording at the station is mostly with tide –15 or –16. abundance is between 41~ 301 inds./m2, The highest abundance is recorded at the station with tide –1.

Third result of the research discovers 11 orders, 19 families and 30 species of Benthos (Table 6.3.2-26, Figure 6.3.2-18), being recorded species including Thin-shelled rock crab (Grapsus tenuicrustatus), Grapsus albolineatus, Uca lactea, Sentinel Crab(Macrophthalmus banzai), Horn-Eyed Ghost crab (Ocypode ceratophthalmus), Stimpson's ghost crab (Ocypode stimpsoni), Sand bubbler crab (Scopimera bitympana), Mictyris brevidactylus, Diogenes edwardsii, Giant Mud Crab (Scylla serrata), Black Fingered Crab(Leptodius sanguineus), the Robust Shell (Littoraria undulata), the mangrove periwinkle(Littorina scabra), Granulilittorina exigua, Pyramid Periwinkle(Nodilittorina pyramidalis), The Blotched Nerite (Nerita albicilla), Schrenck's limpet (nipponacmea schrenckii), Nipponacmea concinna, Thick-lipped monodont (Monodonta labio), the Crowned Turban Shell (Lunella coronata), Chaetopterus, Amphitrite's rock barnacle (Amphibalanus amphitrite), Tetraclita squamosa, Thais clavigera, Saccostrea kegaki, the Pacific oyster (Crassostrea gigas), Periophthalmini, Barbatia, Liolophura and Sea Roach (Ligia exotica).

Research results of each station shows the number of recording species are between 4 to 14 types, the highest number of the species recording at the station is mostly with tide –4. Abundance is between 51~ 191 inds., The highest abundance is recorded at the station with tide –13.

Fourth result of the research discovers 10 main objects, 17 subjects and 29 types of Benthos (table 6.3.2-27, chart 6.3.2-18), being recorded species including Thin-shelled rock crab (Grapsus tenuicrustatus), Grapsus albolineatus, Mictyris brevidactylus, The mangrove swimming crab (Thalamita crenata), Black fingered crab(Leptodius affinis), the Robust Shell (Littoraria undulata), the mangrove periwinkle (Littorina scabra), Granulilittorina exigua, Pyramid Periwinkle(Nodilittorina pyramidalis), The Blotched Nerite (Nerita albicilla), Nerita planospira, Nerita undata, Nerita plicata, Clithon retropictum, Schrenck's limpet (nipponacmea schrenckii), Nipponacmea concinna, Thick-lipped monodont (Monodonta labio), the Crowned Turban Shell (Lunella coronata), Chaetopterus, Haliplanella lineata, Amphitrite's rock barnacle (Amphibalanus amphitrite), Thais clavigera, the pimpled nassa (Nassarius papillosus), Saccostrea kegaki, Ostrea denselamellosa, the Pacific oyster (Crassostrea gigas), Natal Rock Oyster (Saccostrea mordax), Sea Roach (Ligia exotica) and Modiolus metcalfei.

Research results of each station shows the number of recording species are between 6 to 14 types, the highest number of the species being recorded at the station is mostly with tide –5. Abundance is between 96~ 366 inds., The highest abundance is recorded at the station with tide –4.

Fifth result of the research discovers 14 orders, 27 families and 45 species of Benthos (table 6.3.2-28, chart 6.3.2-18), being recorded species including Grapsus albolineatus, Thin-shelled rock crab (Grapsus tenuicrustatus), Mudflat crab (Parasesarma pictum), Penicillate shore crab (Hemigrapsus penicillatus), Rocky shore crab (Gaetice depressus), Horn-Eyed Ghost crab (Ocypode ceratophthalmus), Stimpson's ghost crab (Ocypode stimpsoni), Mictyris brevidactylus, Diogenes edwardsii, Black fingered crab(Leptodius affinis), Japanese porcellanid crab (Petrolisthes japonicus), Alpheus pacificus, the Robust Shell (Littoraria undulata), the mangrove periwinkle(Littorina scabra), Granulilittorina exigua, Pyramid Periwinkle(Nodilittorina pyramidalis), Nereis, Siphonaria laciniosa, Nerita planospira, The Blotched Nerite (Nerita albicilla), Schrenck's limpet (nipponacmea schrenckii), Patelloida striata, Nipponacmea concinna, the Crowned Turban Shell (Lunella coronata), Thick-lipped monodont (Monodonta labio), Chaetopterus, Haliplanella lineata, Siphonaria laciniosa, Amphitrite's rock barnacle (Amphibalanus amphitrite), Sea Roach (Ligia exotica), Modiolus metcalfei, Asian Green Mussel (Perna viridis), Liolophura, Thais clavigera, the pimpled nassa (Nassarius papillosus), Plicarcularia pullus, Indomitrella martensi, Asian Hard Clam (Meretrix lusoria) , the lyrate Asiatic hard clam (Meretrix lyrata), Japanese Dosinia (Dosinorbis japonica), Ostrea denselamellosa, the Pacific oyster (Crassostrea gigas), Natal Rock Oyster (Saccostrea mordax), the Portuguese Oyster (Crassostrea angulata) and Saddle Tree Oyster (Isognomon ephippium).

Research results of each station shows the number of recording species are between 6 to 18 types, the highest number of the species recording at the station is mostly with tide –2 and -6. Abundance is between 73~ 199 inds., The highest abundance is recorded at the station with tide –1.

Greater Changhua offshore wind power generation adds supplementary research at LunWei district in similar fields discovers 14 main objects, 27 subjects and 34 types of Benthos (table 6.3.2-29), being recorded species including Rocky shore crab (Gaetice depressus), Grapsus albolineatus, Stimpson's ghost crab (Ocypode stimpsoni), Macrobrachium australe, Diogenes edwardsii, Clibanarius virescens, Smith's dark fingered crab (Eriphia smithi), Banded-legged swimming crab (Charybdis annulata), Japanese porcellanid crab (Petrolisthes japonicus), Snapping Shrimp (Alpheus pacificus), Matuta victor, the Robust Shell (Littoraria undulata) , Granulilittorina exigua, Pyramid Periwinkle (Nodilittorina pyramidalis), Nereis, Cellana grata, Cellana toreuma, Nerita costata, The Blotched Nerite (Nerita albicilla), Schrenck's limpet (nipponacmea schrenckii), the Broad-ribbed limpet (Patelloida saccharina), Thick-lipped monodont (Monodonta labio), Chaetopterus, Beadlet anemone (Actinia equina), Haliplanella luciae, Tetraclita squamosa, Amphitrite's rock barnacle (Amphibalanus amphitrite), Sea Roach (Ligia exotica), Septifer bilocularis, Liolophura, Thais clavigera, Manila clam (Venerupis philippinarum), Natal

Rock Oyster (Saccostrea mordax) and Bathygobius cyclopterus.

Research results of each station shows the number of recording species are between 14 to 20 types, the number of the species being recorded at the station IT-N2 is the least. Abundance is between 117~ 171 inds., The highest abundance is recorded at the station IT-N1 (Figure 6.3.2-20).

2. analysis of dominance of main class

In the first survey at each testing station, the density of Amphibalanus Amphitrite is the highest (33.33%), follow by Fistulobalanus Albicostatus (11.03%) and Granulilittorina exigua (10.42%), which shows that these three species are the first three dominant species in this experimenting intertidal zone. Besides that, the frequency of occurrence of the benthic organism, which is Amphibalanus Amphitrite, Oyster drills and Granulilittorina exigua is about 83.33%, which shows that they are the common species at this intertidal zone.

In the second survey at each testing station, the density of Amphibalanus Amphitrite is the highest (38.98%), and the others are lower than 10%, which shows that it is the most dominant species in this experimenting intertidal zone. Besides that, the frequency of occurrence of this benthic organism, Amphibalanus Amphitrite is the highest, which shows that this species is the common species at this intertidal zone.

In the third survey at each testing station, the density of Amphibalanus Amphitrite is the highest (34.88%), follow by Granulilittorina exigua (17.01%), and the others are lower than 10%, which shows that this two species are the most dominant species in the experimenting intertidal zone. Next, the frequency of occurrence of Amphibalanus Amphitrite is the highest, which shows that it is the common species in this intertidal zone.

In the fourth survey at each testing station, the density of Amphibalanus Amphitrite is the highest (30.30%), and the others are lower than 10%, which shows that this species is the dominant species in the intertidal zone. Besides that, the frequency of occurrence of Nodilittorina pyramidalis is the highest, which shows that it is the common species in this intertidal zone.

In the fifth survey at each testing station, the density of Amphibalanus Amphitrite is the highest (27.93%), follow by Granulilittorina exigua (13.36%) and Nodilittorina pyramidalis (10.96%), which shows that these three species are the most dominant species in this intertidal zone. Besides that, the frequency of occurrence of Oyster drills is the highest, which shows that it is the common species in this intertidal zone.

In the supplementary investigation record carried out by the Greater Changhua Offshore Wind Power focusing at the same location, it shows that the density of Nodilittorina pyramidalis is the highest (12.83%), follow by Amphibalanus Amphitrite (10.65%) and sea slater (10.17%), which shows that these three species as the dominant species in this intertidal zone. Besides that, the frequency of occurrence of Nodilittorina pyramidalis, Cellana toreuma, Nerita albicilla, sea slater, Oyster drills and saccostrea mordax are the highest, which shows that they are the common species in this intertidal zone.

3. Analysis of diversity index

In the first testing area, the dissimilarity of benthic species is between 1.36 and 1.94, whereas the evenness is between 0.74 and 0.86. The result shows that in each testing area the diversity index does not have significant differences, which means that each testing area is rich in species and does not have obvious dominant species, as shown in figure 6.3.2-19.

In the second testing area, the dissimilarity of benthic species is between 1.01 and 2.62, whereas the evenness is between 0.65 and 0.96. At testing area 3,4, and 17, the Amphibalanus Amphitrite is the dominant species, and the distribution of the species is uneven, which cause the evenness to be the lowest, as shown in figure 6.3.2-19.

In the third testing area, the dissimilarity of benthic species is between 0.65 and 2.13, whereas the evenness is between 0.47 and 0.91. At testing area 1 and 14, the Amphibalanus Amphitrite is the dominant species, and at the testing area 15 and 16, the dominant species is Granulilittorina exigua. The distribution of the species is uneven, which causes the evenness is lower than the other testing area, as shown in figure 6.3.2-19

In the fourth testing area, the dissimilarity of benthic species is between 1.15 and 2.14, whereas the evenness is between 0.61 and 0.97. At testing area 4, the psilocranium nigrican and eriocheir sinensis is the dominant species, and at the testing area 13 and 14, the dominant species is Amphibalanus Amphitrite. The distribution of the species is uneven, which causes the evenness to be the lowest, as shown in figure 6.3.2-19.

n the fifth testing area, the dissimilarity of benthic species is between 1.69 and 2.36, whereas the evenness is between 0.75 and 0.95. At testing area 13, the dissimilarity is lower because of the record of species is lesser as shown in figure 6.3.2-19

In the supplementary investigation record carried out by the Greater Changhua Offshore Wind Power focusing at the same location, it shows that the dissimilarity of benthic species is between 2.34-2.70, evenness is between 0.86 and 0.90. There is only a little difference of dissimilarity of benthic species between the 3 testing station, which shows that the diversity index does not have obvious difference. Besides that, the evenness also does not have obvious difference, which means that in the 3 testing area, the species concentration does not have obvious dominant species as shown in figure 6.3.2-20.

Table 6.3.2-24 Resource Table of Intertidal Zone Benthic Organism During First Quarter of Survey

Order	Family	Chinese Name	Scientific Name	Endemism	Protected Level	潮 1-1	潮 1-2	潮 1-3	潮 1-4	潮 1-5	潮 1-6	RA(%)	OR(%)
	Grapsidae	肉球近方蟹	*Hemigrapsus sanguineus*				2	1				0.36	33.33
Decapoda		白紋方蟹	*Grapsus albolineatus*								1	0.12	16.67
	Mictyridae	短指和尚蟹	*Mictyris brevidactylus*				41					4.97	16.67
	Littorinidae	波紋玉黍螺	*Littoraria undulata*			14		13		21		5.82	50.00
Mesogastropoda		細粒玉黍螺	*Nodilittorina radiata*			12	23	21	14		16	10.42	83.33
		顆粒玉黍螺	*Nodilittorina pyramidalis*			18		23	17		10	8.24	66.67
	Neritidae	玉女蜑螺	*Nerita polita*				7					0.85	16.67
		漁舟蜑螺	*Nerita albicilla*				9			14	11	4.12	50.00
		白肋蜑螺	*Nerita plicata*							2		0.24	16.67
Archeogastropoda	Lottiidae	花青螺	*Notoacmea schrenckii*				3			4		0.85	33.33
		高青螺	*Notoacmea concinna*					5	4			1.09	33.33
		射線青螺	*Patelloida striata*							5	3	0.97	33.33
	Trochidae	草蓆鐘螺	*Monodonta labio*								8	0.97	16.67
Spionida	Chaetopteridae	燐蟲 sp.	*Chaetopteridae sp.*				5					0.61	16.67
Actiniaria	Haliplanellidae	縱條磯海葵	*Haliplanella luciae*				1					0.12	16.67
Sessilia	Balanidae	白脊管藤壺	*Fistulobalanus albicostatus*				91					11.03	16.67
		紋藤壺	*Amphibalanus amphitrite*			86	84	35	41		29	33.33	83.33
Neogastropoda	Muricidae	蚵岩螺	*Thais clavigera*			10	10	8		9	3	4.85	83.33
VENEROIDA	Veneroida	花蛤	*Gomphina aequilatera*				1					0.12	16.67
		環文蛤	*Cyclina sinensis*							1		0.12	16.67
	glyphaeidae	刺牡蠣	*Saccostrea kegaki*				11					1.33	16.67
		拖鞋牡蠣	*Ostrea denselamellosa*				15	8	10			4.00	50.00
Pterioida		長牡蠣	*Crassostrea angulata*			15						1.82	16.67
		黑齒牡蠣	*Saccostrea mordax*							21		2.55	16.67
		棘牡蠣	*Crassostrea echinata*								5	0.61	16.67
BASOMMATOPHORA	Siphonariidae	花松螺	*Siphonaria laciniosa*							4		0.48	16.67
		Total(inds./m^2)				155	303	114	86	81	86		
		Species Diversity Index（*H'*）				1.39	1.94	1.80	1.36	1.86	1.86		
		Evenness Index（*J'*）				0.78	0.74	0.86	0.85	0.85	0.85		

Remarks:1. RA represents Relative Abundance, %; OR represents Occurrence Rate,%.

Table 6.3.2-25 Resource Table of Intertidal Zone Benthic Organism During Second Quarter of Survey (1/2)

Order	Family	Chinese Name	Scientific Name	Endemism	Protected Level	105/06																		RA(%)	OR(%)
						潮-1	潮-2	潮-3	潮-4	潮-5	潮-6	潮-7	潮-8	潮-9	潮-10	潮-11	潮-12	潮-13	潮-14	潮-15	潮-16	潮-17	潮-18		
Decapoda	Grapsidae	肉球近方蟹	*Hemigrapsus sanguineus*								1		1											0.08	11.11
		絨毛近方蟹	*Hemigrapsus penicillatus*						1											2			1	0.15	16.67
		臺灣厚蟹	*Helice formosensis*					2																0.08	5.56
		德氏仿厚蟹	*Helicana doerjesi*						1															0.04	5.56
		雙齒近相手蟹	*Perisesarma bidens*					2											2			1		0.19	16.67
		斑點擬相手蟹	*Parasesarma pictum*						1											2	2	3		0.30	22.22
	Ocypodidae	弧邊招潮蟹	*Uca arcuata*			6	11	3	15													1		1.37	27.78
		清白招潮蟹	*Uca lactea*			11	12	5	2											5		7	7	1.86	38.89
		萬歲大眼蟹	*Macrophthalmus banzai*			5	6		6											3	5	4	1	1.14	38.89
		角眼沙蟹	*Ocypode ceratophthalmus*				3													2	1			0.23	16.67
		北方招潮蟹	*Uca borealis*				5													2	4	5	6	0.84	27.78
		斯氏沙蟹	*Ocypode stimpsoni*								3		3											0.23	11.11
		雙扇股窗蟹	*Scopimera bitympana*											9										0.34	5.56
	Mictyridae	短指和尚蟹	*Mictyris brevidactylus*				6				32		32							16	5		11	3.88	33.33
	Diogenidae	艾氏活額寄居蟹	*Diogenes edwardsii*				2																	0.08	5.56
	Portunoidea	梭子蟹	*Charybdis* sp.								1		1											0.08	11.11
			Portunidae sp.																		1		2	0.11	11.11
	Paguridae	寄居蟹	*Paguroidea* sp.																2		2			0.15	11.11
	Thalassinidea	美食奧螻蛄蝦	*Austinogebia edulis*																		1			0.04	5.56
Mesogastropoda	Littorinidae	波紋玉黍螺	*Littoraria undulata*			36	28	26	35	12		12								11				6.08	38.89
		粗紋玉黍螺	*Littoraria scabra*			21	16	16	15					11	11	12	11	11	21		18	16	16	7.41	72.22
		細粒玉黍螺	*Nodilittorina radiata*							11	16	11	16	8			12	12						3.27	38.89
		顆粒玉黍螺	*Nodilittorina pyramidalis*			16				15		15		15	8	15	15	15						4.33	44.44
Nereid	Nereididae	Nereididae 的一種	*Nereididae* sp.			6	5	2	5													2	5	0.95	33.33
Sipunculoid	Sipunculus	光裸方格星蟲	*Sipunculus nudus*				2		1											1	3			0.27	22.22
Archeogastropoda	Neritidae	玉女蜑螺	*Nerita polita*								5		5											0.38	11.11
		漁舟蜑螺	*Nerita albicilla*			8	3	5	12		6		6								2		6	1.82	44.44
		滑圓蜑螺	*Nerita ocellata*																	1				0.04	5.56
		大圓蜑螺	*Nerita chamaeleon*																	2	1			0.11	11.11
	Lottiidae	花青螺	*Notoacmea schrenckii*								5		5											0.38	11.11
		高青螺	*Notoacmea concinna*							2		2												0.15	11.11
	TROCHIDAE	草蓆鐘螺	*Monodonta labio*			8	5	4	8		3		3						3		2		4	1.52	50.00
	Phasianellidae	雉螺	*Phasianella solida*																14					0.53	5.56
Spionida	Chaetopteridae.	燐蟲	*Chaetopteridae* sp.								8		8											0.61	11.11

Remarks:1. RA represents Relative Abundance, %; OR represents Occurrence Rate,%.

Table 6.3.2-25 Resource Table of Intertidal Zone Benthic Organism During Second Quarter of Survey (2/2)

Order	Family	Chinese Name	Scientific Name	Endemism	Protected Level	105/06																		RA(%)	OR(%)
						潮-1	潮-2	潮-3	潮-4	潮-5	潮-6	潮-7	潮-8	潮-9	潮-10	潮-11	潮-12	潮-13	潮-14	潮-15	潮-16	潮-17	潮-18		
Sessilia	Balanidae	白脊管藤壺	*Fistulobalanus albicostatus*								77		77											5.85	11.11
		紋藤壺	*Amphibalanus amphitrite*			150	86	88	120	76	75	76	75	23	22	23	25	25	28		35	76	23	38.98	94.44
Neogastropoda	Muricidae	蚵岩螺	*Thais clavigera*			6	9	8	14	8	8	8	8	5		4			6	3	9	12	7	4.37	83.33
	NASSARUUDAE	疣織紋螺	*Nassarius papillosus*																		7		1	0.30	11.11
		蟹螯織紋螺	*Plicarcularia pullus*																	8	5			0.49	11.11
		光滑織紋螺	*Zeuxis dorsatus*																	2				0.08	5.56
VENEROIDA	Veneridae	花蛤	*Gomphina aequilatera*								1		1											0.08	11.11
		環文蛤	*Cyclina sinensis*				2		1											6			6	0.57	22.22
		文蛤	*Meretrix lusoria*																	5				0.19	5.56
	Mactridae	方形馬珂蛤	*Mactra veneriformis*																	25	25			1.90	11.11
Pterioida	glyphaeidae	刺牡蠣	*Saccostrea kegaki*								6		6											0.46	11.11
		拖鞋牡蠣	*Ostrea denselamellosa*								11		11						25	5		11		2.39	27.78
		長牡蠣	*Crassostrea angulata*			23	21		16	11		11												3.12	27.78
Perciformes	Gobiidae	青彈塗魚	*Scartelaos histophorus*				2																	0.08	5.56
		彈塗魚	*Periophthalmus modestus*			5	1	4																0.38	16.67
Isopoda	Ligiidae	奇異海蟑螂	*Ligia exotica*											24										0.91	5.56
Heteropoda	Naticidae	小灰玉螺	*Natica gualteriana*																	1	1			0.08	11.11
		豹斑玉螺	*Natica tigrina*																	1	2			0.11	11.11
Pholadomyoida	Laternulidae	截尾薄殼蛤	*Laternula anatina*																	3	3			0.23	11.11
Lingulida	Brachiopoda	鴨嘴海豆芽	*Lingula anatina*																	2	3		6	0.42	16.67
Total						301	225	165	253	135	258	135	258	95	41	54	63	63	101	108	137	138	102		
Species Diversity Index（*H'*）						1.82	2.22	1.63	1.86	1.42	2.00	1.42	2.00	1.82	1.01	1.25	1.33	1.33	1.73	2.62	2.46	1.58	2.39		
Evenness Index（*J'*）						0.71	0.76	0.65	0.67	0.73	0.72	0.73	0.72	0.93	0.92	0.90	0.96	0.96	0.83	0.85	0.80	0.66	0.88		

Remarks:1. RA represents Relative Abundance, %; OR represents Occurrence Rate,%.

Table 6.3.2-26 Resource Table of Intertidal Zone Benthic Organism During Third Quarter of Survey

Order	Family	Chinese Name	Scientific Name	Endemism	Protected Level	105/08																		RA(%)	OR(%)
						潮-1	潮-2	潮-3	潮-4	潮-5	潮-6	潮-7	潮-8	潮-9	潮-10	潮-11	潮-12	潮-13	潮-14	潮-15	潮-16	潮-17	潮-18		
Decapoda	Grapsidae	細紋方蟹	*Grapsus tenuicrustatus*						4		29		3											1.79	16.67
		白紋方蟹	*Grapsus albolineatus*									6	5	2	6	3	5	16		9	6	17	9	4.18	61.11
	Ocypodidae	清白招潮蟹	*Uca lactea*			6	16																	1.09	11.11
		萬歲大眼蟹	*Macrophthalmus banzai*				2																	0.10	5.56
		角眼沙蟹	*Ocypode ceratophthalmus*															4						0.20	5.56
		斯氏沙蟹	*Ocypode stimpsoni*								5													0.25	5.56
		雙扇股窗蟹	*Scopimera bitympana*			2																		0.10	5.56
	Mictyridae	短指和尚蟹	*Mictyris brevidactylus*			4																		0.20	5.56
	Diogenidae	艾氏活額寄居蟹	*Diogenes edwardsii*				5																	0.25	5.56
	Portunoidea	鋸緣青蟳	*Scylla serrata*						1															0.05	5.56
	Xanthidae	肉球皺蟹	*Leptodius sanguineus*						1															0.05	5.56
Mesogastropoda	Littorinidae	波紋玉黍螺	*Littoraria undulata*							9														0.45	5.56
		粗紋玉黍螺	*Littoraria scabra*			16	11	12							8	14				19				3.98	33.33
		細粒玉黍螺	*Nodilittorina radiata*			21		16	19	13	12	13	11	7	5		15	13		83	89	12	13	17.01	83.33
		顆粒玉黍螺	*Nodilittorina pyramidalis*				9		13	11		19	14	14		23	16	9			37	6	6	8.81	66.67
Archeogastropoda	Neritidae	漁舟蜑螺	*Nerita albicilla*			3	2	4	11		5			1	39	3		2			4	2	3	3.93	66.67
	Lottiidae	花青螺	*Notoacmea schrenckii*								4	4		6							6	7		1.34	27.78
		高青螺	*Notoacmea concinna*										1	3										0.20	11.11
	TROCHIDAE	草蓆鐘螺	*Monodonta labio*				8	8	5	2	2		5								5	3	3	2.04	50.00
	Turbinidae	珠螺	*Lunella coronata*						3															0.15	5.56
Spionida	Chaetopteridae.	燐蟲	*Chaetopteridae* sp.						29		9							4	7					2.44	22.22
Sessilia	Balanidae	紋藤壺	*Amphibalanus amphitrite*			98		76		69	54	49	12	19	46	45		129	69			16	19	34.88	72.22
		鱗笠藤壺	*Tetraclita squamosa*														21							1.04	5.56
Neogastropoda	Muricidae	蚵岩螺	*Thais clavigera*			5	4	6	16	5	11					6		6	2	6	11	9	4	4.53	72.22
Pterioida	glyphaeidae	刺牡蠣	*Saccostrea kegaki*			7			37	9	13													3.28	22.22
		長牡蠣	*Crassostrea angulata*				11											3	6	7				1.34	22.22
Perciformes	Gobiidae	彈塗魚	*Periophthalmus modestus*				3																	0.15	5.56
Arcoida	Arcidae	鬍魁蛤	*Barbatia foliata*						2															0.10	5.56
Neoloricata	Chitonidae	大駝石鱉	*Liolophura japonica*						1															0.05	5.56
Isopoda	Ligiidae	奇異海蟑螂	*Ligia exotica*						3			23			10	9	4	5		3	3	56	5	6.02	55.56
		Total				162	71	122	145	118	144	114	51	52	114	103	61	191	84	127	161	128	62		
		Species Diversity Index（*H'*）				1.38	2.11	1.23	2.13	1.37	1.88	1.50	1.73	1.61	1.43	1.55	1.45	1.28	0.65	1.14	1.37	1.75	1.87		
		Evenness Index（*J'*）				0.63	0.91	0.69	0.81	0.71	0.82	0.84	0.89	0.83	0.80	0.80	0.90	0.56	0.47	0.64	0.66	0.80	0.90		

Remarks:1. RA represents Relative Abundance, %; OR represents Occurrence Rate,%.

Table 6.3.2-27 Resource Table of Intertidal Zone Benthic Organism During Fourth Quarter of Survey

Order	Family	Chinese Name	Scientific Name	Endemism	Protected Level	105/11																		RA(%)	OR(%)
						潮-1	潮-2	潮-3	潮-4	潮-5	潮-6	潮-7	潮-8	潮-9	潮-10	潮-11	潮-12	潮-13	潮-14	潮-15	潮-16	潮-17	潮-18		
Decapoda	Grapsidae	細紋方蟹	*Grapsus tenuicrustatus*						3		19		2											0.88	16.67
		白紋方蟹	*Grapsus albolineatus*						5			9	11	8	8	8	12	14	13	13	16	16	15	5.40	72.22
	Mictyridae	短指和尚蟹	*Mictyris brevidactylus*			2			221															8.14	11.11
	Portunoidea	鈍齒短槳蟹	*Thalamita crenata*				2			2														0.15	11.11
	Xanthidae	溝痕皺蟹	*Leptodius exaratus*							1														0.04	5.56
Mesogastropoda	Littorinidae	波紋玉黍螺	*Littoraria undulata*				12				6									26		9		1.94	22.22
		粗紋玉黍螺	*Littoraria scabra*			20	8	13	9	13	14	21		19	12	18							18	6.02	61.11
		細粒玉黍螺	*Nodilittorina radiata*			18	15	26	14	16		15	13	13		7	14	11	6	23	15	16	9	8.43	88.89
		顆粒玉黍螺	*Nodilittorina pyramidalis*			13	10	9	8	10	11	17	18	15	19	21	23	15		18	21	10	13	9.16	94.44
Archeogastropoda	Neritidae	漁舟蜑螺	*Nerita albicilla*			6			5		8	8	64	12	29	5		3			8		7	5.66	61.11
		平頂蜑螺	*Nerita planospira*				1																	0.04	5.56
		粗紋蜑螺	*Nerita undata*							2								2						0.15	11.11
		白肋蜑螺	*Nerita plicata*													2		1						0.11	11.11
		石蜑螺	*Clithon retropictus*															2						0.07	5.56
	Lottiidae	花青螺	*Notoacmea schrenckii*				3	2			5	10	6	23					3	11	9	5	10	3.18	61.11
		高青螺	*Notoacmea concinna*										2	2										0.15	11.11
	TROCHIDAE	草蓆鐘螺	*Monodonta labio*				9		8	5	3											2	6	1.20	33.33
	Turbinidae	珠螺	*Lunella coronata*							3														0.11	5.56
Spionida	Chaetopteridae.	燐蟲	*Chaetopteridae* sp.						23															0.84	5.56
Actiniaria	Haliplanellidae	縱條磯海葵	*Haliplanella luciae*							1														0.04	5.56
Sessilia	Balanidae	紋藤壺	*Amphibalanus amphitrite*			87	47	38		48	67	58	73	38	52	48	33	88	72	24		21	36	30.30	88.89
Neogastropoda	Muricidae	蚵岩螺	*Thais clavigera*			12	7	13	17	7	12				7	10	8	10	8	9	16	12	8	5.70	83.33
	NASSARUUDAE	疣織紋螺	*Nassarius papillosus*								1													0.04	5.56
Pterioida	glyphaeidae	刺牡蠣	*Saccostrea kegaki*				21		41															2.26	11.11
		拖鞋牡蠣	*Ostrea denselamellosa*												22									0.80	5.56
		長牡蠣	*Crassostrea angulata*																7					0.26	5.56
		黑齒牡蠣	*Saccostrea mordax*			15				23														1.39	11.11
Isopoda	Ligiidae	奇異海蟑螂	*Ligia exotica*			5	13	4	12	8	7	27			13	15	8			6	11	48	23	7.30	77.78
mytiloida	Mytilinae	土嘴瓜殼菜蛤	*Modiolus metcalfei*							7														0.26	5.56
		Total				178	148	105	366	146	153	165	189	130	162	134	98	146	109	130	96	139	145		
		Species Diversity Index（*H'*）				1.67	2.12	1.64	1.52	2.13	1.87	1.85	1.51	1.88	1.87	1.87	1.65	1.37	1.15	1.98	1.90	1.91	2.14		
		Evenness Index（*J'*）				0.76	0.85	0.84	0.61	0.81	0.78	0.89	0.73	0.91	0.90	0.85	0.92	0.63	0.64	0.95	0.97	0.87	0.93		

Remarks:1. RA represents Relative Abundance, %; OR represents Occurrence Rate,%.

Table 6.3.2-28 Resource Table of Intertidal Zone Benthic Organism During Fifth Quarter of Survey

Order	Family	Chinese Name	Scientific Name	Endemism	Protected Level	潮-1	潮-2	潮-3	潮-4	潮-5	潮-6	潮-7	潮-8	潮-9	潮-10	潮-11	潮-12	潮-13	潮-14	潮-15	潮-16	潮-17	潮-18	RA(%)	OR(%)
Decapoda	Grapsidae	白紋方蟹	Grapsus albolineatus						3		2	4		1		6	8	3	12	10	2	2	6	2.48	66.67
		細紋方蟹	Grapsus tenuicrustatus																2					0.08	5.56
		斑點擬相手蟹	Parasesarma pictum								3													0.13	5.56
		絨毛近方蟹	Hemigrapsus penicillatus								2													0.08	5.56
		平背蜞	Gaetice depressus				11		15	13	6													1.89	22.22
	Ocypodidae	角眼沙蟹	Ocypode ceratophthalmus				3											2	2					0.29	16.67
		斯氏沙蟹	Ocypode stimpsoni															1						0.04	5.56
	Mictyridae	短指和尚蟹	Mictyris brevidactylus			16	8		12		8													1.85	22.22
	Diogenidae	艾氏活額寄居蟹	Diogenes edwardsii							2														0.08	5.56
	Xanthidae	溝痕皺蟹	Leptodius exaratus							2														0.08	5.56
	Porcellanidae	日本岩瓷蟹	Petrolisthes japonicus							7														0.29	5.56
	Porcellanidae	太平洋槍蝦	Alpheus pacificus							1														0.04	5.56
Mesogastropoda	Littorinidae	波紋玉黍螺	Littoraria undulata				10				5									22		14		2.14	22.22
		粗紋玉黍螺	Littoraria scabra			20	5	14	8	15	11	18		19	14	25							17	6.97	61.11
		細粒玉黍螺	Nodilittorina radiata			25	13	21	11	11		12	31	21		22	28	17	29	31	13	33		13.36	83.33
		顆粒玉黍螺	Nodilittorina pyramidalis			13	9	16	7	12	13	10	14	14	21	31	22	9		19	15	36		10.96	88.89
Nereid	Nereididae	沙蠶	Gen. sp (Nereididae)			2																		0.08	5.56
Archeogastropoda	Siphonariidae	花松螺	Siphonaria laciniosa				2	2			5													0.38	16.67
	Neritidae	平頂蜑螺	Nerita planospira				1																	0.04	5.56
		漁舟蜑螺	Nerita albicilla			11			3	6	9	9	7	11	9			11			6		7	3.74	61.11
	Lottiidae	花青螺	Notoacmea schrenckii			2							4	5	11			4	5	11	2		6	2.10	50.00
		射線青螺	Patelloida striata																		1			0.04	5.56
		高青螺	Notoacmea concinna																2	2				0.17	11.11
	Turbinidae	珠螺	Lunella coronata			3	5			2														0.42	16.67
	TROCHIDAE	草蓆鐘螺	Monodonta labio			5	8		6	6	8		4									5	6	2.02	44.44
Spionida	Chaetopteridae.	燐蟲	Chaetopteridae sp.															5						0.21	5.56
Actiniaria	Haliplanellidae	縱條磯海葵	Haliplanella luciae				2																	0.08	5.56
BASOMMATOPHORA	Siphonariidae	花松螺	Siphonaria laciniosa															3						0.13	5.56
Sessilia	Balanidae	紋藤壺	Amphibalanus amphitrite			65	52	23		50	61	34	29	27	52	31	42	72	49	37		21	20	27.93	88.89
Isopoda	Ligiidae	奇異海蟑螂	Ligia exotica			5	9	4	10	5	7	18	22		3		25	33		11	25	9	21	8.69	83.33
mytiloida	Mytilinae	土嘴瓜殼菜蛤	Modiolus metcalfei			2			5	6														0.55	16.67
		綠殼菜蛤	Perna viridis							3	3													0.25	11.11
Neoloricata	Chitonidae	大駝石鱉	Liolophura japonica			1				1								3						0.21	16.67
Neogastropoda	Muricidae	蚵岩螺	Thais clavigera			19	7	18	20	8	15	11	9		9	19	17	6	14	9	9	6	9	8.61	94.44
	NASSARUUDAE	疣織紋螺	Nassarius papillosus				2																	0.08	5.56
		蟹螯織紋螺	Plicarcularia pullus								1													0.04	5.56
	Columbellidae	似長麥螺	Indomitrella martensi								1													0.04	5.56
VENEROIDA	Veneridae	文蛤	Meretrix lusoria				3																	0.13	5.56
		皺肋文蛤	Meretrix lyrata				1																	0.04	5.56
		日本鏡文蛤	Dosinorbis japonica								1													0.04	5.56
Pterioida	glyphaeidae	拖鞋牡蠣	Ostrea denselamellosa												19									0.80	5.56
		長牡蠣	Crassostrea angulata															15	21					1.51	11.11
		黑齒牡蠣	Saccostrea mordax			8																		0.34	5.56
		葡萄牙牡蠣	Crassostrea angulata													11								0.46	5.56
	Isognomonidae	馬鞍障泥蛤	Isognomon ephippium			2																		0.08	5.56
		Total				199	151	98	100	150	161	116	120	98	138	145	142	184	136	152	73	126	92		
		Species Diversity Index（H'）				2.21	2.36	1.77	2.25	2.32	2.26	1.92	1.84	1.73	1.80	1.84	1.69	1.99	1.74	1.99	1.72	1.78	1.94		
		Evenness Index（J'）				0.80	0.82	0.91	0.94	0.82	0.78	0.92	0.89	0.89	0.87	0.95	0.94	0.75	0.79	0.91	0.83	0.86	0.93		

Table 6.3.2-29 Resource Table of Intertidal Zone Benthic Organism at Common Corridor of Lunwei Area During Supplementary Survey

Order	Family	Chinese Name	Scientific Name	Endemism	Protected Level	10607			RA (%)	OR (%)
						IT-N1	IT-N2	IT-N3		
Decapoda	Grapsidae	平背蜞	*Gaetice depressus*				6		1.45	33.33
		白紋方蟹	*Grapsus albolineatus*			5		7	2.91	66.67
	Ocypodidae	斯氏沙蟹	*Ocypode stimpsoni*					2	0.48	33.33
	Palaemonidae	澳洲沼蝦	*Macrobrachium australe*					1	0.24	33.33
	Diogenidae	艾氏活額寄居蟹	*Diogenes edwardsii*			2			0.48	33.33
		綠色細螯寄居蟹	*Clibanarius virescens*					1	0.24	33.33
	Eriphiidae	司氏酋婦蟹	*Eriphia smithii*				3		0.73	33.33
	Portunoidea	環紋蟳	*Charybdis annulata*			2	2		0.97	66.67
	Porcellanidae	日本岩瓷蟹	*Petrolisthes japonicus*			4			0.97	33.33
	Porcellanidae	太平洋槍蝦	*Alpheus pacificus*			1	1		0.48	66.67
	Matutidae	頑強黎明蟹	*Matuta victor*			2			0.48	33.33
Mesogastropoda	Littorinidae	波紋玉黍螺	*Littoraria undulata*			24		9	7.99	66.67
		細粒玉黍螺	*Nodilittorina radiata*				23	14	8.96	66.67
		顆粒玉黍螺	*Nodilittorina pyramidalis*			30	12	11	12.83	100.00
Nereid	Nereididae	沙蠶	Gen. sp (Nereidae)			2			0.48	33.33
Archeogastropoda	patellidae	斗笠螺	*Cellana grata*					1	0.24	33.33
		花笠螺	*Cellana toreuma*			8	16	4	6.78	100.00
	Neritidae	黑肋蜑螺	*Nerita costata*					7	1.69	33.33
		漁舟蜑螺	*Nerita albicilla*			6	9	6	5.08	100.00
	Lottiidae	花青螺	*Notoacmea schrenckii*					3	0.73	33.33
		鵜足青螺	*Patelloida saccharina*				2		0.48	33.33
	TROCHIDAE	草蓆鐘螺	*Monodonta labio*				7	5	2.91	66.67
Spionida	Chaetopteridae.	燐蟲	*Chaetopterus variopedatus*			8			1.94	33.33
Actiniaria	Actiniidae	等指海葵	*Actinia equina*			4			0.97	33.33
	Haliplanella luciae	縱條磯海葵	*Diadumene lineata*			5		3	1.94	66.67
Sessilia	Tetraclitidae	鱗笠藤壺	*Tetraclita squamosa*				1		0.24	33.33
	Balanidae	紋藤壺	*Amphibalanus amphitrite*			21		23	10.65	66.67
Isopoda	Ligiidae	奇異海蟑螂	*Ligia exotica*			18	14	10	10.17	100.00
mytiloida	Mytilinae	孔雀殼菜蛤	*Septifer bilocularis*					4	0.97	33.33
Neoloricata	Chitonidae	大駝石鱉	*Liolophura japonica*					3	0.73	33.33
Neogastropoda	Muricidae	蚵岩螺	*Thais clavigera*			19	13	8	9.69	100.00
VENEROIDA	Veneridae	花蛤	*Gomphina aequilatera*			3			0.73	33.33
Pterioida	glyphaeidae	黑齒牡蠣	*Saccostrea mordax*			6	8	3	4.12	100.00
Perciformes	Gobiidae	圓鰭深鰕虎	*Bathygobius cyclopterus*			1			0.24	33.33
Total(inds.)						171	117	125		
Species Diversity Index（*H'*）						2.56	2.34	2.70		
Evenness Index（*J'*）						0.86	0.89	0.90		

Figure 6.3.2-18 Statistical Diagram of Benthic Organism at Intertidal Zone

Figure 6.3.2-19 Diversity Index of Benthic Organism at Intertidal Zone

Figure 6.3.2-20 Statistical Diagram and Diversity Index of Common Corridor at Lunwei Area, Derived From Supplementary Survey

(v) Sessile Marine Plant

Sessile marine plants are multicellular algae that grows along the tidal or subtidal zones of the rocky reefs, have rhizoids and can carry out sessile growth. Unlike the normal planktonic microphytes, the sessile marine plants are part of the periphyton where the base of the algae has to be fixed onto a hard bottom material. In general, marine algae prefer seacoasts with either the rocky or coral reefs as their habitat. But West Coast Taiwan are generally beaches where the base matrices are easily scoured by the tides, making it hard for the marine algae to grow fixated; East Coast Taiwan on the other hand are mostly cliffy terrains, making them hard to sample. The tidal zones in this study are mainly beaches or mud flats, with base matrices that are easily scoured by the tides, making it hard for the sessile growth of the marine algae.

Aside from topography, genetics and light, the growth and distribution of algae is also influenced by the ocean's water temperature, tides, waves, wind, current, nutrient salt, pollutants, animal preying and activities, and competitions among the algae species. Although there is riprap alongside of each survey station in this study and marine algae generally grow fixated on the riprap or the illuminated surfaces of the stone blocks, but due to large seasonal changes and generally high water temperature of the algae habitat in the Southwest coast, sand drifts causing topographical changes that lead to the burial of riprap and stone blocks (that serve as the base matrices for sessile growth), and waves scraping off the algae, it is hard for the algae to achieve epiphytic growth.

The tidal zone survey stations in this study all have similar environment, generally being man-made sea dike, riprap, cobble blocks and sand coasts. One can find numerous sessile benthos such as the barnacles on the riprap and cobble blocks, but not large sized sessile algae like sea lettuce or Ulva lactuca. This phenomenon is probably due to the fact that riprap and cobble blocks have long sun exposures and high sand levels in the sea water, making it hard for the larger sized sessile algae to grow. On the other hand, the subtidal zones are sandy beaches with many oyster racks. Although this set up provides an attachment framework for the sessile growth of the algae, but due to the high instances of human disturbance, large sized sessile algae are hardly found. Hence, this study has not noted any large sized sessile algae in the survey stations.

(vi) Fish Survey

1. Fish Egg and Juvenile Fish

A total of 106 fish roe and 25 fish larvae were collected on 13th February 2016 at Wind Farm No.21, with an average fish roe abundance of 11.8±16.1/100 m3 and an average fish larvae abundance of 1.92±2.8/100 m3. In terms of species composition, 7 families and 8 taxa, as well as 1 unknown species of fish roe were identified (Table 6.3.2-30), with the Carangidae Decapterus maruadsi being the most dominant species, followed by the Synodontidae Harpadon nehereus and the Engraulidae Encrasicholina punctifier etc; 13 families and 13 taxa of fish larvae were identified (Table 6.3.2-31), with the Sparidae Acanthopagrus pacificus being the most dominant species, followed by the Seriola dumerili and the Myctophidae Benthosema pterotum etc. It is to be noted that the ratio of the appearance of each species are relatively even for fish larvae.

Wind Farm No.21 analyzed the fish roe and fish larvae using the Shannon-Wiener diversity index, H' and the Pielou's evenness index, J' at each survey station. The former is an overall reflection of the number of species and the proportion of each species in a cluster; The latter is a measurement of the evenness of the number of each species in a cluster (score ranges from 0 to 1, the score being directly proportional to the evenness). Results show that, in terms of fish roe (Figure 6.3.2-21), 8 survey stations (s1, s2, s3, s5, s9-s12) have sampled more than two species, with a diversity index between 0.20-1.10 and an evenness index between 0.29-1.0. There exists a big difference between each survey station as when there is a low number of species sampled per catch while at the same time, having one species showing obvious dominance over others, the two indices tend to record lower scores (e.g.s1); Only one species was sampled in s4, therefore having a diversity index of 0 and no measurable evenness index; No successful sampling was recorded in s6, s7 and s8, hence unable to measure their respective diversity index and evenness index. In terms of fish larvae (Figure 6.3.2-22), only s5 (H':1.53; J':0.74) and s8 (H':0.64; J': 0.92) have sampled more than two species. S5 sampled 8 species with a relatively even abundance between specie as well as having the highest diversity index score out of all survey stations; S7, s10, s11 and s12 each sampled one species, thus scoring 0 for diversity index and unmeasurable evenness index; S1, s2, s3, s4, s6 and s9 show no records of successful sampling, hence unable to measure their diversity index and evenness index.

A total of 7113 fish row and 862 fish larvae are sampled after four rounds of sampling at Wind Farm No.15. In terms of composition, 27 families, 52 taxa and one unknown species of fish roe are identified (Table 6.3.2-32). The most dominant species is the Carangidae Decapterus russelli, having an abundance of 3423/100 m3 (72.03% of total abundance), followed by the Leiognathidae Equulites rivulatus, Menidae Mene maculata and Decapterus maruadsi etc. while the rest of the 48 species have an abundance of less than 100/100 m3 respectively. Obvious species dominance observed; In terms of fish larvae (Table 6.3.2-33), 52 families and 98 taxa are identified. The most dominant species is the Sparidae Acanthopagrus latus with 248/100 m3, followed by Scombridae Auxis rochei rochei (39/100 m3), Engraulidae Encrasicholina heteroloba (26/100 m3) and Scomberoides tol (20/100 m3) etc. Obvious species dominance is observed.

Wind Farm No.15 analyzed the fish roe and fish larvae using the Shannon-Wiener diversity index, H' and the Pielou's evenness index, J'. The former is an overall reflection of the number of species and the proportion of each species in a cluster; The latter is a measurement of the evenness of the number of each species in a cluster (score ranges from 0 to 1, the score being directly proportional to the evenness). In the case of fish roe (Figure 6.3.2-23), the diversity index and evenness index for the first round of sampling are 2.35 and 0.85, the second round being 1.97 and 0.65, the third round being 1.40 and 0.68, and the fourth round being 0.40 and 0.14 respectively; Whereas for fish larvae (Figure 6.3.2-24), the diversity index and evenness index for the first round are 2.95 and 0.80, the second round are 2.80 and 0.92, the third round are 0.82 and 0.30, while the fourth round are 3.11 and 0.89 respectively.

(1) Analysis on The 1stQuarter of Sampling of Wind Farm No.15.

First round of sampling was done on 7th June 2016, having sampled a total of 366 fish roe and 186 fish larvae. In terms of composition, 13 families, 16 taxa and one unknown species of fish roe are identified (Table 6.3.2-34). the most dominant species is the Coryphaenidae Coryphaena hippurus, followed by the Mene maculata and Synodontidae Trachinocephalus myops; As for fish larvae, 28 families and 39 taxa are identified (Table 6.3.2-25), with the Auxis rochei rochei being the most dominant species, followed by the Myctophidae Diaphus thiollierei and Carangidae Scomberoides tol etc.

Analyzing the Shannon-Wiener diversity index, H' and Pielou's evenness index, J' of fish roe and fish larvae. In terms of fish roe (Figure 6.3.2-25), other than survey station s7 that has sampled only one species and thus having a diversity index of 0 and an unmeasurable evenness index, the other 11 survey stations recorded diversity index between 0.38-1.27 and evenness index between 0.35-0.95. As for fish larvae (Figure 6.3.2-26), survey station s11 has sampled only one species, recording a diversity index of 0 and unmeasurable evenness index; Survey stations s5, s7 and s9 have no records of successful sampling and thus, the diversity index and evenness index remain unmeasurable; The rest of the 8 survey stations have each sampled at least two species, having a diversity index between 0.96-2.53 and an evenness index between 0.79-0.91.

(2) Analysis on The 2nd Quarter of Sampling of Wind Farm No.15.

Second round of sampling was carried out on 18th August 2016, sampling a total of 1057 fish roe and 46 fish larvae. In terms of composition, 16 families, 21 taxa and one unknown species of fish roe are identified (Table 6.3.2-36). The most dominant species is the Equulites rivulatus, followed by the Decapterus maruadsi, Mene maculata and Cynoglossidae Cynoglossus bilineatus etc. The rest of the 17 species have a respective abundance of below 40/100 m3; As for fish larvae, a total of 18 families and 21 taxa are identified (Table 6.3.2-37). All species sampled have a respective abundance of less than 10/100 m3, with only the Labridae Iniistius verrens and Myctophidae sp.2 being relatively dominant.

Analyzing the Shannon-Wiener diversity index, H' and Pielou's evenness index, J' of fish roe and fish larvae. For fish roe (Figure 6.3.2-27), all survey stations sampled at least two species each, having a diversity index between 0.68-1.56 and an evenness index between 0.39-0.86. As for fish larvae (Figure 6.3.2-28), 7 survey stations s1, s2, s3, s6, s8, s9 and s10 have each sampled at least two species, having a diversity index between 0.69-2.21 and an evenness index between 0.9.-1.0; Survey stations s4, s11 and s12 only managed to sample one species each, having a diversity index of 0 and unmeasurable evenness index; Survey stations s5 and s7 have no records of successful sampling, leaving the diversity index and evenness index unmeasurable.

(3) Analysis on The 3rd Quarter of Sampling of Wind Farm No.15.

Third quarter of sampling was carried out on 26th November 2016 with a total of 98 fish roe and 481 fish larvae sampled. In terms of species composition, 6 families and 8 taxa of fish roe are identified (Table 6.3.2-38). the most dominant species is the Acanthopagrus latus, followed by the Cynoglossidae Cynoglossus interruptus and Cynoglossus bilineatus etc; 12 families and 15 species of fish larvae are identified (Table 6.3.2-39), again with Acanthopagrus latus being the most dominant species (abundance = 248/100 m3), followed by Encrasicholina heteroloba (23/100 m3), Sillaginidae Sillago sihama (13/100 m3) and Clupeidae Sardinella jussieu (11/100 m3), showing obvious dominance pattern.

Analyzing the Shannon-Wiener diversity index, H' and Pielou's evenness index, J' of fish roe and fish larvae at each survey station. Results show that in terms of fish roe (Figure 6.3.2-29), aside from survey station s9 that only sampled one species and therefore having a diversity index of 0 and unmeasurable evenness index, the rest of the 11 stations managed to score a diversity index between 0.45-1.22 and an evenness index between 0.60-1.0 respectively. In terms of fish larvae (Figure 6.3.2-30), all survey stations have managed to sample at least two species, scoring a diversity index between 0.17-0.93 and an evenness index between 0.25-0.57 respectively. The indices of these two rounds are lower than the previous two as a higher ratio of Acanthopagrus latus is sampled.

(4) Analysis on The 4th Quarter of Sampling of Wind Farm No.15.

Fourth round of sampling was done on 13th March 2017 with a total of 5592 fish roe and 149 fish larvae sampled. In terms of species composition, 13 families and 18 taxa of fish roe are identified (Table 6.3.2-40). The most dominant species is the Decapterus russelli (abundance = 3424/100 m3), followed by the Scombridae Scomber japonicus (97/100 m3) and Mugilidae Moolgarda cunnesius (34/100 m3) etc. A big difference between the abundance and obvious dominance pattern can be noted; 24 families and 33 taxa of fish larvae are identified (Table 6.3.2-41) with the Ammodytidae Bleekeria mitsukurii, Myctophidae Diaphus fragilis and Scombridae Scomber australasicus being the three most dominant species, having an abundance of 12/100 m3 each, followed by the Mullidae Upeneus japonicus. The rest of the 29 taxa each have an abundance of less than 10/100 m3.

As for fish larvae (Figure 6.3.2-32), aside from survey stations s1, s7 and s10 that has caught only 1 species, and thus having a diversity index of 0 and an unmeasurable evenness index, all the other survey stations have managed to catch at least two species, each station scoring a diversity index between 0.87-2.63 and an evenness index between 0.79-1.0.

(5) Additional Investigation on the Common Corridor in Lunwei area by the Greater Changhua Offshore Wind Farm.

Results from additional Investigation on the common corridor in Lunwei area by the Greater Changhua Offshore Wind Farm show that 2954 fish roe and 282 fish larvae are sampled. In terms of composition, 6 families, 8 taxa and one unknown species of fish roe are identified (Table 6.3.2-42), with the Sciaenidae Johnius macrorhynus being the most dominant species, having an abundance of 260/100 m3, followed by Leiognathidae Nuchequula nuchalis etc. The rest of the species have an abundance of less than 100/100 m3 respectively, showing obvious species dominance pattern; As for fish larvae (Table 6.3.2-43), 23 families and 29 taxa are identified with the Carangidae Scomberoides tol (17/100 m3) being the most dominant species, followed by Sillaginidae Sillago sihama (10/100 m3) and Terapontidae Terapon jarbua (10/100 m3) etc. The rest of the species each have an abundance of less than 10/100 m3.

Analyzing the Shannon-Wiener diversity index, H’ and the Pielou’s evenness index, J’ of fish roe and fish larvae. The former is an overall reflection of the number of species and the proportion of each species in a cluster; The latter is a measurement of the evenness of the number of each species in a cluster (score ranges from 0 to 1, the score being directly proportional to the evenness). The diversity index and evenness index of fish roe are 1.34 and 0.64 respectively; As for fish larvae, the diversity index and evenness index are 2.59 and 0.77 respectively.

Analyzing the Shannon-Wiener diversity index, H’ and Pielou’s evenness index, J’ of fish roe and fish larvae. In terms of fish roe (Figure 6.3.2-35a), 3 survey stations have a diversity index between 0.29-1.25 and an evenness index between 0.39-0.77. As for fish larvae (Figure 6.3.2-35b), 3 survey stations recorded a diversity index between 2.10-2.40 and an evenness index between 0.76-0.84.

(6) Discussion

Wind Farm No.15 has completed four quarters of sampling and analysis, with a total 7113 fish roe and 862 fish larvae sampled. The total abundance of fish roe is 4753/100 m3, with the 4th round of sampling being the highest (3703/100 m3), followed by the 2nd round (701/100 m3), the 1st round (270/100 m3) and the 3rd round (79/100 m3); The total abundance of fish larvae is 664/100 m3 and unlike the trend of the fish roe, the highest abundance is achieved by the 3rd round of sampling (318/100 m3), followed by the 1st round (161/100 m3), the 4th round (141/100 m3) and the 2nd round (44/100 m3). In terms of composition, 27 families, 52 taxa and 1 unknown species of fish roe are identified; Whereas for fish larvae, 52 families and 98 taxa are identified. Species of both fish roe and fish larvae that are identified are mainly coastal autopelagic or arenaceous-pelitic based fishes, namely Carangidae, Cynoglossidae, Leiognathidae, Myctophidae, Scombridae and Sparidae etc. Results from cluster analysis show that fish roe (Figure 6.3.2-33) demonstrates an obvious trait of seasonal clustering (Global R: 0.775; $p< 0.1\%$), whereas fish larvae (Figure 6.3.2-34) also demonstrates tendency of clustering (Global R: 0.491; $p< 0.1\%$), showing that the fish roe or fish larvae in that sea territory have a difference in seasonal response. Between the seasons, only fish roe such as Scomberoides tol, Corylphaena hippurus, Cynoglossus bilineatus, Mene maculata, Trachinocephalus myops, Trichiuridae Trichiurus japonicus, Sciaenidae Chrysochir aureus, Platycephalidae Kumococius rodericensis and Scombridae Euthynnus affinis were sampled repeatedly. As for fish larvae, Scomberoides tol, Bothidae Crossorhombus howensis, Myctophidae Ceratoscopelus warmingii, Encrasicholina heteroloba, Auxis rochei rochei and Iniistius verrens were sampled repeatedly between the seasons. There were no repeated sampling of other species. Aside from that, within the same sea territory in the same season, only the fish roe and fish larvae of Encrasicholina heteroloba, Scomberoides tol, Mene maculata, Corylphaena hippurus, Acanthopagrus latus, Terapon jarbua, Trichiurus japonicus, Mugilidae Chelon affinis and Myctophidae Benthosema pterotum were sampled repeatedly. The rest of the species were not sampled repeatedly.

The little overlap between the composition of the fish roe and fish larvae of the same sea territory in the same season, and the difference in composition between seasons, show that not only the spawning ground and feeding ground for each species may be different, adoption of the Snapshot sampling method may also be one of the factors (Shi, 2013). As fish roe and fish larvae present themselves in a cluster distribution in the sea, there is a possibility of variation as time goes by, as well as due to tidal movements (Castro et al., 2011) and diurnal variation (Chiu, 1991) or the different reproduction peak of each fish species (Álvarez et al., 2012), causing a difference in the fish roe and fish larvae species within a short term. Having said that, there needs to be more data collection in order to systematically understand the variation of planktonic fish species composition.

Results from additional Investigation on the common corridor in Lunwei area by the Greater Changhua Offshore Wind Farm show that 2954 fish roe and 282 fish larvae are sampled. The total abundance of fish roe is 660/100 m3; Whereas the total abundance of fish larvae is 96/100 m3. In terms of composition, a total of 6 families, 8 taxa and one unknown species of fish roe are identified; On the other hand, 23 families and 29 taxa of fish larvae are identified. Species of both fish roe and fish larvae that are identified are mainly coastal autopelagic or arenaceous-pelitic based fishes, namely Carangidae, Cynoglossidae, Leiognathidae, Myctophidae, Scombridae and Sparidae etc. In the same sample of the same sea territory, there are no repeated sampling of the same species of fish roe and fish larvae.

The little overlap between the composition of the fish roe and fish larvae of the same sea territory in the same season, and the difference in composition between seasons, show that not only the spawning ground and feeding ground for each species may be different, adoption of the Snapshot sampling method may also be one of the factors (Shi, 2013). As fish roe and fish larvae present themselves in a cluster distribution in the sea, there is a possibility of variation as time goes by, as well as due to tidal movements (Castro et al., 2011) and diurnal variation (Chiu, 1991) or the different reproduction peak of each fish species (Álvarez et al., 2012), causing a difference in the fish roe and fish larvae species within a short term. Having said that, there needs to be more data collection in order to systematically understand the variation of planktonic fish species composition.

Table 6.3.2-30 Composition and Abundance of Fish Eggs at All Sampling Stations of No.21 Offshore Wind Farm on 13th February 2016 (An Egg/100 m^3)

Taxa \ station	Chinese Name	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	Total
Apistidae														
Apistus carinatus	稜鬚簑鮋		1											1
Carangidae														
Decapterus macarellus	頜圓鰺										5			5
Decapterus maruadsi	藍圓鰺	36	5	3	1					3		10	3	61
Engraulidae														
Encrasicholina punctifer	銀灰半稜鯷	2		1							8	2		13
Mugilidae														
Chelon affinis	前鱗龜鮻					1								1
Platycephalidae														
Platycephalus indicus	印度牛尾魚									3				3
Sparidae														
Evynnis cardinalis	紅鋤齒鯛					1								1
Synodontidae														
Harpadon nehereus	印度鐮齒魚									3	41		7	51
Unknown	未知種					1			4					5
Total Abundance		38	6	4	1	3	0	0	4	9	54	12	10	141
Number of Family		2	2	2	1	2	0	0	0	3	3	2	2	7
Number of Class Group		2	2	2	1	2	0	0	0	3	3	2	2	8
Actual Sampling Number of Fish Eggs		16	19	3	1	9	0	0	3	6	35	7	7	106

Table 6.3.2-31 Composition and Abundance of Juvenile Fish at All Sampling Stations of Dong Energy No.21 Offshore Wind Farm on 13th February 2016 (An Individual /100 m^3)

Taxa\station	Chinese Name	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	Total
Callionymidae														
Callionymus filamentosus	絲鰭䲗					1								1
Carangidae														
Seriola dumerili	杜氏鰤								3					3
Engraulidae														
Encrasicholina punctifer	銀灰半稜鯷					1								1
Gobiidae														
Amblychaeturichthys hexanema	六絲鈍尾鰕虎					1								1
Kyphosidae														
Microcanthus strigatus	柴魚										2			2
Leiognathidae														
Eubleekeria splendens	黑邊布氏鰏					1								1
Mugilidae														
Chelon haematocheilus	龜鮻					1								1
Mullidae														
Upeneus japonicus	日本緋鯉							2						2
Myctophidae														
Benthosema pterotum	七星底燈魚					3								3
Paralepididae														
Magnisudis atlantica	大西洋大梭蜥魚								2					2
Sparidae														
Acanthopagrus pacificus	太平洋棘鯛											2	2	4
Stromateidae														
Pampus argenteus	銀鯧					1								1
Synodontidae														
Trachinocephalus myops	準大頭狗母魚					1								1
Total Abundance		0	0	0	0	10	0	2	5	0	2	2	2	23
Number of Family		0	0	0	0	8	0	1	2	0	1	1	1	13
Number of Class Group		0	0	0	0	8	0	1	2	0	1	1	1	13
Actual Sampling Number of Juvenile Fish		0	0	0	0	18	0	1	3	0	1	1	1	25

Table 6.3.2-32 Composition and Abundance of Fish Eggs at Quarters (An Egg/100 m^3)

Taxa/Sampling date	Chinese Name	105/06/07	105/08/18	105/11/26	106/03/13	Total
Ammodytidae						
Ammodytidae sp.	玉筋魚科 sp.	7	1			8
Carangidae						
Alepes djedaba	吉打副葉鰺				11	11
Decapterus kurroides	無斑圓鰺	7				7
Decapterus maruadsi	藍圓鰺		122			122
Decapterus russelli	羅氏圓鰺				3424	3424
Megalaspis cordyla	大甲鰺	2				2
Scomberoides tol	托爾逆鈎鰺	23	8			31
Clupeidae						
Clupeidae sp.	鯡科 sp.	7				7
Dussumieria elopsoides	黃帶圓腹鯡				6	6
Sardinella jussieu	裘氏小沙丁魚	3				3
Sardinella sindensis	中國小沙丁魚				3	3
Coryphaenidae						
Coryphaena hippurus	鬼頭刀	53	7		1	61
Cynoglossidae						
Cynoglossus bilineatus	雙線舌鰨		75	18		93
Cynoglossus interruptus	斷線舌鰨			23		23
Cynoglossus itinus	單孔舌鰨			5		5
Paraplagusia blochii	布氏鬚鰨				20	20
Diodontidae						
Diodon holocanthus	六斑二齒魨	7				7
Engraulidae						
Encrasicholina heteroloba	異葉半稜鯷		5			5
Thryssa chefuensis	芝蕪稜鯷				1	1
Thryssa dussumieri	杜氏稜鯷				12	12
Fistulariidae						
Fistularia commersonii	康氏馬鞭魚		1			1
Gerreidae						
Gerres filamentosus	曳絲鑽嘴魚		22			22
Gobiidae						
Gobiidae sp.	Gobiidaesp.	14				14
Haemulidae						
Pomadasys argenteus	銀雞魚			1		1
Labridae						
Labridae sp.	隆頭魚科 sp.		30			30
Leiognathidae						
Equulites rivulatus	條馬鰏		238			238
Leiognathus equulus	短棘鰏	18				18
Menidae						
Mene maculata	眼眶魚	43	103			146
Mugilidae						
Chelon affinis	前鱗龜鮻				1	1
Moolgarda cunnesius	長鰭莫鯔				34	34
Moolgarda perusii	佩氏莫鯔			1		1

Taxa/Sampling date	Chinese Name	105/06/07	105/08/18	105/11/26	106/03/13	Total
Mullidae						
Upeneus japonicus	日本緋鯉	5				5
Myctophidae						
Benthosema pterotum	七星底燈魚			1		1
Ophichthidae						
Brachysomophis cirrocheilos	鬚唇短體蛇鰻				3	3
Ophichthidae sp.	蛇鰻科 sp.	1				1
Platycephalidae						
Kumococius rodericensis	凹鰭牛尾魚		2		22	24
Platycephalus indicus	印度牛尾魚				7	7
Sciaenidae						
Chrysochir aureus	黃金鰭鰔		35		29	64
Scombridae						
Acanthocybium solandri	棘鰆		1			1
Euthynnus affinis	巴鰹	10	9			19
Katsuwonus pelamis	正鰹		1			1
Scomber japonicus	白腹鯖				97	97
Scomberomorus guttatus	臺灣馬加鰆		3			3
Sparidae						
Acanthopagrus latus	黃鰭棘鯛			29		29
Sphyraenidae						
Sphyraena jello	斑條金梭魚		3			3
Stromateidae						
Pampus echinogaster	鐮鯧				3	3
Synodontidae						
Harpadon nehereus	印度鐮齒魚				26	26
Saurida argentea	銀蛇鯔		5			5
Trachinocephalus myops	準大頭狗母魚	24	27			51
Terapontidae						
Terapon jarbua	花身鯻	21				21
Trichiuridae						
Lepturacanthus savala	沙帶魚		2			2
Trichiurus japonicus	日本帶魚			1	3	4
Unknown	未知種	25	1			26
Total Abundace		270	701	79	3703	4753
Number of Family		13	16	6	13	27
Number of Class Group		16	21	8	18	52
Actual Sampling Number of Fish Eggs		366	1057	98	5592	7113

Table 6.3.2-33 Composition and Abundance of Juvenile Fish at All Quarters (An individual /100 m^3)

Taxa\Sampling date	Chinese Name	105/06/07	105/08/18	105/11/26	106/03/13	Total
Ammodytidae						
Bleekeria mitsukurii	箕作布氏筋魚				12	12
Apogonidae						
Apogonidae sp.	天竺鯛科 sp.	3	1			4
Balistidae						
Canthidermis maculata	疣鱗魨		1			1
Blenniidae						
Blenniidae sp.1	鳚科 sp.1			2		2
Omobranchus sp.	肩鰓鳚屬 sp.			1		1
Bothidae						
Crossorhombus howensis	霍文纓鮃	1	1			2
Bregmacerotidae						
Bregmaceros sp.1	犀鱈屬 sp.1		3			3
Bregmaceros sp.2	犀鱈屬 sp.2			1		1
Bregmaceros sp.3	犀鱈屬 sp.3				4	4
Bregmaceros sp.4	犀鱈屬 sp.4				1	1
Caesionidae						
Pterocaesio digramma	雙帶鱗鰭烏尾鮗	3				3
Callionymidae						
Callionymidae sp.	鰤科 sp.	1				1
Carangidae						
Caranx ignobilis	浪人鰺	1				1
Caranx sexfasciatus	六帶鰺	12				12
Decapterus macarellus	頜圓鰺	2				2
Decapterus maruadsi	藍圓鰺				8	8
Decapterus tabl	泰勃圓鰺	1				1
Scomberoides tol	托爾逆鈎鰺	13			7	20
Trachurus sp.	竹筴魚屬 sp.				8	8
Centrolophidae						
Psenopsis sp.	刺鯧屬 sp.				2	2
Cepolidae						
Acanthocepola limbata	背點棘赤刀魚				2	2
Clupeidae						
Nematalosa japonica	日本海鰶				1	1
Sardinella jussieu	裘氏小沙丁魚			11		11
Coryphaenidae						
Coryphaena hippurus	鬼頭刀	4				4
Engraulidae						
Encrasicholina heteroloba	異葉半稜鯷		3	23		26
Exocoetidae						
Exocoetus sp.	飛魚屬 sp.		1			1
Hirundichthys oxycephalus	尖頭細身飛魚	1				1
Oxyporhamphus sp.	飛鱵屬 sp.		3			3
Gempylidae						
Gempylus serpens	帶鰆	2				2
Gobiidae						
Gobiidae sp.	Gobiidaesp.	1				1
Gonostomatidae						
Cyclothone spp.	圓罩魚屬 spp.	8	1			9
Haemulidae						
Pomadasys argenteus	銀雞魚		2			2
Ipnopidae						
Ipnopidae sp.	爐眼魚科 sp.				2	2
Labridae						

Taxa\Sampling date	Chinese Name	105/06/07	105/08/18	105/11/26	106/03/13	Total
Iniistius verrens	薔薇項鰭魚	9	7			16
Oxycheilinus bimaculatus	雙斑尖唇魚	1				1
Leiognathidae						
Photopectoralis bindus	黃斑光胸鰏			1		1
Secutor ruconius	仰口鰏		2			2
Lethrinidae						
Lethrinus atkinsoni	阿氏龍占魚				1	1
Lethrinus nebulosus	青嘴龍占魚	2				2
Lutjanidae						
Pristipomoides sieboldii	希氏姬鯛	1				1
Malacanthidae						
Branchiostegus auratus	斑鰭馬頭魚				1	1
Megalopidae						
Megalops cyprinoides	大海鰱	1				1
Menidae						
Mene maculata	眼眶魚	4				4
Mugilidae						
Chelon affinis	前鱗龜鮻				1	1
Chelon subviridis	綠背龜鮻			2		2
Mullidae						
Upeneus japonicus	日本緋鯉				10	10
Myctophidae						
Benthosema pterotum	七星底燈魚			2		2
Ceratoscopelus warmingii	瓦明氏角燈魚		2		2	4
Diaphus fragilis	符氏眶燈魚				12	12
Diaphus richardsoni	李氏眶燈魚	4				4
Diaphus sp.1	眶燈魚屬 sp.1		3			3
Diaphus thiollierei	西氏眶燈魚	17				17
Lampanyctus festivus	雜色珍燈魚	1				1
Myctophidae sp.1	燈籠魚科 sp.1				3	3
Myctophidae sp.2	燈籠魚科 sp.2		5			5
Myctophidae sp.3	燈籠魚科 sp.3				9	9
Triphoturus nigrescens	淺黑尾燈魚				1	1
Nemichthyidae						
Nemichthyidae sp.	線鰻科 sp.				1	1
Nemipteridae						
Nemipteridae sp.	金線魚科 sp.	1				1
Nemipterus bathybius	底金線魚	1				1
Nomeidae						
Cubiceps pauciradiatus	少鰭方頭鯧		1			1
Cubiceps sp.	方頭鯧屬 sp.				2	2
Ophichthidae						
Echelus sp.	蠕鰻屬 sp.		1			1
Ophichthidae sp.	蛇鰻科 sp.	1				1
Pisodonophis cancrivorus	食蟹荳齒蛇鰻	3				3
Paralepididae						
Paralepididae spp.	舒蜥魚科 spp.	5	2		1	8
Percichthyidae						
Howella zina	腭齒尖棘鯛	1				1
Pinguipedidae						
Parapercis lutevittata	黃斑擬鱸				1	1
Platycephalidae						
Platycephalidae sp.	牛尾魚科 sp.				7	7
Priacanthidae						
Pristigenys niphonia	日本大鱗大眼鯛	2				2
Ptereleotridae						
Ptereleotris heteroptera	尾斑凹尾塘鱧				1	1
Ptereleotris rubristigma	紅點凹尾塘鱧	2				2

Taxa\Sampling date	Chinese Name	105/06/07	105/08/18	105/11/26	106/03/13	Total
Scaridae						
Scaridae sp.	鸚哥魚科 sp.	1				1
Scarus forsteni	福氏鸚哥魚	1				1
Sciaenidae						
Chrysochir aureus	黃金鰭鰔			1		1
Johnius macrorhynus	大鼻孔叫姑魚			1		1
Scombridae						
Auxis rochei rochei	圓花鰹	30			9	39
Scomber australasicus	花腹鯖				12	12
Scombridae sp.	鯖科 sp.	1				1
Scorpaenidae						
Scorpaenidae sp.1	鮋科 sp.1	2				2
Scorpaenidae sp.2	鮋科 sp.2				3	3
Serranidae						
Epinephelus awoara	青石斑魚				1	1
Serranidae sp.	鮨科 sp.				3	3
Siganidae						
Siganus argenteus	銀臭肚魚	4				4
Sillaginidae						
Sillago parvisquamis	小鱗沙鮻				5	5
Sillago sihama	多鱗沙鮻			13		13
Sillago sp.	沙鮻屬 sp.		2			2
Sparidae						
Acanthopagrus latus	黃鰭棘鯛			248		248
Acanthopagrus sp.	棘鯛屬 sp.				6	6
Acanthopagrus taiwanensis	臺灣棘鯛			9		9
Sphyraenidae						
Sphyraena sp.	金梭魚屬 sp.		1			1
Synodontidae						
Harpadon nehereus	印度鐮齒魚			1		1
Trachinocephalus myops	準大頭狗母魚				2	2
Terapontidae						
Terapon jarbua	花身鯻	8				8
Terapontidae sp.	鯻科 sp.		1			1
Trichiuridae						
Tentoriceps cristatus	隆頭帶魚	5				5
Trichiurus japonicus	日本帶魚			2		2
Trichiurus sp.	帶魚屬 sp.		1			1
Total Abundance		161	44	318	141	664
Number of Family		28	18	12	24	52
Number of Class Group		39	21	15	33	98
Actual Sampling Number of Juvenile Fish		186	46	481	149	862

Table 6.3.2-34 Composition and Abundance of Fish Eggs at All Sampling Stations of No.15 Offshore Wind Farm on 13th February 2016 (An Egg/100 m^3)

Taxa \ station	Chinese Name	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	Total
Ammodytidae														
Ammodytidae sp.	玉筋魚科 sp.							2	4				1	7
Carangidae														
Decapterus kurroides	無斑圓鰺						1						6	7
Megalaspis cordyla	大甲鰺	2												2
Scomberoides tol	托爾逆鉤鰺	1		9		3					10			23
Clupeidae														
Clupeidae sp.	鯡科 sp.						2				5			7
Sardinella jussieu	裘氏小沙丁魚		1		2									3
Coryphaenidae														
Coryphaena hippurus	鬼頭刀		1	4	47							1		53
Diodontidae														
Diodon holocanthus	六斑二齒魨					7								7
Gobiidae														
Gobiidae sp.	Gobiidaesp.		1							10			3	14
Leiognathidae														
Leiognathus equulus	短棘鰏										18			18
Menidae														
Mene maculata	眼眶魚		1	22	3	6	1					6	4	43
Mullidae														
Upeneus japonicus	日本緋鯉									5				5
Ophichthidae														
Ophichthidae sp.	蛇鰻科 sp.			1										1
Scombridae														
Euthynnus affinis	巴鰹								10					10
Synodontidae														
Trachinocephalus myops	準大頭狗母魚	13	11											24
Terapontidae														
Terapon jarbua	花身鯻										21			21
Unknown	未知種						2	1		3	5	2	12	25
Total Abundance		16	15	36	52	16	6	3	14	18	59	9	26	270
Number of Family		1	5	4	3	3	3	1	2	2	4	2	4	13
Number of Class Group		3	5	4	3	3	3	1	2	2	4	2	4	16
Actual Sampling Number of Fish Eggs		23	20	44	90	20	6	3	16	23	77	10	34	366

Table 6.3.2-35 Composition and Abundance of Juvenile Fish at All Sampling Stations of No.15 Offshore Wind Farm on 7th June 2016 (Individual/100 m^3)

Taxa\Station	Chinese Name	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	Total
Apogonidae														
Apogonidae sp.	天竺鯛科 sp.			3										3
Bothidae														
Crossorhombus howensis	霍文纓鮃			1										1
Caesionidae														
Pterocaesio digramma	雙帶鱗鰭烏尾鮗		1	2										3
Callionymidae														
Callionymidae sp.	鰤科 sp.		1											1
Carangidae														
Caranx ignobilis	浪人鰺	1												1
Caranx sexfasciatus	六帶鰺	1	2	4	2								3	12
Decapterus macarellus	領圓鰺				2									2
Decapterus tabl	泰勃圓鰺			1										1
Scomberoides tol	托爾逆鉤鰺		1	1			5		3		3			13
Coryphaenidae														
Coryphaena hippurus	鬼頭刀						1				2	1		4
Exocoetidae														
Hirundichthys oxycephalus	尖頭細身飛魚						1							1
Gempylidae														
Gempylus serpens	帶鰆								1		1			2
Gobiidae														
Gobiidae sp.	Gobiidaesp.				1									1
Gonostomatidae														
Cyclothone sp.	圓罩魚屬 sp.	2		3	2								1	8
Labridae														
Iniistius verrens	薔薇項鰭魚		1	3	2								3	9
Oxycheilinus bimaculatus	雙斑尖唇魚				1									1
Lethrinidae														
Lethrinus nebulosus	青嘴龍占魚			1									1	2
Lutjanidae														
Pristipomoides sieboldii	希氏姬鯛	1												1
Megalopidae														
Megalops cyprinoides	大海鰱		1											1
Menidae														
Mene maculata	眼眶魚			3	1									4
Myctophidae														
Diaphus richardsoni	李氏眶燈魚		1		2								1	4
Diaphus thiollierei	西氏眶燈魚	2	2	2	6								5	17

Taxa\Station	Chinese Name	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	Total
Lampanyctus festivus	雜色珍燈魚												1	1
Nemipteridae														
Nemipteridae sp.	金線魚科 sp.			1										1
Nemipterus bathybius	底金線魚												1	1
Ophichthidae														
Ophichthidae sp.	蛇鰻科 sp.				1									1
Pisodonophis cancrivorus	食蟹荳齒蛇鰻		1										2	3
Paralepididae														
Paralepididae sp.	魣蜥魚科 sp.			2	1								2	5
Percichthyidae														
Howella zina	腭齒尖棘鯛												1	1
Priacanthidae														
Pristigenys niphonia	日本大鱗大眼鯛				1								1	2
Ptereleotridae														
Ptereleotris rubristigma	紅點凹尾塘鱧			1	1									2
Scaridae														
Scaridae sp.	鸚哥魚科 sp.												1	1
Scarus forsteni	福氏鸚哥魚			1										1
Scombridae														
Auxis rochei rochei	圓花鰹	4	4	9	6								7	30
Scombridae sp.	鯖科 sp.												1	1
Scorpaenidae														
Scorpaenidae sp.	鮋科 sp.			1									1	2
Siganidae														
Siganus argenteus	銀臭肚魚				1								3	4
Terapontidae														
Terapon jarbua	花身鯻		1				2		5					8
Trichiuridae														
Tentoriceps cristatus	隆頭帶魚		2	1	1								1	5
Total Abundance		11	18	40	31	0	9	0	9	0	6	1	36	161
Number of Family		5	10	16	13	0	4	0	3	0	3	1	15	28
Number of Class Group		6	12	18	16	0	4	0	3	0	3	1	18	39
Actual Sampling Number of Juvenile Fish		14	20	45	40	0	10	0	9	0	7	1	40	186

Table 6.3.2-36 Composition and Abundance of Fish Egg at All Sampling Stations of Dong Energy No.15 Offshore Wind Farm on 8th August 2016 (An Egg/100 m^3)

Taxa \ station	Chinese Name	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	Total
Ammodytidae														
Ammodytidae sp.	玉筋魚科 sp.											1		1
Carangidae														
Decapterus maruadsi	藍圓鰺	34			15		7		2	59	5			122
Scomberoides tol	托爾逆鈎鰺				1	2			4			1		8
Coryphaenidae														
Coryphaena hippurus	鬼頭刀	2	2		1					1	1			7
Cynoglossidae														
Cynoglossus bilineatus	雙線舌鰨												75	75
Engraulidae														
Encrasicholina heteroloba	異葉半稜鯷												5	5
Fistulariidae														
Fistularia commersonii	康氏馬鞭魚					1								1
Gerreidae														
Gerres filamentosus	曳絲鑽嘴魚				2				4	1		2	13	22
Labridae														
Labridae sp.	隆頭魚科 sp.	3	7	8		1	4		3	2		1	1	30
Leiognathidae														
Equulites rivulatus	條馬鰏	1			28	44		12	89			53	11	238
Menidae														
Mene maculata	眼眶魚	6	4	3	16	13	5	8	29	9		10		103
Platycephalidae														
Kumococius rodericensis	凹鰭牛尾魚				1			1						2
Sciaenidae														
Chrysochir aureus	黃金鰭鰔				4				7			2	22	35
Scombridae														
Acanthocybium solandri	棘鰆					1								1
Euthynnus affinis	巴鰹					9								9
Katsuwonus pelamis	正鰹							1						1
Scomberomorus guttatus	臺灣馬加鰆									3				3
Sphyraenidae														
Sphyraena jello	斑條金梭魚												3	3
Synodontidae														
Saurida argentea	銀蛇鯔		1	2			1			1				5
Trachinocephalus myops	準大頭狗母魚	4	3	2	3	2	3	3	2	3		2		27
Trichiuridae														
Lepturacanthus savala	沙帶魚										1		1	2
Unknown	未知種								1					1
Total Abundance		50	17	15	71	73	20	25	141	79	7	72	131	701
Number of Family		6	4	3	8	7	4	5	7	7	3	8	8	16
Number of Class Group		6	5	4	9	8	5	5	8	8	3	8	8	21
Actual Sampling Number of Fish Eggs		88	22	21	85	105	29	39	221	146	9	117	175	1057

Table 6.3.2-37 Composition and Abundance of Juvenile Fish at All Sampling Stations of No.15 Offshore Wind Farm on 8th August 2016 (An Individual/100 m^3)

Taxa\Station	Chinese Name	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	Total
Apogonidae														
Apogonidae sp.	天竺鯛科 sp.						1							1
Balistidae														
Canthidermis maculata	疣鱗魨								1					1
Bothidae														
Crossorhombus howensis	霍文纓鮃										1			1
Bregmacerotidae														
Bregmaceros sp.1	犀鱈屬 sp.1	1								2				3
Engraulidae														
Encrasicholina heteroloba	異葉半棱鯷										3			3
Exocoetidae														
Exocoetus sp.	飛魚屬 sp.									1				1
Oxyporhamphus sp.	飛鱵屬 sp.		1		1					1				3
Gonostomatidae														
Cyclothone sp.	圓罩魚屬 sp.	1												1
Haemulidae														
Pomadasys argenteus	銀雞魚										1	1		2
Labridae														
Iniistius verrens	薔薇項鰭魚			2			1			2	2			7
Leiognathidae														
Secutor ruconius	仰口鰏								1	1				2
Myctophidae														
Ceratoscopelus warmingii	瓦明氏角燈魚		1							1				2
Diaphus sp.1	眶燈魚屬 sp.1			1						2				3
Myctophidae sp.2	燈籠魚科 sp.2	1		1			1			2				5
Nomeidae														
Cubiceps pauciradiatus	少鰭方頭鯧									1				1
Ophichthidae														
Echelus sp.	蠕鰻屬 sp.									1				1
Paralepididae														
Paralepididae sp.	魣蜥魚科 sp.		2											2
Sillaginidae														
Sillago sp.	沙鮻屬 sp.												2	2
Sphyraenidae														
Sphyraena sp.	金梭魚屬 sp.										1			1
Terapontidae														
Terapontidae sp.	鯻科 sp.										1			1
Trichiuridae														
Trichiurus sp.	帶魚屬 sp.	1												1
Total Abundance		4	4	4	1	0	3	0	2	14	9	1	2	44
Number of Family		4	3	2	1	0	3	0	2	7	6	1	1	18
Number of Class Group		4	3	3	1	0	3	0	2	10	6	1	1	21
Actual Sampling Number of Juvenile Fish		4	4	4	1	0	3	0	2	15	10	1	2	46

Table 6.3.2-38 Composition and Abundance of Fish Egg at All Sampling Stations of No.15 Offshore Wind Farm on 26th November 2016 (An Egg/100 m³)

Taxa \ station	Chinese Name	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	Total
Cynoglossidae														
Cynoglossus bilineatus	雙線舌鰨	2		2	2	4	2	1	3				2	18
Cynoglossus interruptus	斷線舌鰨		4	5	4				4		1	1	4	23
Cynoglossus itinus	單孔舌鰨	1					1		1			2		5
Haemulidae														
Pomadasys argenteus	銀雞魚												1	1
Mugilidae														
Moolgarda perusii	佩氏莫鯔								1					1
Myctophidae														
Benthosema pterotum	七星底燈魚							1						1
Sparidae														
Acanthopagrus latus	黃鰭棘鯛	3	2		1	5	2			4	3	7	2	29
Trichiuridae														
Trichiurus japonicus	日本帶魚			1										1
Total Abundance		6	6	8	7	9	5	2	9	4	4	10	9	79
Number of Family		2	2	2	2	2	2	2	2	1	2	2	3	6
Number of Class Group		3	2	3	3	2	3	2	4	1	2	3	4	8
Actual Sampling Number of Fish Eggs		6	9	11	10	9	5	2	9	4	6	14	13	98

Table 6.3.2-39 Composition and Abundance of Juvenile Fish at All Sampling Stations of No.15 Offshore Wind Farm on 26th November 2016 (An Individual/100 m^3)

Taxa\Station	Chinese Name	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	Total
Blenniidae														
Blenniidae sp.	鳚科 sp.		1								1			2
Omobranchus sp.	肩鰓鳚屬 sp.						1							1
Bregmacerotidae														
Bregmaceros sp.2	犀鱈屬 sp.2										1			1
Clupeidae														
Sardinella jussieu	裘氏小沙丁魚		2		3		1	1	1			2	1	11
Engraulidae														
Encrasicholina heteroloba	異葉半稜鯷				4		5	1			3	5	5	23
Leiognathidae														
Photopectoralis bindus	黃斑光胸鰏								1					1
Mugilidae														
Chelon subviridis	綠背龜鮻		2											2
Myctophidae														
Benthosema pterotum	七星底燈魚						1						1	2
Sciaenidae														
Chrysochir aureus	黃金鰭鰔							1						1
Johnius macrorhynus	大鼻孔叫姑魚					1								1
Sillaginidae														
Sillago sihama	多鱗沙鮻	1		2	3		2			1		3	1	13
Sparidae														
Acanthopagrus latus	黃鰭棘鯛	17	18	25	30	19	29	13	19	13	17	29	19	248
Acanthopagrus taiwanensis	臺灣棘鯛	1	1		2	1		1	1		1	1		9
Synodontidae														
Harpadon nehereus	印度鐮齒魚							1						1
Trichiuridae														
Trichiurus japonicus	日本帶魚						2							2
Total Abundance		19	24	27	42	21	41	18	22	14	23	40	27	318
Number of Family		2	4	2	4	2	7	5	3	2	4	4	5	12
Number of Class Group		3	5	2	5	3	7	6	4	2	5	5	5	15
Actual Sampling Number of Juvenile Fish		21	36	49	69	21	60	23	27	16	41	73	45	481

Table 6.3.2-40 Composition and Abundance of Fish Egg at All Sampling Stations of No.15 Offshore Wind Farm on 13th March 2017 (An Egg/100 m3)

Taxa \ station	Chinese Name	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	Total
Carangidae														
Alepes djedaba	吉打副葉鰺										11			11
Decapterus russelli	羅氏圓鰺	15	239	605	7	173	705	96	603	128	5	705	143	3424
Clupeidae														
Dussumieria elopsoides	黃帶圓腹鯡	1						5						6
Sardinella sindensis	中國小沙丁魚				2			1						3
Coryphaenidae														
Coryphaena hippurus	鬼頭刀		1											1
Cynoglossidae														
Paraplagusia blochii	布氏鬚鰨		1								19			20
Engraulidae														
Thryssa chefuensis	芝蕪稜鯷	1												1
Thryssa dussumieri	杜氏稜鯷		2					10						12
Mugilidae														
Chelon affinis	前鱗龜鮻	1												1
Moolgarda cunnesius	長鰭莫鯔	1			3			30						34
Ophichthidae														
Brachysomophis cirrocheilos	鬚唇短體蛇鰻			3										3
Platycephalidae														
Kumococius rodericensis	凹鰭牛尾魚	6			2			13			1			22
Platycephalus indicus	印度牛尾魚	1			1	1	4							7
Sciaenidae														
Chrysochir aureus	黃金鰭魚或		6		17					4	2			29
Scombridae														
Scomber japonicus	白腹鯖		13	20	3	3	11	12	7	14	4	8	2	97
Stromateidae														
Pampus echinogaster	鐮鯧			3										3
Synodontidae														
Harpadon nehereus	印度鐮齒魚	1			1		4	12	3		1	3	1	26
Trichiuridae														
Trichiurus japonicus	日本帶魚			3										3
Total Abundance		27	262	634	36	177	724	179	613	146	43	716	146	3703
Number of Family		6	6	5	7	3	4	7	3	3	6	3	3	13
Number of Class Group		8	6	5	8	3	4	8	3	3	7	3	3	18
Actual Sampling Number of Fish Eggs		48	267	1192	44	246	820	382	1116	86	51	1172	168	5592

Table 6.3.2-41 Composition and Abundance of Juvenile Fish at All Sampling Stations of No.15 Offshore Wind Farm on 13th March 2017 (Individual/100 m^3)

Taxa\Station	Chinese Name	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	Total
Ammodytidae														
Bleekeria mitsukurii	箕作布氏筋魚		2	1		1	3		3			1	1	12
Bregmacerotidae														
Bregmaceros sp.1	犀鱈屬 sp.1						2		1			1		4
Bregmaceros sp.2	犀鱈屬 sp.2												1	1
Carangidae														
Decapterus maruadsi	藍圓鰺			2			2		2			2		8
Scomberoides tol	托爾逆鈎鰺			1		2			2		1		1	7
Trachurus sp.	竹筴魚屬 sp.			1		2	2		2			1		8
Centrolophidae														
Psenopsis sp.	刺鯧屬 sp.					1	1							2
Cepolidae														
Acanthocepola limbata	背點棘赤刀魚					1	1							2
Clupeidae														
Nematalosa japonica	日本海鰶							1						1
Ipnopidae														
Ipnopidae sp.	爐眼魚科 sp.									2				2
Lethrinidae														
Lethrinus atkinsoni	阿氏龍占魚		1											1
Malacanthidae														
Branchiostegus auratus	斑鰭馬頭魚						1							1
Mugilidae														
Chelon affinis	前鱗龜鮻				1									1
Mullidae														
Upeneus japonicus	日本緋鯉				1	1	1		3	4				10
Myctophidae														
Ceratoscopelus warmingii	瓦明氏角燈魚								1			1		2
Diaphus fragilis	符氏眶燈魚		4	1		2			3	2				12
Myctophidae sp.1	燈籠魚科 sp.1		2						1					3
Myctophidae sp.2	燈籠魚科 sp.2			2			1		1			4	1	9
Triphoturus nigrescens	淺黑尾燈魚		1											1
Nemichthyidae														
Nemichthyidae sp.	線鰻科 sp.						1							1
Nomeidae														
Cubiceps sp.	方頭鯧屬 sp.					1	1							2
Paralepididae														
Paralepididae sp.	魣蜥魚科 sp.											1		1
Pinguipedidae														

Taxa\Station	Chinese Name	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	Total
Parapercis lutevittata	黃斑擬鱸			1										1
Platycephalidae														
Platycephalidae sp.	牛尾魚科 sp.		1			1	1		2			2		7
Ptereleotridae														
Ptereleotris heteroptera	尾斑凹尾塘鱧											1		1
Scombridae														
Auxis rochei rochei	圓花鰹		5							4				9
Scomber australasicus	花腹鯖					1	2		5	2		2		12
Scorpaenidae														
Scorpaenidae sp.	鮋科 sp.			1			2							3
Serranidae														
Epinephelus awoara	青石斑魚						1							1
Serranidae sp.	鮨科 sp.					1			1			1		3
Sillaginidae														
Sillago parvisquamis	小鱗沙鮻	1		1		1			2					5
Sparidae														
Acanthopagrus sp.	棘鯛屬 sp.				4				1			1		6
Synodontidae														
Trachinocephalus myops	準大頭狗母魚		2											2
Total Abundance		1	18	11	6	15	22	1	30	14	1	18	4	141
Number of Family		1	6	6	3	11	14	1	10	4	1	10	4	24
Number of Class Group		1	8	9	3	12	15	1	15	5	1	12	4	33
Actual Sampling Number of Juvenile Fish		1	18	11	6	15	22	1	42	7	1	21	4	149

Table 6.3.2-42 Composition and Abundance of Fish Egg at Common Corridor of Lunwei Area, Derived From Supplementary Survey (An Egg/100 m^3)

Taxa\Station	Chinese Name	M-N1	M-N2	M-N3	Total
Carangidae					
Megalaspis cordyla	大甲鰺		1		1
Engraulidae					
Encrasicholina heteroloba	異葉半稜鯷		1	55	56
Thryssa dussumieri	杜氏稜鯷		23	29	52
Leiognathidae					
Leiognathus equulus	短棘鰏	3			3
Nuchequula nuchalis	項斑項鰏	1	2	218	221
Platycephalidae					
Kumococius rodericensis	凹鰭牛尾魚		1		1
Sciaenidae					
Johnius macrorhynus	大鼻孔叫姑魚			260	260
Sphyraenidae					
Sphyraena jello	斑條金梭魚		3	31	34
unknown	未知種			32	32
Total Abundance		4	31	625	660
Number of Family		1	5	4	6
Number of Class Group		2	6	5	8
Actual Sampling Number of Fish Eggs		12	126	2816	2954

Table 6.3.2-43 Composition and Abundance of Juvenile Fish at Common Corridor of Lunwei Area, Derived From Supplementary Survey (Individual/100 m^3)

Taxa\Station	Chinese Name	M-N1	M-N2	M-N3	Total
Blenniidae					
Blenniidae sp.	鳚科 sp.	1	2	1	4
Carangidae					
Decapterus macarellus	領圓鰺	1	4	2	7
Elagatis bipinnulata	雙帶鰺		1		1
Scomberoides tol	托爾逆鉤鰺	2	13	2	17
Clupeidae					
Sardinella jussieu	裘氏小沙丁魚	1	2		3
Coryphaenidae					
Coryphaena hippurus	鬼頭刀	1	4		5
Diceratiidae					
Bufoceratias sp.	蟾蜍角鮟鱇屬 sp.	1		1	2
Emmelichthyidae					
Erythrocles schlegelii	史氏紅諧魚		2	1	3
Exocoetidae					
Exocoetidae spp.	飛魚科 spp.	1			1
Exocoetus volitans	大頭飛魚	1			1
Gempylidae					
Gempylus serpens	帶鰆	2	1		3
Gerreidae					
Gerres macracanthus	大棘鑽嘴魚	2	1	1	4
Gobiidae					
Asterropteryx semipunctata	半斑星塘鱧		1		1
Istiophoridae					
Istiophorus platypterus	雨傘旗魚	1			1
Leiognathidae					
Leiognathidae spp.	鰏科 spp.			1	1
Lutjanidae					
Lutjanus russellii	勒氏笛鯛		1		1
Megalopidae					
Megalops cyprinoides	大海鰱		1		1
Myctophidae					
Lampadena luminosa	發光炬燈魚		1		1
Myctophidae sp.1	燈籠魚科 sp.1	1	3	1	5
Nomeidae					
Psenes sp.	玉鯧屬 sp.		1		1
Pomacentridae					
Abudefduf bengalensis	孟加拉豆娘魚	1	1	1	3
Neopomacentrus cyanomos	藍黑新雀鯛	1			1

Taxa\Station	Chinese Name	M-N1	M-N2	M-N3	Total
Scombridae					
Euthynnus affinis	巴鰹		3		3
Sillaginidae					
Sillago sihama	多鱗沙鮻	7	3		10
Soleidae					
Liachirus melanospilos	黑斑圓鱗鰨			1	1
Sphyraenidae					
Sphyraena sp.1	金梭魚屬 sp.1	1	1		2
Sphyraena sp.2	金梭魚屬 sp.2		1	1	2
Terapontidae					
Terapon jarbua	花身鯻	3	5	2	10
Tetragonuridae					
Tetragonuridae sp.	方尾鯧科 sp.		1		1
Total Abundance		28	53	15	96
Number of Family		14	18	11	23
Number of Class Group		17	22	12	29
Actual Sampling Number of Juvenile Fish		73	175	34	282

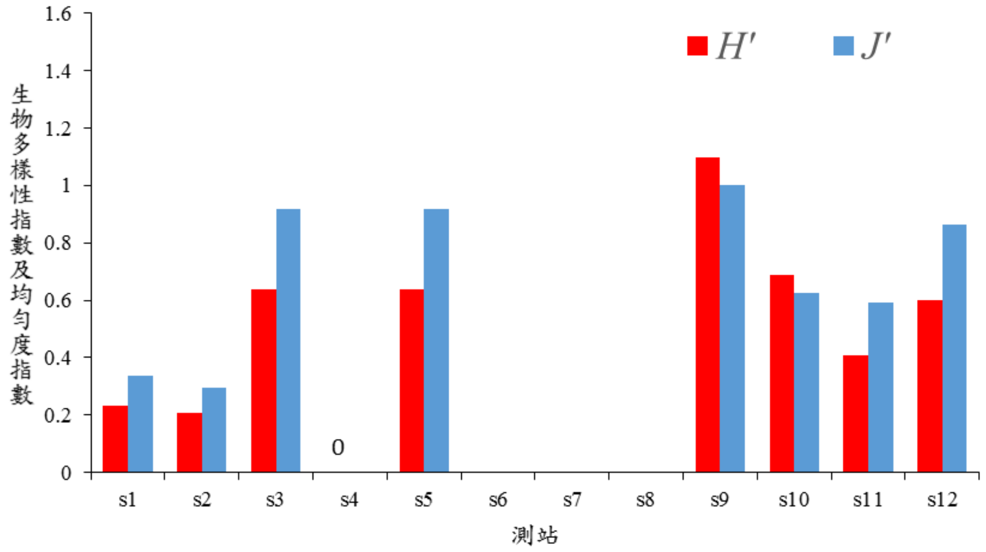


Figure 6.3.2-21 Shannon-Wiener Diversity Index and Evenness Index of Fish Eggs at No.21 Wind Farm on 13th February 2016

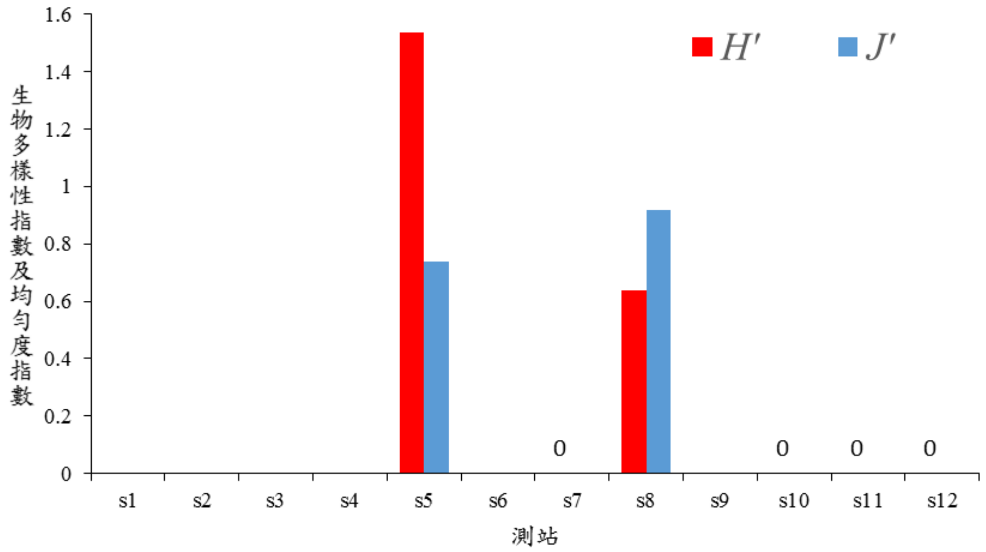


Figure 6.3.2-22 Shannon-Wiener Diversity Index and Evenness Index of Juvenile Fish at No.21 Wind Farm on 13th February 2016

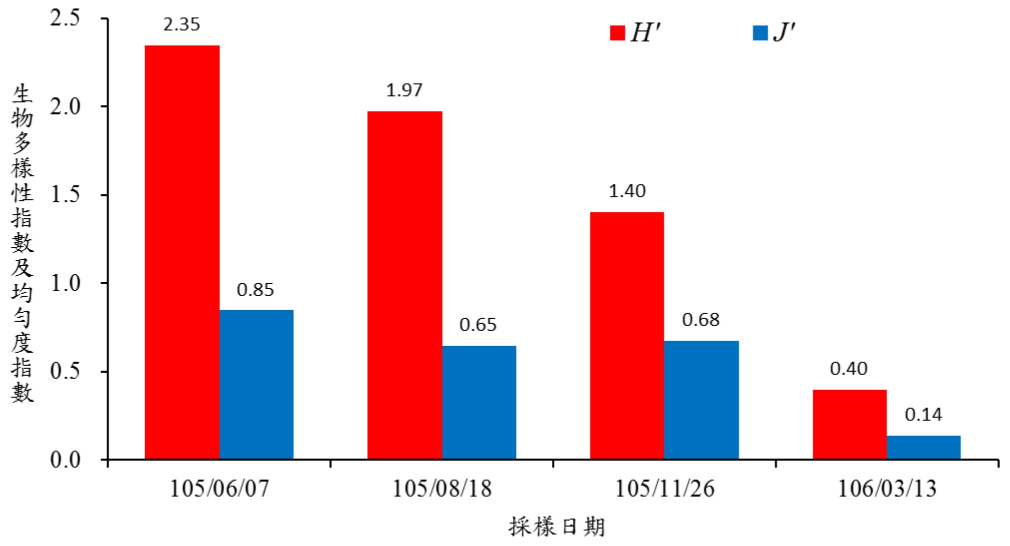


Figure 6.3.2-23 Shannon-Wiener Diversity Index of Fish Eggs at No.15 Wind Farm

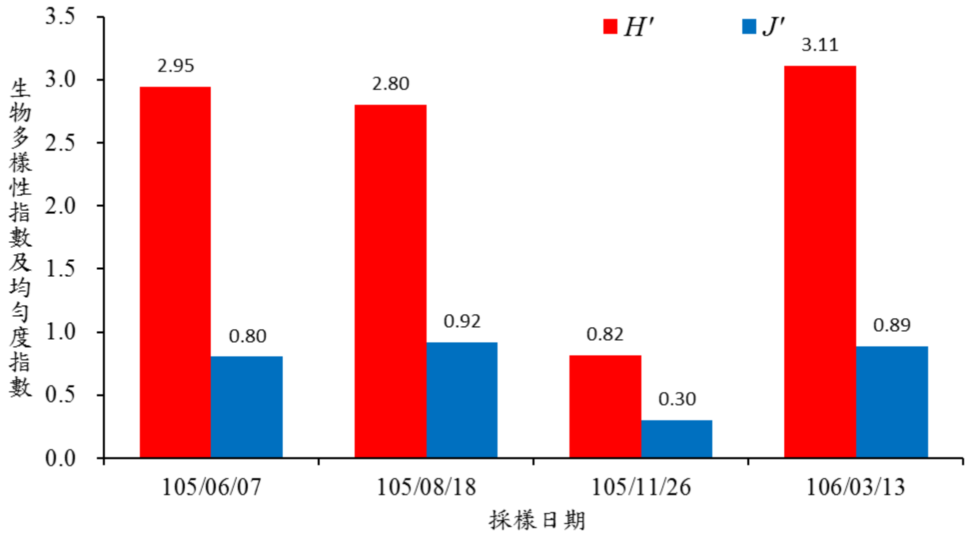


Figure 6.3.2-24 Shannon-Wiener Diversity Index of Juvenile Fish at No.15 Wind Farm at All Quarters

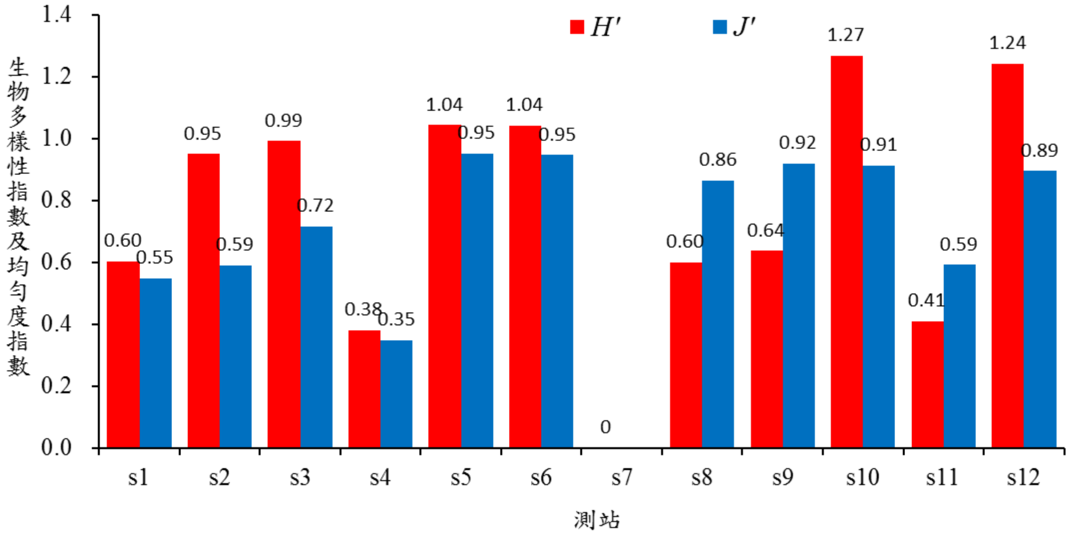


Figure 6.3.2-25 Shannon-Wiener diversity index of Fish Eggs at All Sampling Stations of No.15 Wind Farm on 7th June 2016

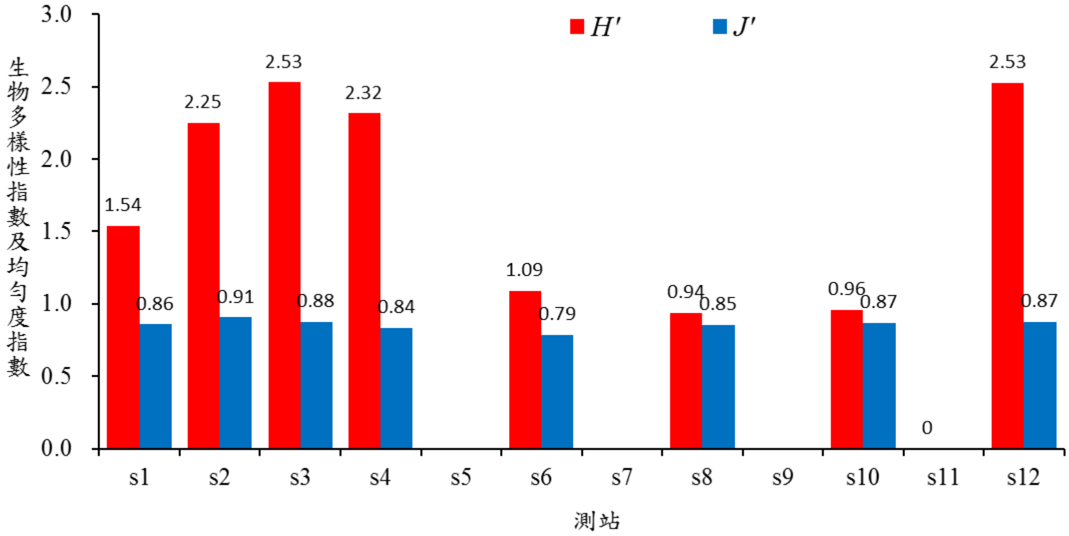


Figure 6.3.2-26 Shannon-Wiener Diversity Index of Juvenile Fish at All Sampling Stations of No.15 Wind Farm on 7th June 2016

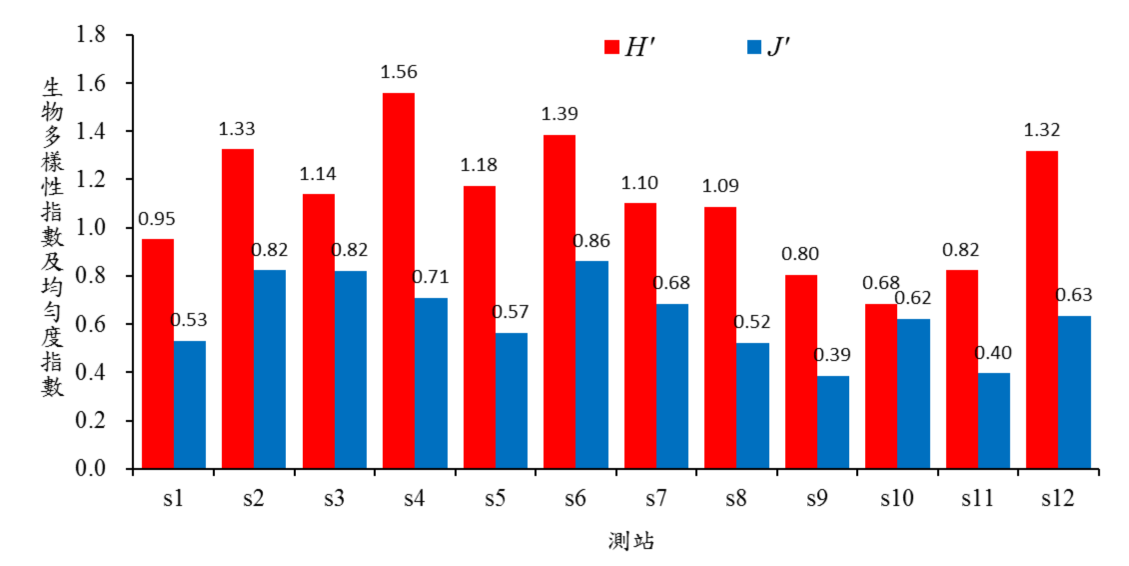


Figure 6.3.2-27 Shannon-Wiener Diversity Index of Fish Eggs at All Sampling Stations of No.15 Wind Farm on 18th August 2016

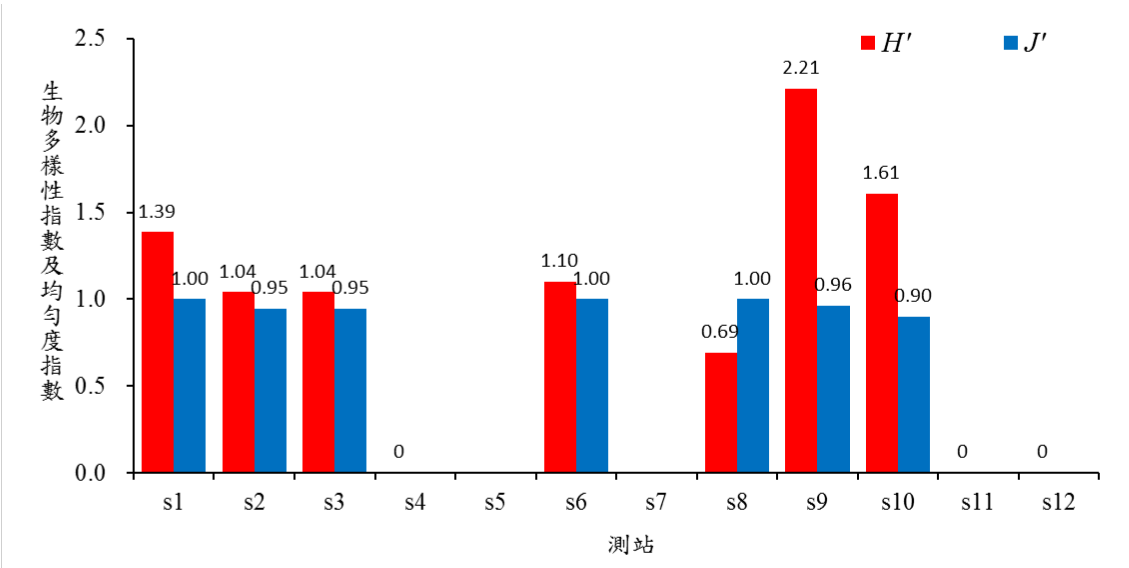


Figure 6.3.2-28 Shannon-Wiener Diversity Index of Juvenile Fish at All Sampling Stations of No.15 Wind Farm on 18th August 2016

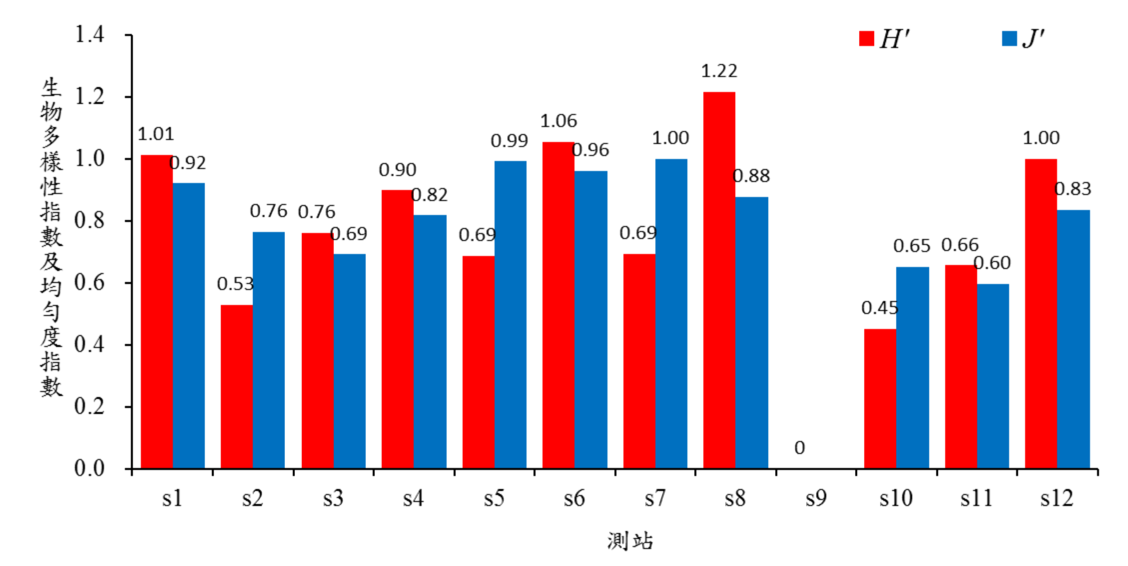


Figure 6.3.2-29 Shannon-Wiener Diversity Index of Fish Eggs at All Sampling Stations of No.15 Wind Farm on 26th November 2016

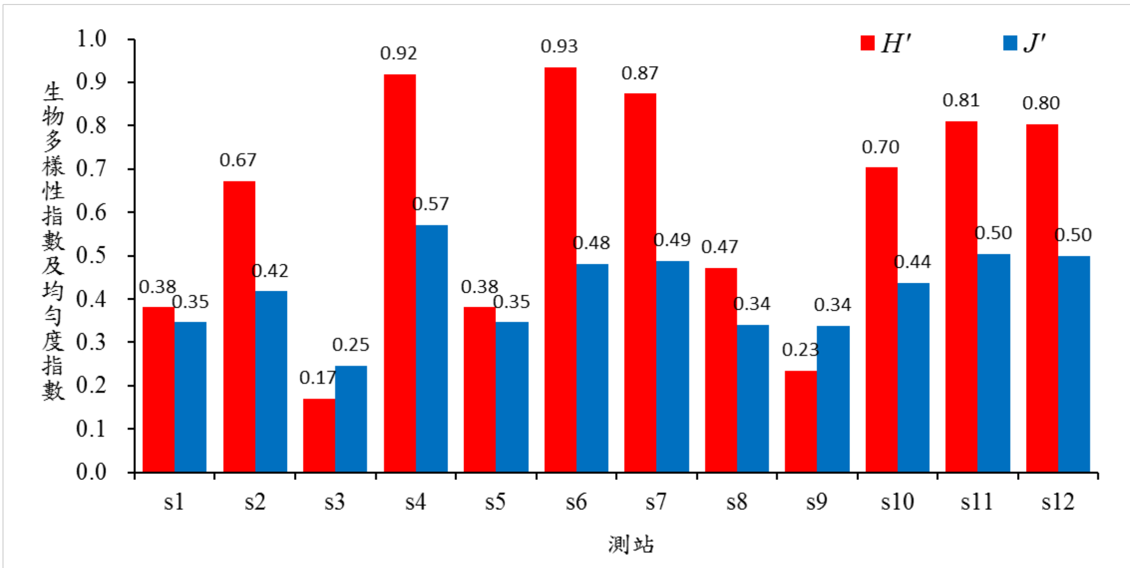


Figure 6.3.2-30 Shannon-Wiener Diversity Index of Juvenile Fish at All Sampling Stations of No.15 Wind Farm on 26th November 2016

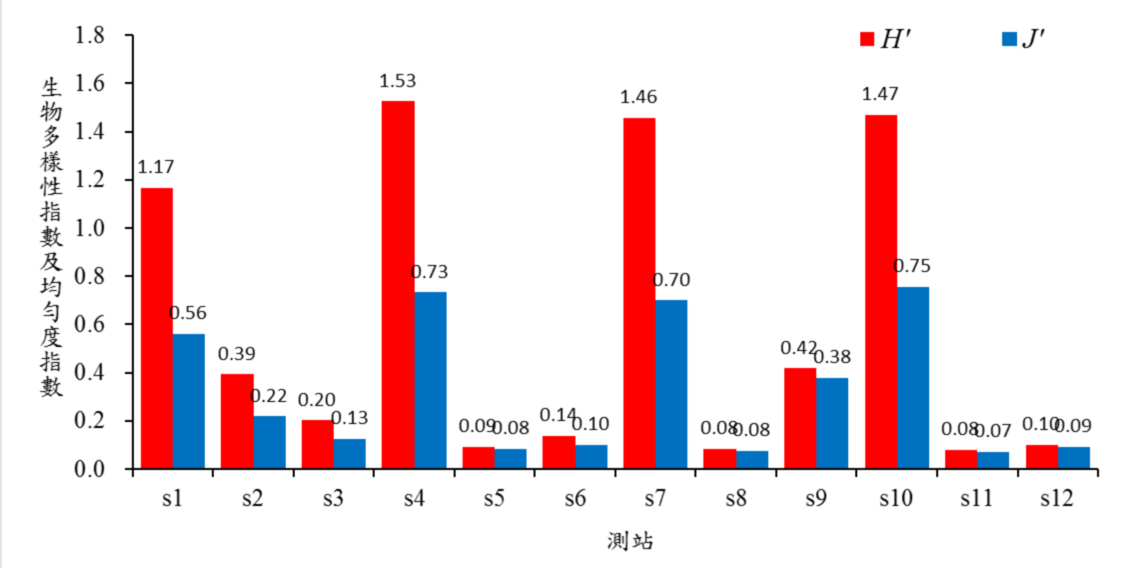


Figure 6.3.2-31 Shannon-Wiener Diversity Index of Fish Eggs at All Sampling Stations of No.15 Wind Farm on 13th March 2017

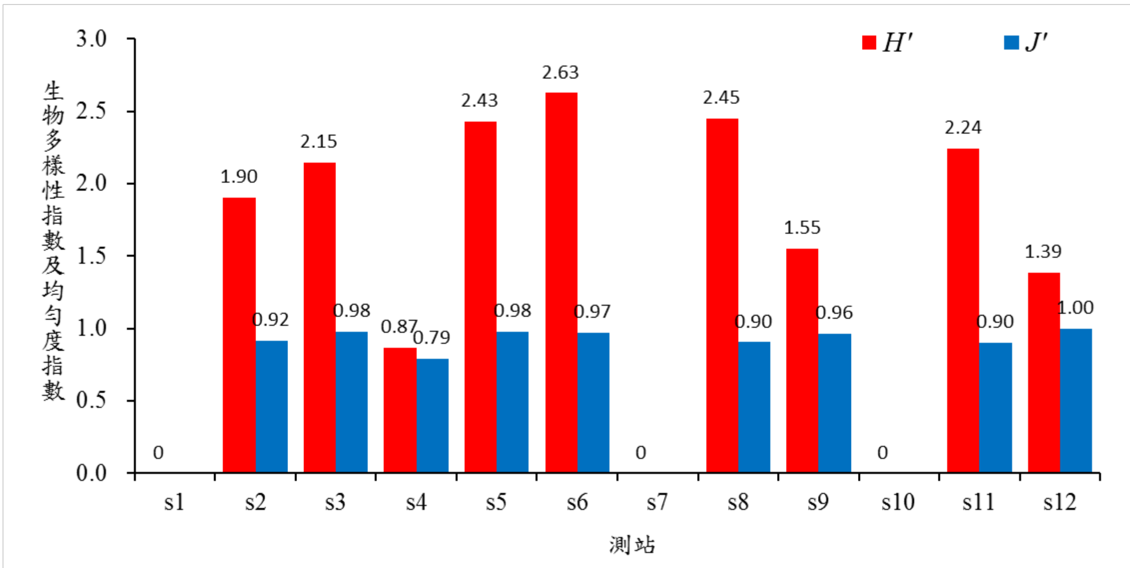


Figure 6.3.2-32 Shannon-Wiener Diversity Index of Juvenile Fish at All Sampling Stations of No.15 Wind Farm on 13th March 2017

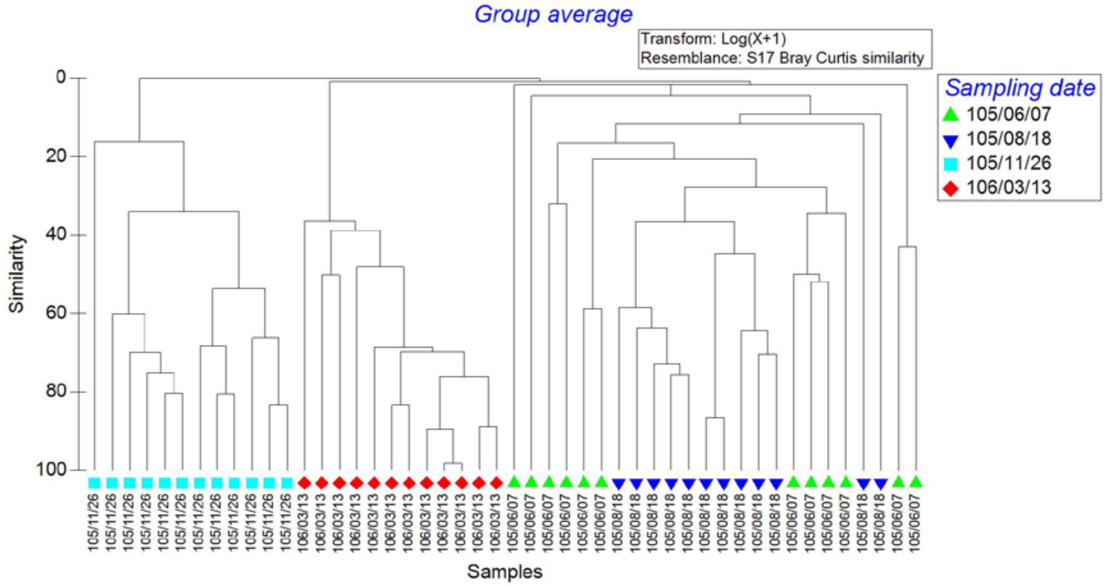


Figure 6.3.2-33 Cluster Analysis of Fish Eggs at No.15 Wind Farm in All Quarters

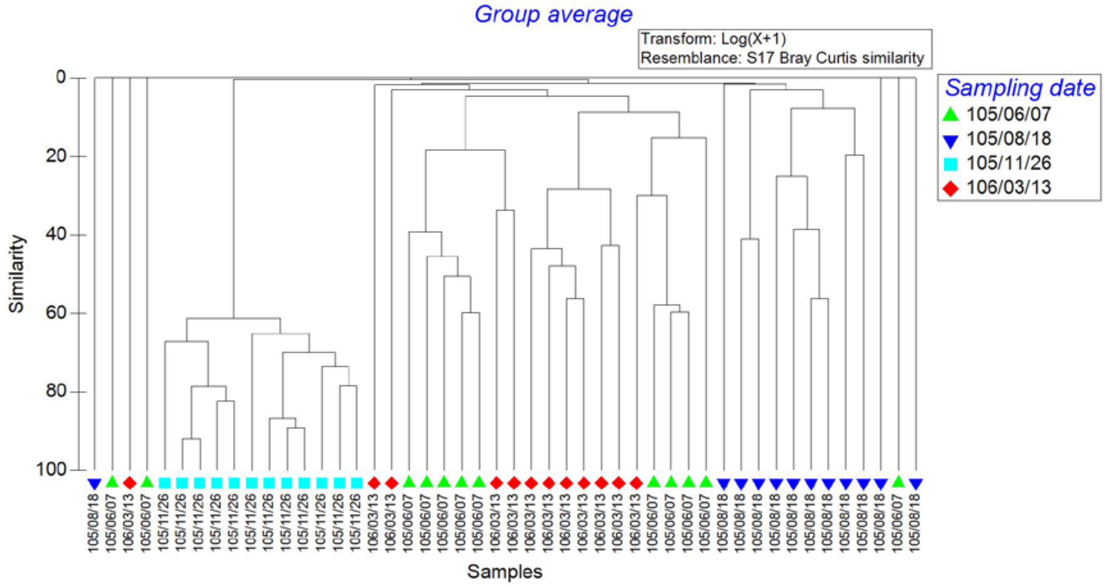


Figure 6.3.2-34 Cluster Analysis of Juvenile Fish at No.15 Wind Farm in All Quarters

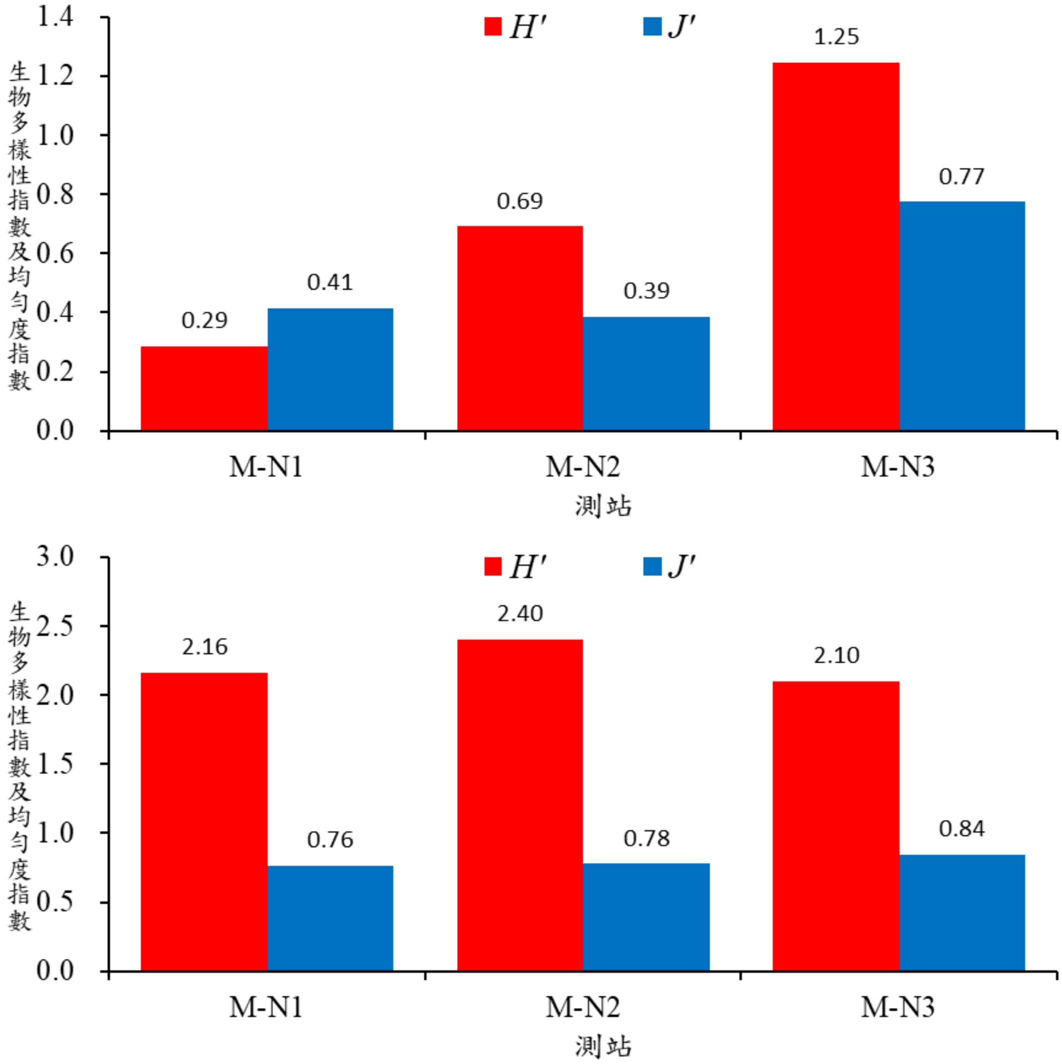


Figure 6.3.2-35 Shannon-Wiener Diversity Index of Fish Eggs and Juvenile Fish at Common Corridor of Lunwei Area, Derived From Supplementary Survey

Adult fish

Survey Results

Wind Farm No.21 carried out its first sampling on 3rd March 2016, a total of 17 families, 23 species, 1555 fishes weighing 13.141kg were caught with the use of three survey trawls. Survey trawl (T1) managed to catch a total of 14 families, 18 species and 376 fishes, weighing a total of 4.158 kg (Table 6.3.2-44). The fish that was caught the most is Secutor ruconius with 239 fish caught and has a low economical value. Samples caught had a length between 5-6.5cm and thus being the juvenile stage of the species. Secutor ruconius are rarely sold in the market and are usually thrown back into the sea or used as forage fish; Following that is the Polydactylus sextarius and Upeneus japonicus, each having 31 fish caught. The Polydactylus sextarius caught had lengths between 9-12 cm, being the juvenile and sub-adult phase of the species. The sizes are slightly smaller than the ones that are in market and are usually used as forage fish; The lengths of the Upeneus japonicus caught are between 9.5-11cm, also in their juvenile stage and are usually used as forage fish; There were 6 species caught that have reasonably good market value, namely Decapterus russelli, Psenopsis anomala, Pennahia pawak, Pennahia macrocophalus, Harpadon nehereus and Trichiurus lepturus, each having 1-10 fish caught. Survey trawl (T2) have caught a total of 13 families, 18 species and 751 fish (Table 6.3.2-44), weighing a total of 5.299kg. The species that was caught the most is Secutor ruconius with 656 fish caught, having the size similar to the ones caught in survey trawl T1; Following that is the Acropoma japonicum with 25 fish caught, having lengths between 4-6cm and was in their juvenile phase. They are normally thrown back into the sea or used as forage fish; The third most caught species is the Pennahia pawak with 16 fish caught, having a size similar to the ones caught in survey trawl (T1). The 6 species with reasonably good market value are the Psenopsis anomala, Polydactylus sextarius, Pennahia argentata, Pennahia pawak, Harpadon nehereus and Trichiurus lepturus, each having 1-10 fish caught; Survey trawl (T3) managed to catch a total of 12 families, 15 species and 428 fish (Table 6.3.2-44), weighing a total of 3.754kg. The species that was caught the most is the Secutor ruconius with 342 fish caught, having lengths between 4-5.5cm, similar to those caught in survey trawls T1 and T2; Following that is the Polydactylus sextarius with 28 fish caught and being in the juvenile phase; 5 other species with good market value are the Decapterus russelli, Upeneus japonicus, Pennahia macrocophalus, Pennahia pawak and Trichiurus lepturus, each having 1-11 fish caught. Comparing the number of fish species: T1=T2>T3; The number of fish yield: T2>T3>T1; The weight of fish yield: T2>T1>T3. The diversity index, H’ of the cluster in each survey station is between 0.66-1.44 whereas the evenness index, J’ is between 0.23-0.50. Looking at the survey stations pairwise, the Sorensen coefficient of each pair is between 0.73-0.79. This means there is a high similarity between the fish species found at the 3 survey stations.

Most of the fish species found in the 3 survey trawls are mainly fishes with arenaceous-pelitic based habitat, especially those species of the families Engraulidae, Synodontidae and

Sciaenidae (having 3 species each). Among those listed, the Sciaenidae are important fish stock for fishermen along the West Coast. Although there are a lot of artificial reef and protection reef placed by the fisheries agencies around the east of the Wind Farm (Xianxi Protection Reef, Shengang Protection Reef, Dadu Estuary Important Wetland Protection Reef), but no rockfish species were caught. The fish species composition sampled is still typical of the arenaceous-pelitic based shallow region of the sea.

Wind Farm No.15 carried out its first sampling on 27th May 2016, having caught a total of 14 families, 14 species and 130 fishes, weighing 27kg using three survey trawls. Survey trawl (T1) managed to catch a total of 10 families, 10 species and 48 fishes, weighing 10.354kg (Table 6.3.2-45). The fish that was caught the most is Arius maculatus that has a low economical value, with 20 fish being caught, all having the length between 25-40cm, marking the species' sub-adult and adult phases, being the market size sold; Following that is Upeneus japonicus with 15 fish caught, having the lengths between 6-12cm, mostly in their juvenile phase, the size being smaller than the ones in market; 4 other species with relatively good market value are the Cynoglossus bilineatus, Dasyatis zugei, Ephippus orbis and Evynnis cardinalis, each having 1-2 fish caught; Survey trawl (T2) has caught 9 families, 9 species and 37 fishes in total (Table 6.3.2-39), weighing a total of 9.034kg. The fish that was most caught is the Arius maculatus with 20 fish, having a size similar to the ones caught in survey trawl T1; Following that is the Diodon holocanthus that has absolutely no economical value, with 5 fish caught, having lengths between 10-13cm, marking the species' sub-adult and adult phases, and are normally thrown back into the sea; 3 other species that have relatively good market value are the Cynoglossus bilineatus, Dasyatis zugei and Sillago asiatica, each with 1-2 fish caught; Survey trawl (T3) caught a total of 7 families, 7 species and 45 fishes (Table 6.3.2-45), weighing a total of 7.33kg. The fish that was caught the most is Arius maculatus with 20 fish, having lengths similar to the ones caught in survey trawl T1 and T2; Following that is the Ephippus orbis which has reasonably good economical value, with 11 fish caught, all having the length between 11-15cm, marking the species' sub-adult and adult stages, the size being similar to the ones in market; 2 other species that have good market value include the Carangoides oblongus and Evynnis cardinalis, each having 1 fish caught. Comparing the number of fish species: T1>T2>T3; The number of fish yield: T1>T3>T2; The weight of fish yield: T1>T2>T3. The diversity index, H' of the cluster in each survey station is between 1.42-1.62 whereas the evenness index, J' is between 0.7-0.73. Looking at the survey stations pairwise, the Sorensen coefficient of each pair is between 0.38-0.71, thus showing relatively high similarity between the fish species found at the 3 survey stations. Aside from that, 3 fishing vessels, 1 platform supply vessel and 3 crabbers from Northern Taiwan were seen operating in the sea territory of the Wind Farm during the time of the survey.

Wind Farm No.15 carried out its second quarter of sampling on 20th July 2016, a total of 12 families, 19 species and 139 fishes carrying a weight of 11kg were caught using three survey trawls. Survey trawl (T1) caught 11 families, 13 species and 94 fishes in total, weighing up to

5.157kg (table 6.3.2-46). The fish that was most caught is the Ephippus orbis that had low economical value, with 51 fish caught, having the lengths between 8-11cm, marking the sub-adult and adult phases of the species, only the ones larger than 10cm are normally sold in market; This is followed by Leiognathus berbis that has no economical value, with 15 fish being caught, all having the length between 4-5cm, mostly in the juvenile phase and are normally thrown back into the sea or used as forage fish; 3 other species with relatively higher market value would be the Seriola dumerili, Seriolina nigrofasciata and Dasyatis zugei, each with 1-2 fish caught; Survey trawl (T2) caught 7 families, 11 species and 29 fishes in total (Table 6.3.2-46), having a total weight of 2.564kg. The fish that was caught the most is the Leiognathus berbis, with 6 fish caught, having a size similar to those caught in survey trawl T1; Following that is the Trachinocephalus myops which has no economical value, with 5 fish caught, all having the length between 6-11cm, marking the sub-adult and adult phases of the species, and are normally used as forage fish; The 2 other species with relatively higher market value are the Dasyatis zugei and Ephippus orbis, each having 2-3 fish caught; Survey trawl (T3) caught a total of 6 families, 9 species and 15 fishes (Table 6.3.2-46), weighing a total of 3.447kg. The fish that was caught the most is the Diodon holocanthus that has no economical value, with 4 fish being caught, having sizes similar to those caught in survey trawls T1 and T2; Following is also another fish with no economical value, the Engyprosopon multisquama that is part of the small flounders, with 3 fish caught, having the lengths between 6-6.6cm and are normally thrown back into the sea or used as forage fish; The other 2 species with relatively good market value are the Dasyatis akajei and Dasyatis zugei, each with 1 fish caught. Comparing the number of fish species: T1>T2>T3; The number and weight of fish yield: T1>T2>T3. The diversity index, H’ of the cluster in each survey station is between 1.61-2.22 whereas the evenness index, J’ is between 0.63-0.93. Looking at the survey stations pairwise, the Sorensen coefficient of each pair is between 0.5-0.58, thus showing relatively high similarity between the fish species found at the 3 survey stations. Aside from that, 2 cargo ships were observed in the sea territory of the Wind Farm, but no fishing vessels nor platform supply vessels were seen operating within the territory.

Wind Farm No.15 had its third sampling on 1st October 2016, having caught a total of 23 families, 32 species and 661 fishes, weighing approximately 80kg with the use of three survey trawls. Survey trawl (T1) caught 19 families, 22 species and 228 fishes with a total weight of 12.667kg (Table 6.3.2-47). The fish that was caught the most is the Upeneus japonicus that has moderate economical value, with 61 fish caught, all having the length between 4-12cm, marking the species’ juvenile stage, fish that are more than 10cm would be sold in market while the ones below would be used as forage fish; Following is a fish with low economical value, the Saurida filamentosa with 54 fish caught, having lengths between 8-25cm, mostly in their juvenile stage, the size caught is smaller than the ones in market and they are usually processed into shredded fish. There are 7 other species of fish that have relatively good market value, for example, the Parastromateus niger, Cynoglossus bilineatus, Dasyatis zugei and Ephippus orbis etc., each having 1-13 fish being caught. Survey trawl (T2) caught a total of 16 families, 19 species and 186 fishes (Table 6.3.2-47) with a total weight of 15.319kg. The fish that was most caught is the Leiognathus berbis with 66 fish caught, all having the length between 4-5.5cm, marking the species' juvenile phase; This is followed by the Ephippus orbis that has reasonable economical value, with 29 fish caught, having lengths between 13-16cm, marking the sub-adult and adult stages of the species, the size being those that are sold in market; There are 8 other species with good market value, namely the Alepes kleinii, Decapterus russelli, Cynoglossus bilineatus, Dasyatis zugei and Sillago asiatica etc., each having 1-9 fish caught; Survey trawl (T3) caught a total of 10 families, 13 species and 197 fishes (Table 6.3.2-47), weighing a total of 52.474kg. The fish that were caught the most are the Decapterus russelli that has a relatively good market value and the Diodon holocanthus that has no market value at all, both with 48 fish caught each. The size of the Diodon holocanthus caught were around the ones sold in market, approximately at the juvenile and sub-adult stages of the species; Following is the fish with a very poor market value, the Arius maculatus with 45 fish caught, all at the juvenile and sub-adult phases of the species, and are normally used as forage fish or thrown back into the sea; There are 6 other species that possess good market value, such as the Caranx sexfasciatus, Cynoglossus bilineatus and Dasyatis zugei etc., each having 1-2 fish caught. Comparing the number of fish species: T1>T2>T3; The number of fish yield: T1>T3>T2; The weight of fish yield: T3>T2>T1. The diversity index, H' of the cluster in each survey station is between 1.70-2.06 whereas the evenness index, J' is between 0.66-0.69. Looking at the survey stations pairwise, the Sorensen coefficient of each pair is between 0.34-0.63, thus showing relatively high similarity between the fish species found at the 3 survey stations. Aside from that, 1 fishing vessel of unknown nationality was seen operating in the sea territory of the Wind Farm during the period of this survey. 2 cargo ships were also seen to have passed by the Wind Farm.

Wind Farm No.15 carried out its fourth sampling on 7th January 2017, catching a total of 18 families, 29 species and 1716 fishes, weighing a total of 12.8kg with the use of three survey trawls. Survey trawl (T1) caught a total of 13 families, 21 species and 858 fishes with a total weight of 5.019kg (Table 6.3.2-48). The fish that was caught the most is the Benthosema pterotum which has no economical value, with 473 fish caught, having lengths between 3-5.5cm, marking the species' juvenile to adult phases, and are normally thrown back into the sea or used as forage fish; Following that is a species with reasonable economical value, the Pennahia macrocophalus with 140 fish caught, all having the length between 6-15cm, presenting in juvenile to adult stage while most of the sample caught were in the juvenile phase of the species. Fish with the length of more than 15cm are normally sold in the market; There are 9 other species with relatively good market value, namely the Polydactylus sextarius, Pennahia pawak and Pampus minor etc., each having 1-68 fish caught; Survey trawl (T2) has caught a total of 15 families, 22 species and 492 fishes (Table 6.3.2-48), weighing a total of 3.965kg. The fish that was most caught is the Benthosema pterotum with 206 fish caught, having the length similar to those of survey trawl T1; Next up is the Pennahia macrocophalus with 114 fish caught, all having the length between 6-14cm, slightly smaller than those caught in survey trawl T1 and are mostly in their juvenile phase; There are 7 other species with relatively good market value, each having 1-48 fish being caught; Survey trawl (T3) caught a total of 9 families, 12 species and 366 fishes (Table 6.3.2-48), weighing a total of 3.836kg. The fish that was caught the most is, once again, Benthosema pterotum with 186 fish caught, having similar length to the ones caught in survey trawls T1 and T2; Next up is, again, the Pennahia macrocophalus with 60 fish caught, having lengths similar to those in survey trawl T2, encompassing phases from the juvenile phase to the sub-adult phase despite having more of the juvenile fish; There are 3 other species with good market value, each having 3-42 fish caught. Comparing the number of fish species and the weight of fish yield: T1>T2>T3; The number of fish yield: T2>T1>T3. The diversity index, H' of the cluster in each survey station is between 1.53-1.81 whereas the evenness index, J' is between 0.5-0.64. Looking at the survey stations pairwise, the Sorensen coefficient of each pair is between 0.59-0.74, thus showing high similarity between the fish species found at the 3 survey stations.

From the results of four rounds of sampling by Wind Farm No.15, a total of 36 families, 67 species and 2596 fishes were caught and sampled (Table 6.3.2-49), there are 3 species that were present in all 4 rounds of sampling in this sea territory, whereas there are 53 species that only appeared in 1 survey. This shows that there are very few species that resides permanently in the sea territory of the Wind Farm. Overall, the species of fish that was caught the most is the Benthosema pterotum, followed by the Pennahia macrocophalus, and the third being Pennahia pawak. The Benthosema pterotum has no economical value, whereas the Pennahia macrocophalus and Pennahia pawak are in the mid price range; The families of fish that were caught the most were the Sciaenidae and Carangidae, each having 7 species; Followed by the Leiognathidae and Engraulidae, each having 5 species. The Carangidae and Engraulidae are part of the mesopelagic and epipelagic group of the migratory species of fish; Whereas the Sciaenidae and Leiognathidae are part of the arenaceous-pelitic benthic species of fish. Out of the 67 fish species that were caught throughout the 4 rounds of sampling, there are 49 species of arenaceous-based fish (73%), 14 species of epipelagic and mesopelagic fish (21%) and 4 species of rockfishes (6%). The fourth round (January) has the largest difference with the other three rounds in terms of the number of fish species and the number of fish yield sampled. In conclusion, almost all of the fish sampled in the four rounds using the 3 survey trawls are arenaceous-pelitic benthic and epipelagic group of the migratory species of fish. Although there are a lot of artificial reef and protection reef placed by the fisheries agencies around the east of the Wind Farm (Xianxi Protection Reef, Shengang Protection Reef, Dadu Estuary Important Wetland Protection Reef), but no rockfish species were caught. The fish species composition sampled is still typical of the arenaceous-pelitic based shallow region of the sea. No fishing vessels from Changhua were seen operating in the sea territory of the Wind Farm throughout the 4 rounds of survey. According to interviews conducted with local Chuanghua fishermen, the sea territory around the Wind Farm is too far and has poor fish yield. And thus, it is not seen as a viable fishing ground for the local fishermen.

Questionnaires

After compiling and sorting out the questionnaires on the gillnet fisheries after collecting them from the fishermen along the Changhua sea territory from March 2016 to February 2017, findings are listed in Table 6.3.2-50~51. Operation log of the fishermen shows that from September to October, fisheries operated for approximately 0-2 days per month. During that period of time, Changhua coastline was suffering from the typhoon and strong winds of the northeast monsoon. The poor sea condition resulted in low number of days of operation of the gillnet fishermen. The fishermen were not able to head out to the sea for any operation during October due to the continuous typhoon. As for December, it is the best month to harvest the mullets following the southward flow of the Chinese coastal current, as shown by the large yield in December. Based on the data collected from the questionnaires as of now, the sea condition in December produces better CPUE and IPUE as there are more catches as well as higher yield of fish species with high economical value (Mugilidae, Sciaenidae and Carangidae). Currently in the fall/winter season, the migratory species of fish from the families Sciaenidae, Mugilidae and Carangidae are the main fish yield for the gillnet fisheries in the Changhua sea territory, with the yield mostly concentrated in November and December. But judging from the data from previous questionnaires, the CPUE and IPUE are generally better from May to July when the sea condition is the most stable, as there are more catches together with higher yield of fish species that have higher economical value (Soleidae, Sciaenidae and Haemulidae). There also exists a difference in the composition of the fish yield in summer and the fall/winter season. The fishermen express that they would focus on fish yield that are more economically competent at the time following the different seasons. Different net design and depth are adopted based on the desired species to be caught. In a nutshell, the gillnet fish yield of Changhua sea territory mainly consists of Scianidae, Cynoglossidae, Ariidae and Haemulidae, these four main arenaceous-pelitic benthic families of fish. There were not much catch on the migratory species of fish, catches are normally carried out in the fall/winter season, mostly focusing on yielding Scombridae and common mullets. As for the fishing activities of Changhua’s gillnet fisheries, they generally take place in the sea territory within 10 nautical miles along the coast between Changhua Coastal Industrial Park and Wanggong region, mostly at regions with the water depth of 10-20 feet, followed by regions with the water depth of 20-20 feet. The overall gillnet fisheries of Changhua sea territory use regions with water depth of 10-30 feet as their main fishing ground.

Artificial Reef

In the period of (2010~2013, it is 40 nautical miles south of the wind farm and 50 nautical miles north of the wind farm, that is, all kinds of artificial reefs in the 11 districts of Miaoli

County to Chiayi County (a steel reef in Chiayi County, Diving survey data of 1 steel reef in Changhua, 2 steel and electric pole reefs in Taichung, 7 steel, cement and electric pole reefs in Miaoli County to predict possible future fish species and fishery effects.由 Table 6.3.2-52 可知各式不 From Table 6.3.2-52, reef with different forms has provided sites from fishing clustering and breeding. Among which , Apogon semilineatus is the mostly recorded species. Chicken grunter is also common this reef zone. Diagramma pictus is frequently recorde as weel. Grouper constitute the majority. Sciaenidae is less recorded in the artifical reef zone. Lutjanidae is common in artificial reef zone. Lutjanus monostigma and Pterocaesio digramma are commonly being recorded. Orange-spotted spinefoot are common in artifical reef. Acanthopagrus berda is being reocrded as well. Chicken grunter, double-lined fusilier, sailfin rubberlip, brown croaker and group are fish which attract the tourist.

From reef survey data, number of species and fish are getiing more. Chaiyi County has the least number and Miaoli County has the most number. Among which, 13 families of economical value are recorded (Table 6.3.2-52, Table 6.3.2-53). 3 to 10 fish species with economical value in ref zone. From sandy sediment, the density of fish clustering is favarable.

Discussion

Drag Net Fishing

From the first operation's data by Wind field number 21, in terms of commercial fish species, this sea area mainly consists of the Carangidae, Mullidae, Polynemidae, Sciaenidae and Regalecidae. There are 11 species of fishes that can be easily caught every time, which is the Acropoma japonicum, Arius maculatus, Secutor ruconius, Thryssa chefuensis, striped fin goatfish, black-spot thread fin, Pennahia macrocophalus, Pennahia pawak, Harpadon nehereus, Saurida wanieso and Trichiurus lepturus. There are also 5 species of fishes which can be caught every 2 times. However, most of the fishes caught in that sea area are smaller in size compared to those in the market, most are prelarval fish, except the Decapterus russelli and Harpadon nehereus, which are in the same size as those in the market. During the operation, other ships were also yet to be seen in that sea area. The wind field is 12 nautical miles away from Changhua's Taipai port, 15 nautical miles away from Taichung's Wuqi port, places which are not local fishermen's common fishing spot.

According to the data of 4 operations, for the part of economic fish species, the sea area of wind field of the 15th has about 36 kinds of economic fishes. Among them, there are only 13 to 14 species with higher economic values, and 26 to 27 with no economic values which are (Acropoma japonicum, Jaydia truncata, Bregmaceros japonicus, Engyprosopon multisquama ---etc.). Although there are high-value fishes appeared in each season, except there will be many during (October and January) of third and fourth seasons. The number of species and the number during the other three seasons are very little, but the economic fish that appeared during the fourth quarter (January) is mostly larval fish and the market value is not high. According to the size of the fish in 4 operations, the length of the captured fishes is from 3.1 to 65 cm. Each species is found from the larval stage to the adult stage, but several types of economic fishes caught in this area compared with the market, the body size is slightly smaller, with the larval fish being the most (except for Decapterus russelli). Plus, the total catch captured is dominated by the Ariidae, Diodontidae, and Tetraodontidae. This is because the catch has the heaviest weight, but the latter two families have no economic value, and the value of the Ariidae is extremely low; the total number of the most captured fishes are Myctophidae, Sciaenidae, Engraulidae, and Leiognathidae. They are fishes with no economic values or very low economic values except Sciaenidae. The main catching target for Chang Hua fishermen are Sciaenidae and Cynoglossidae, but there are not many catches in the sea area of wind field (except season 4 (January), there are many Sciaenidae, however mainly larval fish and has no market value.) It can be seen that the catch of this wind field is extremely poor. In 4 investigations, only a few crabbers or mainland fishing boats from other countries and cities have been seen to be operating at the wind field. Chang Hua fishing boats has not been seen. In terms of fish species and habitats, there are 49 species (73%) of sandy fishes, 14 species (21%) of epipelagic fish and mesopelagic fish, and 4 species (6%) of rock reef fishes. It can be seen that most of the fishes in this area belongs to fish species living at the mud-bottomed, followed by water-surfaced cruise fish. In terms of the number of fish species and the number, the fourth (season) catch is more than the other three seasons. From the cluster analysis results, it can be seen that the fishes have a slight seasonal difference (R: 0.89, p=0.001) (Figure 6.3 .2-36), mainly due to the huge difference between the 4th (January, winter) and other seasons (1st, 2nd, 3rd). This is because the 4th (January, winter) has a very large number of Sciaenidae and Benthosema pterotum, and the third (October, fall) has a large proportion of the Carangidae. Relatively speaking, the first and second seasons are more mixed, the catch are not consistent with the change of each line, and there are no more or fewer differences in line catches. According to the results of 4 samplings, the fishes in this wind filed are typical shallow sea sand & mud fishes in western Taiwan. Although there are many artificial fish reefs and protection reefs placed by the Fisheries Department in the eastern 20 nautical miles of the wind field (west line protection reefs, Shen Gang Protection Reef, Da Du Xi Kou protection reef), but because of the long distance, the number of reef fish caught is very less. The wind field is about 30 nautical miles from Wenzi Fishing Harbor in Changhua, and about 25 nautical miles from Wuqi Fishing Port in Tai Chung. Due to the extreme long distance, and the catch is usually not good, it is not the frequent fishing grounds for local fishermen.

In addition, from the sampling survey of irregular periods for fishing ports and interviews with fishermen, it was found that the southern Rhynchobatidae in the fish caught by the gill net belong to the “Vulnerable (VU)” species under the IUCN classification (VU definition: a group of taxa in the medium term will face the threat of extinction in the wild, those who have not reached the level of severe extinction and endangered are classified as vulnerable species.) The activity of the southern Rhynchobatidae ranges from Cang Lang to 30 meters under water level, and the swimming ability and activity are not good. It is a benthic cartilaginous fish. It feeds on shrimp, crab, shellfish and small fish at the bottom of the sand. In the Chang Hua sea area, the fishermen have a greater chance of catching with gill net during summer. The occasional fishing port vendors' surveys and interviews are done. It can be found that the fishermen indicated that this species is a summer economical fish species. Because of the large meat quality of the individual, the local residents are very fond of it. Generally, they can only be caught by gill nets. The bottom tow fishing boat has few catches, but the production is not much and the number of catches is also unstable. Most of them are only sold in local ports. It is not possible to supply two fish markets of Chang Hua as stable sources. After the establishment of the offshore wind field in the future, it may reduce the capture of gill nets and indirectly protect the number of ethnic groups of southern Rhynchobatidae.

Questionnaire

From the analysis of questionnaire by gillnet fisherman, gillnet operation in Changhua District is mainly during the northeast monsoon has weakened and before the typhoon arrive which is between May and July. The operation area is spread over the water depth of 5~40 meters along the coast of Changhua County, but the depth of 10 to 30 meters is the most common operation of the gillnet (Chart 6.3.2-37), The captured fish species are mainly sand mud and Benthic habitat which is similar to the species caught by drag-net, all composed by the typical western shallow sea fish. In addition, although is not appearing in the questionnaire survey, but through irregular market sample surveys and interviews, species of fishes caught by gillnet, the white-spotted guitarfish (Rhynchobatus australiae) is a Vulnerable (VU) species under the IUCN classification: A group of taxa will face the threat of extinction in the medium term, not seriously extinct, endangered standard but classified as vulnerable species. The activity areas of the white-spotted guitarfish (Rhynchobatus australiae) ranges from the floating area to about 30 meters, swimming ability and activity are not strong, counted as benthic cartilage fish, relying on shrimp, crab, shellfish, and small fish as food source, fishermen have a greater chance of capturing with gillnets during the summer in Changhua sea area, through irregular fishing port fishermen's surveys and interviews can discover, the fishermen said that this species is the main species for summer, due to the size and quality of the fish, is local's most favourite, generally it was mostly caught by using gillnet, drag-net fishing boats are less likely catch this species, but because of the production is not much and the number of captures is unstable, mostly only sold at local port, unable to supply two fish markers in Changhua as stable supply, the future setting up of offshore wind turbine may reduce the capture of gillnets, will protect the number of the ethnic group of the white-spotted guitarfish (Rhynchobatus australiae) indirectly.

Artificial reef and protected reef

Many domestic and foreign research reports point out, set up artificial reefs can provide a variety of water living creatures's habitats, breeding, feeding, migratory and avoiding the environment of the enemy, It is estimated that the pedestal of the future wind field can have a comprehensive effect similar to steel reefs, in the future this wind farm will be combined with several wind farms nearby, may form a broad artificial reef effect, according to the island ecology theory, the larger the island area, the more species and quantity that can be accommodated and endured, therefore, the future formation of protection and polyfish effect should be better than the various artificial reefs at this stage. According to other fish reef surveys in the counties and cities near the north and south of Changhua County, It can be found that will attract and protect more high-economic fish species in the future such as grunts (Haemulidae), snapper, Oplegnathus, The Serranidae, Siganus guttatus et cetera’s fish habitat and reproduction.

Table 6.3.2-44 Fish Species List of Bottom Trawling Sampling at No.21 Wind Farm in March of 2016 (Body length(TL):cm, BW:g, No.of individual)

		時間		2016.03.3			2016.03.3			2016.03.3			2016.03.3	
				拖網T1			拖網T2			拖網T3			Total	Total
魚科名	魚名	中文名	棲性	TL	BW	No.	TL	BW	No.	TL	BW	No.	BW	No.
Acropomatidae	Acropoma japonicum	日本發光鯛	中層	4~7	80	28	4~6	52	25	3~6	45	14	177	67
Apogonidae	*Jaydia lineatus*	細條銀口天竺鯛	沙	5.3	1.8	1							1.8	1
Ariidae	*Arius maculatus*	斑海鯰	沙	30~33	900	2	26~27	570	2	18~35	940	4	2410	8
Carangidae	*Decapterus russelli*	羅氏圓鰺	表	19~22	490	5				17~21	280	3	770	8
Centrolophidae	*Psenopsis anomala*	刺鯧	沙	19	110	1	20	130	1				240	2
Clupeidae	*Nematalosa japonica*	日本海鰶	表	17	45.6	1							45.6	1
Engraulidae	*Setipinna tenuifilis*	黃鯽	沙	10~11.5	30	2				10.5	10	1	40	3
	Thryssa chefuensis	芝蕪稜鯷	沙	10	8	1	7	8	1	8.9	4.7	1	20.7	3
	Engraulidae gen. spp	鯷	表				8.9~10.2	26.3	4	9	3.9	1	30.2	5
Leiognathidae	*Secutor ruconius*	仰口鰏	沙	5~6.5	880	239	5~4.5	3060	656	4~5.5	1410	342	5350	1237
Mullidae	*Upeneus japonicus*	日本緋鯉	沙	9.5~11	500	31	7~11	170	10	8~9	250	14	920	55
Polynemidae	*Polydactylus sextarius*	六指多指馬鮁	沙	9~12	450	31	8~12	180	14	7~10	350	28	980	73
Pristigasteridae	*Ilisha melastoma*	黑口鰳	沙				9	10	1				10	1
Sciaenidae	*Pennahia argentata*	白姑魚	沙				20	120	1				120	1
	Pennahia macrocophalus	大頭白姑魚	沙	5~7	20	10	8	8	1	5~8	12	2	40	13
	Pennahia pawak	斑鰭白姑魚	沙	8~11	150	10	8~12	250	16	8~11	150	11	550	37
Scombridae	*Scomber japonicus*	白腹鯖	表				26	180	1				180	1
Sparidae	*Evynnis cardinalis*	紅鋤齒鯛	沙							11	40	1	40	1
Synodontidae	*Harpadon nehereus*	印度鐮齒魚	沙	21~22	130	2	22~24	220	4	20~21	180	3	530	9
	Saurida wanieso	鱷蛇鯔	沙	12.8~28	207.8	3	12~14	50	2	10.5	8.5	1	266.3	6
	Trachinocephalus myops	大頭花桿狗母	沙	11	10	1	13	30	1				40	2
Tetraodontidae	*Lagocephalus wheeleri*	懷氏兔頭魨	沙	9.1~9.8	34.6	2	8	15	1				49.6	3
Trichiuridae	*Trichiurus lepturus*	白帶魚	沙	30~45	110	6	25~40	150	10	30~46	70	2	330	18
	尾數					376			751			428		1555
	種數					18			18			15		23
	重量				4158			5229			3754		13141	
	歧異度指數(H')					1.44			0.66			0.91		
	均勻度指數(J')					0.50			0.23			0.34		

Table 6.3.2-45 Fish Species List of Bottom Trawling Sampling at No.15 Wind Farm in May of 2016 (Body length(TL):cm, BW:g, No.of individual)

		時間		2016.05.27			2016.05.27			2016.05.27			2016.05.27	
				拖網T1			拖網T2			拖網T3			Total	Total
魚科名	魚名	中文名	棲性	TL	BW	No.	TL	BW	No.	TL	BW	No.	BW	No.
Ariidae	*Arius maculatus*	斑海鯰	沙	25~40	7000	20	25~40	6950	20	25~36	5900	20	19850	60
Carangidae	*Carangoides oblongus*	長圓若鰺	表							11.5	23.8	1	23.8	1
Cynoglossidae	*Cynoglossus bilineatus*	雙線舌鰨	沙	40	300	1	20~25	200	2				500	3
Dasyatidae	*Dasyatis zugei*	尖嘴土魟	沙		1700	2		900	2				2600	4
Diodontidae	*Diodon holocanthus*	六斑二齒魨	礁	11~13	650	3	10~13	700	5	10~12	200	2	1550	10
Emmelichthyidae	*Emmelichthys struhsakeri*	史氏諧魚					4.8	1.2	1				1.2	1
Ephippidae	*Ephippus orbis*	圓白鯧	沙	11~19	300	2				11~15	1000	11	1300	13
Leiognathidae	*Leiognathus berbis*	細紋鰏	沙				5.4	2.1	1				2.1	1
Mullidae	*Upeneus japonicus*	日本緋鯉	沙	6~12	200	15	4~10	55.6	2	4~12	104	9	359.6	26
Platycephalidae	*Suggrundus meerdervoortii*	大眼牛尾魚		7.3~10.5	10.6	2							10.6	2
Sillaginidae	*Sillago asiatica*	亞洲沙鮻	沙				12	25	1				25	1
Sparidae	*Evynnis cardinalis*	紅鋤齒鯛		18	110	1				19	100	1	210	2
Synodontidae	*Trachinocephalus myops*	大頭花桿狗母	沙	7	3.1	1				6.2	2.1	1	5.2	2
Triacanthidae	*Triacanthus biaculeatus*	雙棘三棘魨	沙	17	80	1	14~22	200	3				280	4
	尾數					48			37			45		130
	種數					10			9			7		14
	重量				10354			9034			7330		26718	
	歧異度指數(H')					1.62			1.57			1.42		
	均勻度指數(J')					0.7			0.72			0.73		

Table 6.3.2-46 Fish Species List of Bottom Trawling Sampling at No.15 Wind Farm in July of 2016 (Body length(TL):cm, BW:g, No.of individual)

		時間		2016.07.20			2016.07.20			2016.07.20			2016.07.20	
				拖網T1			拖網T2			拖網T3			Total	
魚科名	魚名	中文名	棲性	TL	BW	No.	TL	BW	No.	TL	BW	No.	BW	No.
Ariidae	*Arius maculatus*	斑海鯰	沙	36	600	1	26	280	1	24~25	400	2	1280	4
Bothidae	*Engyprosopon maldivensis*	馬爾地夫短額鮃	沙							6.4	2.8	1	5.9	2
	Engyprosopon multisquama	多鱗短額鮃	沙				5.7~7.8	6.5	2	6~6.6	8.4	3	14.9	5
	Tarphops oligolepis	高體大鱗鮃	沙				6.5	3.1	1				3.1	1
Carangidae	*Seriola dumerili*	杜氏鰤	表	24	200	1							200	1
	Seriolina nigrofasciata	小甘鰺	表	24	200	1							200	1
Dasyatidae	*Dasyatis akajei*	赤土魟	沙								950	1	950	1
	Dasyatis zugei	尖嘴土魟	沙		600	2		1200	3		700	1	2500	6
Diodontidae	*Diodon holocanthus*	六斑二齒魨	礁	11~15	1150	7	8~18	500	4	9~15	1350	4	3000	15
Ephippidae	*Ephippus orbis*	圓白鯧	沙	8~11	2000	51	7~8	80	2				2080	53
Leiognathidae	*Leiognathus berbis*	細紋鰏	沙	4~5	19.8	15	3.5~4.8	6.2	6	4.5	1.2	1	27.2	22
	Secutor insidiator	長吻仰口鰏	沙				4.5	1.5	1				1.5	1
Mullidae	*Upeneus japonicus*	日本緋鯉	沙	6~8	15.1	4							15.1	4
Platycephalidae	*Suggrundus meerdervoortii*	大眼牛尾魚	沙	6	1.9	1							1.9	1
Synodontidae	*Saurida filamentosa*	長條蛇鯔	沙	7~6.5	6.7	4	5.5~8.8	4.6	2	15.5	20.3	1	31.6	7
	Saurida elongata	長體蛇鯔	沙				22~33	440	2				440	2
	Trachinocephalus myops	大頭花桿狗母	沙	7.5~11.5	44	5	6~11	42.6	5	12.5	15	1	101.6	11
Tetraodontidae	*Lagocephalus lunaris*	月尾兔頭魨	沙	20	200	1							200	1
Triacanthidae	*Triacanthus biaculeatus*	雙棘三棘魨	沙	21	120	1							120	1
	尾數					94			29			15		139
	種數					13			11			9		19
	重量				5157.5			2564.5			3447.7		11173	
	歧異度指數(H')					1.61			2.22			2.03		
	均勻度指數(J')					0.63			0.93			0.92		

Table 6.3.2-47 Fish Species List of Bottom Trawling Sampling at No.15 Wind Farm in October of 2016 (Body length(TL):cm, BW:g, No.of individual)(1/2)

		時間		2016.10.01			2016.10.01			2016.10.01			2016.10.01	
				拖網T1			拖網T2			拖網T3			Total	
魚科名	魚名	中文名	棲性	TL	BW	No.	TL	BW	No.	TL	BW	No.	BW	No.
Apogonidae	*Ostorhinchus kiensis*	中線鸚天竺鯛	沙	2.5~7	10.3	6							10.3	6
Ariidae	*Arius maculatus*	斑海鯰	沙	30~40	1400	3	25~30	4300	21	12~18	22500	45	28200	69
Carangidae	*Alepes kleinii*	克氏副葉鰺	表				25	200	1				200	1
	Caranx sexfasciatus	六帶鰺	表							26	300	1	300	1
	Decapterus russelli	羅氏圓鰺	表				7~7.2	6.7	2	22~26	7900	48	7907	50
	Parastromateus niger	烏鯧	表	22	300	1							300	1
Cynoglossidae	*Cynoglossus bilineatus*	雙線舌鰨	沙	24	150	1	20	56	1	36	200	1	406	3
Dasyatidae	*Dasyatis zugei*	尖嘴土魟	沙		3300	11		150	1		300	1	3750	13
Diodontidae	*Diodon holocanthus*	六斑二齒魨	礁	12~16	600	3	12~15	1200	7	12~15	9600	48	11400	58
Engraulidae	*Stolephorus indicus*	印度側帶小公魚	表	6.6	2.2	1							2.2	1
Ephippidae	*Platax orbicularis*	圓眼燕魚	中層							18	100	1	100	1
	Ephippus orbis	圓白鯧	沙	10~12	1300	13	13~18	4200	29	15~16	200	2	5700	44
Haemulidae	*Plectorhinchus cinctus*	花尾胡椒鯛	礁				25	300	1	24~25	400	2	700	3
	Pomadasys kaakan	星雞魚	沙	28	400	1							400	1
Leiognathidae	*Leiognathus berbis*	細紋鰏	沙	4~6	100	52	4~5.5	100	66				200	118
	Photopectoralis bindus	黃斑光胸鰏	沙	3.1	0.4	1							0.4	1
	Secutor ruconius	仰口鰏	沙	4.2~4.5	8.8	5	5	1.9	1				10.7	6
Mullidae	*Upeneus japonicus*	日本緋鯉	沙	4~12	902	61	3.5~10	112	9				1014	70
Pempheridae	*Parapriacanthus ransonneti*	雷氏充金眼鯛	礁	4	0.5	1							0.5	1
Platyrhinidae	*Platyrhina tangi*	湯氏黃點鯆	沙				36	150	1		450	1	600	2
Rachycentridae	*Rachycentron canadum*	海鱺	表				45	600	1				600	1
Priacanthidae	*Priacanthus macracanthus*	大棘大眼鯛	沙	5.1	2.3	1							2.3	1
Scombridae	*Scomberomorus commerson*	康氏馬加鰆	表	54~68	2500	2							2500	2
Scorpaenidae	*Pterois lunulata*	環紋簑鮋	礁	12	9.1	1							9.1	1
Sillaginidae	*Sillago asiatica*	亞洲沙鮻	沙	5.6	1.2	1	6	0.5	1				1.7	2

Table 6.3.2-47 Fish Species List of Bottom Trawling Sampling at No.15 Wind Farm in October of 2016 (Body length(TL):cm, BW:g, No. of individual)(2/2)

		時間		2016.10.01			2016.10.01			2016.10.01			2016.10.01	
				拖網T1			拖網T2			拖網T3			Total	
魚科名	魚名	中文名	棲性	TL	BW	No.	TL	BW	No.	TL	BW	No.	BW	No.
Soleidae	*Liachirus melanospilos*	黑斑圓鱗鰨	沙							11.5	24.3	1	24.3	1
Synodontidae	*Saurida filamentosa*	長條蛇鯔	沙	8~25	550	54	5~24	151	21				701	75
	Trachinocephalus myops	大頭花桿狗母	沙	8~11	50	4	11	10.5	1				60.5	5
Tetraodontidae	*Lagocephalus lunaris*	月尾兔頭魨	沙	19~21	1000	4	20~26	3600	20	20~25	8500	41	13100	65
	Takifugu oblongus	橫紋多紀魨	沙							24~27	2000	5	2000	5
Trichiuridae	*Tentoriceps cristatus*	隆頭帶魚	沙	60	80	1	65	100	1				180	2
Triglidae	*Lepidotrigla punctipectoralis*	臂斑鱗角魚	沙				20	80	1				80	1
	尾數					228			186			197		611
	種數					22			19			13		32
	重量				12667			15319			52474		80460	
	歧異度指數(H')					2.06			2.02			1.7		
	均勻度指數(J')					0.67			0.69			0.66		

Table 6.3.2-48 Fish Species List of Bottom Trawling Sampling at No.15 Wind Farm in January of 2016(Body length(TL):cm, BW:g, No.of individual)(1/2)

		時間		2017.01.07			2017.01.07			2017.01.07			2017.01.07	
				拖網T1			拖網T2			拖網T3			Total	
魚科名	魚名	中文名	棲性	TL	BW	No.	TL	BW	No.	TL	BW	No.	BW	No.
Acropomatidae	Acropoma japonicum	日本發光鯛	中層	6.5~8	10.5	2	6	2.3	1				12.8	3
Apogonidae	*Apogon ellioti(=Jaydia truncata)*	截尾銀口天竺鯛	沙	3.5~9	120.5	52	4~7.5	69.1	34	4.5~7.5	69.3	24	258.9	110
Bregmacerotidae	*Bregmaceros japonicus*	日本海鰗鰍	沙				6.5	3	1				3	1
Dasyatidae	*Dasyatis zugei*	尖嘴土魟	沙		45.1	1							45.1	1
Engraulidae	*Setipinna tenuifilis*	黃鯽	沙	10~13	836	71	8.5~17	700.6	42	9.2~16.5	448.1	27	1985	140
	Thryssa chefuensis	芝蕪稜鯷	沙	10.2~12.5	46.6	5	10.3~13.5	48.8	4	11.5	33	3	128.4	12
	Thryssa hamiltonii	漢氏稜鯷	沙	20.5~21	135.6	2	21~21.1	140.4	2				276	4
	Thryssa setirostris	長頜稜鯷	沙				14.5~17.5	73.8	2				73.8	2
Leiognathidae	*Eubleekeria splendens*	黑邊布氏鰏	沙				7.8~8	14.7	2				14.7	2
	Leiognathus berbis	細紋鰏	沙	9	7.4	1							7.4	1
	Secutor ruconius	仰口鰏	沙	5.5	2	1							2	1
Mullidae	*Upeneus japonicus*	日本緋鯉	沙	11~11.5	30	2	10.5	13.5	1	11.5	61.2	3	104.7	6
Myctophidae	*Benthosema pterotum*	七星底燈魚	中層	3~5.5	166	473	3.5~5	105	206	3~5.5	105.6	186	376.6	865
Narcinidae	*Narcine prodorsalis*	前背雙鰭電鱝								36	1561.2	3	1561	3
Nettastomatidae	*Saurenchelys taiwanensis*	臺灣蜥鰻	沙	26~40	42.9	4	42~45	36.4	2	36	40.8	3	120.1	9
Platycephalidae	*Grammoplites scaber*	橫帶棘線牛尾魚	沙							12	25.5	3	25.5	3
Platyrhinidae	*Platyrhina tangi*	湯氏黃點鯆	沙					643.3	1				643.3	1
Polynemidae	*Polydactylus sextarius*	六指多指馬鮁	沙	14.5~16	179.1	6	12~15	132.5	5				311.6	11
Pristigasteridae	*Ilisha melastoma*	黑口鰳	沙	10~12	62.2	5	10.5~11	31.9	3				94.1	8
Sciaenidae	*Atrobucca nibe*	黑魚或	沙	15.5	169.6	1							169.6	1
	Johnius amblycephalus	頓頭叫姑魚	沙	12.5	157	1							157	1
	Johnius belangerii	皮氏叫姑魚	沙	6~15	171	2	5~6	6	3	13	75.3	3	252.3	8
	Johnius distinctus	鱗鰭叫姑魚	沙				13~14.5	59.9	2				59.9	2
	Johnius dussumieri	杜氏叫姑魚	沙	9~14	248	7	11.5~15	106.8	4				354.8	11
	Pennahia macrocophalus	大頭白姑魚	沙	6~15	1142	140	6~14	595.6	114	4.5~12	410.1	60	2148	314
	Pennahia pawak	斑鰭白姑魚	沙	7~14.5	1208	68	6.5~13	903.4	48	10~13.8	897	42	3008	158
Stromateidae	*Pampus minor*	鏡鯧	沙	5.5~7	192.4	11	5.5~11	95.1	9				287.5	20
Synodontidae	*Trachinocephalus myops*	大頭花桿狗母	沙	5.5~11	48	3	12.5	15.1	1	10~14	108.9	9	172	13

Table 6.3.2-48 Fish Species List of Bottom Trawling Sampling at No.15 Wind Farm in January of 2017 (Body length(TL):cm, BW:g, No.of individual)(2/2)

		時間		2017.01.07			2017.01.07			2017.01.07			2017.01.07	
				拖網T1			拖網T2			拖網T3			Total	
魚科名	魚名	中文名	棲性	TL	BW	No.	TL	BW	No.	TL	BW	No.	BW	No.
Trichiuridae	*Lepturacanthus savala*	沙帶魚	沙					168.3	5				168.3	5
	尾數					858			492			366		1716
	種數					21			22			12		29
	重量				5019.9			3965.5			3836		12821	
	歧異度指數(H')					1.53			1.81			1.59		
	均勻度指數(J')					0.5			0.58			0.64		

Table 6.3.2-49 Comparison Table of Fish Species By Bottom Trawling Sampling At DE#15 Wid Turbine (BW:g ,No.of individual)(1/3)

		時間		2016.05.27		2016.07.20		2016.10.01		2017.1.7		Total	
魚科名	魚名	中文名	棲性	BW	No.	BW	No.	BW	No.	BW	No.	BW	No.
Acropomatidae	Acropoma japonicum	日本發光鯛	中層							12.8	3	12.8	3
Apogonidae	*Apogon ellioti(=Jaydia truncata)*	截尾銀口天竺鯛	沙							258.9	110	258.9	110
	Ostorhinchus kiensis	中線鸚天竺鯛	沙					10.3	6			10.3	6
Ariidae	*Arius maculatus*	斑海鯰	沙	19850	60	1280	4	28200	69			49330	133
Bregmacerotidae	*Bregmaceros japonicus*	日本海鰗鰍	沙							3	1	3	1
Bothidae	*Engyprosopon maldivensis*	馬爾地夫短額鮃	沙			5.9	2					5.9	2
	Engyprosopon multisquama	多鱗短額鮃	沙			14.9	5					14.9	5
	Tarphops oligolepis	高體大鱗鮃	沙			3.1	1					3.1	1
Carangidae	*Alepes kleinii*	克氏副葉鰺	表					200	1			200	1
	Carangoides oblongus	長圓若鰺	表	23.8	1							23.8	1
	Caranx sexfasciatus	六帶鰺	表					300	1			300	1
	Decapterus russelli	羅氏圓鰺	表					7906.7	50			7906.7	50
	Parastromateus niger	烏鯧	表					300	1			300	1
	Seriola dumerili	杜氏鰤	表			200	1					200	1
	Seriolina nigrofasciata	小甘鰺	表			200	1					200	1
Cynoglossidae	*Cynoglossus bilineatus*	雙線舌鰨	沙	500	3			406	3			906	6
Dasyatidae	*Dasyatis akajei*	赤土魟	沙			950	1					950	1
	Dasyatis zugei	尖嘴土魟	沙	2600	4	2500	6	3750	13	45.1	1	8895.1	24
Diodontidae	*Diodon holocanthus*	六斑二齒魨	礁	1550	10	3000	15	11400	58			15950	83
Emmelichthyidae	*Emmelichthys struhsakeri*	史氏諧魚	中層	1.2	1							1.2	1
Engraulidae	*Setipinna tenuifilis*	黃鯽	沙							1984.7	140	1984.7	140
	Stolephorus indicus	印度側帶小公魚	表					2.2	1			2.2	1
	Thryssa chefuensis	芝蕪稜鯷	沙							128.4	12	128.4	12
	Thryssa hamiltonii	漢氏稜鯷	沙							276	4	276	4
	Thryssa setirostris	長頜稜鯷	沙							73.8	2	73.8	2
Ephippidae	*Platax orbicularis*	圓眼燕魚	表					100	1			100	1
	Ephippus orbis	圓白鯧	沙	1300	13	2080	53	5700	44			9080	110
Haemulidae	*Plectorhinchus cinctus*	花尾胡椒鯛	礁					700	3			700	3
	Pomadasys kaakan	星雞魚	沙					400	1			400	1

Table 6.3.2-49 Comparison Table of Fish Species By Bottom Trawling Sampling At DE#15 Wid Turbine (BW:g ,No.of individual) (2/3)

		時間		2016.05.27		2016.07.20		2016.10.01		2017.1.7		Total	
魚科名	魚名	中文名	棲性	BW	No.	BW	No.	BW	No.	BW	No.	BW	No.
Leiognathidae	*Eubleekeria splendens*	黑邊布氏鰏	沙							14.7	2	14.7	2
	Leiognathus berbis	細紋鰏	沙	2.1	1	27.2	22	200	118	7.4	1	236.7	142
	Photopectoralis bindus	黃斑光胸鰏	沙					0.4	1			0.4	1
	Secutor insidiator	長吻仰口鰏	沙			1.5	1					1.5	1
	Secutor ruconius	仰口鰏	沙					10.7	6	2	1	12.7	7
Mullidae	*Upeneus japonicus*	日本緋鯉	沙	359.6	26	15.1	4	1014	70	104.7	6	1493.4	106
Myctophidae	*Benthosema pterotum*	七星底燈魚	中層							376.6	865	376.6	865
Narcinidae	*Narcine prodorsalis(小密斑)*	前背雙鰭電鱝								1561.2	3	1561.2	3
Nettastomatidae	*Saurenchelys taiwanensis*	臺灣蜥鰻	沙							120.1	9	120.1	9
Pempheridae	*Parapriacanthus ransonneti*	雷氏充金眼鯛	礁					0.5	1			0.5	1
Platycephalidae	*Grammoplites scaber*	橫帶棘線牛尾魚	沙							25.5	3	25.5	3
	Suggrundus meerdervoortii	大眼牛尾魚	沙	10.6	2	1.9	1					12.5	3
Platyrhinidae	*Platyrhina tangi*	湯氏黃點鯆	沙					600	2	643.3	1	1243.3	3
Polynemidae	*Polydactylus sextarius*	六指多指馬鮁	沙							311.6	11	311.6	11
Pristigasteridae	*Ilisha melastoma*	黑口鰳	沙							94.1	8	94.1	8
Rachycentridae	*Rachycentron canadum*	海鱺	表					600	1			600	1
Priacanthidae	*Priacanthus macracanthus*	大棘大眼鯛	沙					2.3	1			2.3	1
Sciaenidae	*Atrobucca nibe*	黑魚或	沙							169.6	1	169.6	1
	Johnius amblycephalus	頓頭叫姑魚	沙							157	1	157	1
	Johnius belangerii	皮氏叫姑魚	沙							252.3	8	252.3	8
	Johnius distinctus	鱗鰭叫姑魚	沙							59.9	2	59.9	2
	Johnius dussumieri	杜氏叫姑魚	沙							354.8	11	354.8	11
	Pennahia macrocophalus	大頭白姑魚	沙							2147.7	314	2147.7	314
	Pennahia pawak	斑鰭白姑魚	沙							3008.4	158	3008.4	158
Scombridae	*Scomberomorus commerson*	康氏馬加鰆	表					2500	2			2500	2
Scorpaenidae	*Pterois lunulata*	環紋簑鮋	礁					9.1	1			9.1	1
Sillaginidae	*Sillago asiatica*	亞洲沙鮻	沙	25	1			1.7	2			26.7	3
Soleidae	*Liachirus melanospilos*	黑斑圓鱗鰨	沙					24.3	1			24.3	1
Sparidae	*Evynnis cardinalis*	紅鋤齒鯛	沙	210	2							210	2

Table 6.3.2-49 Comparison Table of Fish Species By Bottom Trawling Sampling At DE#15 Wid Turbine (BW:g ,No.of individual) (3/3)

		時間		2016.05.27		2016.07.20		2016.10.01		2017.1.7		Total	
魚科名	魚名	中文名	棲性	BW	No.	BW	No.	BW	No.	BW	No.	BW	No.
Stromateidae	*Pampus minor*	鏡鯧	沙							287.5	20	287.5	20
Synodontidae	*Saurida filamentosa*	長條蛇鯔	沙			31.6	7	701	75			732.6	82
	Saurida elongata	長體蛇鯔	沙			440	2					440	2
	Trachinocephalus myops	大頭花桿狗母	沙	5.2	2	101.6	11	60.5	5	172	13	339.3	31
Tetraodontidae	*Lagocephalus lunaris*	月尾兔頭魨	沙			200	1	13100	65			13300	66
	Takifugu oblongus	橫紋多紀魨	沙					2000	5			2000	5
Trichiuridae	*Tentoriceps cristatus*	隆頭帶魚	沙					180	2			180	2
	Lepturacanthus savala	沙帶魚	沙							168.3	5	168.3	5
Triglidae	*Lepidotrigla punctipectoralis*	臂斑鱗角魚	沙					80	1			80	1
	尾數				130		139		611		1716		2596
	種數				14		19		32		29		67
	重量			26718		11173		80460		12821		130771	

Table 6.3.2-50 Survey of Specimen Fish Catch Table By Gill Net at Changhua County From 2016 to 2017 (Weight :Kg)(1/2)

			年度	105年										106年		
魚科	學名	魚種	俗稱　月別	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	總計
牛尾魚科	*Platycephalus indicus*	印度牛尾魚	牛尾	9	2.5	30	4.7	9.1	35.5	24		2.2			3.2	120.2
白鯧科	*Ephippus orbis*	圓白鯧	圓白鯧				1		1							2
石首魚科	*Pennahia argentata*	白姑魚	白口					5								5
	Sciaenidae *gen.* spp.	石首魚科	帕頭	225	200	710	169	325	103	71			4.4	0.5	8	1815.9
	Otolithes ruber	紅牙魚或	三牙	68.7	65	124	125.5	323	183	6.3			0.8		3.7	900
石鱸科	*Pomadasys* spp.	雞魚屬	石鱸、金龍	10		3	20	133	91	22						279
	Plectorhinchus cinctus	花尾胡椒鯛	加志			20										20
大眼鯛科	*Priacanthus spp.*	大眼鯛	大眼鯛									1.3				1.3
舌鰨科	Cynoglossidae *gen.* spp,	舌鰨科	牛舌		175	360	146	135	83.5	22					1	922.5
	Cynoglossidae *gen.* spp,	舌鰨科	比目魚		20											20
合齒魚科	Saurida spp.	蛇鯔屬	狗母					5	20	7						32
馬鮁魚科	*Eleutheronema rhadinum*	多鱗四指馬鮁	午仔	1.9	7	28	2.5	1.4				162.8	405	125	3.4	737
舵魚科	*Girella* spp.	瓜子鱲屬	黑毛										15.9	4.2		20.1
	Kyphosus spp.	舵魚屬	白毛										0.7			0.7
鯛科	*Acanthopagrus berda*	灰鰭棘鯛	黑格	26.4	2			0.8				9	175		23.1	236.3
	Acanthopagrus latus	黃鰭棘鯛	赤翅												0.3	0.3
鯧科	*Pampus chinensis*	中國鯧	白鯧	1.3		2			0.3			0.4	15	10	0.2	29.2
	Pampus minor	鏡鯧	棋只									4				4
海鯰科	*Arius maculatus*	斑海鯰	成仔	32	6	17	359.4	38	18.3	2		20	8.4	1.3	1	503.4
海鰻科	*Muraenesox* spp.	海鰻屬	海鰻										2.5			2.5
長鯧科	*Psenopsis anomala*	刺鯧	肉魚									19.7		10	211	240.7
魟科	Dasyatidae *gen.* spp.	魟科	魟魚	295.6	28	41	3		10.5	2.3		9		3.5		392.9
鯡科	*Nematalosa* spp.	海鰶屬	土黃	1	0.6		2	11	1					0.2		15.8
鯖科	Scombridae *gen.* spp.	鯖科	鯖魚		5										1	6
	Scomberomorus spp.	馬加鰆	馬加									268	13	39	88	408
	Auxis spp.	鯖科	煙仔						1			2.7			28	31.7
鰺科	*Elagatis bipinnulata*	雙帶鰺	青甘									1.3				1.3

Table 6.3.2-50 Survey of Specimen Fish Catch Table By Gill Net at Changhua County From 2016 to 2017 (Weight:Kg)(2/2)

			年度	105年										106年		
魚科	學名	魚種	俗稱 月別	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	總計
	Megalaspis cordyla	大甲鰺	大甲參、鐵甲				1	6	8	4		87				106
	Trachurus japonicus	日本竹筴魚	硬尾		1							3		25		29
	Decapterus spp.	圓鰺屬	赤尾	5.2											22	27.2
	Parastromateus niger	烏鯧	黑鯧									5.9				5.9
	Scomberoides spp.	逆鉤鰺	七星仔						4			16.2	30.5			50.7
	Seriola dumerili	杜氏鰤	紅甘									0.7				0.7
	Seriolina nigrofasciata	小甘鰺	黑甘									0.7				0.7
	Seriola rivoliana	長鰭鰤	扁甘									0.6				0.6
	Alepes djedaba	吉打副葉鰺	吉打副葉鰺									2				2
鮨科	*Epinephelus* spp.	石斑魚	石斑							1.6						1.6
鯔科	*Mugil cephalus*	鯔	烏仔										3104	3.6		3107.6
鑽嘴魚科	Gerres macracanthus	大棘鑽嘴魚	大棘鑽嘴魚					2	0.8							2.8
雞籠鯧科	*Drepane* spp.	雞籠鯧屬	金槍									12	12.5			24.5
龍紋鱝科	*Rhynchobatus djiddensis*	吉打龍紋鱝	龍文沙						1.5							1.5
		大鯊魚	鯊魚			40	70	11.4	5							126.4
鋸腹鰳科	*Ilisha elongata*	長鰳	力魚									175	48.4	117.5		340.9
帶魚科	*Trichiurus lepturus*	白帶魚	白帶魚	9				0.7				23.5		8	45.3	86.5
	Leiognathus equulus	短棘鰏	三角				10	40	7				0.2			57.2
金線魚科	Nemipterus spp.	金線魚	金線魚						5							5
甲殼類	*Portunus pelagicus*	遠海梭子蟹	蟹仔市		4				5							9
	Charybdis feriatus	鏽斑蟳	花腳蟹	16												16
	Portunus trituberculatus	三疣梭子蟹	金門市	187												187
			大蝦	1.8			2.6	3.6	0.6			14.8		0.5	1.3	25.2
頭足類	*Sepia esculenta*	真烏賊	花枝	90	8.6		0.9	3	12.6	0.4			2.5			118
貝類	Babylonia spp.	鳳螺	象牙鳳螺					3								3
		總計		1084.9	524.7	1375	918	1056	597.6	162.6	0	841.8	3839	348.3	440.5	11082.8

Table 6.3.2-51 Number of Operation Days, CPUE and Statistics of Waters by Specimens via Gill Net at Changhua Waters

		105年										106年			
	月別	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	總計	平均
漁戶	A作業天數(黃OO)	9	4	8	10	5	9	2	0	9	6	4	6		
	B作業天數(黃XX)	9	5	5	轉業	轉業	轉業	轉業	轉業	轉業	轉業	轉業	轉業		
水深(M)	區域 平均天數	9	4.5	6.5	10	5	9	2	0	9	6	4	6		
<10	工業區北														
10-20	工業區北														
<10	工業區外														
10-20	工業區外	1				4								5	0.4
20-30	工業區外	2												2	0.2
30-40	工業區外														
<10	工業區南	4												4	0.3
10-20	工業區南	5												5	0.4
20-30	工業區南														
30-40	工業區南														
無	工業區南														
10-20	王功外	4												4	0.3
20-30	王功外						2							2	0.2
30-40	王功外	1												1	0.1
	無	1				8	6			5		2	6	28	2.3
<10	無										2			2	0.2
10-20	無		4	11	5		1				2	2		25	2.1
20-30	無		5	2	5			2		1	2			17	1.4
30-40	無									3				3	0.3
40-50	無														
	刺網捕獲總重	1084.9	524.7	1375	1263	1056	476.4	162.6	0	841.8	3838.8	348.3	440.5		
	作業天數	18	9	13	10	12	9	2	0	9	6	4	6		
	平均CPUE	60.3	58.3	105.8	126.3	88.0	52.9	81.3	0.0	93.5	639.8	87.1	73.4		

Table 6.3.2-52 Dominant Species at Different Forms of Artifical Reefs at Chiayi County to Miaoli County, From 2010 to 2013

	嘉義縣	彰化縣	台中		苗栗縣						
	東石鋼鐵	崙尾鋼鐵	五甲鋼鐵	五甲電桿	外埔電桿	外埔鋼鐵	崎頂鋼鐵	通霄水泥	白新鋼鐵	白新電桿	白新水泥
Apogonidae 天竺鯛科	0~1	1	1~5	0~4	0~3	1	1~7	0~3	0~4	0~1	2~3
Carangidae 鰺科*				0~1	0~1	0~1	0~2		0~1	0~1	
Chaetodontidae 蝶魚科			0~2	0~2	0~1		0~1		0~3	0~1	0~1
Haemulidae 石鱸科*		2	0~3	1~3	0~1		1	1	1~2	1~2	0~2
Kyphosidae 舵魚科				0~2			0~1	1	0~1	0~1	
Labridae 隆頭魚科				0~3		0~1	0~3	0~1	0~1		0~3
Lutjanidae 笛鯛科*		1~2	0~4	0~1	0~1	0~2	0~3	0~1	0~2	1~2	0~1
Moronidae 真鱸科*											
Mullidae 羊魚科*							0~1				
Oplegnathidae 石鯛科*		1	0~2	0~2	0~1	1	0~2	0~1	0~2	2	1
Pomacanthidae 棘蝶魚科				0~1	1		0~1	0~1	0~1	1	0
Pomacentridae 雀鯛科			0~1	1~3	2	1	2~4	1~3	1	0~1	0~2
Scaridae 鸚嘴魚科*									0~1	1	
Scatophagidae 金錢魚科*										0~1	
Sciaenidae 石首魚科*		1		0~1						0~1	0~1
Serranidae 鮨科*	1	1~2	0~5	1~3	2~4		1~3	0~2	0~4	3	0~3
Siganidae 臭都魚科*		0~1	0~1	0~1	0~1	0~1	0~1	0~1	0~1	1	0~1
Sparidae 鯛科*				0~1		0~1	0~1	0~1			
Sphyraenidae 金梭魚科*				0~1		0~1	0~1				
魚種	2~3	8~9	3~15	10~26	8~15	10~12	11~29	10~15	13~18	16~19	6~19

Table 6.3.2-53 Dominant Species at Different Forms of Artifical Reefs at Chiayi County to Miaoli County, From 2010 to 2013

	嘉義縣	彰化縣	台中		苗栗縣						
	東石鋼鐵	崙尾鋼鐵	五甲鋼鐵	五甲電桿	外埔電桿	外埔鋼鐵	崎頂鋼鐵	通霄水泥	白新鋼鐵	白新電桿	白新水泥
Apogonidae 天竺鯛科	0~12	20	1~121	0~460	0~40	300~2000	2~860	0~206	0~1700	0~1	150~630
Carangidae 鰺科*				0~200	0~50	0~200	0~200		0~500	0~100	
Chaetodontidae 蝶魚科			0~2	0~9	0~5		0~2		0~4	0~7	0~1
Haemulidae 石鱸科*		41~51	0~153	8~214	0~300		50~157	8~50	200~350	300~302	0~9
Kyphosidae 舵魚科				0~23			0~6	2~4	0~4	0~13	0
Labridae 隆頭魚科				0~15		0~1	0~20	0~1	0~1		0~8
Lutjanidae 笛鯛科*		1~4	0~4	0~4	0~2	0~3	0~501	0~20	0~101	1~6	1~3
Moronidae 真鱸科*											
Mullidae 羊魚科*							0~6				
Oplegnathidae 石鯛科*		0~2	0~50	0~8	1~2	6	0~7	0~5	0~10	44~76	1~5
Pomacanthidae 棘蝶魚科				0~4	1		0~3	0~1	0~1	2~10	
Pomacentridae 雀鯛科			0~80	7~1006	151~203	200~1000	12~750	370~688	1~400	0~1	0~515
Scaridae 鸚嘴魚科*									0~1	1	
Scatophagidae 金錢魚科*										0~1	
Sciaenidae 石首魚科*		0~1		0~6						0~1	0~1
Serranidae 鮨科*	1~3	1~3	0~45	2~24	2~6		2~15	0~5	0~8	7~9	0~7
Siganidae 臭都魚科*		0~1	0~10	0~80	0~1	0~9	0~4	0~15	0~20	8~30	0~2
Sparidae 鯛科*				0~1		0~1	0~4	0~1			
Sphyraenidae 金梭魚科*				0~20		0~20	0~15				
魚尾數	3~14	67~82	83~271	188~1504	574~1370	728~3236	154~2266	725~945	513~3528	408~526	162~1180

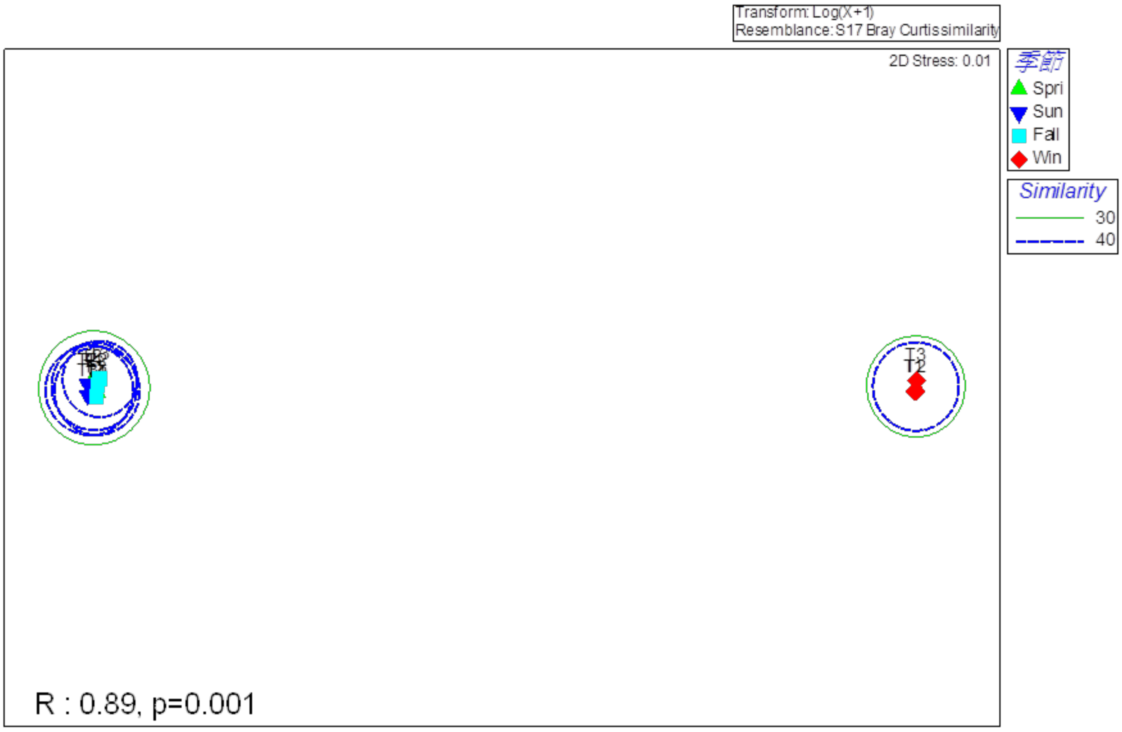


Figure 6.3.2-36. Cluster Analysis Diagram of Sampling (Quarter) and Fish Catch of Sampling Stations at DE#15 Wind Farm

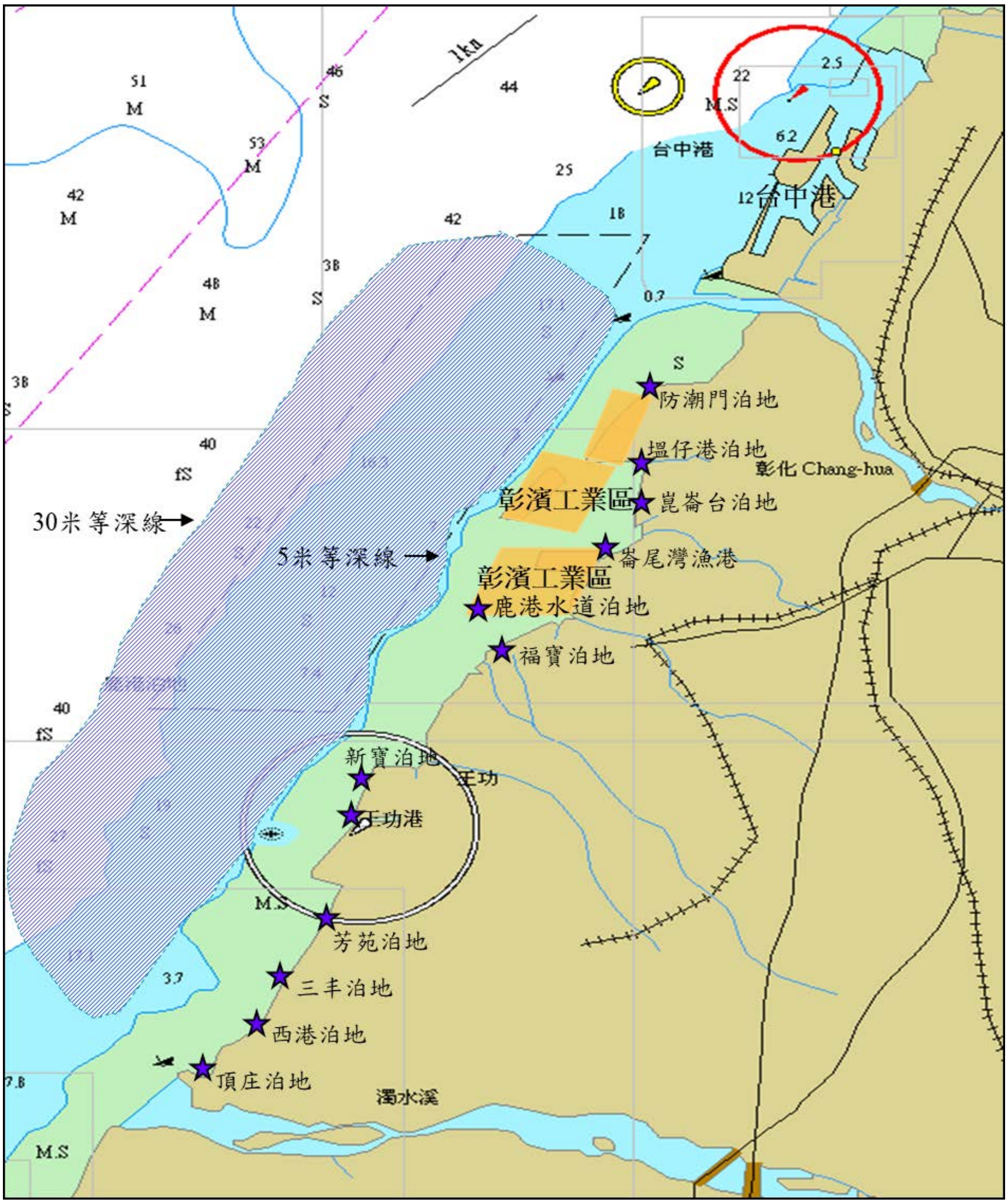


Figure 6.3.2-37. Water Depth Schematic Diagram of Harbors, Anchorage and Area of Gill Net Within Changhua County

Fishery Resources

Fishery Environment

Changhua has a fairly straight and flat coastline. The coastal area covers between Dadu River and Zhuoshui River, which reaches 61 kilometers in length. Due to the influence of drift in Dadu River, Dajia River, and Zhuoshui River, it has formed an uplifted alluvial plain. It is the typical sandy coast in the west. The beach slope is subdued, and the intertidal zone is 3-5 kilometer in width. Water Resources Agency (MOEA) has planted mangroves which grow well in Fangyuan coast. There is a 42 hectare of Ghost Shrimp Breeding Conservation Area from the Dadu River to Changhua Coastal Industrial Park, as well as Aquatic Birds Conservation Area along the Changhua Coastal close to the Dadu Estuary Important Wetland and to the Tianwei drainage coastal area. Part of Changhua Coastal Industrial Park is in offshore development, using watercourses, such as Qing-an, Fu-an, Ji-an, Xianxi, Yong-an, Lunwei, and Lukang waterways, to isolate from the inland. Riverside Park is developed on the west side of the waterway, and a 90-120 meters wide of windbreak is set at the seawall. There is also a 27-50 meters wide of windbreak dike in the north of Lu Kang coastal area. A 12-50 meters wide of green belt is placed along the side of main roads and district boundaries. A well-grown mangroves are planted on the Fangyuan coast. There are 31 wind-driven generators in Xian Xi Lun Wei Industrial Park, and 22 generators in Yongxing district of Wanggong. The coastal wind direction of Changhua in each month mostly heads to the northeast, which occurs between September and the following April. However, the coastal wind changes its direction to south, southwest, and south between May and August. During May to August, the highest number of annual rainfall is over 120mm (Iy-Hsing Engineering Consultants, Inc., 2002). There is a fishery right (subtidal line extends to 3 nautical miles) in the Xianjing sea area with an approved area of 324.6 square kilometers. The approval duration is from March 5, 2009 to June 4, 2019. Approved types and names of fisheries are listed in the table 6.3.2-54.

Mud Shrimp Breeding Conservation Area

The area of Shengang Mud Shrimp Conservation Area covers an area of 36 hectare (including 20 hectare of core area) (Graph 6.3.2-39). The conservation area is within the intertidal zone of mudflats. The zone can be wide when the tide has gone out. The main conservation species is the Austinogebia edulis. According to the survey report of Fishery Agency in 2013, it shows that there is still a significant number of different kinds of mud shrimp in the conservation area (approximately 10-27 shrimps/square meter). Mud shrimps can be caught within the approval duration and area stipulated by Fishery Agency. The catching amount should be reported monthly to Changhua Fishery Association or local "Management Committee of Mud Shrimp". When the catching amount reaches 2 million in a year, prohibited of catching activity will be publicized by Changhua government. Longitudes and latitudes of the conservation area are as below,

Ⅰ（24°10'24"N，120°27'17"E）(TWD97:194597,2674327),

Ⅱ（24°10'22"N，120°27'23"E）(TWD97:194766,2674265),
Ⅲ（24°10'55"N，120°27'32"E）(TWD97:195024,2675280),
Ⅳ（24°10'58"N，120°27'23"E）(TWD97:194770,2675373);
Ⅰ（24°10'8"N，120°27'43"E）(TWD97:195329,2673832),
Ⅱ（24°10'8"N，120°27'22"E）(TWD97:194736,2673835),
Ⅲ（24°9'47"N，120°27'8"E）(TWD97:194338,2673190),
Ⅳ（24°9'47"N，120°27'29"E）(TWD97:194931,2673188).

The area of Wanggong Mud Shrimp Breeding Conservation Area covers an area of 42 hectare (including 17.5 hectare of core area) (Graph 6.3.2-40). It is the new conservation area publicized by Fishery Agency in August 2012. The conservation area is within the mud flat of intertidal zone. The zone can be wide when the tide has gone out. The main conservation species is the Austinogebia edulis. The “core area” is prohibited to catch mud shrimps, bivalves, and other catches throughout the year, except for academic research approved by the authorities. The breeding conservation area is only used for ecological teaching, fishery ecological experience, and academic research which are subject to the approval of the government. Only the demonstration of catching mud shrimps is allowed to carry out in this area. They will be released on site after completing the demonstration and shall not be taken out from the conservation area. Longitudes and latitudes of the conservation area are as graph 6.3.2-40.

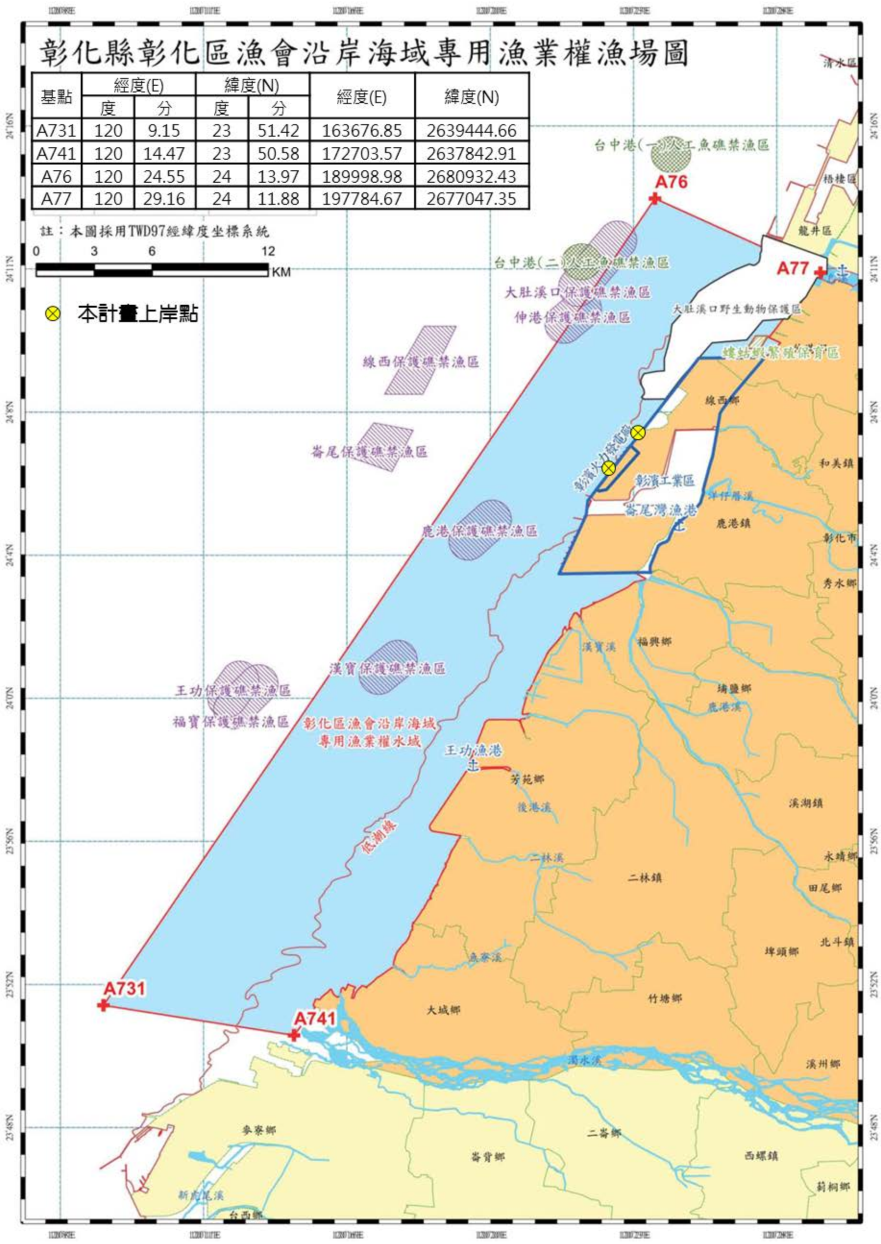
Dadu Estuary Wildlife Refuge

The area of Dadu Estuary Wildlife Refuge covers between Taichung Power Plant’s boundary (Figure 6.3.2-41) and Tianwei drainage in Shenggang, Changhua. East boundary (left coast) is next to the 10 kilometers sand mining site from port upstream (within Changhua). East boundary (right coast) uses No.10 section stake on Longjing dike as the boundary (within Taichung). West boundary extends 2 kilometers into the sea. Taichung and Changhua made a joint announcement in 1998 that the Dadu Estuary Wildlife Refuge is the largest habitat of aquatic bird in central Taiwan. It covers the estuary, drainage basin, wetland, reclaimed land, intertidal zone, marine pond, and also includes protection forest and aquatic bird conservation area. Most of the conservation areas are tidal mud flats, partially built as find ponds. The main conservation targets are estuaries, coastal ecosystems, and birds or wildlifes which inhabit in them. The animal resource in this area are mainly bird. According to Chinese Wild Bird Federation, there are more than 235 species of bird in the conservation area, in which aquatic bird accounts for 70% and 30% is land bird. The bird population in the area is very high in species and density. The aquatic bird season is from December to April. The dominant species of winter migrant birds are dulin, pintail and teal duck. No large mammals are found in the conservation area, but small mammals such as bats and rodents. Wetlands in the conservation area are divided into two ecosystems. The first ecosystem is estuary marsh grass which changes in different water level, and the second ecosystem is coastal which adapts to the harsh environment of strong winds and high salinity in coastal areas.

Table 6.3.2-54 Fishery types and catches of exclusive fishery rights in Changhua

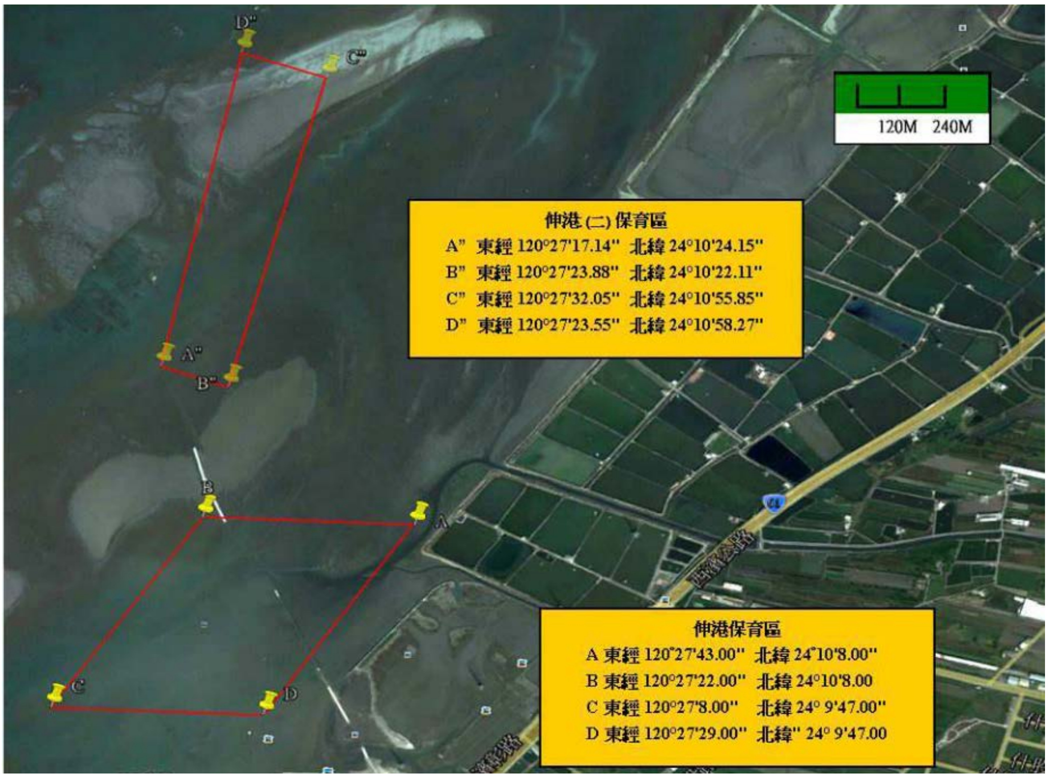
Fishery types	Main catches	Fishing Periods
Gill-net fishery	Spanish mackerel, pomfrets, mullet, and other trash fish	Year round
Push net or scoop net fishery	Fry of eel, mullet, milkmish, etc.	Year round
Pole and line fishery	Oriental sweetlips, croakers, three-banded sweetlips, and other miscellaneous fish	Year round
Shallow sea aquaculture	Oyster, hair clam, steamer clam, other bivalves	Year round
Fisheries of other gears and methods	Coastal fish	Year round

(Source: Changhua Fisheries Association)



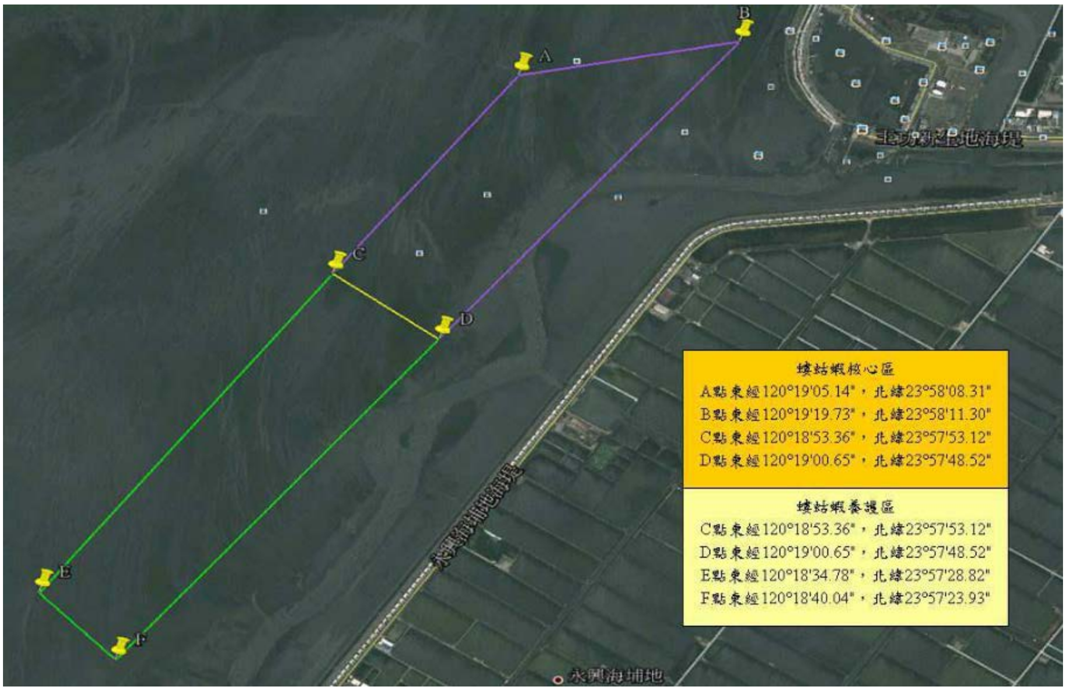
(Data Source: Changhua County Government)

Figure 6.3.2-38 Reserved Area for Industrial Area, Wild Animal Protected Area, Democrated Fishing Righ and Relative Location of Fishery Reef Within Changhua County



Photography Time of google: 2012 (Photo Source: Second Phase of Public Announcement of Changhua County Government)

Figure 6.3.2-39 Location Map Shenggang Protected Area at Changhua County



Photography Time of google: 2012 (Photo Source: Second Phase of Public Announcement of Changhua County Government)

Figure 6.3.2-40 Location Map of Wongkung Protected Area Within Changhua County

(Data Source: Website of Taichung City Government at Coastal Resources and Fishery Development 2017/02/08)

Figure 6.3.2-41 Location Map of Dadu Estuary Wildlife Refuge Within Changhua County

Fishery Facility

The aquaculture fishery population in Changhua County accounts for about 63% of the total fishery population. The main catches of cultured fisheries are oysters, Hard clam, fresh water clam, Eel, Tilapia, Trionychidae, etc. There is currently no cage culture in deeper waters. A large area of fishery aquaculture on the coast has a total area of about 250 hectares in the north of Shengang Township Chuanxin and Shigu seawall and Hanbao, Xinbao, Wang-Gong and Yongxing culture areas in Fangyuan Township. For oyster farming, it is almost in the wide intertidal zone. In the Changan Coastal Industrial Park, the fishermen's oysters are very dense in the muddy bottom of the Ji'an Waterway. They are located in the wide intertidal zone of the Fubao Fishing Harbor, which is the old turbid water stream. The fishermen are breeding oysters and bivalve. The northern end of the Hanbao Seawall and the southern part of the Xinbao reclaimed land are wide in the intertidal zone of the sand. There are deep water ditches about 50 meters offshore and also an oyster breeding area. There are high-density oyster cultures on the outside of Wang-Gong Fishing Harbor and in the intertidal zone outside the Xinjie seawall, using a non-hanging pontoon type.

In terms of fishing and fishing industry, there are currently two second-class fishing ports in Changhua County, Lunweiwan Fishing Harbor and Wang-Gong Fishing Harbor, and 10 berths for boat mooring (Figure 6.3.2-37). Due to the large tidal range in the county, it is a tidal harbor, which means that the entry and exit of fishing vessels is limited by the rise and fall of the tide. For example, Wang-Gong Fishing Harbor will completely expose the flat muddy beach bottom 3 to 4 kilometers from the sea 2 to 3 hours before and after the dry tide. Even the shallowest pipe cannot enter and exit. After 2~3 hours before and after the full tide, the vessel can barely pass carefully. Therefore, only 4 to 6 hours a day is suitable for the ship to enter and leave the port. Located in the Changhua Coastal Industrial Park, Wenzi Harbor is currently a port that can park large tonnage vessels. Both bottom and double tugs, which require greater power, are anchored here. However, because it is also tidal harbor, the entry and exit of fishing boats is limited by the tides rising and falling. The sailing time is only 2~3 hours before and after the full tide, and only 4~6 hours in one day is suitable for the boat to enter and exit.

About 8 artificial reefs were set up in the coastal waters of Changhua County (Table 6.3.2-55, Figure 6.3.2-38). However, because most of them have been set up for a long time, some reef materials have been untestable. In recent years, several steel reefs have been re-launched in Lunwei District.

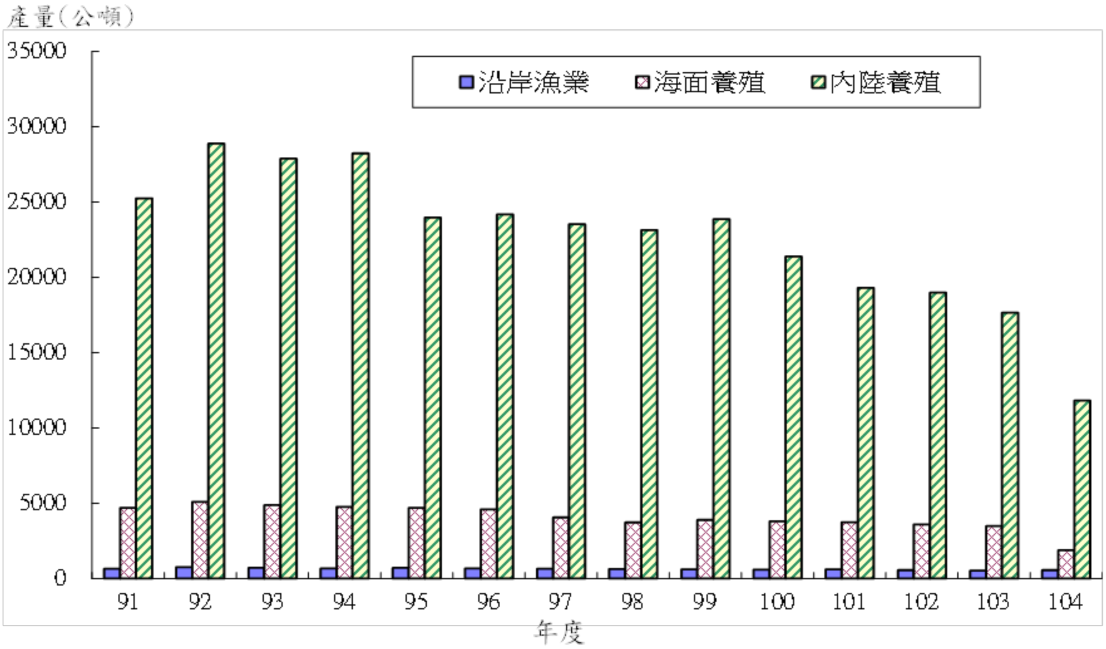
Overview of Fishery Industry

In the past 10 years, the fishery in Changhua County has only coastal and aquaculture fisheries. There are no deep sea fishing, offshore, and inland fishing. The fishery includes two major categories: marine and inland aquaculture. Sea-farming farming only has intertidal culture without maritime cage and oyster pontoon culture. The catch production and output value changes are shown in Figure 6.3.2-42. The catch production and output value are the most inland farming. The coastal fishery only accounts for 2~4% of the total fishery production and catch production, and the annual change is not large, which is also the least proportion of the Changhua fishery. The most productive value and catch production is that inland farming is almost 80% per year. However, after 2012, the catch production decreased slightly, while the output value declined sharply, accounting for about 70% of the total output value by 2015. The aquaculture production is about 13-16% per year, and the output value is about 10% per year (Table 6.3.2-56), but since 2012, the catch production has decreased slightly. However, the output value has increased significantly, accounting for 24 to 30% of the total output value by 2015. In terms of coastal fisheries, there are fixed nets (starting in 2013, the data was changed to "other fisheries") and gill nets. Through field operations, visits and interviews with fishermen, Changhua's fixed net fisheries contain seasonal catches. The operation of the bag net, seasonal stand net, waiting bag net, snake cage and crab cage. Therefore, in 2013, the registration project was changed to "other fisheries", and the original fixed-net fishery was unrecorded. The gillnet fishery includes three forms: bottom gill net, anchored gill net and drift net. The yield and output value of the gill net are 2.2 to 2.5 times that of the fixed net (or other fishery) (Fig. 6.3.2-43). The output value and production of fixed nets (or other fisheries) are roughly equivalent each year. According to the information in the annual report, the fixed output network in 2003 had the highest output (214 metric tons), and then declined year by year. After the change to other fisheries in 2013, the annual output fell to 147 metric tons. The output value has not changed much in the past 10 years. Among them, the highest output value in 2010, the lowest in 2002, but in 2015 there is no record. The output of using gillnet is generally maintained at 450-550 metric tons. In recent years, the output has increased slightly, and the output value has increased year by year. In 2010, it exceeded NT$60,000/year, and 2012 was the highest in the past few years. It can be seen that the gillnet is the main fishing method in the official fishery statistics of Changhua Coast. However, for many years, there is no trawling operation (including single trawl and double trawl) of fishery project statistics, and the fishery record of trawling operations is obviously ignored.

Table 6.3.2-55 Types of Reef and Installed Number at Changhua County (*Vicinity of Wind Farm)

Name of Reef	Coordinates of Center		Labelled Poit	Announced Time	Scope	Year	Form of Reef	Number
	(WGS84)	(TWD97)						
Hanbao Protection Reef Fishing Forbidden Zone *	N24°01'05"",E120°17'22""	177711.29 ,2657210.12	A	1989/1/4	以Ａ、Ｂ兩點所連之標示直線周圍 1000 公尺以內水域屬之	81	2.6M Cross-Type of Protection Reef	110
	N24°00'39"",E120°16'50""	176811.91 ,2656406.16	B					
Shengggang Protection Reef Fishing Forbidden Zone	N24°10'53"",E120°22'31""	186530.59 ,2675254.63	A	1989/1/4	以Ａ、Ｂ兩點所連之標示直線周圍 1000 公尺以內水域屬之	82	2.6M Cross-Type of Protection Reef	200
	N24°10'28","E120°22'01""	185673.62 ,2674483.19	B					
Lukang Protection Reef Fishing Forbidden Zone	N24°05'00","E120°20'00""	182211.58 ,2664409.36	A	1989/1/4	以Ａ、Ｂ兩點所連之標示直線周圍 1000 公尺以內水域屬之	84	2.6M Cross-Type of Protection Reef	300
	N24°04'24","E120°19'20""	181077.58 ,2663307.23	B			92	Pole Reef	200
						94	Pole Reef	250
Dadu River Protection Reef Fishing Forbidden Zone	N24°12'48","E120°23'30""	188212.24 ,2678780.35	A	1989/1/4	以Ａ、Ｂ兩點所連之標示直線周圍 1000 公尺以內水域屬之		2.6M Cross-Type of Protection Reef	
	N24°11'30","E120°22'24""	186332.50 ,2676396.31	B					
Xianxi Protection Reef Fishing Forbidden Zone	N24°10'24","E120°19'00""	180572.28 ,2674385.36	A	1989/1/4	以Ａ、Ｂ、Ｃ、Ｄ四點所連成四方形範圍以內水域均屬之	86	2.6M Cross-Type of Protection Reef	100
	N24°10'24","E120°18'06""	179048.13 ,2674392.88	B					
	N24°08'30","E120°17'00""	177160.59 ,2670902.47	C			87	2.6M Cross-Type of Protection Reef	475
	N24°08'30","E120°18'04""	178969.69 ,2670893.33	D					
Lunwei	N24°07'30","E120°17'48""	178513.21 ,2669045.97	A	1989/1/4	以Ａ、Ｂ、Ｃ、Ｄ四點所連成四	85	2.6M Cross-Type of	300

Protection Reef Fishing Forbidden Zone					方形範圍以內水域均屬之		Protection Reef	
	N24°07'42","E120°16'42""	176644.77 ,2669420.96	B			86	2.6M Cross-Type of Protection Reef	100
	N24°06'45","E120°16'00""	175456.52 ,2667677.15	C			87	2.6M Cross-Type of Protection Reef	300
	N24°06'20","E120°17'12""	177485.80 ,2666902.46	D			88	2.6M Cross-Type of Protection Reef	560
			A	Yet to be announced	以A、B兩點所連之標示直線周圍 1000 公尺以內水域屬之	100	B Type Iron Reef	3
			B			101	B Type Iron Reef	3
Wongkung Protection Reef Fishing Forbidden Zone *	N24°00'30","E120°12'57""	170217.68 ,2656164.48	A	1988/7/14	以A、B兩點所連之標示直線周圍 1000 公尺以內水域屬之	89	Cement Pole Protection Reef	475
	N24°00'00","E120°12'36""	169622.42 ,2655248.52	B			90	Pole Reef	200
						91	Pole Reef	200
						93	Pole Reef	400
						95	Pole Reef	200
Fubao Protection Reef Fishing Forbidden Zone *	N24°00'24","E120°13'29""	171122.20 ,2655982.26	A	1990/8/10	以A、B兩點所連之標示直線周圍 1000 公尺以內水域屬之	89		
	N23°59'41","E120°12'46""	169904.03 ,2654659.93	B					



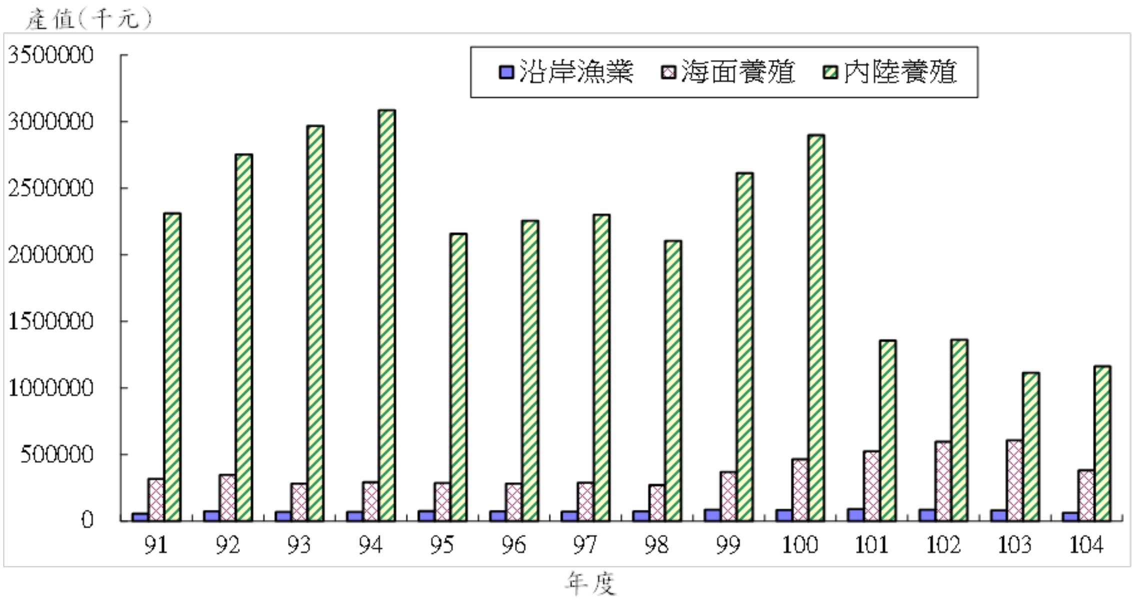
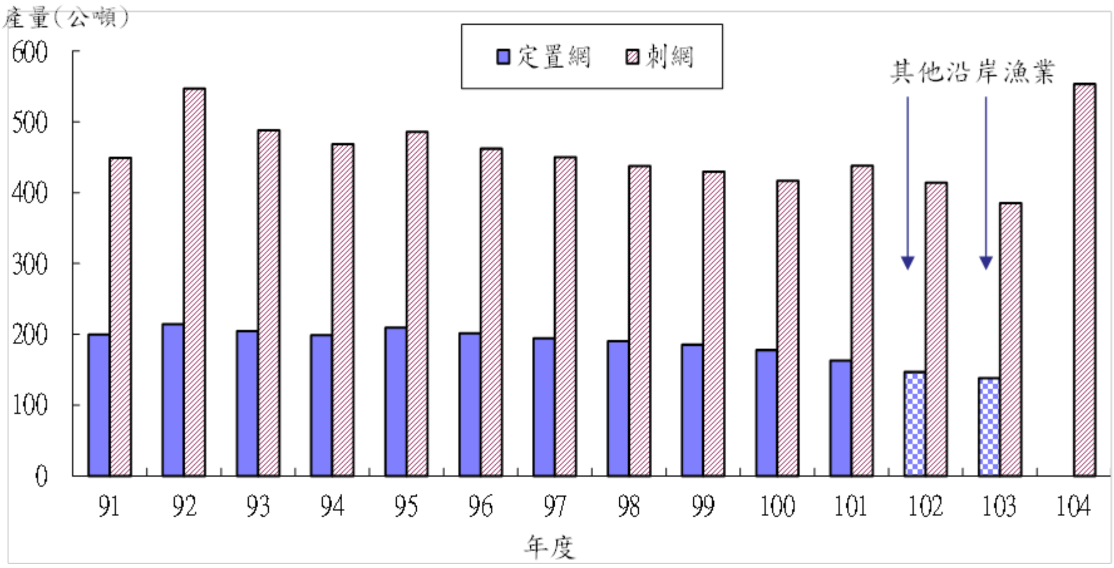


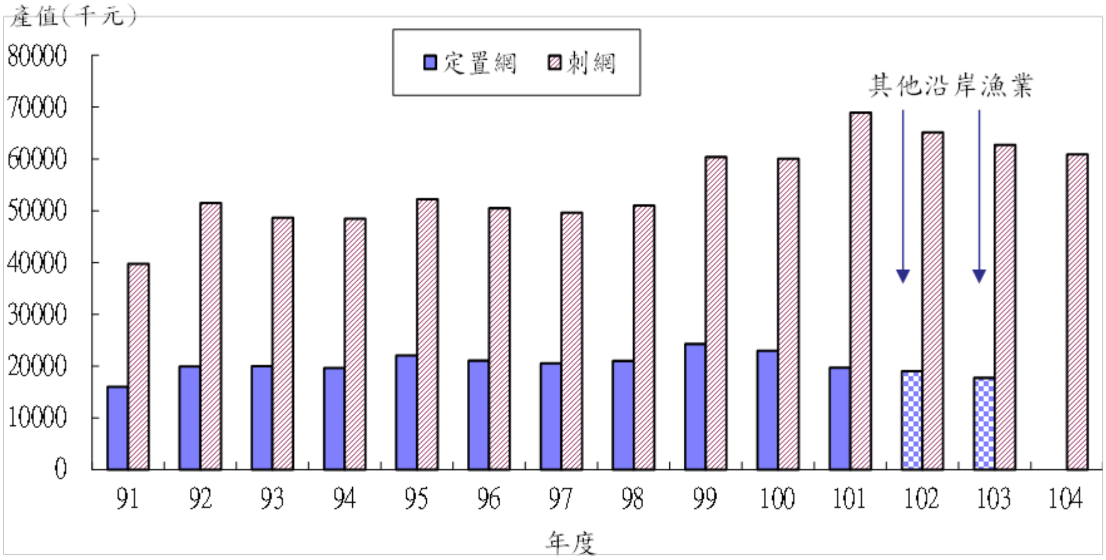
Figure 6.3.2-42 Change of Catch and Value of Coastal Aquaculture, Marine Culture and Inland Culture at Changhua County

Table 6.3.2-56 Comparison of Catch and Value by All Fishing Methods at Changhua County

Year		Total	Coastal Aquaculture				Marine Culture		Inland Culture		
			Total	Other Fishery	Set Net	Gill Net	Total	Shallow Water Aquaculture	Total	Saltwater Fish Farm	Fresh Water Fish Farm
91	Catch	30562	649		200	449	4673	4673	25240	9737	15503
	Value	2683557	55741		15991	39750	317269	317269	2310547	453758	1856789
92	Catch	34704	761		214	547	5081	5081	28862	11165	17697
	Value	3170722	71420		19960	51460	346406	346406	2752897	549379	2203518
93	Catch	33420	693		205	488	4867	4867	27861	9160	18701
	Value	3316157	68581		19985	48597	280350	280350	2967226	510791	2456435
94	Catch	33630	667		198	469	4755	4755	28208	8881	19327
	Value	3443399	68088		19621	48467	290286	290286	3085025	452724	2632301
95	Catch	29333	695		209	486	4679	4679	23959	8897	15062
	Value	2516343	74248		22021	52226	285726	285726	2156369	452302	1704067
96	Catch	29407	663		202	462	4580	4580	24164	8583	15581
	Value	2607820	71523		21051	50473	281006	281006	2255291	439964	1815327
97	Catch	28211	645		195	450	4058	4058	23508	8362	15146
	Value	2656735	70155		20535	49620	286501	286501	2300079	421684	1878395
98	Catch	27469	628		191	438	3725	3725	23116	8108	15008
	Value	2445559	71927		20964	50963	269675	269675	2103958	412187	1691771
99	Catch	28353	614		185	429	3890	3890	23849	8382	15467
	Value	3065398	84582		24254	60328	368186	368186	2612629	445072	2069298
100	Catch	25749	594		178	417	3788	3788	21367	8334	13032
	Value	3442565	82985		22951	60035	462897	462897	2896683	496985	2298860
101	Catch	23629	600		163	438	3735	3735	19294	8301	10993
	Value	1967319	88600		19675	68925	523240	523240	1355479	518917	742630
102	Catch	23113	560	147		414	3586	3586	18967	8146	10821
	Value	2039909	84148	19037		65111	594522	594522	1361239	544962	722806
103	Catch	21630	523	138	-	385	3473	3473	17635	7857	9778
	Value	1797945	80404	17746	-	62658	605651	605651	1111890	532636	494248
104	Catch	14235	553	-	-	553	1868	1868	11814	7053	4761
	Value	1603920	60830	-	-	60830	380666	380666	1162423	296057	813911

Unit：Catch (metric ton)、Value (1000)





Remarks: Set net is replaced with coastal aquaculture since 2013.

Figure 6.3.2-43 Change of Catch and Value by Set Net and Gill Net at Changhua County

Fishery catches

Since the fishery section of Changhua County will no longer provide monthly detailed fishery statistics for 2014 since 2014, the following information is for 2013. The average fishery statics of the fishery economic survey in Changhua County from January to December 2013 was 1926.4 metric tons per month (Table 6.3.2-57), with the highest catches of 2151 metric tons per month in May. Mainly because the production of aquaculture fishery in the month was also the highest in the whole year. The January catches of 1736 metric tons per month was the lowest, mainly due to the low production of aquaculture fishery in the month. Coastal fisheries used only two kinds of fishing gears, namely gill net and fixed net, before 2013, with an average catches of 46.7~50 metric tons/month (2011~2013) (Table 6.3.2-58). In 2013, the fixed net project disappeared and was changed to other coastal fisheries. However, its catches is similar to the original fixed network. For individual fishing gear, the average catch of gill nets is more than twice that of fixed nets (or other coastal fisheries) (Figure 6.3.2-44). In the case of fixed nets (or other coastal fisheries), the catch variation is small, while the catching variation of gill nets is larger.

In terms of aquaculture, the average production from January to December was 1879.7 metric tons per month. Among them, inland aquaculture production is higher than marine culture (intertidal culture) (Table 6.3.2-59, Figure 6.3.2-45). The average production of inland aquaculture is 1580.9 metric tons per month, and its average production is 5-6 times that of sea aquaculture. The average production of sea aquaculture is 298.8 metric tons per month. For individual aquaculture, the highest yield is from freshwater surimi, with an average yield of 901.8 metric tons per month, with the highest catches of 967.3 metric tons in November and the lowest in 828.6 tons in February. The monthly production of freshwater aquaculture is extremely stable throughout the year. The average production of saltwater fish carp was 679.1 metric tons per month, with the highest catches of 810.1 metric tons in April and the lowest in 579.8 metric tons in February. The change in shallow sea aquaculture production ranged from 229.5 metric tons (August) to 374.6 metric tons (May), with an average production of 298.8 metric tons per month.

In coastal fisheries, the catch values for each catch type from January to December are shown in Table 6.3.2-60, with the highest catch in December (81.6 metric tons) and the lowest catch in September (33.9 metric tons). This was due to the large amount of mullet caught in December (8.9% of the total catch), and the catches of different fish species varied little during the rest of the month. Excluding the single-month large catch of mullet, the main catch types of coastal fisheries are other fish, other croaker, other mackerel, threadfin and Misc. seabream. The average catch was 8.9 metric tons per month, 3.6 metric tons per month, 3.4 metric tons per month, 3.2 metric tons per month and 2.7 metric tons per month. The average catch was 19.21%, 7.68%, 7.26%, 6.98% and 5.86% of the total catch, which accounted for 46.95% of the total catch.

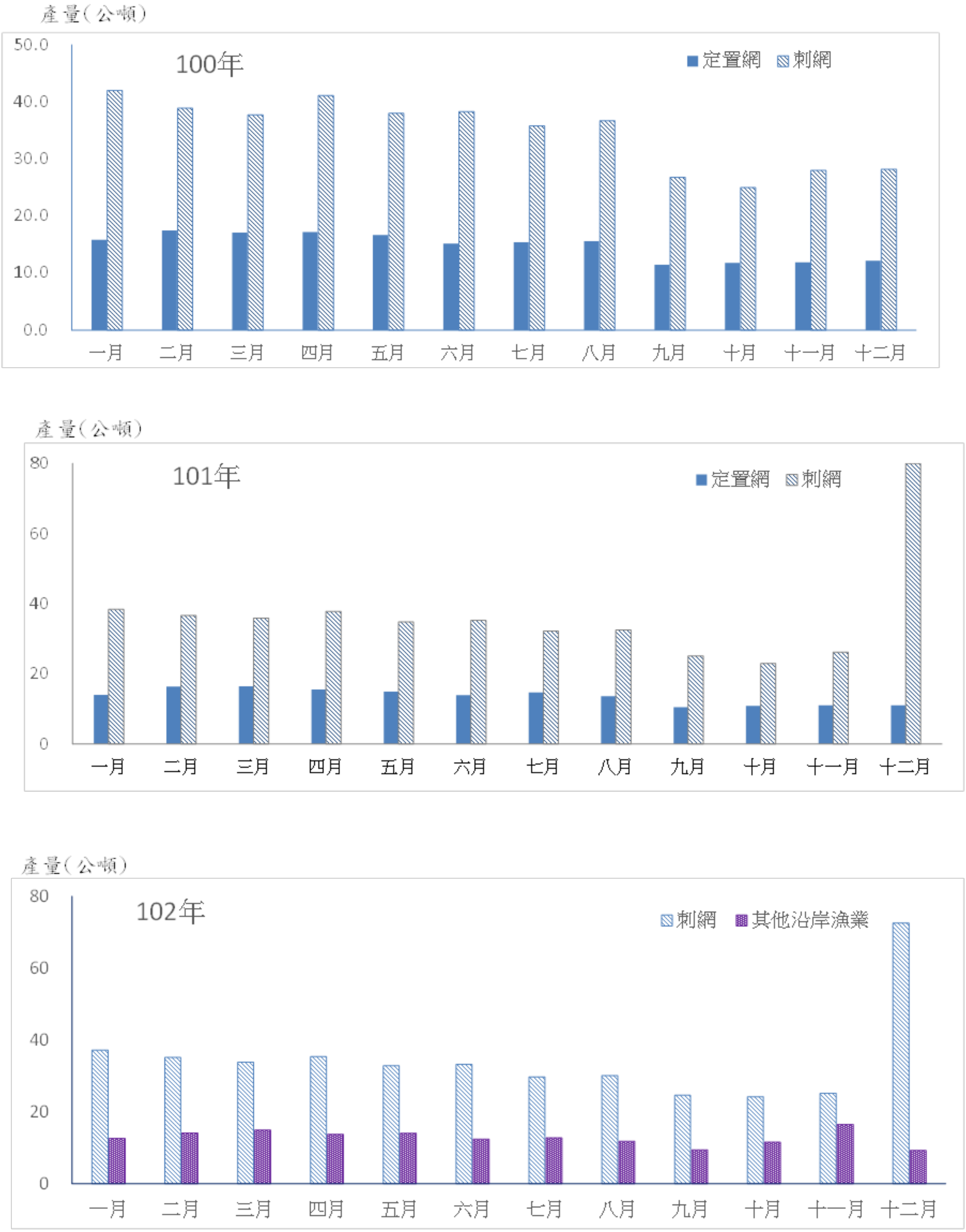
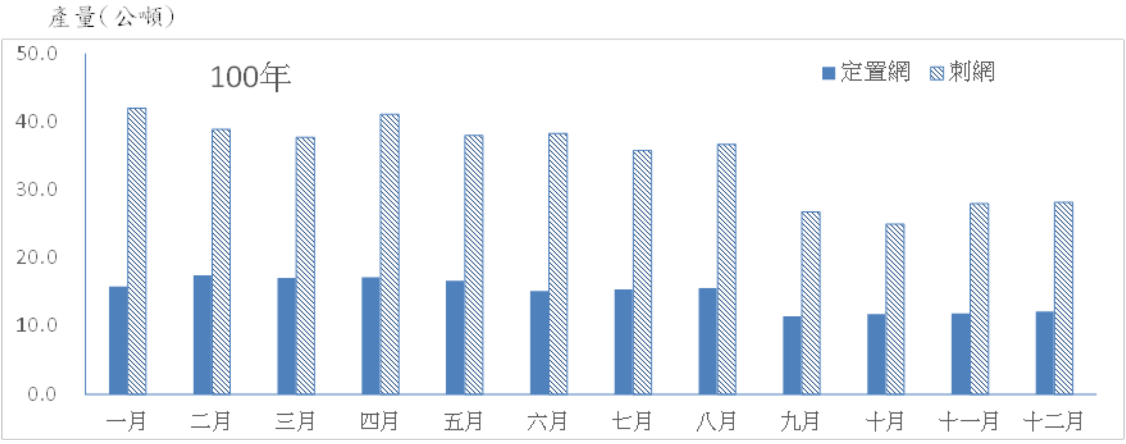
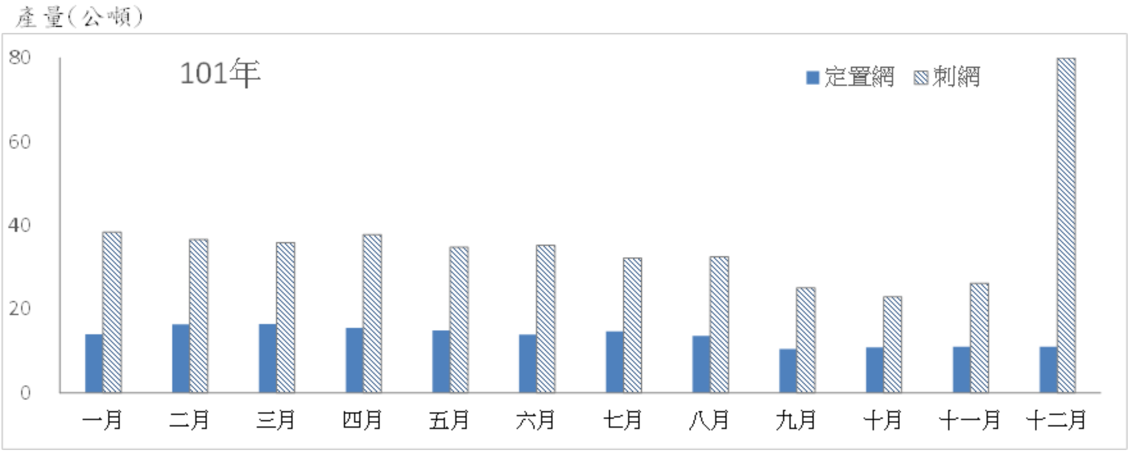


Figure 6.3.2-44 Change of Catch and Value by Set Net and Gill Net at Changhua County, From 2011 to 2013





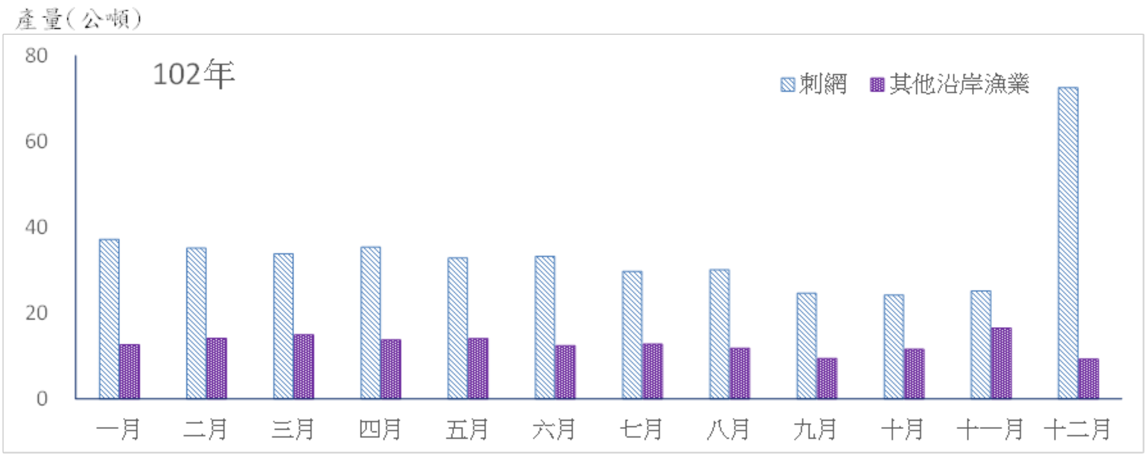


Figure 6.3.2-45 Month Change of Coastal Aquaculture, Marine Culture and Inland Aquaculture at Changhua County, From 2011 to 2013

Table 6.3.2-57 Catch of Changhua County Waters of All Fishery Methods, From January of 2012 to December of 2012

Unit：metric ton

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	Average
Total of Coastal Fishery	52.4	52.9	52.3	53.3	49.7	49.1	46.9	46.1	35.6	33.7	37.2	90.9	600.1	50.0
Set Net	14.0	16.3	16.4	15.5	14.9	13.9	14.7	13.6	10.5	10.8	11.0	11.0	162.6	13.6
Gill Net	38.4	36.6	35.9	37.8	34.8	35.2	32.2	32.5	25.1	22.9	26.2	79.9	437.5	36.5
Long Line														
Swimming Fish														
Other Fishing Method														
Total of Aquaculture	1685.8	1737.3	1989.2	2070.9	2117.3	1938.9	1932.5	1817.0	1934.9	1965.4	1994.5	1845.1	23028.8	1919.1
Total of Marine Culture	242.9	307.7	345.0	357.9	369.8	340.5	263.8	248.5	334.3	346.6	313.8	263.8	3734.6	311.2
Shallow Water Aquaculture	242.9	307.7	345.0	357.9	369.8	340.5	263.8	248.5	334.3	346.6	313.8	263.8	3734.6	311.2
Cage Culture														
Other Aquaculture														
Total of Inland Fishing Fisheries														
Inland Water Fishing														
Reservoir Fishing														
Other														
Total of Inland Aquqculture	1442.9	1429.6	1644.2	1713.0	1747.5	1598.4	1668.7	1568.5	1600.6	1618.8	1680.7	1581.3	19294.2	1607.8
Saltwater Fish Farm	578.6	592.0	774.0	814.9	789.9	675.6	663.7	654	687.6	698	673.7	699.2	8301.2	691.8
Fresh Water Fish Farm	864.3	837.6	870.2	898.1	957.6	922.8	1005.0	914.5	913.0	920.8	1007.0	882.1	10993.0	916.1
Cage Culture														
Aquaculture of Aquarium Fish	406.0	322.4	241.0	181.9	183.91	215.8	415.35	419.73	413.2	348.8	388.0	397.6	3933.6	327.8
Total	1738.2	1790.2	2041.5	2124.2	2167.0	1988.0	1979.4	1863.1	1970.5	1999.1	2031.7	1936.0	23628.9	1969.1

Data Source: Statistical Survey of Fishery Survey, Fisheries Agency,Council of Agriculture

Remarks: Since 2011, aquarium fish is calculated by individual instead of value.

Table 6.3.2-58 Catch of Changhua County Waters of All Fishery Methods, From January of 2012 to December of 2012

Unit：metric ton

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total	Average
Total of Coastal Fishery	49.8	49.2	48.7	49.0	46.8	45.6	42.4	41.9	34.0	35.7	35.6	81.7	560.4	46.7
Set Net														
Gill Net	37.2	35.1	33.8	35.3	32.8	33.2	29.7	30.1	24.6	24.2	25.1	72.5	413.6	34.5
Long Line														
Swimming Fish														
Other Coastal Aquaculture	12.6	14.1	14.9	13.7	14	12.4	12.7	11.8	9.4	11.5	16.5	9.2	152.8	12.7
Total of Aquaculture	1686.6	1698.0	1995.2	2083.5	2104.7	1919.6	1847.4	1755.3	1872.1	1919.5	1894.3	1780.8	22557.0	1879.7
Total of Marine Culture	242.4	289.6	334.8	361.3	374.6	333.7	243.4	229.5	317.9	319.0	288.1	251.6	3585.9	298.8
Shallow Water Aquaculture	242.4	289.6	334.8	361.3	374.6	333.7	243.4	229.5	317.9	319.0	288.1	251.6	3585.9	298.8
Cage Culture														
Other Aquaculture														
Total of Inland Fishing Fisheries														
Inland Water Fishing														
Reservoir Fishing														
Other														
Total of Inland Aquqculture	1444.2	1408.4	1660.4	1722.2	1730.1	1585.9	1604.0	1525.8	1554.2	1600.5	1606.2	1529.2	18971.1	1580.9
Saltwater Fish Farm	605.4	579.8	762.5	810.1	790.8	668.1	643.1	639.2	667.5	663.6	638.9	680.4	8149.4	679.1
Fresh Water Fish Farm	838.8	828.6	897.9	912.1	939.3	917.8	960.9	886.6	886.7	936.9	967.3	848.8	10821.7	901.8
Cage Culture														
Aquaculture of Aquarium Fish	353.8	324.5	318.5	268.3	212.13	279.4	558.04	461.02	503.3	423.9	500.0	480.4	4683.2	390.3
Total	1736.4	1747.2	2043.9	2132.5	2151.5	1965.2	1889.8	1797.2	1906.1	1955.2	1929.9	1862.5	23117.4	1926.4

Data Source: Statistical Survey of Fishery Survey, Fisheries Agency,Council of Agriculture

Remarks: Since 2011, aquarium fish is calculated by individual instead of value

Table 6.3.2-59 Catch of All Fish Species by Coastal Aquaculture, From 2012 January to December

Chinese Name	Name	Jan. (metric ton)	Feb. (metric ton)	Mar. (metric ton)	Apr. (metric ton)	May (metric ton)	Jun. (metric ton)	Jul. (metric ton)	Aug. (metric ton)	Sep. (metric ton)	Oct. (metric ton)	Nov. (metric ton)	Dec. (metric ton)	Total (metric ton)	Average (metric ton)	百分比 (%)
鰈類	Flat fish		0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.2	0.10	0.22%
嘉鱲	Red seabream					0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	1.5	0.20	0.27%
赤□	Yellowback seabream		0.3	0.3	0.3	0.2	0.3	0.2	0.2	0.2	0.3	0.3	0.2	2.8	0.30	0.50%
黑鯛	Black seabream	1.4	1.3	1.3	1.5	1.3	1.4	1.4	1.3	1.5	1.2	1.5	1.1	16.2	1.40	2.91%
其他鯛	Misc. seabream	2.9	3.0	2.9	2.8	2.7	2.6	2.7	2.7	2.7	2.5	2.7	2.4	32.6	2.70	5.86%
大黃魚	Large yellow croaker											0.1		0.1	0.01	0.02%
小黃魚	Small yellow croaker	1.5	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.0	1.2	0.9	0.9	14.3	1.20	2.57%
黑口	Black mouth croaker	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.1	1.5	0.10	0.27%
白口	White mouth croaker	1.1	1.1	1.0	1.2	1.1	1.2	1.1	1.2	1.0	1.0	1.0	1.1	13.1	1.10	2.36%
鮸魚	Brown croaker	1.3	1.4	1.3	1.7	1.8	1.6	1.4	1.4	1.1	1.1	1.1	1.0	16.2	1.40	2.91%
其他黃花魚類	Other croaker	3.7	3.5	4.0	4.4	3.9	3.5	3.8	3.5	2.8	3.3	3.4	2.9	42.7	3.60	7.68%
金線	Golden thredfin bream															
馬頭	Tile fish															
海鯰	Sea catfish	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.1	12.2	1.00	2.19%
皮刀	Moonfish															
其他□	Other scads	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.3	0.1	0.2	0.2	1.9	0.20	0.34%
烏魚	Mullet	1.4	1.1	0.2									49.3	52.0	13.00	9.35%
白鯧	White pomfret	0.7	0.9	0.7	1.0	0.7	0.7	0.7	0.4	0.4	0.6	0.4	0.6	7.8	0.70	1.40%
黑鯧	Black pomfret	1.0	1.0	0.9	1.2	0.9	0.8	0.8	0.8	0.7	0.7	0.6	0.9	10.3	0.90	1.85%
其他鯧	Other pomfret	0.6	0.7	0.7	0.8	0.6	0.6	0.6	0.8	0.5	0.6	0.5	0.5	7.5	0.60	1.35%
肉魚	Japanese butterfish	0.3	0.6	0.5	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	4.2	0.40	0.76%
午仔魚	Threadfin	3.7	4.0	4.1	3.8	4.2	3.7	3.8	3.0	2.2	2.0	2.3	2.0	38.8	3.20	6.98%
沙□	Sand borer	1.9	1.2	1.3	1.5	1.3	1.6	1.4	1.2	1.1	1.1	1.2	0.9	15.7	1.30	2.82%
油魚	Oilfish															
鰶	Flavo-brunneum	0.7	0.8	0.9	0.8	0.9	0.9	0.8	0.6	1.0	1.0	1.0	1.0	10.4	0.90	1.87%

Table 6.3.2-59 Catch of All Fish Species by Coastal Aquaculture, From 2012 January to December (Cont.)

Chinese Name	Name	Jan. (metric ton)	Feb. (metric ton)	Mar. (metric ton)	Apr. (metric ton)	May (metric ton)	Jun. (metric ton)	Jul. (metric ton)	Aug. (metric ton)	Sep. (metric ton)	Oct. (metric ton)	Nov. (metric ton)	Dec. (metric ton)	Total (metric ton)	Average (metric ton)	Percentage (%)
白帶魚	Hairtail	2.0	2.3	2.0	2.0	2.0	1.8	1.5	1.4	1.5	1.8	1.3	1.5	21.1	1.80	3.79%
□	Dorado															
笛鯛類	Snappers															
其他魚昷類	Other sardine	1.1	1.1	1.2	0.7	1.0	1.2	1.0	0.7	0.7	0.7	0.9	0.8	11.1	0.90	2.00%
正鰹	Skipjacks															
闊腹鰆	Korean mackerel	2.4	2.5	2.6	2.3	2.2	2.1	2.2	2.1	1.6	1.4	1.6	1.3	24.3	2.00	4.37%
馬加鰆	Japanese mackerel															
其他鰆類	Other mackerel	3.6	4.2	4.6	3.7	3.4	3.4	3.2	3.4	2.7	2.8	2.8	2.6	40.4	3.40	7.26%
長鰭鮪	Albacore															
大目鮪	Bigeye tuna															
沙條	Young sharks															
□	Skates and rays															
扁甲	Torpedo scad															
其他魚類	Others	12.1	11.2	11.1	10.3	10.9	10.1	8.7	9.7	5.2	6.1	6.2	5.2	106.8	8.90	19.21%
花枝	Cuttlefish	0.2	0.1	0.1	0.3	0.2	0.3	0.2	0.2	0.2	0.1	0.2	0.2	2.3	0.20	0.41%
烏賊	Common cuttlefish				0.3	0.2	0.3	0.1	0.3					1.2	0.20	0.22%
魷魚	Squids															
其他蝦類	Other shrimp	1.7	1.3	1.4	1.0	0.8	1.0	0.8	0.9	0.9	0.8	0.9	0.8	12.3	1.00	2.21%
蟳	Serrated crab															
□	Pelagic crab				0.7	0.5	0.7	0.7	0.6	1.1	0.5	0.9	0.8	6.5	0.70	1.17%
其他蟳蟹類	Other crabs	2.6	2.8	2.7	2.5	2.4	2.3	2.0	1.8	1.7	2.7	1.9	1.7	27.1	2.30	4.87%
文蛤	Hard clam															
Total		49.2	49.0	48.5	48.2	46.3	45.1	42.1	41.4	33.9	35.3	35.5	81.6	556.1	46.34	100.0%

Data Source: Changhua County Government

Table 6.3.2-60 Catch of All Fish Species by Aquaculture, From 2012 January to December

Chinese Name	Code	Name	Jan. Fresh Water Fish Farm	Jan. Saltwater Fish Farm	Jan. Aquaculture of Aquarium Fish	Jan. Shallow Water Aquaculture	Jan. Subtotal	Feb. Fresh Water Fish Farm	Feb. Saltwater Fish Farm	Feb. Aquaculture of Aquarium Fish	Feb. Shallow Water Aquaculture	Feb. Subtotal
吳郭魚	0100	Tilapia	50.2	11.5			61.7	48.70	11.70			60.4
鯉魚	0201	Common carp	2.7				2.7	3.20				3.2
鯽魚	0202	Crucian carp	1.3				1.3	1.30				1.3
草魚	0203	Grass crap	7.6				7.6	5.4				5.4
青魚	0204	Black chinese roach	4.4				4.4	2.3				2.3
大頭鰱	0205	Big-head	3.1				3.1	3.2				3.2
竹葉鰱	0206	Silver carp	0.1				0.1					
其他淡水魚類	0209	Other fresh water fish	56.9				56.9	49.0				49.0
鰻魚	0300	Eel	16.0				16.0	11.00				11.0
淡水鯰	0400	Catfish										
鱸魚	0500	Sea perch	3.7	9.8			13.5	2.60	11.40			14.0
泥鰍	0600	Loach fry	0.4				0.4	0.30				0.3
錦鯉	0701	Koi			3.3		3.3			3.55		3.5
其他觀賞蝦	0789	789			38.8		38.8			285.90		285.9
其他觀賞魚	0799	Other Aquarium fish			311.7		311.7			35.00		35.0
鱒魚	1100	Thout										
虱目魚	1400	Milkfish		11.3			11.3		7.90			7.9
嘉臘	1601	Red porgy										
黑鯛	1604	Black sea bream		4.7			4.7		3.50			3.5
大黃魚	1701	Large yellow croaker										
鱠	2500	Grouper		0.4			0.4		0.2			0.2
烏魚	3200	Mullet	3.6	7.5			11.1	7.90	6.0			13.9
黑鯧	3303	Black pomfret										
其他魚類	6000	Others		1.2			1.2		3.60			3.6
草蝦	6201	Grass shrimp		4.2			4.2		3.80			3.8
斑節蝦	6202	Kuruma shrimp							0.20			0.2
沙蝦	6203	Sand shrimp										
白蝦	6220								1.50			1.5
長腳大蝦	6204	Giant gershwater prawn										
其它蝦類	6299	Other shrimp	0.6	4.3			4.9					
蟳	6401	Serrated crab		0.2			0.2		0.30			0.3
旭蟹	6404	Crimson crab (Frong crab)										
其它蟳蟹類	6499	Other crab							0.20			0.2
牡蠣	6501	Oyster				202.0	202.0				247.60	247.6
文蛤	6502	Hard clam		547.0		32.8	579.8		526.30		33.00	559.3
蜊	6503	Short-necked clam		1.6		5.7	7.3		1.70		6.50	8.2
血蚶	6504	Blood cockle										
九孔	6507	Small abalones										
西施貝	6511	Purple clam		0.7		1.9	2.6		0.70		2.50	3.2
蜆	6513	Fresh water clam	679.4				679.4	677.90				677.9
牛蛙	6601	Frogs										
鱉	6603	Soft-shell turtle	8.8				8.8	15.80				15.8
鱉蛋	6605											
海膽	6700	Sea urchin										
龍鬚菜	7103	Gracilar		0.7			0.7		0.80			0.8
Total			838.8	605.1	353.8	242.4	2040.1	828.6	579.8	324.4	289.6	2022.4

Unit: metric ton, 1000 individuals (aquarium fish)

Table 6.3.2-60 Catch of All Fish Species by Aquaculture, From 2012 January to December (Cont. 1)

Chinese Name	Name	Mar. Fresh Water Fish Farm	Mar. Saltwater Fish Farm	Mar. Aquaculture of Aquarium Fish	Mar. Shallow Water Aquaculture	Mar. Subtotal	Apr. Fresh Water Fish Farm	Apr. Saltwater Fish Farm	Apr. Aquaculture of Aquarium Fish	Apr. Shallow Water Aquaculture	Apr. Subtotal
吳郭魚	Tilapia	53.5	18.4			71.9	58.3	14.7			73.0
鯉魚	Common carp	2.8				2.8	3.5				3.5
鯽魚	Crucian carp	1.3				1.3	1.7				1.7
草魚	Grass crap	6.1				6.1	6.7				6.7
青魚	Black chinese roach	3.0				3.0	5.1				5.1
大頭鰱	Big-head	2.8				2.8	2.9				2.9
竹葉鰱	Silver carp	0.3				0.3	0.1				0.1
其他淡水魚類	Other fresh water fish	47.6				47.6	49.2				49.2
鰻魚	Eel	52.9				52.9	43.0	21.3			64.3
淡水鯰	Catfish										
鱸魚	Sea perch	2.2	7.4			9.6	7.3				7.3
泥鰍	Loach fry	0.5				0.5	0.2				0.2
錦鯉	Koi			1.3		1.3			2.4		2.4
其他觀賞蝦				23.6		23.6			15.3		15.3
其他觀賞魚	Other Aquarium fish			293.5		293.5			250.6		250.6
鱒魚	Thout										
虱目魚	Milkfish		9.9			9.9		12.1			12.1
嘉臘	Red porgy										
黑鯛	Black sea bream		3.3			3.3		3.3			3.3
大黃魚	Large yellow croaker										
鱠	Grouper		0.2			0.2		0.4			0.4
烏魚	Mullet							5.6			5.6
黑鯧	Black pomfret										
其他魚類	Others		3.4			3.4		2.5			2.5
草蝦	Grass shrimp		3.8			3.8		2.9			2.9
斑節蝦	Kuruma shrimp							0.3			0.3
沙蝦	Sand shrimp										
白蝦			1.2			1.2		0.8			0.8
長腳大蝦	Giant gershwater prawn						0.5				0.5
其它蝦類	Other shrimp										
蟳	Serrated crab		0.3			0.3		0.6			0.6
旭蟹	Crimson crab (Frong crab)										
其它蟳蟹類	Other crab		0.6			0.6		0.8			0.8
牡蠣	Oyster										
文蛤	Hard clam		705.1			705.1		741.5			741.5
蜊	Short-necked clam		1.4			1.4		1.7			1.7
血蚶	Blood cockle										
九孔	Small abalones										
西施貝	Purple clam		0.6			0.6		0.8			0.8
蜆	Fresh water clam	680.1				680.1	702.1				702.1
牛蛙	Frogs										
鱉	Soft-shell turtle	10.0				10.0	31.5				31.5
鱉蛋		34.8				34.8					
海膽	Sea urchin										
龍鬚菜	Gracilar		0.7			0.7		0.8			0.8
Total		897.9	756.3	318.5	0.0	1972.6	912.1	810.1	268.3	0.0	1737.5

Unit: metric ton, 1000 individuals (aquarium fish)

Table 6.3.2-60 Catch of All Fish Species by Aquaculture, From 2012 January to December (Cont. 2)

Chinese Name	Name	May					Jun.				
		Fresh Water Fish Farm	Saltwater Fish Farm	Aquaculture of Aquarium Fish	Shallow Water Aquaculture	Subtotal	Fresh Water Fish Farm	Saltwater Fish Farm	Aquaculture of Aquarium Fish	Shallow Water Aquaculture	Subtotal
吳郭魚	Tilapia	25.3	102.9			128.2	100.3	23.3			123.6
鯉魚	Common carp	3.6				3.6	3.4				3.4
鯽魚	Crucian carp	1.7				1.7	1.3				1.3
草魚	Grass crap	6.6				6.6	5.6				5.6
青魚	Black chinese roach	3.5				3.5	2.7				2.7
大頭鰱	Big-head	3.3				3.3	3.0				3.0
竹葉鰱	Silver carp										
其他淡水魚類	Other fresh water fish	55.5				55.5	45.1				45.1
鰻魚	Eel										
淡水鯰	Catfish										
鱸魚	Sea perch	2.9	31.5			34.4	3.8	27.3			31.1
泥鰍	Loach fry					0.0	0.3				0.3
錦鯉	Koi			23.6		23.6			12.3		12.3
其他觀賞蝦				157.1		157.1			18.54		
其他觀賞魚	Other Aquarium fish			31.5		31.5			248.6		248.6
塘魚	Thout			8.6							
虱目魚	Milkfish							7.8			7.8
嘉臘	Red porgy										
黑鯛	Black sea bream		4.8			4.8		2.0			2.0
大黃魚	Large yellow croaker										
鱠	Grouper		0.8			0.8		0.8			0.8
烏魚	Mullet		3.1			3.1		5.0			5.0
黑鯧	Black pomfret										
其他魚類	Others		3.6			3.6					
草蝦	Grass shrimp		4.2			4.2		3.3			3.3
斑節蝦	Kuruma shrimp		0.3			0.3					
沙蝦	Sand shrimp										
白蝦			1.1			1.1		1.4			1.4
長腳大蝦	Giant gershwater prawn										
其它蝦類	Other shrimp										
蟳	Serrated crab		0.5			0.5		0.3			0.3
旭蟹	Crimson crab (Frong crab)										
其它蟳蟹類	Other crab		0.6			0.6		0.4			0.4
牡蠣	Oyster										
文蛤	Hard clam		702.7			702.7		591.7			591.7
蜊	Short-necked clam		1.8			1.8		2.0			2.0
血蚶	Blood cockle										
九孔	Small abalones										
西施貝	Purple clam		0.7			0.7		0.6			0.6
蜆	Fresh water clam						727.3				727.3
牛蛙	Frogs										
鱉	Soft-shell turtle						25.0				25.0
鱉蛋											
海膽	Sea urchin										
龍鬚菜	Gracilar							0.7			0.7
Total		102.4	858.6	220.7	0.0	1118.1	917.8	666.6	279.4	0.0	1584.4

Unit: metric ton, 1000 individuals (aquarium fish)

Table 6.3.2-60 Catch of All Fish Species by Aquaculture, From 2012 January to December (Cont. 3)

		Jul.					Aug.				
Chinese Name	Name	Fresh Water Fish Farm	Saltwater Fish Farm	Aquaculture of Aquarium Fish	Shallow Water Aquaculture	Subtotal	Fresh Water Fish Farm	Saltwater Fish Farm	Aquaculture of Aquarium Fish	Shallow Water Aquaculture	Subtotal
吳郭魚	Tilapia	88.5	17.5			106.0	76.5	17.3			93.8
鯉魚	Common carp	3.3				3.3	3.0				3.0
鯽魚	Crucian carp	1.1				1.1	1.1				1.1
草魚	Grass crap	6.9				6.9	6.3				6.3
青魚	Black chinese roach	5.2				5.2	4.1				4.1
大頭鰱	Big-head	3.7				3.7	3.4				3.4
竹葉鰱	Silver carp										0.0
其他淡水魚類	Other fresh water fish	46.6				46.6	48.6				48.6
鰻魚	Eel	22.5				22.5	14.3				14.3
淡水鯰	Catfish										
鱸魚	Sea perch	3.3	27.1			30.4	6.2	48.3			54.5
泥鰍	Loach fry	0.2				0.2	0.1				0.1
錦鯉	Koi			2.4		2.4			8.7		8.7
其他觀賞蝦				75.4		75.4			74.4		74.4
其他觀賞魚	Other Aquarium fish			480.3		480.3			378.0		378.0
塘魚	Thout										
虱目魚	Milkfish		8.2			8.2		8.9			8.9
嘉臘	Red porgy										
黑鯛	Black sea bream		2.6			2.6		3.0			3.0
大黃魚	Large yellow croaker										
鱠	Grouper		0.9			0.9		0.8			0.8
烏魚	Mullet		5.0			5.0		6.5			6.5
黑鯧	Black pomfret										
其他魚類	Others		2.5			2.5		2.6			2.6
草蝦	Grass shrimp		3.5			3.5		3.1			3.1
斑節蝦	Kuruma shrimp		0.2			0.2					
沙蝦	Sand shrimp		0.2			0.2					
白蝦			1.4			1.4		1.2			1.2
長腳大蝦	Giant gershwater prawn	0.6					0.9				0.9
其它蝦類	Other shrimp										
蟳	Serrated crab		0.3			0.3		0.2			0.2
旭蟹	Crimson crab (Frong crab)										
其它蟳蟹類	Other crab		0.6					0.7			0.7
牡蠣	Oyster										
文蛤	Hard clam		570.4			570.4		544.0			544.0
蜊	Short-necked clam		1.2			1.2		1.4			1.4
血蚶	Blood cockle										
九孔	Small abalones										
西施貝	Purple clam		0.7			0.7		0.5			0.5
蜆	Fresh water clam	756.7				756.7	698.7				698.7
牛蛙	Frogs										
鱉	Soft-shell turtle	21.7				21.7	23.4				23.4
鱉蛋											
海膽	Sea urchin										
龍鬚菜	Gracilar		0.8			0.8		0.7			0.7
Total		960.3	643.1	558.0	0.0	1677.6	886.6	639.2	461.0	0.0	1600.2

Unit: metric ton, 1000 individuals (aquarium fish)

Table 6.3.2-60 Catch of All Fish Species by Aquaculture, From 2012 January to December (Cont. 4)

Chinese Name	Name	Sep. Fresh Water Fish Farm	Sep. Saltwater Fish Farm	Sep. Aquaculture of Aquarium Fish	Sep. Shallow Water Aquaculture	Sep. Subtotal	Oct. Fresh Water Fish Farm	Oct. Saltwater Fish Farm	Oct. Aquaculture of Aquarium Fish	Oct. Shallow Water Aquaculture	Oct. Subtotal
吳郭魚	Tilapia	81.6	19.9			101.5	87.3	20.6			107.9
鯉魚	Common carp	3.4				3.4	3.6				3.6
鯽魚	Crucian carp	1.2				1.2	1.6				1.6
草魚	Grass crap	5.6				5.6	6.8				6.8
青魚	Black chinese roach	2.3				2.3	3.7				3.7
大頭鰱	Big-head	3.3				3.3	2.7				2.7
竹葉鰱	Silver carp					0.0					0.0
其他淡水魚類	Other fresh water fish	42.9				42.9	46.4				46.4
鰻魚	Eel	2.5				2.5	3.1				3.1
淡水鯰	Catfish										
鱸魚	Sea perch	3.7	35.1			38.8	3.1	37.0			40.1
泥鰍	Loach fry	0.1				0.1	0.5				0.5
錦鯉	Koi			12.4		12.4			7.9		7.9
其他觀賞蝦				107.7		107.7			82.6		82.6
其他觀賞魚	Other Aquarium fish			383.2		383.2			333.4		333.4
鱒魚	Thout										
虱目魚	Milkfish		13.2			13.2		13.4			13.4
嘉臘	Red porgy										
黑鯛	Black sea bream		4.7			4.7		5.1			5.1
大黃魚	Large yellow croaker								-		
鱠	Grouper		0.5			0.5		0.3			0.3
烏魚	Mullet		4.7			4.7		5.4			5.4
黑鯧	Black pomfret								-		
其他魚類	Others		3.1			3.1		5.2			5.2
草蝦	Grass shrimp		3.6			3.6			-		
斑節蝦	Kuruma shrimp		0.3			0.3		4.4			4.4
沙蝦	Sand shrimp					0.0		0.2			0.2
白蝦			1.4			1.4		1.6			1.6
長腳大蝦	Giant gershwater prawn						0.5				0.5
其它蝦類	Other shrimp										
蟳	Serrated crab		0.5			0.5		0.4			0.4
旭蟹	Crimson crab (Frong crab)										
其它蟳蟹類	Other crab		0.8			0.8		1.0			1.0
牡蠣	Oyster										
文蛤	Hard clam		576.3			576.3		565.8			565.8
蜊	Short-necked clam		1.7			1.7		1.7			1.7
血蚶	Blood cockle										
九孔	Small abalones										
西施貝	Purple clam		0.6			0.6		0.6			0.6
蜆	Fresh water clam	718.4				718.4	727.9				727.9
牛蛙	Frogs										
鱉	Soft-shell turtle	21.7				21.7	14.9				14.9
鱉蛋							34.8				
海膽	Sea urchin										
龍鬚菜	Gracilar		1.1			1.1		0.9			0.9
Total		886.7	667.5	503.3	0.0	1661.9	936.9	663.6	423.9	0.0	1648.3

Unit: metric ton, 1000 individuals (aquarium fish)

Table 6.3.2-60 Catch of All Fish Species by Aquaculture, From 2012 January to December (Cont. 5)

Chinese Name	Name	Nov.					Dec.				
		Fresh Water Fish Farm	Saltwater Fish Farm	Aquaculture of Aquarium Fish	Shallow Water Aquaculture	Subtotal	Fresh Water Fish Farm	Saltwater Fish Farm	Aquaculture of Aquarium Fish	Shallow Water Aquaculture	Subtotal
吳郭魚	Tilapia	137.8	19.0			156.8	81.9	11.0			92.9
鯉魚	Common carp	3.8				3.8	3.5				3.5
鯽魚	Crucian carp	1.6				1.6	1.3				1.3
草魚	Grass crap	6.6				6.6	5.3				5.3
青魚	Black chinese roach	2.4				2.4	2.3				2.3
大頭鰱	Big-head	2.7				2.7	2.9				2.9
竹葉鰱	Silver carp	0.2				0.2					0.0
其他淡水魚類	Other fresh water fish	49.9				49.9	46.9				46.9
鰻魚	Eel	1.9				1.9	2.7				2.7
淡水鯰	Catfish										
鱸魚	Sea perch	3.3	28.2			31.5	5.0	25.4			30.4
泥鰍	Loach fry	2.7				2.7	0.4				0.4
錦鯉	Koi			6.2		6.2			7.3		7.3
其他觀賞蝦				94.0		94.0			102.5		
其他觀賞魚	Other Aquarium fish			399.8		399.8			370.6		370.6
墫魚	Thout										
虱目魚	Milkfish		9.5			9.5	14.0				14.0
嘉臘	Red porgy										
黑鯛	Black sea bream		4.7			4.7		4.2			4.2
大黃魚	Large yellow croaker										
鱠	Grouper							0.5			
烏魚	Mullet		19.2			19.2		32.0			32.0
黑鯧	Black pomfret										
其他魚類	Others		2.9			2.9		3.4			3.4
草蝦	Grass shrimp		4.4			4.4		2.7			2.7
斑節蝦	Kuruma shrimp										
沙蝦	Sand shrimp							0.5			
白蝦			1.4			1.4		1.3			1.3
長腳大蝦	Giant gershwater prawn	0.60									
其它蝦類	Other shrimp										
蟳	Serrated crab		0.20			0.20		0.20			0.2
旭蟹	Crimson crab (Frong crab)										
其它蟳蟹類	Other crab		1.10			1.10		0.50			0.5
牡蠣	Oyster										
文蛤	Hard clam		545.20			545.20		580.70			580.7
蜊	Short-necked clam		2.10			2.10		2.60			2.6
血蚶	Blood cockle										
九孔	Small abalones										
西施貝	Purple clam		0.40			0.40		0.60			0.6
蜆	Fresh water clam	747.30				747.30	691.6				691.6
牛蛙	Frogs										
鱉	Soft-shell turtle	6.50				6.50	5				5.0
海膽	Sea urchin										
龍鬚菜	Gracilar		0.60			0.60		0.8			0.8
Total		967.3	638.9	500.0	0.0	1699.6	862.8	666.4	480.4	0.0	1528.2

Unit: metric ton, 1000 individuals (aquarium fish)

Data Source: Statistical Survey of Fishery Survey, Fisheries Agency,Council of Agriculture

Remarks: Since 2011, aquarium fish is calculated by individual instead of value.

The survey results of aquaculture fishery are shown in Table 6.3.2-60. The main culture catches are fresh water clam, hard clam, other aquarium fish, tilapia and other freshwater fish. (other fresh water fish). Among them, fresh water clam has the highest production, with an average production of 650.62 metric tons per month, accounting for 38.48% of the total production of aquaculture. Followed by hard clam, the average production of hard clam is 605.21 tons / month, accounting for 35.79% of the total production. The third place is the other aquarium fish, which has an average production of 293.0 metric tons per month, accounting for 17.33% of the total production. Overall, the production of the top three catches is nearly 90% of the total production. Based on the farming methods of the main cultured organisms, fresh water clam and other fresh water fish are completely cultured in fresh water, and tilapia is mainly based on freshwater culture. Hard clam is mainly cultured in salt water, followed by shallow seas. Oysters are completely cultured in shallow seas.

In addition, the plan refers to the Fisheries VDR data of Fisheries Agency from 2011 to 2014, and plots the distribution of total catches in Changhua offshore, as shown in Figure 6.3.2-47 to Figure 6.3.2-54.

Fishery population

According to the Fisheries Agency, the Council of Agriculture's Fisheries yearbook, the number of fishermen in the aquaculture industry in Changhua County in recent years, including fishing and aquaculture, is between 11,000 and 15,000 (Table 6.3.2-61). There is a trend of declining year by year, but it has started to increase in 2015. In 2002, the total number of fisheries in Changhua was 16,264, of which the number of fishing industry was 7,228, accounting for 44.44% of the county's fishery population, and the number of aquaculture fisheries was 9,036. Since 2007, there have been no employees engaged in deep sea fishing and offshore fishery, leaving only 4,157 fishermen along the coast, accounting for 29.76% of the county's fishery population. The number of aquaculture fisheries is 9,071. After 2009, the population of the coastal fishing industry has decreased by 3,101. By 2011, the total number of employees was reduced to 11,719, the number of coastal fishing was 3,052, accounting for 26.04% of the county's fishery population, and the number of aquaculture fisheries was 8,420. In 2012, the total number of employees increased slightly to 11,827, and the number of coastal fishing was 3,063, accounting for 25.9% of the county's fishery population, and the number of aquaculture fisheries was 8,455. In 2014, the coastal fishery population was only 3,060, accounting for 29.56% of the county's fishery population, and the aquaculture fishery increased to 66.82% of the county's fishery population. In 2015, the total fisher population increased dramatically to 14,330, and the coastal industry population increased to 3,969, accounting for 29.56% of the county's fishery population. The aquaculture fishery increased to 66.82% of the county's fishery population, accounting for 27.7% of the county's fishery population, and the aquaculture fishery increased to 68.20% of the county's fishery population. It can be seen that by 2014, deep sea fishing and offshore fishery have shrunk to zero for eight consecutive years. The number of coastal fisheries and the proportion of fishery population is also decreasing year by year. In 2006, it began to sharply decrease to 3/4~2/3 in previous years. In the past seven years, it has remained at around 3,000. However, in 2015, the number of fishermen increased by nearly 4,000, and the number of fishery populations increased, especially the number of offshore fishing population increased by 199. The number of inland fishing population has decreased year by year, from 1,300 to 2,182 in 2002 to 2006, and has dropped to less than 250 in 2011. In 2014 and 2015, it increased slightly to 389 people, compared with more than 10 years ago, only about a quarter of the population. The aquaculture fishery has increased year by year, and the inland aquaculture population is roughly flat, with a slight decrease from 2010 to year after year. The population of marine culture has increased year by year since 2009, and has been decreasing year by year since 2010.

In terms of the total number of employees, the proportion of marine fishing is about 30% in the past decade, except for the particularly high values in 2003 (42.29%) and 2004 (36.86%). The number of professional marine fishing practitioners is about half of that of part-time workers, accounting for 6.6% to 12.31% of the total number of fishing workers (except in 2003). Since 2008, the number and proportion of professional employees have increased slightly year by year. On the other hand, the number and proportion of part-time jobs have slightly decreased (Table 6.3.2-61). Among them, the number of professional employees in inland fishing has decreased sharply since 2003, and the number of part-time workers has dropped sharply since 2008 (Fig. 6.3.2-46). Most of them have remained at around 100~200 in the past four years. The number of part-time workers in marine fishing has also fallen sharply since 2005. For inland aquaculture, there were more part-time workers than professionals before 2012, but since 2012, more professionals than part-time workers. The professional population of inland aquaculture has grown rapidly, but the concurrent business is drastically reduced. Projects that have remained roughly flat or slightly growing over the past 10 years are specialists in marine culture and professionals in marine fishing.

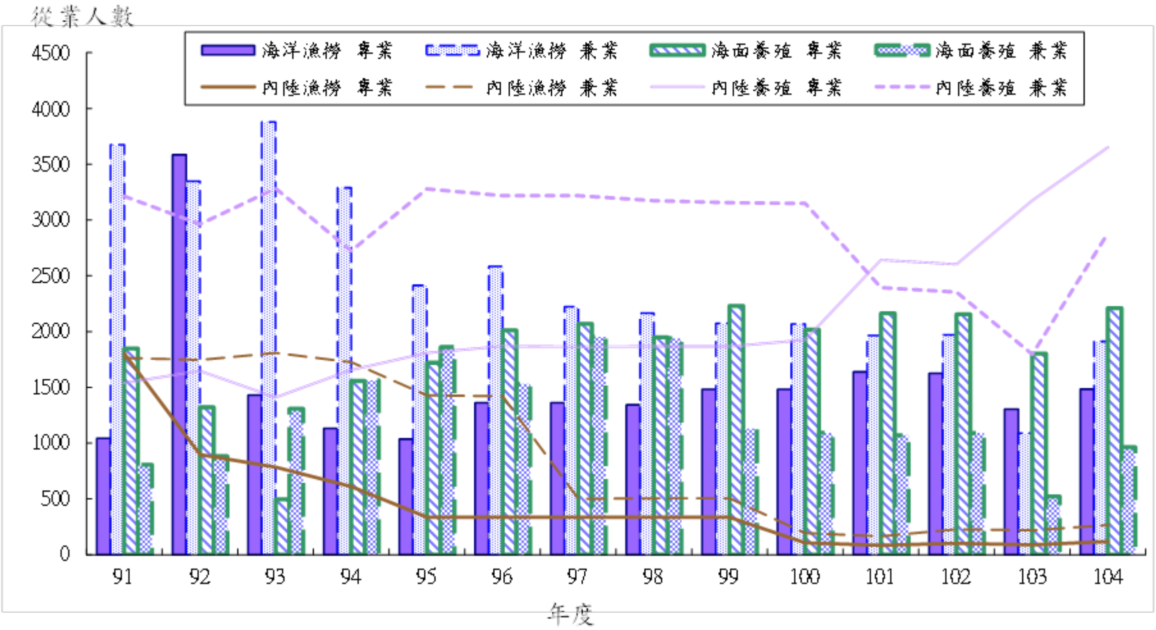


Figure 6.3.2-46 Population Change of Fishing-Catching, Aquaculture and Inland Fishing Fishery and Inland Aquaculture at Changhua County

Figure 6.3.2-47 Distribution of Drift Fishing Boat VDR and Catch at 2011

Figure 6.3.2-48 Distribution of Trawling Fishing Boat VDR and Catch at 2011

Figure 6.3.2-49 Distribution of Drift Fishing Boat VDR and Catch at 2012

Figure 6.3.2-50 Distribution of Trawling Fishing Boat VDR and Catch at 2012

Figure 6.3.2-51 Distribution of Drift Fishing Boat VDR and Catch at 2013

Figure 6.3.2-52 Distribution of Trawling Fishing Boat VDR and Catch at 2013

Figure 6.3.2-53 Distribution of Drift Fishing Boat VDR and Catch at 2014

Figure 6.3.2-54 Distribution of Trawling Fishing Boat VDR and Catch at 2014

Table 6.3.2-61 Population Statistical Table of Fishery Industry at Changhua County, From 2002 to 2015

Year	Population of Fishermen Household												
	Total							Far Sea+offshore	Coastal	Marine Culture	Aquaculture (Marine+Inland)	Aquaculture (Marine+Inland)	Inland Fishing Fisheries
	Total	Far Sea	Offshore	Coastal	Marine Culture	Inland Fishery	Inland Culture	%	%	%	Total	%	%
91	16264	1	60	5867	2944	1300	6092	0.38%	36.07%	18.10%	9036	55.56%	7.99%
92	16429	2	64	4492	1727	2182	7962	0.40%	27.34%	10.51%	9689	58.97%	13.28%
93	14929	2	126	5234	1096	1963	6508	0.86%	35.06%	7.34%	7604	50.93%	13.15%
94	15251	2	126	4551	3064	1725	5783	0.84%	29.84%	20.09%	8847	58.01%	11.31%
95	15218	-	50	3146	3781	1298	6943	0.33%	20.67%	24.85%	10724	70.47%	8.53%
96	13968	-	-	4157	3643	740	5428		29.76%	26.08%	9071	64.94%	5.30%
97	14743	-	-	4300	4034	858	5551		29.17%	27.36%	9585	65.01%	5.82%
98	13592	-	-	3101	4144	822	5525		22.81%	30.49%	9669	71.14%	6.05%
99	12457	-	-	3034	3730	253	5440		24.36%	29.94%	9170	73.61%	2.03%
100	11719	-	-	3052	3229	247	5191		26.04%	27.55%	8420	71.85%	2.11%
101	11827	-	-	3063	3357	309	5098		25.90%	28.38%	8455	71.49%	2.61%
102	11875	-	-	3138	3382	315	5040		26.43%	28.48%	8422	70.92%	2.65%
103	10351	-	-	3060	2103	374	4814		29.56%	20.32%	6917	66.82%	3.61%
104	14330	-	199	3969	3173	389	6600	1.39%	27.70%	22.14%	9773	68.20%	2.71%

Data Source: Annual Report of Fisheries Agency,Council of Agriculture

Table 6.3.2-62 Statistical Table of Population of Fishery Industr

	Total Total			Marine Fishing Far Sea+Offshore+Costal					Marine Culture			Inland Fishing Fisheries Inland Fishing Fisheries			內陸養殖業 Inland Culture		
Year	Total	Full-Time	Part-Time	Total	Full-Time	Part-Time	Full-Time%	Part-Time %	Total	Full-Time	Part-Time	Total	Full-Time	Part-Time	Total	Full-Time	Part-Time
91	15694	6234	9460	4717	1043	3674	6.65%	23.41%	2654	1848	806	3567	1802	1765	4756	1541	3215
92	16395	7453	8942	6934	3586	3348	21.87%	20.42%	2204	1321	883	2645	898	1747	4612	1648	2964
93	14403	4123	10280	5309	1430	3879	9.93%	26.93%	1807	498	1309	2593	785	1808	4694	1410	3284
94	14258	4955	9303	4422	1133	3289	7.95%	23.07%	3120	1556	1564	2337	610	1727	4379	1656	2723
95	13888	4904	8984	3450	1036	2414	7.46%	17.38%	3582	1721	1861	1766	337	1429	5090	1810	3280
96	14332	5577	8755	3944	1360	2584	9.49%	18.03%	3543	2012	1531	1756	335	1421	5089	1870	3219
97	13531	5633	7898	3586	1362	2224	10.07%	16.44%	4024	2070	1954	838	336	502	5083	1865	3218
98	13282	5497	7785	3510	1344	2166	10.12%	16.31%	3890	1950	1940	840	335	505	5042	1868	3174
99	12,781	5,916	6,865	3556	1483	2073	11.60%	16.22%	3360	2230	1130	840	335	505	5025	1868	3157
100	12034	5528	6506	3549	1481	2068	12.31%	17.18%	3109	2015	1094	301	107	194	5075	1925	3150
101	12125	6529	5596	3605	1639	1966	13.52%	16.21%	3235	2164	1071	248	84	164	5037	2642	2395
102	12133	6488	5645	3596	1626	1970	13.40%	16.24%	3246	2154	1092	331	103	228	4960	2605	2355
103	10002	6373	3629	2397	1306	1091	13.05%	10.91%	2326	1803	523	308	90	218	4971	3174	1797
104	13488	7465	6023	3398	1485	1913	11.01%	14.18%	3173	2210	963	384	118	266	6533	3652	2881

Data Source: Annual Report of Fisheries Agency,Council of Agriculture

Number of Fishing Boats and Main Fishing Ports

In recent years, the number of power fishing vessels (including rubber rafts and sampans) in Changhua County is about 330, belonging to Lunweiwan Fishing Port, Wanggong Fishing Port and other berths. Among them, Lunwei Fishing Port, which was formally included in the statistics only in 2005, has a large number of vessels and tonnage. As the main fishing port in Changhua County, there were nearly 400 fishing vessels in 2006-08. However, the Morakot disaster in 2008 made Lunwei Port silt up rapidly, and the number of fishing vessels began to decrease sharply in 2009, which maintained about 180 in recent years. Since the waterway in Wanggong Fishing Port is seriously silted up and made entry and exit difficult, the main types are fishing rafts with shallow draft and dynamic sampans. In terms of output value and output, the output of Lunweiwan Port is slightly more than that of Wanggong Port, and the output value of Lunweiwan Port is about 1.2-1.3 times that of Wanggong Port (Table 6.3.2-64). The vast majority of fishing vessels in Changhua County are mainly gill-net and trawl operations. Only a few fishing vessels with more than 20 tons and less than 50 tons are mixed fisheries (4 of them registered in Changhua Lunwei Fishing Port in 2013), i.e., both trawl and gill-net fishing methods are operated according to weather conditions and fishing season. Before 2011, the number of registered rafts in Changhua County was about 150-300 (320-390 in 2006-08), but the number of fishing boats in 2012-2015 increased sharply to 490-499, nearly twice as much as in previous years. According to the local fishermen, this is related to the development of wind turbines and compensation for vessels. Therefore, the number of boats spiked sharply. Whether the real reason is that the statistical method was changed due to the revision of the 2012 annual fishery report or that there is an increase in the number of fishing vessels actually registered in Changhua County is still under investigation. However, according to the current survey of the deepest Yuanzai Port at the lowest tide, it is found that more than six vessels (CT3) with more than 20 tons and less than 50 tons were berthed in the port. Inquiring the fishermen it is learned that the majority of the vessels were originally registered in Wuqi Port but the owner's registry was Changhua, so the vessels were berthed in Yuanzai Port and worked in the sea area near Changhua.

Table 6.3.2-63 Number of Fishing Vessel and Fishing Raft

Year	Powered Fishing Vessel	Powered Fishing Raft	Non-Powered Fishing Raft	Non-Powered Sampan	Total
2003	107	613	13	0	733
2004	118	606	13	0	737
2005	120	605	11	0	736
2006	123	595	11	0	729
2007	123	573	8	0	704
2008	123	524	6	0	653
2009	128	500	6	0	634
2010	132	513	5	0	650
2011	139	514	4	0	657
2012	143	499	4	0	646
2013	152	491	4	0	647
2014	157	497	2	0	656
2015	165	499	2	0	666

Data Source: Annual Report of Fisheries Agency,Council of Agriculture

Table 6.3.2-64 Catch, Value and Maximum Powered Fishing Vessel of Important Harbor in Changhua County

Year	Fishing Harbor	Number of Vessel and Raft (Vessel)								Number of Vessel and Raft (Vessel)					Annual Catch		Maximum Number of Vessel	Parking Area (m^2)
		Total	Fishing Raft	Non-Powered Sampan	Powered Sampan	Less than 5 tons	More than 5 tons Less than 10 tons	More than 10 tons Less than 20 tons	More than 20 tons Less than 50 tons	more than 50 tons Less than 100 tons	more than 100 tons Less than 200 tons	More than 200 tons Les than 500 tons	More than 500 tons Less than 1000 tons	More than 1000 tons	Catch M.T.	Value $ 1,000 NT		
91	Total	181	163	-	16	1	1	-	-	-	-	-	-	-	3900	317000	250	39500
91	Wongkung Fishing Harbor	181	163	-	16	1	1	-	-	-	-	-	-	-	3900	317000	250	39500
92	Total	173	150	-	21	2	-	-	-	-	-	-	-	-	3622	305190	250	39500
92	Wongkung Fishing Harbor	173	150	-	21	2	-	-	-	-	-	-	-	-	3622	305190	250	39500
93	Total	170	147	-	21	2	-	-	-	-	-	-	-	-	3930	325870	200	39500
93	Wongkung Fishing Harbor	170	147	-	21	2	-	-	-	-	-	-	-	-	3930	325870	200	39500
94	Total	163	141	-	20	2	-	-	-	-	-	-	-	-	3600	298000	180	39500
94	Wongkung Fishing Harbor	163	141	-	20	2	-	-	-	-	-	-	-	-	3600	298000	180	39500
95	Total	560	394	-	132	22	8	4	-	-	-	-	-	-	530	57100	585	89500
95	Wongkung Fishing Harbor	158	136	-	20	2	-	-	-	-	-	-	-	-	150	16100	165	39500
95	Lunwei Fishing Harbor	402	258	-	112	20	8	4	-	-	-	-	-	-	380	41000	420	50000
96	Total	531	360	-	131	32	4	4	-	-	-	-	-	-	507	55010	569	89500
96	Wongkung Fishing Harbor	149	126	-	21	2	-	-	-	-	-	-	-	-	143	15510	145	39500
96	Lunwei Fishing Harbor	382	234	-	110	30	4	4	-	-	-	-	-	-	364	39500	424	50000
97	Total	505	326	-	139	32	8	-	-	-	-	-	-	-	509	55410	532	89500
97	Wongkung Fishing Harbor	137	114	-	21	2	-	-	-	-	-	-	-	-	135	14730	142	39500
97	Lunwei Fishing Harbor	368	212	-	118	30	8	-	-	-	-	-	-	-	374	40680	390	50000
98	Total	317	212	-	81	21	3	-	-	-	-	-	-	-	315	35963	326	64500
98	Wongkung Fishing Harbor	136	111	-	23	2	-	-	-	-	-	-	-	-	135	15429	140	39500
98	Lunwei Fishing Harbor	181	101	-	58	19	3	-	-	-	-	-	-	-	180	20534	186	25000
99	Total	330	223	-	79	22	3	-	3	-	-	-	-	-	310	43970	336	64500
99	Wongkung Fishing Harbor	146	121	-	23	2	-	-	-	-	-	-	-	-	140	19450	146	39500
99	Lunwei Fishing Harbor	184	102	-	56	20	3	-	3	-	-	-	-	-	170	24520	190	25000
100	Total	328	222	-	76	23	4	-	3	-	-	-	-	-	303	42,201	335	64,500
100	Wongkung Fishing Harbor	146	120	-	23	3	-	-	-	-	-	-	-	-	135	18,785	149	39,500
100	Lunwei Fishing Harbor	182	102	-	53	20	4	-	3	-	-	-	-	-	168	23,416	186	25,000
101	Total	642	499		95	33	5	7	3	-	-	-	-	-	600	88,600	499	64,500
102	Total	643	491		95	38	6	9	4	-	-	-	-	-	560	84,148	491	-
103	Total	654	497		92	45	7	9	4	-	-	-	-	-	523	80,404	-	-
104	Total	664	499		93	48	7	11	6	-	-	-	-	-	553	60,830	-	-

Remarks: Annual statistic report of fishery industry has revised since 2012. Annual catch indicates catch of coastal fishery industry. Since 2013, data of parking area is not indicated. In 2014, maximum number of fishing vessel and crafts are not indicated. Data Source: Data Source: Annual Report of Fisheries Agency,Council of Agriculture

Overview of Important Fishery Types

Fishery Agency annual report shows that there are two major projects of gill-net and set net fishing in the coastal fisheries of Changhua (fixed net fishing is subjected to change into other fishery in 2013). However, gill-netting and trawling are the main fishing types in Changhua coastal area, very few pole and line fisheries, seasonal snipe eel stow nets (November to February), few baulk nets, fyke nets, snake cages, and crab pots (the above fishery types are classified under the fixed net fishing). The result of survey by ports and fish markets shows that gill-net and trawl fisheries have the largest catches. Most of the catches by various approved fishery types along the Changhua coastal area are immediately traded at the port or sell directly to the restaurants. Only a few catches are sold through auction in Puxin fish market and Changhua fish market. The catches auctioned by the two fish markets also include catches from imported catches and unidentified catches in non-Changhua sea areas. Therefore, the number of catch registered by the Fisheries Agency should be much lower than the actual catch by fishermen. Below are the main fishery types along Changhua coastal area.

Gill-net fishery

Gill-net is composed of vertical panels of netting. It has a floatline along the top and leadline along the bottom. The net hangs straight up and down into the water like a fence. The net catches fish that swim into it, and the fishes are caught when the net wraps around them. The gill-net fishery of each port in Changhua is divided into three types, which are floating gill-net, drift gill-net, and bottom gill-net. Floating gill-net and bottom gill-net do not move with the current, while drift gill-net flows with the current which only a few ships operate this fishery in recent years. Sampan and rubber raft are the main vehicles for the gill-net fishery in Wanggong Fishing Port, Lunwei Fishing Port, and other ports. Wenzai Fishing port is partly engaged in gill-net fishery (combined of trawling and gill-netting). The vessel has a large tonnage, and its operating capacity varies according to the size of its raft and the number of fishing machines and crews. The bottom gill-net and floating gill-net are mainly operated by human using sampan and rubber raft. There are 2 types of bottom gill-nets, depending on the target species, usually be carried out from April to June. If the target is to catch croakers, 40-50 pieces of single-layer net will be set. The height of net is around 1.5 meters above seabed, and each piece of net is around 120 meters long. If the target is to catch sharks (Wedgefhishes), 30-35 pieces of doule-layer net will be set. The height of net is around 2.5 meters above seabed, 50 meters long of each net. The water depth should be 10-50 meter, and the catching location is 2-3 nautical miles offshore. Single layer and triple layer net are used by floating gill-net of sampan and rubber raft. They are used to catch mullet, threadfin, black sea-bream, spanish mackerel, and white herring. 40-50 pieces of single-layer net will be set. The height of net is around 5 meters above seabed, each piece of net is 60 meters long, and the water depth should be 5-10 meter. Fishing period is between October and January. With a large boat, it is easier to keep the net in a clean deck space and use a machine to haul the net, therefore, 50 pieces of bottom gill-net can be set.

Gill-nets can be operated in two periods of time. The first period is to arrive at the fishing ponds to set the nets before sunset, and haul them after 1-3 hours or during low tide. Another period is to set the nets to sea in the afternoon, haul them and return to the port at dawn. A set of net is usually putting out a day. The gill-nets are limited by the small tonnage and horsepower of vessels, so the number of operating days is highly susceptible to the weather conditions,and the range is generally close to the coast.

Trawling (Otter Trawling and Pair Trawling)

Trawling can be carried out by one trawler (otter trawling) or by two trawlers (pair trawling). Otter trawling uses a net which is held open by a pair of otter boards attached each side on a single vessel. Pair trawling is using two vessels, with wires attached to each boat and the net are held open horizontally while towing. Trawling can be divided based on the depth of the trawl in the water, which are aim trawling, midwater trawling, and bottom trawling. Changhua sea area mainly uses bottom trawl, which is towing the trawl along or close to the seafloor. Bottom trawling may be non-selective, any species of fish and other sea creatures can be caught. This method can only be carried out in shallow sea bottom sand. Due to the greater water resistance, the vessel should be up to 20 tonnage, as the length is longer, the draft is deeper, and the net is less affected by sea and weather conditions. “Restriction or prohibition of operating trawlers less than 50 tons within 3 miles from shore”, “Restriction or prohibition of operating trawlers 50 tons or above within 12 miles from shore” stipulated by The National Fisheries Act (Article 44, Paragraph 4, Fisheries Act). However, 4 pairs of pair trawling vessels (exceeding 50 tons but less than 100 tons of CT4) are found operating within 12 miles of shore in Dacheng sea area in December. The pair trawling vessels belong to fishermen from Tainan and Kaohsiung. There is no large vessels such as CT4 are registered in Changhua.

Most of the bottom trawling vessels can only be docked at Wenzai Fishing port due to the depth of the water, and the operation time is limited by the tides. Generally, the vessels leave port 2 hours before the full tide, and begin towing after arriving at the operating area. They avoid the artificial reefs area which can be destroyed by trawling and also result in net loss. The trawling process takes around 1-1.5 hours. After hauling the net, sorting out the catch species and sizes will be made, and preserving them with crushed ice. 3-4 sets of net are usually putting out a day. The vessels must enter the port (Wenzai Fishing port), unload and sell the catches within 2 hours after full tide. The catches will not put into the auction, because they are freshly caught, the price of every fish types will be 1.5-3 times higher than in the auction market. Main species of catches are black sea-bream, white croaker, yellow croaker, sea catfish, lizard fish, shrimp, carb, chicken grunter, ribbonfish, trash fish and few migratory fishes. Fishing period opens throughout the year.

Snipe Eel Stow Net

Stow net is mostly concentrated along Changhua Coastal Industrial Park shoreline. This is a small-scale stationery fishing type, which can be found in estuary area or gentle sand coast with large tide. This fishery type uses the flowing and falling tide to intercept the passing sea creatures. The bottom of the net is fixed on the sandy seabed by ropes, and the mouth of the net is held open by a buoyancy. 5-10 net mouths can be connected as an interceptor at the estuary. When the current carrying the fishes go through the net, fishes are collect in the cod-end. The main catch will be snipe eels. Fishing period begins from November to February.

Fyke Net

Fyke net is mostly concentrated along Changhua Coastal Industrial Park shoreline. This is a small-sized stationery fishing type, which can be found in estuary area or gentle sand coast with large tide. This fishery type uses the flowing and falling tide to intercept the passing sea creatures. The mouth of the net is fixed on the sandy seabed by stakes. It has wings which guide the fish towards the entrance of the net. It consists of 2-3 cylindrical netting bags, having swum into the net the fishes, shrimps, and crabs are unable to escape. The gear is being set and haul during fall tide. If it is not using, the fyke net is hung on the stakes to dry. The main catches are shrimps, crabs, and mullet. Fishing period opens throughout the year.

Pole and Line

Pole and line in Changhua has fewer catches compared to the above-mentioned fisheries. This fishery type has great flexibility, it can be operated whenever and wherever you want. Pole and line is common to sport fisheries, preferring operated along artificial reefs area and in good sea condition. As a result, the days of operation is limited due to the sea condition.

Main Catch Species

The recent Changhua fish species production in marine fisheries is listed in Table 6.3.2-64, according to the statistics annual report of Fisheries Agency, Council of Agriculture, Executive Yuan. The order of fish species in the table is ranked according to the production in 2015 (annual fishery report in 2011 has been slightly revised, many fish species are not listed, and several projects have been added). The top ten species production in 2015 are shellfish, other marine fishes, giant freshwater prawn, threadfin, mullet, milkfish, white croaker, flower crab, and ribbonfish. The top ten fish production are other marine fishes, threadfin, mullet, milkfish, white croaker, ribbonfish, black sea bream, other sharks, round scad, and other mackerel. Shellfish is officially recorded in 2011, as there is no record before 2010, and its production ranked in the first place for the past five years, including marine-freshwater bred species (4 categories). Milkfish is officially recorded in 2014. Black sea bream begins its production in 2012 while whiteleg shrimp is in 2013. The three types of fish mentioned above are mostly cultured, but less amount of production is caught. Perhaps the cultured black sea bream is mixed into the calculation, and this newly added fish production ranks in the top ten after 2012. The production of mullet, other marine fishes and threadfin have been decreasing in the past three years. However, the production value of other marine fishes is increasing, whilst threadfin is slightly decreasing. The production of other crabs falls into 2 tons, so does its value. Both mullet and threadfin have artificial breeding, the calculation should include the number of breeding and actual caught. Production of mullet fry, gizzard shed, white mouth croaker, pelagic crab, serrated crab, skate, purple clam, grass shrimp and brown croaker has been decreasing each year since 2005. Production in some categories has decreased by more than double from a decade ago, especially crabs, giant freshwater prawn, kuruma shrimp and white mouth croaker. There is 14 categories that have no production record since 2012 (eg. whitings, other croakers, purple clam, brown croaker etc.). Table 6.3.2-65 shows the production value of fish species. Tthe order is ranked according to the value of 2015. Production and production value of purple clam, grass shrimp and gizzard shed are decreasing each year. In the past decade, the production and production value of fish species ranking have slightly changed. The auction price of these eight fishes, white mouth croaker, brown croaker, other croakers, white pomfret, black pomfret, japanese butterfish, and whitings, has risen double within 10 years.

Table 6.3.2-64 Change of Fishery Industry of Fishing Harbor from 2003 to 2015

Unit:metric ton

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
貝類(牡蠣+文蛤+蜊+蜆)	-	-	-	-	-	-	-	-	19655	19614	19321	19052	12251
其他海水魚類	207.5	165.2	148.5	143.4	143.1	146.2	146.1	144.2	143	142	142	129	203
長腳大蝦(羅氏沼蝦)	-	52.1	57.3	19.8	23.3	20.7	17.6	15.1	10.9	5	3	3	83
blind tassel fish	50.5	43	57	56.7	55.6	55.3	54.8	51.9	48.7	45	39	34	67
烏　魚	270.3	381.6	164.7	200.7	174.5	166.1	159.7	171.4	181.2	169	170	156	65
白蝦	-	-	-	-	-	-	-	-	-	-	15	66	61
虱　目　魚	-	-	-	-	-	-	-	-	-	-	-	120	46
白　　　口	49.6	38.3	27.7	30.2	26.6	21.9	19.2	17.7	15.4	14	13	12	33
蠘(遠海梭子蟹)	17.8	15.9	8.6	13.6	11.3	8.1	7.9	7.4	7.3	7	7	5	25
白　帶　魚	33.4	34.8	37.9	36.3	34	31.4	29.2	28.4	26.4	23	21	19	13
黑鯛	-	-	-	-	-	-	-	-	-	67	62	66	13
其他鯊	-	-	-	-	-	-	-	-	-	-	-	-	11
其他蟳蟹類	71.5	81.6	83.6	78.8	72	63.3	60.2	54.7	48.2	41	35	30	2
藍圓鰺	-	-	-	-	-	-	-	-	-	-	-	-	1
其他鰆類	43.4	39.2	35.6	33.6	32.6	33.6	36	39.5	42	42	40	38	1
斑節蝦(日本對蝦)	12.1	14	15.8	17.6	16.3	11.2	10.6	9.1	6.7	2	2	1	1
多毛對蝦	-	-	-	-	-	-	-	-	-	-	-	-	1
鱸　　　魚	-	-	-	-	-	-	-	-	-	-	-	1	-
赤鯮	3	5.4	5.4	4.9	4	4.3	4.3	4.2	3.9	3	3	3	-
其他蝦類	50.4	59.7	40.7	51.9	45.8	46.2	48.8	51.8	57.9	-	-	-	-
其他黃花魚類	39.3	36.7	31.7	36.6	38.2	42.8	44.7	45	47.8	-	-	-	-
西　施　貝	82.9	58.3	47.25	42.6	41.6	38.7	39.4	44	46	-	-	-	-
草　　　蝦	61.2	48	35.1	49.1	46.1	43.2	41.1	36.8	36.6	-	-	-	-
其　他　鯛	30.3	30.4	30.2	30.5	32.4	35.4	34.9	35.6	35.8	36	33	32	-
闊　腹　鰆	28.2	26.8	26.3	25.4	25	24.9	23.9	23.9	24.7	-	-	-	-
鮸　　　魚	14.6	18.5	27.9	27.1	25.7	23.9	22.7	21.3	20.1	-	-	-	-
沙鮻	14.22	13.7	15.4	17.2	18.4	18.7	19.3	19.4	18.4	-	-	-	-
龍　鬚　菜	23	18.2	14.7	15.6	14.5	14.7	14.5	13.4	13	12	10	7	-
海　　　鯰	12.9	14.7	15.5	13.6	13.8	13.9	13.6	13.2	12.8	-	-	-	-
鰶	65.5	35.6	15.2	30.3	21.2	14.2	12.9	12.9	11.4	-	-	-	-
其他鰮類	7.8	9.7	7.8	9.4	9.6	9.6	9.6	10.2	10.5	11	11	9	-
白　鯧	16.1	13.5	17.3	16.2	15.7	14.9	13.9	12.2	10.4	-	-	10	-
黑　鯧	7.3	6.1	7.6	7.5	7.8	7.9	8.1	9	9.7	10	10	-	-
其　他　鯧	5.8	5.9	5.2	5.6	5.4	5.7	5.5	6.2	6.9	-	-	-	-
蟳	29.5	21	17.2	21.7	16.4	13.3	13.1	8.7	5.8	-	-	-	-
肉　魚	2.5	3.1	3.5	3.3	3.3	3.8	4	4.2	4.2	4	4	4	-
烏　　　賊	0.8	2.8	2	1.1	4.5	5.4	5	4.6	4.2	-	-	-	-
鰖	5.9	6.4	3.1	4	2.7	3.5	3.5	3.5	3.5	-	-	-	-
黑　　　口	1.4	1.3	1.2	1.3	1.2	1.2	1.2	1.5	1.6	-	-	-	-
其他鰺	2.1	2.5	1.2	1.4	1.4	1.2	1.3	1.5	1.6	2	2	2	-
鱠	-	-	-	-	-	-	-	-	-	5	6	-	-
嘉鱲	-	-	-	-	-	-	-	-	-	2	2	2	-

註：100年度開始漁業統計年報陸續改版,許多項目魚種未列，並另增貝類、虱目魚、赤鯮、鱠、嘉臘、黑鯛、鱸魚、日本對蝦等項目。
資料來源：行政院農業委員會漁業署漁業年報。

Table 6.3.2-65 Change of Fishery Industry Value of Fishing Harbor from 2003 to 2015

Unit:1000NTD

Year	92	93	94	95	96	97	98	99	100	101	102	103	104
貝類(牡蠣+文蛤+利+蜆)	-	-	-	-	-	-	-	-	-	-	1400277	1388491	866777
白蝦	-	-	-	-	-	-	-	-	-	-	3060	13208	20154
其他海水魚類	12865	10407.6	9652.5	11472	10950	11094.2	11688	11536	11440	11376	11384	10336	11155
長腳大蝦(羅氏沼蝦)	-	2396.6	4011	1386	1677.6	1449	1443.2	1359	1166.3	520	386	300	10164
烏 魚	54060	83952	32940	40140	34900	29898	31940	34280	44756.4	45176	44801	43764	6525
blind tassel fish	6312.5	5934	8037	8051.4	7784	6636	6576	10380	9740	8130	6014	6780	5729
蛾	2314	1908	1032	1292	1243	810	869	1184	1460	1260	1235	668	4679
黑鯛	-	-	-	-	-	-	-	-	-	12502	12731	14542	2961
白 口	2579.2	2029.9	1246.5	1781.8	1622.6	1533	1497.6	1539.9	1524.6	1498	1271	1107	2773
白 帶 魚	2338	2610	2880.4	2649.9	2448	2826	2686.4	3124	3775.2	3159	3334	2703	1974
虱 目 魚	-	-	-	-	-	-	-	-	-	-	-	9968	3129
其他鯊	-	-	-	-	-	-	-	-	-	-	-	-	844
斑節蝦(日本對蝦)	6655	7840	8848	10032	11736	5940	6890	6006	4422	1316	482	-	530
多毛對蝦	-	-	-	-	-	-	-	-	-	-	-	-	225
其他蟳蟹類	7865	8160	8360	6698	6480	5785	5418	5470	4820	-	4117	1734	208
藍圓鰺	-	-	-	-	-	-	-	-	-	-	-	-	41
其他鰆類	5381.6	4900	4628	5040	4890	5040	5400	5925	6300	6240	8686	9134	20
鱸 魚	-	-	-	-	-	-	-	-	-	-	-	129	-
赤鯮	360	615.6	615.6	661.5	640	731	705.2	672	698.1	670	558	519	-
其他蝦類	5544	6089.4	4151.4	5086.2	5496	5775	7320	7252	14880.3	-	-	-	-
草 蝦	15912	13440	9828	12766	12447	10800	9453	8096	9150	-	-	-	-
其他黃花魚類	3144	2862.6	2472.6	4026	3896.4	4280	5587.5	6750	7170	-	-	-	-
其 他 鯛	3030	3100.8	3080.4	3355	3628.8	3964.8	3490	8900	4761.4	4141	4075	1421	-
闊 腹 鰆	4794	4690	4602.5	4318	4300	4282.8	4110.8	4182.5	4322.5	-	-	-	-
沙鮻	1166	1164.5	1309	1479.2	1564	1589.5	1640.5	3880	3680	-	-	-	-
白 鯧	3220	2700	3633	3564	3297	3278	3405.5	3538	3369.6	-	-	1581	-
西 施 貝	5968.8	4081	3307.5	2982	2912	2709	2758	3300	3345	-	-	-	-
鮸 魚	1211.8	1739	2622.6	2981	2724.2	2868	2746.7	2598.6	2532.6	-	-	-	-
蟳	5310	3780	3096	4340	3608	2660	2489	1740	1525.4	-	-	-	-
黑 鯧	569.4	506.3	501.6	660	756.6	869	1134	1440	1474.4	1720	1545	-	-
其他鰛類	538.2	649.9	522.6	611	633.6	633.6	633.6	663	682.5	508	533	294	-
鯮	2489	1352.8	577.6	1515	1102.4	738.4	670.8	709.5	627	-	-	-	-
肉 魚	162.5	204.6	217	250.8	297	361	440	462	617.4	1125	592	616	-
其 他 鯧	290	383.5	338	448	421.2	427.5	374	620	552	-	-	-	-
海 鯰	1125.6	1249.5	1317.5	1169.6	1173	347.5	353.6	277.2	512	-	-	-	-
烏 賊	84.8	243.6	210	99	474	559.5	517	520	476.7	-	-	-	-
龍 鬚 菜	287.5	218.4	176.4	234	232	235.2	232	335	325	310	245	28	-
其他鰺	252	300	144	168	168	144	156	165	312	312	70	81	-
鰻	241.9	307.2	155	200	135	175	175	175	175	-	-	-	-
黑 口	179.2	287.3	265.2	132.6	132	144	120	180	88	-	-	-	-
鰆	-	-	-	-	-	-	-	-	-	1411	1404	-	-
嘉鱲	-	-	-	-	-	-	-	-	-	310	268	260	-

註：100年度開始漁業統計年報陸續改版,許多項目魚種未列，並另增貝類、虱目魚、赤鯮、鰆、嘉臘、黑鯛、鱸魚、日本對蝦等項目。
資料來源：行政院農業委員會漁業署漁業年報。

Fish Auction Market Survey

A general fish auction survey is carried out in Changhua Fish Market and Puxin Fish Market by random sampling basis (2016/03/05, 2016/02/28, 2016/11/17). Puxin Fish Market is divided into frozen and fresh areas. Fish culture in freshwater accounted for the largest catch. Changhua Fish Market is divided into (1) polystyrene area, mainly coastal catches, (2) cultured fish area A, including milkfish, (3) cultured fish area B, catches have been packed in polystyrene, (4) frozen fish area, catches must be taken out from cold storage for grading before auction. The diversity of Changhua Fish Market is higher than Puxin Fish Market, and its fish culture in freshwater also accounted for the largest catch. Several surveys in these two fish markets have found that coastal catches accounted for ¼-⅓ of the total catches on the day. Catches in Changhua’s water account for ½-⅔ of the catches along the coast. The freshness of freshwater fish is excellent (cultured fish), and the marine fish is less fresh. ⅓-¼ of the frozen catches are non-local sea species (eg. yellowfin tuna, marlin, salmon, etc.).

General Discussion

Due to the narrow coast of Changhua and large tide range, establishments port is the main port type in the town. Most catches are sold directly by fishermen, but only a few will be sent to the fish markets (Changhua Fish Market and Puxin Fish Market). Changhua Fishermen’s Association has abolished the port auction system. Therefore, aquaculture fishery, catches along the coast and unknown origin are allowed to sell at auction in Changhua’s fish markets. The official statistics do not fully reflect the actual fishery production in Changhua, and there might be cases of avoiding fishery regulations (unregistered trawling fishery). As for the ffishermen are reluctant to enter the fish market, the following are the reasons concluded through some interviews. (1) Auction prices in fish markets are lower than in local (fishing port); (2) Transport and refrigeration costs do not match the needs of fishermen; (3) Fishermen always get good deals at the local ports, so there is no need to send high-priced fish to fish market for lower-priced at auction. As for the fishery annual report, there has been no record for fixed net fishery in Changhua since 2013, but is recorded in the category of other coastal fisheries. It is estimated that the fixed net fishery is moved to other coastal fishery. The fishing types include in other coastal fishery are stow net, fyke net, snake cage, and others. According to the current survey, gill-net fishery and trawl fishery are the major coastal fisherie other than aquaculture fishery in Changhua sea area.

Fish Finder Survey

The sea areas of western Taiwan have become the key area for the development of offshore wind power plant. According to the “Guidelines of Application For Offshore Wind Farm Site” announced by EPA last year, there are 36 potential offshore wind field sites, from north to south, which are New Taipei City. Taoyuan City, Hsinchu County, Miaoli County, Taichung City, Changhua County, Yunlin County, Tainan City, Kaohsiung City and Pingtung County. All are located in the sea area of western counties and cities. Some sites have been applied by various development units. The necessary environment assessment will be carried out. The survey area is located in the western sea area of Changhua County with an area of 120.4 square kilometers and an average water depth of 40.9 meters. The impact of the wind turbines in this field on the fishery resources before and after the establishment includes the number and distribution of fish stocks. In addition to fishery production activities, it is necessary to have a survey which focuses on fishery activities to objectively assess changes in fishery resources inside and outside the wind farm. Scientific fish surveys are a more common objective method. This scientific fish exploration survey intends to establish the observation data of the total fish population of the wind farm site and also the basic data of the fish stock distribution before the development of the wind farm, as the basis for the evaluation of the fish population in the future development, operation stage and the effect of the power base on fish dispersal or aggregation.

Site water area expedition

Due to the long distance of sea area as well as the poor sea condition, this particular expedition will be renting National Taiwan Ocean University’s R/V Ocean Researcher 2 to carry out the exploration. Departed on 19/9/2016 from Bisha fishing port and arrived at the site on 20/9/2016. The expedition was ended at 1400.The condition of the expedition site was as below, weather is sunny, temperature is 25.0℃ to 28.7℃, Beaufort wind force scale is 6 to 8 degree, wave height at 4 to 55 meter, the temperature of the sea at the beginning of exploration is 26.3℃, salinity of seawater is 33.2psu, clarity of sea is 7 miles, sea condition was rather poor due to the massive sea area. The cruising speed was maintained at around 7 points during the expedition. The route plan of the expedition is as picture 6.3.3-1. The expedition sites were stationed beginning from point A to the end of point J, a total of 10 waypoints was established with 9 sections. Depth of sea is 30.55 to 38.33 meter. The total distance of the expedition is 24.16 miles.

Acoustic System

This expedition uses instrument Simrad EK60 from R/V Ocean Researcher 2 to segment wave beam fish finder sonar system. This particular system is equipped with transmitter and transducer, sound frequency is 38kHz and 120kHz accordingly. Beam angle was all 7˚, further paired with GPS and computer connection to collect longitude and latitude data. Figure 6.3.3-1is the calibration parameters and setting, whereas the setting of the system is as picture 6.3.3-2. As for the operating part of the system, software Simrad ER60 was used via computer to process all sorts of parameter setting as well as command control, further saved all the ping test in accordingly and exported into raw data. The act is to aid the process of data analysis. The acoustic drum device of the detecting instrument which is installed under the R/V Ocean Researcher 2 (as picture 6.3.3-3) connected with the research vessel’s computer system to record data.

Table 6.3.3-1 Calibration Parameters and Setting of Fish Finder System

Parameter	Setting	Unit
Ping interval	1	ping/s
Frequency	38/120	KHz
Absorption coefficient	0.0568330	dB/k
Sound Velocity	1530.3	m/s
Transducer gain	21.93	dB
Transmitted pulse length	0.256	ms
Power	200	watt
Two-Way beam angle	-20.6	dB
Minor axis 3dB beam angle	7.59	degree
Major axis 3dB beam angle	6.38	degree
Minor axis 3dB offset angle	-0.38	degree
Major axis 3dB offset angle	-0.08	degree

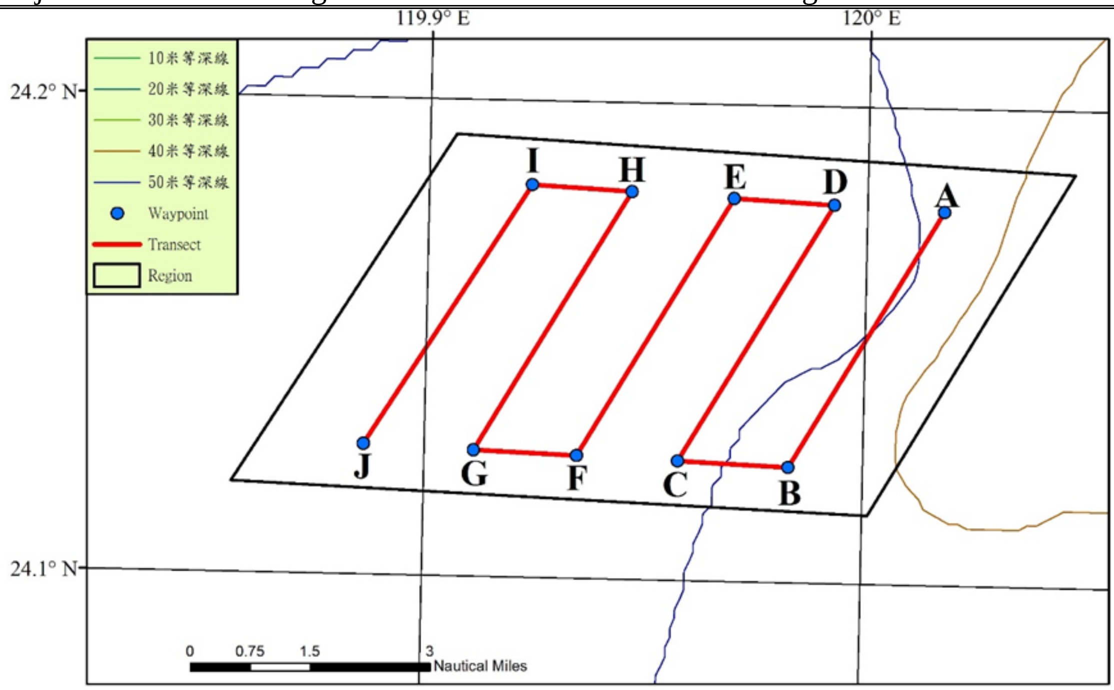


Figure 6.3.3-1 探測路徑與風機位置及周邊等深線之分布情形

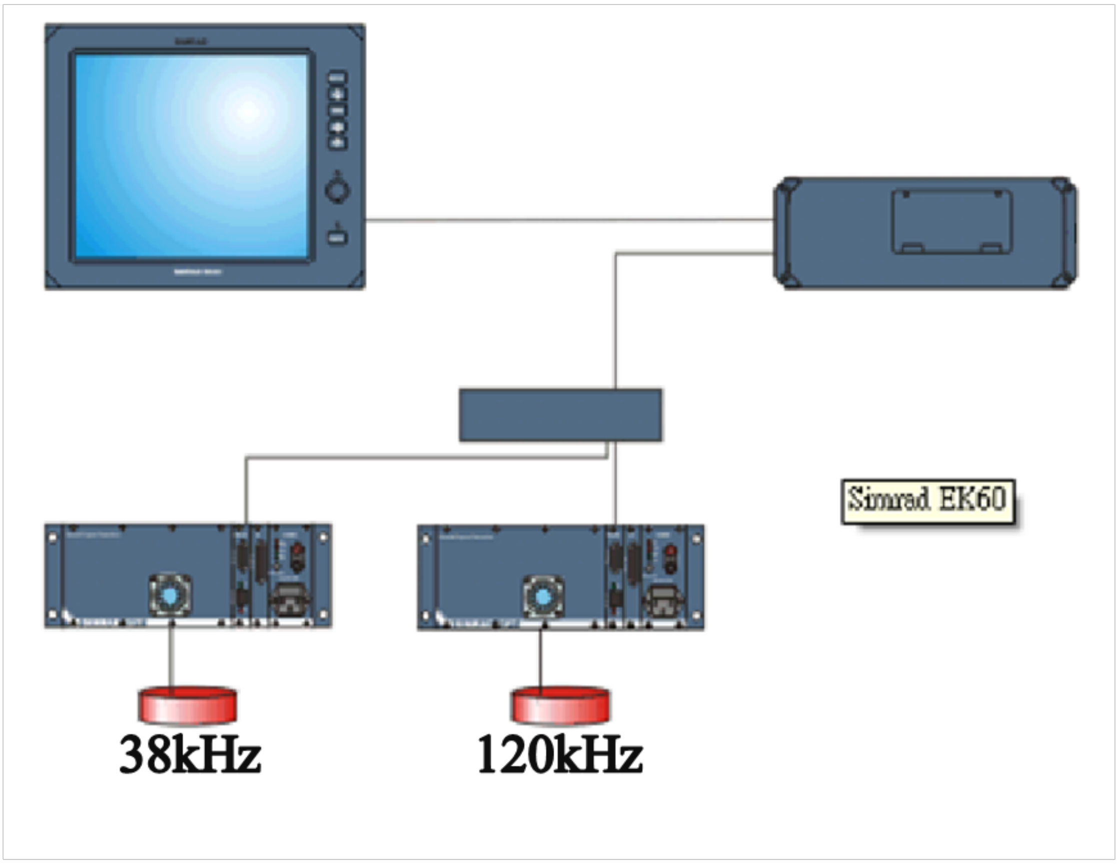


Figure 6.3.3-2 Composition Structure of EK60 Sound Probe System

Figure 6.3.3-3 海研二號(上)，探頭裝設位置(下)

(上)

(下)

Figure 6.3.3-3 海研二號(上)，探頭裝設位置(下)

Data Analysis

The onsite record of the fish finder post-processing data is divided into two main categories, the first one is volume backscattering strength, Sv, it represents the total reflection characteristics of the unit of water. When the value of Sv is higher, the higher the density of the fish that implied the unit of water. Assume that the composition of the fish in this area is similar, the higher the biomass. Another parameter is the individual standard reflection target strength (TS). It is the ratio of the reflected sound energy to the incident sound energy that represents the characteristics of the reflected individual. The higher the value it means that the larger the size of the creature. Representations of Sv or TS are in logarithmic units, which is deci-Bel (dB).

The density and abundance of the fish can be expressed using Area Backscattering Coefficient (ABC, Sa), this is the coefficient of the plane and non-dimensional by transforming Sv and distance. The unit is (m2/m2). ABC is expressed in units of nautical miles and named as NASC (Nautical area scattering coefficient；SA), the spatial conversion is based on ABC, and the unit is (m2/ n.mi.2), also presented as an indicator of relative total biomass.

Import data that is saved in EK60 into Myriax Enchoview for post-processing. Thus, following the latitude and longitude of the detection path to conduct echo integration processing. It is vulnerable to the disturbance of air bubbles and noise from the hull due to the shallow water surface of 5 meters. The sampling distance is based on the horizontal distance of 500 meters as one unit (Elementary Sampling Distance Unit, ESDU). The vertical distance is 5 meters below the surface of the water to the bottom of the sea. The water mass is divided accordingly based on this condition. Obtain result of the average Sv and TS values of each integral unit， further estimate each line of the NASC value. Due to there were many signal noises on the surface of this probe, each set is at minimum threshold of -65 dB, eliminate signal filtering with signal strength that is less than -65 dB, yet in the single target analysis, TS Threshold is set at -50 dB, according to the empirical conversion that is based on Love (1971), it shows that the body of the fish that are smaller than 5 cm are not counted.

Detection Results

38kHz

Figure 6.3.3-4 shows the Sv original trace of each test line at 38 kHz, due to poor sea condition of the expedition, the quality of the echo on each exploration line is affected by wind and waves, causing noise interference on the surface of the sea. Table 6.3.3-1 shows the average value of the detection result parameters of the total detection line. Each detection line represents as an indicator of the total biomass on NASC display. Value is between 0.98-3.63m2/n.mi.2. It indicates that during this detection period, the total biomass measured by the fish finder is extremely low. Moreover, the difference between the test lines is limited, each test line of the area, the overall biomass of the site shows it leans higher on the east side than the west side. Figure 6.3.3-5(a) shows the 3D rendering of the Sv value of the whole test line. The Sv value distribution of the Sv value on the test line is processed by the Natural Neighbor interpolation method as shown in Figure 6.3.3-5(b). The overall site value is shown to be rather low. However, there is a phenomenon that the Sv value in the northeast of the site is high. This indicates that the biomass density in the northeast of the site is higher.

Figure 6.3.3-6 shows the Sv original trace of each test line at 38 kHz, it also shows the noise interference caused by the wind and waves, in order to obtain enough individual standard objects, the conditions of the screening for the individual targets will be more lenient. The relevant information for obtaining the TS value of each test tine is shown in Table 6.3.3-2. The number of TS values detected in each test lines shows a phenomenon of decreasing from east of the site towards the west. The average TS value is higher on the CD line than other test lines. Figure 6.3.3-7(a) shows the 3D representation of the TS values for each 38 kHz test lines. Whereas the average TS value distribution of every 500 meters on the test line is shown in Figure 6.3.3-7(b). It can be observed that most of the TS values are distributed in the eastern part of the site. It means that more fish inhabit in that area.

The test of 38 kHz obtained 98 individual standard objects, as for the frequency distribution of TS; it is shown in Figure 6.3.3-8. Most TS values are concentrated between -46dB and -49dB, with a maximum of -40.16dB, a minimum of -49.99B, and an average of -47.13dB. The standard deviation is 2.26dB, and the 95% confidence interval is -44.87dB to -49.4dB. Due to poor sea conditions, this ship is shaking more vigorously and the number of individual targets taken is limited. It is difficult to further analyze the individual fish track. Therefore, the standard body length is 98 TS individual fish values. Empirical calculations of TS and body length through Love (1971)(Figure 6.3.3-7), body length is distributed at 5 to 17 cm, average body length is 7.76cm, its distribution is 84.69% below 5 to 10 cm, 13.27% from 10 to 15 cm and 2.04% above 15 cm. 95% confidence interval is 5.34 cm to 10.18 cm. The relationship between the size of the fish and the distribution of water depth is shown in Figure 6.3.3-10. In general, fish inhabit in the seabed between the depth of 30 meters and 40 meters. There is a presence of inhabited water depths from 10 meters to the bottom of the sea. However, most of the fish inhabit in the lower layer of the sea (R=0.17, N=98), if distinguish between large, medium and small fish, large fish (>15 cm) mostly inhabit at the bottom of the sea, mainly inhabit the seabed at from 35 meters to 37 meters (R=1, N=2); Medium-sized fish (10-15 cm) also have the same trend, most of them inhabit the seabed at depth of 30 to 40 meters (R = 0.03, N = 13); the inhabited depth distribution of small-sized fish (<10 cm) is broader. There is a distribution from the sea depth of 15 meters to the bottom of the sea, most of them inhabit at the depth below 20 meters, and the depth of the seabed ranges from 30 meters to 40 meters (R=0.16, N=83).

Table 6.3.3-2 Evaluation results of 38kHz transverse air route

Transects	Sv mean (dB)	NASC (m2/n.mi.2)	Number of TS	TS mean (dB)	Maximum TS (dB)	Minimum TS (dB)
AB	-89.788	3.634	51	-47.783	-49.996	-44.267
CD	-91.330	3.541	33	-45.997	-40.161	-49.858
EF	-91.529	1.639	10	-46.906	-42.878	-49.899
GH	-92.742	1.620	3	-48.430	-47.203	-49.924
IJ	-92.919	0.977	1	-49.951	-49.951	-49.951

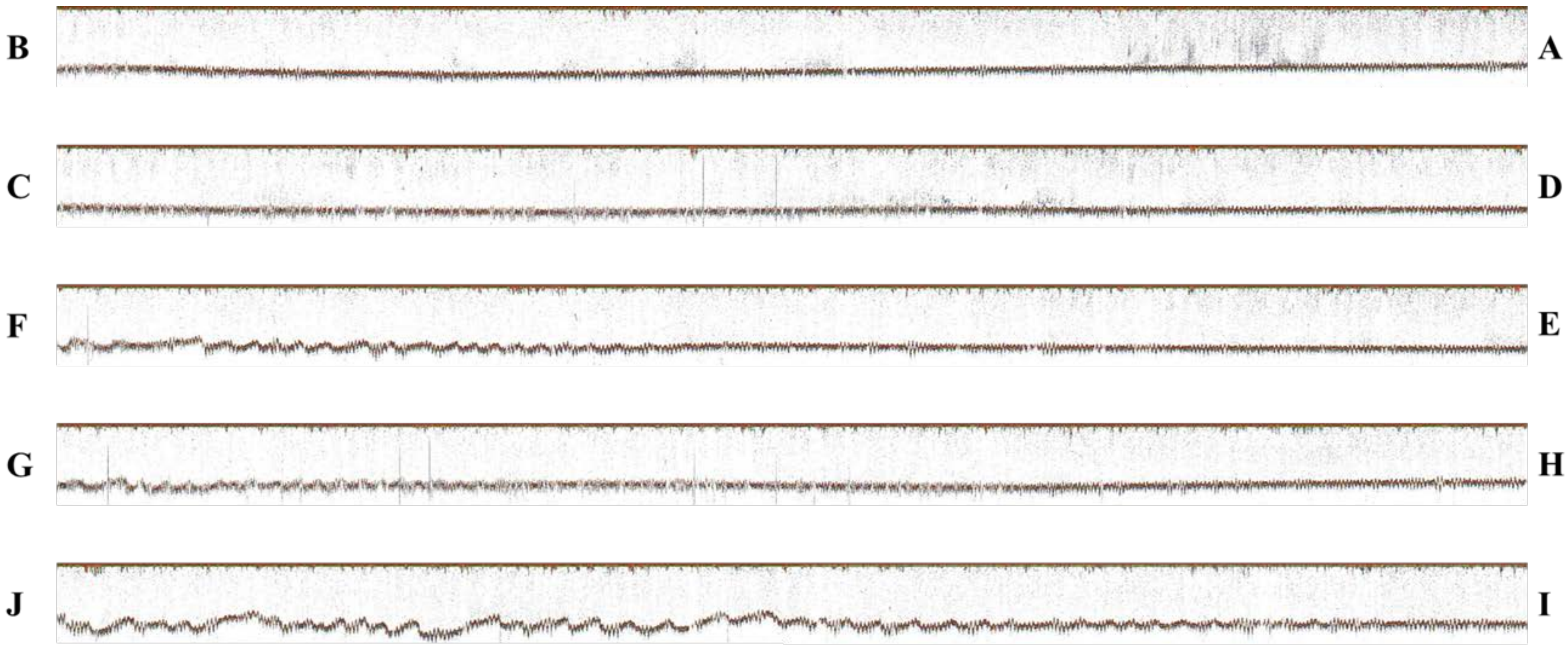
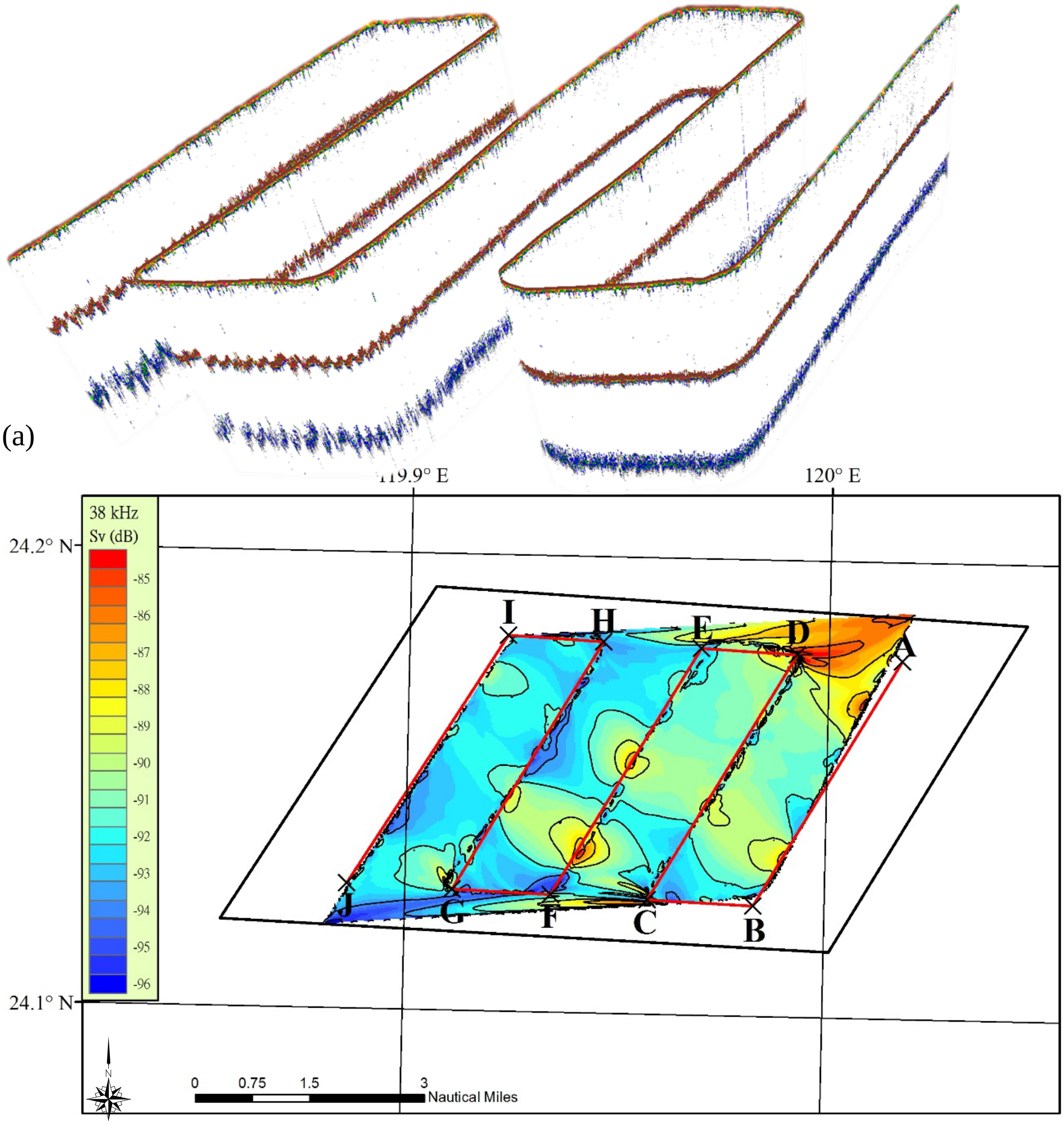


Figure 6.3.3-4 Transverse plot of 38kHz detection path



(a)

(b)

Figure 6.3.3-5 Sv original trace (b) and Sv distribution map of 38kHz detection path

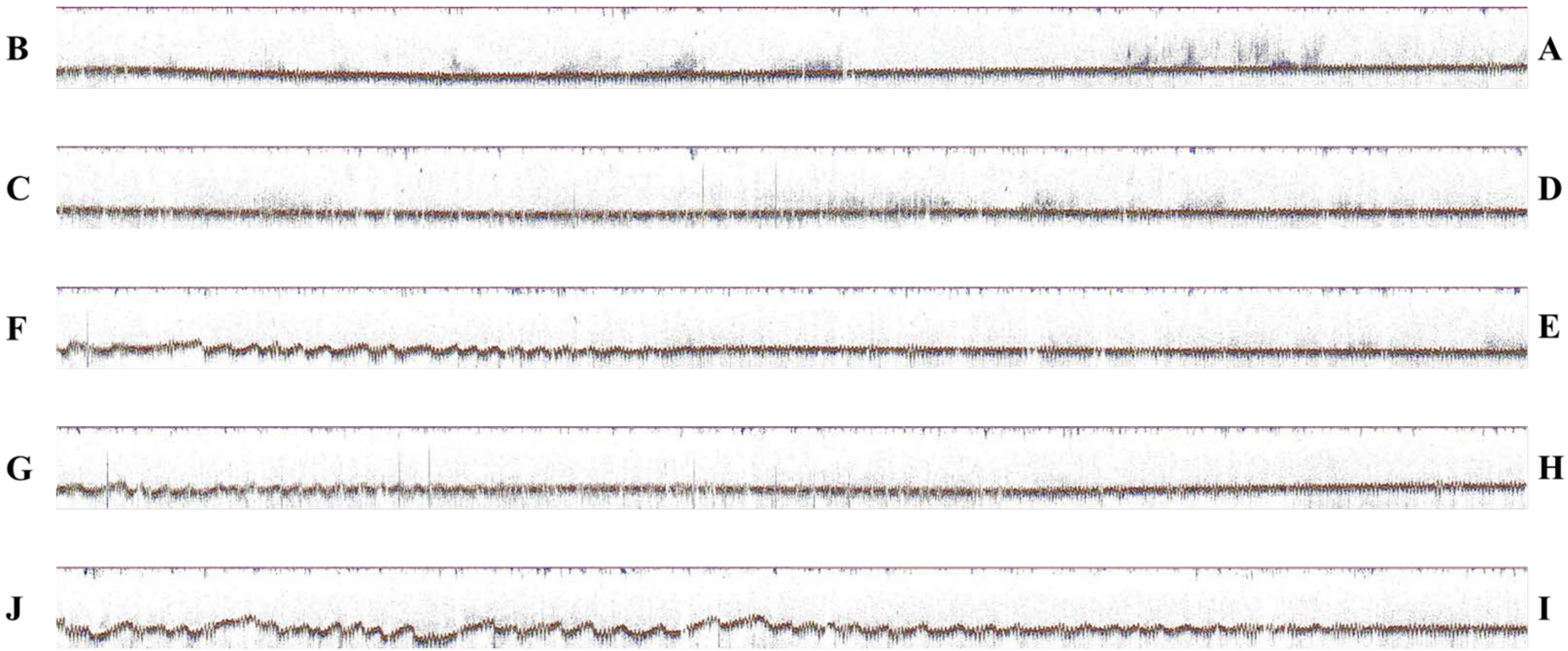
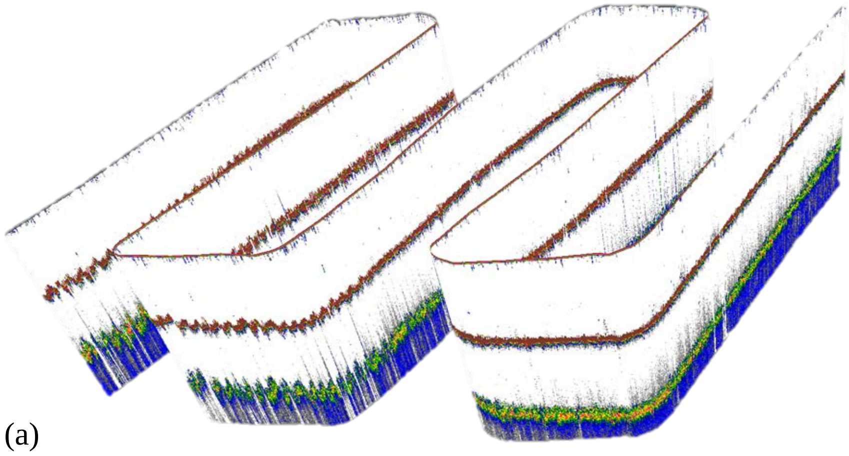


Figure 6.3.3-6 Transverse plot of 38kHz detection path



(a)

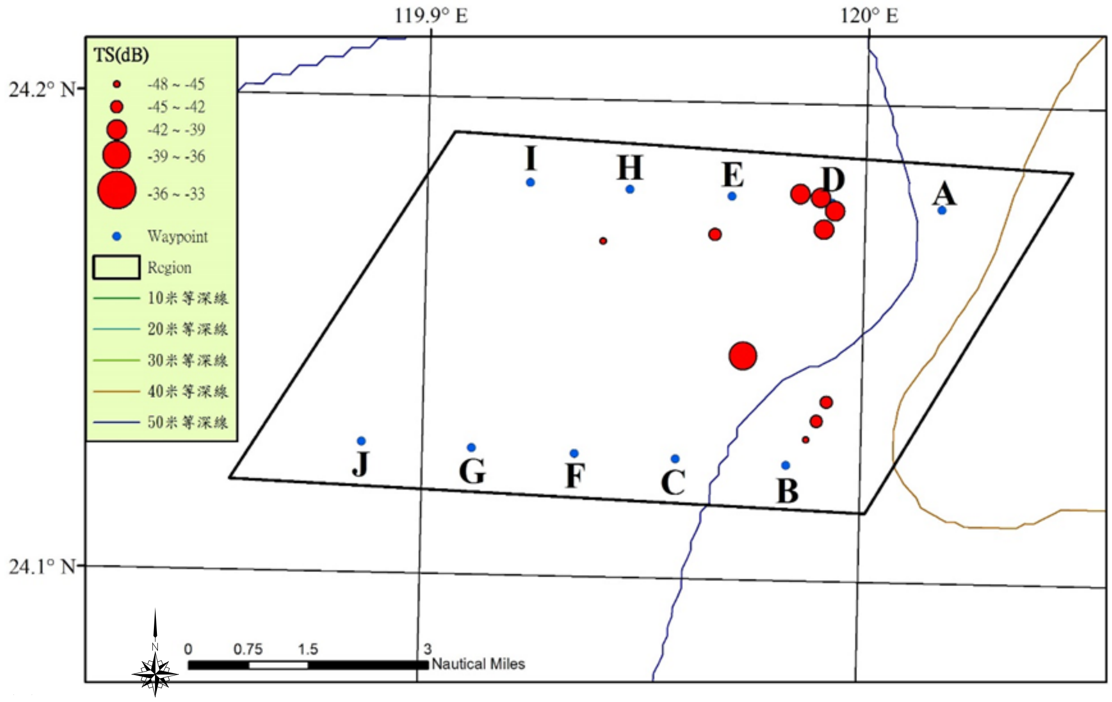


Figure 6.3.3-7 Original TS trace map (a) and TS distribution map (b) of 38kHz detection path

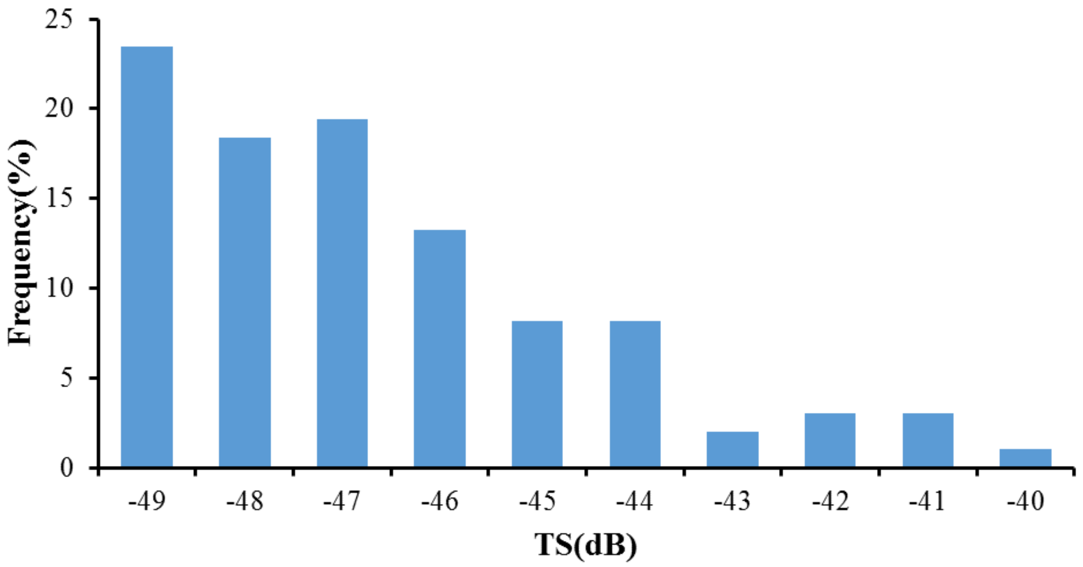


Figure 6.3.3-8 Frequency distribution of reflection intensity (TS) of monomer standard on 38kHz detection path

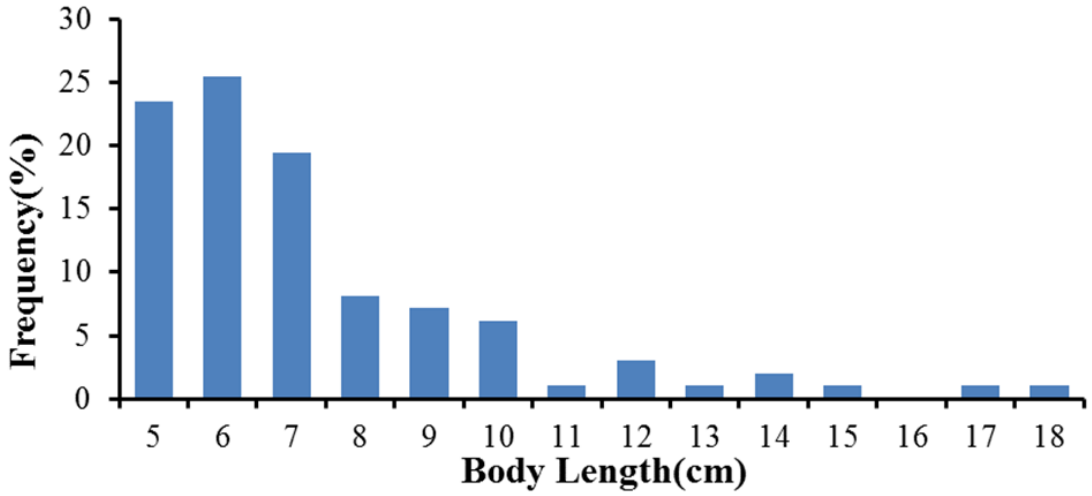


Figure 6.3.3-9 Frequency distribution of reflection intensity (TS) of monomer standard on 38kHz detection path

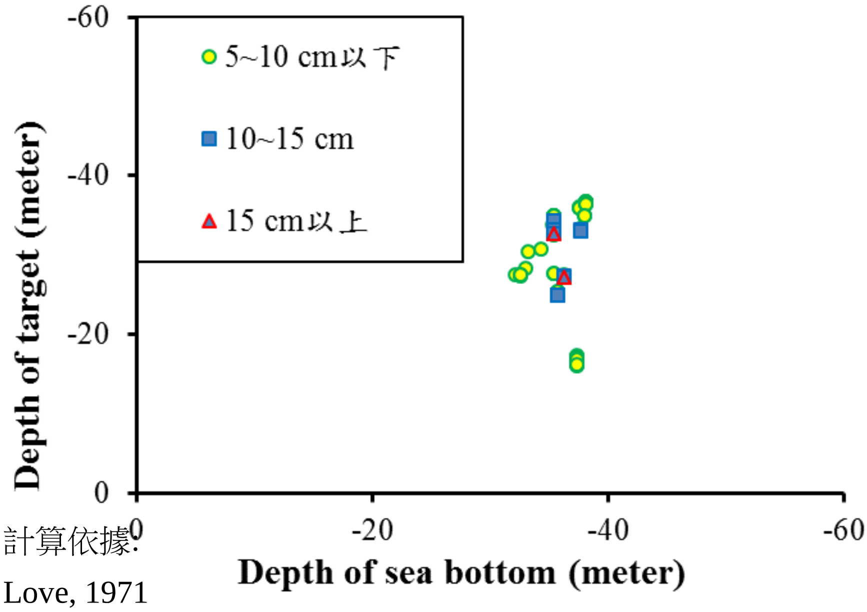


Figure 6.3.3-10　Figure 6.3.3-10 Body depth and distribution depth of fish in the detection path (n=98)

120kHz

Figure 6.3.3-11 shows the Sv original trace of each test line at 120 kHz, due to poor sea condition of the expedition, the quality of the echo on each exploration line is affected by wind and waves, causing noise interference on the surface of the sea. Table 6.3.3-3 shows the average value of the detection result parameters of the total detection line. Each detection line represents as an indicator of the total biomass on NASC display. Value is between 1.77-9.06m2/n.mi.2. It indicates that during this detection period, the total biomass measured by the fish finder is extremely low. Moreover, the difference between the test lines is limited, each test line of the area, and it shows that the value of each test lines is low. However, the values of the CD line and the EF line are slightly higher than the overall site. Figure 6.3.3-12(a) shows the 3D rendering of the Sv value of the whole test line. The Sv value distribution of the Sv value on the test line is processed by the Natural Neighbor interpolation method as shown in Figure 6.3.3-12(b). The Sv value at the EF line and the D point is slightly higher, but the overall site Sv value is lower.

Figure 6.3.3-13 shows the Sv original trace of each test line at 120 kHz, it also shows the noise interference caused by the wind and waves, in order to obtain enough individual standard objects, the conditions of the screening for the individual targets will be more lenient. The relevant information for obtaining the TS value of each test tine is shown in Table 3. The number of TS values detected in each test lines is found to be more towards the east of the site. Besides the part of the average TS value is not detected by the GH line and the IJ line, again the EF line shows a slightly higher phenomenon. Figure 6.3.3-14(a) shows the 3D representation of the TS values for each 120 kHz test lines. Whereas the average TS value distribution of every 500 meters on the test line is shown in Figure 6.3.3-14(b). It can be seen that most of the TS values are distributed in the eastern half of the site. In addition to the large value that appears near the D point, the overall TS value segment appears to be low.

The test of 120 kHz obtained 101 individual standard objects, as for the frequency distribution of TS; it is shown in Figure 6.3.3-15. Half of the values are concentrated between -46dB and -49dB, with a maximum of -38.37dB, a minimum of -49.98dB, and an average of -47.62dB. The standard deviation is 2.22dB, and the 95% confidence interval is -45.4dB to -49.84dB. Due to poor sea conditions, this ship is shaking more vigorously and the number of individual targets taken is limited. It is difficult to further analyze the individual fish track. Therefore, the standard body length is 101 TS individual fish values. Empirical calculations of TS and body length through Love (1971)(Figure 6.3.3-14), body length is distributed at 5 to 21 cm, average body length is 7.34cm, its distribution is 91.09% below 5 to 10 cm, 5.94% from 10 to 15 cm and 2.97% above 15 cm. 95% confidence interval is 4.67 cm to 10.03 cm. The relationship between the size of the fish and the distribution of water depth is shown in Figure 6.3.3-17, the fish inhabit the depth of the seabed between 33 and 37 meters. In general, most of the fish inhabit deeper sea layers (R=0.23, N=101), if distinguish between large, medium and small fish, large fish (>15 cm) mostly inhabit at the bottom of the sea, mainly inhabit the seabed at 35 meters (N=3); most medium-sized fish (10-15 cm) inhabit the deeper layer of the seabed, inhabit at depth of seabed at 34 to 37 meters (R = 0.43, N = 6); the inhabited depth distribution of small-sized fish (<10 cm) is broader, they inhabit in the depth of seabed at 32 to 38 meters (R=0.23, N=29).

Table 6.3.3-3 Evaluation results of 120kHz transverse course

Transects	Sv mean (dB)	NASC (m2/n.mi.2)	Number of TS	TS mean (dB)	Maximum TS (dB)	Minimum TS (dB)
AB	-89.932	4.083	38	-48.682	-46.291	-49.978
CD	-90.013	8.119	42	-47.021	-38.365	-49.983
EF	-89.455	9.056	21	-46.88	-44.056	-49.896
GH	-91.013	1.771	0	N/A	N/A	N/A
IJ	-90.922	2.209	0	N/A	N/A	N/A

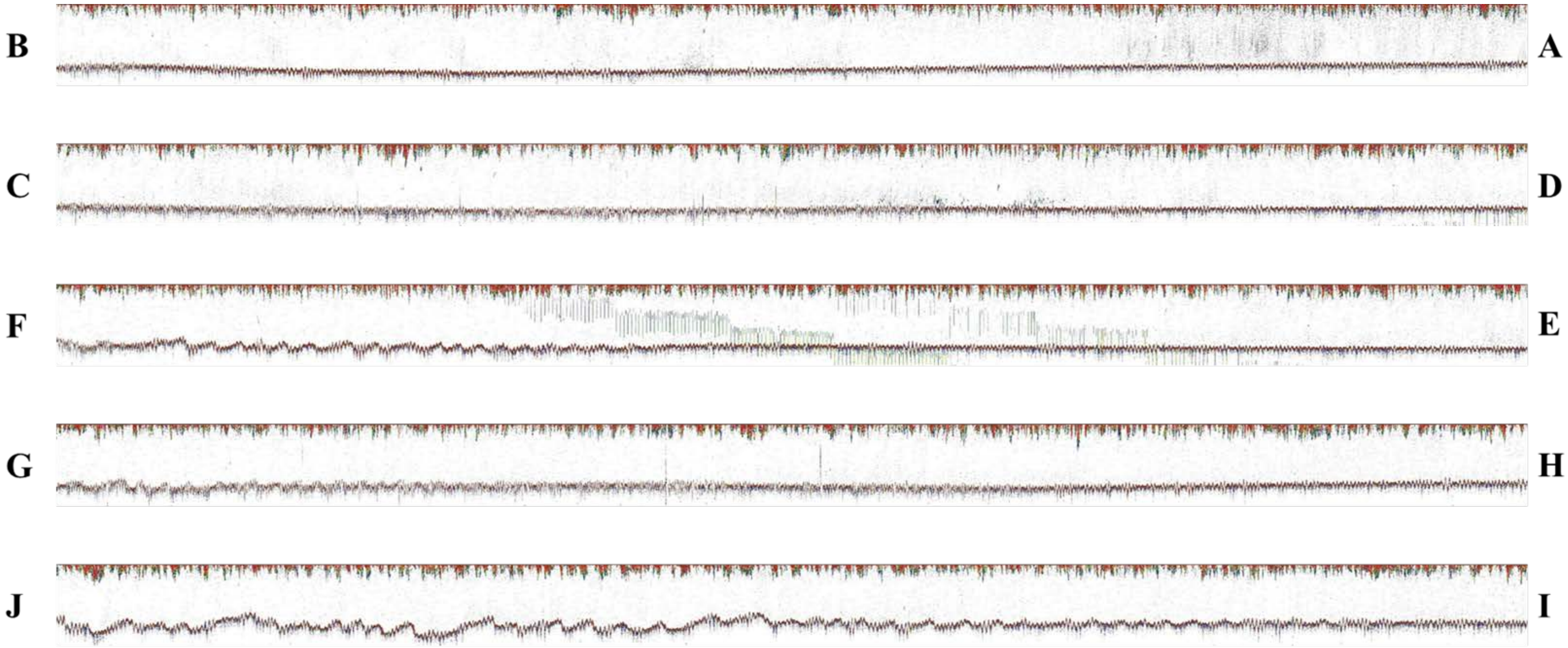
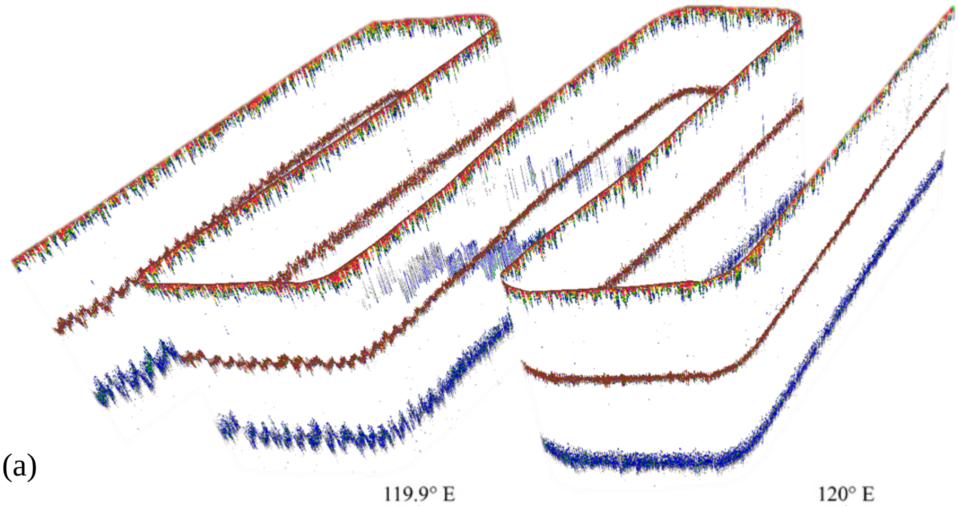
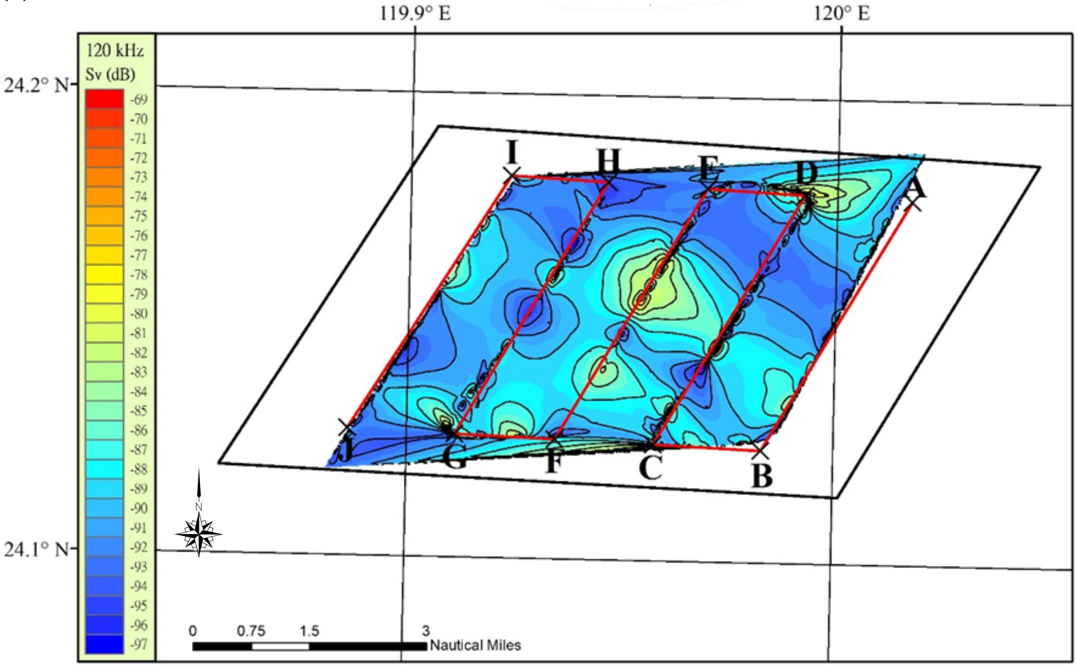


Figure 6.3.3-11 Sv transverse plot on 120kHz detection path



(a)



(b)

Figure 6.3.3-12 Sv original trace diagram (a) and Sv distribution diagram (b) of 120kHz detection path

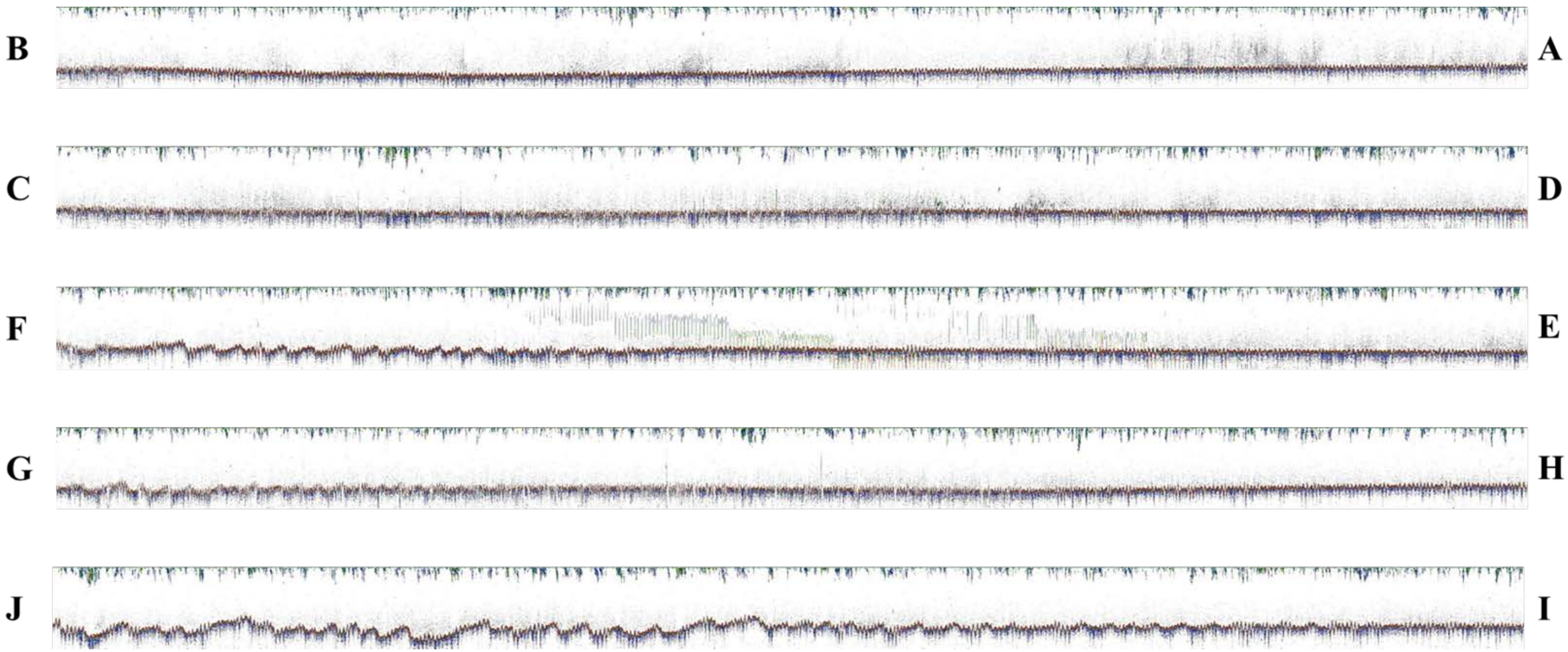


Figure 6.3.3-13 transverse plot of TS on the 120kHz detection path

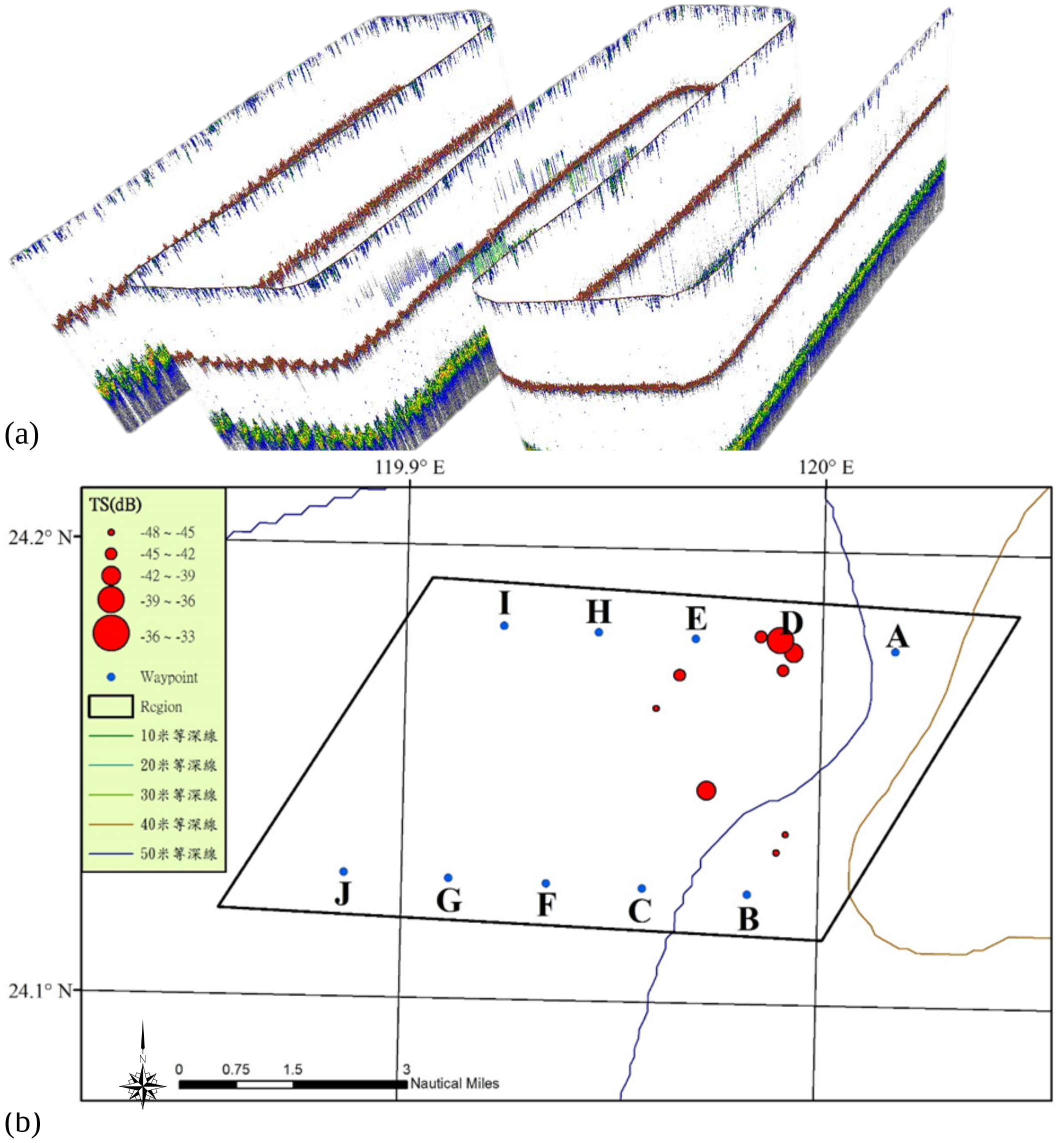


Figure 6.3.3-14 original Ts trace (a) and Ts distribution (b) on the 120kHz detection path

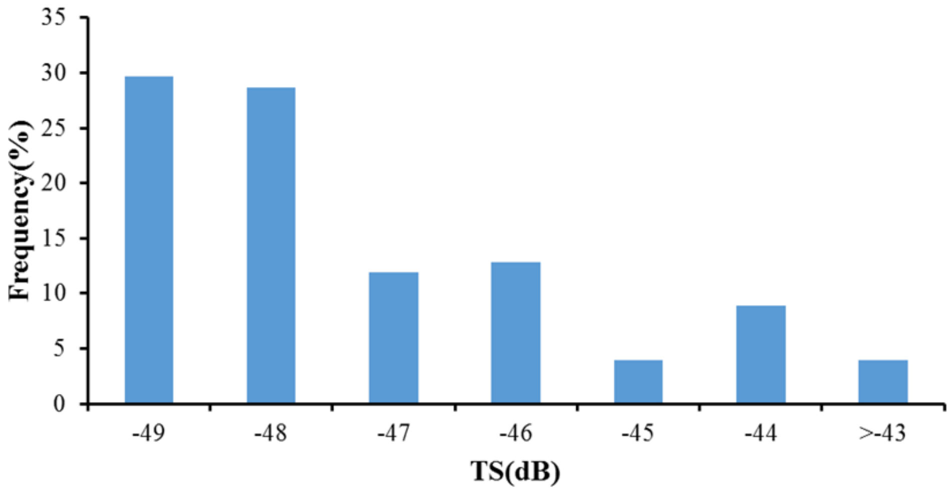


Figure 6.3.3-15 Reflection intensity (TS) frequency distribution of monomer standard appearing on the 120kHz detection path

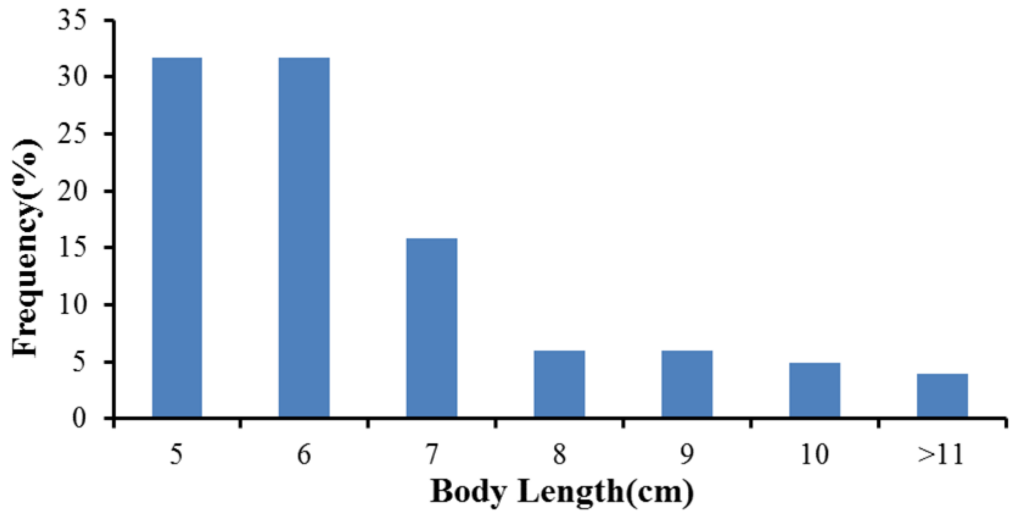


Figure 6.3.3-16 Body length frequency distribution of fish after conversion of 120kHz TS value (Love, 1971)

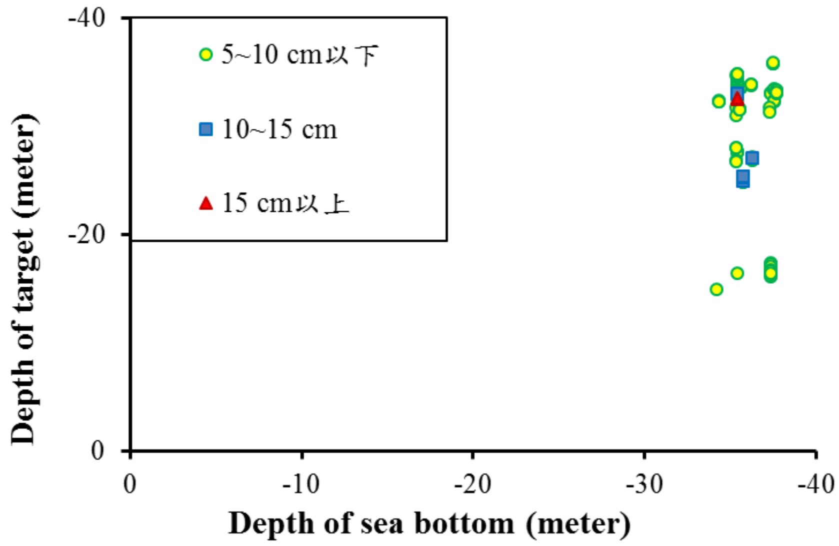


Figure 6.3.3-17 Body depth and distribution depth of fish in 120kHz detection path (n=101)

Summary

The sea condition during the probe process this time is adverse. The acoustic probe data show the biomass to be extremely low. In the aspect of variations of various test lines, the biomass at east side of the site if compared with the entire site is a little higher. Besides, fish number also tends to be higher at the east side. If fish under 5cm is not calculated, fish size fewer than 10cm accounts for the majority, about 84-91% of the total. Fish size of 10-15cm accounts for 5-13% of the total, and above 15cm accounts for 2-3% of the total. As for the fish size in relation to depth, the probe shows the tendency of fish in changing dwelling depth in accompany with water depth is not obvious. Regardless of size, fish generally live at a depth of 30 meters to 40 meters.

Marine Bird Ecology

In this project, the marine and coastal bird surveys were carried out respectively, and the relevant methods and results at this stage are described as follows. The following bird surveys are conducted in accordance with the "Technical Specifications for Animal Ecology" issued by the Environmental Protection Agency of the Executive Yuan (Announcement Huan-shu-zong No. 1000058655C of the Environmental Protection Agency of the Executive Yuan, 2011.7.12).

Survey Methods

Marine Bird Survey

This project is based on the potential wind farm location announced by the Energy Bureau of the Ministry of Economic Affairs of the Republic of China on July 2, 2015. The location of No. 15 wind farm was selected as the evaluation scope according to the potential wind farm location announced by the key points of offshore wind power generation planning site application operation announcement No. 10404015571. The first investigation was the location of No. 21 wind farm, which was originally selected, and then changed to No. 15 wind farm due to channel problems. The survey of birds at sea was carried out by the Buckland et al. 1993 method. The scope of investigation includes the location of potential wind farms No. 21 and No. 15 together with the buffer zone of 1 km around it. Within this scope, a Z-shaped crossing line is set up. Vessels are used to travel along the crossing line at the same speed and birds along the crossing line are recorded (Fig. 6.3.4-1(a), Fig. 6.3.4-1(b)). Each vessel has at least two investigators, equipped with GPS, binocular telescopes with laser ranging function and single-lens digital cameras with telescopes over 400 mm. Investigators also observed in different directions, such as when birds were found to be active, recording the species, number, flight direction and altitude of birds, and using GPS to calibrate the location of birds. Because seabirds are usually far away and flying fast, it is not easy to identify species at sea in real time, so as far as possible we take photographs of all the birds with long lenses for further bird species identification.

The frequency of the survey is monthly in the transit period of spring (March-May) and autumn (September-November), and quarterly in summer (June-August) and winter (December-February), with a total of eight surveys in the whole year. The investigation date is mainly determined by weather and walrus, and the principle is that the wind, wave and visibility do not affect the investigator's observation.

Survey of Coastal Bird

The investigation of coastal birds was conducted in the potential affected area of No. 15 wind farm, i.e. the coastal zone from the south coast of Dadu Creek Estuary to Lugang District of Changbin Industrial Zone, using the Sutherland 1996 method. Waterbirds usually disperse in the mudflats of the intertidal zone to forage at ebb tide, which is not easy to observe; while at high tide, waterbirds will find suitable environment to rest near shore, and mostly gather in groups, which makes it easier to record their numbers. After the preliminary survey, the crossing lines near the main habitats of waterfowl (Fig. 6.3.4-2) were set up within the survey area. Bird facies along the crossing lines were recorded with 8-fold double-barrel or 30-fold single-barrel telescopes. The subjects included waterfowl and conservation birds. In addition to identifying species and calculating numbers, the behavior of birds and their habitats were recorded.

The frequency of the survey is monthly in the transit period of spring (March-May) and autumn (September-November), and quarterly in summer (June-August) and winter (December-February), with a total of eight surveys in the whole year. The survey date must be in line with the tide time, and be limited to a few days around the first or fifteenth day of the lunar calendar, and choose sunny weather as far as possible. The investigation time must be within three hours before and after full tide to ensure that the intertidal zone of the outer beaches is completely submerged and the waterfowls are gathered in temporary habitats at full tide so that the population can be reliably estimated.

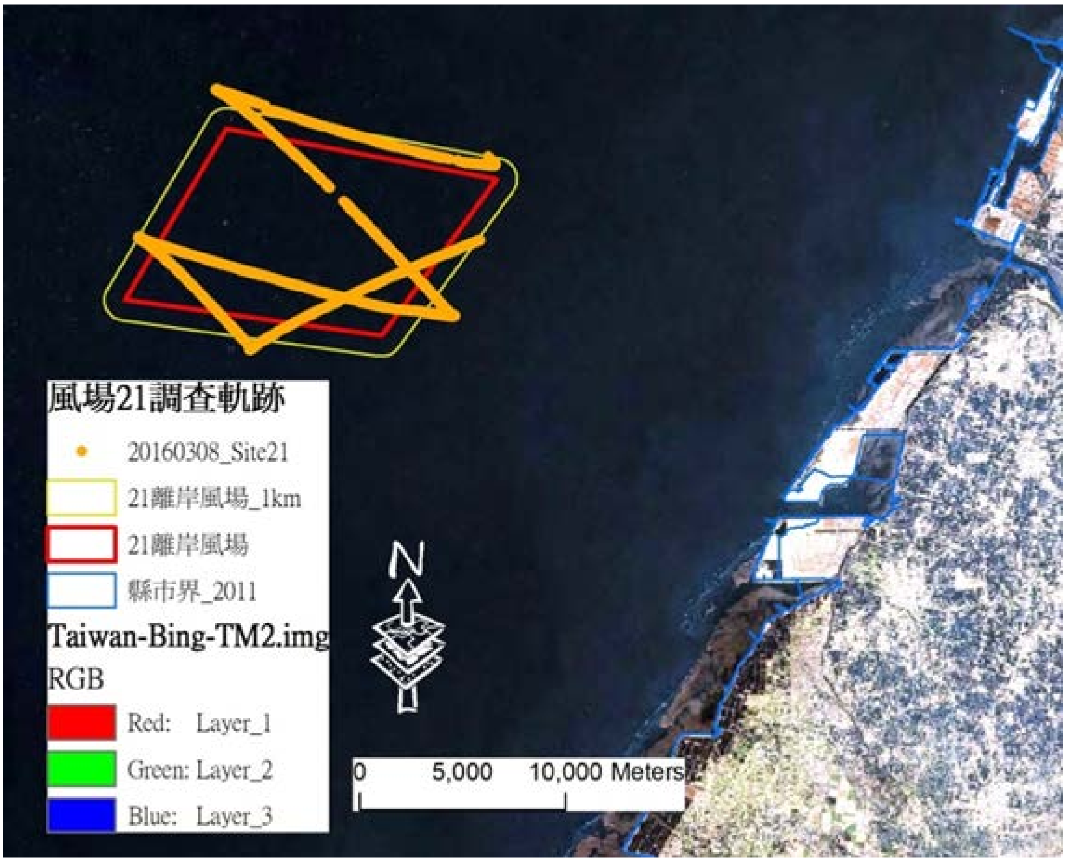


Figure 6.3.4-1(a) Transect Line Survey of Marine Bird at No.21 Wind Farm

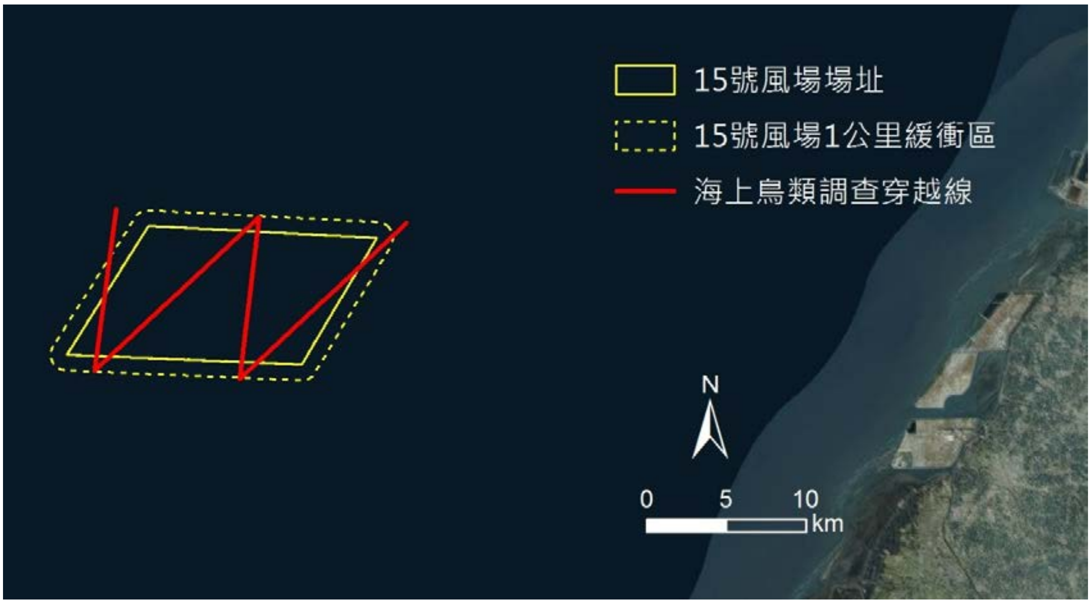


Figure 6.3.4-1(b) Transect Line Survey of Marine Bird at No.15 Wind Farm

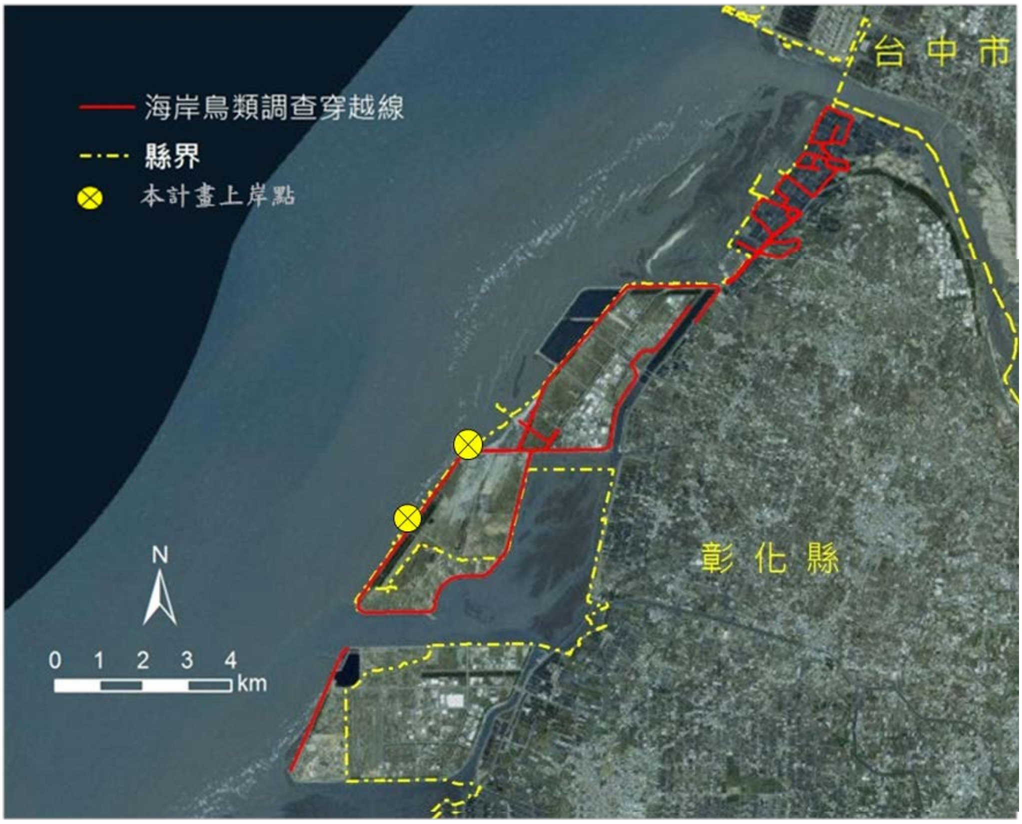


Figure 6.3.4-2 Transect Line Survey at Coastal Area of No.15 Wind Farm

Raptor Migratory Survey

Three weather radars (Kenting, 120 degrees east longitude 51 seconds, north latitude 21 degrees 54 seconds, 42 meters above sea level), Qigu (east longitude 6 minutes 91 seconds, north latitude 14 minutes 77 seconds, 38 meters above sea level), Hualien (121 degrees east longitude 37 minutes, 23 degrees north latitude 59 minutes, 63 meters above sea level) and Air Force Meteorological Unit Qingquanggang (120 degrees east longitude 63 minutes, 24 degrees north latitude 25 minutes, 203 meters above sea level), Magong Meteorological Radar (119 degrees east longitude 63 minutes, north latitude 23 degrees 56 minutes and 48 meters above sea level. The Central Meteorological Bureau uses S-band (10 cm wavelength) Doppler weather radar (horizontal emittance), while the Qingquangang and Magong stations use C-band (5 cm wavelength) dual polarized Doppler weather (horizontal and vertical emittance). The two radars rotate and scan every 8-10 minutes at 8-9 elevation angles (0°~20°). The resolution of the images is between 1°×1°×100 m. In order to increase the observation distance, the lowest elevation angle (0° or 0.5°) and the scanning radius of 100 km are used.

In view of the Changhua wind farm, Magong and Qigu station radars are used. Because Magong and Qigu are about 50 km and 80 km away from the southern end of the wind farm, the radar wave has usually been scanned in the air 500-2,000 m above the sea level, and the height exceeds the impact range of the fan blades (175-200 m). Therefore, this report estimates whether the flight path of the bird flock will pass through the wind farm, and then observes the lower edge of the actual flight altitude when the bird flock passes through the vicinity of the radar station, as a judgment of the flying altitude of the bird flock over the wind farm, provided that the flying altitude and direction of the bird flock remain unchanged during the observation period.

Moreover, although the Magong radar is close to the wind farm, it may use a shorter radar wavelength (5 cm), so the radar waves emitted are more vulnerable to the blockade of water droplets or salt particles in the air, resulting in a detection force 50 kilometers away from the use of long wavelength (10 cm) of the Qigu radar. In view of this, this report mainly relies on the observation results of Qigu radar for analysis.

According to the long-term ground observation data of the Taiwan Raptor Research Association (http://raptor.org.tw/), it can be roughly determined that the birds going south in September are Accipiter soloensis, while the Butastur indicus and their accompanying Accipiter soloensis (5000-10,000) flying south in October, and the Butastur indicus returning North in March-early April, while the Accipiter soloensis do so in mid-late April-early May. In fact, along with these two most common raptors, there are more than 10 species of transit raptors. Because of the scattered number and the indistinguishable species by radar, they are included in one of the two common Eagle groups. After all, all Raptors belong to the conservation category.

This project uses Rainbow 5 software's "vertical cut" function to look sideways at bird flight altitude profile to calculate bird flight altitude. As regards quantity estimation, the relationship between the radar echo (dBZ) and the number of Accipiter soloensis (1.84 dBZ+108) is obtained by using the formula of Sun et al. (2010). As for the Butastur indicus, the current ground record month is October, in which the red-bellied eagle accompanies the flight. Therefore, this report converts the weight ratio (550 g:150 g) to the surface area ratio (2.22:1), calculates the echo volume (dBZ) and the gray-faced eagle from the ground observation number (37,242 gray-faced eagles, 8,689 red-bellied eagles) at Sheding in October 2016 and the ground visible distance (5 km) on both sides of Kenting radar station and work out the relationship between echo volume dBZ and the number of Butastur indicus (1 dBZ≒1.03).

Nocturnal Bird Radar Survey

The solid-state pulse compression Doppler radar scans the flight status of birds at sea. The FURUNO DRS4D Doppler radar is loaded on the research vessel. The actual flight path of birds is recorded by a notebook computer through two different sets of radar with horizontal and vertical settings.

Radar records are scanned in a 12 km scanning range. Through the radar screen and the returns of the observers, the bird spots on the radar screen are moved synchronously, the flight trajectories of the birds are marked and recorded, and the radar scanning trajectories are recorded by a notebook computer.

Wind farms No. 12-15 carried out eight night radar surveys of birds in the sea area, and each wind farm carried out two surveys respectively. The time for each sub-farm survey is as follows: Wind farm No. 12 was conducted on August 28-29, October 02-03, No. 13 on August 24-25, September 24-25, 14 on August 25-26, September 25-26, No. 15 on the night of August 26-27 and September 26-27, 2017. Detailed survey schedules are as follows: 6.3.4-1.

Table 6.3.4-1 Survey Summary of All Wind Farms

Number of Wind Farm	Survey Date	Survey Time
12	2017/08/28-29	18:26-06:34
	2017/10/02-03	17:41-06:10
13	2017/08/24-25	18:20-07:20
	2017/09/24-25	18:49-07:12
14	2017/08/25-26	17:45-07:55
	2017/09/25-26	17:30-06:17
15	2017/08/26-27	17:30-06:00
	2017/09/26-27	17:49-06:15

Survey Results

Marine Bird Survey

The execution of the first-time survey of No. 21 wind farm was started from March 2016, to engage in 4 times of spring sea bird survey, dated separately as March 8, 18, 23-24 and 29. The sea survey photos are shown in Fig. 6.3.4-3.

In the sea bird survey of No. 21 wind farm, the record shows passeriform land bird barn swallow (65 times), streaked shearwater (17 times), and are in spring migration (Table 6.3.4-2).

The survey of marine birds at sea is conducted around the range of No. 15 potential wind farm plus 1 km buffer zone of the surrounding area. The survey investigates whether birds may be affected by the offshore wind force. Eight surveys have been conducted in April and May (spring), July (summer), September, October, November (autumn), December (winter) and March (spring), 2017. In the course of vessel survey, there are investigators in all directions who continuously monitor the sea and the sky, and record the bird's state with a locator and a range telescope. Except for the relatively close bodies, it is difficult to interpret species in marine avian survey. Except for the species with distinct characteristics, other species can only be represented by groups such as seagull and Charadriiformes.

Ninety-four and 212 bird activities at sea (Fig. 6.3.4-3) were recorded in eight surveys, including at least 6 orders and 10 families. The species included burrowing birds, large-water mockingbirds, white-bellied bonito, yellow-headed heron, middle skua, S. anaethetus, pink tern, tern, crested tern, red-collared foot snipe, wild pigeon, domestic tern and Arctic warbler (Table 6.3.4-3). Among them, Passeriformes were the most abundant at 110 bird/times (51.9%) and mainly occurred in the transit period of spring (March and April). The most abundant species were Charadriiformes (30.2%). The Charadriiformes mainly appeared in spring, and the terns in spring and summer were the most active species. The next was the Procellariiformes (12.3%) which were recorded in all seasons except winter. They were birds that used to forage in this area regularly. The largest number of birds was recorded in April, with 77 bird/times, followed by March, with 74 bird/times.

Figure 6.3.4-3 Distribution of Offshore Birds

Figure 6.3.4-4 Dsitribution of Offshore Protected Birds

The most abundant species were terrestrial domestic terns (51.4%) and the other species with more than 5% of the total number of terns including (13.7%), water shavers (8.5%) and red-collared Snipes (8.0%). In terms of conservation bird species, there are three rare conservation species: S. anaethetus, crested tern and pink tern. Their occurrence locations are shown in Figure 6.3.4-3. S. anaethetus were recorded 29 bird/times, mainly in spring and summer; crested terns were recorded 2 bird/times and pink terns were recorded 1 bird/time, all of which appeared in spring.

In terms of flight altitude, 212 flights were recorded below 40 m (Table 6.3.4-4, Figure 6.3.4-5). Among them, the flying altitudes of Procellariiformes and Charadriiformes were all below 10 m; the flying altitudes of Passeriformes were mostly below 15 m, but the flying altitudes of one domestic tern were about 40 m; the flying altitudes of terns were higher, most of which were between 10 and 20 m.

Table 6.3.4-2 Bird Survey Results of No.21 Wind Farm at March of 2016

Species	Number
Small-Sized Scolopacidae	2
Unknown Shearwater	17
Red-necked Phalarope	4
Barn Swallow	65
Scolopacidae	1
Total	89

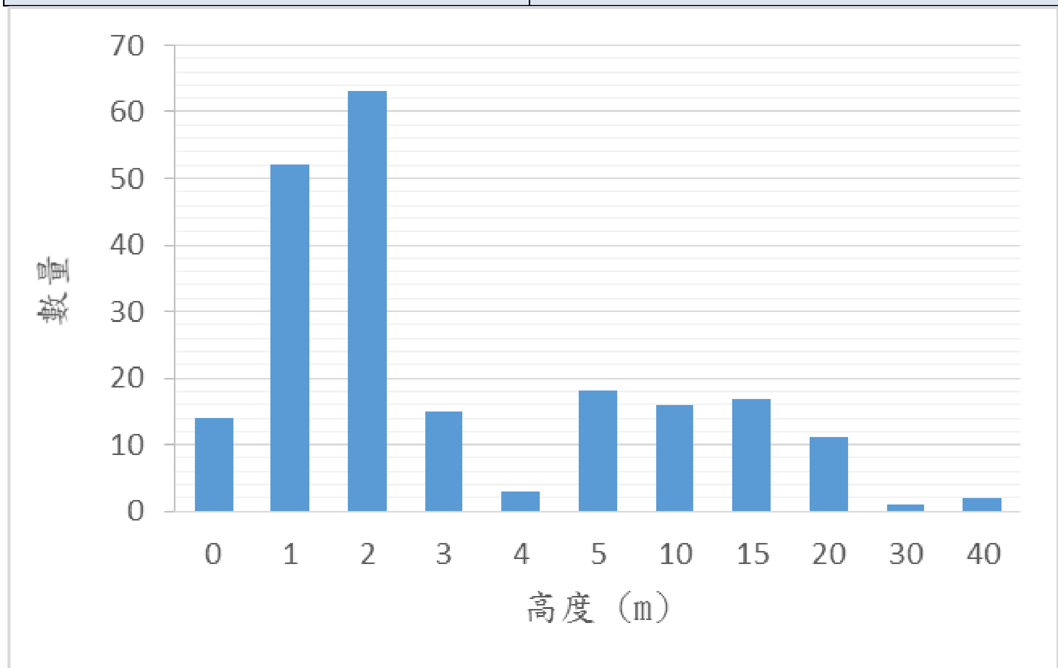


Figure 6.3.4-5 Statistics of Offshore Bird Flying Altitude

Table 6.3.4-3 Monthly Number of Offshore Birds

Species	Scientific Name	Mar.	Apr.	May	Jul.	Sep.	Oct.	Nov.	Dec.	Total	Percentage
鸌形目											
穴鳥	Bulweria bulwerii				2					2	0.9%
大水薙鳥	Calonectris leucomelas	4	4	3	3		4			18	8.5%
未知鸌科	Procellariidae spp.			2	1					3	1.4%
未知海燕科	Hydrobatidae spp.				1					1	0.5%
未知鸌形目	Procellariiformes spp.					1	1			2	0.9%
Total		4	4	5	7	1	5			26	12.3%
鰹鳥目											
白腹鰹鳥	Sula leucogaster			1						1	0.5%
Total				1						1	0.5%
鵜形目											
黃頭鷺	Bubulcus ibis		7							7	3.3%
Total			7							7	3.3%
鴴形目											
中賊鷗	Stercorarius pomarinus			1						1	0.5%
白眉燕鷗	Onychoprion anaethetus		8	5	15	1				29	13.7%
粉紅燕鷗	Sterna dougallii			1						1	0.5%
燕鷗	Sterna hirundo					2				2	0.9%
鳳頭燕鷗	Thalasseus bergii		2							2	0.9%
未知燕鷗	Sterninae spp.		1		2					3	1.4%
紅領瓣足鷸	Phalaropus lobatus		17							17	8.0%
未知鷸鴴類	Unknown shorebirds		7			2				9	4.2%
Total			35	7	17	5				64	30.2%
鴿形目											
野鴿	Columba livia	2		1				1		4	1.9%
Total		2		1				1		4	1.9%
雀形目											
家燕	Hirundo rustica	68	30		9	2				109	51.4%
極北柳鶯	Phylloscopus borealis		1							1	0.5%
Total		68	31		9	2				110	51.9%
Total		74	77	14	33	8	5	1		212	100.0%

Table 6.3.4-4 Flying Altitude of Birds in Survey

Species	Scientific Name	飛行高度 (m)											Total	Percentage
		0	1	2	3	4	5	10	15	20	30	40		
鸌形目														
穴鳥	*Bulweria bulwerii*		2										2	0.9%
大水薙鳥	*Calonectris leucomelas*		14	3				1					18	8.5%
未知鸌科	Procellariidae spp.		3										3	1.4%
未知海燕科	Hydrobatidae spp.		1										1	0.5%
未知鸌形目	Procellariiformes spp.		2										2	0.9%
Total			22	3				1					26	12.3%
鰹鳥目														
白腹鰹鳥	*Sula leucogaster*	1											1	0.5%
Total		1											1	0.5%
鵜形目														
黃頭鷺	*Bubulcus ibis*								7				7	3.3%
Total									7				7	3.3%
鴴形目														
中賊鷗	*Stercorarius pomarinus*									1			1	0.5%
白眉燕鷗	*Onychoprion anaethetus*		5	2		2		9	2	9			29	13.7%
粉紅燕鷗	*Sterna dougallii*							1					1	0.5%
燕鷗	*Sterna hirundo*								2				2	0.9%
鳳頭燕鷗	*Thalasseus bergii*										1	1	2	0.9%
未知燕鷗	Sterninae spp.						2			1			3	1.4%
紅領瓣足鷸	*Phalaropus lobatus*	13		4									17	8.0%
未知鷸鴴類	Unknown shorebirds		7	2									9	4.2%
Total		13	12	8		2	2	10	4	11	1	1	64	30.2%
鴿形目														
野鴿	*Columba livia*				2	1	1						4	1.9%
Total					2	1	1						4	1.9%
雀形目														
家燕	*Hirundo rustica*		17	52	13		15	5	6			1	109	51.4%
極北柳鶯	*Phylloscopus borealis*		1										1	0.5%
Total			18	52	13		15	5	6			1	110	51.9%
Total		14	52	63	15	3	18	16	17	11	1	2	212	100.0%
Percentage		6.6%	24.5%	29.7%	7.1%	1.4%	8.5%	7.5%	8.0%	5.2%	0.5%	0.9%	100.0%	

Coastal Bird Survey

Seashore bird surveys are conducted in the potential affected areas of the No. 15 wind farm, including the coastal zone from the south coast of Daduixi estuary to the Lunwei area of Changbin Industrial Zone. So far, eight surveys have been completed in four seasons, respectively conducted in March, April, May (spring), July (summer), September, October, November (autumn) and December (winter) of 2016.

Eight surveys recorded 24,359 bird/times of 40 species, 13 families and 8 orders (Appendix 2). The spatial distribution was shown in Fig. 6.3.4-6. Within the scope of investigation, the main foraging area for waterfowl was the mudflats on the south bank of Dadu Creek Estuary, followed by the west waterway beaches between the west section of Changbin Industrial Zone and Lugang District. Waterbirds foraging on the south bank of Datui Creek Estuary mainly fly to the fishpond area of the south bank of Dadu Creek Estuary for temporary shelter at full tide, while those foraging on the west channel beach mainly fly to the south at full tide (beyond the scope of temporary shelter investigation).

According to the migration attributes of birds, there are 21 species of winter migrants, 8 species of resident birds, 8 species of transit birds, 2 species of summer migrants and 1 species of exotic birds. The number of winter migrants is the highest (73.1%), followed by resident birds (14.7%), transit birds (10.7%), exotic species (0.9%) and the least number of summer migrants (0.6%).

In terms of population composition, the monthly data statistics show that the six dominant species, i.e. Oriental ring-necked twin (38.3%), small egret (13.4%), red-breasted shorebird (9.8%), yellow-footed snipe (6.6%), big egret (5.8%) and black-bellied shorebird (5.4%) were found to be dominant birds with cumulative proportion of ≧5%. Only one rare species was recorded, including black-winged owl, osprey, cockatoo duck and hemp heron.

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There are no endemic species of coastal birds in this area. The exotic species is only one species of Egyptian T. Aethiopicus, which has been recorded 180 bird/times in each season. Most of them forage on the outer beaches of Dadu Creek estuary, and also in the fishpond area on the south bank of Dadu Creek estuary and the coast of the Xianxi District of Zhangbin Industrial Zone.

Figure 6.3.4-6 Distribution of Coastal Birds

Figure 6.3.4-7 Distribution of Protected Coastal Birds

Raptor Migratory Survey

Professor Sun Yuanxun of Pingtung University of Science and Technology was entrusted with the investigation of Raptor transit. Refer to Appendix 4 for details of the report. In this survey, meteorological radar data of two common daily Raptors (Butastur indicus and Accipiter soloensis) were analyzed. Migration routes and altitudes were observed by Qigu and Magong meteorological radars, which were close to the wind farm in offshore Changhua, in order to assess possible risks. For the migration routes of conservation terns and Platalea minors, ground data are needed to assist interpretation because radar observations have not been conducted in the past. Therefore, the tracking results of other domestic teams using satellite transmitters (no migration altitude information) are cited. The relevant results are summarized as follows:

Chinese Goshawk

Qigu and Magong radar observations showed that in 2015, September 2016, and April 11~30, 2017 that, except for the Accipiter soloensis which did not pass over the wind farm, they passed in the other two years and three seasons (Fig. 6.3.4-8-10). Taking April 2016 as an example, there were two groups of 1,927 birds passing over the wind farm and the lower edge of their flight altitude. It was estimated that 38 of them were lower than the sweeping height (< 260 m) of the fan blades, accounting for 0.02% of the total number (233,460) in September of that year. In September 2016, a group of Accipiter soloensis passed over the wind farm, flying at altitudes ranging from 426 to 760 m, higher than the sweeping range of fan blades. In April 2017, there were 3 groups of 2,686 passing through the wind farm, of which 32 flying altitudes were estimated to enter the sweeping range of the fan blades, accounting for 0.028% of the total number (11,3971) in the current season (Table 6.3.4-4).

Table 6.3.4-4 Data of Chinese Goshawk Passing Through Wind Farm By Qigu and Magong Radar. Lower Edge of Fying Height Below 260 Represents Risk of Collision

Date	Radar Station	Time	Estimated Number	Estimated Risk Number	Flying Speed (km/h)	Lower Edge of Flying Height (m)	Upper Edge of Flying Height (m)
20160415	Qigu	11:27	976	0	66.0	259.3	1092.7
20160416	Qigu	08:42	951	38	74.4	166.7	1074.2
20160917	Magong	09:30	248	0	37.8	426.0	759.3
20170419	Qigu	09:39	1512	0	72.0	463.0	1296.4
20170419	Qigu	11:01	264	0	60.6	1074.2	1537.2
20170419	Qigu	12:46	810	32	62.4	240.8	240.8

Gray-faced Buzzard

According to the ground observations of the Raptor Society of Taiwan from 2015 to October 2016, the main birds are Butastur indicus (30,000 to 40,000) migrating southward and accompanying 5 to 8,000 Accipiter soloensis. The first one to arrive northward in March of the following year is the Butastur indicus, which lasts until April 10.

Radar observations show that the eagles pass through the wind farm in all three seasons in the past two years except October 2016 (Fig. 6.3.4-11-15). For example, from March to April 10, 2016, about 2,630 eagles were estimated to fly at altitudes ranging from 296 m to 1,796 m, exceeding the blade sweep height. About 3,371 Eagles passed through the wind farm in October, flying at altitudes ranging from 463 to 2,241 m, exceeding the blade sweep range. From March to April 10, 2017, about 3,717 Eagles passed through the wind farm, flying at altitudes ranging from 167 to 1,612 m. Among them, 156 Butastur indicus entered the blade sweep range, accounting for 0.2% of the estimated total number of migrations (79,019) by radar in the current season (Table 6.3.4-5).

Table 6.3.4-5 Monthly Number of Offshore of Bird

Date	Radar Station	Time	Estimated Number	Estimated Risk Number	Flying Speed (km/h)	Lower Edge of Flying Height (m)	Upper Edge of Flying Height (m)
20160315	Qigu	09:30	337	0	52.6	1129.7	1796.4
20160318	Qigu	12:57	2293	0	67.2	296.3	740.8
20161026	Qigu	10:54	674	0	42.1	537.1	1055.6
20161026	Qigu	13:39	809	0	45.6	574.1	1037.1
20161026	Qigu	13:39	67	0	49.0	1000.1	1463.1
20161026	Qigu	17:01	337	0	52.6	1129.7	1796.4
20161026	Qigu	17:01	135	0	48.6	1426.0	2240.9
20161027	Qigu	10:31	1349	0	53.4	463.0	629.7
20170319	Qigu	08:31	94	5	38.4	166.7	1611.2
20170318	Qigu	10:31	135	0	34.8	296.3	1537.2
20170320	Qigu	08:23	378	18	56.4	240.8	907.5
20170321	Qigu	08:23	337	0	36.6	407.4	907.5
20170321	Qigu	08:23	135	7	47.4	240.8	463.0
20170408	Qigu	11:24	1079	54	69.0	259.3	537.1
20170409	Qigu	08:00~15:30	1559	72	59.4	240.8	1240.8

Conservation terns

Taiwan's conservation terns include the Class 1 Thalasseus bernsteini and the Class 2 T. bergii, Anous stolidus, and the Sterna sumatrana, S. albifrons, S. anaethetus, and S. dougallii, a total of 7 species. According to a study by Professor Yuan Xiaowei from the Department of Forests of National Taiwan University, 24 Class 2 conservation T. bergii (Fig. 6.3.4-16) breeding in Mazu and Penghu Islands will migrate into the Indochina Peninsula and the Philippines in August and September respectively. Among them, 3/4 of the Mazu T. bergii flew to the Indochina for winter, and on the other hand 3/4 of the Penghu individual was flying to the Philippines for winter, while the Mazu T. bergii migrate to the southeastern coastline of China. The Penghu individual went straight south and did not pass through the wind farm (Figure 6.3.4-17). At present, there are more than 10,000 T. bergii breeding in Mazu and Penghu Islands, and the Thalasseus bernsteini are less than 60, which is extremely rare.

Thousands of terns can be found in the estuaries along the western coast of Taiwan Island during the spring and autumn transit period, with black-bellied terns and white-winged terns being the most common. In addition, hundreds of big crested terns, S. dougallii , Sterna sumatrana, S. anaethetus, thousands of small terns and sporadic Thalasseus bernsteini (Fig. 6.3.4-18) were also found in the coastal wetlands of Chianan (Table 6.3.4-6).In terms of Qigu north dike, the annual observation of Qigu north dike from 2016 to 2017 showed that terns appeared in spring and autumn (August-September, April-June). According to the long-term data on release of terns by the Penghu Bird Association on the uninhabited island, one was recovered in Taiwan (Chou Lizhao, Private Correspondence). Therefore, it is not excluded that the aforementioned tern members in Taiwan come from Penghu or Mazu across the sea (Fig. 6.3.4-19), or from islands to the north of Taiwan. However, the number and migration route, and whether they will pass through the wind farm remains further study in the future.

Table 6.3.4-6 List of Migratory Terns at Qigu Sea Wall

Species[a]	Scientific Name	Estimated Passed Through Number	Remarks
Chinese Crested Tern[I]	*Thalasseus bernsteini*	-	
Greater Crested Tern[II]	*Thalasseus bergii*	<1000	
Caspian Tern	*Hydroprogne caspia*	<500	Rest at sand banl of offshore
Greater Crested Tern	*Gelochelidon nilotica*	>100	
Common Tern	*Sterna hirundo*	>1000	
Roseate Tern[II]	*Sterna dougallii*	<1000	
black-naped tern[II]	*Sterna sumatrana*	<1000	
Bridled Tern[II]	*Sterna anaethetus*	<1000	
Aleutian Tern	*Onychoprion aleuticus*	<1000	
Little Tern[II]	*Sternula albifrons*	>1000	
Whiskered Tern	*Sternula acuticauda*	>10000	
White-winged Tern	*Chlidonias leucopterus*	>10000	
Brown Noddy[II]	*Anous stolidus*	-	Rare
Sooty Tern	*Onychoprion fuscatus*	-	Rare
Sandwich Tern	*Thalasseus sandvicensis*	-	Straggler, Typhoon factor

a I-endangered species，II-rare and valuable species
Data Source：Steve Mulkeen

Black-Faced Spoonbill (Platalea minor)

Platalea minor is a class 1 conservation species. There are 2,029 Platalea minor in Taiwan, accounting for 62% of the global population (3,272). Over the past decade, the population has grown steadily (Wang Ying 2016). Platalea minor may also have transit populations in addition to coming to Taiwan for winter.

From 2012 to 2015, Wang Ying (2016) tracked the migration route of 15 Platalea minor by satellite transmitter, and learned that they flew to Taiwan from the Korean peninsula from October to November, and returned to the breeding ground from March to May of the following year. The start journey happens in both day and night (Figure 6.3.4-20 (a~o)). As far as the migration route is concerned, most of these Platalea minor fly over the Taiwan Strait or the northern waters without going through the wind farm at speeds of 68-76 km. The migration route of a Platalea minor (T60) passes through the wind farm above the sky (Fig. 6.3.4-20(k)) with no flight altitude record. The Platalea minor has similar habits and patterns to the heron family; Lin Yusheng (2007) observed the average flying height of the Heron group by 190.25 m (sd=56.34, n=88) according to observation of the weather radar of Kenting, and the flying height decreased slightly to 160.7 m (sd=45.4, n=11) when the wind was upwind.

Nocturnal Bird Radar Survey

In this project, 2 surveys recorded a total of 111 bird flight activities and 3 flight height records. In the flight direction, a total of 4 (3.6%) flights to the north on sea, 2 (1.8%) flights to the northeast on sea, 37 (33.3%) flights to the sea in the south, and 60 (54.1%) flights to the sea in the southeast, and a total of seven flights (6.3%) to the sea in the southwest and one (0.9%) flight to the sea in the west, but did not record the direction of flight to the southeast and east. The results show that the night bird flight direction in this survey is mainly to the south and southeast. Vertical records were collected only in September, and all three records were above 100 meters, with the lowest record height of 119 meters and a maximum height of 207 meters (Table 6.3.4-7). In terms of time analysis, most bird activity happen at 20-23 hours, and the number of records per hour is more than 15, of which the number of 20-21 hour periods is the highest (25). The number in the rest of the hour period is small, and at 01-03 hours and early morning 05-06 hours shows the lowest quantity recorded in both periods, less than 5 per hour (Figure 6.3.4-21).

A total of 20 bird flight activities were recorded in 4 vertical radar surveys from No.12 to No.15 wind farms (Fig. 6.3.4-22). The flight height was mainly distributed between 25-100 meters (45%), followed by 0~25 meters (30%), and between 100~300 meters (15%), with approximately 60% under 300 meters which is within the range of possible impact hazards. Only 10% is above 300 meters, which shows that the flying height of night birds is 60% with substantial potential impact risk in collision with the wind turbine in the range of 25m~300m (based on the current 20 flying height data), the overall impact risk still needs to consider the avoidance rate and more sufficient survey statistics of various birds. In the future planning stage, a satellite positioning tracking monitoring will be conducted to understand the main bird migration path. Thermal imaging, sonic microphone and radar will be installed during the operation period.

Table 6.3.4-7 Nocturnal Flying Records of No.15 Wind Farm (Scale: 12km)

Code	Observed Date	Observed Time	Observed Bearing	Flying Direction	Code	Observed Date	Observed Time	Observed Bearing	Flying Direction	Code	Observed Date	Observed Time	Observed Bearing	Flying Direction
1	2017/8/26	18:14	NE	S	38	2017/8/26	21:03	W	SE	75	2017/8/27	03:20:46	E	S
2	2017/8/26	18:49	W	S	39	2017/8/26	21:04	E	S	76	2017/8/27	03:24:53	W	S
3	2017/8/26	18:53	NE	S	40	2017/8/26	21:07	W	SE	77	2017/8/27	03:38:37	W	N
4	2017/8/26	19:30	W	S	41	2017/8/26	21:17	NE	SE	78	2017/8/27	04:00:59	NW	S
5	2017/8/26	19:31	W	SE	42	2017/8/26	21:17	NW	SE	79	2017/8/27	04:25:45	E	S
6	2017/8/26	19:41	NW	SE	43	2017/8/26	21:19	SW	S	80	2017/8/27	04:30:20	E	SE
7	2017/8/26	19:53	W	S	44	2017/8/26	21:20	NE	SE	81	2017/8/27	04:34:27	E	S
8	2017/8/26	19:57	W	S	45	2017/8/26	21:23	NE	S	82	2017/8/27	04:37:56	W	SE
9	2017/8/26	19:59	N	SE	46	2017/8/26	21:24	W	SE	83	2017/8/27	04:52:06	N	S
10	2017/8/26	20:04	NE	S	47	2017/8/26	21:24	SW	SE	84	2017/8/27	05:20:12	W	N
11	2017/8/26	20:09	E	S	48	2017/8/26	21:30	SW	SE	85	2017/8/27	05:45:00	W	SE
12	2017/8/26	20:09	NW	S	49	2017/8/26	21:32	SW	SE	86	2017/9/26	18:24:55	SW	N
13	2017/8/26	20:10	W	S	50	2017/8/26	21:32	W	SE	87	2017/9/26	18:29:25	E	S
14	2017/8/26	20:11	W	SE	51	2017/8/26	21:34	E	S	88	2017/9/26	21:46:56	NE	SE
15	2017/8/26	20:13	NW	SW	52	2017/8/26	21:42	NW	SE	89	2017/9/26	22:13:30	NE	SE
16	2017/8/26	20:13	SW	SE	53	2017/8/26	21:42	NE	SE	90	2017/9/26	22:14:09	NE	SE
17	2017/8/26	20:13	NW	SE	54	2017/8/26	21:43	NW	SE	91	2017/9/26	22:16:24	W	SE
18	2017/8/26	20:18	W	SE	55	2017/8/26	21:49	NE	SE	92	2017/9/26	22:39:11	N	S
19	2017/8/26	20:19	NE	SE	56	2017/8/26	21:51	W	SE	93	2017/9/26	22:39:13	N	SE
20	2017/8/26	20:24	W	SE	57	2017/8/26	21:52	SW	SE	94	2017/9/26	22:47:37	W	SE
21	2017/8/26	20:24	W	SE	58	2017/8/26	21:57	SW	SE	95	2017/9/26	22:47:49	SW	SE
22	2017/8/26	20:30	S	SE	59	2017/8/26	22:01	NE	SE	96	2017/9/26	22:57:12	W	SE
23	2017/8/26	20:33	NE	SE	60	2017/8/26	22:08	NW	SE	97	2017/9/26	23:09:54	W	SW
24	2017/8/26	20:33	NE	SE	61	2017/8/26	22:08	N	SE	98	2017/9/26	23:15:20	SE	NE
25	2017/8/26	20:33	W	SE	62	2017/8/26	22:29	NW	SE	99	2017/9/26	23:18:01	E	N
26	2017/8/26	20:34	NW	S	63	2017/8/26	22:34	S	S	100	2017/9/26	23:33:10	NE	S
27	2017/8/26	20:37	NW	SE	64	2017/8/26	22:35	NE	SE	101	2017/9/26	23:34:40	NE	W
28	2017/8/26	20:42	NE	SE	65	2017/8/26	22:41	NE	SE	102	2017/9/27	00:02:05	NE	SW
29	2017/8/26	20:42	W	SE	66	2017/8/26	23:59	W	SE	103	2017/9/27	00:02:31	E	SW
30	2017/8/26	20:45	N	S	67	2017/8/27	00:07	NE	SE	104	2017/9/27	01:05:13	E	SW
31	2017/8/26	20:45	E	S	68	2017/8/27	00:08	W	SE	105	2017/9/27	01:09:47	W	SE
32	2017/8/26	20:51	NE	S	69	2017/8/27	00:12	SE	S	106	2017/9/27	02:07:25	SE	SW
33	2017/8/26	20:51	NE	S	70	2017/8/27	00:39	W	SE	107	2017/9/27	02:48:46	NE	NE
34	2017/8/26	20:52	E	S	71	2017/8/27	00:57	W	SE	108	2017/9/27	02:53:49	W	S
35	2017/8/26	20:53	W	SE	72	2017/8/27	01:03	NE	SE	109	2017/9/27	03:13:56	N	SW
36	2017/8/26	20:56	W	SE	73	2017/8/27	01:43:01	E	S	110	2017/9/27	05:26:16	NW	S
37	2017/8/26	21:03	W	SE	74	2017/8/27	03:18:04	E	S	111	2017/9/27	06:01:48	NW	S

Figure 6.3.4-8 Migratoy Routes of Chinese Goshawk at September 2015

Figure 6.3.4-9 Migratoy Routes of Chinese Goshawk at September 2016

Figure 6.3.4-10 Migratoy Routes of Chinese Goshawk at Second Half of April 2016

Figure 6.3.4-11 Migratoy Routes of Chinese Goshawk at Second Half of April 2017

Figure 6.3.4-12 Migratory Route of Gray-faced Buzzard in October of 2015

Figure 6.3.4-13 Migratory Routes of Gray-faced Buzzard/ Chinese Goshawk in October 2016

Figure 6.3.4-14 Migratory Route of Grey-Faced Buzzard from March of 2016 to April of 2016

Figure 6.3.4-15 Migratory Route of Grey-Faced Buzzard from March of 2017 to April of 2017

Figure 6.3.4-16 Gathering of Greater Crested Tern at Penghu

Figure 6.3.4-17 Migratory Routes of Greater Crested Tern at Matsu and Penghu

Figure 6.3.4-18 Greater Crested Tern Gathering at Tainan Coastal Area in Spring

Figure 6.3.4-19 Common Terns Passing Through Taiwan Coast

Figure 6.3.4-20 Migratory Route of Black-Faced Spoonbill (1/6)

Figure 6.3.4-20 Migratory Route of Black-Faced Spoonbill (2/6)

Figure 6.3.4-20 Migratory Route of Black-Faced Spoonbill (3/6)

Figure 6.3.4-20 Migratory Route of Black-Faced Spoonbill (4/6)

Figure 6.3.4-20 Migratory Route of Black-Faced Spoonbill (5/6)

Figure 6.3.4-20 Migratory Route of Black-Faced Spoonbill (6/6)

Figure 6.3.4-21 Nocturnal Flying Model of No.15 Wind Farm

Figure 6.3.4-22 Nocturnal Flying Model From No.12 to 15 Wind Farm (September Vertical Survey)

Cetacean Survey

Survey Method

The project's cetacean survey commissioned Formosa Natural History Information Co., Ltd. to conduct an investigation. The survey method was based on visual observation, and the fishing boat was hired to conduct a survey through the crossing line. The survey route was designed as a number of Z-shaped crossing lines (Fig. 6.3.5-1). Each survey was selected to take two crossing lines for the observation of whale and dolphins at sea.

The survey was conducted between April 2016 and January 2017 for a total of 20 (day) sea surveys. For each survey there were three to four people carrying out observation, with two of them were on the left and right sides of the vessel, and one was an independent observer. The naked eye and the telescope were used to observe whether there were whales and dolphins on the sea surface. The observers exchanged positions about every 20 minutes to avoid psychological fatigue in observing the same area. After each person rotates three different observation positions (about 1 hour), they will take a break for about 20 minutes to maintain the observer's physical strength. The survey was carried out with a handheld global satellite positioning system and traveled according to the planned route, various environmental factor data (water factors such as water depth, water temperature, salinity and wave level, visibility, etc.) were recorded every 10 minutes.During the survey period, the wave level was less than 5, and the visibility was as far as 500 meters or more. At the same time, the navigation was regarded as an on-effort when designing the crossing line. When a vessel sails between an inbound and outbound port and a route, or if weather conditions are poor, it is difficult to observe effectively, and when observing a group of dolphins, it is considered to be an off-effort and is not included in the analysis of standardized witness rates. The total sailing time is the total time spent from the port of departure to the port of entry, including the amount of on-effort and the amount of off-effort. At sea, the speed of the sailing vessel is maintained at 6-9 knots (nautical miles/hour).

When encountering dolphins, record the location and angle of the dolphins, the distance from the ship, and slowly approach the dolphins as appropriate to estimate its number, observe its behavior, and collect relevant environmental factor data, and fill in the cetacean sighting record. Simultaneous use of a camera or record dolphins images in order to create individual identification photos. If the dolphins do not exhibit significant evasive behavior, continue to follow and record the behavior and location of the group of dolphins. If the tracked dolphin disappears into view and no further sightings are made within 10 minutes of waiting, then return and continue to search for the next group.

Survey Time：2016/4~2017/3 (2016/4/17、5/24、6/9、6/20a、6/20b、6/23a、6/23b、6/26a、6/26b、2016/7/26、8/6、8/18、8/25、9/11、10/25、10/28、11/18、12/21、2017/1/2、1/5、1/29、2/16、3/05)

Survey Scope

Since April 2016, the Z-shaped crossing line (Fig. 6.3.5-1) has been surveyed in the sea area of the scheduled wind farm outside the Changhua Penghu offshore monitoring range between 22 and 55 meters, with an average of 32.9 meters, and sea water temperature is between 27 and 31 degrees, with an average of 29.3 degrees.

Figure 6.3.5-1 Cetacean Survey Route

Figure 6.3.5-1 Cetacean Survey Route (Cont.)

Survey Results

The development of offshore wind turbines is scheduled to be set in the outer seas of Xianxi in Changhua County and the northeastern waters of Penghu. The closest distance is about 35 kilometers from the Changhua coast. This report uses a maritime survey to understand the distribution of cetacean in this sea area as a basis for the cetacean resources in this sea area.

Marine Survey Results

According to the previous plan, 20 sea surveys (Table 6.3.5-1) have been carried out, with a total sailing mileage of 5,419.4 km and an effective sailing mileage of 1,139 km. Among them, the total number of sailing hours is 367 hours, and the effective sailing hours are 74 hours. Tursiops aduncus has been found to record 2 groups of 2 times each (Table 6.3.5-2, Figure 6.3.5-2) with a witness rate of 0.18 groups per 100 km. Among them, Sousa chinensis was not found, and the Tursiops aduncus witnessed was a moving group.

Table 6.3.5-1 Survey Records

Trips	Total Travelled Distance(km)	Time of Survey	Average Speed	有效航程(km)	調查時間	Average 航速
20160417	225	15:14	15	50	03:04	16
20160524	177	12:20	14	49.6	03:36	14
20160609	139	09:03	15	49.8	03:09	16
20160620a	196	12:26	16	41.7	02:42	15
20160620b	196	12:26	16	49.8	02:53	17
20160623a	208	13:43	15	50	03:08	16
20160623b	208	13:43	15	49.7	02:57	17
20160626a	216	13:46	16	49.3	03:09	16
20160626b	216	13:46	16	50	03:00	17
20160726	265	17:34	15	51.6	03:30	15
20160806	275	28:19	10	49.6	03:00	17
20160818	255	16:34	15	49.7	02:52	17
20160825	262	22:47	12	50.0	03:06	16
20160911	296	16:36	15	41.5	02:39	16
20161025	257	27:37	9	60.5	03:39	16.5
20161028	210.5	12	17.6	50.5	03:13	16.2
20161118	239	14:19	17	41.0	02:23	17
20161221	323.2	22:23	15.3	51.7	03:38	14
20170102	295.7	19:33	13.7	48.1	03:00	16
20170105	247	17:22	14	48.1	03:19	14
20170129	295	19:40	15	48.6	03:00	16
20170216	209	14:29	14	60.7	04:04	15
20170305	209	13:18	16	47.9	05:10	12.5
	5419.4	367	14.6	1139	74.2	15.7

Table 6.3.5-2 Results of Cetacean Survey

Date	Class Group	Subdivision	Species	Number
20160417	—	—	—	0
20160524	—	—	—	0
20160609	—	—	—	0
20160620a	—	—	—	0
20160620b	—	—	—	0
20160623a				0
20160623b	—	—	—	0
20160626a	—	—	—	0
20160626b	—	—	—	0
20160726	Mammal	Dolphin	Tursiops truncatus	2
20160806	—	—	—	0
20160818	—	—	—	0
20160825	—	—	—	0
20160911	—	—	—	0
20161025	—	—	—	0
20161028	—	—	—	0
20161118	—	—	—	0
20161221	—	—	—	0
20170102	—	—	—	0
20170105	—	—	—	0
20170129	—	—	—	0
20170216	Mammal	Dolphin	Tursiops truncatus	2
20170305	—	—	—	0

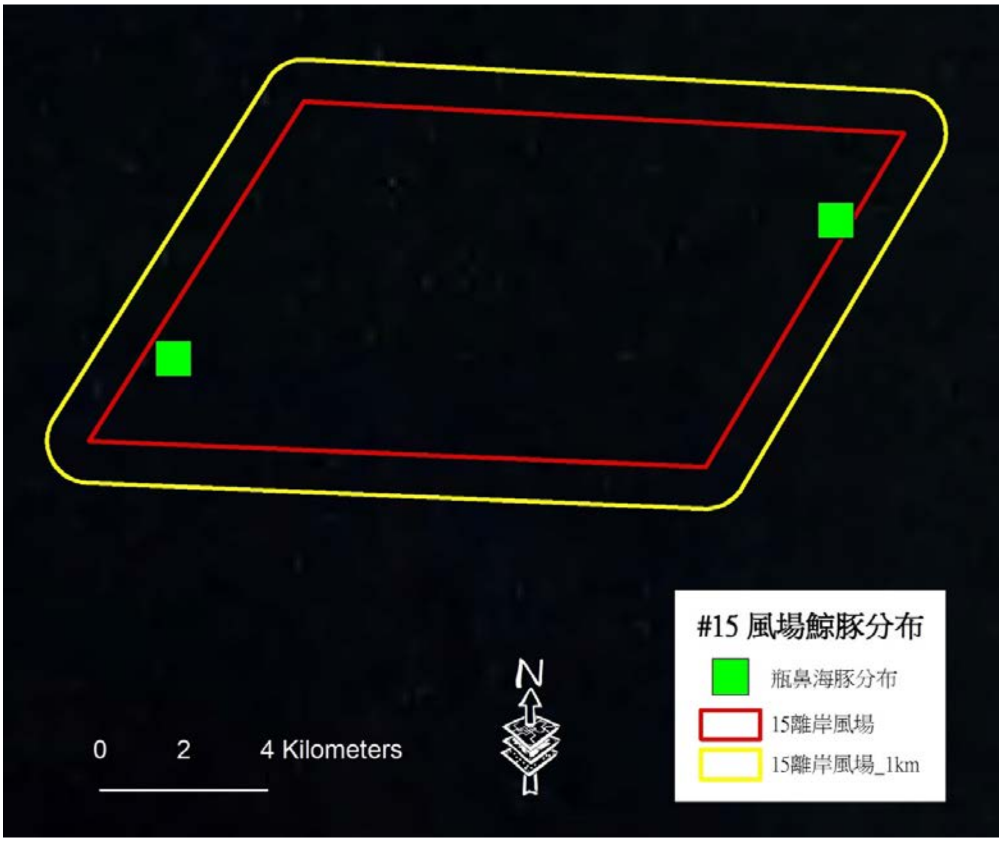


Figure 6.3.5-2 Distribution Plan of Cetacean Survey in This Wind Farm

Tursiops aduncus was only identified around 2000 AD and belongs to a new species (LeDuc 1999) that was isolated from Tursiops truncatus. . Although these two kinds of fine information such as appearance, skull, and muscle DNA can be clearly divided into two categories, they are still easily confused with Tursiops truncatus (Wang et al. 1999). Tursiops aduncus has a relatively thick appearance like the Tursiops truncatus, as well as a sickle-shaped dorsal fin. This appearance is very similar to the Tursiops truncatus and is not easy to distinguish, so it is not distinguished when it is stranded. However, the Tursiops aduncus is slightly smaller than the Tursiops truncatus and has a longer proportion of mouth. The body length is up to 2.7 meters, with regional differences, and the highest weight record is 230 kg. The back of the individual is dark gray, and the body color of the ventral surface is roughly gray. There are many gray spots on the ventral surface during sexual maturity, which is one of the most special features of the Tursiops aduncus. Tursiops aduncus feeds on fish and has a high diversity of food composition. The overall population is less than Tursiops truncatus and can be close to humans. Tursiops aduncus inhabits shallow, shallow coastal waters, mostly in the vicinity of continental sheds and oceanic islands (Shirihai and Jarrett 2006).

Potential Cetacean Distribution

Offshore wind turbine development is scheduled to be located in the offshore waters of Changhua County and Penghu. The cetacean resources in this area are known by sea survey, stranding records, and documentation. The sighting record of the on-site maritime survey was Tursiops aduncus, which witnessed a total of 2 groups/times, and the range of the wind field was its foraging habitat.

According to the Cetacean stranding database of Taiwan Cetacean Stranding Network, since the beginning of 1995, there have been a total of 56 cetacean stranding records in the waters of Changhua and Penghu, with a total of 59 at least 10 species of cetaceans (Table 6.3.5). -2). Among them, Tursiops truncatus was the largest, accounting for 32, all dead individuals; followed by Stenella attenuata, 7 times. Others are Peponocephala electra, Kogia simus, Feresa attenuata, Neophocaena phocaenoides, Grampus griseus, Steno bredanensis, Tursiops aduncus (including partially unrecognized Tursiops truncatus). According to the stranded seasonal analysis (Table 6.3.5-3~Table 6.3.5-4), the peak month of the cetacean stranded is from October to March, concentrated in the winter. The stranding of Tursiops truncatus takes place throughout the year and is dominated by winter and early spring.

As for Sousa chinensis, the project began in March 2016. The investigation has not yet recorded the activities of Sousa chinensis, and it has also conducted in-depth interviews with fishermen. There has never been a record of Sousa chinensis.

According to the satellite tracking of Tursiops aduncus by National Cheng Kung University, the entire Taiwan Strait is a region where it inhabits and forages. The scope of this wind farm is also its active area. The future wind frame should also consider its possible impact.

Table 6.3.5-3 Grounding Records of Cetacean Waters of Changhua and Penghu

Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
many-toothed blackfish									1				1
Tursiops aduncus	1	2			1			1					5
Kogia simus			1										1
Tursiops truncatus	1	1											2
Pantropical spotted dolphin			3	1							3		7
Pygmy killer whale							1		2				3
Indo-Pacific bottlenose dolphin	8	5	10		1	1		4	1		1	1	32
finless porpoise	3	1											4
Risso’ s dolphin				1						1			2
Rough-toothed dolphin				1									1
Mysticeti					1								1
Total	13	9	14	3	3	1	1	5	4	1	4	1	59

Table 6.3.5-4 Monthly Cetacean Grounding Records of Western Coast Where Located at South of Taipei

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
pygmy sperm whale		1			1						2		4
Chinese White Dolphin				1				1					2
Bryde’s Whale							1						1
Fraser’s Dolphin					1				1				2
Tursiops aduncus	2	2	1		2		1	1			1		10
Kogia simus			2			1	1		1	1		1	7
Sperm Whale	1									1			2
blainville’s beaked whale (Blainvilles beaked whale)	3	2	1	1			1			2	1	2	13
False killer whale			1									1	2
blue-white dolphin		1	2				1						4
Tursiops truncatus	11	5	7		1	1			1	2	1	3	32
Globicephala macrorhynchus		1	1	1		1							4
Pantropical spotted dolphin		1	1	1	1	5		2			3		14
Omura’s Whale		1									1		2
Pygmy killer whale	5	4	2		2		2		1				16
Chinese White Dolphin									1			1	2
finless porpoise	1												1
Kogia simus									1		1		2
Sperm Whale					1					1			2
Long-snouted spinner dolphin										1			1
Goose-beaked Whale	1								1	2			4
Tursiops truncatus		1	2	2				4			1	2	12
Globicephala macrorhynchus					1	1							2
Risso’ s dolphin		1		2	1		2	1		1		1	9
Pantropical spotted dolphin			1	1		1							3
Rough-toothed dolphin(皺齒海豚)		1		2	2				1		1		7
Mysticeti					1								1
Total	24	21	21	11	14	10	9	9	8	11	12	11	161

Recreational Landscape

Landscape aethestic and recreational environment surveys are codnucted at 16th Ausgust 2016 and 8th April 2017. Overall environment has slight change. The photo of these 2 surveys are shown as Figure 6.4-1.

In the Vicinity of Rouzongjiao Beach (105.08.16)

In the Vicinity of Rouzongjiao Beach (106.04.08)

Cross-Sea Traffic Ways at Wongkung Fishing Harbor (105.08.16)

Cross-Sea Traffic Ways at Wongkung Fishing Harbor (106.04.08)

Putian Temple (105.08.16)

Putian Temple (106.04.08)

Figure 6.4-1 Photo of Tourist Attraction During 2 Surveys

Landscape Aesthetics and Environment

Investigation Of Development Activities And Resulting Impacts On Current Landscape Aesthetics

The planning unit is located in Changhua County and the offshore area of Lugang town. Besides that, main moving lines surrounding the planned area such as route 17 of provincial road station, the highway of Taiwan west coast, highway 76 heading east of Taiwan, county road 135, 142, 143, 144, 148, 150 and etc will also be involved in this project. Along the coast, mostly the lands from industrial areas, fish farms, river swamps, farming areas, and residential areas will be used. There are minor settlements scattered on the surrounding. Except for the industrial and town area where there is a high density of population and heavy traffic, the coast is mainly made up of windbreak forest, fish farm, wetland, desert, harbour and etc which are rich in natural resources, biodiversity and weather landscape resources, the surroundings are made up of small settlements scattering around where there are lesser human activities; Wangong harbour is known as the local tourist sightseeing spot, which contains rich natural resources, rich in biodiversity and weather landscape resources; there is Changhua coast industrial area and Mailiao industrial area on the north and south side respectively, where the area of the factory is used the main visual measurement.

Wind farms, submarine cable, and overland cable project are planned to be carried out on an area above 35.7 km away from the shore, the exploration area is estimated 120.4 km2, as going through the project, the benefits of current project such as renewable resources, energy diversification, improving quality of environment as well as driving the related industrial production and improve the national sustainable development (the detailed project is illustrated in Figure 6.4.1-1).

Evaluation of quality of landscape from the exploration activities

According to Environmental Impact Assessment Enforcement Rules set by Executive Yuan Environmental Protection Department, using the exploration base as center point, a border will be drawn from the center point which is 1.2 km away as the evaluation area, but due to exploration plan is approximately 35.7 km away from the coast, it has exceeded the distance used for the evaluation assessment of the landscape , therefore as for current plan, the evaluation area is using the Siansi Township, Lukang Township, Fusing Township as well as Fangyuan Township and etc where the areas are located near the Changhua coast, including the industrial area, farming area, wetland, fish farm, harbour and facilities scattered around, including the West Coastal highway passing through, forming a vision which has larger contrast.

Investigation of landscape resources

The wind farm is planned to be located near the open sea of Changhua, which is far away from the shore, but the investigation of landscape resource is mainly on the coast area. The Changhua coast wetland and river area contains rich flora and fauna resources, besides that the visualize space is very wide where the sunset can be view here and present a good visual sight; mainly the industrial area and Taichung harbor is the man-made scenery element, the facilities which have wide areas such as factory and chimney, compared with the natural scenery alongside, the landscape is not so well. The following are the pinpoints on the current plan.

Important natural landscape element

Geographical landscape

This area which forms the flat land is consist of River Wuxi and Zhuoshui River, the terrain is considered as flat, the topography is slow tilt from the south east to the south west, the average altitude is estimated at 7-8 meter. Along the seashore, there is a wide area of wetland where the vision range is wide and considered as the unique coastal landscape of Taiwan west coastline. Lukang Township belong to part of the flat land of Zhuoshui river, the sediments carried by the river current along with the influence of alongshore drift, it makes the tidal land of Lukang Township grows quickly, the coastline is expanding and moving out, and currently has been developed into Zhangbin industrial area successively, where the area has lost the original topography, but due to the occasional monsoon squalling the dried sand, eventually accumulate into unique dune and desert.

The hydrology is rich in this area mainly due to the Hougang river, Erlin river and ZhuoShui river, along with Taiwan strait where the base is located, presenting the wide area of the landscape.

The landscape of the ecosystem

As for the ecosystem aspect, resulting from the sea breeze and salt damage, huge trees are unable to grow easily on the coast, therefore mainly the plants that grow on the coast are the herbaceous plants, including Seashore Vine-Morning Glory, Beach Bean, Littoral Spinegrass, chrysanthemum that grows by the coast, Poison Bulb and etc, as for woody plant including vitex, Goodeniaceae, Coast Hibiscus, Screw pine, Beef Wood and etc; among Erlin river and Houxiang river, there are lots of coastal plant such as Kandelia, Black Mangrove and etc, they are precious fauna. Changhua coast wetland is retained as its most original feature, also the remaining one which has the largest area of river swamp and intestinal zone, the soil of floodplain contains lots of nutrients, which can nurture a variety of Benthic and plankton resources, the intertidal zone will attract amphibians such as fiddler crab, mudskipper and etc, which will be a magnificent landscape, with a wide area of mangrove forest, there will be lots of waterfowl and egret gathering here and rest; migratory bird will be visible in the winter, while the activities of passage migrants can be seen in the spring, mainly Dunlin, Ruddy Turnstone, Common Greenshank, Numenius arquata, Kentish Plover, Grey plover and etc. Special attention should be paid to the impact on habitats during the construction phase in the future.

Visual landscape

Except for the industrial area located in the coast of Changhua, by using the structure of people with a smaller area, the natural view of elements as a whole such as desert, wetland, sea, ecosystem and etc., are having a better resource view level, the actual environment is as per illustrated as picture 6.4.1-2.

註：共同廊道內之預定海纜路徑為示意路徑，未來實際上岸點位置將遵循台電公司規劃及彰濱工業區相關規定辦理

Figure 6.4.1-1 Scope Map of Project

Flat coastal wetland landscape of large area

Rich ecology landscape at the estuary

Ecological resources of the coastal area

Sandbar landscape of large area after ebbing

Rich ecological landscape at the intertidal zone

Animal landscape in the industrial park

Figure 6.4.1-2 Important Natural Landscape Element

Important man-made landscape features

Due to the early development of the Changhua area, there are quite a lot of humanities and historical sites, such as Fuhai Temple, Chaofan Temple, and Putian Temple. Nearby Lukang area, there are Folk Arts Museum, National Monument (Longshan Temple), county (city) designedated monuments (City God Temple, Mazu Temple, Wenwu Temple, Dizangwang Temple, Sanshan King Temple, etc.) and many historical buildings. . These are the famous local cultural landscapes. The activities in the coastal areas are mostly based on aquaculture and fishery, mainly oysters and clams. The important local landmarks of Wang-Gong Fishing Harbor, together with the surrounding wind turbines and small-scale fishing village settlements, form a special coastal scenery and village landscape resources. Taichung Industrial Park and Changhua Coastal Industrial Park are large in size due to the facilities and chimneys. The Western Coast Expressway runs through Taichung City and the west side of Changhua County. Therefore, human activities and vehicle activities are frequent, and the distribution of high-voltage towers along the line is likely to cause visual pressure on the viewer. This situation leads to poor overall landscape quality. The important artificial landscape elements are shown in Figure 6.4.1-3.

High and large wind power turbines become the visual focus

Wangkung fishing port is an important recreation scenic spot

Lukang Town is rich in human landscape resources

Landscape of Changhua Coastal Industrial Park

Keliao and oyster form a specific industrial landscape

Putien Temple building landscape

Figure 6.4.1-3 Important Human Landscape Element

Special landscape features

Changhua is located on the central plain of the west coast of Taiwan and belongs to the subtropical monsoon climate. The summer temperatures in the area are high and the sea breeze is prevalent. The area is dry, warm and has little rainfall during the winter. In the evenings and early mornings of January and April, it is easy to produce dense fog, which is one of the natural phenomena in the region. Changhua has a special landscape of the coastline and presents an open and panoramic view of the vast landscape. The landscape formed by the climate and the blue sky and the sun are the main features. The sunset glow at dusk is a unique natural phenomenon landscape resource in the area. The photo of the special landscape elements is shown in Figure 6.4.1-4.

The special meteorological landscape of the setting sun

The seascape and the sky present a unique visual landscape for the area.

Figure 6.4.1-4 Special Landscape Element Environment

Recreational Environment

Analysis of the characteristics of recreational resources

In terms of the survey of recreational resources, the location of the recreational impact assessment is selected by the accessibility of the traffic and the popularity of the recreation base, the nature of the recreation activities, and the scale and quality of the recreation facilities.

There are many recreational bases in the coastal areas of Changhua, and the types of recreational resources are also quite abundant. According to the area of recreational traffic and recreational behavior in the region, the source of tourists is from local areas and neighboring cities. Due to the close distance, the recreation activities are mostly half-day to one-day trips. At present, the main vehicles are self-use cars and locomotives and large tour buses. The neighboring recreation bases of this project can be divided into the following categories:

Type of natural landscape experience

This type of recreation area mainly includes the type of experience of the coastal landscape, which is mostly distributed on the west side of the coast. It mainly includes Fubao Wetland, Hanbao Wetland, Dacheng Wetland, Estuary Wetland, etc. The recreation activities mainly focus on watching birds, enjoying the tide, playing in the water, observing the wetland ecology, enjoying the sunset and watching the waves. Residents of the Central Region and local residents are the main source of tourists for this area. Cars and locomotives are the main means of transportation for their own use, and most of them take half-day to one-day trips.

Type of monuments and temple visits

Changhua County has preserved many cultural sites such as monuments, ruins, old houses and temples. The Folk Arts Museum, Longshan Temple, City God Temple, Mazu Temple, Wenwu Temple, Dizangwang Temple and Sanshan King Temple are all important cultural attractions in the area. These locations often attract central and even national visitors for leisure activities and cultural experiences. In the Fangyuan area, the local special features of the Chaofang Temple, Shoushan Temple, Fuhai Temple and Putian Temple are quite attractive to local residents, and there are many believers in special festivals.

Types of local industry experience

The oyster shed, fish farm and reclaimed land are the characteristics of the fishing landscape in this area. Such as Hanbao Leisure Farm, Wang-Gong Fishing Harbor, Wenzi Fishing Harbor, etc., together with local industry characteristics, provide a variety of activities and services such as sightseeing fisheries, recreation, catering, exhibition and accommodation. These sightseeing spots attract many tourists on holidays, ranging from half-day trips to one-day trips.

Types of theme museum visits

The Changhua Coastal Industrial Park is home to the theme museums such as the Brand's Health Museum and the Taiwan Glass Gallery. It offers a wide range of exhibition information and recreational activities, and has been a popular local tourist attraction in recent years.

Description of the Neighboring Recreation Spot Survey

The representative and possibly affected recreation sites in the region are selected (Figure 6.4.2-1), and their associated cluster descriptions are described as follows:

Dadu Estuary Wildlife Sanctuary

Dadu Estuary is the largest waterfowl habitat in central Taiwan. It is located in the boundary between Taichung City and Changhua County. It covers an area of about 3,000 hectares and contains a variety of benthic riverbanks. It attracts thousands of migratory birds every winter. . From October to May of each year, it is the main bird watching season of Dadu Estuary. Among them, December to April is the peak season to enjoy Scolopacidae, and April to July is the active season of Tern. A total of 24 conservation birds have been found in the region and are listed as one of the most important wetlands in Asia by the International Union for Conservation of Nature and Natural Resources. This area is rich in ecological resources and belongs to the ecological observation type.

Brand's Health Museum

Founded in 2003, Brand's Health Museum is the largest and the largest Brand's Health Museum in Asia. The pavilion has been planned in the historical district, brand district, air corridor, healthy community and souvenir area, in order to open the general public to visit the production process of chicken essence, and present the history and brand story of Brand's. This is an educational museum that attracts a large number of tourists from all over the country and uses large tour buses and self-use cars as the main means of transportation.

Taiwan Glass Gallery

Founded in 2006 in Changhua Coastal Industrial Park, Taiwan Mirror Glass Enterprise provides a free exhibition area for local Taiwanese artists in order to give the local glass craft a stage to showcase. The company established the Taiwan Glass Gallery in Changhua Coastal Industrial Park in Lukang in 2006. With the motto "Brightness on all sides, amazing in all directions", it combines the characteristics of Taiwan's ecology, culture and art. The theme area of the information intellectual zone, the engineering interior zone, the art creation zone, the living glass zone, and the parent-child experience are planned in the museum to let the public understand the development history, basic materials and production process of the glass. This gallery also shows the world's best works. Here, the public can also experience Ramune, bright beads, glass beads, sand painting, kaleidoscope, color changing cups and other activities, is a museum of fun and education. This gallery attracts a large number of tourists from all walks of life on weekdays and holidays, and uses large tour buses and self-use cars as the main means of transportation.

Lukang Humanities Recreation Area

Lukang is a famous cultural city in Taiwan. Lukang Town consists of three major monuments (Longshan Temple, Mazu Temple, Wenwu Temple) and eight scenic spots (Lombard Street, Ai Gate, Shih Yih Hall, Urn Wall, Xing'an Temple, Xinzu Temple, Lukang Folk Arts Museum and Beitou Fishing Village) and twelve historical significance (Qingchang ancient house, vegetable garden Huang's ancient house, Lugang old-style building, Shih Yih Hall, Shigandang, Half-side well, Rimao Store, Jingyi Garden, Golden Gate Hall, Welling Temple, Hsinzu Temple and Longshan Temple), as well as traditional snacks and craftsmanship, in holidays, it often attract tourists from all over the country. Especially for special festivals, many believers will be attracted to the temple to pilgrimage and pray. In addition to the residents from the south-central region, it also attracts tourists from all over the country, and their use self-use car or locomotives and large-scale tour buses as the main means of transportation.

Fubao Wetland Ecology Park

Fubao Wetland is an important area for natural conservation of waterfowl. It is called "the holy place of waterfowl". It is rich in benthic organisms in the intertidal zone. It attracts waterfowls such as Scolopacidae and Ardeidae, including Himantopus himantopus, Anas crecca and Egretta garzetta, Gallinula chloropus. Artist Leefa Hsieh used 394 driftwood to create a 2 meter high installation art piece that became the landmark of Fubao Wetland. The park also has planned facilities such as bird watching walls and bird watching houses to provide bird lovers and the general public to observe bird activities at close range. Since 2008, it has also added wooden ecological classrooms in the district to provide bird watching information and equipment, thereby becoming an outdoor classroom for teaching and understanding waterfowl outside schools.

Hanbao Wetland

Hanbao Wetland is located at the junction of Fuxing Township and Fangyuan Township in Changhua, between the old Zhuoshui River estuary and the coast of Wangxin drainage ditch, with a total length of about 9 kilometers. Large-scale intertidal beaches often attract large numbers of people to dig and catch crabs after ebb. Most of the land area is fish farms, including swamps, fields, grasses, etc. The area is rich in ecological resources, and more than 170 species of waterfowl have been discovered. Among them, there are many migratory birds. It also attracted the waterfowl that was originally in the Dadu River. At present, local residents have developed towards eco-tourism, opening up “marine leisure pastures” in the fish farms area. By building holiday huts, they have become a very promising tourist attraction. Tourists use their own cars and locomotives as the main means of transportation.

Wongkung Fishing Harbor

Located in Hougan Estuary, Wang-Gong Fishing Harbor is a fishing port with sea and land recreation resources, rich in marine resources and beautiful natural ecological landscape. Wang-Gong's hustle and bustle is famous throughout Taiwan, with rich natural and cultural landscapes such as mangroves, waterfowl, intertidal fiddler crabs, mud skipper and other coastal scenery. Together with the rich fishing villages such as Wang-Gong Fishing Harbor, lighthouse, ecological landscape bridge, Wanghai pavilion and bamboo raft, it attracts many tourists from the south central region. Tourists use their own cars and large tour buses as the main means of transportation.

Putian Temple

The main god of the Putian Temple in Fangyuan is Mazu. The first Mazu in Temple was founded in the 36th year of Emperor Kangxi of the Qing Dynasty (1697 AD). It has a history of more than 300 years and is the belief center of the people in Fangyuan. On the cement wall on the right side of the main hall, there is a statue similar to the floating wall Guanyin. The believers think it is the miracle that Guanyin appears. After the reconstruction of the Putian Temple, the exquisite carvings and paintings of its door gods, hexagonal bell towers, wood carvings, tow wood, algae wells, stone carvings, jade pottery, ridge ornaments, and paintings are very traditional temple architecture. Every year on the 23rd of the lunar calendar is the birthday of Mazu. The Putian Temple will hold a grand celebration to attract many tourists and believers.

Dacheng Wetland

Dacheng Wetland is located in the Estuary of the Zhuoshui River, covering an area of over 21,000 hectares. The windbreaks in the area are home to birds such as Egretta garzetta, Bubulcus ibis and Bubulcus ibis. In the breeding season from April to June each year, the number of Heron inhabited often reaches thousands. In addition, there are Charadrius alexandrinus, Calidris alpina, Numenius arquata, and Larus saundersi in the wetland. On the outskirts of the wetlands, occasionally you can see the unique "Sousa chinensis" in Taiwan. Dacheng Wetland is the largest muddy beach in Taiwan, forming a special scene of cattle farming at sea in the high tide. It has the largest Heron habitat in Taiwan and is currently listed as a national important wetland.

註：共同廊道內之預定海纜路徑為示意路徑，未來實際上岸點位置將遵循台電公司規劃及彰濱工業區相關規定辦理

Figure 6.4.2-1 Analysis Diagram of Recreational System Plan

Socio-Economic Environment

Population and Age Structure

Population

The population number of Changhua County has gradually decreased year by year from 1,316,762 persons in 2004 to 1,289,072 persons in 2015, with a decrease of 27,690 persons. The population density of the whole county has gradually decreased year by year from 1,225.58 persons per square meter in 2004 to 1,199.81 persons per square meter in 2015, with a decrease of 24.90 persons per square meter.

In the 2015, the population of Xianxi Township was 17,040, and the population density was 942.19 people per square kilometer: the population of Lugang Township was 86,407, and the population density was 2189.60 people per square kilometer.

Age Structure

The age structure of the population can be divided into three phases. The first stage is the young population of 0-14 years old or the Dependency young children group, the second stage is the adult population of 15 to 64 years old or the production population group, and the third stage is the elderly population of 65 years old or older or the Dependency elderly group.

The young population percentage aged 0～14 of Changhua County in 2015 is 13.87%, while the adult population accounts for 72.49%, and senior population accounts for 13.64%. The entire dependency ratio is 37.95. Changhua County belongs to the area of population aging (Table 6.5.1-1). Moreover, according to statistics of nearly ten years, the aging index increased from 53.75 in 2004 to 98.28 in 2015, and there is a clear trend of population aging.

The percentage of Xianxi's young people aged 0-14 in 2015 was 14.13% (2,407), the adult population was 73.41% (12,509), and the elderly population was 12.46% (2,124). The overall regional dependency ratio is 36.22, and the aging index is 88.24, which has a trend of population aging.

In Lukang Town, the percentage of young people aged 0-14 in 2015 was 15.62% (13,495), the adult population accounted for 72.11% (62,312), and the elderly population accounted for 12.27% (10,600). The overall regional dependency ratio is 38.67, and the aging index is 78.55, which has a trend of population aging.

Table 6.5.1-1 Changhua County Population and Age Distribution

Item / Year	(1) ages 0 - 14		(2) ages 15 - 64		(3) ages 65 and above		Dependency ratio $\frac{(1)+(3)}{(2)}\times 100$	Aging index $\frac{(3)}{(1)}\times 100$
	Population	Percentage	Population	Percentage	Population	Percentage		
2004	260,995	19.82%	915,494	69.53%	140,273	10.65%	43.83	53.75
2005	252,662	19.20%	918,792	69.83%	144,372	10.97%	43.21	57.14
2006	245,488	18.67%	921253	70.06%	148293	11.28%	42.74	60.41
2007	237,474	18.07%	925134	70.39%	151746	11.55%	42.07	63.90
2008	229,656	17.49%	928420	70.71%	154859	11.79%	41.42	67.43
2009	222,212	16.93%	933042	71.09%	157213	11.98%	40.67	70.75
2010	212,716	16.27%	936561	71.64%	158009	12.09%	39.58	74.28
2011	204,235	15.67%	939650	72.11%	159154	12.21%	38.67	77.93
2012	197,289	15.18%	940,436	72.35%	162,143	12.47%	38.22	82.19
2013	191,555	14.78	938,407	72.41	166,051	12.81	38.11	86.69
2014	185,219	14.34	935,653	72.45	170,602	13.21	38.03	92.11
2015	178,857	13.87	934,430	72.49	175,785	13.64	37.95	98.28

Data source: the “Statistical Year Book of Changhua County – 2015” released by Changhua County Government.

Educational Level

Till the end of 2015, among the population of 1,110,215 persons aged above 15, 394,172 people with educational level above junior college (including graduate school, university, independent college and junior college) level accounting for 35.50%; 339,977 people with senior high school (vocational high school) level accounting for 30.62%; 162,146 people with junior high school level accounting for 14.60%; 174,204 people with primary school level accounting for 15.69%; 4,452 with self-culture level accounting for 0.40%; 35,264 are non-readers accounting for 3.18%. Up to the end of this year, among the population above 15 years old of this county, the ones with senior high school (vocational high school) level account for 66.13%.

By the end of 2015, in Xianxi, the education level of the current population over the age of fifteen was the highest in university or college, with a total of 4,231 (about 28.91%). Secondly, about 4,108 people (about 28.07%) in the high school and vocational higher vocational schools, 2,899 people (about 19.81%) in the junior high school, and 2,320 people (about 15.85%) in the elementary school. However, there are 505 people (about 3.45%) who have illiteracy, 435 (about 2.97%) who have masters, and 135 (about 0.92%) who are self-study.

Industry Structure

Labor Population

The labor force refers to the civilian population who are over 15 years of age, have the ability to work and the willingness to work, and want to get paid work. At the end of 2015, Changhua County had a population of over 1,094,000 people over the age of fifteen. There are 551 thousand men and 543 thousand women. Among the labor force of 652 thousand people, 377 thousand are males, accounting for 57.82%, and females are 275 thousand, accounting for 42.18%. The Labor force participation rate was 59.60% (Table 6.5.2-1).

Employment Population

The employed population refers to the working population who is engaged in paid work within the standard week (the week includes 15th in a month as the standard week), or the working population of unpaid workers who have worked for more than 15 hours. By the end of 2016, the employment population of Changhua County was 628 thousand, and the employment rate was 96.32%. In the past decade, except for the Financial Crisis period from 2009 to 2011, the unemployment rate has decreased from 4.2% to 3.7% year by year, and the unemployment problem has gradually slowed down (Table 6.5.2-1).

Employment Types

In view of the employment population profession attribute of Changhua County in 2015, agriculture, forestry, animnal husbandry and fisheries employment population number is 58,000 people, accounting for 9.24%, industry employment population number is 299,000 people, accounting for 47.61%, while the service industry employment population number is 271,000 people, accounting for 43.15%, The results show that the employed population of the county is mostly engaged in industrial people.

The secondary industrial sectors of Changhua County, which are engaged in manufacturing, construction, mining and quarrying sectors, electricity and gas sectors, have a high proportion of people, accounting for 47.61% by the end of 2015, and the number is about 299 thousand. The number of Tertiary industrial sectors in the commercial, transportation, finance, insurance and services sectors increased from 238 thousand in 2004 to 271 thousand in 2015, accounting for 43.15% of the employed population. The primary industrial sectors for farming, forestry, livestock, fishing sectors and hunting industry decreased from 65,000 in 2004 to 58,000 in 2015, accounting for 9.24% of the employed population. Compared with the Tertiary industrial sectors, the number of primary industrial sectors engaged in farming, forestry, livestock, fishing sectors and hunting has been decreasing year by year. The number of Secondary industrial sectors in the manufacturing, construction, mining and quarrying sectors, electricity and gas sectors, and the Tertiary industrial sectors in the commercial, transportation, finance, insurance and service industries are increasing year by year (see table6.5.2-2 for details).

Business Industry Status

According to the 2015 Changhua County Statistical Annual Report, the number of registered industries in Changhua County is 34,755, an increase of 633 from the previous year. Among all the existing registered industries, there are 22,006 businesses, followed by manufacturing, construction, social and personal services, financial and insurance real estate and business services, transportation and warehousing and communications, farming, forestry, livestock, fishing sectors, electricity and gas sectors. The lesser are the mining and quarrying sectors, a total of 53 (as shown in Table 6.5.2-3). In 2014, the number of registered factories in various industries in Changhua County was 8,794. Among them, 2,753 of the metal products manufacturing industry accounted for the most, accounting for 31.31%, the mechanical equipment manufacturing industry accounted for 11.45%, and the textile industry accounted for 9.40%.

Agriculture, Forestry and Fisheries Status

At the end of 2015, the area of cultivated land in Changhua County was 61,799.29 hectares. Among them, the actual cultivated area is 59,429.00 hectares and the fallow land is 2,370.29 hectares. In 2014, there were 86,678 agricultural households, of which 70,668 were owner-peasants, accounting for 81.53% of the total farmers. This was followed by 11,953 semi-agricultural farmers, accounting for 13.79%, and 4,057 tenant farmers, accounting for 4.68%. The agricultural population was 370,572, a decrease of 9,288 from the end of 2013.In 2014, the fisheries production of Changhua County is 21,630 tons, less by 1,483.48 tons than the previous year if compared.　Among which, the aquaculture production is 13,682.32 tons, accounting for 96.12％ and the coastal fishery production is 553 tons, accounting for 3.88%.

Land Utilization

Land Use

By the end of 2015, the registered land area of Changhua County is 104,337.86 hectares, among which the public land is 21,258.82 hectares, accounting for 20.37％; the private land is 82,499.23 hectares, accounting for 79.07％; while the co-owned public and private land is 579.81 hectares, accounting for 0.56％. Among the registered land area, the non-urban land is 89,736.01 hectares, accounting for 86.01％, and the rest is urban land.

Among the non-urban land areas, 61,156.97 of the land for agriculture and animal husbandry accounted for 5,61% of the total. Followed by 4,685.61 hectares of water use, accounting for 4.49%. Type D construction land is 4,376.66 hectares, accounting for 4.19%, ranking third, while 0.49 hectares of land for monument preservation is the smallest.

Xianxi has registered land area of 2,249.91 hectares in 2015, and construction land (including Type A, B, C, D) in non-urban land is 842.78 hectares, accounting for 37.46% of the land, which is the highest land use. The direct production land (including agriculture, animal husbandry, forestry, and aquaculture) is 806.68 hectares, accounting for 35.85. The traffic water utilization area is 231.83 hectares, accounting for 10.30%. The specific land use (including national security land, graves, and special purpose businesses) is 22.63 hectares, accounting for 1.01%. The site of recreation and land and land security is 13.02 hectares, accounting for 0.58%. In addition, urban land is 322.98 hectares, accounting for 14.80%.

The land area of Lugang Town that has been registered by 2015 is 7,153.97 hectares. The direct production land (including agriculture, animal husbandry, forestry, and aquaculture) in non-urban land is 3,088.31 hectares, accounting for 43.17%, which is the land with the highest land use. Construction land (including Type A, B, C, D) is 2,457.40 hectares, accounting for 34.35%. The traffic water utilization area is 635.62 hectares, accounting for 8.88%. Specific land use (including national security land, graves, and special purpose businesses) is 144.73 hectares, accounting for 2.02%. The recreation sites and land for land security are 0.66 hectares, accounting for 0.01%. Another urban land is 827.26 hectares, accounting for 11.56%.

Use of area partitions in urban plans

From the end of 2015, Changhua County has completed an urban planning area of 133.87 square kilometers, and the rest are non-urban planning areas. The current population in the urban planning area is 638,571, accounting for 49.54% of the county's total population of 1,289,072, and the population density per square kilometer is about 4,770 (see Table 6.5.3-1 for details).

Table 6.5.2-1 Labor Status and Index of Population Aged above 15 over Past Decade in Changhua County

Unit: thousand persons

Items / Year	Total Population	Population for ages 15 above	Labor Population			Non-labor population	Labor participation rate (%)	Employment rate (%)	Unemployment rate (%)
			Employed	Un-employed	Total				
2004	1,317	1,030	551	24	575	455	55.8	95.8	4.2
2005	1,316	1,036	568	24	592	444	57.1	96.0	4.0
2006	1,315	1,070	573	23	596	474	57.0	96.2	3.8
2007	1,314	1,077	588	23	611	466	58.0	96.2	3.8
2008	1,313	1,083	590	26	616	467	57.9	95.8	4.2
2009	1,312	1,090	581	36	617	473	57.7	94.2	5.8
2010	1,307	1,095	602	33	635	460	59.0	94.8	5.2
2011	1,303	1,099	610	28	638	461	58.9	95.6	4.4
2012	1,300	1,086	614	27	641	472	59.0%	95.79	4.2
2013	1,298	1,089	619	26	645	443	59.30	95.97	4.0
2014	1,293	1,091	622	25	648	444	59.3	95.99	3.9
2015	1,289	1,094	628	24	652	442	59.6	96.32	3.7

Data source: the “Statistical Year Book of Changhua County – 2015” released by Changhua County Government.

Table 6.5.2-2 Statistics of Employment Populations of Respective Grade Industries over Past Decade in Changhua County

Unit：thousand person

Item / Year	1st grade industries		2nd grade industries		3rd grade industries		Total	
	Population (thousand persons)	Percentage (%)	Population (thousand persons)	Percentage (%)	Population (thousand persons)	Percentage (%)	Population (thousand persons)	Percentage (%)
2004	65	11.84	248	44.98	238	43.19	551	100
2005	61	10.76	255	44.84	252	44.40	568	100
2006	57	9.91	259	45.17	257	44.92	573	100
2007	57	9.71	275	46.72	256	43.57	588	100
2008	60	10.12	280	47.39	251	42.49	590	100
2009	62	10.70	269	46.33	250	42.96	581	100
2010	69	11.42	278	46.21	255	42.36	602	100
2011	63	10.37	281	46.04	266	43.58	610	100
2012	67	10.91	285	46.42	262	42.67	614	100
2013	59	9.53	297	47.98	263	42.49	619	100
2014	54	8.68	303	48.71	265	42.60	622	100
2015	58	9.24	299	47.61	271	43.15	628	100

Notes: The 1st grade industries cover agricultural, forestry, fishery, husbandry and hunting industries.
The 2nd grade industries include mining and quarrying industries, manufacturing industry, electricity, gas and water industry, and construction industry.
The 3rd grade industries comprise commercial, transportation, warehousing and communications industries as well as financial, insurance, real estate and industrial and commercial service industries, and others.

Data source: the “Statistical Year Book of Changhua County – 2015” released by Changhua County Government.

Table 6.5.2-3 Registered Businesses of Respective Industries over Past Decade in Changhua County

Industry / Year	Agricultural, forestry, fishery, husbandry industries	Mining and quarry industries	Manufacturing industry	Electricity, gas and water industry	Manufacturing industry	Commercial industry	Transportation, warehousing and communications industries	Financial, insurance, real estate and industrial and commercial service industries	Social and personal service industries (including others)	Total
2004	188	78	3,811	3	1,638	20,857	371	996	2,988	30,930
2005	202	60	3,475	5	1,696	20,817	366	961	2,893	30,475
2006	214	55	3,330	4	1,774	21,042	366	968	3,080	30,833
2007	218	55	3,238	197	1,852	21,176	579	1,181	2,392	30,888
2008	243	54	3,169	218	1,906	21,130	565	1,182	2,348	30,815
2009	270	50	3,146	222	1,933	21,248	542	1,192	2,335	30,938
2010	300	54	3,272	241	2,060	21,579	536	1,250	2,399	31,691
2011	327	54	3,424	256	2,182	21,811	548	1,298	2,451	32,351
2012	370	55	3,639	269	2,308	21,907	550	1,339	2,502	32,939
2013	413	52	3.811	291	2.424	22,016	549	1,420	2,711	33,687
2014	472	52	4,055	290	2,588	21,999	544	1,482	2,640	34,122
2015	521	53	4,301	293	2,792	22,006	540	1,542	2,707	34,755

Data source: the “Statistical Year Book of Changhua County – 2015” released by Changhua County Government.
Description: This tanle only encompasses companies with capital below 30 million.

Table 6.5.3-1 Area and Population of Changhua Urban Plannig District

Land Use Type / Year	Area of Urban Planning District (km2)	Population of Urban Planning District		Population Density of Urban Planning District	
		Project Population (Individual)	Current Population (Individual)	Project Population Density (Individual / km2）	Current Population Density （Individual / km2）
2004	127.89	912,150	714,535	7,133	5,587
2005	127.89	900,150	727,704	7,039	5,690
2006	127.89	900,150	705,368	7,039	5,516
2007	127.92	900,150	682,404	7,037	5,335
2008	130.76	900,150	625,539	6,884	4,784
2009	130.74	903,150	648,733	6,908	4,962
2010	130.71	903,150	648,679	6,909	4,963
2011	132.82	907,650	645,518	6,834	4,860
2012	132.96	889,550	727,691	6,690	5,473
2013	132.75	889,550	725,281	6,701	5,464
2014	132.75	889,550	645,067	6,701	4,859
2015	133.87	889,550	638,571	6,645	4,770

Data Source: Changhua County Government, Statistical Annual Report of Changhua County of 2015

Public Facilities

The public facility can be divided into three major items respectively as the educational facility, medical-treatment facility, and the tap-water supply, the current status of which is specified as follows:

Educational Facilities

In accordance with “Statistical Yearbook of Changhua County” of 2015, currently in Changhua County, there are 5 colleges, 24 public/private senior high schools and vocational high schools, 44 junior high schools, 175 primary schools, and 320 kindergartens.

Medical Facilities

Up to the end of 2015, there are 1,054 medical institutes, among which there are 33 hospitals and 1,021 clinics, and 13,372 people as medical practitioners, 6,374 RNP (registered professional nurse) occupies 47.66% of the total medical personnel, and the next is 1, 994 western physician at 14.91%; 0 midwife is the least. The number of total sickbed in public and private medical institution is 7,645, and that of the hospital sickbed is 6,967, in which, the normal sickbed is 5,069, particular sickbed is 1,828. The number of clinical sickbed is 753. Viewing from benefit analyses of the unit populace, we may find that one medical person

shall serve 96.40 citizens, with 59.31 sickbeds for every ten thousand people.
There are 5 medical institutions in the Xiansi Rural Town (where the planning zone is located), with 5 physicians, professional medical personnel. Viewing from the benefit analysis of the unit populace, we may know that each medical person in Xiansi Town shall serve 681.60 villagers and each physician serves 3,408 villagers.
There are 80 medical institutions in Lugang Town (where the planning zone is located), with 296 physicians, 1,645 professional medical personnel, and 1389 normal sickbeds. Viewing from the benefit analysis of the unit populace.
Tap Water Supply
Water-supplying range of the Fifth District Administration of Taiwan Water Corporation comprises Zhanghwa County and Chiayi County. Since 1998, the number of total households in the "Water-supplying District" used to compute the penetration has been amended as the total household in the "Administrating District". In view of the data of 2015, the total population number of the administrative area of Changhua County is 1,289,072 people; the water use population in the water supply area is 1,203,920, with water supply pervasion of 93.39% (please refer to Table 6.5.4-1).

Table 6.5.4-1 Water Supply at Changhua County

Item / Year	〔1〕Total population of administration area (Individual)	〔2〕Population of Water Supply Area (Individual)	Water Supply Pervasion 率(%) 〔2〕/〔1〕x100
2004	1,316,762	1,200,609	91.18
2005	1,315,826	1,205,041	91.58
2006	1,315,034	1,209,157	91.95
2007	1,314,354	1,213,158	92.30
2008	1,312,935	1,212,040	92.32
2009	1,312,467	1,211,589	92.31
2010	1,307,286	1,207,297	92.35
2011	1,303,039	1,204,186	92.41
2012	1,299,868	1,203,933	92.62
2013	1,296,013	1,203,715	92.88
2014	1,291,474	1,202,557	93.12
2015	1,289,072	1,203,920	93.39

Data Source: Changhua County Government, Statistical Annual Report of Changhua County of 2015
Residents-Concerned Matters
Response to Public Comments of "Environmental Impact Assessment Development Forum" of EPA
According to the content of Article 5-1 of the "Operational norm for environmental impact

assessment of the development activities” promulgated by Environmental Protection Administration on Mar. 11, 2009 (Huan-shu-zong No. 0980020851), during the planning phase to start the environmental impact assessment, the developing title, content and location shall be published on the website designated by the competent authority, inclusive of the range of developing behavior, investigation, and assessment to be proceeded. In accordance with this provision, this program was publishing the items abovementioned at website (http://atftp.epa.gov.tw/EIAforum) appointed by the said Administration on Jan. 9, 2016 (please refer to Drawing 6.5.5-1), and no objection was proposed by the populace during the 15-day publishing period.

Figure 6.5.5-1 Content of Project Publsihed On Internet

Public Meetings

In compliance with the provision of Article 10-1 of the “ Operational norm for environmental impact assessment of the development activities”, this program was choosing the conference room at the third floor of Xiansi Township Office nearby the jobsite (No. 983, Hoxian Road, Yupu Village, Xiansi Rural Town) to hold a public meeting and hear the public’s issues in regard to this developing case on Oct. 24, 2016, and publishing the meeting information onto the website of Environmental Protection Administration 10 days prior to the meeting

(Drawing 6.5.5-2). In addition to issuing the meeting notifications, we also invited the related institutions and local people by formal notice to attend the meeting. The minutes is attached as Appendix 7, and the opinion and response presented by local people is specified as per Table 6.5.5-1.

行政院環境保護署
Environmental Protection Administration
Executive Yuan, R.O.C. (Taiwan)

環評書件查詢系統－環評開發案論壇

>> 二登入 | 首頁 | 書件查詢系統首頁 | 手冊 | 意見信箱

A.最新消息區
最新消息
B.範疇界定區
範疇界定
C.公告區
公開會議或說明會
公聽會及現勘
D.討論區
目前討論區
歷史討論區
E.資料查詢區
開發案查詢
F.目的事業主管
預告公聽會
預告現勘
G.開發單位專區
開發案申請
預告公開會議/說明會

>> 回公開會議或說明會訊息

張貼日期：	2016-10-05	卸載日期：	2017-02-02
案件名稱：	大彰化東南離岸風力發電計畫		
公開會議依據：	開發行為環境影響評估作業準則第10條之1		
公開會議時間：	中華民國 105年10月24日 下午 02:00 至 下午 03:30		
公開會議地點：	鹿港文創會館3樓309會議室(鹿港鎮中正路588號)		
公開會議方式：	簡報及意見交換		
開發場所：	擬規劃設置離岸風力發電機組之場址，位於彰化縣線西鄉及鹿港鎮外海區域，風場離岸最近距離約35.7公里。上岸點及陸纜等陸上設施主要設置於線西鄉或鹿港鎮。		
開發行為內容摘要：	本計畫主要位置位於能源局公佈之15號離岸風力發電場址，風場範圍為120.4平方公里，依「離岸風力發電規劃場址申請作業要點」中每平方公里不得小於五千瓩之規定，總裝置容量應在602 MW以上。本計畫場址海域水深介於34.4~44.1公尺，海纜預計將自彰化縣線西鄉或鹿港鎮海堤上岸，並於上岸點接陸纜沿道路連接至自設升壓站，再連接至線西D/S變電所、鹿西D/S變電所或彰濱E/S變電所。		
邀請之機關、團體或人員：	行政院環境保護署、行政院能源及減碳辦公室、行政院農業委員會林務局、行政院農業委員會漁業署、行政院海岸巡防署、經濟部能源局、科技部、交通部航港局、交通部民用航空局、台灣港務股份有限公司台中港務分公司、台灣中油股份有限公司、台灣電力公司、中華電信公司、彰化縣政府、彰化縣政府環境保護局、經濟部工業局、經濟部工業局彰濱工業區服務中心、彰化縣議會、彰化區漁會、彰化縣鹿港鎮公所、彰化縣線西鄉公所、彰化縣鹿港鎮民代表會、彰化縣線西鄉民代表會、社團法人彰化縣環境保護聯盟、社團法人彰化縣野鳥學會、社團法人台灣濕地保護聯盟、社團法人台灣媽祖魚保育聯盟、中華鯨豚協會、立法委員王惠美辦公室(彰化縣第1選區)、彰化縣政府警察局鹿港分局、縣議員賴清美辦公室、縣議員尤瑞春辦公室、縣議員林宗翰辦公室、縣議員林庚壬辦公室、縣議員柯振杯辦公室、縣議員黃文雄辦公室、縣議員林士昌辦公室、縣議員涂淑媚辦公室、縣議員陳秀寶辦公室、縣議員林聖哲辦公室、縣議員蕭國雄辦公室、縣議員楊啟祥辦公室、德興村、頂庄村、線西村、寓埔村、溝內村、塭仔村、頂犁村、下犁村、大有里、中興里、洛津里、順興里、郭厝里、新宮里、玉順里、東石里、永安里、埔崙里、菜園里、街尾里、泰興里、長興里、興化里、龍山里、景福里、詔安里、海埔里、洋厝里、草中里、山崙里、頭南里、頂厝里、東崎里、廖厝里、頭崙里、頂番里、溝墘里、線西社區發展協會、頂庄社區發展協會、寓埔社區發展協會、溝內社區發展協會、塭仔社區發展協會、下犁社區發展協會、頂犁社區發展協會、德興社區發展協會、新厝社區發展協會、頂番社區發展協會、洋厝社區發展協會、溝墘社區發展協會、東崎社區發展協會、頭崙社區發展協會、山崙社區發展協會、草港社區發展協會、南勢社區發展協會、廖厝社區發展協會、福崙社區發展協會、草中社區發展協會、山寮社區發展協會、東興社區發展協會、宮后社區發展協會、頂厝社區發展協會、菜園社區發展協會、萬興社區發展協會、慈后社區發展協會、學子社區發展協會、景福社區發展協會		
開發單位：	大彰化東南離岸風力發電股份有限公司籌備處		
開發單位聯絡人姓名：	高傳勝		
聯絡人電話：	(02)27221617#169		
EMAIL：	jakao@dongenergy.com		

若不克參與會議，請將書面意見提供給開發單位。

會議資料或紀錄下載：

	文件	說明	下載
1	#15_發文附件-開會通知公告.pdf	公開會議說明資料	

Figure 6.5.5-2 Notice of Meeting Published On EPA’s EIA Forum

Table 6.5.5-1 Anser to Reply of Public Meeting and Personnel

Questions and suggestions	Explanation for the questions
1、 Director of the Fishery Promotion Department of Changhua District	
Fisherman's association of Changhua district is fully supporting the development of green energy policy by the government with the hope that the mentioned company is able to protect the environmental ecology.	Our company has appointed professional advisor team to carry out ecosystem related survey, the survey objectives are carried out according to the requirement of the environmental impact assessment law. The results of the survey and the impact assessment will be presented in the environmental impact statement. The development of offshore wind power and environmental ecology is taken into account as well.
This briefing session is only the initial part of the environmental assessment with the hope that after the adoption of the environmental impact assessment in the future, communication and coordination with the association and fishermen can be carried out to reduce the controversy at the time of implementation.	For the sake of smooth communication with the large number of fishermen, our company will stand with the fishermen's association to enable continuous smooth communication.
Fishermen's association is a very good platform to communicate, it acts a bridge for communication between the fishermen and the company with the hope of creating a win-win situation.	Our company thinks that fishermen's association is a good communication platform, our company will continue to communicate with the fishermen. The fishermen's association can be the communication platform between the company and fishermen, they can communicate with the fishermen through fishermen's association, and finally achieve a win-win situation.
2、 Changhua County Government, Huang, Chen-Yun	
It is recommended that the contents of the "Offshore Wind Power Block Development Policy Evaluation Manual" by the project	Currently, the policy of environmental impact assessment has held two preliminary meetings, the terms and conditions are listed

Questions and suggestions	Explanation for the questions
team is included in the environmental impact statement.	in the second meeting. The contents will be confirmed by the energy board and will be submitted to the conference to be passed by the members of the conference in the future. The manual of the environmental impact of this case will be done with the reference of the policy environmental impact assessment. If there is any impact, it will be proposed and a solution will be done and to be listed in the manual.
3、Xianxi district office (written opinion)	
Greater Changhua Northwest Offshore Wind Power Generation Project, Southwest Offshore Wind Power Project, Southeast offshore wind power generation with a total of 4 cases. No 15th rule of environmental impact assessment states that in the same place, if there are more than 2 development activities at the same time, they must be combined for evaluation. The reason of the overall assessment cannot be combined.	Executive Yuan announced that offshore wind power planning site application review on 2nd July 2015. After a careful evaluation, Dong Energy decided to establish 'Da Changhua Southeast Offshore Wind Power Co., Ltd', 'Greater Changhua Northwest Offshore Wind Power Co.',Ltd'. Greater Changhua Northwest Offshore Wind Power Co, Ltd'. 'Greater Changhua Northeast Offshore Wind Power Co., Ltd'. 'Greater Changhua Southwest Offshore Wind Power Co. Ltd.' Development of potential sites 12, 13, 14, and 15 respectively are open for application. Due to the independent development rights of each of the potential site announced by the executive, thus the rule of no 15 of the in the environmental impact assessment is not applicable. However, due to the contiguity of the four wind farms of the Dong Energy, therefore, the feasibility of the assessment will be considered in the review of the environmental impact assessment.
The impact of offshore wind turbines on the residents' lives, social economy, landscape and recreation.	This wind farm project situates in the open sea area, the fan is 35km away from the shore, according the past wind noise simulation and actual test results of related wind projects, there is minimum to no noise pollution when

Questions and suggestions	Explanation for the questions
	the fan is 400m away, thus this project will not affect the citizens. Assessment is undergone on recreation site, related measures is drafted if it is required.
Is there any communication with fishermen's association and fishermen at this stage?	Our company has already contacted Changhua District Fisheries Association and will continue keeping in touch with them. We will communicate with fishermen through fishermen's association and to achieve a win-win situation.
Please explain the land cable and substation facilities in this development which are located in the mentioned village. Are there any traffic, environmental sanitation, noise pollution, electromagnetic wave interference?	The land cable and substation facilities of this project are located in the Zhangbin Industrial Zone, and the distance must be at least 1km away from the housing area. Please be reassured that the related assessment will be included in the statement.
The ways to settle the sediments which is excavated from land and whether there is a secondary pollution.	Changhua Binghai Industrial zone has its own land, earthwork cannot be transported outside the industrial zone, thus the job will be done in the industrial area during construction, or according to the regulations of the industrial area service centre. The contractor will be required to cover the dust-proof mesh during construction to avoid environmental pollution.
Any current successful case of offshore wind power operation?	Our company is under Dong Energy group, it owns 19 operating offshore windfarms, 6 offshore windfarms which are under construction, the capacity is the world number 1. For details, please refer to Dong Energy official website http://www.dongenergy.com/
What are the possible impacts on fishermen, tenants and oysters breeding after the operation of excavation?	The site of this construction project will be away from oyster rack and oyster breeding area, if there is unavoidable situation, the affected areas will be listed out. The issue will be discussed with the fishermen through fishermen's association for related compensation. The submarine cable has been

Questions and suggestions	Explanation for the questions
	buried under the sea during operation. So it will not affect the production of the oyster.
Any rewards or returns from this project?	If there is monitoring related job is needed in the future, the local fishermen will be the priority to carry out this task. Land cable burying and related work is also a priority to consider cooperation with local manufacturers. This can improve job opportunities and economic development.
4、Taiwan's Natural Gas Southern Division District Office (written opinion)	
According to the development plan, submarine cable path crossing the company's submarine pipeline, please provide a coordinate position across the point; if there is any changes, be assure to inform the company to cooperate with relevant safety assessments and take necessary measures.	The plan will be continued to cooperate with the intersection point of the submarine pipeline; if there is any changes, the CPC Corporation will be notified to cooperate with the relevant safety assessment and to take necessary measures.
Please provide your company with a protection project plan that crosses the point and hold a meeting of the submarine cable crossing project with the company.	The project will provide a protection engineering plan for the submarine pipeline, and hold a meeting of the submarine cable crossing project with CPC Corporation.
Water depth conditions based on development sites, consideration of the extension of the anchor system and the potential hazards with the use of heavy-duty marine implements to the marine pipe during construction, installation and operation of the wind farm. This is to ensure the safety of Taiwan’s CPC Corporation subsea pipelines.	The plan will clearly define the scope of work allowed for the project (including related underwater facilities and offshore construction operations) to be within the development site and to ensure the safety of the CPC corporation subsea pipeline.
5、CPC corporation Exploration and Production Division (written suggestion)	
The project is located in the first mining area of the company, the distance of the fan unit setting with the company three dimensional seismic survey territorial waters in the future (survey ship towing with 8 cables). The space	Thanks for the advice.

Questions and suggestions	Explanation for the questions
width is roughly 1000 meters, during the conduction of the surveys, there will inevitably lead to the limitation of cable speed and distance and will increase the company's exploration costs and result in incomplete data collection. The solution is to cooperate with the national green energy policy. The affected principled will be adjusted by our company.	
Low frequency noise pollution and vibration during future fan operation, the company's survey signal transmission and reception may be affected. If necessary, we will ask the power generation company to cooperate. Fan operation during the test period in the area is suspended to avoid interference with surveying operations.	According the experience of mentioned company in Europe, this problem has not happened in offshore wind farm operations. The company will hold a technical meeting with CPC Corporation. Any doubts or problem can be solved through this meeting.
The power generation company is asked to provide the location and quantity of the fan and the noise pollution (including frequency, amplitude and attenuation and etc). This will be the reference of our company in the future operation.	Currently, the configuration of this case has not been fully determined, and the information will be provided after the completion of the plan.
6、 Department of transportation (written suggestion)	
The purpose of setting up offshore wind power plants involves ship navigation safety, the Ministry of Economic Affairs has held symposiums in the North, Central and South Regions. The relevant discussions have yet to be discussed by the Ministry of Economic Affairs. Please ask your company's preparatory office for consultation.	Instructions are followed.

Poll Survey

This project is to understand the attitudes and opinions of residents in the planning area on the development of this project. Political university commission and Market Research Statistics Research Centre is conducting public opinion survey work

Investigations and sampling method

This survey is conducted in the area of "Da Changhua Southeast Offshore Wind Power Project", candidates with 20 years and above (citizens, fishermen, district leaders) is the main sampling of this survey. The main area of the “Da Changhua Southeast Offshore Wind Power Project” is located in the outer sea area of Xixiang and Lugang Town, Changhua County, thus 750 of the public survey is allocated, it will be prioritised in the coastal areas of Xixiang and Lugang Towns in Changhua County. In the coastal areas of Shengang Township and Fuxing Township of Changhua County, the number of samples in each survey area is allocated according to the proportion of the population. The survey is done with the local people and fishermen through face-to-face or telephone interviews from 19th November to 11th December 2016. The total survey done is 750 from the local and 209 from the fishermen. There were 1150 local/fishermen to be approached (191 locals/fishermen refused to do the survey, 750 of the locals and 209 fishermen took the survey). Opinions of the local leaders are collected (including legislators, township heads, county councillors, village chiefs, township and town representatives, fisheries, aquaculture, environmental groups, etc.). the survey from the leader was done from 19th November to 11th December 2016. 63 of the leaders was approached (13 of the leaders refused to take the survey while 50 of the leaders took the survey).

Sampling error

After completing 959 effective public questionnaires, by a 95% confidence level, the sampling error value is □ 3.16%

$$D = Z \times \sqrt{\frac{p \times q}{n}}$$

$$D = 1.96 \times \sqrt{\frac{0.5 \times 0.5}{959}} = 3.16$$

D: The sampling error value

p x q: Maximum sample standard error

Z: Confidence level

n: Sample number

Poll Results Analysis

Perception of Taiwan’s power supply situation

Local residents and fishermen's awareness of Taiwan's power supply situation. Poll results show that 46% of local residents consider Taiwan's power supply as "quite sufficient" or "sufficient", however 20% of local residents also consider Taiwan's power supply as "quite lacking" or "lacking"; 40% of fishermen consider Taiwan's regional power supply as "quite sufficient" or "sufficient", however 29% of fishermen also consider Taiwan's regional power supply as "quite lacking" or "lacking". Local residents and fishermen's response to the need of Taiwan's power supply to improve, local residents and fishermen awareness of the need to add a power plant. Poll results show that 54% of local residents consider the addition of a power plant in Taiwan "unnecessary", but 42% consider the addition of a power plant "necessary"; 55% of fishermen consider the addition of a power plant "necessary", but those who consider the addition of a power plant "unnecessary" sum up to 41%. In conclusion, local residents and fishermen's still consider the current power supply as sufficient, however in terms of their opinion towards the improvement of Taiwan's power supply. Up to 42% of local resident and 55% of the fishermen consider the addition of a power supply necessary.

The perception and attitude towards the "Changhua South-east off-shore Wind Power Project"

Understanding of the project

64% of local residents do not know about the "Changhua South-east Wind Power Project" (will be mentioned as "the project" from now on), only 6% of fishermen do not know about the project. Therefore, the development unit should emphasize on educating the local residents in future projects. If more information could be presented to the local residents certain unnecessary resistance could be avoided, easing the promotion of the project.

Current issues and problems that local residents and fishermen are concerned about

Poll results show that most local residents are concerned on the issue of "will the marine ecosystem be destroyed" (43.1%). Next is "the green power efficiency of wind power" (38.5%). Third is "the spatial planning of the power plant on sea" (28.4 %). Fishermen are more concerned on the issue of "how the fishing industry and activity space of fishermen will be affected" (35.4%). Next is the "compensation towards fishing community". Third is "the effect on fisheries" (32.5%). In general, the local residents' most concerned issue is "will the marine ecosystem be destroyed", "the green power efficiency of wind power" and "the spatial planning of the power plant on sea". Meanwhile, the fishermen's most concerned issue is "how the fishing industry and activity space of fishermen will be affected", "compensation towards fishermen" and "the effect on fisheries".

Local residents, fishermen and opinion leader's agreement on the project

Poll results shows (refer to fig. 6.5.5-3), 43% of local residents agree with the project, 42% conditionally agree with the project and 15% don't agree with the project. 45% of fishermen conditionally agree with the project, 30% agree with the project and 25% disagree with the project. Meantime, 64% of opinion leaders conditionally agree with the project, 24% agree with the project, while 12% don't agree with the project. To conclude, 15% of local residents disagree with the project, 25% of fishermen disagree with the project and 12% of opinion leaders disagree with the project. Consequently in future projects, more effort should be placed on studying the opinion of those who disagree (and conditionally agree) with the project within the fishing community. Especially issues concerning the fishermen, solutions should come up to counter the issues as to gain their support.

Reasons of why local residents, fishermen and opinion leaders agree with the project. Poll results show that (refer to figure 6.5.5-4), local residents agree with the project based on the reason that "wind power is a cleaner source of energy, it reduces carbon emissions" (73.7%). Next is because the project "effectively utilizes wind power" (66.6%). Third most popular reason is because the project "provides sufficient electricity" (31.9%). Most fishermen agree with the project because "wind power is a cleaner source of energy, it reduces carbon emissions" (37.1%). Next is because the project "provides sufficient electricity"(35.5%). Third is because the project "effectively utilizes wind power" (29%). Opinion leaders agree with the project because "wind power is a cleaner source of energy, it reduces carbon emissions" (83.3%). Next is because the project "provides sufficient electricity" (33.3%). Third is because the project can "reduce the usage of other source of energy which causes pollution" (25%). Poll results show that, most local residents, fishermen and opinion leaders agree with the project because wind power is a cleaner source of energy, it can reduce carbon emissions, at the same time reduce other sources of power supply which causes pollution and also make full use of the source of wind energy and provide sufficient supply of energy.

Reasons of why local residents, fishermen and opinion leaders disagree with the project. As shown by the poll results (refer to figure 6.5.5-5), most local residents don't agree with the project because "power supply is already sufficient" (44.7%), next is because "benefits are not good" (41.2%), third is because "there are already a number of wind power supply units" (35.1%). Most fishermen disagree with the project because it "affects the fishing community's livelihood" (66.7%), next is because the project "affects the fishing industry" (50%), third is because the project "affects the fishery's ecological environment" and "the benefits are not the best" (33.3% respectively). Poll results show that, local residents' suspicion towards the project lies in "power supply is already sufficient", "benefits are not good" and "there are already a number of wind power supply units”. Meanwhile, the fishermen’s concern towards the project is because the project “affects the fishing community’s livelihood”, “affects the fishing industry” and “affects the fishery’s ecological environment” and “the benefits are not the best”. Hence, communication with local residents, fishermen and opinion leaders should be emphasized, especially in terms of issues concerning “power supply is already sufficient”, “benefits are not good” and “there are already a number of wind power supply units” among local residents and “affects the fishing community’s livelihood”, “affects the fishing industry” and “affects the fishery’s ecological environment” and “the benefits are not the best” among the fishing community and opinion leaders. If more was explained, it is believed that more support could be garnered.

Reasons for local residents, fishermen and opinion leaders agreeing on the conditional cost plan

The survey results show that, as shown in Figure 6.5.5-6, local residents mostly agree that the conditions are "economically profitable" (54%), followed by "adequate communication with residents/fishermen" (42.2%), and the third is " "There is no impact on the living of the residents" (34.2%); the fishermen favor the condition of "providing compensation/reward measures" (69.1%) with the highest proportion, followed by "no damage to the fishery ecological environment" (24.5%), and the third is " adequate communication with fishermen" (22.3%); opinion leaders agree that the conditions for "providing compensation/reward measures" are the highest (50%), followed by "no damage to the fishery ecological environment" (34.4%), and the third is " adequate communication with residents/fishermen" (31.3%). The survey results show that the local residents' attitude towards the project is mainly based on whether they can do a good job of "economic performance", "adequate communication with residents/fishermen" and "residents' lives will not be affected". The attitude of fishermen towards the project is mainly based on whether it can provide "compensation/reward measures", "the fishery ecological environment will not be destroyed" and "adequate communication with fishermen". The opinion leaders think that it is necessary to consider "providing compensation/reward measures" and "the fishery ecological environment will not be destroyed” and "adequate communication with residents/fishermen." Therefore, in the future, the promotion of this project, especially in the "economic performance" and "living of residents will not be affected" are concerned by the local residents. Local residents, fishermen, and opinion leaders concern about whether "adequate communication with residents/fishermen", "providing compensation/reward measures" and "the fishery ecological environment will not be destroyed". If there are a proper coordination and communication channel, we believe that this project can be supported by local residents, fishermen and opinion leaders.

Matters and expectations for the "Da Chang Hua Southeast Offshore Wind Power

Generation Project"

The most important thing which is paying attention to during the construction of this project.

The local residents think that the most important things to pay attention to are "sea water quality and ecology" (61.7%), followed by "security maintenance" (46.5%), and the third is "fishery, fish catching impact" (34.7%); fishermen think that the matters which must be most concerned are "security maintenance" (44.5%), followed by "sea water quality and ecology" (39.7%), and the third is "fishing operation impact" (36.8%); opinion leaders believe that the most important things to pay attention to are "sea water quality and ecology" with the highest proportion (70%), followed by "noise and vibration" (50%), and the third was "fishery and fish catching impact" (36%). In general, during the construction period of the project being done by development unit in the future, the local residents, fishermen and opinion leaders believe that the most important things to be aware of are "sea water quality and ecology", "security maintenance", "fishery, fish catching impact" and "noise and vibration". In addition, the fishermen think that it is also necessary to pay more attention to the "fishing operation impact."

The most important thing to pay attention to during the operation of this project.

Local residents believe that the most important things to pay attention to are “the water quality and ecology of the sea area” (53.2%), followed by "security maintenance" (52.9%) and the third is "noise and vibration" (34%); fishermen believe that the most important things to pay attention to are "security maintenance" (48.8%), followed by "fisheries and fish catching impacts" (33%), and third, "fishing operation impacts" (32.5%); opinion leaders believe that the most important things to pay attention to are "sea water quality and ecology” with the highest proportion (70%), followed by "noise and vibration" (50%), and the third is "fishery and fish catching impact" (36%). In general, in the future, during the operation of the project being done by operation unit, then the local residents, fishermen and opinion leaders believe that the most important things to be aware of are "sea water quality and ecology", "security maintenance", "fishery, fish catching impact" and "noise and the vibration". In addition, the fishermen think that it is also necessary to pay more attention to the "fishing operation impact."

The communication method that local residents think the development unit should adopt

According to the survey results, local residents believe that the development unit should use the highest percentage of communication methods which is “utilizing mass media” ("56.9%"), followed by "conference briefing/ symposium" (52.3%), and the third one is "firstly informing local public opinion representatives who will explain to the residents" (33.3%); the fishermen think that the communication methods that the development unit should adopt are "conference briefing/ symposium" and "direct meeting with fishermen" with the highest proportion (all 39.7%), followed by "utilizing mass media" (14.8%);

opinion leaders believe that the development unit should use the highest percentage of communication methods which is “conference briefing/ symposium” (78%), followed by "utilizing mass media" (26%), the third is "direct meeting with fishermen" (14%). Local residents, fishermen and opinion leaders believe that the preferred communication methods are "conference briefing/ symposium" and "utilizing of mass media". In addition, fishermen and opinion leaders believe that the development unit can also do "briefing session with fishermen directly".

The main expectation or hope of local residents towards this project

The most important expectations or hopes of the local residents towards this project are, firstly, doing environmental protection and not destroying the ecology, secondly, meeting the economic benefits, and thirdly, informing the project in details and clearly explaining the pros and cons of the project. Fourthly, developing solar power. Fifthly, the wind power generation performance is not good and the wind power generation performance should be improved.

The fishermen’ most important expectations or hopes towards this project

The fishermen' most important expectations or hopes towards this project are firstly, compensation/return to local fishermen, secondly, good communication with fishermen, thirdly, a good arrangement of fishermen' livelihood. Fourthly, clear warning signs, lighting, avoiding nighttime, fishing boats sailing in foggy weather causing collisions to ensure the safety of fishermen' lives. Fifthly, informing the plan in details about the pros and cons of the plan.

Opinion leaders propose comments which are worth providing to the development unit for reference

In addition, among the opinion leaders, several opinions which are worthy of being provided to the development unit were found, firstly, wind power generation is environmentally friendly green energy and is also a future development trend. In present, there are many successful offshore wind power generation projects abroad, as long as everyone has consensus and optimism. Secondly, the Tai Hu Liu Qing and Tai Chung thermal power plants caused serious pollution and the local rebound was very extreme. It is hoped that offshore wind power generation can replace the nearby thermal power generation and reduce environmental pollution. Thirdly, most of the coastal areas of Zhang Bin are factories. The entire coastal area suffers from the pollution of Dioxin. The offshore wind power generation plan can help to clean up the charge of crime and make Chang Hua become the green energy capital. Fourthly, in present, there are Chinese white dolphins in this area, which may be affected by this plan. The impact on the ecology must be minimized, and the development unit should face it. Fifthly. in present, the EIA only has an ecological observation for one year, and many birds are only transiting. They have to live for a short period of one year only. It is necessary to extend the ecological observation to five years so that there is sufficient information to understand the influences of offshore wind power generation towards bird migration. Sixthly, It is hoped that the development unit will hold a public briefing session, express the contents of the plan clearly at the beginning, and the relevant advantages and disadvantages must be analyzed firstly and informed to the local residents. Moreover, it is necessary to hold for more several times, incorporating all opinions and giving appropriate answers to the problems of local residents. We must also provide a smooth communication channel. There is a professional window for people to ask. Every stage of the project must be open and transparent, letting everyone know the plan progress. Seventhly, the symposium should be based on local residents. It is necessary to avoid interference from people with bad intentions and protesters so that the development unit and local residents can communicate well. Eighthly, this project influences fishermen greatly. Communication with the fishermen must be strengthened, plus corresponding feedback measures must be provided. Most of them are considered for the fishermen. Trying to minimize the damage and avoiding for causing disputes. Ninthly, in present, the most concerned part of the fishermen is the content of the feedback mechanism. We hope that the development unit can propose a comprehensive feedback plan. For local residents, fishermen, groups (fishing groups, breeding groups), we must try our best to communicate and coordinate with them, and use the media to promote the benefits of wind power. In present, nuclear energy and thermal power must be decommissioned, and energy supply will not be alleviated. However, the general public simply does not know Taiwan's energy situation and hopes that the development unit will make more efforts to strengthen communication and publicity. Tenthly, we hope that the government will build it, and it will not Profit merchants and factories. Eleventhly, in the year 2020, the Chang Hua Fishing Port will be progressed. It is worrying that the offshore wind power project will affect its construction progress and hinder the development of fisheries. Twelfthly, during the construction period, it is necessary to have perfect transportation supporting measures and plan the construction route in advance to avoid affecting the 61-line and Xi Bin expressway traffic, pay attention to the safety of the construction vehicles, and repair immediately if there is damage. Thirteenly, in the event of an emergency (such as a ship’s oil spill), it must be handled immediately and must be in charge of without delay. Fourteenly, during the construction period, attention should be paid to the construction quality. The northeast monsoon is quite strong and the construction safety must be paid attention. Also, the project must be done well, so as not to trigger public protests. Fifteenly, through this project, does a good job of greening projects, beautify the coastal landscape, and bring tourism effects. Sixteenly, Lu Kang Town industrial zone has some onshore wind power generation. Due to improper maintenance leading to public grievances, it is hoped that the development unit will consider the maintenance and repair methods of the wind turbine in the future. Seventeenly, It is hoped that a special fund will be set up to engage in marine ecological maintenance, and professional scholars will be hired to study changes in topography, geomorphology, and ecology for a long period and to rehabilitate fish stocks while assisting fishermen in transformation. Eighteen, it is hoped that in the future, offshore wind power generation near the coastal area of Chang Hua will be able to give back to the locality in proportion every year and continue to improve the quality of life of residents. Nineteen, there are too many wind turbines along the coast of Chang Hua county and there are too many homes along the east coast. We hope that they will not build along the east coast. Twentiethly, the countryside dislikes the power substation a lot and the development unit has to spend a lot of thoughts to make proper communication.

Comprehensive Conclusion

In conclusion, 85% of local resident, 75% of fishermen, and 88% of the opinion leaders approve of or conditionally agree with this project, expecting the implementation able to effectively utilize resources of the local wind power, for the clean energy can not only reduce both carbon-dioxide exhaust and local pollution, but also supply sufficient power. In terms of the side of disapproval, 15% of local people, 25% of fishermen, and 12% of the opinion leaders are primarily considering the issues that could affect fishermen’s livelihood, fisheries, and ecological environment of the fishing ground, as well as the poor benefit, already sufficient power, and too many wind-power generators. The development unit convinces that they may obtain dissidents’ supports if the developing unit can properly communicate with them in the issues of maintaining ecological environment of the fishing ground and providing compensation/reciprocating measures to conform to economic benefit without any impact on residents’ livelihood. In the aspect of the construction and operation, the most noticeable item is the “Waters’ quality and ecology”, “Precaution against noise and vibration”, “Influence on fisheries and fishery harvesting”, “Impact on operation of fishing boat”, and “Safety maintenance”. Therefore, the developing unit shall hold seminars and use public media to communicate with local resident and fishermen directly, or even convene the illustration meeting and present a set of programs which can be accepted by both parties prior to secure a unanimous support from local resident, fishermen, and opinion leaders.

Figure 6.5.5-3 If Local Residents, Fishermen and Opinion Leader Agree or Disagree This Project

Figure 6.5.5-4 Resons Than Local Residents, Fishermen and Opinion Leader Agree

Figure 6.5.5-5 Reasons Of Local Residents, Fishermen and Opinion Leaders Disagree

Figure 6.5.5-6 Conditions of Local Residents, Fishermen and Opinion Leader Agree

Online announcement of the primary chapter and content

In accordance with the provision of Paragraph 1, Article 10-1 of the “Operational norm for environmental impact assessment of development activities”, prior to produce the specification, the developing unit shall publish the main chapter and content onto the website for the public to express their opinions within 20 days since the date of publication, the content of which is specified according to the description listed in Paragraph 2-4~2-8, Article 6 of the “Environmental Impact Assessment Act”. The relevant written information shall be submitted to the national competent authorities for business objectives, the city/county government (where the developing activity is held), city council/county council, and the township office. This project was publishing the relevant data on the website (http://atftp.epa.gov.tw/EIAforum) assigned by Environmental Protection Administration (please refer to Drawing 6.5.5-7), during which, no opinion being presented by the public, institution, or group.

Figure 6.5.5-7 Main Chapters Published On Internet

Transportation

Description of the Road System

Wind turbine, terrestrial cable, and booster station in this project are located in the waters outside the Xiansi and Lukang of Zhanghwa County. The primary assessing scope in this project is based on Zhanghwa County. This project is planning to use Taichung Harbor as the operational wharf, and the subsequent components will be ashore at the said harbor, then, using vehicles to transport goods to Zhanghwa County (Jobsite). Therefore, the transportation system specified in this specification comprises Taichung City and Zhanghwa County; the former includes the Tai-17, Tai-10, Chung-heng 15-route, Section 2 of Xibin Road, Section 2 of Linkag road, Yukan Road, and Beiti Road while the latter includes the Tai-17, Tai-61-EE-route, Chunghwa Road, Lugon Road, Hexian Road, Xiangon Road, Gi-An Road, Gonye-Ton-1-Route, and Zhang-144-County-Road. The road-geometric characteristics are specified as follows:

Taiwan Provincial Highway No.17

The route is located in the eastside of the project, starting from Jianan, Chinshue District of Taichung City to the Shuidiliao, Fanliao Town of Pintung Count (north to south). The road width is approximately 20~40 meters, adopting the median barrier; there are 3 express lanes and 1 all-purpose lane from Chishui to Linkag Bridge No. 2 (two-way street), and 1 express lane and 1 all-purpose lane from Jianan to Chinshui , or from Chung-Zhang county line to Zhang-Yuan (two way street). Majority of the sidewalks are not being set on both sides of the road (only a few section has the sidewalk with 2.0~2.5 meter in width) while no parking control measure is set on both sides.

Taiwan Provincial Highway No.10

The route is located in the eastside of the project, and the road width is about 50 meters, adopting the median barrier. There are 3 express lanes and I all-purpose lane, and the sidewalk with 2.0~2.5 meters in width is set on both sides of the road, but no parking control measure.

Chung-heng-15th route

The route is located in the eastside of the project, and the road width about 45 meters, adopting the median barrier. There are 3 express lanes and 1 all-purposed lane (two-way street), with sidewalks (2.0~2.5 meters in width) being set on both side of the road. No parking control measure is set on both sides.

Section 2 of Xibin Road

The route is located in the eastside of the project, and the road width about 40 meters, adopting the median barrier. There are 3 express lanes and 1 all-purposed lane (two-way street), with sidewalks (2.0~2.5 meters in width) being set on both side of the road. No parking control measure is set on both sides.

Section 2 of Linkdong East Road

The route is located in the eastside of the project, and the road width about 40 meters, adopting the median barrier. There are 3 express lanes and 1 all-purposed lane (two-way street), with sidewalks (2.0~2.5 meters in width) being set on both side of the road. No parking control measure is set on both sides.

Yukang Road

The route is located in the eastside of the project, and the road width about 30 meters, adopting the median barrier. There are 3 all-purposed lanes (two-way street), with sidewalks (3.0~3.5 meters in width) being set on both side of the road. No parking control measure is set on both sides.

Beiti Road

The route is located in the eastside of the project, and the road width about 25 meters, adopting the median barrier. There are 3 all-purposed lanes (two-way street). No sidewalk, or parking control measure, is set on both sides of the road.

Taiwan No.61 Provincial Highway

The route is located in the eastside of the project, and the road width about 20 meters, adopting the median barrier. There are 1 express lane and 1 all-purposed lane (two-way street). No sidewalk, or parking control measure, is set on both sides of the road.

Chunghwa Road

The route is located in the eastside of the project, and the road width about 30 meters, adopting the median barrier. There are 2 express lanes and 1 all-purposed lane (two-way street). No sidewalk, or parking control measure, is set on both sides of the road.

Lugong Road

The route is located in the eastside of the project, and the road width about 30 meters, adopting the median barrier. There are 2 express lanes and 1 all-purposed lane (two-way street), with sidewalks (3.0~3.5 meters in width) being set on both side of the road. No parking control measure is set on both sides.

Hexian Road

The route is located in the eastside of the project, and the road width about 30 meters, adopting the median barrier. There are 2 express lanes and 1 all-purposed lane (two-way street). No sidewalk, or parking control measure, is set on both sides of the road.

Xiangong Road

The route is located in the eastside of the project, and the road width about 30 meters, adopting the median barrier. There are 2 express lanes and 1 all-purposed lane (two-way street), with sidewalks (1.5~2.0 meters in width) being set on both side of the road. No parking control measure is set on both sides.

Gi-An Road

The route is located in the eastside of the project, and the road width about 20 meters, adopting the median barrier. There are 2 all-purposed lanes (two-way street). No sidewalk, or parking control measure, is set on both sides of the road.

Gonye East-1 Road

The route is located in the eastside of the project, and the road width about 30 meters, adopting the median barrier. There are 2 express lanes and 1 all-purposed lane (two-way street). No sidewalk, or parking control measure, is set on both sides of the road.

Zhang-114-Route

The route is located in the eastside of the project, and the road width about 30 meters, adopting the median barrier. There are 1 express lane and 1 all-purposed lane (two-way street). No sidewalk, or parking control measure, is set on both sides of the road.

Road Type and Definition

According to the definition of the "2011 Taiwan highway Capacity Manuel" published by Institute of Transportation, MOTC, our project area shall be classified as suburban district, thus, the peripheral road system in this project is based on the "Suburban highway with multiple lanes", and the method to assess its service level is adopting V/C specific value as a norm to assess the road-burdened level. According to the definition abovementioned, estimation of the road capacity is specified as follows:

The flow rate (fl/rt) and vehicles necessary for suburban highway can be estimated by following formulas:

Unidirectional Demand Flow Rate：

$$Q_{15} = \frac{Q_{60}}{PHF}$$

Q_{15} = Flow rate for 15 minutes in rush hours (unidirectional)

Q_{60} = Flow rate for 60 minutes in rush hours (unidirectional)

PHF = Factor of the peak hour；

$$q_1 = Q_{15}(P_s f_{s1} + P_B f_{B1} + P_m f_{m1}) \qquad \text{(Formulae 1)}$$

$$q_2 = Q_{15} - q_1$$

q_1 = Flow rate (car/hour) for 15 minutes in rush hours (all-purposed lane)；

q_2 = Flow rate (car/hour) for 15 minutes in rush hours (express lane)

Formulae 1：

Ps、PB、Pm：Ratio of the small car, large vehicle, and motorcycle in total flowing rate

f_{s1}、f_{B1}、f_{m1}：Individual ratio of the small car, large vehicle, and motorcycle in all-purposed lane

Vehicle composition of various lanes

$$P_{k1} = \frac{P_k f_{k1}}{P_S f_{S1} + P_B f_{B1} + P_m f_{m1}} \text{，k=s,B,m} \qquad \text{(Formulae 2)}$$

Where 2：

P_{k1}：small car(k=s)、large vehicle (k=B)or motorcycle (k=m) in all purpose lane.

$$P_{k2} = \frac{P_k(1-f_{k1})}{P_S(1-f_{S1}) + P_B(1-f_{B1}) + P_m(1-f_{m1})} \text{，k=s,B,m (Formulae 3)}$$

Where 3：

P_{k2} ：small car(k=s)、large vehicle (k=B)or motorcycle (k=m)in all purpose lane

Flow rate of the small car and large vehicle can be estimated by following formula:

$$q_{ie} = q_i\left[1 + P_{mi}\left(E_m - 1\right)\right] \qquad (式 4)$$

Where 4：

q_{ie} ：Lane i (i = All-purpose lane，i =2 fast lane) flow rate (car/hour/lane) of the small car and large vehicle for 15 minutes in rush hours:

q_i ：Flow rate for 15 minutes in rush hours (car/hour/lane)

P_{mi} ：Vehicle ratio and the ratio of motorcycle to lane at lane I

E_m ：PCU (Passenger Car Unit) off the motorcycle (recommended value：0.36)

Average free speed of various vehicles on uphill road can be computed by following formula:

$$f_g = \frac{1}{1+e^{-Y}}$$

$$Y = \frac{6.4998}{1+e^{-S_1}} - \frac{8.1753}{1+e^{-S_2}} + \frac{15.0024}{1+e^{-S_3}} - \frac{9.2259}{1+e^{-S_4}} + 10.7942$$

$$S_i = \left[\sum_{j=1}^{3} A_{ij} X_j\right] + A_{i4} \quad , i=1,2,3,4 \qquad \text{(Formula 5)}$$

Where 5：

X_1 ：Gradient (% divided by 100)

X_2 ：Large vehicle percentage (% divided by 100)；

X_3 ：Ramp (meter divided by 4000)

A_{ij} ：Shown as Table 6.6-1:

Average free speed under the ramp

$$V_{gi} = P_{si}V_{fs} + P_{Bi}V_{gB} + P_{mi}V_{fm} \qquad \text{(Formulae 6)}$$

其中式 6：

i ：1(混合車道)或 2(快車道) ；

P_{si} ：Ratio of the small car on the first land

P_{Bi} ：Ratio of the large vehicle on the first land

P_{mi} ：Ratio of the motorbike on the first land

P_{mi} ：Ratio of the motorbike on the first land

V_{fi} ：Free speed of the small car on flat section

V_{gi} ：Average free speed of the lane at critical point

V_{gB} ：Average free speed of the large vehicle at critical point capacity can be computed by following formula:

$$C = C_0 f_w f_g \qquad \text{(Formula 7)}$$

Where 7：

C ：Lane capacity (small car and large vehicle /hour/lane)

C_0 ：The lane capacity under basic condition (small car/hour/lane)

f_w ：Adjusting factor of the horizontal net distance is shown as Table 6.6-2:

f_g ：Gradient-adjusting factor means the ratio between capacity of the gradient section (small car and large vehicle/hour/lane) and capacity of the flat section.

Estimation of flow rate and capacity can be computed by following formula:

$\frac{V}{C} = \frac{q_{ie}}{C_0 f_w f_g}$ ，Service level’s relevant flow rate/capacity is shown as table 6.6-3 (Formula 8))

Table 6.6-1 Ramp Capacity AdjustmentFactor A_{ij} Chart

i	j			
	1	2	3	4
1	-25.4311	1.5927	0.5364	2.0164
2	-28.4141	0.9223	29.0412	3.9001
3	-2.1535	-20.9247	-0.9524	-1.4430
4	-7.7392	2.1329	0.4501	0.7088

Source: 2011 Taiwan Highway Capacity Handbook, Institute of Transportation, 100 years of the Republic of China.

Table 6.6-2 Horizontal Clearance Distance Adjustment Factor Chart

Horizontal Clearance Distance (m)	Adjustment Factor							
	One-side obstacle				Double-side obstacle			
	Lane width (m)							
	3.75	3.50	3.0	2.75	3.75	3.50	3.0	2.75
Multi-lane road with four-line physical separation								
≥ 2.0	1.00	0.97	0.91	0.81	1.00	0.97	0.91	0.81
1.2	0.99	0.98	0.90	0.80	0.98	0.95	0.89	0.79
0.5	0.97	0.94	0.88	0.79	0.94	0.91	0.86	0.76
0	0.90	0.87	0.82	0.73	0.81	0.79	0.74	0.66
Multi-lane road with six-line physical separation								
≥ 2.0	1.00	0.96	0.89	0.78	1.00	0.96	0.89	0.78
1.2	0.99	0.95	0.88	0.77	0.98	0.94	0.87	0.77
0.5	0.97	0.93	0.87	0.76	0.96	0.92	0.85	0.75
0	0.94	0.91	0.85	0.74	0.91	0.87	0.81	0.70
Multi-lane road without four-line physical separation								
≥ 2.0	1.00	0.95	0.89	0.77	1.00	0.95	0.88	0.75
1.2	0.98	0.94	0.88	0.76	0.97	0.93	0.87	0.73
0.5	0.95	0.92	0.86	0.75	0.94	0.91	0.86	0.71
0	0.88	0.85	0.80	0.70	0.81	0.79	0.74	0.66
Multi-lane road without six-line physical separation								
≥ 2.0	1.00	0.95	0.89	0.77	1.00	0.95	0.88	0.77
1.2	0.99	0.94	0.88	0.76	0.97	0.93	0.86	0.75
0.5	0.97	0.93	0.86	0.75	0.96	0.92	0.85	0.73
0	0.94	0.90	0.83	0.72	0.91	0.87	0.81	0.70

Source: 2011 Taiwan Highway Capacity Handbook, Institute of Transportation, 100 years of the Republic of China.

Table 6.6-3 Multi-lane Suburban Road Service Level Standard Table

Service Level	Volume/Capacity Ratio，V/C
A	0.00～0.37
B	0.38～0.62
C	0.63～0.79
D	0.80～0.91
E	0.92～1.00
F	>1.00

Source: 2011 Taiwan Highway Capacity Handbook, Institute of Transportation, 100 years of the Republic of China.

Analysis on Traffic Volume and Service Level

To analysis service level of the section and intersect adjacent to our job site, we conduct an investigation on peripheral roads and traffic traits; the surveying dates respective as Sep. 10, 2016 (Sat. clear day), Sep. 11 (Sunday; clear day), Sep. 22 (Thursday; clear day), Sep. 24 (Sat. clear day), Oct. 6 (Thursday; clear day), and Oct. 8 (Sat. ;clear day). The road surveyed comprises the Tai-17, Tai-10, Tai-61-Yi-Route, Chungheng-15-Routh, Section 2 of Xibin Road, Section 2 of Ligan East Road, Yukan Road, and Beiti Road within the boundary of Taichung City, as well as the Tai-17, Zhang-144 County Road, Chunghwa Road, Access Road No. 5, Hexian Road, Xiangon Road, Gi-An Road, Konye-Tung-1-Road, and Lu-an Road within the boundary of Zhanghwa County. The intersection surveyed includes 3 intersections of Tai-17/Yukan Road, Tai-17/Tai-10, and Tai 17/Section 2 of Likan East Road within the boundary of Taichung City, and 8 intersections of the Tai-17/Tai-61-Yi-Route, Tai-61/Xiangon Road, Tai-61/Lugon Road, Tai-17/Section 2 of Luchao Road, Gi-An Road/Konye-Tung-I-Road, Tai-17/Zhang-144 County Road, Tai-17/Zhang-143, and Tai-17/Chunghwa Road within the boundary of Zhanghwa County, so as to realize the traffic system and service situation onto those sections and intersections adjacent to our job site.

Analysis on service level of the section

According to the definition of the "2011 Taiwan highway Capacity Manuel" published by Institute of Transportation, MOTC, our project is based on the "Suburban highway with multiple lanes", and the method to assess its service level is adopting V/C specific value as a norm to assess the road-burdened level.

The assessing result shows, the section service level is Grade A-C during dull hour in normal day and rush hour in formal holiday; it reveals, traffic flow is running smoothly on each section. The service level of the rush-hour section during normal day and formal holiday is assessed as per List 6.6-4 and 6.6-5 while the service level of currently peripheral road is shown as per Drawing 6.6-1 and 6.6-2. The related description is specified as follows:

Taiwan No.17 Provincial Highway

During dull hour in normal days, V/C is amid 0.02~0.20, and the section service level is

Grade A; during peak hour in formal holidays, V/C is amid 0.03~0.16, and the section service level is Grade A.

Taiwan No.10 Provincial Highway

During dull hour in normal days, V/C is amid 0.04~0.20, and the section service level is Grade A; during peak hour in formal holidays, V/C is amid 0.06~0.08, and the section service level is Grade A.

Chungheng-15-Route

During dull hour in normal days, V/C is amid 0.02~0.06, and the section service level is Grade A; during peak hour in formal holidays, V/C is amid 0.04~0.05, and the section service level is Grade A.

Section 2 of Xibin Road

During dull hour in normal days, V/C is amid 0.07~0.11, and the section service level is Grade A; during peak hour in formal holidays, V/C is amid 0.06~0.07, and the section service level is Grade A.

Section 2 of Linkang East Road

During dull hour in normal days, V/C is amid 0.05~0.13, and the section service levelis Grade A; during peak hour in formal holidays, V/C is amid 0.05~0.08, and the section service level is Grade A.

Yukan Road

During dull hour in normal days, V/C is amid 0.02~0.13, and the section service level is Grade A; during peak hour in formal holidays, V/C is amid 0.03~0.05, and the section service level is Grade A.

Beiti Road

During dull hour in normal days, V/C is amid 0.02~0.10, and the section service level is Grade A; during peak hour in formal holidays, V/C is amid 0.03~0.16, and the section service level is Grade A.

Taiwan 61 Provincial Highway

During dull hour in normal days, V/C is amid 0.04~0.19, and the section service level is Grade A; during peak hour in formal holidays, V/C is amid 0.08~0.12, and the section service level is Grade A.

Section 2 of Linkan East Road

During dull hour in normal days, V/C is amid 0.05~0.13, and the section service level is Grade A; during peak hour in formal holidays, V/C is amid 0.05~0.08, and the section service level is Grade A.

Changhua 144 County Highway

During dull hour in normal days, V/C is amid 0.09~0.12, and the section service level is Grade A; during peak hour in formal holidays, V/C is around 0.03, and the section service level is Grade A.

Chunghwa Road

During dull hour in normal days, V/C is amid 0.02~0.15, and the section service level is Grade A; during peak hour in formal holidays, V/C is amid 0.03~0.11, and the section service level is Grade A.

Access Road No. 5

During dull hour in normal days, V/C is amid 0.04~0.43, and the section service level is Grade A; during peak hour in formal holidays, V/C is amid 0.05~0.09, and the section service level is Grade A.

Lugong Road

During dull hour in normal days, V/C is amid 0.04~0.66, and the section service level is Grade A; during peak hour in formal holidays, V/C is amid 0.06~0.11, and the section service level is Grade A.

Hexian Road

During dull hour in normal days, V/C is amid 0.04~0.29, and the section service level is Grade A; during peak hour in formal holidays, V/C is amid 0.04~0.09, and the section service level is Grade A.

Xiangong Road

During dull hour in normal days, V/C is amid 0.02~0.15, and the section service level is Grade A; during peak hour in formal holidays, V/C is amid 0.05~0.09, and the section service level is Grade A.

Ji'An Road

During dull hour in normal days, V/C is amid 0.01~0.10, and the section service level is Grade A; during peak hour in formal holidays, V/C is amid 0.01~0.03, and the section service level is Grade A.

Gonye-Tung-I-Road

During dull hour in normal days, V/C is amid 0.01~0.20, and the section service level is Grade A; during peak hour in formal holidays, V/C is amid 0.02~0.06, and the section service level is Grade A.

Lu'An Bridge

During dull hour in normal days, V/C is amid 0.02~0.35, and the section service level is Grade A; during peak hour in formal holidays, V/C is amid 0.03~0.12, and the section service level is Grade A.

Table 6.6-4 Current Condition of Weekday and Weekend Peak Hour Road Service Level Evaluation Table (in Taichung City)

Road	Road Section	Direction	Weekday morning peak hour				Weekday afternoon peak hour				Weekend peak hour			
			Capacity	Volume	V/C	Service Level	Capacity	Volume	V/C	Serviece Level	Capacity	Volume	V/C	Service Level
Provincial Highway 17 (Lingang Rd. Sec 6.)	Beiti Rd. North	Southwards	5,390	648	0.12	A	5,350	397	0.07	A	5,396	465	0.09	A
		Northwards	7,162	285	0.04	A	7,201	499	0.07	A	7,201	557	0.08	A
	Beiti Rd. South	Southwards	7,198	570	0.08	A	7,163	521	0.07	A	7,196	520	0.07	A
		Northwards	7,186	459	0.06	A	7,203	506	0.07	A	7,197	466	0.06	A
Provincial Highway 17 (Lingang Rd. Sec 5.)	Provincial Highway 10 North	Southwards	7,193	603	0.08	A	7,199	811	0.11	A	7,212	866	0.12	A
		Northwards	7,194	519	0.07	A	7,203	728	0.10	A	7,215	938	0.13	A
	Provincial Highway 10 South	Southwards	7,196	805	0.11	A	7,189	826	0.11	A	7,209	857	0.12	A
		Northwards	7,186	664	0.09	A	7,198	701	0.10	A	7,213	987	0.14	A
Provincial Highway 17 (Lingang Rd. Sec 1.)	Provincial Highway 61 West	Eastwards	7,198	354	0.05	A	7,205	889	0.12	A	7,208	558	0.08	A
		Westwards	7,206	869	0.12	A	7,190	469	0.07	A	7,191	310	0.04	A
Provincial Highway 17	Lingang East Rd. Sec. 2 South	Southwards	3,604	328	0.09	A	3,605	616	0.17	A	3,609	262	0.07	A
		Northwards	3,597	272	0.08	A	3,595	410	0.11	A	3,608	255	0.07	A
Provincial Highway 10 (Chungchung Rd. Sec. 9)	Provincial Highway 17 East	Eastwards	7,186	262	0.04	A	7,198	588	0.08	A	7,219	581	0.08	A
		Westwards	7,204	495	0.07	A	7,174	330	0.05	A	7,211	457	0.06	A
Chungheng 15 Rd.	Provincial Highway 17 West	Eastwards	7,178	159	0.02	A	7,191	464	0.06	A	7,218	387	0.05	A
		Westwards	7,183	339	0.05	A	7,159	165	0.02	A	7,206	320	0.04	A
Hsipin Rd. Sec. 2	Lingang East Rd. Sec. 2 North	Southwards	7,205	502	0.07	A	7,195	819	0.11	A	7,210	506	0.07	A
		Northwards	7,198	516	0.07	A	7,175	556	0.08	A	7,199	422	0.06	A
Lingang East Rd. Sec. 2	Provincial Highway 61 East	Eastwards	5,401	284	0.05	A	5,408	715	0.13	A	5,409	449	0.08	A
		Westwards	5,406	729	0.13	A	5,392	342	0.06	A	5,412	278	0.05	A

Road	Road Section	Direction	Weekday morning peak hour				Weekday afternoon peak hour				Weekend peak hour			
			Capacity	Volume	V/C	Service Level	Capacity	Volume	V/C	Serviece Level	Capacit y	Volume	V/C	Service Level
Yugang Rd	Provincial Highway 17 East	Westwards	5,398	134	0.02	A	5,402	206	0.04	A	5,404	160	0.03	A
		Eastwards	5,386	225	0.04	A	5,395	112	0.02	A	5,412	146	0.03	A
Beiti Rd	Provincial Highway 17 West	Westwards	5,379	210	0.04	A	5,405	520	0.10	A	5,410	872	0.16	A
		Eastwards	5,383	553	0.10	A	5,392	309	0.06	A	5,410	712	0.13	A

Source: analysis of this project

Table 6.6-5 Current Condition of Weekday and Weekend Peak Hour Road Service Level Evaluation Table (in Changhua County)

Road	Road Section	Direction	Weekday morning peak hour				Weekday afternoon peak hour				Weekend peak hour			
			Capacity	Volume	V/C	Service Level	Capacity	Volume	V/C	Service Level	Capacit y	Volume	V/C	Service Level
Provincial Highway 17 (Jianguo Rd.)	Provincial Highway 61 North	Southwards	3,608	242	0.07	A	3,608	409	0.11	A	3,608	183	0.05	A
		Northwards	3,610	360	0.10	A	3,609	286	0.08	A	3,608	182	0.05	A
	Provincial Highway 61 South	Southwards	3,608	251	0.07	A	3,608	529	0.15	A	3,608	252	0.07	A
		Northwards	3,609	451	0.12	A	3,608	350	0.10	A	3,608	258	0.07	A
Provincial Highway 17	Chunghua Rd. North	Southwards	3,601	192	0.05	A	3,605	67	0.02	A	3,608	218	0.06	A
		Northwards	3,594	134	0.04	A	3,605	193	0.05	A	3,608	333	0.09	A
	Chunghua Rd. South	Southwards	3,601	124	0.03	A	3,608	302	0.08	A	3,608	197	0.05	A
		Northwards	3,607	557	0.15	A	3,601	260	0.07	A	3,609	126	0.03	A
Provincial Highway 17 (Lutsau Rd. Sec. 2)	Provincial Highway 17 North	Southwards	3,608	721	0.20	A	3,608	501	0.14	A	3,609	526	0.15	A
		Northwards	3,606	563	0.16	A	3,607	707	0.20	A	3,610	574	0.16	A
Provincial Highway 17	Lutsau Rd. Sec. 2 West	Southwards	5,404	575	0.11	A	5,412	1,172	0.22	A	5,415	512	0.09	A
		Northwards	5,409	997	0.18	A	5,410	285	0.05	A	5,414	325	0.06	A
Provincial Highway 17	Chang 144 County Rd. North	Southwards	3,603	133	0.04	A	3,607	181	0.05	A	3,607	98	0.03	A
		Northwards	3,609	562	0.16	A	3,609	538	0.15	A	3,609	377	0.10	A
	Chang 144 County Rd. South	Southwards	3,606	85	0.02	A	3,607	239	0.07	A	3,606	147	0.04	A
		Northwards	3,609	556	0.15	A	3,609	505	0.14	A	3,609	352	0.10	A
Provincial Highway 17	Chang 143 County Rd. East	Eastwards	3,609	362	0.10	A	3,606	308	0.09	A	3,608	267	0.07	A
		往西	3,608	281	0.08	A	3,607	282	0.08	A	3,607	306	0.08	A
	Chang 143 County Rd. West	Eastwards	3,609	207	0.06	A	3,606	164	0.05	A	3,608	159	0.04	A
		Westwards	3,608	332	0.09	A	3,607	241	0.07	A	3,607	203	0.06	A
Provincial Highway 61	Chunghua Rd. North	Southwards	3,601	192	0.05	A	3,605	67	0.02	A	3,608	218	0.06	A
		Northwards	3,594	134	0.04	A	3,605	193	0.05	A	3,608	333	0.09	A
	Chunghua Rd. South	Southwards	3,601	124	0.03	A	3,608	302	0.08	A	3,608	197	0.05	A
		Northwards	3,607	557	0.15	A	3,601	260	0.07	A	3,609	126	0.03	A

Source: analysis of this project

Table 6.6-5 Current Condition of Weekday and Weekend Peak Hour Road Service Level Evaluation Table (in Changhua County) (Continued)

Road	Road Section	Direction	Weekday morning peak hour				Weekday afternoon peak hour				Weekend peak hour			
			Capacity	Volume	V/C	Service Level	Capacity	Volume	V/C	Service Level	Capacity	Volume	V/C	Service Level
Provincial Highway 61	Provincial Highway 17 East	Eastwards	3,604	240	0.07	A	3,606	685	0.19	A	3,607	440	0.12	A
		Westwards	3,606	674	0.19	A	3,602	255	0.07	A	3,608	368	0.10	A
	Provincial Highway 17 West	Eastwards	3,601	153	0.04	A	3,606	624	0.17	A	3,606	361	0.10	A
		Westwards	3,606	668	0.19	A	3,597	138	0.04	A	3,607	297	0.08	A
Chang 144 County Rd	Provincial Highway 17 East	Eastwards	3,602	356	0.10	A	3,607	424	0.12	A	3,607	100	0.03	A
		Westwards	3,602	395	0.11	A	3,607	443	0.12	A	3,608	99	0.03	A
	Provincial Highway 17 West	Eastwards	3,602	245	0.07	A	3,608	406	0.11	A	3,607	110	0.03	A
		Westwards	3,601	338	0.09	A	3,607	334	0.09	A	3,608	113	0.03	A
Chuanghua Rd.	Provincial Highway 61 East	Eastwards	5,408	99	0.02	A	5,411	572	0.11	A	5,415	174	0.03	A
		Westwards	5,408	363	0.07	A	5,409	223	0.04	A	5,413	575	0.11	A
	Provincial Highway 17 West	Eastwards	5,399	84	0.02	A	5,413	631	0.12	A	5,415	262	0.05	A
		Westwards	5,411	836	0.15	A	5,399	115	0.02	A	5,414	477	0.09	A
Lianluo No.5 Rd	Provincial Highway 61 East	Eastwards	5,407	237	0.04	A	5,413	1,546	0.29	A	5,412	479	0.09	A
		Westwards	5,413	2,329	0.43	B	5,410	537	0.10	A	5,415	271	0.05	A
Lugung Rd. (Bridge)	Provincial Highway 61 West	Eastwards	5,399	223	0.04	A	5,412	2,258	0.42	B	5,410	607	0.11	A
		Westwards	5,413	3,557	0.66	C	5,405	621	0.11	A	5,413	301	0.06	A
Hehsien Rd.	Provincial Highway 17 East	Westwards	5,414	770	0.14	A	5,411	341	0.06	A	5,413	206	0.04	A
		Eastwards	5,407	237	0.04	A	5,413	1,546	0.29	A	5,412	479	0.09	A
Shiangung Rd. (Bridge)	Provincial Highway 61 West	Eastwards	5,399	84	0.02	A	5,413	631	0.12	A	5,415	262	0.05	A
		Westwards	5,411	836	0.15	A	5,399	115	0.02	A	5,414	477	0.09	A
Ji'An Road	Gongye East No. 1 Rd. North	Southwards	3,608	185	0.05	A	3,608	102	0.03	A	3,609	62	0.02	A
		Northwards	3,609	130	0.04	A	3,609	139	0.04	A	3,610	91	0.03	A
	Gongye East No. 1 Rd. South	Southwards	3,608	252	0.07	A	3,605	49	0.01	A	3,603	21	0.01	A
		Northwards	3,608	39	0.01	A	3,609	345	0.10	A	3,608	120	0.03	A
Gongye	Jian Rd. West	Eastwards	5,396	54	0.01	A	5,413	721	0.13	A	5,414	343	0.06	A

Road	Road Section	Direction	Weekday morning peak hour				Weekday afternoon peak hour				Weekend peak hour			
			Capacity	Volume	V/C	Service Level	Capacity	Volume	V/C	Service Level	Capacit y	Volume	V/C	Service Level
East No. 1 Rd.		Westwards	5,413	1,083	0.20	A	5,402	89	0.02	A	5,413	83	0.02	A
Luan Bridge	Jian Rd. East	Eastwards	3,602	74	0.02	A	3,609	1,002	0.28	A	3,609	435	0.12	A
		Westwards	3,609	1,262	0.35	A	3,602	112	0.03	A	3,608	104	0.03	A

Source: analysis of this project.

Analysis of Intersection Service Level

The intersections relate4d to the Project mainly include the following: Intersections of Tai 17 and Ygang Road, Tai 17 and Tai 10, Tai 17 and Sec. 2 of Lingang East Road, Tai 17 and Tai 61 B, Tai 61 and Xiangong Road, Tai 61 and Lugong Road, Tai 17 and Sec. 2 of Lucao Road, Jian Road and Gongyeh East 1st Road, Tai 17 and Zhang 144, Tai 17 and Zhang 143, and Tai 17 and Zhonghua Road, total 11 intersection with traffic signs.

In order to evaluate the service level of traffic sign intersection at the peripheral of the project site, we input Intersection Turning Traffic Volume, Road Geometric Design and Intersection Time Swap System Plan into HCS Traffic Software to evaluate the intersection service levels of peak hours in the morning and in the evening of week days and peak hour section in holidays for their service level. Also, the service level assessment standard of intersection with traffic signs of “2011 Taiwan Highway Capacity Manual” and the results are shown in Table 6.6-5.

According to the results of evaluation of this Project, the intersection service levels in the peak hours of morning and evening of ordinary days and the peak hours of peak hours of intersections around the Project Site are B to C Class. It means, the conditions of each of the intersections is okay for vehicles to pass through. The service level evaluation of intersection with traffic signs is shown in Table 6.6-7 and Table 6.6-8 and road service levels of the road around the Project Site are shown in Fig. 6.6-1 and Fig. 6.6-2. The conditions of related intersections are given below:

Tai 17 and Yugang Road

In the morning and evening peak hours of ordinary day, each car is delayed for 40.9 to 41.2 seconds in average and the service level is of Class C. The peak hours of holidays, the delay is about 44.2 seconds in average and the intersection service level is Class C.

Tai 17 and Tai 10

In the morning and evening peak hours of ordinary day, each car is delayed for 30.4 to 32.2 seconds in average and the service level is of Class C. The peak hours of holidays, the delay is about 25.9 seconds in average and the intersection service level is Class B.

Tai 17 and Sec. 2 Lingang East Road

In the morning and evening peak hours of ordinary day, each car is delayed for 44.5 to 44.6 seconds in average and the service level is of Class C. The peak hours of holidays, the delay is about 43.4 seconds in average and the intersection service level is Class C.

Tai 17 and Tai 61 B

In the morning and evening peak hours of ordinary day, each car is delayed for 25.8 to 31.4 seconds in average and the service level is of Class B-C. The peak hours of holidays, the delay is about 25.2 seconds in average and the intersection service level is Class B.

Tai 61 and Xiangong Road

In the morning and evening peak hours of ordinary day, each car is delayed for 37.9 to 41.8 seconds in average and the service level is of Class C. The peak hours of holidays, the delay is about 39.3 seconds in average and the intersection service level is Class C.

Tai 61 and Lugong Road

In the morning and evening peak hours of ordinary day, each car is delayed for 31.7 to 41.9 seconds in average and the service level is of Class C. The peak hours of holidays, the delay is about 30.8 seconds in average and the intersection service level is Class C.

Tai17 and Sec. 2, Lucao Road

In the morning and evening peak hours of ordinary day, each car is delayed for 27.0 to 34.7 seconds in average and the service level is of Class B to C. The peak hours of holidays, the delay is about 30.6 seconds in average and the intersection service level is Class C.

Jian Road and Gongyeh East 1set Road

In the morning and evening peak hours of ordinary day, each car is delayed for 29.6 to 32.1 seconds in average and the service level is of Class B-C. The peak hours of holidays, the delay is about 23.6 seconds in average and the intersection service level is Class B.

Tai 17 and Zhang 144

In the morning and evening peak hours of ordinary day, each car is delayed for 29.4 to 31.0 seconds in average and the service level is of Class B to C. The peak hours of holidays, the delay is about 28.5 seconds in average and the intersection service level is Class B.

Tai 17 / Zhang 143

In the morning and evening peak hours of ordinary day, each car is delayed for 21.1 to 28.1 seconds in average and the service level is of Class B. The peak hours of holidays, the delay is about 15.7 seconds in average and the intersection service level is Class B.

Tai 17 and Zhonghua Road

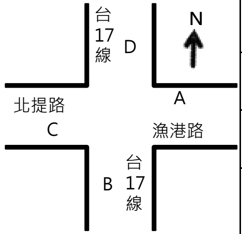
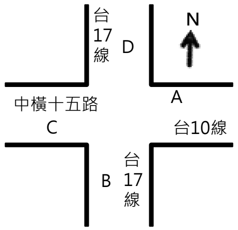
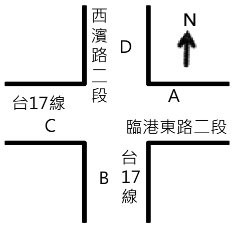
In the morning and evening peak hours of ordinary day, each car is delayed for 39.5 to 40.1 seconds in average and the service level is of Class C. The peak hours of holidays, the delay is about 39.0 seconds in average and the intersection service level is Class C.

Table 6.6-6 Service Level Assessment Table at Haozhihua Intersection

Service Level	Average Delay Seconds at Haozhihua Intersection
A	D≦15
B	15＜D≦30
C	30＜D≦45
D	45＜D≦60
E	60＜D≦80
F	D>80

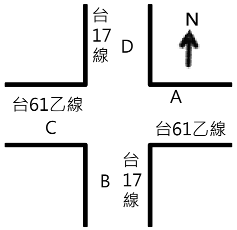
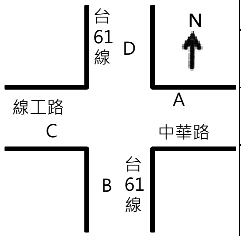
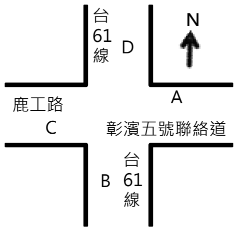
Source: 2011 Taiwan Highway Capacity Handbook, Institute of Transportation, 100 years of the Republic of China.

Table 6.6-7 Compilation Table of Assessment at Houzhihua Intersection (Within Taichung City)

Name	Figure	Direction	Weekday morning peak hour			Weekday afternoon peak hour			Weekend peak hour		
			Average Delay (second)		Service Level	Average Delay (second)		Service Level	Average Delay (second)		Service Level
Taiwan 17 Provincial Highway │ Yugang Road		A	49.2	41.2	C	48.5	40.9	C	48.9	44.2	C
		B	45.7			40.9			46.8		
		C	48.9			49.9			51.0		
		D	33.4			33.9			33.6		
Taiwan 17 Provincial Highway │ Taiwan 10 Provincial Road		A	48.9	32.2	C	62.6	30.4	C	53.1	25.9	B
		B	31.7			18.5			17.2		
		C	40.0			56.6			46.5		
		D	17.2			11.0			12.4		
Taiwan 17 Provincial Highway │ Linggang East road 2 section		A	41.8	44.6	C	41.5	44.5	C	40.5	43.4	C
		B	49.6			48.2			47.8		
		C	40.1			37.4			38.8		
		D	46.5			48.4			46.6		

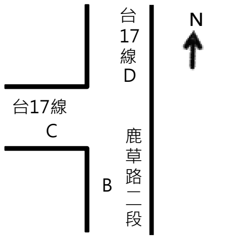
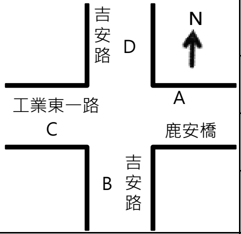
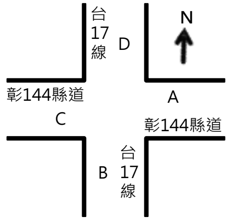
Source: analysis of this project

Table 6.6-8 Compilation Table of Assessment at Houzhihua Intersection (Within ChanghuaCounty)

Name	Figure	Direction	Weekday morning peak hour			Weekday afternoon peak hour			Weekend peak hour		
			Average Delay (second)		Service Level	Average Delay (second)		Service Level	Average Delay (second)		Service Level
Taiwan 17 Provincial Highway ｜ Taiwan 61 B Provincial Highway		A	27.2	25.8	B	64.0	31.4	C	29.6	25.2	B
		B	26.6			25.7			24.7		
		C	20.2			24.0			21.7		
		D	24.4			26.0			23.8		
Taiwan 61 Provincial Highway ｜ Xiangong Road		A	37.4	41.8	C	36.8	37.9	C	40.8	39.3	C
		B	46.5			42.2			40.3		
		C	31.9			36.2			33.6		
		D	41.1			40.0			41.8		
Taiwan 61 Provincial Highway ｜ Lugong Road		A	48.8	41.9	C	36.9	31.7	C	35.6	30.8	C
		B	52.6			47.3			46.6		
		C	18.5			28.0			16.0		
		D	18.6			34.7			45.0		

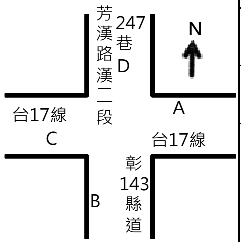
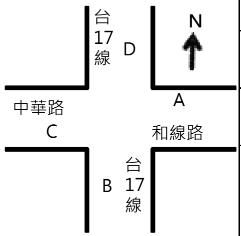
Source: Analysis of this project

Table 6.6-8 Compilation Table of Assessment at Houzhihua Intersection (Within ChanghuaCounty) (Cont. 1)

Name	Figure	Direction	Weekday morning peak hour			Weekday afternoon peak hour			Weekend peak hour		
			Average Delay (second)		Service Level	Average Delay (second)		Service Level	Average Delay (second)		Service Level
Taiwan 17 Provincial Highway │ Lu Cao 2 Section		A	-	34.7	C	-	27.0	B	-	30.6	C
		B	40.3			36.8			37.1		
		C	19.4			18.1			17.3		
		D	39.8			37.6			37.0		
Ji'An Road │ Gong YE 1 Road		A	32.7	32.1	C	20.2	29.6	B	19.5	23.6	B
		B	30.9			36.0			32.1		
		C	17.0			27.6			20.4		
		D	32.8			32.6			31.5		
Taiwan 17 Provincial Highway │ Changhua 144 County Road		A	35.2	29.4	B	37.2	31.0	C	33.4	28.5	B
		B	23.3			23.0			21.8		
		C	32.6			35.4			32.9		
		D	29.5			27.0			26.0		

Source: Analysis of this project

Table 6.6-8 Compilation Table of Assessment at Houzhihua Intersection (Within ChanghuaCounty)(Cont.2)

Name	Figure	Direction	Weekday morning peak hour			Weekday afternoon peak hour			Weekend peak hour		
			Average Delay (second)		Service Level	Average Delay (second)		Service Level	Average Delay (second)		Service Level
Taiwan 17 Provincial Highway │ Changhua 143 County Highway		A	7.0	28.1	B	7.0	21.1	B	7.0	15.7	B
		B	47.8			36.1			33.2		
		C	6.6			6.5			6.5		
		D	41.3			36.2			30.8		
Taiwan 17 Provincial Highway │ Chuanghua Road		A	40.3	39.5	C	37.2	40.1	C	36.4	39.0	C
		B	41.1			44.0			42.5		
		C	32.6			35.9			33.6		
		D	41.3			43.6			42.1		

Source: Analysis of this project

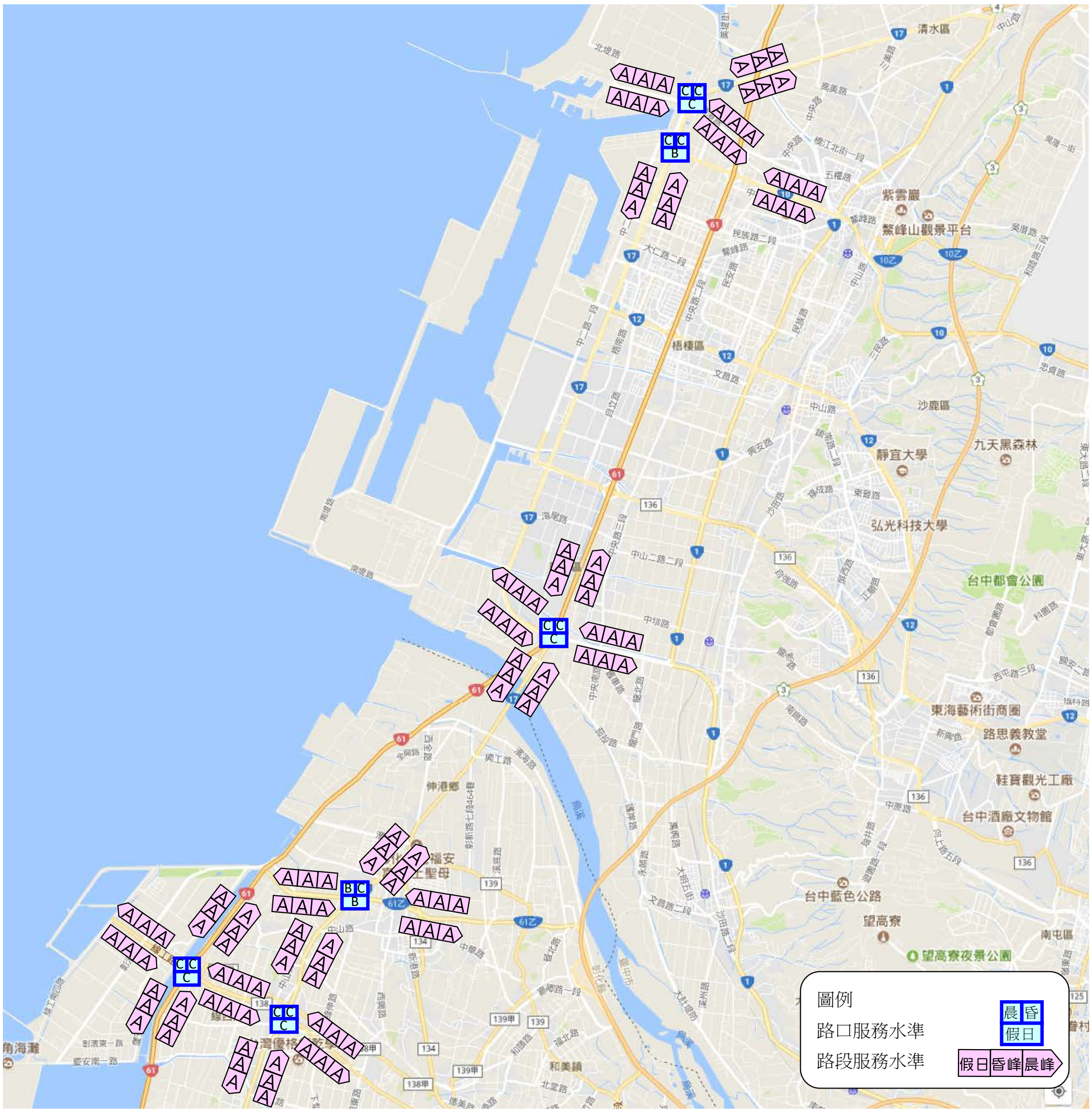


Figure 6.6-1 Schematic Diagram of Serive Level of Roads (1)

Figure 6.6-2 Schematic Diagram of Serive Level of Roads (2)

Culture Resources

Survey Scope

This offshore wind farm is located at estuary of Zhuoshuixi River with 120.4km2. The distance between this project and shore is 35.7km. There are 5 landing points of submarine cable, 3 landing points are located at Xianxi Area of Changhua Coastal Industrial Park, one is located at Lunwei Area and one is located at Lukang Area of Changhua Coastal Industrial Park. Submarine cable of Xianxi Area passess through Qing'an North Road, Xiangong North 4th Road, Zhangbin West 2nd Road and linked to Xianxi and Changbin Substation; Submarine cable of Lunwei Area is laid along sea dikes and Anxi Road and linked to Zhanggong Substation. Submarine cable of Lukang Area is constructed along Lugong Road towards east and linked to Luxi Substation.

Survey Methodologies

Terrestrial

Survey is generalized into literature collection and field survey. Terrestrial survey encompasses both sections. Marine survey is focused on literature collection and marine exploration data analysis. Based on survey results, write the report and assess analysis. Job content and procedures are described as follows:

Collection of Literature

In order to have better understanding about history, geography, humanities and existing cultural resources of survey scope, collect and compile literature and data. At the same time, based on literature data, plan the method of field survey and adjust according to actual situation for further survey.

Field Survey

When in-house work (compilation and reading of literature) is completed. Perform actual field survey based on drafted survey method. As the survey scope encompasses terrestrial area and waters area, thus trekking method is conducted in terrestrial survey to reviewif any exposed cultural layer and archeological relic or phenomenom on stratigraphic section and compile soil. Based on actual situation, explore the situation of stratum with supplementary tool of auger and depth of cultural layer. With respect to marine, marine detecting instrument is used to detect in survey region and analyze according to detected results.

Underwater Cultural Survey

Planning of Survey Line

Interval of survey line is planned to have 100m in principlpe. The designation of survey is shown as Table 6.7-1 and Figure 6.7-1.

Figure 6.7-1 Locus Diagram of Operations (Multibeam Echo Sounder, Side-Scan Sonar, Stratigraphic Section, Reflection-Seismic Method and Magnetic Exploration) and Survey Vessels

Table 6.7-1 Planning of Survey Lines

Survey Items	Equipment Used	Interval of Survey Lines (m)	Settings of Parameters	Quality Requirements
Topographical Survey of Seabed	Multibeam Sounding Sytem	100		The bandwidth is at least 3 times of water depth and 3 datat point per meter square.
Terrain Survey of Seabed	Side-Scan Sonar System	100	100kHz,Range 125m	Ability to image detact 1*1m object on seabed.
Profile Survey of Seabed Stratum	Stratigraphic Profiler	100	3.5 k Hz	Vertical Resolution: Under 0.3m
Magnetic Survey	Marine Magnetometer	100	Towing the fish with 5m away from surface in principle.	Sampling Rate：10 Hz
Reflection-Seismic Exploration	Spark discharge source and wave-floating cable	100	Towing on the surface and designate Sparker source for seismic tomography via DGPS	Vertical Resolution: Under 1m

Sea Bed Topographic Mapping

The whole range of the working areas uses Multi –Beam Echo-Sound System is adopted for Sea Bed Topographic Mapping. The precise water depth data obtained can be apply to cleanly drawing the land form in the sea bed of the area to be surveyed. The sea bed topographic map as structured with the precise water depth data are used to ups and downs as well as exposed targets on the sea bed at the projected work site. The distance between the lines of survey of the wind farm is basically 100 Meters, but it shall reach that the water depth shall be 100% of the sea bed. Following the survey specification of developer, one CTD (Conductivity Temperature Depth) was laid every 2 hours (the electronic file burnt into Great Zhanghua Wind Turbine Generation Plan Data CD) and output of 1 meter grid precise sea bed topography for the subsequent engineering design and searching of targets.

Sea Bed Geomorphology Mapping Method

The survey is conducted with EdgeTech series (100k/400k frequency) Side Scan Sonar to survey the wind far development scope to determine artificial and natural sea bed characteristics. In the working parameters setting, it will be mainly in 100kHz transmitting frequency and in 125 meters transmitting distance in sea bed geomorphologic mapping to obtain the morphology of different levels of sea bed represented by every coarseness of sea bed and images of special targets. Geographical coordinate information is used to pinpointing the location of images collected in trailing, so that the sonar mapping obtained from the overlapping and to and from can be joined together. Also, the magnitude of scattering and characteristics on the joined graphics are used for categorizing sea bed morphology.

Magnetic Survey Method

The magnetic survey for this project uses Geometrics G882 Cesium-Vapor Marine Magnetometer (Altimeter frequency 500 kHz) for detecting the distortion of earth magnetic field due to ferro- magnetic article. It may be wreck of ship, pipeline or other ferro- magnetic obstacles. The survey interval of this survey is 100 meters. The tow fish shall be basically 5 meters above sea bed. In the whole range of survey, Ultra Short Base Line Under Water Positioning System is applied to position the location of tow fish. The data obtained from the survey will display residual field obtained from corrected daily changes and International Geomagnetic Reference Field and joining with analytical signal to magnify location of magnetic source and display the spatial magnet unusual display.

Sub-bottom Profiler System Principle

The principle of work of this survey is transmitting sonic wave of known frequency from center of focus and transmitting through waters to under sea bed. The sonic wave will be reflected due to difference of transmission speed and impedance of density of different layers of sub bottom. The reflected signals, after travelling through waters are received by receivers and the sonic continuous signals are recorded by Recorders into software and become a 2-D Sea Bottom Image (Fig. 6.4). The survey works are carried out by ship bound 3.5K Sea Bottom Profiler and Spark Discharge System. The ship is running along with pre-set route of survey and collect the 2-D Sub-Bottom Image as reflected from the sea bed. Considering the precision of positioning and shallow layers resolution, the Sub Bottom Profiler data will be the main data for display. The interval of the survey lines are 100 meters and the mileage of the survey in the wind farm is estimated at 5,000 km.

Introduction of Survey Area

Natural Environment

This wind farm is located at west part of Zhuoshuixi estuary with area of 120.4km2. The distance between this wind farm and shore is approx. 35.7km. Power transmission line is located at 2 townships: Xianxi Township and Lukang Township with their own landing points.

Shore side terrain of Changhua County is consisted of Changhu Upheaval Coastal Plain, Zuosui River Flood Plain and Bagua Shan Terrace. Xiansi Township and Lugang Township are both of coastal upheaval plain and is low and plain (Lin Juin-Chuan, 1997). The waters system inside including, from north to south, Wuxi (aka Dadusi) Fanya Ditch and Yangzichu draining channel. The one with larger basin among them is Wuxi. Wuxi river runs through mountain area, hilly area, plain and flows into sea at Shenggang. River water brings gravels, slate and sand stone and shale. The alluvia plain at the estuary of Zuosui River is composed of gravel, sand, silt and refill. It is Holocene Non-Marine Alluvia formation and covered on the upheaval coastal plain (Lin Juin-Chuan, 1997:56).

Project site is of sub-tropical monsoon weather. Between October and March the next year, the area is prevailed with northeast monsoon and between April and September, it is of southwest monsoon. The weather data available from Lugang and Mailiao Meteorological Stations, the local win direction of the period close to 40 years, is North East North with average wind speed of 5.1-6.2 M/Sec. It indicates the surveyed area is heavily subject to north east monsoon (Lin Juin-Chuan, 1997:17). Xianxi Township is with Taiwan Strait at the west and the sea current is affected by Kruoshio current and cold current and the coastal current is mainly affected by monsoon and tidal current. In winter, the coastal current is in north east to south west mostly. Surface velocity is about 0.4 m/sec. and bottom current velocity is about 0.5 to 0.7 m/sec. Since the monsoon in summer is rather weak, the coastal current is less obvious, the direction is mainly from north to south and bottom layer velocity is 0.1 m/sec. (Lin Juin-Chuan, 1997: 138). Coastal current is mainly affected by tides and wind. Research in recent years indicated that in waters around the surveyed area, the average current velocity in winter is between 0.1 to 0.19 meter/sec. Also, coast west of Taiwan has the terrain heavily subject to tide and the tidal difference between high and low tides in western Taiwan are different as a result of geological location and terrain. Coastal Fangyuan, located at Chang-Yun-Chia coastal area has two high tides and 2 low tides each day and the cycle for each up and down is averaged at 12 hours 25 minutes. It is normal twin tides. The tidal difference of large tide is 4.3 meter or more and small tidal difference is about 2.1 meters (Lin Juin-Chuan, 1997: 69, 137).

Xianxi Township and Lugang Township are located at middle section of west coast of Taiwan. They have muddy coast and the piling of coast is rapid and formed wide reclamation. This is particularly true with Lugang, Wanggong and Fangyuan area where the reclaimed land is as wide as 4 to 5 kms. The Changbin Industrial Park was reclaimed land at beginning of Japanese Ruling Period (by 1900) and less than 100 years, it was developed into industrial park of today.

History and Humanity

Prehistoric Era

Archeological sits in Changhua increased to a large number today than decades ago (Guo Su-Chiu, 2008, 2009 and 2011). Also, based on new investigation and discoveries, scholars had corrected or make up the pre-history cultural layers of Changhua Area, in sequence and contents, but there are difference in interpretation among different scholars. However, it can be categorized into Dabenkeng Cultural of early Neolithic Age, Neumatou Culture (Fine Rope texture Red Porcelain) of Mid Neolithic Age and Yingpu culture of late Neolithic Age, and Fantzyuan Culture of Metal Ware Age. The following gives brief description of content of the above cultures.

Dabenkeng Culture: The Dabenkeng Culture is in early stage of Neolithic age and the remains uncovered include porcelain ware, knocked rock ax, short rock ax, rock arrowhead, net drop, convex rock. From the locate of site and the nature uncovered remains, it is a culture built from natural environment of ocean, estuary and river/lake.

Neumatou Culture: It is 4500 to 3500 years from now back. The porcelain is in orange red of red brown color and has find rope texture and types are composed of pot, bowl and cup, tripod and multiple cup and stone wares are consisted of ax, net drop, rock knife and arrowhead.

Yingpu Culture: this culture is located in central Taiwan at the midstream and downstream of

river side terrains and hilly land. Remains of the culture is mainly of pot and bowl and there are cap, ring-foot, and is with complicate texture decoration. It has also variety of lithic wares.
Yingpu Culture: this culture is located in central Taiwan at the midstream and downstream of river side terrains and hilly land. Remains of the culture is mainly of pot and bowl and there are cap, ring-foot, and is with complicate texture decoration. It has also variety of lithic wares.
Historical periods

Xianxi Township is located at south bank of estuary of Fangyago river. The area called Xiajiankou, Dingjiankou, Yupu, Wenze and Shiwuzhangli was developed by middle half of 18th century by leaders, Zhuang Yung-quan and Ke Wen-Jeh, the people came from Jianjiang, Fujian. In Ching Dynasty, it was part of Zhulo County. It has been governed under Changhua County, Banxianbao District and Banxianxibao . After separation, it was part of Changhua County. In Japanese ruling period, I was called as Xianxibao District of Xiajiankou of Changhua Branch of Taichung County (1909). After recovering from Japanese, it was changed to be Xianxi Township. On July 1, 1954, it was split into Xianxi and Shenggang Townships. The administrative area adjustment of Oct. 21, 1954, it was placed under Changhua County and is called Xianxi Township of Changhua Conty. Residents are mostly descents of Quanzhou of Fujian and most of them came for farming for living and gradually formed settlements. Most of them have family names of Huang, and the next are Lin, Chen and Hsieh (Hu Ming-Ling, 1999: 275-276)

The township has an area of 18 km2. Later, the reclaimed land at west side was developed into Changbin Industrial Park and it was further divided into Xianxi District, Luwei District and Lugang District. The 2 of landing spots of cables of this Project are located in Changbin Industrial Park , Xianxi District and Lugang District.

Lugang has been known as Lutzigang and it was first appeared in Chronicle of Taiwan in 1800. The name was said to be, 3 of them, 1) This area had been rich in dear (Lu) and this is the place for exporting dear horn, junior dear horn and dear hide; 2) As a rice exporting port, Lugang had many rice barn and the barn in round shape was called as Biang and the square one was called Lu. The rice barn in Lugang were in square shape and it was called Lugang and 3) The river is branched into dear horn shape at the estuary. Before Chinese settlement built up in this area, this is the living grounds of Mazhilin of Babuza. It was until Cheng Cheng-Kong came to Taiwan, Lugang became central port of entry of immigrants and it had the fishing, trading and military functions. By 1730, Lugang had developed into center of grain trading and transportation as well as fishing port. By 1750, Lugang turned itself out to be the grain center and the urban expanded rapidly. By 1790, Lugang was officially a shipping port and shipping service linking Ganjiang in China and Lugang and became 2nd largest city in Taiwan. From becoming a trading port till 1850, this was the most prosperous period of Lugang and was ranked 2nd place among cities in Taiwan. However, the river port of Lugang River has silt piling up and deep water line was shifting and the position of port was changing ever since. After 3 floods, the port was heavily deposited with sand and silt and the appearing of reclaimed land shut Lugang away from the sea shore and affect the function of a trading port. When it came to 1895, under Japanese ruling, the trade with mainland China was restricted and main road, including railway were built away of Lugang and previous hinterland of Lugang turn to Keelung and Kaohsiung for exit and such factors accelerate the falling of Lugang and made it a small town of Changhua. After recovering from Japanese, Lugang had been resume trading function with mainland China. But the control imposed due to civil war between KMT and Communist China, the previous functions were totally wiped out. Though Fangziwa, Wanggong, Chungxi and Fuloong had been backing up to maintain the port services, but the deposit of sand and soil, diminishing hinterland and limited number of trading components (mainly mainland China), Lugang had to shoulder off its role as commercial port and satisfies with the role of local township. (Hong Ming-Lin, 1999 : 245 – 251.

4. Terrestrial Cultural Heritage

Overland cable is located within Xianxi Township and Lukang Township. 27 tangible cultural heritage sites are passeed through. One is located at Xianxi Township and 26 sites are located with Lukang Township. With respect to archeological relics, 6 sites are located within Xianxi Township and 17 sites are located within Lukang Township, 23 sites in total.
Aforementioned cultural heritage and archeological/historical relics are located at least 2km away from overland cable (Figure 6.7-2 to Figure 6.7-3) which has minimal impact on them.
Supplementary survey of cultural heritage along overland cable of Lunwei Area was conducted on 24th October 2017. Based on survey results, there are 27 tangible recorded cultural heritages within the area of Xianxi Township and Lukang Township where the overland located. Among which, one is located at Xianxi Township and 26 are located within Lukang Township. An intangible cultural heritage is recorded within Xianxi Township and the remaining 22 intangible cultural heriage are recorded within Lukang Township.

Tangible Cultural Heritage

At present, there are 27 sites designated and registered tangible cultural heritage (Table 6.7-2). One is located at Xianxi Township and remaining 26 sites are located at Lukang Township.

Intangible Cultural Heirtage

Terrestrial facilities of this project are located within Changhua Coastal Industrial Park, instead of folk culture field. There are 22 intabgible cultural heritages regeistered within Xianxi Township and Lukang Township, Changhua County (Table 6.7-3), one is located in Xianxi Township and 21 are located in Lukang Township. 13 traditional arts, a preserved technique and preserver, a folks art and 7 traditional performing arts

Possible Cultural Heritage: Archeological Sites

Possible cultural heritage is mainly constitued by archeological sites. According to survey data, 6 archeological sites are discovered in Xianxi Township, 17 archeological sites are discovered in Lukang Township, 23 archeological sites in total (Table 6.7-4); The relics are encompassed by late “Panzaiyuan” cultural stage of Copper Age I, mid-late Qing Dynasty and Japanses Colonial Period to early days of Restoration and modern ages.

Aforementioned cultural heritages and archeological sites are located at least 2km away from overland cable (Figure 6.7-4), development has minimal impact on them.

Table 6.7-2 Registered Tangible Cultural Heritage Within Administrative District (1/5)

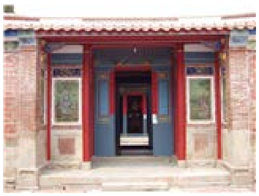
Types	Figure	Name of Heritage	Geographical Region	Types	Level	Official Letter
Relic		Tsing Tzu Temple, Lukang Township	Lukang Township, Changhua County	Temple	County (City) Historic Site	Official Letter 10002395361
		Lukang Kinman Hall	Lukang Township, Changhua County	Temple	County (City) Historic Site	Official Letter 202916 in 2000 by Changhua County Government
		Lukang Fengshan Temple	Lukang Township, Changhua County	Temple	County (City) Historic Site	Official Letter 202916 in 2000 by Changhua County Government
		Lukang Ancient House of Ding's Family	Lukang Township, Changhua County	Residence	County (City) Historic Site	Official Letter 202916 in 2000 by Changhua County Government
		Lukang Jin Mao Hang	Lukang Township, Changhua County	Residence	County (City) Historic Site	Official Letter 132763 in 2000 by Changhua County Government

Table 6.7-2 Registered Tangible Cultural Heritage Within Administrative District (2/5)

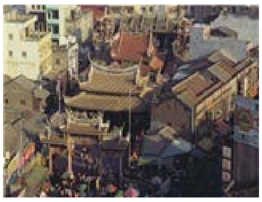
Types	Figure	Name of Heritage	Geographical Region	Types	Level	Official Letter
Relics		Lukang Nanqing Temple	Lukang Township, Changhua County	Temple	County (City) Historic Site	Official Letter 132763 in 2000 by Changhua County Government
		Lukang Meeting Hall	Lukang Township, Changhua County	Other	County (City) Historic Site	Official Letter 132763 in 2000 by Changhua County Government
		Lukang Ai Gate	Lukang Township, Changhua County	Fort	County (City) Historic Site	Official Letter 132763 in 2000 by Changhua County Government
		Lukang Tianhou Temple	Lukang Township, Changhua County	Temple	County (City) Historic Site	Official Letter 357272 in 1985 by Changhua County Government
		Lukang Wenwu Temple	Lukang Township, Changhua County	Temple	County (City) Historic Site	Official Letter 357272 in 1985 by Changhua County Government

Table 6.7-2 Registered Tangible Cultural Heritage Within Administrative District (3/5)

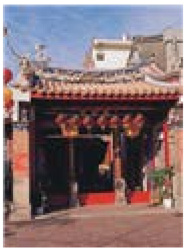
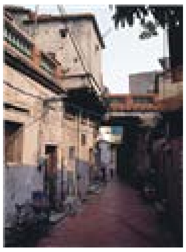
Types	Figure	Name of Heritage	Geographical Region	Types	Level	Official Letter
		Lukang Dicangwang Temple	Lukang Township, Changhua County	Temple	County (City) Historic Site	Official Letter 357272 in 1985 by Changhua County Government
		Lukang Chenghuang Temple	Lukang Township, Changhua County	Temple	County (City) Historic Site	Official Letter 357272 in 1985 by Changhua County Government
Relics		Lukang Sanshanguowang Tenple	Lukang Township, Changhua County	Temple	County (City) Historic Site	Official Letter 357272 in 1985 by Changhua County Government
		Lukang Xingan Temple	Lukang Township, Changhua County	Temple	County (City) Historic Site	Official Letter 357272 in 1985 by Changhua County Government
		Lukang Longshan Temple	Lukang Township, Changhua County	Temple	National Historic Site	Official Letter 202452 in 1983 by Changhua County Government

Table 6.7-2 Registered Tangible Cultural Heritage Within Administrative District (4/5)

Types	Figure	Name of Heritage	Geographical Region	Types	Level	Official Letter
Historical Building		Lukang Heqi Villa	Lukang Township, Changhua County	Residence	None	Official Letter 0990000234C
		Lukang ShihJingyi Ancient Mansion	Lukang Township, Changhua County	Residence	None	Official Letter 0980001965
		Lugang Chai Ancestral Hall	Lukang Township, Changhua County	Ancestral Temple	None	Official Letter 0970000579A
		Lukang Jingyi Yuan Memorial Monument	Lukang Township, Changhua County	Monument	None	Official Letter 0960001615G
		Lukang YuzhenZai	Lukang Township, Changhua County	Other	None	Official Letter 0950002911C
		Lukang Yi He Hang	Lukang Township, Changhua County	Other	None	Official Letter 0950002911D
		Lukang You Lu Gallery	Lukang Township, Changhua County	Other	None	Official Letter 0950002911E

Table 6.7-2 Registered Tangible Cultural Heritage Within Administrative District (5/5)

Types	Figure	Name of Heritage	Geographical Region	Types	Level	Official Letter
Historical Building		Pucuo Police Station	Lukang Township, Changhua County	Government Office	None	Official Letter 09400020681
		Lukang Mayor's Residence	Lukang Township, Changhua County	Other	None	Official Letter 09100062413
		Lukang Yuan Chang Hang	Lukang Township, Changhua County	Other	None	Official Letter 0209025 in 2001 issued by Changhua County Government
Historical Building		Lukang Shiyilou	Lukang Township, Changhua County	Other	None	Official Letter 0209025 in 2001 issued by Changhua County Government
Cultural Landscape		Xianxi Clam Camp	Xianxi Township, Changhua County			

Data Source: Website of Bureau of Cultural Heritage, Ministry of Culture on 17th Oct. 2016.

Table 6.7-3 Registered Intangible Cultural Heritage Within Administrative District (1/4)

Types	Figure	Name of Heritage	Preserver/ Location	Geographical Region	Types	Level	Official Letter
Traditional Arts		Chinese Knot	No.11, Jinde Street	Lukang Township, Changhua County	Other-Chinese Knot	Traditional Arts	Official Letter 1020319658C
Traditional Arts		3D Embroidery	No.20, Sihwei Road	Lukang Township, Changhua County	Embroidery	Traditional Arts	Official Letter 1020319658B
Traditional Arts		Gold Carving	No. 185, Zhongshan Road	Lukang Township, Changhua County	Metal Work	Traditional Arts	Official Letter 1020319658
Traditional Arts		Tin Craft	CHEN,WAN-NENG	Lukang Township, Changhua County	Metal Work	Important Traditional Arts	Official Letter 10030064432
Traditional Arts		Tin Craft		Lukang Township, Changhua County	Other-Tin Craft	Traditional Arts	Official Letter 0980252497
Traditional Arts		Chinese Knot	No.11, Jinde Street	Lukang Township, Changhua County	Other-Chinese Knot	Traditional Arts	Official Letter 1020319658C

Table 6.7-3 Registered Intangible Cultural Heritage Within Administrative District (2/4)

Types	Figure	Name of Heritage	Preserver/		Types	Figure	Name of Heritage
Traditional Arts		Traditional Wooden Carve	No.28 Putou Street	Lukang Township, Changhua County	Carpenter's Work	Traditional Arts	Official Letter 1020319658D
Traditional Arts		Traditional Wooden Carve	SHR,JEN-YANG	Lukang Township, Changhua County	Carpenter's Work	Important Traditional Arts	Official Letter 10030064432
Traditional Arts		Traditional Wooden Carve		Lukang Township, Changhua County	Carpenter's Work	Traditional Arts	Official Letter 0980252498
Traditional Arts		Spruce of Divine Statues	SHR,JR-HUEI	Lukang Township, Changhua County	Carpenter's Work	Important Traditional Arts	Official Letter 10030064432
Traditional Arts		Spruce of Divine Statues	WU,CHING-PO	Lukang Township, Changhua County	Carpenter's Work	Traditional Arts	Official Letter 0980252499 and 0980252500
Traditional Arts		Spruce of Divine Statues		Lukang Township, Changhua County	Carpenter's Work	Traditional Arts	Official Letter 0980252499 and 0980252500
Traditional Arts		Painting of Lantern	WU,DUEN-HOU	Lukang Township, Changhua County	Colored Drawing	Traditional Arts	Official Letter 0980252501

Table 6.7-3 Registered Intangible Cultural Heritage Within Administrative District (3/4)

Types	Figure	Name of Heritage	Preserver/		Types	Figure	Name of Heritage
Preservation Techniques and Preserver		Wood Carving Technique	LI,BING-GUEI	Lukang Township, Changhua County		Preservation Techniques and Preserver	Official Letter 10120170902 issued by Bureau of Cultural Heritage, MOC
Folkway		Lukang Luban Banquet	Chao Yang Lukang Association	Lukang Township, Changhua County	Religion	Folk Culture	Official Letter 0970000561C
Traditional Performing Arts		Nanguan Music	GUO,YING-HU	Lukang Township, Changhua County	Music	Traditional Performing Arts	Official Letter 1030280386B
Traditional Performing Arts		Nanguan Music	HUANG,CHENG-TIAU	Lukang Township, Changhua County	Music	Traditional Performing Arts	Official Letter 1030280386B
Traditional Performing Arts		Beiguan Music	HU,YUAN-DENG	Lukang Township, Changhua County	Music	Traditional Performing Arts	Official Letter 10102701282
Traditional Performing Arts		Yu Qing Xuan Beiguan Music		Lukang Township, Changhua County	Music	Traditional Performing Arts	Official Letter 10102701282

Table 6.7-3 Registered Intangible Cultural Heritage Within Administrative District (4/4)

Types	Figure	Name of Heritage	Preserver/		Types	Figure	Name of Heritage
Traditional Performing Arts		Lukang Eyunzai Nanguan Music		Lukang Township, Changhua County	Music	Traditional Performing Arts	Official Letter 0990000240B
Traditional Performing Arts		Lukang Juying Nanguan Music		Lukang Township, Changhua County	Music	Traditional Performing Arts	Official Letter 0960001620 B
Traditional Performing Arts		Lukang Yazhengzai Nanguan Music		Lukang Township, Changhua County	Music	Traditional Performing Arts	Official Letter 0960001620 A

Data Source: Website of Bureau of Cultural Heritage, Ministry of Culture on 05th Oct. 2016.

Table 6.7-4 Archeological Site Within Site

Township	Historical Site	Cultural Content	Historical Sites and Relics
Xianxi Township	Bagua Liaolun	Pan Zai Yuan /Qing Dynasty or Japaneses Colonial Period	Pottery, Terra Cotta Clay, Ship Plate Remains, Shell-Mound, Grey Bricks Remains of Modern Times
	Ding Jian Kou I	Mid-Late Stage of Qing Dynasty	Blue and White Porcelain
	Ding Jian Kou II	Mid-Late Stage of Qing Dynasty/ Japanese Colonial Period to Early Days of Restoration	Blue and White Porcelain, Porcelain bowl and Tomb during Japanese Colonial Period
	Ding Li	Mid-Late Stage of Qing Dynasty	Blue and White Porcelain, Terra Cotta Clay
	Xai Li	Mid-Late Stage of Qing Dynasty/ Japanese Colonial Period	Blue and White Porcelain, Porcelain, Biscuit Fire and Glazing Terra-cotta Clay
	Kou CUo	Mid-Late Stage of Qing Dynasty/ Japanese Colonial Period to Early Days of Restoration	Tomb of Qianlong, Blue and White Porcelain, Biscuit Fire and Glazing Terra-cotta Clay
Lukang Township	Qi Gou Zi Ⅰ	Later Period of Pan Zai Yuan/ Mid-Late Period of Qing Dynasty/ Japanese Colonial Period to Early Days of Restoration	Greyish Black to Greyish Brown Coarse Pottery, Orangish Red Terrine, Blue and White Porcelain, Porcelain and Terra-Cottas
	Qi Gou Zi Ⅱ	Later Period of Pan Zai Yuan	Greyish Black to Greyish Brown Coarse Pottery, Orangish Red Terrine, Iron Sheet
	Qi Gou Zi Ⅲ	Later Period of Pan Zai Yuan/ Mid-Late Period of Qing Dynasty/ Japanese Colonial Period to Early Days of Restoration	Greyish Black to Greyish Brown Coarse Pottery, Orangish Red Terrine, Blue and White Porcelain, Pottery, Terra-Cottas

	Ding Pan Po	Pan Zai Yuan/ Mid-Late Period of Qing Dynasty/ Japanese Colonial Period to Early Days of Restoration	Orange and Greyish Brown Coarse Pottery, Blue and White Porcelain, Biscuit Fire and Glazing Terra-cotta Clay, Black Tiles of Japanese Colonial Period, Pottery
	Lane Ⅰ	Mid-Late Period of Qing Dynasty/ Japanese Colonial Period to Early Days of Restoration	Blue and White Porcelain, Red Brick of Qing Dynasty, Pottery
	Lane Ⅱ	Mid-Late Period of Qing Dynasty	Blue and White Porcelain
	Gou Wei Ⅰ	Later Period of Pan Zai Yuan/ Japanese Colonial Period to Early Days of Restoration	Greyish Black to Greyish Brown Coarse Pottery, Orangish Red Terrine,Pottery
	Gou Wei Ⅱ	Later Period of Pan Zai Yuan/ Mid-Late Period of Qing Dynasty	Greyish Black to Greyish Brown Coarse Pottery, Orangish Red Terrine, Blue and White Porcelain
	Xue Zi	Later Period of Pan Zai Yuan/ Mid-Late Period of Qing Dynasty	Greyish Black to Greyish Brown Coarse Pottery, Orangish Red Terrine, Blue and White Porcelain, Tomb of Dao Guang, Pottery, Biscuit Fire and Glazing Terra-cotta Clay
	Xie Cuo	Later Period of Pan Zai Yuan/ Mid-Late Period of Qing Dynasty/ Japanese Colonial Period to Early Days of Restoration	Greyish Black to Greyish Brown Coarse Pottery, Orangish Red Terrine, Blue and White Porcelain, Tombs, Pottery, Biscuit Fire and Glazing Terra-cotta Clay, Red Bricks of Qing Dynasty, Copper Coin of Qing Dynasty and Japanese Colonial Period
	Within Chu-Wei Ⅰ	Mid-Late Period of Qing Dynasty	Blue and White Porcelain, Biscuit Fire and Glazing Terra-cotta Clay
	Within Chu-Wei Ⅱ	Japanese Colonial Period to Early Days of Restoration	Pottery, Biscuit Fire and Glazing Terra-cotta Clay, Red Brick, Red

			Tile and Grey Tile
	Lukang ・ Chu-Wei Zai	Mid-Late Period of Qing Dynasty/ Japanese Colonial Period to Early Days of Restoration	Blue and White Porcelain, Pottery, Terra-cottas
	Pu Jiao	Mid-Late Period of Qing Dynasty/ Japanese Colonial Period to Early Days of Restoration	Blue and White Porcelain, Terra-Cottas and Glazing Pottery
	Shi Bei Jiao Lun	Pan Zai Yuan Period/ Japanese Colonial Period	Red and Greyish Brown Sand Pottery, Blue and White Porcelain Bowl of Japanese Colonial Period
	Tuo Ku Village	Mid-Late Period of Qing Dynasty/ Japanese Colonial Period to Early Days of Restoration	Blue and White Porcelain, Terra-Cottas and Glazing Terra-cotta clay
	Caocuo	Later Period of Pan Zai Yuan/ Mid-Late Period of Qing Dynasty/ Japanese Colonial Period to Early Days of Restoration	Greyish Black to Greyish Brown Coarse Pottery, Orangish Red Terrine Blue and White Porcelain, Pottery, Terra-cottas and Glazing Terra-cottas and Red Tiles

Data Source: Survey Project Phase I to Phase III of Historical Sites at Changhua County, Kuo, Su-Chiu.

Figure 6.7-2 Scematic Diagram of Cultural Heritage and Historical Sites of at the Vicinity of Xianxi Overland Cable

Figure 6.7-3 Scematic Diagram of Cultural Heritage and Historical Sites of at the Vicinity of Luxi Overland Cable

Figure 6.7-4 Schematic Diagram of Cultural Heritage and Possible Historical Sites at the Vicinity of Lunwei Overland Cable (Supplementary Survey)

Underwater Cultural Heritage

According to Article 3 of Underwater Cultural Heritage Preservation Act:

"Underwater cultural heritage" means all traces of human existence having a historical, cultural, archaeological, artistic or scientific character which have been partially or totally under water, periodically or continuously such as:

Sites, structures, buildings, artifacts and human remains, together with their archaeological and natural context.

(二) Vessels, aircraft, other vehicles or any part thereof, their cargo or other contents, together with their archaeological and natural context.

(三) Objects of prehistoric character

From 2013 till now, there are 4 places of sinking boats as underwater cultural heritage registered in volume for tracing, including wooden boats of Qing Dynasty at Kungke Island, British vessel S.S. Bokhara, Kohei vessel and SantengMaru vessel. The 4 places of sinking boats are all located in the water territory of Penghu. The related data are shown in Table 6.7-5 (Bureau of Cultural Heritage, MOC, 2013: 53-55).

Table 6.7-5 Underwater Cultural Heritage (Wreck)

No.	Name	Related Location	Sinking Era
1	Wooden boats of Qing Dynasty at Kungke Island	Ocean north to Penghu	(Mid and Late Qing Dynasty)
2	British Vessel S.S . Bokhara	Ocean south to Penghu	1892
3	Kohei Vessel	Ocean north to Penghu	1895
4	SantengMaru Vessel	Ocean north to Penghu	1942

Wooden boats of Qing Dynasty at Kungke Island

In the ancient navigation period, south-west waters of Kungke Island (northern part of Penghu) was an extremely ardous area, It is estimated that wooden boat has sunk during its journey from Minnan district returning to Penghu Taiwan. In June of 2009, a large amount of bricks and tiles, porcelain bowls, underglaze bowls, cups, plates and wooden boat wrecks were discovered at the waters. Based on the sculpture, it is estimated as wooded trader in mid-late period of Qing Dynasty which served as an evidence of trading navigation study.

(二) British Vessel S.S. Bokhara

Discovered in November of 2009 at Gupoyu, S.S. Bokhara was the large-sized steam ship of P. and O. Co. It was departed in 1892 from Shanghai, passing through Hong Kong to Europe (Cricket players who participated in Shanghai were onboard). It was sunk due to striking on a rock after typhoon on 11th October, 23 people were survived out of 148 people. During that time, a wide of coverage to this accidents was reported. Then, fund was generated by United Kingdom to construct lighthouse. A memorial monument was built at Gupoyu. Historical events can be verified by the sinking of Bokhara. Thus, trade situations and living goods can

be understood by related relics and remains.
（Kohei）
It was discovered in June of 2010 at oyster reef of Jiangjyunyu. Kohei was built by Jujian Mawei Shipyard under the reign of emperor Guangxu in the Qing Dynasty and classified as cruiser of navy in Qing Dynasty. It was defeated in Yalu River during Sino-Japanese War (1984). Then, it was surrendered at Weihaiwei and joined Japanese fleet. It was participated in Taiwan and Penghu Mission. Accoridng to records of Government of Taiwan, it was sunk due to striking on a rock on the way to Penghu Archipelago to search for Gu Kui Lin Yan Chen. 37 people were remained unknown out of 160 people. Memorial monuments were built on Penghu and Hiroshima for historical and military study evidence during the late of Qing Dynasty.
SantengMaru
It was discovered on LiuChi Reef in May of 2010. It was the transport ship for Japan during Second World War. It sank in 1942 due to thunking striking.
After survey and excavation, “General 1” is not listed and tracked (Huang, Yung-Chuan 1996, 1997 and 1999). The listed sinking sips are located within Penghu Waters not within waters of this site.
According to literature data (Tang, His-Yung, 2009), many sinking incidents were recorded in the surrounding waters (Table 6.7-3). The description of sinking location is limited in literature, correlation between sinking location and site is unabvle to obtained. 13 records of sinking are described as follows:
No.18 of Ming Dynasty: Erlin is located at downstream of Zhuoshui River and southwest part of Changhua Plain. During the reign of Emperor Kang Xi of the Qing Dynasty, Han Race was moved into. It was evolved into street in the last decades of Qianlong reign. In the middle period of Qianlong, Sanlin Harbor was served as outer harbor (Yongxing Village, Fangyuan Township). Due to harbor siltation and sandstorm, since early stage of Daoguang period, Panzaiwa (it is known as Fangyuan Township, Fangrong, Fangzhong, Ren-Ai and Xinyi Village) as outer harbor. Erlin Street is 1km away from coast. Raw data described as “…tonight, Hollandia Junk encountered with other 4 sea rovers. It chase one of the rovers at Erlin. Another 2 rovers agrounded and sank eventually.” (Chiang, Shu-Sheng 2002 Second Edition of De Dagregisters Van Het Kasteelzeelandia, pg 224).
No.36 Ming Dynasty: The wreck site is described as “upstream direction og Zhuoshui River”. Due to its brief description, it is estimated to have distant distance from project site. According to raw data, it is recorded as “grounding”, sinking is not recorded. (Translated by Chiang, Shu-Sheng 2002 second Edution of De Dagregisters van het Kasteel Zeelandia, pg. 306-309).
No.12 Qing Dynasty: Wreck site is described as offshore area of Qingkunshen where located in the vicinity of Luzai Harbor. Luzai Jarbor is known as Lukang nowadays, it is located at 8.5km away from survey site.

No.109 Qing Dynasty: Wreck site is described as “Xingda Harbor in Changhua”. It is recorded at Shenggang District where around Xingang. Xingang is where now Datong Village, Shigu Village, Haiwei Village and Quanxing Village located. It is located at 2.3km of Taiwan Straits. The name Xinggang indicates newly built harbor. Xingpan Harbor is located at beach of offshore in final years of Guangxu. The silting area of sand is large, the offshore beach is 2km wide (it is 5km wide now). The large-sized sailings ships moor at 1.9km away. “Singda Harbor” mentioned in literature is “Singpan Harbor”. This shipwreck is data is closely related to survey area.

Qing Dynasty No.110: The shipwreck location is described as grounding area of Datu Stream. Datu is located at Xihu Township where is north coast of Zhuoshui River. It was social domain of Hoanya, It is up to 1km away from survey area.

Qing Dynasty No.111: It is similar with (4).

Qing Dynasty No.112: It is similar with (4).

Qing Dynasty No.129: The shipwreck location is described to locate at offshore area of Mai Zai Liao, Changhua County, it is called offshore of Mailiao. It is located at south part of Zhuo Shui River, 1km away from survey area.

Qing Dynasty No.147: Shipwreck is located at Sanlin Harbor of Changhua County where the coastal area of Yongxing Village. Sanlin Harbor is the outer harbor of Erlin Harbor. This area is located at downstream of Old Zhuoshui River, and it is always overflowed. It is 1km away from survey site.

Qing Dynasty No.223: Shipwreck is described to locate at shoal of Lukang Townhsip. Lukang is 8.5km northeast from project site.

Qing Dynasty No.238: Shipwreck is described to locate in the vicinity of Wang-Gong Reef. It is located about 4.5km southwest of survey site.

Qing Dynasty No.309: Shipwreck is described to locate at offshore area of Changhua. It is unable to determine due to brief description.

(十三) Qing Dynasty No.336: Shipwreck is described to aground at Lukang. Lukang is located at 8.5km northeast of survey site.

According to WRECK SITE data, several vessels sank in the vicinity of project site （Table6.7-5）. Among which, “C’heng T’a” is lcoated in the vicinity of No.15 Wind Farm. Another vessel called “MV He Xin No.1” is located in the vicinity of No.14 Wind Farm (Table 6.7-7). The remaining shipwrecks are located up to 1km from wind farm or landing point of submarine cable.

Table 6.7-6 Related Historical Sinking Boat Around Waters

Era of Sinking Boat	Report page No./No. of the Report by Tang, Xi-Yun	No. of Sinking Boat	Nationality	Boast Nature	Carrying Cargo	Carrying Personnel	Navigation Channel	Location of	Era of Sinking Boat	Report page No./No. of the Report by Tang, Xi-Yun	No. of Sinking Boat	Nationality
Ming Dynasty	p.303 No.18			Sea rover				Near Erlin	1643.12.23	War		
Ming Dynasty	p.305/No.36			Sea rover/junk				Zhuoshui River toward upstream direction	1644.7.8~9	War		Piracy 25-30 members died, the rest escaped
Qing Dynasty	p.310 / No.12	Ting-Tze No. 17 of Left Camp, Assistance Biao, The Navy of Qing in Taiwan	Qing Dynasty	Navy ship		Soldiers 18 people	Anping	Cingkunshen offshore of Lutzekang sea surface neighborhood		Under wind rushing to Shantou	Ordnance sinking and loss	All members were saved
Qing Dynasty	p.317/No.109	Ping-Tze No. 6 of Central Camp, Assistance Biao, The Navy of Qing in Taiwan	Qing Dynasty	Navy ship/picket ship		Gob 46 members	Lutzekang—Beiyang	Offshore, Xinda Harbor of Changhua	June 26, Jiaqin 20 (1815)	Under wind	Sinking and loss of ordnance, lead drug, bell symbol and instruction brand, etc.	Gob of 5 members were missing
Qing Dynasty	p.317/No.110	Ping-Tze No. 11 of Central Camp, Assistance Biao, The Navy of Qing in Taiwan	Qing Dynasty	Navy ship/picket ship		Gob 41 members	Lutzekang—Beiyang	Stranded at Daku (Tu) River	June 26, Jiaqin 20 (1815)	Under wind		All members were saved
Qing Dynasty	p.317/No.111	Fang-Tze No. 2 of	Qing Dynasty	Navy ship/picket ship		Gob 34 members	Lutzekang—Beiyang	Offshore, Xinda Harbor of Changhua	June 26, Jiaqin	Under wind	3 cannons were	A member of gob died

Era of Sinking Boat	Report page No./No. of the Report by Tang, Xi-Yun	No. of Sinking Boat	Nationality	Boast Nature	Carrying Cargo	Carrying Personnel	Navigation Channel	Location of	Era of Sinking Boat	Report page No./No. of the Report by Tang, Xi-Yun	No. of Sinking Boat	Nationality
		Central Camp, Central Biao, The Navy of Qing in Taiwan							Emperor 20 (1815)		caught through wreck raise	
Qing Dynasty	p.318/No.112	Fang-Tze No. 5 of Left Camp, Assistance Biao, The Navy of Qing in Taiwan										
	Qing Dynasty	Navy ship/picket ship		Gob 39 members	Lutzekang —Beiyang	Offshore, Xinda Harbor of Changhua	June 26, Jiaqin Emperor 20 (1815)	Under wind	Sinking and loss of ordnance	Gob of 9 members were missing		
Qing Dynasty	p.319/No.129	Chih-Tze No. 7 of Right Camp, Ti Biao, The Navy of Qing in Xiamen	Qing Dynasty	Navy ship/picket ship			Anping to Lukangv	Offshore, Maitzeliao of Changhua	October 23, Daoguang Emperor13 (1833)	Under wind	Gob of 9 members were missing	A person missing
Qing Dynasty	p.320/No.147		North Korea		Horses	30 people	Changsha Island of Naju to？	Drifted to Tatutou, Sanlin Harbor, Changhua	Sept. 12, Yongzheng Emperor 7 (1729)	Under wind		All members were saved, and they were sent to Xiamen on January 15 of Yongzheng Emperor 8 (1730)
Qing Dynasty	p.326/No.223	Bata（Beta）	Great Britain	Barque				Shoal near Lu-chiang/Lokiang	August 1, Guangxu	Aground	The boat was	Sailors were sent to

Era of Sinking Boat	Report page No./No. of the Report by Tang, Xi-Yun	No. of Sinking Boat	Nationality	Boast Nature	Carrying Cargo	Carrying Personnel	Navigation Channel	Location of	Era of Sinking Boat	Report page No./No. of the Report by Tang, Xi-Yun	No. of Sinking Boat	Nationality
								Harbor, west coast of Taiwan	Emperor 10 (1884)		robbed and damaged by aborigines	
Takao via British gunboat Fly												
Qing Dynasty	p.331/No.283	Vessel Uneb	Japan	Steamer	14 people of sailors Sanjiro, etc.			Near Prince Reef	Guangxu Emperor 12 (1886)	Under wind		Sent to return Nagasaki

Table 6.7-7 Recent Sinking at Neigboring Wind Farm

Name	Coordinates										Name
MV He Xin No.1	24°12'00"N 119°48'00"E	28 max	Panama	Cargo	1745	69 x 15 x 5.3	1985	Sinking	max 4	2004/11/30	LIVE
Ch'eng T'a	24°08'12"N 119°59'13"E	40 max	Chile	*	*	*	*	*	*	1966	dead (not found)

Data Source: Compiled from http://www.wrecksite.eu/ on 2017/1/18

Figure 6.7-5 Distribution of Recent Sinking Around Wind Farm

Except for wreck of historical records, prehistoric or archeological relics are existed in waters around Taiwan (Figure 6.7-6). The relics information is mostly from newspapre and media. This information can be served as important reference data for this project. Related information is described as follows (Chien, Jung_Tsung 1994).

Wu, Wen-Chin, a fisherman from San-Tiao-Luen Fishing Harbor, Yunlin County (78 year-old): Relics, plates, bowl, run and pot are dredged at Beigang River, Huwei River and Dongshi Coast. A deep pit is formed as the different of height is great. It is expected that sinking incidents occurred in the past. While catching fisk and shrimps, ancient pottery are dredged as well.

Description from fisherman called Lin, Mu-Tung at Taizihcun, Yunlin County (at his forties): Bengnag Outer Harbor was initially in front of Wanshan Shrine where located at Old Jinhu Harbor. Chaser stone and millstone for sugar extraction can be found at neighborhood around which show that Old Jinhu Harbor was prosperous once. Ancient pottery are dredged at coastal area of Yunlin and Chiayi.

Father and Son of Wu, Wen-Zheng and Wu,ShuCheng from Chaiyi County: Ancient coins and crippled pottery can be picked at Waisanding Sand Bar. Now, Waisanding Sand Bar is submerged into water. Oyster layer is formed by accumulating oysters and clams at approximately 20-40meter away from Dongshi Coast. Whith respect to shrimps, it is a favorable habitat for metapenaepsis barbata. Shipwrecks at this area are not easy to be buried but easily trawled by fishermen. The shipwrecks are adhered to oyster layer for a long time. Once it is being pulled, the oyster layer will be damaged.

Chen, Mao-Shan, director of Taiwan Fishermen Association, indicated that ancient coins were dredged at offshore area of Qingshan Harbor, Tainan County. These coins were unearthed with soil, dating from Ming Dynasty, Kangxi and Daoguang of Qing Dynasty to Meiji and Taisho Period. Ancient urns, incense burner, crippled porcelain and horn fossils were dredged by local fishermen. Thus, they believed in ship’s sinking.

Huang, Lien-Pai from Xihu Township, Yunlin County (87 years old): During Japanese Occupation Period, fishermen did not give much attention to dredged cultural relics. Relics are adhered to clams and oyster, it was inconspicuous. Fishermen threw back to sea again.

Lin, Te-Tsai, Keziliao, Yunlin County (82-year-old): 20 years ago, I dredged pottery at Waisanding Sand Bar and coastal area of Yunlin and Chiayi. I only dried up fish and prawns, the relics were thrown back to sea again.

Lin, Te-Tsai, Keziliao, Yunlin County (82-year-old): 20 years ago, I dredged pottery at Waisanding Sand Bar and coastal area of Yunlin and Chiayi. I only dried up fish and prawns, the relics were thrown back to sea again.

Chen, Lao-Chueh from Shuilin Township, Yunlin County (82-year-old, veteran in antique industry): He always goes to fishery villages in Yunlin, Chiaty and Tainan for purchasing dredged items.

Mr. Cheng., antique trader from Luchang (Interviewed by principal of Min De Elementary

School): Dredge items from fishermen are mostly pottery.
Wu, Tien-Kuei, antique trader from Huwei Township, Yunlin County: Dredged items which purchased from fishermen are mostly floating copper, cannon and mooring.
Wu, Tien-Kuei, antique trader from Huwei Township, Yunlin County: Dredged items which purchased from fishermen are mostly floating copper, cannon and mooring.
From 1994 to 1996, scientific and technical staff of Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences are invited to Museum of Natural Science to study museum collection and researches, including approximately 500 mammals' fossils are dredged up from Penghu Channel and environmental problems related to paleogeography. In order to have better understanding about dredging operation of fossils and location of fossil, research group of Museum of Natural Science rented trawling vessel to Penghu Channel in May of 1995. After 2 days of operations, a thoracic vertebrae of Palaeoloxodon sp., a skull of buffalo, shaft angle and 3 Elaphurus' horns within north latitude 23°16' to 23°23' and east longitude 119°55' to 119°56'. At the end of 1998, fishermen from coastal area of Shi Shi Shi, Quan Zhou Shi, Fukien Province discovered fossils of Palaeoloxodon sp., bear, wild horse, Elaphurus, buffalo and etc where located at waters of north latitude 23°23'to 25°00' and east longtitude of 119°20'. Among thousands of specimens, a humerus fossil, a bone tool and a mandibular base with artificial notch were found by researchers. Age measurement shows than the fossils are 40,000-10,000 years ago. (Data Source from Museum of Natural Science, 20171005).
A bronze shotgun with diameter 4cm and octagon profile was discovered at sand of Kunshen where located at Anping, Tainan (Tu, Tai-Long 2009). ◦
A wooden wreck and 3 ancient cannons were discovered at north waters of Lieyu, Penghu (Central Daily News 1984.1.12).
A porcelain bowl with picture of green flowers and phoenix was dredged up by fishermen from Taizi Village where located at Kouhu Township, Yunlin County (China Times 1999.10.13).

A suspected skeleton was dredged up by fishermen at 72-75m where located at south 1NM of Waisanding Sand Bar (Central Daily News 1996.2.17).

Figure 6.7-6 Distribution of Dredged Cultural Relics

Figure 6.7-7 Location of Dredged Zoolite

6. Survey Results

Terrestrial Survey Results

The first terrestrial survey was conducted on 9th October 2016. The landing points of submarine cable were located in Changhua Coastal Industrial Park which can be divided into Xianxi Area and Lukang Area.

Changhua Industrial Park was a reclaimed land. The industrail park was mainly consisted on plant buildings, many regions were still covered with forest and weed. The submarine cable landing point was located at the northwest corner of industrial park; no significal archaeological remained. The submarine cable landing point of Lukang Area was located at the interaction of Ji'an West Road and Lugong Road, close to seawall. At the east part of seawall was a closed water. Due to broad area of water, many citizens would sail in fall and winter. As it waas a new reclaimed land, the surface of earth was mainly soil and rubbles, no archeaological was sighted.

The second onshore survey was conducted in 18th July of 2017. A new cable landing point was added at the Changhua Coastal Industrial Park's Lunwei Area. Onshore cable was constructed along seawall and Anxi Road and expected to cpnnect with 3 substations and substation of Taiwan Power Compnay in Changhua. The survey area covered the expected route of overland cable and 500 meter around the area.

Changhua Coastal Industrial Park's Lunwei Area, Lukang Area wereboth reclaimed lands. No plant constructions were sighted so far, only several wind turbines along the roads, coast guards and sentry posts. Eastern part of seawall was covered with horsetail tree windbreak forest, distributed in NE-SW. Blank area with flat terrain and covered with weeds was located at the east part of windbreak forest. There are only roads surrounded sites within survey area. During observation, the bare land is mainly constituted by grey sandy soil and gravel. Some regions are piled with large stones. In first and second survey results, no archeological or historical sites or relics are discovered.

Third terrestrial survey is conducted on 24th October 2017, survey area is identical with second survey. Topography and landform are similar as well. Land form within industrial park was flat. Sea dike area and west coastal area of asphalt road are higher than inland. Inland is mostly constituted by beach plant and herbaceous vegetation. From a little part of bare land, it is constituted by greyish black sand and gravel. Some small sand dune jut from the ground. Armor blacks, which made by cement and boulder, are piled on the landing point of overland cable where located at the sea dike. There are some vertical sea dikes. During survey, dismantling of vessel aground called "Union 56" took place at south part of 500m away. It is stuck on armor block. Based on survey results, no archeological or historical site or relics are discovered.

Analysis of Underwater Vehicle

Underwater archeology (marine) is based on wreck (Muckelroy 1978). Transported objects are encompassed within scopes and aims of the study. Accoridng to data of wreck where located at nearshore area of wind farm, 13 wreck records range from Ming Dynasty to Qing Dynasty (1643-1885). The vessels are made by wood, including sea rovers (China, North Korea, Japan, UK and Germany), junk, navy ship, whistle ship, three-master, streamer and etc. It is mainly constitued by navy ships of Qing Dynasty and whistle ship; Based on 13 wreck records, object onboard including armament, lead, ring, appointment cards and etc. Among which, 3 artilleries were dregded from a navy ship of Qing Dynasty on 26th June of 1815 (Jiaqing 20). These information can be referred during underwater survey. It is necessary to know the types, exterior, components and facilities of ships. Chinese yachts can be divided into junk and conferring ships. Based on shape of section of bow, the structures can be divided into bird-watcher's boat, junk, sting ship, conferring ship and cantonese ship. (Figure 6.7-8). Junk is suitable to sail at shallow waters, such as river and lake. The remaining ships are mostly to sail at south waters. Conferring ship and cantonese ship are suitable for long-distance sailing (Tai, Pao-Tsun 2000:34, Tseng, Shu-Ming, Lu, Chuan-Chieh 2013:45). In Qing and Ming Dynasty, Chinese yacht are divided into conferring ships, junk, warship and hook ship, based on their boat types, purposes and performance (Hsu, Chih-Chao, Chen, Cheng Hung 2002). The manucfactures of navy ship and whistle ship continue to use tradition of Ming Dynasty (Li, Chi-Lin 2014: 348). Junk (trade ship mostly constituted by conferring ship and cantonese ship) and navy ship is for ocean trade purpose or military purpose. Most of the conferring and cantonese ships have sharp or round bottom, keel, deep draft, bow, high stern and wide stern which are suitable for trasnoceanic navigation Whistle ship is for coastal patrolling due to its shallow draft, speed and convenient navigation (Figure 6.7-9 to Figure 6.7-10). However, some types of vessels are used in military, transportation and trade. Thus, it is not easy to distinguish. Based on given informations, relics discovered at neighboring waters including pottery, glassware and red bricks (Chien, Jung-Tsung 1994). If unrecorded interviews are included, there are suspected ship plate, mast cap and other ship components (Figure 6.7-11). Based on literature, explain ship types which sailed between Taiwan and China during historical period to reveal the possiblity of wreck site and understand the ship types and the transported objects. This may help the analysis and verification of underwater archeological survey.

Figure 6.7-8 5 Traditional Ship Types of China

Figure 6.7-9 Junk (Navy Ship)

Figure 6.7-10 Whistle Ship

Figure 6.7-11 Wooden Boat Discovered At Underwater of Takashima, Japan

According to formation of archeological sites and sedimentology, artificial reef distribution and marine activity and its frequency are taking into consideration. Analysis is conducted according to sonar reactive substance and its performed image characteristics. Then, it is further selected to be suspected target object for further underwater verification. The encompassed principal of selection conditions are shown as below:

Substances with obvious ship form or suspected archeological value; This type of substances show clear ship characteristics on side-scan sonar, including bowsprit, buttock, mast, ship hull, deck and etc. It is mostly constituted by modern wooden vessels, as the ships sank not in later time. The main ship body structure is mainly built by steel, iron and glass fiber. Thus, the burial and decomposing of is slightly milder than shipwreck in ancient times. The structures remain complete and easy to be identified. There are so ancient shipwrecks which remain complete, the shipwrecks are located in deeper or closed waters.

Those with suspected ship form and archeological value; It might not be complete ship or ships which are shallowly buried by sediment. The features of vessels can be identified by side-scan sonar images.

Those strong back scattering signals that differ from surrounding topography and stratum or suspected archeological value; They may be debris, cargo of ship, reef or coral. They might be debris or cargo attached by marine life.

Topography with comet mark or suspected archeological value; This type indicates ship wreck body or part of cargo are partially buried. Part of the structures are exposed to seabed. It might be reef or outcrop of basement.

In early years, fishermen discovered terra-cotta bottle, blue and white porcelain bowl (plate) which attached with clams or mud, prehistoric animal skeleton, wooden ship plate and other historic cultural relics in west waters. They are generally called dredged cultural relics. Thus, signs of disturbances and strong reflective signal in the vicinity of seabed caused by fishing activities or mooring of vessels shall be paid particular attention. This type is similar to archeological site discovered by terrestrial agriculture and excavation.

Isolated Objects With Suspected Archeological Value

After comparison with survey data, it shows that only a location is reactive to side-scan sonar, 7 locations are magnetic anormalies （Figure6.7-12， Table 6.7-8 to Table 6.7-9）. SSS_01 is long, spiral-like object. It is 11.9m long and 0.2m wide. The seabed surface is accreted by mud and sands. The variation of topography is less noticeable which is significantly different from sand-wave topography in the vicinity. According to magnetic data, that region does not show abnormal magnetic value. It is estimated that it is non-magnetic substance, such as rope or driftwood. The 7 magnetic anormaly areas are mostly under seabed and unable to be identified.

Thus, the sinking locations of SSS_15 is close to Ch’eng Ta. The relationship between these sinking vessel is required to further study and verify.

Based on archelogical point of view and survey waters, no dredged cultural relics were foud.

It is preliominarily predicted that 17 objects discovered on seabed is modern cultural relics or historical relics. T has gretaer probability to be modern cultural relics.

Table 6.7-8 Table of Suspected Subjects

Number	E (TWD97)	N (TWD97)	Longitude (WGS84)	Latitude (WGS84)	Water Depth(m)	Length (m)	Width (m)	Height (m)	Preliminary Interpreatation
SSS_13	147152.3	2671655.9	119°59.28072'E	24°8.80982' N	42	3.1	0.9		Unknown Object
SSS_14	143522.2	2671313.2	119°57.13937'E	24°8.60973' N	38	1.8	1.1		Unknown Object
SSS_16	142494.2	2672517.4	119°56.52719'E	24°9.25782' N	35.8	32.0	9.0		Possible Sinking of Vessel
SSS_17	143569.4	2672073.7	119°57.16388'E	24°9.02186' N	38	2.6	1.0		Unknown Object
SSS_18	149435.4	2674429.2	120°0.61689'E	24°10.32090' N	38	4.3			Unknown Object
SSS_19	146559.3	2670977.1	119°58.93358'E	24°8.43980' N	42	5.7			Unknown Object
SSS_20	145495.6	2669785.5	119°58.31086'E	24°7.79013' N	41	7.6			Unknown Object
SSS_21	145286.9	2676275.5	119°58.15948'E	24°11.30477' N	39	7.9			Unknown Object
SSS_22	140042.5	2672944.8	119°55.07792'E	24°9.47918' N	35	5.1			Unknown Object
SSS_23	144027.2	2670141.6	119°57.44261'E	24°7.97714' N	38	4.6			Unknown Object
SSS_24	146509.2	2673002.5	119°58.89531'E	24°9.53672' N	41	4.9			Unknown Object
SSS_26	148600.6	2673100.1	120°0.12959'E	24°9.59774' N	39	11.0			Unknown Object
SSS_28	142684.9	2672948.8	119°56.63784'E	24°9.49228' N	36	4.7			Unknown Object
SSS_29	141695.8	2672693.8	119°56.05507'E	24°9.35009' N	35	5.9			Unknown Object
SSS_30	142355.5	2672880.2	119°56.44369'E	24°9.45377' N	36	4.4			Unknown Object
IF_15L023_SC001	136842.758	2668271.480	119°53.21090'E	24°6.93423' N	39.5	190			Linear Targeted Object
IF_15L024_SC001	137269.313	2669057.354	119°53.45896'E	24°7.36174' N	37.8	233			Linear Targeted Object
MAG_0069	147153.8	2671656.4	119°59.28161'E	24°8.81010' N	41.78				Possible Buried Magnetic Objects
MAG_0074	140501.5	2671876.1	119°55.35375'E	24°8.90222' N	36.79				Possible Buried Magnetic Objects
MAG_0087	142518.5	2672512.7	119°56.54155'E	24°9.25538' N	37.56				Possible Buried Magnetic Objects
MAG_0101	149523.3	2673282.0	120°0.67357'E	24°9.69982' N	38.90				Possible Buried Magnetic Objects
IF_15L015_MC001	136241.7	2669346.5	119°52.85112'E	24°7.51394' N	36.8				Possible Buried Magnetic Objects
IF_15L012_MC005	139577.2	2675364.6	119°54.79214'E	24°10.78795' N	32.9				Possible Buried Magnetic Objects
IF_15L012_MC006	139623.5	2675438.0	119°54.81914'E	24°10.82790' N	33.0				Possible Buried Magnetic Objects

Figure 6.7-12 Distribution Graph of Suspected Subjetcs

Table 6.7-9 Analysis Results of All Equipments (1/24)

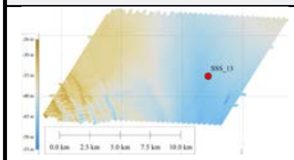
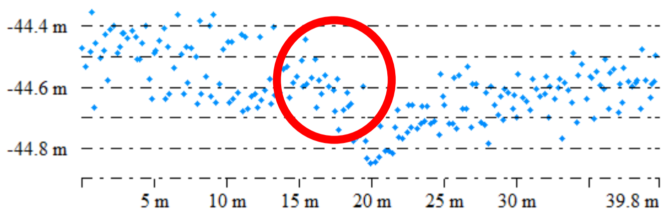
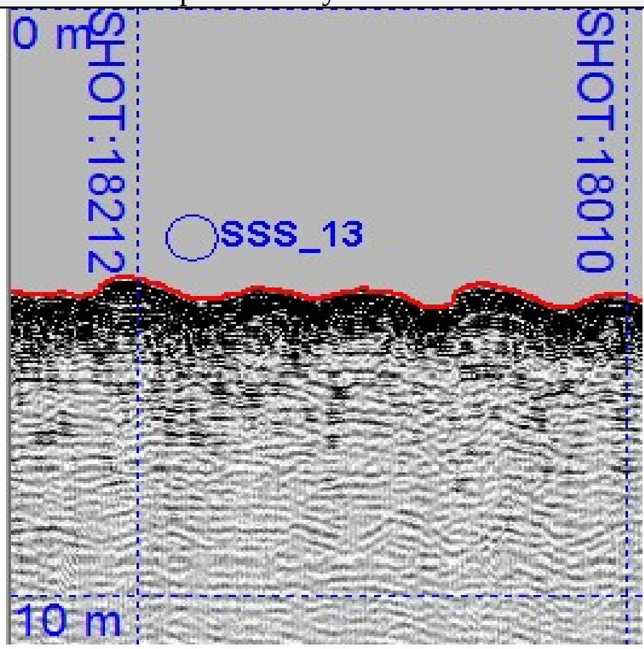
Code of Suspected Subject	X-Axis (TWD97)	Y-Axis (TWD97)	Sizde of Suspected Subject (m)
SSS_13	147152.3	2671655.9	3.1*0.9
Results of Multibeam Echo Sounder		Results of Side-Scan Sonar Model: Edgetech 4200 Operating Frequency (kHz) and range (m): 100kHz, LF: 125m	
 			
Results of Magnetometer Model: Geometric G-882		Model of Stratigraphic Profiler Model：Edgetech 2000 DSS Operating Frequency(kHz)：2 ~ 16 kHz Estimated Depth for Bury: No	
		 Horizontal Scale 50m/Grid	
Remarks			

Table 6.7-9 Analysis Results of All Equipments (2/24)

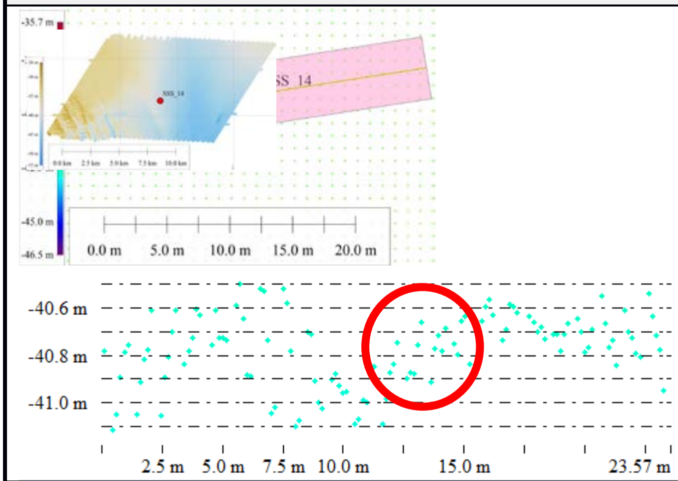
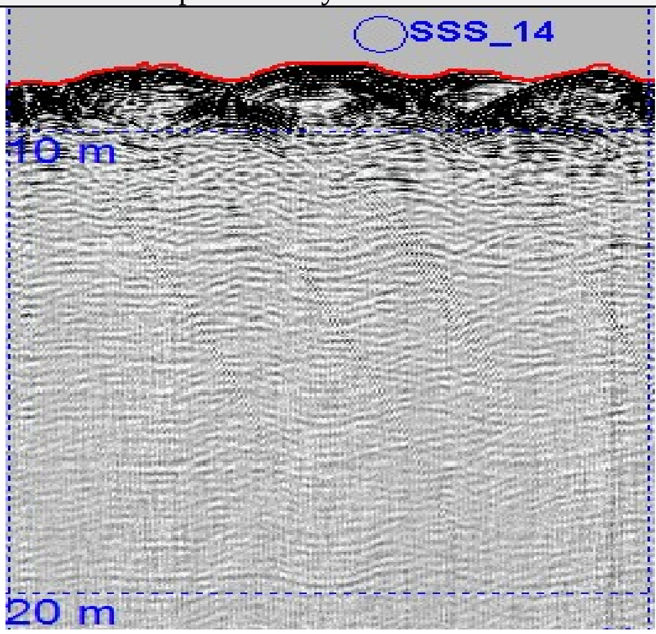
Code of Suspected Subject	X-Axis (TWD97)	Y-Axis (TWD97)	Sizde of Suspected Subject (m)
SSS_14	143522.2	2671313.2	1.8*1.1
Results of Multibeam Echo Sounder		Results of Side-Scan Sonar Model: Edgetech 4200 Operating Frequency (kHz) and range (m): 100kHz, LF: 125m	
 			
Results of Magnetometer Model: Geometric G-882		Model of Stratigraphic Profiler Model：Edgetech 2000 DSS Operating Frequency(kHz)：2 ~ 16 kHz Estimated Depth for Bury: No	
SSS_14 is 5m away from magnetic measuring lines.		 SSS_14 is 5m away from magnetic measuring lines. Horizontal Scale 50m/Grid	
Remarks			

Table 6.7-9 Analysis Results of All Equipments (3/24)

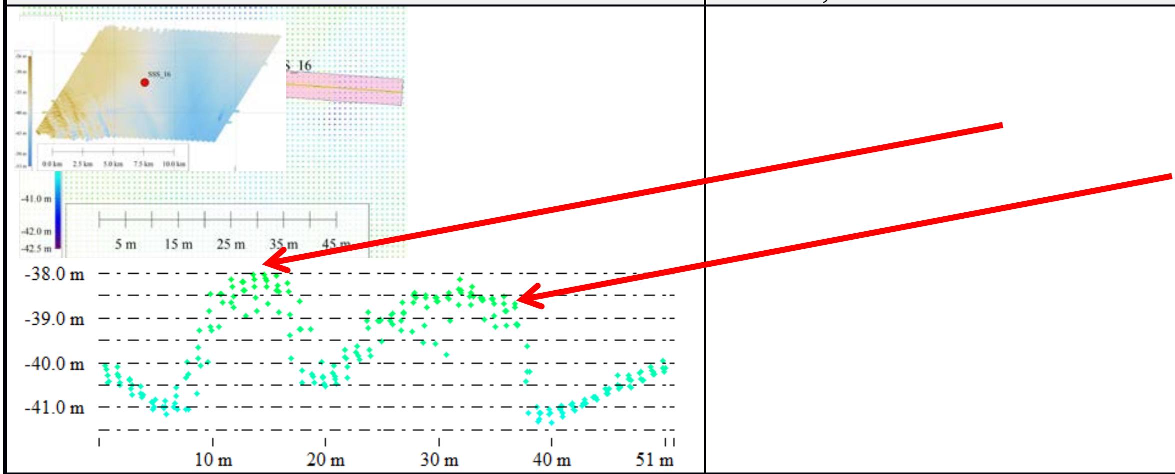
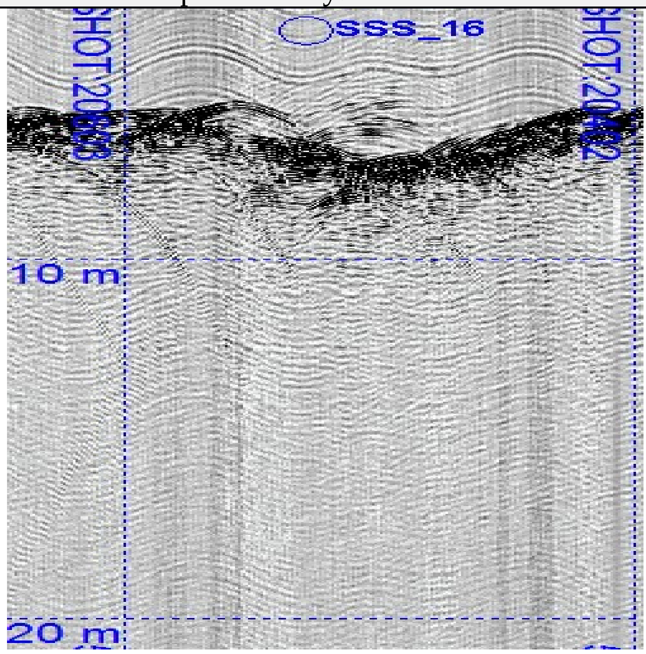
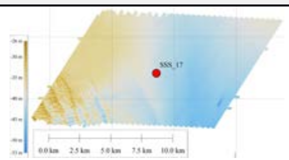
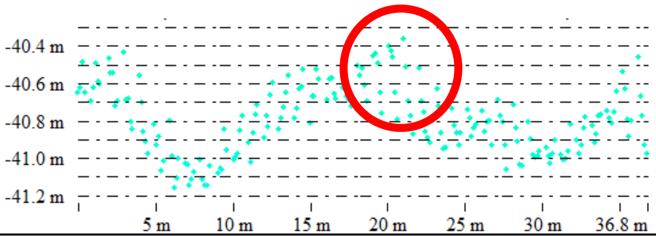
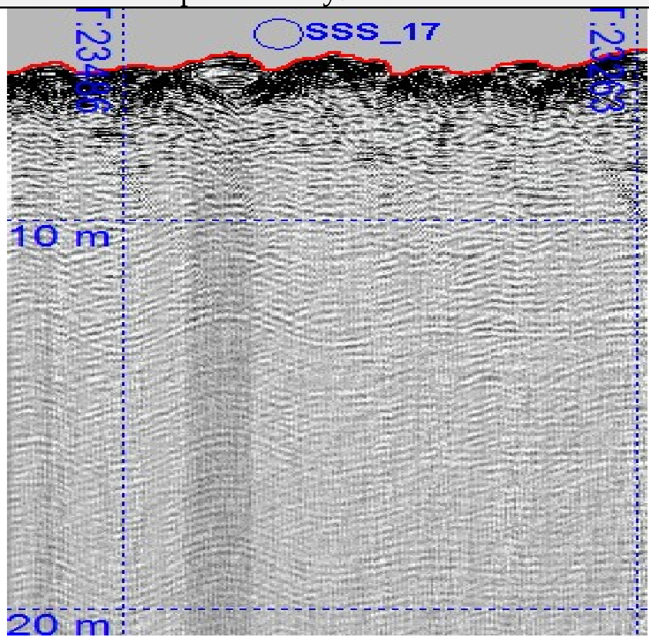
Code of Suspected Subject	X-Axis (TWD97)	Y-Axis (TWD97)	Sizde of Suspected Subject (m)
SSS_16	142494.2	2672517.4	32.0*9.0
Results of Multibeam Echo Sounder		Results of Side-Scan Sonar Model: Edgetech 4200 Operating Frequency (kHz) and range (m): 100kHz, LF: 125m	
			
Results of Magnetometer Model: Geometric G-882		Model of Stratigraphic Profiler Model：Edgetech 2000 DSS Operating Frequency(kHz)：2 ~ 16 kHz Estimated Depth for Bury: No	
SSS_16 is 22m away from magnetic measuring line.		 SSS_16 is 22m away from magnetic measuring line. Horizontal Scale 50m/Grid	
Remarks			

Table 6.7-9 Analysis Results of All Equipments (4/24)

<table>
<tr><td>Code of Suspected Subject</td><td>X-Axis (TWD97)</td><td>Y-Axis (TWD97)</td><td>Sizde of Suspected Subject (m)</td></tr>
<tr><td>SSS_17</td><td>143569.4</td><td>2672073.7</td><td>2.6*1.0</td></tr>
<tr><td colspan="2">Results of Multibeam Echo Sounder</td><td colspan="2">Results of Side-Scan Sonar
Model: Edgetech 4200
Operating Frequency (kHz) and range (m): 100kHz, LF: 125m</td></tr>
<tr><td colspan="2">

</td><td colspan="2"></td></tr>
<tr><td colspan="2">Results of Magnetometer
Model: Geometric G-882</td><td colspan="2">Model of Stratigraphic Profiler
Model：Edgetech 2000 DSS
Operating Frequency(kHz)：2 ~ 16 kHz
Estimated Depth for Bury: No</td></tr>
<tr><td colspan="2">SSS_17 is 2m away from magnetic measuring line.</td><td colspan="2">

SSS_17 is 2m away from magnetic measuring line.
Horizontal Scale 50m/Grid</td></tr>
<tr><td>Remarks</td><td colspan="3"></td></tr>
</table>

Table 6.7-9 Analysis Results of All Equipments (5/24)

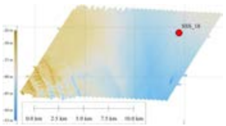
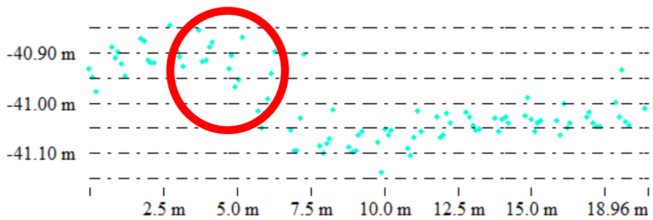
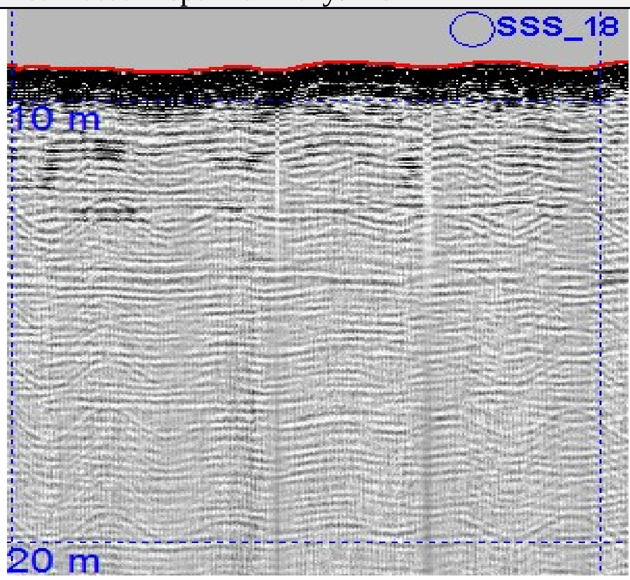
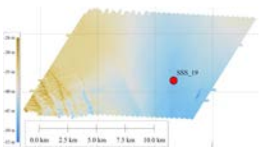
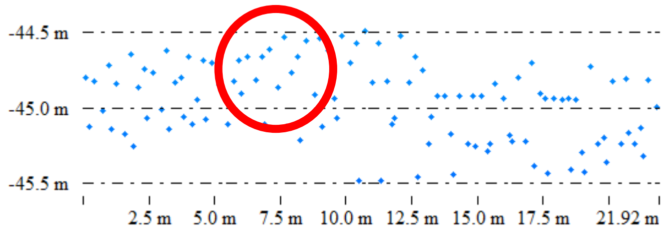
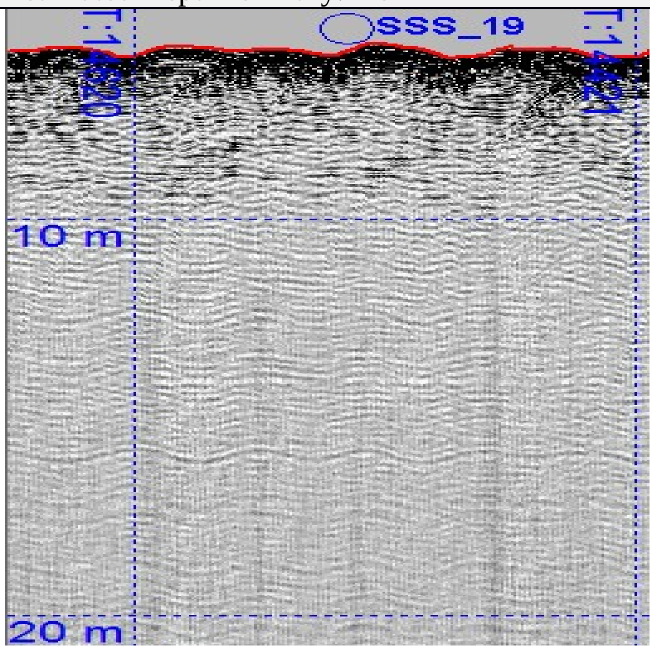
Code of Suspected Subject	X-Axis (TWD97)	Y-Axis (TWD97)	Sizde of Suspected Subject (m)
SSS_18	149435.4	2674429.2	L:4.3
Results of Multibeam Echo Sounder		Results of Side-Scan Sonar Model: Edgetech 4200 Operating Frequency (kHz) and range (m): 100kHz, LF: 125m	
  			
Results of Magnetometer Model: Geometric G-882		Model of Stratigraphic Profiler Model：Edgetech 2000 DSS Operating Frequency(kHz)：2 ~ 16 kHz Estimated Depth for Bury: No	
SSS_18 is 57m away from magnetic measuring line.		 SSS_18 is 57m away from magnetic measuring line. Horizontal Scale 50m/Grid	
Remarks			

Table 6.7-9 Analysis Results of All Equipments (6/24)

<table>
<tr><td>Code of Suspected Subject</td><td>X-Axis (TWD97)</td><td>Y-Axis (TWD97)</td><td>Sizde of Suspected Subject (m)</td></tr>
<tr><td>SSS_19</td><td>146559.3</td><td>2670977.1</td><td>L:5.7</td></tr>
<tr><td colspan="2">Results of Multibeam Echo Sounder</td><td colspan="2">Results of Side-Scan Sonar
Model: Edgetech 4200
Operating Frequency (kHz) and range (m):
100kHz, LF: 125m</td></tr>
<tr><td colspan="2">

</td><td colspan="2"></td></tr>
<tr><td colspan="2">Results of Magnetometer
Model: Geometric G-882</td><td colspan="2">Model of Stratigraphic Profiler
Model：Edgetech 2000 DSS
Operating Frequency(kHz)：2 ~ 16 kHz
Estimated Depth for Bury: No</td></tr>
<tr><td colspan="2">SSS_19 is 136m away from magnetic measuring line.</td><td colspan="2">

SSS_19 is 136m away from magnetic measuring line.
Horizontal Scale 50m/Grid</td></tr>
<tr><td>Remarks</td><td colspan="3"></td></tr>
</table>

Table 6.7-9 Analysis Results of All Equipments (7/24)

Code of Suspected Subject	X-Axis (TWD97)	Y-Axis (TWD97)	Sizde of Suspected Subject (m)
SSS_20	145495.6	2669785.5	L:7.6

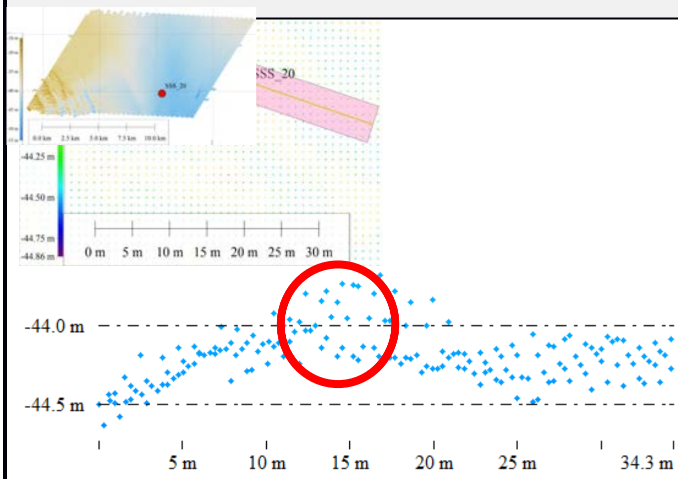
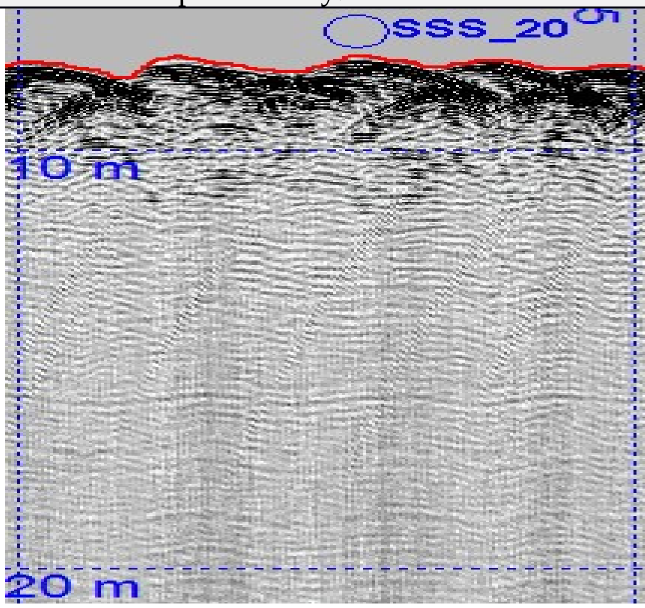
Results of Multibeam Echo Sounder	Results of Side-Scan Sonar Model: Edgetech 4200 Operating Frequency (kHz) and range (m): 100kHz, LF: 125m
	
Results of Magnetometer Model: Geometric G-882	Model of Stratigraphic Profiler Model：Edgetech 2000 DSS Operating Frequency(kHz)：2 ~ 16 kHz Estimated Depth for Bury: No
SSS_20 is 33m away from magnetic measuring line.	 SSS_20 is 33m away from magnetic measuring line. Horizontal Scale 50m/Grid
Remarks	

Table 6.7-9 Analysis Results of All Equipments (8/24)

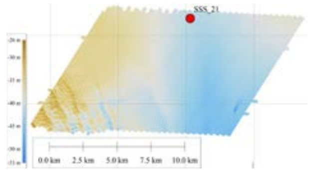
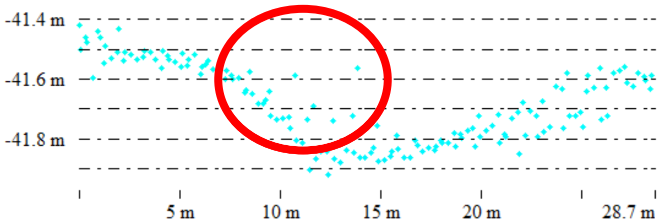
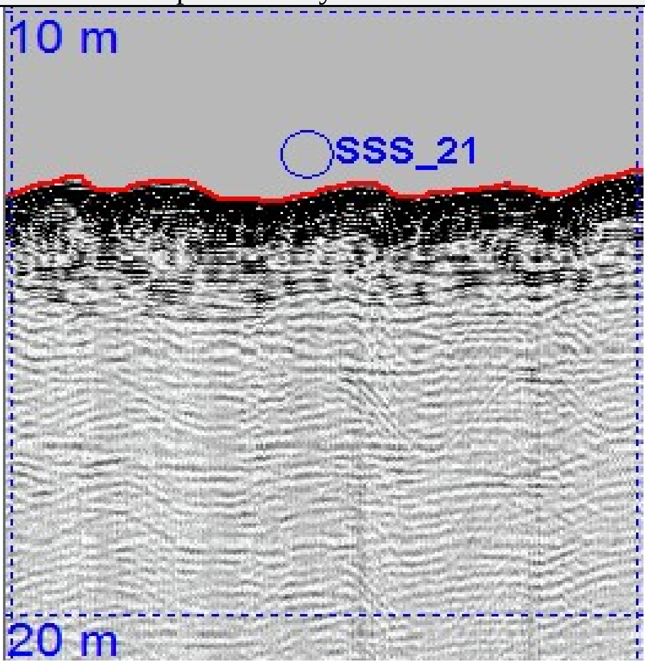
Code of Suspected Subject	X-Axis (TWD97)	Y-Axis (TWD97)	Sizde of Suspected Subject (m)
SSS_21	145286.9	2676275.5	L:7.9
Results of Multibeam Echo Sounder		Results of Side-Scan Sonar Model: Edgetech 4200 Operating Frequency (kHz) and range (m): 100kHz, LF: 125m	
 			
Results of Magnetometer Model: Geometric G-882		Model of Stratigraphic Profiler Model：Edgetech 2000 DSS Operating Frequency(kHz)：2 ~ 16 kHz Estimated Depth for Bury: No	
SSS_21 is 14m away from magnetic measuring line.		 SSS_21 is 14m away from magnetic measuring line. Horizontal Scale 50m/Grid	
Remarks			

Table 6.7-9 Analysis Results of All Equipments (9/24)

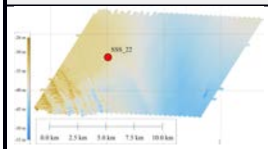
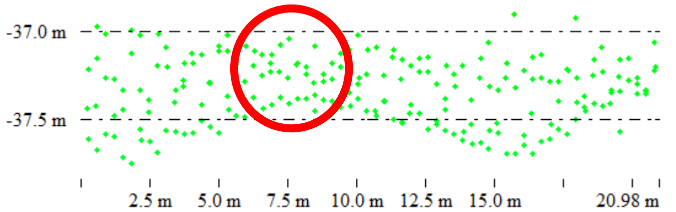
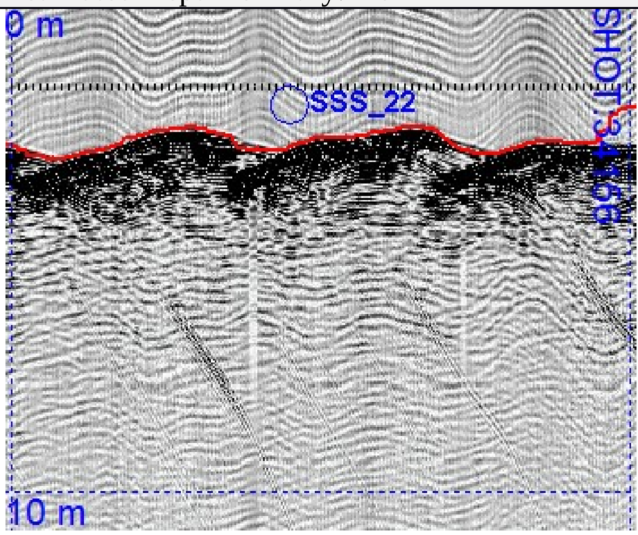
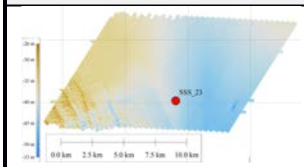
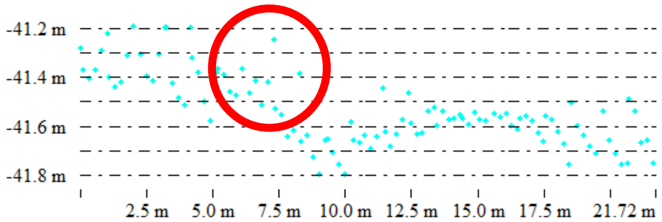
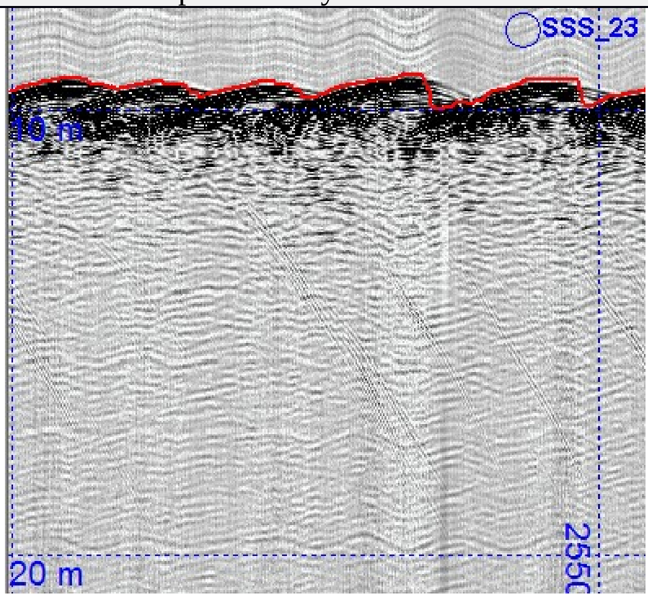
Code of Suspected Subject	X-Axis (TWD97)	Y-Axis (TWD97)	Sizde of Suspected Subject (m)
SSS_22	140042.5	2672944.8	L:5.1
Results of Multibeam Echo Sounder		Results of Side-Scan Sonar Model: Edgetech 4200 Operating Frequency (kHz) and range (m): 100kHz, LF: 125m	
  			
Results of Magnetometer Model: Geometric G-882		Model of Stratigraphic Profiler Model：Edgetech 2000 DSS Operating Frequency(kHz)：2 ~ 16 kHz Estimated Depth for Bury: No	
SSS_22 is 76m away from magnetic measuring line.		 SSS_22 is 76m away from magnetic measuring line. Horizontal Scale 50m/Grid	
Remarks			

Table 6.7-9 Analysis Results of All Equipments (10/24)

<table>
<tr><td>Code of Suspected Subject</td><td>X-Axis (TWD97)</td><td>Y-Axis (TWD97)</td><td>Sizde of Suspected Subject (m)</td></tr>
<tr><td>SSS_23</td><td>144027.2</td><td>2670141.6</td><td>L:4.6</td></tr>
<tr><td colspan="2">Results of Multibeam Echo Sounder</td><td colspan="2">Results of Side-Scan Sonar
Model: Edgetech 4200
Operating Frequency (kHz) and range (m): 100kHz, LF: 125m</td></tr>
<tr><td colspan="2">

</td><td colspan="2"></td></tr>
<tr><td colspan="2">Results of Magnetometer
Model: Geometric G-882</td><td colspan="2">Model of Stratigraphic Profiler
Model：Edgetech 2000 DSS
Operating Frequency(kHz)：2 ~ 16 kHz
Estimated Depth for Bury: No</td></tr>
<tr><td colspan="2">SSS_23 is 21m away from magnetic measuring line.</td><td colspan="2">

SSS_23 is 21m away from magnetic measuring line.
Horizontal Scale 50m/Grid</td></tr>
<tr><td>Remarks</td><td colspan="3"></td></tr>
</table>

Table 6.7-9 Analysis Results of All Equipments (11/24)

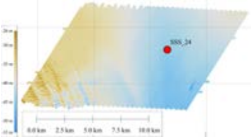
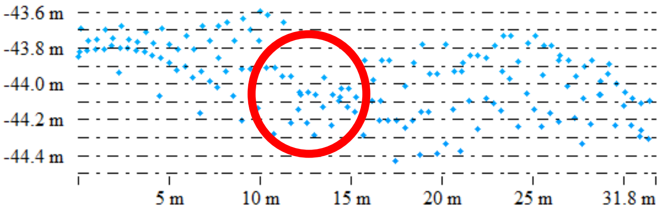
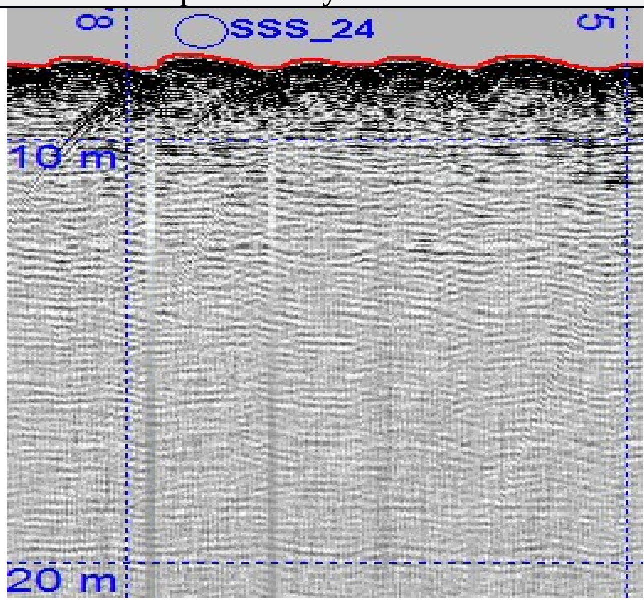
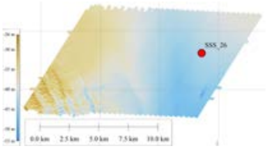
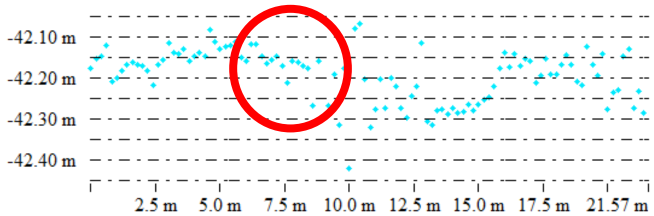
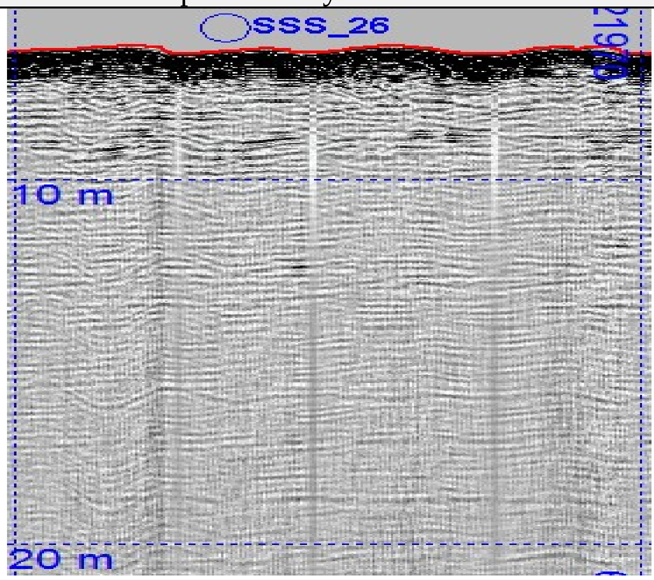
Code of Suspected Subject	X-Axis (TWD97)	Y-Axis (TWD97)	Size of Suspected Subject (m)
SSS_24	146509.2	2673002.5	L:4.9
Results of Multibeam Echo Sounder		Results of Side-Scan Sonar Model: Edgetech 4200 Operating Frequency (kHz) and range (m): 100kHz, LF: 125m	
  			
Results of Magnetometer Model: Geometric G-882		Model of Stratigraphic Profiler Model：Edgetech 2000 DSS Operating Frequency(kHz)：2 ~ 16 kHz Estimated Depth for Bury: No	
SSS_24 is 132m away from magnetic measuring line.		 SSS_24 is 132m away from magnetic measuring line. Horizontal Scale 50m/Grid	
Remarks			

Table 6.7-9 Analysis Results of All Equipments (12/24)

<table>
<tr><td>Code of Suspected Subject</td><td>X-Axis (TWD97)</td><td>Y-Axis (TWD97)</td><td>Size of Suspected Subject (m)</td></tr>
<tr><td>SSS_26</td><td>148600.6</td><td>2673100.1</td><td>L:11.0</td></tr>
<tr><td colspan="2">Results of Multibeam Echo Sounder</td><td colspan="2">Results of Side-Scan Sonar
Model: Edgetech 4200
Operating Frequency (kHz) and range (m):
100kHz, LF: 125m</td></tr>
<tr><td colspan="2">

</td><td colspan="2"></td></tr>
<tr><td colspan="2">Results of Magnetometer
Model: Geometric G-882</td><td colspan="2">Model of Stratigraphic Profiler
Model：Edgetech 2000 DSS
Operating Frequency(kHz)：2 ~ 16 kHz
Estimated Depth for Bury: No</td></tr>
<tr><td colspan="2">SSS_26 is 56m away from magnetic measuring line.</td><td colspan="2">

SSS_26 is 56m away from magnetic measuring line.
Horizontal Scale 50m/Grid</td></tr>
<tr><td>Remarks</td><td colspan="3"></td></tr>
</table>

Table 6.7-9 Analysis Results of All Equipments (13/24)

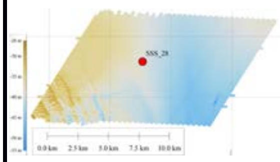
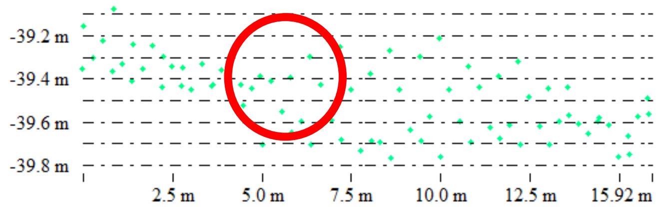
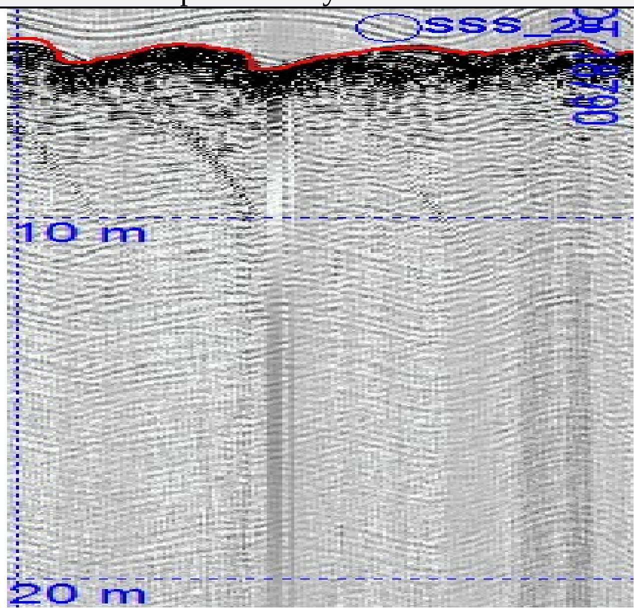
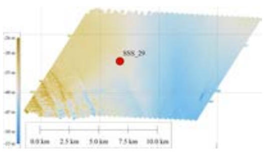
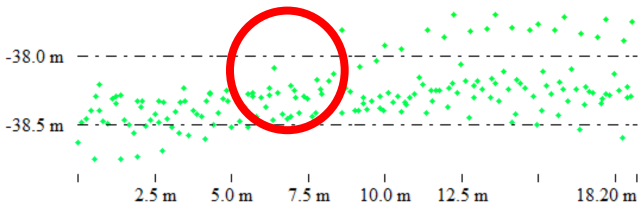
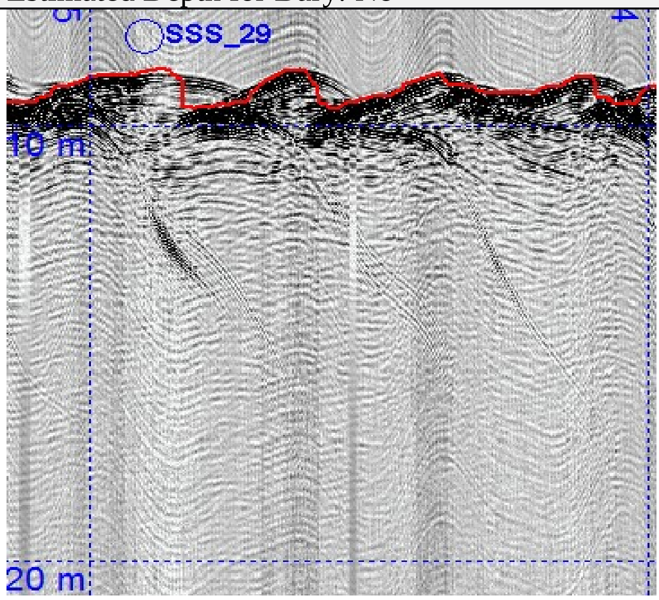
Code of Suspected Subject	X-Axis (TWD97)	Y-Axis (TWD97)	Size of Suspected Subject (m)
SSS_28	142684.9	2672948.8	4.7
Results of Multibeam Echo Sounder		Results of Side-Scan Sonar Model: Edgetech 4200 Operating Frequency (kHz) and range (m): 100kHz, LF: 125m	
  			
Results of Magnetometer Model: Geometric G-882		Model of Stratigraphic Profiler Model：Edgetech 2000 DSS Operating Frequency(kHz)：2 ~ 16 kHz Estimated Depth for Bury: No	
SSS_28 is 34m away from magnetic measuring line.		 SSS_28 is 34m away from magnetic measuring line. Horizontal Scale 50m/Grid	
Remarks			

Table 6.7-9 Analysis Results of All Equipments (14/24)

<table>
<tr><td>Code of Suspected Subject</td><td>X-Axis (TWD97)</td><td>Y-Axis (TWD97)</td><td>Size of Suspected Subject (m)</td></tr>
<tr><td>SSS_29</td><td>141695.8</td><td>2672693.8</td><td>L:5.9</td></tr>
<tr><td colspan="2">Results of Multibeam Echo Sounder</td><td colspan="2">Results of Side-Scan Sonar
Model: Edgetech 4200
Operating Frequency (kHz) and range (m):
100kHz, LF: 125m</td></tr>
<tr><td colspan="2">

</td><td colspan="2"></td></tr>
<tr><td colspan="2">Results of Magnetometer
Model: Geometric G-882</td><td colspan="2">Model of Stratigraphic Profiler
Model：Edgetech 2000 DSS
Operating Frequency(kHz)：2 ~ 16 kHz
Estimated Depth for Bury: No</td></tr>
<tr><td colspan="2">SSS_29 is 9m away from magnetic measuring line.</td><td colspan="2">

SSS_29 is 9m away from magnetic measuring line.
Horizontal Scale 50m/Grid</td></tr>
<tr><td>Remarks</td><td colspan="3"></td></tr>
</table>

Table 6.7-9 Analysis Results of All Equipments (15/24)

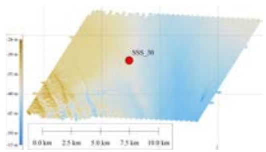
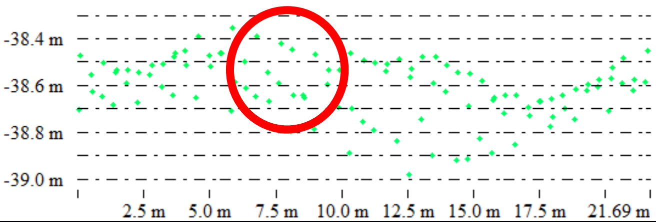
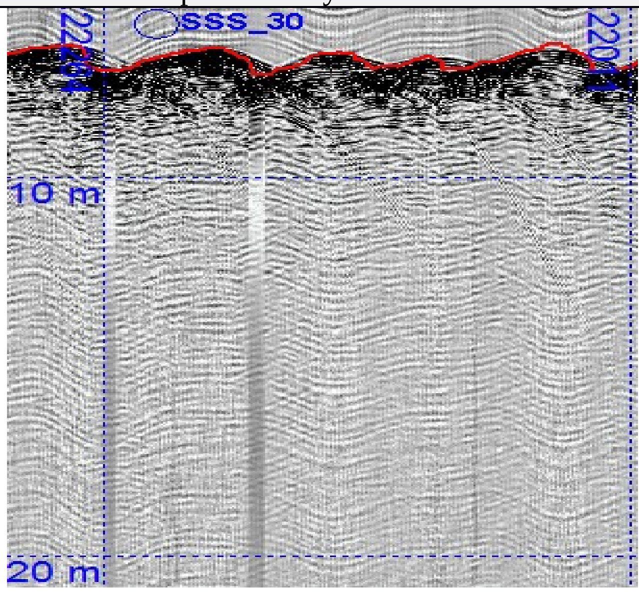
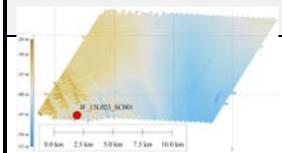
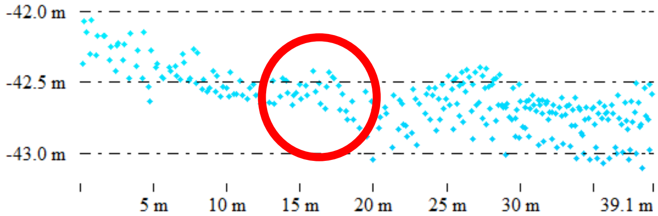
Code of Suspected Subject	X-Axis (TWD97)	Y-Axis (TWD97)	Size of Suspected Subject (m)
SSS_30	142355.5	2672880.2	L:4.4
Results of Multibeam Echo Sounder		Results of Side-Scan Sonar Model: Edgetech 4200 Operating Frequency (kHz) and range (m): 100kHz, LF: 125m	
  			
Results of Magnetometer Model: Geometric G-882		Model of Stratigraphic Profiler Model：Edgetech 2000 DSS Operating Frequency(kHz)：2 ~ 16 kHz Estimated Depth for Bury: No	
SSS_30 is 65m away from magnetic measuring line.		 SSS_30 is 65m away from magnetic measuring line. Horizontal Scale 50m/Grid	
Remarks			

Table 6.7-9 Analysis Results of All Equipments (16/24)

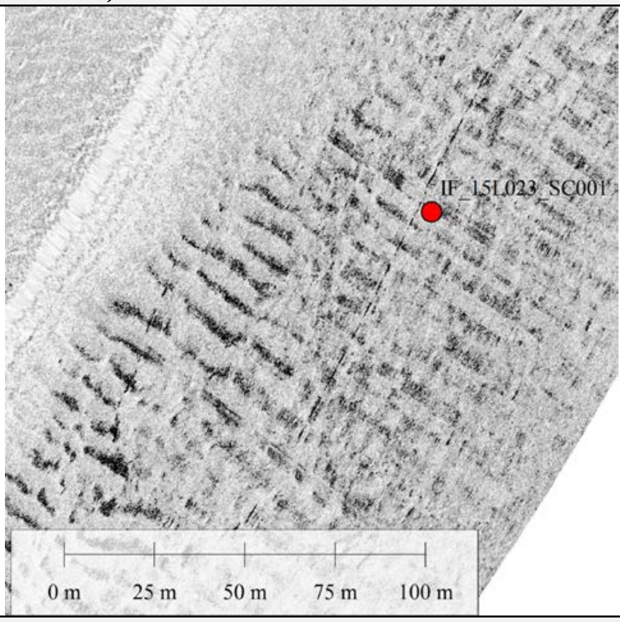
Code of Suspected Subject	X-Axis (TWD97)	Y-Axis (TWD97)	Size of Suspected Subject (m)
IF_15L023-SC001	136842.758	2668271.480	190 m

Results of Multibeam Echo Sounder

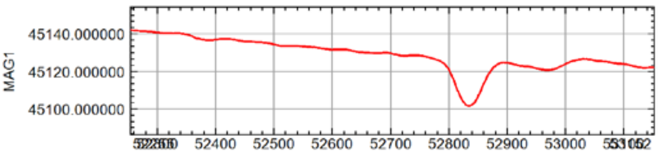




Results of Side-Scan Sonar
Model: Edgetech 4200
Operating Frequency (kHz) and range (m): 100kHz, LF: 125m

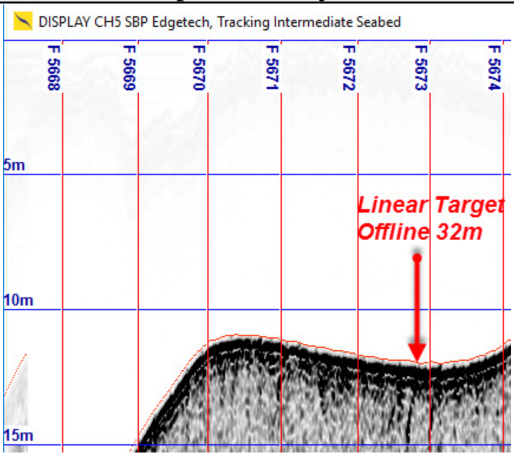


Results of Magnetometer
Model: Geometric G-882



IF_15L023-SC001 is 32m away from magnetic measuring line.

Model of Stratigraphic Profiler
Model：Edgetech 2000 DSS
Operating Frequency(kHz)：2 ~ 16 kHz
Estimated Depth for Bury: No



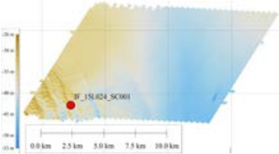
IF_15L023-SC001 is 32m away from magnetic measuring line.
Horizontal Scale 50m/Grid

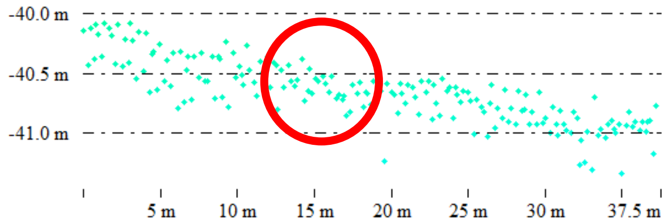
Remarks	

Table 6.7-9 Analysis Results of All Equipments (17/24)

Code of Suspected Subject	X-Axis (TWD97)	Y-Axis (TWD97)	Size of Suspected Subject (m)
IF_15L024_SC001	137269.313	2669057.354	233 m

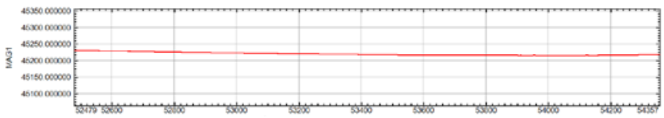
Results of Multibeam Echo Sounder





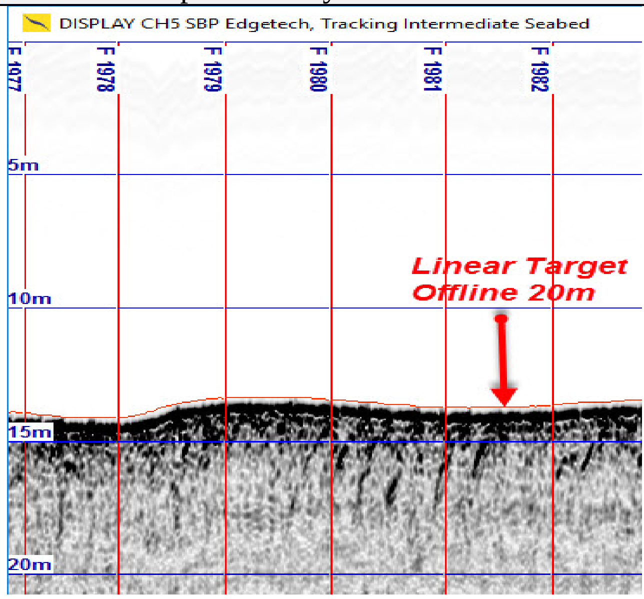
Results of Side-Scan Sonar
Model: Edgetech 4200
Operating Frequency (kHz) and range (m):
100kHz, LF: 125m

Results of Magnetometer
Model: Geometric G-882



IF_15L024_SC001 is 20m away from magnetic measuring line.

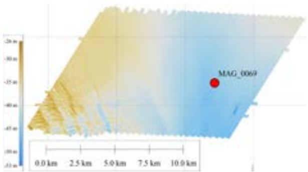
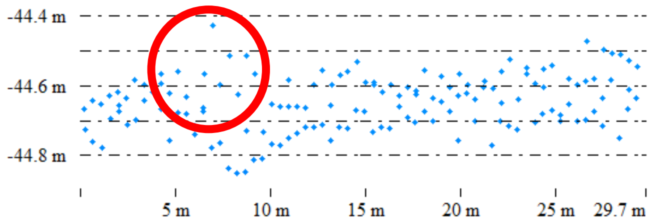
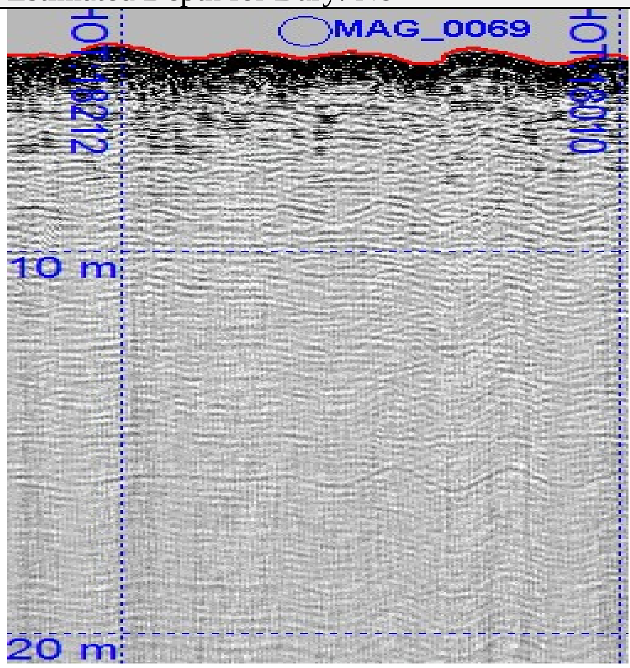
Model of Stratigraphic Profiler
Model：Edgetech 2000 DSS
Operating Frequency(kHz)：2 ~ 16 kHz
Estimated Depth for Bury: No



IF_15L024_SC001 is 20m away from magnetic measuring line.
Horizontal Scale 50m/Grid

Remarks	

Table 6.7-9 Analysis Results of All Equipments (18/24)

<table>
<tr><td>Code of Suspected Subject</td><td>X-Axis (TWD97)</td><td>Y-Axis (TWD97)</td><td>Size of Suspected Subject (m)</td></tr>
<tr><td>MAG_0069</td><td>147153.8</td><td>2671656.4</td><td></td></tr>
<tr><td colspan="2">Results of Multibeam Echo Sounder</td><td colspan="2">Results of Side-Scan Sonar
Model: Edgetech 4200
Operating Frequency (kHz) and range (m):
100kHz, LF: 125m</td></tr>
<tr><td colspan="2">

</td><td colspan="2"></td></tr>
<tr><td colspan="2">Results of Magnetometer
Model: Geometric G-882</td><td colspan="2">Model of Stratigraphic Profiler
Model：Edgetech 2000 DSS
Operating Frequency(kHz)：2 ~ 16 kHz
Estimated Depth for Bury: No</td></tr>
<tr><td colspan="2"></td><td colspan="2">

Horizontal Scale 50m/Grid</td></tr>
<tr><td>Remarks</td><td colspan="3"></td></tr>
</table>

Table 6.7-9 Analysis Results of All Equipments (19/24)

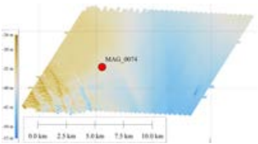
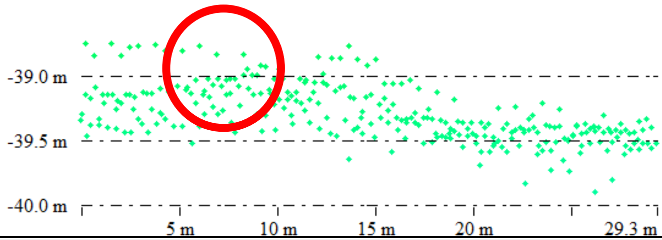
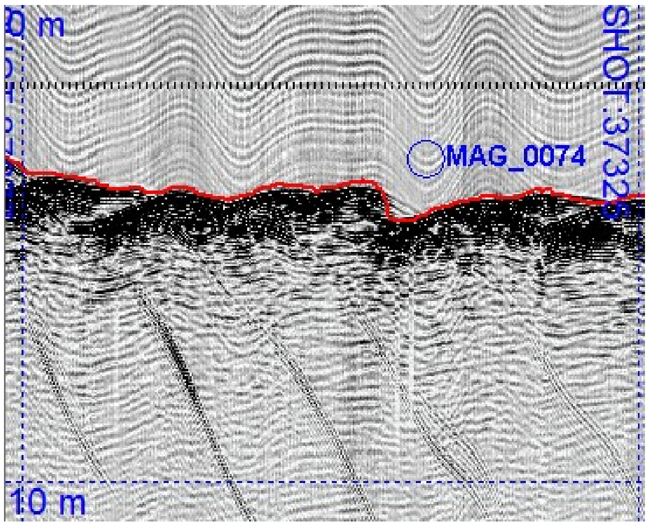
Code of Suspected Subject	X-Axis (TWD97)	Y-Axis (TWD97)	Size of Suspected Subject (m)
MAG_0074	140501.5	2671876.1	
Results of Multibeam Echo Sounder		Results of Side-Scan Sonar Model: Edgetech 4200 Operating Frequency (kHz) and range (m): 100kHz, LF: 125m	
 			
Results of Magnetometer Model: Geometric G-882		Model of Stratigraphic Profiler Model：Edgetech 2000 DSS Operating Frequency(kHz)：2 ~ 16 kHz Estimated Depth for Bury: No	
		 Horizontal Scale 50m/Grid	
Remarks			

Table 6.7-9 Analysis Results of All Equipments (20/24)

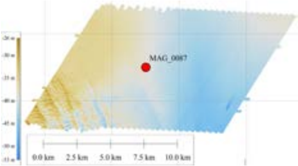
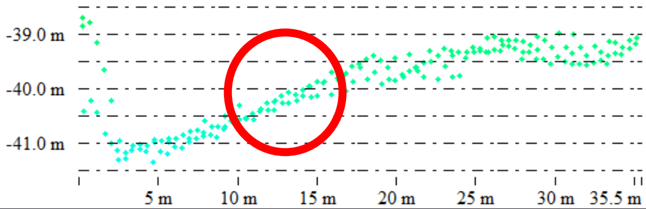
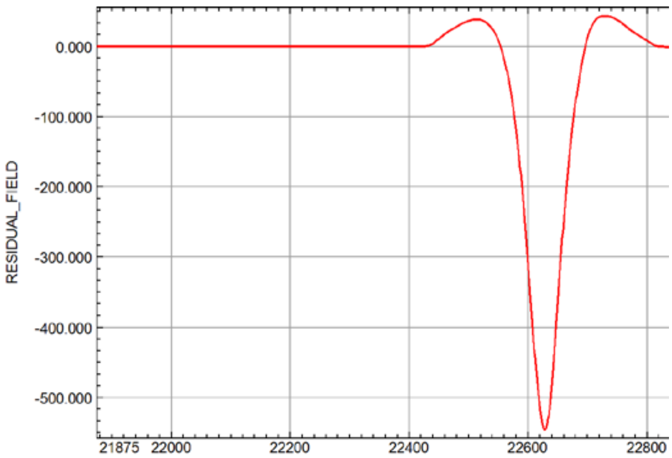
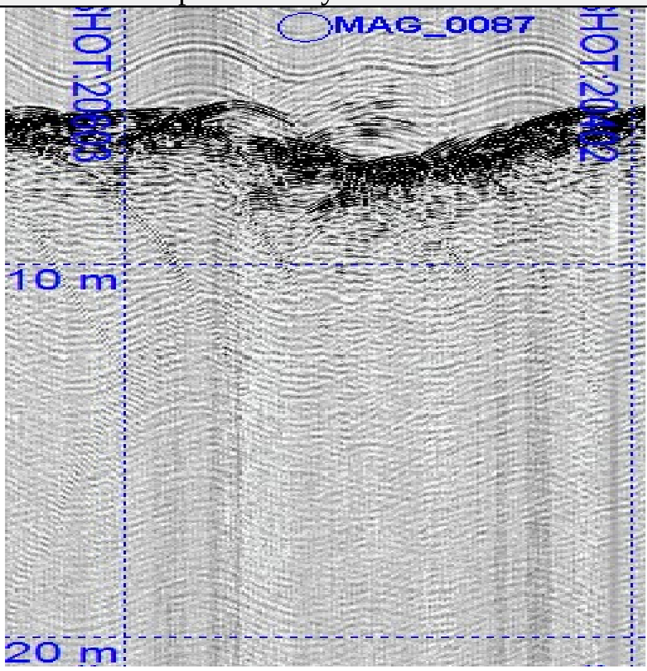
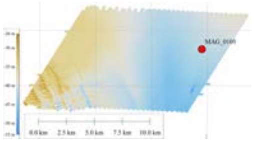
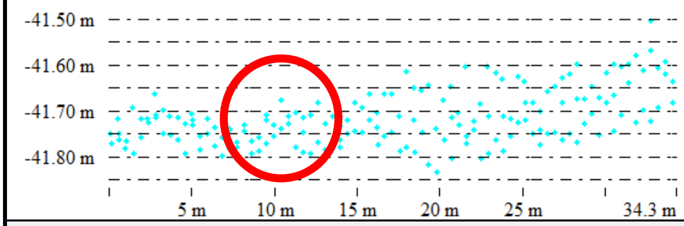
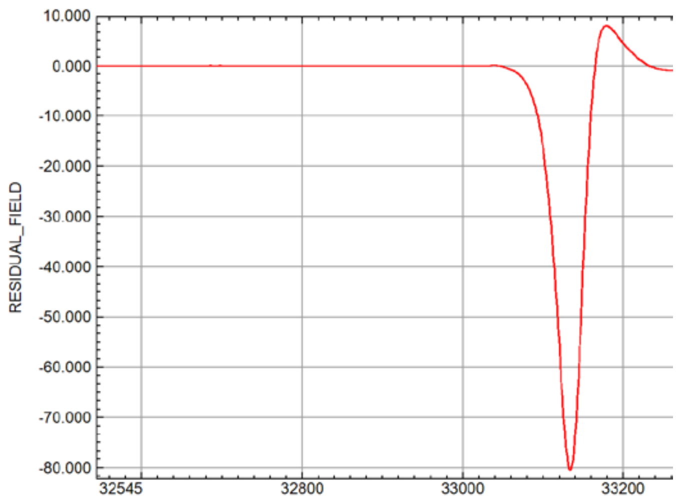
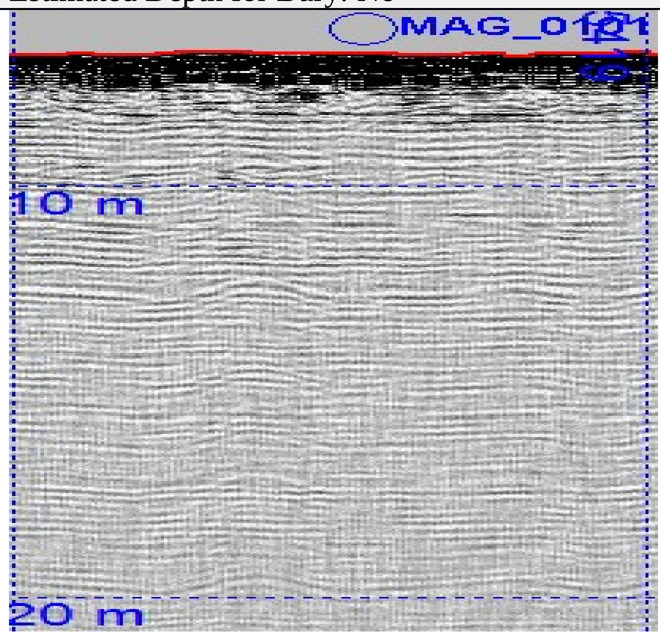
Code of Suspected Subject	X-Axis (TWD97)	Y-Axis (TWD97)	Size of Suspected Subject (m)
MAG_0087	142518.5	2672512.7	
Results of Multibeam Echo Sounder		Results of Side-Scan Sonar Model: Edgetech 4200 Operating Frequency (kHz) and range (m): 100kHz, LF: 125m	
  			
Results of Magnetometer Model: Geometric G-882		Model of Stratigraphic Profiler Model：Edgetech 2000 DSS Operating Frequency(kHz)：2 ~ 16 kHz Estimated Depth for Bury: No	
 		 Horizontal Scale 50m/Grid	
Remarks			

Table 6.7-9 Analysis Results of All Equipments (21/24)

<table>
<tr><td>Code of Suspected Subject</td><td>X-Axis (TWD97)</td><td>Y-Axis (TWD97)</td><td>Size of Suspected Subject (m)</td></tr>
<tr><td>MAG_0101</td><td>149523.3</td><td>2673282</td><td></td></tr>
<tr><td colspan="2">Results of Multibeam Echo Sounder</td><td colspan="2">Results of Side-Scan Sonar
Model: Edgetech 4200
Operating Frequency (kHz) and range (m):
100kHz, LF: 125m</td></tr>
<tr><td colspan="2">

</td><td colspan="2"></td></tr>
<tr><td colspan="2">Results of Magnetometer
Model: Geometric G-882</td><td colspan="2">Model of Stratigraphic Profiler
Model：Edgetech 2000 DSS
Operating Frequency(kHz)：2 ~ 16 kHz
Estimated Depth for Bury: No</td></tr>
<tr><td colspan="2">
</td><td colspan="2">

Horizontal Scale 50m/Grid</td></tr>
<tr><td>Remarks</td><td colspan="3"></td></tr>
</table>

Table 6.7-9 Analysis Results of All Equipments (22/24)

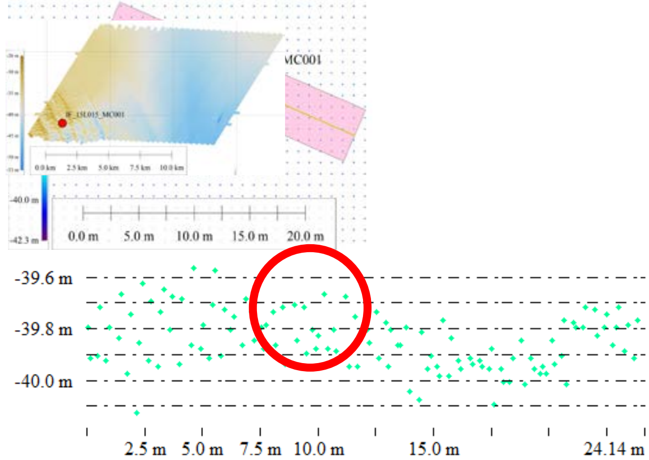
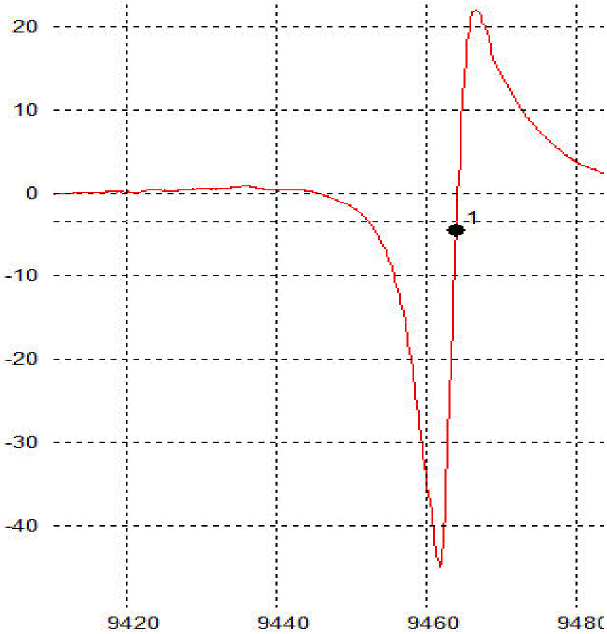
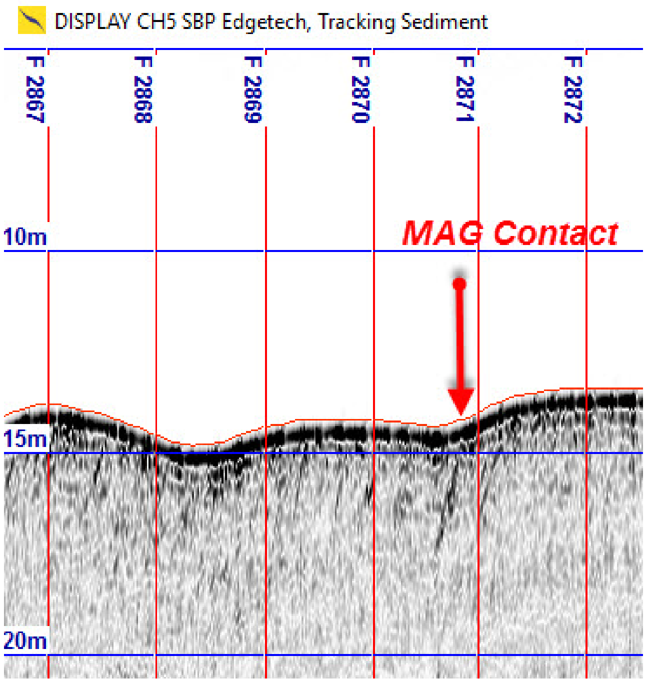
Code of Suspected Subject	X-Axis (TWD97)	Y-Axis (TWD97)	Size of Suspected Subject (m)
IF_15L015_MC001	136241.7	2669346.5	
Results of Multibeam Echo Sounder		Results of Side-Scan Sonar Model: Edgetech 4200 Operating Frequency (kHz) and range (m): 100kHz, LF: 125m	
			
Results of Magnetometer Model: Geometric G-882		Model of Stratigraphic Profiler Model：Edgetech 2000 DSS Operating Frequency(kHz)：2 ~ 16 kHz Estimated Depth for Bury: No	
		 Horizontal Scale 50m/Grid	
Remarks			

Table 6.7-9 Analysis Results of All Equipments (23/24)

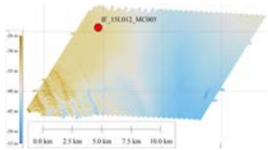
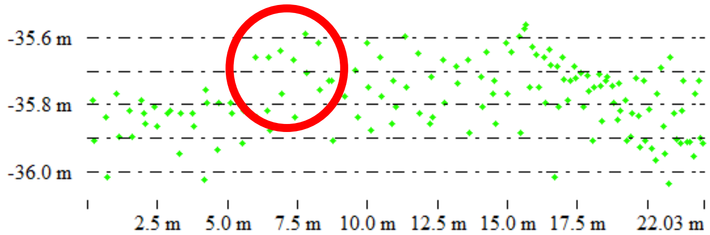
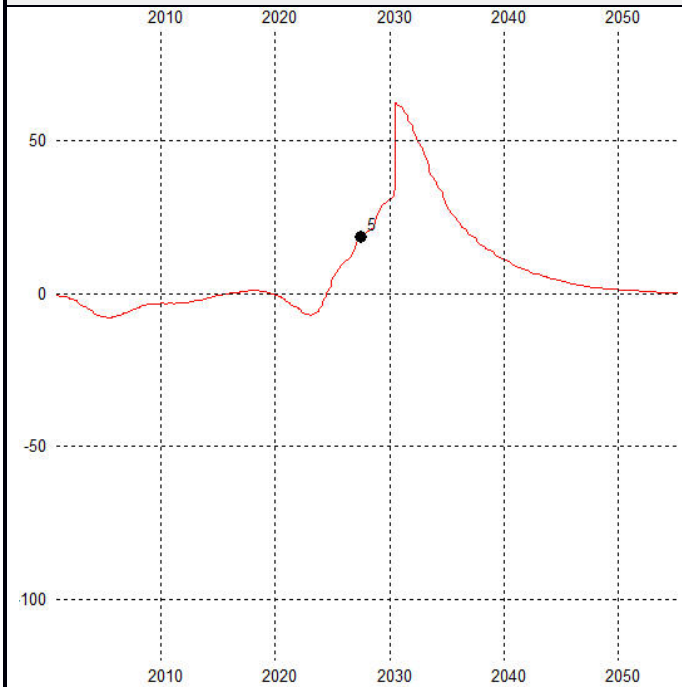
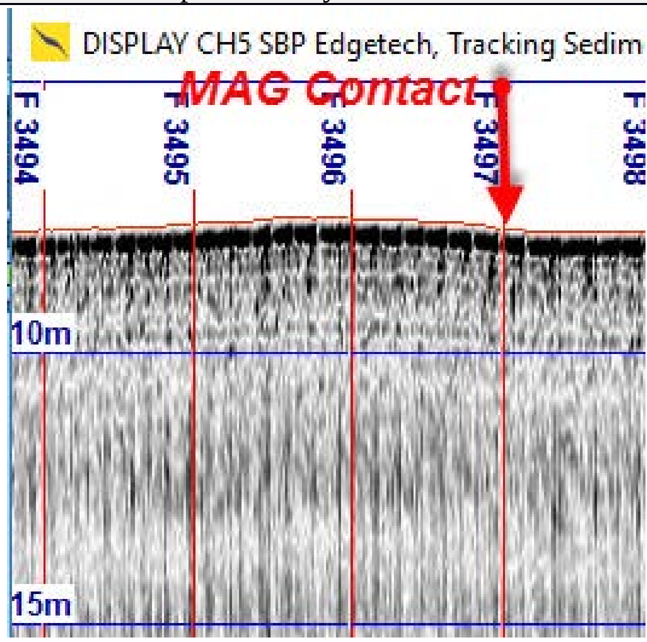
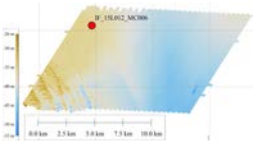
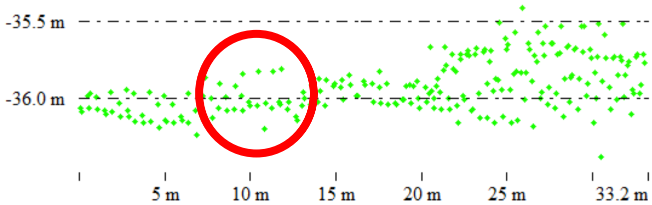
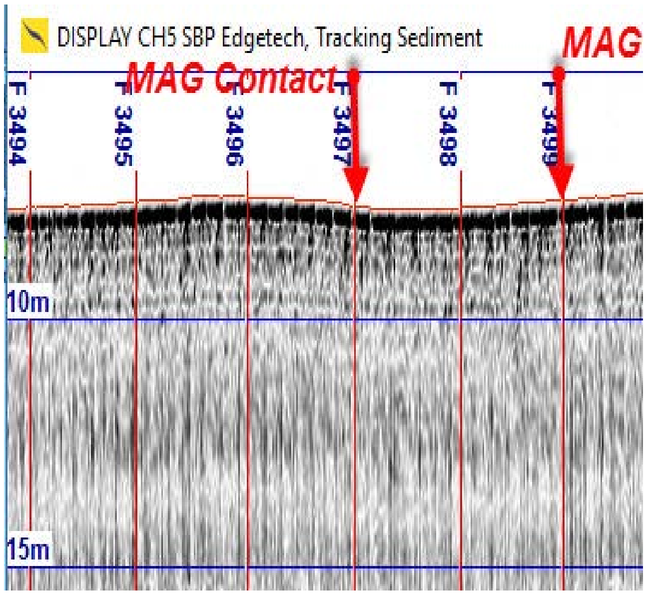
Code of Suspected Subject	X-Axis (TWD97)	Y-Axis (TWD97)	Sizde of Suspected Subject (m)
IF_15L012_MC005	139577.2	2675364.6	
Results of Multibeam Echo Sounder		Results of Side-Scan Sonar Model: Edgetech 4200 Operating Frequency (kHz) and range (m): 100kHz, LF: 125m	
 			
Results of Magnetometer Model: Geometric G-882		Model of Stratigraphic Profiler Model：Edgetech 2000 DSS Operating Frequency(kHz)：2 ~ 16 kHz Estimated Depth for Bury: No	
		 Horizontal Scale 50m/Grid	
Remarks			

Table 6.7-9 Analysis Results of All Equipments (24/24)

Code of Suspected Subject	X-Axis (TWD97)	Y-Axis (TWD97)	Size of Suspected Subject (m)
IF_15L012_MC006	139623.5	2675438	
Results of Multibeam Echo Sounder		Results of Side-Scan Sonar Model: Edgetech 4200 Operating Frequency (kHz) and range (m): 100kHz, LF: 125m	
 			
Results of Magnetometer Model: Geometric G-882		Model of Stratigraphic Profiler Model：Edgetech 2000 DSS Operating Frequency(kHz)：2 ~ 16 kHz Estimated Depth for Bury: No	
		 Horizontal Scale 50m/Grid	
Remarks			

Appendix 7 Table of Environmental Quality Survey

Types		Survey Items	Chapter	Page Number	Unknown Reason (Reason shall be elaborated)
Physicochemistry Types	Meteorological	☑1.Regional Weathe	6.2.1	6-35	
		☑2.Eaqrth SUrface	6.2.1	6-35	
		☑Temperature	6.2.1	6-35	
		☑Wind Direction	6.2.1	6-35	
		☑Wind Speed	6.2.1	6-35	
		☑Relative Humidity	6.2.1	6-35	
		☑Precipitation	6.2.1	6-36	
		☑Number of Days of Precipitation	6.2.1	6-36	
		☑Maximum Rainfall Intensity and Its Time	6.2.1	6-36	
		☑Evaporative Capacity	6.2.1	6-35	
		☑Air Pressure	6.2.1	6-35	
		☑Typhoon	6.2.1	6-35	
		☑Cloud Amount	6.2.1	6-35	
		☑ insolation duration	6.2.1	6-35	
		☑ amount of insolation	6.2.1	6-35	
		☑ global radiation	6.2.1	6-35	
	Air Quality	☑1.Air Quality	6.2.3	6-77	
		☑Particulate Pollutant(TSP、PM10、PM2.5)	6.2.3	6-77	
		☑NOx(NO、NO2)	6.2.3	6-77	
		☑SO2	6.2.3	6-77	
		☑CO	6.2.3	6-77	
		☑O3	6.2.3	6-77	
		☑Pb	6.2.3	6-77	
		☑Fallout Amount	6.2.3	6-79	
		☒Hydrocarbon			This project is offshore wind farm project which does not produce hydrocarbon and volatile organic compounds
		☒volatile organic compounds			

		☒hydrogen chloride ☒hydrogen fluoride ☒Asbestos ☒Heavy metal ☒Dioxin ☒2.Existing Pollutant Source (Fixed and mobile pollutant source)			This project is offshore wind farm project which does not produce hydrogen chloride, hydrogen fluoride, Asbestos, Heavy metal and Dioxin. No fixed and mobile pollutant source at project site.
		☑3.Related Regulations	6.2.3	6-77	
	Noise and Vibration	☑1.Noise Control ZonesTypes	6.2.4	6-90	
		☑2.Source of Source and Vibration	6.2.4	6-90	
		☑3.Sensitive Receiver	6.2.4	6-90	
		☑4.Background Noise and Vibration Level	6.2.4	6-90	

Appendix 7 Table of Environmental Quality Survey (Cont. 1)

Types		Survey Item	Chapter	Page Number	Unknown Reason (Reason shall be elaborated)
Physicochemistry Types	Offensive Odor	☒Concentratrion of Offensive Odor: Ammonia, hydrogen sulphide, methylthioethane、mercaptan, alkylamine and others.			This is an offshore wind farm project which does not produc offensive odor.
		☒Responses of Residents			
	Hydrology and Water Quality	☑1.River	6.2.5	6-97	
		☑Water Quality	6.2.5	6-97	
		☑Water Temperature	6.2.5	6-101	
		☑Concentration of Hydrogen Ions.	6.2.5	6-101	
		☑Dissolved Oxygen	6.2.5	6-101	
		☑BOD	6.2.5	6-101	
		☑Suspended Solid	6.2.5	6-101	
		☑Conductivity	6.2.5	6-101	
		☑Nitrate Nitrogen	6.2.5	6-101	
		☑Ammonia Nitrogen	6.2.5	6-101	
		☑Total Phosphorus	6.2.5	6-101	
		☑Coliform Group	6.2.5	6-101	
		☑Hydrology			
		☑Characteristics of Catchment Area	6.2.5	6-97	
		☑Hydrological factor	6.2.5	6-97	
		☑ Volume flow of Drainage Basin	6.2.5	6-97	
		☒ Volume Flow			This project is offshore wind farm project which no effluent is produced. FUlin River and Dajue River are unaffected which caused no affect on river and hydrology.
		☒ Flow Speed			
		☒ Water Level			
		☒ Sediment Discharge of River			
		☒ Source of Loam			
		☒ Tidal Boundary			
		☒Tidal Level			
		☒ Discharge of Reservoir			

		☐☑ Classification of Water Body at Earth Surface	6.2.5	6-97	
		☐☑ Use of Water Body	6.2.5	6-97	
		☒2. Reservoir and Lake ☒ Water Quality ☒ hydrography			This project is not located within reservoir and catchment area of lake.
		☑3.Waters (Marine) ☑Water Quality ☑Water Temperature ☑ Concentration of Hydrogen Ions ☑ Dissolved Oxygen ☑BOD ☑ Coliform Group	6.2.2 6.2.2 6.2.2 6.2.2 6.2.2 6.2.2 6.2.2	6-63 6-63 6-63 6-63 6-63 6-63 6-63	

Appendix 7 Table of Environmental Quality Survey (Cont. 2)

Types		Survey Item	Chapter	Page Number	Unknown Reason (Reason shall be elaborated)
		☑ Salinity	6.2.2	6-63	
		☑ Transparency	6.2.2	6-63	
		☑Fat	6.2.2	6-63	
		☑Heavy metal	6.2.2	6-63	
		☑ Sea State and Hydrology	6.2.2	6-38	
		☑Tides	6.2.2	6-38	
		☑Tidal Level	6.2.2	6-38	
		☑ Tidal Stream	6.2.2	6-52	
		☑Waves	6.2.2	6-38	
		☑ Heavy metal of sediment	6.2.2	6-70	
		☑4.Unserwater	6.2.5	6-102	
		☑Water Quality	6.2.5	6-102	
		☑ Water Temperature	6.2.5	6-103	
		☑ Concentration of Hydrogen Ions	6.2.5	6-103	
		☑ BOD (or total organic carbon)	6.2.5	6-103	
		☑ sulfate	6.2.5	6-103	
		☑ nitrate	6.2.5	6-103	
		☑ ammonia nitrogen	6.2.5	6-103	
		☑Conductivity	6.2.5	6-103	
		☑Iron	6.2.5	6-103	
		☑Mangenese	6.2.5	6-103	
		☑Chloride	6.2.5	6-103	
		☒Suspended Solid ☒Density of Coliform Group ☒Total Count			This project is offshore wind farm project which has no affect on underwater hydrology. This project has not conducted supplementary survey of underground. Data of sampling stationof EPA are collected (no suspended solid, coliform group and total count).
		☑Hydrology	6.2.5	6-102	
	Soil	☑Surface Soil and Subsoil	6.2.6	6-104	
		☑pH Value	6.2.6	6-104	
		☑Copper, Mercury, Lead, Zinc, Arsenic, Cadmium, Nickel and Chromium	6.2.6	6-104	

	Geology and Topography	☑1.Classification and Division of Topography	6.2.7	6-107	
		☒2.Unique topography			No unique topography in this area.
		☑3.Geology of surface soil and soil distribution	6.2.7	6-112	
		☒4.Unique Geology			No unique geology in this area.
		☑5.Earthquake and Fault	6.2.7	6-119	
		☑6. geologic hazard	6.2.7	6-127	
		☒7.Landslide Area of Catchment Area and Kand Use			This project is not located at landslide area of catchment area.

Appendix 7 Table of Environmental Quality Survey (Cont. 3)

Types		Survey Item	Chapter	Page Number	Unknown Reason (Reason shall be elaborated)
Physicochemistry Types	Waste	☑1.Existing Waste Survey	6.2.8	6-128	
		☑Types	6.2.8	6-128	
		☑Properties	6.2.8	6-128	
		☑Source	6.2.8	6-128	
		☑Physical Form	6.2.8	6-128	
		☑Amount	6.2.8	6-128	
		☑Methods of Storage, Clean and Processing	6.2.8	6-128	
		☑2.Survey of existing spoilban, waster process and facility	6.2.9	6-130	
		☑Designed Capacity	6.2.9	6-130	
		☑Used Capacity	6.2.9	6-130	
		☑Expandable Capacity	6.2.9	6-130	
	Electromagnetic Disturbance	☒1.Television screen situation			This project is offshore wind farm project, demolition of building and other structure are not involved and it is has no disturbance on electromagnetic waves.
		☒2. Topography and landform			
		☒3.Material survey of building and other structures			
		☑4.Monitoring of electromagnetic field	6.2.10	6-135	
Ecology		☑1.Terrestrial Ecology	6.3.1	6-138	Offshore wind turbine has not effect on terrestrial and marine ecology.
		☑Animal	6.3.1	6-170	
		☑Plant	6.3.1	6-152	
		2.Marine Ecology			
		☑3.Marine Ecology	6.3.2	6-179	
		☑Resources of Fishery Industry	6.3.2	6-315	
		☑Scology of Intertidal ZOnes	6.3.2	6-240	
		☑4.Marine Bird Ecology	6.3.4	6-382	
		☑5.Unique Ecosystem (Cetacean)	6.3.5	6-414	
Landscape and Recreational		☑1.Topography Landscape	6.4.1	6-421	
		☑2.Geographic Landscape	6.4.1	6-421	

	☑3.Natural Phenomena	6.4.1	6-423	
	☑4.Ecological Landscape	6.4.1	6-421	
	☑5.Human Landscape	6.4.1	6-424	
	☑6.Visual Landscape	6.4.1	6-421	
	☑7.Analysis of Recreational Situation	6.4.2	6-425	
	☑8.Existing Recreational Landscapes	6.4.2	6-426	
Socio-economy	☑1.Struture and Population of Fishery and Agriculture	6.5.2	6-431	
	☑2.Within area and land use situation (including basin and waters)	6.5.3	6-433	This project is located at waters. Water use within region is described in 6.3.2. This project does not involve with surface water basin. Thus, survey of surface water basin is not required.
	☒3.Exploitation, demolition andaffected population.			Exploitation and demolition are not involved in this project.
	☒4.Implemneted or drafted urban (regional)plan			
	☑5.Public Facility	6.5.4	6-437	
	☑6.Concerned Matters of Residents	6.5.5	6-438	

Appendix 7 Table of Environmental Quality Survey (Cont. 4)

Types	Survey Item	Chapter	Page Number	Unknown Reason (Reason shall be elaborated)
Socio-economy	☒7.Water rights and hydraulic facility ☒8.Community na dliving environment			This project is not involved with water righst and hydraulic facilities. This project is located within waters. The location of overland cable an terrestrial facilityis located within Changhua Coastal Industrial Park, community na dresidency are not involved.
Transportation	☑Road service level	6.6	6-460	
	☒facility of parking lot			This project is not involved with parking lot facility.
	☑Descriptionof roads	6.6	6-460	
Culture	☑ Ancient relic, historical site, ancient object, traditional and related relics, unqie building (including historical building), natural monument and other preserved building and surrounding landscapes.	6.7	6-480	
	☑Underwater cultural heritage	6.7	6-494	
Hygiene of Environment	☒Biological vector, mosquitoes, flies, cockroach, mouse and other hazardous animal.			◦ This is an offshore wind farm project which has low correlation with biological vectors and hazardous animal.

Chapter 7 The Possible Environmental Impact of Planned Development Activities

Due to the rise of environmental awareness and requirement of clean energy, wind power, which is a type of green energy, is being promoted and highly regarded by the European and American countries in recent years. This chapter assesses the environmental factors which may be influenced during construction and operation period of the project. The assessment scenarios of each factor are collected in Table 7-1, and described in the later sections in this chapter.

Table 7-1 Assessment Scenarios for each Environmental Factor

Item	Scenarios
Sea topology	To carry out simulation analysis by using the SW module, HD FM module, ST, MT module in MIKE 21 software.
Sea geology	1. To carry out seismic analysis according to "Seismic Design Specification and Commentary of Buildings (2011)", including small to medium earthquakes, designed earthquakes and the earthquakes with maximum consideration. 2. To perform load-design iteration. For monopile, DEFLEX and OptiMon are applied. For jackets, DEFLEX and ROSAP are applied.
Surface water	1. Run-off : Evaluated by the area of onshore substation. 2. Wastewater：Evaluated by the maximum number of people during construction and operation.
Seawater quality	1. For wind farm foundation, assess the greatest influence during scouring engineering. 2. For sea cable, assess the influence under the scenario of using high pressure flushing machine.
Air quality	Assuming the engineering of onshore substation and land cable work at the same time, evaluate under the maximum number of construction machines.
Environmental noise and vibration	1. Construction：Assuming the engineering of onshore substation and land cable work at the same time, evaluate under the maximum number of construction machines. 2. Operation：To simulate the scenario with maximum number of wind turbines (4MW) operated at the same time.
Underwater noise (construction)	1. To simulate the scenario for foundation pile using jacket type. 2. To simulate the scenario for piling construction using jacket type with pile diameter 4.0m.
Underwater noise (operation)	To simulate the sound transportation at 125 Hz frequency.
Scouring effect	To analyze the variation of scouring of different foundations and to evaluate the maximum scouring by using FLOW-3D and Mike 21 model.
Land EMF	To assess the influence of EMF for each possible land cable route.
Waste	Evaluated by the maximum number of people during construction and operation.
Land ecology	To investigate and assess all the possible land cable routes and onshore substation area.
Ocean ecology (includes fishes, marine mammals, birds, etc.	To investigate with the scenario of maximum number of wind turbines (4MW), then assess according to the investigation results and other simulation results, including the underwater noise and sea water qualities.

Table 7-1 Assessment Scenarios for each Environmental Factor(Continued)

Item	Scenarios
Landscape aesthetics	To separately evaluate the scenarios under maximum number of wind turbines (4MW) and maximum size of wind turbines (11MW).
Recreational environment	To evaluate by screening the sensitive areas or representative recreational spots within the neighboring environment of the Project site.
Traffic environment	To evaluate the traffic during the construction and operation period.
Cultural resources	To investigate the wind farm site and all the possible land cable routes, then assess the impacts according to the investigation results.
Risks of Typhoon	To evaluate the extreme wind speed of typhoon across the wind farm center within the area of 100~300 km.
Shipping safety effect	To assess the influence of sailing all types of ships within the wind farm area according to AIS data.

7.1 Physicochemical environment

7.1.1 Topography and geology

I. Topography

(I) Land topography

1. Construction stage

The land portion of this project consists of the land transmission and distribution system construction (including land underground cable and onshore substation). The connection station is located within Changhua Coastal Industrial Park in Changhua County, where the coastal topography is flat. Part of the topography changes during the construction of the substation and underground cable foundation projects, including site levelling, existing road excavation and culvert burial. However the topographical change is insignificant, it has only slight impact on the topology and geology of the surrounding environment.

2. Operation stage

The wind turbines in this project are all located in the coastal sea area of Changhua. After the wind turbine generators begin operation, there are only system's connection station for the power transmission and distribution, and onshore substation. The land cable are buried using underground pipe culvert. Generally speaking, there is no major change to the topography after this project begins operation. Therefore, this project's land facility operation shall have no impact on the project site and neighbouring topography.

(II) Sea topography

For the numerical simulation process of coastal topography change, as shown in Figure 7.1.1-1, MIKE 21 software developed by Dannish Hydrolic Institute

(DHI) is used in the simulation. Firstly, the wave module (SW module) is used to analyse the wave field of typhoon and monsoon. The water level simulation results of radiation stress and tidal prediction numerical model of the wave field analysis are used to analyse the flow field with the hydrodynamic module (HD FM module), and the flow field flux results based on particle size characteristics are used in sediment module (ST, MT module) for the substrate transport simulation, in order to obtain the characteristics of topology erosion.

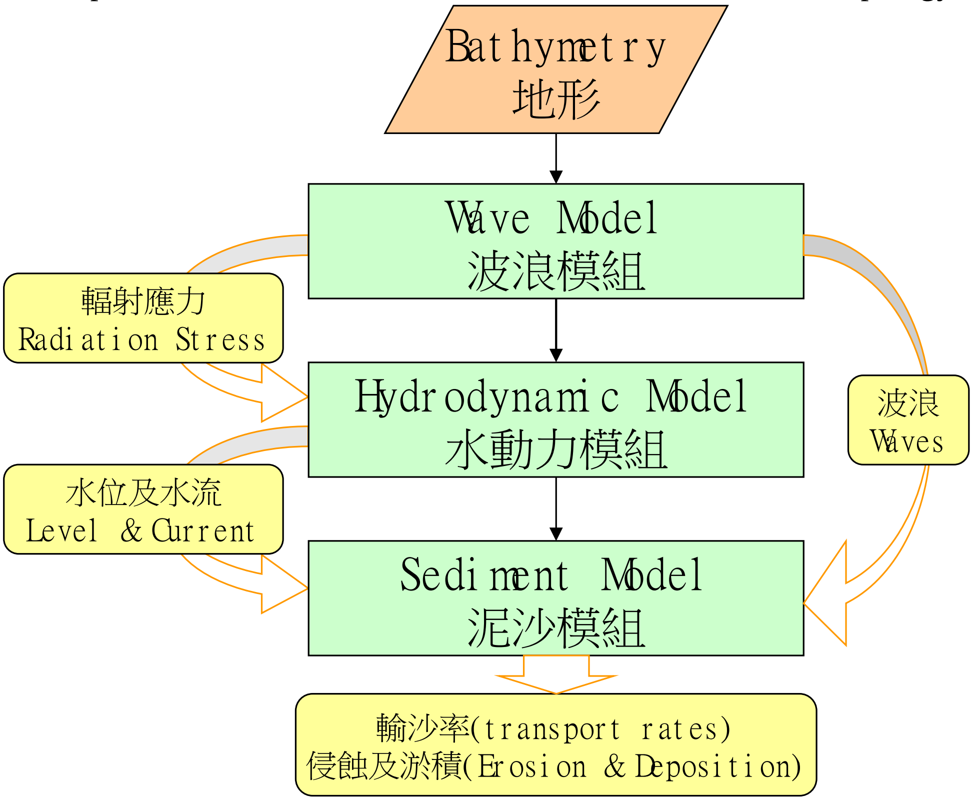


Figure 7.1.1-1 Simulation Flowchart of Change in Coastal Topography from Potential Sediment-Transport Rate

1. Computational Condition

(1) Calculation Range and Topographic Distribution

This project initially collects the results of measuring water depth in Taichung, Changhua county, Mailiao township in Yunlin county. It complements the measurement outside the range by using the numerical seabed topography in the sea near Taiwan obtained from the National Science Council Oceanographic Library. Figure 7.1.1-2 shows detailed topography and mesh distribution within the calculation range, demonstrated by the middle tidal system.

(2) Wave Condition

For the monsoon wave conditions, the statistical analysis of the waves in Taichung Port during winter and summer is used as reference. While for typhoon wave conditions, the Project site affected by about 1~2 typhoon(s) a year is taken into consideration. Therefore, the 10-year regression period under typhoon wave is the chosen condition. For the wave directions, the WSW and NNW directions are the chosen conditions due to significant effect on sand-drift activity within the Project site. The wave characteristics are summarized as shown in Table 7.1.1-1.

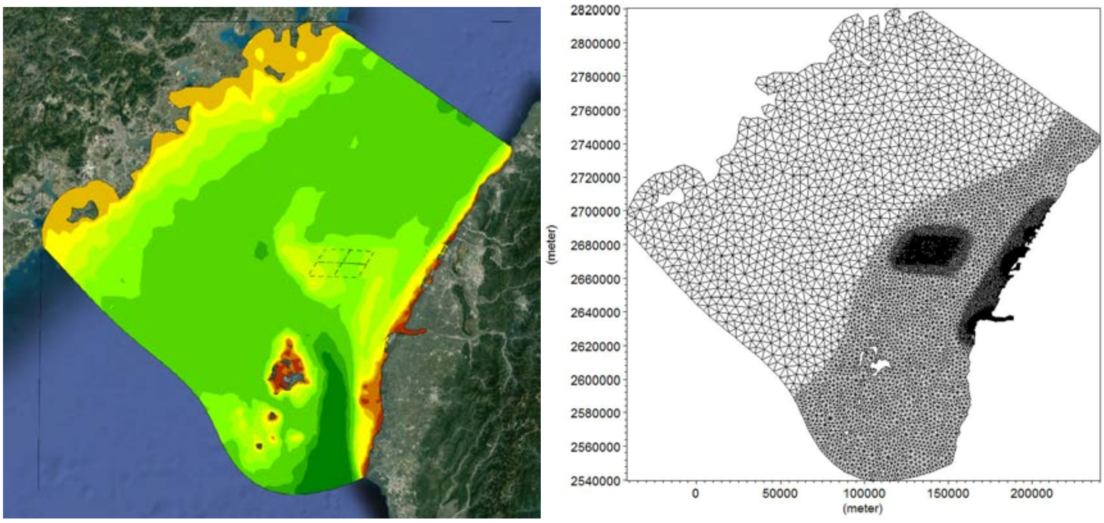


Figure 7.1.1-2 The Coastal Topographic Changes Analysis—Map of Water Depth and Mesh Distribution Within The Calculation Range

Table 7.1.1-1 Summary of Wave Input Conditions in the Planned Areas

Wave Direction		Wave Height(m)	Cycle(s)
Winter	N	2.5	7.1
Summer	W	1.4	6.1
Typhoon	WSW	4.2	8.6
	NNW	4.7	9.1

(3) Water Level Condition

The Project first uses the output derived from the global ocean tidal forecast model (NAO.99b model) developed by Matsumoto et al (2000) as the remote open boundary conditions, and then obtains simulation results from local sea area boundary of the Project site based on the simulation results from the flow field sea area around Taiwan Island in the distance, as the water level boundary conditions required for local area analysis.

(4) Sediment

For the sediments characteristics of the sea waters within the Project site, please refer to the sediments particle size survey data from the sea waters around Taichung Harbor, Changhua Coastal Industrial Park and Mailiao

Township of Yunlin County. Conditions for sediments in the sea waters adopts an average median diameter of 0.2 mm, but sediments in the Project site uses the data from sediments drilling investigation, of which the median diameter is 0.145~0.31mm.

(5) Characteristics of Rivers

Since there are Da'an River, Dajia River, Wu River and Zhuoshui River along the adjacent coast of the Project site, the effects on topographic changes of sea waters by sediment transported from the adjacent rivers are taken into consideration. Therefore, Hydrological Year Book of Taiwan issued by Water Resources Agency, Ministry of Economic Affairs, were collected and aggregated into Table 7.1.1-2 showing detailed input conditions from nearby streamflows and sediment-transport rate of the Project site.

Table 7.1.1-2 River Input Conditions

Month		1	2	3	4	5	6	7	8	9	10	11	12
Dadu River	Flow rate	110.1	49.5	58.8	77.9	132.5	255.5	186.9	221.7	139.7	71.0	58.3	58.5
	Sediment concentration	2,861	815	1,068	1,660	3,824	10,732	6,569	8,586	4,159	1,434	1,052	1,059
Dajia River	Flow rate	7.5	15.2	6.9	8.2	79.4	16.6	83.3	30.8	17.3	4.9	4.2	36.0
	Sediment concentration	53.2	137.9	47.0	60.0	1324.5	156.4	1414.1	363.5	164.7	29.4	24.0	449.4
Daan River	Flow rate	4.5	11.1	19.8	26.6	41.9	79.5	42.8	61.4	39.0	14.3	5.6	4.5
	Sediment concentration	65.0	199.3	405.4	583.2	1018.8	2235.6	1045.5	1626.3	933.3	271.4	86.9	66.1
Zhuoshui River	Flow rate	15.0	8.8	11.9	33.4	119.3	282.9	303.9	358.1	268.3	98.7	43.9	34.2
	Sediment concentration	319.8	117.7	206.9	1404.9	14782.1	73020.1	83329.8	112894.5	66176.0	10412.3	2328.5	1466.1

2. Verification Results

(1) Tidal Current Verification

The actual measured data required for simulation verification of tidal flow conditions are collected from Changhua Coastal Industrial Park observation station (CH7W) and Mailiao Township Industrial Park observation station (YLCW) near the Project site. The simulation time was from August 1~ August 31, 2006. The simulation time covered a tidal cycle (14.5 days) in order to truly grasp the characteristics of tidal flow which occurs twice a month.

Figure 7.1.1-3 and Figure 7.1.1-4 shows the flow velocity and flow pattern of the tidal current verification collected from Changbin sea waters (CH7W observation station) and Mailiao Township sea waters (YCLW observation station). As shown in the figures, the simulation results of flow velocity and flow condition are in accordance with the actual measured values, which indicate that the numerical hydrodynamic model adopted by the Project can accurately reflect the tidal characteristics of the sea waters near the Project site; therefore, the tidal simulation results are reasonable.

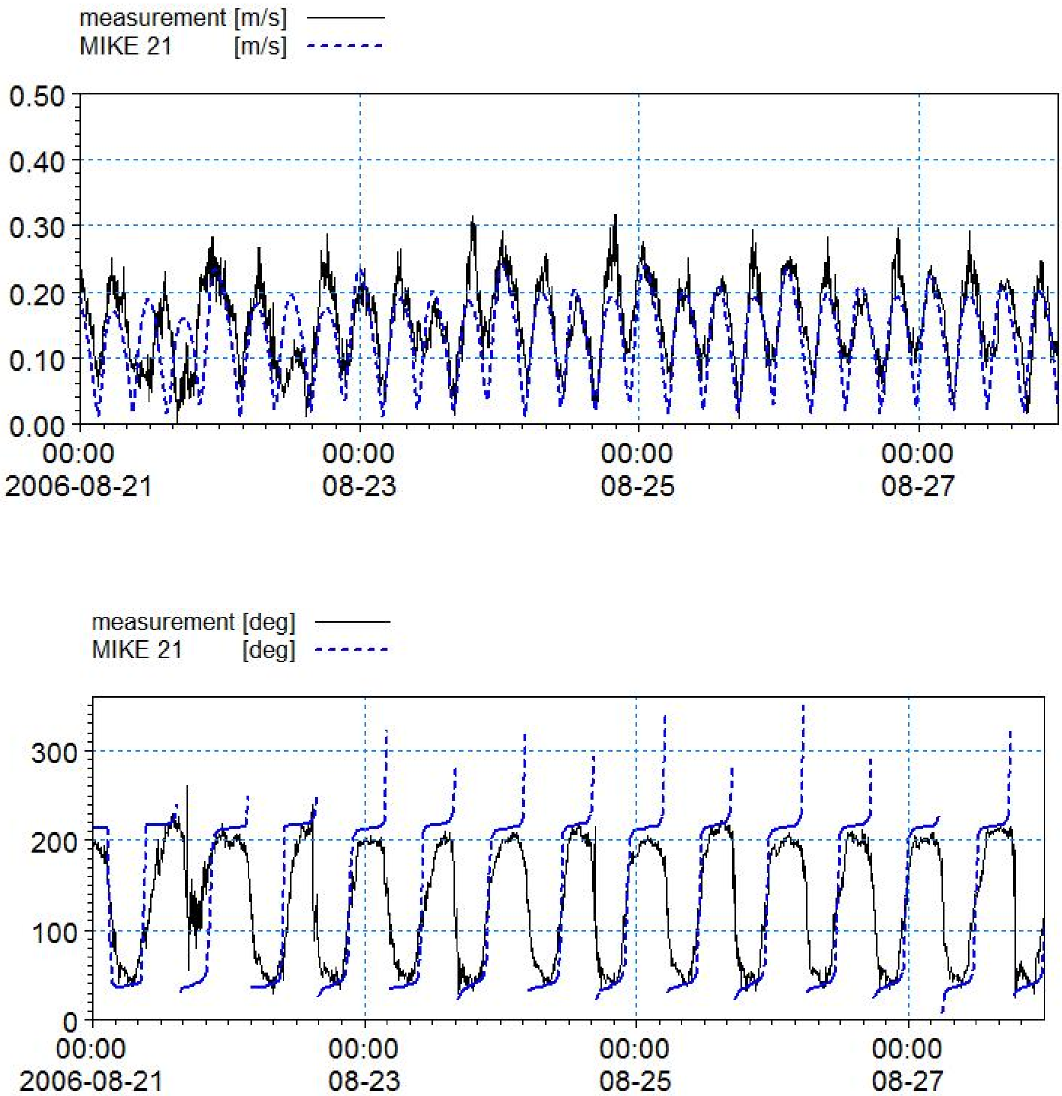
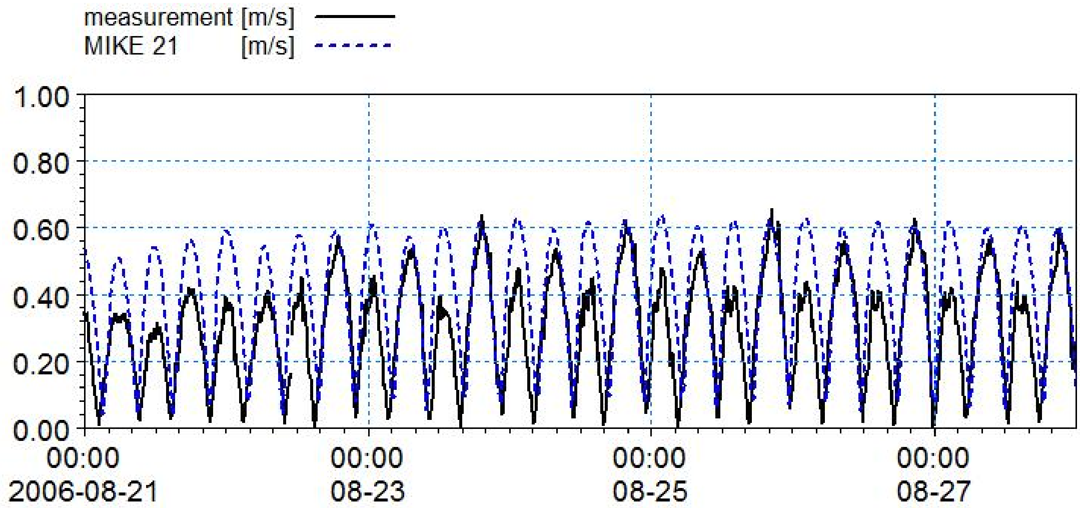


Figure 7.1.1-3 Sequence Diagram of Tidal Current Verification Collected from Changbin Sea Waters (CH7W Observation Station – Upper Diagram: Flow Velocity; Lower Diagram: Flow Direction)



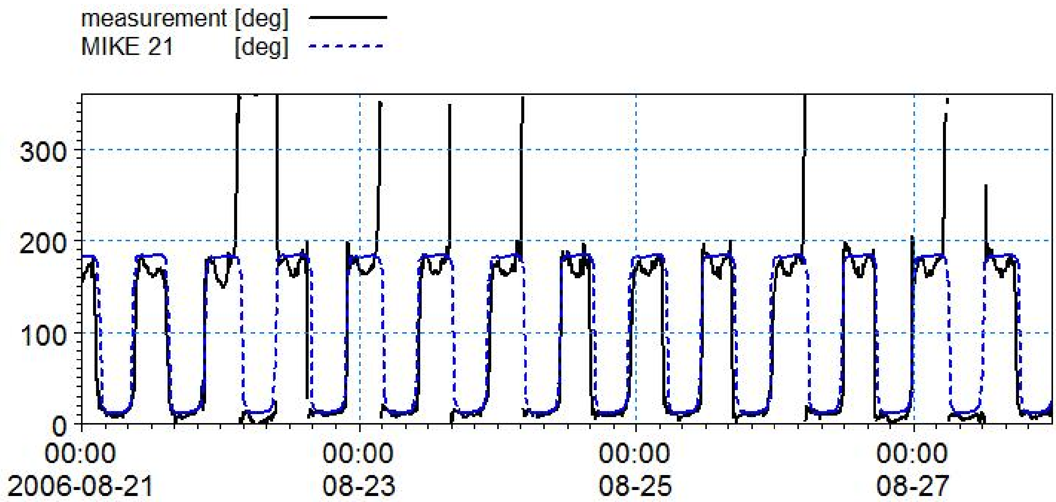
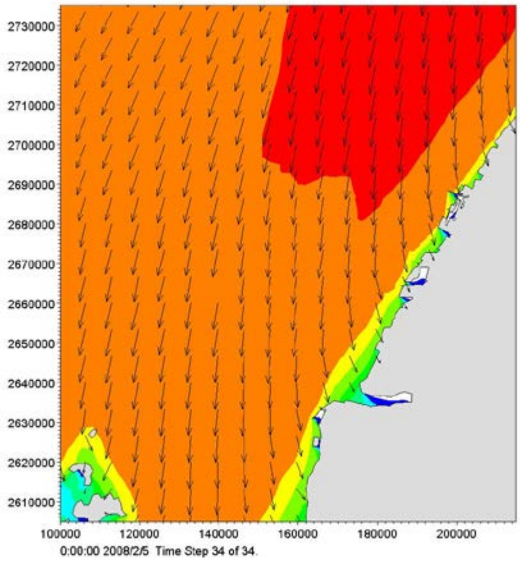


Figure 7.1.1-4 Sequence Diagram of Tidal Current Verification Collected from Mailiao Township Sea Waters (YCLW Observation Station – Upper Diagram: Flow Velocity; Lower Diagram: Flow Direction)

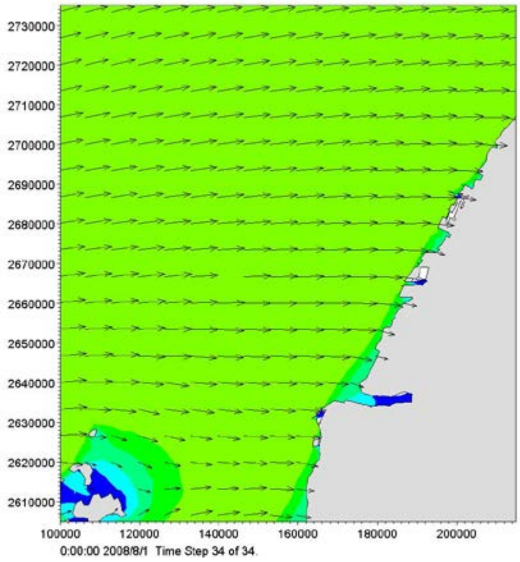
(2) Tidal Flow Analysis

A. Wave Field Analysis

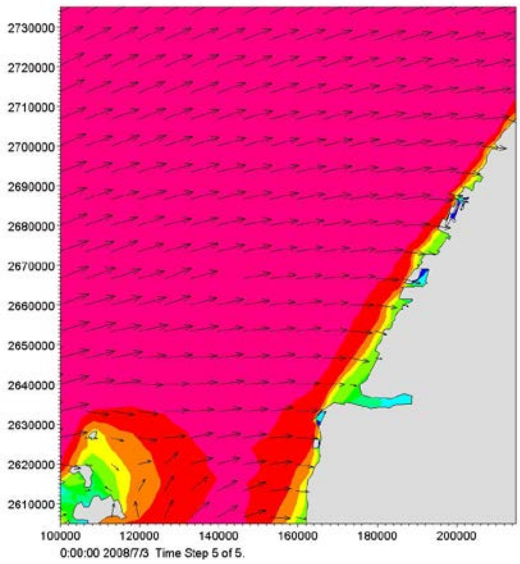
Figure 7.1.1-5 is the wave field distribution diagram showing the status quo of the Project site under the influences of winter waves, summer waves, and 10-year regression period with WSW and NNW (direction) typhoon waves. As shown in the figure, wave energy during the monsoon is relatively small, while wave height in the sea waters within the project site shows larger distribution during the winter, which is approximately 2m. Wave energy in the open sea during typhoon is relatively large; wave height distribution in the sea waters within the project site reaches to approximately 4m and above.



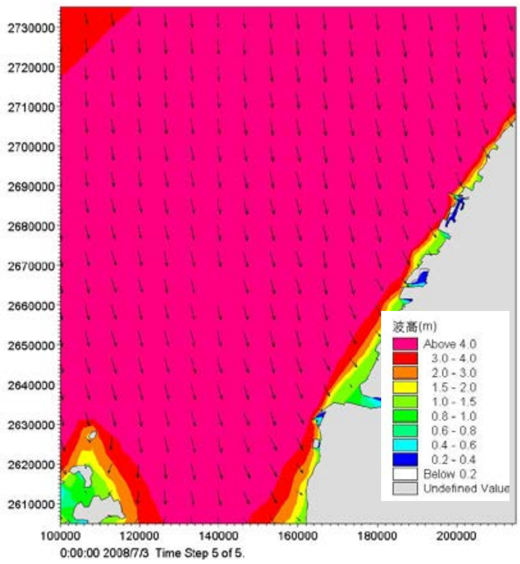
(a) Winter waves in N direction



(b) Summer waves in W direction



(c) Typhoon waves in WSW direction

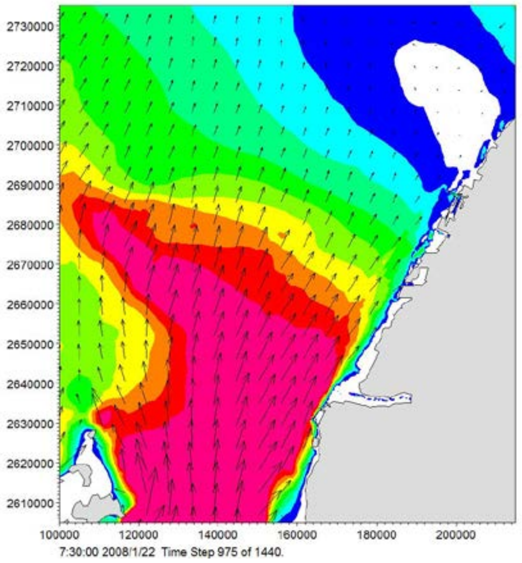


(d) Typhoon waves in NNW direction

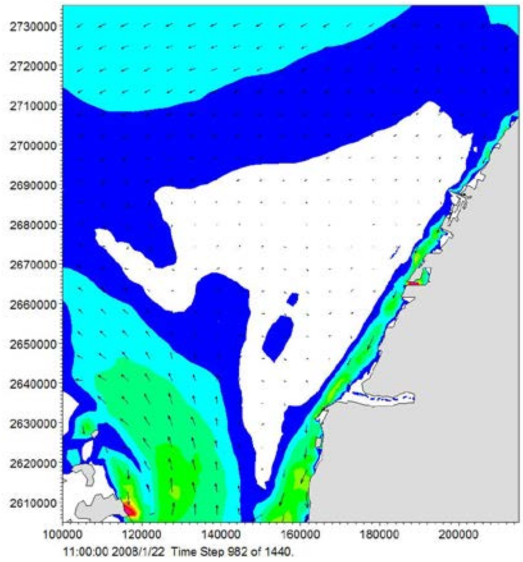
Figure 7.1.1-5 Wave Field Distribution Diagram Based on the Status Quo of the Sea Waters within the Project Site

B. Flow field analysis

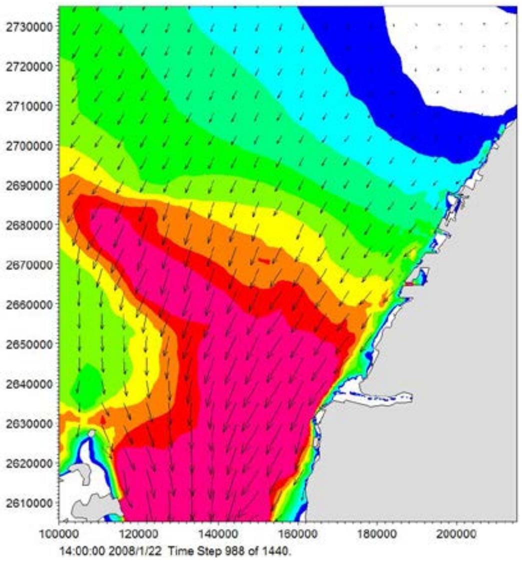
The tidal current flow condition of the sea waters within the Project site flows northward at high tide and southward at low tide. Taking the winter monsoon as an example, Figure 7.1.1-6 shows the tidal current distribution under the influence of the winter monsoon wave. As shown in the figure, the flow direction is south to north during rising tide, and flow velocity off the coast of Mailiao Township of Yunlin County can reach 0.9m/sec and above; the flow direction is north to south during falling tide, and flow velocity off the coast off Mailiao Township of Yunlin County can also reach 0.9m/sec and above. In addition, since the water depth varies relatively significant near the Project site, which is approximately -30m ~ -50m, therefore, flow velocity affected by the topography during high tide and low tide is also relatively significant.



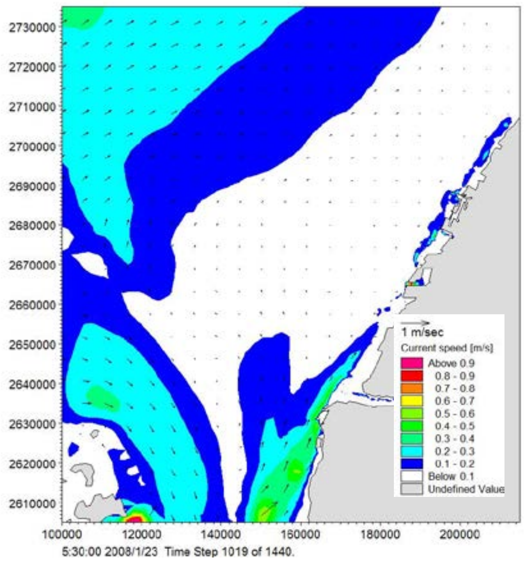
(a) Rising tide stage



(b) High tide



(c) Falling tide stage

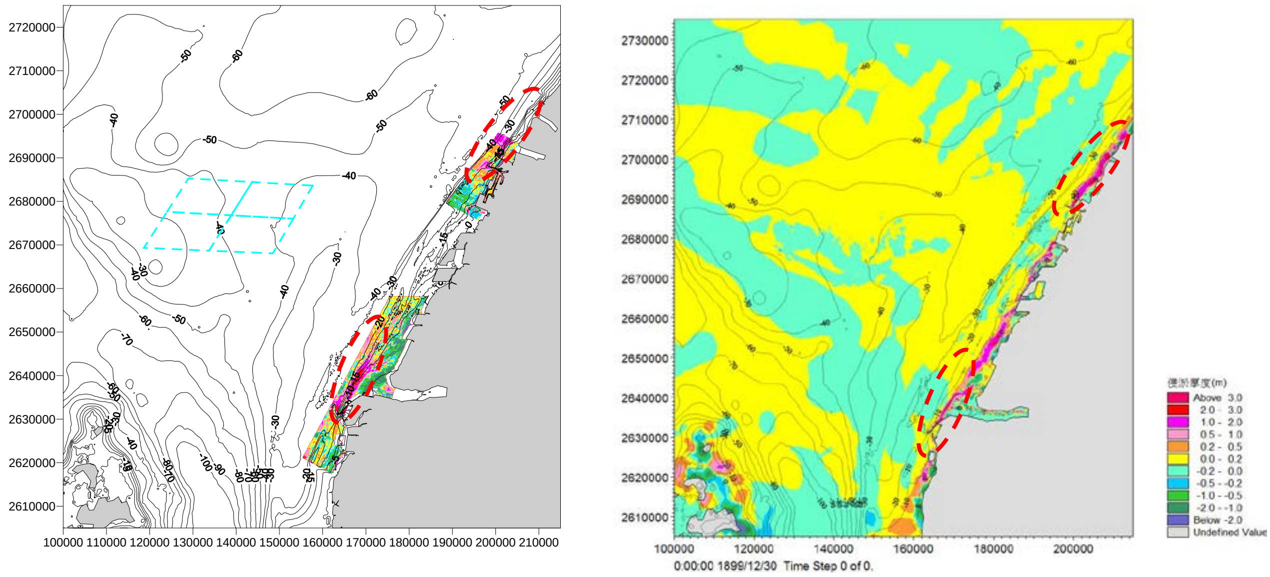


(d) Low tide

Figure 7.1.1-6 Flow Field Distribution Diagram Based on the Status Quo of the Sea Waters within the Project Site (during winter)

C. Sediment Transport Analysis

Figure 7.1.1-7 shows the analysis results of measured topographic erosion and numerical simulations of the topographical change in the sea waters within the Project site. As shown in Figure (a), sea waters in Taichung County and Yunlin County are affected by the embankments of Taichung Harbor and Mailiao Harbor respectively, the sedimentation is more significant around and at the northern part of the embankment. However, analysis results (b) from the numerical simulations of the topographical change is also similar to that of actual coastal topographic erosion characteristics, which indicate that the Project's numerical model of topographical change is reasonable. Overall speaking, the main topographic erosion range is generally within the sea waters with water depth of 0~20m.



(a) Distribution of measured topographic erosion between 2008～2009

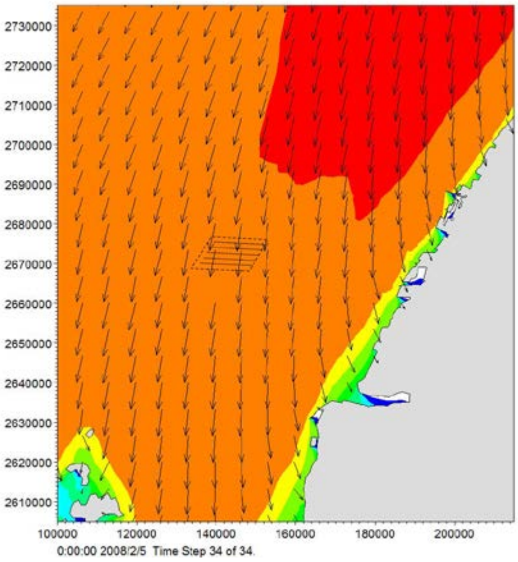
(b) Analysis results from the numerical simulations of the topographical change in sea waters

Figure 7.1.1-7 Analysis Results of Measured Topographic Erosion and Numerical Simulation Based on the Status Quo of the Sea Waters within the Project Site

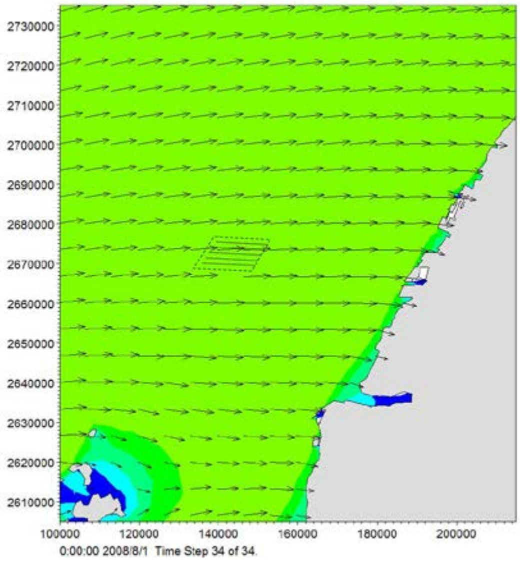
3. Analysis on Wind Farm of the Project

(1) Wave Field Analysis

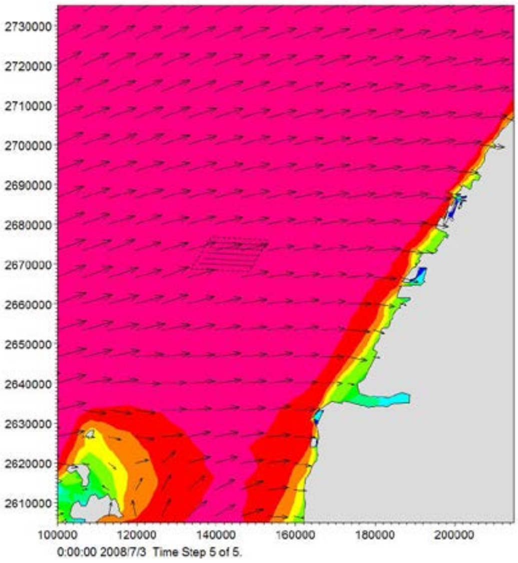
Figure 7.1.1-8 is the wave field distribution diagram of the Project site #15 under the influences of winter waves, summer waves, and 10-year regression period with WSW and NNW (direction) typhoon waves. As shown in the figure, wave field distributions during monsoon and typhoon are similar to the status quo, in which wave energy during monsoon in the open sea is relatively small, while wave height in the sea waters within the Project site shows larger distribution during the winter, which is approximately 2m. Wave energy in the open sea during typhoon is relatively large; wave height distribution in the sea waters within the Project site reaches approximately 4m and above.



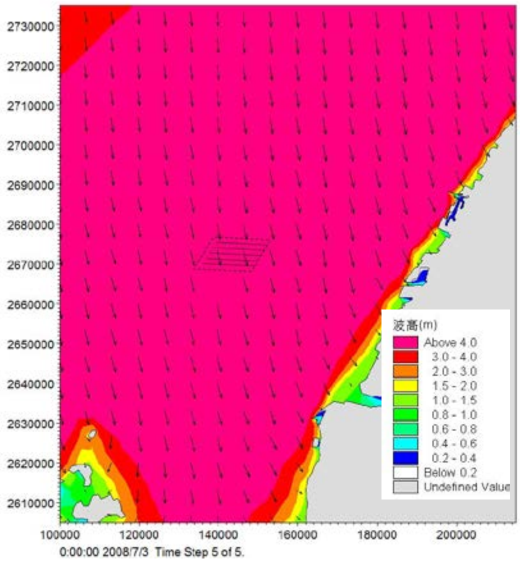
(a) Winter waves in N direction



(b) Summer waves in W direction



(c) Typhoon waves in WSW direction

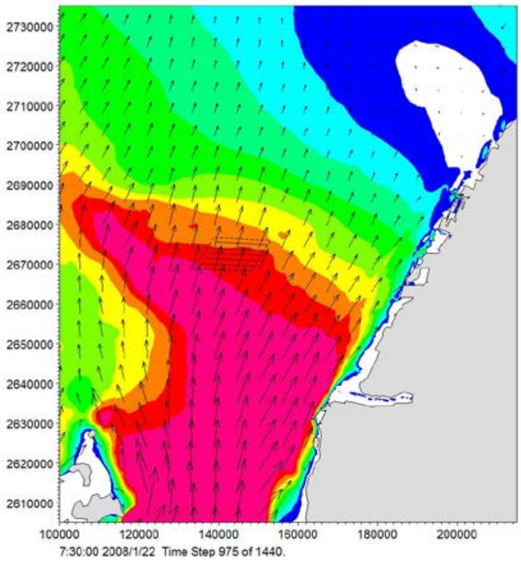


(d) Typhoon waves in NNW direction

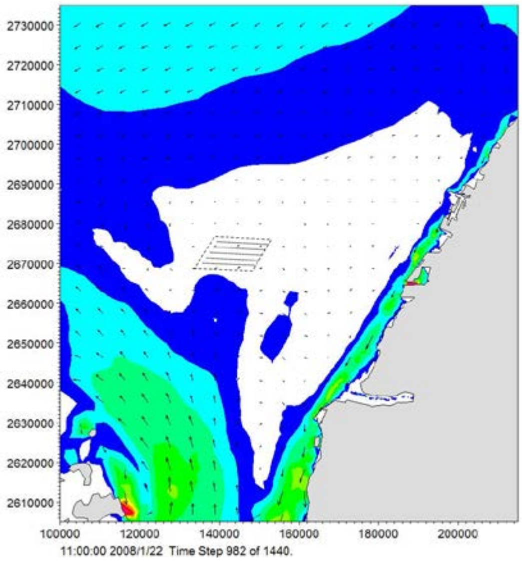
Figure 7.1.1-8 Wave field distribution diagram of Project site#15 based on wind field configuration

(1) Flow Field Analysis

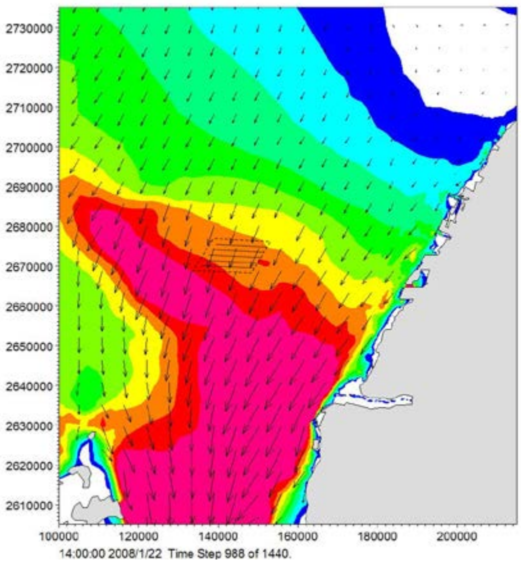
Figure 7.1.1-9 is the tidal wave current distribution of Project site #15 under the impact of the winter monsoon wave. As shown in the figure, the flow field distribution is similar to the current situation. During the rising tide, the flow direction is from south to north, and flow velocity off the coast of Mailiao Township of Yunlin County can reach 0.9m/sec and above; the flow direction is from north to south during the ebb tide, and flow velocity off the coast of Mailiao Township of Yunlin County is also 0.9m/sec and above.



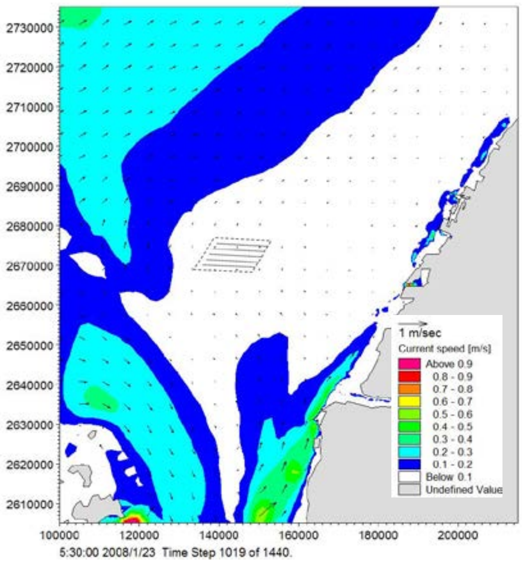
(a) Rising tide section



(b) High tide



(c) Ebb tide section



(d) Low tide

Figure7.1.1-9 Flow field distribution diagram (during winter) of Project site #15 based on wind field configuration

(2) Sediment Transmission Analysis

Figure7.1.1-10 shows the results of numerical simulation analysis of the geomorphic change of the wind field configuration in Project site #15. As shown in the figure, the results of bathymetry analysis are similar to the current situation, which the main topographic erosion range is generally within the water depth of 0~20m. This indicates that the Project's wind field configuration has limited impact on geomorphic change in the sea waters.

Figure 7.1.1-11～Figure 7.1.1-13 are the distribution diagrams of the Project site #15 showing the wave height differences during the current winter period based on the wind field configuration, flow velocity differences at winter ebb tide and topographic erosion thickness differences. As shown in the figure, the wave height around the Project site is relatively small during winter and the wave height difference is less than 0.03m due to the impact of the wind field configuration; the flow velocity change around the Project site is approximately less than -0.002～+0.005m/sec; and topographic erosion thickness change of the Project site is approximately less than -0.005～+0.005m. This indicates that wind field configuration of Project site #15 has insignificant effect on wave height, flow conditions and geomorphic change of the adjacent sea waters.

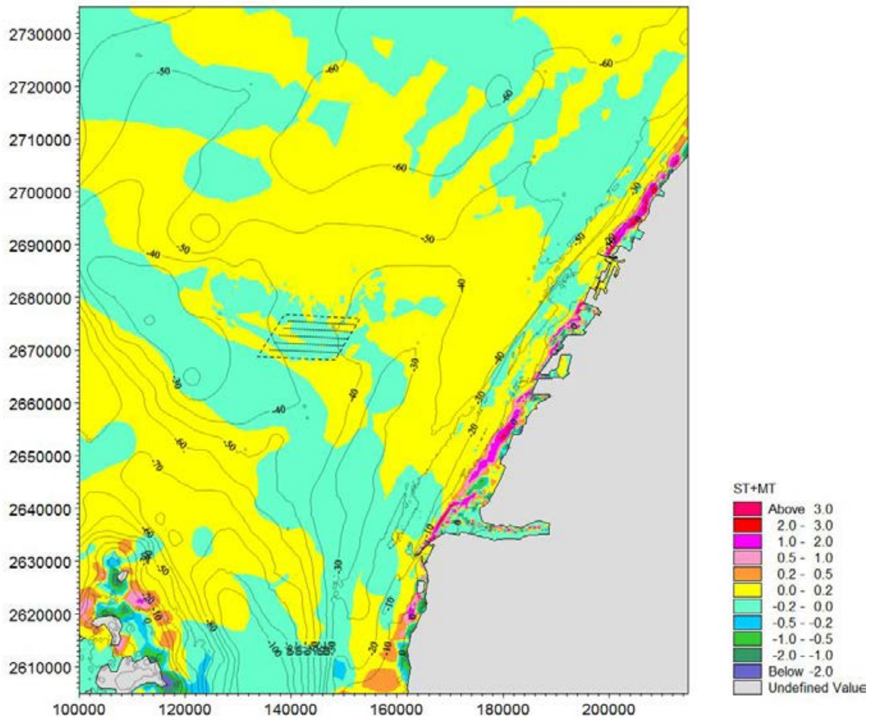


Figure 7.1.1-10 Geomorphic change analysis of the sea waters within Project site #15 based on the wind field configuration

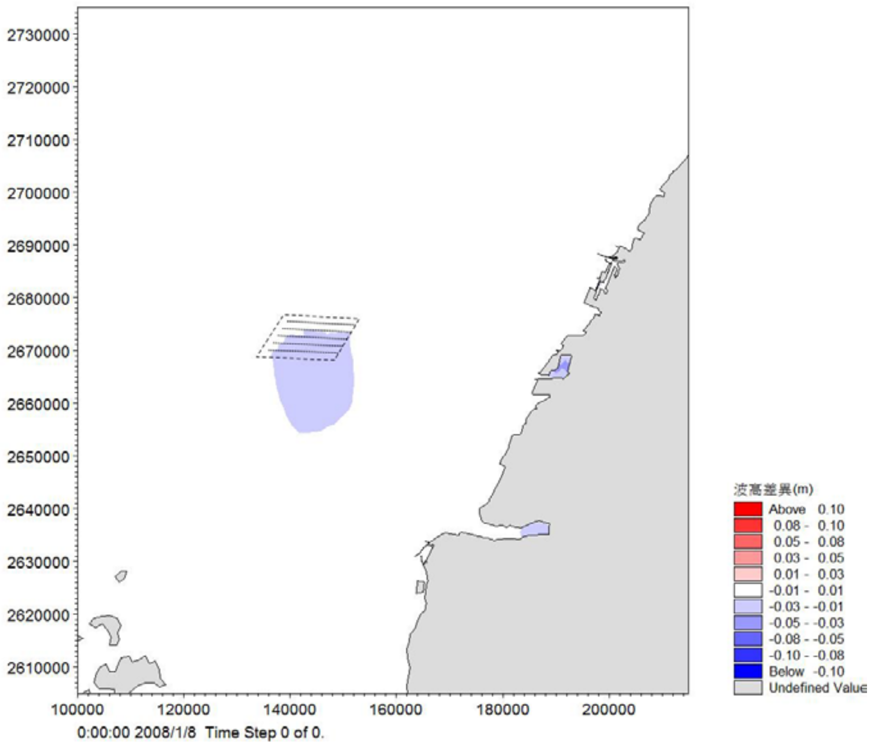


Figure 7.1.1-11 Distribution diagram of wave height differences (during winter period) at Project site #15 based on the wind field configuration

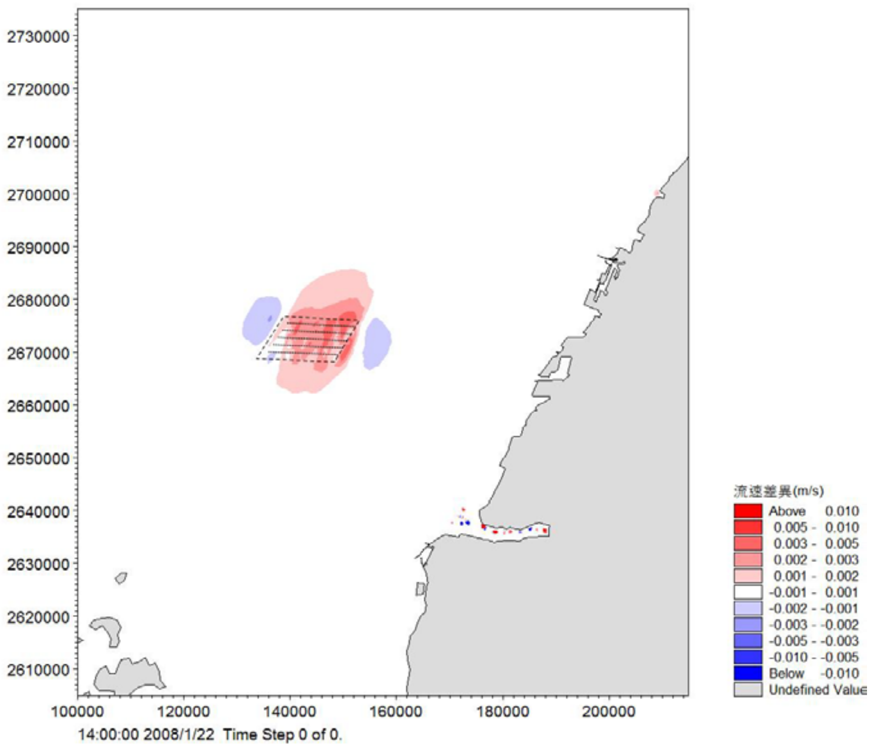


Figure 7.1.1-12 Distribution diagram of flow velocity differences at ebb tide section for Project site #15 based on current wind field configuration (during winter period)

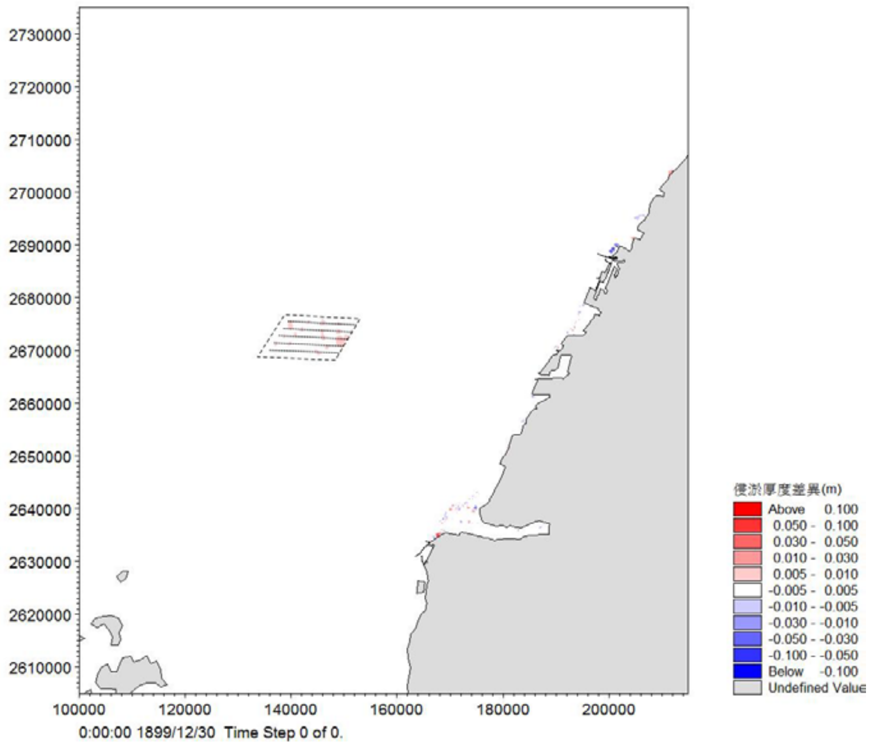


Figure 7.1.1-13 Distribution diagram of topographic erosion thickness difference for Project site #15 based on current wind field configuration

1. Combined analysis of wind field numbers 11~19

(1) Numerical ssimulation analysis of sea area wave field before and after the construction of offshore wind field

A. Before the setup of offshore wind field

Figure 7.1.1-14 is the flat wave field distribution diagram of the 50-year recurring typhoon waves (outer sea wave height 10.63m, cycle 13.69s, wave direction NNE). The overall result shows that when the wave height 10.63m, cycle 13.69s and wave direction NNE are set as wave incident condition during the typhoon, the wave height near the position of Changhua Offshore Wind Field (Zone# 11 to 19) obtained by the pattern calculation is between 1 and 12m. Figure 7.1.1-15 shows the flat wave field distribution diagram of the 50-year recurring typhoon waves (outer sea wave height 10.70m, cycle 13.74s, wave direction N). The overall result shows that the wave height near the wind field position is between 2m and 12m. Figure 7.1.1-16 shows the distribution diagram of the flat wave field of the winter monsoon wave (outer sea wave height 4.54m, cycle 10.10s, wave direction NNE). The overall result shows that the wave height near the wind field position is between 1.0m and 5m. Figure 7.1.1-17 is the distribution of the flat wave field of the summer monsoon wave (outer sea wave height 3.64m, cycle 9.70s, wave direction W). The overall result shows that the wave height near the wind field position is between 1.5m and 5m.

B. After the setup of offshore wind field (the most dense configuration)

Figure 7.1.1-18 is the flat wave field distribution diagram of the 50-year recurring typhoon waves (outer sea wave height 10.63m, cycle 13.69s, wave direction NNE). The overall result shows that when the wave height 10.63m, cycle 13.69s and wave direction NNE are set as wave incident condition during the typhoon, the wave height near the position of the Changhua Offshore Wind Field (Zone# 11 to 19) obtained by the pattern calculation is between 1 and 12m. Figure 7.1.1-19 shows the flat wave field distribution diagram of the 50-year recurring typhoon waves (outer sea wave height 10.70m, cycle 13.74s, wave direction N). The overall result shows that the wave height near the wind field position is between 1m and 12m. Figure 7.1.1-20 shows the distribution diagram of the flat wave field of the winter monsoon wave (outer sea wave height 4.54m, cycle 10.10s, wave direction NNE). The overall result shows that the wave height near the wind field position is between 1.5m and 5m. Figure 7.1.1-21 is the distribution of the flat wave field of the summer monsoon wave (outer sea wave height 3.64m, cycle 9.70s, wave direction W). The overall result shows that the wave height near the wind field position is between 2.0m and 5m.

C. Comprehensive Assessment

Before the setup of offshore wind turbines in Changhua Offshore Wind Field (Zone# 11~19), the 50-year regression period of typhoon wave distribution in the sea area near the wind field was about 1~12m, and the monsoon wave distribution was about 1.0~5m; when the offshore wind field is setup in zones 11~19, the incident wave hits the wind support structure and causes the diffraction effect, making the wave height to have a slight downward trend; however the reflection effect on the upstream of the wind support structure slightly increases the wave height. The typhoon wave distribution in the 50-year regression period in the offshore wind field is about 1~12m, and the monsoon wave distribution is about 1.5~5m. Influenced by the offshore wind field, the wave height distribution in the sea area downstream behind the wind field is slightly lower than before the offshore wind field is setup; in this project, the offshore wind field is far from the coast, and the wave height distribution in the coastal sea area is still lower compares to before the setup of the offshore wind field, even there is any change in the wave distribution nearer to the coastal sea area. The lower wave height in the nearshore area indicates that the threat to coastal erosion during the typhoon is reduced.

(2) Numerical simulation analysis of sea area wave field before and after the construction of offshore wind field

A. Before the setup of offshore wind field

Figure 7.1.1-22 is the flat flow field distribution diagram of the 50-year recurring typhoon waves (outer sea wave height 10.63m, cycle 13.69s, wave direction NNE). Figure 7.1.1-23 shows the flat flow field distribution diagram of the 50-year recurring typhoon waves (outer sea wave height 10.70m, cycle 13.74s, wave direction N). Figure 7.1.1-24 shows the distribution diagram of the flat flow field of the winter monsoon wave (outer sea wave height 4.54m, cycle 10.10s, wave direction NNE). Figure 7.1.1-25 is the distribution of the flat flow field of the summer monsoon wave (outer sea wave height 3.64m, cycle 9.70s, wave direction W). The overall result shows that the distinct nearshore flow area under the influence of typhoon waves is between 0m and 20m in water depth. The scope of wind field due to water depth about 20~55m and the nearshore flow field is not clear, the flow rate is slightly higher in the local area, but it is still lower than 0.5 m/s.

B. After the setup of offshore wind field (the most dense configuration)

Figure 7.1.1-26 is the flat flow field distribution diagram of the 50-year recurring typhoon waves (outer sea wave height 10.63m, cycle 13.69s, wave direction NNE). Figure 7.1.1-27 shows the flat flow field distribution diagram of the 50-year recurring typhoon waves (outer sea wave height 10.70m, cycle 13.74s, wave direction N). Figure 7.1.1-28 shows the distribution diagram of the flat flow field of the winter monsoon wave (outer sea wave height 4.54m, cycle 10.10s, wave direction NNE). Figure 7.1.1-29 is the distribution of the flat flow field of the summer monsoon wave (outer sea wave height 3.64m, cycle 9.70s, wave direction W). The overall result shows that the distinct nearshore flow area under the influence of typhoon waves is between 0m and 20m in water depth. The scope of wind field due to water depth about 20~55m and the nearshore flow field is not clear, the flow rate is slightly higher in the local area, but it is still lower than 0.5 m/s. As the waves are obstructed by the wind turbine base pillar, flow field and flow direction in certain areas within the scope of wind field is affected by the wind turbine, and therefore the magnitude of flow speed is slightly slower than before the offshore wind field is setup.

C. Comprehensive Assessment

After the setup of offshore wind turbines in Changhua Offshore Wind Field (Zone# 11~19), the flow field in the sea area near the wind turbine is slightly changed due to the influence of the foundation and supporting structure of the wind turbine. The magnitude of the flow speed is slightly slower than before the offshore wind field is setup but the effect is only local. The flow speed will return to the inflow condition after leaving the wind field setting range, and the magnitude of flow speed will be slightly reduced, mainly due to change in the flow field within the range of 10 to 15 times the pile diameter of each wind turbine foundation (average about 100m). The affected scope of the flow field velocity distribution variation is only 100m outside the wind field setup area. The flow speed which is interfered by the wind turbine foundation pile will return to the inflow condition after the flow exceeds 100m (according to Hailong and Haiding ring-storytelling related to monopile three-dimensional brush simulation systematic description). In this case, the distance between the foundation piles of all wind turbines exceeds 400m to 1000m, the affected scope of the flow field change caused by the foundation piles is 4 times greater. In principle, the interaction of the flow field generated by the foundation piles after the wind turbines are setup is not clear. As for the splendid nearshore flow area, the water depth is 0~20m, the height of waves in the local nearshore area caused by the interference of the wind field foundation piles in zones 11~19 is lower than before the offshore wind field is setup, the magnitude of nearshore flow speed brought by the current is also slightly reduced. A decrease in the flow speed in the nearshore area indicates a reduction in the extent of coastal erosion and deposition.

(3) Numerical simulation analysis of sea topology change before and after the construction of offshore wind field

A. Before the setup of offshore wind field

Figure 7.1.1-30 shows the result of the topographical sediment erosion change from the numerical pattern simulation in the area before the Changhua Offshore Wind Field is setup. The depth of the sediment erosion is about ±0.3m in the whole calculation range. The scope of the main topographical sediment erosion is about 0~20m depth in water, which is the splendid nearshore flow area led by typhoon.

B. After the setup of offshore wind field (the most dense configuration)

Figure 7.1.1-31 shows the result of the topographical sediment erosion change from the numerical pattern simulation of the area after the wind turbines are set up in Changhua Offshore Wind Field (Zone# 11~19). From the simulation result, we can see the distributed situation of the sediment erosion. The depth of the sediment erosion is about ±0.3m in the whole calculation range. The scope of the main topographical sediment erosion is about 0~20m depth in water, which is the splendid nearshore flow area led by typhoon. However, the scope of sediment erosion which is greater than ±0.1m is smaller than before the offshore wind field is setup.

C. Comprehensive Assessment

The effect of topographical sediment erosion change after the wind turbines are set up in Changhua Offshore Wind Field (Zone# 11~19), we can see from the simulation result the level of impact is insignificant.

The wind field in this case is far from the coastline, the flow interfered by wind turbines is mainly in the wind field range of 100m, thereafter it will return to the inflow condition. The main reason that affects the change of coastal topography is mainly the nearshore flow: (1) For the effect on the topographical change in the adjacent coastal area caused by the wind field setup, the degree of erosion and deposition in the nearshore area with the water depth of 0-20m is reduced; the scope of erosion and deposition which is greater than ±0.1m (less than ±0.3m) is smaller than before the offshore wind field is setup. This indicates the degree of topographical sediment erosion in the nearshore area can be slowed down after the setup of all offshore wind fields in zones 11~19 with the most dense configuration. (2) For sea area within the scope of the wind field, the topographical change trend of the offshore wind field changes little (less than ±0.1m), and only the local minimum area has a topographical change of about ±0.3m. Basically, the effect of the flow field on the overall topographical variation within the scope of the wind field is negligible.

(4) Conclusion

The main purpose of this project is to explore the impact after the wind turbine foundations are setup in the entire zones from 11th to 19th in Changhua Offshore Wind Field, on the change of coastal topology. First, the numerical simulation of the wave flow field in Changhua sea area is carried out, and the distribution of coastal topographical change under the effect of wave flow field provides specific analysis results of environmental impact assessment. Based on the analysis and research results of this project, the following conclusions are made:

A. Before the setup of offshore wind turbines in Changhua Offshore Wind Field (Zone# 11~19), the 50-year regression period of the typhoon wave distribution in the sea area near the wind field was about 1~12m, and the monsoon wave distribution was about 1.0~5m; when the offshore wind field is setup, the incident wave hits the wind support structure and causes the diffraction effect, making the wave height to have a slight downward trend; however the reflection effect on the upstream of the wind support structure slightly increases the wave height. The typhoon wave distribution in the 50-year regression period in the offshore wind field is about 1~12m, and the monsoon wave distribution is about 1.5~5m. Influenced by the offshore wind field, the wave height distribution in the sea area downstream behind the wind field is slightly lower than before the offshore wind field is setup; in this project, the offshore wind field is far from the coast, and the wave height distribution in the coastal sea area is still lower compares to before the offshore wind field is setup, even there is any change in the wave distribution nearer to the coastal sea area. The lower wave height in the nearshore area indicates the threat to coastal erosion during the typhoon is reduced.

B. After the setup of offshore wind turbines in Changhua Offshore Wind Field (Zone# 11~19), the flow field in the sea area near the wind turbine is slightly changed due to the influence of the foundation and supporting structure of the wind turbine. The magnitude of the flow speed is slightly slower than before the offshore wind field is setup. The flow speed will return to the inflow condition after leaving the wind field setting range. In principle, the interaction of the flow field generated by the foundation piles after the wind turbines are setup is not clear. As for the splendid nearshore flow area, the water depth is 0~20m, the height of waves in the local nearshore area caused by the interference of the wind field foundation piles in zones 11~19 is lower than before the offshore wind field is setup, the magnitude of nearshore flow speed brought by the current is also slightly reduced. A decrease in the flow speed in the nearshore area indicates a reduction in the extent of coastal erosion and deposition.

C. The impact on the degree of topographical sediment erosion is little after the setup of offshore wind field in Changhua (Zones # 11~19). The main cause affecting the coastal topographical change is the nearshore flow, the degree of erosion and deposition in the nearshore area with the water depth of 0-20 m, which is greater than ±0.1m (less than ±0.3m), smaller than before the offshore wind field is setup. This indicates the degree of topographical sediment erosion in the nearshore area can be slowed down after the setup of all offshore wind fields in zones 11~19.

D. For sea area within the scope of the wind field, the topographical change trend of the offshore wind field in zones 11~19 has minimal changes (less than ±0.1m), and only the local minimum area has a topographical change of about ±0.3m. Basically, the effect of the flow field on the overall topographical variation within the scope of the wind field is negligible.

Figure 7.1.1-14 Wave Field Distribution Diagram of 50-Year Recurring Typhoon Before the Setup of Wind Field #11~19 (Offshore Wave Height 10.63m, Cycle 13.69s, Wave Direction NNE)

Figure 7.1.1-15 Wave Field Distribution Diagram of 50-Year Recurring Typhoon Before the Setup of Wind Field #11~19 (Offshore Wave Height 10.70m, Cycle 13.74s, Wave Direction N)

Figure 7.1.1-16 Wave Field Distribution Diagram of Winter Monsoon Wave Before the Setup of Wind Field #11~19 (Outer Sea Wave Height 4.54m, Cycle 10.10s, Wave Direction NNE)

Figure 7.1.1-17 Wave Field Distribution Diagram of Summer Monsoon Wave Before the Setup of Wind Field #11~19 (Outer Sea Wave Height 3.64m, Cycle 9.70s, Wave Direction W)

Figure 7.1.1-18 Wave Field Distribution Diagram of 50-Year Recurring Typhoon After the Setup of Wind Field #11~19 (Outer Sea Wave Height 10.63m, Cycle 13.69s, Wave Direction NNE)

Figure 7.1.1-19 Wave Field Distribution Diagram of 50-Year Recurring Typhoon After the Setup of Wind Field #11~19 (Outer Sea Wave Height 10.70m, Cycle 13.74s, Wave Direction N)

Figure 7.1.1-20 Wave Field Distribution Diagram of Winter Monsoon Wave After the Setup of Wind Field #11~19 (Outer Sea Wave Height 4.54m, Cycle 10.10s, Wave Direction NNE)

Figure 7.1.1-21 Wave Field Distribution Diagram of Summer Monsoon Wave After the Setup of Wind Field #11~19 (Outer Sea Wave Height 3.64m, Cycle 9.70s, Wave Direction W)

Figure 7.1.1-22 Flow Field Distribution Diagram of 50-Year Recurring Typhoon Before the Setup of Wind Field #11~19 (Outer Sea Wave Height 10.63m, Cycle 13.69s, Wave Direction NNE)

Figure 7.1.1-23 Flow Field Distribution Diagram of 50-Year Recurring Typhoon Before the Setup of Wind Field #11~19 (Outer Sea Wave Height 10.70m, Cycle 13.74s, Wave Direction N)

Figure 7.1.1-24 Flow Field Distribution Diagram of Winter Monsoon Wave Before the Setup of Wind Field #11~19 (Outer Sea Wave Height 4.54m, Cycle 10.10s, Wave Direction NNE)

Figure 7.1.1-25 Flow Field Distribution Diagram of Summer Monsoon Wave Before the Setup of Wind Field #11~19 (Outer Sea Wave Height 3.64m, Cycle 9.70s, Wave Direction W)

Figure 7.1.1-26 Flow Field Distribution Diagram of 50-Year Recurring Typhoon After the Setup of Wind Field #11~19 (Outer Sea Wave Height 10.63m, Cycle 13.69s, Wave Direction NNE)

Figure 7.1.1-27 Flow Field Distribution Diagram of 50-Year Recurring Typhoon After the Setup of Wind Field #11~19 (Outer Sea Wave Height 10.70m, Cycle 13.74s, Wave Direction N)

Figure 7.1.1-28 Flow Field Distribution Diagram of Winter Monsoon Wave After the Setup of Wind Field #11~19 (Outer Sea Wave Height 4.54m, Cycle 10.10s, Wave Direction NNE)

Figure 7.1.1-29 Flow Field Distribution Diagram of Summer Monsoon Wave After the Setup of Wind Field #11~19 (Outer Sea Wave Height 3.64m, Cycle 9.70s, Wave Direction W)

Figure 7.1.1-30 Nearby Sea Area Numerical Simulation of 1-Year Topographical Sediment Erosion Change Diagram Before the Setup of Wind Field Number 11~19

Figure 7.1.1-31 Nearby Sea Area Numerical Simulation of 1-Year Topographical Sediment Erosion Change Diagram After the Setup of Wind Field Number 11~19

II. Geology

(I) Earthquake

The earthquakes happen quite frequently in Taiwan. When designing the offshore wind turbine foundation, it is necessary to reasonably evaluate the seismic characteristics of the worksite, and take earthquake resistance factors into consideration. However, at this stage, the country has not established relevant design specifications for wind turbine structural foundation, but to refer to the relevant design specification of offshore wind turbine foundation in overseas. However the wind fields in advanced European countries are not located in the earthquake zone with strong magnitude at the moment, and the existing offshore wind turbine foundation design specifications [BSH (2008), DNV-OS-J101 (2014), Germanischer Lloyd (GL). (2010) & (IEC) 6140-3(2009)] do not clearly suggest the calculation method for seismic strength. If our existing national Seismic Design Specification and Commentary of Buildings (2011) are used for seismic strength calculation and design, the design outcome may be excessively conservative due to the far higher construction cost of offshore wind turbines (environment, weather, construction equipment, construction technology, etc.) than onshore wind turbines. Therefore the design phase shall take the environmental characteristics of the offshore wind field into consideration appropriately, in order to achieve the most suitable wind turbine foundation form and size.

Refer to the recommendation of the offshore structure specification ISO19901-2 (2004) and API RP 2EQ (2014), worksite seismic hazard analysis can be performed in areas with frequent earthquakes. Therefore, based on the partial spirit of our national Seismic Design Specification and Commentary of Buildings (2011), the seismic hazard analysis of Zhangbin Offshore Wind Field site can be carried out to establish the seismic hazard curve of Zhangbin Offshore Wind Field. This can be used as a basis for subsequent seismic strength calculation to avoid excessive conservative design.

1. Seismic Design Specification and Commentary of Buildings (2011)

The basic principle of earthquake resistance design is that the structure must remain within the elastic limit during medium to small earthquakes; plastic deformation is allowed during designed earthquakes, but the toughness requirement must not exceed the allowable toughness capacity; while during earthquakes with maximum consideration, the building must remain intact and must not collapse. Among them, the three levels of earthquakes are:

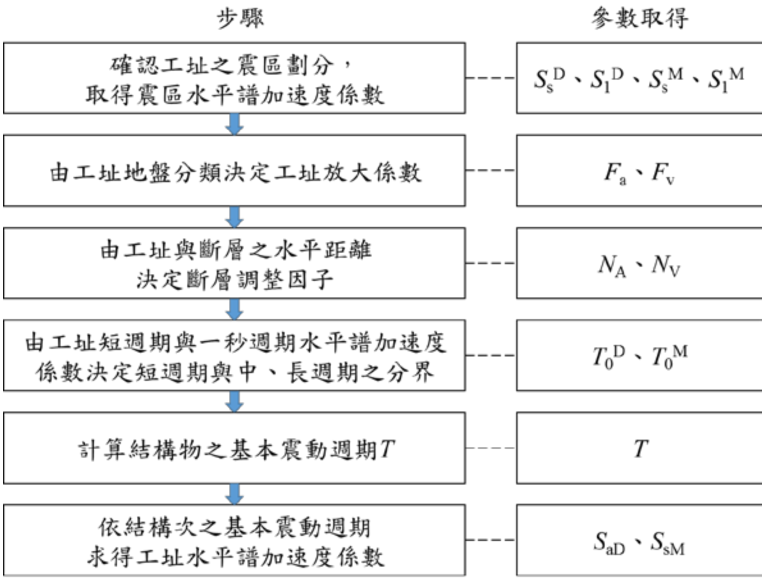
(1) Medium to small earthquakes: Earthquakes with a 30-year regression period, its 50-year turnover rate is about 80%.

(2) Designed earthquakes: Earthquakes with a 475-year regression period, its 50-year turnover rate is about 10%.

(3) Earthquake with maximum consideration: Earthquakes with a 2500-year regression period, its 50-year turnover rate is about 2%.

A brief description of the procedure based on the design guidelines in seismic design specifications are shown in Fig 7.1.1-14.

The basin type and seismic area horizontal response spectral acceleration coefficient were used to set worksite amplification coefficients Fa and Fc to consider the soil non-linear amplification effects. When calculating the worksite design horizontal response spectral acceleration coefficients SDS and SD1, the worksite amplification coefficients Fa and Fv must be obtained based on the seismic area design horizontal response spectral acceleration coefficient and Tables 7.1.1-3 and 7.1.1-4. When calculating the maximum considered horizontal response acceleration coefficients SMS and SM1 for the worksite, the worksite amplification coefficients Fa and Fv must be obtained based on the seismic area's maximum considered horizontal response acceleration coefficients SMS and SM1 and Tables 7.1.1-5 and 7.1.1-6.



Source of data: Seismic Design Specification and Commentary of Buildings (2011)

Fig. 7.1.1-32 Procedure for Obtaining Horizontal Response Spectral Acceleration Coefficients SaD and SaM

Table 7.1.1-3 Short-Term Structural Site Amplication Factor

地盤分類	震區短週期水平譜加速度係數 S_S (S_S^D 或 S_S^M)				
	$S_S \leq 0.5$	$S_S=0.6$	$S_S=0.7$	$S_S=0.8$	$S_S \geq 0.9$
第一類地盤	1.0	1.0	1.0	1.0	1.0
第二類地盤	1.1	1.1	1.0	1.0	1.0
第三類地盤	1.2	1.2	1.1	1.0	1.0

Source of data: Seismic Design Specification and Commentary of Buildings (2011)

Table 7.1.1-4 Long-Term Structural Site Amplification Factor Fv

地盤分類	震區一秒週期水平譜加速度係數 S_1 (S_1^D 或 S_1^M)				
	$S_1 \leq 0.30$	$S_1=0.35$	$S_1=0.40$	$S_1=0.45$	$S_1 \geq 0.50$
第一類地盤	1.0	1.0	1.0	1.0	1.0
第二類地盤	1.5	1.4	1.3	1.2	1.1
第三類地盤	1.8	1.7	1.6	1.5	1.4

Source of data: Seismic Design Specification and Commentary of Buildings (2011)

The domain classification that determines the worksite domain magnification factor is determined by the average shear wave velocity V_{S30} of the soil within 30m below the surface of the worksite. The domains in Taiwan are classified into three categories according to the degree of their solidity and weakness. Among them, VS30 ≥ 270 m/s is the first category domain (solid domain); 180 m/s ≤ VS30 ≤ 270 m/s is the second category domain (ordinary domain); VS30 ≤ 180 m/s is the third category domain (weak domain). The average shear wave velocity V_{S30} of the soil within 30m below the surface of the worksite is calculated as per the formula below:

$$V_{S30} = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} d_i / V_{si}} \qquad (1)$$

Where *di* is the thickness (m) of the i-th layer, and V_{si} is the average shear wave velocity (m/sec) of the i-th layer.

After obtaining the worksite design horizontal response spectral acceleration coefficient S_{aD} and the maximum consideration horizontal response spectral acceleration coefficient S_{aM}, the formula provided by the specification can be used to calculate the minimum design standard total transverse strength V, the medium and small earthquakes designed seismic strength V* and the earthquakes with maximum consideration designed seismic strength VM, the minimum design standard total transverse strength V can be calculated as per the formula below:

$$V = \frac{S_{aD} I}{1.4 \alpha_y F_u} W \qquad (2)$$

Since the Zhanghai Offshore Wind Field is in seismic zone not classified under earthquake resistance design specification, its designed seismic strength is calculated according to to the designed seismic parameters of the adjacent land areas - Fangyuan District, Lugang District and West Line of Changhua County; according to Table 7.1.1-6 Seismic Design Specification (2011), the horizontal response spectral acceleration coefficients corresponding to these areas are S_{SD}=0.7, S_{1D}=0.4, S_{SM}=0.9 and S_{1M}=0.5 respectively. And the average shear wave velocity <180 m/s within 30m below the surface of each hole position is calculated, therefore it is the third category domain (weak domain), and the table shows the short-cycle worksite amplification coefficient is $Fa(S_S^D) = 1.1$, $Fa(S_S^M) = 1.0$.

From the above parameters, the worksite short-cycle design horizontal response spectral acceleration coefficient S_{DS} and the maximum consideration horizontal response spectral acceleration coefficient can be calculated respectively $S_{DS} = 0.77$; $S_{MS} = 0.9$.

$$\begin{cases} S_{DS} = Fa(S_S^D) \times S_S^D \\ S_{MS} = Fa(S_S^M) \times S_S^M \end{cases}$$

The surface acceleration value A of the worksite medium and small earthquakes, designed earthquakes, earthquakes with maximum consideration can be further calculated. The surface acceleration of small and medium earthquakes is A=0.073g; the surface acceleration of designed earthquakes is A=0.308g; the surface acceleration of earthquakes with maximum consideration is A=0.36g.

$$\begin{cases} A = \dfrac{0.4S_{DS}}{4.2}g & \text{中小度地震} \\ A = 0.4S_{DS}g & \text{設計地震} \\ A = 0.4S_{MS}g & \text{最大考量地震} \end{cases}$$

2. Offshore wind field seismic hazard analysis

Referring to the recommendations of the offshore structure specification ISO19901-2 (2004) and API RP 2EQ (2014), it is suggested the worksite seismic hazard analysis to be carried out in areas with frequent earthquakes, and the seismic potential of hidden seismic sources leading to possible hazard near Zhangbin Offshore Wind Field are considered. The data of the hole position at different field sites are needed to perform seismic hazard analysis and worksite domain response is needed to obtain the designed seismic strength, then seismic hazard analysis and the relevant earthquake resistance design assessment can be performed. If the seismic hazard degree method is used first to calculate the designed seismic strength in the sea area of Zhangbin, the designed seismic strength in the sea area may be smaller than that of the land area. Therefore it is suggested the seismic hazard analysis of Zhangbin Offshore Wind Field to be performed before the liquefaction analysis, in order to avoid excessive conservative design of the offshore wind turbines.

Since each seismic source is affected by the position and distance of the area, therefore each wind field needs to perform the seismic hazard and worksite domain response analysis for the field site condition. It is necessary to rely on the geotechnical design parameter database to determine the target offshore wind field dynamic geotechnical design parameters to response to the target offshore wind field worksite soil layer effect. The calculation of the designed seismic strength is mainly completed in the following 6 steps:

(1) Collect seismic historical data around the worksite and complete the division of the seismic source with geological data.

(2) Establish the relationship between earthquake scale and reoccurring frequency.

(3) Assess the ground vibration of the worksite possibly caused by each seismic source.

(4) Complete seismic hazard curve of the worksite.

(5) Obtain the ground vibration parameters from the seismic hazard curve and establish the domain seismic response spectrum.

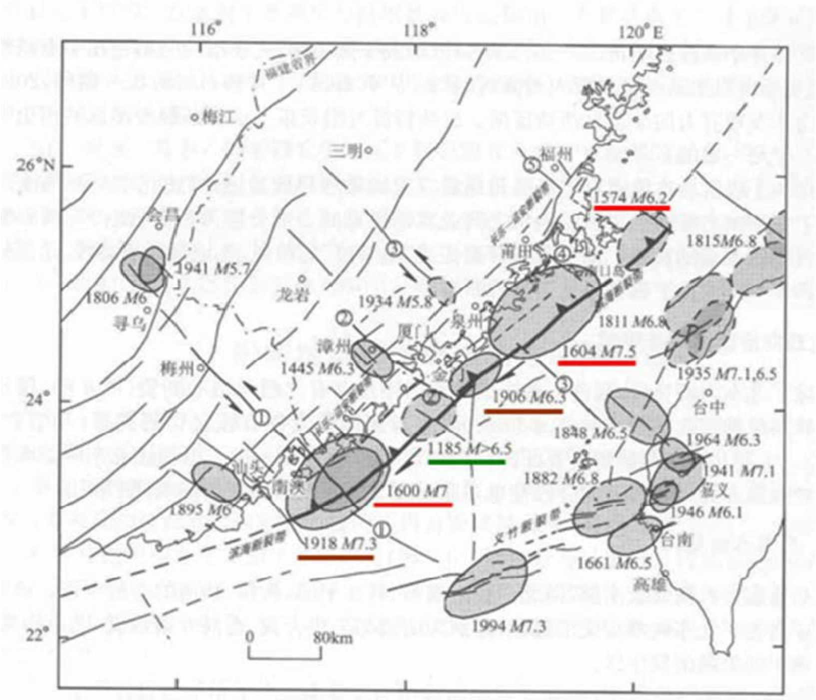
(6) Obtain dynamic parameters of the soil at the worksite.

(7) Perform domain response analysis to obtain worksite seismic response spectrum, surface seismic acceleration duration and maximum surface acceleration Amax.

A Probabilistic Seismic Hazard Analysis (PSHA) is commonly performed for seismic hazards. The PSHA includes possible seismic sources within a certain range of the worksite into and analysis to individually establish its probability analysis model. The analysis results are expressed as hazard curves or seismic intensity distribution maps. The parameters and analysis models which must be considered are: Geological status around the worksite, faults and seismic activity, earthquake catalog, seismic zones and focal depths (see Fig 7.1.1-15), source models, etc…

The seismic hazard curve obtained for the Changbin offshore wind field using PSHA, the horizontal spectral acceleration coefficients SSD, S1D, SSM and S1M calculated for the Changbin offshore wind field, worksite horizontal spectral acceleration coefficients SAD and SAM obtained using the procedure in Fig 7.1.1-14, offshore wind field design earthquake (475 years) and maximum considered earthquake (2500 years) horizontal acceleration response spectrum are shown in Fig 7.1.1-16.

In addition, since offshore wind turbine is a power generation facility, it is not a land structure for personnel to occupy permanently. The risk impact on the environment, personnel and economic losses caused by the damage of the supporting structure is lower than that of the land structure. Therefore, there is a need to discuss if the offshore wind turbine support structure and foundation design shall follow our national land structure design requirements, and the 475-year regression period is the decisive criterion for designing seismic response spectrum.



Source of data: (Zhu Jin-Fang, 2004)

Fig. 7.1.1-33 Epicenter Distribution and Active Structure Distribution at the Fujian and Guangdong Coastal Fault Zone from Historical Earthquake Records

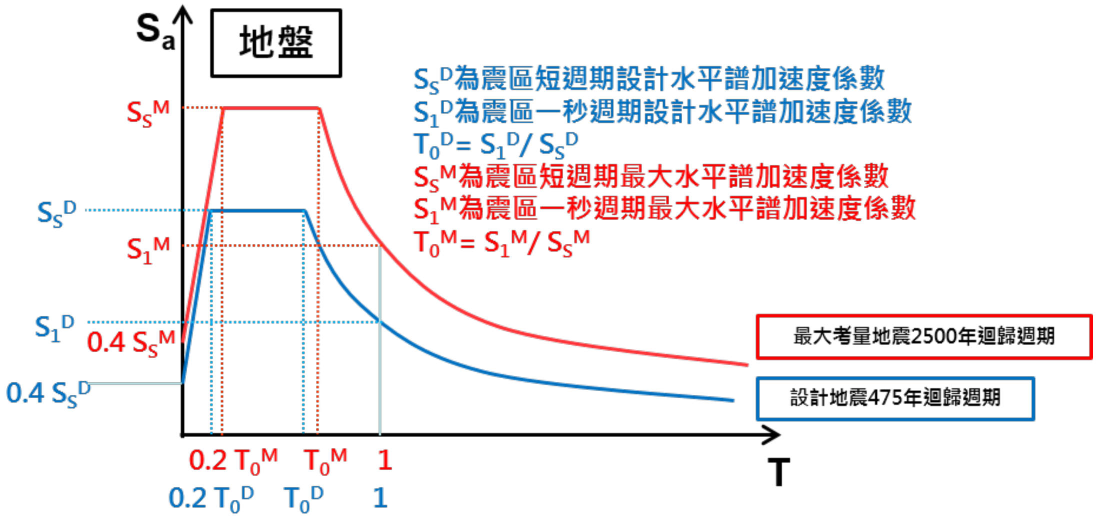


Fig. 7.1.1-34 Expected Design Earthquake and Maximum Considered Earthquake Horizontal Acceleration Response Spectrum for Changbin Offshore Wind Field

3. Summary

There is no active fault in this Project field site and onshore facilities. There is no active fault within 10km of this Project's onshore facilities. The Changhua fault with potential action is about 11km away from the onshore facilities in this field site. In future, seismic strength calculation should take into account the influence of both soil condition of the offshore wind field site and the historical earthquakes, and first analyze the seismic hazard of the field site, after that obtain the correct designed seismic strength, then carry out relevant earthquake resistance design consideration.

Initial seismic horizontal acceleration coefficient calculations were performed for the project using seismic coefficients from nearby land regions in the seismic design specifications. These coefficients together with CPT data from this geological survey were used for the liquefaction analysis of each hole site. However, this data did not consider how fines content contributes to anti-liquefaction potential. The analysis results showed each hole at the wind field had liquefaction potential trends at the majority of stratum within a depth of 20m below the sea floor under design earthquake conditions and all exceeded 15 severe liquefaction on the potential liquefaction index based on Iwasaki et al. (1982) recommendations.

The preliminary findings of this project have confirmed the shallow soil under the seabed has a liquefaction potential trend, and subsequent supplementary geological surveys will be carried out at the detailed design stage to further quantify the impact of individual foundation position. For the foundation size in the current planning stage, the depth of the monopile foundation is 45~70m under the seabed, the length of the foundation pile of the jacket foundation is about 80~85m under the seabed. The depth has been taken into consideration as the depth of safety design required for the liquefaction effect.

This Project is currently conducting a detailed Probabilistic Seismic Hazard Assessment (PSHA) study to determine the seismic requirements for all wind field site characteristics. After a more in-depth geophysical survey and analysis, it is confirmed that there is no evidence at the moment to directly indicate any fault belt below the four wind fields. The Probabilistic Seismic Hazard Assessment (PSHA) in future, will determine the Peak Ground Acceleration (PGA) and time axis of the seabed based on domain Site Response Analysis (SRA), while the domain Site Response Analysis (SRA) dynamic laboratory test is currently underway. However, cyclical laboratory testing is currently underway as well to determine the soil liquefaction risk, and the result will be combined with domain response analysis of non-standard pore water pressure energization pattern. Shall the soil be liquefied as a result of the assessment, there will be consideration to omit or reduce the bearing capacity of this layer of soil in the design.

(II) Foundation Structural analysis

The key to optimal and reliable support structure design is an integrated dynamic soil-structure-WTG model. The WTG modelling is one of the corner stones in this. DEWP develops and maintains aerodynamic models of all WTGs in its portfolio.

DEWP has two sets of tools to perform load-design iterations. For monopile DEWP applies DEFLEX and OptiMon while for jackets DEWP applies DEFLEX and ROSAP. OptiMon is an in-house developed tool which has supported design of roughly 700 monopile – all of them realised and certified. ROSAP is a tool developed and maintained by Ramboll, which DEFLEX runs under a license. ROSAP was originally developed for oil and gas but has been matured for offshore WTG support structure design. It has supported numerous offshore wind farm jacket and monopile designs.

1. DEFLEX-OptiMon design iteration

   Since changes in monopile or tower geometry alters the stiffness and hence the response of the structure a series of load-design iterations must be run to ensure that loads and structural design/response have converged. The iteration process is illustrated in Figure 7.1.1-17.

   Initially DEFLEX can simulate with the complete support structure, random wave hydrodynamic loading, and aerodynamics in response to random wind (turbulence). By such modelling potentially critical resonances can be detected and addressed in the design. In the order of 5.000-10.000 simulations are run. The section forces above seabed are exported to OptiMon, which automatically undertake an optimised design of the tower and substructure. At seabed the section forces are applied to derive the pile length and soil response, taking soil non-linearity into account. The output of the analysis is soil response, section forces in the pile, pile design and a stiffness matrix at seabed level representing the soil and structure, which then is fed back into DEFLEX for another iteration round.

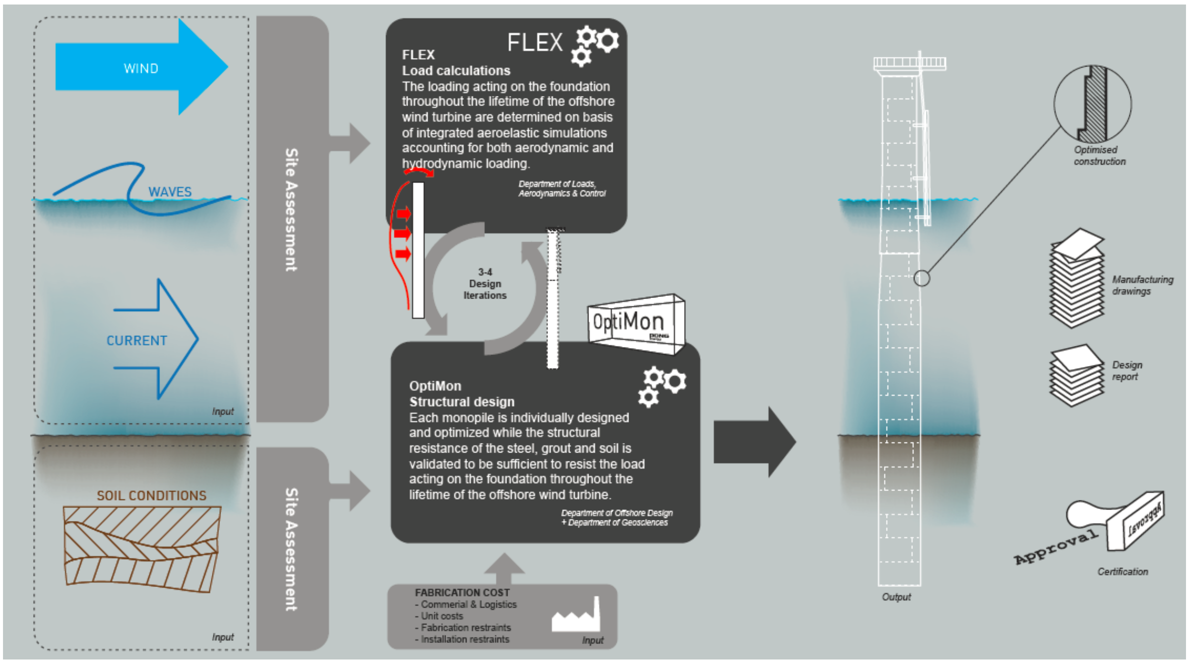


Fig. 7.1.1-35 schematic of the design process for monopile

2. DEFLEX-ROSAP modelling

For jacket design, loads and structural modelling is combined through two tools. From an initial estimate on loads and information about water depths and soil properties, the main geometry of the jacket is laid out: foot-print, number of bays, leg and brace diameters and wall-thickness. Through so-called Craig-Bampton modelling in ROSAP a condensed representation of the jackets dynamical properties are exported to DEFLEX. Load calculations are undertaken in DEFLEX and interface loads are returned to ROSAP, which expands this into loads in the jacket and the foundations (buckets or piles). ROSAP entails a beam model for the jacket and super elements for the transition piece and the suction buckets or piles.

Since changes in jacket geometry changes load distribution throughout the structure a series of iterations needs to be run to ensure that loads and design of the structure in the separate models have converged. The iteration process is illustrated in Figure 7.1.1-18.

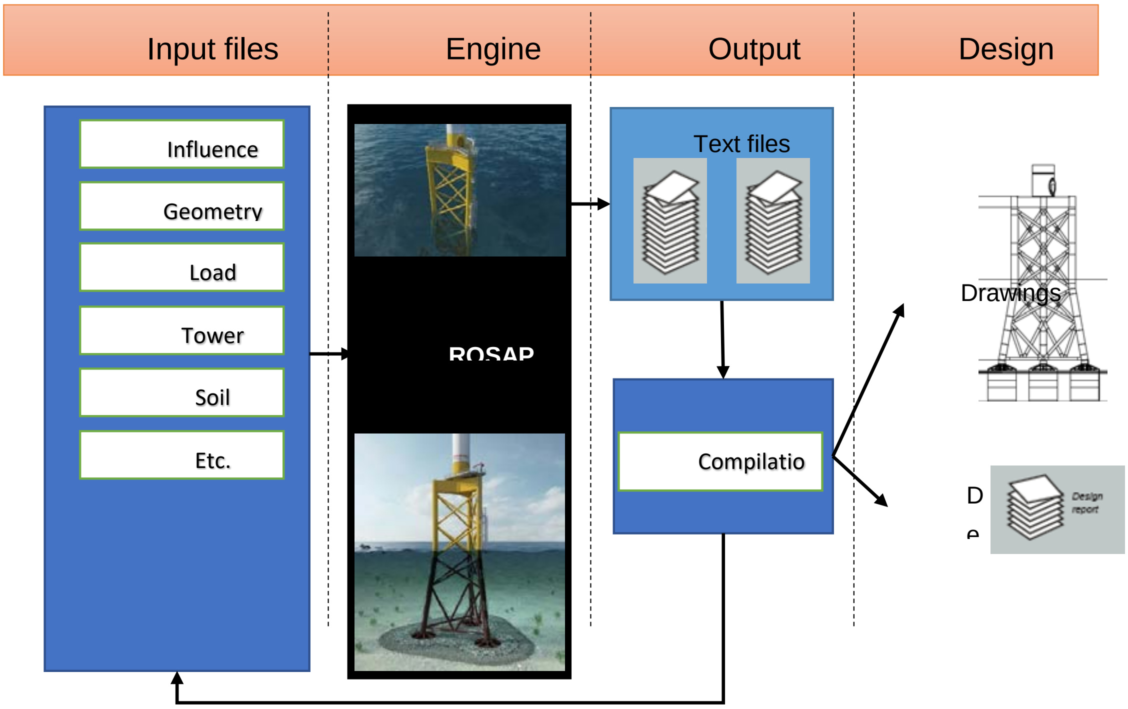


Fig. 7.1.1-36 Schematic of the design process for jackets

3. Structural Analysis of Turbine Foundations.

(1) Monopile

The OptiMon structural analysis/optimisation program is used for the structural design of monopoles, including the following factors:

A. ULS soil capacity generally related to strength in cyclic loading

B. Permanent deformation

C. Soil stiffness modelling

For cyclic loading a generic 35-hr storm event has been considered in Northern Europe (see NORSOK). The relevance of such a storm event will be examined for Taiwanese environmental conditions. Permanent deformations are mainly driven by storm events.

The lateral geotechnical soil response is based on the p-y-approach, see Figure 7.1.1-19. However, DEWP has developed various modifications to the standard API approach based on measurements of frequency response of existing turbines as well FE modelling and physical pile load tests. DEWP has in recent years been heading the industry leading Joint Industry Project "PISA" on lateral pile behaviour. The focus of this work is the behaviour of large short piles in static loading. The initial stiffness of the foundations has been one of the focus points, as it is critical for frequency predictions and therefore reliable loads and a robust design. The soil stiffness applied is a best estimate reflecting that soil stiffness properties should be modelled as accurately as possible to obtain correct results in the dynamic simulation.

The modifications implied by PISA have been certified and are now part of standard design for relevant soils. Soil liquefaction will affect this stiffness' dramatically for the duration of the earthquake, say in the order of 1-2 minutes. Procedures will be developed to account for this.

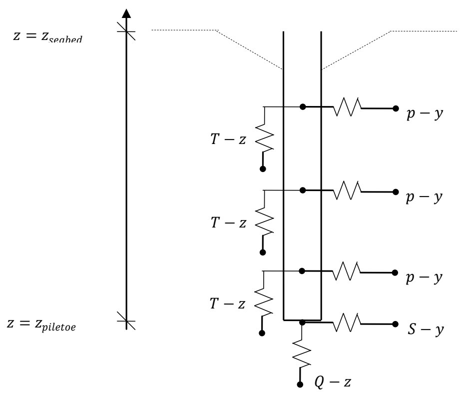


Fig. 7.1.1-37 p-y approach to monopile

(2) Piles for Jackets

For piled jacket foundations DEWP have previously used an in-house soil module together with the ROSAP package. This module considers both standard API design methods as well as more advanced CPT based methods.

(3) Liquefaction potential analysis

This project conducted a 5-point Cone Penetration Test (CPT) in the wind field in year 2016. The investigation depth reached 80m below the seabed. For the 5-point drilling soil samples, several advanced tests had been carried out. For example, resonance column, bender element, and Direct Simple Shear (DSS) in slow speed and fast speed tests were performed to construct field site response analysis and design spectrum of land surface and depth; in order to evaluate the possible effects of increased pore water pressure on soil liquefaction, a cyclic Direct Simple Shear test (cyclic DSS) was also performed. The soil liquefaction analysis had also been carried out for each hole position. The analysis result showed this wind field under the designed earthquakes, most soil layers had a safety factor against liquefaction potential of less than 1 for each hole within 20m depth under the seabed, as shown in Figure 7.1.1-38. It indicated the degree of liquefaction resistance was lower above this interface, which might be loose sediment deposited in the not-very-distant past. The sediment below the interface might be older, compacted and harder, with a higher degree of liquefaction resistance. The drilling result showed the interface was located between layer B and layer C as shown by the seismic survey section, which meant the shallowest layers, A and B had a higher risk of liquefaction potential. To match the use of sparker seismic survey system by Ørsted Energy Company in performing a large-scale multi-channel high-resolution seismic survey in 2017, the interface was depicted on the seismic survey section (Figure 7.1.3-39 light blue line); the thickness distribution diagram of the level of potential liquefied soil layer and the lateral extension were also constructed. The depth of the interface had been confirmed to be between 18 and 48m below the seabed of four wind fields in this project (Figure 7.1.1-40).

In order to understand the age of the upper and lower layers of the interface, the carbon-14 dating and enamel research on drilling sampling is carried out specifically in this case, and dating result of the layer position is mapped to the shallow layer section (Figure 7.1.1-41). We observe there is a big age gap below and above the interface. The sediment age above the interface is about the Holocene period (less than 11,700 years); the sediment age below the interface can be as high as 40,000 years, which belongs to the sediment in the late Pleistocene period. In addition to the age of the unconformity, since there is no actual sample obtained from the interface, the age of the interface is mainly estimated based on the relationship between the age of the upper and lower layers and the change of the sea surface (Figure 7.1.1-42). From the age of the upper and lower layers of the interface, the interface age should be between 8,970 and 42,000 years. The possible closest age of the interface near the upper layer of the 8,970-year layer interface, is estimated by observing the shallow layer section. In addition, considering that during the last ice age (about 27,000~18,000 years), the Taiwan Strait emerged on the sea level, causing sedimentary disruption and erosion resulting in the loss of the layers. At the same time, from the sea surface change curve in the west coast of Taiwan, we can know the late Pleistocene sea level began around 15,000 years, that is, the age of the interface is about 15,000 years or less (that is, 15KA). At that time, the sea level was lower than the layer, so the sediments above this layer were mainly deposited by sediments from rivers in Taiwan for 15,000 years. According to the composition and nature of the soil and the scale of the earthquakes, the risk of sediment liquefaction above this layer is high. The results of further CPT test and drilling data analysis show the soil below this layer is usually tighter and harder, and it is not easily liquefied, which can be used as a reference for future wind turbine foundation pile design for its foundation depth.

This project proposes a follow-up plan for soil liquefaction assessment in considering the high potential of shallow soil liquefaction in this Project site, which will be completed before construction, explained as follow:

A. Ørsted Energy Company will carry out supplementary offshore geological survey for 4 development field sites inGreater Changhua . The execution details include minimum four 80m deep drilling holes and minimum fifteen 20-80m CPT tests, and based on CPT test results to establish the relationship between CPT and liquefaction potential at this field site. At the same time, the Static Cone Penetration Test (SCPT) will be used to determine the local soil shear wave velocity to advance the worksite response analysis proficiently.

B. Prior to the detailed design, drilling or CPT will be performed at each wind turbine position to determine the specific liquefaction risk. The drilling or CPT depth will be deeper than the predetermined pile length. According to current research, this project intends to drill hole or CPT depth of approximately 80-85m below the seabed for each wind turbine position.

C. The design phase will assess and consider the risk of liquefaction based on the geological drilling results of each wind turbine position.

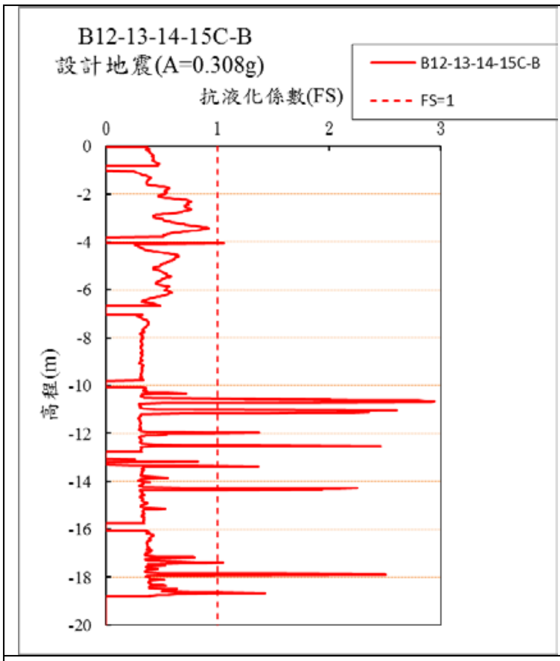
D. In the future design of this project, consideration will be given to omitting or reducing the bearing capacity of the soil layer with liquefaction risk, which is, improving the safety factor of the design.

E. This project is currently working with professors around the world with relevant experience using the most advanced offshore foundation design method UWA, through the Work Together Program (ICP), to determine how these methods can be applied to soils in Taiwan, including liquefied soils.

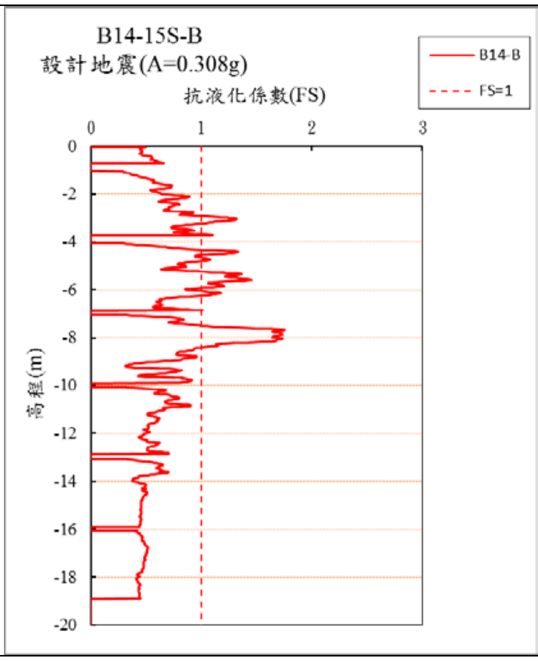
F. This project has worked with local professors in Taiwan to ensure an effective combination of local experience, including expertise in earthquakes and liquefaction, as well as advanced laboratory test and soil survey.

G. In the Nordic offshore wind fields, the soil liquefaction problem possibly caused by negative pressure of wind and waves is also often taken into consideration. Therefore this is also an important issue especially in Taiwan where soil is more susceptible to liquefaction. This Project will take this consideration in the detailed design and will also carry out investigation.

H.

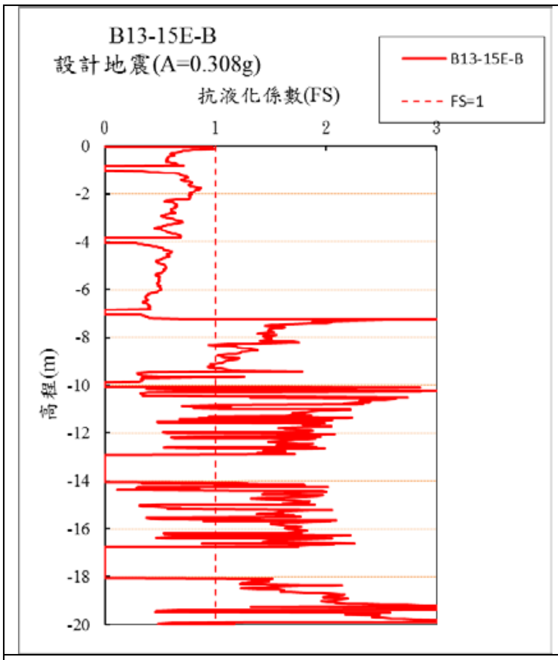


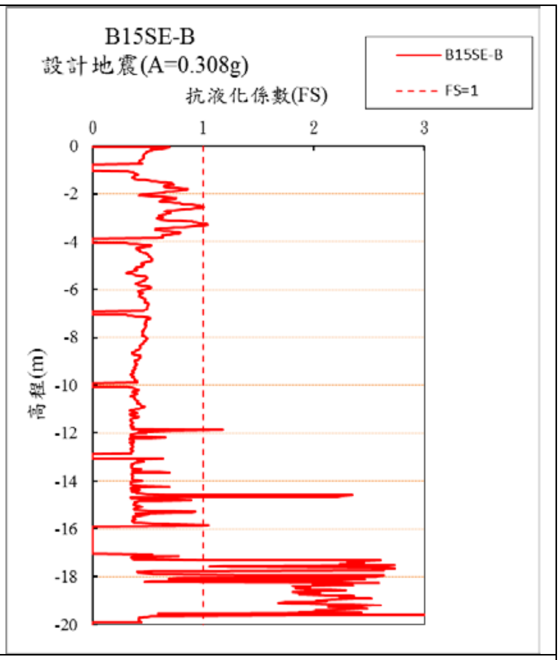
B12-13-14-15C-B (Amx=0.308g)
Safety factor of liquefaction



B14-15S-B (Amx=0.308g)
Safety factor of liquefaction

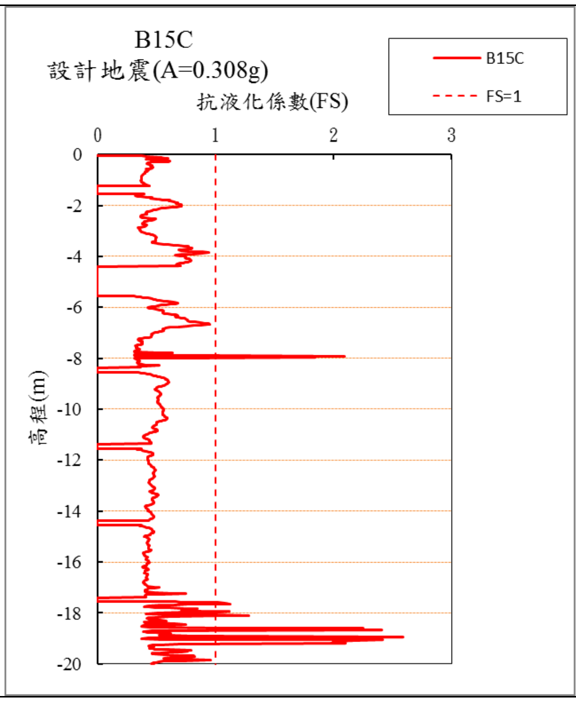
Figure 7.1.1-38 Shows Soil Liquefaction Analysis Results





B13-15E-B (Amx=0.308g) Safety factor of liquefaction	B15SE-B (Amx=0.308g) Safety factor of liquefaction

Figure7.1.1-38 Soil Liquefaction Analysis Results (Continued 1)



B15C (Amx=0.308g)
Safety factor of liquefaction

Figure7.1.1-38 Soil Liquefaction Analysis Results (Continued 2)

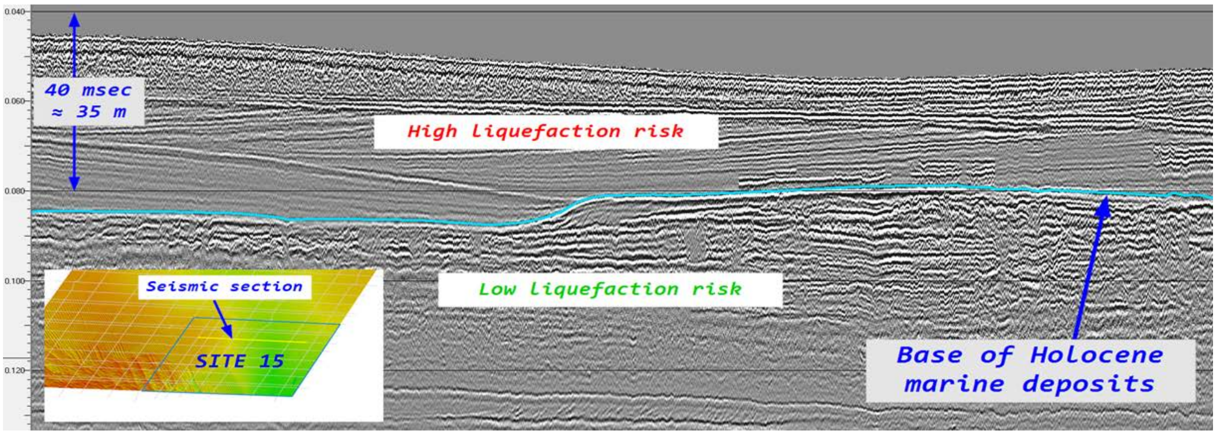
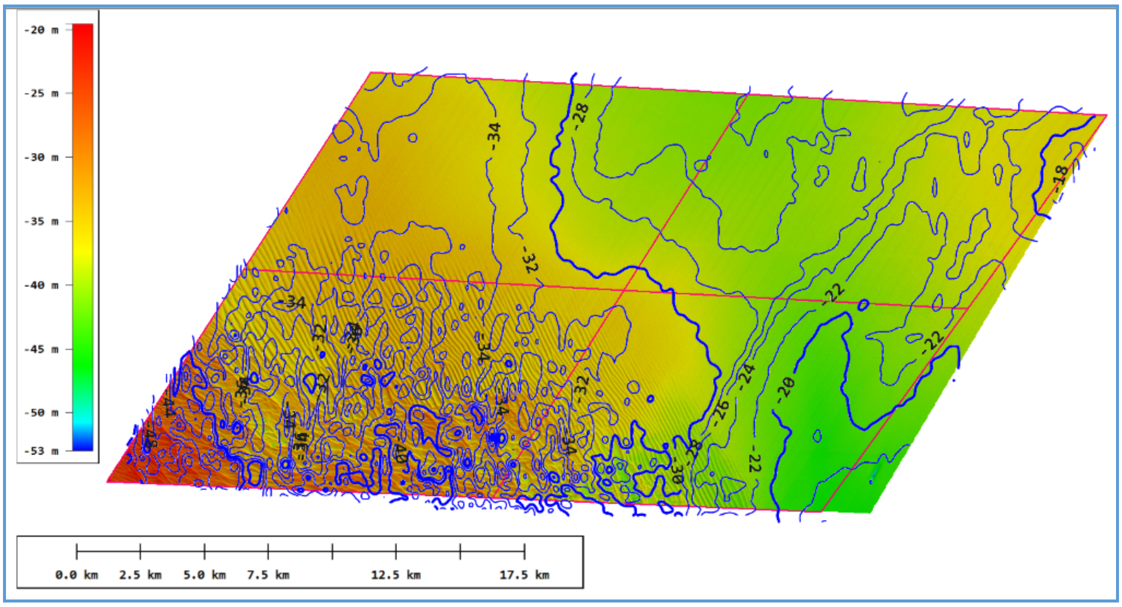


Figure7.1.1-39 Multi-channel High-resolution Seismic Survey Profile



Note：The thickness line indicates the thickness distribution diagram, the background colour scale indicates the depth of the seabed.

Figure7.1.1-40 High Risk Liquefaction Sediment Thickness Diagram

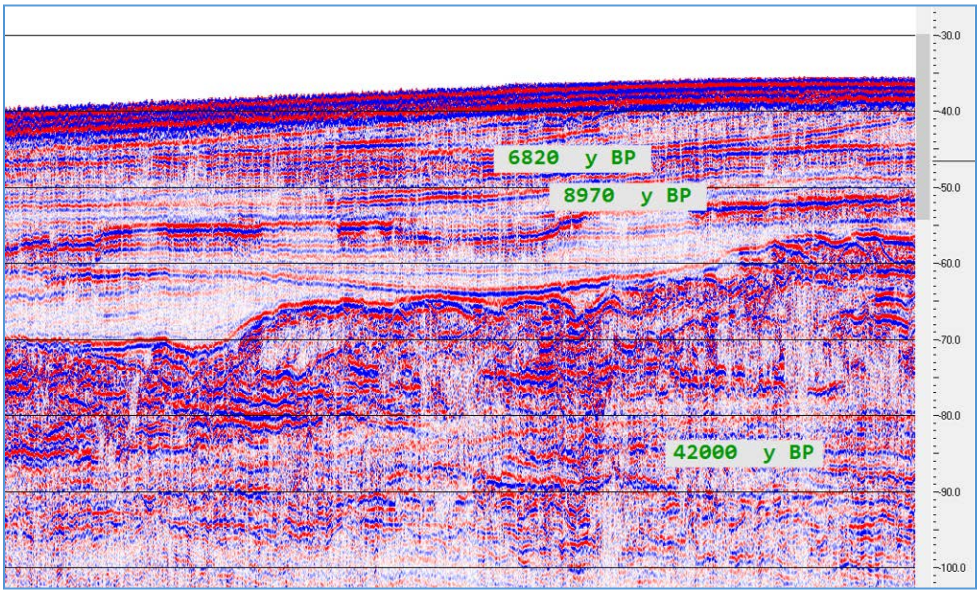
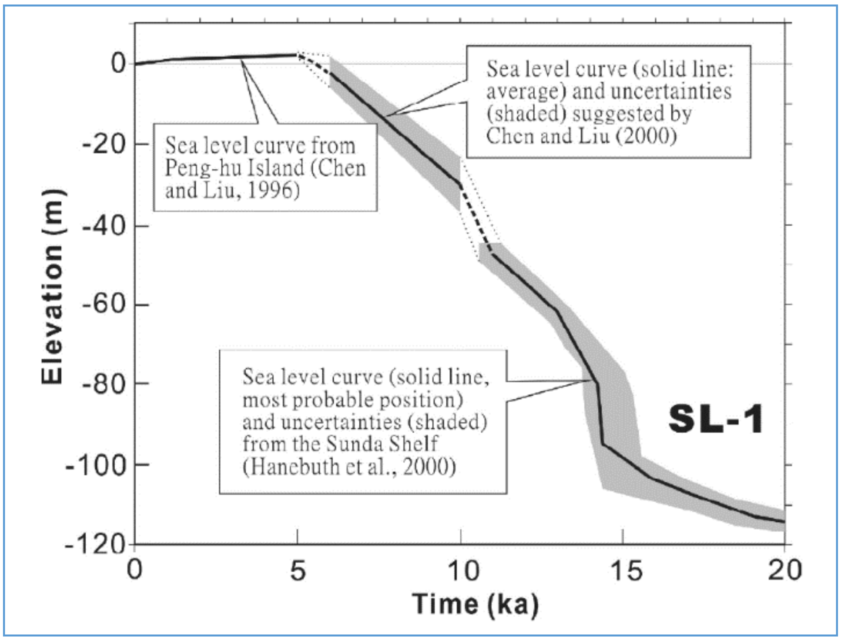


Figure7.1.1-41 Display of Possible Chronological Interface Locations In Shal low Stratigraphic Sections Based On Adjacent Drilling Dating Data



Source of data：Hsieh et al., 2005

Note：The grey zone is the possible error range of uncertainty.

Figure7.1.1-42 Relation curve of Taiwan West Coast Sea Surface Change and Chronology

7.1.1 Hydrology and Water Quality

I. Surface Water

(I) Construction period

1. Surface Run-Off

(1) Runoff Coefficient (C)

According to reference table of the runoff coefficient of Article 18 in the “Regulations Of Soil and Water Conservation”, the runoff coefficient are as follows:

A. The land area for the booster station is approximately 23,800m^2. As there is no new construction road, the surface runoff area will only be restricted at the land area with the booster station. The land is currently grassland. The runoff coefficient (C) adopted is 0.45, but runoff coefficient of 1.0 will be conservatively adopted during the construction phase.

B. The hinterland of the assembly work and back line work is located in Taichung Harbor. It is the only harbour. Currently, the surface is reinforced concrete pavement, so surface runoff will not be increased during construction in the future.

(2) Rainfall Intensity (I)

According to Article 16 of the “Regulations of Soil and Water Conservation”, the formula for rainfall intensity (I) is as follows:

$$\frac{I_t^T}{I_{60}^{25}} = (G + H \log T) \quad \frac{A}{(t+B)^C}$$

$$I_{60}^{25} = \left(\frac{P}{25.29+0.094P}\right)^2$$

$$A = \left(\frac{P}{-189.96+0.31P}\right)^2$$

B=55

$$C = \left(\frac{P}{-381.71+1.45P}\right)^2$$

$$G = \left(\frac{P}{42.89+1.33P}\right)^2$$

$$H = \left(\frac{P}{-65.33+1.836P}\right)^2$$

Where T：recurrence interval (year)

t：rainfall delay or collection time (minute)

I_t^T ：rainfall intensity when recurrence interval is T year and rainfall delay is t minute (mm/hour)

I_{60}^{25} ：rainfall intensity when recurrence interval is 25 years and rainfall delay is 60 minutes (mm/hour)

P ：average annual rainfall (mm)

A、B、C、G、H: coefficient

Time of concentration is 10 minutes; recurrence interval is 25 years. According to Wuqi Meteorological Station, average annual rainfall in Changhua area during the 10-year period from year 2006~2015 was 1,385.90mm, while the rainfall intensity (I_{10}^{25}) was 99.26mm/hr.

(3) Runoff rate analysis results

Rational formula as follows:

$$Q_p = \frac{1}{360} CIA$$

where,

Q_p：peak discharge (CMS),

C：runoff coefficient,

I：rainfall intensity (mm/hour),

A：catchment area (hectare)

After substituting the above estimated parameters into the rational formula of (Q = CIA/360), total direct runoff rate (Q_0) of 0.295CMS for the booster station can be derived prior to the construction, while the runoff rate (Q_1) during construction is 0.656CMS due to the additional 0.361CMS runoff wastewater added during construction.

2. Domestic wastewater

Domestic wastewater from construction workers of the Project will be estimated referring to the “Technical Specifications of Building Sewage Treatment Facilities” announcement issued by the Construction and Planning Agency Ministry of the Interior, in which the estimated daily residential wastewater per person per day is 225 liters and non-residential wastewater per person per day is 100 liters.

There will be 2 construction areas for this Project which are the land area for the booster station and Taichung Harbor. In the construction area for the land transmission and distribution system engineering, as the construction is done by stages, there will be 220 persons at peak hours, and there will be no personnel stationed at the construction site. The maximum amount of wastewater generated will be approximately 22.00CMD.

In the construction area at the Taichung Harbor terminals, there will be 150 persons at peak hours, whereof the personnel stationed at the working dock will not exceed 50 persons. The wastewater flow generated by the construction workers during the construction period will be approximately 21.25CMD. If two construction sites are operating simultaneously, the maximum wastewater generated will only be approximately 43.25CMD, which is a very slight increase. Wastewater of the construction workers will be processed by rented portable toilet or the adjacent existing buildings, which will not be arbitrarily discharged into the surface water body; therefore, wastewater of the construction workers during the Project's construction period would impose no effect on the nearby water bodies.

(II) Operation period

1. Surface Runoff

After the development, green landscape will be planted inside the booster station to increase rainwater infiltration rate. Therefore, the runoff coefficient (C) adopted is 0.9. Total area of the catchment (A) will be 23,800m^2, which is the total area of the base. The direct runoff rate Q_2 will be 0.591CMS, which will be increased by 0.295CMS on top of the status quo. The Project will have a complete drainage system which should be able to exclude runoff rate successfully, in order not to cause impact upon the hydrology of drainage channel around the base.

2. Domestic Wastewater

During the operational period of the Project's offshore wind power plant, maximum number of people working in the booster station will be 100 persons. Refer to the "Technical Specifications of Building Sewage Treatment Facilities" announcement published by the Construction and Planning Agency Ministry of the Interior, the number of users shall be calculated by ¼ of the number of workers and wastewater generated daily shall be estimated at 150 liters per unit number of users. Therefore, maximum wastewater generated during operational period of the Project will be approximately 3.75CMD. The Project will set up wastewater treatment facilities for buildings or apply for nanotubes to connect with the sewage systems without discharging into the ditches around the base. Therefore, no adverse impact will be imposed upon water quality of nearby surface water bodies.

II. Groundwater

(I) Construction period

As the excavation depth for the land transmission and distribution system construction of the Project is limited, therefore, pumping down groundwater during the construction period will not be necessary. On the other hand, the maximum excavation depth for the booster station will be 1-3 meters; the excavation depth will not be deep and the construction period will not be long, therefore, it will not cause any groundwater upwelling. During the construction period, there will be minimal temporary impact on the groundwater level due to infiltration of direct runoff, but it will recover naturally upon the completion of construction, therefore, impact on the overall groundwater level in this area will be minor.

Concrete is used for grouting work during the excavation period for this project and existing roads are selected for construction access road. The construction area has been reduced. Routine maintenance and upkeep is performed on construction vehicles to oil leakage by construction vehicles to eliminate this source of ground water pollution. Therefore, there is no impact on groundwater quality during the project's construction period.

(II) Operation period

During the operation of this project, water will be supplied by Taiwan Water Supply Company without pumping the groundwater. Therefore, there is no impact on groundwater.

III. Seawater quality

The maritime engineering that may affect the quality of seawater during the construction of this project is mainly divided into two parts which are the wind turbine foundation and marine cable laying construction. When construction is carried out in the sea, suspended solid may have impact to the quality of seawater surrounding. In order to understand the impact brought by the suspended solids produced during the construction, this Project will assess the distribution of suspended solids in the nearby sea by using numerical simulation.

(I) Description of the diffusion of suspended solids in the sea

1. Description of construction method

This Project has scheduled to install wind turbine at Changhua's offshore area. The maritime engineering that may affect the quality of seawater during the construction of this project is mainly divided into two parts which are the wind turbine foundation and marine cable laying construction:

(1) Foundation pile setting construction

This project comprehensively analyses the water depth variation range, geology, marine, environmental impact factors and possible wind turbines in the sea. The basic types that may be used include gravity, monopole, jacket pile and etc. Except for the gravity type, the foundation piles will be hit into the seabed by striking or drilling. These two construction methods are only slight disturbances to the water body. The footing may need some protective settings to prevent it to be under washed by tides and waves. The main method is to remove the soil and sand near the footing and replace them with different grades of gravel. This Project will only cause slight disturbance to the suspended solids in water during the removal of soil and sand and the replacement of gravel laying. Generally, the rate of excavation and riprap is about 100m^3/hr. This effect shall be greater than when piling is used. So, it is the evaluated.

(2) Construction of marine cable trench digging

There are many experiences in marine cable laying construction both domestic and abroad. Trench digger can be used to excavate trench near the shore. Generally, marine excavator or grab dredger is used for excavation, laying and backfilling for marine cable laying in shallow water (within 50m). Otherwise, high-pressure flushing type of laying equipment is used as the main construction method for excavation, marine cable laying and backfilling to be carried out together.

Assess the impact caused during the marine cable laying construction and evaluate the high-pressure flushing type burial laying equipment that brings larger impact. This method is to first lay the cable on the seabed and uses the high-pressure flush to wash out a trench to bury the marine cable naturally. Then, the trench is backfilled naturally by the tidal current and wave action. Therefore, the impact imposed to the seawater quality shall be in the stage where the trench is being washed out by the high-pressure flushing. The flushing rate is different due to the seabed geology, machine form and output. After preliminary study, the maximum conservative propulsion rate of high-pressure flushing is about 350 m/hr, the width of excavation is about 1-2 m, depth is about 0.5-1.5 m, the maximum flush rate is about 1050 m^3/hr. So, this flush rate is taken for evaluation.

2. Suspended solids diffusion

The impact of wind turbine foundation to the seawater quality shall be lower than the marine cable laying construction during the construction period. Based on different water depth, the marine cable laying construction uses either marine excavator to excavate trench or high-pressure flushing type laying equipment to carry out excavation, laying and backfilling together. The sand mud which is excavated by the excavation and backfilling of this construction method will be lower than that of the sand mud which is raised by the high-pressure flushing. Therefore, in order to understand the maximum impact of the construction, the marine cable laid with high-pressure flushing is taken as the evaluation standard.

During the construction in the sea, suspended solids will be produced and moved along with the tidal current. According to the sedimentation mentioned above, the particles are assumed to be spheres. According to Stroke’s Law, due to the different diameter of the particles, the larger particle sizes of suspended solids have settled to the bottom of the sea within 100-200m of emission. The sub-large particle size suspended solids can float to 500-1,000 m, and the smaller particle size suspended solids can float to 2 km or more. Besides that, the sedimentation velocity is greatly affected by ocean current. The height is H, influent flow rate is Q, sedimentation velocity is Vs. The transfer time is calculated as follows.

T=H/V

T: transfer time (second)

H: area length or depth (meter)

V: ocean current (meter/second)

Assume that it is 200 m from the construction site, when the ocean current is 25cm/s, the horizontal transfer time of the particles from the mud area to the 200m construction site is 200 × 100 ÷ 25 = 800(s). The minimum sedimentation velocity for the particles to settle to the bottom of the sea vertically within 200 m is 6 × 100 ÷ 800 = 0.75 cm/s, where 6 m is the estimated vertical (water depth) sedimentation distance (related to the water depth at the construction site and dredger). From the relation curve of particle size and sedimentation velocity shown in Figure 7.1.2-1, the diameter of the particles can be obtained as 0.075 mm. That is the minimum sedimentation velocity and diameter of suspended solid with a diameter greater than 0.075 mm at distances of 200 m, 500 m, 1,000 m, 2,000 m, and 4,000 m. According to the particle size distribution curve obtained from the soil analysis, determine the percentage of sediment particle size nearby this area that is lower than this value and plot the relation curve of percentage of particle size and the mud area size as shown in Figure 7.1.2-2. From the graph, the percentage of solids that are still suspended in seawater against those escaped at any distance can be found. Then, the percentage of solids that are still suspended in the seawater against those escaped at any distance can be estimated according to the relationship between the particle size and sedimentation velocity.

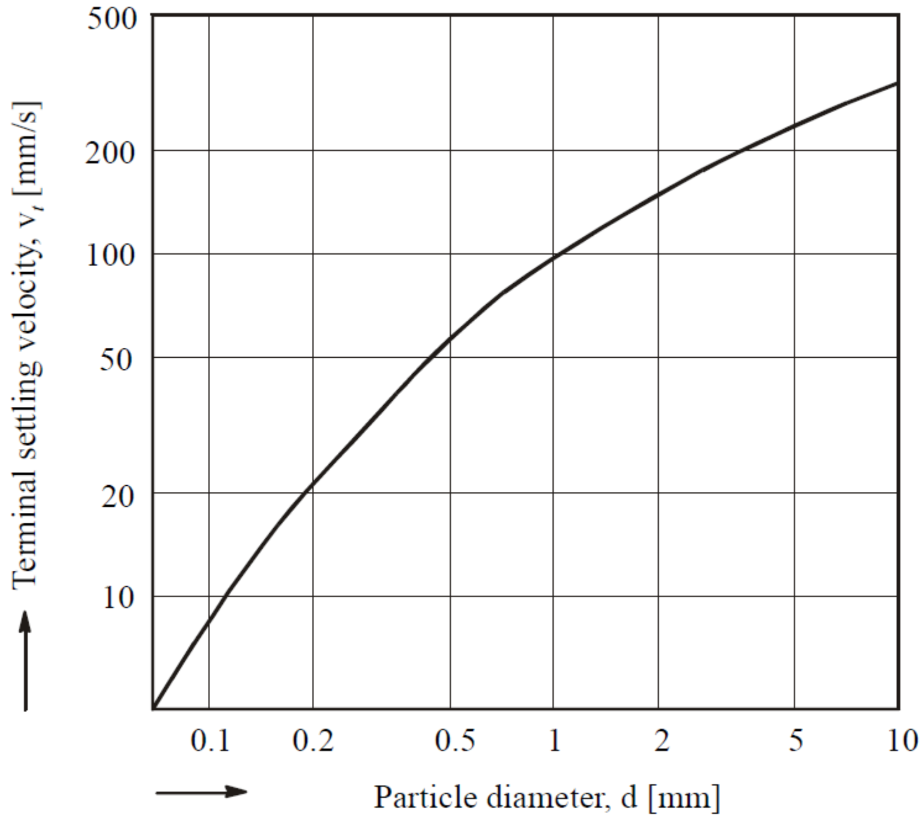


Figure 7.1.2-2 Relation Curve of Particle Size And Sedimentation Velocity

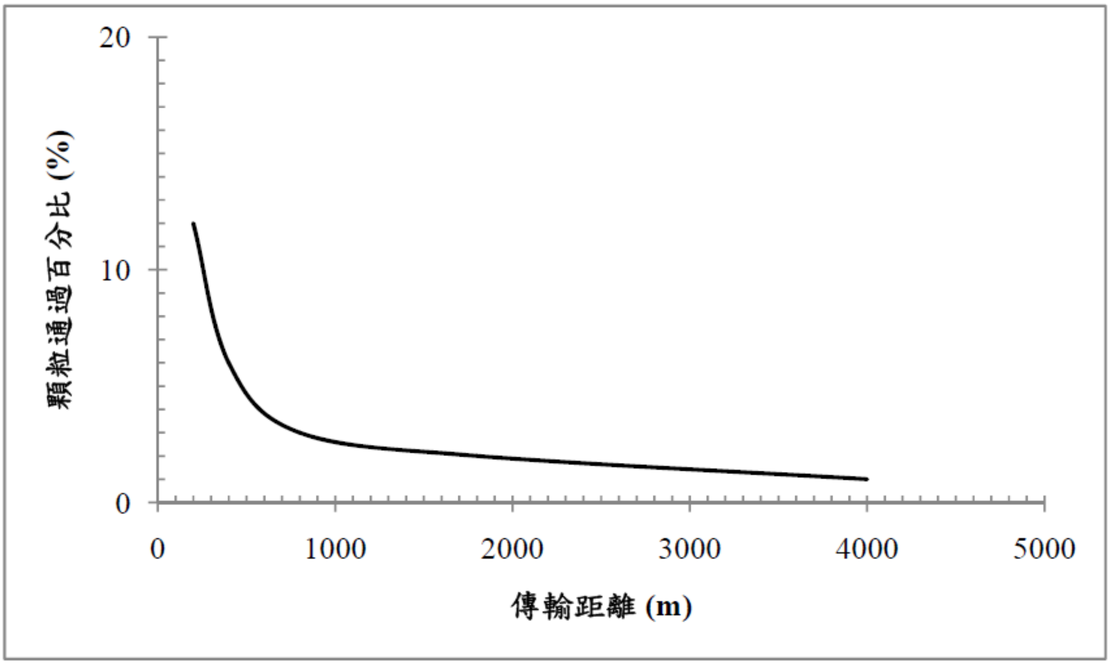


Figure 7.1.2-3 Relation Curve Of Particle Transport Distance And The Percentage Of Unsettled Particles

The estimation of loss of the mud area, the flush rate of marine cable laying towards the seabed, solid particle size and the type of machine are closely related. Under the appropriate construction planning, it is conservatively estimated that the loss is 20% of the flush rate during the construction. The input value of the suspended solid pollution source used in the simulation is the muddy rate multiplied by mud loss (20%) and multiplied by the percentage of unsettled particles. The percentage of unsettled particles means that the lighter solids from mud loss and particle distribution are affected by the ocean current before they settle to the bottom of the sea will affect the simulation of the distribution. For example, assume it is 100 m from the construction site as simulation, referring to Changhua Coastal, the percentage of the seabed sandy particle size shall be lower than 20%. The numerical simulation of the impact imposed by marine cable construction on the seabed soil is based on the estimated percentage rate. According to the available data, the project area is mainly a sandy stratum. Based on the previous analysis, the flush rate is about 450 m^3/hr. The rate of loss is about 450 × 20% ×20% = 18 m^3/hr. This can be used as a basis for the evaluation of the loss of suspended solids and the distribution of suspended solids in the sea.

(II) The Establishment of The Distribution of The Sea Suspended Solids Monitor

1. Description of The Model

This model is the Water Quality Monitor (WQM) developed by EOT. It is currently one of the most complete water and water quality model. It can simulate the water and water quality characteristics of rivers, harbors and oceans effectively and rationally, especially the ability to simulate the concentration of heavy metals in water. This model can simulate up to 20 types of water quality parameters including water quality parameter concentration, algae, biochemical oxygen demand, dissolved oxygen, chemical oxygen demand, nitrate nitrogen, nitrite nitrogen, ammonia nitrogen, organic nitrogen, phosphate, phenols, total oil, coliform, suspended solids and heavy metals (copper, lead, cadmium, zinc, chromium, mercury) and etc. In the process of solving, taking all the water quality parameters that have interactions, precipitation, and growth into account. This model has been used by many locations in the States and passed many seawater quality evaluations in Taiwan. It has also passed environmental evaluations on water quality simulation for many offshore wind power plans (Marine Offshore Wind Power Plan, Taipower Changhua First Phase Offshore Wind Power Plan, and etc) as well as implements the Environmental Protection Agency's “Research on Water Quality Acceptance Capacity in Southwest China” (1996) and provide technology transfer.

WQM model is based on the finite element method for solving fluid mechanics equation, convection-diffusion equation and energy equation. These equations are derived from mass, momentum, and energy conservation law. This model first solves the flow rate and water level of the fluid. Then, substitute with the diffusion equation and energy equation to solve the characteristics of the parameters such as water quality and water temperature. Therefore, this model is separated into two stages to solve. The fluid flow rate and water level are first solved by hydromechanical simulation and the result is then applied to the diffusion equation and energy equation to solve the distribution characteristics of the water quality parameters of the water body.

Verification of the water quality model is a difficult job. It is unable to conduct hydraulic experimentation comparison especially when facing with complex ocean current. There are many factors affecting the ocean current such as wind power, permanent current and etc. It is very hard to get the same flow field by simulating the complex ocean current using the model. Therefore, it is acceptable if the calculated results and measured values fall within the reasonable error range.

2. Mesh Establishment

The solution process uses the finite element method to solve two-dimensional fluid mechanics equation, diffusion equation and energy equation. The shape function used is a linear triangle. The establishment of mesh depends on the conditions of the boundary. If there is tidal data near the project area, an individual mesh can be built. If there is no appropriate tidal data, mesh of different sizes shall be built for the use. Tidal data is also needed for big mesh at the boundary. The calculated results can be used for small mesh on the condition of the boundary. This Project establishes computational domain finite element mesh which covers about 40 km wide and 50 km long. Figure 7.1.2-3 shows the diagram of established finite element mesh while the model building mesh related parameters is shown in Table 7.1.2-1.

3. Verification of Comparison Between Hydraulic Routing and Measured Ocean Current

This Project uses Water Quality Monitor (WQM) to simulate the diffusion of suspended solids during construction period. Since diffusion of suspended solids is caused by ocean current, tidal current and water quality diffusion, it is seawater quality physical diffusion, it is difficult to do on-site measurement on the verification of drifting sand in the sea. In the hydraulic model test, the scale of fine sand, silt, clay and etc. in the sea is unable to use in the hydraulic laboratory (generally about 1/100) according to scale. Therefore, in general, the verification is done according to the on-site flow situation and compare the related parameters. So, the simulation results of suspended solids driven by the current and diffused in the sea can be quite reasonable.

This Project has compared between the hydraulic routing and the measured current data. The measured diachronic flow velocity of Changbin Industrial

Zone Open Sea is shown in Figure 7.1.2-4. The diachronic comparison diagram of simulated flow velocity and measured data are shown in 7.1.2-5 and Figure 7.1.2-6. From Figure 7.1.2-5 and Figure 7.1.2-6, the simulation result shows that the flow velocity magnitude and direction have considerable degree of consistency which can further confirm the justifiability of the model.

Table 7.1.2-1 Mesh Parameter Configuration Within The simulation Range

Coordinate system	Geographic coordinate – TWD67
Mesh scale	Mesh points(Node)：3,958 Mesh number(Element)：7,604 Δ≈100~300m
Simulation context	north：southern side of Taichung Harbor south：northern side of the Changhua County and Yunlin County junction east：inland west：water depth is approximately -40~-60m in open sea

Figure 7.1.2-3 Diagram of Finite Element Mesh Simulation

Figure 7.1.2-4 Verification of Flow Velocity Model Site Plan

Figure 7.1.2-5 Diachronic Comparison Diagram of Simulated Flow Velocity Magnitude And Measured Data

Figure 7.1.2-6 Diachronic Comparison Diagram of Simulated Flow Velocity Direction And Measured Data

4. Simulation Result Analysis of Sea Water Quality

(1) Individual Simulation of This Project

In order to manage the impact to the sea water quality, numerical simulation analysis of water quality is carried out. The compute mode starts from computing water simulation such as water level and water flow, and then simulate the diffusion and transmission of the water quality parameters from the water simulation results. The input of boundary water level is a time series. It covers the effect of high and low tide on the transmission of water quality parameters. In addition, the results shown in this simulation are all long term calculation. The initial condition is set to start from 0 and continue to calculate along the construction period. Taking 14 days as the time basis, under this situation, the sea water quality has reached an equilibrium condition. In the long-term construction in the sea, the concentration of suspended solids in the overall calculation domain is no longer drastically changed but only changes slightly with the tidal levels such as high and low tides.

To calculate the diffusion of the pollutant in the sea after discharge, besides the main input conditions including the water level of each node of the mesh and flow velocity obtained from hydraulic routing, the initial concentration of water quality parameters to be calculated shall also be given. Therefore, refer to the previous data of the rate of suspended solids that may be generated during the construction as the initial input value. This Project does simulation analysis on the distribution of suspended solids after concentration increment. It can be seen from the simulation results that after the long-term construction reaches a roughly stable state, the water quality changes only slightly with the change of the high and low tide, and at low tide, the sea level is usually lower, which is usually a larger increment, that is, the poor environmental condition.

After understanding the amount of suspended solids produced during the construction, the effect of suspended solid concentration increment on the nearby sea during the marine cable construction can be estimated by calculating with the numerical simulation. Since the construction scope of the marine cable is applied from the shore to the unit location, and the effect of suspended solid during construction is smaller at the deeper water, the simulation is carried out at the marine cable landing point where the water depth is about 5m. There are 4 marine cable landing points in this Project. They will undergo the suspended solid concentration increment evaluation separately. In addition, the foundation construction site will be simulated for the suspended solid concentration increment by the unit nearest to shore.

Table 7.1.2-3 and Figure 7.1.2-9 ~ Figure 7.1.2-16 are the distribution diagrams showing the concentration increment of the suspended solid at the marine cable landing point #1 (northern side), the marine cable landing point #2 (middle side), the marine cable landing point #3 (southern side), the marine cable landing point #4 (Taipower's current planned northern side common corridor) and construction site (at water depth of 5m), and at the foundation construction site (the unit nearest to shore) during low and high tide levels.

The simulation result shows that the suspended solid concentration basically reduces very rapidly. The suspended solid concentration increment within the construction site range (approximately 200 meters) of the marine cable landing point #1 is reduced rapidly down to 5.0mg/L due to the diffusion force by the tidal current; the concentration increment at the area which is 500m from the construction site is only about 4.0mg/L at the low tide level; the concentration increment at the area which is 1,000m from the construction site is only about 3.5mg/L; and the concentration increment near the shore is approximately 0.7mg/L. The suspended solid concentration increment within the construction site range (approximately 200 meters) of the marine cable landing point #2 has reduced down to approximately 4.5mg/L; at the area which is 500m from the construction site is only about 4.0mg/L; at the area which is 1,000m from the construction site is approximately 3.5 mg/L; near the shore is approximately 1.0 mg/L. The suspended solid concentration increment within the construction site range (approximately 200 meters) of the marine cable landing point #3 has reduced down to approximately 4.2mg/L; at the area which is 500m from the construction site is only about 3.8mg/L; at the area which is 1,000m from the construction site is approximately 3.0 mg/L; near the shore is approximately 1.5 mg/L. The suspended solid concentration increment within the construction site range (approximately 200 meters) of the marine cable landing point #4 (Taipower's current planned northern side common corridor) has reduced to approximately 4.5mg/L; at the area which is 500m from the construction site is only about 4.0mg/L; at the area which is 1,000m from the construction site is approximately 3.5 mg/L; near the shore is approximately 0.8 mg/L. Because the water depth is relatively deeper during foundation engineering of the units, the suspended solid concentration increment within the range of 200 meters has reduced down to approximately 0.43mg/L; at the area which is 500m from the construction site is only about 0.35mg/L; at the area which is 1,000m from the construction site is approximately 0.25mg/L. The location of the foundation is approximately 30~40km from the shore, therefore, there would be no effect on the shoreside. The simulation result shows that the suspended solid incurred during the construction period would be diffused within short distances by two-way forces of the double day tide, therefore, it will not cause too much impact on the sea waters.

In conclusion, foundation construction and marine cable laying are only temporary activities during construction period. Therefore, the impacts on the nearby sea should be partial and temporary. The numerical simulation carried out according to the construction condition also shows that the degree of impact is low.

Table 7.1.2-2 Description Of The Suspended Solid Concentration Increment At The Area Which Is 200m、500m、1,000m From the Construction Site, And Near the Shore side

suspended solid (SS) concentration increment (Unit of Measurement：mg/L)		200m From the Construction Site concentration increment	500m From the Construction Site concentration increment	1,000m From the Construction Site concentration increment	Near the Shore side concentration increment
marine cable landing point #1 --Impact on water quality during construction	simulation results at low tide	5.0	4.0	3.5	0.7
	simulation results at high tide	4.5	3.5	3.0	0.7
marine cable landing point #2 --Impact on water quality during construction	simulation results at low tide	4.5	4.0	3.5	1.0
	simulation results at high tide	4.0	3.5	3.0	1.0
marine cable landing point #3 --Impact on water quality during construction	simulation results at low tide	4.2	3.8	3.0	1.5
	simulation results at high tide	3.8	3.3	3.0	1.5
marine cable landing point #4 --Impact on water quality during construction	simulation results at low tide	4.5	4.0	3.5	0.8
	simulation results at high tide	4.0	3.5	3.0	0.8
Impact on water quality during foundation engineering	simulation results at low tide	0.43	0.35	0.25	No effect
	simulation results at high tide	0.41	0.35	0.25	No effect

Figure 7.1.2-7 Distribution Diagram Showing Simulation Results Of Suspended Solid Concentration Increment At Marine Cable Landing Point #1 During Construction (At Low Tide Level)

Figure 7.1.2-8 Distribution Diagram Showing Simulation Results Of Suspended Solid Concentration Increment At Marine Cable Landing Point #1 During Construction (At High Tide Level)

Figure 7.1.2-9 Distribution Diagram Showing Simulation Results Of Suspended Solid Concentration Increment At Marine Cable Landing Point #2 During Construction (At Low Tide Level)

Figure 7.1.2-10 Distribution Diagram Showing Simulation Results Of Suspended Solid Concentration Increment At Marine Cable Landing Point #2 During Construction (At High Tide Level)

Figure 7.1.2-11 Distribution Diagram Showing Simulation Results Of Suspended Solid Concentration Increment At Marine Cable Landing Point #3 During Construction (At Low Tide Level)

Figure 7.1.2-12 Distribution Diagram Showing Simulation Results Of Suspended Solid Concentration Increment At Marine Cable Landing Point #3 During Construction (At High Tide Level)

Figure 7.1.2-13 Distribution Diagram Showing Simulation Results Of Suspended Solid Concentration Increment At Marine Cable Landing Point #4 During Construction (At Low Tide Level)

Figure 7.1.2-14 Distribution Diagram Showing Simulation Results Of Suspended Solid Concentration Increment At Marine Cable Landing Point #4 During Construction (At High Tide Level)

Figure 7.1.2-15 Distribution Diagram Showing Simulation Results Of Suspended Solid Concentration Increment During Foundation Engineering (At Low Tide Level)

Figure 7.1.2-16 Distribution Diagram Showing Simulation Results Of Suspended Solid Concentration Increment During Foundation Engineering (At High Tide Level)

(2) The Combined Assessment of Changhua County, Hai Long and Haiding Offshore Wind Turbine

The cumulative effect analysis has been carried out for the units and marine cable laying that are nearer to the shore for each development case. Description of the assessment is as follows:

A. Foundation Engineering

(a) Simultaneous Construction in Changhua County and Haiding

Foundation engineering includes excavation of land, piling, riprap and protection works. There is only slight impact on the water body and sea bed during piling. Therefore, the assessment is carried out based on the excavation and riprap. The impact on sea water quality suspended solid (SS) concentration increment during the foundation engineering at the units near to Changhua County and Haiding is shown in Figure 7.1.2-17. Under this situation, it is known that the impact on SS concentration increment at the area which is 200m from the construction site is approximately 0.4~0.5mg/L. There is no synergistic effect. There is only synergistic effect at the area which is 500m from the construction site. But the concentration increment is only 0.1 mg/L. These concentration increments are much lower compared to the background value of suspended solid concentration in the nearby sea area. Besides that, the units of these 2 project are located more than 30 km offshore and the water depth is about 40m. Therefore, the impact on the sea water quality is still very low even if the wind turbines in the adjacent sea area carry out construction at the same time.

(b) Simultaneous Construction in Haiding and Hai Long

The impact on sea water quality suspended solid (SS) concentration increment during the foundation engineering at the units near to Haiding and Hai Long is shown in Figure 7.1.2-18. Under this situation, it is known that the impact on SS concentration increment at the area which is 200m from the construction site is approximately 0.3~0.4mg/L. There is no synergistic effect. There is only synergistic effect at the area which is 500m from the construction site. But the concentration increment is only 0.1 mg/L. The units of these 2 projects are located more than 40 km offshore and the water depth is about 40m. Therefore, the impact on the sea water quality is still very low even if the wind turbines in the adjacent sea area carry out construction at the same time.

(c) Simultaneous Construction in Changhua County, Haiding and Hai Long

The impact on sea water quality suspended solid (SS) concentration increment during the foundation engineering at the units of these 3 projects is shown in Figure 7.1.2-19. Under this situation, it is known that the impact on SS concentration increment at the area which is 200m from the construction site is approximately 0.2~0.4mg/L. There is no synergistic effect. Besides that, the distance between them is about 8-10km. There will be no impact when the constructions are done simultaneously. The units of these 3 projects are located about 40km offshore and the water depth is about 40km. Therefore, Therefore, the impact on the sea water quality is still very low even if the wind turbines in the adjacent sea area carry out construction at the same time.

B. Marine Cable Construction

(a) Simultaneous construction of two marine cables about 2km from the nearshore water

Marine cable construction near the shore side is mainly plowing method. This method uses high-pressure flushing to wash out a trench and lay the marine cable. Since the seabed is dominated by sand, so it can be backfilled naturally after some time. The assessment is carried out according to the flush rate, width and depth during the construction. The impact on sea water quality suspended solid (SS) concentration increment during the simultaneous construction of two marine cables about 2km from the nearshore water is shown in Figure 7.1.2-20. Under this situation, it is known that the impact on SS concentration increment at the area which is 200m from the construction site is approximately 2.0~2.2mg/L. There is no synergistic effect. There is only synergistic effect at the area which is about 500~1,000m from the construction site. But the concentration increment is only 0.4~0.5 mg/L. The increment is within the variation range of suspended solid concentration increment. Therefore, the impact on the sea water quality is still very limited even if the construction of the two marine cables are carried out at the same time.

(b) Simultaneous construction of two marine cables about 2~5km from the far shore

In this situation, the impact on the sea water quality suspended solid concentration increment during the simultaneous construction of two marine cables is shown in Figure 7.1.2-21. Under this situation, it is known that the impact on SS concentration increment at the area which is 200m from the construction site is approximately 1.2~1.4mg/L and there is no synergistic effect. There is only synergistic effect at the area which is about 500~1,000m from the construction site. But the increment is approximately 0.4~0.5mg/L. The increment is within the variation range of suspended solid concentration increment. Therefore, the impact on the sea water quality is still very limited even if the construction of the two marine cables are carried out at the same time.

Figure 7.1.2-17 Distribution Diagram Showing The Impact On SS Concentration Increment During Simultaneous Construction in Changhua County, Haiding And Hai Long (At Low Tide Level)

Figure 7.1.2-18 Distribution Diagram Showing the Impact On SS Concentration Increment During Simultaneous Construction in Haiding and Hailong (At Low Tide Level)

Figure 7.1.2-19 Distribution Diagram Showing The Impact On SS Concentration Increment During Simultaneous Construction In Changhua County, Haiding And Hai Long (At Low Tide Level)

Figure 7.1.2-20 Distribution Diagram Showing The Impact On SS Concentration Increment During Simultaneous Construction Of Two Marine Cables About 2km From The Nearshore Water (At Low Tide Level)

Figure 7.1.2-21 Distribution Diagram Showing The Impact On SS Concentration Increment During The Simultaneous Construction Of Two Marine Cables About 2~5km From The Far Shore (At Low Tide Level)

7.1.3 Air Quality

This Project is set for offshore wind turbine. Since the wind turbine uses no pollution wind power generation. It will not produce any air pollutants such as carbon dioxide, nitrogen oxides, sulphides or granules and will not affect air quality. Since the offshore wind turbines are installed in the sea area, regardless of the basic seabed construction or unit assembly construction during the construction period, the impact of the exhaust gas generated by the ship machinery construction operation on the land-sensitive receivers is rather slight. The main impacts of this development project on environmentally sensitive receivers come from the land constructions including land cable construction and the construction of new booster stations, where the air pollutants are produced from exposed surface fugitive dust in construction zone, vehicular dust and construction units. The Project assesses the effect of construction activities on ambient air quality in the most conservative manner, based on the simultaneous construction activities of land cable embedment engineering and booster station construction.

I. Construction work area air pollutant emissions

(I) Fugitive dust during construction

1. Exposed surface fugitive dust in construction zone

A. Particulate pollutants fugitive dust

(A)New booster station construction project

Based on Table B2 of Taiwan Region 2013 (base year) area source – fugitive particulate pollutant emission factor in the latest area source emission factor TEDS9.0 update announced by the EPA, the total suspended particulate emission factor produced by the region development construction (industry) work items is 0.944kg/m^2• month (3.64×10^{-4} g/m^2/s). PM_{10} emission index is 0.5245kg/m^2•month (2.02×10^{-4} g/m^2/s). Besides that, $PM_{2.5}$ accounts for 0.111 of TSP，where $PM_{2.5}$ emission index is 0.105kg/m^2•month(4.05×10^{-5} g/m^2/s)。

By using water sprinkling on exposed surfaces of the work area to control flying dust, the TSP is lowered by 50 %, which reduces the emission factor to 1.82×10^{-4} g/m2/s. PM_{10} is lowered by 50 %, which reduces it to 1.01×10^{-4}g/m^2/s. $PM_{2.5}$ is lowered by 50 %, which reduces it to 2.02×10^{-5} g/m^2/s.

(B) Land cable installation project

Based on Table B2 of Taiwan Region 2013 (base year) area source – fugitive particulate pollutant emission factor in the latest area source emission factor TEDS9.0 update announced by the EPA, the TSP emission factor produced by cable excavation project is 0.256 kg/m^2•month (9.88×10^{-5} g/m^2/s). PM_{10} emission factor is

0.1422kg/m^2•month (5.49×10^{-5} g/m^2/s). $PM_{2.5}$ accounts for 0.111 of TSP, where $PM_{2.5}$ emission factor is 0.028kg/m^2•month(1.10×10^{-5}g/m^2/s)。

By using water sprinkling on exposed surfaces of the work area to control flying dust, the particulate pollutant emission index is lowered by 50 %. TSP is lowered by 50 %, which reduces the emission factor to 4.94×10^{-5} g/m^2/s. PM_{10} is lowered by 50 %, which reduces it to 2.74×10^{-5}g/m^2/. $PM_{2.5}$ is lowered by 50 %, where reduces it to 5.48×10^{-6} g/m^2/s.

B. Exposed surface area in construction zone

(A)New booster station construction project

The construction area for this project's booster substation is 23,800 sq. meters. The construction area was used for work area exposed surface estimates. As there are four scheduled construction areas located at Xianxi Industrial Park, Lukang Industrial Park (North and South) and Lunwei Industrial Park. In the future, one of these locations will be chosen to install the booster station. At this stage, these four scheduled locations for booster station installation will be evaluated.

(B)Land cable laying project

Land cable embedment will require excavation of roads, total length of the land cable will not exceed 8km. Assuming that during each construction, the land cable will advance by 200 meters with maximum excavation width of 5.8 meters, and the maximum exposed area of land will be 5.8m × 200m. Constructions like backfilling and tar laying will be done after excavation work is done.

2. Construction machinery air pollutant emissions

Please refer to the Environmental Protection Agency's AP-42 information, as described in Table 7.1.3-1, for emission factor of the operating equipment that may be involved during construction of the Project, and refer to the "Specification for Automotive Diesel Fuel" amended and released by Environmental Protection Agency's Circular No. 0980065735 on July 29, 2009 stipulates that as of July 1, 2011 the maximum standard sulfur content in gasoline component shall be 10 ppm (mg/kg) in order to revise SO_2 emission coefficient. The construction units mainly use diesel fuel. Referring to "Taiwan Emission Data System" (TEDS), the main TSP in the units' exhaust gas is PM_{10}, where PM_{10} is 100% of TSP. Besides that, $PM_{2.5}$ stands 92% of TSP. The emission factor of various pollutants is shown in 7.1.3-1.

Assuming that various construction equipment are operating simultaneously and concentrated at the exposed area of the construction sites during the construction period of the Project, the estimated air pollutant emission in each construction site is shown as follows:

A. New booster station construction project

The booster station project can be divided into grading work, architectural work, and electrical and mechanical work. There will be more machine used during grading work and the air pollutants emission will be more. The comprehensive evaluation for the impact on air quality is done at the grading work stage. The estimated air pollutant emission is shown in 7.1.3-2.

B. Land cable laying project

Land cable laying project is divided into earth work and pavement restoration work. In the case of not over-lapping the construction periods, the air pollutants discharge by the machines used during Earth excavation and backfilling work are much higher. Assuming that various construction equipment are operating simultaneously and concentrated at the construction sites where are the nearest to the booster station, the estimated air pollutant emission is shown in Table 7.1.3-2.

When combining the constructions at the booster station and land cable, the exposed surface fugitive dust emission and air pollutant emission from construction equipment is shown in Table 7.1.3-3.

Table 7.1.3-1 Air Pollution Index of Each Diesel Machinery

Machinery	Air Pollution Index (gram/hour/vehicles)				
	TSP	PM_{10}	$PM_{2.5}$	SOx	NOx
Excavator	184	184	169.3	4.77	1740.7
Bulldozer	75	75	69.0	3.59	575.8
Motor Grader	22.7	22.7	20.9	0.69	392.9
Shovel Loader	77.9	77.9	71.7	1.88	858.2
Dump Truck	77.9	77.9	71.7	0.38	858.2
Street Sprinkler	77.9	77.9	71.7	0.38	858.2
Crane	50.7	50.7	46.6	1.42	570.7
Concrete Mixer	61.5	61.5	56.6	0.19	575.8
Air Compressor	63.2	63.2	58.1	1.47	767.3
Miscellaneous	63.2	63.2	58.1	1.47	767.3

Remark：In accordance to the revision of the law No. 0980065735 regarding ‘The Regulation of Standard of Diesel Composition in Vehicles’ by Environmental Protection Agency (EPA) in 2009, the standard of diesel fuel use by vehicles will be tighten from 2011 onwards. This includes the correction of standard of sulphur composition to 10ppmw compared to the previous standard of 0.22% by U.S EPA AP-42 Emission Index 1985.

Table 7.1.3-2 Air Pollution Index by Land Machineries

Machineries	Max. no. of simultaneous operation	Emission Factor (g/h)				
		TSP	PM_{10}	$PM_{2.5}$	SOx	NOx
Booster Station Project						
Bulldozer	2	75	75.0	69.0	3.59	575.8
Dump Truck	7	77.9	77.9	71.7	0.38	859.2
Excavator	4	184	184.0	169.3	4.77	1740.7
Crawler Crane	2	50.7	50.7	46.6	1.42	570.7
Electronic Tower Crane	1	50.7	50.7	46.6	1.42	570.7
Concrete Mixer	3	61.5	61.5	56.6	0.19	575.8
Total Emission (g/s)		0.4911	0.4911	0.4518	0.0094	4.8802
Source Emission Rate(g/s/m^2)		2.06×10^{-5}	2.06×10^{-5}	1.90×10^{-5}	3.93×10^{-7}	2.05×10^{-4}
Land Cable Burying Project						
Pneumatic Rubber Tyred Roller	2	22.7	22.7	20.9	0.69	392.90
Dump Truck	4	77.9	77.9	71.7	0.38	859.19
Excavator	2	184	184.0	169.3	4.77	1740.74
Crane	2	50.7	50.7	46.6	1.42	570.70
Total Emission(g/s)		0.2296	0.2296	0.2112	0.0042	2.4571
Source Emission Rate(g/s/m^2)		1.98×10^{-4}	1.98×10^{-4}	1.82×10^{-4}	3.66×10^{-6}	2.12×10^{-3}

Table 7.1.3-3 Total Emission of Pollutant for Land Projects

Projects		Emission Rate (g/m^2/s)		
		TSP	PM_{10}	$PM_{2.5}$
Booster Station Project	Uncovered Construction Area	1.82×10^{-4}	1.01×10^{-4}	2.02×10^{-5}
	Machineries	2.06×10^{-5}	2.06×10^{-5}	1.90×10^{-5}
	Total	2.03×10^{-4}	1.22×10^{-4}	3.92×10^{-5}
Land Cable Burying Project	Uncovered Construction Area	4.94×10^{-5}	2.74×10^{-5}	5.48×10^{-6}
	Machineries	1.98×10^{-4}	1.98×10^{-4}	1.82×10^{-4}
	Total	2.47×10^{-4}	2.25×10^{-4}	1.88×10^{-4}

(II) Evaluation Model of Construction Area

The ISCST3 model preferred by the United States Environmental Protection Agency (EPA) has been chosen as the evaluation model for pollution index of the uncovered construction areas and the machineries. The metrological data is supported by 2015's Environmental Protection Agency ISC weather standard. The information sources are Wuqi Metrological Station and Banqiao District Radiosonde Station. The simulated mode control parameter is listed in Table 7.1.3-4 and the 7 projects included are: (1) Urban Rural Model Setting, (2) Coefficient of Vertical Wind Speed Section, (3) Smoke Plume Pattern Selection, (4) Vertical Temperature Gradient, (5) Chimney Downrush Effect Selection, (6) Buoyancy Dispersion Selection and (7) Static Wind Process. The usage of each project are listed in details as below.

Table 7.1.3-4 ISCST3 Mode Control Parameter

<table>
<tr><td rowspan="5">Area of Construction</td><td rowspan="5">1.Xianxi
2.North Lukang
3.South Lukang</td><td rowspan="2">Simulation Area (TWD97 Coordinate)</td><td>X Starting Point</td><td>181400</td><td>X Terminal Point</td><td>201400</td></tr>
<tr><td>Y Starting Point</td><td>2656500</td><td>Y Terminal Point</td><td>2676500</td></tr>
<tr><td rowspan="3">Loading points distribution</td><td colspan="4">Cartesian coordinate network : 41points× 41points</td></tr>
<tr><td colspan="4">Polar coordinate network:</td></tr>
<tr><td colspan="4">Discrete loading point: 2points</td></tr>
<tr><td colspan="2" rowspan="11">Control Parameters</td><td>Model</td><td colspan="2">■ Rural Model</td><td colspan="2">□ Urban Model</td></tr>
<tr><td>Vertical section parameter</td><td colspan="2">■ Uses model's internal value</td><td colspan="2">□ User define the value</td></tr>
<tr><td rowspan="2">Smoke plume pattern</td><td colspan="4">■ Uses the highest smoke plume height</td></tr>
<tr><td colspan="4">□ Uses the distance of wind below as the function of ascending plume</td></tr>
<tr><td>Vertical temperature gradient</td><td colspan="2">■ Uses model's setting</td><td colspan="2">□ Set by user</td></tr>
<tr><td>Correction of topography</td><td colspan="2">□ Used</td><td colspan="2">■ Not used</td></tr>
<tr><td>Chimney downrush</td><td colspan="2">□ Used</td><td colspan="2">■ Not used</td></tr>
<tr><td>Buoyancy dispersion</td><td colspan="2">■ Used</td><td colspan="2">□ Not used</td></tr>
<tr><td rowspan="2">Static wind process</td><td colspan="4">■ Use the model's internal static wind process</td></tr>
<tr><td colspan="4">□ Do not use the model's internal static wind process</td></tr>
</table>

1. Urban Rural Model Setting

According to the specification of simulation air quality model – appendix 1 Gaussian Diffusion Mode usage specification, the urban rural model setting will affect the selection model of diffusion coefficient. The simulated areas in this project included Changhua District Xianxi Town and Lukang Town. Both are specified under rural area and the rural model diffusion coefficient is being used.

2. Coefficient of Vertical Wind Speed Section

The coefficient of vertical wind speed section uses the model's internal value. There are 6 levels in it (A-F) and the index value for each of them are 0.15, 0.15, 0.2, 0.25, 0.3, 0.3 respectively.

3. Smoke Plume Pattern Setting

The current project uses the final height of the ascending plume as it is the ISCST3 model's internal value. The degree and concentration of pollutant is estimated by the final height of ascending plume by not considering the location of loading distribution point.

4. Vertical Temperature Gradient

The vertical temperature gradient uses the model's internal value, which consisted from 6 degree of stability (A-F). Each of those represents 0.0, 0.0, 0.0, 0.0, 0.02 and 0.035 respectively.

5. Chimney Downrush Effect

The model does not use the height of chimney to simulate the chimney downrush effect (Briggs, 1973).

6. Buoyancy Dispersion

The model of Buoyancy Induced Dispersion has been chosen for the project.

7. Static Wind Process

It uses the model's internal value of static wind process which has a wind speed of 1 meter per second.

(III) Ozone Limited Method

The increment of transition of NOx to NO_2 in this project is based on The Air Quality Support Centre's incremental limit simulation of Gaussian Diffusion Mode ISCST3 Usage Specification. The simulation result of nitrogen oxide is also based on the Ozone Limited Method (OLM), for the transition of nitrogen oxide to nitrogen dioxide. The ozone test value is tested with the data of 2015's Xianxi's air quality control station. The conversion formula is listed as below:

$[NO_2]$ concentration amendment = (0.1)×$[NO_X]$ simulated concentration value + X

X = {(0.9)×[NO_X] simulated concentration value, or (46/48)×[O_3] background concentration value. Take the smallest value among the two.

(IV)Air Quality Simulation Result

1. Project Simulation

(1) Xianxi Industrial Area

Under the model simulation of ISCST3 and the simultaneous projects progression, the simulation result of pollution of each project is listed in Table 7.1.3-5 and Diagram 7.1.3-1-2.

The daily maximum average increment of TSP is 62.75μg/m^3 and the annually maximum average increment of TSP is 10.64μg/m^3, whilst the rate of sensitive receptor in dispersion area, which is Xianxi Service Centre has a daily and annually maximum average increment of 0.09μg/m^3 and 0.94μg/m^3 respectively. The sum of sensitive receptor and concentration of background value exceeded the air quality standard, which is 379μg/m^3 in this project.

The daily maximum average increment of PM_{10} is 37.70μg/m^3 and the annually maximum average increment of PM_{10} is 6.39μg/m^3, whilst the rate of sensitive receptor in dispersion area, which is Xianxi Service Centre has a daily and annually maximum average increment of 0.61μg/m^3 and 0.06μg/m^3 respectively. The sum of sensitive receptor and concentration of background value exceeded the air quality standard, which is 157μg/m^3 in this project.

The daily maximum average increment of $PM_{2.5}$ is 12.13μg/m^3 and the annually maximum average increment of $PM_{2.5}$ is 2.06μg/m^3, whilst the rate of sensitive receptor in dispersion area, which is Xianxi Service Centre has a daily and annually maximum average increment of 0.21μg/m^3 and 0.03μg/m^3 respectively. The sum of sensitive receptor and concentration of background value exceeded the air quality standard, which is 48μg/m^3 in this project.

The hourly maximum average increment of SO_2 is 0.49ppb, the daily and annually maximum average increment is 0.03ppb and 0.01ppb respectively. The sensitive receptor of Xianxi Service Centre has an hourly maximum average increment of 0.02ppb, daily and annually maximum average increment of 0.00 (0.0012)ppb and 0.00 (0.0002)ppb respectively. The result after adding up with background concentration value matches the air quality standard.

The hourly and annually maximum average increment of NO_2 is 80.39ppb and 3.40ppb respectively while the sensitive receptor of Xianxi Service Centre has an hourly and annually maximum average increment of 12.60ppb and 0.12ppb respectively. The result after adding up with background concentration value matches the air quality standard.

(2) North Lukang Industrial Area

Under the model simulation of ISCST3 and the simultaneous projects progression, the simulation result of pollution of each project is listed in Table 7.1.3-6 and Diagram 7.1.3-3-4.

The daily and annually maximum average increment of TSP is 56.25μg/m^3 and 6.21μg/m^3 respectively, whilst the TSP rate of senstive receptor in dispersion area, which is Chang Bing Show Chwan Memorial Hospital has a daily and annually maximum average increment of 0.45μg/m^3 and 0.04μg/m^3 respectively. The sum of sensitive receptor and concentration of background value exceeded the air quality standard, which is 379μg/m^3 in this project.

The daily and annually maximum average increment of PM_{10} is 33.80μg/m^3 and 3.74μg/m^3 respectively, whilst the PM_{10} rate of senstive receptor in dispersion area, which is Chang Bing Show Chwan Memorial Hospital has a daily and annually maximum average increment of 0.29μg/m^3 and 0.02μg/m^3 respectively. The sum of sensitive receptor and concentration of background value exceeded the air quality standard, which is 157μg/m^3 in this project.

The daily and annually maximum average increment of $PM_{2.5}$ is 10.88μg/m^3 and 1.21μg/m^3 respectively, whilst the $PM_{2.5}$ rate of sensitive receptor in dispersion area, which is Chang Bing Show Chwan Memorial Hospital has a daily and annually maximum average increment of 0.11μg/m^3 and 0.01μg/m^3 respectively. The sum of sensitive receptor and concentration of background value exceeded the air quality standard, which is 48μg/m^3 in this project.

The hourly maximum average increment of SO_2 is 0.43ppb, the daily and annually maximum average increment is 0.04ppb and 0.01ppb respectively. The sensitive receptor of Chang Bing Show Chwan Memorial Hospital has an hourly maximum average increment of 0.01ppb, daily and annually maximum average increment of 0.00 (0.0006)ppb and 0.00 (0.0004)ppb respectively. The result after adding up with background concentration value matches the air quality standard.

The hourly and annually maximum average increment of NO_2 is 96.54ppb and 3.13ppb respectively while the sensitive receptor of Chang Bing Show Chwan Memorial Hospital has an hourly and annually maximum average increment of 8.32ppb and 0.03ppb respectively. The result after adding up with background concentration value matches the air quality standard.

(3) South Lukang Industrial Area

Under the model simulation of ISCST3 and the simultaneous projects progression, the simulation result of pollution of each project is listed in

Table 7.1.3-7 and Diagram 7.1.3-5-6.

The daily and annually maximum average increment of TSP is 48.99μg/m^3 and 10.43μg/m^3 respectively, whilst the TSP rate of senstive receptor in dispersion area, which is Chang Bing Show Chwan Memorial Hospital has a daily and annually maximum average increment of 0.82μg/m^3 and 0.08μg/m^3 respectively. The sum of sensitive receptor and concentration of background value exceeded the air quality standard, which is 379μg/m^3 in this project.

The daily and annually maximum average increment of PM_{10} is 29.44μg/m^3 and 6.27μg/m^3 respectively, whilst the PM_{10} rate of senstive receptor in dispersion area, which is Chang Bing Show Chwan Memorial Hospital has a daily and annually maximum average increment of 0.52μg/m^3 and 0.05μg/m^3 respectively. The sum of sensitive receptor and concentration of background value exceeded the air quality standard, which is 157μg/m^3 in this project.

The daily and annually maximum average increment of $PM_{2.5}$ is 9.47μg/m^3 and 2.02μg/m^3 respectively, whilst the $PM_{2.5}$ rate of sensitive receptor in dispersion area, which is Chang Bing Show Chwan Memorial Hospital has a daily and annually maximum average increment of 0.21μg/m^3 and 0.02μg/m^3 respectively. The sum of sensitive receptor and concentration of background value exceeded the air quality standard, which is 48μg/m^3 in this project.

The hourly maximum average increment of SO_2 is 0.47ppb, the daily and annually maximum average increment is 0.04ppb and 0.01ppb respectively. The sensitive receptor of Chang Bing Show Chwan Memorial Hospital has an hourly maximum average increment of 0.02ppb, daily and annually maximum average increment of 0.00 (0.0010)ppb and 0.00 (0.0001)ppb respectively. The result after adding up with background concentration value matches the air quality standard.

The hourly and annually maximum average increment of NO_2 is 76.65ppb and 3.45ppb respectively while the sensitive receptor of Chang Bing Show Chwan Memorial Hospital has an hourly and annually maximum average increment of 12.72ppb and 0.07ppb respectively. The result after adding up with background concentration value matches the air quality standard.

(4) Lunwei Industrial Area

Under the model simulation of ISCST3 and the simultaneous projects progression, the simulation result of pollution of each project is listed in Table 7.1.3-8 and Diagram 7.1.3-7-8.

The daily and annually maximum average increment of TSP is 42.96μg/m^3 and 4.52μg/m^3 respectively, whilst the TSP rate of senstive receptor in dispersion area, which is Chang Bing Show Chwan Memorial Hospital has a daily and annually maximum average increment of 1.20μg/m^3 and 0.11μg/m^3 respectively. The sum of sensitive receptor and concentration of background value exceeded the air quality standard, which is 379μg/m^3 in this project.

The daily and annually maximum average increment of PM_{10} is 25.82μg/m^3 and 2.76μg/m^3 respectively, whilst the PM_{10} rate of senstive receptor in dispersion area, which is Chang Bing Show Chwan Memorial Hospital has a daily and annually maximum average increment of 0.73μg/m^3 and 0.07μg/m^3 respectively. The sum of sensitive receptor and concentration of background value exceeded the air quality standard, which is 157μg/m^3 in this project.

The daily and annually maximum average increment of $PM_{2.5}$ is 8.53μg/m^3 and 0.96μg/m^3 respectively, whilst the $PM_{2.5}$ rate of sensitive receptor in dispersion area, which is Chang Bing Show Chwan Memorial Hospital has a daily and annually maximum average increment of 0.27μg/m^3 and 0.03μg/m^3 respectively. The sum of sensitive receptor and concentration of background value exceeded the air quality standard, which is 48μg/m^3 in this project.

The hourly maximum average increment of SO_2 is 0.44ppb, the daily and annually maximum average increment is 0.03ppb and 0.00 (0.0044)ppb respectively. The sensitive receptor of Chang Bing Show Chwan Memorial Hospital has an hourly maximum average increment of 0.01ppb, daily and annually maximum average increment of 0.00 (0.0013)ppb and 0.00 (0.0001)ppb respectively. The result after adding up with background concentration value matches the air quality standard.

The hourly and annually maximum average increment of NO_2 is 86.62ppb and 3.56ppb respectively while the sensitive receptor of Chang Bing Show Chwan Memorial Hospital has an hourly and annually maximum average increment of 12.44ppb and 0.09ppb respectively. The result after adding up with background concentration value matches the air quality standard.

Table 7.1.3-5 Air Pollutants Simulation Result in the Booster Station Construction Site of Xianxi Industrial Area

Air Pollutants	Location	Simulation Project	Max. Simulation Coordinate (TWD97 System)	Background Value (Remark)	Total	Air Quality Standard
TSP ($\mu g/m^3$)	Maximum Ground Concentration	24-hour Value	62.75 (191400,2671500)	379	441.75	250
		Annual Average	10.64 (191400,2671000)	—	—	130
	Xianxi Service Centre	24-hour Value	0.94	379	379.94	250
		Annual Average	0.09	—	—	130
PM_{10} ($\mu g/m^3$)	Maximum Ground Concentration	24-hour Value	37.70 (191400,2671500)	157	194.70	125
		Annual Average	6.39 (191400,2671000)	—	—	65
	Xianxi Service Centre	24-hour Value	0.61	157	157.61	125
		Annual Average	0.06	—	—	65
$PM_{2.5}$ ($\mu g/m^3$)	Maximum Ground Concentration	24-hour Value	12.13 (191400,2671500)	48	60.13	35
		Annual Average	2.06 (191400,2671000)	—	—	15
	Xianxi Service Centre	24-hour Value	0.21	48	48.21	35
		Annual Average	0.03	—	—	15
SO_2 (ppb)	Maximum Ground Concentration	Max Hourly Value	0.49 (191400,2671000)	15	15.49	250
		24-hour Value	0.03 (192400,2672000)	8	8.03	100
		Annual Average	0.01 (191400,2671000)	—	—	30
	Xianxi Service Centre	Max Hourly Value	0.02	15	15.02	250
		24-hour Value	0.00(0.0012)	8	8.00	100
		Annual Average	0.00(0.0002)	—	—	30
NO_2 (ppb)	Maximum Ground Concentration	Max Hourly Value	80.39 (191900,2671000)	21	101.39	250
		Annual Average	3.40 (192400,2671500)	—	—	50
	Xianxi Service Centre	Max Hourly Value	12.60	21	33.60	250
		Annual Average	0.12	—	—	50

Remark: The background concentration of the simulated environmental sensitive point is based on the value of temporary air quality monitoring station in the sensitive areas of the site (refer table 6.2.3-2-4 for details). The background concentration of the maximum landing position is based on the maximum value of the air quality monitoring station located near the site.

Table 7.1.3-6 Air Pollutants Simulation Result in the Booster Station Construction Site of North Lukang Industrial Area

Air Pollutants	Location	Simulation Projects	Max. Simulation Coordinate (TWD97 System)	Background Value (Remark)	Total	Air Quality Standard
TSP ($\mu g/m^3$)	Maximum Ground Concentration	24-hour Value	56.25 (187400,2664000)	379	435.25	250
		Annual Average	6.21 (187400,2663500)	—	—	130
	Chang Bing Show Chwan Memorial Hospital	24-hour Value	0.45	379	379.45	250
		Annual Average	0.04	—	—	130
PM_{10} ($\mu g/m^3$)	Maximum Ground Concentration	24-hour Value	33.80 (187400,2664000)	157	190.80	125
		Annual Average	3.74 (187400,2663500)	—	—	65
	Chang Bing Show Chwan Memorial Hospital	24-hour Value	0.29	157	157.29	125
		Annual Average	0.02	—	—	65
$PM_{2.5}$ ($\mu g/m^3$)	Maximum Ground Concentration	24-hour Value	10.88 (187400,2664000)	48	58.88	35
		Annual Average	1.21 (187400,2663500)	—	—	15
	Chang Bing Show Chwan Memorial Hospital	24-hour Value	0.11	48	48.11	35
		Annual Average	0.01	—	—	15
SO_2 (ppb)	Maximum Ground Concentration	Max Hourly Value	0.43 (186900,2664000)	15	15.43	250
		24-hour Value	0.04 (187400,2664000)	8	8.04	100
		Annual Average	0.01 (187900,2664000)	—	—	30
	Chang Bing Show Chwan Memorial Hospital	Max Hourly Value	0.01	15	15.01	250
		24-hour Value	0.00(0.0006)	8	8.00	100
		Annual Average	0.00(0.00004)	—	—	30
NO_2 (ppb)	Maximum Ground Concentration	Max Hourly Value	96.54 (187400,2664000)	21	117.54	250
		Annual Average	3.13 (187400,2663500)	—	—	50
	Chang Bing Show Chwan Memorial Hospital	Max Hourly Value	8.32	21	29.32	250
		Annual Average	0.03	—	—	50

Remark: The background concentration of the simulated environmental sensitive point is based on the value of temporary air quality monitoring station in the sensitive areas of the site (refer table 6.2.3-2-4 for details). The background concentration of the maximum landing position is based on the maximum value of the air quality monitoring station located near the site.

Table 7.1.3-7 Air Pollutants Simulation Result in the Booster Station Construction Site of South Lukang Industrial Area

Air Pollutants	Location	Simulation Projects	Max. Simulation Coordinate (TWD97 System)	Background Value (Remark)	Total	Air Quality Standard
TSP ($\mu g/m^3$)	Maximum Ground Concentration	24-hour Value	48.99 (186400,2662500)	379	427.99	250
		Annual Average	10.43 (185400,2661500)	—	—	130
	Chang Bing Show Chwan Memorial Hospital	24-hour Value	0.82	379	379.82	250
		Annual Average	0.08	—	—	130
PM_{10} ($\mu g/m^3$)	Maximum Ground Concentration	24-hour Value	29.44 (186400,2662500)	157	186.44	125
		Annual Average	6.27 (185400,2661500)	—	—	65
	Chang Bing Show Chwan Memorial Hospital	24-hour Value	0.52	157	157.52	125
		Annual Average	0.05	—	—	65
$PM_{2.5}$ ($\mu g/m^3$)	Maximum Ground Concentration	24-hour Value	9.47 (186400,2662500)	48	57.47	35
		Annual Average	2.02 (185400,2661500)	—	—	15
	Chang Bing Show Chwan Memorial Hospital	24-hour Value	0.21	48	48.21	35
		Annual Average	0.02	—	—	15
SO_2 (ppb)	Maximum Ground Concentration	Max Hourly Value	0.47 (186400,2662500)	15	15.47	250
		24-hour Value	0.04 (186400,2662500)	8	8.04	100
		Annual Average	0.01 (186400,2662500)	—	—	30
	Chang Bing Show Chwan Memorial Hospital	Max Hourly Value	0.02	15	15.02	250
		24-hour Value	0.00(0.0010)	8	8.00	100
		Annual Average	0.00(0.0001)	—	—	30
NO_2 (ppb)	Maximum Ground Concentration	Max Hourly Value	76.65 (186900,2662500)	21	97.65	250
		Annual Average	3.45 (186900,2662500)	—	—	50
	Chang Bing Show Chwan Memorial Hospital	Max Hourly Value	12.72	21	33.72	250
		Annual Average	0.07	—	—	50

Remark: The background concentration of the simulated environmental sensitive point is based on the value of temporary air quality monitoring station in the sensitive areas of the site (refer table 6.2.3-2-4 for details). The background concentration of the maximum landing position is based on the maximum value of the air quality monitoring station located near the site.

Table 7.1.3-8 Air Pollutants Simulation Result in the Booster Station Construction Site of Lunwei Industrial Area

Air Pollutants	Location	Simulation Projects	Max. Simulation Coordinate (TWD97 System)	Background Value (Remark)	Total	Air Quality Standard
TSP ($\mu g/m^3$)	Maximum Ground Concentration	24-hour Value	42.96 (190400,2669000)	379	421.96	250
		Annual Average	4.52 (190400,2669000)	—	—	130
	Xianxi Service Centre	24-hour Value	1.20	379	380.20	250
		Annual Average	0.11	—	—	130
PM_{10} ($\mu g/m^3$)	Maximum Ground Concentration	24-hour Value	25.82 (190400,2669000)	157	182.82	125
		Annual Average	2.76 (190400,2669000)	—	—	65
	Xianxi Service Centre	24-hour Value	0.73	157	157.73	125
		Annual Average	0.07	—	—	65
$PM_{2.5}$ ($\mu g/m^3$)	Maximum Ground Concentration	24-hour Value	8.53 (190400,2669000)	48	56.53	35
		Annual Average	0.96 (190400,2669000)	—	—	15
	Xianxi Service Centre	24-hour Value	0.27	48	48.27	35
		Annual Average	0.03	—	—	15
SO_2 (ppb)	Maximum Ground Concentration	Max Hourly Value	0.44 (190400,2668500)	15	15.44	250
		24-hour Value	0.03 (190400,2669000)	8	8.03	100
		Annual Average	0.00(0.0044) (190900,2668500)	—	—	30
	Xianxi Service Centre	Max Hourly Value	0.01	15	15.01	250
		24-hour Value	0.00(0.0013)	8	8.00	100
		Annual Average	0.00(0.0001)	—	—	30
NO_2 (ppb)	Maximum Ground Concentration	Max Hourly Value	86.62 (190900,2669000)	21	107.62	250
		Annual Average	3.56 (190900,2668500)	—	—	50
	Xianxi Service Centre	Max Hourly Value	12.44	21	33.44	250
		Annual Average	0.09	—	—	50

Remark: The background concentration of the simulated environmental sensitive point is based on the value of temporary air quality monitoring station in the sensitive areas of the site (refer table 6.2.3-2-4 for details). The background concentration of the maximum landing position is based on the maximum value of the air quality monitoring station located near the site.

Figure 7.1.3-1 Simulation Figure of Maximum 24-hour TSP Increment during the Construction of Booster Station in Xianxi Industrial Area

Figure 7.1.3-2 Simulation Figure of Maximum Annual TSP Increment during the Construction of Booster Station in Xianxi Industrial Area

Figure 7.1.3-3 Simulation Figure of Maximum 24-hour TSP Increment during the Construction of Booster Station in North Lukang Industrial Area

Figure 7.1.3-4 Simulation Figure of Maximum Annual TSP Increment during the Construction of Booster Station in North Lukang Industrial Area

Figure 7.1.3-5 Simulation Figure of Maximum 24-hour TSP Increment during the Construction of Booster Station in South Lukang Industrial Area

Figure 7.1.3-6 Simulation Figure of Maximum Annual TSP Increment during the Construction of Booster Station in South Lukang Industrial Area

Figure 7.1.3-7 Simulation Figure of Maximum 24-hour TSP Increment during the Construction of Booster Station in Northeast Lunwei Industrial Area

Figure 7.1.3-8 Simulation Figure of Maximum Annual TSP Increment during the Construction of Booster Station in Northeast Lunwei Industrial Area

2. A Merged Assessment with Other Developing Cases

The developer of the current project is also having three other projects in Northwest, Southeast and Southwest of Changhua Area. Future plans for construction and assembling of wind turbine foundation, cable layering and other facilities' construction has been planned and will be carried out soon. There will not be simultaneous construction of the same facilities at the same period of time. Due to the concern of construction period overlapping with the development of 2 Hailong and 3 Haiding offshore wind power plan projects, there will be an explanation follow up for the possibility of affected air quality merging assessment result.

Due to the excess reading in background concentration of TSP, PM_{10} and $PM_{2.5}$, the overall reading of maximum increment of sensitive receptors and background concentration exceeded the air quality standard. Whereas the overall reading of maximum increment of sensitive receptors and background concentration of SO_2 and NO_2 matches the air quality standard. The details are listed as below:

The projects on land are the booster station project and the land cable burying project. Due to 4 projects from Changhua, 2 projects from Hailong and 3 projects from Haiding with a total of 3 developers, they have coordinated the period for construction among themselves. Given the situation where 3 developers only has one construction going on simultaneously in each area, the senstive receptor points will be set up at Xianxi Service Centre, which is located near the construction area of the booster station project. The data acquired during the construction period will be collected and key into ISCST3 system for calculation and the data will be added up with the maximum reading of air quality data from other construction sites from other developers. Table 7.1.3-9 will show the accumulated pollution result of the merged assessment of each simulated project.

(1) Xianxi Industrial Area

While 3 construction sites were constructing simultaneously, TSP spread to sensitive receptor of Xianxi Service Centre acquired a maximum daily and annually average increment of 11.42 $\mu g/m^3$ and 1.12 $\mu g/m^3$ respectively. The background concentration of TSP is 379 $\mu g/m^3$, which exceeded the air quality standard and the overall reading of background concentration and sensitive receptor also exceeded the air quality standard.

While 3 construction sites were constructing simultaneously, PM_{10} spread to sensitive receptor of Xianxi Service Centre acquired a maximum daily and annually average increment of 6.94 $\mu g/m^3$ and 0.69 $\mu g/m^3$ respectively. The background concentration of PM_{10} is 157 $\mu g/m^3$, which exceeded the air quality standard and the overall reading of background concentration and sensitive receptor also exceeded the air quality standard.

While 3 construction sites were constructing simultaneously, $PM_{2.5}$ spread to sensitive receptor of Xianxi Service Centre acquired a maximum daily and annually average increment of 2.34 $\mu g/m^3$ and 0.24 $\mu g/m^3$ respectively. The background concentration of $PM_{2.5}$ is 48 $\mu g/m^3$, which exceeded the air quality standard and the overall reading of background concentration and sensitive receptor also exceeded the air quality standard.

While 3 construction sites were constructing simultaneously, SO_2 spread to sensitive receptor of Xianxi Service Centre acquired a maximum hourly, daily and annually average increment of 0.11ppb, 0.01ppb and 0.00(0.0010)ppb respectively. The overall reading of background concentration and sensitive receptor matches the air quality standard.

While 3 construction sites were constructing simultaneously, NO_2 spread to sensitive receptor of Xianxi Service Centre acquired a maximum hourly and annually average increment of 53.67ppb and 0.67ppb respectively. The overall reading of background concentration and sensitive receptor matches the air quality standard

(2) Lunwei Industrial Area

While 3 construction sites were constructing simultaneously, TSP spread to sensitive receptor of Xianxi Service Centre acquired a maximum daily and annually average increment of 5.07 $\mu g/m^3$ and 0.49 $\mu g/m^3$ respectively. The background concentration of TSP is 379 $\mu g/m^3$, which exceeded the air quality standard and the overall reading of background concentration and sensitive receptor also exceeded the air quality standard.

While 3 construction sites were constructing simultaneously, PM_{10} spread to sensitive receptor of Xianxi Service Centre acquired a maximum daily and annually average increment of 3.07 $\mu g/m^3$ and 0.30 $\mu g/m^3$ respectively. The background concentration of PM_{10} is 157 $\mu g/m^3$, which exceeded the air quality standard and the overall reading of background concentration and sensitive receptor also exceeded the air quality standard.

While 3 construction sites were constructing simultaneously, $PM_{2.5}$ spread to sensitive receptor of Xianxi Service Centre acquired a maximum daily and annually average increment of 1.02 $\mu g/m^3$ and 0.10 $\mu g/m^3$ respectively. The background concentration of $PM_{2.5}$ is 48 $\mu g/m^3$, which exceeded the air quality standard and the overall reading of background concentration and sensitive receptor also exceeded the air quality standard.

When 3 construction sites were constructing simultaneously, SO_2 spread to sensitive receptor of Xianxi Service Centre acquired a maximum hourly, daily and annually average increment of 0.05ppb, 0.00(0.0041)ppb and 0.00(0.0004)ppb respectively. The overall reading of background concentration and sensitive receptor matches the air quality standard.

When 3 construction sites were constructing simultaneously, NO_2 spread to sensitive receptor of Xianxi Service Centre acquired a maximum hourly and annually average increment of 31.12ppb and 0.29ppb respectively. The overall reading of background concentration and sensitive receptor matches the air quality standard.

Table 7.1.3-9 Air Pollutants Simulation Result of the Offshore Wind Power Plan Booster Station Construction Site of Changhua, Hailong and Haiding.

Area	Air Pollutants	Location	Simulated Projects	Simulated Max. Value	Background value	Total	Air Quality Standard
Xianxi Industrial Area	TSP (μg/m³)	Xianxi Service Centre	24-hour Value	11.42	379	390.42	250
			Annual Average	1.12	—	—	130
	PM_{10} (μg/m³)		24-hour Value	6.94	157	163.94	125
			Annual Average	0.69	—	—	65
	$PM_{2.5}$ (μg/m³)		24-hour Value	2.34	48	50.34	35
			Annual Average	0.24	—	—	15
	SO_2 (ppb)		Max. hour Value	0.11	15	15.11	250
			24-hour Value	0.01	8	8.01	100
			Annual Average	0.00(0.0010)	—	—	30
	NO_2 (ppb)		Max. hour Value	53.67	21	74.67	250
			Annual Average	0.67	—	—	50
Lunwei Industrial Area	TSP (μg/m³)	Xianxi Service Centre	24-hour Value	5.07	379	384.07	250
			Annual Average	0.49	—	—	130
	PM_{10} (μg/m³)		24-hour Value	3.07	157	160.07	125
			Annual Average	0.30	—	—	65
	$PM_{2.5}$ (μg/m³)		24-hour Value	1.02	48	49.02	35
			Annual Average	0.10	—	—	15
	SO_2 (ppb)		Max. hour Value	0.05	15	15.05	250
			24-hour Value	0.00(0.0041)	8	8.00	100
			Annual Average	0.00(0.0004)	—	—	30
	NO_2 (ppb)		Max. hour Value	31.12	21	52.12	250
			Annual Average	0.29	—	—	50

Remark: The background concentration of the simulated environmental sensitive point is based on the maximum value from the temporary air quality monitoring station in the sensitive areas of construction site of all 3 cases. The background concentration of the maximum landing position is based on the maximum value from the temporary air quality monitoring station set up near the construction site.

3. Simultaneous Constructions of the Land Facilities and Sea Operations

This current project is scheming the landing points and also its facilities which located at Chang Bing’s Lunwei Industrial Area in accordance to the common gallery of the radio company. The air quality simulation of both the land and sea projects will be assessed using the ISCST3 model simultaneously and the pollution dispersion result will be projected in table 7.1.3-10 with details as below:

While the land and sea constructions were constructing simultaneously, TSP acquired shows a daily and annually maximum average increment of 42.96 μg/m³ and 4.52 μg/m³ respectively. After the dispersion to sensitive receptor of Chang Bing Show Chwan Memorial Hospital, it has acquired a maximum daily and annually average increment of 1.16 μg/m³ and 0.22 μg/m³ respectively. Meanwhile, the dispersion to sensitive receptor of Xianxi Service Centre has acquired a maximum daily and annually average increment of 1.20 μg/m³ and 0.11 μg/m³ respectively. The background value of TSP is 379 μg/m³, which exceeded the air quality standard and the overall reading of background concentration and sensitive receptor also exceeded the air quality standard.

While the land and sea constructions were constructing simultaneously, PM_{10} acquired shows a daily and annually maximum average increment of 25.82 μg/m^3 and 2.76 μg/m^3 respectively. After the dispersion to sensitive receptor of Chang Bing Show Chwan Memorial Hospital, it has acquired a maximum daily and annually average increment of 0.72μg/m^3 and 0.14 μg/m^3 respectively. Meanwhile, the dispersion to sensitive receptor of Xianxi Service Centre has acquired a maximum daily and annually average increment of 0.73 μg/m^3 and 0.07 μg/m^3 respectively. The background value of PM_{10} is 157 μg/m^3, which exceeded the air quality standard and the overall reading of background concentration and sensitive receptor also exceeded the air quality standard.

While the land and sea constructions were constructing simultaneously, $PM_{2.5}$ acquired shows a daily and annually maximum average increment of 8.53 μg/m^3 and 0.96 μg/m^3 respectively. After the dispersion to sensitive receptor of Chang Bing Show Chwan Memorial Hospital, it has acquired a maximum daily and annually average increment of 0.26μg/m^3 and 0.05 μg/m^3 respectively. Meanwhile, the dispersion to sensitive receptor of Xianxi Service Centre has acquired a maximum daily and annually average increment of 0.27 μg/m^3 and 0.03 μg/m^3 respectively. The background value of PM_{10} is 48 μg/m^3, which exceeded the air quality standard and the overall reading of background concentration and sensitive receptor also exceeded the air quality standard.

When the land and sea constructions were constructing simultaneously, SO_2 acquired shows an hourly, daily and annually maximum average increment of 3.99ppb, 0.17ppb and 0.01ppb respectively. After the dispersion to sensitive receptor of Chang Bing Show Chwan Memorial Hospital, it has acquired a maximum hourly, daily and annually average increment of 3.65ppb, 0.15ppb and 0.01ppb respectively. Meanwhile, the dispersion to sensitive receptor of Xianxi Service Centre has acquired a maximum hourly, daily and annually average increment of 2.61ppb, 0.13ppb and 0.01ppb respectively. The overall reading of background concentration and sensitive receptor matches the air quality standard.

When the land and sea constructions were constructing simultaneously, NO_2 acquired shows an hourly maximum increment of 82.66ppb and annually maximum average increment of 3.56ppb. After the dispersion to sensitive receptor of Chang Bing Show Chwan Memorial Hospital, it has acquired an hourly maximum increment of 7.76ppb and annually maximum average increment of 0.16ppb. Meanwhile, the dispersion to sensitive receptor of Xianxi Service Centre has acquired an hourly maximum increment of 12.44ppb and annually maximum average increment of 0.09ppb. The overall reading of background concentration and sensitive receptor matches the air quality standard.

Table 7.1.3-10 Air Pollutants Simulation Result while Constructing Land and Sea Facilities

Air Pollutants	Location	Simulated Projects	Max. Simulation Coordinate (TWD97 System)	Background Value (Remark)	Total	Air Quality Standard
TSP ($\mu g/m^3$)	Maximum Ground Concentration (Land)	24-hour Value	42.96 (190400,2669000)	—	—	250
		Annual Average	4.52 (190400,2669000)	—	—	130
	Chang Bing Show Chwan Memorial Hospital	24-hour Value	1.16	379	380.16	250
		Annual Average	0.22	—	—	130
	Xianxi Service Centre	24-hour Value	1.20	379	380.20	250
		Annual Average	0.11	—	—	130
PM_{10} ($\mu g/m^3$)	Maximum Ground Concentration (Land)	24-hour Value	25.82 (190400,2669000)	—	—	125
		Annual Average	2.76 (190400,2669000)	—	—	65
	Chang Bing Show Chwan Memorial Hospital	24-hour Value	0.72	157	157.72	125
		Annual Average	0.14	—	—	65
	Xianxi Service Centre	24-hour Value	0.73	157	157.73	125
		Annual Average	0.07	—	—	65
$PM_{2.5}$ ($\mu g/m^3$)	Maximum Ground Concentration (Land)	24-hour Value	8.53 (190400,2669000)	—	—	35
		Annual Average	0.96 (190400,2669000)	—	—	15
	Chang Bing Show Chwan Memorial Hospital	24-hour Value	0.26	48	48.26	35
		Annual Average	0.05	—	—	15
	Xianxi Service Centre	24-hour Value	0.27	48	48.27	35
		Annual Average	0.03	—	—	15
SO_2 (ppb)	Maximum Ground Concentration (Land)v	Max. hour Value	3.99 (195300,2669200)	—	—	250
		24-hour Value	0.17 (195300,2669200)	—	—	100
		Annual Average	0.01 (190800,2665700)	—	—	30
	Chang Bing Show Chwan Memorial Hospital	Max. hour Value	3.65	15	18.65	250
		24-hour Value	0.15	8	8.15	100
		Annual Average	0.01	—	—	30
	Xianxi Service Centre	Max. hour Value	2.61	15	17.61	250
		24-hour Value	0.13	8	8.13	100
		Annual Average	0.01	—	—	30
NO_2 (ppb)	Maximum Ground Concentration (Land)	Max. hour Value	86.62 (190900,2669000)	—	—	250
		Annual Average	3.56 (190900,2668500)	—	—	50
	Chang Bing Show Chwan Memorial Hospital	Max. hour Value	7.76	21	28.76	250
		Annual Average	0.16	—	—	50
	Xianxi Service Centre	Max. hour Value	12.44	21	33.44	250
		Annual Average	0.09	—	—	50

Remark: The background concentration of the simulated environmental sensitive point is based on the value from temporary air quality monitoring station in the sensitive areas of the site (refer table 6.2.3-2-4 for details). The background concentration of the maximum landing position is based on the maximum value from the air quality monitoring station located near the site.

2. Emission of Waste Gas by Workboat during Offshore Sea Construction

(1) Emission Rate of Air Pollutants by Workboat during Offshore Sea Construction

The future possible effect towards the quality of air is mainly due to the air pollutants release by burning fuel from each kind of boat or vessel, such as workboats, vigilating boats, supporting boats, surveying boats and large vessels. Each and every location of vessel will be a single target point for air pollutants emission and the rate will be calculated based on it.

This project is using the simulation analysis of ISCST3 point model to analyse the effect of vessels towards the quality of air, with the data reference of U.S. EPA's 'Emissions Processing and Sensitivity Air Quality Modeling of Category 3 Commercial Marine Vessel Emissions'. The other large vessels' chimney has a specification as stated below:

- Height of Pipe Tunnel：20 meter
- Flow Velocity of Pipe Tunnel：25m/s
- Diameter of Pipe Tunnel：0.8 meter
- Temperature of Pipe Tunnel：282 °C

All the pipe tunnel of large vessels in this project will be evaluated conservatively, the rate will have a reference according to TEDS 9.0's parameter of 'Burning fuel of commercial vessels' (refer to table 7.1.3-10). All kind of boats and vessels will be evaluated by measuring the fuel consumption as well as the size of vessels. Conversion of the data will be made to measure the rate and coefficient of air pollutants towards the air (refer to table 7.1.3-12).

Table 7.1.3-11 Coefficient of Air Pollutants on Vessels' Operations

Emission Coefficient (Kg/Kl)				
TSP	PM_{10}	$PM_{2.5}$	SOx	NOx
1.78	1.78	1.48	17.00S	2.66

Remark: Composition of sulphur heavy oil in international commercial vessels are 2.7%.

Source of information: Taiwan Air Pollution Emission Rate [TEDS9.0] Plane source – Emission Rate Estimation Manual (Ver. 3rd Jan 2017)

(I) Sea Operations and Vessels

The Sea Operations of this project include the sea substation project, offshore cable project, wind turbine foundation project, assembling of wind turbine project and also the initial testing project. The amount and type of vessels needed in this operation is listed in table 7.1.3-13.

Given if all the projects are operating simultaneously at the nearby wind field at offshore, the maximum amount of vessels operating per day will be 31 vessels and the maximum fuel consumption per day will be around 406.5 metric ton, as stated in table 7.1.3-13.

Table 7.1.3-12 Emission Rate and Emission Coefficient of Air Pollutants by Vessels in Current Project

Type of Vessels	Fuel Consumption per vessel	Emission Coefficient per vessel (g/s)				
	(mt/day)	TSP	PM_{10}	$PM_{2.5}$	SO_X	NO_2
Crew transport ship	2.5	0.0172	0.0172	0.0142	0.4427	0.0257
Medium crew transport ship	4	0.0275	0.0275	0.0228	0.7083	0.041
Large crew transport ship	8	0.0549	0.0549	0.0456	1.4167	0.0821
Lift-off ship	35	0.2404	0.2404	0.1995	6.1979	0.3592
Towboat	5	0.0343	0.0343	0.0285	0.8854	0.0513
Turbine assembling boat	35	0.2404	0.2404	0.1995	6.1979	0.3592
Foundation workboat	25	0.1717	0.1717	0.1425	4.4271	0.2566
Surveying boat	15	0.103	0.103	0.0855	2.6563	0.1539
Cable workboat	25	0.1717	0.1717	0.1425	4.4271	0.2566
Large supporting boat	7	0.0481	0.0481	0.0399	1.2396	0.0718
Small supporting boat	2.5	0.0172	0.0172	0.0142	0.4427	0.0257
Electromechanical testing engineering boat	35	0.2404	0.2404	0.1995	6.1979	0.3592
Vigilating boat	2.5	0.0172	0.0172	0.0142	0.4427	0.0257

Remark: Table above is a reference of type, size and fuel consumption of vessels needed in the operation. It is subject to change according to the needs in actual operations.

Table 7.1.3-13 Type and Amount of Vessels Needed in Each Project of The Sea Operations

Projects	Type of Vessels	Fuel Consumption per vessel	Amount	Max. Fuel Consumption per day
		(mt/day)		(mt)
Sea Substation Project	Lift-off ship	35	1	35.0
	Electromechanical testing engineering boat	35	1	35.0
	Large supporting boat	7	1	7.0
	Vigilating boat	2.5	1	2.5
	Crew transport boat	2.5	2	5.0
Offshore Cable Project	Small supporting boat	2.5	2	5.0
	Cable workboat	25	6	150.0
	Crew transport boat	2.5	4	10.0
	Vigilating boat	2.5	2	5.0
	Medium crew transport ship	4	1	4.0
	Surveying boat	15	1	15.0
	Towboat	5	2	10.0
Wind Turbine Project	Foundation workboat	25	3	75.0
Assembling of Wind Turbine and Initial Testing Project	Turbine assembling Ship	35	1	35.0
	Large crew transport ship	8	1	8.0
	Crew transport ship	2.5	2	5.0
Total		—	31	406.5

(II) Evaluation Model of Air Pollution Emission in The Construction Site

The current project has chosen the recommended model by U.S. EPA, which is the ISCST3 model to evaluate the uncovered plane source and the emission rate of air pollution by construction used machineries. As for the metrological data, it uses the standard metrological file of the year 2015 by EPA support centre. The source of information are from Wuqi Metrological Station and Banqiao District Radiosonded Station. Simulation control parameter is listed in table 7.1.3-14.

Table 7.1.3-14 ISCST3 Model Control Parameter

Area of Constructions	Simulation Area (TWD97 Coordinate)	X Starting Point	95800	X Terminal Point	215800
		Y Starting Point	2611700	Y Terminal Point	2701700
	Loading Point Distribution	Cartesian Coordinate Network:241points×181points			
		Polar Coordinate Network:			
		Descrete Loading Point :2points			
Control Parameters	Urban Rural Model	■Rural		□Urban	
	Vertical section parameter	■Uses model’s internal value		□Set by user	
	Smoke Plume Pattern	■Uses the highest smoke plume height			
		□Uses the distance of wind below as the function of ascending plume			
	Vertical temperature gradient	■Uses model’s setting		□Set by user	
	Topography correction	□Used		■Not used	
	Chimney downrush	□Used		■Not used	
	Buoyancy dispersion	■Used		□Not used	
	Static Wind Process	■Use the model’s internal static wind process			
		□Do not use the model’s internal static wind process			

(III) Simulation Result of Single Sea Operation towards the Environmental Air Quality

Under the conservative simulation of ISCST3 model, the result of air pollutant dispersion simulation result with maximum amount of vessels working simulataneously is projected in table 7.1.3-15 and figure 7.1.3-9-15. The maximum ground concentration falls on the area around the construction site.

Under the wide dispersion of TSP to the sensitive receptor of Chang Bing Show Chwan Memorial Hospital, the maximum daily and annually average increment has a result of 0.01 $\mu g/m^3$ and 0.00(0.0009) $\mu g/m^3$ respectively. As for the wide dispersion to another sensitive receptor, which is Xianxi Service Centre, the result acquired shows a maximum daily and annually average increment of 0.01

μg/m^3 and 0.00(0.0009) μg/m^3 respectively. The background value of TSP in this project is 379 μg/m^3, which exceeded the air quality standard. The evaluation of background concentration and sensitive receptor also exceeded the air quality standard.

Under the wide dispersion of PM_{10} to the sensitive receptor of Chang Bing Show Chwan Memorial Hospital, the maximum daily and annually average increment has a result of 0.01 μg/m^3 and 0.00(0.0009) μg/m^3 respectively. As for the wide dispersion to another sensitive receptor, which is Xianxi Service Centre, the result acquired shows a maximum daily and annually average increment of 0.01 μg/m^3 and 0.00(0.0009) μg/m^3 respectively. The background value of TSP in this project is 157 μg/m^3, which exceeded the air quality standard. The evaluation of background concentration and sensitive receptor exceeded the air quality standard.

The maximum daily average increment of $PM_{2.5}$ is 0.01μg/m^3 after the remote diffusion to the sensitive receiver Chang Bing Show Chwan Memorial Hospital, with the maximum annual average increment of 0.00(0.0008)μg/m^3. The background value of $PM_{2.5}$ is 48μg/m^3, which exceeded the air quality standard. The addition of evaluated sensitive receptor and background concentration is higher than the air quality standard.

The maximum hourly average increment of SO_2 is 2.99ppb after the remote diffusion to the sensitive receiver Chang Bing Show Chwan Memorial Hospital, the daily average maximum increment is 0.14ppb, and the annual average increment is 0.01ppb; the maximum hourly average increment is 2.65ppb after the remote diffusion to the sensitive receiver Xianxi Service Center, the daily average maximum increment is 0.14ppb, and the annual average increment is 0.01ppb. After addition with background concertration, it meets the air quality standard.

The maximum hourly average increment of NO_2 is 0.24ppb after the remote diffusion to the sensitive receiver Chang Bing Show Chwan Memorial Hospital, the annual average maximum increment is 0.00(0.0007)ppb; the maximum hourly average increment is 0.21ppb after the remote diffusion to the sensitive receiver Xianxi Service Center, the annual average maximum increment is 0.00(0.0007)ppb, which meets the air quality standard when added to the background concentration.

Table 7.1.3-15 Simulation Results of Air Pollutants from Ships Operating at Sea

Air pollutants	Site	Simulation item	Maximum Simulated	Background value (Note)	Total	Air Quality Standard
TSP ($\mu g/m^3$)	Chang Bing Show Chwan Memorial Hospital	24-hour value	0.01	379	379.01	250
		Annual average	0.00(0.0009)	—	—	130
	Xianxi Service Center	24-hour value	0.01	379	379.01	250
		Annual average	0.00(0.0009)	—	—	130
PM_{10} ($\mu g/m^3$)	Chang Bing Show Chwan Memorial Hospital	24-hour value	0.01	157	157.01	125
		Annual average	0.00(0.0009)	—	—	65
	Xianxi Service Center	24-hour value	0.01	157	157.01	125
		Annual average	0.00(0.0009)	—	—	65
$PM_{2.5}$ ($\mu g/m^3$)	Chang Bing Show Chwan Memorial Hospital	24-hour value	0.01	48	48.01	35
		Annual average	0.00(0.0008)	—	—	15
	Xianxi Service Center	24-hour value	0.01	48	48.01	35
		Annual average	0.00(0.0008)	—	—	15
SO_2 (ppb)	Chang Bing Show Chwan Memorial Hospital	Max hourly value	2.99	15	17.99	250
		24-hour value	0.14	8	8.14	100
		Annual average	0.01	—	—	30
	Xianxi Service Center	Max hourly value	2.65	15	17.65	250
		24-hour value	0.14	8	8.14	100
		Annual average	0.01	—	—	30
NO_2 (ppb)	Chang Bing Show Chwan Memorial Hospital	Max hourly value	0.24	21	21.24	250
		Annual average	0.00(0.0007)	—	—	50
	Xianxi Service Center	Max hourly value	0.21	21	21.21	250
		Annual average	0.00(0.0007)	—	—	50

Note: The background concentration of the simulated environmental sensitive point is the maximum measured value (see Table 6.2.3-2-4 for details) from temporary air quality monitoring station set at the sensitive areas. The background concentration of maximum landing position is the maximum measured value from temporary air quality monitoring station set up near the site.

Figure 7.1.3-9 Simulation Diagram Of Maximum 24-Hr TSP Increment During Construction of Ships at Sea

Figure 7.1.3-10 Simulation Diagram Of Average Annual TSP Increment During Construction of Ships at Sea

Figure 7.1.3-11 Simulation Diagram of Maximum Hourly SO_2 Increment During Construction of Ships at Sea

Figure 7.1.3-12 Simulation Diagram of $SO_2$24 Hourly Value Increment During Construction of Ships at Sea

Figure 7.1.3-13 Simulation Diagram Of Average Annual SO_2 Increment During Construction of Ships at Sea

Figure 7.1.3-14 Simulation Diagram Of Maximum Hourly NO_2 Increment During Constructionof Ships at Sea

Figure 7.1.3-15 Simulation Diagram Of Average Annual NO_2 Increment During Construction of Ships at Sea

(IV) The Project assesses the simulation results of onshore facilities and offshore operations on ambient air quality simultaneously. The onshore project mainly consists of booster station projects and land cable embedding projects. The possible impact of sea construction behavior on the air is mainly caused by the air pollutants emitted by large vessels such as workboats, warning vessels, auxiliary vessels and measurement vessels. Xianxi Service Center is set as sensitive receptor site. The construction area is assumed to be the predetermined location of the lifting (lowering) pressure station nearest to the Xianxi Service Center. The air pollutants generated during the aforementioned construction are inputted into the ISCST3 model for calculation and superimposed with the maximum background value of air quality obtained from the current survey results of each development case. The pollution diffusion simulation results of the combined evaluation simulation projects are shown in table 7.1.3-16.

During the simultaneous construction of onshore facilities and sea operations of the project, the maximum daily average increment of TSP diffused to the sensitive receptor Chang Bing Show Chwan Memorial Hospital is 1.16μg/m^3, the maximum annual average increment is 0.22μg/m^3, the maximum daily average increment of TSP diffused to the sensitive receptor Xianxi Service Center is 1.20μg/m^3, the maximum annual average increment is 0.11μg/m^3. The background value of TSP is 379μg/m^3, which exceeded the air quality standard. The addition of evaluated sensitive receptor and background concentration is higher than the air quality standard.

During the simultaneous construction of onshore facilities and sea operations of the project, the PM_{10} maximum daily average increment in sensitive receptor Chang Bing Show Chwan Memorial Hospital is 0.72μg/m^3, the maximum annual average increment is 0.14μg/m^3, the PM_{10} maximum daily average increment for sensitive receptor Xianxi Service Center is 0.73μg/m^3, the maximum annual average increment is 0.07μg/m^3. The background value of PM_{10} is 157μg/m^3, which exceeded the air quality standard. The addition of evaluated sensitive receptor and background concentration is higher than the air quality standard.

During the simultaneous construction of onshore facilities and sea operations of the project, the $PM_{2.5}$ maximum daily average increment in sensitive receptor Chang Bing Show Chwan Memorial Hospital is 0.26μg/m^3, the maximum annual average increment is 0.05μg/m^3, c

During the simultaneous construction of onshore facilities and sea operations of the project, the maximum hourly increment of SO_2 diffused to the sensitive receptor Chang Bing Show Chwan Memorial Hospital is 2.99ppb, the maximum daily average increment is 0.14ppb, the maximum annual average increment is 0.01ppb, the maximum daily average increment diffused to the sensitive receiver Xianxi Service Center is 2.65ppb, the maximum daily average increment is 0.14ppb, and the maximum annual average increment is

0.01ppb. The addition of evaluated sensitive receiver and background concentration meets the air quality standard.

During the simultaneous construction of onshore facilities and sea operations of the project, the maximum hourly increment of NO_2 diffused to the sensitive receptor Chang Bing Show Chwan Memorial Hospital is 7.76ppb, the maximum annual average increment is 0.16ppb, the maximum hourly average increment diffused to the sensitive receptor Xianxi Service Center is 12.44ppb and the maximum annual average increment is 0.09ppb. The addition of evaluated sensitive receptor and background concentration meets the air quality standard.

Figure 7.1.3-16 Simulation Results Of Air Pollutants During Simultaneous Construction of Onshore Facilities and Offshore Operations of the Project

Air Pollutant	Site	Simulation Item	Maximum Analog	Background Value (Note)	Total	Air Quality Standard
TSP (μg/m^3)	Chang Bing Show Chwan Memorial Hospital	24-hour value	1.16	379	380.16	250
		Annual average	0.22	—	—	130
	Xianxi Service Center	24-hour value	1.20	379	380.20	250
		Annual average	0.11	—	—	130
PM_{10} (μg/m^3)	Chang Bing Show Chwan Memorial Hospital	24-hour value	0.72	157	157.72	125
		Annual average	0.14	—	—	65
	Xianxi Service Center	24-hour value	0.73	157	157.73	125
		Annual average	0.07	—	—	65
$PM_{2.5}$ (μg/m^3)	Chang Bing Show Chwan Memorial Hospital	24-hour value	0.26	48	48.26	35
		Annual average	0.05	—	—	15
	Xianxi Service Center	24-hour value	0.27	48	48.27	35
		Annual average	0.03	—	—	15
SO_2 (ppb)	Chang Bing Show Chwan Memorial Hospital	Max hourly value	2.99	15	17.99	250
		24-hour value	0.14	8	8.14	100
		Annual average	0.01	—	—	30
	Xianxi Service Center	Max hourly value	2.65	15	17.65	250
		24-hour value	0.14	8	8.14	100
		Annual average	0.01	—	—	30
NO_2 (ppb)	Chang Bing Show Chwan Memorial Hospital	Max hourly value	7.76	21	28.76	250
		Annual average	0.16	—	—	50
	Xianxi Service Center	Max hourly value	12.44	21	33.44	250
		Annual average	0.09	—	—	50

Note:The background concentration of the simulated environmental sensitive point is the maximum measured value from temporary air quality monitoring station set at the sensitive areas. The background concentration of maximum landing position is the maximum measured value from temporary air quality monitoring station set up near the site.

(V) The project and the adjacent development case simultaneously carried out onshore facilities and offshore construction

This case belongs to the same development group as the other three cases of Changhua (northwest, southeast and southwest), and it has been planned that the wind turbine foundation, assembly, cable embedding, land facilities and other projects will be constructed in sequence during the future construction period, and same projects will not be performed at the same time. In addition, this plan takes into account that the construction periods of two adjacent development projects, namely, the Hai Long Offshore Wind Farm Project (2 projects in total) and the Haiding Offshore Wind Power Generation Project (3 projects in total), may overlap with this plan. Explain the combined assessment results of possible air quality impacts.

The possible impact of sea construction behavior on the air is mainly caused by the air pollutants emitted by large vessels such as workboats, warning vessels, auxiliary vessels and measurement vessels. The onshore project mainly consists of booster station projects and land cable embedding projects. Considering that Changhua (four cases), Hailong (two cases) and Haiding (three cases) belong to three development groups, the project schedule of each case will be coordinated within each development group and the construction method will be adopted in accordance with the sequence. Each development group has only one construction area at the same time for each project, so under the most conservative circumstances, there will be three onshore construction areas and three offshore construction areas to carry out the construction of all projects at the same time.

This project chose Xianxi Service Center as the sensitive receiver site, inputted the air pollutants generated during the aforementioned construction into the ISCST3 model for calculation and superimposed with the maximum background value of air quality obtained from the current survey results of each development case. The pollution diffusion simulation results of the combined evaluation simulation projects are shown in table 7.1.3-17.

When the project and adjacent development project, as well as the onshore facilities and sea operations were under construction simultaneously, the maximum 24 hours TSP increment that diffused into Xianxi Service Center sensitive receiver is 5.07μg/m^3, and the maximum annual average increment is 0.49μg/m^3. The background value of TSP is 379μg/m^3, which exceeded the air quality standard. The addition of evaluated sensitive receptor and background concentration is higher than the air quality standard.

When the project and adjacent development project, as well as the onshore facilities and sea operations were under construction simultaneously, the PM_{10} maximum daily average increment for Xianxi Service Center sensitive receiver is 3.07μg/m^3, the maximum annual average increment is 0.30μg/m^3. The background value of PM_{10} is 157μg/m^3, which exceeded the air quality standard.

The addition of evaluated sensitive receptor and background concentration is higher than the air quality standard.

When the project and adjacent development project, as well as the onshore facilities and sea operations were under construction simultaneously, the $PM_{2.5}$ maximum daily average increment for Xianxi Service Center sensitive receiver is 1.027μg/m^3, the maximum annual average increment is 0.10μg/m^3. The background value of $PM_{2.5}$ is 487μg/m^3, which exceeded the air quality standard. The addition of evaluated sensitive receptor and background concentration is higher than the air quality standard.

When the project and adjacent development project, as well as the onshore facilities and offshore operations were under construction simultaneously, the 24 hours SO_2 increment that diffused into Xianxi Service Center sensitive receiver is 3.68ppb, 24 hours increment is 0.22ppb, and the maximum annual average increment is 0.02ppb. The addition of evaluated sensitive receiver and background concentration meets the air quality standard.

When the project and adjacent development project, as well as the onshore facilities and offshore operations were under construction simultaneously, the 24 hours NO_2 increment that diffused into Xianxi Service Center sensitive receiver is 31.12ppb and the maximum annual average increment is 0.302ppb. The addition of evaluated sensitive receiver and background concentration meets the air quality standard.

Figure 7.1.3-17 Simulation Results of Air Pollutants During Simultaneous Construction of Onshore Facilities and Offshore Operations of Project and Adjacent Development Projects

Air Pollutants	Site	Simulation Item	Maximum Analog	Background Value (Note)	Total	Air Quality Standard
TSP (μg/m^3)	Xianxi Service Center	24-hour value	5.07	379	384.07	250
		Annual average	0.49	—	—	130
PM_{10} (μg/m^3)		24-hour value	3.07	157	160.07	125
		Annual average	0.30	—	—	65
$PM_{2.5}$ (μg/m^3)		24-hour value	1.02	48	49.02	35
		Annual average	0.10	—	—	15
SO_2 (ppb)		Max hourly value	3.68	15	18.68	250
		24-hour value	0.22	8	8.22	100
		Annual average	0.02	—	—	30
NO_2 (ppb)		Max hourly value	31.12	21	52.12	250
		Annual average	0.30	—	—	50

Note: The background concentration of the simulated environmental sensitive point is the maximum measured value from temporary air quality monitoring station set at the sensitive areas. The background concentration of maximum landing position is the maximum measured value from temporary air quality monitoring station set up near the site.

(I) Earth Disposal Transport and Construction Vehicle Exhaust Emissions and Flying Dust from Travelling Vehicles

According to the regulations of Changhua Coastal Industrial Park, the Project needs to level or fill the earth in-situ within industrial park in lieu of transport out of the industrial park; the earthmoving vehicles will only run within industrial park. If the booster station is decided to be set in Xianxi Industrial Park, Changbin Road will be impacted; if the booster station is decided to be set in Lukang Industrial Park, Lukong Road will be impacted.

Since the Project needs to level or fill the earth in-situ within industrial park, the rest will be handled according to the regulations of the industrial zone and will not be transported out of the industrial park, thus the demand for earthmoving vehicles is relatively low. Assuming that the frequency of spoil transporting and construction vehicles entering and leaving the construction site is approximately 4 trip/hr (roundtrip), and assuming that the vehicles concentrated on the road along the cable embedment route as the worst-case scenarios, the estimated emissions of particulate matter and gaseous pollutants based on the emission factor of transporting lorry shown in Table 7.1.3-18 are as follows:

(II) Total suspended particle emissions (Q_{TSP})

$Q_{TSP} = (Q_1+Q_2)\times V$

Q1 is suspended particles in vehicle emissions. The emissions database established by the EPA (version TEDS9.0). The suspended particle emission factor for 2019 Changhua County (other county/city category) vehicles scheduled for project work was used as a basis. Assuming the vehicle speed is 40 km/hr, the total suspended particle emission factor for each vehicle is 0.7012 g/km.

Q2: The flying dust amounts of passing vehicles from other sources including vehicle surface dust content and road surface dust content. The TSP emission factor (2.503 g/VKT) for road vehicles driving in flying dust for vehicles travelling in city and township roads (paved roads) TEDS9.0 Table B2-1 Taiwan Area 2013 (base year) area source – fugitive particulate pollutant emission factor announced by the EPA.

VKT(Vehicle Kilometer Traveling)= Mileage per vehicle per unit (km).

V: Number of vehicles entering and exiting each day.

Figure 7.1.3-18 Air Pollutants Emission Factor Of Transporting Lorry Under Different Speed

Unit of Measurement：gram/km/vehicle

Speed (km/hour)	TSP	SOx	NOx	CO
15	0.7012	0.0046	12.3300	8.5700
20	0.7012	0.0044	11.1500	6.9300
25	0.7012	0.0043	10.2100	5.7100
30	0.7012	0.0041	9.4900	4.7800
40	0.7012	0.0039	8.5300	3.5400
50	0.7012	0.0037	8.1000	2.8100
60	0.7012	0.0036	8.1300	2.3900
70	0.7012	0.0036	8.6100	2.1900

Source of information：Extracted Vehicle Emission Factor in Changhua County (other cities and counties) from TEDS version 9.0 issued by Environmental Protection Administration, Executive Yuan. The targeted year of construction is year 2019.

(I) Exhaust Emission (Q′)

Q′＝Emission factor × number of trips per day

Assuming that the earthmoving vehicles entering and leaving the construction site at the rate of 4 trip/hr (roundtrip), by referring to the air pollutants emission factor in Table 7.1.3-18, and assuming the speed is 40 km/hr, then the various pollutant emission values that can be obtained are shown in Table 7.1.3-19.

Table 7.1.3-19 Air Pollutant Emission Of Transporting Lorry For Land Cable Embedment Engineering

Type of vehicle	Large trucks			
Transport frequency (trip/day)	4 (roundtrip)			
Pollutant emission factor (g/km/trip)	TSP	SO_X	NO_X	CO
	5.159	0.0039	8.5300	3.5400
Emissions from vehicle routes (g/km/s)	0.0071	0.00000867	0.01895556	0.00786667

Source of information：Estimation and aggregation by the Project.

(II) Assessment Model for Air Pollutants Emission from Transporte Vehicles

In the Project, "CALINE-4 Line Source Air Pollutant Dispersion Model" is used to simulate the air pollutant emission from transport vehicles. The input parameters are based on the worst-case meteorological conditions, and air pollutants increment in the area along the roadside ia simulated by assuming all the transport vehicles concentrated on the road along the booster substation and cable embedment route.

1. Wind Direction: Worst Case (same direction as cars).

2. Wind Speed: 1 meter per second (model minimum speed) is adopted.

3. Average Temperature: 23.0 °C (Wuqi Meteorological Station 2006~2015 Annual Average, see table 6.2.1-1 for details).
4. Stability: 6 (Turner's most stable level).
5. Mixing Height: 300 meters (assumed height of stable lower atmosphere).
6. Road Width: Changbin Road 40 meters wide, Lukong Road 35 meters wide, Anxi Road 20 meters wide.

(III) Simulation Results

Table 7.1.3-20 shows the simulation results of air pollutants increment in the area along the roadside when the construction vehicles run on Changbin Road. Within 50 meters of Changbin Road, the TSP increment is less than 5.16 μg/m^3, the PM_{10} increment is less than 2.84μg/m^3, the $PM_{2.5}$ increment is less than 1.421μg/ m^3, the SO_2 increment is less than 0.002 ppb, the NO_2 increment is less than 7.54 ppb, and the CO increment is less than 4.84 ppb.

Table 7.1.3-21 shows the simulation results of air pollutants increment in the area along the roadside when the construction vehicles run on Lukong Road. Within 50 meters of Lukong Road, the TSP increment is less than 5.58 μg/m^3, the PM_{10} increment is less than 3.07μg/m^3, the $PM_{2.5}$ increment is less than 1.531μg/ m^3, the SO_2 increment is less than 0.003 ppb, the NO_2 increment is less than 8.20 ppb, and the CO increment is less than 5.24 ppb.

Table 7.1.3-22 shows the simulation results of air pollutants increment in the area along the roadside when the construction vehicles run on Lukong Road. Within 50 meters of Anxi Road, the TSP increment is less than 7.08 μg/m^3, the PM_{10} increment is less than 3.89μg/m^3, the $PM_{2.5}$ increment is less than 1.951μg/ m^3, the SO_2 increment is less than 0.0034 ppb, the NO_2 increment is less than 10.94 ppb, and the CO increment is less than 6.64 ppb.

The background values of TSP, PM_{10} and $PM_{2.5}$ in this case are 379μg/m^3, 157μg/m^3 and 48μg/m^3, respectively, which have exceeded the air quality standard. The addition of evaluated sensitive receptor and background concentration is higher than the air quality standard.

In the initial stage of excavation, the TSP increment will be the largest due to the frequent transportation of earthwork. However, if control measures such as cleaning tires and sprinkler are taken, 50% of the granular pollutants can be reduced, and the excavation phase is short-term construction which will slightly affect the nearby air quality. Upon completion of the excavation phase, the impact of the excavated truck on the nearby air quality will be reduced.

Figure 7.1.3-20 Diffusion Concentration Of Air Pollutants From Transporting Lorry Running On Changbin Road During Construction Phase Of The Designated Xianxi Industrial Park's Own Booster Station

Distance (m)	Type of pollutant					
	TSP (μg/m^3)	PM_{10} (μg/m^3)	$PM_{2.5}$ (μg/m^3)	SO_2 (ppb)	NO_2 (ppb)	CO (ppb)
200	0.91	0.50	0.25	<0.001	1.28	0.84
110	1.36	0.75	0.37	<0.001	1.91	1.25
90	1.49	0.82	0.41	<0.001	2.09	1.38
70	1.69	0.93	0.46	<0.001	2.38	1.57
50	2.03	1.12	0.56	<0.001	2.85	1.89
40	2.54	1.40	0.70	0.001	3.57	2.37
30	3.34	1.84	0.92	0.002	4.69	3.12
20	4.58	2.52	1.26	0.002	6.44	4.30
10	4.70	2.59	1.29	0.002	7.25	4.42
0	4.54	2.50	1.25	0.002	7.54	4.28
-10	5.16	2.84	1.42	0.002	7.25	4.84
-20	4.58	2.52	1.26	0.002	6.44	4.30
-30	3.34	1.84	0.92	0.002	4.69	3.12
-40	2.54	1.40	0.70	0.001	3.57	2.37
-50	2.03	1.12	0.56	<0.001	2.85	1.89
-70	1.69	0.93	0.46	<0.001	2.38	1.57
-90	1.49	0.82	0.41	<0.001	2.09	1.38
-110	1.36	0.75	0.37	<0.001	1.91	1.25
-200	0.79	0.43	0.22	<0.001	1.28	0.73
Background air quality	379.00	157.00	48.00	15.00	21.00	900.00
Max increment	5.16	2.84	1.42	0.002	7.54	4.84
Max total	384.16	159.84	49.42	15.00	28.54	904.84
Air quality standard	250	125.00	35.00	250	250	35,000

Figure 7.1.3-21 Diffusion Concentration Of Air Pollutants From Transporting Lorry Running On Lukong Road During Construction Phase Of The Designated Lukang Industrial Park Booster Station

Distance (m)	Type of pollutant					
	TSP (μg/m^3)	PM_{10} (μg/m^3)	$PM_{2.5}$ (μg/m^3)	SO_2 (ppb)	NO_2 (ppb)	CO (ppb)
200	0.92	0.51	0.25	<0.001	1.30	0.85
110	1.38	0.76	0.38	<0.001	1.94	1.28
90	1.51	0.83	0.42	<0.001	2.12	1.39
70	1.72	0.95	0.47	<0.001	2.42	1.59
50	2.05	1.13	0.56	<0.001	2.88	1.91
40	2.55	1.40	0.70	0.001	3.58	2.37
30	3.29	1.81	0.90	0.002	4.63	3.07
20	4.70	2.59	1.29	0.002	6.60	4.41
10	5.12	2.82	1.41	0.003	7.85	4.81
0	4.99	2.74	1.37	0.003	8.20	4.70
-10	5.58	3.07	1.53	0.003	7.85	5.24
-20	4.70	2.59	1.29	0.002	6.60	4.41
-30	3.29	1.81	0.90	0.002	4.63	3.07
-40	2.55	1.40	0.70	0.001	3.58	2.37
-50	2.05	1.13	0.56	<0.001	2.88	1.91
-70	1.72	0.95	0.47	<0.001	2.42	1.59
-90	1.51	0.83	0.42	<0.001	2.12	1.39
-110	1.38	0.76	0.38	<0.001	1.94	1.28
-200	0.80	0.44	0.22	<0.001	1.30	0.74
Background air quality	379.00	157.00	48.00	15.00	21.00	900.00
Max increment	5.58	3.07	1.53	0.003	8.20	5.24
Max total	384.58	160.07	49.53	15.00	29.20	905.24
Air quality standard	250	125.00	35.00	250	250	35,000

Figure 7.1.3-22 Diffusion Concentration Of Air Pollutants From Transporting Lorry Running On Anxi Road During Construction Phase Of The Designated Lunwei Industrial Park Booster Station

Distance (m)	Type of pollutant					
	TSP ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	SO_2 (ppb)	NO_2 (ppb)	CO (ppb)
200	0.96	0.53	0.26	<0.001	1.34	0.88
110	1.42	0.78	0.39	<0.001	2.00	1.31
90	1.57	0.86	0.43	<0.001	2.21	1.45
70	1.77	0.97	0.49	<0.001	2.49	1.64
50	2.11	1.16	0.58	<0.001	2.97	1.96
40	2.60	1.43	0.72	0.001	3.65	2.41
30	3.26	1.79	0.90	0.002	4.58	3.02
20	4.40	2.42	1.21	0.002	6.18	4.10
10	6.63	3.65	1.82	0.003	9.95	6.23
0	6.91	3.80	1.90	0.004	10.94	6.51
-10	7.08	3.89	1.95	0.003	9.95	6.64
-20	4.40	2.42	1.21	0.002	6.18	4.10
-30	3.26	1.79	0.90	0.002	4.58	3.02
-40	2.60	1.43	0.72	0.001	3.65	2.41
-50	2.11	1.16	0.58	<0.001	2.97	1.96
-70	1.77	0.97	0.49	<0.001	2.49	1.64
-90	1.57	0.86	0.43	<0.001	2.21	1.45
-110	1.42	0.78	0.39	<0.001	2.00	1.31
-200	0.82	0.45	0.23	<0.001	1.34	0.76
Background air quality	379.00	157.00	48.00	15.00	21.00	900.00
Max increment	7.08	3.89	1.95	0.004	10.94	6.64
Max total	386.08	160.89	49.95	15.00	31.94	906.64
Air quality standard	250	125.00	35.00	250	250	35,000

7.1.4 Noise Vibration

I. Construction phase of onshore power transmission and distribution facilities

(i) Noise

This assessment and analysis were carried out by using the “SoundPLAN” noise modeling software developed by Braunstein + Berndt GMBH of Germany. The characteristics of this model are that different types of noise sources, such as point source, line source and non-point source can be considered simultaneously or separately. Besides estimating the noise level of individual sensitive points, it can also predict the iso-noise lines inside and outside the whole project area. After synthesizing the predicted volume with the background volume of each receptor, the level of impact can be determined according to the noise impact assessment flowchart recommended by the EPA (Fig 7.1.4-1). This assessment includes the noise sources of the separate construction of Greater Changhua Northeast Offshore Wind Field and simultaneous construction of Greater Changhua 4 Wind Field.

1. Noise Sources during Separate Construction of Greater Changhua Southeast Offshore Wind Field

The land based project in this project includes the booster substation and land cable laying project. The number, types and noise level of construction machinery are shown in Table 7.1.4-1. The construction noise during the construction phase of this project is about 66.6dB(A) for the boundary noise of the booster stations (designated location) in Xianxi Industrial Zone, and about 66.6dB(A) for the boundary noise of the booster stations on the north and south sides of the Lugang Industrial Zone, which all meet the daytime standard volume of 80dB(A) for noise control of Class IV construction projects. The noise of construction machines and tools predicts the combined volume of construction machines and tools at the same time in each construction stage. The distance between the designated location of the Xian booster station and the Changbin Industrial Zone Service Center is about 1,500 meters; the distance between the booster station (designated location) in the northern land area of Lugang Industrial Zone and land cable excavation site and Changbing Hospital is about 2,400 meters; the distance between the booster station (designated location) in the southern area of Lugang Industrial Zone and land cable excavation site and Changbing Hospital is about 3,600 meters, and the distance between the booster station (designated location) in the northeast land area of Lunwei Industrial Zone and land cable excavation site and the Changbin Industrial Zone Service Center is about 3,400 meters.

Model simulation results will input the noise generated by the construction surface during the construction into the SoundPLAN model for computation; after inputting relevant data such as the topography and noise sensitive receivers, the model will automatically calculate the results of its distance attenuation reflection, shading and volume composition. The analysis results of its average noise generated are shown in Table 7.1.4-2. The curve of equivalent noise is shown in Figure 7.1.4-2. The results are described as follows:

(1) Xianxi Industrial Park

The construction noise generated by the construction of booster substation (designated location) and land cable excavation project in the Xianxi Industrial Zone is estimated and simulated to be 26.2dB(A) after being attenuated to the Changbin Industrial Zone Service Center. The background volume of the Changbin Industrial Zone Service Center is assumed to be the same as that of the Changbin Road and Xiangong Road intersection. After being combined with the measured background volume of 66.3dB(A), the L-day predicted combined volume is 66.3dB(A), which can meet the Criteria of Environmental Sound Level Control Area IV of 75dB(A), and the noise increment is 0.0dB(A)(0~5). According to the noise impact level evaluation process, it is a no or negligible impact.

(2) Lukang Industrial Park

The volume of the booster substation (designated location) and the land cable excavation project in Lukang Industrial Zone (nothern side) is 26.2dB(A) after being attenuated to the Show Chwan Memorial Hospital. After being combined with the measured background volume of 55.9dB(A), the L-day predicted combined volume is 55.9dB(A), which can meet the Criteria of Environmental Sound Level Control Area II of 60dB(A), and the noise increment is 0.0dB(A)(0~5). According to the noise impact level evaluation process, it is a no or negligible impact.

The volume of the booster substation (designated location) and the land cable excavation project in Lukang Industrial Zone (southern side) is 35.0dB(A) after being attenuated to the Show Chwan Memorial Hospital. After being combined with the measured background volume of 55.9dB(A), the L-day predicted combined volume is 55.9dB(A), which can meet the Criteria of Environmental Sound Level Control Area II of 60dB(A), and the noise increment is 0.0dB(A)(0~5). According to the noise impact level evaluation process, it is a no or negligible impact.

(3) Lunwei Industrial Park (northeast side)

The volume of the booster substation (designated location) and the land cable excavation project in Lunwei Industrial Zone (northeast side) is 17.7dB(A) after being attenuated to the Changbin Industrial Zone Service Center. After being combined with the measured background volume of 66.3dB(A), the L-day predicted combined volume is

66.3dB(A), which can meet the Criteria of Environmental Sound Level Control Area II of 75dB(A), and the noise increment is 0.0dB(A)(0~5). According to the noise impact level evaluation process, it is a no or negligible impact.

The control standard of low-frequency noise in construction projects refers to the revision of the noise control standard issued by the Environmental Protection Department, Executive Yuan No. 1020065143 of the Environmental Protection of the People's Republic of China on August 5, 2013. The assessment of the construction of low-frequency noise volume is based on the seminar materials of the “Developing a Draft low-frequency noise control standard for factories (sites)” commissioned by the Environmental Protection Department and proposed by Ouyi Technology Co. Ltd. in November 2005. When the noise from outdoor construction enters the room, it decreases by 38.9%, while the low-frequency noise from indoor construction is about 84% of the total noise. The volume of Xianxi Industrial Zone is 26.2(A) after booster substation (designated location) and the ground cable excavation work diffused into Changbin Industrial Zone Service Center, and the indoor low-frequency noise (Leq,LF) is about 13.4dB(A), which can meet the requirements of class IV control standard daytime 40dB(A); the volume of Lugang Industrial Zone (northern side) is 26.2(A) after booster substation (designated location) and the ground cable excavation work diffused into Chang Bing Show Chwan Memorial Hospital, and the indoor low-frequency noise (Leq,LF) is about 13.4dB(A), which can meet the requirements of class II control standard daytime 37dB(A); the volume of Lugang Industrial Zone (southern side) is 35.0(A) after booster substation (designated location) and the ground cable excavation work diffused into Chang Bing Show Chwan Memorial Hospital, and the indoor low-frequency noise (Leq,LF) is about 17.9dB(A), which can meet the requirements of class II control standard daytime 37dB(A).

Figure 7.1.4-1 Noise Impact Assessment Procedures

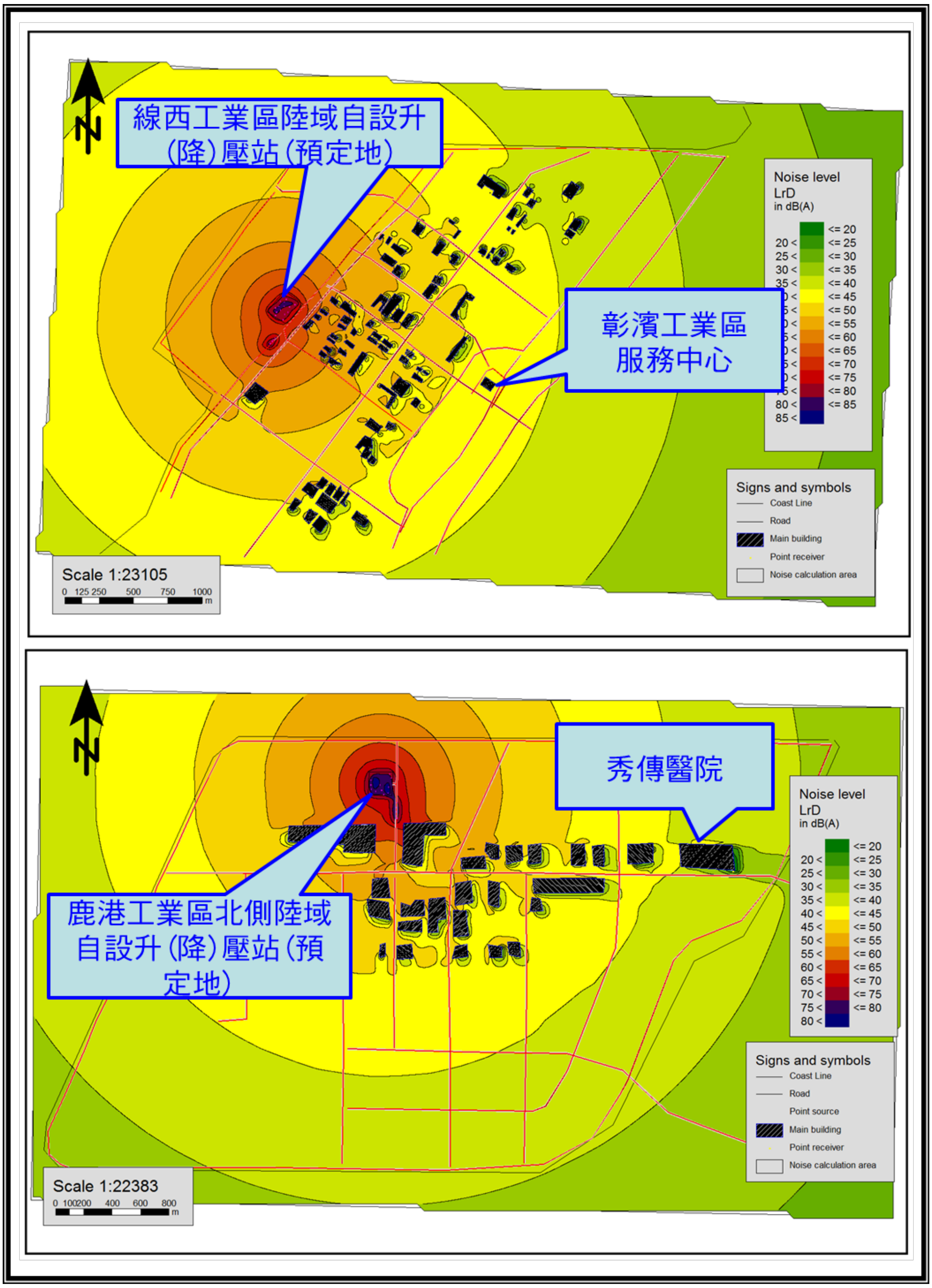


Figure 7.1.4-2 Simulation Diagram Of Noise Impact During Construction

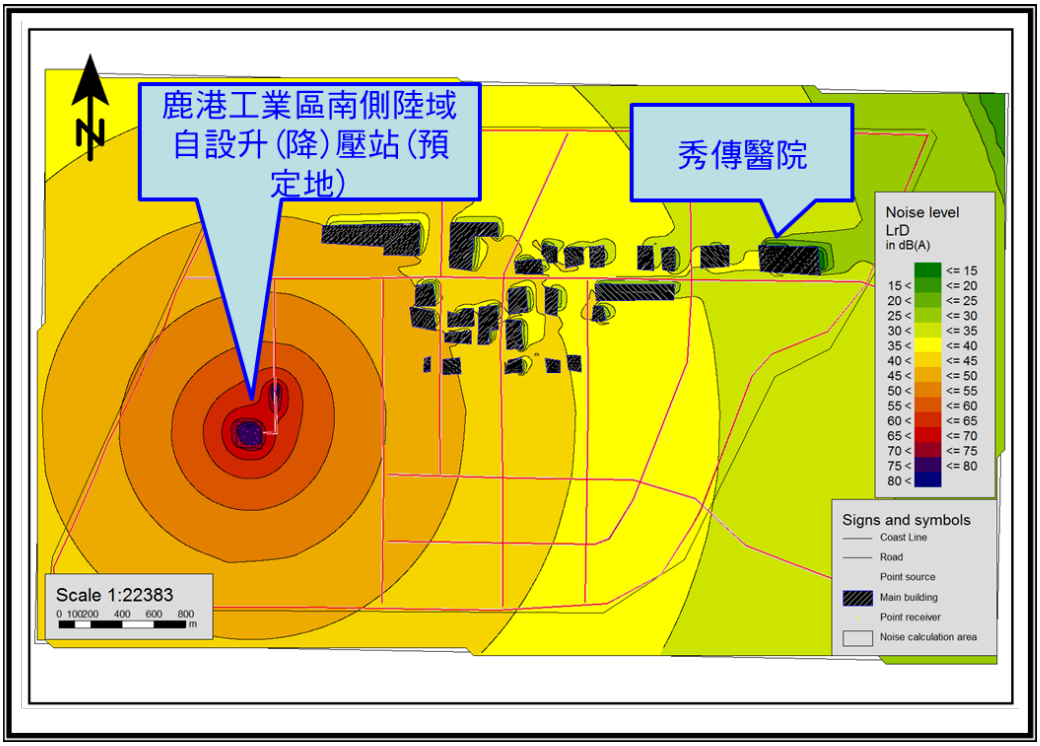


Figure 7.1.4-2 Simulation Diagram Of Noise Impact During Construction (continued)

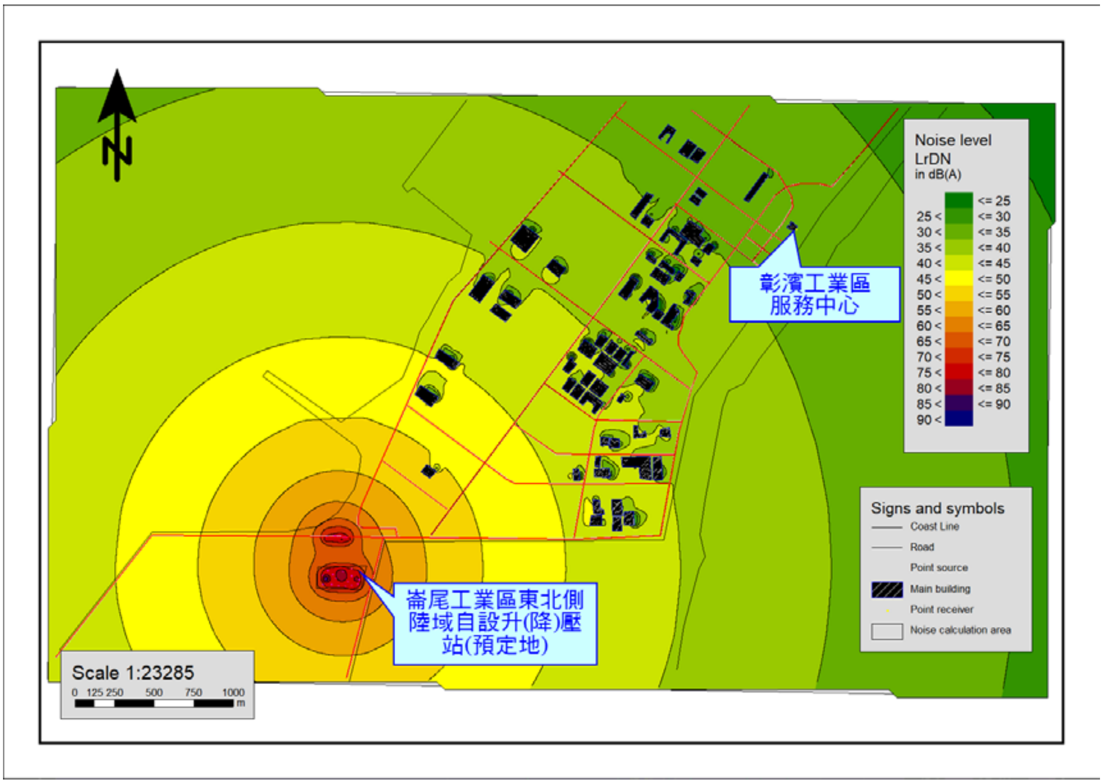
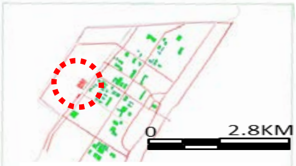


Figure 7.1.4-2 Simulation Diagram Of Noise Impact During Construction (continued 2)

Table 7.1.4-1 Noise Impact Assessment For Each Major Construction Phase Of The Construction Projects

【Schematic Diagram Of Major Construction Equipment Configuration】
booster station and land cable engineering



Xianxi Industrial Park booster station (designated site) and land cable engineering

Lukang Industrial Park (northern side) booster station (designated site) and land cable engineering

Lukang Industrial Park (southern side) booster station (designated site) and land cable engineering

Lunwei Industrial parl (northeast side) booster station (designated site) and land cable engineering

Project	Equipment name	Max.no. of simultaneous operations	Sound power level dB(A)	Sound source and perimeter *distance (meter)	Combined noise from equipment during simultaneous construction dB(A)	Combined noise during construction phase
Xianxi Industrial Park booster station (designated site)	bulldozer	2	110	150	57.7	66.6
	excavator	4	111	150	61.7	
	concrete mixer truck	3	108	150	57.5	
	crawler cranes	2	107	150	54.7	
	electric tower crane	1	95	150	39.7	
	dump truck	7	109	150	62.2	
Xianxi Industrial Park land cable construction	excavator	2	111	200	55.0	59.7
	crawler cranes	2	107	200	51.0	
	dump truck	4	109	200	56.0	
	road roller	2	106	200	50.0	
Lugang Industrial Park (northern side) booster station (designated site)	bulldozer	2	110	150	57.7	66.6
	excavator	4	111	150	61.7	
	concrete mixer truck	3	108	150	57.5	
	crawler cranes	2	107	150	54.7	
	electric tower crane	1	95	150	39.7	
	dump truck	7	109	150	62.2	
Lugang Industrial Park (northern side) land cable construction	excavator	2	111	200	55.0	59.7
	crawler cranes	2	107	200	51.0	
	dump truck	4	109	200	56.0	
	road roller	2	106	200	50.0	

Table 7.1.4-1 Noise Impact Assessment For Each Major Construction Phase Of The Construction Projects (continued)

Project	Equipment name	Max.no. of simultaneous operations	Sound power level dB(A)	Sound source and perimeter *distance (meter)	Combined noise from equipment during simultaneous construction dB(A)	Combined noise during construction phase
Lugang Industrial Park (northern side) booster station (designated site)	bulldozer	2	110	150	57.7	66.6
	excavator	4	111	150	61.7	
	concrete mixer truck	3	108	150	57.5	
	crawler cranes	2	107	150	54.7	
	electric tower crane	1	95	150	39.7	
	dump truck	7	109	150	62.2	
Lugang Industrial Park (northern side) land cable construction	excavator	2	111	200	55.0	59.7
	crawler cranes	2	107	200	51.0	
	dump truck	4	109	200	56.0	
	road roller	2	106	200	50.0	
Lunwei Industrial Park (northeast side) booster station (designated site)	bulldozer	2	110	150	57.7	66.6
	excavator	4	111	150	61.7	
	concrete mixer truck	3	108	150	57.5	
	crawler cranes	2	107	150	54.7	
	electric tower crane	1	95	150	39.7	
	dump truck	7	109	150	62.2	
Lunwei Industrial Park (northeast side) land cable construction	excavator	2	111	200	55.0	59.7
	crawler cranes	2	107	200	51.0	
	dump truck	4	109	200	56.0	
	road roller	2	106	200	50.0	

* Boundary: If there is a wall or physical divider, it is used as the boundary. If there is no physical dividers, the property boundary line or a line which is not often approached by the public is used as the boundary.

Table 7.1.4-2 Construction Project Noise Estimate Simulation Result Output Summary（L 日）

Unit: dB(A)

Item / Receiver Nama		Current environmental background noise	Background noise during construction[1]	Combined noise at each construction stage: booster substation and	Combined noise at each construction stage: land cable embedment engineering	Max construction noise during construction period	Combined noise during construction period [3]	Noise increment [4]	Noise control area category	Environmental sound volume criteria	Impact level [5]
Xianxi Industrial Park	Changhua Coastal Industrial Park Service Center[6]	66.3	66.3	24.1	21.8	26.2	66.3	0.0	Control Area IV standard	75	No impact or negligible impact
Lugang Industrial Park (northern side)	Chang Bing Show Chwan Memorial Hospital	55.9	55.9	20.1	24.9	26.2	55.9	0.0	Control Area II standard	60	No impact or negligible impact
Lugang Industrial Park (northern side)	Chang Bing Show Chwan Memorial Hospital	55.9	55.9	33.0	30.5	35.0	55.9	0.0	Control Area II standard	60	No impact or negligible impact
Lugang Industrial Park (northern side)	Changbin Industrial Park Service Center [6]	66.3	66.3	14.5	14.8	17.7	66.3	0.0	Control Area IV standard	75	No impact or negligible impact

Note[1]：This assessment work assumes 〝background noise without construction vehicles〞 and 〝current environment background noise〞 are the same

[2]：The estimated "maximum construction noise during construction" is combined with the construction noise of all work tools that may be operated simultaneously, i.e. the construction noise simulation analysis is carried out at the construction stage with the greatest impact.

[3]：combined noise including construction vehicles〞＝〝background noise without construction vehicles〞⊕〝construction vehicle traffic noise.〞.⊕ indicates addition based on sound calculation principles

[4]：Noise increment〞＝〝construction period combined noise〞－〝background noise without construction vehicles〞（when 〝combined noise including construction vehicles〞 meets 〝environmental sound volume criteria〞）.

[5]：See Fig 7.1.4-1 for level of impact assessment

[6]：Assuming background volume of Changbinl Industrial Park Service Center is the same as the Changbin Road and Xiangong Road intersection.

During the construction of booster substation (designated location) and land cable construction in Xianxi Industrial Zone, transport vehicles mainly use Xiangong North 4th Road to travel in the north-south direction. In addition to backfilling in situ, the remaining earthwork generated from land cable embedment project and the excavation of booster substation will need to be transported to the industrial zone for treatment. It is estimated that the frequency of earthmoving vehicles is about 4 vehicles per hour (two-way). According to the model simulation evaluation results (Table 7.1.4-3), the noise of construction vehicles decreases to 57.1 dB(A) on L day after reaching Changbin Road and Xiangong Road intersection. After combined with the measured background volume of 66.3 dB(A), the increment is 0.5

dB(A)(0~5) and can meet the road standard of 76 dB(A) of Control Area III or IV standard that is closely adjacent to 8-meter or larger roads, which according to the noise impact level assessment process, it is of no impact or negligible impact. The noise of construction vehicles is 45.9 dB(A) on the L-day after attenuation to the Changbin Industrial Zone Service Center. After being combined with the measured background volume of 66.3 dB(A), the predicted combined volume on the L-day is 66.3 dB(A), the noise increment is 0 dB(A) (0~5), and it can meet the requirements of 75 dB(A) of Control Area IV standard, which according to the noise impact level assessment process, it is of no impact or negligible impact. The noise of construction vehicles is 53.0dB(A) on the L-day after attenuation to the Changbin Road and Changbin Road intersection. After being combined with the measured background volume of 72.0 dB(A), the predicted combined volume on the L-day is 72.1dB(A), the noise increment is 0.1 dB(A) (0~5), and it can meet the requirements of 75 dB(A) of Control Area III or IV standard that is closely adjacent to 8-meter or larger roads, which according to the noise impact level assessment process, it is of no impact or negligible impact.

The noise of construction vehicles in Lukang Industrial Zone decreases to 49.8dB(A) on L-day after reaching Lukang Road and Lugong S. 7th Road intersection. After being combined with the measured background volume of 59.3 dB(A), the predicted combined volume on the L-day is 59.8dB(A), the noise increment is 0.5 dB(A) (0~5), and it can meet the requirements of 76 dB(A) of Control Area III or IV standard that is closely adjacent to 8-meter or larger roads, which according to the noise impact level assessment process, it is of no impact or negligible impact; the noise of construction vehicles is 51.0 dB(A) on the L-day after attenuation to Chang Bing Show Chwan Memorial Hospital. After being combined with the measured background volume of 55.9 dB(A), the predicted combined volume on the L-day is 57.1 dB(A), the noise increment is 1.2 dB(A) (0~5), and it can meet the requirements of 60 dB(A) of Control Area IV standard, which according to the noise impact level assessment process, it is of no impact or negligible impact.

The noise of construction vehicles in Lunwei Industrial Zone (northeast side) decreases to 55.1dB(A) on L-day after attenuation to Anxi Road. After being combined with the measured background volume of 62.8 dB(A), the predicted combined volume on the L-day is 63.5dB(A), the noise increment is 0.7 dB(A) (0~5), and it can meet the requirements of 67 dB(A) of Control Area III or IV standard that is closely adjacent to 8-meter or larger road, which according to the noise impact level assessment process, it is of no impact or negligible impact.

Table 7.1.4-3 Construction vehicle traffic noise simulation result output summary (L_{Day})

Unit: dB(A)

Item / Receiver	Current environment background noise	Background noise with no construction vehicles [1]	Construction vehicle traffic noise	Combined noise including construction vehicles [2]	Noise increment[3]	Noise control area category	Environment sound volume criteria	Level of impact[4]
Changbin Road and Xiangong Road intersection	66.3	66.3	57.1	66.8	0.5	8-meter or larger roads closely adjacent to Control Area III or IV	76	No or negligible impact
Changbin Road Idustrial Park Service Center [5]	66.3	66.3	45.9	66.3	0.0	Control Area IV standard	75	No or negligible impact
Changbin Access Road and Changbin Intersection	72.0	72.0	53.0	72.1	0.1	8-meter or larger roads closely adjacent to Control Area III or IV	76	No or negligible impact
Lukong Road and Lugong S. 7th Road intersection	59.3	59.3	49.8	59.8	0.5	8-meter or larger roads closely adjacent to Control Area III or IV	76	No or negligible impact
Chang Bing Show Chwan Memorial Hospital	55.9	55.9	51.0	57.1	1.2	Control Area II standard	60	No or negligible impact
Anxi Road	62.8	62.8	55.1	63.5	0.7	8-meter or larger roads closely adjacent to Control Area III or IV	76	No or negligible impact

Note: [1]：This assessment work assumes 〝background noise without construction vehicles〞 and 〝current environment background noise〞 are the same.

[2]：〝combined noise including construction vehicles〞＝〝background noise without construction vehicles〞⊕〝construction vehicle traffic noise.〞.⊕ indicates addition based on sound calculation principles.

[3]: 〝Noise increment〞＝〝construction period combined noise〞－〝background noise without construction vehicles〞（when 〝combined noise including construction vehicles〞 meets 〝environmental sound volume criteria〞）。

[4]: See Fig 7.1.4-1 for level of impact assessment.

[5]：Assuming background volume of Changhua Coastal Industrial Park Service Center is the same as the Changbin Road and Xiangong Road intersection.

2. Combined Assessment

The noise and vibration of the Project can meet the road standards within 8-meter or larger roads closely adjacent to Control Area III or IV after attenuation to each sensitive point and combination of measured background volume through combined assessment simulation. According to the noise impact level assessment process, the noise and vibration is of slight impact, no impact or negligible impact. The detailed evaluation process is as follows:

Considering that Changhua (four cases), Hailong (two cases) and Haiding (three cases) belong to three development groups, and their respective internal projects should have been coordinated, it is assumed that each development group has only one construction area at the same time for each project, i.e. there are three construction areas at the same time, it is assumed that the three construction areas are constructed at the same time, and seven sensitive receptor sites are considered, namely, Changbin Industrial Zone Service Center, Changbin West 2nd Road, Changbin East 3rd Road and Xiangong South 2nd Road Intersection, Changbin Road and Xiangong Road Intersection, Changbin Substation, Qingan Road and Qingan South 1st Road Intersection, Xiangong Road and Zhongua Road Intersection. The noise generated during the above-mentioned construction operations is input into the SoundPLAN mode for calculation. After inputting relevant data such as terrain and noise sensitive receptors, the mode automatically calculates the results of distance attenuation reflection, masking and volume synthesis, and superimposes the maximum background noise among the three cases. According to the noise impact assessment flow chart recommended by the Environmental Protection Department (Table 7.1.4-1), the degree of impact is determined. After analysis, the average noise production is shown in Table 7.1.4-4, and the iso-noise diagram is shown in Figure 7.1.4-3. The results are described as follows:

The construction noise of simultaneous construction in three work areas is estimated and simulated to be 46.1dB(A) after attenuation to the Changbin Industrial Zone Service Center. After being combined with the measured background volume of 51.2dB(A), the predicted combined volume on L-day is 52.4dB(A), it can meet the requirements of 76 dB(A) of Control Area III or IV standard that is closely adjacent to 8-meter or larger road, which according to the noise impact level assessment process, it is of no impact or negligible impact.

According to the evaluation simulation, it is known that the volume is 69.1dB(A) after attenuation to Changbin West 2nd Road, and after being combined with the measured background volume of 61.7dB(A), the predicted combined volume on L-day is 69.8dB(A), it can meet the requirements of 76 dB(A) of Control Area III or IV standard that is closely adjacent to 8-meter or larger road, which according to the noise impact level assessment process, it is of slight impact.

According to the evaluation simulation, it is known that the volume is 46.3dB(A) after attenuation to Changbin East 3rd Road and Xiangong South 2nd Road intersection, and after being combined with the measured background volume of 61.8dB(A), the predicted combined volume on L-day is 61.9dB(A), it can meet the requirements of 76 dB(A) of Control Area III or IV standard that is closely adjacent to 8-meter or larger road, which according to the noise impact level assessment process, it is of no impact or negligible impact.

According to the evaluation simulation, it is known that the volume is

50.2dB(A) after attenuation to Changbin Road and Xiangong Road intersection, and after being combined with the measured background volume of 66.3dB(A), the predicted combined volume on L-day is 66.4dB(A), it can meet the requirements of 76 dB(A) of Control Area III or IV standard that is closely adjacent to 8-meter or larger road, which according to the noise impact level assessment process, it is of no impact or negligible impact.

According to the evaluation simulation, it is known that the volume is 46.6dB(A) after attenuation to Changbin Substation, and after being combined with the measured background volume of 63.4dB(A), the predicted combined volume on L-day is 63.5dB(A), it can meet the requirements of 76 dB(A) of Control Area III or IV standard that is closely adjacent to 8-meter or larger road, which according to the noise impact level assessment process, it is of no impact or negligible impact.

According to the evaluation simulation, it is known that the volume is 46.6dB(A) after attenuation to Qingan Road and Qing'an South 1st Road intersection, and after being combined with the measured background volume of 61.1dB(A), the predicted combined volume on L-day is 61.2dB(A), it can meet the requirements of 76 dB(A) of Control Area III or IV standard that is closely adjacent to 8-meter or larger road, which according to the noise impact level assessment process, it is of no impact or negligible impact.

According to the evaluation simulation, it is known that the volume is 43.5dB(A) after attenuation to Xiangong Road and Zhonghua Road intersection, and after being combined with the measured background volume of 70.7dB(A), the predicted combined volume on L-day is 70.7dB(A), it can meet the requirements of 76 dB(A) of Control Area III or IV standard that is closely adjacent to 8-meter or larger road, which according to the noise impact level assessment process, it is of no impact or negligible impact.

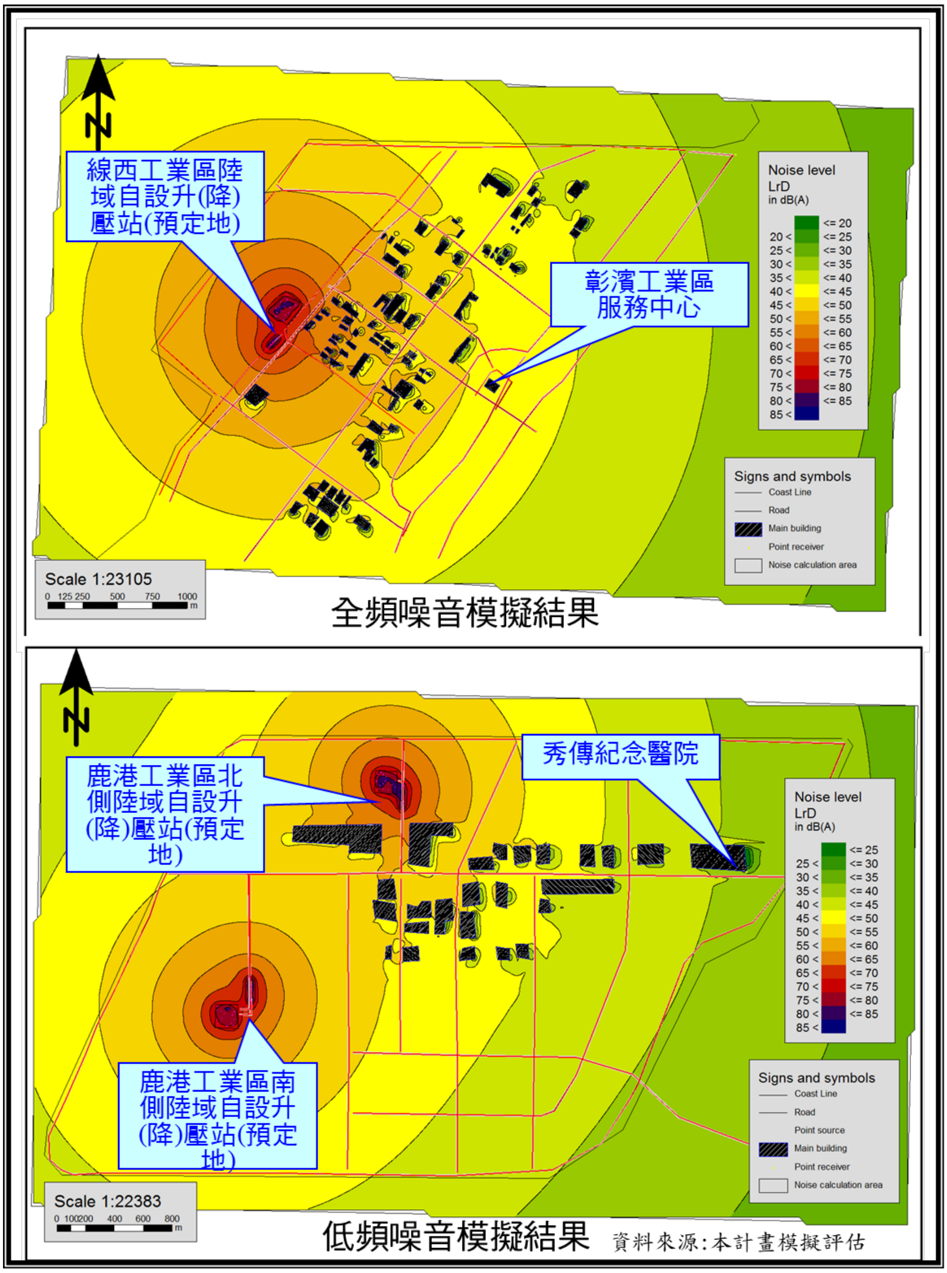


Figure 7.1.4-3 Simulation Diagram Of Noise Impact During Construction

Table 7.1.4-4 Summary Table of Output Results of Noise Assessment Simulation for Booster Substation and Land Cable Embedment Engeneering in Three Cases (Day L)

Unit：dB(A)

Item / Receiver Name	Current environmental background noise	Background noise during construction[1]	Max construction noise during construction period of booster substation and land cable embedment engineering	Combined noise during construction period [3]	Noise increment [4]	Noise control area category	Environmental sound volume criteria	Impact level [5]
Changbin Industrial Park Service Center	51.2	51.2	46.1	52.4	1.2	8-meter or larger roads closely adjacent to Control Area III or IV	76	No or negligible impact
Changbin West 2nd Road	61.7	61.7	69.1	69.8	8.1	8-meter or larger roads closely adjacent to Control Area III or IV	76	Low impact
Changbin East 3rd Road and Xiangong South 2nd Road Intersection	61.8	61.8	46.3	61.9	0.1	8-meter or larger roads closely adjacent to Control Area III or IV	76	No or negligible impact
Changbin Road and Xiangong Road intersection	66.3	66.3	50.2	66.4	0.1	8-meter or larger roads closely adjacent to Control Area III or IV	76	No or negligible impact
Changbin Substation	63.4	63.4	46.6	63.5	0.1	8-meter or larger roads closely adjacent to Control Area III or IV	76	No or negligible impact
Qiangan Road and Qiangan South 1st Intersection	61.1	61.1	43.2	61.2	0.1	8-meter or larger roads closely adjacent to Control Area III or IV	76	No or negligible impact
Xianggong Road and Zhonghua Intersection	70.7	70.7	43.5	70.7	0	8-meter or larger roads closely adjacent to Control Area III or IV	76	No or negligible impact

Note [1]：This assessment work assumes 〝background noise without construction vehicles〞 and 〝current environment background noise〞 are the same.

[2]：The estimated "maximum construction noise during construction" is combined with the construction noise of all work tools that may be operated simultaneously, i.e. the construction noise simulation analysis is carried out at the construction stage with the greatest impact.

[3]：〝combined noise including construction vehicles〞＝〝background noise without construction vehicles〞⊕〝construction vehicle traffic noise.〞.⊕ indicates addition based on sound calculation principles.

[4]：〝Noise increment〞＝〝construction period combined noise〞－〝background noise without construction vehicles〞（when 〝combined noise including construction vehicles〞 meets 〝environmental sound volume criteria〞）.

[5]：See Fig 7.1.4-1 for level of impact assessment.

(ii) Vibration

1. Assessment standard

Regarding the effect of vibration, the project performed an impact assessment analysis based on the EPA's Specifications for Environmental Vibration Assessment Models. For the impact of construction machinery vibration, estimates were made based on Attachment 5 Guidelines for the Use of Factory and Worksite Vibration Prediction Models. For the impact of road traffic vibration, estimates were calculated in accordance with Attachment 4 Guidelines for Use of Traffic Vibration Models from the Japan's Ministry of Construction.

The vibration produced by development activities have a different level of impact on nearby buildings and residential life. Serious vibrations can cause building cracks and interfere with physiological sleep as shown in Table 7.1.4-5. In the table, it can be seen that vibrations under 55dB are undetectable (the level which vibrations are detectable by the human body is 55dB). The vibration control standards in Japan's Enforcement Rules for Vibration Regulation Act (as shown in Table 7.1.4-6) serve as a supplementary comparison standard for the vibration impact assessments in this chapter.

Table 7.1.4-5 Analysis of the Effect of Vibration on Buildings and Daily Living Environment

Effect Assessment	(Japan Meteorological Agency)	(Ejima Atsushi – plate vibration countermeasure)	Japan (JIS)	
Vibration level	Earthquake level	Damage effect on buildings	Physiological effect	Effect on Sleep
Under 55dB	Level 0 - Undetectable	—	Frequent microgravity	—
55-65dB	Level Ⅰ – Slight tremor	No injuries—Weak vibrations	Start to feel vibrations	No effect on sleep
65-75dB	Level Ⅱ – Light tremor	No injuries —Moderate vibrations	—	Felt during light sleep
75-85dB	Level Ⅲ – Weak tremor	Plaster cracks — Heavy vibrations	Plant workers feel uncomfortable for 8 hours	Felt during moderate sleep
85-95dB	Level Ⅳ – Moderate tremor	Wall cracks— Powerful vibrations	Physiological effects start to appear on human body	Felt during deep sleep
95-105 dB	Level Ⅴ– Strong tremor	Structural damage— Extremely powerful vibration	Significant physiological effects	—
105-110	Level Ⅵ – Powerful tremor	—	—	—
Above 110dB	Level Ⅶ– Violent tremor	—	—	—

Table 7.1.4-6 Enforcement Standards for Japanese Vibration Regulation Act

Unit: dB

Area	Time period	
	Daytime	Nighttime
Type 1 area	65	60
Type 2 area	70	65

Note: 1. Translated from Japan Environmental Agency General Affairs Section Environmental Six Codes, 2001.
2. Type 1 area: Areas for residential use which need to be quiet.
Type 2 area: Areas for industrial use and areas which need to protect the living environment of all residents.
3. Daytime: 5:00 am (or 6:00 am, 7:00 am, 8:00 am)～ 7:00 pm (or 8:00 pm, 9:00 pm, 10:00 pm).
Nightime: 7:00 pm (or 8:00 pm, 9:00 pm, 10:00 pm)～ 5:00 am (or 6:00 am, 7:00 am, 8:00 am) on the following day

2. Vibration Impact during Construction Stage

The main sources of vibration in construction stage are construction machinery vibration and road traffic vibration. Construction machines with large vibration include excavators, pile driver, etc. Road traffic vibration is caused by construction trucks transporting heavy parts, sand and materials, etc. The following points are used to evaluate the maximum vibration impact of these two sources during construction.

(1) Vibration Effects of Construction Machinery

Groundborne Vibration is the main factor that causes vibration during construction, which includes piling, compaction, earthwork excavation, etc.

The vibration construction equipment of the Project is assessed the same way as the noise construction equipment; the following vibration assessment is based on this assessment. Vibration level of the construction equipment shall be determined according to “Guidelines for Highway Road Construction Environmental Management and Monitoring Techniques” (MOTC Taiwan Area National Expressway Engineering Bureau, 1992, as listed in Table 7.1.4-7), and estimate according to “User's Guide Of The Vibration Prediction Models For Factory And Workplaces” (Appendix V) of the “Project Planning for Addition or Revision to Technical Specifications for Noise and Vibration Assessment Models” published on January 9, 2003 by the Environmental Protection Administration, Executive Yuan, as shown in Table 7.1.4-8.

Table 7.1.4-7 Vibration Level Measured for Concrete Machinery

Name of Machinery	Vibration Level Measured at a Distance of 10m
Excavator	54～71 dB
Bulldozer	68～74 dB
Grader	63～67 dB
Road roller	62～71 dB
Vibration roller	65～71 dB
Pneumatic tired roller	62～66 dB
Reverse circulation boring machine	64～72 dB
Driller	53～61 dB
Dump truck	54～58 dB
Trailer	54～58 dB
Crane	53～57 dB
Concrete pump truck	55～60 dB
Concrete mixer	54～58 dB
Concrete vibrator	64～71 dB
Asphaltic concrete paver	53～57 dB
Blasting	97～101 dB
Air compressor	48～52 dB

Note: 1. Reference value: 10^{-5}m/sec^2
2. Source of data: Guidelines for Highway Road Construction Environmental Management and Monitoring Techniques, MOTC Taiwan Area National Expressway Engineering Bureau, 1992.

Table 7.1.4-8 Construction Machinery Vibration Level Estimates

Name of construction machinery		No.	L_0 (single)	L_0 (combined)	L_{v10} (combined) At distance of 50m
Booster station construction work	Bulldozer	2	74	77.0	0.0
	Excavator	4	71	77.0	0.0
	Concrete mixer	3	58	62.8	0.0
	Dump truck 11t	7	58	66.5	0.0
	Crawler crane	2	57	60.0	0.0
	Electric tower crane	1	57	57.0	0.0
Land cable underground construction	Excavator	2	71	74.0	0.0
	Crawler crane	2	57	60.0	0.0
	Dump truck	4	58	64.0	0.0
	Road roller	2	71	74.0	0.0
	Total			82.1	0.0

Note: For this estimate, n is 2, α is 0.02 and r_0 is 10 m. Vibration unit: dB

C. Mode description

$$L_{V10} = L_0 - 20\log(r/r_0)^n - 8.68\alpha(r - r_0)$$

L_{V10} ： Vibration level measured at a distance r(m) (Prognostic value)

L_0 ： Vibration level measured at a distance r_0 (m) (Fiducial level)

N ： The seismic wave on semi-infinite free surface n=2

r ： The distance of prognostic point from elevated central line

r_0 ：The distance of fiducial point from central line

α ：Internal attenuation of the site (clay : 0.01~0.02, sludge : 0.02~0.03）

D. Estimated outcome

This project has planned to place a booster station at west coastal and land cable construction spot at a distance of 1500m from Changhua Coastal Industrial Park Service Center; a booster station at the north coastal of Lu Kang area and land cable construction spot at a distance of 2400m from Show Chwan Memorial Hospital; a booster station at the south coastal of Lukang area and land cable construction spot at a distance of 3600m from Show Chwan Memorial Hospital; a booster station at the north east coastal of Lunwei area and land cable construction spot at a distance of 3400m from the service center. Table 7.1.4-8 has shown the combined vibration level of all construction machinery within 1500m from the nearest spot construction site, Changhua Coastal Industrial Park Service Center, had reduced to 0dB. Hence, the booster station at the north south of Lukang area and land cable construction spot which are even further from the hospital, the combined vibration level has reduced to 0dB as well. It has no impact on humans sensation towards vibration (Vibration sensation of human body is at 55dB). It has no impact on sensitivity spot under normal circumstances.

(2) Impact of road traffic vibration

Due to the diversity of transmission medium, it is difficult to apply a widely used analytical formulas to predict the vibration that caused by trucks when transporting. Therefore, estimates were calculated in accordance with Attachment 4 Guidelines for Use of Traffic Vibration Models from the Japan’s Ministry of Construction. The results are shown in Table 7.1.4-9.

A. Mode description

The vibration unit of estimated fiducial point is L_{V10}（dB）

$$L_{V10} = 65\log(\log Q^*) + 6\log V + 4\log M + 35 + \alpha_\sigma + \alpha_f$$

L_{V10}：The upper value of 80% of the vibration level (Prognostic value) (dB)

Q^*：The equivalent traffic volume of each car lane in 500 seconds (vehicle/ 500seconds/ car lane), calculated by formula below:

$$Q^* = \frac{500}{3600} \cdot \frac{1}{M} \cdot \left(Q_1 + 12Q_2\right)$$

Q_1：Hourly traffic volume of light vehicle (vehicles/ hr)

Q_2：Hourly traffic volume of heavy vehicle (vehicles/ hr)

M：Total number of two-way lane

V：Average running speed (km/hr)

α_σ：Correction value based on the road flatness（dB）

α_σ= 14logσ：asphalt road，σ≧1mm

18logσ：concrete road，σ≧1mm

0：σ≦1mm

Hereby, σ：is the standard deviation value for uneven road using 3m profile meter (mm).

α_f：Correction value based on good ground vibration frequency (dB)

α_f = -20logf ：f≧8

-18 ：8＞f≧4

-24+10logf：4<f

f：Good ground vibration frequency (Hz)

B. Estimated Outcome

The average vehicle traffic of this project is around 4 times (two-way) per hour. After the assessment, the maximum vibration increment of transport vehicle vibration during construction period and environmental vibration is 0.0dB, the maximum combined vibration level is 0.0dB. This is conformed with the standard of Japanese Vibration Regulation Act (70dB). Hence, the impact of the transportation is estimated to be extremely low.

Table 7.1.4-9 Construction Transport Vehicle Vibration Simulation Result Output Summary

Unit: dB

Item / Receiver name	Current Environmental Vibration	Background Vibration during Construction Period[1]	average distance from the receptor (m)	Transport Vehicle Vibration during Construction Period	Transport Vehicle Combined Vibration during Construction Period[2]	Vibration Increment[3]	Environmental Vibration Standard[4]
Changhua Coastal Industrial Park Service Center[5]	41.4	41.4	1400	0.0	41.4	0.0	70
Changbin Show Chwan Memorial Hospital	41.7	41.7	3000	0.0	41.7	0.0	70
Chang'an West Road	29.6	29.6	3400	0.0	29.6	0.0	70

Note: 1. The background vibration during the construction period is assumed to be the same as the current environmental vibration.

2. "transport vehicle combined vibration during the construction period"="background vibration during the construction period" ⊕ "transport vehicle vibration during the construction period" 。 ⊕ indicates addition based on vibration calculation principles.

3. "vibration increment"="transport vehicle combined vibration during the construction period"–"background vibration during the construction period"

4. For environmental vibration standards, see Enforcement Standards for Japanese Vibration Regulation Act.

5. Assuming background volume of Changhua Coastal Industrial Park Service Center is the same as the Changbin Road and Xiangong Road intersection.

I. Operation Stage

(i) Source of noise

The noise during the operation period of the wind turbine is mainly due to the spinning of the fan. Environmental Protection Administration has announced revision to the Noise Control Standards on August 5, 2013. It has included noise control standards for wind turbines on full-frequency and low-frequency. The simulation test has been done focusing on that aspect.

(ii) Noise spectral density

This simulation will be carried out with maximum number of wind turbines. 8W wind turbine with a 132m wheel hub is selected for this simulation. The measured value of each frequency at wind speed of 10m/s (relatively more appropriate for the Project site) according to IEC 61400-11 measurement standards.

(iii) Evaluation method

In order to know the possible impact from wind turbine's running noise, the Project will input the measured full-frequency and low-frequency volume into the SoundPLAN model as the point source; will input measured value of each frequency at wind speed of 10m/s (relatively more appropriate for the Project site) according to IEC 61400-11 measurement standards into the SoundPLAN model as the point source; altitude of the sound source will be 132m; the SoundPLAN simulation will be carried out with maximum number of 76 wind turbines, and perform analog calculation for the single point of outdoor noise as shown in Table 7.1.4-10, Table 7.1.4-11. The results from Grid map analog calculation for outdoor noise are shown in Figure 7.1.4-4.

(iv) Simulation Test Result

1. Noise source of South East Wind Farm of Greater Changhua (independent operation)

(1) Wind turbine operation in Full Frequency Noise (20 Hz - 20 kHz)

The measured value of each frequency at wind speed of 10m/s (relatively more appropriate for the Project site) according to IEC 61400-11 measurement standards will be inputted into the SoundPLAN model as the point source; altitude of the sound source will be 132m. The results of analog calculation are shown in Table 7.1.4-11 and Figure 7.1.4-4. It has discovered that the full frequency noise from the operation of all wind turbines has reduced to nearly the same as the receptor. The noise of a receptor is 0.0dB(A). Noise increment from different period of time are 0.0dB(A) as well. The level of impact of full frequency noise of this operation operation is no impact or negligible impact.

(2) Wind turbine operation in Low Frequency Noise (20 Hz - 200 Hz)

The measured value of each frequency at wind speed of 10m/s (relatively more appropriate for the Project site) according to IEC 61400-11 measurement standards will be inputted into the SoundPLAN model as the point source; altitude of the sound source will be 132m. The results of analog calculation are shown in Table 7.1.4-11 and Figure 7.1.4-4. It has discovered that the Low Frequency Noise from the operation of all wind turbines has reduced to nearly the same as the receptor. The noise of a receptor is 0.0dB(A). Noise increment from different period of time are 0.0dB(A) as well. The level of impact of full frequency noise of this operation is no impact or negligible impact.

Table 7.1.4-10 Simulation Test Result on Full Frequency Noise of South East Wind Farm of Greater Changhua during Independent Operation

Unit: dB(A)

Item / Name of receiver	Time	Current environment background full frequency noise	Background full frequency noise without wind turbine operation	Wind turbine operation full frequency noise	Combined noise including wind turbine operation	Noise increment	Noise control area category	Noise control standard	Level of impact
Changhua Coastal Industrial Park Service Center	day	66.3	66.3	0.0	66.3	0.0	Control Area IV standards	75	No impact or negligible impact
	evening	57.3	57.3	0.0	57.3	0.0	Control Area IV standards	70	No impact or negligible impact
	night	53.7	53.7	0.0	53.7	0.0	Control Area IV standards	65	No impact or negligible impact
Chang Bing Show Chwan Memorial Hospital	day	55.9	55.9	0.0	55.9	0.0	Control Area II standards	60	No impact or negligible impact
	evening	54.2	54.2	0.0	54.2	0.0	Control Area II standards	55	No impact or negligible impact
	night	51.0	51.0	0.0	51.0	0.0	Control Area II standards	50	No impact or negligible impact
Municipal Haibu Elementary School	day	69.8	69.8	0.0	69.8	0.0	Control Area II standards	60	No impact or negligible impact
	evening	66.7	66.7	0.0	66.7	0.0	Control Area II standards	55	No impact or negligible impact
	night	61.3	61.3	0.0	61.3	0.0	Control Area II standards	50	No impact or negligible impact

Table 7.1.4-11 Simulation Test Result on Low Frequency Noise of South East Wind Farm of Greater Changhua during Independent Operation

Unit: dB(A)

Item / Name of receiver	Time	Current environment background low frequency noise	Background low frequency noise without wind turbine operation	Wind turbine operation low frequency noise	Combined noise including wind turbine operation	Noise increment	Noise control area category	Noise control standard	Level of impact
Changhua Coastal Industrial Park Service Center	Daytime	50.7	50.7	0.0	50.7	0.0	Control Area IV standards	47	No impact or negligible impact
	Evening	51.7	51.7	0.0	51.7	0.0	Control Area IV standards	47	No impact or negligible impact
	Nighttime	52.8	52.8	0.0	52.8	0.0	Control Area IV standards	47	No impact or negligible impact
Municipal Haibu Elementary School	Daytime	38.0	38.0	0.0	38.0	0.0	Control Area II standards	39	No impact or negligible impact
	Evening	32.1	32.1	0.0	32.1	0.0	Control Area II standards	39	No impact or negligible impact
	Nighttime	27.5	27.5	0.0	27.5	0.0	Control Area II standards	39	No impact or negligible impact
Putian Temple	Daytime	33.1	33.1	0.0	33.1	0.0	Control Area III standards	39	No impact or negligible impact
	Evening	21.7	21.7	0.0	21.7	0.0	Control Area III standards	39	No impact or negligible impact
	Nighttime	22.2	22.2	0.0	22.2	0.0	Control Area III standards	39	No impact or negligible impact
Wuqi Elementary School	Daytime	44.7	44.7	0.0	44.7	0.0	Control Area II standards	39	No impact or negligible impact
	Evening	40.3	40.3	0.0	40.3	0.0	Control Area II standards	39	No impact or negligible impact
	Nighttime	35.1	35.1	0.0	35.1	0.0	Control Area II standards	39	No impact or negligible impact

Note: 1. The background noise assumption for the project's operation period is the same as the current background level.
2. The background level used for sensitive areas is the maximum level measured.
3. Combined value = Background noise during operation ⊕ background noise subtotal." ⊕" indicates addition based on sound calculation basis.
4. Noise increment = combined value － background noise during operation

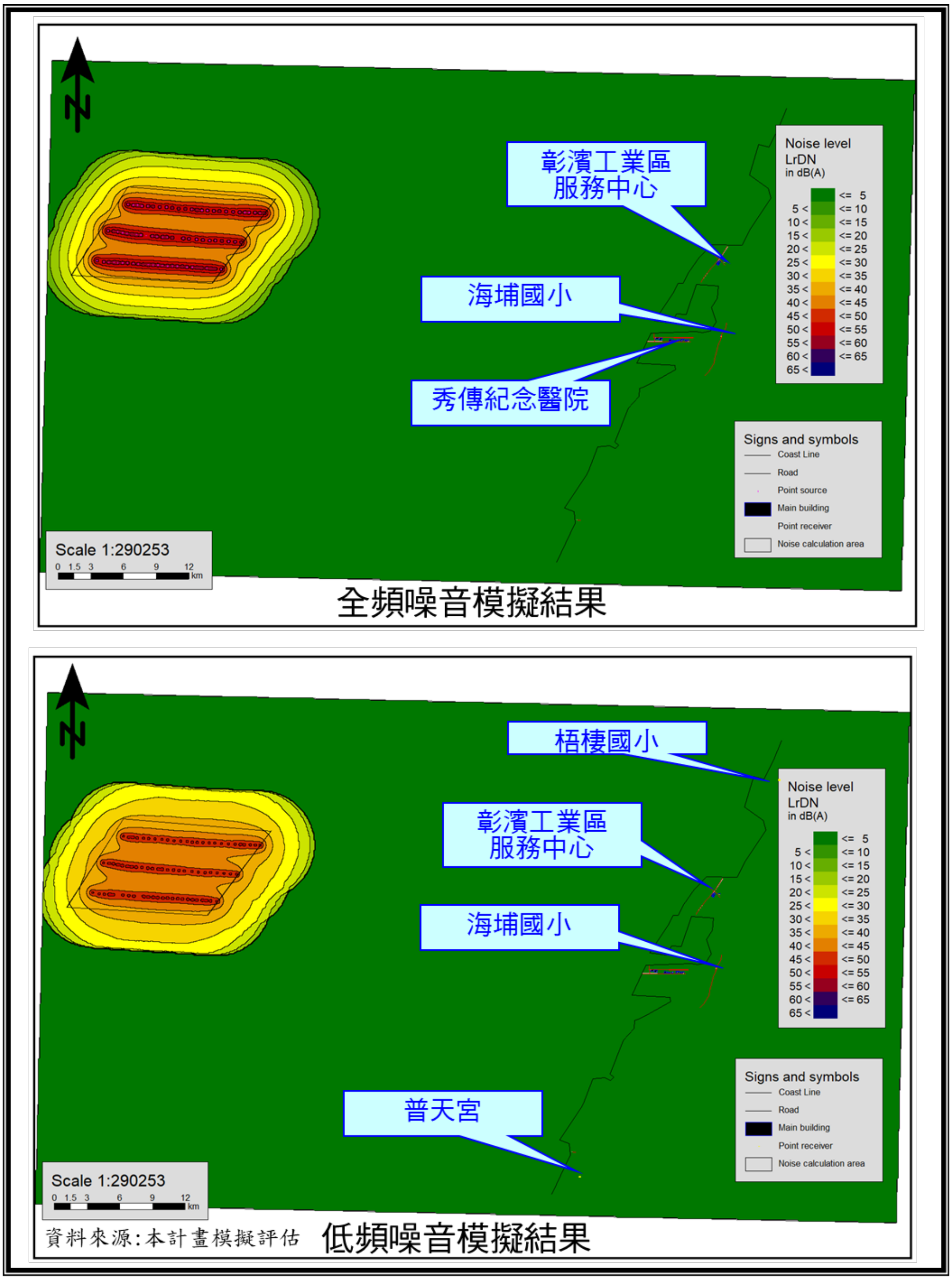


Figure 7.1.4-4 Wind Turbine Noise Impact of South East Wind Farm of Greater Changhua during Independent Operation

2. Noise source of Greater Changhua 4 when operation simultaneously.

(1) Wind turbine operation in Full Frequency Noise (20 Hz - 20 kHz)

The measured value of each frequency at wind speed of 10m/s (relatively more appropriate for the Project site) according to IEC 61400-11 measurement standards will be inputted into the SoundPLAN model as the point source; altitude of the sound source will be 132m. The results of analog calculation are shown in Table 7.1.4-12 and Figure 7.1.4-5. It has discovered that the full frequency noise from the operation of all wind turbines has reduced to nearly the same as the receptor. The noise of a receptor is 0.0dB(A). Noise increment from different period of time are 0.0dB(A) as well. The level of impact of full frequency noise of this operation is no impact or negligible impact.

(2) Wind turbine operation in Low Frequency Noise (20 Hz - 200 Hz)

The measured value of each frequency at wind speed of 10m/s (relatively more appropriate for the Project site) according to IEC 61400-11 measurement standards will be inputted into the SoundPLAN model as the point source; altitude of the sound source will be 132m. The results of analog calculation are shown in Table 7.1.4-13 and Figure 7.1.4-5. It has discovered that the Low Frequency Noise from the operation of all wind turbines has reduced to nearly the same as the receptor. The noise of a receptor is 0.0dB(A). Noise increment from different period of time are 0.0dB(A) as well. The level of impact of full frequency noise of this operation is no impact or negligible impact.

Table 7.1.4-12 Simulation Result on Full Frequency Noise of Greater Changhua 4 during Simultaneous Operation

Unit: dB(A)

Item / Name of receiver	Time	Current environment background full frequency noise	Background full frequency noise without wind turbine operation	Wind turbine operation full frequency noise	Combined noise including wind turbine operation	Noise increment	Noise control area category	Noise control standard	Level of impact
Changhua Coastal Industrial Park Service Center	day	66.3	66.3	0.0	66.3	0.0	Control Area IV standards	75	No impact or negligible impact
	evening	57.3	57.3	0.0	57.3	0.0	Control Area IV standards	70	No impact or negligible impact
	night	53.7	53.7	0.0	53.7	0.0	Control Area IV standards	65	No impact or negligible impact
Chang Bing Show Chwan Memorial Hospital	day	55.9	55.9	0.0	55.9	0.0	Control Area II standards	60	No impact or negligible impact
	evening	54.2	54.2	0.0	54.2	0.0	Control Area II standards	55	No impact or negligible impact
	night	51.0	51.0	0.0	51.0	0.0	Control Area II standards	50	No impact or negligible impact
Municipal Haibu Elementary School	day	69.8	69.8	0.0	69.8	0.0	Control Area II standards	60	No impact or negligible impact
	evening	66.7	66.7	0.0	66.7	0.0	Control Area II standards	55	No impact or negligible impact
	night	61.3	61.3	0.0	61.3	0.0	Control Area II standards	50	No impact or negligible impact

Table 7.1.4-13 Simulation Result on Low Frequency Noise of Greater Changhua 4 during Simultaneous Operation

Unit: dB(A)

Item / Name of receiver	Time	Current environment background low frequency noise	Background low frequency noise without wind turbine operation	Wind turbine operation low frequency noise	Combined noise including wind turbine operation	Noise increment	Noise control area category	Noise control standard	Level of impact
Changhua Coastal Industrial Park Service Center	Daytime	50.7	50.7	0.0	50.7	0.0	Control Area IV standards	47	No impact or negligible impact
	Evening	51.7	51.7	0.0	51.7	0.0	Control Area IV standards	47	No impact or negligible impact
	Nighttime	52.8	52.8	0.0	52.8	0.0	Control Area IV standards	47	No impact or negligible impact
Municipal Haibu Elementary School	Daytime	38.0	38.0	0.0	38.0	0.0	Control Area II standards	39	No impact or negligible impact
	Evening	32.1	32.1	0.0	32.1	0.0	Control Area II standards	39	No impact or negligible impact
	Nighttime	27.5	27.5	0.0	27.5	0.0	Control Area II standards	39	No impact or negligible impact
Putian Temple	Daytime	33.1	33.1	0.0	33.1	0.0	Control Area III standards	39	No impact or negligible impact
	Evening	21.7	21.7	0.0	21.7	0.0	Control Area III standards	39	No impact or negligible impact
	Nighttime	22.2	22.2	0.0	22.2	0.0	Control Area III standards	39	No impact or negligible impact
Wuqi Elementary School	Daytime	44.7	44.7	0.0	44.7	0.0	Control Area II standards	39	No impact or negligible impact
	Evening	40.3	40.3	0.0	40.3	0.0	Control Area II standards	39	No impact or negligible impact
	Nighttime	35.1	35.1	0.0	35.1	0.0	Control Area II standards	39	No impact or negligible impact

Note: 1. The background noise assumption for the project’s operation period is the same as the current background level.
2. The background level used for sensitive areas is the maximum level measured.
3. Combined value = Background noise during operation ⊕ background noise subtotal.” ⊕” indicates addition based on sound calculation basis.
4. Noise increment = combined value － background noise during operation

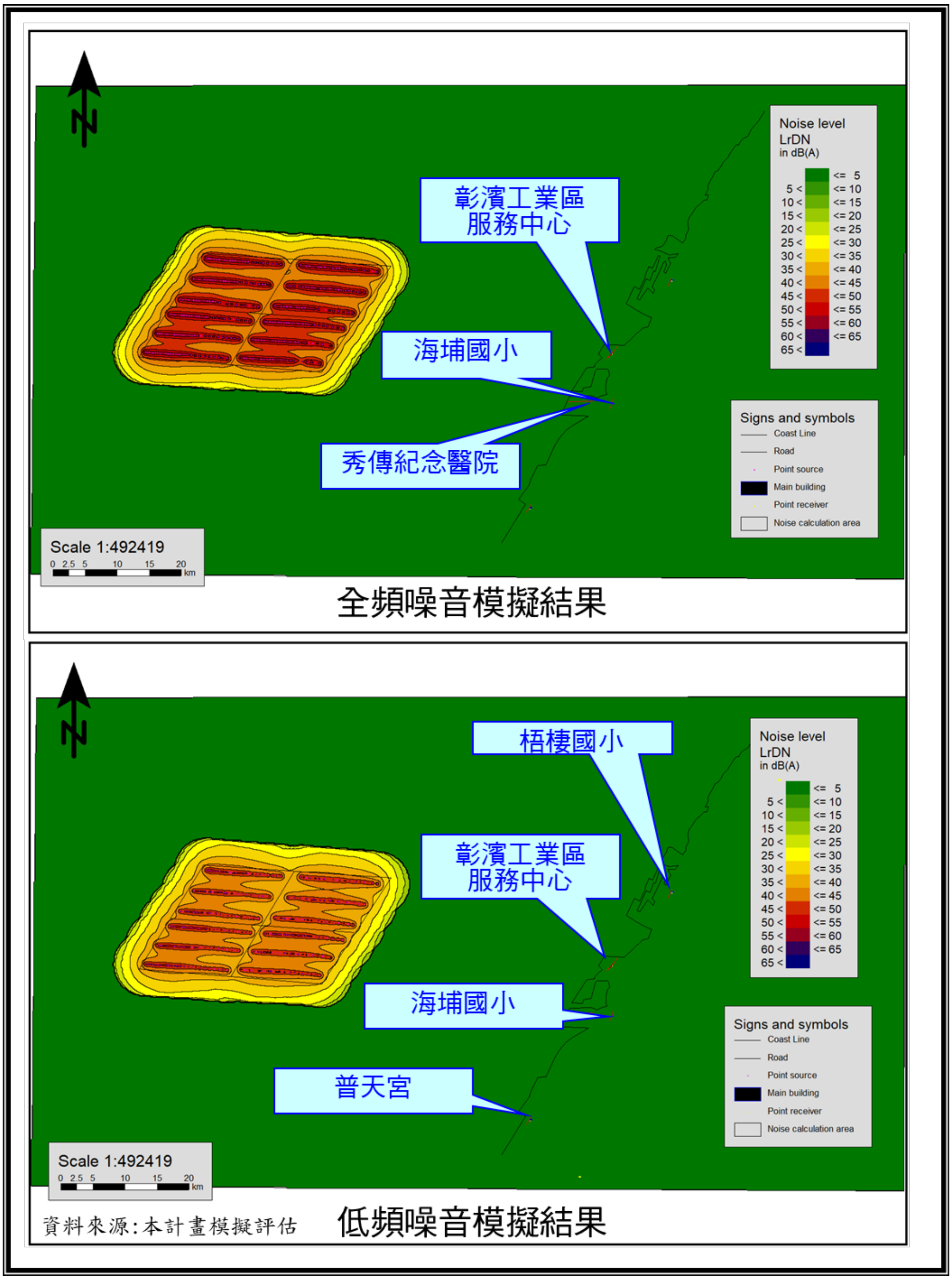


Figure 7.1.4-5 Wind Turbine Noise Impact of Greater Changhua 4 during Simultaneous Operation

II. Underwater noise

(i) Underwater noise and the simulation of wind turbine construction

The locations of the simulation are shown in Fig. 7.1.4-6, the 4 places that have been marked are assessed with the noise emitting from underwater and the wind turbine construction. Numerical model is used to estimate the sound field and propagation of the ocean, in order to understand the impact of the construction noise towards the ocean environment.

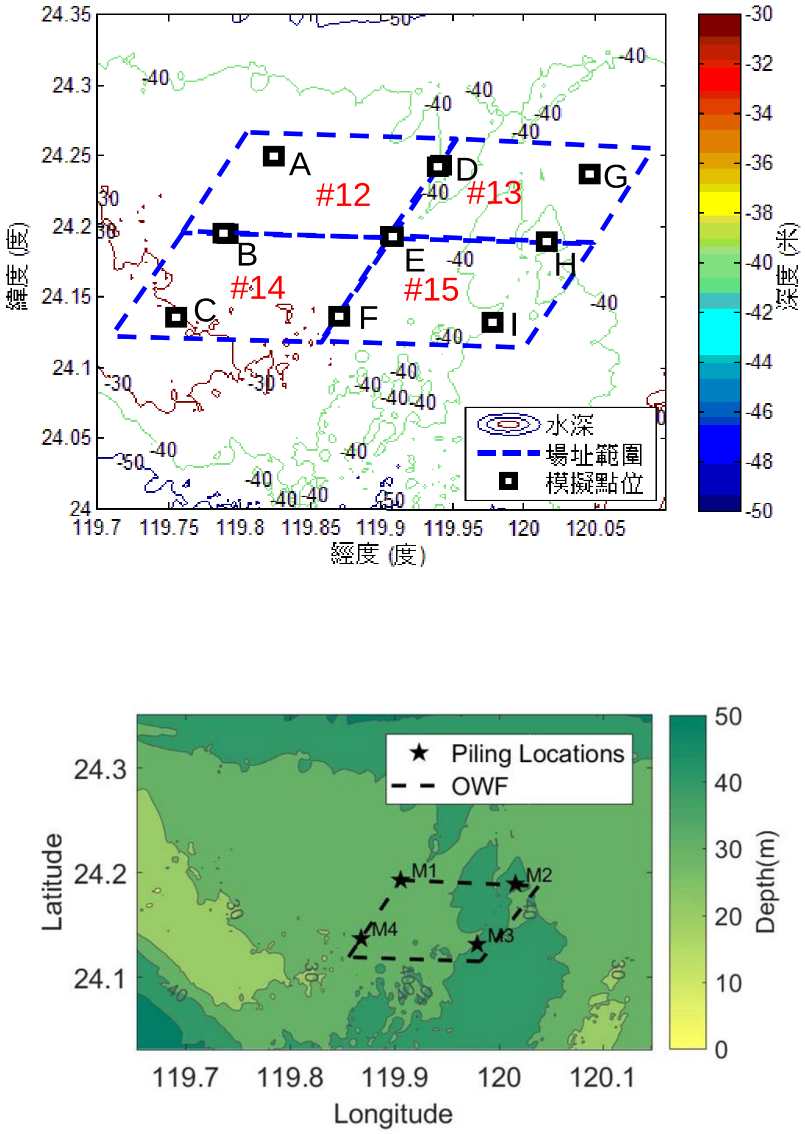


Figure 7.1.4-6 Sites of simulations for pile driving noise

Table 7.1.4-14 locations and depth of the simulation sites

Simulation site#	Longitude (E)	Latitude (N)	Water depth (m)
M1	119º 54.36'	24º 11.56'	35.5
M2	119º 0.960'	24º 11.33'	36.5
M3	119º 58.76'	24º 7.875'	44.6
M4	119º 52.10'	24º 8.205'	31.6

(ii) Pile Driving Noise Source Simulation

The two demonstration wind turbines in Miao Li of Taiwan were installed and the base piles were installed in September of 2016. Noise measurements were done at 750m and 3000 m from the pile driving sites. Fig 7.1.4-7 shows the measurement result at 750m, the band level is 170dB re 1μPa (rms), and the band level at 3000m is 155~160dB re 1μPa (rms) as shown in Fig. 7.1.4-8. The noise source levels can be inverted from the range as 210~219 dB.

The current plan is to use 8 - 11MW wind turbine for the wind farm. The sub-structure type is assumed to be Jacket type. The biggest diameter (4m) of the pile driving is used in this conservative calculation. Actual measurement from German Alpha Ventus is mainly use as reference when calculating the strength of the sound source. Figure 7.1.4-9 shows the noise time series measurement and its noise spectrum and Figure 7.1.4-9 (b) shows the noise spectrum of 1/3 octave band, 1Hz can be obtained after conversion, refer figure 7.1.4-10, the red line at the top right.

High-frequency noise will de-amplify quickly in the water depending on the distance. Contribution of high-frequency noise is far lower than low-frequency noise when the propagation distance is more than 10 km, refer to figure 7.1.4-9(b). After considering the strong penetrating power of low-frequency noise and the long distance which might harm marine lives if the noise is too strong, the low-frequency band in the simulation is set as 80 Hz - 400Hz[3].

Simulation has shown that it is similar to the frequency in sound level pressure of figure 7.1.4-9, refer to the top left blue line in figure 7.1.4-10. Therefore, this noise source will be used in the subsequent simulation test with sound pressure level (peak to peak) to be 236dB (RMS 220dB) re 1μPa as the prototype for sound pressure level [4], refer to figure 7.1.4-9. The source level for monopile type is set as sound pressure level (peak to peak) to be 240 – 270 dB (or equivalent to sound pressure level RMS 250dB) re 1μPa.

Moreover, Dong Energy is used in providing the Pile Driving Noise Source Spectrum and the simulation has been conducted with noise from the biggest pile driving diameter. The frequency is 63 Hz - 512 Hz, pile driving diameter is 4.0m, hammer energy is 2000 kj and the overall SEL is 216.5 dB, as shown in figure 7.1.4-10 and table 7.1.4-17.

Table7.1.4-15 Source levels of different pile types and parameters

	Sub-structure Type	Turbine	Water Depth	Soil Type	Individual Length	Approximate Number of Blows		Approx. dB	Hammer Energy[1]
		MW	m		(m)	Plugged	Unplugged		(kJ)
MIN	MONOPILE	3.6	20	B1	42	-	4360	240 -270	550-800
MAX	MONOPILE	5	30	B1	52	-	Refusal at 40m		
MIN	JACKET	3.6	20	B1	34	3994	4074	180-230	108-206
MAX	JACKET	7	50	C3	46	5851	3410		
MIN	KEYSTONE	3.6	20	B1	35	4571	3779		
MAX	KEYSTONE	7	50	B2	-	-	-		
MIN	TRIPOD	3.6	20	B1	31	Refusal at 28m	2541		
MAX	TRIPOD	5	40	B2	40	Refusal at 25m	3352		

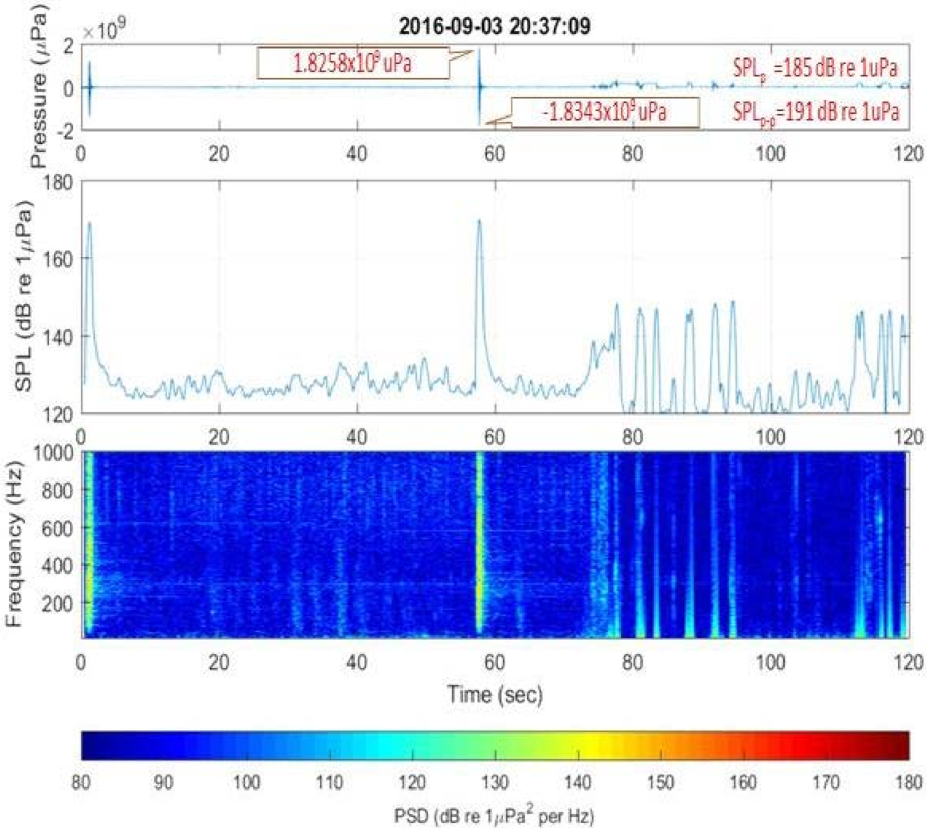


Figure 7.1.4-7 Noise measurement at 750m

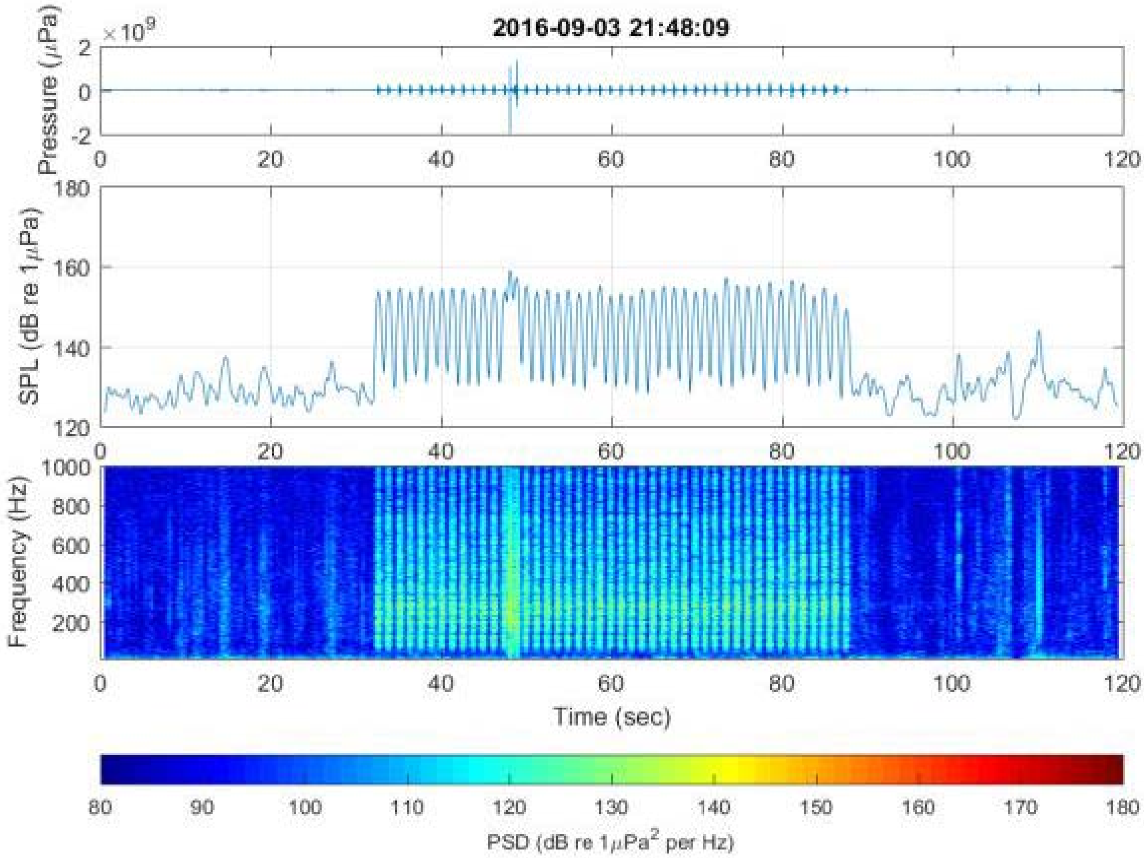


Figure 7.1.4-8 Noise measurement at 3000m

Figure 7.1.4-9 German Alpha Ventus noise time series measurement and noise spectrum of one-third octave band

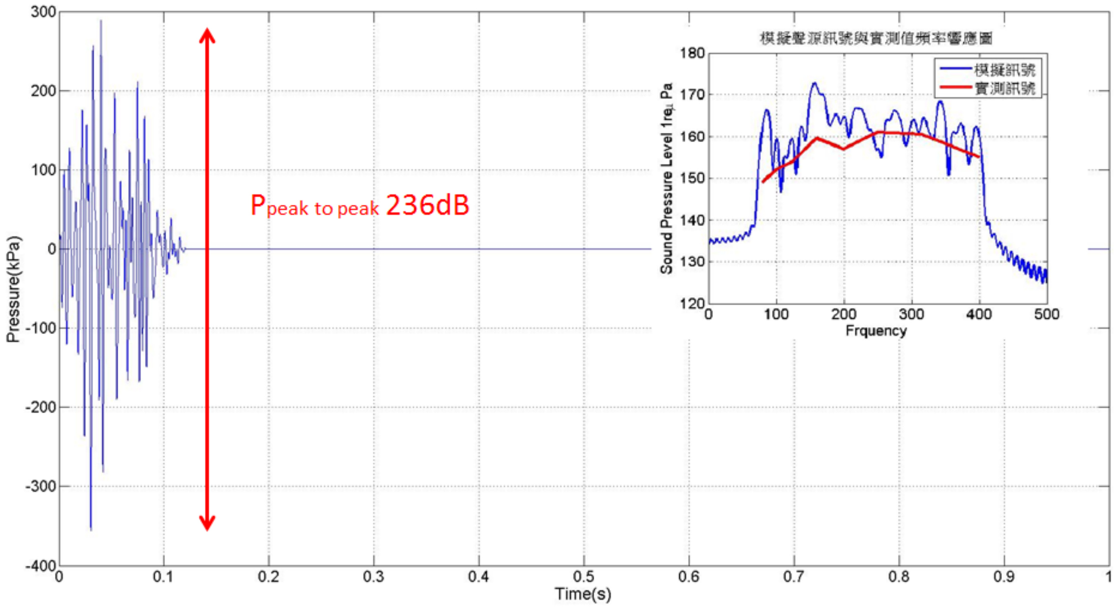


Figure 7.1.4-10 Time series used in simulation with peak-peak pressure level a 236 dB re 1 uPz, and the one-third octave band spectrum, red line is the measured data, blue line is the simulated spectrum in one Hz band.

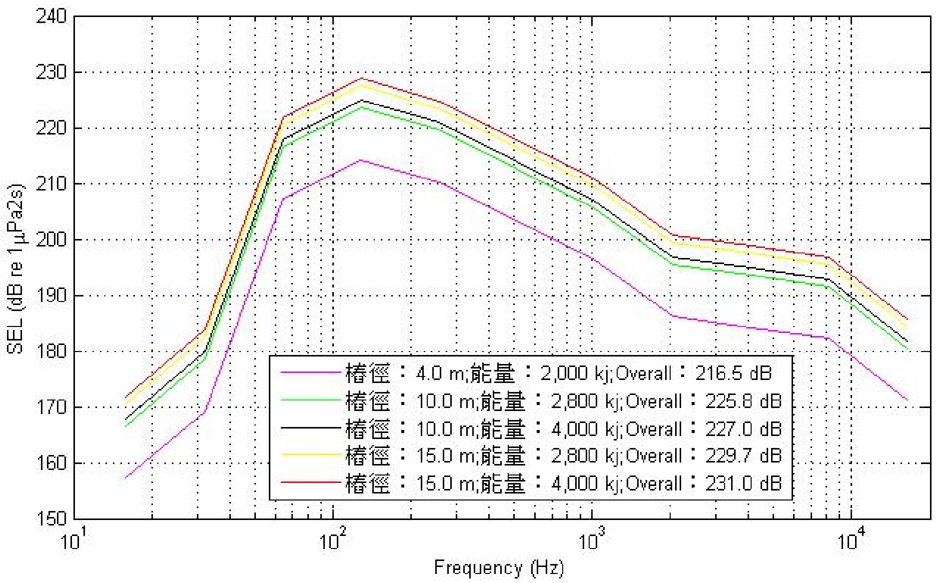


Figure 7.1.4-11 Pile Driving Noise Source Spectrum provided by Dong Energy

Table 7.1.4-16 Pile Driving Noise Source Spectrum provided by Dong Energy

Pile diameter (m)	4.0
Hammer energy (kJ)	2000
Frequency (Hz)：64	207.2
128	214.2
256	210.2
512	203.2
1024	196.2
2048	186.2
4096	184.2
8192	182.2
16384	171.2
Overall SEL(dB re 1 uPa2s)	216.5

1. Broad-band Simulation for Pile Driving Noise

The acoustic transmission model used in pile driving noise field is Pseudo-Parabolic Equation based numerical model RAM (Range-dependent Acoustic Model) version 1.5. Broadband simulation is done for the band of 80Hz to 400 Hz. The time series is calculated using Fourier synthesis with the simulation result from each frequency. [6] The simulation procedure is shown in Figure 7.1.4-12.

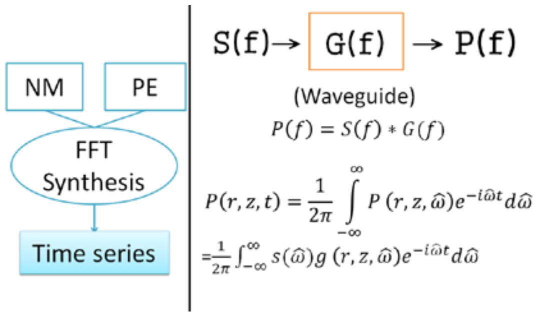


Figure 7.1.4-12 Broad band simulation procedure

The environmental database for the sound field simulation includes three parts, which are properties (mainly water temperature and salinity and current) of the water column, the bathymetry, and the geo-acoustical properties. The properties of the water column are obtained using TCONFS (Taiwan Coastal Ocean Nowcast/Forecast System) developed by ITRI. [8], which would provide more complete description of the water column than the historical and measured data both in time and in space. The bathymetric database is taidp200m of Ocean database of the Ministry of Science and Technology of Taiwan, which has grid interval of 200m. The geo-acoustical properties of the ocean bottom are obtained by combining the surficial sediment database from

Ref. 7 [7] and Hamilton empirical equation. There is also an artificial absorption layer added in the environmental model, which is characterized with absorption coefficient 10（dB/λ）.

Noise source depth is set at 5m depth, and the receiver depth is 5 m depth. The azimuthal interval is 22.5 degree such that there are 12 azimuthal calculations. The maximum calculation range is set as 10 km with 100m range interval, the vertical depth grid is 1 m. Only one sound speed profile at the source location is used throughout the simulation due to the calculation area is small compared to the oceanographic variation scale.

2. Peak Sound Pressure Level and Acoustic Energy

According to a report [Hu Deng Ren, 2016], acoustic energy from pile driving noise (band level of 10Hz – 20kHz) L_{rms} is 170 dB re 1 μPa, whereas peak sound pressure level, $L_{pk,\ flat}$ is at 185 dB re 1 μPa. Based on the data, the deviation between acoustic energy and peak sound pressure level is 15 dB. Therefore, simulation result on acoustic threshold of 180 dB (re 1 μPa) and 160 dB (re 1 μPa) in correspondent with sound peak pressure level are 195 dB (re 1 μPa) and 175 dB (re 1 μPa) respectively.

NOAA NMFS has announced at July, 2016 on Permanent Threshold Shift (PTS). The peak sound pressure level for Mid-Frequency (MF) Cetaceans is 230 dB (re 1 μPa), as shown in table 7.1.4-15, simulation test result is proved to be lower than MF Cetaceans. Another reason causing PTS to MF Cetaceans is MF weighted 24-hour sound exposure level. $L_{E,MF,24h}$ dB re 1 $\mu Pa^2 s$ is calculated with acoustic energy (L_{rms}) with MF weighted approach, then multiply with the number of pile driving within 24 hours (N)

$L_{E,MF,24h}$ dB re 1 $\mu Pa^2 s$ = $L_{E,\ MF}$ + 10 log (N)

Unweighted acoustic energy L_{rms} is higher than weighted mid-frequency sound exposure level ($L_{E,MF,}$), deviation is estimated to be 30 dB. Therefore, simulation result on acoustic threshold of 180 dB (re 1 μPa) and 160 dB (re 1 μPa) in correspondent with sound peak pressure level are 150 dB (re 1 $\mu Pa^2 s$) and 130 dB (re 1 $\mu Pa^2 s$) respectively. Provided N as 4000 and 10 log (N) is 36 dB，acoustic threshold (L_{rms}) of 180 dB (re 1 μPa) and 160 dB (re 1 μPa) in correspondent with MF weighted 24-hour sound exposure level ($L_{E,MF,24h}$) are 186 dB (re 1 $\mu Pa^2 s$) and 166 dB (re 1 $\mu Pa^2 s$) respectively.

Table 7.1.4-17 PTS onset acoustic thresholds (NOAA，2016)

	PTS Onset Thresholds* (Received Level)	
Hearing Group	**Impulsive**	**Non-impulsive**
Low-Frequency (LF) Cetaceans	*Cell 1* $L_{pk,flat}$: 219 dB $L_{E,LF,24h}$: 183 dB	*Cell 2* $L_{E,LF,24h}$: 199 dB
Mid-Frequency (MF) Cetaceans	*Cell 3* $L_{pk,flat}$: 230 dB $L_{E,MF,24h}$: 185 dB	*Cell 4* $L_{E,MF,24h}$: 198 dB
High-Frequency (HF) Cetaceans	*Cell 5* $L_{pk,flat}$: 202 dB $L_{E,HF,24h}$: 155 dB	*Cell 6* $L_{E,HF,24h}$: 173 dB
Phocid Pinnipeds (PW) (Underwater)	*Cell 7* $L_{pk,flat}$: 218 dB $L_{E,PW,24h}$: 185 dB	*Cell 8* $L_{E,PW,24h}$: 201 dB
Otariid Pinnipeds (OW) (Underwater)	*Cell 9* $L_{pk,flat}$: 232 dB $L_{E,OW,24h}$: 203 dB	*Cell 10* $L_{E,OW,24h}$: 219 dB

3. Pile Driving Noise Simulation Result

(1) Independent Simulation Test

Noise threshold of pile driving noise from different range can be received with the calculation above, as shown in figure 7.1.4-13. Sound pressure of noise measurement at 750m from different directions are shown from figure 7.1.4-14 to figure 7.1.4-21. All simulation result are listed on table 7.1.4-18~19. Pile driving noise from Point M1 and Point M4 within 800m have reduced to 170dB and even reached 160dB within the distance of 3900m. The sound pressure level at a distance of 750m is between 168 dB~170 dB. It is essential to use noise reduction method or prevent noise to diffuse underwater. Pile driving noise from other points within 100m have reduced to 170dB and 160dB within 400m. The sound pressure level at a distance of 750m is between 155 dB - 157 dB. Different types of seabed and topography can affected the simulation test. West sea area is shallow water type. It has the most aggressive absorption and reflection on the noise between water surface and he topography. Hence, topography is the most direct influencing factor.

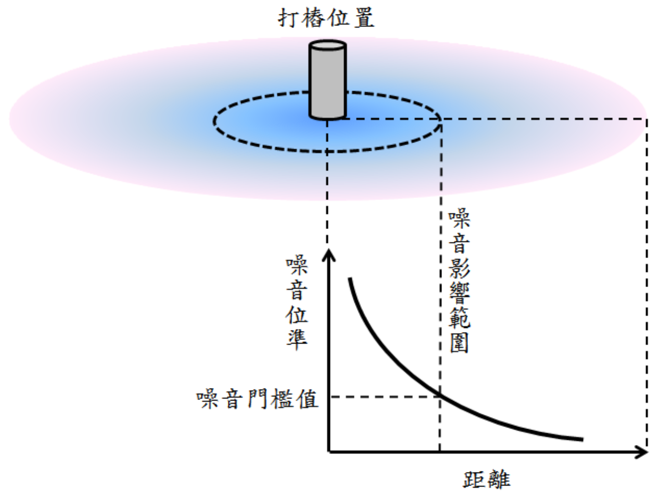


Figure 7.1.4-13 Pile Driving Noise decays with transmission range and range where it reaches the noise threshold

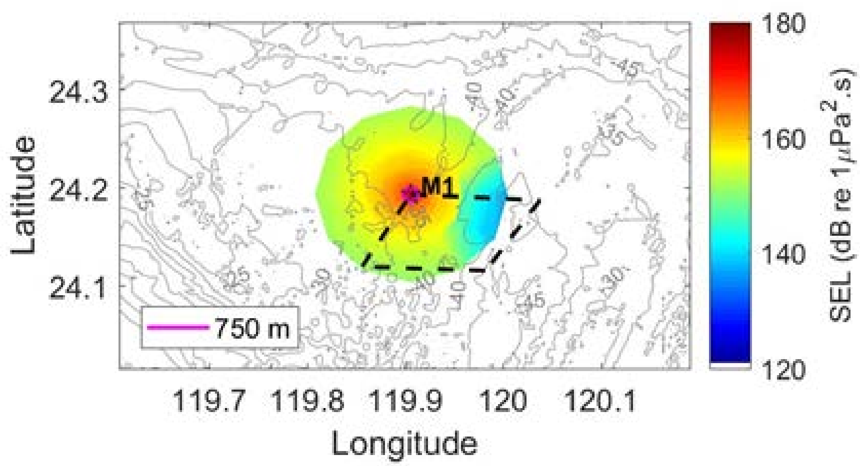


Figure 7.1.4-14 Pile Driving at Point M1, Distribution of Sound Pressure Level at 750m with SEL 216.5 dB

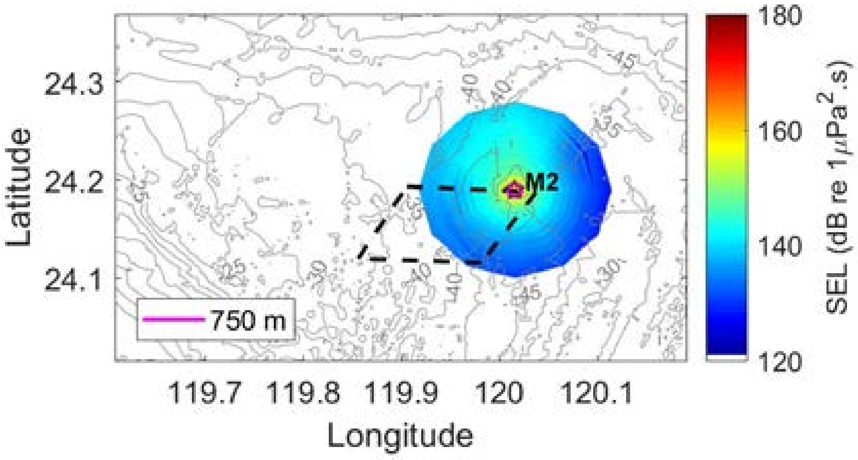
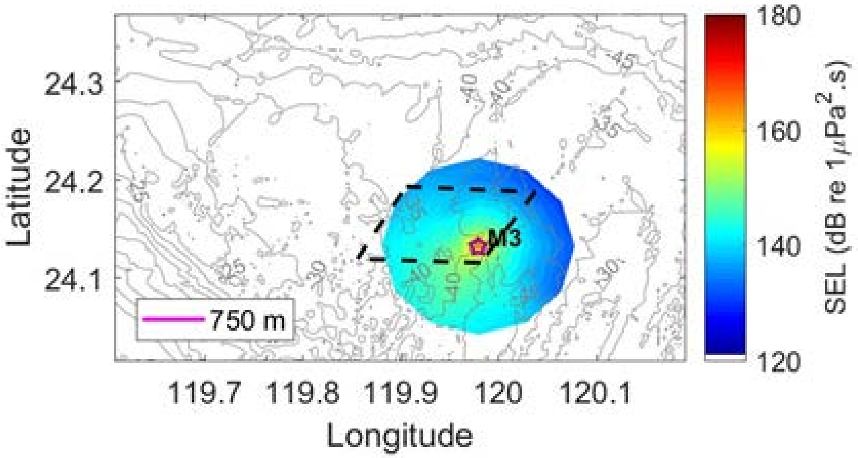
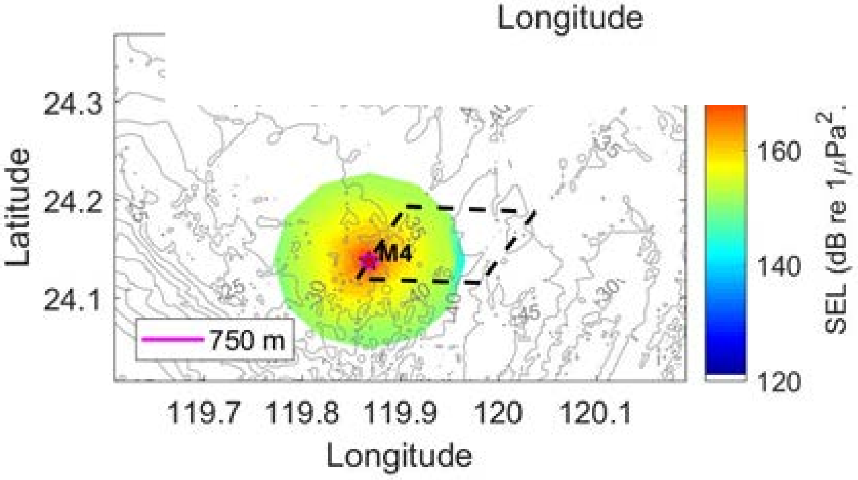


Figure 7.1.4-15 Pile Driving at Point M2, Distribution of Sound Pressure Level at 750m with SEL 216.5 dB





of Sound Pressure

Fig. 7.1.4-17 Distribution of sound pressure from a distance of 750 meters away from sound source with intensity level of SEL216.5dB in M3 piling site.

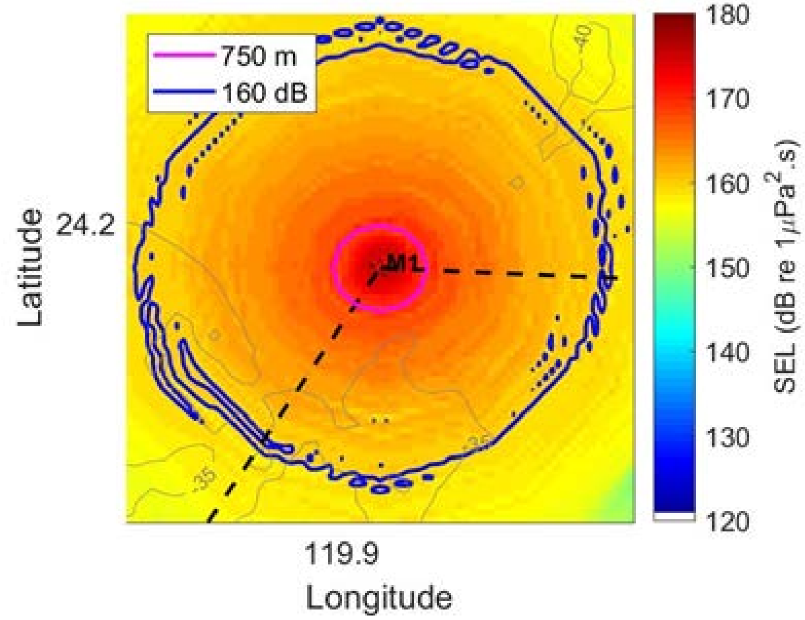


Fig. 7.1.4-18 Distribution of sound pressure from a distance of 750 meters away from sound source with intensity level of SEL216.5dB in M1 piling site.

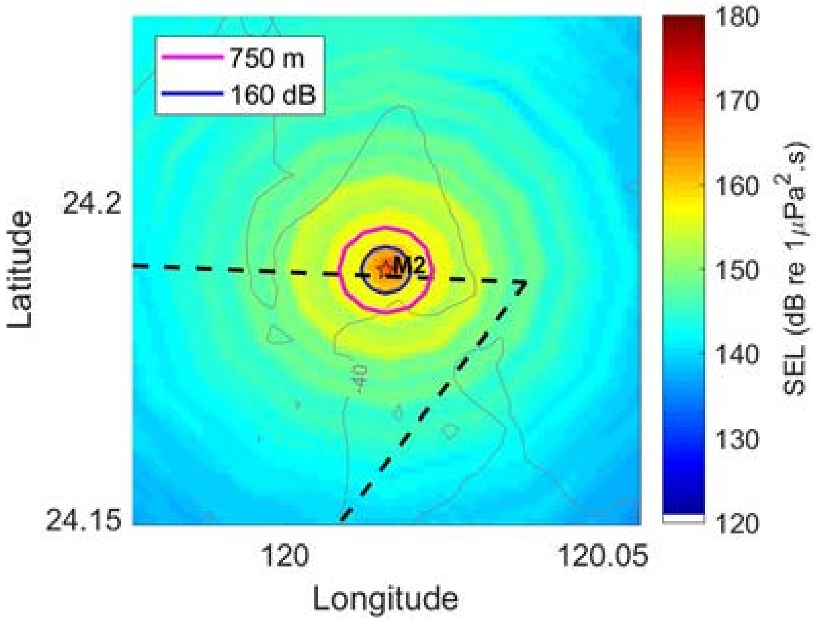


Fig. 7.1.4-19 Distribution of sound pressure from a distance of 750 meters away from sound source with intensity level of SEL216.5 dB decrease to threshold value SEL160 dB in M2 piling site.

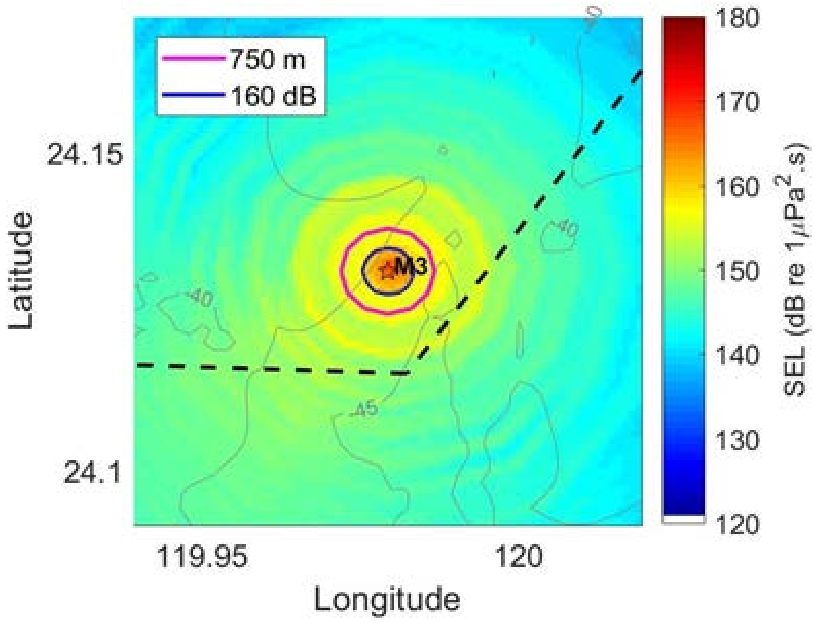


Fig. 7.1.4-20 Distribution of sound pressure from a distance of 750 meters away from sound source with intensity level of SEL216.5 dB decrease to threshold value SEL160 dB in M3 piling site.

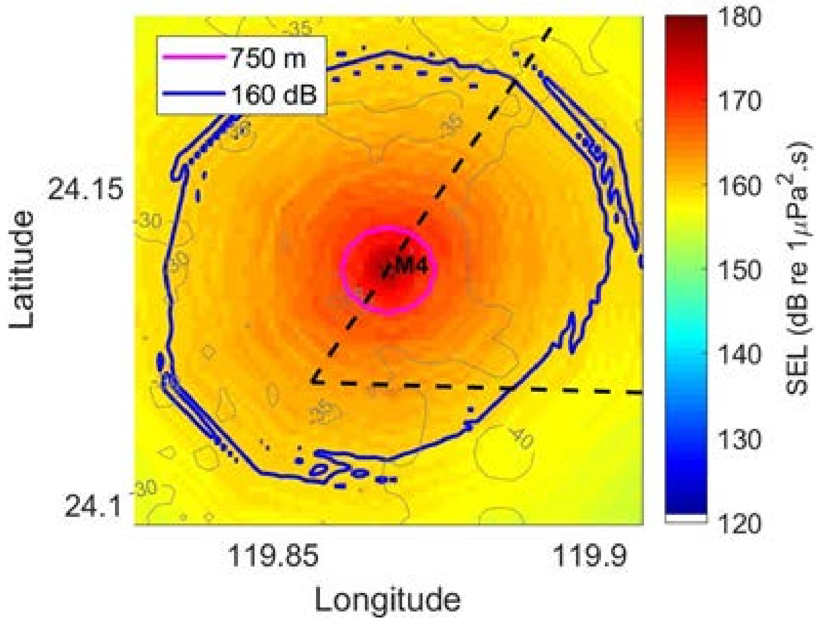


Fig. 7.1.4-21 Distribution of sound pressure from a distance of 750 meters away from sound source with intensity level of SEL216.5 dB decrease to threshold value SEL160 dB in M4 piling site.

Table 7.1.4-18 Sound source with intensity level of 216.5 dB from a distance of 750 meters away at different headings are reduced to threshold value SEL160 dB and SEL170dB.

headings	M1			M2			M3			M4		
	SEL 160dB	SEL 170dB	Distance 750m	SEL 160dB	SEL 170dB	Distance 750m	SEL 160dB	SEL 170dB	Distance 750m	SEL 160dB	SEL 170dB	Distance 750m
0^0	3100m	600m	169dB	400m	100m	156dB	400m	100m	156dB	3500m	800m	170db
30^0	3600m	600m	169dB	400m	100m	156dB	400m	100m	156dB	3500m	700m	169dB
60^0	3700m	600m	169dB	400m	100m	156dB	400m	100m	157dB	3400m	700m	169dB
90^0	3600m	600m	169dB	400m	100m	156dB	400m	100m	157dB	3500m	500m	168dB
120^0	3000m	600m	169dB	400m	100m	156dB	400m	100m	157dB	2900m	500m	168dB
150^0	3400m	700m	169dB	400m	100m	156dB	400m	100m	156dB	2700m	600m	168dB
180^0	3000m	700m	169dB	400m	100m	156dB	400m	100m	157dB	3300m	800m	170dB
210^0	3500m	700m	169dB	400m	100m	156dB	400m	100m	156dB	3500m	700m	169dB
240^0	3400m	700m	169dB	400m	100m	156dB	400m	100m	156dB	3900m	700m	169dB
270^0	3600m	600m	169dB	400m	100m	156dB	400m	100m	155dB	3500m	800m	170dB
300^0	3500m	600m	169dB	400m	100m	156dB	400m	100m	156dB	3400m	700m	169dB
330^0	3400m	600m	169dB	400m	100m	156dB	400m	100m	156dB	3500m	800m	170dB

(note: heading 0^0 represents due north, 90^0 is due east, etc)

Distribution of sound pressure with intensity SEL 216.5 dB when noise mitigation measurements taken (reduction of 10 dB) are plotted in Figure 7.1.4-22~29. Results of each simulation points are listed in Table 7.1.4-19. The simulation results show that the noise emission direction is close to the land. However, sound intensity from each sound source point to the open sea area should be attenuated to 170 dB in the range of 100 meters. Sound intensity of M2 and M3 sites attenuate to 160 dB in the range of 100 meters while the sound pressure from a distance of 750 meters away from the piling point is between 145 to 147 dB. Sound intensity of M1 and M4 sites attenuate to 160 dB within 500 to 800 meters, and the sound pressure from a distance of 750 meters away from the pile driving point is between 158 dB to 160 dB.

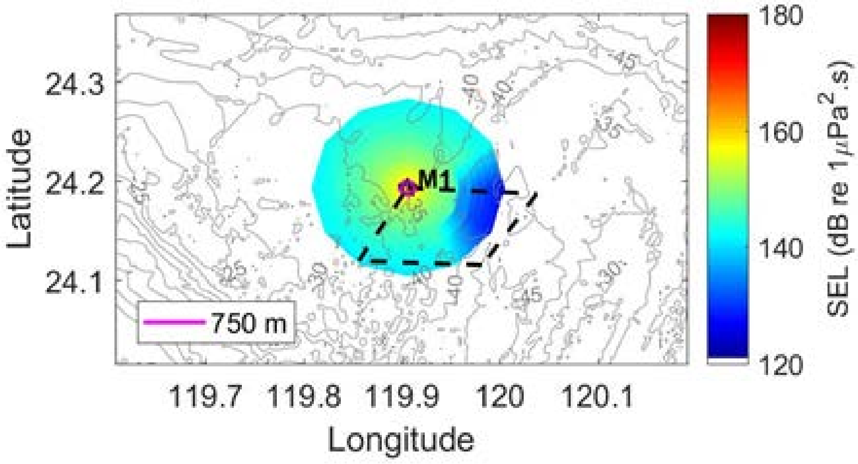


Fig. 7.1.4-22 Distribution of sound pressure from a distance of 750 meters away where sound source intensity level of SEL216.5 dB decrease to threshold value SEL160 dB in M1 piling site when noise mitigation measurement is taken (reduction of 10dB).

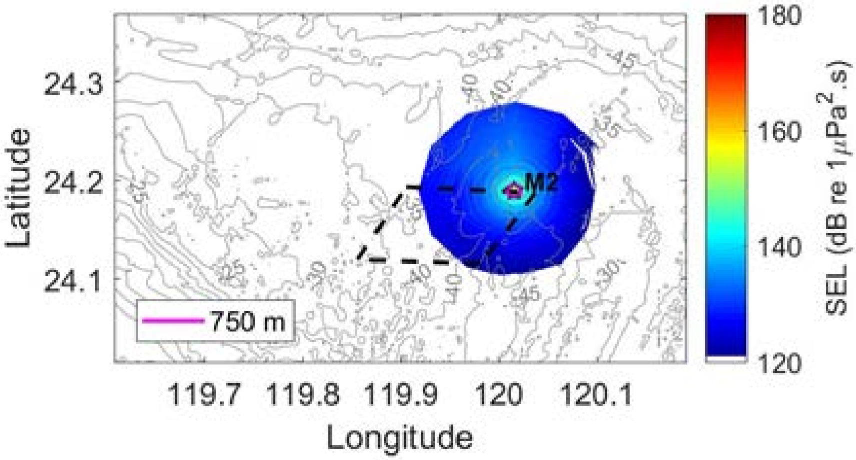


Fig. 7.1.4-23 Distribution of sound pressure from a distance of 750 meters away where sound source intensity level of SEL216.5 dB decrease to threshold value SEL160 dB in M2 piling site when noise mitigation measurement is taken (reduction of 10dB).

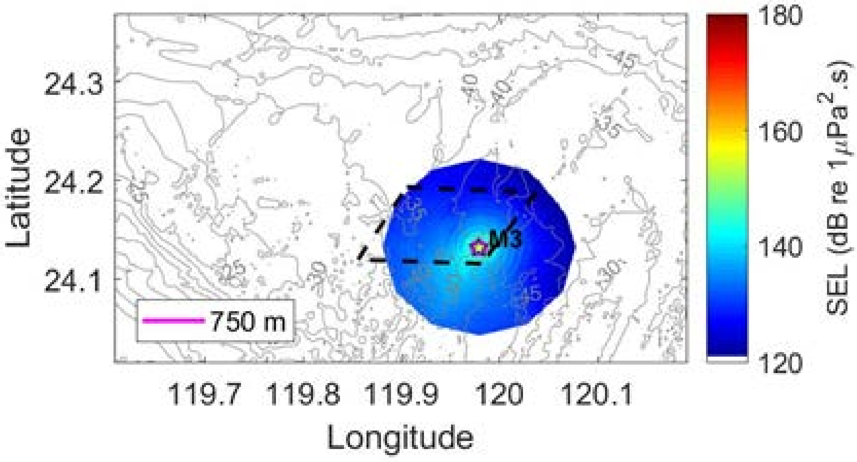


Fig. 7.1.4-23 Distribution of sound pressure from a distance of 750 meters away where sound source intensity level of SEL216.5 dB decrease to threshold value SEL160 dB in M3 piling site when noise mitigation measurement is taken (reduction of 10dB).

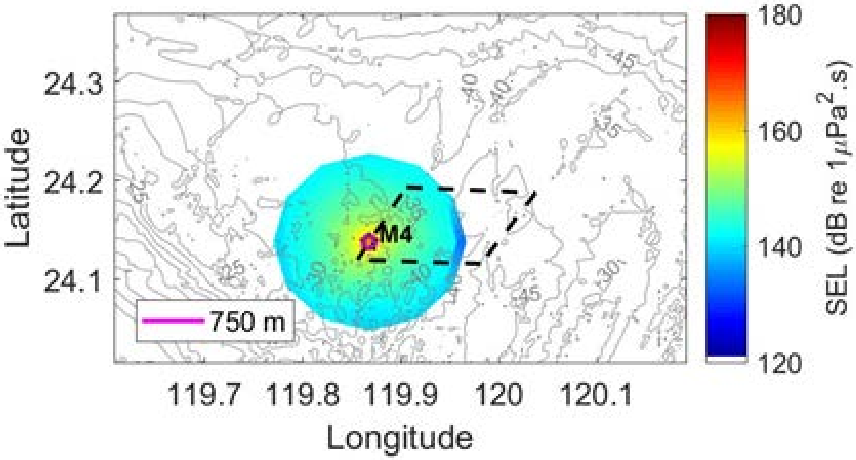


Fig. 7.1.4-25 Distribution of sound pressure from a distance of 750 meters away where sound source intensity level of SEL216.5 dB decrease to threshold value SEL160 dB in M4 piling site when noise mitigation measurement is taken (reduction of 10dB).

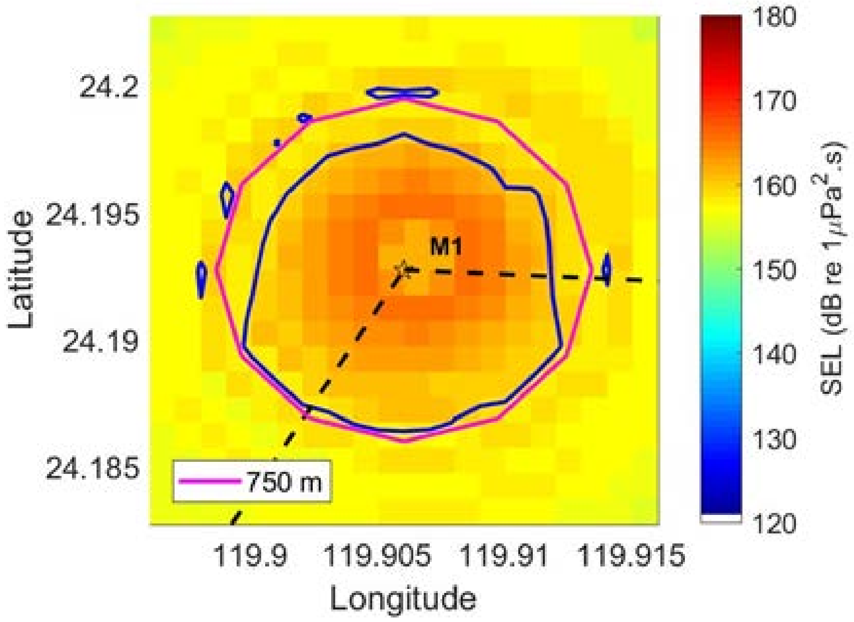


Fig. 7.1.4-26 Distribution of sound pressure from a distance of 750 meters away where sound source intensity level of SEL216.5 dB decrease to threshold value SEL160 dB in M1 piling site when noise mitigation measurement is taken (reduction of 10dB).

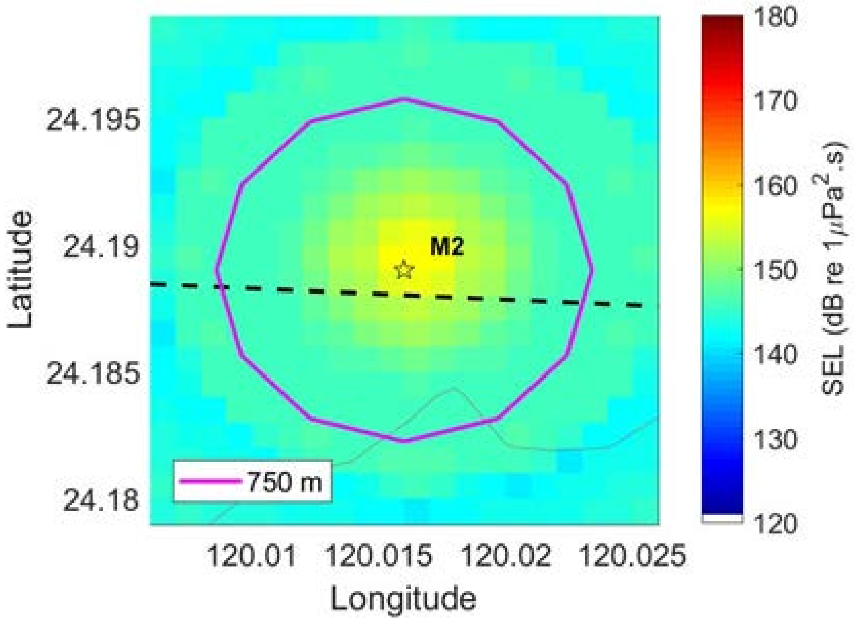


Fig. 7.1.4-27 Distribution of sound pressure from a distance of 750 meters away when sound source intensity level of SEL216.5 dB decrease to threshold value SEL160 dB in M1 piling site when noise mitigation measurement is taken (reduction of 10dB).

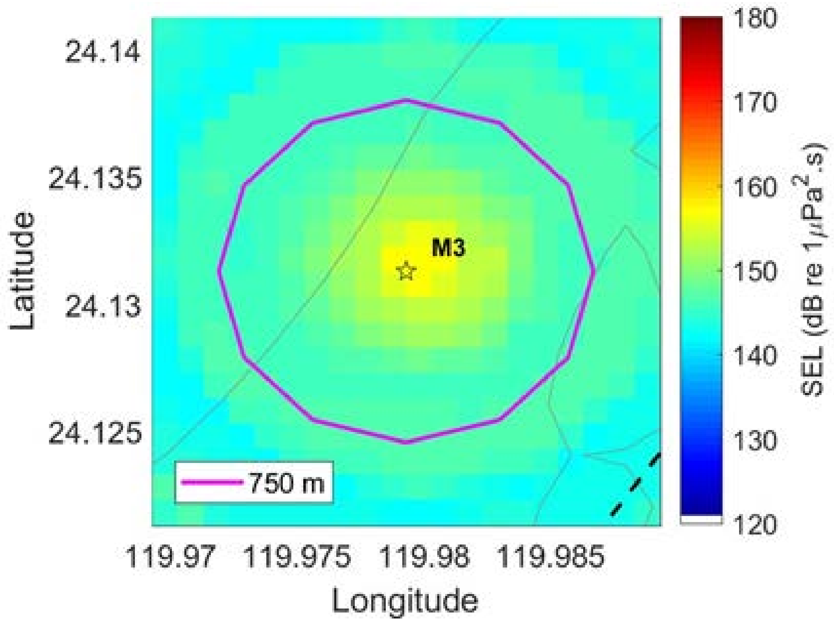


Fig. 7.1.4-28 Distribution of sound pressure from a distance of 750 meters away with sound source intensity level of SEL216.5 dB decrease to threshold value SEL160 dB in M1 piling site when noise mitigation measurement is taken (reduction of 10dB).

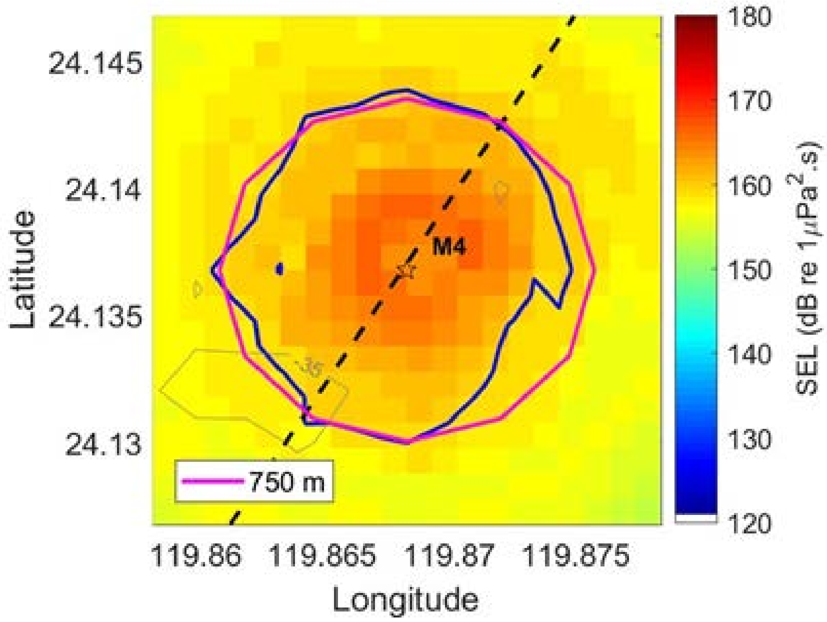


Fig. 7.1.4-29 Distribution of sound pressure from a distance of 750 meters away with sound source intensity level of SEL216.5 dB decrease to threshold value SEL160 dB in M1 piling site when noise mitigation measurement is taken(reduction of 10dB).

Table 7.1.4-18 Sound pressure value of M1- M4 sites from 750 meters away are reduced from 216.5 dB to threshold value SEL160 dB and SEL170dB at different headings when noise mitigation measurement is taken (reduction of 10dB).

headings	M1			M2			M3			M4		
	SEL 160dB	SEL 170dB	Distance 750m	SEL 160dB	SEL 170dB	Distance 750m	SEL 160dB	SEL 170dB	Distance 750m	SEL 160dB	SEL 170dB	Distance 750m
0^0	600m	100m	159dB	100m	100m	146dB	100m	100m	146dB	800m	100m	160dB
30^0	600m	100m	159dB	100m	100m	146dB	100m	100m	146dB	800m	100m	159dB
60^0	600m	100m	159dB	100m	100m	146dB	100m	100m	147dB	700m	100m	159dB
90^0	600m	100m	159dB	100m	100m	146dB	100m	100m	147dB	500m	100m	158dB
120^0	600m	100m	159dB	100m	100m	146dB	100m	100m	147dB	500m	100m	158dB
150^0	700m	100m	159dB	100m	100m	146dB	100m	100m	146dB	600m	100m	158dB
180^0	700m	100m	159dB	100m	100m	146dB	100m	100m	147dB	800m	100m	160dB
210^0	700m	100m	159dB	100m	100m	146dB	100m	100m	146dB	700m	100m	159dB
240^0	700m	100m	159dB	100m	100m	146dB	100m	100m	146dB	700m	100m	159dB
270^0	600m	100m	159dB	100m	100m	146dB	100m	100m	145dB	500m	100m	160dB
300^0	600m	100m	159dB	100m	100m	146dB	100m	100m	146dB	700m	100m	159dB
330^0	600m	100m	159dB	100m	100m	146dB	100m	100m	146dB	800m	100m	160dB

(note: heading 0^0 represents due north, 90^0 is due east. Unit=m)

(2) Combined Evaluation

The cumulative impact assessment of underwater noise samples 9 different wind farms in Changhua area, that are most likely using jacket foundation, for simulation and analysis of underwater noise cumulative effect caused by piling activities. The construction of this project will adopt a gradual construction where each wind turbine foundation in each wind farm will be constructed one by one in future. However, in order to have a better understanding of the worst case scenario where 4 offshore wind farms in the northeast, southeast, southwest and northwest of Changhua to be constructed simultaneously after the planning stage, and 3 developers of 9 wind farms outside the fairways that may be undergoing individual foundation construction simultaneously, different schemes of piling-generated underwater noise simulation are developed to analyse the possible conditions that may occur in the future. The schemes are explained below:

A. Simulation assessment result of 2 wind farms and 2 wind turbine units undergo foundation piling simultaneously.

Two wind turbines, each from northeast and southeast of Greater Changhua from the offshore wind power generation plan which is near to the fairways are chosen, (#13 is the northeast wind farm and #15 is the southeast wind farm of the project). Foundation piling construction of these two units are done simultaneously. The results are as follows:

a. When piling of 2 wind turbine units are constructed simultaneously, underwater noise value of windfield#13 has reduced to 160dB while the distance was kept within 150m from piling point.

b. When piling of 2 wind turbine units are constructed simultaneously, underwater noise value of windfield#15 has reduced to 160dB while the distance was kept within 130m from piling point.

According to the simulation results (fig. 7.1.4-30), the underwater noise value of two units (from northeast and southeast wind field) of piling constructed simultaneously from 9km away are reduced to 160dB, the value is almost the same as the value generated by the piling construction of single unit of wind turbine. The cumulative effect of two wind turbine piling construction happens at the same time in two wind farms is not significant.

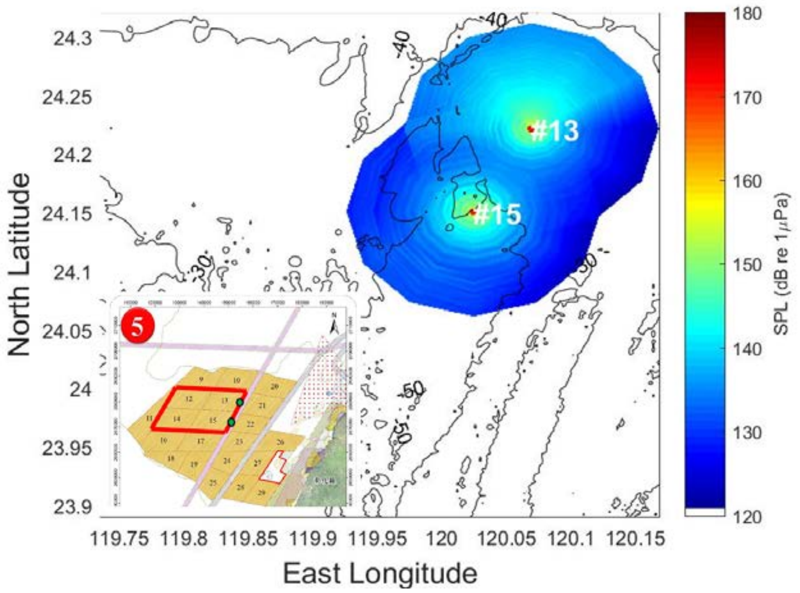


Fig. 7.1.4-30 Distribution of underwater noise source attenuated when construction is done simultaneously in northeast and southeast wind farmsSL(RMS)=220 dB re 1 Pa @ 1m; SL(SEL)=210 dB re 1μP^2.s

B. Simulation evaluation results of 6 wind turbine units from 6 wind farms of 3 developers (each developer provide 2 wind farms and 1 unit) construct foundation piling at the same time.

Wind turbines of offshore wind power generation plan which is near to the fairways, each from northeast and southeast of Greater Changhua (#13 is the northeast wind farm and #15 is the southeast wind farm of the project), second and third wind farm of Hai Ding, second and third wind farm of Hai Long are chosen. Foundation piling of these six wind turbine units are constructed simultaneously. The results are as follows:

a. When piling of 6 wind turbine units are constructed simultaneously, underwater noise value of windfield#13 was reduced to 160dB and the distance was kept 150m within piling point.

b. When piling of 6 wind turbine units are constructed simultaneously, underwater noise value of windfield#15 has reduced to 160dB and the distance was kept 130m within piling point.

c. When piling of 6 wind turbine units are constructed simultaneously, underwater noise value of 3rd wind field of Hai Deng#17 has reduced to 160dB and the distance was kept 1300m within piling point.

d. When piling of 6 wind turbine units are constructed simultaneously, underwater noise value of 2nd wind field of Hai Deng#16 has reduced to 160dB and the distance was kept 1500m within piling point.

e. When piling of 6 wind turbine units are constructed simultaneously, underwater noise value of 2nd wind field of Hai Long#19 has reduced to 160dB and the distance was kept 700m within piling point.

f. When piling of 6 wind turbine units are constructed simultaneously, underwater noise value of 3rd wind field of Hai Deng#18 has reduced to 160dB and the distance was kept 1400m within piling point.

According to the simulation results (fig. 7.1.4-31), the distance between two wind turbine unit of Greater Changhua, northeast and southeast wind farms is about 9 km, distance between 2nd wind turbine and 3rd wind turbine of Hai Ding is about 12.5 km, distance between 2nd wind turbine and 3rd wind turbine of Hai Ding is about 9 km. When piling of six wind turbines are constructed simultaneously, the underwater noise value are reduced to 160dB, the value is almost the same as the value of single unit of wind turbine piling construction. Thus, the cumulative effect of six wind turbine piling construction happens at the same time in six wind farms is not significant.

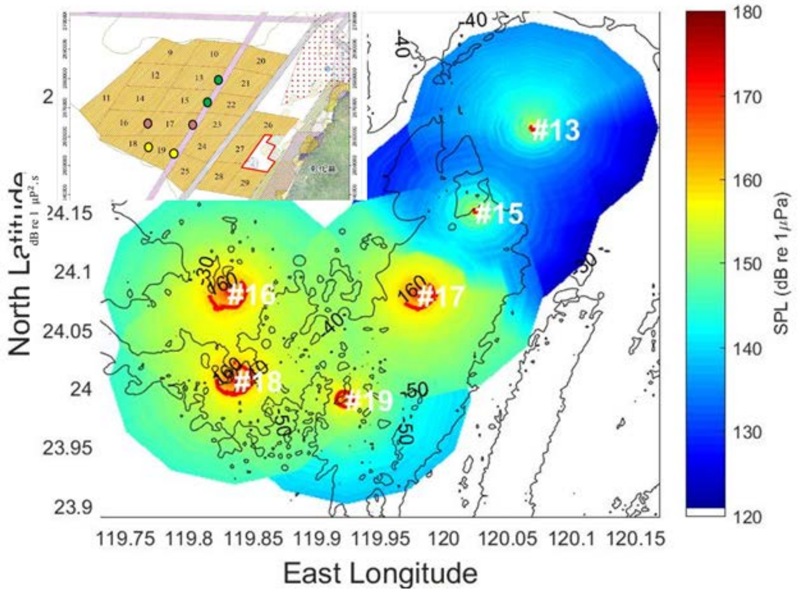


Figure 7.1.4-31 Distribution of underwater noise noise source attenuation when construction is done simultaneously in Greater Changhua's northeast wind farm, Greater Changhua's southeast wind farm, second and third wind farm of Hai Ding and second and third wind farm of Hai Long. SL(RMS)=220 dB re 1 µPa @ 1m ; SL(SEL)=210 dB re 1 µP2.s

(i) Single Frequency Simulation For Operational Noise

1. Operational Sound Source

According to the information below: SIEMENS Co. measured operational noise generated by SIEMENS-SWT-4.0- 120 wind turbine according to the IEC 61400-11 regulation, the measured data (L_W, Sound Power Level) are listed in Table 7.1.4-20. L_{WA} in the table is the weighted value of A to convert noise signals into the amount of noise heard and felt by human ears. Therefore, it is necessary to include the frequency-domain weighting on signals measured with noise level meter in different frequency domains.

In Figure 7.1.4-32, the blue line represents the actual sound power level. The conversion shows that the maximum noise occurs in the low frequency band. Information of noise sources is generated by wind shear noise of wind turbine's blades. However, the underwater operational noise is different. In fact, the underwater operational noise is transmitted by wind turbine vibration through derrick to underwater. Therefore, with reference of "One, Measurement of Wind Turbine Vibration and Noise" of "Fu Hai Offshore Wind Power Generation Project", data of operational sound source vibration is shown in Figure 7.1.4-33.

The vibration measurement of wind turbine shows the maximum velocity in z-direction is $u_{3.15\text{-Hz}} = 2.8\times10^{-4}$ m/s, but the frequency is below hearing band(3.15Hz). Thus, we use the next peak velocity at 125 Hz $u_{125\text{-Hz}} = 1.7\times10^{-4}$ m/s to calculate the source level using acoustic impedance,

$$20\log\frac{u_{125-Hz}\rho_0 c}{p_{ref}} = 20\log\frac{1.7\times10^{-4}\times1.48\times10^{6}}{1\times10^{-6}}$$

$$\cong 168 \text{ dB re } 1\mu\text{Pa @1m}$$

However the above measurement and calculation is in the air, for noise transmission in water, the added mass of water is three-times of the added mass in air, and the fluid damping is 5 times. Thus the vibration in water is 15 times less than it is in air, the source level for wind turbine noise in water should be less of 24 dB, i.e. the source level of underwater noise from wind turbine operation is 144 dB re 1 uPa @1m.

Table 7.1.4-20 wind speed is 8 m/s，1/1 octave band spectrum

1/1 oct. band, center freq.	63	125	250	500	1000	2000	4000	8000
L_{WA}	91.2	98.3	100.2	101.4	102.2	100.8	93.5	82.1
A-weighting	-26.2	-16.1	-8.6	-3.2	0	1.2	1	-1.1
L_W	117.4	114.4	108.8	104.6	102.2	99.6	92.5	83.2

Fig. 7.1.4-32 Actual value (Blue line, L_W) and A-weighting (Red line, L_{WA}) 1/1 octave band spectrum

Fig. 7.1.4-33 Vibration Speed spectrum in z-direction of No.1 wind turbine

2. Operational Operational Noise-Single Frequency simulation

Acoustic harmonic wave equation in cylindrical coordinate is shown below [4]:

$$\frac{\partial^2 y}{\partial x^2} + \rho \frac{\partial}{\partial x}\left(\frac{1}{\rho}\frac{\partial p}{\partial z}\right) + k^2 p = 0 \qquad (1)$$

Where ρ is density, k is wavenumber, c is sound speed, and ω is frequency.

Eq. (1) can be represented as Eq. (2)

$$\left(\frac{\partial}{\partial r} + ik_0(1+x)^{\frac{1}{2}}\right)\left(\frac{\partial}{\partial r} - ik_0(1+x)^{\frac{1}{2}}\right)p = 0 \qquad (2)$$

$$X = k_0^{-2}\left(\rho\frac{\partial}{\partial z}\frac{1}{\rho}\frac{\partial}{\partial z} + k^2 - k_0^{-2}\right) \qquad (3)$$

where $k = \left(1 + i\mu\beta\frac{\omega}{c}\right)$，β 為衰減率，$\eta = (40\pi\log_{10}e)^{-1}$，$k_0 = \frac{\omega}{c_0}$

C0 is reference sound speed, the out-going acoustic wave equation is

$$\frac{\partial p}{\partial r} = ik_0(1+X)^{\frac{1}{2}}p \qquad (4)$$

Eq. (4) can be solved as Eq. (5)

$$p(r+\Delta r, z) = \exp\left(ik\Delta r(1+X)^{\frac{1}{2}}\right)p(r,z) \qquad (5)$$

M.D. Collins used first-order rational function for Eq. (5) [11]：

$$p(r+\Delta r, z) = \exp\left(ik\Delta r(1+X)^{\frac{1}{2}}\right)\prod_{j=1}^{n}\frac{1+\alpha_{j,n}X}{1+\beta_{j,n}X}p(r,z) \qquad (6)$$

$$TL = 20\log p(r+\Delta r, z) \qquad (7)$$

RAM is coded based on Eq. (7), which has the advantage of large marching range step thus less computation time. Eq. (8) gives sound pressure level being equal to source level deducting transmission loss. **SPL**(Sound Pressure Level) = **SL**(Source Level) – **TL**(Transmission Loss) (8)

3. Operational Noise – Single Frequency Simulation

Operational Noise simulation is done with single frequency (125 Hz) simulation. The maximum calculation range is set as 10 km, the horizontal range grid is 100m, vertical depth grid is 1m, and the receiving depth and source depth are 5m. The sound pressure level can be obtained using Eq. 8. Similar to the piling noise simulation, there are 12 azimuthal headings in the simulation. Since the ambient noise level at 125 Hz is about 100 dB or lower, the operational noise would be 4 dB higher than the ambient noise under the assumption of source level as 144dB and the transmission loss equal to 40dB. Fig. 7.1.4-34 shows the ranges where transmission loss is equal to 40 dB, and Table 7.1.4-21 lists the ranges where transmission is equal to 40 dB at different headings at M1 – M4 sites.

Table 7.1.4-21 Maximum Ranges of 40 dB Transmission Loss (TL) in different headings at M1~M4 for Frequency 125Hz (in meters)

Unit: m

Headings	M1	M2	M3	M4
0	200	100	100	400
30	200	100	100	400
60	200	100	100	400
90	200	100	100	400
120	200	100	100	500
150	200	100	100	500
180	200	100	100	400
210	200	100	100	400
240	200	100	100	400
270	200	100	100	400
300	200	100	100	400
330	200	100	100	400

(Note: heading 0^0 represents due north, 90^0 is due east)

Fig. 7.1.4-34 Maximum Ranges of 40 dB Transmission Loss (TL) at M1~M4 for Frequency 125Hz

7.1.5 Impact Analysis Impact Analysis on Scouring of Wind Turbine Foundation

I. Numerical Model

This section examines the topographical change of the sea waters adjacent to the anchor system of individual units. Therefore, the FLOW-3D fluid numerical model analytical software is used, coupled with Sediment Scour Model to conduct scour analysis on wind turbine foundation. FLOW-3D modal is a fluid analysis software introduced by Flow Science in 1985 for commercial purpose. In addition to VOF free-surface modelling technique, it also contains many other important technologies, such as Multi-Block Grids and Fractional Area Volume Obstacle Representation (FAVOR).

The FLOW-3D mode uses the mass continuity equation and the momentum continuous equation as the governing equation. The sediment scouring model is introduced to predict sediment transport and siltation process. It can be used to simulate different properties of gravel, silt and non-cohesive sediments at the same time. The parameters used to determine the characteristics of sand drift on seabed in FLOW-3D model are critical Shields number, Critical shear stress, average particle diameter, density of sediment particle, angle of repose, sediment drag factor, cohesive sediment fraction and rate of erosion. The FLOW-3D simulation process is shown in Figure 7.1.5-1.

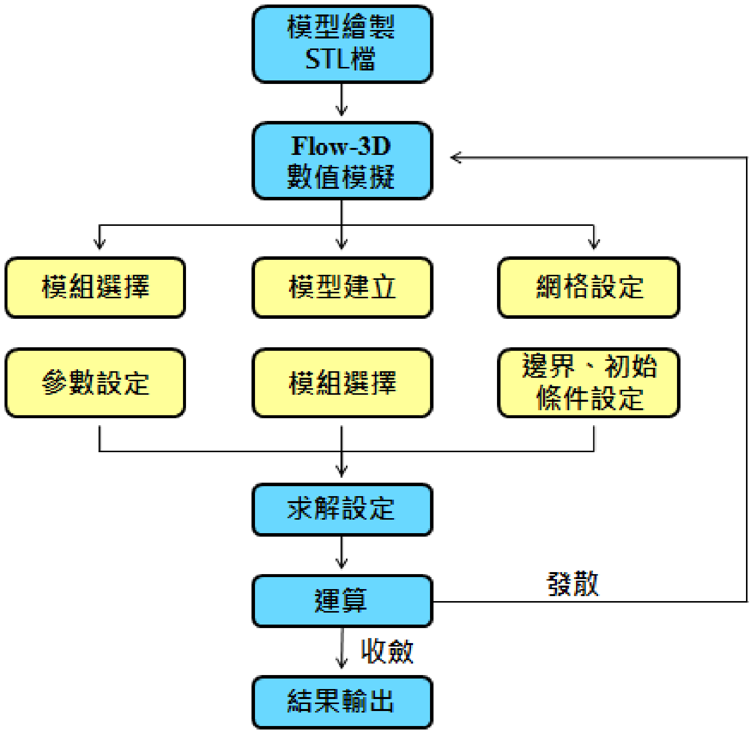


Figure 7.1.5-1 FLOW-3D model calculation flowchart

II. Computational Condition

(i) Physical Model

Three different wind turbine foundation types were initially planned based on wind turbine energy, which include mono-pile, jacket with fixed pile and jacket with suction bucket. The relevant dimensions are shown in Table 7.1.5-1.

Table 7.1.5-1 foundation types of individual unit

Unit of measurement: m		8MW WTG	11MW WTG
jacket with fixed pile	number of piles	4	4
	external diameter of the pile	3.5	4
	pile spacing	38	40

(ii) Mesh Setting

The schematic detail of FLOW-3D mesh setting is shown in Figure 7.1.5-2. The illustration is an example of jacket with fixed pile (diameter of 3.5m). The calculation range is 120m × 80m × 60m; the mesh size is 1m. Accuracy of the structure and seabed scour analysis computations were taken into account, with the mesh range set as 120m × 50m × 12m and the mesh size as 0.5m. Figure 7.1.5-3 is a computational model based on the Fractional Area-Volume Obstacle Representation (FAVOR) of FLOW-3D.

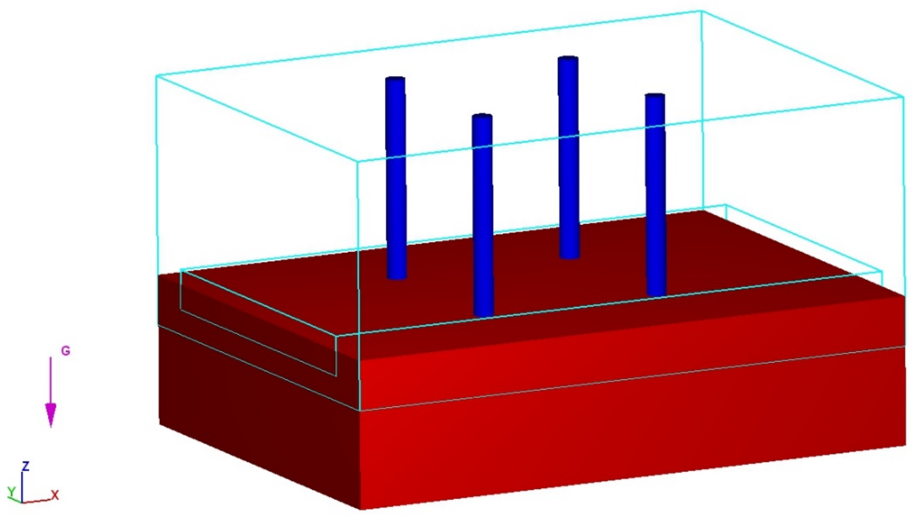


Figure 7.1.5-2 Schematic Diagram Of FLOW-3D Mesh Setting (jacket with fixed pile, diameter of 3.5m)

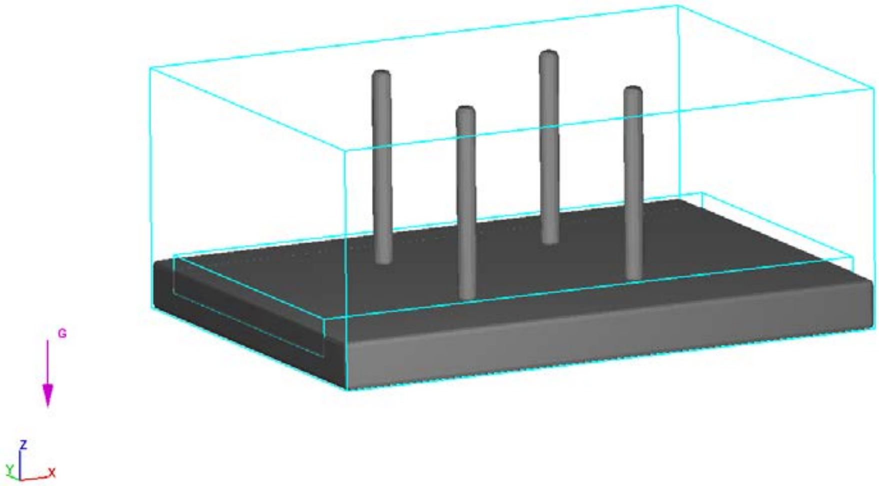


Figure 7.1.5-3 Jacket with fixed pile (diameter of 3.5m) model

(iii) Input Criteria

The marine meteorological observation data (CHW01 Watchmate STA) of the project site was taken into consideration and derived the current rosette during the monitoring period was shown in Figure 7.1.5-4. As shown in the figure, the flow at the project site is mainly in NNE-SSW direction, and mostly with flow velocity of 0.5 ~ 0.75m/sec; therefore, it is intended to apply flow velocity of 1.0m/sec for seabed scour analysis in order to conservatively assess the seabed erosion thickness change of each unit. In addition, water depth of the calculation range is set to 35m. Particle size of sediments referred to the drilling data (hole position B13NE-B) from the adjacent project sites and applied median diameter of 0.15mm.

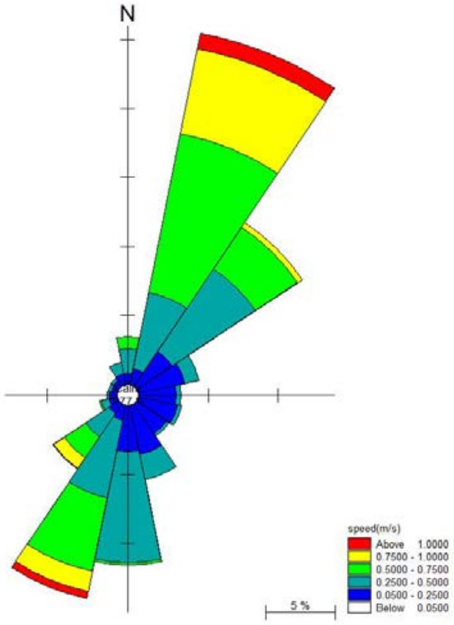


Figure 7.1.5-4 Current Rosette At The Project Site (CHW01 Watchmate STA)

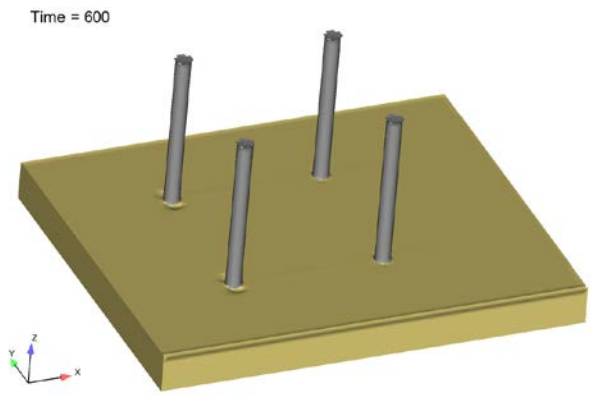
III. Scour Analysis Of Individual Unit

(i) Jacket with fixed pile (diameter of 3.5m)

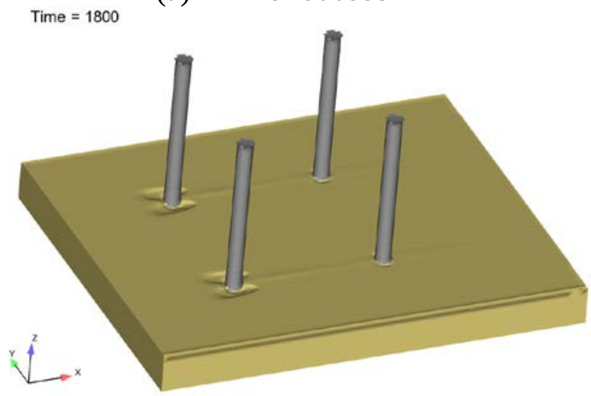
Figure 7.1.5-5 and Figure 7.1.5-6 show the distribution diagrams of seabed scour and seabed sediment thickness for jacket with fixed pile (diameter of 3.5m) under the influence of 600, 1800, and 3600 seconds, respectively, of flow velocity. Due to the impact of flow velocity around the jacket with fixed pile, the seabed gradually develops scouring phenomenon, causing the maximum scour depth at 3060sec reaches up to -1.5m before the change in scour depth slows down, with larger scour depth around upstream of the jacket with fixed pile; by the time of 3600sec, scour depth around the pile is approximately -1.51m, while sediment thickness at downstream of the jacket with fixed pile is approximately 0.32m.

(ii) Jacket with Fixed Pile (diameter of 4m)

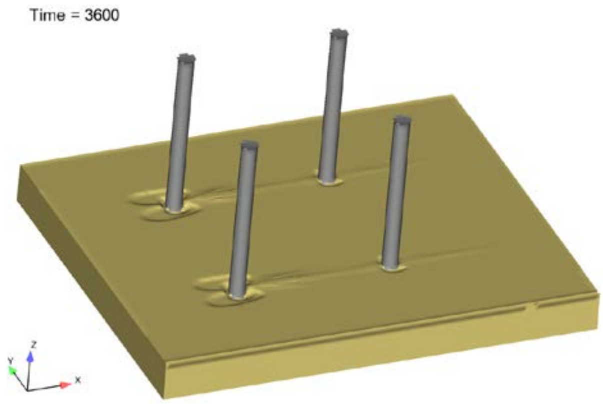
Figure 7.1.5-7 and Figure 7.1.5-8 show the distribution diagrams of seabed scour and seabed sediment thickness for jacket with fixed pile (diameter of 4m) under the influence of 600, 1800, and 3600 seconds of flow velocity respectively. Due to the impact of flow velocity around the jacket with fixed pile, the seabed gradually develops scouring phenomenon, causing the maximum scour depth at 3060sec reaches up to -1.5m before the change in scour depth slows down, with larger scour depth around upstream of the jacket with fixed pile; by the time of 3600sec, scour depth around the jacket with fixed pile is approximately -1.51m, while sediment thickness at downstream of the foundation is approximately 0.31m.



(a) Time=600sec

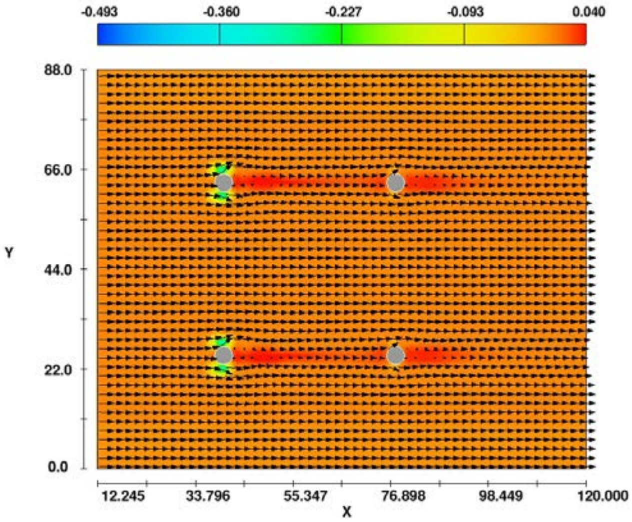


(b) Time=1800sec

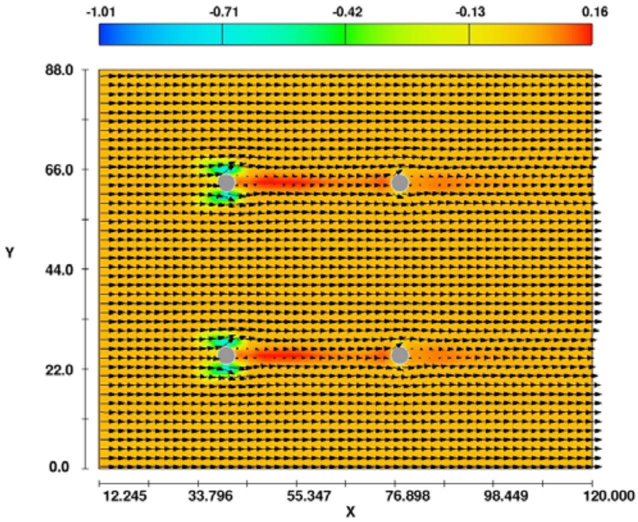


(c) Time=3600sec

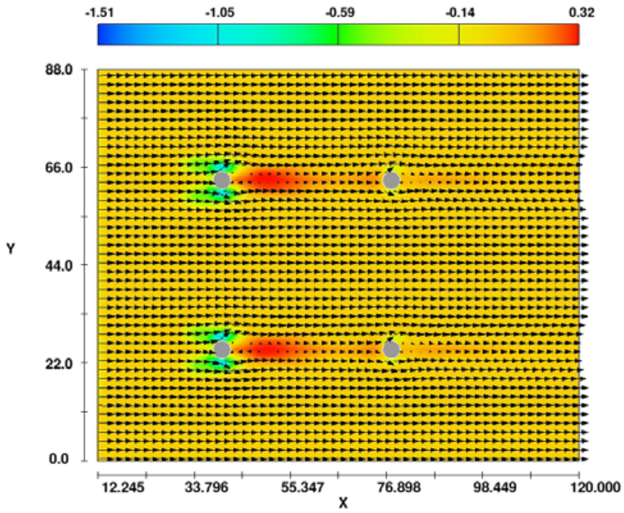
Figure 7.1.5-5 Distribution Diagram Of Seabed Scour For Jacket With Fixed Pile (diameter of 3.5m)



(a) Time=600sec

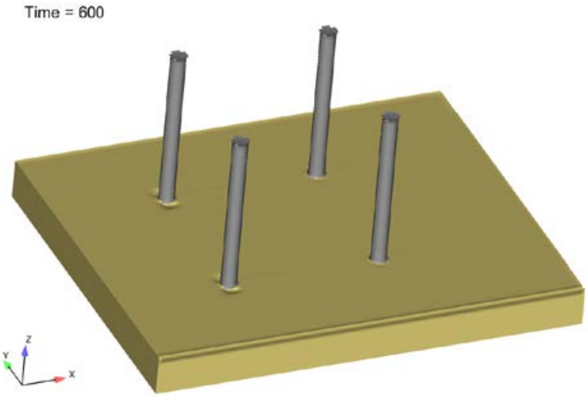


(b) Time=1800sec

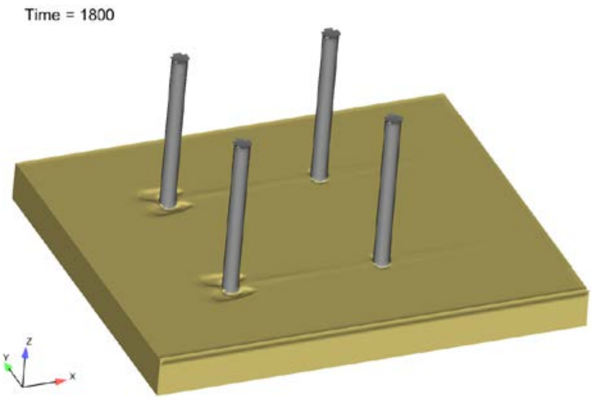


(c) Time=3600sec

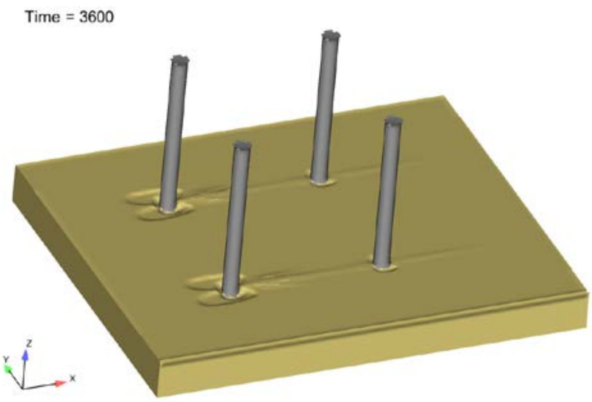
Figure 7.1.5-6 Distribution Diagram Of Seabed Sediment Thickness For Jacket With Fixed Pile (diameter of 3.5m)



(a) Time=600sec

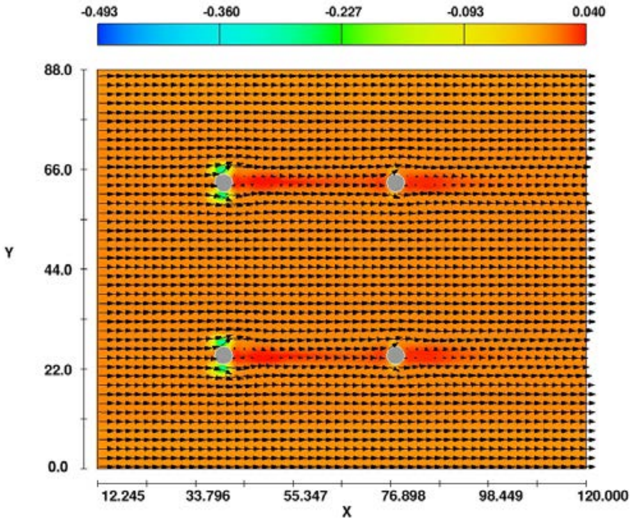


(b) Time=1800sec

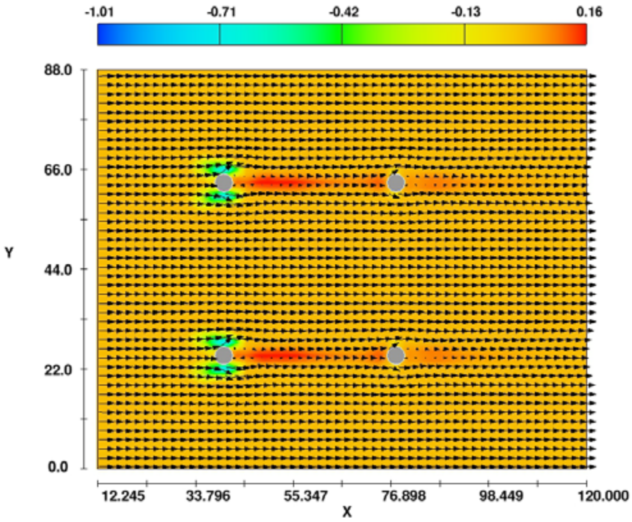


(c) Time=3600sec

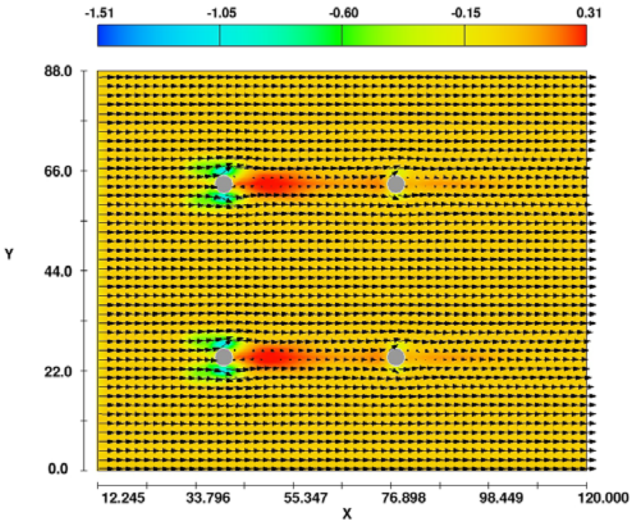
Figure 7.1.5-7 Distribution Diagram Of Seabed Sediment Thickness For Jacket With Fixed Pile (diameter of 4.0m)



(a) Time=600sec



(b) Time=1800sec



(c) Time=3600sec

Figure 7.1.5-8 Distribution Diagram Of Seabed Sediment Thickness For

Jacket With Fixed Pile (diameter of 4.0m)

IV. Summary

According to the aforementioned scour analysis of individual units, we can see that under the influence of 3600sec of flow velocity, the scour change at the foundation tends to be stabilized. The scour depth and scope for each type of foundation are shown in Table 7.1.5-2.

Figure 7.1.5-2 The Scour Depth And Scope For Each Type Of Foundation

		Scour Depth		Scour Scope
		S(m)	S/D	
Jacket with Fixed Pile	D=3.5m	-1.51	0.43	≒2.5D
	D=4.0m	-1.51	0.38	≒2.5D

V. Estimation of maximum scour depth

(i) Calculation of scour depth

1. Scouring calculation tool of MIKE 21

Considering that calculating the maximum scour depth of foundation piles with FLOW-3D model requires a huge number of computing calculation and time-consuming. Our project choose to use Scour Calculator of MIKE 21 to estimate the scour depth of foundation, in which the flow velocity condition, depth of foundation piles and the sediment condition are the same as aforementioned. In addition, the wave condition of 50 years recurrence interval of planning area maximum wave height (8.1m) and duration (11.9sec) are taken into account. The foundation types and wave-current conditions of each individual unit are summarized as shown in Table 7.1.5-3.

Table 7.1.5-4 shows the details of scour depth calculation of each individual unit with scouring calculation tools of Mike 21. Under different wave and current condition, the scour depth of Jacket With Fixed Pile is about 1.15m, while the scour depth of Jacket With Fixed Pile at downstream is between 0.59m to 0.78m. However, the calculation of Jacket With Fixed Pile at upstream is not found in the calculation tool of MIKE 21 due to insignificant flow velocity distribution. Overall, the scour depth of each unit of wind turbine in this project is between 0.15D-0.33D

Fig. 7.1.5-3 Model and wave-current condition of each individual unit

No.	Types	External diameter of pile (m)	water depth (m)	D50 (mm)	Flow velocity (m/sec)	Wave height (m)	duration (sec)
01	Jacket with Fixed Pile	3.5	35	0.15	1.0	8.07	11.93
02	Jacket with Fixed Pile (downstream)	3.5	35	0.15	0.73	8.07	11.93
03	Jacket with Fixed Pile	4	35	0.15	1.0	8.07	11.93
04	Jacket with Fixed Pile (downstream)	4	35	0.15	0.61	8.07	11.93

Note：1. Considering that the jacket with fixed pile of downstream will be affected by the upstream foundation, flow velocity around it will be smaller than the upstream flow velocity. Thus, the maximum flow velocity between the foundation pile of upstream and downstream is calculated by the MIKE 21's HD mode, flow velocity of downstream pile is set as conservative mode.

Table 7.1.5-4 Tabulation of Individual unit's scour depth calculation (MIKE 21)

No.	Type	External diameter of the pile, D (m)	Scour Depth, S(m)	S/D
01	Jacket with Fixed Pile	3.5	1.15	0.33
02	Jacket with Fixed Pile (downstream)	3.5	0.78	0.22
03	Jacket with Fixed Pile	4	1.15	0.29
04	Jacket with Fixed Pile (downstream)	4	0.59	0.15

Note: ratio of scour depth to diameter of pile(Sc/D) under steady flow is 1.3.

2. Empirical formula estimation

The calculation of Sumer and Fredsøe (2002)'s empirical formulas are shown in Table 7.1.5-5. The S/D value under the influence of flow velocity take ratio of water depth to diameter of pile (h/D) into consideration for the influence of scour depth (i.e. S/Sc=1-exp(-0.55h/D)). Thus, the value of scour depth is between 0.94D to 1.11D. In addition, scour depth under influence of wave and current of all unit is between 0.04D~0.45D, which is similar to the result of the MIKE 21's calculation tool.

According to the individual unit's scour depth calculation given by both of the calculation tools, S/D value of each individual unit under influence of wave and current is between 0.21-0.45. The value is less than the ratio of scour depth to diameter of pile under steady flow(1.3). Figure 7.1.5-9 which shows the relationship between ratio of scour depth to pile diameter based on Sumer and Fredsøe (2002). Wave height of planning area's 50 years recurrence interval is about 185m, the value of D/L is about 0.02 according to the outer diameter of pile. Therefore, the value of S/D is about 0.03-1.3, which shows that it is reasonable to estimate the scour depth under the action of wave and current according to the two calculation tools mentioned above.

Table 7.1.5-5 Estimation of Scour Depth For Each Individual Unit

No.	Types	external diameter of the pile, D (m)	Flow velocity		wave and current	
			S(m)	S/D	S(m)	S/D
01	Jacket with Fixed Pile	3.5	3.50	1.00	1.56	0.45
02	Jacket with Fixed Pile (downstream)	3.5	3.50	1.00	1.09	0.31
03	Jacket with Fixed Pile	4	4.00	1.00	1.56	0.39
04	Jacket with Fixed Pile (downstream)	4	4.00	1.00	0.83	0.21

Note: 1. Sc/D ratio of scour depth to diameter of pile under steady flow is 1.3.
2. KC value of wave condition's 50 years recurrence interval is less than 6. Thus, it is impossible to form horseshoe vortex and unable to calculate the scour depth value under influence of wave.
3. The empirical formula for scouring is for equal-section upright. Therefore, the outer diameter of suction caisson refer to the seabed foundation value.

Fig. 7.1.5-9 Relationship diagram of scour depth to pile diameter

(ii) Summary

The reciprocating motion of water particles may cause sediment deposition under the influence of flow velocity. Previous experiment result of upright structure scouring shows that the ratio of scour depth to pile diameter (S/D) under the influence of wave and current usually smaller than the ratio of scour depth to pile diameter under steady flow (Sc/D=1.3). Therefore, based on the conservative estimation of the foundation's scour depth, it is recommended to consider the influence of the flow velocity and correct the scour depth value based on ratio of water depth to pile diameter as shown in table 7.1.5-6. Based on the table, the value of each individual unit's scour depth is about 1.0 D.

In addition, the scour depth calculation is limited to equal-section upright. Therefore, it is necessary to use the hydraulic model test to justify the scour depth. The foundation of mono-pile and jacket with fixed pile of this project are also similar to the upright structure, so no hydraulic model test is required.

Table 7.1.5-6 Compiled table of each individual unit's scour depth

Types	external diameter of the pile, D(m)	Flow velocity	
		S(m)	S/D
Jacket with Fixed Pile	3.5	3.50	1.00
Jacket with Fixed Pile	4	4.00	1.00

Note: The empirical formula for scouring is for equal-section upright. Therefore, Therefore, the outer diameter of suction caisson refer to the seabed foundation value.

7.1.6 Electromagnetic Fields

I. Evaluation Method

The electromagnetic field estimation will be carried out in accordance with the "Specification for Electromagnetic Field Measurement and Electromagnetic Field Strength Review Statement" of Taiwan Power Company. The electromagnetic field review and calculation will be carried out for the Xian Xi Substation, Zhang Bin Substation, Lu Xi Substation, the land transmission line along the land and booster stations. Electromagnetic field value of distribution route after the project started operation will be simulated and estimated. The assessment steps are as follows:

(i) Calculating the electromagnetic field values of the sensitive points along the distribution route: Calculating the triaxial electromagnetic field value from a stationary point.

(ii) Calculating the source of three dimensional electromagnetic field: Assessment is done based on the most conservative scenario, including 345 kV, 220 kV and 161 kV power cables in horizontal and vertical directions.

(iii) Considerations: Underground cables of all directions are considered during calculation, and the calculation of two phase sequence arrangements of 3-pin plug are done separately.

(iv) Calculation result: Compare with the EPD 833.3 mG regulatory standard (recommended value).

The electromagnetic field simulation calculation method of power frequency magnetic field is derived from relevant electromagnetic field theory. The magnetic field generated by power frequency field source is similar to static magnetic field.

By using the finite element method software, carrying current simulation calculation of 345kV, 220kV, 161kV three dimensional 3-pin plug, L-type configuration and electric cable will be done. After determining the magnetic field calculation conditions, the three-dimensional space configuration of 345kV, 220kV and 161kV booster station are simulated and calculated.

II. Input Conditions

(i) Electromagnetic Field Calculation Discussion Points

The measurement points for the project are based on the current environmental monitoring of the magnetic field as shown in Table 7.1.6-1 and Fig 7.1.6-1. There are a total of 14 measurement points.

(ii) Power Cable 3D Configuration Simulation

Sectional view of the underground land cable pipelines of the project is shown in Figure 7.1.6-2 The embedment depth is up to 4.2m; there is 1.5m at the upper portion for backfill. During simulation, 3D simulation is used to simulate the electromagnetic field sources, including all 345kV, 220kV, 161kV power cable in the horizontal and vertical directions.

During electromagnetic field simulation, the correct current value of each circuit is required. The total output power of this project is 613MW. In terms of land cable configuration, 220 kV and 345kV are calculated by based on double-circuit lines, while 161kV is calculated based on triple-circuit lines. Land cable routes are divided into six types. Voltage connecting booster station of land area and the landing point is set as 220 kV. Transmission voltage connecting to Xian Xi Substation, Zhang Bin Substation, Lu Xi Substation might differ depending on the situation.

Table 7.1.6-1 Measurement Code And Location Of The Electromagnetic Field Of The Project

survey point	survey point code
Xian Xi landing point	T1
Xian Xi turning point 1	T2
Xian Xi turning point 2	T3
Xian Xi Substation	T4
Chang Bin Intersection 1	T5
Chang Bin Intersection 2	T6
Chang Bin landing point	T7
measuring point	T8
Sheng Lun	T9
Chang Bin ES	T10
Lu Xi landing point	T11
Lu Xi intersection	T12
Lu Xi factory	T13
Lu Xi Substation	T14

1. Landing point B2→(220kV) →Xian Xi Substation(DE) →(161kV) →Xian Xi D/S
2. Landing point B2→(220kV) →Xian Xi Substation(DE) →(345kV)→ Chang Bin E/S.
3. Landing point B1-1→(220kV) →Xian Xi Substation(DE) →(161kV)→ Xian Xi D/S.
4. Landing point B1-1→(220kV) →Xian Xi Substation(DE) →(345kV)→ Chang Bin E/S.
5. Landing point A3→(220kV) →West Lu Gang Substation(DE) →(161kV)→ Lu Xi D/S.
6. Landing point A3→(220kV) →South Lu Gang Substation(DE) →(161kV)→ Lu Xi D/S.

Figure 7.1.6-1 Monitoring Bitmaps Of The Electromagnetic Field Of The Project's Terrestrial Transmission And Distribution

Figure 7.1.6-2 Sectional Schematic Diagram Of The Underground Land Cable Pipeline Embedment

When the transmission voltage is 220 kV, the current of each phase, each circuit is 804.3539A. When the transmission voltage is 161 kV, the current of each phase, each circuit is 732.7448A. When the transmission voltage is 345 kV, the current of each phase, each circuit is 512.9213A. The current calculation process is as follows:

Maximum total output: 613MW

Transmission Voltage 220kV (double-circuit lines)：

$$\frac{613M}{\sqrt{3}*220k*2} = 804.3539\ \text{A}$$

$$\frac{561M}{\sqrt{3}*220k*2} = 736.1216\ \text{A}$$

Transmission Voltage 161kV (triple-circuit lines)：

$$\frac{613M}{\sqrt{3}*161k*3} = 732.7448\ \text{A}$$

$$\frac{561M}{\sqrt{3}*161k*3} = 670.5870\ \text{A}$$

Transmission Voltage 345kV (double-circuit lines)：

$$\frac{613M}{\sqrt{3}*345k*2} = 512.9213\ \text{A}$$

III. Simulated Calculation Results

The calculated values of electromagnetic fields at each observation point are shown in Table 7.1.6-2 to Table 7.1.6-7. The calculation result shows that the maximum value of Lu Xi intersection (T12) from A3 to Lu Xi D/S is 31.986 milligauss, but it is still far below the 833.3 mG reference point of the Environmental Protection Department, and it is not sensitive to residential or school receptors.

Table 7.1.6-2 Calculated Value And Background Value Of Landing Point B2 To Xian Xi D/S

survey point code	survey point	calculated value (mG)note 1	Estimated value(mG)note 2
T1	Xian Xi landing point	0.545720	0.545720
T2	Xian Xi turning point 1	0.014586	0.014586
T3	Xian Xi turning point 2	0.005454	0.197442
T4	Xian Xi Substation	0.021924	0.117562
T5	Chang Bin Intersection 1	3.418366	3.418403
T6	Chang Bin Intersection 2	3.594746	3.594816

Note 1：The calculated value is the calculated value of simulation.

Note 2: The estimated value is the result of geometric average of the calculated value and the background maximum.

Table 7.1.6-3 Calculated Value And Background Value Of Landing Point B2 To Chang Bin E/S

survey point code	survey point	calculated value (mG)note 1	Estimated value(mG)note 2
T1	Xian Xi landing point	0.544314	0.544314
T5	Chang Bin Intersection 1	1.189230	1.189337
T6	Chang Bin Intersection 2	1.802787	1.802927
T7	Chang Bin landing point	7.606692	7.606712
T8	Measuring point	7.994027	8.091032
T9	Sheng Lun	2.248606	2.382126
T10	Chang Bin ES	1.457866	3.822680

Note 1：The calculated value is the calculated value of simulation.

Note 2: The estimated value is the result of geometric average of the calculated value and the background maximum.

Table 7.1.6-4 Calculated Value And Background Value Of Landing Point B1-1 To Xian Xi D/S

survey point code	survey point	calculated value (mG)note 1	Estimated value(mG)note 2
T7	Chang Bin landing point	0.993161	0.993316
T6	Chang Bin Intersection 2	5.094732	5.094781
T5	Chang Bin Intersection 1	3.902700	3.902733
T4	Xian Xi Substation	6.449222	6.450256

Note 1：The calculated value is the calculated value of simulation.

Note 2: The estimated value is the result of geometric average of the calculated value and the background maximum.

Table 7.1.6-5 Calculated Value And Background Value Of Landing Point B1-1 To Chang Bin E/S

survey point code	survey point	calculated value (mG)note 1	Estimated value(mG)note 2
T7	Chang Bin landing point	8.286050	8.286069
T8	Measuring point	7.995601	8.092587
T9	Sheng Lun	2.248862	2.382367
T10	Chang Bin ES	1.457843	3.822671

Note 1：The calculated value is the calculated value of simulation.

Note 2: The estimated value is the result of geometric average of the calculated value and the background maximum.

Table 7.1.6-6 Calculated Value And Background Value Of Landing Point A3 To Lu Xi D/S

survey point code	survey point	calculated value (mG)note 1	Estimated value(mG)note 2
T11	Lu Xi landing point	11.292542	11.292815
T12	Lu Xi intersection	1.731421	1.750081
T13	Lu Xi Factory	1.594661	1.633582
T14	Lu Xi Substation	1.353164	1.433726

Note 1：The calculated value is the calculated value of simulation.

Note 2: The estimated value is the result of geometric average of the calculated value and the background maximum.

Table 7.1.6-7 Calculated Value And Background Value Of Landing Point A3 To Lu Xi D/S

survey point code	survey point	calculated value (mG)note 1	Estimated value(mG)note 2
T11	Lu Xi landing point	0.606680	0.611740
T12	Lu Xi intersection	31.985844	31.986860
T13	Lu Xi Factory	17.134762	17.138428
T14	Lu Xi Substation	2.426335	2.472169

Note 1：The calculated value is the calculated value of simulation.

Note 2: The estimated value is the result of geometric average of the calculated value and the background maximum.

IV. Supplementary Survey

A supplementary survey was conducted on 14th July 2017. In this survey, four sensitive points near the scheduled routes of land cables and pipelines in Lun Wei District are simulated and calculated. The locations of each point are shown in Figure 7.1.6-3, and the four sensitive points are numbered T1-T4 in sequence.

(i) Evaluation Method

1. Calculating the electromagnetic field values of the sensitive points along the distribution route: Calculating the triaxial electromagnetic field value from a stationary point.
2. Calculating the source of three-dimensional electromagnetic field: Assessment is done based on the most conservative scenario, including 345 kV, 220 kV and 161 kV power cables in horizontal and vertical directions.
3. Considerations: Underground cables of all directions are considered during calculation, and the calculation of two-phase sequence arrangements are done separately.
4. Calculation result: Compare with the EPD 833.3 mG regulatory standard (recommended value).

(ii) Input Criteria

1. Electromagnetic Field Calculation Discussion Points

   In this survey, four sensitive points near the scheduled routes of land cables and pipelines in Lun Wei District are simulated and calculated. The locations of each point are shown in Figure 7.1.6-3, and the four sensitive points are numbered T1-T4 in sequence.

2. Power Cable 3D Configuration Simulation

   The total output power of this project is 2423.5MW. During electromagnetic field simulation, the correct current value of each circuit is required. In this project, 161kV is a three-circuit line and 220Kv is a double-circuit line. The current calculation process is as follows:

   The total capacity of this project is about 2423.5 MW. When simulating electromagnetic field, the correct current value of each circuit is needed. In this project, 161 kV is a three-circuit line and 220 Kv is a double-circuit line. The current calculation process is as follows:

   Total output: 2423.5MW。

   161kV current in every circuit:

$$\frac{613M}{\sqrt{3}*161k*3} = 732.7448\ \text{A} \qquad \frac{2423.5MW}{\sqrt{3}\times 161\text{kV}\times 3} \approx 2896.91A$$

$$\frac{561M}{\sqrt{3}*161k*3} = 670.5870\ A$$

220kV current in every circuit :

$$\frac{613M}{\sqrt{3}*345k*2} = 512.9213\ A \frac{2423.5MW}{\sqrt{3} \times 220kV \times 2} \approx 3180.02A$$

(iii) Simulated Calculation Results

Table 7.1.6-8 shows the calculated values of electromagnetic fields at each observation point. The calculation result shows around maximum value of substation C (T2) is 14.25 milligauss. However, it is still far below the 833.3 mG reference point of the Environmental Protection Department, and it is not sensitive to residential or school receptors.

Table 7.1.6-8 Calculated values and estimated values for each point

survey point code	survey point	calculated value (mG)note 1	estimated value(mG)note 2
T1	Landing point	0.113154	0.16
T2	Around substation C	14.23621	14.25
T3	Around substation B	0.001167	0.07
T4	Zhang Gong substation	0.014851	0.12

Figure 7.1.6-3 Electromagnetic field supplementary survey monitoring location map of this project

7.1.7 Waste

I. Construction Period

The domestic waste produced by the construction workers are domestic waste. It can be collected at a designated location temporarily and be taken care in coordination with the waste management agency or the neighboring township public offices. The maximum number of construction workers working at the same time during the project construction period will be approximately 220 persons. According to the year 2015 statistical data from the Environmental Protection Administration, daily waste output per person in Changhua County is 0.818 kg. Thus, the daily waste output of the construction workers will be 179.96g per day. The waste produced during the construction period will be recycled and reused actively to achieve sustainable resources utilization and waste reduction. The waste will be collected in the garbage collection bins of each construction site of each district. Waste management agency or the township office will be entrusted to handle the waste. Little amount of domestic garbage is generated; thus, it has no effect on the qualified waste management agency or treatment facilities in Changhua County.

II. Operating Period

The maximum number of workers working in the booster station during the operating period will be 100 persons. According to the year 2015 statistical data from the Environmental Protection Administration, daily waste output per person in Changhua County is 0.818 kg. The waste produced during the construction period will be recycled and reused actively to achieve sustainable resources utilization and waste reduction. The waste will be properly collected in the garbage collection bins of each construction site of each district. Waste management agency or the township office will be entrusted to handle the waste. Little amount of domestic garbage is generated; thus, it has no effect on the qualified waste management agency or treatment facilities in Changhua County.

During the operation of the wind farm, all waste generated by offshore construction will be collected and transported back to the shore. Waste transported back will be treated in accordance with relevant regulations. Our project will assign a waste manager to be ashore. Suppose that a crew transport vessel (CTV, Crew Transfer Vessel) is used, each vessel can carry 12 passengers and 3 crew members, a total of 15 crew members. The project conservatively estimates that each person produces 12 liters of marine waste per day, and that each CTV vessel should have a capacity of 180-200 liters of waste collection sump, which is larger than the estimated amount of human waste generated. We will ensure the offshore vessel used in this project will have enough capacity of waste collection sump to carry the waste generated by the staff back to shore safely for disposal.

7.1.8 Surplus Earthwork Disposal Plan

According to the “Land Lease Guidelines of Changhua Coastal Industrial Park in Xian Xi Township or Lu Gang Township”, Changhua Coastal Industrial Park is a state-owned land; therefore, the spoils from construction works within this area shall be handled by in-situ levelling in lieu of moving out from the Changhua Coastal Industrial Park.

The project will submit an application to the service center of Changhua Coastal Industrial Park prior to the construction of land cable embedment engineering and booster station construction. Earthwork produced by excavation of the project will be used in in-situ backfill and the spoils will be handled by in-situ levelling in lieu of moving out from the Changhua Coastal Industrial Park.

7.1.9 Communication Interference

Any larger and mobile structure can generate electromagnetic interference (EMI), and the wind turbine will cause electromagnetic interference due to the refracting signal of the blade. The cause of the interference is the refraction signal has a different delay duration due to the length of the path and the Doppler effect which is caused by the rotation of the blade. Among them, the metal blade is most likely to cause radio wave interference, but currently, most of the blade is made of glass fibre reinforced plastic (FRP) material, so there is less likely for interference to happen. The wind turbine setting position can avoid communication interference as long as it is not on the main transmission route.

The wind farm of the project is approximately 35.7km away from the nearest shore, and it is not in the main telecommunication route; therefore, there would be very minimal interference on video and communications radiofrequency of the coastal residents. At the same time, an inquiry with the Coast Guard Administration, Executive Yuan, regarding the impact on the coastal radars was made prior to the registration of the project, preliminary advice was received. Wind farm of the project is located outside the average range of radar coverage, therefore, the preliminary written review assessed that there should be no effect on radar detection. In the future, relevant information of the wind farm will be provided to the competent authorities according the need in grasping information of the sea waters. In addition, responsibility will be taken for improvement if the radar function is in anyway impacted by subsequent construction.

For interference of wind turbines on ship radar, the Maritime and Coastguard Agency of United Kingdom has mentioned the influence of wind turbines on ship radar in Marine Guidance Note, MGN 372. The wind turbines will reflect radar waves to give early warning to vessels. However, the reflected signals may produce multiple reflections or sidelobe echoes within 1.5 nautical miles (1.852 kilometres) from the wind turbines, which may obscure the actual target. When the distance is greater than 1.5 nautical miles (1.852 kilometres), this phenomenon will continue to descend.

Bureau of Energy and The Maritime and Port Bureau are planning the waterway near to the wind farm of the project, The Maritime and Port Bureau will consider using TSS (Traffic Separation Scheme) because TSS has a safe buffer range of 2 nautical miles (3.70 kilometres), so most of the vessels sailing in the waterway will not be affected.

7.1.10 Greenhouse Gas Reduction

I. Definition Of Greenhouse Gas Category

Estimation of Greenhouse gas emissions and reductions during the construction and operation of the project are done according to Greenhouse Gas Emissions Incremental Assessment and Offset Planning Calculation for development Guidelines.

(i) Source Of Greenhouse Gas Emission

1. Construction Period

Main onshore construction includes the booster station project, the land cable project, and the assembly and hoisting operation in China, Hong Kong and Taiwan (working dock). Its main sources of greenhouse gas emissions are fuel for construction machinery, transport vehicles and hoisting machine/vehicle.

2. Operating Period

(1) Electricity consumption of operation and maintenance centre.

(2) Electricity consumption of booster station machine room.

(3) Fuel consumption of vessels for wind turbine maintenance and repairment.

3. Decommissioning Period

Considering that the decommissioning process is reverse of installation construction, the project assume that the greenhouse gas emissions during decommissioning shall be less than the greenhouse gas emission during the construction period. However, since the actual execution period of decommissioning will be later than 20 years after, the decommissioning plan for this project is based on the current technology of decommissioning. In future, environmental impact assessment will be done again before decommissioning to have a more accurate calculation of greenhouse gas emissions.

(ii) Source Of Greenhouse Gas Reduction

During operation, the electricity consumption of traditional coal-fired gas will be replaced by wind turbine generated electricity.

II. Calculation Basis Of Diesel Usage During Construction

In addition to reference to relevant local research reports (Lin Zhengxing et al., 2009), the average fuel consumption of loading trucks with different cargo-carrying capacity is included to estimate the diesel fuel consumption during construction. Based on development experience of offshore wind farms in the past, the number of vessels, implements or transport vehicles required is multiplied by the estimated daily fuel consumption then multiplied by the estimated number of construction days.

III. Estimation Of Greenhouse Gas Emission And Reduction

(i) Greenhouse Gas Emission During Construction

1. Construction On Land

(1) The greenhouse gas emission sources of this project are mainly divided into two parts: machinery fuel and electricity consumption of working deck. The main machinery fuel is used for booster station project, the land cable project, and the assembly and hoisting operation in China, Hong Kong and Taiwan (working dock). Its main sources of greenhouse gas emissions are fuel for earthwork transport vehicles, concrete mixer truck and hoisting machinery.

(2) Machinery Fuel- Booster Station And Land Cable Project

Referring to relevant local research reports (Lin Zhengxing et al., 2009), the average fuel consumption of loading trucks and concrete mixer trucks of different cargo-carrying capacity are shown in Table 7.1.10-1. The greenhouse gas emissions generated by construction on land (Table 7.1.10-2) are explained below.

Table 7.1.1-11 Transport vehicle specifications and fuel consumption rate

Name	Fuel	Cargo-carrying capacity(m^3)	Average fuel consumption(l/h)
Loading truck	Premium diesel	5	13.63
		8	19.27
		12	25.38
Concrete mixer truck	Premium diesel	3.5	19.43
		5.5	27.47

Sources: Ecological Engineering Energy Conservation and Carbon Reduction Assessment, Lin Zhengxing, etc., 2009, Cross-Strait Conference on Hydraulic Technology.

The total remaining earthwork (lose volume) of this project is about 234,120 m^3. Based on loading capacity of 12 m^3, about 19,510 trips of loading truck (one-way) with an average fuel consumption of 25.38 litres per hour is needed. The total diesel fuel consumption of dump trucks is about 990,328 litres, multiplied by a diesel greenhouse gas emission coefficient of 2.646 kg CO_2e/l. The estimated greenhouse gas emissions of loading trucks during construction are about 2,620 tonne of CO_2e.

This project assumes that about 48,000 m^3 of ready-mixed concrete is needed in the booster station. Assuming that grouting is carried by 5.5 tonne of concrete mixer truck, it takes about 8,728 trips (one-way), and the average fuel consumption per trip is 27.47 liters per hour. The total diesel fuel consumption of concrete mixer truck is 479,516 liters, multiplied by the greenhouse gas emission coefficient of diesel oil 2.646 kg CO_2 e/l, thus, the greenhouse gas emissions of concrete mixer truck during construction is about 1,269 tonne of CO_2.

(3) Machinery Fuel- Hoisting Operation In China, Hong Kong And Taiwan (Working Dock).

This project has the largest number of 8MW units. Lifters, cranes, forklift and transport vehicles are mainly used in assembly and hoisting operations. Assembly and hoisting operations will take about 160 days, 8 hours a day to be done. Based on current project planning and past construction experience, it is estimated that the total fuel consumption during the assembly and hosting operation is about 328,800 litres of diesel. When multiplied by the diesel greenhouse gas emission coefficient of 2.646 kg CO_2 e/l, the greenhouse gas emission is about 870 tons of CO_2 E. The estimated calculation is listed below:

$328{,}800 \times 2.646 kgCO_2e/l \div 1{,}000 \fallingdotseq 870$ tonne CO_2e

(4) Electricity Consumption Of Working Dock

Referring to our past experience in Belfast Port of United Kingdom, the average monthly electricity consumption of the working dock (including construction base) is about 89,000 kWh. The construction period of the working dock is estimated to be completed in about 6 months. Therefore, the total electricity consumption during the construction period is about 534,000 kWh. According to the announcement of Bureau of Energy, Ministry of Economic affairs, in year 2016, the electricity emission coefficient of Republic of China is 0.529 kg CO2e/degree Celsius. Thus, the greenhouse gas emission is estimated to be 282 tonne.

2. Naval Construction

The main naval construction in this project includes marine cable construction, wind turbine foundation construction, installation of wind turbine upper component, offshore substation construction, etc. The main source of greenhouse gas emissions is the fuel of working vessels. Based on the construction period of each project, the greenhouse gas emissions of each project during the construction period are estimated as shown in Table

7.1.10-3:

(1) Marine Cable Construction

Fuel consumption of the working vessels is about 14,580,000 litres of diesel, multiplied by the greenhouse gas emission coefficient of diesel which is 2.646 kg CO_2 e/l, the greenhouse gas emission is about 38,579 metric tonne of CO_2 E. The estimated calculation is listed below:

14,580,000×2.646kgCO_2e/l÷1,000≒38,579 tonne of CO_2e

(2) Wind Turbine Foundation Construction

Fuel consumption of the working vessels during wind turbine foundation construction period is about 6,750,000 litres of diesel, multiplied by the greenhouse gas emission coefficient of diesel which is 2.646 kg CO_2 e/l, the greenhouse gas emission is about 17,861 metric tonne of CO_2 E. The estimated calculation is listed below:

6,750,000×2.646kgCO_2e/l÷1,000≒17,861 tonne of CO_2e

(3) Installation Of Wind Turbine Upper Component

Fuel consumption of the working vessels during installation of wind turbine upper component is about 8,640,000 litres of diesel, multiplied by the greenhouse gas emission coefficient of diesel which is 2.646 kg CO_2 e/l, the greenhouse gas emission is about 22,861 tonne of CO_2 E. The estimated calculation is listed below:

8,640,000×2.646kgCO_2e/l÷1,000≒22,861 tonne of CO_2e

(4) Offshore Substation Construction

Fuel consumption of the working vessels during installation of wind turbine upper component is about 7,380,000 litres of diesel, multiplied by the greenhouse gas emission coefficient of diesel which is 2.646 kg CO_2 e/l, the greenhouse gas emission is about 19,527 tonne of CO_2 E. The estimated calculation is listed below:

7,380,000×2.646kgCO_2e/l÷1,000≒19,527 tonne of CO_2e

(ii) Greenhouse Gas Emissions During Operation

1. Electricity consumption of Operations and Maintenance Centre (Management Centre)

Referring to our team's experience in Europe (Westermost Rough offshore wind farm, UK), the annual power consumption of the management centre is estimated to be about 440,000 Kilowatt hours. According to the announcement of Bureau of Energy, Ministry of Economic affairs, the electricity emission coefficient of Republic of China in year 2016 is 0.529

kg CO2e/degree Celsius. It is estimated that the greenhouse gas emission of this project will be at least 233 tonne in the year. Assessment results are summarized in table 7.1.9-2:

440,000kWh ×0.5290kg CO_2/degree Celsius÷1,000≒233 tonne of CO_2

2. Power Consumption of Booster Station

According to the experience of offshore wind farm development, the annual power consumption of the booster station is estimated to be 1,100,000 kWh. According to the Bureau of Energy, Ministry of Economics Affair, the carbon emission factor in 2016 is reported to be 0.529 $kgCO_2e/kWh$, which results in at least 582 metric tons of annual greenhouse gas (GHG) emissions. The results of the assessment are summarized in Table 7.1.10-2.

1,100,000kWh × 0.529kg CO_2/kWh÷1,000≒582 metric tons CO_2

Figure 7.1.10-2 Greenhouse Gas Emission

Items				Diesel usage (l)	Energy used (kWh)	CO2 emission factor (kg-CO_2e/l) (kgCO_2e/kWh)	GHG emissions (metric tons)
During Construction	Onshore Operation	Construction of booster station and land cable embedment	Dump truck	990,328	—	2.646	2,620
			Concrete mixer truck	479,516	—	2.646	1,269
		Components hoisting operations		328,800	—	2.646	870
	Offshore Operation	Site cables		14,580,000	—	2.646	38,579
		Construction of turbine foundation		6,750,000	—	2.646	17,861
		Installation of turbine components		8,640,000	—	2.646	22,861
		Offshore transformer substation		7,380,000	—	2.646	19,527
During Operation	Power consumption of operation center			—	440,000	0.529	233
	Power consumption of booster station			—	1,100,000	0.529	582
	Turbine maintenance and servicing			2,400,000	—	2.646	6,350
Decommisioning				39,148,644	—		103,587
Total				80,697,288	1,540,000	—	214,339

3. Fuel consumption of the vessel during maintenance or servicing of the turbines

The main vessels used in the operational phase include the "Operation and Maintenance" vessels, motor boats and jack-up vessels. By referring to the catalogue of the relevant vessels, namely Crew Transfer Vessel (CTV) and Service Operation Vessel (SOV), the fuel consumptions of the Operation and Maintenance vessel and the motor boat are estimated to be 2,500 liters/day and 8,000 liters/day, respectively. The fuel consumption of the jack-up construction vessel is assumed to be approximately 35,000 liters/day. Based on the operating experience in Europe, the annual fuel consumption of this wind farm is estimated to be 2,400,000 liters/year, multiplied by the diesel greenhouse gas emission factor of 2.646kg CO_2e/l, so the annual GHG emissions from the maintenance of fuel consumed by the vessels during the operation period is about 6,350 metric tons of CO_2e.

(iii) GHG emissions during decommissioning

Considering that the decommissioning process is roughly the reverse process of the construction, it is estimated that the greenhouse gas emissions during the decommissioning should not be more than that of the construction period.

The total greenhouse gas emissions of sea and land projects during the construction period of this project are approximately 103,587 metric tons of CO2e. Therefore, the greenhouse gas emissions during the decommissioning period should be no more than that amount.

(iv) GHG reduction during operation

Taking into account the factors such as the energy performance, transmission efficiency, overall operating rate of the power plant, hysteresis effect, unit and blade loss, and wake effect, the annual net power generation of this project is about 2,400 GWh/year. Multiplying it with the carbon emission factor of 0.529 kgCO_2e/kWh, given by Bureau of Energy, the estimated greenhouse gas reduction for the year of the project is 1,269,600 metric tons of CO_2e. The results of the assessment are summarized in Table 7.1.10-3:

2,400,000 kWh (2,200 GWh) × 0.529 kgCO_2e/kWh = 1,269,600 metric tons CO_2e

Table 7.1.10-3 Greenhouse Gas Reduction during Operation

Type	Total Power Production (MWh)	CO_2 emission factor (kgCO_2e/kWh)	GHG reduction (metric tons)
Wind turbine units (8.0MW，76 units)	2,400,000	0.529	1,269,600
Total			1,269,600

Note: According to the Bureau of Energy, Ministry of Economics Affair, the carbon emission factor in 2016 is reported to be 0.529 kgCO2e/kWh.

IV. International Carbon Market

At the moment, the international carbon market includes mandatory markets (such as CDM, JI, etc.) and voluntary markets (such as VCS, GS, etc.). The participants in the mandatory market must be the Member State of the United Nation (UN) whereas the voluntary market can be joined by non-member of the UN. Since Taiwan is not a member of the UN Member State it is more feasible to participate in the international voluntary market to obtain the carbon rights in the future. In Taiwan, GHG offset project proposed by the Environmental Protection Administration (EPA) is more feasible, as shown in Table 7.1.10-4. The later section will provide the further evaluation of the suitable approach in obtaining the carbon rights. The following provides descriptions of the international voluntary market and the domestic replacement project:

(i) Voluntary Carbon Rights

1. The Voluntary Carbon Standard (VCS) : The Standard was published in the International Emissions Trading Association (IETA) and the World Economic Forum Global Greenhouse Register (WEF) in the end of 2005. VCS uses at its core the requirements of ISO 14064-2 to monitor the quality of greenhouse gas reduction projects, establish a standard for the development fo high quality GHG emission reductions in voluntary markets, provide a reliable framework for Voluntary Carbon Unit (VCU), and achieve the goal of GHG emission reduction by free trade.
2. Gold Standard：The gold standard was established in 2003 by WWF and other international NGOs as a standard of practice for carbon emissions projects under the United Nations Clean Development Mechanism (CDM). Currently there are more than 80 NGO supporters and more than 1,400 projects.

Table 7.1.10-4 Summarization of Technical Feasibility of Carbon trade exchange

Market model	Any case study of applation of renewable energy project in Taiwan	Technical feasibility
International mandatory markets (CDM, JI, etc.)	No	Not feasible at the moment
International voluntary markets (VCS, GS)	Yes	Feasible
Domestic GHG offset project	Yes	Feasible

(ii) EPA GHG Offset Project

The project is in accordance with the UN’s Clean Development Mechanism (CDM) and the EPA’s GHG emission reduction regulations. Applicants must submit the project plan document (PDD) according to the EPA regulations. After being validated, reviewed, and registered, the applicant shall implement and operate the registered PDD in accordance with description in the registered PDD. The monitoring results shall be verified via Verification Bodies that EPA recognized, afterward, the applicant could request for issuance of reward credit to EPA. The implementation of GHG Offset Project shall be followed the description of methodology designated by EPA. The GHG offset program can be divided into three categories: renewable energy, fuel conversion, and energy efficiency improvement. Renewable energy power generation can replace fossil fuels to generate electricity, thereby reducing GHG emissions. After calculating the performance of the reduction, an offset program proposal is made and submitted to EPA for carbon rights application. Cases of Taiwan applications are listed in Table 7.1.10-5.

Table 7.1.10-5 Applications of EPA's GHG Offset Program

Project Name	Stage of application	Status	Annual average emission reduction estimation (tCO_2e)*
Wind Turbine at Port of Taichung	Proposal submission	---	485877
Phase I, II and III of Offshore Wind Power Project by Taiwan Power Company	Proposal submission	---	1520717
Longgang Wind Power Project	Proposal submission	Withdrawn	177919

Source: Taiwan GHG Emissions Registry https://ghgregistry.epa.gov.tw/offset/offset_Search.aspx。

7.2 Ecological Environment

7.2.1 Ecology on Land

I. Plant Ecology

i. Possible Impacts on Plant Species Compositions

The investigation zone is mainly composed of plantations and saline-alkali wasteland. The plantations are all windbreaks with flat topography, deep soil layers and plant species similar with those in the nearby areas. 50.89% of the species compositions found in the investigation were native species, followed by 43.75% of naturalized species. Engineering operations will have greater influence on habitat destruction but limited damage on the diversity of native species. .

ii. Possible Impacts on Rare and Endemic Species

There are 3 unique plants in this zone, which are Koelreuteria elegans, Chloris formosana and Phoenix hanceana. There is only 1 rare species, Thespesia populnea, which is listed in the Preliminary Red List of Vascular Plants of Taiwan. Since it can be planted artificially and is not listed as the rare plant species in Taiwan according to the “Technical Specification for Plant Ecological Assessments”, no special treatment is given.

iii. Potential Impacts on the Ecology of Local Vegetation

Although the vegetation within the investigation zone consists of low naturalness plantation and saline-alkali wasteland, the wind gap generated by the engineering operations may cause fragmentation of plantation, which could affect the native biological interactions. In addition to that, afforestation is difficult to be carried out due to strong wind in the area. The above can be the causes of the vegetation depletion, the reduction of animal habitats, and loss of food sources, all of which force the animals to seek new habitats. All of the above are irreversible ecological damages. However, according to the current development path, damage on forest development is almost non-existent.

II. Animal Ecology

i. General Species

Since the investigation zone is located in the industrial park which is low in naturalness, the animal species found in the area are mainly those which can adapt to man-made environment and frequent human activities. It is estimated that the interferences and destruction upon habitats of terrestrial animals caused by construction activities and machinery should be local and temporary. The use of construction vehicles may result in roadkill of small mammals, amphibians and reptiles. However, the general species in the area are of high fecundity and strong migration ability, therefore the amount of roadkill will be minimal.

ii. Endangered Species

According to the results of the two-season terrestrial ecological surveys, there are no endangered species among terrestrial mammals, amphibians, reptiles, butterflies and dragonflies. There are four endangered birds species, of which two species of raptors, the Falco tinnunculus and Elanus caeruleus, are classified as level II – Rare and Valuable Species; the summer visitor of Oriental Pratincole and winter visitor of Lanius cristatus are classified as level III – Other Conservation-deserving Species. Falco tinnunculus and Elanus caeruleus would circulate at a large open area for food hunting; the excavation area of land cable is small and the construction is temporary, therefore, it will not cause severe loss in the birds' foraging habitat. According to the investigation, the Oriental Pratincole was only flying by and would not be affected much by the land cable construction. The winter visitor Lanius cristatus is widely distributed at the west part of Taiwan, where there are multiple suitable habitats, thus local and temporary construction activities will not cause any significant effect on the species.

7.2.2 Marine Ecology

The current research data on marine ecology of offshore wind turbine zone is mainly collected from the European countries such as Denmark, Germany, Sweden, and the United States, where most studies are focusing on individual species and there is still inadequate knowledge of impact on tropical oceans and the entire ecosystem. The International Union for Conservation of Nature (IUCN) has assessed the possible temporal and spatial effects of offshore wind turbine zone on marine life, as described in Table 7.2.2-1.

Offshore wind turbines may change or interfere local sea hydrology, water quality, sediment, topography and landforms due to noise and electromagnetic fields generated during the construction and operation period. This will affect the physiology, ecology or behavior of marine species, including fishes, planktons, marine mammals, birds, benthic organisms, sea turtles and etc., thereby affecting the structure and function of regional marine ecosystem and fishery resources.

Table 7.2.2-1 Possible Impacts of Offshore Wind Turbine Construction and Operation on Marine Ecology and Coastal Fisheries

Primary Environmental Topics		Level of Impact (1 Low to 5 High)	Amount of Impact (n.a=not available)		
			Space	Time	Severity (-) or Benefits (+) for species and clusters inside the wind farm
Fishes	Impact of sound wave during construction	5	Local	n.a	Small(-)
	Change or loss of habitats during construction	3	Very Local	Short	Large (-)
	Diffusion of suspended particles during construction	1	Broad	Short	Small (-)
	Noise interference during operation	4	Very Local	Long	Small (-)
	Trawling difficulty	5	Broad	Long	Large (+)
	Effects of artificial reef	3	Local	Long	Medium(+)
	Magnetic field	2	Local (Except Migrant Fishes)	Long	Small (-)
	Wind turbine impact	2	n.a	n.a	Small (-)
	Biological sound blinded by noise	2	Local	Long	Small (-)

[The grades of the spatial scales in the table: 'Very local' refers to distances of up to 10 m from the wind turbines, 'local' means distances of 10-100 m, 'wide' refers to distances of 100-1,000 m, and 'very wide' refers to distances greater than 1,000 m. Time gradients: 'short term' refers to only during the construction period, while 'long term' includes the operational period. Impact size refers to the impact on the cluster structure and number of types, signified as light ('small'), medium ('medium ') or significant ('large')]

In general, offshore wind turbines may affect benthos, whales, seabirds, bats and other species due to the generated noise, electromagnetic fields, hydrology, water quality, habitat substrate, topography, landforms and other factors. In this project, however, the current wind farm is 3 nautical miles away from the shallow waters where the endangered species Sousa chinensis most frequently appear. The intertidal cables will not be located at the significant costal wetland as the construction will most probably bring negative impact, according to the current foreign data. However, properly planned construction of the wind turbine is more likely to bring positive effects such as:

1. It can effectively prevent bottom trawling, a non-selective fishing method that sweeps both marketable and undesirable fish and fish of both legal and illegal sizes. The establishment of wind farm will obstruct and prevent the trawling activities and operations.
2. The structure and foundation of offshore wind turbines are attached with fouling organisms, providing food, habitat, and shelter. They are also suitable for

incubation and can function as signposts. The fish aggregation effect of artificial reef may be exerted to attract and cultivate the reef fish resources, causing the habitat change from soft muddy bottom to hard bottom reef and hence, increasing the number of species. In addition to the wind turbine structures that provide shelter and orientation, Fish Aggregation Devices (FAD) can also be installed to the wind turbine structures on the pelagic zone to attract fish and increase the survival rate of fish.

Based on current European wind farm operation experience, no matter the types of seafloor foundation, the cement foundation or truss structure above creates similar effect to artificial reef, where species number and quantity will increase linearly with the size of area. In other words, seafloor foundation will provide protection and create fish aggregation effects similar to various kinds of artificial reefs. Take the monopile foundation of offshore wind farm in Egmond aan Zee, Netherlands for example, 90% of the surface is covered with bivalvia and starfish at a depth of 0~7 meters; whereas 100% of the surface is covered with molluscs such as anemones, hydrozoans, oysters, etc., at a depth of 7~15 meters (as shown in Figure 7.2.2-1). Referring to the case of offshore wind farm in Denmark's Horns Rev., placing anti-scouring rocks on the seabed will create similar effect as artificial reef, which is to attract fishes and sea creatures as shown in Figure 7.2.2-2.

3. Offshore wind turbines may function as marine protected areas (MPA) by restricting fishing and providing fish a shelter for inhabitation and reproduction, hence increasing the survival rate and growth rate. Spillover may happen when the resources of fish go beyond demand, thereby they will be supplied to the nearby fishery for sustainable use by fishermen.

   Since offshore wind turbine is Taiwan’s new energy policy, the effects of underwater noise and vibration and electromagnetic fields on fish have rarely been studied before in Taiwan. At present, it can only be evaluated based on foreign experience and related research results. According to the ready results of foreign studies, it is known that only the strong sound waves generated by offshore wind turbine created by piling during construction period will have significant impact on fish. The noise created during operation period is far weaker than the contruction noise of piling, the test has only be done in the artificial storage tank which the fish cannot escape and is exposed for a long period has been affected (example: Chanos chanos). In short, there are not many studies on the effect of low-frequency noise generated by offshore wind turbines on physiology of fish. Even if it does has an impact, it is inferred that only a few of fish species which capable to hear will be affected. The safety distance needed may varies with different species. The low-frequency noise generated by the wind turbine when operation ended may be 100-200 Hz, and the maximum sound pressure at close range will not exceed 140 dB. Fish species can only hear if it stays within close distance from wind turbine. However, due to the different auditory waveform of various fish species, the level of impact will be different.

The foreign wind turbines which operates for years apparently has fish aggregation effect near its foundation, therefore it is inferred that the noise generated by wind turbine has no effect on fish. However, follow-up study has to be carried out continuously in order to obtain a more rigid conclusion.

Currently, there are only a few native marine fish species in Taiwan with available auditory curves but there are at least 30 species of commercially important fishes in the western part of Taiwan. Sufficient number of living fish is needed to perform the measurement of the auditory curves. Therefore, this investigation has yet to be carried out. Starting from this May, the Bureau of Energy has requested the Ministry of Science and Technology to carry out relevant research and The Institute of Marine Biology and National Taiwan Ocean University are in collaboration with the Institute of Cellular and Organismic Biology. They had set up and finished testing an ABR (Auditory Brainstem Response) instrument which allows them to start collecting live samples of major fish species near the wind farm to measure and compute the auditory curves of the respective species. The effect of indoor simulation of piling noise and noise generated by wind turbine during operation period on the physiology and endocrine functions of fish will also be assessed, but at least a period of 6 to 12 months is needed to obtain some preliminary results.

The impact of electromagnetic fields on fish is considered small as inferred by the international research results, which fail to to conclude that "non-ionizing" electromagnetic waves (especially in the microwave frequency band) is harmful to human body. The submarine cables responsible for power transmission and distribution can fundamentally block or reduce the release of electromagnetic waves into the water, provided that the coating material of the outer layer and shielding effect are good and that the cables are buried under the seabed. According to foreign research reports on wind turbines in operation, no significant effect of electromagnetic waves on the surrounding marine species has been found. For example, the environmental impact study of wind farms in Nysted, Denmark stated that carefully designed cables can prevent the negative effects of electromagnetic waves on migration behaviors of local fish, etc. (Petersen & Malm 2006). Therefore, this topic is not of major interest in foreign researches. The heat generated by electromagnetic waves will not bring any impact to the marine organisms and ecology as it is of very low amount and will be quickly cooled down by seawater even when released into the sea.

According to the previous experience of establishing offshore wind turbines, the impacts on ecological environment of the sea area may not necessarily be negative. Despite the short-term disruptions caused by the construction, the compensation to the fishing industry can be done. Also, the wind farm can provide the similar benefits as a protected area since its operation will cause inconvenience and limit the net fishing activities in the area. The foundation of the turbine and the structure itself can act as artificial reefs by attracting fishes and increasing the biodervisity and abundance of the marine life. The following section provides the evaluation and analysis of the impact of the project on the marine ecology.

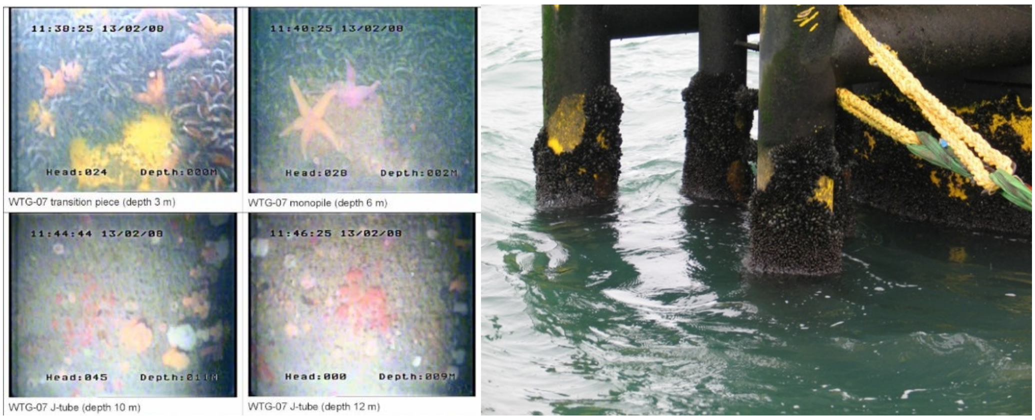


Figure 7.2.2-1 Fundametal Ecology of Egmond aan Zee Offshore Wind Turbine

Figure 7.2.2-2 Denmark's Horns Rev Anti-Scour Rocks

I. Assessment Summary for Construction Period

The impact of construction of the wind turbine foundation and the transmission lines on the marine ecology mostly includes the noise generated by piling, altering the habitat environments, and the proliferation of suspended solids. The noise generated during piling and the shock waves due to high pressure will certainly affect or injure marine life within a close range. Marine species which are able to swim or crawl may escape but they might be hurt or killed if they are not able to do so. Fortunately, the seabed on the west coast of Taiwan consists mainly of sandy mud and most fish species there are migratory. Therefore, the impact should be very little, as opposed to reef habitats with non-migratory fish. It is believed that marine species living in pelagic zone and benthic zone will escape to a distance during piling, and return after the completion of construction. There may be a greater impact on larger invertebrates such as echinoderms, shrimps and crabs, which move slowly along the surface of the seabed, as well as those living below the seabed.

Piling will certainly change the topography and sediments of the original seabed, but the area affected is relatively small compared to the overall wind farm area and it will have a slight effect on phytoplankton and nekton in the pelagic zone. For benthic organisms, seabed creatures living in the soft sediment will leave to somewhere 5 to 10 meter away from the wind turbine foundation as the sediments are affected during the construction. In addition, sand or suspended solids will be stirred up within a very small range, causing turbidity of the seawater; however, it will return to normal within a short period of time with the diffusion force of the current. The concentration of these suspended solids will not be too high and the solid suspension will not last long, therefore, the impact on marine ecology can be ignored.

II. Assessment Summary for Operational Period

The hard substrates that are created after construction and the surface of the turbine foundation will begin to host a significant amount of attached organism such as algae, bryophytes, sponges, nematocysts and even sea squirts, bivalve molluscs, belanus barnacles, etc. This in turn produces an artificial reef which attracts fish shoals and fosters resources, thereby increasing the biodiversity of marine life. In other words, ecosystems that originally consisted of sandy soils are being transformed into rocky reef ecosystems that can increase the diversity of habitats. Most of the seabed in the waters surrounding Taiwan is sandy and muddy with low biodiversity, therefore this change of habitat should be considered favorable. During the operation of the wind turbines, the only concern on marine life or ecology is the low-frequency noise generated. However, its related research is very limited; the useful references can only be found from some researches on basic fish physiology or field monitoring conducted in the offshore wind farms in Europeans countries. Currently, most of the existing researches focus on cetaceans, turtles and a minimal amount of commercial fish; studies on other marine species remain scarce.

It is presumed that noise generated by wind turbine will affect marine life. According to current preliminary investigation results, offshore wind farm in Sweden, that used underwater audio file to simulate the possible noise generated by wind turbines operations, noticed that long-term noise may cause the anxiety of fish when exposed to a considerable level of sound pressure. For example, Chanos chanos have to be within 1m radius of wind turbine in order for its plasma cortisol concentration and the gene expression amount which responsible for cortisol synthesis (11β-hydroxylated hydrazine; cyp11b1) to be increased. Referring to the empirical studies and theoretical inference, noise generated by wind turbine may cause the anxiety or even death of fish, However, there is no solid conclusion from current research.

In the environmental impact assessment of Europe offshore wind power, the investigation of impacts of electromagnetic waves towards marine ecology commonly used shark, Rajidae and Rajomorphii as research objects. The following is a summary of relevant research:

The research by Danish Energy Agency (2006) shows that the electromagnetic waves generated by Nysted offshore wind farm have no impact on fish. In addition, according to the findings of Marine Management Organisation (2014) which focus on "The Impact of Electromagnetic Field of Submarine Cables towards Elasmobranchii", there is no evidence that implies electromagnetic waves pose a significant risk towards Elasmobranchii or the number of the fish in wind farm. As long as the cable is buried to a depth of about 1 meter, there will be less eviction effect on Elasmobranchii located in few meters area.

The latest study of the Kriegers Flak offshore wind farm in 2015 also proves that electromagnetic fields have no significant effect on fish.

Similarly, the environmental impact assessment of offshore wind farms and submarine cables in Germany does not present any direct evidence of the impact caused by electromagnetic waves towards fish.

Based on the research results of Nysted Wind Farm in Denmark on year 2003 and 2004, the electromagnetic field generated by the wind farm cable will have zero effect on dolphins.

7.2.3 Fishery Resources

I. Summary Assessment for Construction Period

(i) Impact on Fish Species

Research on the effects of sound waves on fish created by piling during construction period is very limited. If the sound waves are beyond the fishes hearing threshold, they will demonstrate an escape response. Fishes such as salmon and cod have hearing range of within 2km and 0.6-2.5km radius respectively. Most of the data is of temperate species; tropical and subtropical species are in large quantities but yet to be studied. Apart from adult fish, the effects of sound waves will be different depending on life history periods, body lengths and species. It is presumed that the larval and juvenile fish are not capable to escape as their swimming ability is weak, therefore the impact of sound waves will be larger as compared to adult fish. Many benthic fish such as flounder, are less sensitive to sound pressure than the migratory pelagic fish due to their lack of swim bladder or degeneration. On the other hand, sound waves do have the same effect on planktons. Although piling will drive fishes away, most of them will return after construction has been completed. However, due to the volume of noise and sound pressure of piling, sound attenuation in water is slower than that in the air. Therefore, precaution measures should be taken in order to reduce the impact of piling noise on marine life. According to the investigation's preliminary results of DNA identification and the composition of fish eggs and juvenile fish, Coryphaena hippurus fish egg and Auxis rochei juvenile fish has the most advantage, followed by Myctophidae and Scomberoides tol in the spring. There is spawning peak of Equulites rivulatus, followed by Decapterus maruadsi and Mene maculate; whereas Hemipteronotus caerulopunctatus and Myctophidae juvenile fish has the most advantage in the summer. In the autumn, Acanthopagrus latus reproduces the most number of eggs, followed by Cynoglossus interruptus; Acanthopagrus latus also shows the highest number of juvenile fish, followed by Encrasicholina heteroloba, Sillago sihama, etc. The number of Decapterus russelli fish eggs is the highest in winter, followed by Scomber japonicus; whereas the number of juvenile fish are mainly of Ammodytes personatus, Diaphus luetkeni and Scomber australasicus. The number of Sciaenidae appears less in this wind farm and is limited to Chrysochir aureus. As for Cynoglossidae, it has low acoustic sensitivity since it does not possess swim bladder; as for Leiognathidae, it is mostly used as forage fishes or is disposed directly into the sea since it is not main commercial fish species, hence the impact is not significant; as for Sciaenidae, it would produce courtship sound during breeding season, fishermen often use acoustic fishing method based on this characteristic, which cause depletion of fish resources. However, the fish eggs and juvenile fish of Sciaenidae collected within that area is not large in number, it is presumed that the wind farm may not be the incubation site of Sciaenidae. Other species that may produce sound such as Caranginae, Lutjanidae, Periophthalmini, etc., do not use it for breeding purpose, hence there will be no disturbance on reproduction and has no impact towards fish resources.

From the data accumulated from gillnet questionnaire, it is inferenced that the coastal waters along Changhua may be one of the huge breeding sites of main commercial fishes such as Cynoglossidae, Sciaenidae and Haemulidae, in the west coast of Taiwan. However, the wind farm is approximately 20 nautical miles away from the nearest shore and the number of Cynoglossidae, Sciaenidae and Haemulidae fishes collected is very minimal, which indicates the wind farm is neither the habitat nor breeding grounds of above three fish species. It is not the the gillnetting or trawling area of Changhua fishermen. There is only a small number of crab boat from Taiwan's outlying counties and fishing boats from mainland China operate in the water by the wind farm, therefore, there shouldn’t be major impact on these commercial fishes during future constructions and operations. As for the Rhynchobatus australiae which classified as Vulnerable (VU) by the IUCN, it is found from shallow waters to a depth of approximately 30m with weak swimming ability and motility. It is classified as benthic cartilaginous fish that feed on shrimps, crabs, shellfish, small fish in the mud sediment. Nevertheless, there is a lack of life history and research data of this species, therefore, the constructional impact upon this species is obscure, but with the future establishment of offshore wind turbine, the number of Rhynchobatus australiae may be conserved indirectly due to the inconvenience in fishing.

The Acoustical Society of America (ASA) provides methods and suggestions to develop sensitivity standards (including the definitions of fish damage and its behavior). Fish has been generally grouped into the following four categories according to ASA standard (Popper et al., 2014)：Chondrichthyes belongs to Type I (Elasmobranchii), the sound sensitvity of Sciaenidae has made it be concluded as Type II fish according to Ramcharitar et al. (2006) in Popper (2012).

1. Type I: Fish with no swim bladder, only sensitive to acoustic particle motion and limited to narrow hearing frequency range (including flatfish and Elasmobranchii)
2. Type II: Fish with swim bladder in which it is not for hearing functions, only sensitive to acoustic particle motion and narrow hearing frequency range (including salmon and part of the Scombridae family)
3. Type III: Fish with swim bladder that is close but not attached to the ear, sensitive to acoustic particle motion and wider hearing frequency range which up to 500 Hz, comparable to Type I and II (including Gadidae and Anguilliformes)
4. Type IV: Fish with special physiological structure, possess functional physical connection between the swim bladder and the inner ear. This type of fish has wider hearing frequency range, can reach up to several kHz and is generally high sensitivity to sound pressure comparable to to Type I, II and III (including Clupeidae such as herring, sprattus and American shad).

In the environment impact assessment of United Kingdom, only Type IV fish (with the highest sensitivity to noise) will be taken into account.

Type I (Chondrichthyes) and Type III fishes (Sciaenidae) are less sensitive to acoustic pressure as they may hear through the detection of particle motion. These fishes may demonstrate behavioral response (such as escape) based on sensitive detection of sound pressure, in the form of particle motion, they are not harmed.

In conclusion, piling noise has slight impact on Chondrichthyes and Sciaenidae.

(ii) Impact On Fisheries (Impact By Different Fishing Methods)

According to the investigation, currently the waters by the wind farm is not the fishing area of gillnetting, trawling and hook and line fishing, but individual analysis of each fishing method and its possible impact is discussed below.

1. Gillnetting (including drift gillnetting and bottom gillnetting): There is negligible drift gillnetting and bottom gillnetting in this sea waters. The impact upon Changhua fishery sea waters by the entering and exiting of construction vessels during the offshore wind turbines construction period will mainly due to the operation area of the working vessels will obstruct the navigation of fishing boats and rafts, especially during fishing period. The sea waters by the currently planned wind farm does not overlap with the traditional fishing ground, except some collision risks between the working vessels and fishing boats during the construction period. In order to ensure the smoothness of future offshore wind farm operations, a restriction on keeping boats from entering the navigation zone of the working vessels during the construction period will be installed to maintain a safe distance.

2. Bottom trawling (including single trawling and pair trawling): These sea waters are 20 nautical miles away from the only fishing harbor in Changhua which operates bottom trawling. The journey takes approximately 2-3 hours. The wind farm does not overlap with the bottom trawling fishing ground, except the wind turbine constructions will obstruct the navigation of fishermen's boats, thereby creates collision risks between the working vessels and fishing boats especially during the construction period. In order to ensure the smoothness of future offshore wind farm operations, a restriction on keeping boats from entering the navigation zone of the working vessels during the construction period will be installed to maintain a safe distance.

3. Hook and line fishing: The wind farm located in open ocean, which is approximately 20-25 nautical miles away from Wanggong Fishing Port, and is not a recreational hook and line fishing ground. There are some minor collision risks between the working vessels and fishing boats during the construction period. In order to avoid causing fishermen's loss of ships and the smoothness of future offshore wind farm operations, a restriction on keeping hook and line fishing boats from entering the navigation zone of the working vessels during the construction period will be installed to maintain a safe distance.

4. Other fisheries (including beach seining, stone trap fishing, flow net fishing and stownet fishing): This operation zone is located in the intertidal zone, therefore the establishment of wind turbines will not affect the operation of other fisheries in Changhua.

II. Summary Assessment for Operational Period

(i) Effects on Fish

1. Noise and Vibration

The noise and vibrations generated by wind turbines during operation are related to the design of the blades, the structural configuration of the wind turbines and the foundation design. Taking Swedish offshore wind farms are an example, generally speaking, the noise frequency is mainly broadband noise below 600Hz, with a 100-200Hz resonance. However, the noise near 200Hz will increase linearly with the speed of wind turbines, and become audibly evident above the background noise. Past studies in the area have mentioned that although piling noise during wind turbine construction significantly affects the swimming behavior of local fish at close range, operating noise in the same frequency range does not cause any difference in fish behavior or distribution. Additionally, the distance or range of sound that fish species can hear varies dramatically with different species, ranging from absolutely no hearing to being able to hear at dozens of kilometers of distance. Using a fish pond to carry out simulation of the effects of wind turbine noise on the physiology and endocrine functions of fish, it was found that long-term noise may cause the urge to escape in fish, but they had to be exposed to considerable sound pressure for this to happen. Current known sound pressure of noise generated by wind turbine is not high, and will gradually decrease, hence the impact on fish is rather small. However, there is a lack of data (bases) on the hearing curves of local fish, the biological parameter information of different species based on noise impact towards the physiological or endocrine functions (such as valve or hormone secretion or growth rates), actual piling in the construction of wind turbines (on which to carry out research), various fields of sound pressure, audio detection, as well as the current composition of fish shoals, swimming behavior, shoal size, and other suchlike items of monitoring, further analysis and validation needs to be carried out after wind turbines have been completed and are in operation. For all above reasons, current scientific research is insufficient to determine how much the impact of wind turbines' operational noise will have on the fish. At least, from the current monitoring and research data on offshore wind farms in Europe that have been completed and are in operation, no significant impact of wind turbine noise on fish has been reported.

2. Artificial Reefs

Referring to foreign findings on functions of artificial reef (Bohnsack, 1989; Bohnsack & Sutherland, 1985; Grove & Nakamura, 1991), the main factors that cause fish-attracting effect of natural reef are i) The reef could change the seabed topography, causing vertical mixing of waterbody and creating vortex through current, tides, waves, etc., stirring the mineral deposits on the sea floor and enhance the reproduction ability of plankton, ii) The reef surface provides many sessile organisms (invertebrate organisms such as algae and coelentus, sponges, molluscs, annelids, etc.) with growing and spawning site, in order to form an excellent food sources which attracts migratory fish to aggregate and loiter around, iii) The pores and caves formed by the structure of reef itself, the overlapping effect of reef and sessile organisms on the surface, will become the protective home for demersal fish, shellfish and juvenile fish, thus plays the role of cultivating resources, iv) The surface and hidden area of reef provide an incubation site for adhesive eggs of fish, squid eggs, etc. and later as shelter for growth of fish larvae, v) Provide orientation mechanisms which guides fish migrating.

Offshore wind turbine is currently divided into 2 main categories, i.e. the traditional fixed-foundation turbine and the new floating turbine. At the moment, the offshore wind turbines located at Europe’s Baltic Sea and North Sea are mostly traditional fixed-foundation turbines. However, in order to adapt to deeper sea areas or particular sediment characteristic, alternative design of anchoring the floating platform that carries wind turbine on the seabed has been developed in the past few years. Regardless of the form, artificial structures such as foundation piles or floating platforms that are fixed to the seabed may attract fish like artificial reefs or the pelagic Fish Aggregation Device (FAD) and even create new artificial habitats. This reef effect is a potential positive effect caused by offshore wind farms. Denmark's Horns Rev is one of the world's largest offshore wind farms, located in transitional water at a depth of not more than 20m. According to a study by Denmark’s International Institute of Aquatic Resources, by comparing the fishery resources in the vicinity of wind farm before construction and after operation, it is found that the wind turbines have no adverse effects on the local fish. The study also implies that these stones structure protected by the turbine foundation can be used as artificial reef to attract fish, as fish abundance is greater in the vicinity of the turbines. According to domestic and foreign research reports, the establishment of artificial reefs may provide marine species with the environment of habitation, reproduction, food resource, migration and shelter from predator (Linley et al. 2007; Langhamer 2012; Ambrose & Anderson, 1990; Bohnsack, J. A. 1989; Bohnsack & Sutherland, 1985; Bohnsack et al. 1994; Chang et al. 1994; Pickering & Whitmarsh, 1997; Wilhelmsson D., 1998; Arena et al. 2007). In the past ten years, the study on the impact of offshore wind turbine on the marine ecosystem has been mainly conducted by European countries. Wilhelmsson et al. (2006) investigate the potential for wind turbines to function as artificial reefs and fish aggregation devices (FADs), i.e. whether they would locally increase fish densities or alter fish assemblages. Fish abundance was greater in the vicinity of the turbines than in surrounding areas, while species richness and Shannon－Wiener diversity (H’) were similar. On the monopiles of the turbines (within 1m radius from wind turbines), fish community structure was different, and total fish abundance was greater. Wilhelmsson et al. (2006) propose that wind turbines may functions as artificial reefs and fish aggregation devices (FADs). Reubens et al. (2013) analyses the data of fish in the vicinity of Belgium Offshore (North Sea) Wind Farm from 2009 to 2012, and discovered the Atlantic cod (Gadus morhua) that appears in the vicinity of turbine has age of majority at 1 and 2, whereas the age of majority of pouting (Trisopterus luscus) is at 0 and 1. Both of the species display no significant difference on fish stomach content of different research site. Comparing to the surround sandy bottom area, these 2 species were recorded larger in size and higher degree of stomach content, although the prey composition in both research area is different. There is no evidence shows that artificial reef in wind farm has the effect of ecological trap towards Atlantic cod and pouting.

Reubens et al. (2014) studied the effects of the offshore wind farm on the ecology of the pelagic fish by analyzing the Atlantic cod (Gadus morhua) and pouting (Trisopterus luscus) species; the results indicate the Atlantic cod and pouting of a specific age group will be seasonally attracted by the offshore wind turbines. They inhabitat the area, show high site fidelity, and feed on pelagic fish. Reubens et al. (2014) also suggest that no fishing activities should be allowed in the wind farm area. In another case study (review in Petersen & Malm 2006), Øresund Bridge that is located between Denmark and Sweden has become covered in Blue Mussels and now act as an artificial reef (Anonymous, 2005). Two wind turbine in the strait of Kalmar, central Baltic Sea are also reported to possess reef effect, abundance of Blue Mussels residents on the monopoles. The growth of sessile organisms will creates more microhabitats, which provide shelter to small fish such as Gobiusculus flavescens juvenile fish and Crustacean. This is a significant part for reef effect (Wilhelmsson et al. 2006).

The hard substratum of coastal area provides demensal organisms with various kinds of surfaces and microhabitats to reside and grow. Artificial structure that has been placed on seabed is similar to artificial reef, which it will attract fish and other marine organisms. The turbine foundation and scour protective wall is made of hard substratum, it will increase the local heterogeneity and become the residential base of sessile organisms. Currently, relative report of offshore wind turbine is mainly about the marine ecological research at temperate sea. The literature related to offshore wind turbine's impact on demensal fish in tropical and subtropical oceans remains scarce.

Referring to the report of Science and Technology Research Project carried by Council of Agriculture, Executive Yuan in year 2008-2012, the main factors that cause fish-attracting effect of natural reef are: (i) The reef could change the seabed topography, causing vertical mixing of waterbody and creating vortex through current, tides, waves, etc., stirring the mineral deposits on the sea floor and enhance the reproduction ability of plankton. (ii) The surface of reef provides many sessile organisms (invertebrate organisms such as algae and coelentus, sponges, molluscs, annelids, etc.) with growing and spawning site, in order to form an excellent feeding farm which attracts migratory fish to aggregates and loitering around. (iii) The pores, crevices and caves formed by the structure of reef itself, the overlapping effect of reef and sessile organisms on the surface, will become the protective home for demersal fish, shellfish and juvenile fish, thus plays the role of cultivating resources. (iv) The surface and hidden area of reef provide an incubation site for adhesive eggs of fish, squid eggs, etc. and later as shelter for growth of fish larvae. According to the investigation of artificial reefs in the southern and northern cities of Changhua County, it is found that artificial reefs can attract, aggregate and even protect more habitats and reproduction site of commercially important fish.

It is without a doubt that wind turbine will change the ecological system of the surrounding environment, because organisms attached on the surface of the artificial reef can provide food and shelter, increasing the inhabitants of coral reef-dwelling fish. Area 50~100 meters away from the tubines should be unaffected. According to the foreign study by Stenberg et al. (2015) at the North Sea Horn Rev #1 on the effects of electric field produced by 80 wind turbines on fish assemblages. They used multiple layers of gillnet at a distance of 0-100m, 120-220m, and 230-330m away from the turbine. The results of the three experimental stations were compared to the results from two control stations without wind turbines. The biodiversity is found to be higher in the area close to the turbine structures, that have the effect of artificial reefs to attract inhabitants without affecting the original silty sand ecology. In other words, these increased reef-dwelling fishes do not change or alter the composition of fish species in the silty sand because of the differences in habitat, activity space and feeding guild or resource partitioning. They can coexist without the negative effects of mutual exclusion or competition, but with the positive effects of coexistence. Even though there were more than ten thousands of artificial reefs in the Changhua area, the proportion of the altered ecology in the vast coastal area of the Taiwan Strait is very low, so it should not be significant enough to cause any change in the ecological structures.

The wind turbine foundation lies vertically from the bottom of the sea. Its effective height is higher than that of the artificial reef and is expected to have better fish-attracting effect. In addition, as there is no protective reef near the current wind farm, with the nearest protective reefs (Xianxi, Lunwei) are 14 nautical miles away; therefore, the wind farm may possibly form an individual artificial reef and protective zone in the future. According to the survey conducted in the Changhua reef zone over the years, it is estimated that it would be able to attract and protect more highly economical fishes such as Haemulidae, Lutjanidae, Oplegnathidae, Serranidae (groupers), Siganidae, etc. to come for habitating and breeding.

Based on current European wind farm operation experience, no matter the types of seafloor foundation, the cement foundation or truss structure above creates similar effect to artificial reef, where species number and quantity will increase linearly with the size of area. In other words, seafloor foundation will provide protection and create fish aggregation effects similar to various kinds of artificial reefs. Take the monopile foundation of offshore wind farm in Egmond aan Zee, Netherlands for example, 90% of the surface is covered with bivalvia and starfish at a depth of 0~7 meters; whereas 100% of the surface is covered with molluscs such as anemones, hydrozoans, oysters, etc., at a depth of 7~15 meters.

(ii) Impact on Fisheries (Impact on each fishing method)

According to the investigation, currently the waters by the wind farm is not the fishing area of gillnetting, trawling and hook and line fishing, but the impacts on fisheries are still described respectively as follows:

1. Gillnet fisheries (including drift gillnetting and bottom gillnetting): The

drift gillnetting and bottom gillnetting in these sea waters can be omitted. The fishery activities in Changhua are mainly concentrated in coastal sea waters (within 12 nautical miles) at water depths of 10-30m. Although the water depth is almost the same as of the future wind farm, but since the voyage is too far and the results is poor, therefore it is not the gillnetting fishing ground for Changhua fishermen. When the wind farm construction is completed, it will not affect the gillnetting fishing operation of the Changhua fishermen.

2. Bottom trawling fisheries: The Fisheries Agencies restricts bottom trawling fisheries to be operated 3 nautical miles off the coast. The wind farm is 20 nautical miles away from the nearest shore. Since the voyage is too far and the catch is poor, it’s not a regular local bottom trawling fishing area; therefore, the future wind farm construction will not obstruct the trawler’s operation.

3. Hook and line fishing: The wind farm is approximately 20-25 nautical miles away from Wanggong Fishing Port, not a hook and line recreational fishing ground. Therefore, establishment of the wind turbine will not affect Changhua’s hook and line recreational fishery operations, and may even become a shelter for fishes due to the reef effect.

4. Other fisheries (including beach seining, stone trap fishing, flow net and stownet fishing): This operation zone is located in the intertidal zone, so the establishment of wind turbines will not affect the operation of other fisheries in Changhua.

The sea waters hosting the Changhua fishery operations is vast and the wind farm is located 20-30 nautical miles away from the shore, therefore, upon completion of the construction, it will not cause reduction or restriction upon space of the original fishing zones of the gillnetting fishery and bottom trawling fishery in these sea waters. Most of the fishing rafts in the county are in small scales and with limited mobility. Local fishermen's fishing activities are mostly confined within 12 nautical miles off the coast; chances to take risk and operate at the wind farm is very rare.

III. Decommission Period

The impact to fishery during the decommissioning period is similar to that of the construction period where risks of collision between working vessels and fishing boats is the main concern. In order to prevent fishing boat losses of the fishermen, plus to ensure the success of the decommissioning operation, various operating vessels (bottom trawling, gillnetting and hook and line fishing) must be limited to a safe distance from the sailing zone of working vessels during the decommissioning period in which the effects of decommissioning are temporary.

7.2.4 Bird Ecology

I. Impact On Seabirds

The seabirds recorded during eight previous marine surveys include 27 oceanic birds (Procellariiformes and Suliformes) and 38 gulls and terns. The area where the oceanic birds are active is very broad, suggesting that the wind farm development is unlikely to cause significant effect on habitat loss. These species mostly fly close to the surface of the ocean; the observed flight altitudes within the wind farm are all below 10m. Therefore, even if the oceanic birds enter the operative wind farm, the risk of death by colliding into the wind turbines will also be very low. The terns recorded at wind farm site #15 may be the breeding population from Penghu Islands. Comparing to the oceanic birds' frequent change in the habitat, the breeding population usually has more specific habitat use, and its habitat model is associated to the distance to the breeding sites and the abundance of food. Wind farm #15 is approximately 60km from the Penghu Islands, which is considerably distant, and according to the current survey, the relative number of terns is not high; therefore, the impact on habitat loss should be limited. The flight altitudes of the terns recorded are all below 40m and since the blade operating altitudes for both 8 MW and 11 MW turbine types that will be used in wind farm #15 are above 30m, the risk of colliding into the wind turbines will not be high. However, the number of samples collected in the current investigation is limited, and there are three protected tern species in the wind farm, namely the Sterna anaethetus, Thalasseus bernsteini and Sterna dougallii. For the above reasons, the impact of wind farm development on the ecology of tern should be monitored continually.

II. Impact On Migratory Birds

The Changhua coastal wetlands are important habitats for migratory birds. Take the Dadu Xikou Coast nearby the project for example, it is a highly valued site that is listed as wildlife sanctuary, Taiwan's Wetlands of Importance, and International Important Bird Area. With more than 20,000 birds recorded in the 7 shorebird surveys conducted jointly with Changhua Coastal Industrial Park, the project recorded a number of protected species such as Platalea minor, Elanus caeruleus, Pandion haliaetus, Falco tinnunculus, Sterna albifrons, Glareola maldivarum, etc., which clearly demonstrate the importance of the coasts in this region.

Wind farm #14 is approximately 60km away from the shore. Although it will not cause direct impact on the coastal activities of the birds, relevant information is extremely scarce on whether these birds migrate directly through the straits to the wind farm or along the coast of north and south end of Taiwan. During the survey of sea vessels, 6 migratory birds were in the wind farm, namely Bubulcus ibis, Phalaropus lobatus, Numenius madagascariensis, Columba livia, Irundo rustica and Phylloscopus magnirostris, indicating that at least some species of migratory birds would pass through the wind farm. Although the species and numbers recorded currently are not much and the flight altitudes are lower than that of the turbine blade, it is known that most of the migratory Plovers, Sandpipers, Snipes and

Passeriformes birds migrate mainly during the night. Whether the wind farm is located in the migration route of these migratory birds, the number of the species, the flight altitudes, etc., remain unknown; these issues should be studied in the future.

III. Literature of Impacts On Birds

According to the results from the 8 surverys conducted in the wind farm of this project and other farms located in its northwest, southwest and northeast, only 4 out of the recorded 882 birds species have flight attitude above 30 meters, indicating the low possibility of colloding with the wind turbines.

The concern of bird deaths by collision with the wind turbine is greatly reduced according to a foreign research done by the British Trust for Ornithology (BTO), which reported that 99% of birds tend to avoid colliding with the wind turbines. With a low number of exceptions, more than 99% of the seabirds would avoid flying near the wind farm by changing their flying direction. As shown in Figure 7.2.4-1, another radar survey conducted by Denmark researcher, Horns Rev in 2003~2005 revealed similar findings on the change of flight direction to avoid collision with the wind turbines. Based on the research carried out at Nysted Wind Farm in Denmark, annually there are about 200,000-300,000 coomon eiders and 10,000 swam flying by the wind farm, as indicated in Figure 7.2.4-2.

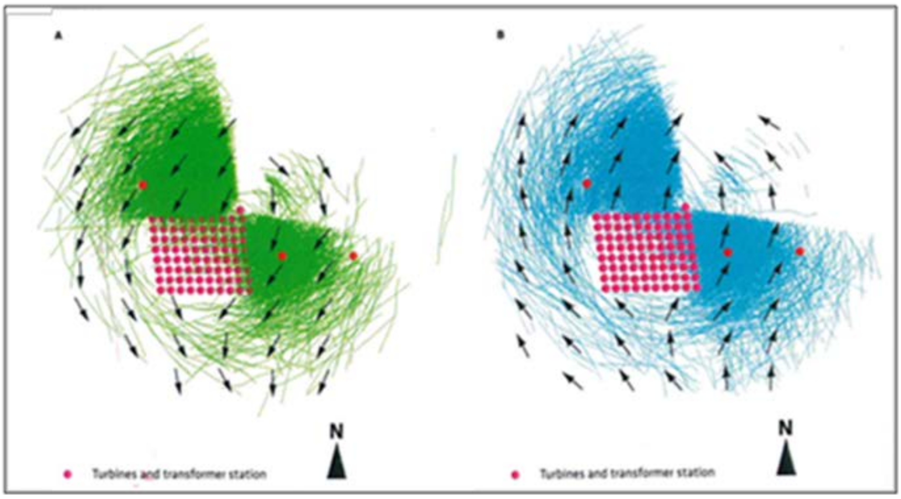
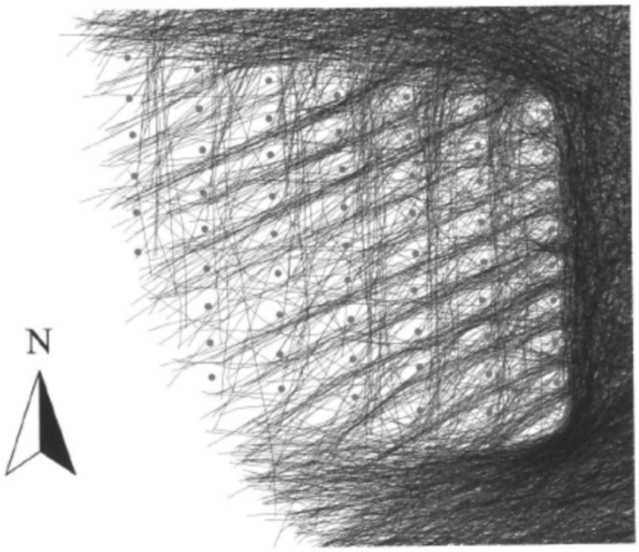


Figure 7.2.4-1 Denmark's Horns Rev Offshore Wind Farm Radar Survey Results (2003~2005)



The westerly orientated flight trajectories of birds tracked by radar at the Nysted Offshore Wind Farm during the initial operation of the wind turbines. Black lines indicate migrating waterbird flocks and the red dots indicate the wind turbines. Reproduced from Desholm & Kahlert (2005) with permission from Royal Society of London.

Figure 7.2.4-2 Denmark's Nysted Offshore Wind Farm Radar Survey Results in 2005

The distance between the turbine layouts in this project is at least 500 meters, which is less than 500m compared with Nysted; and the row spacing of the turbines is 1,775-2,600m. Considering that Nysted could achieve 99% of bird avoidance rate with only 850m of row spacing, the larger distance between the turbines in this project should create a much bigger space and be able to achieve a higher bird avoidance rate.

It is worth mentioning that geese, which are not very agile, could exhibit high evasive performance. The migratory birds in this case including the passerines, pigeons, and especially the swallows have better agility than the goose, so the avoidance rate should be higher.

In fact, the avoidance rate of 99% is an underestimated value. This is because birds with flight altitudes higher and lower than the rotor structures were not taken into account in the simulation of bird behaviors based on the radar survey results. In addition, survey results at Nysted show that seabirds will reduce their flight altitude when passing through the wind farm. At low wind speeds, birds can even fly through the rotor blades, and this too was not included in the estimation of avoidance rate. For the above reasons, the actual avoidance rate is expected to be higher.

In addition, the studies at Nysted wind farm show that the mechanism of avoidance is not dependent on the wind direction. Thus, influence of the wind direction of the Taiwan Strait does not need to be considered in calculating the avoidance rate in this case.

The Nysted study of nocturnal activities of migratory birds indicates that they are more likely to enter the wind field during the day. Since they tend to fly away from the wind turbines at night and travel through the space between the blades, collisions can be avoided. This behavior is not affected by the installation of warning lights on the blades. Despite having no obvious effects on birds, Danish Energy Agency will still ensure that the appropriate number of warning lights are installed to comply with the aviation and ship safety regulations.

The height of the blades of this project was reviewed after reviewing the safety of the unit, the foundation and the installation and hoisting capacity of the wind turbine, the internationally-recognized planning practices and specifications, and the field survey results of the birds.

After reviewing and considering the safety of the unit, the ability of installing the foundation and hoisting the turbine, the internationally accepeted planning practices and specifications, and the survey results, the blade height is positioned at 25 meters above the mean sea level (MSL) set by TaiWan Vertical Datum 2001 (TWVD 2001). As shown by the results from foreign studies, more than 99% of seabirds will change their flight direction and avoid colliding into the wind turbines by flying along the edge of the wind farm, indicating that the possibility of colliding into the wind turbines is not high. Also, there is enough space between the blades to provide passage for birds to fly through the turbine groups.

IV. Bird Collision Impact Assessment

(i) Assessment method

To assess the risk of bird impact, it is necessary to 1) obtain the information related to the species and density of birds in each season/month in the wind farm through field surveys, 2) collect the parameters required for the analysis model, including the nature of each species, the specifications of the wind farm, and the design of the wind turbine, and 3) use a mathematical model with the above information to estimate the impact risk. The four major Changhua wind farms have conducted eight bird surveys in the four seasons from April 2016 to March 2017 to obtain the bird density and perform the simulation using the widely used Band Model in Europe (Band 2012, Masden 2015). The details are further explained in the following:

1. Marine Bird Surveys

The boat survey is a commonly used biological research method in the marine environment (Camphuysen et al. 2004). According to the size of the survey area, the researchers set up a transect line that can fully cover the area and a buffer zone of 1 km around it. The vessel moves along the transect line at a constant speed of about 12 km/h to record the birds appear.

At least two competent observers are required per boat equipped with GPS, binoculars with laser range finder, and a DSLR camera with telephoto lens of 400 mm or more. Observers will run down continuously when the ship sails. Whenever bird activities are observed, the bird species, number of birds, flight direction and altitude, observers' GPS locations and the azimuth angle should be recorded. The GPS locations and the angle will be processed and converted to compute the coordinates of the bird and its vertical distance from the transect line. Since seabirds are usually flying at a high speed far from the observer, it is not easy to differentiate the species at the survey field. Therefore, it is recommended to take pictures of all the observed birds using a long lens for further species identification.

Using the distance sampling method, the data from the survey can be used to determine the density of each species in the wind farm (Buckland et al. 1993). The detection probability is dependent on the distance from the transect line; the relationship between distance and the probability of detecting (detection function) can vary due to the differences in body size and flight pattern. Therefore, in order to estimate the bird density more accurately, the detection probability of each species needs to be derived before calculating the effective stripe width and making correction by comparing with the survey results. However, if only the survey data in a single wind field is used, the number of records of each species is not sufficient to establish the detection function. Therefore, the database of the Formosa Plastics Marine Corporation is used to derive the function. This database contains all the survey data of marine birds surveyed by Formosa Natural History Information Corporation in the northeast of the Taiwan Strait. The derivation of the detection function and the monthly calculation of the bird density at each wind farm are mainly done using the Rdistance package of the R statistical software (McDonald et al. 2015).

2. Model-related parameters

(1) Wind farm specification and turbine physical parameters

Calculation of collision model requires a number of parameters related to wind turbine and wind farm, including the total capacity, local wind speed, height of wind turbine, blades length, largest width of blades, turning speed, blades angles, etc. (as shown in Figure 7.2.4-3), which may vary according to the design of wind farm and wind turbine specifications. The parameters used by the wind farm in this project are as shown in Figure 7.2.4-1.

(2) Parameter of Birds Species

To carry out the collision test, information such as bird's flight height, body size and speed are needed. The bird species' distribution of flight height is attained from marine data base of Formosan Natural History Society. Information such as birds' body length and wing span was referred from Wild Birds of Taiwan (Wu et al., 1999), The Avifauna of Taiwan (Liu et al., 2012) and Field Guide of Wild Bird in Taiwan (Xiao & Li, 2015). Information about flight speed of birds is limited, thus it was referred from Alerstam et al. (2007). The estimated relative function based on 138 species of birds' flight speed (m/sec) and weight (kg) is as follow:

Flight speed (v) = 15.93 × $(\text{weight})^{0.13}$

Table 7.2.4-1 Parameter of Wind Turbine Configuration in Changhua Wind Field Site No. 12-15

Generating Capacity of Each Unit (MW)	Number of Wind Turbine in Each Wind Field Site				Radius of Rotation (m)	Minimum Height of Blades (m)
	#12	#13	#14	#15		
4	147	140	158	151	68	25
6	99	95	107	102	77	25
8	74	71	80	76	82	25
11	54	51	58	55	105	25

Note: The radius of wind turbine rotation in this project is between 68-105m, the actual development for each wind turbine in the future will be designed by needs.

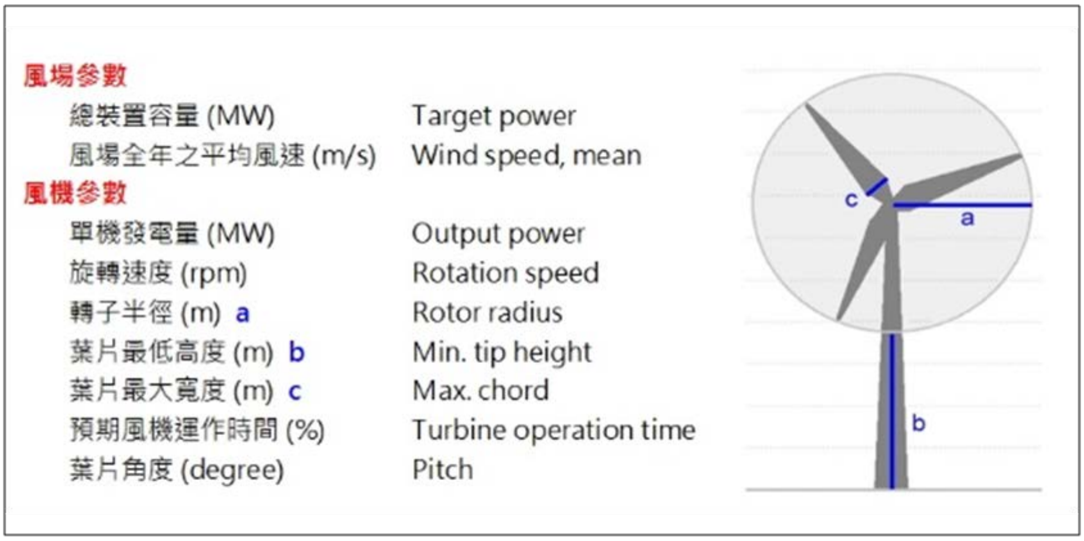


Figure 7.2.4-3 Simulation Diagram of Parameter of Wind Turbine Needed In Different Band Model

3. Band Model

In the past 20 years, there are more than 10 models to estimate collision risk of birds through simulation operation (Masden & Cook, 2016). The collision risk model of Scottish Natural Heritage (SNH) and British Wind Energy Association is used here. This model was established back in year 2000, then it was improved several times by B. Band in order to be used in offshore wind farm (Band, 2012), thus commonly known as "Band Model". It is the most common collision risk model.

The main concept of Band Model is: (1) to count number of birds around blades' rotation in wind field, (2) to count probability of collision of one bird in the rotation area, (3) to combine results of (1) and (2) with time of operation and birds' avoidance behaviour, in order to estimate the number of birds which might collide with wind turbine. Further explanations are as follow:

(1) The number of birds flying around rotation area of wind turbine

In the basic setting of this model, the estimated number of bird species around blades of wind turbine is to convert density of birds (D_A) from survey of ships, planes or radar to Bird Flux (FL), which is the number of birds around a blade's rotation area within a specific time. Then, multiply FL with the total unit of wind turbines in the wind field and time of bird's activity (t) to get the number of birds around rotation area of the wind field. Its formula is as below:

The total number of bird around the blades (N_p)

$$= FL \times N \times t$$
$$= \left(v \times \frac{D_A \times Q_{2R}}{2R} \right) \times N\pi R^2 \times \left(t_{day} + f_{night} \times t_{night} \right)$$

Where v is the flying speed of birds, Q_{2R} is the ratio of birds flying at risky height, R is the radius of wind turbine rotation, N is the total number of wind turbine in the wind field, t_{day} and t_{night} represent length of day and night respectively, f_{night} is nocturnal activity factor.

(2) Probability of collision

The probability of birds to collide with wind turbine depends on their body length (L), wing span (W), flight speed (v), also radius of blade rotation (R), width of blade (c), angle of blade (γ, pitch), speed of rotation angle (Ω) and many more. The physique of bird will be simplified to a symmetrical cross, and the collision probability of a bird around rotation area (r, φ) of a wind turbine will be:

$$p(r, \varphi) = (b\Omega/2\pi v) [\ | \pm c \sin\gamma + \alpha c \cos\gamma | + \max(L, W\alpha F)\ ]$$

Where r is the distance between approaching point and centre point of rotation, φ is azimuth of approaching point in the rotation area, b is number of blades on a wind turbine, coefficient α is $v/r\Omega$, while F is related to birds' flying behaviour. When the target is mainly flying with flapping wings, then F = 1, when the target is gliding, then F = $\cos\varphi$.

Integrate the above function with rotation area, then divide it by rotation area, thus the average collision probability when a bird is around a rotation area can be obtained (P_c).

(3) Operating time of the wind farm

A wind turbine does not operate all the time. When the wind power is too weak to generate electricity efficiently, or when the wind power is too strong that safety must be taken into consideration, the wind turbines will be shut down. Besides, the wind turbines also need to be shut down for a certain period of time every year for regular maintenance. It is presumed that birds will not collide with static objects, hence the wind turbines will only pose a collision risk to the birds during operation, and the proportion of operating time of the wind turbines (Q_{op}) must be taken into account.

(4) Avoidance rate

Majority of the birds demonstrate avoidance behaviour towards wind turbines (Desholm & Kahlert 2005, Plonczkier & Simms 2012). The mode of avoidance may be by making a detour to avoid entering wind farm (macro avoidance), or may be by controlling flight after entering wind farm to avoid collision (micro avoidance). These actions will reduce the actual mortality risk from collisions, therefore it is necessary to include the avoidance rate (A) into consideration.

Integrating the above parameters, the expected collisions will be:

Expected collisions = $(1\text{-}A) \times N_p \times P_c \times Q_{op}$

Birds' avoidance behaviour varies depending on the location of the wind farms and also the target species. Scottish Natural Heritage (2010) has provided avoidance rate for 25 studied bird species as reference, while for the other species which are lack of relevant information, it is recommended to use the avoidance rate of 0.98 while assessing the collision risk of birds to the wind turbines.

It should be noted that at times the wind farm may form an environment for fishes clustering, which attracts birds to forage for them. Wind farms' lighting at night is also likely to have an attracting effect on the birds. These conditions will increase the risk of birds to get into a collision, which can be represented by using negative avoidance rate value in the calculation.

4. Discussion on the uncertainty of the simulation results

The error in the assessment of birds collision is principally due to: (1) Simplification of the model, (2) Variation and uncertainty of the information on the birds, and (3) Uncertainty of the space configuration of the generator sets in the wind farm. The values of error from these three sources can be evaluated respectively, and integrated into a summative range of error by using the following formula:

Summative range of error = $\sqrt{(u_1^2 + u_2^2 + u_3^2)}$

u_1^2 、u_2^2 、u_3^2 each represents the value of error from different sources, and denoted with percentage.

However, in practical situation, the value of error from source (2) and (3) often lack quantifiable data. Band (2012) assessed, the error value due to simplification of the model (u_1) is approximately ±20%.

Simplified presumptions based on Band Model include:

(1) To simplify the shape of birds into cruciform shape represented by the body length and wingspan. This is slightly smaller than the actual bird size, hence possibly underestimating the collision rate.

(2) It is presumed that the flight direction of birds is all perpendicular to the area of rotation of the wind turbines, without considering that the longer time is required for an individual to pass through the area from an oblique angle, hence underestimating the collision rate.

(3) The basic form of the model presumes that the density of birds in the whole rotation area is the same; however in fact the density of seabirds is normally higher at the lower part of the rotation area. This difference will lead to overestimation of the collision rate.

(4) The model presumes birds will not collide with static objects, the wind turbines are only dangerous when operating; however at night or when there is dense fog, the birds might still collide with static wind turbines, therfore underestimating the collision rate.

(5) Birds' flight and rotation of the wind turbines are regarded as independent events in this model; but the turbulence and slipstream at the front part of the wind turbines' blades during operation might affect birds' flight, and result in deviation in the collision rate.

However, in this analysis, the variation and uncertainty of the information on the birds are the main sources of the error and deviation. The basic information of Taiwan's birds is fairly deficient, among the parameters required in the simulation, information about flight speed, flight altitude and avoidance rate is incomplete. Among all, there is completely no information on the flight speed, which it can only be estimated by referring to regression functions from literatures, and there will certainly be errors. Flight altitude is obtained from the team's cumulative survey records of the ships, but survey out to sea is deeply limited by marine weather, visual surveillance is also restricted to daytime, wherefore it is unable to reflect birds' flight mode in different weather conditions or at night. The lack of avoidance rate has the greatest impact on the simulation results, because Band Model is especially sensitive towards avoidance rate, yet Taiwan has no related studies on this, and the bird species composition is very different with European countries, hence the datas cannot be used directly. Satellite tracking and radar investigation on birds should be strengthened in the future, in order to improve the understandings on birds' flight speed, flight altitude and avoidance rate.

Owing to the lack of datas on avoidance rate, this project follows the suggestion by Scottish Natural Heritage, which is to adopt the avoidance rate of 0.98 for all bird species in making analysis. Due to the high uncertainty of the avoidance rate, the collision value from this simulation has to be regarded with deviation of approximately ±50%, this nonetheless will not affect the functions of this model to make comparison between different wind turbines configurations, assessment of the bird species that needs the most attention, and to point out the season that most needs monitoring strengthening.

(ii) Simulation results

Below are the estimated collision counts of each bird species yearly in each wind farm with different configurations at a presumed avoidance rate of 0.98. As there are merely 8 surveys done throughout the year, whereby once monthly in the 6 months of spring and autumn seasons, and once every three months in summer and winter seasons; hence the calculation of the estimation of annual collision counts is done by multiplying the monthly collision counts in summer and winter months by three times, then added with each monthly collision counts in spring and autumn months.

Table 7.2.4-2 Annual Estimated Collision Counts of Each Bird Species with Different Wind Turbines Configurations in Wind Farm No. 12 at Avoidance Rate of 0.98

Avoidance Rate：0.98						
Chinese Name	English Name	Scientific Name	Power per Unit(MW)			
			4	6	8	11
穴鳥	Bulwer's Petrel	*Bulweria bulwerii*	< 0.01	<0.1	<0.1	< 0.01
未知穴鳥	Unknown petrel	Procellariidae spp. (petrels)	< 0.01	<0.1	<0.1	< 0.01
大水薙鳥	Streaked Shearwater	*Calonectris leucomelas*	< 0.01	<0.1	<0.1	< 0.01
未知水薙鳥	Unknown shearwater	Procellariidae spp. (shearwaters)	< 0.01	<0.1	<0.1	< 0.01
未知鸌形目	Unknown Procellariiformes	Procellariiformes spp.	0.00	<0.1	<0.1	0.00
白腹鰹鳥	Brown Booby	*Sula leucogaster*	< 0.01	<0.1	<0.1	< 0.01
黃頭鷺	Cattle Egret	*Bubulcus ibis*	14.12	9.00	7.70	5.78
紅領瓣足鷸	Red-necked Phalarope	*Phalaropus lobatus*	< 0.01	<0.1	<0.1	< 0.01
未知鷸鴴類	Unknown shorebirds	Charadriiformes spp. (shorebirds)	39.66	25.6	22.2	14.85
白眉燕鷗	Bridled Tern	*Onychoprion anaethetus*	18.35	12.3	10.5	6.66
燕鷗	Common Tern	*Sterna hirundo*	6.02	4.10	3.50	2.18
鳳頭燕鷗	Great Crested Tern	*Thalasseus bergii*	10.29	7.30	6.20	3.76
未知燕鷗	Unknown terns	Sterninae spp.	8.40	5.40	4.60	3.10
野鴿	Rock Pigeon	*Columba livia*	11.90	8.40	7.30	4.35
家燕	Barn Swallow	*Hirundo rustica*	2.43	1.80	1.50	0.90
未知燕科	Unknown swallows	Hirundinidae spp.	0.77	0.50	0.50	0.28
極北柳鶯	Arctic Warbler	*Phylloscopus borealis*	0.22	0.10	0.10	0.08
Total			112.15	74.60	64.10	41.93

Table 7.2.4-3 Annual Estimated Collision Counts of Each Bird Species with Different Wind Turbines Configurations in Wind Farm No. 13 at Avoidance Rate of 0.98

Avoidance Rate：0.98						
Chinese Name	English Name	Scientific Name	**Power per Unit (MW)**			
			4	6	8	11
穴鳥	Bulwer's Petrel	*Bulweria bulwerii*	< 0.01	<0.1	<0.1	< 0.01
未知穴鳥	Unknown petrel	Procellariidae spp. (petrels)	< 0.01	<0.1	<0.1	< 0.01
大水薙鳥	Streaked Shearwater	*Calonectris leucomelas*	< 0.01	<0.1	<0.1	< 0.01
未知鸌形目	Unknown Procellariiformes	Procellariiformes spp.	0.00	<0.1	<0.1	0.00
未知鷸鴴類	Unknown shorebirds	Charadriiformes spp. (shorebirds)	19.41	11.9	10.2	7.27
白眉燕鷗	Bridled Tern	*Onychoprion anaethetus*	12.35	7.80	6.70	4.48
鳳頭燕鷗	Great Crested Tern	*Thalasseus bergii*	8.92	6.00	5.10	3.26
未知燕鷗	Unknown terns	Sterninae spp.	23.82	14.5	12.4	8.78
野鴿	Rock Pigeon	*Columba livia*	0.78	0.50	0.50	0.29
灰沙燕	Bank Swallow	*Riparia riparia*	0.25	0.20	0.10	0.09
家燕	Barn Swallow	*Hirundo rustica*	4.19	2.90	2.50	1.55
Total			69.73	43.90	37.50	25.71

Table 7.2.4-4 Annual Estimated Collision Counts of Each Bird Species with Different Wind Turbines Configurations in Wind Farm No. 14 at Avoidance Rate of 0.98

Avoidance Rate：0.98						
Chinese Name	English Name	Scientific Name	**Power per Unit（MW）**			
			4	6	8	11
穴鳥	Bulwer's Petrel	*Bulweria bulwerii*	< 0.01	<0.1	<0.1	< 0.01
大水薙鳥	Streaked Shearwater	*Calonectris leucomelas*	< 0.01	<0.1	<0.1	< 0.01
長尾水薙鳥	Wedge-tailed Shearwater	*Puffinus pacificus*	< 0.01	<0.1	<0.1	< 0.01
未知鸌科	Unknown Procellariidae	Procellariidae spp.	< 0.01	<0.1	<0.1	< 0.01
未知鸌形目	Unknown Procellariiformes	Procellariiformes spp.	0.00	<0.1	<0.1	0.00
白腹鰹鳥	Brown Booby	*Sula leucogaster*	< 0.01	<0.1	<0.1	< 0.01
黃頭鷺	Cattle Egret	*Bubulcus ibis*	1.72	1.20	1.00	0.70
未知鷺科	Unknown Ardeidae	Ardeidae spp.	56.00	37.90	32.80	22.90
黦鷸	Far Eastern Curlew	*Numenius madagascariensis*	9.15	6.30	5.40	3.43
紅領瓣足鷸	Red-necked Phalarope	*Phalaropus lobatus*	< 0.01	<0.1	<0.1	< 0.01
未知鷸鴴類	Unknown shorebirds	Charadriiformes spp. (shorebirds)	2.21	1.50	1.30	0.83
白眉燕鷗	Bridled Tern	*Onychoprion anaethetus*	14.28	10.20	8.80	5.18
粉紅燕鷗	Roseate Tern	*Sterna dougallii*	0.40	0.30	0.20	0.14
燕鷗	Common Tern	*Sterna hirundo*	1.29	0.90	0.80	0.47
鳳頭燕鷗	Great Crested Tern	*Thalasseus bergii*	7.30	5.60	4.80	2.67
野鴿	Rock Pigeon	*Columba livia*	1.06	0.80	0.70	0.39
家燕	Barn Swallow	*Hirundo rustica*	2.41	1.90	1.70	0.89
極北柳鶯	Arctic Warbler	*Phylloscopus borealis*	0.37	0.30	0.20	0.14
Total			96.21	66.80	57.80	37.74

Table 7.2.4-5 Annual Estimated Collision Counts of Each Bird Species with Different Wind Turbines Configurations in Wind Farm No. 15 at Avoidance Rate of 0.98

Avoidance Rate：0.98						
Chinese Name	English Name	Scientific Name	**Power per Unit（MW）**			
			4	6	8	11
穴鳥	Bulwer's Petrel	*Bulweria bulwerii*	< 0.01	<0.1	<0.1	< 0.01
大水薙鳥	Streaked Shearwater	*Calonectris leucomelas*	< 0.01	<0.1	<0.1	< 0.01
未知鸌科	Unknown Procellariidae	Procellariidae spp.	< 0.01	<0.1	<0.1	< 0.01
未知鸌形目	Unknown Procellariiformes	Procellariiformes spp.	0.00	<0.1	<0.1	0.00
白腹鰹鳥	Brown Booby	*Sula leucogaster*	< 0.01	<0.1	<0.1	< 0.01
黃頭鷺	Cattle Egret	*Bubulcus ibis*	12.23	7.80	6.80	5.00
紅領瓣足鷸	Red-necked Phalarope	*Phalaropus lobatus*	< 0.01	<0.1	<0.1	< 0.01
未知鷸鴴類	Unknown shorebirds	Charadriiformes spp. (shorebirds)	24.41	15.90	13.80	9.14
中賊鷗	Pomarine Jaeger	*Stercorarius pomarinus*	3.45	2.30	2.00	1.25
白眉燕鷗	Bridled Tern	*Onychoprion anaethetus*	21.33	14.40	12.30	7.74
粉紅燕鷗	Roseate Tern	*Sterna dougallii*	0.42	0.30	0.20	0.15
燕鷗	Common Tern	*Sterna hirundo*	3.93	2.70	2.30	1.42
鳳頭燕鷗	Great Crested Tern	*Thalasseus bergii*	2.97	2.10	1.80	1.09
未知燕鷗	Unknown terns	*Sterninae spp.*	5.79	3.80	3.20	2.13
野鴿	Rock Pigeon	*Columba livia*	1.26	0.90	0.80	0.46
家燕	Barn Swallow	*Hirundo rustica*	4.85	3.60	3.10	1.79
極北柳鶯	Arctic Warbler	*Phylloscopus borealis*	0.19	0.10	0.10	0.07
Total			80.81	53.90	46.50	30.24

(iii) Collision analysis

1. Vulnerability of each bird group to collision with wind turbines

Below has combined four criteria to evaluate the vulnerability of different bird groups to collision with wind turbines, which are flight altitude, flexibility of habitat use, survival rate of adult birds, and conservation status in Taiwan (Garthe & Hüppop 2004). Due to the lack of detailed information on these parameters of most of the investigated bird species, therefore the unit being used here is bird group rather than bird species, moreover only general indexes such as “low”, “medium” and “high” are used to compare the relative intensity of these four groups of birds in every criterion.

Table 7.2.4-6 Vulnerability of Different Bird Groups to Collision with Wind Turbines

Groups	Flight Altitude	Flexibility of Habitat Use	Survival Rate of Adult Birds	Quantity of Protected Species	Vulnerability
Breeding Seabirds	Medium	Low	High	3	High
Non-breeding Seabirds	Low	High	High	-	Low
Migratory Waterbirds	Low – High	Medium	Medium	-	Medium
Migratory Landbirds	Low	Medium	Low	-	Low

Breeding seabirds’ medium flight altitude mainly falls within 5 – 10 m. Because the use of their foraging sea area is linked to limited specific breeding ground, hence the flexibility of habitat use is relatively low. Adult terns have relatively high survival rate, which means any additional deaths will be an obvious loss to the breeding group. Besides that, there are three types of terns in this sea area listed as protected species. Hence breeding seabirds have a comparatively high vulnerability.

Survival rate of non-breeding seabirds is also high, and this will magnify the impact of deaths to the group. However, as majority of them fly close to the sea, the risk of them to get collided with wind turbines is extremely low. In addition, these non-breeding seabirds are mostly oceanic birds, and the flexibility of habitat use is exceptionally high. Thus, vulnerability of non-breeding seabirds is lower.

In current records, migratory waterbirds have wide range of flight altitude. There is a possibility for them to adjust the migration route to avoid wind farms, but the change in route is limited by the presence of suitable transit location, and this often will increase the energy burden of an individual; hence the flexibility of habitat use is evaluated as medium. The survival rate of its adult birds is also considered as medium among the studied bird groups, therefore migratory waterbirds are evaluated as having medium vulnerability.

Based on the same reason as migratory waterbirds, the flexibility of habitat use of migratory landbirds is also medium. While their flight altitude are mostly very low, there is little chance of colliding with wind turbines. Adult migratory landbirds' survival rate is relatively low, thus the impact of deaths from collision towards the group is less severe. Through comprehensive evaluation, the vulnerability of migratory landbirds is low.

2. Configurations of wind turbines and bird groups

(1) Collision Evaluation

In Changhua County, the annual collision counts of each bird species in Wind Farms No.12~No.15 with different configuration of wind turbines, are shown in Table 7.2.4-2 ~ Table 7.2.4-5. Collision count per unit of different equipments, collision count based on power generation per unit, and total collision count are shown in Table 7.2.4-7. The annual collision rate of birds in Wind Farm No. 12 and No. 14 are higher than Wind Farm No. 13 and No. 15. In each wind farm, the higher the power generation per unit , the bird collisions caused will be lesser. Overall, migratory waterbirds (mainly shorebirds and Ardeidae) and breeding seabirds (mainly terns) are the groups of birds with higher annual collision counts. In Wind Farm No. 12 and No. 14, migratory waterbirds are the most collided group, whereas breeding seabirds are the most in Wind Farm No. 13 and No. 15.

Table 7.2.4-7 Collision Count with Different Equipments in Different Wind Farms, Collision Count based on Power Generation per Unit, and Total Collision Count

Power per Unit	Collision Count per Unit (count/wind turbine・year)				Collision Count based on Power Generation per Unit (MW/wind turbine・year)				Total Collision Count (count/year)			
	#12	#13	#14	#15	#12	#13	#14	#15	#12	#13	#14	#15
6 MW	0.75	0.47	0.63	0.54	0.13	0.08	0.11	0.09	74.6	43.9	66.8	53.9
8 MW	0.87	0.54	0.73	0.62	0.11	0.07	0.09	0.08	64.1	37.5	57.8	46.5
11 MW	0.76	0.47	0.69	0.55	0.07	0.04	0.06	0.05	41.9	25.7	37.7	30.2

Regarding the estimation on avoidance rate of birds' collision assessment, in reality, there is no empirical evidence about seabirds illustrating the avoidance rate of seabirds, main reason being the extremely high difficulty to practically measure the seabirds' avoidance rate and collision rate. However, this knowledge gap has been gradually filled. Thanet offshore wind farm has already conducted surveys on seabirds for more than two years. The research makes use of radar, photography equipment and laser rangefinder to obtain datas on birds' flight. Other than survey done by Thanet offshore windfarm, the birds' avoidance rate that is being used by United Kingdom is adopted from the guideline by Scottish

Natural Heritage, and this guideline is using datas from the operating “land” wind turbines as referrence.

With the lack of information on seabirds generally, it is possible to opt for appropriate alternative species（proxy species）to carry out survey on seabirds’ avoidance rate, with the condition that the proxy species and the studied species must have similar behavioural response towards the environment. For instance, survey by United States Department of the Interior, Bureau of Ocean Energy Management, Regulation and Enforcement has shown that, Sterna hirundo can be used as alternative species for Sterna dougallii, while Sterna hirundo’s habits around wind turbines can provide precise datas for the collision risk evaluation of Sterna dougalli. In Europe, Scottish Natural Heritage has also made use of this method to investigate birds’ flight altitude of species with the similar patterns.

Similarly, in Changhua county which lacks empirical evidence, this project’s actual practice is by selecting alternative species to conduct the birds’ collision risk assessment, and include the uncertainties in the process of evaluation. The selected alternative species must have similarities with the studied species in terms of physical features (flight speed, body length, wingspan and flight mode) and behavioural characteristics (foraging behaviour, migratory species or resident species).

Closely related species usually possess similar features, hence the grouping is a useful guide in determining alternative species. For example, current datas on the behaviour of Thalasseus sandvicensis are fairly sufficient, which includes distribution of flight altitude. In taxonomy (and physical and behaviours) is obviously similar with Greater crested tern. Therefore, Thalasseus sandvicensis can be used as the alternative species for Greater crested tern, and to use the current flight datas of the former in the analysis of the collision for the Greater crested tern.

(2) Ecological indicators

The specific indicators that can monitor the ecological impact of the development plan on birds are as follows:

A. Collision Impact Indicators -- Each wind farm shall commit to setting up of thermal image monitoring equipment and sound recording equipment to monitor the actual collision count of birds.

B. Barrier Effect Indicators -- Each wind farm shall commit to setting up of radar to record the flight path of birds and to assess the barrier effect caused by wind farm development.

C. Loss of Foraging Sites Indicators -- Commitment to continuous marine bird investigations ten times a year during both construction and operation periods, using changes in bird density as indicators of loss foraging sites for both resident and oceanic birds.。

In the future, if the survey results shows environmental damage and there is no suitable mitigation countermeasures, the supervisory committee will discuss the possible countermeasures and rehabilitation compensation.

3. Collision counts of protected bird species

Based on eight marine-based investigations, there were two types of class II protected species found in Wind Farms No.12 and No.13, namely, Bridled Tern, and Great Crested Tern. Besides, there were three types of class II protected species found in Wind Farms No.14 and No.15, namely Bridled Tern, Great Crested Tern, and Roseate Tern. The collision count of each protected bird species in the four wind farms stated above is shown in Table 7.2.4-8. Among the four Wind Farms, the collision received by Bridled Tern and Great Crested Tern is greater; the former mainly appears in the vicinity of the four Wind Farms in spring , while the latter appears in the vicinity of the four Wind Farms in both spring and summer.

Table 7.2.4-8 Annual Collision Counts of Each Protected Bird Species in Four Wind Farms

Chinese Name (English Name)	Power per Unit (MW)			
	4	6	8	11
白眉燕鷗(Bridled Tern)	66.31	44.7	38.3	24.06
粉紅燕鷗(Roseate Tern)	0.82	0.60	0.40	0.29
鳳頭燕鷗(Great Crested Tern)	29.48	21.00	17.90	10.78

(1) Bridled Tern

The global population of the Bridled Tern is estimated to be between 610,000 and 1,500,000 (Wetlands International 2006). It is spread over a wide range of tropical and subtropical waters from the Atlantic Ocean through the Indian Ocean to the Western Pacific. Bridled Terns are summer migratory birds in Taiwan and breeding communities in both Cotton and Penghu Islands (Liu Deng 2012). Bridled Terns visit the Penghu Island from April to September each year, gather and breed on uninhabited islands. It has the largest amount of terns in the Penghu Island, the number of community is relatively stable, estimated 6,000 of them. The largest breeding population is in Mao Island, accounting for about half of the total population of Penghu (Zheng 2012).

In the four major Changhua wind farms, the highest density recorded by the Bridled Tern was 0.38/km2. In a stand-alone capacity of 4 MW, blade with the lowest height of 25m in the fan configuration, using the

0.98 avoidance rate for calculation, estimated 24.06 Bridled Terns die in the four major Changhua wind farms each year due to collision.

There is no numerical value of background mortality for the Bridled Terns in the Penghu Island. In northwestern Australia, the annual survival rate of Bridled Tern is estimated in between 0.78 and 0.83 (Dunlop & Jenkins 1994). If the average value of 0.8 (equivalent to annual mortality rate of 0.2) is used as the annual survival rate of the Penghu Island population, this 6,000 population has approximately 1,200 deaths per year; consider the Bridled Tern only spend six months each year in Penghu, the number of deaths in this period is estimated at around 600. A single-machine of capacity 4~11 MW fan is used in four wind farms. Using the avoidance rate of 0.98 of calculation in the situation, 24.06~66.31 individuals die every year due to the wind turbine collision, which is minor impact on the overall group of Bridled Tern.

(2) Crested Tern

The global population of the Crested Tern is estimated between 150,000 - 1,100,000 (Wetlands International 2006). Its distribution in the old world tropical and subtropical coasts and islands, from South Africa's Atlantic coast via Southeast Asia and Australia to the Pacific Ocean's small island. It is mainly a summer migratory bird in Taiwan. However, there are still sporadic records throughout the year. Until the middle of the 20th century, there are large number of Crested Terns breed on islands such as Keelung, Cotton, and etc, and they are visible throughout the year on the North Shore. However, the breeding population in the north has now completely disappeared, this situation is still quite common in the Taiwan Strait (Liu Deng 2012).

The Crested Terns in the Penghu Island gather on uninhabited islands every year from April to September. The number of the ethnic groups fluctuates between 1,000 and 3,000, the location of breeding clusters during the year is also unstable, different islands may be used each year. Crested terns are quite sensitive to disturbances, and if they are disturbed before they start laying eggs, they may give up and leave (Zheng 2012).

Among the four large Changhua wind farms, the highest density recorded by the Crested Tern was 0.2/km2. In a stand-alone capacity of 4 MW, blade with the lowest height of 25m in the fan configuration, using the 0.98 avoidance rate for calculation, estimated 10.78 Crested Terns die in the four major Changhua wind farms each year due to collision.

Literally there is no background mortality of Crested Tern in the Peng

Hu Island for further exploration, nor other study can be found in other areas on the mortality of the adult terns. If extensive reference is made to other terns' data, the annual survival rate of adult terns is very large, ranging from 0.74 to 0.93. (Møller 1983, Dunlop & Jenkins 1994, Renken & Smith 1995, Spendelow et al. 1995, Nisbet & Cam 2002, Feare & Doherty 2004). If the average value of 0.84 (equivalent to an annual mortality rate of 0.16) is used as the annual survival rate of the Crested Terns in the Penghu Islands, in the situation of a maximum population of 3,000, there are approximately 480 deaths per year. Consider that the Crested Tern only spend six months a year in Peng Hu, the number of death in this period is estimated at 240. Single-machine 4~11 MW fan is used in all four wind farms, using the 0.98 avoidance rate for calculation, estimated about 10.78~29.48 individuals die each year due to the wind turbine collision, which is minor impact on the overall group of Crested Tern.

(3) Pink Tern

Pink terns are widely distributed in tropical and subtropical sea area, the global population is estimated at around 200,000 - 220,000 (Wetlands International 2012). It is summer migratory bird in Taiwan, cluster breeding on uninhabited islands in the Penghu Island (Liu Deng 2012). According to the information of recycling, the Pink Tern of Penghu may live in Australia during the non-breeding season.

The number of Pink Terns breeding in Penghu fluctuates between 3,000 and 5,000. Similar to Crested Tern, Pink Terns often use different islands in different years (Zhang 2012).

Pink Tern has a very low density in the large Changhua wind farm. Therefore, in a stand-alone capacity of 4 MW, under the fan configuration with a minimum blade height of 25m, when using the 0.98 avoidance rate for calculation, it is estimated that about 0.29 Pink Terns die in the four major Changhua wind farms each year due to collision. Overall, the impact of the large Changhua Wind Farm on the Pink Tern is very slight.

(I) Comprehensive Discussion

1. Among the four large Changhua Wind Farm, the collision of birds on the 12th and 14th wind farms on the west side is higher, while the impact of the 13 and 15 wind farms on the east side is slightly lower. The reason is because there are more migratory waterbirds passing through the wind farms 12 and 14, majority are spring mites at the wind farm 12, at 14 majority are Ardeidae. The difference is due to the fact that the wind farm on the west side is closer to the migratory line of migratory birds, or just randomness of sampling, still need more information to further clarify.

2. Compare the four-type fan configuration, the single unit has larger capacity, caused smaller amount of impact for birds, although the fan with large single power generation capacity has a larger radius of rotation, the threat to birds is also greater, but the number of fans required is lesser, therefore, the overall impact on birds is relatively minor.

3. Migratory waterbirds (mainly scorpions and herons) and breeding seabirds (mainly terns). This is due to the flying height of these species are more overlapping with the range of fan rotation, therefore, the possibility of collision is larger. Although there are a considerable number of large water ostriches and swallows in the region, but these birds usually fly close to the sea level, hardly get into wind turbine collision.

4. Spring transit (April) is one of the peak periods of the impact, At the farm 14, there is also a peak of impact during the autumn crossing (October). Showing this group of migratory birds needs special attention in the area. There are also many collision incident at the wind farm 12 and 13 during summer, mainly due to the activities of the Bridled Tern.

5. After eight seasons of sea surveys, four large Changhua wind farms have recorded a total of three secondary conservation classes, including Bridled Tern, Crested Tern and Pink Tern. The number of Pink Tern is very small, only appeared in the spring occasionally. Crested Terns mainly appear in this area during spring, Bridled Terns are active in spring and summer.

   If total up four wind farms, use 4MW fan configuration, carry out a conservative assessment of the avoidance rate of 0.98, the annual impact of Crested Tern and Bridled Tern are estimated at 66 and 29 respectively, the degree of impact is light for the synthesis Crested Tern and Bridled Tern.

   However, the avoidance rate 0.98 suggested by SNH, the value may be quite conservative in the terns, due to the excellent driving power of the terns. Therefore, it is usually possible to have good microscopic avoidance behaviour, according to the monitoring results of several wind farms in Europe (SmartWind 2015), the avoidance rate of Sternula Albifrons, Sterna Hirundo, Thalasseus Sandvicensis is usually above 0.99. If the avoidance rate of 0.99 is applied to Crested Tern and Bridled Tern, the estimated mortality can be reduced, this may be closer to the actual situation. It is necessary to further study after the wind farm is built in the future to confirm.

6. The wind farm has a considerable number of migratory birds moving through the spring and autumn seasons. During summer, there are conservation Bridled Terns move about at the wind farm, therefore, it will have a certain impact on birds, but among the many wind farms in Changhua’s outer sea, the impact is relatively minor. However, due to the current limited amount of data, the situation of bird migration at night is not clear, still need to plan and investigate the mitigation measures, and continue to monitor bird's impact

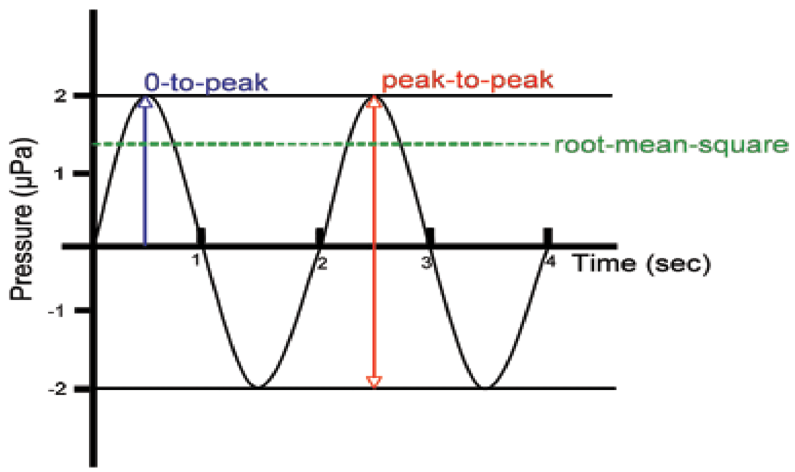
rate and density, strive for environmental friendliness.

7.2.5 Cetaceans

The development of offshore wind power generation plans, the main impact on cetaceans should be limited to underwater noise and vessel traffic (Madsen et al. 2006). Cetaceans are highly sound-dependent creatures (Weilgart 2007), they can hear underwater piling construction sounds even within ten kilometres (Kastelein 2013b), and all cetacean species are under conservation, so this report collects researches and cases of cetaceans, as a reference for foreign mariner for the impact of noise on cetaceans.

I. Characteristics of Underwater Noise

Before understanding the underwater noise, one should first understand the difference between underwater sounds and sound units in the air, so as not to compare them with different standards. Underwater sound use dB re 1 µPa as a unit, while in the air is dB re 20 µPa, therefore, comparing the sound pressure energy of 100 decibels (dB) in air, the sound pressure of 100 decibels in the water is much higher. So when comparing the sound pressure of two noise sources, the unit standard should be confirmed first. Sound pressure level (SPL: sound pressure level) is the pressure measuring the sound directly, there are description ways of peak-to-peak, zero to peak or simply called crest, and under the long-term sound pressure of root mean square (figure 7.2.5-1). SEL (sound exposure level) which the total energy is normalised to the energy that lasts for one second, its single unit is indicated in dB re 1 µPa2˙s. This plan will represent the intensity of underwater sound in dB, but SEL or SPL will be noted, and p-p, peak, and RMS will be indicated for SPL to distinguish the different standards.



0-to-peak, peak-to-peak, root-mean-square

Information source: http://www.dosits.org/science/advancedtopics/signallevels/

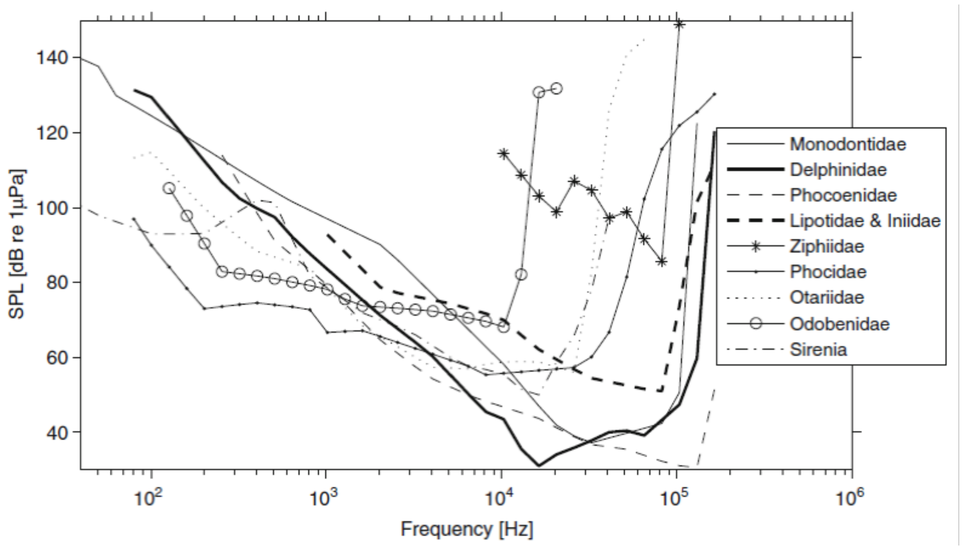
Figure7.2.5-1 Use Different Units To Represent The Sound Pressure

II. Cetacean Hearing

The sound plays a very important role in the adaptation of cetacean to the underwater environment, other than using the communication between creatures, it is more important for echolocation systems assisting visually to detect and sense the environment. Thus the cetacean has accurate and sensitive hearing. Cetacean hearing thru the electrophysiological experiment (auditory evoked potential methodology) to measure brainwave auditory evoked potentials at different frequencies and volumes, be able to get sensitivity of hearing. Figure 7.2.5-2 (Popper & Hawkins 2012), results of the study on the hearing threshold of cetaceans, comparing to the human hearing of only 20 Hz- 20 kHz, cetaceans can hear a very wide range of frequencies, best hearing response between approximately 10-120 kHz, and different cetaceans have different hearing thresholds. Also many artificial noises are often distributed in this frequency range. Hence, we must pay special attention to the potential impact of these artificial noises on cetacean.

Refer to the most detailed and scientifically credible NOAA (National Oceanic and Atmospheric Administration), the technical specifications of human noise for marine mammals (2016), recognized by the latest international national standard (UN CMS), having 124 countries’ signatories, this specification has a considerable amount of research on Tursiops Truncatus and incorporates relevant guidelines to follow. The boundary value proposed in NOAA (2016) has been a conservative estimation, reason being the norm is classified into different hearing groups according to the hearing sensitivity of the cetacean.

The Tursiops Truncatus is belong to the intermediate frequency, discovered by the wind farm. The frequency range of hearing sensitivity is 150Hz-160 kHz (NOAA 2016) (Table 7.2.5-1). The permanent hearing attenuation (PTS) threshold for Tursiops Truncatus is shown to be higher than 190 dB cSEL24h. However, this threshold shall apply to all mid-audio hearing range species (including dolphins, toothed whales, orca whales and Tursiops Truncatus). Fformer NOAA (2016) proposed a more conservative proposal cSEL24h 185 dB, although the results of the survey are only found in Tursiops Truncatus, but it is still supported to adopt a more conservative recommendation, using cSEL24h 185 dB.



Information source: Erbe 2010 in Popper & Hawkins 2012

Figure 7.2.5-2 The Lowest Auditory Threshold For Different Frequencies Of Cetaceans

Figure 7.2.5-1 Marine Mammal Hearing Groups (NOAA，2016)

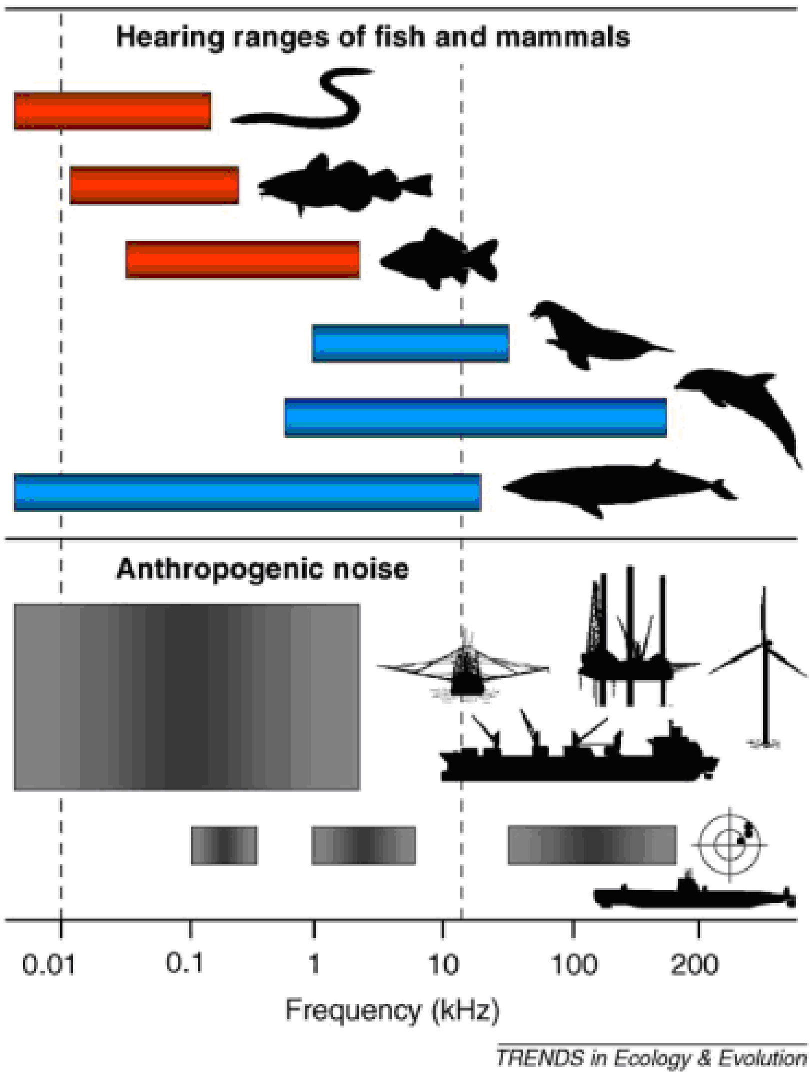
Hearing Group	Generalized Hearing Range*
Low-frequency (LF) cetaceans (baleen whales)	7 Hz to 35 kHz
Mid-frequency (MF) cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	150 Hz to 160 kHz
High-frequency (HF) cetaceans (true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*)	275 Hz to 160 kHz
Phocid pinnipeds (PW) (underwater) (true seals)	50 Hz to 86 kHz
Otariid pinnipeds (OW) (underwater) (sea lions and fur seals)	60 Hz to 39 kHz

III. The Possible Mechanism Of Underwater Noise On Cetacean

The frequency range of cetacean hearing and man-made noise can be seen in Figure 7.2.5-3 (Slabbekoorn et al. 2010), it is known that the frequency of human noise (such as: vessel, piling, fan operation, medium frequency sonar noise) and the low hearing frequency range of Tursiops Truncatus is overlapped, also overlaps with most of the hearing frequency range of fin whales. So cetacean can hear human noise and may even be affected by the noise. The noise's effect on cetaceans can be divided into four levels with the noise energy received (Richardson et al. 1995; Thomsen et al. 2006) (Fig. 7.2.5-4), noise distance sources from near to far: (1) hearing loss or drop, (2) responsiveness, (3) masking effect, (4) audibility. The details of its impact are as follows:

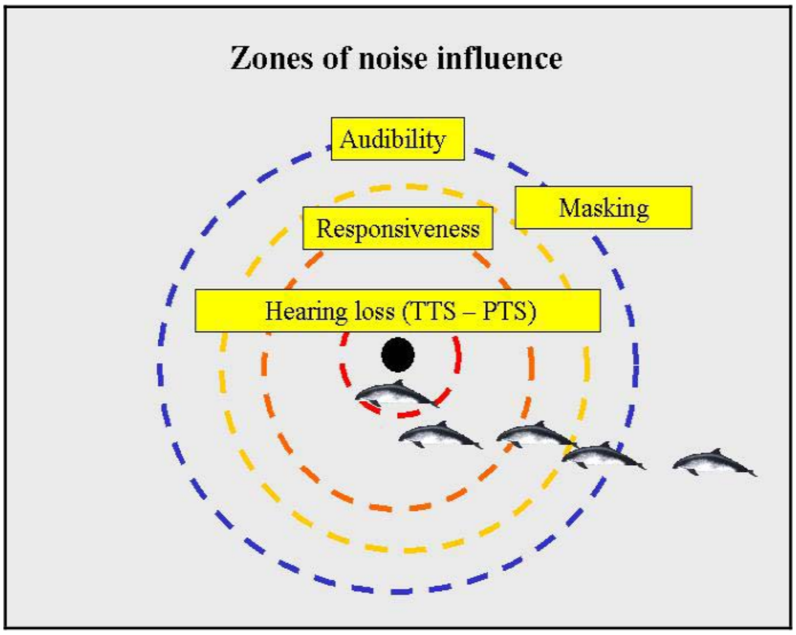
(i) Hearing Attenuation

When cetacean is very close to the noise source, may cause hearing attenuation. This type of hearing attenuation is a physiological injury to the hearing organs, which is permanent threshold shift (PTS), unable to recover, or it is temporary threshold shift (TTS), can be recovered in a certain period of time. During the period of hearing attenuation, it may affect its behavior and endanger its survival. The excessive strong sound not only can cause TTS, when cetaceans are exposed to a long period of noise, the threshold that causes it to produce TTS will also reduced (Nedwell et al. 2003). TTS is produced when animals are exposed to high intensity noise, hearing threshold is increased, this is a way for animals to avoid injuries. When TTS happens, animals may not be able to detect sounds that could have been heard, have to use a higher intensity sound in order to detect, but this phenomenon can be done by letting the animals rest, after reducing its exposure to the intensity of noise, the TTS will recover over time. But if after TTS happens and again the animal is repeatedly exposed to these noises, to an even higher intensity noise, it is possible to transform this TTS into PTS (Weilgart 2007). At this time, cetaceans that depend on hearing, they will lose important senses and affect their survival.



Note: From top to bottom, marine mammals are European squid, Atlantic salmon, goldfish, Zalophus californianus, Tursiops truncatus, and Balaenoptera physalus. From top to bottom, the man-made noise is piling, fan noise, ship noise, and military sonar noise.
Information source: Slabbekoorn et al. 2010

Figure 7.2.5-3 Fish And Marine Mammals Hearing Ability And Human-Made Noise Frequency Range



Information source: Thomsen et al. 2006

Figure: 7.2.5-4 Possible effects of noise in different ranges

Table 7.2.5-2 lists the different noise exposures causes cetacean TTS. In the same hearing sensitivity frequency band, the lower frequency of noise exposure, the more severe it causes the TTS. If the time of noise exposure is increases, the time for the cetacean to return from TTS to normal will increases as well. It is worth noting that the latest published paper in 2016 (Kastelein et al. 2016), base on actual record, a single piling SELss 145 dB re 1 μPa2 s was released to Harbor Porpoise, hearing loss can be detected in as short as 30 minutes, the SELcum at this time is 176dB re 1 μPa2 s, hearing can return to normal after hearing about 50-60 minutes of noise. Base on the estimated condition of no noise reduction by general wind turbine piling equipment, the range of influence can reach ten kilometers (Kastelein et al. 2013b).

NOAA (2016) and related noise control standards such as UN CMS are currently using permanent hearing attenuation (PTS) thresholds to regulate, rather than a temporary hearing attenuation (TTS) threshold. It is worth mentioning that the auditory sensitivity of the mid-range Tursiops Truncatus (PTS 185 dB cSEL24h) and the high-frequency dolphin (PTS 155 dB SEL24h) are very different. The Harbor Propoise often found in Europe is a high-frequency dolphin, the species usually seen in Taiwan are the common Tursiops Truncatus, its PTS threshold is 30 dB higher than the Harbor Porpoise. This should be taken into consideration when determining Taiwan's PTS threshold.

(ii) Behavioural Response

A little further from the noise source, Although it does not cause physical damage but it may cause behavioural disturbance or harassment to the cetacean. These reactions may be due to the fact that the cetaceans have to interrupt the original behaviour by avoiding the sound interference, even migrating to find a quieter place to rest. If the cetacean changes its habitat due to noise, the result of this is the impact of a habitat displacement, tt may cause the cetacean to lose its foraging or breeding habitat.

Table 7.2.5-3 listed noise changes in cetacean's behaviour or habitat displacement. Tougaard et al. (2003, 2005) once recorded during the construction of the offshore wind farm in Horns Reef, North Sea, Denmark, the behaviour of the Harbor Porpoise has changed significantly during each underwater piling. During each pilling, the acoustic activity of the Harbor Porpoise and the density of the dolphins are significantly lower than in the pre-piling period, the scope affects 15 kilometres, and when the piling is not carried out, dolphin behaviour is mainly foraging, but when piling, it changes into a directional mobile trip, indicating that piling causes the dolphins showing an evasive response. Würsig et al. (2000) has observed when underwater piling is carried out, the swimming speed Hong Kong Chinese became faster, and the long-term monitoring of local construction discovered that the number of white dolphins that appeared in the piling stage is small, compared to other pre-operational stages and after completion.

There are also reports indicated that Killer Whale left the original habitat due to being disturbed by the noise of the sound-driven device (Morton & Symonds 2002). Reports of noise from geological detection devices in the waters near UK also indicate that almost all dolphins, toothed whales and baleen whales are significantly away from this high-intensity source of noise when noise is generated, especially small dolphins show a stronger response from the reaction (Stone & Tasker 2006).

Kastelein et al. (2013b) broadcast the recorded piling sounds to the Harbor Dolphins at different volumes. It was found that when receiving noise within 30 minutes, and when the Harbor Porpoise receives an average volume of SPL 0-p151 dB re 1 μPa, SELss 127 dB re 1 μPa2s), the number of jumping out of the water is significantly more. Analyse the spectrum of the piling sound replay in this experiment, the noise impact is estimated to be up to 50 kilometres. This shows that piling noise can indeed affect the physiology and behaviour of Harbor Porpoises, and the scope of influence is as far as tens of kilometres (Tougaard et al 2009, Bailey et al. 2010, Kastelein et al. 2013b).

A comprehensive study was carried out recently in several offshore wind projects in the North Sea of Germany, data of 2009-2013 was obtained. Studies have shown that the cetacean (in this case, Harbor Porpoise) is far from the area during piling, average time is about 20-31 hours (about 2 km range). Therefore, it is obvious that marine mammals will return to the original piling range soon after piling, some wind farms have recorded that marine mammals return to the wind field 16 hours after the end of piling, the underwater noise range during piling is between 163 and 180 dB. These studies show short-term behavioural effects such as staying away from piling range and etc., the sound thresholds is above 160 dB, we believe that Tursiops Truncatus will also exhibit similar short-term behavioural response. Therefore, it is expected to have a slight impact on a wide range of Tursiops Truncatus.

(iii) Covering effect:

When the distance is further, the disturbance behaviour is lesser. At this point, the noise level may still be higher than the sound that the cetacean may hear in the environment. For instance, the sound of communication or echolocation between the same cetaceans, the sound of fish, the sound of predators such as Killer Whales, this phenomenon is called covering effect. The occlusion effect occurs when the artificial noise is produced higher than the ambient noise in a particular frequency range, and there is an overlap in the frequency range of specific sound signals (Madsen et al. 2006). Once the covering situation occurs, it may affect the cetacean’s communication, the chance of mating is reduced, even reducing the ability to detect the environment, predator and predator's voices, causes decrease of its fitness (Richardson et al. 1995).

When there are boats approaching the Australian humpback dolphin, the mother-child pair will increase the number of times it is called, the investigators speculated that this was because the noise of the ship covered the original sound of mother-child pair, making the mother and child have to use more calls to achieve the result vocal contact (Van Parijs & Corkeron 2001).

(iv) Perceptible:

Finally, although the cetacean have heard the human-noise, but there is no obvious behavioural interference or covering effect that occurs, only at the level of hearing. In the state of detectable noise, physiological variability between individuals and different behavioural variations may make interference noise unpredictable. Due to the differences in tolerance to noise between individuals, some individuals may be less prone to behavioural reactions, in addition, the same individuals' tolerance to noise disturbances varies in different behavioural states (Weilgart 2007). According to the reports of Richardson et al. (1995, 1999), when the bowhead whale migrates in the fall, it appeared to an escape response when exposed to geological detector noise of 120-130 dB re 1 μPa. But when the bow-headed whales are foraging in the summer. However, it only has obvious avoidance response when the same detection noise reached 158-170 dB re 1 μPa. Hereby it is known that different noise tolerances between individuals in different behavioural states. Finally, as offshore wind turbines are emerging developments in recent years. Therefore, there is still no research to counter the long-term immune performance of individuals affected by the noise of offshore wind turbines. However, in the range of detectable noise, if the cetacean is exposed to noise that is not in the original habitat for a long time, whether it will be affected by noise or not, the individual's long-term immune response must still be noted.

So far, only two studies have examined the effects of perceptible low-volume noise on the physiological urgency of cetacean, the experiment of Captive Beluga Whales has no effect (Thomas et al. 1990), but field surveys of North Atlantic Right Whales are thought to have an impact (Rolland et al. 2012). Still collecting research on the physiological response of small and medium-sized Tursiops Truncatus in low-volume ambient noise, and how to define whether the cetacean is disturbed by noise is still very complicated. However, the noise should be reduced so that the behaviour of the cetacean in the adjacent waters is not affected, it should be understood that the noise generated by human beings specifically affects the range of cetacean communication.

Table 7.2.5-2 Cetacean Temporal Hearing Loss Caused By Exposure Noise

實驗物種 (隻數) Experimental species	Noise Type	Noice frequency	Amount of noise causing TTS	Noise exposure time causing TTS	Amount of time to recover	Conclusions and references
白鯨 (2) 瓶鼻海豚 (5) Beluga (2) Tursiops aduncus (5)	(pure tones)	Beluga: 3, 10, 20, Tursiops aduncus: 3, 10, 20, 75	192-201 dB (SPL, r.m.s)	One second	5-17 mins 4-18 mins	Very short and loud noises can also cause TTS in animals
瓶鼻海豚 (1) Tursiops aduncus (1)	Single frequency and continuous noise	3, 20	3 kHz: 190dB (SEL) 20 kHz: 181dB (SEL)	16 seconds	Lack of information	(Finneran & Schlundt 2010) The closer to animal's hearing sensitive frequency band, the lower the noise level of TTS
瓶鼻海豚 (2) Tursiops aduncus (2)	Single frequency and continuous noise	3	190 dB (SEL) 207 dB (SEL) 215 dB (SEL)	64 sec 32 sec >32 sec	8mins 8-16mins >32mins	The greater the noise exposure, the shorter the time will cause TTS, and the longer the hearing recovery will take
瓶鼻海豚 (1) Tursiops aduncus (1)	Single frequency and continuous noise	3	192 dB (SPL) ~ 204dB (SEL)	16sec*1round 16sec*4rounds (224sec interval) 64sec*1round	~20mins >30mins >30mins	With the same amount of noise, the longer the exposure time, the larger the TTS value and the longer the time to recover. Even if there is a brea, in between
江豚 (2) Finless porpoise (2)	Octave band) Intensive pulse sound	32, 64, 128	140-160 dB	1-30mins (1,3,10,30mins)	10~>100mins 5-20mins 5-20mins	In the same hearing-sensing frequency band, the lower exposed noise frequency, the serious the TTS, there are even situation which the hearing cannot be restored with more than 100mins at 32kHz (-0.5 Octave)

Remark: The above experiments were carried out in a captive environment.
SPL: Sound pressure leve (dB re 1 μPa); r.m.s: root mean square; SEL: Sound Exposure Level (dB re 1 μPa^2-s)

Table 7.2.5-2 Cetacean Temporal Hearing Loss Caused By Exposure Noise (continued)

實驗物種 (隻數) Experimental species	Noise type	Noise frequency	Amount of noise causing TTS	Noise exposure time causing TTS	Time returning to normal hearing	Conclusions and references
瓶鼻海豚 (2) Tursiops aduncus (2)	Single frequency and continuous noise	3-80	120-191 dB (SPL, r.m.s)	16sec	30mins	(Finneran & Schlundt 2013) 10-30 kHz is most susceptible
白鯨 (2) Beluga (2)	Narrowband and continuous noise	11-90 (center)	165 dB (SPL, r.m.s)	1-30mins (1,3,10,30mins)	1-60mins	(Popov et al. 2013) Low frequency can cause serious TTS
瓶鼻海豚 (3) Tursiops aduncus (3)	(Seismic air gun) Broadband pulse sound	Broadband	196-210 dB (peak)	0.5sec	2-10mins	(Finneran et al. 2015) Dolphins appeared with abnormal behaviour
港灣鼠海(2) Harbor Porpoise	Piling noise	Broadband	145 dB (SEL single strike) 173-187 dB (cumulative SEL) 144 dB (average SPL over time)	15-360mins	60mins	Volume and time that causes TTS can also cause behavioural changes

Remark: The above experiments were carried out in a captive environment.
SPL: Sound pressure leve (dB re 1 μPa); r.m.s: root mean square; SEL: Sound Exposure Level (dB re 1 μPa2-s)

Table 7.2.5-3 Cases Of Artificial Activity Noise Causing Cetaceans Behavioural Changes Or Habitat Displacement

Aminal/location	Noise source	(dB re 1 µPa) Noise pressure	Influences	References
Harbor Pospoise/ Denmark	(Horns Rev I) Offshore wind turbine construction	191 dB at 230 m (RL, p-p)	During the construction period (one year), the density of the dolphin population within 15 km of the construction site was significantly reduced, and its density was less than that before construction; the behavior of dolphins was observed to change from foraging to directional mobile travel.	Tougaard et al.2003, 2005,2009
Harbor Pospoise/ Denmark	(Nysted) Offshore wind turbine operation	(Utgrunden) Largest 126 dB at 83 m 180 Hz	During the operation period, through the long-term monitoring of sound, the detection rate of the dolphins is much lower than that before the construction, indicating that the ethnic group leaves the area.	Teilmann et al. 2012
Chinese White Dolphine /Hong Kong	Underwater piling	162-170 dB at 250 m (RL, r.m.s.)	During the construction period (five months a year), the dolphins swim faster, the number of local dolphins decreases, and the number gradually recovers after the construction.	Würsig et al. 2000
Grey Whales/ Mexico	Dredging and ship noise	Lack of information	When the noise decreased, the number of local ethnic groups decreased. After the 8th year, the whales all left this important breeding habitat. In the 7th year after the noise source ceased, the gray whale returned to the bay.	Bryant et al. 1984 cited by Tyack 2008
Killer Whale/Canada	acoustic harassment devices (AHDs)	Single Airmar AHD sends a 10 kHz signal 194 dB re 1 Pa at 1 m	Killer whales avoid noise area activities, and the number of whales in this area has been significantly reduced (influenced up to six years)	Morton & Symonds 2002
At least 11 types of cetaceans	(seismic airguns) Geological exploration	Largest 235-250 dB at 1m (SL)	During the geological exploration, the whales and dolphins significantly avoid the noise source and swim in the opposite direction.	Stone &Tasker 2006

Remark: The above experiments were carried out in a captive environment.
RL: received level; SL: Source level; p-p: peak to peak; r.m.s: root mean square

IV. The Source of Underwater Noise At The Offshore Wind Farm

The underwater noise source of the offshore wind farm can be divided into two periods: Construction and operation period. Noise during construction, including trenching, dredging, filling, piling, and vessel traffic (Nedwell & Howell, 2004). Among them, the underwater noise of pile driving is the loudest and the widest frequency range (Richardson et al. 1995). It is one of the key projects to evaluate the impact of wind turbine construction on cetacean. The noise during the operation period may come from the the offshore wind farm itself and the vessel's maintenance. According to the literature collection of foreign countries on the impact of offshore wind noise on cetacean in recent years. The three types of noise forms and impacts such as the construction period, the operation period and the noise generated by the ship are explained as follows:

(i) Noise During Construction

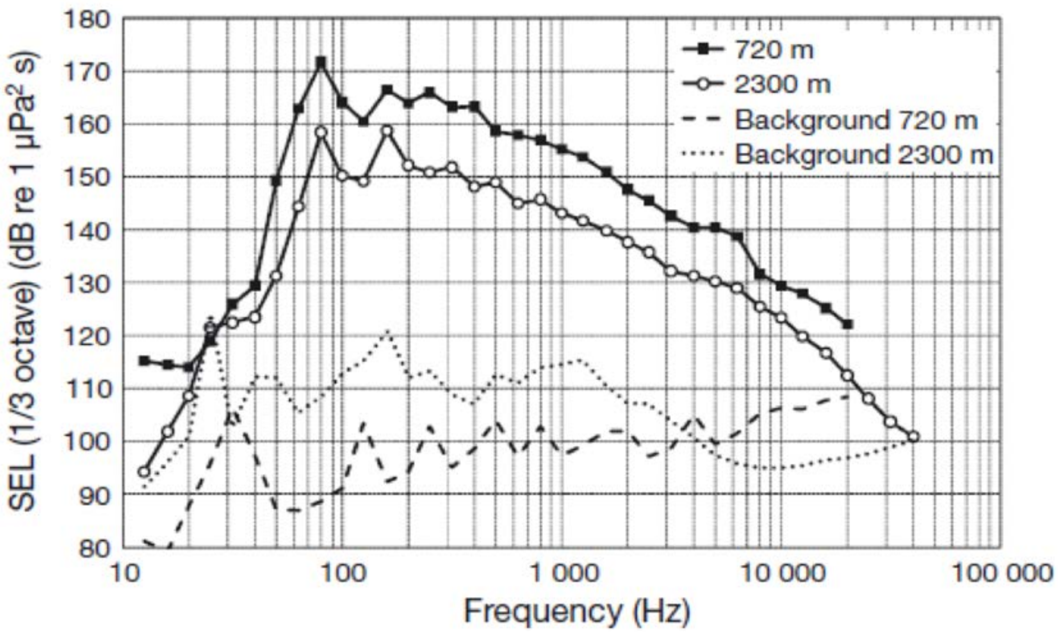
The foundation of the seabed is used in the project’s plan, the pedestal involving piling is divided into a single pile foundation and a pipe rack foundation, all of the above basic constructions generated noise, but the noise generated by a single pile into the seabed is most severely affected (Madsen et al. 2006). Therefore, the current environmental assessment simulations for offshore wind turbine construction in countries focus on the noise impact of underwater piling (Madsen et al. 2006).

Piling noise is impulsive, the main frequency is below 2 kHz and from the source of 100 meters is 200 dB re 1 μPa (RMS) (Brandt et al. 2011; Madsen et al. 2006), figure 7.2.5-5 shows underwater piling’s noise spectrum of the Horns Rev II in Denmark. The amount of noise energy and frequency generated during piling is related to the size of hydraulic raft, pile, striking force, and the base. When the pile diameter is less than 5 meters, the pile size is positively correlated with the piling’s noise volume. The larger the pile diameter, the greater the noise pressure (Nedwell et al. 2005; Tougaard & Teilmann 2007), the stronger the tap force, the greater the noise pressure (Brandt et al. 2011), when the pile diameter is greater than 5 meters, the pile size is wirelessly related to the noise level of the piling. Piling noise was measured during the construction of offshore wind farms around the world, along with the measurement position differs from the noise source and the water depth, the sound pressure value of the pushback pile noise source at the nearest place has exceeded 220 dB (range 226-297 dB), the wind farms at each sea area have different environment, so the noise attenuation situation is also different, 500 meters can reduce the noise level at about 4-20 dB.

(ii) Noise During Operation

The noise of offshore wind power plants during operation is mainly due to the vibration of the fan operation, noise energy is distributed below 1 kHz, most of which are below 700 Hz (Madsen et al. 2006; ITAP 2005 in Thomsen et al.

2006), figure 7.2.5-6 is a plot of the operating noise spectrum recorded by the Institute of Theoretical Applied Physics (ITAP) in Germany at the Utgrunden offshore wind farm (1.5 MW) in Sweden. The frequency distribution is mainly related to the design properties of its implements, the only studies show that apparently its frequency distribution is less correlated with wind speed changes (Degn 2000; Ingemansson Techonology 2003). Wind power plants usually include ten to hundreds of fans, the intensity of the recorded noise may be enhanced by the additive effect of the audio in the same frequency band (Madsen et al. 2006). However, there is no relevant empirical research report of the cumulative effect on the cetacean.



Remark: Single pile diameter 3.9m, water dept 4-14m, sandy ground, biggest tapping force 850 kj.
Information source: Brandt et al. 2011

Figure 7.2.5-5 Underwater Piling Noise Spectrum Recorded During The Construction Of The Offshore Wind Farm In Horns Rev II, Denmark

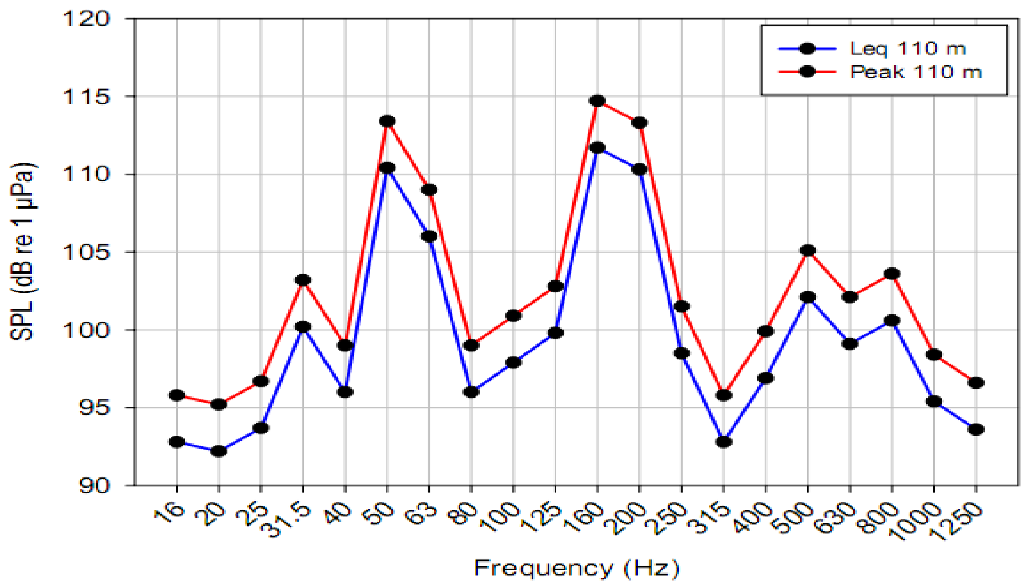
(iii) Ship Noise

Regardless of the construction or operation period at the offshore wind farm, the ships are required to carry out work. The ship’s movement not only causes behavioural disturbances to the cetacean, the huge noise generated by the engine also produces underwater noise pollution. The intensity and frequency range of various ship noises will vary depending on the size of the vessel and its speed, table 7.2.5-4 shows the different sizes and speeds of ships at different frequencies of sound pressure. Richardson et al. (1995) pointed out in the report that medium-sized vessels of 30 meters or longer may produce approximately 160 dB re 1 μPa (RMS) at 250 Hz, the survey result of cetacean is the Tursiops Truncatus, according to its hearing characteristics, it belongs to the middle frequency (MF), its hearing sensitivity range is from 150Hz to 160kHz, so the low-frequency noise impact of the construction vessels in the project area is relatively mild compared to the impact during the piling period.

V. Comprehensive Evaluation of Cetacean In This Project

Wind field is scheduled to be Changhua Waihai, the project is not located in the important habitat of Chinese white dolphins. Based on the actual cetacean survey results within the wind farm, only in July 2016, a group of Tursiops Aduncus were recorded in the wind farm as moving groups. considering the period of construction piling has the greatest impact on cetacean.

Also, from the simulation results of the operational noise impacts, the noise generated from turbines 400m away can have an attenuation of about 40dB, which will not affect the hearing of cataceans even on a temporary level.



Remark：The operation noise spectrogram of Utgrunden, Sweden offshort wind farm (1.5MW) a 12 m/s wind speed, 110m away from the turbines.
Source：ITAP 2005 in Thomsen et al. 2006

Figure 7.2.5-6 Noise Frequency Spectrum Diagram of Utgrunden, Sweden Offshore Wind Farm (100m away from wind turbines)

Chart 7.2.5-4 Sound Pressure at each Frequency for Vessels with Different Size and Speed

			Source spectral density (dB re 1μPa^2/Hz at 1m)				
Ship Type	Length (m)	Speed (m/s)	10 Hz	25 Hz	50 Hz	100 Hz	300 Hz
Supertanker	244-366	7.7-11.3	185	189	185	175	157
Large tanker	153-214	7.7-9.3	175	179	176	166	149
Tanker	122-153	6.2-8.2	167	171	169	159	143
Merchant	84-122	5.1-7.7	161	165	163	154	137
Fishing	15-46	3.6-5.1	139	143	141	132	117

Source of data：NRC 2003

7.3 Impacts on Landsacpe Aesthetics and the Recreation Value

7.3.1 Impacts on Landscape Aesthetics and Environment

I. The investigation of Development Activities and Resulting Impacts on Current Landscape Aesthetics

(i) The Range of Development Activities and Viewshed Impact

According to technical specification evaluation on activities development, observable and unobservable region is distinguishes from the centre of viewshed. The better the viewshed within the region is selected for development behaviour, visibility on status of delevopment activities will be increased. In other word, it will attracts more human activities to be participated at the viewshed, once the traffic accessibility and relevant factors are measured. The quality assessment will be bring forward for follow up purposes.

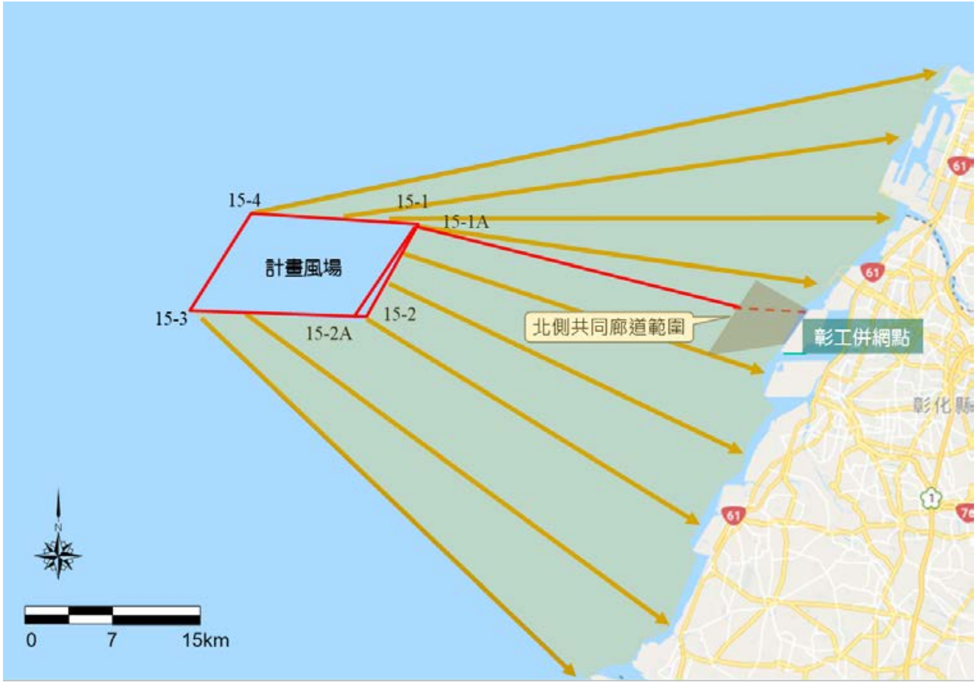
Region of the viewshed is varied based on the observation position. In overviewing the topography of viewshed, planning is located at Changhua offshore where it is topographically flat and spacious. It provides fish farm, farmland and industrial area, as well as embankment and elevated road facilities. The wind turbines generator system are to locate at more than 34.7km away from the offshore. The visibility of wind turbine is low because the topography of Changhua offshore is flat, west side facing Taiwan strait where it considers as an open viewshed, and the ashore view point is slightly too far away. Zhangbin industrial area, flat coast line, WangGong Fishing Port and Putian Temple which have higher level can see a very small area of wind turbines during good weather. In contrast, other selected district are not observable due to the impacts of settlement, embankment and wind-break forest. (Figure 7.3.1-1)

(ii) Selection of lanscape control points (vantage points) for investigating the development activities.

The landscape observation points selected by the Project which is mainly located at coastal area and also the impacts of development activities during and after the construction. Thus, the selection of landscape view point have to be based on the impact of development activities according to the 3 principles, they are, development bahviour and the distance between landscape viewshed, the position of viewshed and, the visibility status from the development activities planning. In order to obtain the result, the analysis has carried out (Please refer to the Simulation of Landscape Aesthetics and Principle 7.3.1-1). The analysis shows that the development behaviour is considered as surface wind turbines generator system, this is because the distance is slightly too far and the blocking of settlement, embankment and windbreak forest affects the visibility of wind turbines planning. Regardless of the flat topography of offshore, without visual barrier or good weather, only a small area of wind turbines can be seen. The lanscape obersation points seleted by the Project are mainly located in the coastal areas where there are human actitivities, including Rouzongjiao Beach, WangGong Fishing Port and PuTian Temple. The locations of landscape control points are shown in Figure 7.3.1-2.

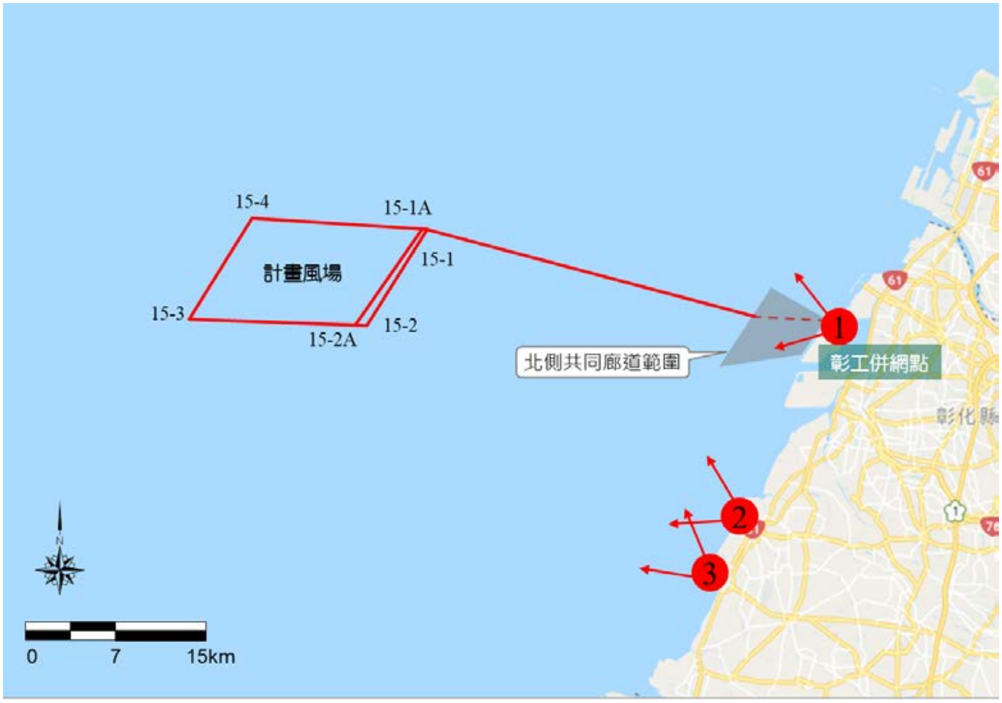
(iii) Analysis of the actual environment and landscape aesthethics

Major areas affected by this development project include coastal recreational and scenic area with significant and natural features, industrial landscape as well as unique scenes of sunset and ocean skylines Meteorological change. Therefore, landscape aesthetics are mostly good to excellent. Below is an analysis based on the environment colour of each landscape vantage point, including contents mentioned above organised as an analytic chart from table 7.3.1-1 to 7.3.1-3.



註：共同廊道內之預定海纜路徑為示意路徑，未來實際上岸點位置將遵循台電公司規劃及彰濱工業區相關規定辦理

Figure 7.3.1-1 Landscape Viewshed Range Analysis



註：共同廊道內之預定海纜路徑為示意路徑，未來實際上岸點位置將遵循台電公司規劃及彰濱工業區相關規定辦理

Figure 7.3.1-2 Viewpoint Location Map

Table 7.3.1-1 Analaysis Form For Vantage Point 1

<table>
<tr><th colspan="4">Information of the Landscape Control Point 1</th></tr>
<tr><td colspan="2">Location of Landscape Control Point: Around the Ruozongjiao Beach</td><td colspan="2" rowspan="2">Distance to the boundary of developing wind farm: 37.3km
Located□ Closed Range □ Mid-Range ■ Far Long Range</td></tr>
<tr><td colspan="2">Landscape Control Point Sea-Level Elavation (m): 0m</td></tr>
<tr><td>Position of Observer: Middle</td><td colspan="3">Photographs taken：August, 16 2016</td></tr>
<tr><td colspan="4">Latitudinal/ Longitutinal Coordinates of Landscape Control Point：24° 7’30.93” North 120°24’36.73” East</td></tr>
<tr><th colspan="2">Outlook Direction of Landscape Control Point 1</th><th colspan="2">Summary of Current Environmental Conditions of Landscape Control Point 1</th></tr>
<tr><td colspan="2">
</td><td colspan="2">This landscape control point is located around the Rouzongjiao Beach, which is approximately 37.7km from wind farm of the Project. It is a distant view with median observer slight level. There is a large area of breach during falling tide. The surrounding area are abundant in ecological resources. It is important breeding grounds for precious rare wild animal, the Sterna albifrons, which has more significant visual impact on the visitors; therefore, it is slected as the landscape control point. Due to its flat topography and vast beach area, the viewshed range is quite open. You can enjoy vast area of beach, the ocean and rotating wind turbine. The vast sky is the visual background; you can enjoy the sunset scene at dusk when the weather permits. The background color is the composition of blue, brown and gray tones from the sky and beach, displaying a rather simple open space profile with overall pleasing landscape aesthetics.</td></tr>
<tr><th colspan="2">Current Photo of Landscape Control Point 1</th><th colspan="2">Description of Environmental Colors of Landscape Control Point 1</th></tr>
<tr><td colspan="2"></td><td colspan="2">
</td></tr>
</table>

Table 7.3.1-2 Analysis Form For Vantage Points 2

Information of the landscape control point 2

Location of Landscape Control Point：Cross ocean arch bridge of Wanggong Fishing Port	Distance to the boundary of developing wind farm: 37.2km
Landscape Control Point Sea-Level Elevation（m）：5m	Located □ Close Range □ Mid-Range ■ Far Long Range
Position of the observer: Middle	Date of Investigation：August, 16 2016

Latitudinal/Longitudinal Coordinates of Landscape Control Point ： 23°58'5.41" North 120°19'26.69"East

Outlook Direction of Landscape Control Point 2	Summary of Current Environmental Conditions of Landscape Control Point 2
	This landscape control point is located on the cross ocean arch bridge inside Wanggong Fishing Port, approximately 37.2km away from the project wind turbines and is considered as long distance view with observer in the center position. Te location has a considerable amount tourists and an open viewshed that directly impact the observer's vision that makes it one of the chosen point. Due to its flat topography and the slightly higher location for observation, the viewshed range is relatively open. During the receding tide, large amount of sands and oyster racks become the primary visual elements and the vast range of blur ocean and sky take over the background during rising tide, plus a beautiful sunset to appreciate during the dusk when the weather permits. The environmental colors are composed of blue and brown from the surrounding nature and artificial facilities, displaying a rather simple open space profile with an overall pleasing landscape aesthetics.

Current Photo of Landscape Control Point 2	Description of Environmental Colors of Landscape Control Point 2
	

Table 7.3.1-3 Analysis Form For Vantage Point 3

<table>
<tr><td colspan="4">Information of the landscape control point 3</td></tr>
<tr><td colspan="2">Location of Landscape Control Point：Pu Tian Temple</td><td colspan="2" rowspan="2">Distance to the boundary of developing wind farm: 38.6km
Located □ Close Range □ Mid-Range ■ Far Long Range</td></tr>
<tr><td colspan="2">Landscape Control Point Sea-Level Elevation（m）：10m</td></tr>
<tr><td>Position of the observer: Middle</td><td colspan="3">Date of Investigation：August, 16 2016</td></tr>
<tr><td colspan="4">Latitudinal/Longitudinal Coordinates of Landscape Control Point ： 23°55'45.58" North 120°18'59.21"East</td></tr>
<tr><td colspan="2">Outlook Direction of Landscape Control Point 3</td><td colspan="2">Summary of Current Environmental Conditions of Landscape Control Point 3</td></tr>
<tr><td colspan="2">

</td><td colspan="2">This landscape control point is located on the 3rd floor of Putian Temple, about 38.6km away from the project wind turbines and is considered as long distance view with observer in the center position. Putian Temple is an important religious center in Changhua that attracts many worshipers and tourists, which is the reason why it was chosen. The large surface mangrove and the ocean view during rising tide makes up for the main element while the wide-open skyline forms the visual background. The entire space appears to be open due to the flat topography and higher viewing location. Colors in the environmental are composed of blue, grey and deep green from the sky and green area. The makeup of the entire space is simple and observers can enjoy th sunset in good weather conditions, making an excellent overall landscape aesthetics.</td></tr>
<tr><td colspan="2">Current Photo of Landscape Control Point 3</td><td colspan="2">Description of Environmental Colors of Landscape Control Point 3</td></tr>
<tr><td colspan="2">

</td><td colspan="2">

</td></tr>
</table>

II. Prediction of Impacts to Landscape from Development Behaviour

In connection of future development behaviour and the impacts of current viewpoint condition, the content from proposal of development activities and environment impact evaluation has mainly taken into planning content. According to the guide of Environment Impact Assessment (EIA) stage, the weight and height, scale, bearing of the wind turbines have to undergo simulation for the purpose of understanding the variation before and after the development.

(i) Simulation Operation of Development Behaviour

The analysis results of viewpoint before and after development according to the control point of different positions has carried out to view the differences between current condition of the environment and rear stage of operation. The composition of environment is similarly simple, only the changes of front or rear view is affected. Therefore, analysis of the changes of front and rear view is carried out for the purpose of understanding the distance of observation point that brings impacts to the interior.

According to analysis results, since the wind turbines is located in the sea and the distance is relatively far, changes in the scope of the foreground cannot be seen but a small area of the blades and columns, the extent of change for the background is quite small. Since the project my adopt 8MW or 11MW wind turbines, and since the amount of 8MW wind turbines more, therefore, 8MW wind turbines are used to analyse the degree of landscape canges. The relevant degree of change analysis are shown in Table 7.3.1-4~7.3.1-6.

(ii) Landscape Impact Predictions

This project is to build wind turbines system according to the current situation, upon construction and three stages after the operation with regard to the environment viewpoint impact condition of control point, make use of naturalness, compatibility, vividness, intergrity, uniqueness of the environment through qualitative method to conduct the prediction of viewpoint impact in each stages. Since the Project may adopt 8MW or 11MW wind turbines, therefore, the following landscapre prediction points will carry out stimulation and assessment for these two different wind turbines based on three terrestrial recreation sites.

Table 7.3.1-4 Analysis Table Showing The Degree of Changes for Observation Point 1 Before and After Development

Landscape Control Point 1			
Foreground Range			
	3115.5879		0
	Degree of Change	0%	
Background Range			
	4384.4121		0.9666
	Degree of Change	0.9666/4384.4121*100%=0.022%	

Table 7.3.1-5 Analysis Table Showing The Degree of Changes for Observation Point 2 Before and After Development

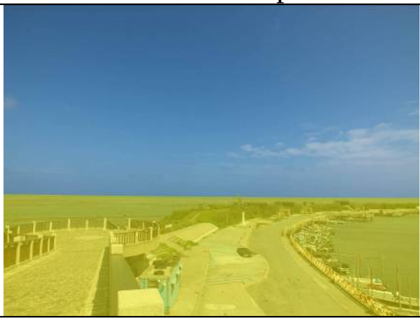
Landscape Control Point 2		
Foreground Range		
	2900.3557	0
	Degree of Change	0%
Background Range		
	4599.6443	1.2618
	Degree of Change	1.2618/4599.6443*100%=0.027%

Table 7.3.1-6 Analysis Table Showing the Degree of Changes for Observation Point 3 Before and After Development

Landscape Control Point 3		
Foreground Range		
	3061.4134	0
	Degree of Change	0%
Background Range		
	4438.5866	2.1763
	Degree of Change	2.1763/4438.5866*100%=0.049%

Table 7.3.1-7 Landscape of Observation Point 1 Before, During and After Development

<table>
<tr><td colspan="2">Information of the landscape control point 1</td></tr>
<tr><td>Location of landscape control point: Around the Rouzongjiao Beach</td><td rowspan="6">
</td></tr>
<tr><td>Latitudinal/Longitudinal Coordinates of Landscape Control Point :
24° 7'30.93" North 120°24'36.73" East</td></tr>
<tr><td>Landscape Control Point Sea-level (m)：0m</td></tr>
<tr><td>Position of the observer: Middle</td></tr>
<tr><td>Distance to the boundary of developing wind farm：37.3km
Located:□ Close Range□ Close Range ■ Far Long Range</td></tr>
<tr><td colspan="2">Prediction of Landscape Impact at Landscape Control Point 1</td></tr>
<tr><td colspan="2">Current Condition</td></tr>
<tr><td></td><td>This scenic spot is located near Ruozongjiao Beach, where local residents and tourists are the main influencing targets. The area is flat topography with fairly open viewshed, and appears to be an open space. The overall environment is dominated by vast area of beach and ocean. The naturalness, compatibility and intergrity of the overall environment are good. The adjacent wind turbines are tall and large, can attract observer's attention to enhance the uniqueness of the region; coupled with sunset under good weather which presents rich meterological variations to increae vividness of the visual environments, making excellent overall landscape aesthetics.</td></tr>
<tr><td colspan="2">76 units of 8MW Wind Turbines</td></tr>
<tr><td colspan="2">During Construction</td></tr>
<tr><td></td><td>There are relatively more wind turbines in the project and there is no visual barrier. However, since the observatory point is very far away, visibility on the status of the wind turbine construction is still not high even under fair weather, therefore, change to the naturalness, vividness, intergrity, compatibility and uniqueness of the environment are minimal, making slight or no effect on overall landscape aesthetics.</td></tr>
<tr><td colspan="2">Upon Operation</td></tr>
<tr><td></td><td>Upon operation of the Project's wind turbines, even though there are vast area of offshore wind turbine facilities, but since the wind turbines are very far from this observatory point, visibility is quite low. Change to the naturalness, vividness, intergrity, compatibility and uniqueness of the environment is limited, therefore, making slight or no effect on overall landscape aesthetics.</td></tr>
</table>

Table 7.3.1-7 Impact Prediction Analysis Table – Landscape of Observatory Point 1 Before, During and After Development (Cont.)

<table>
<tr><th colspan="2">Information of Landscape Control Point 1</th></tr>
<tr><td>Location of Landscape Control Point:
Nearby Rouzongjiao Beach</td><td rowspan="5">
</td></tr>
<tr><td>Latitude and Longitude Coordinates of Landscape Control Point:
24° 7'30.93" North
120°24'36.73" East
(TWD97:190050.34,2669025.98)</td></tr>
<tr><td>Sea-level Elevation of Landscape Control Point (m)：0m</td></tr>
<tr><td>Position of Observer: Middle</td></tr>
<tr><td>Distance from the boundary of developing wind farm: 37.4km
Located □ Close Range □ Middle Range ■ Far Range</td></tr>
<tr><th colspan="2">Prediction of Impact on Landscape Control Point 1</th></tr>
<tr><td colspan="2">Current Condition</td></tr>
<tr><td></td><td>This landscape control point is located near the Rouzongjiao Beach, where local residents and tourists are the main target. The terrain is flat with fairly open viewshed. The landscape is dominated by large areas of beaches and oceans. The overall environment is natural, compatible and complete; the adjacent wind turbines are tall and large. It can attract the attention of the viewers, enhance the uniqueness of the region, and the weather in the evening is rich in meteorological changes, which can increase the vividness of the visual environment, and the overall view is of good quality.</td></tr>
<tr><th colspan="2">55 units of 11MW Wind Turbines</th></tr>
<tr><td colspan="2">During Construction</td></tr>
<tr><td></td><td>This landscape control point is very far from the project area. Although there is no visual barrier, the visibility of the wind turbine construction is not high even when the weather is good. There will be limited degree of change in the naturalness, vividness, integrity, compatibility and uniqueness of the environment in the region, and slight to no effect on overall landscape aesthetics.</td></tr>
<tr><td colspan="2">Upon Operation</td></tr>
<tr><td></td><td>Upon the operation of the wind turbine, eventhough there are large-scale offshore wind power generation facilities, but the visibility remain low due to the distance. There will be limited degree of change in the naturalness, vividness, integrity, compatibility and uniqueness of the environment in the region, and slight to no effect on overall landscape aesthetics.</td></tr>
</table>

Table 7.3.1-8 Impact Prediction Analysis Table – Landscape of Observatory Point 2 Before, During and After Development

<table>
<tr><th colspan="2">Information of Landscape Control Point 2</th></tr>
<tr><td>Location of Landscape Control Point: Cross-Ocean Bridge of Wanggong Fishing Port</td><td rowspan="5">
</td></tr>
<tr><td>Latitude and Longitude Coordinates of Landscape Control Point:
23°58'5.41" North
120°19'26.69" East
(TWD97:181214.89,2651666.19)</td></tr>
<tr><td>Sea-level Elevation of Landscape Control Point (m)：5m</td></tr>
<tr><td>Position of Observer：Middle</td></tr>
<tr><td>Distance from the boundary of developing wind farm: 37.2km
Located □ Close Range □ Middle Range ■ Far Range</td></tr>
<tr><th colspan="2">Prediction of Impact on Landscape Control Point 2</th></tr>
<tr><td colspan="2">Current Condition</td></tr>
<tr><td></td><td>This landscape control point is located on the cross-ocean bridge of Wanggong Fishing Port. Local tourists are the main considerations. The main visual elements are the fishing port facilities and large areas of beach, sea and sky. Due to the high viewing position and the surrounding terrain, the space is considered open and the environment color and spatial elements are simple. The integrity, compatibility, naturalness and vividness of the overall environment are good. The uniqueness is relatively higher as the region is able to bring stronger visual impact to the viewers.</td></tr>
<tr><th colspan="2">76 units of 48MW Wind Turbines</th></tr>
<tr><td colspan="2">During Construction</td></tr>
<tr><td></td><td>Due to the absence of obstructive buildings and other elements, the viewshed is quite open. However, due to the distance, the visibility of the wind turbine construction is not high even when the weather is good. There will be limited degree of change in the naturalness, vividness, integrity, compatibility and uniqueness of the environment in the region, and slight to no effect on overall landscape aesthetics.</td></tr>
<tr><td colspan="2">Upon Operation</td></tr>
<tr><td></td><td>Upon operation after the completion of construction, the visibility remain low as the large-scale wind turbine group is located far away from the landscape control point. It will not affect the sunset landscape. It has little influence on the viewer's visual and psychological feelings. The overall space is natural and vivid. The degree of change in integrity, compatibility, and uniqueness are limited with minor or no impact.</td></tr>
</table>

Table 7.3.1-8 Impact Prediction Analysis Table – Landscape of Observatory Point 2 Before, During and After Development (Cont.)

<table>
<tr><td colspan="2">Information of Landscape Control Point 2</td></tr>
<tr><td>Location of Landscape Control Point: Cross-Ocean Bridge of Wanggong Fishing Port</td><td rowspan="5">
</td></tr>
<tr><td>Latitude and Longitude Coordinates of Landscape Control Point:
23°58'5.41" North
120°19'26.69" East
(TWD97:181214.89,2651666.19)</td></tr>
<tr><td>Sea-level Elevation of Landscape Control Point (m)：5m</td></tr>
<tr><td>Position of Observer：Middle</td></tr>
<tr><td>Distance from the boundary of developing wind farm: 37.2km
Located □ Close Range □ Middle Range
■ Far Range</td></tr>
<tr><td colspan="2">Prediction of Impact on Landscape Control Point 2</td></tr>
<tr><td colspan="2">Current Condition</td></tr>
<tr><td></td><td>This landscape control point is located on the cross-ocean bridge of Wanggong Fishing Port. Local tourists are the main considerations. The main visual elements are the fishing port facilities and large areas of beach, sea and sky. Due to the high viewing position and the surrounding terrain, the space is considered open and the environment color and spatial elements are simple. The integrity, compatibility, naturalness and vividness of the overall environment are good. The uniqueness is relatively higher as the region is able to bring stronger visual impact to the viewers.</td></tr>
<tr><td colspan="2">55 units of 11MW Wind Turbines</td></tr>
<tr><td colspan="2">During Construction</td></tr>
<tr><td></td><td>Due to the absence of obstructive buildings and other elements, the viewshed is quite open. However, due to the distance, the visibility of the wind turbine construction is not high even when the weather is good. There will be limited degree of change in the naturalness, vividness, integrity, compatibility and uniqueness of the environment in the region, and slight to no effect on overall landscape aesthetics.</td></tr>
<tr><td colspan="2">Upon Operation</td></tr>
<tr><td></td><td>Upon operation after the completion of construction, the visibility remain low as the large-scale wind turbine group is located far away from the landscape control point. It will not affect the sunset landscape. It has little influence on the viewer's visual and psychological feelings. The overall space is natural and vivid. The degree of change in integrity, compatibility, and uniqueness are limited with minor or no impact.</td></tr>
</table>

Table 7.3.1-9 Impact Prediction Analysis Table – Landscape of Observatory Point 3 Before, During and After Development

Information of Landscape Control Point 3	
Location of Landscape Control Point: Putian Temple Latitude and Longitude Coordinates of Landscape Control Point: 55'45.58" North 120°18'59.21" East (TWD97:180410.38,2647361.73) Sea-level Elevation of Landscape Control Point (m)：10m Position of Observer: Middle Distance from the boundary of developing wind farm: 38.6km Located □ Close Range □ Middle Range ■ Far Range	
Prediction of Impact on Landscape Control Point 3	
Current Condition	
	This landscape control point is on the third floor of Putian Temple with worshipers and tourists as the main target in concern. The main visual elements are wetlands, mangroves and large areas of ocean and sky. The landscape is highly homogenous. As the viewshed of the space is open and colors in the environment are simple, the original natural environment and cultural architectural characteristics are all preserved even with man-made facilities such as the temple in existence. The integrity, compatibility, naturalness, vividness and uniqueness of the overall environment are good.
76 units of 8MW Wind Turbines	
During Construction	
	Since the observatory point of this landscape control point is relatively higher than surrounding flat topography, its spatial viewshed is broad. However, as it is approximately 39.5km away from the project, the visibility is quite low. Coupled with the relatively small proportional visual scale of the wind turbines, degree of change to the naturalness, vividness, integrity, compatibility and uniqueness of this environment are limited, making slight or no effect on overall landscape aesthetics.
Upon Operation	
	Since it is very far from the project's wind farm, degree of change to the spatial viewshed range, environmental color and skyline is low, and would not affect the sunset scenery and quiet visual landscape. Assessment on the naturalness, vividness, integrity, compatibility and uniqueness concluded as slight or no effect. It is possible to maintain the existing landscape aesthetics.

Table 7.3.1-9 Impact Prediction Analysis Table – Landscape of Observatory Point 3 Before, During and After Development (Cont.)

<table>
<tr><th colspan="2">Information of Landscape Control Point 3</th></tr>
<tr><td>Location of Landscape Control Point: Putian Temple</td><td rowspan="5">
</td></tr>
<tr><td>Latitude and Longitude Coordinates of Landscape Control Point:
55'45.58" North
120°18'59.21" East
(TWD97:180410.38,2647361.73)</td></tr>
<tr><td>Sea-level Elevation of Landscape Control Point (m)：10m</td></tr>
<tr><td>Position of Observer: Middle</td></tr>
<tr><td>Distance from the boundary of developing wind farm: 38.6km
Located □ Close Range □ Middle Range ■ Far Range</td></tr>
<tr><th colspan="2">Prediction of Impact on Landscape Control Point 3</th></tr>
<tr><td colspan="2">Current Condition</td></tr>
<tr><td></td><td>This landscape control point is on the third floor of Putian Temple with worshipers and tourists as the main target in concern. The main visual elements are wetlands, mangroves and large areas of ocean and sky. The landscape is highly homogenous. As the viewshed of the space is open and colors in the environment are simple, the original natural environment and cultural architectural characteristics are all preserved even with man-made facilities such as the temple in existence. The integrity, compatibility, naturalness, vividness and uniqueness of the overall environment are good.</td></tr>
<tr><th colspan="2">55 units of 11MW Wind Turbines</th></tr>
<tr><td colspan="2">During Construction</td></tr>
<tr><td></td><td>Since the observatory point of this landscape control point is relatively higher than surrounding flat topography, its spatial viewshed is broad. However, as it is approximately 39.5km away from the project, the visibility is quite low. Coupled with the relatively small proportional visual scale of the wind turbines, degree of change to the naturalness, vividness, integrity, compatibility and uniqueness of this environment are limited, making slight or no effect on overall landscape aesthetics.</td></tr>
<tr><td colspan="2">Upon Completion</td></tr>
<tr><td></td><td>Since it is very far from the project's wind farm, degree of change to the spatial viewshed range, environmental color and skyline is low, and would not affect the sunset scenery and quiet visual landscape. Assessment on the naturalness, vividness, integrity, compatibility and uniqueness concluded as slight or no effect. It is possible to maintain the existing landscape aesthetics.</td></tr>
</table>

7.3.2 Impacts on the Recreational Environment

I. Predicted Impact of the Development

In order to predict and evaluate the impact of development towards quality of recreational locale, high-sensitivity recreation sites in the planning area are screened to be represented sites to make the comparison on the recreational quality that may occur before and after the development of the project. The wind turbine construction project is planned to be at least 34.7 km away from the coast. Due to the wide coastline and no visual obstruction, local residents and tourists have a small chance to see the development of the project during clear weather. However, as the distance is quite far away, the visibility of the wind turbine remain relatively low. Therefore, the wind turbines have little influence on the visual impact even after completion. The degree of influence on the quality of the recreation is insignificant. The following are discussion divided into the two periods: during construction period and post-construction opreational period.

(i) Predicted Impacts on Recreational Quality During Construction

1. Impacts on Traffic Accessibility to the Recreational Locale

During the construction phase of this project, construction machinery and trucks carrying construction materials will be entering and leaving the project area, generating additional traffic that may impact traffic accessibility along surrounding roads as well as the quality of various recreational locales and environment. Construction road usage plans should be formulated in order to mitigate traffic impacts during the construction process.

2. Impacts on recreational experiences in nearby recreational locales caused by the construction process

During the construction of the wind turbine, the material stacking on the shore will change the visual impression, and the neighboring recreation sites may affect the visual impression of the visitors.

(ii) Predicted Impacts on Recreational Quality After Completion

1. Visual Impact After Setting Up Wind Power Turbines

Due to the considerable distance of the wind turbines, the visibility of the observers on land is rather limited and the degree of visual impact is quite limited.

2. Traffic Accessibility of The Recreational Locale

Upon operation after completion, primary and secondary traffic lines shall be restored back to the original state. Therefore, impact on traffic services of this regions will not be significant.

II. Prediction and Evaluation of Impacts on The Recreational Areas

In order to predict and evaluate the impact of development towards quality of recreational locale, high-sensitivity recreation sites in the planning area are screened to be represented sites to make the comparison on the recreational quality that may occur before and after the development of the project.

During the construction phase of this project, construction machinery and trucks might generate additional traffic that may impact traffic accessibility along surrounding roads, while the material stacking on the shore might affect the visual impression. However, primary and secondary traffic lines shall be restored back to the original state upon completion of project. Due to the considerable distance of the wind turbines, the visibility of the observers on land is rather limited and causing slight to no negative impact on visual impression. Based on the investigation, table below shows the degree of impact on recreational experience, accessibility, and tourist volume before and after construction for each recreational location.

(i) Dadu River Wildlife Sanctuary

The Project’s wind farm is located 42 kilometres to the west of Dadu River Wildlife Sanctuary. This strongpoint is one of the most important wetlands in Asia. A rich variety of wildlifes can be found here. During bird watching season, visitors can enjoy the phenomena of migration by the migratory birds. Here, visitors can also learn more about nature, enjoy sceneries, bird-watching and more. Automobiles serve as the main transportations here. As the Project’s wind farm is quite distant from this recreation point, during the construction phase and operation period of this project, additional construction machinery and trucks carrying construction materials will be entering and leaving the project area, generating additional traffic that may impact traffic accessibility along surrounding roads. It may affect the traffic conditions here and causes mild traffic inconveniences to the public. The wind turbines would not affect the area as tourists are mainly attracted by the wildlifes and sceneries of nature here. It will not affect the ecosystem as it is quite distant and there are no detrimental effects to the recreational experiences here. The traffic service standards will be restored to pre-construction levels after the project and the recreational experience will only be mildly or not affected by the construction.

(ii) BRAND’s Health Museum

BRAND’s Health Museum is located 38 kilometres linearly to the southeast of the project area. It is the biggest BRAND’s Health Museum in Taiwan and the first in Asia. It is a place for tourists to visit, shop and more. Numerous visitors are attracted by the museum. For this area, most of the visitors are from nearby districts. There will be more visitors from all over during public holidays. The main consumers targeted are family and friends. Automobiles and tour buses are the main transportations around here. It is predicted that during the construction phase and operation period, the project area cannot be observed due to far distance and the blocking of the construction site. There are no significant effects to the recreational experience of the area. Provincial Highway 17 may see an increase in traffic due to the ongoing project. As the distance between Provincial Highway 17 and the project area is significant and the traffic flows are not overlapped, it will not affect the number of tourists and the traffic for the area.

(iii) Taiwan Glass Pavillion

Taiwan Glass Pavillion is located 38 kilometres linearly to the southeast of the project's wind farm. Besides showing the manufacturing processes and the histories of glasses, many exquisite glass products are also displayed. It attracts numerous tourists from various places and the main transportions used are tour buses and automobiles. According to the data from the Tourism Bureau (2015), there are around 1.32 million visitors annually. It is predicted that during the construction phase and operation period, the project area cannot be observed as the distance between it and the recreation point is significant. However, it will not affect the recreational experience of the area. Provincial Highway 17 may see an increase in traffic due to the ongoing project. As the distance between Provincial Highway 17 and the project area is significant and the traffic flows are not overlapped, it will affect slightly the recreational experience of the area, the number of tourists and the traffic for the area. Overall, it belongs to the slight or no effect category.

(iv) Lukang Cultural and Recreational Area

Lukang Cultural and Recreational Area is located 42 kilometres linearly to the southeast of the project area. It is a well-known heritage site in Taiwan and many ancient buildings and temples are located in the area. It is considered as the pride of Taiwan in recreational resources. Numerous tourists visit here and the main transportations used are tour buses and automobiles. According to the statistics of Lukang Lungshan Temple from the Tourism Bureau in 2015, there are around 1.21 visitors annually. It is predicted that during the construction phase and operation period, the project area cannot be observed as the recreational area is crowded with people and quite far from the recreation point. Construction machinery and trucks carrying construction materials will be entering and leaving the project area, generating additional traffic that may mildly impact traffic accessibility along surrounding roads. The traffic service standards will be restored to pre-construction levels after the project. The recreational experience and the number of tourists will only be mildly or not affected by the construction.

(v) Fubao Ecopark

Fubao Ecopark is located 37.7 kilometres linearly to the southeast of the project area. It is an important place for the conservation of aquatic birds and their ecosystem. Besides having a huge variety of floras and faunas, many art works are also displayed. The park attracts more tourists or bird lovers during the holidays and it is considered a recreational area with natural sceneries. Visitors are mainly from nearby areas and the main transportations used are automobiles. As this recreation point is coastal and far from the project area, the project area has poor visibility. Small area of the project area can be observed if the weather conditions are well. It is predicted that during the construction phase and operation period, the recreational experience of the area would not be affected significantly. However, construction machinery and trucks carrying construction materials will be entering and leaving the project area, generating additional traffic that may impact traffic accessibility along surrounding roads and affect the recreational experience of the area. The traffic service standards will be restored to pre-construction levels after the project. The offshore wind farm is hardly visible too. The recreational experience and the number of tourists will only be mildly or not affected by the construction.

(vi) Hanbao Wetlands

Hanbao Wetlands is located 37.3 kilometres linearly to the southeast of the project’s wind farm. It has a diverse ecosystem and it is gradually developed into a site for ecotourism. It is considered as a natural ecological landscape. Visitors mainly come from the Central Taiwan and the main transportations used are automobiles. It is predicted that during the construction phase, the project area cannot be observed as this recreation point is too far from it and the vision is blocked by levees too. However, it is not hugely affecting the recreational experience of the area. Construction machinery and vehicles may use Provincial Highway 17, which may affect the traffic conditions here slightly but overall the recreational experience will only receive slight to no effect at all.

(vii) Wanggong Fishing Port

Wanggong Fishing Port is located 37 kilometres linearly to the southeast of the project’s wind turbines. Visitors are attracted by the oyster picking activities and the beautiful sunset scenery here. Visitors can ride oyster trucks and experience oyster picking during the receding tide. Visitors can also enjoy the sight of the intertidal zone’s ecosystem. The lighthouse, landscape bridge and the wind farm along shore also become famous local landmarks. The main transportations used are tour buses and automobiles. Most of the visitors are locals or from the nearby districts. Wanggong Fishing Port is considered as a natural ecological landscape with ecological education purpose. As this recreation point has a vast view, the wind turbines can be seen. However, it is predicted that during the construction phase and operation period, the project’s wind turbines will have poor visibility as they are too far from the observatory point. The effect of this towards the recreational experience is not significant. During the construction phase, the traffic conditions may be slightly affected as the operation hour of Provincial Highway 17 may be extended. However, visitors are not affected significantly by this change. The traffic service standards will be restored to pre-construction levels after the project. Overall, the recreational environment will receive slight to no effect at all.

(viii) Putian Temple

Putian Temple is located 39.5 kilometres linearly to the southeast of the project's wind turbines. Goddess Mazu, is one of the central religious figure for the people of Fangyuan Township and her statue can be found in Putian Temple. Putian Temple is built based on traditional temple architectures and structures. Many pilgrims and visitors will visit Putian Temple during the Goddess of The Sea festival or other festivals. Putian Temple is considered as a religious structure and a recreational area to visit. This recreation point is quite far from the wind turbines' power plant, therefore the visibility of the wind turbines are limited even if the weather conditions are well. It is predicted that during the construction phase, the construction of the wind turbines will not affect the recreational experience of the visitors significantly. Construction machinery and vehicles may use Provincial Highway 17, which may affect the traffic conditions here slightly. During the operation period, the traffic conditions will be restored to pre-construction levels and it will not affect the experiences of the visitors and the number of visitors as well. The recreational experience and the number of tourists will only be mildly or not affected by the construction.

(ix) Dacheng Wetlands

Dacheng Wetlands is located 41.5 kilometres linearly to the southeast of the project's wind turbines. It is the largest mudflat in the country and it has the largest heron forest in the country too. Dacheng Wetlands is considered as a national-level wetlands that is very important to the country. This wetland is filled with diverse bird species and considered as a natural ecological recreational resource. Visitors are mainly from the southcentral Taiwan region and the main transportations used are automobiles. As this recreation point is quite far from the project area, it is predicted that during the construction phase and the operation period, the project area cannot be observed. However, the recreational experience and the number of tourists will only be mildly or not affected by this. Construction machinery and vehicles may use Provincial Highway 17 and the surrounding roads, which may affect the traffic conditions here slightly. The traffic service standards will be restored to pre-construction levels after the project. Overall, the recreational environment will receive slight to no effect at all.

III. Integrated evaluation of impacts on the recreational areas

This project has highlighted 9 observatory points that are unique from the project area and the surroundings of it. This is to compare the recreational standards before, after and during the project. The observatory points are chosen according to their sensitivity and height.

Results from pre- and post-construction assessments for recreational environments and locations near the project area were compiled and reviewed. Overall impact on recreational experience, accessibility, and tourist volume mostly ranges from mildly negative to slight or no effect. Upon operation, primary and secondary traffic lines will be restored back to the original state, therefore, impact on traffic services of this region will not be significant. The visibility of the wind turbines' power plant is also low and it will not affect the visual experience of the visitors. Overall impact on recreational experiences will range from slight or no effect to mildly positive. Table 7.3.2-1 shows the degree of impact on recreational experience, accessibility, and tourist volume before and after construction for each recreational location. As the Project's wind farm is averagely 35 kilometres away from each observatory points, the wind turbines will not be visible even if the weather conditions are well and the views are unobstructed. The navigating distance for this Project's wind farm is also further compared to other wind farms, therefore limited in tourism or sightseeing aspect. The Project will not attract large amount of visitors to the recreation points around Changhua area, therefore each recreation points will only be slightly affected or not at all.

Table 7.3.2-1 Recreational Impact Estimates Summary Table

Recreational location		Impact to accessibility	Recreational experience Effects	Changes to tourist volume	Integrated evaluation
1.Dadu River wildlife sanctuary Quality of recreational resource:BClass Regional importance:AClass	During construction	Slight affects main and secondary routes Mildly negative	Slight or no effect	Slight or no effect	Slight or no effect
	Operation period	Transportation Service Standards Recovered Slight or no effect	Slight or no effect	Slight or no effect	Slight or no effect
2. BRAND'S Health Museum Quality of recreational resource:CClass Regional importance:AClass	During construction	Slight affects main and secondary routes Mildly negative	Slight or no effect	Slight or no effect	Slight or no effect
	Operation period	Transportation Service Standards Recovered Slight or no effect	Slight or no effect	Slight or no effect	Slight or no effect
3. Taiwan Glass Pavilion Quality of recreational resource:CClass Regional importance:AClass	During construction	Slight affects main and secondary routes Mildly negative	Slight or no effect	Slight or no effect	Slight or no effect
	Operation period	Transportation Service Standards Recovered Slight or no effect	Slight or no effect	Slight or no effect	Slight or no effect
4. Lukang Cultural and Recreational Area Quality of recreational resource:AClass Regional importance:AClass	During construction	Slight affects main and secondary routes Mildly negative	Slight or no effect	Slight or no effect	Slight or no effect
	Operation period	Transportation Service Standards Recovered Slight or no effect	Slight or no effect	Slight or no effect	Slight or no effect
5. Fubao Ecopark Quality of recreational resource:BClass Regional importance:BClass	During construction	Slight affects main and secondary routes Mildly negative	Slight or no effect	Slight or no effect	Slight or no effect
	Operation period	Transportation Service Standards Recovered Slight or no effect	Slight or no effect	Slight or no effect	Slight or no effect
6. Hanbao Wetlands Quality of recreational resource:BClass Regional importance:bClass	During construction	Slight affects main and secondary routes Mildly negative	Slight or no effect	Slight or no effect	Slight or no effect
	Operation period	Transportation Service Standards Recovered Slight or no effect	Slight or no effect	Slight or no effect	Slight or no effect
7. Wanggong Fishing Port Quality of recreational resource:BClass Regional importance:AClass	During construction	Slight affects main and secondary routes Mildly negative	Slight or no effect	Slight or no effect	Slight or no effect
	Operation period	Transportation Service Standards Recovered Slight or no effect	Slight or no effect	Slight or no effect	Slight or no effect
8. Putian Temple Quality of recreational resource:CClass Regional importance:AClass	During construction	Slight affects main and secondary routes Mildly negative	Slight or no effect	Slight or no effect	Slight or no effect
	Operation period	Transportation Service Standards Recovered Slight or no effect	Slight or no effect	Slight or no effect	Slight or no effect
9. Dacheng Wetlands Quality of recreational resource:AClass Regional importance:AClass	During construction	Slight affects main and secondary routes Mildly negative	Slight or no effect	Slight or no effect	Slight or no effect
	Operation period	Transportation Service Standards Recovered Slight or no effect	Slight or no effect	Slight or no effect	Slight or no effect

Comprehensive Assessment of Impacts to Recreation:
Impacts to recreation during construction Slight or no effect
Impacts to recreation after completion and operation begins Slight or no effect

7.4 Social Economics

7.4.1 Usage of Land

This is a project for developing an offshore wind energy (OWE) farm. Relevant planning and laws involved in land use are described in the following.

I. Plans for maritime land acquisition for the offshore wind farm

The laws and regulations for the wind farm and maritime land are as below:

(i) According to the *Law on the Territorial Sea and the Contiguous Zone of the Republic of China* and the *Law on the Exclusive Economic Zone and the Continental Shelf of the Republic of China*, sovereignty in the territorial sea and the adjacent zone belongs exclusively to the Exclusive Economic Zone (EEZ) and the Continental Shelf. The country has 12 nautical miles of territorial sea from the baseline, 12 nautical miles of adjacent zone on the outer side of the territorial sea, 200 nautical miles of Exclusive Economic Zone (EEZ) and water domain of the Continental Shelf.

(ii) According to the first description from the first section of Article 14, Land Act stated that lands lying within certain limits of the seacoast shall not be privately owned. According to report number 727170 published by the Ministry of Interior (MOI), it is said that the lands lying within certain limits of the seacoast shall not be privately owned. However, it is not stated that the lands cannot be used for private purposes and the lands are not non-public use properties.

(iii) In 1st July 2004, report number 0930019486 that was published by the Ministry of Finance has discussed few points regarding the use of non-public land for the construction of power plant for wind turbines.

1. Developers of the power plant on non-public land must follow the Directions of Development for Non-Public Land. Deposits and operation expenses will be charged according to the size of development. Permissions must be requested from the agency-in-charge and the developers can only set up the area of development after the agency-in-charge grants them permission. The area can only be developed by methods of outsourcing. Besides the points that are mentioned above, developers must follow Article 50 and the 3rd rule of the 1st section from Article 42 of the National Property Law, which is to offer the land for sale by tender or to lease the land.

2. Spaces for air transportations are taken up by the blades of the wind turbines, therefore routes of air transportations should be referred to allow possible travel. The area of the wind turbine should be measured with the vertically projected area of the blades and deducted with the area of the wind turbines' base. A 2% reimbursement is charged onto the total area

according to the declared land value.

3. In accordance with the implementation of the national energy policy and the development time of the area, developers who had not registered their cadaster can lease out the land or offer it for sale by tender. It requires deposits, rental fees or fees for the right of outsourcing. The fees are processed through the Assessed Present Value and the declared land value of similar lands. If any unregistered land owned by the deveopers are registered as public land, the developers must sell the land.

4. At the end of year 2011, the Resource Agency of the Ministry of Economic Affairs, along side the National Property Administration from the Ministry of Finance have stopped granting permits for maritime land to avoid developers from occupying the lands without developing it.

An establishment permit application will be submitted together with the related certification documents and approved development permits from local government authorities to the Bureau of Energy in accordance with related legal requirements.

II. Submarine power cable routes

For the routing of the submarine power cables, documentation must be attached and submitted to the Ministry of the Interior (MOI), Department of Land Administration (DLA) Territorial Administration Section according to the provisions of the *Regulations of Permission on Delineation of Course for Laying, Maintaining, or Modifying Marine cables or Pipelines on the Continental Shelf of the Republic of China*. For the laying of submarine power cables, the applicant need only submit a routing project to the competent authority for review and approval. There is no need for the applicant to acquire land for laying the route.

II. The sea-land cable connection point and land-based step-up (down) substation

After the power generated by the offshore wind turbine, it will be connected to the offshore substation via the array cable. The submarine cable will be connected to the sea-land cable connection point, and the land cable will be connected to the land-based step-up (down) substation, and then select one station to merge with the existing substations. The preliminary project shows the Xianxi D/S substation, Luxi D/S substation or Changhua Binhai E/S substation can be merged with the existing substation. The project is scheduled to set a sea-land cable connection point near the adjacent submarine cable landing site and a land-based step-up (down) substation near the existing Taipower substation. The relevant land will be acquired according to regulations.

III. Transmission cables setting

Article 51 of the Electricity Act: the electric industry may install cables on underground, underwater, private forest or other people's houses, or on buildings without land whenever necessary, provided that its original usage and safety are not affected and should prior notify the owner or possessor in writing. At present, the overhead transmission cables through public and private land are on a free-of-charge basis, while the underground cables are either free-of-charge or payment of the usage fees, etc. The tower bases are able to obtain the right to set up through purchase, lease, and the use of loans. The land transmission cable setting of this project is connected by underground cable from the sea-land cable connection point and land-based set-up (down) substation to the Xianxi D/S substation, Luxi D/S substation or Changhua Binhai E/S substation. The path will be based on the established road as the main consideration and total length of the cable is about 8 kilometers.

7.4.2 Social environment

I. Population

Besides technical labor, the employment of local labor force will be the priority choice for installation of land power cables, booster stations and substation construction. If only partial of the labor force are from foreign areas, the impact to local population will be very subtle.

The wind power turbines will be operating under a wholly automated surveillance system during its operation and closely monitored by adjacent units to maintain an instantaneous connection with the wind farm in order to acquire the real-time status of the operation and record related data. There is usually no on-site operator at the wind farm except the entry of maintenance personnel during the maintenance period, and should have no impacts on the population of the nearby area.

II. Public facilities

Provincial highways 17 and 61 are the main transportation roads for vehicles entering and leaving the project’s land cable installation work area. These main transportation roads can still maintain grade A levels of service during the construction period.

Hospital and healthcare systems are the primary public facilities required during the construction period. This project intends to utilise neighbouring community hospitals or clinics to seek aid or support in the event of emergencies or accidents. During operations, the wind turbines will be monitored using a wholly automated system. No on-site operator will be stationed at the wind farm. Provision of services by local public facilities will therefore be unaffected.

7.4.3 Economic environment

I. Fisheries compensation

The project mainly compensates the fishermen for the affected fishing activities. The Fisheries Agency, Council of Agriculture, Executive Yuan issued the offshore wind power plant fishery compensation standard on November 30, 2016. In the future, the preparatory office will compensate the fishermen who have suffered losses due to this development by complying with the benchmark. 10% of the total amount of the compensation will be used as the administrative fee for the assistance and handling of the fishery.

In addition, the Energy Bureau of the Ministry of Economic Affairs considers the issue of fishermen's transformation, the coexistence of fisheries and offshore wind power, Article 65 of the Electricity Law Amendment passed by the Legislative Yuan on the Third Reading has clearly stated that a certain proportion of power development assistance is required for wind power generation in the power generation industries. However, the proportion and allocation principle of the assistance fund is still pending to be announced by the Central Competent Authority. The preparatory office will follow the above measures and arrange relevant meetings to inform the fishermen through the fisheries meeting. The power development assistance fund is divided by the proportion of the allocation and the target is the fishermen's association. The fund is also considered for the development of the local community and the overall planning of the county/city government. After the determination of the allocation ratio, the preparatory office will guide the transformation of the fishermen and foster talents through the successful experience of our Group in Europe. For example, the Institute of Mechanical Engineers (IMechE) publicly recognises our Group's talent cultivation work in UK; our Group also sponsors the Scottish Fishermen's Federation (SFF) to assist the fishermen's transformation to participate in the offshore wind power industries. All of these are voluntary corporate social responsibility initiatives of our Group.

II. Economic environment

The offshore wind farm will be staffed by a team of technicians and field managers who are responsible for the operation of the wind farm within the design life. In the future, the preparatory office will employ a local team with experienced staff to provide support and training during the initial operational phase. The purpose of this job proficiency and training period are to transfer the best practices and experience of existing organisations to align them with the operating organisation and shorten the learning period.

At the beginning stage (about 5 years), the site organisation of the preparatory office will be supported by the wind turbine manufacturer's operation and maintenance service organization and work together to ensure smooth operation during the operation period. This initial assessment may be adjusted based on actual operational needs and potential synergies with other wind farms in the region.

The project will employ local teams for wind farm maintenance and operations. The local team refers to the local Taiwanese employees, their academic experience and qualifications may vary according to the different projects within the team. The primary maintenance team can be divided into two categories, namely fan technicians and office personnel. Fan technicians should be best equipped with mechanical and mechanical engineering backgrounds, just graduated or having relevant industry experiences. The office staffs include the site manager, planning dispatcher, warehouse manager, etc.; their background of the study is not limited, but the experience of owning the energy industry or infrastructure engineering is particularly good.

Nowadays, the development of offshore wind power in Taiwan is still in its infancy. The local employees employed by Taiwan should have no experience. Therefore, the Ørsted Group, which belongs to this project, will send experienced transportation personnel from Europe to Taiwan in the early stage of operation to support the local team, ensure that Taiwanese employees have complete on-job training, impart transportation courses, and share experiences.

According to the researches done by VDMA (Mechanical Engineering Industry Association)/BWE (German Wind Energy Association)/OWIA (Offshore Wind Industry Alliance), Germany's offshore wind power generated 5,800 jobs related to transportation by the end of 2015. Its offshore wind power plant capacity is about 3GW, so it created about 1.9 jobs per MW. Despite the different regions and different market conditions, the amount of employment created per MW was not concentrated in a single country, and some jobs remained in the established market through exports. However, Taiwan has the opportunity to become the leading position of offshore wind power in Asia. Therefore, the estimated number should be able to estimate the amount of employment that may be created in this project. Take the wind farm No. 12 as an example, it may create about 1100 jobs, while wind farm No. 13 may create about 1,000 jobs. For the case of wind farm No. 14, it may create about 1,200 employment volume; the wind farm No. 15 is likely to create about 1,100 jobs.

In view of this, it can be expected that the operation of the offshore wind farm in the future will generate a series of indirect job opportunities in the local community, including different departments and industries, such as residential services (accommodation, restaurants, housing, etc.), transportation services, facility maintenance, maintenance of ships and other equipment.

7.5 Traffic environment

I. Forecast of natural growth traffic volume

The evaluation range of this project includes Taichung City and Changhua County, taking into account the natural growth of roads in various districts. The project counted the annual growth rate of motor vehicles in Taichung City and Changhua County in the past 5 years (from year 2011 to year 2016). According to the statistical analysis of the project, the average data of Taichung City and Changhua County in the past five years were 1.29%, and 0.20%, respectively. Therefore, the project will set the annual natural growth rate of the target year for each development stage, in which 1.09%/year for Taichung City and 0.20%/year for Changhua County. These data will serve as a basis for the follow-up assessment on the road sections and intersections service level at normal peak hours and the holiday peak hours prior to the target year of development. The statistics for the number of registered motor vehicle in Taichung City and Changhua County in the past five years are shown in Tables 7.5-1 and 7.5-2.

Table 7.5-1 Statistics for the number of registered motor vehicles in Taichung City during the past 5 years

Year (CE)	Privately owned small passenger vehicles		Motorcycles		Total (PCU)	Total Annual growth (%)
	Number Registered	Annual growth (%)	Number Registered	Annual growth (%)		
2011	908,446	—	1,744,402	—	1,431,767	—
2012	932,765	2.68%	1,759,900	0.89%	1,460,735	2.02%
2013	956,780	2.57%	1,678,392	-4.63%	1,460,298	-0.03%
2014	982,330	2.67%	1,647,752	-1.83%	1,476,656	1.12%
2015	1009374	2.75%	1650878	0.19%	1,504,637	1.89%
2016	1,026,880	1.73%	1,665,116	0.86%	1,526,415	1.45%
Average	—	2.48%	—	-0.90%	—	1.29%

Source：Directorate General of Highways.

Table 7.5-2 Statistics for the number of registered motor vehicles in Changhua County during the past 5 years.

Year (CE)	Privately owned small passenger vehicles		Motorcycles		Total (PCU)	Total Annual growth (%)
	Number Registered	Annual growth (%)	Number Registered	Annual growth (%)		
2011	430,133	—	932,730	—	709,952	—
2012	438,608	1.97%	923,743	-0.96%	715,731	0.81%
2013	447,012	1.92%	852,061	-7.76%	702,630	-1.83%
2014	456,978	2.23%	824,255	-3.26%	704,255	0.23%
2015	468,381	2.50%	816,564	-0.93%	713,350	1.29%
2016	473,081	1.00%	812,850	-0.45%	716,936	0.50%
Average	—	1.92%	—	-2.67%	—	0.20%

Source：Directorate General of Highways.

II. The traffic impact analysis during the construction phase

The traffic impact caused by the adjacent road system during the construction phase of the project, including the impacts of construction vehicles commuting trips, construction materials or landfill transportation on the traffic will be assessed through the derived vehicles trips at peak hours during the construction phase. The project also includes the calculation of the derivative vehicle travel trips of the adjacent wind turbine unit development project to evaluate the impact of the construction target year (2019) on the surrounding traffic environment.

(i) Derived vehicles volume in the construction phase

1. Wind turbines unit development derived vehicles volume

In this project, wind turbines at Changhua Northeast together with the other 3 wind turbines at Changhua Southeast, Changhua Southwest, and Changhua Northwest, there are about 370 construction workers work at the land dock area and land cable laying project during the peak period. It is assumed that 30% of the construction personnel use passenger vehicles and 70% of the construction personnel commute to work by motorcycle. Conservatively estimating that each vehicle carries only one person. For these vehicles, 1 and 0.5 were taken as their equivalent value. After calculation, the number of construction workers' derivative trips is 241 PCU. Meanwhile, another land-based work dock area and land-based cable burial project-derived project vehicles (sand truck), marked about 8 trips per hour. The equivalent value of this motor vehicle is 3.0, as they belong to special vehicles and the number of derivative trips is 24 PCU. The total number of peak-time derivative trips in the construction phase of this project is 265 PCU (one-way).

2. Adjacent wind turbines project derived vehicles volume

By considering there are another 6 wind turbines in the adjacent areas (including Taipower Phase II, Hailong No. 2, Hailong No. 3, Haiding No. 1, Haiding No. 2 and Haiding No. 3) had the same construction target year with the current project. Thus, this project will take into consideration the derivative vehicles volume during the construction phase at those 6 wind turbines areas to understand the impact on the road system during the construction phase for this project. According to the evaluation results of this project, there will be a total of 161 PCU (one-way) in the vicinity of 6 wind turbines in the future construction phase, and the number of derivative vehicles trips in the construction phase of the adjacent wind turbines is shown in Table 7.5-3.

Table 7.5-3 Summary table of the adjacent wind turbines construction phase derivative vehicles trips

Projects	Derived vehicle trips during the construction phase (PCU)
Taipower Phase II	23
Hailong No. 2	87
Hailong No. 3	
Haiding No. 1	51
Haiding No. 2	
Haiding No. 3	
Total	161

Source：Investigation and analysis of the project.

3. Subtotal

According to the above analysis of the derivative vehicles volume during the wind turbine construction phase, the total number of derivative trips in this project and the construction phase of the adjacent wind turbines is 426PCU (one-way).

(ii) Description of traffic impact during the construction phase

1. Road section service level analysis

According to the evaluation on the impact of derivative traffic volume during the construction phase in this project, it is shown that the service level of each road section can be maintained above Grade C. The service level of each road section is the same as the current situation. The road section service level assessment of the normal day and the holiday peak hours during the construction phase are shown in Table 7.5-4 to Table 7.5-5. Meanwhile the schematic diagrams of the surrounding road service level during the construction phase are shown in Figure 7.5-1 to Figure 7.5-2.

2. Intersection service level analysis

According to this project to assess the impact of the derivative traffic volume during the construction phase, it is shown that the service level of each intersection can be maintained at the Grade A-C. In the normal day and evening peak hours, the service levels at intersections between Taiwan Provincial 17 and Section 2, Lucao Road dropped from Grade B to Grade C, the remaining intersections remained the same as the current situation. The service level assessments for the normal and holiday peak hours of the construction phase are shown in Tables 7.5-6 and 7.5-7. Meanwhile the schematic diagrams of the surrounding road service level during the construction phase are shown in Figure 7.5-1 to Figure 7.5-2.

(iii) Preliminary planning for the traffic maintenance plan during the construction phase.

1. A special person is selected at the entrance and exit of the construction area to command the construction vehicles to enter and exit, to remind the vehicles to drive safely, and to maintain construction safety.
2. If it is necessary to occupy the traffic lane during construction, the application is needed to make to the competent authority in accordance with relevant regulations. For the traffic control of the lanes, the layout and planning of the signs, signs and warning lights should comply with the operational standards of the “Traffic Engineering Manual” by the Ministry of Transportation and Communications to ensure smooth traffic and safe driving.
3. All materials and tools during construction shall be placed in the work area and shall not be stacked on both sides of the entry and exit roads.
4. Roads entering and leaving the road should be inspected frequently. Damaged roads should be repaired immediately to maintain road quality and traffic safety. Roadside parking is prohibited in the construction area and adjacent roads. The construction signs, road construction signs, and lights should be inspected and maintained regularly.
5. The sand truck should drive according to the specified route, time and frequency.

Table 7.5-4 Summary table of service level assessment at normal day and holiday peak hours (Taichung City)

Intersection	Road section	Direction (towards)	Normal Morning Peak Hours				Normal Evening Peak Hours				Holiday Peak Hours			
			Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality	Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality	Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality
Taiwan Provincial 17 (Sec 6, Lingang Rd.)	Beiti Rd. (North)	South	5,389	874	0.15	A	5,358	572	0.10	A	5,393	680	0.11	A
		North	7,167	467	0.06	A	7,197	711	0.09	A	7,197	767	0.10	A
	Beiti Rd. (North)	South	7,194	793	0.10	A	7,166	734	0.09	A	7,193	725	0.09	A
		North	7,184	679	0.09	A	7,198	730	0.09	A	7,193	704	0.09	A
Taiwan Provincial 17 (Sec 5, Lingang Rd.)	Taiwan Provincial 10 (North)	South	7,190	848	0.11	A	7,196	1,063	0.14	A	7,208	1,133	0.14	A
		North	7,191	732	0.09	A	7,199	993	0.12	A	7,211	1,261	0.15	A
	Taiwan Provincial 10 (South)	South	7,194	1,055	0.13	A	7,188	1,074	0.14	A	7,206	1,128	0.14	A
		North	7,185	883	0.11	A	7,195	961	0.12	A	7,209	1,308	0.16	A
Taiwan Provincial 17 (Sec 1, Lingang Rd.)	Taiwan Provincial 61 (West)	East	7,193	575	0.07	A	7,202	1354	0.15	A	7,203	863	0.10	A
		Wesr	7,203	1,232	0.14	A	7,188	686	0.09	A	7,187	471	0.06	A
Taiwan Provincial 17	Sec 2, Lingang East Rd. (South)	South	3,600	541	0.13	A	3,602	883	0.21	A	3,603	469	0.11	A
		North	3,594	468	0.12	A	3,594	675	0.16	A	3,602	451	0.11	A
Taiwan Provincial 10 (Section 9, Zhongqing Rd.)	Taiwan Provincial 17 (East)	East	7,186	308	0.04	A	7,198	708	0.08	A	7,219	704	0.08	A
		West	7,204	548	0.07	A	7,174	358	0.05	A	7,211	511	0.06	A
Zhongheng 15th Rd.	Taiwan Provincial 17 (West)	East	7,178	201	0.02	A	7,191	572	0.07	A	7,218	511	0.05	A
		Wesr	7,183	389	0.05	A	7,159	180	0.02	A	7,206	369	0.05	A
Section 2, Xibin Rd.	Sec 2, Lingang East Rd. (North)	South	7,205	625	0.07	A	7,195	1,049	0.12	A	7,210	655	0.07	A
		North	7,198	642	0.07	A	7,175	621	0.08	A	7,199	505	0.06	A
Section 2, Lingang East Rd.	Taiwan Provincial 61 (East)	East	5,401	345	0.05	A	5,408	904	0.14	A	5,409	561	0.09	A
		Wesr	5,406	912	0.14	A	5,392	429	0.07	A	5,412	301	0.05	A
Yugang Rd.	Taiwan Provincial 17 (East)	West	5,398	171	0.03	A	5,402	280	0.04	A	5,404	221	0.03	A
		East	5,386	276	0.04	A	5,395	157	0.02	A	5,412	188	0.03	A
Beiti Rd.	Taiwan Provincial 17 (West)	West	5,379	255	0.04	A	5,405	644	0.10	A	5,410	1,001	0.17	A
		East	5,383	653	0.11	A	5,392	378	0.06	A	5,410	861	0.13	A

Source：Investigation and analysis of the project.

Table 7.5-5 Summary table of service level assessment at normal day and holiday peak hours (Changhua County)

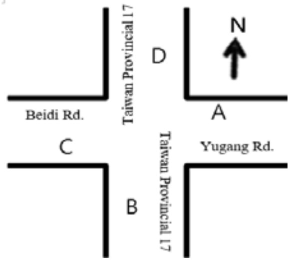
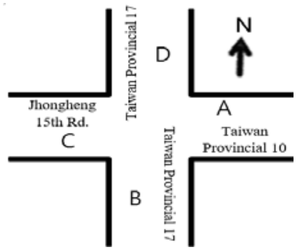
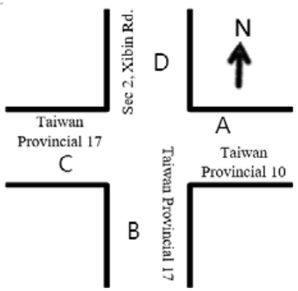
Intersection	Road section	Direction (towards)	Normal Morning Peak Hours				Normal Evening Peak Hours				Holiday Peak Hours			
			Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality	Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality	Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality
Taiwan Provincial 17 (Jianguo Road)	Taiwan Provincial 61B (North)	South	3,608	318	0.07	A	3,608	574	0.12	A	3,608	281	0.05	A
		North	3,610	466	0.10	A	3,609	405	0.08	A	3,608	239	0.05	A
	Taiwan Provincial 61B (South)	South	3,608	316	0.07	A	3,608	691	0.15	A	3,608	351	0.07	A
		North	3,609	563	0.13	A	3,608	471	0.10	A	3,608	312	0.07	A
Taiwan Provincial 17	Zhonghua Rd. (North)	South	3,601	204	0.05	A	3,605	73	0.02	A	3,608	228	0.06	A
		North	3,594	137	0.04	A	3,605	199	0.05	A	3,608	369	0.09	A
	Zhonghua Rd. (South)	South	3,601	129	0.03	A	3,608	332	0.09	A	3,608	228	0.06	A
		North	3,607	656	0.16	A	3,601	271	0.07	A	3,609	141	0.04	A
Taiwan Provincial 17 (Sec 2, Lucao Road,)	Taiwan Provincial 17 (North)	South	3,608	1,101	0.20	A	3,608	745	0.14	A	3,609	786	0.15	A
		North	3,606	813	0.16	A	3,607	1,067	0.20	A	3,610	793	0.16	A
Taiwan Provincial 17	Sec 2, Lucao Rd. (West)	South	5,404	749	0.11	A	5,412	1,599	0.22	A	5,415	635	0.10	A
		North	5,409	1,267	0.19	A	5,410	352	0.05	A	5,414	457	0.06	A
Taiwan Provincial 17	Zhang 144 County Rd.(North)	South	3,597	335	0.08	A	3,600	398	0.10	A	3,598	297	0.07	A
		North	3,606	1,108	0.20	A	3,606	923	0.20	A	3,605	692	0.15	A
	Zhang 144 County Rd.(Sorth)	South	3,597	290	0.07	A	3,601	439	0.11	A	3,599	330	0.09	A
		North	3,606	1,119	0.20	A	3,605	881	0.19	A	3,604	652	0.14	A
Taiwan Provincial 17	Zhang 143 County Rd.(East)	East	3,604	707	0.15	A	3,601	531	0.13	A	3,602	471	0.12	A
		West	3,603	523	0.12	A	3,602	536	0.12	A	3,603	605	0.13	A
	Zhang 143 County Rd.(West)	East	3,603	478	0.10	A	3,599	369	0.09	A	3,600	346	0.09	A
		West	3,604	651	0.14	A	3,602	478	0.11	A	3,601	485	0.10	A
Taiwan Provincial 61	Zhonghua Rd. (North)	South	3,597	367	0.10	A	3,595	238	0.06	A	3,601	391	0.11	A
		North	3,592	301	0.08	A	3,599	362	0.10	A	3,603	530	0.14	A
	Zhonghua Rd. (South)	South	3,595	293	0.08	A	3,602	494	0.13	A	3,601	391	0.10	A
		North	3,604	814	0.20	A	3,597	433	0.12	A	3,599	305	0.08	A
Taiwan Provincial 61B	Taiwan Provincial 17 (East)	East	3,604	281	0.07	A	3,606	806	0.19	A	3,607	485	0.12	A
		West	3,606	768	0.19	A	3,602	283	0.07	A	3,608	401	0.10	A
	Taiwan Provincial 17 (West)	East	3,601	187	0.04	A	3,606	738	0.18	A	3,606	410	0.10	A
		West	3,606	773	0.19	A	3,597	164	0.04	A	3,607	327	0.08	A

Table 7.5-5 Summary table of service level assessment at normal day and holiday peak hours (Changhua County) (Continued)

Intersection	Road Section	Direction (Towards)	Normal Morning Peak Hours				Normal Evening Peak Hours				Holiday Peak Hours			
			Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality	Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality	Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality
Zhang 144 County Rd.	Taiwan Provincial 17 (East)	East	3,602	408	0.10	A	3,607	481	0.12	A	3,607	250	0.03	A
		West	3,602	460	0.11	A	3,607	522	0.12	A	3,608	259	0.03	A
	Taiwan Provincial 17 (West)	East	3,602	268	0.07	A	3,608	422	0.11	A	3,607	273	0.03	A
		West	3,601	387	0.10	A	3,607	378	0.09	A	3,608	238	0.03	A
Zhonghua Rd.	Taiwan Provincial 61 (East)	East	5,408	114	0.02	A	5,411	609	0.11	A	5,415	191	0.03	A
		West	5,408	454	0.07	A	5,409	250	0.04	A	5,413	724	0.11	A
Zhonghua Rd.	Taiwan Provincial 17 (West)	East	5,399	98	0.02	A	5,413	682	0.12	A	5,415	282	0.05	A
		West	5,411	1,023	0.16	A	5,399	138	0.02	A	5,414	590	0.09	A
Connection Rd. No. 5	Taiwan Provincial 61 (East)	East	5,407	271	0.04	A	5,413	2,157	0.29	A	5,412	561	0.09	A
		West	5,413	3,389	0.43	B	5,410	580	0.10	A	5,415	295	0.05	A
Lugong Rd. (Bridge)	Taiwan Provincial 61 (West)	East	5,399	257	0.04	A	5,412	2,922	0.42	B	5,410	713	0.11	A
		West	5,413	4,871	0.66	C	5,405	668	0.12	A	5,413	337	0.06	A
Hexian Rd.	Taiwan Provincial 17 (East)	West	5,411	238	0.04	A	5,411	846	0.11	A	5,412	409	0.06	A
		East	5,414	863	0.14	A	5,411	428	0.06	A	5,413	252	0.04	A
Xiangong Rd.(Bridge)	Taiwan Provincial 61 (West)	East	5,399	98	0.02	A	5,413	682	0.12	A	5,415	282	0.05	A
		West	5,411	1,023	0.16	A	5,399	138	0.02	A	5,414	590	0.09	A
Ji'an Rd.	Gongye East 1st Rd. (North)	South	3,608	277	0.05	A	3,608	114	0.03	A	3,609	80	0.02	A
		North	3,609	173	0.04	A	3,609	164	0.04	A	3,610	110	0.03	A
	Gongye East 1st Rd. (Sorth)	South	3,608	369	0.07	A	3,605	55	0.01	A	3,603	26	0.01	A
		North	3,608	41	0.01	A	3,609	418	0.10	A	3,608	157	0.03	A
Gongye East 1 Rd.	Xi'an Rd. (West)	East	5,396	67	0.01	A	5,413	1,150	0.13	A	5,414	515	0.06	A
		West	5,413	1,595	0.20	A	5,402	116	0.02	A	5,413	108	0.02	A
Lu'an Bridge	Xi'an Rd. (East)	East	3,602	88	0.02	A	3,609	1,488	0.28	A	3,609	643	0.12	A
		West	3,609	1,841	0.35	A	3,602	141	0.03	A	3,608	134	0.03	A

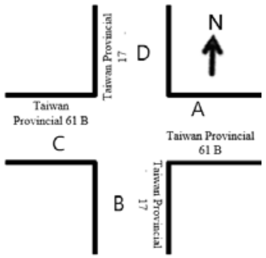
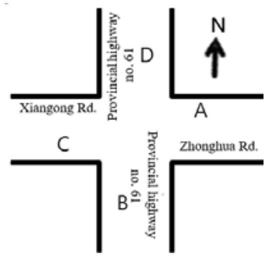
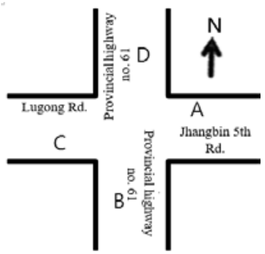
Source: Investigation and analysis of the project.

Table 7.5-6 Summary table of intersection service level assessment during the construction phase (Taichung City)

Intersection	Intersection Icon	Direction	Morning Peak Hours			Evening Peak Hours			Holiday Peak Hours		
			Average delay (seconds)		Service Quality	Average delay (seconds)		Service Quality	Average delay (seconds)		Service Quality
Taiwan Provincial 17 ｜ Yugang Rd.		A	49.2	41.2	C	48.6	40.9	C	48.9	44.2	C
		B	43.4			39.5			44.3		
		C	49.0			50.6			51.1		
		D	34.3			34.4			33.4		
Taiwan Provincial 17 ｜ Taiwan Provincial 10		A	49.4	32.2	C	62.8	30.4	C	53.5	25.9	B
		B	29.4			17.2			17.2		
		C	40.1			56.8			46.6		
		D	18.2			11.7			13.2		
Taiwan Provincial 17 ｜ Sec. 2, Lingang East Rd.		A	41.9	44.5	C	41.5	45.0	C	40.6	43.4	C
		B	49.6			49.5			48.3		
		C	38.9			38.4			37.9		
		D	46.5			48.4			46.6		

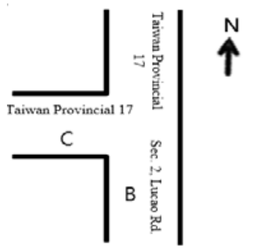
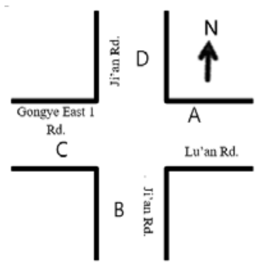
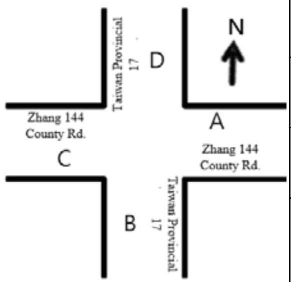
Source：Investigation and analysis of the project.

Table 7.5-7 Summary table of intersection service level assessment during the construction phase (Changhua County)

Intersection	Intersection Icon	Direction	Morning Peak Hours			Evening Peak Hours			Holiday Peak Hours		
			Average delay (seconds)		Service Quality	Average delay (seconds)		Service Quality	Average delay (seconds)		Service Quality
Taiwan Provincial 17 │ Taiwan Provincial 61 B		A	27.2	27.6	B	64.8	32.0	C	29.6	26.3	B
		B	30.1			28.7			27.4		
		C	20.2			24.1			21.7		
		D	27.1			29.2			26.2		
Taiwan Provincial 61 │ Xiangong Rd.		A	37.4	43.1	C	36.8	40.9	C	40.8	42.2	C
		B	46.0			47.2			43.8		
		C	31.9			36.2			33.6		
		D	44.9			42.7			47.5		
Taiwan Provincial 61 │ Lugong Rd.		A	48.9	43.5	C	37.0	35.8	C	35.6	39.4	C
		B	53.4			53.5			52.0		
		C	18.5			28.1			16.0		
		D	27.2			47.3			56.6		

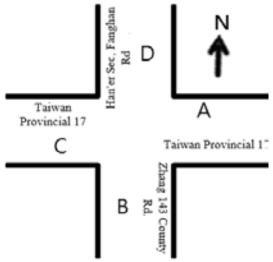
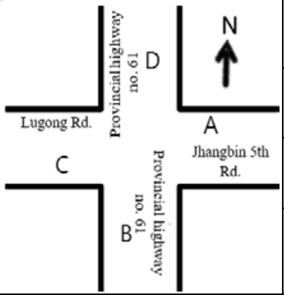
Source：Investigation and analysis of the project.

Table 7.5-7 Summary table of intersection service level assessment during the construction phase (Changhua County)(Continued)

Intersection	Intersection Icon	Direction	Morning Peak Hours			Evening Peak Hours			Holiday Peak Hours		
			Average delay (seconds)		Service Quality	Average delay (seconds)		Service Quality	Average delay (seconds)		Service Quality
Taiwan Provincial 17 | Sec. 2, Lucao Rd.		A	-	42.0	C	-	36.7	C	-	38.6	C
		B	40.4			36.9			37.2		
		C	28.4			26.1			25.7		
		D	55.8			56.8			52.4		
Ji'an Rd. | Gongye East 1 Rd.		A	32.9	32.3	C	20.2	29.7	B	19.5	23.6	B
		B	30.9			36.0			32.1		
		C	17.0			27.7			20.4		
		D	32.8			32.6			31.5		
Taiwan Provincial 17 | Zhang 144 County Rd.		A	35.2	29.4	B	37.3	31.0	C	33.4	28.5	B
		B	26.0			25.6			24.2		
		C	32.6			35.5			32.9		
		D	27.3			27.9			26.2		

Source：Investigation and analysis of the project.

Table 7.5-7 Summary table of intersection service level assessment during the construction phase (Changhua County)(Continued)

<table>
<tr><th rowspan="2">Intersection</th><th rowspan="2">Intersection Icon</th><th rowspan="2">Direction</th><th colspan="3">Morning Peak Hours</th><th colspan="3">Evening Peak Hours</th><th colspan="3">Holiday Peak Hours</th></tr>
<tr><th colspan="2">Average delay (seconds)</th><th>Service Quality</th><th colspan="2">Average delay (seconds)</th><th>Service Quality</th><th colspan="2">Average delay (seconds)</th><th>Service Quality</th></tr>
<tr><td rowspan="4">Taiwan Provincial 17
｜
Zhang 143 County Rd.</td><td rowspan="4"></td><td>A</td><td>8.0</td><td rowspan="4">28.1</td><td rowspan="4">B</td><td>8.1</td><td rowspan="4">21.1</td><td rowspan="4">B</td><td>7.9</td><td rowspan="4">15.7</td><td rowspan="4">B</td></tr>
<tr><td>B</td><td>48.1</td><td>36.1</td><td>33.2</td></tr>
<tr><td>C</td><td>7.2</td><td>7.2</td><td>7.1</td></tr>
<tr><td>D</td><td>41.4</td><td>36.2</td><td>30.8</td></tr>
<tr><td rowspan="4">Taiwan Provincial 17
｜
Zhonghua Rd.</td><td rowspan="4"></td><td>A</td><td>40.3</td><td rowspan="4">41.3</td><td rowspan="4">C</td><td>37.2</td><td rowspan="4">43.3</td><td rowspan="4">C</td><td>36.4</td><td rowspan="4">42.1</td><td rowspan="4">C</td></tr>
<tr><td>B</td><td>43.7</td><td>48.5</td><td>45.8</td></tr>
<tr><td>C</td><td>32.6</td><td>36.0</td><td>33.6</td></tr>
<tr><td>D</td><td>44.0</td><td>47.7</td><td>45.2</td></tr>
</table>

Source: Investigation and analysis of the project.

Figure 7.5-1 Schematic diagram of the surrounding road service level during the construction phase (1)

Figure 7.5-2 Schematic diagram of the surrounding road service level during the construction phase (2)

III. The traffic impact analysis before the operation

According to the statistics, the average annual growth rate of motor vehicles in Taichung City in the past five years was 1.29%, and the average data of Changhua County in the past five years was 0.20%. Therefore, the annual natural growth rate of the target year for each development stage is set at 1.29%/year for Taichung City and 0.20%/year for Changhua County to evaluate the service level of the normal days and holiday days peak hours at road sections and intersections in the target year before the operation of the project.

(i) Service level analysis of the road sections

According to the assessment results of this project, although the natural growth of traffic volume increased before the operation, the service levels of all road sections have remained the same as the current conditions. The service level assessments for the pre-operational phase at normal days and holiday days peak hours are shown in Table 7.5-8 to Table 7.5-9, and the schematic diagrams of the surrounding road service level during the pre-operation phase are shown in Figure 7.5-3 to 7.5-4.

(ii) Service level analysis of the intersections

According to the assessment results of this project, although the natural growth of traffic volume increased before the operation, the service levels of all intersections have remained the same as the current conditions. The service level assessments for the pre-operational phase at normal days and holiday days peak hours are shown in Table 7.5-10 to Table 7.5-11, and the schematic diagrams of the surrounding road service level during the pre-operation phase are shown in Figure 7.5-3 to 7.5-4.

Table 7.5-8 Summary table of road sections service level assessment during the pre-operational phase(Taichung City)

Intersection	Road section	Direction	Normal Morning Peak Hours				Normal Evening Peak Hours				Holiday Peak Hours			
			Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality	Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality	Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality
Taiwan Provincial 17 (Sec 6, Lingang Rd.)	Beiti Rd.(North)	South	5,390	792	0.13	A	5,350	465	0.08	A	5,396	582	0.10	A
		North	7,162	352	0.04	A	7,201	616	0.08	A	7,201	676	0.09	A
	Beiti Rd. (South)	South	7,198	704	0.09	A	7,163	640	0.08	A	7,196	630	0.08	A
		North	7,186	581	0.07	A	7,203	636	0.08	A	7,197	608	0.07	A
Taiwan Provincial 17 (Sec 5, Lingang Rd.)	Taiwan Provincial 10 (North)	South	7,193	763	0.09	A	7,199	996	0.12	A	7,212	1,071	0.13	A
		North	7,194	638	0.08	A	7,203	920	0.11	A	7,215	1,209	0.14	A
	Taiwan Provincial 10 (Sorth)	South	7,196	987	0.12	A	7,189	1,007	0.13	A	7,209	1,066	0.13	A
		North	7,186	801	0.10	A	7,198	885	0.11	A	7,213	1,261	0.15	A
Taiwan Provincial 17 (Sec 1, Lingang Rd.)	Taiwan Provincial 61 (West)	East	7,198	469	0.05	A	7,205	1,310	0.14	A	7,208	779	0.09	A
		West	7,206	1,178	0.13	A	7,190	588	0.07	A	7,191	356	0.05	A
Taiwan Provincial 17	Sec 2, Lingang East Rd. (South)	South	3,604	432	0.10	A	3,605	801	0.19	A	3,609	355	0.08	A
		North	3,597	353	0.08	A	3,595	576	0.13	A	3,608	335	0.08	A
Taiwan Provincial 10 (Sec 9, Zhongqing Rd.)	Taiwan Provincial 17 (East)	East	7,186	332	0.04	A	7,198	765	0.09	A	7,219	761	0.09	A
		West	7,204	592	0.08	A	7,174	387	0.05	A	7,211	552	0.07	A
Zhongheng 15th Rd.	Taiwan Provincial 17 (West)	East	7,178	217	0.02	A	7,191	618	0.07	A	7,218	552	0.06	A
		West	7,183	420	0.05	A	7,159	195	0.03	A	7,206	399	0.05	A
Sec 2, Xibin Rd.	Sec 2, Lingang East Rd. (North)	South	7,205	675	0.08	A	7,195	1,133	0.13	A	7,210	708	0.08	A
		North	7,198	693	0.08	A	7,175	671	0.09	A	7,199	545	0.06	A
Sec 2, Lingang Rd.	Taiwan Provincial 61 (East)	East	5,401	373	0.06	A	5,408	976	0.15	A	5,409	606	0.09	A
		West	5,406	985	0.15	A	5,392	463	0.07	A	5,412	325	0.06	A
Yugang Rd.	Taiwan Provincial 17 (East)	West	5,398	185	0.03	A	5,402	303	0.04	A	5,404	239	0.03	A
		East	5,386	298	0.05	A	5,395	170	0.02	A	5,412	203	0.03	A
Beidi Rd.	Taiwan Provincial 17 (West)	West	5,379	276	0.04	A	5,405	696	0.11	A	5,410	1081	0.18	A
		East	5,383	705	0.11	A	5,392	409	0.06	A	5,410	929	0.15	A

Source: Investigation and analysis of the project.

Table 7.5-9 Summary table of road sections service level assessment during the pre-operational phase(Changhua County)

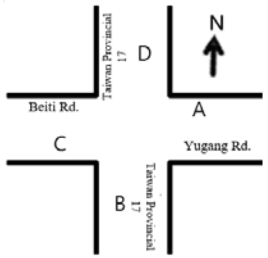
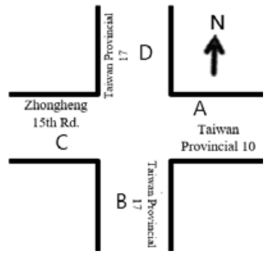
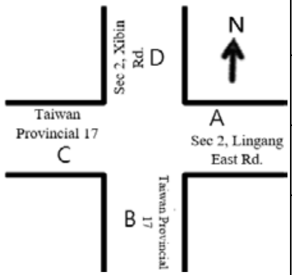
Intersection	Road section	Direction (towards)	Normal Morning Peak Hours				Normal Evening Peak Hours				Holiday Peak Hours			
			Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality	Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality	Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality
Taiwan Provincial 17 (Jianguo Rd.)	Taiwan Provincial 61 B (North)	South	3,608	318	0.07	A	3,608	574	0.12	A	3,608	281	0.05	A
		North	3,610	466	0.10	A	3,609	405	0.08	A	3,608	239	0.05	A
	Taiwan Provincial 61 B (Sorth)	South	3,608	316	0.07	A	3,608	691	0.15	A	3,608	351	0.07	A
		North	3,609	563	0.13	A	3,608	471	0.10	A	3,608	312	0.07	A
Taiwan Provincial 17	Zhonghua Rd.(North)	South	3,601	204	0.05	A	3,605	73	0.02	A	3,608	228	0.06	A
		North	3,594	137	0.04	A	3,605	199	0.05	A	3,608	369	0.09	A
	Zhonghua Rd.(South)	South	3,601	129	0.03	A	3,608	332	0.09	A	3,608	228	0.06	A
		North	3,607	656	0.16	A	3,601	271	0.07	A	3,609	141	0.04	A
Taiwan Provincial 17 (Sec 2, Lucao Rd.)	Taiwan Provincial 17 (North)	South	3,608	1,101	0.20	A	3,608	745	0.14	A	3,609	786	0.15	A
		North	3,606	813	0.16	A	3,607	1,067	0.20	A	3,610	793	0.16	A
Taiwan Provincial 17	Sec 2, Lucao Rd. (West)	South	5,404	749	0.11	A	5,412	1,599	0.22	A	5,415	635	0.10	A
		North	5,409	1,267	0.19	A	5,410	352	0.05	A	5,414	457	0.06	A
Taiwan Provincial 17	Zhang 144 County Rd. (North)	South	3,603	172	0.04	A	3,607	235	0.05	A	3,607	133	0.03	A
		North	3,609	954	0.16	A	3,609	767	0.15	A	3,609	533	0.11	A
	Zhang 144 County Rd. (South)	South	3,606	126	0.02	A	3,607	277	0.07	A	3,606	166	0.04	A
		North	3,609	965	0.16	A	3,609	724	0.14	A	3,609	492	0.10	A
Taiwan Provincial 17	Zhang 143 County Rd. (East)	East	3,609	548	0.10	A	3,606	370	0.09	A	3,608	309	0.08	A
		West	3,608	361	0.08	A	3,607	375	0.08	A	3,607	445	0.09	A
	Zhang 143 County Rd. (West)	East	3,609	316	0.06	A	3,606	205	0.05	A	3,608	183	0.04	A
		West	3,608	491	0.09	A	3,607	316	0.07	A	3,607	323	0.06	A
Taiwan Provincial 61	Zhonghua Rd. (North)	South	3,601	204	0.05	A	3,605	73	0.02	A	3,608	228	0.06	A
		North	3,594	137	0.04	A	3,605	199	0.05	A	3,608	369	0.09	A
	Zhonghua Rd. (South)	South	3,601	129	0.03	A	3,608	332	0.09	A	3,608	228	0.06	A
		North	3,607	656	0.16	A	3,601	271	0.07	A	3,609	141	0.04	A
Taiwan Provincial 61 B	Taiwan Provincial 17 (East)	East	3,604	281	0.07	A	3,606	806	0.19	A	3,607	485	0.12	A
		West	3,606	768	0.19	A	3,602	283	0.07	A	3,608	401	0.10	A
	Taiwan Provincial 17 (West)	East	3,601	187	0.04	A	3,606	738	0.18	A	3,606	410	0.10	A
		West	3,606	773	0.19	A	3,597	164	0.04	A	3,607	327	0.08	A

Table 7.5-9 Summary table of road sections service level assessment during the pre-operational phase(Changhua County) (Continued)

Intersection	Road section	Direction (Towards)	Normal Morning Peak Hours				Normal Evening Peak Hours				Holiday Peak Hours			
			Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality	Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality	Road capacity (C) (PCU/hr)	Peak hour volume (V)(PCU/hr)	V/C	Service Quality
Zhang 144 County Rd.	Taiwan Provincial 17 (East)	East	3,602	408	0.10	A	3,607	481	0.12	A	3,607	250	0.03	A
		West	3,602	460	0.11	A	3,607	522	0.12	A	3,608	259	0.03	A
	Taiwan Provincial 17 (West)	East	3,602	268	0.07	A	3,608	422	0.11	A	3,607	273	0.03	A
		West	3,601	387	0.10	A	3,607	378	0.09	A	3,608	238	0.03	A
Zhonghua Rd.	Taiwan Provincial 61 (East)	East	5,408	124	0.02	A	5,411	664	0.12	A	5,415	208	0.04	A
		West	5,408	495	0.07	A	5,409	272	0.05	A	5,413	789	0.12	A
Zhonghua Rd.	Taiwan Provincial 17 (West)	East	5,399	107	0.02	A	5,413	743	0.13	A	5,415	308	0.05	A
		West	5,411	1,115	0.17	A	5,399	151	0.02	A	5,414	643	0.10	A
Connection Rd. No. 5	Taiwan Provincial 17 (East)	East	5,407	295	0.05	A	5,413	2,351	0.31	A	5,412	611	0.10	A
		West	5,413	3,693	0.47	B	5,410	632	0.11	A	5,415	321	0.05	A
Lugong Rd. (Bridge)	Taiwan Provincial 61 (West)	East	5,399	280	0.05	A	5,412	3,184	0.46	B	5,410	777	0.12	A
		West	5,413	5,307	0.72	C	5,405	728	0.13	A	5,413	367	0.06	A
Hexian Rd.	Taiwan Provincial 17 (East)	West	5,414	941	0.16	A	5,411	467	0.07	A	5,413	275	0.04	A
		East	5,374	78	0.01	A	5,412	1,295	0.19	A	5,412	1,162	0.17	A
Xiangong Rd.(Bridge)	Taiwan Provincial 61 (West)	East	5,399	99	0.02	A	5,413	690	0.12	A	5,415	286	0.05	A
		West	5,411	1,035	0.16	A	5,399	140	0.02	A	5,414	597	0.09	A
Ji'an Rd.	Gongye East 1st Rd. (North)	South	3,608	280	0.05	A	3,608	115	0.03	A	3,609	81	0.02	A
		North	3,609	175	0.04	A	3,609	166	0.04	A	3,610	112	0.03	A
	Gongye East 1st Rd. (Sorth)	South	3,608	374	0.07	A	3,605	55	0.01	A	3,603	26	0.01	A
		North	3,608	42	0.01	A	3,609	423	0.10	A	3,608	159	0.03	A
Gongye East 1st Rd.	Ji'an Rd. (West)	East	5,396	68	0.01	A	5,413	1,164	0.14	A	5,414	522	0.06	A
		West	5,413	1,614	0.20	A	5,402	117	0.02	A	5,413	110	0.02	A
Lu'an bridge	Ji'an Rd. (East)	East	3,602	89	0.02	A	3,609	1,506	0.28	A	3,609	650	0.12	A
		West	3,609	1,863	0.36	A	3,602	142	0.03	A	3,608	135	0.03	A

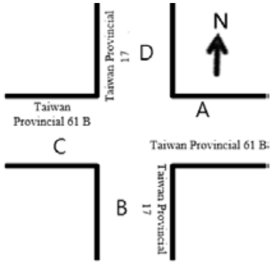
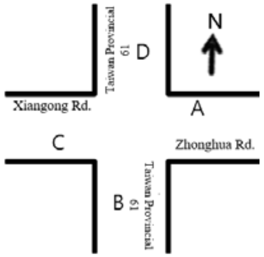
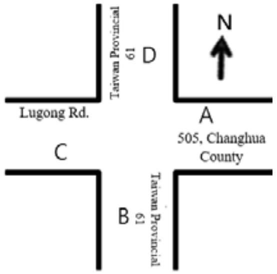
Source: Investigation and analysis of the project.

Table 7.5-10 Summary table of intersections service level assessment during the pre-operational phase(Taichung City)

<table>
<tr><th rowspan="2">Intersection</th><th rowspan="2">Intersection Icon</th><th rowspan="2">Direction</th><th colspan="3">Morning Peak Hours</th><th colspan="3">Evening Peak Hours</th><th colspan="3">Holiday Peak Hours</th></tr>
<tr><th colspan="2">Average delay (seconds)</th><th>Service Quality</th><th colspan="2">Average delay (seconds)</th><th>Service Quality</th><th colspan="2">Average delay (seconds)</th><th>Service Quality</th></tr>
<tr><td rowspan="4">Taiwan Provincial 17
|
Yugang Rd.</td><td rowspan="4">
</td><td>A</td><td>49.2</td><td rowspan="4">41.2</td><td rowspan="4">C</td><td>48.6</td><td rowspan="4">41.8</td><td rowspan="4">C</td><td>48.9</td><td rowspan="4">44.3</td><td rowspan="4">C</td></tr>
<tr><td>B</td><td>45.8</td><td>41.0</td><td>46.9</td></tr>
<tr><td>C</td><td>49.0</td><td>50.6</td><td>51.1</td></tr>
<tr><td>D</td><td>33.5</td><td>33.9</td><td>33.6</td></tr>
<tr><td rowspan="4">Taiwan Provincial 17
|
Taiwan Provincial 10</td><td rowspan="4">
</td><td>A</td><td>49.4</td><td rowspan="4">32.4</td><td rowspan="4">C</td><td>62.8</td><td rowspan="4">30.5</td><td rowspan="4">C</td><td>53.5</td><td rowspan="4">26.0</td><td rowspan="4">B</td></tr>
<tr><td>B</td><td>32.0</td><td>18.5</td><td>17.3</td></tr>
<tr><td>C</td><td>40.1</td><td>56.8</td><td>46.6</td></tr>
<tr><td>D</td><td>17.3</td><td>11.1</td><td>12.4</td></tr>
<tr><td rowspan="4">Taiwan Provincial 17
|
Sec 2, Lingang East Rd.</td><td rowspan="4">
</td><td>A</td><td>41.9</td><td rowspan="4">44.6</td><td rowspan="4">C</td><td>41.5</td><td rowspan="4">44.6</td><td rowspan="4">C</td><td>40.6</td><td rowspan="4">43.5</td><td rowspan="4">C</td></tr>
<tr><td>B</td><td>49.7</td><td>48.3</td><td>47.9</td></tr>
<tr><td>C</td><td>40.1</td><td>37.4</td><td>38.8</td></tr>
<tr><td>D</td><td>46.5</td><td>48.4</td><td>46.6</td></tr>
</table>

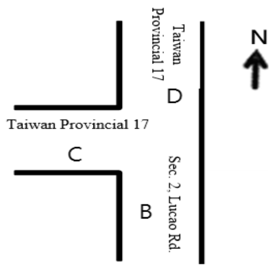
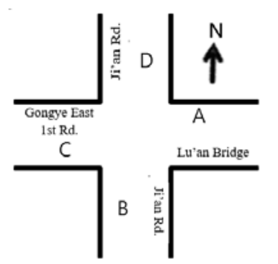
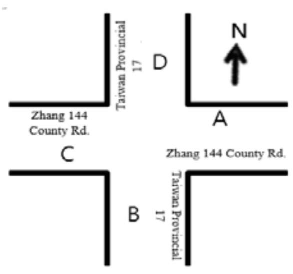
Source: Investigation and analysis of the project.

Table 7.5-11 Summary table of intersections service level assessment during the pre-operational phase(Changhua County)

Intersection	Intersection icon	Direction	Morning Peak Hours			Evening Peak Hours			Holiday Peak Hours		
			Average delay (seconds)		Service Quality	Average delay (seconds)		Service Quality	Average delay (seconds)		Service Quality
Taiwan Provincial 17 | Taiwan Provincial 61 B		A	27.2	25.8	B	64.8	31.5	C	29.6	25.2	B
		B	26.6			25.7			24.7		
		C	20.2			24.1			21.7		
		D	24.4			26.0			23.8		
Taiwan Provincial 61 | Xiangong Rd.		A	37.4	41.8	C	36.8	37.9	C	40.8	39.3	C
		B	46.6			42.2			40.3		
		C	31.9			36.2			33.6		
		D	41.1			40.0			41.8		
Taiwan Provincial 61 | Lugong Rd.		A	48.9	42.0	C	37.0	31.8	C	35.6	30.8	C
		B	52.6			47.3			46.6		
		C	18.5			28.1			16.0		
		D	18.6			34.7			45.0		

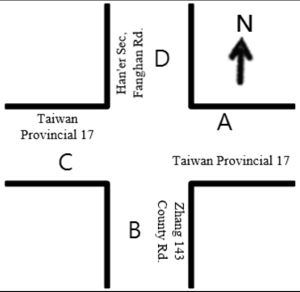
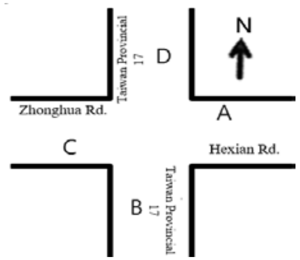
Source: Investigation and analysis of the project.

Table 7.5-11 Summary table of intersections service level assessment during the pre-operational phase(Changhua County) (Continued)

Intersection	Intersection icon	Direction	Morning Peak Hours			Evening Peak Hours			Holiday Peak Hours		
			Average delay (seconds)		Service Quality	Average delay (seconds)		Service Quality	Average delay (seconds)		Service Quality
Taiwan Provincial 17 │ Sec 2, Lucao Rd.		A	-	34.7	C	-	27.0	B	-	30.6	C
		B	40.4			36.9			37.2		
		C	19.4			18.2			17.4		
		D	39.8			37.6			37.0		
Ji'an Rd. │ Gongye East 1st Rd.		A	32.9	32.3	C	20.2	29.7	B	19.5	23.6	B
		B	30.9			36.0			32.1		
		C	17.0			27.7			20.4		
		D	32.8			32.6			31.5		
Taiwan Provincial 17 │ Zhang 144 County Rd.		A	35.2	29.4	B	37.3	31.0	C	33.4	28.5	B
		B	23.3			23.0			21.8		
		C	32.6			35.5			32.9		
		D	29.5			27.0			26.0		

Source: Investigation and analysis of the project.

Table 7.5-11 Summary table of intersections service level assessment during the pre-operational phase(Changhua County) (Continued)

Intersection	Intersection icon	Direction	Morning Peak Hours			Evening Peak Hours			Holiday Peak Hours		
			Average delay (seconds)		Service Quality	Average delay (seconds)		Service Quality	Average delay (seconds)		Service Quality
Taiwan Provincial 17 | Zhang 143 County Rd.		A	7.0	28.3	B	7.0	21.0	B	7.0	15.7	B
		B	48.1			36.1			33.2		
		C	6.6			6.5			6.5		
		D	41.4			36.2			30.8		
Taiwan Provincial 17 | Zhonghua Rd.		A	40.3	39.5	C	37.2	40.1	C	36.4	39.0	C
		B	41.1			44.1			42.5		
		C	32.6			36.0			33.6		
		D	41.3			43.7			42.1		

Source: Investigation and analysis of the project.

Figure 7.5-4 Schematic diagram of the surrounding road service level during the pre-operation phase(1)

Figure 7.5-4 Schematic diagram of the surrounding road service level during the pre-operation phase (2)

IV. Analysis of traffic impact after the operation

The amount of derivative traffic after the operation of the project can be divided into the maintenance staffs entry and the recreational sightseeing trips, as detailed below:

(i) Analysis on the entry of maintenance staffs

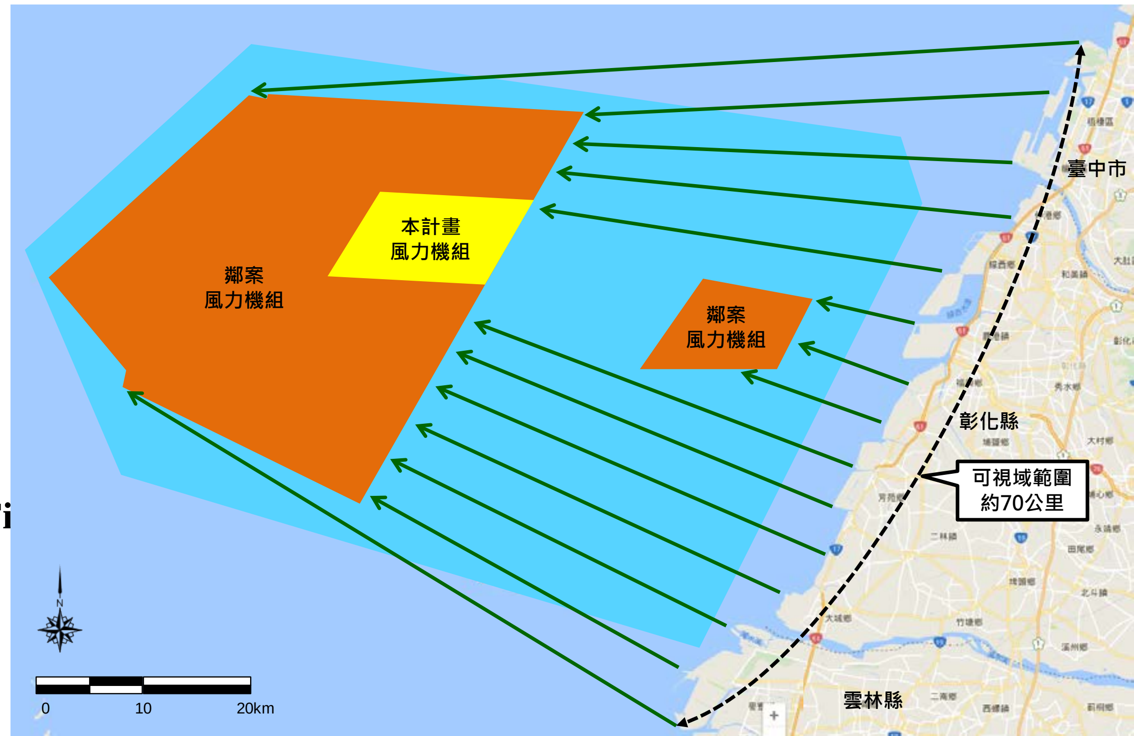
In this project, Changhua Northeast together with the other three wind turbines at Changhua Southeast, Changhua Southwest and Changhua Northwest are operating by using a wholly automatic monitoring system and located in the offshore area. There is usually no on-site operator during the operation period at the wind farm except the entry of maintenance personnel during the maintenance period. The maintenance personnel during the maintenance period is estimated to be 100 people. It is assumed that 30% of the construction personnel use passenger vehicles and 70% of the construction personnel commute to work by motorcycle. Conservatively estimating that each vehicle carries only one person. For these vehicles, 1 and 0.5 were taken as their equivalent value, thus the derivative vehicles trips of maintenance personnel at peak hours is 65 PCU. In addition, the derivative vehicles trips by maintenance personnel for nearby 6 offshore wind turbines; Taipower Phase II, Hailong No. 2, Hailong No. 3, Haiding No. 1 Haiding No. 2, Haiding No. 3 at peak hours is 150 PCU, therefore the total is 215 PCU.

(ii) Analysis of the recreational sightseeing trips

The tour and sightseeing trips derived from wind turbines projects can be generally divided into non-specific and special-purpose trips. For the non-specific trips, people who saw the wind turbines for this development project, drop by the roadside to enjoy the scenery or take photo. This kind of road trip did not increase the traffic volume, so this case was not included in the assessment.

For special-purpose trips, those who are intentionally paying visit to the wind turbines landscape in this project, and the increase in the derivative vehicles trips was the main focus of the traffic impact assessment post development of the project.

The wind turbines in this project were set at about 37-52 km offshore, which were still within the visible area of the coast. In order to accurately evaluate the special-purpose trips derived from the wind turbines landscape in this project, this project conducted a survey at the surrounding attractions of the wind turbines that have been completed. The investigation is used as a basis for the subsequent evaluation of the derived tour and sightseeing trips during the operation phase of the project. The scope of the visual field range of this project is shown in Figure 7.5-5.



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Taichung City. In this area, investigation on the actual entry and exit of vehicles was carried out at the nearby attractions suitable for viewing the wind turbines. The investigation time was from September 24, 2017 (Friday) from 7:00 to 9:00 and 17:00 to 19:00, and September 23 (Saturday) from 16:30 to 18:30. The relevant survey location is shown in Figure 7.5-6.

Figure 7.5-6 Schematic diagram of the survey location on the recreational traffic volume in a similar development project

According to the survey results, the trips to the wind turbines were higher during holidays, and the vehicles entry trips at peak hours were 50 passenger vehicles and 26 motorcycles, while the vehicles exit trips were 45 passenger vehicles and 26 motorcycles. The normal days trips to the wind turbines were relatively low. 9 passenger vehicles and 3 motorcycles entered during the morning peak hours, while 10 passenger vehicles and 3 motorcycles exited; there are 18 passenger vehicles and 18 motorcycles entered at evening peak hours, 29 passenger vehicles and 19 motorcycles exited. The results of the survey on the derivative vehicles of the current wind turbines for recreational sightseeing is shown in Table 7.5-12.

Table 7.5-12 Summary table of the current wind turbines derivative vehicles for recreational sightseeing

Detail	Normal morning peak hours		Normal evening peak hours		Holiday peak hours	
	Passenger vehicles	Motorcycle	Passenger vehicles	Motorcycle	Passenger vehicles	Motorcycle
Number of entering vehicles	9	3	24	18	50	26
Number of leaving vehicles	10	3	29	19	45	26

Source: Investigation and analysis of the project.

In this project, the length of the visible area of the wind turbine is about 61-kilometres, and it is also included in the visual field range for adjacent project of 9 wind turbines, with a total length of about 70-kilometres. According to the above-mentioned survey of the 30-kilometres coastline-derived sightseeing bus, it can be estimated that the morning peak hours of the vehicle's trips in this project were 21 passenger vehicles and 7 motorcycles, and 23 passenger vehicles and 7 motorcycles exited; vehicles trips at the evening peak hours were 56 passenger vehicles and 42 motorcycles, and 68 passenger vehicles and 44 exited; vehicles trips at the holiday peak hours were 117 passenger vehicles and 61 motorcycles, and 105 passenger vehicles and 61 motorcycles exited. The results of the survey on the derivative vehicles of the wind turbines in this project for recreational sightseeing is shown in Table 7.5-13.

Table 7.5-13: Summary table of evaluation results for recreational and tourist derivatives of wind turbines

Project	Morning peak hour during weekdays		Evening peak hour during weekdays		Peak hour during weekends and public holidays	
	Car	Motorcycle	Car	Motorcycle	Car	Motorcycle
Number of entering	21	7	56	42	117	61
Number of leaving	23	7	68	44	105	61

Source of data：Analysis of the study

1. Analysis of service standard at road sections

   Based on the evaluation results of this study, although the service is affected by the maintenance and sightseeing vehicle after operation, the service standard of each road sections remain the same as before. The evaluation results of the road section service standard after operation during weekdays, weekends and public holidays within peak hour are shown in table 7.5-14 to 7.5-15 and the surrounding road service standards after operation are shown in figure 7.5-7 to 7.5-8.

2. Analysis of service standard at road intersections

   Based on the evaluation results of this study, although the service is affected by the travel times of recreational sightseeing buses, the service standard of each road intersections are still able to maintain above C level. Among them, one of the service standards during peak hour on weekdays at Taiwan Provincial Highway No.17/ County Highway 144 decreases from B level to C level, while the other service standard of road intersections remains the same as before. The evaluation results of service standards at road intersections after operation during weekdays, weekends and public holidays within peak hour are shown in table 7.5-16 to 7.5-17, and the surrounding road service standards after operation are shown in figure 7.5-7 to 7.5-8.

Table 7.5-14 Summary of evaluation results for service standard at road section after operation during weekdays, weekends and public holidays within peak hour (Located in Taichung City area)

Road	Road section	Direction	Morning peak hour during weekdays				Evening peak hour during weekdays				Peak hour during weekends			
			Capacity	Volume	V/C	Service standard	Capacity	Volume	V/C	Service standard	Capacity	Volume	V/C	Service standard
Taiwan Provincial Highway No.17 (Section 6, Lingang Road)	The north of Beidi Road	South	5,391	824	0.14	A	5,363	582	0.10	A	5,400	773	0.12	A
		North	7,166	384	0.05	A	7,204	732	0.09	A	7,206	867	0.11	A
	The south of Beidi Road	South	7,199	736	0.09	A	7,172	757	0.09	A	7,202	821	0.10	A
		North	7,188	613	0.07	A	7,205	753	0.09	A	7,203	799	0.09	A
Taiwan Provincial Highway No.17 (Section 5, Lingang Road)	The north of Taiwan Provincial Highway No.10	South	7,194	795	0.10	A	7,201	1113	0.14	A	7,213	1262	0.15	A
		North	7,196	670	0.08	A	7,205	1036	0.12	A	7,216	1400	0.16	A
	The south of Taiwan Provincial Highway No.10	South	7,197	1020	0.13	A	7,192	1124	0.14	A	7,211	1257	0.15	A
		North	7,188	834	0.11	A	7,201	1002	0.12	A	7,214	1452	0.17	A
Taiwan Provincial Highway No.17 (Section 1, Lingang Road)	The west of Taiwan Provincial Highway No.61	East	7,199	501	0.06	A	7,206	1427	0.15	A	7,210	970	0.11	A
		West	7,206	1210	0.14	A	7,195	705	0.08	A	7,201	547	0.07	A
Taiwan Provincial Highway No.17	The south of Section 2, Lingang Road	South	3,604	464	0.11	A	3,606	918	0.21	A	3,610	546	0.12	A
		North	3,598	386	0.09	A	3,597	693	0.15	A	3,609	526	0.12	A
Taiwan Provincial Highway No.10 (Section 9, Zhongqing Road)	The east of Taiwan Provincial Highway No.17	East	7,186	332	0.04	A	7,198	765	0.09	A	7,219	761	0.09	A
		West	7,204	592	0.08	A	7,174	387	0.05	A	7,211	552	0.07	A
15, Zhonheng Road	The west of Taiwan Provincial Highway No.17	East	7,178	217	0.02	A	7,191	618	0.07	A	7,218	552	0.06	A
		West	7,183	420	0.05	A	7,159	195	0.03	A	7,206	399	0.05	A

Road	Road section	Direction	Morning peak hour during weekdays				Evening peak hour during weekdays				Peak hour during weekends			
			Capacity	Volume	V/C	Service standard	Capacity	Volume	V/C	Service standard	Capacity	Volume	V/C	Service standard
Section 2, Westcoast Road	Section 2, Lingang Road	South	7,205	675	0.08	A	7,195	1133	0.13	A	7,210	708	0.08	A
		North	7,198	693	0.08	A	7,175	671	0.09	A	7,199	545	0.06	A
Section 2, Lingang Road	The east of Taiwan Provincial Highway No.61	East	5,401	373	0.06	A	5,408	976	0.15	A	5,409	606	0.09	A
		West	5,406	985	0.15	A	5,392	463	0.07	A	5,412	325	0.06	A
Yugang Road	The east of Taiwan Provincial Highway No.61	West	5,398	185	0.03	A	5,402	303	0.04	A	5,404	239	0.03	A
		East	5,386	298	0.05	A	5,395	170	0.02	A	5,412	203	0.03	A
Beidi Road	The west of Taiwan Provincial Highway No.61	West	5,379	276	0.04	A	5,405	696	0.11	A	5,410	1081	0.18	A
		East	5,383	705	0.11	A	5,392	409	0.06	A	5,410	929	0.15	A

Source of data：Analysis of the study.

Table 7.5-15 Summary of evaluation results for service standard at road sections after operation during weekdays, weekends and public holidays within peak hour (Located in Changhua County Area)

Road	Road section	Direction	Morning peak hour during weekdays				Evening peak hour during weekdays				Peak hour during weekends			
			Capacity	Volume	V/C				Capacity	Volume	V/C			
Taiwan Provincial Highway No.17 (Jianguo Road)	The north of Line 2, Taiwan Provincial Highway No.61	South	3,609	589	0.14	A	3,609	929	0.21	A	3,609	711	0.16	A
		North	3,610	737	0.18	A	3,609	761	0.17	A	3,609	669	0.16	A
	The south of Line 2, Taiwan Provincial Highway No.61	South	3,609	587	0.14	A	3,608	1047	0.24	A	3,609	781	0.18	A
		North	3,609	834	0.20	A	3,609	826	0.19	A	3,609	742	0.18	A
Taiwan Provincial Highway No.17	The north of Zhonghua road	South	3,606	475	0.13	A	3,609	429	0.11	A	3,609	658	0.17	A
		North	3,605	408	0.11	A	3,608	554	0.14	A	3,609	799	0.20	A
	The south of Zhonghua road	South	3,607	400	0.11	A	3,609	687	0.18	A	3,609	658	0.16	A
		North	3,608	927	0.23	A	3,606	627	0.16	A	3,610	571	0.14	A
Taiwan Provincial Highway No.17 (Section 2, Lucao Road)	The north of Taiwan Provincial Highway No.17	South	3,608	1372	0.28	A	3,609	1101	0.23	A	3,609	1216	0.26	A
		North	3,607	1084	0.23	A	3,608	1422	0.29	A	3,610	1223	0.27	A
Taiwan Provincial Highway No.17	The west of Section 2, Lucao Road	South	5,407	1020	0.16	A	5,412	1954	0.28	A	5,415	1065	0.17	A
		North	5,410	1538	0.24	A	5,412	708	0.11	A	5,414	887	0.13	A
South	The north of County Highway 144	South	3,607	443	0.11	A	3,609	590	0.14	A	3,609	563	0.13	A
		North	3,609	1225	0.23	A	3,609	1122	0.24	A	3,610	963	0.21	A
	The south of County Highway 144	South	3,609	398	0.10	A	3,609	632	0.16	A	3,609	596	0.15	A
		North	3,609	1236	0.23	A	3,609	1079	0.23	A	3,609	922	0.21	A
Taiwan Provincial Highway No.17	The east of County Highway 143	East	3,609	819	0.18	A	3,608	726	0.18	A	3,609	739	0.18	A
		West	3,609	632	0.15	A	3,608	730	0.17	A	3,609	875	0.19	A
	The west of County Highway 143	East	3,609	587	0.13	A	3,609	561	0.14	A	3,609	613	0.15	A
		West	3,609	762	0.17	A	3,609	672	0.16	A	3,609	753	0.16	A
Taiwan Provincial Highway No.61	The north of Zhonghua road	South	3,606	475	0.13	A	3,609	429	0.11	A	3,609	658	0.17	A
		North	3,605	408	0.11	A	3,608	554	0.14	A	3,609	799	0.20	A
	The south of Zhonghua road	South	3,607	400	0.11	A	3,609	687	0.18	A	3,609	658	0.16	A
		North	3,608	927	0.23	A	3,606	627	0.16	A	3,610	571	0.14	A
Line 2, Taiwan Provincial Highway No.61	The east of Taiwan Provincial Highway No.17	East	3,607	552	0.14	A	3,607	1162	0.28	A	3,608	915	0.23	A
		West	3,607	1039	0.26	A	3,606	639	0.16	A	3,609	831	0.21	A
	The west of Taiwan Provincial Highway No.17	East	3,606	459	0.12	A	3,607	1094	0.27	A	3,608	840	0.21	A
		West	3,607	1044	0.26	A	3,606	519	0.13	A	3,609	757	0.19	A

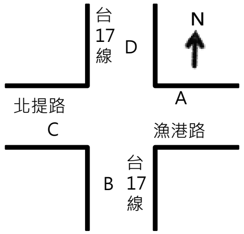
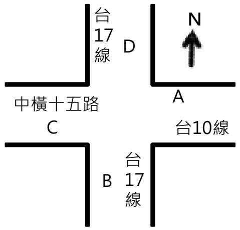
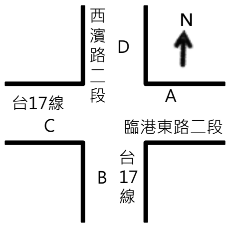
Source of data：Analysis of the study.

Table 7.5-15: Summary of evaluation results service standards at road intersections after operation during weekdays, weekends and public holidays within peak hour (Located in Changhua County Area) (Continue part 1)

Road	Road section	Direction	Morning peak hour during weekdays				Evening peak hour during weekdays				Peak hour during weekends			
			Capacity	Volume	V/C				Capacity	Volume	V/C			
County Highway 144	The east of Taiwan Provincial Highway No.17	East	3,602	408	0.10	A	3,607	481	0.12	A	3,607	250	0.03	A
		West	3,602	460	0.11	A	3,607	522	0.12	A	3,608	259	0.03	A
	The west of Taiwan Provincial Highway No.17	East	3,602	268	0.07	A	3,608	422	0.11	A	3,607	273	0.03	A
		West	3,601	387	0.10	A	3,607	378	0.09	A	3,608	238	0.03	A
Zhonghua road	The east of Taiwan Provincial Highway No.61	East	5,408	115	0.02	A	5,411	616	0.11	A	5,415	193	0.03	A
		West	5,408	460	0.07	A	5,409	253	0.04	A	5,413	733	0.11	A
Zhonghua road	The west of Taiwan Provincial Highway No.17	East	5,399	99	0.02	A	5,413	690	0.12	A	5,415	286	0.05	A
		West	5,411	1035	0.16	A	5,399	140	0.02	A	5,414	597	0.09	A
No. 5, Da Nan Connecting Rd	The east of Taiwan Provincial Highway No.61	East	5,407	274	0.04	A	5,413	2184	0.29	A	5,412	568	0.09	A
		West	5,413	3430	0.44	B	5,410	587	0.10	A	5,415	298	0.05	A
Lugong Road (Bridge)	The west of Taiwan Provincial Highway No.61	East	5,399	260	0.04	A	5,412	2957	0.42	B	5,410	721	0.11	A
		West	5,413	4929	0.67	C	5,405	676	0.12	A	5,413	341	0.06	A
He Xian Road	The east of Taiwan Provincial Highway No.17	West	5,411	240	0.04	A	5,411	856	0.11	A	5,412	414	0.06	A
		East	5,414	874	0.14	A	5,411	434	0.06	A	5,413	255	0.04	A
Hsien Kung Road (Bridge)	The west of Taiwan Provincial Highway No.61	East	5,399	99	0.02	A	5,437	698	0.12	A	5,415	286	0.05	A
		West	5,411	1035	0.16	A	5,423	142	0.02	A	5,414	597	0.09	A
Ji An Road	The north of Gong Ye E. 1st Road	South	3,608	280	0.05	A	3,624	117	0.03	A	3,609	81	0.02	A
		North	3,609	175	0.04	A	3,625	168	0.04	A	3,610	112	0.03	A
	The south of Gong Ye E. 1st Road	South	3,608	374	0.07	A	3,621	56	0.01	A	3,603	26	0.01	A
		North	3,608	42	0.01	A	3,625	428	0.10	A	3,608	159	0.03	A
Gong Ye E. 1st Road	The west of Ji An Road	East	5,396	68	0.01	A	5,437	1178	0.14	A	5,414	522	0.06	A
		West	5,413	1614	0.20	A	5,426	119	0.02	A	5,413	110	0.02	A
Lu An Bridge	The east of Ji An Road	East	3,602	89	0.02	A	3,625	1524	0.28	A	3,609	650	0.12	A
		West	3,609	1863	0.36	A	3,617	144	0.03	A	3,608	135	0.03	A

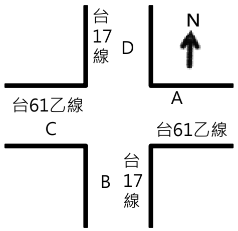
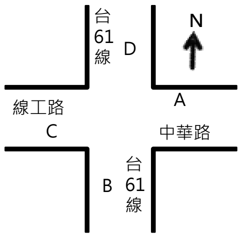
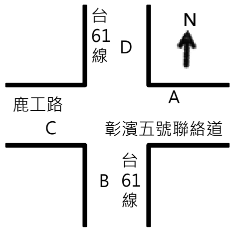
Source of data：Analysis of the study

Table 7.5-16: Summary of service standard evaluation for signalized junction (Located in Taichung City area)

Name of junction	Figure of junction	Direction	Morning peak hour during weekdays			Evening peak hour during weekdays			Peak hour during weekends		
			Average delay time (s)		Service standard	Average delay time (s)		Service standard	Average delay time (s)		Service standard
Taiwan Provincial Highway No.17 | Yugang road		A	49.2	41.2	C	48.6	41.8	C	48.9	44.3	C
		B	45.6			40.8			45.9		
		C	49.0			50.6			51.1		
		D	33.5			34.0			33.4		
Taiwan Provincial Highway No.17 | Taiwan Provincial Highway No.10		A	49.4	32.4	C	62.7	30.5	C	53.5	26.0	B
		B	31.7			18.1			17.2		
		C	40.1			56.8			46.6		
		D	17.4			11.2			12.8		
Taiwan Provincial Highway No.17 | Section2, Lingang east road		A	41.9	44.6	C	41.5	44.9	C	40.6	44.2	C
		B	49.6			48.5			47.8		
		C	40.1			37.4			38.8		
		D	46.6			48.5			47.2		

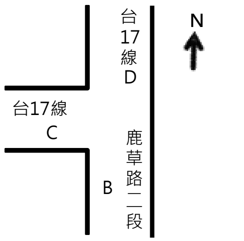
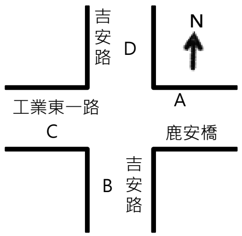
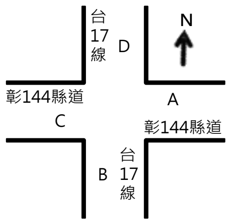
Source of data：Analysis of this study

Table 7.5-17: Summary of service standard evaluation for signalized junction (Located in Changhua County Area)

Name of junction	Figure of junction	Direction	Morning peak hour during weekdays: Average delay time (s)		Morning peak hour during weekdays: Service standard	Evening peak hour during weekdays: Average delay time (s)		Evening peak hour during weekdays: Service standard	Peak hour during weekends: Average delay time (s)		Peak hour during weekends: Service standard
Taiwan Provincial Highway No.17 │ Line 2, Taiwan Provincial Highway No.61		A	27.2	27.7	B	64.8	32.3	C	29.6	27.1	B
		B	30.3			29.5			28.6		
		C	20.2			24.1			21.7		
		D	27.2			29.6			27.3		
Taiwan Provincial Highway No.61 │ Xiangong Road		A	37.4	43.2	C	36.8	41.7	C	40.8	44.4	C
		B	46.0			48.8			46.2		
		C	31.9			36.2			33.6		
		D	45.1			43.1			51.8		
Taiwan Provincial Highway No.61 │ Lugong Road		A	48.9	43.6	C	37.0	36.7	C	35.6	43.9	C
		B	53.6			55.4			55.2		
		C	18.5			28.1			16.0		
		D	27.6			49.0			64.2		

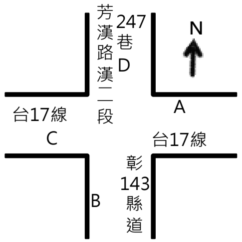
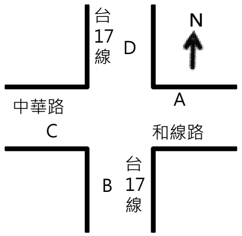
Source of data：Analysis of this study

Table 7.5-17: Summary of service standard evaluation for signalized junction (Located in Changhua County Area) (Continued part 1)

Name of junction	Figure of junction	Direction	Morning peak hour during weekdays			Evening peak hour during weekdays			Peak hour during weekends		
			Average delay time (s)		Service standard	Average delay time (s)		Service standard	Average delay time (s)		Service standard
Taiwan Provincial Highway No.17 | Section 2, Lucao Road		A	—	42.9	C	—	40.3	C	—	44.7	C
		B	40.4			36.9			37.2		
		C	28.9			29.4			29.7		
		D	57.8			63.3			64.3		
Ji An Road | Industry E. Rd. 1		A	32.9	32.3	C	20.2	29.7	B	19.5	23.6	B
		B	30.9			36.0			32.1		
		C	17.0			27.7			20.4		
		D	32.8			32.6			31.5		
Taiwan Provincial Highway No.17 | County Highway 144		A	35.2	44.1	C	35.2	31.0	C	33.4	28.7	B
		B	61.1			26.1			25.3		
		C	32.6			35.5			32.9		
		D	27.5			28.5			28.4		

Source of data：Analysis of this study

Table 7.5-17: Summary of service standard evaluation for signalized junction (Located in Changhua County Area) (Continued part 2)

Name of junction	Figure of junction	Direction	Morning peak hour during weekdays			Evening peak hour during weekdays			Peak hour during weekends		
			Average delay time (s)		Service standard	Average delay time (s)		Service standard	Average delay time (s)		Service standard
Taiwan Provincial Highway No.17 ｜ County Highway 143		A	8.1	28.3	B	8.3	21.0	B	8.4	15.7	B
		B	48.1			36.1			33.2		
		C	7.2			7.3			7.4		
		D	41.4			36.2			30.8		
Taiwan Provincial Highway No.17 ｜ Zhonghua Road		A	40.3	41.4	C	37.2	44.1	C	36.4	43.6	C
		B	43.9			49.9			47.6		
		C	32.6			36.0			33.6		
		D	44.1			48.4			46.8		

Source of data：Analysis of this study

Figure 7.5-7: The surrounding road service standards after operation (1)

Figure 7.5-8: The surrounding road service standards after operation (2)

7.6 Cultural resources

I. Terrestrial cultural assets

This study will be carry out terrestrial cultural assets on 9th October 2016, 18th July 2017, and 24th October 2017. The survey did not find any archeological sites inside the survey area. Since the survey area is a reclaimed land and there are mostly factory buildings inside the area, no cultural resources will be affected.

By integrating the result of these three terrestrial cultural assets, this survey did not find any ruins and legacies on the scheduled land route. Moreover, the tangible cultural assets in the administrative area of the project are located in the central area of the township which is quite far away from the project, the possibility of direct impact will be relatively low. For the intangible cultural assets, the activity has to be held in an indoor environment due to most of them are traditional craft or traditional performing arts. The folk style "Lukang Lo Pan Banquet" will be held in indoor such as hall, activity center etc. Moreover, the site of these intangible cultural assets are in the township center, which is far from the coastal industrial area where the project is located. Hence, it will not easily affected by the cable construction projects.

The land facility of this project is located in the sea reclaimed project of Zhangbin Industrial Zone. This trait is embodied in the stratum section exposed by the construction of embankment and drainage ditch in the industrial area. By considering the artificial backfilling land environment and the results of field survey, the possibility of encountering archaeological sites within the affected area of cable construction is relatively low.

II. Submarine culture resources

With regard to submarine culture resources, the wind field site is 35.7km offshore at depths ranging from 34.4 to 44.1 m. There are no submerged reefs distributed within. Excluding vessel sinking caused by factors such as natural climate, mechanical malfunction and fire, the marine navigation conditions are good. In addition, the western coast intertidal zone at Changhua is very wide reaching 4 to 5 km at its widest. In the past, ships entering and exiting these zones had to follow the tides. The same is true today. Or be transferred from open seas into port by smaller boats. Choppy waters commonly occur in poor marine meteorological conditions in seas near the low tide line at a distance of 4 to 5km from the shore which poses a considerable threat to anchoring ships.

In respect of suspected targets, there are 24 suspected targets on the sea bed in the wind field. Their appearance is mostly in rectangular shape and has magnetic reaction. It is inferred that it may be a modern wreck, and it is less likely that it belongs to an ancient wooden wreck. However, it is suggested that underwater verification should be carried out to identify its nature and importance.

According to the results of underwater survey, 38 side-scan sonar reactants were detected on the seabed in the four cases of Changhua County (1 northwest case, 13 northeast case, 7 southwest case and 17 Southeast case). There were 24 buried magnetic anomalies (5 northwest case, 2 northeast case, 10 southwest case and 7 Southeast case). Three of them overlapped. According to the results of the examination by the Cultural Assets Bureau of the Ministry of Culture of the Republic of China on 24th January 2018. 59 suspected objects of underwater cultural assets in the Changhua County offshore wind power project (four cases) have been identified, which may be left over by modern materials or archaeological relics with historical and cultural value. However, it is possible to reasonably infer that these objects belong to the former from an archaeological point of view. Detailed investigation will be carried out for wind turbine position and cable position in detail design phase.

In this project, the location of wind turbines and cable routes are used in the disturbance area of the seabed, while the depth and scope of disturbance are depending on the construction method. If there is conflict between the side scan sonar reactants on the seabed and the buried magnetic anomalies, the relevant facilities will avoid the above objects and the magnetic anomalies. If it is impossible to avoid them, the provisional office promises to conduct more detailed inspection and verification before obtaining the approval of the Energy Bureau for the preparation of the establishment of the submarine cables in order to clarify its attributes and values and avoid direct impact on it.

The survey of underwater cultural assets carried out in 105 years has been carried out with full coverage of multi-beam topography, side-scan sonar detection, magnetic detection and bottom profiler survey. In accordance with the “Law on the Preservation of Underwater Cultural Assets of the Ministry of Culture” and the “Regulations on the Investigation and Treatment of Underwater Cultural Assets before the Development of Waters”, a report on the investigation of “Underwater Cultural Assets” has to be submitted for examination by the Ministry of Culture. After consideration by the Ministry of Culture on 25th May 2017, the Underwater Cultural Resources Bureau of the Ministry of Culture issued the minutes of the meeting on 20th June 2017 (Letter No. 1063006424 from the Cultural and Funding Bureau) and obtained the Ministry of Culture's reference on 17th July 2017 (Cultural and Funding Bureau's Relics No. 10630075273). According to the reference letters as shown in Appendix 8, the provisional office shall obtain approval in accordance with the rules for the registration of the telecommunications industry. Before that, a detailed investigation plan of underwater cultural assets was proposed to the Ministry of Culture. With the consent of the Ministry of Culture, the detailed investigation of water areas was carried out accordingly.

The provisional office submitted a detailed investigation plan for review by the Cultural Resources Bureau of the Ministry of Culture on 16th October 2017, and the case was examined by the Cultural Resources Bureau of the Ministry of Culture on 10th October 2017. According to the results of the examination by the Cultural Assets Bureau of the Ministry of Culture on 24th January 2018, the scope of the detailed investigation plan for the underwater cultural assets of the Offshore Wind

Power Project of the Republic of China has been defined as 59 objects for the review of the previous investigation results. (Four Winds Meter) The investigation is expected to begin in March 2018 and will be submitted to the Cultural Assets Bureau of the Ministry of Culture for examination in September. The detailed investigation (review) plan for underwater cultural assets has been currently approved and included in the final version of the environmental impact statement of the project, as shown in Appendix 8. According to the present detailed investigation plan submitted for consideration as shown in Appendix 8, the follow-up work of this project includes the target object review operation, the supplementary investigation extending 500 meters from the development area, and the underwater cultural assets investigation of the submarine cable route corridor. The definitions are:

(i) The target review operation

According to the Technical Guidelines for Underwater Cultural Assets Survey and Instrument Detection promulgated by the Ministry of Culture on 14th July 2017, this project will carry out target review for underwater objects found in the waters of development and utilization zones. This section includes 13 sonar reaction targets and 2 magnetic reflection targets (detailed information table 6.7-8; detailed location figure 6.7-12) which discovered from the investigation in year 2016, and underwater targets found in the cable route corridor area. These underwater targets will be reviewed in accordance with relevant specifications (technical guidelines for underwater cultural assets investigation and instrument detection).

Based on the purpose of reconfirming the position, state and existence of the discovered underwater target, four kinds of instruments will be used in this stage: multi-beam, side-scan sonar, magnetometer and bottom profiler. In order to collect high-precision and high-density target materials, a multi-directional line-finding plan is synchronized with the setting of smaller line spacing and shooting distance. In order to achieve this goal, the survey will focus on the objects found. If there is a displacement of the objects, the scope of the review should be having the length and width of at least 100 x 100 meters (the size of the objects will still be adjusted appropriately on the job site). The setting for working parameters of the overall review are shown in Table 7.6-1, and the equipment used to carry out various survey items is listed in Table 7.6-2.

The review steps for the target are shown as below (refer to Table 7.6-1).

Table 7.6-1 Setting of working parameters for target review work

Survey items	Equipment used	Setting parameters
Review of targets for side sonar detection	Side scan sonar system (Frequency above 400 kHz)	HF: 50m; LF: 75m
Review of targets for high density water depth exploration	Multi-Beam Sounding System	Provide 1 meter grid precision water depth
Review of targets for magnetic detection	Marine Magnetometer	The Principle of Appropriate Height from Bottom of Traw
Review of targets for Bottom Profiler Survey	Stratigraphic Profiler	2-16 kHz continuous variable frequency source as domain

Table 7.6-2 List of Target Reinspection and Survey Instruments

Items	Survey equipment		Number
Location	Fugro SeaStar DGPS、Kongsberg Hipap 350p、AAE EasyTrak		2
Navigation	Hypack、In House PIMS system		2
Pointing calculation	Applanix POS MV		1
Dynamic compensator			
Multi-beam sounding system	Kongsberg EM2040 and EM2040C		2
Sound velocity profiler	AML Minos CTD		2
Side scan sonar system	Edgetech 2000DSS、4200-FS		2
Stratum profiler	Edgetech 2000DSS		2
Magnetometer	Geometrics G882 Marine Magnetometer		2
Remotely Operated underwater Vehicle (ROV)	SeaEye Panther		1
Data Processing Software	Multi-tone beam	CARIS HIPS	2
	Side scan sonar system	Sonarwiz	2
	Stratigraphic section	GeoSuite、Triton SBI	2
	Magnetic	GeoSoft Oasis Montaj	2

1. Side scan sonar scanning stage：

   At a distance of 20 meters from a predetermined target point, the suspected target (yellow and blue lines) is scanned in two orthogonal ways. By taking SSS as the base, MBES, SBP and MAG are turned on together. Sonar images show complete morphology and characteristics. If the attributes are not confirmed, the Remotely Operated Underwater Vehicle (ROV) is placed for visual inspection.

2. Stratigraphic profiler and magnetic inspection stage:

   If the morphology of the target is not obvious (semi-buried) or not found, the main detection methods are MAG and SBP, which are used to detect the buried state and ferromagnetic properties of the target.

3. Target displacement and size confirmation:
   If the target is not found in the red line of the previous stage, the survey is carried out with four instruments on both right and left sides of the target, each 10 meters offset until the green line is found. The purpose is to determine whether the target is displaced or not in the previous stage. If the target is found in the red line, the green line is still carried out to further confirm the size of the target.

4. Expanding confirmation attributes:

   If the target is not found in the green surveying line in the previous stage (each 10 meters offset), four kinds of instrument surveys are carried out with two lines on both left and right sides of the target and two lines on each 20 meters offset until the grey surveying line is found. In order to find out the target size in the first three stages exceeds the range of the green surveying line, the gray surveying line is carried out to reconfirm the attribute size of the target again.

(ii) The supplementary investigation extending 500 meters from the development area

The Ministry of Culture convened the "Guidelines for Underwater Cultural Assets Survey and Instrument Detection Technology Seminar" on 23th August 2017. It was decided that the provisional offices should investigate the external geographic boundaries in accordance with Article 6, paragraph 3, of the "Measures for Investigation and Treatment of Underwater Cultural Assets before the Development and Utilization of Waters", which includes the development and utilization of the covered area and its surrounding areas that extended at least 500 meters away. The provisional office is scheduled to conduct a supplementary survey of this area in year 2018.

This plan will use 100-meter line spacing in the area for full-duplex side-scan sonar detection, high density magnetic detection and depth profiler detection instrumentation as shown in table 7.6-3 during supplementary investigations. Supplementary surveys will be conducted in accordance with relevant regulations (Guidelines for Underwater Cultural Assets Survey Operations and Instrument Detection Technology). Survey line planning is shown in Figure 7.6-2.

III. The supplementary investigation extending 500 meters from the development area.

When investigating the underwater cultural assets of the cable route corridor for this project, full-duplex scanning sonar detection, full-duplex high-density water depth detection, magnetic detection and stratum profiler detection will be used with 100-meter line spacing. The survey area is the development and utilization area of the cable seat which will be extended 500 meters in both left and right side. A distance of 100 meters shall be used where the water depth is greater than 20 meters whereas a distance of 50 meters shall be used where the water depth is less than 20 meters. The survey shall be carried out in accordance with the relevant specifications (Guidelines for Underwater Cultural Assets Survey and Instrument Detection Technology), as shown in Table 7.6-3.

If a suspected underwater target is found in the cable route corridor, immediate review shall be carried out in accordance with the review criteria.

Table 7.6-3: Supplementary list of survey instruments

<table>
<tr><th>Items</th><th colspan="2">Survey equipment</th><th>Number</th></tr>
<tr><td>Location</td><td colspan="2">Fugro SeaStar DGPS、Kongsberg Hipap 350p、
AAE EasyTrak</td><td>2</td></tr>
<tr><td>Navigation</td><td colspan="2">Hypack、In House PIMS system</td><td>2</td></tr>
<tr><td>Pointing calculation</td><td colspan="2" rowspan="2">Applanix POS MV</td><td rowspan="2">1</td></tr>
<tr><td>Dynamic compensator</td></tr>
<tr><td>Multi-beam sounding system</td><td colspan="2">Kongsberg EM2040 and EM2040C</td><td>2</td></tr>
<tr><td>Sound velocity profiler</td><td colspan="2">AML Minos CTD</td><td>2</td></tr>
<tr><td>Side scan sonar system</td><td colspan="2">Edgetech 2000DSS、4200-FS</td><td>2</td></tr>
<tr><td>Stratum profiler</td><td colspan="2">Edgetech 2000DSS</td><td>2</td></tr>
<tr><td>Magnetometer</td><td colspan="2">Geometrics G882 Marine Magnetometer</td><td>2</td></tr>
<tr><td rowspan="4">Remotely Operated underwater Vehicle (ROV)</td><td>Multi-tone beam</td><td>CARIS HIPS</td><td>2</td></tr>
<tr><td>Side scan sonar system</td><td>Sonarwiz</td><td>2</td></tr>
<tr><td>Stratigraphic section</td><td>GeoSuite、Triton SBI</td><td>2</td></tr>
<tr><td>Magnetic</td><td>GeoSoft Oasis Montaj</td><td>2</td></tr>
</table>

Figure 7.6-1: Target review process

Figure 7.6-2: Supplementary Survey Line Planning

Figure 7.6-3: Cable Routing Corridor Survey Line

7.7 Safety evaluations

Based on the site geological characteristics, stratigraphic distribution, extreme marine meteorology caused by earthquake and lightning strikes which were considered for this project, an initial design analysis was performed on the wind turbine foundation, models, structure and overall safety, a natural disaster and construction / operation risk assessment was made and possible countermeasures are submitted.

I. Environmental, climate and human factors

The sea wind field work site is on the sea. The work equipment are primary ships. Ship transport is greatly affected by marine meteorological conditions. Project progress and results are commonly affected by factors such as waves, undercurrents, typhoons and water depth. Due to the special marine and submarine work environments, close coordination is needed among the project team and personnel with special skills are needed to perform the work. Project team cooperation and technical skills are one of the key factors in determining the success of the marine project.

II. Work method risk

No work method is absolutely essential for the marine and submarine project. The work methods are determined based on the climate at the worksite environment and the extensive experience of project team members. Each work method has its own critical factors for success. The pre-construction survey plan, on-site condition coordination, vessel mobilization and the experience and adaptability of the project teams can be said to be indispensable.

7.7.1 Risks of Typhoons

I. Analysis of Historical Typhoons

The typhoon season occurs in the summer and fall of each year and typhoons strike Taiwan very often during this time. Past data shows an average of 3 to 4 typhoons strike Taiwan each year. Seeing that the strong winds produced by typhoons may damage wind turbines, these possible hazards are factors which must be taken into account during wind field development and operation. Based on the table of typhoon intensity division in Taiwan (Table 7.7.1-1), the intensity of typhoon is based on the maximum 10-minute mean wind speed near the center. The maximum wind speed near the center of typhoon is more than 51 m/s, whereas the maximum wind speed of typhoon usually occurs within the eyewall of typhoon within 100 km from the center.

In order to understand the frequency and characteristics of the past typhoons that have invaded the planned wind field, we refer to 1,718 Best Track data from the RSMC-Tokyo Center of Japan from February 1951 to October 2016 (66 years), which records the center of every six hours during the typhoon event. Location coordinates, atmospheric pressure and maximum 10-minute mean wind speed near the center (@10m A.S.L., Best Track data added after 1977) were used to evaluate the possible effects of typhoons on wind field during the design period. ◦

Table 7.7.1-1 Classification Table of Typhoon Strengths

Typhoon intensity	Maximum wind speed which near to the center			
	km/h	m/s	mile/h	Beaufort wind scale
Mild typhoon	62~117	17.2~32.6	34~63	8~11
Moderate typhoon	118~183	32.7~50.9	64~99	12~15
Strong typhoon	184 and above	51.0 and above	100 and above	16 and above

The design and operation for wind speed of the wind turbine hub height (calculated at 100m for the time of design and operation) is an important evaluation factor. According to the IEC 61400-3 specification, the wind speed profile V(z) is a function of the average wind speed varying with the height Z of the static water surface. The power function can be expressed as follows.

$$V(z) = V_{ref}\left(\frac{Z}{Z_{ref}}\right)^{\alpha}$$

Where： V_{ref} = 10m high wind speed

$V(z)$ = Wind speed at altitude Z

Z_{ref} = Reference height (10m)

z = Estimated height(Calculated as 100m hub height)

α = Power law index number, based on IEC 61400-3, 0.11 is recommended for extreme wind conditions.

Based on the above relations, the average wind speed of 10 minutes and gust speed of 3 seconds at hub height of each typhoon classification are listed as shown in Table 7.7.1-2:

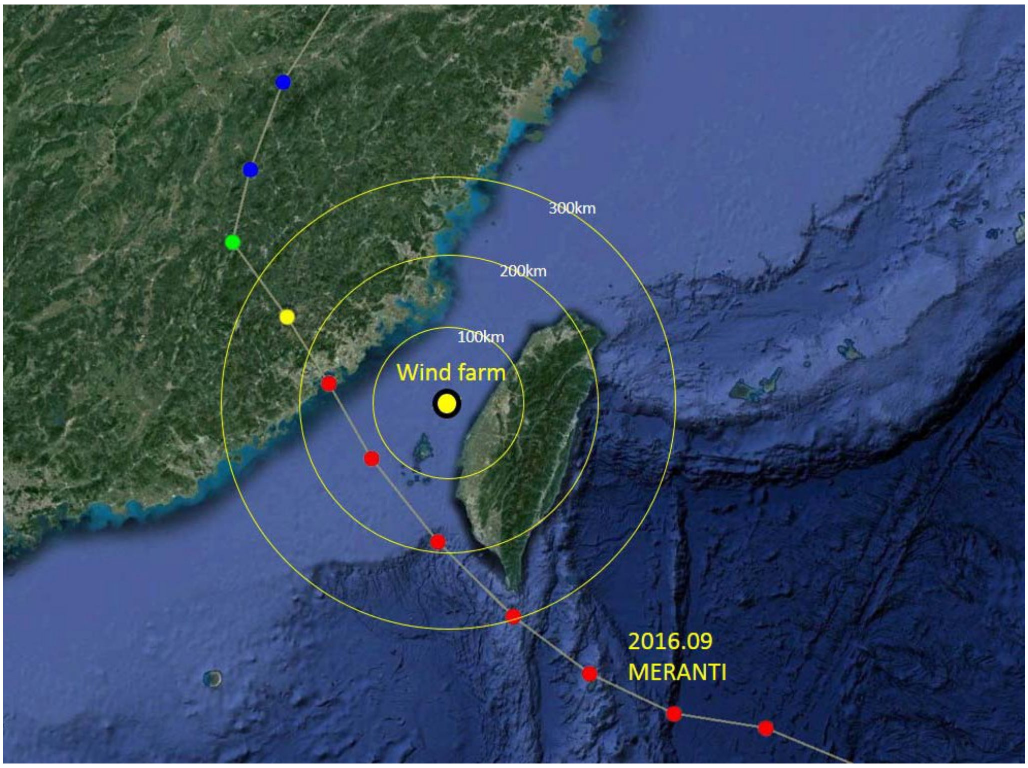
Table 7.7.1-2 Classification Table of Typhoon Strengths

Typhoon category	Wind speed (m/sec)		
	10-min average @10m	10-min average @100m	3-sec gust @100m
Category 3	17-24	22-31	31-43
Category 4	24-33	31-43	43-60
Category 5	>33	>43	>60

II. Analysis of the number of past typhoons which have struck the wind field

The planned area is located at the northwest side of Taiwan. According to the statistical results of typhoon tracks that invaded Taiwan in the past, most typhoon tracks invaded from west to east. Due to the effect of Central Mountains, the intensity of typhoon to the west side of Taiwan obviously weakened. Therefore, it is important to reasonably reflect the intensity of typhoon to the planned wind field and analyze the number of typhoons which attacking the wind field with different intensity.

This project's wind field center (119.905342E，24.192255N) is a circle center. Typhoon intensity at the point closest to the wind field was used at intervals of 100km. Typhoon events passing within a range of 100 – 300km from the wind field center. Details are shown in Fig 7.7.1-1. The analysis results are shown in Table 7.7.1-3 and Fig 7.7.1-2～Fig 7.7.1-3. From the analysis results, it can be seen that the number of Cat. 5 typhoons which have passed through a 100 – 300km range in the past 66 years is roughly the same. From the analysis results of accumulated number of typhoons, it can be seen that 9 Cat. 5 typhoons have passed within a 100km range of the wind field center which is equivalent to 0.14 times/year, 20 Cat. 5 typhoons have passed within a 200km range of the wind field center which is equivalent to 0.30 times/year and 31 Cat. 5 typhoons have passed within a 300km range of the wind field center which is equivalent to 0.47times/year.



Google image photography time：Year 2016.

Fig. 7.7.1-1: Project Wind Farm Location and Typhoon Route

Table 7.7.1-3: Number of Typhoons Entering Ranges of 100 - 300m from the Center of the Wind Farm (1951 ~ 2016)

Typhoon category	10-min sustained wind @100m(m/sec)	3-sec gust @100m(m/sec)	Distance from the wind field center (km)		
			100km	200km	300km
Cat.3	22-31	31-43	7	14	8
Cat.4	31-43	43-60	17	18	10
Cat.5	>43	>60	9	11	11
Cat.3(Accumulated)	22-31	31-43	7	21	29
Cat.4(Accumulated)	31-43	43-60	17	35	45
Cat.5(Accumulated)	>43	>60	9	20	31

Fig. 7.7.1-2 Number of Typhoons Entering Ranges of 100 – 300 km from the Center of the Wind Field (100km interval)(1951 ~ 2016)

Fig. 7.7.1-3 Cumulative Number of Typhoons Entering Ranges of 100 ~ 300km from the Center of the Wind Field (1951 ~ 2016)

III. Analysis of the Times when Past Typhoons Have Struck the Wind Field

This project’s wind field center (119.905342E，24.192255N) is a circle center. By taking the typhoon events passing within a range of 100 – 300km from the wind field center and their intensity, the length of time which different intensity typhoons within this range affect the wind field may be calculated. The analysis results are shown in Table 7.7.1-4 and Figs 7.7.1-4～ 7.7.1-5. From the analysis results of typhoons over the past 66 years, it can be seen that Cat. 4 typhoons had longest time of impact within a range of 300km and Cat. 5 typhoon hub height near the center had 10-min sustained winds reaching 43m/sec and 3-sec gust speeds of 60m/sec or more. From the cumulative time analysis results, it can be seen that the total time of Cat. 5 typhoons striking inside a 100km range from the project wind field center is 108 hours which is equivalent to 1.6 hours/year, the total time of those striking inside a 200km range from the project wind field center is 516 hours which is equivalent to 7.8 hours/year and total time of those striking inside a 300km range from the project wind field center is 1,194 hours which is equivalent to 18.1 hours/year.

Table 7.7.1-4 Hours of Impact of Typhoons Entering Ranges of 100 – 300km from the Center of Wind Field (1951 ~ 2016)

Typhoon category	10-min sustained wind @100m(m/sec)	3-sec gust @100m(m/sec)	Distance from wind field		
			100km	200km	300km
Cat.3	22-31	31-43	78	396	528
Cat.4	31-43	43-60	174	480	588
Cat.5	>43	>60	108	408	678
Cat.3(cumulative)	22-31	31-43	78	474	1002
Cat.4(cumulative)	31-43	43-60	174	654	1242
Cat.5(cumulative)	>43	>60	108	516	1194

IV. Extreme wind speed analysis

The RSMC-Tokyo Center has included 10-min maximum wind speed near the typhoon center into BestTrack data since 1977, so this project using the 1977 – 2016 (40 year) typhoon Best Track data to make another estimate of wind turbine hub height 10-min sustained wind speed and 3-sec gust speed based on the power relation of the above wind speeds and performed an assessment of those typhoon events within different ranges of the wind field which exceeded the basic strength parameters for Class I and Class II wind turbines as defined in IEC 61400-1 as shown in Table 7.7.1-5 and Table 7.7.1-6. From the analysis results, it can be seen there were no typhoon events exceeding the wind turbine strength specification that passed within a 200km range from the wind field center over the past 40 year. However, a typhoon event with a hub height maximum 10-min sustained wind speed reaching 48.9m/sec and 3-sec gust reaching 88.1m/sec which passed within a 300km range did exceed the IEC Class I wind turbine strength specification. From the analysis of the number of typhoons, it can be seen that there were 5 typhoons exceeding the IEC Class I wind turbine strength specifications which passed within a 300km range from the wind field center, equivalent to 0.125 typhoons per year. These five typhoons are listed in Table 7.7.1-7. Their path maps are shown in Figure 7.7.1-6 to Figure 7.7.1-10.

Generally, the maximum wind speed of typhoon occurs in the eyewall of typhoon within 100 km from the center. From the above analysis, it can be seen that no typhoon has exceeded the standard intensity of IEC Class I wind turbine strength specifications passed within a 200km range of the project area. Perhaps, due to the plan area is located in the middle of the west coast of Taiwan, the typhoon hit by the towering central mountains, the structure will be affected by the terrain damage caused typhoon wind field. It has substantially reduced the strength of the other by a close distance (300km range) and more than IEC Class I wind turbine to standardize the intensity of the 5 cases. Data shows that although in the hub near the typhoon center height in 3 seconds of wind gust speed can reach 74.2-88.1 m/sec, but it is 215-299 km away from the wind field and far away from the eye wall. Therefore, for IEC Class I wind turbine, the wind conditions affected by typhoon in this planning area should be fully applied.

Fig. 7.7.1-4 Time which Typhoons Enter Ranges of 100 – 300km from the Center of the Wind Field (100km interval)(1951 ~ 2016)

Fig. 7.7.1-5 Cumulative Time which Typhoons Enter Ranges of 100 – 300km from the Center of the Wind Field (1951 ~ 2016)

By considering the uncertainty of mesoscale meteorological system and also the accuracy of Best Track data in time and intensity is limited, the follow up procedures will proceed to a more detailed numerical simulation of wind field to determine the reasonable design conditions. Other than that, the possibility of more than 70 m/sec wind speed occurring within 20 years of service should be retained in the design stage. In the future, IEC Class I grade should be adopted and IEC Class S should be considered as the typhoon status for selecting wind turbine. The relevant structure of wind turbine will be designed according to the site conditions and typhoon conditions to ensure the structural safety of wind turbine is within their service life.

Table 7.7.1-5 Maximum wind speed entering the typhoon center within 100-300 km from the wind field center (1977-2016)

Range (km)	10-min sustained wind @10m(m/sec)	10-min sustained wind @100m(m/sec)	3-sec gust @100m(m/sec)
0～100	38.6	49.7	69.6
0～200	38.6	49.7	69.6
0～300	48.9	63.0	88.1

Table 7.7.1-6 Number of Typhoons Exceeding the Wind Turbine Basic Strength Parameter (1977 ~ 2016)

Wind turbine conditions	Distance from wind field center(km)		
	0～100	0～200	0～300
IEC Class I wind turbine (gust speed >70.0m/sec)	0	0	5
IEC Class II wind turbine (gust speed >59.5m/sec)	6	13	23

Table 7.1.1-7 Maximum wind speed entering the typhoon center within 100-300 km from the wind field center (1977-2016)

Number of typhoon	Name of typhoon	Minimum Pressure within the Life Cycle (hPa)	Maximum wind speed near center within the life cycle (10 minutes average wind @10m (m/sec))	Closest Distance from Center to Wind Field(km)	Maximum near-center wind speed at the closest approach to wind field (10 minutes average wind at 10m (m/sec))	Maximum near-center wind speed at the closest approach to wind field (10 minutes average wind at 100m (m/sec))	Maximum near-center wind speed at the closest approach to wind field (3 seconds average wind at 100m (m/sec))
197909	HOPE	900	56.6	299	48.9	63.0	88.1
198520	BRENDA	955	43.7	295	43.7	56.3	78.9
199107	AMY	930	48.9	215	41.2	53.0	74.2
199413	DOUG	925	51.4	232	43.7	56.3	78.9
200313	DUJUAN	950	41.2	289	41.2	53.0	74.2

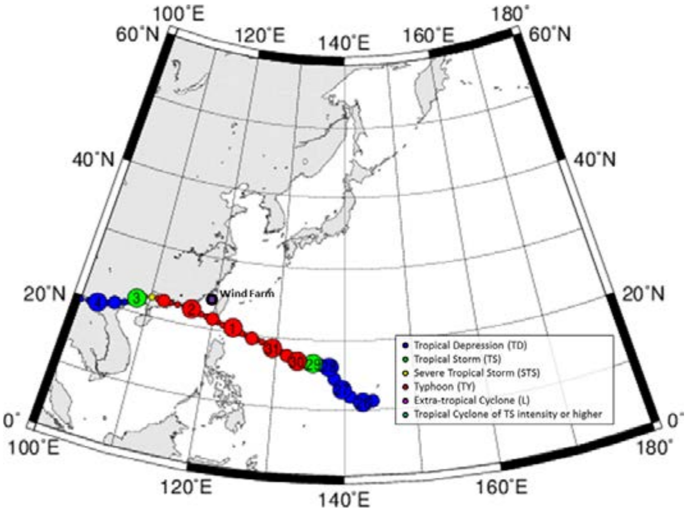


Figure 7.7.1-6　197909HOPE Typhoon path map

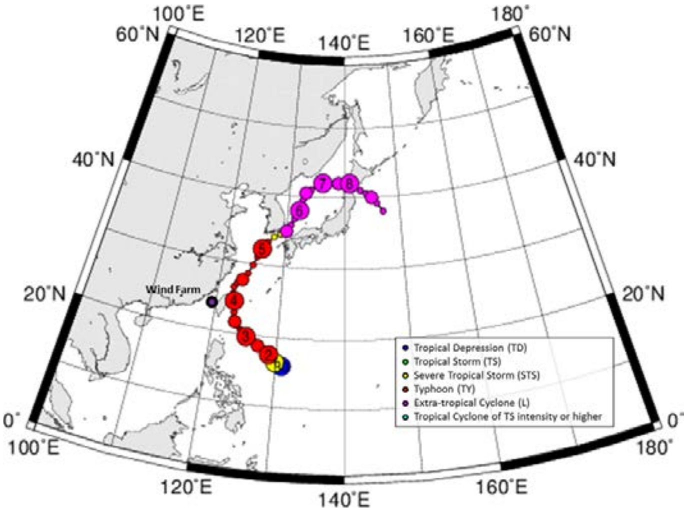


Figure 7.7.1-7 198520BRENDA Typhoon path map

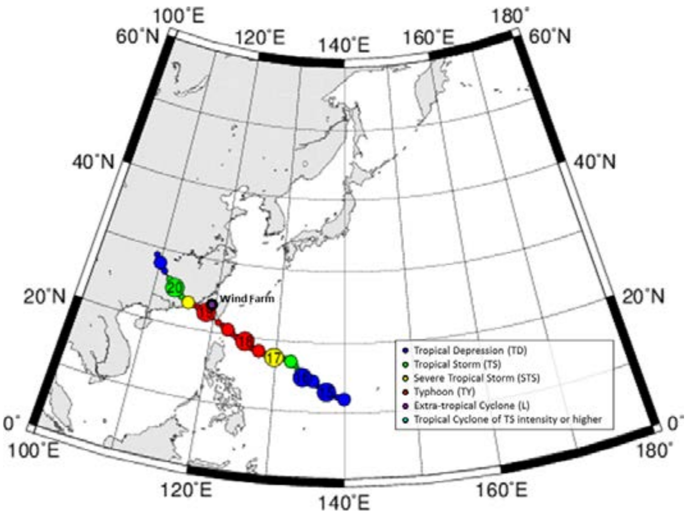


Figure 7.7.1-8 199107AMY Typhoon path map

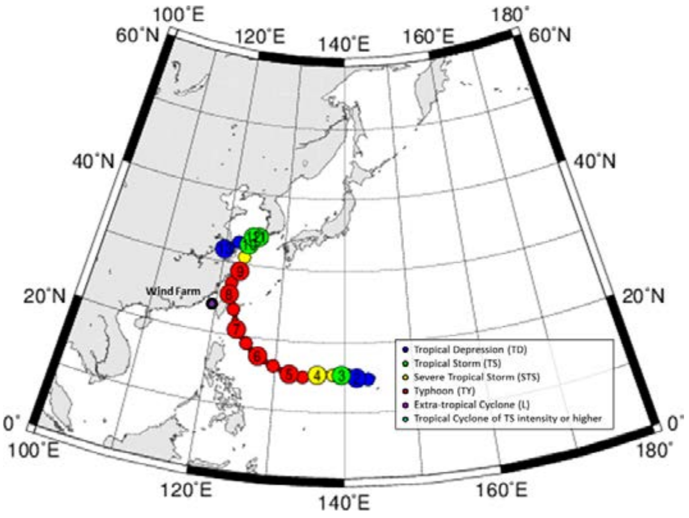


Figure 7.7.1-9 199413DOUG Typhoon path map

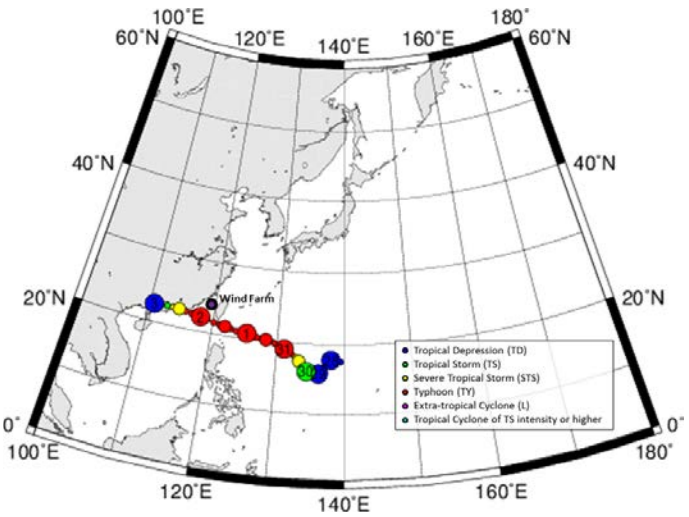


Figure 7.7.1-10: 200313DUJUAN Typhoon path map

V. Analysis of Typhoon Invasion Tolerance to Wind Turbines

Currently, the preliminary risk assessment report has been completed. Through the risk assessment report and historical typhoons, the provisional office has been aware of the risks related. From the analysis results and the history of typhoon in the past 40 years, no typhoon incident which exceeds the strength specifications of wind turbines happens before within the range of 200 km from the wind farm (year 1977-2016); The number of typhoons that having an average wind speed of 50 m/s over 10 minutes and a strong gust of 70 m/s within 300 km of the wind field center occurred is 5, which is equivalent to the frequency of 0.125 times per year.

In fact, the current wind turbine design is considered to bear with an average wind speed of 54-57 m/s in 10 minutes for 50 years, or 3 seconds gust wind speed in the range of 70-74 m/s. Meanwhile, by participating in the marine demonstration wind farm project, the provisional office has established cooperation with local experts, who will participate in the development and planning of Changhua County wind farm. Relevant wave conditions include oscillatory wave heights (Hs) in the range of 9.5-11.5 m and individual wave heights up to 17-21 m, which are much higher than Europe's worst offshore areas. Due to the function of typhoon, the steepness of wave is greater than Nordic and thus causing a more severe load.

The use of load safety factor is based on IEC 61400-1 and 61400-3. This part has been confirmed by an in-depth investigation which submitted to IEC 61400-1 committee in order to make sure that both of them have considered the higher risk of typhoon. Corresponding to the average wind speed of 10 minutes 54-57 m/s, the safety factor ensures that the wind turbine and supporting structure are able to withstand the load in the range of 63-67 m/s of the average wind speed for 10 minutes. From the wind field assessment report and Taiwan's building technical specifications, the return period of these stronger wind speed designs is about 800 years, and the probability of exceeding them is about 3% in the 25-year plan life cycle. Typhoon risk will be reflected in the asset insurance of the provisional office.

According to the experience of observing wind turbine collapsed under typhoon conditions, the operation ability of wind turbine during typhoon is an important aspect to manage the risk of typhoon, especially the yaw steering ability of wind turbine during typhoon. Therefore, we consider to strengthen the standby power or similar measures of wind turbine yaw steering system in high-risk events when power grid jumps out during typhoon. Typhoon may be an extreme event beyond the scope of wind turbine operation. However, current warning system of the National Central Meteorological Bureau can be prepared in advance.

It is inevitable to encounter typhoon during construction. All work will be stopped during typhoon to ensure the safety of personnel and worker. According to the standard procedure, the inclination of all foundations should be measured immediately upon completion of construction to prove that the design requirements and workers permitted errors are met. This will also ensure that the foundation during construction might exceed its permitted value due to severe typhoon loads will be detected.

VI. Preventive measures: wind turbine safety monitoring system (SCADA system)

The overall SCADA expert system will be improved by considering the frequency, severity and vulnerability analysis. Moreover, various study will be conducted to improve the system.

In terms of frequency, the development of wind turbine control system able monitor and control individual wind turbine in order to maintain the structural integrity and safety. Wind field SCADA system monitors the balance of wind turbines and wind field 24 hours per day.

In terms of severity, the operation and maintenance department of the provisional office has an advance emergency response plan, which takes into account with different severity problems in the aspects of wind field integrity and personnel safety. Namely, the system has an automatic shutdown emergency procedure (automatic expert system) to protect the wind field integrity and personnel safety. Our onsite coordination, all-weather control and monitoring system of offshore wind farms utilize SCADA system to ensure the safety operation and overall control of wind farm.

In terms of vulnerability analysis, the standard procedure of the provisional office is to monitor the structural safety of the base and load during the whole operation period of the wind farm. Content includes:

1. There is at least one measuring device specially installed in the wind turbine / foundation (measuring position).
2. The SCADA system of wind turbine is used for automatic monitoring, which includes tower top accelerometer and wind speed measurement to determine the severity of typhoon or earthquake. In addition, inclinometer will also be installed.

Measuring equipment will be installed in representative locations (every equipment will be at different elevation locations): accelerometers, strain gauges, tiltmeters and wind meters. The settlement evaluation will be carried out annually. From SCADA, other wind turbine locations can be evaluated whether it is more severe than the monitoring locations. If overload or abnormal conditions are detected, the wind turbine will be automatically shut down. The wind turbine can reoperate after the technical team has checked and confirmed that there are no safety issues.

7.7.2 Earthquake hazard risk

This plan collects relevant documents and data which includes historical data before year 1900, instrumental data of the World Standard Seismic Network since year 1961 and instrumental seismic data from the Real-time Seismic Monitoring Network of Central Meteorology Division since year 1990. The maps of major seismic sources in Taiwan region are compiled. The catalogue covers the areas from year 1881 to 2016 with the scale of $1.3 \leq M \leq 8.3$. A total of 60,818 data were collected.

Based on the data shown above, this plan builds a source model in 22 source regions. Each region represents similar tectonic and seismic characteristics. The definition of source region is based on topographic spatial graphics, seismic location and activity, historical seismicity and previous source modules, which is shown in Figure 7.7.2-1.

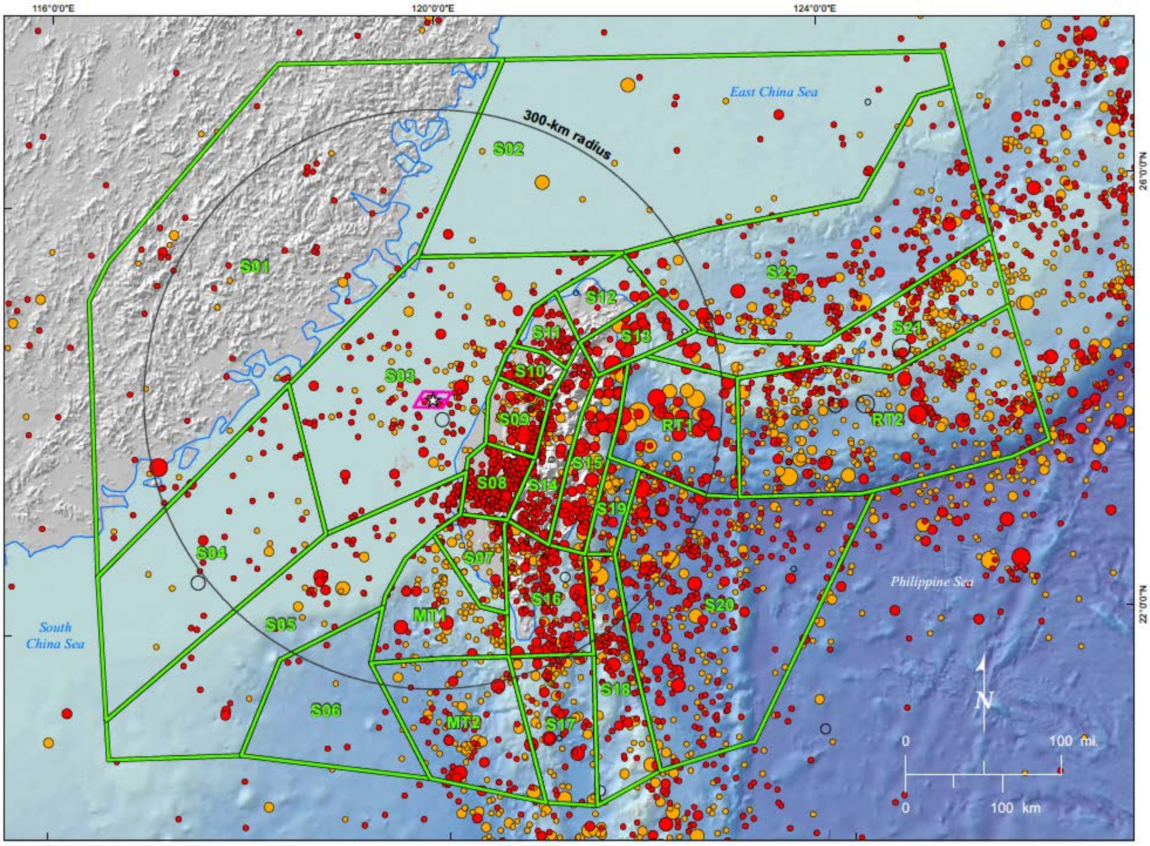


Figure 7.7.2-1 Seismic Focus Modelling of Shallow Earthquake and Subduction Zone Earthquake Catalog

According to the historical data of seismic activity, the largest earthquake ever recorded in the Taiwan Strait area was located at Seismic Focal Region 5 (S05), happened in year 1994 with the magnitude of 6.7, approximately 210km away from the current project site.

This project is located at Seismic Focal Region 3 (S03). From the seismic source zoning map (See Figure 7.7.2-1), a total of 165 earthquake events were recorded in S03 (Mw 2.6 to 6.5). 4 of the events were recorded exactly within Wind Field Region 12-15 (As listed in Table 7.7.2-1 and Figure 7.7.2-2). These 4 events were relatively smaller with a maximum magnitude of 4.0. Compared with the total of 60,818 earthquake events in the whole research area, the risk of earthquake event should be lower.

Table 7.7.2-1 The Earthquake Record within this Project's Wind Field Region

No.	Year	Month	Day	Latitude (degrees)	Longitude (degrees)	Magnitude (Mw)
1	1985	5	10	24.141	119.983	3.9
2	1992	12	23	24.245	120.004	2.6
3	1994	2	15	24.169	119.821	4.0
4	1997	4	6	24.210	119.870	3.1

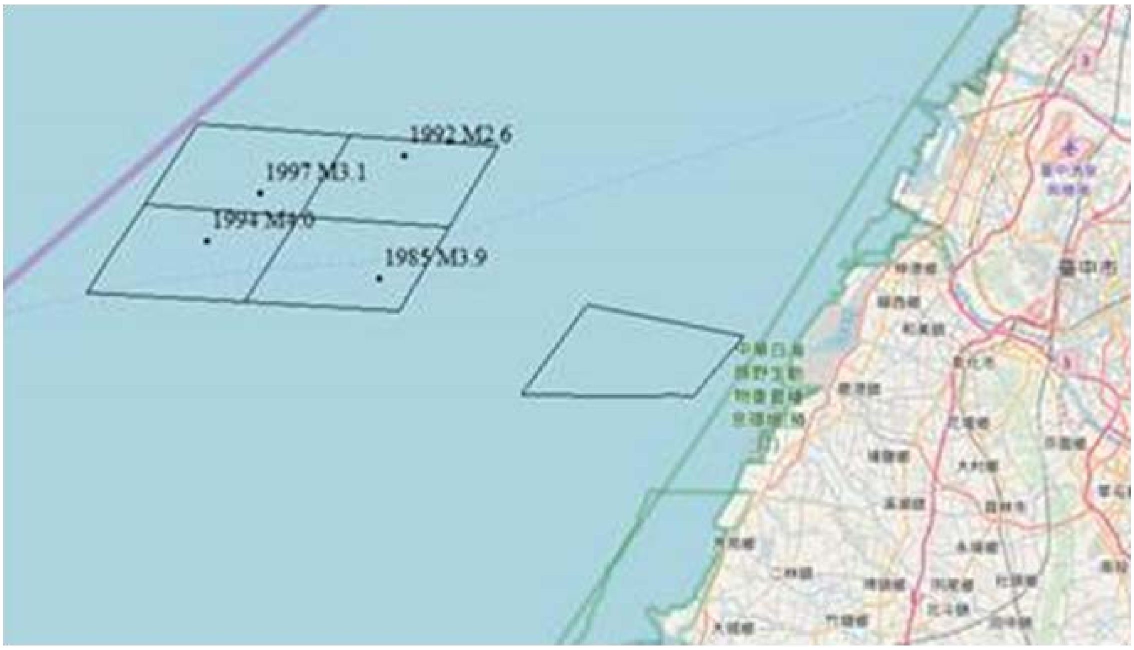


Fig 7.7.2-2 Seismic focus that occurred in the wind field of the project

A Probabilistic Seismic Hazard Analysis (PSHA) is commonly performed for seismic hazards. The PSHA includes possible seismic focus within a certain range of the worksite into analysis to establish individually its probability analysis model. The analysis results are expressed as hazard curves or seismic intensity distribution maps. The parameters and analysis models which must be considered are: geological status around the worksite, faults and seismic activity, earthquake catalog, seismic zones and focal depths (see Fig 7.1.1-33), source models, etc…

The project has conducted PSHA to obtain the horizontal spectral acceleration coefficients SSD, S1D, SSM and S1M for the Changbin offshore wind field, calculate the worksite horizontal spectral acceleration coefficients SAD and SAM by following the procedure in Fig 7.1.1-32, and draw the offshore wind field design earthquake (475 years) and maximum considered earthquake (2500 years) horizontal acceleration response spectrum, as shown in Fig 7.1.1-34.

The analysis result shows that the maximum peak ground acceleration (PGA value) of the 475-year regression period (design earthquake) is 0.20~0.22g, which is 0.3g lesser than in Changhua area under Taiwan building code; PGA value in 2500 year regression period (maximum consideration earthquake) is 0.34~0.36g; the analysis result shows that for the pipe-rack foundation, the seismic load is even less than half of the typhoon load. In fact, the seismic load of the 2500-year regression period is still much lower than the typhoon load, which means the earthquake risk is far less than the typhoon risk. In the case of project of 25 years, it is estimated that the probability of occurrence of earthquakes that exceed the bearing capacity should be below 5%.

It is said to be an extreme event if the earthquake is harmful to wind turbine or the earthquake occurs without warning and is most likely to occur while the wind turbine is working. Modern wind turbines are equipped with vibration sensors that detect significant vibrations regardless of the source of vibration. If the vibration exceeds a certain limit, the wind turbine will stop working.

7.7.3 Assessment of Impact on Shipping Safety

In order to understand the interaction between the project's offshore wind power generation field and ships navigating through the Taiwan Strait, the project analyzed the project area's navigation restrictions, the sea traffic of ships in the area, traffic density of various types of ships and ship traffic flow time and density distributions nearby the offshore wind field development area based on data collected by the company from the Automatic Identification System (AIS) ship movement database on July and October of 2015.

I. Current wind field status and its restrictions

The wind field planned for investment and construction by the company is located 35.7km from offshore of Changhua as shown in Fig 7.7.3-1. at potential site no. 15 mentioned in the "Rules and Regulations of Offshore Wind Farm Site Application" announced by the Bureau of Energy on 2 July 2015.

Existing navigational facilities in seas nearby the project area are shown in Fig 7.7.3-1. Navigation facilities include the cross-strait direct navigation routes, the Taichung port area boundary line and its anchorages, navigation lights, lighthouses, coastal radar, etc. In the figure, it can be seen that the project area locations overlap with a portion of the cross-strait direct navigation routes announced by the Maritime Port Bureau. However, according to the official letter No. 1052010934 from Enviromental Impact Assessment Consultancy of the company announced by the Maritime and Port Bureau on 9 May 2016, the current cross-strait direct navigation tracks will be moved northward to the potential site No. 9 and No. 10 to retain the development of larger area of the other potential site, so that the impact of the project site on the navigation tracks will be ruled out in the future. Regarding the navigation lights, lighthouses and coastal radar, the respective impact of these facilities and the project site is low as shown in Fig 7.7.3-2. The search radius of the coastal radar is between 10 – 20 nautical miles ending at the boundary of the wind field.

Besides marine and ship navigation facilities, information on marine cables and pipelines on the seafloor needs to be collected and analyzed. The project analysis results are shown in Fig 7.7.3-3. There is a 36” natural gas submarine pipeline from Yongan, Kaohsiung to Tongxiao Miaoli which passes by wind farm no.15 owned by CPC, and a Taichung – Kinmen, Penghu - Kinmen submarine telecommunications cable which is owned by Chunghwa Telecom and a Philippines - Shanghai international telecommunication cable. The project must request approval from the companies which own the marine cable when the project's offshore wind field marine cable pass over the above marine cables in the future.

Fig. 7.7.3-1 Compilation of Navigation Facilities Surrounding the Project Offshore Wind Field

Fig. 7.7.3-2 Coastal Radar Search Range for the Changhua Region

II. Analysis of ship traffic density statistics

The project collected AIS ship density data in July and October of year 2015 to review the Greater Changhua Offshore Wind Field Site and its nearby ship navigation conditions as shown in Fig 7.7.3-4. The analysis compiled statistics on the tracks of all ships passing through a unit (0.5 nm * 0.5 nm) in these two months. The cold color (green) on the map indicates lower density of ship traffic and the warm color (red) indicates high density of ship traffic exceeding 75 trips. The yellow areas indicate moderate density ship traffic ranging from 7 to 25 trips. The green area indicate low density area with less than one trip. From the map, it can be seen that the ship traffic densities are high near Taichung Port and Mailiao Port whereas the project area is located at area ranges from low to medium density.

From the ship traffic density distribution map, it can be seen that the ships at offshore Changhua mostly travel in a south – north direction. A conference attended by domestic shipping companies was held by the Maritime Port Bureau to discuss these matters. Shipping companies believed that these were conventional navigation routes and the majority of ships travelling northward and southward use these areas of sea for navigation so the area of impact includes potential offshore wind field sites no. 8, 20~28, 30~32. With regard to the area of water near the halfway line of the straits, the initial analysis result shows the traffic density near the Taiwan side is low. However, the data is insufficient for the China side due to the limited scanning range of AIS so the ship traffic density cannot be determined.

By summarizing analysis results of the above statistical data, the initial conclusions are as follows:

1. Ships sailing directly between the two coasts may use the two navigation routes to and from Taichung Port and Mailiao Port approved by the Maritime Port Bureau, which will affect the potential wind field sites No.8, 9,10,20 (entering and leaving Taichung Port) and No.31, 32 (entering and leaving Mailiao Port).
2. The navigation range marks and harbor lights of Taichung entering and leaving port may be obstructed by potential site No. 8.
3. The leading lights and harbor lights of Mailiao entering and leaving port may be obstructed by potential sites No. 24, 25.
4. For the wind field sites located at No. 12 – No. 15 which are planned for development for this project, the ship traffic density ranges from low to medium so there is a relatively low level of interaction between the wind fields and ship traffic.

Fig. 7.7.3-3 Existing Submarine Pipeline and Cable Locations Of Changhua Offshore

Fig. 7.7.3-4 Ship Traffic Density Statistics of Changhua Offshore

III. AIS data analysis

In order to further discuss the impact of various ship traffic on the area of sea near Changhua, the project performed the following analysis based on the collected AIS data.

1. Area-wide statistics

According the AIS records in July and October 2015 collected by the project, the navigation tracks taken by the various ships are shown in Fig 7.7.3-5 and Fig 7.7.2-6. Cargo ships comprised 47% which was the largest percentage, followed by oil tankers and fishing boats which made up 20% and 13% respectively.

In the period when the record is made, the daily ship traffic in these areas of sea is in average of 198 ships. The peak amount occurred on October 29, 2015. On that day, a total of 438 vessels were recorded passing through this area. The diagram of navigation tracks of various ships on that day is shown in fig 7.7.3-7.

2. Cargo ship statistics

From the area-wide statistical data, it can be seen that the most common type of ships navigating in Taichung, Changhua and Yunlin seas are cargo ships (comprising 47%). Hence, further analysis has been performed on the cargo ship navigation tracks as shown in Fig 7.7.3-8. It can be seen the main navigation direction of the cargo ships is a north-south direction parallel to the coast of Taiwan which would have the greatest impact on potential wind fields no. 8, 20~25. Provided that the inertial navigation of the ships is not changed, potential wind field sites no. 8, 20~25 are not suitable for offshore wind power development. In addition, most of the cargo ships use the direct navigation routes between the two coasts which pass by point I for the east-west navigation route entering and leaving Taichung Port and pass by point C for the east-west navigation route near Mailiao Port.

3. Oil tanker statistics

The second most common type of ship navigating in Changhua and Yunlin seas is oil tankers (20%). Hence, further analysis has been performed on the oil tanker navigation tracks as shown in Fig 7.7.3-9. It can be seen that the main navigation direction of oil tankers is a north-south direction parallel to the coast of Taiwan which would have the greatest impact on potential wind fields no. No. 8, 20~22. Provided that the inertial navigation of the ships is not changed, potential wind field sites no. 8, 20~22 are not suitable for offshore wind power development. In addition, some of the oil tankers use the direct navigation routes between the two coasts passing by point C for the east-west navigation route entering and leaving Mailiao Port.

4. Fishing boat statistics

Fishing boats are the third most common ship navigating through the seas in this area comprising 13% of sea traffic as shown in Fig 7.7.3-10. Most of these fishing boats operate and end up in the seas offshore Taichung within 10 -15 nautical miles off the coast. Only a small number of fishing boats operate in area 20 – 40 nautical miles offshore Taichung. Therefore, the potential wind field site no. 8 would have the greatest impact on fishing boats.

5. Passenger ship statistics

Passenger ships are not very common in these seas, making up only 1% of the sea traffic. However, since the passenger ship navigation needs to be time efficient and carries many personnel onboard, hence the direction of passenger ships should be fully considered. The navigation tracks of passenger ships as shown in Fig 7.7.3-11 are almost all within the area of the direct cross-strait navigation routes. For example, Cosco Star and Superstar Virgo mainly travel back and forth between Taiwan Port and Xiamen Port. These regular ferries will have the greater impact on potential wind fields No.8, 15, 17, 20, 21, 22. However, according to the official letter No. 1052010934 from Enviromental Impact Assessment Consultancy of the company announced by the Maritime and Port Bureau on 9 May 2016, the current cross-strait direct navigation tracks will be moved northward to the potential site No. 9 and No. 10 to retain the development of larger area of the other potential site, so that the impact of the project site on the passenger ships will be ruled out in the future.

IV. Relevant regulations on the restricted navigation area near the wind turbine

The regulations in United Kingdom and Germany on the restricted navigation area near the wind turbine are as follows:

(i) United Kingdom

1. During construction

In the period from the completion of basic installation to the completion of the test run, 50 meters around the wind turbine is the prohibited area. However, when there is a large workboat operation (lifting workboat) during the installation of wind turbine, the prohibited area must be expanded to 500 meters around the wind turbine.

2. During operation

Currently there is no regulation in UK has been stipulated regarding the prohibited area around wind turbine in the operation of wind farm. However, if there is a large workboat operation when the wind turbines are under maintenance, 500 meters around the wind turbine is considered as the prohibited area.

(ii) Germany

1. During construction

The maritime and shipping authorities in Germany stipulate that area within the wind farm and 500 meter from the boundary of the wind farm are prohibited area. During the construction period, non-work related ships are restricted from entering the area.

2. During operation

During the operation of wind farm, only unrelated workboats of less than 24 meters are allowed to enter the wind farm during daytime and good weather condition. Any commercial fishery is restricted within the wind farm.

There are no regulations on the restricted navigation area in China at present, but according to the announcement of the planned navigation point of navigation track on 11 August 2017, the wind farm area, the navigation between the navigation tracks and the safety buffer zone have been taken into consideration to avoid the risk of collision of ships. In addition, before applying for the establishment approval in future from the Energy Bureau, should obtain opinion from the relevant departments of the ship safety, such as the Maritime and Port Bureau and the Fisheries Department etc. The topics concerning the safety of navigation around the wind turbines will be included in the discussion to avoid collision risk.

(iii) Influence Analysis of Shipping in Potential Sites

1. Analysis on Amount of Watercraft

According to the record of AIS shipping trajectory above, this project analyzed a post from Energy Research and Development Administration (ERDA) about the daily average amount of watercraft that pass by Changhua off-shore wind power potential sites, as shown in Table 7.7.3-12. Among them, potential sites numbered 8, 20, 21 achieve the highest amount of watercraft. They have the average of 15 watercraft passing by in a day, which affect the future of wind field implementation the most. In contrast, the amount of potential sites no.17,18,19 are the lowest, they have the least influence of wind sites construction in the future. Potential sites numbered 13 and 15 are placed secondly. Although no.12 and 14 potential sites are not listed in Table 7.7.3-12, by referring back to Table 7.7.3-5, we can estimate the amount of watercraft are similar with the amount at potential sites no.17 and 18. Table 7.7.3-13 represents the number of watercraft passing by in each potential site. According to official letter 1052010934 issued by Maritime and Port Bureau, MOTC on 2016/5/9, we recently plan that the overland through traffic will be northing to potential sites no.9 and no. 10 for the reservation of other potential sites to develop into larger area. Hence, the issue of passenger ships affected by potential sites can be solved.

2. Analysis on Types of Watercraft

According to the record of AIS shipping trajectory above, daily average types of watercraft passing by in Changhua off-shore wind power potential sites is as shown in Table 7.7.3-14. Based on the table, the freighter has the highest percentage of occurrence which occupies 60% ~ 80%, followed by oil tankers which occupies 18% ~ 33%.

3. Analysis on Risk Issues

Even though we collected data on shipping details of only two months in 2015, we can still analyze the amount of watercraft traffic in the surrounding of scheduled potential sites based on the samples collected. We can also analyze the off-shore wind field impact to the potential sites. From the data, we plot a table as shown in Table 7.7.3-1 ~ Table 7.7.3-15 about the influence and risk relatively to the off-shore wind field potential sites by the watercraft navigation accordingly.

Table 7.7.3-1 Order of Impact on Shipping at Changhua off-shore wind field potential sites (1/2)

Potential Sites	Level of Shipping Safety	Explanation on Risk Latency
8	**High**	• Crossing between overland direct water-route, hence has a high impact of shipping safety. • Density of watercraft relatively high in the construction sites. • Daily amount of watercraft relatively high. • Ships travelling north-south can be obviously seen. • The possibility of watercraft deviate from voyage route is relatively high when they pass by the construction sites. • Located at Taichung port main route, has the high impact of shipping safety. • Affect the Taichung port in-out navigation facilities. • Accumulate the impact of boarding of the pilot crew. • Located nearby the concentrated fishing industrial area, causing accumulative impact. • May cause accumulative impulse at the berth if the watercraft is travelling out of voyage route.
20	**High**	• Crossing between overland direct water-route, hence has a high impact of shipping safety. • Density of watercraft relatively high in the construction sites. • Daily amount of watercraft relatively high. • Ships travelling north-south can be obviously seen. • The possibility of watercraft deviate from voyage route is relatively high when they pass by the construction sites. • Located at Taichung port main route, has the high impact of shipping safety. • Affect the Taichung port in-out navigation facilities. • Accumulate the impact of boarding of the pilot crew. • Located nearby the concentrated fishing industrial area, has accumulative impact. • May cause accumulative impulse at the berth if the watercraft is travelling out of voyage route.
21	**High**	• Crossing between overland direct water-route, hence has a high impact of shipping safety. • Density of watercraft relatively high in the construction sites. • Daily amount of watercraft relatively high. • Ships travelling north-south can be obviously seen. • The possibility of watercraft deviate from voyage route is relatively high when they pass by the construction sites. • Located at Taichung port main route, has the high impact of shipping safety. • Affect the Taichung port in-out navigation facilities. • Intersect with passenger ships, affects the scheduled flight. • May cause accumulative impulse at the berth if the watercraft is travelling out of voyage route.
22	**High**	• Crossing between overland direct water-route, hence has a high impact of shipping safety. • Density of watercraft relatively high in the construction sites. • Daily amount of watercraft relatively high. • Ships travelling north-south can be obviously seen. • The possibility of watercraft deviate from voyage route is relatively high when they pass by the construction sites. • Intersect with passenger ships, affects the scheduled flight. • May cause accumulative impulse at the berth if the watercraft is travelling out of voyage route.

Potential Sites	Level of Shipping Safety	Explanation on Risk Latency
23	**Moderate High**	• Density of ships relatively high in construction sites. • Daily amount of watercraft relatively high. • Ships travelling north-south can be obviously seen. • The possibility of watercraft deviate from voyage route is relatively high when they pass by the construction sites. • May affect oil tankers navigation • May cause accumulative impulse at the berth if the watercraft is travelling out of voyage route.
24	**Moderate High**	• Density of ships relatively high in construction sites. • Daily amount of watercraft relatively high. • Ships travelling north-south can be obviously seen. • The possibility of watercraft deviate from voyage route is relatively high when they pass by the construction sites. • May affect oil tankers navigation • May cause accumulative impulse at the berth if the watercraft is travelling out of voyage route.
25	**Moderate High**	• Crossing between overland direct water-route, hence has a high impact of shipping safety. • Daily amount of watercraft relatively high. • Density of ships relatively high in construction sites. • Ships travelling north-south can be obviously seen. • The possibility of watercraft deviate from voyage route is relatively high when they pass by the construction sites. • May affect oil tankers navigation • May cause accumulative impulse at the berth if the watercraft is travelling out of voyage route.
10	**Moderate High**	• Crossing between overland direct water-route, hence has a high impact of shipping safety. • Daily amount of watercraft moderately high. • Density of ships relatively high in construction sites. • The possibility of watercraft deviate from voyage route is relatively high when they pass by the construction sites. • Moderate impact on significant entry route of port and harbor boundaries.
12	**Moderate**	• Density of watercraft is medium high in construction sites. • Daily amount of watercraft is medium high. • The possibility of watercraft deviate from voyage route is medium when they pass by the construction sites. • Moderate impact on significant entry route of port and harbor boundaries. • Intersect with passenger ships, affects the scheduled flight. • According to official letter 1052010934 issued by Maritime and Port Bureau, MOTC on 2016/5/9, the overland through traffic will be northing to potential sites no.9 and no. 10 for the reservation of other potential sites to develop into larger area so that the issue of passenger ships which affected by potential sites can be solved.
13	**Moderate**	• Density of watercraft is medium high in construction sites. • Daily amount of watercraft is medium high. • The possibility of watercraft deviate from voyage route is medium when they pass by the construction sites. • Moderate impact on significant entry route of port and harbor boundaries. • Intersect with passenger ships, affects the scheduled flight. • According to official letter 1052010934 issued by Maritime and Port Bureau, MOTC on 2016/5/9, the overland through traffic will be northing to potential sites no.9 and no. 10 for the reservation of other potential sites to develop into larger area so that the issue of passenger ships which affected by potential sites can be solved.

Potential Sites	Level of Shipping Safety	Explanation on Risk Latency
15	**Moderate**	• Density of watercraft is medium in construction sites. • Daily amount of watercraft is medium. • The possibility of watercraft deviate from voyage route is medium when they pass by the construction sites. • Intersect with passenger ships, affects the scheduled flight. • According to official letter 1052010934 issued by Maritime and Port Bureau, MOTC on 2016/5/9, the overland through traffic will be northing to potential sites no.9 and no. 10 for the reservation of other potential sites to develop into larger area so that the issue of passenger ships which affected by potential sites can be solved.
14	**Moderate Low**	• Density of watercraft is low in construction sites. • Daily amount of watercraft is low. • The possibility of watercraft deviate from voyage route is low when they pass by the construction sites. • According to official letter 1052010934 issued by Maritime and Port Bureau, MOTC on 2016/5/9, the overland through traffic will be northing to potential sites no.9 and no. 10 for the reservation of other potential sites to develop into larger area so that the issue of passenger ships which affected by potential sites can be solved.
17	**Moderate Low**	• Density of watercraft is medium in construction sites. • Daily amount of watercraft is medium. • The possibility of watercraft deviate from voyage route is low when they pass by the construction sites. • Intersect with passenger ships, affects the scheduled flight.
18	**Moderate Low**	• Density of watercraft is low in construction sites. • Daily amount of watercraft is low. • The possibility of watercraft deviate from voyage route is low when they pass by the construction sites.
19	**Moderate Low**	• Density of watercraft is low in construction sites. • Daily amount of watercraft is low. • The possibility of watercraft deviate from voyage route is low when they pass by the construction sites.

Notes:
1.Ranking of watercraft navigation density and amount of watercraft are compared relatively.
2.This AIS data is only collected at 20 nautical miles outside the off-shore wind field potential sites.
3.The relevant order of risk do not include the factor of adverse weather to the watercraft momentum, ship activity and port operation.
4.The relevant order of risk do not consider the accumulative impact on working vessels to other navigating vessels when the potential sites are under construction simultaneously.

Fig. 7.7.3-5 Track of Various Types of Watercraft Sailing through Off-sea of Taichung, Changhua and Yunlin

Fig. 7.7.3-6 Statistic of Various Types of Watercraft Travelling through Off-sea of Taichung, Changhua and Yunlin

Fig. 7.7.3-7 2015/10/29 Locus of Sailing Watercraft on Peak Day

Fig. 7.7.3-8 Locus of Freighter Navigation

Fig. 7.7.3-9 Locus of Oil Tanker Navigation

Fig. 7.7.3-10 Locus of Fishing Boat Navigation

Fig. 7.7.3-11 Locus of Passenger Boat Navigation

Fig. 7.7.3-12 Statistic of Daily Average of Watercraft Traffic at Each Changhua Offshore Potential Sites

Fig. 7.7.3-13 Illustration of Daily Average of Watercraft Traffic at Each Changhua Offshore Potential Sites

Fig. 7.7.3-14 Analysis on the Types of Watercraft Travelling through Changhua Offshore Potential Sites

Fig. 7.7.3-15 Safety Analysis on Shipping through Changhua Offshore Potential Sites

V. Adjustment and Simulation on Coping with Routes

(i) Background

The area of Changhua wind power generation is based on the potential sites numbered 12, 13, 14, 15 announced by Energy Research and Development Administration (ERDA), to cope with the design of north-south pathway for the simulation of construction range after some adjustment. The relevant positions are shown in Fig. 7.7.3-16 while the before-after coordinates are as shown as Table 7.7.3-2.

Fig. 7.7.3-17 represents the result of overlaying sea maps and potential sites. The red frame line shows the buffer zone with 2 nautical miles long, which connect the potential sites mentioned above and the southing route. Taichung port and Fangyuan both have a lighthouse. From the figure, we can see that there are two direct routes that pass through the wind field, which is the path that passes through point I to Taichung port, another one passes through point C to the offshore direct route of Taichung port respectively. From Fig. 7.7.3-18, the second one will be cancelled while the first one will moving to north. We will carry an assessment on the risk of shipping according to the status after adjustment is made.

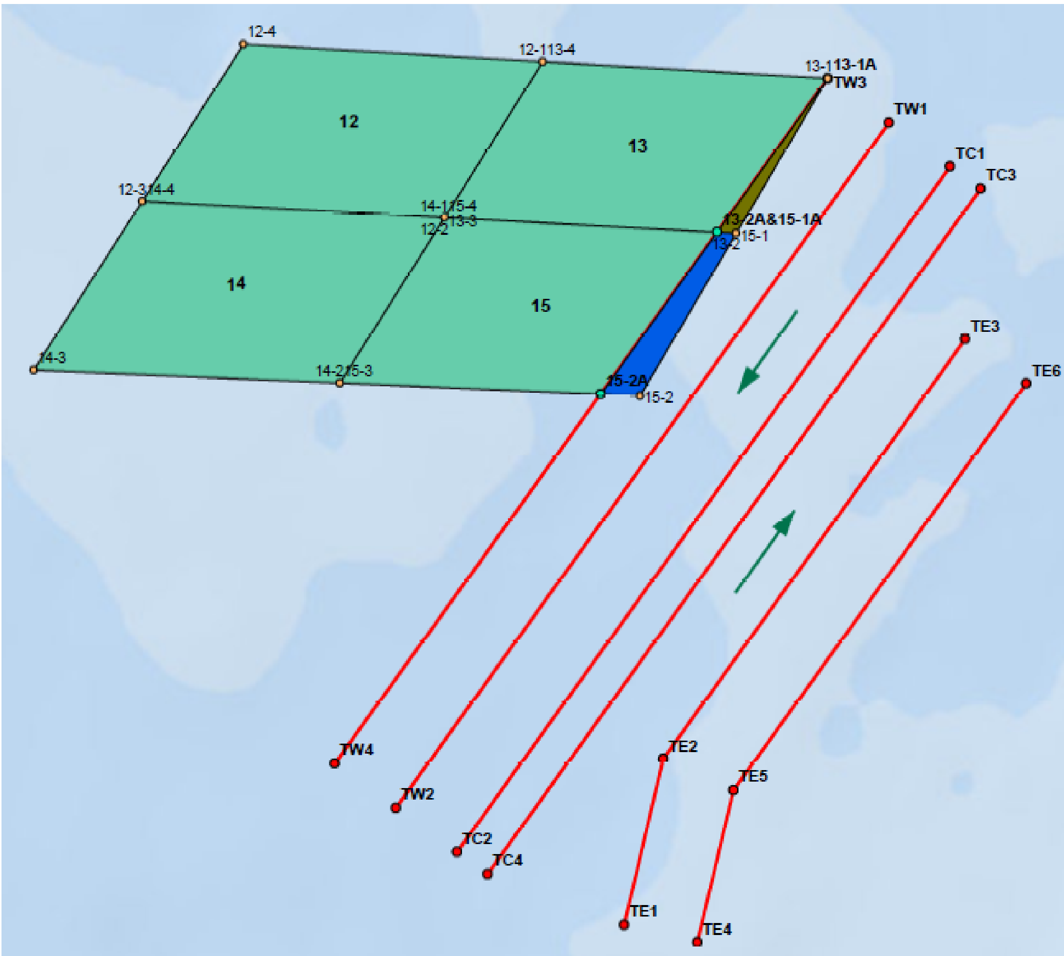


Fig. 7.7.3-16 Representation of Zone and Position in the Project

Table 7.7.3-2 Ranking of Potential Offshore Wind Field that have been affected by the Shipping Activities in Changhua

Before			After		
Label	X (m)	Y (m)	Label	X (m)	Y (m)
12-1	143699,29	2684443,01	12-1	143699,29	2684443,01
12-2	138862,45	2676799,81	12-2	138862,45	2676799,81
12-3	124013,39	2677604,37	12-3	124013,39	2677604,37
12-4	128982,01	2685299,04	12-4	128982,01	2685299,04
13-1	**157716,94**	**2683627,67**	**13-1A**	**157716,30**	**2683627,71**
13-2	**153204,92**	**2676022,70**	**13-2A**	**152269,96**	**2676073,36**
13-3	138862,45	2676799,81	13-3	138862,45	2676799,81
13-4	143699,29	2684443,01	13-4	143699,29	2684443,01
14-1	138862,45	2676799,81	14-1	138862,45	2676799,81
14-2	133729,18	2668688,18	14-2	133729,18	2668688,18
14-3	118670,52	2669330,10	14-3	118670,52	2669330,10
14-4	124013,39	2677604,37	14-4	124013,39	2677604,37
15-1	**153204,92**	**2676022,70**	**15-1A**	**152269,96**	**2676073,36**
15-2	**148480,29**	**2668059,38**	**15-2A**	**146551,53**	**2668141,60**
15-3	133729,18	2668688,18	15-3	133729,18	2668688,18
15-4	138862,45	2676799,81	15-4	138862,45	2676799,81

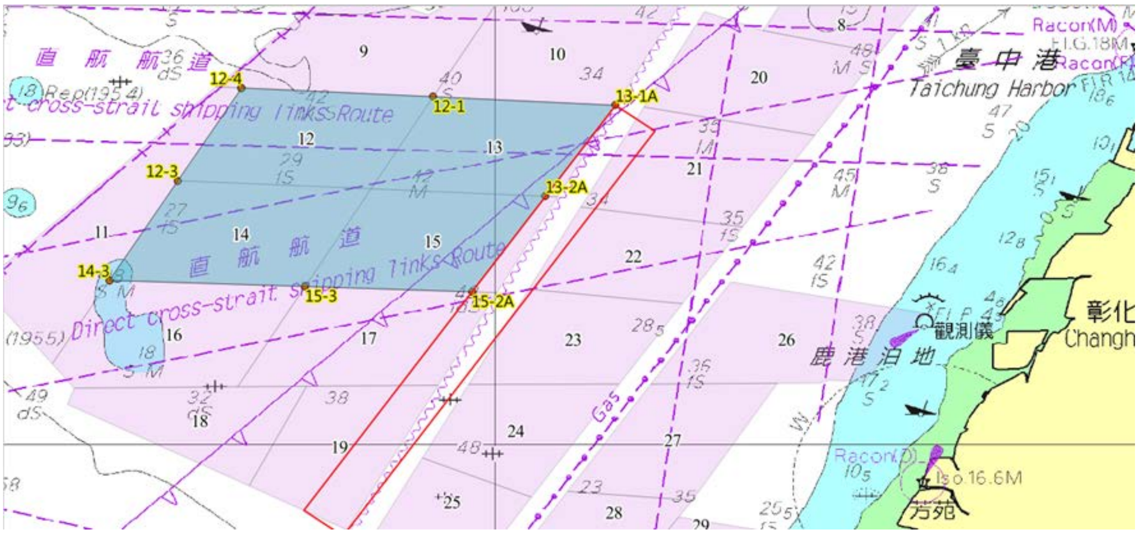


Figure 7.7.3-17 Navigational Chart and Potential Offshore Wind Field

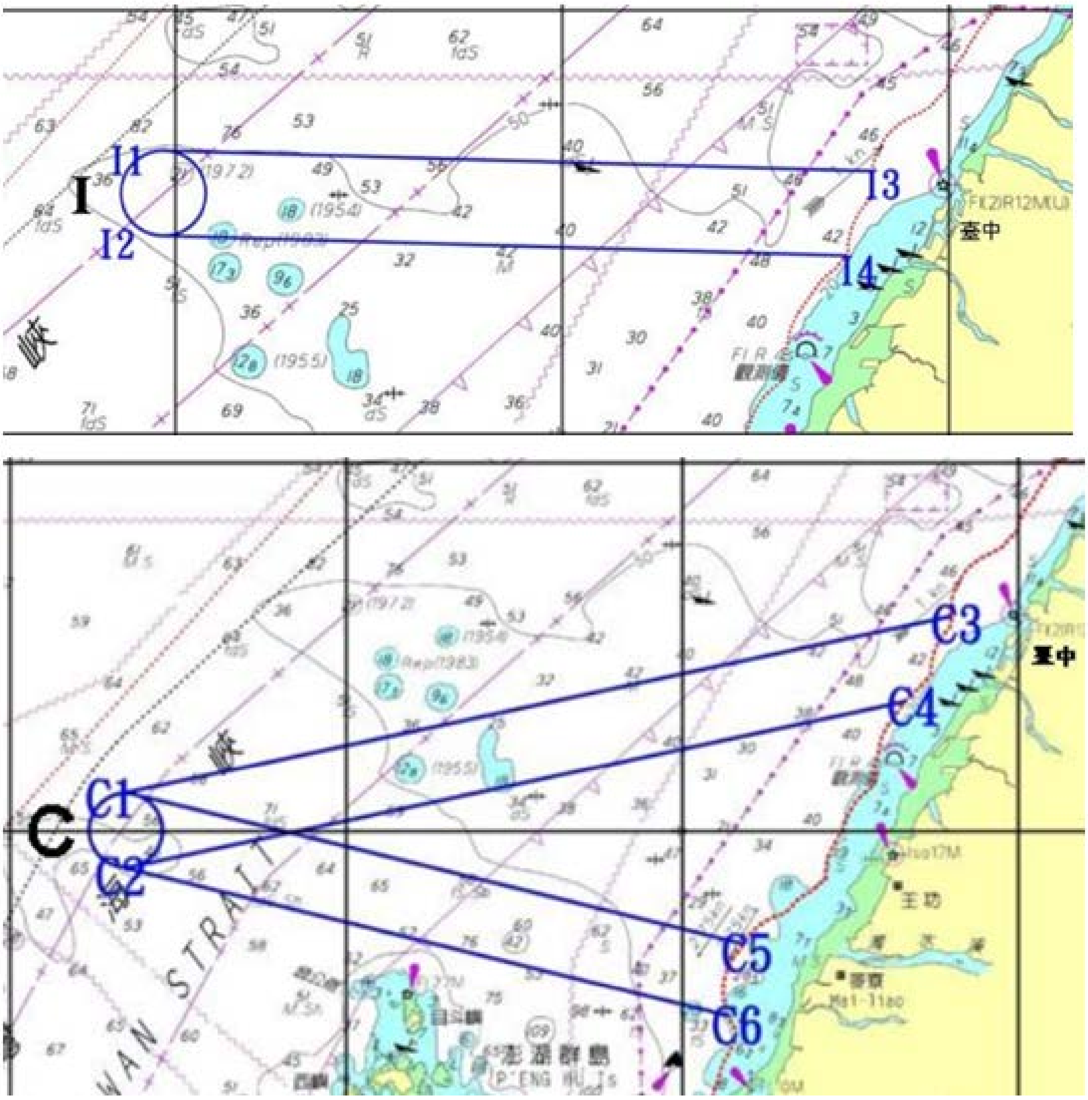


Figure 7.7.3-18 The Cross-straits Direct Link of Ocean Freight to Taichung Harbor （Revised in 1998）

This project is intended to analyze the relevant issues and evaluate the impact of the offshore wind field development on the safety and efficiency of ship's navigation. The 2015 AIS data used in this project retrieved from AIS network set up by the Harbor and Marine Technology Center and National Taiwan Ocean University.

(ii) Work Content and Scope

The location of offshore wind field development is shown in Figure 7.7.3-16. The dynamic and static data of ship collected from Harbor and Marine Technology Automatic Identification System (AIS) database will be used for the navigation impact assessment. Data retrieved are within 10 nautical miles around the development zone (depending on the needs of the assessment situation, the scope of the assessment will be appropriately expanded).

Project works：

1. Analysis of ship traffic and sea navigation environment
2. Impact on the lighthouse and improvement measures
3. Ship navigation risk assessment, and propose a mitigation measure based on the assessment content
4. Construction ship safety assessment

Navigational Risk Assessment includes：

(1) Risk of collision between ships（head on, overtaking, crossing situation）

(2) Risk of stranding or reefing（Uncontrolled drifting cause by external forces or ship malfunction）

(3) Risk of still structure collision such as fan if trespass into wind field（Uncontrolled drifting cause by external forces or ship malfunction）

Methods and results of this evaluation will be based on the standard offshore risk assessments and previous case reports. In addition to the use of self-developed tools, SN. 1/Circ.296: "Degree of Risk Evaluation" from International Maritime Organization (IMO) and IALA Recommendation O-134 IALA Risk Management recommended toolbox will be used.

The expected results are mainly to propose the possible and degree of impact and recommendations for mitigation measures, such as: number of voyages that may affected by the wind field and the degree of changes cause by various types of navigational accidents.

(iii) Analysis of time and space density of the ship traffic flow

This analysis is based on the Automatic Identification System (AIS) 2015 annual data retrieved from Institute of Transportation. Figure 7.7.3-19 is the distribution of traffic density near the project area. The displayed 200m×200m grid is according to the annual statistic of trajectories number.

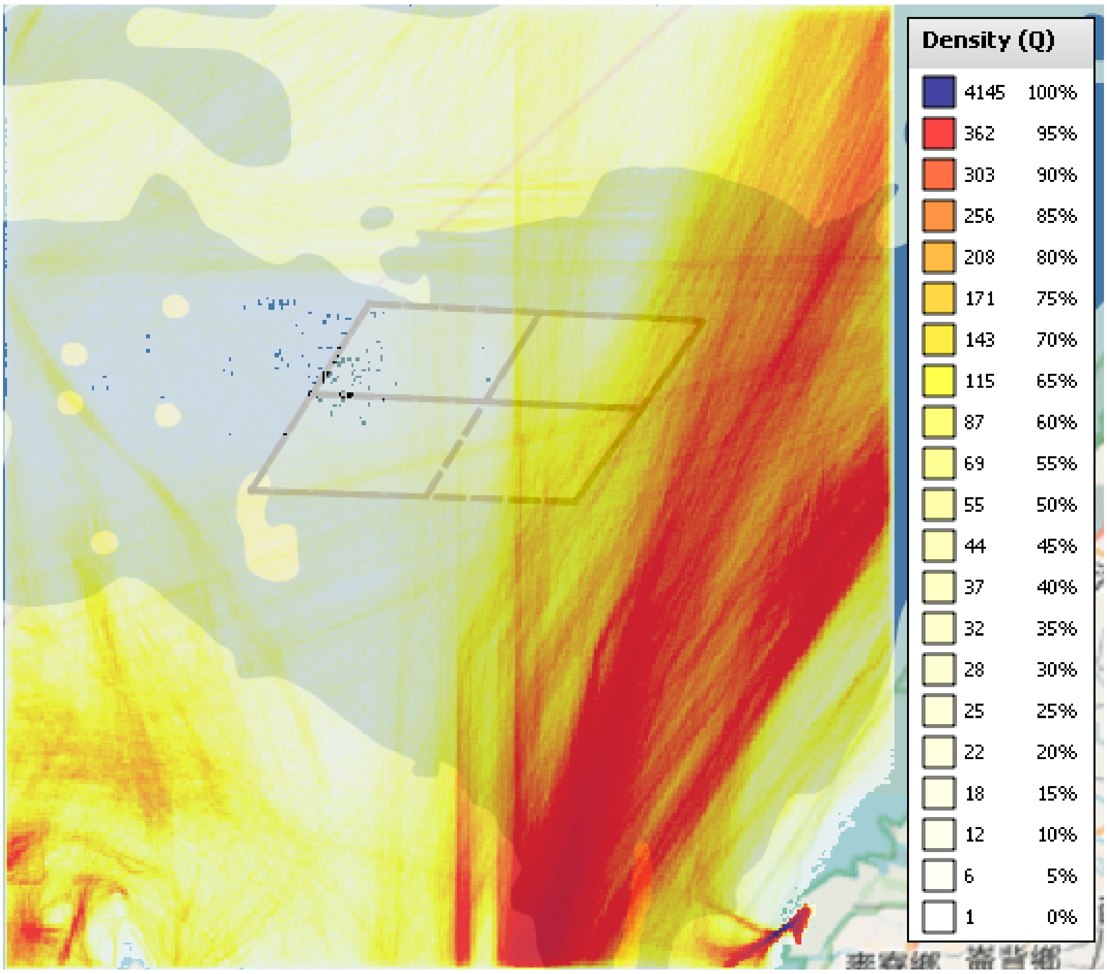
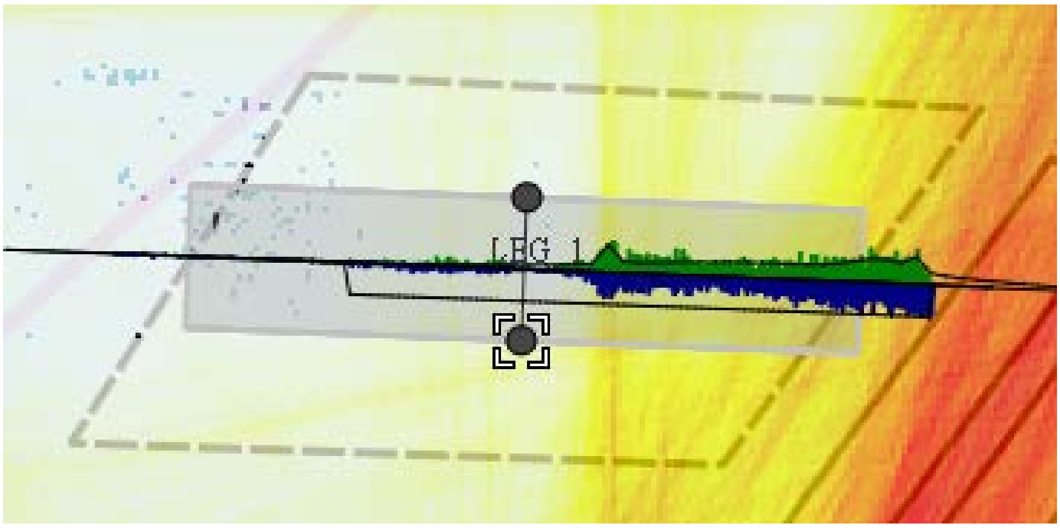


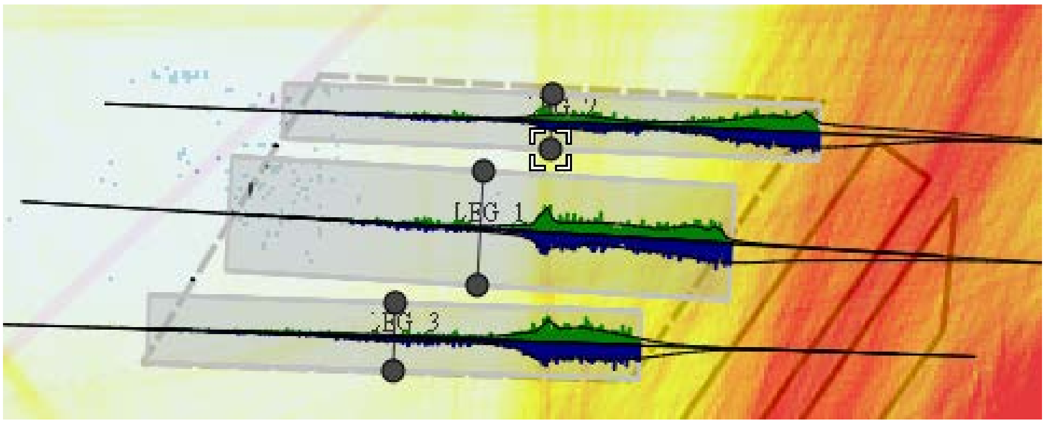
Figure 7.7.3-19 Annual Ship Trajectory Density near the Planned Area

(iv) Ship traffic flow through the offshore wind field area

For year 2015, if the segment LEG_1 marked in Figure 7.7.3-20 is taken to cover the track within 90 digress of the two-way angle difference between the entire wind field and the segment, it will be 1570 times to the north and 2001 times to the south. The horizontal traffic distribution is shown in Figure 7.7.3-20 (a); The horizontal distribution of traffic and the results of the analysis as shown in Figure 7.7.3-20 (b). If the analysis divided into three-segment and the two-way angle difference within 45 degree of the track that covers the ship crossing the project wind field, the average towards north is 1743 while 2264 southward.



(a) Analysis of the difference between the track and the two-way segment within 90 degrees

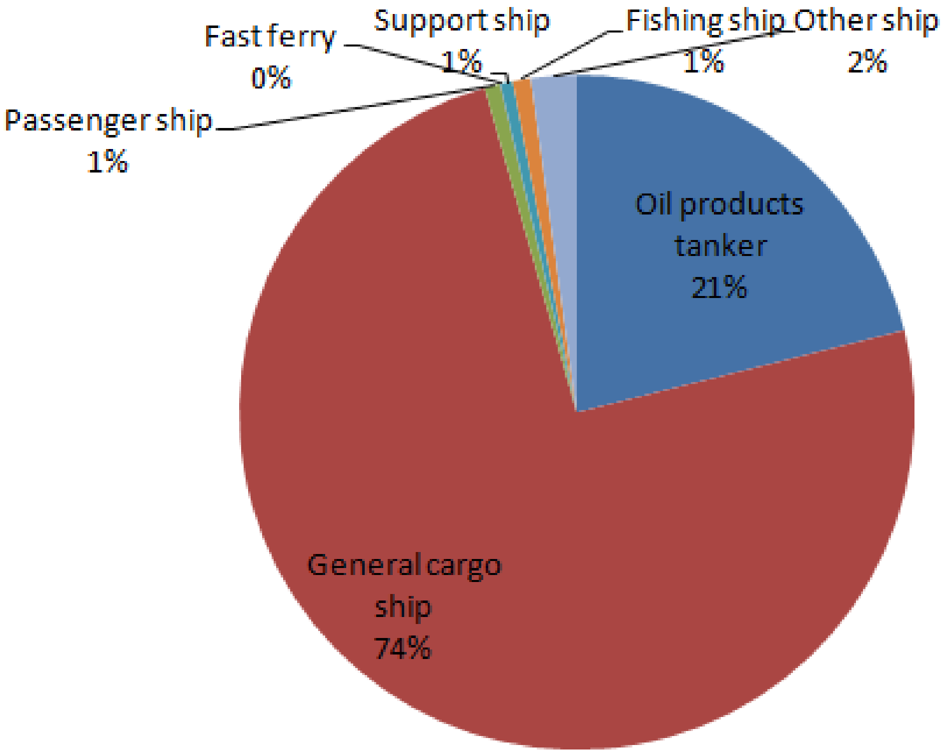


(b) The three-segment analysis and the two-way segment angle difference within 90 degrees

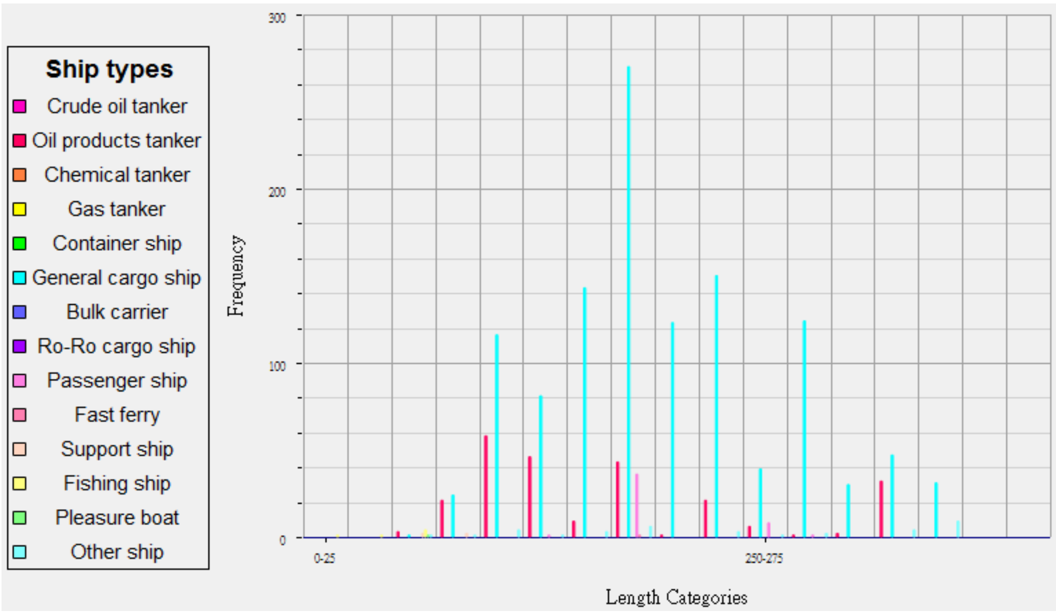
Figure 7.7.3-20 Horizontal Distribution of Ship Traffic across the Wind Field Area in this Project

The deepest draft depth ship passing through this wind field area is mainly the oil product tanker: towards south is about 12.2m while towards north is about 17.2m. The average draft of the most frequent cargo ships was 9.1m.

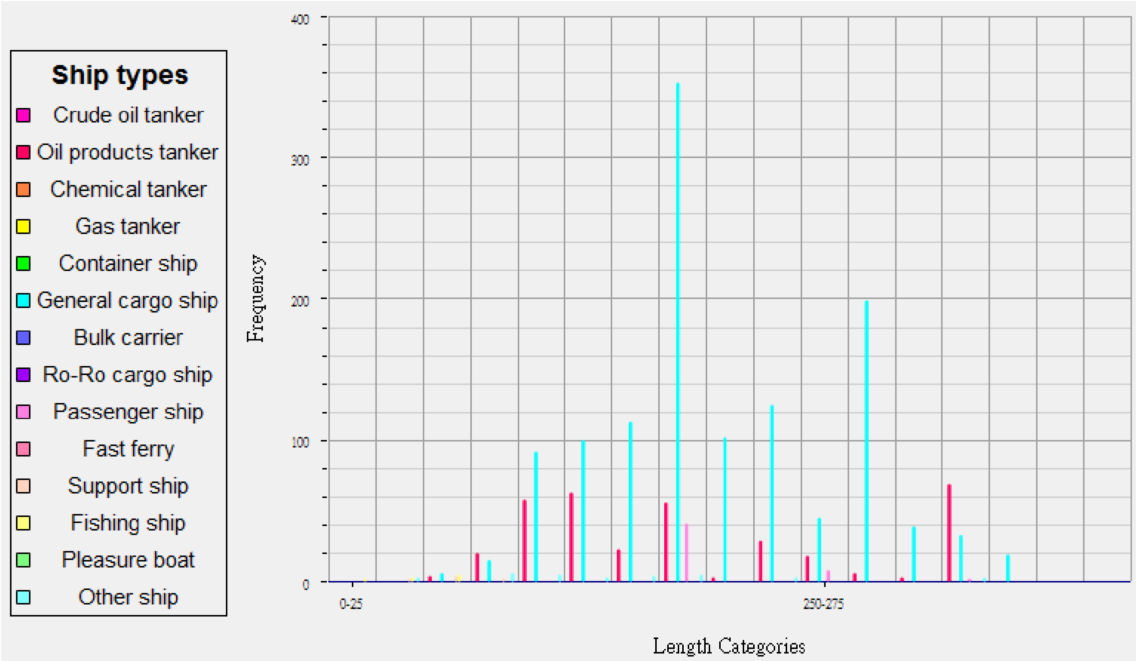
The type, length distribution and traffic composition of the ship crossing this offshore wind field are shown in Figure 7.7.3-21.



(a) Traffic composition passing through the wind field



(b) Type and length distribution of ships passing through wind field within 90 degrees' northward



(c) Type and length distribution of ships passing through the wind field within 90 degrees' southward

Figure 7.7.3-21 Ship Traffic Composition through the Wind Field Area of this Project

(v) Time density profile of ship traffic flow in neighboring areas

In terms of density distribution over time, there is an average of 2.53 ship per hour (covering the area of the project and 10 nautical miles of its surrounding area), with an average of 58.9 ship per day. The distribution is shown in Figure 7.7.3-22 and Figure 7.7.3-23.

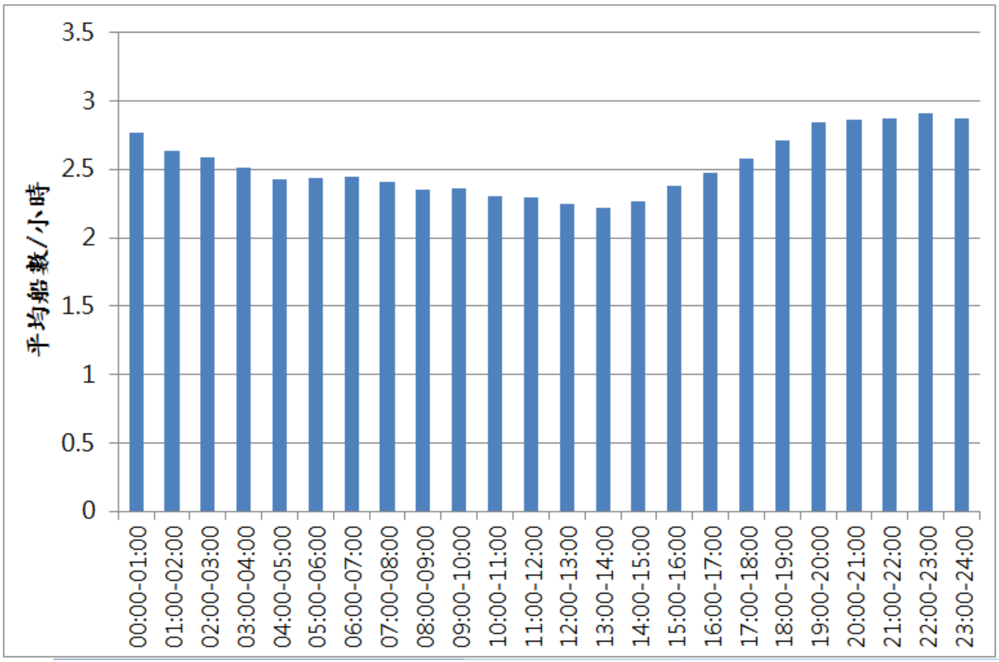


Figure 7.7.3-22 Average Ship Distribution Passing Through Neighboring Areas Throughout the Day

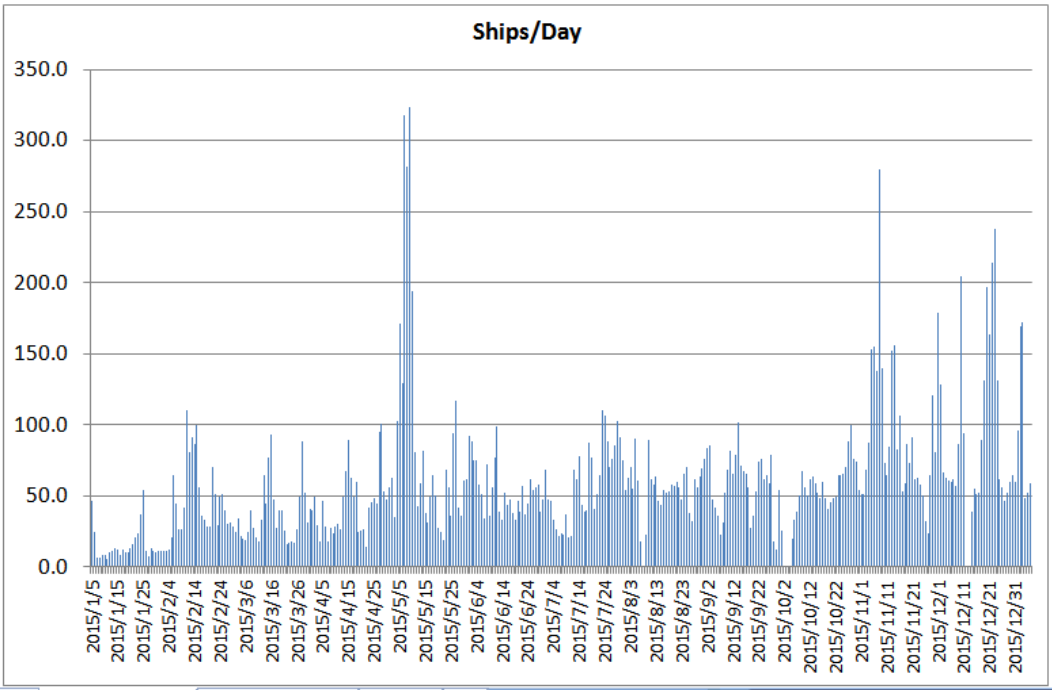


Figure 7.7.3-23 Daily Ships that Passing through the Adjacent Area from the AIS Estimate

(vi) Ship mooring or fishing boat operation

Ship mooring and fishing boat operations can be track from the distribution of AIS at low speed. The results of track density distribution with speed lower than 3 knot are shown in Figure 7.7.3-24. The track density of fishing vessels with length more than 1 m and a speed greater than 1 knot are shown in Figure 7.7.3-25.

(vii) Track density of ship and route model

The route model established based on the nearby traffic flow density is shown in Figure 7.7.3-26.

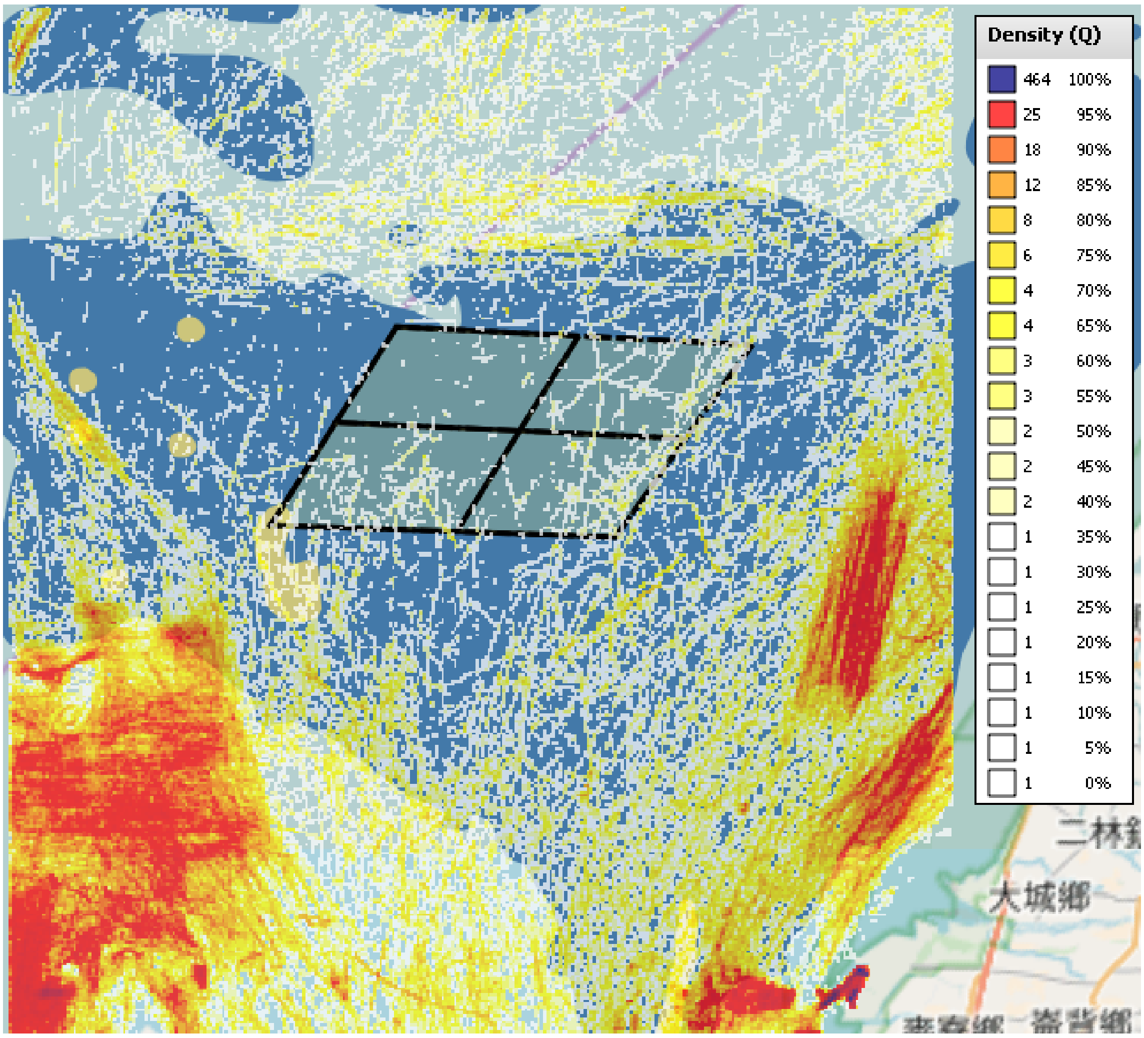


Figure 7.7.3-24 Ship Track Density of Mooring Drift or Operating Vessel with Speed <3 knot in the Neighboring Area

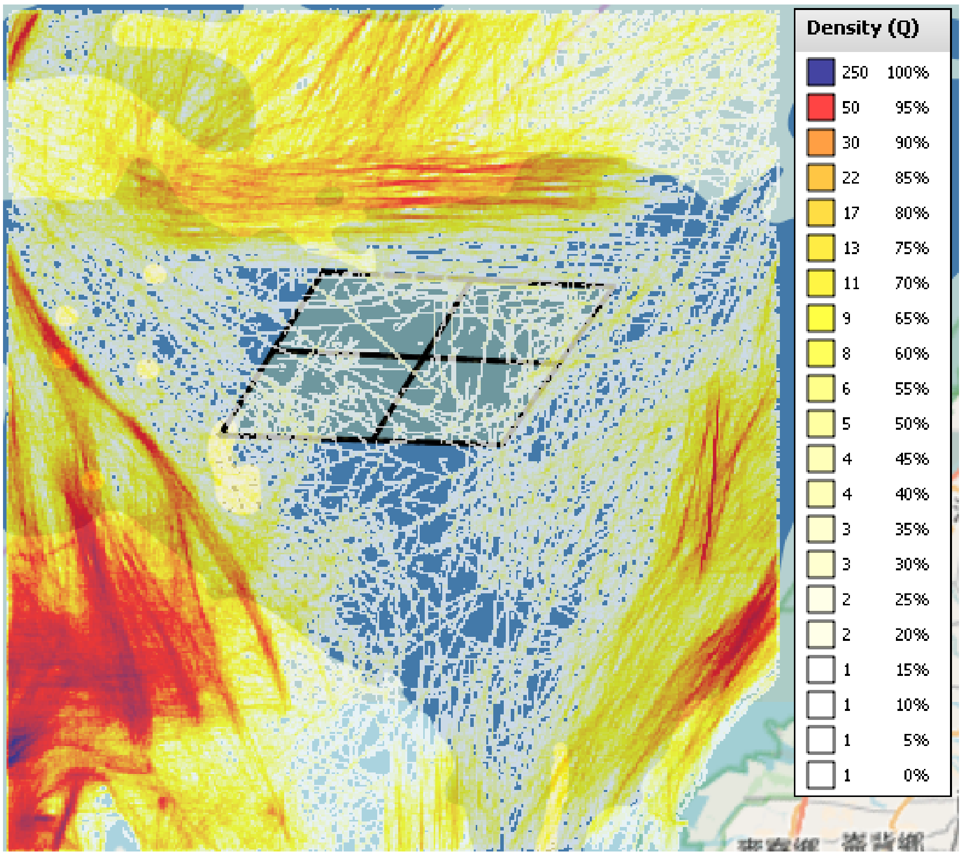


Figure 7.7.3-25 Ship Track Density of Fishing Ships in Neighboring Areas

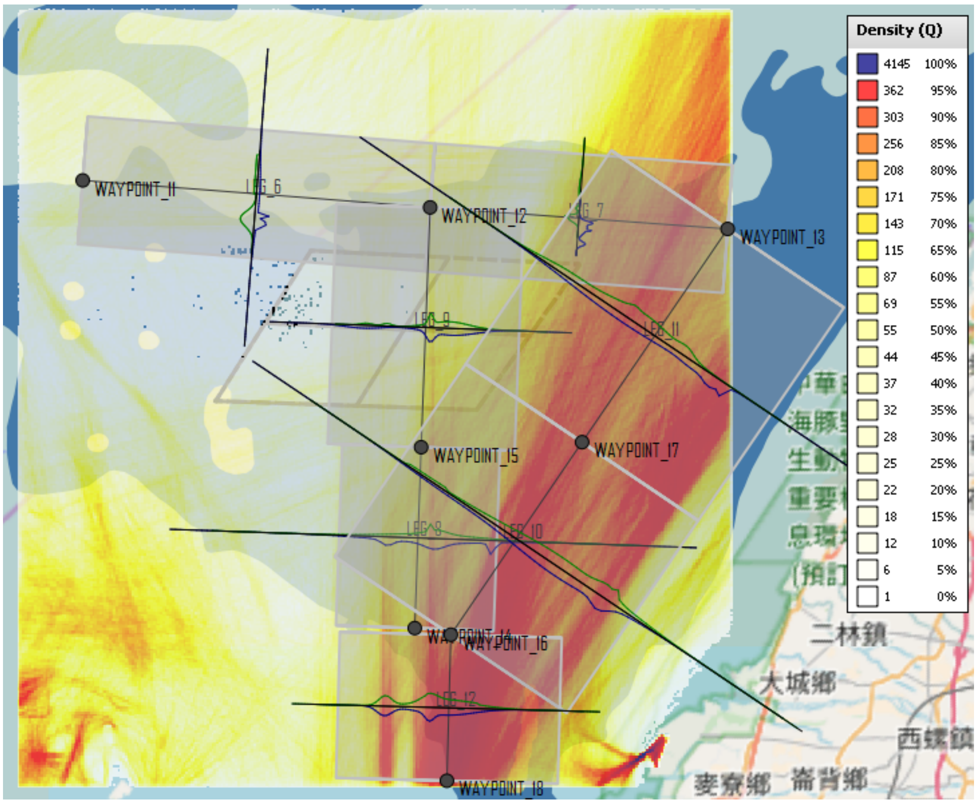


Figure 7.7.3-26 Ship Track Density and Route Model in Neighboring Areas

VI. Impact assessment and mitigation measures on navigational risks

(i) Navigational risk from the current traffic flows

The water depth data required to analyze the stranding of the reef is taken from the chart, as shown in Figure 7.7.3-27.

Figure 7.7.3-27 Water Depth Data Needed to Analyze the Risk of Stranding

According to the traffic distribution of the route model and the water depth evaluation, the risk assessment results under the existing traffic flow distribution are shown in Figure 7.7.3-28. The risk of collision between ships is marked by color with different segment and waypoint. The darker the color, the higher the risk. The risk of stranding is marked by the color of the boundary of the water depth. The darker the color, the higher the risk. The risk of stranding in the case of existing traffic flow and the risk of collision between ships are shown in Table 7.7.3-3 and Table 7.7.3-4, respectively. It can be seen from Figure 7.7.3-28 that the highest risk of collision between ships is LEG_12 that close to Penghu Waterway and Mai Liao Port. As can be seen from Table 7.7.3-3, the risk of collision between ships is mainly due to ship to ship head-on situation.

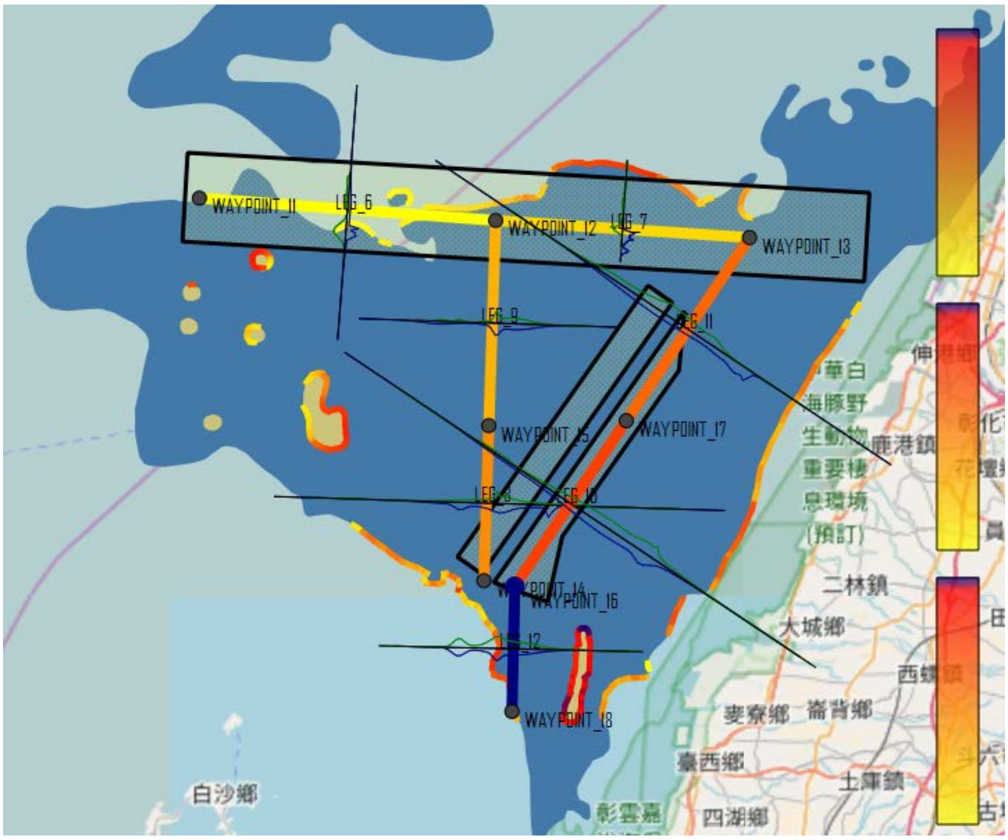


Figure 7.7.3-28 Navigational Risk Assessment on Existing Traffic Flow Distribution

Table 7.7.3-3 Stranded risk under existing traffic flows conditions

	Accident interval (year)	Frequency of accidents (time/year)
Propulsion stranded	13.31	7.51E-02
Drifting stranded	119.8	8.35E-03
Stranded (Total)	11.98	8.35E-02

Table 7.7.3-4 Ship collision risk under existing traffic flow conditions

	Accident interval (year)	Frequency of accidents (time/year)
Overtaking	5,132	1.95E-04
Head-on	846.4	1.18E-03
Bend	8,102	1.23E-04
Collision (Total)	666.8	1.50E-03

If a wind field is set up, the risk of stranded and the collision between the ships will not change without changing the existing route and traffic distribution. However, the risk of the ship entering the offshore wind field and hitting the wind turbine or other structures under the condition of drifting due to force or loss of power is added, as shown in Table 7.7.3-5. The highest risk location is on the northeast side of the wind field, as shown in Figure 7.7.3-29. The relative risk of the allision with the structures in wind field is indicated by the color of the wind field boundary. The darker the color, the higher the risk.

Table 7.7.3-5 Risk of Structure Allision after Accidental Entry into the Wind Field based on Existing Traffic Flow Conditions

	Accident interval (year)	Frequency of accidents (times/year)
Powered Allision	289.1	3.46E-03
Drifting Allision	3.954	2.53E-01
Total Allisions	3.901	2.56E-01

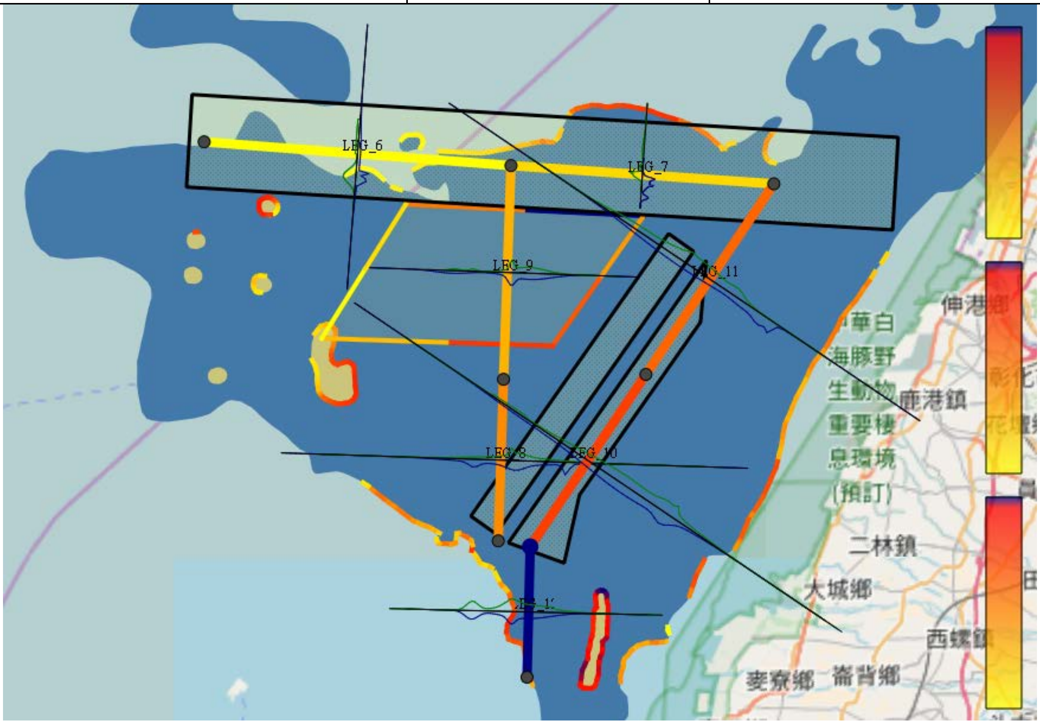


Figure 7.7.3-29 Navigational Risk after Setting Offshore Wind Field based on Existing Traffic Flow Distribution

(ii) Navigational risk and impact assessment under a reorganized traffic flow

In order to cope with the overall plan for the development of offshore wind power blocks, the direct navigation waterway on both sides of the strait will be adjusted to cancel the direct entering to Taichung Port via C point. The original route will be changed to Taichung port through I point, and the route will be slightly moved northward; It is also proposed to set up a waterway at Block 20 to 25 for the north-south approach ships, as shown in Figure 7.7.3-16. Assuming that the above-mentioned navigation measures are implemented, all traffic flows of the original routes will be adjusted and incorporated into the planned waterway.

The horizontal traffic flow distribution on the waterway is usually similar to the Gaussian distribution, which is described by two parameters: centreline position and standard deviation. According to deviation of the Gaussian distribution, the value proposed by the European Union SAFETSHIP program in 2005 are often quoted internationally: about 0.5-1.0 nautical miles on a wide waterway; about 0.5 nautical miles on the navigation lane of a traffic separation system; significant navigation points such as seamark or buoys can be reduced to 0.3-0.4 nautical miles; on the inbound waterway, they are 0.2-0.3 nautical miles.

In order to evaluate the impact of waterway measures on reducing navigational risk, firstly, east side of the wind field is plan according to north-south lane navigation system while the north side is plan according to the adjusted direct navigation channel. The waterway model and risk assessment results are shown in Figure 7.7.3-30. The assessment results of various risks are shown in Table 7.7.3-6, Table 7.7.3-7 and Table 7.7.3-8.

Table 7.7.3-6 Risk of Stranded after Reorganizing the Traffic Flow

	Accident interval (year)	Frequency of accidents (times/year)
Propulsion stranded	2,870	3.48E-04
Drifting stranded	18,760	5.33E-05
Stranded (Total)	2,489	4.02E-04

Table 7.7.3-7 Risk of Ship Collision After Reorganizing the Traffic Flow

	Accident interval (year)	Frequency of accident (times/year)
Overtaking	197.1	5.07E-03
Head-on	1,674	5.97E-04
Bend	70.45	1.42E-02
Collision (Total)	50.34	1.99E-02

Table 7.7.3-8 Risk of Ship-Structure Allision if Accidentally Enter Wind Field After the Reorganization of the Traffic Flow

	Accident interval (year)	Frequency of accident (times/year)
Powered Allision	2,870	3.48E-04
Drifting Allision	18,760	5.33E-05
Total Allisions	2,489	4.02E-04

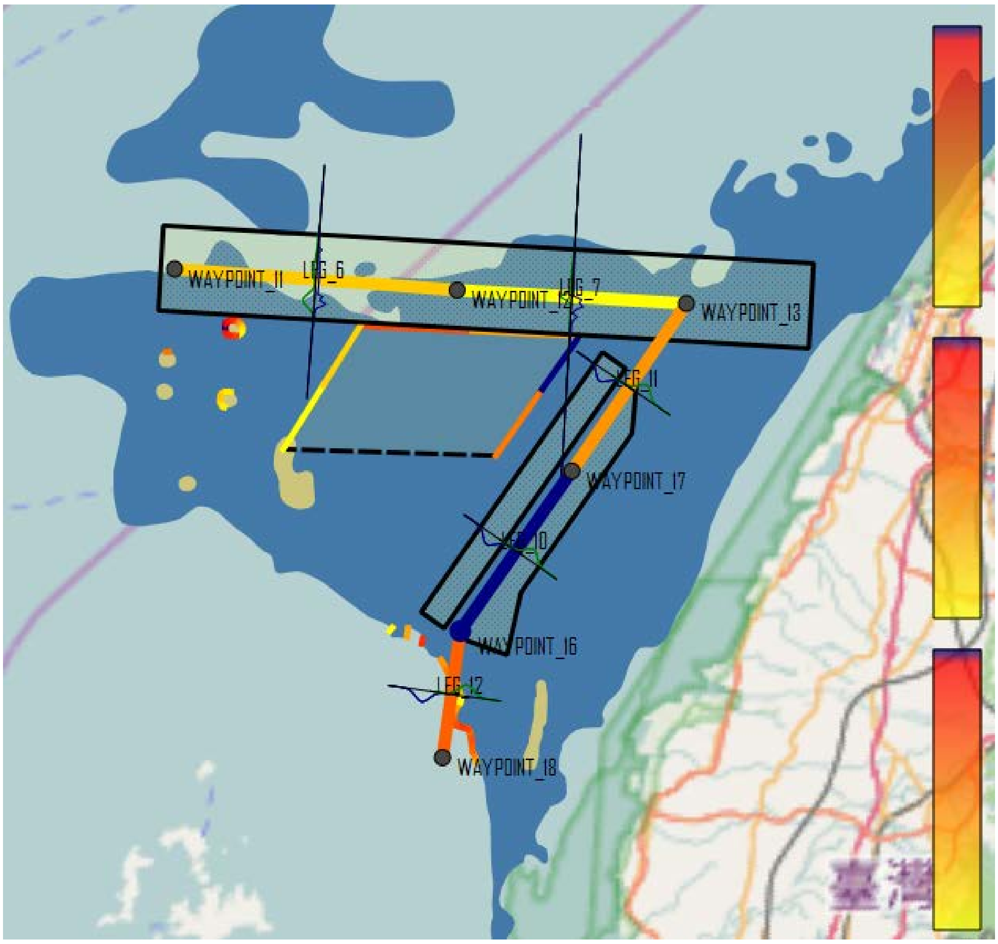


Figure 7.7.3-30 Adjustment of Waypoints around Project Area and Its Evaluation Result

From Figure 7.7.3-30, risk of allision with structures in the wind field is higher on north-east side of the wind field. Such incidents have been 98.2% reduced as reported in Table 7.7.3-8 and Table 7.7.3-5, the interval was extended from 3.9 to 2489 years. The risk of collision between ships is mainly at the turning point of the waterway (Waypoint 16), which is far from the wind field. This part is subjected to detailed route planning and the mark of turning point should be strengthening.

Overall, by plotting the waterway and structures such as wind turbines on the sea chart based on IALA Recommendation O-139 (excerpted in Appendix A), offshore wind field will provide a better waterway sign, in addition with the ship traffic services, the negative impact on navigation safety can be mitigated and even brings positive benefits.

VII. Conclusion

The AIS data in this report is provided by the Harbor and Marine Technology Center, while the risk analysis tools (including models and preset parameters) are recommended by IMO and IALA quantitative risk assessment tool that utilized by many countries. The sea navigation environment related data is taken from the sea chart and related maritime publications.

The following conclusions are drawn from the analysis and evaluation of the above sections:

1. According to the analysis of 2015 AIS annual track, ships passing through wind field are divided into 74% cargo ships and 21% oil tankers. From the north and southwest of the wind field are mostly fishing boats and the eastside which are nearer to Penghu waterway are mainly for ships that are using north-south navigation route.
2. The main impact of offshore wind fields on navigation risk: ship loses power thereby cause drifting into the wind farm and collide with wind turbine. The higher risk of allision is on the northeast side of the wind field.
3. If the waterway planning introduces route measures to organize traffic flow, such as two-way traffic separation, the risk of ship-structure allision can be reduced by 98.2% (the accident interval was extended from 3.9 to 2489 years), as compared to the original ship traffic flow.
4. Offshore wind fields that are marked according to IALA recommendations (such as Appendix A), with navigation aids of AIS and RACON, can greatly reduce their negative impact and even providing positive benefits. In particular, it provides all day route sign that is less affected by visibility. Addition, positioning of ship is assisted electronically and the relevant navigation safety information can be send through AIS.

7.7.4 Risk of Lightning Strike Damage

There are two types of lightning monitoring station available in the country. One is manufactured by the US TOA company and built by the Central Weather Bureau. This set has a total of nine stations, focusing on detecting “Cloud to Ground Lightning”, the data will be updated every five minutes. The other monitoring set is manufactured by a Finland company Vaisala and built by the Taiwan Power Company. There are a total of eight stations in Taiwan, mainly detecting “Intra-Cloud”, however the data generated is non-instant disclosure.

According to the data of cloud-to-ground lightning measured by the TOA system provided by Central Weather Bureau, the number of lightning between year 2016 and 2017 exceeded 100 times per square kilometre, that is, an annual average lightning density of 50 times per square kilometre. This high lightning density are mainly the area near to the sea (see Figure 7.7.4-1), including offshore of Yilan, Hualien, Yunlin and Chiayi.

Lightning strike in the wind field that located in Changhua offshore within this two years (Figure 7.7.4-2) is about 32.4 times per square kilometer, which has an annual average lightning density of 16.2 times per square kilometre. As compare to Changhua city with an annual average lightning density of 33.1 times per square kilometre, risk of lightning strikes in offshore area is relatively lower than the land area.

In addition, this project uses a wind turbine with a capacity of 8 to 11 MW for a single unit. The area of 8MW and 11MW wind turbines is about 0.015 square kilometre and 0.035 square kilometre respectively. When the 8MW wind turbine is used, the proportion of the swept area is about 1.9% per square kilometre, and the probability of lightning strike in the swept range is about 0.31 times per year. When using 11MW wind turbine, the proportion of swept area is about 1.7% per square kilometre, and the probability of lightning strike in the sweeping range is about 0.27 times per year.

Figure 7.7.4-1 Cloud-to-ground Lightning Statistics in Taiwan

Figure 7.7.4-2 Cloud-to-ground Lightning Strike Statistics near the Offshore Wind Field

7.7.5 Construction Operational Risk

The offshore wind field is located on the sea and the volume of various wind field components is huge, hence the main concern will be focused on maritime engineering. Risk assessment during construction will be concentrated on seabed geology, various wind field components and installation process. After installation, operation and maintenance of the wind turbine is also on the sea and the main risk control is to reduce the loss of power generation. The following steps describe the risk assessment and list of the risk assessment results of construction and operation.

I. Risk Identification

(i) Identify sources of risk that may hinder or delay the achievement of the project's objectives.

(ii) Develop a risk list

II. Risk Analysis

(i) Determine the impact of the risk and separate the secondary risk from the primary

(ii) Determine important information to assist in the risk assessment and risk reduction

(iii) Determine the risk level, consequences and the likelihood of the risk to happen

(iv) Provide an overview of the likelihood, probability and consequences of a risk using a risk matrix, as shown in Table 7.7.5-1

Table 7.7.5-1 Risk Matrix

<table>
<tr><td colspan="2" rowspan="2">Risk Level</td><td colspan="5">Consequences</td></tr>
<tr><td>Insignificant
Abrasion or wear out/ Normal operation/maintenance</td><td>Minor
Damage equipment but able to operate/maintain safely</td><td>Moderate
Damage equipment, partial power supply after backup system initiated</td><td>Major
Partial turbine cannot operate/maintain in safely</td><td>Critical
Entire wind field unable to operate/maintain safely</td></tr>
<tr><td rowspan="5">Likelihood</td><td>Rare</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>Unlikely</td><td>2</td><td>4</td><td>6</td><td>8</td><td>10</td></tr>
<tr><td>Possible</td><td>3</td><td>6</td><td>9</td><td>12</td><td>15</td></tr>
<tr><td>Likely</td><td>4</td><td>8</td><td>12</td><td>16</td><td>20</td></tr>
<tr><td>Almost certain</td><td>5</td><td>10</td><td>15</td><td>20</td><td>25</td></tr>
</table>

III. Risk Assessment

(i) Comparing risk analysis results with standard risk acceptance criteria

(ii) Decide whether the risk level is acceptable

(iii) Assess risks based on standard risk levels and develop management actions, as shown in Table 7.7.5-2

Table 7.7.5-2 Risk Assessment Table

Degree of Risk		Risk Response Standard
Acceptable		Acceptable risks even if no action taken. To take action, it needs to be cost effective.
Acceptable, action should be taken		If action taken at this risk level, the actions must be cost effective and be monitored.
Unacceptable, take appropriate action		Risk action must be implemented at this level.

IV. Construction Risk Assessment

Offshore operations are greatly affected by the climate, hence during the construction period, special attention will be paid on monitoring weather conditions. However, after completion of meteorological assessment and the on-site operations has begun, if the environmental conditions gradually deteriorate, it is necessary to evaluate the total time that are needed for the completion of operation until returning to safe state, as well as the time require for the reverse operation to the returning to safe state. The assessed risk, their likelihood and consequences as well as mitigation measures are shown in Table 7.7.5-3.

V. Operational Risk Assessment

Equipment damage is the major risk factor affecting operational safety. The most common damages are bare seabed cables and oil spillage, fires, collisions or stranding of ships. The climatic factor also affecting the maintenance work as it requires to take ships to the sea. The risk assessment for the operation is shown in Table 7.7.5-3.

VI. Decommissioning Risk Assessment

Climatic factor is affecting the feasibility of carrying out decommissioning projects and cleaning of oil spillage at docks or offshore sites. Therefore, during decommission, special attention should be paid to monitor weather forecasts and actual weather conditions. In addition, detailed environment management systems and marine pollution contingency plans should be implement. The risk assessment for the decommissioning is shown in Table 7.7.5-3.

Table 7.7.5-3 Risk Assessment of Construction, Operation and Decommissioning

No.	Range	Stage	Name/Description	Consequences	Pre-improvement Score	Measures and Actions	Post-improvement Score
1	All	Construction/ Operation	Typhoon: Inevitable during this stage	Personnel or ships should be evacuated before/after typhoon at this stage; the structure and equipment of wind turbine should be able to withstand the extreme conditions under typhoon	16	1. Monitor the weather and evacuate offshore in accordance with emergency plans. 2. The safety load is determine in accordance with IEC 61400-1 and 61400-3. IEC 61400-1 committee confirmed that typhoon has been taken into account. 3. The safety design ensures that the fan and supporting structure can withstand loads with an average wind speed of 63 to 67 m/s for 10 minutes. 4. The typhoon risk will be reflected in the asset insurance of this project. 5. SCADA system is used to ensure safe operation in the wind field with an overall control of the off-site coordination, all-weather control and monitoring systems. 6. The standard procedure of monitoring is to track the safety status and load of the structures. If excessive load is detected, the fan will automatically shut down and the technical team will check and re-operate if there are no safety issues involved.	4
2	All	Construction/ Operation	Earthquake: During construction period, consideration should be given to the possible impact of the earthquake on the stability of the ship and structure. During operation period, seismic force should be considered.	Earthquake Risk: inertia load/ soil liquefaction/ slope instability Tsunami	16	1. Conduct on-the-spot exploration to obtain the geological data of the site, provide seismic design (seismic force and soil liquefaction); Implement contingency plan, training, and drill to ensure rapid and reliable responses to situation: during earthquake/after earthquake. 2. All modern fans are equipped with vibration sensors, which will detect obvious vibration. If the vibration exceeds a certain limit, the fans will stop running. 3. Studies shown that for casing-type foundations, the seismic load is less than half of the typhoon load. In fact, the load of the 2500-year-old earthquake is much lower than the load generated by typhoon, that is, earthquake risk is far less than the typhoon risk. 4. The excessive tilt caused by earthquake will be measured by inclinometer, and SCADA	4

No.	Range	Stage	Name/Description	Consequences	Pre-improvement Score	Measures and Actions	Post-improvement Score
						data will show impact of the cabin acceleration, at the same time to assess whether one or more fans are affected. If the tilt has exceeded the limit, same strain program as typhoon is used. In future, soil improvement method will be considered in mitigation measures for soil liquefaction.	
3	All	Construction/ Operation	Lightning Strike	According to European countries, Germany, Denmark, and Sweden, offshore wind turbines accounted for the largest proportion of lightning damage	12	1. Maritime and Helicopter Coordination center (MHCC) is responsible for informing the site construction unit of the weather information and reporting the forecast weather at the daily meeting. The weather forecast will be reviewed prior voyage to determine the latest lightning/weather alert. 2. Any work should be stopped and all personnel should be evacuated as soon as possible after the lightning strike arrives or receives a lightning strike warning during construction, 3. If there is thunder or lightning, the personnel should not immediately evacuate to avoid risk of electric shock. According to emergency response plan, personnel should standby in an arranged safe area until the captain confirms that they have not heard thunder or at least 15 minutes after lightning. 4. Select blades with good lightning protection can effectively reduce the damage caused by lightning strikes to wind turbines. 5. Good grounding and construction design can reduce the damage caused by transient voltage induced by the malfunction of power and control system after lightning struck on the turbines. 6. The power circuit and control signal circuit are equipped with a surge absorber to reduce the damage caused by the abnormal voltage of the lightning strike.	4
4	All	Construction/ Operation	Oil Spillage	Serious oil pollution incidents in the	12	1. Ships have perfect oil and grease leak-proof device, hence there will be no	4

No.	Range	Stage	Name/Description	Consequences	Pre-improvement Score	Measures and Actions	Post-improvement Score
				country are caused by accidents (reefing, collision, stranding, etc.)		oil pollution incidents under normal operation. 2. Ships used in this project are scheduled and executed by professional teams, and a proper ship safety inspections are carried out. The operation is located in the wind field site and ship is driven according to the approved construction waterway. During construction period, relevant warning facilities will also be set up to avoid collisions. 3. In accordance to Marine Pollution Control Act, if there is shipwreck or other accident, causing pollution to sea, the captain and owner of the ship shall take measures to prevent, eliminate or mitigate pollution. They should also notify local aviation administration, port management and local authority. 4. If accident happens, relevant competent authorities (Maritime Port Bureau, Changhua Country Government, Environment Protection Bureau Changhua Country) will be notified according to "Marine Oil Pollution Emergency Response" and "Water Pollution Incident Emergency Response". In conjunction with the contingency measures, relevant map and personnel who familiar with pollution facilities will be assisted.	
5	All	Construction/ Operation	Conflagration	Fire during construction/operation may result in damage to personnel and equipment.	8	1. Working Period ■ Installation should be completely stop ■ Use on-site firefighting equipment to put off the fire ■ Rescue measures should be taken when necessary ■ Notify Maritime and Helicopter Coordination Center (MHCC) ■ Please evacuate the operator according to the emergency rescue contingency plan. ■ Avoid inhalation of smog. ■ Count all operators.	2

No.	Range	Stage	Name/Description	Consequences	Pre-improvement Score	Measures and Actions	Post-improvement Score
						■ Keep your eyes clear and avoid inhaling toxic fumes and debris. 2. Further Procedures： ■ Evacuate from the working site ■ Withdraw with the rescue helicopter 3. Personnel Boat ■ Move to a safe location ■ Evacuate the combusting facility ■ Liaise with MHCC for further action 4. Other Ships ■ In accordance with the instructions of MHCC and the Sea Guard ■ Maintain in channel 16/VHF and keep monitoring ■ Maintain readiness and mobility ■ Provide assistant upon request ■ Standby at a safe spot, keep the line of sight clear 5. Maritime and Helicopter Coordination Center (MHCC) ■ Ensure maritime patrol has been notified and take action in accordance to instructions. ■ Close the wind field or the corresponding wind turbine. Inform smart grid to control the zone ■ Arrange the wounded ashore ■ Notify the emergency response team leader ■ Notify each unit once emergency is over 6. Disaster Mitigation Measures： ■ Manned devices should be fitted with fire detection systems ■ Regular testing and maintenance on fire detection system ■ Regular fire drills	
6	All	Construction/ Operation	Ship on fire	Risk of damage to personnel, ship and equipment cause by fire during construction/operation of the ship	8	1. On the ship ■ Extinguish the fire according to procedures on board ■ Notify Maritime and Helicopter Coordination Center (MHCC) ■ Reduce casualties ■ Start first aiding of necessary	2

No.	Range	Stage	Name/Description	Consequences	Pre-improvement Score	Measures and Actions	Post-improvement Score
						■ Notify personnel offshore situation 2. Further Procedures： ■ Crew injury count ■ Prevent marine pollution 3. Other ships ■ Maintain in channel 16/VHF and keep monitoring ■ Maintain readiness and mobility ■ Provide assistant upon request 4. Maritime and Helicopter Coordination Center (MHCC) ■ Action taken in accordance to Dong Company's emergency response ■ Provide first aid if necessary, notify rescue helicopter and emergency doctor. ■ Notify emergency response team leader to further contact the parties based on emergent level and situation 5. Disaster Reduction ■ Ships should install fire detection system ■ Fire detection system maintenance is subject to relevant regulatory requirements. ■ Crew members should conduct fire drills frequently ■ Firefighting equipment should be installed according to regulations ■ Ship inspection by company's maritime inspectors	
7	Project Management	Construction/ Operation	Insufficient of manpower and resources cause delays in time	Additional cost and delayed in time	4	1. Set detailed schedule for planning and manpower, resource demand schedule, regular tracking and adjustment according to situation. Project manager must pre-propose possible human and resource requirements to reduce potential risk of execution	2
8	Wind turbine	Construction	Dock geological conditions	Higher cost for alternative lifting method; more detailed soil assessment needed; additional cost for ships delay;	9	1. Investigate and consult possible work terminals as early as possible to ensure the loading dock configuration and geological conditions are in line with work planning and design requirements.	4

No.	Range	Stage	Name/Description	Consequences	Pre-improvement Score	Measures and Actions	Post-improvement Score
				increased overall resources requirement			
9	Basic	Construction	Delayed manufacturing process; Time course is accelerated due to the underlying manufacturing delays (General delay risk)	The basic installation and all other offshore installation operations are delayed	12	1. Screen experienced and qualified suppliers as early as possible. 2. Establish detailed manufacturing schedules for follow-up. 3. List the quality control verification procedures and items for the product specifications. 4. Keep progress on-track and develop timing checkpoints.	4
10	Basic	Construction	Delay in workboat mobilization; Previous mobilization was delayed.	The chain of offshore operation is delayed; extending the construction period may cause environment impact	12	1. Review work schedule and develop related contingency plans.	4
11	Basic	Construction	Malfunction of main installation work platform (loading crane, cargo securing, centralizing tool, pile hammer, pile grabber, ship installation, etc.) except during maintenance	Additional costs and possible delays, including equipment with a longer lead time in new markets	12	1. Ensure a solid installation work platform. 2. Contractor is required to have important spare parts. 3. Make a work plan to confirm the construction equipment meet the design requirements. 4. Ships and equipment used in this project is audited prior to mobilization.	4
12	Basic	Construction	Lifting operations are expected in the soft seabed	Extend lifting time; installation of program chain delay	9	1. Carry out a detailed geological drilling to obtain geological data of the site, contractor shall evaluate the lifting operation in detail, formulate the work plan and confirm the construction tools and equipment meet the design requirements (including the lifting assessment), which shall be reviewed by the owner.	4
13	Basic	Construction	Issues between the underlying supplier and the installation contractor for the	Start-up time is delayed, the installation time extended, and the final closing project	9	1. The preparatory office in this project has detailed design, material supply and integration of construction companies. The implementation process will screen and confirm qualified manufacturers as	4

No.	Range	Stage	Name/Description	Consequences	Pre-improvement Score	Measures and Actions	Post-improvement Score
			installed items	delayed; ship and equipment under standby mode; environmental impact may be increased		soon as possible; a meeting is conduct between design unit, manufacturers, and installation contractors to clarify the integration issues.	
14	Basic	Construction	Steel products supplied were found to have quality concerns	Additional costs; may cause delays	3	1. Screen experienced and qualified suppliers as early as possible. 2. Inspect the material supplier and set the quality inspection procedures. 3. List the quality control procedures, sampling frequency and production specifications.	1
15	Cable	Construction	Inexperienced contractors and subcontractors; low quality products	Additional costs and work delay; may cause environmental impact	12	1. Screen experienced and qualified suppliers as early as possible. 2. Establish detailed manufacturing schedules for follow-up. 3. List the quality control procedures and production specifications. 4. Keep progress on-track and develop timing checkpoints.	4
16	Cable	Construction	Malfunction of equipment during array cable installation; faulty of crane, turntable or remote control vehicle	Additional costs; may cause subsequent process delays, including equipment may have longer lead time in new markets	9	1. Develop an emergency plan to prepare additional equipment for scheduling for major equipment.	3
17	Cable	Construction	Grid parallel; general delay risk	Additional costs and work delays	9	1. Onshore substations need to be included in the wind field development schedule for follow-up 2. List the production inspection procedures. 3. Keep progress on-track and develop timing checkpoints. 4. Meeting Taipower regularly to understand the needs and progress of the on-grid.	4
18	Cable	Construction	Technical problems encountered during the	Cable traction delayed; generators may be required.	1	1. Horizontal Directional Drilling (HDD) experts are invited to review the construction and supervise the progress. 2. Start the horizontal directional drilling as	1

No.	Range	Stage	Name/Description	Consequences	Pre-improvement Score	Measures and Actions	Post-improvement Score
			implementation of horizontal wire drilling methods may results in delay in cable traction.			early as possible, and reserve the time for traction operation as much as possible.	
19	Cable	Construction/ Operation	Seabed in construction area varies greatly (sand waves), and the cable has the risk of exposure or damage due to fishing activities and temporary anchorage.	Additional costs and possible corrections; may cause environment impact.	9	1. This project is responsible for the protection of cables, hence a risk assessment is carried out on the cable burial (CBRA) to determine potential risks in the wind field, such as fishing activities, temporary anchorage, and seabed fluidity. Based on the evaluation results, the "threat line" is used to determine the effective buried depth required. The seabed has been determined to be mobile (such as Taiwan), the lowest expected elevation of the seabed throughout this project is defined as "reference seabed elevation surface RSBL)". Referring to this elevation surface, CBRA evaluation performed on the treat line application. The minimum buried depth (minimum reduction depth-MDoL) from the risk point of view has been defined. The feasibility of achieving this depth depends on the specifications of the installation tool and the limitations of the site conditions. They must be evaluated to determine a reasonable target burial depth (target reduction depth- TDoL). 2. If target depth of some areas is shallower than the minimum demand depth, it is necessary to prepare countermeasures to facilitate the risk of management after construction. These countermeasures include cable re-burial or external protection during wind field operation phase. It is also expected that routine and	3

No.	Range	Stage	Name/Description	Consequences	Pre-improvement Score	Measures and Actions	Post-improvement Score
						non-routine MBES (multi-beam sonar) submarine cable path monitoring will be used to assess the risk of cable exposure.	
20	Offshore substation	Construction	Malfunction of ships during installing of superstructure.	Test run time delay; cable traction delay; ships on standby mode (overall progress delay); Contractor's loss due to delay in installation	9	1. Screen experienced and qualified personnel and ships as early as possible. Develop emergency response plans for temporary dispatch and emergency response.	4
21	Terminal and Logistics	Construction	Maritime investigation permit is delay; maritime investigation permit delay due to incomplete information or due to new markets	Additional costs; may cause delays in the project.	4	1. Screen experienced and qualified suppliers as early as possible.	2
22	Terminal and Logistics	Construction	The number of personnel for transport, maintenance work for the installation of foundations, cables and wind turbines is limited, additional new ships are required.	May need to build the needed facilities; increase costs and risk of delay.	3	1. Screen experienced and qualified personnel and ships as early as possible. Produce qualified ship databases for dispatch and emergency needs.	1
23	Regulations and public affairs	Construction	Limitation in working hour, training, national and local emergency response specifications	Delay and additional costs due to regulation and regulatory restrictions.	4	1. Prepare a regulatory requirements list to ensure the processes and instructions of the development unit comply with local laws and regulations. 2. The emergency response plan should include communications and action plans as required by local laws and regulations.	2
24	All	Operation	Ship stranded	After the setup of	4	1. Overall planning for the development of	1

No.	Range	Stage	Name/Description	Consequences	Pre-improvement Score	Measures and Actions	Post-improvement Score
				wind fields, the risk of stranding remains unchanged without changing the existing route and traffic distribution.		offshore wind field, the direct navigation waterway on both sides of the straits will be adjusted. After implementation, all traffic flows in the neighbouring of the original routes will be adjusted and merged into the planned navigation waterway. According to Recommendation O-139 (excerpted in Appendix A and plotted on the sea chart), with the aid of navigation and ship traffic services, the offshore wind field will provide a better route marking, reduce negative effects and bring positive benefits.	
25	All	Operation	Collision between ships	After the setup of wind field, the risk of collision between ships will not change without changing the existing route and traffic distribution.	9	1. Overall planning for the development of offshore wind field, the direct navigation waterway on both sides of the straits will be adjusted. After implementation, all traffic flows in the neighbouring of the original routes will be adjusted and merged into the planned navigation waterway. 2. The collision risk between ships is mainly due to the turning point of the route. This position is far away from the wind field. This part needs to be detailed planning and strengthen the marking of the turning point. 3. According to the IALA Recommendations O-139 (excerpted in Appendix A and plotted on the sea chart), with the aid of navigation and ship traffic services, the offshore wind field will provide a better route marking, reduce negative effects and bring positive benefits. **Emergency Procedures** 1. On the ship ■ Assess the condition of the ship ■ Take appropriate rescue and preventive measures ■ Notify MHCC	4

No.	Range	Stage	Name/Description	Consequences	Pre-improvement Score	Measures and Actions	Post-improvement Score
						■ Start other emergency procedures ■ If necessary, please contact the sea guard 2. Other ships ■ Maintain channel on 16/VHF and keep monitoring ■ Maintain readiness and mobility ■ Provide assistant upon request ■ If the parked ship is in the process of collision, the safe ship shall react as appropriate and inform the MHCC of the situation. 3. Working ■ Receive shipwreck under guidance of MHCC, maintain readiness and mobility. ■ In the case of danger, instructions should be made in accordance with MHCC and/or the ship in distress. ■ If a marine operator needs a rescue operation, please contact MHCC.	
25 (Continued)	All	Operating	Collision between Ships	After setting up wind farm, risk of collision between ships remains the same without changing current routes and traffic.	9	1.Maritime and Helicopter Coordination Centre (MHCC) - Contact personnels on board, provide suggestions based on current situations and measures, carefully consider discontinuing current jobs. - Closing wind fields and maritime facilities based on current needs. - Activate evacuation. - Notify other moored ships. - Notify/ consult coastal patrol and continue monitoring ships. - When in need, provide emergency facilities, notify rescue helicopters, emergency doctors and MHCC. - Notify team leader in emergency, contact personnel according to emergency stage and situation. - Once the emergency situation has ended, notify all units.	4

No.	Range	Stage	Name/Description	Consequences	Pre-improvement Score	Measures and Actions	Post-improvement Score
						2. Main points - When third party ships collide, salving vessels will contact respective ships and notify mooring instructions. - Notify coastal patrol, follow up with ships that are involved in the collision. - Safety vessels should operate according to MHCC and coastal patrol's instructions. - All third party personnel has to evacuate to shore according to the wind energy generator instructions. 3. Disaster Reduction Strategy - Salving vessels have to be present during construction period. - Advise third party vessels to be equipped with AIS facility while entering wind power generating farm.	
26	All	Operating	Vessels Collision Structure	After the wind farm is set up, risks of ships that have movements or lose movements to sail will leave the shore and collide with wind power generator	12	1. The risk of accidental entry into the wind farm domain collision structure is higher in the northeast side of the wind farm. In view of the overall planning for the development of offshore wind power blocks, the direct navigation channels on both sides of the strait will be adjusted. After the implementation, all traffic flows in the vicinity of the original routes will be adjusted and merged into the planned navigation channels. The risk of such accidents will be reduced. 2. According to the IALA Recommendation O-139 advice on labelling (Recorded in appendix A) and plotted on the coastal map, the offshore wind farm site can provide better route markings. By using the route markings and traffic services provided to the vessels, negative impacts on the safety while navigating can be reduced while bringing positive benefits.	4

No.	Range	Stage	Name/Description	Consequences	Pre-improvement Score	Measures and Actions	Post-improvement Score
						Emergency Response Procedures 1. On board - Assess the situation on board. - Carry out appropriate safety and prevention procedures. - Notify MHCC. - Activate other emergency procedures. - If needed, contact Coast Guard Agency.	
26 (continued)	All	Operating	Vessels Collision Structure	After the wind farm is set up, risks of ships that have movements or lose movements to sail will leave the shore and collide with wind power generator	12	2. Other ships - Maintaining at the 16/ VHF channel and maintain supervisory control. - Maintain prepared and manoeuvrable status. - Provide help as instructed. - If other moored ships have collided, safety vessels should react accordingly and notify the situation to MHCC. 3. In operation - Receive shipwrecked vessels' and MHCC messages and instructions, maintain prepared and manoeuvrable status. - In emergency and dangerous situation, react according to MHCC and/or shipwrecked vessels' instructions. - If operating crew require help during operation, please contact MHCC, 4. Maritime and Helicopter Coordination Centre (MHCC) - Contact operating crew on board, provide assistance according to current situation and discontinue current tasks accordingly, - Shut down respective wind farm and maritime facilities. - Activate evacuation. - Notify other moored vessels. - Notify/ advice Coast Guard Agency and continue monitoring ships. - When in need, provide further emergency aid, notify rescue helicopter pilots, emergency doctors and MHCC. - Notify emergency response team leader, contact personnel according to emergency level and situation.	4

No.	Range	Stage	Name/Description	Consequences	Pre-improvement Score	Measures and Actions	Post-improvement Score
						- Once the emergency situation is over, notify all units. 5. Main Points - In the event of third party ships collision, moored safety vessels will communicate with respective ships and provide instructions on mooring the vessel. - Notify Coast Guard Agency, follow up with collided ships. -Safety backup ships will operate according to MHCC and Coast Guard Agency's instructions. - Other third party ships' crews will evacuate to shore according to instructions from the wind power farm. 6. Disaster Reduction Strategy - Safety vessels will be present on site during construction period. - Advise third party vessels to be equipped with AIS facility when entering wind power generating farm.	
27	All	Operating	Lack of Land Operation and Maintenance Site	Increase in travelling time to offshore site; complicated operating and maintenance work.	12	1. Investigate and consult with potential harbour as early as possible. 2. Decide on maintenance site as early as possible.	4
28	Wind Farm Foundation	Operating	Communication and Radar Interruption: Wind Farm Foundation Causes Electromagnetic Disturbance Due to Refraction of Signals	Disturbance in telecommunication of coastal residents; Disturbance in Coastal Guard Agency radar; Disturbance in ships' radar.	3	1. This plan is more than 35 km away from shore and not along the telecommunication route, it will bring the least disturbance to the coastal residents. 2. This plan is outside the average radar coverage, preliminary assessment shows no effects on the radar. 3. If Traffic Separation Scheme (TSS) is used in the future, the safety buffer is 2 miles, therefore most ships on the route will not be affected.	1
29	All	Decommission	Extreme wind conditions; Typhoon	If typhoon hits during the decommissioning period, all ships and personnel should evacuate.	16	1. Monitor weather forecast and evacuate according to emergency response plan.	4

No.	Range	Stage	Name/Description	Consequences	Pre-improvement Score	Measures and Actions	Post-improvement Score
30	All	Decommission	Lightning	During the decommissioning period, ensure that all personnel and equipments can be safely evacuated when lightning and thunder strikes.	12	1. Maritime and Helicopter Coordination Centre (MHCC) is responsible for notifying construction units regarding the weather information and reporting the next day's weather forecast during daily meeting. 2. Cease constructions and start evacuation when lightning and thunder occurs or when radar reports that it is forecasted to occur. 3. If lightning is seen or thunder is heard, in order to reduce risks of electric shock during evacuation, guide staff and other contractors personnel to wait at a safe area until the captain confirms the absence of lightning or thunder for at least 15 minutes.	4
31	All	Decommission	Oil Leak	Oil leaking situation at the harbour or offshore site.	12	1. Every stage of this plan will carry out careful environmental management system and response plan for sea pollution. This plan includes having prepared backup equipments for the oil leak situation on operating ships. Regular supervising and drill will be carried out.	4
32	All	Decommission	Decommission Strategy Is Not Complete	Decommission work is delayed; Linked to the delay until winter.	9	1. Surveying and assessment work on site must be carried out before any jack up work. All works should be carried out safely according to the appropriate methods and ships' specifications. Other than that, suitable harbour for the ships should be confirmed as early as possible in order to plan the work which includes confirming the length of port, sea depth and load support capacity of the seabed at the port during jack up activity. At last, dismantle job preparation includes wind power farm site, foundation, offshore transformer station etc., dismantling job includes checking the heavy lift point, cutting of the electrical cables, removing and loosening of structures etc.	1

7.7.6 Abrasion Risk Assessment

Offshore wind power farm system is easily worn down by the vapor, salt humidity and waves which will cause the wind power generator equipments to wear or cause the foundation in the sea to be weak. Taiwan is in the tropical region where weather is mainly humid and wet, hence, the wind power farm system is affected by the sea and industrial atmosphere. The wind speed is strong which will cause a more severe physical abrasion phenomena. Normally wind power generator manufacturers produce a sufficient abrasion prevention and isolation treatment, however the structure of the generator is insufficient to prevent the abrasion on the carbon steel due to the salinity and weather of the Western Taiwanese sea region.

According to studies regarding Western Taiwanese sea region abrasion due to salinity, namely "Offshore Steel Abrasion Rate Assessment" (Chen Guo Ming etc., 2017), the rate of abrasion on steel due to the atmosphere is around 0.05cm- 0.07cm per year and the effects due to humidity and temperature are different. If the wind power farm has a lifespan of 20 years and abrasion thickness is 1.4cm, safety of the structure will be compromised.

This proposal plans to use mitigation methods such as coating, cathodic corrosion protection, corrosion allowance and dehumidification (transferring segments, tower, rotor and cabin interior), as explained below:

I. Coating

Orsted Limited has developed a coating standard DWTS-09 according to NORSOK M-501 and EN ISO 12944, as shown in table 7.7.6-1. This proposal development standard is for the adverse situation at the North Atlantic, satisfying needs exceeding NORSOK M-501 and EN ISO 12944. If designed according to this standard, the coating has a lifespan of 15-20 years in normal condition.

Considering environment factors such as higher average temperature in Taiwan than Northern Europe, average sunlight exposure which is 2-3 times more than Northern Europe, average rainfall that is more than 50% and tropical low pressure and wind speed that is higher than Europe, this proposal will update according to DWTS-09, using thicker and greater layers of coating.

Table 7.7.6-1 Orsted Company Standard for Coating in Northern Europe

Region	Coating System Minimum Standard
Tower	Interior: 60μm zinc epoxy primer, 2 layers 100μm epoxy resin Exterior: 80μm thermal spray metal, 2 layers 125μm epoxy resin, 60μm Polyurethane topcoat
Atmospheric and tidal areas that are below the tidal area of 1m	2 layers of 300μm solvent free or highly built epoxy resin, 60μm polyurethane topcoat
Immersed 1m under the minimum astronomical tidal area until the 3m seabed/ scouring area	2 layers 225μm solvent free or highly built epoxy resin, 60μm polyurethane topcoat

Note 1: Included in DWTS-09.
Note 2: Topcoat system provided by certified structural manufacturer.

II. Cathodic Corrosion Protection

Orsted Limited has referenced “DNV-GL RP B401 cathodic protection” standard, this proposal will design according to Orsted Limited specification, utilizing aluminium anode as the cathode corrosion protection. The corrosion-resistant current density used in tropical climates is shown in Table 7.7.6-2.

Orsted Limited design has taken into consideration the current consumption from the tidal zone to the seabed area and the bottom of the pile. At the same time, it has been considered that the temperate waters have lower dissolved oxygen content than the tropical waters, resulting in lower current density in the tropics than in the temperate zone. Therefore, the number of anodes in tropical climate regions will be moderately reduced.

In addition, Orsted Limited is currently conducting soil surveys (organic content, chloride, sulfate, carbonate content) for the wind farm area. The results of this survey will also be used as a basis for evaluating the cathodic corrosion rating in the future.

Table 7.7.6-2 Cathodic Corrosion Protection Current Density System

	Design current densities, mA/m2 bare steel		
Zone	Initial	Mean	Final
Splash to MSL	180	84	120
MSL to LAT	150	70	100
LAT to 30 m water depth	150	70	70
>30-100 m water depth	120	60	80
Buried	20	20	20

III. Corrosion Margin

Corrosion protection provided by the coating may be shorter than the design life of the structure. Therefore, in the structural calculation, this is compensated by the corrosion margin. The design must meet sufficient safety factor to ensure the safety of the fan by optimizing the coating system or preserving the corrosion allowance of the structure.

In addition, the plan will establish monitoring, inspection and maintenance plans to determine design assumptions and take remedial action when needed.

Dehumidification

The rotor, nacelle, tower, and transfer section areas will be equipped with a dehumidification system to prevent condensation from rising in internal air humidity to reduce corrosion degradation of internal surfaces and moisture sensitive components.

Under all operating conditions, the dehumidification system will be able to control the relative humidity of the internal air below approximately 60%. A sea salt filter will be installed on the dehumidifier.

The foundation structure can be divided into the transfer section, the tower dehumidification zone, the closed steel pipe rack foot pipe and the truss structure according to the structure itself. The environment can be divided into the following areas according to the external environment: the atmospheric interval, the tidal section, and the immersion where the following basic corrosion protection measures are applied respectively:

1. Atmospheric segment: coating and corrosion margin
2. Tidal section: coating, corrosion margin and partial cathodic corrosion protection
3. Submerged section: Cathodic corrosion protection combined with coating
4. Buried section: cathodic corrosion protection, partial coating and corrosion allowance

7.6 Health Risk Assessment

According to one of the provisions of Article 30 of the Environmental Protection Department's “Development Behavior Environmental Impact Assessment Operation Guidelines (Revised Announcement of July 3, 104)”, development units will carry out health risks assessments and evaluate technical specifications for health risk assessment based on hazardous substances that occur during the development operation and include it in the manual or the first draft of the assessment. However, this development plan is a development plan for clean renewable energy wind power generation. During the operation phase, only the natural wind power is used to provide the unit to generate electricity during the operation of the unit. It is not used or derived as a hazardous chemical substance as mentioned in Article 3 of the “Technical Specifications for Health Risk Assessment (Revised by the Law of July 20, 100)”. There is no incremental risk to the health of residents in neighbouring areas, so no health risk assessment is required.

Chapter VIII Environmental Protection Measures and Alternative Plans

8.1 Environmental Protection Measures

Any development plan will have some degree of impact on the local environment, whether lesser or greater. This chapter will elaborate on the environmental impact mitigation (or avoidance) countermeasures for the environmental impact caused by the development activities of this offshore wind farm project. It is divided according to the construction phase and operational period, and formulated in terms of the impact, extent and characteristics of offshore and onshore development activities on the environment. The Developer will inform the competent authority for the industry and the competent environmental protection authority in writing of the scheduled date of construction within 30 days prior to the development plan's commencement of construction.

8.1.1 Preconstruction Period

Due to the difference in onshore and offshore construction area, the offshore protective measures (seabirds, cetacean, marine ecology, fishery resources, marine topography and geology, vessels, underwater cultural heritage) are to be conducted before offshore construction; the onshore protective measures are to be conducted before the onshore construction, as described below:

1. Offshore birds

   a. Lower the effect of wind turbine collision

      An interval of 500m should be kept between turbines. The space between turbines should be reserved to a sufficient degree to allow birds to fly through.

   b. Adjust the wind farm layout

      i. The actual planning of the bird corridor will be based on the 2017 autumn and 2018 spring bird environmental impact survey report, and finalised upon review according to Article 18 of the Environmental Impact Assessment Act.
      ii. The 4 Greater Changhua wind farms plan to retain 8 corridors altogether to benefit the birds to avoid collision and pass. Each corridor is at least 2km in width, as shown in Figure 8.1.1-1.
      iii. Between wind farms, a buffer zone of 6 times the rotor diameter should be kept for the ease of birds to pass through.

   c. Prior to construction, conduct bird banding survey once per season along the coast of Changhua. Use satellite tracking to confirm the migratory birds' migratory route, in order to understand the major migratory pathways of birds.

2. Cetacean

   Before construction, conduct 1 year of cetacean survey by the ship-based visual method, monitoring 20 trips to grasp cetacean activities and understand the potential impacts construction may have on cetaceans.

3. Marine Ecology

In considering the technical feasibility and rationality of the case, the submarine cables shall be connected to land with the shortest distance possible to reduce environmental impacts from construction activities. This project shall follow the BOE approved "Changhua Offshore Wind Power Marine Cable Common Corridor" adjustments promulgated on August 2nd 2017, to mitigate the marine cable's effect on the marine and intertidal zones during construction.

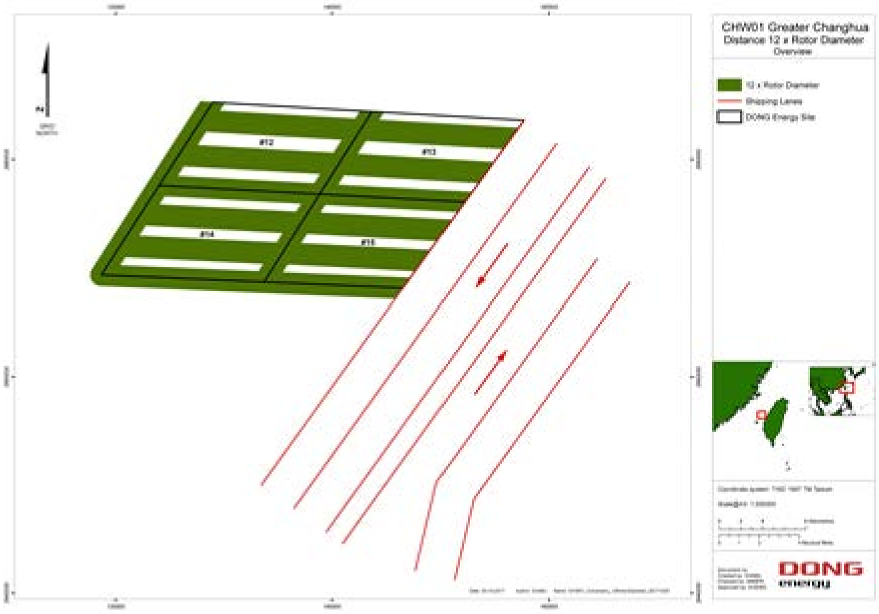


Figure 8.1.1-1 Bird corridor between project and neighbouring wind farms

4. Fishery Resources

Denmark's Horns Rev is one of the world's largest offshore wind farms, located in shallow waters with depths of less than 20 meters. According to the indications of a research report by the Danish Institute for Fisheries Resources on the Horns Rev wind farm, which compared data taken from before and after the construction of the farm, the turbines were found to have had no adverse effect on local fish species. At the same time, this study also demonstrated that these foundational protective artificial stone structures can be used as artificial reefs to attract fish, and the closer to the places where turbines are located, the more new varieties of fish can be found.

The site of this project is located off the coast of Changhua County. A broad artificial fish reef effect can be achieved. So far visits to local fishermen groups and local opinion leaders have been conducted. Such visits allow communication and discussion with the local, and increase understanding of their needs. In the future, they will be invited for the pre-construction public hearing to continue the communication and consistent visits to Changhua District Fishermen's association and Changhua County Aquaculture Fisheries Development Association etc. will be carried out to ensure better communication and negotiation. For fishing right areas that are affected by this project, we will attend to compensation matters after the project is approved by the BOE.

5. Marine Topography and Geology

a. More detailed geophysical and geotechnical surveys will be carried out prior to construction. Further geotechnical surveys at each turbine foundation will be carried out to provide a basis for the design of wind turbine foundation and its construction. Construction should be carried out in response to the geotechnical characteristics of the site.

b. Orsted company will conduct supplementary offshore geological surveys for the 4 development sites. The work will at least include 4 80m boreholes and at least 15 20-80m CPT tests, then based on the results, develop the site's relationship with liquefaction potentials. Meanwhile the use of SCPT will measure the in-situ soil's shear wave velocity to improve the construction site's response analysis.

c. Before planning the detailed designs, each turbine location will conduct borehole testing or CPT in order to confirm if there is actual liquefaction potentials. The borehole or CPT's depth will be greater than the scheduled pile foundation. According to current studies, the projects plans to conduct boreholes or CPT at a depth of 80-85m below seabed.

d. During the design stage, the liquefaction risk will be assessed and considered based on the geophysical results at each turbine location.

e. In the future when designing, it may be considered to neglect or lower the soil's carrying capacity with potentials of liquefaction, in other words, to increase the safety factor of the design.

f. This project is cooperating with relevant professors at UWA specializing in the most state of the art offshore piling foundation designs through the Industrial Cooperation Program (ICP), and confirming how these methods may be used in local Taiwanese soil, including liquefaction issues

g. This project is already cooperating with Taiwanese professors, to ensure combining local experience, including earthquake and liquefaction knowledge, and using advanced laboratory experiments and soil investigation.

h. In northern Europe offshore wind farms, the negative pressure of wind and waves are often considered in causing soil liquefaction. Especially Taiwanese soil is even more prone to liquefaction; hence this is also an important subject. During the more detailed design stage, the aforementioned will be taken into consideration and conduct investigation.

6. Vessels

a. Prior to acquiring the establishment permit, this project shall provide relevant info of the wind farm, as a reference for the Coast Guard Administration.

b. Navigation channel

Design a construction channel from the site to the work harbour. Prior to construction, the construction unit will submit to the ports corporation requesting approval for reference, and publicly announce at each harbour and relevant units such as fishery and commercial vessels, and notify the vessels which navigate in the area to be cautious in avoiding marine accidents.

7. Underwater cultural heritage

Before construction, conduct geological drilling and sampling at each planned turbine location, and commission certified archeologists to conduct interpretation of the borehole results, determine whether the soil under the seabed may contain cultural heritage or objects and ruins which are of prehistoric significance.

8. Terrestrial cultural heritage

Before construction, for the onshore booster (step-down) stations, conduct at least over 3 points of geological drilling. Provide pictures of the geological drilling to certified archaeologists for interpretation of whether cultural heritage exists below.

9. Surface water hydrology and water quality

Before construction, submit the Runoff Wastewater Pollution Reduction Plan, and construction may only commence after it has been reviewed and approved by the competent authority.

8.1.2 Construction Period

8.1.2.1 Marine Environment

I. **Whales and Dolphins**

(1) The foundation type chosen is the jacket-type foundation, due to its relatively lower piling noise.

(2) Prevention measures taken at the start of construction:

1. No use of Acoustic Deterrent Devices (ADDs).
2. Confirm there is no cetacean activity within the construction site with two types of monitoring methods, including sound monitoring method and human observation method, during pile driving.
   a. Sound monitoring method: this project will consider expanding the cetacean's detection range, hence plan 4 underwater acoustic devices to be placed 750m away from the piling locations at 4 directions for continuous monitoring of piling noise level and whether there is nearby cetacean activities. The layout of the underwater acoustic devices will include 4 directions, by monitoring at different directions and distance to have a full picture of the monitoring results (Figure 8.1.2.1-1and 8.1.2.1-2).
   b. Human monitoring method: There are at least 3 (at least 1 of them is a member of the local ecological group) conducting visual searches during piling, which the area should include 4 direction of warning area (within 750m) and monitoring area (1,500m), as depicted in Figure 8.1.2.1-2.
   c. MMO training and certificates: this project will introduce the criterion of Marine Mammal Observer Association (MMOA) and UK Joint Nature Conservation Committee (JNCC), as well as to establish the training and certification procedures of cetacean observing personnel with local groups and relevant institutes. Such training process will invite international cetacean experts to Taiwan to establish a professional and credible third-party cetacean monitoring team.
3. The two monitoring methods (sound monitoring method and human observation method) need to confirm that there are no cetacean activities within the warning area (750m) for at least 30 minutes before piling starts.
4. During piling, the underwater acoustic monitoring device is a supplementary tool for the MMO. Visual inspection, with the combination of underwater acoustic monitoring device and MMO, the cetacean's distance from site can be determined and specified whether it is within the 750m warning area or 1500m monitoring area, or beyond these areas. If cetacean activity is detected within the warning area (750m) during the pile driving period, the construction unit shall immediately stop pile driving provided there are no project safety concerns. After waiting for thirty minutes once the cetaceans have left the warning area, progressive pile driving is gradually resumed until pile driving continues at normal strength. If cetaceans are detected in the monitoring area(1500m), their movement

direction shall be observed and recorded to determine if the dolphins are moving towards the warning area (750m).

"No project safety concerns" by definition means when cetaceans enter the 750m danger area, and also satisfy the following , then will stop piling activities:

a. The foundation has sufficient depth and does not need the support of construction vessles, allowing itself to withstand to the next piling activity, and will not cause any construction danger.

b. The construction area has fine weather conditions, which stopping piling activities will not impose workers and the vessel team to unbearable weather conditions.

5. Use progressive construction method for pile driving. Gradually increase pile driving from low strength to full strength to give cetaceans time to leave the pile driving noise source area.
6. No start of new piling activity during the period of 1 hour before sunset until before sunrise.
7. All pile driving activities (including on-site pile suspension and rotation) must be fully recorded. The images must show the date and time of the recording, and files be kept for reference for at least 5 years.

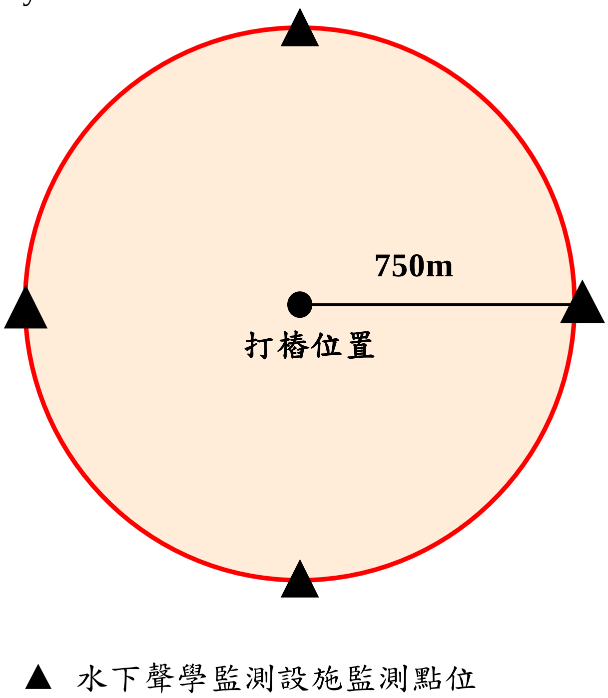


Figure 8.1.2.1-1 Underwater acoustic device layout

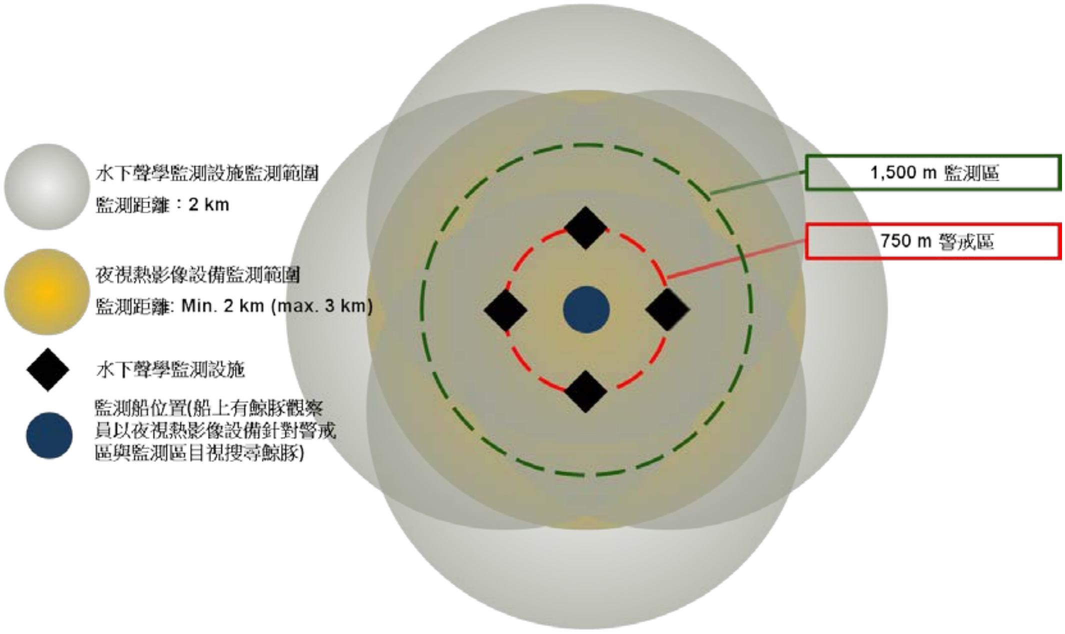


圖 8.1.2.1-2 Underwater acoustic monitoring device and night time thermal imagery detection area

(3) Noise reduction measures during the construction period

The project is committed to monitor at 750m with an underwater Sound Exposure Level (SEL) shall not exceed 160[(dB) re. 1µPa2s], as the impact assessment threshold.

When calculating underwater Sound Exposure Level (SEL), adopt single-event as baseline, with a duration length of 30 seconds for analysis, calculate the piling number N and average level or equivalent SEL (also L_{eq30s}), then convert to the “single-event (average value of 30-second analyses) underwater SEL of piling”. This value will be used as the threshold.

All turbine foundation piling process will adopt the state-of-the-art commercially available noise prevention method, to ensure at the warning area 750m away from construction, noise can be maintained below 160dB SEL. The details on noise mitigation measures will be decided before the installation, which will consider the state-of-the-art noise reduction technique, such as bubble curtain or balloon curtain.

(4) Vessel speed control

During construction, when construction vessels pass by 1500m radius of the Chinese white dolphin habitat and its borders, vessel speed should be kept below 6 knots, and try to avoid entering the Chinese white dolphin hot spots during their peak activity periods. The navigation channel will be designed to avoid sensitive areas.

(5) Real time noise monitoring:

Over the entire construction process, each turbine foundation’s construction will include a one-time monitoring of pile driving at 750m away from the piling, beginning from soft start. The entire piling process will be monitored with the use of noise reduction methods. If the noise measured at 750m has exceeded the tolerance level, the construction unit will immediately adopt measures to lower the sound to within the limit. Relative measures including lowering piling speed (amount of piling strikes), decreasing the intensity of pile energy (kJ), and adjusting noise mitigation equipment. Before construction, detailed modeling will be conducted on the expected noise emission. The previous mentioned noise level will be related to the foundation status, type and piling energy. These elements can be used as factors in modeling.

(6) Long-term cetacean monitoring

During construction, cetacean monitoring will be continuously carried out. The method used will be vessel-based visual monitoring. The monitoring frequency is at least 20 times per year to keep track of cetacean activity and understand the possible impacts of the construction work on cetaceans.

II. Underwater Noise

The developer shall only conduct at most 1 turbine piling at once.

III. Air Quality

(1) All vessels shall use the least sulfur containing oil available in Taiwan at the time.

(2) The exhaust air emission of vessel-carrying personnel, such as CTV or SOV should install smoke filters or activated carbon filters or other start-of-the-art commercially available technologies.

IV. Seabirds

Ship-based monitoring will be conducted according to the monitoring plan.

V. **Quality of Seawater**

(1) To avoid vessel collision accidents due to non-work vessel entering into construction zone and oil spill, warning devices around construction zone shall be set up.

(2) This project shall follow the Marine Pollution Prevention Law. In case of sea accidents resulting in concerns of polluting the marine area, the captain and vessel personnel should take measures to prevent, remove or mitigate pollution, and instantly notify local navigation authorities, harbour management authorities or local competent authorities.

(3) To appropriately deliberate on the construction process, and to formulate various construction plans to ensure good control of the construction progress, the construction area will be clearly delineated, thereby reducing vessel collision accidents caused by non-work vessels entering into the construction area.

(4) We will ensure that seawater quality monitoring will be performed and other commitments related to environmental monitoring during construction, in order to understand the impact of the marine construction on the overall quality of the marine environment.

VI. **Vessels**

(1) Port Area

1. Vessels should conduct regular maintenance of machinery and equipment.
2. Wastewater (and sewage) and waste oil should be handled in accordance with the provisions of relevant water pollution control laws.
3. The wastewater generated by machinery and vessels during their maintenances tends to be oilier. Centralized disposal best management practices (BMP) shall be adopted, by which the water would be collected and processed to avoid polluting nearby water bodies.

(2) Navigation Channels

1. Due to the considerable number of large-scale operational vessels and frequent sailings between the site and construction port area, taking into consideration navigational safety and smooth operations, a navigation safety plan should be formulated, to avoid hampering nearby fishing vessels or the safety of ships entering and leaving construction port.
2. According to the strict HSE standards of the project, only well-maintained construction vessels will be used. Ensure good construction planning and management to maintain navigation safety.
3. According to proposed navigation channel coordinates announced on 11th August 2017 by MOTC, the wind farm area and the navigation channel shall keep a safety buffer zone of 2nm. This project has reduced the wind farm area as a result to reduce vessel collision risk.

(3) Work Site

1. Boats shall be deployed around the construction sites and appropriate offshore warning devices shall be put up to warn other ships not to enter the operational waters.

2. Ship wastewater (and sewage), oil, scrap or other pollutants, except where specified as may be excreted in the ocean, will be retained on board or excreted at onshore facilities.
3. The ballast water of work boats is required to have ballast water treatment equipment. Only after proper treatment can it be discharged.
4. If a vessel has an accident causing marine pollution or danger of such pollution, measures will be taken to prevent, eliminate or reduce pollution, and notifying local shipping administration authorities, port authorities and local government authorities.
5. Construction equipment and vessels which satisfy the QHSE standards will be selected, regular and unscheduled maintenance work will be done, and maintenance records will be kept, in order to reduce concentrations of pollutants emitted.
6. The oil products used by the developer on construction machinery will be subject to stringent requirements, which meet regulatory standards.
7. It should be specified the suitable construction activities (wind turbine foundation and submarine cable installation) under different weather conditions, and the construction timeline for each activity. In addition, for the safety of construction personnel at work, regular weather updates such as wind and wave shall be obtained during construction phase.
8. This project ensures sufficient storage capacity for wastewater tanks to collect wastewater generated by the crew during offshore operations. The waste water will be disposed onshore.

(4) Collision

1. All work vessels are dispatched by professional teams, and undergo sound vessel safety inspection. The area of operation covers each wind farm, and shall navigate on approved navigation channels. Relevant warning facilities will be implemented during construction to prevent collision.
2. This project shall follow the Marine Pollution Prevention Law. In case of sea accidents resulting in concerns of polluting the marine area, the captain and vessel personnel should take measures to prevent, remove or mitigate pollution, and instantly notify local navigation authorities, harbour management authorities or local competent authorities.
3. In case accidents happen, then notify pertinent competent authorities (CGA, Changhua county government, Changhua EPB) following the Major Marine Oil Pollution Emergency Contingency Plan and Operation Rules of Water Pollution Incident Emergency Response Prevention System, and cooperate with the response operation to provide graphs and information, and have personnel familiar with the pollution-related facts assist in handling.
4. Vessles need to equip night lights and light number following the Regulations for Preventing Collisions at Sea.
5. Be sure to follow the Disaster Prevention and Protection Act. When hazards occur, the operating unit shall contact the industry competent authority, rescue and support unit for multiple reporting.
6. According to the Maritime and Port Bureau’s announcement on August 11, 2017 for the planned navigation channel’s coordinates, the wind farm area and navigation channel should have separate channels, and have at least a 2 Nn buffer zone are taken into consideration to avoid risk of vessel collision. In the future, prior to applying for the BOE’s establishment permit, the safety suggestions of the Maritime Port Bureau and Fisheries Agency will be obtained, and navigation safety issues will be discussed to reduce collision risks.
7. During construction and after completion, the O-139『IALA Recommendation O-139 on the Marking of Man-Made Offshore Structure』 and Offshore wind power route identification setting criteria, Offshore wind farm's route marking implementation and implementation specifications (draft) shall be followed to reduce vessel collision risks. The transition piece of each turbine will be painted yellow,

the border foundation transition pieces need to be in sync with yellow flashing lights (The nominal optical path is 5Nm and 2Nm, respectively, and the difference between them should be noticeable), with usability of 99.0%. Each turbine should install letter boards to be distinguishable, and the wind farm should implement AIS navigation marks.

8. This project will implement a Marine and Helicopter Coordination centre (MHCC) to control and manage vessels inside the wind farm. In case of emergency, MHCC will respond to the situation and command relevant vessels, and contact the Coast Guard Administration if necessary.
9. The Marine and Helicopter Coordination centre (MHCC) is in charge of informing the construction unit of the weather info, and will forecast the weather tomorrow during meeting each day. Before the vessel sets sail, it will review the weather and confirm using the latest lightning/weather warning. During the day of construction, the MHCC will monitor the weather, and tell the unit on site the weather warnings by the forecaster. The MHCC will continue to report the weather, and contact relevant units such as activating emergency plans, and will report to all parties after the emergency is over.
10. Deploy guard boats during construction.

VII. **Marine Ecology**

(1) Protective seabed work stones are designed to protect the wind turbine foundation. Meanwhile, it can serve as artificial reef, providing marine habitat.

(2) If the construction area is close to oyster shelf area, anti-turbidity curtains will be used to avoid affecting the quality of the oyster shelf area.

(3) The intertidal area will not conduct excavation, and will use horizontal cable laying method, and will avoid migratory period of November to next March.

(4) Before construction, conduct an underwater video recording at 1 planned turbine location. After piling, conduct an underwater video recording at where previously the video recording conducted was conducted before construction.

(5) During construction, conduct 1 fishery survey every season (including turbine location species distribution and changes monitoring

VIII. **Underwater Cultural Assets**

(1) During the construction period, according to Article 13 of Underwater Cultural Assets Preservation Act, if suspected underwater cultural assets are found in this project, it is necessary to immediately stop activities affecting the underwater cultural assets, keep the site intact, and immediately notify the competent authority for handling.

However, such activities shall not stop in the event of avoiding emergency disaster or for requirement of major public interests and should immediately notify the competent authority upon discovery. If the underwater cultural assets have already been taken out from water, immediately turn them over to the competent authority for handling.

(2) If this project found that the underwater cultural assets are suspected objects but cannot be firmly identified, it is necessary to adjust the location of the wind turbine to another place with no suspected underwater cultural assets.

8.1.2.2 Terrestrial Environment

I. **Air Quality**

(1) In future construction, the Control Method of Air Quality Deterioration will be followed, promulgated on June 9, 2017. When local authority officially announces air quality deteriorating warnings, conduct air pollution prevention measures, and enhance water spraying after the warning was issued. After a secondary degree deteriorating waning has been issued, immediate stop construction work to avoid construction making worsening the air quality.

(2) During construction, follow the Construction Air Pollution Prevention Equipment Management promulgated by the EPA to conduct dust divergence for pollution prevention work.

(3) Before starting construction work, follow the Air Pollution Control Fee Collection Regulations to pay pertinent fees.

(4) During booster (step down) station construction, the construction site borders should implement fixed Full barrier fence and overflow prevention bases, among which the fences should not be lower than 2.4m. But those at the street corners or 10m within street corners need to install semi-blocking fences.

(5) Construction equipment and transport vehicles in sound condition will be selected, regular and unscheduled maintenance work will be carried out, and maintenance records will be kept, in order to reduce the concentration of pollutants emitted.

(6) Appropriate watering should be utilized at each electricity transmission and distribution work of the terrestrial construction site, and accumulated dust should be cleared, to reduce site dust. The bare surfaces during booster station construction should be appropriately watered during dry weather, and for the roads around the work area, maintenance and cleaning should be carried out in order to keep dust down.

(7) During construction, the cleaning of construction roads 100m altogether will be conducted (except for raining days) to decrease fugitive dust caused by transporting cars.

(8) The driving route in the construction site adopts anti-dusting facilities such as laying steel plates, laying concrete, laying asphalt concrete or laying coarse grading or other equivalent functions.

(9) Soil-carrying vehicles must be covered in order to avoid air pollution caused by stirred-up dust. Contractors will be instructed to use anti-dust mesh covers in order to keep dust from rising.

(10) The route taken by transportation trucks should avoid densely populated areas, and if this cannot be avoided, the setting and execution of driving standards should be improved. When passing through densely populated areas, speed should be reduced to avoid lifting dust.

(11) Vehicles accessing the site must be cleaned before exiting the site.

(12) Oil products used by contractors' construction machinery will without question be subject to stringent requirements which meet regulatory standards, and periodic maintenance must be carried out in order to reduce emissions of pollutants.

(13) Vehicles used by contractors in construction will be required to comply with the latest emission standards to reduce environmental impacts.

(14) The construction cars should by law use diesel with sulphur containing less than 10ppmw (including biodiesel).

(15) Land excavation facilities (excavator) should follow the same rule as diesel trucks over class 4 emission standard, or install smoke filters and conduct periodic maintenance, which can increase the improvement of PM2.5 emission.

(16) Following the Management Regulations for Construction Project Air Pollution Control Facilities Article 5, Signs indicating the construction project owner and the construction project period shall be installed at the construction site. The content of the signs in the foregoing paragraph shall explicitly state the construction project air pollution control fee

collection control serial number, the name and telephone number of the statutory responsible person at the construction site as well as the local environmental agency's telephone number for reporting public nuisances.

II. **Hydrology and Surface Water Quality**

(1) Surface runoff and wastewater generated by base construction of booster station will have provisional sedimentation and grit equipment installed for wastewater recycling, or discharge effluents in compliance with relevant construction standards; their actual size and position will be set based on actual site needs.

(2) The construction materials will be stored in a designated area and covered, and maintenance area covered and isolated, to reduce the chance of contact with the rain and avoid surface runoff pollution.

(3) Portable toilets would be rented or water treatment would be set up for the construction personnel to use, and qualified cleaning staff will be commissioned to maintain the cleanliness and dispose wastewater produced.

(4) A pre-construction 'runoff wastewater pollution reduction plan' will be examined and reviewed by the competent authority, and work may only commence after it has received approval.

III. **Noise and Vibrations**

The main sources of noise in the construction phase originate with construction machinery noise and mechanical noise generated by transportation vehicles, thus construction contracts will stipulate stringent management measure requirements for construction units to abide by. These include, at a minimum, the following number of items:

(1) When engineering contracting work is to be carried out, noise control standards need to be included in the construction specifications and should be diligently maintained during the construction period.

(2) The use of construction equipment during the construction phase will be in accordance with noise control standards measured at the perimeter of the engineering area during construction work, and engineering contractors will be instructed to regularly inspect and maintain the silencing apparatus of construction machinery equipment.

(3) When the piping of onshore cables are unearthed, the earth and rock carried by the excavator need to be loaded onto trucks. Trucks will be parked near the excavators to minimize the high noise from the excavators moving back and forth, which can create unnecessary noise.

(4) Construction vehicles are subject to regular maintenance, lubrication and correct operation, as well as reducing speed in order to decrease volume.

(5) Construction equipment at the on-land work area will utilize a low noise approach to construction work, and be subject to frequent maintenance, to maintain in good state of repair and normal operation.

(6) Development activity shall follow Noise Control Standards and its pertinent regulations.

IV. **Traffic & Transportation**

(1) We will coordinate with local traffic and road authorities, cooperating in the handling of the following matters: traffic signals, signs, marking removal and setting, as well as signal time system adjustments. Traffic flow will be eased and traffic violations will be prohibited.

(2) While carrying out lifting operations, safety of passers-by and work site operations should be maintained.

(3) Should install appropriate signage, install warning of lane narrowing and prohibit lane changing or speed reduction in front of the work area.

(4) Should install clear traffic signs, warning signs, and safety notices at important road junctions and sections of road frequently used by the public and assign personnel exclusively responsible for traffic control and easing traffic flow, keeping traffic moving smoothly.

(5) If this project involves road excavation or road use, approval from relevant units shall be obtained before construction commences.
(6) During construction, the relevant vehicles or construction personnel personal vehicles shall not be parking on Xianbei 4th road and the corner of Xiangong road.

V. **Waste Materials**

(1) At the time of contracting this project, we will actively request that the excavated soil shall be backfilled whenever possible, while the remaining earth will be dealt with according to Changbin Industrial zone regulations.
(2) To avoid overloading the amount of excavated earth and construction waste in transit, they should be covered to minimize the impacts on surrounding environment along the way.
(3) The normal waste produced by construction workers should be collected and classified in the work area to facilitate recycling, and should be handled by the local garbage disposal system and removed by local garbage trucks and recycling trucks.
(4) During the construction period, waste such as waste parts, waste components, waste tires, waste batteries, waste solvents and so on, which are replaced by maintenance work, shall be properly collected and disposed according to general waste disposal regulations to avoid arbitrary discard and environmental pollution in construction area. For some recyclable wastes, they shall be recycled.
(5) The general wastes produced by workers from construction should be properly managed rather than disposed in Xianxi township hall garbage transfer station or nearby of it.

VI. **Plant Ecology**

(1) Prior to construction of booster station and onshore cables, planning must be made in advance and the area of use controlled, to avoid carrying out extensive vegetation removal works.
(2) During construction, the prevention and control of air pollution will be improved. For example, bare earth will be watered to prevent dust being released into the atmosphere. As for the area occupied by material storage, the bulldozers and the gravel trucks, these will be covered to reduce the impact of dust on plant growth. During construction, vegetation next to the construction roads will be regularly watered to prevent clouds of dust rising and to shelter plants.
(3) Booster Substation and other onshore construction sites will be fenced off to reduce pollution generated from construction.
(4) Washing facilities should be installed at entrances for construction vehicles entering and leaving the work area to wash the wheels and chassis of vehicles, and thereby to avoid bringing in alien invasive seeds or plants which may be caught in up in earth.

VII. **Animal Ecology**

(1) Management of construction implements used during construction will be improved and low noise implements will be utilized, to avoid the interference of increased construction noise in the area.
(2) Contractors will be instructed to improve the education of construction workers. Construction workers will be prohibited from capturing, harassing or abusing wild animals.
(3) Progressive construction methods will be adopted during the construction process, to reduce the impact on local wildlife and provide sufficient time and space for biological habitat in the area to migrate.
(4) Avoid discharging polluted water and dumping of soil during the construction period so that the ecological functions of muddy intertidal shores will not be interfered. Construction waste shall be managed centrally.

VIII. **Cultural Assets**

(1) Should relevant relics be discovered during the future development of this case, they shall be

handled in accordance with the provisions of Article 50 of the 'Cultural Heritage Preservation Act'.

a. For future discoveries of ruins, historical monuments, tribal buildings, suspected archaeological sites, ancient objects, natural landscapes, natural monuments during construction, the Cultural Heritage Preservation Act Article 33, 57, 77 and 88 shall be followed.

b. According to Article 57 of the Cultural Heritage Preservation Act, Any discovery of possible archaeological sites shall be forthwith reported to the municipal, county or city competent authorities at the locales of such possible archaeological sites for taking necessary protection measures. If a possible archaeological site is discovered in the course of a construction project or other land development work, such construction or development work shall be immediately suspended and the discovery shall be reported to the municipal, county or city competent authority at the locale of such possible archaeological site.

Besides the measures under the preceding paragraph, the competent authority shall forthwith conduct investigations, submit the case for review by the review committee, and take other relevant measures. Before the conclusion of the review procedure, the developer shall not resume the development activities.

c. According to Article 77 of the Cultural Heritage Preservation Act, If any potential antiquity is discovered in the course of a construction project or other land development activities, such construction or development work shall be immediately suspended and the discovery shall be reported to competent authority at the municipality, county or city where the antiquity is located for review according to the procedure set forth in Article 67.

d. According to Article 88 of the Cultural Heritage Preservation Act, any discovery of a site deserving of the designation of a natural landscape or natural monument shall forthwith be reported to the competent authority.If a site deserving of the designation of a natural landscape or natural monument is discovered in the course of a construction project or other land development activities, such construction or development work shall be immediately suspended and the discovery shall be reported to the competent authority.

(2) During the land construction of booster (step-down) stations and cable excavation period, commission cultural heritage archaeologists to monitor the entire process.

IX. **Landscape Esthetics**

The machinery and materials of the terrestrial transmission and distribution system engineering as well as the temporary piling of waste materials must take into consideration the overall appearance of the landscape during the construction period, and be placed in locations in keeping with the construction, rather than arbitrarily stacked here and there, to avoid any damage to the original visual landscape.

8.1.3 Period of Operations

8.1.3.1 Marine Environment

I. **Fishery Resources**

Denmark's Horns Rev is one of the world's largest offshore wind farms, located in shallow waters with depths of less than 20 meters. According to the indications of a research report by the Danish Institute for Fisheries Resources on the Horns Rev wind farm, which compared data taken from before and after the construction of the farm, the turbines were found to have had no adverse effect on local fish species. At the same time, this study also demonstrated that these foundational protective artificial stone structures can be used as artificial reefs to attract fish, and the closer to the places where turbines are located, the more new varieties of fish can be found.

The site of this project is located off the coast of Changhua County. A broad artificial fish reef effect can be achieved. So far visits to local fishermen groups and local opinion leaders have been conducted. Such visits allow communication and discussion with the local, and increase understanding of their needs. In the future, they will be invited for the pre-construction public hearing to continue the communication and consistent visits to Changhua District Fishermen's association and Changhua County Aquaculture Fisheries Development Association etc. will be carried out to ensure better communication and negotiation. For fishing right areas that are affected by this project, we will attend to compensation matters after the project is approved by the BOE.

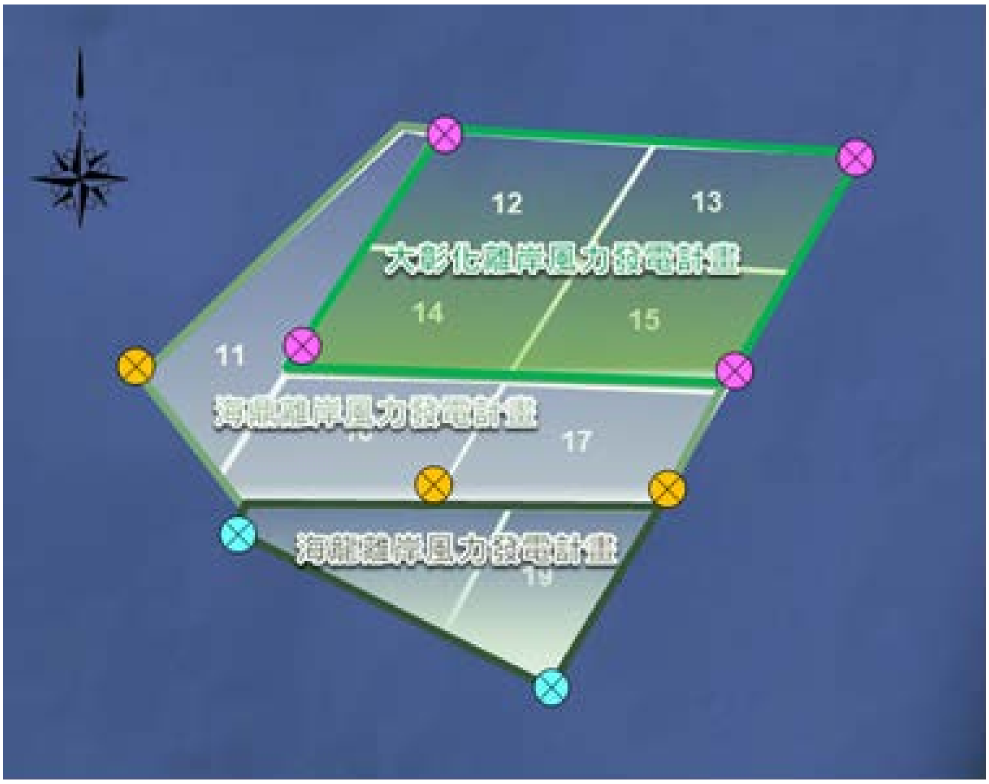
II. **Ornithology**

(1) Lower the collision impacts

1. According to European experience, if too many lights are installed on the turbine, it may have risk of attracting birds to fly close to it. The project shall follow Article 17 of the Aviation obstacle sign and obstacle light setting standard, the electric generator structure should use Type A obstructing light. Its implementing method should follow horizontal direction intervals not exceeding 900m, and be implemented on the corners or most outer row. Hence the number of warning lights installed on the turbines will be based on the wind farm layout configuration.
2. At time of environment monitoring, if large flocks of protected species or large-sized birds are passing through wind farm, the operator shall be committed to conduct a feasible speed reduction mechanism.

(2) Implement 3 high performance video recording devices to monitoring bird activities within the wind farm.

1. Implement 2 recording devices to record bird images, as a supplementary data for monitoring offshore birds. (Due to devices prone to malfunctioning offshore, continuous recording of images cannot be guaranteed, hence it serves as a supplementary info. The bird monitoring during operation need to be based on actual surveys conducted).
2. The greater Changhua, Hailong and Haiding projects shall set up a joint bird monitoring system. The monitoring system, thermal imagery, sound wave microphone, and high-performance radars' location will be implemented based on the wind farms' order and wind farm layout. The aforementioned technologies or state-of-the-art technologies at the time will be utilized for monitoring to monitor bird activities. The thermal imagery device and sound recording device are used to detect possible bird collision; radar records the birds' flying route, in order to assess barrier effect. (Figure 8.1.3.1-2)。



Note：The offshore monitoring devices' actual installation will be based on the order of the wind farms construction. This is just a conceptual design.

Figure 8.1.3.1-2 The Conceptual Design of the Joint Bird Monitoring System of this Project and Neighboring Projects

3. This project will conduct regular maintenance according to the specifications of various monitoring equipment and instruments to maintain the normal operation of the monitoring equipment. However, this cannot eliminate the possibility of natural hazards or man-made destruction. In case of such cases, the impaired devices will be repaired or replaced immediately after sea conditions permit.
4. This project has discussed the best commercialized monitoring equipment during the 9 blocks common communication platform, and shall submit the plan for approval of the supervisory committee before actual installation.
5. The monitoring device shall monitor large flocks of protected species passing the wind farm during operation to observe changes in bird density to assess the risk of bird feeding loss.

(3) Conduct ship-based bird monitoring

Shall conduct visual bird monitoring by use of monitoring vessels, conducting once per month during March to November, and conduct 1 time between December to February.

Reduce possibility of birds' colliding with wind turbines:

(2) Monitoring of birds' activities in OWF:

On south and north locations within the wind farm, camera will be installed and the video record will be supplemental data for ship-based visual monitoring.

(3) Execute monitoring plan of birds:

Ship-based visual monitoring according to monitoring plan.

III. Cetacean

The monitoring method is ship-based visual inspection at a frequency of at least 20 trips per year in order to understand their activity and the possible effects of construction on cetaceans.

IV. **Countermeasures to Reduce the Risk of Ship Collision**

The project has developed relevant mitigation countermeasures with the aim of reducing risk. Strategies which should be taken are described below:

(1) To avoid collisions with unpowered drifting boats, the operational management unit should

establish mutual rapid notification mechanisms with the coast guard, port authorities, and disaster prevention units, for the benefit of being able to issue timely notification and maximize contingency and full time to mitigate disaster should accidents occur, thereby reducing the occurrence of collision accidents as well as losses from such disasters.

(2) To avoid collisions with powered drifting boats, relevant measures include setting up relevant warning facilities.

(3) With respect to disaster mitigation, disaster response measures will achieve immediate notification, and rapid disaster prevention, with the aim of effectively mitigating disaster.

(4) When an offshore wind power plant is set up, a dedicated unit should be established to be responsible for maritime safety at all stages of construction, operation and maintenance, for collaboration with the local coast guard, port, fisheries, disaster prevention and related agencies, and for formulating maritime security disaster contingency measures.

(5) This project will set Marine and Helicopter Coordination centre (MHCC), MHCC will be the one using VTMS system to control vessel traffic within wind farm. The MHCC can get support from neighbour sites' MHCC such as SOV, CTV, crew members or rescue team when emergency happened. The emergency plan of 4 sites will be combined to utilize the max. resources.

(6) Upon completion of the wind farms, the integrated information will be proactively reported to the competent unit for publication including the location coordinates of wind turbines, seabed cable paths, emergency response measures, as well as maintenance work for large vessels and other information for relevant units and personnel to ensure at the occurrence of accidents relevant personnel will have sufficient information and know how to handle and respond. The emergency response measures are as follows:

1. If there is doubt being straddled or tripped over the seabed cables, do not attempt to pull back the fishing tools to avoid hurting personnel or damaging the vessel.
2. As far as possible describe/specify the vessel location in detail.
3. Notify the marine guard unit in the area and call 24-hour emergency telephone number to report the incident in detail.

(7) This project will use the Vessel Traffic Management System (VTMS) to control ship traffic within the wind farm. The VTMS system will integrate different systems monitoring including radar, AIS vessel automatic identification system and CCTV for display on the electronic marine map. The various systems also provide integrated cross support including the identified vessel name and number by the identification system and reflect on the radar system. CCTV can change focus of picture of unknown vessels (AIS detectable range reaches 37km and CCTV can reach approx. 10km depending on weather conditions) on the radar system. For details of this project's scheduled deployment, refer to Fig. 8.1.2.1-3). VTMS can monitor a specific area and notify the user if a vessel enters the area. VTMS can store the monitoring data and retrieve data of a specific time frame such as vessel movement, etc. This project will provide VTMS system data for use by the competent authority or the third party approved by the competent authority. In the future, with regard to this project, discussing with vessel safety related units such as the Shipping and Port Administration, Coast Guard Agency and Fishery Agency on navigation safety issues will be conducted to minimize the risk of collision. .

(8)) In case the marine wind farm equipment encounter emergency, or emergency of operation personnel on sea, contractor personnel and vessels having emergency conditions, MHCC shall be responsible for providing immediate rescue and medical first aid. The primary liaison object of such emergency shall be the MHCC coordinating personnel on duty. The on-duty offshore coordinating personnel shall be responsible for immediately reporting to the Coast Guard Agency and engage in liaison and cooperation with the related Coast Guard Agency Action Center to resolve emergency situations.

(9) If there is an emergency involving other ships or personnel (third parties) in the vicinity or in the wind farm, the relevant personnel may notify the incident. If possible, the emergency

incident can be assessed by MHCC. According to international maritime agreements and practices (such as the SOLAS Convention), when CGA or MOTC asks for assistance, our developer of this project will also provide assisting support if possible.

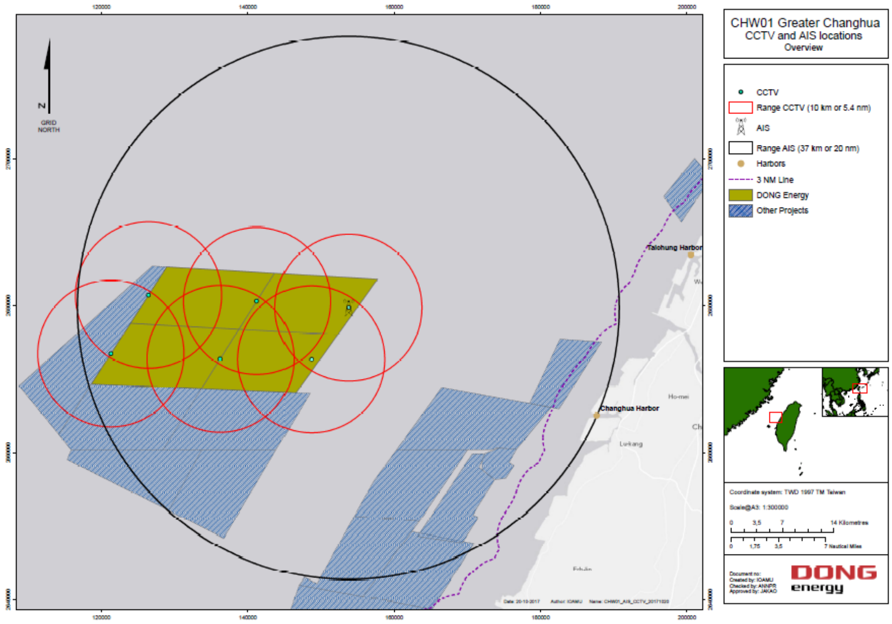


Figure 8.1.3.1-3 CCTV and AIS Planned Layout

V. Air Quality

All oil used on the vessels should be the lowest containing in sulphur, available in Taiwan at the time.

8.1.3.2 Terrestrial Environment

I. Recreation

In coordination with the needs of local recreational attractions, should there be appropriate locations available for use; we will set up signs or explanation facilities so that in their extra time visitors to the area are able to obtain relevant information, in order to enhance the diversity of their recreational experiences.

II. Terrestrial Ecology

(1) Maintenance work on booster station and onshore cables during operations should avoid relevant personnel going through them directly and causing damage to planting and disturbing wildlife habitats.

(2) Habitat restoration work (landscape planting work) will be carried out on areas surrounding on-land facilities, in order to facilitate the return of more environmentally sensitive animals.

III. Transportation

IV. Waste

V. Noise

VI. Air Quality

(1) Encourage personnel to take public transit or eliminate 2-trip motorbikes. In the future personnel are restricted to ride 2-trip motorbikes into the O&M center.

(2) The O&M center should procure electric cars under its ownership in the year of operation. At the parking lot, there should reserve motors and car chargers.

(3) Be sure to conduct air quality monitoring.

8.2 Environmental Management Program

In order to implement environmental impact assessments and ensure that the construction and operation of wind turbines does not adversely affect the environment, during the construction and operation periods, the following items of environmental management planning will be carried out:

I. **Countermeasures to Reduce Environmental Impact During Construction and Operations**
With respect to the environmental impact caused by this project's actions of development, in section 8.1 of the project's Environmental Impact Statement, environmental impact reduction (or avoidance) countermeasures are elaborated, and countermeasures are formulated according to the degree, scope, and characteristics of environmental impact of developmental actions during the construction period and operational period.

The project will require contractors to conduct self-management, checking on a daily basis whether or not each item of environmental protection measures has been implemented and executed, and the Developer's construction unit will carry out checks at unscheduled times. The environmental protection personnel of the construction unit will carry out regular inspections, and clearly stipulate penalties for contractors, while the Developer's environmental protection personnel will carry out unscheduled supervision to ensure that the project is indeed executed in accordance with the content of the Environmental Impact Assessment.

II. **Environmental Monitoring Plan**
The main purpose of environmental monitoring is to carry out regular measurement of the quality of the environment near the project site, to learn whether this project has created any adverse effects on the environment during the construction and operational periods, including the marine offshore wind turbine modules and the on-land electricity transmission and distribution work, in order to promptly take appropriate measures to prevent the occurrence of pollution, and genuinely achieve the functions of the Environmental Impact Assessment. This plan has formulated stringent environmental monitoring procedures for such items as air, construction noise, noise vibrations, underwater noise, and seawater quality and ecology (including avian ecology, terrestrial ecology, and marine ecology).

Each monitoring item of the physio-chemical environment of this environmental monitoring plan will commission qualified testing companies to execute monitoring. For various other specialized items of the ecology, underwater noise and so on, ecological consultancy companies or experts will be commissioned to carry out investigation. The Developer will also carry out internal auditing.

III. **Constructing and Operating a Safety Management Plan**
To prevent the occurrence of disaster, a safety management plan is a pre-planned scheme made in response to a variety of sudden incidents. Its aim is to ensure that matters do not develop into disasters, so that a small disaster is limited in scale and doesn't become a huge catastrophe. Before construction is carried out on the offshore wind farm, rational and appropriate work procedures should be planned according to the base assembly conditions, maritime transport conditions and the capacity of facilities. Before offshore construction begins, surveys of the weather and sea conditions should be carried out, to gain an immediate understanding of short-term forecast data, and appropriate transport times should be selected accordingly, avoiding the possibility of carrying out transportation in heavy seas or rainstorms. As for the meteorological and sea conditions suitable for ship navigation operations, these should be determined after comprehensive considerations such as vessel configuration and performance, technical requirements of equipment and so on. See Section 8.2.3 for Construction Safety Management

Plan details; Section 8.2.4 for operational Safety Management Plan details.

8.2.1 Environmental Management Organization

I. Environmental Management During the Construction Phase

(1) Environmental Organization

The units involved in the construction of this engineering project include the developer, and engineering contractors. All business at the site needs to go through coordinated operations between the two. Therefore, matters related to the site's environmental protection work will be implemented jointly by the developer and contractors.

(2) Key Points of Management

1. Contractor's construction plans and environmental management plans shall be audited before they can commence work only after approval.
2. Maintenance of the work area's environmental quality
   a. Maintenance of air quality
   b. Prevention of noise and vibration
   c. Pollution control of the work site's effluence
   d. Environmental, Waste Management and Spill Response Systems being in place at aeach construction site and vessel
   e. Minimising waste
3. Maintenance of road traffic
4. Maintenance of the site's landscape
5. Good-neighbor policy
6. Environmental monitoring of the construction phase
7. Evaluation of effectiveness of environmental protection and management
8. Establishment of an accident and disaster relief working group

(3) Key Points of Operational Execution

1. Developer
   a. Listing of the Environmental Impact Statement's construction phase environmental protection measures, carrying out auditing of the contractor implementation procedures on a regular basis, and making records of them.
   b. Carrying out environmental monitoring during construction, regularly collating environmental monitoring reports, to facilitate public assess and scrutiny and the tracking of investigative information.
   c. The implementation of environmental monitoring will be subject to timely adjustments according to the monitoring results.
2. Contractors
   a. Execution of work site environmental protection measures, including the prevention and control of water pollution, control of air pollution, control of construction noise, waste disposal, landscape maintenance, and so forth.
   b. Flexible adjustment of operational practices will be carried out according to the instructions of the development unit to improve environmental protection measures, in order to comply with regulatory standards.
3. Management System
   a. Scheduled discussion of environmental matters will be held between the work area working group and contractors.
   b. Scheduled work site safety, health and environmental review meetings will be held.
   c. Scheduled environmental health and safety training of personnel will be held.
   d. Personnel will be sent to attend various environmental workshop classes held by each unit in order to gain a clear understanding of relevant laws and measures.

II. **Environmental Management During the Operational Phase**

(1) Environmental Organization

After operations begin, environmental management work will be carried out by the developer and relevant contractors, which will be responsible for the implementation of various environmental management protection matters.

(2) Key Points of Management

1. To carry out the environmental protection matters as per the commitments of the Environmental Impact Statement
2. To address cases of public complaint and public communications on environmental matters
3. Collection and promotion of environmental regulations and technical data
4. The writing and execution of industrial health and safety work regulations
5. The formulation and practice of disaster prevention and emergency response drills
6. The implementation of environmental protection work

III. **Environmental Management During the Decommissioning Phase**

(1) Environmental Organization

The units responsible for the decommissioning of the Project include the developer and the Project Contractor. All on-site work should be conducted jointly by the two units through coordination. The EP work related to the decommissioning of the wind farm will be carried out jointly by the developer and the Contractor.

(2) Key Points of Management

a. Only after the auditing and approval of contractor's decommissioning plans and environmental management plans, decommissioning work may be carried out.
b. Public communication
c. Assessment of the effectiveness of environmental protection and management
d. Establishment of contingency and emergency task force

IV. Supervisory committee (Environmental protection supervisory team)

. The developer has committed to establishing an environmental supervision group before construction to inspect the situations of handling issues involved with protected species and environmental monitoring from the EIS report review conclusions. The members should be no less than 15, with experts and scholars consisting no less than 1/3, local groups, residents and fishermen representatives should be no less than 1/3. 1 week prior to the meeting being held, the information should be posted in places or on websites suitable to the public, so that the general public can apply to participate or raise comments. Relevant survey and supervisory information should be published on the developer’s website for public reference, so as to disclose information.

8.2.2 Environmental Monitoring Plan

The environmental monitoring plan of this project is formulated and determined in accordance with the development content, environmental status, the results of environmental impact assessment, environmental impact reduction measures, environmental regulations, and so forth. The purpose of environmental monitoring is:

1. To track substantial impacts on the environment resulting from the project's construction work and operations.
2. To carry out necessary improvements to various pollution control measures in a timely manner.
3. To understand unexpected environmental impacts, and rapidly seek countermeasures in response.

As the effects of this project on the environment are different at various stages of its implementation, the reduction measures adopted are also not the same. For this reason, the monitoring plan is separated as the pre-construction phase, construction phase and operational phase. Monitoring survey methods are mainly carried out in accordance with or with reference to the Environmental Protection Agency's publicly announced technical standards for animals, plants, and marine ecology. Items of monitoring during the pre-construction phase of the monitoring plan include cetacean ecology and underwater noise; monitoring items during construction phase included air quality, construction noise, noise vibrations, seawater quality, terrestrial ecology, avian ecology, marine ecology, underwater noise surveys and so forth; while those for the operational stage include avian ecology, marine ecology, underwater noise surveys, and so forth. Details of the monitoring plan are shown in tables 8.2.2-1 to 8.2.2-3. Before ceasing the execution of monitoring items during the operational period, in accordance with the provisions of Article 37 of the Environmental Impact Assessment Act Enforcement Rules, application to carry out changes will be made.

Relevant survey and supervisory information should be published on the developer's website for public reference, so as to disclose information.

Table 8.2.2-1 Environment Monitoring Plan Before Construction Stage

Category	Monitoring Items	Location	Frequency
Marine Ecology	Cetacean ecology investigation	wind farm and its peripheral	20 trips/year, lasting for one year before construction
Under water noise	Underwater noise of 20 Hz～20kHz range, Analysis of Spectrogram and 1-Hz band、1/3 Octave band	2 stations on the wind farm boundary	4 season/year. 30 days each season, lasting for one year before construction
Seawater quality	Water temperature, pH, BPD, salinity, dissolved oxygen, Ammonia nitrogen, nutrients, suspended solids and Chlorophyll, e.coli	12 points adjacent to the turbines	Once per season, conduct 1 full year survey before construction
Bird ecology	Species, quantity, habitat and activity, flying route, seasonal changes in groups (including coastal birds and water birds)	wind farm peripheral and coastal areas nearby the landing point	2 years before construction, conduct monthly between March to November. From December to February conduct once, in total conduct 10 seasons of survey per year
	Bird radar survey（vertical and horizontal）	wind farm and its peripheral	2 years before construction, once per season (spring, summer, fall at least 5 times, winter will depend on weather, each survey will include day and night survey)
	Bird band satellite tracking	Coastal region of Changhua	Before construction, conduct once per season
Cultural heritage	Underwater cultural heritage interpretation	Turbine location borehole sampling	Archaeologists assist in interpretation (before construction, each turbine location borehole sampling)
	Terrestrial cultural heritage interpretation	Terrestrial booster (step-down) station location borehole sampling	Archaeologists assist in interpretation (3 spots before construction)

Note 1：Terrestrial monitoring (terrestrial cultural heritage) items will start based on the starting date of the terrestrial construction (booster station and terrestrial construction) and counting ahead of it.

Note 2：Marine monitoring (marine ecology, underwater noise, seawater quality, bird ecology, underwater cultural heritage) items will start based on the starting date of the marine construction, and counting ahead of it.

Table 8.2.2-2 Environment Monitoring Plan in Construction Period

Category		Monitoring Item	Location	Frequency
Terrestrial	Air Quality (Note)	Wind direction and wind speed, particle pollutants (TSP、PM_{10}、$PM_{2.5}$)	1. Wuqi fishing port 2. One station at adjacent of Booster Station	Once a season
	Noise & Vibration (Note)	Equivalent energy Sound Level and Day and Night Vibration Level (Daytime, Evening and Night time)	1. 1 station near sensitive point of land-based construction. 2. 1 station at the entrance/exit of road to land-based construction.	Once a season and each time 24 hours monitoring continuously
	Terrestial Ecology (Note)	Shore side animal and plant ecology (Conduct per Animal and Plant Technical Code of EPA)	Shore side power transmission and distribution system (incl. area next to Booster station and Shore Cable area)	Once a season
	Construction Noise	1. Low Frequency （20 Hz ～200 Hz, Leq） 2. Ordinary frequency (（20 Hz～200 Hz, Leq and Lmax）	1. 1 station at the border of power distribution substation. 2. 1 station at the border of on-land power cable.	Once a month
Marine	Marine Water Quality	Water temperature, Hydrogen Ion concentration, BOD, Salinity, Oxygen Solubility, Nitrogen, Nutrient sale, Suspending solid and Chlorophyll A and e-Coli culture	12 stations at neighboring area of wind far	Once a season
	Bird Ecology	Species, quantity, habitant, and activities, flying route, seasonal change of population (including shore side bird and Water bird)	Wind farm and the neighboring shore areas at landing point	Once per season in summer (June~Aug) and winter (Dec~Feb); Once per month in spring (March~May) and autumn (Sep~Nov)
	Marine Ecology	1.Ecology of intertidal zone	Conduct investigation in area 50 m within the location marine cable goes up from the sea.	Once a season
		2.plankton, fish eggs, fish larvae, benthic organisms	12 stations at wind farm and neighboring area	
		3. Fish	Investigate 3 measuring lines	Once a season
		4. Cetacean Ecology Investigation	Wind farm area	20 times / year (at least once per season)
		5. Underwater video recording of turbine bottom fish aggregation	Select one turbine	Conduct before and after piling, 1 time each.
	Under Water Noise	Underwater noise of 20 Hz ～20kHz range, Analysis of Spectrogram and 1-Hz band、1/3 Octave band	one station at 750m away from piling location for wind turbine	Once a month during piling period
			2 stations in the periphery of the wind turbines.	Once a season

Note: 1. Construction noise monitoring will be conducted during the construction of power distribution substation and land-based power cable deployment.
2. Terrestrial monitoring items (air quality, noise, vibration and Terrestrial ecology) will be conducted during construction period of onshore works of the project
3. Marine monitoring items (marine water quality, marine avian, marine ecology and underwater noise) will be conducted during the period of marine construction.

Table 8.2.2-3 Environment Monitoring Plan during Operation Stages

Category	Monitoring Items	Location	Frequency
Bird Ecology	Species, quantity, habitant, and activities, flying route, seasonal change of population (including onshore and offshore birds)	Wind farm and the neighboring shore areas at landing point	Once per season in summer (June~Aug) and winter (Dec~Feb); Once per month in spring (March~May) and autumn (Sep~Nov)
	Joint monitoring system (install thermal imagery, sound wave microphone, and high performance radar, or any higher advanced monitoring devices at the time)[note]	1 spot in the wind turbine area	Continuous monitoring
	Bird image recording (install video recording device)	2 spots within the wind farm	Continuous monitoring
Marine Ecology	1. plankton, 2. fish eggs, fish larvae, 3. benthic organisms	12 stations in wind farm and the peripheral	Once a season
	4. Fish (include the distribution of species and monitoring of changes in richness by location of wind turbine)	3 measuring lines investigation for fish	Once a season
	5.Cetacean ecology investigation	Wind farm area	20 times / year
	6. Underwater video recording of turbine bottom fish aggregation	Select 2 turbines	Conduct once per season during operation
Under water noise	Underwater noise of 20 Hz～20kHz range, Analysis of Spectrogram and 1-Hz band、1/3 Octave band	2 stations near wind farm boundary	Once a season
Fishery economy	Analyze the fishery annual report issued by the FA including data relevant to fishery economy (fishery environment, fishing equipment, fish catch, fishermen, etc.)	The fishery annual report announced by the FA	Once per year

Note: Before suspending performance of the monitoring items, it shall be applied for suspending the monitoring works in operation stages pursuant to Clause 37 of Enforcement Regulations for Environmental assessment.

8.2.3 Safety Management Plan

This project will adopt a Risk Based approach to the management of HSE for all aspects of operations. This Risk Based approach requires that all hazards to the health and safety of persons and the protection of the environment during operation are to be eliminated, or their associated risks reduced wherever possible and, as a minimum, to levels below tolerable risk during the design and planning of the work and prior to the commencement of any associated activities. Further risk reduction shall be sought to levels As Low As Reasonably Practicable (ALARP). This project will implement the Site Safety Rules for all persons attending the Onshore Base or any vessel or any offshore structure.

The safety management items below are suitable for construction and operation phase, and the safety management targeting specifically for construction and operation will be elaborated in the next two sections.

I. During development, construction, operation, maintenance and decommissioning or repowering of the developer's offshore windfarms, the developer will make every effort to ensure environmental protection and the health and safety of all persons that might in any way be affected by the project's activities.

The health and safety of all persons involved directly or indirectly in this project and the protection of the environment, are the primary objectives of all those concerned with the successful HSE management of the operation. Consequently, HSE objectives for the operation are that all work will be completed without injury to, or damage to the health of any person whether engaged on the works or not, and without damage to the environment. These objectives also apply to Contractors, their subcontractors and any third party involved in the operation. The project's HSE principles include:

1. Reduction of emissions harmful to environment and health
2. Targeted work on most resource-efficient production of energy, use more environmentally friendly raw materials, reduction of environmentally harmful chemicals
3. Waste will be avoided and recycled as possible
4. Immediate consideration of the environment and the surrounding nature during operation;
5. To provide a safe, healthy and attractive workplace for employees.

II. Emergency Response Organization

1. The emergency response organisation is divided into three levels:

    a. 1st line emergency response is responsible for combat and rescue at the site of damage.
    b. 2nd line emergency response is a support function and is to supply tactical guidance to the 1st line emergency response.
    c. 3rd line emergency response is a strategic function that deals with contact to superior partners and management within the company.

2. The purpose of the risk assessment process:

    a. identify hazardous situations and potential accidental events such as the potential for earthquakes and weather related events during the typhoon season,
    b. identify initiating events and describe their potential causes,

c. analyse accidental sequences and their possible consequences,
d. identify and assess risk reducing measures,
e. provide a nuanced and overall picture of the risk, presented in a way suitable for the various target groups/users and their specific needs and use.

3. The risk assessment will consist on the following:

   a. Establishing the context
   b. Hazard Identification (HAZID)
   c. Analysis of potential initiating events
   d. Analysis of potential consequences
   e. Establishing the risk picture
   f. Risk Evaluation

4. Emergency preparedness
   The emergency preparedness will be determined after having established the Defined Situations of Hazard and Accidents (DSHA) which will include events like earthquake and extreme weather situations due the high winds and seas during the typhoon season. The emergency preparedness will also determine the performance requirements which will be defined by this project and based upon relevant legislation. The performance requirements are basically the time it is accepted that the response to the DSHAs should take.

   The determination of the emergency preparedness will consist of the following steps:
   a. Establishing Defines Situations of Hazard and Accident Situations (DSHA)
   b. Establishing governing performance requirements
   c. Identify response strategies

5. Communication Plan
   The 1st Line Emergency Response will include a communication plan in order to ensure that 2nd and 3rd line in informed in case the emergency response plan is activated. The communication plan will also include the Search and Rescue (SAR) resources that are available and contact information to official bodies like the coast guard, relevant ministries and other authorities.

6. Training and exercises
   The 1st Line Emergency response Plan will include the training requirements for involved personnel and an exercise plan for maintaining the emergency preparedness capabilities in the organisation.

7. Instructions to emergency personnel
   The instructions to emergency personnel will be prepared as a part of the 1st Line Emergency Response Plan. The content of those instructions will be based on the response strategies and reflect the responsibilities, tasks and skills of the individual teams/positions.

III. Emergency Preparedness and Response

The operation requires an effective emergency preparedness and response plan that amongst others

1. continually reviews the emergency response scenario’s given by this project and Contractors on applicability, realism and effectiveness;

2. ensures the availability of an operation internal response and group level internal response depending on the severity of the emergency to ensure, the protection of life and the environment, the preservation of the assets and of the company.
3. Identifies training needs of personnel in respect to emergency preparedness and ensures the developer and Contractors personnel are informed and trained;
4. plans and executes emergency exercises, either table top or live, to assess the emergency plans with regard to scenarios, course of actions and equipment;
5. ensures the suitable recording and control of information of the emergency response proceedings.

Contractors shall ensure that they have in place an Emergency Preparedness Plan supported by such procedures for emergency response as are needed for the nature of their scope of work. Their Emergency Response Plans are to become an integral part of the overall operation's emergency response system, shall comply with the overall requirements and will be regularly updated. Each time two or more Emergency Response Plans are interacting, a bridging document shall be created and implemented.

IV. Communication, participation and consultation

1. Safety meetings

To ensure adequate and effecting HSE related communication, the following meetings shall be held regularly.

a. Meetings on site shall be held either at the onshore facility or on board a suitable vessel. They shall include at least the coordination with Contractors regarding the site and health, safety and environmental issues. The developer will record minutes of the meetings. Additional meetings may be held as required.

b. A documented Toolbox Talk or HSE briefing shall be conducted prior to the work shift (daily) and at the commencement of a task with new risks or risk control measures. Topics of discussion shall include, but not be limited to, workplace incidents and reviews of task specific risk assessments, method statements, lift plans and Job Safety Analysis.

c. The developer will prepare and issue Safety Briefings as appropriate and as required. These briefings deliver topical safety information to Contractors, e.g. lessons learned from Incident investigations.

d. Safety Awareness Workshops are workshops with specific topics in relation to health and safety. They are led by the Operation HSE Manager to raise specific HSE issues to people and Contractors on site as appropriate and required.

e. As far as required the developer will participate at meetings with public authorities. Contractors are to be informed about the results in the regular meetings on site.

f. A Safety Meeting will be held and documented. The Safety Meeting will be led by the HSE Site Manager and/or the Project HSE Manager. The personnel in the meeting should as minimum include the representatives of all contractors on site as well as contractors commencing their work within the next two weeks. The Safety Meeting can be held by telephone conference as deemed appropriate by the HSE Site Manager, e.g. in phases when only few contractors are present on site. It can be combined with the Toolbox Meeting (see above).

g. A log of events (so called ‘Safety Log’), incidents, near misses, first aid cases etc. is to be established by the contractor and submitted according to the procedure “Incident Reporting and Investigation”. The events will be discussed in the Safety Meetings until all actions derived from the event have been closed out.

V. Personal Protective Equipment (PPE)

1. Rules and Requirements

All developer, Contractors, Vendor, personnel and visitors will be expected to use adequate Personal Protective Equipment (PPE),

The following requirements apply to PPE and to their user.

a. All PPE must meet the necessary European and local standards.

b. All personnel on site must be equipped with appropriate, tested and approved PPE as per risk assessment by the employer;

c. All employees will be provided with suitable instruction, information and training to enable them to make effective and safe use of the PPE provided:

d. All PPE must be worn, used, inspected, stored, washed and disposed of as per manufacturer’s instructions. Lifespan shall not be exceeded. Equipment provided for personal safety must not be misused or removed from its rightful place.

The following rules apply to PPE and to their user.

a. It is strictly forbidden to tamper with safety equipment, including PPE.

b. Do not mark or label PPE unless the PPE has a dedicated space signalled for such use.

c. All PPE must be put out of use and brought to the appointed expert inspector following a shock or a use of their safety function (e.g. after a fall).

d. Know the risks associated with the use of shock absorbers.

e. Positioning lanyards are not be used as fall arrester as do not offer this function.

f. Protective equipment is to be used only for work purposes and not for domestic use.

g. It is the duty of any person witnessing someone wearing inadequate PPE for the task/area they are in to inform them to either correct the situation or leave the area immediately.

2. Inspection and maintenance

Regulations compliant inspection and maintenance schedules shall be implemented to ensure continued suitability of PPE.

3. PPE minimum requirements

Adequate PPE must be worn by all persons. PPE requirements for all tasks shall be identified and worn in accordance with the work instructions, task procedure, Permit to

Work and/or risk assessment. A detailed PPE minimum requirement will be determined at a later stage.

Contractors must provide approved, adequate and relevant PPE for their own people.

VI. Special activities with increased hazardous risks and work procedures

Special activities with increased hazardous risks have to be controlled with a documented and detailed risk assessment. These activities are inter alia:

1. Electrical work
2. Working at height
3. Working over or adjacent to water (e. g. on ships, WTG)
4. Offshore transfer
5. Crane and lifting operations
6. Electrical works
7. Access to and working in confined spaces
8. Drilling and earth work
9. Working with or storing of hazardous substances
10. Diving
11. Hot works (e. g. welding work)
12. Working with ionizing radiation
13. Abrasive blasting and varnishing
14. Bunkering
15. Scaffolding work
16. Work with hydraulic devices and tools
17. Work at safety devices and systems (e. g. vertical climbing protection, fire and gas warning system, loudspeaker system, rescue and fire extinguishing system)
18. Work during adverse weather conditions (e. g. storm, thunderstorm)
19. Stay in the nacelle of WTG during test runs

VII. Fire protection

1. Fire fighting equipment and drills

   a. Emergency exits and escape routes have to be kept clear at all times.

   b. All employees shall be familiar with the firefighting arrangements for the site including the locations of fire alarms portable fire extinguishers and escape and rescue plans. Firefighting equipment shall not be altered, tampered with or blocked and be ready for use.

   c. All personnel must participate in site fire drills.

2. Fire prevention

   The following rules must be observed:

   a. When handling flammable materials, smoking or open flames are prohibited.

   b. All engines should be shut down before fuelling except when the refuelling location is sufficiently removed from the engine.

c. Explosion proof equipment shall be used in any location where flammable mixtures can be expected or may be present. Extreme caution should be taken in areas where flammable vapours are present or suspected

d. Flammable liquids such as gasoline, kerosene, fuel oil, etc. shall be transported and stored only in approved metal containers and the containers are to be correctly labelled. Make sure that all loose inflammable materials are removed from the immediate area.

e. Combustible materials such as rags, paper, and trash shall be disposed of in proper containers and the containers labelled according to legal requirements. Rubbish must not be burned on-site.

f. Should a "naked flame" (gas torch, oxyacetylene torch etc.) be necessary concerning a specific job/work process or any other kind of work been carried out requiring or causing heat sources, ensure that a "Hot Work" permit has been issued and remains valid.

VIII. Unfavourable Weather

Contractors shall ensure the existence and application of a procedure to ensure the protection of the health and safety of persons in regards to the risks associated with environmental conditions and bad weather. The procedure shall define measures to mitigate the potential risks. This should include, but is not limited to, restricted access due to weather conditions, special weather clothing, pauses frequency and provision of water.

IX. Earthquakes and Typhoon

After the occurrence of earthquakes, close attention should be paid to the release of tsunami warnings. Should work boats be unable to bear the impact of the tsunami's wave height, personnel on board should be transported at the earliest opportunity to the nearest larger work boat or take refuge in completed wind turbine towers.

Attention must be paid to typhoon formation at any time and emergency evacuation preparations must be made two days before sea typhoon forecast. After sea typhoon forecasts have been released, emergency evacuation should be carried out. The workboat fleet should withdraw according to the following procedures:

1. Ceasing construction-related operations such as lifting.

2. Placing underwater recovery equipment on deck.

3. All machine equipment should be secured.

4. Lighters and tug boats should assist in hauling back anchor and anchor lines.

5. All work personnel must be on board for safety reasons.

6. Tug boats should carefully tow work vessels into harbor to be securely moored at designated piers.

X. Control of substances hazardous to health

The use and storage of hazardous materials will be in accordance with the relevant legislation and the developer’s procedures. All statutory medical requirement and training for the use of substances particularly hazardous to health shall be observed.

XI. Noise

The exposure of employees to noise shall be risk assessed and a relevant procedure with mitigations measures shall be in place. Regulatory requirements and best practices shall be implemented.

XII. Oil Leakage

The project developer has made an emergency oil leakage plan as follows, but the construction vessel team itself has relevant emergency response plans such as SOPEP(Ship Oil Pollution Prevention Plan). If such incidents take place, the project developer shall cooperate to prevent pollution from expanding.

Table 8.2.3-1 Oil Leakage Emergency Response Table

Marine pollution from installation **08**

Installation contingency

Person	Action
Installation	• Stop the incident. • Carry out prevention containment and clean-up activities - Alert crew boat - Identify source - Control discharge - Contain pollution and clean-up to fullest extent possible by available means.
Crew boat	• Proceed to the installation • Transfer spill kits to installation • Pick up additional technicians on other installations to assist in the clean-up activities • Inform MHC Inform rescue centre (e.g. JRCC/MRCC).
MHC	• Ensure that the rescue centre (e.g. JRCC/MRCC) has been informed of incident.

Note:
Chemical dispersants must not be used at any time, except in accordance with specific instructions from the relevant authority

Service	Contact	VHF	Service	Contact	VHF
MHC		Px	JRCC / MRCC		Ch. 16

In addition, the plan will also be accompanied by relevant regulations for notification and contingency work, as explained below.

(1) Reporting work (according to water pollution emergency responses operating points, report to pertinent competent authorities)

1. Reporting person’s name, job title, unit, location

2. Source of pollution and reason.

3. Incident occurring time, location or coordinates.

4. Pollutant type and characteristics 污染物種類及特性。

5. Level of pollution, amount and measures taken

6. Weather condition and possible pollution impact

(2) Response Measure

1. Provide detailed structural drawings, equipment, pipelines, and cargo and oil distribution maps of relevant facilities or hulls in which marine pollution occured

2. Assist in dispatching personnel familiar with the polluting facilities or ship decks, engineers, and refueling personnel to deal with the contingency and participate in the emergency response team established by each agency

3. Coordination and dispatch of equipment for pollution and response personnel in the emergency center.

(3) Response equipment in proximity

Changhua County has placed relevant relevant materials and equipment in 7 locations according to the potential of marine pollution and sensitive locations. Please refer to Figure 8.2.3-1. The project will actively grasp the latest information on the pollution potential and sensitive location of Changhua County during construction and operation.

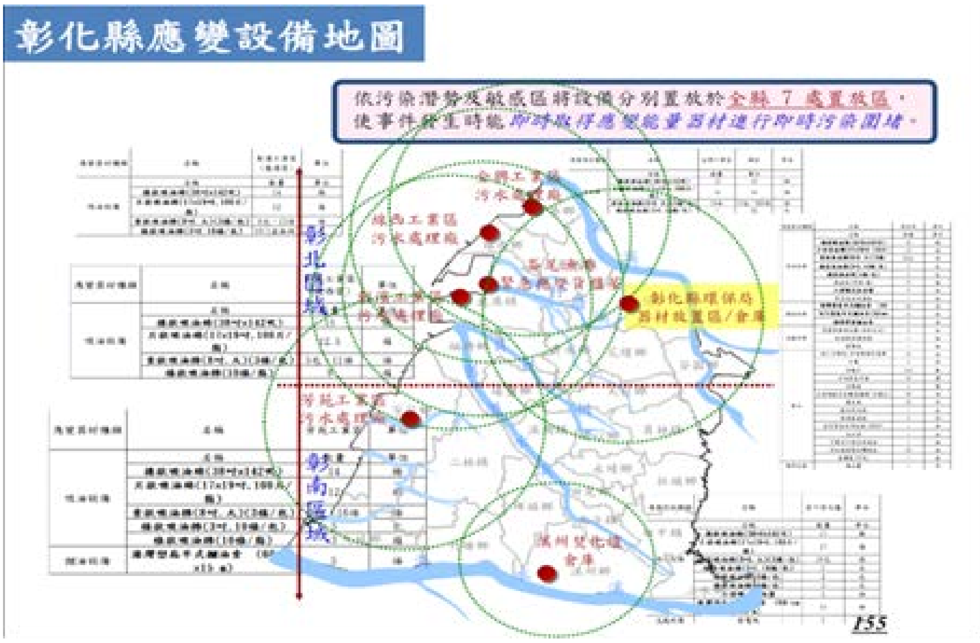


Figure 8.2.3-1 Changhua County Response Equipment Map

XIII. Working at Height

1. All works with a risk of falling at heights or depths shall be the defined in a risk assessed method statement.
2. A special emphasis is to be given to rescue and emergency situations.
3. When defining corrective measures, collective fall prevention measures shall always be preferred to individual measures.

4. Working at height, including the use of scaffold, ladders and mobile/self-elevating platforms, shall be in accordance with legal regulations.

XIV. Lifting Operations

This project differentiates simple lifting operations which are straightforward, common lifting operations such as lifting a box or small equipment from complex lifting operations which are complicated and unusual such as main components installation, tandem lifts or blind lifts.

All lifting operations are subject to special safety requirements. These requirements are described in the general instructions. Only competent and trained persons shall participate in lifting operations or their preparation. Lift operations shall be the object of a permit to work system.

The competent person appointed for the lift, whether simple or complex, shall ensure that nobody is working or passing under the load. The lift area shall be signalled as dangerous area and intrusions prevented.

1. Lifting equipment

Lifting equipment is subject to a planned maintenance programme in conjunction with the statutory inspection requirements.

2. Simple lifts

Simple lifts can be done according to one generic lift plan and risk assessment.

3. Complex lifts

Complex lifts require a specific lift plan and risk assessment. All lifting operations will be reviewed like installation activities.

4. Transportation of Persons

The Transport of persons using a crane is only allowed with approved lifting appliances and lifting attachment. It shall be ensured that a risk assessment and a method statement has been created prior to the transportation of persons using a lifting device. An emergency plan shall be developed, communicated and understood. In the event of a malfunction reliable means of rescue must be available.

XV. Excavation Works

This general instruction defines the requirements for safe working and practice with regard to excavations. It ensures that a risk assessment for this activity is sufficient and addressed all hazards.

XVI. Disposal of Waste

Each contractor is obligated to avoid waste to the extent possible. The aim is to conserve natural resources, prevent waste, as well as high-quality environmentally sound recovery of unavoidable waste. It is important to ensure proper use of material separation and collection.

XVII. Lone Working

For safety reasons, lone working will not be permitted on any onshore or offshore construction site. Generally a working team on a wind turbine or on the substation consists of a minimum of two persons. For special works (e. g. working at height or in confined spaces) a Permit to Work is required. Based on the risk assessment more persons may be needed.

For office environment, lone working is only allowed when risk assessed and when appropriate mitigation measures are in place.

XVIII. Risk management – Construction and Commissioning

The risk management for construction and commissioning have specific procedures in place for:

1. Risk Assessed Method Statements

This project requires that all activities within the Project are to be risk assessed before the work starts. Therefore, all contractors are obliged to submit the risk assessments complemented by the respective method statements and operating instructions to the Project HSE Manager in due time to allow for exchange of comments with the originator.

2. Changes in Construction & Commissioning

When it is proposed to make a change to any construction procedure, Method Statement or Safe System of Work, such changes, whenever they might arise shall require the change to be risk assessed. The Project HSE Manager will be promptly notified of the proposed change and the Management of Change process followed.

3. Risk Assessment Workshops

The Contractor is expected to use industry recognised tools to construct its risk assessment. Participation of personnel directly involved in the operations is essential.

For interfaces between contractors, major installation activities and contingency activities, the Project HSE Manager can call for a meeting called "Risk and Readiness Review" with all stakeholders in order to review the risks of the planned activities and how these risks have been addressed as well as to review the level of readiness of the contractors to perform their tasks. The contractor shall participate in this meeting.

XIX. Construction Safety Training

Contractors are obliged to ensure that all works under their management are conducted by personnel who are qualified and competent to do conduct these works.The training requirements for a person working offshore on specific tasks are governed by the specific function to be performed and the associated risk assessment. This could include e.g.:

1. Confined and Enclosed Space
2. Electrical Instructions
3. Wind turbine safety rules
4. Training for emergency response
5. Work with electrical hazard
6. HV- works
7. Helicopter Landing Officer

8. Lifting operations
9. Construction site vehicle driver
10. Helicopter Underwater Escape Training

XX. Operation Safety Training

Contractors are obliged to ensure that all works under their management are conducted by personnel who are qualified and competent to do conduct these works.

The training requirements for a person working offshore on specific tasks are governed by the specific function to be performed and the associated risk assessment. This could include, but not limited to:

1. Confined and Enclosed Space
2. Electrical Instructions
3. Wind turbine safety rules
4. Training for emergency response
5. Work with electrical hazard
6. HV- works
7. Helicopter Landing Officer
8. Lifting operations incl. the use of cranes
9. Helicopter Underwater Escape Training, if relevant

8.3 Alternatives

The alternative in this project includes: 1). Zero project; 2). Location alternative; 3). Technic alternatives; 4). Alternatives for environmental protecting measure. Alternatives for this developing project is specified as follows (abstract is shown as Chart 8.3-1):

8.3.1 Zero Program

"Zero Project" means termination of the wind farm project. The wind farm Project aims at supporting the government's energy policy and the objective to make Taiwan a non-nuclear area in 2025. The Project steps up the development of offshore wind farm in support of the policy of diversified energy sources, energy self-sufficiency, and environmental protection. In line with the government's energy policy, a ratio is set between the recyclable energy and total power generation capacity of Taiwan. The Project will bring international experience to Taiwan's wind power generation industry through in-depth interchange and interaction arrangement. The Project will also integrate the resources of the industry, government, and academic fields for a better future in terms of energy development. As a result, the Project has a positive significance. After the Project has been implemented, Taiwan has a better opportunity to lead the development of the energy clusters in Asia and Pacific. Therefore, the project is not suitable to be adopted.

8.3.2 Site Alternatives

No site alternative is in this project.

8.3.3 Technology Alternatives

Under this Proect, a wind turbine can be installed in single-pile or jacket structure. An alternative is to use gravity seabed foundation for the wind turbine. A gravity seabed foundation is made with reinforced concrete or steel structure to which the pillar of a wind turbine is attached. The gravity seabed foundation is further fixed with ballast consisting of sand, iron ore, or rocks to support the wind turbine.

Since gravity seabed foundation doesn't need piling, this method has less impact on the marine mammals. However, this method requires a solid geological seabed. The projected site of the wind farm is in a location consisting of the sediments carried by Zhuoshui River and deposited in Taiwan Strait. In case gravity seabed foundations are erected in this area, seismic waves produced by earthquakes may lead to soil liquefaction, resulting in the loss of ground sheer stress and carrying capacity. Therefore, this Project will not adopt gravity seabed foundation.

8.3.4 Alternatives of Environmental Protecting Measure

This project will use human monitoring method during construction. Qualified MMOs will be placed on installation vessel to conduct cetacean monitoring. An alternative is to set up small monitoring vessels and place the MMOs on them. The details of the alternative plan are as follows:

I. A 1400m sided square is set up as a survey zone with the pile driving site at its center. Use two monitoring vessels at opposing angles to patrol in a clockwise or counterclockwise direction (Fig 8.3.4-1). The area inside the survey zone is the warning area and a 1500m square outside the pile driving site is the monitoring area.

II. There are at least 2 trained and qualified observers on each vessel conducting visual searches of the warning and monitoring zones. If the construction work observation time exceeds six hours, one person must be added so personnel can rest in shifts. The visual range of trained and qualified sea dolphin observers is approx. 1km which can fully cover the entire warning and monitoring zones.

Considering that the wind farm site is 50 km away from the coast, the sea weather condition at wind farm is worse than near shore wind farm sites. If the MMOs are placed on monitoring vessels, these monitoring vessels should meet more stringent HSE standard to resist bad sea weather condition and to protect MMOs. On the other hand, the installation vessel is large-scale marine engineering vessel, which can better withstand the bad sea weather. If the MMOs work on installation vessel, the MMOs can work under a more stable environment with high magnification telescope equipment during the process of monitoring. Besides, the large-scale marine engineering vessel provides sufficient height for MMOs to gain greater visibility so that the monitoring range is larger. This means that if the MMOs are on installation vessel, they can overlook the monitoring zone as widely as they are on monitoring vessels.

Therefore, considering the factors described above, the project will not adopt the option to have the MMOs on monitoring vessels.

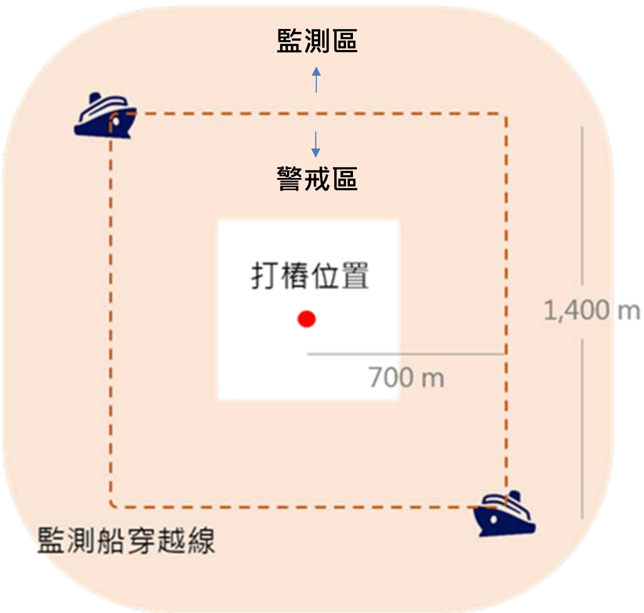


Fig 8.3.4-1 Project Sea Observation Vessel Monitoring Diagram

Table 8.3-1 Alternative Plan

Alternatives	Yes	No	Unknow	Contents	Estimation of the possibly negative impact on environment at target year	Comparative analysis with the main project
1.Zero Program		✓		Stop the process of this developing project	Stopping the development for this project means that the power demand needed to be satisfied through other power supply. Considering that other green energy is not sufficient to meet the current energy demand, it would need to increase the non-renewable power supply, which can create negative impacts on the environment.	The wind farm Project aims at supporting the government's energy policy and the objective to make Taiwan a non-nuclear area in 2025. The Project steps up the development of offshore wind farm. The Project will bring international experience to Taiwan's wind power generation industry through in-depth interchange and interaction arrangement. The Project has a positive significance. Thus, "Zero Project" is not appropriate.
2.Location Alternatives		✓		No site alternatives	No site alternatives will not produce the possibly negative impact on environment	No site alternatives.
3. Technology Alternatives	✓			Under this Project, a wind turbine can be installed in single-pile or jacket structure. An alternative is to use gravity foundation for the wind turbine.	In case gravity seabed foundations are erected in this area, seismic waves produced by earthquakes may lead to soil liquefaction, resulting in the loss of ground sheer stress and carrying capacity.	Though the Alternative Plan has the advantages of less impact to marine mammals, the weight carrying capability of the projected site is not strong enough. To avoid soil liquefaction which may have an adverse impact on geological safety, the Project does not adopt the Alternative Plan.
4. Alternatives for		✓		The main plan is to place qualified MMOs on	Since the wind farm site is far from the coast, the sea	The installation vessel is large-scale marine

Environmental Protecting Measure				installation vessel to conduct cetacean monitoring. The alternative is to set up 2 small monitoring vessels and place at least 2 MMOs on them. A 1400m sided square is set up as a survey zone with the pile driving site at its center. The MMO's visual range covers the warning and monitoring zones.	weather condition at wind farm is worse than near shore wind farm sites. If the MMOs are placed on monitoring vessels, these monitoring vessels should meet more stringent HSE standard to resist bad sea weather condition and to protect MMOs.	engineering vessel. If the MMOs work on installation vessel, the MMOs can work under a safer, more stable environment with high magnification telescope equipment during the process of monitoring. Besides, the large-scale marine engineering vessel provides sufficient height for MMOs to gain greater visibility so that the monitoring range is larger. Hence, this project will not consider the option to place the MMOs on monitoring vessels.

Chapter 9　Cost of Environmental Protection

Environmental protection works include environmental protection construction and environmental monitoring. During the execution of the offshore wind farm, the preparatory office shall monitor and track. At the beginning of construction, the working items shall be tracked internally which comply with follow-up assessment of environmental protection units to implement environmental impact assessment.

9.1 Cost of Environmental Protection Construction

The main environmental constructions can be generalized into the following 3 items:

I. Equipment Cost of Environmental Protection During Construction

II. Cost of Air Pollution Control

III. Beautification of the Landscape and Plants

Based on preliminary estimation, the cost of environmental protection construction during the construction phase is approximately thirty million NTD (shown as Table 9-1).

Table 9-1 Summary Statement of Environmental Protection Construction

Item		Cost (new Taiwan Dollar)		Remarks
		Construction	Operation Phase (Per Year)	
Cost of Environmental Protection Construction	Equipment Cost of Environmental Protection During Construction	15 million	–	Equipment cost of preventing pollution, waste disposal cost, traffic equipment maintenance cost and etc.
	Cost of Air Pollution Control	10 million	–	Including processing fee of construction air pollution control and fee for air pollution control.
	Beautification of the Landscape and Plants	5 million	–	The construction cost of landscape beautification, lighting cost and maintenance fee.
Subtotal		30 million	0	

9.2 Cost of Environmental Monitoring

Environmental impact items are conducted during pre-construction, construction and operation, including air quality, noise vibration construction noise, terrestrial ecology, marine water quality, bird ecology, marine ecology, underwater noise, cultural heritage and etc. to master current situation of environmental quality and serve as bases and references for mitigations. The estimated cost for pre-construction monitoring is 17,420,000 NTD. The monitoring cost for construction is 24,120,000 NTD. The monitoring cost per year for operation is 13,060,000 NTD. The related monitoring cost is listed in Table 9.2-1 List of Environmental Monitoring Cost.

Table 9.2-1 List of Environmental Monitoring Cost

Phase	Items		Number of Station	Frequency (Trip/ Year)	Unit Price	Compound Price
Pre-Construction	Marine Water Quality		12 sta.	4	40,000	1,920,000
	Marine Ecology (Cetacean Ecological Survey)		1 trip	20	150,000	3,000,000
	Underwater Noise		2 sta.	4	300,000	2,400,000
	Bird Ecology	Visual Survey	1 zone	8	300,000	2,400,000
		Radar Survey	1 zone	8 times for 2 years	300,000	2,400,000
	Interpretation of Underwater Cultural Heritage		1 trip	1	5,000,000	5,000,000
	Interpretation of Terrestrial Cultural Heritage		1 trip	1	300,000	300,000
Total of Pre-Construction						**17,420,000**
Construction	Air Quality		2 sta.	4	50,000	400,000
	Noise Vibration		2 sta.	4	20,000	160,000
	Construction Noise		2 sta.	12	5,000	120,000
	Terrestrial Ecology		1 zone	4	400,000	1,600,000
	Cultural Heritage (Monitor)		1 trip	1	2,000,000	2,000,000
	Marine Water Quality		12 sta.	4	40,000	1,920,000
	Bird Ecology		1 zone	10	300,000	3,000,000

Table 9.2-1 List of Environmental Monitoring Cost (Continued)

Phase	Items		Number of Station	Frequency (Trip/ Year)	Unit Price	Compound Price
Construction	Marine Ecology	Ecology of Intertidal Zone	1 zone	4	240,000	960,000
		Plankton, Juvenile Fish, Fish Eggs and Benthic Organism	12 sta.	4	70,000	3,360,000
		Fish	1 trip	4	400,000	1,600,000
		Cetacean Ecological Survey	1 trip	20	150,000	3,000,000
	Underwater Noise	Around Piling	1 sta.	12	300,000	3,600,000
		Perimeter of Wind Farm	2 sta.	4	300,000	2,400,000
Total of Construction (Per Year)						**24,120,000**
Operation	Bird Ecology		1 zone	8	300,000	2,400,000
	Marine Ecology	Plankton, Juvenile Fish, Fish Eggs and Benthic Organism	12 sta.	4	70,000	3,360,000
		Fish	1 trip	4	400,000	1,600,000
		Cetacean Ecological Survey	1 trip	20	150,000	3,000,000
	Underwater Noise		2 sta.	4	300,000	2,400,000
	Fishery Economy		1 trip	1	300,000	300,000
Total of Operation (Per Year)						**13,060,000**

Source: Compiled by this project.

Chapter 11 Table of Whether the Project Should Conduct Environmental Impact Assessment

Table 11-1 Table of Whether the Project Should Conduct Environmental Impact Assessment

Does it cause great impact on environment	Assessment Information Proposed by Developer
I. If any incompatibilities exists with neighboring related projects.	The site is not located within Important Habitat of Chinese White Dolphin. This project and neighboring offshore wind farm are not overlapped. After assessing this project and neighboring related projects, no adverse incompatibilities are existed.
II. Significantly adverse impact on environmental resources or environmental characteristics.	The site is not located within important habitat of Chinese White Dolphin. This project is developed in spot form, no large surface of construction. Assessments of all items display marginal impact, no significantly adverse impact on environmental resources and environmental characteristics.
III. Significantly adverse impact on habitat of protected or rare animal and plant species.	i. Terrestrial Plant 3 endemic plant species and a rare plant species are discovered along overland cable route. The majority is constituted by artificial cultivated plants. Protection measures including avoid or transplant are not required in development. ii. Terrestrial Animal No protected species of mammal, reptile, amphibian, butterfly and dragonfly are documented. 4 endemic species of mammal, an endemic species of reptile and 2 endemic species of butterflies are documented. They are not documented within estimated overland cable construction area but mainly distributed at buffer zone. It has marginal impact on them. iii. Avian Species 4 protected species are documented in

Does it cause great impact on environment	Assessment Information Proposed by Developer
	terrestrial survey. 7 protected species are documented in coastal survey. Overland cable construction is considered as short period of construction which will be reinstated after completion. The construction has marginal impact on terrestrial and coastal birds. 3 protected species are documented in marine survey. During operation, the collision rate within wind farm is low, the impact on bird collision is marginal. iv. Cetacean Based on actual cetacean results of this project in 2016, a group of Tursiops aduncus is documented in June of 2016. It has marginal impact on cetacean, the mitigations measures of cetacean are listed as follows: 1. Jacket-type foundation with lower piling noise is selected for this project. 2. Monitoring and preventative measures during construction. (1) Acoustic deterrent devices (ADD) are not adopted in this project. (2) Acoustic monitoring and surveillance monitoring are conducted during piling period to make sure no cetaceans within construction zone. (3) The piling can be started when double monitoring method (including acoustic monitoring and surveillance monitoring) has confirmed precautionary area (750m) has no cetacean for 30 minutes. (4) During piling, underwater acoustic monitoring facility is supplementary tool of marine mammal observer (MMO). Visual observation can determine the distance of cetacean and inspect via underwater acoustic

Does it cause great impact on environment	Assessment Information Proposed by Developer
	monitoring facility if the cetacean is within 750m precautionary area, 1500m monitoring area or far away from monitoring area. If any cetaceans enter 750m precautionary area, marine mammal observer shall notify personnel of piling. The construction unit shall terminate the piling under safety conditions. After leaving for 30 minutes, progressive piling is adopted to continue the construction. If any cetaceans enter monitoring area (within 1500m), observe and record their direction to make sure it is not moving towards precautionary area (750m). (5) The piling construction shall activate softstart for at least 30 minutes. The piling strength shall start from low to high, this is to ensure cetaceans have sufficient time to leave. (6) The piling is prohibited to activate one hour prior to sunset and after sunrise. (7) All piling operation (including crane and turnover crane) shall be recorded on working vessel. Date and time shall be indicated in recording video. The recorded video shall be kept for at least 5 years. 3. Noise Reduction Measures During Construction According to Noise Induced Permanent Threshold (PTS) of NOOA (2016), species with middle frequency (including bottlenose dolphins), the threshold values are Lpk,flat 230 dB and cSEL24h 185 dB, as they are applicable to all species with middle frequency (including dolphins, toothed whales, goose-beaked whale and

Does it cause great impact on environment	Assessment Information Proposed by Developer
	bottlenose dolphin). In this survey, bottlenose dolphin is discovered, the recommended threshold value is reasonable. For piling of foundation Commercialized and optimal noise control method is adopted during application to ensure noise of precautionary area (750m) is lower than 24 hours Sound Exposure Level 185dB (PTS), 180dBRMS, 170dB Single Click Exposure Level cSEL24h 185 dB. Details of noise mitigation measures are determined before installation, including state-of-the-art noise reduction technology, such as sponge curtain or balloon curtain. 4. Vessel Speed Control: During construction, the speed vessel shall be lower than 6 knots while passing through habitat of Chinese White Dolphins and 1500m of perimeter. 5. Instant Noise Monitoring: During construction of every pile, a piling noise monitoring is conducted at boundary of precautionary area (750m). Softstart is initiated during monitoring. Monitoring and noise reduction method are adopted throughout the piling. If noise level of 750m has exceeded tolerance level, the construction unit shall act promptly to reduce underwater noise within threshold value. Related measures include reducing piling speed (number of piling), reducing the intensity of piling (kJ) and adjusting noise reduction tools. Before construction, noise emission shall be conducted detailed simulation. Noise level is closely related to situation of piling, model and intensity, these factors can be served as parameters for simulation.

Does it cause great impact on environment	Assessment Information Proposed by Developer
	6. Long Term Monitoring of Cetacean Cetacean monitoring shall be conducted before construction and during construction. Vessel observation is conducted for at least 20 trips per year to master cetacean activities and understand possible impact on cetacean. v. Marine Ecology Impact of piling sound waves on fish has been little studied. Many studies show that majority of the fish will return to wind farm after construction. With respect to benthic organisms, no endemic species and protected animal are discovered in marine benthic organisms and intertidal zone animal survey. Construction has marginal impact on them. After assessment, this project has no adverse impact on rare and protected animal species.
IV. Exceed local environmental quality standard or local environmental assimilative capacity.	Based on environmental background survey results, the particulate matters (TSP, PM10, PM2.5) of Lukang Industrial Park have exceeded air quality control standards. After consolidating air quality simulation results and background air quality, TSP, PM_{10} and $PM_{2.5}$ still exceed air quality standards. SO_2, NO_2 and CO comply with environmental air quality standard. According to noise vibration simulation results, after consolidating with actual background value, all air sensitive receivers are compliance with environmental volume standards, increase of volume is considered as no impact or negligible impact. Based on marine water quality simulation results, in the vicinity of landing point 1's construction site (approx. 200m), the concentration of suspended solid declines to 5.0mg/L after diluted by ocean current. Where 500m away from construction site during low

Does it cause great impact on environment	Assessment Information Proposed by Developer
	water, the increase of concentration is approx. 4.0mg/L. At 1000m away of construction site, the increase of concentration is approx. 3.5mg/L. For nearshore boundary, the increase of concentration is approx. 0.7mg/L; Landing point 2 where is 200m way, the concentration of suspended solid declines to 4.5mg/L. For 500m away from construction site, the increase is approx. 4.0mg/L. For 1000m away from construction site, the increase of which is approx. 3.5mg/L. In nearshore, the increase of which is 1.0mg/L. With regard to landing point 3 where is 200m away, the concentration of which is declined to 4.2mg/L. As for 500m away from construction site, the increase of which is approx. 3.8mg/L. Suspended solid concentration where 1,000m away from construction site is about 3.0mg/L. As for boundary of nearshore, the concentration of which is 1.5mg/L. Landing point 4 (North common corridor planned by Taiwan Power Company) where are 200m away, the increase of which is approximate 4.5mg/L. For 500m away from construction site, the concentration of which is 4.0mg/L. 3.5mg/L of increase concentration is documented in 1000m away from construction site. As for nearshore, the concentration of suspended solid is 0.8mg/L. Due to deep water depth of foundation construction, increase suspended solid concentration where 200m away from the site is 0.37mg/L. For 500m away from the site, the increase of which is barely 0.3mg/L. As for 1000m away from construction site, the concentration of suspended solid is about 0.20mg/L. The distance between foundation and shore is from 30km to 40km, it has no impact on terrestrial coast. According to simulated results, due to 2 tidal events per day, suspended solid diffuse in a short distance during construction which will cause minimal effect on marine.

Does it cause great impact on environment	Assessment Information Proposed by Developer
	This project is a clean energy development plan. During operation, it shall be generated by natural wind power, local environment quality standard or local environment assimilative capacity shall not be exceeded.
V. Significantly adverse impact on migration and equity of local residents, traditional lifestyle of minority.	This project is located in waters area. After completion of submarine and overland cable, it will be reinstated to its original state. Related terrestrial facility will obtain right of access according to regulations. Migration of local residents, equity and traditional lifestyle of minority are unaffected.
VI. Significantly adverse impact on citizen health and safety.	This project is a clean energy development plan. During operation, it shall be generated by natural wind power, "Technical Regulation of Health Risk Assessment" of EPA is not adopted or derived (Revised and promulgated on 20th July 2011). With respect to chemical hazardous substances mentioned in Article 3, there is no incremental risk to the health of neighboring residents.
VII. Significantly adverse impact on national environment.	This project is classified as renewable energy wind energy development plan. During operation, wind turbines are generated by natural wind power. The results of assessment are compliance with standards, the impact area is limited within site, no significantly adverse impact on national environment.
VIII. Authorize by other competent authorities.	This project is a renewable energy wind energy development plan. During operation, wind turbines are generated by natural wind power. The competent authorities identify that it has no significant factors of impact.