

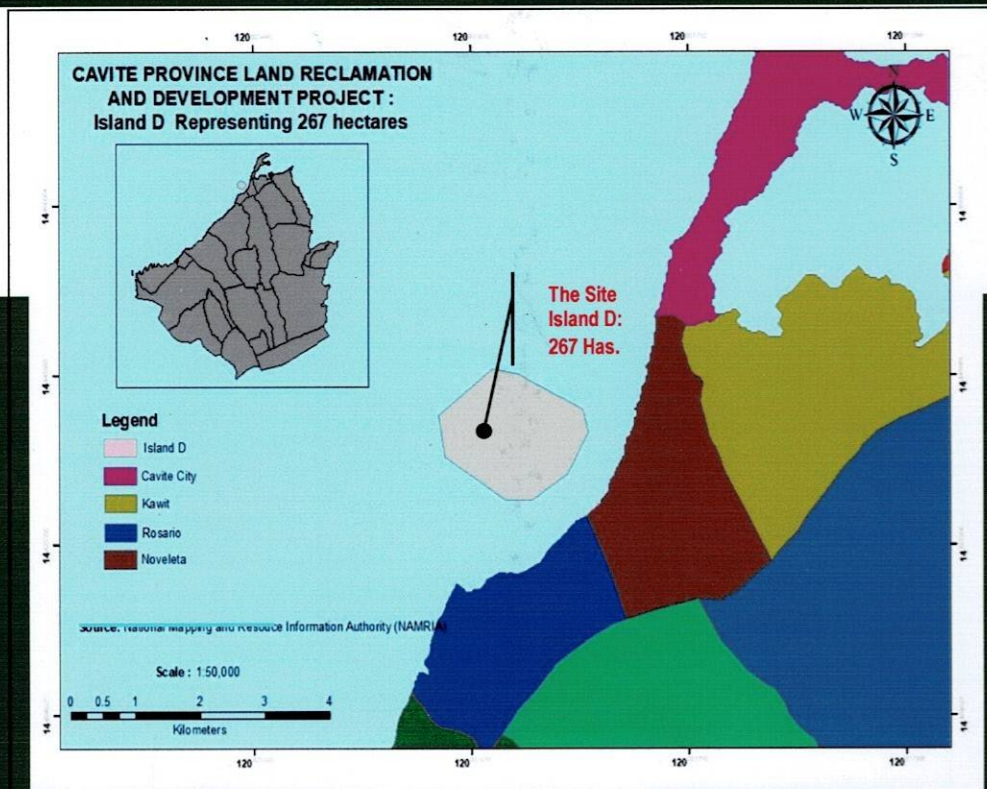
# ENVIRONMENTAL IMPACT STATEMENT (EIS)

FOR THE PROPOSED

## CAVITE PROVINCE LAND RECLAMATION AND DEVELOPMENT PROJECT

### **ISLAND D: 267 HECTARES**

ALONG THE COASTAL WATERS OF NOVELETA AND ROSARIO  
WITHIN THE JURISDICTION OF CAVITE PROVINCE



SUBMITTED BY:



SUBMITTED TO:



CAVITE PROVINCIAL GOVERNMENT  
OFFICE ADDRESS: PROVINCIAL CAPITOL OFFICE, TRECE MARTIRES CITY, PRO  
SITE LOCATION: ALONG COASTAL WATERS OF NOVELETA AND ROSARIO WITH

DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES  
Environmental Management Bureau – Central Office  
DENR Compound, Visayas Avenue, Diliman, Quezon City

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Republic of the Philippines  
Province of Cavite  
**OFFICE OF THE PROVINCIAL GOVERNOR**  
Trece Martires City



25 August 2020

**DIRECTOR WILLIAM P. CUÑADO**  
Environmental Management Bureau  
DENR Compound, Visayas Avenue  
Diliman, Quezon City



**Attention:** **ENGR. ESPERANZA A. SAJUL**  
Chief, Environmental Impact Assessment and Management Division

**Subject:** **APPLICATION FOR ENVIRONMENTAL COMPLIANCE CERTIFICATE (ECC)  
FOR THE PROPOSED 'CAVITE RECLAMATION AND DEVELOPMENT PROJECT  
ISLAND D: 267 HECTARES' TO BE LOCATED ALONG THE COASTAL WATERS  
OF NOVELETA AND ROSARIO WITHIN THE JURISDICTION OF CAVITE  
PROVINCE**

Dear Director Cuñado:

Transmitting herewith one (1) Revised Draft Environmental Impact Study (EIS) for the proposed "Cavite Reclamation and Development Project Island D: 267 Hectares," which incorporates the results of the Additional Baseline Sampling conducted last 23 and 24 June 2020 for the following:

1. Marine Water Sampling-Additional for North, South, West and East;
2. Two (2) Sediment Sampling; and
3. Surface Water (Mouth of the River)-Imus, Ylang-Ylang and Maalimango.

We hope you find the above requirements in order. We look forward to your immediate kind attention on the application.

We hope you find the above requirements in order. We look forward to your immediate kind attention on the application.

Thank you very much.

Very truly yours,

  
**JUANITO VICTOR C. REMULLA**  
Governor

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## LIST OF ABBREVIATIONS

| Abbreviation/ Symbol | Meaning  |
|----------------------|--|
| %                    | Percentage   |
| °C                   | Degree Celsius   |
| μ                    | Poisson's Ratio  |
| AAS                  | Atomic Absorption Spectroscopy                                     |
| AASHTO               | American Association of State Highway and Transportation Officials |
| AFE                  | Actual Fishing Encounters  |
| AMLLW                | Above Mean Lower Low Water   |
| As                   | Arsenic  |
| ASTM                 | American Society for Testing and Materials                         |
| BFAR                 | Bureau of Fisheries and Aquatic Resources                          |
| BH                   | Borehole   |
| BHU                  | Barangay Health Unit   |
| BOD                  | Biological Oxygen Demand   |
| BSWM                 | Bureau of Soils and Water Management                               |
| CAAP                 | Civil Aviation Authority of the Philippines                        |

| Abbreviation/ Symbol | Meaning   |
|----------------------|---|
| CALABARZON           | Cavite Laguna Batangas Rizal Quezon                     |
| CALAX                | Cavite-Laguna Expressway                                |
| CAVITEx              | Cavite Expressway                                       |
| CCA                  | Climate Change Adaptation                               |
| CDR                  | Crude Death Rate  |
| cells/L              | Cells per Liter   |
| CH <sub>4</sub>      | Methane   |
| CLUP                 | Comprehensive Land Use Plan                             |
| cm                   | Centimeter  |
| cm/sec <sup>2</sup>  | Centimeter per Square Second                            |
| cm/yr                | Centimeter per Year                                     |
| CO <sub>2</sub>      | Carbon Dioxide  |
| CRO                  | Community Relation Officer                              |
| CRPP                 | Community Relations and Participation Plan              |
| DAO                  | DENR Administrative Order                               |
| DED                  | Detailed Engineering Design                             |
| DEM                  | Digital Elevation Model                                 |
| DENR                 | Department of Environment and Natural Resources         |
| DepEd                | Department of Education                                 |
| DIA                  | Direct Impact Areas                                     |
| DICT                 | Department of Information and Communications Technology |
| DIV                  | Dutch Intervention Value                                |
| DO                   | Dissolved Oxygen  |
| DOE                  | Department of Energy                                    |
| DOH                  | Department of Health                                    |
| DOT                  | Department of Tourism                                   |
| DOTr                 | Department of Transportation                            |
| DPWH                 | Department of Public Works and Highways                 |
| DRR                  | Disaster Risk Reduction                                 |
| DSWD                 | Department of Social Welfare and Development            |
| E-NIPAS              | Expanded National Integrated Protected Areas System     |
| ECA                  | Environmentally Critical Area                           |
| ECC                  | Environmental Compliance Certificate                    |
| ECP                  | Environmentally Critical Project                        |
| EGF                  | Environmental Guarantee Fund                            |
| EGGA                 | Engineering Geological and Geohazard Assessment         |
| EIA                  | Environmental Impact Assessment                         |
| EIS                  | Environmental Impact Statement                          |
| EMB                  | Environmental Management Bureau                         |
| EMF                  | Environmental Monitoring Fund                           |
| EMoP                 | Environmental Monitoring Plan                           |
| EMP                  | Environmental Management Plan                           |
| EO                   | Executive Order   |
| EPA                  | Environmental Protection Agency (USA)                   |
| EPZA                 | Export Processing Zone Authority                        |
| ERP                  | Emergency Response Plan                                 |
| ESE                  | East Southeasterly                                      |
| EVF                  | East Valley Fault                                       |
| FARMC                | Fisheries and Aquatic Resources Management Council      |
| FEM                  | Finite Element Analysis                                 |
| FGD                  | Focus Group Discussions                                 |
| FS                   | Feasibility Study                                       |
| FS/ FoS              | Factor of Safety  |
| GHG                  | Green House Gasses                                      |
| GMMA                 | Greater Metro Manila Area                               |
| GPS                  | Global Positioning System                               |
| ha                   | Hectare   |
| HFC                  | Hydrofluorocarbon                                       |
| Hg                   | Mercury   |
| HH                   | Household   |



| Abbreviation/ Symbol | Meaning   |
|----------------------|---|
| ICP-OES              | Inductively Coupled Plasma Optical Emission Spectroscopy            |
| IEC                  | Information, Education and Communication                            |
| IIA                  | Indirect Impact Areas   |
| IMP                  | Impact Management Plan  |
| InSAR                | Interferometric Synthetic Aperture Radar                            |
| IPCC                 | Intergovernmental Panel on Climate Change                           |
| ISF                  | Informal Settler Family   |
| IUCN                 | International Union for Conservation of Nature                      |
| JICA                 | Japan International Cooperation Agency                              |
| JSCE                 | Japan Society of Civil Engineers                                    |
| kg                   | kilogram  |
| kh                   | Coefficient of lateral subgrade reaction unit                       |
| km <sup>2</sup>      | Square Kilometer  |
| kms                  | Kilometers  |
| kN                   | kiloNewton (Weight unit)  |
| kN/m <sup>3</sup>    | kiloNewton per cubic meter (Weight density unit)                    |
| kP                   | kiloPond (Force unit)   |
| kPa                  | kiloPascal (Pressure unit)  |
| kph                  | Kilometers per Hour   |
| kt                   | kiloton (Mass unit)   |
| kv                   | kilovolt (electrical potential unit)                                |
| L                    | Liter   |
| LEM                  | Limit-Equilibrium Method  |
| LGU                  | Local Government Unit   |
| LIDAR                | Laser Imaging Detection and Ranging                                 |
| LLDA                 | Laguna Lake Development Authority                                   |
| LONO                 | Letter of No Objection  |
| LPPCHEA              | Las Piñas-Parañaque Critical Habitat and Ecotourism Area            |
| LPPWP                | Las Piñas-Parañaque Wetland Park                                    |
| m                    | Meter   |
| m/s                  | Meter per Second  |
| m <sup>2</sup>       | Square Meter  |
| MAO                  | Municipal Agriculture Office  |
| MARPOL               | International Convention for the Prevention of Pollution from Ships |
| masl                 | Meters Above Sea Level  |
| MBCMS                | Manila Bay Coastal Management Strategy                              |
| MBCS                 | Manila Bay Coastal Strategy   |
| mbgl                 | Meters Below Ground Level   |
| MC                   | Memorandum Circular   |
| MENRO                | Municipal Environmental and Natural Resources Office                |
| MERALCO              | Manila Electric Company   |
| mg/L                 | Milligram per Liter   |
| MGB                  | Mines and Geosciences Bureau  |
| ml                   | Milliliter  |
| mm                   | Millimeter  |
| mm/yr                | Millimeter per Year   |
| MMT                  | Multi-partite Monitoring Team                                       |
| mo                   | Month   |
| MPa                  | Megapascal (Pressure unit)  |
| MPDC                 | Municipal Planning and Development Council                          |
| Mph                  | Miles per Hour  |
| MPTC                 | Metro Pacific Tollways Corporation                                  |
| MRF                  | Material Recovery Facility  |
| Ms                   | Surface wave magnitude (of earthquake)                              |
| MSL                  | Mean Sea Level  |
| MT                   | Metric Ton  |
| Mw                   | Moment magnitude (of earthquake)                                    |
| N                    | Number of blows   |
| N <sub>2</sub> O     | Nitrous Oxide   |
| NAAQGV               | National Ambient Air Quality Guideline Values                       |

| Abbreviation/ Symbol | Meaning   |
|----------------------|---|
| NAIA                 | Ninoy Aquino International Airport  |
| NAMRIA               | National Mapping and Resource Information Authority                         |
| NAVFAC               | Naval Facilities Engineering Command  |
| NBCP                 | National Building Code of the Philippines                                   |
| NCR                  | National Capital Region   |
| NEDA                 | National Economic and Development Authority                                 |
| NGO                  | Non-Government Organization   |
| NHCP                 | National Historical Commission of the Philippines                           |
| NIPAS                | National Integrated Protected Areas System                                  |
| NOAA                 | National Oceanic and Atmospheric Administration                             |
| NOAH                 | Nationwide Operational Assessment of Hazards (UP Project NOAH)              |
| NPCC                 | National Pollution Control Commission                                       |
| NTC                  | National Telecommunication Commission                                       |
| NTP                  | Notice to Proceed   |
| NWRB                 | National Water Resources Board  |
| OWS                  | Oil Water Separator   |
| PAGASA               | Philippine Atmospheric Geophysical and Astronomical Services Administration |
| PAR                  | Philippine Area of Responsibility   |
| Pb                   | Lead  |
| PCG                  | Phil. Coast Guard   |
| PCLUPZO              | Provincial Comprehensive Land Use Plan and Zoning Ordinance                 |
| PCO                  | Pollution Control Officer   |
| PDRRMO               | Provincial Disaster Risk Reduction Management Office                        |
| PEATC                | Public Estates Authority Tollway Corporation                                |
| PEIS                 | PHIVOLCS Earthquake Intensity Scale   |
| PEM                  | Philippine Earthquake Model   |
| PEMAPS               | Project Environmental Monitoring and Audit Prioritization Scheme            |
| PENRO                | Provincial Environmental and Natural Resources Office                       |
| PEO                  | Provincial Engineering Office   |
| PEZA                 | Philippine Economic Zone Authority  |
| PFC                  | Per Fluorocarbon  |
| PFZ                  | Philippine Fault Zone   |
| PGA                  | Peak Ground Acceleration  |
| pH                   | Potential of Hydrogen   |
| PHIVOLCS             | Philippine Institute of Volcanology and Seismology                          |
| Php                  | Philippine Peso   |
| PMB                  | Philippine Mobile Belt  |
| PNP                  | Philippine National Police  |
| PO                   | People's Organization   |
| PPA                  | Philippine Ports Authority  |
| PPDO                 | Provincial Planning and Development Office                                  |
| PRA                  | Phil Reclamation Authority  |
| psf                  | pounds per square foot  |
| PVD                  | Preloading with Prefabricated Drains  |
| RA                   | Republic Act  |
| RHU                  | Rural Health Unit   |
| ROW                  | Right-of-Way  |
| RPM                  | Revised Procedural Manual   |
| RQD                  | Rock Quality Designation  |
| RROW                 | Road-Right-of-Way   |
| SAFDZ                | Strategic Agriculture and Fisheries Development Zone                        |
| SDF                  | Social Development Framework  |
| SDP                  | Social Development Plan   |
| SEASEE               | Southeast Asia Association of Seismology and Earthquake Engineering         |
| SMR                  | Self-Monitoring Report  |
| SO2                  | Sulfur Dioxide  |
| SPIA                 | Sangley Point International Airport   |
| SPT                  | Standard Penetration Test   |
| St.                  | Street  |
| Stn                  | Station   |

| Abbreviation/ Symbol | Meaning   |
|----------------------|---|
| TESDA                | Technical Education and Skills Development Authority                    |
| TMP                  | Traffic Management Plan   |
| TPY                  | Tons per Year   |
| TS                   | Tropical Storm  |
| TSHD                 | Trailing Suction Hopper Dredger   |
| TSP                  | Total Suspended Particulates  |
| TSS                  | Total Suspended Solids  |
| UP                   | University of the Philippines   |
| UP-MSI               | University of the Philippines-Marine Science Institute                  |
| UP-NIGS              | University of the Philippines-National Institute of Geological Sciences |
| VFZ                  | Valley Fault Zone   |
| WQ                   | Water Quality   |
| WVF                  | West Valley Fault   |
| yr                   | Year  |

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## EXECUTIVE SUMMARY (ES)

### ES 1.0 Project Fact Sheet

**Table ES-1. Project Fact Sheet**

|   |   |   |
|---|---|---|
| <b>Name of Project</b>  | <b>PROPOSED CAVITE PROVINCE LAND RECLAMATION AND DEVELOPMENT PROJECT: ISLAND D (267 HECTARES)</b>   |   |
| <b>Project Location</b>   | Along the Coastal Waters of Noveleta and Rosario, Within the Jurisdiction of Cavite Province  |   |
| <b>Project Category per EMB MC 2014-005</b>   | Category A: Environmentally Critical Project (ECP)<br>Major Reclamation Project $\geq$ 25 hectares  |   |
| <b>Project Classification per EMB MC 2014-005</b>   | 3.3 Reclamation and other land restoration project  |   |
| <b>Scope of Project</b>   | Horizontal development Only Including Road Networks and Utilities<br>(Note: separate ECCs will be applied for the vertical development, source of reclamation materials, disposal of dredged materials and all connectors/bridges)  |   |
| <b>Project Area</b>   | 267 Hectares  |   |
| <b>Project Cost</b>   | Php 18.000 Billion  |   |
| <b>Summary of Major Components</b><br><br>(Only the "Construction" Phase covered in ECC application, i.e. dredging, reclamation and horizontal development works) | <b>Major Components</b>   | <b>Brief Description</b>  |
|   | One (1) Island  | 267 has (Land area allocation for Saleable, Non-Saleable and Government Share)  |
|   | Internal Road Network   | Composed of main roads, interior secondary roads sidewalks and curb & gutters.  |
|   | Storm Surge Protection/ Containment Structure   | To consist of sheet piles installed around the perimeter of the proposed reclaimed area; and/or combination with the use of armor rocks. The general procedure in the installation of sheet pile is the choice of a suitable driving system.  |
|   | Drainage System   | To consist of networks of drainage pipelines (reinforced concrete pipe) and/or covered canals, box culvert, manholes, inlets and other appurtenant structures. General layout will be along/parallel to the internal roads.   |
|   | Utilities<br>Water Supply<br>Power Lines<br>Telecommunication   | Water supply will be connected to the Manila Water Service Inc. distribution system.<br>Power shall be tapped from Meralco.<br>Telecommunication shall be linked to nearest existing PLDT exchange and also through the mobile telephone/internet companies. The power and telecom lines shall follow the same lines as much as possible. |
|   | Sewerage Facilities   | Integrated sewage disposal system with a sewage treatment plant (STP)   |
| <b>Project proponent</b>  | <b>CAVITE PROVINCIAL GOVERNMENT</b><br><br><b>The Honorable Governor Juanito Victor C. Remulla</b><br>Office of the Governor<br>Provincial Capitol Compound, Provincial Capitol Building, Trece Martires City<br>Telephone No.: (046) 419-1919  |   |
| <b>EIA Preparer / Consultant</b>  | <b>CEnSe Technical Consultancy Services</b><br>Unit 405 Yrreverre Square Building, 888 Mindanao Avenue, Quezon City<br>Mobile No.: (0927) 511-6742; Landline: (02) 455-2022; Email add: <a href="mailto:cense_tech@yahoo.com.ph">cense_tech@yahoo.com.ph</a><br>Contact Person: Engr. Venice Montemayor – Team Leader |   |



## ES 1.1 Project Description Summary

The ECC application covers only the horizontal development or the reclamation of land. The proposed reclamation project covers 267 hectares designated as Island D out of a total proposed reclamation area/project of the province of approximately 1,043.28 hectares.

The project will be situated along the Coastal Waters of Noveleta and Rosario within the territorial jurisdiction of Cavite Province fronting the 3 coastal barangays namely San Rafael 2, San Rafael 3 and San Rafael 4 in Noveleta and 9 coastal barangays namely Bagbag I, Kanluran, Ligdong I, Muzon II, Sapa II, Sapa III, Wawa I, Wawa II and Wawa III in Rosario.

## ES 2.0 Process Documentation of the Conduct of EIA

The content of the EIS report was established during the conduct of Technical Scoping on 17 December 2018 (See **Annex ES-A**). As prescribed by the EMB/DENR under the Revised Manual for Coverage Screening and Standardized Requirements under the PEISS, the appropriate type of documentation for this project is the Environmental Impact Statement (EIS).

As per Section 14 of the DENR Administrative Order No. 2018-14 or the “Guidelines on the Issuance of Area Clearance for Reclamation Projects and Proclamation/Special Patents over Reclaimed Lands”, the Operations Phase (Vertical Developments) of the project shall be subjected to a programmatic Environmental Impact Assessment (EIA) requirements. Pursuant to Section 9.6 of the DENR Administrative Order No. 2018-18, the proponent is compliant with the preliminary requirements which was the basis for the Notice to Proceed (NTP) issued by the DENR IV-A dated December 19, 2019, findings of the Composite Team and its current conditional status is presented in **Table ES-1A**.

**Table ES-1A NTP-Findings of the Composite Team and Status**

| No. | Findings  | Status  |
|-----|---|---|
| a   | The proposed inner Island A covers an area of 247.28 hectares within the municipal waters of Cavite City and Bacoar Bay side and portions of the territorial waters of Kawit, Cavite. This observation as shown on the sketch submitted may affect seven (7) coastal barangays of Kawit with more or less 3,888 informal settler families; it may also affect foreshore establishment like the First Orient International Venture Corporation and the GLY Van Terminal. | Island A is discussed separately in its EIS Report and is located along Bacoar Bay and coastal waters of Kawit And Cavite City, within the jurisdiction of Cavite Province. No inland establishment will be affected, except for some existing fishnets in Island A which shall be relocated and transferred. |
| b   | In Cavite City, it may affect thirty-seven (37) coastal barangays with an increasing population of informal settlers  | The coastal barangays were being considered as our Direct Impact Area (DIA). No inland informal settlers will be displaced.   |
| c   | The proposed Island B covers an area of 220 hectares within the coastal waters of Cavite City, Island C covers an area of 205 hectares within the municipal waters of Noveleta, Island D covers an area of 267 hectares is within the municipal waters of Noveleta and Rosario; while Island E with an area of 324 hectares is within the municipal waters of Rosario.  | Island B has been relinquished in favor of Sangley Point International Airport (SPIA). The decision was made based on the result of overlapping plots of portion of Island B and SPIA.  |
| d   | Noveleta has three (3) coastal barangays while Rosario has eleven (11) coastal barangays directly affected within the proposed reclamation.   | Noveleta's coastal barangays was being considered as our Direct Impact Area (DIA). No inland informal settlers will be displaced.   |
| e   | Those coastal areas adjoining the proposed reclamation are inhabited by 2,368 informal settlers/families for Noveleta and 558 informal settlers/families for Rosario.   | The coastal barangays were being considered as our Direct Impact Area (DIA). No inland informal settlers will be displaced.   |
| f   | Both municipalities have Beach Resorts, Long Beach and Lido Beach Resort for Noveleta and Island Bonita, Mount Sea Resort and Restaurant and a Petron Depot Terminal in Brgy. Wawa, Rosario, Cavite   | The preparation of Impact Management Plan (IMP) discussed in Chapter 3 to ensure that every sensitive areas shall be considered, properly addressed and mitigated. The existing resorts are at least 200 meters away from the proposed site.  |
| g   | Another municipality adjoining Rosario is Tanza which has twelve (12) coastal barangays with 127 informal settler/families. Establishments along the foreshore area with Foreshore Lease Application are the F and E De Castro Resort, Tanza Oasis Hotel and Resort, Cavite Gateway Terminal, Villa Excellence Beach Resort and the Agripacific Corporation.  | Application shall take into consideration that currently FLA application to ensure no conflicts among the applicants and existing establishments.   |
| h   | Vast mangrove area lush vegetable is likely to be affected by the proposed reclamation project, such that utmost conservation measures must be affected to preserve the integrity of the fragile ecosystem.   | Establishment of buffer zone away from the site shall be strictly observed to all sensitive area.   |



| <b>Environmental Issues</b> |   |   |
|-----------------------------|---|---|
| 1                           | The proposed Cavite Reclamation Project consist of five (5) artificial islands to be constructed detached from the shoreline of Manila Bay. The first four will be sited in succession parallel to the coastline of Manila Bay while the last will be separated from the rest and will be located between the inner confluence of the sandpits where Cavite City rests and maintains facing Kawit and Bacoor.   | The proponent only applies for four (4) artificial islands, relinquishing one (1) island named as Island B, therefore reducing it to first three (3) which will be sited in succession parallel to the coastline and one island will be separated from the rest.  |
| 2                           | These proposed Island-type reclamation will partly enclose the near shores of Rosario, Noveleta, Kawit and Cavite City, all in Cavite Province. Based on studies, the island-type reclamation is more advantageous in terms of reduced adverse environmental impacts compared to peninsular-type reclamation (reclamation that is connected to the mainland/shoreline). However, the proponent must guarantee that the proposed project will not cause potential siltation and reduction of water exchange in the adjacent waterways.   | Impact Management Plan (IMP) discussed in Chapter 3 to ensure that siltation will be properly mitigated through installation of silt curtain thus reducing water turbidity. The separation of islands thus creating three (3) islands instead of one (1) to give way for water exchange, drainage and circulation.  |
| 3                           | There are at least five (5) major sources of seismic activity that may generate severe impact to Manila Bay Region, namely the Valley Fault System (VFS), the Philippine Fault Zone (PFZ), the Lubang Fault and Manila Trench. Movement from these geologic structures may bring forth tsunami, ground motion and liquefaction to the bay area.   | The assessment derived during the preparation of EGGAR discussed the management measures for the identified seismic forces in the area.   |
| 4                           | Based on the Project Description submitted by the proponent, the project's ECC application being applied for involves only the horizontal phase. The proponent will engage in land reclamation by raising the elevation of the seabed for the sole purpose of creating new land intended for various functional purposes. However, it is crucial that the design and construction of the horizontal phase should need the weight of the intended load to be emplaced at its top in order to withstand hazard such as, earthquakes and tsunamis and other external forces such as current, waves, precipitation and winds.   | The proponent confirms the application only for land development including road and utilities. While it is crucial that the weight or load for future vertical development, we will assure that prior to any vertical construction, another borehole test and geotechnical investigation study shall be done to determine the load bearing capacity of the area. In this way, heights and weight of the structures will be established. |
| 5                           | More importantly, the developer must foresee how the reclaimed land will likely respond to the weight of the load in order to decipher the fill's performance and functional requirements into measurable properties with special attention on density, strength and stiffness vis-à-vis liquefaction and breaching. With this underlying mechanism, it is imperative that blueprints for construction of vertical and horizontal phases for ECC application be required simultaneously in order to assess both requirements.   | All possible hazards such as geologic, hydrologic, and coastal hazards were considered in the study. These studies will help in the preparation of detailed designs. Vertical components including its blueprint at this point is not feasible to provide.  |
| 6                           | As per result of the MGB on flooding hazard, the large contiguous coastlines fronting the proposed project areas were found experiencing very high to moderate susceptibility to flooding due to interference of the surrounding natural drainage that coincides with the prevailing hydrologic/oceanographic phenomena along Manila Bay region. Moreover, a research study conducted by PAGASA revealed that the shape and height of Natib and Mariveles stratovolcanoes found west of the proposed project produce an orographic effect and dispersive tail of rain clouds. These further discuss the possible behavioral changes of the abovementioned flooding precursors with the proposed construction of the artificial islands vis-à-vis flooding hazards of Manila Bay Region. | Flooding hazard assessment and management measures is discussed in the submitted EGGAR.   |
| 7                           | Based on the results of the MGB on the coastal geo-hazard assessments covering the concerned study area. The whole shoreline stretch of Rosario municipality is experiencing high coastal accretion while the northern portion of Cavite City has occurrences of low accretion. Coastal erosion is almost negligible to low from Noveleta municipality up to Cavite City. It is therefore recommended that the proposed projects be subjected to hydraulic study to assess the negative impacts to coastal geo-hazards. The study may include hydrodynamics and morphological changes via a modeling approach. Of the studies show adverse impacts, then the developer should offer feasible mitigating measures.   | Coastal Engineering Assessment or Hydrodynamics Modelling prepared by AMH Philippines is discussed in Chapter 2.2. Likewise, full report is attached in the submitted application for Area Clearance, also attached as Annex 2.2-B.   |
| 8                           | The developer is taking into consideration San Nicolas Shoal as the primary source that will supply landfill materials for the said reclamation projects. The proponent must conduct a separate hydraulic study for this purpose to guarantee that there will be no major interruption to the fragile equilibrium of sediment movement in the littoral cell. The proponent must also determine the potential impacts caused by sediment extraction on coastal geomorphology and hydro dynamics and the consequential beach erosion and accretion on the coastlines of Manila Bay Region.  | This was discussed and addressed in the EIS of SNS separately.  |
| 9                           | The developer is also considering "lahar or volcanic ejecta from Mount Pinatubo as optional sources of fill materials. Fine to medium quartz sands are to be preferred ideal materials. The proponent must therefore conduct extensive and comprehensive study as to the strength and competence of this material.  | Prior to any acceptance of filling materials. Material testing shall be done to ensure that specifications are within required standards. Sources from river dredging in Zambales, Pampanga and Batangas shall also be considered as alternative.   |

## ES 2.1 The EIA Team

The table showing the list of EIA Preparer is provided below.



**Table ES-2. EIA Team Composition**

| Team Member  | Field of Expertise                           | EMB Registry No. | Company                              |
|--|--|------------------|--------------------------------------|
| Engr. Venice Montemayor  | Team Leader                                  | IPCO-260         | CEnSE Technical Consultancy Services |
| Engr. Rodel Olivares   | Asst. Team Leader                            | IPCO-132         | CEnSE Technical Consultancy Services |
| Felixberto H. Roquia Jr., Ph.D.  | Sociology                                    | IPCO-028         | Independent                          |
| Benjamin Francisco   | Marine and Fresh Water Ecology (Team Leader) | IPCO-038         | Independent                          |
| Virgilio Pantaleon   | Coral Reef, Seagrass                         | -                | Independent                          |
| Michael Francisco  | Fisheries                                    | IPCO-040         | Independent                          |
| Nazario Sabello  | Air Quality                                  | IPCO-240         | Independent                          |
| Neil John S. Tolentino   | Geology                                      | -                | Independent                          |
| Engr. Emerson B. Doralles  | Ocenography                                  | -                | Independent                          |
| <b>Proponent's External Expertise</b>  |  |                  |                                      |
| <ul style="list-style-type: none"> <li>Arch. Armand Alli, EnP – Master Planning</li> <li>Engr. Ricardo Yuson – Engineering</li> <li>Engr. Jon Kasilag (AMH Philippines, Inc.) – Oceanography/Modeling</li> <li>Engr. Lhyman Banganan (FF Cruz) – Topography/Bathymetry</li> <li>Princess Camille Mercado (THEIDI) – Reclamation Methodology</li> </ul> |  |                  |                                      |

The accountability statements of the proponent and the preparers are in **Annex ES-B and Annex ES-B1**.

## ES 2.2 EIA Schedule

The following are the activities that were conducted for this study. Continuing activities will be based on the results of the Review Committee Meetings.

**Table ES-3. EIA Study Schedule**

| ACTIVITY   | DATE  |
|--|---|
| Secondary Data Researches  | January - March 2018  |
| Marine Study   | October - November 2017 and February 2019   |
| Bathymetric Survey   | September – December 2017 by F.F. Cruz  |
| Geotechnical Survey  | December 2017 – April 2018 By A.M. Geoconsult   |
| Engineering Geological and Geohazard Assessment Report (EGGAR)   | 24 September 2019   |
| Preliminary Concept Master Plan and Engineering Design   | March 2018 – February 2019  |
| Water Quality Sampling   | 18 October 2017 and 19 February 2019  |
| Air Quality Sampling   | 12 December 2018 – 1 hr ambient air sampling<br>18 February 2019 – 24 hr ambient air sampling |
| <b>SOCIAL PREPARATION UNDERTAKEN</b>   |   |
| IEC and Perception Survey (Public participation Documentation provided in <b>Annex ES-C</b> )  |   |
| Initial Perception Survey  | 13-19 October 2018  |
| Information, Education and Communication (IEC)   | 12 October 2018   |
| Focus Group Discussion   | 22 June 2018 and 10 July 2018   |
| Public Scoping   | 20-21 November 2018   |
| Technical Scoping  | 17 December 2018  |
| Perception Survey Coverage: Barangays San Rafael II, San Rafael III, San Rafael IV, Wawa III, Sapa III, Wawa II. Sapa II, Ligdong, Wawa I, Bagbag, Kanluran and Muzon II | January – March 2019  |
|  |   |





## ES 2.3 EIA Methodologies

**Table ES-4. EIA Methodology**

| Module                         | Baseline   | Methodology   |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
|--------------------------------|--|---|-----|------------------------------|-------------|--------------|------------------------------|-------------|-----------------|---------------------|--------------|-----------------|---------------------|-----------------|-------|----------------------------|-----------------------|
| <b>LAND</b>                    |  |   |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| Land Use Classification        | <b>Secondary data:</b> Comprehensive Land Use Plan (CLUP) of Noveleta and Rosario, Province of Cavite  | Assessment of compatibility of the proposed project in the land use classification, Manila Bay Coastal Strategy, Consistency with the PRA Implementing Rules and Regulations, Relation to the PRA Master Plan for Manila Bay  |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| Geology                        | <b>Secondary data:</b> Geologic, seismic, liquefaction, slope hazard maps and evaluation based on government data and maps.<br><br><b>Primary data:</b> Borehole drilling by 3 <sup>rd</sup> party   | Identify and assess project impact in terms of the changed in topography including existing hazard as maybe aggravated Conduct of EGGA.<br>MGB Methodology  |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| Pedology / Soil                | <b>Primary data:</b> Geotechnical Investigation  | Physical and chemical properties relevant for design purposes   |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| <b>WATER</b>                   |  |   |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| Hydrology / Hydrogeology       | <b>Secondary data:</b> Existing drainage system. Historical flooding occurrences   | Identify and assess project impact on the change in drainage morphology, local drainage and resulting effects of flooding   |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| Marine Water Quality           | <b>Primary data:</b> Standard Methods for Water Quality Sampling and Monitoring.<br><br><b>Water Body Classification:</b> DENR Class SB<br><b>Parameters Considered:</b> Total Coliforms, Fecal Coliforms, Dissolved Oxygen, Oil & Grease, Arsenic, Mercury, Cadmium, Chromium, Lead, pH, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS) | Assess impacts on siltation of surface and coastal marine waters<br>DAO 2016-08<br><br>Analytical Methods: by CRL Laboratory, recognized by DENR.<br>Metals : Spectrophotometry AAS<br>Cold Vapour AAS for Hg<br>Coliform : Multiple Tube Fermentation<br>BOD : Azide Modification Winkler<br>O & G: Gravimetry (n-Hexane extraction)<br>DO : Winkler/Titrametric<br>pH : Electrometry<br>TSS : Gravimetry  |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| Oceanography                   | <b>Primary data:</b><br><b>Tide Measurements</b><br>Bathymetric data   | Tidal Station<br><br>Echo sounder or equivalent   |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| Marine                         | <b>Primary data:</b> Abundance / density / distribution of ecologically and economically important species, mangroves, benthism planktons, coral reefs, algae, seaweeds, sea grasses<br>Presence of pollution indicators   | Transect, manta tow and spot dives surveys, marine resource characterization (e.g. city/municipal and commercial fisheries data), Key informant interview.<br><br>Microscopic Examination   |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| <b>AIR</b>                     |  |   |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| Ambient Air Quality            | <b>Primary data:</b> Ambient air quality sampling and testing.<br><br><b>DENR Classification Ambient Air and Noise Classification: Class B – Commercial Area</b><br><br>Parameters Considered: TSP, PM10, SO <sub>2</sub> , NO <sub>2</sub>  | <b>Methodology:</b> Standard Methods for Ambient Air Quality Sampling by Volume Sampler <table border="1" style="margin-top: 10px;"> <tr> <td>TSP</td><td>Grase by High Volume Sampler</td><td>Gravimetric</td></tr> <tr> <td>PM10, PM 2.5</td><td>Grase by High Volume Sampler</td><td>Gravimetric</td></tr> <tr> <td>So<sub>2</sub></td><td>Gas Bubbler Sampler</td><td>Pararosanine</td></tr> <tr> <td>NO<sub>2</sub></td><td>Gas Bubbler Sampler</td><td>Griess Saltzman</td></tr> <tr> <td>Noise</td><td>Type 2 – Sound Level Meter</td><td>Instantaneous reading</td></tr> </table> | TSP | Grase by High Volume Sampler | Gravimetric | PM10, PM 2.5 | Grase by High Volume Sampler | Gravimetric | So <sub>2</sub> | Gas Bubbler Sampler | Pararosanine | NO <sub>2</sub> | Gas Bubbler Sampler | Griess Saltzman | Noise | Type 2 – Sound Level Meter | Instantaneous reading |
| TSP                            | Grase by High Volume Sampler   | Gravimetric   |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| PM10, PM 2.5                   | Grase by High Volume Sampler   | Gravimetric   |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| So <sub>2</sub>                | Gas Bubbler Sampler  | Pararosanine  |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| NO <sub>2</sub>                | Gas Bubbler Sampler  | Griess Saltzman   |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| Noise                          | Type 2 – Sound Level Meter   | Instantaneous reading   |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| Ambient Noise Quality          | <b>Primary data:</b> Noise Meter   |   |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| Contribution in terms of GHG   | Data on Greenhouse Gases   | Estimation of projected greenhouse gasses (GHG)   |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| <b>PEOPLE</b>                  |  |   |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |
| Demographic Profile / Baseline | <b>Primary data:</b> Conduct of Public Perception Survey, Public Scoping<br><b>Secondary data:</b> Comprehensive Land Use Plan (CLUP) of Noveleta and Rosario  |   |     |                              |             |              |                              |             |                 |                     |              |                 |                     |                 |       |                            |                       |



## **ES 2.4 Public Participation Activities**

### **ES 2.4.1 Information, Education and Communication (IEC) Activities**

IEC activities were conducted with the concerned stakeholders on 12 October 2018 at Roofdeck Noveleta Public Market, attended by twenty-three (23) stakeholders, 22 June 2018 at Mount Resort, Municipality of Rosario attended by eleven (11) participants and 10 July 2018 at Cofftea Zone, Cavite City and Municipal Hall of Noveleta attended by forty-five (45) participants. Among these invited were LGU Officials, Government Offices, Non-Government Organizations (NGO) / People's Organization (PO), Private Offices and Impact Barangays. Provided below in Table ES-5 are the top key issues raised during the IEC and FGD conducted.

**Annex ES-C1 for the documentation of the the conducted IEC Activities.**

**Table ES-5. Key Issues and Concerns raised during IEC and FGD conducted**

| <b>Sector or Representative Who Raised the Issue/ Suggestion</b>  | <b>Issues/Suggestions Raised by Stakeholder</b>  | <b>How it was Addressed in the EIS</b>  |
|---|--|---|
| Mr. Alex Maniago<br>Municipality of Rosario   | Source of Filling Materials  | The alternatives for the sources of materials are presented in Chapter 1. Current best option is San Nicholas Shoal. Other options include lahar from Pampanga, river dredging, etc.  |
| Mr. Alex Maniago<br>Municipality of Rosario<br><br>Resident of Barangay 8<br>Cavite City<br><br>Councilor Cris Go of<br>Municipality of Rosario | Impacts on Fisherfolks;<br>near coast fishing areas<br>will have to move further<br>offshore | <p>This is discussed under Chapter 2.2 Marine Ecology.</p> <p>Few fishers, as well as gleaners for macro-invertebrates in the proposed reclamations islands will be dislocated momentarily during reclamation activities but will ultimately resume fishing operations in coastal waters past the reclaimed area. It is noted however, that a sizeable nearshore fishing ground will be lost to reclamation affecting largely small-scale fishers. On the other hand, effects on demersal fisheries productivity will be minimal as no benthic fish habitats will be affected or altered due to the extreme silt and muddy sediments currently deposited in the area. However, schools of Sardinella that normally enter inshore waters can be disturbed and move away from the reclamation site. Tilapia and sardines fisheries in this area will be dislocated and loss of income from fishing will be felt during reclamation activities. Fisheries operation in fishing grounds offshore of the reclamation and generally in the mouth Manila Bay will not be affected as fishers will move to new fishing grounds further away from the reclaimed area where seawater will probably be less polluted and pelagic fish more abundant. However, this will require modifications on fishing gears used. It is likewise noted that there are no permanent or stationary lift nets or "sapras" directly inside the proposed reclamation site.</p> <p>Provision of new fishing paraphernalia to enable affected small-scale fishers to move to deeper fishing grounds past the reclamation area; Provision of alternative livelihoods to affected fishers.</p> |
| Ms. Vivian Tolentino<br>Municipality of Kawit   | Impacts on nearby municipalities   | <p>The various reclamation projects in the Province as well as in other parts of Manila Bay are complementary to each other. The PRA, DENR and other agencies who review and approves various pertinent permits see to it that this is so.</p> <p>In Chapter 1 - Project Description, the project's location is described relative to important landmarks, other reclamation projects, protected areas, etc. Relative to this, the impact areas as well as the potential effects are described.</p>   |
| Representative from<br>Philippine Coast Guard   | Navigability of channels<br>between island projects  | The 3 island projects on the other side of Bacoor Bay will be separated by 200m channels which are navigable. This is discussed under Chapter 2.2 Water - subsection on circulation modeling. The reclamation project will ensure that adequate seawater channels in between islands are designed and maintained open to boat navigation. Such channels will be adequately engineered to ensure suitable depth and seawater flow.   |
| Councilor Cris Go of<br>Municipality of Rosario   | Estimate Project<br>Timeline   | The Implementation Schedule is provided as a gantt chart under 1.7.3. Construction (including consolidation and stabilization) will take approx 5 years, while site development will take about 2 years for a total of 7 years. This will only start after a Notice to Proceed is issued by the PRA.  |
| Philippine Coast Guard  | Impacts on Flooding  | This is discussed under Chapter 2.1.3 - Geological Hazards and under Chapter 2.2 Oceanography. Numerical modeling was done and it showed that the island will not cause nor aggravate flooding susceptibility in the municipalities fronting or near the island.  |



### **INITIAL SURVEY WITH THE COMMUNITIES NEAR THE PROJECT SITE**

The results of the initial surveys covering the communities near the project site are presented in **Annex ES-C2**. The said surveys were conducted as part of the Information, Education and Communication (IEC).

The Preliminary Perception Survey conducted last October 13-19 2018 with a total of 360 respondents, to assess the socio-cultural economic situation of the communities that are to be affected by the proposed reclamation, particularly the 3 barangays-namely: San Rafael 2, San Rafael 3 and San Rafael 4 for the Municipality of Noveleta and the 9 barangays-namely: Bagbag II, Kanluran, Ligton I, Muzon II, Sapa II, Sapa III, Wawa I, Wawa II and Wawa III for the Municipality of Rosario.

As far as the **perceived benefits** is concerned, top answers are on livelihood and business opportunities, improvement of roads and other infrastructure, additional tax, good service of the government and water services. On the other hand, **perceived adverse impacts** are traffic, water pollution, loss of job, tsunami, corruption, loss of fresh air from the Manila Bay, flood, death of marine species and loss of view.

### **ENHANCED PERCEPTION SURVEY**

Further and enhanced household perception surveys were made post the activities on January to March 2019 to 30, 2019 respondents from 12 barangays in the municipalities of Noveleta and Rosario.

For **perceived beneficial and adverse impacts**, top answers are on employment and livelihood, additional tax, road construction, good service of the government and development of the barangay and municipality. On the other hand, perceived adverse impacts are health concerns, traffic and water and air pollution.

### **ES 2.4.2 Public Scoping**

The Public Scoping's conducted on 20 November 2018 at Youth Crisis Center, DSWD Compound, San Roque, Cavite participated by seventy-two (72) stakeholders and 21 November 2018 at Roof Top Noveleta, Public Market and Mount Sea Resort, Municipality of Rosario and was attended by Ninety-one (91) participants from different sectors. Among those invited were LGU Officials, Government Offices, Non-Government Organizations (NGO) / People's Organization (PO), and others. The Summary of Participants during the Public Scoping is provided in **Annex ES-C3**.

### **Summary of Issues and Concerns Raised during Public Scoping Activity**

The objective of the conducted Public Scoping Activity and other continuing IEC to be conducted is to ensure that the Environmental Impact Assessment (EIA) will address the relevant issues and concerns of the stakeholders and that it will be consistent with the Philippine Environmental Impact Statement System (PEISS). Issues and Concerns raised during the Public Scoping Activity is provided in Table ES-6 below.

**Table ES-6. Major Issues and Concerns during Public Scoping Activity**

| <b>Sector or Representative Who Raised the Issue/ Suggestion</b> | <b>Issues/Suggestions Raised by Stakeholder</b> | <b>How it was Addressed in the EIS</b>   |
|--|---|--|
| Marcos Aristotle P. Alvarez                                      | Source of Filling Materials                     | The alternatives for the sources of materials are presented in Chapter 1. Current best option is San Nicholas Shoal. Other options include lahar from Pampanga, river dredging, etc. |



| Sector or Representative Who Raised the Issue/ Suggestion                        | Issues/Suggestions Raised by Stakeholder                        | How it was Addressed in the EIS   |
|--|---|---|
| Michael L. Del Rosario<br>Kap. Jomer M. Bumatayo<br>Mayor Jose V. Ricafrente III | Impact on artificial coral reefs and fishing grounds            | All observations recorded muddy substrate mixed with coarse sand and shellfish carapace across the entire "Island D" reclamation site. The benthic observations did not encounter coral colonies, soft corals, algal assemblages or significant underwater rocky structures that can serve as habitats for demersal species of fish, macro-invertebrates and crustaceans. The spot dives conducted in four stations to verify alleged claims by boatmen that rocky substrate occur in the area yielded negative results – only mud and silted sand were encountered. Elsewhere in the reclamation site, extensive systematic snorkeling around shallow portions of the sea where corals can normally thrive revealed the same absence of coral life forms. Impacts on fishing discussed under Table ES-5 above. |
| Congressman Michael Del Rosario  | Impacts on drainage system                                      | Project is at sea about 200m offshore, will not impede or block drainages   |
| Alex Mañago Sr.  | Employment opportunities for residents                          | As discussed in Chapter 2.4-People, hiring of local residents will be given priority for as long as there are qualified individuals locally. This is also discussed under Manpower requirements in Chapter 1.   |
| Devina M. Cenizal<br>Resident of Tanza, Cavite                                   | Impacts on nearby municipalities                                | The various reclamation projects in the Province as well as in other parts of Manila Bay are complementary to each other. The PRA, DENR and other agencies who review and approves various pertinent permits see to it that this is so.<br><br>In Chapter 1 - Project Description, the project's location is described relative to important landmarks, other reclamation projects, protected areas, etc. Relative to this, the impact areas as well as the potential effects are described.  |
| Pipo Nipomoceno  | Impacts on archeological/historical sites                       | In Chapter 2.1, conflict in landuse issues, this is discussed in connection with coordination with government agencies to acquire LONOs, wherein their specific conditions and concerns are addressed. The proponent shall be coordinating with the National Museum Authority and other concerned agencies in this regard.  |
| Randy Legaspi  | Impacts on subsidence, storm surge and other geological hazards | As discussed under Chapter 2.1, the project will not induce natural geological hazards. For storm surge and/or tsunamis, the island can potentially serve as protection or shield for the coastal areas.  |

### ES 3.0 EIA Summary

#### ES 3.1 Summary of Alternatives

This is discussed in Chapter 1.3 from which the key parameters are as follows:

#### Territorial Jurisdiction

- Must not be in or conflict with ECAs or Protected Areas as declared in the NIPAS, principally the LPP Wetland Park and mangrove communities
- The site should be legally within the juridical jurisdiction of the LGU-Proponent, which for this project is Province of Cavite. Conflict on jurisdiction with other LGUs should be avoided.

#### ES 3.2 Summary of Main Impacts and Residual Effects after Applying Mitigation

**Table ES-7. Summary of Main Impacts and Residual Effects**

| Activity / Resource Likely                             | Potential Impact  | Options for Prevention or Mitigation* or Enhancement   | Target Performance/ Efficiency   |
|--|---|--|--|
| <b>CONSTRUCTION PHASE- DREDGING ACTIVITY/OPERATION</b> |   |  |  |
| Removal of unwanted seabeds and silt                   | Water pollution brought about by silt disturbance within the project area | Installation of silt curtains around the dredging vessel and around the perimeter area of dredging area/activities   | 100 % Compliant to RA 9275 and DAO 2016-08 standards outside the silt curtain area |
| Transport of dredged material to disposal site         | Water pollution due to accidental spillage of dredged materials           | The hauler shall ensure that vessels used for transporting are in good condition to prevent dredged materials from leaking or spilling   | 100% Compliant to RA 9275 and DAO 2016-08 standards outside the silt curtain area  |
| Dumping of dredged material to disposal site (Inland)  | Soil and water Pollution due to disposal of dredged materials             | Installation of high-density polyethylene (HDPE) liner and/or clay for the spoil disposal site to prevent soil and water (ground and surface) contamination and zero discharge | 100% No soil contamination and 100% Compliant to RA 9275 and DAO 2016-08           |



**CHAPTER ES**  
**Executive Summary**

**Proposed Cavite Province Land Reclamation and Development Project: ISLAND D (267 ha)**  
Cavite Provincial Government

| Activity / Resource Likely  | Potential Impact  | Options for Prevention or Mitigation* or Enhancement  | Target Performance/ Efficiency   |
|---|---|---|--|
| Dredging of filling material for reclamation  | Water pollution due to turbidity  | <ul style="list-style-type: none"> <li>Installation of silt curtains around the dredging vessel and/or dredging area</li> </ul>   | 100% Compliant to RA 9275 and DAO 2016-08 standards  |
| Barging of fill materials for reclamation   | Water Pollution due to possible spillage of dredged materials during barging<br>Increase of suspended solids affecting the settlement of marine species in the dredging and reclamation areas | <ul style="list-style-type: none"> <li>Provision of containment facility to prevent spillage</li> <li>Provision of control measures when transporting filling materials</li> </ul>  | 100% Compliant to RA 9275 and DAO 2016-08 standards<br><br>100% no proliferation of suspended solids   |
| <b>RECLAMATION ACTIVITY/OPERATION</b>   |   |   |  |
| Construction of containment wall system/revetment structures<br><br>Installation of containment wall system combination of rock dike, accropode wick drains, sand bag, and grid plate shall be used along certain areas along the perimeter of the project area | Water pollution/ Increase turbidity of adjacent areas due to Infrastructure /Construction Activities of adjacent areas  | <ul style="list-style-type: none"> <li>Installation of a silt curtain 50m away from the working area, surrounding the area to be filled with reclamation materials and in the containment wall system/revetment structures area.</li> <li>Provision of geotextile membrane on the containment structures throughout the perimeters of the project area.</li> </ul>  | 100% Compliant to RA 9275 and DAO 2016-08 standards<br><br>100% no freshwater quality degradation and loss of freshwater species particularly Ylang Ylang River and 100% no cutting of mangroves |
| Filling the project area with reclamation materials<br><br>Delivery of filling and other construction materials through barges  | Water pollution /Increase turbidity due to filling materials near reclamation areas   | <ul style="list-style-type: none"> <li>Installation of a silt curtain 50m away from the working area, surrounding the area to be filled with reclamation materials and in the containment system area.</li> <li>Silt curtains shall be removed after filling inside the containment system.</li> <li>Installation of silt curtains within the 50m away from the barge (for comments of the proponent)</li> <li>Provision of permeable geotextile membrane to prevent sediments during high and low tide outside the project area</li> </ul>   | 100% Compliant to RA 9275 and DAO 2016-08 standards  |
| Hauling of filling materials  | Increase in Noise generation  | <ul style="list-style-type: none"> <li>Use of very efficient silencers on equipment and other noise dissipating device on all equipment to be used. Prior to project implementation, the proponent shall submit inventory of noise dissipating devices such as silencers that will be installed in each heavy equipment and corresponding noise level.</li> <li>Avoid use of heavy machinery during night hours. Activities should be strictly done from 8:00 AM to 5:00 PM only.</li> <li>Installation of noise barriers along haul roads that will be used by heavy equipment.</li> </ul> | 100% compliant to Noise Standards  |
|   | Dust pollution due to vehicle movements:<br>-Along the road leading to the reclamation area<br>-Within the project area activities  | The project proponent shall ensure its haulers have appropriate mitigating measures to address the impact of dust pollution such as: <ul style="list-style-type: none"> <li>Sprinkling of water using water tanker at least four times a day along all possible roads leading to the reclamation area, especially during dry season.</li> <li>Covering all loaded trucks properly/fully using tarpaulin throughout the hauling period.</li> <li>All trucks shall be road-worthy.</li> </ul>   | 100% compliant to RA 8749 in terms of air quality standards  |
|   | Health and Safety due to exposure to Construction Hazard  | Implement wearing of PPE's at all times when inside the project site  | 100% compliant to PPEs and Zero accident   |
| <b>LAND DEVELOPMENT ACTIVITY/OPERATION</b>  |   |   |  |
|   | Land  | <ul style="list-style-type: none"> <li>Liquefaction due to improper compaction</li> </ul>   | 100 % No liquefaction  |





| Activity / Resource Likely  | Potential Impact  | Options for Prevention or Mitigation* or Enhancement  | Target Performance/ Efficiency   |
|---|---|---|--|
| Compaction/Soil stabilization of the project area   | Noise pollution due to heavy equipment operation  | <ul style="list-style-type: none"> <li>Use of very efficient silencers on equipment and other noise dissipating device on all equipment to be used. Prior to project implementation, the proponent shall submit inventory of noise dissipating devices such as silencers that will be installed in each heavy equipment and corresponding noise level.</li> <li>Avoid use of heavy machinery during night hours. Activities should be strictly done from 8:00 AM to 5:00 PM only.</li> <li>Installation of fences/noise barriers along the perimeter of the project area. Corresponding areas to be monitored shall be submitted to EMB.</li> </ul> | 100% compliant to RA 8749 in terms of air quality standards  |
|   | Air pollution emission of dust due to heavy equipment operation                             | <ul style="list-style-type: none"> <li>Sprinkling of water using water tanker at least four times a day within the project area especially during dry season.</li> <li>Providing adequate water spraying device per hauling unit to water along all possible roads leading to the reclamation area.</li> </ul>  | 100% compliant to RA 8749 in terms of air quality standards  |
| Construction of horizontal structures such as follows:<br>A. Road networks<br>B. Drainage system<br>C. Water distribution<br>D. Power and telecommunication lines | Land pollution due to indiscriminate /improper dumping of solid wastes and toxic substances | <p>The proponent shall ensure that its contractors shall practice on-site segregation and establish storage facility of the following:</p> <ul style="list-style-type: none"> <li>Construction debris such as used drum, used tires, wood cuttings, iron bar cuttings, etc.</li> <li>Hazardous wastes such as used oil, busted lamps, oily rags, etc.</li> </ul> <p>The above waste materials shall be hauled and disposed of by a DENR accredited hauler and treater. Biodegradable materials shall be used for composting. Compost materials shall be used for greening activities.</p>   | 100% compliant to the following:<br><ul style="list-style-type: none"> <li>RA 9003</li> <li>DAO 1992-29 and DAO 2013-22 and its Revised Procedural Manual</li> </ul> |
|   | Generation of untreated/improper disposal of domestic wastewater                            | Personnel stationed at the reclaimed land will be provided with on-site portable toilets and washrooms. Collection and disposal will be done by an DENR accredited hazardous waste hauler and treater   | 100% Zero discharge of domestic waste to Bacoor Bay  |
|   | Water Pollution due Increase storm water run-offs surrounding the Areas                     | <ul style="list-style-type: none"> <li>Drainage system should to lead to settling ponds</li> <li>Provision of storm water collection system</li> </ul>  | 100% Compliant to RA 9275 and DAO 2016-08 standards  |
|   | Dust pollution emanating from open areas  | <ul style="list-style-type: none"> <li>Sprinkling of water along all possible routes leading to the reclamation area, at least four times a day, especially during dry season.</li> <li>Open areas should be covered with greeneries such as grass, shrubs, etc.</li> </ul>   | 100% compliant to RA 8749 in terms of air quality standards  |
|   | Health and Safety due to exposure to Construction Hazard                                    | <ul style="list-style-type: none"> <li>Implement wearing of PPE's at all times when inside the project site</li> <li>Implement SDP in terms of priority for local hirees</li> </ul>   | 100% compliant to PPEs and Zero accident<br>100% SDP implementation  |

### ES 3.3 Risks and uncertainties relating to the findings and implications for decision making

The advance reclamation methodologies and the engagement of experienced reclamation contractor will significantly reduce project risks and uncertainties. The containment wall design and construction is a significant aspect in the reduction of risks and uncertainties that could otherwise challenge the integrity of the reclaimed land.

The Detailed Engineering and Design (DED) requirements of the Philippine Reclamation Authority which are complied with post ECC and in the application for a Notice to Proceed (NTP) are another aspect of risk and uncertainty minimization.

The dredging activities to be undertaken at the source of the fill materials, presumably the San Nicholas Shoal (SNS) must necessarily be backed up the expertise in dredging and by complete knowledge of the characteristics (particularly geologic) of the San Nicholas seabed.



## **Chapter 1. PROJECT DESCRIPTION**

### **INTRODUCTION**

On the simultaneous applications for the horizontal and the vertical phase, these cannot be done at the same time. The vertical phase is subject to a different EIS process and may involve a Programmatic Type of document. Moreover, the proponent(s) for the vertical phase, which must be the personality to apply for the ECC, are not identified at this time.

However, as a Planning Tool, the EIS Report in fact considers the vertical phase, as reflected in the Master Development Plan, the Drainage System and the Access ways from the Shore.

The Proponent has demonstrated consideration of geotechnical risk issues in the submission of the EIS, including assessment of settlement, liquefaction and stability of the preliminary revetment sections. Such considerations indicate an understanding of environmental risks and the proposal of mitigation measures, when warranted, for the purpose of securing an environmental permit, particularly that within the mandate of the PRA.

It is also the understanding of the Proponent that additional, comprehensive analysis as well as further construction details will be necessary prior to the issuance a PRA Notice for the construction work, which will be technical speaking, a “permit”.

On November 11, 2018, the Provincial Government of Cavite passed a Resolution No. 1077 granting the Provincial Governor authority to award to Century Peak Corporation (CPC) and its consortium the Cavite Reclamation Project and to sign a Joint Venture Agreement (CPC) for the purpose of Ordinance 002-2-2012 otherwise known as the ‘Provincial Government of Cavite’s PPP Code’, attached in **Annex 1-A**. Further, since Island D is within the jurisdiction of Noveleta and Rosario, Resolution Nos. 2019-03 and 10-2019 dated January 28, 2019, respectively, interposing no objection to apply for the proposed reclamation project, **Annexes 1-B** attached are the Resolution issued by the LGU (Noveleta and Rosario).

### **Brief Summary of Regulatory Process in Reclamation Projects (PRA Process)**

Reclamation projects are governed by several decrees and proclamations as described hereunder in chronological order:

Presidential Decree No. 3-A mandates that all reclamation of foreshore, submerged and offshore areas shall be limited to the National Government or any person authorized by it under a proper contract;

Executive Order No. 525, dated February 12, 1979, designated the Philippine Estates Authority-PEA (now known as the Philippine Reclamation Authority-PRA) as the agency primarily responsible for all reclaimed projects for and in behalf of the National Government and mandates that all reclamation projects be submitted to the President for his approval, upon recommendation by the PEA and the same to be undertaken by the PEA or through a proper contract executed by it with any person or entity;

Executive Order No. 543, dated June 24, 2006, delegates to the PRA the authority of the President to approve reclamation projects;

EO No. 146, dated November 13, 2013, transferred the power to approve reclamation projects from the PRA Board to the National Economic and Development Authority (NEDA) Board. Pursuant to Section 6 of this EO, the NEDA-PRA Joint Order was issued.



EO 74, dated February 1, 2019, transferred the PRA to the control and supervision of the Office of the President (OP). EO No. 74 repeals the EOs designating power to the DENR and NEDA Board over the PRA. Furthermore, in this EO, the power of the President to approve all reclamation projects shall be delegated to the PRA Governing Board. Also, it mandates the PRA to seek advisory opinions from the NEDA, DENR, and Department of Finance on any proposed reclamation project. It states that no reclamation project shall be approved by the PRA without the required area clearance and environmental compliance certificate from the DENR.

**PRA Administrative Order No. 2019-4** embodies the Implementing Rules and Regulations (IRR) of EO 54. Under this IRR, “Area Clearance”, one of the mandatory documents for a reclamation project, is defined as:

*3.2 Area Clearance refers to the document issued by the DENR declaring an area suitable for reclamation on the basis of:*

- a. Valid Geohazard Assessment of the Area duly prepared and signed by a licensed Geologist; and*
- b. Community Environment and Natural Resources Office (CENRO) Certification on the status of the area and land classification of adjacent land.*

The capacity of the Province of Cavite to reclaim is pursuant to Republic Act (RA) No. 7160 or the Local Government Code of 199. The Department of Interior and Local Government, under Memorandum Circular No. 120, s.2016, confirmed the authority of local government units to enter into Public-Private Partnerships and Joint Ventures for reclamation projects pursued consistent with the mandate and charter of the PRA. This project is under the EO 543 since this is already covered by the existing JVA Agreement, such application met the minimum requirements as stipulated in the IRR of EO 543.

In connection with the Area Clearance application, a Notice to Proceed has been granted by the DENR-Region IV-A in favor of this proposed project. This enables the Project Proponent to proceed with the ECC Application process.

The NTP and Area Clearance Application are shown in **Annex 1-C**.

### **Project Overview:**

The Province of Cavite plans to build four artificial islands (A, C, D and E) 300 to 600 m offshore from Cavite City, Kawit, Noveleta, and Rosario in Cavite Province, Southeast of Manila Bay, Philippines. The project covers a total area of 1,043.28 hectares and creates four islands through land backfill.

Based on the preliminary plan, the four islands will be built into a modern aerotropolis in the future. Table 1-A presents conceptual overall configuration of the proposed Cavite Reclamation Project. See Figure 1-A for the preliminary overall master plan showing the location of the specific Island D for application.

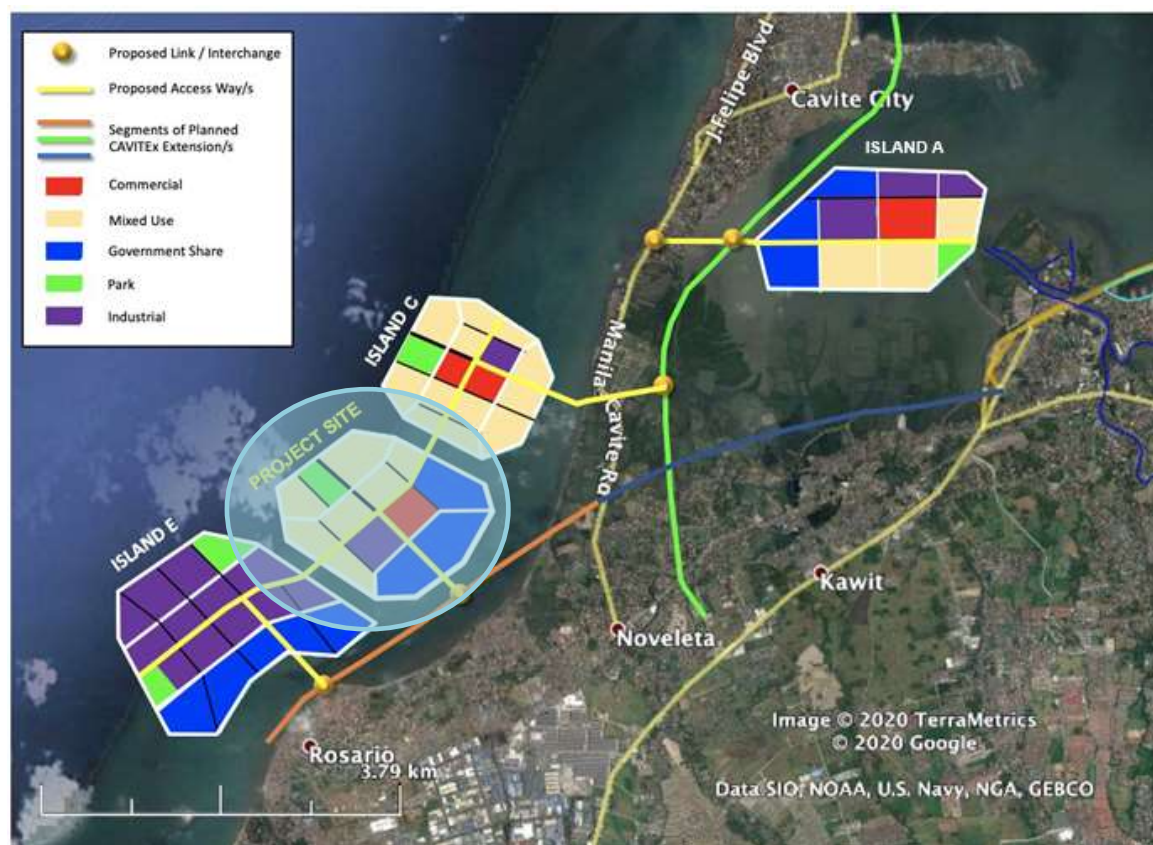


**CHAPTER ONE**  
**Project Description**

**Proposed Cavite Province Land Reclamation and Development Project: ISLAND D (267 ha)**  
Cavite Provincial Government

**Table 1-A Conceptual Overall Configuration of the Proposed Cavite Reclamation Project**

| Description   | Island A  | Island C  | Island D   | Island E   |
|---|---|---|--|--|
| <b>Project Area</b>   | 247.28 hectares   | 205.00 hectares   | 267.00 hectares  | 324.00 hectares  |
| <b>No. of Island</b>  | One (1) Island  | One (1) Island  | One (1) Island   | One (1) Island   |
| <b>Volume of Earth Fill</b>   | 21.95 Million cubic meters  | 21.23 Million cubic meters  | 25.22 Million cubic meters   | 31.93 Million cubic meters   |
| <b>Finished Platform Elevation</b>                                  | + 4.50 meters above MLLW  | + 4.50 meters above MLLW  | + 4.50 meters above MLLW   | + 4.50 meters above MLLW   |
| <b>Dredging Equipment</b>   | Cutter Suction Dredger  | Cutter Suction Dredger  | Cutter Suction Dredger   | Cutter Suction Dredger   |
| <b>Reclamation Method</b>   | Hydraulic Sand Filling Method   | Hydraulic Sand Filling Method   | Hydraulic Sand Filling Method                                      | Hydraulic Sand Filling Method                                      |
| <b>Design of Containment System (Ground Improvement under Dike)</b> | Drainage and consolidation method   | Drainage and consolidation method   | Drainage and consolidation method                                  | Drainage and consolidation method                                  |
| <b>Length of the Dike</b>   | 6,601 linear meters   | 4,910 linear meters   | 5,710 linear meters  | 7,043 linear meters  |
| <b>Structure Type and Materials of Dike</b>                         | Sloping Dike using Sand Bags  | Sloping Dike using Rock and Sand Bags   | Sloping Dike using Rock and Sand Bags                              | Sloping Dike using Rock and Sand Bags                              |
| <b>Armor Structure</b>  | Natural Stone Armor   | Artificial block armor (Accropode) and Concrete Grid Plate  | Artificial block armor (Accropode) and Concrete Grid Plate         | Artificial block armor (Accropode) and Concrete Grid Plate         |
| <b>Soil Stabilization</b>   | Vertical Drains Plus Surcharge  | Vertical Drains Plus Surcharge  | Vertical Drains Plus Surcharge                                     | Vertical Drains Plus Surcharge                                     |
| <b>Inter-Island Connectivity/Bridge</b>                             | None  | C-D<br>~ 200 meters   | D-E<br>200 meters  | None   |
| <b>External Bridge</b>  | From Manila-Cavite Road and CAVITEx Extension with provision of Access Road (Bridge)<br>To Island A | From Manila-Cavite Road and CAVITEx Extension with provision of Access Road (Bridge)<br>To Island C | Planned Road with provision of Access Road (Bridge)<br>To Island D | Planned Road with provision of Access Road (Bridge)<br>To Island E |
| <b>Purpose of the Application</b>                                   | <b>ISLAND D</b>   |   |  |  |



Base Map: Satellite Image by Digital Globe, Google Earth. 2020

**Figure 1-A Preliminary Overall Master Plan showing the location of Island D**

## **1.1 Project Area, Location and Accessibility**

### **1.1.1 Location and Political Boundaries**

The proposed project will occupy a total reclaimed land area of **267 hectares**. The project is located along the Coastal Waters of the municipalities of Noveleta and Rosario, within the jurisdiction of Cavite Province.

Provided in Figure 1-1 is the NAMRIA map and in Figure 1-2 the aerial satellite map of the proposed project site. The barangays/municipality adjacent to and fronting the project site (which are also the impact barangays) are shown in Figures 1-5 and 1-6.

### **1.1.2 Geographic Coordinates (Shape File Data) of Project Area**

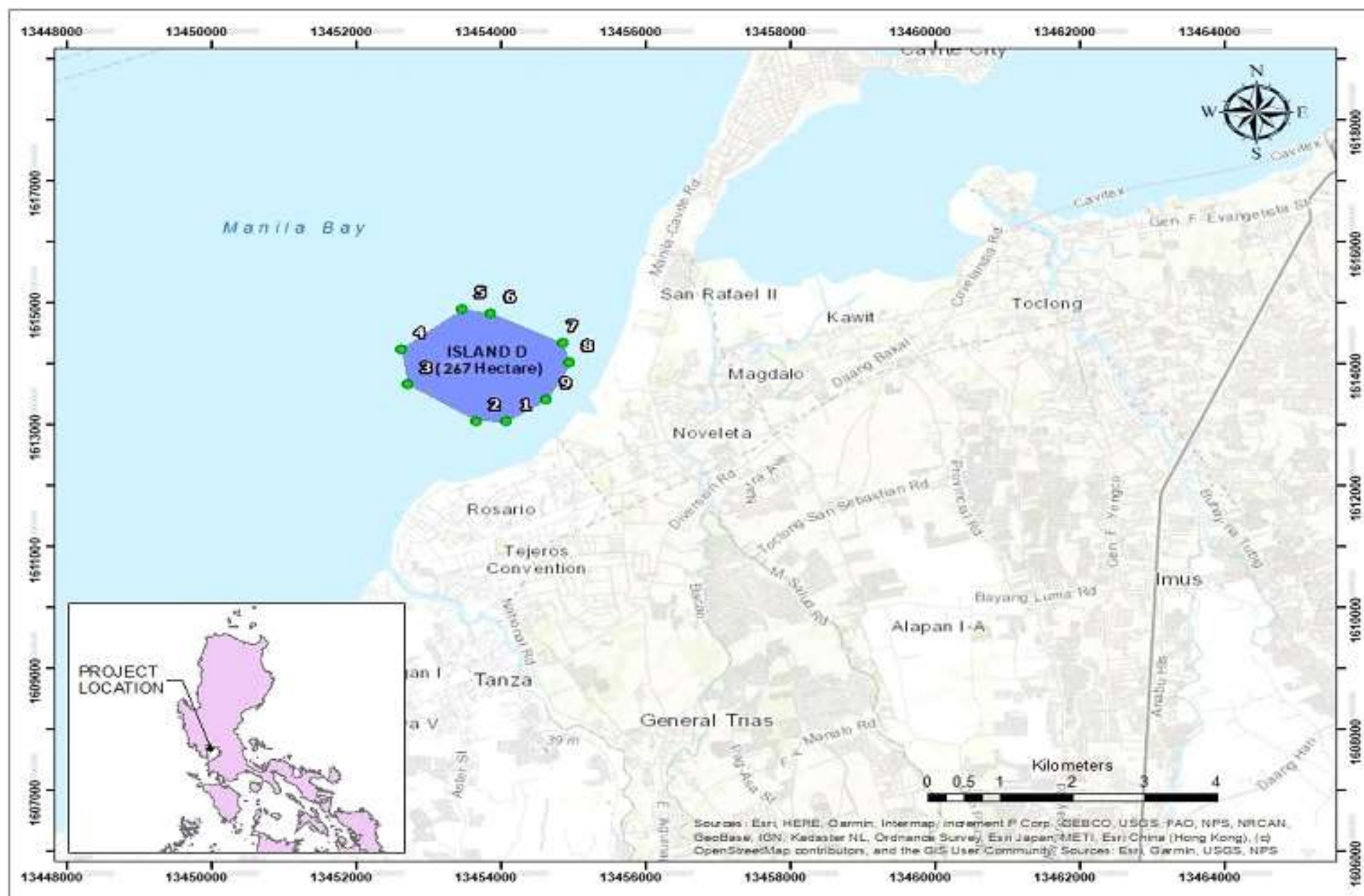
The coordinates are vital for (a) identifying the Scope of the ECC that is being applied for, (b) providing the footprints from which evaluations may be made, e.g. water circulation, bathymetry; geotechnical investigation and marine surveys and for (c) ascertaining that the site is indeed within the political boundaries of the Municipality. See Figures 1-3 and 1-4.



**Table 1- 1 Geographic Coordinates (Shape File Data in WGS 84) of the Project Landform**

| CORNER            | LONGITUDE           | LATITUDE           |
|-------------------|---------------------|--------------------|
| ISLAND D (267 ha) |                     |                    |
| 1                 | 120° 51' 36.2344" E | 14° 25' 50.7075" N |
| 2                 | 120° 51' 22.7066" E | 14° 25' 50.6928" N |
| 3                 | 120° 50' 52.0701" E | 14° 26' 10.0747" N |
| 4                 | 120° 50' 48.8697" E | 14° 26' 28.0708" N |
| 5                 | 120° 51' 16.3934" E | 14° 26' 47.8042" N |
| 6                 | 120° 51' 28.7479" E | 14° 26' 45.6971" N |
| 7                 | 120° 52' 00.4339" E | 14° 26' 30.3667" N |
| 8                 | 120° 52' 03.7365" E | 14° 26' 20.5834" N |
| 9                 | 120° 51' 53.5284" E | 14° 26' 01.8486" N |

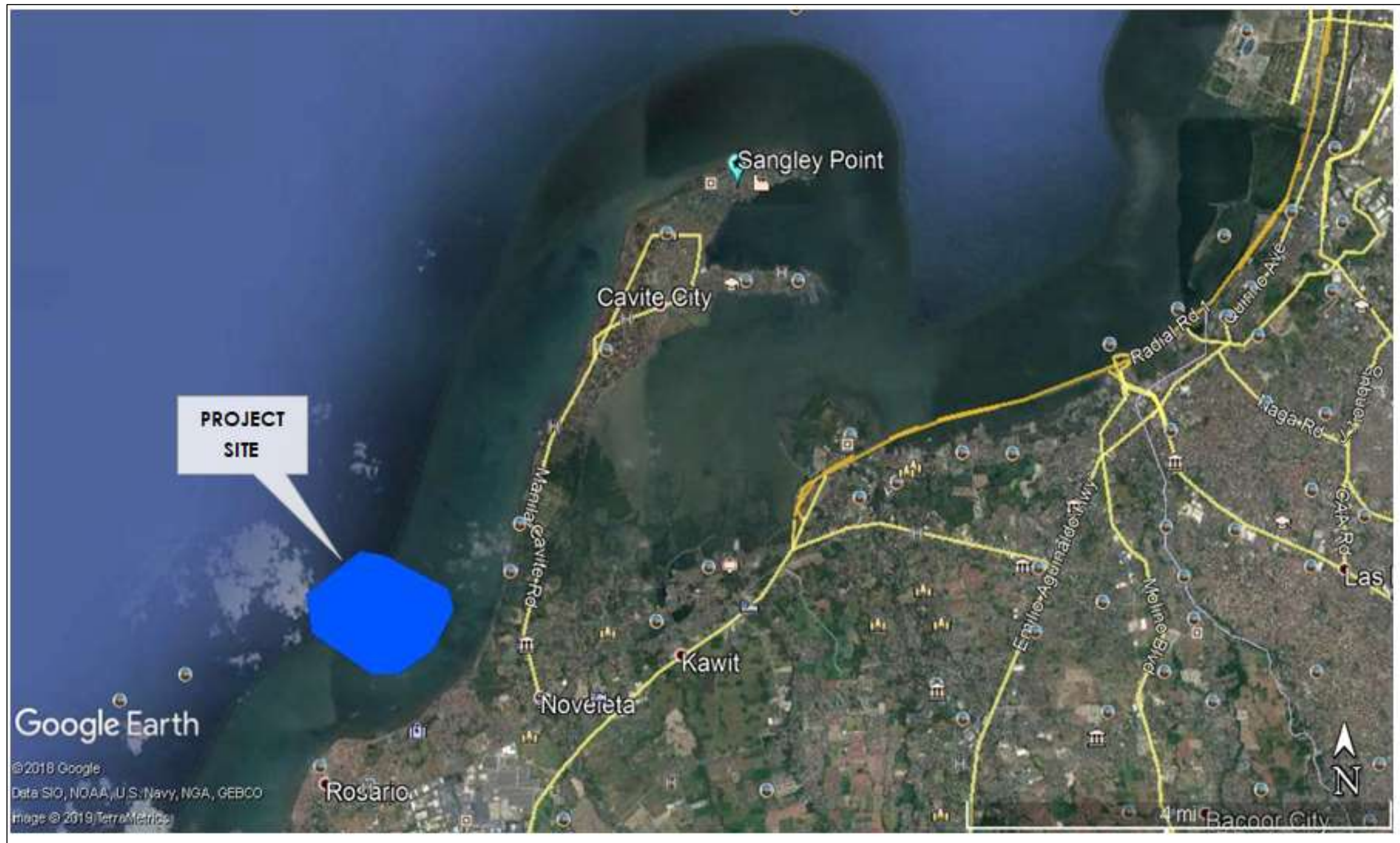




Source: NAMRIA Map Sheet 3129 1, July 2001

Figure 1- 1 Project Site Location on a NAMRIA Base Map

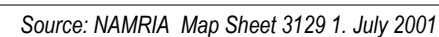
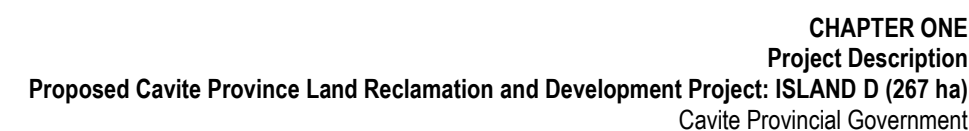




Base Map: Satellite Image by Digital Globe, Google Earth. 2020

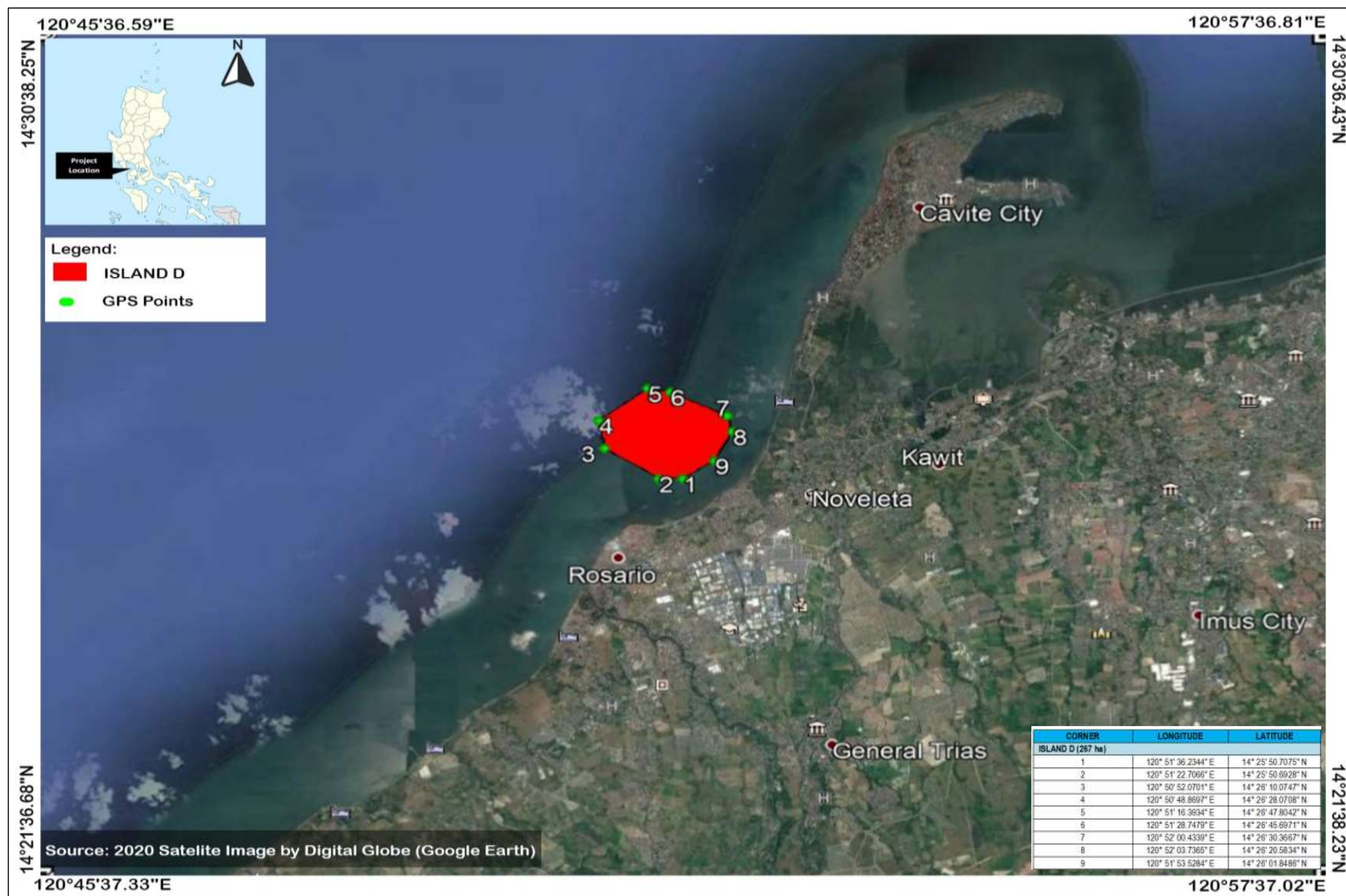
Figure 1- 2 Project Site Location on a Google Earth Map





**Figure 1-3** Location Map of Proposed Project indicating its Geographical Points (NAMRIA Map)





Base Map: Satellite Image by Digital Globe, Google Earth. 2020

Figure 1- 4 Location Map of Proposed Project indicating its Geographical Points (Google Earth Map)



### **1.1.3 Accessibility**

#### ***Existing Transport Network Systems***

The nearest existing major road to the proposed project site on Manila Bay side of Noveleta and Rosario is the Manila-Cavite Road (NS orientation), approximately located at a range of 1.1 kilometers straight distance from the nearest corner of Islands D, shown in Figure 1-7. Another major road is the Marseilla Street, which runs almost parallel to the coast spanning the towns of Rosario and Noveleta, and joins Magdiwang Highway going to Kawit. Another important thoroughfare in the area is the Centennial Road (R1), which links the CAVITEx to the towns of Kawit and Rosario.

Cavite enjoys strategic access to Manila. Its proximity to the urban centers as well as the international gateways of the country has made it accessible through 12 major entry and exit points. It is located at Region IV-A or the CALABARZON Region. ([www.cavite.gov.ph](http://www.cavite.gov.ph))

These access points are currently being expanded and re-developed to further ease the burden of reaching Manila and its neighboring cities. ([www.cavite.gov.ph](http://www.cavite.gov.ph)). The roads important to the project are:

- Manila-Cavite Coastal Road via Talaba, Bacoor City
- Cavite Toll Expressway (CAVITEx) or R-1 Expressway Extension

#### ***Planned Transport Network System***

There is a project in the pipeline for the Manila-Cavite Expressway, also known as Coastal Road/ CAVITEx, (a tollway linking Manila to Cavite Province) to be extended northwards from the Imus Interchange to Sangley Point. This road shall pass over the waters of Bacoor Bay, and is seen as an opportunity for linkage to Island D.

#### ***Planned Road Network System***

The 7.7-kilometer long expressway will connect C5 road to the Manila-Cavite Toll Expressway and is expected to be fully operational by 2019. It will include a 2x3 lane carriageway, an R1 Expressway (Coastal Road) interchange, Sucat toll barrier, Merville ramp and a flyover. Phase 1 is the construction of a flyover that will connect C5 to Merville Subdivision in Paranaque while Phase 2 connects Merville Subdivision to Cavite, virtually linking Paranaque to the province of Cavite.

#### ***Planned Railway System***

11.7 km extension of the LRT Line 1 with eight stations from Baclaran Station in Paranaque City, Metro Manila to Niyog Station, Bacoor City, Cavite Province. Of 11.7km extension, approximately 10.5 km will be elevated and 1.2 km will be at-grade.

#### ***The Access Ways***

Preliminary design works are underway for the link from shore to the reclaimed land. In any case, the initial plan is for access ways/viaducts to be linked to the Manila-Cavite Road for Island D. Figure 1-7.

#### ***Inter-island Connectivity***

Inter-island bridges will be built to connecting Islands 1 and 2 will be built. Furthermore, the access ways to island D shall be interconnected, and will pass over land.



- **Inter-City Connectivity**

The proposed viaduct system could have spur lines that can connect Cavite City, Noveleta and Rosario, as well as all of their adjoining LGUs.

- **Inter-Regional Connectivity**

The proposed viaduct system that can connect the Cavite reclamation islands can also effectively interconnect the Project with the southern NCR/ MMA cities of Pasay, Parañaque, and Las Piñas. To effectively connect the Project with the NCR/ MMA, additional or separate linkages to existing, ongoing and planned transit systems and to tollway systems have to be planned.

- **Extra-Regional Connectivity**

Aside from the planned and existing surface linkages, extra- regional travel (over straight-line distances of from 60 to more than 100 kilometers/km) may already require other forms of non-overland transport i.e. ships, ferries, private boats/yachts, helicopters, and the like. The marina/s that may be later proposed for the Project may effectively host water-borne traffic while the transportation and utility blocks can host heliports and helistops atop the multi-modals/ intermodals/ parking structures; should express (or high speed) railway services become available in the near future. It is also hoped that the viaduct can host this level of service. In such an event, the inter-reclamation island viaduct alignment shall have 4 separate services i.e. water, drainage and wastewater lines at sub-grade level, surface traffic at grade, a commuter rail (express) service cum utility alignments i.e. fiber optic/ telecommunications, power, gas/ fuel, etc. at the 2nd level, a light rail service at the 3rd level, a tollway service at the 4th level and possibly even a Project-wide cable car or monorail service at the 5th level.

#### **1.1.4 Vicinity Map and Adjacent Landmarks**

The vicinity map is shown in Figures 1-8. Important landmarks in the area are historical sites, old churches, industrial parks, and beach resorts. The nearest landmarks from the project site include:

*Noveleta*

- Casa Tribunal de Noveleta - the place where Gen. Emilio Aguinaldo wrestled with two guardia civils on duty on August 31, 1896.
- Villa Mar / Lido Beach Resorts (Brgy. San Rafael IV)
- Long Beach Resort

*Rosario*

- Cavite Economic Zone II
- Cavite Export Processing Zone (CEPZA)
- Casa Hacienda de Tejeros
- Our Lady of the Most Holy Rosary Parish Church
- Diocesan Shrine of St. Augustine – Sta. Cruz de Malabon Church
- La Isla Bonita de Salinas
- Mount Sea Resort (Ligtong IV)

#### **1.1.5 Adjacent Proposed Reclamation and Other Projects**

The adjacent new reclamation projects are shown in Figure 1-9. These include the following:





**Table 1- 2      List of Nearby Reclamation Projects**

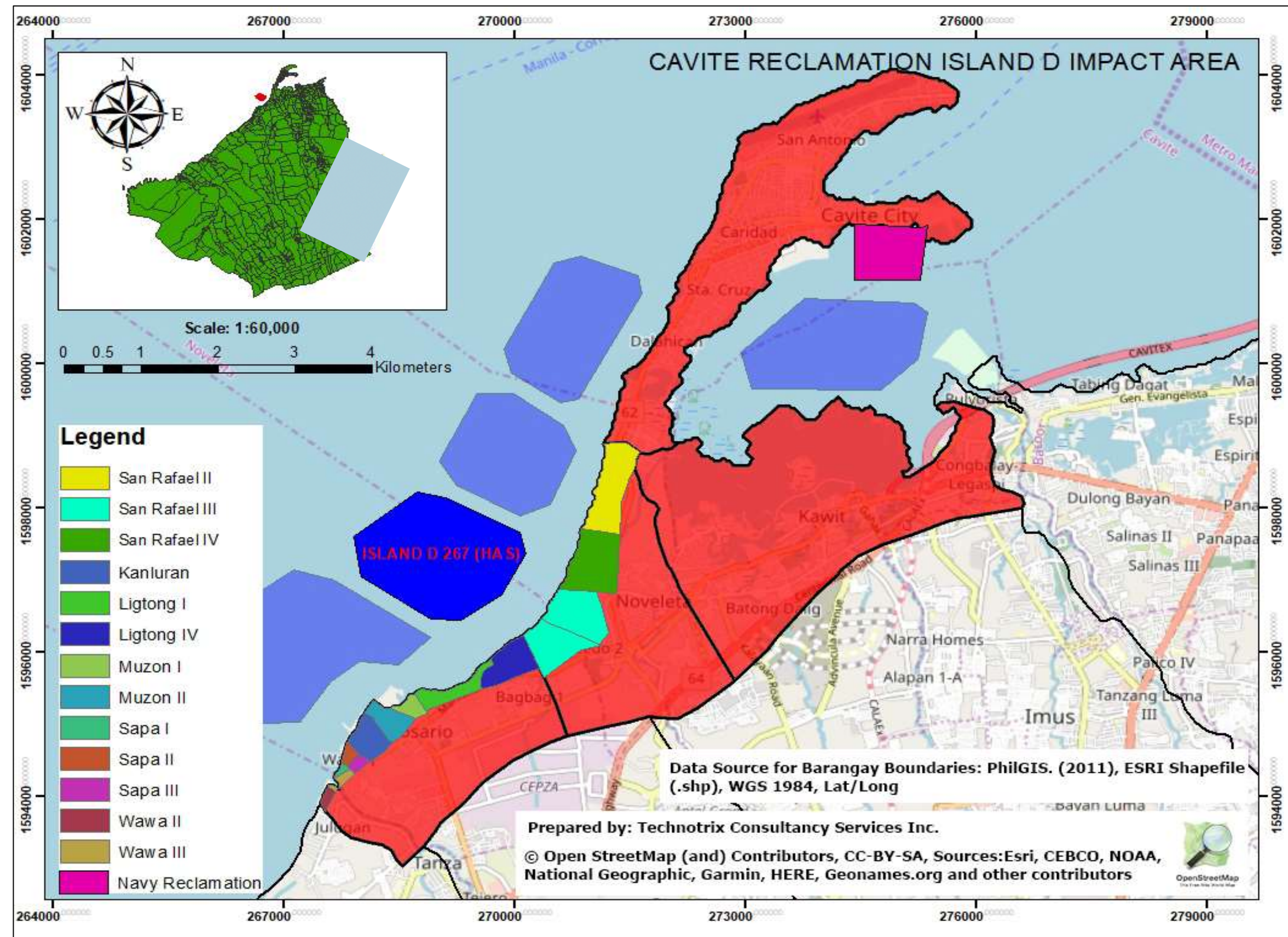
| <b>Project</b>                              | <b>Area (Hectare)</b> | <b>Status of ECC</b>        |
|---|-----------------------|-----------------------------|
| Bacoor Reclamation and Development Project  | 320                   | With ECC                    |
| Diamond Reclamation and Development Project | 100                   | With ECC                    |
| Sangley Point International Airport Project | >1,400                | Planning stage              |
| Philippine Navy Reclamation Project         |                       | Planning stage              |
| Parañaque 286.86-ha Reclamation Project     | 286.86                | Application process ongoing |

At this time, however, the ECC applications for the SPIA and PN projects have not been lodged with the DENR-EMB.

There are no overlaps in boundaries between these other projects and this application as there were adjustments made by the proponent with respect to landform and area coverage in consideration of the SPIA and PN reclamation projects to ensure that there will be no conflicts.

#### **1.1.6      Relative Location of the Las Piñas-Parañaque Wetland Park (LPPWP)**

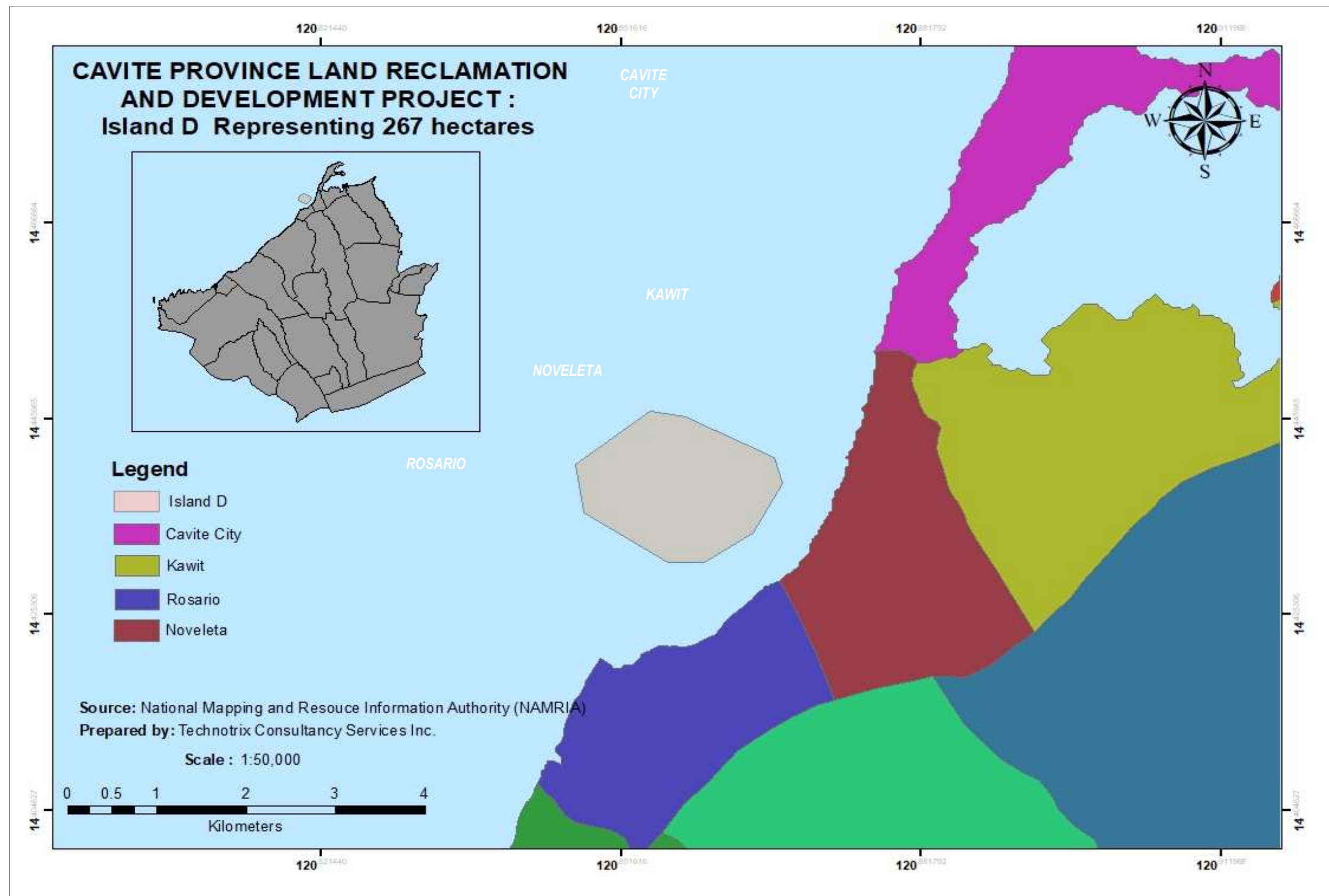
The potential impact of the Project on LPPCHEA is well considered. Figure 1-10 shows the LPPWP being **12.5 km** away from the site a big distance to cause concern over potential impacts of the project.



Base Map: Google

Figure 1- 5 Geopolitical Map of Province of Cavite indicating the Proposed Project Site and Impact Barangays





Base Map: NAMRIA

Figure 1- 6 Geopolitical Map – Province of Cavite and Adjacent Municipalities Indicating the Project Site





Figure 1- 7 The Preliminary Conceptual Access Way of the Proposed Cavite Island D Reclamation Project.



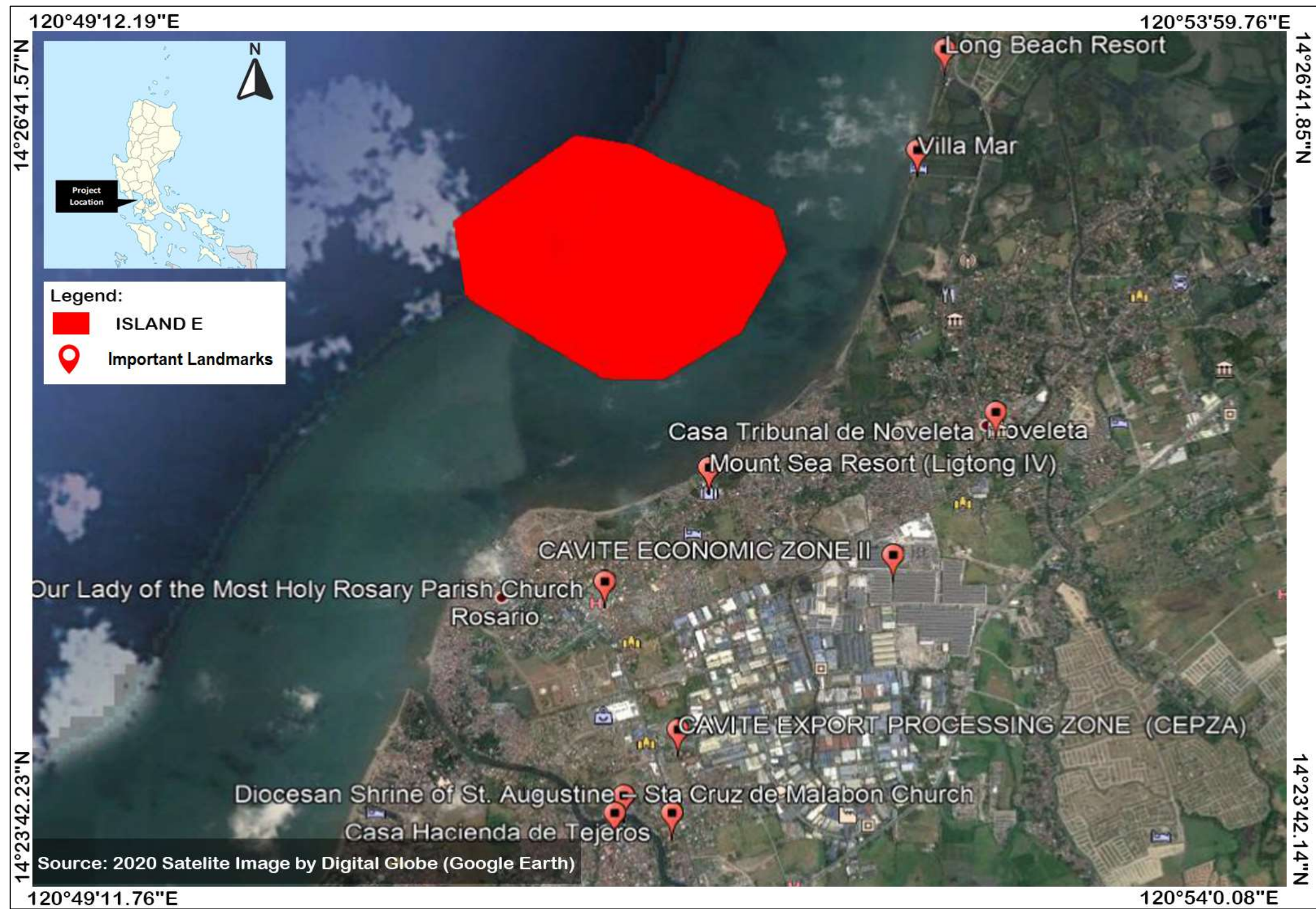


Image by Digital Globe, Google Earth. 2020

Base Map: Satellite

Figure 1- 8 Vicinity Map Showing the Important Landmarks





Base Map: Satellite Image by Digital Globe, Google Earth. 2020

Figure 1- 9 Nearby Reclamation Projects





Base Map: Satellite Image by Digital Globe, Google Earth. 2020

Figure 1- 10 Map Showing the Distance of the Project Site from the LPPWP in a Google Earth Map



### 1.1.7 Delineation of Impact Areas

The Delineation of Direct Impact Area (DIA) and Indirect Impact Area (IIA) followed the provisions under Section 10, of DENR Administrative Order (DAO) 2017-15 and the results of the Coastal Engineering Assessment or Hydrodynamics Modelling. The study areas are identified in the discussions of the specific modules, i.e. Land, Water, Air and People.

**For the proposed project, the DIA's** are the area where ALL project facilities are proposed to be constructed/situated and where all operations are proposed to be undertaken. For most projects, the DIA is equivalent to the total area applied for an ECC identified as:

- The reclamation with area of 267 hectares wherein the construction activities will be undertaken. This area is currently the body of water covered by the planned landform. There are no structures or fishing activities and settlers at the DIA.
- All barangays fronting the proposed site such as: San Rafael II, San Rafael III and San Rafael IV for Municipality of Noveleta; Bagbag II, Kanluran, Ligdong I, Muzon II, Sapa II, Sapa III, Wawa I, Wawa II and Wawa III for Municipality of Rosario.
- Nearest existing road where access ways will be built

**For the proposed project, the IIA** are the stretch of the river/s OUTSIDE the project area but draining the project site which can potentially transport Total Suspended Solids and other discharges from the project towards downstream communities such as:

- Navigation lane of dredging vessel.
- The other adjacent proposed reclamation project is the 1,700 - Hectare Sangley Point Reclamation Project, which is still being planned in finality.

**Table 1- 3      Impact Areas**

|                           | MAJOR IMPACTS   | SITES/IMPACT AREAS   |
|---------------------------|---|--|
| <b>DIRECT IMPACT AREA</b> |   |  |
| Land                      | Impacts in terms of compatibility with existing land use                              | Deemed not applicable, project is at sea. Land Use Certification already issued  |
|                           | Impact in existing land tenure issue/s  | Adjacent impact barangays are: San Rafael II, San Rafael III and San Rafael IV for Municipality of Noveleta; Bagbag II, Kanluran, Ligdong I, Muzon II, Sapa II, Sapa III, Wawa I, Wawa II and Wawa III for Municipality of Rosario. <b>No land tenure issues related to project which is at sea.</b> |
|                           | Improper of Solid Waste Management and Other related Impacts                          | At and vicinity of site  |
|                           | Inducement of natural hazards such as liquefaction, storm surge, tsunami, debris flow | Impact Barangays of the Municipalities of Noveleta and Rosario   |
|                           | Soil Erosion  | At and vicinity of site<br>Shoreline   |
| Water                     | Change in drainage morphology   | At and vicinity of site/onshore  |
|                           | Perception of Floods  | Impact Barangays of the Municipalities of Noveleta and Rosario   |
|                           | Change in bathymetry  | At and vicinity of site  |
|                           | Change in water circulation   | Project site and vicinities  |
|                           | Degradation of surface water quality  | Project site and adjacent water bodies   |



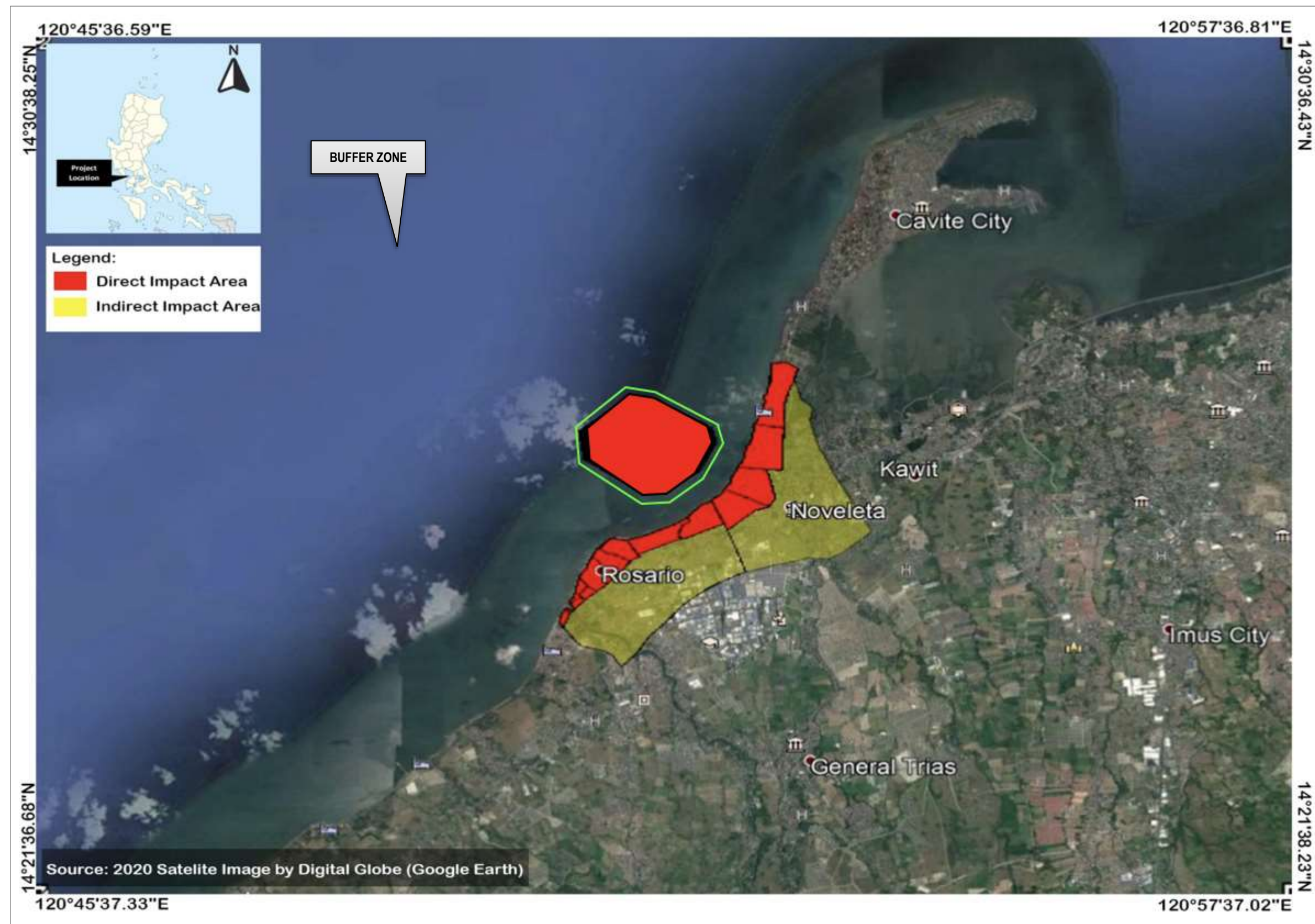


|                              | MAJOR IMPACTS   | SITES/IMPACT AREAS   |
|------------------------------|---|--|
|                              | Degradation of coastal water quality  | Project site and adjacent water bodies                                     |
|                              | Displacement of established fishing areas that are within the proposed site       | 12 Impact Barangays  |
|                              | Displacement of lifts and mussel farms  | Declared Aquaculture and fishing zones                                     |
| People                       | Positive impacts on employment and livelihood                                     | Impact Barangays/Municipality of Noveleta and Rosario                      |
|                              | Positive impacts on economic uplift of the Province of Cavite                     | Impact Barangays/Municipality of Noveleta and Rosario                      |
|                              | Competition or otherwise enhancement of livelihood or businesses adjacent to site | Impact Barangays/Municipality of Noveleta and Rosario                      |
| <b>INDIRECT IMPACT AREAS</b> |   |  |
| Land                         | Impacts on Las Piñas – Parañaque Wetland Park                                     | Las Piñas – Parañaque Wetland Park   |
| Water                        | Potential Damage to fish cages due to Navigation of Dredging Vessel               | Fish lifts/sapras within the area  |
|                              | Potential damage to adjacent creeks and rivers                                    | Project site and adjacent water bodies                                     |
| Air                          | Degradation of Air Quality and Increase of Ambient Noise                          | Roads outside project site<br>Site of access way connecting points onshore |
| People                       | Competition with Small Establishments   | Municipalities of Noveleta and Rosario                                     |
|                              | Impacts on traffic in nearby existing roads                                       | Project site and adjacent areas  |

The map of the DIA, and IIA is provided in Figure 1-11.

#### 1.1.8 Proposed Buffer Zone

Generally defined, an environmental buffer zone is a geographical zonal area that separates a project site from the impact areas (water, land, air and people) thereby providing protection from the impacts of the project to communities/people and resources. For the project the buffer zone is the water itself surrounding the landform and about 200-meters from the coastal area. The buffer zone is also shown in Figure 1-11.



Base Map: Satellite Image by Digital Globe, Google Earth. 2020

Figure 1- 11 Map of the Direct and Indirect Impact Areas and Buffer Zone of the Proposed Project



## **1.2 Project Rationale**

The basic rationale for the Island D Reclamation Project has to be taken in the context of the entire Cavite Land Reclamation and Development Project, which consists of four islands.

The Province of Cavite has the advantage of being near/ adjacent to major urban centers in Metro Manila. As such, it enjoys strategic access to Manila. Cavite is committed to becoming a major international gateway and a preferred hub for global companies. Presently, it hosts several industrial/economic productivity zones that continue to persuade investors to choose Cavite.

The increase in businesses also results to population growth. In addition, the areas of Cavite nearest to Metro Manila are increasingly becoming a popular choice for residential areas because of its easy access to work places/business centers, schools, and commercial areas.

The overwhelming congestion in Metro Manila has led urban planners to seek areas for expansion, and what better options are there but for adjacent provinces such as Cavite. In fact, the Sangley Point has been shown to be the most feasible area for the airport-seaport complex with enabling reclamation component. With this, it is necessary for Cavite to provide large parcels of land to accommodate envisioned developmental growth.

### ***Economic Growth***

The proposed Cavite land reclamation project for Island D of 267 hectares located along the coast of Manila Bay, near the Sangley Point, can produce some 13,300,000 square meters of additional buildable/developable space. This could be translated into about 9,310,000 square meters of building gross floor area, based on the existing 70% buildable vis-à-vis to 30% open space/public area ratio. This additional gross floor area can be allocated for tourism, office, residential, commercial, and other non-industrial mixed uses in a master planned community. It can be a pride for the province and will put it in the world map of business, leisure and investment.

The municipalities of Noveleta and Rosario will have additional land areas for expansion and development. Also, they will have new saleable and leasable prime properties; the project will be completed at no cost to the government; provide additional revenues through taxation, permits and licenses from the various economic activities of the said Project. These taxes in turn will be utilized for the improvement and lifting up of the level of public services being provided by the local government unit in particular as well as the those of the national government in general. The host Province and its cities/municipalities will then be transformed into new, vibrant and self-sufficient communities where employment and other income generating activities could be secured all year round.

Moreover, there will be a new destination for local and international tourists. Furthermore, it can serve as a buffer to the coastal areas from storm surge.

The proposed project will further promote the well-being of the people of the 12 impact barangays, the Municipalities of Noveleta and Rosario, as well as the Province of Cavite, especially in terms of employment and livelihood. The increase in employment opportunities for the locals will also translate to increased buying capacity of the residents, which will eventually translate into down-the-line benefits in terms of increased sales or business opportunities to local entrepreneurs.

Proceeds from the reclamation shall enable the Provincial as well as the 2 Municipal LGUs to expand and continually provide for its existing and future projects as indicated in their Comprehensive Development Plans (CDP) such as (i) school and healthcare facilities and services; (ii) medical, burial, educational assistance; (iii) financial assistance to barangays and to victims of fire and other calamities; (iv) social pension and senior citizens' welfare; (v) cash gifts and financial and emergency relief assistance; (vi) medical missions and emergency relief programs; (viii) livelihood programs and others.





### **1.3 Project Alternatives**

#### **1.3.1 Siting Alternative Criteria**

The key to siting of the project is to determine the best option available that will not result in serious environmental and social impacts.

**Territorial Jurisdiction:** The site should be legally within the judicial jurisdiction of the LGU-Proponent, which for this project is Province of Cavite. Conflict on jurisdiction with other LGUs should be avoided.

**Distances from important landmarks:** As required and identified by the LGU, the project site will be set back from the coast for at least 200m, hence, it will have enough buffer to the important landmarks onshore.

**Must not be in or conflict with ECAs or Protected Areas as declared in the E-NIPAS:** The project site is not within the LPP Wetland Park nor does it infringe on the mangrove communities (see Figure 1-10).

**With respect to the other possible reclamation projects in the future**

There is sufficient buffer zone between the site and these other projects.

**With respect to configuration:**

- Site and configuration must be acceptable to concerned other government entities, e.g. the PPA as would be established during the securing of the Letters of No Objection (LONOs)
- The Master Plan and the configuration should be harmonized

**With respect to number of islands:**

As a whole, the Proponent has lodged 4 separate ECC applications for 4 islands, no other siting locations were considered for the proposed project. Though with individual applications, the planning of the proponent is wholistic, considering overall impacts to its environs. These were subdivided into 4 islands instead of 1 to allow sufficient water circulation; sedimentation factors, passage of sea traffic, buffer zones for other users, overall aesthetics, and other factors, the number of islands was based on the results of the coastal engineering assessment and hazard assessment in the area.

**Site options with Analysis and Evaluation of Site Engineering Geological Conditions:**

***Evaluation of the Site Stability and Suitability***

The geological structure activity in the investigated area is relatively stable, and no adverse geological action such as neotectonics movement, active fault zone, and landslide, etc., and obstacles affecting the project are seen. Soft muddy soil with some thickness is distributed in the shallow part of the survey site. It is in the adverse section for building seismicity. However, according to the analysis for engineering geological conditions of the site, the overall stability of the site is good. This region has obtained rich building experience that overcomes these unfavorable factors. Therefore, the survey site is a general site for construction, which is suitable for the construction of this project

The geological and met-ocean risks are the same for the coastal areas of the Province of Cavite, and therefore, are not germane to site selection. Moreover, engineering/design and construction methodology interventions will be adapted and applied to the landforms in whichever site is selected.

***Assessment on Engineering Geological Conditions for Marine Levee***

There is a good natural shallow foundation bearing layer available in the proposed area. Therefore, the soft soil in the proposed area is the key which affects the design and construction of the cofferdam. The soft soil layer of the superficial part shall be strengthened necessarily to improve the bearing capacity of the shallow





foundation soil layer and ensure the stability and safety of the cofferdam during construction and after being put into use.

## **Environmental**

1. Social acceptability of the land reclamation project
2. Compliances with the national environmental laws and regulatory regimes, including recent laws on climate change adaptation (CCA), disaster risk reduction and management (DRRM), and the like, specifically their stream of regulations, including all the related executive issuances covering referral codes (RCs) and derivate regulations (DRs); and
3. Adjoining developments and / or physical conditions that materially affect the land reclamation project e.g. shelf shape / configuration that limit land reclamation expanse, flooding conditions at landslide, livelihood of coastal communities, relocation and resettlement, sources of reclamation materials and or labor, potential hazards such as liquefaction, tsunamis, storm surges, etc.

### **1.3.2 Technology Options**

#### **Reclamation Method - Options Considered on Choice of Method(s) of Reclamation**

With advance technology and available state of the art equipment and construction methods, reclaiming land offshore even with large area nowadays could easily be implemented efficiently and effectively. With available source, filling materials could easily be extracted and transported within the project area through different equipment and large transportation vessels. Use of large capacity pumps makes it possible to extract sand from the source and convey the materials through long tubes and pipes. In preparation for dredging plan, selection of dredging equipment and dredging-conveying-reclamation methods we considered.

##### **1.3.2.1 Dredging/Reclamation Equipment**

This is closely identified with the equipment to be used. This shall be dependent on the dredging/reclamation contractor. Options for equipment are:

##### ***Trailing Suction Hopper Dredger (TSHD)***

There are two types of Trailing Suction Hopper Dredger; a) Trailing type that utilizes dredging pump inside the ship, slowly sails and dredges the soil and b) Moored type that fixes the Anker, adjusts the Anker rope and dredges. Sans special conditions or situations, trailing type is more widely used. Trailing type is the type that sucks the dredged soil through the Drag Head on the fleet of suction pipe.

After loading the dredged soil to the Hopper and arriving at the reclamation site, the gate bar opens and the soil is loaded or conveyed by a pipe. This dredger type is less affected by weather and unfavorable sea condition and widely used in deep sea soil sourcing. It can hold the Hopper itself, can be separately transported, and is very advantageous for long distance destination.

However, it has a disadvantage in which it will transport more water when it dredges some soil such as clay, and other similar types of soil. Trailing suction hopper dredger has a big dredging capacity (more than 100,000~150,000 m<sup>2</sup>/day) and long conveying distance (more than 20 km), yet, it is not well applied for the area with low water level like the condition of the project area.



### ***Cutter Suction Dredger***

One type of dredging equipment contains a ladder with a cutter, called as Cutter Suction Dredger. The dredging system is executed by lowering the ladder into the dredging area, and as the ladder hit the target dredging area, the cutter attached to the bottom of the ladder is activated and operated. The soil or sand dredged by the equipment and the water are then extracted simultaneously by the pump and transported and delivered to the identified area using an extension pipe as conveyor.

Generally, cutter suction dredger with engine capacity 12,000 HP is widely used, though project requiring higher engine capacity can secure up to 20,000 HP.

Capacity of cutter suction dredger differs based on the soil condition. A 12,000 HP Dredger can dredge 1,200~1,300 m<sup>2</sup>/hour with maximum conveying distance of 5km (soft soil characteristic). It has a capacity 5 times bigger than Grab Dredger (bucket capacity 16 m<sup>2</sup>).

Due to the high pressure at the discharge side, it is impossible for cutter suction dredger to directly load the soil into the barge such that it directly conveys the soil to the reclaimed land by a conveyor pipe. Generally, 20,000HP pump dredger and pipes are used to convey dredged soil to the reclamation site for up to a distance of about 5-10 km. On some cases, one 20,000 HP pump dredger in series with one 12,000 HP pump dredger is used for reclaiming sites or land with a distance of more than 10 km.

### ***Barge Loading Dredger***

Barge loading dredger is one of the alternative methods when there are some difficulties in conveying the dredged soil using a pipe, when the conveying distance is more than 15 km and when the higher dredging capacity is necessary. In dredging sandy material, the use of this dredger type is more economical, causes less pollution. Dredging capacity can be increased by increasing the capacity of the pump. However, efficiency of barge loading significantly decreases when the dredged soil mainly composed of mud. Severe pollution will occur due to overflow, and some adverse impacts occur due to the dispersion of sediments.

The dredging method using a pump without cutter usually discharges high pressure water to disturb soil and sand and then sucks them. Knife be may applied in case of solid or hard ground and when excavation difficulties are encountered. Collecting capacity of barge loading cutter dredger varies according to the installed pump capacity. Dredging barges are moored on the both sides of mining boat and then dredged soil is discharged through the discharge pipe of the pump into the barges.

Depending on the soil conditions, an appropriate knife shall be attached in order to improve the excavation capacity. On the other hand, cutter-less suction dredger is usually used for sourcing underwater sand or dredging along soft mud zone. It sucks the soil and conveys the soil for short and medium distance. Using a high-pressure pump instead of cutter knife, it disturbs the sand and earth spewed from inlet port in the end of the ladder and sucks it up. This type is suitable for sandy soil.

### ***Grab Dredger***

Grab dredger operates by loading the crane equipped with grab into moored dredging barges. Grab bucket capacity is expressed as a specification of grab dredger. Grab dredger is suitable for small places, small scale dredging, deep places, and primary excavation. Conveying process during dredging is usually done by a dredging barge and the dredging barge is towed to the area by a tugboat. Comparing with the other dredger, disturbance on earth and sand is less, moisture content is low, and water drawn by the vessel is less so that this dredger may be used for dredging in shallow area.

Grab dredger (with a dredging capacity of 200 m<sup>2</sup> / hr and bucket capacity of 12.5 m<sup>2</sup>) has a lower dredging capacity when compared to that of a pump dredger with capacity of 6 m<sup>2</sup> and 25 m<sup>2</sup>/hr. Moreover, in very



loose soil, percentage loss of dredged soil in grab bucket is so high that it becomes less efficient (dredging capacity is lower than 1/3 when compared to that of pump dredgers). It is also very uneconomical to operate as compared to pump dredgers.

### **Selection of Dredging Equipment**

**Cutter Suction Dredger** - Dredging method is selected by considering the capacity of dredging equipment, the distance between dredging area and reclamation land and the effect of dredging activities to the environment. Cutter Suction Dredger is selected because pipes can be used for reclamation work, which has less impact to the environment. Considering such factors as long conveying distance from the source, large scale dredging volume, and other economic issues, large dredger should be used. However, 10,000HP CSD has been observed to be the optimum dredger that can be feasibly used for the Project.

#### **1.3.2.2 Reclamation Technology**

##### **General Layout of Land Reclamation**

The proposed project consists of Island D in which the island boundary areas of which is 267 ha. The land formation areas of the island is 233 ha.

According to the tide-proof standard of 100-year Return Period and the 100-year wave parameter, taking into account the sea level rise factor, the average elevation of the land formation is +4.50 meters.

##### **Hydraulic Sand Fill Method**

The island will be reclaimed with hydraulic sand fill which is better to be constructed layer by layer. The estimated volume of hydraulic sand fill is about 25.22 Million cum.

#### **1.3.2.3 Containment System**

To form closed land formation region, dikes shall be built. Length of the dike for Island D is 5710m. The return period for tide protection of the dike is 100 years. The dike protection level is level 1. The standard of wave protection is the same as the one of tide protection, i.e. for the wave once every 100 years. The control standard of overtopping is that the overtopping shall be  $\leq 0.05\text{m}^3/(\text{s.m})$  under the combination that high tide once every 100 years and wave every 100 years.

##### **Design loads**

- 1) Load in land formation area: hydraulic sand fill, the bulk density is 16~20kN/m<sup>3</sup>;
- 2) Load during construction of dike: the uniform load on the top of the dike is vehicles during construction, the load is assumed to be smaller than 10kPa

##### **Ground Improvement under Dike**

There is 0~12m thick soft soil layers in the project area. To make the dike structure economical, reasonable and to meet the requirements of stability and settlement, the soft soil layers shall be ground improved. There are many ground improvement methods. According to the similar projects, the common ground improvement method is drainage and consolidation, silt displacement, etc.



### ***Drainage and Consolidation Method***

Drainage and consolidation method is to drain the water out of the soft soil and make the soft soil layer consolidated and then to construct the upper dike structure. The cost of this method is low, the construction is convenient and reliable, and the influence to the environment is small. The disadvantage of this method is that the construction time of drainage and consolidation method is relatively long.

### ***Silt displacement method***

Silt displacement method focuses on the surface soft soil or the soil layer with soft soil interlayers. This method eliminates the surface soft soil layers and use ship to fill sand or stone back to the dredged trench. The slope of dredged trench is usually 1:3~1:6. The trench shall be re-filled after being dredged immediately. The construction of this method is convenient, but there are many working procedures and large amount of silt shall be disposed of, which has great influence on the environment. And the problem that silt returns is very serious, two times silt dredging is required, the overall construction time is long.

### **Selection of Ground Improvement under Dike**

**Drainage and Consolidation Method.** The area of this project is very large and the soft soil layer in the construction region is relatively thick. Drainage and consolidation method as the ground improvement method is relatively reasonable. In summary, it is recommended to use drainage and consolidation method in the area that there is soft soil layer, and then the upper dike structure can be constructed. For the area that there is no soft soil layer, the upper dike structure can be constructed directly on the natural ground.

#### **1.3.2.4 Structure Type of Dike**

##### ***Vertical Gravity Dike***

The structure features a gravity dike: the inside and the outside of the section are all vertical or approximately vertical walls. This structure generally consists of the riprap foundation bed and the wall. The waves are always reflected in front of the wall. The major advantage of the gravity structure is that when the water depths is relatively deep, the consumption of building materials of this structure is lower than the one of the sloping structures (Plate 1-1).

The major disadvantage of the gravity – type structure: First, the effect of wave elimination is poor. When the depth of water in front of the revetment is smaller than the critical depth of water, the width of the revetment needs to be increased because of the pressure of breaking waves, which leads to the increasing of construction cost. Second, since the foundation stress is relatively high, this structure is sensitive to differential settlement and therefore some reinforcement measures for the foundation are required when it is built on soft foundation. Third, it is difficult to repair a vertical structure once it is damaged.

In summary, vertical gravity – type dike is usually adopted in the area that the water depth is relatively deep and the natural foundation is relatively good.



**Plate 1-1. Vertical Gravity – type Dike**

#### ***Vertical Pile Foundation Dike***

The vertical pile foundation dike consists of piles or sheet piles which are made up of reinforced concrete. The construction is convenient and fast, the cost is cheap, but the structure integrity is relatively not good. Owing to the limitation of size and bearing capacity of the piles, this structure can only be adopted to the condition that the water is not deep, the wave is small and the horizontal load is relatively low (Plate 1-2).



**Plate 1-2. Vertical Pile Foundation Dike**

#### ***Sloping Dike***

The characteristics of the sloping dike are as follows: this structure is built up with excavated natural stones or artificial blocks such as concrete blocks or bagged sand; the section is trapezoidal; and when the waves occur, most of the wave energy will be absorbed or eliminated on the slope (Plate 1-3).

The major advantages of the sloping structure are that the structure is simple and can be applied to different foundations, the construction is convenient, the stability is good, local materials can be sufficiently used and this structure is easy to be repaired after damage happens.

The major disadvantage is that sloping dike consumes large amount of materials and covers large areas.



**Plate 1-3.      Sloping dike**

### **Selection of Structure Type of Dike**

Considering that the wave is big and there are various thicknesses of soft soil layer in the project area, vertical gravity dike or vertical pile foundation dike is inappropriate and sloping dike is recommended.

#### **1.3.2.5    Material of Dike Body**

##### ***Rock Dike***

Rock is a traditional dike material with long history and mature technology, which has a large range of applications. The main advantages are that the structure is secure, the durability is good and also the capacity of wave and wind resistance is great. The disadvantage is that large amount of rocks will be consumed (Plate 1-4).

##### ***Sand Bag Dike***

The advantages of sand bag are quicker construction, low impact to the traffic, low cost, good integrity of the dike body, etc. There are also some disadvantages but these shall be addressed strictly to ensure the quality of the construction (Plate 1-5).

### **Selection of Material of Dike Body**

Considering that the wave is high in the area of island B, C, D and E, it is recommended to use rock as the material for the dikes which faces the waves directly. The southeast dikes of these 4 islands can be built up with sand bags since they are not affected by the wave from the sea directly.





**Plate 1-4.      Rock Dike**



**Plate 1-5.      Sand Bag Dike**

#### **1.3.2.6    Armor Structure**

Design of armor shall be based on different wave height to choose the appropriate armor structure. Common armor structures are natural stone armor, grid plate armor, shaped block armor, etc.

##### ***Artificial block armor***

The characteristics of artificial blocks are fixed effect between blocks which can make the armor layer have good integrity, the wave elimination capacity and the stability are good, the construction is convenient (Plate 1-6). At present, common types of artificial blocks are hollow block with four supporting feet, dolosses, accropodes, etc.



**Plate 1-6. Artificial Block Armor**

***Sheet shape artificial block armor***

The primary sheet shaped artificial block is concrete grid plate (Plate 1-7). The advantages of grid plate structure are that the members are easy to be prefabricated and the visual impact is good. Grid plate structure is usually thin and is applied to regions where the water is shallow and the waves are small. When the wave height is higher than 4m, grid plate structure is not appropriate



**Plate 1-7. Grid Plate**

***Natural Stone Armor***

Natural stone armor is widely used in sloping structure (Plate 1-8). Using natural stone armor can make full use of the advantages such as local materials using, short transport distance, convenient and fast construction, easy future repairing, low cost, good capacity to adapt settlement, etc. Natural stone armor is applied to regions where the waves are relatively small.



**Plate 1-8. Natural Stone Armor**

### **Selection of Armor Structures**

The wave is high in island B, C, D and E. Accropode is recommended to be used as the armor structure for the dikes that have a direct contact on waves. For the southeast dikes of these four islands which do not face the wave directly, concrete grid plate is recommended to be used as the armor structure.

### **1.3.3 Resources**

Alternative sources of power, water, raw materials and other resources needed including factors significant to the selection such as supply sustainability and climate change projections.

The “*raw materials*” needed for reclamation are the fill materials and rocks. There will be no wastes or recycle streams when using these raw materials.

### ***Fill Materials***

#### **General Specifications for the Fill Materials (Preliminary)**

- All materials used for fill shall be free of rock boulders, wood, scrap materials, and refuse.
- These should not have high organic content.
- Not more than 10 percent (10%) by weight shall pass the No. 200 sieve (75 microns). Maximum particle size shall not exceed to 100 mm diameter.
- Maximum particle size shall not exceed 75 mm.
- Shall be capable of being compacted in the manner and to the density of not less than 95 %.
- Shall have a plasticity index of not more than 6 as determined by AASHTO T 90.
- Shall have a soaked CBR value of not less than 25 % as determined by AASHTO T 193.



## Estimated Requirements

Total volume of fill material for the entire reclamation area is approximately 124.92 Million cu.m. of which **25.22 million cu.m.** is the requirement for Island D.

With respect to the potential sources, the following are the options identified at this time:

- **San Nicholas Shoal (SNS)**
  - Since materials also coming from Manila Bay characteristics relatively similar to the seabed at project site, minimizing introduction of foreign materials.
  - Closest to project site
  - However, the securing of necessary permits by the PRA to extract the sand is reported nearing.

Additional alternatives to be considered are:

- **River Dredging**
  - Pampanga
  - Zambales
  - Batangas

Supply sustainability will not be an issue since this will be contracted out prior to the start of the reclamation works.

## General Specifications for Rocks (Preliminary)

- Rocks should be angular, hard, durable and not likely to disintegrate in seawater,
- Minimum unit weight is 2,650 kg/m<sup>3</sup> on dry basis
- Rocks of the primary cover layer should be sound durable and hard and should be free from laminations, weak cleavages and undesirable weathering.
- Following test designations should be complied with  
Apparent Specific Gravity ASTM C-127 and Abrasion ASTM C-131

The various options are to be evaluated and the appropriate selection will also depend partly on:

- (a) The requirements based on the final engineering works;
- (b) Cost;
- (c) Transport consideration; and
- (d) Permitting/clearances requirements.

### 1.3.4 Power and Water Supply

**Power** - During the dredging/reclamation works, electrical power that will be required by sea craft and auxiliary equipment (e.g. pumps) will be sourced on board these sea vessels.

During soil consolidation, which may take approximately 1 to 2 years, the minimal power requirements of the maintenance crew and for lighting on the reclaimed land will be sourced through MERALCO.

**Water** - Water supply by the vessel/barge crews will also be onboard. No underground water extraction. Internal sourcing by individual contractors or water can be tapped from the MWSS-designated concessionaire. The reclamation works are “dry” in nature.





### 1.3.5 Hazard Identification and Consideration During the Design Process

Table 1-3a presents the hazard identification, assessment and consideration and measures during the site selection process.

**Table 1-3a Hazard Identification, Assessment and Measures**

| Identified Hazard   | Assessment  | Measures                 |
|---|---|--------------------------|
| <b>Geologic Hazard</b>  |   |                          |
| <b>Seismic Hazard</b><br><i>Ground Shaking/Acceleration</i><br><i>Ground Rupture</i><br><i>Differential Settlement</i><br><i>Liquefaction</i><br><i>Tsunami</i><br><i>Landslide</i> | <ul style="list-style-type: none"> <li>• The area investigated is prone to ground shaking hazards due to the presence of several earthquake generators in the region.</li> <li>• Reclaimed lands in general, are considered prone to liquefaction.</li> <li>• Safe with regards to ground rupture; may be affected by strong ground shaking; highly susceptible to liquefaction; and prone to tsunami as it is within the tsunami inundation zone. The nearest active fault to the project site is the WVF, which is approximately 19.1km to the east.</li> <li>• The project site may be affected by strong ground shaking</li> <li>• Buffer zone at least 5m on both sides of a fault trace or from the edge of deformation zone. This hazard is seemingly absent in the project area since the nearest active fault, the West Valley Fault, is about 8.9 kilometers to the east.</li> <li>• The proposed reclamation project will undergo backfilling and is considered to be highly susceptible to this hazard</li> <li>• The proposed project being a reclamation area located along the shoreline of the Manila Bay/Bacoor Bay is inherently susceptible to liquefaction</li> <li>• Susceptible to this hazard due to the presence of an active subduction zone – Manila Trench located west of the area and other active faults and or earthquake generators</li> <li>• The project site is not susceptible to earthquake-triggered landslides. Due to the generally flat topography in the municipalities of Noveleta and Rosario, the earthquake-induced landslide risk is relatively low for the most part</li> </ul> | Engineering Intervention |
| <b>Mass Movement</b><br><i>Landslide</i><br><i>Settlement/Subsidence</i>  | <ul style="list-style-type: none"> <li>• Landslides can be induced by heavy rains, which add weight and lubricate the soils. The project site, which sits on a flat terrain, is not susceptible to rain-induced landslides</li> </ul>   | Engineering Intervention |
| <b>Volcanic Hazards</b>   |   |                          |
| <i>Ash Fall</i>   | <ul style="list-style-type: none"> <li>• Probably the greatest threat to Cavite is Taal Volcano in Tagaytay but is unlikely to cause major problems. It is about 56 aerial kilometers to the southeast of the project site</li> </ul>   | Engineering Intervention |
| <b>Hydrologic Hazards</b>   |   |                          |
| <i>Flooding</i>   | <ul style="list-style-type: none"> <li>• The project area falls within the delineated areas with high susceptibility to flooding. Considering that it is low-lying and has a flat terrain, the project site</li> </ul>  | Engineering Intervention |





|   |   |   |
|---|---|---|
|   | could experience localized flooding especially if the drainage systems are inadequate.  |   |
| <b>Coastal Hazards</b>                      |   |   |
| <i>Storm Surges / Seiches / Storm Waves</i> | <ul style="list-style-type: none"> <li>The reclaimed land will be in front of the existing coastline and therefore the reclaimed land will form the new sea front. This makes it most vulnerable to storm surge and flooding from the sea.</li> <li>The proposed reclamation project may potentially shelter the existing coastal areas from direct impact from storm surges (wave impact). However, the existing coastline is also sheltered by the CAVITEX. The platform level will be above the 100-year RP water level with consideration of sea level rise and/or subsidence. PRA requires a level of minimum +4m MLLW.</li> </ul> | To prevent flooding engineering measures will be implemented in project and the sea front will be designed so little flood risk are present and Preparation of Tsunami Contingency Plan |

Detailed discussion is provided in Engineering Geologic and Geohazard Assessment Report (EGGAR) is attached in **Annex 2.1-D and Annex 2.1-A2** is the MGB Endorsement.

**1.3.6 Summary and Discussion of comparison of environmental impacts of each alternative for facility siting, development design, process/technology selection and resource utilization are presented in Table 1-4.**

**Table 1-4 Summary Comparison of Environmental Impacts of Each Alternative**

|          | <b>Technology Option</b>               | <b>Efficiency/Key Features</b>   | <b>Advantage</b>  | <b>Disadvantage</b>  | <b>Impact to the Environment</b>   |
|----------|--|--|---|--|--|
| <b>1</b> | <b>Dredging Equipment</b>              |  |   |  |  |
|          | Trailing Suction Hopper Dredger (TSHD) | Sucks the dredged soil through the Drag Head on the fleet of suction pipe. After loading the dredged soil to the Hopper and arriving at the reclamation site, the gate bar opens and the soil is loaded or conveyed by a pipe. It can hold the Hopper itself, can be separately transported, and is very advantageous for long distance destination. Transport more water when it dredges some soil such as clay, and other similar types of soil. | <ul style="list-style-type: none"> <li>Not well applied for the area with low water level like the condition of the project area</li> <li>Can work safely effectively, economically in rough and open waters</li> <li>Does not interfere with or obstruct traffic</li> <li>Ability to transport material over long sailing distances. Dredged material is discharged commonly via pipeline for land reclamation.</li> </ul> | <ul style="list-style-type: none"> <li>Its deep draft precludes use in shallow waters</li> <li>Cannot dredge continuously</li> <li>Economic load is reduced when dredging a contaminate sediments</li> <li>Difficulty dredging side banks</li> </ul> | <ul style="list-style-type: none"> <li>Increases turbidity</li> <li>Resuspension of sediments</li> <li>Decreases in Dissolved Oxygen</li> </ul>                |
|          | Cutter Suction Dredger                 | The dredging system is executed by lowering the ladder into the dredging area, and as the ladder hit the target dredging area, the cutter attached to the bottom of the ladder is activated and operated. The soil or sand dredged by the equipment and the water are then extracted simultaneously by the pump and transported and delivered  | <ul style="list-style-type: none"> <li>Use in new work and maintenance projects and capable of excavating most types of materials and pumping it through pipelines for long distances to upland disposal sites</li> <li>Operates on an almost continuous dredging cycle resulting to</li> </ul>   | <ul style="list-style-type: none"> <li>Operation problems with areas with high waves</li> <li>The pipeline from cutterhead can cause navigation problems in small, busy waterways and harbors</li> </ul>   | <ul style="list-style-type: none"> <li>Increases turbidity is much lesser</li> <li>Resuspension of sediments</li> <li>Decreases in Dissolved Oxygen</li> </ul> |



|  |                       |   |   |  |   |
|--|-----------------------|---|---|--|---|
|  |                       | to the identified area using an extension pipe as conveyor  | <p>economic and maximum economy and efficiency</p> <ul style="list-style-type: none"> <li>• Able to dredge rocklike formation</li> <li>• Dredging takes place while the vessel is moored by means of spuds and/or anchors and combines cutting action with suction. Dredged material is discharged into barges or more commonly pumped via a pipeline for land reclamation. The maximum distance of pipeline operation should be 3 km from the shoreline</li> </ul> |  |   |
|  | Barge Loading Dredger | Conveying the dredged soil using a pipe, when the conveying distance is more than 15 km and when the higher dredging capacity is necessary. Dredging capacity can be increased by increasing the capacity of the pump. However, efficiency of barge loading significantly decreases when the dredged soil mainly composed of mud. | <ul style="list-style-type: none"> <li>• Capability of dredging a level bottom topography;</li> <li>• Ability to work in narrow or restricted areas;</li> <li>• Versatility in handling a wide range of sediments; and</li> <li>• Side loaded barges are generally filled with a high solids-to-water ratio</li> </ul>  | <ul style="list-style-type: none"> <li>• Limited dredging depth</li> <li>• Obstruction to navigation routes</li> </ul>   | <ul style="list-style-type: none"> <li>• Increases turbidity</li> <li>• Resuspension of sediments</li> <li>• Decreases in Dissolved Oxygen</li> </ul> |
|  | Grab Dredger          | Suitable for small places, small scale dredging, deep places, and primary excavation. Conveying process during dredging is usually done by a dredging barge and the dredging barge is towed to the area by a tugboat.   | <ul style="list-style-type: none"> <li>• Capabilities in blasted rock and compact materials are less</li> <li>• Density of materials excavated is about the same as the in-place density of the bottom materials, therefore increases the efficiency of operation in the transportation of materials from the dredging to the disposal area</li> </ul>  | <ul style="list-style-type: none"> <li>• Barge is brought along side and moored into place by winches and cables</li> <li>• Dredge begins digging and placing the materials into the moored barge</li> </ul> | <ul style="list-style-type: none"> <li>• High turbidity</li> <li>• Resuspension of sediments</li> <li>• Decreases in Dissolved Oxygen</li> </ul>      |

**Selection of Dredging Equipment**

**Cutter Suction Dredger** as of now is selected because pipes can be used for reclamation work, which has less impact to the environment. Considering such factors as long conveying distance from the source, large scale dredging volume, and other economic issues, large dredger should be used. Depending on the availability, the proponent may opt to utilize variable equipment in order to meet the desired timetable.



**Table 1-4a Summary of Comparison for Ground Improvement Under Dike**

| Ground Improvement Under Dike   |  |   |  |                        |   |   |
|---|--|---|--|------------------------|---|---|
|   | General Standards  | Design Loads  | Criteria   |                        |   |   |
| Dredging and Consolidation  | (a) Return period for tide protection of the dike is 100 year<br>(b) Standard of wave protection is 100 years<br>(c) Control standard of overtopping shall be $\leq 0.05 \text{ m}^3/(\text{s.m})$ | (a) Load in land formation area: hydraulic sand fill, the bulk density is 16~20kN/m <sup>3</sup><br>(b) Load during construction of dike: the uniform load on the top of the dike is vehicles during construction, the load is assumed to be smaller than 10kPa | Construction Process   | Construction Cost      | Duration  | Environmental Impact  |
|   |  |   | The method is to drain the water out of the soft soil and make the soft soil layer consolidated and then to construct the upper dike structure. The construction method is convenient and reliable.  | Low Construction Cost  | The construction time of this method is relatively long due to its process. | Low in silt return and volume of dredge materials   |
| Silt Displacement Method  |  |   | The method focuses on the surface soft soil or the soil layer with soft soil inter-layers. This method eliminates the surface soft soil layers and use ship to fill sand or stone back to the dredged trench. The slope of dredged trench is usually 1:3~1:6. The trench shall be re-filled after being dredged immediately. The construction of this method is convenient, but there are many working procedures. | High Construction Cost | The construction time of this method is long due to many working procedure  | High in Silt Return and two times silt dredging which results to large volume of dredge materials |
| <b>Scheme Comparison</b><br><br>If silt displacement method is used in this project, the dredging section is large which will results to high construction cost, volume of silt disposal that shall be disposed is large and high influence on the environment due to silt returns and large volume of dredge materials to be disposed while drainage and consolidation method is relatively reasonable due to uncomplicated construction process, low construction cost and low impact on the environment. |  |   |  |                        |   |   |



**Table 1-4b      Summary of Comparison for Structure Type of Dike**

| Structure Type of Dike  |   |   |  |   |   |   |  |
|---|---|---|--|---|---|---|--|
|   | General Standards   | Design Loads  | Criteria   |   |   |   |  |
| Vertical Gravity Dike   | (a) Return period for tide protection of the dike is 100 year<br>(b) Standard of wave protection is 100 years<br>(c) Control standard of overtopping shall be $\leq 0.05$ m3/ (s.m) | (a) Load in land formation area: hydraulic sand fill, the bulk density is 16~20kN/m3<br>(b) Load during construction of dike: the uniform load on the top of the dike is vehicles during construction, the load is assumed to be smaller than 10kPa | Construction Process   | Wave Elimination  | Soil Foundation Stability   | Construction Cost                                 | Structural Stability   |
|   |   |   | The inside and the outside of the section are all vertical or approximately vertical walls. This structure generally consists of the riprap foundation bed and the wall. The waves are always reflected in front of the wall. <u>The construction process is convenient but not appropriate to project site since the water depth is not deep.</u> The major advantage of the gravity structure is that when the water depths is relatively deep, the consumption of building materials of this structure is lower than the one of the sloping structures. | Poor wave elimination<br>When the depth of water in front of the revetment is smaller than the critical depth of water, the width of the revetment needs to be increased because of the pressure of breaking waves, which leads to the increasing of construction cost. | Since the foundation stress is relatively high, this structure is sensitive to differential settlement and therefore some reinforcement measures for the foundation are required when it is built on soft foundation. | High cost due to the site location of the project | Good   |
| Vertical Pile Foundation Dike   |   |   | consists of piles or sheet piles which are made up of reinforced concrete. <u>The construction is convenient and fast but the structure integrity is relatively not good.</u>  | Poor wave elimination since this structure is adoptable to project site with low waves  | Owing to the limitation of size and bearing capacity of the piles, this structure can only be adopted to the condition that the water is not deep and the horizontal load is low.                                     | Low cost  | Relatively not good, due to limitation of size and bearing capacity of the piles |
| Sloping Dike  |   |   | The characteristics of the sloping dike are as follows: this structure is built up with excavated natural stones or artificial blocks such as concrete blocks or bagged sand; the section is trapezoidal; and when the waves occur, most of the wave energy will be absorbed or eliminated on the slope. <u>The construction is convenient and the sloping structure is simple and applicable to different type of foundation.</u>   | Good wave elimination due to the trapezoidal shape of its section. It has a good capacity of wave and wind resistance.  | This sloping structure is suitable to any type of foundation and the stability is good.   | Low cost  | Good   |
| <b>Scheme Comparison</b><br><br><b>Considering that the wave is big and there are various thicknesses of soft soil layer in the project area, vertical gravity dike or vertical pile foundation dike is inappropriate and sloping dike is recommended</b> |   |   |  |   |   |   |  |





**Table 1-4c Summary of Comparison for Material of Sloping Dike**

| Material of Sloping Dike   |   |   |  |
|--|---|---|--|
|  | Criteria  |   |  |
|  | Construction Process  | Wave Elimination  | Stability  |
| <b>Dike Body</b>   |   |   |  |
| Sand Bag and Rock  | The advantage of using sand bag for slopping dike structure is that the construction is convenient and quick.   | <u>Good wave elimination capacity and wind resistance</u>   | Good stability, good integrity of the dike body and durable. |
| <b>Armor Structure</b>   |   |   |  |
| Artificial Block Armor   | The characteristics of artificial blocks are fixed effect between blocks which can make the construction convenient.  | <u>Good wave elimination capacity</u>   | Good Stability   |
| Sheet shape artificial block armor   | The primary sheet shaped artificial block is concrete grid plate. The advantages of grid plate structure are that the members are easy to be prefabricated and the visual impact is good. | <u>Poor wave elimination</u> since natural stone armor is usually applied where the waves are relatively small. | Good Stability   |
| Natural Stone Armor  | Natural stone armor is widely used in sloping structure because its construction is fast and convenient.  | <u>Poor wave elimination</u> since natural stone armor is usually applied where the waves are relatively small. | Good Stability and the capacity to adapt to settlement       |
| <b>Scheme Comparison</b><br><br>The wave is high in island B, C, D and E. Accropode is recommended to be used as the armor structure for the dikes that have a direct contact on waves. For the southeast dikes of these four islands which do not face the wave directly, concrete grid plate is recommended to be used as the armor structure. Island A is inside the bay and is not affected by the wave, natural stone armor is recommended. |   |   |  |

### 1.3.7 Discussion on the consequences of not proceeding with the project on a “No project option”

Under this scenario:

- The vision of the Province of Cavite for development will be impaired because of the absence of land. Lands onshore are not easy to consolidate into a single area for development.
- The Province of Cavite will lose the opportunity to have developed land at no cost. It will therefore have to find land onshore and pay from its financial resources.
- Taxes to be paid during the reclamation works will be denied the Province of Cavite.
- The economic benefits during the operations phase including employment and livelihood opportunities will be lost.
- The province will lose the opportunity of business and economic growth expansion for commercial, industrial, residential and government facilities resulting to backlog of housing, employment, congestion in other cities and limited public services to the community.
- Permanent protection and shield against storm surge and tsunami to coastal barangays will be gone, thus, exposure to coastal hazards will continue to experience.



## 1.4 Project Components

The Master Plan will undergo iterative process prior to finalization. Among the decision parameters are: (a) project cost (b) timetable (c) market considerations (d) long term vision of the Province and (e) environmental considerations.

The Final Master Development Plan will cover a long-term period of at least twenty-five (25) years noting that it may take long period before the reclaimed land is fully utilized by the prospective locators.

The components herein listed are those associated with the various activities during the dredging/reclamation and horizontal development works only.

Table 1-5 presents the Project Components, Supporting Facilities and Utilities and Pollution Control Facilities.

**Table 1-5. Project Components**

| Facilities  | Project Components  |                            |   |
|---|---|----------------------------|---|
|   | No. of units  | Area (sq.m)/ Capacity      | Specification/ Description/ Remarks   |
| Project Area  | 267.00 hectares   |                            |   |
| No. of Island   | One (1) Island  |                            |   |
| Volume of Earth Fill  | 25.22 Million cubic meters                                |                            |   |
| Finished Platform Elevation                                   | + 4.50 meters above MLLW                                  |                            |   |
| Dredging Equipment  | Cutter Suction Dredger                                    |                            |   |
| Reclamation Method  | Hydraulic Sand Filling Method                             |                            |   |
| Design of Containment System (Ground Improvement under Dike)  | Drainage and consolidation method                         |                            |   |
| Structure Type and Materials of Dike                          | Sloping Dike using Rock and Sand Bags                     |                            |   |
| Armor Structure   | Artificial block armor (Accropde) and Concrete Grid Plate |                            |   |
| Soil Stabilization  | Vertical Drains Plus Surcharge                            |                            |   |
| MAJOR COMPONENT   |   |                            |   |
| Containment Wall System/Structures in a form of Sloping Dikes | 1   | 5,710 linear meters        | Considering that the wave is high in the area of island D, it is recommended to use rock as the material for the dikes which faces the waves directly. The southeast dikes of the island can be built up with sand bags since they are not affected by the wave from the sea directly |
| Reclamation Method using Hydraulic Sand Fill Method           | 1   | 25.22 Million Cubic Meters | Cutter Suction Dredger shall be used for dredging activity which can be used both for dredging and reclamation using appropriate filling materials from valid source with permit.   |
| Commercial Area   | 1 lot   | 16.34 Hectares             | Commercial, high density superblocks and superblocks  |
| Mixed-used Development Area                                   | 7 lots  | 118.01 Hectares            | This is a combined and balance of mainly office/business or mainly residential  |



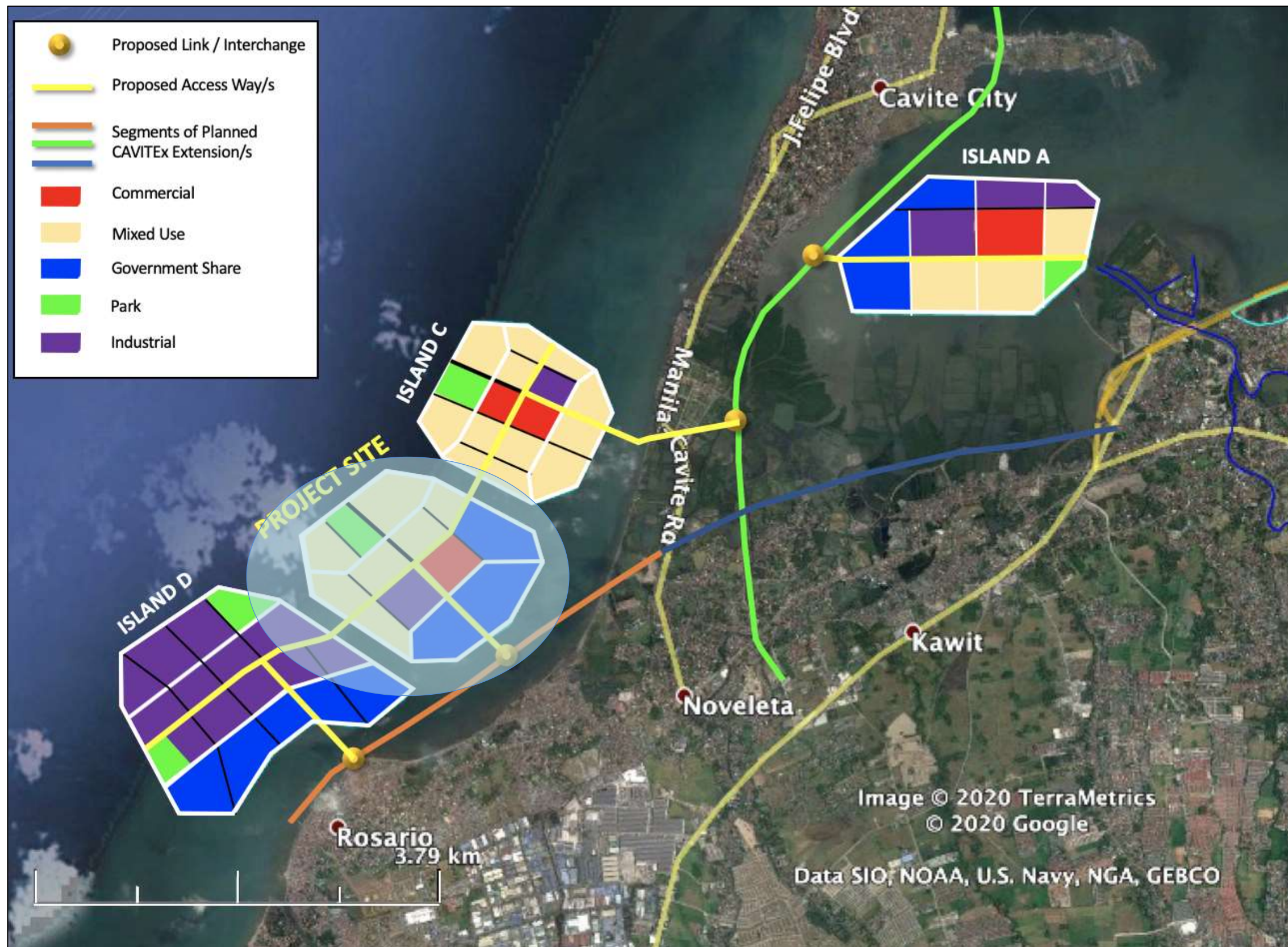
|  |        |                               |   |
|--|--------|-------------------------------|---|
| Government Share Area                                    | 3 lots | 75.90 Hectares                | Government's allocation for information systems, schools, libraries, transportation systems, hospitals, power plants, water supply networks, waste management, law enforcement, and other community services.   |
| Open Space and Parks                                     | 1 lot  | 12.34 Hectares                | Area allocated for vast open areas including open spaces (parks), rotundas (place identifiers)  |
| Road Connectivity<br>Road-Right-of-Way (RROW)            | 1 lot  | 29.42 Hectares                | <p>a. Principal Main Road, collects all traffic from the development areas and convey them to the existing major roads and vice versa.</p> <p>b. Secondary roads - serves traffic from proposed development areas along the routes while at the same time collecting traffic from tertiary roads.</p> <p>c. Tertiary Roads - serves traffic from pocket development areas and convey them to secondary or even to the primary main road</p>   |
| Utility Area   | 1 lot  | 16.51 Hectares                | This is allotted for the transportation and utilities of the project.   |
| <b>SUPPORTING FACILITIES AND UTILITIES</b>               |        |                               |   |
| Admin Support (Site Office, and Barracks/ Quarters etc.) | 1      | 100 square meters (Temporary) | The project shall be provided with admin and barracks for use of office and site personnel.   |
| Water Supply System                                      | -      | 20.0 cu.m/day                 | Water supply by the vessel/barge crews will also be onboard. Mobile water tanks most likely to be used by contractors. No underground water extraction. The proposed development will be provided with adequate water supply system which will be connected to the existing water supply network of Maynilad, specifically to the existing 900 mm diameter water pipeline running along the Manila Cavite Coastal Road  |
| Electrical Supply System                                 | -      | 20.0 cu.m/day                 | <p>During the dredging/reclamation works, electrical power that will be required by sea craft and auxiliary equipment (e.g. pumps) will be sourced on-board these sea vessels.</p> <p>During soil consolidation, which may take approximately 1 to 2 years, the minimal power requirements of the maintenance crew and for lighting on the reclaimed land will be sourced through MERALCO.</p> <p>The power source is located along the Manila Cavite City Road while substations will be constructed in each island. Separate tapping or connection points were proposed should there will</p> |



|   |    |                                 |  |
|---|----|---------------------------------|--|
|   |    |                                 | be power interruption in one section. Power emergency system was also considered in the study.   |
| Drainage System                         | NA | Underground RCP                 | Properly designed surface run-off thru construction of drainage system to divert to the settling pond  |
| <b>POLLUTION CONTROL FACILITIES</b>     |    |                                 |  |
| Silt Curtain                            | 1  | 5,710 linear meters             | Silt curtain shall be installed along the perimeter of the area in order to contain potential dispersion of silt materials and turbidity   |
| Cofferdam                               | 1  | 500,000 cum.<br>(Estimate Only) | Cofferdam should be set around the reclaimed area before the land is reclaimed. To reserve enough settling time for the mud inside, and to guarantee the concentration of suspended substances in overflow water, non-woven geotextile should be set |
| Solid Waste Management Facility (MRF)   | 1  | 100                             | MRF shall be provided which shall form part of the utility area.   |
| Toxic and Hazardous Waste Facility      | 1  | 100                             | Toxic and Hazardous Waste Facility area shall be provided which shall form part of the utility area.   |
| Domestic Wastewater Management Facility | NA | NA                              | For future locators, an individual treatment facility shall be strictly enforced by the city for treatment of their own wastes.  |
| Buffer Zone                             | 1  | NA                              | Buffer zone shall be observed at least 200 meters along the coastline. LPPCHEA is located 12.5 km northeast of the proposed site.  |

**Preliminary Master Development Plan is presented in Figure 1-12**





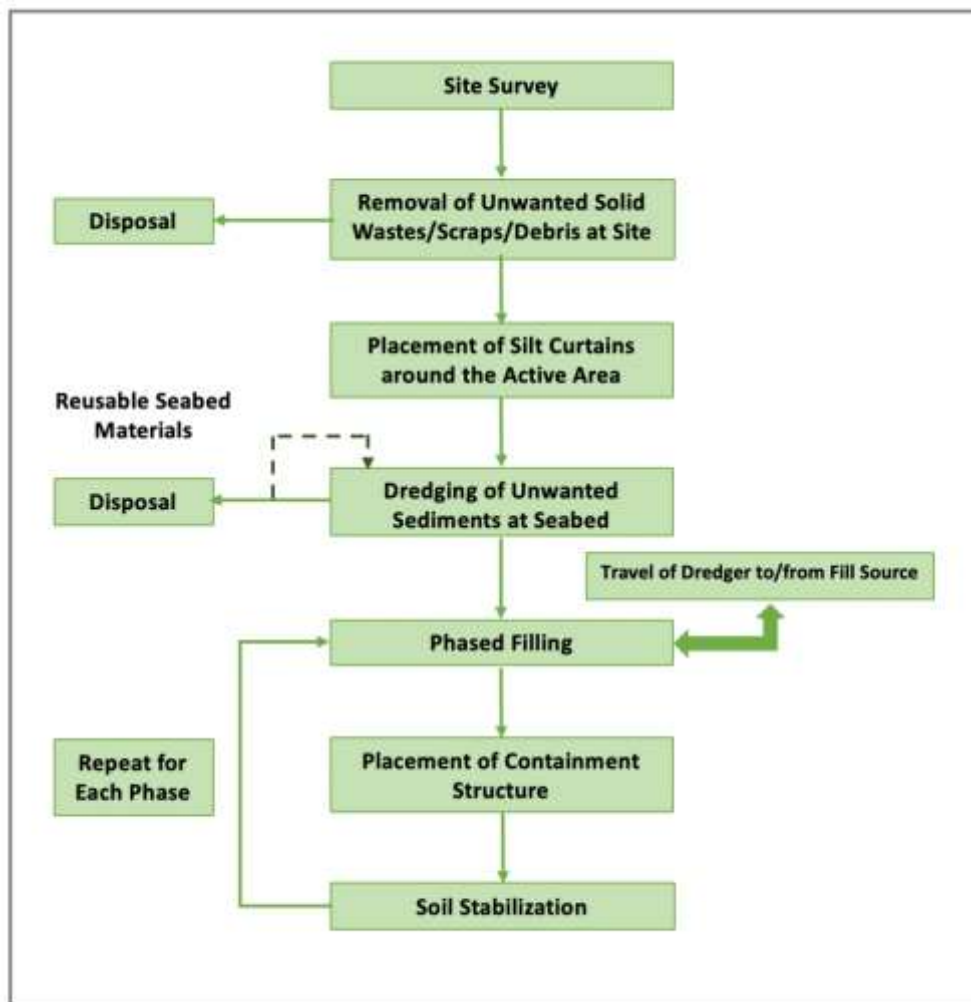
Base Map: Google

Figure 1- 12 Preliminary Master Development Plan



## 1.5 Process/Technology

a. The process flow chart involving the reclamation activity is presented in Figure 1-13.



**Figure 1- 13      Process Flow” Diagram for Reclamation Projects**



Referring to the above, the major activities or aspects of the reclamation works are described below.

### 1.5.1 Site Survey

Establishing of boundaries of the property is essential in the reclamation project so as not to encroach the boundaries of coastal waters.



### Impacts and Mitigation Measures

Domestic solid, liquid and hazardous wastes to be generated by the workers during setting of temporary facilities, barracks, among others.

-  Use of portable toilets or portalets for construction workers
-  Provision for temporary treatment facility such as portable septic purifying tanks





-  Segregation and disposal through a disposal entity or the LGU solid waste management unit in compliance to RA 9003.
-  Segregation, proper labeling and temporary storage of hazardous wastes




### **1.5.2 Removal of Unwanted Solid wastes/Scraps/Debris at the Site**

Clearing of the site of debris, scraps, plastic wastes and silts shall be done at the site as part of the preparation process. The solid wastes at the seabed (e.g. plastics, metallic scraps, etc.) will be collected and disposed onshore through a third-party disposal entity.

Also, to be cleared are silts, which have accumulated with wastes discharged with storm water onshore. These wastes will most likely be disposed outside of the reclamation site in an approved dumpsite onshore.

### **Impacts and Mitigation Measures**

During removal of unwanted solids, it is expected that domestic solid, liquid, hazardous wastes and other wastes to be generated including disturbance of the area such as marine and existing fish lifts structures

-  Coordinate with LGU for proper disposal
-  Transfer/scrape net marine lives
-  Relocation/transfer of lift nets or fish lifts

### **1.5.3 Construction of Environmental Protection**

#### **1.5.3.1 Placement of containment boom and silt curtains Area**

By its term, these are literally curtains that serve as physical barriers for the migration of silt to the water body by containing them within the contained or curtained area. These are made of geotextile materials placed around portions of the reclamation work area wherein fugitive dredged materials/silts may be generated. Silt curtains are a common and well-established method for containing and minimizing sediment plume spread, and when properly deployed, are an effective measure for mitigating adverse impacts due to release and transport of suspended solids.

Silt Curtains shall be installed around civil works in or adjacent to waterways to control the migration of suspended silt and sediment into the waterway. Turbidity curtains should be placed parallel to the direction of flow of a moving body of water to mitigate the load and strain on the system

The two layered (inner and outer layer separated at 30 meters) containment boom and silt curtain will utilize fine mesh sized material to filter fine and very fine sands to prevent transport across the block boundary. The containment boom and silt curtain will control suspended solids and turbidity in the water column generated by dredging and unloading of the dredged materials. Type II silt and turbidity curtain and containment boom will be installed at the unloading site where the water swell is up to 36 inches. The Type III silt and turbidity curtains will be used at the dredging site to keep turbidity and silt contained. This type of material is built specifically for moving water in conditions where there are rough waves, fast moving waters or harsh tidal conditions (*cited in the EIS for SNS Project - [www.erosionpollution.com](http://www.erosionpollution.com). Erosion Control and Water Pollution Prevention Products*).

The curtain extends to the bottom of the seawater so as to trap the heavier particles, which may tend to settle down the water column.

Plate 1-9 illustrates a typical installation of silt curtains.

Plate 1-10 illustrates a typical cross section of a silt curtain.



## Locations of the Silt Curtains

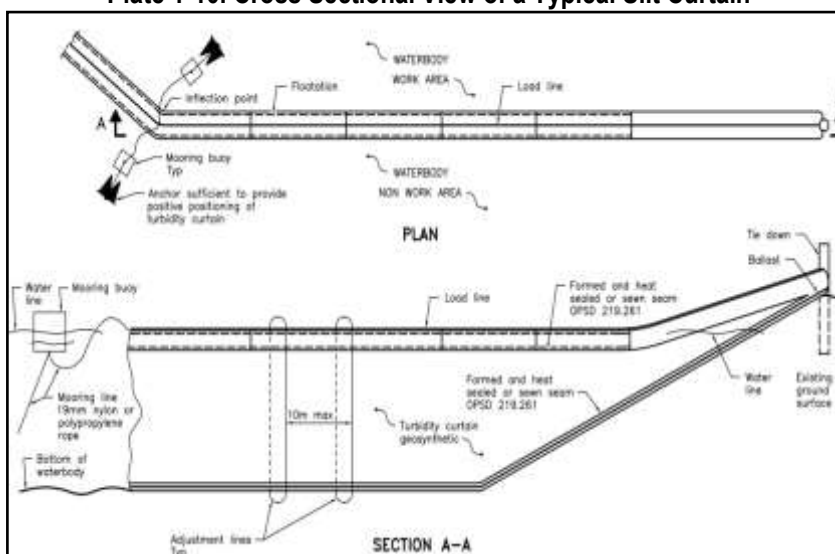
Inasmuch as the function of the silt curtains is to prevent dispersal of silts from dredging and filling activities these are to be located to enclose the active work areas and thus the locations are variable.

**Plate 1-9. Typical Silt Curtain Installation**



Source: Terrafox Geosynthetics Inc. Silt Curtains. Retrieved from <http://terrafixgeo.com/products/silt-curtains/>

**Plate 1-10. Cross Sectional View of a Typical Silt Curtain**



## Maintenance and Care

The maintenance of a silt curtain most commonly involves cleaning and the replacement of sections of the screen and anchor lines that are worn or damaged.

### 1.5.3.2 Construction of Cofferdam

Cofferdam should be set around the reclaimed area before the land is reclaimed. To reserve enough settling time for the mud inside, and to guarantee the concentration of suspended substances in overflow water, non-woven geotextile should be set.





#### **1.5.4 Dredging of Unwanted seabed materials and seabed**

The work area will be dredged beyond the soft/clayey layer to allow the fill materials to occupy a large volume of the seabed, thus further ensuring integrity of the land to be created using Cutter Suction Dredger equipment

A geotechnical investigation comprising three boreholes (BH-22, BH-24 and BH-27) to 30m below the seabed (total of 450m) was carried out in October 19 to November 16, 2017 by A. M. Geoconsult and Associates (AMGA), in the proposed project site. All boreholes were drilled within the vicinity of the property boundaries to establish the existing geotechnical conditions at the site. This basically removal of silt, debris, sediment and/or rock from the seabed or bottom of the water body derived from the result of the borehole.

47 Standard Penetration Testing (SPT) was performed at 1.5 m interval and core samples are taken when hard strata or rock material is encountered. Undisturbed Sampling was also done on selected boreholes, aimed at acquiring very soft soil. 47 particle size analysis, 18 hydrometer analysis, 47 natural moisture content, 47 Atterberg Limits, 47 Unified Soil Classification System, and 47 specific gravity of soil were tested.

Based on these boreholes, the site subsurface generally consists of an upper 0m to 4.5m thick layer of very soft to soft silts and clays and very loose to loose sands (N-value < 10). It is underlain by about 9m-13.5m thick layers of stiff to very stiff silts and clays and medium dense sands. These are all underlain by the competent strata consisting of dense to very dense sands and hard clays encountered at depths from 9m to 15m.

The designation of this disposal site is subject to approval/permits from government entities i.e. the Philippine Coast Guard and the Province of Cavite

Buffer zone shall be observed from the edge of the landform about 200 meters from the coastline and 12.50km northeast from LPPCHEA.

#### **Impacts and Mitigation Measures**

The use dredging equipment to dredge the unwanted seabed materials will result to disturbance of marine ecosystem, increase in turbidity resulting to silt dispersal, hazardous waste emission coming from the vessel or machine and the generation of domestic solid, liquid and hazardous wastes from vessel and equipment operators.

- ✚ Provision for Silt curtain
- ✚ Implement Bilge Water Management
- ✚ Compliance with MARPOL 73/78
- ✚ For Sea-based Operations- These are generally garbage from the crew and are segregated onboard, placed in bins and disposed onshore.
- ✚ No disposal of liquid and solid wastes at the sea
- ✚ Compliance to Sections of the Philippine Clear Air Act, R.A. 8749
- ✚ Equipment shall be provided with muffler filter media.



### 1.5.5 Reclamation Activity and Method

The reclamation activity includes construction of dikes with total length of 5,710 meters and construction of landforms with total fill volume 25.22 Million cubic meters sea sand land formation materials.

#### 1.5.5.1 Construction of Dikes

There are two (2) types of dikes to be constructed for Island D identified as Dike I which is the Rock Dike + Accropode + Wick Drains (Plate 1-11) and Dike II which is the Sand Bag Dike + Grid Plate + Wick Drains (Plate 1-12), Figure 1-14 shows the location of Dike I and Dike II for Island D. The construction process for each type as enumerated as follows, *source: Cavite Reclamation Project Feasibility Study, THEIDI Construction Corporation, Version March 20, 2018.*

##### **Rock Dike + Accropode Blocks + Wick Drains (Dike I)**

This design is applied in the sea-facing dikes of island D with length of 4,510.83 meters. First, the 1m-thick medium coarse sand bag cushion shall be laid on water, and then the wick drains can be constructed on water. Stone shall be laid stage by stage, allowing drainage and consolidation of the remaining soft soil with the aid of soil subsidiary stress caused by dike gravity, thus improving the strength of soft soil layer. The toe protection of outside slope is stone and the one of inside slope is sand bags. Along with the dike rising up until its formation, the stone armor and accropode block armor of outside slope, as well as the bags of crushed aggregates, geotextile and sand bags of inside slope are constructed up. After the dike reaches its sedimentation stability, the reinforced concrete wave wall, the crest road and subsidiary facilities can be constructed.

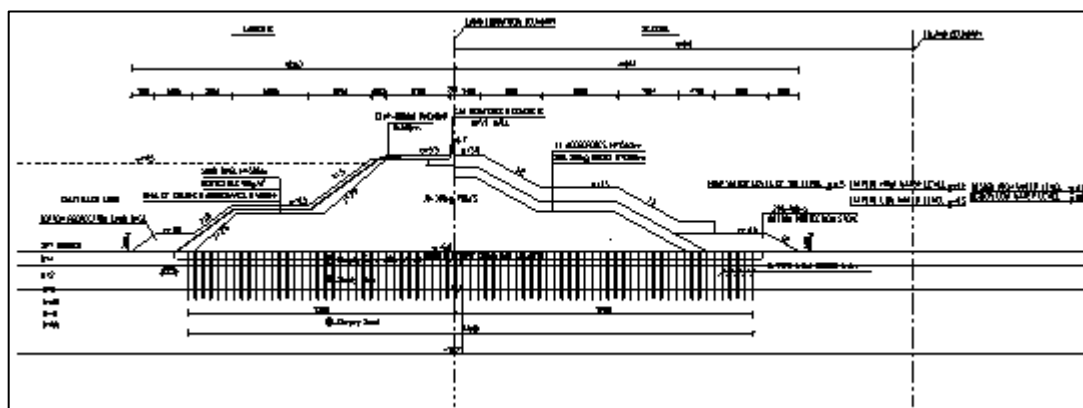
##### *Dike Ground Improvement*

The thickness of soft soil under island D dike is assumed to be 4m, which refers to borehole BH-22 nearby. Natural ground surface elevation and thickness of soft soil under the sea-facing dikes of island D. The natural ground elevation facing dike and thickness of soft soil is -4.0~-6.0m and thickness of the soil is 4m.

Dike ground improvement method is to lay the medium coarse sand bag cushion, and then to construct C type wick drains on water. The wick drains are arranged into square with spacing of 1m and shall be constructed through the soft soil and into the hard soil no less than 1m.

##### *Dike Structure*

The dike material is rock. The elevation of crest is 5.5m. Considering 2-way traffic of construction vehicles, the width of the crest is 8.3m. 50cm Clay-bound macadam is paved on the crest, and C40 reinforced concrete wave wall is constructed on the sea side of the crest, with the top wall elevation of 6.7m. The elevation of the crest and wall top is based on the wave data. One-stage platform is set up on the outside slope of sea-facing dike of island D with elevation of 1.5m and length of 10m. The length of platform is based on the slope stability, and the outside slope gradients are all 1:2. With the effect of waves, armor structure is set up in the outside slope, which is 1200mm-thick 300~500kg stone armor, and 4t accropode block, respectively, from inside to outside. The toe protection of outside slope is 200~400kg stone, with width of 12m and thickness of 2m, and the stability weight is based on the bottom velocity of wave in front of the dike. One-stage platform is set up on inside slope, with the elevation of -0.5m and length of 10~20m, of which the length is based on the inside slope stability. The inside slope gradients are all 1:1.5. Filter layer shall be set up on the inside slope, and the armor structure is bags of crushed aggregates with thickness of at least 600mm, 400g/m<sup>2</sup> geotextile and 500mm-thick sand bags, respectively, from inside to outside. The toe protection of inside slope is sand bags with width of 5m and thickness of 2m. Plate 1-11 illustrates the Rock riprap dike + Accropodes blocks + wick drains.



**Plate 1-11. Rock riprap dike + Accropodes blocks + wick drains**

### **Sand Bag Dike + Grid Plate + Wick Drains (Dike II)**

This dike is applied in the southeast dike of Island D with total length of 1,198.95 meters.

#### *Dike Ground Improvement*

The thickness of soft soil under the dike of Island D is assumed to be 4m, which refers to borehole BH22 nearby. Natural ground surface elevation and thickness of soft soil under the southeast dike of Island D is -2.5~-3.0m and thickness of soft soil is 4m.

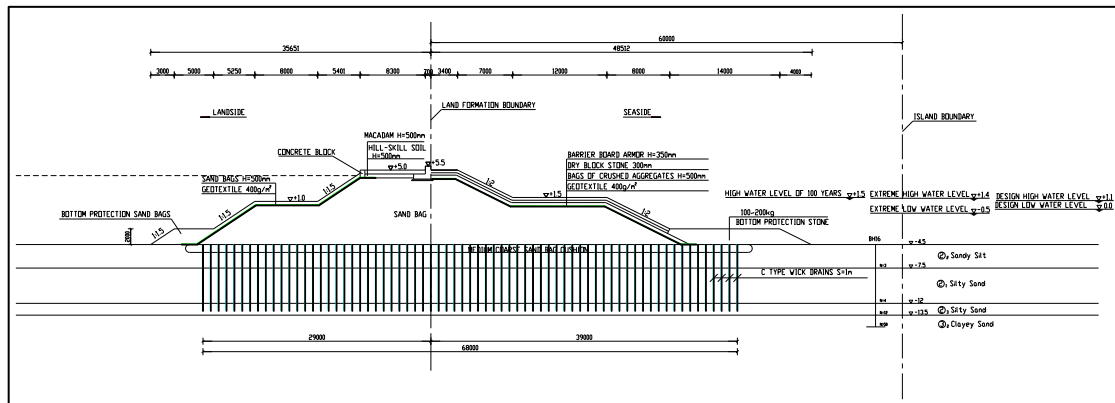
Dike ground improvement method is to lay the medium coarse sand bag cushion first then construct C type wick drains on water. The wick drains are arranged into square with spacing of 1m and shall be constructed through the soft soil and into the hard soil no less than 1m.

#### *Dike Structure*

The dike material is sand bags. The elevation of the crest is 5.0m. Considering 2-way traffic of construction vehicles, the width of the crest is 8.3m. 50cm thick clay-bound macadam is paved on the crest, and C40 reinforced concrete wave wall is constructed on the sea side of the crest, with the top wall elevation of 6.7m. 50cm-thick Clay-bound macadam is paved on the crest with 50cm-thick hill-skill soil below, and C40 reinforced concrete wave wall is constructed on the sea side of the crest, with the top wall elevation of 5.5m. The elevation of the crest and wall top is based on the wave data. One-stage platform is set up on the outside slope, with the elevation of 1.5m and the length of 10~21.5m. The length of the platform is based on the slope stability, and the outside slope gradients are all 1:2. Influenced by wave, armor structure is set up on the outside slope, which is 400g/m<sup>2</sup> geotextile, 500mm-thick bags of crushed aggregates, 300mm-thick dry masonry block stone, and 350mm-thick barrier board, respectively, from inside to outside. The toe protection of outside slope is 100~200kg stone, with width of 9~14m and thickness of 2m, and the stability weight is based on the bottom velocity of wave in front of the dike. One-stage platform is set up on the inside slope, with the elevation of +1.0m and length of 8~17m, the length is based on the inside slope stability. The inside slope gradients are all 1:1.5. For the inside slope, and the armor structure is 400g/m<sup>2</sup> geotextile and 500mm-thick sand bags, respectively, from inside to outside. The toe protection of inside slope is sand bags with width of 3~5m and thickness of 2m. Plate 1-12 illustrates the Sand bag + grid plate + wick drains.

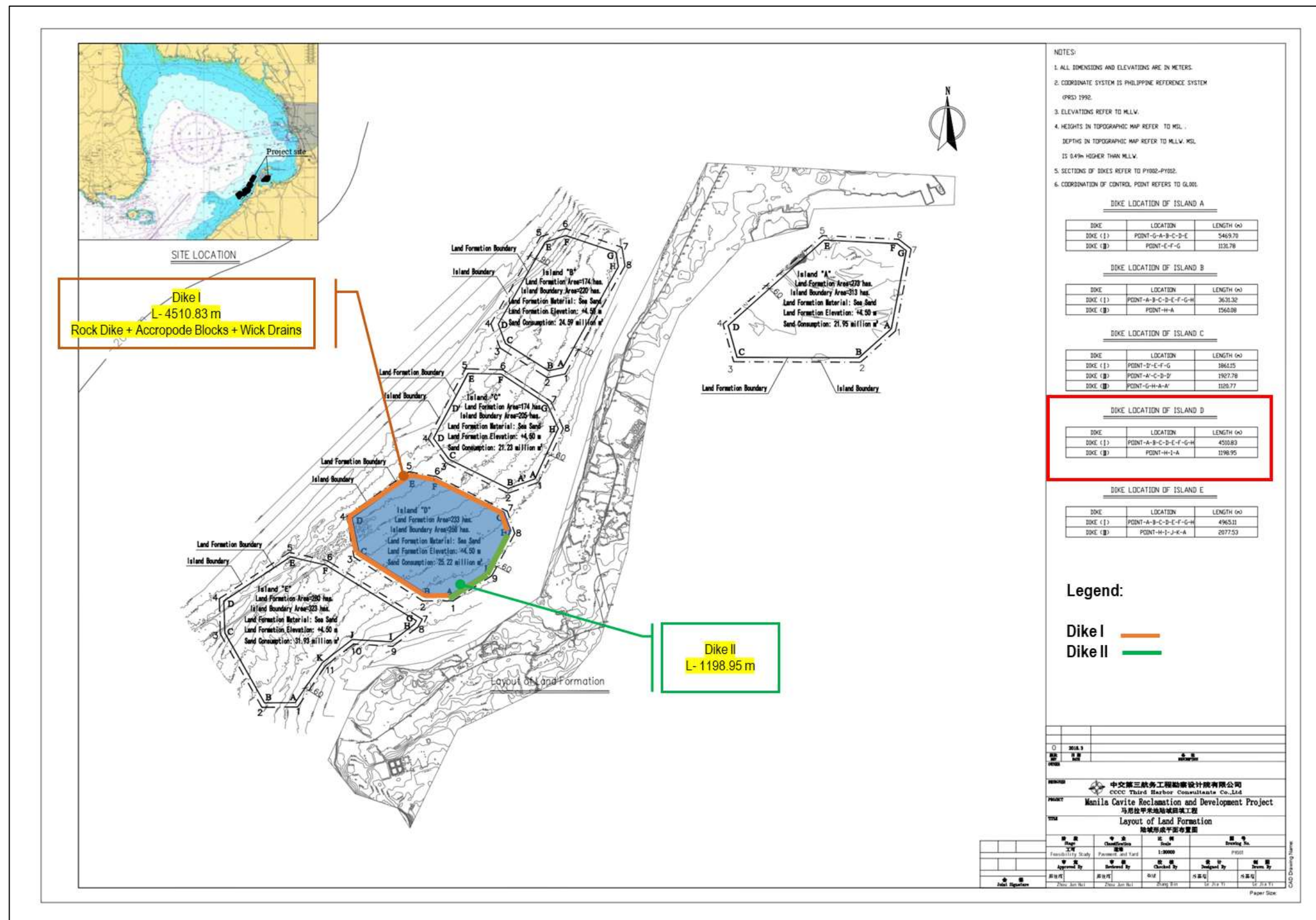


**CHAPTER ONE**  
**Project Description**  
**Proposed Cavite Province Land Reclamation and Development Project: ISLAND D (267 ha)**  
Cavite Provincial Government



**Plate 1-12. Sand bag + grid plate + wick drains**





Source: Cavite Reclamation and Development Project Feasibility Study, THEIDI Construction Corp., March 2018

Figure 1- 14 Location of Dike I and Dike II



### **1.5.5.2 Construction of Landform using Hydraulic Sand Fill Method**

The land form shall be developed through filling with sand to be sourced from the dredging of an estimated volume of approximately **25.22 million cubic meters** of fill materials from a reliable and feasible sand source. The reclaimed land of 267.00 hectares will have a finished platform elevation of +4.5 meters above Mean Lower Low Water (MLLW). The activity is presented below:

- (1) The land reclaimed layer by layer. Every layer shall be 2m~3m thick. There shall be a certain consolidation time after every layer of land formation then the upper land formation can be carried out. The land formation material is sand, drainage and land formation can be carried out synchronously.
- (2) The pipes are set up in the land formation area and the disturbance from each other shall be avoided.
- (3) Maintenance and inspection for pipelines shall be strengthened during construction to avoid leakage and destruction of the pipeline. The location of hydraulic fill shall be adjusted appropriately according to the land formation condition.
- (4) When it is hydraulic filled to the design elevation, the elevation of layout shall be controlled. Hydraulic filling and pipeline moving shall be carried out synchronously. The higher shall be eliminated while the lower shall be filled.

#### **Transport of the Dredging Vessel to/from Source of Fill Materials.**

Dredge-fill materials abound in the PRA offshore burrow area at the San Nicolas Shoal (SNS), which reportedly has a vast deposit and which replenishes on its own through time. Shown in Figure 1-15 is the location of the SNS relative to the project is about 17.3 KM. As may be needed, alternate sources to the SNS will be studied; these include the lahar deposits in Pampanga and Zambales, which can be transported to the proposed site by barges. Other sources for evaluation may be dredged materials from the Pampanga River within Manila Bay.

#### **Securing/Sourcing of the Burrows/Fill Materials**

The initially identified burrow area for this project is the SNS. The quarrying in SNS for the fill materials needed for the Project is covered by an EIS Report and an ECC application by the PRA. The environmental concerns and mitigation and legal responsibilities therefore fall on the PRA. When the reclamation contractor undertakes dredging at the SNS, it will have to observe the rules of PRA in respect of environmental concerns. The Project recognizes the environmental concerns at the SNS and **commits to faithfully comply with the requirements of the PRA**. As one requirement to secure permit from the PRA, the Contractor will need to submit an Environmental Protection and Enhancement Plan (EPEP) approved by the MGB.

The ensuing discussions are derived from the EIS Report for the SNS Quarry Project, for which the securing of said information was cleared with the PRA.

#### **Basic Information on the SNS:**

The following basic information relates to the Reclamation Project.

|                         |   |
|-------------------------|---|
| <b>Project Name:</b>    | <b>PRA Seabed Quarry Project</b>  |
| <b>Location:</b>        | San Nicolas Shoal (SNS) along coastal towns and the offshore areas of the barangays of Ternate, Naic, Tanza and Rosario of Cavite |
| <b>Type of Project:</b> | Offshore Quarrying Project  |
| <b>Project Size:</b>    | 20,000 hectares   |



The expressed intention by PRA for the SNS Quarry Project is to provide the various reclamation projects in Manila Bay with most suitable fill materials.

The water environment is the most important component of the resources. The EIS Report for the SNS stated the absence of major marine species and that there are essentially no coral covers except for approximately 2-4% coral cover for the Municipality of Ternate while the rest of the quarry area has no coral community.

### Volume of SNS Reserves and Volume of Fill Materials Required for the Project

Based on the PRA EIS Report, Table 1-6, the volume of reserve at the SNS totals to **2,009,336,597 m<sup>3</sup>**. It may therefore be concluded that the Project can well be provided by SNS with the required fill materials (of approximately **25.22 M m<sup>3</sup> total for Island D and total of 100.33 M m<sup>3</sup> for the four Islands**). Is considerably much lesser than the estimated volume of reserves of the SNS shown below (*Reference: EIS of the "PRA Seabed Quarry Project"*)

**Table 1-6. Volume of Reserve Per Area**

| Area                 | Size of Area (Hectares) | Volume Reserve (Cubic Meters) |
|----------------------|-------------------------|-------------------------------|
| 1                    | 4,393.60                | 337,266,377                   |
| 2                    | 5,606.40                | 849,399,596                   |
| 3                    | 10,000                  | 822,670,624                   |
| <b>Total Reserve</b> |                         | <b>2,009,336,597</b>          |

### Heavy Metal Content of the SNS Sands

Any and all materials that will be introduced to the reclamation area will be subject to pre-screening to ensure that the reclamation site will not be contaminated with undesirable elements or substances. It is notable that based on the information for SNS fills shown hereunder, Table 1-8 the metallic elements are present in minimal concentrations.

**Table 1-7. Concentrations of Selected Heavy Metals in the PRA GSQP**

| Sample                    | Cr, mg/Kg | Cd, mg/Kg | As, mg/Kg | Pb, mg/Kg | Hg, mg/Kg |
|---------------------------|-----------|-----------|-----------|-----------|-----------|
| 1                         | 4.50      | 4.65      | 36.84     | 9.10      | <.004     |
| 2                         | 12        | 6.08      | 75.28     | 10.09     | <0.004    |
| 3                         | 2         | 6.08      | 54.84     | 3.75      | <0.004    |
| 4                         | 1.5       | 5         | 17.92     | 22.28     | <0.004    |
| 5                         | 3.75      | 4.55      | 15.38     | 18.9      | <0.004    |
| 6                         | 4         | 6.53      | 47.76     | 7.73      | <0.004    |
| Dutch Intervention values | 380       | 12        | 55        | 530       | 10        |
| Dutch Target Values       | 100       | 0.8       | 29        | 85        | 0.3       |

*Soil remediation intervention values (Ref: email communications with LLDA)*

From the above table it can be deduced that:

- The SNS fills will not contaminate the reclamation project area
- There is no need for any intervention related to the quality of the fill materials.

The materials encountered in two borings conducted south of San Nicholas Shoals (between Timalan and Maragondon Pt.) in connection with other Manila Bay Land Reclamation Projects are of a rather similar character. Materials with the actual grain size distribution are prone to liquefaction if not densified by means of relevant techniques.



## Impacts and Mitigation Measures

The perceived relevant wastes for the proposed project are silts, which are the solid wastes from the dredging of undesired seabed materials, possible silt dispersal, emission of CO and NO<sub>x</sub> from dredging equipment and domestic solid, liquid and hazardous wastes generated

- ✚ Secure dredging permit from the source of filling materials
- ✚ Adhere to the compliances of the permit acquired by the filling material source
- ✚ Implement Bilge Water Management
- ✚ Compliance with MARPOL 73/78
- ✚ Compliance with the PCG Protocol
- ✚ For Sea-based Operations- These are generally garbage from the crew and are segregated onboard, placed in bins and disposed onshore.
- ✚ No disposal of liquid and solid wastes at the sea
- ✚ Compliance to Sections of the Philippine Clear Air Act, R.A. 8749
- ✚ Compliance to RA 9003

### 1.5.6 Soil Stabilization

The newly reclaimed area needs to be compacted and consolidated to a specified strength so that it can support the roads, infrastructure, utilities, and buildings. Several stabilization methods are available but the most common is the paper wick drain with surcharge method. This method can accomplish the compaction process within a year or less.

The project shall adopt the Vertical Drains Plus Surcharge. This method functions in exactly the same way as the Sand Drains Plus Surcharge Method. The only difference is that with this system, the sand drain piles are replaced with the vertical drains, which are manufactured for the purpose in the form of wicks or strips and made of non-degradable materials. The core consists of ducts where water can flow upwards and wrapped around with very porous sheeting through which water can enter the core. The wick comes in various trademarks and designs but more or less uniform in the overall dimensions. For ease in handling and installation, the wick comes in coils.

Under this method, the vertical drains have high breaking strength and reinforce the soil in tension. Various types of drains are commercially available that a specific type of drain can be chosen to be exactly consistent with the actual permeability of the soil. Equipment required to install the drain is very light and can easily be supported by the newly reclaimed land. The rate of flow within the drain is higher, thus less height of surcharge is required. From the economic viewpoint, the surcharge can be eliminated if good dredge fill materials are available. Upon completion of the reclamation, the dredge fill itself will function as the surcharge.

Trapped water could weaken the integrity of the reclaimed land and therefore should be removed. An acceptable method for removal of water is by the use of wick drains.

In order to accelerate the consolidation of the underlying strata at the platform, and hence the use of the reclaimed areas for final structures in a short period of time, it is foreseen to install vertical wick drains over the total area.

Wick Drains are artificial drainage paths consisting of central core which functions as a free-draining water channel, surround by geosynthetics filter jacket. With the drainage of water consolidation of soils is expedited and long-term settlement is limited. Typical image of wick drains is shown in Plate 1-13:





**Plate 1-13. Illustration of the Principle of Wick Drains**



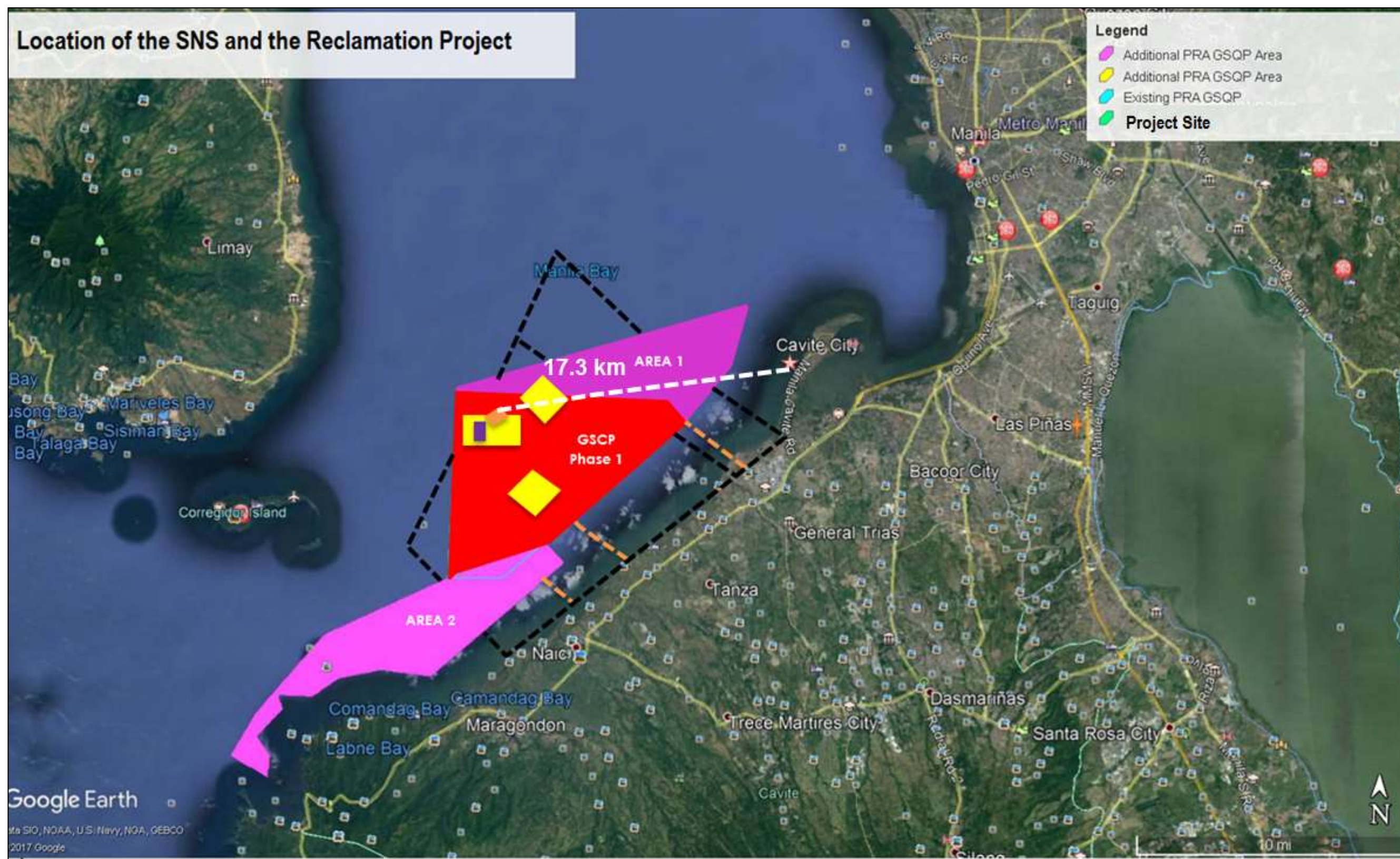
Source: US Wick Drain. Wick Drain. Retrieved from <http://www.uswickdrain.com/faqs.htm>. Retrieved on July 2017

### **Impacts and Mitigation Measures**

Potential impacts identified are Emission of CO and NOx from dredging equipment, Domestic solid, liquid and hazardous wastes generated and Noise Pollution

- ✚ Installation of vertical drain pipes (wick drains)
- ✚ No disposal of liquid and solid wastes at the sea
- ✚ Compliance R.A. 8749
- ✚ Compliance to RA 9003
- ✚ Properly maintained equipment





Adopted from PRA, PRA Seabed Quarry Project EIS

Figure 1- 15 Relative Location of the SNS and the Cavite Province Land Reclamation and Development Project: ISLAND D





**b. Description of the Pollution Control Devices and Waste Management System**

Table 1-8 presents the Pollution Control Device and waste management system based on the process technology of the project.

**Table 1-8. Major Components, Pollution Control Devices in Relation to Various Project Activities**

| Item No | Activity                               | Environmental Component          | Environmental Impacts  | Pollution Control Device and Waste Management System   |
|---------|--|----------------------------------|--|--|
| 1       | Site Survey/Works/Temporary facilities | <b>The Land</b>                  | <ul style="list-style-type: none"> <li>Domestic solid, liquid and hazardous wastes generated</li> </ul>  | <ul style="list-style-type: none"> <li>Use of portable toilets or portalets for construction workers</li> <li>Provision for temporary treatment facility such as portable septic purifying tanks</li> <li>Segregation and disposal through a disposal entity or the LGU solid waste management unit in compliance to RA 9003.</li> <li>Segregation, proper labeling and temporary storage of hazardous wastes</li> </ul>   |
|         |  | <b>The People</b>                | <ul style="list-style-type: none"> <li>Displacement of existing fish lifts</li> </ul>  | <ul style="list-style-type: none"> <li>Relocation and compensate affected fisherfolks</li> </ul>   |
| 2       | Removal of Unwanted Solids/wastes      | <b>The Water</b>                 | <ul style="list-style-type: none"> <li>Disturbance of the area<br/>Such as marine</li> </ul>   | <ul style="list-style-type: none"> <li>Coordinate with LGU for proper disposal</li> <li>Transfer/scrape net marine lives</li> </ul>  |
| 3       | Dredging of Sediments/Seabed           | <b>The Water, Air and People</b> | <ul style="list-style-type: none"> <li>Disturbance of the area<br/>Such as marine</li> <li>Increase in Turbidity</li> <li>Silt Dispersal</li> <li>Emission of CO and NOx from dredging equipment</li> <li>Domestic solid, liquid and hazardous wastes generated</li> </ul> | <ul style="list-style-type: none"> <li>Provision for Silt curtain</li> <li>Implement Bilge Water Management</li> <li>Compliance with MARPOL 73/78</li> <li>For Sea-based Operations- These are generally garbage from the crew and are segregated onboard, placed in bins and disposed onshore.</li> <li>No disposal of liquid and solid wastes at the sea</li> <li>Compliance to Sections of the Philippine Clear Air Act, R.A. 8749</li> <li>Equipment shall be provided with muffler filter media.</li> </ul> |
| 4       | Disposal of unwanted seabed materials  | <b>The water</b>                 | <ul style="list-style-type: none"> <li>Turbidity</li> <li>Silt Dispersal</li> </ul>  | <ul style="list-style-type: none"> <li>Secure permit from National and Local agencies in terms of final disposal location</li> <li>Implement Bilge Water Management</li> <li>Compliance with the PCG Protocol</li> <li>Compliance with MARPOL 73/78</li> <li>For Sea-based Operations- These are generally garbage</li> </ul>  |



| Item No | Activity  | Environmental Component                | Environmental Impacts   | Pollution Control Device and Waste Management System  |
|---------|---|--|---|---|
|         |   |  |   | <p>from the crew and are segregated onboard, placed in bins and disposed onshore.</p> <ul style="list-style-type: none"> <li>• No disposal of liquid and solid wastes at the sea</li> <li>• Segregation of solid wastes</li> <li>• Compliance to Sections of the Philippine Clear Air Act, R.A. 8749</li> <li>• Equipment shall be provided with muffler filter media.</li> </ul>   |
| 5       | Placement of Containment Wall/Dike                          | <b>The Water and People</b>            | <ul style="list-style-type: none"> <li>• Disturbance of the area</li> <li>• Increase in Turbidity</li> <li>• Emission of CO and NOx from dredging equipment</li> <li>• Domestic solid, liquid and hazardous wastes generated</li> </ul> | <ul style="list-style-type: none"> <li>• Provision for Silt curtain</li> <li>• Compliance R.A. 8749</li> <li>• Compliance to RA 9003</li> <li>• Installation of wave deflectors</li> </ul>  |
| 6       | Construction of Land Form                                   | <b>The Water, Air and People</b>       | <ul style="list-style-type: none"> <li>• Possible silt Dispersal</li> <li>• Emission of CO and NOx from dredging equipment</li> <li>• Domestic solid, liquid and hazardous wastes generated</li> </ul>                                  | <ul style="list-style-type: none"> <li>• Secure dredging permit from the source of filling materials</li> <li>• Adhere to the compliances of the permit acquired by the filling material source</li> <li>• Implement Bilge Water Management</li> <li>• Compliance with MARPOL 73/78</li> <li>• Compliance with the PCG Protocol</li> <li>• For Sea-based Operations- These are generally garbage from the crew and are segregated onboard, placed in bins and disposed onshore.</li> <li>• No disposal of liquid and solid wastes at the sea</li> <li>• Compliance to Sections of the Philippine Clear Air Act, R.A. 8749</li> <li>• Compliance to RA 9003</li> </ul> |
| 7       | Development of Land form (Island) above the sea water level | <b>The Land, Water, Air and People</b> | <ul style="list-style-type: none"> <li>• Possible Erosion</li> <li>• Dust and noise Pollution</li> <li>• Emission of CO and NOx from dredging equipment</li> <li>• Domestic solid, liquid and hazardous wastes generated</li> </ul>     | <ul style="list-style-type: none"> <li>• Provision for temporary sedimentation pond</li> <li>• Immediate compaction of soil</li> <li>• No disposal of liquid and solid wastes at the sea</li> <li>• Compliance R.A. 8749</li> <li>• Compliance to RA 9003</li> <li>• Properly maintained equipment</li> </ul>   |





| Item No | Activity  | Environmental Component                | Environmental Impacts  | Pollution Control Device and Waste Management System   |
|---------|---|--|--|--|
| 8       | Soil Stabilization  | <b>The Land, Water, Air and People</b> | <ul style="list-style-type: none"> <li>Emission of CO and NOx from dredging equipment</li> <li>Domestic solid, liquid and hazardous wastes generated</li> <li>Noise Pollution</li> </ul>   | <ul style="list-style-type: none"> <li>Installation of vertical drain pipes (wick drains)</li> <li>No disposal of liquid and solid wastes at the sea</li> <li>Compliance R.A. 8749</li> <li>Compliance to RA 9003</li> <li>Properly maintained equipment</li> </ul>  |
| 9       | Construction of Horizontal Development such as Road, Drainage and Water line system | <b>The Land, Water, Air and People</b> | <ul style="list-style-type: none"> <li>Emission of CO and NOx from dredging equipment</li> <li>Domestic solid, liquid and hazardous wastes generated</li> </ul>  | <ul style="list-style-type: none"> <li>No disposal of liquid and solid wastes at the sea</li> <li>Compliance R.A. 8749</li> <li>Compliance to RA 9003</li> </ul>   |
| 3       |   | <b>Noise Pollution</b>                 | <ul style="list-style-type: none"> <li>The mechanical noise caused by the operation of machines (such as hammers, bulldozers and concrete mixers, etc.).</li> <li>The traffic noise caused by transport vehicles and ships.</li> </ul> | <ul style="list-style-type: none"> <li>Construction and operation time should be scheduled well and strengthen the inspection of the site, equipment with high noise should be limited working time to reduce the impact to the sensitive surrounding environment.</li> <li>Choose the construction machines and trucks with low noise and vibration priority. Enhance the maintenance of them to make work smoothly.</li> <li>The machines and trucks should be scheduled well and the traffic should be guided on time. Strictly control the whistles of the trucks and ships to reduce the traffic noise</li> </ul> |

### **Other Wastes**

The perceived relevant wastes for the proposed project are silts. Silts are the solid wastes from the dredging of undesired seabed materials. Silt curtains will be used as waste management facility to contain the dispersal of these materials. These are discussed in the section on Reclamation Methodology.

The proponent shall strictly comply with Requirements and Standards of the Philippine Coast Guard for Vessels such as:

- MC No. 01-2005 Revised Rules on Prevention, Containment, Abatement and Control of Oil Marine Pollution.** The purpose of this Memorandum Circular is to provide implementing guidelines pursuant to the above-mentioned authorities as rationalized in accordance with the International Convention for the Prevention of Pollution from Ships, MARPOL 73/78;
- MC No. 07-2005 Prevention of Pollution by Sewage from Ships Discharge of Sewage.** The purpose of this Memorandum Circular is to provide implementing rules to prevent pollution by sewage from ships;



- **MC No. 01-2006 Rules Prohibiting the Dumping and Discharging of Wasters and Other Harmful Matters.** To prescribe the procedures and policies for the proper dumping of wastes and other harmful matters into Philippine waters in order to prevent pollution which may create hazards to human health, marine life and other resources, damage amenities or interfere with other legitimate uses of the sea.

**Annex 1-D** attached are MC No. 01-2005, MC 07-2005 and MC No. 01-2006

#### **b. Operation and Maintenance of the Facility**

During the reclamation activity, all equipment, vessel and machine shall be maintained on a regular basis depending on the specification of each equipment following the manual of operation. The equipment shall be operated by a well-trained and educated crew as the inspection requires the sufficient knowledge of mechanical equipment and its function. Establish a system of regular preventative inspection. Otherwise, it will take more time and money to rectify damage by acting after problems happen. Items of equipment to be inspected, inspection interval and the crew in charge, etc. should be decided for each dredger.

As inspection items and intervals are generally recommended by the manufacturer of engine or equipment, inspection works should follow these instructions.

General inspection items are shown below for reference.

- ✚ Quantity, pressure and temperature of lubricating oil
- ✚ Quantity, pressure and temperature of cooling water
- ✚ Quantity of fuel oil
- ✚ Exhaust gas temperature
- ✚ Leakage of oil or water
- ✚ Filter
- ✚ Abnormal vibration or noise

All pollution control facilities such as:

- ✚ The maintenance of a silt curtain most commonly involves monthly cleaning and the replacement of sections of the screen and anchor lines that are worn or damaged.
- ✚ Temporary portable purifying septic tank shall be desludged at least once a month by an accredited hauler, and
- ✚ Buffer zone shall be observed at all times

### **1.6 Project Size**

The Proposed Cavite Province Land Reclamation and Development Project: **ISLAND D** will occupy a total reclaimed land area of 267 hectares along the coastal waters of Noveleta and Rosario, Province of Cavite. Hence, the proposed project is covered under Category A of EMB MC No. 2014-005, which covers projects undertakings that are classified as Environmentally Critical Projects (ECPs) and are required to secure an Environmental Compliance Certificate (ECC).

### **1.7 Development Plan**

The reclamation project involves two (2) type of development, First is the development below or under the sea thru the reclamation activity method discussed above under Section 1.5.5 and second is the development of above the sea. This section describes the development of based on the conceptual master development plan.



### 1.7.1 Pre-construction (e.g. planning, acquisition of clearances, permits etc.)

There are no activities during this phase that will result in significant environmental impacts. Project Implementation Schedule, the activities are: design and engineering, technical plans and documentations, securing of permits and clearances

Following are the clearances, permits and documentations needed is presented in Table 1-9:

**Table 1-9 Permits and Clearances to be secured**

| Item                           | Authorities Involved   |
|--------------------------------|--|
| ECC                            | DENR   |
| NTP/Area Clearance             | RED/DENR   |
| Letters of No Objection (LONO) | a. Department of Tourism (DOT)<br>b. Bureau of Fisheries and Aquatic Resources (BFAR)<br>c. Philippine Navy<br>d. Department of Energy (DOE)<br>e. Regional Development Council (RDC)<br>f. Philippine Reclamation Authority (PRA)<br>g. Department of Public Works and Highways (DPWH)<br>h. Department of Information and Communications Technology (DICT)<br>i. National Headquarters Philippine Coast Guard (PCG)<br>j. Philippine Ports Authority (PPA)<br>k. National Commission for Culture and the Arts<br>l. Department of Health (DOH) |
| Notice to Proceed (NTP)        | Philippine Reclamation Authority (PRA)   |
| Construction Permits           | <ul style="list-style-type: none"><li>• LGU</li><li>• DPWH</li><li>• Philippine Coast Guard</li></ul>  |

### 1.7.2 Construction Phase

#### 1.7.2.1 Landform Preparation -Structure (1 Reclamation Island-Dredging and Reclamation)

The land form shall be developed through construction of containment wall/dike, dredging and reclamation using hydraulic sand fill method, and soil stabilization with an estimated volume of approximately 25.22 million cubic meters of fill materials from a reliable and feasible sand source of offshore area up to a finished platform elevation of +4.5 meters above Mean Lower Low Water (MLLW).

#### 1.7.2.2 Horizontal Development

Upon reaching the finished platform elevation of +4.5 meters above Mean Lower Low Water (MLLW), horizontal development based on conceptual development plan shall be constructed. This includes construction of Road and access and construction of utilities such as drainage system, sewer collection, power and telecommunication. Table 1-10 provides an idea of how the reclaimed land will be allocated which identifies as 50.32% is considered saleable, 21.82% is non-saleable and 28.43% is for government share. (This table is based on the originally-planned land areas and will be accordingly revised for the final area).

The Project, once completed, shall be ready for the development and construction of various structures such as commercial, industrial, institutional and residential buildings.



**Table 1-10 Land Area Allocation**

|                          | Island D      | Percentage    |
|--------------------------|---------------|---------------|
| <b>A. Saleable</b>       |               |               |
| Mixed Use Dev't/MXD      | 118.01        | 44.20         |
| Commercial               | 16.34         | 6.12          |
| Industrial               |               |               |
| <b>Sub-total A (ha)</b>  | <b>134.35</b> | <b>50.32</b>  |
| <b>B. Non-Saleable</b>   |               |               |
| Utility & Transportation | 16.51         | 6.18          |
| Parks & Open Spaces      | 12.34         | 4.62          |
| RROWs                    | 29.42         | 11.02         |
| <b>Sub-total B (ha)</b>  | <b>58.27</b>  | <b>21.82</b>  |
| <b>C. Others</b>         |               |               |
| Government Share         | 75.9          | 28.43         |
| <b>Grand Total (ha)</b>  | <b>267</b>    | <b>100.00</b> |

Presented in Table 1-11 are the description of the impact and waste management system during Earthmoving, and Re-filling of earth materials to achieve the designed elevation of the landform and soil stabilization.

**Table 1-11 Description of the Impact and Waste Management Measures During Land Development**

| Key Environmental Aspects   | Environmental Impact   | Waste Management System  |
|---|--|--|
| Earthmoving, and Re-filling of earth materials to achieve the designed elevation of the landform and soil stabilization | Water - Possible Siltation of the sea<br><br>Road Safety and Traffic<br><br>Dust Pollution and Increase in Noise Level | <ul style="list-style-type: none"> <li>• Immediate compaction of the area to further mitigate the dust.</li> <li>• Implementation of traffic management that is appropriate for the area</li> <li>• Road signs shall be placed at appropriate locations to alert motorist along the highway.</li> <li>• Traffic warden shall be stationed at strategic locations to guide traffic.</li> <li>• Observed operating hours</li> <li>• Regular Maintenance of equipment and vehicles</li> </ul> |

**a. Access Ways / Access Link to the Shore / Road Transport Accessibility**

All proposed access links/connectors and bridges are not part of this application which shall be applied separately. However, based on the initial plan, the proposed land reclamation project shall be provided with main access system through the construction of Elevated Access Road or Viaduct to be connected to the existing Radial Road R1 or Manila Cavite Expressway Project or Cavite Expressway Project and its proposed alignment expansion, Segment 5. The proposed main access system connecting the 4 islands shall consist of 4 km viaduct and an interchange which shall interface with the Manila Cavite Expressway Project to provide all directional traffic movements from the existing roadway to the proposed reclamation project area and vice versa.

For Island D, the plan is to put up an approximately 1.1km viaduct going east to the Manila-Cavite Road. This is shown in Figure 1-7 above.





### **The Internal Road Network and Pavement Structure System**

The proposed Cavite Land Reclamation Project will be developed with complete access system consisting of primary arterial road, Secondary Road and tertiary road systems. All islands will be connected by link bridge structures in between.

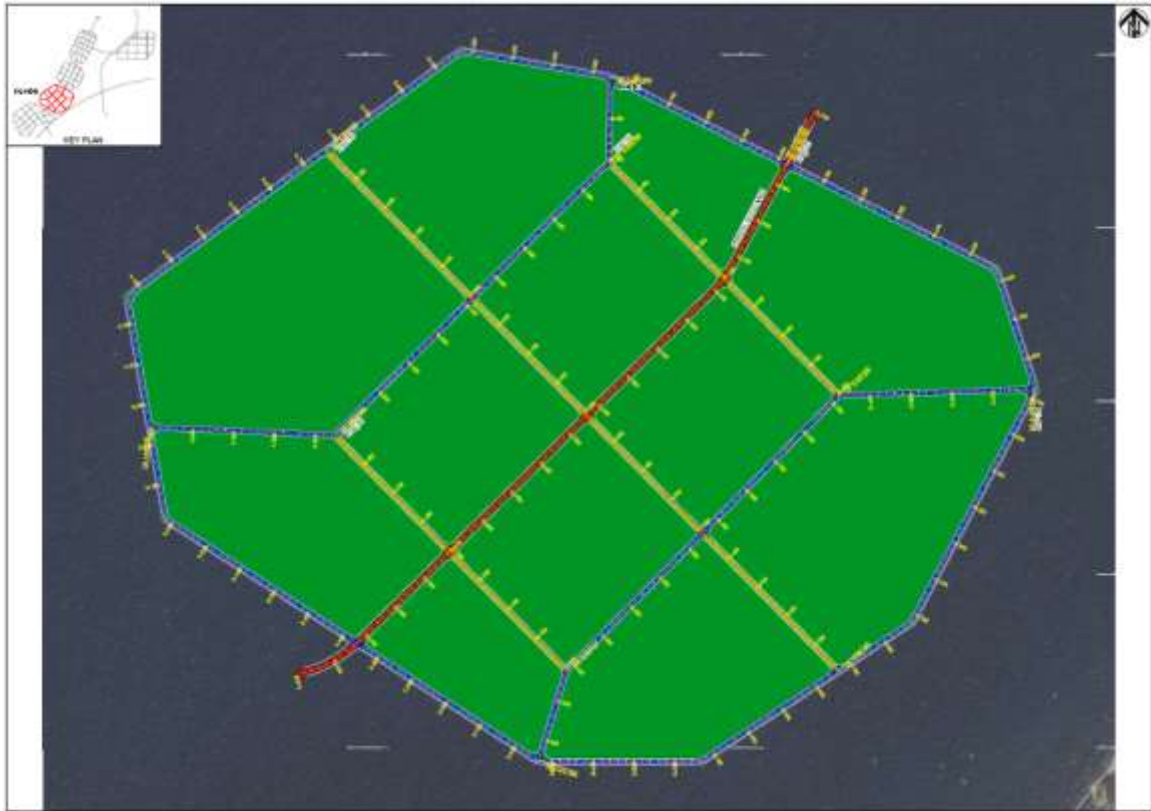
Road access will be made through the proposed CAVITEX Expansion, Segment 5 while railway system can be developed from the Proposed Extension of LRT Line 1, which traverses alongside the Manila Cavite Coastal Road and terminates in Brgy. Niog, Bacoor, Cavite.

Two (2) types of pavement structure system were considered in the evaluation, i.e., Rigid Type or Portland Cement Concrete Pavement (PCCP) and Flexible Pavement or Asphalt Concrete Pavement (ACP). While PCCP offers more advantages in terms of availability of material locally and minimum maintenance requirement, such system however, is very expensive to reconstruct or repair. Noting that the subgrade will rest on embankment with height of more than nine (9) meters, the area is susceptible to settlement in spite of application of stabilization measure. Settlement of the underlying supporting material will result as well in differential settlement of the pavement and eventually to its deterioration, which will require reconstruction.

Application of flexible pavement or Asphalt Concrete Pavement, offers an alternative to this kind of development issue since the flexible pavement adopts to the subgrade movement without significant material damage. Further, the surface of the pavement lends itself to future expansion or improvement without necessarily disturbing the existing riding surface. The work on the pavement could be completed earlier and the completed pavement can be opened to traffic after minimum curing time or within the day after completion. PCCP needs at least minimum of seven (7) days to 14 days before the completed surface can be opened to traffic.

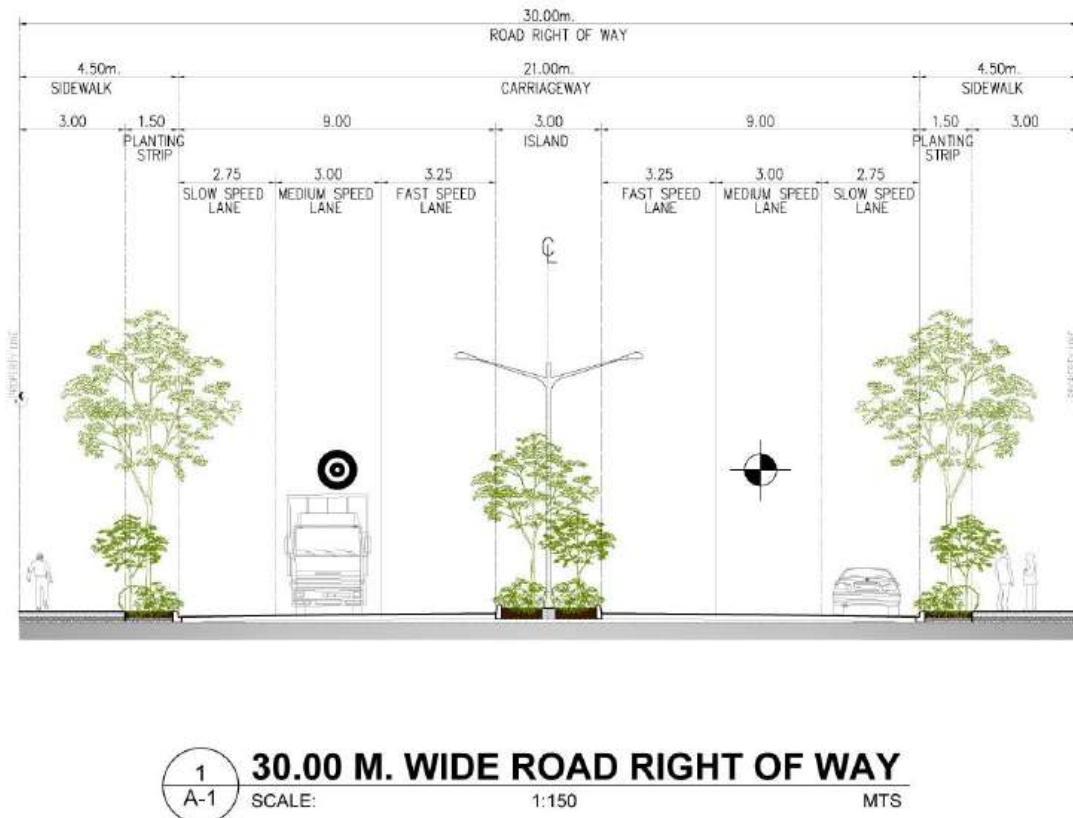
Based on the proposed conceptual land use plan, a road network system plan was developed and recommended, Figure 1-16 presents the road network system for Island D which consists of the following road classifications:

- a. Principal Main Road, collects all traffic from the development areas and convey them to the existing major roads and vice versa.
- b. Secondary roads - serves traffic from proposed development areas along the routes while at the same time collecting traffic from tertiary roads.
- c. Tertiary Roads - serves traffic from pocket development areas and convey them to secondary or even to the primary main road



**Figure 1- 16      Road Network System Layout, Island D**

Figures 1-17 hereafter show the initial conceptual plans for the planned road rights-of-way (RROWs, including esplanade. The use of an all-underground utility system (including power and telecom fiber optics) is also under consideration



**Figure 1- 17 Illustration of 30.0-meter RROW and Road-side Tree Planting**

Presented in Table 1-12 are the description of the impact and waste management system during construction of internal and external road system.

**Table 1-12 Description of the Impact and Waste Management Measures During Construction of Road**

| Key Environmental Aspects                         | Environmental Impact  | Waste Management System  |
|---|---|--|
| Construction of Internal and External Road System | <p>Water - Possible Siltation of the sea</p> <p>Road Safety and Traffic</p> <p>Dust Pollution and Increase in Noise Level</p> | <ul style="list-style-type: none"> <li>• Immediate compaction of the area to further mitigate the dust.</li> <li>• Implementation of traffic management that is appropriate for the area</li> <li>• Road signs shall be placed at appropriate locations to alert motorist along the highway.</li> <li>• Traffic warden shall be stationed at strategic locations to guide traffic.</li> <li>• Observed operating hours</li> <li>• Regular Maintenance of equipment and vehicles</li> </ul> |



**b. Construction of Utilities**

**Drainage System**

***Storm Drainage System***

The existing development will be provided with adequate site drainage system to ensure that the surface is free from flooding and surface inundation or water ponding. The proposed drainage system consists of curb inlet manholes and pipe drains or covered concrete drainage structure discharging to the existing sea water surface. Sufficiently sized pipe or rectangular drainage outfalls will be provided to discharge estimated surface runoff discharge, Figure 1-17 presents the Preliminary Drainage Plan.

***Open Spaces as Drainage Facilities***

The parks and open spaces shall be utilized for drainage facilities as well as rainwater harvesting. Surface runoff retention tanks will be installed, both for the use of water for plants and other domestic use, as well as for flood control.

**Sewer Collection and Treatment System**

The project locators will provide the sewer collection and treatment systems within their respective properties and connects with the site drainage system of the development, if combined sewer and storm drainage system will be allowed in the proposed development.

Separate sewerage system for the handling of treated wastewater effluents will be constructed and will involve underground concrete pipes.

The DED to be submitted to the PRA for the purpose of securing an NTP shall include consideration of the storm run-off and wastewater/sewage along the following basis:

- a. Location must allow for flow by gravity to the discharge channels/canals
- b. The population of the various land use locators
- c. The City's own land use planning for the share of land it will get at no cost to the government
- d. Use of rainfall intensities in the Rational Formula based on Climate Change Projections.

**Power Generating Facility or Energy Source**

The sea vessels will have their individual onboard power generating facility while the electricity for lighting purposes will be reclaimed at the soil being stabilized and will be sourced from the Manila Electric Company.

Meralco shall supply the power requirements of the development. Should the Proponent decide to install the development's power system underground, proposed ducting provision was considered in the study.

Meralco shall supply the power requirements of the development. The power source is located along the Manila Cavite City Road while substations will be constructed in each island. Separate tapping or connection points were proposed should there will be power interruption in one section. Power emergency system will also be considered.



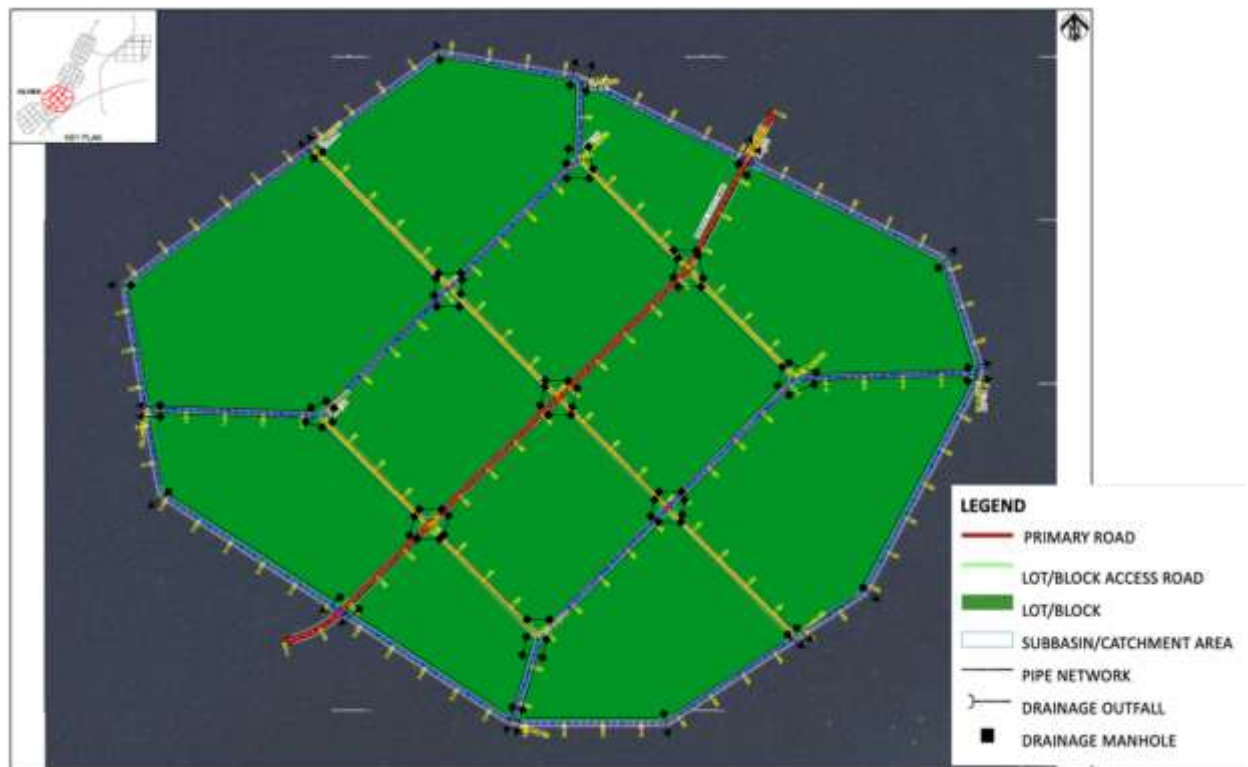


Figure 1-18 Island D Preliminary Drainage Layout



## Telecommunications

For the construction phase, telecommunications will be among and between crew at sea and contacts at land and will be through mobile phones and/or radio.

Table 1-13 presents the description of the impact and waste management measures during the construction of utilities.

**Table 1-13 Description of the impact and Waste Management Measures During Construction of Utilities**

| Key Environmental Aspects | Environmental Impact  | Waste Management System  |
|---------------------------|---|--|
| Construction of Utilities | Water - Possible Siltation of the sea<br><br>Road Safety and Traffic<br><br>Dust Pollution and Increase in Noise Level<br><br>Solid Wastes Generation | <ul style="list-style-type: none"><li>• Immediate compaction of the area to further mitigate the dust.</li><li>• Implementation of traffic management that is appropriate for the area</li><li>• Road signs shall be placed at appropriate locations to alert motorists along the highway.</li><li>• Traffic warden shall be stationed at strategic locations to guide traffic.</li><li>• Observed operating hours</li><li>• Regular Maintenance of equipment and vehicles</li><li>• Implement Solid Waste management plan such as segregation at source</li></ul> |

### 1.7.3 Implementation Schedule

The preliminary implementation schedule is presented in the Gantt chart under Table 1-14. The concept is that one (1) island for construction of containment wall/dikes and landform will be completed first prior to the construction of the next island which will last for fifteen (15) years. Based on the preliminary implementation plan, the following sequence applies for Island C-D and E:

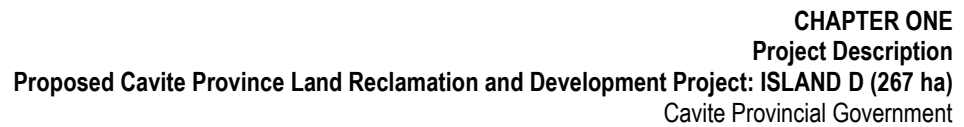
- Island C will start when the construction phase (dredging and reclamation) of Island A has reached 70%
- Island D will start dredging and reclamation (construction phase) when consolidation and stabilization of Island C has reached at least 30% or at least a year after
- Island D will complete construction phase (dredging and reclamation) simultaneous with Island C consolidation and stabilization stage
- Island D consolidation and stabilization stage will be finished simultaneous with Island C site development
- Island E shall commence simultaneous with Island D consolidation and stabilization stage
- Island D site development will be finished while doing the Island E consolidation and stabilization stage
- Island E will be completed three (3) years after Island D site development is finished.

Given the availability of the number of equipment, number of years may further shorten to six (6) years, the schedules shall be adjusted based on the demand for land during the implementation period.



**Table 1-14 Preliminary Implementation Gantt Chart**

| Cavite Reclamation Project   | IMPLEMENTATION SCHEDULE |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
|--|-------------------------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|
|  | 1                       | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| Pre-Construction   |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| <b>Cavite Island A = 247.27 has</b>  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| Construction Phase – Dredging and Reclamation  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| a. Removal and disposal of unwanted seabed/scraps/debris   |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| b. Construction of Environmental Protection such as installation of silt curtain and construction of cofferdam |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| c. Dredging of Seabed  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| d. Reclamation-Filling of Materials  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| d.1 Construction of Containment Wall/Dikes   |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| d.2 Construction of Land Formation   |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| e. Land filling development above the sea  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| Consolidation and Stabilization  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| Site Development such as roads and utilities   |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| Operation Phase  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| <b>Cavite Island C=205 has</b>   |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| Construction Phase – Dredging and Reclamation  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| a. Removal and disposal of unwanted seabed/scraps/debris   |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| b. Construction of Environmental Protection such as installation of silt curtain and construction of cofferdam |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| c. Dredging of Seabed  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| d. Reclamation-Filling of Materials  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| d.1 Construction of Containment Wall/Dikes   |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| d.2 Construction of Land Formation   |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| e. Land filling development above the sea  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| Consolidation and Stabilization  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| Site Development such as roads and utilities   |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| Operation Phase  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| <b>Cavite Island D=267 has</b>   |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| Construction Phase – Dredging and Reclamation  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| a. Removal and disposal of unwanted seabed/scraps/debris   |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| b. Construction of Environmental Protection such as installation of silt curtain and construction of cofferdam |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| c. Dredging of Seabed  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| d. Reclamation-Filling of Materials  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| d.1 Construction of Containment Wall/Dikes   |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| d.2 Construction of Land Formation   |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| e. Land filling development above the sea  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |
| Consolidation and Stabilization  |                         |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |



#### 1.7.4 Operation Phase (Construction of Vertical Structures)

### 1.7.5 Decommissioning Phase

## 1.8 Manpower

### 1.8.1 Construction (Reclamation Phase)

## Dredging / Reclamation Works

The Reclamation/Dredging Contractor will directly hire these personnel because of the technical requirements prescribed by the Contractor. Policies on the hiring of men and women and on PWG and age will be dictated by the safety requirements of working in sea vessels and operating heavy equipment as well as the technical training required for the personnel.

There are no known indigenous peoples in the Province. The nature of the project construction and the needs for specialized works at the sea vessels may not encourage certain sectors of the society. Expertise/skills needed for the dredging/filling vessel are indicated in Table 1-15.





**Table 1-15 Manpower Specialized Skills Requirement**

| POSITION   | Expertise/skills needed for the dredging/reclamation vessels | Estimated Number of Manpower |
|--|--|------------------------------|
| <b>Pre-Construction Phase</b>  |  |                              |
| Technical Consultants  | All Professionals and Experts (Local and Expats)             | 50                           |
| <b>Construction Phase</b>  |  |                              |
| Sea-Based Crew   | Professional   | 240                          |
| <b>Land Formation</b>  |  |                              |
| Project Manager, Engineers, Equipment Operators, CADD Operators, Surveyors | Professional   | 30                           |
| Admin Officer and Staff, Guard, Mechanics, Etc.                            | Graduate and requirement with corresponding Licenses         | 30                           |
| Various Construction Workers   | Skilled and Semi-Skilled                                     | 80                           |
| <b>Horizontal Development</b>  |  |                              |
| Foreman  | Skilled  | 50                           |
| Helper   | Semi-skilled   | 250                          |
| Utilities  | Semi-skilled   | 100                          |
| <b>Estimated Number of Manpower During Construction Phase</b>              |  | <b>780</b>                   |

#### **Soil Stabilization/Horizontal Works Phase**

During the horizontal works, skills needed will be more of the usual on-land construction works, and could serve as temporary employment opportunities for skilled construction workers of the Province as priority will be given to locals, **if the skills are available**. The proponent shall give priority to all qualified locals hires with proper coordination with the concerned barangay Local Government Units (LGUs).

#### **1.8.2 Vertical Construction Works**

After the creation of soil stabilized reclaimed land complete with horizontal components, vertical construction works will take place. These will provide substantial job opportunities. The job hiring will be undertaken by the individual contractors; they will be persuaded to give preferences to qualified locals. Payment of wages and provision for all benefits prescribed by the DOLE will be ensured by the Province since it will be part of the Consortium that will implement the Project.

It must be emphasized, however, that this phase is outside the scope of this ECC application.

#### **1.9 Project Cost. Indicative Project Investment Cost**

The estimated total investment costs for the reclamation project including attendant expenses is estimated at **Php 18.00 Billion**

***Estimated cost of reclamation and land development including supporting data (i.e., existing labor force, structure and average cost and available equipment and average cost/rental rates)***

#### **Funding Scheme**

The Project is expected to be financed by the private sector. The private funds will be sourced from investors' equity and borrowings, with an assumed equity-loan mix of 30%-70% — the usual industry practice. Any fund shortfall, if any, will be covered by additional equity infusion.



## Chapter 2. KEY ENVIRONMENTAL IMPACTS

The assessment of environmental impacts were identified based on the preparation of simple checklist presented in **Table 2-1** below.

**Table 2-1. Identification of Environmental Impacts**

| Impacts                | Construction-Dredging and Reclamation | Consolidation and Stabilization | Site Development |
|------------------------|---------------------------------------|---------------------------------|------------------|
| <b>LAND</b>            |                                       |                                 |                  |
| Land Use and Formation | ✓                                     |                                 |                  |
| Solid Wastes           | ✓                                     | ✓                               | ✓                |
| Hazardous Wastes       | ✓                                     | ✓                               | ✓                |
| Geologic Hazard        |                                       | ✓                               | ✓                |
| <b>WATER</b>           |                                       |                                 |                  |
| Water (Marine) Quality | ✓                                     | ✓                               | ✓                |
| Domestic Wastewater    | ✓                                     | ✓                               | ✓                |
| Hydrologic Hazard      | ✓                                     |                                 |                  |
| Coastal Hazard         | ✓                                     | ✓                               | ✓                |
| Marine Ecology         | ✓                                     |                                 |                  |
| Navigational Traffic   | ✓                                     | ✓                               | ✓                |
| <b>AIR AND NOISE</b>   |                                       |                                 |                  |
| Air Quality            | ✓                                     | ✓                               | ✓                |
| Noise Quality          | ✓                                     | ✓                               | ✓                |
| <b>PEOPLE</b>          |                                       |                                 |                  |
| Socio-Economics        | ✓                                     | ✓                               | ✓                |
| Health and Safety      | ✓                                     | ✓                               | ✓                |

### 2.1 LAND

#### 2.1.1 Land Use and Classification

##### 2.1.1.1 Impact in Terms of Compatibility with Existing Land Use

The proposed project site is situated in the waters of Manila Bay within the political jurisdiction of the municipalities of Noveleta and Rosario, Province of Cavite. The communities are in full support to the proposed reclamation project noting that the project proponent is the Provincial Local Government Unit (LGU).

The 2010 Provincial Comprehensive Land Use Plan and Zoning Ordinance (PCLUPZO) is provided in Figure 2.1-1. From this map may be gleaned the already congested land for commercial and business developments.

With regards to the land use classification, the proposed project site is within the indicated area for municipal fishing zone and fishery management zone as delineated in the Proposed Coastal Land and Sea Use Zone Map (Figure 2.1-2) as well as in the existing Protection Framework Plan map of Cavite Province (Figure 2.1-3). Furthermore, under Republic Act No. 8435 otherwise known as Agriculture and Fishery Modernization Act of 1997 (AFMA), portions of the municipal waters of Noveleta is declared as a Strategic Fishery Development Zone (Figure 2.1-4). For the Municipality of Rosario, there is a proposal that the municipal water shall be divided into four zones – Municipal Fishing Zone, Marine Protection Zone, Traditional Fishing Zone and Buffer Zones. An Integrated Coastal Management Plan shall be drafted and later implemented. There is also a plan to reclaim underwater lots for socialized housing and commercial purposes. (CLUP of Rosario, 2011-2020).



Historically, In the latter part of 1960s or early 1970s, the land adjacent to the San Roque isthmus was reclaimed. The new land is now occupied by the San Sebastian College - Recoletos de Cavite and some residences. The present Cavite City Hall is built where the north tower end of the western wall was, which was already partly reclaimed by 1945.

In addition, the CAVITEX itself is principally a road built on reclaimed land. In fact, it is owned and operated by the Public Estates Authority Tollway Corporation (PEATC), a government-owned and controlled corporation and a subsidiary of the PRA. To date, a total length of 7 km was reclaimed along the coast of Bacoor Bay to construct the extension of the Manila-Cavite Expressway (CAVITEX) connecting the province to Metro Manila (PPDO 2016).

At present, there is the proposed Sangley Point Development Project with enabling reclamation. This project aims to transform Sangley Point into an international logistics hub with a modern airport (and seaport) through Executive Order no. 629 of 2007, directing the PRA to execute the plan.

The Municipality of Noveleta has a limited land area of 604 hectares. The general land use is quickly changing because it is a direct influence area of the Cavite Economic Zone in the nearby municipality of Rosario. The agricultural activity ceased to be productive and profitable due to high cost of inputs and the absence of irrigation facility. Another issue is that the agricultural crop production areas are located within the residential zones as per zoning plan approved by the Housing and Land Use Regulatory Board in 1981. The continuous increase in population had great influence in the massive construction of housing/commercial subdivisions, individual residential units, and apartments/boarding houses. Due to this situation, the municipality is now shifting to the development of fishing industry which is considered viable and potential income earner for the fishermen if properly managed.

The agricultural sector in Noveleta encompasses crop production, fishery, livestock and poultry raising. Fishery is a major source of livelihood in the municipality. Areas for aquaculture and fishpond activities are mostly in Barangays San Rafael II, III, and IV. Saltbeds and fishponds cover 71.50 hectares or about 11.84 percent of the total land area. Industrial use comprises 3 hectares representing 0.50 percent. (MPDC Noveleta, 2017)

The Municipality of Rosario, on the other hand, has a land area of 768.364 hectares and is predominantly industrial. The combined area of the industrial and commercial zones account for about 216.40 hectares or 28.16%. The arrival of more investors and expansion in the Cavite Economic Zone, together with the number of commercial and business establishments' build-up along Gen. Trias Drive - the town's major thoroughfare greatly induced the land uses in Rosario. (MPDC Rosario, 2011)

The most noticeable transformation in the pattern of land uses was the reduction in agricultural area. From a total of 32 hectares, this was reduced to just 27 hectares in 1999 and eventually zeroed presently. The high growth of urbanization translated to the rapid disappearance of agricultural lands. Industrial development continues inside and outside of Cavite Economic Zone. (MPDC Rosario, 2011)

Before the onset of industrialization, Rosario was dominantly coastal in nature. Much has been reckoned for its costal prominence such as the fish net weaving industry, boat manufacturing and the famed "Tinapang Salinas", to name a few. Smoked fish-making industry and traditional fishing is still a major source of income for residents of the 9 coastal barangays. The Municipal Fish Port and Ligtong Fish Landing create a systematic transport and download of fish catch. Lengthy beach and adjoining areas are in consideration for reclamation. Some of its shorelines are being developed to be tourist spot and beach resort, e.g. Isla de Bonita de Salinas. (MPDC Rosario, 2011)



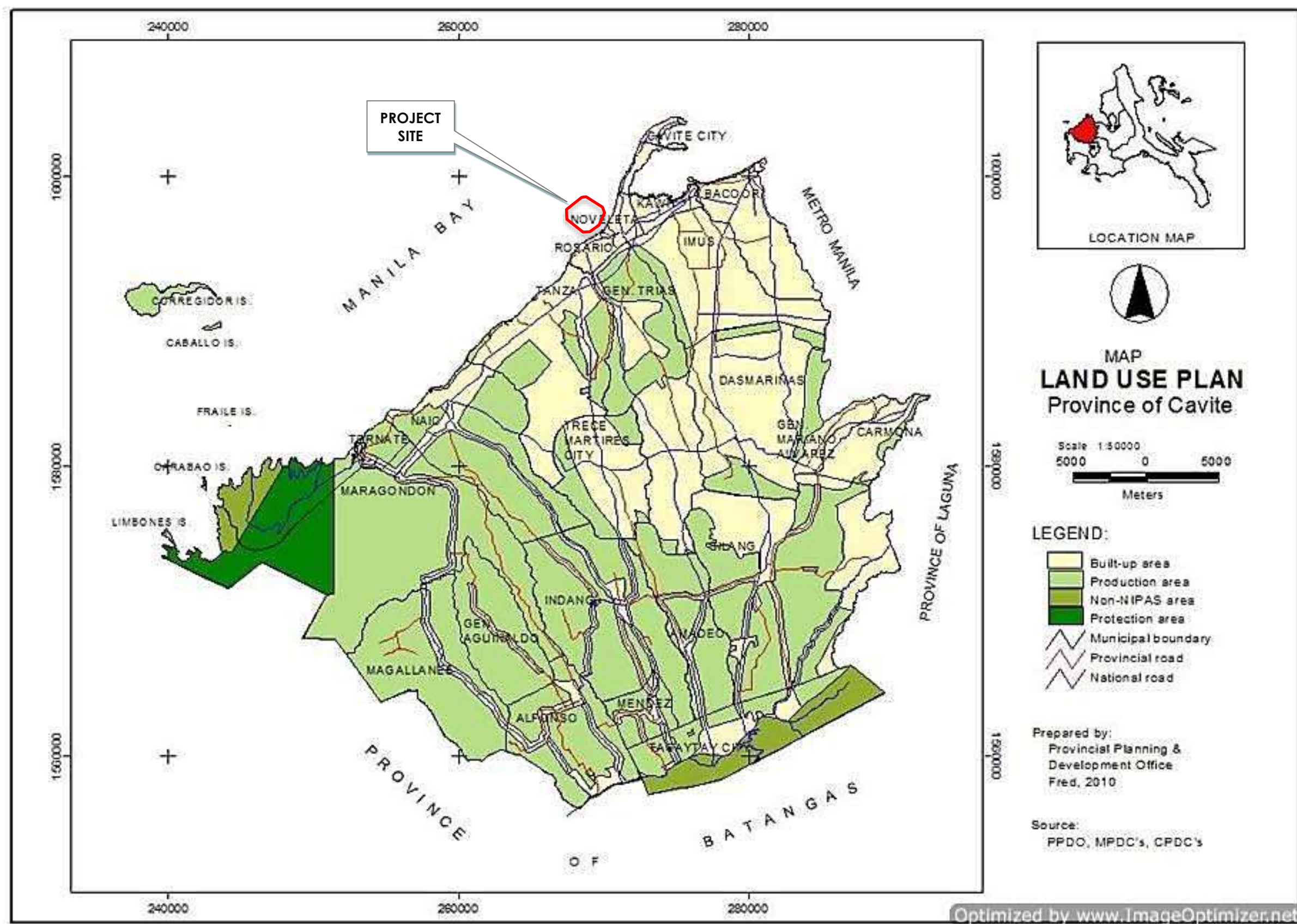
On the other hand, the industrial area of the PNOC property extends up to the coast of Rosario. The pipeline of the Oil Depot passes through the jurisdiction of Barangay Wawa II up to the territorial waters of Rosario. Mangroves can be found in the shore of Barangay Ligdong I and Barangay Wawa III.

The land use within the proposed project shall be planned in accordance with the existing and planned developments in the area, i.e., it will conform to the presence of airport, sea port, and various economic (industrial) productivity zones in nearby Sangley Point. As such, an aerotropolis is envisioned to be the driving development concept for the proposed Cavite Reclamation Project. A metropolitan sub-region where the layout, infrastructure, and economy are centered on an airport, which serves as a multimodal "airport city" commercial core. It is similar in form to a traditional metropolis, which contains a central city commercial core and commuter- linked suburbs. In particular, Islands A and B can serve as a partial and full logistics center respectively. As a logistics center, it has the potential to become the future clearing house and supply center for all manner of goods and services for the CALABARZON Region (Region IV-A). In support of Cavite's vision to become a major industrial hub, Islands B and C shall host industrial complexes.

In compliance with DAO 2007-20 dated 31 July 2007, an Area Clearance is being applied for wherein a Notice to Proceed (NTP) for ECC application was already issued (See **Annex 1-D**). The securing of the Letters of No Objection (LONOs) from the various concerned agencies, in support of the application for Area Clearance will reveal if there are conflicts with the Land Use and Classification of the proposed project (**Annex 2.1-A**). At present, the LONOs were already issued by the following stakeholder agencies:

1. Philippine Ports Authority (PPA);
2. Department of Tourism (DOT)
3. DA-Bureau of Fisheries and Aquatic Resources (BFAR)
4. Department of Information and Communications Technology (DICT)
5. Phil. Coast Guard
6. Phil Reclamation Authority (PRA)
7. Department of Energy (DOE); and
8. Department of Public Works and Highways (DPWH)

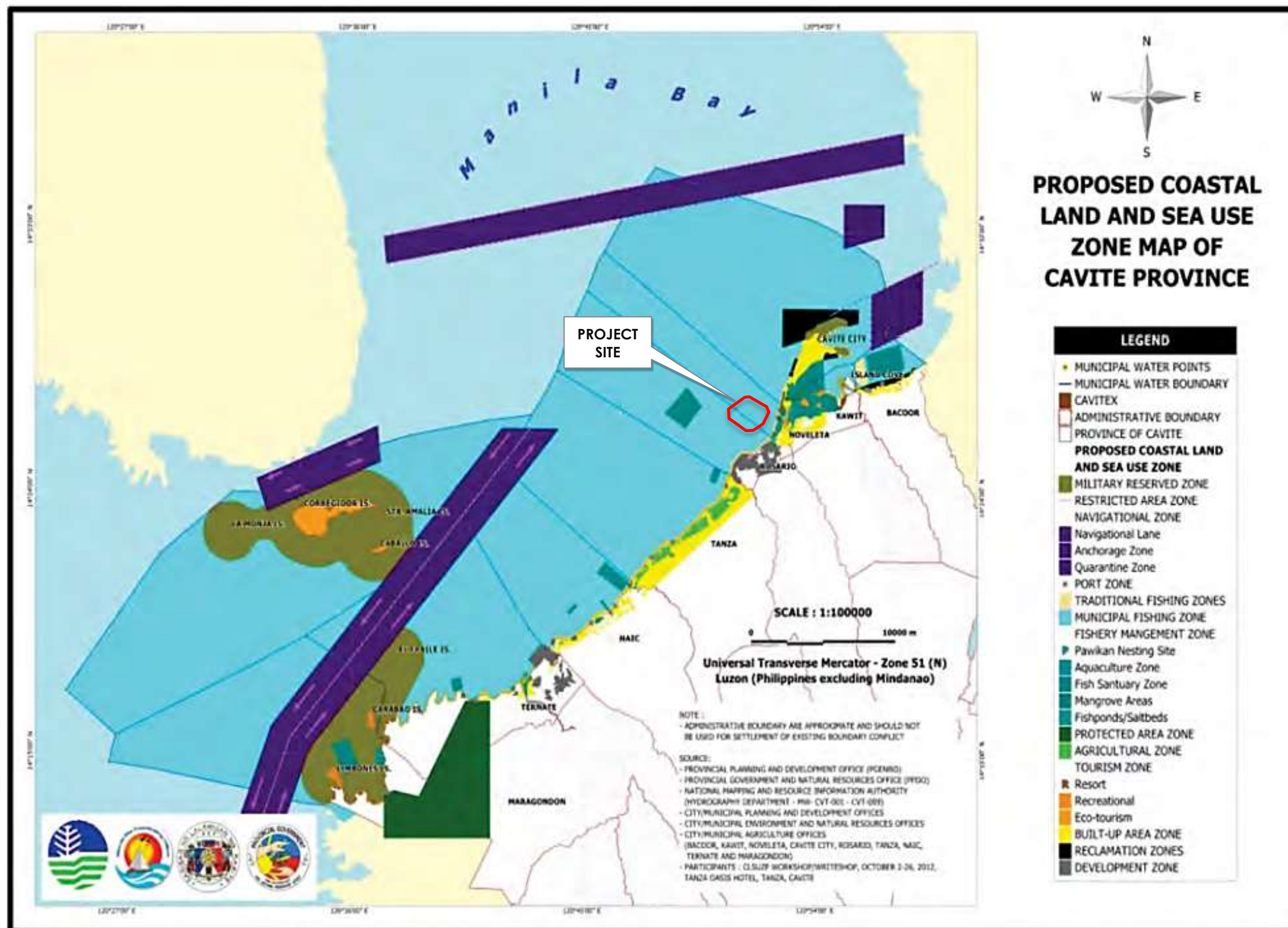




Source: Cavite PPDO 2016

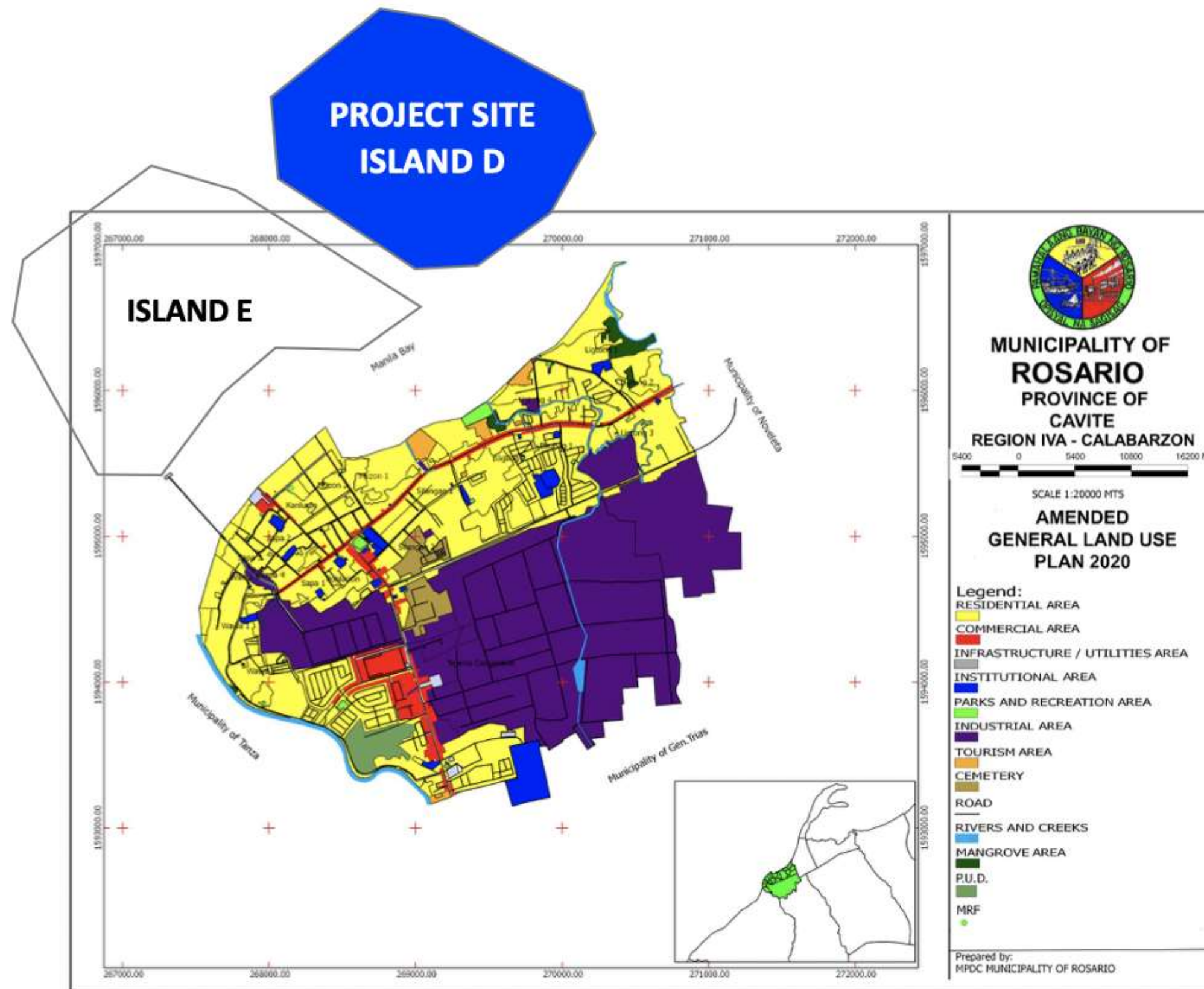
Figure 2.1-1. Official Zoning Map of Cavite Province





Source: Cavite PG-ENRO 2012

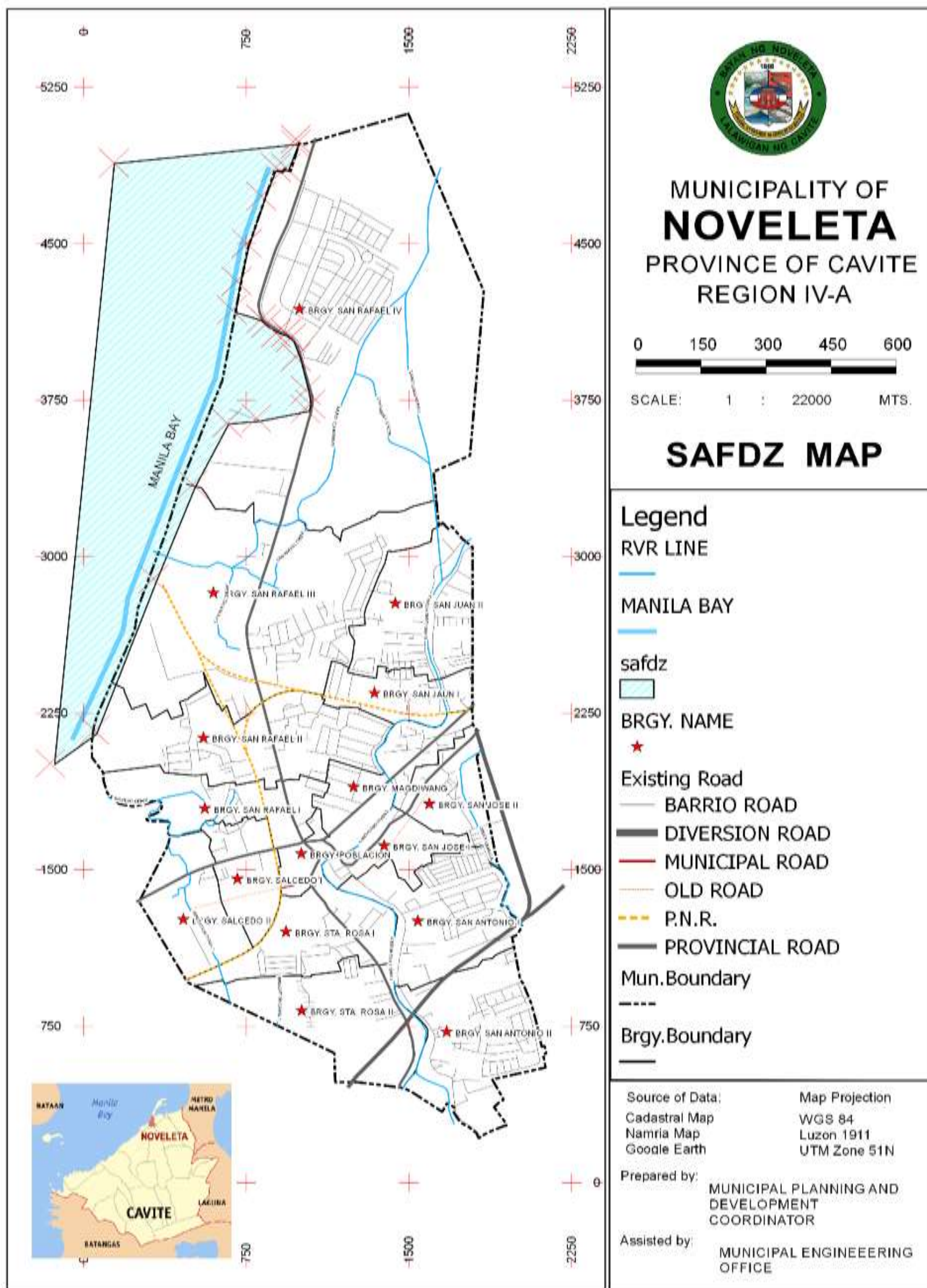
Figure 2.1-2. Proposed Coastal Land and Sea Use Zone Map of Cavite Province



Source: CLUP of Rosario (2011-2020)

Figure 2.1-3. Amended General Land Use Plan 2020 of the Municipality of Rosario





Source: Municipality of Noveleta Comprehensive Land Use Plan (2018-2028)

Figure 2.1-4. Strategic Fishery Development Zone of the Municipality of Noveleta





### 2.1.1.2 Impact on Compatibility with Classification as an Environmentally Critical Area (ECA)

The intent of declaration of ECAs is that projects within ECAs must secure an ECC, as stipulated in PD 1586.

In reference to EMB MC 2014-005, the Project falls under Infrastructure Type and is greater than 50 hectares and thus, an Environmentally Critical Project (ECP).

Furthermore, the project will be located in a declared environmentally critical area (ECA) as defined by Presidential Proclamation No. 2146, series of 1981 and Table 1 (Technical Definition of ECA and Corresponding Operationalization Guide) of DENR-EMB MC 2014-005. Specifically, the project site is within ECA Category # 6, wherein area is prone to ground shaking, liquefaction, tsunami, and storm surge. See table below.

**Table 2.1-1. The 12 ECA Categories under DENR-EMB MC 2014-005 in Relation to the Project**

| No. | ECA CATEGORIES  | APPLICABILITY TO PROJECT SITE  |
|-----|---|--|
| 1   | All areas declared by law as national parks, watershed reserves, wildlife preserve and sanctuaries                              | Project site is not located within this category. LPPWP is distant at approx. 12.5km.  |
| 2   | Areas set aside as aesthetic potential tourist spots  | Project site is not a declared tourist spot  |
| 3   | Areas which constitute the habitat for any endangered or threatened species of Indigenous Philippine Wildlife (flora and fauna) | Project area is not a habitat of any endangered or threatened species  |
| 4   | Areas of unique historic, archaeological, or scientific interests   | Project area has no known historic, archaeological and scientific resources based on the marine survey and the soil tests done on the seabed. Also, there was no reported encounter of any archaeological finding in all of the existing reclamation areas in the Bay. Nevertheless, proponent shall coordinate with the NHCP and National Museum. |
| 5   | Areas which are traditionally occupied by cultural communities or tribes  | Project area is on water, and is not occupied by cultural communities or tribes.   |
| 6   | Areas frequently visited and/or hard-hit by natural calamities, geologic hazards, floods, typhoons, volcanic activity, etc.     | Manila Bay (project location) is relatively less frequented by typhoons (5 cyclones in 3 years - PAGASA). Flooding susceptibility is low to moderate. Area is safe from ground rupture but prone to ground shaking, liquefaction, and tsunami. Safe from volcanic hazards.   |
| 7   | Areas with critical slopes  | Coastal area fronting site is flat, no critical slopes.  |
| 8   | Areas classified as prime agricultural lands  | Project site is not located within this category   |
| 9   | Recharge areas of aquifers  | Project site is not located within this category   |
| 10  | Water bodies characterized by one or any combination of the following conditions:   |  |
|     | a. tapped for domestic purposes;  | Project site is not located within this category   |
|     | b. within the controlled and/or protected areas declared by appropriate authorities;  | Project site is not located within this category   |
|     | c. which support wildlife and fishery activities.   | No significant marine fishes, macro invertebrates or crustaceans encountered during marine ecology survey.   |
| 11  | Mangrove areas characterized by one or any combination of the following conditions:   |  |
|     | a. with primary pristine and dense young growth;  | no primary pristine and dense young growth   |



| No. | ECA CATEGORIES  | APPLICABILITY TO PROJECT SITE |
|-----|---|-------------------------------|
|     | b. adjoining mouth of major river systems;  | no major river systems nearby |
|     | c. near or adjacent to traditional productive fry or fishing grounds;                 | none                          |
|     | d. which act as natural buffers against shore erosion, strong winds and storm floods; | none                          |
|     | e. on which people are dependent for their livelihood.                                | none                          |
| 12  | Coral reef characterized by one or any combination of the following conditions:       |                               |
|     | a. with 50% and above live coral line cover;  | none                          |
|     | b. Spawning and nursery grounds for fish;   | none                          |
|     | c. Which act as natural breakwater of coastlines                                      | none                          |

### **The NIPAS**

Protected areas are designated under the National Integrated Protected Areas Systems (NIPAS). Restrictions or prohibitions of activities in Protected Areas fall under this law.

There are no protected or proclaimed areas/sites within the Project Location; this may be gleaned from Figures 2.1-5 and 2.1-6. Figures 2.1-7 and 2.1-8 show the Protection Areas Map and Protection Framework Plan of Cavite, respectively, which show that the project site is outside any protection area. It should be emphasized that these protection areas are not covered by any NIPAS declaration.

The site of the wetlands nearest the project site is the Las Piñas-Parañaque Wetland Park (LPPWP), formerly known as Las Piñas-Parañaque Critical Habitat and Ecotourism Area (LPPCHEA).

R.A. 11038 signed on June 22, 2018 is an amendment to R.A. 7586, which created 94 new protected areas in the Philippines including the LPPWP.

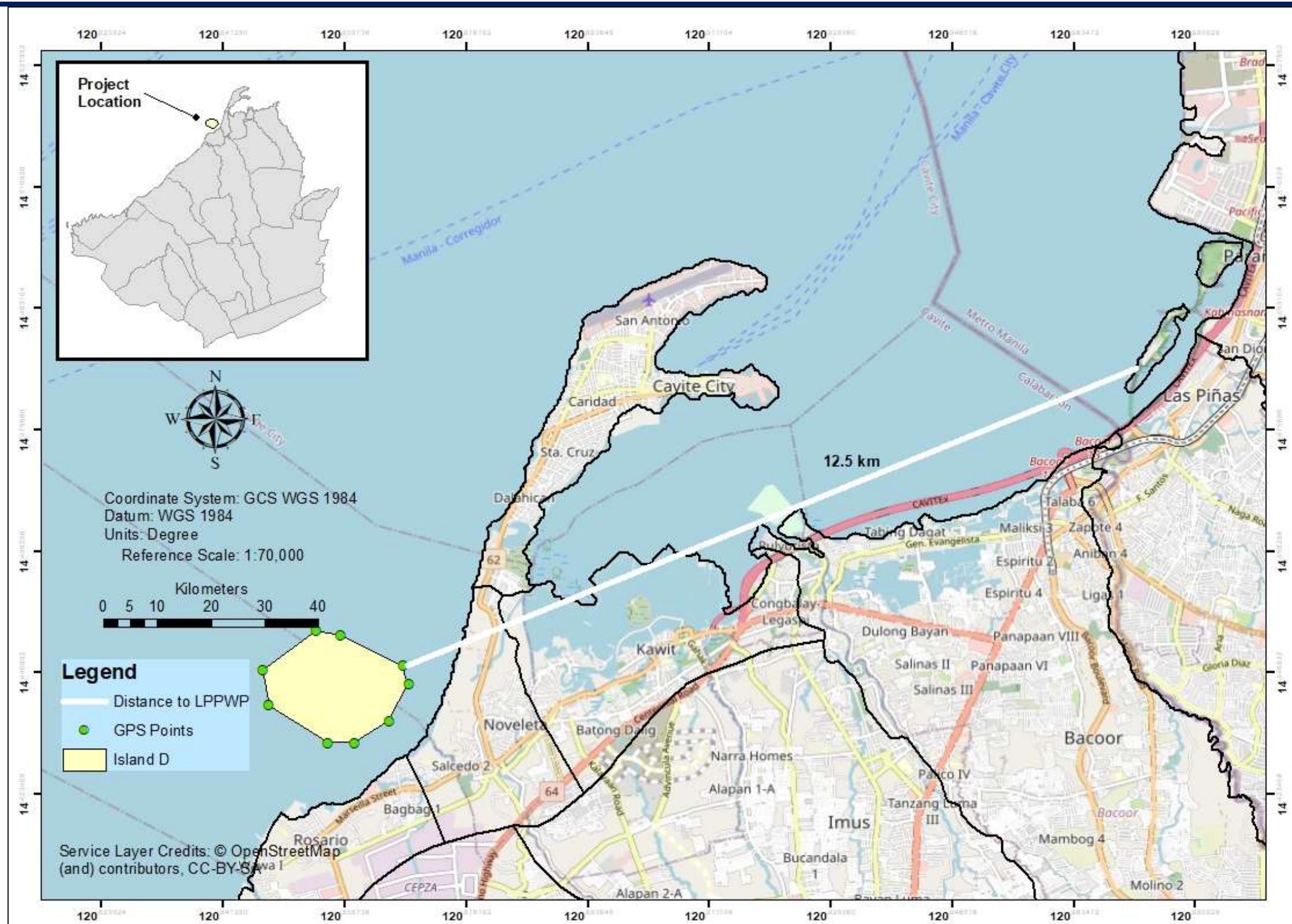
The LPPWP is also a bird sanctuary although exotic and rare bird species were sighted hovering over the site and immediate vicinity. The reclamation area is not detrimental to birds. In fact, it will also have open parks and spaces where birds can go, similar to near-shore development areas in other countries.

The area is distant at approximately 12.5 km northeast from the project site. Refer to Figure 2.1-5.

### **Sites under the Scope of the Ramsar Convention**

The Convention on Wetlands or Ramsar Convention is an intergovernmental treaty officially named the Convention on Wetlands of International Importance especially as Waterfowl Habitat. Its original emphasis was on the conservation and wise use of wetlands primarily to provide habitat for water birds. The LPPWP is among the sites under this Convention.

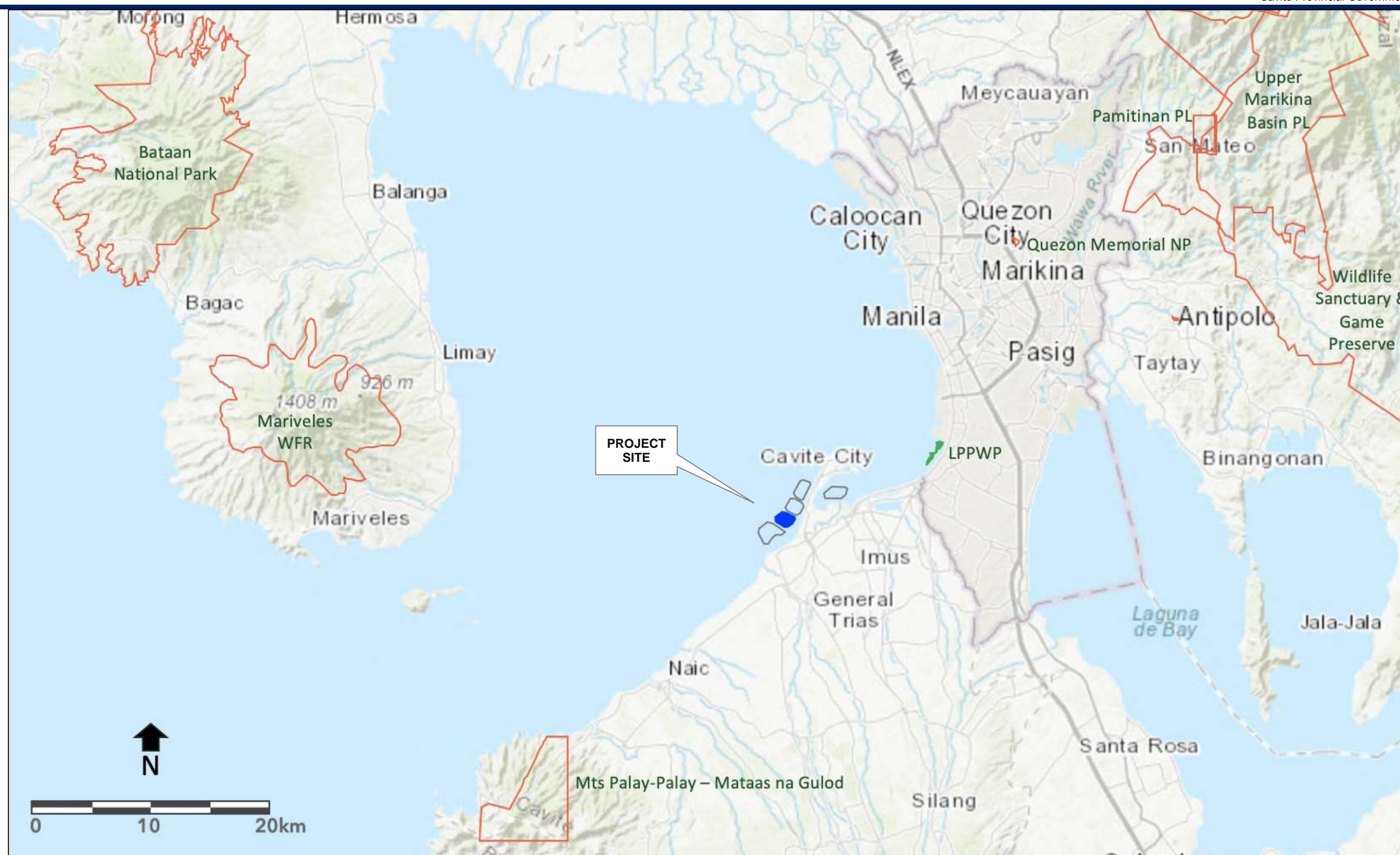




Source: 2020 Google Earth Map

Figure 2.1-5. Map of the LPPWP Relative to Project Site

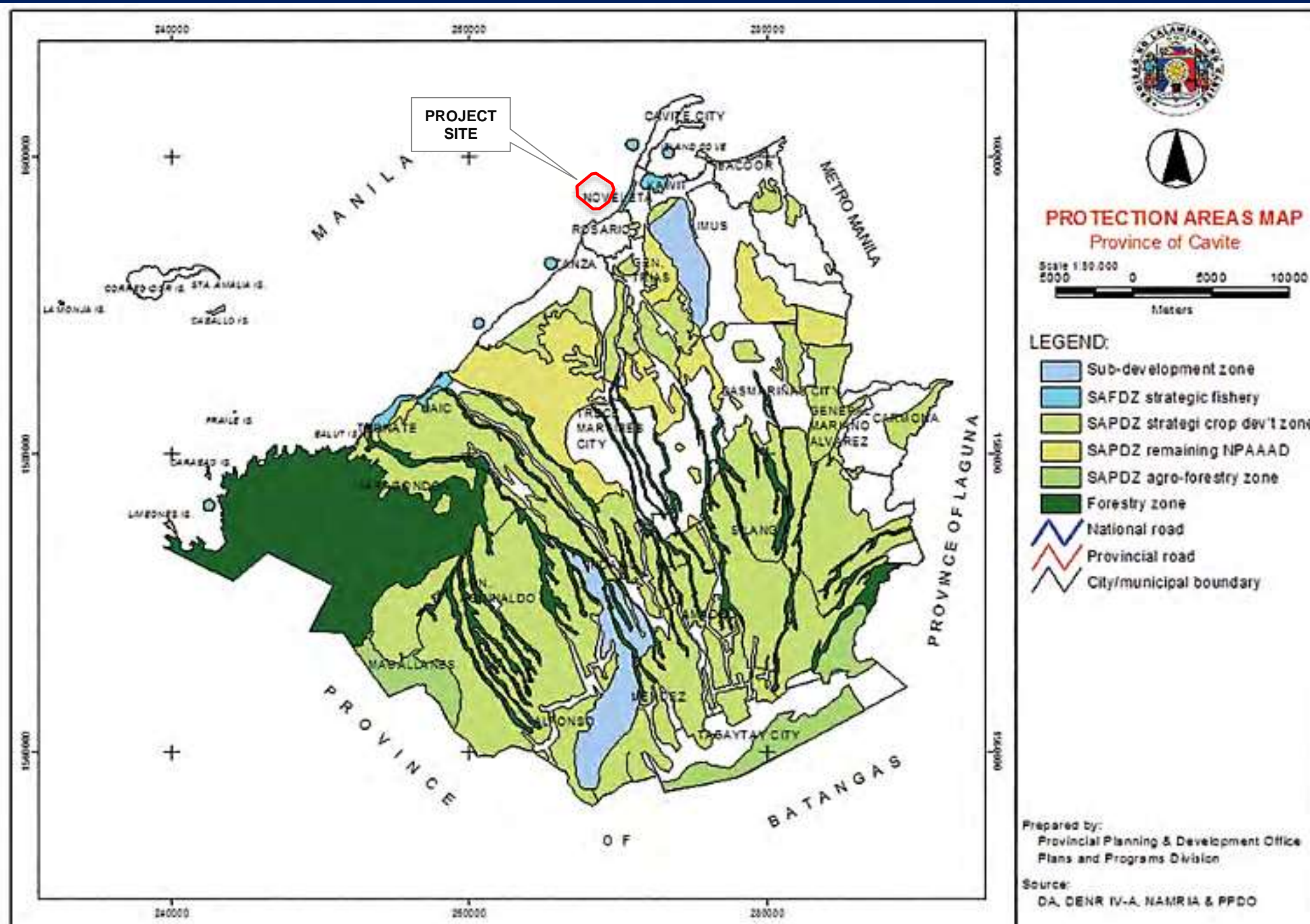




Source: ArcGIS Online, screen captured February 2020. <https://www.arcgis.com/home/webmap/viewer.html?useExisting=1>

Figure 2.1-6. Map of the Protected Areas in the Greater Manila Area

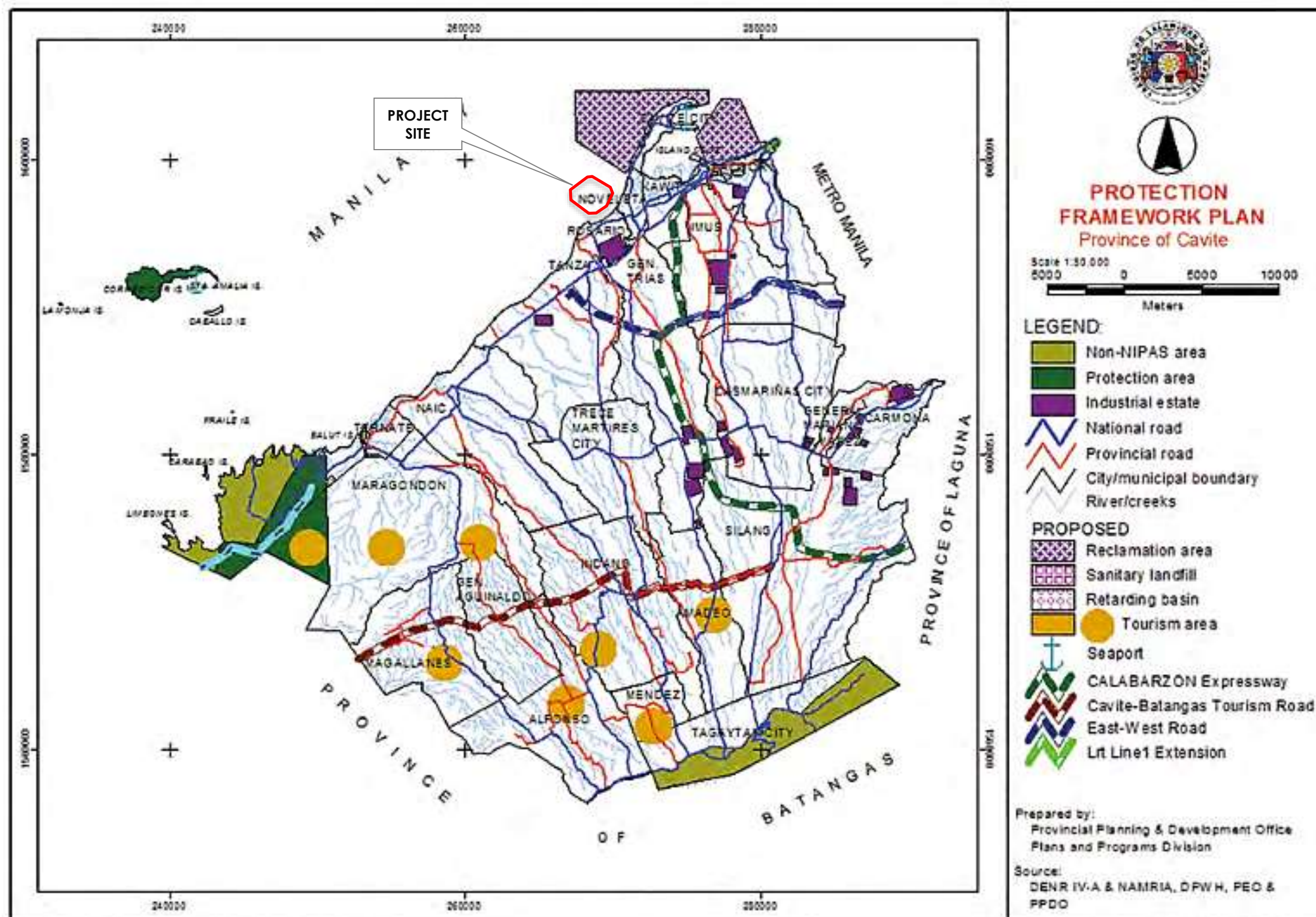




Source: Cavite PPDO 2016

Figure 2.1-7. Protection Areas Map of Cavite (not NIPAS-declared)





Source: Cavite PPDO 2016

Figure 2.1-8. Protection Framework Plan of Cavite



### On Proclamation 41 dated July 5 1954

The spirit behind the proclamation is seen to be preservation of parks and wildlife by the Commission on Parks and Wildlife.

The project is compatible with the Proclamation and is in fact not relevant to it for the following reasons:

- There are no parks and wildlife in the project site
- The authority over the project site, which is portion of the sea body is on the Province of Cavite.
- The CLUP of the Province / Municipality does not see issues vis-à-vis Proclamation 41.
- There have been reclamation works in the boundaries of the proclaimed parks and wildlife

A general summary of compatibility for the project with various rules/issuances and policies is shown in the table below.

**Table 2.1-2. Summary of Compliances to and Consistencies with Various Regulations/Laws/Treatises**

| Regulations/Laws/Issuances               | Consistency With and Compliance To   |
|--|--|
| PRA Guidelines                           | Consistent with General Guidelines<br>Specific Guidelines to be Defined when Proponent applies for Notice to Proceed (NTP) from PRA; one of requirements for NTP is an ECC |
| Environmental Critical Area of the NIPAS | Project not in conflict  |
| Ramsar Convention                        | Site is NOT within Project included in the Convention  |
| Manila Bay Coastal Strategy (MBCS)       | Policies and Guidelines of MBCS to be complied with  |
| Supreme Court Mandamus on Manila Bay     | Mandamus serves as guideline for EMP<br>Mandamus itself does not directly restrict reclamation projects in Manila Bay  |

### Areas Vulnerable/Susceptible to Natural Hazards

The project area being located within Manila Bay, is susceptible to various natural hazards such as earthquake-related hazards (i.e., ground shaking, liquefaction, tsunami and subsidence), flooding and storm surge. These are discussed in more detail under subsection 2.1.2.3. Inducement of subsidence, liquefaction, landslides, mud / debris flow, etc., including maps.

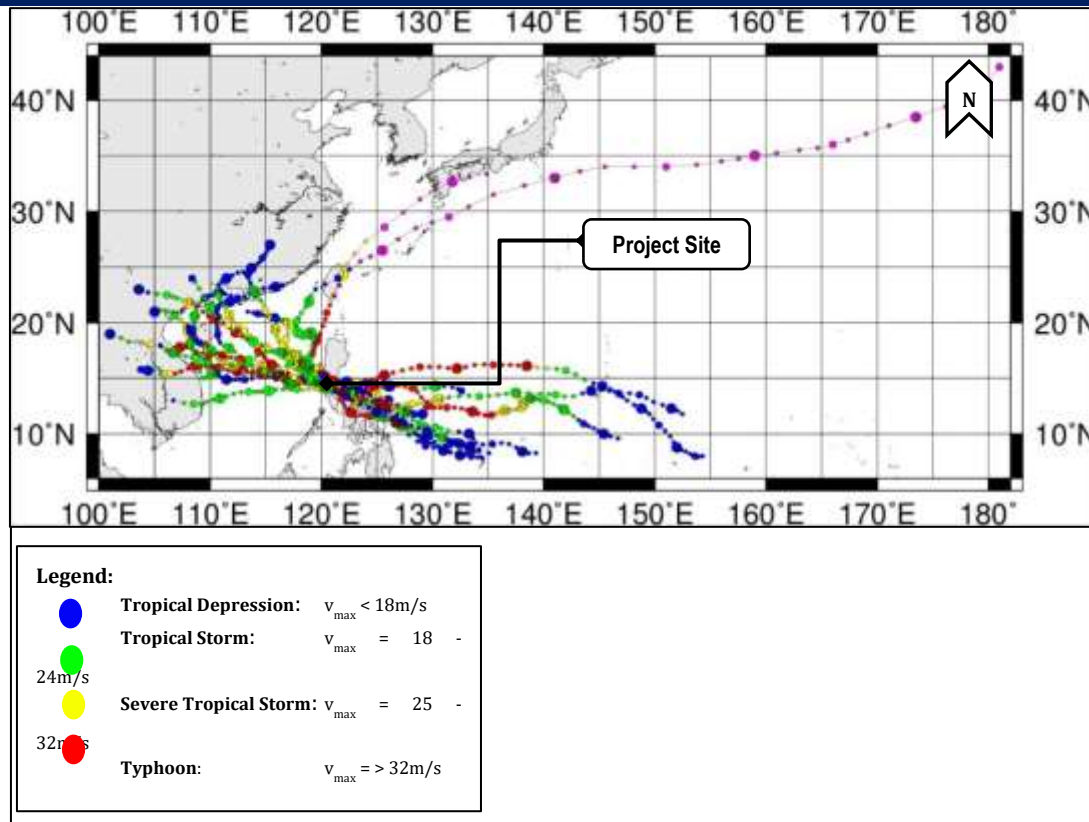
### Historical Typhoon Passage Frequency

An average of 20 typhoons enter the Philippine area of responsibility (PAR) annually, 9 of which make landfall passing through the southern part of Luzon island and eastern part of the Visayan islands. (Lapidez et al., 2015). Manila Bay is relatively less exposed to cyclones and typhoons with an average of 5 cyclones in 3 years (PAGASA).

The top 5 strongest historical typhoons based on wind speed that have affected the project site and vicinities are: Typhoon Rita / Kading in 1978 (203.72 kph), Typhoon Georgia / Ruping in 1986, Typhoon Patsy / Yoling in 1970, Typhoon Betty / Herming in 1987, and Typhoon Koppu / Lando in 2015. Typhoon Xangsane (Milenyo) likewise devastated Metro Manila and Cavite in 2006.

The municipalities of Noveleta and Rosario are most often affected by flooding when typhoons and/or continuous heavy rains pass through the site especially when coupled with high tides.





Source: Digital Typhoon

**Figure 2.1-9. Typhoon Tracks within 200km of Project Site**

Historical typhoons are discussed in more detail under subsection 2.2.1.2. Meteorological Data.

### 2.1.1.3 Impact on Existing Land/Water Tenure Issue/s

The proposed project site will be on the municipal waters of Noveleta and Rosario and not on land. As such, there are no issues with respect to CARP, CADC / CADT / CALC/ CALT, IFMA/CBFMA or COC. Likewise, it is not within MPSA or other tenurial instruments.

The capacity of the Province of Cavite to reclaim is pursuant to Republic Act No. 7160 or the Local Government Code of 1999, the Department of Interior and Local Government, under Memorandum Circular No. 120, s.2016, confirmed the authority of local government units to enter into Public-Private Partnerships and Joint Ventures for reclamation projects pursued consistent with the mandate and charter of the PRA.

The proposed project will reclaim about 267 hectares of land in Manila Bay. It is important to note that the proposed project is to be located at sea and not onshore (land) and is within the territorial waters of the Municipalities of Rosario and Noveleta, within the jurisdiction of the Province of Cavite, thus there is no existing tenure issues present in the proposed project.

Based on Presidential Decree No. 3-A, all reclamation of foreshore, submerged and offshore areas shall be limited to the National Government or any person authorized by it under a proposed contract.

On the other hand, Executive Order No. 52 dated February 12, 1979 designates then Public Estates Authority (PEA) presently called as the PRA as the agency primarily responsible for all reclamation projects for and in behalf of the National Government and mandated that all reclamation projects be submitted to the President for his approval, upon the recommendation by the PEA and the same to be undertaken by the PEA or through a proposed contract executed by it with any person or entity.





Based on Executive Order No. 146, Former President Benigno S. Aquino III issued an order transferring the power to approve reclamation projects from PRA Board to the National Economic and Development Authority (NEDA) Board on 13-November-2013.

The ownership of the reclaimed land will be stipulated in the JVA to be executed among PRA, the Cavite Provincial Government, and the Private Sector Project Developer.

### **Nearby Reclamation Projects**

The nearby reclamation projects (figure below) are being pursued by other LGU-private sector project developer partnerships, which are independent of each other. There are no overlaps in boundaries between these other projects and this application. The ability of the projects to be implemented after the securing of their individual ECCs will be subject to the granting of individual Notices to Proceed (NTPs), which are under the mandate of the PRA.

The map of these projects is shown in Figure 2.1-10. This also shows that the proposed project site as well as the other proposed islands are not in conflict with other projects.

**Table 2.1-3. List of Nearby Reclamation Projects**

| <b>Project</b>                              | <b>Area (Hectare)</b> | <b>Status of ECC</b>        |
|---|-----------------------|-----------------------------|
| Bacoor Reclamation and Development Project  | 320                   | With ECC                    |
| Diamond Reclamation and Development Project | 100                   | With ECC                    |
| Sangley Point International Airport Project | >1,400                | Planning stage              |
| Philippine Navy Reclamation Project         |                       | Planning stage              |
| Parañaque 286.86-ha Reclamation Project     | 286.86                | Application process ongoing |





Source: 2020 Google Earth Map

Figure 2.1-10. Nearby Reclamation Projects vis-à-vis Project Site and other Proposed Islands





## Other Conflicting Tenurial/Water Issues

### Informal Settlers/Water-based Settlement

Informal settlers at the site (at sea) are absent and likewise on land where the access way to the shore will be connected.

### Fishing

The fishermen of Noveleta and Rosario mostly fish either near the coast or out in the open waters. The project area is not used as areas for significant or commercial fishing, source of commercial/economic supply of fish and other marine species.

In the absence of significant benthic habitats, pelagic fish species are the principal target of fishing boats in the Rosario-Noveleta area. A total of only 8 actual fishing encounters (AFE) from Cavite City to Rosario were observed and documented during the marine survey in February 2019. Two of these were within proposed Island D. One AFE was along the coast fronting the island. Moreover, there are no lift nets nor mussel farms in the area.

A Letter of No Objection (LONO) was already secured from the DA-Bureau of Fisheries (See **Annex 2.1-A**). Moreover, the proponent will conduct FGDs with fishermen and other stakeholders in both the Manila Bay side and Bacoor Bay side.

Matters relating to fisheries and aquatic management are discussed in more detail in the Chapter on “Water” (Chapter 2.2)



Base Map: 2018 Google Earth

**Figure 2.1-11.**

**Location of Actual Fishing Operations Documented Across the Proposed Reclamation Islands**



### **Port**

There are no port/s in the project area nor in Noveleta as a whole. In Rosario, there is 1 fish port (operated by the LGU itself) and 1 private port. Both ports are given consideration in the planning, configuration of Island D and Island E, as well as their relative location to the coast.

### **Water Supply**

The project site will be at sea, which is not used as a source of bulk water supply.

### **Navigational Lane**

The LONO was already secured from the Philippine Ports Authority on this matter while the LONO from the Philippine Navy is being coordinated.

The figure below shows the PPA navigation lane indicating that there is no overlap, blockage or restriction of the proposed reclamation project within the PPA. Furthermore, no PPA-administered port or lawfully-operated private port apparently operates within the subject portion of Manila Bay.



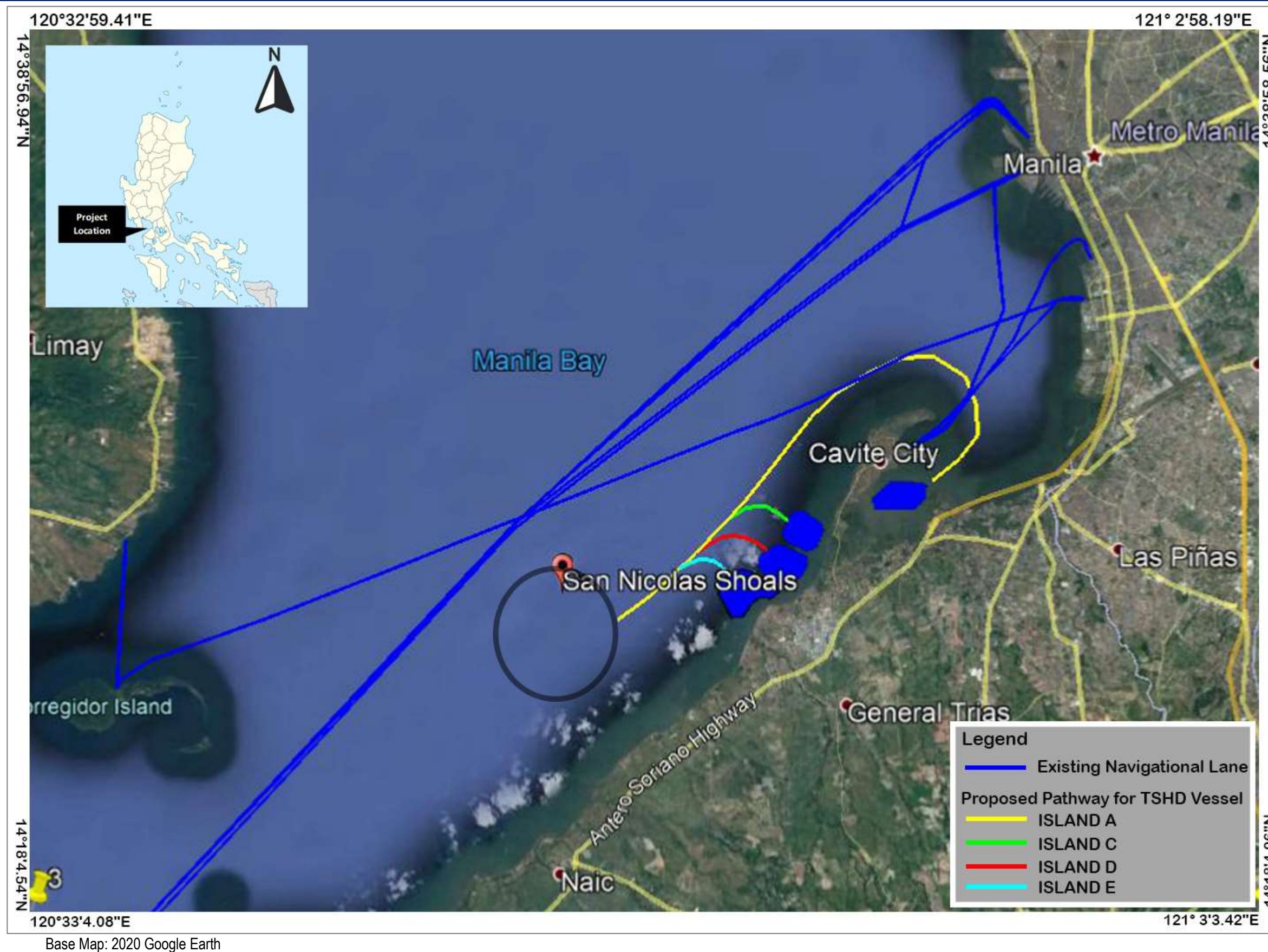


Figure 2.1-12. Navigational Lanes of the PPA Relative to the Cavite Island D 267-ha Reclamation Project



#### **2.1.1.4 Impairment of Visual Aesthetics**

The proposed development highlight within the reclamation area will have height restriction limits around the waterfront area to allow those located deep into the reclaimed area and those at the mainland to have a visual corridor to the world-famous Manila Bay sunset.

The matter of the Manila Bay sunset while considered significant is deemed to be more relevant in other reclamation projects, i.e. those in the City of Manila.

#### **2.1.1.5 Devaluation of Land Value as a Result of Improper Solid Waste Management and Other Related Impacts**

Existing laws on solid waste management and wastewater management shall be strictly adhered to.

The devaluation of land value as a result of improper solid waste management and other related impacts is not perceived. Solid wastes are generated by the population near the project site and solid wastes to be generated by the proposed project are specific to the type and site of activities such as:

- The use of construction equipment will necessarily involve fossil fuels and products such as lubricating oil and generate spent oil wastes. These wastes will not be disposed to the bay waters and instead be disposed to DENR-accredited third party TSD entities.
- On the other hand, maintenance works on the machinery and equipment, which would generate wastes e.g. oil filters will be confined to the maintenance shop(s) onshore.
- Seabed silts are the solid wastes from the dredging of undesired seabed materials. Silt curtains will be used as waste management facility to contain the dispersal of these materials. The unwanted solid wastes will be disposed outside the project site by a third-party accredited disposal firm into a site that will be approved by the DENR and the Philippine Coast Guard (PCG) with pertinent permits to be acquired from both agencies. Alternatively, these silts may still be usable as fill materials and compressed on site thus avoiding disposal outside the reclamation site.
- Domestic wastes from workers during the construction stage will be monitored weekly through visual count weekly; the garbage will either be picked up by the garbage disposal unit of the City or transported to its garbage dumpsite.

#### **Estimates of Domestic Solid Waste Generation in Vessels and in land stabilization and horizontal component construction.**

The sea-based crew is very minimal with only 30 people at the start and will peak at about 240 members. At a rate of 1kg per person per day, 30kg of solid wastes will be generated on a daily basis to a peak of 240kg of solid wastes per day.

#### **Estimates of Domestic Solid Waste Generation in Land Stabilization and Horizontal Component Construction.**

Compacting, configuring and development structuring of the reclaimed area will result to increased human activity in the project site due to the influx of workers and this is expected to generate a significant amount of solid wastes.

About 140 workers will be at the site during the soil stabilization phase, at which period, the total volume of wastes produced will amount to 140kg/day.

During the horizontal component construction, the number of workers could peak at around 400, and therefore, solid wastes generation will be at 0.4t/day.





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**Compliance with MARPOL 73/78 and PCG Guidelines on Handling and Disposal of Solid wastes in Vessels.**

The contractor for the proposed project will be required to comply with the applicable environmental laws with respect to DENR, MARPOL 73/78, and PCG guidelines, and provide the appropriate mitigating measures at their expense.

Bilge water (wastewater in the vessel) can be managed by either retaining it onboard the vessel in the holding tank and later discharging it to an accredited third-party waste treater onshore. Onboard treatment may also be undertaken as an option.

Oil which represents a significant portion of the bilge water falling in the category of “hazardous” wastes may be treated in Oily Water Separators (OWS). Current regulations of oily bilge water discharge from vessels is based on Annex I of the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78).

The bilge separators are treatment systems that combine a gravity oil-water separator (OWS) or centrifuge with one or more additional unit operations that “polish” the bilge water effluent to reduce concentrations of emulsified oil.

To ensure the continued efficiency of the OWS, an Oil Content Monitor and Control System will be installed.

**Additional Wastewater Management under MARPOL 73/78**

- a. Oil filtering systems for connection to treated wastewater discharges
- b. Continuous monitoring and recording of all discharges
- c. Maintenance of valves and ensuring these are “NC” (Normally Closed)
- d. Installation of Slop Tanks and Continuous Maintenance and Cleaning
- e. Categorization and Specific Regulations for “Noxious” Substances
- f. As maybe applicable installation of sewage treatment plant onboard
- g. Special procedures for handling of food wastes and garbage

**PCG Guidelines**

There are 3 existing circulars set by PCG with regards to waste management at sea. The dredging/reclamation contractor shall be made to comply with all these, and are as follows:

PCG MC No. 01-2005, otherwise known as the Revised Rules on Prevention, Containment, Abatement and Control of Oil Marine Pollution,

- a. All vessels shall have onboard wooden scupper plugs equivalent to the number of scupper lips and various sizes of wooden plugs for use on possible holes that may develop in the hull.
- b. There shall be a minimum of 3kg of rags or other appropriate sorbent materials and appropriate number of open-ended drums with cover for clean-up of oil spills on decks and pump rooms.
- c. Vessels of 400 gross tons and above but less than 10,000 GT shall be fitted with an oil-water separating equipment or filtering system duly approved by PCG to ensure that any oil mixture discharged into the open sea after passing through the separator or filtering system shall have an oil content of not more than 15 ppm. Effluent discharges in ports and harbors to include other navigable lakes and rivers shall not exceed the water quality standards.
- d. Vessels of 10,000 gross tons and above shall be fitted, in addition to OWS, with an oil discharge monitoring and control system.
- e. Every vessel of 400 gross tons and above shall be provided with tank or tanks of adequate capacity, having regard to the type of machinery and length of voyage to receive the oil residues.
- f. All shipping companies shall provide for a system of collection and disposal of all types of wastes accumulated aboard ship notwithstanding public port reception facilities duly approved by the PCG.



- A Plan for Collection and Disposal of Waste shall likewise be submitted by these shipping companies to the PCG for approval. Cooperative efforts among shipping companies in connection with the acquisition and utilization of such system of collection and disposal is highly encouraged.
- g. Chemical dispersant to be utilized by the ship owner, master of the vessel, oil companies, terminals/depots, power plants/barges, oil drillers, oil tankers, shipyards and salvors during oil spill shall be duly accredited by the PCG.

PCG MC No. 07-2005, otherwise known as the Prevention of Pollution by Sewage from Ships; Discharge of Sewage:

The discharge of sewage into Philippine waters is prohibited except when:

- The ship is discharging contaminated and disinfected/treated sewage at a distance of more than 5 nautical miles from the nearest shoreline;
- The ship is discharging sewage which is not contaminated or disinfected/treated at a distance of more than 12 nautical miles from the nearest shoreline;
- The ship has in operation an approved sewage treatment plant and that the effluent shall neither produce visible and floating solids nor cause the discoloration of surrounding waters; or
- The discharge is necessary for purposes of securing the safety of the ship and/or saving life at sea in case of a real, grave and imminent danger, provided that all reasonable precautions have been taken to prevent or minimize the discharge. Provided further, that in the first two exceptions, the sewage that has been stored in holding tanks shall not be discharged instantaneously but at a moderate rate when the ship is enroute and proceeding at no less than 4 knots.

PCG MC No. 01-2006, otherwise known as the Rule Prohibiting the Dumping and Discharging of Wastes and Other Harmful Matters

Concerned parties shall initiate measures to protect the marine environment against pollution caused by:

- Hydrocarbons, including oil and their wastes;
- Other noxious or hazardous matter transported by vessels for purposes other than dumping; and
- Wastes generated in the course of operations of vessels, aircraft, platform and other man-made structures at sea

### 2.1.2 Geology/ Geomorphology

#### Methodology

The geological assessment consists of collation and interpretation of existing geologic reports and literature of the project area, including topographic, geologic, and other thematic maps. These data and reports are predominantly from concerned government agencies and academic institutions such as: Department of Environment and Natural Resources-Mines and Geosciences Bureau (DENR-MGB), Department of Science and Technology-Philippine Institute of Volcanology and Seismology (DOST-PHIVOLCS), and the University of the Philippines Nationwide Operational Assessment of Hazards (UP-NOAH), previously DOST-Project NOAH.

The borehole drilling, preliminary geotechnical and coastal engineering studies were undertaken by an independent drilling contractor from which interpretations were made by AMH Consulting Phils., Inc.

A follow-up geotechnical studies will be conducted post-ECC as part the Detailed Engineering Design work.

#### Nature/Source of Information

Study of previous works include among others, available geological, seismological and hydrological reports and maps covering the project area that were conducted by the Department of Environment and Natural Resources-Mines and Geosciences Bureau (DENR-MGB), Department of Science and Technology-





Philippine Institute of Volcanology and Seismology (DOST-PHIVOLCS), the University of the Philippines Nationwide Operational Assessment of Hazards (UP-NOAH), previously DOST-Project NOAH, the University of the Philippines-National Institute of Geological Sciences (UP-NIGS), and the University of the Philippines-Marine Science Institute (UP-MSI).

### 2.1.2.1 Change in Surface Landform/ Topography/ Terrain / Slope

#### Geomorphology

The Municipalities of Noveleta and Rosario in Cavite Province and vicinities belong to the coastal lowlands, particularly the lowest lowland and the lowland areas (Figures 2.1-13 and 2.1-14).

Cavite Province is divided into four physiographical areas, namely: the lowest lowland area, lowland area, the central hilly area and the upland mountainous area. (PDRMO 2010)

The lowest lowland area is the coastal plain in particular, which are the areas nearest to the project site. These areas have extremely low ground level of 0 to 2 meters elevation compared to the high tide level of about 0.8m elevation from the Mean Sea Level (MSL). These are the municipalities of Bacoor, Kawit, Noveleta and Rosario. (PDRMO 2010)

The lowland area consists of the coastal and alluvial plains. These areas have flat ground slope of less than 0.5 percent and low ground elevation of 2 to 30 meters elevation. The alluvial plain can be found in the municipality of Imus and southern part of General Trias. Within these municipalities forms the transition area between the coastal plain and the central hilly area. It also covers some areas of Bacoor, Kawit, Noveleta, Rosario and Tanza. (PDRMO 2010)

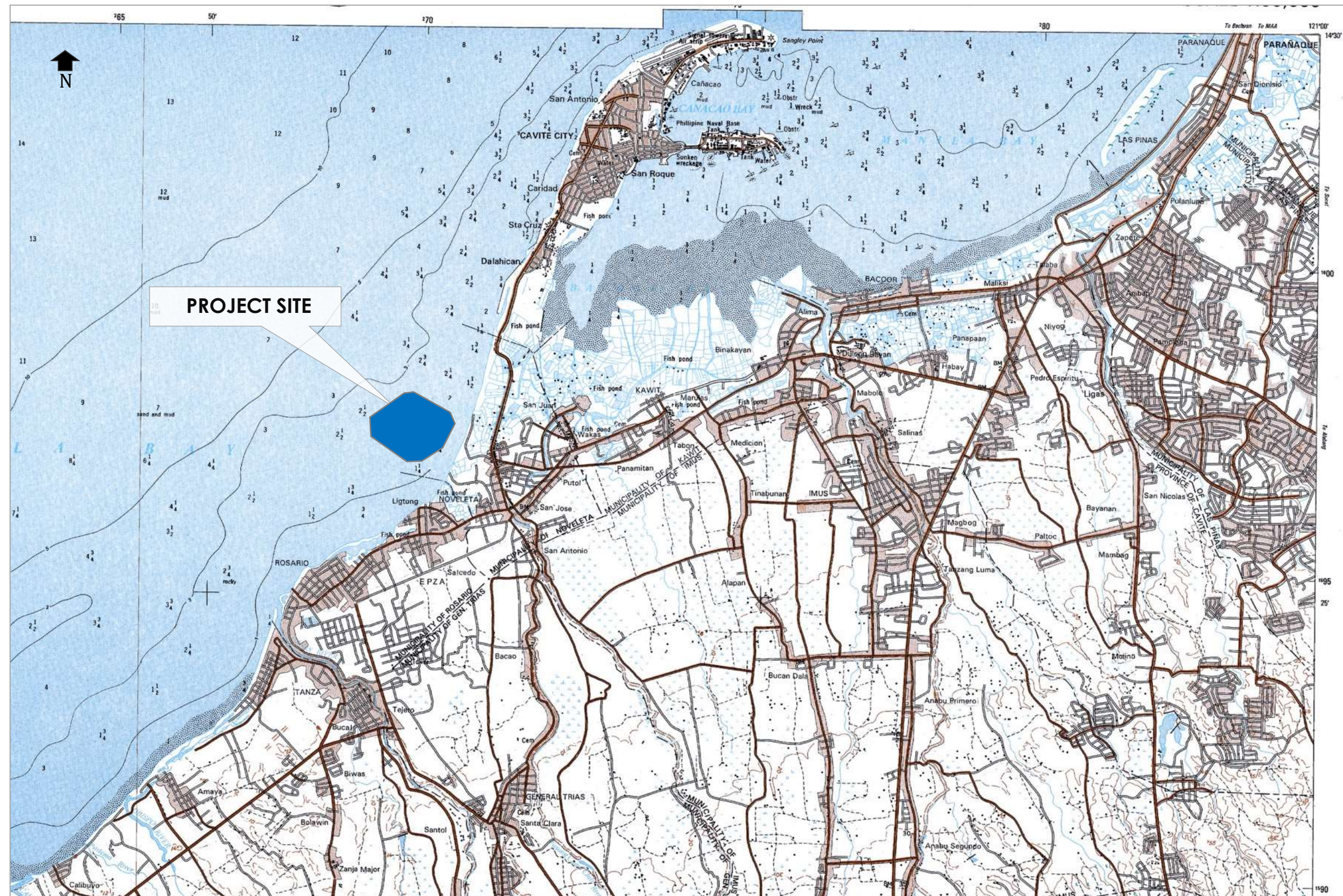
The central hilly area and the upland mountainous areas are found distant from the project site from the mountain footslopes and the uplands. These have elevations from 30m to 400m and are found in Trece Martires, Dasmarinas, Indang Silang, and Tagaytay City.

This land is dissected by drainage systems emptying into the Manila Bay. The nearest natural rivers to the project site include Maragondon, Labac, Cañas, San Juan, Bacoor and Imus rivers. These have various tributaries passing through the towns of the province.

Within the coastal plain, the river course is morphologically controlled, running parallel to the coastline following the landward boundary of the beach ridges and exhibits a meandering course. The flow in the coastal plain is generally sluggish, dominated by standstill water condition. This is mainly caused by the influence of tidal fluctuations and the flat topography.

On the opposite side of the Cavite Spit, at about 12.5 km to the east of the project site is the LPPWP. For the proposed Island D, which is located to the west of Cavite Spit, LPPWP is approximately 12.5 km to the northeast. LPPWP is a coastal wetland composed of 2 inter-connected reclamation islands called Freedom Island and Long Island, plus a smaller island to the south. This wetland is composed of: intertidal mudflats; intertidal forested wetlands; intertidal marshes; coastal brackish/saline lagoons/ponds; and estuarine waters. The mudflat is adjacent to a densely populated mangrove swamp. This serves multiple purposes such as a pollutant “sink” and provide shoreline defense against floods, erosion and storm surges. It is a catchment area for floodwaters.





Source: NAMRIA 1:50,000, July 2001 (3129-I)

Figure 2.1-13. Topographic Map of Cavite - NAMRIA



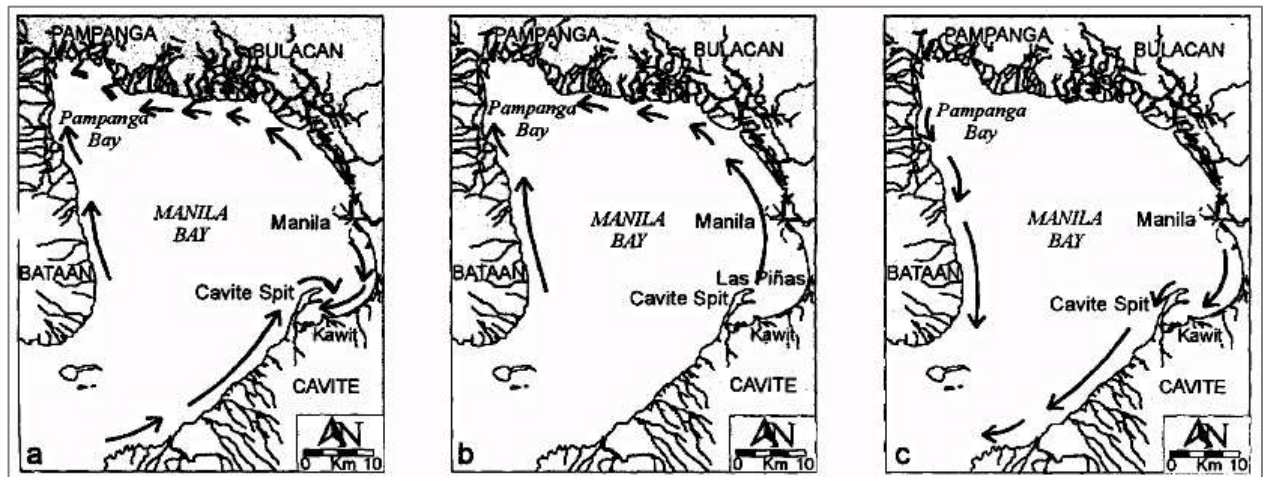


### General Profile of Manila Bay

Manila Bay is a semi-enclosed water body facing the South China Sea. It has a surface area of about 1,800 square kilometers and coastal length of about 190 kilometers (EMB, 1992). The bay width varies from 19 kilometers at its mouth to a maximum of about 60 kilometers. The bay's length is about 52 kilometers with the average depth of 17 meters with a volume of 31 km<sup>3</sup>. It has a gently sloping basin with increasing depth at a rate of 1 m/km (PRRP, 1999). Manila Bay's coastal margin is a low-lying flat strip of land with elevations of <5 meters. The catchment area is bounded by the Sierra Madre mountain range to the east, the Caraballo mountains to the north, the Zambales mountains to the northwest and the Bataan mountains to the west (BFAR, 1995). The bay receives discharged water from numerous sources including 26 river catchments (account for about 17,000 km<sup>2</sup>), and domestic and industrial water from Metro Manila and Laguna Bay.

Various sub-environments characterize the coastal areas. Near the mouth, Cavite and Bataan coastlines are rocky and deeply embayed, with local pockets of sand forming thin strips of beach at the head of coves. Going north towards Bulacan, the coastline becomes more linear marked by a series of beach ridges. In Bulacan, the ridges are sandy but the surrounding fishpond areas are muddy. (Siringan and Ringor, 1997)

The combined effects of fluvial, wave and tidal processes creating longshore currents, as well as the morphology of the bay, have influenced the sediment dispersal pattern. The net sediment drift is to the NE along Cavite, to the NW along Manila-Bulacan (from Pasig River mouth to Meycauayan R.), to the SW from Zapote to Bacoar, and to the north along Bataan. Siringan and Ringor (1997) in their report entitled "Predominant Nearshore Sediment Dispersal Pattern in Manila Bay", stated that the wind direction plays an important role in the characteristics of sediment dispersal in Manila Bay. Southwesterly winds produce longshore currents that flow up the bay along Bataan and to the northeast along Cavite. Refraction at the tip of Cavite Spit causes longshore currents along the Las Piñas-Kawit coast. For southeasterly winds, the currents move to the NW along Manila-Pampanga coast and to the north along Bataan. NE winds create currents that move towards the mouth of the bay. During rainy days with winds predominantly coming from the southwest, greater input of sediments from rivers flows into the bay. The greater amount of the fine sediment gets transported in the northeastern Manila Bay (Figure 2.1-14). (Siringan and Ringor, 1997)



Source: Siringan and Ringor, 1997

**Figure 2.1-14. Longshore currents associated with locally generated waves**  
**a) south westerlies; b) south easterlies; c) north easterlies**

The **Cavite Spit** is a very prominent feature of the bay (Figure 2.1-13). It is 10km-long, 1.25km wide at its broadest portion, and has two recurved termination at its northeast end. It is approximately 30 km from the southern edge of the mouth of Manila Bay (Siringan and Ringor, 1997). The proposed Island D project will be located on the western fringes of Cavite Spit.



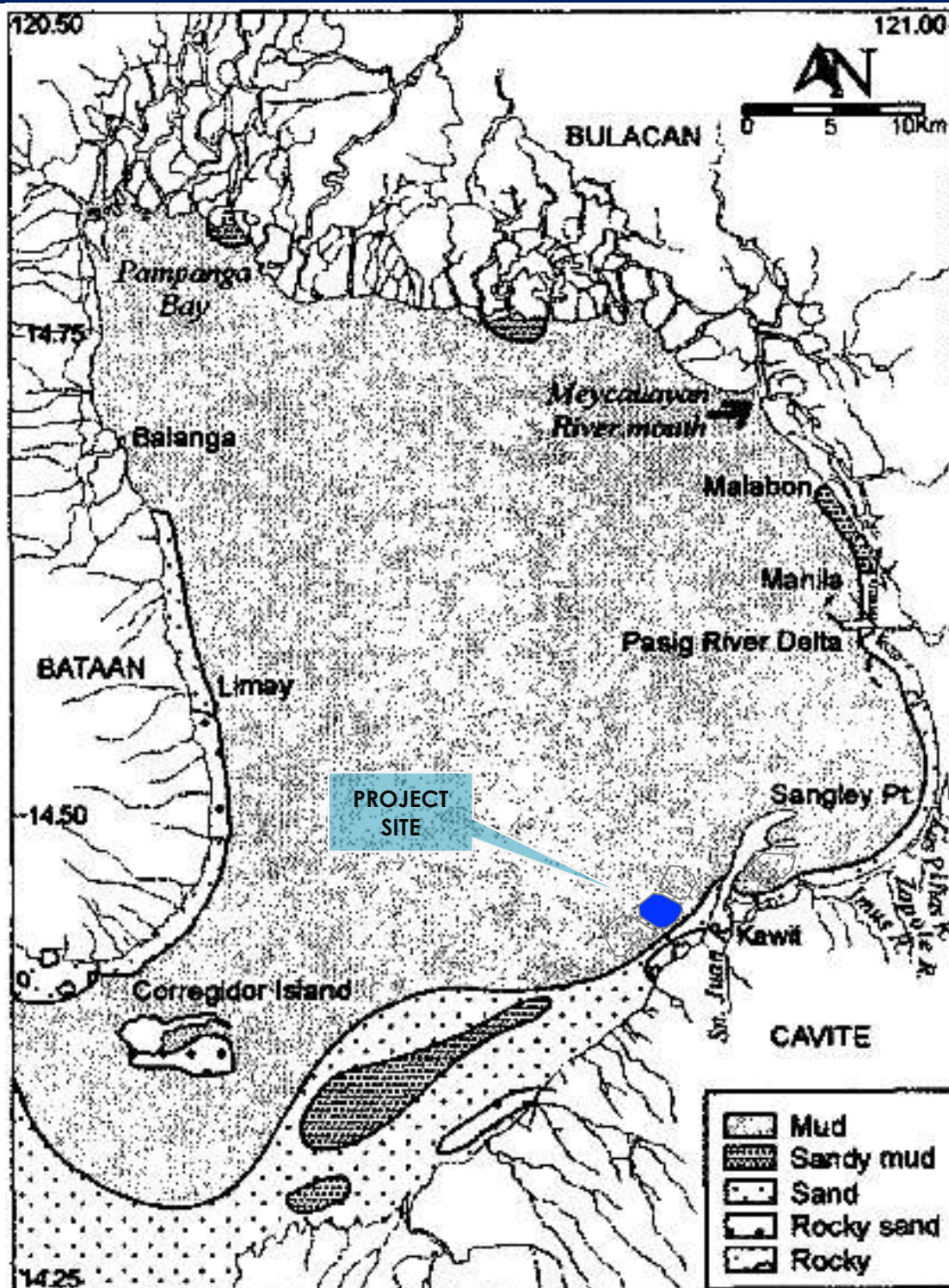
On the opposite side is Bacoor Bay, a large inlet of southeastern Manila Bay partly enclosed by the Cavite Spit. Its northeastern edge is defined by a smaller spit that serves as a divide between this bay and Cañacao Bay. The latter is a smaller inlet within Manila Bay bordered to the north by Sangley Point (Danilo Atienza Air Base) and by Cavite Point (Naval Base) to the south.

The Cavite coastline lies on the southern opening of Manila Bay. It is dissected by several large rivers such as Maragondon, Labac, and Cañas rivers characterized by wave-dominated deltas, as indicated by a series of arcuate sandy strandplain ridges and by a lack of major distributaries. Spits mark the mouth of smaller rivers. The mouths of these rivers are deflected to the northeast, indicating the predominance of northeasterly sediment drift. (Siringan and Ringor, 1997)

Shielded by wave impact in the lee of Cavite Spit, fluvial-dominated deltas have formed at the mouths of the San Juan/Ylang-ylang and Imus rivers. Wave defraction at the tip of Cavite Spit has probably caused the western distributary of Las Piñas River to be deflected to the SW, the delta of Imus River to be skewed to the SW, and created a southeastern net sediment drift. It also turned the area from wave-dominated to fluvial-dominated. According to Siringan (1997), prior to the formation of Cavite Spit, longshore transport was probably uninterrupted from Cavite to Bulacan. The spit cut-off the sediment supply thus turning the northern part into a muddier environment. Siringan et.al., further suggests that the planned reclamation of the bay to almost the tip of the spit may re-establish the continuous northeastward sediment drift. This could also cause rapid shallowing of the gap between new reclaimed land and the spit, and of Bacoor Bay.

Rocky, rocky sand, and sandy substrates characterize the areas at the baymouth and along the Cavite coastline. At the lee side in Bacoor Bay, the substrate consists of mud, similar to the rest of the bay except for the Bataan coastline, which is rocky. Small pockets of sandy mud are found in Bulacan and Pampanga coasts. (Siringan and Ringor, 1997) Figure 2.1-15 shows the sediment distribution within Manila Bay.





Source: Siringan and Ringor, 1998

Figure 2.1-15. Manila Bay Sediment Distribution Map based on NAMRIA Data

#### Impact Analysis - Creation of Landform

The creation of landform of the island is a key direct impact of the proposed project. A landform of one (1) island will arise with the configuration of the master layout and with a minimum finished platform elevation of 4m above Mean Lower Low Water (MLLW). The platform surface is flat.



The reclamation landform, which will be located at the western coast of Cavite, will not disturb any existing landform. The nearest wetland is about 12.5 km to the northeast – the LPPWP area.

There will be a change in the configuration of the coastline. Island D (together with the other 3 proposed projects nearby) will be aligned to the present coastline, hence the change will be more of “widening” the Cavite Spit and shielding it from wave action and erosion. With respect to the relative size and shape of these islands, their addition somehow makes the general coastal outline more linear, which is where coastal processes generally lead up to.

In terms of the flow of water from Cañas River, a numerical modeling was conducted and presented under Chapter 2.2.2 Oceanography. The sediment transport model, on the other hand, is presented under Chapter 2.2.1. Hydrology/hydrogeology.

In relation to storm surges and tsunamis, the reclamation project will act as a shield to the surrounding coastal areas, and hence, will lessen the impact of these natural hazards. On the other hand, the project will not cause or aggravate other hazards such as liquefaction, ground shaking, and subsidence. These are discussed in more detail under Chapter 2.1.2.3. Inducement of subsidence, liquefaction, landslides, mud / debris flow, etc.

Changes in surface landform/topography/terrain/slope of the land (onshore outside of the reclamation site) are deemed not relevant because no activities will be undertaken herein, except the construction of connecting points for the access way(s) to the land. The construction will not result in changes in geology.

### **2.1.2.2 Changes in Subsurface Geology / Underground Conditions**

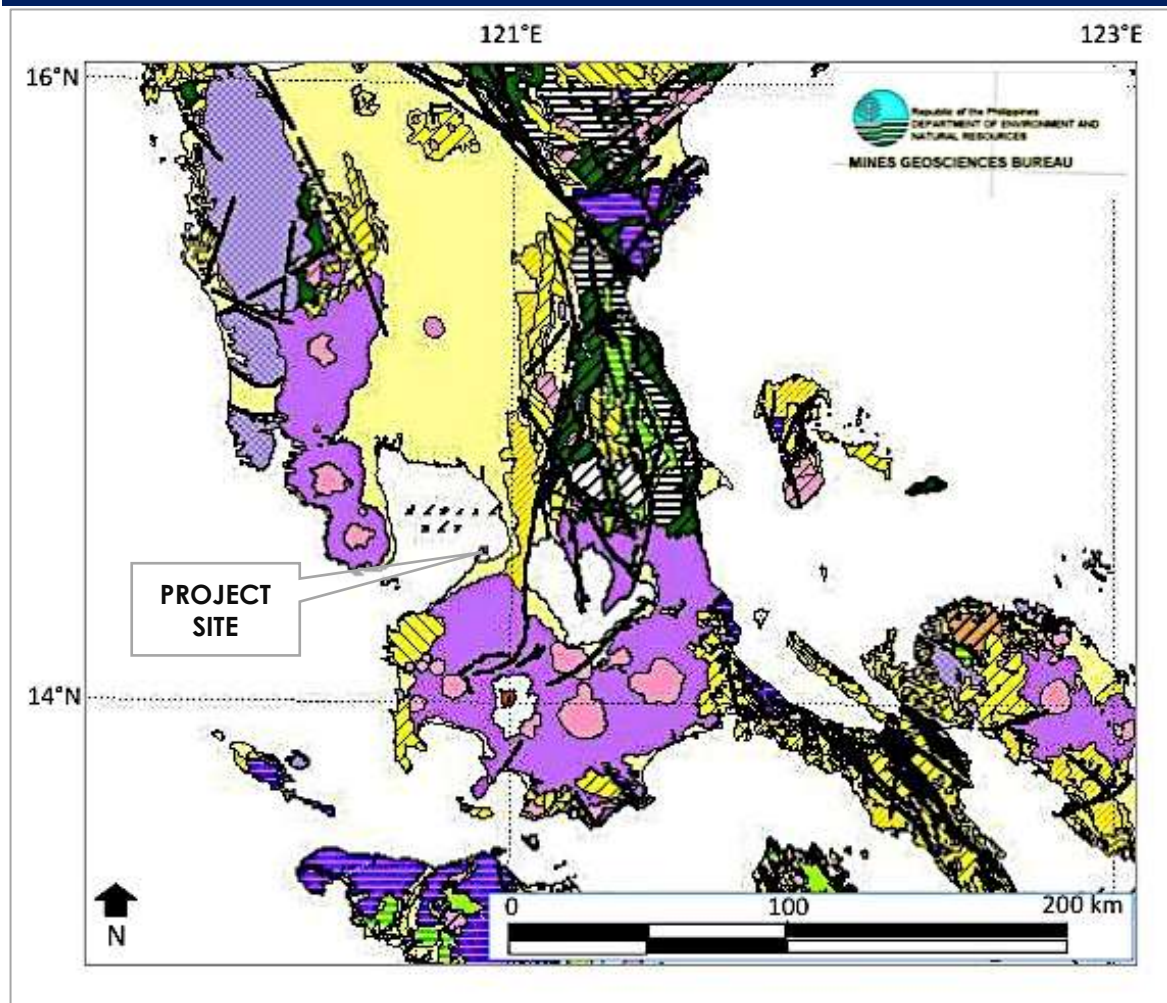
#### **2.1.2.2.1 Regional Geologic Setting**

The southwestern part of Luzon represents the southern segment of the West Luzon Volcanic Arc, which is related to the eastward subduction of the South China Sea Plate at the Manila Trench.

Different kinds of rocks can be found in southwestern Luzon (Figure 2.1-16). The greater part of Cavite consists of volcanic materials, tuff, cinders, basalt, breccia, agglomerate and interbeddings of shale and sandstone.

The southern part occupied by Batangas Province likewise exhibits mixed rock types that include andesite, limestone, agglomerate tuff, alluvium, quartz-diorite, metavolcanics, metasediments, dacite, and shale. The general geology of Laguna shows alluvium, conglomerate, sandstone, tuff, andesite, basalt and volcanic breccia particularly in the southern shores of Laguna de Bay, western side of Mt. Makiling, Mt. Lagula, and Nagcarlan.





Source: Cropped from the Geologic Map of the Philippines, Aurelio and Pena (DENR-MGB) 2002

Figure 2.1-16. Geologic Map of Northern Philippines

#### 2.1.2.2.2 Regional Stratigraphy

The regional stratigraphic setting covering Cavite and the adjacent provinces of Laguna and Batangas is composed of sedimentary and volcanic rock formations. The stratigraphic units are described below:

**Recent Alluvium:** (Holocene) composed of unconsolidated deposits of silt, sand and gravel

**Guadalupe Formation:** Composed of the Alat Conglomerate member (conglomerate, sandstone, mudstone) and Diliman Tuff member (tuffs, pyroclastic breccias, and tuffaceous sandstones). It unconformably overlies the Tartaro Formation. The formation occupies a large area from Quezon City, Pasig, Makati, southern Rizal, eastern Bulacan, to southeastern Nueva Ecija. (Aurelio and Peña, 2002)

**Pinamucan Formation:** (Pliocene) named by Avila (1980) for the interbedded sequence of conglomerate, sandstone and shale that crop out in the vicinity of upper Pinamucan, upper Calumpit and middle Lobo rivers, where they rest unconformably over the Tolos Quartz Diorite and metavolcanic rocks of the San Juan Formation. The conglomerate is poorly indurated but well sorted with pebbles of andesite, diorite and metasediments set in a sandy tuffaceous matrix. The sandstone and shale are well-bedded, poorly indurated and tuffaceous. The upper horizon is intercalated with pyroclastic rocks designated as Lobo Agglomerate. (Aurelio and Peña, 2002)





**Looc Volcanic Complex:** (Middle Miocene) found in Looc, Taysan, and Lobo, Batangas. It may be divided into three members: andesitic pyroclastic member, andesitic pyroclastics and flows, and dacitic pyroclastics and flows. Altogether, the thickness of the three members totals about 500 m. This unit is equivalent to the Batangas Volcanics (Corby and others, 1951), Talahib Andesite (Avila, 1980), and Banoy Volcanics (Wolfe and others, 1980).

**Calatagan Formation:** (Early Pliocene) equivalent to Mapulo Limestone (Avila, 1980). This is found at Calatagan Peninsula; Taysan; Conde Mataas; Mt. Banoy, peninsulas and islands south and east of Mabini, Batangas province. The lithology varies from soft tuffaceous marine siltstone to coralline limestone. The limestone is massive, white to buff, soft and porous with abundant coral fingers.

**San Juan Formation:** (Oligocene) refers to the metavolcanic rocks found at San Juan and Lobo, Batangas. It is composed of basalt, andesite, graywacke, shale, slates, paraschists, marble, and hornfels. It is intruded by the Tolos Diorite.

#### 2.1.2.2.3 Tectonic Setting

The Philippine Islands is generally interpreted as a collage of insular arcs, ophiolitic suites and continental rocks of Eurasian affinity. The formation of this belt is controlled by subductions, collisions and major strike-slip faults. (Aurelio and Peña, 2002). It has evolved from the collision between the Eurasian Plate, South China Sea Plate, the Philippine Sea Plate, and the Pacific Plate. The collision resulted to several subduction zones marked by oceanic trenches. The development of the archipelago was caused by the active squeezing and magma rise producing a chain of volcanoes from the remelting of the subducting lithosphere.

The Philippine Mobile Belt (PMB) is surrounded by subduction zones moving in opposing directions simultaneously. On the western side, the Eurasian Plate (or South China Plate) subducts eastward beneath Luzon Island along the Manila Trench. On the eastern side, the Philippine Sea Plate subducts westward along the East Luzon Trench. This results to an actively deforming zone in between 2 active subduction systems as manifested by high seismic activity. (Aurelio and Peña, 2002).

The significant geologic structures in the region include: the Philippine Fault; Valley Fault System; Lubang Fault; Manila Trench; and Macolod Corridor. The maps of distribution of active faults and trenches in the Philippines, distribution of active faults and trenches in Region 4A, are shown in Figures 2.1-17 and 2.1-18.

#### Philippine Fault

The 1,200 km-long Philippine Fault Zone (PFZ), a major strike-slip fault extending from Lingayen to Davao, lies parallel to the subduction trenches. The PFZ is assumed to release the shear stress caused by the oblique subduction of the ocean plates. On the southwest, the seafloor of the Sulu Plate subducts near the west side of Negros Island along the Negros Trench and along Sulu Trench near the northwest side of Zamboanga. The Celebes Sea Plate subducts near the west side of Central Mindanao along the Cotabato Trench and in Davao Gulf along the Davao Trench.

About one-third of the destructive earthquakes that have affected Cavite, Metro Manila and vicinity were generated from the PFZ. Its movement produced the majority of the most devastating earthquakes in Philippine history including the 16 July 1990 earthquake event. The 1990 earthquake generated from the PFZ's northern segment, the Digdig Fault, was recorded at Ms 7.8. A seismic gap along this fault located about 82km east of Manila can produce a future earthquake in the order of at least magnitude 7 is highly possible (upon the release of large stresses stored along the locked portion).



### Valley Fault System

Many faults are identified around Cavite Province. The project site is found about 19.1 km west of the western extension of the Valley Fault System (VFS). The VFS consists of two northeast-trending structures that bound the Marikina Valley: the West Valley Fault (WVF) on the west and on the east, the East Valley Fault (EVF). The EVF was traced for 38 km from San Rafael, Rodriguez (Montalban) in the north to the Pasig City area. However, LANDSAT imagery shows that it extends farther to the northeast. However, PHIVOLCS (2000) reported that EVF is ~10 km long. It is located approximately 40 km northeast from the project site.

The WVF, on the other hand, stretches out north of Rodriguez in western Rizal province, passes east of Metro Manila and possibly extends as far as the Batangas-Cavite boundary at Tagaytay Ridge in the south. It is ~90 km long (PHIVOLCS, 2000; READY, 2008; JSP & MLPM, 2009). This is a geomorphologically active fault that is thought to pose the greatest threat to Metropolitan Manila and vicinities due to their proximity. Recent investigation by PHIVOLCS along the Sucat-Muntinlupa-Alabang stretch have confirmed the existence of creep (active fault movement) along what is believed to be a step-over segment of the fault there (Rimando et al, 1995). With regards to recorded events, the WVF moved 4 times in the past 1,400 years, hence, PHIVOLCS places its movement interval to ~ 400 years (Solidum, 2013).

### Lubang Fault

Lubang Fault is considered to play a significant role in the transition from subduction along the Manila Trench to collision in the Mindoro-Palawan-Panay area (Aurelio and Pena, 2004). It is an active strike-slip fault that has also been the site of large earthquakes in the past, notably that of 1852 and 1972 (Daligdig and Besana, 1993). The most recent one was the 1994 earthquake in Mindoro, which registered a seismic magnitude of 7. It is located about 101 km south-southwest of the project site.

### Manila Trench

Manila Trench, found about 180 km west of the project site, is a 1,100-km long trench system, which extends from south of Taiwan to west of Mindoro Island in Southwest Luzon (Bautista, 1999). The Manila Trench represents the morphologic expression of the subduction of the oceanic crust of the South China Sea under the Luzon Arc (Karig, 1973; Cardwell and others, 1980). It is an elongated bathymetric depression that reaches depths of 5,100 m in the latitude of Manila (Ludwig and others, 1967).

Bautista et al. (2001) describe the Manila trench as a straight line from 13-18°N, which swerves abruptly to ESE at latitudes lower than 13°N because of a collision of micro-continental fragments with Mindoro and Panay islands. Hayes and Lewis (1984) state that the rate of subduction along the northern Manila Trench is probably not extended so far south.

### Macolod Corridor

The Macolod Corridor is an approximately 40 km-wide zone located in southwestern Luzon and pervaded by active intense Quaternary volcanism, faulting, and crustal thinning. It perpendicularly crosses Luzon in a NE-SW direction (Förster et al., 1990). The alignment of the corridor is at a right angle to the Manila Trench; and is distinguished from other active volcanic areas of Luzon, which are aligned in one or two chains parallel to the Manila Trench (Yueh et al., 2009). According to Defant et al., (1988) the corridor is a northeast-southwest trending pull-apart rift zone that includes directional lineaments (northeast trending fracture lineaments) and volcanic centers. The NE-trending Tagaytay Ridge is the corridor's northern structural boundary.



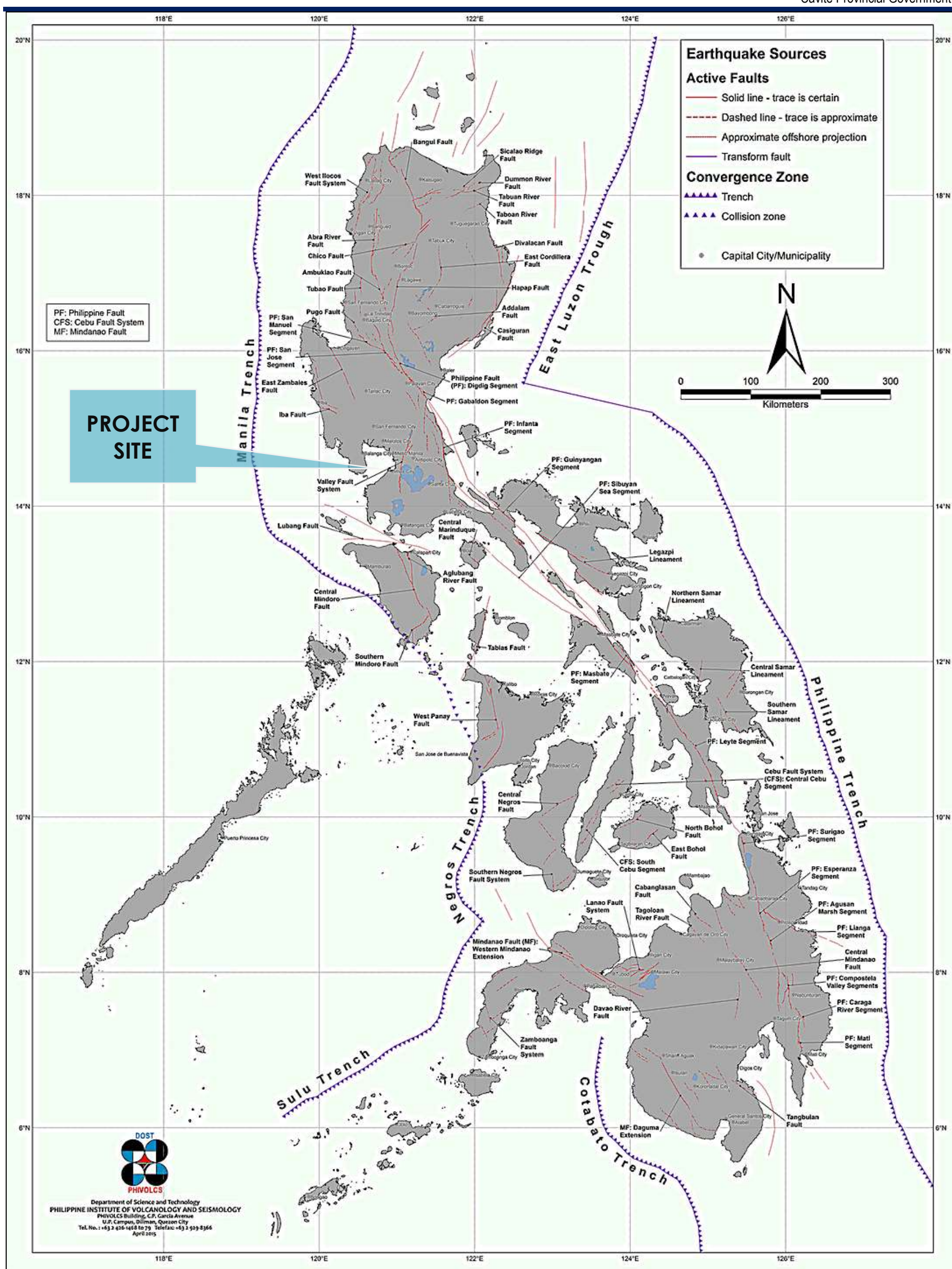
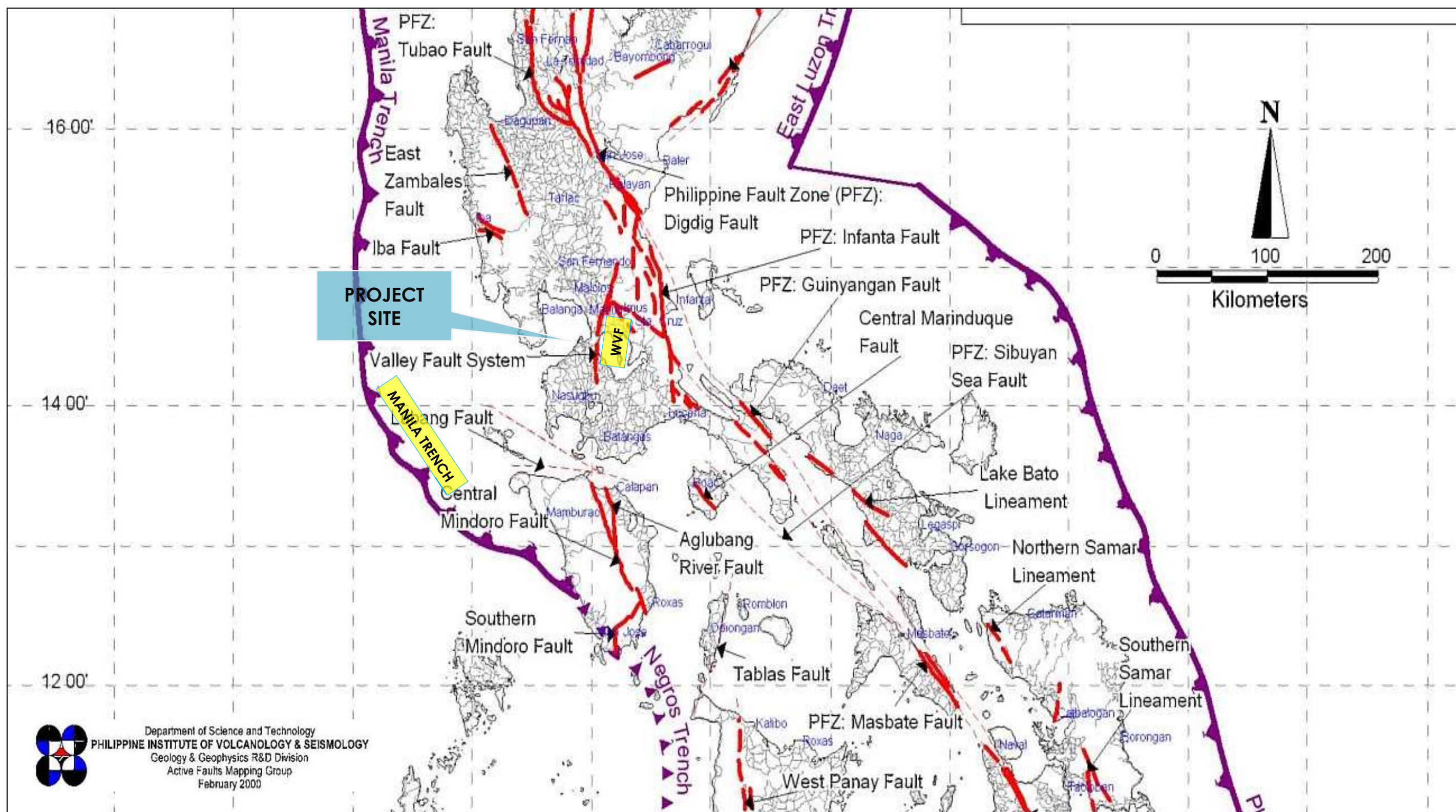


Figure 2.1-17. Distribution of Active Faults and Trenches in the Philippines





Source: PHIVOLCS, February 2000

Figure 2.1-18. Distribution of Active Faults and Trenches in Western Luzon



#### 2.1.2.2.4 Local Stratigraphy

The most dominant rock formation in the area is the Guadalupe Formation (Pleistocene Age). It consists of an upper member, the Diliman Tuff, and a lower member, the Alat Conglomerate. Diliman Tuff, the most widespread rock in the area, is generally flat-lying (dips generally ranging from 3° to 10°) and medium to thin bedded. It is composed of thin- to medium-bedded, fine-grained vitric tuffs and welded pyroclastic breccias with minor fine- to medium-grained tuffaceous sandstone. The tuff varies from well lithified and massive to loosely-bedded (Aurelio and Peña, 2002). These are the rocks found at the northern parts of Cavite Province.

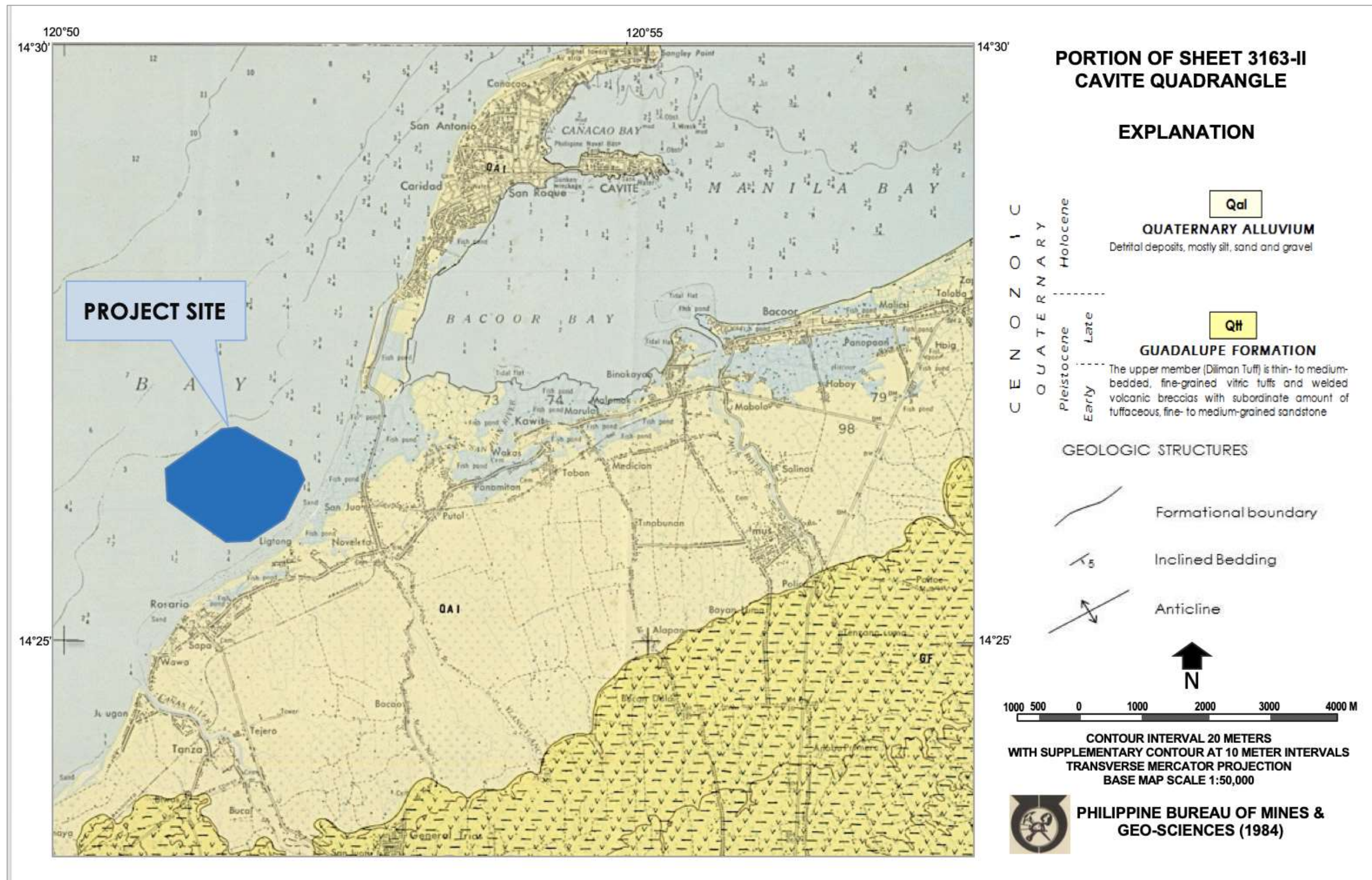
Conformably overlying the Guadalupe Formation is the Quaternary Alluvium consisting of unconsolidated deposits of silt, sand and gravel. These are deposited during the Holocene. The alluvium deposits are commonly found along stream channels, flood plains and coastal areas. The project site vicinity is underlain by sand, gravel, cobbles with clay and silt material and falls under this formation. The beaches and nearshore areas of the Cavite coastline are underlain by rocks, rocky sand, sand, and mud. The fringes of the Cavite Spit are underlain by sand at the western part and mud at the northern tip and lee side (Figure 2.1-15). Immediately to the south of the spit, is a rocky shoreline made up of the Diliman Tuff.

The offshore area of Manila Bay is underlain by stiff to very dense sandy silt materials. Below this, layers of tuff, tuffaceous sandstone and siltstone of Guadalupe Formation are found.

Dell, et.al., (2001) wrote Characterization of the Reclaimed Soil in the Foreshore Area of Manila Bay, Philippines based on site investigations including boreholes, SPT's, CPT's, etc. It reveals similar discussion of geology wherein Guadalupe Tuff is the "bedrock". It was deposited under marine conditions. The ash is pozzolanic, rendering the tuff weakly cemented. The tuff varies in grain size from "gravel", through "sand", "silt", and clay. The first three types are relatively strong, with strengths of approximately 1-7 MPa and less susceptible to weathering. The clay type has strengths of 0.6-1.5 MPa, showing slickensided structure that is typical of active clays. Paleosol layers were encountered within the Guadalupe Tuff. This is unconformably overlain by clayey layers, then by silty sand, and then by soft mud layers. The silty sand layers are generally loose below the water table, which is liquefaction-prone.

The geology of the project site and vicinities is shown in Figure 2.1-19.





Source: Geological Map of Manila and Quezon City Quadrangle, MGB, 1983 and 1984

Figure 2.1-19. Geological Map of Cavite and vicinities





## Impact Analysis

The subsurface geology will experience changes but in the nature of enhancement because of the replacement of portion of the seabed with fill materials and rocks to lend geotechnical integrity to the reclaimed land when vertical structures and roads are built during the Operations Phase. The extent of the changes will depend on the Design and Engineering Details (DED), the detailed geotechnical investigations and the master plan which (the latter) will show the specific locations of load bearing structures and thus, the engineering/geotechnical interventions necessary.

## Mitigating Measures

To ensure the stability of the new landform and other superstructures, the following measures will be undertaken.

- Geotechnical investigations already conducted confirming the properties of the fill materials/borrow.
- In Manila Bay, the settlement of the reclaimed platform is mainly depending on the foundation and on the fill materials. There are available process engineered solutions such as vertical drains and surcharge to speed up the settlement and stabilization. The time needed for consolidation depends on the technique used, but it is safe to say that 90% of primary consolidation will be reached after.
- The soil investigation will necessarily be updated prior to the execution of the engineering design.
- For greater stability of tall and heavy structures current plans are to place these on piles.
- The proponent will follow internationally accepted soil remediation procedures for reclaimed land.
- Necessary steps to be taken to achieve land mass stability are as follows:
  - ✓ Removal of unwanted materials (dredging) at the reclamation site
  - ✓ Placement of containment structures
  - ✓ Rock or concrete revetment
  - ✓ Dumping of the fill
  - ✓ Soil stabilization (determine location of the infrastructure and buildings, to be built later during the operation phase, that will require higher degree of soil stabilization)
  - ✓ Installation or construction of supporting components of the reclaimed land such as wave deflectors and overall drainage system

More details on the reclamation technology options are discussed in Chapter 1.0.

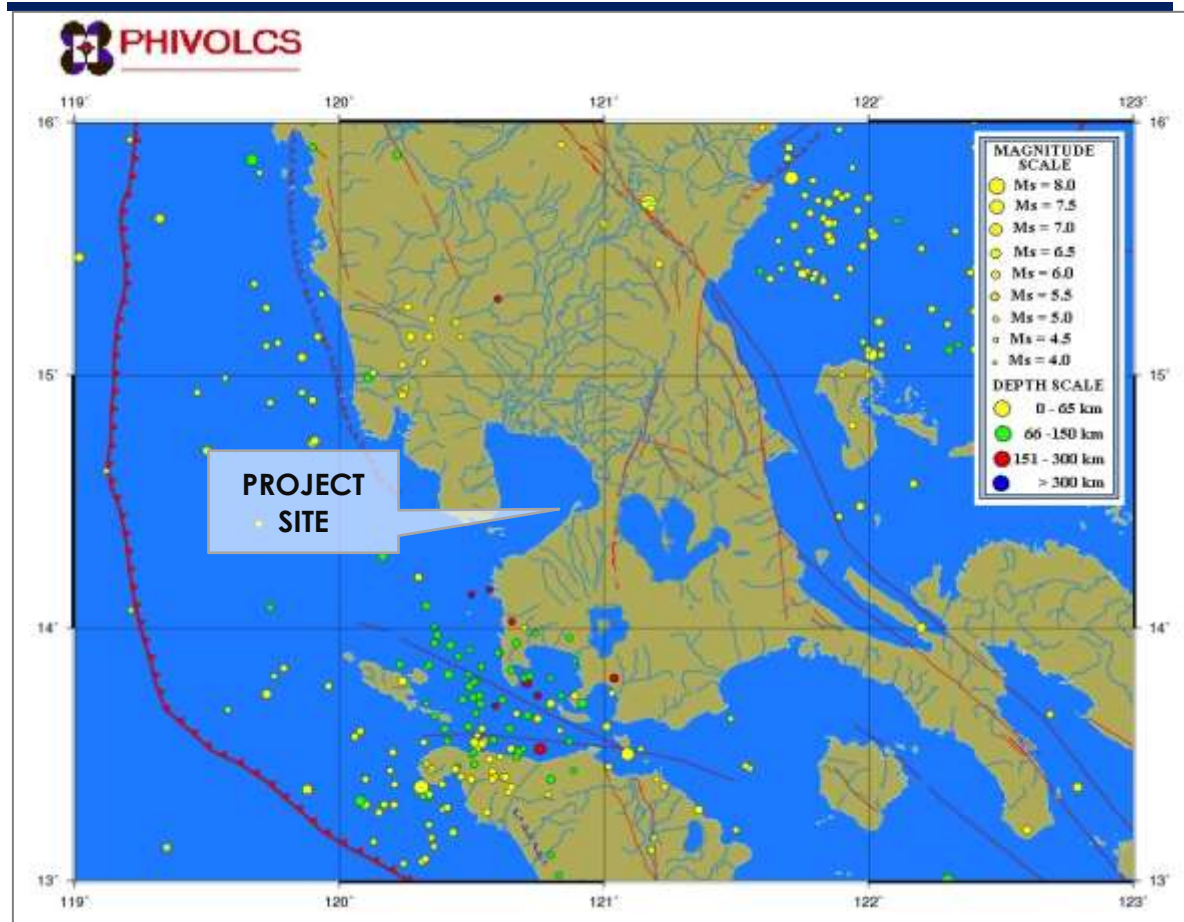
Observation stations shall be established in strategic locations within the reclaimed land. These will be used to monitor the degree of compaction and stability of the reclaimed land. These will record settlement/compaction rates.

### 2.1.2.3 Inducement of Subsidence, Liquefaction, Landslides, Mud/Debris Flow, etc.

#### 2.1.2.3.1 Seismic Hazard

Earthquake is the perceptible trembling to violent shaking of ground caused by either tectonic movements or volcanic activity. Areas that are most susceptible to this hazard are those underlain by unconsolidated soils and sediments deposited on the low-lying areas and reclaimed areas (Figures 2.1-20 and 2.1-21).

The area investigated is prone to ground shaking hazards due to the presence of several earthquake generators in the region (Punongbayan, 1989). These possible seismogenic structures include the active Valley Fault System, Lubang Fault, the Philippine Fault and Manila Trench.



Source: PHIVOLCS, May 2017

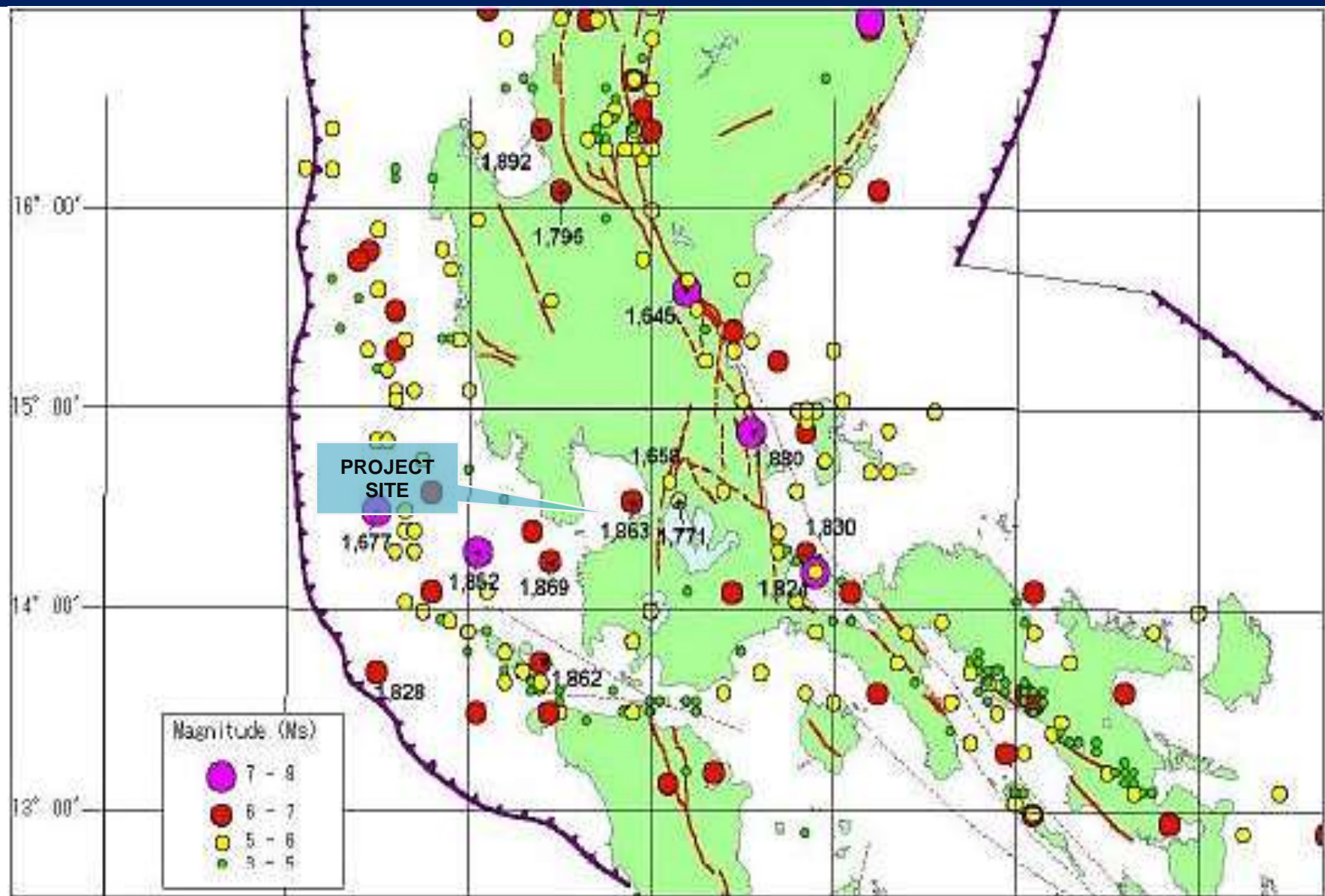
**Figure 2.1-20. Seismicity Map of Manila, Magnitude 5.0 and above (1965-2015)**

A record of the recent earthquakes affecting Metro Manila and vicinities is shown in **Table 1 of Annex 2.1-B: List of Earthquakes**. These recently-recorded earthquakes of magnitudes 5 and above are shown on the seismicity map in Figure 2.1-19 above.

The MMEIRS provided a list of the most destructive earthquakes that affected Metro Manila and vicinities from 1608 to 1895 and its distribution is shown in Figures 2.1-20 and 2.1-21. The Southeast Asia Association of Seismology and Earthquake Engineering (SEASEE) lists the historical earthquakes in the Philippines in its report entitled “Series on Seismology, Volume IV – Philippines”. From this catalog, the earthquakes that affected Cavite Province including the three most destructive episodes are extracted and shown in **Table 2 of Annex 2.1-B**. The top three on the list are the 1863 (6.5 Ms; 298.3 PGA gal), 1880 (7.6 Ms, 139.8 PGA gal originating from PFZ: Infanta Segment) and, 1937 (7.5 Ms, 174.7 PGA gal, originating from Laguna-Banahaw Fault) earthquakes. All three brought damages to Cavite City and vicinities.

These lists provide reference information, but it does not necessarily follow that the occurrence or not of an earthquake and the magnitude thereof will be related to recent episodes.





Source: MMEIRS Executive Summary Vol 2, March 2004

Figure 2.1-21. Distribution of Historical Earthquakes from 1608 to 1895



Source: PHIVOLCS 1999

Figure 2.1-22. Distribution of Most Destructive Earthquakes from 1608 to 1999






## Earthquake-induced Hazards


The attendant hazards attributable to earthquake events include ground rupture, ground shaking, liquefaction, landslide, and tsunami.

Landslide hazard in the vicinity is nil as it has a flat to gently rolling topography. Reclaimed lands in general, are considered prone to liquefaction.

An Earthquake Hazard Assessment was issued by PHIVOLCS as shown in below. According to the report, the WVF is 18.8 km from the site of Island C, which is deemed safe from ground rupture, susceptible to liquefaction, and prone to tsunami hazard and it is within the tsunami inundation zone. Furthermore, it can be affected by strong ground shaking.



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Department of Science and Technology  
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DATE 18 February 2019

FOR TECHNATRIX CONSULTANCY SERVICES, INC.

REPRESENTED BY EDGARDO G. ALABASTRO

PURPOSE EIA requirement

**EARTHQUAKE HAZARD ASSESSMENT**

| PROJECT NAME, LOCATION  | GROUND RUPTURE | LIQUEFACTION | TSUNAMI |
|---|----------------|--------------|---------|
| <b>Proposed Cavite Reclamation and Development Projects;</b><br>Brgys. 8 (Manuel S. Rojas), 11 (Lawin), 13 (Aguila), 14 (Loro), 5 (Hen. E. Evangelista), 6 (Diego Silang), 7 (Kapitan Kong), 10-M (Kingfisher), 10-A (Kingfisher A), 10-B (Kingfisher B), 22-A (Leo A), 27 (Sagitarus), 28 (Taurus), 57 (Repolyo), 58 (Patola), 58-A (Patola A), 58-M (Patola M), 61 (Talong; Poblacion), 61-A (Talong A; Poblacion), 62 (Kangkong; Poblacion) and 62-A (Kangkong A; Poblacion), Cavite City, Cavite;<br>Brgys. San Rafael 2, San Rafael 3 and San Rafael 4, Noveleta, Cavite;<br>Brgys. Bagbag II, Kanluran, Ligdong I, Muzon II, Sapa II, |                |              |         |

@B:\P\TUFF\Volume\_2\01 SERVICES\_DATABASE\UTS\DM\T5\Hazard Assessment Services\2019\Feb\has5-EQ-04\_Technatrix Consultancy Services, Inc.-Cavite

PHIVOLCS Building, C.P. Garcia Avenue, U.P. Campus, Diliman, Quezon City 1101 Philippines  
Tel. Nos.: (+632) 426-1468 to 79; (+632) 926-2611 | Fax Nos. (+632) 929-8366; (+632) 928-3757  
Website: www.phivolcs.dost.gov.ph




|  |   |             |   |  |
|--|---|-------------|---|--|
| Sapa III, Wawa I, Wawa II and Wawa III, Rosario, Cavite; Brgys. Santa Isabel Wasak II, Kaingen, Marulas, Binakayan-Aplaya, Samala-Marquez, Polvorista, Balsahan-Bisita, Kanluran, Pamitan and Congbalay, Kawit, Cavite |   |             |   |  |
| Island A   | Safe; Approximately 14.4 kilometers west of the West Valley Fault | Susceptible | Prone; within the tsunami inundation zone |  |
| Island B   | Safe; Approximately 16.2 kilometers west of the West Valley Fault | Susceptible | Prone; within the tsunami inundation zone |  |
| Island C   | Safe; Approximately 18.8 kilometers west of the West Valley Fault | Susceptible | Prone; within the tsunami inundation zone |  |
| Island D   | Safe; Approximately 19.1 kilometers west of the West Valley Fault | Susceptible | Prone; within the tsunami inundation zone |  |
| Island E   | Safe; Approximately 20.2 kilometers west of the West Valley Fault | Susceptible | Prone; within the tsunami inundation zone |  |

#### EXPLANATION AND RECOMMENDATION

- ✓ All hazard assessments are based on the latest available hazard maps and on the location indicated in the vicinity map provided.
- ✓ Ground rupture hazard assessment is the distance to the nearest known active fault. The recommended buffer zone, or Zone of Avoidance, against ground rupture hazard is at least 5 meters on both sides of the active fault or from its zone of deformation.
- ✓ All sites may be affected by strong ground shaking.
- ✓ Ground shaking and liquefaction hazards can be mitigated by following the provisions of the National Building Code and the Structural Code of the Philippines.



|               |   |   |
|---------------|---|---|
| ✓             | Tsunami threat to people's lives can be addressed by community preparedness and tsunami evacuation plan. Advice for tsunami evacuation comes from public agencies and local governments. But more importantly, coastal communities must learn to evacuate themselves when they recognize the three natural signs of tsunami, namely 1) strong ground shaking, 2) unusual rise or fall of sea level, and 3) strong or unusual sound coming from the sea. |   |
| ✓             | This hazard assessment supersedes previous assessment made by this office regarding the site.   |   |
| Assessed by   | Daniel Jose L. Buhay  | Officer-of-the-Day  |
| Verified by   | Mabelline T. Cahulogan  | Senior Science Research Specialist  |
| Approved by   | <br>RENATO U. SOLIDUM, JR.   | Undersecretary for DRR and CC, DOST<br>and<br>Officer-in-Charge, PHIVOLCS |
| V2-2017-05-19 |   |   |

#### 2.1.2.3.1.1 Ground Shaking/Acceleration

Most of the known damages incurred during earthquakes are caused by strong ground vibration. This results from the passage of seismic waves from the earthquake source to the ground surface.

Ground shaking refers to the actual trembling or jerking motion produced by an earthquake. Seismic magnitude, epicenter distance to earthquake generators and the modifying effects of subsoil conditions mainly influence the intensity of ground vibration in an earthquake. Soil that is thicker, more unconsolidated and water saturated is more prone to ground shaking. It is usually stronger on areas that are filled or underlain by alluvium and colluvium, which may also be considered as soft soil. The proposed project site is underlain by water-saturated alluvium and the future reclamation area shall also be considered as soft soil. The project site may be affected by strong ground shaking.

Factors that influence the intensity of ground shaking include the following: magnitude of the earthquake, distance of the site in relation to the earthquake generator, characteristics of the underlying rocks and the soundness of the buildings/structures.

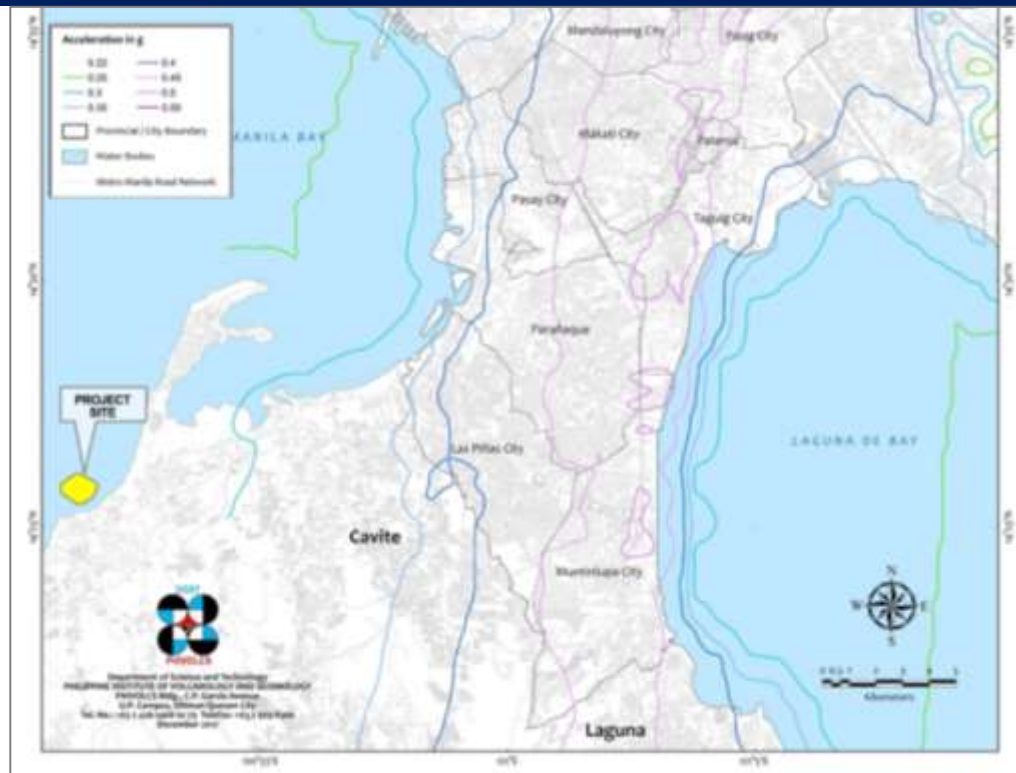
The Philippine Institute of Volcanology and Seismology (PHIVOLCS) and the United States Geological Survey (USGS) conducted a ground motion hazard mapping in terms useful to engineering design using modern probabilistic methodology. In the study, the peak horizontal ground accelerations that have a 10% probability of being exceeded in 50 years have been uniformly estimated for rock, medium soil and soft soil site condition.

The following PGA maps (Figures 2.1-23 to 2.1-25) from PHIVOLCS's Philippine Earthquake Model – A Probabilistic Seismic Hazard Assessment of the Philippines and of Metro Manila (2017) indicate the maximum site acceleration response from a most probable earthquake. These are based on VS30 (shear wave velocity on the upper 30 meters of soil layer) site model.

Based on these maps, the ground acceleration for 500 year return period at the project site for Vs30 site model is: 0.25; for 1,000 year return period is: 0.3; and for 2,500 year return period is: 0.35 .

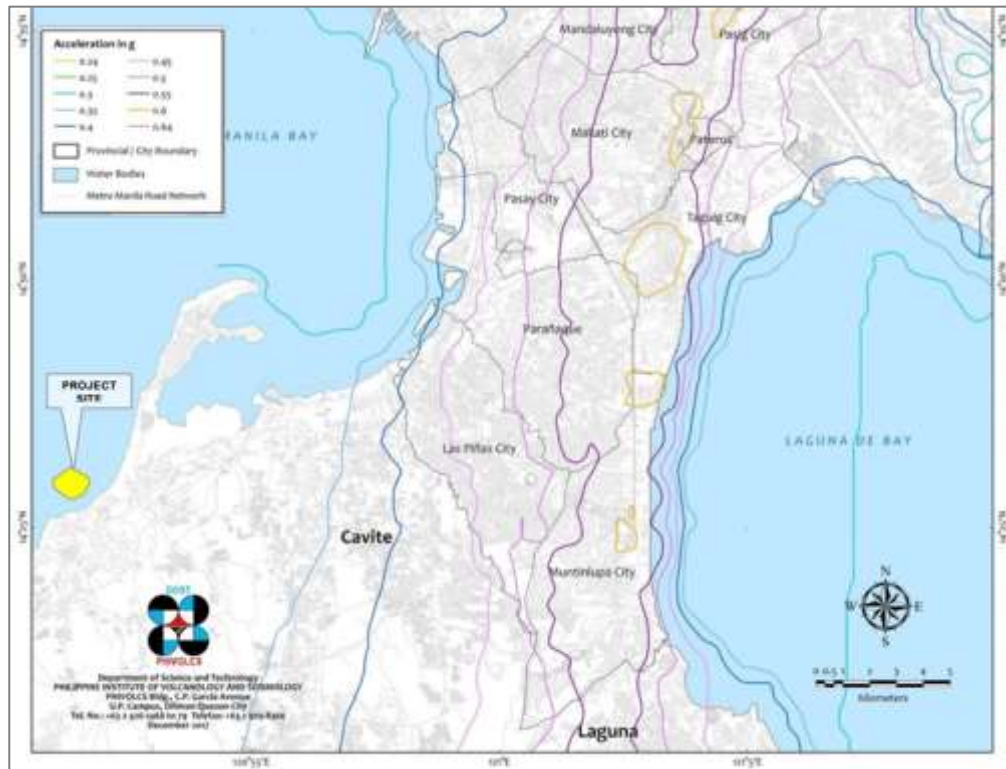
For probabilistic ground acceleration estimates, values derived in a study by Thenhaus, et al. (1994) suffice for preliminary estimates. However, site-specific probabilistic determinations may be performed for projects of major importance such as large dams and bridges, elevated highways, seaports, reclamation and the like.





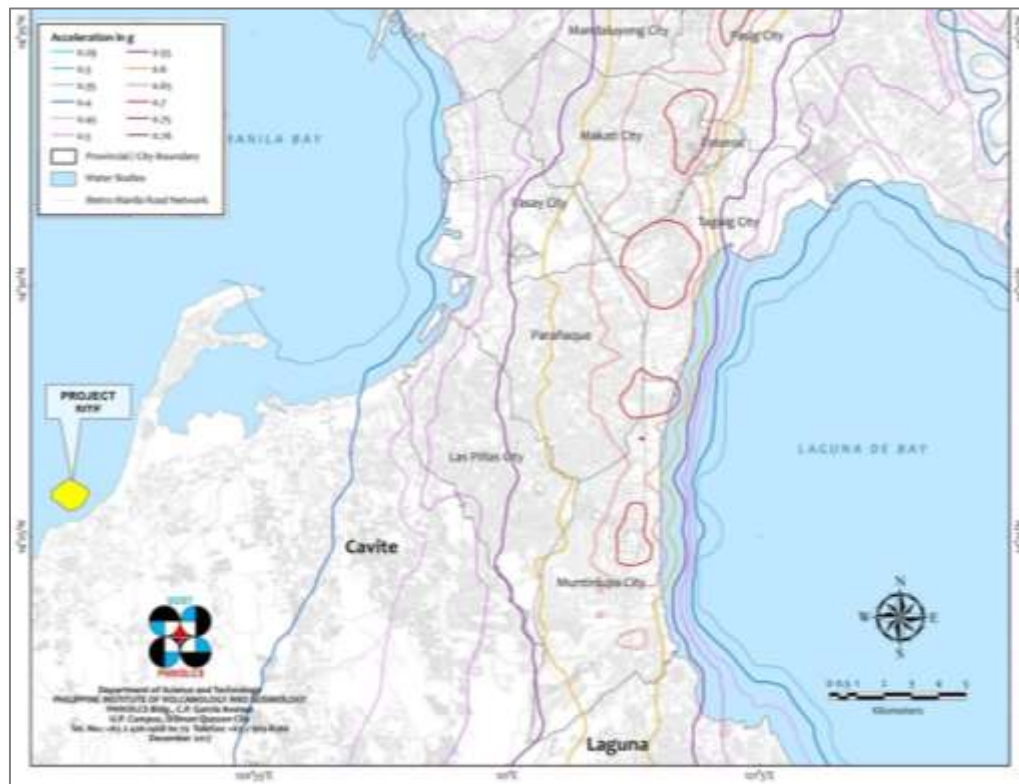
Source: PHIVOLCS 2017. The Philippine Earthquake Model

**Figure 2.1-23. Peak Ground Acceleration Map of Metro Manila, 500-Year Return Period on  $VS_{30}$  Site Model with 10% Probability of Exceedance in 50 Years**



Source: PHIVOLCS 2017. The Philippine Earthquake Model

**Figure 2.1-24. Peak Ground Acceleration Map of Manila, 1,000-Year Return Period on  $VS_{30}$  Site Model with 10% Probability of Exceedance in 50 Years**



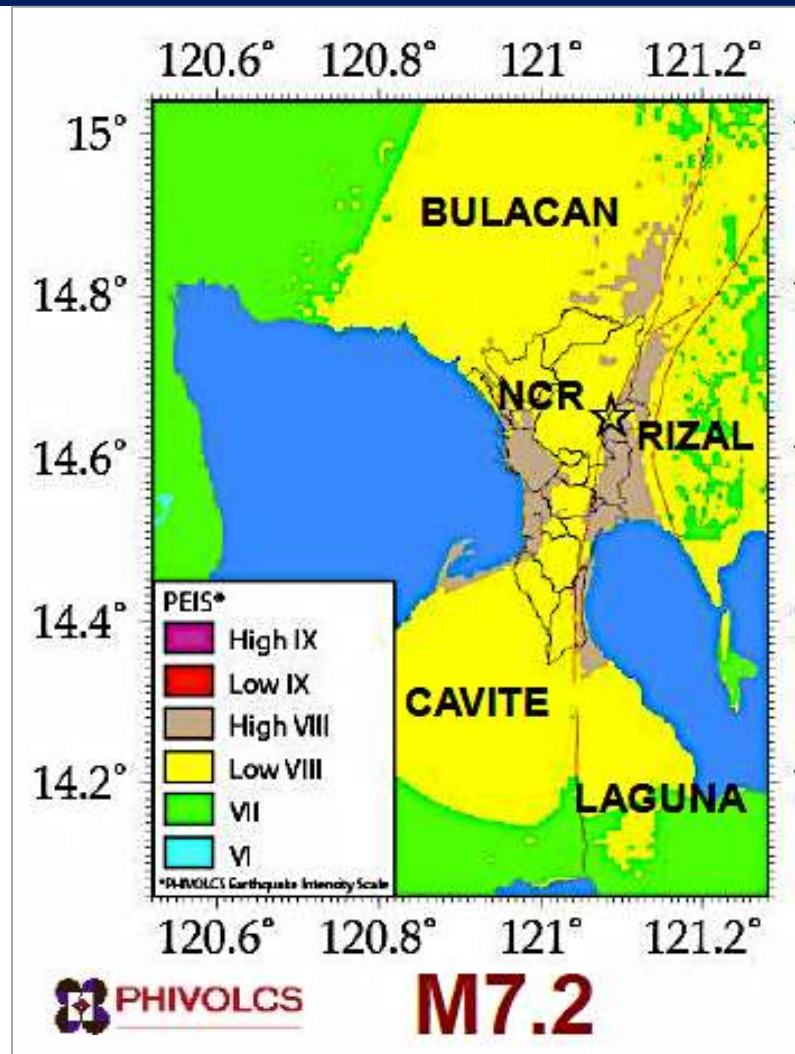
Source: PHIVOLCS 2017. The Philippine Earthquake Model

**Figure 2.1-25. Peak Ground Acceleration Map of the Philippines, 2,500-Year Return Period on Rock Site with 10% Probability of Exceedance in 50 Years**

The nearest active fault to the project site is the West Valley Fault found about 19.1 km to the east. The paleoseismological studies on this structure by Nelson et al (2000) concluded that the chance of an earthquake larger than M7 on the two faults of the VFS is seemingly small. However, in the MMEIRS, a M7.2 earthquake is the estimated largest credible earthquake that can be generated by a movement of the VFS, based on available geological and seismological data. Earthquakes cannot be predicted. What may be estimated is the return period of this earthquake which is at about 200 -400 years and that no large earthquake has happened in the West Valley Fault since the 1700s. The last significant event was in 1658, almost 360 years ago.

Figure 2.1-26 shows that in Model 08 (magnitude 7.2 from WVF), the PEIS is HIGH VIII (brown) or destructive in the vicinity of the project site.

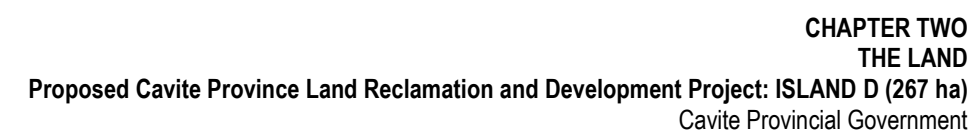
The Ground Shaking Hazard Map released through the READY Project in June 2008 shows that the whole northernmost portion of Cavite Province, including the project site vicinity, is within the PEIS VIII (red) zone. Please refer to Figure 2.1-27.



Source: Risk Analysis Project, 2013: PHIVOLCS

Figure 2.1-26. Ground Shaking in Greater Metro Manila and Vicinities (WVF Earthquake)





**Figure 2.1-27. Ground Shaking Hazard Map of Cavite**



Estimation of PGA factors using the deterministic method of Tanaka and Fukushima with the following attenuation relation:

$$\text{Log}_{10}A = 0.41M - \log_{10}(R + 0.032 \times 10^{0.41M}) - 0.0034R + 1.30$$

Where: A= mean of the peak acceleration from two horizontal components at each site (cm/sec<sup>2</sup>)

R= shortest distance between site and fault rupture (km)

M= surface-wave magnitude

Considering an earthquake magnitude of 7.2 and distance of the site of 19.1 km to the WVF, the following peak ground acceleration (PGA) values of 0.197g, 0.329g, and 0.46g for bedrock, medium soil and soft soil, respectively were computed as shown in the table below. The project site being reclaimed land will fall under the soft soil condition and will experience 0.449g, which is slightly higher than the probabilistic estimates shown on PEM map (Figure 2.1-25). Thus, the recommended 'g' value to be used in seismic load evaluation and building design is 0.46g.

The table below shows different values of PGA based on assumptions made. The appropriate choice will, be based on several other considerations, including the Codes/Standards of the National Structural Code of the Philippines and the expertise/experiences of the particular design/engineering expert of firm.

**Table 2.1-4. Computed PGA Values for Different Earthquake Generators**

| Earthquake Generator | Magnitude | Distance | Calculated PGA (g) Values |             |           |
|----------------------|-----------|----------|---------------------------|-------------|-----------|
|                      |           |          | Bedrock                   | Medium Soil | Soft Soil |
| West Valley Fault    | 7.2       | 19.1     | 0.197                     | 0.329       | 0.460     |
| Manila Trench        | 7.9       | 181      | 0.022                     | 0.036       | 0.051     |
| PFZ: Infanta Segment | 8         | 81.1     | 0.087                     | 0.145       | 0.203     |
| East Valley Fault    | 7         | 38.4     | 0.108                     | 0.180       | 0.252     |
| Lubang Fault         | 8         | 100.9    | 0.065                     | 0.109       | 0.152     |

### Impact Analysis

This is a natural hazard that can occur with or without the project. It can bring damage to the project but the project will not bring aggravating effects on ground acceleration. Ground acceleration caused by earthquakes if not properly addressed in engineering and design may potentially result to great damage and destruction to property and infrastructure and maybe accompanied by loss of life in the reclaimed land itself and vicinities.

There were no major structures identified in the surveyed area. The WVF, an active fault, lies about 19.1 km east of the proposed project site. Still, the area and its vicinities are prone to ground acceleration.

### Mitigating Measures

Ground acceleration caused by earthquakes if not properly addressed in engineering and design may potentially result to great damage and destruction to property and infrastructure and maybe accompanied by loss of life.

The buildings, infrastructure, wave deflectors, containment wall and other defense structures that would be constructed on the proposed reclamation site should conform to the National Structural Code of the Philippines. These structures must be able to withstand an earthquake with a magnitude of at least 7.2. The computed "g" values of 0.449g must be utilized in the design of the structures. The retaining wall that will support the earth fill materials must be properly designed to resist the lateral and hydrostatic pressures. This PGA value should also serve as guide in the degree of soil remediation/compaction.



#### **2.1.2.3.1.2 Ground Rupture**

Ground rupture occurs when a new rupture is created or when renewed movement of old fractures takes place (Punongbayan, 1994). PHIVOLCS is recommending a buffer zone at least 5m on both sides of a fault trace or from the edge of deformation zone. Please refer to Figure 2.1-28.

#### **Impact Analysis**

This hazard is seemingly absent in the project area since the nearest active fault, the WVF, is about 20-km away. Furthermore, the reclamation project will not aggravate this. Therefore, there will be no impact on the project nor by the project to the environment.



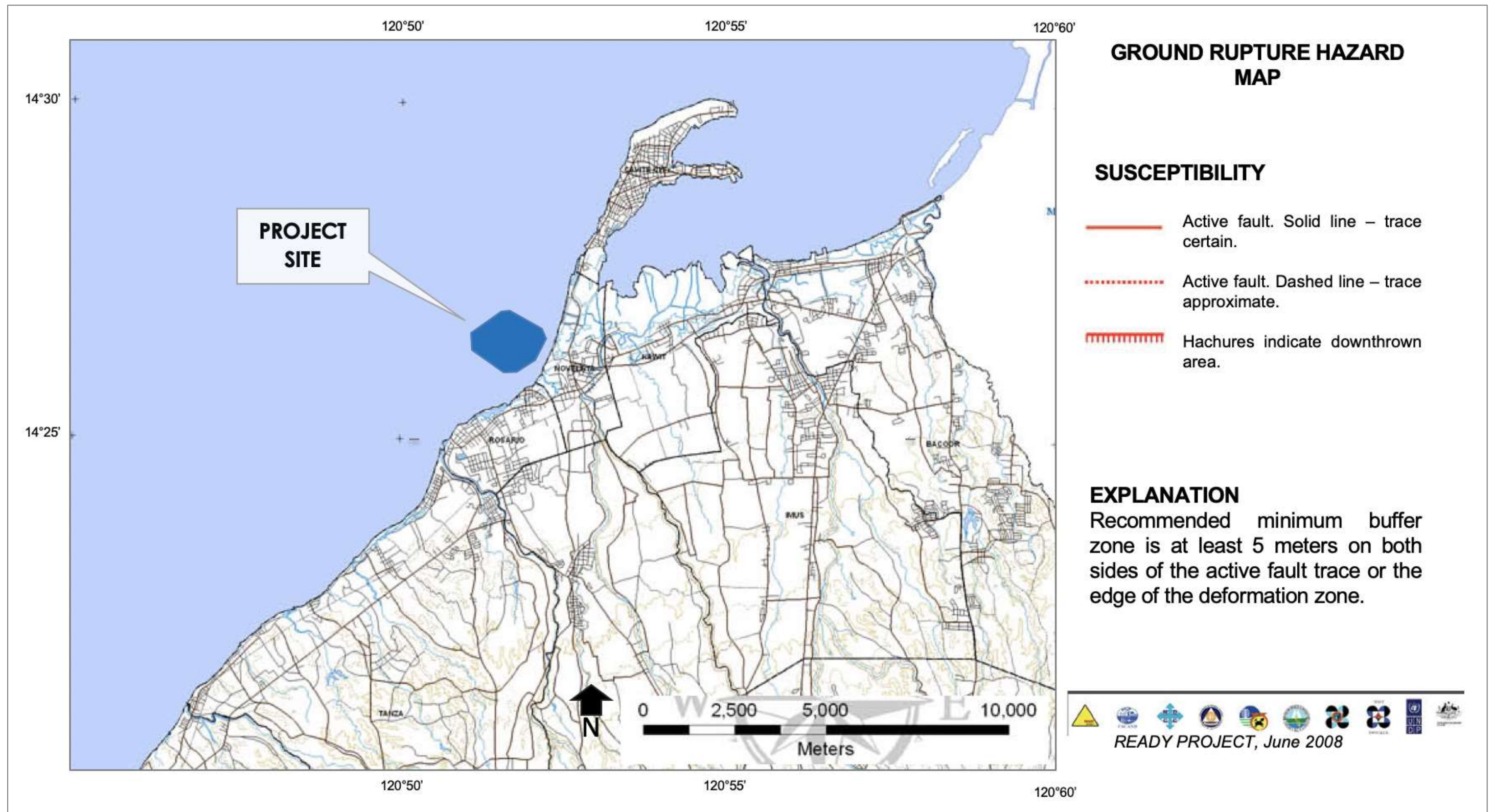


Figure 2.1-28. Ground Rupture Hazard Map of Cavite



#### **2.1.2.3.1.3 Differential Settlement**

In broad terms, settlement refers to the distortion or disruption of parts of a structure or building due to either; unequal compression of its foundations, shrinkage or by undue loads being applied to the structures/buildings. Differential settlement is the unequal settling of materials; gradual uneven downward movement of foundation due to compression of soil during loading or ground shaking due to earthquake event.

Areas susceptible to liquefaction (discussed below) are likewise susceptible to differential settlement.

The proposed reclamation project will undergo backfilling and is considered to be highly susceptible to this hazard. Furthermore, it has been established that the coastal lowlands of Manila, underlain by unconsolidated settlements, is highly susceptible to settlement and subsidence due to both natural (geology and tectonic setting) and anthropogenic (groundwater extraction) causes. The cumulative effects can be very damaging to the project if not properly addressed in the engineering design.

#### **2.1.2.3.1.4 Liquefaction**

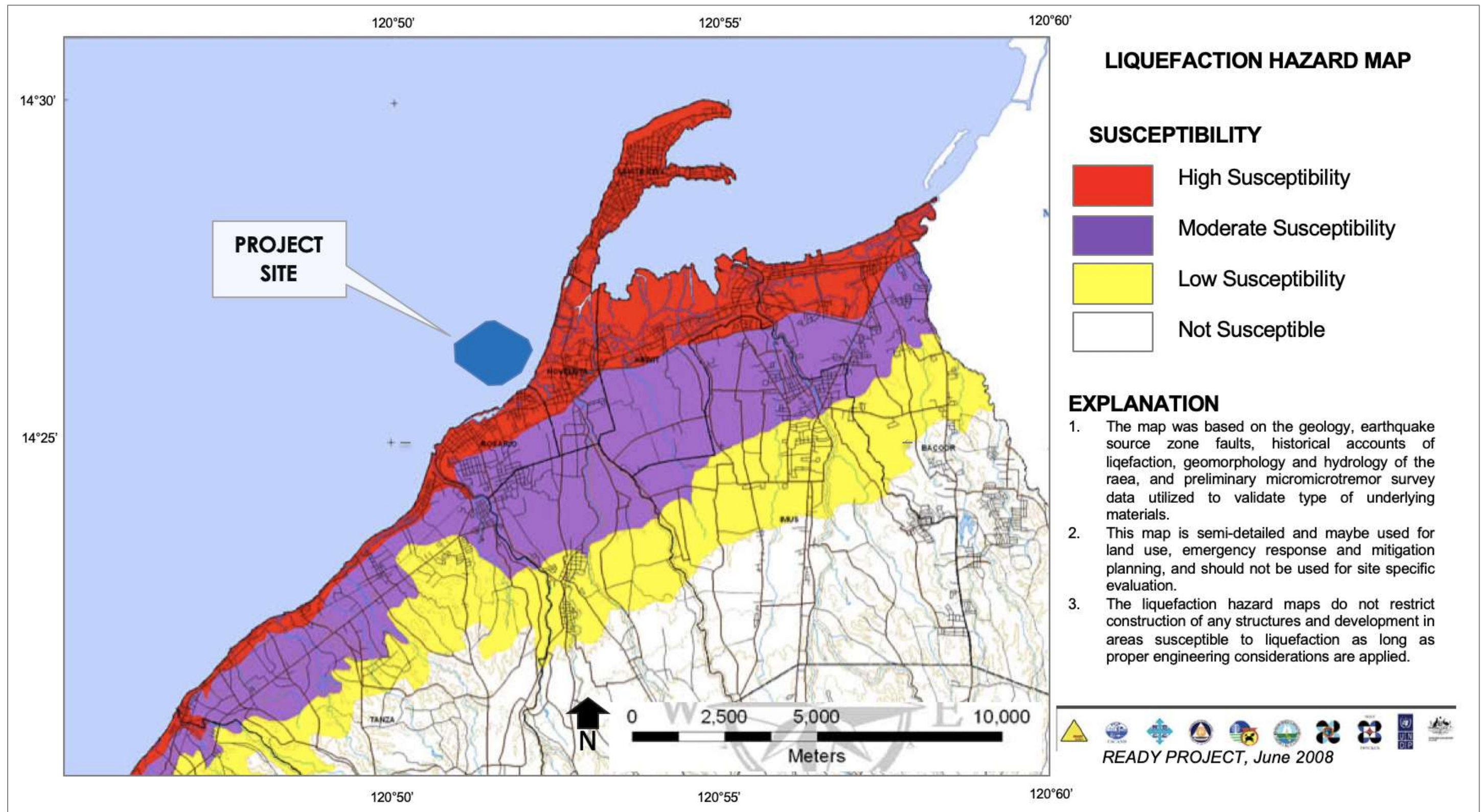
Liquefaction is the process that transforms the behavior of cohesionless water-saturated unconsolidated sediments from a solid to a liquid state usually caused by seismic stresses (Torres et al, 1994) that create ground shaking. Water saturated soils loose strength and liquefy and thus the material tends to flow causing buildings to sink and rotate or lean into the soil (Keller, 1985).

Saturated sandy soil may suddenly change into a liquid-like muddy water when subjected to earthquake shaking. Liquefaction is a phenomenon in which a granular material changes to a liquid state, whether the material is saturated with water or not. When sandy soil deforms due to shear stress caused by vibration during an earthquake, contact between the particles is lost, so that the shear resistance of the soil is lost. Then, the force originally supported in a vertical direction through the contact points is then transmitted through the pore water. The soil will stabilize again when the pore water flows out, but settling (volume decrease) will have occurred. (K. Zen., et.al., 2007. Handbook on Liquefaction Remediation on Reclaimed Land. Edited by: Port & Harbor Research Inst.)

Reyes et al, of UP-Engineering Research and Development Foundation, Inc., in their soil study of areas that liquefy during the 16th July 1990 Luzon earthquake came out with the following soil conditions for the potential liquefiable layers: 1) loose soil classification; 2) upper layers of the surveyed areas; 3) water table near the ground surface; 4) N-value of less than 30 using the American Association of State Highway and Transportation Officials (AASHTO) method and less than 35 using the Japan Society of Civil Engineers (JSCE) method; and 5) 50% passing (D50) of approximately 0.001-1.8mm.

The proposed project being a reclamation area located along the shoreline of the Manila Bay is inherently susceptible to liquefaction. On the delineated liquefaction potential areas in the READY Project (2008), the land areas adjacent to the project site falls within the High Susceptibility (red) area (Figure 2.1-29).





Source: READY Project, June 2008

Figure 2.1-29. Liquefaction Hazard Map of Cavite





### **Geotechnical Liquefaction Analysis (by AMH Phils., Inc.)**

Soil liquefaction is a phenomenon that occurs mostly in medium to fine-grained sands wherein a mass of soil loses a large percentage of its shear resistance when subjected to monotonic, cyclic or shock loading, and flows in a manner resembling a liquid. Much of the damage on substructures and foundation during earthquake is attributed to this phenomenon.

Liquefaction analysis considering SPT data was undertaken using LiquefyPro software for the six (6) boreholes within the vicinity of the project site. This is based on the most recent methods recommended by the National Center for Earthquake Engineering Research (NCEER).

The Factor of Safety (FS) for liquefaction potential is calculated as the ratio of the Cyclic Resistance Ratio (CRR) to the Cyclic Stress Ratio (CSR).

$$FS = CRR_M / CSR_{fs}$$

From the results of the initial analysis, numerical calculation shows that the thick layer of loose sand observed at depth of 0.0m to 12m is liquefiable but to a lesser degree as compared to nearby areas. These liquefiable layers may induce settlements ranging from 19.3 to 112.1mm as summarized in the table below.

**Table 2.1-5. Summary of Liquefaction-induced Settlement**

| <b>BH No.</b> | <b>Liquefiable Layers, m</b> | <b>Liquefaction-induced Settlement, mm</b> |
|---------------|------------------------------|--|
| 19            | 3.0 - 4.5, 9.0 - 10.5        | 19.3                                       |
| 20            | 0.0 - 4.5, 6.0 - 10.5        | 112.1                                      |
| 21            | 0.0 - 6.0                    | 58.6                                       |
| 22            | 0.0 - 3.0, 6.0 - 12.0        | 70.4                                       |
| 24            | 0.0 - 3.0                    | 23.5                                       |
| 27            | 0.0 - 6.0, 7.5 - 9.0         | 54.5                                       |

### **Impact Analysis**

The reclaimed land will not induce nor aggravate liquefaction, but the project will be vulnerable to this hazard.

The reclaimed land will not always undergo liquefaction during an earthquake. Occurrence of liquefaction is strongly related to the age of the landfill, type of fill materials and the construction methods (K. Zen., et.al., 2007).

The reclamation project site would be underlain by fill materials that are highly compressible, which makes it prone to this hazard. The presence of soft saturated unconsolidated material with very low N values up to a depth of 15 meters from the surface along the reclamation site makes the area a high-risk zone for liquefaction.

This hazard has deleterious effects on the environment including: trigger minor seismicity; ground cracking, tilting and cracking of buildings, loss/reduction of soil resistance; threaten the security and stability of infrastructure facilities such as underground pipes and drainage system; can impact all the utilities (gas, electric, petroleum pipe lines, storm sewers, sewage and septic systems, and water supplies); and reduced bearing capacity of foundation soil causing settlement and ground displacement. Moreover, the potential lowering of the ground level can cause wider expansion of inland and coastal flooding areas, and tides moving into areas that were once above sea level thereby expanding the coverage and deeper water depth of flooded (inundated) areas. Another possible effect is the disruption of the water management and related



effects (changing gradient of streams, canals and drains, increased salt water intrusion, and increased need for pumping).

The impacts are further exacerbated by extreme weather events (short term) and rising sea levels (long term). Sea level has been recorded at Manila's South Harbor since 1902. It rose around 1.3 mm/yr (the global rate) until the early 1960s, when it increased to about 2.6 cm/yr (Siringan and Ringor, 1998; Siringan and Rodolfo, 2003).

### **Mitigating Measures**

Remediation options include: compaction – densifying sandy soil with vibration and impact; pore water pressure rod (vibro) compaction, dissipation – installing permeable drain pipes; cementation and solidification – mixing stabilizing material in sandy soil; replacement; lowering of groundwater level; shear strain restraint; preload; and structural measures. A combination of these methods has been found to be more effective. The choice of the remediation method will depend on site characteristics. It is important that the chosen method will minimize or mitigate the impacts to the reclaimed land and at the same time, will not bring adverse effects to its immediate environs. The selection is in accordance with international standards and suitability to the reclaimed land in terms of type of fill materials and existing ground conditions.

Precisely because of this physical characteristic of the underlying fill materials, deep foundation systems for planned structures should be undertaken to address or mitigate this hazard. A settlement criterion shall be calculated and will include settlements that will develop in the natural subsoil and those that will develop in the reclamation fill from project handover to the end of project life. The reclamation to be constructed must be founded on the solid bedrock and appropriate foundation design should be put in place to mitigate these hazards

The fill materials must be fully engineered and compacted/densified to ensure stability and mitigate liquefaction potential. The soil remediation process that will increase the N-value should be advanced to the bottom of pre-existing alluvium, which is the cohesionless soft soil at the upper layers of the subsurface.

A study by Yasuda, et.al., on the liquefaction event in Kobe City shows that soil remediation is effective in mitigating liquefaction even though the ground shaking was as extreme as more than 400 gals of maximum surface acceleration. During the 1995 Hyogoken-Nambu earthquake (7.2M), some zones in two big artificial islands, Port Island and Rokko Island, in Kobe City, Osaka Bay did not liquefy even though the zones surrounding the islands liquefied. Very strong shaking, of 400 gal or more, hit the site. The order of decreasing subsidence is the same as the order of increase in N values in SPT. (Yasuda, et.al., 1996).

The platform level shall be above the extreme water level, securing a safe situation for future inhabitants. The required platform level will therefore be above the most extreme water level that can occur given the design life of the land reclamation, also considering the storm surge for the defined safety level of 1/1000 year. The platform level has to be at least +4.0 MLLW at the moment the Proponent hands over the land to the PRA, as per the latter's requirement. Predictions/modeling will be done in consideration of the cumulative effects of subsidence, settlement, liquefaction and SLR to ensure that the platform level is still meeting requirements at the end of the design life.

#### **2.1.2.3.1.5 Tsunami**

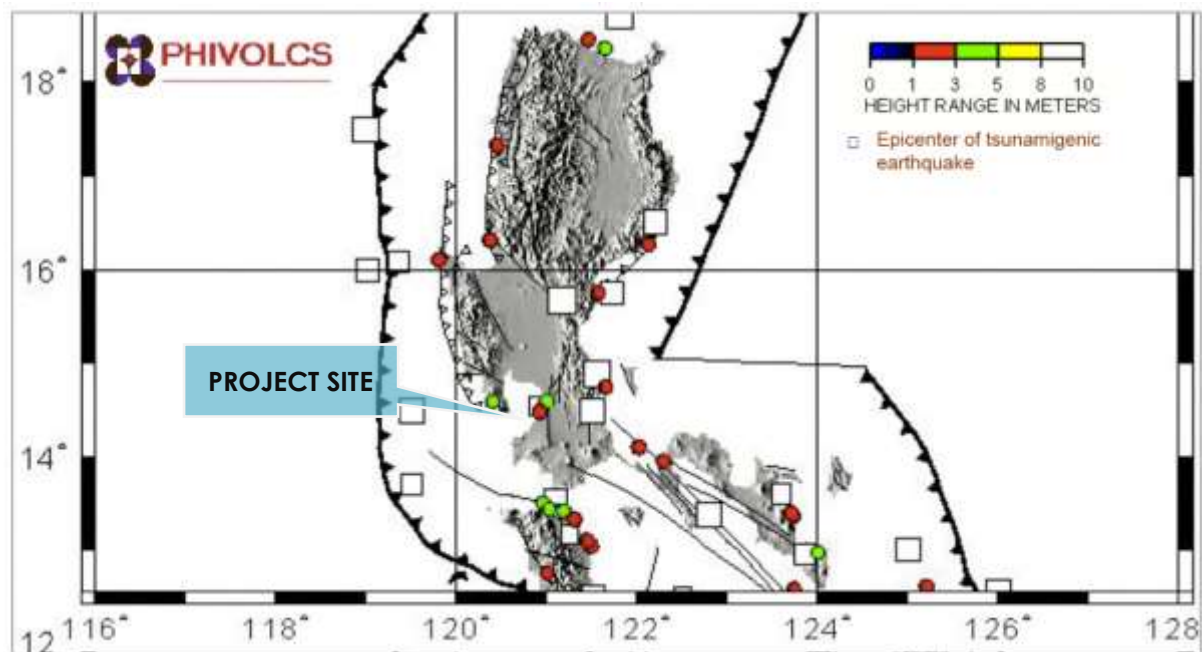
Tsunami, sometimes incorrectly referred to as tidal wave, is a series of huge sea waves brought about by massive underwater disturbances that may be caused by under-the-sea earthquakes, submarine eruptions and undersea landslides (Punongbayan, 1994). Tsunami is considered the most dangerous coastal hazard. It can exceed 25 meters in height. It can occur when the earthquake is shallow-seated and strong enough to displace parts of the seabed and disturb the mass of water over it (PHIVOLCS). The magnitude of



earthquake that can cause tsunami usually exceeds 7.0 and earthquakes that had caused tsunami occurred in the shallow parts of the crust and were usually offshore in the deep parts of the ocean (Punongbayan, 1994).

The project site, being located along the coast of Manila Bay, is susceptible to this hazard due to the presence of an active subduction zone – Manila Trench located west of the area and other active faults and or earthquake generators. See Figure 2.1-30 below.

In PHIVOLCS' (2008) map of tsunami prone areas of Cavite Province, there are no marks of tsunami inundation area (red in Figure 2.1-31) in the immediate vicinity of the project site. However, in the 2014 READY Project map (Figure 2.1-32), an earthquake-generated tsunami can inundate the whole Cavite Spit and the coastal areas of Cavite. Potential wave height near the project site is estimated at 6.2m.



Source: PHIVOLCS (Bautista, B.), 2001

Figure 2.1-30. Map of Epicenters of Tsunamigenic Earthquakes in the Philippines

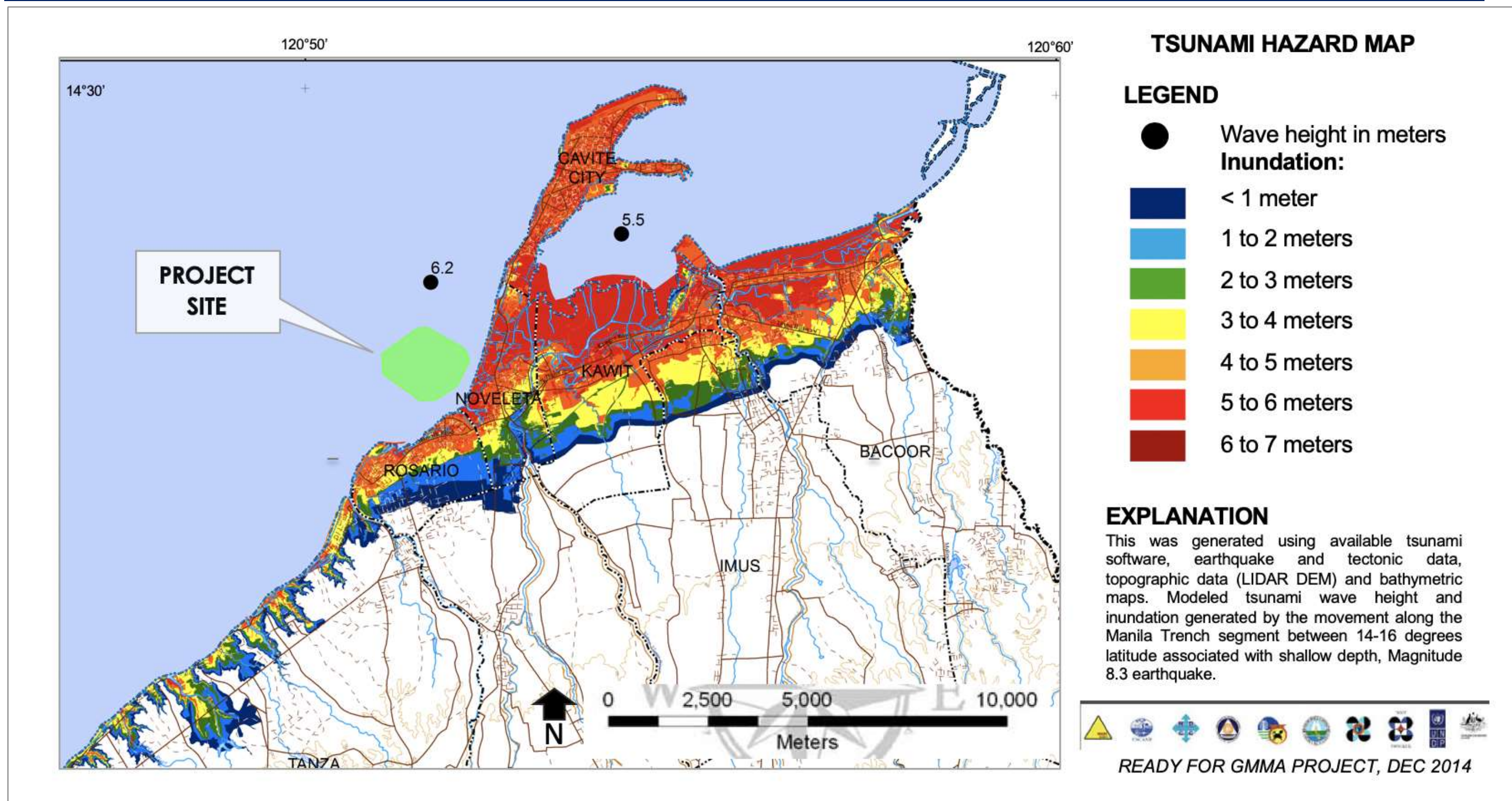




Source: PHIVOLCS, June 2008

Figure 2.1-31. Tsunami Hazard Map of Cavite Province (PHIVOLCS)



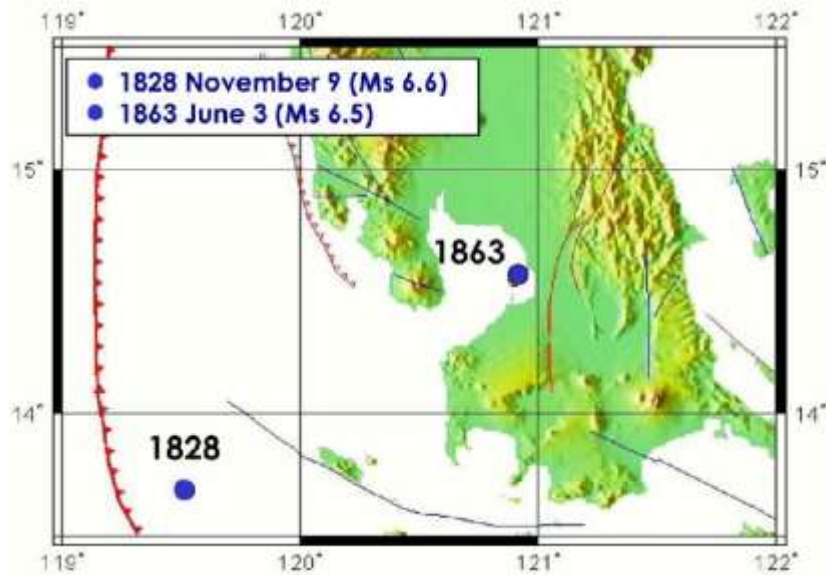


Source: READY Project, December 2014

Figure 2.1-32. Tsunami Hazard Map of Cavite Province (READY Project)

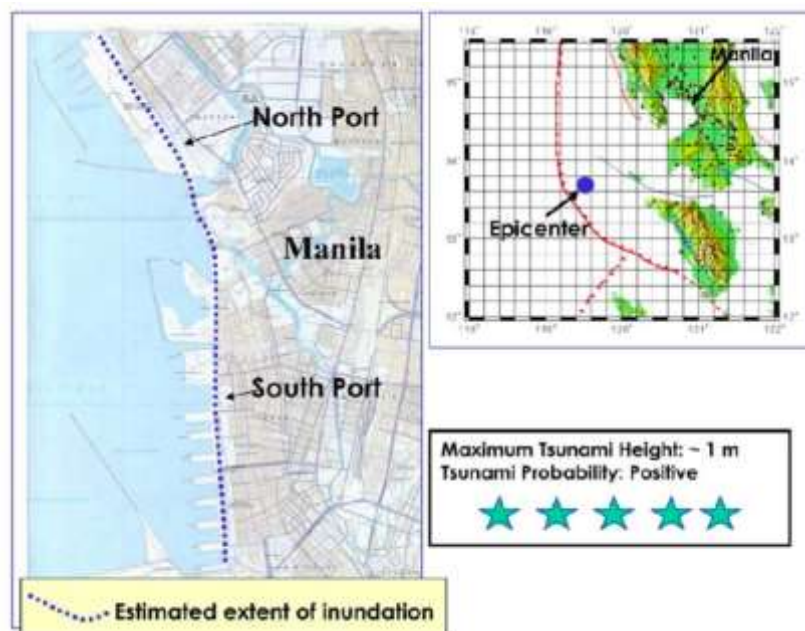


Five candidate earthquakes were investigated by PHIVOLCS for possible tsunami effects to the shores of Metro Manila: December 1770 (quite possible), November 9, 1828 (positive), September 16, 1852 (quite possible), March 4, 1862 (doubtful) and June 3, 1863 (positive). Of these 5, only two earthquakes were confirmed to have caused tsunamis to occur. The Nov 1828 earthquake was recorded at Ms 6.6 with estimated tsunami height at the port of Manila of about 1 meter while the 1863 earthquake was recorded at Ms 6.5. In Manila Bay, the wave action was observed as coming from the SE to NW. Tsunami height in Manila is estimated to be 1-2 meters. (Bautista et al., 2014) See Figures 2.1-33 to 2.1-35.



Source: PHIVOLCS 2014

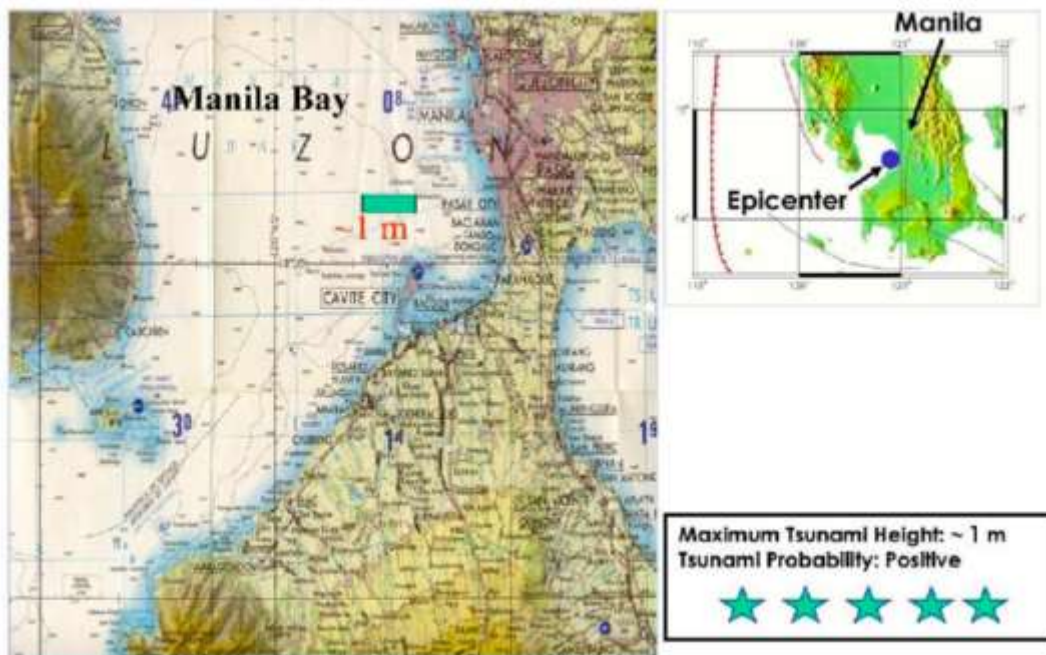
Figure 2.1-33. Tsunamigenic Earthquakes that affected Metro Manila shores



Source: PHIVOLCS 2014

Figure 2.1-34. The November 9, 1828 Tsunami in Manila





Source: PHIVOLCS 2014

**Figure 2.1-35. The June 3, 1863 Tsunami in Manila**

### Impact Analysis

Manila Bay is at lower risk compared to Pacific coastal areas in the Philippines, but due to population density, a tsunami would be devastating. Approximately 90 destructive earthquakes occurred for the past 400 years with ~ 40 tsunamis for the past 400 years – an average of 1 in 10 years (Solidum, 2016). Coastal areas at eastern and western margins fronting major seas and inland seas have been affected by tsunamis.

Overtopping could potentially result in a scenario of high tsunami heights. Manila Bay was affected by storm waves riding atop storm surge. The gentle seabed slopes of the bay means higher waves can affect the shore.

The location of the reclaimed land will be such that it will be the nearest to the waterfront relative to land-based sites. This makes it the most vulnerable to tsunami. At worst case, the project will not increase the effects on land-based structures and facilities as well as on population. In fact, the proposed reclamation project has the potential of sheltering onshore population and structures/properties from tsunamis.

More discussions on the analysis of tsunami hazard are presented under Chapter 2.2.1 Hydrology/hydrogeology.

### Mitigating Measures

A more detailed design is considered based on the additional height/volume of seawater near the coast, which could be created by a tsunami/waves. This could be significantly deflected from reaching land, thus creating flood by the elevated reclaimed land.

Conservative scenarios of high tsunami heights, which could result from a case of strong earthquakes will be studied and mathematical modeling will be applied. The final design of the platform level will consider both the tsunami scenario and the guidelines and requirements of the PRA, as well as economic viability.



An updated mathematical modeling will be conducted to simulate the storm surges/waves in terms of force and direction. Wave deflectors and other similar defenses such as revetment will be part of the study. The modeling will consider the volume of water that will inundate the project area should tsunami reach to maximum predicted wave heights as well as the appropriation of “no-build zone” and wave water catchment channels. The “no-build” zone will observe the requirements of the PRA, which is 50 meters from the coastline.

During the final design stage of the project by which time other aspects of the Project shall have been firmed up, such as but not limited to: a) exact configuration of the islands b) use of stilts in certain portions of the project c) final platform level, etc., consultation will be made with PHIVOLCS and other concerned agencies on this matter as well as on other design aspects such as liquefaction and ground shaking.

The elevation of the reclaimed land and the use of properly designed structures such as wave deflectors will provide further effective method of dissipating storm waves, such protection not available in a “No Project Scenario”.

### **2.1.2.3.2 Mass Movement**

#### **2.1.2.3.2.1 Landslide**

The project site is not susceptible to earthquake-triggered landslides. Due to the generally flat topography in Noveleta and Rosario, the earthquake-induced landslide risk is relatively low for the most part. Landslides can also be induced by heavy rains, which add weight and lubricate the soils. They can also be induced by ground shaking from an earthquake. Risk may be increased if an earthquake occurred in the wet season. See Figures 2.1-37 and 2.1-38 for earthquake-induced landslide susceptibility maps and Figure 2.1-39 for rain-induced landslide. There is still a remote possibility of collapse of the fill materials in the reclamation area due to engineering/structural failures.

### **Impact Analysis**

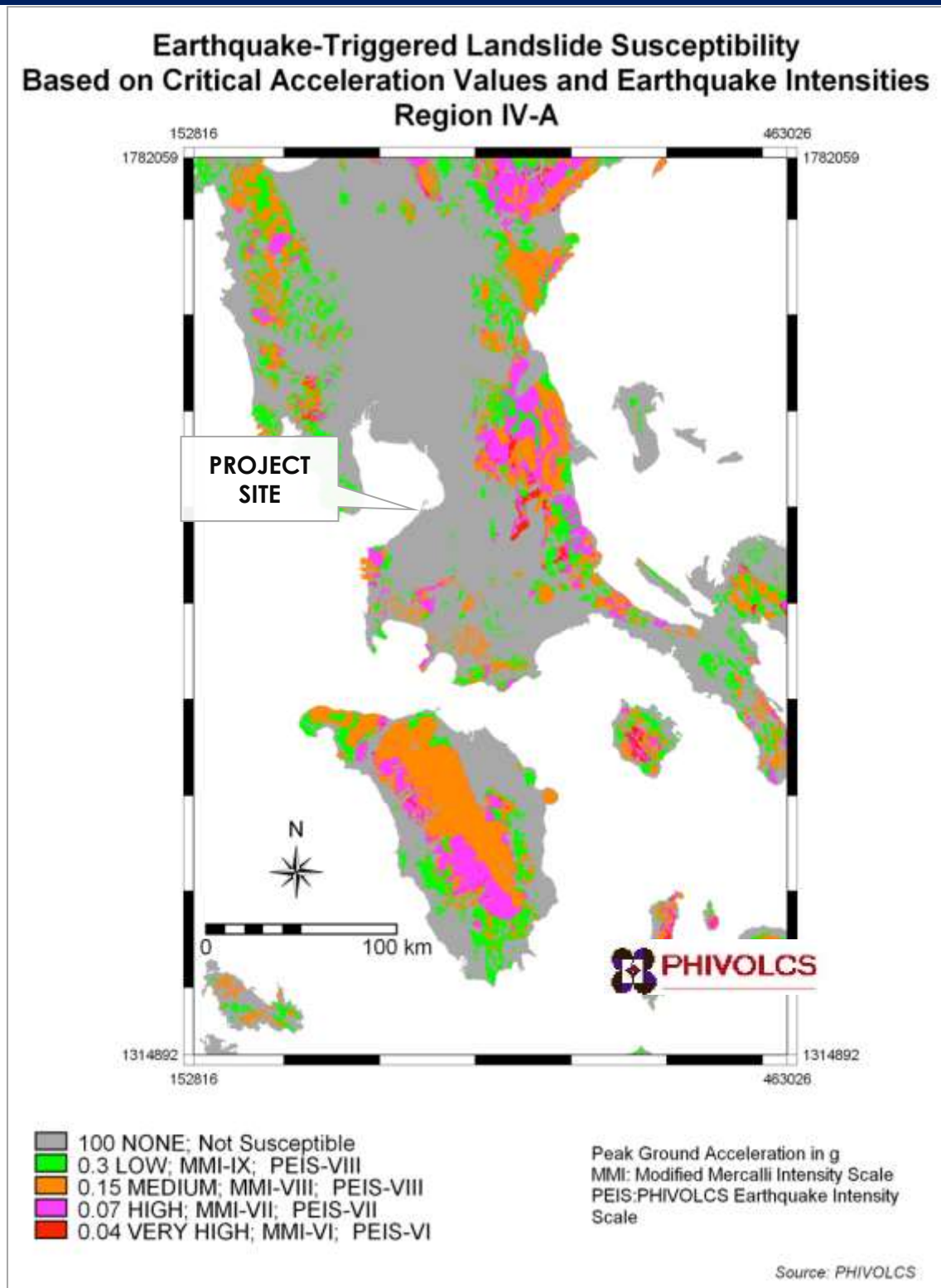
The project site has low susceptibility to landslide. That said, there is still a remote possibility of collapse of the fill materials in the reclamation area due to engineering/structural failures. Below is a numerical stability analysis for the containment structure of the island.

There will be no impact by the project to the environment.

### **Mitigating Measures**

This hazard is seemingly absent in the project area and therefore no mitigation measures to be implemented.

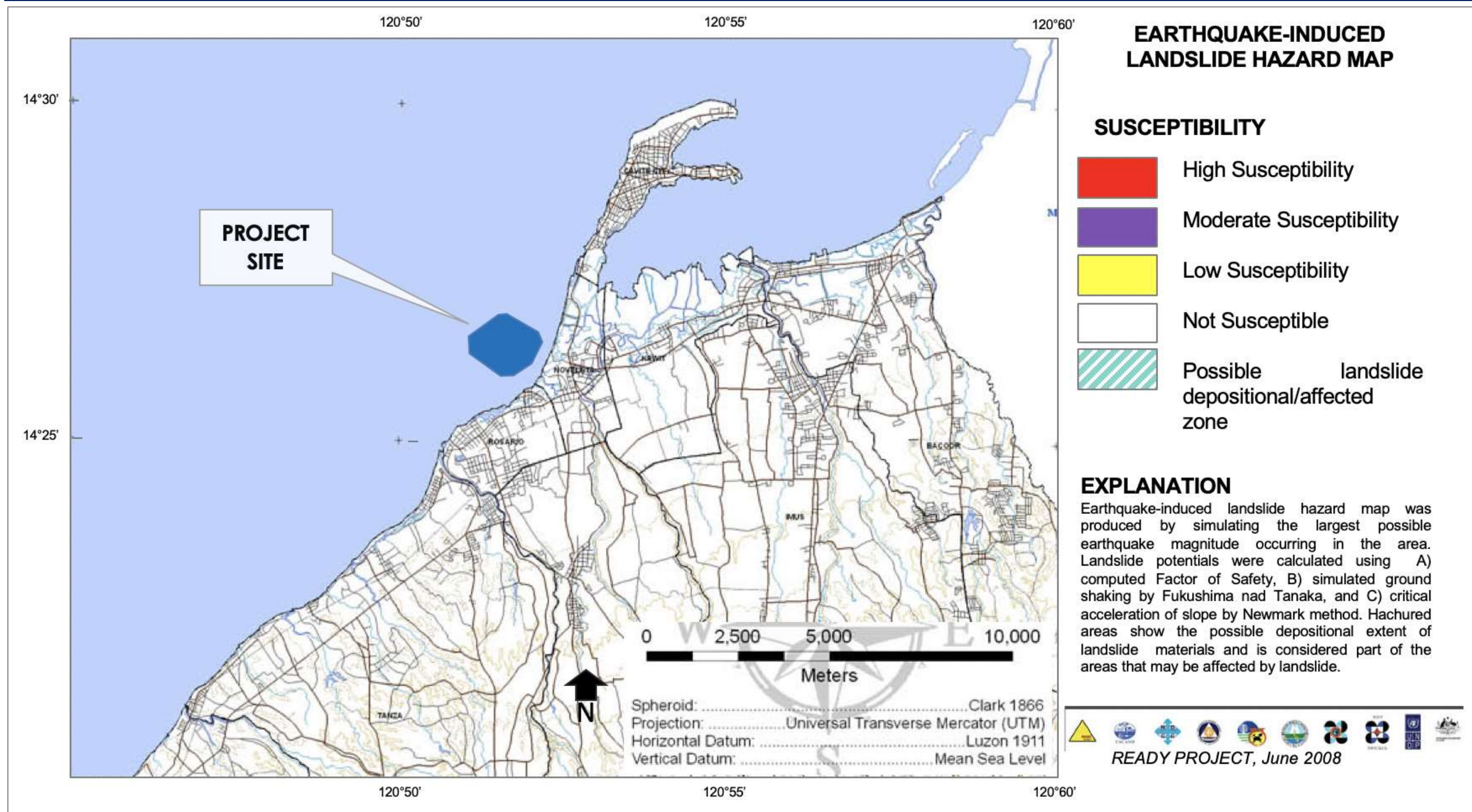
That said, there is still a remote possibility of collapse of the fill materials in the reclamation area due to engineering/structural failures. The retaining wall that will support the earth fill materials must be properly designed to resist the lateral and hydrostatic pressures.



Source: PHIVOLCS, October 2008

**Figure 2.1-36. Earthquake-Induced Landslide Susceptibility Map of Region IV-A**

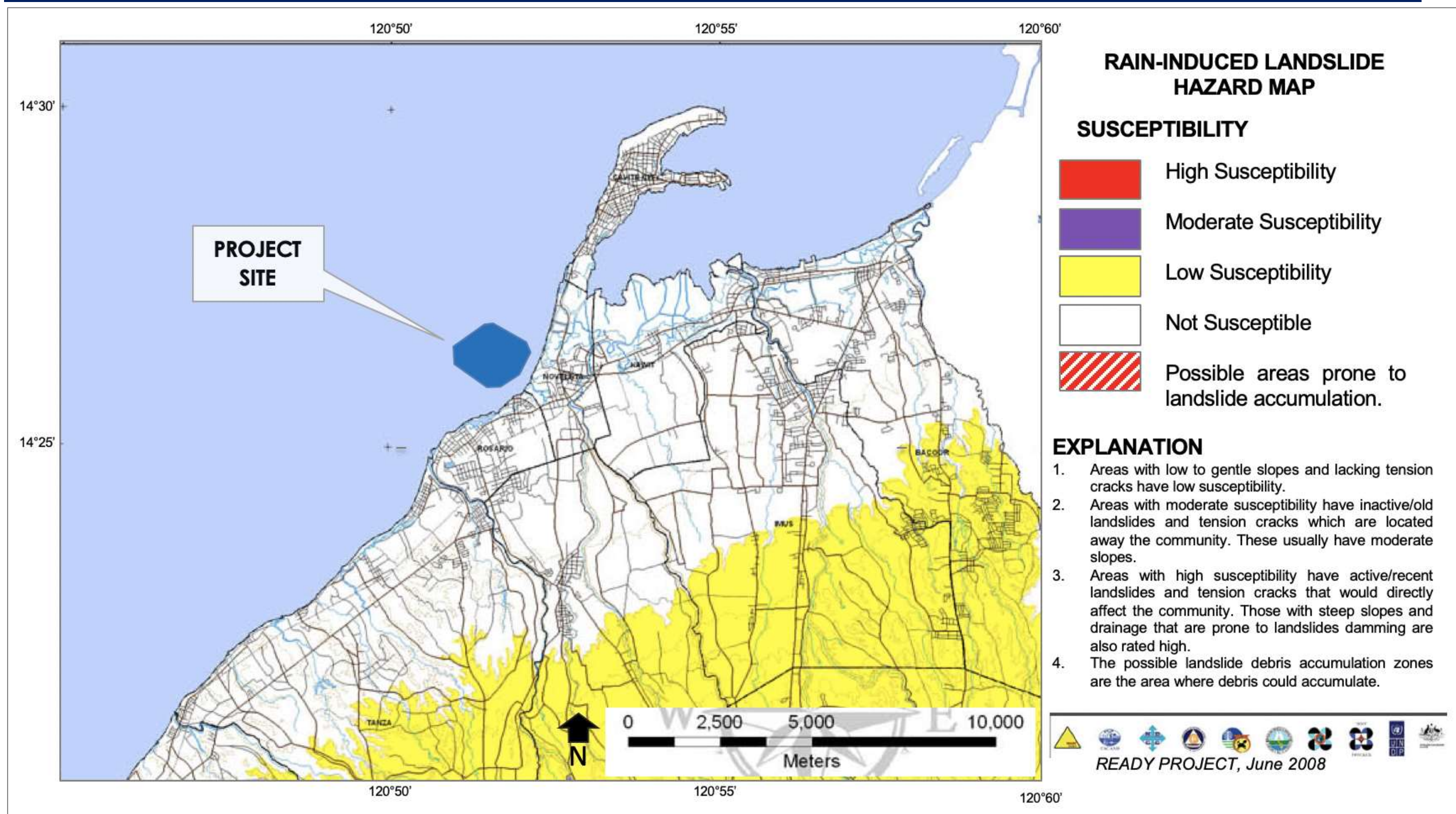




Source: READY Project, June 2008

Figure 2.1-37. Earthquake Induced Landslide Hazard Map of Cavite





Source: READY Project, June 2008

Figure 2.1-38. Rain-Induced Landslide Hazard Map of Cavite



### Stability Analysis of Confinement Walls (by AMH Phils., Inc.)

Two (2) methods were considered as possible confinement measures for the reclamation area: 1) Sand Bag and Rock Dike and 2) Anchored sheet pile wall. In order to establish the stability and adequacy of each method, stability analysis by Limit-Equilibrium Method (LEM) for the Dike System and Finite Element Analysis (FEM) for the Anchored Sheet Pile Wall is performed.

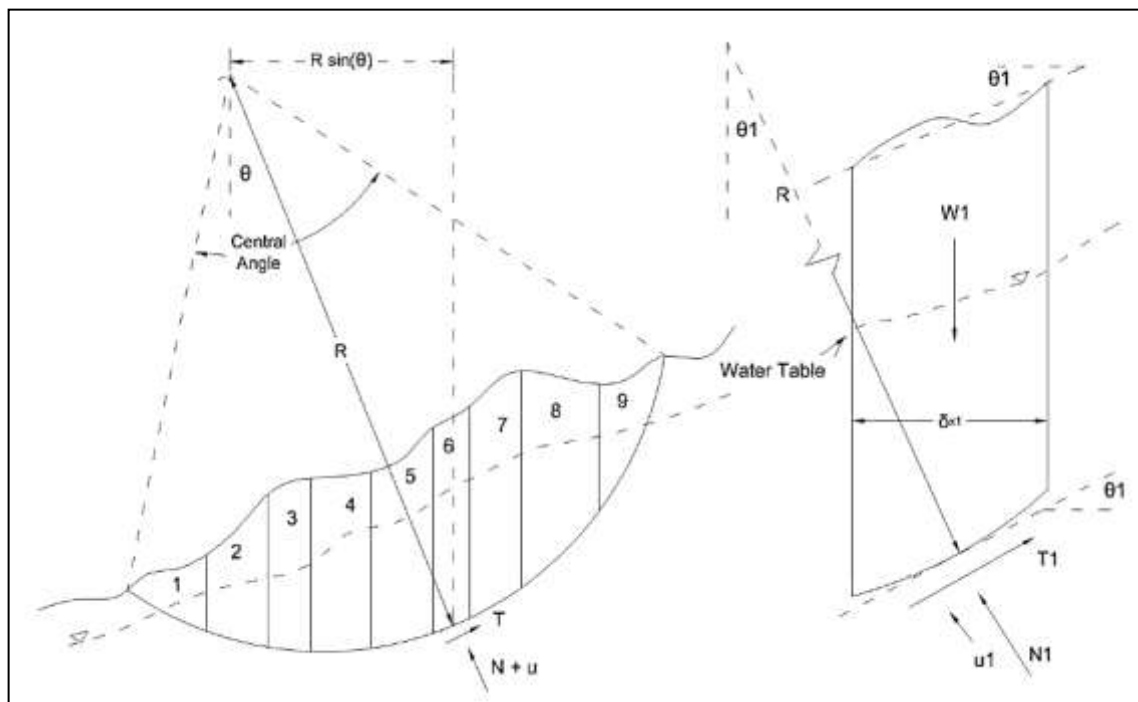
The following section presents the schematic design for each confining measures as well as the preliminary stability analyses.

#### 1. Sand Bag and Rock Dike

##### Limit Equilibrium Methods

Slope stability is the potential or likelihood of a slope to fail due to a specific mechanism. It involves the interplay of two types of forces: a) driving forces which promotes the downward movement of materials and b) resisting forces which defer the downward movement of materials. Typical causes of slope failures are erosion, rainfall, earthquakes, geologic features, and specifically for the project, the induced loads.

The analysis of slope stability is done by Limit-Equilibrium Methods. The mass is divided into small slices along an assumed or known failure surface as shown in the figure below. Forces that are acting on each slice such as weight, normal and tangential reactions, and shear forces are determined and by equilibrium conditions, the moment of the driving forces about the center of the failure surface should be equal to the moment of the resisting forces.



**Figure 2.1-39. Stability Analysis by Limit-Equilibrium Methods**

The Factor of Safety (FS) is expressed as the ratio of resisting forces to the driving or overturning forces.

$$FS = \frac{\text{Resisting Forces}}{\text{Overturning Forces}}$$





## Where

- $FS < 1$  indicates an unstable slope  
 $FS = 1$  indicates a critically stable slope  
 $FS > 1$  indicates a stable slope

An acceptable factor of safety is based on various considerations such as the recurrent period of heavy rainfall, seismic activity, as well as the assessment of risk or hazard brought about by the slope failure. With these factors considered, recommended factors of safety for static conditions range from 1.2 to 1.5, and a value greater than unity ( $>1$ ) for earthquake conditions (References: a) Cheng, et. al. Slope Stability Analysis and Stabilization; b) Duncan, et. al. An Engineering Manual for Slope Stability Studies; c) Towhata. Seismic Behavior of Slopes and Embankments)

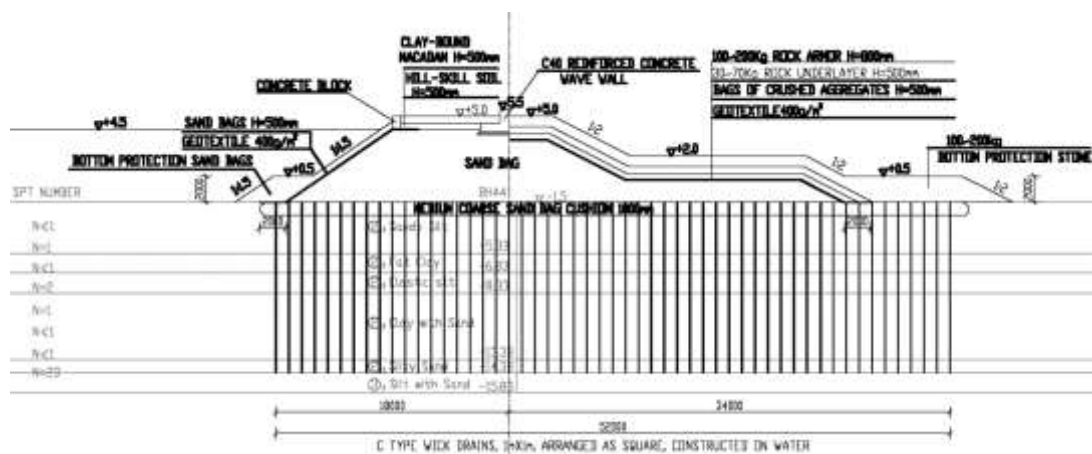
For this study, the following factors of safety were used:

- Factor of Safety for Static Conditions: 1.5
- Factor of Safety for Pseudo-Static Conditions: 1.1

Rocscience Slide 6.0®, a slope stability computer software, was utilized to facilitate calculations for determining the global stability of the embankments for proposed dike system. This modeling software performs slope stability analysis procedure based on Limit Equilibrium Methods. Several trials were carried out, varying the slip circle coordinates for determining the minimum factor of safety under static and pseudo-static (earthquake) conditions.

## Slope Section

An initial analysis is performed for nearby proposed Island A Dike (I) in order to assess and verify the stability of the proposed design for the dike system. The following figure was used as reference in modelling of the slope in Slide 6.0. This nearby Island A reclamation project is used for the analysis for reasons of conservatism because it is also identified as the most critical area due to the thick soft soil layer (~15.0m) (and therefore may be considered as the worst-case scenario).



Source: Client-issued

**Figure 2.1-40. Section of Island D Dike (I)**

## Geotechnical Parameters

The following table presents the geotechnical parameters used in the subsequent analyses. BH-22 of the proposed project Island D was used as reference borehole since it has the thickest soft soil layer.



Table 2.1-6. Geotechnical parameters for proposed dike

| Depth (m)                               | Soil Type | Relative Density | SPT N-value | Geotechnical Parameters |         |     |
|---|-----------|------------------|-------------|-------------------------|---------|-----|
|   |           |                  |             | (kN/m <sup>3</sup> )    | c (kPa) | (°) |
| 0.0 - 15.0                              | Clay      | Very Soft        | 1           | 11                      | 20      | 0   |
| > 15.0                                  | Sand      | Very Dense       | 50          | 20                      | 0       | 38  |
| Sand Bag                                |           |                  |             | 18                      | 5       | 31  |
| Backfill Sand                           |           |                  |             | 18                      | 5       | 31  |
| Clay-bound Macadam                      |           |                  |             | 17                      | 50      | 0   |
| Hill-skill Soil                         |           |                  |             | 18                      | 0       | 30  |
| Rock Armor / Rock Underlayer            |           |                  |             | 20                      | 50      | 30  |
| Crushed Aggregates                      |           |                  |             | 19                      | 0       | 35  |
| Concrete                                |           |                  |             | 24                      | 150     | 26  |
| Ground Improvement (Soil Cement Column) |           |                  |             | 15                      | 250     | 0   |

A uniform load of 12.0 kN/m is applied on top of the road for traffic loading. The figure below presents the dike system as modelled in Slide 6.0.

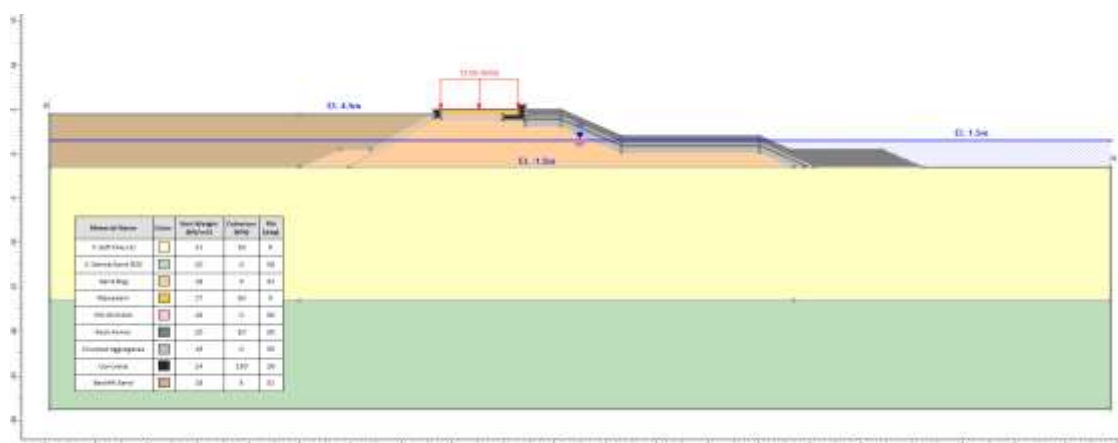


Figure 2.1-41. Slope Model of Island D Dike

### Results of the Analysis

The following table presents the summary of the results of the slope stability analysis for Island A Dike (I). The resulting FoS considering static conditions is found to be adequate, however, the FoS considering pseudo-static (earthquake) conditions is below the passing criteria.

As seen in Figure 2.1-43, the failure plane for the slope is deep-seated in nature and can be mainly attributed to the underlying soft soil layer. Ground improvement may be necessary to improve the strength parameters of the soil and address the slope failure during earthquake conditions.

Table 2.1-7. Summary of SSA Results

| Case No. | Type of Analysis | Seismic Coefficients |        | Min. FS                |
|----------|------------------|----------------------|--------|------------------------|
|          |                  | kh (g)               | kv (g) |                        |
| 1        | Static           | 0.00                 | 0.00   | 1.440 $\approx$ 1.5 OK |
| 2        | Earthquake       | 0.20                 | 0.10   | 0.542 < 1.1            |

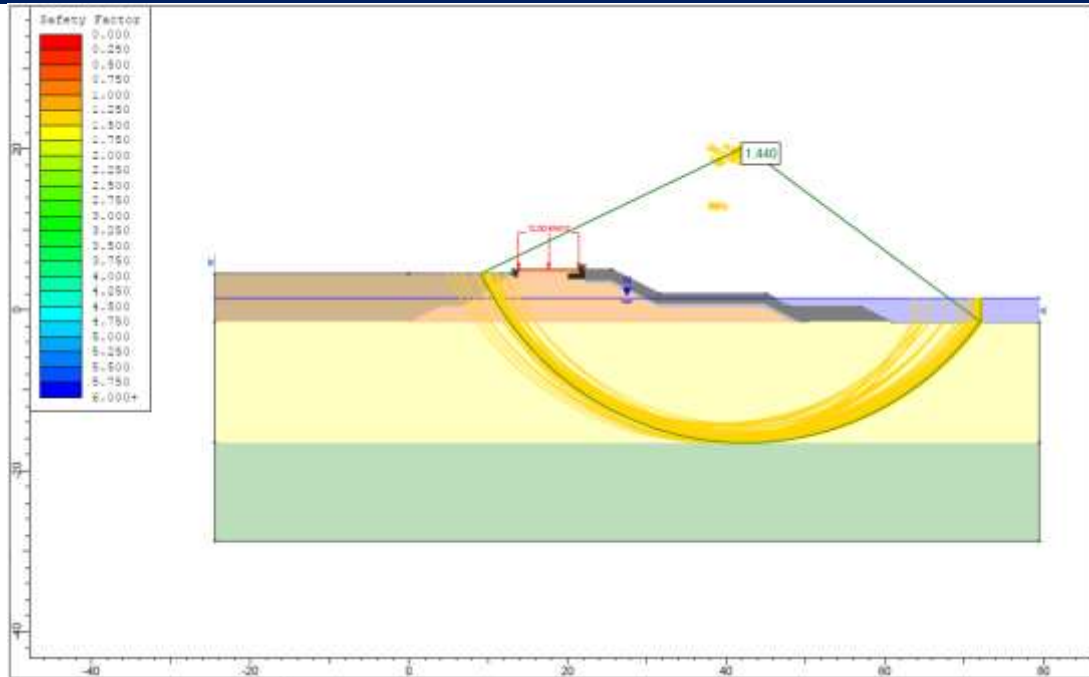


Figure 2.1-42. Case 1: Static (FoS=1.440)

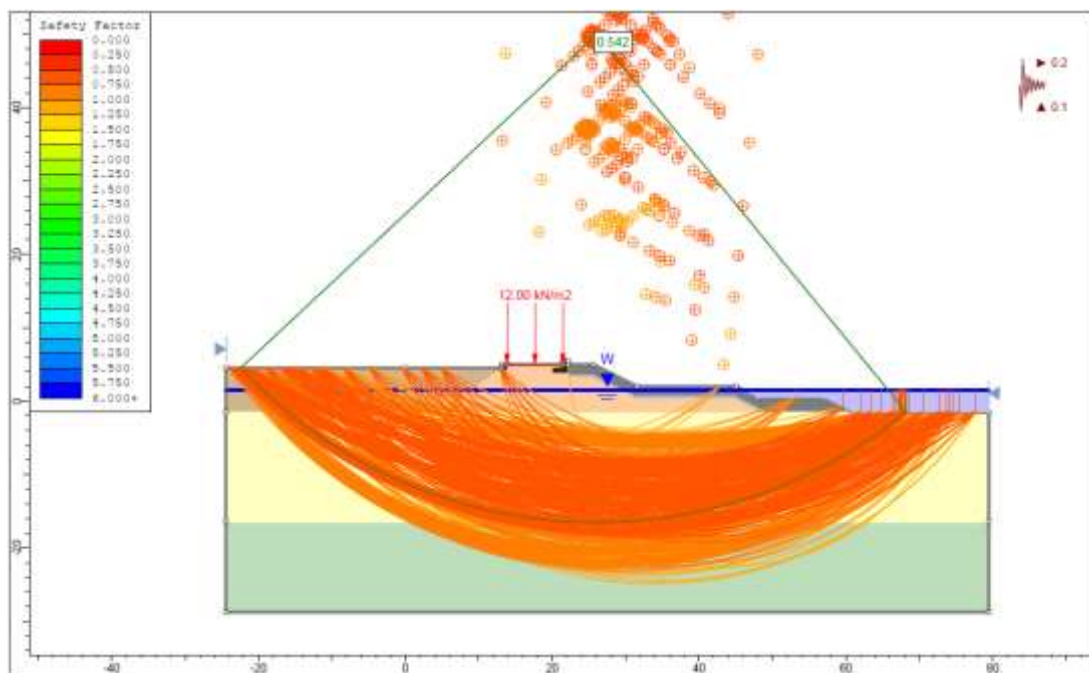


Figure 2.1-43. Case 1: Earthquake (FoS=0.542)

### Proposed Ground Improvement

One option for ground improvement is by construction of soil cement columns. In this method, columns of specified spacing made up of a mixture of soil and cement is inserted into the ground by deep mixing method. The columns formed will then increase the shear strength of the underlying soil and improve the overall geotechnical capacity of the ground.





In Slide 6.0, the soil cement column is modelled until the depth of the soft soil layer (15.0m) and as a composite material with cohesion of 250 kPa. The value for cohesion is calculated from the weighted average of the cohesion of the surrounding soft soil and the soil-cement column.

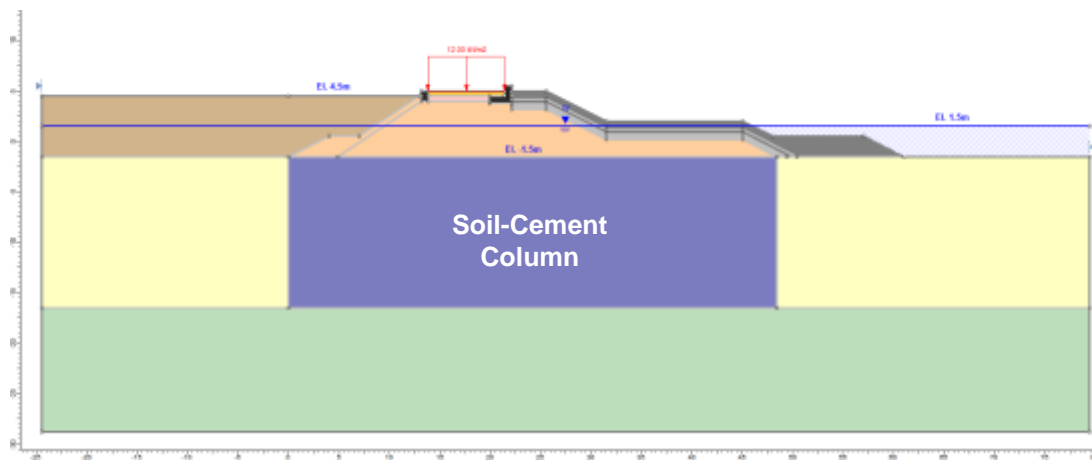


Figure 2.1-44. Slope Model with Soil Cement Column

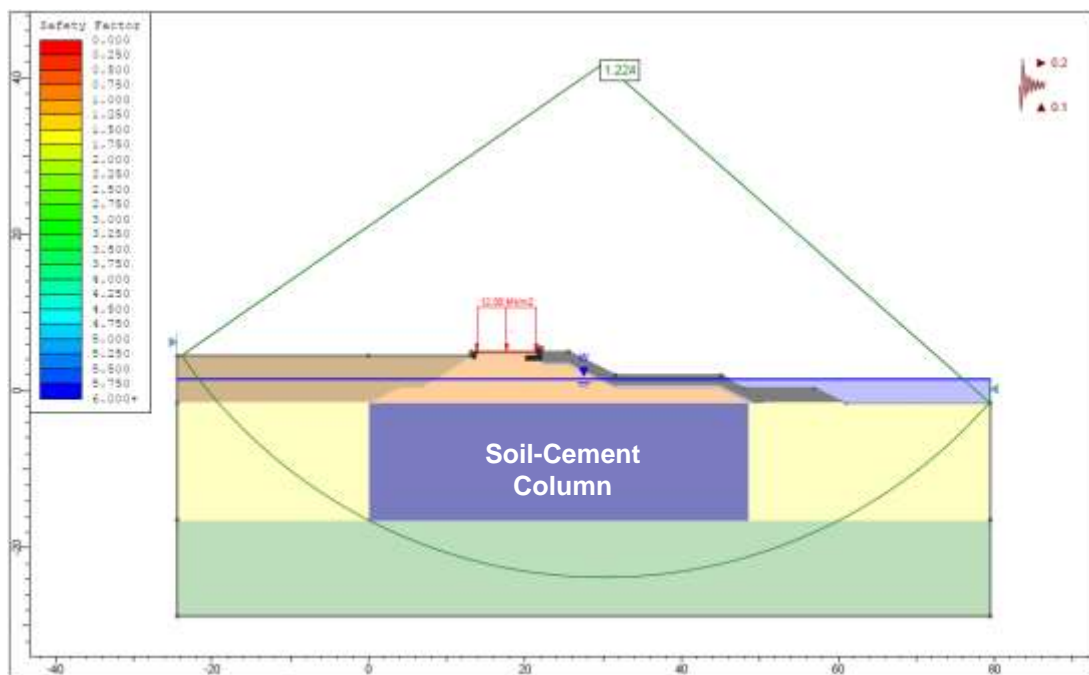


Figure 2.1-45. Case 2: Earthquake (FoS=1.224)

From the results of the re-run, the FoS considering earthquake conditions is adequate ( $1.224 > 1.1$ ). Hence, ground improvement is recommended to mitigate deep-seated slope failures beyond the dike system. Depth of the ground improvement will most likely be equal to the depth of the soft soil layer for each location. Further study should be conducted for the ground improvement.

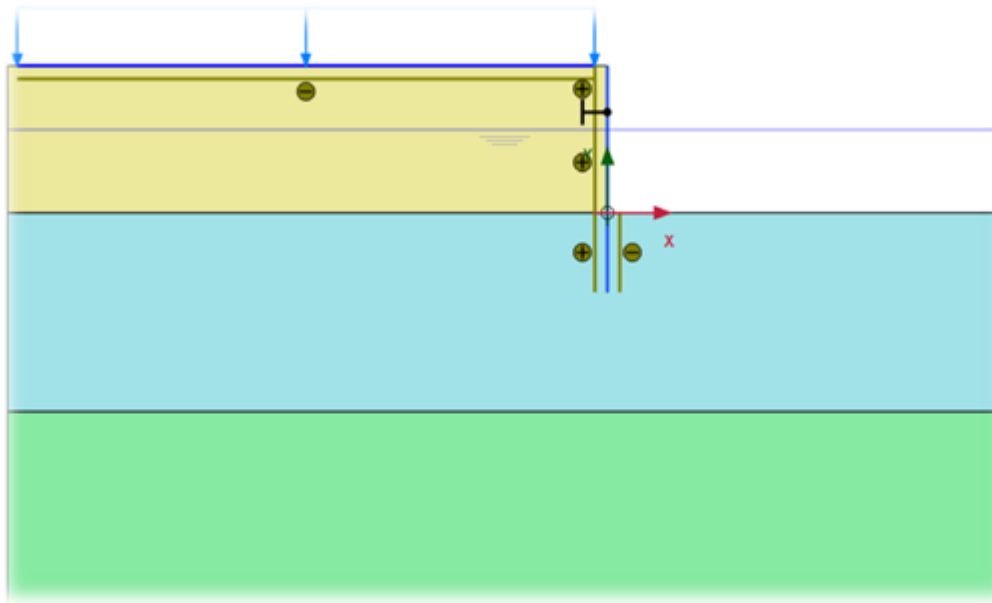


## 2. Anchor Sheet Pile Wall

### Finite Element Analysis

Although Limit Equilibrium is most commonly used and a simple solution method, it can become inadequate if the slope fails by complex mechanisms (e.g. internal deformation and brittle fracture, progressive creep, liquefaction of weaker soil layers, etc.). In these cases, more sophisticated numerical modeling techniques should be utilized. Plaxis 2D is a finite element modeling software capable of two-dimensional analysis of deformation and stability for various problems in geotechnical engineering. Plaxis is also capable of creating complex soil and structure interactive models and can constitute nonlinear strength, time dependent and anisotropic behaviors of soils and rocks. It provides more thorough analysis and investigation of the problem using 2D Finite Element Method analysis with more refined soil model.

For the containment structure of the Cavite Reclamation sites, the sheet pile wall was analyzed using finite element model utilizing Plaxis 2D. The figure below presents the model prepared for the analysis of each island.



**Figure 2.1-46. Plaxis Model**

The following table summarizes the geotechnical parameters used:

**Table 2.1-8. Geotechnical Parameters**

| Depth (m)  | Soil Type | Unit Weight (kN/m <sup>3</sup> ) | Cohesion (kPa) | Angle of Friction (deg.) | Elastic Modulus (MPa) | Poisson's Ration ( $\mu$ ) |
|------------|-----------|----------------------------------|----------------|--------------------------|-----------------------|----------------------------|
| 0.0 - 1.5  | Sand      | 16                               | 0              | 28                       | 5                     | 0.15                       |
| 1.5 - 3.0  | Clay      | 16                               | 50             | 0                        | 30                    | 0.25                       |
| 3.0 - 30.0 | Sand      | 20                               | 0              | 38                       | 40                    | 0.35                       |

### **Results of Analysis**

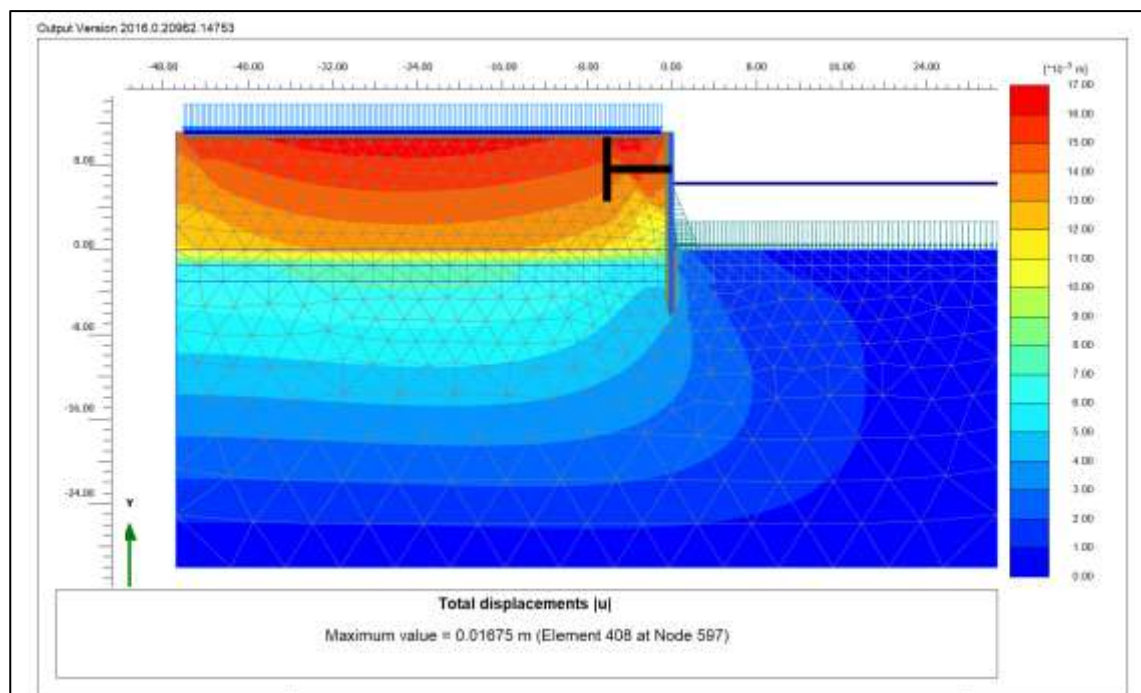
The table below presents the summary of the findings while the succeeding figures contain the screenshot images of the results from Plaxis 2D.



**Table 2.1-9. Plaxis 2D Results**

| Max. Exposed Height (m) | Anchor Length (m) | Anchor Dia. (mm) | Sheet Pile Type | Max. Disp* (mm) | Max. Moment (kN-m) | Sheet Pile Adequate? | Max. Tensile Force (kN) | Anchor diameter adequate? |
|-------------------------|-------------------|------------------|-----------------|-----------------|--------------------|----------------------|-------------------------|---------------------------|
| 10.25                   | 16                | 46               | PZC 18          | 16.75           | 62.5               | Yes                  | 419.2                   | Yes                       |

\*Displacement after compaction of backfill



**Figure 2.1-47. Plaxis Result – Total Displacement (Island D)**

The results of the finite element analysis show that the preliminary design will be able to sustain the loads during construction stage, operation, and during seismic conditions. Moreover, the displacements after compaction of backfill are within the tolerable limits.

#### 2.1.2.3.2.2 Settlement/Subsidence

Metro Manila's coastal areas are sinking as fast as 9 cm/y (Rodolfo et al. 2003, Siringan and Rodolfo 2003, Rodolfo and Siringan 2006). Accelerating subsidence of the coastal lands bordering the bay is worsening both floods and high-tide invasions. Aggravating factors likewise exist in the area. Siringan and Rodolfo (2003) and Rodolfo and Siringan (2006) have established that accelerated sediment compaction and ground subsidence occur in areas north of Manila Bay due to excessive groundwater withdrawal. Before 1991, the area subsides at a rate of 0.16-0.56 cm/yr, 0.36 cm/yr on the average. This natural compaction accounts for 2 to 8 percent of the estimated 2 to 8 cm/yr typical subsidence rates from 1991 – 2001 (Rodolfo and Siringan, 2006). This implies that enhanced dewatering of the upper 30 m of the sediment column can potentially account for almost 98 % of the subsidence rates during the past decade. (Soria, et.al., 2005)

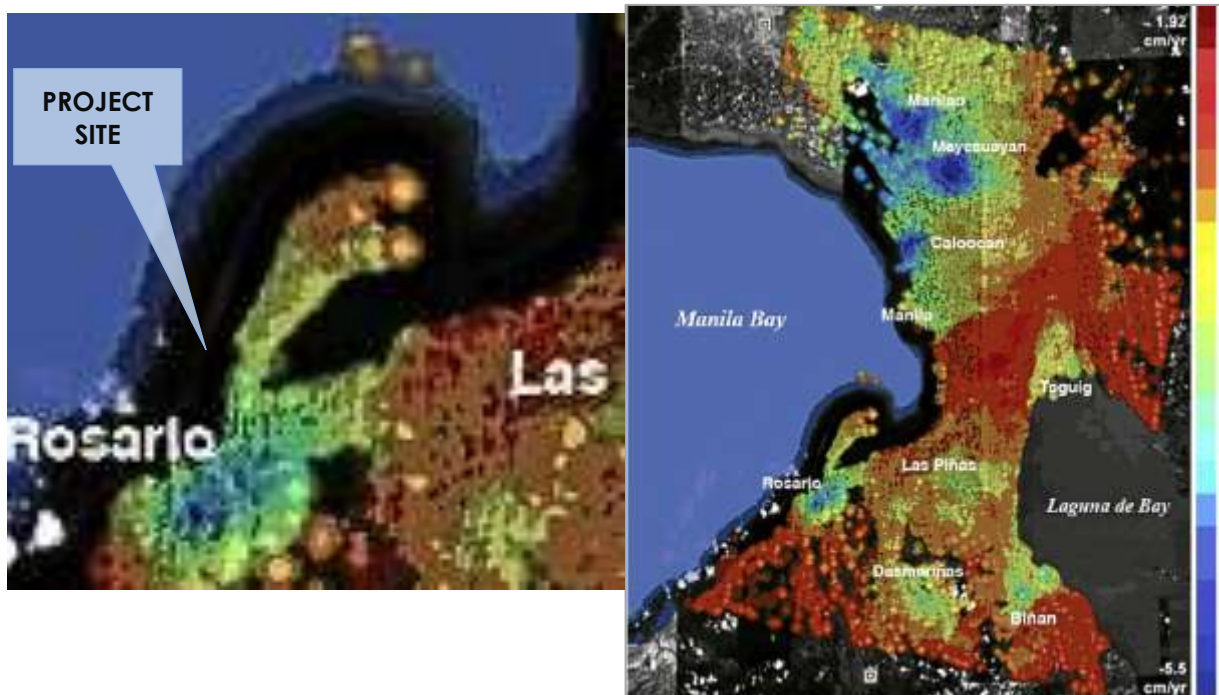
Considered as critical areas for subsidence susceptibility in Metro Manila are: 1) Guiguinto 2) Bocaue-Marilao 3) Meycauayan-North Caloocan 4) Navotas-Caloocan-West Quezon City 5) Makati-Mandaluyong-Pasig-Pateros 6) Parañaque-Pasay 7) Las Piñas-Muntinlupa and 8) Dasmariñas, Cavite (NWRB (2004).





"The Volcano-Tectonics Laboratory at U.P. Diliman's National Institute of Geological Sciences (Lagmay 2011, Eco et al. 2013) has analyzed Persistent Scatterer Interferometric Synthetic Aperture Radar data from satellites to verify subsidence over wide areas of Metro Manila, with the proposed reclamation areas experiencing up to 6 cm/y." (Rodolfo. K.S., 2014)

The satellite image of Metro Manila and vicinities shows movement of the ground. (See figure below.) Blue areas correspond to sinking ground with the highest rates of subsidence at 5.5 cm per year. The image was processed by Narod Eco of the DOST project team. Subsidence will aggravate flooding from heavy rainfall and constitute a coastal-dike breach hazard in areas near Manila Bay. (Lagmay, 2011). From the map, it can be deduced that subsidence rate within the Cavite Spit is from 3 to 4 cm/yr. However, towards Rosario, a circular blue pattern indicates a higher rate of 4.5 cm/yr. This is likewise attributed to groundwater extraction.



Source: <http://opinion.inquirer.net/12757/large-areas-of-metro-manila-sinking> (Lagmay, 2011)

**Figure 2.1-48. Satellite Image of Metro Manila and Vicinities Showing Ground Movement**

According to the report "Sinking Cities, An integrated approach towards solutions" by Deltares - Taskforce Subsidence (October 2013), the mean cumulative subsidence 1900-2013 is 1,500mm, mean current subsidence rate is up to 4.5 cm/yr, maximum is 4.5 cm/yr, estimated additional mean cumulative subsidence until 2025 is 40cm.

In the lowland areas covering the towns of Bacoor, Imus, General Trias, Dasmariñas, Naic, Tanza, Ternate, hundreds of artesian wells and deepwells provide water supply for both domestic and irrigation purposes. According to a JICA study, the groundwater in Cavite is depleting at a rate of 1m water level decrease per year. Consequently, subsidence has also occurred in the northern and central parts of Cavite.

#### **Geotechnical Settlement Analysis (by AMH Phils., Inc.)**

The settlement analysis was carried out with the aid of Settle 3D software. Settle 3D is a 3-dimensional program for the analysis of vertical consolidation and settlement under foundations, embankments, and surface loadings.

The subsurface conditions were idealized and the most critical condition, i.e. thickest soft soil layer, was modelled in the analysis. Settlement analysis was conducted for Island D. The parameters used in the



analysis based on the results of the soil investigation as well as established correlations for settlement parameters are presented in Table 2.1-10.

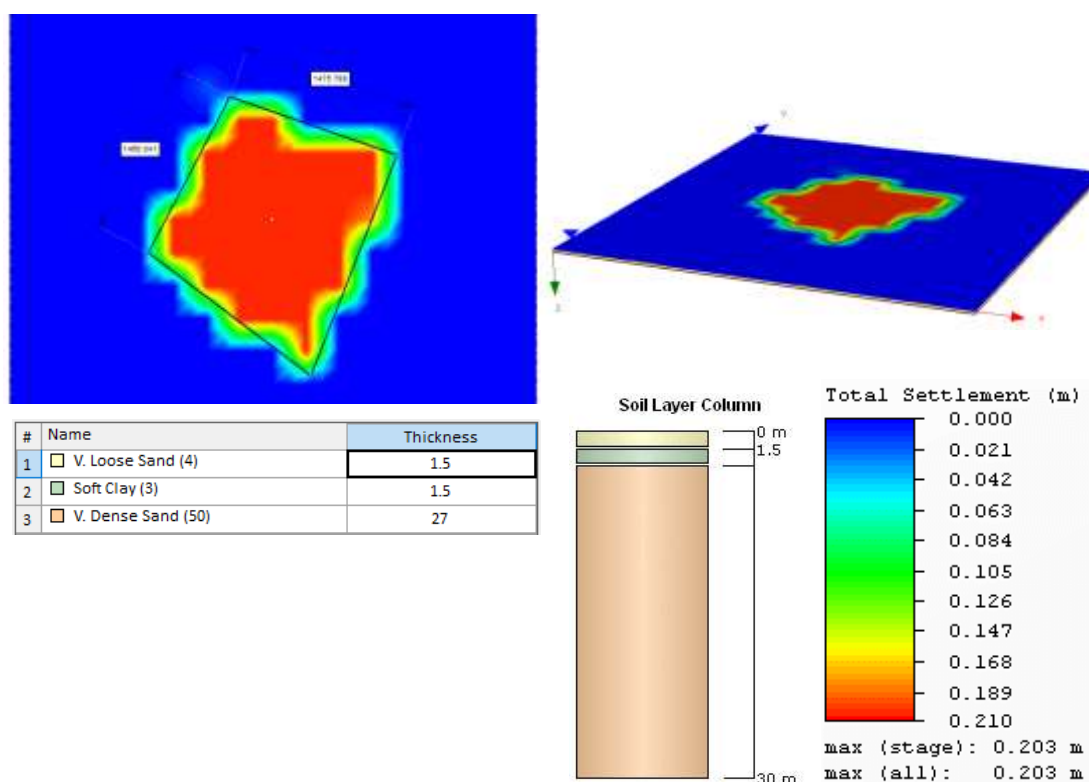
**Table 2.1-10. Geotechnical Parameters for Settlement Analysis**

| Depth, m   | Soil Type | N  | Consistency | Ave LL | g  | E    | C <sub>c</sub> | C <sub>r</sub> | e <sub>0</sub> | C <sub>v</sub> | OCR |
|------------|-----------|----|-------------|--------|----|------|----------------|----------------|----------------|----------------|-----|
| 0.0 - 1.5  | Sand      | 4  | Very Loose  | -      | 16 | 7500 | -              | -              | -              | -              | -   |
| 1.5 - 3.0  | Clay      | 3  | Soft        | 32     | 14 | -    | 0.198          | 0.0198         | 0.9            | 0.002          | 1   |
| 3.0 - 30.0 | Sand      | 50 | Very Dense  | -      | 20 | -    | -              | -              | -              | -              | -   |

In the analysis, the fill needed to achieve final elevation of +4.00m was considered as surface loading on top of the existing soil layers. The corresponding surface load for each fill height is summarized in the following table.

**Table 2.1-11. Equivalent Surface Load for Each Reclamation Fill Height**

| Thickness of Fill (Seabed to Elev +4m), m | Surface Load, kPa |
|---|-------------------|
| 9.0                                       | 162               |
| 12.0                                      | 216               |



**Figure 2.1-49. Settlement Analysis Results for 9m fill height**

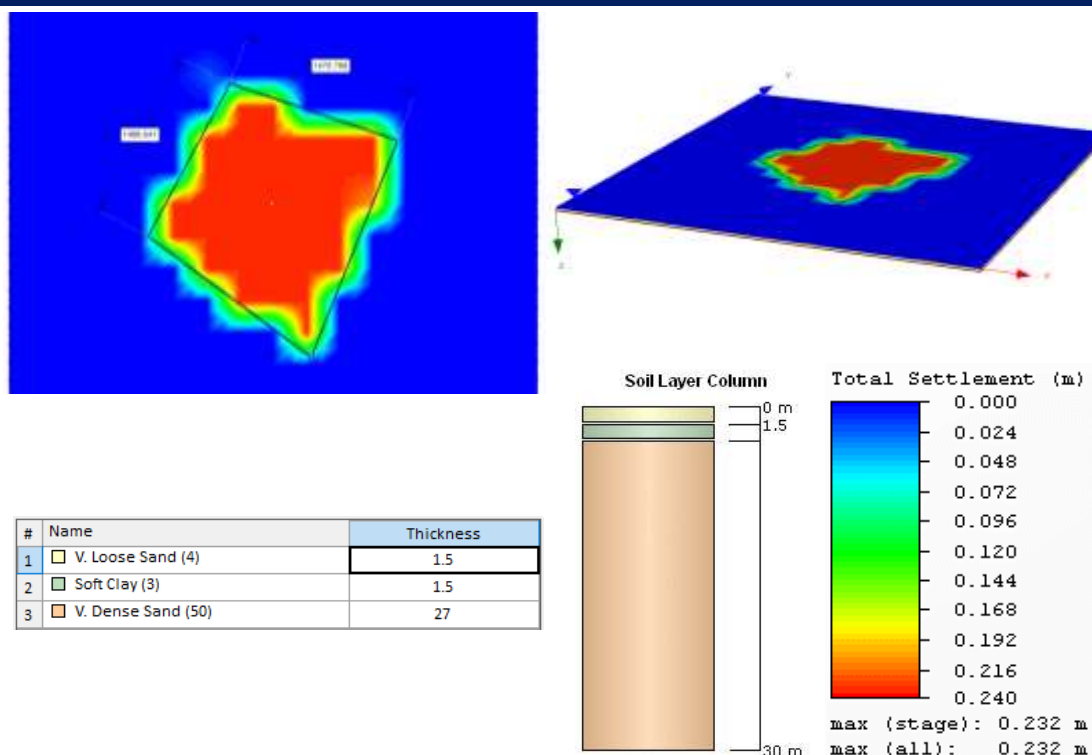


Figure 2.1-50. Settlement Analysis Results for 12m fill height

The results of the settlement analysis show that for the underlying silts and clays of varying plasticity, the maximum estimated settlement ranges from 203mm to 232mm for Island D where the thickness of soft soil is only ~4.5m. Pre-loading with prefabricated vertical drains (PVD) is recommended to accelerate the consolidation / long-term settlement.

Table 2.1-12. Results of Settlement Analysis

| Depth of Fill<br>Required for<br>Elev. +4m, | Immediate<br>Settlement,<br>mm | Consolidation<br>Settlement,<br>mm | Total<br>Settlement,<br>mm | Time to 95%<br>Consolidation,<br>month |
|---|--------------------------------|------------------------------------|----------------------------|--|
| 9   | 32.4                           | 203                                | 203                        | 2.6                                    |
| 12  | 43.2                           | 232                                | 232                        | 2.5                                    |

### Impact Analysis

Settlement is a natural geological hazard that exist with or without the project. The reclaimed land will not induce nor aggravate this hazard, but the project will be vulnerable to them. To a certain extent, load of constructions and infrastructure (i.e. settlement of high compressibility soil) and site dewatering for foundation excavations can induce settlement/subsidence if not done properly. However, as dredging of foundation/unwanted seabed materials will be above groundwater level, no significant settlement will arise.

The main causes of settlement in Cavite and Manila Bay area as a whole are natural compaction of soil and excessive groundwater drawdown. These can bring about serious effects on the project if not properly addressed. The proposed land reclamation is located at a relatively large distance from the reported critical spots in Navotas and Malabon cities, and the Manila Port area. However, the Municipality of Rosario is likewise considered as a critical area due to excessive groundwater drawdown.





Furthermore, the reclamation project site would be underlain by fill materials that are highly compressible, which makes it prone to these hazards. Construction of buildings or other structures on the site will put additional load on the fill materials that could result to settlement. The presence of soft saturated unconsolidated material with very low N values up to a depth of 4.5 from the surface along the reclamation site makes the area a medium-risk zone for settlement and subsidence.

The impacts of settlement are further exacerbated by extreme weather events (short term) and rising sea levels (long term). Sea level has been recorded at Manila's South Harbor since 1902. It rose around 1.3 mm/yr (the global rate) until the early 1960s, when it increased to about 2.6 cm/yr (Siringan and Ringor, 1998; Siringan and Rodolfo, 2003).

### Mitigating Measures

Remediation options include: compaction – densifying sandy soil with vibration and impact; pore water pressure rod (vibro) compaction, dissipation – installing permeable drain pipes; cementation and solidification – mixing stabilizing material in sandy soil; replacement; lowering of groundwater level; shear strain restraint; preload; and structural measures. A combination of these methods has been found to be more effective. The choice of the remediation method will depend on site characteristics. It is important that the chosen method will minimize or mitigate the impacts to the reclaimed land and at the same time, will not bring adverse effects to its immediate environs. The selection is in accordance with international standards and suitability to the reclaimed land in terms of type of fill materials and existing ground conditions.

Precisely because of this physical characteristic of the underlying fill materials, deep foundation systems for planned structures should be undertaken to address or mitigate this hazard. A settlement criterion shall be calculated and will include settlements that will develop in the natural subsoil and those that will develop in the reclamation fill from project handover to the end of project life. The reclamation to be constructed must be founded on the solid bedrock and appropriate foundation design should be put in place to mitigate these hazards

The fill materials must be fully engineered and compacted/densified to ensure stability and mitigate liquefaction potential. The soil remediation process that will increase the N-value should be advanced to the bottom of pre-existing alluvium, which is the cohesionless soft soil at the upper layers of the subsurface.

Another important mitigating measure is to avoid or discontinue the excessive groundwater extraction in Rosario and vicinities. Alternative sources of water must be made available to the residents and other consumers.

### Deep Foundation

Considering the geotechnical conditions of the site wherein the upper 1.5m-4.5m of the existing soil layer consist of very loose to loose sands and very soft silts and clays (N-value < 10), deep foundation may not be extremely necessary. From the subsurface idealizations, the bearing layer (SPT N-value > 50 for sand, > 30 for clays) is estimated to be at depths of about 9m to 15m below the seabed.

Still, calculations of pile capacities were carried out using the AllPile software. AllPile is capable of vertical and lateral analysis for both driven and bored piles. Vertical analysis is based on the approaches and methods recommended by Federal Highway Administration (FHWA), American Association of State and Highway Transport Officials (AASHTO), and NAVY Design Manual-07 Naval Facilities Engineering Command (NAVFAC). Lateral analysis uses the finite-difference method to model soil-structure interaction.

Input parameters include pile geometry (including orientation) and head/loading conditions and soil properties. The reclaimed area (Elev. +4m from MLLW) was considered in modelling the soil profile. Shear



strength parameters were estimated using established SPT-N correlations and local project experiences. Included in the parameters are the coefficient of lateral subgrade reaction (kh), used in lateral analysis of piles. These are presented in terms of 'B', the pile diameter or width. The geotechnical parameters for deep foundations are shown in Table 2.1-17 under Pedology subsection.

To obtain the safe pile capacities (axial downward and uplift), a Factor of Safety (FS) of 3.0 was adopted for axial capacities and the FS for uplift capacity is 3.0. Calculations of pile capacities were carried out considering 600mm, 800mm, and 1000mm concrete bored piles. Pile lengths are reckoned from the final reclamation elevation of +4.00m from MLLW level. The pile tips are estimated to be embedded 3.0m below the competent strata.

The following table provides the summary of the computed allowable pile capacities.

**Table 2.1-13. Summary of Allowable Pile Capacities for Concrete Bored Piles**

| Borehole No. | Width mm | Estimated Pile Length m | Compression kN | Uplift kN | Lateral kN |
|--------------|----------|-------------------------|----------------|-----------|------------|
| BH-19        | 600      | 22                      | 1095           | 575       | 200        |
|              |          | 27                      | 1375           | 755       | 200        |
|              |          | 32                      | 1655           | 935       | 200        |
|              | 800      | 22                      | 1730           | 860       | 375        |
|              |          | 27                      | 2165           | 1145      | 375        |
|              |          | 32                      | 2595           | 1425      | 375        |
|              | 1000     | 22                      | 2445           | 1170      | 590        |
|              |          | 27                      | 3070           | 1580      | 590        |
|              |          | 32                      | 3685           | 1990      | 590        |
| BH-20        | 600      | 22                      | 985            | 500       | 210        |
|              |          | 27                      | 995            | 685       | 210        |
|              |          | 32                      | 1515           | 905       | 210        |
|              | 800      | 22                      | 1570           | 760       | 375        |
|              |          | 27                      | 1550           | 1060      | 375        |
|              |          | 32                      | 2390           | 1380      | 375        |
|              | 1000     | 22                      | 2225           | 1035      | 590        |
|              |          | 27                      | 2170           | 1460      | 590        |
|              |          | 32                      | 3365           | 1900      | 590        |
| BH-21        | 600      | 21                      | 1035           | 480       | 210        |
|              |          | 26                      | 1315           | 660       | 210        |
|              |          | 31                      | 1590           | 835       | 210        |
|              | 800      | 21                      | 1720           | 785       | 375        |
|              |          | 26                      | 2210           | 1105      | 375        |
|              |          | 31                      | 2705           | 1420      | 375        |
|              | 1000     | 21                      | 2395           | 1105      | 590        |
|              |          | 26                      | 3025           | 1600      | 590        |
|              |          | 31                      | 3655           | 2095      | 590        |
| BH-22        | 600      | 25                      | 1075           | 525       | 210        |



| Borehole No. | Width mm | Estimated Pile Length m | Compression kN | Uplift kN | Lateral kN |
|--------------|----------|-------------------------|----------------|-----------|------------|
|              |          | 30                      | 1130           | 560       | 210        |
|              |          | 35                      | 1615           | 875       | 210        |
|              |          | 25                      | 1860           | 900       | 370        |
|              | 800      | 30                      | 2340           | 1205      | 370        |
|              |          | 35                      | 2820           | 1515      | 370        |
|              |          | 25                      | 2665           | 1260      | 585        |
|              | 1000     | 30                      | 3345           | 1705      | 585        |
|              |          | 35                      | 4025           | 2145      | 585        |
|              |          | 22                      | 1180           | 570       | 210        |
| BH-24        | 600      | 27                      | 1460           | 750       | 210        |
|              |          | 32                      | 1735           | 925       | 210        |
|              |          | 22                      | 1960           | 935       | 370        |
|              | 800      | 27                      | 2455           | 1255      | 370        |
|              |          | 32                      | 2960           | 1575      | 370        |
|              |          | 22                      | 970            | 560       | 590        |
|              | 1000     | 27                      | 1245           | 735       | 590        |
|              |          | 32                      | 1520           | 910       | 590        |
|              |          | 26                      | 1185           | 695       | 200        |
| BH-27        | 600      | 31                      | 1460           | 875       | 200        |
|              |          | 36                      | 1740           | 1055      | 200        |
|              |          | 26                      | 1875           | 1055      | 370        |
|              | 800      | 31                      | 2350           | 1360      | 370        |
|              |          | 36                      | 2830           | 1670      | 370        |
|              |          | 26                      | 2645           | 1435      | 580        |
|              | 1000     | 31                      | 3310           | 1870      | 580        |
|              |          | 36                      | 3980           | 2305      | 580        |

#### Shallow Foundation Analysis (by AMH Phils., Inc)

The choice of the foundation scheme mainly depends on the magnitude of the structural loads that have to be transmitted by the foundations into the underlying ground.

In the subsequent analyses, the fill materials required to reach reclamation elevation of +4m (from MLLW) was considered. From the range of fill height required for the island, the depth of fill ranges from 9m to 12m, hence, it was assumed in the analysis that shallow foundations lie directly on the reclaimed fill. The parameters for the fill are shown in the table below.

**Table 2.1-14. Properties of Sand Fill for Shallow Foundation Analysis**

| Ground Improvement       | N-value | Unit Weight, g (kN/m <sup>3</sup> ) | Cohesion, c (kPa) | Friction Angle, ° |
|--------------------------|---------|-------------------------------------|-------------------|-------------------|
| Vibrocompacted sand fill | 15      | 18                                  | 0                 | 30                |





For the reclamation area, the safe bearing capacity is **90 kPa ( $\approx 1870$  psf)** at a minimum foundation depth of 1.0m BGL (below ground level – reclaimed area at elev. +4m). For proportioning of various foundation widths and depths, allowable bearing capacity charts are presented in the graph below.

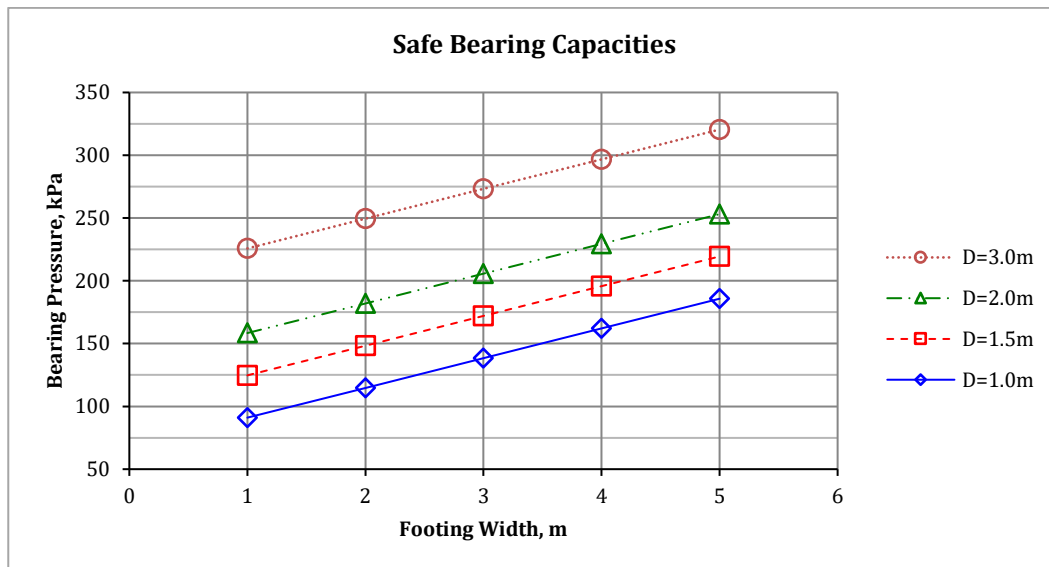


Figure 2.1-51. Safe bearing capacities for the reclamation area

#### 2.1.2.3.3 Volcanic Hazards (Ash Fall)

The dangers posed by volcanoes are associated with eruption. Hazard from volcanic eruption depends on the magnitude of its explosion. Hazards associated with volcanic eruptions include pyroclastic flows and base surges, lava flows, lahars and the ash or tephra fall.

Probably the greatest threat to Cavite is Taal Volcano in Tagaytay but is unlikely to cause major problems. It is about 56 aerial kilometers to the southeast of the project site. The ash fall may be a nuisance and reduce air quality. Taal Volcano is closely monitored and one would likely receive a few weeks warning of a possible eruption. However, considering the distance of the project site to Taal Volcano, even the far-reaching ash fall/tephra fall hazard has little effect the proposed project.

#### Impact Analysis

There will be no impact on the project except probably for some degree of nuisance (dust particles). Similarly, the project will not aggravate this hazard to harm the environment.

#### Mitigating Measures

This hazard is seemingly absent in the project area and therefore no mitigation measures to be implemented.

#### 2.1.2.3.4 Hydrometeorological Hazards

##### 2.1.2.3.4.1 Flooding

The Philippines lies in the Western Pacific basin, the world's most active typhoon belt. It is visited by an average of 20 typhoons a year. Typhoons and monsoons often bring disasters such as flooding, landslides, and storm surge. Floods usually occur during or after heavy rainfall wherein the river channels are saturated



with water resulting to river swelling and overflowing of floodplains. The low-lying areas and those areas with poor drainage system are susceptible to flood hazard.

The project area falls within the delineated areas with high susceptibility to flooding as shown in the flood hazard maps (Figures 2.1-52 and 2.1-53) by MGB (2010) and READY Project (2008). Considering that it is low-lying and has a flat terrain, the project site could experience localized flooding especially if the drainage systems are inadequate. The 100-Year Flood Hazard Maps (Figure 2.1-54) by Project NOAH is consistent with the other two hazard maps. The whole Cavite Spit and the coastal areas from Bacoar to Rosario are highly susceptible to flooding, though in varying extent. Areas near the rivers are more flood-prone.

Generally, flooding in Cavite is only experienced in low-lying towns of the Province based on the study conducted by the Japan International Cooperation Agency (JICA) in 2008. There are major rivers of the Province that serves as catchment areas.

The flooding in Cavite has three types: the River Overflow Flood, Inland Flood and Coastal Flood.

**River overflow** flood is defined as the flood caused by the overflow from the river. This flood type is usually associated with typhoons. In Cavite, this flooding is due to inadequate flow capacity of various rivers and tributaries. The floods usually occur at the low dike section, narrow or bottleneck sections and the bridge sections. This is because those areas are usually clogged with debris. This can also be attributed to intensive land conversion and development for industrial and residential uses. In the year 2000-2006, there are four major river overflow floods recorded. These were brought by Typhoons Reming, Gloria, Inday and Milenyo. Typhoon Milenyo and Reming both caused damages to properties as well as public infrastructure such as bridges, dams and ripraps of flood ways. The water volume coming from the upland part of the province also contributes to the volume of water in the lowland rivers and tributaries. The upland municipalities of Indang, Amadeo and Silang also experience river overflow flooding but at minimal circumstances and extents. (PDRRMO, 2010)

**Inland flood** is defined as inundation caused by the stagnation of the storm rainfall and/or the overflow from the local drainage channel. Intrusion of seawater during high tide would also cause this kind of flooding. (PDRRMO, 2010)

The project site in the towns of Noveleta and Rosario is generally highly susceptible to flooding. In fact, all barangays have been affected by flooding in the past. (PDRRMO, 2010)

Cavite is shielded by mountain ranges but is open to rains brought in by the Southwest Monsoon locally known as “Habagat.” This natural phenomenon occurs when warm moist air flows over the country from the southwest direction that brings rain to the western portion of the country. Cavite was one of the provinces affected by the two consecutive-years of extreme flooding referred to as the “2012 and 2013 Habagat Floods.” (PDRRMO, 2010)

**Coastal Flooding.** Cavite’s coastline stretches around 123 km and could be found along Cavite City, Bacoar, Kawit, Noveleta, Rosario, Tanza and Naic. The coastal barangays of these towns are highly susceptible to flooding. The coastal plain in Kawit, Noveleta, and Rosario has extremely low ground level of EL. 0 to 2 meters, and the tidal flood often occurs in its substantial part even without storm rainfall. Such tidal inundation is being aggravated by the progress of land subsidence. (PDRRMO, 2010)

Table 2.1-15 enumerates the recent typhoons that affected the Province of Cavite.



**Table 2.1-15. List of Recent Typhoons that Affected Cavite**

| Tropical Cyclone          | Date of Occurrence     | Maximum sustained winds (kt) | Population/Areas Affected   | Impact  |
|---------------------------|------------------------|------------------------------|---|---|
| TS Santi (Nari)           | 11-Oct-13              |                              |   |   |
| TS Maring (Trami)         | 22-Aug-13              |                              | Carmona, Cavite City, Bacoor, Dasmariñas, Imus, GMA, Gen. Trias, Indang, Kawit, Naic, Noveleta, Rosario, Silang, Tanza, Ternate, Trece Martires |   |
| TS Gener (Saola)          | Jul 30-31, 2012        |                              | Bacoor, Cavite City, Imus, Ternate, Kawit, Naic, Rosario, Noveleta, Ternate   |   |
| TS Pedring (Nesat)        | Sep 26-28, 2011        |                              | Cavite City   |   |
| TS Falcon (Meari)         | 21-Jun-11              |                              | Kawit – 23 barangays, 4,438 families, 8,870 individuals   | No significant damages incurred   |
| TS Dodong (Sarika)        | 9-Jun-11               |                              | Noveleta flooded. 20 fam and 40 ind   | No significant damages incurred   |
| Typhoon Juan (Megi)       | October 13-24, 2010    | 155                          | Tagaytay City – 1 brgy, 15 fam, 57 ind<br>Ternate – 1 brgy, 64 fam, 315 ind<br>Cavite City – 2 brgy, 107 fam, 428 ind                           | No significant damages incurred   |
| Typhoon Basyang (Conson)  | July 11-18, 2010       | 75                           | All municipalities of Cavite - with 729 brgys, 49,678 fam, 247,537 ind  | Dead – 14, Injured – 13, Missing 3, totally damaged houses (TDH) - 2,558; partially damaged houses (PDH) - 32,735; Cost – Php 14M |
| Typhoon Santi (Mirinae)   | Oct. 27-Nov. 3, 2009   | 90                           | 16 mun, 126 brgys, 4,141 fam, 18,954 ind  | Dead – 1; Injured – 13; TDH - 155; PDH -1,267; Cost of damages - Php 177.72M  |
| Typhoon Pepeng (Parma)    | Sept. 27-Oct. 14, 2009 | 130                          | 5 mun, 470 fam, 1,402 ind   |   |
| Typhoon Ondoy (Ketsana)   | Sept. 25-30, 2009      | 90                           | 19 mun, 442 brgys., 113,817 fam, 534,209 ind  | Dead – 6; Injured – 5; Missing - 1; TDH - 293; PDH -2,325; Cost -: Php 37M  |
| Flashflood – Pansol River | 21-Sep-09              |                              | Dasmariñas, barangays Paliparan & Sampaloc IV   | Dead - 5  |
| Typhoon Isang (Molave)    | July 15-19, 2009       | 65                           | Kawit, Rosario, Imus, Bacoor, Noveleta and Naic: 53 barangays, 16,993 families  | TDH - 11<br>PDH – 120   |
| Typhoon Ferie (Nangka)    | June 22-27, 2009       | 45                           | 3 mun, 8 brgy, 706 fam, 3,484 ind   | TDH - 84<br>PDH - 5   |
| Typhoon Frank (Fengshen)  | June 18-26, 2008       | 95                           | 12 mun, 166 brgy, 40,645 fam, 206,827 ind   | TDH - 43<br>PDH –227; Cost of Damages – Php 40.43M  |
| Typhoon Hana (Lekima)     | Sep 30 - Oct 4, 2007   | 70                           | Rosario and Noveleta: 639 families.   | TDH - 28<br>PDH - 10  |
| Typhoon Egay (Sepat)      | August 12-20, 2007     | 140                          | 14 mun, 232 brgy, 53,090 fam, 260,561 ind   | 1 missing   |
| Typhoon Chedeng (Pabuk)   | August 5-9, 2007       | 65                           | 11 mun, 122 brgy, 87,920 fam, 438,701 ind   | Partially damaged houses - 13   |





| Tropical Cyclone           | Date of Occurrence    | Maximum sustained winds (kt) | Population/Areas Affected                                 | Impact   |
|----------------------------|-----------------------|------------------------------|---|--|
| Typhoon Milenyo (Xangsane) | Sep 25 to Oct 2, 2006 | 125                          | All mun, 463 brgy, 164,137 fam, 794,339 ind               | Dead – 31; Injured – 64; Missing – 18; TDH - 8,509; PDH - 48,562; Cost - PhP 835.24M |
| Typhoon Florita (Bilis)    | 13-Jun-06             |                              | 7 mun, 45 brgy, 2,260 fam, 1,111 ind                      | TDH - 51<br>PDH - 38   |
| Typhoon Inday (Halong)     | July 2002             |                              | Bacoor, Noveleta, Rosario, Imus, Kawit, etc., 168,025 ind | Dead – 1   |
| Typhoon Gloria (Chataan)   | July 2002             |                              | Bacoor, Noveleta, Rosario, Imus, Kawit, etc., 173,075 ind |  |
| Typhoon Reming (Xangsane)  | Oct 2000              |                              | Bacoor, Noveleta, Rosario, Imus, Kawit, etc., 380,616 ind | Dead – 10  |

Source: NDCC, Cavite PDCC, Cavite PSWDO

As sea levels rise due to climate change, low-lying coastal areas are frequently flooded by the sea. Global warming is known to be causing stronger cyclones and rising oceans levels. Other aggravating factors include occurrence of high tide at same time with heavy rains, and non-climate factors (e.g. land subsidence and loss of natural retention areas mostly due to concreting of ground surface).

The rising sea level will adversely affect any properties located near the shoreline and in reclaimed areas of Metro Manila and vicinities. Geologically, these areas are those located along what geologists dubbed the Coastal Margin. A lot of areas in the coastal lowlands are already experiencing perennial flooding with or without the proposed project.

### Impact Analysis

Where land reclamation is known to cause loss of wetlands, floodwater storage is likewise lost or decreased and thus may lead to flooding. For this project, the project site on the fringes of the Cavite Spit facing Manila Bay is devoid of wetlands or marshes, and therefore, it will not aggravate flooding in the area. The island will be separated from the mainland, hence, it will not cause narrowing of the mouths of tidal inlets and Cañas River. In effect, the project will not impede discharge of excess rainwater from the river, and hence, will not cause riverine flooding.

According to the PRA, well-designed and properly constructed reclamation projects will not cause flooding. On the contrary, they can prevent flooding by providing added protection, such as sea barriers to mitigate the effects of accelerated rising sea levels, which is a direct effect of global warming. What happened, in fact, was that the whole stretch covered by the reclamation projects under the Boulevard 2000 Plan along Roxas Boulevard—from the Cultural Center of the Philippines to the coastal road—did not suffer the same catastrophic rush of seawater, unlike the areas from the Manila Yacht Club to the US Embassy. The seawalls built to protect the reclaimed area saved the establishments and inhabitants there. <http://opinion.inquirer.net/15993/on-reclamation-and-flooding> (October 2011)

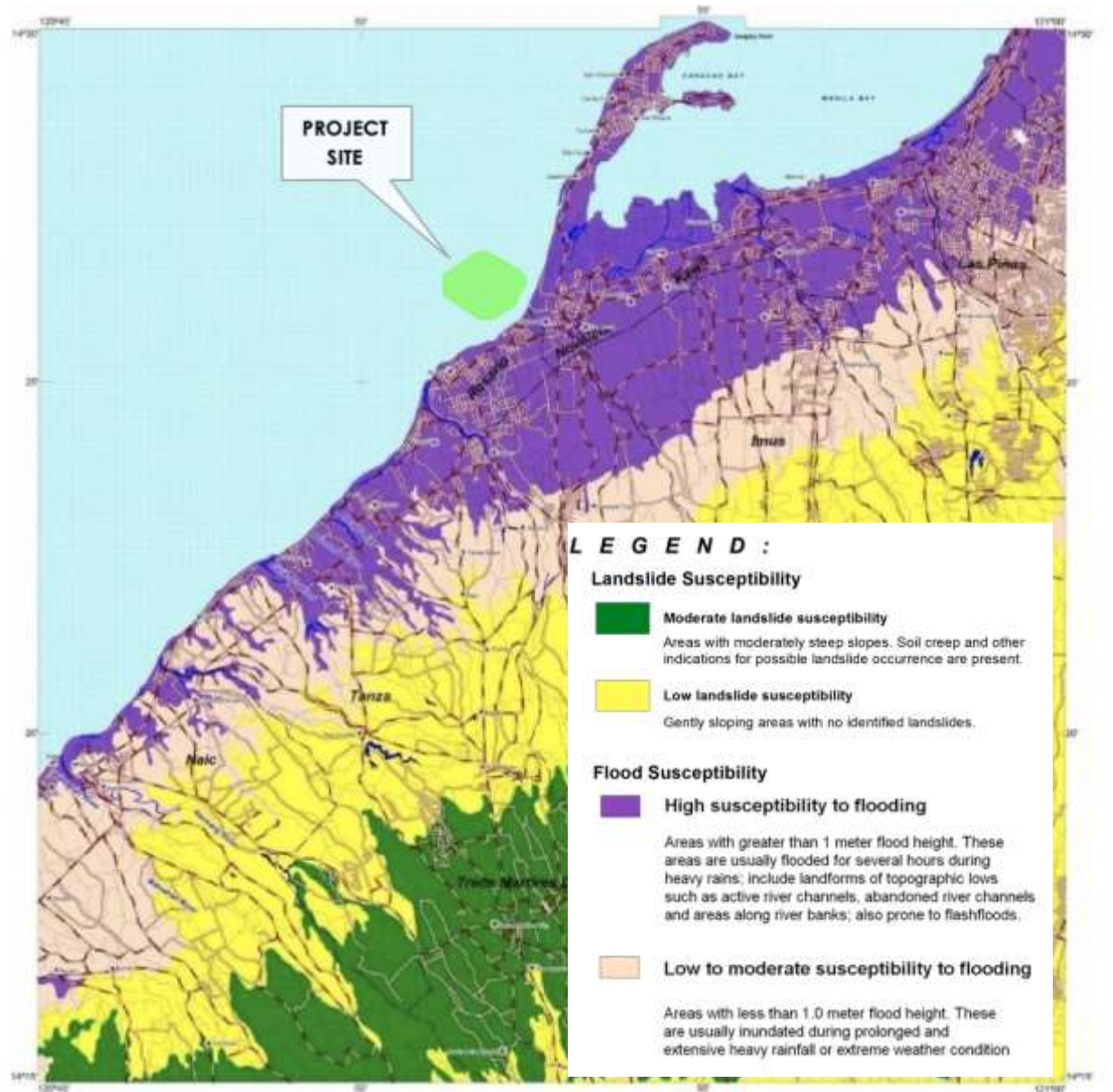
More detailed analysis on flood hazard are presented under Chapter 2.2.1 Hydrology/Hydrogeology – Flood Studies.

### Mitigating Measures

To help mitigate flooding, the engineering design of the reclamation should provide for adequate channels, drainages and runoff discharges to the open sea as well as non-blockage of river outfalls and other flood paths.



The design of structural flood defenses should account for possible overtopping but should not be over-estimated as this could also possibly cause trapping of floodwaters. Where flood defenses are breached, it will usually result in sudden flooding with little or no warning and will present a significant hazard and danger to life.



Source: MGB 2010 (from 1:50,000 base maps)

**Figure 2.1-52. Landslide and Flood Susceptibility Map of Cavite City Quadrangle**



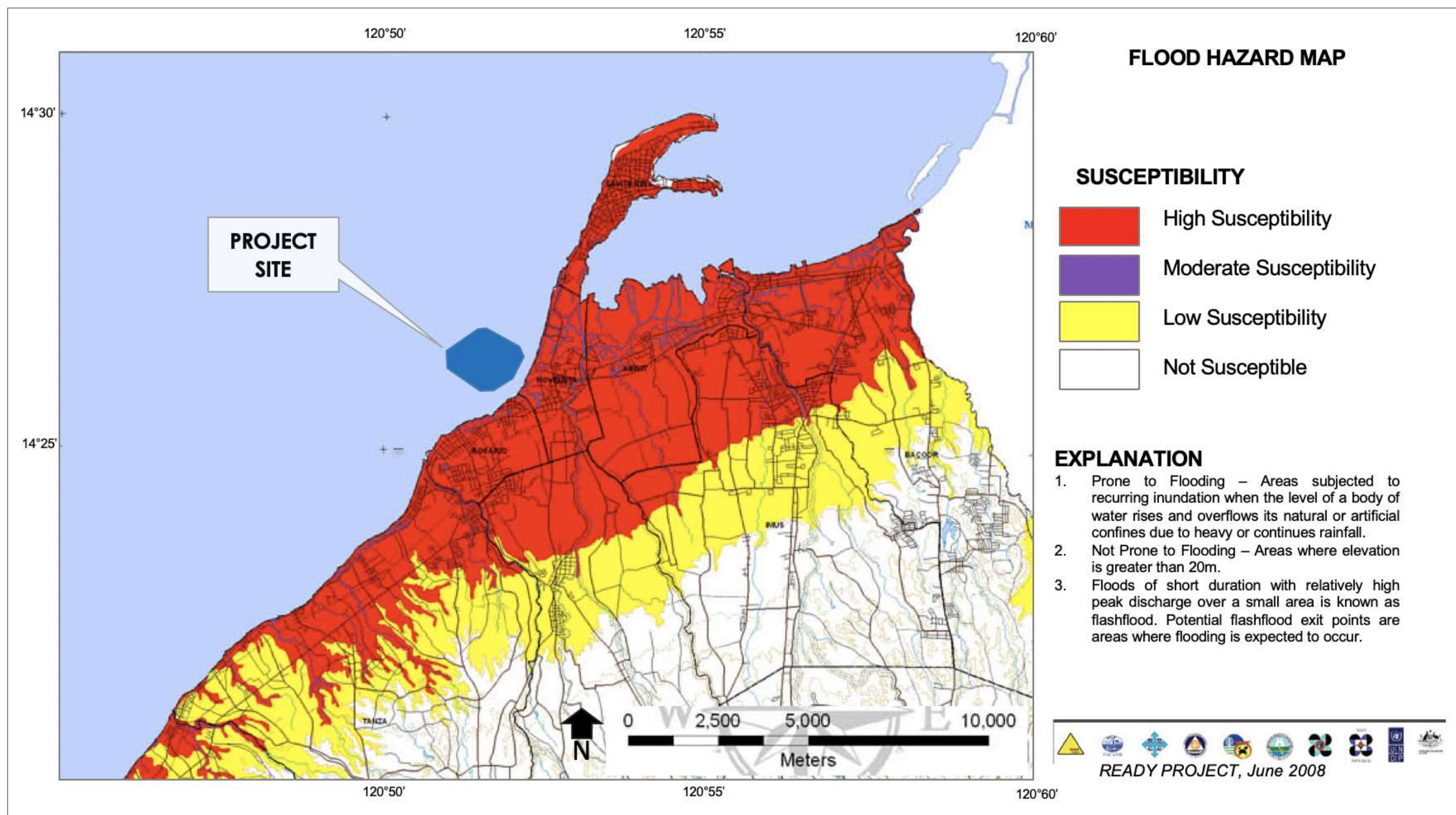
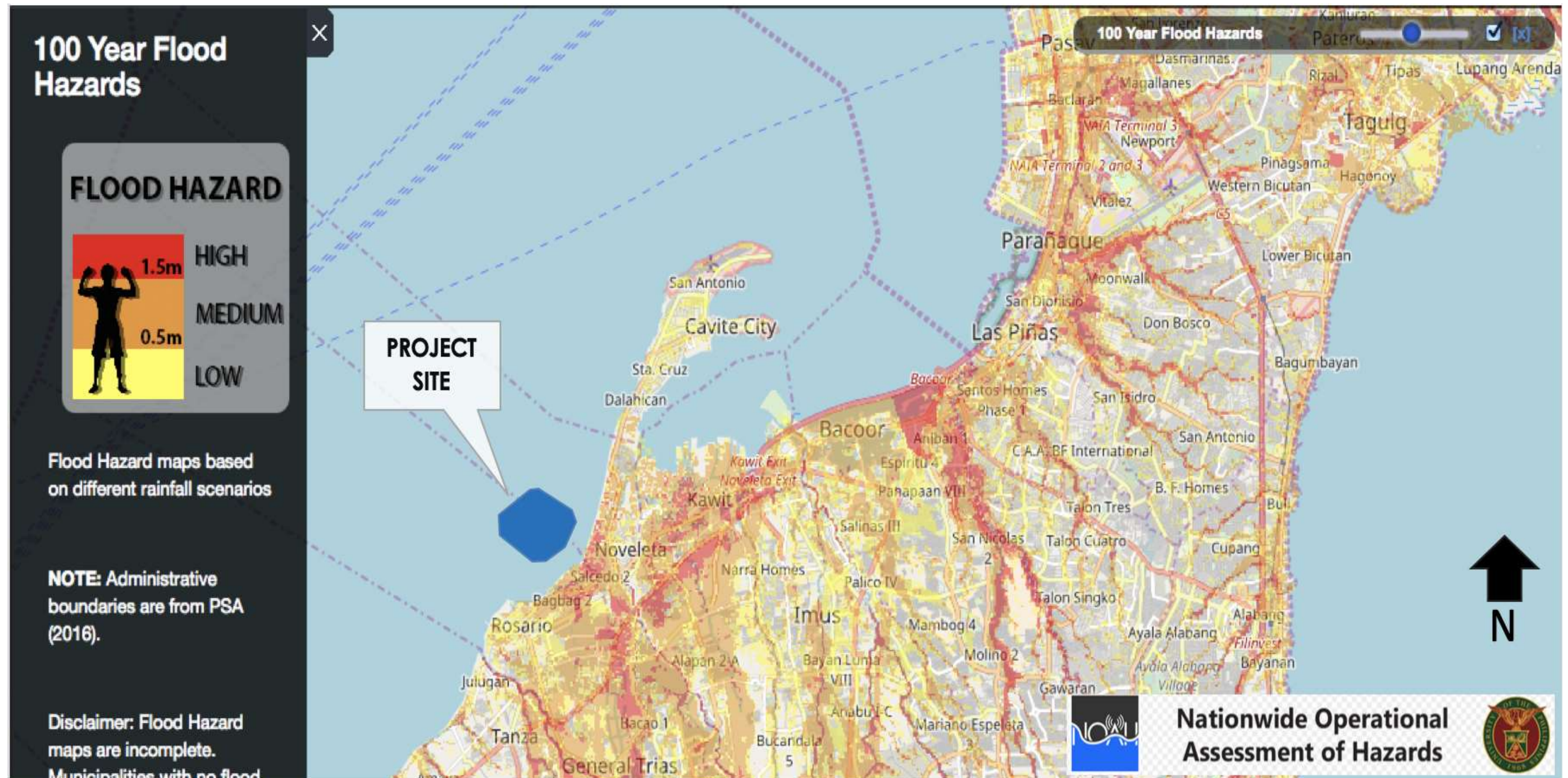


Figure 2.1-53. Flood Hazard Map of Cavite





Source: UP Project Noah, screen captured on August 2017

Figure 2.1-54. 100-Year Flood Hazard Map of Cavite and vicinities



#### **2.1.2.3.4.2 Storm Surges / Seiches / Storm Waves**

Storm surge is an abnormal rapid rise of sea level resulting from strong winds pushing water towards the shore (NOAA, 2013). This can cause severe destruction and damage in its surrounding areas. High winds push the ocean's surface that causes water pile up higher than the ordinary sea level. Storm surges have known to damage nearby coastal structures, resulting from the wave impacts and debris carried by the surge. Other effects include flooding of low-lying coastal areas and intense wave erosion of beaches, dunes and other structures. Based on the meteorological data, Manila Bay is exposed to an average of 5 typhoons in 3 years period vulnerable during the 2nd and 4th quarter of the year.

According to PAGASA, storm surges occurred seven times from 1960–72. Table 2.1-16 below is a list of storm surge events that affected the Manila Bay area. This is taken from the Compilation of Storm Surge Occurrences in the Philippines (Project NOAH, 2014).

On September 26-28, 2011, Typhoon Pedring (international name T. Nesat) hit the country generating storm surge as high as 6 meters in Manila Bay that damaged part of the breakwater and sea wall along Roxas Boulevard resulting to waist-deep flooding of the road and areas along the shoreline and causing millions of damages to properties. In 2012, Typhoon Saola (Gener) caused another surge that damaged the seawall and deposited tonnes of rubbish and filth along Roxas Boulevard and affected Brgys. San Rafael 3 & 4, Cavite City.

Dr. Mahar Lagmay stated that the 2011 storm surge was 1.5m high, "with splash waves higher than the coconut trees" while Yolanda's surge in Tacloban was 5m.

Parts of the municipalities of Bacoor and Kawit are susceptible to inundation of 1m surges, while the coastline along parts of Cavite City are exposed to inundations of > 1m to 4m surges. The former two are considered to be of low susceptibility level while the latter three are classified under moderately susceptible (PDRMO, 2010). One documented major storm surge, which affected Cavite, occurred at the peak of Typhoon Sening on October 10-15, 1970 and had an **actual height of 3-5 m** (PAGASA, 2004).

Therefore, it can be safely stated that waves/surges can occur with or without the project.

**Table 2.1-16. Storm Surges in the Manila Bay Area and Vicinities**

| No. | Date of Occurrence  | Associated Tropical Cyclone | Surge Height (m) | Affected Areas                      | Casualties | Damage  |
|-----|---------------------|-----------------------------|------------------|-------------------------------------|------------|---|
| 1   | June 29, 1589       | Unnamed typhoon             |                  | Manila Bay                          |            |   |
| 2   | Aug 29, 1863        | Unnamed typhoon             |                  | Manila                              |            | Destroyed Bagumbayan drive due to inundation, several houses unroofed |
| 3   | Sep 20-26, 1867     | Unnamed typhoon             |                  | Manila Bay                          |            | 17 ships tossed onto Sta Lucia & Tondo shores                         |
| 4   | Oct 25, 1873        | Unnamed typhoon             | 0.6              | Cavite                              |            |   |
| 5   | October 10-15, 1970 | Typhoon Sening*             | 3-5              | Cavite                              |            |   |
| 6   | Nov 19, 1970        | Typhoon Yoling (Patsy)      | 4                | Manila Bay, southern coast of Luzon |            | Destroyed \$40M property, sank 21 fishing boats near North Harbor     |





| No. | Date of Occurrence | Associated Tropical Cyclone | Surge Height (m) | Affected Areas  | Casualties | Damage   |
|-----|--------------------|-----------------------------|------------------|---|------------|--|
| 7   | Jun 23-25, 1972    | Typhoon Konsing (Ora)       |                  | Manila Bay & Bicol region   | 1          | Several ships washed ashore                        |
| 8   | Jul 2, 1983        | Typhoon Bebang (Vera)       | 4                | Bataan & at least 10 villages in Manila Bay's western banks   | 182        | 49,000 houses                                      |
| 9   | Sep 26-28, 2011    | Typhoon Pedring (Nesat)     | 6                | Coastal areas of Manila Bay, Brgys San Rafael 3 & 4, Cavite, Brgy. Pasungol, Santa, Ilocos Sur & Sta Rita Aplaya, Batangas City | 12         | Damaged the breakwaters & seawall along Roxas Blvd |
| 10  | Jul 30-31, 2012    | Typhoon Gener (Saola)       |                  | Zamboanga del Norte, Ternate, Cavite, Bulan, Sorsogon, & So. Tinago, Bgy Tibpuan, Lebak, Sultan Kudarat                         |            | 214 houses   |
| 11  | Aug 22, 2013       | Typhoon Maring (Trami)      |                  | Bgy Mabolo, Naic, Cavite & Molo District, Iloilo  |            | 14 houses damaged                                  |
| 12  | Oct 11, 2013       | Typhoon Santi (Nari)        |                  | Manila Bay  |            |  |

Source: Project <http://blog.noah.dost.gov.ph/2014/02/04/compilation-of-storm-surgeoccurrences-in-the-philippines/>. NOAH Open File Report Vol 2. Pages 7-11, February 2014

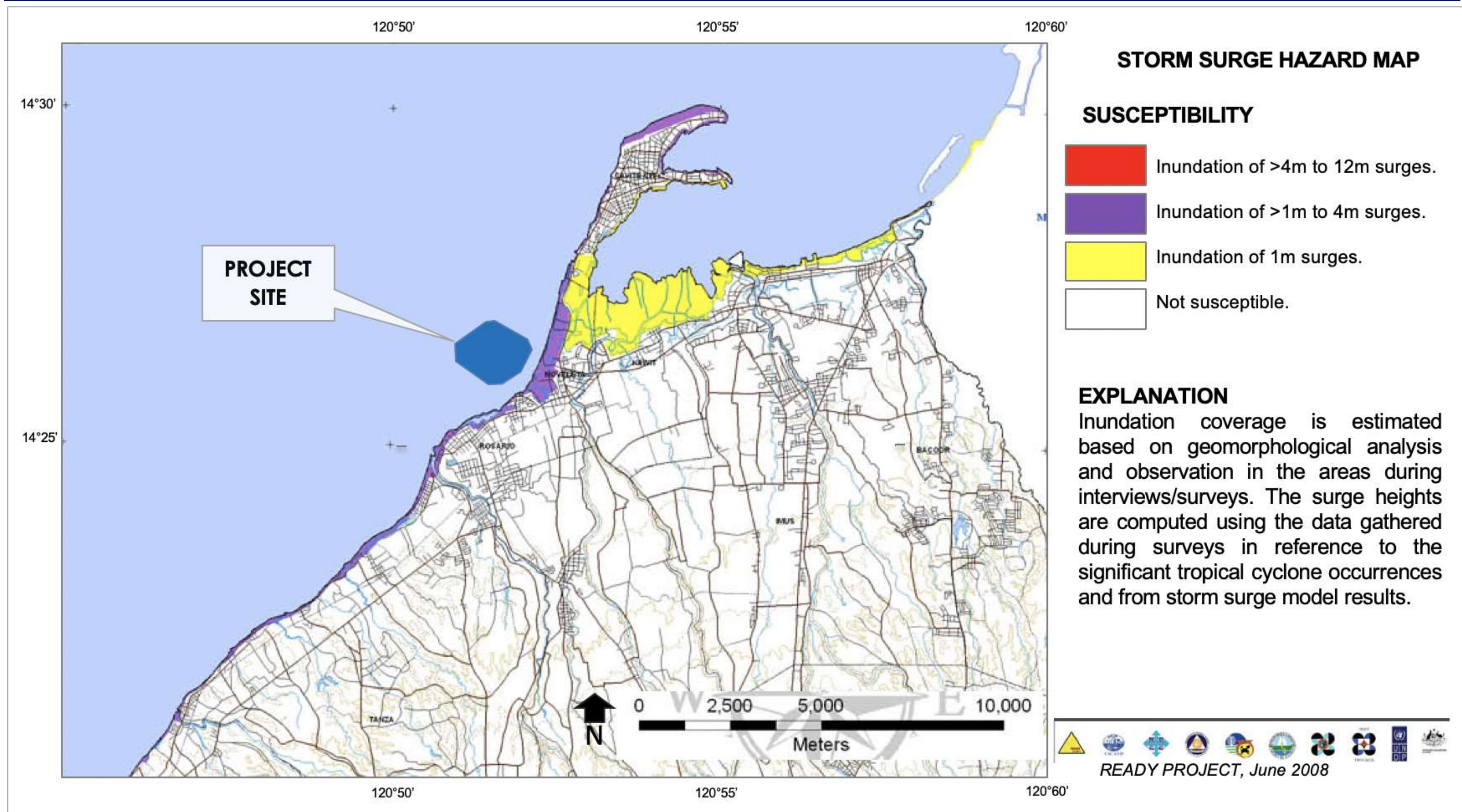
\* - Source is PAGASA, 2004 as cited in the Cavite Provincial Risk Reduction and Management Plan 2011-2016.

The Storm Surge Hazard Map of Cavite is presented in Figure 2.1-55 from READY Project while Figure 2.1-56 is the storm surge (advisory 2) map by UP NOAH.

Climate change (global warming) has potential impacts on the frequency and strength of typhoons, and hence, on storm surge and storm waves. Rise in sea levels, spurred by climate change, will increase water depths and, by extension, wave heights in stormy weather. Even if the rise in sea level during storms does not flood the coastal areas, the resulting waves probably will. Storm surges can also be enhanced by tidal fluctuations and can be difficult to prepare for unless one has an hour-by-hour estimation of the weather situation.

As sea levels rise due to climate change, low-lying coastal areas are permanently flooded by the sea. The likelihood and severity of storm surges also rises since weaker winds will also be able to increase the sea level enough to flood coastal areas. In addition, as the sea level rises, the water depth increases and the wave base becomes deeper; waves reaching the coast have more energy and therefore can erode and transport greater quantities of sediment.

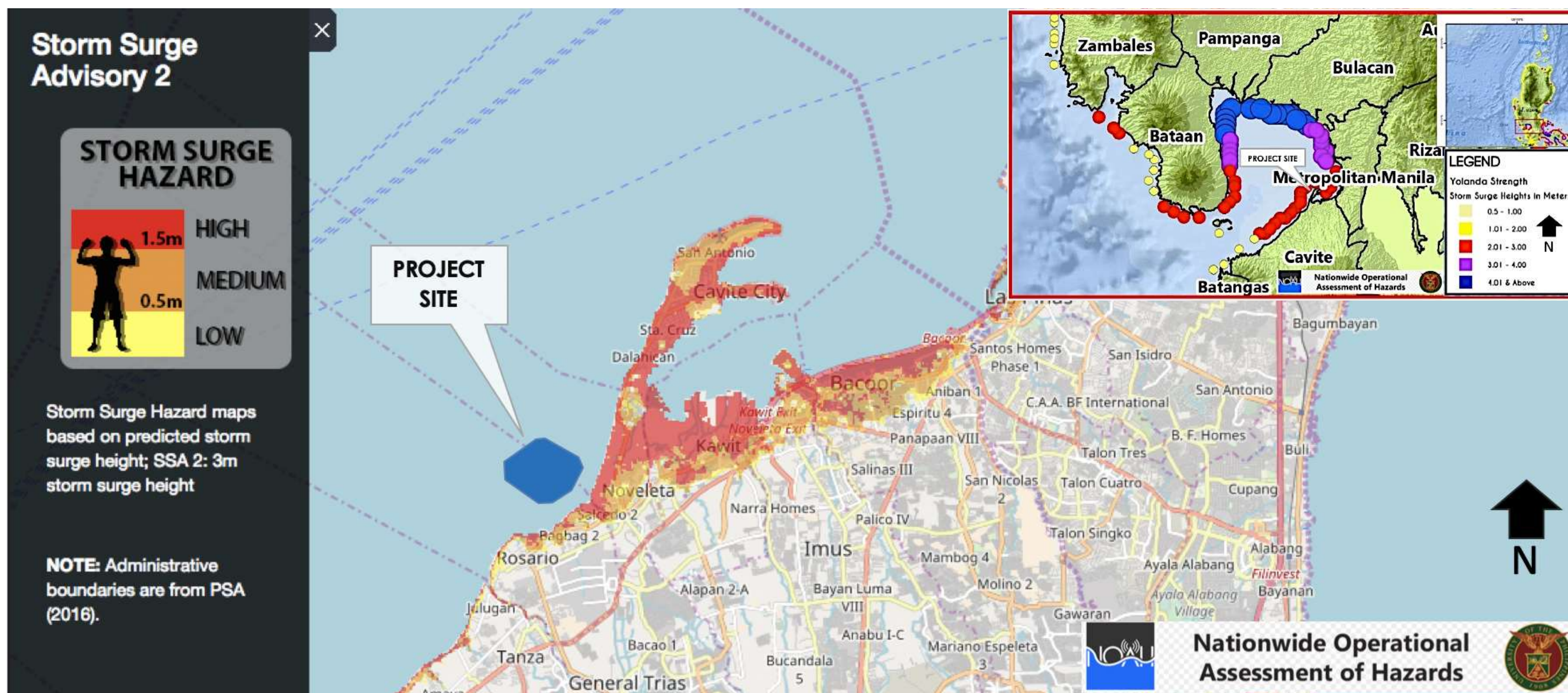




Source: READY Project, June 2008

Figure 2.1-55. Preliminary Storm Surge Hazard Map of Metro Manila





Source: UP Project Noah, screen captured on October 2017  
Inset – Maximum Storm Surge Height (Lapidez et al., 2014)

Figure 2.1-56. Storm Surge Advisory 2 Hazard Map of Cavite and vicinity



## **Impact Analysis**

Manila Bay was affected by storm waves riding atop storm surge. The gentle seabed slopes of the bay means higher waves can affect the shore.

The location of the reclaimed land will be such that it will be the nearest to the waterfront relative to land-based sites. This makes it the most vulnerable to storm surge and flooding. At worst case, the project will not increase the effects on land-based structures and facilities as well as on population. In fact, the proposed reclamation project has the potential of sheltering onshore population and structures/properties from storm surges or storm waves. This is evident in the areas along Roxas Boulevard in Pasay and Paranaque where reclaimed lands fringe the coastline. Going back to the Storm Surge Hazard Map – SSA2 (Figure 2.1-56), it is clear that the areas behind MOA to CCP Complex are safe from this hazard.

For the proposed project site in Noveleta and Rosario, Cavite, Island D will have a shielding effect on the coastal areas fronting the island.

Reclaimed lands are in fact known to serve as massive breakwater. Environmental planner Armando Alli and architect Jun Palafox agree that reclamation may serve as a breakwater. Alli cites the success of reclamation projects in China, Hong Kong, the Netherlands, and Dubai in terms of maximizing available space; while Palafox agrees that reclaimed patches of land do become tsunami or wave breakers if executed properly. <http://lifestyle.inquirer.net/99009/but-why-reclaim-manila-bay-in-the-first-place/> (Robillos A., Apr 17, 2013, inquirer).

## **Synthesis of Storm Conditions/Tide Levels**

This is discussed under 2.2.1.1 Change in Bathymetry.

## **Synthesis of Storm Waves**

This is discussed under Chapter 2.2.1 Hydrology/Hydrogeology.

## **Mitigating Measures**

At worst case, the project will not increase the effects on land-based structures and facilities as well as on population. In so far as those in the reclaimed land itself, in addition to the platform level, some structures may be placed in stilts while others will be designed with certain parts (floors) of a building/structure at high levels. The proposed project will include a “no build” zone and wave water catchment channels.

A more detailed design is considered based on the additional height/volume of seawater near the coast, which could be created by a tsunami/waves. This could be significantly deflected from reaching land, thus creating flood by the elevated reclaimed land.

An updated mathematical modeling will be conducted to simulate the storm surges/waves in terms of force and direction. Wave deflectors and other similar defenses such as revetment will be part of the study. The modeling will consider the volume of water that will inundate the project area should storm surges and tsunami reached to maximum predicted wave heights as well as the appropriation of “no-build zone” and wave water catchment channels. The “no-build” zone will observe the requirements of the PRA, which is 50 meters from the coastline.

The elevation of the reclaimed land and the use of properly designed structures such as wave deflectors will provide further effective method of dissipating storm waves, such protection not available in a “No Project Scenario”.





Storm surges are difficult to mitigate, however, the construction of wave deflector may help in minimizing the effect of surges. Construction of breakwater could also minimize the effect of storm surges

### **Overall Safety Awareness and Preparedness**

An essential part of hazard mitigation is the people's awareness and preparedness.

Safety drills should be institutionalized throughout the project life. This will include fire drills, earthquake drills, and the like. Evacuation muster points will be established. These efforts shall be in consonance with the Disaster/Risk Reduction and Management Plan of the government.

Lastly, the proponent will be actively involved in the Information, Education and Communication campaign to increase public awareness (especially the island dwellers and stakeholders) on hazard management.

A multi-hazard mitigation and protection plan for natural coastal hazards should be developed. Similarly, awareness about climate change impacts on coastal zone systems such as coastal erosion, sea level rise, and flooding risks should be promoted with emphasis in the threat to life, structures, and economic production.

### **Monitoring Plan**

Vigilance and sustained community-level public education on tsunami awareness, preparedness and mitigations are very important. The coastal communities must be aware of tsunami facts and must react appropriately during an earthquake event

### **Deformation Monitoring**

Monitoring of ground level should be done during the reclamation phase up to the end of the project. This is to determine quantitative surface movements with respect to both spatial and temporal rates. Known accurate measuring techniques include: InSAR (Interferometric Synthetic Aperture Radar) satellite imagery - time-series techniques; GPS surveys; leveling surveys; optical leveling; Laser Imaging Detection and Ranging (LIDAR); and field observations (ground truthing on buildings and infrastructure, including the use of extensometers). This can be done in partnership with government agencies to allow sharing of data

Field monitoring is essential for construction control when waiting periods are used with staged construction. Theoretical design computations usually do not provide reliable estimates of the rate of consolidation.

Considerable settlement, or deformations in general, occur when constructing projects such as highway embankments, bridge approaches, dikes, dams, large storage areas, tanks, or buildings on soft compressible soil, due to the consolidation of soil under the superimposed load. Severe pavement damage and structural failure can be a direct result of settlement and therefore it is critical that movement be detected and measured. This work consists of providing, installing, maintaining, and reading various types of geotechnical instrumentation at different locations. The most common field instrumentation to monitor progress of consolidation is the surveying method.

In the event that serious settlement or deformation develops during the construction of the embankment or within the required settlement period, the work is required to be suspended and corrective measures taken as directed.

All necessary precautions shall be taken to prevent undue damage to instruments and keep alignments in a plumb position. If an instruments installation is hit, dislodged, damaged, etc. during construction, the test point must be reported and repaired before further readings are taken.



## Structural Defenses

Structural defenses and infrastructure will be inspected periodically for integrity and soundness.

Continuous monitoring of structural defenses should be implemented. Likewise, the Proponent should encourage awareness on all geohazards. Make use of the government's alert systems such as those of PAGASA, MGB, PHIVOLCS, NOAA and other such agencies.

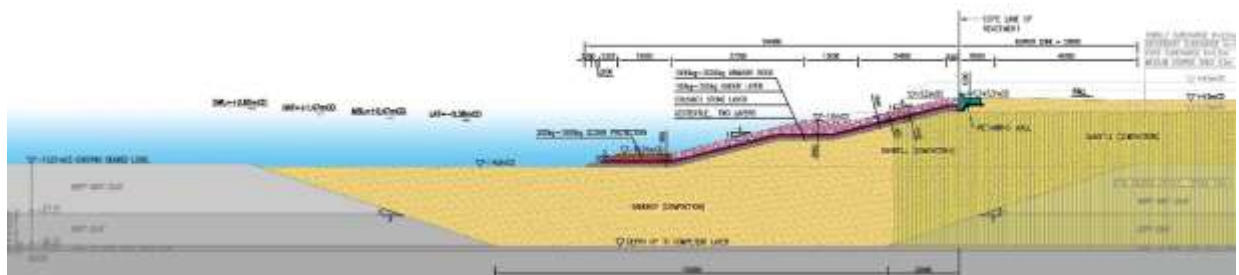
### 2.1.3 Pedology

#### 2.1.3.1 Soil Erosion / Loss of Topsoil / Overburden.

In the traditional context, soil erosion/topsoil/overburden refers to activities/works onshore. The reclamation work shall involve the seabed of the reclamation area and hence, it is deemed that this matter is not germane to this project.

Moreover, "soil erosion" is confined to the reclamation area that will be dredged and on which land will be created and not a wide range of the sea.

Illustrated below is a typical scheme for the construction of the containment wall or structures within this confined seabed area. This containment wall in fact prevents erosion of the seabed.



The top part of the surface to upper 1.5m made up of thick layer of very soft to soft silts and clays and very loose to loose sands (N-value < 10) shall be dredged as part of ground preparation before the area is filled with sand materials. It is possible that part of the dredged materials will be re-used and put back to the seabed.

### Summary of Soil Investigation Report – Geotechnical Studies

The geotechnical investigation program consists of six (6) boreholes at depths ranging from 12m to 30m each. All boreholes were drilled within the vicinity of the property boundaries to establish the existing geotechnical conditions at the site. The location of the drilled holes is presented in Figure 2.1-57.

The full factual report for the geotechnical drilling, including borehole logs is provided in **Annex 2.1-C**.



**Figure 2.1-57. Borehole Location Plan**

#### **SPT Drilling Procedure per ASTM D1586**

The Standard Penetration Test (SPT) was done in accordance with ASTM specifications, with energy transfer efficiency of at least 60%. For each test, a 2-inch (50.8mm) outside diameter Split – Spoon sampler was driven into the soil at a depth of 18 inches (460 mm) by means of a 140 lb. (63.5 kg) driving mass falling freely from a height of 30 inches (760 mm). The number of blows needed to drive the split spoon sampler 18 inches (460 mm) was recorded and the number of blows needed to drive the last 12 inches (305 mm) was taken as the N – value. Soil samples were recovered using the spoon sampler and were then taken to the laboratory for testing and analysis.

#### **Rock Coring and Sampling per ASTM D2113**

Whenever Standard Penetration Test (SPT) refusal is reached, rock coring was performed. SPT refusal occurs when a total of 50 hammer blows causes less than or equal to 25.4 mm of ground penetration, or no measurable penetration occurs after 10 hammer blows.

Coring techniques were performed in accordance with the American Society for Testing and Materials (ASTM D2113). The core recoveries were analyzed, stored in core boxes, delineated by properly marked spacers marked with indelible ink, labelled and wrapped in plastic bags for laboratory strength tests

##### **2.1.3.1.1 Subsurface Idealization**

The succeeding table presents the subsurface conditions at each borehole location based on the results of the soil investigation. Engineering parameters were assigned on the following soil profiles necessary for the design of foundations and various geotechnical analysis.





From the results of the soil investigation, the site subsurface generally consists of an upper thin layer (0m to 1.5m) of silts and loose sands (N-value < 10). It is underlain by 1.5m to 7.5m thick layers of stiff to very stiff silts and clays and medium dense sands. These are all underlain by the competent strata consisting of dense to very dense sands and hard clays, encountered at depths of around 3.0m to 9.0m. It can be said that the seabed in the project site is generally stiff to dense with only minimal soft layers, and thus maybe considered as competent.

**Table 2.1-17. Idealized Subsurface Conditions based on Results of Borehole Tests**

| Hole No. | Depth, m    | Soil Description                       | SPT                 | Consistency / Relative Condition | $\gamma$ | c (kPa) | $\phi$ (°) | $k_h$ (kPa/m) |
|----------|-------------|--|---------------------|----------------------------------|----------|---------|------------|---------------|
| BH-19    | 0.0 – 1.5   | CL                                     | 9                   | Medium Stiff                     | 17       | 48      | 0          | 5,760/B       |
|          | 1.5 – 6.0   | CL                                     | 37 – 44 [22]        | Hard                             | 20       | 180     | 0          | 21,600/B      |
|          | 6.0 – 7.5   | SC                                     | 'refusal'           | Very Dense                       | 20       | 0       | 34         | 27,000/B      |
|          | 7.5 – 10.5  | SM / ML                                | 20 – 31             | Medium Dense to Dense            | 18       | 0       | 31         | 13,500/B      |
|          | 10.5 – 30.0 | SP-SM / SM / CL / SC-SM / ML           | 'refusal'           | Very Dense                       | 20       | 0       | 34         | 81,000/B      |
|          |             |  |                     | Hard                             | 20       | 180     | 0          | 21,600/B      |
| BH-20    | 0.0 – 1.5   | SP-SM                                  | 9                   | Loose                            | 17       | 0       | 28         | 300/B         |
|          | 1.5 – 9.0   | SP-SM / SM                             | 15 - 25             | Medium Dense                     | 18       | 0       | 30         | 19,125/B      |
|          | 9.0 – 30.0  | CL / SM / MH / ML                      | 42 – 'refusal'      | Dense to Very Dense              | 19       | 0       | 34         | 48,750/B      |
|          |             |  |                     |                                  | 20       | 0       | 34         | 78,000/B      |
|          |             |  |                     | Hard                             | 20       | 180     | 0          | 21,600/B      |
| BH-21    | 0.0 – 1.5   | SM                                     | 8                   | Loose                            | 17       | 0       | 28         | 300/B         |
|          | 1.5 – 4.5   | SM                                     | 13 – 27             | Medium Dense                     | 18       | 0       | 30         | 4,500/B       |
|          | 4.5 – 6.0   | ML                                     | 46                  | Dense                            | 19       | 8       | 34         | 13,125/B      |
|          | 6.0 – 30.0  | CL / SM / CH / ML / SM / SW-SM / SP-SM | 'refusal'           | Very Dense                       | 20       | 0       | 34         | 72,000/B      |
|          |             |  |                     | Hard                             | 20       | 180     | 0          | 21,600/B      |
| BH-22    | 0.0 – 1.5   | SC                                     | 4                   | Very Loose                       | 16       | 0       | 28         | 300/B         |
|          | 1.5 – 4.5   | CL                                     | 3 – 9               | Soft to Medium Stiff             | 14       | 12      | 0          | 1,440/B       |
|          |             |  |                     |                                  | 17       | 48      | 0          | 5,760/B       |
|          | 4.5 – 12.0  | SM / SC                                | 39 – 'refusal' [16] | Dense to Very Dense              | 19       | 0       | 34         | 20,625/B      |
|          |             |  |                     |                                  | 20       | 0       | 34         | 33,000/B      |
|          | 12.0 – 30.0 | SC-SM / SM / MH                        | 'refusal'           | Very Dense                       | 20       | 0       | 34         | 84,000/B      |
|          |             |  |                     | Hard                             | 20       | 180     | 0          | 21,600/B      |
| BH-24    | 0.0 – 1.5   | SM                                     | 15                  | Medium Dense                     | 18       | 0       | 29         | 1,125/B       |
|          | 3.0 – 7.5   | ML / CH / SM                           | 24 - 34             | Dense                            | 18       | 0       | 32         | 13,125/B      |
|          |             |  |                     | Very Stiff                       | 19       | 150     | 0          | 18,000/B      |
|          | 7.5 – 12.0  | SM                                     | 'refusal'           | Very Dense                       | 20       | 0       | 34         | 39,000/B      |
| BH-27    | 0.0 – 1.5   | SC-SM                                  | 9                   | Loose                            | 17       | 0       | 28         | 300/B         |
|          | 1.5 – 4.5   | SC-SM                                  | 17                  | Medium Dense                     | 18       | 0       | 30         | 4500/B        |
|          | 4.5 – 12.0  | ML / CL / MH                           | 14 - 29 [38]        | Stiff to Very Stiff              | 17       | 65      | 0          | 7,800/B       |
|          |             |  |                     |                                  | 17       | 105     | 0          | 12,600/B      |
|          | 12.0 – 13.5 | SM                                     | 39                  | Dense                            | 19       | 0       | 34         | 31,875/B      |
|          | 13.5 – 30.0 | SM / MH / CL                           | 39 – 'refusal'      | Very Dense                       | 20       | 0       | 34         | 87,000/B      |



| Hole No. | Depth, m | Soil Description | SPT | Consistency / Relative Condition | $\gamma$ | c (kPa) | $\phi$ (o) | $k_h$ (kPa/m) |
|----------|----------|------------------|-----|----------------------------------|----------|---------|------------|---------------|
|          |          | / SC-SM / ML     |     | Hard                             | 20       | 180     | 0          | 21,600/B      |

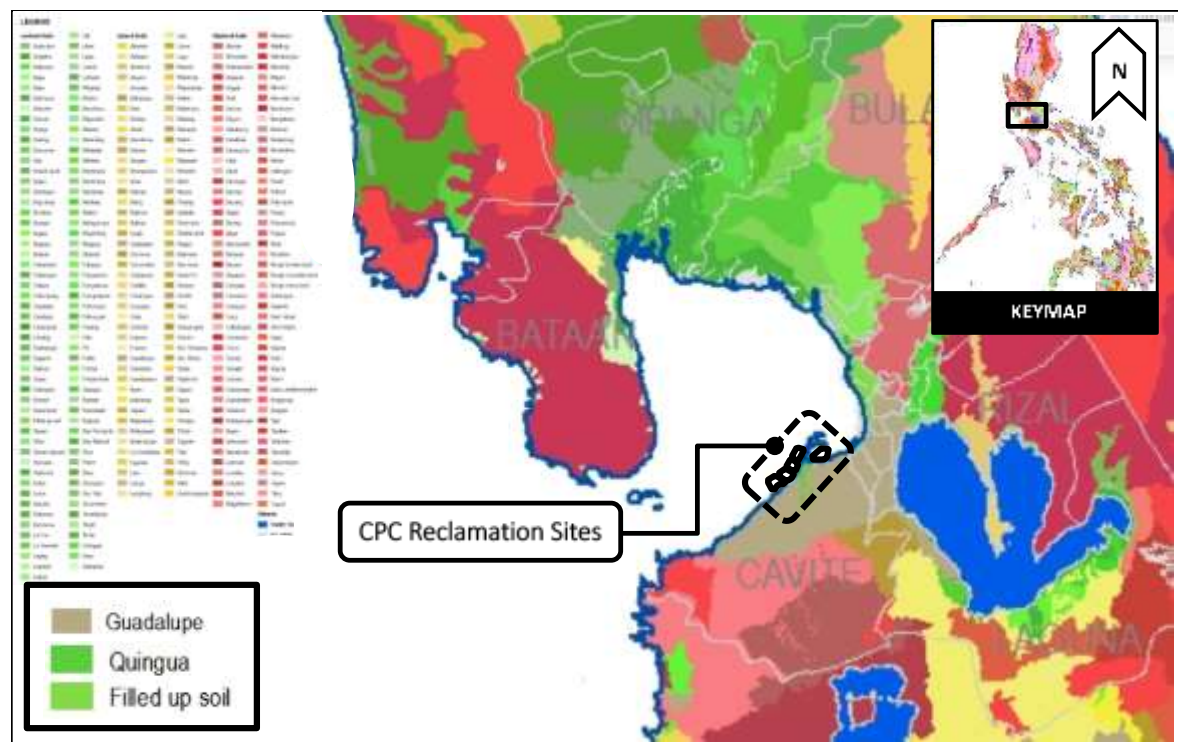
The maximum thickness of soft soil in the project area is only 1.5m. Therefore, the range of depth required to fill the reclamation area up to elevation +4.00m above Mean Low Low Water (MLLW) is **9 to 12 meters**. Since there are no available data on elevations of the tide and seabed in the area of the project site, it is assumed that the measured water level during drilling is the mean sea level (MSL).

From the Philippine Ports Authority Manual, the nearest port with tide records which shall be used as reference for this project is the Manila South Harbor. It is approximately 15km northeast of the project site. The recorded MSL is +0.49m (or approx. +0.50m) and MLLW is +0.00m.

### Soil Types

The Bureau of Soils and Water Management (BSWM) of the Department of Agriculture (DA) published and released soil maps of the Philippines. The maps aim to provide information on the type of surface soil the country is composed of to aid in land development, agriculture, etc. These characterization and evaluation of soil play a major role since different soil type/group affects the parameters that are used in a hydrologic study (i.e. peak discharge calculations).

Based on the Philippine Soil Series Map of the BSWM, the southern part of Metro Manila and lowland area of Cavite are underlain by Guadalupe Soil. Guadalupe soils are composed of weathering clay residuum, and waterlaid tuffaceous material that are very poorly drained on flat areas and a major lowland for soils. This soil type is categorized as coarse when dry, and sticky and plastic when wet.



Source: BSWN

Figure 2.1-58. Clipped Philippine Soil Series Map



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## **Water and Wind Erodibility Potential**

The project site will be on water, soil pertains to seabed materials, which will not be subject to erodibility.

### **Sediment Sources**

The Cañas River is the nearest major waterway in the vicinity that will contribute sediments to the project site and vicinities. Also, longshore currents coming into Manila Bay bring in coarse sediments to the area of Cavite Spit. In fact, this spit was formed through time because of the large amount of sediments coming into the bay and deposited in the area.

### **Riverbank Stability**

The proposed project will be located in Manila Bay, at a distance from Cañas and Maalimango rivers. Thus, the capability of the land/riverbank to accommodate the proposed development with minimal or without soil erosion/loss of topsoil/overburden is deemed irrelevant.

### **Proposed Methodology for Compaction.**

Ground improvement measures for densifying upper loose sand layer and strengthening bearing capacity include jet grouting, vibroflotation/vibro replacement, and pre-loading.

#### **Jet Grouting**

Jet grouting is a ground stabilization procedure which uses the principle of ultra-high pressure injection of cement grout (>100m/s) into the ground. It increases the soil bearing capacity of the underlying weak soil. Jet grouting can be employed in all types of soils, from clay to coarse gravel.

Jet grouting creates in-situ geometries of soilcrete (grouted soil, 3000 – 6000 psi), using a grouting monitor attached to the end of a drill stem. The jet grout monitor is advanced to the maximum treatment depth, at which time high velocity grout jets (and sometimes water and air) are initiated from ports in the side of the monitor. The jets erode and mix the in-situ soil as the drill stem and jet grout monitor are rotated and raised. Jet grouts can be installed at angles from vertical to 45°.

#### **Vibroflotation/Vibro Replacement**

Vibro Replacement is an effective technique for improvement of soft clays, mixed deposits of clay, silt and sand with fines of more than 10%, and fine sands. It reduces the liquefaction potential of fine sands where the ground water table is at a shallow level.

Originally used for improving loose, granular soils, these techniques have been improved by NSCC to extend their range of application from loose granular soils to poor cohesive soils in which stone columns are built by the wet or dry method.

Stone columns refer to columns of compacted, gravel size stone particles constructed vertically in the ground to improve the performance of soft or loose soils. The stone can be compacted with impact methods, such as with a falling weight or an impact compactor or with a vibroflot, the more common method. The method is used to increase bearing capacity (up to 5 to 10 ksf or 240 to 480 kPa), reduce foundation settlements, improve slope stability, reduce seismic subsidence, reduce lateral spreading and liquefaction potential, permit construction on loose/soft fills, and pre-collapse sinkholes prior to construction in karst regions.

A specific application is referred to as vibro piers. The process refers to short, closely spaced stone columns designed to create a stiff block to increase bearing capacity and reduce settlement to acceptable values.





Vibro piers are typically constructed in cohesive soils in which a full depth predrill hole will stay open. The stone is compacted in 1 to 2 ft (0.4 to 0.8 m) lifts, each of which is rammed and compacted with the vibroflot.

### **Preloading with Prefabricated Drains (PVD)**

Surcharging alone can induce bearing failures and the settlement of soil may extend over a long period of time because of its low permeability. Vertical drains are installed together with preloading in order to shorten the drainage path of the pore water and accelerate settlement. Vertical drains are artificial drainage paths inserted into the cohesive soil layer allowing the water to flow faster in the horizontal direction towards the vertical drains. Since most clayey soils have higher horizontal permeability, water can flow faster into the drain and out of the soil rather than the conventional preloading where water can only flow vertically.

#### **2.1.4.2 Change in Soil Quality or Fertility**

The soil of relevance in a reclamation project is the seabed that will be dredged and thus raise concern of possible migration of fugitive silt materials in other parts of the sea outside the reclamation project. Such concern, however, is essentially preempted with the following measures:

Silt curtains are placed in the periphery of the dredged area to trap any dispersed silts/soils.

The unwanted soil is disposed outside of the project area in a dumping place to be approved by the authorities. Normally this is located at a distance from the dredged area. Special permits are to be secured for the disposal of the unwanted soil.

Another method for handling the unwanted soil is the placement of such in —sand bags and the use of these sand bags as fill materials for the reclamation.

At depths, the soils are essentially homogeneous over a large part of Manila Bay as they are geologically contiguous. These are the weathering derivatives of Guadalupe formation, a rock suite of volcanic materials predominantly made up of tuff and pyroclastics.

Sediments are usually a useful medium of monitoring pollutants in aquatic systems due to their ability to accumulate contaminants while maintaining reasonable uniform composition (Larsen and Jensen, 1989; Chapman, et.al., 1992). Most eroded materials are trapped in reservoirs, lakes and flood plains or much of it is deposited in deltas, bays and estuaries (Gehm and Bregman, 1976).

The key parameters for the sediments are the metallic elements because silt dispersal could potentially occur to other areas of the Manila Bay outside of the project site, thereby transporting these elements. "Fertility" is not germane to this project because the site is offshore, hence, fertility is more relevant to projects that involve or which could impact on plantations and agriculture.

The Dutch standards for soil remediation shall be adopted by the Project Proponent until Philippine standard have been formulated.

The TARGET VALUE (Ref: email communications with LLDA) is the baseline concentration value below which compounds and/or elements are known or assumed not to affect the natural properties of the soil.

The INTERVENTION VALUE (Ref: email communications with LLDA) is the maximum tolerable concentration above which remediation is required. This occurs if one or more compounds in concentrations equal to or higher than the intervention value is found in more than 25 m<sup>3</sup> of soil or 1000 m<sup>3</sup> of ground water.



**Table 2.1-18. The Dutch Target/Intervention Values**

|               | EARTH/SEDIMENT (mg/kg dry matter)      |                        |                    |
|---------------|--|------------------------|--------------------|
|               | National Background Concentration (BC) | Target Value (incl BC) | Intervention Value |
| <b>Metals</b> |  |                        |                    |
| Antimony      | 3                                      | 3                      | 15                 |
| Arsenic       | 29                                     | 29                     | 55                 |
| Barium        | 160                                    | 160                    | 625                |
| Cadmium       | 0.8                                    | 0.8                    | 12                 |
| Chromium      | 100                                    | 100                    | 380                |
| Cobalt        | 9                                      | 9                      | 240                |
| Copper        | 36                                     | 36                     | 190                |
| Mercury       | 0.3                                    | 0.3                    | 10                 |
| Lead          | 85                                     | 85                     | 530                |
| Molybdenum    | 0.5                                    | 3                      | 200                |
| Nickel        | 35                                     | 35                     | 210                |
| Zinc          | 140                                    | 140                    | 720                |

### Secondary Baseline Data for Seabed Sediment Quality

Three secondary data sources were gathered for this study which includes:

- 13 seabed sediment samples from a nearby area conducted by TCSI in Aug 2017 in June to August 2018 for the Bacoar Reclamation and Development Project of the Bacoar City LGU. The laboratory tests were done by CRL Environmental Corp. These samples are within Bacoar Bay to the east of Island A.
- 2 samples taken by the Filipinas Dravo Corporation in January 2019 for the Manila-Cavite Toll Expressway (MCTEP) Segment 5 Project EIS Report (in behalf of the Cavite Infrastructure Corp). SQ1 is located in Dalahican Coast in Cavite City while SQ4 is located near the mouth of Maalimango River in Rosario; and
- 9 grab samples collected within Manila Bay by the Integrated Environmental Monitoring Program for Manila Bay (IEMP-MB) team on Feb 10–11, 2005, analyzed for selected elements at the DOST-PNRI by XRF method. These were extracted from Olivares, R.R., et al., June 18, 2019. Environmental Assessment of Metal Pollution in Manila Bay Surface Sediments, DOST-PNRI.

The sampling station map is provided in the figure below wherein only Station 7 of the IEMP-MB work is included as it is the only station in the Cavite area. For a bigger picture of the bay, a separate location map for the 9 samples of IEMP-MB is provided in Figure 2.1-60. The test results from TCSI and Filipinas Dravo are listed in Table 2.1-19 while the IEMP-MB data are separately provided (Table 2.1-20).

### Baseline Data for Seabed Sediment Quality, June 24, 2020

Sediment sampling was conducted on June 24, 2020 for two (2) sampling per island. The sampling station map is provided in the Figure 2.1-60a below while the test results are in Table 2.1-21. Based on the quality of sediments for Island D, parameters such as Arsenic, Lead, Mercury, Hexavalent Chromium were all within the acceptable limits except for Cadmium are higher than the allowable limit. The laboratory tests were conducted by CRL Environmental Corp attached in Annex 2.1-D, for Laboratory Results.



Data Sources: TCSI 2018, IEMP-MB 2005, MCTEP 2019, Base Map: 2020 Google Earth

Figure 2.1-59. Soil Sampling Location Map





**Table 2.1-19. Test Results for Seabed Sediments**

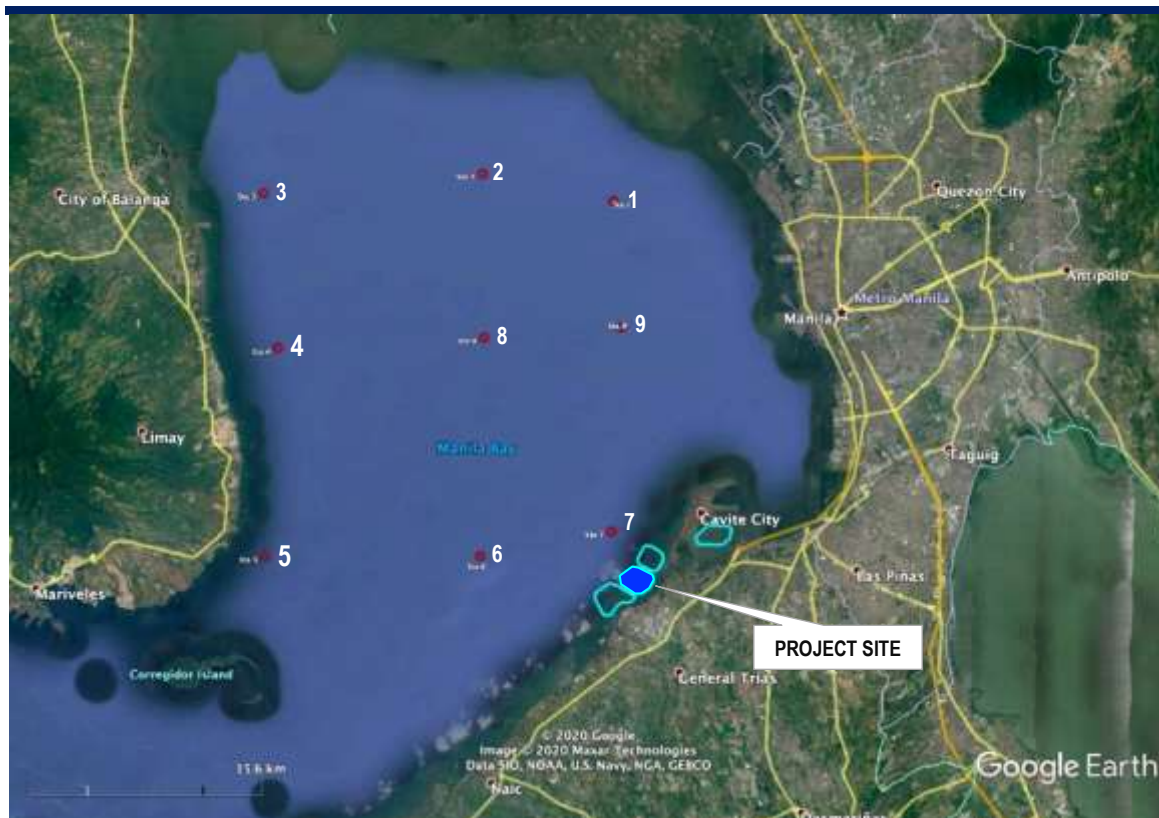
| Sample ID           | As (mg/kg) | Cd (mg/kg) | Pb (mg/kg) | Hg (mg/kg)            | Cr +6 (mg/kg)     | pH        | Date Sampled | Date Reported |
|---------------------|------------|------------|------------|-----------------------|-------------------|-----------|--------------|---------------|
| <b>Test Methods</b> | ICP-OES    | Flame AAS  | Flame AAS  | Manual Cold Vapor AAS | DCM (SM3500-Cr-B) | EPA 9045D |              |               |
| <b>MDL</b>          | 0.4        | 0.2        | 1          | 0.1                   | 0.1               | 0.1       |              |               |
| <b>BH-10</b>        | 2          | 0.8        | 23         | <0.1                  | <0.1              | 7.1       | 08/05/2018   | 10/15/2018    |
| <b>BH-11</b>        | 2.3        | 0.8        | 26         | <0.1                  | <0.1              | 6.8       | 08/07/2018   | 10/15/2018    |
| <b>BH-12</b>        | 2.3        | 0.8        | 22         | <0.1                  | <0.1              | 6.9       | 08/04/2018   | 10/15/2018    |
| <b>BH-14</b>        | 5.5        | 0.8        | 9.9        | <0.1                  | <0.1              | 7.7       | 07/29/2018   | 10/15/2018    |
| <b>BH-15</b>        | 3.4        | 0.5        | 5.3        | <0.1                  | <0.1              | 7.7       | 07/27/2018   | 10/15/2018    |
| <b>SS1</b>          | 2          | <0.2       | 15         | <0.1                  | <0.1              |           | 06/12/2018   | 7/31/2018     |
| <b>SS2</b>          | 1.9        | <0.2       | 9.7        | <0.1                  | <0.1              |           | 06/12/2018   | 7/31/2018     |
| <b>SS4</b>          | 3.1        | <0.2       | 22         | <0.1                  | <0.1              |           | 06/12/2018   | 7/31/2018     |
| <b>1A</b>           | 3          | <0.2       | 30         | <0.1                  | <0.1              |           | 06/12/2018   | 7/31/2018     |
| <b>2A</b>           | 1.9        | 0.3        | 22         | <0.1                  | <0.1              |           | 06/12/2018   | 7/31/2018     |
| <b>5A</b>           | 1.7        | 0.6        | 19         | <0.1                  | <0.1              |           | 06/12/2018   | 7/31/2018     |
| <b>10A</b>          | 4.8        | <0.2       | 28         | <0.1                  | <0.1              |           | 06/12/2018   | 7/31/2018     |
| <b>16A</b>          | 2.1        | 0.4        | 20         | <0.1                  | <0.1              |           | 06/12/2018   | 7/31/2018     |
| <b>SED1</b>         |            | 1.2        | 23         |                       | <0.1              |           | 08/03/2017   | 10/08/2018    |
| <b>SED2</b>         |            | 0.8        | 28         |                       | <0.1              | 7.1       | 08/03/2017   | 10/08/2018    |
| <b>SED3</b>         |            | 0.3        | 27         |                       | <0.1              |           | 08/03/2017   | 10/08/2018    |
| <b>SQ1</b>          | <0.10      | <0.015     | <0.05      | <0.60                 |                   |           | 01/25/2018   | 2018          |
| <b>SQ4</b>          | <0.10      | <0.015     | <0.05      | <0.60                 |                   |           | 01/25/2018   | 2018          |

Source: TCSI 2018 and Filipinas Dravo Corp. 2018 data

It may be seen from the above table that the sediment properties of all the TCSI and MCTEP samples in Manila Bay are well within the intervention value to cause concerns of metallic interventions in the quality of Manila Bay waters. Moreover, mercury and hexavalent chromium tests all came back undetected or below the minimum detection limit.

Based on Table 2.1-16 above, Cr and Zn were higher in the northern part of the bay (Station 1) whereas Cu, Fe, Ti, Ca, Mg, and K were higher in the eastern and southeastern (Stations 6 and 7) coastal sites. Please note that **Station 7** is the nearest to the project site on the western side of Cavite Spit. The spatial distribution profiles of selected trace elements are shown in Figure 2.1-58 below. Unlike these elements, Pb is higher in the central part of the bay (Station 8). Mn was found higher in the southwestern side (Station 5) while Ni was lower in Stations 6, 7, and 8. While it is expected that the Metro Manila side has more population and possibly more domestic and industrial wastes, Station 9 generally has lower metal concentration levels. (Olivares, R.R., et.al., June 18, 2019). For **Station 7** in Cavite, titanium, copper, aluminum and iron are the metallic elements that appear higher than in other areas.

Stations 1 and 2, located on the northern part of the bay, exceeded the reference values for chromium and considered moderately enriched. Ni concentrations are all below the criteria values, and enrichment levels were categorized as low. For copper, all sites generally exceeded the reference values and is particularly high on Stations 5, 6, and 7 located southern part of the bay (near coastal areas of Bataan and Cavite). Most of the stations are considered moderately enriched except that Station 5 obtained an EF ratio of 5.3, which is significant. Also, Station 5 exhibited the highest value for Fe, Mn and Pb having an EF of 2.4, 5.5 and 2.9, respectively. (Olivares, R.R., et.al., June 18, 2019).



Source: Olivares, R.R., et.al., June 18, 2019

**Figure 2.1-60. Surface Sediment Sampling (Feb 10-11, 2005) Location Map**

**Table 2.1-20. Test Results for Seabed Sediments (2005)**

| Element<br>Conc.<br>(ppm) | Sampling Station |         |         |         |         |         |         |         |         |
|---------------------------|------------------|---------|---------|---------|---------|---------|---------|---------|---------|
|                           | 1                | 2       | 3       | 4       | 5       | 6       | 7       | 8       | 9       |
| Na                        | 458,000          | 450,000 | 448,000 | 624,000 | 552,000 | 22,000  | 101,000 | 588,000 | 562,000 |
| Mg                        | 5,310            | 6,060   | -       | 1,050   | 1,910   | 28,180  | 11,400  | 975     | 4,210   |
| Al                        | 29,500           | 30,600  | 32,600  | 16,200  | 16,000  | 53,400  | 68,200  | 17,800  | 22,000  |
| Si                        | 85,300           | 82,120  | 75,890  | 35,520  | 36,500  | 137,640 | 152,000 | 41,200  | 59,800  |
| S                         | 8,160            | 7,460   | 7,150   | 7,700   | 7,920   | 5,005   | 5,790   | 7,910   | 7,530   |
| Cl                        | 140,000          | 162,000 | 210,000 | 262,000 | 200,000 | 111,000 | 45,300  | 200,000 | 189,000 |
| K                         | 4,660            | 4,830   | 4,960   | 2,200   | 1,750   | 6,788   | 6,380   | 2,432   | 3,246   |
| Ca                        | 11,700           | 8,062   | 8,220   | 5,090   | 6,030   | 94,450  | 28,200  | 5,570   | 10,200  |
| Ti                        | 3,550            | 3,430   | 3,140   | 2,060   | 1,780   | 4,071   | 5,410   | 3,000   | 3,130   |
| Cr                        | 139              | 127     | 107     | 67      | 52      | 58      | 49      | 72      | 71      |
| Mn                        | 896              | 909     | 1,020   | 841     | 1,810   | 1,288   | 1,100   | 1,250   | 1,050   |
| Fe                        | 45,100           | 43,400  | 43,300  | 37,200  | 38,200  | 51,400  | 56,600  | 44,300  | 38,700  |
| Ni                        | 16               | 17      | 17      | 17      | 18      | 9.9     | 12      | 10      | 18      |
| Cu                        | 66               | 57      | 70      | 74      | 85      | 76      | 90      | 71      | 77      |
| Zn                        | 124              | 102     | 86      | 75      | 84.5    | 104     | 86      | 122     | 80      |
| Pb                        | 13               | 14      | 16      | 87      | 18      | 14      | 13      | 27      | 20      |
| Br                        | 144              | 176     | 131     | 171     | 182     | 106     | 139     | 192     | 217     |
| Rb                        | 25               | 21      | 23      | 37      | 33      | 30      | 25      | 20      | 20      |
| Sr                        | 124              | 111     | 126     | 100     | 129     | 1350    | 200     | 102     | 119     |
| Y                         | 14               | 12      | 13      | 11      | 9.3     | 14      | 12      | 11      | 9.5     |
| Zr                        | 54               | 47      | 51      | 49      | 53      | 62      | 81      | 62      | 54      |
| Mo                        | 0.65             | 1.7     | 1.7     | 2.4     | 1.9     | 1.2     | 2.1     | 2.1     | 2       |

Source: Olivares, R.R., et.al., June 18, 2019



**Table 2.1-21. Sediment Sampling Results, June 24, 2020**

| Sample ID                                       | Arsenic (As) (mg/kg) | Cadmium (mg/kg) | Pb (mg/kg) | Hg (mg/kg)            | Cr +6 (mg/kg)     | pH        | Date Sampled | Date Reported |
|---|----------------------|-----------------|------------|-----------------------|-------------------|-----------|--------------|---------------|
| <b>Test Method</b>                              | ICP-OES              | Flame AAS       | Flame AAS  | Manual Cold Vapor AAS | DCM (SM3500-Cr-B) | EPA 9045D |              |               |
| MDL   | 1.0                  | 0.32            | 2.41       | 0.1                   | 0.1               | 0.1       |              |               |
| <b>SD1</b><br>N 14°26'08.23"<br>E 120°51'25.62" | 6.2                  | 1.1             | 19         | ND                    | ND                | 8.1       | 06/24/2020   | 7/6/2020      |
| <b>SD2</b><br>N 14°26'01.49"<br>E 120°51'50.18" | 6.2                  | 1.1             | 19         | ND                    | ND                | 7.9       | 06/24/2020   | 7/6/2020      |

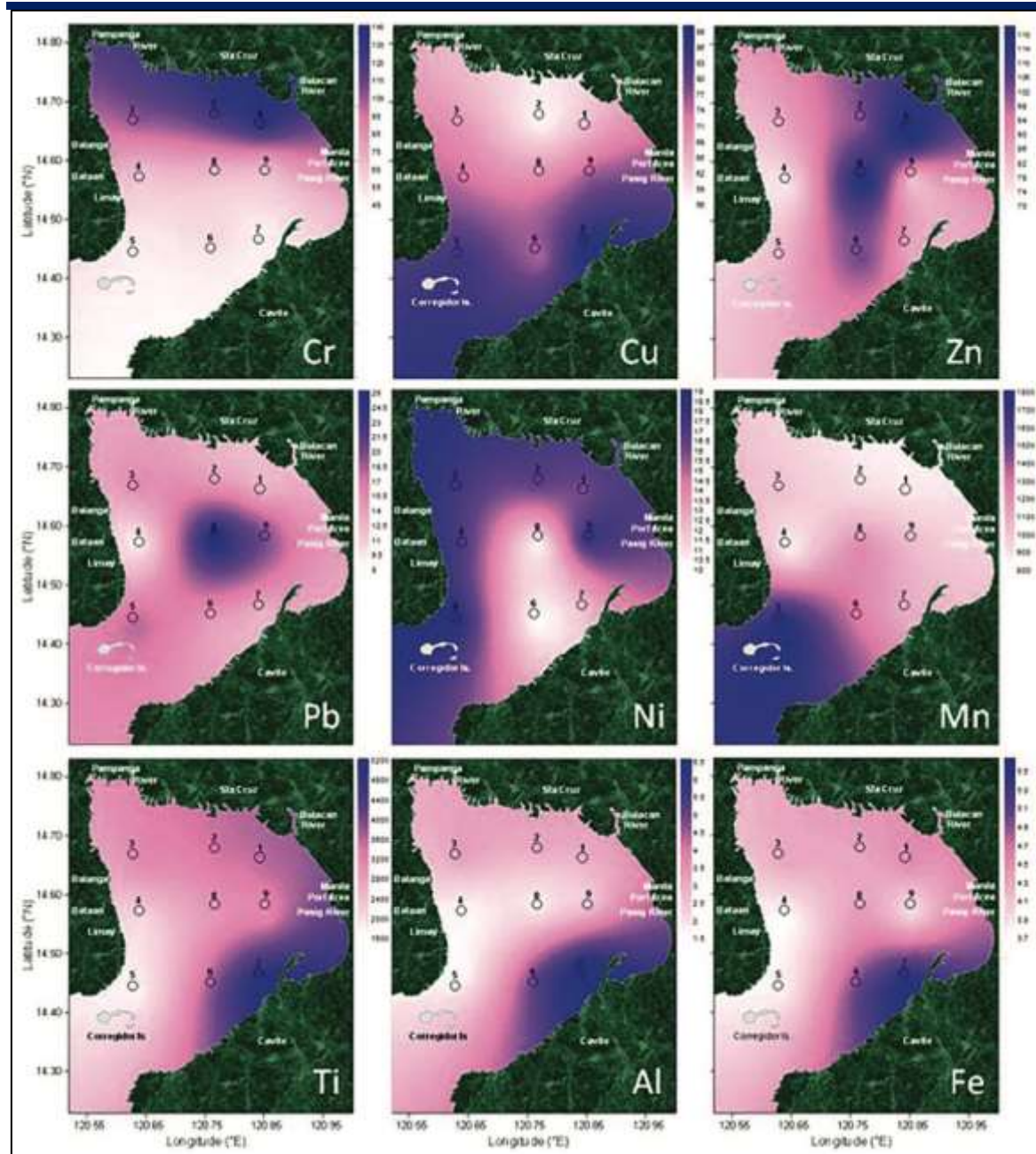
Source: CRL Environmental Corporation, July 6, 2020



Source: Base Map: 2020 Google Earth

**Figure 2.1-60a Sediment Sampling Map, June 24, 2020**





Source: Olivares, R.R., et.al., June 18, 2019. Environmental Assessment of Metal Pollution in Manila Bay Surface Sediments, DOST-PNRI

Figure 2.1-61. Spatial Profile of Trace Metal Concentrations (ppm) in Manila Bay Sediments.



### 2.1.4 Terrestrial Ecology

By way of discussion, based on the Manila Bay Coastal Strategy, one of the ecological values of the Manila Bay is the mangroves. At the turn of the 20th century, there were about 54,000 hectares of mangrove around the Bay. By 1990, only 2,000 hectares were recorded, and in 1995, only about 794 hectares remained (BFAR, 1995).

On the other hand, millions of shorebirds rest and feed in wetlands of Manila Bay area when flying south from their breeding grounds in the arctic tundra during September to April, and returning North during the short northern hemisphere summer of May to August.

The photographs below, which include the other proposed islands, indicate the absence of terrestrial ecological resources except mangrove communities. Mangroves are discussed in more detail in Chapter 2.2 (Water/Marine Ecology).



Base Map: 2017 Google Earth

### SUMMARY OF IMPACT MANAGEMENT

Mangroves are more appropriately discussed in Chapter 2.2. Marine.

### IMPACTS OF THE PROPOSED PROJECT ON TERRESTRIAL ECOLOGICAL RESOURCES

Biodiversity involving terrestrial resources is deemed not significant for the project for the following reasons:

The reclamation works will be undertaken at sea and distant from lands.

The access links, roads and bridges are not components of the project located on shore and will not impact (disturb or damage) the floral and faunal species on these construction areas.

The migratory and important avian species are located at the LPPWP, distant from the project site.



## SUMMARY OF IMPACT MANAGEMENT AND MONITORING – LAND RESOURCES

Based on the baseline conditions for Land discussed in the foregoing, the following are the identified impacts and the corresponding management and monitoring plans. Also included are issues raised during the Public Scoping.

**Table 2.1-22. IMPACT MANAGEMENT AND MONITORING – LAND RESOURCES**

| IMPACTS  | MANAGEMENT   | MONITORING   |
|--|--|--|
| <b>PRE- CONSTRUCTION PHASE</b>   |  |  |
| Not Applicable. The activities at sea which are largely survey works have been completed.                  |  |  |
| <b>CONSTRUCTION PHASE</b>  |  |  |
| Inconsistency or incompatibility with the operational plan of the Manila Bay                               | In general, the Vision of the Province and its CLUP and in particular the Reclamation Project will be consistent with the Manila Bay Coastal Strategy (MBCS)   | Monitoring of Master Plans   |
| Solid waste generation (debris and waste) during construction phase  | Reclamation activities do not generate debris and wastes; except domestic garbage from construction crews, which are disposed on shore according to RA 9003. No garbage disposal to the Manila Bay.  | Inventory of solid wastes, principally garbage through records of amount of garbage disposed on shore. |
| Urban Renewal  | The Project is supportive of the Province's Vision for Enhanced Urbanization   | Monitoring of Master Plan  |
|  |  |  |
| Aesthetics (Manila Bay sunset)   | Viewing spot in the master plane   | Monitoring of Master Plan for provision for viewing spot(s)  |
| Perception of Flooding onshore as a result of reclamation. Flooding may also occur before the project.     | Project will not cause flooding; Cavite is prone to flooding with or without the project.  | Recording of flooding events including factors e.g. typhoons, heavy rainfalls.                         |
| Change in subsurface geology   | Reclamation will instead provide enhancement by improving soil properties  | Monitoring of potential fugitive silt dispersals near the work areas                                   |
| Erosion/sedimentation  | Engineering design – to consider mitigation of impacts water changes in the bay profile.   | Visual observation especially along the shorelines fronting the Project                                |
|  | In-depth study (including simulations) on prevailing and predicted sedimentation patterns, wave transformation, longshore currents, tidal currents, wind patterns, bay morphology and bottom topography, etc.  |  |
|  | Some areas in the vicinity will be shielded from erosion because the project will serve as barrier against strong waves that can cause erosion.  |  |
| Storm surges/storm waves/tsunamis and flooding on land and impacts of the proposed project during typhoons | Reclamation platform itself with wave deflector gives sheltering effect. Reclaimed lands are in fact known to serve as massive breakwater.   | Recording of events  |
|  | Structural defense options are: seawalls at breakwaters, wave deflectors, other similar defenses such as revetment; angled bypass walls. Appropriate structure to be selected in the DED.  |  |
|  | For the vertical structures, especially those facing the main body of the Bay, the structures are to be designed to resist wave forces, i.e.: lowest horizontal structure above wave crest; rigid connection of roof; lateral bracing; deep protective piles; placement of buildings on stilts or locate at higher levels; and with many openings on the |  |





| IMPACTS                                 | MANAGEMENT   | MONITORING  |
|---|--|---|
|   | ground floor.  |   |
|   | Layout of the land use and structures in the entire reclaimed land will provisions for easy “evacuation routes” in case of early and swift evacuation to elevated areas  |   |
|   | Flood control infrastructure will be installed within the reclaimed land, i.e., adequate channels, drainages and runoff discharges to the open sea as well as non-blockage of river outfalls and other flood paths; pumping; retention tank, etc.  |   |
|   | The design of structural flood defenses will account for possible overtopping but should not be over-estimated as this could also possibly cause trapping of floodwaters.  |   |
|   | For riverine flooding, design will ensure outflow of floodwaters to Manila Bay will not be obstructed  |   |
| Subsidence, Settlement and Liquefaction | Caused by underground water extraction, which will not be undertaken.  | Monitoring of ground level will be done during the period of soil stabilization. This is to determine quantitative surface movements with respect to both spatial and temporal rates. Known accurate measuring techniques include: InSAR (Interferometric Synthetic Aperture Radar) satellite imagery - time-series techniques; GPS surveys; leveling surveys; optical leveling; Laser Imaging Detection and Ranging (LIDAR); and field observations (ground truthing on buildings and infrastructure, including the use of extensometers). |
|   | Engineering intervention. Design of containment using geotechnical survey baselines.   |   |
|   | In-depth studies and monitoring to be undertaken settlement of reclaimed land (fill materials), incorporating cumulative effects of natural subsidence of foundation/underlying soil/rock.   |   |
|   | Buildings and structures to be constructed will be founded on the solid bedrock or dense layer and appropriate foundation design will be put in place  |   |
|   | Remediation options include: compaction – densifying sandy soil with vibration and impact; pore water pressure rod (vibro) compaction, dissipation – installing permeable drain pipes; cementation and solidification – mixing stabilizing material in sandy soil; replacement; lowering of groundwater level; shear strain restraint; preload; and structural measures. A combination of these methods has been found to be more effective. The choice of the remediation method will depend on site characteristics. |   |
|   | A settlement criterion shall be calculated and will include settlements that will develop in the natural subsoil and those that will develop in the reclamation fill from project handover to the end of   |   |



| IMPACTS                          | MANAGEMENT   | MONITORING  |
|----------------------------------|--|---|
|                                  | project life   |   |
|                                  | Fill materials will be fully engineered and compacted/densified. The soil remediation process that will increase the N-value should be advanced to the to the bottom of pre-existing alluvium. |   |
| Ground shaking                   | Engineering intervention: structural and engineering designs to withstand ground shaking   | Recording of events   |
|                                  | The computed “g” values of 0.449g will be utilized in the design of the structures and also serve as guide in the degree of soil remediation/compaction  |   |
| All known geohazards in the area | Public education, awareness and preparedness campaign to include each of the known hazards. This will include evacuation drills, placing of signages, and establishing alert systems.          | Geohazards will be monitored throughout the construction phase through monitoring of existing government forecasts and warning systems. |



## Chapter 2.2. THE WATER

### 2.2.1 Hydrology/Hydrogeology

The succeeding discussions are essentially the same as all of the Islands (A, C, D, E) of the Cavite Province Reclamation Project.

#### Groundwater in the Greater Metro Manila Area (GMMMA)

The major (confined) aquifers of Metro-Manila is found in groundwater formations underneath the Guadalupe Plateau and the Antipolo Plateau. The main aquifer is the one formed by the Guadalupe Formation, 15 to 45m thick, which covers 472 km<sup>2</sup> predominantly spanning the area of the NCR. This extends beneath the bed of Laguna Lake. Groundwater is stored and transmitted in this main aquifer by openings and fractures in the tuffaceous formation. This main aquifer is under pressure (artesian) and is separated from the overlying material by a semi-permeable or semi-confining layer, also called an aquitard. The semi-permeable layer separates the aquifer below and is responsible for creating a pressurized condition. However, in some parts of Metro-Manila where drawdowns of more than 50 m have been caused by over-pumping, the main aquifer has been converted to a water table aquifer.

Water is also stored in the materials above the confining layers of the main aquifer (water table aquifers). Alluvial sediments provide the medium or material for water table aquifers. These occur within the Manila Bay deltaic plain (50m thick), the Marikina Valley, and the alluvial deposits found at the periphery and bottom of Laguna Lake (100m thick). The layers confining the main pressurized aquifer in the predominantly tuffaceous strata and the water table aquifer in the overlying alluvial formation are not totally impermeable, however. Some "leakage" is believed to take place between the main pressurized (or confined) aquifer and the overlying water table aquifer. (Clemente R.S., et al., 2001)

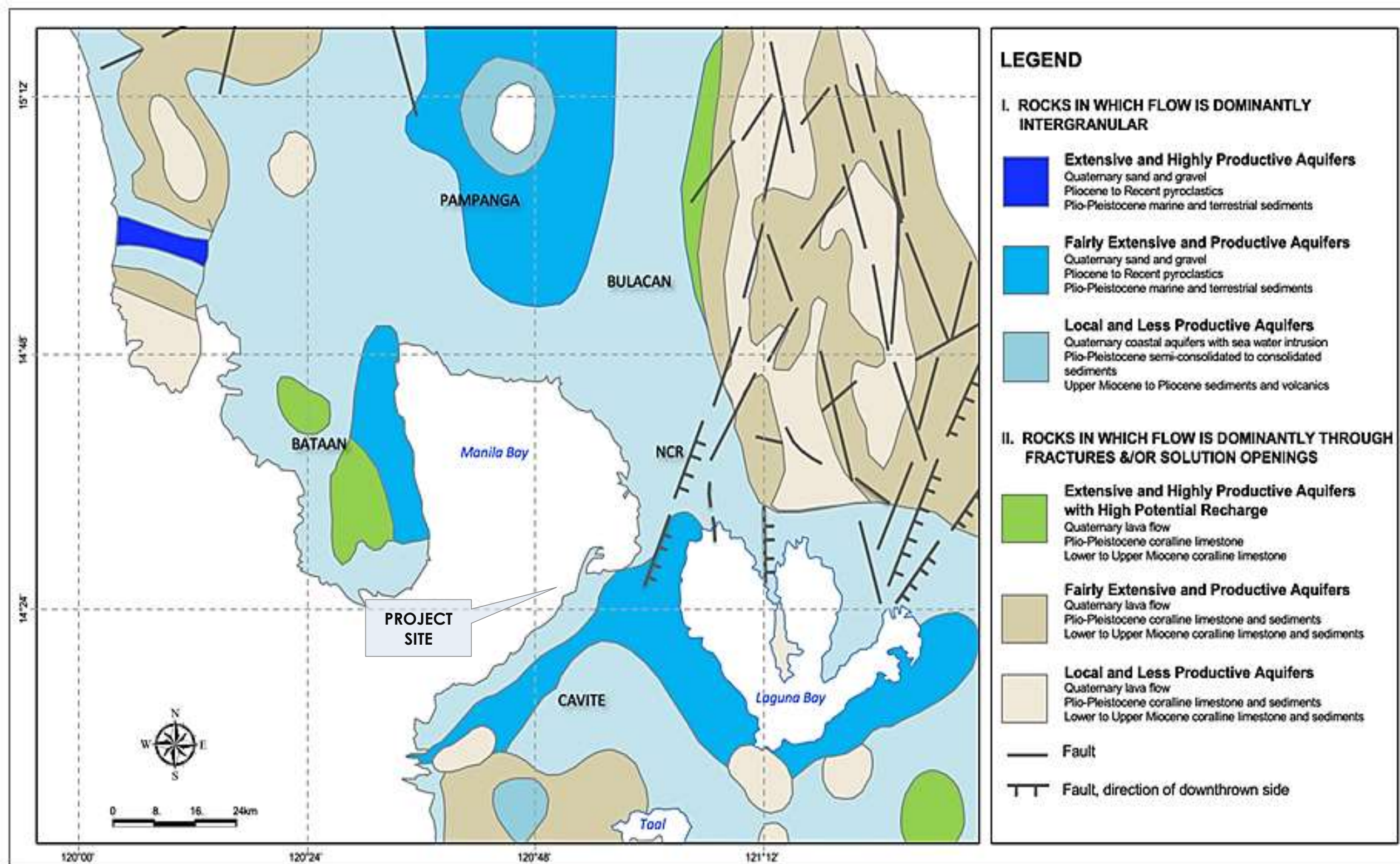
Due to over-pumping, the water pressure in the artesian aquifer becomes lower than the hydrostatic head of the water table aquifer, thus, causing leakage in the downward direction. In this scenario, the overlying water table aquifer recharges the artesian aquifer below, and this is what is occurring in the Metro-Manila aquifer system. (Clemente R.S., et al., 2001)

In the lowland areas spanning Noveleta, Rosario and Cavite City, there are 1,962 artesian wells and deep wells (1995) provide water supply for both domestic and irrigation purposes. Which have caused the salt water intrusion in the aquifers due to over-extraction. The groundwater in Cavite is depleting at a rate of 1m water level / year. In the upland areas of the province, groundwater is tapped mainly for domestic use through local water supply systems. There are two tanks with 400,000-gallon capacity in the CEZ and 10 Maynilad pumping stations in the area. The average surface water level is 5.20 m from a range of 3.05 m. to 12.07 m. The average specific capacity is 1.23 L/s/m and the average specific discharge is 5.88 L/s.

The hydrogeologic map is given in Figure 2.2-1. It is seen from this map that the onshore areas adjacent to the project site is within the classification of "*Local and less productive aquifers with very low to moderate permeability*".

The project will not involve underground water extraction as the water will be sourced from the water concessionaire. This fact is likewise relevant from the perspective of land subsidence in Metro Manila, which is generally attributable and accepted to be the major cause of land subsidence in the city.





Source: MGB, undated

Figure 2.2-1. Regional Hydrogeologic Map



### **2.2.1.1 Change in Drainage Morphology / Inducement of Flooding / Reduction in Stream Volumetric Flow**

#### **General Statements**

Changes in drainage morphology, inducement of flooding as a result of these changes, reduction in stream volumetric flow and identification of aquifers are significant considerations if the reclamation landform and the activities during the Construction Phase of the project will cause diversion and/or disturbance of the existing drainage system.

- The landform is located at sea
- The existing drainage system will not be disturbed
- The construction works onshore are those associated with the construction of the connecting points of the access ways

There are no bodies of freshwater, natural or manmade, the latter in the case of manmade drainage channels or canals that are located in or within the project site.

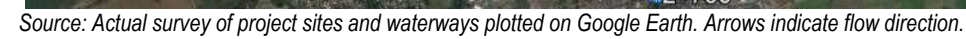
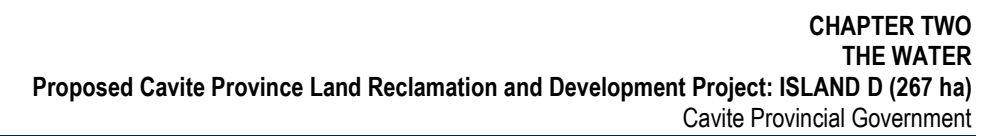
In respect of climate change considerations, rainfall intensity is a key parameter in climate change projections. The project will not in any way affect rainfall. In the design of the reclamation drainage system, however, rainfall is an important input in the application of the relevant formula.

Figure 2.2-1 shows the rivers adjacent to Island D and to the other islands of the total project (islands A, C, and E) from which is gleaned that these rivers will not be significantly affected by the project. Furthermore, there are no lakes within the project site.

Concerning aquifers, there will be no groundwater extractions to serve the needs of the Project during the Construction Phase.

Plate 2.2-1 is an initial conceptual master development plan for Island D and all the other Islands wherein may be gleaned that the landform is distant from the shore at which the existing drainage systems are located.



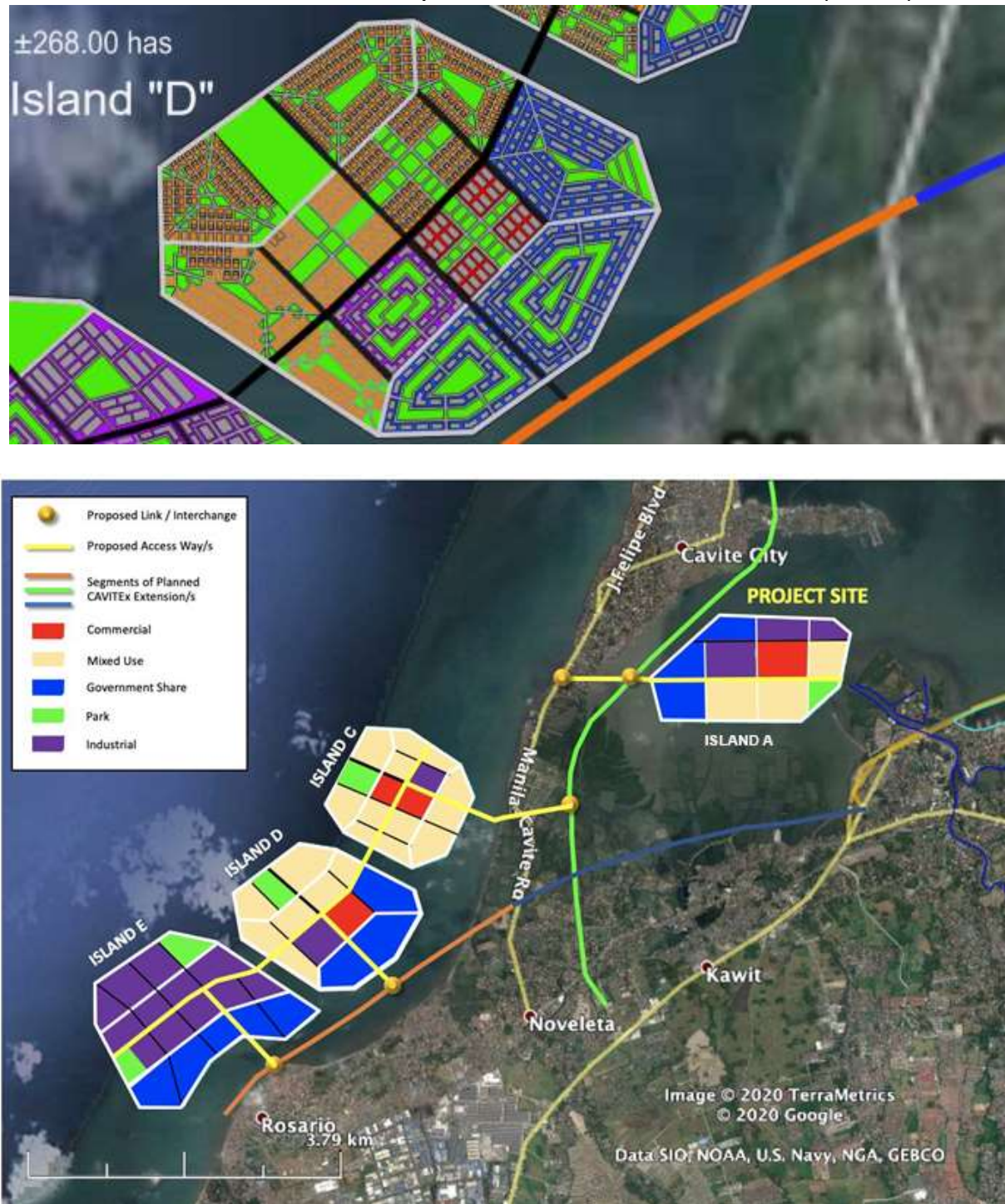


**Figure 2.2-2. Map Showing the Project (Island D) as well as the adjacent other projects (Islands A, C & E) in relation to existing surface waters.**





Plate 2.2-1. Initial Master Development Plan for Island D and other Islands (A, C & E)

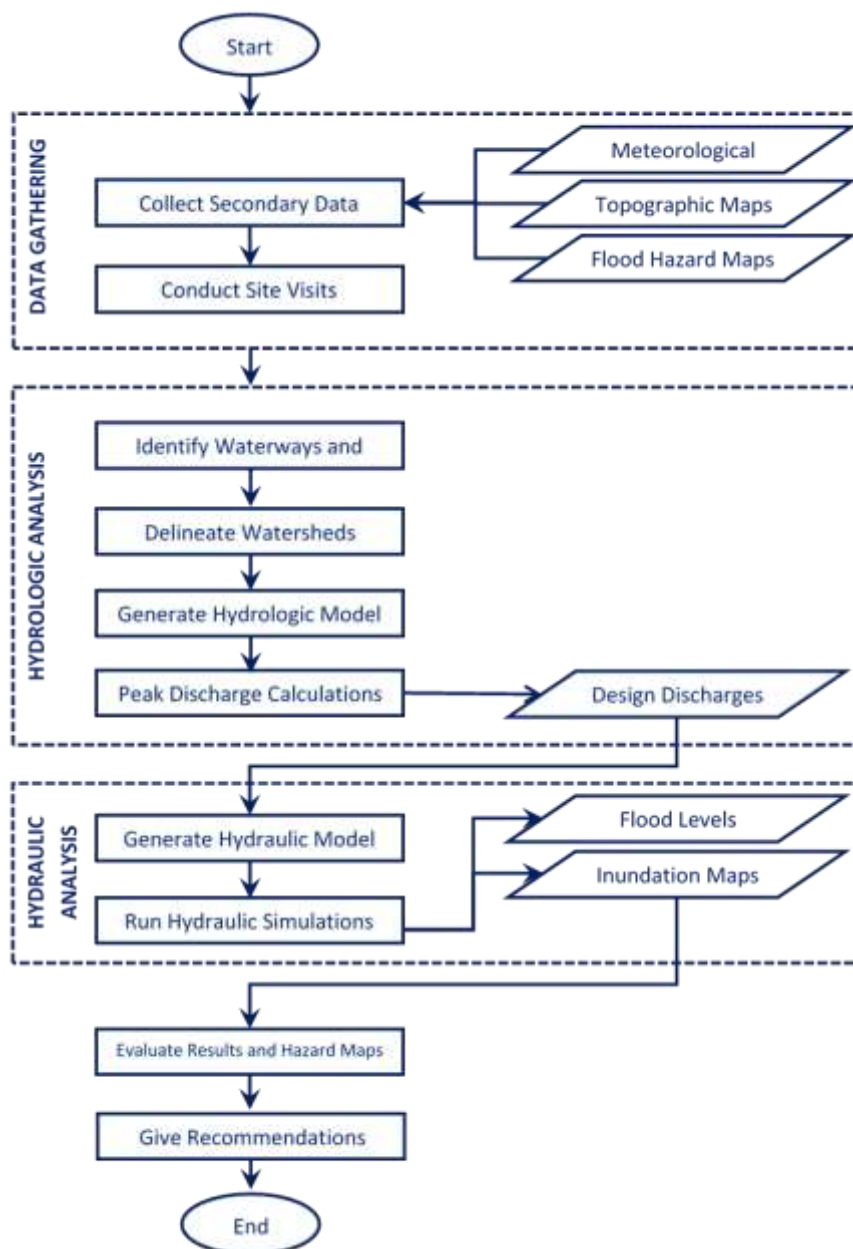




#### 2.2.1.1.1 Flood Studies

##### General Methodology

Plate 2.2-2. Flood Studies Process Flow



##### Hydrologic Analysis:

A flood runoff-routing modelling software HEC-HMS was used in the study to estimate the Peak Discharge of the waterways with catchment size greater than or equal to 20sq.km. Simulations were done for various return period. The Hydrologic Modelling System (HEC-HMS) was developed by the US Army Corps of Engineers to simulate the rainfall-runoff processes in the watershed systems.



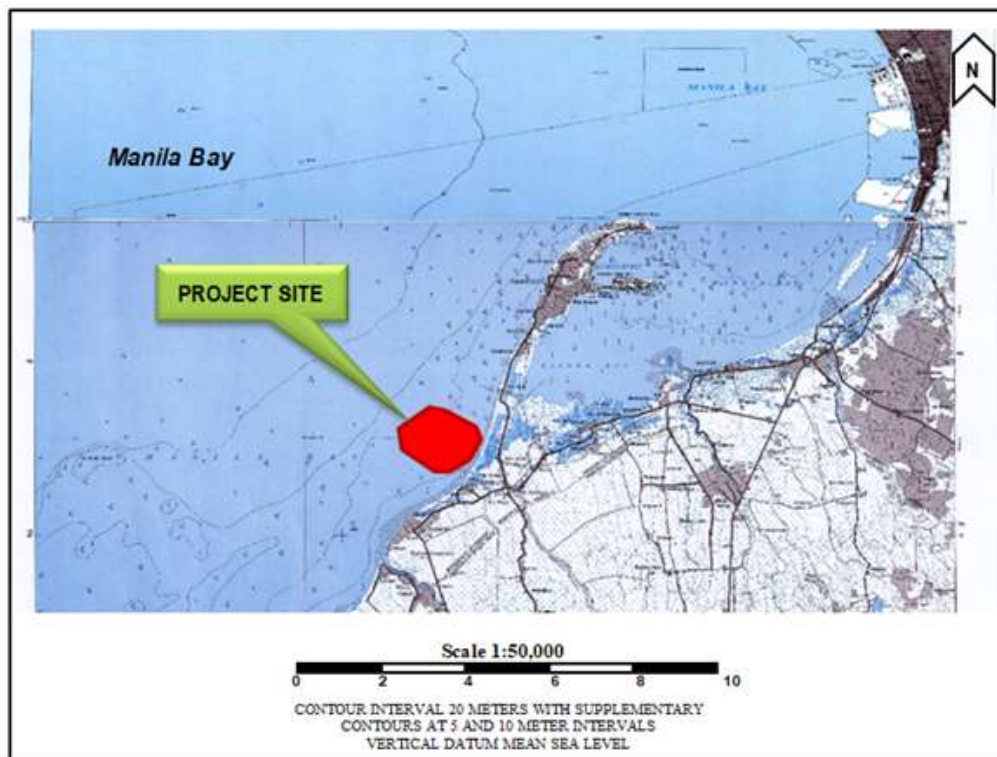
### Hydraulic Analysis:

The river system was analyzed with the aid of HEC-RAS (Hydraulic Engineering Center River Analysis System). HEC-RAS is a public-domain program developed by the US Army Corps of Engineers that allows modelling of one-dimensional, two-dimensional, steady flow, unsteady flow, sediment transport/mobile bed computations, and water temperature modelling. For this study, HEC-RAS was utilized to simulate one-dimensional steady flow, or coupled one-dimensional and two-dimensional, unsteady flow on the river network for the multiple return period discharge hydrographs derived from the hydrologic calculations.

### General Topography

A topographic map and a bathymetric map are graphical representations of the topography of the landforms above and below the sea level, respectively. Both maps are represented through the use of contour lines corresponding to elevation values to illustrate the locations of vertical depressions and protrusions of the area.

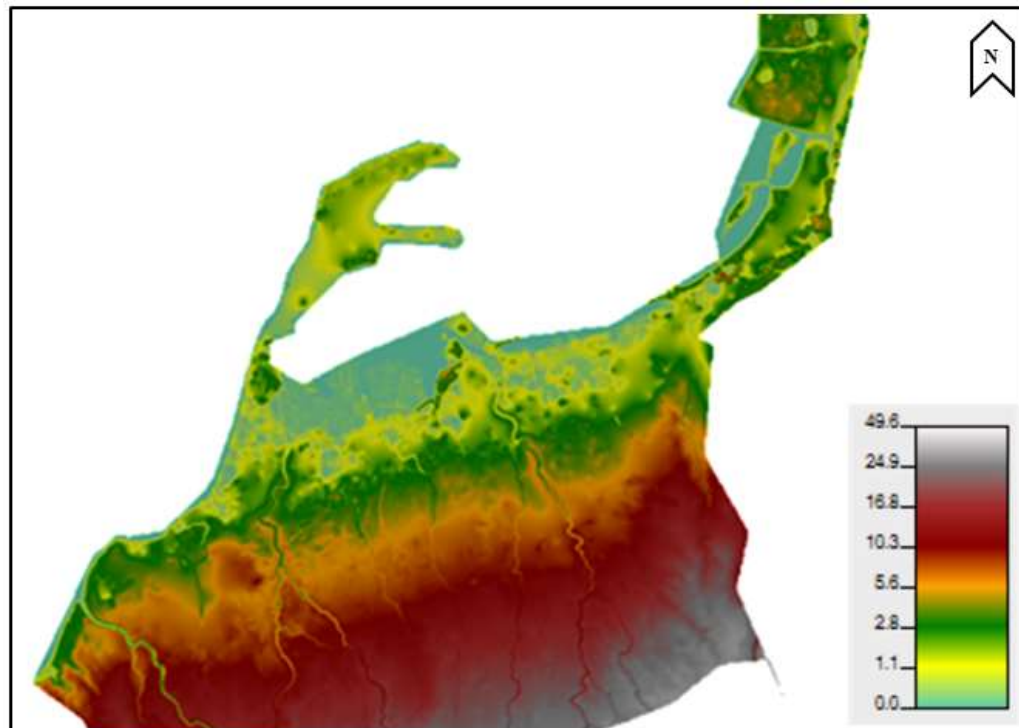
The general topographic information for the project area was obtained from the National Mapping and Resource Information Authority (NAMRIA), under the Department of Environmental and Natural Resources (DENR) of the Philippines. Based on the stitched clipped topographic map of the Cavite (Map #3129-I), Muntinlupa City (Map #3229-IV), Quezon City (Map #3230-III), and Manila (Map #7172-II), the municipalities near the project site have relatively flat topography (Figure 2.2-2). Due to the sparseness of data, the local topographic features of the shore or site are not evident, and hence AMH requested remote sensing data in the form of IfSAR-based DTM's from NAMRIA (Figure 2.2-3).



Source: NAMRIA

**Figure 2.2-3. Topographic Map of the Project Site**





Source: NAMRIA

**Figure 2.2-4. IfSAR Data of the Project Site**

### **Existing Waterways**

Cañas River drains to Manila Bay, and is about 2.5 km distant from Island D. Maalimango River and an unnamed tidal creek also drain into Manila Bay, approximately 200m to the southeast of Island D. The outfalls of Ylang-Ylang River, Panamitan River, and Imus River are located on the lee side of Cavite Spit, in Bacoar Bay near Island A. There are other small waterways which also drains to the coast near the same island, traversing the fishpond areas south of Island A.

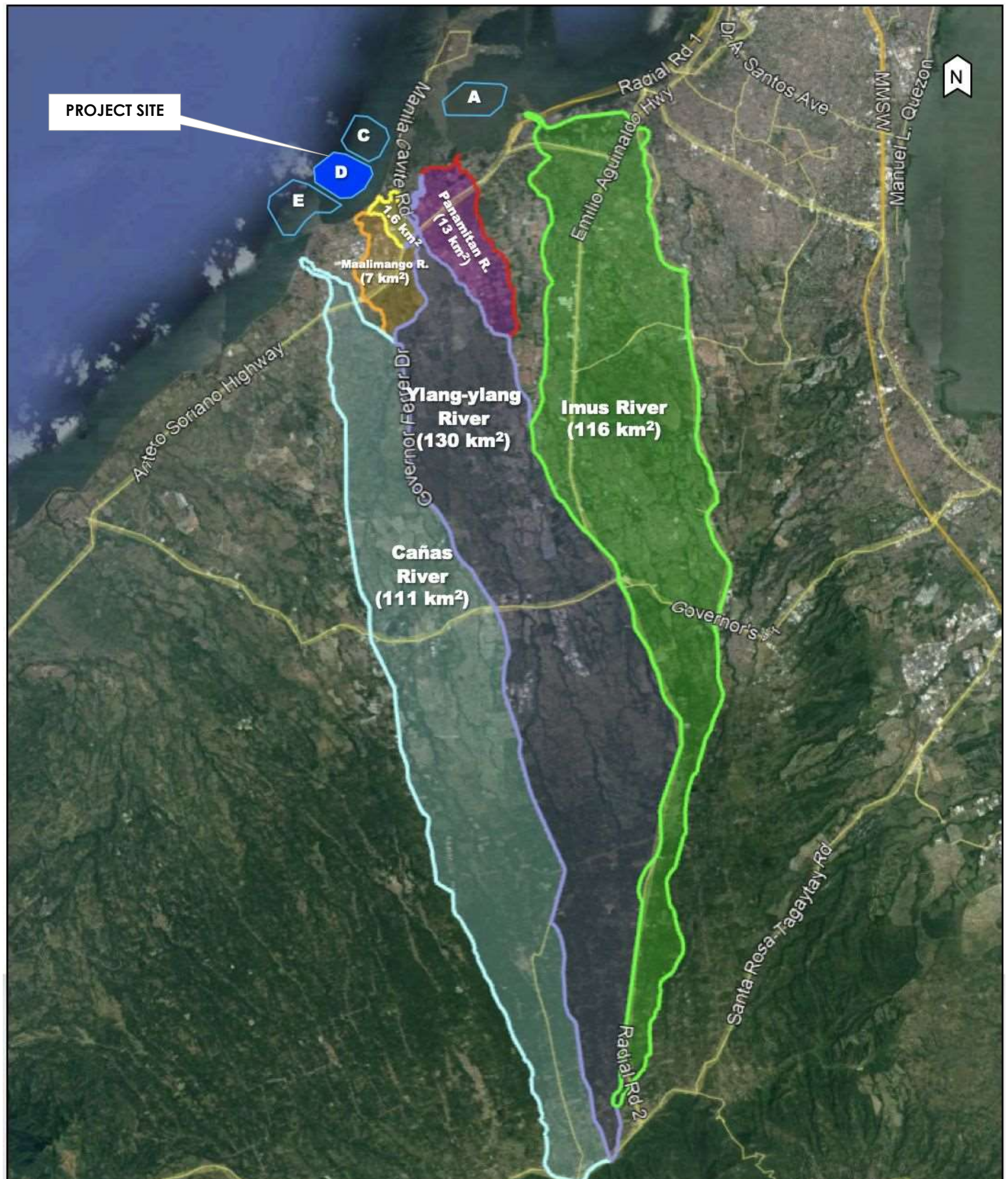
This is shown in Figure 2.2-2 above.

### **Catchment Delineation**

A watershed, also called a catchment or drainage basin, refers to the topographic area that collects and discharges surface stream flow through one outlet or mouth (Mays, 2005), termed as “control point” in this report. Watershed delineation is the process in which the boundaries of a watershed are identified by passing an imaginary line that traces the ridges and divides. The delineated area represents a “bowl” that drains into a lowest portion, known as the outfall or outlet.

The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) from Japan’s Ministry of Economy, Trade and Industry (METI) and Interferometric Synthetic Aperture Radar (IfSAR) from NAMRIA Digital Elevation Models were used to delineate the extent of the catchments of the six (6) major outfalls near the reclamation site. The resulting delineations were overlain onto satellite imagery for checking. The resulting catchments were also verified using the NAMRIA 1:50,000 topographic map.





Base Map: Satellite Image by Digital Globe, Google Earth 2020

Figure 2.2-5. Catchment Delineation of Waterway Discharge Points Near the Reclamation Site





## Soil Map

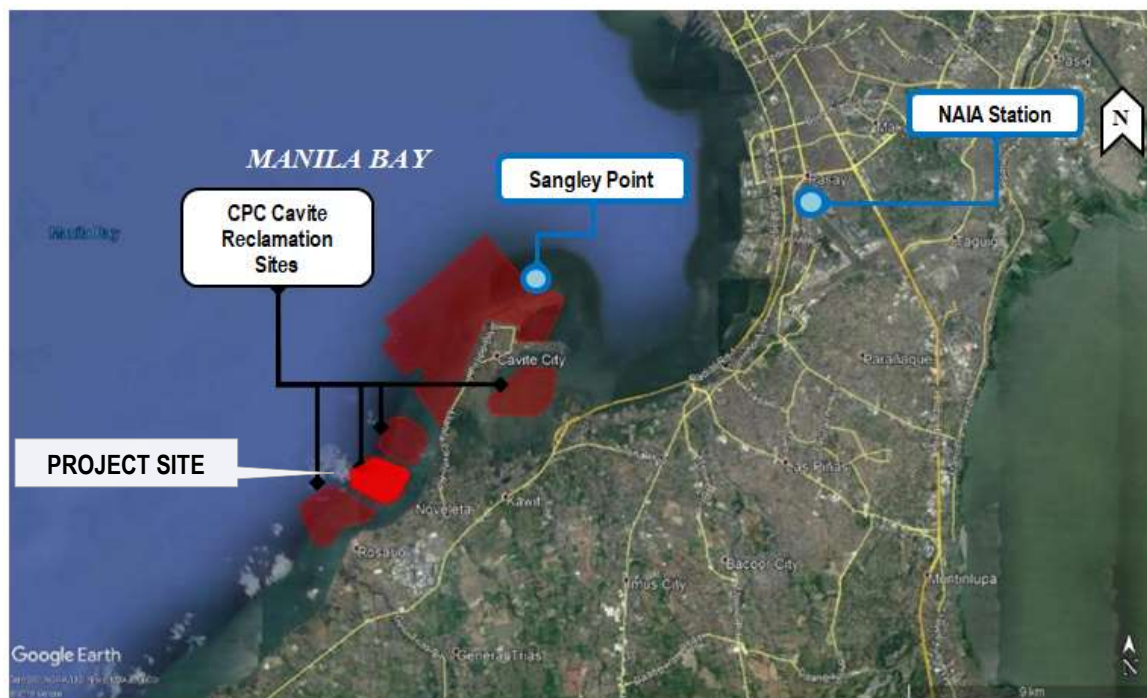
Discussion and maps for soil are presented under Chapter 2.1.4. Pedology.

Based on the Philippine Soil Series Map of the BSWM, the southern part of Metro Manila and lowland area of Cavite are underlain by Guadalupe Soil. Guadalupe soils are composed of weathering clay residuum, and waterlaid tuffaceous material that are very poorly drained on flat areas and a major lowland for soils. This soil type is categorized as coarse when dry, and sticky and plastic when wet.

## Design Rainfall

The Rainfall Intensity Duration and Frequency (RIDF) Data is a tabulation of the rainfall depth (or equivalent rainfall intensity) corresponding to a selected storm duration and return period. These values are based on probabilistic analysis on the rainfall data collected for an extensive period of time.

For this study, the RIDF data served as the basis for the design frequency storm used in the hydrologic analysis. The rainfall data from Sangley Point station was used for the hydrologic analysis of the inland waterways due to their proximity, topography and length of record.



Base Map: 2018 Google Earth

**Figure 2.2-6. Nearest RIDF Stations**

The RIDF Data (Table 2.2-1) is a tabulation of the rainfall depth (or equivalent rainfall intensity) corresponding to a selected storm duration and return period. These values are based on probabilistic analysis on the rainfall data collected for an extensive period of time.

**Table 2.2-1. Recorded Extreme Values of Precipitation (mm) – Sangley Point**

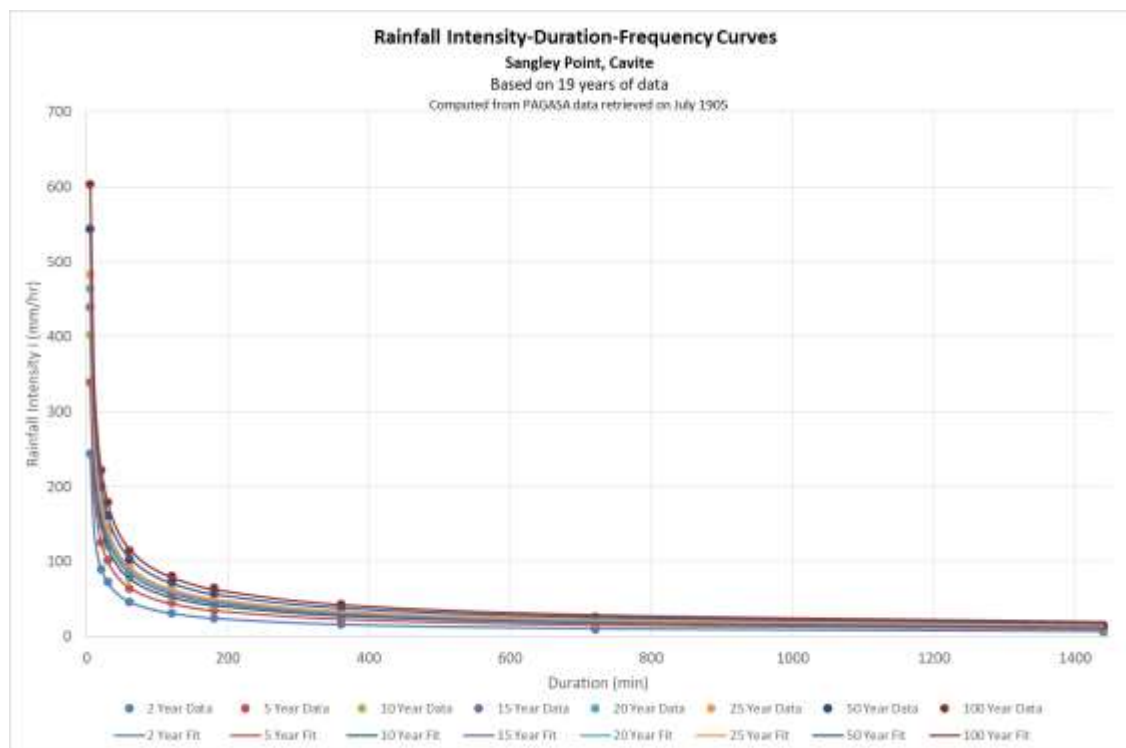
| Return Period (yr) | 5 Min | 20 min | 30 min | 60 min | 120 min | 3 hr  | 6 hr  | 12 hr | 24 hr |
|--------------------|-------|--------|--------|--------|---------|-------|-------|-------|-------|
| 5                  | 28.3  | 41.8   | 50.8   | 64.6   | 89.8    | 106.8 | 140.3 | 174.0 | 209.4 |
| 10                 | 33.6  | 49.7   | 60.2   | 76.7   | 107.3   | 128.2 | 169.2 | 210.0 | 250.1 |
| 25                 | 40.3  | 59.6   | 72.1   | 91.9   | 129.5   | 155.2 | 205.8 | 255.5 | 301.5 |





| Return Period (yr) | 5 Min | 20 min | 30 min | 60 min | 120 min | 3 hr  | 6 hr  | 12 hr | 24 hr |
|--------------------|-------|--------|--------|--------|---------|-------|-------|-------|-------|
| 50                 | 45.3  | 66.9   | 80.9   | 103.3  | 146.0   | 175.2 | 233.0 | 289.3 | 339.7 |
| 100                | 50.3  | 74.2   | 89.7   | 114.5  | 162.3   | 195.1 | 259.9 | 322.8 | 377.6 |

Source: PAGASA Sangley Point Station



Source: PAGASA Sangley Point Station

**Figure 2.2-7. Rainfall Intensity Duration Frequency Curves for PAGASA Sangley Point Station, Cavite**

Based on the RIDF data from PAGASA, RIDF curves were derived for Sangley Point, Cavite Station. The RIDF curves were used to develop design hyetographs for this study using the alternating block method. The alternating block hyetograph method determines the rainfall intensities for a specific increment of time.

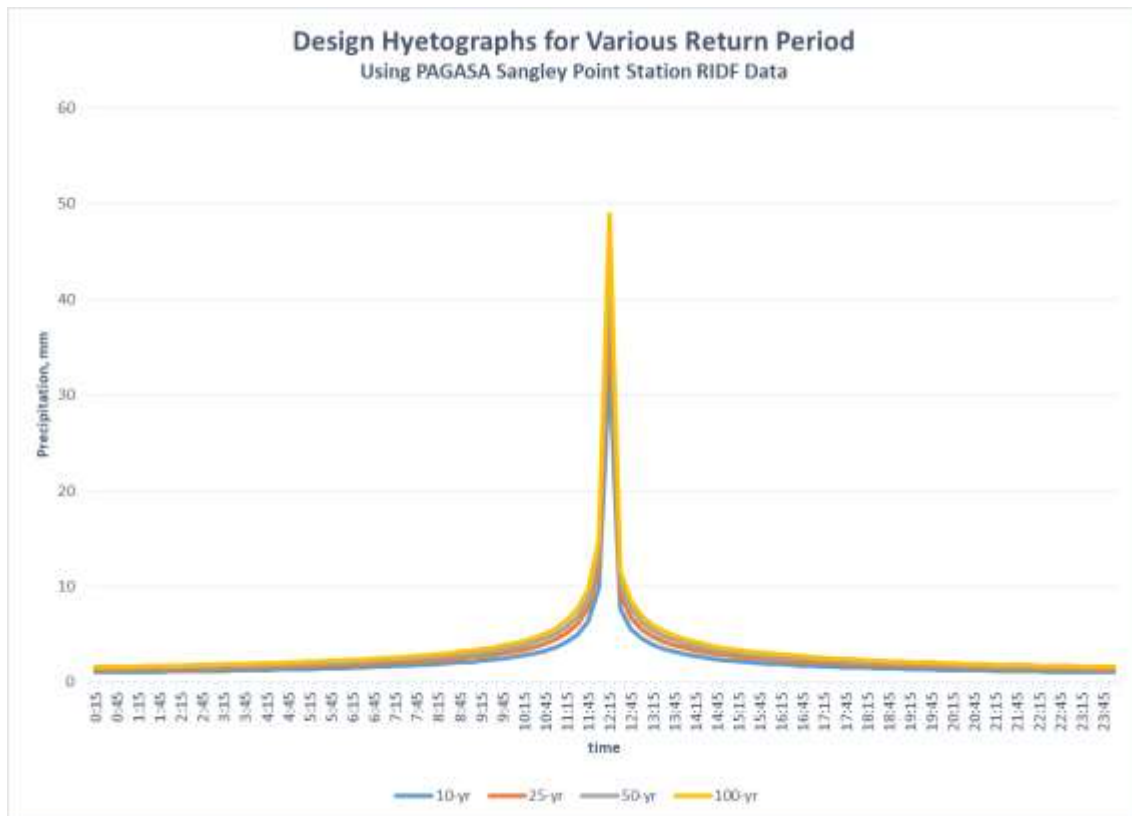
For large catchment areas, rainfall of an extreme precipitation event is unlikely to be distributed uniformly over all subbasins. An area reduction factor may be applied to reduce the point rainfall and use the value as the basin rainfall depth. This can be calculated using the Horton's Formula:

$$r = r_o e^{[-0.1(0.386A)^{0.31}]}$$

Where

r = basin mean rainfall (mm)  
 r<sub>o</sub> = point rainfall (mm)  
 A = catchment area (km<sup>2</sup>)

The final design hyetograph for various return periods are presented in the figure below.



Source: PAGASA Sangley Point Station

**Figure 2.2-8. Design Hyetograph, PAGASA Sangley Point Station RIDF Data**

The return period is the average interval of time within which the magnitude of a hydrologic event will be equaled or exceeded once, on the average. It is determined by taking the reciprocal of the probability of exceedance per year of an event. The probability of exceedance is determined by analyzing a set of data (e.g. rainfall depths, river gages, etc.) that has been collected for an extensive period of time. For example, a storm event with a probability of exceedance per year of 1% (0.01) is equivalent to a return period of  $1/0.01$  or 100 years.

### Climate Normals

Climatological Normals are period averages computed for a uniform and relative long period comprising of at least 3 consecutive 10-year periods. It summarizes the average values of rainfall, temperature, and wind speed per month.



**Table 2.2-2. Recorded Normal Values of Precipitation (Sangley Point)**

|        | Rainfall       |              | Temperature |             |              |                  |                  |                 |                            |                   |               | Wind           |              |                 |      | No. Days w/ |  |
|--------|----------------|--------------|-------------|-------------|--------------|------------------|------------------|-----------------|----------------------------|-------------------|---------------|----------------|--------------|-----------------|------|-------------|--|
| Month  | Amount<br>(mm) | No. of<br>RD | Max<br>(°C) | Min<br>(°C) | Mean<br>(°C) | Dry Bulb<br>(°C) | Wet Bulb<br>(°C) | Dew Pt.<br>(°C) | Vapor<br>Pressure<br>(mbs) | Rel.<br>Hum.<br>% | MSLP<br>(MBS) | DIR<br>(16 pt) | SPD<br>(mps) | Cloud<br>(okta) | TSTM | LTNG        |  |
| JAN    | 16.9           | 4.0          | 30.0        | 23.3        | 26.6         | 26.8             | 23.9             | 22.8            | 27.7                       | 79.0              | 1012.5        | ESE            | 3            | 5               | 0    | 0           |  |
| FEB    | 11.1           | 2.0          | 30.8        | 23.6        | 27.2         | 27.4             | 24.1             | 22.9            | 27.7                       | 76.0              | 1012.7        | ESE            | 3            | 5               | 0    | 0           |  |
| MAR    | 9.4            | 2.0          | 32.7        | 24.6        | 28.6         | 28.7             | 25.0             | 23.7            | 29.1                       | 74.0              | 1012.1        | ESE            | 3            | 4               | 1    | 1           |  |
| APR    | 18.5           | 2.0          | 34.4        | 25.9        | 30.1         | 30.3             | 26.0             | 24.6            | 30.6                       | 71.0              | 1010.5        | ESE            | 3            | 4               | 2    | 5           |  |
| MAY    | 139.1          | 9.0          | 34.1        | 26.1        | 30.1         | 30.3             | 26.5             | 25.3            | 32.0                       | 74.0              | 1008.8        | ESE            | 3            | 5               | 11   | 16          |  |
| JUN    | 264.5          | 15.0         | 32.8        | 25.8        | 29.3         | 29.5             | 26.4             | 25.4            | 32.3                       | 78.0              | 1008.4        | ESE            | 3            | 6               | 14   | 18          |  |
| JUL    | 422.4          | 20.0         | 31.7        | 25.3        | 28.5         | 28.6             | 26.0             | 25.1            | 31.8                       | 81.0              | 1008.0        | W              | 3            | 6               | 16   | 17          |  |
| AUG    | 457.2          | 14.0         | 31.3        | 25.2        | 28.3         | 28.2             | 25.8             | 25.0            | 31.5                       | 83.0              | 1007.6        | SW             | 3            | 7               | 13   | 14          |  |
| SEP    | 341.8          | 19.0         | 31.4        | 25.2        | 28.3         | 28.4             | 25.9             | 25.1            | 31.7                       | 82.0              | 1008.4        | W              | 3            | 6               | 15   | 16          |  |
| OCT    | 224.3          | 15.0         | 31.4        | 25.3        | 28.4         | 28.4             | 25.8             | 24.9            | 31.4                       | 81.0              | 1009.3        | ESE            | 3            | 6               | 9    | 14          |  |
| NOV    | 110.5          | 11.0         | 31.1        | 25.0        | 28.1         | 28.1             | 25.3             | 24.3            | 30.3                       | 80.0              | 1010.4        | ESE            | 3            | 6               | 4    | 5           |  |
| DEC    | 62.7           | 7.0          | 30.0        | 23.9        | 27.0         | 27.1             | 24.3             | 23.3            | 28.4                       | 79.0              | 1011.9        | ESE            | 3            | 5               | 1    | 1           |  |
| ANNUAL | 2078.4         | 127.0        | 31.8        | 24.9        | 28.4         | 28.5             | 25.4             | 24.4            | 30.4                       | 78.0              | 1010.1        | ESE            | 3            | 5               | 86   | 107         |  |

Source: PAGASA Sangley Point Station

### Climate Extremes

Climatological Extremes refer to maximum and, where applicable, minimum values of weather-related data at a certain station as determined from a long record of data. These values include the precipitation, temperature, wind speed, and sea level pressure at the weather station and can be requested from PAGASA at monthly or annual extremes. It is from this data that tropical cyclone events which affected the project site in the past can be extrapolated.

**Table 2.2-3. Recorded Extreme Values of Precipitation – Sangley Point**

| MONTH            | TEMPERATURE (°C) |            |      |            | GREATEST DAILY RAINFALL (mm) |            | STRONGEST WINDS (mps) |     |            | SEA LEVEL PRESSURES (mbs) |            |        |            |
|------------------|------------------|------------|------|------------|------------------------------|------------|-----------------------|-----|------------|---------------------------|------------|--------|------------|
|                  | HIGH             | DATE       | LOW  | DATE       | AMOUNT                       | DATE       | SPD                   | DIR | DATE       | HIGH                      | DATE       | LOW    | DATE       |
| JAN              | 34.8             | 01-25-1999 | 19.0 | 01-03-1982 | 94.0                         | 01-12-1977 | 17                    | ESE | 01-19-2010 | 1023.4                    | 01-16-1999 | 1001.9 | 01-31-2001 |
| FEB              | 35.2             | 02-28-1998 | 18.0 | 02-01-1982 | 45.8                         | 02-06-2016 | 15                    | ESE | 02-27-1992 | 1019.9                    | 02-03-1993 | 1005.4 | 02-21-2001 |
| MAR              | 36.6             | 03-29-1981 | 19.1 | 03-25-1980 | 52.4                         | 03-22-2013 | 24                    | ESE | 03-23-1998 | 1020.5                    | 03-05-2005 | 1003.9 | 03-06-1999 |
| APR              | 37.8             | 04-07-1983 | 21.5 | 04-03-2007 | 53.9                         | 04-24-1975 | 16                    | ESE | 04-05-1996 | 1017.5                    | 04-14-1993 | 1002.0 | 04-30-1988 |
| MAY              | 38.5             | 05-16-1987 | 22.0 | 05-15-1980 | 237.1                        | 05-26-1997 | 27                    | SW  | 05-22-1976 | 1015.5                    | 05-25-1983 | 993.4  | 05-22-1976 |
| JUNE             | 38.4             | 06-04-1987 | 22.0 | 06-16-1981 | 172.4                        | 06-27-1985 | 25                    | SE  | 06-08-2011 | 1014.3                    | 06-08-1997 | 997.6  | 06-28-2004 |
| JULY             | 38.3             | 07-25-2007 | 21.2 | 07-15-1982 | 231.4                        | 07-20-2002 | 54                    | E   | 07-13-2010 | 1013.8                    | 07-29-1983 | 988.1  | 07-15-2014 |
| AUG              | 36.5             | 08-16-2009 | 22.0 | 08-02-1994 | 475.4                        | 08-19-2013 | 30                    | W   | 08-16-1990 | 1014.5                    | 08-13-2005 | 996.1  | 08-17-1990 |
| SEP              | 35.8             | 09-02-1996 | 21.0 | 09-16-1979 | 275.4                        | 09-22-2013 | 44                    | NNW | 09-28-2006 | 1015.6                    | 09-18-2005 | 984.3  | 09-28-2006 |
| OCT              | 35.8             | 10-08-1996 | 21.0 | 10-24-1986 | 260.7                        | 10-05-1986 | 45                    | NW  | 10-21-1994 | 1016.4                    | 10-27-1993 | 990.3  | 10-21-1994 |
| NOV              | 36.4             | 11-08-1978 | 21.5 | 11-26-1982 | 171.2                        | 11-02-2000 | 49                    | NW  | 11-03-1995 | 1017.5                    | 11-30-1989 | 977.0  | 11-03-1995 |
| DEC              | 34.0             | 12-06-1998 | 20.0 | 12-24-1985 | 131.3                        | 12-10-2006 | 22                    | NNW | 12-05-1993 | 1019.1                    | 12-31-1992 | 997.9  | 12-02-2004 |
| ANNUAL           | 38.5             | 05-16-1987 | 18.0 | 02-01-1982 | 475.4                        | 08-19-2013 | 54                    | E   | 07-13-2010 | 1023.4                    | 01-16-1999 | 977.0  | 11-03-1995 |
| Period of Record | 1974 - 2015      |            |      |            | 1974 - 2015                  |            | 1974 - 2015           |     |            | 1974 - 2015               |            |        |            |

Maximum Wind (MPs)

Lowest Pressure

### Flood Hazard Maps

#### MGB Flood Hazard Map

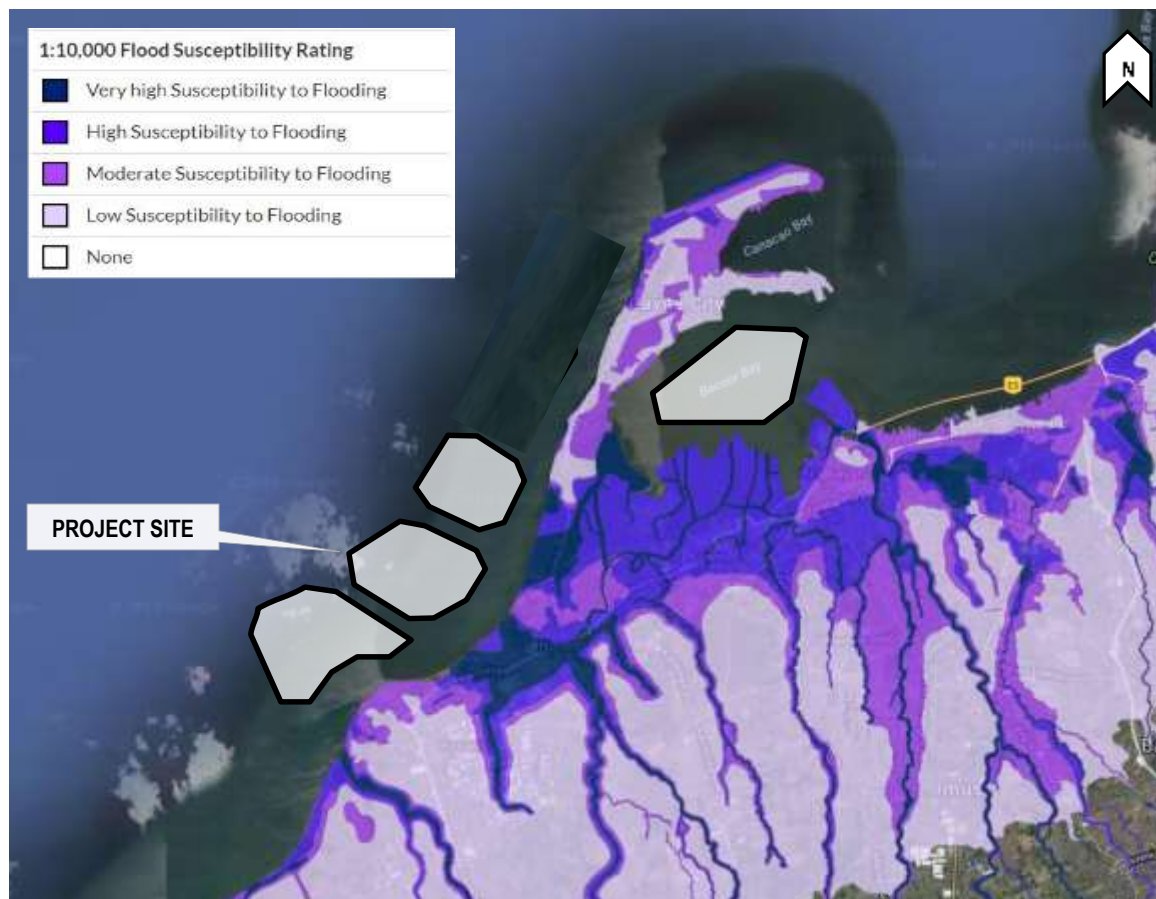
Philippine topography varies from lowlands to mountain ranges, valleys, alluvial plains and coastal rims. Major bodies of water such as rivers and lakes are dominant in the country. Being an archipelago, the country is surrounded by seas and ocean. Varying topography means varying susceptibility to different hazards such as landslides and floods. Since the country experiences an average of 20 typhoons every year, many parts of the country are prone to landslides and floods.





To address the issue on these possible hazards, landslide and flood susceptibility maps for the entire country were published by the Mines and Geosciences Bureau (MGB). The map shown below were based on the 1:10,000 scale topographic maps by NAMRIA. Generally, rolling to steep terrains was classified for their susceptibility to landslides, while flatter and low-lying areas were classified for their susceptibility to flooding.

The MGB Flood Susceptibility Map shows that the project vicinity is low to moderately susceptible to flooding. Noveleta, which provides access to Cavite City from the south, is generally classified under high to very high flood susceptibility. Ylang-Ylang River, Panamitan River, Imus River, Cañas River and the other small waterways are expected to overflow during extreme rainfall events.



Source: MGB 2015

**Figure 2.2-9. MGB 1:10,000 Flood Susceptibility Map**

Other flood maps by MGB and UP Project NOAH as well as discussion on flooding are shown in **Chapter 2.1.2.3. Inducement of subsidence, liquefaction, mud / debris flows, etc.**

### **Flood Study of Maalimango River**

#### **a. Hydrologic Analysis**

The peak discharges for the catchment are determined using Rational Formula based on the parameters calculated and discussed in the previous chapters. Rational formula is used when a watershed (catchment area) is less than or equal to 20 km<sup>2</sup>. The formula is defined by:

$$Q=KC_iA$$

Where



|   |   |                                    |
|---|---|------------------------------------|
| Q | = | peak discharge (m <sup>3</sup> /s) |
| K | = | conversion factor (0.278)          |
| C | = | runoff coefficient                 |
| i | = | rainfall intensity (mm/hr)         |
| A | = | catchment area (km <sup>2</sup> )  |



Base Map: 2018 Google Earth

**Figure 2.2-10. HEC-HMS Model for Maalimango River Catchment**

The land cover defines the runoff coefficient of the catchment area. The runoff coefficient is a dimensionless coefficient with value between zero and one that describes the catchment's permeability to excess rainfall. A runoff coefficient equal to one (1) indicates that the catchment is very impermeable, and 100% of the rainfall on a catchment area is converted to direct runoff. The NAMRIA topographic maps and existing satellite images were utilized to determine the pre-development condition. As of the present, approximately 45% of the total catchment is paved, 26% is grass area, 17% is cultivated land, and the remaining 12% is forest and woodland is considered for the existing conditions.

The peak discharges for each catchment for the various storm even return periods are summarized in the table below.

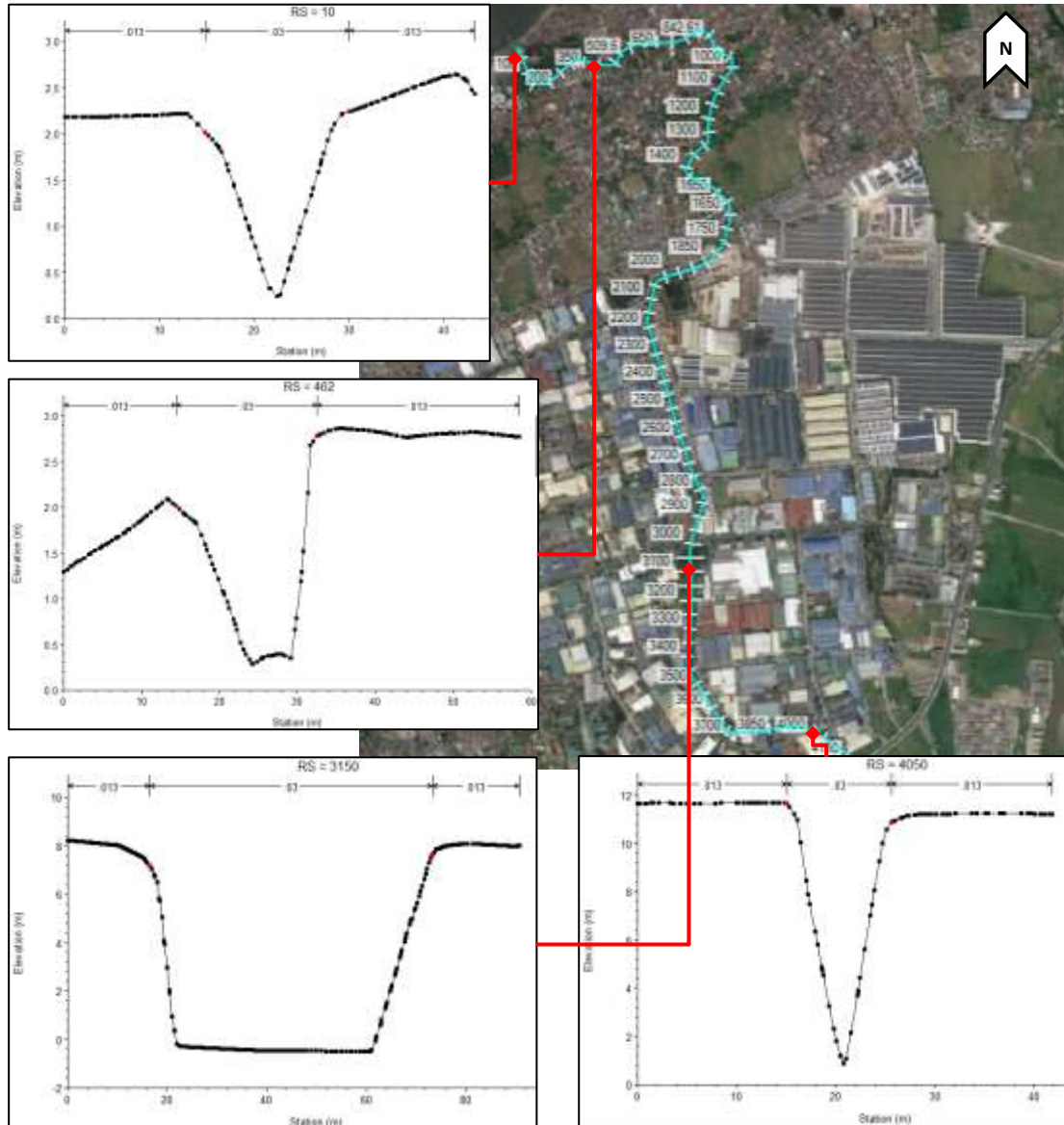
**Table 2.2-4. Calculated Peak Discharges for Maalimango River**

| Return Period (Probability of Occurrence) | Peak Discharge (cms) |
|---|----------------------|
| 10-year Return Period (10%)               | 36 m <sup>3</sup> /s |
| 25-year Return Period (4%)                | 50 m <sup>3</sup> /s |
| 50-year Return Period (2%)                | 62 m <sup>3</sup> /s |
| 100-year Return Period (1%)               | 76 m <sup>3</sup> /s |



### b. Hydraulic Analysis

The elevation data from the client-issued creek survey were used to generate the river sections of Maalimango River. Shown in Figure 2.2-11 is the HEC-RAS model. The sections were extended beyond the banks to generate the floodplains wherein the floods will extend in the case that the river section is inadequate to contain the estimated river discharges.



**Figure 2.2-11. HEC-RAS Model and Sample Sections for Maalimango River**

Table 2.2-5 shows the different parameters used in the hydraulic analysis of the two rivers using HEC-RAS. Different values of Manning's roughness coefficient were used for all the portions of the river (main channel and banks). The roughness coefficient is an empirical coefficient used to represent the surface roughness of the channel and overbanks, to take into account the energy loss due to the roughness/friction. The overbank is defined as the area above and beyond the main channel depression, in which water does not usually flow under normal conditions.





To simulate the pre-development conditions and post-development conditions, the water level values from the coastal engineering study were used as downstream control. Another simulation was done for the highest maximum historical water level at Manila South Harbor Tide Station.

**Table 2.2-5. HEC-RAS model parameters**

|                                    |  |
|------------------------------------|--|
| Channel                            | Maalimango River   |
| Flow Regime                        | Subcritical  |
| Type of Flow                       | Steady   |
| Downstream Control                 | Known Water Level (MSL)<br><br>Extreme condition - Maximum Recorded Water Level = 1.48m<br>Pre-development Conditions - Storm Tide Level = 1.2m*<br>Post-development Conditions - Storm Tide Level= 1.2m*<br>*from coastal engineering study |
| Manning's Coefficient for Channel  | 0.03 for channel   |
| Manning's Coefficient for overbank | 0.013 for Concrete, 0.03 for Riprap, 0.04 for settlements  |

Source: AMH Philippines, May 2019

The results and findings of the hydraulic analysis are as follows:

- Downstream control – highest historical water level (Manila South Harbor Tide Station)

Inundation maps for the varying rainfall conditions as shown in the figures below were plotted using RAS MAPPER, the floodplain mapping extension built-in the HEC-RAS Program. The blue areas reflect the flood extents, with darker shades indicating deeper water depths. Based on the inundation maps, even at a 10-year rainfall event, the downstream extent of Waterway 5 is at risk of flooding with the upstream portion is not susceptible to flooding.



**Figure 2.2-12. Inundation Map of Maalimango River for 10-yr Return Period (based on Highest Historical Water Level at Manila South Tide Station)**



Figure 2.2-13. Inundation Map of Maalimango River for 25-yr Return Period (based on Highest Historical Water Level at Manila South Tide Station)



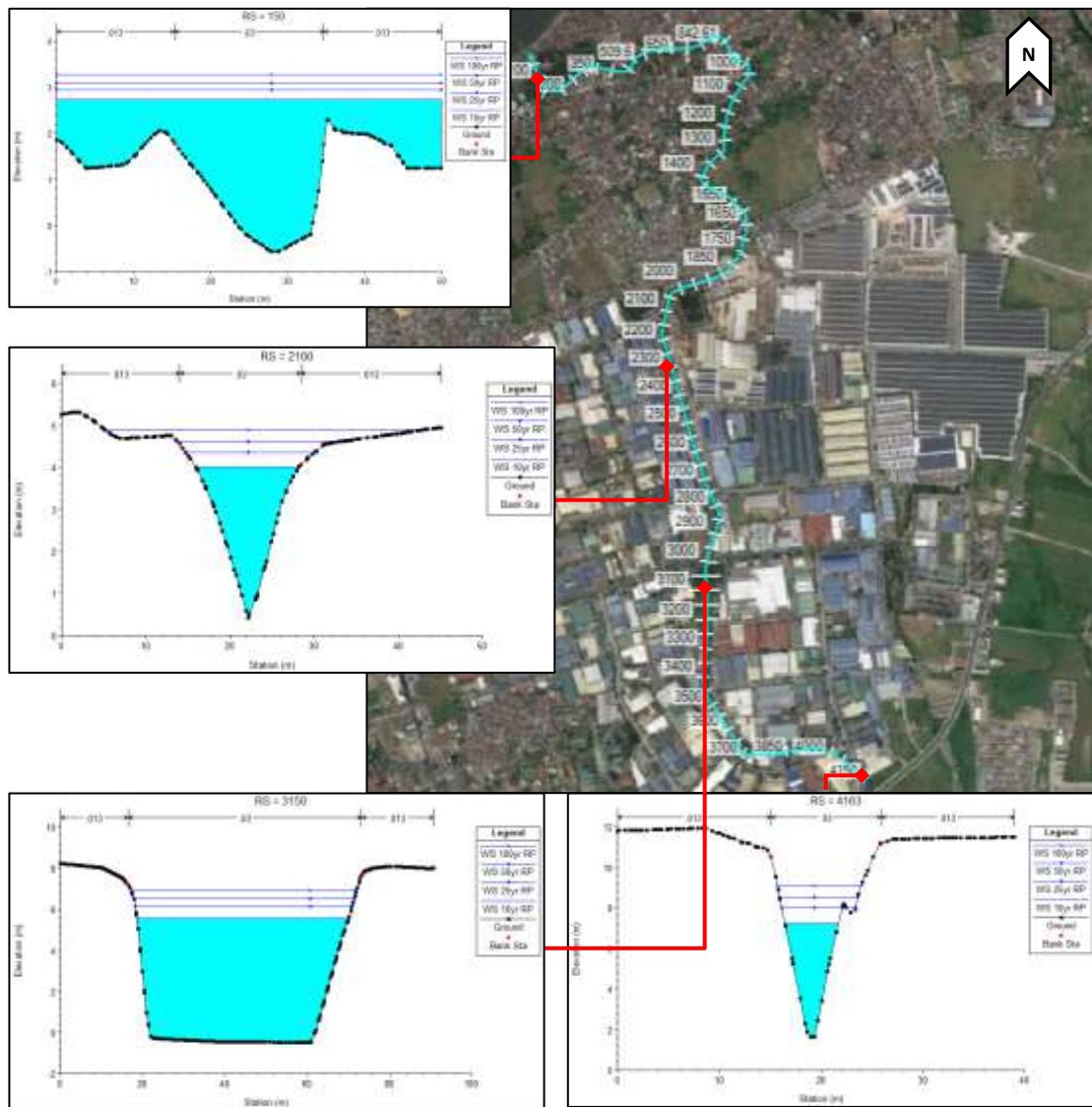
Figure 2.2-14. Inundation Map of Maalimango River for 50-yr Return Period (based on Highest Historical Water Level at Manila South Tide Station)





**Figure 2.2-15. Inundation Map of Maalimango River for 100-yr Return Period (based on Highest Historical Water Level at Manila South Tide Station)**





**Figure 2.2-16. Sample Cross-Sections of Maalimango River (based on highest historical water level at Manila South Tide Station)**

- Downstream control – Water elevation at outfall for Pre-development condition (based on results of the coastal engineering study)

Inundation maps for the varying rainfall conditions as shown in the figures below were plotted using RAS MAPPER. Similar with the previous scenario, the downstream extent of Maalimango River is at risk of flooding with the upstream portion is not susceptible to flooding.



Figure 2.2-17. Inundation Map of Maalimango River for 10-yr Return Period (Pre-development and Post-development Condition)



Figure 2.2-18. Inundation Map of Maalimango River for 25-yr Return Period (Pre-development and Post-development Condition)



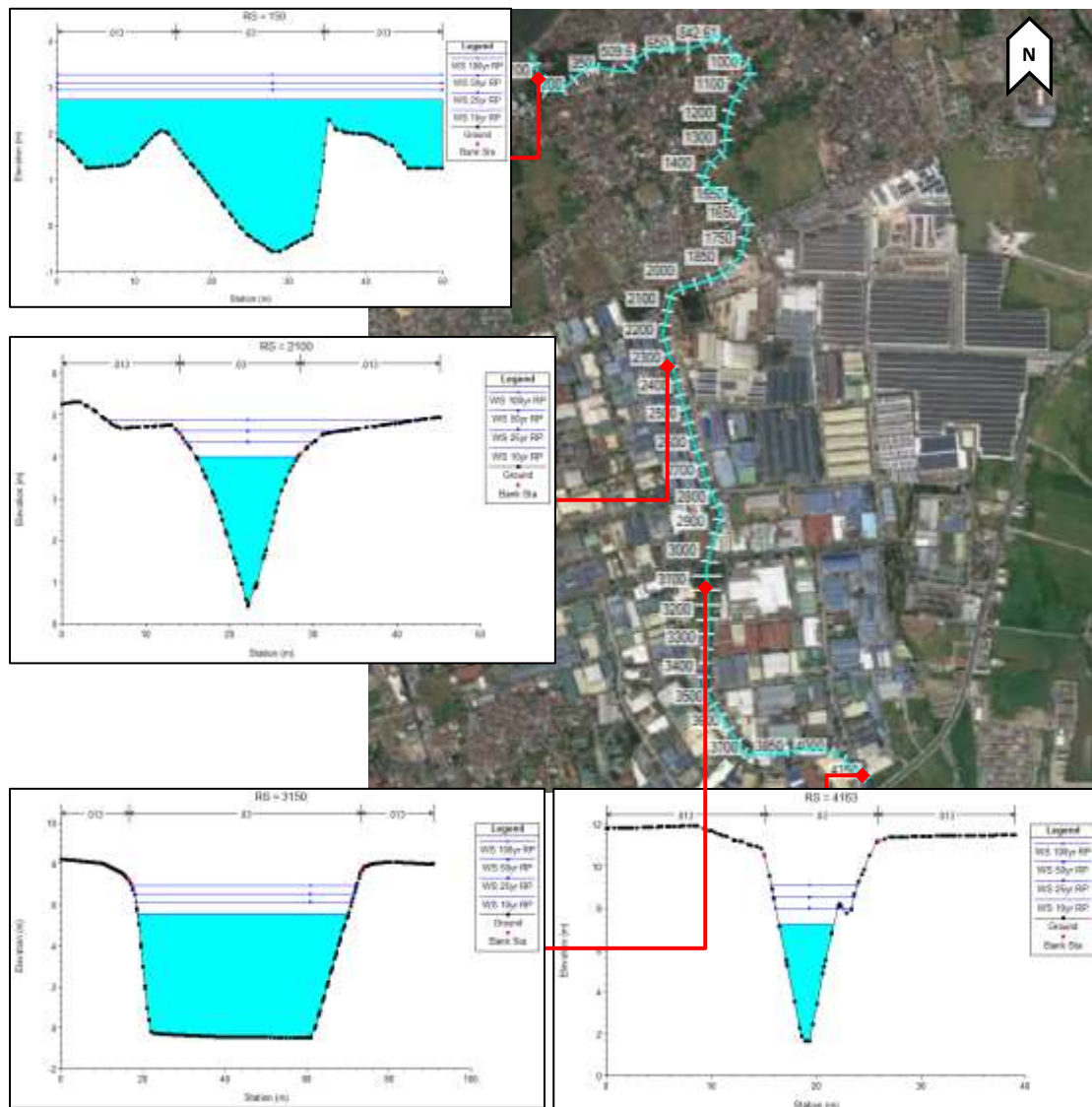


Figure 2.2-19. Inundation Map of Maalimango River for 50-yr Return Period (Pre-development and Post-development Condition)



Figure 2.2-20. Inundation map of Maalimango River for 100-yr Return Period (Pre-development and Post-development Condition)





**Figure 2.2-21. Sample Cross-Sections of Maalimango River (Pre-development and Post-development Condition)**

- Downstream control – Water elevation at outfall for Post-development condition (based on results of the coastal engineering study)

Based on the storm tide levels for TS Rita, one of the past typhoon events critical to the project site, the water levels at the Waterway 5 outfall for post-development condition is equal to the water levels for pre-development condition. In effect, the downstream control of the Hydraulic model for both scenarios are known water levels of equal values. It can be concluded that the proposed reclamation sites will have negligible impact to the inland flooding of areas near Maalimango River.

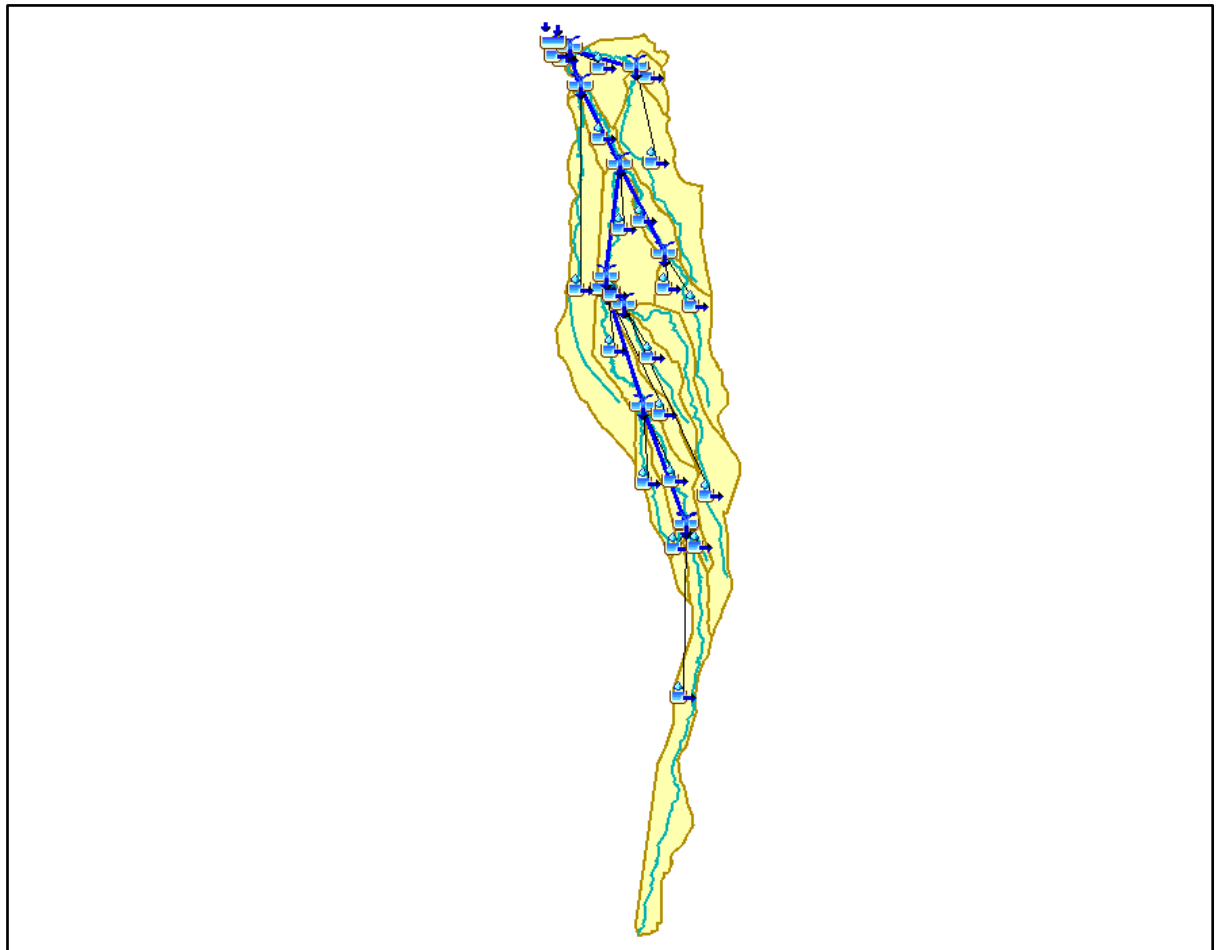
The results of the hydraulic analysis agree with Project NOAH flood hazard map (Figure 2.1-54), the area is at risk of experience flood heights greater than 1.5m (high risk). The existing flood risk in the project area vicinity are not likely to be aggravated by the proposed reclamation project.



## Flood Study of Cañas River

### a. Hydrologic Analysis

The HEC-HMS basin model was generated based on the catchment delineation and parametrization using the available elevation datasets. Figure 2.2-22 shows the HEC-HMS model domain consisting of subbasins, reaches, and junction elements.



**Figure 2.2-22. HEC-HMS Model for Cañas River**

The catchment area is characterized in terms of total area, flow length, slope, and land use. Two land cover conditions were considered: pre-development conditions and post-development conditions. The NAMRIA topographic maps and existing satellite images were utilized to determine the pre-development condition. As of the present, approximately 20% of the total catchment is paved, while the remaining 80% is grass area or cultivated land, is considered for the existing conditions.

**Table 2.2-6. Subbasin Characteristics of Cañas River Catchment**

| SUBBASIN | AREA (SQ.KM.) | Basin Slope (%) | Hydrologic Soil Group |
|----------|---------------|-----------------|-----------------------|
| SB1      | 0.33          | 0.18            | D                     |
| SB2      | 6.49          | 19.57           | D                     |
| SB3      | 3.97          | 12.56           | D                     |
| SB4      | 2.41          | 18.76           | D                     |



| SUBBASIN   | AREA (SQ.KM.) | BASIN SLOPE (%) | HYDROLOGIC SOIL GROUP |
|------------|---------------|-----------------|-----------------------|
| SB5        | 3.53          | 12.39           | D                     |
| SB6        | 0.03          | 11.39           | D                     |
| SB7        | 0.70          | 13.10           | D                     |
| SB8        | 2.99          | 15.18           | D                     |
| SB9        | 5.24          | 10.97           | D                     |
| SB10       | 6.73          | 12.14           | D                     |
| SB11       | 9.83          | 6.16            | D                     |
| SB12       | 13.53         | 8.70            | D                     |
| SB13       | 10.31         | 11.40           | D                     |
| SB14       | 1.39          | 11.95           | D                     |
| SB15       | 5.77          | 8.90            | D                     |
| SB16       | 0.09          | 6.99            | D                     |
| SB17       | 7.22          | 7.29            | D                     |
| SB18       | 4.44          | 6.03            | D                     |
| SB19       | 9.73          | 9.70            | D                     |
| SB20       | 16.44         | 6.14            | D                     |
| Cañas (21) | 1.10          | 0.18            | D                     |
| Cañas (22) | 0.57          | 19.57           | D                     |
| Cañas (1)  | 16.20         | 12.56           | D                     |

The above-mentioned basin parameters were determined by processing maps and terrain data using ArcMap 10.2, a Geographic Information System (GIS) software. GIS software are designed to store, process, analyze and manage spatial datasets.

After completing the watershed model and meteorologic models, simulation for Cañas River was done in HEC-HMS. The control specification for the simulation was set to 24 hours. Table below shows the calculated peak discharge at the control point.

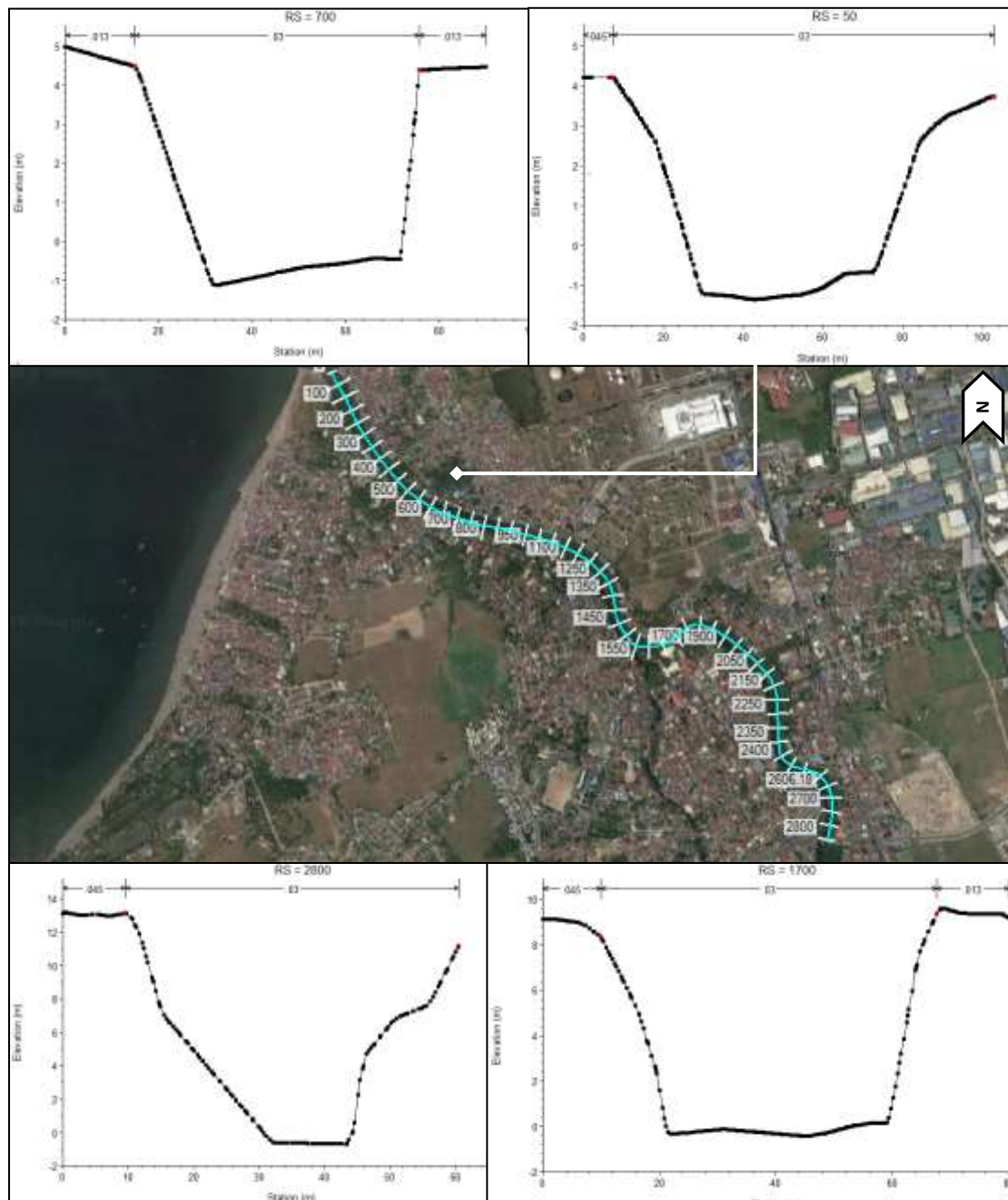
**Table 2.2-7. Calculated Peak Discharge of Cañas River Catchment**

| Return Period (Probability of Occurrence) | Peak Discharge (cms)  |
|---|-----------------------|
| 10-year Return Period (10%)               | 621 m <sup>3</sup> /s |
| 25-year Return Period (4%)                | 765 m <sup>3</sup> /s |
| 50-year Return Period (2%)                | 872 m <sup>3</sup> /s |
| 100-year Return Period (1%)               | 977 m <sup>3</sup> /s |

#### **b. Hydraulic Analysis**

The elevation data from the client-issued creek survey were used to generate the river sections of Cañas River. Shown in Figure 2.2-23 is the HEC-RAS model. The sections were extended beyond the banks to generate the floodplains wherein the floods will extend in the case that the river section is inadequate to contain the estimated river discharges.





**Figure 2.2-23. HEC-RAS Model and Sample Sections for Cañas River**

Table 2.2-8 shows the different parameters used in the hydraulic analysis of the two rivers using HEC-RAS. Different values of Manning's roughness coefficient were used for all the portions of the river (main channel and banks). The roughness coefficient is an empirical coefficient used to represent the surface roughness of the channel and overbanks, to consider the energy loss due to the roughness/friction. The overbank is defined as the area above and beyond the main channel depression, in which water does not usually flow under normal conditions.

To simulate the pre-development conditions and post-development conditions, the water level values from the coastal engineering study were used as downstream control. Another simulation was done for the highest maximum historical water level at Manila South Harbor Tide Station.



**Table 2.2-8. HEC-RAS Model Parameters**

|                                    |  |
|------------------------------------|--|
| Channel                            | Cañas River  |
| Flow Regime                        | Subcritical  |
| Type of Flow                       | Steady   |
| Downstream Control                 | Known Water Level (MSL)<br><br>Extreme condition - Maximum Recorded Water Level = 1.48m<br>Pre-development Conditions - Storm Tide Level = 1.2m*<br>Post-development Conditions - Storm Tide Level= 1.2m*<br><br>*from coastal engineering study |
| Manning's Coefficient for Channel  | 0.03 for channel   |
| Manning's Coefficient for overbank | 0.013 for Concrete, 0.03 for Riprap, 0.04 for settlements  |

The results and findings of the hydraulic analysis are as follows:

- Downstream control – highest historical water level (Manila South Harbor Tide Station)

Inundation maps for the varying rainfall conditions as shown in the figures below were plotted using RAS MAPPER, the floodplain mapping extension built-in the HEC-RAS Program. The blue areas reflect the flood extents, with darker shades indicating deeper water depths. Based on the inundation maps, even at a 10-year rainfall event, some sections of Cañas River in the downstream portion were at risk of flooding, while the upstream-most areas are unlikely to be flooded.



**Figure 2.2-24. Inundation Map of Cañas River for 10-yr Return Period (based on highest historical water level at Manila South Tide Station)**





Figure 2.2-25. Inundation Map of Cañas River for 25-yr Return Period (based on highest historical water level at Manila South Tide Station)



Figure 2.2-26. Inundation Map of Cañas River for 50-yr Return Period (based on highest historical water level at Manila South Tide Station)





Figure 2.2-27. Inundation Map of Cañas River for 100-yr Return Period (based on highest historical water level at Manila South Tide Station)

- Downstream control – Water elevation at outfall for Pre-development condition (based on results of the coastal engineering study)

Inundation maps for the varying rainfall conditions as shown in the figures below were plotted using RAS MAPPER. Similar with the previous scenario, **the downstream extent of Cañas River is at risk of flooding while the upstream portion is not susceptible.**



Figure 2.2-28. Inundation Map of Cañas River for 10-yr Return Period (Pre-development and Post-development Condition)



Figure 2.2-29. Inundation Map of Cañas River for 25-yr Return Period (Pre-development and Post-development Condition)



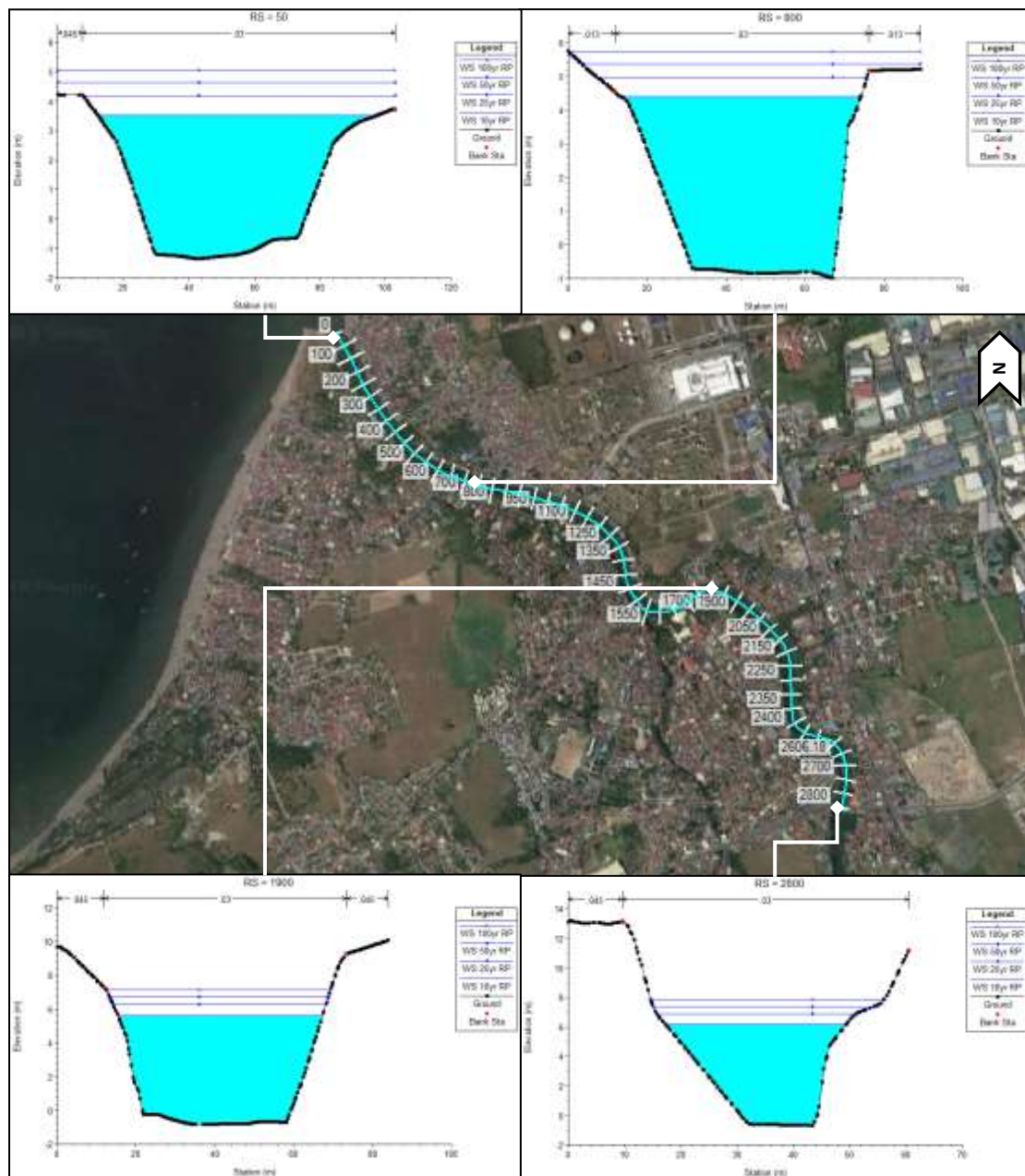


Figure 2.2-30. Inundation Map of Cañas River for 50-yr Return Period (Pre-development and Post-development Condition)



Figure 2.2-31. Inundation map of Cañas River for 100-yr Return Period (Pre-development and Post-development Condition)





**Figure 2.2-32. Sample Cross-Sections of Cañas River (Pre-development and Post-development Condition)**

- Downstream control – Water elevation at outfall for Post-development condition (based on results of the coastal engineering study)

Based on the storm tide levels for TS Rita, one of the past typhoon events critical to the project site, the water levels at the Cañas River outfall for post-development condition is equal to the water levels for pre-development condition. In effect, the downstream control of the Hydraulic model for both scenarios are known water levels of equal values. It can be concluded that the proposed reclamation sites will have negligible impact to the inland flooding of areas near Cañas River.

- The results of the hydraulic analysis agree with the existing flood hazard maps. According to the MGB Flood Susceptibility Map, the extent of the river model is classified as highly to very highly susceptible



to flooding. Based on Project NOAH flood hazard map (Figure 2.1-54), the area is at risk of experience flood heights greater than 1.5m (high risk). The existing flood risk in the project area vicinity are not likely to be aggravated by the proposed reclamation project.

#### **2.2.1.1.2 Internal Drainage System**

The primary objective of hydrology study for the internal drainage system is to provide information on meteorology and climate and derived extreme rainfall frequencies for use in the hydraulic analysis. The design discharges of waterways through the area and reclamation drainage design discharges will be derived. Coastal analysis may also be included in the study.

Information from hydrology will be used in hydraulic analysis to derive dimensions of the inland channels, drainage layout pipes or channels and design tide levels of the project.

Basic data sources included or will include:

1. Sangley Point rainfall and climatological data were obtained from Philippine Atmospheric Geophysical Services Administration (PAGASA).
2. Data from Sangley Point, PASAGA Synoptic Station includes monthly historical climatological normals of rainfall, temperature, wind and number of rainy days that may not only be relevant during the planning and design stage but also during construction stage.
3. Sangley Point Rainfall Intensity Duration Frequency (RIDF) was from also PAGASA prepared by Hydrometeorological Data Application Section, Hydrology Division, PAGASA.

RIDF values were derived from data sets of historical record of extreme rainfall duration measurements in a day say 10 minutes to 24 hr duration. These sets of data were subjected to statistical analysis to derive the return periods. Statistical methods commonly used are Gumbel and Log Pearson 2 analysis.

The analysis will give return period that a value of extreme rainfall probability to occur again in a given time but that given time may occur any time.

1. Site development and grading plan prepared for the project.
2. Land use map
3. Areal map (Google Earth etc.)
4. Updated tidal levels from the Bureau of Coast and Geodetic Survey or from Hydrographic Division of the NAMRIA

### **Design Discharge Estimates**

#### **a. Rational Method**

The Rational Method is based on the following empirical formula in which rainfall information and watershed characteristics (area, slope, and surface cover) are used to determine discharge.

$$Q = Q_i = 0.278 C I_i A$$

Where:

|       |   |   |
|-------|---|---|
| $Q_i$ | = | The design discharge, m <sup>3</sup> /sec                     |
| $C$   | = | The runoff coefficient $C$ equal to 1 for mostly paved areas. |
| $I_i$ | = | The rainfall intensity in minute                              |
| $A$   | = | The catchment area in km <sup>2</sup>                         |



For Node 1 or Manhole 1,  $Q_1 = CI A_1$ ; for Manhole 2,  $Q_2 = CI(A_1 + A_2)$  and so on  $Q_n = CI(A_1 + A_2 + A_3 \dots + A_n)$  until the outfall

### Catchment Area Delineation

Catchment area per manhole will be drawn based from the site grading and roads of the project. Assignment of runoff coefficient will also depend from the existing or future land use of the area.

**Rainfall Intensity Duration Frequency** For catchment area not more than 10 km<sup>2</sup> and in an urban drainage, design discharges were estimated using the Rational Formula using the RIDF data mentioned earlier, Rainfall depth duration and rainfall intensity duration frequency curves are illustrated in **Figures 2.2-33** below and **2.2-7** above.

**Table 2.2-9. Rainfall Intensity Duration Frequency Analysis Data**  
SANGLEY POINT, Paranaque City  
**COMPUTED EXTREME VALUES (in mm) OF PRECIPITATION , Based on 19 years of record**

| T<br>(yrs) | 10<br>min | 20<br>min | 30<br>min | 60<br>min | 120<br>min | 180<br>min | 360<br>min | 720<br>min | 1440<br>min |
|------------|-----------|-----------|-----------|-----------|------------|------------|------------|------------|-------------|
| 2          | 20.3      | 30.0      | 36.6      | 46.4      | 63.2       | 74.6       | 96.6       | 119.6      | 147.9       |
| 5          | 28.3      | 41.8      | 50.8      | 64.6      | 89.8       | 106.8      | 140.3      | 174.0      | 209.4       |
| 10         | 33.6      | 49.7      | 60.2      | 76.7      | 107.3      | 128.2      | 169.2      | 210.0      | 250.1       |
| 15         | 36.6      | 54.1      | 65.5      | 83.5      | 117.2      | 140.3      | 185.6      | 230.3      | 273.1       |
| 20         | 38.7      | 57.2      | 69.2      | 88.3      | 124.2      | 148.7      | 197.0      | 244.6      | 289.1       |
| 25         | 40.3      | 59.6      | 72.1      | 91.9      | 129.5      | 155.2      | 205.8      | 255.5      | 301.5       |
| 50         | 45.3      | 66.9      | 80.9      | 103.3     | 146.0      | 175.2      | 233.0      | 289.3      | 339.7       |
| 100        | 50.3      | 74.2      | 89.7      | 114.5     | 162.3      | 195.1      | 259.9      | 322.8      | 377.6       |

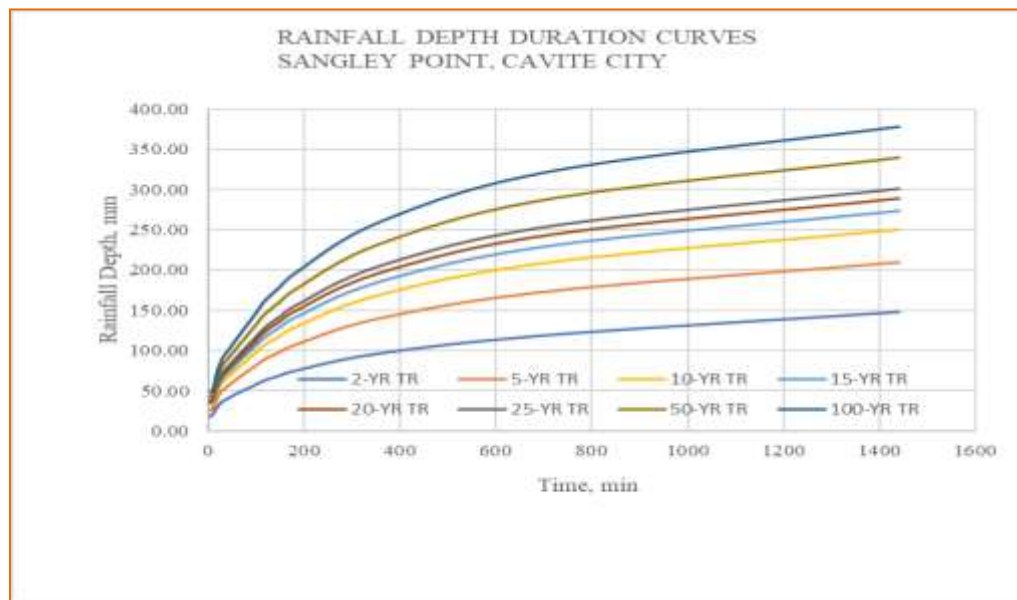
Source: PAGASA Sangley Point Station

**Table 2.2-10. The Hydrometeorological Data Applications Section (HMDAS)**  
**Equivalent Average Intensity (in mm/hr) of Computed Extreme Value**

| T<br>(yrs) | 10<br>min | 20<br>min | 30<br>min | 60<br>min | 120<br>min | 180<br>min | 360<br>min | 720<br>min | 1440<br>min |
|------------|-----------|-----------|-----------|-----------|------------|------------|------------|------------|-------------|
| 2          | 112.5     | 90.0      | 73.2      | 46.4      | 31.6       | 24.9       | 16.1       | 10.0       | 6.2         |
| 5          | 169.7     | 125.5     | 101.6     | 64.6      | 44.9       | 35.6       | 23.4       | 14.5       | 8.7         |
| 10         | 201.6     | 149.0     | 120.4     | 76.7      | 53.7       | 42.7       | 28.2       | 17.5       | 10.4        |
| 15         | 219.6     | 162.3     | 131.0     | 83.5      | 58.6       | 46.8       | 30.9       | 19.2       | 11.4        |
| 20         | 232.2     | 171.5     | 138.5     | 88.3      | 62.1       | 49.6       | 32.8       | 20.4       | 12.0        |
| 25         | 242.0     | 178.7     | 144.2     | 91.9      | 64.8       | 51.7       | 34.3       | 21.3       | 12.6        |
| 50         | 271.9     | 200.7     | 161.8     | 103.3     | 73.0       | 58.4       | 38.8       | 24.1       | 14.2        |
| 100        | 301.6     | 222.6     | 179.3     | 114.5     | 81.2       | 65.0       | 43.3       | 26.9       | 15.7        |

Source: PAGASA Sangley Point Station





**Figure 2.2-33. Rainfall Depth Duration Curves, Sangley Point, Cavite City**

### Time of Concentration

Time of concentration is the time required for a run-off to travel from most remote point in the watershed to point of interest. Time of concentration used in the estimate of rainfall intensity (I) and computed from this equation:

$$t_c = \frac{L}{51H^{0.38}}^{1.15}$$

where :

- tc - time concentration in minutes. In urban area a minimum value of 5 minutes is set for time of concentration and increases with length the water travels
- L - length of longest water course in watershed in meters
- H - difference in elevation between the highest point of the watershed and point under consideration in meter

### Coefficient of Runoff

Coefficient of runoff, C is a factor that represents that portion of runoff which results from a unit of rainfall. It is dependent on the terrain and topography. The rate of runoff to precipitation which takes into account that not all of the rainfall flows as runoff due to terrain and topography like ground cover and terrain condition and land use.

In commercial areas wherein most of the ground surface is paved a higher value of coefficient will be adopted. In flooded and clogged areas, the coefficient of runoff will approach to 1 depending on the degree of flooding. The values of run-off coefficients specified for types of terrain and ground cover is shown in the table below.



**Table 2.2-11. Theoretical Values of Runoff Coefficient C (Adopted by DPWH)**

| Watershed Condition                     | Recommended Range of C Values |
|---|-------------------------------|
| Concrete or Asphalt Pavement            | 0.90 - 1.00                   |
| Steep Mountainous Area                  | 0.75 - 0.90                   |
| Alluvial Deposits in Mountainous Area   | 0.70 - 0.80                   |
| Silt and Sand (Upstream and Downstream) | 0.50 - 0.75                   |
| Flat Agricultural Area                  | 0.45 - 0.60                   |
| Paddy Field With Water                  | 0.70 - 0.80                   |
| River in Mountainous Area               | 0.75 - 0.85                   |
| Rivers in Flat Plain Area               | 0.45 - 0.75                   |
| Major River in Flat Plain Area          | 0.50 - 0.75                   |
| Rocky Surface                           | 0.70 - 0.90                   |
| Residential Area (City)                 | 0.30 - 0.60                   |

### Hydraulic Analysis

Hydraulic design and investigation will be conducted based from the updated DPWH design criteria as tabulated below.

**Table 2.2-12. DPWH Updated Hydraulic Design Criteria**

| Structure                                  | Return Period, years |          |
|--|----------------------|----------|
|  | Design               | Checking |
| Dams/Major Bridges (CA>40km <sup>2</sup> ) | 100                  | -        |
| Minor Bridges (CA<40km <sup>2</sup> )      | 50                   | 100      |
| Tunnel                                     | 100                  | -        |
| Reinforced Concrete Box Culverts           | 25                   | 50       |
| Reinforced Concrete Pipe Culverts          | 15                   | 25       |
| Embankment                                 | 15                   | -        |
| Side Ditches and Surface Drainage/Gutter   | 5                    | -        |

### Urban Drainage

Based from the computed design Q, pipe sizes will be estimated node to node or manhole to manhole from this basic equation:

$$Q = AV$$

Where:

- A = Flow area  
V = Mean Velocity, m/sec computed by Manning's Equation,  
 $V = \frac{1}{n} R^{2/3} S^{1/2}$

Where :

- V = Design Velocity, m/sec  
n = Manning's Roughness coefficient  
R = Hydraulic Radius  
S = Design slope

**Table 2.2-13. Values of Manning's Roughness Coefficient "n"**



| Type of Material                   | n                    |         |
|------------------------------------|----------------------|---------|
| Glass, plastic, mechanical metal   | 0.010                |         |
| Dressed timber, joints flush       | 0.011                |         |
| Sawn timber, joints uneven         | 0.014                |         |
| Cement plaster                     | 0.011                |         |
| Concrete, steel toweled            | 0.012                |         |
| Concrete, timber forms, unfinished | 0.014                |         |
| Untreated unite                    | 0.015                | - 0.017 |
| Brickwork or dressed masonry       | 0.014                |         |
| Rubble set in cement               | 0.017                |         |
| Earth, smooth, no weeds            | 0.020                |         |
| Earth, some stones and weeds       | 0.025                |         |
| <i>Natural river channels:</i>     |                      |         |
| Clean and straight                 | 0.025                | - 0.030 |
| Winding, with pools and shoals     | 0.033                | - 0.040 |
| Very weedy, winding and overgrown  | 0.015                | - 0.300 |
| Clean straight alluvial channels   | $0.031d^{1/6}$       |         |
|                                    | (d=D-75 size in ft.) |         |

### Pavement Drainage

Pavement drainage is necessary to maintain highway traffic safety. Water on the pavement can interrupt traffic and cause accidents due to skidding and hydroplaning. Hydroplaning can reduce driver's visibility and cause difficulty in driving due to splash and spray as vehicle wheels encounters puddles.





**Table 2.2-14. Pavement Drainage-Inlet Spacing Computation Sheet Conceptual and For Illustration Purposes Only**

| GUTTER FLOW               |          |                  |                    |                    |         | INLET SPACING                       |          |                  |            |                |                               |      |                |         |  |
|---------------------------|----------|------------------|--------------------|--------------------|---------|-------------------------------------|----------|------------------|------------|----------------|-------------------------------|------|----------------|---------|--|
| Curb-opening Inlet        |          | W =              | 0.30               | m                  |         | Curb-opening Inlet Intercepted Flow |          | C <sub>W</sub> = | 1.60       | m              |                               |      |                |         |  |
|                           |          | L =              | 1.00               | m                  |         |                                     |          |                  |            |                |                               |      |                |         |  |
| Design Criteria           |          | n =              | 0.015              |                    |         | Design Criteria                     |          | C =              | 0.80       |                |                               |      |                |         |  |
|                           |          | K <sub>u</sub> = | 0.376              |                    |         |                                     |          |                  |            |                |                               |      |                |         |  |
| Allowable Spread, Legends |          | T =              | 2.00               | m                  |         | Allowable Spread, Legends           |          | T =              | 2.00       | m              | If Q <sub>i</sub> > Q, PASSED |      |                |         |  |
|                           |          | HP =             | High Point         |                    |         |                                     |          |                  |            |                |                               |      |                |         |  |
|                           |          | LP =             | Low Point          |                    |         |                                     |          | HP =             | High Point |                |                               |      |                |         |  |
|                           |          | LP =             | Low Point          |                    |         |                                     |          | LP =             | Low Point  |                |                               |      |                |         |  |
| ROAD 2B                   |          |                  |                    |                    |         | ROAD 2B                             |          |                  |            |                |                               |      |                |         |  |
|                           |          | Road width       | 22                 | m                  |         |                                     |          | Road width       | 22         | m              |                               |      |                |         |  |
| Station                   |          | Length (m)       | S <sub>L</sub> m/m | S <sub>x</sub> m/m | Q       | Station                             |          | Spacing          | Q          | S <sub>x</sub> | T                             | d    | Q <sub>i</sub> | REMARKS |  |
| LP-HP/HP-LP               |          | m                | m/m                | m/m                | m³/sec  | LP-HP/HP-LP                         |          | m                | m³/sec     | m/m            | m                             | m    | m³/sec         |         |  |
| 0+000.00                  | 1+037.88 | 1037.88          | 0.00300            | 0.02               | 0.00711 | 0+000.00                            | 1+037.88 | 12.00            | 0.01245    | 0.02           | 2.00                          | 0.04 | 0.0128         | OK      |  |
| ROAD 2G                   |          |                  |                    |                    |         | ROAD 2G                             |          |                  |            |                |                               |      |                |         |  |
|                           |          | Road width       | 30                 | m                  |         |                                     |          | Road width       | 30         | m              |                               |      |                |         |  |
| Station                   |          | Length (m)       | S <sub>L</sub> m/m | S <sub>x</sub> m/m | Q       | Station                             |          | Spacing          | Q          | S <sub>x</sub> | T                             | d    | Q <sub>i</sub> | REMARKS |  |
| LP-HP/HP-LP               |          | m                | m/m                | m/m                | m³/sec  | LP-HP/HP-LP                         |          | m                | m³/sec     | m/m            | m                             | m    | m³/sec         |         |  |
| 0+000.00                  | 0+570.00 | 570.00           | 0.00300            | 0.02               | 0.00711 | 0+000.00                            | 0+570.00 | 9.00             | 0.01273    | 0.02           | 2.00                          | 0.04 | 0.0128         | OK      |  |
| 0+570.00                  | 1+077.71 | 507.71           | 0.00396            | 0.02               | 0.00840 | 0+570.00                            | 1+077.71 | 9.00             | 0.01273    | 0.02           | 2.00                          | 0.04 | 0.0128         | OK      |  |
| ROAD 2H                   |          |                  |                    |                    |         | ROAD 2H                             |          |                  |            |                |                               |      |                |         |  |
|                           |          | Road width       | 30                 | m                  |         |                                     |          | Road width       | 30         | m              |                               |      |                |         |  |
| Station                   |          | Length (m)       | S <sub>L</sub> m/m | S <sub>x</sub> m/m | Q       | Station                             |          | Spacing          | Q          | S <sub>x</sub> | T                             | d    | Q <sub>i</sub> | REMARKS |  |
| LP-HP/HP-LP               |          | m                | m/m                | m/m                | m³/sec  | LP-HP/HP-LP                         |          | m                | m³/sec     | m/m            | m                             | m    | m³/sec         |         |  |
| 0+027.04                  | 1+060.00 | 1032.96          | 0.00368            | 0.02               | 0.00804 | 0+027.04                            | 1+060.00 | 9.00             | 0.01273    | 0.02           | 2.00                          | 0.04 | 0.0128         | OK      |  |
| 1+060.00                  | 1+864.83 | 804.83           | 0.00326            | 0.02               | 0.00747 | 1+060.00                            | 1+864.83 | 9.00             | 0.01273    | 0.02           | 2.00                          | 0.04 | 0.0128         | OK      |  |



### 2.2.1.2 Change in Stream / Lake Water Depth

There are no streams, rivers and lake water bodies in the impact areas that the Proposed Reclamation Project will disturb or divert.

### 2.2.1.3 Depletion of Water Resources / Competition in Water Use

Noting the following features of the Project:

- Only the reclamation works are included in the application for an ECC.
- Activities (reclamation and dredging) are confined to the project site which is at sea
- These activities are dry in nature; no water is used except by the construction crews for domestic purposes.
- The water supply for the construction crew is from purchase of bottled water onshore.

The following statements are thereby made:

- There are no current or projected water use sourced from ground or from the surface water in the project area and adjacent areas.
- There are no springs and wells in the project area and adjacent areas.
- There are no competitions in water use.

The PAGASA medium to long term projects are deemed not germane to the reclamation works with respect to water sourcing.

Water usage and potential competition during the Operations Phase are recognized. The baseline information on water supply for the City are provided in Chapter 2.4.4. The water balance will be subject to more in-depth studies for the master planning for the operations phase and will include water sourcing such as from rain harvesting in addition to the sourcing of supply from the water concessionaires.

### Water Balance

It is estimated that the total annual recharge to the groundwater system of GMMA is about 217 million m<sup>3</sup>/yr or 594,000 m<sup>3</sup>/day. Much of this amount comes from precipitation over a 790 km<sup>2</sup> area (148 m<sup>3</sup>/yr). Induced flow from Laguna Lake is estimated at 22 m<sup>3</sup>/yr; inflow from the North, at 12 m<sup>3</sup>/yr; and inflow from the South, at 10 m<sup>3</sup>/yr. Recharge from MWSS pipeline leakage is estimated at 25 million m<sup>3</sup>/yr. (Clemente, R.S. et al., 2001)

Haman (1996) has come up with a consolidated chart showing the rate of groundwater withdrawal from the aquifer system (Guadalupe and Antipolo) in the NCR region including the Antipolo-San Mateo area from 1931 to 1994. There was a remarkable rise in groundwater withdrawal from 1973 to 1980, attributed to the rapid growth of population in Makati, Pasig, and Quezon City, which could not be supplied by the MWSS. The rate of increase in groundwater withdrawal during the 1980s and early 1990s were relatively less steep. (Clemente, R.S. et al., 2001)

By 1990, total groundwater withdrawal had reached about 930,000 m<sup>3</sup>/day, of which 841,000 m<sup>3</sup>/day were pumped by private deep wells and the remainder by MWSS wells. As of 1995, the estimated groundwater withdrawal from the NCR aquifer system was about 1 million m<sup>3</sup>/day. This is equivalent to about a five-fold increase in groundwater withdrawal since the early 1970s. (Clemente, R.S. et al., 2001)

Of the 1 million m<sup>3</sup> daily groundwater withdrawal, 973,000 m<sup>3</sup> is taken from the Guadalupe aquifer. The estimated recharged rate of the Guadalupe aquifer is 594,000 m<sup>3</sup>/day, indicating an over-pumping rate of



about 379,000 m<sup>3</sup>/day (Haman, April 1996). In subsequent paper (dated October 1996), Haman adjusted this estimate of the over-pumping rate to about 307,000 m<sup>3</sup>/day after accounting for the effect of induced infiltration potential in areas along Laguna Lake. Based on historical pumping data, it appears that groundwater withdrawal in excess of recharge—or groundwater mining—has been occurring since 1979. (*Clemente, R.S. et al., 2001*)

Since then, population growth rate has continued to rise in the NCR. By 2015, the number of HHs needing tap water supply provision is greatest in NCR at more than 1.6 million. (*NEDA, 2018*) The government through the NWRB has long been tapping surface water in lieu of pumping groundwater – which is now strictly regulated.

According to MWSS, the main sources of GMMA's water supply at present are the Angat (since 1968), Ipo (1984), and La Mesa (1929) Dams. The water from these dams are then processed by the La Mesa and Balara Treatment Plants, which converts it from a raw state to clean and potable water.

The Angat Watershed has a moderate to intensive forest cover and has an area of about 568 square kilometers, which receives an average annual rainfall of about 4,200 millimeters. Angat Dam supplies 98 percent of Metro Manila's water needs with a storage capacity of about 850 million cubic meters. (*manilawater.com*)

The water from the Angat Dam, the major supply source for the metropolis, is funneled into the other dams and eventually into the La Mesa Dam and the La Mesa Portal. From the La Mesa Portal, 60% of the flow goes to the nearby La Mesa Treatment Plant, out of which another 40% again travels to the Balara Treatment Plant. The La Mesa Water Treatment Plant, with very minimal electromechanical equipment, relies mostly on water's hydraulic properties to backwash its filter and gravity to convey raw water from the source into the plant and out into the distribution system.

It can only process 2,400 MLD of raw water, while the Balara Treatment Plant, has a full production capacity of 1,600 MLD and can supply more than 6 million people throughout the metropolis. When both Balara and La Mesa Treatment Plants are operation, the total processing capacity will be 4,000 MLD. The La Mesa Water Treatment Plant serves the western half of Metro Manila, while the existing Balara Water Treatment Plant supplies the eastern half.

## 2.2.2 Oceanography

### 2.2.2.1 Change in water circulation pattern, littoral current, and coastal erosion and deposition

#### 2.2.2.1.1 Bathymetric Survey, measured bathymetry and bathymetric map

Bathymetry is a key baseline in the evaluation of oceanography.

#### General Bathymetry

A topographic or bathymetric map is a graphical representation of the topography of the ground surface or seabed through the use of contour lines corresponding to elevation values to illustrate the locations of vertical depressions and protrusions of the area. These maps are usually measured from the Mean Tide Level (MTL), while depth soundings are measured from Mean Lower Low Water (MLLW). The following charts have been collected:

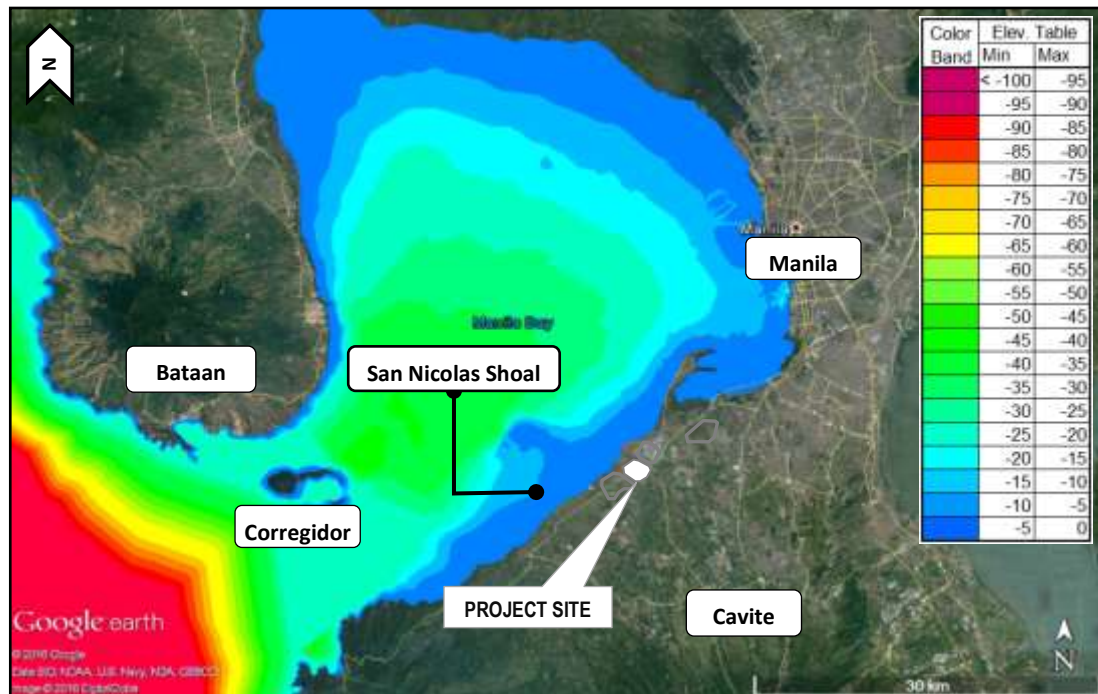
- NAMRIA Nautical Chart 1501 (Manila Bay and Approaches),
- NAMRIA Nautical Chart 4243 (Manila to Cavite),
- NAMRIA Nautical Chart 4236 (Fairways and Anchorages), and
- General Bathymetry Chart of the Oceans (GEBCO) which provides gridded depth points at 30 arc-second intervals (~1 km).





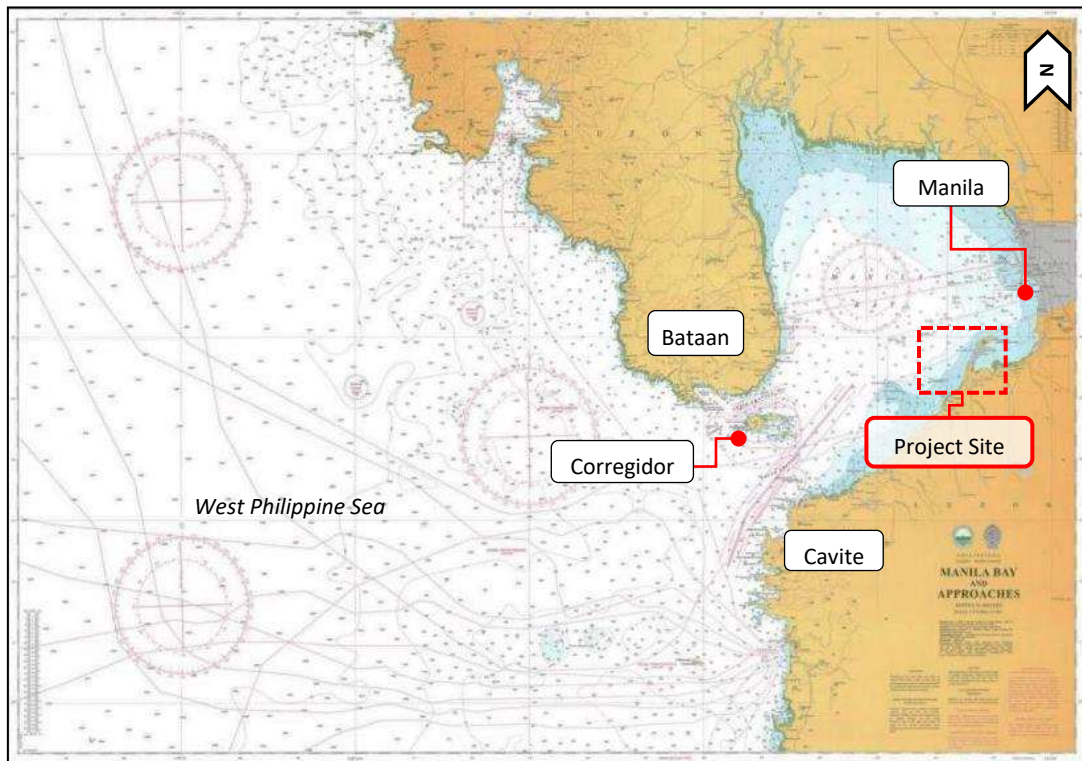
Based on the NAMRIA topography and nautical map of Manila Bay and Approaches shown in Figure 2.2-35, the bathymetry of the project site is mild; at one location the depth of only 10 m is reached at 2.5 km away from the shore, where at another location the 10 m depth only materializes at 5 km from the shore.

From the maps, it can be seen that Manila Bay generally has a mild slope; at one location the depth of only 10 m is reached at 2.5 km away from the shore, where at another location the 10 m depth only materializes at 5 km from the shore. Figure 2.2-34 shows a Digital Elevation Model (DEM) of the bathymetry in the vicinity of the project area, overlain on Google Earth satellite imagery, derived from various Nautical Charts available for Manila Bay.



Source: 2016 Google Earth and NAMRIA

**Figure 2.2-34. Bathymetric Digital Elevation Model (DEM) Project Area**



Source: NAMRIA Chart#1501

**Figure 2.2-35. Nautical Chart - Manila Bay and Approaches**

#### **USLE/Similar modelling when applicable**

The bathymetric information above are considered sufficient and complete for the purpose of modeling. The Universal Soil Loss Equation (USLE) is deemed not applicable as the USLE relates to estimation of soil cover loss due to surface runoff action from upstream of a catchment area. Since the project is an island development and the project site is water, this approach is not applicable.

#### **2.2.2.1.2 Meteorological Data**

Meteorology, being another key baseline in oceanographic assessment is presented hereunder, notwithstanding that similar discussions are separately made in Chapter 2.3 ("Air" Module)

The Philippine Astronomical and Geophysical Services Administration (PAGASA) installed several surface synoptic stations, agro-meteorological stations, and other weather stations that collect meteorological, astronomical, and climatological information over the country. The weather station that is nearest to the project site and has comparable meteorological condition is the Sangley Point station in Sangley Point, Cavite, which is approximately 7.0 kilometers north of the property and has 19 years of record. See figure below.



Base Map: 2018 Google Earth

**Figure 2.2-36. Nearby PAGASA Weather Stations**

Climatological extremes refer to maximum and minimum values of weather-related data at a certain station as observed and determined from a long record of data. These values include the precipitation, temperature, wind speed, and sea level pressure at the weather station and can be requested from PAGASA at monthly or annual extremes. The climatological extremes of the NAIA Station as of 2016, and the Sangley Point Station as of 2016 are shown in Tables 2.2-15 and 2.2-16, respectively. This table contains the highest winds in meters per second (MPS) and lowest pressures in millibars (MBS). Generally low sea level pressures (highlighted in blue) coupled with high wind speeds (highlighted in red) correspond to a strong typhoon tracking close to the weather station.

**Table 2.2-15. Summary of Climatological Extremes of NAIA Station**

| MONTH            | TEMPERATURE (°C) |            |      |            | GREATEST DAILY RAINFALL (mm) |            | STRONGEST WINDS (mps) |     |            | SEA LEVEL PRESSURES (mbs) |            |        |            |
|------------------|------------------|------------|------|------------|------------------------------|------------|-----------------------|-----|------------|---------------------------|------------|--------|------------|
|                  | HIGH             | DATE       | LOW  | DATE       | AMOUNT                       | DATE       | SPD                   | DIR | DATE       | HIGH                      | DATE       | LOW    | DATE       |
| JAN              | 35.8             | 01-07-1989 | 14.8 | 01-18-1961 | 55.3                         | 01-03-1970 | 20                    | ENE | 01-12-1986 | 1022.3                    | 01-27-1987 | 1004.4 | 01-01-1950 |
| FEB              | 35.1             | 02-21-1998 | 14.6 | 02-01-1962 | 16.5                         | 02-27-1950 | 20                    | E   | 02-28-1988 | 1021.4                    | 02-01-1998 | 1003.8 | 02-21-2001 |
| MAR              | 36.5             | 03-30-1978 | 16.0 | 03-03-1963 | 36.0                         | 03-07-2011 | 26                    | E   | 03-29-1992 | 1021.1                    | 03-02-1987 | 1002.4 | 03-06-1999 |
| APR              | 37.8             | 04-23-1948 | 18.7 | 04-01-1994 | 63.0                         | 04-04-1992 | 22                    | ESE | 04-06-1986 | 1019.9                    | 04-23-1987 | 1002.8 | 04-21-2001 |
| MAY              | 38.2             | 05-18-2014 | 19.1 | 05-11-1950 | 229.1                        | 05-27-1960 | 31                    | SW  | 05-22-1976 | 1015.9                    | 05-09-1957 | 992.2  | 05-17-1989 |
| JUNE             | 38.0             | 06-02-1991 | 20.0 | 06-22-1954 | 353.8                        | 06-01-1958 | 36                    | S   | 06-29-1964 | 1016.0                    | 06-07-1997 | 974.6  | 06-29-1964 |
| JULY             | 36.4             | 07-26-2016 | 18.3 | 07-28-1948 | 472.4                        | 07-20-1972 | 36                    | W   | 07-08-1986 | 1014.9                    | 07-07-1953 | 990.1  | 07-16-2014 |
| AUG              | 35.2             | 08-29-1989 | 17.4 | 08-09-1949 | 401.8                        | 08-10-1947 | 30                    | WSW | 08-16-1984 | 1015.2                    | 08-12-1958 | 992.8  | 08-24-1978 |
|                  | 35.2             | 08-19-2014 |      |            |                              |            |                       |     |            |                           |            |        |            |
| SEP              | 35.2             | 09-02-2013 | 19.1 | 09-15-1950 | 228.9                        | 09-08-1963 | 40                    | NNW | 09-28-2006 | 1016.2                    | 09-18-2005 | 986.7  | 09-30-1995 |
| OCT              | 36.0             | 10-24-1976 | 18.0 | 10-23-1981 | 274.5                        | 10-09-1978 | 27                    | W   | 10-18-1985 | 1017.0                    | 10-25-1986 | 977.9  | 10-14-1970 |
| NOV              | 35.8             | 11-17-1972 | 17.2 | 11-26-1949 | 121.7                        | 11-14-1977 | 56                    | W   | 11-19-1970 | 1019.4                    | 11-03-1989 | 899.4  | 11-03-1995 |
| DEC              | 34.2             | 12-29-1978 | 16.3 | 12-18-1955 | 125.5                        | 12-15-2015 | 25                    | NW  | 12-30-1950 | 1020.9                    | 12-08-1960 | 995.5  | 12-02-2004 |
| ANNUAL           | 38.2             | 05-18-1969 | 14.6 | 02-01-1962 | 472.4                        | 07-20-1972 | 56                    | W   | 11-19-1970 | 1022.3                    | 01-27-1987 | 899.4  | 11-03-1995 |
| Period of Record | 1947 - 2015      |            |      |            | 1949 - 2015                  |            | 1950 - 2015           |     |            | 1950 - 2015               |            |        |            |

Maximum Wind (MPS)

Lowest Pressure

Source: PAGASA





**Table 2.2-16. Summary of Climatological Extremes of Sangley Point, Cavite**

| MONTH            | TEMPERATURE (°C) |            |      |            | GREATEST DAILY RAINFALL (mm) |            | STRONGEST WINDS (mps) |     |            | SEA LEVEL PRESSURES (mbs) |            |        |            |
|------------------|------------------|------------|------|------------|------------------------------|------------|-----------------------|-----|------------|---------------------------|------------|--------|------------|
|                  | HIGH             | DATE       | LOW  | DATE       | AMOUNT                       | DATE       | SPD                   | DIR | DATE       | HIGH                      | DATE       | LOW    | DATE       |
| JAN              | 34.8             | 01-25-1999 | 19.0 | 01-03-1982 | 94.0                         | 01-12-1977 | 17                    | ESE | 01-19-2010 | 1023.4                    | 01-16-1999 | 1001.9 | 01-31-2001 |
| FEB              | 35.2             | 02-28-1998 | 18.0 | 02-01-1982 | 45.8                         | 02-06-2016 | 15                    | ESE | 02-27-1992 | 1019.9                    | 02-03-1993 | 1005.4 | 02-21-2001 |
| MAR              | 36.6             | 03-29-1981 | 19.1 | 03-25-1980 | 52.4                         | 03-22-2013 | 24                    | ESE | 03-23-1998 | 1020.5                    | 03-05-2005 | 1003.9 | 03-06-1999 |
| APR              | 37.8             | 04-07-1983 | 21.5 | 04-03-2007 | 53.9                         | 04-24-1975 | 16                    | ESE | 04-05-1996 | 1017.5                    | 04-14-1993 | 1002.0 | 04-30-1988 |
| MAY              | 38.5             | 05-16-1987 | 22.0 | 05-15-1980 | 237.1                        | 05-26-1997 | 27                    | SW  | 05-22-1976 | 1015.5                    | 05-25-1983 | 993.4  | 05-22-1976 |
| JUNE             | 38.4             | 06-04-1987 | 22.0 | 06-16-1981 | 172.4                        | 06-27-1985 | 25                    | SE  | 06-08-2011 | 1014.3                    | 06-08-1997 | 997.6  | 06-28-2004 |
| JULY             | 36.3             | 07-25-2007 | 21.2 | 07-15-1982 | 231.4                        | 07-20-2002 | 54                    | E   | 07-13-2010 | 1013.8                    | 07-29-1983 | 986.1  | 07-15-2014 |
| AUG              | 36.5             | 08-16-2009 | 22.0 | 08-02-1994 | 475.4                        | 08-19-2013 | 30                    | W   | 08-18-1990 | 1014.5                    | 08-13-2005 | 998.1  | 08-17-1990 |
| SEP              | 35.6             | 09-02-1996 | 21.0 | 09-16-1979 | 275.4                        | 09-22-2013 | 44                    | NNW | 09-28-2006 | 1015.6                    | 09-18-2005 | 984.3  | 09-28-2006 |
| OCT              | 35.8             | 10-08-1996 | 21.0 | 10-24-1986 | 260.7                        | 10-05-1986 | 45                    | NW  | 10-21-1994 | 1016.4                    | 10-27-1993 | 990.3  | 10-21-1994 |
| NOV              | 36.4             | 11-06-1978 | 21.5 | 11-26-1982 | 171.2                        | 11-02-2000 | 49                    | NW  | 11-03-1995 | 1017.5                    | 11-30-1989 | 977.0  | 11-03-1995 |
| DEC              | 34.0             | 12-06-1998 | 20.0 | 12-24-1985 | 131.3                        | 12-10-2006 | 22                    | NNW | 12-05-1993 | 1019.1                    | 12-31-1992 | 997.9  | 12-02-2004 |
| ANNUAL           | 36.5             | 05-16-1987 | 18.0 | 02-01-1982 | 475.4                        | 08-19-2013 | 54                    | E   | 07-13-2010 | 1023.4                    | 01-16-1999 | 977.0  | 11-03-1995 |
| Period of Record | 1974 - 2015      |            |      |            | 1974 - 2015                  |            | 1974 - 2015           |     |            | 1974 - 2015               |            |        |            |

Maximum Wind (MPS)

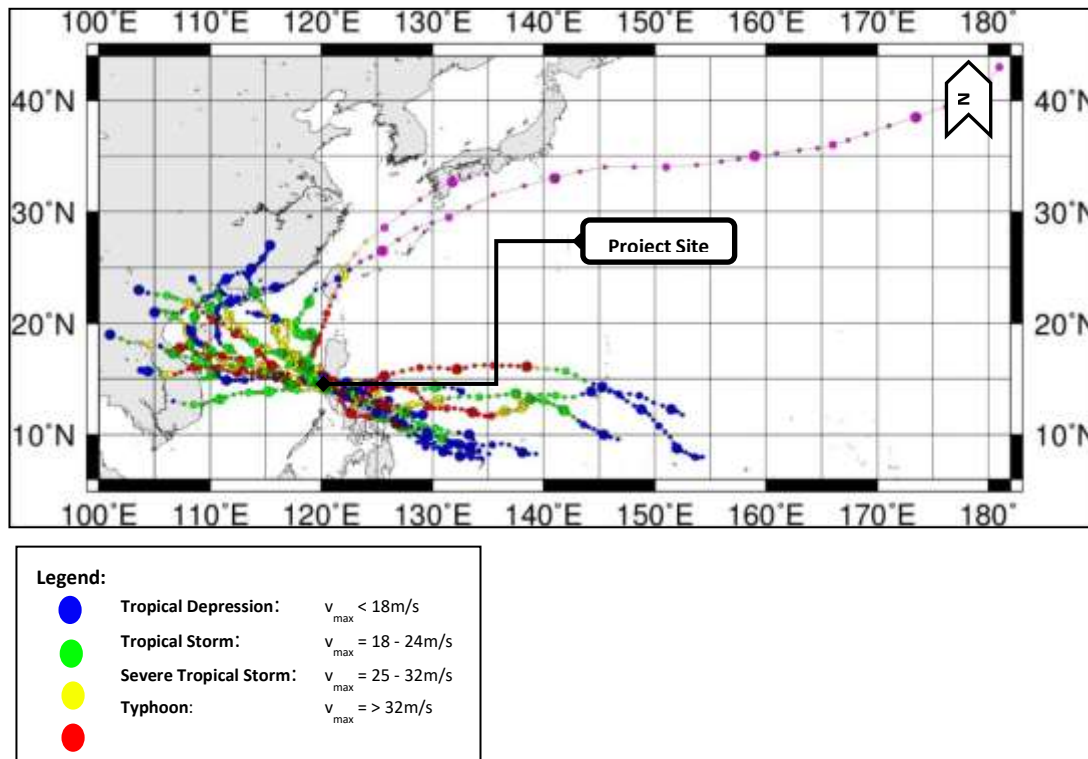
Lowest Pressure

Source: PAGASA

### 2.2.2.1.3 Historical Typhoons

A tropical cyclone is caused by large temperature differences between the sea surface and the overlying atmosphere. Water vapor rises from the sea surface releasing latent heat that decreases atmospheric pressure and induces atmospheric currents that further affect the sea surface. This interaction of the seawater with the atmosphere, together with the effect of the earth's rotation, can cause the seawater to swirl into a vortex with a translational motion, with a large pressure drop at the center and extreme wind speeds and gustiness around it. In the Philippines classification system, a tropical storm is formed when sustained gust speed reach 61 kph (16.94 mps), and a typhoon when gust speeds reach 117 kph (32.5 mps). Tropical storms and typhoons are thus characterized by a large atmospheric pressure drop ( $\Delta P_c$ ), extreme gusts with sustained wind speed ( $V_{max}$ ), and some translational or forward speed of their centers ( $V_f$ ). The size of typhoons is associated with the radius from the center ( $R_{max}$ ) to where the wind gusts reach their maximum speeds, while the strength of the typhoon is associated with both the maximum wind speed,  $V_{max}$ , and the cyclone's lifetime.

To determine the potentially critical typhoons which could affect the project site, all typhoons whose tracks passed within a 200 km radius from the site were determined from secondary data Figure 2.2-37. From this long list, the top five (5) strongest typhoons in terms of wind speed were further selected, with their properties shown in Table 2.2-17. The individual tracks of the top five typhoons are shown in Figures 2.2-38.

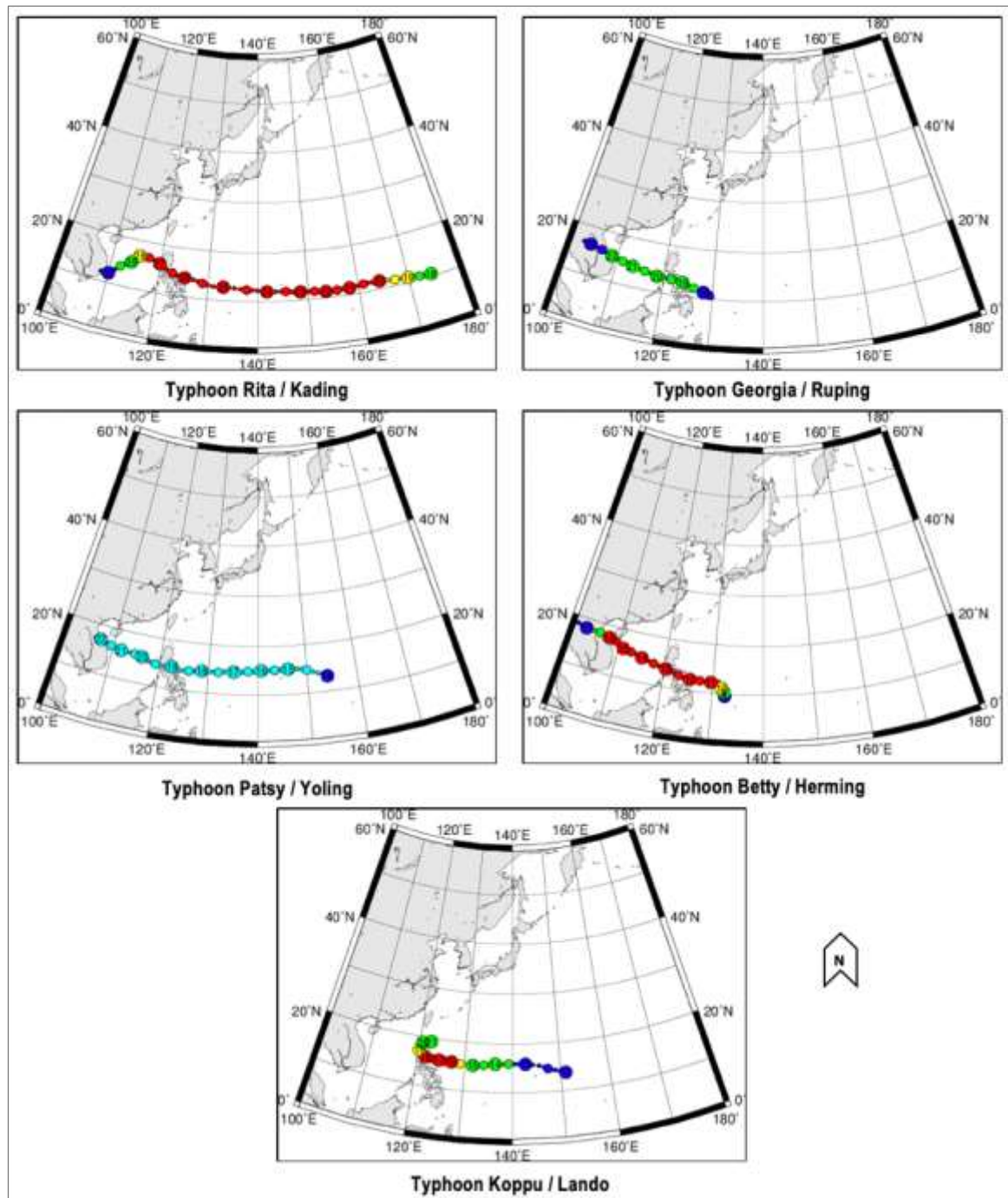


Source: Digital Typhoon

**Figure 2.2-37. Typhoon Tracks within 200km of Project Site**

**Table 2.2-17. Top 5 Historical Typhoons passing within a 200km radius of the Property based on Wind Speed**

| No. | Name Int'l / Local | JMA No. | Duration         | Vmax (kph) | Rmax (km) | Pc (hPa) | Relative Track to the Site |
|-----|--------------------|---------|------------------|------------|-----------|----------|----------------------------|
| 1   | Rita / Kading      | 197826  | 11 Days 18 Hours | 203.72     | 14.42     | 905      | S                          |
| 2   | Georgia / Ruping   | 198622  | 4 Days 6 Hours   | 198.57     | 17.33     | 920      | S                          |
| 3   | Patsy / Yoling     | 197025  | 8 Days 0 Hours   | 192.66     | 18.31     | 925      | S                          |
| 4   | Betty / Herming    | 198709  | 8 Days 0 Hours   | 185.20     | 19.28     | 930      | S                          |
| 5   | Koppu / Lando      | 201524  | 7 Days 18 Hours  | 185.20     | 18.31     | 925      | N                          |



Source: Digital Typhoon

Figure 2.2-38. Individual Tracks of Top 5 Typhoons

#### 2.2.2.1.4 Wind Rose Data

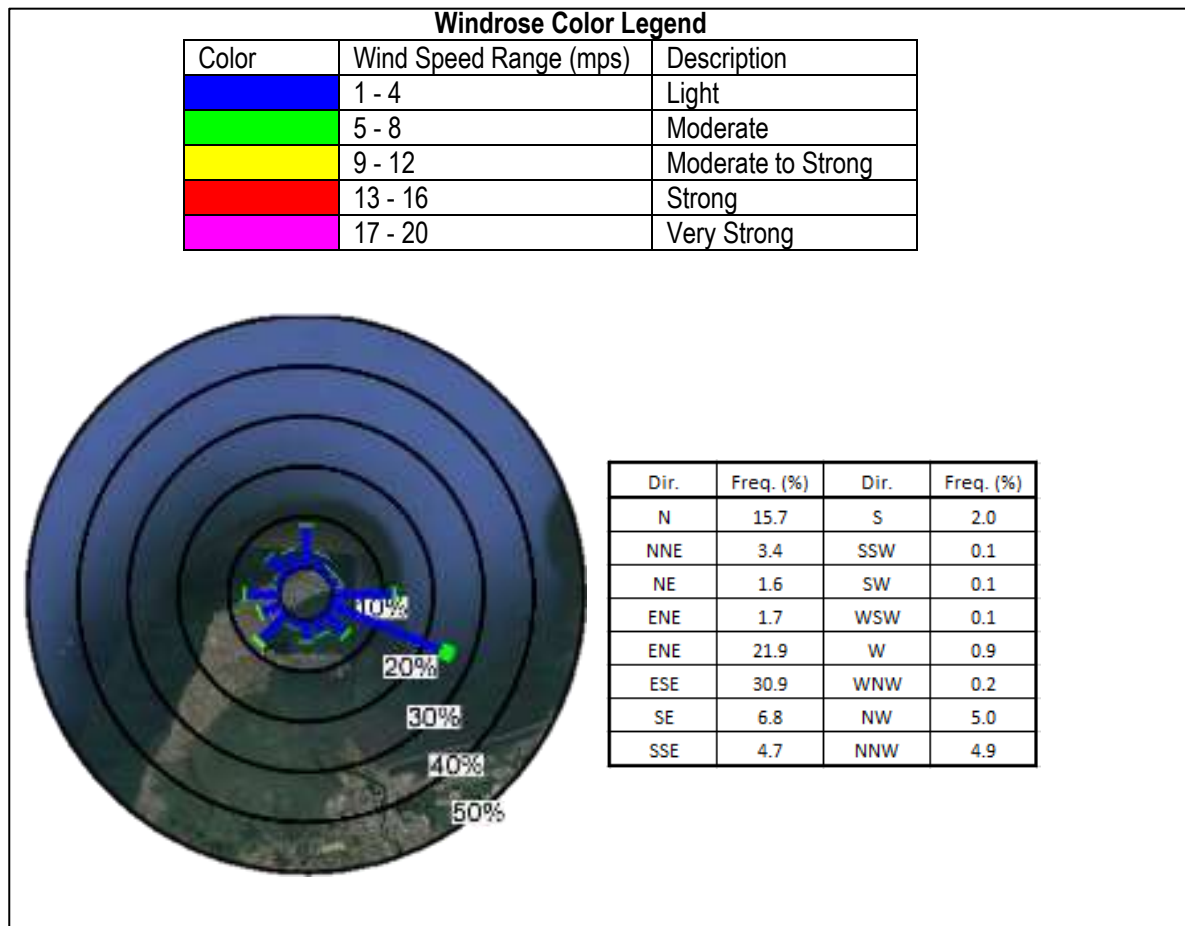
A wind rose diagram represents the frequency of winds blowing from particular directions. It uses sixteen (16) cardinal directions—North (N), North-northeast (NNE), Northeast (NE), East-northeast (ENE), East (E), East-southeast (ESE), Southeast (SE), South-southeast (SSE), South (S), South-southwest (SSW), Southwest (SW), West-southwest (WSW), West (W), West-northwest (WNW), Northwest (NW), and North-northwest (NNW). The Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) wind station at Sangley Point was used to determine the wind conditions at the project site.





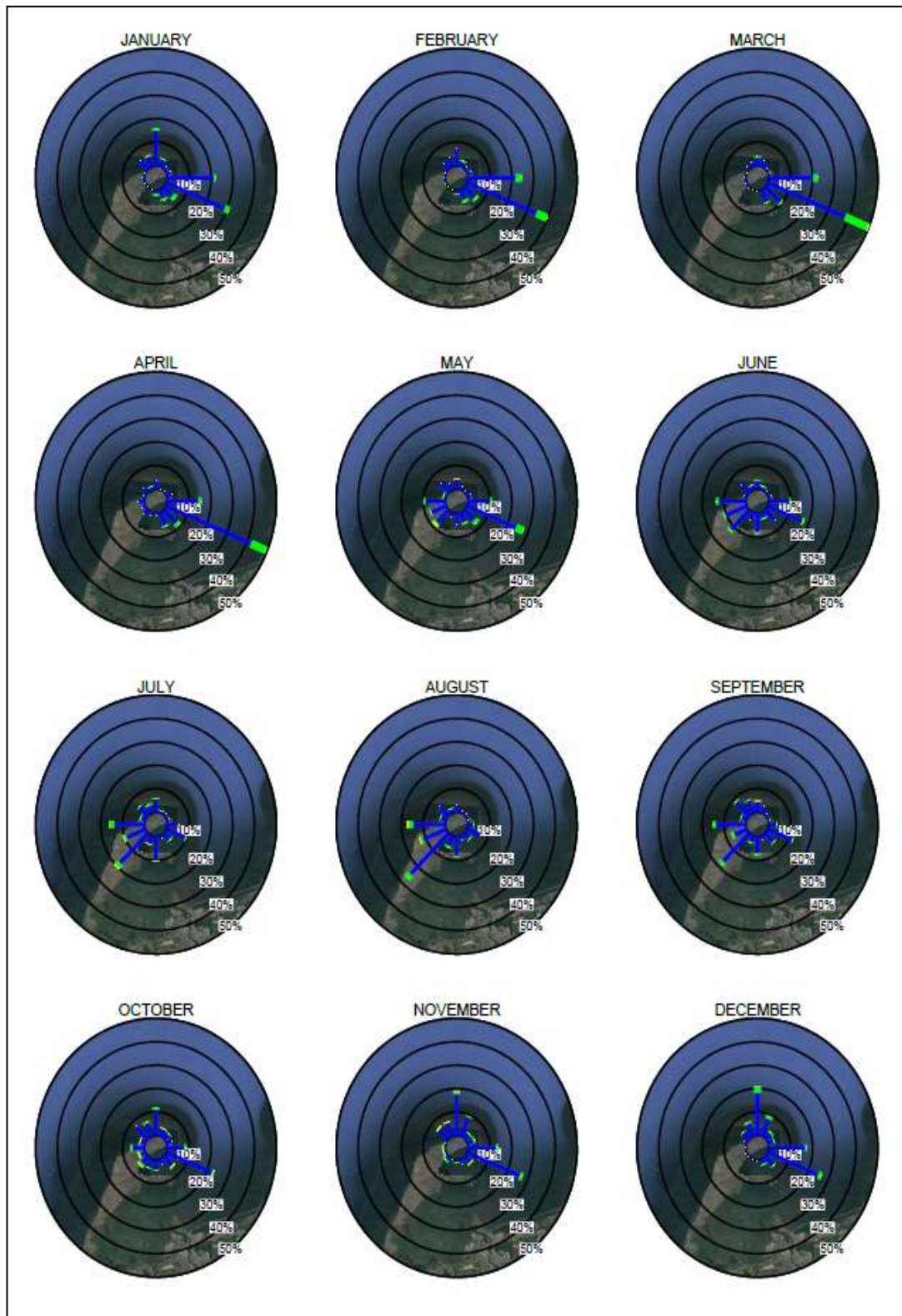
From the annual wind rose diagram (Figure 2.2-39), it is evident that the prevailing critical wind directions are from the west northwest, west, west southwest, and southwest. Although there are other prevailing directions, these are not as critical due to exposure of the project site to winds coming from the West Philippine Sea.

The monthly wind rose diagram (Figure 2.2-40) shows the variation of the wind directions over the entire year. The northeasterly winds occur during the Amihan season from November to April, while the southwesterly winds occur during the Habagat season from June to September. The remaining months are considered transition months between the two seasons.



Source: PAGASA

**Figure 2.2-39. Annual Wind Rose Diagram at Sangley Point Wind Station**



Source: PAGASA

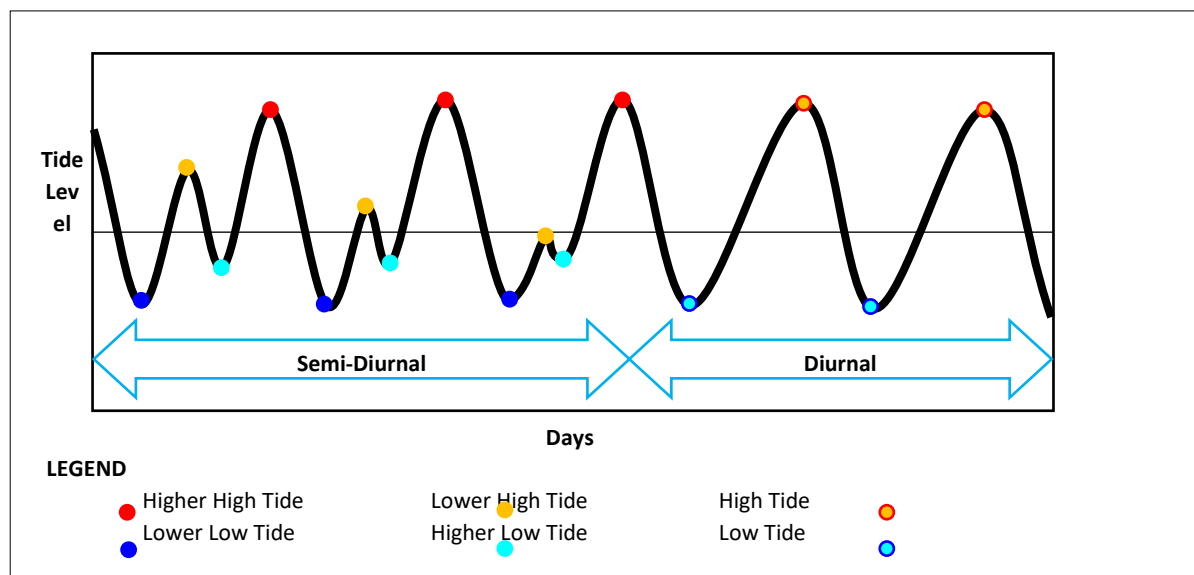
Figure 2.2-40. Monthly Wind Rose based on the Sangley Point Wind Station



#### 2.2.2.1.5 Tide Data/ Tidal Analysis

Tide levels are the horizontal planes representing averaged vertical positions of the sea surface at a particular site as influenced by astronomical effects such as the combined effects of the gravitational forces of attraction between the earth, sun, and moon, and modified by the land masses on the earth's surface. These levels are determined from daily sea surface fluctuation recordings over a period of at least nineteen (19) years. In general, the levels are typically noted as the Mean Tide Level (MTL), Mean High Water (MHW), Mean Higher High Water (MHHW), Mean Low Water (MLW), and Mean Lower Low Water (MLLW).

Tides in the Philippines vary from diurnal (high tide occurs once a day) to semi-diurnal (high tide occurs twice a day), depending on the location and date as illustrated in Figure 2.2-41. Up to Day Four in the figure, there are two high tides and two low tides per day (semi-diurnal); after which, the tides become diurnal again. The Mean Higher High Water (MHHW) corresponds to the average of all higher high tide (during semi-diurnal seasons) and high tide (during diurnal seasons) levels, while the Mean High Water corresponds to the average of all high tides (including the lower high tide). The corresponding MLLW and MLW follow the same principle.



**Figure 2.2-41. Sample Tide Levels**

The location and data of nearby tide stations are shown in Figure 2.2-42 and Table 2.2-19, respectively. The nearby stations consist of one (1) primary station (Manila South Harbor) and two (2) secondary station (Puerto Azul & Mariveles).





Source: 2018 Google Earth Map


**Figure 2.2-42. Tide Station Location**

**Table 2.2-18. Tide Station Information**

| NAME                | TYPE      | LAT     | LONG     | MUNICIPALITY         | BM    | EL. (MTL) |
|---------------------|-----------|---------|----------|----------------------|-------|-----------|
| Manila South Harbor | Primary   | 14°35'N | 120°58'E | South Harbor, Manila | BM 66 | 1.30      |
| Mariveles Harbor    | Secondary | 14°26'N | 120°30'E | Mariveles, Bataan    | BM 1  | 2.696     |
| Puerto Azul         | Secondary | 14°47'N | 120°41'E | Ternate, Cavite      | BM 2A | 3.386     |

Shown in Table 2.2-19 are the tide data recorded and tide statistics in the Manila South Harbor, Mariveles Harbor, and Puerto Azul stations. For every station, tide data indicating the mean, high, and low elevations are presented. The closest tide station to the project site is the Manila South Harbor station, which has a mean tidal range of 1.0m – the difference between the mean higher high water (MHHW) and mean lower low water level (MLLW).

**Table 2.2-19. Tide Data in Manila Bay**

|  | Tide Elevation (m)  |                             |   |                              |                              |                             |                                       |                            |
|---|---------------------|-----------------------------|---|------------------------------|------------------------------|-----------------------------|---------------------------------------|----------------------------|
|   | Station             | HHWL<br>Highest<br>Observed | MHHW<br>Mean<br>Higher<br>High<br>Water | MHW<br>Mean<br>High<br>Water | MTL<br>Mean<br>Tide<br>Level | MLW<br>Mean<br>Low<br>Water | MLLW<br>Mean<br>Lower<br>Low<br>Water | LLWL<br>Lowest<br>Observed |
|   | Manila South Harbor | 1.475                       | 0.51                                    | 0.39                         | 0                            | -0.38                       | -0.49                                 | -1.635                     |
|   | Mariveles Harbor    | 1.083                       | 0.50                                    | 0.42                         | 0                            | -0.41                       | -0.48                                 | -0.977                     |
|   | Puerto Azul         | 1.293                       | 0.51                                    | 0.42                         | 0                            | -0.42                       | -0.49                                 | -0.967                     |

Note: All heights are referred to mean tide level (MTL) in meters

Shown in Tables 2.2-20 to 2.2-22 are the available data of the annual highest and lowest tide level at each station and the dates when the tidal extremes occurred.



**Table 2.2-20. Annual Tidal Extremes for the Manila South Harbor Station**

| YEAR | HIGHEST TIDE LEVEL |      |       | LOWEST TIDE LEVEL  |       |        |
|------|--------------------|------|-------|--------------------|-------|--------|
|      | MONTH              | DATE | METER | MONTH              | DATE  | METER  |
| 1997 | AUGUST             | 18   | 0.975 | DECEMBER           | 31    | -0.885 |
| 1998 | NOVEMBER           | 22   | 1.095 | JANUARY            | 28    | -0.885 |
| 1999 | APRIL              | 22   | 1.085 | FEBRUARY           | 14    | -0.805 |
| 2000 | JULY               | 4    | 1.205 | DECEMBER           | 13/14 | -0.665 |
| 2001 | JUNE               | 30   | 1.205 | JANUARY            | 10    | -0.715 |
| 2002 | JULY               | 11   | 1.175 | FEBRUARY           | 26    | -0.905 |
| 2003 | OCTOBER            | 5    | 0.985 | DECEMBER           | 24    | -1.265 |
| 2004 | DECEMBER           | 14   | 1.005 | DECEMBER           | 14    | -0.975 |
| 2005 | JUNE               | 24   | 1.205 | FEBRUARY           | 8     | -0.985 |
| 2006 | AUGUST             | 9    | 1.415 | DECEMBER           | 22    | -0.865 |
| 2007 | NOVEMBER           | 26   | 1.295 | DECEMBER           | 25    | -0.895 |
| 2008 | DECEMBER           | 14   | 1.365 | JANUARY            | 21    | -0.935 |
| 2009 | JUNE               | 24   | 1.395 | JANUARY            | 12    | -0.905 |
| 2010 | AUGUST             | 8    | 1.225 | JANUARY            | 30    | -0.885 |
| 2011 | SEPTEMBER          | 27   | 1.475 | JANUARY            | 19    | -0.715 |
| 2012 | JULY               | 30   | 1.345 | DECEMBER           | 15    | -0.715 |
| 2013 | OCTOBER            | 12   | 1.275 | JANUARY / DECEMBER | 12/5  | -0.665 |
| 2014 | JULY               | 16   | 1.305 | JANUARY / DECEMBER | 2/24  | -0.695 |
| 2015 | SEPTEMBER          | 27   | 1.075 | JANUARY            | 22    | -0.685 |
| 2016 | OCTOBER            | 20   | 1.165 | JANUARY            | 11    | -0.685 |

Note: All heights are referred to mean tide level (MTL) in meters.

Source: NAMRIA

**Table 2.2-21. Annual Tidal Extremes for the Mariveles Harbor Station**

| YEAR | HIGHEST TIDE LEVEL |      |       | LOWEST TIDE LEVEL |      |        |
|------|--------------------|------|-------|-------------------|------|--------|
|      | MONTH              | DATE | METER | MONTH             | DATE | METER  |
| 2002 | JULY               | 12   | 0.863 | DECEMBER          | 6    | -0.837 |
| 2003 | NOVEMBER           | 26   | 0.823 | DECEMBER          | 25   | -0.927 |
| 2004 | JUNE               | 6    | 0.943 | DECEMBER          | 14   | -0.977 |
| 2005 | JULY               | 22   | 0.873 | JUNE              | 23   | -0.967 |
| 2006 | JULY               | 13   | 0.913 | JULY              | 11   | -0.857 |
| 2007 | JULY               | 14   | 0.943 | JUNE/FEBRUARY     | 1/15 | -0.857 |
| 2008 | JULY               | 3    | 1.063 | DECEMBER          | 14   | -0.817 |
| 2009 | JUNE               | 25   | 1.083 | JANUARY           | 11   | -0.897 |
| 2010 | AUGUST             | 9    | 0.933 | FEBRUARY          | 26   | -0.827 |
| 2011 | JANUARY            | 20   | 0.843 | JANUARY           | 20   | -0.747 |
| 2012 | AUGUST             | 2    | 0.903 | MAY               | 8    | -0.857 |
| 2013 | AUGUST             | 21   | 1.213 | JUNE              | 24   | -0.697 |
| 2014 | JULY               | 13   | 0.823 | FEBRUARY          | 27   | -0.687 |

Note: All heights are referred to mean tide level (MTL) in meters.

Source: NAMRIA



**Table 2.2-22. Annual Tidal Extremes for the Puerto Azul Station**

| YEAR | HIGHEST TIDE LEVEL |      |       | LOWEST TIDE LEVEL |      |        |
|------|--------------------|------|-------|-------------------|------|--------|
|      | MONTH              | DATE | METER | MONTH             | DATE | METER  |
| 2002 | JUNE               | 26   | 0.953 | DECEMBER          | 6    | -0.807 |
| 2003 | JUNE               | 16   | 0.873 | DECEMBER          | 25   | -0.867 |
| 2004 | AUGUST             | 1    | 0.923 | DECEMBER          | 14   | -0.967 |
| 2005 | JULY               | 22   | 1.013 | JANUARY           | 10   | -0.937 |
| 2006 | JULY               | 13   | 1.003 | JANUARY/DECEMBER  | 29/7 | -0.897 |
| 2007 | NOVEMBER           | 26   | 1.293 | JANUARY           | 4    | -0.887 |

Note: All heights are referred to mean tide level (MTL) in meters.

Source: NAMRIA

#### 2.2.2.1.6 Hydrodynamic Modeling

The software(s) used for the numerical modelling, considered adequate and complete is: MIKE 21, which is a computer program developed by Danish Hydraulic Institute (DHI), an established global organization in the field of water and environmental engineering, specifically for modeling coasts and seas. It can simulate physical, chemical or biological processes in the coastal or marine areas using rectangular grid, nested grid or flexible meshes which make it particularly well-suited to handle variable spatial resolution in the model domain. The model includes the main physical phenomena such as wave-wave interaction, white capping, dissipation, refraction and shoaling.

Hydrodynamic module solves equations for the conservation of mass and momentum as well as for salinity and temperature in response to a variety of forcing functions. The Spectral Wave module simulates the growth, decay and transformation of wind-generated waves and swells in offshore and coastal areas.

A public domain software like the USEPA EFDC, although recognized is not used because the software utilized for the analysis work is likewise an industry-standard tool with comparable level of sophistication and output capability as the ones listed above.

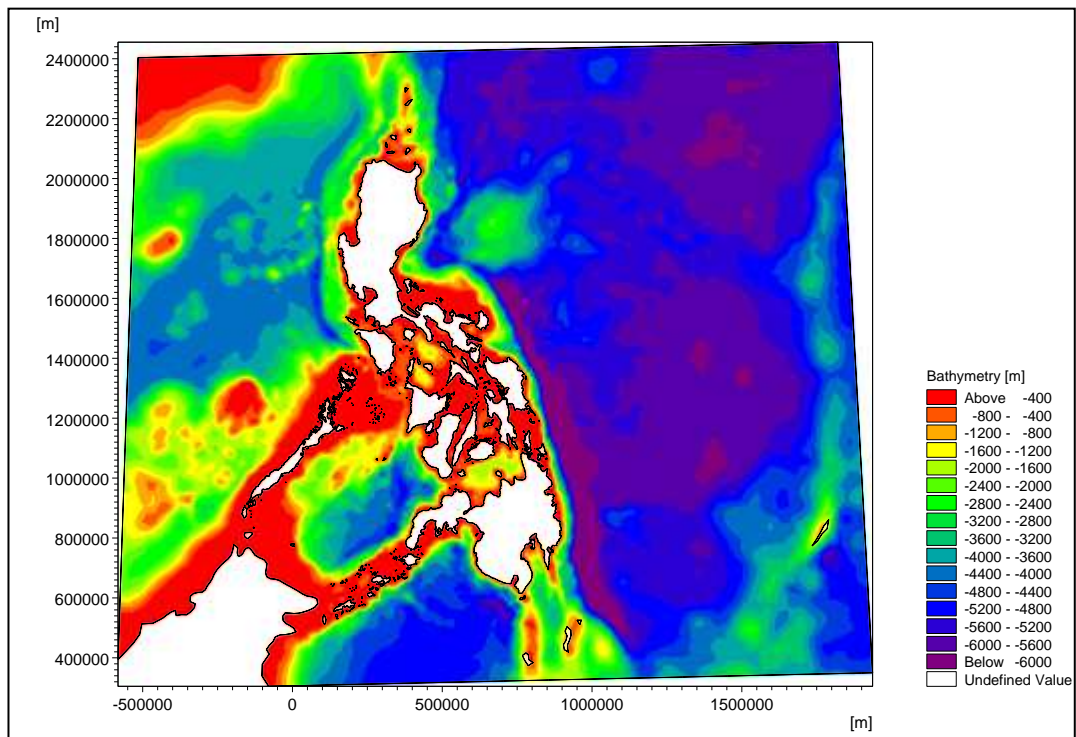
#### Introduction

The hydrodynamics of the sea waters around and far offshore of the project coast is described by the water level variation and currents induced by both astronomic and meteorological tides. In this study, numerical modelling of tide flows is carried out for the project's offshore region. The governing mathematical model applies to the so-called "long-period oscillations" that are non-dispersive, but accounts for the nonlinearity of the tide motion. It also accounts for the Coriolis effects (due to the earth's rotation), wind shear stress, translating pressure field, long-period wave damping, and bottom friction (linear and nonlinear). While the numerical model used can handle inundation conditions along the coasts, such as that caused by storm surge overtopping, this model capability is not activated during the simulations. In the sea hydrodynamics modelling, the main external loadings are as follows: (1) astronomic tides through the open boundaries; (2) surface wind field due a translating pressure field (typhoons).

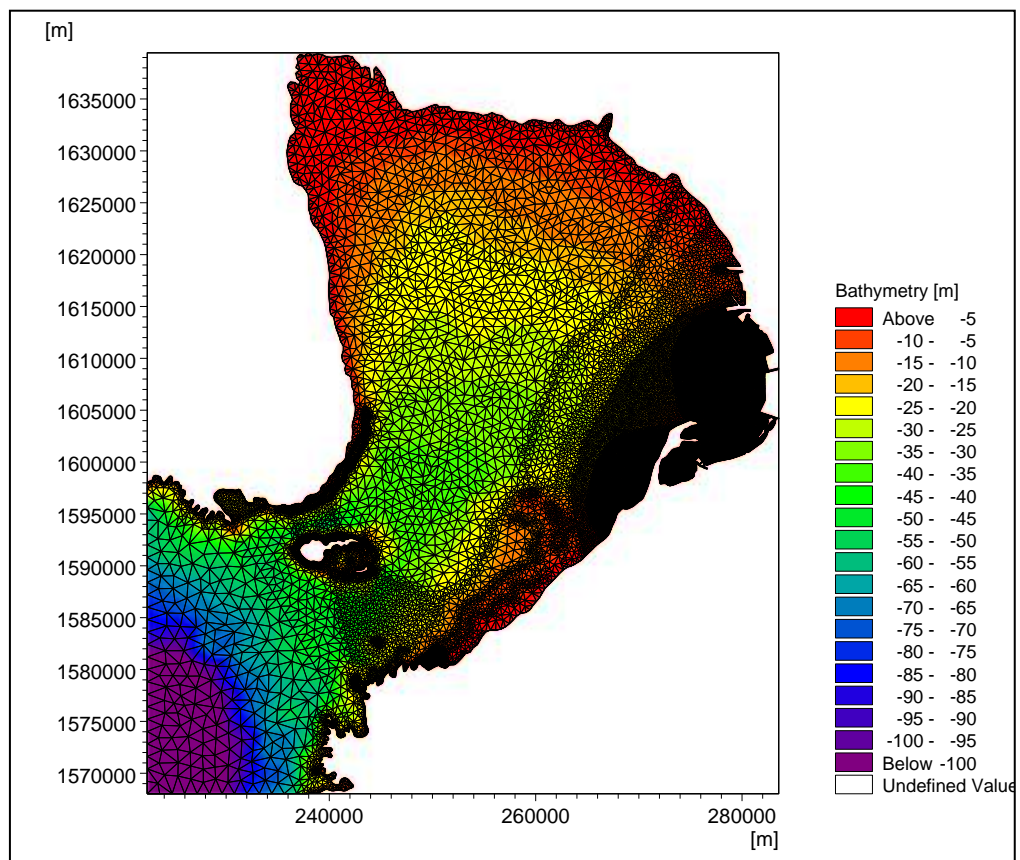
#### Computational Domain

An unstructured mesh is used in order to resolve the spatial scales required by the variation of depths and the irregular shape of the coastline. Two numerical domains were used for the analyses, namely the regional model (Figure 2.2-43) encompassing the entire Philippine archipelago, and the local domain limited to Manila Bay alone (Figure 2.2-44). All bathymetric data was consolidated to ensure all simulations are based on a common bathymetric model. The datum used for the simulations is the mean tide level (MTL).





**Figure 2.2-43. Domain extents for the hydrodynamic computation of the regional model**



**Figure 2.2-44. Flexible Element Mesh of the local model at Manila Bay**



The marine region around the project area is modeled with a finer mesh in order to improve the accuracy of simulated hydrodynamics in this region. A depth-adaptive mesh is used to satisfy the conditional stability condition of the numerical model. Smaller grids are used for shallow waters and around small islands while larger grids are designed for deep waters and along open boundaries where the astronomic tides are forced as boundary conditions.

### **Development/Modeling Scenarios**

For all succeeding simulations, two basic scenarios were considered namely pre-development and post-development. Pre-development assumes the existing conditions with **no projects in place**, whereas the post-development scenarios are based on the following:

Imposed additional reclaimed areas within Manila Bay that have been approved by DENR. Hence, no separate simulation assuming only the project site has been done. The list of reclamation projects included in the computational domain are:

- Cumulative assessment of all Islands (A, B, C, D, and E)

It is noted that Islands A, C, and E are covered in the separate EIS Applications while Island B is still in planning stage.

- Sangley Point International Airport (SPIA)

The SPIA is recognized being another milestone project of the Province of Cavite, notwithstanding that there exist no records of formal application for an ECC for this Project.

Thus, the computational domains are based on the above.

However as all of these projects are by various different proponents and are at differing levels of refinement, the plan-forms of the reclamation projects shown in Figure 2.2-46 may be subjects of the final layouts of these projects.

Additionally, due to the inclusion of these other projects, it is not readily feasible at this time to ascertain which effects – either detrimental or beneficial – can be directly attributed to the reclamation of the individual projects.

For planning purposes, which is the essence of an EIS/ECC (i.e. the EIS/ECC is not a permit but a planning tool, articulated in public discussions such as in the EIAMD/EMB-driven Public Scoping), the assessments herein made are complete and sufficient. The “Design and Engineering Details” stage will be necessarily undertaken post ECC.

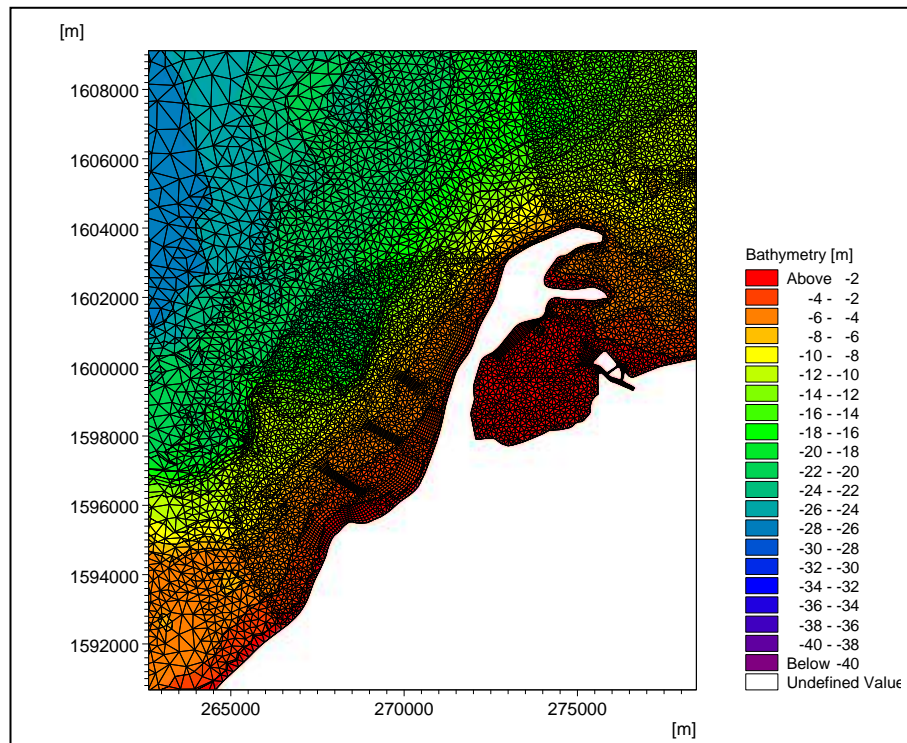


Figure 2.2-45. Flexible Element Mesh of the local model at the project site (Pre-Dev.)

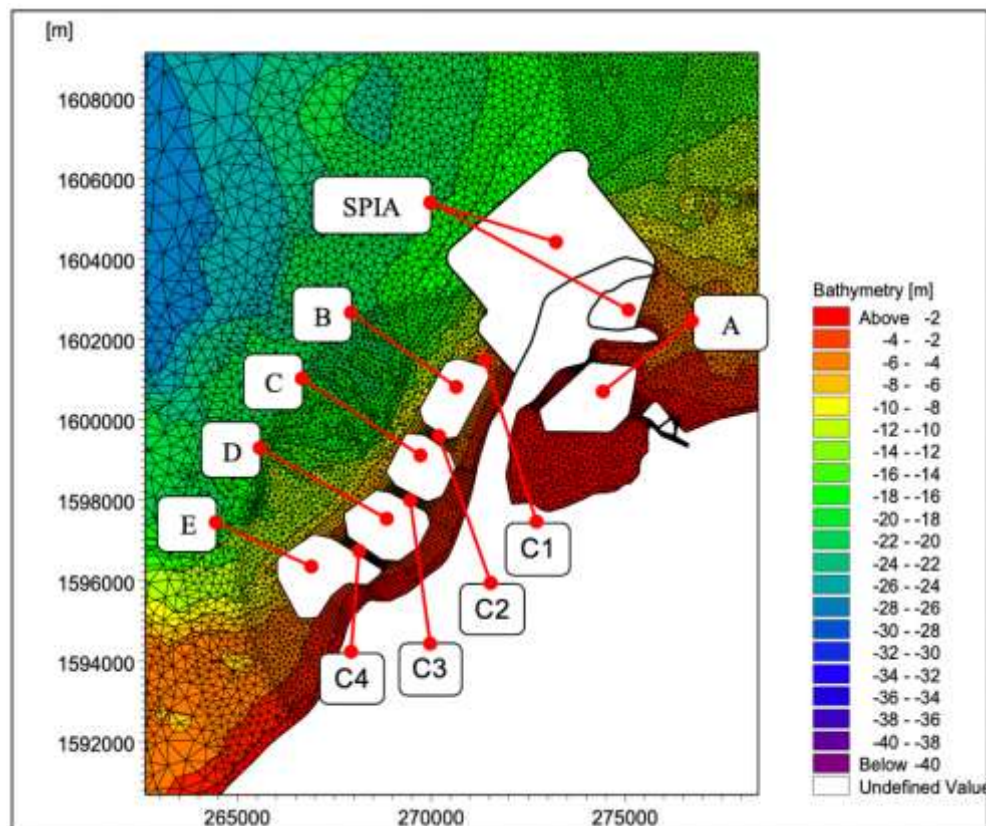


Figure 2.2-46. Flexible Element Mesh of the local model at the project site (Post-Dev.)





## Model Calibration

To model the hydrodynamics of Manila Bay, a numerical model was used namely the Mike21 Flexible Mesh Hydrodynamic Model; it can simulate the water level and current changes caused by various external forces. To calibrate the local model, tidal forcing was extracted from a regional tidal model (Figure 2.2-45) and applied to the offshore boundary outside of the local model of Manila Bay (Figure 2.2-46). The simulation time included one month during a non-typhoon period, namely the month of February 2016, to minimize meteorological effects on the tidal fluctuations, was selected. Hence, no meteorological forcing was applied to this tidal current model. One month was selected to allow for adequate warm-up time of the simulation and to ensure two tidal cycles – including the spring and neap tides – are included in the simulation (Figure 2.2-47). A statistical comparison of the simulated water surface elevations against actual tide readings acquired from NAMRIA resulted in a coefficient of determination ( $R^2$ ) value of 0.91 at Manila South Harbor.

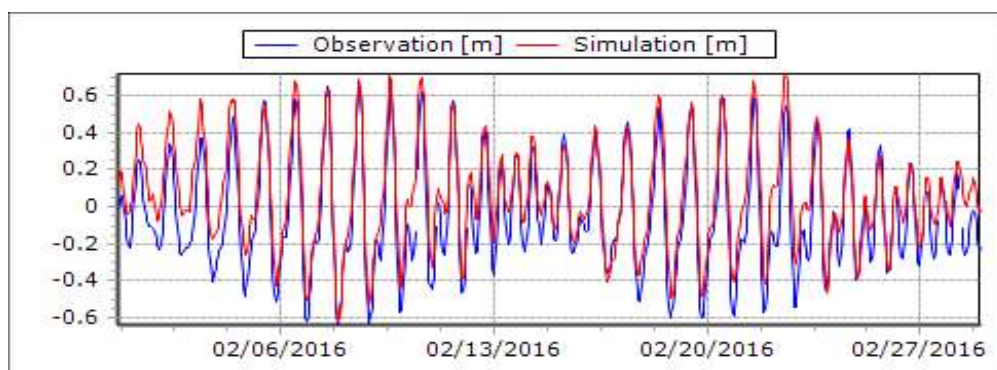


Figure 2.2-47. Simulated Tide Levels at Manila Bay South Harbor

## Prevailing Wave Simulation

Local waves at the project site were determined by analyzing the transformation of hindcast deepwater wave conditions at the mouth of Manila Bay as they propagate to the site, while simultaneously adding a constant wind shear on the surface water within the local domain of the numerical model; this was done using the Mike21 Spectral Wave module. This module is capable of simulating the growth, decay, and transformation of offshore swells and wind-generated waves (DHI, Mike21 SW FM Short Description).

Based on the prevailing winds, six directions were modelled, namely E, ESE, N, SW, W, and WSW. A summary of the wind conditions in the simulation cases are shown in Table 2.2-24, with the results shown in Figures 2.2-48 to 2.2-65. The figures show the spatial distribution of the significant wave height ( $H_s$ ) in the nearshore region fronting the project waterfront during MHHW, as this would generally result in a more agitated wave climate. For ease of reference and comparison, all plots have the same range of wave heights. Also shown are the resulting wave climates under post-development conditions.

Table 2.2-23. Wind and Deepwater Wave Condition for Simulated Wave Conditions

| Direction | Velocity Range | Annual Occurrence Frequency (%) | Remark on wind             | Deepwater Wave Height (m) | Deepwater Wave Period (s) | Figure          |
|-----------|----------------|---------------------------------|----------------------------|---------------------------|---------------------------|-----------------|
| N         | 1-4            | 8.2                             | 3 <sup>rd</sup> prevailing | n/a                       | n/a                       | 2.2-50 & 2.2-51 |
|           | 5-8            | 0.4                             |                            |                           |                           | 2.2-52 & 2.2-53 |
|           | 9-12           | 0                               |                            |                           |                           |                 |
| E         | 1-4            | 11.9                            |                            | n/a                       | n/a                       | 2.2-54 & 2.2-55 |



| Direction | Velocity Range | Annual Occurrence Frequency (%) | Remark on wind             | Deepwater Wave Height (m) | Deepwater Wave Period (s) | Figure          |
|-----------|----------------|---------------------------------|----------------------------|---------------------------|---------------------------|-----------------|
|           | 5-8            | 0.8                             | 2 <sup>nd</sup> prevailing |                           |                           | 2.2-56 & 2.2-57 |
|           | 9-12           | 0                               |                            |                           |                           |                 |
| ESE       | 1-4            | 23.7                            | 1 <sup>st</sup> prevailing | n/a                       | n/a                       | 2.2-58 & 2.2-59 |
|           | 5-8            | 2.6                             |                            |                           |                           | 2.2-60 & 2.2-61 |
|           | 9-12           | 0                               |                            |                           |                           |                 |
| SE        | 1-4            | 5.6                             | 6 <sup>th</sup> prevailing | n/a                       | n/a                       | 2.2-62 & 2.2-63 |
|           | 5-8            | 0.5                             |                            |                           |                           | 2.2-64 & 2.2-65 |
|           | 9-12           | 0                               |                            |                           |                           |                 |
| SW        | 1-4            | 7.4                             | 4 <sup>th</sup> prevailing | 0.63                      | 3.41                      | 2.2-66 & 2.2-67 |
|           | 5-8            | 0.7                             |                            | 1.95                      | 5.55                      | 2.2-68 & 2.2-69 |
|           | 9-12           | 0.1                             |                            | 3.64                      | 7.23                      | 2.2-70 & 2.2-71 |
| WSW       | 1-4            | 4.2                             | 8 <sup>th</sup> prevailing | 0.68                      | 3.62                      | 2.2-72 & 2.2-73 |
|           | 5-8            | 0.4                             |                            | 2.19                      | 6.02                      | 2.2-74 & 2.2-75 |
|           | 9-12           | 0.1                             |                            | 4.21                      | 7.95                      | 2.2-76 & 2.2-77 |
| W         | 1-4            | 6.5                             | 5 <sup>th</sup> prevailing | 0.69                      | 3.68                      | 2.2-78 & 2.2-79 |
|           | 5-8            | 0.6                             |                            | 2.27                      | 6.17                      | 2.2-80 & 2.2-81 |
|           | 9-12           | 0                               |                            | -                         | -                         |                 |
| NW        | 1-4            | 4.9                             | 7 <sup>th</sup> prevailing | n/a                       | n/a                       | 2.2-82 & 2.2-83 |
|           | 5-8            | 0.1                             |                            |                           |                           | 2.2-84 & 2.2-85 |
|           | 9-12           | 0                               |                            |                           |                           |                 |

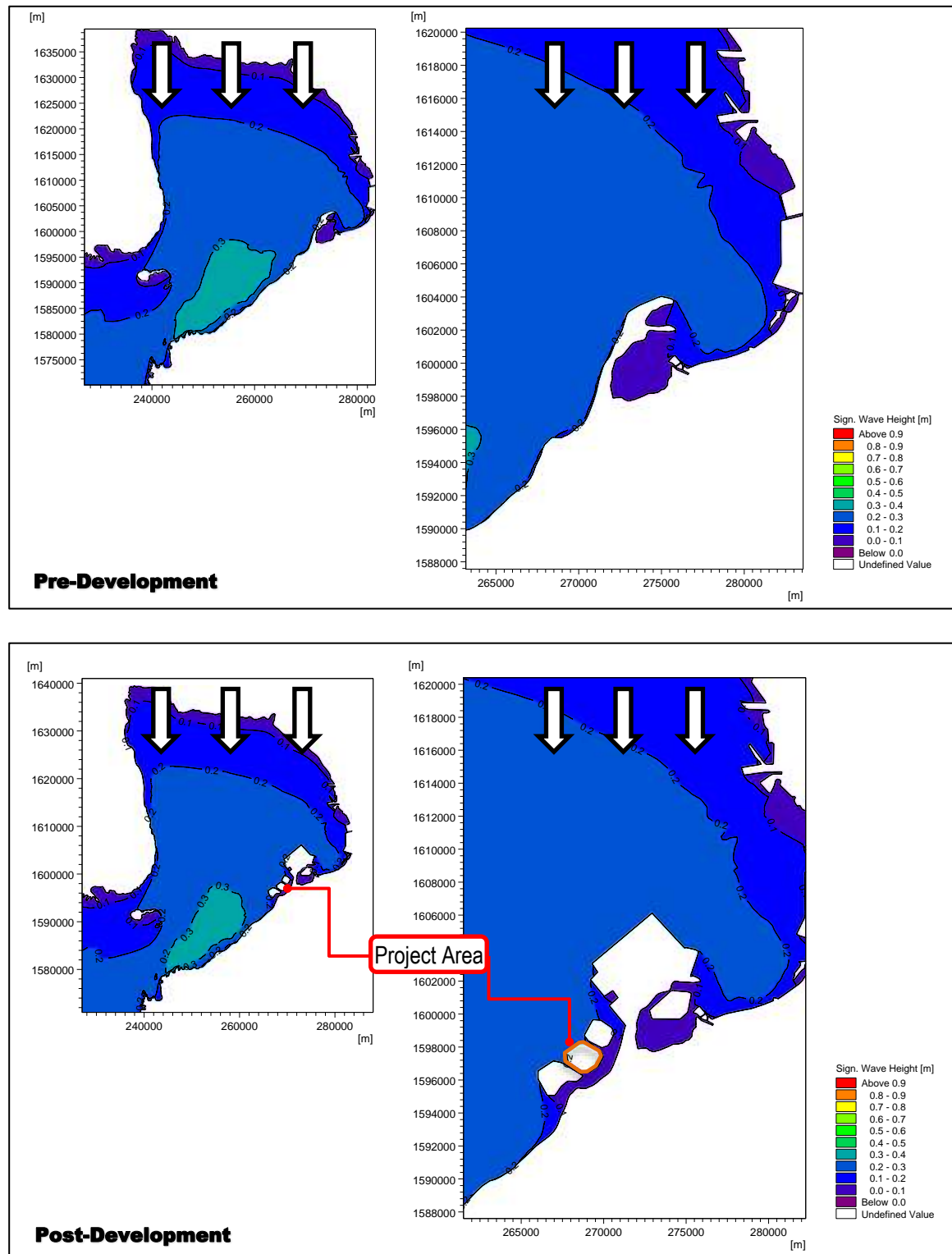


Figure 2.2-48. Wave Climate due to 1-4 mps Surface Winds & Offshore Waves from N at MHHW (Pre & Post-Devt.)



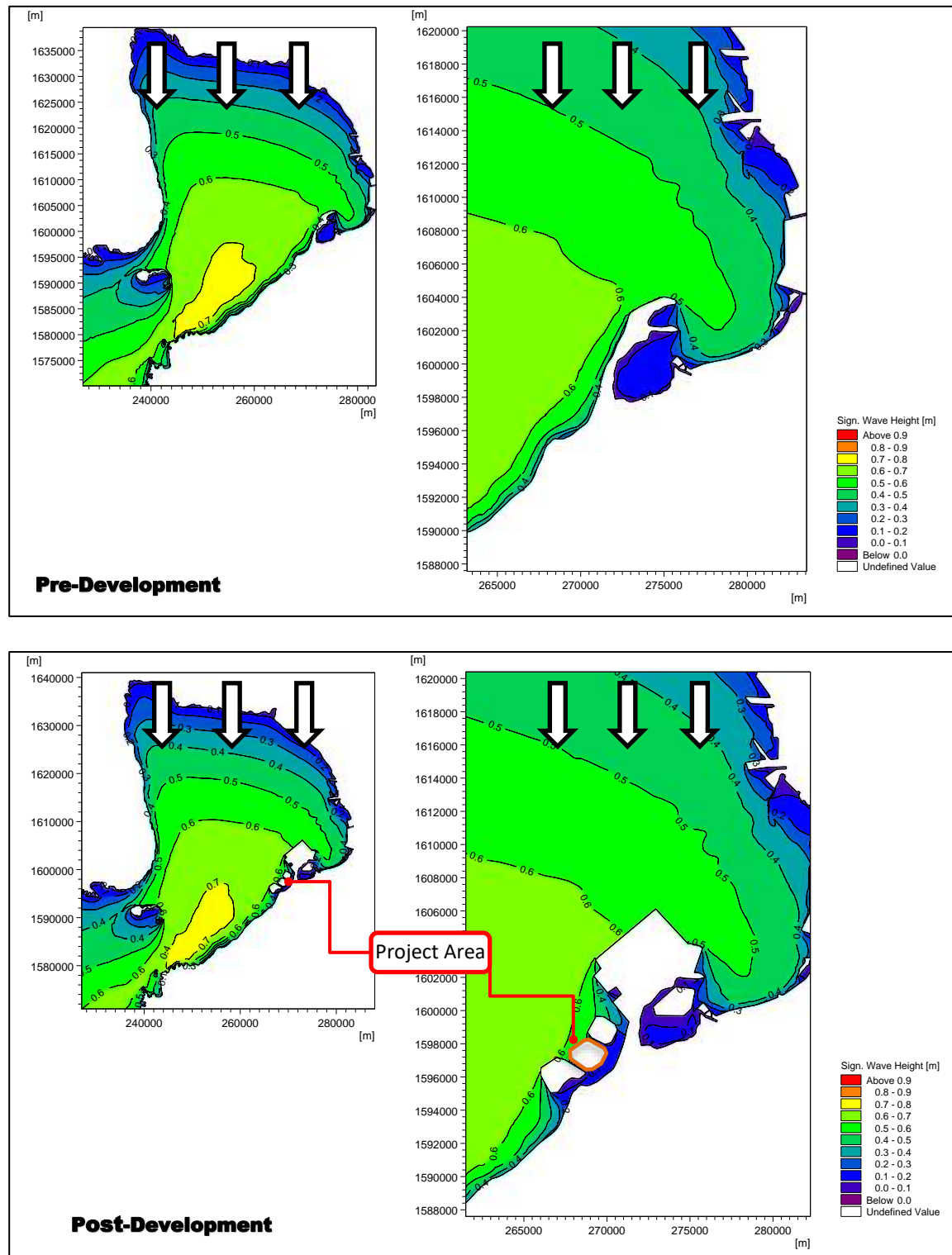


Figure 2.2-49. Wave Climate due to 5-8 mps Surface Winds & Offshore Waves from N at MHHW (Post & Post-Dev.)

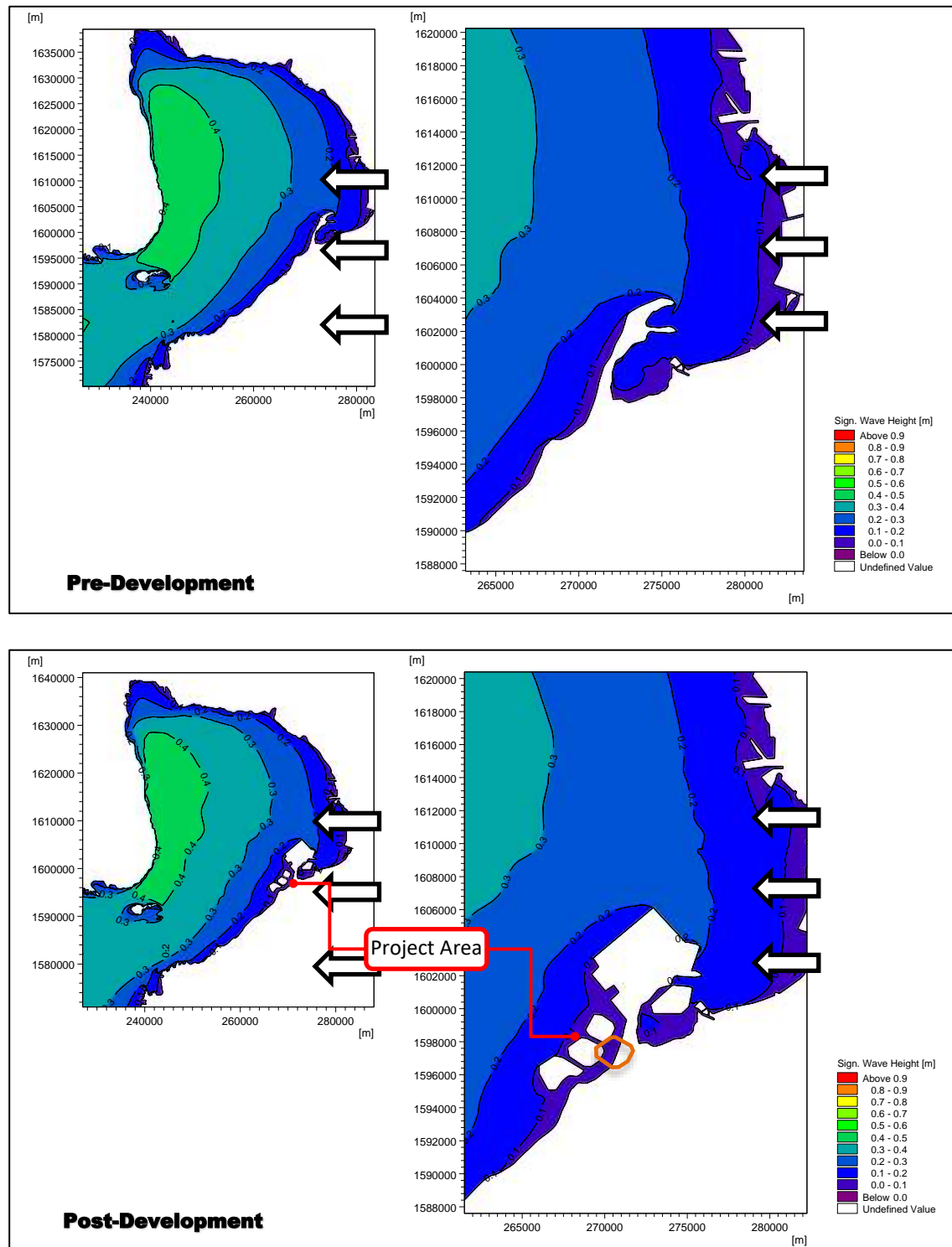


Figure 2.2-50. Wave Climate due to 1-4 mps Surface Winds & Offshore Waves from E at MHHW for (Pre & Post-Dev't.)

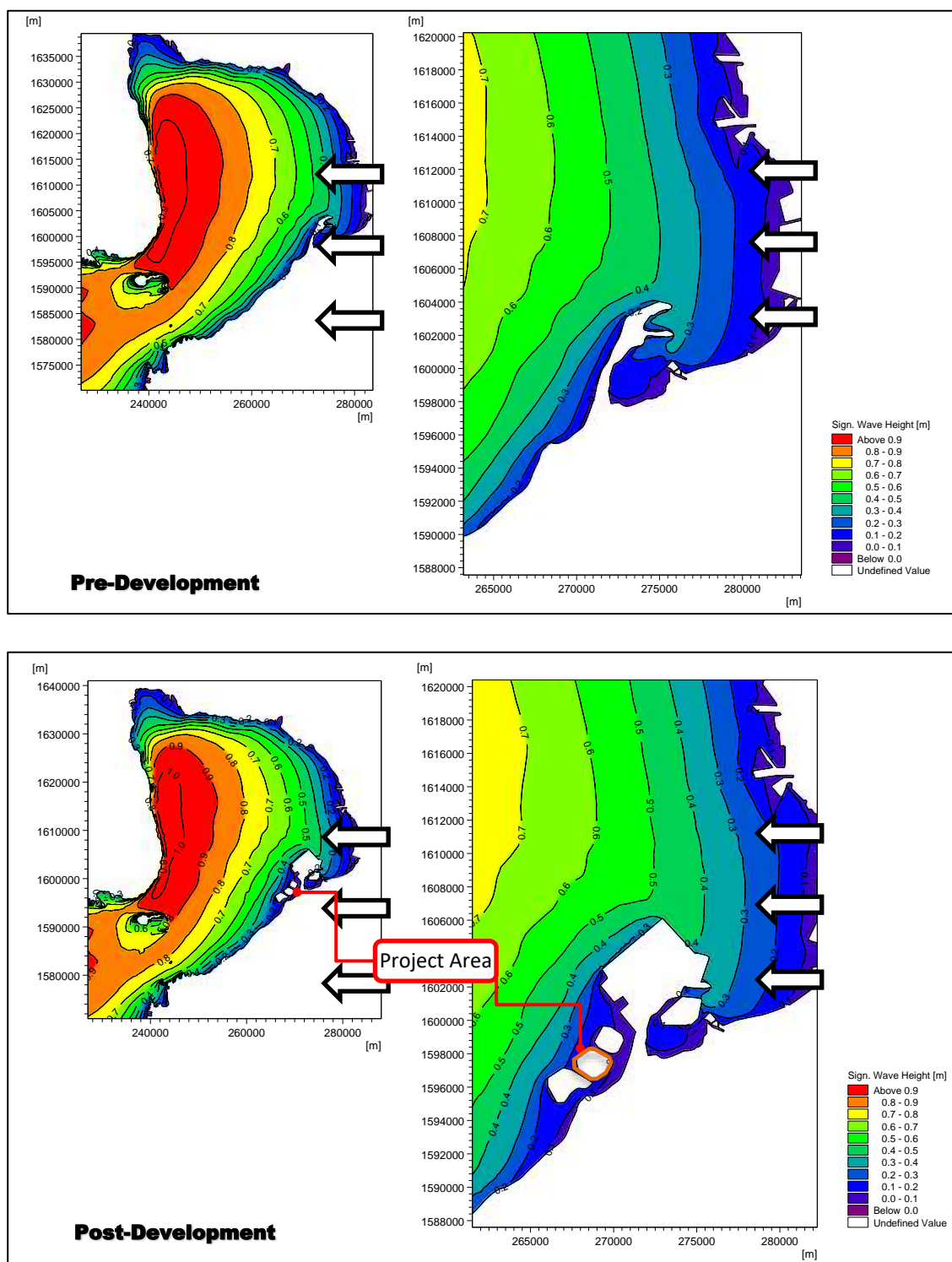


Figure 2.2-51. Wave Climate due to 5-8 mps Surface Winds & Offshore Waves from E at MHHW (Pre & Post-Dev.)



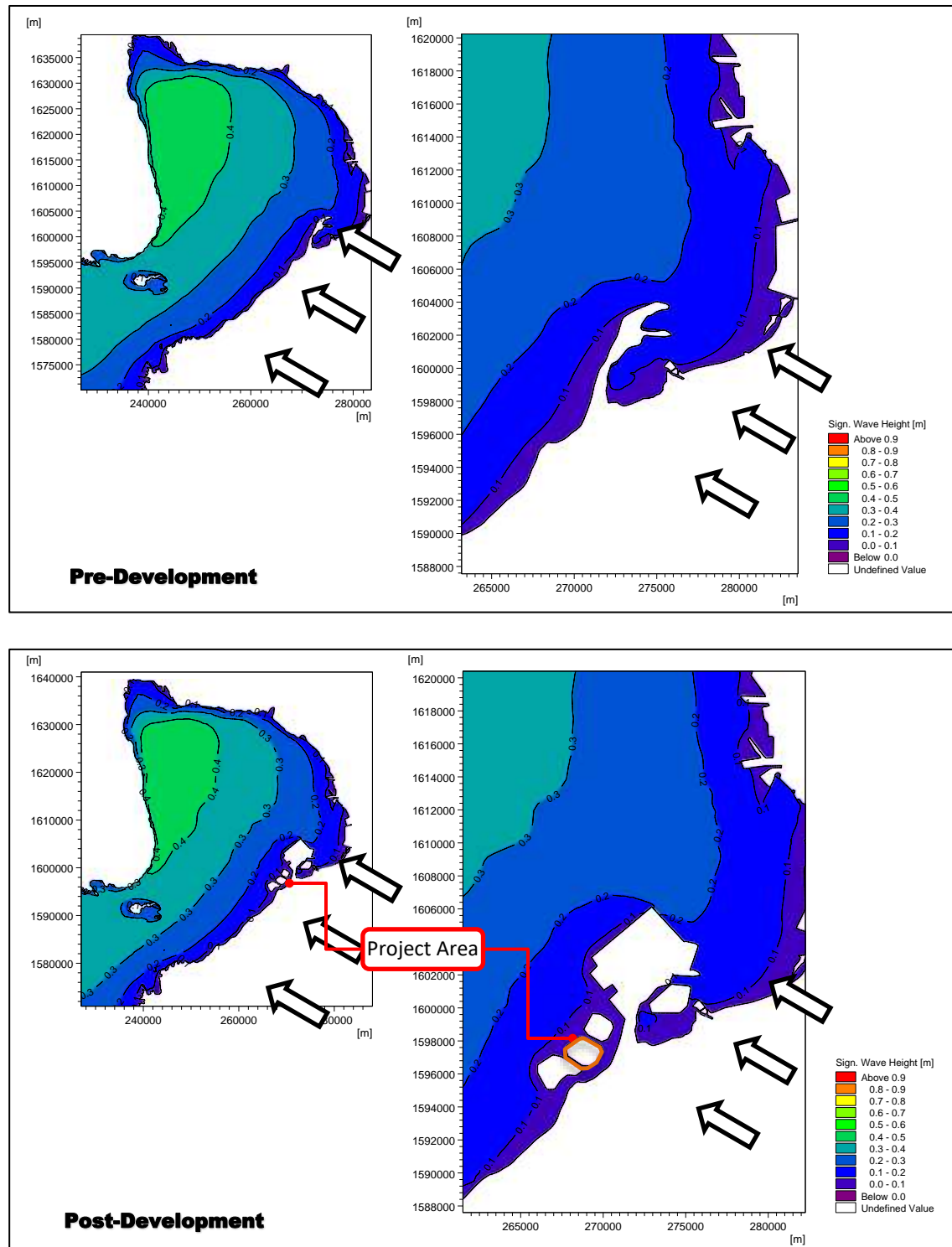
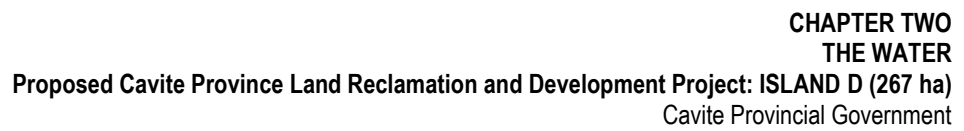


Figure 2.2-52. Wave Climate due to 1-4 mps Surface Winds & Offshore Waves from ESE at MHHW (Pre & Post-Dev.)



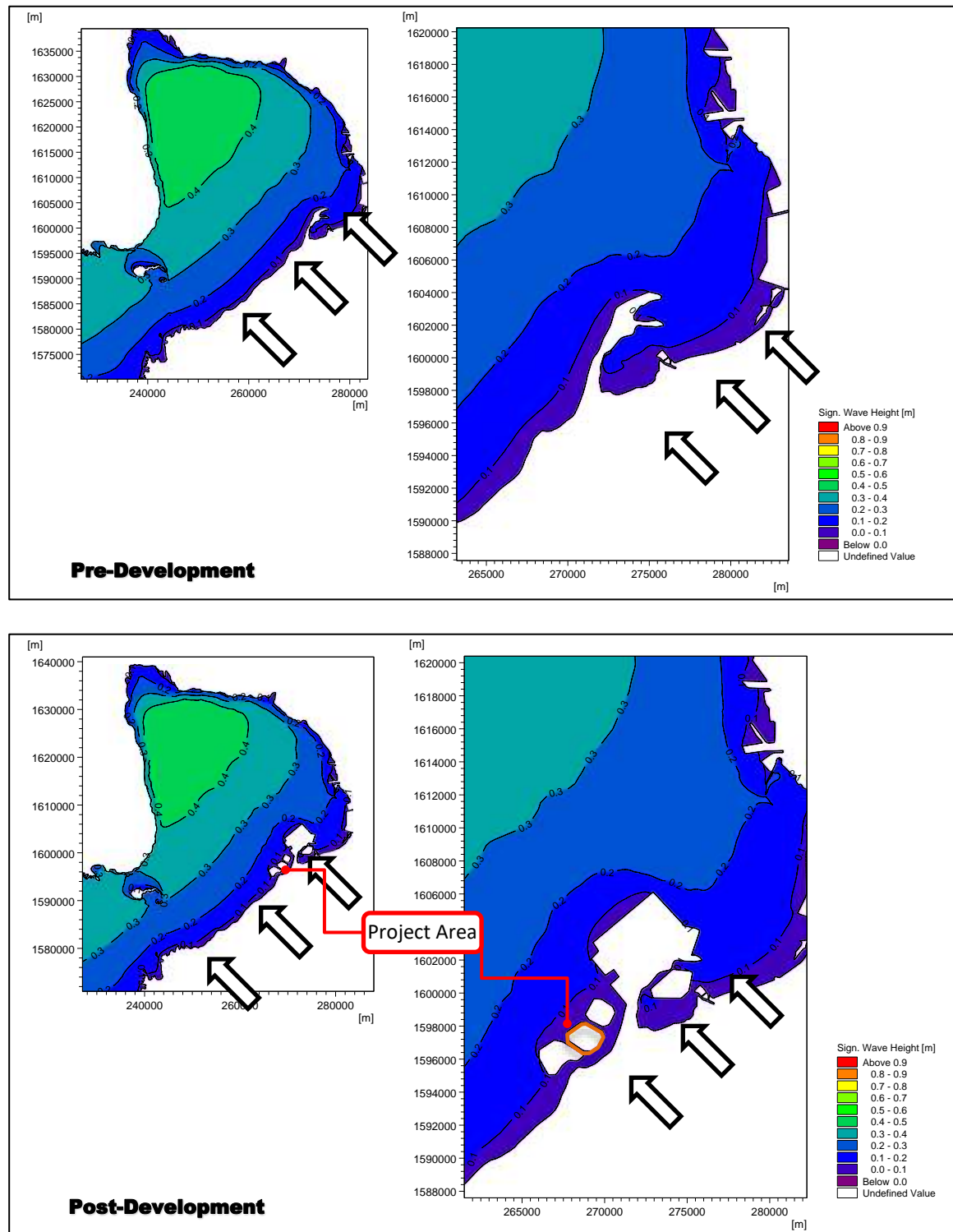


Figure 2.2-54. Wave Climate due to 1-4 mps Surface Winds & Offshore Waves from SE at MHHW (Pre & Post Devt.)



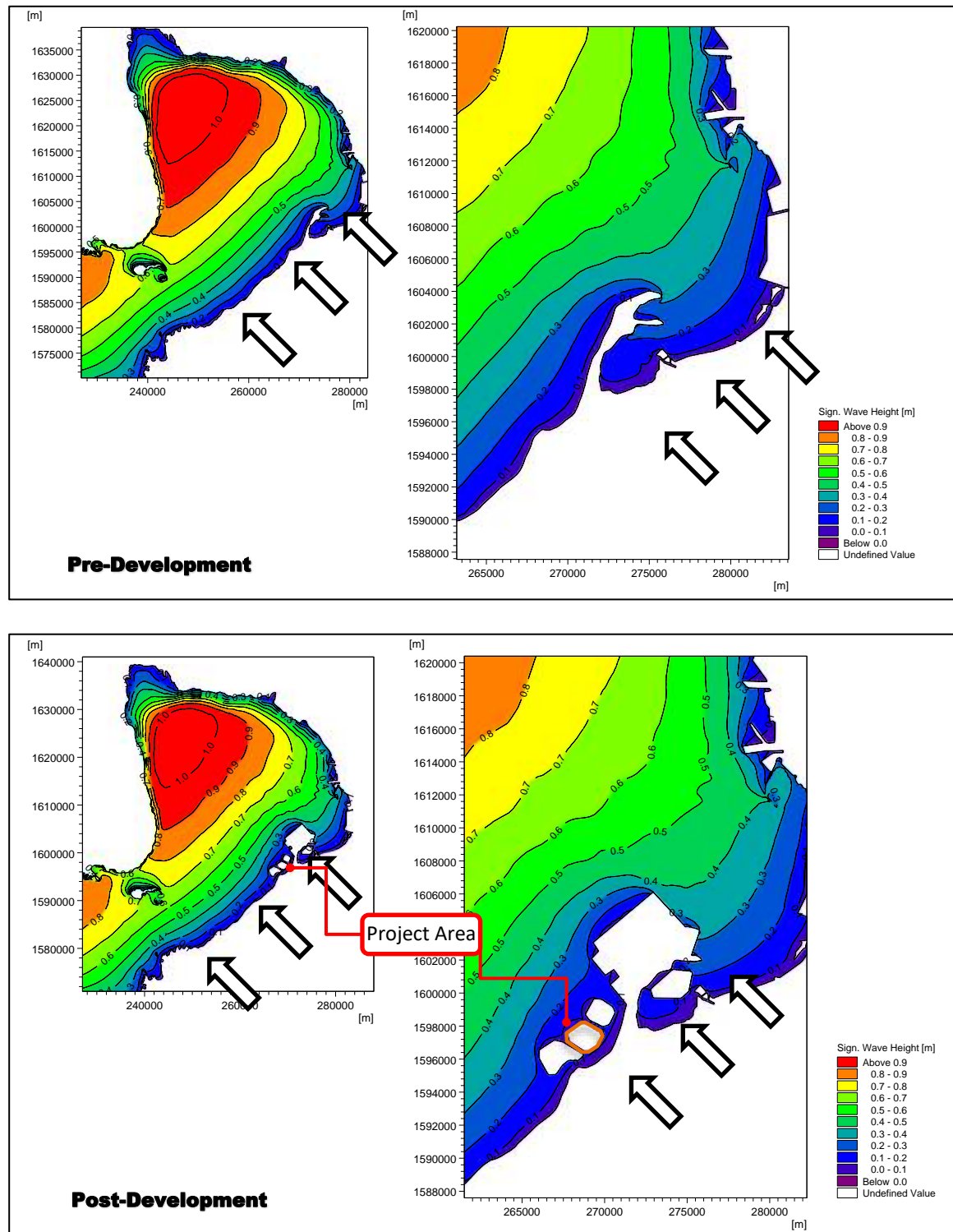


Figure 2.2-55. Wave Climate due to 5-8 mps Surface Winds & Offshore Waves from SE at MHHW (Pre & Post-Dev.)

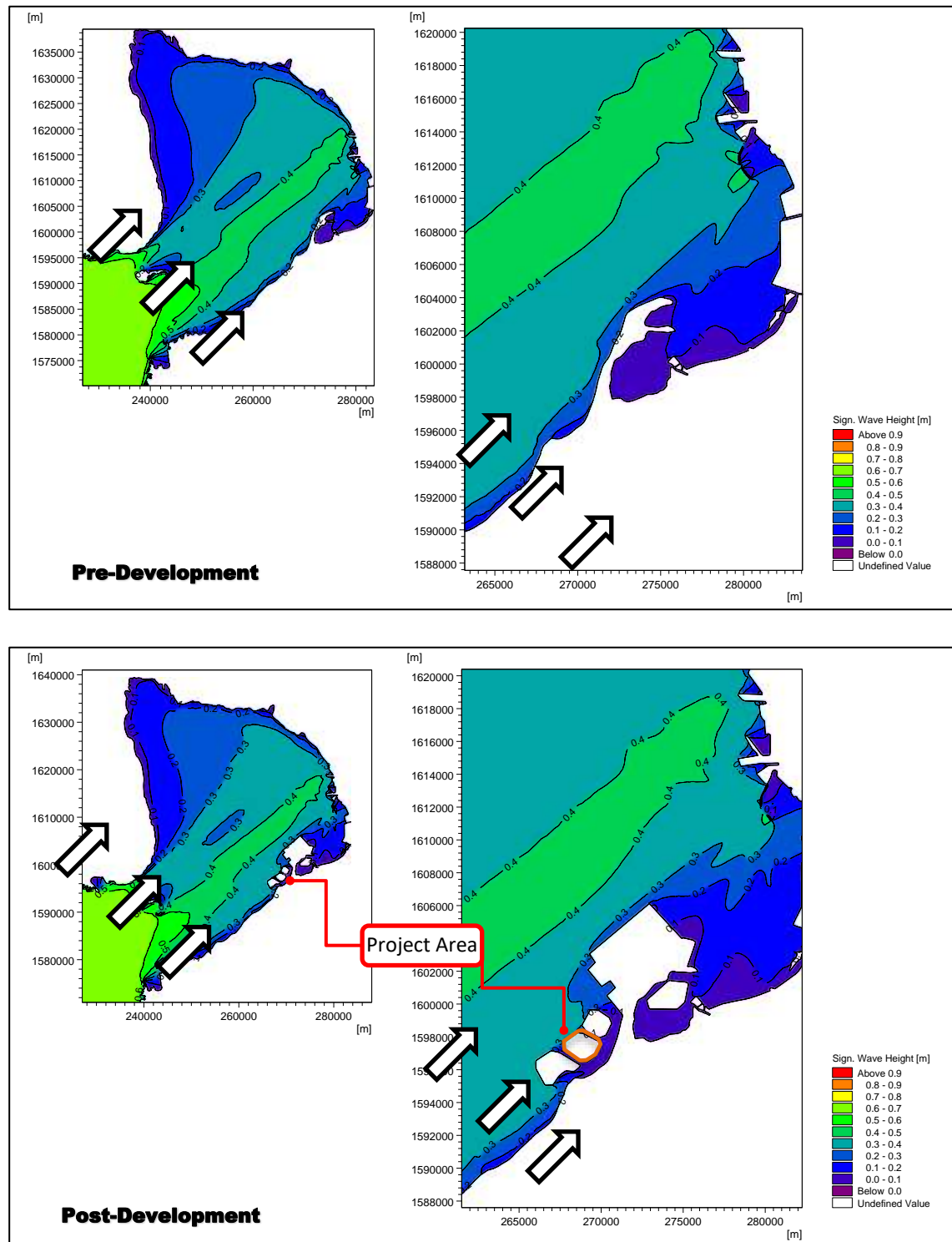


Figure 2.2-56. Wave Climate due to 1-4 mps Surface Winds & Offshore Waves from SW at MHHW (Post & Pre-Devt.)

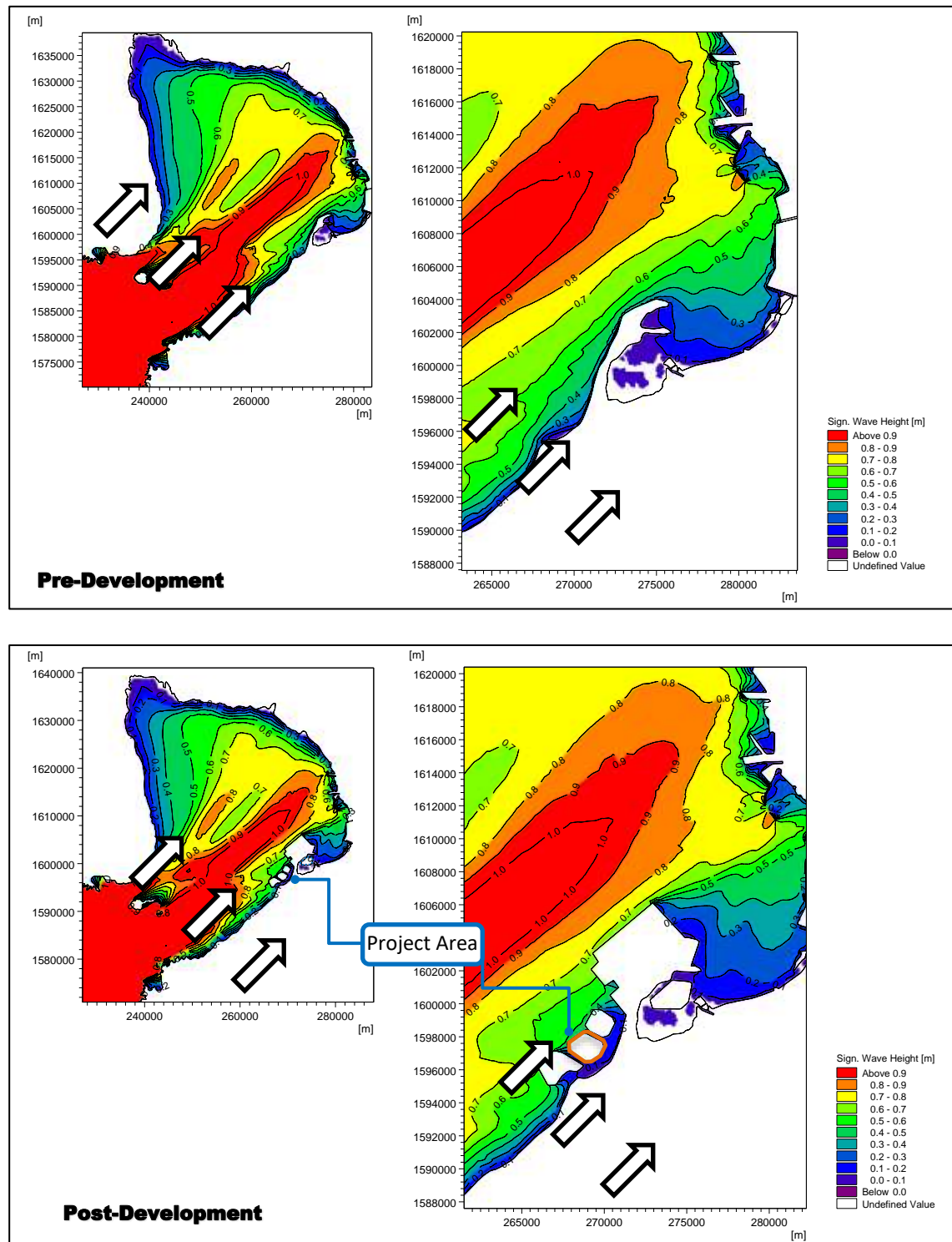


Figure 2.2-57. Wave Climate due to 5-8 mps Surface Winds & Offshore Waves from SW at MHHW (Pre & Post Devt.)



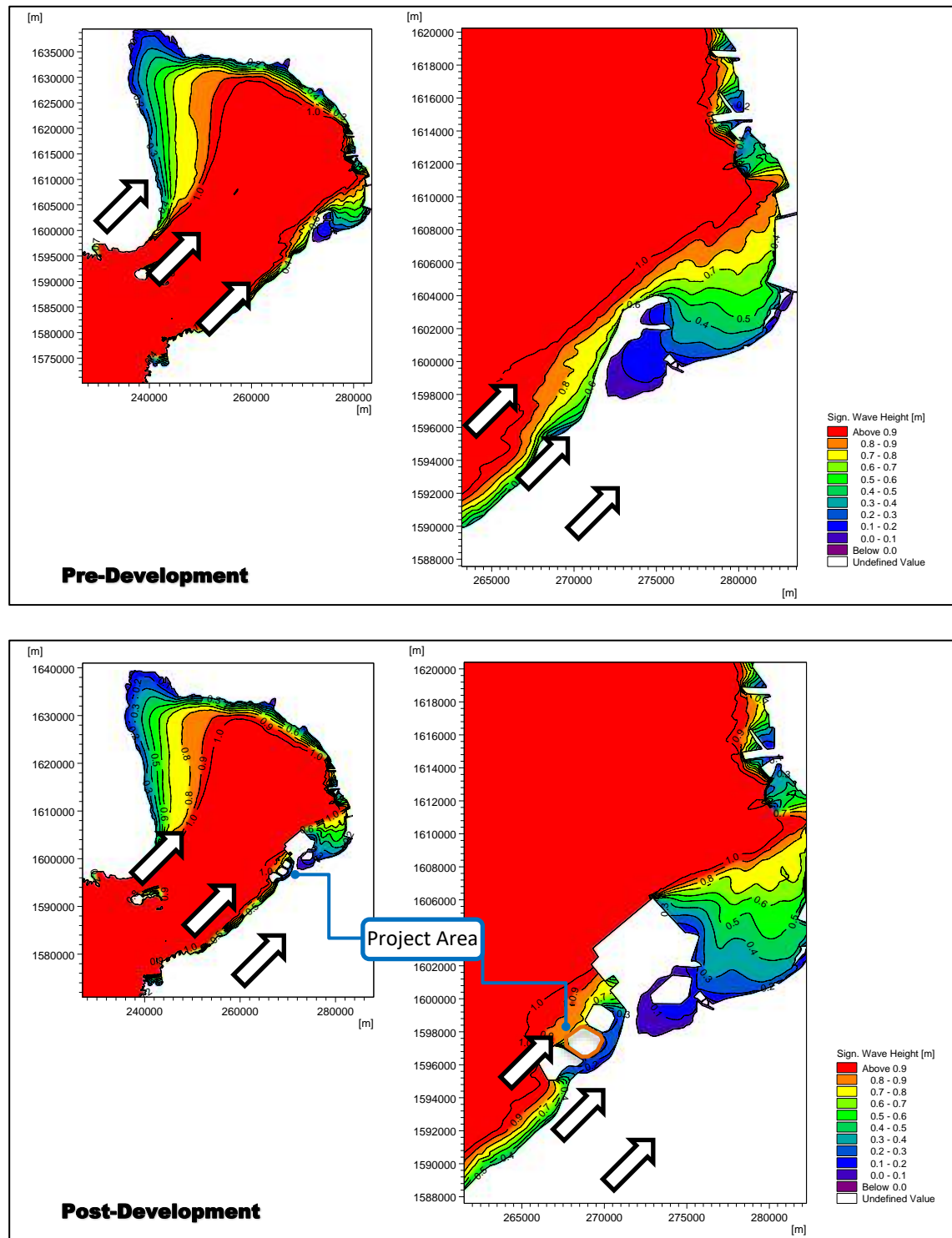


Figure 2.2-58. Wave Climate due to 9-12 mps Surface Winds & Offshore Waves from SW at MHHW (Pre & Post Devt.)

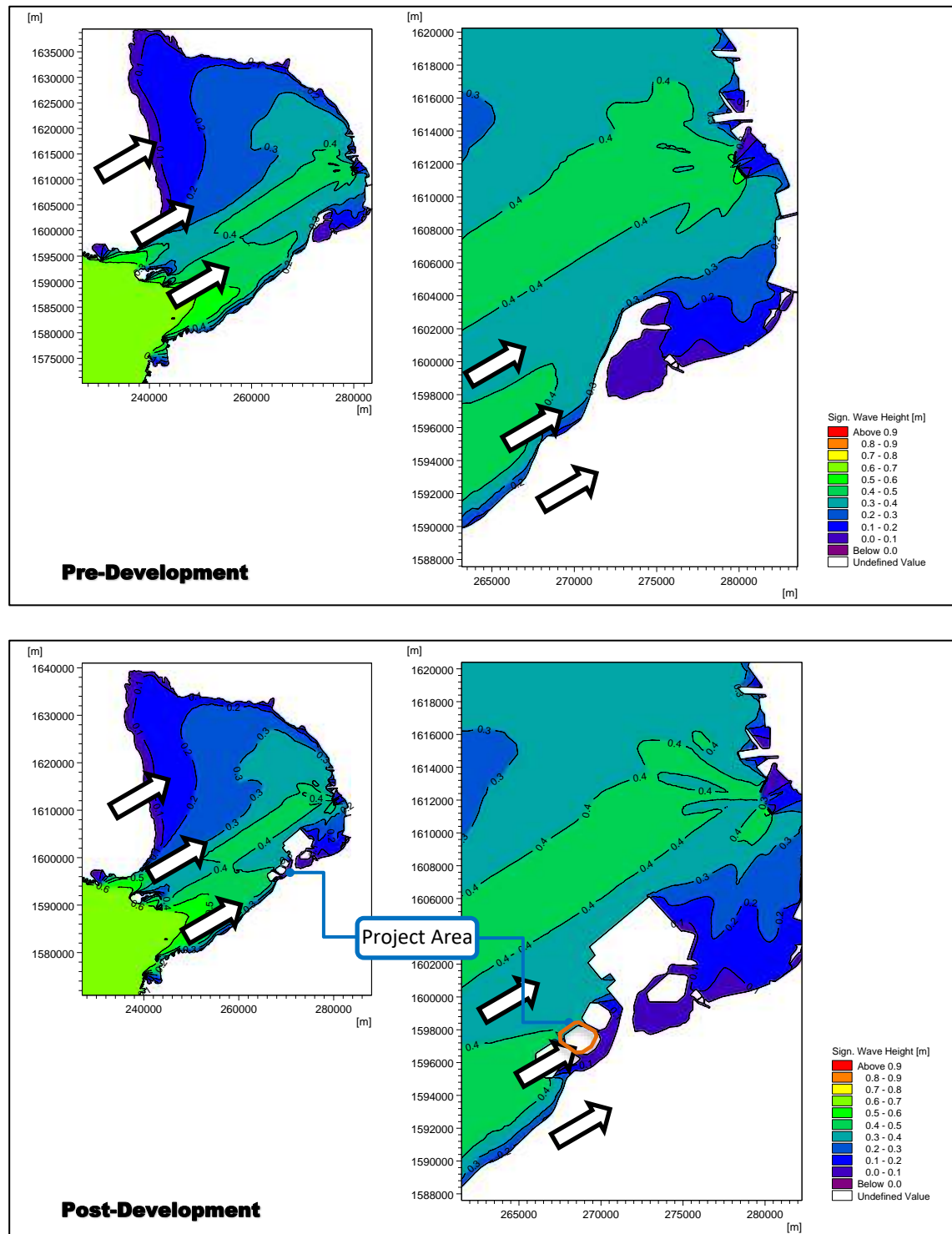


Figure 2.2-59. Wave Climate due to 1-4 mps Surface Winds & Offshore Waves from WSW at MHHW (Pre & Post Devt.)

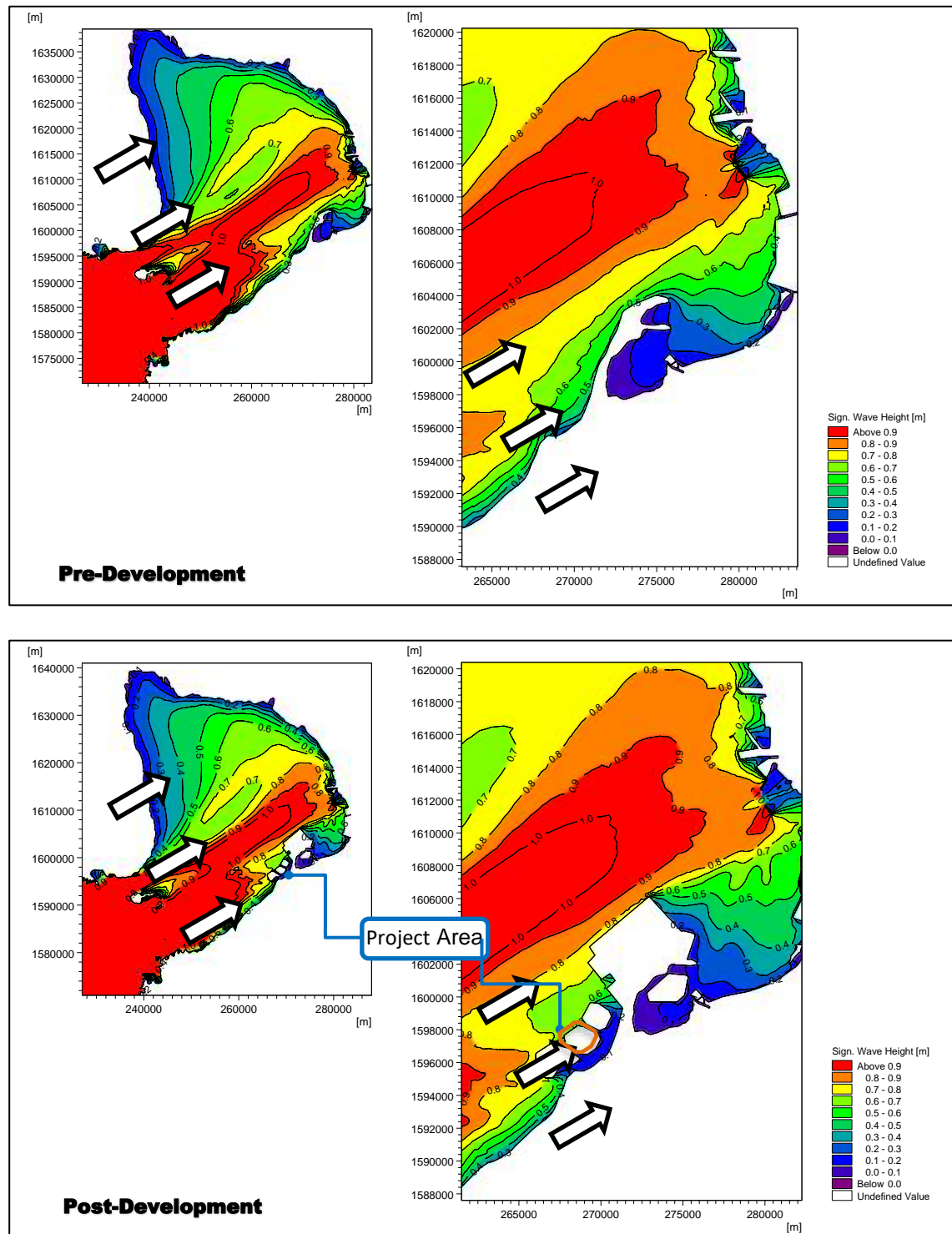


Figure 2.2-60. Wave Climate due to 5-8 mps Surface Winds & Offshore Waves from WSW at MHHW (Pre & Post Devt.)



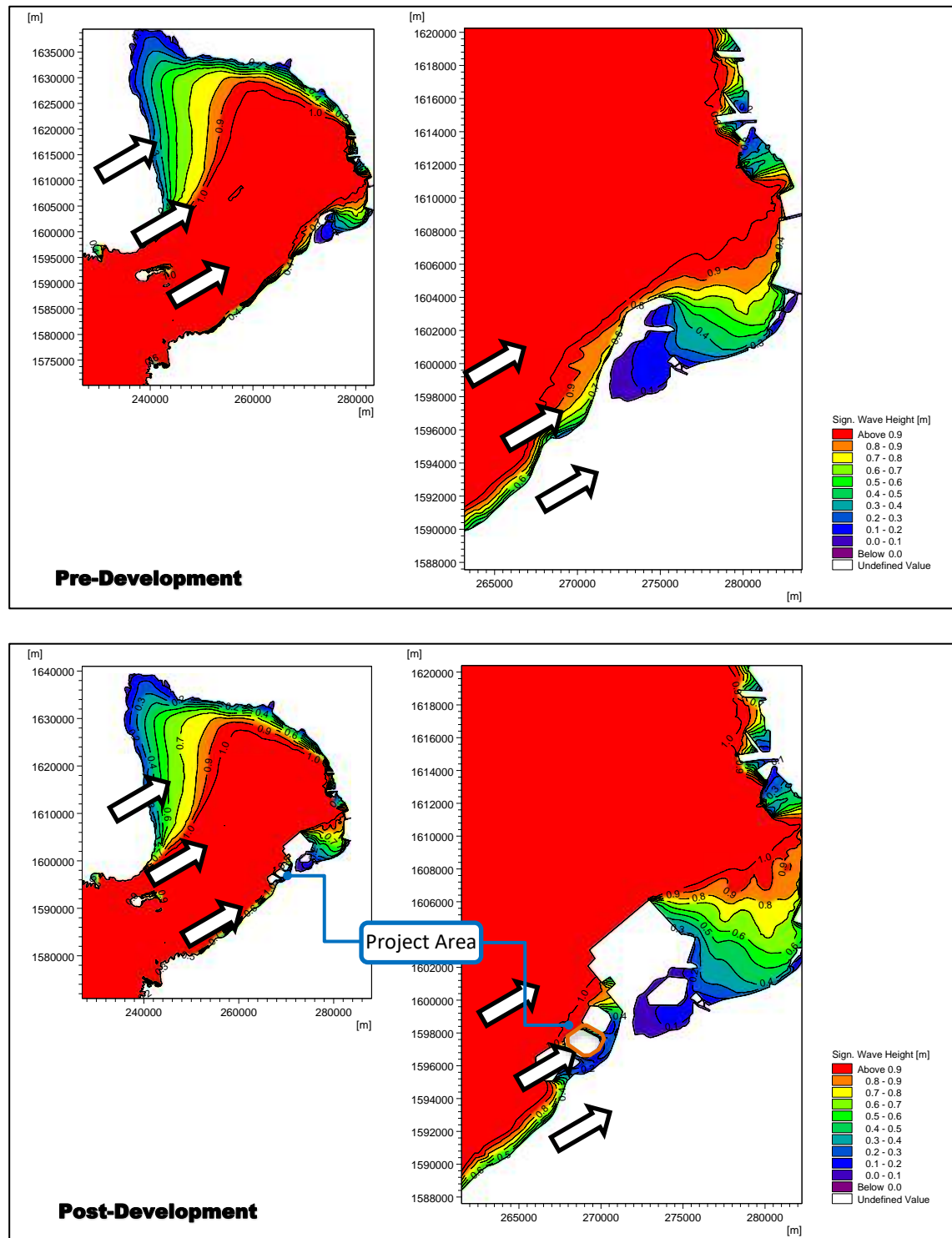


Figure 2.2-61. Wave Climate due to 9-12 mps Surface Winds & Offshore Waves from WSW at MHHW (Pre & Post Devt.)

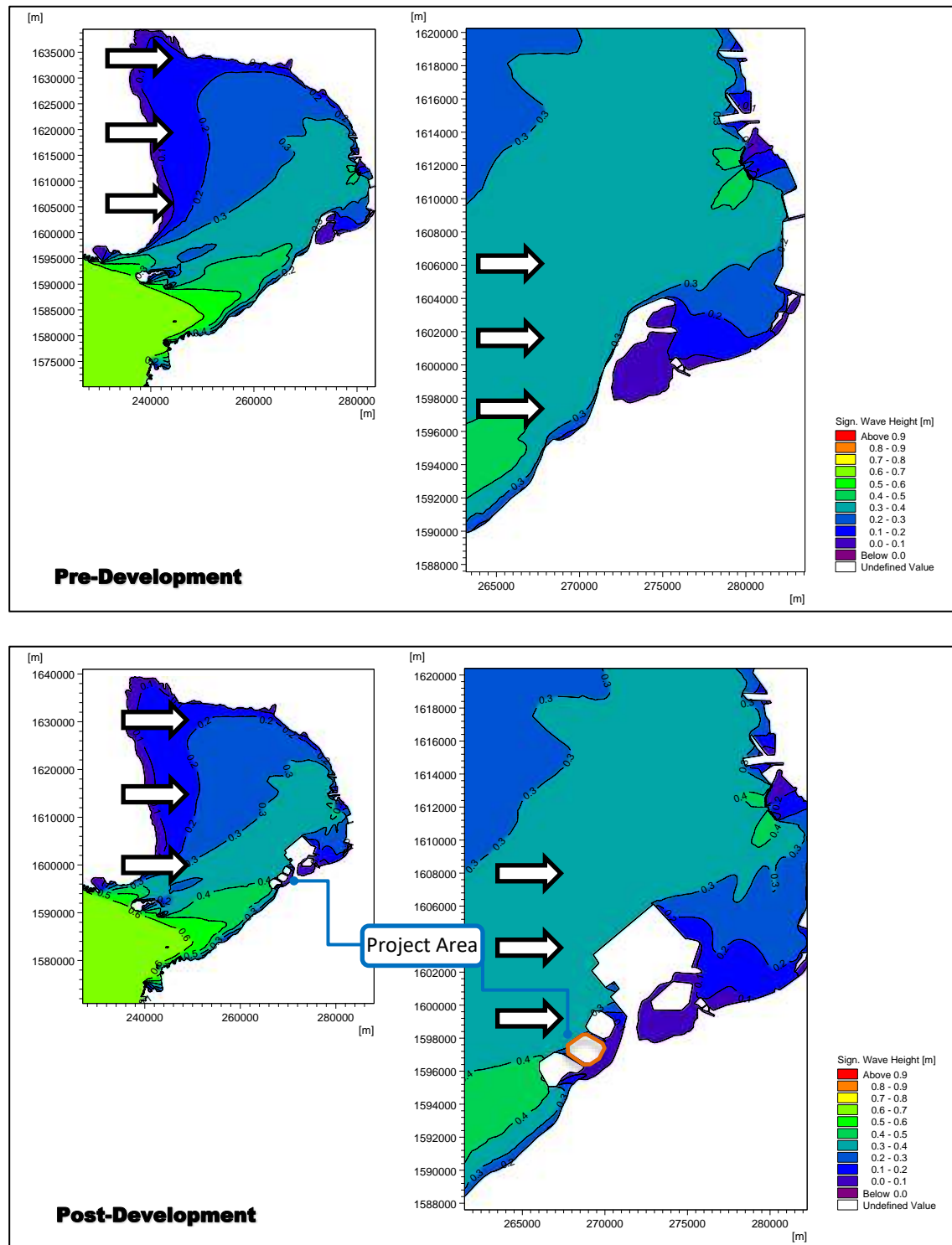


Figure 2.2-62. Wave Climate due to 1-4 mps Surface Winds & Offshore Waves from W at MHHW (Pre & Post Devt.)

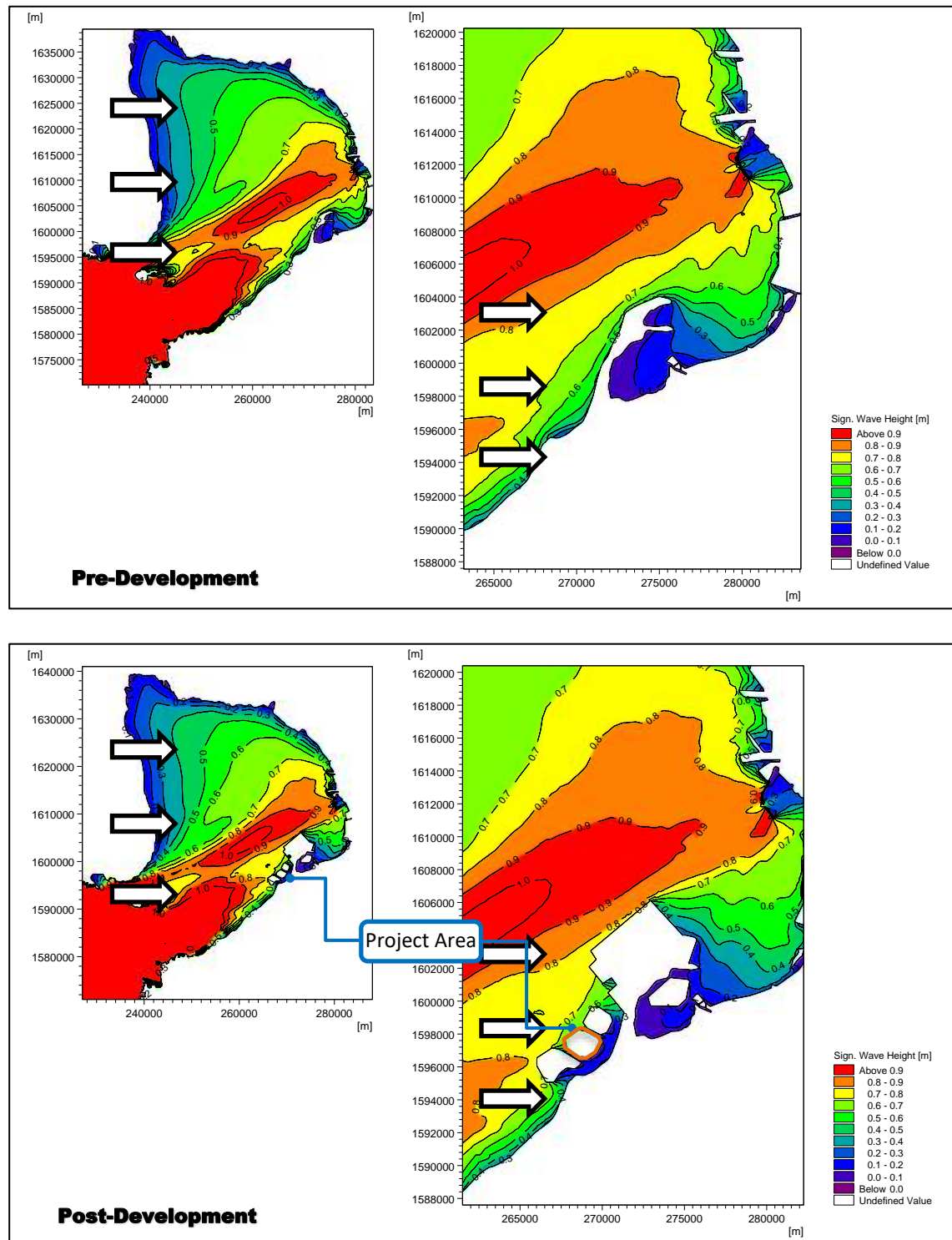


Figure 2.2-63. Wave Climate due to 5-8 mps Surface Winds & Offshore Waves from W at MHHW (Pre & Post Devt.)



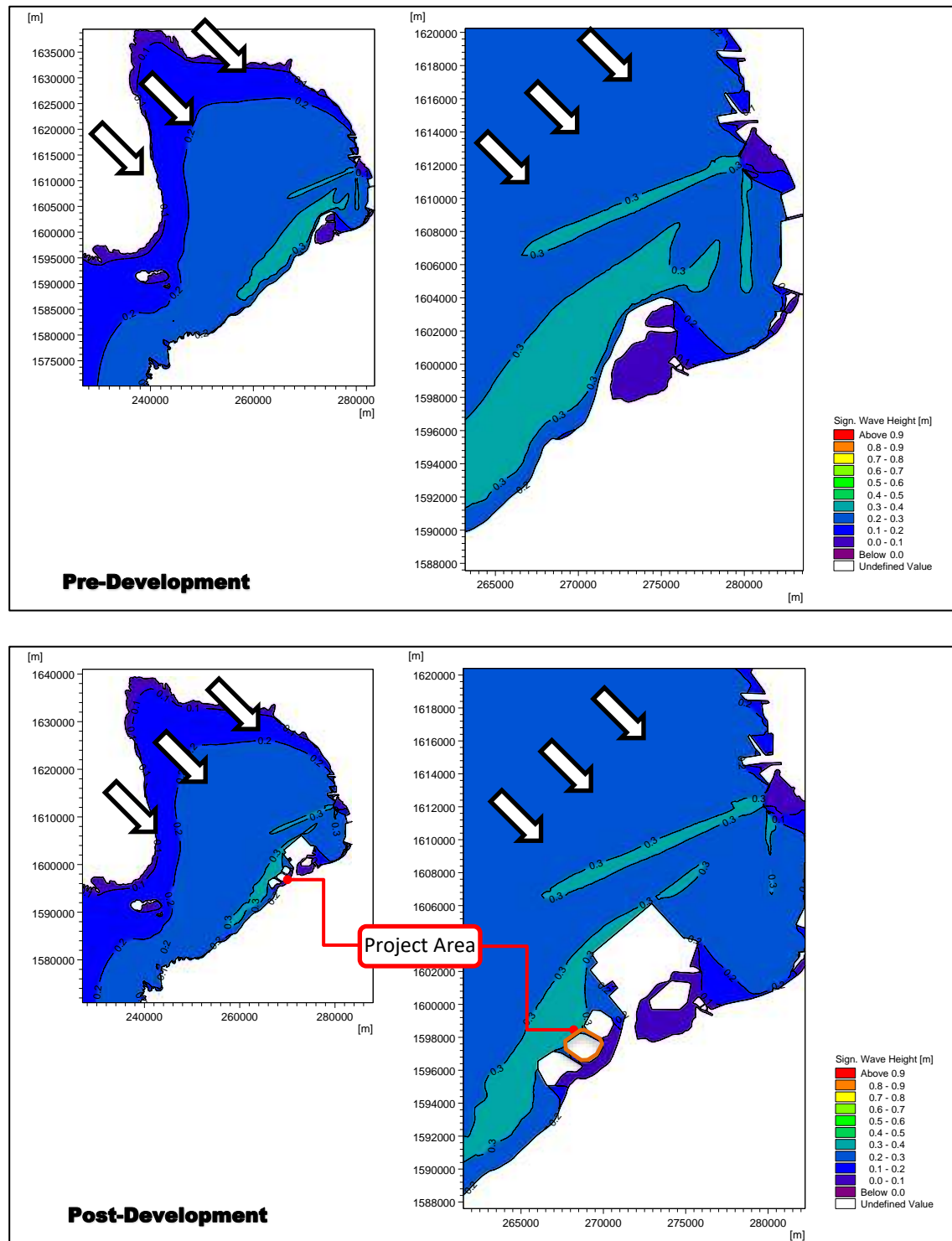


Figure 2.2-64. Wave Climate due to 1-4 mps Surface Winds & Offshore Waves from NW at MHHW (Pre & Post Devt.)

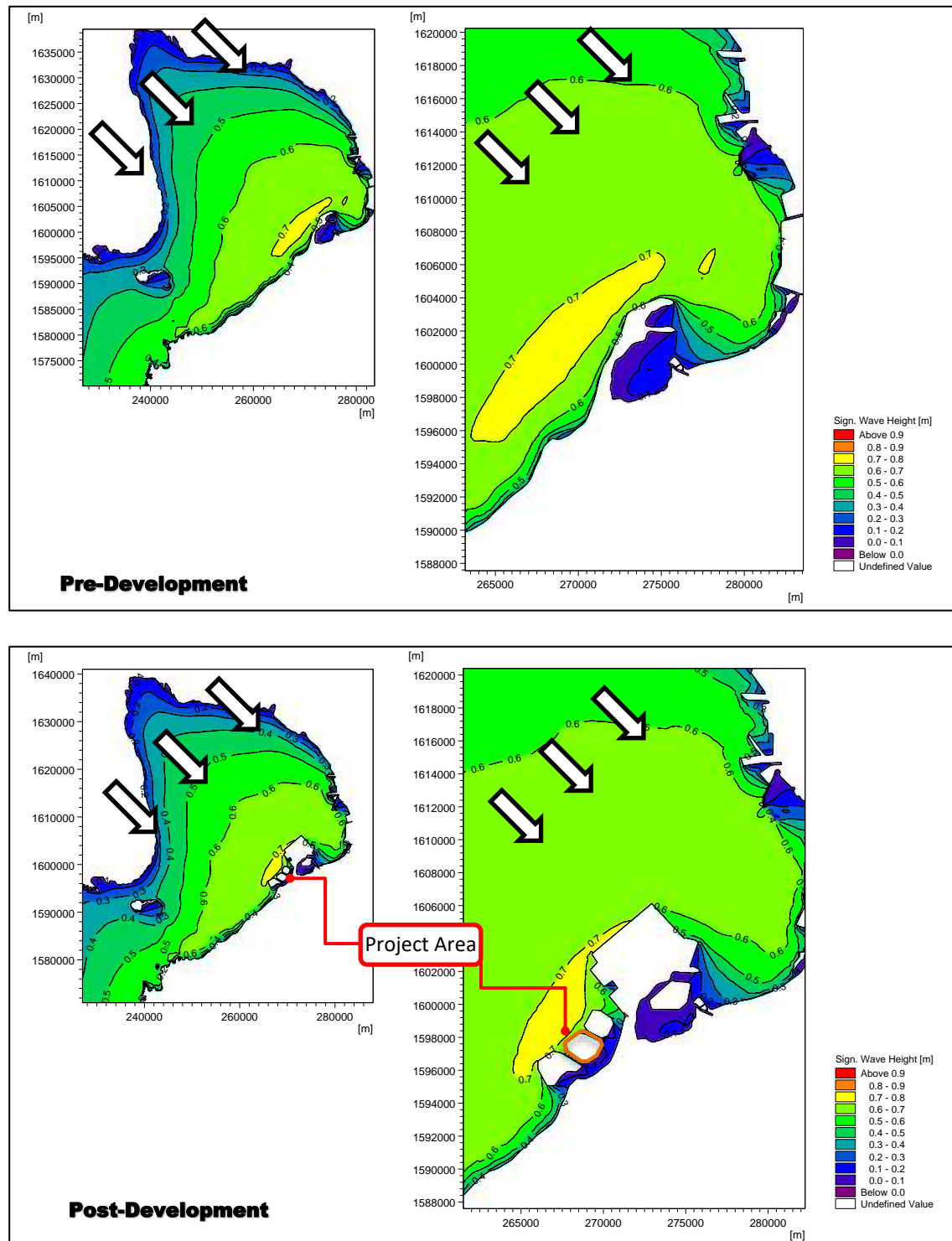


Figure 2.2-65. Wave Climate due to 5-8 mps Surface Winds & Offshore Waves from NW at MHHW (Pre & Post Devt.)



The hydrodynamic models derived for the project was based on historical data, local bathymetry and wave/current data in the public domain. During detailed engineering design, site specific calibration may be conducted using locally collected information on wave heights and current speeds considering final island configuration and all other developments surrounding the project. Final validation of the hydrodynamic model may be conducted at this stage.

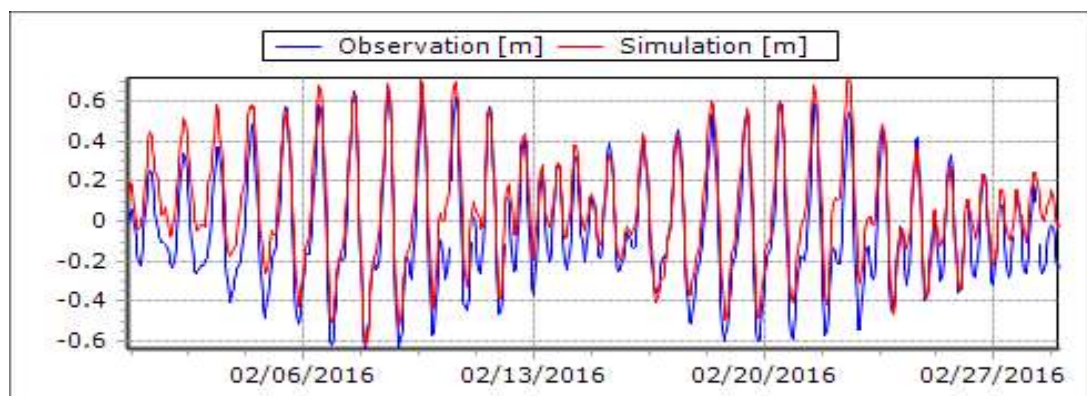
#### **2.2.2.1.7 Tidal Current Analysis/ Changes/Disruption in Water Circulation Pattern**

##### **Water Circulation Patterns**

##### **Littoral Currents**

##### **Introduction**

Pressure gradients exerted by tide level differences generate currents at the seabed that may affect existing activities and post-development operations within the project's marine area. In this study, these tidal currents were also analyzed within the entire Manila Bay area, with tidal forcing extracted from a regional tidal model applied to the offshore boundary outside of the local model of Manila Bay (Figure 2.2-66). The simulation time included one month during a non-typhoon period, namely the month of February 2016, to minimize meteorological effects on the tidal fluctuations. Hence, no meteorological forcing was applied to this tidal current model. One month was selected to allow for adequate warm-up time of the simulation, and also to ensure two tidal cycles – including the spring and neap tides – are included in the simulation Figure 2.2-67. This also served as a calibration run for the model; a statistical comparison of the simulated water surface elevations against actual tide readings acquired from NAMRIA resulted in a coefficient of determination ( $R^2$ ) value of 0.91 at Manila South Harbor.



**Figure 2.2-66. Simulated tide levels at Manila Bay South Harbor**

##### **Sample Effects of the Project on Tidal Currents**

To better illustrate the effects of the reclamations on the tidal-induced current, snapshots of the current vectors during a spring tide were taken. A spring tide was chosen as this would induce a higher water level difference between high and low tide levels, thus also increasing the current velocity; the effects during neap tide are not shown as the vectors are nearly nil. Two snapshots per scenario were taken, namely during ebb and flow tide.

During ebb flow (Figure 2.2-67 for pre and post development) it can be seen that there has been a significant change at Bacoor Bay, wherein the current speed has increased significantly at the gap; elsewhere however in Bacoor Bay the speed has decreased. There is also a slight increase within the waterway on the leeside of Island D. There has also been a decrease in current speed on the west side of Sangley Spit.



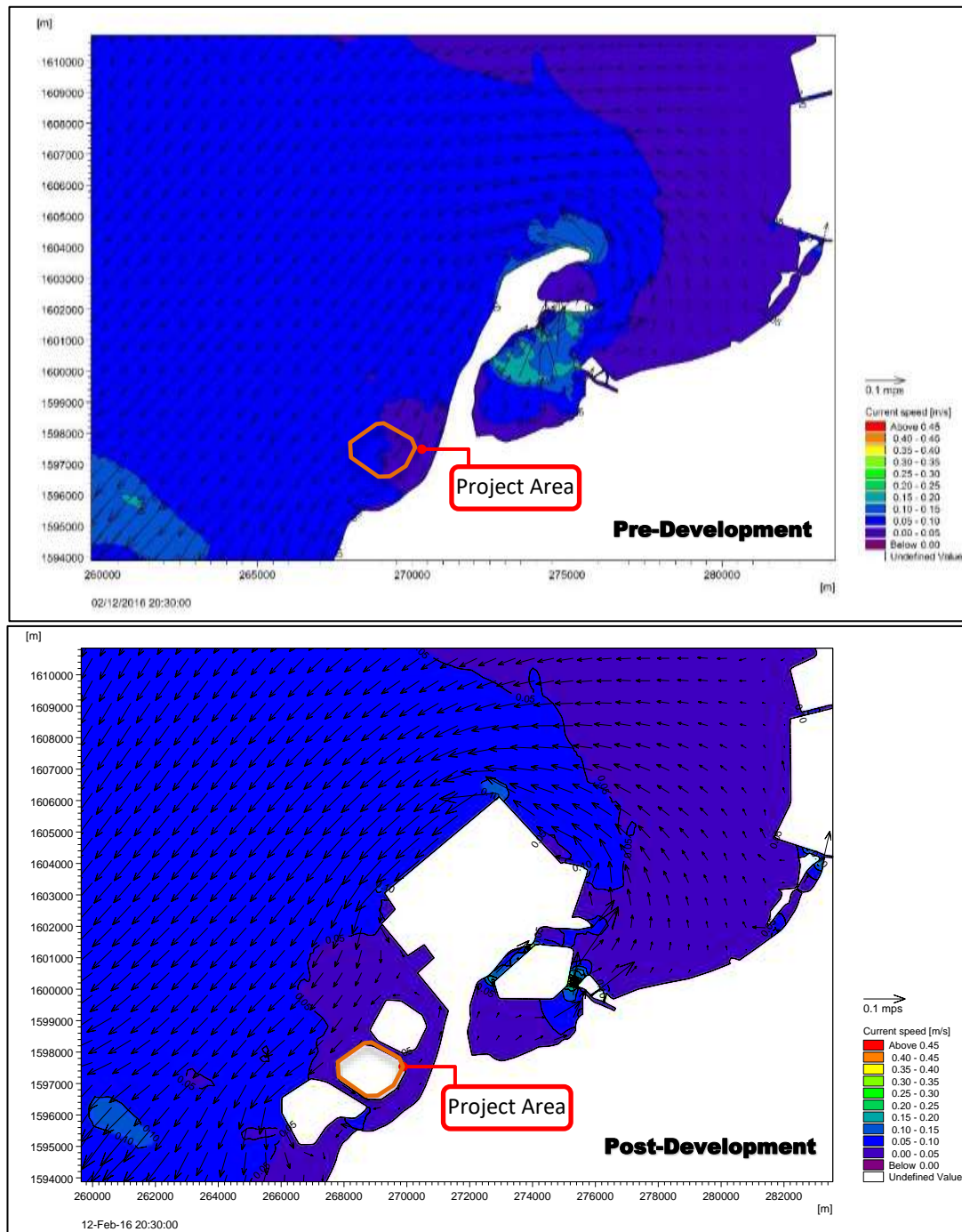
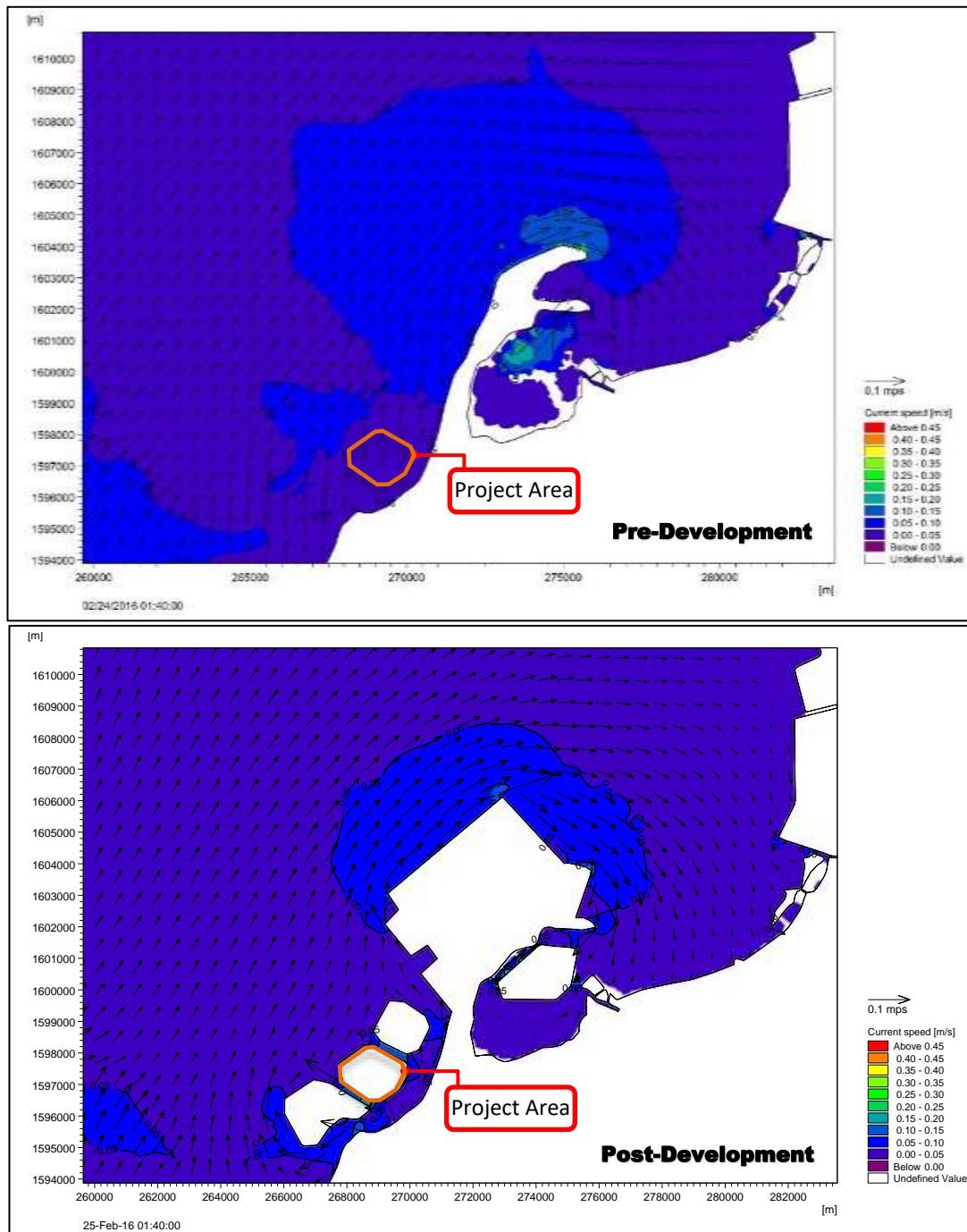


Figure 2.2-67. Snapshot of current magnitude & direction during ebb tide (20:30 Feb 12, 2016)  
Pre & Post-Dev.

For the sample flow tide case, there is a **slight decrease** in current speed along the seaward side of Islands B-E. Otherwise there are no macro changes in the current speeds and directions.



**Figure 2.2-68. Snapshot of current magnitude & direction during flow tide (01:40 Feb 24, 2016) Pre & Post Devt.**

### **Synthesis of Maximum Currents, Including Circulation Patterns and Littoral Currents**

The effects of the reclamation projects on the maximum tidal currents within the simulated time frame were also analyzed and can be seen in Figure 2.2-69 (pre and post development). It should be noted that this section and figures herein only take into consideration the maximum magnitude within the simulated time frame (February 2016), and thus does not take into consideration the direction of flow nor the annual average. In the post-development scenario, various changes in the maximum tidal-induced currents were noted. These changes are specifically:



- An extreme increase of current speed at the gaps of Island A within Bacoar Bay
- A moderate increase of current speed between the Islands B-E.
- A significant increase of current speed on the leeside of Island E within the waterway

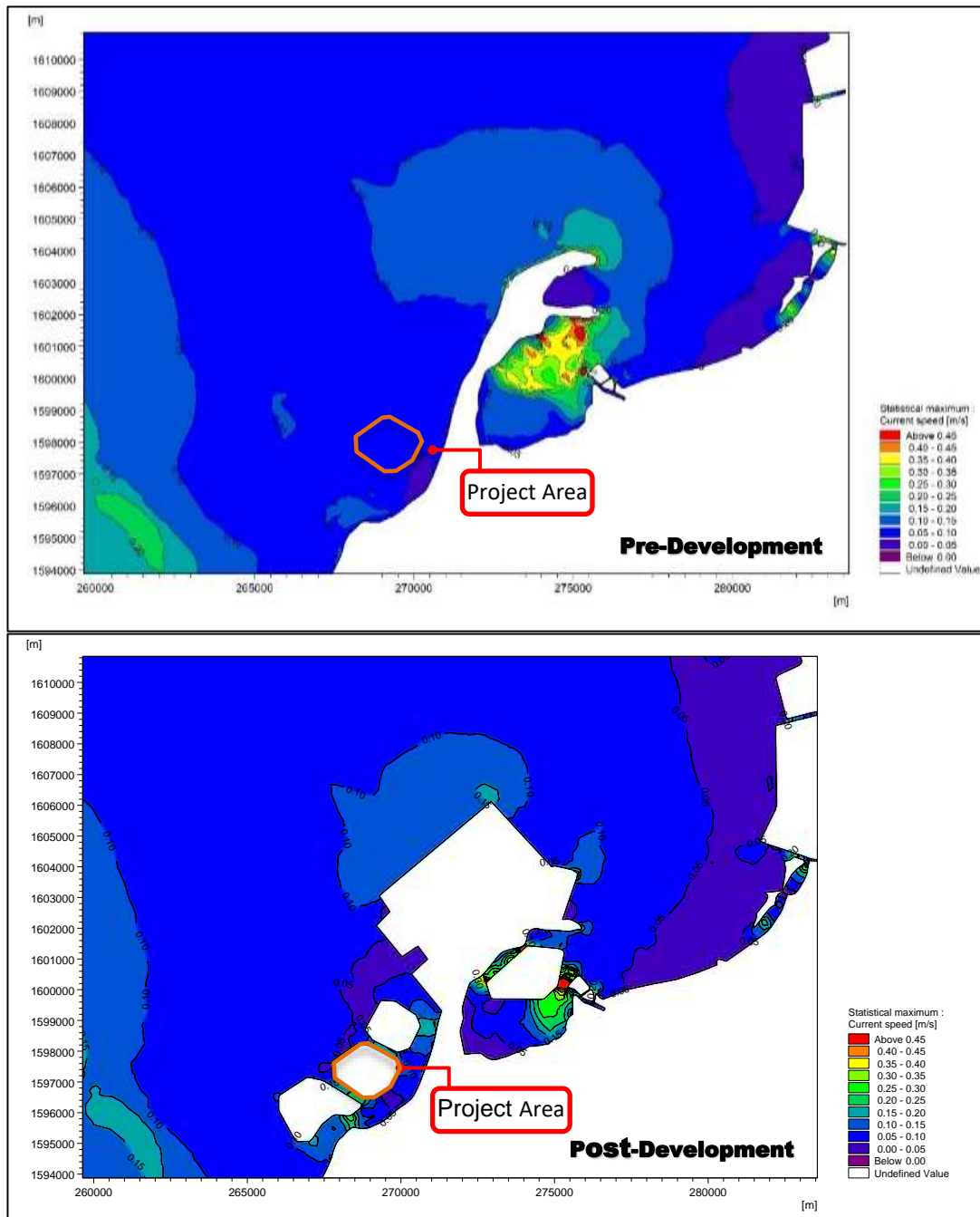


Figure 2.2-69. Maximum current (Jan 29, 2016 – Feb 29, 2016)  
Pre & Post Devt.





#### 2.2.2.1.8 Tidal Circulation Analysis

##### Introduction

Tidal currents generated by pressure gradients due to water surface fluctuations may affect ambient conditions such as the movement of surface runoff from inland and the transport of sediments along the coastline. Even in the absence of wind-induced shear stress on the water surfaces, these currents also impact the viability of operational activities such as river and coastal navigation, mooring of vessels, and offshore anchoring of ships. On the other hand, these currents are important in circulating the water within the wave-sheltered zones so that seawater does not stagnate over extended durations under prevailing winds and tides. The circulatory motion of the waters is also needed for the exchange of water mass and with the offshore area of the adjoining bays, Manila Bay, and Cañacao and Bacoar Bays, so that the seawater fronting the project coastline is periodically replenished by these open offshore waters. . Finally, a good tidal circulation is necessary to improve the rejuvenation of water-entrained oxygen in the interior zones of the wave-sheltered zones of the post-development scenario.

##### Tidal Circulation Characteristics

Time frames of tidal currents are analyzed for the circulatory patterns generated both outside and inside the project nearshore zone during a 15-day window of February 2016, an Amihan month. The simulated currents are highly dependent on the movement of the water surface driven by the offshore tides, morphology of the existing coast and the modified coastlines due to the post-development scenario. Chronological snapshots of the water levels and currents field are captured in Figure 2.2-72. The currents are shown superimposed on the nearshore zone at ambient tide levels.

A recent study indicates that circulation in an enclosed water body, such as the nearshore zone of a marina or partially enclosed beach coast, is driven mainly by tidal fluctuations and only weakly by surface winds surface (Cruz and Santos, 2018). This means that only a full tidal cycle (15 days), with no particular prevailing non-storm wind forcing, is sufficient to establish the tidal circulation characteristics. Thus, the circulation patterns are also applicable to a Habagat season.

It is seen that the fronting waters of the reclaimed 6 lands experience oscillatory directions of currents, which indicates that there is exchange of seawater along the post-development waterfront with the open waters of Manila Bay. In addition, the narrow foreshore area Zone 1 and the 4 engineered channels C1 to C4 (*C3 is the channel between islands C and D while C4 is between islands D and E*) all undergo flow reversals that will permit an exchange of waters with the bay.

Chronological snapshots of the water levels and currents field within the tidal cycle are captured in Figure 2.2-72. The currents are shown superimposed on the wet area of the nearshore area at ambient tide levels. The basin to the north of Island A in Cañacao Bay also experiences tide flood and ebb flows, indicating an exchange of water mass, and thereby significant replenishment of dissolved gases, with the larger basin of Bacoar Bay. The exterior flows around the reclaimed land F (Sangle Point International Airport) are also seen to be periodically reversing, with current intensities of around 0.1-0.3 mps which are considered adequate to flush out stagnated pollutants in those depths. The tidal circulation around this block also reverses, with both clockwise circulation (left panels) and counter clockwise circulation (right panels).

It can also be seen that the currents penetrate the channelized waterways C1 to C4. Due to their smaller size and adjacency to Manila Bay, these waterways will easily rejuvenate water with the large bay.



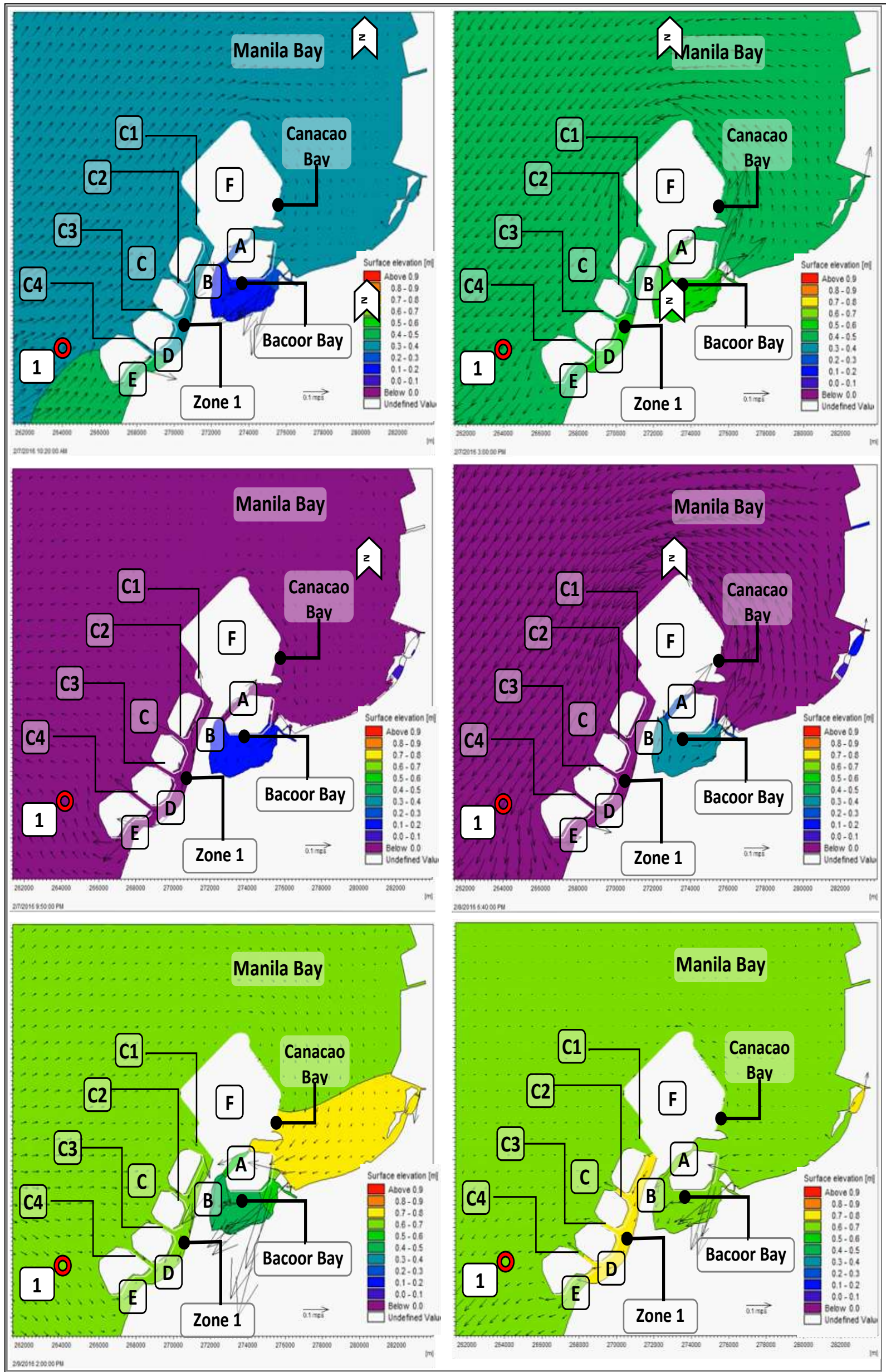
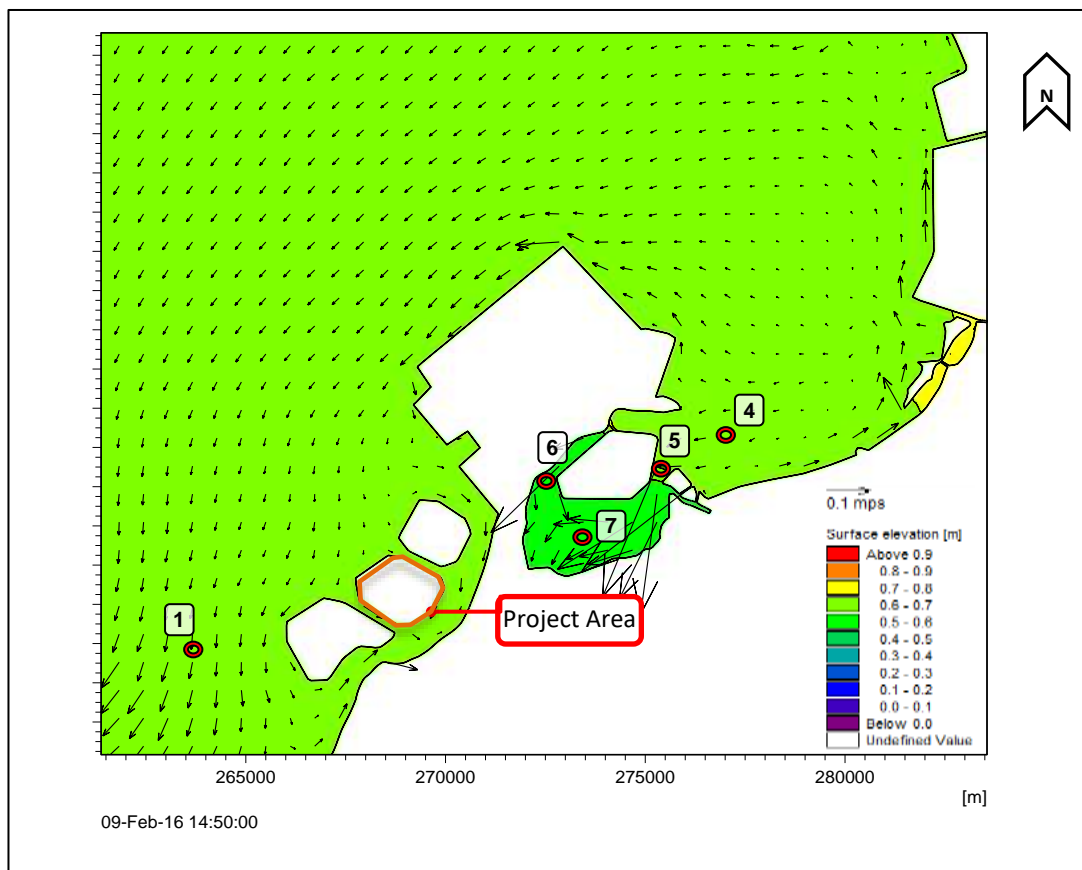


Figure 2.2-70. Chronological snapshots of tidal currents during Jan. 29 – Feb 20, 2016



### Tidal Currents around the Project Area

To track the tidal currents' time histories, a number of monitoring points (MP) are located in the nearshore domain as shown in Figure 2.2-71. Over a tidal cycle of 15 days, Figures 2.2-72 and 2.2-73 summarize the time series of the tidal current vector at the reference (offshore) station 1, and at the constricted locations 5, 6, 8, 9 and 12. At these narrow waterways created by the post-development scenario, the tidal currents experience a full range of current intensities, with amplitudes of about 0.6 mps at MP 5 and 6, 0.12 mps at MP 8, about 0.05 mps at MP 9, and about 0.09 mps at MP 12. The time series also indicate that the flow direction oscillates, which indicates redistribution of by tidal currents of confined seawaters in the channels towards the adjacent open bays (Bacoar and Manila Bays). The tidal currents also reverse with approximately equal durations of inward and outward flows, except at MPs 5 and 6, where outward flows, i.e. towards the NNE and NE respectively, are significantly longer, and at MP 8 where the inward flows, i.e. towards SSE, are nominally longer than outward flows.



**Figure 2.2-71. Location of Monitoring Points**



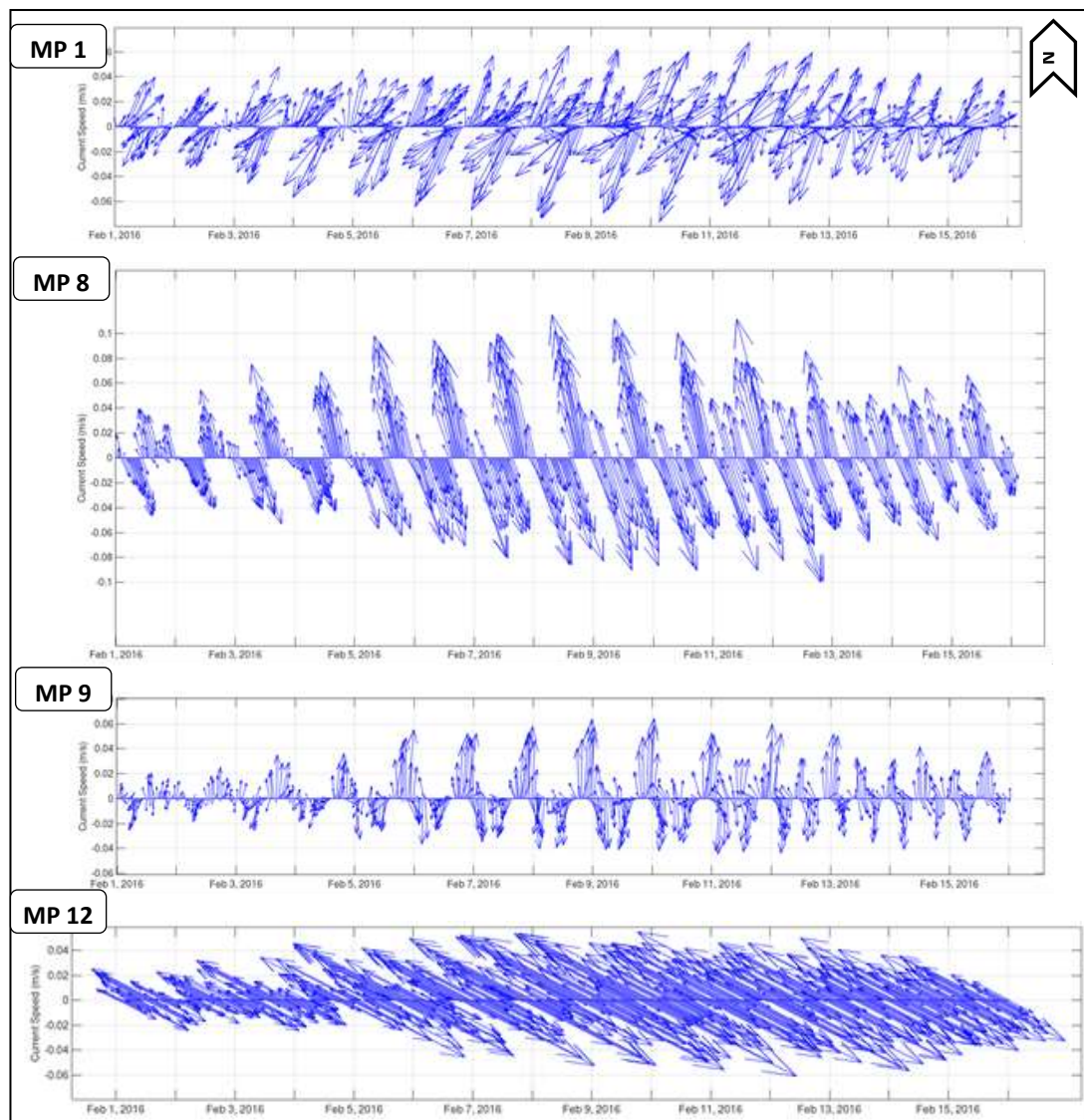
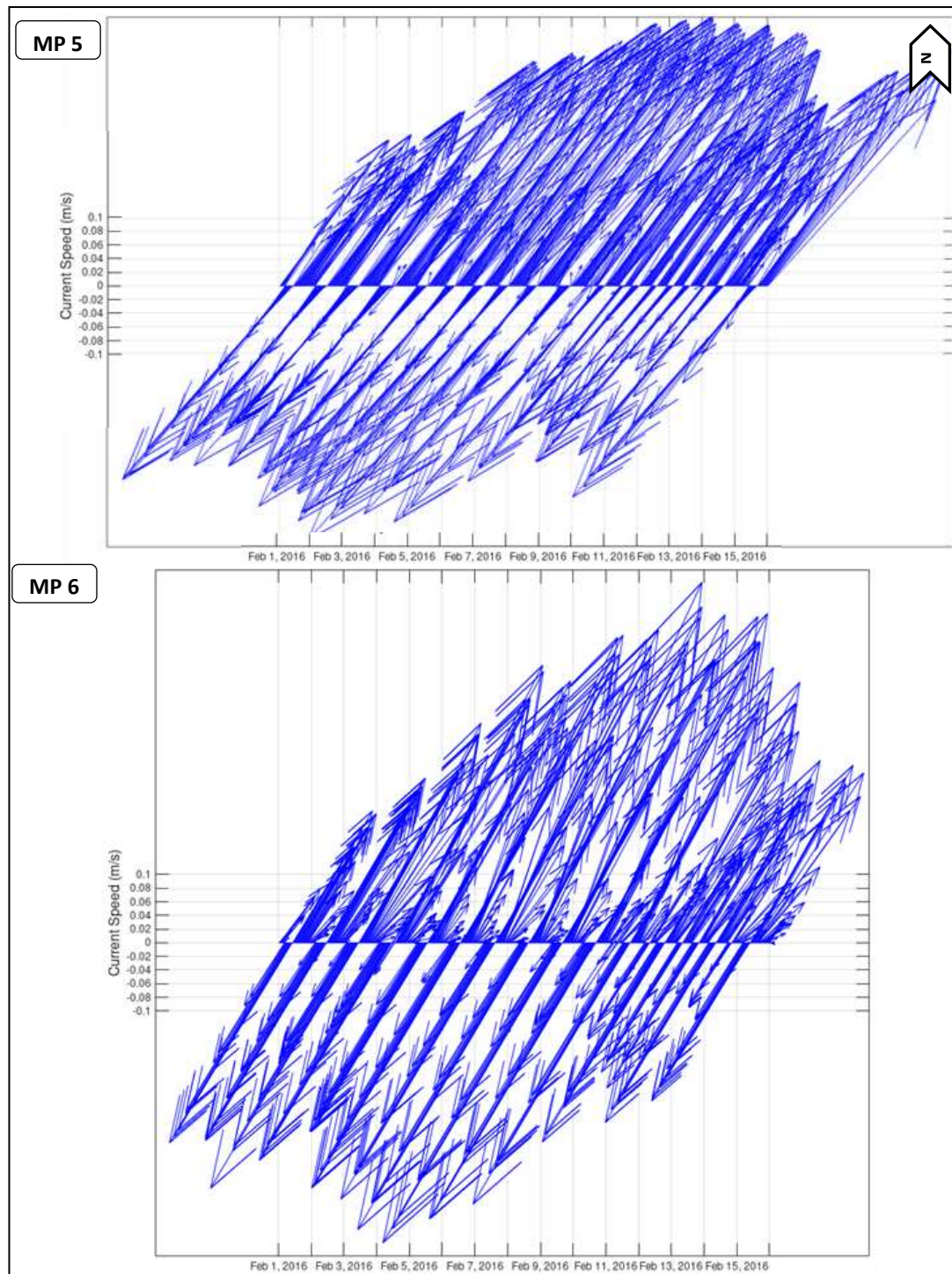


Figure 2.2-72. Tidal current time histories over 15 days at selected monitoring points (MPs 1, 8, 9, & 12).



**Figure 2.2-73. Tidal current time histories over 15 days at selected monitoring points (MPs 5 & 6).**

In summary, the tidal currents modified by the post-development scenario will still allow significant circulation of seawaters within both partially enclosed waterways and channelized waterways between the reclaimed islands. The circulation currents have a wide range of amplitudes of 0.05 to 0.6 mps, as well as oscillating directions signifying dispersion of outward currents. Channelized waterways created between the reclaimed islands B to E experience reversal of flows, indicating bi-directional transport of seawaters that would be otherwise be confined in these channels.



Littoral currents which pertain to the **nearshore** the part of a sea are adequately covered by and in the above discussions.

#### **2.2.2.1.9 Storm Condition Analysis**

##### **Introduction**

A storm surge is defined by a change in water level due to atmospheric disturbances such as low-pressure areas and extreme wind continuously blowing over a body of water, both of which occur during typhoons. Storm surges should not be confused with the astronomic tide levels (MHHW, MHW, MTL, MLW, and MLLW) which are caused by the combined effects of the gravitational forces between the earth, sun, and moon. They should also not be confused with tsunamis which are caused by a sudden displacement of water due to seabed displacements usually caused by offshore seismic events.

When the storm's center is in the oceans, these effects are generally small on account of the large depth of water to mobilize and the vast expanse of water. However, these effects are quickly amplified when the storm reaches the shallow water. As the storm reaches the coasts the small depth of water in the coastal areas and the flow-impeding effect of land boundaries cause a pronounced elevation of the mean sea surface. These result in the rise of the mean sea surface, which is termed "storm surge". The combined level of storm surge and the astronomic tide at time of the storm's landfall is referred to as "storm tide".

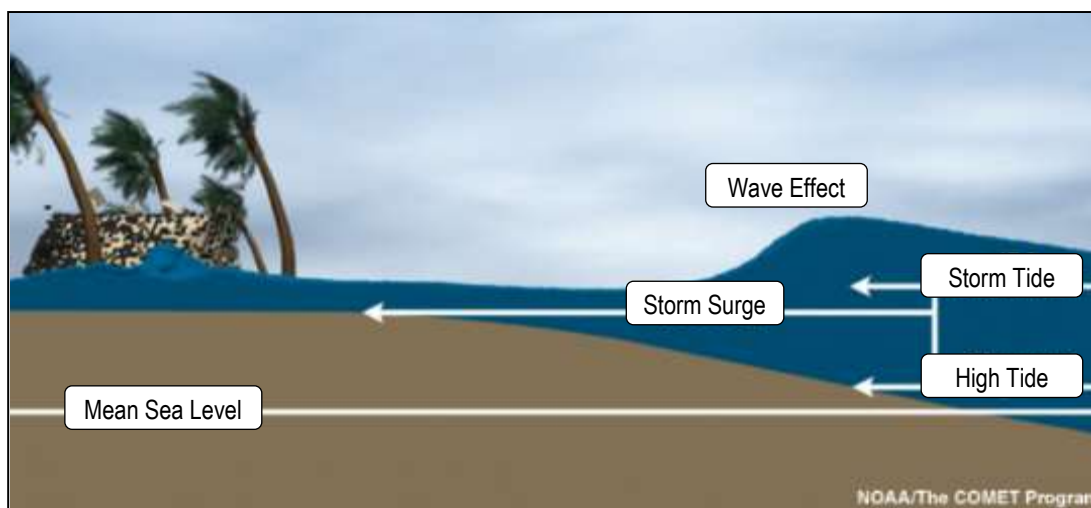
Waves, with a period of about 10 to 15 seconds are also generated by the storms and ride on the storm tides on landfall. Unlike the organized and long-crested waves induced by prevailing winds in deep water, these storm-induced waves are generally scattered in various directions from the storm's center. The highest level of the sea surface inclusive of these higher-frequency storm-induced waves is the maximum elevation of the water surface at landfall.

Wind Storm Surge is the component of storm surge that is induced by wind gusts acting on the surface of the sea, imparting shear stresses that raise the water as it tracks toward land boundaries. The area within the radius of maximum wind speed and the immediate outside vicinity of this radius experience the highest wind storm surge. Pressure Surge is the phenomena wherein the low-pressure zone in the middle of a tropical cyclone induces a suction action of the water below. As the cyclone moves generally westward towards land, the water surface is uplifted particularly in near the coasts where water is shallow. This pressure storm surge is highest near the storm's center

It should be noted, however, that the typhoon tracks shown in Figures 2.2-38, may not necessarily cause the most critical storm tide at the project site, as wind speed alone is not the only factor.

The relative track of the typhoon (north or south), closest distance to the site, and astronomic tides all factor in to determining the historical tide level specifically at the site. For example (Figure 2.2-74), a typhoon can cause a storm surge of 1 m, which would ride on top of the astronomic tide; in the case of the figure the storm surge and high tide coincide in time, causing a net higher storm tide level (STL). If, on the other hand, the storm surge occurs at a low tide (below Mean Sea Level), the overall net storm tide can be smaller. Considering the tidal range of the project site is 1 m, the timing of the astronomic tides plays a large role in determining the overall storm tide; thus, a detailed numerical model was used to determine how these factors affect each other.





Source: NOAA

**Figure 2.2-74. Illustration of the Combined Effects of Astronomic Tide and Storm Surge**

### Synthesis of Storm Tide Levels

From the list of typhoons in Table 2.2-19, further analyses resulted in the narrowing down to three (3) potentially critical typhoons as shown in Table 2.2-24. The following figures (Figures 2.2-75 to 2.2-77) show the maximum storm tide elevation (i.e. astronomic tide plus storm surge) for pre and post-development conditions for all three typhoons.

**Table 2.2-24. Simulated typhoons at the project site**

| <b>Typhoon</b>              | <b>Year</b> | <b>Vmax<br/>(kph)</b> | <b>Rmax<br/>(km)</b> | <b>Pc<br/>(hPa)</b> | <b>Relative Track to<br/>the Site</b> |
|-----------------------------|-------------|-----------------------|----------------------|---------------------|---------------------------------------|
| Rita ( <i>Kading</i> )      | 1978        | 203                   | 14                   | 905                 | N                                     |
| Patsy ( <i>Yoling</i> )     | 1970        | 192                   | 17                   | 920                 | N                                     |
| Xangsane ( <i>Milenyo</i> ) | 2006        | 101                   | 27                   | 980                 | S                                     |

For the pre-development scenario (Figure 2.2-75) Typhoon Rita caused a storm tide level of roughly 1.0 m – 1.1 m at Islands B-E, with the higher storm tides manifesting closer to the shore. Island A, on the other hand, results in storm tide levels of roughly 0.6 m – 0.8 m, with the lower storm tide situated within Bacoar Bay. This range did not increase significantly for the post-development scenario (Figure 2.2-75), except for the channel between Island E and the existing coastline, wherein the storm tide rose from roughly 1.1 m to roughly 1.2 m. The resulting storm tide in Bacoar Bay, on the other hand, has been significantly reduced, mostly due to the blocking effect of the proposed reclamation on the storm tide. Little to no changes to the storm tide levels are noted further away from the project site.

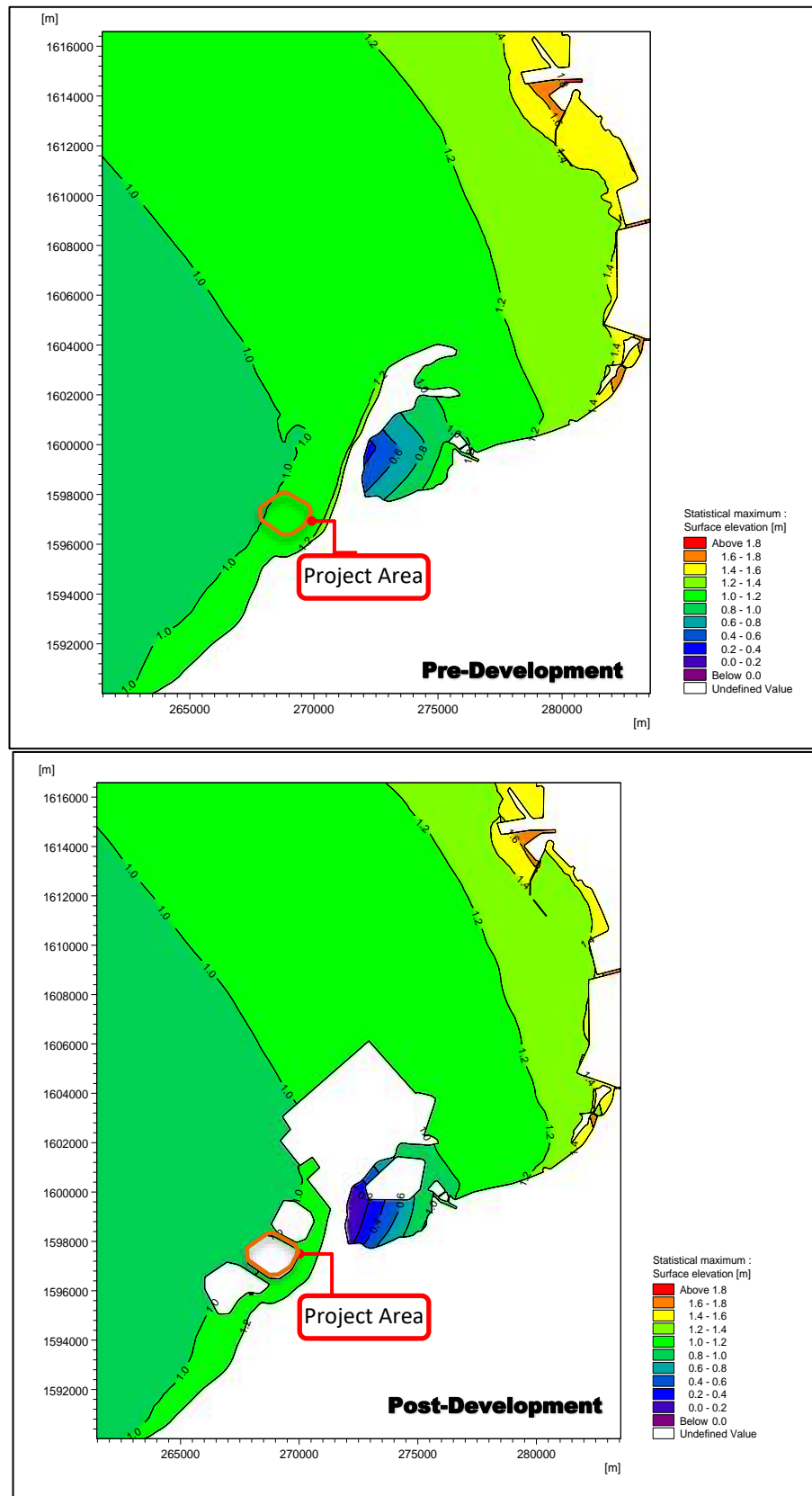


Figure 2.2-75. Simulated Storm Tide Level for Typh. Rita/Kading (1978)  
Pre & Post Devt.



For the pre-development scenario, the storm tide levels generated by Typhoon Patsy (Figure 2.2-76) average at roughly 0.8 m – 0.9 m for all the islands. Similar to Typhoon Rita, the higher storm tide levels manifest closer to the shore, even within Bacoor Bay, which reaches roughly 1.2 m. The post-development scenario, on the other hand, shows a slight increase in the storm tide level (Figure 2.2-76) at the eastern portion of the proposed Sangley Point International Airport (SPIA) and Island A. As another development was included in the simulations, it is difficult to determine if this increase can be attributed to a single project.

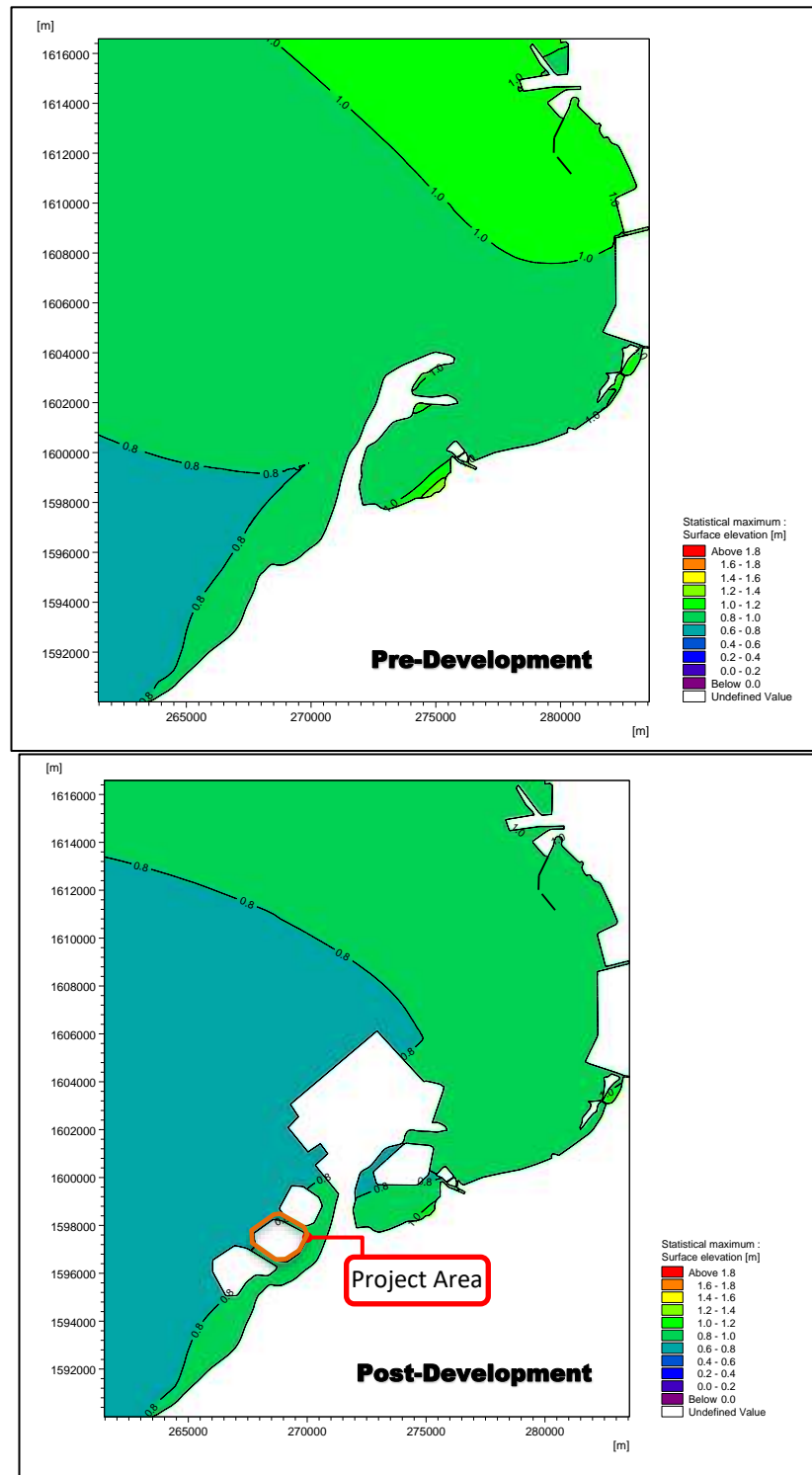


Figure 2.2-76. Simulated Storm Tide Level for Typh. Patsy/Yoling (1970) Pre & Post-Dev.





The storm tide for the pre-development scenario caused by Typhoon Xangsane (Figure 2.2-77) is significantly lower than the previous two typhoons, with the storm tide level averaging 0.8 m for all islands. Within Bacoar Bay, however, the storm tide can be seen to increase to nearly 1.4 m. For the post-development scenario, there is nearly no change in the observed simulated storm tide level, with the average still at roughly 0.8 m. The storm tide within Bacoar Bay, however, was noted to have been lowered to 1.2 m.

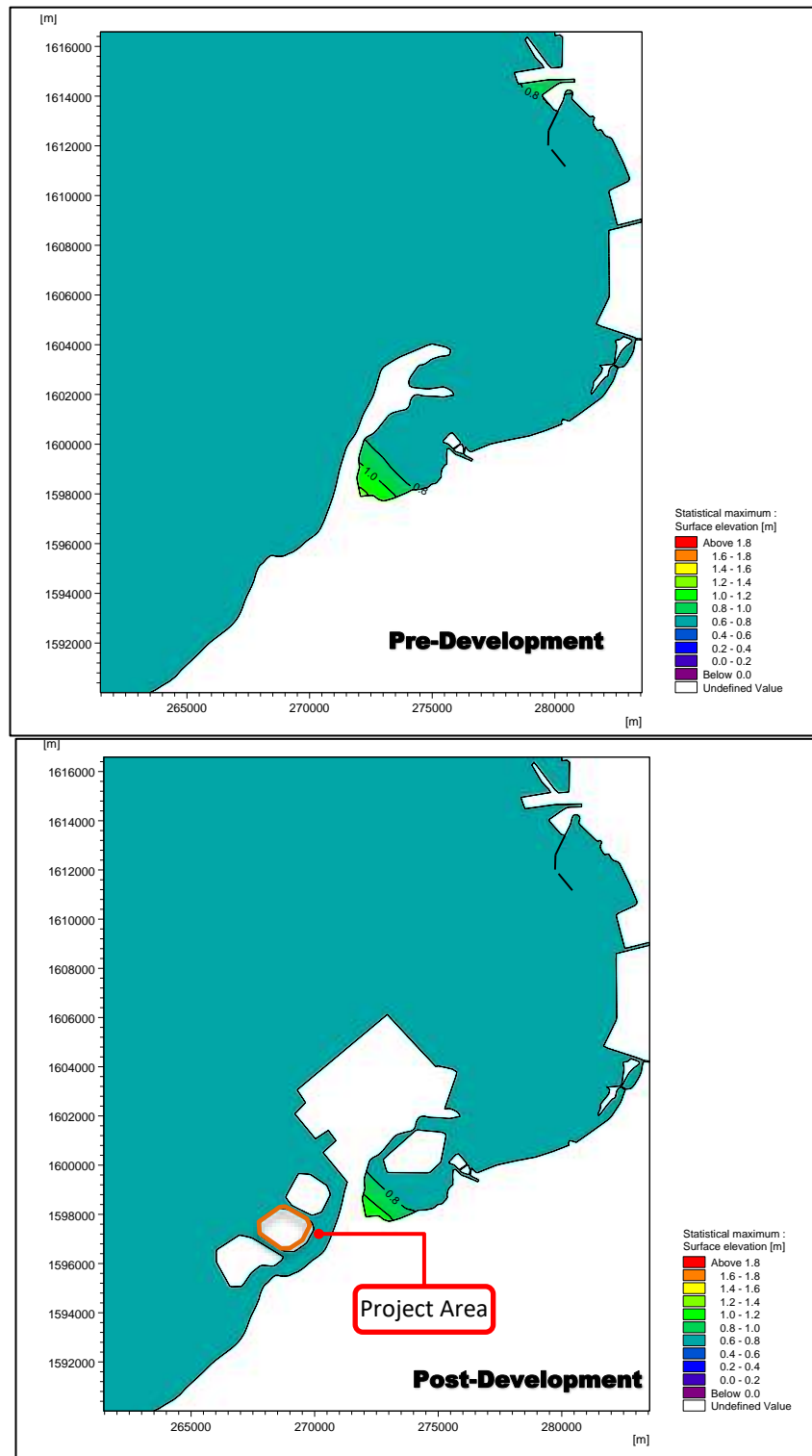


Figure 2.2-77. Simulated Storm Tide Level for Typh. Xangsane/Milenyo (2006) – Pre & Post-Dev.  
Synthesis of Storm Waves



The surface waves induced by the passage of typhoons are also numerically simulated using the spectral-wave module of the hydrodynamic model, with the results shown in (Figures 2.2-78 to 2.2-80). This module solves the wave action equation that governs the propagation of the spectral components of storm waves, from which various statistics of wave heights and periods, such as the significant wave and maximum wave, are derived. The forces induced by these extreme wave heights should be considered in the detailed design stage.

For all three typhoons, it can be seen that the proposed reclamation islands in the post-development scenarios will provide a sheltering effect on all shorelines leeward of the reclamations, with the most significant effect caused by SPIA, primarily due to the fact its single island is significantly larger than islands A-E.

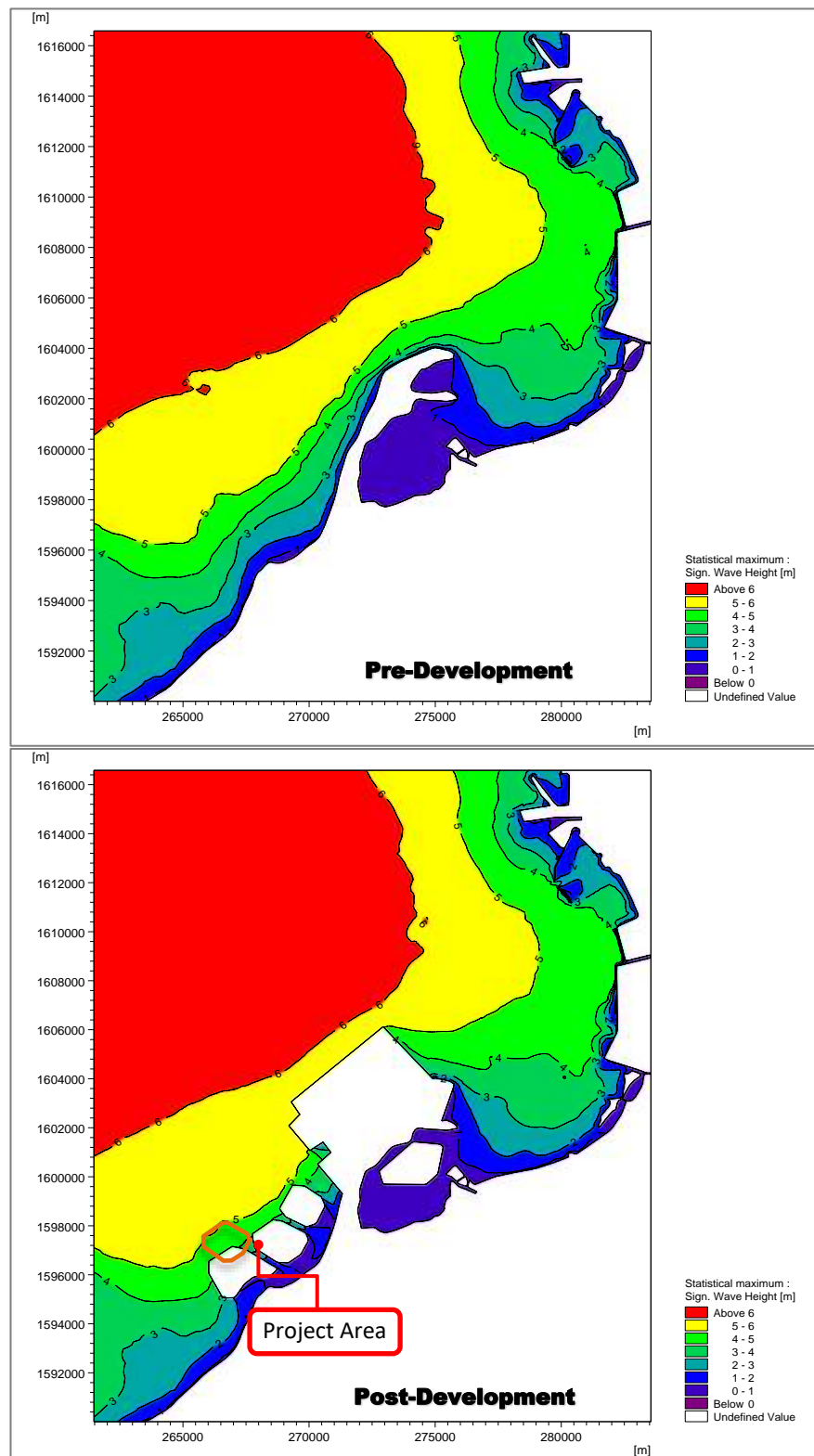


Figure 2.2-78. Simulated Maximum Significant Wave Heights for Typh. Rita/Kading (1978) Pre & Post Devt.



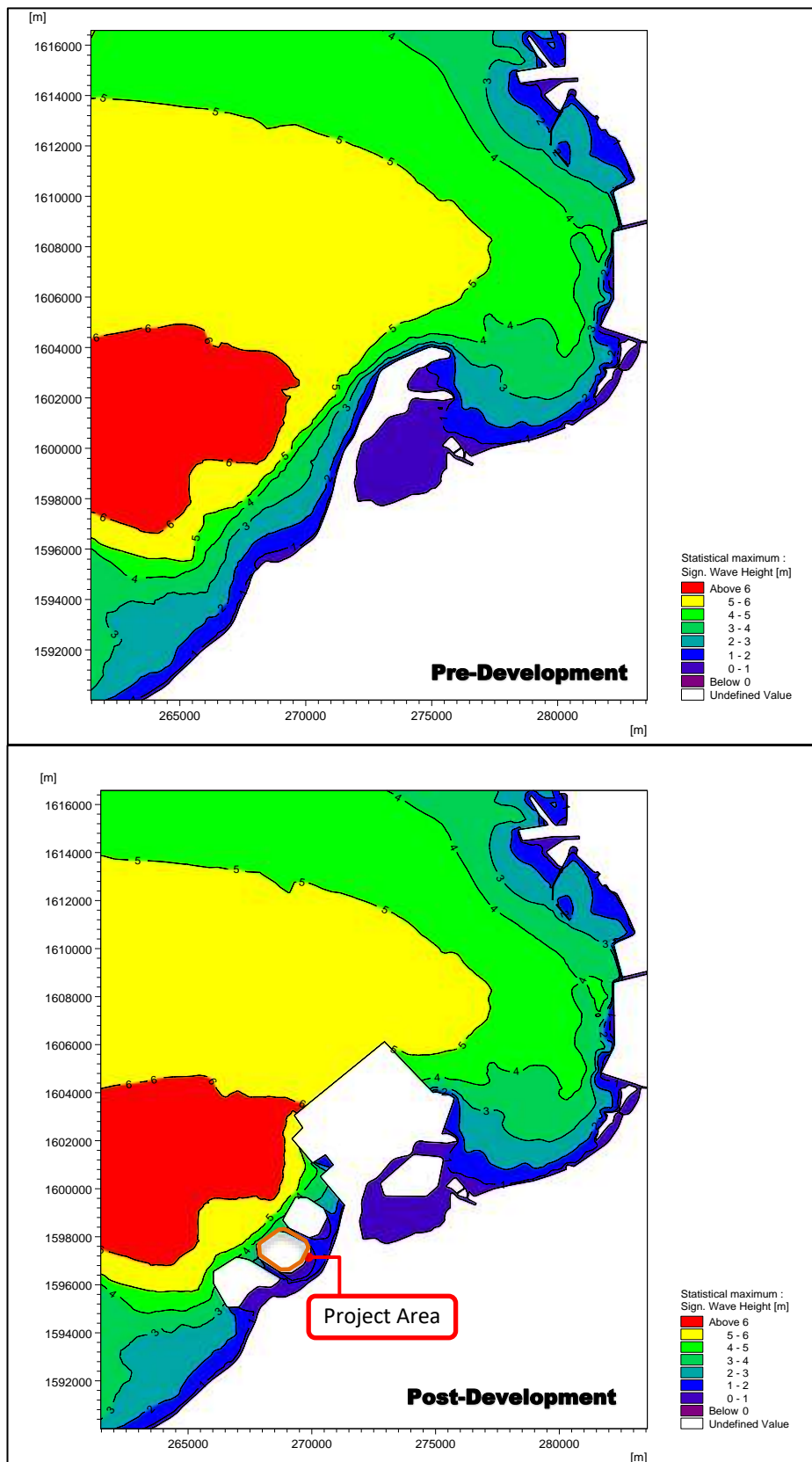


Figure 2.2-79. Simulated Maximum Significant Wave Heights for Typh. Patsy/Yoling (1970) Pre & Post Devt.

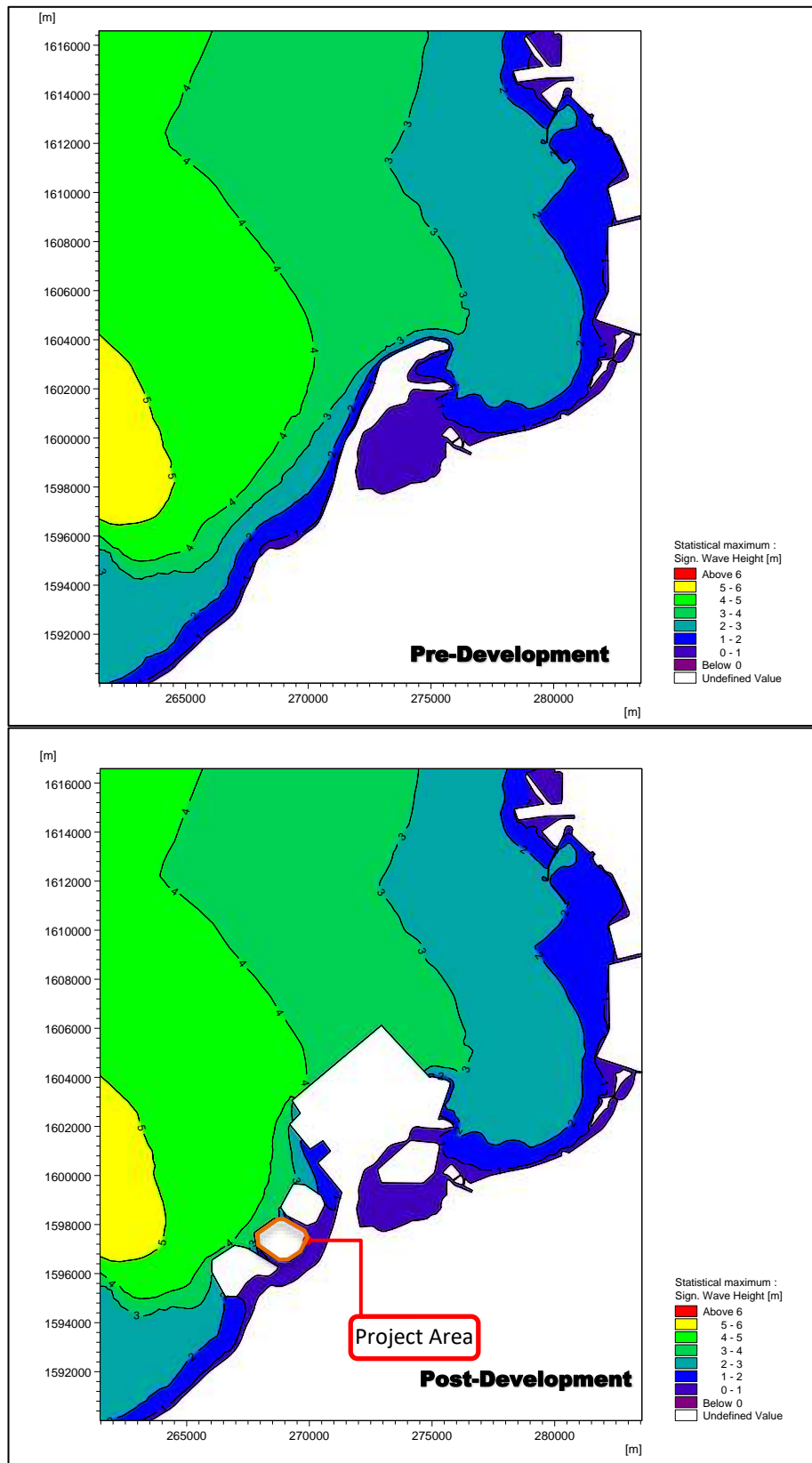


Figure 2.2-80. Simulated Maximum Significant Wave Heights for Typh. Xangsane/Milenyo (2006)  
Pre- & Post-Dev.



### 2.2.2.1.10 Computation of Non-Overtopping Crest Elevation

Different structures, such as revetments or sea walls, are built to protect coastal areas from flooding or inundation due to high water levels. To ensure water does not inundate into the protected area, the crest of the structure should be sufficiently higher than the highest water level. This height of the structure is known as the non-overtopping crest elevation (NOCE). The NOCE is obtained by adding two components: (1) the still water level (SWL), or the mean water level associated with astronomical tides and storm surges, and (2) the wave runup, which occurs when the wave impinges and breaks on a sloping structure causing water to rise along the slope.

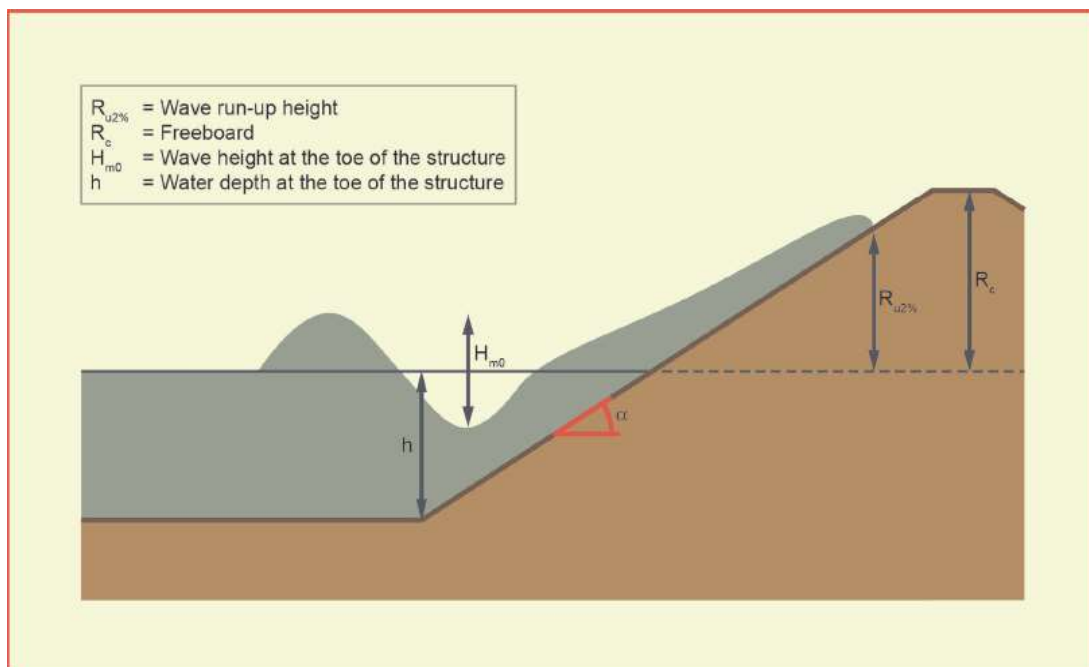
Wave runup is a complex phenomenon which considers the local water level, the characteristics of the incident wave, and the structure being run up. The computation of the runup is largely empirical; it is based on various laboratory measurements that relates runup to the breaking wave surf similarity parameter  $\xi$  to reduce the number of variables. The wave runup for impermeable and permeable slopes are computed as shown below (Delft Hydraulics 1989):

For impermeable slopes:

$$\frac{R_u}{H_s} = \begin{cases} A\xi_{om}, & 1 < \xi_{om} \leq 1.5 \\ B(\xi_{om})^c, & \xi_{om} > 1.5 \end{cases} \quad (1)$$

For permeable slopes:

$$\frac{R_u}{H_s} = \begin{cases} A\xi_{om}, & 1 < \xi_{om} \leq 1.5 \\ B(\xi_{om})^c, & 1.5 < \xi_{om} \leq (D/B)^{1/c} \\ D, & (D/B)^{1/c} < \xi_{om} \leq 7.5 \end{cases} \quad (2)$$



Source: EurOtop 2016

**Figure 2.2-81. Wave Runup on a Smooth Impermeable Slope**

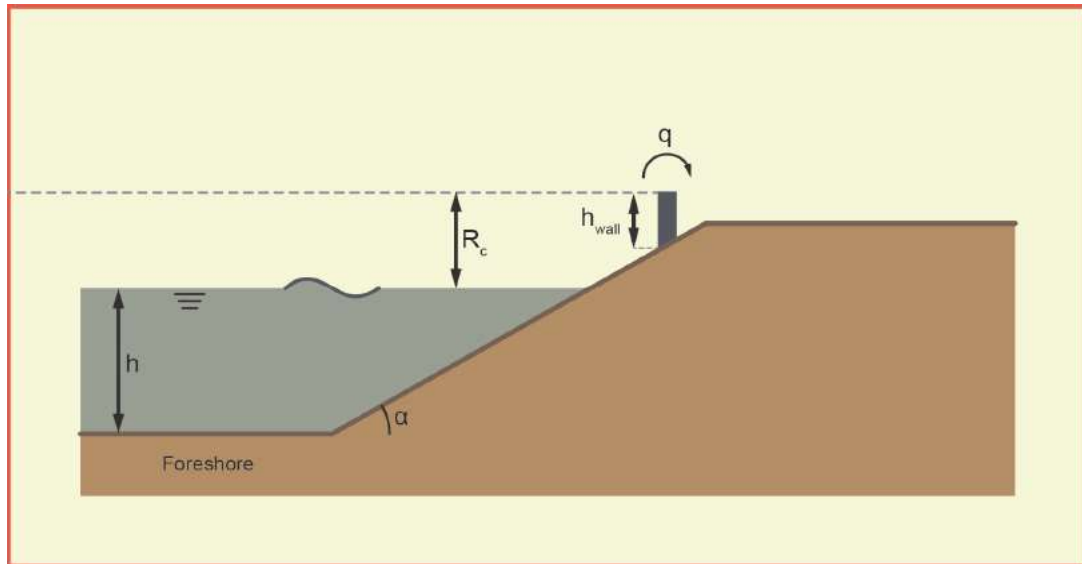
Due to economical, spatial, and other practical considerations, structures are typically built lower than the NOCE, resulting to the highest runup levels exceeding the provided crest freeboard, and water flowing over





the structure or wave overtopping. Overtopping discharge rates for different crest elevations should be used as a design parameter to check if the overtopping values are within allowable limits (EurOtop Manual, 2007).

Overtopping discharge caused by wind-generated waves during a storm is unevenly distributed in time and space, and thus information regarding overtopping discharge is given as the time averaged overtopping discharge in terms of m<sup>3</sup>/s per linear meter of the structure. Methods in obtaining the overtopping discharge are highly empirical and are based from hydraulic model test results for specific structure geometries (CEM, 2006). In general, the overtopping discharge is a function of the wave characteristics as well as the structure geometry.



Source: EurOtop 2016

**Figure 2.2-82. Overtopping Discharge of a Slope with Storm Wall**

For the case of the reclamation, the EurOtop (2007) model was implemented for the computation of the overtopping discharge, which is the most flexible of all the models for it is not restrained to a specific structural geometry. The overtopping discharge,  $q$ , is a function of the geometry of the structure, wave and tide characteristics, and a series of reduction factors. It is modeled by the equation below:

$$(3) \quad \frac{q}{\sqrt{g \cdot H_{mo}^3}} = \frac{0.026}{\sqrt{\tan \alpha}} \gamma_b \cdot \xi_{m-1,0} \cdot \exp \left[ - \left( 2.5 \frac{R_c}{\xi_{m-1,0} \cdot H_{mo} \cdot \gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \gamma_v} \right)^{1.3} \right]$$

with a maximum of:

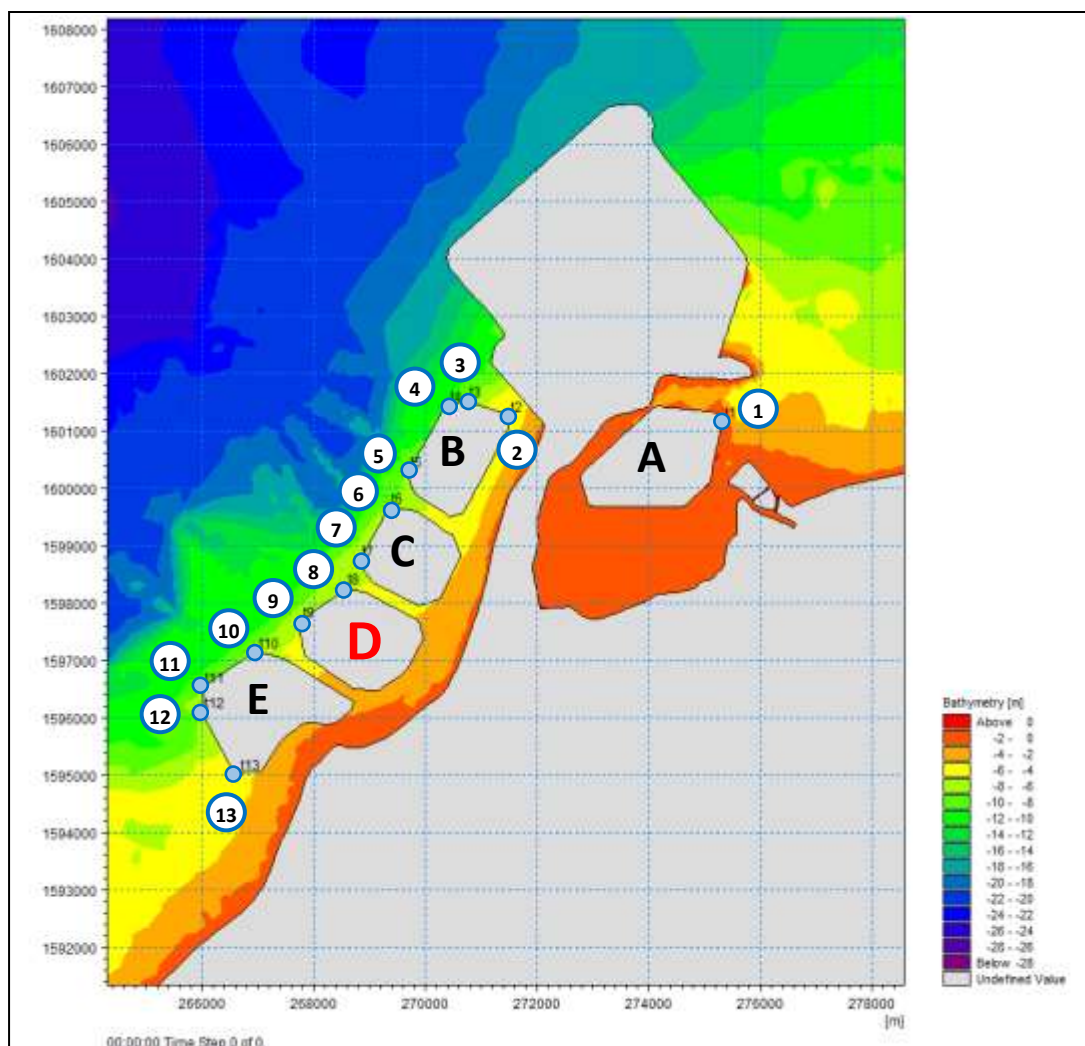
$$(4) \quad \frac{q}{\sqrt{g \cdot H_{mo}^3}} = \frac{0.1035}{\sqrt{\tan \alpha}} \cdot \exp \left[ - \left( 1.35 \frac{R_c}{H_{mo} \cdot \gamma_f \cdot \gamma_\beta \cdot \gamma^*} \right)^{1.3} \right]$$

### Analysis and Results

The methodology used for the calculation of the wave runup is based from Delft Hydraulics as presented in the Coastal Engineering Manual (2006), which requires wave characteristics and structural geometry. From the storm condition analysis, two scenarios are considered in determining the NOCE: the first case is when the SWL is at maximum and the corresponding wave characteristics are taken, and the second case is when the wave height is at maximum and the corresponding SWL and other wave characteristics are used for computation. The higher computed NOCE is considered to be the critical value and is used for the



determination of the overtopping discharge. For this project, thirteen (13) points near the project boundary are taken as points of extraction for the computation of non-overtopping crest elevation, as shown in Figure 2.2-83. The computed non-overtopping crest elevations during maximum tide and maximum wave conditions are presented in the following tables.



**Figure 2.2-83. Location of Extraction Points**

**Table 2.2-25. Non-overtopping Crest Elevation Results During Maximum Tide Conditions**

| Typhoon | Point | Depth (m) | Time             | Tide <sub>max</sub> (m) | Corresponding |            | NOCE Result (m) |
|---------|-------|-----------|------------------|-------------------------|---------------|------------|-----------------|
|         |       |           |                  |                         | Wave (m)      | Period (s) |                 |
| Rita    | Pt. 1 | 1.10      | 10/26/1978 19:00 | 1.02                    | 1.00          | 2.22       | 2.21            |
|         | Pt. 2 | 4.71      | 10/26/1978 18:50 | 1.11                    | 3.00          | 7.39       | 5.96            |
|         | Pt. 3 | 8.63      | 10/26/1978 18:50 | 1.03                    | 4.28          | 7.05       | 7.29            |
|         | Pt. 4 | 10.26     | 10/26/1978 18:50 | 1.02                    | 4.54          | 6.84       | 7.50            |
|         | Pt. 5 | 7.82      | 10/26/1978 19:00 | 1.01                    | 4.26          | 6.77       | 7.14            |
|         | Pt. 6 | 7.63      | 10/26/1978 18:50 | 1.01                    | 4.05          | 6.52       | 6.80            |
|         | Pt. 7 | 6.76      | 10/26/1978 18:50 | 1.01                    | 3.90          | 6.83       | 6.76            |
|         | Pt. 8 | 6.42      | 10/26/1978 18:50 | 1.01                    | 3.56          | 6.81       | 6.36            |



| Typhoon  | Point  | Depth (m) | Time             | Tide <sub>max</sub> (m) | Corresponding |            | NOCE Result (m) |
|----------|--------|-----------|------------------|-------------------------|---------------|------------|-----------------|
|          |        |           |                  |                         | Wave (m)      | Period (s) |                 |
|          | Pt. 9  | 6.55      | 10/26/1978 18:50 | 0.99                    | 3.47          | 6.53       | 6.13            |
|          | Pt. 10 | 7.19      | 10/26/1978 19:00 | 0.96                    | 3.63          | 6.29       | 6.21            |
|          | Pt. 11 | 8.08      | 10/26/1978 19:00 | 0.95                    | 3.88          | 6.15       | 6.42            |
|          | Pt. 12 | 8.34      | 10/26/1978 19:00 | 0.96                    | 3.58          | 5.99       | 6.03            |
|          | Pt. 13 | 4.72      | 10/26/1978 18:50 | 1.02                    | 2.60          | 5.50       | 4.83            |
| Patsy    | Pt. 1  | 1.10      | 11/19/1970 6:40  | 0.93                    | 0.47          | 1.98       | 1.57            |
|          | Pt. 2  | 4.71      | 11/19/1970 6:24  | 0.81                    | 1.39          | 4.08       | 2.86            |
|          | Pt. 3  | 8.63      | 11/19/1970 6:24  | 0.83                    | 1.75          | 3.61       | 3.16            |
|          | Pt. 4  | 10.26     | 11/19/1970 6:24  | 0.83                    | 1.85          | 3.59       | 3.25            |
|          | Pt. 5  | 7.82      | 11/19/1970 6:40  | 0.81                    | 1.40          | 4.32       | 2.93            |
|          | Pt. 6  | 7.63      | 11/19/1970 6:40  | 0.80                    | 1.27          | 4.91       | 2.87            |
|          | Pt. 7  | 6.76      | 11/18/1970 17:04 | 0.80                    | 0.69          | 2.62       | 1.78            |
|          | Pt. 8  | 6.42      | 11/18/1970 17:04 | 0.80                    | 0.69          | 2.62       | 1.78            |
|          | Pt. 9  | 6.55      | 11/18/1970 17:04 | 0.80                    | 0.69          | 2.63       | 1.78            |
|          | Pt. 10 | 7.19      | 11/18/1970 17:04 | 0.80                    | 0.69          | 2.63       | 1.78            |
|          | Pt. 11 | 8.08      | 11/18/1970 17:04 | 0.80                    | 0.70          | 2.64       | 1.78            |
|          | Pt. 12 | 8.34      | 11/18/1970 17:04 | 0.80                    | 0.70          | 2.64       | 1.78            |
|          | Pt. 13 | 4.72      | 11/18/1970 17:04 | 0.80                    | 0.67          | 2.62       | 1.76            |
| Xangsane | Pt. 1  | 1.10      | 9/29/2006 18:00  | 0.68                    | 0.04          | 5.00       | 0.75            |
|          | Pt. 2  | 4.71      | 9/29/2006 18:00  | 0.68                    | 0.24          | 5.95       | 1.08            |
|          | Pt. 3  | 8.63      | 9/29/2006 18:00  | 0.68                    | 0.24          | 5.70       | 1.09            |
|          | Pt. 4  | 10.26     | 9/29/2006 18:00  | 0.68                    | 0.25          | 5.67       | 1.10            |
|          | Pt. 5  | 7.82      | 9/29/2006 17:44  | 0.68                    | 0.26          | 5.75       | 1.11            |
|          | Pt. 6  | 7.63      | 9/29/2006 17:44  | 0.68                    | 0.27          | 5.73       | 1.12            |
|          | Pt. 7  | 6.76      | 9/29/2006 17:44  | 0.68                    | 0.32          | 6.32       | 1.21            |
|          | Pt. 8  | 6.42      | 9/29/2006 17:44  | 0.68                    | 0.32          | 6.41       | 1.21            |
|          | Pt. 9  | 6.55      | 9/29/2006 17:44  | 0.68                    | 0.35          | 6.48       | 1.27            |
|          | Pt. 10 | 7.19      | 9/29/2006 17:44  | 0.68                    | 0.41          | 6.69       | 1.36            |
|          | Pt. 11 | 8.08      | 9/29/2006 17:44  | 0.67                    | 0.47          | 7.02       | 1.47            |
|          | Pt. 12 | 8.34      | 9/29/2006 17:44  | 0.67                    | 0.45          | 7.01       | 1.44            |
|          | Pt. 13 | 4.72      | 9/29/2006 17:44  | 0.67                    | 0.48          | 7.37       | 1.48            |

**Table 2.2-26. Non-overtopping Crest Elevation Results During Maximum Wave Conditions**

| Typhoon | Point | Depth (m) | Time             | Wave <sub>max</sub> (m) | Corresponding |          | NOCE Result (m) |
|---------|-------|-----------|------------------|-------------------------|---------------|----------|-----------------|
|         |       |           |                  |                         | Period (s)    | Tide (m) |                 |
| Rita    | Pt. 1 | 1.10      | 10/26/1978 18:00 | 1.02                    | 2.28          | 0.97     | 2.20            |
|         | Pt. 2 | 4.71      | 10/26/1978 17:10 | 3.01                    | 7.40          | 1.02     | 5.88            |
|         | Pt. 3 | 8.63      | 10/26/1978 16:40 | 4.63                    | 7.24          | 0.82     | 7.56            |
|         | Pt. 4 | 10.26     | 10/26/1978 15:50 | 4.94                    | 6.94          | 0.69     | 7.64            |
|         | Pt. 5 | 7.82      | 10/26/1978 18:00 | 4.52                    | 6.92          | 0.93     | 7.41            |
|         | Pt. 6 | 7.63      | 10/26/1978 18:00 | 4.27                    | 6.59          | 0.94     | 7.01            |
|         | Pt. 7 | 6.76      | 10/26/1978 17:30 | 4.06                    | 6.90          | 0.92     | 6.88            |





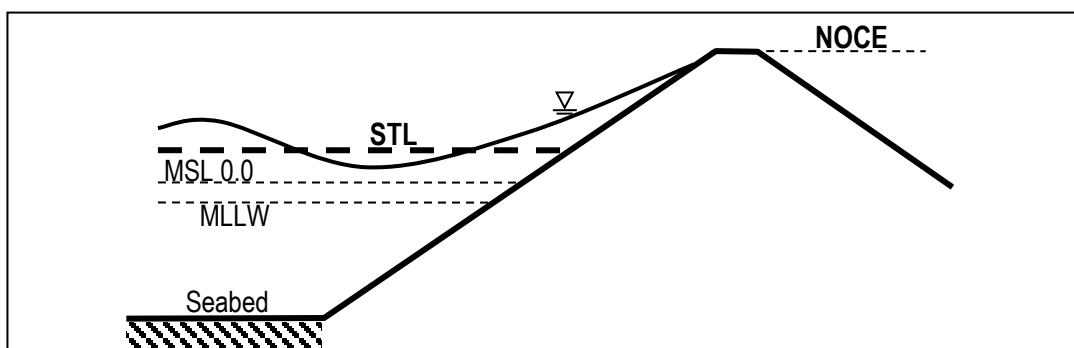
| Typhoon  | Point  | Depth (m) | Time             | Wave <sub>max</sub> (m) | Corresponding |          | NOCE Result (m) |
|----------|--------|-----------|------------------|-------------------------|---------------|----------|-----------------|
|          |        |           |                  |                         | Period (s)    | Tide (m) |                 |
|          | Pt. 8  | 6.42      | 10/26/1978 17:50 | 3.78                    | 6.95          | 0.94     | 6.59            |
|          | Pt. 9  | 6.55      | 10/26/1978 17:30 | 3.74                    | 6.89          | 0.89     | 6.48            |
|          | Pt. 10 | 7.19      | 10/26/1978 16:30 | 4.13                    | 6.91          | 0.75     | 6.80            |
|          | Pt. 11 | 8.08      | 10/26/1978 16:10 | 4.41                    | 6.87          | 0.69     | 7.04            |
|          | Pt. 12 | 8.34      | 10/26/1978 16:10 | 4.20                    | 6.94          | 0.72     | 6.84            |
|          | Pt. 13 | 4.72      | 10/26/1978 17:20 | 2.96                    | 6.19          | 0.94     | 5.38            |
| Patsy    | Pt. 1  | 1.10      | 11/19/1970 3:02  | 0.96                    | 2.63          | 0.30     | 1.58            |
|          | Pt. 2  | 4.71      | 11/19/1970 3:06  | 2.53                    | 7.47          | 0.21     | 4.46            |
|          | Pt. 3  | 8.63      | 11/19/1970 2:14  | 4.21                    | 6.98          | -0.18    | 5.98            |
|          | Pt. 4  | 10.26     | 11/19/1970 3:08  | 4.93                    | 7.00          | -0.01    | 6.96            |
|          | Pt. 5  | 7.82      | 11/19/1970 3:28  | 4.07                    | 7.27          | 0.02     | 6.13            |
|          | Pt. 6  | 7.63      | 11/19/1970 3:08  | 3.83                    | 7.07          | 0.08     | 5.83            |
|          | Pt. 7  | 6.76      | 11/19/1970 3:06  | 3.66                    | 6.96          | 0.12     | 5.63            |
|          | Pt. 8  | 6.42      | 11/19/1970 3:14  | 3.38                    | 7.26          | 0.22     | 5.50            |
|          | Pt. 9  | 6.55      | 11/19/1970 3:26  | 3.29                    | 7.68          | 0.21     | 5.52            |
|          | Pt. 10 | 7.19      | 11/19/1970 3:10  | 3.76                    | 7.37          | 0.09     | 5.87            |
|          | Pt. 11 | 8.08      | 11/19/1970 3:22  | 4.28                    | 7.21          | 0.15     | 6.48            |
|          | Pt. 12 | 8.34      | 11/19/1970 3:04  | 3.87                    | 7.10          | 0.10     | 5.92            |
|          | Pt. 13 | 4.72      | 11/19/1970 3:14  | 2.64                    | 7.84          | 0.38     | 4.82            |
| Xangsane | Pt. 1  | 1.10      | 9/28/2006 3:04   | 0.89                    | 3.35          | -0.11    | 1.22            |
|          | Pt. 2  | 4.71      | 9/28/2006 0:28   | 2.23                    | 5.66          | -0.38    | 3.04            |
|          | Pt. 3  | 8.63      | 9/28/2006 2:04   | 3.38                    | 5.39          | -0.43    | 4.20            |
|          | Pt. 4  | 10.26     | 9/28/2006 2:04   | 3.62                    | 5.34          | -0.43    | 4.44            |
|          | Pt. 5  | 7.82      | 9/28/2006 2:04   | 3.37                    | 5.71          | -0.41    | 4.34            |
|          | Pt. 6  | 7.63      | 9/28/2006 2:04   | 3.24                    | 5.78          | -0.39    | 4.23            |
|          | Pt. 7  | 6.76      | 9/28/2006 2:06   | 3.07                    | 5.79          | -0.37    | 4.06            |
|          | Pt. 8  | 6.42      | 9/28/2006 2:06   | 3.07                    | 6.00          | -0.35    | 4.15            |
|          | Pt. 9  | 6.55      | 9/28/2006 2:48   | 3.13                    | 6.14          | -0.29    | 4.33            |
|          | Pt. 10 | 7.19      | 9/28/2006 2:20   | 3.51                    | 6.31          | -0.33    | 4.78            |
|          | Pt. 11 | 8.08      | 9/28/2006 2:06   | 3.69                    | 6.11          | -0.34    | 4.90            |
|          | Pt. 12 | 8.34      | 9/28/2006 2:12   | 3.43                    | 6.25          | -0.32    | 4.68            |
|          | Pt. 13 | 4.72      | 9/28/2006 3:16   | 2.41                    | 7.05          | -0.17    | 3.84            |

**Table 2.2-27. Summary of Non-overlapping Crest Elevation Results**

| Typhoon | Point | NOCE Result (m)     |                     | Governing Case  |
|---------|-------|---------------------|---------------------|-----------------|
|         |       | Tide <sub>max</sub> | Wave <sub>max</sub> |                 |
| Rita    | Pt. 1 | 2.21                | 2.20                | Max Tide        |
|         | Pt. 2 | 5.96                | 5.88                | Max Tide        |
|         | Pt. 3 | 7.29                | 7.56                | Max Tide        |
|         | Pt. 4 | 7.50                | 7.64                | Max Wave Height |
|         | Pt. 5 | 7.14                | 7.41                | Max Wave Height |
|         | Pt. 6 | 6.80                | 7.01                | Max Wave Height |
|         | Pt. 7 | 6.76                | 6.88                | Max Wave Height |
|         | Pt. 8 | 6.36                | 6.59                | Max Wave Height |
|         | Pt. 9 | 6.13                | 6.48                | Max Wave Height |



| Typhoon  | Point  | NOCE Result (m)     |                     | Governing Case  |
|----------|--------|---------------------|---------------------|-----------------|
|          |        | Tide <sub>max</sub> | Wave <sub>max</sub> |                 |
|          | Pt. 10 | 6.21                | 6.80                | Max Wave Height |
|          | Pt. 11 | 6.42                | 7.04                | Max Wave Height |
|          | Pt. 12 | 6.03                | 6.84                | Max Wave Height |
|          | Pt. 13 | 4.83                | 5.38                | Max Wave Height |
| Patsy    | Pt. 1  | 1.57                | 1.58                | Max Wave Height |
|          | Pt. 2  | 2.86                | 4.46                | Max Wave Height |
|          | Pt. 3  | 3.16                | 5.98                | Max Wave Height |
|          | Pt. 4  | 3.25                | 6.96                | Max Wave Height |
|          | Pt. 5  | 2.93                | 6.13                | Max Wave Height |
|          | Pt. 6  | 2.87                | 5.83                | Max Wave Height |
|          | Pt. 7  | 1.78                | 5.63                | Max Wave Height |
|          | Pt. 8  | 1.78                | 5.50                | Max Wave Height |
|          | Pt. 9  | 1.78                | 5.52                | Max Wave Height |
|          | Pt. 10 | 1.78                | 5.87                | Max Wave Height |
|          | Pt. 11 | 1.78                | 6.48                | Max Wave Height |
|          | Pt. 12 | 1.78                | 5.92                | Max Wave Height |
|          | Pt. 13 | 1.76                | 4.82                | Max Wave Height |
| Xangsane | Pt. 1  | 0.75                | 1.22                | Max Wave Height |
|          | Pt. 2  | 1.08                | 3.04                | Max Wave Height |
|          | Pt. 3  | 1.09                | 4.20                | Max Wave Height |
|          | Pt. 4  | 1.10                | 4.44                | Max Wave Height |
|          | Pt. 5  | 1.11                | 4.34                | Max Wave Height |
|          | Pt. 6  | 1.12                | 4.23                | Max Wave Height |
|          | Pt. 7  | 1.21                | 4.06                | Max Wave Height |
|          | Pt. 8  | 1.21                | 4.15                | Max Wave Height |
|          | Pt. 9  | 1.27                | 4.33                | Max Wave Height |
|          | Pt. 10 | 1.36                | 4.78                | Max Wave Height |
|          | Pt. 11 | 1.47                | 4.90                | Max Wave Height |
|          | Pt. 12 | 1.44                | 4.68                | Max Wave Height |
|          | Pt. 13 | 1.48                | 3.84                | Max Wave Height |



**Figure 2.2-84. NOCE Illustration**

As shown in Table 2.2-28, highlighted cells denote the case that governed, i.e. the greater value obtained from the two cases considered. For a 1:2 embankment slope with rock armor, the critical NOCE obtained is 7.64 m based on Typhoon Rita and located on extraction point 4. On the other hand, Typhoon Patsy and Typhoon Xangsane resulted to lower maximum non-overtopping crest elevations of 6.96 meters and 4.44 meters, respectively. The resulting NOCE for all the extractions points on all the Cavite islands are summarized in the table below.

**Table 2.2-28. Synthesized NOCE of Island D.**

| Extraction Points | NOCE (maMSL) | Governing Condition |
|-------------------|--------------|---------------------|
| 8, 9              | 6.59         | Max Wave Height     |

Wave overtopping occurs when the structure crest elevation is lower than the wave runoff level. With computed NOCE of 6.59 to 7.64 m in Islands B to E, wave overtopping is acceptable because building the required crest elevation would entail massive construction costs and spatial requirements. For the computation of the overtopping discharge, the procedures from EurOtop Manual on Wave Overtopping of Sea Defenses and Related Structures are used. This is applicable for dikes and sea embankments with smooth or rough armored slopes. To further reduce the average overtopping discharge, the influence of the addition of a wall on top of the slope is included in the computation considerations, as shown in Figure 2.2-84. The following table summarizes the obtained overtopping discharge per meter length for various crest elevations. These values are based on critical case obtained from Typhoon Rita, in which the highest value of NOCE was obtained.

**Table 2.2-29. Overtopping Discharge Results**

| q (m <sup>3</sup> /s/m) |     | Reclamation Backfill Elevation (maMSL) |       |       |
|-------------------------|-----|--|-------|-------|
|                         |     | +4.0                                   | +4.5  | +5.0  |
| h <sub>wall</sub> (m)   | 1.0 | 0.028                                  | 0.015 | 0.008 |
|                         | 1.5 | 0.010                                  | 0.005 | 0.003 |

The computed overtopping discharge may be compared with the tolerable overtopping discharges from various field studies. This provides a rough guideline for the structural safety for a given value of the discharge. However, it must be noted that the intensity of water hitting a specific location is still dependent on the geometry and distance from the structure and thus maximum intensities locally may be over the obtained overtopping discharge.

In terms of design, the Coastal Engineering Manual (CEM) recommends a range of critical values of average overtopping discharges for various coastal structures considering structural safety and the safety of traffic Table 2.2-30. For example, for an embankment seawall, it expects damage to the structure if its crest is not protected if an overtopping discharge of 0.002 to 0.02 cms/m is experienced. Following CEM, Table 2.2-32 summarizes the expected damage condition and range of overtopping discharges q for embankment seawall





and building structures. For example, damage to an embankment seawall occurs if the back slope is not protected and the overtopping rate is between 0.02 – 0.005 cms/m. By using the lowest value  $q$  in this table together with various Reclamation Backfill Elevations (RBE) and the simulated wave conditions and storm tide levels in Table 2.2-30 corresponding to the critical NOCE condition, the required minimum elevation  $h_{min}$  of a vertical wall on top of the sloping embankment can be computed.

Table 2.2-30 summarizes the results of these computations based on Eq. (4) under the above conditions.

**Table 2.2-30. Critical values of average overtopping discharges**

**Table VI-5-6  
Critical Values of Average Overtopping Discharges**

| $q$<br>$m^3/s \text{ per } m$ |  | $q$<br>$litres/s \text{ per } m$                                   |                                    |                 |                                 |        |
|-------------------------------|--|--|------------------------------------|-----------------|---------------------------------|--------|
| SAFETY OF TRAFFIC             |  | STRUCTURAL SAFETY  |                                    |                 |                                 |        |
| VEHICLES                      | PEDESTRIANS  | BUILDINGS  | EMBANKMENT SEAWALLS                | GRASS SEA-DIKES | REVETMENTS                      |        |
| $10^0$                        |  |  |                                    |                 | Damage even for paved promenade | 1000   |
|                               |  |  | Damage even if fully protected     | Damage          | Damage if promenade not paved   | 200    |
| $10^{-1}$                     | Very dangerous                                     |  | Damage if back slope not protected |                 |                                 | 100    |
|                               |  | Structural damage  |                                    |                 |                                 | 50     |
| $10^{-2}$                     |  |  | Damage if crest not protected      |                 |                                 | 20     |
|                               |  |  |                                    | Start of damage |                                 | 10     |
| $10^{-3}$                     |  |  |                                    |                 |                                 | 2      |
|                               |  | Dangerous on grass sea dikes, and horizontal composite breakwaters |                                    |                 |                                 | 1      |
| $10^{-4}$                     | Unsafe parking on horizontal composite breakwaters |  |                                    |                 |                                 |        |
|                               | Dangerous on vertical wall breakwaters             |  |                                    |                 | No damage                       | 0.1    |
| $10^{-5}$                     | Unsafe parking on vertical wall breakwaters        |  |                                    |                 |                                 | 0.03   |
|                               | Unsafe driving at high speed                       | Minor damage to fittings, sign posts, etc.                         | No damage                          | No damage       |                                 | 0.02   |
| $10^{-6}$                     |  |  |                                    |                 |                                 | 0.01   |
|                               | Wet, but not uncomfortable                         |  |                                    |                 |                                 | 0.004  |
| $10^{-7}$                     | Safe driving at all speeds                         | No damage  |                                    |                 |                                 | 0.001  |
|                               |  |  |                                    |                 |                                 | 0.0001 |

Source: Coastal Engineering Manual

**Table 2.2-31. CEM Stipulated Overtopping Rates for Various Structures.**

| Structure          | Range of average $q$ (cms/m) | Damage Condition                           |
|--------------------|------------------------------|--|
| Embankment Seawall | 0.02 – 0.05                  | Damage if back slope not protected         |
|                    | 0.002 – 0.02                 | Damage if crest is not protected           |
| Buildings          | 0.000001 – 0.00002           | Minor damage to fittings, sign posts, etc. |

**Table 2.2-32. Synthesized NOCE of Island D**



| RBE<br>(maMSL) | Required Minimum Wall Height (m) |                 |                    |
|----------------|----------------------------------|-----------------|--------------------|
|                | $q=0.02$ cms/m                   | $q=0.002$ cms/m | $q=0.000001$ cms/m |
| 4.0            | 0.424                            | 1.235           | 3.497              |
| 4.5            | 0.108                            | 0.932           | 3.216              |
| 5.0            | Sufficient Backfill              | 0.623           | 2.930              |

#### 2.2.2.1.11 Tsunami Hazard

Coastal sites are exposed to hazards associated with extraordinary events in the oceans, such as tsunamis, especially for a seismically active and archipelagic country like the Philippines. Tsunamis are surface water waves generated by the displacements of the ocean floor and are characterized by a long wave period, or the time for two successive wave crests to pass a fixed location. Tsunami periods can be of the order of 5 minutes to 1 hour, depending on the nature, location, and characteristic magnitude of the generating source.

Compared with the usual sea waves, tsunamis have long wavelengths, typically of the order of several kilometers in the deep oceans, and a few kilometers in the coastal area. Such long wavelength is one cause of concern for the potential damage that can be brought onto the coastal area by a tsunami. Since tsunamis have low wave steepness (ratio of the wave height to the wavelength), they propagate to the shore largely without breaking.

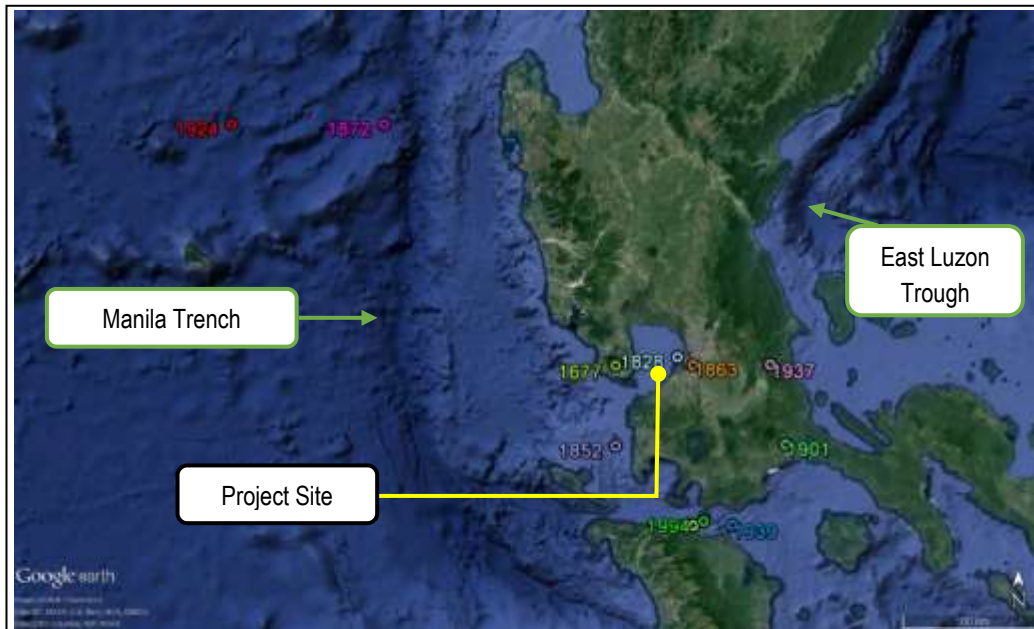
Wave breaking is a physical process that naturally dissipates much of the energy of incoming waves. Without breaking, tsunami energy can only be damped, usually insignificantly, by seabed friction. In addition, being long-period waves, tsunamis exert much higher dynamic pressures on solid surfaces they impinge, compared to the usual surface waves of the same height. These two prominent characteristics of tsunamis are the bases for the potentially catastrophic damage associated with their incursion into the coastal area.

#### Tsunami Susceptibility of the Project Area

The project site lies along a coastline that has been classified by PHIVOLCS as prone to trench related local tsunamis. The site's location in Manila Bay is proximate to the Valley Fault System, a known seismic generator which runs from Bulacan all the way to Laguna and is located about 20 km east of the project area. Moreover, the project site is about 190 kilometers away from Manila Trench, which has several earthquake-triggered tsunami occurrences associated with it and can generate a M8.3 earthquake. The site thus lies in a water body that is susceptible to tsunami events.

#### Historical Tsunami Data

The project site lies along the coastline of Manila Bay which is near sources of tsunamigenic earthquakes recorded by National Center of Environmental Information (NCEI) of the United States National Oceanic and Atmospheric Administration. A local search in the center's database returned 11 tsunami events near the project area as shown in Figure 2.2-86. A parallel search for tsunami-induced runup observations returned thirty-one (31) data as shown in Figure 2.2-85.



Source: NCEI-NOAA

**Figure 2.2-85. Nearby Historical Tsunamigenic Events**

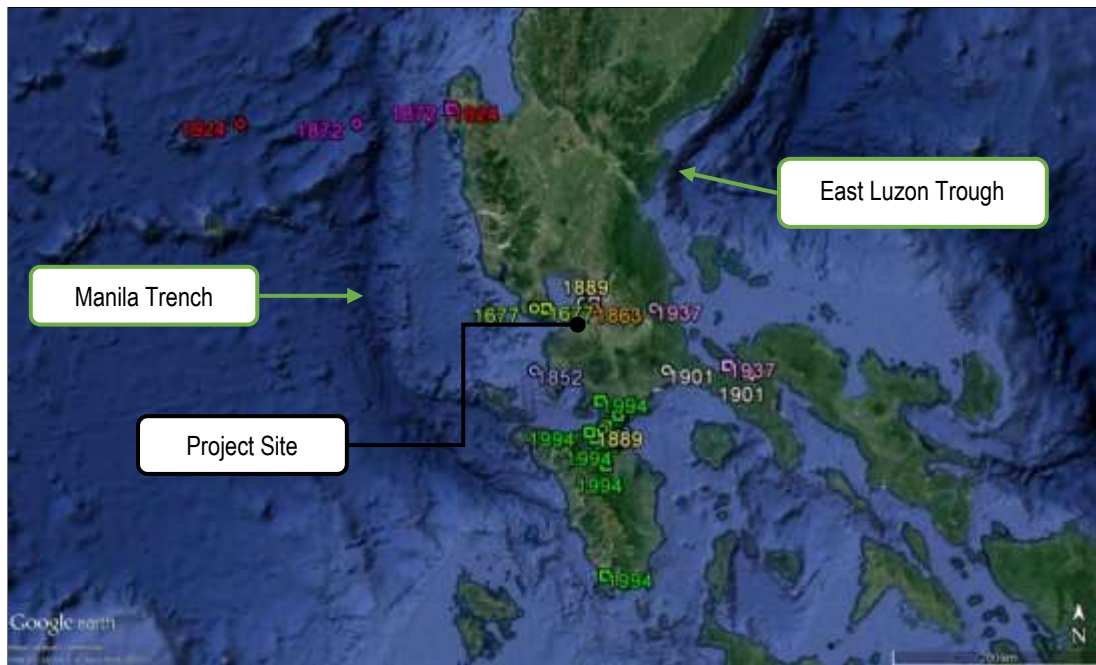
The six (6) potentially critical tsunamigenic events are summarized in Table 2.2-33. These events were attributed to seismic events that generated earthquake magnitudes of at least 6.0. Though these events are temporally far apart (with the earliest record dating as far back as 1677), there is no indication that the sources of the seismic activity have become inactive, as exemplified in the more recent 1994 event that triggered numerous tsunami runup observations in neighboring coastlines.

**Table 2.2-33. Historical Tsunamis**

| Year | EQ Magnitude | Focal Depth (m) | Tsunami Event      |          |           | Max Water Height | # of Runup Data |
|------|--------------|-----------------|--------------------|----------|-----------|------------------|-----------------|
|      |              |                 | Location           | Latitude | Longitude |                  |                 |
| 1828 | 7.5          | -               | W. Luzon Island    | 14.55    | 120.50    | -                | 1               |
| 1852 | 7.5          | -               | W. Luzon Island    | 14.00    | 120.50    | -                | 1               |
| 1872 | 6.0          | -               | W. Luzon Island    | 16.00    | 119.00    | -                | 1               |
| 1889 | 6.8          | -               | Mindoro Island     | 13.50    | 121.00    | -                | 1               |
| 1924 | 6.5          | 33              | W. Luzon Island    | 16.00    | 118.0     | -                | 1               |
| 1994 | 7.1          | 32              | Philippine Islands | 13.53    | 121.07    | 7.3              | 24              |

Source: NOAA-NCEI





Source: NCEI-NOAA

**Figure 2.2-86. Tsunami-induced Runup Observations**

For the same area of search, the NCEI database returned thirty-one (31) observations of tsunami runup heights, but almost all the runup data were associated with the 1994 tsunami event that resulted in numerous fatalities. The 1828 and 1852 tsunamis have higher magnitude compared to the 1994 tsunami, however, no runup values are recorded for the said events. Table 2.2-34 shows the runup locations and observed runup heights for the corresponding tsunamigenic events listed in Table 2.2-35. It should be noted that the runup elevation is based on various sources such as field survey, printed media, or published papers; some tsunami runup events thus may not have data.

**Table 2.2-34. Location of Runup Points**

| Year | Latitude | Longitude | Location                | Coastal Distance (m) | MTL Elevation (m) | Runup Elevation (m) |
|------|----------|-----------|-------------------------|----------------------|-------------------|---------------------|
| 1828 | 14.55    | 121.00    | Pasig River, Manila Bay | 2,047                | 10                | -                   |
| 1852 | 14.55    | 121.00    | Pasig River, Manila Bay | 2,047                | 10                | -                   |
| 1872 | 16.12    | 119.80    | Agno, Pangasinan        | 2,420                | 10                | -                   |
| 1889 | 14.60    | 10.98     | Manila                  | 2,346                | 17                | 0.1                 |
| 1924 | 16.12    | 119.80    | Agno, Pangasinan        | 2,420                |                   | -                   |
| 1994 | 13.75    | 121.04    | Batangas Port           | 160                  | 5                 | 1.25                |
|      | 13.41    | 121.12    | Baco                    | 90                   | 7                 | 1.46                |
|      | 13.63    | 121.22    | Lagadlarin              | 10                   | 3                 | 3.37                |
|      | 13.63    | 121.21    | Lagadlarin              | 100                  | 7                 | 3.63                |
|      | 13.41    | 121.12    | Baco                    | 100                  | 7                 | 3.57                |
|      | 13.23    | 121.09    | Verde Island            | 20,500               |                   | 2.81                |
|      | 13.41    | 121.14    | Pampisan                | 30                   | 7                 | 2.17                |
|      | 13.41    | 121.13    | Pampisan                | 100                  | 7                 | 2.99                |
|      | 13.55    | 121.09    | Verde Island            | 70                   | 41                | 3.55                |
|      | 13.47    | 121.16    | Baco Island             | 110                  | 30                | 6.14                |



| Year | Latitude | Longitude | Location    | Coastal Distance (m) | MTL Elevation (m) | Runup Elevation (m) |
|------|----------|-----------|-------------|----------------------|-------------------|---------------------|
|      | 13.41    | 121.05    | Wawa Island | 130                  | 51                | 3.51                |
|      | 13.41    | 121.05    | Wawa Island | 11                   | 16                | 3.82                |
|      | 13.43    | 121.19    | Calapan     | 15                   | 6                 | 2.74                |
|      | 13.44    | 121.02    | San Teodoro | 110                  | 8                 | 3.87                |
|      | 13.42    | 121.18    | Calapan     | 8                    | 5                 | 3.14                |
|      | 13.41    | 121.18    | Calapan     | 65                   | 5                 | 2.41                |
|      | 13.45    | 121.00    | Villafior   | 30                   | 8                 | 2.9                 |
|      | 13.41    | 121.14    | Wawa        | 15                   | 5                 | 2.07                |
|      | 13.41    | 121.14    | Wawa        | 10                   | 5                 | 2.59                |
|      | 13.40    | 121.14    | Wawa        | 1240                 | 10                | 3.23                |
|      | 13.41    | 121.14    | Baruyan     | 370                  | 4                 | 2.77                |
|      | 13.41    | 121.15    | Charico     | 5                    | 9                 | 1.97                |
|      | 13.41    | 121.16    | Charico     | 55                   | 6                 | 2.36                |
|      | 13.42    | 121.16    | Balete      | 65                   | 12                | 2.39                |
|      | 12.33    | 121.08    | San Jose    | 380                  | 4                 | 0.01                |
|      | 13.63    | 121.20    | Lobo        | 110                  | 6                 | 2.68                |

Source: NCEI-NOAA

### Tsunami Modelling

The above discussions on tsunamis is considered adequate for assessment purposes.

#### 2.2.2.1.12 Longshore Sediment Transport; Coastal Erosion and Deposition.

##### Particle dispersion modeling and map

##### Introduction

Knowledge of the movement and transport of **sediments (the terms “sediments” and “particles” are used interchangeably in these discussions)** along the project coasts is important in assessing the long-term stability of beach coastlines. In particular, the direction of the net transport of sediments is important in the planning of permanent coastal infrastructures, such as reclamations. Knowledge of longshore movement of littoral drift is also important in determining maintenance schedule and inspection of reclamation structures such as bulkheads, revetment and/or seawalls.

The region within which littoral drift is most actively entrained and transported is the surf zone, which spans from the wave breaking point to the swash zone in a beach coast. The main driver of littoral drift within the surf zone is the longshore currents generated by the wave breaking process. Currents from channel flow carrying surface runoff from inland usually cause additional influx of sediments and transport driving forces, but they are usually limited to a region around the outfall in the bay or sea.

The littoral zone is that swath of the coast where sediment materials are transported by waves and currents. The transported material, called littoral drift, affects the vertical profile and plan forms of the coast, causing deposition in certain reaches and erosion in others. The longshore volumetric transport rate  $Q$  is the rate (in units of volume/time) at which littoral drift is moved parallel to the shoreline. If one looks out to the sea from land, the longshore transport rate to the right is denoted by  $Q_+$ , considered positive, and the rate to the left by  $Q_-$  which is considered negative. The algebraic sum of  $Q_+$  and  $Q_-$ , or the net longshore transport rate  $Q_n$ , can



be positive or negative, and indicates the direction and magnitude of longshore transport. The total or gross transport rate  $Q_t$  is the sum of the magnitudes of the right and left transport rates.

The total transport rate is normally used to predict the rates of shoaling or accumulation of littoral drift in sea inlets that are not controlled, e.g. without engineered entrances. It also serves as an upper limit to the magnitudes of the other transport rates. The net transport rate is used in determining the occurrence of beach erosion along an open coast, and in the design of engineered or protected inlets. For the Cavite reclamation coast, the actual rates of both directional and total transport rates are affected by the sediment influx of the outfalls of different waterways in Cavite, which should be assessed and quantified in longshore sediment transport model to provide a more realistic and seasonal variation of sediment movement along the project coast.

The directional transport rates  $Q_+$  and  $Q_-$  are applied in the design of jetties (defined here as inlet stabilization structures, not as piers) and impoundment basins at the lee of weir jetties (USACE, 2005). As reference values, gross transport rates typically fall within 100 to 250 mcm/yr (million cubic meters per year) for open coasts in the United States (CERC, 1984).

### **Longshore Sediment Transport Rates along the Project Coast**

Following the methodology of CERC (1984), which is widely applied in U.S. beach coasts, an analysis of the longshore transport rates along the Cavite reclamation coast was undertaken and the results reported herein. The methodology requires input of the following data:

- Beach morphology based on the mean shoreline;
- Distributions of deepwater wave heights  $H_o$  with offshore approach directions; and
- Annual occurrence frequencies of  $H_o$ .

The methodology is based on the application of the wave energy flux in conjunction with shallow-water breaking criterion (also called breaker index) for the transformation of waves in the breaking zones. It is implicitly assumed in the methodology that the surf zone has a monotonic seabed profile such that breaking continues to the coastline once initiated.

For the project coast, since measured wave heights are not available, they were determined from the surface wind data and the effective wave fetches reckoned from the deepwater depth contour using fetch-limited and wind speed-limited hindcasting formulas (CERC, 1984).

Due to the long and complicated shoreline at the project coast, fifty-eight (58) stations of varying tributary lengths are considered in the analysis, as annotated in with the directions of the shore-normals. For ease of discussion, the stations will be subdivided into three groups: northern stations composed of Sta. 01 – Sta. 18, middle stations composed of Sta. 19 – Sta. 36, and the western stations composed of Sta. 37 – Sta. 58. The longshore sediment transport rates at these stations are computed under two conditions, the baseline and the modified condition, to assess the possible effects of the development to the transport of sediments.

For the baseline or existing condition, Table 2.2-35 summarizes the computed directional transport rates  $Q_+$  and  $Q_-$ , net longshore transport rate  $Q_n$ , and total longshore transport rate  $Q_t$ , all in units of tcm/yr (thousand cubic meters per year). It is seen that for the northern stations the  $Q_+$  values are generally moderate ranging from 5 to 27 tcm/yr, the  $Q_-$  values are generally lower ranging from 3 to 19 tcm/yr, resulting to a generally positive  $Q_n$  values of 1 to 19 tcm/yr, and  $Q_t$  in 9 to 41 tcm/yr. For the middle stations, the directional, net, and gross transport rates are generally low ranging from -2 to 5 tcm/yr. Furthermore, for the western stations  $Q_+$  values are generally high ranging from 8 to 62 tcm/yr,  $Q_-$  values are moderate ranging from 2 to 13 tcm/yr, resulting to high positive  $Q_n$  values of 2 to 50 tcm/yr, and an even higher  $Q_t$  of 11 to 74 tcm/yr. The high transport rates along western stations can be attributed to higher effective wave fetches than the stations located inside the Manila Bay and Bacoar Bay.





The computed net transport rates for the baseline condition are plotted graphically and approximately to scale at the stations. It is seen that the net transport rates for the northern stations are generally directed to the north with the direction changing at Sta. 17. For the middle stations, the net transport rates are low, and the direction greatly varies because of the complicated shoreline. However, for the western stations, the net transport rates are high, and all directed to the north and east.

Table 2.2-36 summarizes the annual transport rates under modified condition, which considers the future reclamations along the project coast. For stations located on future reclamations sites (Sta. 33 to Sta. 42), the transport rates were considered to be zero. It is seen that for the northern stations, Q+ rates decreased significantly, now ranging from 2 to 12 tcm/year, while the Q- rates only decreased slightly, now in 3 to 13 tcm/yr. This results to a reversal of net transport direction to some of the northern stations, where Qn rates are from -5 to 10 tcm/yr, and the total transport rates are from 7 to 24 tcm/yr. For the middle stations, the modified condition resulted to an even lower directional, net, and gross transport rates, all now ranging from -1 to 4 tcm/yr. The transport rates at stations located east of the Cavite reclamation sites, namely Sta. 43 to Sta. 49, have decreased greatly, now only ranging from -1 to 2 tcm/yr, while for the rest of the western stations, the Q+ rates are relatively unchanged while the Q- rates decreased resulting to higher Qn values ranging from 17 to 56 tcm/yr, although relatively similar Qt rates from the baseline condition graphically plot the transport rates at the 58 stations.

**Table 2.2-35. Annual longshore sediment transport rates – Baseline Condition**

| Shore-normal<br>(deg, from<br>N) | Station<br>ID | Tributary<br>length<br>m | Q+<br>(to right)<br>(1000m <sup>3</sup> / yr) | Q-<br>(to left)<br>(1000m <sup>3</sup> / yr) | Qn<br>(net)<br>(1000m <sup>3</sup> / yr) | Qt<br>(gross)<br>(1000m <sup>3</sup> / yr) |
|----------------------------------|---------------|--------------------------|---|--|--|--|
| 246                              | 1             | 1000                     | 19.09   | 15.68  | 3.41                                     | 34.78                                      |
| 246                              | 2             | 1000                     | 21.53   | 19.61  | 1.92                                     | 41.14                                      |
| 330                              | 3             | 1000                     | 10.52   | 0.48   | 10.04                                    | 11.00                                      |
| 255                              | 4             | 1000                     | 23.28   | 12.51  | 10.78                                    | 35.79                                      |
| 255                              | 5             | 1000                     | 19.46   | 12.90  | 6.57                                     | 32.36                                      |
| 269                              | 6             | 1000                     | 18.35   | 8.25   | 10.10                                    | 26.60                                      |
| 269                              | 7             | 1000                     | 27.48   | 8.87   | 18.61                                    | 36.35                                      |
| 269                              | 8             | 1000                     | 8.30  | 7.39   | 0.90                                     | 15.69                                      |
| 297                              | 9             | 875                      | 12.22   | 7.41   | 4.81                                     | 19.63                                      |
| 199                              | 10            | 875                      | 0.29  | 8.19   | -7.90                                    | 8.49                                       |
| 349                              | 11            | 875                      | 5.25  | 0.33   | 4.92                                     | 5.59                                       |
| 278                              | 12            | 750                      | 5.52  | 6.30   | -0.78                                    | 11.82                                      |
| 354                              | 13            | 750                      | 7.38  | 0.99   | 6.39                                     | 8.38                                       |
| 302                              | 14            | 1125                     | 8.80  | 7.80   | 1.00                                     | 16.61                                      |
| 325                              | 15            | 1200                     | 5.76  | 5.61   | 0.15                                     | 11.38                                      |
| 345                              | 16            | 1000                     | 5.65  | 3.39   | 2.26                                     | 9.04                                       |
| 339                              | 17            | 1050                     | 3.90  | 5.24   | -1.33                                    | 9.14                                       |
| 345                              | 18            | 1000                     | 4.38  | 4.69   | -0.32                                    | 9.07                                       |
| 346                              | 19            | 1125                     | 1.81  | 3.51   | -1.70                                    | 5.32                                       |
| 37                               | 20            | 1125                     | 3.50  | 0.89   | 2.61                                     | 4.39                                       |
| 47                               | 21            | 1250                     | 2.39  | 1.98   | 0.41                                     | 4.37                                       |
| 272                              | 22            | 1500                     | 0.78  | 0.37   | 0.42                                     | 1.15                                       |
| 342                              | 23            | 1375                     | 0.53  | 0.34   | 0.19                                     | 0.87                                       |
| 330                              | 24            | 1375                     | 0.39  | 1.24   | -0.85                                    | 1.63                                       |
| 31                               | 25            | 1500                     | 0.95  | 0.64   | 0.31                                     | 1.59                                       |
| 66                               | 26            | 1500                     | 0.48  | 1.80   | -1.33                                    | 2.28                                       |



| Shore-normal<br>(deg, from<br>N) | Station<br>ID | Tributary<br>length<br>m | Q+<br>(to right)<br>(1000m <sup>3</sup> / yr) | Q-<br>(to left)<br>(1000m <sup>3</sup> / yr) | Qn<br>(net)<br>(1000m <sup>3</sup> / yr) | Qt<br>(gross)<br>(1000m <sup>3</sup> / yr) |
|----------------------------------|---------------|--------------------------|---|--|--|--|
| 103                              | 27            | 1500                     | 0.96  | 1.14   | -0.19                                    | 2.10                                       |
| 139                              | 28            | 1250                     | 4.14  | 0.15   | 4.00                                     | 4.29                                       |
| 130                              | 29            | 1250                     | 3.30  | 0.58   | 2.72                                     | 3.88                                       |
| 92                               | 30            | 1500                     | 0.18  | 2.32   | -2.14                                    | 2.50                                       |
| 157                              | 31            | 1250                     | 1.56  | 0.91   | 0.65                                     | 2.47                                       |
| 237                              | 32            | 1000                     | 0.59  | 0.13   | 0.46                                     | 0.72                                       |
| 2                                | 33            | 1250                     | 0.22  | 0.92   | -0.70                                    | 1.14                                       |
| 127                              | 34            | 1500                     | 2.83  | 0.10   | 2.73                                     | 2.93                                       |
| 163                              | 35            | 1125                     | 4.01  | 0.28   | 3.73                                     | 4.29                                       |
| 108                              | 36            | 750                      | 2.35  | 1.97   | 0.37                                     | 4.32                                       |
| 2                                | 37            | 750                      | 8.32  | 2.36   | 5.96                                     | 10.68                                      |
| 338                              | 38            | 750                      | 8.91  | 7.03   | 1.88                                     | 15.94                                      |
| 338                              | 39            | 750                      | 16.39   | 7.35   | 9.04                                     | 23.74                                      |
| 336                              | 40            | 750                      | 17.83   | 7.95   | 9.87                                     | 25.78                                      |
| 285                              | 41            | 875                      | 47.20   | 9.56   | 37.64                                    | 56.76                                      |
| 304                              | 42            | 1000                     | 39.12   | 10.40  | 28.71                                    | 49.52                                      |
| 283                              | 43            | 1000                     | 47.77   | 9.55   | 38.22                                    | 57.32                                      |
| 304                              | 44            | 1000                     | 41.58   | 11.27  | 30.31                                    | 52.84                                      |
| 282                              | 45            | 1000                     | 47.29   | 9.67   | 37.62                                    | 56.96                                      |
| 287                              | 46            | 1000                     | 43.08   | 10.30  | 32.78                                    | 53.38                                      |
| 293                              | 47            | 1000                     | 51.92   | 11.04  | 40.88                                    | 62.96                                      |
| 317                              | 48            | 1000                     | 34.98   | 11.15  | 23.83                                    | 46.13                                      |
| 0                                | 49            | 1000                     | 9.09  | 2.70   | 6.39                                     | 11.78                                      |
| 313                              | 50            | 1000                     | 39.68   | 12.39  | 27.29                                    | 52.07                                      |
| 282                              | 51            | 1000                     | 42.00   | 10.07  | 31.93                                    | 52.07                                      |
| 295                              | 52            | 1000                     | 61.71   | 12.11  | 49.60                                    | 73.82                                      |
| 308                              | 53            | 1000                     | 59.29   | 12.18  | 47.11                                    | 71.48                                      |
| 329                              | 54            | 1000                     | 24.55   | 10.81  | 13.74                                    | 35.36                                      |
| 310                              | 55            | 1000                     | 47.24   | 13.00  | 34.25                                    | 60.24                                      |
| 314                              | 56            | 1000                     | 37.32   | 13.05  | 24.26                                    | 50.37                                      |
| 322                              | 57            | 1000                     | 29.71   | 12.61  | 17.09                                    | 42.32                                      |
| 348                              | 58            | 1000                     | 14.08   | 7.22   | 6.86                                     | 21.30                                      |

**Table 2.2-36. Annual longshore sediment transport rates – Modified Condition**

| Shore-normal<br>(deg, from<br>N) | Station<br>ID | Tributary<br>length<br>m | Q+<br>(to right)<br>(1000m <sup>3</sup> / yr) | Q-<br>(to left)<br>(1000m <sup>3</sup> / yr) | Qn<br>(net)<br>(1000m <sup>3</sup> / yr) | Qt<br>(gross)<br>(1000m <sup>3</sup> / yr) |
|----------------------------------|---------------|--------------------------|---|--|--|--|
| 246                              | 1             | 1000                     | 12.01   | 11.67  | 0.34                                     | 23.68                                      |
| 246                              | 2             | 1000                     | 10.44   | 12.95  | -2.52                                    | 23.39                                      |
| 330                              | 3             | 1000                     | 10.32   | 0.56   | 9.76                                     | 10.89                                      |
| 255                              | 4             | 1000                     | 7.41  | 8.95   | -1.54                                    | 16.37                                      |
| 255                              | 5             | 1000                     | 4.04  | 8.71   | -4.67                                    | 12.75                                      |
| 269                              | 6             | 1000                     | 7.70  | 6.92   | 0.79                                     | 14.62                                      |
| 269                              | 7             | 1000                     | 6.15  | 7.09   | -0.94                                    | 13.24                                      |



| Shore-normal<br>(deg, from<br>N) | Station<br>ID | Tributary<br>length<br>m | Q+<br>(to right)<br>(1000m <sup>3</sup> / yr) | Q-<br>(to left)<br>(1000m <sup>3</sup> / yr) | Qn<br>(net)<br>(1000m <sup>3</sup> / yr) | Qt<br>(gross)<br>(1000m <sup>3</sup> / yr) |
|----------------------------------|---------------|--------------------------|---|--|--|--|
| 269                              | 8             | 1000                     | 4.54  | 7.05   | -2.52                                    | 11.59                                      |
| 297                              | 9             | 875                      | 7.72  | 7.29   | 0.42                                     | 15.01                                      |
| 199                              | 10            | 875                      | 0.29  | 3.52   | -3.23                                    | 3.80                                       |
| 349                              | 11            | 875                      | 3.50  | 0.33   | 3.16                                     | 3.83                                       |
| 278                              | 12            | 750                      | 3.36  | 6.02   | -2.66                                    | 9.38                                       |
| 354                              | 13            | 750                      | 6.56  | 0.89   | 5.67                                     | 7.45                                       |
| 302                              | 14            | 1125                     | 5.04  | 7.62   | -2.57                                    | 12.66                                      |
| 325                              | 15            | 1200                     | 3.88  | 5.36   | -1.47                                    | 9.24                                       |
| 345                              | 16            | 1000                     | 3.73  | 3.27   | 0.45                                     | 7.00                                       |
| 339                              | 17            | 1050                     | 2.88  | 4.70   | -1.82                                    | 7.59                                       |
| 345                              | 18            | 1000                     | 2.65  | 3.88   | -1.23                                    | 6.54                                       |
| 346                              | 19            | 1125                     | 1.72  | 3.50   | -1.78                                    | 5.22                                       |
| 37                               | 20            | 1125                     | 3.50  | 0.89   | 2.61                                     | 4.39                                       |
| 47                               | 21            | 1250                     | 2.30  | 1.98   | 0.32                                     | 4.28                                       |
| 272                              | 22            | 1500                     | 0.68  | 0.13   | 0.55                                     | 0.81                                       |
| 342                              | 23            | 1375                     | 0.37  | 0.18   | 0.19                                     | 0.55                                       |
| 330                              | 24            | 1375                     | 0.36  | 0.61   | -0.26                                    | 0.97                                       |
| 31                               | 25            | 1500                     | 0.49  | 0.38   | 0.10                                     | 0.87                                       |
| 66                               | 26            | 1500                     | 0.23  | 1.44   | -1.21                                    | 1.68                                       |
| 103                              | 27            | 1500                     | 0.41  | 0.81   | -0.40                                    | 1.22                                       |
| 139                              | 28            | 1250                     | 0.95  | 0.12   | 0.83                                     | 1.07                                       |
| 130                              | 29            | 1250                     | 0.37  | 0.18   | 0.18                                     | 0.55                                       |
| 92                               | 30            | 1500                     | 0.13  | 0.94   | -0.81                                    | 1.06                                       |
| 157                              | 31            | 1250                     | 1.25  | 0.16   | 1.09                                     | 1.42                                       |
| 237                              | 32            | 1000                     | 0.27  | 0.05   | 0.22                                     | 0.31                                       |
| 2                                | 33            | 1250                     | 0.00  | 0.00   | 0.00                                     | 0.00                                       |
| 127                              | 34            | 1500                     | 0.00  | 0.00   | 0.00                                     | 0.00                                       |
| 163                              | 35            | 1125                     | 0.00  | 0.00   | 0.00                                     | 0.00                                       |
| 108                              | 36            | 750                      | 0.00  | 0.00   | 0.00                                     | 0.00                                       |
| 2                                | 37            | 750                      | 0.00  | 0.00   | 0.00                                     | 0.00                                       |
| 338                              | 38            | 750                      | 0.00  | 0.00   | 0.00                                     | 0.00                                       |
| 338                              | 39            | 750                      | 0.00  | 0.00   | 0.00                                     | 0.00                                       |
| 336                              | 40            | 750                      | 0.00  | 0.00   | 0.00                                     | 0.00                                       |
| 285                              | 41            | 875                      | 0.00  | 0.00   | 0.00                                     | 0.00                                       |
| 304                              | 42            | 1000                     | 0.00  | 0.00   | 0.00                                     | 0.00                                       |
| 283                              | 43            | 1000                     | 0.27  | 1.53   | -1.27                                    | 1.80                                       |
| 304                              | 44            | 1000                     | 0.17  | 0.16   | 0.01                                     | 0.32                                       |
| 282                              | 45            | 1000                     | 0.69  | 0.96   | -0.27                                    | 1.65                                       |
| 287                              | 46            | 1000                     | 0.39  | 0.15   | 0.24                                     | 0.53                                       |
| 293                              | 47            | 1000                     | 0.35  | 0.22   | 0.14                                     | 0.57                                       |
| 317                              | 48            | 1000                     | 0.26  | 0.28   | -0.02                                    | 0.54                                       |
| 0                                | 49            | 1000                     | 0.12  | 0.13   | -0.01                                    | 0.25                                       |
| 313                              | 50            | 1000                     | 10.77   | 0.08   | 10.68                                    | 10.85                                      |
| 282                              | 51            | 1000                     | 40.48   | 1.18   | 39.30                                    | 41.65                                      |
| 295                              | 52            | 1000                     | 61.65   | 5.95   | 55.70                                    | 67.60                                      |





| Shore-normal<br>(deg, from<br>N) | Station<br>ID | Tributary<br>length<br>m | Q+<br>(to right)<br>(1000m <sup>3</sup> / yr) | Q-<br>(to left)<br>(1000m <sup>3</sup> / yr) | Qn<br>(net)<br>(1000m <sup>3</sup> / yr) | Qt<br>(gross)<br>(1000m <sup>3</sup> / yr) |
|----------------------------------|---------------|--------------------------|---|--|--|--|
| 308                              | 53            | 1000                     | 59.28   | 8.06   | 51.22                                    | 67.34                                      |
| 329                              | 54            | 1000                     | 24.50   | 7.67   | 16.83                                    | 32.17                                      |
| 310                              | 55            | 1000                     | 39.74   | 11.41  | 28.33                                    | 51.15                                      |
| 314                              | 56            | 1000                     | 36.63   | 11.80  | 24.83                                    | 48.43                                      |
| 322                              | 57            | 1000                     | 28.48   | 11.57  | 16.91                                    | 40.05                                      |
| 348                              | 58            | 1000                     | 14.43   | 6.72   | 7.70                                     | 21.15                                      |

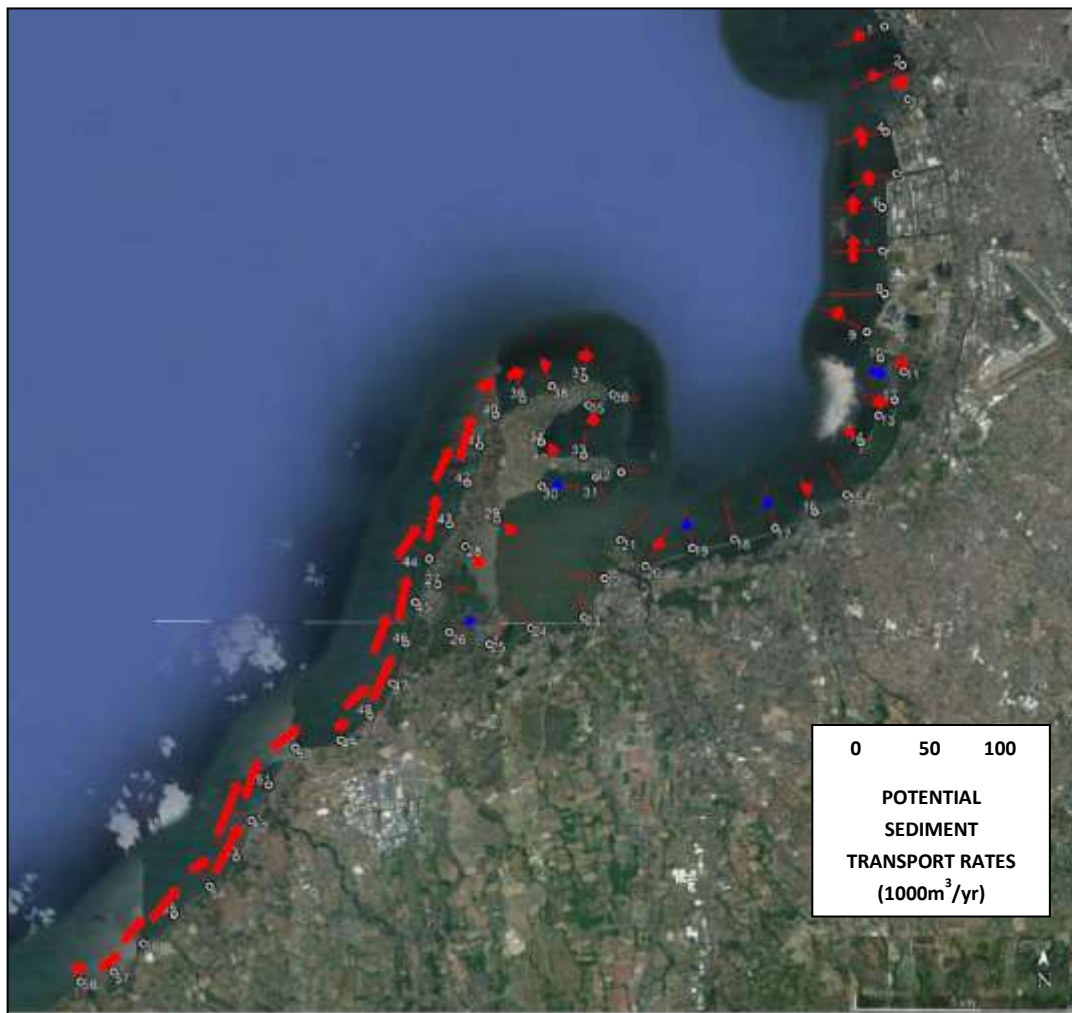
In order to see the local changes of the rates, Table 2.2-37 summarizes the variations of the rates at the 58 stations, i.e. MC rates – BC rates. It can be observed that for most of the stations, the modified condition resulted to a decrease in directional, net, and gross transport rates (i.e. negative  $\Delta Q_n$ ), except for the stations at the western stations which are not fronted by the proposed reclamation. The plot of  $Q_n$  shown in Figure 2.2-87 indicates that local regions marked by dotted circle are potential accretion zones in the Modified Condition at the western stations.

**Table 2.2-37. Differences of Transport Rates (Modified Condition-Baseline Condition)**

| Shore-normal<br>(deg, from<br>N) | Station<br>ID | Tributary<br>length<br>m | Q+<br>(to right)<br>(1000m <sup>3</sup> / yr) | Q-<br>(to left)<br>(1000m <sup>3</sup> / yr) | Qn<br>(net)<br>(1000m <sup>3</sup> / yr) | Qt<br>(gross)<br>(1000m <sup>3</sup> / yr) |
|----------------------------------|---------------|--------------------------|---|--|--|--|
| 246                              | 1             | 1000                     | -7.085  | -4.013                                       | -3.072                                   | -11.098                                    |
| 246                              | 2             | 1000                     | -11.098                                       | -6.658                                       | -4.439                                   | -17.756                                    |
| 330                              | 3             | 1000                     | -0.198  | 0.083  | -0.281                                   | -0.115                                     |
| 255                              | 4             | 1000                     | -15.871                                       | -3.552                                       | -12.319                                  | -19.423                                    |
| 255                              | 5             | 1000                     | -15.424                                       | -4.183                                       | -11.241                                  | -19.607                                    |
| 269                              | 6             | 1000                     | -10.650                                       | -1.335                                       | -9.316                                   | -11.985                                    |
| 269                              | 7             | 1000                     | -21.324                                       | -1.783                                       | -19.541                                  | -23.107                                    |
| 269                              | 8             | 1000                     | -3.757  | -0.337                                       | -3.421                                   | -4.094                                     |
| 297                              | 9             | 875                      | -4.506  | -0.114                                       | -4.392                                   | -4.619                                     |
| 199                              | 10            | 875                      | -0.005  | -4.677                                       | 4.672                                    | -4.682                                     |
| 349                              | 11            | 875                      | -1.757  | 0.001  | -1.758                                   | -1.757                                     |
| 278                              | 12            | 750                      | -2.160  | -0.283                                       | -1.877                                   | -2.443                                     |
| 354                              | 13            | 750                      | -0.826  | -0.105                                       | -0.721                                   | -0.931                                     |
| 302                              | 14            | 1125                     | -3.760  | -0.187                                       | -3.573                                   | -3.947                                     |
| 325                              | 15            | 1200                     | -1.875  | -0.258                                       | -1.618                                   | -2.133                                     |
| 345                              | 16            | 1000                     | -1.924  | -0.120                                       | -1.804                                   | -2.044                                     |
| 339                              | 17            | 1050                     | -1.023  | -0.534                                       | -0.489                                   | -1.557                                     |
| 345                              | 18            | 1000                     | -1.723  | -0.811                                       | -0.912                                   | -2.535                                     |
| 346                              | 19            | 1125                     | -0.091  | -0.010                                       | -0.082                                   | -0.101                                     |
| 37                               | 20            | 1125                     | 0.000   | 0.000  | 0.000                                    | 0.000                                      |
| 47                               | 21            | 1250                     | -0.087  | -0.003                                       | -0.084                                   | -0.090                                     |
| 272                              | 22            | 1500                     | -0.106  | -0.236                                       | 0.130                                    | -0.342                                     |
| 342                              | 23            | 1375                     | -0.160  | -0.163                                       | 0.003                                    | -0.323                                     |
| 330                              | 24            | 1375                     | -0.033  | -0.620                                       | 0.588                                    | -0.653                                     |
| 31                               | 25            | 1500                     | -0.460  | -0.258                                       | -0.203                                   | -0.718                                     |
| 66                               | 26            | 1500                     | -0.243  | -0.360                                       | 0.117                                    | -0.603                                     |



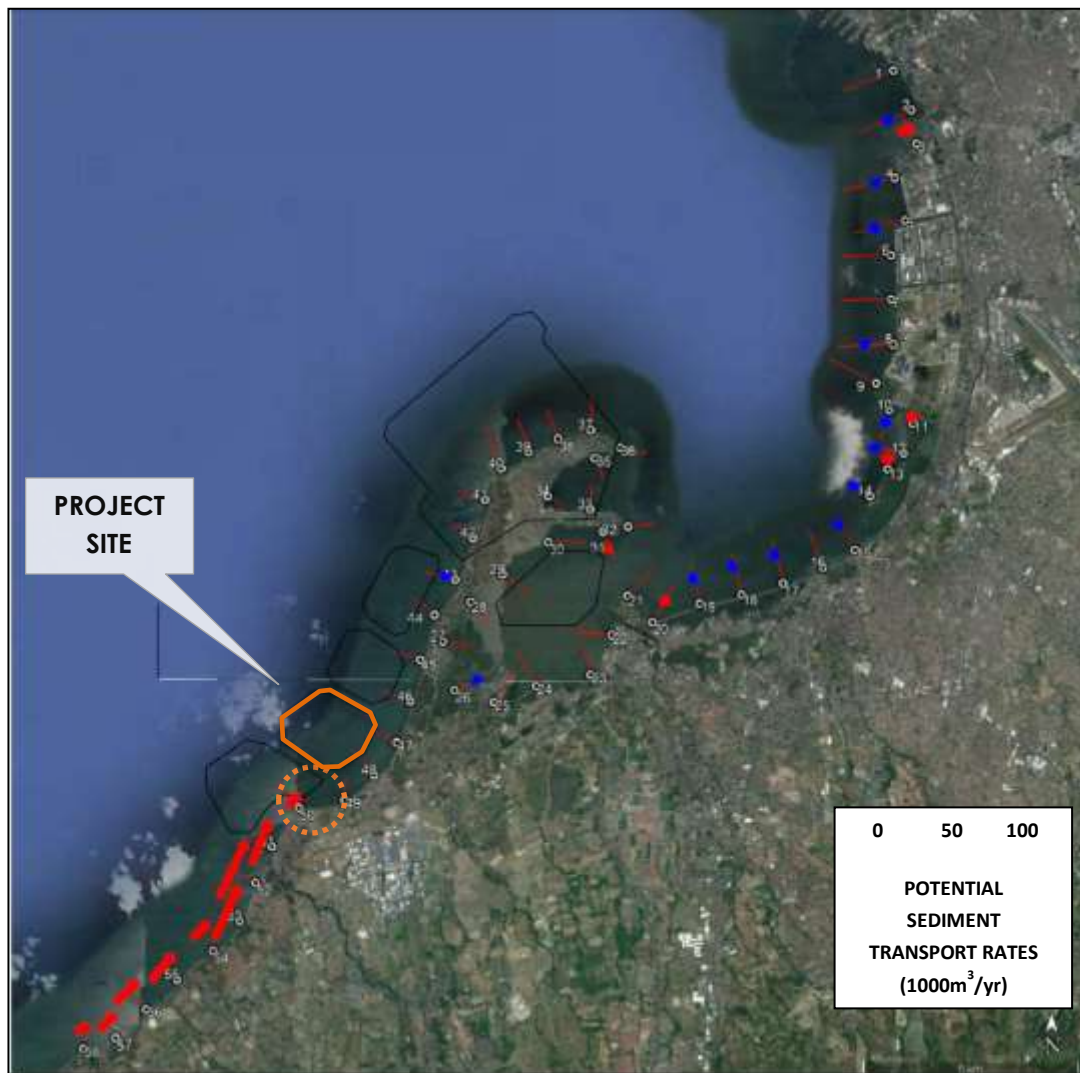
| Shore-normal<br>(deg, from<br>N) | Station<br>ID | Tributary<br>length<br>m | Q+<br>(to right)<br>(1000m <sup>3</sup> / yr) | Q-<br>(to left)<br>(1000m <sup>3</sup> / yr) | Qn<br>(net)<br>(1000m <sup>3</sup> / yr) | Qt<br>(gross)<br>(1000m <sup>3</sup> /<br>yr) |
|----------------------------------|---------------|--------------------------|---|--|--|---|
| 103                              | 27            | 1500                     | -0.549  | -0.331                                       | -0.218                                   | -0.879  |
| 139                              | 28            | 1250                     | -3.194  | -0.029                                       | -3.165                                   | -3.223  |
| 130                              | 29            | 1250                     | -2.929  | -0.398                                       | -2.531                                   | -3.327  |
| 92                               | 30            | 1500                     | -0.051  | -1.383                                       | 1.332                                    | -1.434  |
| 157                              | 31            | 1250                     | -0.302  | -0.750                                       | 0.448                                    | -1.052  |
| 237                              | 32            | 1000                     | -0.322  | -0.088                                       | -0.234                                   | -0.410  |
| 2                                | 33            | 1250                     | -0.223  | -0.920                                       | 0.698                                    | -1.143  |
| 127                              | 34            | 1500                     | -2.829  | -0.101                                       | -2.728                                   | -2.930  |
| 163                              | 35            | 1125                     | -4.007  | -0.282                                       | -3.726                                   | -4.289  |
| 108                              | 36            | 750                      | -2.347  | -1.974                                       | -0.372                                   | -4.321  |
| 2                                | 37            | 750                      | -8.318  | -2.357                                       | -5.961                                   | -10.675                                       |
| 338                              | 38            | 750                      | -8.911  | -7.034                                       | -1.877                                   | -15.944                                       |
| 338                              | 39            | 750                      | -16.389                                       | -7.353                                       | -9.037                                   | -23.742                                       |
| 336                              | 40            | 750                      | -17.828                                       | -7.955                                       | -9.873                                   | -25.783                                       |
| 285                              | 41            | 875                      | -47.199                                       | -9.556                                       | -37.643                                  | -56.756                                       |
| 304                              | 42            | 1000                     | -39.115                                       | -10.402                                      | -28.714                                  | -49.517                                       |
| 283                              | 43            | 1000                     | -47.499                                       | -8.018                                       | -39.481                                  | -55.518                                       |
| 304                              | 44            | 1000                     | -41.405                                       | -11.112                                      | -30.293                                  | -52.517                                       |
| 282                              | 45            | 1000                     | -46.602                                       | -8.710                                       | -37.891                                  | -55.312                                       |
| 287                              | 46            | 1000                     | -42.698                                       | -10.153                                      | -32.544                                  | -52.851                                       |
| 293                              | 47            | 1000                     | -51.567                                       | -10.819                                      | -40.748                                  | -62.386                                       |
| 317                              | 48            | 1000                     | -34.722                                       | -10.872                                      | -23.850                                  | -45.594                                       |
| 0                                | 49            | 1000                     | -8.969  | -2.570                                       | -6.399                                   | -11.539                                       |
| 313                              | 50            | 1000                     | -28.914                                       | -12.309                                      | -16.606                                  | -41.223                                       |
| 282                              | 51            | 1000                     | -1.523  | -8.893                                       | 7.370                                    | -10.416                                       |
| 295                              | 52            | 1000                     | -0.062  | -6.158                                       | 6.096                                    | -6.219  |
| 308                              | 53            | 1000                     | -0.012  | -4.119                                       | 4.107                                    | -4.130  |
| 329                              | 54            | 1000                     | -0.051  | -3.143                                       | 3.092                                    | -3.194  |
| 310                              | 55            | 1000                     | -7.503  | -1.589                                       | -5.914                                   | -9.092  |
| 314                              | 56            | 1000                     | -0.687  | -1.253                                       | 0.565                                    | -1.940  |
| 322                              | 57            | 1000                     | -1.225  | -1.045                                       | -0.180                                   | -2.271  |
| 348                              | 58            | 1000                     | 0.344   | -0.495                                       | 0.840                                    | -0.151  |



Base Map: Google Earth

**Figure 2.2-87. Directions and Magnitudes of Annual Net Longshore Transport  $Q_n$  for Baseline Condition**





Base Map: Google Earth

**Figure 2.2-88. Directions and magnitudes of annual net longshore transport  $Q_n$  for Modified Conditions**

Figures 2.2-89 and 2.2-90 graphically show the total transport rates  $Q_t$  at all stations under Baseline and Modified Conditions. It is clear that  $Q_t$  decreases at the locations where the shoreline is fronted by the proposed reclamation, i.e. parts of the middle stations and western stations.



Base Map: Google Earth

**Figure 2.2-89. Directions and magnitudes of annual gross longshore transport  $Q_t$  for Baseline Condition**



Base Map: Google Earth

**Figure 2.2-90. Directions and magnitudes of annual gross longshore transport  $Q_t$  for Modified Conditions**

### Findings and Recommendations

Based on currently available information and the modeling work covering the risks identified for the project site, it is evident that the results of the post-development scenarios covering the five (5) islands of the entire Cavite Provincial Government (CPG) reclamation projects as well as the Sangley International Airport Project do not show highly significant negative impacts.

These impacts extend individually to Island D, which is the subject of this application.

#### 2.2.2.2 Effects/Changes in Bathymetry

The project will have impact on the bathymetry only insofar as local plan form is concerned, since the reclamation project precisely involves the creation of a new island within the approved project site boundaries. Overall, however the changes in the bathymetry of the entirety of the Manila Bay is deemed insignificant considering that the project is going to occupy a mere fraction of the Bay and its adjacent areas.





### **Effects on Prevailing Waves**

Comparing the prevailing wave climate results under the pre-development and post-development scenarios, it can be seen that the waves are relatively calm, with wave heights below 0.7 m in the tip of the Sangley Point. The reclamation islands generally induced lower wave heights in its vicinity. This may be attributed to a significant amount of wave energy being blocked by the islands. In some of these cases, the calm wave climate may cause potential water stagnation issues.

### **Effects of Climate Change/Sea Level Rise**

The Global Climate Risk Index places the Philippines as among the top 5 countries which would be most severely impacted by climate change and sea level rise. The IPCC Report on Climate Change estimates a 460mm rise should the oceans warm another 2 degree by the year 2100. While this project cannot, by itself, alter the impacts of climate change, it is possible to mitigate the risk to the project by providing adequate freeboard in the determination of the finished elevation of the reclamation. For this project, this freeboard is 600mm.

### **Effects on Storm Surge**

Storm tide levels of 3 potentially critical typhoons, Rita, Patsy and Xangsane, were simulated at the vicinity of the project site. The effects of the reclamation to the storm tide levels vary.

Typhoon Rita caused storm tide levels of roughly 1.0 m – 1.1 m at Islands B to E, and 0.6 m – 0.8 m at Island A. The addition of the reclamation induced a slight increase of roughly 0.1 m in storm tide levels at the channel between Island E and the existing coastline. On the other hand, the reclamation resulted to a significant reduction in the storm tide levels in Bacoar Bay. Typhoon Patsy caused storm tide levels of roughly 0.8 m – 0.9 m for all islands and the reclamation resulted to a slight increase in storm tide levels at the eastern portion of the proposed SPIA and Island A. Lastly, typhoon Xangsane resulted in the lowest storm tide levels at roughly 0.8 m for all islands and the reclamations did not change the result significantly.

### **Storm Surge Hazard, Vulnerability**

A hazard is defined as condition with the potential to inflict harm, cause loss of life and damage to property. It is significant in relation to the presence of vulnerable population (e.g. those who would be likely impacted by the hazards). In the case of this project, the vulnerable population/areas would include the onshore populace and fisherfolk, as well as structures such as those for fishing.

With or without the reclamation projects the storm surge hazard exist and the vulnerability of the affected population and important activities are thus also present. However, with the reclamation islands in fact provide “sheltering” effects and thus are not expected to exacerbate the storm surge hazard and vulnerabilities.

The design of the final reclamation enclosure should make consideration for sea level rise in the form of freeboard. The minimum recommended freeboard is 600mm.

### **Effects on Storm Wave**

Simulative analyses of storm waves generated by 3 historical typhoons were carried out. The storm wave heights induced by these typhoons ranges from 0 m to 3 m at the harbor and along the coastline. For all three typhoons, it can be seen that the proposed reclamation islands in the post-development scenarios will provide a sheltering effect on all shorelines leeward of the reclamations, with the most significant effect caused by SPIA, primarily due to the fact its single island is significantly larger than Islands A-E.

### **Discussion of how the impacts may be affected by climate change especially sea level rise.**



### **Required Reclamation Crest Elevation**

The structure crest elevation which is not overtopped by typhoon waves depends highly on the design of the reclamation wall structure in terms of seaward slope, hydraulic roughness, profile, and armor unit type and geometry. For a 1:2 embankment slope with rock armor, the critical non-overtopping crest elevation obtained is 7.64 m based on Typhoon Rita. With the obtained required elevation not viable, wave overtopping is to be expected for lower design crest elevations, and thus a slope with seawall on top was considered. Setting the FGL at 4 m to 5 m and wall heights of 1 to 1.5 m, the obtained wave overtopping discharge ranges from 0.003 to 0.028 m<sup>3</sup>/s/m. With these obtained values, it is recommended to protect the embankment crest based from the critical values of overtopping discharges from the Coastal Engineering Manual.

### **Possible Combinations of Reclamation Backfill Elevation and Embankment Seawall Height**

To satisfy CEM code requirements specifying damage condition for a protective coastal structure such as an embankment seawall, combinations of minimum seawall height and RBE (reclamation backfill elevation, or height of fill above MSL) were computed to meet the maximum wave overtopping discharge for the damage condition (Table 2.2-29). For example, in order not to damage the embankment seawall assuming no additional protection of the crest, the required minimum height for Island B is +2.19 m for an RBE of +4.0 m. Under the same conditions, Island D would need +1.24 m to meet the same damage condition.

### **Effects on Tidal Currents**

In the post-development scenario, various changes in the maximum tidal-induced currents were noted, including an extreme increase of current speed at the gaps of Island A within Bacoor Bay. A moderate increase of current speed between the Islands B-E, and a significant increase of current speed on the leeside of Island E within the waterway. All these changes can be attributed to the constriction of flow in these areas.

### **Effects on Tidal Circulation**

Monitoring of time histories of tidal currents indicate that the tidal currents modified by the post-development scenario will still allow significant circulation of seawaters within both partially enclosed waterways and channelized waterways between the reclaimed islands. The circulation currents have a wide range of amplitudes of 0.05 to 0.6 mps, as well as oscillating directions signifying dispersion of outward currents. Channelized waterways created between the reclaimed islands B to E experience reversal of flows, indicating bi-directional transport of seawaters that would be otherwise be confined in these channels.

### **Effects on Longshore Sediment Transport**

In the pre-development condition, the net transport rates at the coast are generally positive, ranging from 3 to 19 tcm/yr for northern stations, -2 to 5 tcm/yr for the middle stations and higher values of 2 to 50 tcm/yr for western stations. This indicates that the sediment transport is generally directed to the right. The gross transport rates follow the same trend, with low rates for the middle stations and higher values for western stations. For the post development condition, a reversal of net transport direction to some of the northern stations are observed, where net transport rates are from -5 to 10 tcm/yr. For the middle stations, the modified condition resulted to an even net and gross transport rates, both now ranging from -1 to 4 tcm/yr. The transport rates at stations fronted by the Cavite reclamation sites, namely Sta. 43 to Sta. 49, have decreased greatly, now only ranging from -1 to 2 tcm/yr, and for the rest of the western stations, net transport rates increased, now ranging from 17 to 56 tcm/yr.

Longshore Sediment Transport is influenced among others by currents and tides which in turn may be influenced by climate change especially sea level rise. However, the foregoing discussions demonstrate the minimal effect of climate change and sea level rise.



### **Effects on Tsunami**

The site lies in a water body that is susceptible to tsunami events. There have been nearby tsunamigenic events in the coastline in the vicinity of the project. These events triggered runup observations in nearby coastlines, with recorded tsunami runup values, mostly from the 1994 tsunami event, that went as high as 6.14 m. These tsunami heights shall be considered in the design of the crest height of the coastal structure.





### **2.2.3 Water Quality**

#### **2.2.3.1 Degradation of Groundwater Quality**

##### **Baseline Condition**

Based on the Cavite Integrated Water Resource Management Master Plan (*Cavite PPDO, 2012*), the groundwater resources in the future will no longer be adequate to meet the long-term water requirements of the province. Groundwater availability has reached a critical point. Groundwater mining, rapid growth in population, increased economic activity, decreasing groundwater levels resulting in salt-water intrusion in coastal areas, pollution in rivers, and competition over water rights, which could adversely affect the environment, already appears to be occurring in some cities/municipalities in Cavite Province.

Near the coast, particularly in Cavite City, all deepwells have been abandoned due to the decline of water level below mean sea level that resulted to saline water intrusion. Overdevelopment of groundwater resources through wells in areas near the coastline will ultimately result to inland movement of seawater once the cone of depression created by pumping reaches the sea. Potable water is not reported in the nearshore areas due to the presence of alluvial deposits, which may be brackish and saline and are not safe for drinking and other domestic use.

Saltwater intrusion in Manila Bay is caused mainly by groundwater withdrawal. Saline water has moved considerably inland especially along the coasts of Cavite and is associated with the proliferation of wells that are used to extract groundwater. In the future, saltwater intrusion is likely to move further inland if current rate of groundwater withdrawal continues and if sea level rise increases due to projected warming of temperature.

##### **Potential Impact of Project**

The proposed project will not affect the quality of groundwater in the area because the activities during the Construction Phase only involves the reclamation phase, which will not require groundwater extraction.

No groundwater extraction shall be done for the proposed project during construction and operation phase. During the construction phase, water supply shall be in the form of bottled water that will be purchased and brought to the vessels and/or the project site. Furthermore, effluent discharges will be treated onboard through the use of the bilge system.

During operations phase, the proposed development will be provided with adequate water supply system, which will be connected to the existing water supply network of Maynilad, specifically to the existing 900 mm diameter water pipeline running along the Manila Cavite Coastal Road.

With regards to the disposal of unwanted dredged materials offshore, the specific site for disposal area is not yet identified. Ideally, these materials will be disposed offshore outside of the reclamation site, which based on actual experience by a previous dredging contractor could be at a site in Manila Bay with depths of at least 20 meters. The designation of this disposal site is to be determined by the PCG, subject to permitting from the PCG and the DENR through the Manila Bay Coordinating Office (MBCO). The offshore areas of Manila Bay with minimum depth of 20m are not known to be utilized for groundwater resource extraction. Hence, there is nil chance to cause groundwater quality degradation.

##### **Groundwater Quality Secondary Baseline Data**

Although there will be no groundwater abstraction to be done for the project, secondary data on water quality is herein presented to characterize the baseline conditions. These were taken from the published EIS – Preparatory Survey for Cavite Industrial Area Flood Management Project prepared by KRC Environmental Services Inc. for the DPWH, in partnership JICA-CTI Engineering International Co. Ltd. (undated) The samples



were collected on February 17, 2016 from hand-pumped shallow wells in the municipalities of Noveleta and Rosario.

**Table 2.2-38. Groundwater Quality Test Results**

| Parameter, unit           | Sampling Station                        |   |                                  |                     |                        | PNSDW Limits      |
|---------------------------|---|---|----------------------------------|---------------------|------------------------|-------------------|
|                           | GW1                                     | GW2                                     | GW3                              | GW4                 | GW5                    |                   |
|                           | Love Memorial Park Salcedo II, Noveleta | Marcella St. Brgy. Ligdong III, Rosario | 409 Tramo Road Bagbag 1, Rosario | Poblacion, Noveleta | Sta. Rosa II, Noveleta |                   |
| pH                        | 7.2                                     | 7.8                                     | 7.6                              | 7.2                 | 7.4                    | 6.5 - 8.8         |
| Temperature, °C           | 29                                      | 28.8                                    | 28.6                             | 27.8                | 28                     |                   |
| Conductivity, µS/cm       | 996                                     | 610                                     | 624                              | 1,720               | 1,070                  | 250               |
| BOD, mg/L                 | 1                                       | 2                                       | 2                                | 3                   | 4                      |                   |
| Salinity, mg/L            | 734                                     | 359                                     | 441                              | 473                 | 441                    | 250 (as Chloride) |
| Total Coliform, MPN/100mL | <1.1                                    | <1.1                                    | <1.1                             | 16                  | <1.1                   | <1.1              |

Source: DPWH, Cavite Flood Mitigation for Lowland Areas EIS Report, 2017

Based on PNSDW limits, it can be seen from the results that only the total coliform of GW4 has exceeded. Most coliform bacteria are generally harmless but may also pose health risks if there is presence of fecal coliform. There are no limits for the other parameters analyzed. For salinity, if this is compared to Chloride standard, all samples are beyond the standard of 250 mg/L. The high salinity values probably indicate saltwater intrusion in the sampled areas.



Source: DPWH, Cavite Flood Mitigation for Lowland Areas EIS Report, 2017

**Figure 2.2-91. Groundwater Sample Location Map**





### 2.2.3.2 Degradation of Surface Water Quality

The important surface freshwater bodies nearest to the project site are Maalimango (Ligtong) River, which is 690m to the southeast and Cañas River, which is 2.47km to the southwest from the southernmost corner of Island D (Figure 2.2-2).

The proposed project will not significantly affect the quality of the surface waters for the following reasons:

The potential sources of water quality degradation of nearby freshwater or marine water within and surrounding the project site will be the dredging and loading reclamation activities. The impacts and causes of water quality degradation during construction period are the following:

- Dredging and loading operation for unsuitable materials and for fill materials that may cause silt dispersal (increase in background levels of TSS);
- Disposal of unsuitable dredged materials;
- Discharges of bilge water;
- Indiscriminate disposal of solid wastes and domestic wastewater; and
- Accidental Oil Spills.

To mitigate these potential problems, the following shall be strictly implemented:

- Installation of silt curtain, rock bund and/or cofferdam in areas of dredging, loading and dispersal operation;
- Proper disposal of unwanted dredged materials in areas designated and approved by the PCG and DENR, and with proper permits;
- Proper disposal of solid wastes in designated landfills and release of treated domestic wastewater/bilge water only in approved areas; and
- Oil spill management (discussed under Chapter 4 – ERA).

Most importantly, the project proponent shall rigidly conform to the Supreme Court Mandamus on Manila Bay in all its proposed operations within the area.

In any case, the proposed project will not significantly affect the quality of these freshwater bodies for the following reasons:

The primary generators of wastewaters are from the sea-going vessels. The vessels are mobile and continuously navigate between the project site and the SNS.

- These generators shall not navigate close to the rivers;
- The wastewater are relatively small inflows; the population of the vessels which could generate domestic waste water is small i.e. approximately 50 to 75 vessel personnel;
- The period for generation of wastewaters is short-lived; e.g., the vessel will operate only for 15 hours/day; and
- There are essentially no toxic and hazardous effluents.

### Baseline Conditions

Primary data gathering for water quality of the nearest Maalimango/Ligtong River was conducted, wherein 3 samples were taken and analyzed. The table below shows the results while the official laboratory test results are in **Annex 2.2-A**. The sampling stations are shown in Figure 2.2-92, which also shows seawater sampling locations.

The data indicate that the dissolved oxygen content of all river water samples along Maalimango are all very low and do not pass the Class C standards. Moreover, fecal coliform, total coliform, ammonia, and sulfate



contents all exceed the limits. In terms of other parameters, all samples are within the limits, in fact, the arsenic, mercury, cadmium, chromium, Irad, selenium, and chromium are all below detection limits.

In addition, secondary data for water quality monitoring was taken from the DENR Region IV-A. These are the results of their monitoring for the 1<sup>st</sup> Quarter of 2018, Jan-Sep 2019, and Jan 2020, which are herein presented for a more comprehensive view of the baseline conditions in the area. These are shown in Tables 2.2-39 and 2.2-40. The sampling stations are shown in Figure 2.2-93.

**BOD** – in Maalimango River, majority is above the standards (7 mg/L) for Class C waters, lowest is 4 mg/L taken on Sep 2019 at Mount Sea Resort, and highest is 143 mg/L from Ligdong 1, taken in April 2019. For Cañas River, majority is within the standards except for Paradahan Bridge (CR-6) ranging from 5-19 mg/L. High BOD levels indicate a condition where there is a reduction of oxygen availability to the microbial population to degrade organic content.

Results for **Dissolved Oxygen** content are all failures in terms of the limits except for Patda and Panaysayan bridges further inland in Trece Martirez along Cañas River, which range from 5.2-9 mg/L.

The **Total Suspended Solids** (TSS) in the 2 rivers are generally low except for the January 2020 results for Julugan and Tejero Bridge in Cañas River. This measure is closely related to turbidity, indicating high content of silt or particulates.

All of the **Total Coliform** results (1<sup>st</sup> Q of 2018 data only) show very high values way beyond the DENR standard, with highest at 3.3M taken at Paradahan Bridge. This is a general indicator of potential contamination of the presence of pathogenic and disease-causing organisms.

All **Fecal Coliform** values range from 2,000 to 4.6M MPN/100mL, which are way over the standard. The FC in Paradahan Bridge (CR-6) is consistently in the millions. The presence of fecal bacteria in a water sample indicates that such sample might contain microorganisms harmful to human health.

The phosphate values (data is limited to 1<sup>st</sup> Q 2018 and Jan 2020 only) are all beyond the limits while the ammonia and chloride contents (1<sup>st</sup> Q 2018) at the mouth of Cañas River and at Ligdong 1 along Maalimango River are higher than the limits as well. The nitrogen levels (Jan 2020 data only) all pass the standard.

### Baseline Conditions-Additional Sampling Locations

Freshwater sampling at the mouths of Ylang-Ylang, Imus and Maalimango rivers was conducted on June 24, 2020. The parameters to be tested are: Ammonia, Phosphate, BOD, Nitrates, TSS, Surfactants and Total Coliform. The results is presented in Table 2-37a which shows that all parameters tested for Ylang-ilang and Imus Rivers failed the DENR Standards except for oil and grease which is below the reporting limit while Maalimango River failed for Nitrates, *Laboratory Result is attached Annex 2-2a.*

**Table 2.2-38a Water Quality Results for Ylang-ilang, Imus and Maalimango River Rivermounts, June 24, 2020**

| Station  | Date of Sampling | NH <sub>3</sub> , mg/L | BOD, mg/L | Nitrates, mg/L | O & G, MPN/100mL | Phosphate, mg/L | Surfactants, mg/L | TSS, mg/L | FC, MPN/100mL       |
|--|------------------|------------------------|-----------|----------------|------------------|-----------------|-------------------|-----------|---------------------|
| <b>DENR Class C Standard</b>                     |                  | 0.007                  | 1.0       | 0.003          | 1                | 0.006           | 1                 | 2         | 1.8                 |
| Ylang-ylang<br>N 14°27'44.01"<br>E 121°53'13.16" | June 24, 2020    | 1.84                   | 46        | 1.74           | <1               | 0.959           | 0.2               | 85        | 2.6x10 <sup>5</sup> |
| Imus<br>N 14°27'50.39"<br>E 121°50'59.21"        | June 24, 2020    | 2.51                   | 52        | 0.575          | <1               | 0.220           | 0.2               | 19        | 7.9x10 <sup>4</sup> |
| Maalimango<br>N 14°24'42.81"<br>E 121°50'38.39"  | June 24, 2020    | 2.83                   | 87        | <0.003         | 3                | 1.64            | 0.2               | 7         | 3.5x10 <sup>6</sup> |

Source: Elarsi, Inc., June 24, 2020



Table 2.2-39. Freshwater Quality Test Results (Primary Data)

| Parameter              | Test Methods   | Class C Standards | Unit      | Test Results                           |  |  |
|------------------------|--|-------------------|-----------|--|--|--|
|                        |  |                   |           | C-DR1<br>N 14.430917°<br>E 120.871306° | C-DR2<br>N 14.424159°<br>E 120.870182° | C-DR3<br>N 14.424787°<br>E 120.866543° |
| Date of Sampling       |  |                   |           | 18 October 2017                        |  | 17 February 2019                       |
| BOD                    | Azide Modification Winkler (SM 5210B)                | 7                 | mg/L      | <1                                     | -                                      | -                                      |
| DO                     | Winkler.Titrimetric                                  | 5 (min)           | mg/L      | 4                                      | <2.0                                   | <2.0                                   |
| Total Suspended Solids | Gravimetry (SM2540 D)                                | 80                | mg/L      | 11                                     | 25                                     | 20                                     |
| Total Coliform         | Multiple Tube Fermentation Technique                 | 1,000             | MPN/100mL | -                                      | 9,200                                  | 9,200,000                              |
| Fecal Coliform         | Multiple Tube Fermentation Technique                 | 200               | MPN/100mL | -                                      | 9,200                                  | 9,200,000                              |
| Dissolved Oxygen       | Winkler.Titrimetric                                  | 5                 | mg/L      | 4                                      | <2.0                                   | <2.0                                   |
| Oil & Grease           | Gravimetry (n-Hexane Extraction)                     | -                 | mg/L      | 0.3                                    | 0.67                                   | 0.44                                   |
| pH                     | Electrometric Method                                 | 6.5 – 8.5         | mg/L      | 8.0                                    | -                                      | -                                      |
| COD                    | Open Reflux Method (SM5220B)                         | -                 | mg/L      | 16                                     | 165                                    | 94                                     |
| Arsenic                | SDDC, Spectrophotometry                              | 0.02              | mg/L      | <0.01                                  | <0.008                                 | <0.008                                 |
| Mercury                | Manual Cold Vapor AAS                                | 0.002             | mg/L      | <0.0002                                | <0.0002                                | <0.0002                                |
| Cadmium                | Flame AAS-MIBK Extraction                            | 0.005             | mg/L      | <0.001                                 | <0.001                                 | <0.001                                 |
| Chromium               | Diphenylcarbazide, Colorimetric Method (SM3500-Cr B) | 0.05              | mg/L      | <0.005                                 | -                                      | -                                      |
| Lead                   | Flame AAS-MIBK Extraction                            | 0.05              | mg/L      | <0.005                                 | <0.005                                 | <0.005                                 |
| Selenium               | ICP – OES  | -                 | mg/L      | -                                      | <0.01                                  | <0.01                                  |
| Ammonia                | Phenate Method (SM 4500-NH3 F)                       | 0.05              | mg/L      | -                                      | 3.0                                    | 4.1                                    |
| Sulfate                | Turbidimetric Method                                 | 275               | mg/L      | -                                      | 685                                    | 826                                    |
| Hexavalent Chromium    | Diphenylcarbazide, Colorimetric Method (SM3500-Cr B) | 0.05              | mg/L      | -                                      | <0.002                                 | <0.002                                 |
| Boron                  | Carmine Method                                       | 5                 | mg/L      | -                                      | 2.4                                    | 2.9                                    |
| Fluoride               | SPADNS Method (SM4500-F D)                           | 1.5               | mg/L      | -                                      | 1.1                                    | 1.1                                    |

Date Sampled: October 18, 2017 and February 17, 2019

Analyzed by: CRL Environmental Corporation

Red highlight indicates result is beyond DENR standards



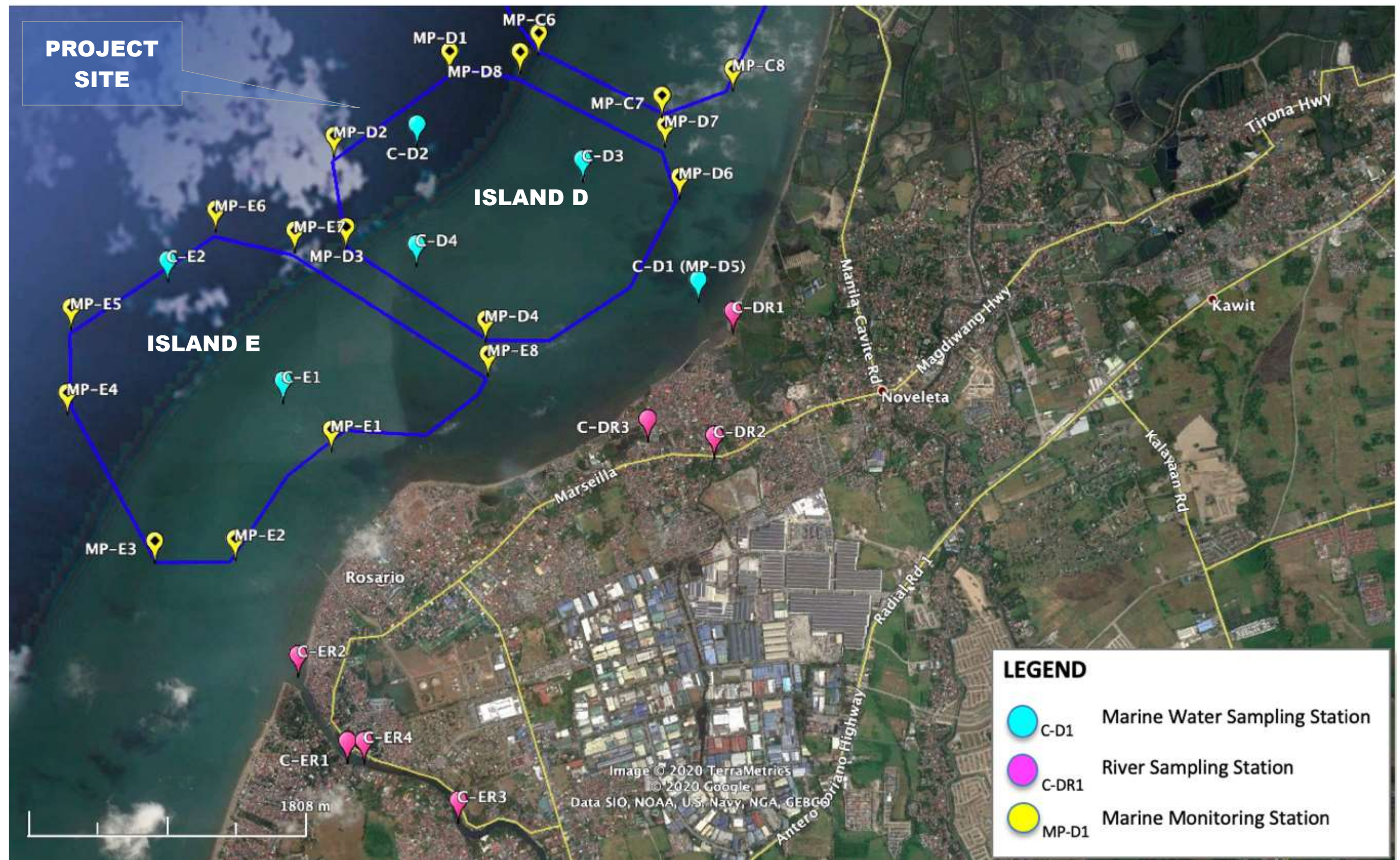


Figure 2.2-92. Water Quality Sampling Stations (Primary Data)





## SECONDARY DATA

### CAÑAS RIVER

Table 2.2-40. Results of Water Quality Analysis of Cañas River (DENR-R4A)

| Parameter, unit                           | Class C Standard | 1Q 2018 Average | Jan 2019 | Feb 2019 | Mar 2019 | Apr 2019 | May 2019 | Jun 2019 | Jul 2019 | Aug 2019 | Sep 2019 | Jan 2020 |
|---|------------------|-----------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| <b>CR-1 (Cañas River Mouth - 1)</b>       |                  |                 |          |          |          |          |          |          |          |          |          |          |
| BOD, mg/L                                 | 7                |                 |          |          |          |          |          |          |          |          |          |          |
| DO, mg/L                                  | 5 (min)          | 4.9             |          |          |          |          |          |          |          |          |          | 1.6      |
| TSS, mg/L                                 | 80               | 8               |          |          |          |          |          |          |          |          |          | 4        |
| Phosphate, mg/L                           | 0.5              | 0.674           |          |          |          |          |          |          |          |          |          | 0.53     |
| Total Coliform, MPN/100mL                 | 1,000            | 14,954          |          |          |          |          |          |          |          |          |          |          |
| Fecal Coliform, MPN/100mL                 | 200              | 8,551           | 490,000  | 920,000  | 7,800    | 240,000  | 540,000  | 49,000   | 110,000  | 49,000   | 130,000  | 79,000   |
| pH  | 6.5 - 9          | 7.73            |          |          |          |          |          |          |          |          |          | 7.81     |
| Nitrogen, mg/L                            | 7                |                 |          |          |          |          |          |          |          |          |          | 0.17     |
| Chlorides, mg/L                           | 350              | 523             |          |          |          |          |          |          |          |          |          |          |
| Ammonia, mg/L                             | 0.05             | 1.47            |          |          |          |          |          |          |          |          |          |          |
| <b>CR-2 (Cañas River Mouth - 2)</b>       |                  |                 |          |          |          |          |          |          |          |          |          |          |
| DO, mg/L                                  | 5 (min)          |                 |          |          |          |          |          |          |          |          |          | 1.3      |
| TSS, mg/L                                 | 80               |                 |          |          |          |          |          |          |          |          |          | 5        |
| Phosphate, mg/L                           | 0.5              |                 |          |          |          |          |          |          |          |          |          | 0.58     |
| Fecal Coliform, MPN/100mL                 | 200              |                 | 110,000  | 2,000    | 170,000  | 79,000   | 540,000  | 170,000  | 170,000  | 79,999   | 17,000   | 49,000   |
| pH  | 6.5 - 9          |                 |          |          |          |          |          |          |          |          |          | 7.72     |
| Nitrogen, mg/L                            | 7                |                 |          |          |          |          |          |          |          |          |          | 0.4      |
| <b>CR-3 (Cañas River Mouth - 3)</b>       |                  |                 |          |          |          |          |          |          |          |          |          |          |
| DO, mg/L                                  | 5 (min)          |                 |          |          |          |          |          |          |          |          |          | 1.9      |
| TSS, mg/L                                 | 80               |                 |          |          |          |          |          |          |          |          |          | 8        |
| Phosphate, mg/L                           | 0.5              |                 |          |          |          |          |          |          |          |          |          | 0.62     |
| Fecal Coliform, MPN/100mL                 | 200              |                 | 130,000  | 49,000   | 7,900    | 17,000   | 220,000  | 79,000   | 70,000   | 130,000  | 68,000   | 49,000   |
| pH  | 6.5 - 9          |                 |          |          |          |          |          |          |          |          |          | 7.82     |
| Nitrogen, mg/L                            | 7                |                 |          |          |          |          |          |          |          |          |          | 0.16     |
| <b>CR-4 (Julugan Wawa Hanging Bridge)</b> |                  |                 |          |          |          |          |          |          |          |          |          |          |
| BOD, mg/L                                 | 7                | 5               | 7        | 6        | 4        | 11       | 7        | 5        | 6        | 4        | 2        | 7        |



| Parameter, unit                | Class C Standard | 1Q 2018 Average | Jan 2019  | Feb 2019  | Mar 2019  | Apr 2019  | May 2019  | Jun 2019  | Jul 2019  | Aug 2019  | Sep 2019  | Jan 2020  |
|--------------------------------|------------------|-----------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| DO, mg/L                       | 5 (min)          | 3.5             |           |           |           |           |           |           |           |           |           | 2.55      |
| TSS, mg/L                      | 80               | 7               |           |           |           |           |           |           |           |           |           | 351       |
| Phosphate, mg/L                | 0.5              | 0.64            |           |           |           |           |           |           |           |           |           | 0.95      |
| Total Coliform, MPN/100mL      | 1,000            | 49,000          |           |           |           |           |           |           |           |           |           |           |
| Fecal Coliform, MPN/100mL      | 200              | 49,000          | 790,000   | 170,000   | 1,100     | 17,000    | 68,000    | 220,000   | 1,300,000 | 49,000    | 240,000   | 4,000     |
| pH                             | 6.5 - 9          | 8.01            |           |           |           |           |           |           |           |           |           | 7.63      |
| Nitrogen, mg/L                 | 7                |                 |           |           |           |           |           |           |           |           |           | 0.59      |
| Chlorides, mg/L                | 350              | 23              |           |           |           |           |           |           |           |           |           |           |
| Ammonia, mg/L                  | 0.05             | 0.001           |           |           |           |           |           |           |           |           |           |           |
| <b>CR-5 (Tejero Bridge)</b>    |                  |                 |           |           |           |           |           |           |           |           |           |           |
| BOD, mg/L                      | 7                | 2               | 4         | 5         | 5         | 19        | 4         | 15        | 5         | 6         | 2         | 6         |
| DO, mg/L                       | 5 (min)          | 4.2             |           |           |           |           |           |           |           |           |           | 1.7       |
| TSS, mg/L                      | 80               | 13              |           |           |           |           |           |           |           |           |           | 192       |
| Phosphate, mg/L                | 0.5              | 0.75            |           |           |           |           |           |           |           |           |           | 1.1       |
| Total Coliform, MPN/100mL      | 1,000            | 130,000         |           |           |           |           |           |           |           |           |           |           |
| Fecal Coliform, MPN/100mL      | 200              | 49,000          | 130,000   | 46,000    | 4,900     | 40,000    | 23,000    | 79,000    | 200,000   | 130,000   | 33,000    | 79,000    |
| pH                             | 6.5 - 9          | 7.59            |           |           |           |           |           |           |           |           |           | 7.49      |
| Nitrogen, mg/L                 | 7                |                 |           |           |           |           |           |           |           |           |           | 0.47      |
| Chlorides, mg/L                | 350              | 14              |           |           |           |           |           |           |           |           |           | 24        |
| Ammonia, mg/L                  | 0.05             | 0.001           |           |           |           |           |           |           |           |           |           |           |
| <b>CR-6 (Paradahan Bridge)</b> |                  |                 |           |           |           |           |           |           |           |           |           |           |
| BOD, mg/L                      | 7                | 12              | 10        | 11        | 12        | 18        | 19        | 11        | 5         | 8         | 5         | 12        |
| DO, mg/L                       | 5 (min)          | 3.6             |           |           |           |           |           |           |           |           |           | 0.8       |
| TSS, mg/L                      | 80               | 10              |           |           |           |           |           |           |           |           |           | 60        |
| Phosphate, mg/L                | 0.5              | 1.10            |           |           |           |           |           |           |           |           |           | 1.58      |
| Total Coliform, MPN/100mL      | 1,000            | 3,300,000       |           |           |           |           |           |           |           |           |           |           |
| Fecal Coliform, MPN/100mL      | 200              | 1,700,000       | 3,300,000 | 4,900,000 | 1,400,000 | 1,300,000 | 7,800,000 | 4,600,000 | 780,000   | 2,300,000 | 1,300,000 | 2,200,000 |
| pH                             | 6.5 - 9          | 8.23            |           |           |           |           |           |           |           |           |           | 7.74      |
| Nitrogen, mg/L                 | 7                |                 |           |           |           |           |           |           |           |           |           | 1.03      |
| Chlorides, mg/L                | 350              | 28              |           |           |           |           |           |           |           |           |           |           |
| Ammonia, mg/L                  | 0.05             | 0.001           |           |           |           |           |           |           |           |           |           |           |





| Parameter, unit                        | Class C Standard | 1Q 2018 Average | Jan 2019 | Feb 2019 | Mar 2019 | Apr 2019 | May 2019 | Jun 2019 | Jul 2019 | Aug 2019 | Sep 2019 | Jan 2020 |
|--|------------------|-----------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| <b>CR-7 (Mag-asawang Layon Bridge)</b> |                  |                 |          |          |          |          |          |          |          |          |          |          |
| BOD, mg/L                              | 7                | 8               | 2        | 4        | 2        | 5        | 4        | 2        | 2        | 1        | 1        | 12       |
| DO, mg/L                               | 5 (min)          | 6               |          |          |          |          |          |          |          |          |          | 2.4      |
| TSS, mg/L                              | 80               | 2               |          |          |          |          |          |          |          |          |          | 7        |
| Phosphate, mg/L                        | 0.5              | 0.57            |          |          |          |          |          |          |          |          |          | 0.89     |
| Total Coliform, MPN/100mL              | 1,000            | 46,000          |          |          |          |          |          |          |          |          |          |          |
| Fecal Coliform, MPN/100mL              | 200              | 21,000          | 13,000   | 11,000   | 24,000   | 54,000   | 4,500    | 2,000    | 450,000  | 70,000   | 33,000   | 22,000   |
| pH                                     | 6.5 - 9          | 8.15            |          |          |          |          |          |          |          |          |          | 8.28     |
| Nitrogen, mg/L                         | 7                |                 |          |          |          |          |          |          |          |          |          | 0.93     |
| Chlorides, mg/L                        | 350              | 9               |          |          |          |          |          |          |          |          |          |          |
| Ammonia, mg/L                          | 0.05             | 0.001           |          |          |          |          |          |          |          |          |          |          |
| <b>CR-8 (Patda Bridge)</b>             |                  |                 |          |          |          |          |          |          |          |          |          |          |
| BOD, mg/L                              | 7                | 2               | 4        | 5        | 4        | 4        | 12       | 3        | 3        | 3        | 2        | 1        |
| DO, mg/L                               | 5 (min)          | 8.6             |          |          |          |          |          |          |          |          |          | 5.2      |
| TSS, mg/L                              | 80               | 9               |          |          |          |          |          |          |          |          |          | 1        |
| Phosphate, mg/L                        | 0.5              | 1.37            |          |          |          |          |          |          |          |          |          | 0.91     |
| Total Coliform, MPN/100mL              | 1,000            | 240,000         |          |          |          |          |          |          |          |          |          |          |
| Fecal Coliform, MPN/100mL              | 200              | 240,000         | 130,000  | 110,000  | 22,000   | 130,000  | 22,000   | 110,000  | 450,000  | 170,000  | 130,000  | 540,000  |
| pH                                     | 6.5 - 9          | 8.15            |          |          |          |          |          |          |          |          |          | 8.11     |
| Nitrogen, mg/L                         | 7                |                 |          |          |          |          |          |          |          |          |          | 0.7      |
| Chlorides, mg/L                        | 350              | 5               |          |          |          |          |          |          |          |          |          |          |
| Ammonia, mg/L                          | 0.05             | 0.001           |          |          |          |          |          |          |          |          |          |          |
| <b>CR-9 (Panaysayan Bridge)</b>        |                  |                 |          |          |          |          |          |          |          |          |          |          |
| BOD, mg/L                              | 7                | 4               | 3        | 4        | 3        | 27       | 10       | 3        | 2        | 1        | 1        | 4        |
| DO, mg/L                               | 5 (min)          | 9               |          |          |          |          |          |          |          |          |          | 5.2      |
| TSS, mg/L                              | 80               | 5               |          |          |          |          |          |          |          |          |          | 1        |
| Phosphate, mg/L                        | 0.5              | 1.32            |          |          |          |          |          |          |          |          |          | 3.96     |
| Total Coliform, MPN/100mL              | 1,000            | 790,000         |          |          |          |          |          |          |          |          |          |          |
| Fecal Coliform, MPN/100mL              | 200              | 490,000         | 350,000  | 49,000   | 49,000   | 330,000  | 45,000   | 540,000  | 200,000  | 2,000    | 240,000  | 92,000   |
| pH                                     | 6.5 - 9          | 8.03            |          |          |          |          |          |          |          |          |          | 8.3      |
| Nitrogen, mg/L                         | 7                |                 |          |          |          |          |          |          |          |          |          | 1.27     |



| Parameter, unit | Class C Standard | 1Q 2018 Average | Jan 2019 | Feb 2019 | Mar 2019 | Apr 2019 | May 2019 | Jun 2019 | Jul 2019 | Aug 2019 | Sep 2019 | Jan 2020 |
|-----------------|------------------|-----------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| Chlorides, mg/L | 350              | 4               |          |          |          |          |          |          |          |          |          | 17       |
| Ammonia, mg/L   | 0.05             | 0.013           |          |          |          |          |          |          |          |          |          |          |

Source: Status of Implementation of 2017-2022 OPMBCS Report, DENR-R4A. 1st Quarter 2018; DENR R4 Water Quality Status (Cavite), 20 Nov 2019; & EMB IV-A Water Quality Information System (wqis.emb.gov.ph). 1<sup>st</sup> Q 2020.

Note: Highlighted values are below/ exceedances in DAO 2016-08 Criteria for Class C waters.

## MAALIMANGO (LIGTONG) RIVER

Table 2.2-41. Results of Water Quality Analysis of Maalimango/Ligtong River (DENR-R4A)

| Parameter, unit                 | Class C Standard | 1Q 2018 Average | Jan 2019 | Feb 2019 | Mar 2019 | Apr 2019 | May 2019 | Jun 2019  | Jul 2019  | Aug 2019 | Sep 2019  | Jan 2020 |
|---------------------------------|------------------|-----------------|----------|----------|----------|----------|----------|-----------|-----------|----------|-----------|----------|
| <b>MR-1 (Maalimango Bridge)</b> |                  |                 |          |          |          |          |          |           |           |          |           |          |
| BOD, mg/L                       | 7                | 22              | 10       | 35       | 38       | 14       | 20       | 13        | 4         | 13       | 8         | 18       |
| DO, mg/L                        | 5 (min)          | 4.2             |          |          |          |          |          |           |           |          |           | 3        |
| TSS, mg/L                       | 80               | 59              |          |          |          |          |          |           |           |          |           | 20       |
| Phosphate, mg/L                 | 0.5              | 0.85            |          |          |          |          |          |           |           |          |           | 0.85     |
| Fecal Coliform, MPN/100mL       | 200              | 22,000          | 790,000  | 350,000  | 240,000  | 270,000  | 790,000  | 2,400,000 | 1,100,000 | 790,000  | 1,300,000 | 47,000   |
| pH                              | 6.5 - 9          | 8.01            |          |          |          |          |          |           |           |          |           | 8        |
| Nitrogen, mg/L                  | 7                |                 |          |          |          |          |          |           |           |          |           | 2.81     |
| Chlorides, mg/L                 | 350              | 133             |          |          |          |          |          |           |           |          |           |          |
| Ammonia, mg/L                   | 0.05             | 0               |          |          |          |          |          |           |           |          |           |          |
| <b>MR-2 (Mount Sea Resort)</b>  |                  |                 |          |          |          |          |          |           |           |          |           |          |
| BOD, mg/L                       | 7                | 22              | 7        | 114      | 29       | 9        | 7        | 14        | 54        | 15       | 4         |          |
| DO, mg/L                        | 5 (min)          | 1.8             |          |          |          |          |          |           |           |          |           | 0.7      |
| TSS, mg/L                       | 80               | 9               |          |          |          |          |          |           |           |          |           | 22       |
| Phosphate, mg/L                 | 0.5              | 1.08            |          |          |          |          |          |           |           |          |           | 0.92     |
| Fecal Coliform, MPN/100mL       | 200              | 3,300,000       | 490,000  | 79,000   | 12,000   | 33,000   | 330,000  | 33,000    | 7,800     | 330,000  | 79,000    | 320,000  |
| pH                              | 6.5 - 9          | 8.03            |          |          |          |          |          |           |           |          |           | 7.6      |
| Nitrogen, mg/L                  | 7                |                 |          |          |          |          |          |           |           |          |           | 1.11     |
| Chlorides, mg/L                 | 350              | 205             |          |          |          |          |          |           |           |          |           |          |
| Ammonia, mg/L                   | 0.05             | 0.028           |          |          |          |          |          |           |           |          |           |          |
| <b>MR-3 (Ligtong 1)</b>         |                  |                 |          |          |          |          |          |           |           |          |           |          |



## CHAPTER TWO THE WATER

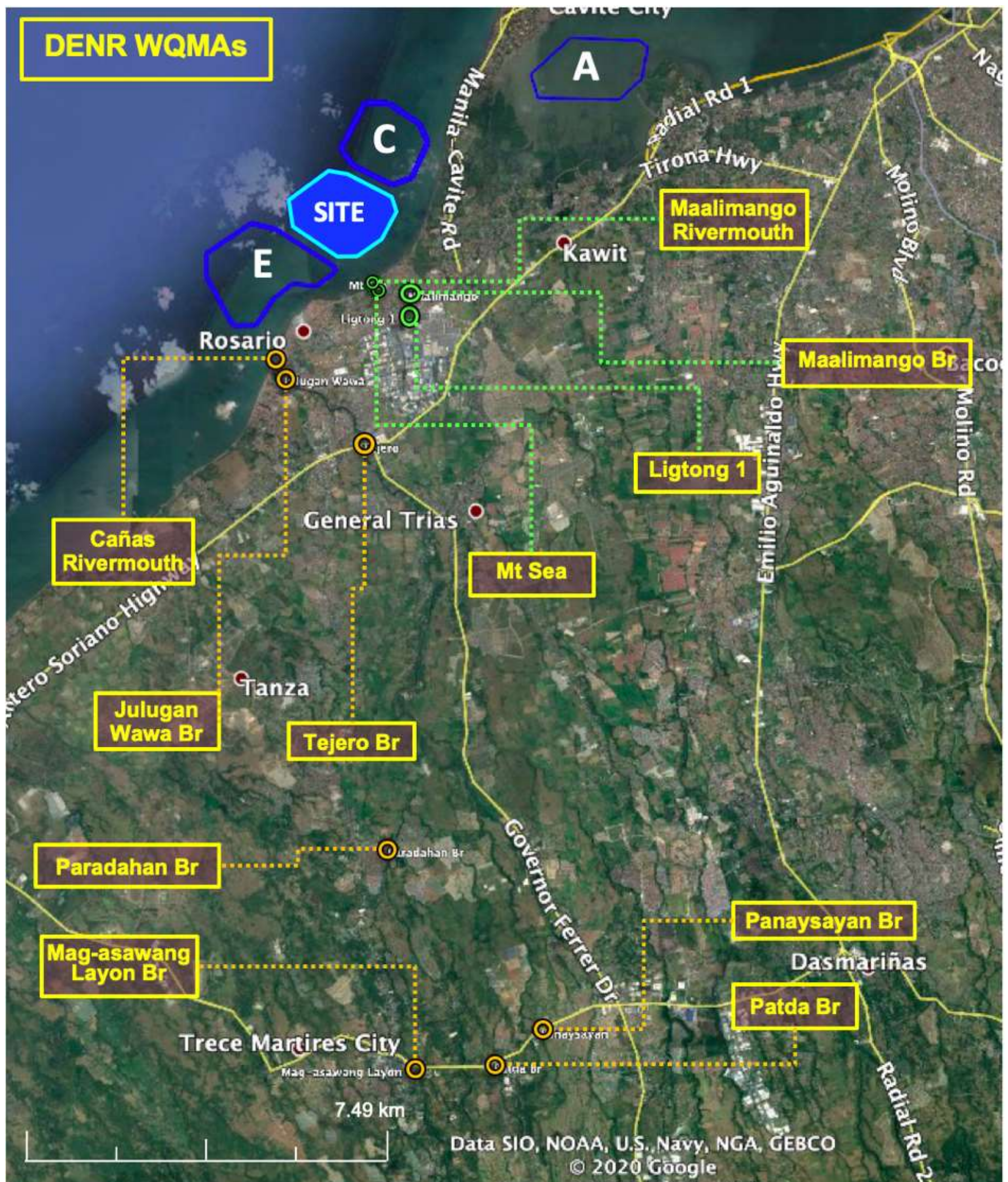
### Proposed Cavite Province Land Reclamation and Development Project: ISLAND D (267 ha) Cavite Provincial Government

| Parameter, unit           | Class C Standard | 1Q 2018 Average | Jan 2019 | Feb 2019 | Mar 2019  | Apr 2019 | May 2019  | Jun 2019 | Jul 2019 | Aug 2019 | Sep 2019  | Jan 2020 |
|---------------------------|------------------|-----------------|----------|----------|-----------|----------|-----------|----------|----------|----------|-----------|----------|
| BOD, mg/L                 | 7                | 24              | 6        | 129      | 28        | 143      | 40        | 7        | 5        | 14       | 6         |          |
| DO, mg/L                  | 5 (min)          | 1.1             |          |          |           |          |           |          |          |          |           | 5.1      |
| TSS, mg/L                 | 80               | 12              |          |          |           |          |           |          |          |          |           | 28       |
| Phosphate, mg/L           | 0.5              | 1.40            |          |          |           |          |           |          |          |          |           | 1.23     |
| Fecal Coliform, MPN/100mL | 200              | 490,000         | 130,000  | 330,000  | 1,300,000 | 490,000  | 5,400,000 | 49,000   | 330,000  | 490,000  | 1,300,000 | 7,800    |
| pH                        | 6.5 - 9          | 8.15            |          |          |           |          |           |          |          |          |           | 8.54     |
| Nitrogen, mg/L            | 7                |                 |          |          |           |          |           |          |          |          |           | 2.97     |
| Chlorides, mg/L           | 350              | 378             |          |          |           |          |           |          |          |          |           |          |
| Ammonia, mg/L             | 0.05             | 0.007           |          |          |           |          |           |          |          |          |           |          |

Source: Status of Implementation of 2017-2022 OPMBCS Report, DENR-R4A. 1st Quarter 2018; DENR R4 Water Quality Status (Cavite), 20 Nov 2019; & EMB IV-A Water Quality Information System (wqis.emb.gov.ph). 1<sup>st</sup> Q 2020.

Note: Highlighted values are below/ exceedances in DAO 2016-08 Criteria for Class C waters.





Source: Status of Implementation of 2017-2022 OPMBCS Report, DENR-R4A. 1<sup>st</sup> Quarter 2018

Figure 2.2-93. Maalimango and Cañas Rivers Sampling Stations (DENR-R4A)





### 2.2.3.3 Degradation of Coastal / Marine Water Quality

The following factors are considered in the assessment of marine water quality degradation and are similar to those relating to degradation of surface waters.

- The sources of wastewater are not point sources but mobile sea vessels; and
- The wastewater are relatively small inflows; the population of the vessels which could generate domestic wastewater is small estimated at fifty (50) vessel personnel

The period for generation of wastewater is short-lived; e.g., the TSHD will operate only for 15 hours/day and 300 days/year at a total operating time of 54600 hours (2 275 days) or maximum of approximately 6 years.

The major contributors to potential marine water quality degradation are:

- Fugitive silt (Suspended Solids) generated during the dredging activities at the project site.
- Oil and Grease from accidental oil spills from the vessels; and
- Domestic waste water from the vessel crews.

### Water Quality Parameters and Test Results

The test results are shown in Table 2.2-41, while the sample locations are included in Figure 2.2-92 above.

The primary data indicate that seawater in the vicinity of the project site are mostly within the limits for Class SB waters except for: the DO levels of samples C-D2 to C-D4; fecal coliform of samples C-D1; and Total Coliform of C-D1 and C-D2. The metal contents such as arsenic, mercury, cadmium, chromium, lead and selenium, are all below detection limits. The ammonia, sulfate and boron contents from stations C-D3 to C-D4 exceed the Class SB standards.

### Additional Baseline Data Gathering, June 23, 2020

Marine water sampling was conducted June 24, 2020 which was set along the perimeter, outside of the proposed island, with stations on each side/direction (N, S, E, W) as presented in Table 2.2-41a and Table 2.2-42 for the results. These stations (denominated as MP-D1 to MP-D4) are shown in Figure 2.2-93a below.

The results showed that Total Coliform for stations South and East exceeded the allowable limits. Sulfate and Copper parameters failed to all stations while the Oil and Grease revealed higher for North, South and East. The rest of the parameters passed the standards.

**Table 2.2-41a Island D Marine Sampling Stations Coordinates**

| Point                           | Latitude      | Longitude      |
|---------------------------------|---------------|----------------|
| <b>Island D</b>                 |               |                |
| <b>Monitoring stations</b>      |               |                |
| MP-D1                           | 14°26'49.76"N | 120°51'22.43"E |
| MP-D2                           | 14°25'49.09"N | 120°51'26.59"E |
| MP-D3                           | 14°26'15.22"N | 120°50'47.89"E |
| MP-D4                           | 14°26'17.26"N | 120°52'4.86"E  |
| <b>Marine Sampling stations</b> |               |                |
| C-D1                            | 14°25'59.16"N | 120°52'7.11"E  |
| C-D2                            | 14°26'31.99"N | 120°51'7.77"E  |
| C-D3                            | 14°26'23.94"N | 120°51'46.33"E |
| C-D4                            | 14°26'5.43"N  | 120°51'10.10"E |



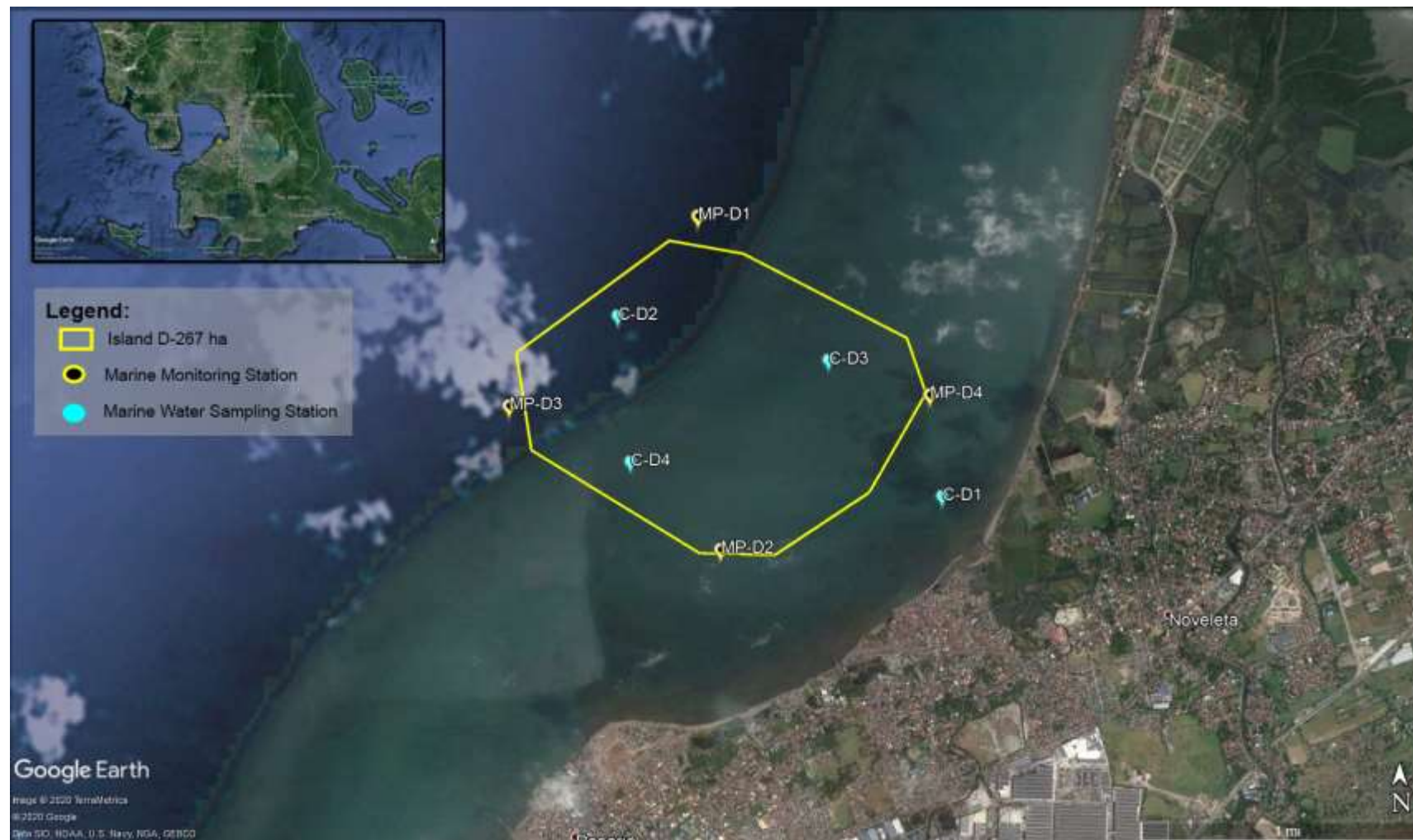
Table 2.2-42. Seawater Quality Test Results (Primary Data)

| Parameter              | Test Methods                           | Class SB Standard | Unit      | Test Results, June 24, 2020 |                     |                     |             | Test Results    |         |                  |         |
|------------------------|--|-------------------|-----------|-----------------------------|---------------------|---------------------|-------------|-----------------|---------|------------------|---------|
|                        |  |                   |           | North (MPD1)                | South (MPD2)        | East (MD3)          | West (MPD4) | C-D1            | C-D2    | C-D3             | C-D4    |
| Date of Sampling       |  |                   |           |                             |                     |                     |             | 18 October 2017 |         | 17 February 2019 |         |
| Total Coliform         | Multiple Tube Fermentation Technique   | 100               | MPN/100mL | 23                          | 1.7x10 <sup>2</sup> | 2.2x10 <sup>2</sup> | 7.8         | 3,500           | 170     | <1.8             | 4.5     |
| Fecal Coliform         | Multiple Tube Fermentation Technique   | 100               | MPN/100mL | 7.8                         | 4.5                 | 49                  | 4.5         | 1,700           | 11      | <1.8             | 4.5     |
| Total Suspended Solids | Gravimetry (SM2540 D)                  | 50                | mg/L      | 20                          | 30                  | 27                  | 3           | 31              | 28      | 7.0              | 24      |
| Oil & Grease           | Gravimetry (n-Hexane Extraction)       | 2                 | mg/L      | 5.0                         | 5.0                 | 4.0                 | <0.1        | 0.3             | 0.5     | 0.44             | 0.44    |
| pH                     | Electrometric Method                   | 7.0-8.5           | mg/L      | 6.54                        | 6.78                | 5.84                | 5.51        | 7.9             | 7.6     | -                |         |
| COD                    | Open Reflux Method (SM5220B)           | NA                | mg/L      | 38                          | 52                  | 51                  | 51          | 60              | 74      | 209              | 144     |
| Arsenic                | SDDC, Spectrophotometry                | 0.01              | mg/L      | <0.001                      | <0.001              | <0.001              | <0.001      | <0.01           | <0.01   | <0.008           | <0.008  |
| Mercury                | Manual Cold Vapor AAS                  | 0.001             | mg/L      | <0.0003                     | <0.0003             | <0.0003             | <0.0003     | <0.0002         | <0.0002 | <0.0002          | <0.0002 |
| Cadmium                | Flame AAS-MIBK Extraction              | 0.003             | mg/L      | <0.003                      | <0.003              | <0.003              | <0.003      | <0.001          | <0.001  | <0.001           | <0.001  |
| Chromium (Hexavalent)  | Diphenylcarbazide, Colorimetric Method | 0.05              | mg/L      | -                           | -                   | -                   | -           | <0.005          | <0.005  | <0.002           | <0.002  |
| Lead                   | Flame AAS-MIBK Extraction              | 0.01              | mg/L      | <0.001                      | <0.001              | <0.001              | <0.001      | <0.005          | <0.005  | <0.005           | <0.005  |
| Selenium               | ICP – OES                              | 0.01              | mg/L      | <0.001                      | <0.001              | <0.001              | <0.001      | -               | -       | <0.01            | <0.01   |
| Ammonia                | Phenate Method (SM 4500-NH3 F)         | 0.05              | mg/L      | 0.060                       | 0.023               | 0.041               | 0.016       | -               | -       | 0.3              | 0.2     |
| Sulfate                | Turbidimetric Method                   | 250               | mg/L      | 477                         | 477                 | 1,016               | 1,016       | -               | -       | 1,940            | 2,220   |
| Boron                  | Carmine Method                         | 0.5               | mg/L      | -                           | -                   | -                   | -           | -               | -       | 4.0              | 4.1     |
| Fluoride               | SPADNS Method (SM4500-F D)             | 1.5               | mg/L      | 0.9                         | 0.9                 | 0.9                 | 0.9         | -               | -       | 1.1              | 1.1     |
| Temperature            | Laboratory Method                      | 26-30             | °C        | 20.0                        | 20.0                | 20.0                | 20.0        | -               | -       | -                | -       |
| Color                  | Visual Comparison                      | 50                | mg/L      | 5@pH 6.54                   | 5@pH 6.78           | 5@pH 5.84           | 5@pH 5.51   | -               | -       | -                | -       |
| Chloride               | Argentometric                          | n/a               | mg/L      | 18,576                      | 19,514              | 18,168              | 20,475      | -               | -       | -                | -       |
| Phosphates             | Stannous Chloride                      | 0.50              | mg/L      | 0.026                       | 0.041               | 0.062               | 0.154       | -               | -       | -                | -       |
| Nitrates               | Brucine-Sulfanilic                     | 10                | mg/L      | <0.003                      | <0.003              | <0.003              | <0.003      | -               | -       | -                | -       |
| Surfactants            | Methylene Blue                         | 0.30              | mg/L      | <0.01                       | <0.1                | <0.1                | <0.1        | -               | -       | -                | -       |
| Phenols                | Chloroform Extraction                  | 0.001             | mg/L      | <0.003                      | <0.003              | <0.003              | <0.003      | -               | -       | -                | -       |
| Benzene                | Gas Chromatography/FID                 | 0.01              | mg/L      | <0.01                       | <0.01               | <0.01               | <0.01       | -               | -       | -                | -       |
| Barium                 | Flame AAS                              | 0.70              | mg/L      | <0.1                        | <0.1                | <0.1                | <0.1        | -               | -       | -                | -       |
| Copper                 | Flame AAS                              | 0.02              | mg/L      | 0.630                       | 0.640               | 0.641               | 0.641       | -               | -       | -                | -       |
| Nickel                 | Flame AAS                              | 0.04              | mg/L      | <0.03                       | <0.03               | <0.03               | <0.03       | -               | -       | -                | -       |
| Manganese              | Flame AAS                              | 0.40              | mg/L      | <0.01                       | <0.01               | <0.01               | <0.01       | -               | -       | -                | -       |
| Zinc                   | Flame AAS                              | 0.50              | mg/L      | <0.1                        | <0.1                | <0.1                | <0.1        | -               | -       | -                | -       |

Date Sampled: Oct 18, 2017, Feb 17, 2019 and Sep 26, 2019

Analyzed by: CRL Environmental Corporation; Red highlight indicates the sample is beyond DENR standard





Source: Base Map: 2020 Google Earth

Figure 2.2-93a Map of Marine Quality Sampling Stations



***Impacts Analysis. Possible Increase in the Degree of Pollution Loadings Due to the Proposed Project.***

*It is imperative to note that the assessment of the degree of pollution loadings be reckoned from the perspective of the Scope of the Project, which is confined to the formation of land and that the activities post the reclaimed land are aspects of the “Operations Phase “. “Reclamation” covers only the formation of the land to horizontal development and does not include the “Operations Phase”, the latter involving vertical developments and the works/activities of the various locators in the reclaimed land. Moreover, the receptors of pollution load during the reclamation works are the marine species. Thus, increases in pollution should be confined to this phase of the work only. There will be no wastewater discharges during this phase.*

The main concern during this phase is silt loadings arising from disturbance of the seabed during dredging and filling at the project site.

The mitigating measures for silt loadings are adequately discussed in the other sections of the EIS and are essentially:

- The use of silt curtains and containment walls;
- Unwanted sea bed materials will be likely disposed also in portions of Manila Bay likely outside the project site and will be subject to separate clearances and permitting processes; and
- Dissolved Oxygen, COD, coliform, Oil and Grease and metallic discharges are more relevant during the operations phase (Phase 2).

**Impact Analysis, Mitigating Measures and Monitoring**

The short-term dredging and reclamation activities will be primarily confined to the ships. The potential sources of water quality degradation are: discharges of bilge water; accidental oil spills; and silt dispersal.

Mitigation consists of: observance by the vessel operator/management of the MARPOL Convention relating to Pollution Control; onboard treatment of bilge water; maintenance of ship facilities especially of fuel-using equipment to avoid accidental oil spills; and use of onboard oil spill containment and recovery systems. Compliance; observance of the Philippine Coast Guard safeguards and of the Manila Bay Oil Contingency Plan; and use of silt curtains and of containment structures.

Monitoring will be undertaken at sites wherein the vessels operate including along the navigational lane to the San Nicholas Shoal. Moreover, suspended solids, oil and grease content of discharges are the important monitoring parameters.

**2.2.4 Freshwater Ecology**

The Ligdong/Maalimango River was inspected by the marine survey team on 17 February 2019. The river is extremely polluted with dark gray water (Plate 2.2-3, Figure 2.2-94). Fish biota is apparently limited to Tilapia but even as this is the case, dead tilapias were floating in the river, obviously caused by oxygen depletion in the water column. River pollution is evidently caused by sewage outfalls and domestic wastewater from households lining up the river. The riverbank has been sequestered by concrete household walls and barriers. Other than plants and palm trees inside the house compounds, no significant vegetation was observed. No fisheries activities occur. The width of the river varies from 8 to 10 meters, with almost stagnant flow.



**Plate 2.2-3. The heavily polluted Maalimango River with dead tilapia (encircled).**



**Mitigating Measures:**

To ensure the protection of the nearby freshwater bodies in the area, the Proponent shall install appropriate silt curtains around the work area to prevent silt dispersal. Solid waste and wastewater management shall be strictly implemented and there will be no discharges of the wastes to the bay.

River quality parameters will be monitored on a quarterly basis, starting with fresh baseline assessment prior to start-up of reclamation activities. Monitoring will include aquatic biota – freshwater species diversity, abundance, species richness and biomass, fishing practices and catch rates, turbidity, depth and river vegetation especially in the estuary.



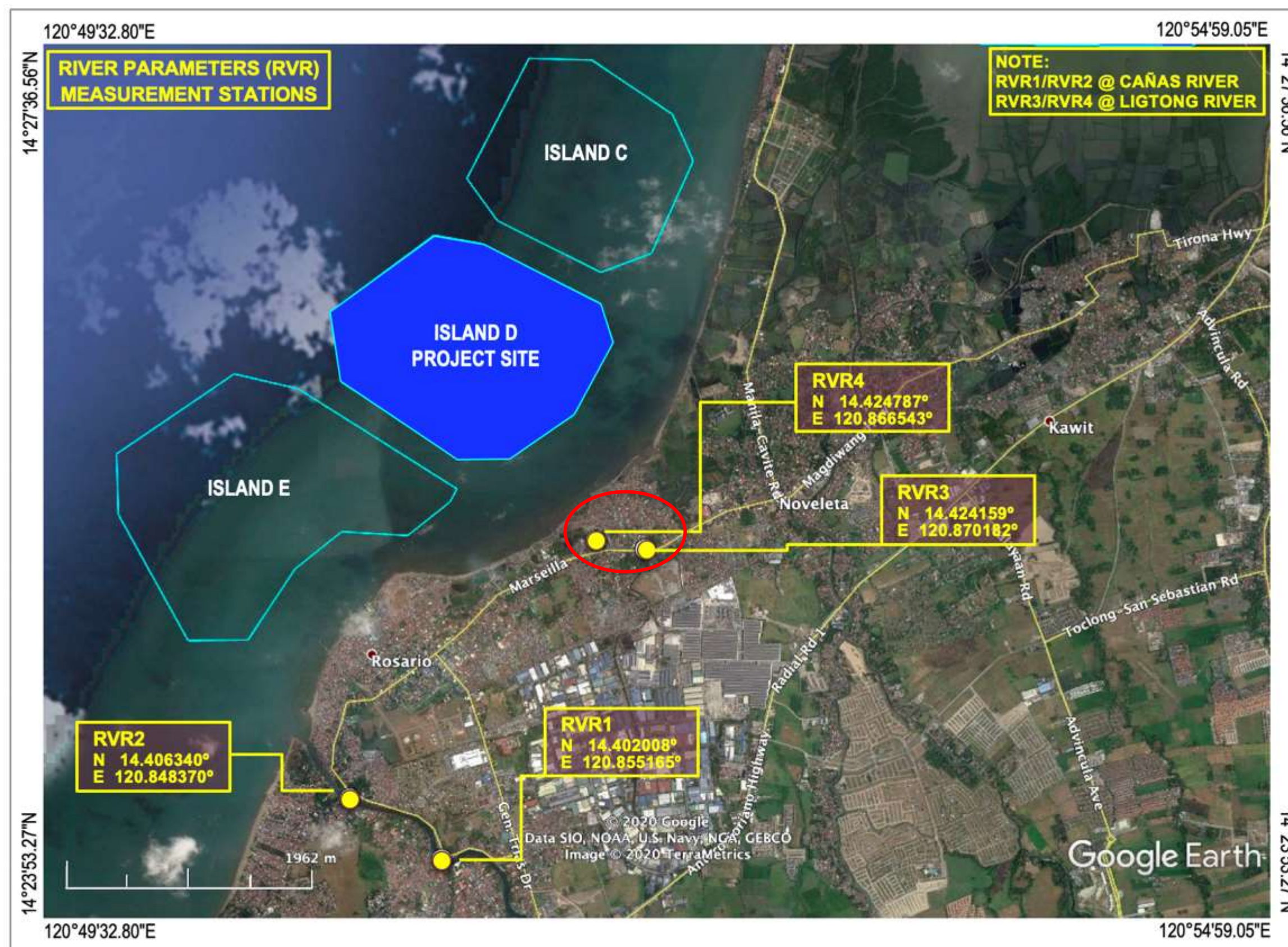


Figure 2.2-94. Location of Observation Stations inside the Maalimango River in Noveleta, Cavite, February 2019.





## **2.2.5 Marine Ecology**

### **2.2.5.1 Survey Area and Objectives**

The proposed Cavite Reclamation and Development Project: Islands A to E – are spread out in the municipalities of Rosario and Noveleta, and in Cavite City. (Figures 2.2-95 and 2.2-96):

All the proposed reclamation islands are located in nearshore coastal waters of outer Manila Bay. Island D straddles part of the coastline of Rosario and the 3-kilometer coastline of Noveleta, starting in Barangay Ligton, Rosario. The coastal water in the proposed reclamation island is shallow, ranging from 1.25 to 2.5 fathoms in a broad shelf extending 1.5 kilometers from the shoreline (Plate 2.2-4).

A comprehensive *in-situ* marine ecology baseline assessment in the “islands” of the proposed reclamation Project was conducted as part of the overall Environmental Impact Assessment (EIA) study associated with the establishment of the project. The survey aimed to define the benthic morphology of the proposed site for reclamation and validate presence or absence of coral reef habitats or similar benthic life forms and resources. A team of fisheries biologists, a GIS specialist, a plankton/harmful algal bloom specialist and a marine biologist, undertook the survey on October and November 2018 and recently on February 16 to 17, 2019 (Plate 2.2-4). The survey was conducted in the broader impact area of the proposed reclamation project, focusing on identifying and describing benthic habitats and resources in the direct impact area of the proposed reclamation, in order to identify and define the distribution and condition of specific ecological niches and ecosystem functions that can be susceptible to anthropogenic disturbances arising from the project. The characterization of susceptible endpoints, particularly benthic resources, and identification of causes and pathways that carry stressors will enable informed decision-making and provide valuable data from where mitigating measures can be drawn. Moreover, the baseline data set can provide a comparable index from where future monitoring data can be comparatively analyzed in order to distinguish impacts of the project and effectiveness of mitigating measures.

Coastal waters are perennially turbid, with two river systems (Maalimango/Ligton River in Noveleta and Wawa/Cañas River in Rosario) draining murky water into the coastal sea. These rivers are the principal receiving water bodies for drainage and sewage system in the 2 municipalities. Coastal waters in the rest of the areas proposed to be reclaimed are also turbid and solid wastes are wantonly disposed into the Bay or carried through canals from communities and market halls in the three municipalities and Cavite City. Pre-survey anecdotal accounts from key informants revealed that the proposed area to be reclaimed are largely devoid of significant benthic life form communities, particularly corals and similar benthic life forms that can serve as habitats for cryptic and demersal species of marine animals. Coastal waters are immensely contaminated by domestic wastewater and the reduced sunlight penetration in the water column has rendered the nearshore seabed as unlikely settlement areas for coral recruits. On the other hand, most of the coastline of the municipalities where the proposed reclamation ‘islands’ are to be established have been virtually sequestered and converted into household settlements, breakwater structures, boat docks and household fortifications.



**Plate 2.2-4. The coastline and coastal waters in the proposed island D reclamation area in Noveleta and Rosario, Cavite.**







Source: 2017 Google Earth Map

Figure 2.2-95. Map of Marine Surveys Areas for the Cavite Reclamation Projects.



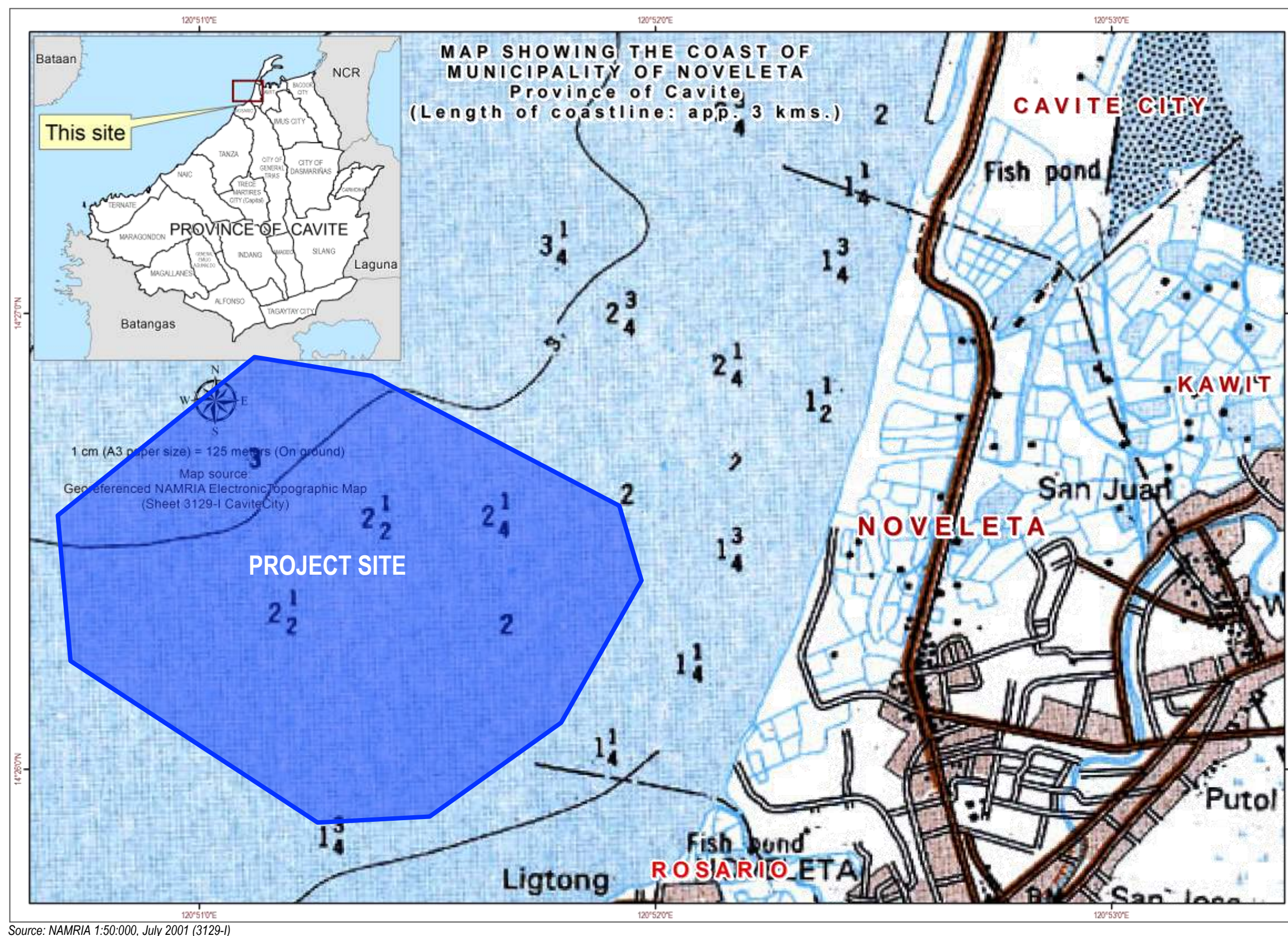


Figure 2.2-96. The Coastline and General Coastal Habitat Type in the Municipalities of Noveleta and Rosario, Cavite.





### 2.2.5.2 Survey Methods and Survey Stations

Standard scientific survey methods prescribed in the marine survey manual formulated by *English, et. al.* (1997) was employed in investigating various ecological attributes of the coastal environment. The scope of the assessment includes the following:

***Validation of presence or absence of benthic life forms - corals and coral-associated fauna and define the nature of the benthic environment.***

Two methods were employed to characterize benthic habitats, characterize the nature of the seabed and substrate, and validate the presence or absence of coral life forms and associated benthic habitats:

#### ***Broad Area Manta Tows***

Intensive manta tow surveys employing supplementary 'tuck dives' and systematic snorkeling with free dives in shallower portions of the proposed reclamation area were conducted to determine the general benthic morphology in all of the proposed five islands. Manta tow surveys enable the observation of the benthic environment and substrate composition through systematic snorkeling over a broad swath of coastal area by an observer being towed slowly. In areas where significant coral reefs occur as discerned from spot dives and key informant interviews, results from a manta tow survey is used to pinpoint the location of specific stations where more detailed underwater coral characterization employing line intercept transects can be undertaken. To the extent possible the entire stretch of nearshore shallow waters where project "island" is located were subjected to intensive manta tows and validation dives as indicated in Figure 2.2-97. In Island D, a total of 20 manta tows with 'tuck dives' were completed covering a linear distance of 4.8 km.

Benthic observations on the seabed during the manta tow observations also aimed to locate seagrass beds and macro algal colonies if they occur in the area, as well as document diversity of demersal fish aggregations if such resources are encountered. The manta tow observation pathways are displayed in Figure 2.2-97; the coordinates of the stations surveyed is shown in Table 2.2-46 (under Chapter 2.2.4.3 - discussion of survey results).

#### ***Seabed and Substrate Spot Dives***

In as much as coastal waters in study area turbid, the survey team undertook periodic validation dives aided with underwater torch in order to confirm that no other benthic fauna occur in the vicinity of the muddy substrates observed in the manta tow pathways. A total of four (4) spot/validation dives were completed (Figure 2.2-98; Plate 2.2-5), with two dives inside and two dives outside the proposed reclamation area. The spot dives involved the inspection of the benthic condition over a 10-meter diameter radius around the spot dive points. The coordinates of the stations are listed in Table 2.2-43. In the same stations, the nature of sediment and substrate were documented and samples were obtained.

**Table 2.2-43. Coordinates of Spot Dive (SPD) Stations in the Proposed Island D; February 2019.**

| WP Code | LATITUDE     | LONGITUDE      | Remarks   |
|---------|--------------|----------------|---|
| SPD-D1  | N 14.444526° | E 120.849637°  | Dive station located outside of the proposed reclamation area in the NW; depth at 7.5 m |
| SPD-D2  | N 14.438736° | E 120.856949°  | Inside the proposed reclamation area; central portion; depth at 6.5 m                   |
| SPD-D3  | N 14.432623° | E 120.8659778° | Outside the proposed reclamation area about 700 m from the coastline; depth at 4.7 m    |
| SPD-D4  | N 14.433490° | E 120.859570°  | Inside the proposed reclamation area in the southern sector; depth at 6.2 m             |

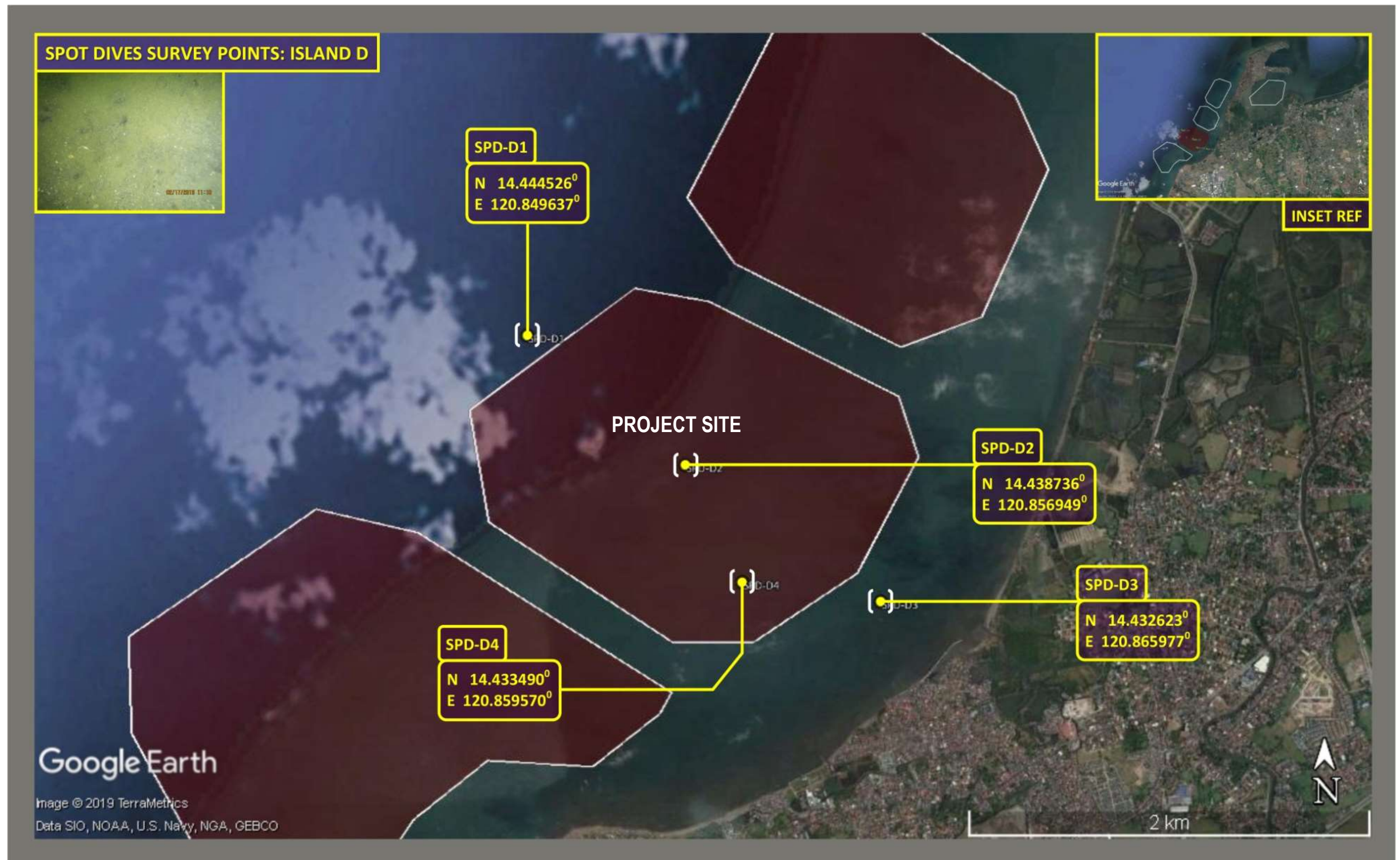




Base Map: 2018 Google Earth Map

Figure 2.2-97. Manta Tow Pathways in Island D; Oct and Nov 2018 and February 2019.





Base Map: 2019 Google Earth Map

Figure 2.2-98. Location of Spot Dives in Island D; October and Nov 2018 and Feb 2019.



**Plate 2.2-5. Spot Dives with Scuba in Island D; February 2019.**



### Fisheries and Fishing Practices

As in Rosario, the dominant fisheries in Noveleta is the use of encircling gill nets to capture sardines locally called “law-law”. The main fishing fleet is based in Barangays Ligton and San Rafael. About 100 hectares in the shoreline is devoted to aquaculture in fish ponds, principally in Barangay San Rafael. While catches of the eminent ‘law-law’ sardines have remained robust, although fluctuating seasonally, fishers claim that catches of demersal species have decreased considerably, and the increasing dominance of juvenile fish in the catch of hook and line and small gill net fishers indicate an overfished stock. The fisheries situation is exacerbated by the use of illegal and ‘active’ fishing gears in offshore fishing grounds and competition from highly efficient commercial fishing boats. The illegal gears include motorized push nets, large ring nets, use of fine mesh nets and explosives. Unproductive fisheries have caused fishers with larger boats to fish farther offshore and only a handful of small-scale fishers employing cast net, spear and small gill nets were encountered during the survey. A total of eight (8) actual fishing encounters (AFE) were observed and documented during the survey across five reclamation islands. In a follow-up survey, a lone fisher using gill net to catch swimming crabs was also documented. In the absence of reef-associated fish assemblages, identification of pelagic fish species present in the area at the time of survey was undertaken through boat-based surveillance and opportunistic observations of catch rate and catch composition of actual fishing operations of fishing boats encountered at the time of the surveys, mostly using ring net, hook and line and gill nets. Fisheries profiling was reinforced with Key Informant (KI) interviews in the Rosario Fish Port and in Barangay Pandawan to validate dominant fisheries resource practices, catch composition and indicative productivity of fishing gears.

The coordinates of the actual fishing encounters and fish observations are listed in Table 2.2-44 and locations are shown in Figure 2.2-99.

**Table 2.2-44. Coordinates of Actual Fishing Encounters (AFE)s in and nearby Island D; Oct and Nov 2018 and Feb 2019**

| WP Code       | LATITUDE     | LONGITUDE     | Remarks   |
|---------------|--------------|---------------|---|
| AFE – Feb2019 | -            | -             | Crab gill net fisher operating inside Island D  |
| AFE3          | N 14.431330° | E 120.869960° | Lone fisher using cast net in Ligton/Maalimango River estuary in the boundary of Rosario and Noveleta; Island D                         |
| AFE4          | N 14.406250° | E 120.848778° | Two fishers using cast net to catch Tilapia inside the Wawa River about 600 meters from river mouth.                                    |
| AFE5          | N 14.432900° | E 120.856640° | Two small-scale fishers operating in southern corner of proposed island D using gill net  |
| AFE8          | N 14.442183° | E 120.858152° | 6 fishers in motorized boat using surrounding gill net to catch sardines, approximately 1.6 km from shoreline inside proposed island D. |



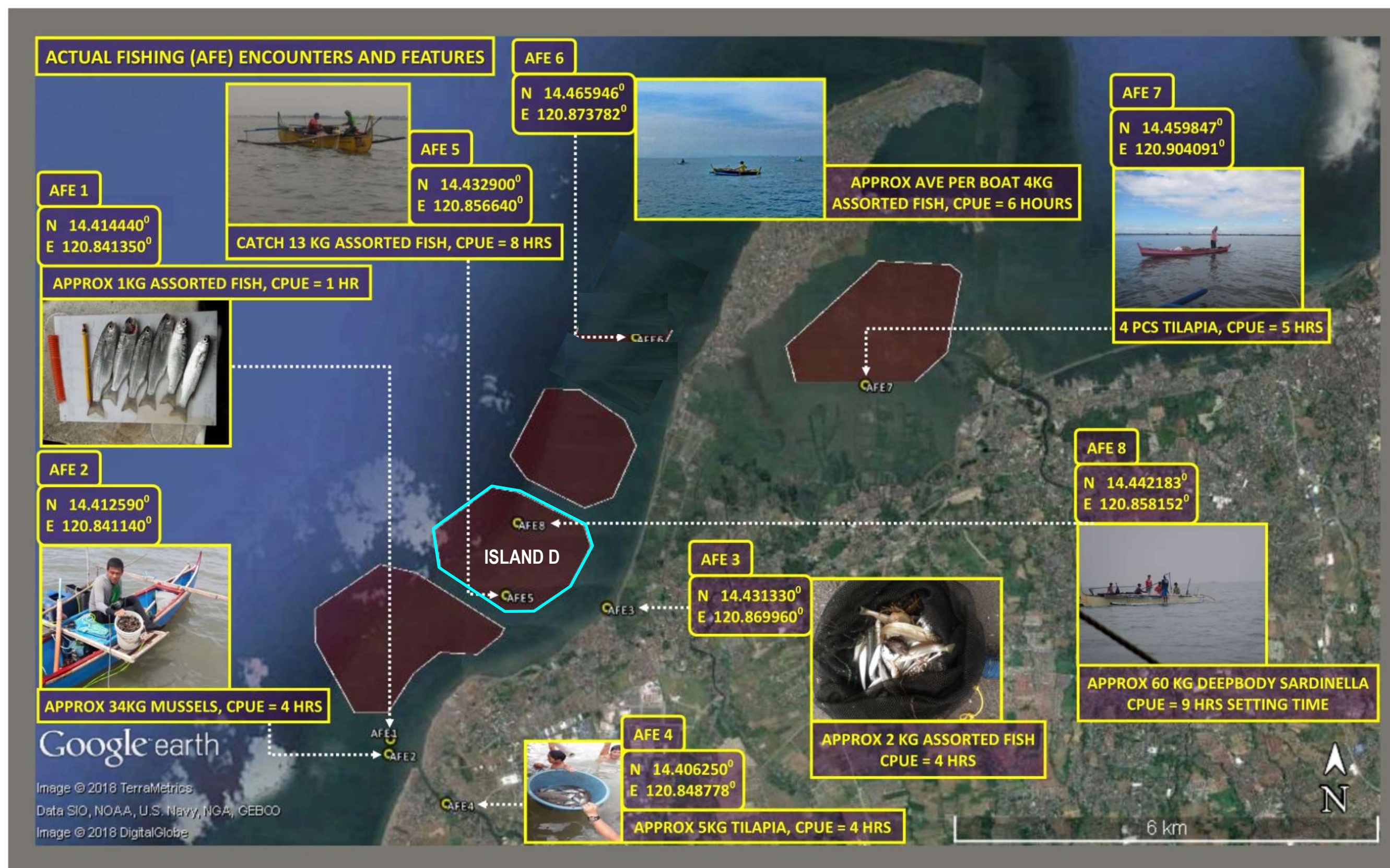


Figure 2.2-99. Location of Actual Fishing Operations Documented Across the Study Area; Nov 2018 and Feb 2019





## Plankton Community

Composition, abundance and density of phytoplankton communities was analyzed from water samples taken in twenty-four (24) stations spread out across the five 'islands' of the proposed reclamation area. Plankton samples were collected using a 20 µm plankton net with a mouth diameter of 0.3m. In every station, the plankton net was lowered at 1m and hauled at a rate of about 0.5m/sec. Duplicate samples of zoo- and phytoplankton were collected for each station and placed in properly labeled plastic containers. Phytoplankton samples were preserved with Lugol's solution, while samples of zooplankton were fixed with 10% formalin immediately after collection. For phytoplankton samples, a 1ml aliquot subsample was placed in a Sedgewick-Rafter cell counter and was examined under a Nikon Alphaphot II YS2 microscope. For zooplankton samples, a 1ml aliquot subsample was placed in a Petri dish with grids and examined under a microscope. Phytoplankton will be counted and identified to the lowest taxonomic level (genera) possible using standard taxonomic guide. Zooplankton will be identified to major groups using available references. Analysis of diversity and abundance was undertaken employing the Shannon-Weaver Diversity/Evenness Indices and bio-assessment metrics. Identification of harmful algal bloom-causing plankton (HAB) was undertaken in the UP MSI laboratory. The plankton station coordinates are detailed in Table 2.2-45 and a map of station location is shown in Figure 2.2-100; also see Plate 2.2-6.

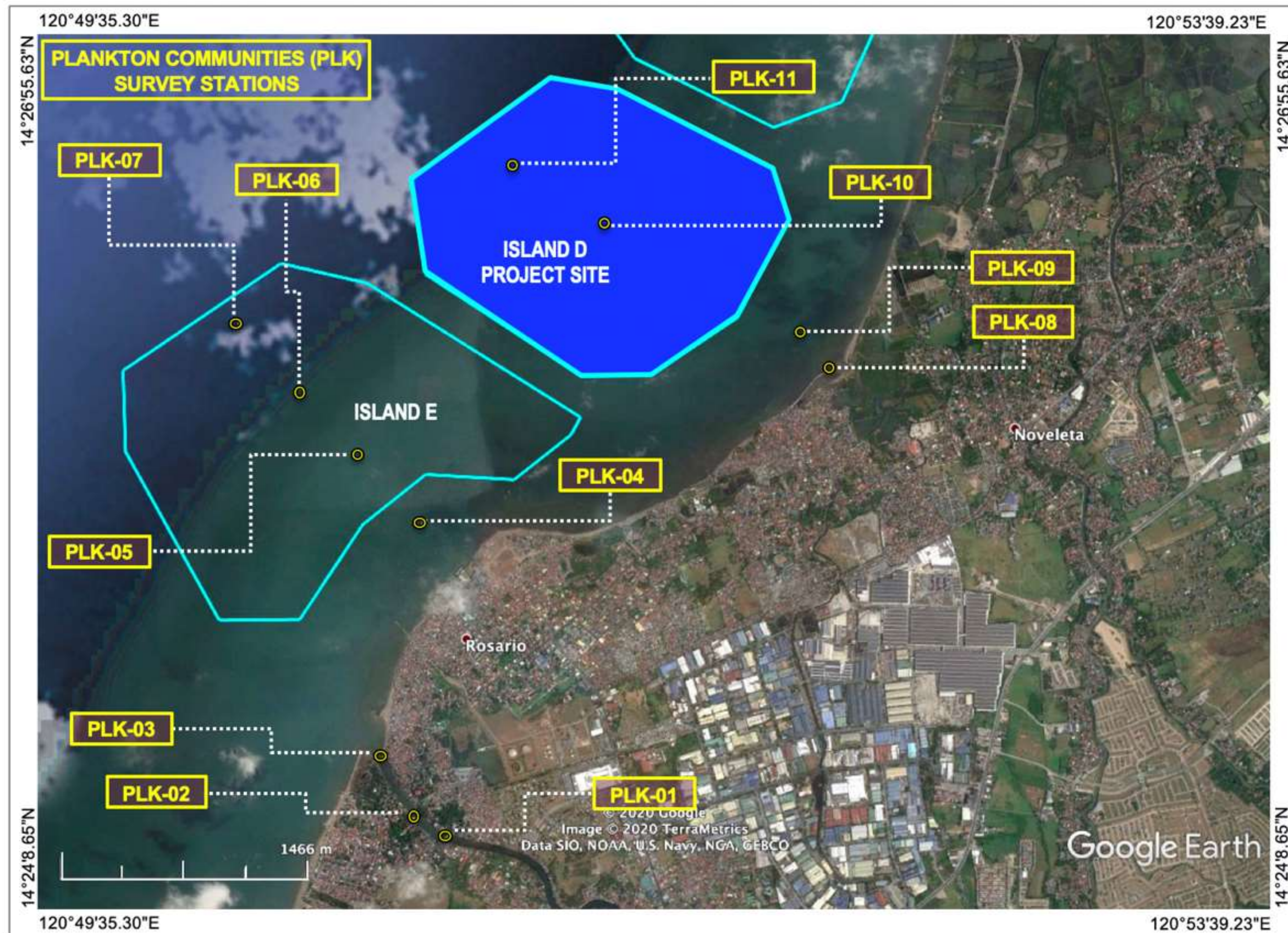
**Table 2.2-45. Coordinates of Plankton Sampling Stations inside Island D; November 2018**

| Station | Northing     | Easting       | Remarks   |
|---------|--------------|---------------|---|
| PLK08   | N 14.431167° | E 120.869889° | Dominant phytoplankton <i>Pseudonitzschia</i> spp. at 3,500 cells/L, while dominant zooplankton nauplius (larval form) at 34,200 indiv/m <sup>3</sup>       |
| PLK09   | N 14.433000° | E 120.868278° | Dominant phytoplankton <i>Pseudonitzschia</i> spp. at 176 cells/L, while dominant zooplankton cyclopoid copepod (adult form) at 56,700 indiv/m <sup>3</sup> |
| PLK10   | N 14.438833° | E 120.857528° | Dominant phytoplankton <i>Skeletonema</i> spp. at 344 cells/L, while dominant zooplankton nauplius (larval form) at 34,600 indiv/m <sup>3</sup>             |
| PLK11   | N 14.441972° | E 120.852472° | Dominant phytoplankton <i>Pseudonitzschia</i> spp. at 6,514 cells/L, while dominant zooplankton nauplius (larval form) at 45,600 indiv/m <sup>3</sup>       |

**Plate 2.2-6. Plankton sampling and benthos sorting being undertaken; Nov 2018 and Feb 2019**







Base Map: 2020 Google Earth Map

Figure 2.2-100. Location of Plankton Community Sampling Stations; Nov 2018 and Feb 2019





### Macro-invertebrates of Commercial Significance

Benthic and in-faunal invertebrates are usually found in inter-tidal flats, seagrass and coral substrates but these habitats do not exist in the proposed Cavite Reclamation Project in as much as most of the coastlines in the site have been converted to settlement areas and breakwater structures. The survey team conducted macro-invertebrate community assessment in three stations where rocky revetments along the coastline were encountered. Coordinates are listed in Table 2.2-46 and shown in Figure 2.2-101.

Note that there were no stations established in or near Island D as there were no rocky revetments encountered.

**Table 2.2-46. Coordinates of Macro-invertebrate Survey Stations; Nov 2018.**

| WP Code | LATITUDE     | LONGITUDE     | Remarks  |
|---------|--------------|---------------|--|
| MAC1    | N 14.417550° | E 120.845870° | Located in sandy-rocky coastline near Wawa river estuary approximately 800 meters from proposed island 'E' |
| MAC2    | N 14.423060° | E 120.851100° | Located in rocky revetments of old jetty structure in Rosario near proposed reclamation island 'E'         |
| MAC3    | N 14.457060° | E 120.878553° | Locate in rocky fortifications near households in Noveleta coastline near island 'C'                       |



Base Map:: 2018 Google Earth Map

Figure 2.2-101. Location of Macro-invertebrate Stations; November 2018.





### Seagrasses and Associated Macrobenthic Algae

Manta tows and spot dives revealed absence of seagrass meadows in the sandy and muddy shelves of the proposed reclamation islands in Cavite. Algae communities were, however, observed in submerged rocks in the breakwater structures in Rosario and Noveleta but these were too sparse and uneven.

### Mangroves

A small patch of mangrove exists along the estuary of the Ligdong/Maalimango River in the boundary of Rosario and Noveleta, Cavite; in fact the only mangrove resource in the long coastline along the proposed reclamation islands C, D and E in Rosario, Noveleta and Cavite City. Two (2) stations were established and assessed employing the standard quadrat method for tree inventory, species distribution, and crown cover in the vicinity of the mangroves in the Ligdong/Maalimango River estuary about 700m east of island D. The coordinates are listed in Table 2.2-47 and shown in Figure 2.2-102.

**Plate 2.2-7. Mangroves in the Ligdong River Estuary in Noveleta (right).**



**Table 2.2-47. Coordinates of Stations Assessed for Mangrove Communities; Oct and Nov 2017**

| WP Code | LATITUDE     | LONGITUDE     | Remarks   |
|---------|--------------|---------------|---|
| MGV1    | N 14.430980° | E 120.871060° | Small patch of mangroves in the Ligdong/Maalimango River, estuary in Noveleta; Composed of 36 stands distributed in 2 species. <i>Avicennia marina</i> dominant @ 26 stands (72%) |
| MGV2    | N 14.430580° | E 120.870710° | Mangrove in the Ligdong/ Maalimango river estuary at back of station 1; composed of 23 stands distributed in 2 species. <i>Avicennia alba</i> dominant @ 13 stands (57%)          |

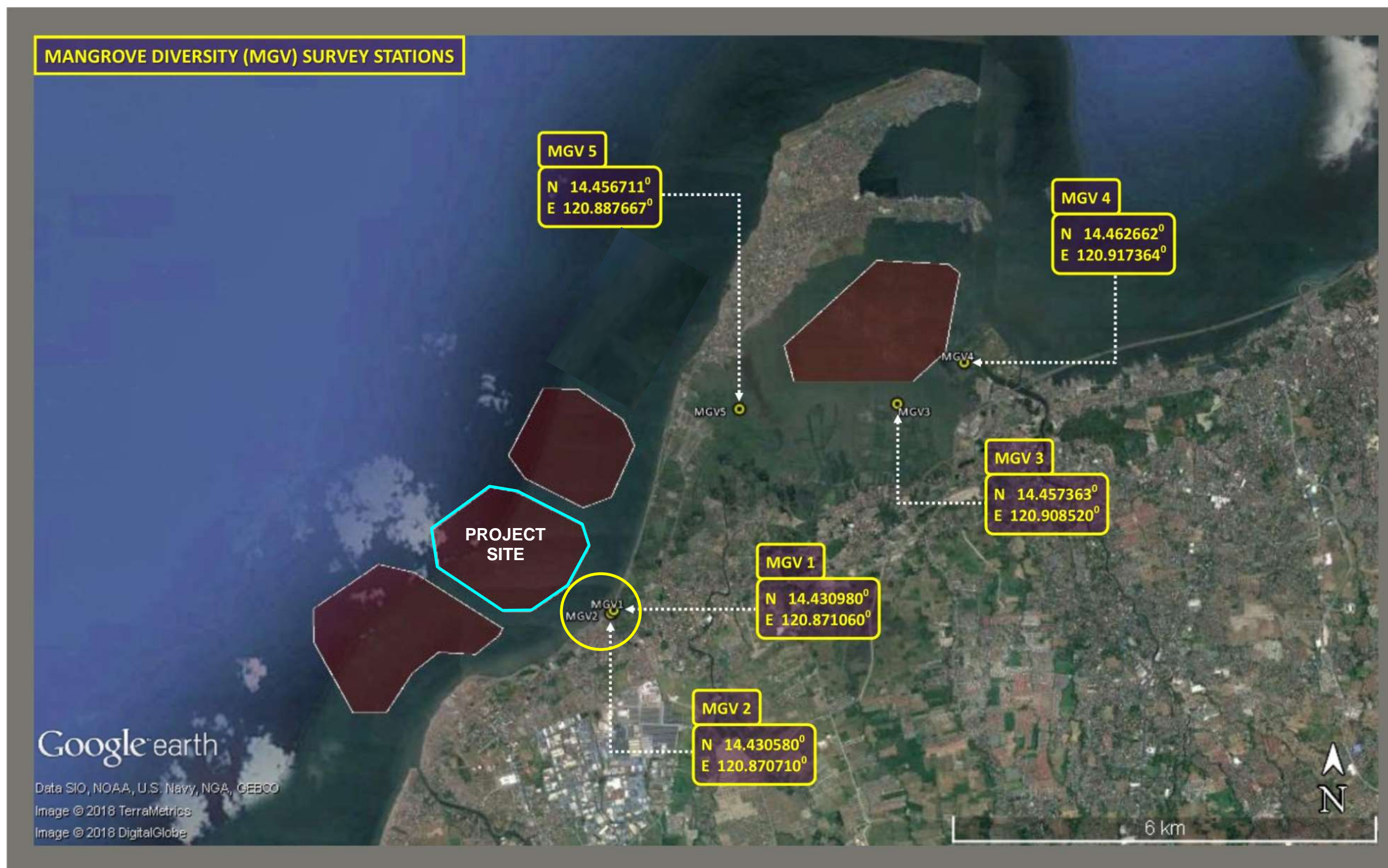
### Sediment Collection

To reinforce findings on the nature of the seabed and the absence of fragile benthic habitats in the proposed reclamation area, sediments were collected from twenty (20) stations spread across the study area. Four of the twenty stations are in Island D. The station coordinates are shown in Table 2.2-48 and Figure 2.2-103.

**Table 2.2-48. Sediment Sampling Stations in Island D.**

| WP Code | LATITUDE     | LONGITUDE     | Remarks   |
|---------|--------------|---------------|---|
| SED05   | N 14.431167° | E 120.869889° | Same coordinates as PLK08; dark gray silt/mud collected |
| SED06   | N 14.433000° | E 120.868278° | Same coordinates as PLK09; dark gray silt/mud collected |
| SED07   | N 14.438833° | E 120.857528° | Same coordinates as PLK10; dark gray silt/mud collected |
| SED08   | N 14.441972° | E 120.852472° | Same coordinates as PLK11; dark gray silt/mud collected |

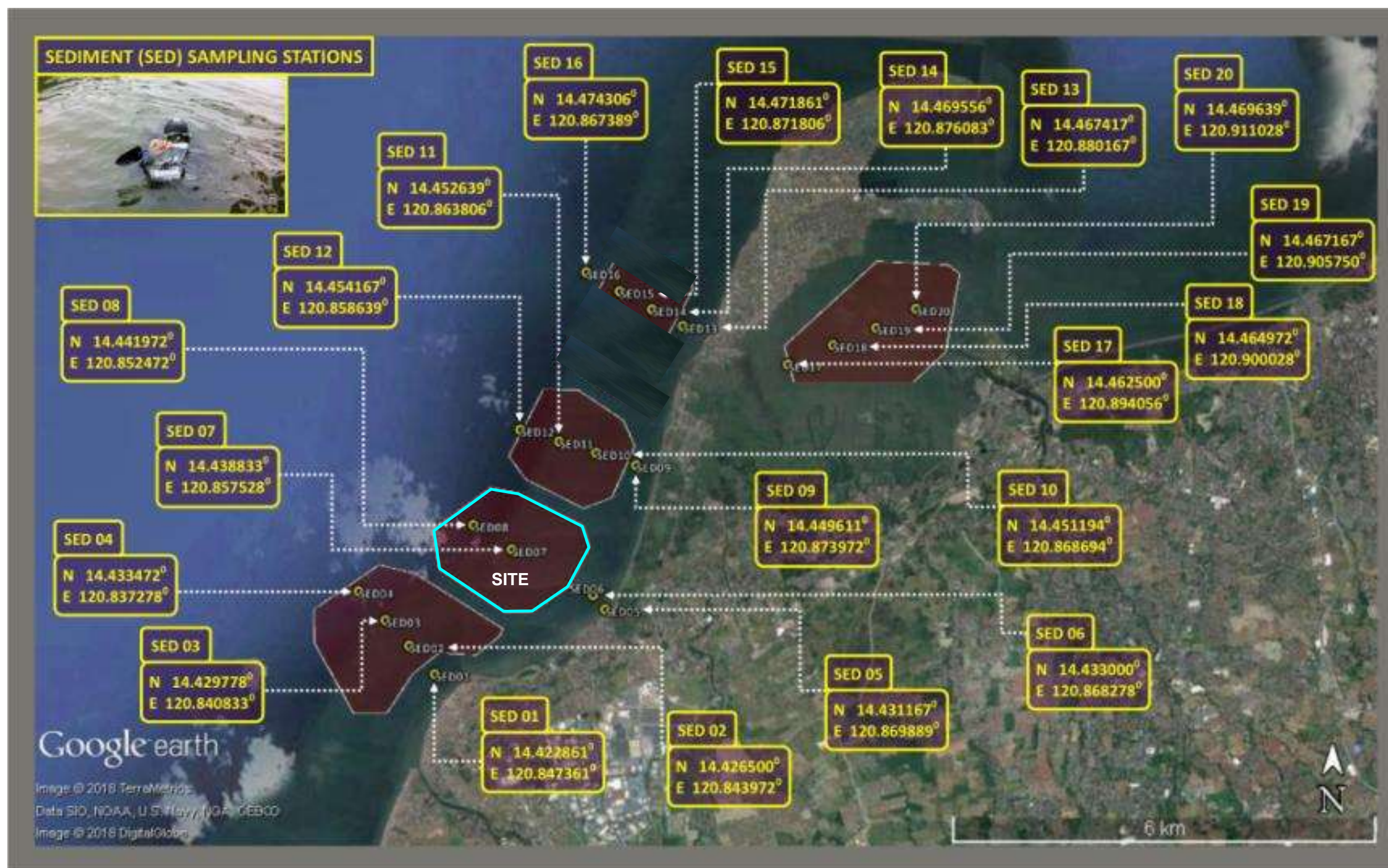




Base Map: 2018 Google Earth Map

Figure 2.2-102. Location of Two Mangrove Stations in the estuary of the Ligdong/Maalimango River; November 2018





Base Map: 2018 Google Earth Map

Figure 2.2-103. Location of Sediment Sampling Stations; Oct and Nov 2018.



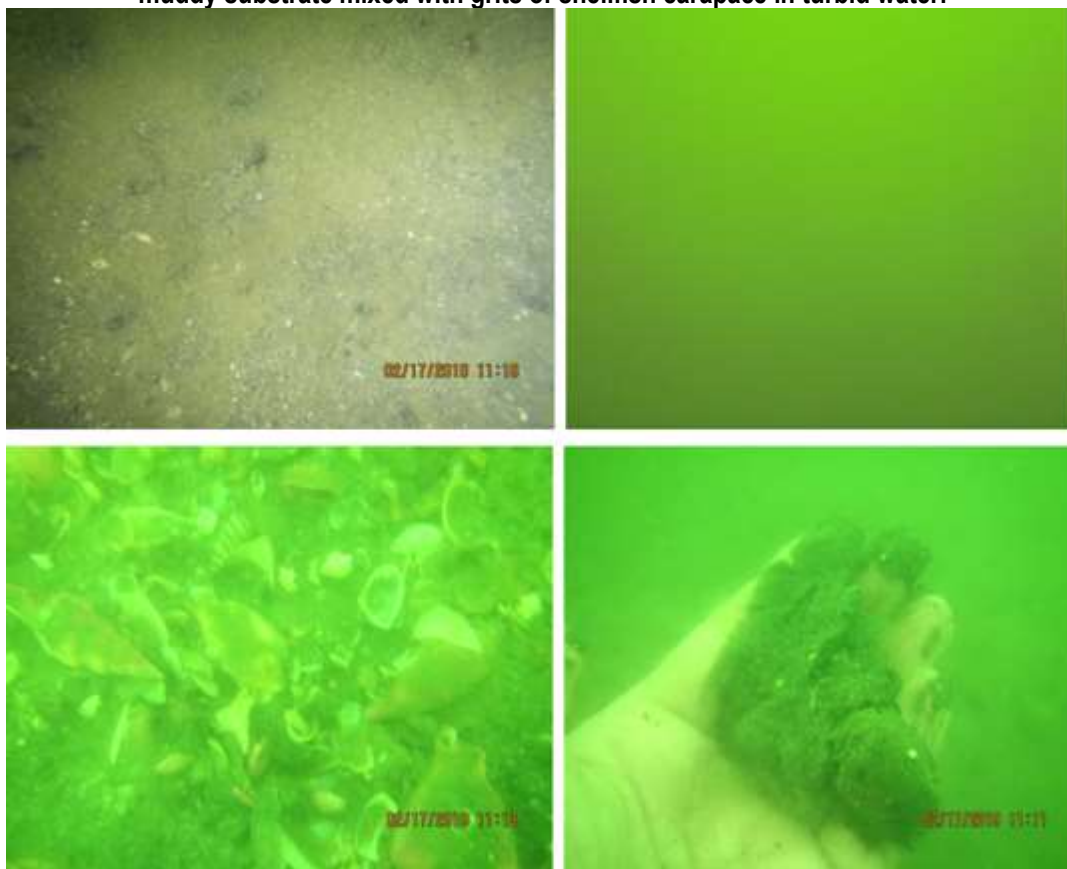


### 2.2.5.3 Results and Discussion

#### Benthic Profiling and Substrate Characterization

Twenty manta tows were undertaken, supported by 'tuck dives and free dives by boat crew, meandering across the proposed 267-hectare reclamation Island 'D' located in Noveleta up to the boundary of Rosario, Cavite. All tow and tuck dive observations recorded muddy substrate mixed with coarse sand and shellfish carapace across the entire "Island D" reclamation site. The benthic observations did not encounter coral colonies, soft corals, algal assemblages or significant underwater rocky structures that can serve as habitats for demersal species of fish, macro-invertebrates and crustaceans. The spot dives conducted in four stations to verify alleged claims by boatmen that rocky substrate occur in the area yielded negative results – only mud and silted sand were encountered (Plate 2.2-8). Elsewhere in the reclamation site, extensive systematic snorkeling around shallow portions of the sea where corals can normally thrive revealed the same absence of coral life forms. The results of manta tow surveys are presented in Table 2.2-49 and displayed in Figure 2.2-104. Note the 100% sandy substrate in Island D.

**Plate 2.2-8. Benthic environment in Island D and sediments collected revealed sandy and muddy substrate mixed with grits of shellfish carapace in turbid water.**



**Table 2.2-49. Results of 20 Manta Tow Benthic Life Form and Substrate Investigations in Island D; Nov 2018.**

| Tow Coverage | Location [DecDeg]             | LHC | SC | DC | DCA | CR | S   | Remarks  |
|--------------|-------------------------------|-----|----|----|-----|----|-----|--|
| S00d         | N 14.436642°<br>E 120.847258° | -   | -  | -  | -   | -  | -   | Start of Tow   |
| S00d-T01     | N 14.438412°<br>E 120.848143° | 0   | 0  | 0  | 0   | 0  | 100 | Turbid water; Substrate is sand and mud with shellfish grits (tuck dive) |





**CHAPTER TWO  
THE WATER**

**Proposed Cavite Province Land Reclamation and Development Project: ISLAND D (267 ha)**  
Cavite Provincial Government

| Tow Coverage                           | Location [DecDeg]             | LHC  | SC | DC | DCA | CR | S   | Remarks  |
|--|-------------------------------|--|----|----|-----|----|-----|--|
| T01-T02                                | N 14.440182°<br>E 120.848861° | 0  | 0  | 0  | 0   | 0  | 100 | Turbid water; Substrate is sand and mud with shellfish grits   |
| T02-T03                                | N 14.441738°<br>E 120.849968° | 0  | 0  | 0  | 0   | 0  | 100 | Turbid water; Substrate is sand and mud with shellfish grits   |
| T03-T04                                | N 14.442812°<br>E 120.851685° | 0  | 0  | 0  | 0   | 0  | 100 | Turbid water; Substrate is sand and mud with shellfish grits   |
| T04-T05                                | N 14.443348°<br>E 120.853845° | 0  | 0  | 0  | 0   | 0  | 100 | Turbid water; Substrate is sand and mud with shellfish grits   |
| T05-T06                                | N 14.443080°<br>E 120.856283° | 0  | 0  | 0  | 0   | 0  | 100 | Turbid water; Substrate is sand and mud with shellfish grits   |
| T06-T07                                | N 14.441203°<br>E 120.857225° | 0  | 0  | 0  | 0   | 0  | 100 | Turbid water; Substrate is sand and mud with shellfish grits   |
| T07-T08                                | N 14.439272°<br>E 120.856395° | 0  | 0  | 0  | 0   | 0  | 100 | Turbid water; Substrate is sand and mud with shellfish grits   |
| T08-T09                                | N 14.437770°<br>E 120.855287° | 0  | 0  | 0  | 0   | 0  | 100 | Turbid water; Substrate is sand and mud with shellfish grits   |
| T09-T10                                | N 14.436322°<br>E 120.853903° | 0  | 0  | 0  | 0   | 0  | 100 | Substrate is sand and mud with shellfish grits   |
| T10-T11                                | N 14.434606°<br>E 120.852741° | 0  | 0  | 0  | 0   | 0  | 100 | Turbid water; Substrate is sand and mud with shellfish grits   |
| T11-T12                                | N 14.432353°<br>E 120.852022° | 0  | 0  | 0  | 0   | 0  | 100 | Turbid water; Substrate is sand and mud with shellfish grits   |
| T12-T13                                | N 14.431389°<br>E 120.854292° | 0  | 0  | 0  | 0   | 0  | 100 | Substrate is sand and mud with shellfish grits   |
| T13-T14                                | N 14.432515°<br>E 120.856230° | 0  | 0  | 0  | 0   | 0  | 100 | Turbid water; Substrate is sand and mud with shellfish grits   |
| T14-T15                                | N 14.434071°<br>E 120.857836° | 0  | 0  | 0  | 0   | 0  | 100 | Substrate is sand and mud with shellfish grits   |
| T15-T16                                | N 14.435733°<br>E 120.859275° | 0  | 0  | 0  | 0   | 0  | 100 | Substrate is sand and mud with shellfish grits   |
| T16-T17                                | N 14.437342°<br>E 120.860881° | 0  | 0  | 0  | 0   | 0  | 100 | Substrate is sand and mud with shellfish grits   |
| T17-T18                                | N 14.438630°<br>E 120.862652° | 0  | 0  | 0  | 0   | 0  | 100 | Substrate is sand and mud with shellfish grits   |
| T18-T19                                | N 14.439703°<br>E 120.864756° | 0  | 0  | 0  | 0   | 0  | 100 | Substrate is sand and mud with shellfish grits   |
| T19-T20                                | N 14.440722°<br>E 120.867082° | 0  | 0  | 0  | 0   | 0  | 100 | Substrate is sand and mud with shellfish grits   |
| Average Reef and Substrate Composition |                               | 0  | 0  | 0  | 0   | 0  | 100 |  |
| Site name:                             |                               | Western coastal waters across Rosario and Noveleta                                 |    |    |     |    |     | Survey Team:<br><br><br><br><br><br><br><br><br><br><br>1. Benjamin Francisco<br>2. Marivel Llavan<br>3. Liza Gobrin |
| Time / Date:                           |                               | 0931H-1217H / 18 October 2017  |    |    |     |    |     |  |
| Tow Speed:                             |                               | 4.0 kmh (ave)  |    |    |     |    |     |  |
| Visibility:                            |                               | Varies from 30-100cm due to mixing of seawater and sand/silt                       |    |    |     |    |     |  |
| Weather:                               |                               | Sunny  |    |    |     |    |     |  |
| Wave:                                  |                               | Rolling at 15cm crests   |    |    |     |    |     |  |
| Current:                               |                               | None   |    |    |     |    |     |  |
| Tide:                                  |                               | Lowering @ 0.85m to 0.54m; as ref from Cavite –Manila Bay Tidal Station (WXTIDE32) |    |    |     |    |     |  |
| Water Temp:                            |                               | Varying from approx. ± 30°C  |    |    |     |    |     |  |
| Wind:                                  |                               | Beaufort Scale #2  |    |    |     |    |     |  |
| Cloud Type:                            |                               | Cumulus Clouds   |    |    |     |    |     |  |

*Note: Tow area coverage are expressed in Decimal Degrees notation in reference to WGS84 Map Datum*

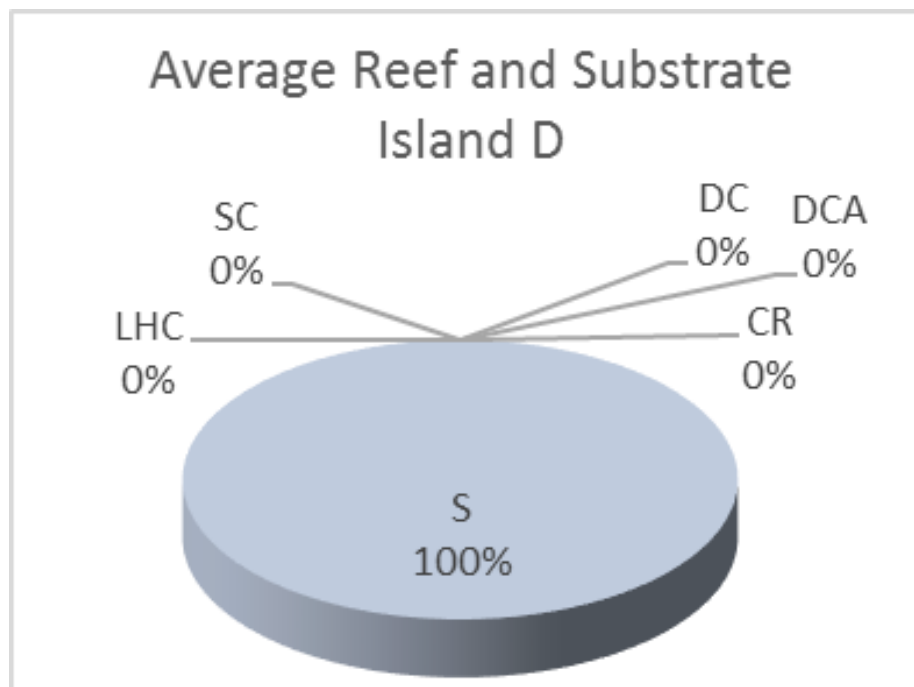


Figure 2.2-104. Results of Benthic Observations from 20 Manta Tow Pathways Across Island D; November 2018 and February 2019.



Base Map: 2018 Google Earth Map

Figure 2.2-105. Results of Benthic/Substrate Surveys from 20 Manta Tow Pathways across Island D; Nov 2018 and Feb 2019.





## Fisheries and Fishing Practices

The total number of registered fishers and fishing boats in Rosario, Noveleta and Kawit are listed in the table below:

**Table 2.2-50. Number of fisher and fishing boats in Rosario, Noveleta and Kawit\*.**

| Municipality | Coastal Population | Total number of municipal fishers | Number of fishing boats | Annual production (MT) |
|--------------|--------------------|-----------------------------------|-------------------------|------------------------|
| Rosario      | 52,537             | 300                               | 410                     | No data available      |
| Noveleta     | 9,292              | 540                               | 156                     | 2998                   |
| Kawit        | No data            | 1040**                            | 350                     | No data available      |
| Cavite City  | No data available  |                                   |                         |                        |

\*\*including mussel and oyster farmers and workers, vendors, processors and traders;

Source of data: Municipal Fisheries Profiles; 2018

## Fishery Resources

Pelagic fish species are the main target species in Noveleta, particularly species of *Sardinella* which occur year-round. The dominant pelagic species is sardines, principally the deep bodied herring *Sardinella brachysoma*, locally called “Law-law”, other sardines species and seasonal occurrences of Anchovy (*Stolephorus spp.*). No significant aggregations of demersal fish species were encountered in the manta tows, spot dives and systematic snorkeling around the proposed reclamation site. The major demersal species is swimming/blue crabs caught by crab pots and gill nets but the major fishing grounds are located about 4 to 5 kilometers offshore.

Other target species, albeit with much lower abundance compared to sardines include the common whiting (*Asohos*, *Sillago sihama*), mullet (*Mugil sp.*), and the gizzard shad (Kabasi, *Anodontostoma chacunda*). The latter species – Kabansi – is particularly abundant in Bacoar Bay during its peak season from October to February but is lesser in abundance in the area of Rosario to Noveleta. Mackerel scads (i.e. alumahan), swimming crabs and nemipterids (Bisugo) also constitute a minor portion of target species. The list of common species caught in the vicinity of the proposed islands is presented in Table 2.2-51 (please also see Plate 2.2-9).

**Table 2.2-51. List of Fish Species Caught in Fishing Grounds of Rosario, Noveleta, and Cavite City**

| English Name        | Local Name    | Scientific Name               |
|---------------------|---------------|-------------------------------|
| Deep bodied herring | Law-law       | <i>Sardinella brachysoma</i>  |
| Anchovy             | Dilis         | <i>Stolephorus sp</i>         |
| Nile Tilapia        | Tilapia       | <i>Oreochromis nilotica</i>   |
| Flathead mullet     | Banak         | <i>Mugil cephalos</i>         |
| Long-arm mullet     | Aligasin      | <i>Valamugil cunnessius</i>   |
| Gizzard shad        | Kabansi       | <i>Clupanodon thrissa</i>     |
| Spotted mojarra     | Latab         | <i>Gerres filamentosus</i>    |
| Caranx              | Samin-samin   | <i>Ulva mentalis</i>          |
| Common whiting      | Asohos        | <i>Sillagos ihama</i>         |
| Spadefish           | Kitang        | <i>Scatophagus argus</i>      |
| Goat fish           | Saramolyete   | <i>Upeneus species</i>        |
| Rabbitfish          | Samaral/budas | <i>Siganus punctatus</i>      |
| Rabbitfish          | Danggit       | <i>Siganus species</i>        |
| Indian mackerel     | Alumahan      | <i>Rastrelliger kanagurta</i> |
| Mackerel scad       | Galunggong    | <i>Decapterus macarellus</i>  |
| Diamondback squid   | Pusit         | <i>Thysanoteuthis rhombus</i> |
| Suahe               | Pasayan       | <i>Metapenaeus ensis</i>      |



**Plate 2.2-9. Dominant target species in coastal waters around the proposed site in Rosario and Noveleta**  
**top row left to right: sardines (law-law/tamban) and flathead mullet(Banak); bottom row left to right: swimmer crab (alimasag) and gizzard shad (kabansi).**



### Fishing Practices

The use of encircling gill net to capture “law-law” (sardines) is the dominant fisheries in Noveleta. Fishing grounds for the sardines are located offshore, 8 to 10 km in outer Manila Bay. Operators of this gear – considered as “active fishing gear under the Fisheries Code of the Philippines - claim that catches of sardines are better in deeper fishing grounds. No law-law operation is being carried out in nearshore water, including coastal area within the proposed reclamation Island D. However, small-scale fishers employing bottom set gill net, hook and line, spear and beach seines are being operated in the shallow confines of the proposed reclamation area.

Large boats with crab pots are operated to catch swimming crabs (*Portunus pelagicus*) in offshore fishing grounds but the declining catch rate has slowly eroded profitability of the gear and the number of crab fishers has significantly waned over the last few years (key informant). In nearshore areas, where reclamation islands are proposed to be located, small scale fishers principally operate surface gill nets, handlines and spear to catch and flathead mullet (*Mugil cephalos*) or Banak, tilapia, sardines and spadefish (Kitang, *Scatophagus argus*).



### Catch Rates and CPUE; Results of actual fishing operations

In February 2018, a lone fisher using a crab gill net was encountered during spot dives in the area of reclamation island D. The catch consisted of about 4 kilograms of blue crab – all juvenile size – and a 1kg cuttlefish, a rare catch in the area (Plate 2.2-10). The gear is a 500-meter monofilament gill net, set at five (5) hours. CPUE is computed at 1 kg per hour of fishing time.

**Plate 2.2-10. Crab fisher encountered in the vicinity of Island D with a catch of 4 kg blue crabs using a gill net.**



Observation of another gill net boat with five (5) fishers encountered in the vicinity of Island D (AFE 5 in map – Figure 2.2-105) yielded thirteen (13) kg of assorted fish including gizzard shad (*Anodontostoma chacunda*), asohos (*Sillago sihama*), spadefish (*Scatophagus argus*), tilapia and mullet (*Mugil* sp); or a CPUE 1.6 kg per hour. In AFE 3, a fisher using a cast net in the Ligtong River estuary two (2) kg of assorted fish, mainly asohos (*Sillago sihama*); a CPUE – 0.5 kg per hour (plate below).

**Plate 2.2-11. Gill net boat in the vicinity of Island D with a yield of approximately 13 kg of assorted pelagic fish and a cast net with 2 kg of asohos, banak and malakapas.**



Key informants claim that that catch rates for law-law vary largely depending on the size of boat, gear and fishing grounds. Offshore fishing grounds employing 30-foot boats with a crew of seven fishers harvest 4 to 10 tubs per day during months when 'current is slow'. Fishers interviewed during actual fishing documentation and fishers unloading their catch in the Rosario Fish Port alleged that the catch rates for sardines have remained stable in the





last five years, with surges in catch rates after the species' spawning season from October to December of each year. In the Rosario Fish Port, the catch composition in fish landings appears to be limited to at least seven species of pelagic fish. With the exception of mature *Sardinella* species, the rest of the catch composition is comprised of juvenile size fish. On the other hand, according to fishers in the Rosario fish port, the catch rate averages 3 kg of Tilapia plus 1 kg of assorted species (e.g., asohos and mullet) per 4 hours of fishing operation or an income of about P 150.00 per day. The CPUE is quite high at 1 kg per hour. Small gill nets catch mainly Tilapia, spadefish and mullet, as well as occasional catches of Theraponids (*Bugaong*). The normal catch rate ranges from 5 to 10 kilos per day of mostly tilapia, still considered worthwhile in spite of the turbid waters. The BFARMC claims that in 'good' fishing days, fishers allegedly net an income of between PhP 300 to PhP 600/day.

### Actual Fishing Encounters

Observation of eight (8) actual fishing operations in various proposed reclamation islands encountered during the marine ecology survey yielded the following actual fishing data (Table 2.2-52, Figure 2.2-106).

**Table 2.2-52. Results of actual fishing encounters documented; November 2018.**

| WP Code | Vicinity                          | Fishing Gear         | Catch rate/catch composition/CPUE   |
|---------|-----------------------------------|----------------------|---|
| AFE1    | south of Island 'E'               | Gill net             | 1 kg of small flathead mullet ( <i>Mugil cephalus</i> ); CPUE 1 kg/hr   |
| AFE2    | Island E                          | compressor           | 34 kg of mussel <i>Perna viridis</i> ; CPUE 8.5 kg per hour with use of compressor (considered illegal)   |
| AFE3    | Island D                          | cast net             | 2 kg of assorted fish, mainly asohos ( <i>Sillago sihama</i> ); CPUE – 0.5 kg per hour  |
| AFE4    | Near Island E; Wawa River         | cast net             | 5 kg of Tilapia inside the Wawa river; CPUE – 1.25 kg per hour  |
| AFE5    | Island D                          | gill net             | 13 kg of assorted fish including gizzard shad ( <i>Anodontostoma chacunda</i> ), asohos ( <i>Sillago sihama</i> ), spadefish ( <i>Scatophagus argus</i> ), tilapia and mullet ( <i>Mugil sp</i> ); CPUE 1.6 kg per hour |
| AFE6    | North of Island C                 | hook and line        | 4 kg assorted fish - goatfish, spadefish ( <i>Scatophagus argus</i> ), tilapia and mullet ( <i>Mugil sp</i> ); CPUE 0.66 kg per hour  |
| AFE7    | Island A                          | gill net             | 4 pieces of Tilapia in 4 hours; CPUE – 1 piece of Tilapia per hour  |
| AFE8    | Island D<br>1.6 km from shoreline | surrounding gill net | 60 kg of Law-law with seven fishers on board; CPUE 6.6 kg per hour  |

### Sapras (Lift Nets)

The sapra or lift net, which is operated with the aid of lights to catch small pelagic species of fish, is a popular gear in Bacoor Bay and offshore waters of Cavite City. The lift net is not being operated – at the time of the surveys – in the offshore municipal waters of Rosario and Noveleta.

### Mussel Farms, Fish Corals and Fish Pens

There are no mussel or oyster farms in Noveleta and Rosario, particularly in the vicinity of Island D.



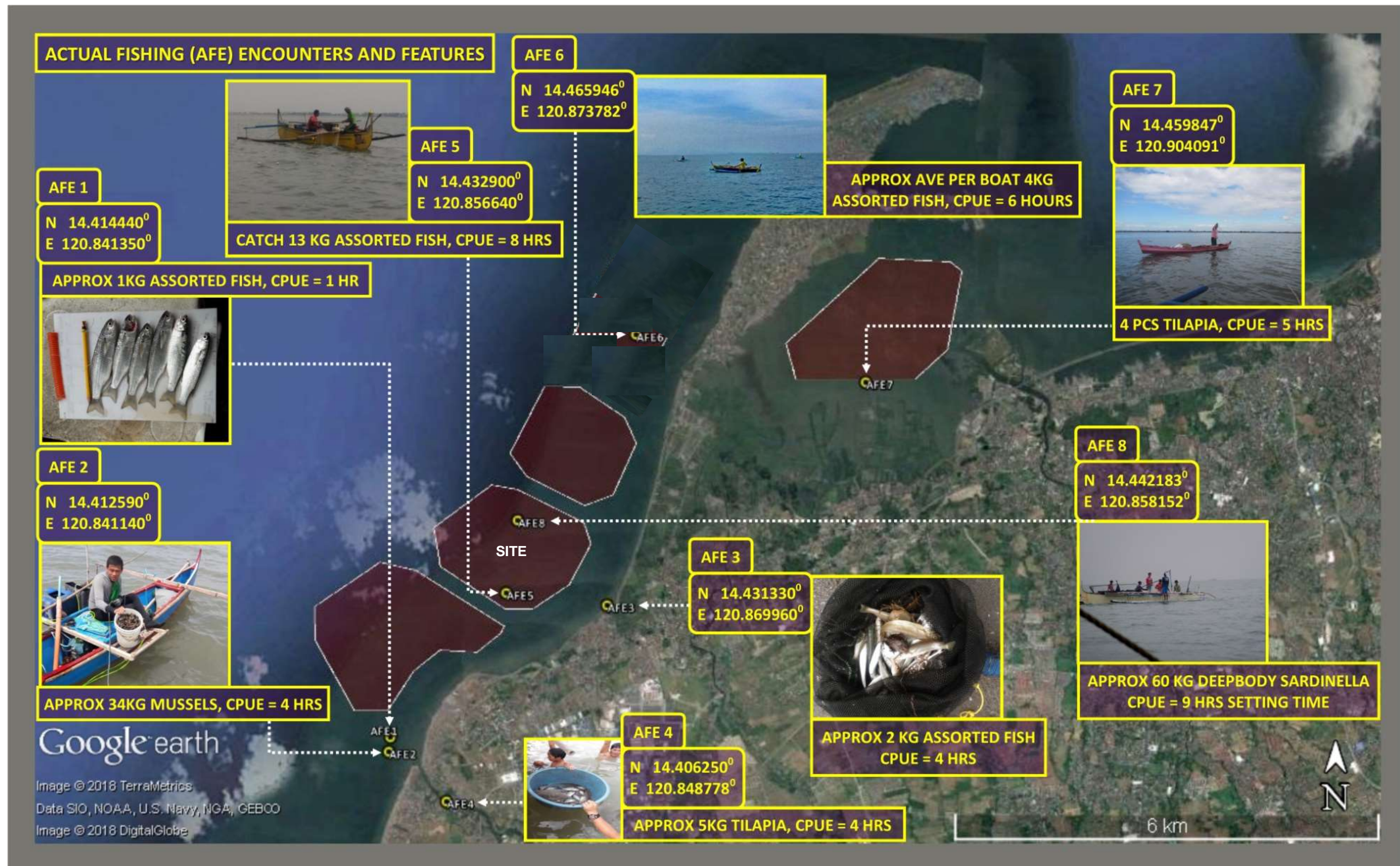


Figure 2.2-106. Results of 8 AFEs; various dates in November 2018 and February 2019.





## Mangroves

Two mangrove stations were investigated in the estuary of the Ligton River. The first station consisted of a small patch of *Avicennia* species mixed with Aroma trees only about 1 hectare in area. Fishponds bordered the back side of the mangrove patch.

The mangrove survey in the vicinity of Island D yielded a total of 59 trees in 4 quadrats, comprised of two species – *Avicennia marina* and *Avicennia officinalis* in two transects laid across the northern flank of the estuary of the Ligton River which actually hosted the main patch of mangroves (Table 2.2-53). Only mangrove trees were observed; seedlings and saplings were completely absent.

*Avicennia marina* is the dominant species in Station 1, accounting for 72% of the mangrove community, with a total of 26 trees in the transect corridor (Table 2.2-54 and Figure 2.2-107). *Avicennia marina* dominated the height and crown cover of the mangroves, at 3.6 meters but crown cover was equally shared by *A. officinalis*, measured at 50% per species (Figures 2.2-108 and 2.2-109).

**Table 2.2-53. Mangrove Species Distribution in Station 1 in the Ligton River Estuary, Noveleta; November 2018**

Location: Barangay Ligton, Noveleta, Cavite  
Observers: Marivel Llanan and Liza Gobrin

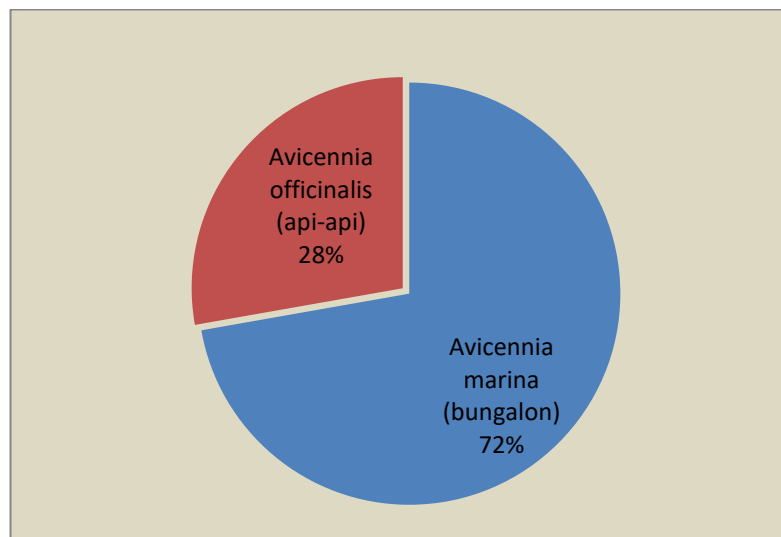
Date: November 2018  
MGV1 Coordinates

| Transect #<br>1       | Tree # | Substrate | Species                                | Ht. (m) | Crown Diameter (m) |           |              | Observations   |
|-----------------------|--------|-----------|--|---------|--------------------|-----------|--------------|--|
|                       |        |           |  |         | Reading 1          | Reading 2 | Ave. C.Cover |  |
| Quadrat #1<br>10mx10m | 1      | Muddy     | <i>Avicennia marina</i> (bungalon)     | 4       | 0.5                | 0.5       | 0.5          | - dump site<br>-migratory birds<br>-coastal community<br>bordering the<br>mangroves<br>-old fishpond |
|                       | 2      |           | <i>Avicennia marina</i> (bungalon)     | 4       | 0.5                | 0.5       | 0.5          |  |
|                       | 3      |           | <i>Avicennia marina</i> (bungalon)     | 4       | 0.5                | 0.5       | 0.5          |  |
|                       | 4      |           | <i>Avicennia marina</i> (bungalon)     | 4       | .5                 | 0.5       | 0.5          |  |
|                       | 5      |           | <i>Avicennia marina</i> (bungalon)     | 4       | .5                 | 0.5       | 0.5          |  |
|                       | 6      |           | <i>Avicennia marina</i> (bungalon)     | 4       | .5                 | 0.5       | 0.5          |  |
|                       | 7      |           | <i>Avicennia marina</i> (bungalon)     | 4       | 0.5                | 0.5       | 0.5          |  |
|                       | 8      |           | <i>Avicennia marina</i> (bungalon)     | 4       | .5                 | 0.5       | 0.5          |  |
|                       | 9      |           | <i>Avicennia marina</i> (bungalon)     | 4       | .5                 | 0.5       | 0.5          |  |
|                       | 10     |           | <i>Avicennia officinalis</i> (api-api) | 4       | 0.5                | 0.5       | 0.5          |  |
|                       | 11     |           | <i>Avicennia officinalis</i> (api-api) | 4       | .5                 | 0.5       | 0.5          |  |
|                       | 12     |           | <i>Avicennia officinalis</i> (api-api) | 4       | .5                 | 0.5       | 0.5          |  |
|                       | 13     |           | <i>Avicennia officinalis</i> (api-api) | 4       | .5                 | 0.5       | 0.5          |  |
|                       | 14     |           | <i>Avicennia officinalis</i> (api-api) | 4       | 0.5                | 0.5       | 0.5          |  |
| Quadrat #2<br>10x10m  | 1      |           | <i>Avicennia marina</i> (bungalon)     | 3       | 1.0                | 0.5       | 0.75         | Outside the transect<br>another species was<br>found - <i>Sonneratia alba</i><br>(pagatpat)          |
|                       | 2      |           | <i>Avicennia marina</i> (bungalon)     | 3       | 1.0                | 0.5       | 0.75         |  |
|                       | 3      |           | <i>Avicennia marina</i> (bungalon)     | 3       | 1.0                | 0.5       | 0.75         |  |
|                       | 4      |           | <i>Avicennia marina</i> (bungalon)     | 3       | 1.0                | 0.5       | 0.75         |  |
|                       | 5      |           | <i>Avicennia marina</i> (bungalon)     | 3       | 1.0                | 0.5       | 0.75         |  |
| Quadrat #3<br>10mx10m | 6      |           | <i>Avicennia marina</i> (bungalon)     | 3       | 1.0                | 0.5       | 0.75         |  |
|                       | 7      |           | <i>Avicennia marina</i> (bungalon)     | 3       | 1.0                | 0.5       | 0.75         |  |
|                       | 1      |           | <i>Avicennia marina</i> (bungalon)     | 3       | 0.5                | 0.5       | 0.50         |  |
|                       | 2      |           | <i>Avicennia marina</i> (bungalon)     | 3       | 0.5                | 0.5       | 0.5          |  |
|                       | 3      |           | <i>Avicennia marina</i> (bungalon)     | 3       | 0.5                | 0.5       | 0.50         |  |
|                       | 4      |           | <i>Avicennia marina</i> (bungalon)     | 3       | 0.5                | 0.5       | 0.5          |  |
|                       | 5      |           | <i>Avicennia marina</i> (bungalon)     | 3       | 0.5                | 0.5       | 0.5          |  |
|                       | 6      |           | <i>Avicennia marina</i> (bungalon)     | 3       | 0.5                | 0.5       | 0.5          |  |





| Transect #<br>1                         | Tree # | Substrate                                      | Species                                | Ht. (m) | Crown Diameter (m) |              |                 | Observations |
|---|--------|--|--|---------|--------------------|--------------|-----------------|--------------|
|   |        |  |  |         | Reading<br>1       | Reading<br>2 | Ave.<br>C.Cover |              |
|   | 7      |  | <i>Avicennia marina (bungalon)</i>     | 3       | 0.5                | 0.5          | 0.5             |              |
|   | 8      |  | <i>Avicennia marina (bungalon)</i>     | 3       | 0.5                | 0.5          | 0.5             |              |
|   | 9      |  | <i>Avicennia marina (bungalon)</i>     | 3       | 0.5                | 0.5          | 0.5             |              |
|   | 10     |  | <i>Avicennia marina (bungalon)</i>     | 3       | 0.5                | 0.5          | 0.5             |              |
|   | 11     |  | <i>Avicennia officinalis (api-api)</i> | 3       | 0.5                | 0.5          | 0.5             |              |
|   | 12     |  | <i>Avicennia officinalis (api-api)</i> | 3       | 0.5                | 0.5          | 0.5             |              |
|   | 13     |  | <i>Avicennia officinalis (api-api)</i> | 3       | 0.5                | 0.5          | 0.5             |              |
|   | 14     |  | <i>Avicennia officinalis (api-api)</i> | 3       | 0.5                | 0.5          | 0.5             |              |
|   | 15     |  | <i>Avicennia officinalis (api-api)</i> | 3       | 0.5                | 0.5          | 0.5             |              |
|   |        | Summary Results:                               |  |         |                    |              |                 |              |
| TOTAL AVERAGE CROWN COVER:              |        | 19.75  |  |         |                    |              |                 |              |
| TOTAL HEIGHT OF ALL TREES:              |        | 122  |  |         |                    |              |                 |              |
| AVERAGE HEIGHT:                         |        | 122/ 36 trees = 3. 38 meters ( fair condition) |  |         |                    |              |                 |              |
| No seedlings found<br>No saplings found |        |  |  |         |                    |              |                 |              |



**Figure 2.2-107. Relative Distribution of Mangrove Species in Station 1, Ligdong, Noveleta, in November 2018**

**Table 2.2-54. Relative Distribution of Mangrove Trees in Station 1 in Ligdong, Noveleta; November 2018**

| Species                      | Local Name      | Number of Trees | Relative distribution (% of total trees ) |
|------------------------------|-----------------|-----------------|---|
| <i>Avicennia marina</i>      | <i>Bungalon</i> | 26              | 72  |
| <i>Avicennia officinalis</i> | <i>Api-api</i>  | 10              | 28  |
|                              |                 | 36              | 100%                                      |

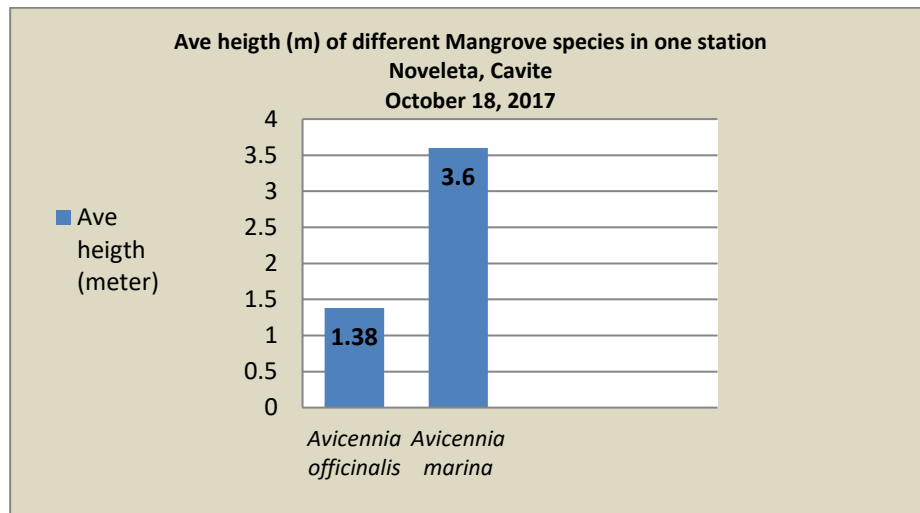


Figure 2.2-108. Relative Distribution of Height (m) of Two Mangrove Species in Station 1, Ligdong, Noveleta, November 2018

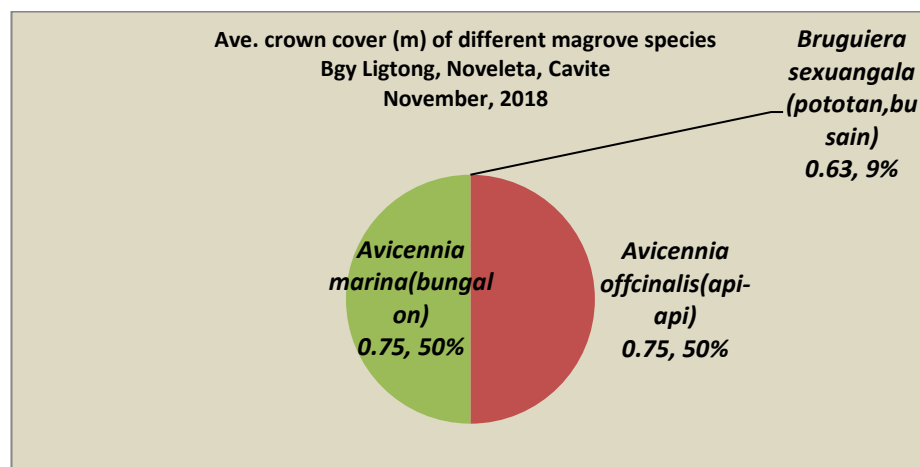


Figure 2.2-109. Average Crown Cover (in percentage of total canopy) of Two Species in Mangrove Station 1 in Ligdong, Noveleta, November 2018.

Plate 2.2-12. Mangroves in the Ligdong River estuary were mixed with Aroma trees; the river and mangrove patch is vividly strewn with trash.





Sparse mangrove trees mixed with Aroma trees were catalogued in station 2, with a total of twenty-three trees comprised of *Avicennia alba* and *Avicennia marina* (Table 2.2-55). The latter species dominated the community, comprising 57% of the community in two quadrats (Table 2.2-56 and Figure 2.2-110). *Avicennia alba* was much taller than the latter species, towering almost 2 meters in height compared to 0.5 meter for *A. marina*. This indicates excellent growth for the said species. On the other hand, crown cover was shared by both species (Figure 2.2-111). As in station 1, there was a complete absence of seedlings and saplings. This indicates that both stations are in disturbed condition.

**Table 2.2-55. Mangrove Species Distribution in Station 2 in the Ligton River Estuary, Noveleta; November 2018.**

Location: Barangay Ligton, Noveleta, Cavite  
Observers: Marivel Llawan and Liza Gobrin

Date: November 2018  
MGV2 Coordinates

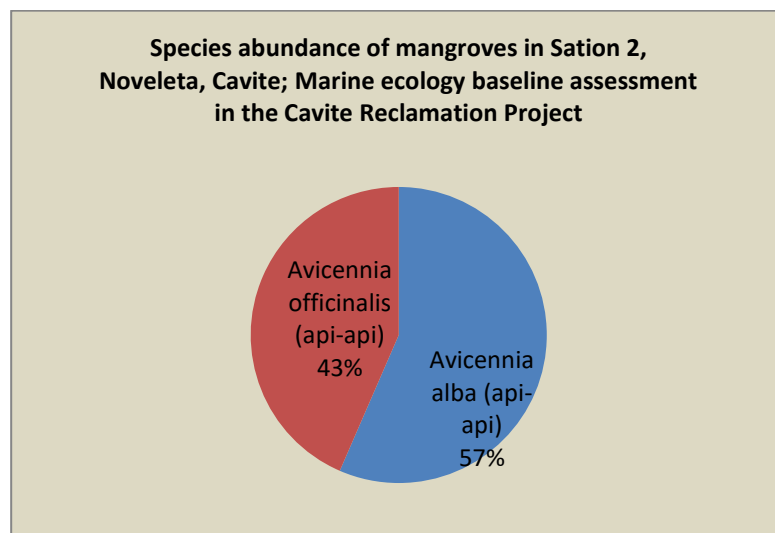
| Transect # 2               | Tree # | Substrate                                  | Species                                  | Ht. (m) | Crown Diameter (m) |           |              | Observations   |
|----------------------------|--------|--|--|---------|--------------------|-----------|--------------|--|
|                            |        |  |  |         | Reading 1          | Reading 2 | Ave. C.Cover |  |
| Quadrat # 1<br>10mx10m     | 1      | Muddy                                      | <i>Avicennia alba (api-api)</i>          | 4       | 0.5                | 0.5       | 0.5          | - dump site  |
|                            | 2      |  | <i>Avicennia alba (api-api)</i>          | 4       | 0.5                | 0.5       | 0.5          |  |
|                            | 3      |  | <i>Avicennia alba (api-api)</i>          | 4       | 0.5                | 0.5       | 0.5          |  |
|                            | 4      |  | <i>Avicennia alba (api-api)</i>          | 4       | 0.5                | 0.5       | 0.5          |  |
|                            | 5      |  | <i>Avicennia alba (api-api)</i>          | 4       | 0.5                | 0.5       | 0.5          |  |
|                            | 6      |  | <i>Avicennia alba (api-api)</i>          | 4       | 0.5                | 0.5       | 0.5          |  |
|                            | 7      |  | <i>Avicennia alba (api-api)</i>          | 4       | 0.5                | 0.5       | 0.5          |  |
|                            | 8      |  | <i>Avicennia alba (api-api)</i>          | 4       | 0.5                | 0.5       | 0.5          |  |
|                            | 9      |  | <i>Avicennia alba (api-api)</i>          | 4       | 0.5                | 0.5       | 0.5          |  |
|                            | 10     |  | <i>Avicennia officinallis (bungalon)</i> | 4       | 0.5                | 0.5       | 0.5          |  |
| Quadrat # 2<br>10x10m      | 1      |  | <i>Avicennia alba (api-api)</i>          | 3       | 1                  | 0.5       | 0.75         | - coastal community<br><br>- migratory birds<br><br>- old fishpond |
|                            | 2      |  | <i>Avicennia alba (api-api)</i>          | 3       | 1                  | 0.5       | 0.75         |  |
|                            | 3      |  | <i>Avicennia alba (api-api)</i>          | 3       | 1                  | 0.5       | 0.75         |  |
|                            | 4      |  | <i>Avicennia alba (api-api)</i>          | 3       | 0.5                | 0.5       | 0.5          |  |
|                            | 5      |  | <i>Avicennia officinallis (bungalon)</i> | 3       | 0.5                | 0.5       | 0.5          |  |
|                            | 6      |  | <i>Avicennia officinallis (bungalon)</i> | 3       | 0.5                | 0.5       | 0.5          |  |
|                            | 7      |  | <i>Avicennia officinallis (bungalon)</i> | 3       | 0.5                | 0.5       | 0.5          |  |
|                            | 8      |  | <i>Avicennia officinallis (bungalon)</i> | 3       | 0.5                | 0.5       | 0.5          |  |
|                            | 9      |  | <i>Avicennia officinallis (bungalon)</i> | 3       | 0.5                | 0.5       | 0.5          |  |
|                            | 10     |  | <i>Avicennia officinallis (bungalon)</i> | 3       | 0.5                | 0.5       | 0.5          |  |
|                            | 11     |  | <i>Avicennia officinallis (bungalon)</i> | 3       | 0.5                | 0.5       | 0.5          |  |
|                            | 12     |  | <i>Avicennia officinallis (bungalon)</i> | 3       | 0.5                | 0.5       | 0.5          |  |
|                            | 13     |  | <i>Avicennia officinallis (bungalon)</i> | 3       | 0.5                | 0.5       | 0.5          |  |
| SUMMARY RESULTS            |        |  |  |         |                    |           |              |  |
| TOTAL AVERAGE CROWN COVER  |        | 19.75                                      |  |         |                    |           |              |  |
| TOTAL HEIGHT OF ALL TREES: |        | 79   |  |         |                    |           |              |  |
| AVERAGE HIEIGHT:           |        | 79/ 23 trees = 3.43meters (fair condition) |  |         |                    |           |              |  |
|                            |        | No seedlings found<br>No saplinas found    |  |         |                    |           |              |  |



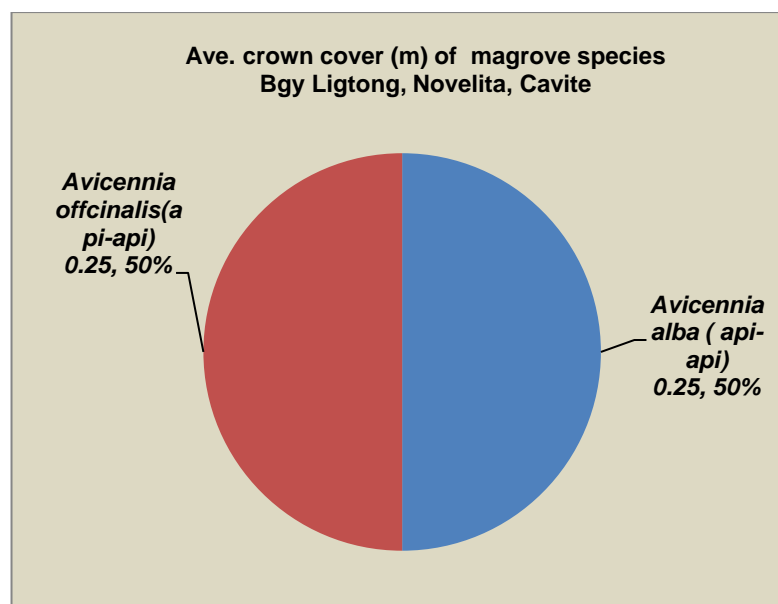


**Table 2.2-56. Relative Distribution of Mangrove Trees in Station 2 in Ligdong, Noveleta; November 2018**

| Species                      | Local Name      | Number of Trees | Relative distribution (% of total trees ) |
|------------------------------|-----------------|-----------------|---|
| <i>Avicennia alba</i>        | <i>Api-api</i>  | 13              | 57  |
| <i>Avicennia officinalis</i> | <i>bungalon</i> | 10              | 43  |
|                              |                 | 23              | 100%                                      |



**Figure 2.2-110. Relative Distribution of Mangrove Species in Station 2 in Barangay Ligdong, Noveleta; November 2018**



**Figure 2.2-111. Average Crown Cover (in percentage of total canopy) of Two Species in Mangrove Station 2 in Barangay Ligdong, Noveleta, Cavite; November 2018.**



## Plankton Community

### Zooplankton

A total of sixteen (16) zooplankton groups (adult and larval forms) were identified in five stations sampled within proposed reclamation island D in Noveleta, Cavite (Table 2.2-57). These groups identified include copepod (calanoid, cyclopoid and harpacticoid), bivalve veliger, larvacean, decapod zoea, polychaete, polychaete trocophore, salps, echinoderm larvae, flatworm larvae, cnidarian larvae, chaetognaths, rotifer, gastropod veliger. Adult forms were the most abundant group constituting for 54% while larval forms were composed of 46% (Figure 2.2-112). Both adult forms and larval forms had 8 zooplankton groups identified. Other important groups like bivalve veliger, and decapod zoea only contributed for less than 5% and 3% respectively. There was no rare or endemic zooplankton species found in the area and majority of the groups are common and cosmopolitan in distribution.

**Table 2.2-57. Zooplankton Composition and Abundance (ind/m<sup>3</sup>) in 4 Stations in Island D; February 2019.**

| TAXA                    | ZP1    | ZP2    | ZP3    | ZP4     | Total   | Rel Abundance |
|-------------------------|--------|--------|--------|---------|---------|---------------|
| Adult forms             | 33,000 | 63,300 | 20,400 | 72,200  | 188,900 | 53.76         |
| Calanoid                | 1,300  | 3,500  | 4,500  | 22,200  | 31,500  | 8.96          |
| Chaetognaths            | 600    | 700    | 500    | 800     | 2,600   | 0.74          |
| Cyclopoid               | 24,300 | 56,700 | 7,800  | 34,900  | 123,700 | 35.20         |
| Harpacticoid            | 600    | 1,100  | 4,500  | 4,600   | 10,800  | 3.07          |
| Larvacean               | 1,600  | 1,300  | 1,300  | 3,500   | 7,700   | 2.19          |
| Polychaete              | 4,600  |        | 700    | 600     | 5,900   | 1.68          |
| Rotifer                 |        |        | 1,100  |         | 1,100   | 0.31          |
| Salps                   |        |        |        | 5,600   | 5,600   | 1.59          |
| Larval forms            | 45,800 | 13,400 | 49,300 | 54,000  | 162,500 | 46.24         |
| Bivalve veliger         | 4,500  | 5,600  | 3,400  | 2,300   | 15,800  | 4.50          |
| Cnidarian larvae        |        |        |        | 1,200   | 1,200   | 0.34          |
| Decapod zoea            | 400    | 300    | 8,900  | 800     | 10,400  | 2.96          |
| Echinoderm larvae       |        |        |        | 1,300   | 1,300   | 0.37          |
| Flatworm Larvae         |        | 500    |        | 500     | 1,000   | 0.28          |
| Gastropod veliger       |        |        | 1,100  | 1,400   | 2,500   | 0.71          |
| Nauplius and Copepodite | 34,200 | 6,700  | 34,600 | 45,600  | 121,100 | 34.46         |
| Trocophore              | 6,700  | 300    | 1,300  | 900     | 9,200   | 2.62          |
| Grand Total             | 78,800 | 76,700 | 69,700 | 126,200 | 351,400 | 100           |
| Richness                | 10     | 10     | 12     | 15      |         |               |
| Evenness (I')           | 0.66   | 0.44   | 0.69   | 0.65    |         |               |
| Diversity (H')          | 1.51   | 1.02   | 1.72   | 1.75    |         |               |

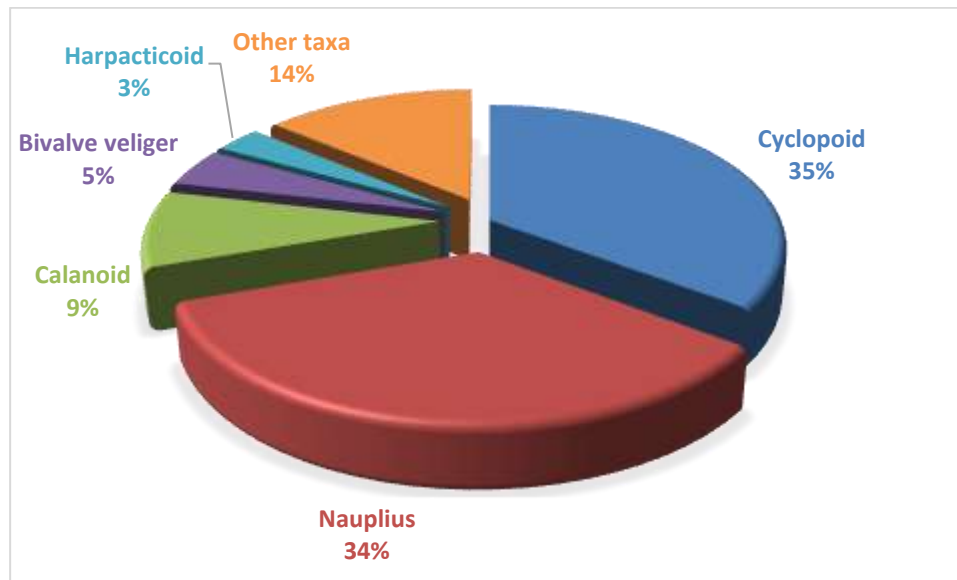


Figure 2.2-112. Percentage Composition of Major Zooplanktons in 4 Stations in Island D; Feb 2019.

The mean estimate of abundance was 351,400 individuals/m<sup>3</sup> for all sampling stations recorded during this survey (Figure 2.2-113). Spatially, station ZP4 had the highest zooplankton abundance with 126,200 ind/m<sup>3</sup> and the most taxa rich station with 15 (Figure 2.2-113). The lowest zooplankton abundance was quantified in station ZP3 with 69,700 recorded taxa. All diversity measurements were low (<2) with the highest values observed in station ZP4 with 1.75 while the lowest in station ZP4 with 1.02. The computed index of evenness was generally low ranging from 0.62 to 0.68.

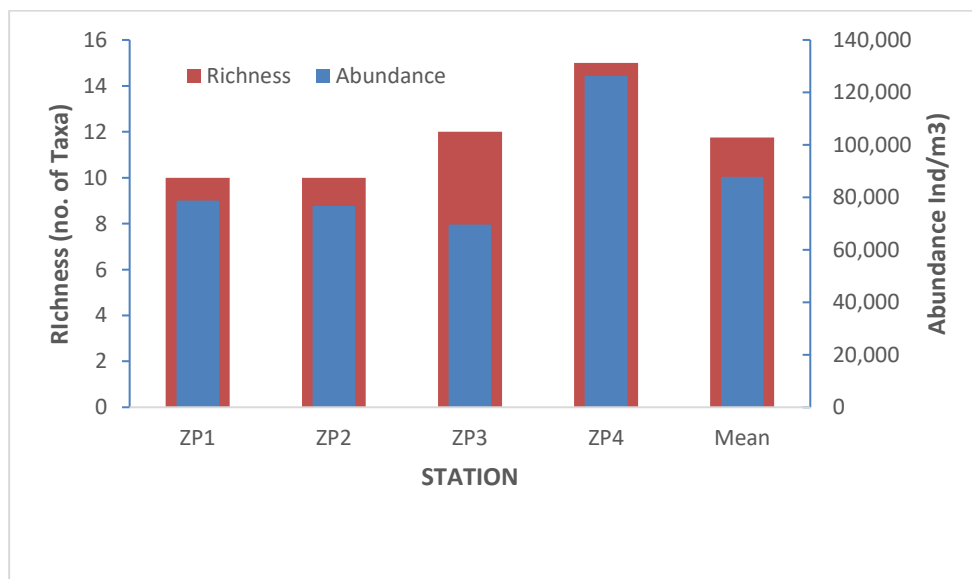


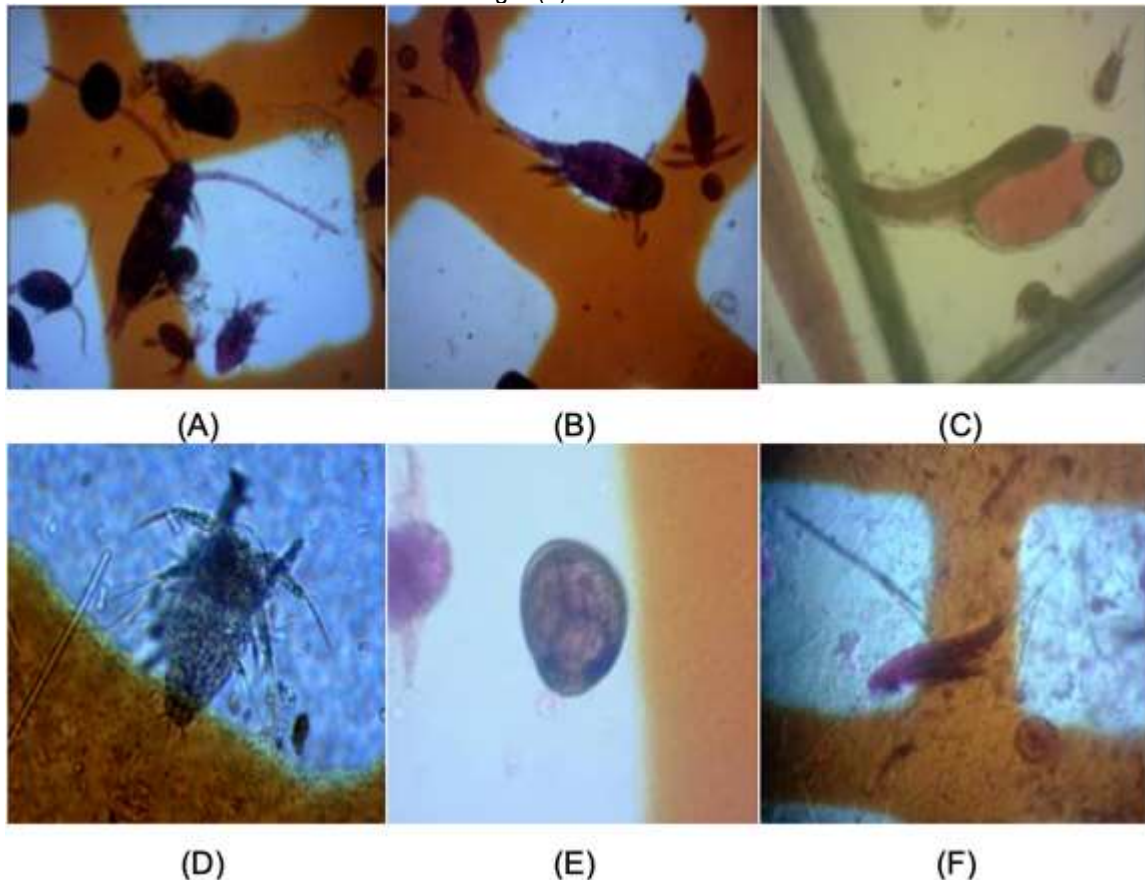
Figure 2.2-113. Zooplankton Abundance and Taxa Richness in four stations in Island D; February 2019 sampling.

Photomicrographs of major zooplankton species catalogued across all five reclamation islands in the Cavite Reclamation Project are shown in Plate 2.2-13.





**Plate 2.2-13. Photomicrographs of the dominant and important zooplankton groups**  
(A) Calanoid copepod (B) Cyclopoid copepod (C) Harpacticoid copepod (D) Copepod Nauplius (E) Bivalve veliger (F) Fish larvae.



### **Phytoplankton**

A total of twenty-three (23) phytoplankton species belonging to Bacillariophytes (diatoms) with 12 species, Dinophytes (dinoflagellates) with 10 species, Cyanophytes (blue-green algae) with 1 species was recorded in four stations sampled in the proposed reclamation Island (Table 2.2-58). Diatoms totally dominated the phytoplankton community accounting for 97% of the phytoplankton abundance (Figure 2.2-114). Dinoflagellates only represented for 3 % while cyanobacteria were almost negligible with only 0.42% contribution to the total phytoplankton count. Among the diatoms, the pennate chain forming diatom, *Pseudonitzschia* was the most abundant genus accounting for 81% of the total phytoplankton count. A centric chain-forming diatom, *Skeletonema* also contributed high density contributing with 8%. Both diatom genera are commonly found in warm tropical marine environment and play major role in the overall primary productive of the marine environment in the area. The only cyanophyte genus observed was *Trichodesmium* with maximum cell density of 41 cells/L.

The potentially harmful phytoplankton species observed were *Pseudonitzschia* spp and *Dinophysis caudata*. Some species of *Pseudonitzschia* are known to produce domoic acid, a toxin associated with Amnesic Shellfish Poisoning (ASP). *Dinophysis caudata* are dinoflagellates associated to Diarrhetic Shellfish Toxins (DSP). *Pyrodinium bahamense* var. *compressum*, the dinoflagellate historically associated with Paralytic Shellfish Poisoning (PSP) in Manila Bay including Cavite area was not observed in this survey. Cell densities of *Dinophysis* and *Pseudonitzschia* however observed during the sampling was relatively low compared to areas where blooms of these organisms have been reported (Azanza and Taylor 2001). In addition, there is no confirmed incidence of ASP and DSP was reported in the Philippines, but it is still highly recommended to



continue monitoring after the project to preventive negative public health impact brought about by possible blooms of these species.

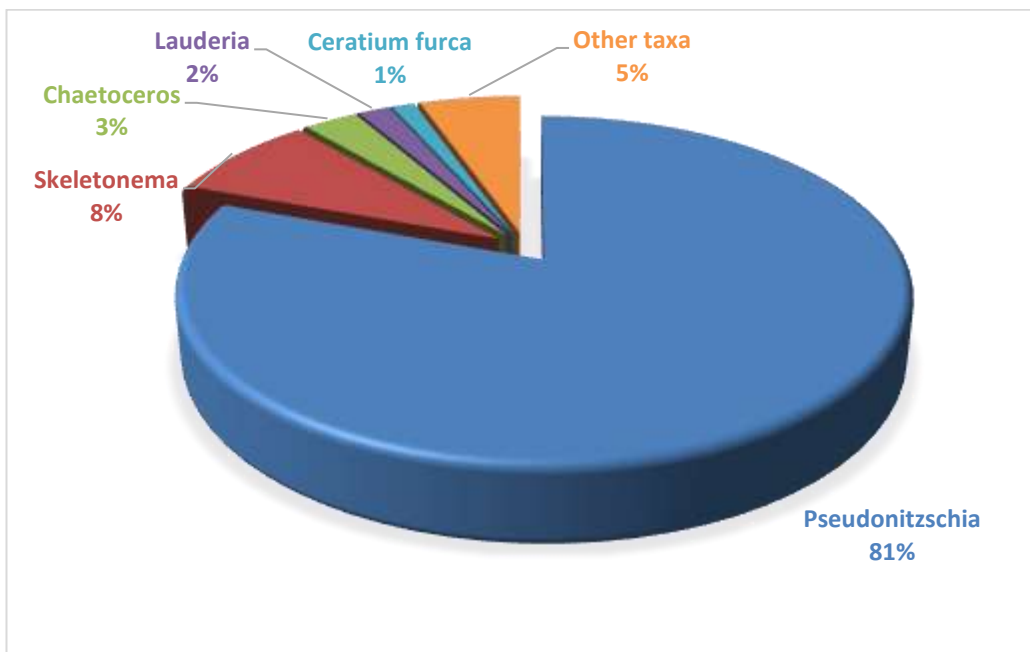


Figure 2.2-114. Percentage Composition of Major Phytoplankton Groups in 24; February 2019.

Table 2.2-58. Phytoplankton Composition and Abundance (cells/L) in 4 Stations in Island D; February 2019

| TAXA                      | 8     | 9   | 10  | 11    | Total  | Rel Abund. |
|---------------------------|-------|-----|-----|-------|--------|------------|
| <b>Cynophyte</b>          | 4     | 41  | 9   | 0     | 54     | 0.42       |
| <i>Trichodesmium</i>      | 4     | 41  | 9   | 0     | 54     | 0.42       |
| <b>Diatoms</b>            | 4,453 | 452 | 676 | 6,943 | 12,524 | 96.94      |
| <i>Chaetoceros</i>        | 211   | 134 | 23  | 6     | 374    | 2.89       |
| <i>Coscinodiscus</i>      | 8     | 0   | 9   | 0     | 17     | 0.13       |
| <i>Guinardia</i>          | 6     | 0   | 4   | 9     | 19     | 0.15       |
| <i>Lauderia</i>           | 213   | 0   | 6   | 4     | 223    | 1.73       |
| <i>Leptocylindrus</i>     | 67    | 0   | 9   | 0     | 76     | 0.59       |
| <i>Odonetlla</i>          | 78    | 14  | 13  | 17    | 122    | 0.94       |
| <i>Pleurosigma</i>        | 27    | 9   | 4   | 24    | 64     | 0.50       |
| <i>Pseudonitzschia</i>    | 3,500 | 176 | 222 | 6,514 | 10,412 | 80.59      |
| <i>Rhizosolenia</i>       |       | 34  | 34  | 34    | 102    | 0.79       |
| <i>Skeletonema</i>        | 311   | 77  | 344 | 322   | 1,054  | 8.16       |
| <i>Thalassionema</i>      | 23    | 0   | 5   | 13    | 41     | 0.32       |
| <i>Thalassiosira</i>      | 9     | 8   | 3   | 0     | 20     | 0.15       |
| <b>Dinoflagellates</b>    | 25    | 0   | 147 | 169   | 341    | 2.64       |
| <i>Alexandrium</i>        | 9     | 0   |     | 13    | 22     | 0.17       |
| <i>Ceratium furca</i>     | 3     | 0   | 78  | 77    | 158    | 1.22       |
| <i>Ceratium maroceros</i> | 0     | 0   | 11  | 2     | 13     | 0.10       |
| <i>Ceratium tripes</i>    | 0     | 0   | 9   | 4     | 13     | 0.10       |



| TAXA                       | 8            | 9           | 10          | 11           | Total         | Rel Abund. |
|----------------------------|--------------|-------------|-------------|--------------|---------------|------------|
| <i>Dinophysis caudata</i>  | 0            | 0           | 2           | 11           | 13            | 0.10       |
| <i>Diplopsalis</i>         | 0            | 0           | 13          | 0            | 13            | 0.10       |
| <i>Gonyaulax</i>           | 0            | 0           | 3           | 13           | 16            | 0.12       |
| <i>Prorocentrum micans</i> | 0            | 0           | 13          | 27           | 40            | 0.31       |
| <i>Protoperdinium</i>      | 13           | 0           | 9           | 22           | 44            | 0.34       |
| <i>Scripsiella</i>         | 0            | 0           | 9           | 0            | 9             | 0.07       |
| <b>Grand Total</b>         | <b>4,482</b> | <b>493</b>  | <b>832</b>  | <b>7,112</b> | <b>12,919</b> | <b>100</b> |
| <b>Richness</b>            | <b>15</b>    | <b>8</b>    | <b>22</b>   | <b>17</b>    |               |            |
| <b>Evenness (I')</b>       | <b>0.34</b>  | <b>0.79</b> | <b>0.61</b> | <b>0.15</b>  |               |            |
| <b>Diversity (H')</b>      | <b>0.93</b>  | <b>1.64</b> | <b>1.89</b> | <b>0.44</b>  |               |            |

Generally, the mean cell density of all the phytoplankton in nine stations was 12,919 cells/L. In terms of spatial distribution, station PH4 had the highest phytoplankton abundance with 7,112 cells/L (Table 2.2-56, Figure 2.2-115). The most taxa rich station occurred in station PH3. The lowest total phytoplankton density and the most depauperate station was observed in station PH2 with 493 cells/L with 8 genera. The highest calculated diversity index based on Shannon Weiner is observed in station PH3 with 1.89 while the lowest was observed in stations PH4 with only 0.44 (Table 2.2-55). The poor diversity measurement only indicates a bloom of particular taxa dominating which in this survey the diatom *Pseudonitzschia*. It is important to note that phytoplankton abundance is highly variable and has seasonality. The overall impression of the phytoplankton community during the survey is poor as indicated low abundance of phytoplankton organisms and presence of potentially harmful phytoplankton.

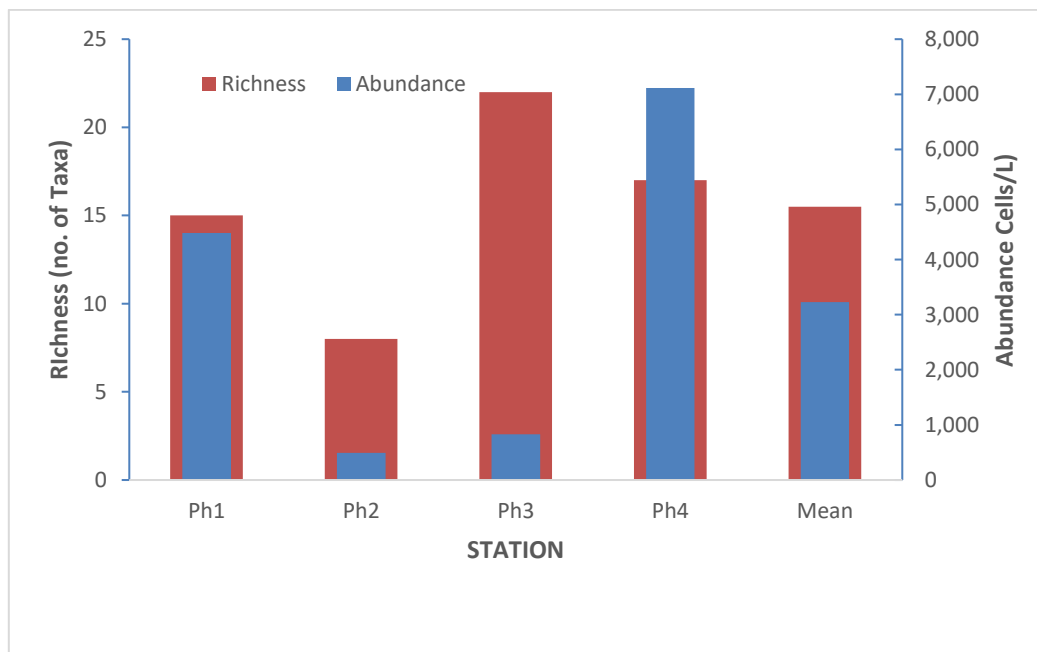


Figure 2.2-115. Phytoplankton Abundance and Taxa Richness in 4 Stations in Island D; February 2019 Plankton Sampling.

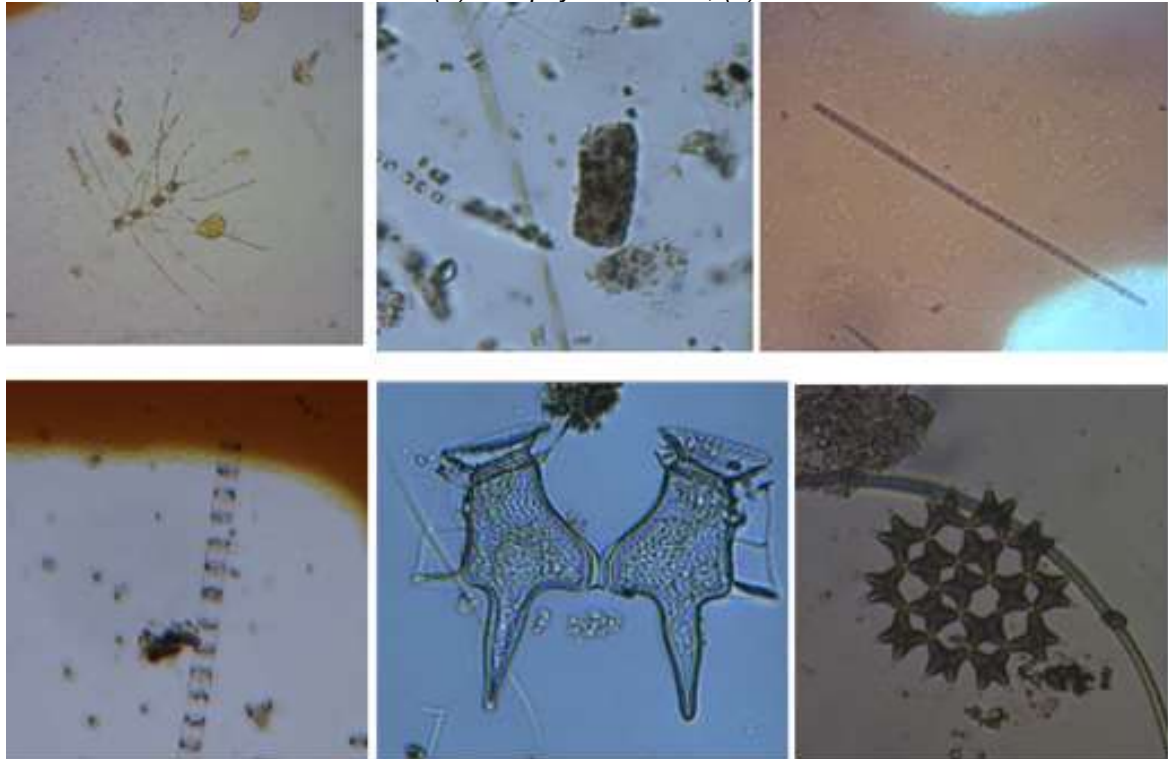
Photomicrographs of dominant and common phytoplankton are shown in the plate below.





**Plate 2.2-14. Photomicrographs of common and important phytoplankton observed in Cavite City/Kawit coastal waters:**

Top row L-R: (A) *Chaetoceros* (B) *Pseudonitzschia* (C) *Trichodesmium*; Bottom row L-R: (D) *Skeletonema* (E) *Dinophysis caudate*, (F) *Pediastrum*



**Macro-invertebrates Significant to Livelihood**

The conversion of inter-tidal flats into human settlements and household revetments in most parts of the coastline from Rosario to Cavite City has led to a dearth in populations of macro-invertebrates, particularly gastropods and echinoderms. Overharvesting is also suspected to have caused serious loss of bivalve populations in the few remaining patches of sandy beaches in Noveleta. Three stations were investigated during the survey, in areas where rocks and boulders were found in the coastline which could serve as suitable habitats for macro-invertebrates. Results of the investigations revealed that shellfish existing in the coastline of the proposed reclamation project is almost exclusively dominated by mussels (*Perna viridis*). Other than mussels, few shellfish species were seen attached to rocks that serve as shoreline breakwater in Noveleta. These include periwinkles *Litoria* sp., limpets *Patella flexuosa*, the swamp cerith *Telescopium telescopium*, and solitary shore crabs. In the mangroves in Kawit, turban shells (*Turbo* sp), conch shells (*Strombus* sp) and the swamp cerith (*Terebralia sulcata*) were the only macro-invertebrates encountered.

Unlike in Baccor City where abundant ark shells ("halaan") are harvested in Bacoar Bay, data gathered during the survey indicate the absence of significant macro-invertebrate population in the shoreline bordering the proposed reclamation project.



**Plate 2.2-15. Few species of macro-invertebrate were found in three stations surveyed, dominated almost entirely by mussels, *Perna viridis*.**



### Sediment Sampling

Twenty (20) sediment investigations all showed sandy and muddy substrates in all the proposed reclamation islands of the Cavite reclamation project. No other significant benthic ecological niches were encountered during dives for sediment collection (Plate 2.2-16).

**Plate 2.2-16. Sediments collected from the study area of the Cavite Reclamation Project consisted entirely of mud, silt, discarded oyster shells and grits of other shellfish.**



### 2.2.5.4 Probable Environmental Impacts

#### Sediment Fluxes and Re-suspension of Silt

The reclamation site is covered by loose sand and constant sediment deposition. This condition is unlikely to degenerate with reclamation activities but filling, piling and compacting of the reclaimed area will significantly



disturb the silt and aggravate re-suspension of substrates decayed organic matter and presumably a host of other organic and inorganic terrigenous matter. Further spoilage of sea water quality through proliferation of suspended solids will only further depress recruitment and settlement of marine animals due to the impaired condition of marine food webs in affected areas. Seagrass settlement is unlikely to occur. In the direct reclamation areas, the impacts of silt and sediment disturbance, and further sediment deposition loading in the sandy substrate contiguous to the reclamation area will have profound effects on an already heavily-taxed fisheries resource base and further reduce the viability of productive nearshore fisheries through the loss of inshore fishing grounds and impairment of primary productivity if sediment streams from reclamation are not controlled effectively. The dispersion of silt clouds will further increase seawater turbidity and water quality deterioration in the impact area and may lead to enhancement of localized deterioration of primary productivity due to further blocking of sunlight. Negative impacts on primary productivity will likely depress natural processes that propagate a healthy marine food chain and fisheries stock recovery, including impairment of reproductive processes and larval growth. The further alteration of benthic habitats due to sediment loading would most likely result to the movement of fish and fish recruits away from the coastal area affected by the Project.

Planktonic communities can be affected albeit, these organisms can readily regenerate. Fish aggregations will also be disturbed and fish are expected to move away from the site. The silt and sediment fluxes will be temporary as the area is completely reclaimed, stabilized and “greened”. Primary productivity will eventually improve over the long term as the establishment of water treatment facilities will ultimately result to disposal of cleaner waters around the reclaimed site. Farther away from the impact area, the effect may not be likely felt as the movement of the water along the water column would result to dispersion of silt to a greater area.

Over the long run, the reduction of photosynthetic function will have little impact as hardly any significant group of benthic marine animals dwell in the seabed within the project’s impact area and contiguous waters. While no significant epi-benthic macro-invertebrates have been encountered in the seabed itself during the survey, smothering of the dominant macrobenthos catalogued in the survey (mollusks), particularly juveniles of filter feeding bivalves and other detritus feeders in the immediate area can happen with compacting of the seabed. Extreme turbidity can also impair fish feeding and reproductive physiology but fish aggregations have been found to be minimal in the area and the dominant species – Tilapia – will simply evade the disturbed area and seek safer shelter and grazing grounds around the reclamation site.

### **Effects on Fisheries**

Few fishers, as well as gleaners for macro-invertebrates in the proposed reclamations islands will be dislocated momentarily during reclamation activities but will ultimately resume fishing operations in coastal waters past the reclaimed area. It is noted however, that a sizeable nearshore fishing ground will be lost to reclamation affecting largely small-scale fishers. On the other hand, effects on demersal fisheries productivity will be minimal as no benthic fish habitats will be affected or altered due to the extreme silt and muddy sediments currently deposited in the area. However, schools of *Sardinella* that normally enter inshore waters can be disturbed and move away from the reclamation site. Tilapia and sardines fisheries in this area will be dislocated and loss of income from fishing will be felt during reclamation activities. Fisheries operation in fishing grounds offshore of the reclamation and generally in the mouth Manila Bay will not be affected as fishers will move to new fishing grounds further away from the reclaimed area where seawater will probably be less polluted and pelagic fish more abundant. However, this will require modifications on fishing gears used.

Finally, it is noted that there are no permanent or stationary lift nets or “sapras” directly inside the proposed reclamation site.





### **Oil and Grease Contamination**

The risk of oil and grease contamination in seawater around the reclamation site can occur if disposal of marine vessel bilge water and if accidental spillage from refueling at sea is experienced. While the issue is not anticipated to be severe, oil slicks caused by inadvertent disposal or spillage may remain sequestered in coastal waters and carried in small blotches towards the direction of tidal movement. While the issue is not anticipated to be severe, oil slicks from inadvertent spillage may remain sequestered in the water column or carried to the shoreline in blotches. Areas with inter-tidal corals in Bataan and mussel colonies in Cavite can be considered at risk from exposure to such slicks, leading to immediate coral and shellfish mortality. In open waters of Manila Bay, the chain reaction can be far-reaching, affecting not only benthic communities but stocks of fish that are dependent on plankton and zooplankton as their primary diet. Sandy substrate in areas near the reclamation can likewise be at risk as some portion of spilled oil can enter the water column either as a dissolved fraction or suspended in small aggregations and settle to the bottom. Subsurface oil is a possibility in some spills, particularly if the spilled product is heavy, with a density approaching or exceeding that of seawater, and if conditions permit oil to mix with sediment material to further increase density.

### **Possible Threats to Benthic Communities**

This survey generated poor macrobenthos diversity in the area, as indicated on the low numbers of soft-bottom benthos taxa, bivalves and gastropods. There are no rare and endemic taxa. Any impact brought about by the reclamation project would be temporary and the macrobenthic community can readily colonize the new areas in the reclamation boundaries. It is furthermore noteworthy that macro-benthic communities are known to be resilient and have the locomotion ability to migrate in less stressful areas; hence the project is not expected to pose a significant impact on this aquatic community. Over the long term, it can be anticipated that populations of macro-invertebrates can colonize concrete revetments that will be built around reclaimed areas.

### **Threat to Plankton Community**

Phytoplankton and zooplankton would be generally subjected to short-term impacts during the construction. Threat to plankton community would come from the increase load of suspended solids during the construction of the project resulting to reduction of depth of photosynthetic activity of the phytoplankton. Similarly, highly turbid water would affect the grazing success of zooplankton. This would temporarily result to lower rates of photosynthesis and primary production. However, plankton population recovery after construction would be generally rapid due to quick reproduction periods including recruitment and advection from adjacent unaffected areas. A laboratory experiment conducted over a two week with different zooplankton showed that mortality was high at levels over 10,000 mg/L of Total Suspended Solids (TSS) but generally, studies have not shown any significant impact at the levels experienced from activities such as dredging and related activities (Clarke & Wilbur 2000). In addition, many larval stages are only in the plankton stage for short periods and other groups have short life cycles which mean recovery can be relatively quick (less than a year) depending on the time of year and source of larvae (James et al 2015). Given, the temporary and limited extent of the effect of highly turbid waters relative to the overall area of Manila Bay, the impact on plankton community are predicted to be low in long term.

### **Potential HAB inducement**

Harmful Algal Blooms (HAB) is the term used to describe the "bloom" or rapid multiplication of toxic single-celled phytoplankton. In Manila Bay and Cavite, HAB episodes have been occurring for more than two decades and the primary causative organism for paralytic shellfish poisoning is the dinoflagellate *Pyrodinium bahamense* var. *Compressum*. *Pyrodinium* and other biotoxin - forming phytoplankton species produce potent neurotoxins that can be transferred through the food web which for years has affected the mussel and oyster industry in Bacoar Bay. Among others, recent investigations point to excessive nutrient loading in coastal waters from land-based sources and sudden changes in seawater temperature as primary factors. The occurrence of El Nino – La Nina episodes, exacerbated by hyper-nutrient and sediment loading



from untreated domestic wastewaters from the Metropolis further enhance the possibility of algal blooms over a broad expanse of the sea where such waste streams are occurring. There are no species of potentially harmful phytoplankton observed in water samples taken in the proposed reclamation area. *Pyrodinium bahamense* var. *compressum*, the dinoflagellate historically associated with Paralytic Shellfish Poisoning (PSP) in Manila Bay including Cavite area was not observed in this survey. The potentially harmful phytoplankton species observed were *Pseudonitzschia* spp and *Dinophysis caudata*. Some species of *Pseudonitzschia* are known to produce domoic acid, a toxin associated with Amnesic Shellfish Poisoning (ASP). *Dinophysis caudata* are dinoflagellates associated to Diarrhetic Shellfish Toxins (DSP). Cell densities of *Dinophysis* and *Pseudonitzschia* observed during the sampling, however, was relatively low compared to areas where blooms of these organisms have been reported (Azanza and Taylor 2001). In addition, there is no confirmed incidence of ASP and DSP reported in the Philippines but it is still highly recommended to institute a monitoring program for HABs after the project has been established in order to prevent negative public health impacts brought about by possible blooms of these species. In general, it is unlikely that the reclamation project would trigger for HAB episodes.

#### **Increase in domestic waste water around the reclamation site**

Compacting, configuring and development structuring of the reclaimed area will result to increased human activity in the project site due to the influx of workers and this is expected to generate a significant amount of solid wastes and domestic wastewater that could find its way to the coastal and marine environment if waste disposal and management systems are not sufficient. The outflow of domestic wastewaters from project facilities if such waste streams are not properly treated and managed can lead to hyper-nutrient loading which in turn can cause algal blooms. In the project area where seawater flushing is moderate and water turbidity is already intense, such phenomenon can lead to problems on paralytic shellfish poisoning (PSP).

Further, when combined with organic wastewaters from domestic sources due to increased waste streams from project operations, marine pollution can spread horizontally away from the project site and contribute to episodes of algal blooms in other areas where hyper-nutrient loading from domestic wastewaters is intense. Significant sardine fisheries and shellfish resources in Bacoar Bay can be contaminated by algal blooms, and oxygen depletion can occur in localized portions of the sea and lead to spoilage and discoloration of water columns.

However, the risk of waste contamination of benthic resources directly in the reclamation area is insignificant due to the absence of significant benthic habitats. The predicted impact of this threat to epi-benthic soft bottom communities in the seabed could be more pronounced.

#### **Mangroves**

Depressed tidal flow in the mangrove swamps in the Ligton River estuary can negatively affect growth of mangroves, leading to stunted trees in the long term.

#### **Potential Impacts Arising from Climate Change Scenarios**

The reclamation will not contribute to enhancement of impacts arising from climate change, notably rise in surface sea water temperature. However, if hyper-nutrient loading in warm waters become intensified – either from domestic wastewaters or from point sources in the project, the risk of oxygen depletion and fish kills over a broad area can be possible. In the long term, immediate extensive vegetation planting around the reclaimed sites will in fact contribute to sequestration of greenhouse gasses in the future.



**Loss of Navigational Channels going to the Rosario Fish Port**

The reclamation islands will block traditional navigational lanes of fishing boats delivering their fish catch to the Rosario Fish Port and nearby fishing communities, resulting to slightly longer route and possibly higher fuel costs.

**2.2.5.5 Mitigation Measures**

***Mitigation of Potential Sediment Fluxes***

Sedimentation is predicted to be high during reclamation area filling and compacting and impacts are predicted to range from moderate to high depending on the implementation of mitigating measures in the primary impact area. Minimizing sediment influx from the project site to the coastal waters is a critical and underpinning strategy. The overall mitigation strategy for all phases of reclamation activities and its operational phases is to ensure that silt and sediment streams emanating from reclamation activities do not infiltrate into surrounding coastal waters indiscriminately and further deteriorate water quality and sediment blanketing where sandy seabed occur. A diverse array of sediment mitigation measures will include installation of silt curtains and screens in project areas where reclamation filling and compacting activities will be undertaken. Where sites have been filled up and reclaimed, diversion canals leading to sediment impoundments will be installed in order to ensure that fugitive soil run-off is contained. Moreover, loose reclamation filling materials shall be stockpiled in areas where erosion control measures can be easily applied and run-off can be controlled effectively. As a precautionary approach, the stabilization of reclaimed areas through vegetation cover enrichment and enhancement will be undertaken in order to increase sediment amalgamation capacity and soil compacting.

***Wastewater Management***

Waste minimization and retrieval will be practiced in all aspects of reclamation activities. Modern and sufficient sanitation facilities and disposal systems will be installed. Modern latrines with 3-chambered septic tanks shall be installed in all project facilities where wastewaters and other effluents are generated from areas already reclaimed. Waste minimization will be practiced in all aspects of the reclamation and all shipboard wastes will be retrieved and disposed of in land-based systems. There will no disposal of wastes at sea. The objective is to ensure that pollution-causing effluents that can be potentially carried downstream are treated at the source.

***Solid Waste Management***

Solid waste shall be disposed of in appropriate waste bins positioned across reclaimed areas. Solid wastes from project personnel and marine vessels will be completely collected and disposed of properly. A rigid waste management and retrieval system will be enforced in all aspects of reclamation activity.

***Oil and Grease Containment***

Potential risks of small oil spills will be controlled through strict fuel and oil dispersal protocols backed-up by an oil/fuel spill contingency plan. An oil and grease recovery system will be adopted employing the best facilities. A strict protocol against disposal of bilge water by vessels delivering reclamation materials to the site will be established and implemented. Any accidental spills will be dealt with efficiently and promptly through the formulation of oil spill contingency and recovery plan. The project will enforce strict policies against indiscriminate disposal of oily wastes.





### ***Fisheries and Fishing Gears – Mussel Farms and Fish Pens***

In general, long term improvement in fish stocks is contingent on the application of interventions that are designed to perpetuate growth, maturation and recruitment. This can be pursued by ensuring enough habitats for a wide range of fish species are protected against anthropogenic issues arising from reclamation activities and its post-reclamation development. Curtailment of fishing practices that contributes to growth and recruitment overfishing needs to be considered as a collaborative activity with the local government units and the BFAR.

There are no mussel farms nor fish pens in Island D. Any fishing gear that will be dislocated by reclamation filling and operations will be compensated through the provision of fishing gear paraphernalia, as well as technical assistance in re-establishing fishing operations.

Pelagic species of sardines will continue to move to areas close to the shore and their seasonal movement into the coastal seas surrounding the reclamation project will be sustained. In other nearshore areas, this will involve the provision of seawater channels to ensure that plankton communities will continue to enrich inshore fishing grounds between the shoreline and the inner boundary of reclaimed sites so that sardines and other small pelagic fishes can continue to migrate and graze into such areas. Efforts to sustain macro-invertebrate recruitment and settlement will be studied and applied in suitable areas.

The demand for fishery products, both in fresh and processed form, is likely to increase significantly as a result of increased demand during project establishment and can lead to enhanced fishing effort in an already heavily-fished fishery and competition for a dwindling resource base can drive fishers to use more illegal fishing methods. On the other hand, the operation of the Project is also seen to increase employment opportunities for skilled labor and provide certain fisheries-based livelihood to local fishers. With assistance from the Project, small-scale aquaculture and fisheries product value-adding can evolve into profitable livelihoods, especially for women in fisheries.

The Project will assist in refurbishing and increasing the number of fish aggregating device (FADs) previously set in coastal waters by the MAO and its sustainable management. New, more suitable sites will be identified and the design of ARs will consider aggregation of both demersal and pelagic species of fish. In addition, the Project will assist the LGU in the provision of more appropriate fishing gears to organized fishers to enable them to fish further offshore where stocks of sardines (*Sardinella lemuru*) are more plentiful. Further, through collaboration with BFAR, the project will support diversification of fisher livelihoods into cage culture of Pompano and other full-cycle species.

The reclamation project will ensure that adequate seawater channels in between islands are designed and maintained open to boat navigation. Such channels will be adequately engineered to ensure suitable depth and seawater flow.

### ***Mangroves***

A critical strategy is reforestation of mangrove forest trees along the Ligton/Maalimango River estuary as compact mangrove trees are eminent natural filters and enhancers of sediment accretion. The project shall look into the adoption of informal stewardship agreements with residents along the rivermouth to entice them to care for plantations.

The proposed project will not alter the distribution pattern of fish larvae and other marine species migrating in the mangrove areas. Adequate channels and buffer zones between the shoreline and the proposed reclamation island will be maintained to ensure unimpeded drifting of fish larvae and bivalve veligers.

In addition, fish larvae sampling will be undertaken in conjunction with annual water quality monitoring in coastal waters immediate to the reclamation site.



To support the protection and conservation of nearby mangrove areas, the Proponent shall include in its environmental protection management a mangrove reforestation program in suitable area/s, in coordination with the fisherfolks' association. Also, there will absolutely be no cutting of mangrove anywhere in the area.

Mangrove species already occurring in nearby coastlines shall be used in the enrichment planting such as: *Avicennia marina* and *Avicennia officinalis*. The location shall be in the existing mangrove patch in the estuary of Ligdong River.

***Ensuring fishing boat navigation to fishing grounds and into the Rosario Fish Port***

The reclamation project will ensure that adequate seawater channels in between islands are designed and maintained open to boat navigation. Such channels will be adequately engineered to ensure suitable depth and seawater flow.

***Presence of Pollution Indicator Species***

*Filter-feeding bivalves* – Algal blooms are natural phenomenon and can be influenced by a number of factors. These include cultural eutrophication, unusual climatological conditions and transport of dinoflagellates through ballast waters, and transfer of shellfish stocks. Mussels and oysters are standard biotoxin monitoring medium and the BFAR implements a periodic monitoring system of plankton levels and toxicity analysis through bioassay in mussel and oysters in Manila Bay. While the reclamation project would not be a primary trigger for HAB episode enhancement, bivalves farmed near in project area –specifically island 'A', will be placed under a strict biotoxin monitoring system through engagement of BFAR personnel. Moreover, the Project will support the conduct of information, education and communication (IEC) campaigns to promote red tide awareness and to pinpoint sources of nutrient loading into the sea.



Table 2.2-59. Environmental Management Plan for Coastal and Fisheries Management

| Project Activity<br>CONSTRUCTION<br>PHASE   | Environmental Component<br>Likely to be Affected  | Potential Impact  | Options for Prevention or Mitigation or<br>Enhancement   |
|---|---|---|--|
| Reclamation, soil<br>filling and compacting | Coastal water quality;<br>Benthic communities of marine<br>organisms; pelagic fish<br>populations   | Increase in siltation/sedimentation loading in coastal<br>waters; increase in turbidity and suspended solids;<br><br>Reduction in photosynthesis and primary productivity<br><br>Suffocation of bivalve veliger in soft bottom benthos;<br><br>Disruption of fish feeding and benthos larval growth;<br><br>Impairment in fish and shellfish reproductive process.<br><br>Disturbance to schools of sardines and mullets feeding in<br>inshore waters | Provision of silt curtains where sediment streams are likely<br>to occur and escape.<br><br>Collection and trans-location of macro-invertebrates found<br>within the reclamation area.<br><br>Monitoring of sediment fluxes and application of more<br>stringent control measures when necessary; or temporary<br>cessation of activities.<br><br>Sediment canals in reclaimed areas will be installed to<br>divert sludge into filters and weirs that capture sediments<br>and fugitive reclamation filling materials at source.  |
|   | Wastewaters emanating due to<br>influx of reclamation workers can<br>add to marine pollution and<br>negatively affect benthic<br>communities of macro-<br>invertebrates; plankton<br>community fish | Inadvertent spill of domestic wastewaters<br>can cause coastal water pollution, loss of macro-<br>invertebrate population, impairment in fish and shellfish<br>reproductive physiology.   | Install liquid waste management system ensuring modern<br>waste retrieval and treatment system. Treatment and<br>disposal of liquid waste at point source will involve<br>collecting liquids of point source origin; directing waste into<br>integrated multiple waste streams facilities or collecting<br>vessels, and application of treatments. Any fluid effluent<br>to be discharged at sea will be monitored and tested before<br>discharging.<br><br>Installation of latrines and waste receptacles; collection<br>facilities;<br><br>Adoption of clean practices by all project operating units<br>and personnel;<br><br>Efficient waste retrieval system; |





| Project Activity<br>CONSTRUCTION<br>PHASE | Environmental Component<br>Likely to be Affected | Potential Impact   | Options for Prevention or Mitigation or<br>Enhancement   |
|---|--|--|--|
|   |  |  | Greening of reclamation area   |
|   | Coastal waters                                   | Oil and grease contamination   | Adoption of an oil and grease recovery and treatment system;<br><br>Implementation of rigid policies against indiscriminate disposal of oily waste and marine vessel bilge water.  |
|   | Fisheries and mariculture<br>livelihood          | Loss of mussel farms and fish pens/fish corrals.<br><br>Loss of nearshore fishing grounds; dislocation of gill net and hook and line fishers | No mussel farms and fish pens in Island E area<br><br>Provision of new fishing paraphernalia to enable affected small-scale fishers to move to deeper fishing grounds past the reclamation area; Provision of alternative livelihoods to affected fishers. |
|   |  |  |  |



## Chapter 2.3 THE AIR

### INTRODUCTION

The potential impacts on the air environment and climate change phenomenon relative to the activities during the reclamation works are shown in Table 2.3-1.

**Table 2.3-1. Reclamation Activities in Relation to Impacts on Air Resources and Climate Change**

| Major Activities  | Sub Activities with Potential Impacts on Air and Climate Change   | Remarks   |
|---|---|---|
| <b>Preparatory Works at Reclamation Site</b>  |   |   |
| Dredging<br>(To remove undesirable seabed materials)  | Operation of dredging equipment, use of power generating sets involving combustion of fuel oils   | <ul style="list-style-type: none"> <li>○ Distant from ESRs</li> <li>○ Short term only</li> <li>○ Fuel used in generating sets and heavy equipment will generate CO<sub>2</sub> and other criteria pollutants</li> </ul> |
| Creation of 2.4728 sq km of land form ( ) equivalent to 0.13% of the area of Manila Bay (1,800 sq.km. (Source PEMSEA) | Impacts on GHG<br>CO <sub>2</sub> from combustion of Marine Diesel Oil (MDO)<br>Loss of sea surface thus of GHG sequestration by ocean            | <ul style="list-style-type: none"> <li>○ Deemed minimal because of small change (in percentage) in land form of the Manila Bay</li> </ul>   |
| <b>Reclamation Proper</b>   |   |   |
| Sea travel of dredging vessel from site to San Nicholas Shoal (Distance of approx. 6.97 km)                           | Use of fuel (diesel oil) to propel vessel and power dredgers/cutters will generate combustion products (air pollutive) and GHG (CO <sub>2</sub> ) | <ul style="list-style-type: none"> <li>○ Pollution source is mobile in nature</li> <li>○ Activity is short term; TSHD will operate for est. <b>54600 hours</b> for the entire reclamation phase.</li> </ul>             |
| Filling/Land reclamation  | Same as above   | <ul style="list-style-type: none"> <li>○ Same as above</li> </ul>   |
| Installation of sub structures, e.g. containment sheets or silt curtains  | Use of barges   | <ul style="list-style-type: none"> <li>○ Minor generation of combustion products; relatively short term operation of barges</li> </ul>  |
| Leveling of reclaimed area to desired elevation   | Use of compaction and other equipment, potential use of generating sets,  | <ul style="list-style-type: none"> <li>○ Minor generation of combustion products</li> <li>○ Potential fugitive dust generation.</li> </ul>  |
| Horizon works/Construction of support facilities, roadways, drainage system, etc.                                     | Use of miscellaneous construction equipment, potential use of generating sets<br>Temporary concrete mix batching plant may be opted.              | <ul style="list-style-type: none"> <li>○ Minor and short generation of combustion products</li> <li>○ Potential fugitive dust generation.</li> </ul>  |
| Soil Stabilization  | Minimum use of heavy equipment; use of wick drains  | <ul style="list-style-type: none"> <li>○ Essentially no significant air pollution discharges</li> </ul>   |
| All dredging, filling and horizontal development works  | Noise generated by equipment  | <ul style="list-style-type: none"> <li>○ Deemed not significant due to distance from noise generator to ESRs and short term activities</li> </ul>   |

#### Air Pollution Impacts during Operation of the Dredging Equipment and Sea Vessels

The most important aspect of the vessel operations in respect to potential air pollution is that of the dredging/filling vessel(s) operating at sea. The aspect of the operations that generates air discharges is the combustion of oil during the travel to/from site to the San Nicholas Shoal. Thus, the air impact area and the receptors of air pollutants are the areas within the navigational lane shown in Figure 2.3-1; such impact area not being populated.





Figure 2.3-1. Sea Lane to the San Nicholas Shoal Showing Approximate Distance





It is noted that the actual dredging and related operations at and within the San Nicholas Shoal are covered by a separate Environmental Compliance Certificate (ECC) and therefore compliances thereto are covered by this ECC.

### **2.3.1 Meteorology / Climatology**

#### **2.3.1.1 Change in the local climate e.g. local temperature**

In broad terms, microclimate refers to the climate of a very small or restricted area, especially when this differs from the climate of the surrounding area of which temperature is a key aspect.

“Microclimate pertains to local climatic patterns which are superimposed on the global pattern as a function of geography and topography. The primary geographic variables are latitude and longitude. For example, the Philippine’s climatic characteristic is tropical because of the archipelago’s location relative to the warm equator. As a result, the country is generally said to experience pronounced dry (summer) and wet (rainy) seasons. However, because of differences in topography, sizes and positions relative to large water bodies and other oceanographic parameters, the country is further characterized into four distinct climatic zones

#### **Topography**

Among the factors to consider in the assessment of the impact of topography on microclimate are elevation, steepness and direction of slope, position of the slope and aspect or orientation of the area (e.g. Sartz, 1972; Sevruck et al., 1998; Rich and Fu, 2000). The combined effects of these parameters influence the microclimatic conditions in an area such as “incoming solar radiation (insolation), soil temperature, air temperature, wind, precipitation, evapotranspiration, water flow (accumulation and runoff), snow accumulation, and snow melt” (e.g. Rich and Fu, 2000).

#### **Diurnal Rainfall Variation**

The diurnal variation of rainfall at any tropical location is determined by a combination of many factors such as radiation heating and cooling, land-sea breeze effects, topography, tidal effects, frequency of synoptic disturbances, among others. Local circulations such as land-sea breeze, mountain-valley winds, and radiation surface-heating may be of secondary importance, at least during the months of maximum rainfall.

#### **Daily Rainfall Distribution**

In the tropics, synoptic-scale disturbances are primarily responsible for most rainfall on a daily basis, whereas convective and cloud-scale motions are related to time scales of hours and tenths of hours (Garstang, 1966). These synoptic-scale disturbances provide an environment favourable for the development of convective-scale systems (Henry, 1966). As the rainstorm intensity increases, the importance of orography declines.

#### **Rainfall Variation with Elevation**

Orography is undoubtedly a major factor in determining rainfall distribution. However, previous studies which attempted to derive statistical relationships between elevations and mean rainfall amounts have had very limited success. For example, Stidd and Leopold (1951) found only a weak relationship between elevation and mean relations between mean January and July rainfall amounts and elevation for all available stations on the island of Oahu. Cobb (1966) listed five factors which influence terrain effect: (1) shape, size and roughness of the mountains, (2) direction and distance from the moisture source, (3) intervening terrain between moisture source and the orographic barrier, (4) wind velocity, and (5) thickness and stability of the moist layer.



The effect of smaller topographic features on precipitation was investigated by James (1964) following contentions that “the orographic effect does not come into play (at least in middle Europe) on a hill low enough not to be a factor in the rising, and thus in the cooling, of inflowing air” (Geiger, 1959). It is proposed that a hill less than 300 feet (~91 m) than the surrounding area would have little influence on the distribution of local precipitation (James, 1964) “.

### **Wind**

Changes in wind circulation and velocity patterns can impact on micro climate.

### **Solar Energy**

Radiational heating refers to atmospheric heating caused by solar radiation being readily transmitted inward through the earth's atmosphere. During the transition months between the wet and dry seasons, surface heating is greater (due to the reduced cloud cover) and maybe more important in determining changes in daily rainfall.

### **Carbon Dioxide, Water Vapour and Other GHGs**

Climate and microclimate changes are directly influenced by GHG emissions, these emissions are however reckoned from global and not local inventories.

Table 2.3-1 indicates that noting the activities involved, there will be no changes in microclimate particularly in temperature. There will be no significant discharges to the atmosphere of air pollution and of substances at elevated temperatures. Moreover, the construction works involving the major shipping vessels (TSHD) will be undertaken for short period of time only.



### 2.3.1.2 Monthly Average Rainfall and Temperature in the Area

*Climatological normals/extremes; Wind rose diagrams; Frequency of Tropical cyclones*

The climatological Normals of the project site are shown in **Table 2.3-2** below.

**Table 2.3-2. Climatological Extremes**

**YEAR: AS OF 2016**  
**ELEVATION: 21m**

**LATITUDE: 14°30'25.75"N**  
**LONGITUDE: 121°00'15.90"E**

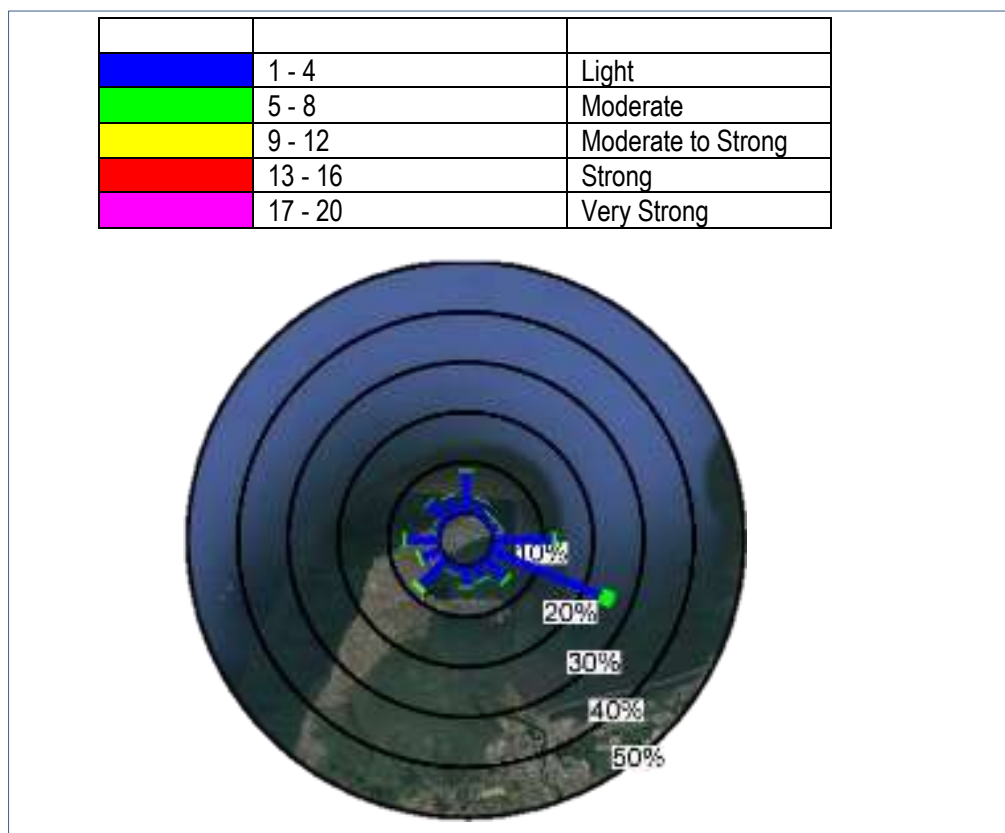
| MONTH                   | TEMPERATURE (°C) |                   |             |                   | GRATEST DAILY RAINFALL (mm) |                   | STRONGEST WINDS (mps) |          |                   | SEA LEVEL PRESSURES (mbs) |                   |              |                   |
|-------------------------|------------------|-------------------|-------------|-------------------|-----------------------------|-------------------|-----------------------|----------|-------------------|---------------------------|-------------------|--------------|-------------------|
|                         | HIGH             | DATE              | LOW         | DATE              | AMOUNT                      | DATE              | SPD                   | DIR      | DATE              | HIGH                      | DATE              | LOW          | DATE              |
| JAN                     | 35.8             | 01-07-1989        | 14.8        | 01-18-1961        | 55.3                        | 01-03-1970        | 20                    | ENE      | 01-12-1986        | 1022.3                    | 01-27-1987        | 1004.4       | 01-01-1950        |
| FEB                     | 35.1             | 02-21-1998        | 14.6        | 02-01-1962        | 16.5                        | 02-27-1950        | 20                    | E        | 02-28-1988        | 1021.4                    | 02-01-1998        | 1003.8       | 02-21-2001        |
| MAR                     | 36.5             | 03-30-1978        | 16.0        | 03-03-1963        | 36.0                        | 03-07-2011        | 26                    | E        | 03-29-1992        | 1021.1                    | 03-02-1987        | 1002.4       | 03-06-1999        |
| APR                     | 37.8             | 04-23-1948        | 18.7        | 04-01-1994        | 63.0                        | 04-04-1992        | 22                    | ESE      | 04-06-1986        | 1019.9                    | 04-23-1987        | 1002.4       | 04-21-2001        |
| MAY                     | 38.2             | 05-18-2014        | 19.1        | 05-11-1950        | 229.1                       | 05-27-1960        | 31                    | SW       | 05-22-1976        | 1015.9                    | 05-09-1957        | 992.2        | 05-17-1989        |
| JUNE                    | 38.0             | 06-02-1991        | 20.0        | 06-22-1954        | 353.8                       | 06-01-1958        | 36                    | S        | 06-29-1964        | 1016.0                    | 06-07-1997        | 974.6        | 06-29-1964        |
| JULY                    | 36.4             | 07-26-2016        | 18.3        | 07-28-1948        | 472.4                       | 07-20-1972        | 36                    | W        | 07-08-1986        | 1014.9                    | 07-07-1953        | 990.1        | 07-16-2014        |
| AUG                     | 35.2             | 08-29-1989        | 17.4        | 08-09-1949        | 401.8                       | 08-10-1947        | 30                    | WSW      | 08-16-1984        | 1015.2                    | 08-12-1958        | 992.8        | 08-24-1978        |
|                         | 35.2             | 08-19-2014        |             |                   |                             |                   |                       |          |                   |                           |                   |              |                   |
| SEP                     | 35.2             | 09-02-2013        | 19.1        | 09-15-1950        | 228.9                       | 09-08-1963        | 40                    | NNW      | 09-28-2006        | 1016.2                    | 09-18-2005        | 986.7        | 09-30-1995        |
| OCT                     | 36.0             | 10-24-1976        | 18.0        | 10-23-1981        | 274.5                       | 10-09-1978        | 27                    | W        | 10-18-1985        | 1017.0                    | 10-25-1986        | 977.9        | 10-14-1970        |
| NOV                     | 35.8             | 11-17-1972        | 17.2        | 11-26-1949        | 121.7                       | 11-14-1977        | 56                    | W        | 11-19-1970        | 1019.4                    | 11-03-1989        | 899.4        | 11-06-1995        |
| DEC                     | 34.2             | 12-29-1978        | 16.3        | 12-18-1955        | 125.5                       | 12-15-2015        | 25                    | NW       | 12-30-1950        | 1020.9                    | 12-06-1960        | 955.5        | 12-02-2004        |
| <b>ANNUAL</b>           | <b>38.2</b>      | <b>05-18-1969</b> | <b>14.6</b> | <b>02-01-1962</b> | <b>472.4</b>                | <b>07-20-1972</b> | <b>56</b>             | <b>W</b> | <b>11-19-1970</b> | <b>1022.3</b>             | <b>01-27-1987</b> | <b>889.4</b> | <b>11-03-1995</b> |
| <b>Period of Record</b> | <b>1947-2016</b> |                   |             |                   | <b>1949-2016</b>            |                   | <b>1950-2016</b>      |          |                   | <b>1950-2016</b>          |                   |              |                   |

Prepared by: 2016 CADS/CAD/PAGASA





The monthly wind rose diagrams are provided in **Annex 2.3-A** while the annual diagram is shown in Figure 2.3-2.



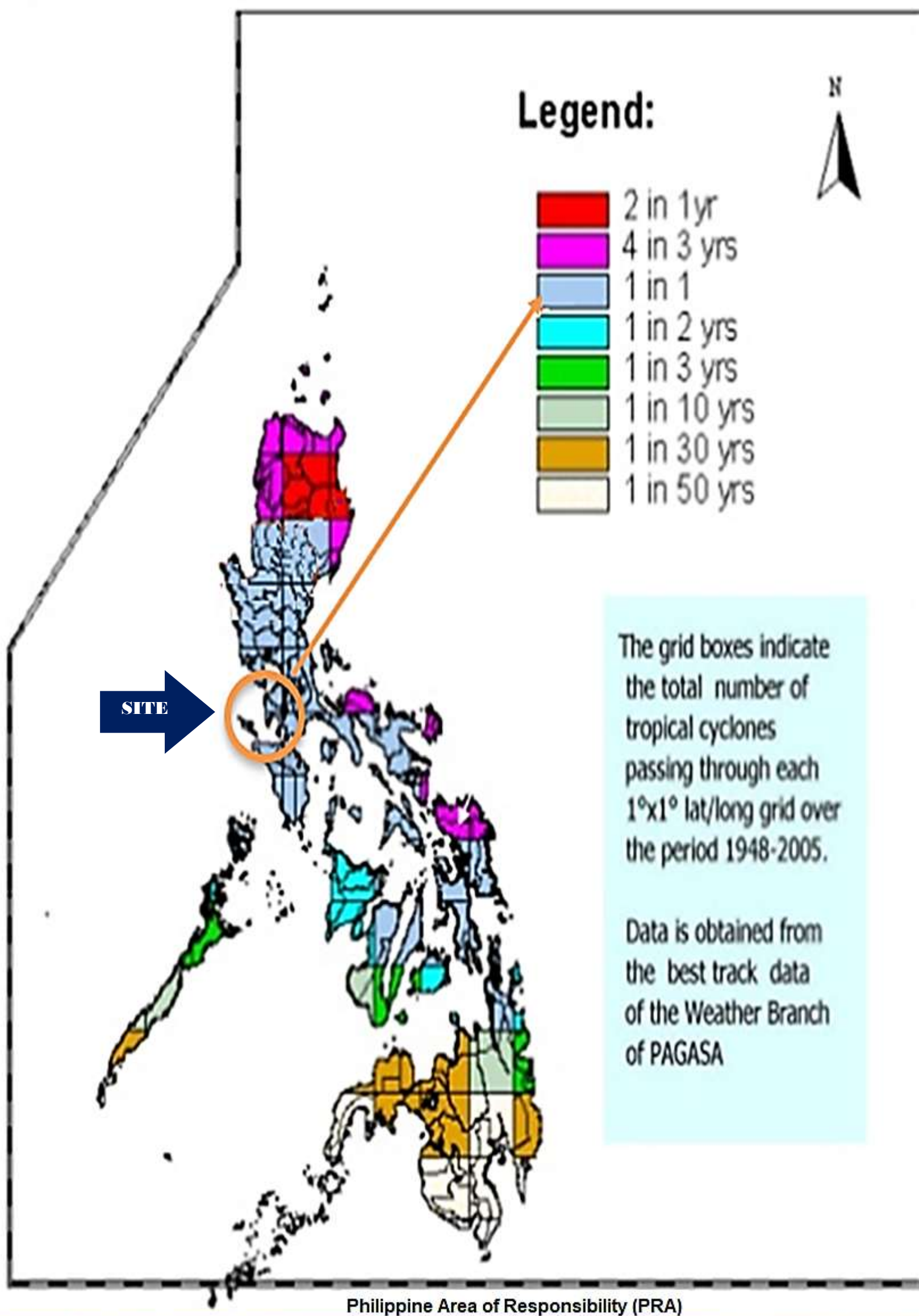
Source: PAGASA

**Figure 2.3-2. Annual Windrose Diagram for the Project Site and Environs**

### Frequency of Tropical Cyclones

This is shown in Figures 2.3-3.

The reclamation site experiences 2 cyclones per year equivalent to a percentage frequency of 16 %. This information is useful guide considering that the works will be done at sea and therefore tropical cyclones are important considerations vis-à-vis navigational safety.



Cinco, T.A. et al (2006). Updating Tropical Cyclone climatology in the PAR. Phil. Met-Hydro Congress, 2006

Source: Cinco, T.A. et al (2006). Updating Tropical Cyclone climatology in the PAR. Phil. Met-Hydro Congress, 2006

Figure 2.3-3. Map Showing Frequency of Tropical Typhoons in the Philippines



### 2.3.1.3 Contribution in Terms of Greenhouse Gas Emissions (or GHG Mitigation Potential)

*Effects of climate change using PAGASA medium to long term projections.*

The major GHG of relevance to the project is carbon dioxide because of oil combustion to generate power from generating units stationed in the vessels. Nitrous Oxide is also present, however, methane is not considered relevant in the absence of methane generators. Nevertheless, it may be likely that the disturbance of the sediments during the dredging operations may release trapped methane.

The major GHG of relevance to the project is carbon dioxide because of oil combustion to generate power from generating units stationed in the vessels. Nitrous Oxide is also present, however, methane is not considered relevant in the absence of methane generators.

#### Estimation of GHG emissions from the Project

##### Scope 1 emissions

**These are the Direct GHG** emitted by sources resulting from the dredging, reclamation and horizon development activities and includes:

**GHG generation** from the combustion of fossil fuels used by shipping vessels.

The GHG is estimated based on direct calculation of CO<sub>2</sub> generated from the combustion of heavy fuel oils. The main source of air discharges is the TSHD, which will operate only for a short period of time through the completion of the reclamation.

#### Calculation of CO<sub>2</sub> generated by the TSHD, the major vessel/dredging/reclamation equipment.

Basis and assumptions: (Source: THEIDI Construction Corporation)

|  |   |
|--|---|
| Travel cycle of TSHD from site to SNS and back | 7 hours/cycle                                 |
| Trench Dredging Cycle                          | 350 hours                                     |
| Total  | 6.5 years                                     |
| Hopper Capacity                                | 1500-3000 m <sup>3</sup>                      |
| Volume Fill required for 5 islands             | 124,920,000 m <sup>3</sup>                    |
| Total Number of cycles                         | 7800  |
| Total hours operating                          | 54600 hours                                   |
| Fuel carried by TSHD                           | 2200 m <sup>3</sup>                           |
| Total Oil Used                                 | 195,000 ton for the entire reclamation period |

#### Estimation of GHGs (Order of Magnitude)

Estimated Heat Content = 42,700 kJ/kg,  
[www.effship.com/PartnerArea/MiscPresentations/Dr\\_Wild\\_Report.pdf](http://www.effship.com/PartnerArea/MiscPresentations/Dr_Wild_Report.pdf)

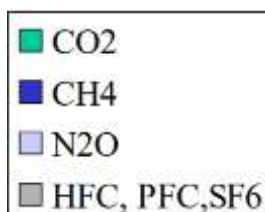
or:

$$195,000,000 \text{ kg} \times 41,700 \text{ kJ/kg} = 8.132 \times 10^{12} \text{ kJ or } 7\,707\,648.822 \times 10^{12} \text{ BTU}$$

**Scope 1 Emission** (Ref <https://www3.epa.gov/ttnchie1/conference/ei10/ghg/barbour.pdf>)

Estimated GHG Emissions expressed as C equivalent, defined as the composite of the various GHGs as follows:





### Components of the Carbon Equivalent of the GHG

Referenced Order of Magnitude Estimation  
(<https://www3.epa.gov/ttnchie1/conference/ei10/ghg/barbour.pdf>)

$$\text{MMTCE (Million Metric Tons Carbon Equivalent)} = (\text{Btu}/1000)(19.33\text{MMTCE}/\text{Tbtu})(0.99)$$

$$\text{Btu}/1000)(19.33\text{MMTCE}/\text{Tbtu})(0.99) = 2.53 \times 10^{-6} \text{ MMTCE}$$

Table 2.3-3 shows the official Philippine GHG Inventory.

**Table 2.3-3. Officially Reported Philippine GHG Inventory**

| Category                     | In CO <sub>2</sub> Equivalent (kilotons)<br>(2000) | In CO <sub>2</sub> Equivalent (kilotons)<br>(1994) |
|------------------------------|--|--|
| Energy                       | 69,667   | 50,040.33  |
| Agriculture                  | 37,002   | 33,128.57  |
| Waste                        | 11,599   | 7,094.78   |
| Industrial Processes         | 8,609  | 10,602.93  |
| Subtotal                     | 126,878  | 100,866.61   |
| Land-Use Change and Forestry | -107,387   | -126.49  |
| <b>TOTAL</b>                 | <b>19,491</b>                                      | <b>100,740.12</b>                                  |

*References: 2<sup>nd</sup> National Communication of the Philippines and UNFCCC website*

**Scope 2 emissions are referred to as Energy Indirect GHG**, and are defined as ‘emissions from the consumption of purchased electricity, steam, or other sources of energy) generated upstream from the organization’.

**Mitigation** consists of minimizing the use of fuel, which can be achieved through the use of efficient engines and boilers in vessels, when applicable.

**From use of fossil fuels during the construction of roads, the operations of the wick drain placer equipment, trucks, compactors and others.**

The various equipment are of different sizes with respect to horsepower and operate at different times and with different duration of works. For purposes of estimation of GHG it is assumed that the net equipment capacity is equivalent to 1000 kW. For a continuous operation of 1 year, the GHG is estimated at emission factor of 9.45 kg CO<sub>2</sub> per gallon of biodiesel (Reference: USEPA)

**Diesel Usage = 7.5 Ton/hour**

**CO<sub>2</sub> generation (estimates only) = 420 tons/day**

### **Loss of sequestration of CO<sub>2</sub> by the displaced sea body/Disturbance of the sea surface**

The ocean has a significant role in maintaining the concentration of CO<sub>2</sub> in the atmosphere by absorbing the GHG.



It is reported that  $2.3\text{PgCyr}^{-1}$  or 2.3 billion metric tons is sequestered by the ocean which roughly translate to 2.25 metric tons per cu km.

For the project there will be a displacement of sea water from the creation of land. However when the fill materials are dredged from Manila Bay there will be an equivalent creation of water body from the shoal area.

### **Estimation of LUCF GHG emissions**

#### **LUCF (Land-Use Change and Forestry)**

Land-use refers to the type of activity being carried out on a unit of land, such as forest land, cropland and grassland. IPCC 1996GL refers to sources and sinks associated with GHG emissions/removals from human activities that:

- Change the way land is used (e.g. clearing of forest for agriculture, conversion of grassland to forest);
- Affect the amount of biomass in existing biomass stocks (e.g. forest, village trees, savanna) and soil carbon stocks..."(UNFCC Handbook on Land Use Change and Forestry Sector)

Based on the above, it appears that LUCF GHG emissions are not the primary contributors to GHG emissions from the Project. The disturbance of sediments, i.e. the soft and clayish portions of the sub seabed is a temporary short-term situation if a reclamation technology that re-uses these disturbed materials is applied. This means that the sediments would be placed back to the seabed.

### **Effects of climate change using PAGASA medium to long-term projections**

The projected seasonal temperature increase, seasonal rainfall change and frequency of extreme events in 2020 and 2050 under the medium-range emission scenario in the provinces in Region 4-A are presented in the succeeding tables.

To use the tables and arrive at values of seasonal mean temperature and seasonal rainfall in 2020 and 2050 in any of the provinces, the projections are added to the observed values (presented in each of the tables).

For example, in Quezon, the projected values in 220 are:

- a. DJF mean temperature =  $(25.1\text{ C} + 0.9\text{ C}) = 26.0\text{ C}$ ;
- b. DJF rainfall =  $\{827.7\text{ mm} + 827.7 (6.5\%) \text{mm}\} = (827.7-53.8)\text{ mm}$  or 763.9mm;
- c. Number of days with  $T_{\text{max}} > 35\text{ C}$  in Casiguran during the 2006-2035 period (centered in 2020) = 1,720;
- d. Number of dry days in Casiguran during the 2006-2035 period (centered at 2020) = 4,520; and
- e. Number of days with rainfall  $> 300\text{mm}$  in Casiguran during the 2006-2035 period (centered at 2020) = 20

**Table 2.3-4. Seasonal temperature increase (in °C) in 2020 and 2050 under medium-range emission in Cavite Province**

| Observed baseline (1971-2000) |       |       |      | CHANGE in 2020 (2006-2035) |       |      |     | CHANGE in 2050 (2036-2065) |       |      |     |
|-------------------------------|-------|-------|------|----------------------------|-------|------|-----|----------------------------|-------|------|-----|
| DJF                           | MAM   | JJA   | SON  | DJF                        | MAM   | JJA  | SON | DJF                        | MAM   | JJA  | SON |
| Degree Centigrade (°C)        |       |       |      |                            |       |      |     |                            |       |      |     |
| 25.7                          | 28.2  | 27.3  | 26.9 | 1                          | 1.2   | 0.9  | 1   | 2                          | 2.2   | 1.8  | 1.9 |
| Percent (%)                   |       |       |      |                            |       |      |     |                            |       |      |     |
| 124.9                         | 242.8 | 985.7 | 579  | -26.1                      | -28.2 | 13.1 | 0.4 | -19.1                      | -30.5 | 24.2 | 5.9 |



**Table 2.3-5. Frequency of extreme events in 2020 and 2050 under medium-range emission scenario in Cavite Province**

| Station | No. of Days w/Tmax>35°C |      |      | No. of Dry Days |      |      | No. of Days w/Rainfall >200mm |      |      |
|---------|-------------------------|------|------|-----------------|------|------|-------------------------------|------|------|
|         | OBS<br>(1971-2000)      | 2020 | 2050 | OBS             | 2020 | 2050 | OBS                           | 2020 | 2050 |
| Sangley | 630                     | 1697 | 2733 | 7352            | 6635 | 6565 | 6                             | 9    | 9    |

From the table presented, the following may be observed:

- Maximum seasonal temperature increase of 2.2°C may be expected in the long term (2036-2065).

The above projections will be largely experienced during the operations phase of the project which has significantly much longer period of time that the relatively shorter construction phase and for which the major impacts are:

- Rainfall will impact on storm water flows from the reclaimed area. The drainage system will be engineered accordingly. More importantly, the channels of the reclaimed land will also be engineered in detail to ensure the storm water discharges are not constricted.

### **On Climate Change Adaptation**

The following are the key Climate Change hazard scenarios and the adaptation measures to be adopted:

- **Accelerated Sea Level Rise**
  - ✓ The reclaimed land platform will be at elevation of 4 meters above MMLL
- **Storm surges**
  - ✓ The reclaimed land itself will provide sheltering effect during episodes of storm surges.
  - ✓ Wave deflectors will be installed in strategic places.

## **2.3.2 Air Quality**

### **2.3.2.1 Degradation of Air Quality**

#### **2.3.2.1.1 Ambient Air Quality**

#### **Rationale/Perspective**

The baselines have to be reckoned from the standards, which for air pollution is referred to the guideline values under the Philippine Clean Air Act of 1999.

These guidelines are taken to refer to guideline values at lands and no guidelines are provided for values taking the sea as the reference locations or sites.

For this type of project, the sources of air pollution are from the mobile sea vessels on which combustion of Marine Diesel Oil (MDO) takes place.

There are no Environmentally Sensitive Receptors of air pollution at sea.

The generation of air pollution by the engines on board the sea vessels are short term and intermittent during the construction period of approximately 6-7 years.





The above premises considered, following baseline results are presented.

### Parameters

The choice of the parameters **TSP**, **PM10**, **SO<sub>2</sub>** and **NO<sub>2</sub>** is based on the Philippine Clean Air Act of 1999

#### a) For National Ambient Air Quality Guideline for Criteria Pollutants:

| Pollutants                  | Short Term <sup>a</sup> |          | Long Term <sup>b</sup> |        |                     |
|-----------------------------|-------------------------|----------|------------------------|--------|---------------------|
|                             | µg/NCM                  | ppm      | Averaging              | µg/NCM | ppm                 |
|                             | Averaging               | Time     | Time                   |        |                     |
| Suspended Particulate       |                         |          |                        |        |                     |
| Matter <sup>c</sup> - TSP   | 230 <sup>d</sup>        | 24 hours | 90                     | --     | 1 year <sup>e</sup> |
| - PM-10                     | 150 <sup>f</sup>        | 24 hours | 60                     | --     | 1 year <sup>e</sup> |
| Sulfur Dioxide <sup>c</sup> | 180                     | 0.07     | 24 hours               | 80     | 0.03 1 year         |
| Nitrogen Dioxide            | 150                     | 0.08     | 24 hours               | --     | --                  |
| Photochemical Oxidants      | 140                     | 0.07     | 1 hour                 | --     | --                  |
| As Ozone                    | 60                      | 0.03     | 8 hours                | --     | --                  |
| Carbon Monoxide             | 35 mg/NCM               | 30       | 1 hour                 | --     | --                  |
|                             | 10 mg/NCM               | 9        | 8 hours                | --     | --                  |

(RA 8749) as follows:

### Test Methods

The standard and acceptable test methods were used by the DENR-recognized laboratory (**Industramach Inc.**) as follows:

The DENR standard ambient sampling equipment and analytical procedures were used in the sampling activity. These equipment and procedures are specified below:

#### Total Suspended Particulates (TSP)

Procedure: USEPA, 40 CFR 50, Appendix B

Sampling Equipment: Graseby PM 10 High Volume Sampler

Method of Analysis: Gravimetric Method

#### Particulate Matter 10 Microns (PM 10)

Procedure: USEPA, 40 CFR 50, Appendix M

Sampling Equipment: Graseby PM 10 High Volume Sampler

Method of Analysis: Gravimetric Method

#### Particulate Matter 2.5 Microns (PM 2.5)

Procedure: USEPA, 40 CFR 50, Appendix N

Sampling Equipment: Graseby PM 10 High Volume Sampler

Method of Analysis: Gravimetric Method

The TSP and PM10 filters were placed inside a sealed brown envelope lined with clean paper. PM2.5 filters were placed in a traveling filter container. The samples were transported to the laboratory for analysis.



### **Noise Level Measurement**

A precision type, digital sound level meter was used in noise measurement. The said instrument is an EXTECH sound level meter Model 407780A (Extech). As declared in the certificate of conformity, with the accuracy of 1.5 dB, the sound level meter fulfills the guidelines of 89/336/ECC. The sound level meter conforms also with DIN EN 60651, (IEC 651), Class 2 standards.

The sound level meter was calibrated by Switchtek Measurement Systems using a Lutron sound level calibrator model SC-940. By comparative technique, Standard Sound Generator was introduced to the Extech at a constant value of 114.0 dB and at a uniform frequency of 1000 Hz. Data were gathered and tabulated.

The 4-time period noise level measurements were conducted at least five (5) minutes every sampling periods (morning, daytime, evening and nighttime). Statistical noise values, minimum, maximum, mean (average) and median, were determined from each set of noise meter readings. Median noise values were compared with the applicable DENR Noise Limits

### **Sampling Stations**

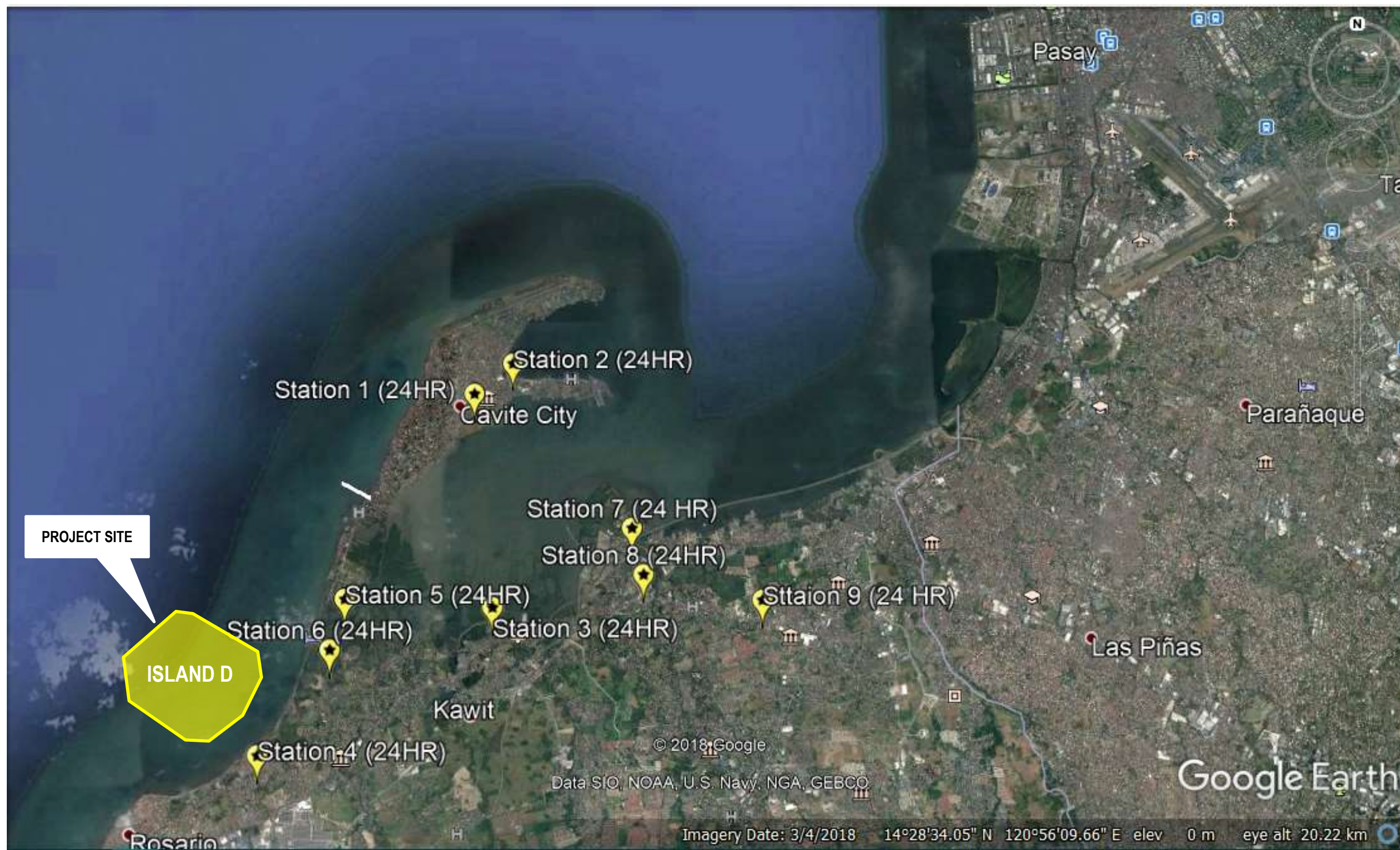
The air pollution sources as well as the receptors are located at sea. These sources are also mobile being from the operation of air pollution devices in moving sea crafts.

It is noted that the Clean Air Act guidelines prescribe standards at land, i.e. at the population centers.

Moreover, the Construction Phase (i.e. during the dredging and reclamation phase) does not involve significant air and noise generation. The Operations Phase instead is the more relevant phase of the project cycle with respect to the Air and Noise Module.

The sampling stations are arbitrarily chosen along the coastal roads along Manila Bay, i.e. onshore and shown in Figure 2.3-4.





Base Map: 2018 Google Earth

Figure 2.3-4. Map of the Ambient Air Sampling Station (24-HR)





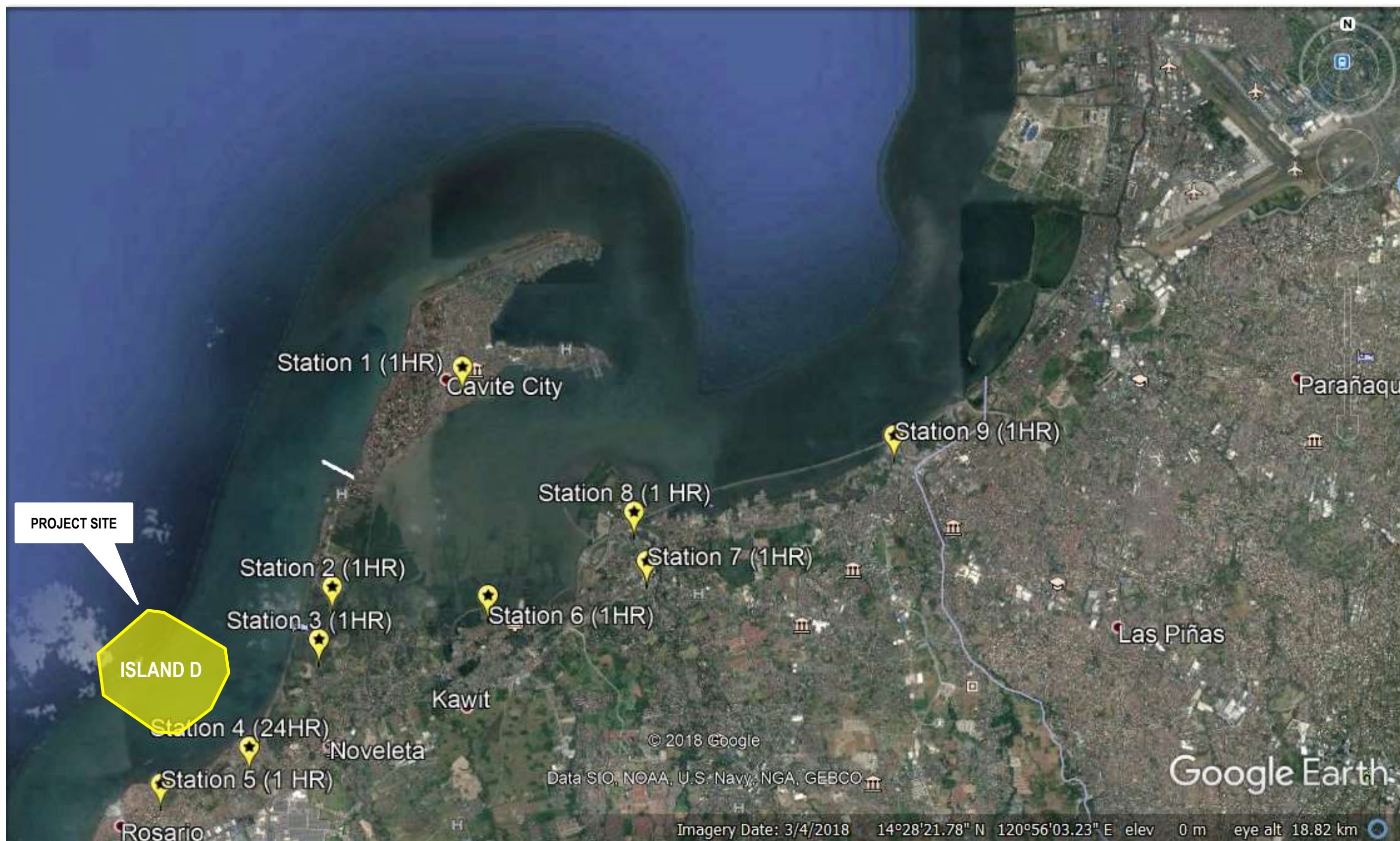
**Table 2.3-6. Results of the Ambient Air Quality Measurements (24-HR)**

| Stn                  | LOCATION   | TSP<br>μG/Nm <sup>3</sup> | PM10<br>μG/Nm <sup>3</sup> | PM2.5<br>μG/Nm <sup>3</sup> |
|----------------------|--|---------------------------|----------------------------|-----------------------------|
| 1                    | Barangay Molina, San Roque, Cavite City              | 69.7                      | 15.4                       | 15.5                        |
| 2                    | Manila-Cavite Road, Noveleta                         | 35.1                      | 16.9                       | 15.9                        |
| 3                    | Barangay San Rafael IV, San Juan, Noveleta, Cavite   | 95.8                      | 40.7                       | 28.9                        |
| 4                    | Barangay Bagbag II, Roasario, Cavite                 | 146.5                     | 53.8                       | 20.6                        |
| 5                    | Barangay Muzon II, Rosario                           | 154.3                     | 81.8                       | 29.3                        |
| 6                    | Barangay Kaingen, Kawit, Cavite                      | 115.5                     | 42.6                       | 16.4                        |
| 7                    | Barangay Pulvorista, Binakayan, Kawit, Cavite        | 123.4                     | 38.7                       | 17.2                        |
| 8                    | Barangay Congbalay-Legaspi, Binakayan, Kawit, Cavite | 123.2                     | 38.3                       | 13.0                        |
| 9                    | Barangay Talaba II, Bacoar, Cavite                   | 228.8                     | 79.8                       | 30.3                        |
| <b>DENR NAAQSSAP</b> |  | <b>230</b>                | <b>150</b>                 | <b>50</b>                   |

**Table 2.3-7. Results of the Noise Level Measurements (24-HR)**

| Stn. | Period    | Date       | Time        | Max.<br>(dBA) | MIN<br>(dBA) | Ave.<br>(dBA) | MEDIAN<br>(dBA) | DENR (dBA)* |         |
|------|-----------|------------|-------------|---------------|--------------|---------------|-----------------|-------------|---------|
|      |           |            |             |               |              |               |                 | Class A     | Class B |
| 1    | Morning   | 2.18.2019  | 05:23-05:28 | 56.1          | 51.4         | 53.1          | 53.1            | -           | 60      |
|      | Daytime   | 2.17.2019  | 13:48-13:53 | 57.9          | 54.1         | 55.9          | 56.0            | -           | 65      |
|      | Evening   | 2.17.2019  | 20:00-20:05 | 72.6          | 56.2         | 62.4          | 61.3            | -           | 60      |
|      | Nighttime | 2.18.2019  | 02:12-02:16 | 65.3          | 56.5         | 58.2          | 58.0            | -           | 55      |
| 2    | Morning   | 2.19.2019  | 06:61-06:56 | 80.4          | 59.0         | 68.2          | 67.4            | 50          | 60      |
|      | Daytime   | 2.18.2019  | 16:15-16:19 | 76.8          | 62.4         | 68.3          | 67.3            | 55          | 65      |
|      | Evening   | 2.18.2019  | 20:41-20:46 | 80.6          | 57.6         | 64.8          | 64.3            | 50          | 60      |
|      | Nighttime | 2.19.2019  | 02:49-02:54 | 80.1          | 58.2         | 65.5          | 65.2            | 45          | 55      |
| 3    | Morning   | 2.20.2019  | 06:46-06:51 | 82.2          | 64.9         | 71.9          | 72.5            | -           | 60      |
|      | Daytime   | 2.19.2019  | 16:23-16:28 | 85.6          | 57.5         | 70.7          | 70.0            | -           | 65      |
|      | Evening   | 2.19.2019  | 20:44-20:49 | 77.2          | 57.1         | 69.1          | 71.8            | -           | 60      |
|      | Nighttime | 2.20.2019  | 03:28-03:32 | 77.9          | 53.3         | 60.0          | 57.0            | -           | 55      |
| 4    | Morning   | 2.25.2019  | 05:17-05:22 | 79.4          | 58.3         | 67.6          | 67.2            | 50          | 60      |
|      | Daytime   | 2.24.2019  | 10:19-10:24 | 79.9          | 61.8         | 70.1          | 69.7            | 55          | 65      |
|      | Evening   | 2.24.2019  | 19:01-19:06 | 84.5          | 63.4         | 74.2          | 73.9            | 50          | 60      |
|      | Nighttime | 2.24.2019  | 23:45-23:50 | 80.2          | 58.6         | 60.8          | 59.4            | 45          | 55      |
| 5    | Morning   | 2.21.2019  | 04:33-04:37 | 60.7          | 50.8         | 54.1          | 53.8            | 50          | -       |
|      | Daytime   | 2.20.2019  | 17:42-17:47 | 83.1          | 54.2         | 60.8          | 58.6            | 55          | -       |
|      | Evening   | 2.20.2019  | 19:46-19:51 | 66.0          | 51.1         | 54.9          | 54.0            | 50          | -       |
|      | Nighttime | 2.21.2019  | 04:19-04:24 | 76.0          | 51.8         | 64.5          | 65.8            | 45          | -       |
| 6    | Morning   | 02.26.2019 | 06:33-06:38 | 69.2          | 48.5         | 55.4          | 52.4            | 50          | -       |
|      | Daytime   | 02.25.2019 | 12:48-12:53 | 67.2          | 47.1         | 52.8          | 50.7            | 55          | -       |
|      | Evening   | 02.25.2019 | 19:16-19:21 | 57.9          | 49.0         | 50.8          | 50.0            | 50          | -       |
|      | Nighttime | 02.26.2019 | 01:03-01:07 | 62.5          | 42.9         | 48.7          | 48.2            | 45          | -       |
| 7    | Morning   | 02.27.2019 | 06:53-06:58 | 79.4          | 58.3         | 67.7          | 67.6            | 45          | 60      |
|      | Daytime   | 02.27.2019 | 10:02-10:06 | 81.5          | 64.7         | 70.8          | 71.0            | 50          | 65      |
|      | Evening   | 02.26.2019 | 20:10-20:10 | 81.5          | 59.3         | 69.1          | 67.7            | 45          | 60      |
|      | Nighttime | 02.27.2019 | 4:30-04:354 | 78.6          | 57.5         | 65.8          | 64.0            | 40          | 55      |
| 8    | Morning   | 02.28.2019 | 06:32-06:37 | 71.5          | 56.0         | 59.9          | 59.2            | 50          | -       |
|      | Daytime   | 02.27.2019 | 14:25-14:30 | 73.6          | 56.3         | 64.0          | 62.2            | 55          | -       |
|      | Evening   | 02.27.2019 | 19:06-19:11 | 71.0          | 53.2         | 58.3          | 57.6            | 50          | -       |
|      | Nighttime | 02.28.2019 | 03:18-03:23 | 70.3          | 53.9         | 57.1          | 56.5            | 45          | -       |
| 9    | Morning   | 03.01.2019 | 06:04-06:09 | 81.8          | 70.9         | 76.1          | 75.8            | 50          | 60      |
|      | Daytime   | 02.28.2019 | 15:12-15:17 | 83.5          | 68.8         | 76.3          | 76.5            | 55          | 65      |
|      | Evening   | 02.28.2019 | 21:35-21:40 | 84.7          | 67.4         | 73.8          | 73.6            | 50          | 60      |
|      | Nighttime | 03.01.2019 | 00:40-00:45 | 75.7          | 61.4         | 65.3          | 64.1            | 45          | 55      |





Base Map: 2018 Google Earth

Figure 2.3-5. Map of the Ambient Air Sampling Station (1HR)





**Table 2.3-8. Results of the Ambient Air Quality Measurements (1-HR)**

| Stn                  | LOCATION  | TSP<br>μG/Nm <sup>3</sup> | PM10<br>μG/Nm <sup>3</sup> | SO2<br>μG/Nm <sup>3</sup> | NO2<br>μG/Nm <sup>3</sup> |
|----------------------|---|---------------------------|----------------------------|---------------------------|---------------------------|
| 1                    | Market Parking Lot Cavite City                  | 60                        | 49                         | 16.55                     | 6.94                      |
| 2                    | Samonte Park Cavite City                        | 99                        | 47                         | 8.63                      | 2.71                      |
| 3                    | Front Mary Magdalene Parish Church Kawit        | 96                        | 122                        | 4.48                      | 2.23                      |
| 4                    | Vacant LotBrgy. Bagbag 1 Rosario Cavite         | 363                       | 255                        | 39.42                     | 18.81                     |
| 5                    | Manila-Noveleta Road San Rafael Kuatro          | 66                        | 55                         | 11.66                     | 4.00                      |
| 6                    | Manila- Noveleta Raod Cavite San Rafael Tres    | 199                       | 113                        | 7.42                      | 1.80                      |
| 7                    | Legazpi St., Binakayan, Kawit Cavite            | 74                        | 109                        | 10.50                     | 5.30                      |
| 8                    | Brgy. Mabolo/ Tirona Highway Bacoar Cavite      | 335                       | 727                        | 8.51                      | 4.92                      |
| 9                    | Brgy. Dulong Bayan/Tirona Highway Bacoar Cavite | 104                       | 184                        | 9.00                      | 3.56                      |
| <b>DENR NAAQSSAP</b> |   | <b>300</b>                | <b>200</b>                 | <b>340</b>                | <b>260</b>                |

**Table 2.3-9. Results of the Noise Level Measurements**

| Station No. | Date & Time of Sampling   | MIN (dBA) | MAX (dBA) | MEAN (dBA) | MEDIAN (dBA) | DENR (dBA) Class B |
|-------------|---------------------------|-----------|-----------|------------|--------------|--------------------|
| 1           | Dec. 12, 2018 1409H-1414H | 49.7      | 56.4      | 52.3       | 52.2         | 55                 |
| 2           | Dec. 12, 2018 1555H-1600H | 58.6      | 74.5      | 65.4       | 65.6         | 50                 |
| 3           | Dec. 13, 2018 0832H-0837H | 49.6      | 69.8      | 55.8       | 54.5         | 50                 |
| 4           | Dec. 13, 2018 1050H-1055H | 58.5      | 84.5      | 69.8       | 69.7         | 55                 |
| 5           | Dec. 13, 2018 1250H-1255H | 58.4      | 80.7      | 71.0       | 71.6         | 55                 |
| 6           | Dec. 13, 2018 1455H-1500H | 56.4      | 79.4      | 69.2       | 71.0         | 55                 |

**Discussion of Results:**

The above results may be deemed as adequate for an EIS Report because the actual activities related to the project will not be undertaken until after a much later date after the securing of the ECC. Additional baseline tests would likely be required by the Multipartite Monitoring Team (MMT) which will be organized after the securing of the ECC.

The sampling in Stations 1 to 3 were conducted on a sunny weather condition with light to moderate southeasterly wind; while cloudy weather condition with light northerly wind were prevailing for Stations 4 to 9

The results showed that the TSP, PM10, SO2 and NO2 concentrations in all sampling stations, except for Stations 4 and 8, were within the applicable AAQGV as prescribed in the Philippine Clean Air Act and the DENR Standards. The exceedances in TSP and PM10 were attributable to road dusts dispersed by passing vehicles.

For the noise measurements, the standards are based on the 1978 Rules and Regulations of the then National Pollution Control Commission (NPCC) shown in the table below. Different limits are set the various times of the day and area categories.

**Table 2.3-10. Noise Level Standards (NPCC Guidelines of 1978)**

| Category of the Area | Daytime (dBA) | Morning & Evening (dBA) | Nighttime (dBA) |
|----------------------|---------------|-------------------------|-----------------|
| AA                   | 50            | 45                      | 40              |
| A                    | 55            | 50                      | 45              |





| Category of the Area | Daytime (dBA) | Morning & Evening (dBA) | Nighttime (dBA) |
|----------------------|---------------|-------------------------|-----------------|
| B                    | 65            | 60                      | 55              |
| C                    | 70            | 65                      | 60              |
| D                    | 75            | 70                      | 65              |

#### Category of Areas

AA Areas within 100 m from school sites and hospitals

A Residential Areas

B Commercial Areas

C Light Industrial Area

D Heavy Industrial Area

#### Air Dispersion Modelling deemed not applicable because:

- The sources of air discharges are moving (i.e. at sea)
- Only short time duration of works
- Traffic which attributes to area air dispersion is not a concern during this phase (but is during the operations phase)

#### 2.3.2.2 Increase in Ambient Noise Levels

Ambient Noise is deemed not relevant to the Project for the following reasons:

- The receptors are on land are distant from the project site, which is at sea
- The major noise generators e.g. dredgers, pumps on vessels, boilers on vessel, etc. are based on sea crafts which are mobile.
- These noise generators are intermittent in operation.
- There are no guidelines nor standards for noise levels at sea; these being reckoned for noise levels at land where there are population centers.

Nevertheless, noise level measurements were conducted and reported in Tables 2.3-7 and 2.3-9 above.



## Chapter 2.4. THE PEOPLE

### Methodology and Limitations

The people module is one of the vital components of the EIA system because it highlights the impacts of the proposed project to the primary and secondary impact or affected communities. More importantly “People” factor could be a key to the success of a project.

Baselines presented in this module were gathered and conducted for the discussion of the proposed reclamation project. Most of the data presented in this module are derived from the existing 2018-2028 Noveleta Comprehensive Land Use Plan and 2011-2020 Municipality of Rosario Comprehensive Land Use Plan.

The preliminary household perception survey was conducted last June 13-18, 2018 to assess the socio-cultural economic situation of the communities that are to be affected by the proposed reclamation. See **Annex 2.4-A**.

On the other hand, secondary information was also gathered from existing websites of relevant government agencies such as the National Statistics Coordination Board (NSCB) and Philippine Statistics Authority 2015 Census of Population. The said data gathering was undertaken to gather baselines, assess the potential impacts and provide appropriate measures.

### BACKGROUND

The proposed project site is situated along the coast of Manila Bay and the Coastline of Noveleta and Rosario, within the jurisdiction of Cavite Province.

As the proposed project spans in 2 towns, 12 barangays fronting the site and hosting onshore establishments are considered DIAs for socio-economic aspects and perhaps for environmental/risks aspects as well, principally regarding flooding and storm surges. Thus, baselines of the affected areas are presented to evaluate the projected impacts of the proposed project and provide necessary mitigation.

### Land Area

#### Municipality of Noveleta

Municipality of Noveleta has a total land area of 604.0145 hectares which is roughly 0.47 % of the total land area of the Province of Cavite. The municipality is politically subdivided into 16 barangays.

Among the 16 barangays, San Rafael IV is the largest with 169.01 hectares representing about 27.98 % of the municipality’s total land area. The second largest is Brgy. San Rafael III which comprises 86.48 hectares or about 14.32 % of the total land area. The smallest barangay is Poblacion with 5.88 hectares representing about 0.98 % of the municipality’s land area. Provided in **Table 2-4-1** is the total population, land area and density per barangay.

**Table 2.4-1. Noveleta Land Area and Population Density By Barangay; 2015**

| Barangay       | Population | Area (ha) | Density (Person/ha) |
|----------------|------------|-----------|---------------------|
| Magdiwang      | 2,036      | 16.4715   | 124                 |
| Poblacion      | 2,234      | 5.8772    | 380                 |
| Salcedo I      | 2,137      | 16.3809   | 130                 |
| Salcedo II     | 6,032      | 19.3927   | 311                 |
| San Antonio I  | 4,869      | 39.3453   | 124                 |
| San Antonio II | 1,855      | 37.6117   | 49                  |



| Barangay       | Population    | Area (ha)       | Density (Person/ha) |
|----------------|---------------|-----------------|---------------------|
| San Jose I     | 1,105         | 11.267          | 98                  |
| San Jose II    | 1,653         | 13.2205         | 125                 |
| San Juan I     | 2,312         | 10.4482         | 221                 |
| San Juan II    | 2,994         | 28.4677         | 105                 |
| San Rafael I   | 1,353         | 15.7484         | 86                  |
| San Rafael II  | 3,656         | 78.7201         | 46                  |
| San Rafael III | 6,073         | 86.4811         | 70                  |
| San Rafael IV  | 2,147         | 169.0101        | 13                  |
| Sta. Rosa I    | 4,177         | 24.2981         | 172                 |
| Sta. Rosa II   | 1,213         | 31.274          | 39                  |
| <b>Total</b>   | <b>45,846</b> | <b>604.0145</b> | <b>76</b>           |

Source: 2018-2028 Comprehensive Land Use Plan of Municipality of Noveleta

Based on the available data, the dominant land use of the municipality is for residential purposes, which comprise 362.20 hectares or about 59.97% of the total land area. These include the privately owned subdivisions mostly located around the municipal center. Some 53.70 hectares or 8.89 percent are still devoted to lowland rice and other agricultural crops.

This is to note that these are within the zoned area for residential purposes as per zoning plan approved by the Housing and land Use Regulatory Board in 1981.

Saltbeds and fishponds cover 71.50 hectares or about 11.84 percent of the total land area. Industrial use comprises 3 hectares representing 0.50 percent.

### Municipality of Rosario

Rosario, the second smallest town in Cavite has an approximate land area of 768.3640 hectares. This significantly differs with the records of the Land Management Bureau (560 ha) and Land Classification Division of the National Mapping and Resource Information Authority (540 ha). This however compares favorably from that of Pastora project estimate (789 ha).

While boundary disputes between municipalities remain a controversial issue that hampers the delineation of actual areas of jurisdiction, other factors which affect the accurate determination of land area include cross-municipal property tax declaration/payment and human errors in the area survey and measurement due to the nature of methodology and technical employed. For this reason (and assuming that the base maps provided by MPDC are correct), the computer-assisted Geographical Information System (GIS) software generated 768.364 hectares is adopted. Pursuant to Sec. 118 of the Local Government Code of 1991, resolution boundary disputes rest with the Sangguniang Panlalawigan.

The municipality has 20 barangays, some of which came about only in 1990. Tejeros Convention, the biggest barangay with 402.9201 hectares hosts the Cavite Economic Zone (CEZ). Bagbag II has 49.5784 hectares; Ligdong III (28.5870 ha); and Ligdong II (20.7914 ha). Other barangays with less than ten hectares include Sapa II and Sapa IV. See Table 2.4-2.

**Table 2.4-2. Noveleta Land Area and Population Density By Barangay; 2015**

| Barangay    | Population | Area (ha) | Density (Person/ha) |
|-------------|------------|-----------|---------------------|
| Bagbag I    | 6,070      | 24.7939   | 245                 |
| Bagbag II   | 5,890      | 49.5784   | 119                 |
| Kanluran    | 3,971      | 13.536    | 293                 |
| Ligdong I   | 4,674      | 23.3449   | 200                 |
| Ligdong II  | 2,055      | 20.7914   | 99                  |
| Ligdong III | 6,821      | 28.587    | 239                 |
| Ligdong IV  | 2,893      | 12.4596   | 232                 |





| Barangay           | Population     | Area (ha)      | Density (Person/ha) |
|--------------------|----------------|----------------|---------------------|
| Muzon I            | 3,923          | 20.2362        | 194                 |
| Muzon II           | 3,051          | 10.8786        | 280                 |
| Poblacion          | 1,894          | 20.6975        | 92                  |
| Sapa I             | 2,210          | 11.9535        | 185                 |
| Sapa II            | 7,254          | 13.2269        | 548                 |
| Sapa III           | 3,953          | 6.0583         | 652                 |
| Sapa IV            | 969            | 3.9497         | 245                 |
| Silangan I         | 7,683          | 25.6523        | 300                 |
| Silangan II        | 4,612          | 16.5626        | 278                 |
| Tejeros Convention | 19,697         | 402.9201       | 49                  |
| Wawa I             | 4,894          | 12.5205        | 391                 |
| Wawa II            | 6,271          | 10.6621        | 588                 |
| Wawa III           | 11,921         | 26.0964        | 457                 |
| Rivers and Creeks  |                | 13.8581        |                     |
| <b>Total</b>       | <b>110,706</b> | <b>768.364</b> | <b>144</b>          |

Source: <http://rosario-cavite.com/index.php/layout/innerleft-center-right/demography> and POPCEN 2015

## Demographic Profile

### Population Size and Historical Growth

#### Municipality of Noveleta

The population of the municipality in 2015 based on the 2015 Census is 45,846 (**Table 2.4-1**). San Rafael III, San Antonio I, Sta. Rosa 1 and Salcedo II account for the most populated among the 16 barangays with 21,151 population. Such concentration is primarily due to establishment of residential subdivisions and their accessibility to transportation and proximity to commercial establishments located at the Poblacion and the nearby city of Cavite and the CEZ, which is only about 6 kilometers away.

The historical growth of the population in the municipality of Noveleta indicates a consistent increase since the year 1903 up to the last censal year 2015. The recorded population in 1903 was 2,343 and eventually increased to 2,886 in the next censal year 1918 (15 years) with an annual growth rate of 1.59 %.

The 2015 population of Noveleta is at 45,846, an increase of 33.79 % from 20,409 in 1990. Based on this increase, the average annual growth rate is 5.60 %, which is lower than the provincial growth rate of 6.92 percent. For the period 2000-2010, the growth rate is 2.69%; and in 2000 to 2015 is 2.39%. This further strengthens the role of the municipality as an urban area. The population is distributed among its 16 barangays and is considered to be about 1.24 percent of the total provincial population of 3,678,301. See Table 2.4-3.

The high annual growth rate of the municipality can be attributed to natural birth and in-migration which was influenced by the increasing number of industries at the CEZ in the nearby municipality of Rosario and the influx of people from the congested City of Cavite and other nearby towns as well as from the Metropolitan Manila area.

**Table 2.4-3. Historical Population Growth of Noveleta**

| Year | Population | Increase | % Increase / Decrease | Average Growth Rate |
|------|------------|----------|-----------------------|---------------------|
| 1903 | 2,343      | -        | -                     | -                   |
| 1918 | 2,886      | 543      | 23.18                 | 1.40                |
| 1939 | 4,241      | 1,355    | 46.95                 | 1.82                |
| 1948 | 5,003      | 762      | 17.97                 | 1.85                |
| 1960 | 7,029      | 2,026    | 40.50                 | 2.87                |
| 1970 | 10,560     | 3,531    | 50.23                 | 4.15                |
| 1975 | 12,141     | 1,581    | 14.97                 | 2.83                |
| 1980 | 14,460     | 2,319    | 19.1                  | 3.56                |



| Year | Population | Increase | % Increase / Decrease | Average Growth Rate |
|------|------------|----------|-----------------------|---------------------|
| 1990 | 20,409     | 5,949    | 41.14                 | 3.51                |
| 1995 | 27,306     | 6,897    | 33.79                 | 5.60                |
| 2000 | 31,959     | 4,653    | 17.04                 | 3.43                |
| 2007 | 39,291     | 7,335    | 22.95                 | 2.87                |
| 2010 | 41,678     | 2,384    | 6.07                  | 1.98                |
| 2015 | 45,846     | 4,168    | 10.00                 | 1.59                |

Source: 2018-2028 Comprehensive Land Use Plan of Municipality of Noveleta

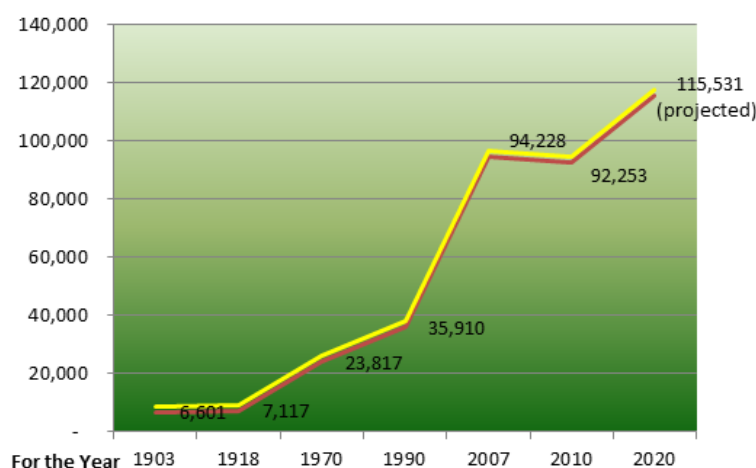
### Municipality of Rosario

Rosario's total population, according to the 2015 figures of the Philippine Statistics Authority, is 110,706 (Table 2.4-1). Rosario's potential labor force comprises 59.25% of the figure given above, with the majority engaged in fishing and trade activities. The average family size is at 4.21 per household. It remains to be the most densely populated town of the province. Its soaring population is attributed to the existence of Cavite Economic Zone (CEZ), a favorite destination for job seekers and migrants from neighboring municipalities and provinces.

The population growth of Rosario is largely being affected by in-migration, which in turn is due to flock of workers from the Metro Manila and nearby provinces looking for more liveable, cost efficient and accessible locations for their residences. A significant number is also brought about by the efforts to eliminate informal settlers in other municipalities and cities. They are able to find decent dwellings in various localities in Cavite and/or cheap boarding houses around Rosario.

In the year 1903, Rosario had a little population of 6,601. This increased by 516 persons in censal year 1918. The biggest average growth was 3.91 percent recorded in 1970 where the population grows to 23,817. The trend continued up to 1980 where the persons indicated numbers to 33,312. Between 1980 and 1990, there was a rapid growth of population counted at 12,093 persons or 3.14% which were attributed to workers belonging to locators inside Cavite Economic Zone.

Since the year 1990 up to the year 2007, the population growth rate of Rosario was highly ranged at 3.45%. However, in the year 2010, the population growth rate started to show a downward trend as exhibited by the decrease of 1,975. The average growth rate per annum is 2.27% (2000 to 2010), which is due to displacement of workers in the CEZ. In 2010 to 2015, the annual growth rate rose to 3.53%. These data on population growth rate shows the uniqueness of demography characteristics in the Municipality.



Source: Philippine Statistics Authority. 2015

Figure 2.4-1. Population Growth Rate of the Municipality of Rosario



**Table 2.4-4. Historical Population Growth of Rosario**

| Year | Population | Increase | % Increase / Decrease |
|------|------------|----------|-----------------------|
| 1960 | 16,227     | -        | -                     |
| 1970 | 23,817     | 7,590    | 46.77                 |
| 1975 | 28,725     | 4,908    | 20.61                 |
| 1980 | 33,312     | 4,587    | 15.97                 |
| 1990 | 45,405     | 12,093   | 36.30                 |
| 1995 | 54,086     | 8,681    | 19.12                 |
| 2000 | 73,665     | 19,579   | 36.20                 |
| 2007 | 94,228     | 20,563   | 27.91                 |
| 2010 | 92,253     | -1,975   | (2.10)                |
| 2015 | 110,706    | 18,453   | 20.00                 |

Source: Philippine Statistics Authority. 2015

### Population Density

#### Municipality of Noveleta

Table 2.4-1 shows that if the population of Noveleta were evenly distributed over its land area of 604.01 hectares, there will be a gross density of about 76 persons for every hectare. Poblacion has the biggest population density at 380 persons per hectare, followed by Salcedo II at 311 persons per hectare. San Rafael IV has the smallest population density at 13 persons per hectare.

#### Municipality of Rosario

Rosario has a population density of 144 persons per hectare. Among its 20 barangays, Sapa III is the most dense with 652 pers/ha; followed by Wawa II with 588 pers/ha and Sapa II with 548 pers/ha.

The Barangays of Sapa II, Tejeros Convention and Wawa III have become overpopulated in the recent past due to the presence of informal settlers who were displaced from other places. Thus, it has a present population of 38,872.

As to household population, Barangay Sapa IV has the least number of household at 229 while Barangay Tejeros Convention has the most, numbering to 3,566. The average family size of the municipality household is currently measured at 4.21.

### Population Projection

The population projection indicates that with the average annual growth rate of 1.59 percent, it will reach the count of 56,279 for the year 2028; and will be 60,897 by the year 2033. These data are reflected in **Table 2.4-5**. Population projection per barangay designates Barangay San Rafael III as having the highest participation rate and is projected to reach 7,455 by the year 2028.





**Table 2.4-5. Projected Population By Barangay, Municipality of Noveleta (2015-2033)**

| Barangay       | 2015 Population | Participation Rate | Projected Population* |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
|----------------|-----------------|--------------------|-----------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|                |                 |                    | 2016                  | 2017   | 2018   | 2019   | 2020   | 2021   | 2022   | 2023   | 2024   | 2025   | 2026   | 2027   | 2028   | 2029   | 2030   | 2031   | 2032   | 2033   |
| Magdiwang      | 2,036           | 0.044410           | 2,068                 | 2,101  | 2,135  | 2,169  | 2,203  | 2,238  | 2,274  | 2,310  | 2,347  | 2,384  | 2,422  | 2,460  | 2,499  | 2,539  | 2,579  | 2,620  | 2,662  | 2,704  |
| Poblacion      | 2,234           | 0.048728           | 2,270                 | 2,306  | 2,342  | 2,379  | 2,417  | 2,456  | 2,495  | 2,534  | 2,575  | 2,616  | 2,657  | 2,699  | 2,742  | 2,786  | 2,830  | 2,875  | 2,921  | 2,967  |
| Salcedo I      | 2,137           | 0.046613           | 2,171                 | 2,205  | 2,241  | 2,276  | 2,312  | 2,349  | 2,386  | 2,424  | 2,463  | 2,502  | 2,542  | 2,582  | 2,623  | 2,665  | 2,707  | 2,750  | 2,794  | 2,839  |
| Salcedo II     | 6,032           | 0.131571           | 6,128                 | 6,225  | 6,324  | 6,425  | 6,527  | 6,631  | 6,736  | 6,843  | 6,952  | 7,062  | 7,175  | 7,289  | 7,405  | 7,522  | 7,642  | 7,763  | 7,887  | 8,012  |
| San Antonio I  | 4,869           | 0.106203           | 4,946                 | 5,025  | 5,105  | 5,186  | 5,268  | 5,352  | 5,437  | 5,524  | 5,612  | 5,701  | 5,791  | 5,883  | 5,977  | 6,072  | 6,169  | 6,267  | 6,366  | 6,467  |
| San Antonio II | 1,855           | 0.040462           | 1,884                 | 1,914  | 1,945  | 1,976  | 2,007  | 2,039  | 2,072  | 2,104  | 2,138  | 2,172  | 2,206  | 2,241  | 2,277  | 2,313  | 2,350  | 2,387  | 2,425  | 2,464  |
| San Jose I     | 1,105           | 0.024102           | 1,123                 | 1,140  | 1,159  | 1,177  | 1,196  | 1,215  | 1,234  | 1,254  | 1,274  | 1,294  | 1,314  | 1,335  | 1,356  | 1,378  | 1,400  | 1,422  | 1,445  | 1,468  |
| San Jose II    | 1,653           | 0.036055           | 1,679                 | 1,706  | 1,733  | 1,761  | 1,789  | 1,817  | 1,846  | 1,875  | 1,905  | 1,935  | 1,966  | 1,997  | 2,029  | 2,061  | 2,094  | 2,127  | 2,161  | 2,196  |
| San Juan I     | 2,312           | 0.050430           | 2,349                 | 2,386  | 2,424  | 2,463  | 2,502  | 2,541  | 2,582  | 2,623  | 2,665  | 2,707  | 2,750  | 2,794  | 2,838  | 2,883  | 2,929  | 2,976  | 3,023  | 3,071  |
| San Juan II    | 2,994           | 0.065306           | 3,042                 | 3,090  | 3,139  | 3,189  | 3,240  | 3,291  | 3,343  | 3,397  | 3,451  | 3,505  | 3,561  | 3,618  | 3,675  | 3,734  | 3,793  | 3,853  | 3,915  | 3,977  |
| San Rafael I   | 1,353           | 0.029512           | 1,375                 | 1,396  | 1,419  | 1,441  | 1,464  | 1,487  | 1,511  | 1,535  | 1,559  | 1,584  | 1,609  | 1,635  | 1,661  | 1,687  | 1,714  | 1,741  | 1,769  | 1,797  |
| San Rafael II  | 3,656           | 0.079745           | 3,714                 | 3,773  | 3,833  | 3,894  | 3,956  | 4,019  | 4,083  | 4,148  | 4,214  | 4,281  | 4,349  | 4,418  | 4,488  | 4,559  | 4,632  | 4,705  | 4,780  | 4,856  |
| San Rafael III | 6,073           | 0.132465           | 6,170                 | 6,268  | 6,367  | 6,468  | 6,571  | 6,676  | 6,782  | 6,890  | 6,999  | 7,110  | 7,223  | 7,338  | 7,455  | 7,574  | 7,694  | 7,816  | 7,940  | 8,067  |
| San Rafael IV  | 2,147           | 0.046831           | 2,181                 | 2,216  | 2,251  | 2,287  | 2,323  | 2,360  | 2,398  | 2,436  | 2,474  | 2,514  | 2,554  | 2,594  | 2,636  | 2,677  | 2,720  | 2,763  | 2,807  | 2,852  |
| Sta. Rosa I    | 4,177           | 0.091109           | 4,243                 | 4,311  | 4,379  | 4,449  | 4,520  | 4,592  | 4,665  | 4,739  | 4,814  | 4,891  | 4,968  | 5,047  | 5,128  | 5,209  | 5,292  | 5,376  | 5,461  | 5,548  |
| Sta. Rosa II   | 1,213           | 0.026458           | 1,232                 | 1,252  | 1,272  | 1,292  | 1,313  | 1,333  | 1,355  | 1,376  | 1,398  | 1,420  | 1,443  | 1,466  | 1,489  | 1,513  | 1,537  | 1,561  | 1,586  | 1,611  |
| Total          | 45,846          | 1.000000           | 46,575                | 47,315 | 48,067 | 48,831 | 49,607 | 50,396 | 51,197 | 52,011 | 52,838 | 53,678 | 54,531 | 55,398 | 56,279 | 57,174 | 58,083 | 59,006 | 59,944 | 60,897 |

\* Based on 1.59% Annual Growth Rate

Source: Philippine Statistics Authority, Office of the Municipal Planning & Development Coordinator. 2015

## Education

### Existing Situation Municipality of Noveleta

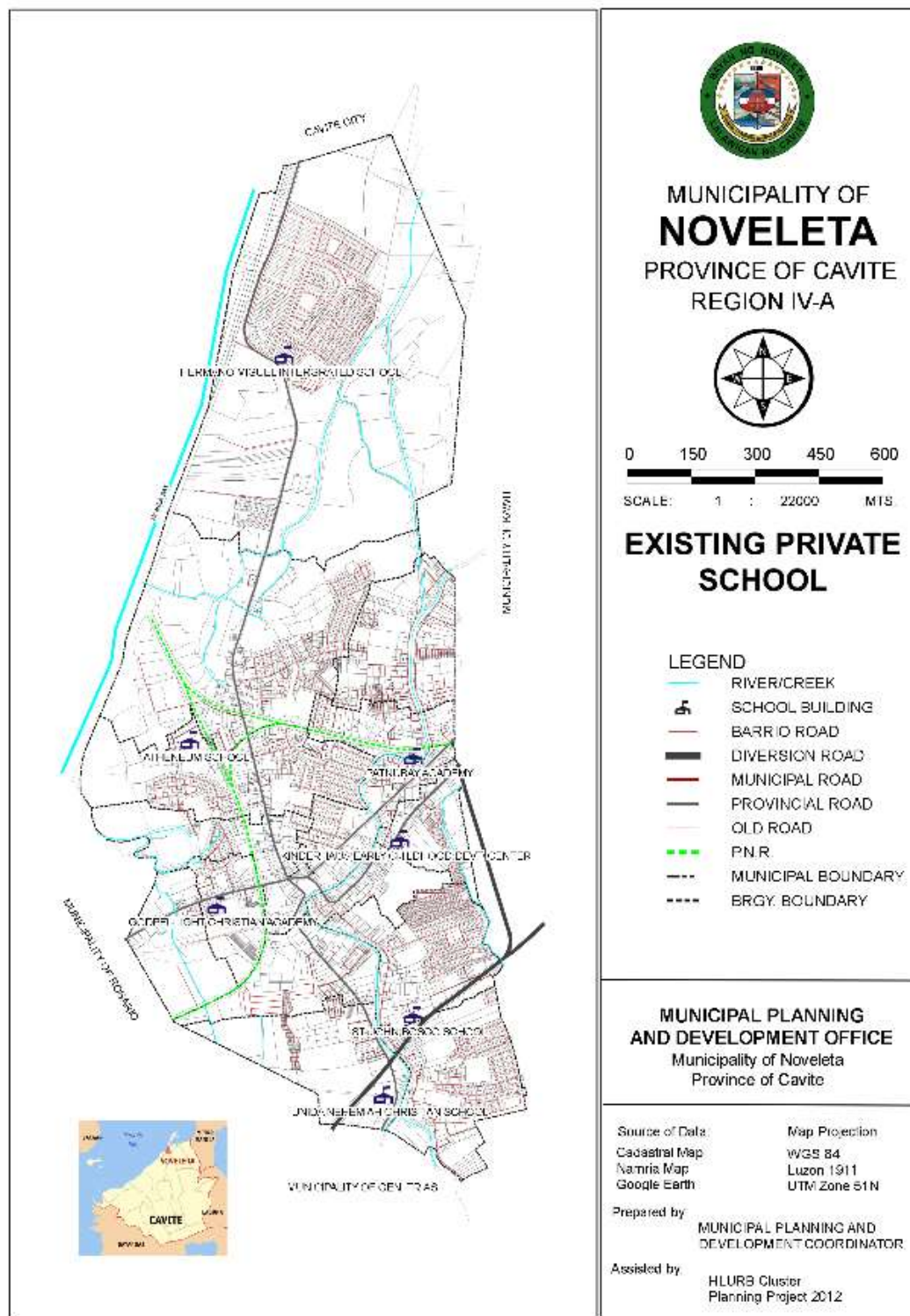
There are sixteen (16) formal educational institutions in the Municipality of Noveleta in the year 2018. Of these, nine (9) are public and the remaining seven (7) are privately owned institutions. Generally, all the schools have the required facilities being used by the students.

In addition, there are fifteen (15) day care centers and four (4) Rural Improvement Club centers with an average area of 50 square meters which offer pre-school education. These are being supervised by the Municipal Social Welfare and Development Office and the Municipal Agriculture Office, respectively.

There is one (1) maritime training center which caters to the skills training needs of educational institutions offering maritime courses

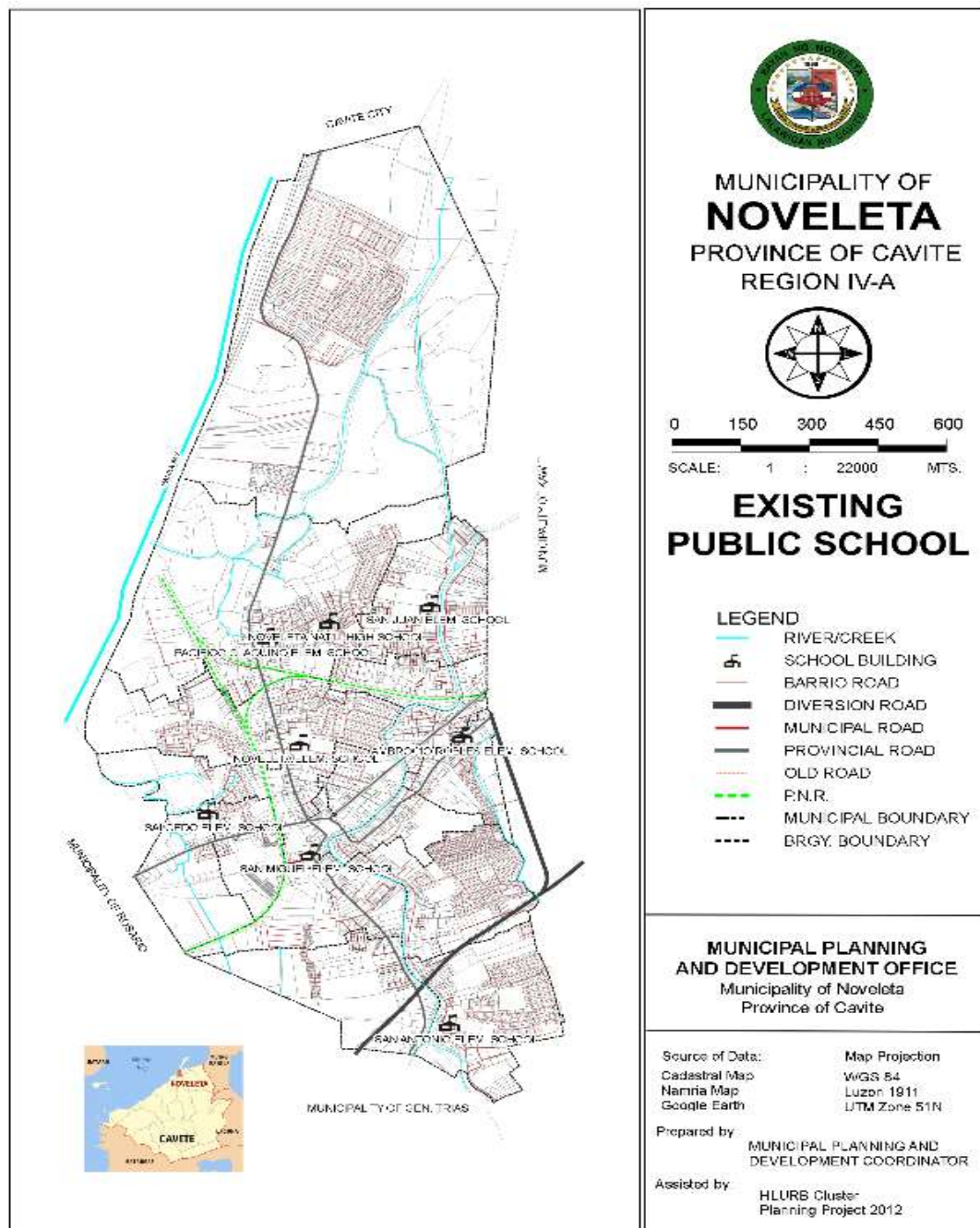
This is Mariners Training Center at Barangay San Rafael IV.

To provide basic skills for better livelihood opportunities to the locality's out-of-school youth and women, the municipal government of Noveleta established the Municipal Livelihood and Skills Training Center. This local institution offers Basic and Advanced Computer Education, Industrial Sewing Machine Operation, to date, majority of the graduates are already employed



Source: 2018-2028 Comprehensive Land Use Plan of Municipality of Noveleta

Figure 2.4-2. Map of the Existing Private School in Noveleta



Source: 2018-2028 Comprehensive Land Use Plan of Municipality of Noveleta

**Figure 2.4-3. Map of the Existing Public Schools in Noveleta**

### Municipality of Rosario

Rosario provides education from pre-school to graduate courses. Educational institutions to date include 20 day care centers, 8 public elementary schools, 2 private elementary schools, 2 national high schools, 1 state university offering secondary and tertiary education, 3 private high schools, and 3 other prominent computer schools.





### School-Going Age Population

One of the most important data is the determination of the school-going age population who are likely to enroll in the elementary, secondary and tertiary school.

In Noveleta, there were 7,911 children in 2015 with ages 5-14 who qualify for elementary studies. Of these, 7,619 were attending school or 96.3%. In Rosario, 18,813 out of 19,760 children (or 95.2%) in this age group are attending school. (Table 2.4-6)

For the age group 15-24, 3,371 of the 8,870 or only 38% of these young people in Noveleta are in school. In Rosario, the percentage is even lower at 25.7% or 6,336 out of 24,700. This could be because of the high percentage of college dropouts or majority may have graduated already. (Table 2.4-6)

Moreover, it should be noted that majority of the in-migrants go to these areas mostly to look for jobs, and not to go to college.

**Table 2.4-6. Household Population 5 to 24 Years Old Who Were Currently Attending School: 2015**

| Age Group       | Household Population 5 to 24 Years Old |        |        | Household Population 5 to 24 Years Old Who Were Currently Attending School |        |        |
|-----------------|--|--------|--------|--|--------|--------|
|                 | Both Sexes                             | Male   | Female | Both Sexes   | Male   | Female |
| <b>NOVELETA</b> |  |        |        |  |        |        |
| Total           | 16,781                                 | 8,519  | 8,262  | 10,990   | 5,606  | 5,384  |
| 5 - 9           | 3,960                                  | 2,014  | 1,946  | 3,757  | 1,889  | 1,868  |
| 10 - 14         | 3,951                                  | 2,039  | 1,912  | 3,862  | 1,992  | 1,870  |
| 15 - 19         | 4,251                                  | 2,174  | 2,077  | 2,763  | 1,409  | 1,354  |
| 20 - 24         | 4,619                                  | 2,292  | 2,327  | 608  | 316    | 292    |
| <b>ROSARIO</b>  |  |        |        |  |        |        |
| Total           | 44,460                                 | 22,406 | 22,054 | 25,149   | 12,925 | 12,224 |
| 5 - 9           | 10,090                                 | 5,200  | 4,890  | 9,536  | 4,907  | 4,629  |
| 10 - 14         | 9,670                                  | 4,983  | 4,687  | 9,277  | 4,725  | 4,552  |
| 15 - 19         | 10,622                                 | 5,353  | 5,269  | 5,433  | 2,783  | 2,650  |
| 20 - 24         | 14,078                                 | 6,870  | 7,208  | 903  | 510    | 393    |

Source: Philippine Statistics Authority, 2015 Census of Population

### Projected Enrollment

To determine the future teacher and classroom requirement up to the year 202, the enrollment is projected for elementary, secondary and tertiary schools. In Noveleta, the enrollment for elementary is projected to reach 5,245 by the school year 2006-2007 and 7,182 by the school year 2011-2012; secondary is expected to total 2,392 in the school year 2006-2007 and 4,324 in the school year 2011-2012; and tertiary to be 1,852 in the school year 2006-2007 and 4,146 in the school year 2011-2012.

### Literacy

The literacy rates in both towns are very high with 99.77% for Noveleta and 99.72% for Rosario (see table below). This is almost equal across all age groups and for both sexes. In Noveleta, there is even a 100% literacy among the females in the age groups of 30-34 y.o. and 40-44 y.o. In Rosario, a slight decrease to 98.94 % literacy exists among the seniors.



**Table 2.4-7. Literacy of the Household Population 10 Years Old and Over: 2015**

| Age Group             | Household Population<br>10 years old and over |              |              | Literate     |              |              |
|-----------------------|---|--------------|--------------|--------------|--------------|--------------|
|                       | Both Sexes                                    | Male         | Female       | Both Sexes   | Male         | Female       |
| <b>NOVELETA</b>       |   |              |              |              |              |              |
| <b>Total</b>          | <b>38004</b>                                  | <b>18552</b> | <b>19452</b> | <b>37918</b> | <b>18499</b> | <b>19419</b> |
| 10 - 14               | 3951  | 2039         | 1912         | 3938         | 2031         | 1907         |
| 15 - 19               | 4251  | 2174         | 2077         | 4245         | 2168         | 2077         |
| 20 - 24               | 4619  | 2292         | 2327         | 4613         | 2287         | 2326         |
| 25 - 29               | 4115  | 2039         | 2076         | 4111         | 2036         | 2075         |
| 30 - 34               | 3677  | 1799         | 1878         | 3674         | 1796         | 1878         |
| 35 - 39               | 3580  | 1736         | 1844         | 3575         | 1732         | 1843         |
| 40 - 44               | 2958  | 1502         | 1456         | 2952         | 1496         | 1456         |
| 45 - 49               | 2748  | 1301         | 1447         | 2741         | 1298         | 1443         |
| 50 - 54               | 2274  | 1131         | 1143         | 2268         | 1126         | 1142         |
| 55 - 59               | 1793  | 857          | 936          | 1786         | 854          | 932          |
| 60 - 64               | 1527  | 697          | 830          | 1524         | 696          | 828          |
| 65 years old and over | 2511  | 985          | 1526         | 2491         | 979          | 1512         |
| <b>ROSARIO</b>        |   |              |              |              |              |              |
| <b>Total</b>          | <b>89980</b>                                  | <b>44067</b> | <b>45913</b> | <b>89729</b> | <b>43929</b> | <b>45800</b> |
| 10 - 14               | 9670  | 4983         | 4687         | 9639         | 4961         | 4678         |
| 15 - 19               | 10622   | 5353         | 5269         | 10587        | 5329         | 5258         |
| 20 - 24               | 14078   | 6870         | 7208         | 14050        | 6854         | 7196         |
| 25 - 29               | 12233   | 6036         | 6197         | 12206        | 6025         | 6181         |
| 30 - 34               | 9238  | 4599         | 4639         | 9225         | 4593         | 4632         |
| 35 - 39               | 8159  | 4014         | 4145         | 8144         | 4005         | 4139         |
| 40 - 44               | 6400  | 3118         | 3282         | 6387         | 3107         | 3280         |
| 45 - 49               | 5510  | 2702         | 2808         | 5496         | 2693         | 2803         |
| 50 - 54               | 4384  | 2105         | 2279         | 4370         | 2099         | 2271         |
| 55 - 59               | 3249  | 1564         | 1685         | 3241         | 1562         | 1679         |
| 60 - 64               | 2519  | 1172         | 1347         | 2506         | 1165         | 1341         |
| 65 years old and over | 3918  | 1551         | 2367         | 3878         | 1536         | 2342         |

Source: Philippine Statistics Authority, 2015 Census of Population

### Educational Attainment

For the Municipality of Noveleta, 29,824 of the population are within the ages of 20 and above. Of these, 94 (0.35%) did not finish any grade level; 4 went to pre-school only; 27 to Special Education; 3,130 (10.49%) completed elementary; 1,847 (6.19%) are High School undergraduates; 13,400 (44.93%) finished High School; 857 (2.57%) went to Post Secondary school; 4,798 (16.08%) are College undergraduates; 5,632 (18.89%) are degree holders; and only 35 went to post-graduate school. This means that only <20% of the population will be able to work as professionals.

In Rosario, there are 69,810 persons at or above the age of 20. Of these, 239 (0.34%) did not finish any grade level; 8 went to pre-school only; 16 to Special Education; 10,742 (15.39%) completed elementary; 5,466 (7.8%) are High School undergraduates; 37,390 (53.56%) finished High School only; 1,717 (2.45%) went to Post Secondary school; 6,714 (9.62%) are College undergraduates; 7,475 (10.71%) are degree holders; and only 43 went to post-graduate school. Percentage wise, the degree holders of Rosario are way lower than in Noveleta.

These are based on the Total Population 5 Years Old and Over by Highest Grade/Year Completed: 2015 published by PSA in 2015.



## Socio Cultural Profile

### Employment

Based on the DILG Region IV-A, the data published on 08 May 2014 stated that the major income sources in the municipalities of Noveleta and Rosario are fishing and services related jobs.

On July 2018, the Philippine Statistics Authority (PSA) provided The Current Labor Statistics quarterly publication, which shows regional data on employment. The table below shows Region IV-A where the Municipality of Noveleta and Rosario are located. It also shows that the number of unemployed gets lower in Region IV-A in the year 2018.

Table 2.4-8 Household Population 15 Years Old and Over and Employment Status by Region, Philippines: 2016 - April 2018 as below was conducted by the Philippine Statistics Authority showing the current labor statistics.

**Table 2.4-8. Household Population 15 Years Old and Over and Employment Status by Region, Philippines: 2016 – April 2018**

| INDICATOR                                  | 2016  |       |       |       |       | 2017  |       |       |       |       | 2018  |                  |
|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------------------|
|  | Ave   | Jan   | Apr   | Jul   | Oct   | Ave   | Jan   | Apr   | Jul   | Oct   | Jan   | Apr <sup>a</sup> |
| <b>REGION II - CAGAYAN VALLEY</b>          |       |       |       |       |       |       |       |       |       |       |       |                  |
| Household Population 15 Years Old and Over | 2,327 | 2,315 | 2,305 | 2,336 | 2,352 | 2,366 | 2,362 | 2,364 | 2,378 | 2,361 | 2,389 | 2,402            |
| Labor Force                                | 1,529 | 1,545 | 1,468 | 1,541 | 1,562 | 1,499 | 1,505 | 1,479 | 1,468 | 1,545 | 1,560 | 1,556            |
| Employed                                   | 1,482 | 1,502 | 1,424 | 1,487 | 1,515 | 1,452 | 1,430 | 1,432 | 1,434 | 1,513 | 1,495 | 1,520            |
| Underemployed                              | 190   | 246   | 150   | 138   | 224   | 197   | 229   | 230   | 115   | 214   | 370   | 317              |
| Unemployed                                 | 124   | 130   | 116   | 94    | 154   | 143   | 176   | 155   | 69    | 172   | 271   | 205              |
| Unemployment Rate (%)                      | 47    | 44    | 44    | 54    | 47    | 47    | 75    | 47    | 34    | 32    | 66    | 36               |
| Labor Force Participation Rate (%)         | 65.7  | 66.8  | 63.7  | 66.0  | 66.4  | 63.4  | 63.7  | 62.6  | 61.7  | 65.4  | 65.3  | 64.8             |
| Employment Rate (%)                        | 96.9  | 97.2  | 97.0  | 96.5  | 97.0  | 96.8  | 95.0  | 96.8  | 97.7  | 97.9  | 95.8  | 97.7             |
| Underemployment Rate (%)                   | 12.8  | 16.4  | 10.5  | 9.3   | 14.8  | 13.6  | 16.0  | 16.0  | 8.0   | 14.2  | 24.8  | 20.8             |
| Unemployment Rate (%)                      | 3.1   | 2.8   | 3.0   | 3.5   | 3.0   | 3.2   | 5.0   | 3.2   | 2.3   | 2.1   | 4.2   | 2.3              |
| <b>REGION III - CENTRAL LUZON</b>          |       |       |       |       |       |       |       |       |       |       |       |                  |
| Household Population 15 Years Old and Over | 7,555 | 7,512 | 7,515 | 7,546 | 7,647 | 7,752 | 7,648 | 7,719 | 7,794 | 7,846 | 7,853 | 7,810            |
| Labor Force                                | 4,693 | 4,724 | 4,636 | 4,674 | 4,738 | 4,548 | 4,428 | 4,433 | 4,719 | 4,614 | 4,769 | 4,704            |
| Employed                                   | 4,383 | 4,377 | 4,310 | 4,378 | 4,468 | 4,247 | 4,130 | 4,135 | 4,385 | 4,338 | 4,531 | 4,451            |
| Underemployed                              | 706   | 655   | 675   | 619   | 873   | 488   | 613   | 401   | 451   | 439   | 517   | 412              |
| Unemployed                                 | 328   | 294   | 335   | 306   | 377   | 238   | 294   | 210   | 221   | 228   | 252   | 244              |
| Unemployment Rate (%)                      | 31.0  | 34.7  | 32.6  | 29.5  | 27.0  | 30.2  | 298   | 298   | 335   | 276   | 257   | 253              |
| Labor Force Participation Rate (%)         | 62.1  | 62.9  | 61.7  | 61.9  | 62.0  | 58.7  | 57.9  | 57.4  | 60.3  | 58.8  | 60.7  | 60.2             |
| Employment Rate (%)                        | 93.4  | 92.7  | 93.0  | 93.7  | 94.3  | 93.4  | 93.3  | 93.3  | 92.9  | 94.0  | 94.6  | 94.6             |
| Underemployment Rate (%)                   | 16.1  | 15.0  | 15.7  | 14.1  | 19.5  | 11.5  | 15.8  | 9.7   | 10.3  | 10.0  | 11.5  | 12.8             |
| Unemployment Rate (%)                      | 6.6   | 7.3   | 7.0   | 6.3   | 5.7   | 6.6   | 6.7   | 6.7   | 7.1   | 6.0   | 5.4   | 5.4              |
| <b>REGION IV-A - CALABARZON</b>            |       |       |       |       |       |       |       |       |       |       |       |                  |
| Household Population 15 Years Old and Over | 9,539 | 9,479 | 9,537 | 9,520 | 9,618 | 9,787 | 9,733 | 9,721 | 9,846 | 9,855 | 9,973 | 10,062           |
| Labor Force                                | 6,125 | 6,162 | 6,168 | 5,982 | 6,190 | 6,235 | 6,150 | 6,188 | 6,143 | 6,457 | 6,276 | 6,249            |
| Employed                                   | 5,687 | 5,711 | 5,703 | 5,521 | 5,814 | 5,800 | 5,645 | 5,747 | 5,716 | 6,092 | 5,852 | 5,838            |
| Underemployed                              | 887   | 1,161 | 893   | 594   | 902   | 810   | 836   | 663   | 824   | 917   | 764   | 743              |
| Unemployed                                 | 430   | 523   | 437   | 325   | 434   | 412   | 432   | 420   | 362   | 435   | 418   | 363              |
| Unemployment Rate (%)                      | 438   | 452   | 465   | 460   | 375   | 435   | 505   | 441   | 427   | 365   | 423   | 412              |
| Labor Force Participation Rate (%)         | 64.2  | 65.0  | 64.7  | 62.8  | 64.4  | 63.7  | 63.2  | 63.7  | 62.4  | 65.5  | 62.9  | 62.1             |
| Employment Rate (%)                        | 92.8  | 92.7  | 92.5  | 92.3  | 93.9  | 93.0  | 91.8  | 92.9  | 93.0  | 94.3  | 93.3  | 93.4             |
| Underemployment Rate (%)                   | 15.6  | 20.3  | 15.7  | 10.8  | 15.5  | 14.0  | 14.8  | 11.5  | 14.4  | 15.1  | 13.1  | 12.7             |
| Unemployment Rate (%)                      | 7.2   | 7.3   | 7.5   | 7.7   | 6.1   | 7.0   | 8.2   | 7.1   | 7.0   | 5.7   | 6.7   | 6.6              |

Notes: 1. Totals may not add up to totals due to rounding.

2. Rates were computed based on actual figures.

3. Starting April 2018 round, the Labor Force Survey (LFS) adopted the 2013 Master Sample Design as well as the population projection based on the 2010 Census of Population and Housing (COPH) with previous survey results were derived using the 2010 CPH population projections.

4. January 2018 data reflected were based on the 2018 CPH population projections to compute for the annualized data for 2018.

5. Preliminary.

6. Number of visibly underemployed persons includes the number of underemployed persons who were with jobs but did not work during the reference period.

Furthermore, the minimum wage earners in private establishments in CALABARZON received a basic wage increase of P9.50 to P10.00 upon effectivity of Wage Order No. RBIVA-17 starting July 1, 2018. This brings the new minimum wage to a range of P317 to P400 in non-agriculture; P303 to P370 in agriculture sector; and P303 in retail/service establishments regularly employing not more than 10 workers.

Based on Table 2.4-9, 20,690 or 45.13% of the 45,846 total population of Noveleta are gainful workers 15 years old and over. Of these, 22.64% are technicians and associate professionals, 15% are service and sales workers, and 13.66% are plant and machine operators and assemblers. The professionals make up 7.28% of the employed.

The gainful workers of Rosario are slightly higher at 47.92% (20,690) of the 110,706 population. Same as Noveleta, the most dominant are the technicians and associate professionals at 35.63%, followed by service





and sales workers at 15.9%, and Craft and Related Trades workers at 10.55%. The professionals are way lower at 2.90%.

**Table 2.4-9. Gainful Workers 15 Years Old and Over by Major Occupation Group: 2015**

| Major Occupation Group                            | Total Gainful Workers<br>15 Years Old<br>and Over | Percentage   |
|---|---|--------------|
| <b>NOVELETA</b>                                   |   |              |
| <b>TOTAL</b>                                      | <b>20,690</b>                                     |              |
| Managers  | 1,397   | 6.75         |
| Professionals                                     | 1,506   | 7.28         |
| Technicians and Associate Professionals           | 4,684   | 22.64        |
| Clerical Support Workers                          | 2,036   | 9.84         |
| Service and Sales Workers                         | 3,103   | 15.00        |
| Skilled Agricultural Forestry and Fishery Workers | 355   | 1.72         |
| Craft and Related Trades Workers                  | 2,489   | 12.03        |
| Plant and Machine Operators and Assemblers        | 2,826   | 13.66        |
| Elementary Occupations                            | 2,161   | 10.44        |
| Armed Forces Occupations                          | 91  | 0.44         |
| Other Occupation Not Elsewhere Classified         | -   | 0.00         |
| Not Reported                                      | 42  | 0.20         |
| <b>ROSARIO</b>                                    |   |              |
| <b>TOTAL</b>                                      | <b>53,053</b>                                     | <b>47.92</b> |
| Managers  | 2,866   | 5.40         |
| Professionals                                     | 1,537   | 2.90         |
| Technicians and Associate Professionals           | 18,905  | 35.63        |
| Clerical Support Workers                          | 2,680   | 5.05         |
| Service and Sales Workers                         | 8,435   | 15.90        |
| Skilled Agricultural Forestry and Fishery Workers | 2,629   | 4.96         |
| Craft and Related Trades Workers                  | 5,596   | 10.55        |
| Plant and Machine Operators and Assemblers        | 4,905   | 9.25         |
| Elementary Occupations                            | 5,404   | 10.19        |
| Armed Forces Occupations                          | 83  | 0.16         |
| Other Occupation Not Elsewhere Classified         | -   | 0.00         |
| Not Reported                                      | 13  | 0.02         |

Source: Philippine Statistics Authority, 2015 Census of Population

#### **Average Family Income and Expenditure vis-à-vis Poverty Level**

Family income sources are the salaries, wages, allowances etc. while expenditures are the expenses made for items to be consumed. Average family income in 2009 is 206 thousand pesos while the average family expenditures is Php176,000.00. (These figures are as of 04 February 2011 of NSCB 2009 Family Income and Expenditure).

In the same manner, NSCB reports Php166,841.00 as the annual per Capita over threshold, meaning, families whose income falls below it are considered poor.



## **2.4.1 Displacement of People, Livelihood and Properties**

### **2.4.1.1 Displacement of Settlers/Fisherfolks**

The proposed project will reclaim 267 hectares of land in Manila Bay. Inasmuch the issue on displacement of settlers is irrelevant since the proposed project site is situated offshore; there are no current settlers in the proposed reclamation area.

The fisherfolks and residents at the coastal areas shall not be dislocated from their homes, hence there will be no resettlement necessary. Also, there are no permanent fishing structures such as lift nets or mussel/oyster farms within the project site Noveleta and Rosario.

Few fishers, as well as gleaners for macro-invertebrates in the proposed reclamations islands will be dislocated momentarily during reclamation activities but will ultimately resume fishing operations in coastal waters past the reclaimed area. On the other hand, effects on demersal fisheries productivity will be minimal as no benthic fish habitats will be affected or altered due to the extreme silt and muddy sediments currently deposited in the area. However, schools of *Sardinella* that normally enter inshore waters can be disturbed and move away from the reclamation site. Tilapia and sardines fisheries in this area will be dislocated and loss of income from fishing will be felt during reclamation activities.

In the long-term, the site of the project will no longer be available as fishing ground which may affect those who fish near the coast, which are predominantly the small-scale fishers. Only a handful of small-scale fishers employing cast net, spear and small gill nets were encountered during the survey because unproductive fisheries have caused fishers with larger boats to fish farther offshore. The major demersal species is swimming/blue crabs caught by crab pots and gill nets but the major fishing grounds are located about 4 to 5 km offshore. In nearshore areas, small-scale fishers principally operate surface gill nets, handlines and spear to catch and flathead mullet (*Mugil cephalos*) or Banak, tilapia, sardines and spadefish. Fisheries operation in fishing grounds offshore of the reclamation and generally in the mouth Manila Bay will not be affected as fishers will move to new fishing grounds further away from the reclaimed area where seawater will probably be less polluted and pelagic fish more abundant. However, this will require modifications on fishing gears used.

In any case, the near-shore areas within 200m from the coast will be untouched and will remain as fishing grounds. This includes about 100 hectares in the shoreline that is devoted to aquaculture in fish ponds, principally in Barangay San Rafael, Rosario.

In general, long term improvement in fish stocks is contingent on the application of interventions that are designed to perpetuate growth, maturation and recruitment. This can be pursued by ensuring enough habitats for a wide range of fish species are protected against anthropogenic issues arising from reclamation activities and its post-reclamation development. Curtailment of fishing practices that contributes to growth and recruitment overfishing needs to be considered as a collaborative activity with the local government units and the BFAR.

There are no mussel farms and fish pens in Island D. Any fishing gear that will be dislocated by reclamation filling and operations will be compensated through the provision of fishing gear paraphernalia, as well as technical assistance in re-establishing fishing operations.

Pelagic species of sardines will continue to move to areas close to the shore and their seasonal movement into the coastal seas surrounding the reclamation project will be sustained. In other nearshore areas, this will involve the provision of seawater channels to ensure that plankton communities will continue to enrich inshore fishing grounds between the shoreline and the inner boundary of reclaimed sites so that sardines and other



small pelagic fishes can continue to migrate and graze into such areas. Efforts to sustain macro-invertebrate recruitment and settlement will be studied and applied in suitable areas.

The demand for fishery products, both in fresh and processed form, is likely to increase significantly as a result of increased demand during project establishment and can lead to enhanced fishing effort in an already heavily-fished fishery and competition for a dwindling resource base can drive fishers to use more illegal fishing methods. On the other hand, the operation of the Project is also seen to increase employment opportunities for skilled labor and provide certain fisheries-based livelihood to local fishers. With assistance from the Project, small-scale aquaculture and fisheries product value-adding can evolve into profitable livelihoods, especially for women in fisheries.

There will be programs by the LGU/Project Proponent to assist the fisherfolks such as: assistance in upgrading to bigger motorized boats/bancas for fishermen who use the "sagwan" boats in view of the longer routes they have to take; skill development training seminars for fisherfolks and their families such as livelihood training, fishery product value-adding, modern fishing technology, and aquaculture; introduction and sponsoring of sustainable livelihood projects; technical and financial assistance in the marketing/sales/promotion of local products.

### Change/conflict in Right of Way and Impact on Public Access

These relate to the connections of the access ways to points on shore. **Figure 2.4-5** show the initial Framework Plan for the access ways. Avoidance of ROW conflicts is a key consideration for these access ways.

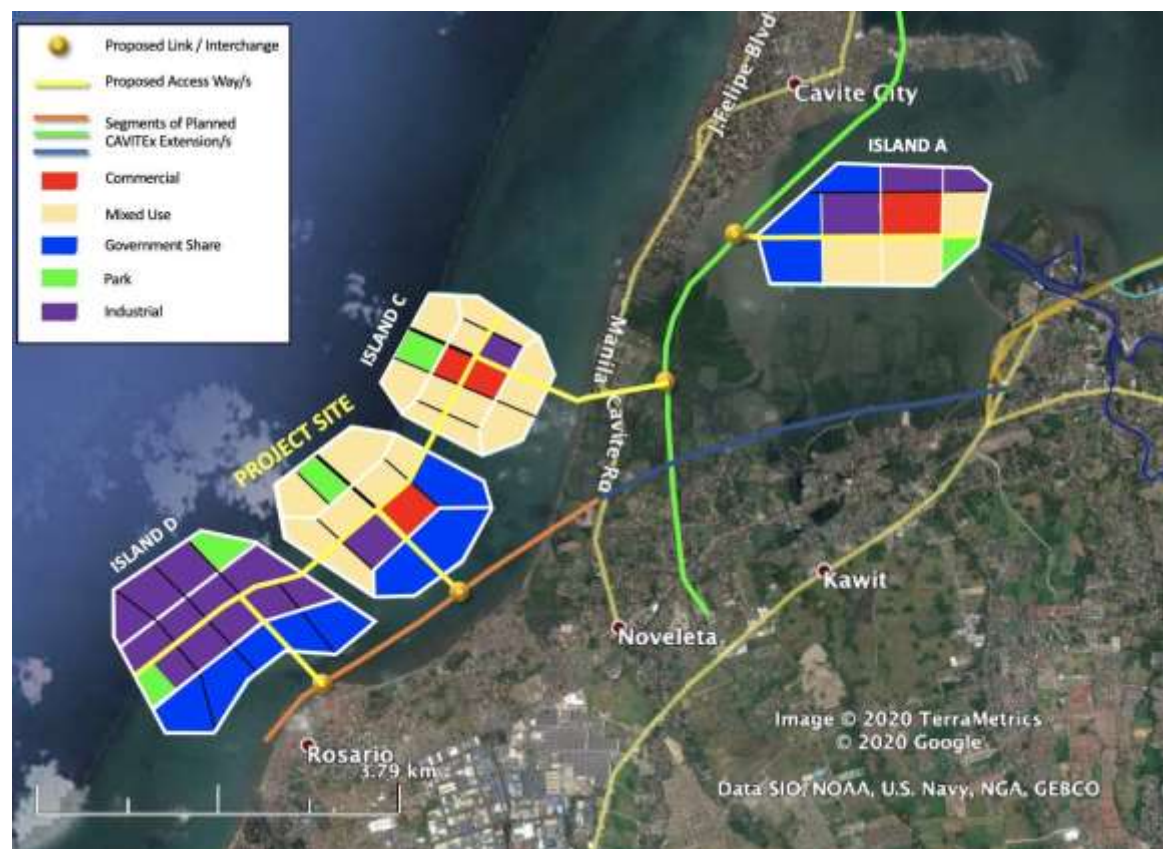


Figure 2.4-4. Initial Framework Plan Showing the Access Ways





#### **2.4.2 In-Migration/ Proliferation of Informal Settlers**

There will be no proliferation of informal settlers or property that will be displaced nor disturbed or cultural/Lifestyle change since there are neither informal settlers nor IPs within the proposed project site. Temporary in-migration may take place but only for a short period of time because these may compose the technical team that will undertake the engineering and design requirements and construction requirements under the Contractor's responsibility. Also, even if new employees will be hired when land will be reclaimed, in-migration will not take place because target employees are qualified residents of the area who have their own houses to live in.

#### **2.4.3 Cultural/Lifestyle Change (especially on Indigenous Peoples (IPs), if there's any)**

The influx of people into the area may bring about the following:

- Potential social tensions due to income and wealth disparity between those who will be benefited economically from the project and those who will not be benefited.
- Workers and other in-migrants may introduce different lifestyles and patterns of behaviour leading to social tensions.

To prevent this from happening, the proponent will implement a code of conduct for employees, contractors, and subcontractors to prevent potential impacts on lifestyle and behaviour. Furthermore, IEC activities, open dialogue and communication with the stakeholders will be undertaken regularly by the proponent to address the concerns of the stakeholders.

#### **2.4.4 Impacts on Physical Cultural Resources**

- The conduct of an Archaeological Survey/Assessment is being planned and will be coordinated with the National Museum.
- It is deemed practical to undertake this work during the site preparation works because at this phase of the project sea based transport vessels will be available and underwater scuba teams will be needed by the reclamation contractor. Thus, there will be effective synchronization / harmonization of the archaeological survey with the own survey of the reclamation contractor.

#### **National Heritage**

The proposed project site will be situated in the territorial jurisdiction of the Municipalities of Noveleta and Rosario. As indicated in the Manila Bay Coastal Strategy, Manila Bay is the premier international gateway to the country's political, economic and social center. The bay has been known for its strategic importance ever since the pre-colonial times. One of the finest natural harbors in the world, Manila Bay was a focal point of the Manila-Acapulco Galleon Trade. The bay has been a scene of many battles, and until today a historic naval base in Cavite stands, guarding the entrance to the Bay. Thus, Manila Bay is considered to have historical and religious values, geological and archaeological sites, cultural sites, natural values, tourism and recreational values.

#### **Historical and Cultural Values** **Historical and Religious Sites**

Based on the Manila Bay Coastal Strategy (2001), Manila Bay area is a place of many striking contrasts. Monuments and sculptured images of heroes past stand amidst glass, steel and concrete skyscrapers. Centuries-old churches are a stone's throw away from big shopping malls and posh hotels. The walled city of Intramuros – the bastion of Spanish rule, Corregidor's ruined barracks and artilleries – testimony of heroism



in World War II, ancestral houses, museums and historical markers take one down along memory lane. Theater and open-air performances offer a cultural interlude.

### **Geological and Archaeological Sites**

Based on the Manila Bay Coastal Strategy (2001), marine fossils have been found in the mountains of Antipolo, Rizal, indicating that this part of the Sierra Madre mountain range was once under the sea. In Angono, Rizal, prehistoric petroglyphs or rock engravings dating back to 3000 B.C. have been included in the World Inventory of Rock Art under the auspices of UNESCO, and nominated as one of the '100 Most Endangered Sites of the World' under the World Monument Watch List. Archeological excavations in Santa Ana, Manila, revealed habitation and burial sites of early settlers and ancient data from the 12<sup>th</sup> to 13<sup>th</sup> centuries (DOT 1999). These are all very distant from the project site.

### **Cultural Sites**

Based on the Manila Bay Coastal Strategy (2001), the National Museum Complex, National Library, Metropolitan Theatre and the Cultural Center Complex are found in Manila. Inside Intramuros, one can find the museums of Fort Santiago and San Agustin Church. Open-air concerts and plays are shown at the Paco Park and the Rajah Sulayman Theatre in Fort Santiago. These are all very distant from the project site.

## **2.4.5 Threat to Delivery of Basic Services /Resource Competition**

### **2.4.5.1 Water Supply**

One of the pre-requisites to the orderly and well balanced growth of the urban areas is an effective system of local utilities, the absence of which is recognized as a deterrent to economic growth. Domestic water system is one of the most basic and essential elements of local utility systems.

At present, the municipality is under the coverage of the Maynilad Water Services, Inc. (MWSI). All barangays are being served by the water utility. Based on the provincial profile, the MWSI has a total of 1,156 customers in the year 2017, broken down as follows: 983 households, 29 commercial/institutional and 4 semi-business establishments.

They are served only from 4:00 to 9:00 in the morning daily. The service schedule is expected to be improved once the utility's expansion program is completed.

As to Level I water supply facilities, there is a total of 1,190 units in the municipality. There are 336 public wells (45 shallow wells and 291 deep wells) and 854 private wells (195 shallow wells and 659 deep wells).

### **Water Demand**

Based on projected population in 2028 and standard water demand of 144 liters per capita per day, the total estimated water demand is 8,104,176 liters per day (lcpd) or about 8,104.176 cubic meters per day. Generally, the present water supply is sufficient for the local population.

On the other hand, ground water is abundant in Rosario which is the major sources both commercial and industrial uses. Water is supplied by Maynilad Water Services Inc. (formerly Metropolitan Waterworks and Sewerage System), domestic deep well and shallow well are used to supply the needs of the populace.

At this stage, the engineering work activities are dry in nature. Moreover, during reclamation works, no water will be used except by the construction crews for domestic purposes. The water supply for the construction crew is from purchase of bottled water onshore, thus there will not be any water resource competition.



During the operations phase, water will be required for the operation of the various establishments, commercial centers, and by the locators. Water will be sourced from a concessionaire who will supply the requirements without depriving the users outside of the reclamation project with their water needs.

#### **2.4.5.2 Power Supply**

The Manila Electric Company (MERALCO) supplies the power requirements of the municipality. Based on the provincial profile, the present number of customers served by MERALCO is 10,787 for residential, 3 for industrial and 1320 for commercial uses and various barangay streetlights.

Correspondingly, the average monthly power consumption based on the report of MERALCO is 173.04 kwh for residential uses, while the commercial and industrial purposes utilize 930.61 kwh and 1,348.36 kwh, respectively and 1,511.58 kwh for streetlights.

Generally, the power service being provided in the municipality is adequate. However, power rate schedule is considerably high with the inclusion of Power Purchase Adjustment (PPA) for all types of uses.

Further, the Municipality's power requirements are supplied by MERALCO. The demand for power supply has not shown a remarkable increase since the last five periods. Commercial sector is the second biggest consumer of electricity followed by residential sector.

The Proposed Project will not create competition on power supply. The power requirements during the reclamation/dredging works will be sourced from onboard power generators for the obvious reason that the sea vessels will not be able to connect to the power lines onshore. Hence, there will be no competition with the communities.

During the operations phase, power will most likely be sourced from MERALCO, which will provide the requirements without depriving the communities with their own energy needs.

#### **2.4.5.3 Communications**

##### **Municipality of Noveleta**

##### **Postal Services**

There is one postal office managed by the Philippine Postal Corporation located in the municipal building. Mail delivery within the area is efficiently handled by three (3) mail carriers.

In addition, a private company LBC is located at Barangay Magdiwang which accepts and delivers mail and parcels within the municipality and the different localities in the country. This is complemented by the presence of high technology communication facilities such as internet services.

##### **Telecommunications**

The Philippine Long Distance Telephone (PLDT) Company & Globe Telecoms provide telephone services in the municipality.

Aside from this, telephone providers, mobile communication and internet is being used to as form of communication.





### **Print/Broadcast Media**

Being an urban area near Metropolitan Manila, national daily newspapers as well as tabloids and magazines are available in the municipality.

Radio broadcast and television shows can also be enjoyed by the local residents. Cable television is also being served by the Cavite Cable.

### **Municipality of Rosario**

Majority of households and business entities are using the services of PLDT for landline services. Application for landline service is now easy due to the sudden outburst of competitors like Globe Telecom and Digitel. Access to mobile services is also quite a breeze. Smart Communication and Globe Telecoms are the stalwarts of this business line. Telecommunications transmitters were constructed in various areas of the municipality giving a wide-spread coverage of their network.

At present telephone requirements are provided by the Philippine Long Distance Telecommunications Company (PLDT), Globe Telecom, Digitel and cellular phone companies like Smart, Sun Cellular, Talk-and-Text Mobile for mobile phone services. Globe transmission towers are located in the whole municipality while Smart and Sun Cellular users are quite visible among the town residents.

Broadcast media (televisions and radio stations) continues to progress and provides information, entertainment and relevant up-dates to the residents. Cable subscription is offered by Sky Cable, and Signal.

Newspaper, magazines are bulletin printed and circulated in the Metropolitan are readily available to local residents.

The proposed project will not pose threat on the above. During the reclamation/dredging activities, communications will largely be via radio on-board the sea vessels. Hence, no competition with the communities will arise.

There will be adequate communications systems from the various service providers such as Smart Communications, Globelines, Sun, PLDT, Bayantel, etc. Land line and mobile systems will be adequately available in the project area.

## **2.4.6 Threat to Public Health and Safety**

### **2.4.6.1 Peace and Order / Crime**

#### **Protective Services**

The concern of the municipality does not merely focus on its progress and development through urbanization. The overall success of the desired development could not be attained if protective services are not well in place. Hand-in-hand with progress is the maintenance of peace and order which is one of the primary concerns of the municipal leadership.

#### **Exisitng Situation**

At present, the police department, the barangay police, the fire department and other private security agencies provide the protective services in the municipality.

The peace and order situation in the area has been favorable and under control of the local police unit with the headquarters located in the municipal hall in the Poblacion. The Philippine National Police (PNP) Force



has an actual strength of eighteen (18) officers and men while the fire department consists of seven (7) BFP personnel and five (5) volunteers. see Table 42 for reference.

The PNP as protector of the citizenry and with close coordination of the municipal leadership, undertakes the following:

1. Dispersal of the police from the headquarters to the streets and enhancement of crime prevention and control;
2. Restoration of the trust and confidence of the people on the police and gain community support;
3. Elimination of street and neighborhood crimes and improvement of public safety; and
4. Arrest of all criminal elements, common or organized in coordination with other pillars of the criminal justice system and law enforcement agencies.

### **Impact Analysis and Mitigation Measures**

The personnel and the activities of the proposed reclamation during construction phase will be confined in the project site only. Thus, the Project will not pose a threat on the existing peace and order/crime. The construction crew will be managed Municipality of Noveleta and Rosario and its private partner and third party contractor which will be hired during the reclamation works. The proponent will set safety and control measures and restrictions to prevent any situation that can trigger crime. The hired workers during construction and operations phase will be restricted on carrying firearms or any deadly weapons. Moreover, propriety among the workers and guests shall be observed.

During the operations phase, the reclaimed land will be populated. Nevertheless, the various activities will still be confined to the reclaimed land thereby creating some degree of isolation from the general public.

The management organization for the locators will provide full security and safeguards within reclaimed land and the immediate vicinity to ensure that the people will be least exposed to public safety risks.

#### **2.4.6.2 Public Health**

##### **2.4.6.2.1 Health Services/Facilities**

Human development and a better quality of life for all Filipinos are the overriding goals of the national government. In line with the objective of adopting an integrated and comprehensive approach to health development which shall endeavour to make essential goods, health and other social services available to all the people at affordable cost as provided for in the Constitution of the Republic of the Philippines, the Municipality of Noveleta, as mandated by the Local Government Code of 1991 (RA 7160), discharges the functions and responsibilities of the national agencies and offices devolved to them in terms of basic health services delivery and maintenance of facilities.

#### **Existing Situation**

Based on the 2018-2028 Comprehensive Land Use Plan of the Municipality of Noveleta, presently, the available public health services and facilities serving the municipality consist of a Rural Health Unit (RHU) located at the Poblacion with nine (9) Barangay Health Stations.

The medical force provided by the government is composed of 1 doctor, 1 nurse, 7 midwives who are assigned in the different barangays, 1 dentist, 2 sanitary inspectors and 20 barangay health workers. The medical force is supported by the Barangay Nutrition Scholars. The facilities found in the Municipal Health Center include 3 beds, dental and laboratory facilities, and first-aid equipment.



There is one private medical hospital, St. Martin Hospital, located at Salcedo II with 26 doctors, 21 nurses, 1 midwife, 6 medical technologists, 3 radiologists, and 4 pharmacists. It has 25 rooms with 41 beds that include the following: 1 single bed suite room (air-conditioned); 12 single bed private rooms (air-conditioned); 1 single bed isolation room (air-conditioned); 1 two-bed, 2 three-bed semi private rooms (air-conditioned); and 4 wards including 1 five-bed OB-Gyne room (air-conditioned); 1 four-bed pediatric room (air-conditioned); 1 four-bed female ward; and 1 four-bed male ward. The hospital services offered include Obstetrics and Gynecology; Pediatrics; Medicine; Surgery; Urology; ENT (Ear, Nose, Throat); Ophthalmology; Orthopedics; Anesthesia; Occupational Medicine; Pharmacy; Complete Laboratory Examination; and X-Ray and Ultrasound.

There are 4 ambulances in the locality to provide logistics support to the municipal medical force.

As indicated in the 2017 Annual Accomplishment of the Municipal Health Office, medical services performed include births, NTP, prenatal care, post-partum care, child care, and family planning. Other services include control of diarrheal diseases, control of acute respiratory infection, nutrition program, environmental health service and dental service.

The RHU has full implementation of the restructured health care delivery system serving the poblacion area, while the 4 Rural Health Midwives assigned to different barangays are delivering the primary health care services to the people of the communities where they are assigned.

Available records at the Municipal Health Office show that in 2017, there have been 916 live births which is about 1.99% percent of the projected population of 45,830. Out of the total births, 463 or 50.54% percent are male while 453 or about 49.34% percent are female. Barangay San Rafael 3 has the biggest number with 480 births. Barangays San Antonio 1, San Rafael 3, Salcedo 2, and Sta. Rosa 1 also accounted for 8 infant deaths.

On the total number of deaths, a total of 258 deaths was recorded, of which, 139 were male while 119 were female. Barangay San Rafael III has the biggest number at 52.

As to **morbidity**, URTI with 2,224 cases topped the ten leading causes of morbidity in the last 5 years followed by bronchial asthma with 1,963 cases.

To determine the degree of malnutrition in the municipality, the Municipal Health Center regularly conducts Operation Timbang. The results in 2017 indicate that a total of 3,389 children with ages under 1, 1-4 and 5-6-year-old were weighed. Out of this, 3,389 children representing 100% percent of the total children weighed were found severely underweight; 18 or 0.6% percent were moderately underweight; 112 or 3.8 percent were mildly underweight and 2,749 or 93.8 percent were normal. 51 children representing about 1.7 percent were found to be overweight.

The above-stated figures show that the general nutrition situation of the pre-school children in the municipality is encouraging. However, the municipality, through the local health office and the municipal nutrition council must exert efforts to minimize, if not, eradicate malnutrition among our children. The incidence of malnutrition (overweight and underweight) can be attributed to misconception on health and nutrition practices, economic status and lifestyle, accessibility to food establishments, change in eating patterns and habits, educational background and cultural beliefs.

There are 8,531 households which have toilet facilities, broken down as follows: 8,007 Sanitary Toilet and 524 Unsanitary Toilet. There were 524 households which have no toilet facilities.





### Health Insurance Program

As of the year 2017, the Municipal Social Welfare and Development conducted an outreach program through the efforts of the Municipal Government which aims at providing free health insurance for indigent families in the municipality in accordance with the national program of providing health assistance for the people.

### Impact Analysis

During the reclamation/dredging phase, there will be minimal impact on **public** health because the activities and the small number of persons (the construction crew) involved will be based on the sea vessels. The risk health factor that needs to be carefully identified during the reclamation phase is the potential contamination of the Bay with toxic and hazardous substance that may be present in the filling materials.

If the filling materials would be sourced from Manila Bay itself, this risk is greatly reduced or would be absent. Pre-screening of any filling materials with respect to complete chemical analysis for toxic elements, e.g.: cyanide, mercury, lead, chromium, etc. will be undertaken. To ensure environmental compliance, the use of and sourcing of the filling materials will be subject to prior permits and clearances including a separate ECC.

Moreover, mitigation measures will be put in place for dispersal of silts/disturbed seabed. The use of silt curtains or rock bund along the perimeter of the project will further ensure that the silt and potential hazardous substances are contained within the reclamation area.

#### 2.4.6.2.2 Disaster Risk Reduction (DRR)

Disaster management in the proposed reclamation and development project and its environs is critical in the success or failure of the project. The proper identification of the risks involving the project and its surroundings is vital to properly prepare all the people involved including the community that hosts the project. The impacts of disasters will not only affect the project but also its surrounding communities and the structures and properties. When properly planned, mitigating measures can be put in place at the proper time so that all parties are informed and prepared in case something happens. Also, the mitigating measures can alleviate the potential impacts. The Project Proponent can be of service to the residents in the implementation of DRR efforts as it can provide the necessary funding, training, and manpower in preparing the community against disasters.

With respect to marine traffic considering the routes of the Coast Guard, Navy as well as commercial ships and fishing boats, the Proponent shall be in constant coordination with the PCG regarding the planned/scheduled movements of all its vessels so that permits to sail and Notice/s to Mariners can be issued in a timely manner. Beforehand, and as early as the securing of LONOs, coordination with the PCG and PN were done in respect of planned routes of dredging vessels. This shall be firmed up during the DED stage and shall be coordinated once again with these agencies.

### Risk Profile of the Proposed Project

The profile of the various risks, including perceived risks are discussed in several sections of this EIS Report and the major risks hereunder briefly summarized in the matrix below.

**Table 2.4-10. Major Issues that May Affect the Communities In Case of Disaster/s**

| Hazard   | Cause/Related Activities | Concerns/Issues | Mitigation Measure |
|--|--------------------------|-----------------|--------------------|
| <b>NATURAL HAZARDS (not caused by the project)</b> |                          |                 |                    |
| <b>Met-Ocean Hazards</b>                           |                          |                 |                    |



| <b>Hazard</b>                                  | <b>Cause/Related Activities</b>   | <b>Concerns/Issues</b>  | <b>Mitigation Measure</b>  |
|--|---|---|--|
| <b>Flood</b>                                   | With our without the project, the project site (land adjacent to the site) will be subject to episodes of floods, as actually being experienced at this time. | Loss of life and property; panic among residents and/or workers | The reclamation land configuration and the appropriate design and engineering intervention will provide measures to address these risks.<br>Proper and adequate drainage system, island configuration and distance vis-à-vis mainland and other proposed islands |
| <b>Storm Surge</b>                             | Similar to floods, these could occur with or without the project.   | Loss of life and property; panic among residents and/or workers | Appropriate design and engineering intervention will be provided. Elevated platform and storm wave deflectors.<br><br>The reclaimed island will serve as shield to mainland and its population.  |
| <b>Earthquakes and seismic related Hazards</b> |   |   |  |
| <b>Tsunami</b>                                 | Similar to floods, these could occur with or without the project.   | Loss of life and property; panic among residents and/or workers | Appropriate design and engineering intervention will be provided. Elevated platform and storm wave deflectors.<br><br>The reclaimed island will serve as shield to mainland and its population.  |
| <b>Subsidence</b>                              | In the current situation, this is due to groundwater extraction, which does not apply to the project.   | Loss of life and property; panic among residents and/or workers | Appropriate ground/soil compaction measures  |
| <b>Liquefaction</b>                            | Existing soil properties - soft, unconsolidated and water-saturated, which will potentially be disturbed during earthquakes                                   | Loss of life and property; panic among residents and/or workers | Appropriate ground/soil compaction measures  |
| <b>Ground Shaking</b>                          | Proximity to active faults (20.2km from West Valley Fault)  | Loss of life and property; panic among residents and/or workers | Design and Engineering intervention in accordance with National Building Code.   |
| <b>ACCIDENTS</b>                               |   |   |  |
| <b>Fire</b>                                    | Dredging/reclamation activities/ movement of vessels  | Loss of life and property; panic among residents and/or workers | Marine Diesel Oil (MDO) used has high Flash Point > 600 C  |
| <b>Explosion</b>                               | Dredging/reclamation activities/ movement of vessels  | Loss of life and property; panic among residents and/or workers | MDO not explosive  |
| <b>Release of Toxic Substances</b>             | Dredging/reclamation activities/ movement of vessels  | Loss of life and property; panic among residents and/or workers | Bilge water treatment<br>No HAPs (Hazardous Air Pollutants) from exhaust of engines  |
| <b>Oil Spills from Dredging Vessels</b>        | Dredging/reclamation activities/ movement of vessels  | Loss of marine life, environmental damage                       | a. Assurance of sea-worthiness of the sea vessel<br>• Compliance with international and local (PCG) standards<br>• Training of vessel crew and personnel<br>• Possession of adequate navigational aids   |



| Hazard                                  | Cause/Related Activities   | Concerns/Issues  | Mitigation Measure  |
|---|--|--|---|
|   |  |  | b. Inspection by the PCG of the integrity of the oil storage tank in the vessel<br>• Record of last inspection of the tank<br>• Checking of safety instruments of the oil system e.g. valves, fittings<br><br>c. Provision for onboard oil spill containment and recovery equipment e.g.<br>• Oil Spill Boom<br>• Approved oil spill dispersant<br>• Oil recovery equipment e.g. oil pump                         |
| <b>Collision between marine vessels</b> | Movement of dredging vessels vis-à-vis movement of other vessels of the PCG, PN, commercial ships, and smaller fishing boats | Loss of life and property  | There will be Mariners' Notice issued to all parties concerned with regards to planned trips of each vessel.<br>The vessels shall make the necessary communication, depending on the type and operations of the vessel, with other vessels and/or with the Radio Room by means of the VHF channel that has been set up for the project.<br>Rigid adherence to Marine Safety guidelines as discussed in Chapter 4. |
| <b>Failure/collapse of Structure</b>    | Inadequate design/engineering measures   | Endanger life, property and/or the environment. Accidents to construction crew | Use of internationally-accepted construction technology and methodology, the use of sound fill materials and rocks and the employ of proven Contractor.<br>-Safety training of all personnel<br>-Use of safety gears/equipment and PPEs   |

**Risks that may be attributable to the project itself, e.g. potential failure of the reclaimed land. Design and engineering intervention will be undertaken. Baselines from the geotechnical investigation will be used.**

#### **Disaster Risk Reduction (DRR)**

This is inherently considered and provided for in the miscellaneous discussions of risks and include but not limited to:

- DRR through design and engineering intervention such as in the construction of the land itself using geotechnical investigation reports as baselines.
- Provisions for reduction of risks from storm surges, e.g. from the design of the islands and from the use of wave deflectors.
- Elevated platform to reduce risks from tsunamis, as well as from storm surges and other potential met-ocean risks/hazards.
- Coordination with the National/Local Disaster Risk and Reduction Management Council

**The Project Proponent shall implement overall disaster risk awareness and preparedness before and during the project implementation.**





Safety drills will be institutionalized throughout the project life. This will include fire drills, earthquake drills, and the like. Evacuation muster points will be established. These efforts shall be in consonance with the Disaster/Risk Reduction and Management Plan of the government.

Lastly, the proponent will be actively involved in the IEC campaign to increase public awareness on hazard management.

A multi-hazard mitigation and protection plan for natural coastal hazards will be developed. Similarly, awareness about climate change impacts on coastal zone systems such as coastal erosion, sea level rise, and flooding risks should be promoted with emphasis in the threat to life, structures, and economic production.

In case of disaster occurring in the area, may it be caused by natural hazards or by the project, the Private Partner shall be assisting the concerned LGU in the disaster relief operations such as: evacuation of populace; search and rescue operations; distribution of relief goods; medical assistance; etc. This shall be entrenched in the SDP-IEC programs.

#### **2.4.7 Generation of Local Benefits from the Project**

##### **Main Sources of Income and Livelihood**

###### ***Construction Phase***

The construction phase may not significantly bring about local benefits that will be generated in terms of:

- Direct Opportunities for employment
- Direct Opportunities for livelihood

During this phase, only few construction workers will be hired and since the activities involve highly specialized tasks, the opportunity for hiring local residents is not highly significant. Thus, the LGU proponent must thoroughly conduct IEC on manpower requirement during and after construction activities with concerned barangays so as not to create false hopes.

In any case, the increased revenues for the Cavite City and Municipality of Kawit through tax payments will be flowed back to the residents in terms of development projects of the City.

###### **Operations Phase (Not part of the application for ECC)**

During the operations phase whereby the locators will be conducting their individual businesses, employment and livelihood will be significantly experienced. The envisioned business developments in the reclamation area shall bring about employment opportunities for the people of Cavite City and Municipality of Kawit and the Province of Cavite. If a large number of those working in Manila will have the option to work nearer their homes, their daily spending will be concentrated locally, and thus, will stimulate local economy.

#### **2.4.8 Traffic Generation**

##### **Baseline/Existing Transportation/Traffic Situation in Municipality of Noveleta**

###### **Road Network**

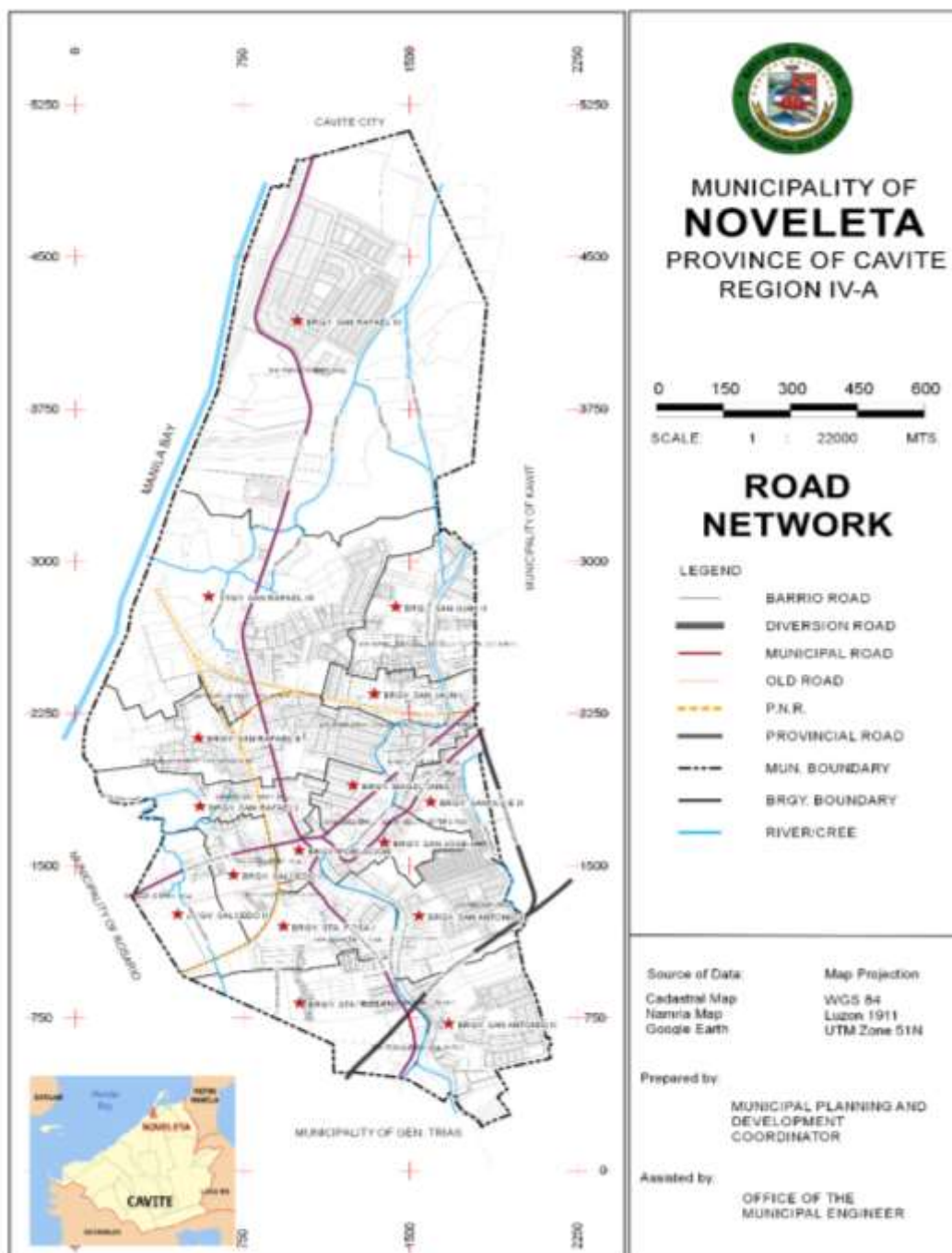
The road network of the municipality has a total length of 20,091.80 meters (20.09 kilometers). Broken down to the types of road according to classification and length, national road comprises about 6.3 kilometers or 31.46 percent of the total road length; provincial road with about 5.3 kilometers or 26.37 percent; municipal road with about 1.5 kilometers or 7.79 percent; and barangay road with about 6.9 kilometers or 34.38 percent.



About 19.3 kilometers or a little more than 95 percent of the total road network is covered with concrete pavement. About 825 meters or 4 percent is still with earth fill.

Footpaths of about 1.5 meters wide are present for access of residents living far from the roads.

See Figure 2.4-5 for the Road Network Map.



Source: 2018-2028 Comprehensive Land Use Plan of Municipality of Noveleta

Figure 2.4-5. Road Network Map of Municipality of Noveleta



## Bridges

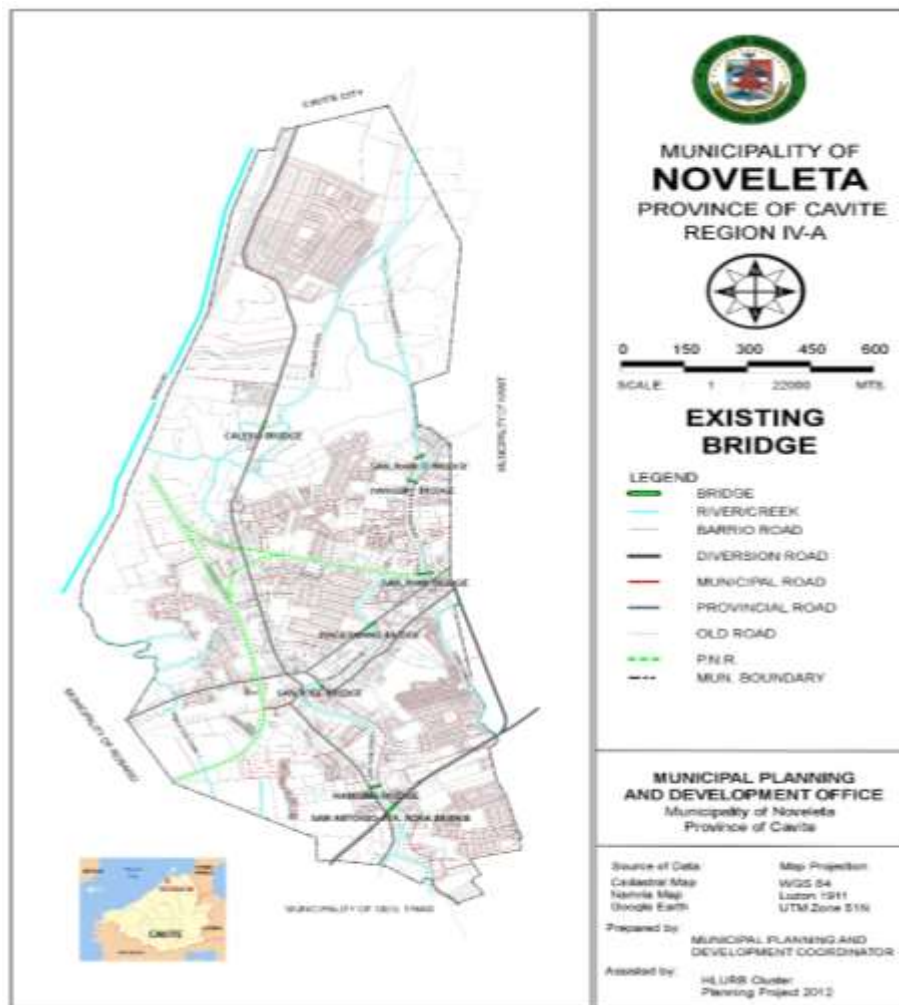
There are nine (9) bridges in the municipality, of which, five (5) are national; two (2) are provincial; and two (2) which are hanging bridges are municipal. See Table 2.4-11.

As to type of construction, six (6) bridges are concrete; one (1) is steel; and the hanging bridges timber. All bridges are generally in good condition.

**Table 2.4-11. Bridge Inventory; 2017**

| Bridge Name  | Location                    | Bridge Description |               |           |                      | Number of Lanes | Classification | Remarks                      |
|--|-----------------------------|--------------------|---------------|-----------|----------------------|-----------------|----------------|------------------------------|
|  |                             | No. of Span        | Length (m)    | Width (m) | Type of Construction |                 |                |                              |
| Hanging Bridge   | San Juan II                 | 1                  | 28.00         | 1.00      | Timber               |                 | Municipal      | Fair                         |
| Hanging Bridge   | San Antonio II/Sta. Rosa II | 1                  | 35.20         | 1.00      | Timber               |                 | Municipal      | Fair                         |
| San Juan Bridge  | San Juan I                  | 1                  | 23.30         | 6.00      | Concrete             | Double          | Provincial     | Fair                         |
| San Juan Bailey Bridge                                 | San Juan II                 | 1                  | 19.30         | 4.00      | Steel                | Single          | Provincial     | Needs Repair and Improvement |
| Noveleta Diversion Bridge                              | Magdiwang                   | 1                  | 32.20         | 6.00      | Concrete             | Double          | National       | Fair                         |
| Noveleta-Rosario Diversion Bridge (Ylang-Ylang Bridge) | San Antonio II/Sta. Rosa II | 2                  | 45.20         | 6.50      | Concrete             | Double          | National       | Needs Improvement (Widening) |
| Soriano Bridge   | Poblacion/San Jose I        | 1                  | 21.95         | 6.00      | Concrete             | Double          | National       | Fair                         |
| Malimango  | Salcedo II                  | 1                  | 14.00         | 6.00      | Concrete             | Double          | National       | Fair                         |
| Calero Bridge  | San Rafael III & IV         | 1                  | 21.95         | 6.00      | Concrete             | Double          | National       | Needs Improvement (Widening) |
| <b>TOTAL</b>   |                             |                    | <b>241.10</b> |           |                      |                 |                |                              |





Source: 2018-2028 Comprehensive Land Use Plan of Municipality of Noveleta

Figure 2.4-6. Map of Existing Bridges

### Mode of Transport

The modes of transport in the municipality are public buses, jeepney, FX taxis, tricycle, pedicabs and private vehicles.

The Noveleta Junction at the Poblacion is considered as the crossroad for vehicles traveling to the Municipalities of Rosario, General Trias, Tanza, Kawit, Cavite City and Metro Manila and even Olongapo City and Baguio City.

Commuters from Noveleta can conveniently travel to these places by bus and jeepney which may be found passing along the following streets:

- General P. Alvarez and Dr. Jose Salud streets: route to Cavite City from Kawit, Bacoor. Zapote and/or Metro Manila and Olongapo/Baguio City and vice versa.
- M. Luna and General P. Alvarez streets: route to Cavite City from General Trias and vice versa.
- Gen. M. Alvarez and General P. Alvarez streets: route to Cavite City from Rosario, General Trias, Tanza, Trece Martires and Naic and vice versa.



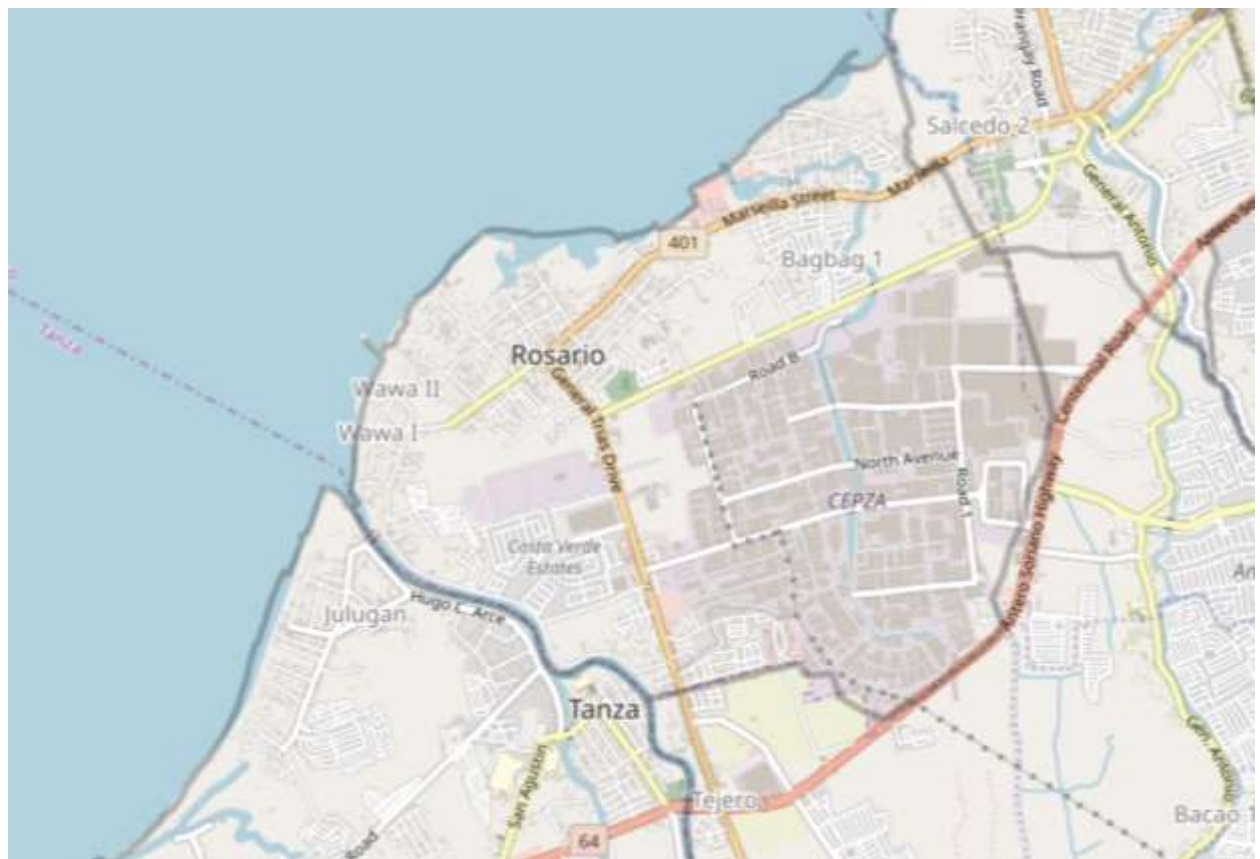
- d. General M. Alvarez and Dr. Salud streets: route to Naic, Tanza and General Trias from Kawit, Bacoor, Zapote and/or Metro Manila and vice versa.

For short/long distance travel within the municipality, tricycle and pedicabs are available. Pedicabs may be found at the entrance of selected subdivisions and barangay roads, while tricycles have terminals in the Poblacion and selected corners of municipal and barangay roads.

### **Baseline/Existing Transportation/Traffic Situation in Municipality of Rosario**

#### **Transportation Network**

Land transportation is accessible from Metro Manila from the six (6) cities and from the other sixteen (16) municipalities of the province. Traffic volume in Rosario is moderate to heavy. Heavy traffics occur almost every day along the commercial areas extending up to the industrial zone (PEZA), especially during rush hours.



Source: UP Project Noah Open Street Map, screen-captured 2020

**Figure 2.4-7. Road Network Map of Municipality of Rosario**

#### **Transportation**

Rosario is easily accessed by land means from neighbouring cities and towns. It is only 12 km from the provincial capitol and 30 km from Manila. Travelling is even more trouble-free as PEZA-Bacoor Diversion Road is linked to Centennial Road towards the Cavitex Entrance in Kawit.



National roads traversing the municipality are interconnected with Marseilla St. and Gen. Trias Drive. Combined, it has a length of about 4 km. All roads totalling more than 32.331 km lead to the 20 barangays.

The municipality is likewise accessible by sea transportation passing through Manila Bay.

### **Impacts of Reclamation and Horizontal Construction Phase on Traffic**

The existing traffic congestion is due to the uncontrolled growth and urban sprawl in the whole GMMA with millions of people travelling everyday to and from the national capital for work, school, entertainment, etc.

The direct impact of the project with regards to addition to traffic congestion will only be very minimal during the pre-construction phase. This is mostly due to vehicles of the personnel engaging in further studies and planning in areas towards the project location. This impact will increase only during the initial stages of the horizontal development construction phase upon the arrivals and exits of equipment via land, and on other occasions throughout the project implementation, but not too frequent or prolonged. The proponent shall be using the sea access as much as possible, and these are also for logistical and cost considerations. The traffic towards and in the areas directly accessing the project location would be limited only to the few personnel who will travel to the project site by land.

The proponent will strictly comply with traffic rules and implement speed limits to ensure safety of the potentially affected communities. Furthermore, there will be close liaison with local traffic authorities and installation of improved signage to reduce the risk of accidents.

With regards to sea vessel traffic, the project will have no direct impact on the established navigational routes of the Navy and PPA.

For the fishermen, their traditional route from the sea towards the Rosario Fish Port will be impacted. The configuration of the islands is done in such a way that boats and small ships can pass through the channels. However, it could mean a longer route for the fishermen. One option that is being looked at is having a fish wharf in one of the islands. It could be established in a way that it will attract tourists or buyers to the area. This is in a very early stage and talks are still in progress among the stakeholders.

Increase in sea traffic due to the use of large ships and vessels during reclamation is also unavoidable. To address these impacts, it is recommended that the affected fisherfolks will be provided additional livelihood opportunities. Peak hours of fishing activities shall be considered during the reclamation activities.

### **2.4.9 Public Perception Survey**

The Preliminary Perception Survey conducted last October 13-19 2018 with a total of 360 respondents, to assess the socio-cultural economic situation of the communities that are to be affected by the proposed reclamation, particularly the three (3) barangays-namely: Barangays **San Rafael 2, San Rafael 3 and San Rafael 4** for the Municipality of Noveleta and the nine (9) barangays-namely: Barangays **Bagbag II, Kanluran, Ligtong I, Muzon II, Sapa II, Sapa III, Wawa I, Wawa II and Wawa III** for the Municipality of Rosario which are closest to the site. Table below presents the summary of the Perception Survey conducted for the Proposed Project.

**Sex Distribution** – The respondents were composed of 32.77% males and 67.22 females.





**Table 2.4-12. Impact Barangays: Sex Distribution**

| Barangay                 | GENDER             |       |                    |       |                   |   | Total              |     |
|--------------------------|--------------------|-------|--------------------|-------|-------------------|---|--------------------|-----|
|                          | Male               |       | Female             |       | No Answer         |   | No. of HH surveyed | %   |
|                          | No. of HH surveyed | %     | No. of HH surveyed | %     | No.of HH surveyed | % |                    |     |
| Municipality of Noveleta |                    |       |                    |       |                   |   |                    |     |
| San Rafael 2             | 8                  | 26.66 | 22                 | 73.33 | 0                 | 0 | 30                 | 100 |
| San Rafael 3             | 8                  | 26.66 | 22                 | 73.33 | 0                 | 0 | 30                 | 100 |
| San Rafael 4             | 23                 | 76.66 | 7                  | 23.33 | 0                 | 0 | 30                 | 100 |
| Municipality of Rosario  |                    |       |                    |       |                   |   |                    |     |
| Bagbag II                | 16                 | 53.33 | 14                 | 46.66 | 0                 | 0 | 30                 | 100 |
| Kanluran                 | 23                 | 76.66 | 7                  | 23.33 | 0                 | 0 | 30                 | 100 |
| Ligtong I                | 4                  | 13.33 | 26                 | 86.66 | 0                 | 0 | 30                 | 100 |
| Muzon II                 | 7                  | 23.33 | 23                 | 76.66 | 0                 | 0 | 30                 | 100 |
| Sapa II                  | 3                  | 10    | 27                 | 90    | 0                 | 0 | 30                 | 100 |
| Sapa III                 | 9                  | 30    | 21                 | 70    | 0                 | 0 | 30                 | 100 |
| Wawa I                   | 5                  | 16.66 | 25                 | 83.33 | 0                 | 0 | 30                 | 100 |
| Wawa II                  | 4                  | 13.33 | 26                 | 86.66 | 0                 | 0 | 30                 | 100 |
| Wawa III                 | 8                  | 26.66 | 22                 | 73.33 | 0                 | 0 | 30                 | 100 |
| Total                    | 118                | 32.77 | 242                | 67.22 | 0                 | 0 | 360                | 100 |

Data Source: EIA Perception Survey 2018

**Civil Status** – Based on the table below, 66.11% of the respondents are married (or 238 out of 360 respondents) followed by single 15.83% and the rest are widower, live-in and separated.



Table 2.4-13. Impact Barangays: Civil Status

| Barangay                 | CIVIL STATUS       |       |                    |       |                    |       |                    |      |                    |       | Total              |     |
|--------------------------|--------------------|-------|--------------------|-------|--------------------|-------|--------------------|------|--------------------|-------|--------------------|-----|
|                          | Single             |       | Married            |       | Widower            |       | Separated          |      | Atbp. (Lived in)   |       | No. of HH surveyed | %   |
|                          | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %    | No. of HH surveyed | %     |                    |     |
| Municipality of Noveleta |                    |       |                    |       |                    |       |                    |      |                    |       |                    |     |
| San Rafael 2             | 6                  | 20    | 19                 | 63.33 | 1                  | 3.33  | 0                  | 0    | 4                  | 13.33 | 30                 | 100 |
| San Rafael 3             | 0                  | 0     | 28                 | 93.33 | 0                  | 0     | 0                  | 0    | 2                  | 6.66  | 30                 | 100 |
| San Rafael 4             | 3                  | 10    | 25                 | 83.33 | 2                  | 6.66  | 0                  | 0    | 0                  | 0     | 30                 | 100 |
| Municipality of Rosario  |                    |       |                    |       |                    |       |                    |      |                    |       |                    |     |
| Bagbag II                | 7                  | 23.33 | 15                 | 50    | 3                  | 10    | 0                  | 0    | 5                  | 16.66 | 30                 | 100 |
| Kanluran                 | 10                 | 33.33 | 15                 | 50    | 2                  | 6.66  | 2                  | 6.66 | 1                  | 3.33  | 30                 | 100 |
| Ligtong I                | 4                  | 13.33 | 16                 | 53.33 | 1                  | 3.33  | 3                  | 10   | 6                  | 20    | 30                 | 100 |
| Muzon II                 | 5                  | 16.66 | 21                 | 70    | 2                  | 6.66  | 1                  | 3.33 | 1                  | 3.33  | 30                 | 100 |
| Sapa II                  | 7                  | 23.33 | 16                 | 53.33 | 1                  | 3.33  | 1                  | 3.33 | 5                  | 16.66 | 30                 | 100 |
| Sapa III                 | 5                  | 16.66 | 20                 | 66.66 | 5                  | 16.66 | 0                  | 0    | 0                  | 0     | 30                 | 100 |
| Wawa I                   | 6                  | 20    | 22                 | 73.33 | 1                  | 3.33  | 0                  | 0    | 1                  | 3.33  | 30                 | 100 |
| Wawa II                  | 2                  | 6.66  | 20                 | 66.66 | 2                  | 6.66  | 2                  | 6.66 | 4                  | 13.33 | 30                 | 100 |
| Wawa III                 | 2                  | 6.66  | 21                 | 70    | 4                  | 13.33 | 3                  | 10   | 0                  | 0     | 30                 | 100 |
| Total                    | 57                 | 15.83 | 238                | 66.11 | 24                 | 6.67  | 12                 | 3.33 | 29                 | 8.05  | 360                | 100 |

Data Source: EIA Perception Survey 2018

**Religion Affiliations-** Table 2.4-14 shows that 87.78% of the total respondents interviewed are Roman Catholics followed by 5.55%, which are Aglipayan, Protestant, Inc and Born Again.

Table 2.4-14. Impact Barangays: Religious Affiliation

| Barangay                 | RELIGIOUS AFFILIATION |       |                    |       |                    |       |                    |      |                    |      | Total              |     |
|--------------------------|-----------------------|-------|--------------------|-------|--------------------|-------|--------------------|------|--------------------|------|--------------------|-----|
|                          | Catholic              |       | Protestant         |       | Aglipayan          |       | INC                |      | Others             |      | No. of HH surveyed | %   |
|                          | No. of HH surveyed    | %     | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %    | No. of HH surveyed | %    |                    |     |
| Municipality of Noveleta |                       |       |                    |       |                    |       |                    |      |                    |      |                    |     |
| San Rafael 2             | 8                     | 26.66 | 3                  | 10    | 19                 | 63.33 | 0                  | 0    | 0                  | 0    | 30                 | 100 |
| San Rafael 3             | 28                    | 93.33 | 0                  | 0     | 0                  | 0     | 0                  | 0    | 2                  | 6.66 | 30                 | 100 |
| San Rafael 4             | 28                    | 93.33 | 0                  | 0     | 0                  | 0     | 2                  | 6.66 | 0                  | 0    | 30                 | 100 |
| Municipality of Rosario  |                       |       |                    |       |                    |       |                    |      |                    |      |                    |     |
| Bagbag II                | 23                    | 76.66 | 4                  | 13.33 | 1                  | 3.33  | 1                  | 3.33 | 1                  | 3.33 | 30                 | 100 |
| Kanluran                 | 29                    | 96.66 | 0                  | 0     | 0                  | 0     | 0                  | 0    | 1                  | 3.33 | 30                 | 100 |



| Barangay     | RELIGIOUS AFFILIATION |              |                    |            |                    |             |                    |             |                    |             | Total              |            |
|--------------|-----------------------|--------------|--------------------|------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|------------|
|              | Catholic              |              | Protestant         |            | Aglipayan          |             | INC                |             | Others             |             | No. of HH surveyed | %          |
|              | No. of HH surveyed    | %            | No. of HH surveyed | %          | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %           |                    |            |
| Ligtong I    | 29                    | 96.66        | 0                  | 0          | 0                  | 0           | 0                  | 0           | 1                  | 3.33        | 30                 | 100        |
| Muzon II     | 30                    | 100          | 0                  | 0          | 0                  | 0           | 0                  | 0           | 0                  | 0           | 30                 | 100        |
| Sapa II      | 28                    | 93.33        | 1                  | 3.33       | 0                  | 0           | 0                  | 0           | 1                  | 3.33        | 30                 | 100        |
| Sapa III     | 28                    | 93.33        | 1                  | 3.33       | 0                  | 0           | 0                  | 0           | 1                  | 3.33        | 30                 | 100        |
| Wawa I       | 27                    | 90           | 0                  | 0          | 0                  | 0           | 2                  | 6.66        | 1                  | 3.33        | 30                 | 100        |
| Wawa II      | 29                    | 96.66        | 0                  | 0          | 0                  | 0           | 0                  | 0           | 1                  | 3.33        | 30                 | 100        |
| Wawa III     | 29                    | 96.66        | 0                  | 0          | 0                  | 0           | 0                  | 0           | 1                  | 3.33        | 30                 | 100        |
| <b>Total</b> | <b>316</b>            | <b>87.78</b> | <b>9</b>           | <b>2.5</b> | <b>20</b>          | <b>5.55</b> | <b>5</b>           | <b>1.39</b> | <b>10</b>          | <b>2.78</b> | <b>360</b>         | <b>100</b> |

Data Source: EIA Perception Survey 2018

**Ethnicity** - The Municipality's dialect is mostly Tagalog (86.39%) there are migrants from other provinces that are also Tagalog speaking. Others are Visayan, Ilocano, Bicolano and Waray.

Table 2.4-15. Impact Barangays: Ethnicity

| Barangay                 | ETHNICITY          |       |                    |       |                    |       |                    |       |                    |       | Total              |     |
|--------------------------|--------------------|-------|--------------------|-------|--------------------|-------|--------------------|-------|--------------------|-------|--------------------|-----|
|                          | Tagalog            |       | Cebuano            |       | Bicolano           |       | Waray              |       | Others             |       | No. of HH surveyed | %   |
|                          | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %     |                    |     |
| Municipality of Noveleta |                    |       |                    |       |                    |       |                    |       |                    |       |                    |     |
| San Rafael 2             | 25                 | 83.33 | 0                  | 0     | 0                  | 0     | 0                  | 0     | 5                  | 16.67 | 30                 | 100 |
| San Rafael 3             | 30                 | 100   | 0                  | 0     | 0                  | 0     | 0                  | 0     | 0                  | 0     | 30                 | 100 |
| San Rafael 4             | 29                 | 96.67 | 0                  | 0     | 0                  | 0     | 1                  | 3.33  | 0                  | 0     | 30                 | 100 |
| Municipality of Rosario  |                    |       |                    |       |                    |       |                    |       |                    |       |                    |     |
| Bagbag II                | 27                 | 90    | 1                  | 3.33  | 0                  | 0     | 0                  | 0     | 2                  | 6.67  | 30                 | 100 |
| Kanluran                 | 26                 | 86.67 | 0                  | 0     | 4                  | 13.33 | 0                  | 0     | 0                  | 0     | 30                 | 100 |
| Ligtong I                | 30                 | 100   | 0                  | 0     | 0                  | 0     | 0                  | 0     | 0                  | 0     | 30                 | 100 |
| Muzon II                 | 23                 | 76.67 | 0                  | 0     | 6                  | 20    | 0                  | 0     | 1                  | 3.33  | 30                 | 100 |
| Sapa II                  | 28                 | 93.33 | 0                  | 0     | 0                  | 0     | 2                  | 6.67  | 0                  | 0     | 30                 | 100 |
| Sapa III                 | 25                 | 83.33 | 2                  | 6.67  | 0                  | 0     | 3                  | 10    | 0                  | 0     | 30                 | 100 |
| Wawa I                   | 20                 | 66.67 | 7                  | 23.33 | 3                  | 10    | 0                  | 0     | 0                  | 0     | 30                 | 100 |
| Wawa II                  | 26                 | 86.67 | 0                  | 0     | 3                  | 10    | 1                  | 3.33  | 0                  | 0     | 30                 | 100 |
| Wawa III                 | 22                 | 73.33 | 0                  | 0     | 3                  | 10    | 5                  | 16.67 | 0                  | 0     | 30                 | 100 |
| Total                    | 311                | 86.39 | 10                 | 2.78  | 19                 | 5.28  | 12                 | 3.33  | 8                  | 2.22  | 360                | 100 |

Data Source: EIA Perception Survey 2018





**Income, Livelihood and Employment** - The main source of income of the respondents is mostly Fishing, Regular Private/Government Employee, family business and through contractual jobs. On the other hand, 61.39% of the respondents stated that the husband is the primary earner in the household while 16.39% has the wife as the primary earner. (Tables 2.4-16 and 2.4-17) In terms of monthly income, 25.56% are earning between Php 10,001-Php 20,000, while respondents earning Php 1,001-Php 5,000 make up 23.61% followed by 16.39% earning below Php 1,000. See Table 2.4-18.

**Table 2.4-16. Impact Barangays: Main Source of Livelihood of Respondents**

| Barangay                 | OCCUPATION         |       |                               |       |                                |       |                        |       |                    |       | Total              |     |
|--------------------------|--------------------|-------|-------------------------------|-------|--------------------------------|-------|------------------------|-------|--------------------|-------|--------------------|-----|
|                          | Fishing            |       | Regular Private/Govt Employee |       | Contractual Job/Sub-Contractor |       | Vendor/Family Business |       | Others             |       | No. of HH surveyed | %   |
|                          | No. of HH surveyed | %     | No. of HH surveyed            | %     | No. of HH surveyed             | %     | No. of HH surveyed     | %     | No. of HH surveyed | %     |                    |     |
| Municipality of Noveleta |                    |       |                               |       |                                |       |                        |       |                    |       |                    |     |
| San Rafael 2             | 0                  | 0     | 13                            | 43.33 | 2                              | 6.67  | 6                      | 20    | 9                  | 30    | 30                 | 100 |
| San Rafael 3             | 16                 | 53.33 | 5                             | 16.67 | 4                              | 13.33 | 5                      | 16.67 | 0                  | 0     | 30                 | 100 |
| San Rafael 4             | 23                 | 76.67 | 0                             | 0     | 0                              | 0     | 4                      | 13.33 | 3                  | 10    | 30                 | 100 |
| Municipality of Rosario  |                    |       |                               |       |                                |       |                        |       |                    |       |                    |     |
| Bagbag II                | 10                 | 33.33 | 5                             | 16.67 | 0                              | 0     | 7                      | 23.33 | 8                  | 26.67 | 30                 | 100 |
| Kanluran                 | 1                  | 3.33  | 3                             | 10    | 4                              | 13.33 | 4                      | 13.33 | 18                 | 60    | 30                 | 100 |
| Ligtong I                | 14                 | 46.67 | 4                             | 13.33 | 3                              | 10    | 6                      | 20    | 3                  | 10    | 30                 | 100 |
| Muzon II                 | 19                 | 63.33 | 1                             | 3.33  | 1                              | 3.33  | 4                      | 13.33 | 5                  | 16.67 | 30                 | 100 |
| Sapa II                  | 12                 | 40    | 4                             | 13.33 | 3                              | 10    | 9                      | 30    | 2                  | 6.67  | 30                 | 100 |
| Sapa III                 | 9                  | 30    | 5                             | 16.67 | 4                              | 13.33 | 4                      | 13.33 | 8                  | 26.67 | 30                 | 100 |
| Wawa I                   | 15                 | 50    | 3                             | 10    | 3                              | 10    | 5                      | 16.67 | 4                  | 13.33 | 30                 | 100 |
| Wawa II                  | 17                 | 56.67 | 1                             | 3.33  | 3                              | 10    | 5                      | 16.67 | 4                  | 13.33 | 30                 | 100 |
| Wawa III                 | 14                 | 46.67 | 10                            | 33.33 | 1                              | 3.33  | 5                      | 16.67 | 0                  | 0     | 30                 | 100 |
| Total                    | 150                | 41.67 | 54                            | 15    | 28                             | 7.78  | 64                     | 17.78 | 64                 | 17.78 | 360                | 100 |

Data Source: EIA Perception Survey 2018

**Table 2.4-17. Impact Barangays: Primary Earner**

| Barangay                 | PRIMARY EARNER     |       |                    |    |                    |    |                    |      |                    |       | Total              |     |
|--------------------------|--------------------|-------|--------------------|----|--------------------|----|--------------------|------|--------------------|-------|--------------------|-----|
|                          | Husband            |       | Wife               |    | Son                |    | Daughter           |      | Others             |       | No. of HH surveyed | %   |
|                          | No. of HH surveyed | %     | No. of HH surveyed | %  | No. of HH surveyed | %  | No. of HH surveyed | %    | No. of HH surveyed | %     |                    |     |
| Municipality of Novelata |                    |       |                    |    |                    |    |                    |      |                    |       |                    |     |
| San Rafael 2             | 14                 | 46.67 | 3                  | 10 | 3                  | 10 | 2                  | 6.67 | 8                  | 26.67 | 30                 | 100 |



| Barangay                | PRIMARY EARNER     |              |                    |              |                    |             |                    |             |                    |              | Total              |            |
|-------------------------|--------------------|--------------|--------------------|--------------|--------------------|-------------|--------------------|-------------|--------------------|--------------|--------------------|------------|
|                         | Husband            |              | Wife               |              | Son                |             | Daughter           |             | Others             |              | No. of HH surveyed | %          |
|                         | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %            |                    |            |
| San Rafael 3            | 19                 | 63.33        | 9                  | 30           | 0                  | 0           | 2                  | 6.67        | 0                  | 0            | 30                 | 100        |
| San Rafael 4            | 23                 | 76.67        | 6                  | 20           | 0                  | 0           | 1                  | 3.33        | 0                  | 0            | 30                 | 100        |
| Municipality of Rosario |                    |              |                    |              |                    |             |                    |             |                    |              |                    |            |
| Bagbag II               | 13                 | 43.33        | 4                  | 13.33        | 2                  | 6.67        | 2                  | 6.67        | 9                  | 30           | 30                 | 100        |
| Kanluran                | 20                 | 66.67        | 1                  | 3.33         | 3                  | 10          | 0                  | 0           | 6                  | 20           | 30                 | 100        |
| Ligtong I               | 21                 | 70           | 4                  | 13.33        | 1                  | 3.33        | 3                  | 10          | 1                  | 3.33         | 30                 | 100        |
| Muzon II                | 24                 | 80           | 2                  | 6.67         | 1                  | 3.33        | 1                  | 3.33        | 2                  | 6.67         | 30                 | 100        |
| Sapa II                 | 18                 | 60           | 5                  | 16.67        | 2                  | 6.67        | 2                  | 6.67        | 3                  | 10           | 30                 | 100        |
| Sapa III                | 17                 | 56.67        | 7                  | 23.33        | 1                  | 3.33        | 2                  | 6.67        | 3                  | 10           | 30                 | 100        |
| Wawa I                  | 20                 | 66.67        | 6                  | 20           | 1                  | 3.33        | 3                  | 10          | 0                  | 0            | 30                 | 100        |
| Wawa II                 | 12                 | 40           | 10                 | 33.33        | 4                  | 13.33       | 4                  | 13.33       | 0                  | 0            | 30                 | 100        |
| Wawa III                | 20                 | 66.67        | 2                  | 6.67         | 2                  | 6.67        | 1                  | 3.33        | 5                  | 16.67        | 30                 | 100        |
| <b>Total</b>            | <b>221</b>         | <b>61.39</b> | <b>59</b>          | <b>16.39</b> | <b>20</b>          | <b>5.56</b> | <b>23</b>          | <b>6.39</b> | <b>37</b>          | <b>10.27</b> | <b>360</b>         | <b>100</b> |

Data Source: EIA Perception Survey 2018

**Table 2.4-18. Impact Barangays: Monthly Income of the Respondents**

| Barangay                 | MONTHLY INCOME     |       |                    |       |                     |       |                    |       |                    |       |                    |       | Total              |     |
|--------------------------|--------------------|-------|--------------------|-------|---------------------|-------|--------------------|-------|--------------------|-------|--------------------|-------|--------------------|-----|
|                          | P1,000 below       |       | P1,001-P5,000      |       | P5,001-10,000       |       | P10,001-20,000     |       | P20,001 Above      |       | Others/No Answer   |       | No. of HH surveyed | %   |
|                          | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveye d | %     | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %     |                    |     |
| Municipality of Noveleta |                    |       |                    |       |                     |       |                    |       |                    |       |                    |       |                    |     |
| San Rafael 2             | 8                  | 26.67 | 7                  | 23.33 | 1                   | 3.33  | 7                  | 23.33 | 7                  | 23.33 | 0                  | 0     | 30                 | 100 |
| San Rafael 3             | 6                  | 20    | 3                  | 10    | 8                   | 26.67 | 11                 | 36.67 | 2                  | 6.67  | 0                  | 0     | 30                 | 100 |
| San Rafael 4             | 2                  | 6.67  | 9                  | 30    | 10                  | 33.3  | 6                  | 20    | 3                  | 10    | 0                  | 0     | 30                 | 100 |
| Municipality of Rosario  |                    |       |                    |       |                     |       |                    |       |                    |       |                    |       |                    |     |
| Bagbag II                | 4                  | 13.33 | 4                  | 13.33 | 1                   | 3.33  | 1                  | 3.33  | 0                  | 0     | 20                 | 66.67 | 30                 | 100 |
| Kanluran                 | 1                  | 3.33  | 8                  | 26.67 | 5                   | 16.67 | 10                 | 33.33 | 5                  | 16.67 | 1                  | 3.33  | 30                 | 100 |
| Ligtong I                | 6                  | 20    | 13                 | 43.33 | 7                   | 23.33 | 4                  | 13.33 | 0                  | 0     | 0                  | 0     | 30                 | 100 |
| Muzon II                 | 17                 | 56.67 | 7                  | 23.33 | 1                   | 3.33  | 1                  | 3.33  | 0                  | 0     | 4                  | 13.33 | 30                 | 100 |
| Sapa II                  | 5                  | 16.67 | 15                 | 50    | 7                   | 23.33 | 1                  | 3.33  | 1                  | 3.33  | 1                  | 3.33  | 30                 | 100 |
| Sapa III                 | 3                  | 10    | 1                  | 3.33  | 7                   | 23.33 | 18                 | 60    | 1                  | 3.33  | 0                  | 0     | 30                 | 100 |
| Wawa I                   | 2                  | 6.67  | 8                  | 26.67 | 3                   | 10    | 15                 | 30    | 2                  | 6.67  | 0                  | 0     | 30                 | 100 |
| Wawa II                  | 0                  | 0     | 5                  | 16.67 | 7                   | 23.33 | 13                 | 43.33 | 4                  | 13.33 | 1                  | 3.33  | 30                 | 100 |
| Wawa III                 | 5                  | 16.67 | 5                  | 16.67 | 1                   | 3.33  | 5                  | 16.67 | 3                  | 10    | 11                 | 36.67 | 30                 | 100 |



| Barangay     | MONTHLY INCOME     |              |                    |              |                    |              |                    |              |                    |             |                    |              | Total              |            |
|--------------|--------------------|--------------|--------------------|--------------|--------------------|--------------|--------------------|--------------|--------------------|-------------|--------------------|--------------|--------------------|------------|
|              | P1,000 below       |              | P1,001-P5,000      |              | P5,001-10,000      |              | P10,001-20,000     |              | P20,001 Above      |             | Others/No Answer   |              | No. of HH surveyed | %          |
|              | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %           | No. of HH surveyed | %            |                    |            |
| <b>Total</b> | <b>59</b>          | <b>16.39</b> | <b>85</b>          | <b>23.61</b> | <b>58</b>          | <b>16.11</b> | <b>92</b>          | <b>25.56</b> | <b>28</b>          | <b>7.78</b> | <b>38</b>          | <b>10.56</b> | <b>360</b>         | <b>100</b> |

Data Source: EIA Perception Survey 2018

**Educational Attainment** - Table below shows that the largest percentage or 52.5% of the respondents are high school graduate followed by elementary, vocational and college graduates.

**Table 2.4-19. Impact Barangays: Educational Attainment**

| Barangay                 | EDUCATIONAL ATTAINMENT |   |                    |       |                    |       |                    |       |                    |      | Total              |     |
|--------------------------|------------------------|---|--------------------|-------|--------------------|-------|--------------------|-------|--------------------|------|--------------------|-----|
|                          | Wala (None)            |   | Elementary         |       | High School        |       | Vocational         |       | College            |      | No. of HH surveyed | %   |
|                          | No. of HH surveyed     | % | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %    |                    |     |
| Municipality of Noveleta |                        |   |                    |       |                    |       |                    |       |                    |      |                    |     |
| San Rafael 2             | 0                      | 0 | 8                  | 26.67 | 3                  | 10    | 19                 | 63.33 | 0                  | 0    | 30                 | 100 |
| San Rafael 3             | 0                      | 0 | 12                 | 40    | 16                 | 53.33 | 0                  | 0     | 2                  | 6.67 | 30                 | 100 |
| San Rafael 4             | 0                      | 0 | 10                 | 33.34 | 14                 | 46.66 | 3                  | 10    | 3                  | 10   | 30                 | 100 |
| Municipality of Rosario  |                        |   |                    |       |                    |       |                    |       |                    |      |                    |     |
| Bagbag II                | 0                      | 0 | 5                  | 16.66 | 20                 | 66.67 | 4                  | 13.33 | 1                  | 3.34 | 30                 | 100 |
| Kanluran                 | 0                      | 0 | 8                  | 26.66 | 18                 | 60    | 1                  | 3.34  | 3                  | 10   | 30                 | 100 |
| Ligtong I                | 0                      | 0 | 8                  | 26.66 | 16                 | 53.33 | 3                  | 10    | 3                  | 10   | 30                 | 100 |
| Muzon II                 | 0                      | 0 | 12                 | 40    | 14                 | 46.66 | 1                  | 3.34  | 3                  | 10   | 30                 | 100 |
| Sapa II                  | 0                      | 0 | 13                 | 43.33 | 14                 | 46.66 | 3                  | 10    | 0                  | 0    | 30                 | 100 |
| Sapa III                 | 0                      | 0 | 11                 | 36.66 | 17                 | 56.66 | 1                  | 3.34  | 1                  | 3.34 | 30                 | 100 |
| Wawa I                   | 0                      | 0 | 8                  | 26.66 | 19                 | 63.33 | 1                  | 3.34  | 2                  | 6.67 | 30                 | 100 |
| Wawa II                  | 0                      | 0 | 11                 | 36.66 | 19                 | 63.33 | 0                  | 0     | 0                  | 0    | 30                 | 100 |
| Wawa III                 | 0                      | 0 | 7                  | 23.33 | 19                 | 63.33 | 2                  | 6.67  | 2                  | 6.67 | 30                 | 100 |
| Total                    | 0                      | 0 | 113                | 31.39 | 189                | 52.5  | 38                 | 10.56 | 20                 | 5.56 | 360                | 100 |

Data Source: EIA Perception Survey 2018





• Health Profile

**Sickness in the Family-** Based on the survey conducted, 50.83% of the household respondents have experienced three (3) sick family members for the past five years. 13.61% of the household respondents have experienced four (4) sick family members for the past five years. Common sicknesses in the barangay are fever, colds, gastrointestinal diseases, heart disease, asthma, skin disease, tuberculosis and gastrointestinal diseases. See Tables 2.4-20 and 2.4-21.

Most of the respondents consult to Private Clinic, existing Barangay Health Centers, Government Hospital and some of the respondents opted to self-medicate at home. See Table 2.4-22.

**Table 2.4-20. Number of Family Member Who Got Sick for the Past 5 Years**

| Barangay                 | NUMBER OF FAMILY MEMBER WHO GOT SICK FOR THE PAST 5 YEARS |       |                    |       |                    |       |                    |       |                    |       |                    |       | Total              |     |
|--------------------------|---|-------|--------------------|-------|--------------------|-------|--------------------|-------|--------------------|-------|--------------------|-------|--------------------|-----|
|                          | 1   |       | 2                  |       | 3                  |       | 4                  |       | 5                  |       | NO ANSWER          |       | No. of HH surveyed | %   |
|                          | No. of HH surveyed  | %     | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %     |                    |     |
| Municipality of Noveleta |   |       |                    |       |                    |       |                    |       |                    |       |                    |       |                    |     |
| San Rafael 2             | 10  | 33.33 | 8                  | 26.67 | 0                  | 0     | 0                  | 0     | 0                  | 0     | 12                 | 40    | 30                 | 100 |
| San Rafael 3             | 21  | 70    | 3                  | 10    | 2                  | 6.67  | 1                  | 3.33  | 2                  | 6.67  | 1                  | 3.33  | 30                 | 100 |
| San Rafael 4             | 3   | 10    | 1                  | 3.33  | 1                  | 3.33  | 0                  | 0     | 0                  | 0     | 25                 | 83.33 | 30                 | 100 |
| Municipality of Rosario  |   |       |                    |       |                    |       |                    |       |                    |       |                    |       |                    |     |
| Bagbag II                | 0   | 0     | 1                  | 3.33  | 18                 | 60    | 4                  | 13.33 | 0                  | 0     | 7                  | 23.33 | 30                 | 100 |
| Kanluran                 | 0   | 0     | 0                  | 0     | 12                 | 40    | 2                  | 6.67  | 4                  | 13.34 | 12                 | 40    | 30                 | 100 |
| Ligtong I                | 0   | 0     | 0                  | 0     | 22                 | 73.33 | 4                  | 13.33 | 2                  | 6.67  | 2                  | 6.67  | 30                 | 100 |
| Muzon II                 | 1   | 3.33  | 1                  | 3.33  | 24                 | 80    | 0                  | 0     | 0                  | 0     | 4                  | 13.33 | 30                 | 100 |
| Sapa II                  | 1   | 3.33  | 0                  | 0     | 23                 | 76.67 | 3                  | 10    | 1                  | 3.33  | 2                  | 6.67  | 30                 | 100 |
| Sapa III                 | 1   | 3.33  | 0                  | 0     | 1                  | 3.33  | 27                 | 90    | 1                  | 3.33  | 0                  | 0     | 30                 | 100 |
| Wawa I                   | 0   | 0     | 0                  | 0     | 28                 | 93.33 | 1                  | 3.33  | 1                  | 3.33  | 0                  | 0     | 30                 | 100 |
| Wawa II                  | 0   | 0     | 0                  | 0     | 30                 | 100   | 0                  | 0     | 0                  | 0     | 0                  | 0     | 30                 | 100 |
| Wawa III                 | 0   | 0     | 0                  | 0     | 22                 | 73.33 | 7                  | 23.33 | 1                  | 3.33  | 0                  | 0     | 30                 | 100 |
| Total                    | 37  | 10.28 | 14                 | 3.89  | 183                | 50.83 | 49                 | 13.61 | 12                 | 3.33  | 65                 | 18.05 | 360                | 100 |

Data Source: EIA Perception Survey 2018



Table 2.4-21. Common Illness in the Community

| Barangay                 | SOURCE OF TREATMENT FOR ILLNESS OF RESPONDENTS |   |                    |       |                    |       |                    |       |                    |      | Total              |     |
|--------------------------|--|---|--------------------|-------|--------------------|-------|--------------------|-------|--------------------|------|--------------------|-----|
|                          | Gastrointestinal Disease                       |   | Cold               |       | Fever              |       | Others             |       | No Answer          |      | No. of HH surveyed | %   |
|                          | No. of HH surveyed                             | % | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %     | No .of HH surveyed | %    |                    |     |
| Municipality of Noveleta |  |   |                    |       |                    |       |                    |       |                    |      |                    |     |
| San Rafael 2             | 0  | 0 | 8                  | 26.67 | 3                  | 10    | 19                 | 63.33 | 0                  | 0    | 30                 | 100 |
| San Rafael 3             | 0  | 0 | 12                 | 40    | 16                 | 53.33 | 0                  | 0     | 2                  | 6.67 | 30                 | 100 |
| San Rafael 4             | 0  | 0 | 10                 | 33.34 | 14                 | 46.66 | 3                  | 10    | 3                  | 10   | 30                 | 100 |
| Municipality of Rosario  |  |   |                    |       |                    |       |                    |       |                    |      |                    |     |
| Bagbag II                | 0  | 0 | 5                  | 16.66 | 20                 | 66.67 | 4                  | 13.33 | 1                  | 3.34 | 30                 | 100 |
| Kanluran                 | 0  | 0 | 8                  | 26.66 | 18                 | 60    | 1                  | 3.34  | 3                  | 10   | 30                 | 100 |
| Ligtong I                | 0  | 0 | 8                  | 26.66 | 16                 | 53.33 | 3                  | 10    | 3                  | 10   | 30                 | 100 |
| Muzon II                 | 0  | 0 | 12                 | 40    | 14                 | 46.66 | 1                  | 3.34  | 3                  | 10   | 30                 | 100 |
| Sapa II                  | 0  | 0 | 13                 | 43.33 | 14                 | 46.66 | 3                  | 10    | 0                  | 0    | 30                 | 100 |
| Sapa III                 | 0  | 0 | 11                 | 36.66 | 17                 | 56.66 | 1                  | 3.34  | 1                  | 3.34 | 30                 | 100 |
| Wawa I                   | 0  | 0 | 8                  | 26.66 | 19                 | 63.33 | 1                  | 3.34  | 2                  | 6.67 | 30                 | 100 |
| Wawa II                  | 0  | 0 | 11                 | 36.66 | 19                 | 63.33 | 0                  | 0     | 0                  | 0    | 30                 | 100 |
| Wawa III                 | 0  | 0 | 7                  | 23.33 | 19                 | 63.33 | 2                  | 6.67  | 2                  | 6.67 | 30                 | 100 |
| Total                    | 0  | 0 | 113                | 31.39 | 189                | 52.5  | 38                 | 10.56 | 20                 | 5.55 | 360                | 100 |

Data Source: EIA Perception Survey 2018

Table 2.4-22. Place of Treatment for illness of respondents

| Barangay                 | PLACE OF TREATMENT FOR ILLNESS OF RESPONDENTS |       |                        |       |                     |       |                    |       |                    |   |                    |       |                    |   | Total              |     |
|--------------------------|---|-------|------------------------|-------|---------------------|-------|--------------------|-------|--------------------|---|--------------------|-------|--------------------|---|--------------------|-----|
|                          | House   |       | Barangay Health Center |       | Government Hospital |       | Private Clinic     |       | Herbalist          |   | Others             |       | No Answer          |   | No. of HH surveyed | %   |
|                          | No. of HH surveyed                            | %     | No. of HH surveyed     | %     | No. of HH surveyed  | %     | No. of HH surveyed | %     | No. of HH surveyed | % | No. of HH surveyed | %     | No. of HH surveyed | % |                    |     |
| Municipality of Noveleta |   |       |                        |       |                     |       |                    |       |                    |   |                    |       |                    |   |                    |     |
| San Rafael 2             | 8   | 26.67 | 7                      | 23.33 | 1                   | 3.33  | 7                  | 23.33 | 0                  | 0 | 7                  | 23.33 | 0                  | 0 | 30                 | 100 |
| San Rafael 3             | 6   | 20    | 3                      | 10    | 8                   | 26.67 | 11                 | 36.67 | 0                  | 0 | 2                  | 6.67  | 0                  | 0 | 30                 | 100 |
| San Rafael 4             | 2   | 6.67  | 9                      | 30    | 10                  | 33.3  | 6                  | 20    | 0                  | 0 | 3                  | 10    | 0                  | 0 | 30                 | 100 |



| Barangay                | PLACE OF TREATMENT FOR ILLNESS OF RESPONDENTS |       |                        |       |                     |       |                    |       |                    |   |                    |       |                    |       | Total              |     |
|-------------------------|---|-------|------------------------|-------|---------------------|-------|--------------------|-------|--------------------|---|--------------------|-------|--------------------|-------|--------------------|-----|
|                         | House   |       | Barangay Health Center |       | Government Hospital |       | Private Clinic     |       | Herbalist          |   | Others             |       | No Answer          |       | No. of HH surveyed | %   |
|                         | No. of HH surveyed                            | %     | No. of HH surveyed     | %     | No. of HH surveyed  | %     | No. of HH surveyed | %     | No. of HH surveyed | % | No. of HH surveyed | %     | No. of HH surveyed | %     |                    |     |
| Municipality of Rosario |   |       |                        |       |                     |       |                    |       |                    |   |                    |       |                    |       |                    |     |
| Bagbag II               | 4   | 13.33 | 4                      | 13.33 | 1                   | 3.33  | 1                  | 3.33  | 0                  | 0 | 20                 | 66.67 | 0                  | 0     | 30                 | 100 |
| Kanluran                | 1   | 3.33  | 8                      | 26.67 | 5                   | 16.67 | 10                 | 33.33 | 0                  | 0 | 1                  | 3.33  | 5                  | 16.67 | 30                 | 100 |
| Ligtong I               | 6   | 20    | 13                     | 43.33 | 7                   | 23.33 | 4                  | 13.33 | 0                  | 0 | 0                  | 0     | 0                  | 0     | 30                 | 100 |
| Muzon II                | 17  | 56.67 | 7                      | 23.33 | 1                   | 3.33  | 1                  | 3.33  | 0                  | 0 | 4                  | 13.33 | 0                  | 0     | 30                 | 100 |
| Sapa II                 | 5   | 16.67 | 15                     | 50    | 7                   | 23.33 | 1                  | 3.33  | 0                  | 0 | 1                  | 3.33  | 1                  | 3.33  | 30                 | 100 |
| Sapa III                | 3   | 10    | 1                      | 3.33  | 7                   | 23.33 | 18                 | 60    | 0                  | 0 | 0                  | 0     | 1                  | 3.33  | 30                 | 100 |
| Wawa I                  | 2   | 6.67  | 8                      | 26.67 | 3                   | 10    | 15                 | 30    | 0                  | 0 | 0                  | 0     | 2                  | 6.67  | 30                 | 100 |
| Wawa II                 | 0   | 0     | 5                      | 16.67 | 7                   | 23.33 | 13                 | 43.33 | 0                  | 0 | 1                  | 3.33  | 4                  | 13.33 | 30                 | 100 |
| Wawa III                | 5   | 16.67 | 5                      | 16.67 | 1                   | 3.33  | 5                  | 16.67 | 0                  | 0 | 11                 | 36.67 | 3                  | 10    | 30                 | 100 |
| Total                   | 59  | 16.39 | 85                     | 23.61 | 58                  | 16.11 | 92                 | 25.56 | 0                  | 0 | 50                 | 13.89 | 16                 | 4.44  | 360                | 100 |

Data Source: EIA Perception Survey 2018

**Environmental Health and Sanitation** - Majority of the total respondents indicated that they have access to sanitation facilities.

Table 2.4-23. Type of Toilet Facility Used by Respondents

| Barangay                 | TYPE OF TOILET FACILITY USED BY RESPONDENTS |      |                           |       |                                |       |                    |      |                    |       | Total              |     |
|--------------------------|---|------|---------------------------|-------|--------------------------------|-------|--------------------|------|--------------------|-------|--------------------|-----|
|                          | None  |      | Water-sealed (pour flush) |       | Water-sealed (with flush tank) |       | Antipolo Type      |      | Others             |       | No. of HH surveyed | %   |
|                          | No. of HH surveyed                          | %    | No. of HH surveyed        | %     | No. of HH surveyed             | %     | No. of HH surveyed | %    | No. of HH surveyed | %     |                    |     |
| Municipality of Noveleta |   |      |                           |       |                                |       |                    |      |                    |       |                    |     |
| San Rafael 2             | 6   | 20   | 19                        | 63.33 | 1                              | 3.33  | 0                  | 0    | 4                  | 13.33 | 30                 | 100 |
| San Rafael 3             | 0   | 0    | 28                        | 93.33 | 0                              | 0     | 0                  | 0    | 2                  | 6.66  | 30                 | 100 |
| San Rafael 4             | 3   | 10   | 25                        | 83.33 | 2                              | 6.66  | 0                  | 0    | 0                  | 0     | 30                 | 100 |
| Municipality of Rosario  |   |      |                           |       |                                |       |                    |      |                    |       |                    |     |
| Bagbag II                | 1   | 3.33 | 4                         | 13.33 | 23                             | 76.66 | 1                  | 3.33 | 1                  | 3.33  | 30                 | 100 |
| Kanluran                 | 0   | 0    | 29                        | 96.66 | 0                              | 0     | 0                  | 0    | 1                  | 3.33  | 30                 | 100 |





| Barangay     | TYPE OF TOILET FACILITY USED BY RESPONDENTS |             |                           |              |                                |              |                    |             |                    |             | Total              |            |
|--------------|---|-------------|---------------------------|--------------|--------------------------------|--------------|--------------------|-------------|--------------------|-------------|--------------------|------------|
|              | None  |             | Water-sealed (pour flush) |              | Water-sealed (with flush tank) |              | Antipolo Type      |             | Others             |             | No. of HH surveyed | %          |
|              | No. of HH surveyed                          | %           | No. of HH surveyed        | %            | No. of HH surveyed             | %            | No. of HH surveyed | %           | No. of HH surveyed | %           |                    |            |
| Ligtong I    | 0   | 0           | 29                        | 96.66        | 0                              | 0            | 0                  | 0           | 1                  | 3.33        | 30                 | 100        |
| Muzon II     | 0   | 0           | 30                        | 100          | 0                              | 0            | 0                  | 0           | 0                  | 0           | 30                 | 100        |
| Sapa II      | 0   | 0           | 1                         | 3.33         | 28                             | 93.33        | 0                  | 0           | 1                  | 3.33        | 30                 | 100        |
| Sapa III     | 0   | 0           | 1                         | 3.33         | 28                             | 93.33        | 0                  | 0           | 1                  | 3.33        | 30                 | 100        |
| Wawa I       | 0   | 0           | 27                        | 90           | 2                              | 6.66         | 0                  | 0           | 1                  | 3.33        | 30                 | 100        |
| Wawa II      | 0   | 0           | 29                        | 96.66        | 0                              | 0            | 0                  | 0           | 1                  | 3.33        | 30                 | 100        |
| Wawa III     | 0   | 0           | 29                        | 96.66        | 0                              | 0            | 0                  | 0           | 1                  | 3.33        | 30                 | 100        |
| <b>Total</b> | <b>10</b>                                   | <b>2.78</b> | <b>251</b>                | <b>69.72</b> | <b>84</b>                      | <b>23.33</b> | <b>1</b>           | <b>0.28</b> | <b>14</b>          | <b>3.89</b> | <b>360</b>         | <b>100</b> |

Data Source: EIA Perception Survey 2018



## Perception of the Community

### Knowledge About The Proposed Project

Table below shows the frequency of the respondents who answered that they already had prior knowledge and idea about the Proposed Cavite Province Land Reclamation and Development Project. Out of the 360 respondents, 151 or 41.94% of them answered yes, while 148 or 41.11% answered no, and the remaining 61 or 16.94% had no responses.

**Table 2.4-24. Household Knowledge about the Proposed Project**

| Barangay                 | KNOWLEDGE ABOUT THE PROPOSED PROJECT |       |                    |       |                    |       | Total              |     |
|--------------------------|--------------------------------------|-------|--------------------|-------|--------------------|-------|--------------------|-----|
|                          | Yes                                  |       | No                 |       | No Answer          |       | No. of HH surveyed | %   |
|                          | No. of HH surveyed                   | %     | No. of HH surveyed | %     | No. of HH surveyed | %     |                    |     |
| Municipality of Noveleta |                                      |       |                    |       |                    |       |                    |     |
| San Rafael 2             | 12                                   | 40    | 15                 | 50    | 3                  | 10    | 30                 | 100 |
| San Rafael 3             | 1                                    | 3.33  | 25                 | 83.33 | 4                  | 13.33 | 30                 | 100 |
| San Rafael 4             | 0                                    | 0     | 27                 | 90    | 3                  | 10    | 30                 | 100 |
| Municipality of Rosario  |                                      |       |                    |       |                    |       |                    |     |
| Bagbag II                | 8                                    | 26.67 | 12                 | 40    | 10                 | 33.33 | 30                 | 100 |
| Kanluran                 | 6                                    | 20    | 5                  | 16.67 | 19                 | 63.33 | 30                 | 100 |
| Ligtong I                | 23                                   | 76.67 | 4                  | 13.33 | 3                  | 10    | 30                 | 100 |
| Muzon II                 | 8                                    | 26.67 | 10                 | 33.33 | 12                 | 40    | 30                 | 100 |
| Sapa II                  | 21                                   | 70    | 5                  | 16.67 | 4                  | 13.33 | 30                 | 100 |
| Sapa III                 | 2                                    | 6.67  | 25                 | 83.33 | 3                  | 10    | 30                 | 100 |
| Wawa I                   | 23                                   | 76.67 | 7                  | 23.33 | 0                  | 0     | 30                 | 100 |
| Wawa II                  | 26                                   | 86.67 | 4                  | 13.33 | 0                  | 0     | 30                 | 100 |
| Wawa III                 | 21                                   | 70    | 9                  | 30    | 0                  | 0     | 30                 | 100 |
| Total                    | 151                                  | 41.94 | 148                | 41.11 | 61                 | 16.94 | 360                | 100 |

Data Source: EIA Perception Survey 2018

Majority of the respondents answered that their source of information about the Proposed Reclamation Project was learned from the Barangay with a frequency of 34.17% while 55 respondents or 15.28% answered that they heard from their neighbor, 13 respondents or 3.61% answered that they heard the project from the media, 9 respondents or 2.51% learned from IEC by Proponent and the remaining 160 respondents or 44.54% had no responses. See Table 2.4-25.

**Table 2.4-25. Household Source of Information about the Proposed Project**

| Barangay                 | SOURCE OF INFORMATION |       |                    |       |                    |      |                    |       |                    |       | Total              |     |
|--------------------------|-----------------------|-------|--------------------|-------|--------------------|------|--------------------|-------|--------------------|-------|--------------------|-----|
|                          | Neighbor              |       | Barangay           |       | IEC by Proponent   |      | Media              |       | No Answer          |       | No. of HH surveyed | %   |
|                          | No. of HH surveyed    | %     | No. of HH surveyed | %     | No. of HH surveyed | %    | No. of HH surveyed | %     | No. of HH surveyed | %     |                    |     |
| Municipality of Noveleta |                       |       |                    |       |                    |      |                    |       |                    |       |                    |     |
| San Rafael 2             | 0                     | 0     | 13                 | 43.33 | 0                  | 0    | 3                  | 10    | 14                 | 46.66 | 30                 | 100 |
| San Rafael 3             | 2                     | 6.67  | 8                  | 26.66 | 0                  | 0    | 1                  | 3.33  | 19                 | 63.33 | 30                 | 100 |
| San Rafael 4             | 12                    | 40    | 12                 | 40    | 1                  | 3.33 | 1                  | 3.33  | 4                  | 13.33 | 30                 | 100 |
| Municipality of Rosario  |                       |       |                    |       |                    |      |                    |       |                    |       |                    |     |
| Bagbag II                | 11                    | 36.67 | 17                 | 56.67 | 1                  | 3.33 | 0                  | 0     | 1                  | 3.33  | 30                 | 100 |
| Kanluran                 | 0                     | 0     | 13                 | 43.33 | 3                  | 10   | 0                  | 0     | 14                 | 46.67 | 30                 | 100 |
| Ligtong I                | 2                     | 6.67  | 8                  | 26.66 | 1                  | 3.33 | 0                  | 0     | 19                 | 63.33 | 30                 | 100 |
| Muzon II                 | 12                    | 40    | 12                 | 40    | 1                  | 3.33 | 1                  | 3.33  | 4                  | 13.33 | 30                 | 100 |
| Sapa II                  | 0                     | 0     | 5                  | 16.67 | 1                  | 3.33 | 4                  | 13.33 | 20                 | 66.67 | 30                 | 100 |
| Sapa III                 | 2                     | 6.67  | 7                  | 23.33 | 0                  | 0    | 2                  | 6.67  | 19                 | 63.33 | 30                 | 100 |
| Wawa I                   | 12                    | 40    | 12                 | 40    | 1                  | 3.33 | 1                  | 3.33  | 4                  | 13.33 | 30                 | 100 |
| Wawa II                  | 2                     | 6.67  | 12                 | 40    | 0                  | 0    | 0                  | 0     | 16                 | 53.33 | 30                 | 100 |
| Wawa III                 | 0                     | 0     | 4                  | 13.33 | 0                  | 0    | 0                  | 0     | 26                 | 86.67 | 30                 | 100 |
| Total                    | 55                    | 15.28 | 123                | 34.17 | 9                  | 2.5  | 13                 | 3.61  | 160                | 44.44 | 360                | 100 |

Data Source: EIA Perception Survey 2018



## Perceived Impacts

The respondents were also asked on their view on the possible beneficial and adverse impacts of the proposed Cavite Province Land Reclamation and Development Project. As far as the perceived benefits is concerned, top answers are on livelihood and business opportunities, improvement of roads and other infrastructure, additional tax, good service of the government and water services. On the other hand, perceived adverse impacts are traffic, water pollution, loss of job, tsunami, corruption, loss of fresh air from the Manila Bay, flood, death of marine species and loss of view.

**Table 2.4-26. Possible beneficial impacts of the Proposed Cavite Reclamation Project**

|                |  |
|----------------|--|
| <b>Answers</b> | 1. Livelihood and business opportunities         |
|                | 2. Improvement of roads and other infrastructure |
|                | 3. Land taxes                                    |
|                | 4. Improvement of government services            |
|                | 5. Improvement of water services                 |

Data Source: EIA Perception Survey 2018

**Table 2.4-27. Adverse Impacts of the Proposed Cavite Reclamation Project**

|                |   |
|----------------|---|
| <b>Answers</b> | 1. Increased traffic                              |
|                | 2. Flooding                                       |
|                | 3. Health and safety hazard                       |
|                | 4. Air, water and land pollution                  |
|                | 5. Generation of wastes                           |
|                | 6. Loss of plants, trees and other infrastructure |
|                | 7. Loss of existing livelihood                    |

Data Source: EIA Perception Survey 2018

## Enhanced Perception Survey

Further and enhanced household perception surveys were made post the activities under DAO 2017-15. The discussions below are based on the households perception survey conducted last January to March 2019. The Tables below present the summary of the Perception Survey conducted for the Proposed Project

**Age Distribution, by Sex** - In terms of age and sex distribution, majority of the respondents of the twelve (12) barangays are female. The data on age distribution are presented in Table 2.4-29.

**Table 2.4-28. Impact Barangays: Sex Distribution**

| Barangay                        | GENDER             |              |                    |              |                    |             |                    |            |
|---------------------------------|--------------------|--------------|--------------------|--------------|--------------------|-------------|--------------------|------------|
|                                 | FEMALE             |              | MALE               |              | NO ANSWER          |             | TOTAL              |            |
|                                 | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %           | No. of HH surveyed | %          |
| <b>Municipality of Noveleta</b> |                    |              |                    |              |                    |             |                    |            |
| San Rafael II                   | 76                 | 31           | 171                | 69           | 0                  | 0           | 247                | 100        |
| San Rafael III                  | 121                | 53           | 86                 | 38           | 21                 | 9           | 228                | 100        |
| San Rafael IV                   | 18                 | 62           | 11                 | 38           | 0                  | 0           | 29                 | 100        |
| <b>Municipality of Rosario</b>  |                    |              |                    |              |                    |             |                    |            |
| Wawa III                        | 328                | 85           | 58                 | 15           | 0                  | 0           | 386                | 100        |
| Sapa III                        | 118                | 62           | 72                 | 38           | 0                  | 0           | 190                | 100        |
| Wawa II                         | 358                | 77           | 101                | 22           | 8                  | 2           | 467                | 100        |
| Sapa II                         | 245                | 74           | 82                 | 25           | 2                  | 1           | 329                | 100        |
| Ligtong                         | 220                | 70           | 93                 | 30           | 2                  | 1           | 315                | 100        |
| Wawa I                          | 260                | 77           | 75                 | 22           | 1                  | 0           | 336                | 100        |
| Bagbag                          | 168                | 64           | 90                 | 34           | 4                  | 2           | 262                | 100        |
| Kanluran                        | 182                | 41           | 258                | 59           | 1                  | 0           | 441                | 100        |
| Muzon II                        | 194                | 53           | 175                | 47           | 0                  | 0           | 369                | 100        |
| <b>Total</b>                    | <b>2,288</b>       | <b>63.57</b> | <b>1,272</b>       | <b>35.34</b> | <b>39</b>          | <b>1.08</b> | <b>3,599</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019





Table 2.4-29. Impact Barangays: Age Distribution

| Barangay                 | AGE DISTRIBUTION   |             |                    |              |                    |              |                    |              |                    |              |                    |             |                    |             |                    |              |                    |            |
|--------------------------|--------------------|-------------|--------------------|--------------|--------------------|--------------|--------------------|--------------|--------------------|--------------|--------------------|-------------|--------------------|-------------|--------------------|--------------|--------------------|------------|
|                          | 15-20              |             | 21-30              |              | 31-40              |              | 41-50              |              | 51-60              |              | 61-70              |             | 71 ABOVE           |             | NO ANSWER          |              | TOTAL              |            |
|                          | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %          |
| Municipality of Noveleta |                    |             |                    |              |                    |              |                    |              |                    |              |                    |             |                    |             |                    |              |                    |            |
| San Rafael II            | 6                  | 2           | 41                 | 16           | 55                 | 21           | 27                 | 11           | 34                 | 13           | 14                 | 5           | 9                  | 4           | 70                 | 27           | 256                | 100        |
| San Rafael III           | 7                  | 3           | 51                 | 22           | 58                 | 26           | 25                 | 11           | 27                 | 12           | 3                  | 1           | 3                  | 1           | 53                 | 23           | 227                | 100        |
| San Rafael IV            | 1                  | 3           | 5                  | 17           | 5                  | 17           | 5                  | 17           | 1                  | 3            | 0                  | 0           | 0                  | 0           | 12                 | 41           | 29                 | 100        |
| Municipality of Rosario  |                    |             |                    |              |                    |              |                    |              |                    |              |                    |             |                    |             |                    |              |                    |            |
| Wawa                     | 12                 | 3           | 76                 | 20           | 101                | 26           | 73                 | 19           | 54                 | 14           | 33                 | 9           | 7                  | 2           | 30                 | 8            | 386                | 100        |
| Sapa III                 | 8                  | 4           | 16                 | 8            | 28                 | 15           | 26                 | 14           | 30                 | 16           | 10                 | 5           | 6                  | 3           | 66                 | 35           | 190                | 100        |
| Wawa II                  | 11                 | 2           | 79                 | 17           | 112                | 24           | 106                | 23           | 84                 | 18           | 36                 | 8           | 5                  | 1           | 34                 | 7            | 467                | 100        |
| Sapa II                  | 8                  | 2           | 58                 | 18           | 65                 | 20           | 48                 | 15           | 50                 | 15           | 15                 | 5           | 3                  | 1           | 82                 | 25           | 329                | 100        |
| Ligtong                  | 4                  | 1           | 52                 | 14           | 66                 | 17           | 70                 | 18           | 63                 | 16           | 29                 | 8           | 14                 | 4           | 85                 | 22           | 383                | 100        |
| Wawa I                   | 11                 | 3           | 63                 | 18           | 56                 | 16           | 74                 | 22           | 56                 | 16           | 21                 | 6           | 2                  | 1           | 59                 | 17           | 342                | 100        |
| Bagbag                   | 24                 | 9           | 24                 | 9            | 23                 | 8            | 23                 | 8            | 15                 | 5            | 6                  | 2           | 2                  | 1           | 159                | 58           | 276                | 100        |
| Kanluran                 | 9                  | 2           | 30                 | 7            | 65                 | 15           | 73                 | 17           | 34                 | 8            | 12                 | 3           | 10                 | 2           | 208                | 47           | 441                | 100        |
| Muzon II                 | 6                  | 2           | 26                 | 9            | 28                 | 10           | 33                 | 11           | 24                 | 8            | 13                 | 4           | 8                  | 3           | 154                | 53           | 292                | 100        |
| <b>Total</b>             | <b>107</b>         | <b>3.03</b> | <b>438</b>         | <b>12.39</b> | <b>662</b>         | <b>18.73</b> | <b>583</b>         | <b>16.49</b> | <b>472</b>         | <b>13.35</b> | <b>192</b>         | <b>5.43</b> | <b>69</b>          | <b>1.95</b> | <b>1,012</b>       | <b>28.63</b> | <b>3,535</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019

**Civil Status** - Data coming from the conducted EIA survey are used to present the baseline condition of the impact barangay residents where majority or 58.31% (2,078 out of the 3,564 respondents) are married and the rest are single, lived-in, single parents or widower.

Table 2.4-30. Impact Barangays: Civil Status

| CIVIL STATUS             |                    |    |                    |    |                    |    |                    |    |                    |    |                    |   |                    |    |                    |     |
|--------------------------|--------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|----|--------------------|---|--------------------|----|--------------------|-----|
| Barangay                 | DALAGA/BINATA      |    | MAY ASAWA          |    | BYUDA/BYUDO        |    | HIWALAY            |    | LIVE-IN            |    | OTHERS             |   | NO ANSWER          |    | TOTAL              |     |
|                          | No. of HH surveyed | %  | No. of HH surveyed | %  | No. of HH surveyed | %  | No. of HH surveyed | %  | No. of HH surveyed | %  | No. of HH surveyed | % | No. of HH surveyed | %  | No. of HH surveyed | %   |
| Municipality of Noveleta |                    |    |                    |    |                    |    |                    |    |                    |    |                    |   |                    |    |                    |     |
| San Rafael II            | 18                 | 7  | 182                | 74 | 27                 | 11 | 15                 | 6  | 0                  | 0  | 3                  | 1 | 2                  | 1  | 247                | 100 |
| San Rafael III           | 44                 | 19 | 143                | 63 | 8                  | 4  | 5                  | 2  | 0                  | 0  | 4                  | 2 | 24                 | 11 | 228                | 100 |
| San Rafael IV            | 5                  | 17 | 19                 | 66 | 0                  | 0  | 1                  | 3  | 2                  | 7  | 0                  | 0 | 2                  | 7  | 29                 | 100 |
| Municipality of Rosario  |                    |    |                    |    |                    |    |                    |    |                    |    |                    |   |                    |    |                    |     |
| Wawa III                 | 88                 | 23 | 225                | 58 | 23                 | 6  | 9                  | 2  | 12                 | 3  | 5                  | 1 | 24                 | 6  | 386                | 100 |
| Sapa III                 | 19                 | 10 | 130                | 68 | 18                 | 9  | 12                 | 6  | 3                  | 2  | 1                  | 1 | 7                  | 4  | 190                | 100 |
| Wawa II                  | 11                 | 2  | 79                 | 17 | 112                | 24 | 106                | 23 | 84                 | 18 | 36                 | 8 | 34                 | 7  | 462                | 100 |
| Sapa II                  | 33                 | 10 | 238                | 72 | 21                 | 6  | 16                 | 5  | 6                  | 2  | 3                  | 1 | 12                 | 4  | 329                | 100 |



| CIVIL STATUS |                    |              |                    |              |                    |             |                    |             |                    |             |                    |             |                    |             |                    |            |
|--------------|--------------------|--------------|--------------------|--------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|------------|
| Barangay     | DALAGA/BINATA      |              | MAY ASAWA          |              | BYUDA/BYUDO        |             | HIWALAY            |             | LIVE-IN            |             | OTHERS             |             | NO ANSWER          |             | TOTAL              |            |
|              | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %          |
| Ligtong      | 54                 | 19           | 182                | 63           | 26                 | 9           | 19                 | 7           | 4                  | 1           | 2                  | 1           | 1                  | 0           | 288                | 100        |
| Wawa I       | 61                 | 19           | 205                | 65           | 32                 | 10          | 9                  | 3           | 1                  | 0           | 1                  | 0           | 8                  | 3           | 317                | 100        |
| Bagbag       | 102                | 37           | 122                | 45           | 26                 | 9           | 11                 | 4           | 2                  | 1           | 2                  | 1           | 9                  | 3           | 274                | 100        |
| Kanluran     | 62                 | 14           | 321                | 73           | 16                 | 4           | 25                 | 6           | 3                  | 1           | 1                  | 0           | 13                 | 3           | 441                | 100        |
| Muzon II     | 69                 | 18           | 232                | 62           | 44                 | 12          | 15                 | 4           | 5                  | 1           | 0                  | 0           | 8                  | 2           | 373                | 100        |
| <b>Total</b> | <b>566</b>         | <b>15.88</b> | <b>2,078</b>       | <b>58.31</b> | <b>353</b>         | <b>9.90</b> | <b>243</b>         | <b>6.82</b> | <b>122</b>         | <b>3.42</b> | <b>58</b>          | <b>1.63</b> | <b>144</b>         | <b>4.04</b> | <b>3,564</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019

**Educational Characteristics and Literacy** - About 49.22% (or 1,730 out of the 3,515 respondents) are in secondary high school level, 21.28% (or 748 out of the 3,515 respondents) are in primary education level followed by 11.49% (or 404 out of the 3,515 respondents) tertiary education level. Only 5.46% (192 out of 3,515 respondents) opted not to answer while about 7.99% (or 281 out of 3,515 respondents) have undergone vocational trainings.

**Table 2.4-31. Impact Barangays: Educational Attainment**

| EDUCATIONAL ATTAINMENT          |                    |             |                    |              |                    |              |                    |             |                    |              |                    |             |                    |             |                    |            |
|---------------------------------|--------------------|-------------|--------------------|--------------|--------------------|--------------|--------------------|-------------|--------------------|--------------|--------------------|-------------|--------------------|-------------|--------------------|------------|
| Barangay                        | NONE               |             | ELEMENTARY         |              | HIGH SCHOOL        |              | VOCATIONAL         |             | COLLEGE            |              | POST GRADUATE      |             | NO ANSWER          |             | TOTAL              |            |
|                                 | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %          |
| <b>Municipality of Noveleta</b> |                    |             |                    |              |                    |              |                    |             |                    |              |                    |             |                    |             |                    |            |
| San Rafael II                   | 12                 | 4.86        | 92                 | 37.25        | 115                | 46.56        | 7                  | 2.83        | 18                 | 7.29         | 0                  | 0           | 3                  | 1.21        | 247                | 100        |
| San Rafael III                  | 7                  | 3.07        | 13                 | 5.70         | 97                 | 42.54        | 40                 | 17.54       | 46                 | 20.18        | 2                  | 0.88        | 23                 | 10.09       | 228                | 100        |
| San Rafael IV                   | 0                  | 0.00        | 7                  | 24.14        | 12                 | 41.38        | 2                  | 6.90        | 5                  | 17.24        | 1                  | 3.45        | 2                  | 6.90        | 29                 | 100        |
| <b>Municipality of Rosario</b>  |                    |             |                    |              |                    |              |                    |             |                    |              |                    |             |                    |             |                    |            |
| Wawa III                        | 4                  | 1           | 57                 | 17           | 165                | 49           | 22                 | 7           | 47                 | 14           | 36                 | 11          | 3                  | 1           | 334                | 100        |
| Sapa III                        | 5                  | 3           | 40                 | 21           | 95                 | 50           | 2                  | 1           | 18                 | 9            | 2                  | 1           | 28                 | 15          | 190                | 100        |
| Wawa II                         | 2                  | 0           | 155                | 33           | 259                | 55           | 4                  | 1           | 26                 | 6            | 10                 | 2           | 11                 | 2           | 467                | 100        |
| Sapa II                         | 9                  | 3           | 98                 | 30           | 186                | 57           | 11                 | 3           | 22                 | 7            | 2                  | 1           | 1                  | 0           | 329                | 100        |
| Ligtong                         | 7                  | 2           | 66                 | 17           | 229                | 57           | 29                 | 7           | 64                 | 16           | 1                  | 0           | 3                  | 1           | 399                | 100        |
| Wawa I                          | 0                  | 0           | 66                 | 20           | 162                | 49           | 45                 | 14          | 51                 | 15           | 6                  | 2           | 0                  | 0           | 330                | 100        |
| Bagbag                          | 17                 | 7           | 27                 | 10           | 121                | 47           | 24                 | 9           | 49                 | 19           | 21                 | 8           |                    | 16          | 259                | 116        |
| Kanluran                        | 8                  | 2           | 99                 | 30           | 187                | 56           | 12                 | 4           | 23                 | 7            | 3                  | 1           | 2                  | 1           | 334                | 100        |
| Muzon II                        | 5                  | 1           | 28                 | 8            | 102                | 28           | 83                 | 22          | 35                 | 9            | 0                  | 0           | 116                | 31          | 369                | 100        |
| <b>Total</b>                    | <b>76</b>          | <b>2.16</b> | <b>748</b>         | <b>21.28</b> | <b>1,730</b>       | <b>49.22</b> | <b>281</b>         | <b>7.99</b> | <b>404</b>         | <b>11.49</b> | <b>84</b>          | <b>2.39</b> | <b>192</b>         | <b>5.46</b> | <b>3,515</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019



## Socio-Cultural Profile

**Place of Birth and Origin** - Most of the respondents of the twelve (12) barangays were born outside the barangay/municipality while 46% of the total respondents of Barangay Ligdong were born within the barangay/municipality.

**Table 2.4-32. Impact Barangays: Birth Place**

| Barangay                        | BIRTH PLACE                   |              |                              |              |                  |              |                  |            |
|---------------------------------|-------------------------------|--------------|------------------------------|--------------|------------------|--------------|------------------|------------|
|                                 | Born Outside the Municipality |              | Born Within the Municipality |              | No Answer        |              | TOTAL            |            |
|                                 | # of HH surveyed              | %            | # of HH surveyed             | %            | # of HH surveyed | %            | # of HH surveyed | %          |
| <b>Municipality of Noveleta</b> |                               |              |                              |              |                  |              |                  |            |
| San Rafael II                   | 153                           | 62           | 42                           | 17           | 52               | 21           | 247              | 100        |
| San Rafael III                  | 85                            | 37           | 71                           | 31           | 72               | 32           | 228              | 100        |
| San Rafael IV                   | 23                            | 79           | 0                            | 0            | 6                | 21           | 29               | 100        |
| <b>Municipality of Rosario</b>  |                               |              |                              |              |                  |              |                  |            |
| Wawa III                        | 223                           | 58           | 47                           | 12           | 116              | 30           | 386              | 100        |
| Sapa III                        | 79                            | 41           | 60                           | 31           | 56               | 29           | 195              | 100        |
| Wawa II                         | 266                           | 57           | 148                          | 32           | 53               | 11           | 467              | 100        |
| Sapa II                         | 155                           | 47           | 96                           | 29           | 78               | 24           | 329              | 100        |
| Ligdong                         | 72                            | 24           | 135                          | 46           | 89               | 30           | 296              | 100        |
| Wawa I                          | 91                            | 28           | 75                           | 23           | 161              | 49           | 327              | 100        |
| Bagbag                          | 58                            | 22           | 33                           | 13           | 169              | 65           | 260              | 100        |
| Kanluran                        | 80                            | 31           | 97                           | 38           | 79               | 31           | 256              | 100        |
| Muzon II                        | 34                            | 12           | 21                           | 7.27         | 234              | 81           | 289              | 100        |
| <b>Total</b>                    | <b>1,319</b>                  | <b>39.86</b> | <b>825</b>                   | <b>24.93</b> | <b>1,165</b>     | <b>35.21</b> | <b>3,309</b>     | <b>100</b> |

Data Source: EIA Perception Survey 2019

**Ethnicity** - The Municipality's dialect is mostly Tagalog (79.47%) there are migrants from other provinces that are also Tagalog speaking. Others are Visayan, Ilocano, Kapampangan, Bicolano and Waray.





Table 2.4-33. Impact Barangays: Ethnicity

| Barangay                 | ETHNICITY          |              |                    |              |                    |             |                    |             |                    |             |                    |             |                    |             |                    |            |
|--------------------------|--------------------|--------------|--------------------|--------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|------------|
|                          | Tagalog            |              | Visayan            |              | Ilocano            |             | Kapampangan        |             | Bicolano           |             | Others             |             | No Answer          |             | TOTAL              |            |
|                          | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %          |
| Municipality of Noveleta |                    |              |                    |              |                    |             |                    |             |                    |             |                    |             |                    |             |                    |            |
| San Rafael II            | 184                | 74           | 47                 | 19           | 6                  | 2           | 0                  | 0           | 0                  | 0           | 7                  | 3           | 3                  | 1           | 247                | 100        |
| San Rafael III           | 194                | 85           | 4                  | 2            | 3                  | 1           | 3                  | 1           | 0                  | 0           | 2                  | 1           | 22                 | 10          | 228                | 100        |
| San Rafael IV            | 21                 | 72           | 5                  | 17           | 2                  | 7           | 1                  | 3           | 0                  | 0           | 0                  | 0           | 0                  | 0           | 29                 | 100        |
| Municipality of Rosario  |                    |              |                    |              |                    |             |                    |             |                    |             |                    |             |                    |             |                    |            |
| Wawa III                 | 257                | 67           | 54                 | 14           | 3                  | 1           | 1                  | 0           | 0                  | 0           | 13                 | 3           | 58                 | 15          | 386                | 100        |
| Sapa III                 | 164                | 78           | 35                 | 17           | 1                  | 0           | 1                  | 0           | 0                  | 0           | 6                  | 3           | 2                  | 1           | 209                | 100        |
| Wawa II                  | 309                | 65           | 117                | 24           | 5                  | 1           | 2                  | 0           | 0                  | 0           | 37                 | 8           | 9                  | 2           | 479                | 100        |
| Sapa II                  | 257                | 76           | 60                 | 18           | 4                  | 1           | 1                  | 0           | 4                  | 1           | 6                  | 2           | 4                  | 1           | 336                | 100        |
| Ligtong                  | 367                | 90           | 29                 | 7            | 4                  | 1           | 3                  | 1           | 1                  | 0           | 2                  | 0           | 2                  | 0           | 408                | 100        |
| Wawa I                   | 258                | 76           | 55                 | 16           | 7                  | 2           | 5                  | 1           | 1                  | 0           | 6                  | 2           | 9                  | 3           | 341                | 100        |
| Bagbag                   | 236                | 89           | 10                 | 4            | 4                  | 2           | 4                  | 2           | 1                  | 0           | 4                  | 2           | 5                  | 2           | 264                | 100        |
| Kanluran                 | 409                | 92           | 31                 | 7            | 1                  | 0           | 2                  | 0.5         | 0                  | 0           | 0                  | 0           | 1                  | 0.2         | 444                | 100        |
| Muzon II                 | 316                | 86           | 35                 | 9            | 11                 | 3           | 1                  | 0.3         | 0                  | 0           | 3                  | 0.8         | 3                  | 1           | 369                | 100        |
| <b>Total</b>             | <b>2,972</b>       | <b>79.47</b> | <b>482</b>         | <b>12.89</b> | <b>51</b>          | <b>1.36</b> | <b>24</b>          | <b>0.64</b> | <b>7</b>           | <b>0.19</b> | <b>86</b>          | <b>2.30</b> | <b>118</b>         | <b>3.15</b> | <b>3,740</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019

**Religious Affiliations** - Results of the survey indicated that 89.27% or 3,278 of the respondents are Roman Catholics followed by Protestant and the INC and affiliates of the Islam, as presented in table below:

Table 2.4-34. Impact Barangays: Religion in Noveleta

| Barangay                 | RELIGIOUS AFFILIATION |    |                    |    |                    |   |                    |     |                    |   |                    |     |                    |     |                    |     |
|--------------------------|-----------------------|----|--------------------|----|--------------------|---|--------------------|-----|--------------------|---|--------------------|-----|--------------------|-----|--------------------|-----|
|                          | ROMAN CATHOLIC        |    | PROTESTANT         |    | AGLIPAYAN          |   | INC                |     | ISLAM              |   | CHRISTIAN          |     | OTHERS             |     | NO ANSWER          |     |
|                          | No. of HH surveyed    | %  | No. of HH surveyed | %  | No. of HH surveyed | % | No. of HH surveyed | %   | No. of HH surveyed | % | No. of HH surveyed | %   | No. of HH surveyed | %   | No. of HH surveyed | %   |
| Municipality of Noveleta |                       |    |                    |    |                    |   |                    |     |                    |   |                    |     |                    |     |                    |     |
| San Rafael II            | 230                   | 93 | 0                  | 0  | 0                  | 0 | 11                 | 4   | 0                  | 0 | 0                  | 0   | 6                  | 2   | 0                  | 0   |
| San Rafael III           | 176                   | 77 | 2                  | 1  | 16                 | 7 | 3                  | 1   | 0                  | 0 | 4                  | 2   | 5                  | 2   | 22                 | 10  |
| San Rafael IV            | 28                    | 97 | 0                  | 0  | 0                  | 0 | 1                  | 3   | 0                  | 0 | 0                  | 0   | 0                  | 0   | 0                  | 0   |
| Municipality of Rosario  |                       |    |                    |    |                    |   |                    |     |                    |   |                    |     |                    |     |                    |     |
| Wawa III                 | 257                   | 67 | 54                 | 14 | 3                  | 1 | 1                  | 0   | 0                  | 0 | 13                 | 3   | 58                 | 15  | 386                | 100 |
| Sapa III                 | 164                   | 78 | 35                 | 17 | 1                  | 0 | 1                  | 0   | 0                  | 0 | 6                  | 3   | 2                  | 1   | 209                | 100 |
| Wawa II                  | 309                   | 65 | 117                | 24 | 5                  | 1 | 2                  | 0   | 0                  | 0 | 37                 | 8   | 9                  | 2   | 479                | 100 |
| Sapa II                  | 257                   | 76 | 60                 | 18 | 4                  | 1 | 1                  | 0   | 4                  | 1 | 6                  | 2   | 4                  | 1   | 336                | 100 |
| Ligtong                  | 367                   | 90 | 29                 | 7  | 4                  | 1 | 3                  | 1   | 1                  | 0 | 2                  | 0   | 2                  | 0   | 408                | 100 |
| Wawa I                   | 258                   | 76 | 55                 | 16 | 7                  | 2 | 5                  | 1   | 1                  | 0 | 6                  | 2   | 9                  | 3   | 341                | 100 |
| Bagbag                   | 236                   | 89 | 10                 | 4  | 4                  | 2 | 4                  | 2   | 1                  | 0 | 4                  | 2   | 5                  | 2   | 264                | 100 |
| Kanluran                 | 409                   | 92 | 31                 | 7  | 1                  | 0 | 2                  | 0.5 | 0                  | 0 | 0                  | 0   | 1                  | 0.2 | 444                | 100 |
| Muzon II                 | 316                   | 86 | 35                 | 9  | 11                 | 3 | 1                  | 0.3 | 0                  | 0 | 3                  | 0.8 | 3                  | 1   | 369                | 100 |



| Barangay | RELIGIOUS AFFILIATION |       |                    |      |                    |      |                    |      |                    |      |                    |      |                    |      |                    |      |                    |     |
|----------|-----------------------|-------|--------------------|------|--------------------|------|--------------------|------|--------------------|------|--------------------|------|--------------------|------|--------------------|------|--------------------|-----|
|          | ROMAN CATHOLIC        |       | PROTESTANT         |      | AGLIPAYAN          |      | INC                |      | ISLAM              |      | CHRISTIAN          |      | OTHERS             |      | NO ANSWER          |      | TOTAL              |     |
|          | No. of HH surveyed    | %     | No. of HH surveyed | %    | No. of HH surveyed | %    | No. of HH surveyed | %    | No. of HH surveyed | %    | No. of HH surveyed | %    | No. of HH surveyed | %    | No. of HH surveyed | %    | No. of HH surveyed | %   |
| Wawa III | 339                   | 89    | 5                  | 1    | 2                  | 1    | 6                  | 2    | 3                  | 1    | 0                  | 0    | 25                 | 7    | 2                  | 1    | 382                | 100 |
| Sapa III | 176                   | 93    | 2                  | 1    | 0                  | 0    | 2                  | 1    | 0                  | 0    | 0                  | 0    | 4                  | 2    | 6                  | 3    | 190                | 100 |
| Wawa II  | 438                   | 94    | 6                  | 1    | 0                  | 0    | 6                  | 1    | 1                  | 0    | 4                  | 1    | 3                  | 1    | 9                  | 2    | 467                | 100 |
| Sapa II  | 310                   | 94    | 3                  | 1    | 3                  | 1    | 7                  | 2    | 1                  | 0    | 1                  | 0    | 4                  | 1    | 0                  | 0    | 329                | 100 |
| Ligtong  | 373                   | 97    | 1                  | 0    | 0                  | 0    | 5                  | 1    | 0                  | 0    | 3                  | 1    | 0                  | 0    | 1                  | 0    | 383                | 100 |
| Wawa I   | 259                   | 78    | 41                 | 12   | 9                  | 3    | 16                 | 5    | 0                  | 0    | 0                  | 0    | 9                  | 3    | 0                  | 0    | 334                | 100 |
| Bagbag   | 194                   | 71    | 16                 | 6    | 7                  | 3    | 11                 | 4    | 3                  | 1    | 2                  | 1    | 31                 | 11   | 9                  | 3    | 273                | 100 |
| Kanluran | 415                   | 94    | 4                  | 1    | 4                  | 1    | 8                  | 2    | 2                  | 0    | 2                  | 0    | 5                  | 1    | 1                  | 0    | 441                | 100 |
| Muzon II | 340                   | 92    | 15                 | 4    | 3                  | 1    | 6                  | 2    | 0                  | 0    | 0                  | 0    | 1                  | 0    | 4                  | 1    | 369                | 100 |
| Total    | 3,278                 | 89.27 | 95                 | 2.59 | 44                 | 1.19 | 82                 | 2.23 | 10                 | 0.27 | 16                 | 0.44 | 93                 | 2.53 | 54                 | 1.47 | 3,672              | 100 |

Data Source: EIA Perception Survey 2019

## Socio-economic Profile

**Sources of Income, Income Levels and Poverty Incidence** - Sources of income of the respondents are generally from fishing. Most of the respondents are Jeepney driver, security guard, sales clerk, sales lady, vendor, sari-sari store vendor, cashier, bnk teller and entrepreneur.

In terms of average monthly income of the households, 20.63% of the total respondents have average household monthly income ranging from below Php 1000-4999, 18.19% earning below Php 1,000, 16.70% earning Php 5,000-9999, 11.31% earning from Php 10,000-14,999, 4.83% earning Php 15,999-19,999, 3.68% earning Php25,000 above, 3.54% earning Php 20,000 – 24,999 and the remaining 21.11% opted not to answer the question.

Table 2.4-35, 2.4-36 presents the results on source of income of respondents, and monthly income, respectively.

Table 2.4-37 stated that the husband is the primar earner in the household.



Table 2.4-35. Impact Barangays: Occupation

| Barangay                 | PAGSASAKA          |             | PANGINGISDA        |              | EMPLEYADO          |              | KONTRAKWAL         |              | NAGTITINDA/NAGBEBE NTA |              | SARILING NEGOSYO NG PAMILYA |             | MAY OFW NA KAMAG ANAK |             | IBA PA             |             | NO ANSWER          |              | TOTAL              |            |
|--------------------------|--------------------|-------------|--------------------|--------------|--------------------|--------------|--------------------|--------------|------------------------|--------------|-----------------------------|-------------|-----------------------|-------------|--------------------|-------------|--------------------|--------------|--------------------|------------|
|                          | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed     | %            | No. of HH surveyed          | %           | No. of HH surveyed    | %           | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %          |
| Municipality of Noveleta |                    |             |                    |              |                    |              |                    |              |                        |              |                             |             |                       |             |                    |             |                    |              |                    |            |
| San Rafael II            | 0                  | 0           | 35                 | 14           | 25                 | 10           | 40                 | 16           | 24                     | 10           | 8                           | 3           | 11                    | 4           | 54                 | 22          | 50                 | 20           | 247                | 100        |
| San Rafael III           | 0                  | 0           | 9                  | 4            | 39                 | 17           | 53                 | 23           | 20                     | 9            | 19                          | 8           | 18                    | 8           | 12                 | 5           | 63                 | 27           | 233                | 100        |
| San Rafael IV            | 1                  | 3           | 3                  | 10           | 1                  | 3            | 11                 | 38           | 3                      | 10           | 1                           | 3           | 0                     | 0           | 5                  | 17          | 4                  | 14           | 29                 | 100        |
| Municipality of Rosario  |                    |             |                    |              |                    |              |                    |              |                        |              |                             |             |                       |             |                    |             |                    |              |                    |            |
| Wawa III                 | 64                 | 14          | 50                 | 11           | 67                 | 15           | 115                | 25           | 38                     | 8            | 14                          | 3           | 16                    | 4           | 53                 | 12          | 38                 | 8            | 455                | 100        |
| Sapa III                 | 0                  | 0           | 38                 | 19           | 17                 | 8            | 19                 | 9            | 29                     | 14           | 7                           | 3           | 5                     | 2           | 16                 | 8           | 73                 | 36           | 204                | 100        |
| Wawa II                  | 0                  | 0           | 124                | 24           | 83                 | 16           | 89                 | 17           | 64                     | 13           | 34                          | 7           | 23                    | 4           | 33                 | 6           | 62                 | 12           | 512                | 100        |
| Sapa II                  | 2                  | 1           | 113                | 35           | 38                 | 12           | 29                 | 9            | 55                     | 17           | 9                           | 3           | 4                     | 1           | 26                 | 8           | 50                 | 15           | 326                | 100        |
| Ligtong                  | 9                  | 2           | 89                 | 22           | 52                 | 13           | 9                  | 2            | 56                     | 14           | 20                          | 5           | 24                    | 6           | 24                 | 6           | 122                | 30           | 405                | 100        |
| Wawa I                   | 3                  | 1           | 91                 | 27           | 110                | 33           | 33                 | 10           | 23                     | 7            | 10                          | 3           | 4                     | 1           | 8                  | 2           | 56                 | 17           | 338                | 100        |
| Bagbag                   | 7                  | 3           | 18                 | 6            | 55                 | 20           | 23                 | 8            | 27                     | 10           | 10                          | 4           | 12                    | 4           | 6                  | 2           | 122                | 44           | 280                | 100        |
| Kanluran                 | 2                  | 1           | 114                | 34           | 39                 | 12           | 30                 | 9            | 56                     | 17           | 10                          | 3           | 5                     | 1           | 27                 | 8           | 51                 | 15           | 334                | 100        |
| Muzon II                 | 29                 | 8           | 32                 | 9            | 14                 | 4            | 10                 | 3            | 0                      | 0            | 0                           | 0           | 0                     | 0           | 44                 | 12          | 240                | 65           | 369                | 100        |
| <b>Total</b>             | <b>117</b>         | <b>3.14</b> | <b>716</b>         | <b>19.19</b> | <b>540</b>         | <b>14.47</b> | <b>461</b>         | <b>12.35</b> | <b>395</b>             | <b>10.58</b> | <b>142</b>                  | <b>3.80</b> | <b>122</b>            | <b>3.27</b> | <b>308</b>         | <b>8.25</b> | <b>931</b>         | <b>24.95</b> | <b>3,732</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019

Table 2.4-36. Impact Barangays: Monthly Income

| Barangay                 | BELOW 1000         |       | 1000-4999          |       | 5000-9999          |       | 10000-14999        |       | 15999-19999        |       | 20000-24999        |      | 25000 ABOVE        |       | NO ANSWER          |       | TOTAL              |     |
|--------------------------|--------------------|-------|--------------------|-------|--------------------|-------|--------------------|-------|--------------------|-------|--------------------|------|--------------------|-------|--------------------|-------|--------------------|-----|
|                          | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %    | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %   |
| Municipality of Noveleta |                    |       |                    |       |                    |       |                    |       |                    |       |                    |      |                    |       |                    |       |                    |     |
| San Rafael II            | 71                 | 28.74 | 59                 | 23.89 | 43                 | 17.41 | 27                 | 10.93 | 11                 | 4.45  | 8                  | 3.24 | 3                  | 1.21  | 25                 | 10.12 | 247                | 100 |
| San Rafael III           | 6                  | 2.75  | 23                 | 10.55 | 39                 | 17.89 | 30                 | 13.76 | 21                 | 9.63  | 20                 | 9.17 | 29                 | 13.30 | 50                 | 22.94 | 218                | 100 |
| San Rafael IV            | 9                  | 31.03 | 2                  | 6.90  | 3                  | 10.34 | 7                  | 24.14 | 3                  | 10.34 | 1                  | 3.45 | 0                  | 0.00  | 4                  | 13.79 | 29                 | 100 |
| Municipality of Rosario  |                    |       |                    |       |                    |       |                    |       |                    |       |                    |      |                    |       |                    |       |                    |     |
| Wawa III                 | 29                 | 7     | 95                 | 22    | 114                | 27    | 115                | 27    | 24                 | 6     | 14                 | 3    | 10                 | 2     | 22                 | 5     | 423                | 100 |
| Sapa III                 | 35                 | 18    | 42                 | 22    | 23                 | 12    | 15                 | 8     | 6                  | 3     | 2                  | 1    | 1                  | 1     | 66                 | 35    | 190                | 100 |
| Wawa II                  | 123                | 26    | 88                 | 19    | 127                | 27    | 50                 | 11    | 22                 | 5     | 9                  | 2    | 9                  | 2     | 39                 | 8     | 467                | 100 |
| Sapa II                  | 100                | 30    | 96                 | 29    | 54                 | 16    | 22                 | 7     | 8                  | 2     | 5                  | 2    | 3                  | 1     | 41                 | 12    | 329                | 100 |
| Ligtong                  | 103                | 26    | 70                 | 18    | 43                 | 11    | 31                 | 8     | 8                  | 2     | 15                 | 4    | 15                 | 4     | 107                | 27    | 392                | 100 |
| Wawa I                   | 76                 | 22    | 78                 | 22    | 46                 | 13    | 26                 | 7     | 20                 | 6     | 32                 | 9    | 50                 | 14    | 23                 | 7     | 351                | 100 |
| Bagbag                   | 20                 | 7     | 59                 | 21    | 25                 | 9     | 27                 | 10    | 19                 | 7     | 9                  | 3    | 7                  | 3     | 112                | 40    | 278                | 100 |





## CHAPTER TWO THE PEOPLE

### Proposed Cavite Province Land Reclamation and Development Project: ISLAND D (267 HECTARES) Cavite Provincial Government

| Barangay     | BELOW 1000         |              | 1000-4999          |              | 5000-9999          |              | 10000-14999        |              | 15999-19999        |             | 20000-24999        |             | 25000 ABOVE        |             | NO ANSWER          |              | TOTAL              |            |
|--------------|--------------------|--------------|--------------------|--------------|--------------------|--------------|--------------------|--------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|--------------|--------------------|------------|
|              | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %          |
| Kanluran     | 33                 | 12           | 97                 | 36           | 55                 | 20           | 23                 | 9            | 9                  | 3           | 6                  | 2           | 4                  | 1           | 42                 | 16           | 269                | 100        |
| Muzon II     | 43                 | 12           | 26                 | 7            | 23                 | 6            | 30                 | 8            | 21                 | 6           | 5                  | 1           | 0                  | 0           | 221                | 60           | 369                | 100        |
| <b>Total</b> | <b>648</b>         | <b>18.19</b> | <b>735</b>         | <b>20.63</b> | <b>595</b>         | <b>16.70</b> | <b>403</b>         | <b>11.31</b> | <b>172</b>         | <b>4.83</b> | <b>126</b>         | <b>3.54</b> | <b>131</b>         | <b>3.68</b> | <b>752</b>         | <b>21.11</b> | <b>3,562</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019

**Table 2.4-37. Impact Barangays: Primary Earner**

| Barangay                        | Asawang Lalake     |              | Asawang Babae      |              | Anak Na Lalaki     |             | Anak Na Babae      |             | Lalaking Kamag Anak |             | Babaeng Kamag Anak |             | Iba Pa             |             | No Answer          |              | TOTAL              |            |
|---------------------------------|--------------------|--------------|--------------------|--------------|--------------------|-------------|--------------------|-------------|---------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|--------------|--------------------|------------|
|                                 | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed  | %           | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %          |
| <b>Municipality of Novelata</b> |                    |              |                    |              |                    |             |                    |             |                     |             |                    |             |                    |             |                    |              |                    |            |
| San Rafael II                   | 140                | 57           | 32                 | 13           | 26                 | 11          | 14                 | 6           | 7                   | 3           | 4                  | 2           | 7                  | 3           | 17                 | 7            | 247                | 100        |
| San Rafael III                  | 106                | 49           | 18                 | 8            | 9                  | 4           | 3                  | 1           | 7                   | 3           | 1                  | 0           | 35                 | 16          | 39                 | 18           | 218                | 100        |
| San Rafael IV                   | 21                 | 72           | 1                  | 3            | 0                  | 0           | 1                  | 3           | 0                   | 0           | 0                  | 0           | 1                  | 3           | 5                  | 17           | 29                 | 100        |
| <b>Municipality of Rosario</b>  |                    |              |                    |              |                    |             |                    |             |                     |             |                    |             |                    |             |                    |              |                    |            |
| Wawa III                        | 234                | 63           | 48                 | 13           | 18                 | 5           | 10                 | 3           | 4                   | 1           | 4                  | 1           | 20                 | 5           | 33                 | 9            | 371                | 100        |
| Sapa III                        | 95                 | 44           | 25                 | 12           | 18                 | 8           | 11                 | 5           | 2                   | 1           | 1                  | 0           | 11                 | 5           | 53                 | 25           | 216                | 100        |
| Wawa II                         | 292                | 53           | 81                 | 15           | 55                 | 10          | 42                 | 8           | 8                   | 1           | 6                  | 1           | 8                  | 1           | 54                 | 10           | 546                | 100        |
| Sapa II                         | 206                | 61           | 46                 | 14           | 29                 | 9           | 8                  | 2           | 6                   | 2           | 3                  | 1           | 6                  | 2           | 34                 | 10           | 338                | 100        |
| Ligtong                         | 77                 | 26           | 59                 | 20           | 19                 | 6           | 24                 | 8           | 5                   | 2           | 4                  | 1           | 17                 | 6           | 91                 | 31           | 296                | 100        |
| Wawa I                          | 170                | 49           | 40                 | 12           | 18                 | 5           | 25                 | 7           | 33                  | 10          | 10                 | 3           | 9                  | 3           | 40                 | 12           | 345                | 100        |
| Bagbag                          | 75                 | 27           | 30                 | 11           | 27                 | 10          | 6                  | 2           | 8                   | 3           | 10                 | 4           | 19                 | 7           | 100                | 36           | 275                | 100        |
| Kanluran                        | 128                | 48           | 47                 | 18           | 30                 | 11          | 9                  | 3           | 7                   | 3           | 4                  | 1           | 7                  | 3           | 35                 | 13           | 267                | 100        |
| Muzon II                        | 68                 | 18           | 25                 | 7            | 9                  | 2           | 14                 | 4           | 0                   | 0           | 0                  | 0           | 27                 | 7           | 229                | 62           | 372                | 100        |
| <b>Total</b>                    | <b>1,612</b>       | <b>45.80</b> | <b>452</b>         | <b>12.84</b> | <b>258</b>         | <b>7.33</b> | <b>167</b>         | <b>4.74</b> | <b>87</b>           | <b>2.47</b> | <b>47</b>          | <b>1.34</b> | <b>167</b>         | <b>4.74</b> | <b>730</b>         | <b>20.74</b> | <b>3,520</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019

### Community Services

**Water** – Based on the survey, an accounted 11.09% of households are “*sariling patubigan*” for source of water supply. Although 24.51% of the total respondents opted not to answer, it can also be noted that 15.48% of the respondents use deepwell 7.09% use other sources of water supply.



Table 2.4-38. Impact Barangays: Source of water supply

| Barangay                 | Sariling Patubigan |       | Nakikiigib          |       | Deep Well           |       | Artesian Well       |      | Shallow Well        |      | Dug Well            |      | Ilog/Sapa/Batis    |      | Bottled Water/Distilled |       | Tanker Truck/Peddler |      | Others             |      | No Answer          |       | TOTAL               |     |
|--------------------------|--------------------|-------|---------------------|-------|---------------------|-------|---------------------|------|---------------------|------|---------------------|------|--------------------|------|-------------------------|-------|----------------------|------|--------------------|------|--------------------|-------|---------------------|-----|
|                          | No. of HH surveyed | %     | No. of HH surveye d | %     | No. of HH surveye d | %     | No. of HH surveye d | %    | No. of HH surveye d | %    | No. of HH surveye d | %    | No. of HH surveyed | %    | No. of HH surveyed      | %     | No. of HH surveyed   | %    | No. of HH surveyed | %    | No. of HH surveyed | %     | No. of HH surveye d | %   |
| Municipality of Noveleta |                    |       |                     |       |                     |       |                     |      |                     |      |                     |      |                    |      |                         |       |                      |      |                    |      |                    |       |                     |     |
| San Rafael II            | 34                 | 14    | 49                  | 20    | 20                  | 8     | 2                   | 1    | 8                   | 3    | 0                   | 0    | 0                  | 0    | 28                      | 12    | 0                    | 0    | 46                 | 19   | 54                 | 22    | 241                 | 100 |
| San Rafael III           | 64                 | 30    | 32                  | 15    | 21                  | 10    | 0                   | 0    | 0                   | 0    | 1                   | 0    | 0                  | 0    | 17                      | 8     | 0                    | 0    | 33                 | 15   | 45                 | 21    | 213                 | 100 |
| San Rafael IV            | 4                  | 14    | 11                  | 38    | 1                   | 3     | 0                   | 0    | 0                   | 0    | 0                   | 0    | 0                  | 1    | 3                       | 0     | 0                    | 3    | 10                 | 9    | 31                 | 29    | 100                 | 100 |
| Municipality of Rosario  |                    |       |                     |       |                     |       |                     |      |                     |      |                     |      |                    |      |                         |       |                      |      |                    |      |                    |       |                     |     |
| Wawa III                 | 13                 | 3     | 21                  | 5     | 74                  | 19    | 8                   | 2    | 1                   | 0    | 8                   | 2    | 0                  | 0    | 176                     | 46    | 1                    | 0    | 26                 | 7    | 58                 | 15    | 386                 | 100 |
| Sapa III                 | 5                  | 2     | 64                  | 31    | 24                  | 12    | 1                   | 0    | 3                   | 1    | 3                   | 1    | 0                  | 0    | 35                      | 17    | 4                    | 2    | 2                  | 1    | 63                 | 31    | 204                 | 100 |
| Wawa II                  | 134                | 26    | 222                 | 43    | 71                  | 14    | 2                   | 0    | 0                   | 0    | 2                   | 0    | 0                  | 0    | 55                      | 11    | 1                    | 0    | 6                  | 1    | 23                 | 4     | 516                 | 100 |
| Sapa II                  | 17                 | 5     | 123                 | 38    | 50                  | 16    | 1                   | 0    | 6                   | 2    | 4                   | 1    | 0                  | 0    | 44                      | 14    | 1                    | 0    | 11                 | 3    | 64                 | 20    | 321                 | 100 |
| Ligtong                  | 11                 | 3     | 74                  | 19    | 89                  | 23    | 3                   | 1    | 16                  | 4    | 6                   | 2    | 0                  | 0    | 41                      | 11    | 3                    | 1    | 12                 | 3    | 126                | 33    | 381                 | 100 |
| Wawa I                   | 45                 | 13    | 74                  | 22    | 69                  | 20    | 1                   | 0    | 1                   | 0    | 2                   | 1    | 0                  | 0    | 19                      | 6     | 0                    | 0    | 89                 | 26   | 43                 | 13    | 343                 | 100 |
| Bagbag                   | 41                 | 15    | 15                  | 5     | 36                  | 13    | 1                   | 0    | 4                   | 1    | 9                   | 3    | 1                  | 0    | 16                      | 6     | 8                    | 3    | 10                 | 4    | 133                | 49    | 274                 | 100 |
| Kanluran                 | 11                 | 3     | 124                 | 38    | 51                  | 16    | 2                   | 1    | 7                   | 2    | 5                   | 2    | 1                  | 0    | 45                      | 14    | 2                    | 1    | 12                 | 4    | 65                 | 20    | 325                 | 100 |
| Muzon II                 | 12                 | 4     | 41                  | 14    | 40                  | 14    | 6                   | 2    | 0                   | 0    | 0                   | 0    | 0                  | 0    | 12                      | 4     | 0                    | 0    | 0                  | 0    | 181                | 62    | 292                 | 100 |
| Total                    | 391                | 11.09 | 850                 | 24.11 | 546                 | 15.48 | 27                  | 0.77 | 46                  | 1.30 | 40                  | 1.13 | 2                  | 0.06 | 489                     | 13.87 | 20                   | 0.57 | 250                | 7.09 | 864                | 24.51 | 3,525               | 100 |

Data Source: EIA Perception Survey 2019

**Power** – Based on the survey conducted, majority of the households in the twelve (12) barangays have their own legal power connection. On the hand, 12% of households in Barangay Muzon II said that they do not have legal power connection. Based on the survey, household without legal power connection in the entire twelve (12) barangays total to 4.36 percent.

Data on Source of Electricity of respondents can be seen in Table 2.4-39 below.

Table 2.4-39. Impact Barangays: Availability of Electricity

| Barangay                        | Oo                 |    | Wala               |   | No Answer          |    | TOTAL              |     |
|---------------------------------|--------------------|----|--------------------|---|--------------------|----|--------------------|-----|
|                                 | No. of HH surveyed | %  | No. of HH surveyed | % | No. of HH surveyed | %  | No. of HH surveyed | %   |
| <b>Municipality of Noveleta</b> |                    |    |                    |   |                    |    |                    |     |
| San Rafael II                   | 212                | 86 | 13                 | 5 | 22                 | 9  | 247                | 100 |
| San Rafael III                  | 186                | 82 | 2                  | 1 | 40                 | 18 | 228                | 100 |
| San Rafael IV                   | 24                 | 83 | 0                  | 0 | 5                  | 17 | 29                 | 100 |
| <b>Municipality of Rosario</b>  |                    |    |                    |   |                    |    |                    |     |
| Wawa III                        | 352                | 91 | 16                 | 4 | 20                 | 5  | 388                | 100 |
| Sapa III                        | 135                | 71 | 7                  | 4 | 48                 | 25 | 190                | 100 |
| Wawa II                         | 427                | 91 | 13                 | 3 | 27                 | 6  | 467                | 100 |
| Sapa I                          | 253                | 78 | 26                 | 8 | 45                 | 14 | 324                | 100 |
| Ligtong                         | 240                | 64 | 15                 | 4 | 120                | 32 | 375                | 100 |



| Barangay     | Oo                 |              | Wala               |             | No Answer          |              | TOTAL              |            |
|--------------|--------------------|--------------|--------------------|-------------|--------------------|--------------|--------------------|------------|
|              | No. of HH surveyed | %            | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %          |
| Wawa I       | 291                | 89           | 5                  | 2           | 31                 | 9            | 327                | 100        |
| Bagbag       | 150                | 55           | 2                  | 1           | 120                | 44           | 272                | 100        |
| Kanluran     | 194                | 44           | 23                 | 5           | 224                | 51           | 441                | 100        |
| Muzon II     | 78                 | 27           | 34                 | 12          | 180                | 62           | 292                | 100        |
| <b>Total</b> | <b>2,542</b>       | <b>71.00</b> | <b>156</b>         | <b>4.36</b> | <b>882</b>         | <b>24.64</b> | <b>3,580</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019

**Availability of Comfort Rooms** – It can be noted on the survey conducted that majority of the household respondents have their own comfort room.

**Table 2.4-40. Impact Barangays: Availability of Toilet**

| Barangay                        | Meron              |              | Wala               |             | No Answer          |              | TOTAL              |            |
|---------------------------------|--------------------|--------------|--------------------|-------------|--------------------|--------------|--------------------|------------|
|                                 | No. of HH surveyed | %            | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %          |
| <b>Municipality of Noveleta</b> |                    |              |                    |             |                    |              |                    |            |
| San Rafael II                   | 205                | 83.00        | 13                 | 5.26        | 29                 | 11.74        | 247                | 100        |
| San Rafael III                  | 194                | 87.39        | 6                  | 2.70        | 22                 | 9.91         | 222                | 100        |
| San Rafael IV                   | 24                 | 82.76        | 0                  | 0.00        | 5                  | 17.24        | 29                 | 100        |
| <b>Municipality of Rosario</b>  |                    |              |                    |             |                    |              |                    |            |
| Wawa III                        | 357                | 93           | 12                 | 3           | 15                 | 4            | 384                | 100        |
| Sapa III                        | 125                | 66           | 9                  | 5           | 56                 | 29           | 190                | 100        |
| Wawa II                         | 390                | 84           | 46                 | 10          | 31                 | 7            | 467                | 100        |
| Sapa II                         | 253                | 77           | 37                 | 11          | 39                 | 12           | 329                | 100        |
| Brgy. Ligtong                   | 159                | 51           | 47                 | 15          | 104                | 34           | 310                | 100        |
| Wawa I                          | 301                | 92           | 11                 | 3           | 16                 | 5            | 328                | 100        |
| Bagbag                          | 133                | 44           | 30                 | 10          | 140                | 46           | 303                | 100        |
| Kanluran                        | 168                | 68           | 38                 | 15          | 40                 | 16           | 246                | 100        |
| Muzon II                        | 124                | 34           | 17                 | 5           | 228                | 62           | 369                | 100        |
| <b>Total</b>                    | <b>2,433</b>       | <b>70.77</b> | <b>266</b>         | <b>7.77</b> | <b>725</b>         | <b>21.17</b> | <b>3,424</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019

**Solid Waste Disposal** – Based on the survey conducted, majority of the respondents stated that solid wastes are being collected once in a week. Thus, it clearly shows that the City has been collecting the garbage. See Table 2.4-41 and Table 2.4-42.





Table 2.4-41. Impact Barangays: Garbage Collection

| Barangay                        | May Nangungulikta  |              | Hukay Sa Bakuran   |             | Tinatapon Sa Ilog  |             | Sinusunog          |             | Iba Pa             |             | No Answer          |              | TOTAL              |            |
|---------------------------------|--------------------|--------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|--------------|--------------------|------------|
|                                 | No. of HH surveyed | %            | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %          |
| <b>Municipality of Noveleta</b> |                    |              |                    |             |                    |             |                    |             |                    |             |                    |              |                    |            |
| San Rafael II                   | 157                | 64           | 13                 | 5           | 0                  | 0           | 50                 | 20          | 4                  | 2           | 23                 | 9            | 247                | 100        |
| San Rafael III                  | 102                | 63           | 1                  | 1           | 0                  | 0           | 4                  | 2           | 14                 | 9           | 40                 | 25           | 161                | 100        |
| San Rafael IV                   | 20                 | 69           | 0                  | 0           | 0                  | 0           | 7                  | 24          | 1                  | 3           | 1                  | 3            | 29                 | 100        |
| <b>Municipality of Rosario</b>  |                    |              |                    |             |                    |             |                    |             |                    |             |                    |              |                    |            |
| Wawa III                        | 303                | 79           | 3                  | 1           | 4                  | 1           | 19                 | 5           | 29                 | 8           | 26                 | 7            | 384                | 100        |
| Sapa III                        | 135                | 69           | 4                  | 2           | 0                  | 0           | 1                  | 1           | 2                  | 1           | 53                 | 27           | 195                | 100        |
| Wawa II                         | 165                | 34           | 121                | 25          | 125                | 26          | 24                 | 5           | 23                 | 5           | 30                 | 6            | 488                | 100        |
| Sapa II                         | 194                | 59           | 41                 | 12          | 8                  | 2           | 30                 | 9           | 7                  | 2           | 49                 | 15           | 329                | 100        |
| Ligtong                         | 151                | 38           | 12                 | 3           | 10                 | 3           | 89                 | 23          | 7                  | 2           | 125                | 32           | 394                | 100        |
| Wawa I                          | 257                | 76           | 33                 | 10          | 0                  | 0           | 9                  | 3           | 22                 | 6           | 19                 | 6            | 340                | 100        |
| Bagbag                          | 134                | 49           | 1                  | 0           | 10                 | 4           | 14                 | 5           | 12                 | 4           | 101                | 37           | 272                | 100        |
| Kanluran                        | 216                | 61           | 42                 | 12          | 9                  | 3           | 31                 | 9           | 8                  | 2           | 50                 | 14           | 356                | 100        |
| Muzon II                        | 78                 | 27           | 5                  | 2           | 1                  | 0           | 23                 | 8           | 3                  | 1           | 182                | 62           | 292                | 100        |
| <b>Total</b>                    | <b>1,912</b>       | <b>54.83</b> | <b>276</b>         | <b>7.92</b> | <b>167</b>         | <b>4.79</b> | <b>301</b>         | <b>8.63</b> | <b>132</b>         | <b>3.79</b> | <b>699</b>         | <b>20.05</b> | <b>3,487</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019

Table 2.4-42. Impact Barangays: Schedule of Garbage Collection

| Barangay                        | Araw Araw          |    | 2-3 Beses Kada Lingo |    | Isang Beses Sa Isang Lingo |    | Regular            |   | Iba Pa             |   | No Answer          |    | TOTAL              |     |
|---------------------------------|--------------------|----|----------------------|----|----------------------------|----|--------------------|---|--------------------|---|--------------------|----|--------------------|-----|
|                                 | No. of HH surveyed | %  | No. of HH surveyed   | %  | No. of HH surveyed         | %  | No. of HH surveyed | % | No. of HH surveyed | % | No. of HH surveyed | %  | No. of HH surveyed | %   |
| <b>Municipality of Noveleta</b> |                    |    |                      |    |                            |    |                    |   |                    |   |                    |    |                    |     |
| San Rafael II                   | 13                 | 5  | 41                   | 17 | 115                        | 48 | 18                 | 7 | 12                 | 5 | 43                 | 18 | 242                | 100 |
| San Rafael III                  | 2                  | 1  | 51                   | 25 | 104                        | 51 | 13                 | 6 | 2                  | 1 | 33                 | 16 | 205                | 100 |
| San Rafael IV                   | 3                  | 10 | 7                    | 24 | 15                         | 52 | 0                  | 0 | 2                  | 7 | 2                  | 7  | 29                 | 100 |
| <b>Municipality of Rosario</b>  |                    |    |                      |    |                            |    |                    |   |                    |   |                    |    |                    |     |
| Wawa III                        | 103                | 27 | 155                  | 41 | 60                         | 16 | 30                 | 8 | 5                  | 1 | 25                 | 7  | 378                | 100 |
| Sapa III                        | 34                 | 18 | 53                   | 28 | 32                         | 17 | 5                  | 3 | 3                  | 2 | 63                 | 33 | 190                | 100 |
| Wawa II                         | 141                | 32 | 213                  | 48 | 75                         | 17 | 5                  | 1 | 1                  | 0 | 12                 | 3  | 447                | 100 |
| Sapa II                         | 112                | 34 | 103                  | 31 | 37                         | 11 | 20                 | 6 | 4                  | 1 | 53                 | 16 | 329                | 100 |
| Ligtong                         | 64                 | 17 | 103                  | 27 | 60                         | 16 | 13                 | 3 | 16                 | 4 | 121                | 32 | 377                | 100 |
| Wawa I                          | 22                 | 7  | 149                  | 44 | 105                        | 31 | 23                 | 7 | 5                  | 1 | 33                 | 10 | 337                | 100 |
| Bagbag                          | 43                 | 16 | 38                   | 14 | 68                         | 25 | 11                 | 4 | 7                  | 3 | 102                | 38 | 269                | 100 |



| Barangay     | Araw Araw          |              | 2-3 Beses Kada Lingo |              | Isang Beses Sa Isang Lingo |              | Regular            |             | Iba Pa             |             | No Answer          |              | TOTAL              |            |
|--------------|--------------------|--------------|----------------------|--------------|----------------------------|--------------|--------------------|-------------|--------------------|-------------|--------------------|--------------|--------------------|------------|
|              | No. of HH surveyed | %            | No. of HH surveyed   | %            | No. of HH surveyed         | %            | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %          |
| Kanluran     | 172                | 44           | 104                  | 26           | 38                         | 10           | 21                 | 5           | 5                  | 1           | 54                 | 14           | 394                | 100        |
| Muzon II     | 62                 | 21           | 22                   | 8            | 8                          | 3            | 18                 | 6           | 0                  | 0           | 182                | 62           | 292                | 100        |
| <b>Total</b> | <b>771</b>         | <b>22.09</b> | <b>1,039</b>         | <b>29.78</b> | <b>717</b>                 | <b>20.55</b> | <b>177</b>         | <b>5.07</b> | <b>62</b>          | <b>1.78</b> | <b>723</b>         | <b>20.72</b> | <b>3,489</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019

## Health

**Sickness in the Family-** Based on the survey conducted, 22.48% of the household respondents have experienced one (1) sick family member for the past three years. 15.01% of the household respondents have experienced two (2) family members for the past three years. Common sickness in the barangay as indicated by the household respondents is gastrointestinal diseases, cough, fever, skin disease, upper respiratory diseases, heart disease and cancer.

**Table 2.4-43. Impact Barangays: History of having sick for the past 3 years**

| Barangay                        | Oo                |              | Hindi              |              | No Answer          |              | TOTAL              |            |
|---------------------------------|-------------------|--------------|--------------------|--------------|--------------------|--------------|--------------------|------------|
|                                 | No of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %          |
| <b>Municipality of Noveleta</b> |                   |              |                    |              |                    |              |                    |            |
| San Rafael II                   | 184               | 74.49        | 36                 | 14.57        | 27                 | 10.93        | 247                | 100        |
| San Rafael III                  | 159               | 64.37        | 34                 | 13.77        | 54                 | 21.86        | 247                | 100        |
| San Rafael IV                   | 19                | 65.52        | 6                  | 20.69        | 4                  | 13.79        | 29                 | 100        |
| <b>Municipality of Rosario</b>  |                   |              |                    |              |                    |              |                    |            |
| Wawa III                        | 265               | 70           | 69                 | 18           | 45                 | 12           | 379                | 100        |
| Sapa III                        | 91                | 48           | 34                 | 18           | 65                 | 34           | 190                | 100        |
| Wawa II                         | 208               | 45           | 112                | 24           | 147                | 31           | 467                | 100        |
| Sapa II                         | 223               | 68           | 62                 | 19           | 44                 | 13           | 329                | 100        |
| Ligtong                         | 184               | 50           | 76                 | 21           | 106                | 29           | 366                | 100        |
| Wawa I                          | 165               | 52           | 96                 | 30           | 58                 | 18           | 319                | 100        |
| Bagbag                          | 114               | 45           | 24                 | 10           | 114                | 45           | 252                | 100        |
| Kanluran                        | 213               | 66           | 63                 | 20           | 45                 | 14           | 321                | 100        |
| Muzon II                        | 76                | 26           | 35                 | 12           | 181                | 62           | 292                | 100        |
| <b>Total</b>                    | <b>1,901</b>      | <b>55.29</b> | <b>647</b>         | <b>18.82</b> | <b>890</b>         | <b>25.89</b> | <b>3,438</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019



**Table 2.4-44. Impact Barangays: Year of having Sick**

| Barangay                        | YEAR OF HAVING SICK |              |                    |             |                    |             |                    |              |                    |            |
|---------------------------------|---------------------|--------------|--------------------|-------------|--------------------|-------------|--------------------|--------------|--------------------|------------|
|                                 | 2014                |              | 2013               |             | 2012               |             | No Answer          |              | TOTAL              |            |
|                                 | No. of HH surveyed  | %            | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %          |
| <b>Municipality of Noveleta</b> |                     |              |                    |             |                    |             |                    |              |                    |            |
| San Rafael II                   | 120                 | 48.58        | 25                 | 10.12       | 14                 | 5.67        | 88                 | 35.63        | 247                | 100        |
| San Rafael III                  | 109                 | 45.04        | 28                 | 11.57       | 1                  | 0.41        | 104                | 42.98        | 242                | 100        |
| San Rafael IV                   | 11                  | 37.93        | 5                  | 17.24       | 3                  | 10.34       | 10                 | 34.48        | 29                 | 100        |
| <b>Municipality of Rosario</b>  |                     |              |                    |             |                    |             |                    |              |                    |            |
| Wawa III                        | 127                 | 31           | 33                 | 8           | 20                 | 5           | 231                | 56           | 411                | 100        |
| Sapa III                        | 59                  | 31           | 4                  | 2           | 7                  | 4           | 120                | 63           | 190                | 100        |
| Wawa II                         | 94                  | 20           | 15                 | 3           | 14                 | 3           | 344                | 74           | 467                | 100        |
| Sapa II                         | 141                 | 42           | 38                 | 11          | 39                 | 12          | 114                | 34           | 332                | 100        |
| Ligtong                         | 105                 | 38           | 23                 | 8           | 22                 | 8           | 127                | 46           | 277                | 100        |
| Wawa I                          | 80                  | 24           | 40                 | 12          | 22                 | 7           | 188                | 57           | 330                | 100        |
| Bagbag                          | 58                  | 22           | 25                 | 10          | 11                 | 4           | 168                | 64           | 262                | 100        |
| Kanluran                        | 67                  | 26           | 39                 | 15          | 40                 | 15          | 115                | 44           | 261                | 100        |
| Muzon II                        | 56                  | 19           | 11                 | 4           | 1                  | 0           | 224                | 77           | 292                | 100        |
| <b>Total</b>                    | <b>1,027</b>        | <b>30.75</b> | <b>286</b>         | <b>8.56</b> | <b>194</b>         | <b>5.81</b> | <b>1,833</b>       | <b>54.88</b> | <b>3,340</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019

**Table 2.4-45. Impact Barangays: Number of Family Members Who Got Sick**

| Barangay                        | 1                  |    | 2                  |    | 3                  |    | 4                  |   | 5                  |    | Higit pa           |    | No Answer          |    | Total              |     |
|---------------------------------|--------------------|----|--------------------|----|--------------------|----|--------------------|---|--------------------|----|--------------------|----|--------------------|----|--------------------|-----|
|                                 | No. of HH surveyed | %  | No. of HH surveyed | %  | No. of HH surveyed | %  | No. of HH surveyed | % | No. of HH surveyed | %  | No. of HH surveyed | %  | No. of HH surveyed | %  | No. of HH surveyed | %   |
| <b>Municipality of Noveleta</b> |                    |    |                    |    |                    |    |                    |   |                    |    |                    |    |                    |    |                    |     |
| San Rafael II                   | 64                 | 26 | 55                 | 22 | 24                 | 10 | 17                 | 7 | 14                 | 6  | 15                 | 6  | 58                 | 23 | 247                | 100 |
| San Rafael III                  | 50                 | 22 | 62                 | 27 | 18                 | 8  | 10                 | 4 | 3                  | 1  | 4                  | 2  | 81                 | 36 | 228                | 100 |
| San Rafael IV                   | 9                  | 31 | 4                  | 14 | 1                  | 3  | 0                  | 0 | 4                  | 14 | 2                  | 7  | 9                  | 31 | 29                 | 100 |
| <b>Municipality of Rosario</b>  |                    |    |                    |    |                    |    |                    |   |                    |    |                    |    |                    |    |                    |     |
| Wawa III                        | 94                 | 24 | 74                 | 19 | 38                 | 10 | 18                 | 5 | 12                 | 3  | 35                 | 9  | 115                | 30 | 386                | 100 |
| Sapa III                        | 51                 | 28 | 10                 | 5  | 11                 | 6  | 7                  | 4 | 5                  | 3  | 3                  | 2  | 95                 | 52 | 182                | 100 |
| Wawa II                         | 112                | 24 | 53                 | 11 | 17                 | 4  | 5                  | 1 | 6                  | 1  | 270                | 58 | 4                  | 1  | 467                | 100 |
| Sapa II                         | 100                | 30 | 52                 | 16 | 28                 | 9  | 25                 | 8 | 26                 | 8  | 13                 | 4  | 85                 | 26 | 329                | 100 |
| Ligtong                         | 95                 | 24 | 51                 | 13 | 27                 | 7  | 10                 | 3 | 9                  | 2  | 12                 | 3  | 190                | 48 | 394                | 100 |
| Wawa I                          | 65                 | 19 | 46                 | 14 | 18                 | 5  | 17                 | 5 | 14                 | 4  | 5                  | 1  | 171                | 51 | 336                | 100 |
| Bagbag                          | 54                 | 20 | 36                 | 14 | 17                 | 6  | 3                  | 1 | 8                  | 3  | 18                 | 7  | 130                | 49 | 266                | 100 |





## CHAPTER TWO THE PEOPLE

Proposed Cavite Province Land Reclamation and Development Project: ISLAND D (267 HECTARES)  
Cavite Provincial Government

| Barangay     | 1                  |              | 2                  |              | 3                  |             | 4                  |             | 5                  |             | Higit pa           |              | No Answer          |              | Total              |            |
|--------------|--------------------|--------------|--------------------|--------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|--------------|--------------------|--------------|--------------------|------------|
|              | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %          |
| Kanluran     | 82                 | 26           | 53                 | 17           | 29                 | 9           | 26                 | 8           | 27                 | 9           | 14                 | 4            | 86                 | 27           | 317                | 100        |
| Muzon II     | 22                 | 6            | 37                 | 10           | 19                 | 5           | 6                  | 2           | 5                  | 1           | 0                  | 0            | 280                | 76           | 369                | 100        |
| <b>Total</b> | <b>798</b>         | <b>22.48</b> | <b>533</b>         | <b>15.01</b> | <b>247</b>         | <b>6.96</b> | <b>144</b>         | <b>4.06</b> | <b>133</b>         | <b>3.75</b> | <b>391</b>         | <b>11.01</b> | <b>1,304</b>       | <b>36.73</b> | <b>3,550</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019

**Table 2.4-46. Impact Barangays: Type of Disease**

| Barangay                        | TYPE OF DISEASE           |             |                    |              |                    |              |                    |             |                            |             |                     |             |                    |             |                    |             |                    |             |                    |             |                    |              |                    |            |
|---------------------------------|---------------------------|-------------|--------------------|--------------|--------------------|--------------|--------------------|-------------|----------------------------|-------------|---------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|--------------|--------------------|------------|
|                                 | Gastrointestinal Diseases |             | Pag ubo/sipon      |              | Lagnat             |              | Skin Disease       |             | Upper Respiratory Diseases |             | Hereditary Diseases |             | STD                |             | Heart Diseases     |             | Cancer             |             | Others             |             | No Answer          |              | Total              |            |
|                                 | No. of HH surveyed        | %           | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %           | No. of HH surveyed         | %           | No. of HH surveyed  | %           | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %          |
| <b>Municipality of Noveleta</b> |                           |             |                    |              |                    |              |                    |             |                            |             |                     |             |                    |             |                    |             |                    |             |                    |             |                    |              |                    |            |
| San Rafael II                   | 9                         | 4           | 72                 | 29           | 74                 | 30           | 12                 | 5           | 8                          | 3           | 0                   | 0           | 0                  | 0           | 8                  | 3           | 2                  | 1           | 11                 | 4           | 51                 | 21           | 247                | 100        |
| San Rafael III                  | 3                         | 1           | 71                 | 31           | 76                 | 33           | 1                  | 0           | 4                          | 2           | 4                   | 2           | 0                  | 0           | 2                  | 1           | 2                  | 1           | 2                  | 1           | 66                 | 29           | 231                | 100        |
| San Rafael IV                   | 0                         | 0           | 5                  | 17           | 11                 | 38           | 0                  | 0           | 0                          | 0           | 1                   | 3           | 0                  | 0           | 1                  | 3           | 0                  | 0           | 0                  | 0           | 11                 | 38           | 29                 | 100        |
| <b>Municipality of Rosario</b>  |                           |             |                    |              |                    |              |                    |             |                            |             |                     |             |                    |             |                    |             |                    |             |                    |             |                    |              |                    |            |
| Wawa III                        | 19                        | 5           | 123                | 32           | 93                 | 24           | 4                  | 1           | 9                          | 2           | 0                   | 0           | 1                  | 0           | 1                  | 0           | 1                  | 0           | 23                 | 6           | 107                | 28           | 381                | 100        |
| Sapa III                        | 7                         | 3           | 54                 | 23           | 53                 | 22           | 6                  | 3           | 9                          | 4           | 0                   | 0           | 0                  | 0           | 2                  | 1           | 1                  | 0           | 8                  | 3           | 98                 | 41           | 238                | 100        |
| Wawa II                         | 16                        | 3           | 92                 | 16           | 116                | 20           | 9                  | 2           | 22                         | 4           | 6                   | 1           | 0                  | 0           | 16                 | 3           | 8                  | 1           | 25                 | 4           | 263                | 46           | 573                | 100        |
| Sapa II                         | 11                        | 3           | 109                | 31           | 104                | 30           | 5                  | 1           | 13                         | 4           | 3                   | 1           | 0                  | 0           | 7                  | 2           | 4                  | 1           | 12                 | 3           | 81                 | 23           | 349                | 100        |
| Ligtong                         | 5                         | 1           | 69                 | 18           | 82                 | 21           | 4                  | 1           | 8                          | 2           | 2                   | 1           | 0                  | 0           | 13                 | 3           | 3                  | 1           | 20                 | 5           | 186                | 47           | 392                | 100        |
| Wawa I                          | 1                         | 0           | 105                | 31           | 46                 | 14           | 3                  | 1           | 8                          | 2           | 1                   | 0           | 0                  | 0           | 7                  | 2           | 0                  | 0           | 6                  | 2           | 163                | 48           | 340                | 100        |
| Bagbag                          | 19                        | 7           | 45                 | 16           | 48                 | 17           | 2                  | 1           | 10                         | 4           | 3                   | 1           | 2                  | 1           | 4                  | 1           | 3                  | 1           | 20                 | 7           | 128                | 45           | 284                | 100        |
| Kanluran                        | 3                         | 1           | 110                | 31           | 105                | 30           | 6                  | 2           | 14                         | 4           | 4                   | 1           | 1                  | 0           | 8                  | 2           | 5                  | 1           | 13                 | 4           | 82                 | 23           | 351                | 100        |
| Muzon II                        | 6                         | 1           | 69                 | 15           | 78                 | 17           | 0                  | 0           | 0                          | 0           | 0                   | 0           | 0                  | 0           | 13                 | 3           | 0                  | 0           | 22                 | 5           | 276                | 59           | 464                | 100        |
| <b>Total</b>                    | <b>99</b>                 | <b>2.55</b> | <b>924</b>         | <b>23.82</b> | <b>886</b>         | <b>22.84</b> | <b>52</b>          | <b>1.34</b> | <b>105</b>                 | <b>2.71</b> | <b>24</b>           | <b>0.62</b> | <b>4</b>           | <b>0.10</b> | <b>82</b>          | <b>2.11</b> | <b>29</b>          | <b>0.75</b> | <b>162</b>         | <b>4.18</b> | <b>1,512</b>       | <b>38.98</b> | <b>3,879</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019

**Where do they Consult?** – Based on the survey conducted, 30.41% of the household respondents opted to consult in the existing Barangay Health Centers. 16.66% opted to consult in Government Hospitals while 9.42% opted not to consult.



Table 2.4-47. Impact Barangays: Place of Treatment

| Barangay                 | Bahay              |             | Barangay Health Center |              | Government Hospital |              | Private Clinic     |             | Herbalist/Traditional Medicine |             | Iba pa             |             | No Answer          |              | Total              |            |
|--------------------------|--------------------|-------------|------------------------|--------------|---------------------|--------------|--------------------|-------------|--------------------------------|-------------|--------------------|-------------|--------------------|--------------|--------------------|------------|
|                          | No. of HH surveyed | %           | No. of HH surveyed     | %            | No. of HH surveyed  | %            | No. of HH surveyed | %           | No. of HH surveyed             | %           | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %          |
| Municipality of Noveleta |                    |             |                        |              |                     |              |                    |             |                                |             |                    |             |                    |              |                    |            |
| San Rafael II            | 14                 | 6           | 92                     | 37           | 47                  | 19           | 6                  | 2           | 18                             | 7           | 7                  | 3           | 63                 | 26           | 247                | 100        |
| San Rafael III           | 14                 | 6           | 128                    | 56           | 10                  | 4            | 23                 | 10          | 0                              | 0           | 1                  | 0           | 54                 | 23           | 230                | 100        |
| San Rafael IV            | 0                  | 0           | 19                     | 66           | 3                   | 10           | 2                  | 7           | 0                              | 0           | 0                  | 0           | 5                  | 17           | 29                 | 100        |
| Municipality of Rosario  |                    |             |                        |              |                     |              |                    |             |                                |             |                    |             |                    |              |                    |            |
| Wawa III                 | 74                 | 19          | 164                    | 42           | 37                  | 10           | 27                 | 7           | 3                              | 1           | 3                  | 1           | 78                 | 20           | 386                | 100        |
| Sapa III                 | 6                  | 3           | 66                     | 32           | 29                  | 14           | 7                  | 3           | 1                              | 0           | 2                  | 1           | 94                 | 46           | 205                | 100        |
| Wawa II                  | 67                 | 14          | 56                     | 12           | 49                  | 10           | 60                 | 12          | 0                              | 0           | 0                  | 0           | 253                | 52           | 485                | 100        |
| Sapa II                  | 27                 | 6           | 155                    | 36           | 157                 | 36           | 15                 | 3           | 4                              | 1           | 4                  | 1           | 69                 | 16           | 431                | 100        |
| Ligtong                  | 25                 | 6           | 107                    | 28           | 43                  | 11           | 33                 | 8           | 4                              | 1           | 8                  | 2           | 169                | 43           | 389                | 100        |
| Wawa I                   | 7                  | 2           | 121                    | 35           | 37                  | 11           | 11                 | 3           | 1                              | 0           | 4                  | 1           | 160                | 47           | 341                | 100        |
| Bagbag                   | 27                 | 9           | 68                     | 24           | 39                  | 14           | 25                 | 9           | 0                              | 0           | 6                  | 2           | 120                | 42           | 285                | 100        |
| Kanluran                 | 73                 | 15          | 156                    | 32           | 158                 | 33           | 16                 | 3           | 5                              | 1           | 5                  | 1           | 70                 | 14           | 483                | 100        |
| Muzon II                 | 41                 | 9           | 78                     | 17           | 54                  | 12           | 24                 | 5           | 0                              | 0           | 0                  | 0           | 271                | 58           | 468                | 100        |
| <b>Total</b>             | <b>375</b>         | <b>9.42</b> | <b>1,210</b>           | <b>30.41</b> | <b>663</b>          | <b>16.66</b> | <b>249</b>         | <b>6.26</b> | <b>36</b>                      | <b>0.90</b> | <b>40</b>          | <b>1.01</b> | <b>1,406</b>       | <b>35.33</b> | <b>3,979</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019

### Perception By the Community

#### Knowledge About the Proposed Project

When the respondents were asked if they are aware of the proposed Cavite Province Land Reclamation and Development Project that will be constructed in their Barangays, 42.78% said that they are aware while 33.06% are not aware. Majority of the respondents or 29.89% knew about the proposed project from barangay officials. Others indicated that they knew the proposed project from their neighborhood or 18.15%, media (3.71%) and other people (3.21 percent). And the rest (50.46%) opted not to answer.

Table 2.4-48. Impact Barangays: Knowledge about the Reclamation

| Barangay                 | Oo                 |       | Hindi              |       | No Answer          |       | TOTAL              |     |
|--------------------------|--------------------|-------|--------------------|-------|--------------------|-------|--------------------|-----|
|                          | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %     | No. of HH surveyed | %   |
| Municipality of Noveleta |                    |       |                    |       |                    |       |                    |     |
| San Rafael II            | 51                 | 25.76 | 117                | 59.09 | 30                 | 15.15 | 198                | 100 |
| San Rafael III           | 103                | 45.18 | 75                 | 32.89 | 50                 | 21.93 | 228                | 100 |



| Barangay                       | Oo                 |              | Hindi              |              | No Answer          |              | TOTAL              |            |
|--------------------------------|--------------------|--------------|--------------------|--------------|--------------------|--------------|--------------------|------------|
|                                | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed | %          |
| San Rafael IV                  | 15                 | 51.72        | 10                 | 34.48        | 4                  | 13.79        | 29                 | 100        |
| <b>Municipality of Rosario</b> |                    |              |                    |              |                    |              |                    |            |
| Wawa III                       | 217                | 56           | 151                | 39           | 18                 | 5            | 386                | 100        |
| Sapa III                       | 65                 | 34           | 73                 | 38           | 52                 | 27           | 190                | 100        |
| Wawa II                        | 258                | 55           | 186                | 40           | 23                 | 5            | 467                | 100        |
| Sapa II                        | 147                | 45           | 127                | 39           | 55                 | 17           | 329                | 100        |
| Brgy. Ligton                   | 80                 | 22           | 169                | 47           | 108                | 30           | 357                | 100        |
| Wawa I                         | 242                | 70           | 73                 | 21           | 29                 | 8            | 344                | 100        |
| Bagbag                         | 81                 | 28           | 74                 | 25           | 137                | 47           | 292                | 100        |
| Kanluran                       | 207                | 47           | 84                 | 19           | 150                | 34           | 441                | 100        |
| Muzon II                       | 87                 | 24           | 61                 | 17           | 221                | 60           | 369                | 100        |
| <b>Total</b>                   | <b>1,553</b>       | <b>42.78</b> | <b>1,200</b>       | <b>33.06</b> | <b>877</b>         | <b>24.16</b> | <b>3,630</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019

**Table 2.4-49. Impact Barangays: Source of Knowledge about the reclamation**

| Barangay                        | Kapitbahay         |              | Barangay           |              | Iec Ng May Ari Ng Proyekto |             | Media              |             | Iba Pa             |             | No Answer          |              | TOTAL              |            |
|---------------------------------|--------------------|--------------|--------------------|--------------|----------------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|--------------|--------------------|------------|
|                                 | No. of HH surveyed | %            | No. of HH surveyed | %            | No. of HH surveyed         | %           | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %          |
| <b>Municipality of Noveleta</b> |                    |              |                    |              |                            |             |                    |             |                    |             |                    |              |                    |            |
| San Rafael II                   | 10                 | 4            | 43                 | 17           | 7                          | 3           | 4                  | 2           | 29                 | 12          | 154                | 62           | 247                | 100        |
| San Rafael III                  | 21                 | 9            | 76                 | 33           | 3                          | 1           | 3                  | 1           | 4                  | 2           | 121                | 53           | 228                | 100        |
| San Rafael IV                   | 3                  | 10           | 12                 | 41           | 0                          | 0           | 0                  | 0           | 2                  | 7           | 12                 | 41           | 29                 | 100        |
| <b>Municipality of Rosario</b>  |                    |              |                    |              |                            |             |                    |             |                    |             |                    |              |                    |            |
| Wawa III                        | 76                 | 20           | 96                 | 25           | 7                          | 2           | 24                 | 6           | 32                 | 8           | 151                | 39           | 386                | 100        |
| Sapa III                        | 21                 | 11           | 54                 | 28           | 1                          | 1           | 7                  | 4           | 1                  | 1           | 106                | 56           | 190                | 100        |
| Wawa II                         | 219                | 46           | 23                 | 5            | 3                          | 1           | 12                 | 3           | 6                  | 1           | 210                | 44           | 473                | 100        |
| Sapa II                         | 42                 | 13           | 105                | 32           | 2                          | 1           | 23                 | 7           | 5                  | 2           | 152                | 46           | 329                | 100        |
| Ligton                          | 8                  | 3            | 65                 | 23           | 1                          | 0           | 16                 | 6           | 10                 | 4           | 178                | 64           | 278                | 100        |
| Wawa I                          | 108                | 32           | 108                | 32           | 13                         | 4           | 16                 | 5           | 7                  | 2           | 86                 | 25           | 338                | 100        |
| Bagbag                          | 26                 | 15           | 77                 | 45           | 4                          | 2           | 7                  | 4           | 5                  | 3           | 53                 | 31           | 172                | 100        |
| Kanluran                        | 50                 | 15           | 38                 | 12           | 5                          | 2           | 14                 | 4           | 8                  | 2           | 212                | 65           | 327                | 100        |
| Muzon II                        | 33                 | 8.21         | 81                 | 20           | 8                          | 2           | 0                  | 0           | 0                  | 0           | 280                | 70           | 402                | 100        |
| <b>Total</b>                    | <b>617</b>         | <b>18.15</b> | <b>778</b>         | <b>22.89</b> | <b>54</b>                  | <b>1.59</b> | <b>126</b>         | <b>3.71</b> | <b>109</b>         | <b>3.21</b> | <b>1,715</b>       | <b>50.46</b> | <b>3,399</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019





## Perceived Impacts

The respondents were also asked on their own view on the possible beneficial and adverse impacts of the proposed Cavite Province Land Reclamation and Development Project. As far as the benefits are concerned, top answers are on employment and livelihood, additional tax, road construction, good service of the government and development of the barangay and municipality. On the other hand, perceived adverse impacts are health concerns, traffic and water and air pollution.

**Table 2.4-50. Impact Barangays: Benefits of the Project**

| Barangay                        | Pag unlad ng serbisyo ng tubig |             | Kabuhayan at negosyo sa mamamayan |              | Buwis sa kalupaan  |             | Pagpapaayos ng kalsada at imprastraktura sa bayan |              | Pag aayos ng serbisyo ng gobyerno |             | Iba pa             |             | No Answer          |              | Total              |            |
|---------------------------------|--------------------------------|-------------|-----------------------------------|--------------|--------------------|-------------|---|--------------|-----------------------------------|-------------|--------------------|-------------|--------------------|--------------|--------------------|------------|
|                                 | No. of HH surveyed             | %           | No. of HH surveyed                | %            | No. of HH surveyed | %           | No. of HH surveyed                                | %            | No. of HH surveyed                | %           | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %          |
| <b>Municipality of Noveleta</b> |                                |             |                                   |              |                    |             |   |              |                                   |             |                    |             |                    |              |                    |            |
| San Rafael II                   | 3                              | 1           | 20                                | 8            | 1                  | 0           | 24  | 10           | 9                                 | 4           | 54                 | 23          | 126                | 53           | 237                | 100        |
| San Rafael III                  | 14                             | 6           | 60                                | 26           | 0                  | 0           | 23  | 10           | 18                                | 8           | 4                  | 2           | 111                | 48           | 230                | 100        |
| San Rafael IV                   | 1                              | 3           | 4                                 | 14           | 0                  | 0           | 2   | 7            | 2                                 | 7           | 4                  | 14          | 16                 | 55           | 29                 | 100        |
| <b>Municipality of Rosario</b>  |                                |             |                                   |              |                    |             |   |              |                                   |             |                    |             |                    |              |                    |            |
| Wawa III                        | 82                             | 21          | 76                                | 20           | 15                 | 4           | 51  | 13           | 45                                | 12          | 27                 | 7           | 87                 | 23           | 383                | 100        |
| Sapa III                        | 4                              | 2           | 34                                | 17           | 6                  | 3           | 22  | 11           | 19                                | 10          | 3                  | 2           | 110                | 56           | 198                | 100        |
| Wawa II                         | 75                             | 16          | 171                               | 36           | 1                  | 0           | 21  | 4            | 16                                | 3           | 7                  | 1           | 183                | 39           | 474                | 100        |
| Sapa II                         | 18                             | 5           | 81                                | 24           | 7                  | 2           | 40  | 12           | 30                                | 9           | 8                  | 2           | 148                | 45           | 332                | 100        |
| Ligtong                         | 8                              | 2           | 32                                | 9            | 3                  | 1           | 38  | 11           | 0                                 | 0           | 11                 | 3           | 260                | 74           | 352                | 100        |
| Wawa I                          | 26                             | 8           | 86                                | 25           | 8                  | 2           | 143   | 42           | 0                                 | 0           | 8                  | 2           | 72                 | 21           | 343                | 100        |
| Bagbag                          | 41                             | 14          | 6                                 | 2            | 30                 | 10          | 14  | 5            | 41                                | 14          | 9                  | 3           | 158                | 53           | 299                | 100        |
| Kanluran                        | 69                             | 14          | 173                               | 36           | 3                  | 1           | 23  | 5            | 18                                | 4           | 9                  | 2           | 185                | 39           | 480                | 100        |
| Muzon II                        | 20                             | 7           | 26                                | 9            | 1                  | 0           | 10  | 3            | 12                                | 4           | 1                  | 0           | 222                | 76           | 292                | 100        |
| <b>Total</b>                    | <b>361</b>                     | <b>9.89</b> | <b>769</b>                        | <b>21.07</b> | <b>75</b>          | <b>2.06</b> | <b>411</b>  | <b>11.26</b> | <b>210</b>                        | <b>5.76</b> | <b>145</b>         | <b>3.97</b> | <b>1,678</b>       | <b>45.98</b> | <b>3,649</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019



Table 2.4-51. Impact Barangays: Disadvantages of the Project

| Barangay                 | Kalusugan at seguridad |              | Pagkaubos ng puno at halaman |              | Epekto sa hangin at lupa |             | Pagdagdag ng basura |             | Paglala ng trapiko |             | Iba pa             |             | No Answer          |              | Total              |            |
|--------------------------|------------------------|--------------|------------------------------|--------------|--------------------------|-------------|---------------------|-------------|--------------------|-------------|--------------------|-------------|--------------------|--------------|--------------------|------------|
|                          | No. of HH surveyed     | %            | No. of HH surveyed           | %            | No. of HH surveyed       | %           | No. of HH surveyed  | %           | No. of HH surveyed | %           | No. of HH surveyed | %           | No. of HH surveyed | %            | No. of HH surveyed | %          |
| Municipality of Noveleta |                        |              |                              |              |                          |             |                     |             |                    |             |                    |             |                    |              |                    |            |
| San Rafael II            | 34                     | 14           | 29                           | 12           | 25                       | 10          | 7                   | 3           | 10                 | 4           | 21                 | 9           | 121                | 49           | 247                | 100        |
| San Rafael III           | 49                     | 21           | 25                           | 11           | 2                        | 1           | 9                   | 4           | 20                 | 9           | 1                  | 0           | 123                | 54           | 229                | 100        |
| San Rafael IV            | 2                      | 7            | 5                            | 17           | 0                        | 0           | 3                   | 10          | 1                  | 3           | 2                  | 7           | 16                 | 55           | 29                 | 100        |
| Municipality of Rosario  |                        |              |                              |              |                          |             |                     |             |                    |             |                    |             |                    |              |                    |            |
| Wawa III                 | 132                    | 35           | 37                           | 10           | 34                       | 9           | 46                  | 12          | 8                  | 2           | 32                 | 8           | 89                 | 24           | 378                | 100        |
| Sapa III                 | 33                     | 15           | 15                           | 7            | 21                       | 9           | 24                  | 11          | 4                  | 2           | 8                  | 4           | 117                | 53           | 222                | 100        |
| Wawa II                  | 108                    | 22           | 133                          | 27           | 32                       | 6           | 19                  | 4           | 5                  | 1           | 8                  | 2           | 191                | 39           | 496                | 100        |
| Sapa II                  | 85                     | 36           | 26                           | 11           | 22                       | 9           | 26                  | 11          | 18                 | 8           | 8                  | 3           | 51                 | 22           | 236                | 100        |
| Ligtong                  | 24                     | 7            | 11                           | 3            | 17                       | 5           | 8                   | 2           | 12                 | 3           | 16                 | 5           | 260                | 75           | 348                | 100        |
| Wawa I                   | 69                     | 20           | 20                           | 6            | 16                       | 5           | 80                  | 23          | 66                 | 19          | 11                 | 3           | 83                 | 24           | 345                | 100        |
| Bagbag                   | 71                     | 22           | 23                           | 7            | 19                       | 6           | 22                  | 7           | 11                 | 3           | 7                  | 2           | 168                | 52           | 321                | 100        |
| Kanluran                 | 133                    | 25           | 135                          | 25           | 34                       | 6           | 21                  | 4           | 7                  | 1           | 10                 | 2           | 193                | 36           | 533                | 100        |
| Muzon II                 | 42                     | 15           | 4                            | 1            | 3                        | 1           | 5                   | 2           | 2                  | 1           | 1                  | 0           | 225                | 80           | 282                | 100        |
| <b>Total</b>             | <b>782</b>             | <b>21.33</b> | <b>463</b>                   | <b>12.63</b> | <b>225</b>               | <b>6.14</b> | <b>270</b>          | <b>7.36</b> | <b>164</b>         | <b>4.47</b> | <b>125</b>         | <b>3.41</b> | <b>1,637</b>       | <b>44.65</b> | <b>3,666</b>       | <b>100</b> |

Data Source: EIA Perception Survey 2019



Based on these tables, it may be seen that the social development aspects of the Project would have to be in harmony with the results of the perception survey.

Moreover, and equally important the organizational plan (Institutional Plan) are relevant to the implementation of the SDPs. The Institutional Plan is presented in Chapter 8.

**Public participation was observed through the IEC, the Public Scoping and perception surveys.**

It may be noted that the Public Participation activities were not specifically conducted for the individual communities in each of the Islands A, C, D and E. Moreover, the Public Scoping was done for the entire reclamation project including all the 4 Islands then the issues presented for each individual island are for the entire reclamation project.

**IEC** – Discussed in Section ES and **Annex ES-B2**.

**Perception Surveys** – Discussed in Chapter **2.4.9**.

**Public Scoping** – As discussed in the **ES**, the Public Scoping conducted on 21 November 2018 for the Municipality of Noveleta and Rosario and was attended by participants from different sectors. The concerned stakeholders, especially those known to have opposing on reclamation projects, as well as those located in the Impact Areas were invited to participate. The objective of the conducted Public Scoping is to ensure that the Environmental Impact Assessment (EIA) will address the relevant issues and concerns of the stakeholders and that it will be consistent with the Philippine Environmental Impact Statement System (PEISS). A matrix summary of issues/suggestions raised during the public scoping is shown in Tables 2.4-52 and 2.4-53.

#### **2.4.10 Impacts on Tourism**

The impacts on tourism is on enhancement because the reclamation project once operational shall provide alternative destinations for foreign and local tourists.

A Letter of No Objection from the DOT was already secured (**Annex 2.1-A**).





**Table 2.4-52. Matrix Summary of Issues and Concerns Raised in the Public Scoping in Municipality of Noveleta**

| <b>EIA Module</b> | <b>Sector or Representative Who Raised the Issue/ Suggestion</b> | <b>Issues/Suggestions Raised by Stakeholder</b>  | <b>Proponent's Response during Public Scoping Activity</b>  | <b>Page discussed in the EIS</b> |
|-------------------|--|--|---|----------------------------------|
| <b>LAND</b>       | <b>Mr. Edgardo S. Chavez</b>                                     | Liquefaction ay problemang nangyayari pagkatapos ng lindol, gumuguho at lumalambot ang mga lupa malapit sa bodies of water, ano po kaya ang mitigating measures natin para dito?   | <b>Dr. Edgardo Alabastro:</b> Land Hazard Assessment and Geotechnical Assessment ang aming gagawin para malaman ang mga posibleng Hazards. Walang liquefaction kase mag coconduct muna kame ng geotechnical survey/ investigation. Malayo naman ang area sa west valley fault. At isipin nyo to magiinvest ka ba ng malaki kung hindi ka sigurado sa kaligtasan ng iyong project? May mga engineering techniques kaming gagawin para masigurado ang kalidad ng aming proyekto |                                  |
|                   | <b>Mr. Alvin Bunag</b>   | Yung part ng Imus river medyo mababaw na po. Yung malapit sa may island cove. Pupwede mo ng lakaran halos yung ilog sa babaw nito eh, baka pupwedeng pag aralan kung maaring gawing panambak ang lupa mula sa imus river. Nakatulong na po kayo sa amin at sanay makatulong din kame sa inyo salamat po.                         | <b>Dr. Edgardo Alabastro:</b> Pagaaralan namin yan, matutulungan nyo kame pero dapat makapag pakita muna kayo ng study at geological features at kung may quarry permit na ang lupa sa ilog na yan.   |                                  |
| <b>WATER</b>      | <b>Ms. Mercy F. Pasco</b>  | Base po kase sa aking obserbasyon dati hindi binabaha ang area malapit sa pinag tayuan ng MOA at Macapagal pano nyo masisiguro na hindi mangyayari sa cavite ang pagbaha sa MOA at Macapagal?  | <b>Dr. Edgardo Alabastro:</b> Iba ang MOA at Macapagal sa Cavite, iba ang klase ng pagkakagawa iba ang mga expertong humawak at madami pang iba, pero gagamitin namin ang experience na ito at ikukonsidera para magamit sa aming report.   |                                  |
|                   | <b>Mr. Arman Bernal</b>  | Catch basin po ng tubig mula sa upland, ang aming mga nasasakupan hindi ba mahaharangan ang daloy ng mga tubig mula sa taas baka magdulot ito ng pagbaha sa aming mga ka nayon? Sana ay magkaroon ng pag aaral tungkol dito para mamitigate ang issue na ito.  | <b>Engr. Lene Ramboyong:</b> Noted  |                                  |
| <b>PEOPLE</b>     | <b>Ms. Vivian Tolentino</b>                                      | Noong nakaraang October 10 Hindi kasama ang kawit sa report pero kung titingnan ang inyong plano Kawit ang pinaka apektado ng Island A. Ang Kawit ay may size na more than 1,330 halos kakambal na sa size ng munisipyo at kame ay natatakot sa posibleng maging epekto nito sa amin kung sakaling maitayo na ang project na ito | <b>Dr. Edgardo Alabastro:</b> Hindi namin kinokonsidera sa ngayon ang mga apektadong lugar, mas pinapahalagahan muna namin ang mga technical aspects bago ang mga area.<br><br><b>Engr. Lene Ramboyong:</b> Makikita po ninyo ang mga report na aming marerecieve sa aming website, maaaccess po ninyo ito at magbibigay din kame ng kopya sa inyong mga barangay.  |                                  |
|                   | <b>Konsehal Buddy Samartino</b>                                  | Kung magkakaroon po ng relocation e puro mangingisda ang mga tao sa amin baka naman ilipat nyo sila sa bukirin, ano  | <b>Engr. Lene Ramboyong:</b> Hindi po maaaring ilipat ang mga mangingisda sa bukirin, sa aming review pag aaralan pong  |                                  |



| EIA Module    | Sector or Representative Who Raised the Issue/ Suggestion | Issues/Suggestions Raised by Stakeholder  | Proponent's Response during Public Scoping Activity  | Page discussed in the EIS |
|---------------|---|---|--|---------------------------|
|               |   | namang klaseng buhay ang kanilang makukuha doon di po ba?   | mabuti kung saan magandang ilipat sila na makuha nila ang kanilang dating trabaho.   |                           |
| <b>OTHERS</b> | <b>Konsehal Boy Alvares</b>                               | May proposed Project po ang JICA SA Noveleta Rosario, Kawit at Gentri, ito pong proposed cavite reclamation project ay di po ba magcoconflict sa site kase hektahektarya po ang pinag uusapan po dito.  | <b>Dr. Edgardo Alabastro:</b> Bahagi po ng aming report na tugunan ang katanungan nyong ganyan. Kung May Project pa na magcoconflict sa aming project at idudulog namin sa proponent ng lalawigan. Aalamin po muna namin kung approve na ba ang project na ito o ano na ang status nito. Meron na bang funding at higit sa lahat meron na po bang ECC.<br><br><b>Engr. Lene Ramboyong:</b> So wala pang idea ang preparer tungkol sa project na ito at hindi pa nila masasagot kung magkakaroon ng overlapping |                           |
|               | <b>ENS. Kenneth Amiel Jaho</b>                            | May info ba kayo o knowledge na may proposed reclamation ang Philippine Navy along the coast of Bacoor Bay  | <b>Ms. Nadia Conde:</b> We consider sa pag aaral namin kase as of now wala pa kaming any concrete idea tungkol sa project nyong yan pero icoconsider po namin yan sa pag gawa ng report naming.  |                           |
|               | <b>Mr.Rene Zaldy Porlaje</b>                              | Yung sa invitation po ay 1331 tapos ngayon 1332 ano po ba talga ang exact area po ng project?<br><br>Inform po namin kayo na based on our studies madaming present marine species sa area tulad ng corals at sea grass at egg larva.<br><br>May mga concrete plan na po ba kayo sa mga fisher folks, madami ang fisherfolks sa project area nyo may data po kame, may mga financial package po ba as an example?<br><br>Benefits ng 41 barangays na apektado sa project site. Reclamation, Settlement o kaya Discount kapag gustong bumili ng property ng mga nakatira dto. | <b>Dr. Edgardo Alabastro:</b> Proposal stage palang kame, walang relevant impact sa Land, Water, Air and People as of Now. Makikita natin yung posibleng maging epekto ng project pagkatapos magawa ang whole EIS document. At pag nagpulong pulong muli tayo saka namin masasagot lahat lahat ng inyong mga katanungan.   |                           |
|               | <b>Mr. Alvin Bunag</b>                                    | Sino po ang financer po nyan?   | <b>Dr. Edgardo Alabastro:</b> Hindi pa po natin masasabi kung sino sino ang mag iinvest sa project. Nasa stage po tayo na mag  |                           |



| EIA Module | Sector or Representative Who Raised the Issue/ Suggestion | Issues/Suggestions Raised by Stakeholder   | Proponent's Response during Public Scoping Activity  | Page discussed in the EIS |
|------------|---|--|--|---------------------------|
|            |   |  | <p>aapply palang po tayo ng ECC. Sa aking experience makakahikayat lang ng mga investors ang isang project kapag may ECC na parang ito ang nag aanyaya sa kanila na mag invest basta may ECC na madali nalang lahat ng yan.</p> <p><b>Engr. Lene Ramboyong:</b> Malinaw lang po na ang proponent ay ang Provincial Government of Cavite,</p> |                           |
|            | <b>Mr. Alvin Tamaros</b>                                  | <p>Katulad ng sinabi ni vice mayor ay may kinalaman ito sa pag baha, yung proposed project po ng JICA, Flood Control project. 100m from Kawit to Salcedo at popondohan ng JICA at ng Gobyerno. Sa katunayan ay suportado ito ng ating pangulong Duterte. Almost 800 families po ang affected ng relocation pero nagsasagawa na sila ng pag aaral at dito sa Noveleta ang naghahanap ng lilipatan. Sana maisama sa pag aaaral nyo po ito.</p> <p>Isa pa diba pag nag reclaim ka mayroong sharing ang local Government dito?</p> | <p><b>Engr. Lene Ramboyong:</b> Noted</p> <p><b>PRA:</b> Hindi pa namin masasagot iyan kase proposal pa lang pero siguradong magkakaroon ng share ang government at LGU.</p>   |                           |
|            | <b>Rene Zaldy Porlaje</b>                                 | <p>Hindi na po namin tinatanggap ang ginamit nyong method sa pag kuha ng marine survey sa area.</p> <p>Baka may iba pa kayong pwedeng pagkuhanan ng lupa para sa reclamation area. Bukod sa san Nicolas , puro kase san Nicolas shoal ang pagkukuhanan ng panambak sa napakadaming reclamation area sa Manila Bay.</p> <p>Ang mga concerns lang naman po namin ay may kinalaman sa water bodies salamat po</p> <p>Resettlement Plan in required.</p>   | <p><b>Dr. Edgardo Alabastro:</b> Ituro ninyo kung saan pa pwedeng makakuha ng lupang panambak, pakitaan nyo kame ng permits para mapag aralan, malaking tulong sa amin kung may maipapakita kayo.</p> <p><b>Engr. Lene Ramboyong:</b> Noted</p>  |                           |





**Table 2.4-53. Matrix Summary of Issues and Concerns Raised in the Public Scoping in Municipality of Rosario**

| EIA Module | Sector or Representative Who Raised the Issue/ Suggestion | Issues/Suggestions Raised by Stakeholder   | Proponent's Response during Public Scoping Activity  | Page discussed in the EIS |
|------------|---|--|--|---------------------------|
| LAND       | Mr. Marcos Aristotle P. Alvarez                           | Maganda po kase yung inyong nagiging proposal nakikita naman po natin yan na ginagawa sa ibang bansang kapit bahay natin, Singapore at Malaysia. Ang tanong ko lang po diba sabi nyo kanina may curtain na hindi guguh, ang tanong ko lang saan natin kukunin yung pantatambak doon sa dagat? Kasi nung una maiisip natin saan mapupunta yung water na madidisplace doon kung galing halimbawa po sa bundok yung lupang panambak syempre tataas po ang tubig pero sa tingin ko kung sa dagat nga kukunin yung water na matatangal dun ay lilipat lang kung saan kinuha yung lupang panambak, saan nga po kukunin? Di po ba sa cavite kase maaari din po yang magdulot ng maguho doon sa baybay dagat natin at lumiit po yung lupa. Kase napapansin po namin sa Noveleta po unti unting nawawala po yung shorelines so maaring epekto nga po yan ng unti unting mapaguh na hindi natin nakikita na eventually ay lumilipas po yung time ay ganon po yung mangyayari kaya po kung may curtain yun mga itatayong isla then what will happen gaya po nyan di natin alam san kukunin ang panambak natin dyan. | <b>Ms. Nadia Conde:</b> Yan pong filling materials ay meron na tayong iniisip na pwedeng pagkuhanan, ang source ay yung San Nicolas Shoal yun po. . Common reclamation sources po yun ng Manila Bay area po, yun po ang pinopropose na pagkukuhanan at kung doon talaga hindi po natin masabe kase San Nicolas Shoal ay dagat din po yan, pero hindi naman po pwedeng basta basta kumuha ng panambak, and hindi lang po buhangin ang itatambak meron pong mga armour rocks po na ilalagay na dapat po ay nasa tama po sya at meron po dyan na specification. . So lahat po ay pag aaralan po muna, so wala pa po akong hundred percent na sources talaga ng pagkukuhanan so tinitingnan pa po naming ang mga options. Yung sinasabi naman po ninyo na magpapatag ng bundok or what so hindi naman po siguro kase iba naman po yung klase ng lupa doon eh pero syempre pinagaaralan po lahat. |                           |
|            | Message from Mayor Jose V. Ricafrente III                 | Yung position ng magno property, pwede nyong idugtong ang reclamation project na may about 3-5 hectares na nasasakupan ng Barangay Kanluran. Reclaimed area sya.   | <b>Ms. Nadia Conde:</b> Noted  |                           |
|            | Kap. Jomer M. Bumatayo                                    | Meron pa pong nakaready na area na may tambak na mga bato malapit sa nasasakupan ng reclaimed area na .  |  |                           |
| WATER      | Mr. Michael L. Del Rosario                                | Yung sa Fishing grounds, di naman lingid sa inyo na madami po kaming nilagay na artificial coral reefs na nilagay dito sa  | <b>Ms. Nadia Conde:</b> As to fishing grounds naman po, sabi ko nga po initial stage palang po wala pa po kaming ginagawang buong pag aaral, mag uumpisa po talaga kami right after ng technical   |                           |



| EIA Module | Sector or Representative Who Raised the Issue/ Suggestion | Issues/Suggestions Raised by Stakeholder  | Proponent's Response during Public Scoping Activity   | Page discussed in the EIS |
|------------|---|---|---|---------------------------|
| PEOPLE     |   | municipal waters , papaanong recovery po ang gagawin natin? Panigurado pong tatamaan po iyon ng reclamation.  | scoping na gagawin sa EMB kung ano po ang irerequire nila na gagawin namin. Pero icoconsider po namin yung concern ninyo about sa corals and we have marine experts na mag coconduct ng study on the area and we will coordinate din po with the BFAR kase may mga studies din po silang kinoconduct sa buong Manila Bay so icoconsider po namin yung concern na yon. Pero kung sa plan as of now sir wala pa po kaming plano at makikipag coordinate pa po kame sa DENR kung ano po ang gagawin kase we have certain laws about coral reefs. Hindi naman po pupwedeng kunin natin at ilipat sa ibang area.<br><br><b>Engr. Lene Ramboyong:</b> Kami din po sa ibang reclamation project na hinawakan ng DENR, Isa din po yun talaga sa mga binabantayan namin yung mga coral reefs. Kung sakaling matutuloy po ang proyekto at kung ano ang maari nilang gawin kung maapektuhan man sila, kung ililipat man nila . kase lahat po yun ay kinocoordinate namin sa other government agencies. . Kasi hindi po kame pwedeng gumalaw na hindi po nila alam , kasi meron po silang sariling guidelines pero maaasahan nyo po na yung inyong concern kasama po yan sa sasabihin po namin sa kanila na pag-aralan nyo mabuti kung paano ma mimitigate yung damages na mangayayari doon sa mga coral reefs. |                           |
|            | <b>Congressman Michael Del Rosario</b>                    | Kasi po yung magno property po natatamaan po ang aming drainage system. Sana mabili po ito at masama sa reclaimed area. . Ang magiging impact po sa amin ng reclamation project nyo ay maaayos po ang aming drainage system which is malaking benefits na magiging maluwag po kase parang kanal nalang po ang aming drainage system | <b>Engr. Lene Ramboyong:</b> Any project must consider the drainage system. Hindi pwedeng maharangan ang daanan ng tubig.   |                           |
|            | <b>Mr. Alex Mañago Sr.</b>                                | At ang concern ko lang po sir kase kame po yung nag interview ng mga tao dito, ang parati pong tanong sa amin magkakaroon ba kame ng trabaho dyan?. Ang sagot ko naman dyan priority kayo pag inumpisahan na tong project na to, priority tayo na taga rito para magkaroon ng trabaho , yun   | <b>Ms. Nadia Conde:</b> Tulad nga po ng sinabi ko kanina priority po ang local residents. Qualified local Residents yun po ang lagi nating sinasabi para po walang sabihin at masabing walang issue .kasi hindi naman po pupwede na Kahit kayo po hindi naman pupwede na magpagawa kayo ng bahay tapos sasabihin  |                           |



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|            |   | po ang naisagot ko sa kanila. Ano po ba ang totoo? Pwede po ba sila na makapagtrabaho doon sa gagawing reclamation na iyan?                     | <p>nyo na ako po . di naman pupwede na kukunin nyo ko dahil kapit bahay nyo ako. And with regards to your concern na sure ba talaga? Not us, and developer man yun o ang construction group definitely mag cocoordinate dun sa local government.</p> <p><b>Engr. Lene Ramboyong:</b> Isa din po yun sa laging sinasabi namin sa mga humahawak ng proyekto lalo na doon sa mga proponent. Na lagi nyong bigyan pansin yung mga local residence, hanggat maaari imaximize nyo po ang yung qualified na mga aplikante bago kayo kumuha sa labas.</p> <p><b>Congressman Michael Delrosario:</b> In behalf po ng sangguinang bayan, gagawa po kami ng ordinansa o batas na sa amin muna po yung priority ng pagkuha po ng empleyado, resolusyon po iyon na sa lahat ng gagawin po priority po muna yung taga Rosario para mabigyan po ng hanap buhay. Yung aming mga kabnayon. Ginawa na po natin yan doon sa mga iba po sa EPZA. Kahit po sa SM before na meron pong kasunduan na almost 80 % po ata ay empleyado ay taga Rosario, so dito po ay pwede po nating gawin yun ng mabigyan natin ng kasagutan yung tanong ng ating mga taga ka nayon.</p> |                           |
|            | <b>Ms. Devina M. Cenizal</b>                              | Ang tanong ko po kase ako po ay taga Tanza , ano po ang magiging effect nyan sa aming mga taga Tanza kase kapit bahay lang yan , kasunod lang . | <b>Ms. Nadia Conde:</b> Yung Effect na sinasabi nyo eto pong Municipality ng Rosario , Noveleta and Cavite city yun po yung tinatawag namin na Direct Impact Areas (DIA) pero it doesn't mean na dahil direct impact areas sila lang and positive meron ding negative , so ang Tanza, Kawit almost nearby Municipality sila kinoconsider po natin yuna as impact areas which is indirect impact area pero it doesn't mean na pababayaang kayo at kung negative effect . syempre po kung may negative effect definitely dun din sa municipalities na sakop meron din so yun po ang iiwasan natin ayaw ko sabihin na kayo may negatibo tapos sila positibo lang. So iiwasan po natin kung ano man ang posibleng maging negative impact, and for the positive impacts naman  |                           |



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|            |   |   | <p>hindi naman po hundred percent na siguradong mga impact areas lang ang makikinabang dito, yung benefits din po ay syempre kasama na din po kayo , pag nagtayo kayo ng sm hindi naman siguro yung tatlong munisipyo lang ang makikinabang so for the economic benefits syempre it's a provincial project naman po, governors project po.</p> <p><b>Engr. Lene Ramboyong:</b> Kase sa EIA dalawa po yan yung indirect at direct impact assessment, yung indirect impact assessment hindi kayo kasama dun sa direct impact areas pero just the same lagi silang kasama sa assessment. Lalong lao na kailangang masagot doon na kasama sya. Kailangang masagot yun sa EIA, laong lalo na yung modules ng Land, Water, Air, and lalong lalo na po ang people. Lagi po namng hinahanap yan sa dokumento nila kapag nawala po yung indirect impacts na yon, ibabalik po namin sa kanila yung report para sagutin nila kung ano ang magiging impact nito mapa positive o negative dito sa indirect impact area lagi po silang kasama.</p> |                           |
|            | <b>Kap. Jomer M. Bumatayo</b>                             | Sa mga mamalakaya, pag na reclaim na po yung area saan po magkakaroon ng garahihan yung mga Bangka saan po ilalagay yung mga Bangka ? | <p><b>Ms. Nadia Conde:</b> Kung kalangan po ng exact location wala pa po kaming definite na location kung saan exactly, pero kinoconsider po namin yun sa pag aaral.. With coordination with the local government at alam namig na di papayagan na maichapwera kayo.</p> <p><b>Engr. Lene Ramboyong:</b> Hindi pa po natin malalaman yan ngayon hanggat hindi pa po sila nagsusubmit ng tinatawag nating EIS report. Doon po makikita nyo yung mga datos na nakuha nila bago pa mag patayo ng proyekto. Makikita nyo po yan sa tinatawag nating Draft EIS. Hanggang sa dumaan na po ito sa mga proseso para sa ecc application at hindi po matutuloy ang proyekto hangat di nila nasasagot ang inyong mga katanungan.dapat maaddress lahat ng issues and concerns bago sila bigyan ng ECC.</p>   |                           |





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|------------|---|--|---|---------------------------|
| OTHERS     | <b>Mr. Sergio Serico Nepomuceno</b><br>CPRD-National Museum | Naka attend na po kame ng mga ganitong Public Scoping na may kinalaman sa mga reclamation project at marami ng nang yayari sa Manila ngayon. Nais ko lang pong ipagbigay alam sa inyong mga taga Cavite gaya po ng sinabi ko kahapon sa Cavite City na pinapahalagahan po ng pambansang Museo ang makasaysayang lalawigan ng Cavite at ang mga ganito nga pong pagkakataon na may mga reclamation project ay nabubungkal po ang nasa ilalim ng lupa lalo na yung nasa karagatan , kasi po nung araw ay aktibo po itong karagatan ng Cavite at maaari po na may mga marine vessels at cultural property objects na maaaring nasa inyo pong karagatan. So nakikipagugnayan po kame sa mga project developers na sila po ay magapply po sa amin ng Archeological Assessment kung saan po sila ay hahanap ng archeologist of their choice para gumawa at magprepare po ng report na isusubmit po sa amin for clearance purposes po. At matapos po naming maapprove ang archeological clearance ay continues naman po ang monitoring ng cultural properties regulation division pati po yung aming maritime underwater division. Atleast may idea po kayo na bukod po sa environmental concerns ay pinapahalagahan din po natin ang aspeto pong pangkalinangan o yung mga tinatawag naming cultural properties. | <b>Engr. Lene Ramboyong:</b> Noted po   |                           |
|            | <b>Kap. Ernesto "JonJon" V. Cupino Jr.</b>                  | Mam Yung Technotrix Consultancy Services Inc. ay bukod po ba dito sa project na to ay mga nakaraang projects papo kayo na nag reclaim po kayo ng mga areas ?   | <b>Ms. Nadia Conde:</b> Up to ECC issuance lang po kame ako po personally ang mga nahandle ko na pwede ko ng I announce is we have the Pasay City Reclamation and we have the Manila Reclamation. . Ngayon sir may ECC na pero wala pa nung tinatawag natin na area clearance para makakuha sila ng notice to proceed sa PRA para ma authorize na sila to reclaim in short wala pang nauumpisahan dun pero meron na po syang ECC. |                           |
|            | <b>Mr. Randy Legaspi</b>                                    | Potential Impact lahat kase may mitigation and enhancement ang accidental spoilage lang ang wala.  | <b>Ms. Nadia Conde:</b> Hindi pa po kase final ang aming report maaari pong nung day na yon hindi pa naiinput ang data pero meron na po.  |                           |



| EIA Module | Sector or Representative Who Raised the Issue/ Suggestion | Issues/Suggestions Raised by Stakeholder  | Proponent's Response during Public Scoping Activity  | Page discussed in the EIS |
|------------|---|---|--|---------------------------|
|            | <b>Message from Mayor Jose V. Ricafrente III</b>          | <p>May proposed expansion po ang Cavtex dito din po sya mangyayari po sa ating dagat din po yung proposed expansion , kasama po ba yung daang gagawin from Cavtex to something? Dito din po kase yung development , baka po kase sa pag aaral magkaroon po ng problema kase baka mag conflict .</p> <p>Sa mga mamamalakaya yung mga maliliit po naming mangingisda minsan kinukuha nila yung kakainin nila sa dagat baka magkaroon sila ng restriction. Sana mainclude po ito sa inyong report.</p> <p>Gaano po kalayo yung distance ng shore sa reclaimed area po para sa kaalaman ng lahat.</p> <p>Kailan po masisimulan?</p> | <p><b>Engr. Lene Ramboyong:</b> Noted po</p> <p><b>Ms.Nadia Conde:</b> Lilinawin po namin pero ang alam po namin around 200 meters nga po siguro.</p> <p><b>Engr. Lene Ramboyong:</b> Tatlo po kase ang magiging response ng DENR Approval, Denial at return documents kaya binibigyan lang namin sila ng 1 year to submit their EIS. Pero ang problema hindi po ECC ang magpapaumpisa sa start ng project meron pa pong ibang documents needed.</p> |                           |





## Chapter 3. KEY IMPACT MANAGEMENT PLAN (IMP)

### Explanatory Notes:

The following explanatory notes are deemed relevant to the formulation of the IMP for the following reasons:

- The paradigm that an EIS/ECC is a “Planning Tool” and not a Permit is expounded.
- This emphasis is useful when seeking the LONOs from the various agencies to impress on them that they can still exercise their respective mandates even if the ECC shall have been secured.
- It also impresses on the PRA, which has the mandate to issue the NTP to allow project implementation that it can still prescribe other requirements during the conduct of the Design and Engineering Details (DED).
- Equally important, in cases of challenges from the Court, this explanation will serve as an important basis for any court intervention.
- Similarly, when/should challenges or issues arise in the future concerning the ECC, this discussion will become relevant.
- For Reclamation Projects, Impact Management Plan (IMP) declared in the EIS Report are further validated by government authorities post ECC in contrast with other ECPs whereby project implementation may immediately proceed after the securing of their ECCs. Th concepts are illustrated in Figure 3-1.

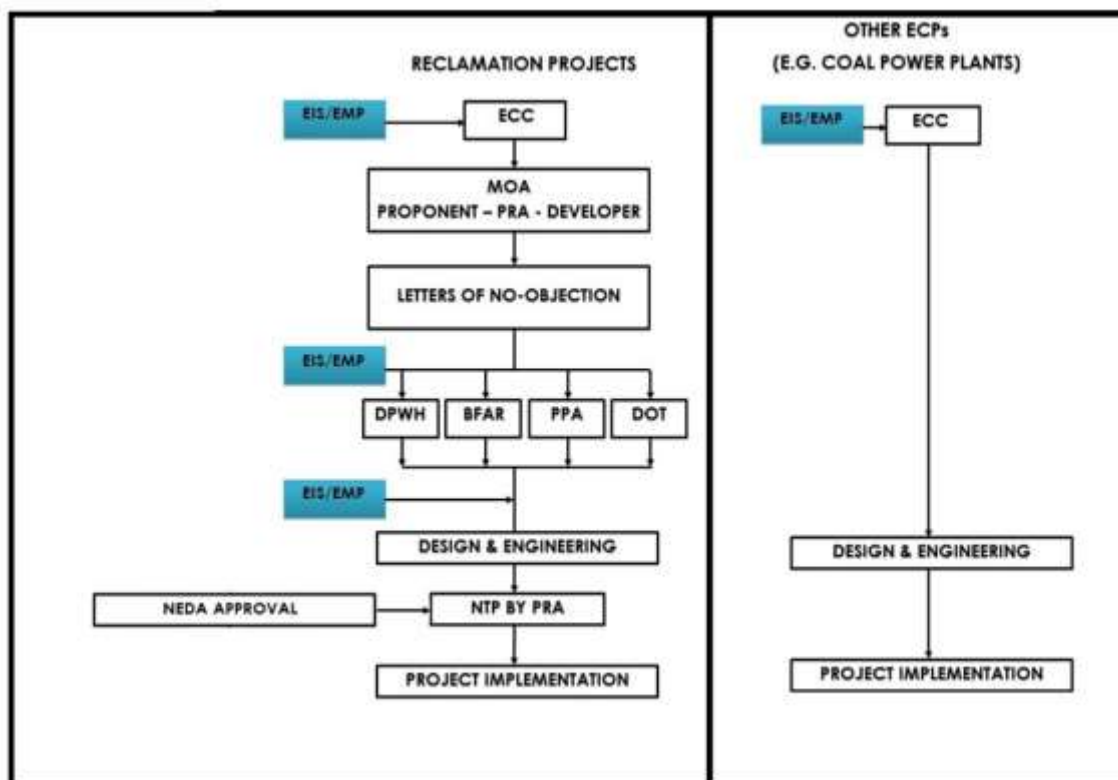


Figure 3-1. Post ECC Implementation of the IMP





The above notes and Figure 3-1 imply the following:

- The EIS Report and the ECC are only planning tools. Environmental protection is more firmly assured in the activities post ECC such as the conduct of Detailed Engineering Design (DED).
- For other ECPs, projects may be implemented (i.e. construction could start) after securing of the ECC, undertaking an internal (by the Proponent) DED and securing construction permits from authorities.
- In the case of Reclamation Projects, there are still two (2) levels of approvals prior to actual construction works. These involve (1) the validation of the IMP prior to the signing of a MOA involving the project the developer and (2) another stage which is the securing of Letters of No Objection (LONO) from concerned agencies. **Thus, environmental protection is planned in the EIS/ECC and further enhanced post ECC by agencies other than the DENR/EMB.**
- Even after the securing of an ECC, changes may be imposed on the master plan for a reclamation project. e.g. the case of the reclamation project in Las Piñas-Paranaque whereby the configuration of the islands was changed to allow for better water circulation.
- ***Another key point is that a Multi Partite Monitoring Team (MMT) is to be organized post ECC. The MMT will further add to additional requirements for the EMP.***

#### **Impacts, Mitigating Measures and the IMP**

The Impact Management Plan (iMP) is summarized in Table 3-1 as derived from the assessment of environmental impacts. This focuses on the major impacts wherein mitigating measures are required.

Moreover the issues and concerns raised during the Public Scoping, a key aspect of the Public Participation activity under DAO 2017-15 are incorporated in the IMP. The impact analysis and proposed mitigation/management measures cover the Land, Water, Air and People modules.



**Table 3-1. Impact Management Plan**

| Project Phase / Environmental Aspect  | Environmental Component Likely to be Affected | Potential Impact Residual Effects (When applicable)                       | Options for Prevention or Mitigation* or Enhancement   | Efficiency of Measures   | Responsible Entity                          | Cost  | Guarantee / Financial Arrangements   |
|---|---|---|--|--|---|---|--------------------------------------|
| <b>I. PRE-CONSTRUCTION PHASE</b>  |   |   |  |  |   |   |                                      |
| Geotechnical Survey Completed. Clearances from the Philippine Coast Guard were secured prior to the actual survey works. Limited and non-destructive activities (Marine ecology survey, bathymetric survey and geotechnical exploration). There are no residual impacts on the environment. |   |   |  |  |   |   |                                      |
| <b>II. CONSTRUCTION PHASE</b>   |   |   |  |  |   |   |                                      |
| <b>DREDGING WORKS ACTIVITY</b>  |   |   |  |  |   |   |                                      |
| Removal of unwanted seabeds and silt  | Water Quality                                 | Water pollution brought about by silt disturbance within the project area | Installation of silt curtains around the dredging vessel and around the perimeter area of dredging area/activities   | Allowable Ambient Criteria or 100% Compliant to RA 9275 and DAO 2016-08 standards outside the silt curtain area. | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | MOA among Consortium; ECC commitment |
|   | People  | Impact on the livelihood of fisherfolks that will be displaced            | <ul style="list-style-type: none"> <li>Assistance in refurbishing and increasing the number of fish aggregating device (FADs) previously set in coastal waters by the MAO and its sustainable management. New, more suitable sites will be identified and the design of ARs will consider aggregation of both demersal and pelagic species of fish.</li> <li>Provision of more appropriate fishing gears to organized fishers to enable them to fish further offshore where stocks of sardines (<i>Sardinella lemuru</i>) are more plentiful.</li> </ul> | 100% Compliance to livelihood and Fish Aggregating Device (FAD)  | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | MOA among Consortium; ECC commitment |



**CHAPTER THREE**  
**Impact Management Plan (IMP)**  
**Proposed Cavite Province Land Reclamation and Development Project: ISLAND D (267 ha)**  
Cavite Provincial Government

| Project Phase / Environmental Aspect                  | Environmental Component Likely to be Affected | Potential Impact Residual Effects (When applicable)   | Options for Prevention or Mitigation* or Enhancement   | Efficiency of Measures   | Responsible Entity                          | Cost  | Guarantee / Financial Arrangements   |
|---|---|---|--|--|---|---|--------------------------------------|
|   |   |   | Collaboration with BFAR, the project will support diversification of fisher livelihoods into cage culture of Pompano and other full-cycle species                              |  |   |   |                                      |
| Transport of dredged material to disposal site        | Water Quality                                 | Water pollution due to accidental spillage of dredged materials   | The hauler shall ensure that vessels used for transporting are in good condition to prevent dredged materials from leaking or spilling   | Allowable Ambient Criteria or 100% Compliant to RA 9275 and DAO 2016-08 standards outside the silt curtain area.                   | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | MOA among Consortium; ECC commitment |
| Dumping of dredged material to disposal site (Inland) | Soil and water quality                        | Soil and water Pollution due to disposal of dredged materials   | Installation of high density polyethylene (HDPE) liner and/or clay for the spoil disposal site to prevent soil and water (ground and surface) contamination and zero discharge | No soil contamination and Allowable Ambient Criteria due to disposal of dredged materials  | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | MOA among Consortium; ECC commitment |
| Dredging of filling material for reclamation          | Water Quality                                 | Water pollution due to dredged filled materials   | Installation of silt curtains around the dredging vessel and/or dredging area  | Allowable Ambient Criteria or 100% Compliant to RA 9275 and DAO 2016-08 standards  | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | MOA among Consortium; ECC commitment |
| Barging of fill materials for reclamation             | Water Quality                                 | Water Pollution due to accidental spillage of dredged materials during barging<br><br>Increase of suspended solids affecting the settlement of marine | Provision of containment facility to prevent spillage<br><br>Provision of control measures when transporting filling materials   | Allowable Ambient Criteria or 100% Compliant to RA 9275 and DAO 2016-08 standards<br><br>100% No proliferation of suspended solids | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | MOA among Consortium; ECC commitment |



| Project Phase / Environmental Aspect  | Environmental Component Likely to be Affected    | Potential Impact Residual Effects (When applicable)  | Options for Prevention or Mitigation* or Enhancement   | Efficiency of Measures   | Responsible Entity                          | Cost  | Guarantee / Financial Arrangements   |
|---|--|--|--|--|---|---|--------------------------------------|
|   |  | species in the dredging and reclamation areas  |  |  |   |   |                                      |
| <b>RECLAMATION ACTIVITY</b>   |  |  |  |  |   |   |                                      |
| Construction of containment structures<br><br>Installation of sand bags/containment wall system along certain areas along the perimeter of the project area | Water Quality                                    | Water pollution/ Increase turbidity of adjacent areas due to Infrastructure /Construction Activities of adjacent areas | <ul style="list-style-type: none"> <li>Installation of a silt curtain 50m away from the working area, surrounding the area to be filled with reclamation materials and in the revetment structures area.</li> <li>Provision of geotextile membrane on the containment structures throughout the perimeters of the project area.</li> </ul> | Allowable Ambient Criteria or 100% Compliant to RA 9275 and DAO 2016-08 standards                    | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | MOA among Consortium; ECC commitment |
|   | Water Quality                                    | Water quality degradation of Ylang-Ylang River   | Conduct of periodic monitoring of water quality and the occurrence of freshwater fish (i.e., abundance, species richness and biomass)  | 100% No freshwater quality degradation and loss of freshwater species particularly Ylang Ylang River | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | MOA among Consortium; ECC commitment |
|   | Water- Change in current pattern and wave action | Fish larvae and other marine species migrating to nearby mangrove areas  | Sustainability of mangrove protection and conservation thru preparation of mangrove conservation plan  | 100% No cutting of mangroves   | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | MOA among Consortium; ECC commitment |
|   | Hazard/Safety                                    | Tsunami/Storm surges   | Strictly implement the recommendation of the EGGAR report  | 100% No flooding and permanent defense   | MMT Members                                 | Part of Project Development Cost of             | MOA among Consortium;                |





**CHAPTER THREE**  
**Impact Management Plan (IMP)**  
**Proposed Cavite Province Land Reclamation and Development Project: ISLAND D (267 ha)**  
Cavite Provincial Government

| Project Phase / Environmental Aspect   | Environmental Component Likely to be Affected | Potential Impact Residual Effects (When applicable)                                 | Options for Prevention or Mitigation* or Enhancement   | Efficiency of Measures   | Responsible Entity                          | Cost  | Guarantee / Financial Arrangements   |
|--|---|---|--|--|---|---|--------------------------------------|
|  |   |   |  | against tsunami/storm surge  | And Proponent's Self-Monitoring             | Php 18.00 B                                     | ECC commitment                       |
|  | People  | Decrease of fish catch production of affected fishermen                             | Livelihood of fisherfolks that will be displaced   | 100% sustained the income of affected fishermen                                    | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | MOA among Consortium; ECC commitment |
|  |   | Health and Safety due to exposure to Construction Hazard                            | Implement wearing of PPE's at all times when inside the project site   | 100% Compliant to PPEs and Zero accident   | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | MOA among Consortium; ECC commitment |
|  |   | Employment  | Priority to qualified local hirees   | 100% Compliance to SDP in terms of local employment                                | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | MOA among Consortium; ECC commitment |
| -Filling the project area with reclamation materials<br>-Delivery of filling and other construction materials through barges | Water Quality                                 | Water pollution /Increase turbidity due to filling materials near reclamation areas | <ul style="list-style-type: none"> <li>• Installation of a silt curtain 50m away from the working area, surrounding the area to be filled with reclamation materials and in the revetment structures area.</li> <li>• Silt curtains shall be removed after all necessary components and materials are in place inside the revetment sections.</li> </ul> | Allowable Ambient Criteria or 100% Compliant to RA 9275 and DAO 2016-08 standards" | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | EIS / ECC Commitment                 |
|  |   | Increase in sedimentation outside the project area                                  | Provision of permeable geotextile membrane to prevent sediments during high and low tide outside the project area.   | Allowable Ambient Criteria or 100% Compliant to RA 9275 and DAO 2016-08 standards  | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | EIS / ECC Commitment                 |



| Project Phase / Environmental Aspect              | Environmental Component Likely to be Affected | Potential Impact Residual Effects (When applicable)  | Options for Prevention or Mitigation* or Enhancement   | Efficiency of Measures                                      | Responsible Entity                          | Cost  | Guarantee / Financial Arrangements |
|---|---|--|--|---|---|---|------------------------------------|
| Hauling of filling materials                      | Air (noise)                                   | Noise generation   | Use of efficient silencers on equipment and other noise dissipating device on all equipment to be used. Avoid use of heavy machinery during night hours. Observe allowable work hours to limit noise.  | 100% Compliant with Noise Standards                         | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | EIS / ECC Commitment               |
|   | Air (Quality)                                 | Dust pollution due to vehicle movements:<br>-Along the road leading to the reclamation area<br>-Within the project area activities | <ul style="list-style-type: none"> <li>Sprinkling of water using water tanker at least four times a day along all possible roads leading to the reclamation area (as shown in an indicative haul route map in the EIS), especially during dry season.</li> <li>Covering all loaded trucks properly/fully using tarpaulin throughout the hauling period.</li> <li>All trucks shall be road-worthy.</li> </ul> | 100% Compliant to RA 8749 in terms of air quality standards | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | EIS / ECC Commitment               |
| <b>LAND DEVELOPMENT</b>                           |   |  |  |   |   |   |                                    |
| Compaction/Soil stabilization of the project area | Land  | Liquefaction due to improper compaction  | Geotechnical analysis of materials and proper design for mitigation EGGAR report   | 100 % No liquefaction                                       | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | EIS / ECC Commitment               |
|   | Water Hazard                                  | Flooding due to insufficient drainage network  | Proper Engineering design of Drainage network  | 100% No flooding  | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | EIS / ECC Commitment               |
|   | Water Quality                                 | Increase sedimentation fluxes  | Stabilization or reclaimed areas through vegetation cover enrichment/enhancement   | 100% No further siltation/sedimentation will occur          | MMT Members                                 | Part of Project Development Cost of             | EIS / ECC Commitment               |



| Project Phase / Environmental Aspect   | Environmental Component Likely to be Affected | Potential Impact Residual Effects (When applicable)   | Options for Prevention or Mitigation* or Enhancement  | Efficiency of Measures  | Responsible Entity                          | Cost  | Guarantee / Financial Arrangements |
|--|---|---|---|---|---|---|------------------------------------|
|  |   |   |   |   | And Proponent's Self-Monitoring             | Php 18.00 B                                     |                                    |
|  | Air (Quality)                                 | Noise pollution due to heavy equipment operation  | <ul style="list-style-type: none"> <li>• Use of efficient silencers on equipment and other noise dissipating device on all equipment to be used.</li> <li>• Observe allowable work hours to limit noise.</li> </ul>   | 100% Compliant to Noise Standards   | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | EIS / ECC Commitment               |
|  |   | Dust pollution due to heavy equipment operation including transport vessels                 | <ul style="list-style-type: none"> <li>• Sprinkling of water using water tanker at least four times a day within the project area especially during dry season.</li> <li>• Transport vessels/barges shall be fully and properly covered and load secured throughout the hauling period.</li> </ul>  | 100% Compliant to RA 8749 in terms of air quality standards"  | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | EIS / ECC Commitment               |
| Construction of horizontal structures such as follows:<br>A. Road networks<br>B. Drainage system (sewage and sewerage system)<br>C. Water distribution<br>D. Centralized wastewater treatment facility<br>E. Power and telecommunication lines | Land  | Land pollution due to indiscriminate /improper dumping of solid wastes and toxic substances | <p>Ensure that its contractors shall practice onsite segregation and establish storage facility of the following:</p> <ol style="list-style-type: none"> <li>1. Construction debris such as used drum, used tires, wood cuttings, iron bar cuttings, etc.</li> <li>2. Hazardous wastes such as used oil, busted lamps, oily rags, etc.</li> </ol> <p>The above waste materials shall be hauled and disposed of by a DENR accredited hauler and treater. Composting facility will be provided to</p> | <p>100% compliance with the following:</p> <ul style="list-style-type: none"> <li>• RA 9003</li> <li>• DAO 1992-29 and DAO 2013-22 and its Revised Procedural Manual</li> </ul> | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | EIS / ECC Commitment               |



| Project Phase / Environmental Aspect | Environmental Component Likely to be Affected | Potential Impact Residual Effects (When applicable)                     | Options for Prevention or Mitigation* or Enhancement   | Efficiency of Measures   | Responsible Entity                          | Cost  | Guarantee / Financial Arrangements |
|--------------------------------------|---|---|--|--|---|---|------------------------------------|
|                                      |   |   | process biodegradable waste. Compost materials shall be used for greening activities.  |  |   |   |                                    |
|                                      | Land/Water                                    | Generation of untreated/ improper disposal of domestic wastewater       | Personnel stationed at the reclaimed land will be provided with on-site portable toilets and washrooms<br>Collection and disposal will be done by a DENR accredited hazardous waste hauler and treater   | Zero discharge of domestic waste to Bacoar Bay.                                    | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | EIS / ECC Commitment               |
|                                      | Water Quality                                 | Water Pollution due Increase storm water run-offs surrounding the Areas | <ul style="list-style-type: none"> <li>• Drainage system should to lead to settling ponds</li> <li>• Sewage and sewerage systems shall have dual piping (going to the wastewater treatment facility and for redistribution)</li> <li>• Provision of storm water collection system</li> </ul> | Allowable Ambient Criteria or 100% Compliant to RA 9275 and DAO 2016-08 standards" | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | EIS / ECC Commitment               |
|                                      | Air (Quality)                                 | Dust pollution emanating from open areas                                | <ul style="list-style-type: none"> <li>• Sprinkling of water along all possible routes leading to the reclamation area, at least four times a day, especially during dry season.</li> <li>• Open areas should be covered with greeneries such as grass, shrubs, etc.</li> </ul>              | 100% compliance with RA 8749 in terms of air quality standards                     | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | EIS / ECC Commitment               |





| Project Phase / Environmental Aspect                                     | Environmental Component Likely to be Affected | Potential Impact Residual Effects (When applicable)      | Options for Prevention or Mitigation* or Enhancement  | Efficiency of Measures                              | Responsible Entity                          | Cost  | Guarantee / Financial Arrangements   |
|--|---|--|---|---|---|---|--------------------------------------|
|  | People  | Health and Safety due to exposure to Construction Hazard | <ul style="list-style-type: none"><li>Implement wearing of PPE's at all times when inside the project site</li></ul>  | 100% compliance to PPEs and Zero accident           | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | MOA among Consortium; ECC commitment |
|  |   | Employment   | <ul style="list-style-type: none"><li>Priority to qualified local hirees</li></ul>  | 100% compliance to SDP in terms of local employment | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | MOA among Consortium; ECC commitment |
| III. ABANDONMENT PHASE   |   |  |   |   |   |   |                                      |
| Dismantling of equipment, clean-up, cessation of construction activities | People  | Reduction and eventual termination of employment         | <ul style="list-style-type: none"><li>Promote alternative livelihood at early stage of project operation.</li><li>Pay employees termination pay and other payment mandated by laws.</li></ul> | 100% compliance with SDP                            | MMT Members And Proponent's Self-Monitoring | Part of Project Development Cost of Php 18.00 B | EIS / ECC Commitment; SDP            |



## Chapter 4. ENVIRONMENTAL RISK ASSESSMENT (ERA)

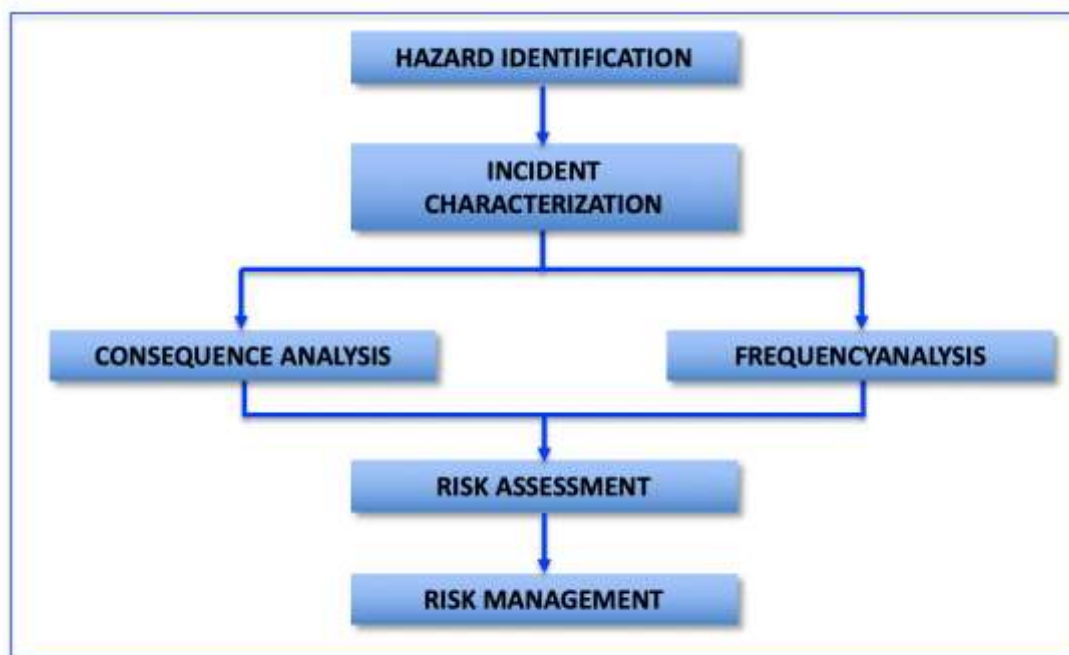
### INTRODUCTION:

The term “risk” is not clearly delineated because the word may have two meanings. It can mean in one context a hazard or a danger of an exposure to an accident, mischance or peril. In another context, risk is interpreted more narrowly to mean the probability or chance of suffering an adverse consequence from a fortuitous event. To illustrate, “flood risk” can refer to the presence of a danger of flooding while a flood hazard to a specific probability such a flood event may occur and can be expressed in quantitative terms such as a “0.10% probability”.

Environmental risk refers to actual or potential threats or adverse effects on living organisms (man, plants, animals, fish, etc.) and the environment caused by effluents, emissions, wastes, resource depletion, etc., arising out of activities involved in a project (*Martin et al., 1977*).

Risk assessment is a systematic method of identifying and analyzing the hazards associated with an activity and establishing a level of risk for each hazard. The hazards cannot be completely eliminated, and thus, there is a need to define and estimate an accident risk level that can be presented either in quantitative or qualitative way.

Figure 4-1 is an illustration of the risk assessment process.



**Figure 4-1. Risk Assessment Process**

Hazard identification involves the identification of all possible events or processes that could lead to disastrous or fatal incidents including potential hazards from substances, chemicals and materials (both physical and biological) used in the project process that could result in adverse effects on personnel/people and the environment. As an example for the reclamation project, “materials” could include the fills sourced from other sites, which will be examined for presence of harmful chemicals such as metals, which if present could present risk of contamination of the sea.



Consequence analysis involves the assessment of the adverse or unacceptable effects or results of an incident or episode from a project activity. When applicable, mathematical models may be employed for consequence analysis.

**Frequency analysis** is the estimation of the likelihood of number of occurrences of the identified hazard and/or the time occurrences of such.

**Risk management** refers to the overall process of prevention and reduction of the evaluated hazards, containment of the actual incident/episode, instituting response measures and the monitoring and communicating of the risks to stakeholders and project proponent/developer.

The main objective of this section is to identify and analyze hazards, the event sequences leading to hazards, the risk of hazardous events and the management of the elements of risks, which are particular to this Project relating to the coverage of the ECC being applied for.

The discussions below are based on of the Revised Procedural Manual of DAO 03-30 in particular Annex 2-7e. As stated in the RPM, an ERA, within the context of Philippine EIS System, is concerned primarily with safety risks (characterized by low probability, high consequence, accidental nature and acute effects associated and focused on human safety).

As discussed in previous sections, this EIS Report and the ECC application being made is for the reclamation works (Construction Phase of the EIS cycle) while the Operations Phase will be subject to separate requirements of the PEISS. Thus, focus is made on the creation of stable reclaimed land up to and including horizontal developments.

The ERA is focused on the movements at sea of vessels, dredging and related activities. Once the land is created, the ensuing period of at least one (1) year will no longer require the use of the vessels and dredging equipment (such as the TSHD and/or other dredgers) and will instead involve land/soil stabilization only as well as horizon development activities.

#### 4.1 Level of Coverage of the ERA

Reference is made to Annex 2-7e of the RPM for DAO 2003-30

##### I. LEVELS OF COVERAGE AND SCOPING REQUIREMENTS

The requirement for the conduct of ERA shall be defined in three (3) levels:

**Level 2** – for facilities that will use, manufacture, process or store hazardous materials in excess of **Level 2** threshold inventory shall be required to conduct a Quantitative Risk Assessment (QRA) and prepare an Emergency/Contingency Plan based on the results of the QRA.

**Level 1** – for facilities that will use, manufacture, process or store hazardous materials in excess of **Level 1** threshold inventory shall be required to prepare an Emergency/Contingency Plan based on the worst-case scenario. The Plan shall be based on a Hazard Analysis study.

Risk Screening Level – specific facilities or the use of certain processes shall require the conduct of a risk screening study even if the projected or estimated inventory does not reach the threshold levels.

##### II. TECHNICAL GUIDELINES FOR THE CONDUCT OF ENVIRONMENTAL RISK ASSESSMENT

###### Determination of Risk Levels

###### Levels of Coverage and Requirements



**Risk Screening Level.**

The following activities are required to undertake a risk screening exercise:

- 1) Facilities for the production or processing of organic or inorganic chemicals using:
  - alkylation
  - amination by ammonolysis
  - carbonylation
  - condensation
  - dehydrogenation
  - esterification
  - halogenation and manufacture of halogens
  - hydrogenation
  - hydrolysis
  - oxidation
  - polymerization
  - sulphonation
  - desulphurization, manufacture and transformation of sulphur-containing compounds
  - nitration and manufacture of nitrogen-containing compounds
  - manufacture of phosphorus-containing compounds
  - formulation of pesticides and of pharmaceutical products.
  - distillation
  - extraction
  - solvation
- 2) Installations for distillation, refining or other processing of petroleum products.
- 3) Installations for the total or partial disposal of solid or liquid substances by incineration or chemical decomposition.
- 4) Installations for the production or processing of energy gases, for example, LPG, LNG, SNG.
- 5) Installations for the dry distillation of coal or lignite.
- 6) Installations for the production of metals or non-metals by a wet process or by means of electrical energy.
- 7) Installations for the loading/unloading of hazardous materials as defined by RA 6969 (or DAO 29)

Levels 1 and Level 2 Threshold Inventory. The following threshold levels shall be used to determine whether a proposed project or undertaking shall be required to prepare a QRA and/or an emergency/contingency plan:

**Table 4-1. Levels 1 and Level 2 Threshold Inventory**

| <b>CATEGORY</b>                | <b>LEVEL 1 (tons)</b> | <b>LEVEL 2 (tons)</b> |
|--------------------------------|-----------------------|-----------------------|
| Explosives                     | 10                    | 50                    |
| Flammable substances           | 5,000                 | 50,000                |
| Highly flammable substances    | 50                    | 200                   |
| Extremely flammable substances | 10                    | 50                    |
| Oxidizing substances           | 50                    | 200                   |
| Toxic substances (low)         | 50                    | 200                   |
| Toxic substances (medium)      | 10                    | 50                    |
| Toxic substances (high)        | 5                     | 20                    |
| Toxic substances (very high)   | 0.2                   | 1                     |
| Toxic substances (extreme)     | 0.001                 | 0.1                   |
| Unclassified (Type A)          | 100                   | 500                   |
| Unclassified (Type B)          | 50                    | 200                   |

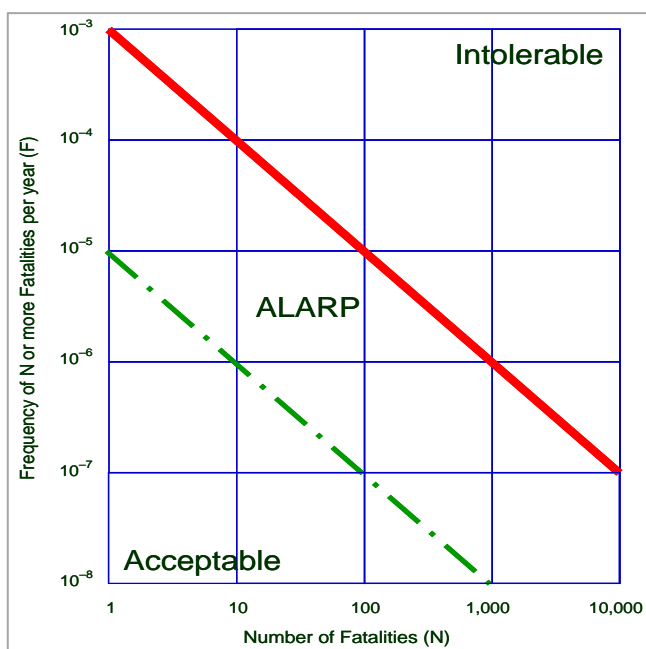




**Table 4-2. Categories of Hazardous Materials**

| Category   | Definition   |
|--|--|
| A. Explosives<br>(Reactivity)  | <ol style="list-style-type: none"> <li>1. A substance or preparation, which creates the risk of an explosion by shock, friction, fire, or other sources of ignition.</li> <li>2. A pyrotechnic substance (or mixture of substances) designed to produce heat, light, sound, gas, or smoke or a combination of such effects through non-detonating self-sustained exothermic chemical reactions.</li> </ol>   |
| B. Flammable Substances<br><br>(Highly flammable and extremely flammable substances) | <ol style="list-style-type: none"> <li>1. Flammable substances are substances and preparations having a flash point equal to or greater than 21°C and less than or equal to 55°C, capable of supporting combustion.</li> <li>2. Highly flammable substances are substances and preparations which may become hot and finally catch fire in contact with air at ambient temperature without any input of energy, or substances which have a flash point lower than 55°C and which remain liquid under pressure, where particular processing conditions, such as high pressure or high temperature, may create major-accident hazards.</li> <li>3. Extremely flammable substances are liquid substances and preparations which have a flash point lower than 0°C and the boiling point (or, in the case of a boiling range, the initial boiling point) of which at normal pressure is less than or equal to 35°C; gaseous substances and preparations which are flammable when in contact with air at ambient temperature and pressure, whether or not kept in the gaseous or liquid state under pressure; or, liquid substances or preparations maintained at a temperature above their boiling point.</li> </ol> |
| C. Oxidizing substances  | Substances which give rise to highly exothermic reaction when in contact with other substances, particularly flammable substances.   |
| D. Toxic Substances  | <p>Low, medium, high, very high and extreme toxicity of substances or preparation are classified as follows:</p> <ol style="list-style-type: none"> <li>1. A substance shall be considered as a liquid if vapor pressure is less than 1 bar at 20°C.</li> <li>2. A substance shall be considered as a gas if vapor pressure is greater than 1 bar at 20°C.</li> <li>3. The sum of (a) and (b) as provided in Tables 2 and 3 shall determine the toxicity class as contained in Table 1.</li> </ol>   |
| E. Unclassified Substances   | Substances or preparations that react violently with water (Type A), and substances or preparations, which release or liberate toxic gas in contact with water (Type B).   |

Moreover, the guideline for Societal Risk is reflected in Figure 4-2.



Source: Figure 1 of Annex 2-7 e

**Figure 4-2. Societal Risk Criteria**



Following are the key information in risk assessment:

The project site is at sea whereat there are no population centers. Therefore “**societal risk**” is not germane to the project. The construction phase personnel are stationed at ships and small in number, i.e. of less than about fifty (50) persons.

Activities which would be undertaken at or near populated areas are those associated with the construction of the connecting points to the land of the access ways.

In the dredging and land formation works, Environmental Risks are most relevant to and associated with the operations of the type of equipment to be used as chosen by the Contractor to be awarded the works. Either a Trailing Suction Hopper Dredger (TSHD) or a Cutter Section Dredger (CSD) will be employed.

In case a TSHD will be use risks may potentially arise during the transport or movement of the vessel.

In the identification of hazardous materials to establish threshold levels Marine Diesel Oil (MDO) is the reference material. Being a heavy fuel oil, flash and fire points are not of significant concerns.

The general operating cycle of the TSHD is shown below:

|  |   |
|--|---|
| Travel cycle of TSHD from site to SNS and back | 7 hours/cycle                                 |
| Trench Dredging Cycle                          | 350 hours                                     |
| Total  | 6.5 years                                     |
| Hopper Capacity                                | 1500-3000 m <sup>3</sup>                      |
| Volume Fill required for 5 islands             | 124,920,000 m <sup>3</sup>                    |
| Total Number of cycles                         | 7800  |
| Total hours operating                          | 54600 hours                                   |
| Fuel carried by TSHD                           | 2200 m <sup>3</sup>                           |
| Total Oil Used                                 | 195,000 ton for the entire reclamation period |

### An Assessment

With respect to the guidelines stipulated in Annex 2-7 e of the Revised Procedural Manual, titled “Procedural Guidelines for Scoping of Environmental Risk Assessment (ERA)”, the following conclusions are thereby made:

- Under the criterion of processes, the project does not fall in any of the guidelines/criteria
- Under the “hazardous” classification, the fuel does not fall under the categories on “Explosivity, Flammability and Toxicity”.
- Under the Threshold Inventory guidelines, the type of fuel oil does not fall in the category and thus the volume criterion is not relevant.
- The project is also outside the “Societal Risk” Criteria because the number of people who may be affected by risks is only approximately less than 50 who are the crew and officers of the TSHD

## 4.2 Safety Risks

Focus is herein made on “**safety risks**” rather than on “**impacts**”, the latter being potential results of regular activities while the former is a result of probabilistic events.

The key aspects of risks for the reclamation/dredging (construction) phase are:



- Fire
- Explosion
- Release of toxic substances

#### 4.2.1 Description of conditions, events and circumstances, which could be significant in bringing about identified safety risks

Table 4-3 summarizes the identified safety risks from which it may be stated that such are remotely identified with the reclamation/dredging activities.

**Table 4-3. Summary Matrix of Safety Risks**

| Activities  | Safety Risks                    | Probability of Incident   | Prevention/Control Measures/Remarks   |
|---|---------------------------------|---|---|
| Dredging<br><br>(At site and at source of fill, i.e., San Nicholas Shoal) | Fire                            | Nil to Minimal  | Marine Diesel Oil (MDO) used has high Flash Point > 60° C                           |
|   | Explosion                       | Nil   | MDO not explosive   |
|   | Release of hazardous substances | Nil to insignificant<br>Spent oil or on board leaks discharged to bilge not overboard                       | Bilge water treatment<br>No HAPs (Hazardous Air Pollutants) from exhaust of engines |
| Filling at Site   | Fire                            | Nil to Minimal  | Marine Diesel Oil (MDO) used has high Flash Point > 60° C                           |
|   | Explosion                       | Nil   | MDO not explosive   |
|   | Release of hazardous substances | Nil to insignificant<br>Spent oil or on board leaks discharged to bilge not overboard                       | Bilge water treatment<br>No HAPs (Hazardous Air Pollutants) from exhaust of engines |
| Operation of Heavy Equipment<br>(e.g. pumps, pile drivers)                | Fire                            | Nil to Minimal  | Marine Diesel Oil (MDO) used has high Flash Point > 60° C                           |
|   | Explosion                       | Nil   | MDO not explosive   |
|   | Release of hazardous substances | Oil sludge generated at vessel  | Not discharged to bay, instead to onshore   |
| Land Stabilization<br>Soil stabilization                                  | Fire                            | No Relevant Activity<br>Involves only land compaction; placement of wick drains and allowing land to settle | Not Relevant  |

Based on the above table, there are no significant safety risks involved with the proposed project. The activities involved are confined to the vessels at sea, away from population centers, thus, there are no societal risks associated.

It is noted, however, that the construction crew would be preparing meals and using LPG - a fire and explosive substance. Cooking is confined to a designated place and the LPG used is a standard cooking fuel. The LPG inventory however, does not classify this activity as a safety and risk undertaking.

The possibility that bombs/ordnance from World War II may be present on the seabed will not be overlooked. The preparatory works to dredging will be on the lookout for these explosive materials.



## 4.2.2 Description & assessment of the possible accident scenarios posing risk to the environment

### 4.2.2.1 Potential Accidents Involving Fishing Operations Along the Navigational Lane of the TSHD

The risks to and accidents involving fisher folks are noted but are deemed not highly significant because:

Although there are existing fishing activities (BY USE OF SAPRAS) and mussel farms within or adjacent the reclamation site these need to be relocated if validated before the start of the construction period that such activities would be existing; The relocation site will not be in the pathway of the movements of the TSHD.

The work area at the site will be cordoned to avoid ingress of fisher folks and persons not involved with the reclamation works.

The environmental resources that could **potentially** be at risk in a potential accident scenario are the lift nets within the waters of the municipalities involved as well as those adjacent to the navigational lane of the TSHD. During the travel of the TSHD to/from the San Nicholas Shoal, there could exist potential risks of the vessel drifting towards the fish lifts such as during stormy weathers.

The mangrove communities were also considered but are deemed essentially free from risk because of its distance from the navigational lane and the reclamation site.

Figure 4-3 indicates the tentatively identified navigational pathway of the major dredging/reclamation vessels.



**Figure 4-3. Map of the Tentative Pathway of the TSHD Vessel**

The relocation site for the lift nets will also have to consider the pathway (navigational lane of the TSHD).

### 4.2.2.2 Potential Oil Spills from the TSHD Vessel

The fact that the TSHD will carry Marine Diesel Oil (MDO) suggests that risks be considered on potential oil spills.





The preventive measures consist of

- a. Assurance of sea-worthiness of the sea vessel (TSHD) through:
  - Compliance with international and local (PCG) standards
  - Training of vessel crew and personnel
  - Possession of adequate navigational aids
  - These features of the vessel are discussed in Section 1
- b. Inspection by the PCG of the integrity of the oil storage tank in the vessel
  - Record of last inspection of the tank
  - Checking of safety instruments of the oil system e.g. valves, fittings
- c. Provision for on board oil spill containment and recovery equipment e.g.
  - Oil Spill Boom
  - Approved oil spill dispersant
  - Oil recovery equipment e.g. oil pump
- d. Oil spills collected must not be discharged at sea but on shore through an accredited third party TSD
- e. Proper training and accreditation of the Vessel crew

**4.2.3 Description of the hazards, both immediate (acute effects) and delayed (chronic effects) for man and the environment posed by the release of toxic substance, as applicable.**

*The safety policy and emergency preparedness guidelines consistent with the regulatory requirements. Emergency Preparedness should also consider natural hazards to the infrastructures and facilities*

By way of reference, typical classification of hazardous wastes is provided in Table 4-4.

**Table 4-4. Typical Classification of Hazardous Wastes and Relevance to Reclamation Work**

| Classification Under DAO 36 | Proposed Revisions  | Remarks  |
|-----------------------------|---|--|
| Putrescible Organic Wastes  | Grease trap wastes<br><br>Used or Waste Oils from operation of on board equipment | From food preparation of vessel crew<br><br>Collected separately and disposed on shore or discharged to the bilge<br>Collected separately and disposed on shore or discharged to the bilge |
| Inks/Dyes/Pigments, etc.    | Resinous Materials  | Not involved in reclamation  |
| Containers                  | Waste containers previously containing hazwastes                                  | Hazwastes involved are minimal quantities of spent lighting bulbs and computer parts   |
| Organic Chemicals           | Wastes containing halogenated chemicals   | Not involved in reclamation works  |
| Miscellaneous Wastes        | Containing Pathogens  | Not involved in reclamation works  |
| Not specified               | Waste electrical and electronic equipment (WEEE)                                  | Computer system only WEEE aspect of project  |

Source: Public Consultation on MMT Organized by the EMB dated April 12-13, 2016 at Hotel Jen, Manila

It may be deduced from the above table that the project does not involve hazardous wastes based on present classification (DAO 36) and prospective reclassification.



#### **4.2.2.1 Chronic Risks. Concentrations of Toxic/Hazardous Substances (i.e. cyanide, mercury, etc.) in Water**

The generation of significant quantities of toxic and hazardous substances is considered nil in the proposed project as this is not included in the activities during the reclamation/ construction phase.

The risk factor that needs to be carefully identified during the construction phase is the potential contamination of the Bay with toxic and hazardous substance that may be present in the filling materials.

If the filling materials would be sourced from Manila Bay itself, this risk is greatly reduced or would be absent. Pre-screening of any filling materials to be used would be mandatory; complete chemical analysis for toxic elements, e.g.: cyanide, mercury, lead, chromium, etc. must be necessarily undertaken.

The use of and sourcing of the filling materials from its likely source, i.e., the San Nicholas Shoal in Cavite, is to be subject to prior permits and clearances from the Philippine Reclamation Authority. One of the requirements for securing such permits/clearances is an ECC.

Notwithstanding that the import of filling/burrows are to undergo strict screening and evaluation, mitigation measures will nevertheless will put in place for dispersal of silts/disturbed sea beds. The use of containment sheet piles along the perimeter of the project will further ensure that any toxic/hazardous substances will not disperse beyond the reclamation area.

#### **4.2.2.2 Concentrations of Toxic/Hazardous Substances (i.e., cyanide, mercury, etc.) in Air and Land**

The substances/materials listed below are not considered as highly significant considering the low quantities involved with the nature of the project, which involves the construction phase only.

**Table 4-5. Initial Listing of Potential Toxic and Hazardous Substances Involved in the Reclamation Activities**

| <b>Nature of Substance</b> | <b>Source</b>  | <b>Estimated Inventory</b>          |
|----------------------------|--|-------------------------------------|
| Oil Waste                  | From Use of Diesel Oil in Dredging Vessel            | ≈ 10-20 drums                       |
| Spent Lighting Fixtures    | From Dredging Vessel                                 | 10-20 units                         |
|                            | From street lighting during soil stabilization phase | 25 units                            |
| Computer Parts Scraps      | From onsite office                                   | 100 kg                              |
| Spoiled Food Wastes        | From construction workers abroad dredging vessel     | Minimal (regular on shore disposal) |

The potential presence of toxic/hazardous substances in the fill materials is not included in the above list because the fill materials may be sourced from Manila Bay itself, i.e., the San Nicholas Shoal. All fill materials will be subject first to prescreening, which will include tests of the presence of toxic and hazardous substances.

During the operations phase, the common materials designated under RA 6969 as being hazardous will be generated. These will include the following:

- a. Spent lighting fixtures which may contain metallic elements

These are disposed through third-party accredited TSD (Treatment, Storage and Disposal) companies accredited with the EMB.

- b. Mobile Source Air Toxics (MSATs)



These are generated by vehicles and may include benzene, aromatics, aldehydes, polycyclic aromatic benzenes, and other hydrocarbons inherently present in fossil fuels. The reclamation works will not involve use of land-based vehicles.

The use of clean fuel such as Euro IV P gasoline or diesel oil should be encouraged. The specification for marine fuels is dictated by International Standards, e.g. the "MARPOL" or International Convention for the Prevention of Pollution from Ships, the US EPA and others.

### 4.2.3 Dangerous Substances/Organisms with Risk of being released into the environment

The various issues / concerns on dangerous substances/organisms are explained below.

How dangerous are the substances/organisms that risk being released into the environment? The basic information on the Project discussed in several chapters of this EIS is herein reiterated to give a good appreciation of the responses:

The nature and scope of the Project includes only the construction phase or the reclamation activities the components of which are the following:

**Table 4-6. Summary of Project Components (Based from Chapter 1)**

| Components  | Specifications  | Potentially Dangerous Substances or Organisms that Risk Release   |
|---|---|---|
| <b>Reclaimed Land: 1 island with total land area = 267 ha</b> |   |   |
| Platform elevation  | 4.0 m above MLLW  | NIL   |
| Water Channels  | 5.99 km from Cañas River  | To serve as buffer zone and for water circulation. No materials or substances involved.   |
| Vertical Containment Structure                                | Containment wall (seawall) consisting of a combination of rock mound and sheet piles.   | Will be firmed up during the Detailed Engineering Works No dangerous substances or organisms involved; materials are made of ordinary construction materials such as steel. |
| Wave Deflector  | Concrete with water sump (For defense against storm surges)   | No dangerous substances or organisms involved; only ordinary materials of construction e.g. concrete aggregates, cement, reinforcing steel.                                 |
| <b>SUPPORT FACILITIES</b>                                     |   |   |
| Drainage System   | To consider using the Rational Formula $Q = 0.278 CIA$  | No dangerous substances or organisms involved; only ordinary materials of construction e.g. concrete aggregates, cement, reinforcing steel.                                 |
| Electricity, water and communications systems                 | Temporary connection with Meralco e.g. for lighting purposes; generating sets for construction works. Mobile communications   | To be sourced from service providers. No dangerous substances or organisms involved.  |
| Wastewater treatment units                                    | In house facilities during the Reclamation Phase (e.g. toilets in barges) Disposal through accredited waste handling entities | Use of approved portable toilets on reclaimed land. Dangerous substances or organisms not involved nor used.  |
| Water supply system (During Reclamation Phase)                | Internal sourcing by individual contractors   | Water supplied by concessionaires or imported from external sources.  |
| Street Lighting   | High Pressure Sodium Lamps  | To be sourced from accredited HPS lamps suppliers. No dangerous substances or organisms involved; lighting fixtures similar to those used in streets.                       |
| General Notes on  | Not Applicable  | Activities of Construction Workers will take place  |



| Components   | Specifications | Potentially Dangerous Substances or Organisms that Risk Release  |
|--|----------------|--|
| Reclamation/Construction Activities  |                | in work stations located at sea, e.g. in dredging vessel, in pile driving facilities, etc.<br>There is no population at these construction sites. Domestic wastes are generated; not released to the environment but instead confined to portable toilet facilities for disposal on shore.<br>Waste materials classified as hazardous include spent lighting fixtures, computer inks and parts which are disposed on shore.<br>No medical wastes, pathogens and harmful organisms involved or generated. |
| <i>Note: The sourcing of the Fill Materials. The dredging and related activities for the sourcing of fill materials will be subject so separate ECC application when the source(s) are identified and approved by the PRA.</i> |                |  |

#### 4.3 Physical Risks- Failure of Structure which could endanger life, property and/or the environment

- Description of conditions, events and “trigger”, which could be significant in bringing about identified physical risks
- Description & assessment of the possible accident scenarios posing risk to the environment
- Description of the hazards both immediate (acute effects) and delayed (chronic effects) for man and the environment posed by the failure of structure, as applicable

The “failure of structure” referred to in this Phase is the collapse of the reclaimed land. There will be no vertical structures to be constructed during this Phase.

Although highly unlikely because of engineering and design interventions, use of internationally-accepted construction technology and methodology, the use of sound fill materials and rocks and the employ of proven Contractor, a discussion are nevertheless made on this potential physical risk.

The environment that will be at risk is the Direct Impact Area of the project, i.e., the boundaries of the landform including the islands.

The immediate remedial activity is to deploy silt curtains to the boundaries of the landform to prevent dispersal of silt.

Temporary containment structures, e.g. sheet piles or armor rocks will be imbedded to prevent dispersal of other heavier materials from the collapsed landform.

**Table 4-7. Summary Matrix of Physical Risks**

| Activities                   | Physical Risks                      | Probability of Incident | Prevention/Control Measures  |
|------------------------------|-------------------------------------|-------------------------|--|
| Dredging                     | Accidents to Construction Personnel | Nil to insignificant    | <ul style="list-style-type: none"> <li>• Safety Training of Construction Crews</li> <li>• Safe worthy equipment</li> </ul> |
| Filling                      | Accidents to Construction Personnel | Nil to insignificant    | <ul style="list-style-type: none"> <li>• Safety Training of Construction Crews</li> <li>• Safe worthy equipment</li> </ul> |
| Operation of Heavy Equipment | Accidents to Construction Personnel | Nil to insignificant    | <ul style="list-style-type: none"> <li>• Safety Training of Construction Crews</li> <li>• Safe worthy equipment</li> </ul> |

It is thus concluded that there exists no significant safety risks, further since the activities are confined to the reclamation area and away from population centers there are no societal risks associated.





### **4.3.1 Risks During the Horizontal Development Works**

The horizontal development works are included in the scope of the “construction phase” and include the following activities which will be undertaken at the reclaimed land.

- Road Construction
- Construction of Drainage System
- Installation of electrical power and water distribution system

Physical risks, i.e. to construction workers are deemed as the major considerations during these works. This is because of the use of heavy equipment during the above-cited works.

### **Assessment and Recommendations**

During the horizontal development activities, the major risks are those associated to accidents and safety. These may however, be minimized or prevented through the following:

- Training of construction workers and equipment operators;
- Use of personnel safety equipment;
- Regular maintenance of heavy equipment; and
- Compliance with the engineering design and the applicable construction codes.

## **4.4 Emergency Response Policy and Generic Guidelines**

### **Policies on HSE**

Inasmuch as the direct responsibility for Health, Safety and Environmental concerns rest on the Dredging/Reclamation Contractor, a judicious selection process for the Contractor will necessarily be made. The formal award of the Contract cannot be made until after the securing of an ECC. However, provided below are basic policies and guidelines on HSE of an international reclamation practitioner.

### **4.4.1 General**

All vessels working / sailing for the project have to comply with the local and international maritime requirements or protocol such as that prescribed by the Philippine Coast Guard and under the MARPOL.

Some of the requirements are:

- Communication procedures with Port Authorities;
- Anchoring;
- Towing;
- Speed limitation within port; etc

All vessels / barges must have valid harbor craft license or equivalent. Official inspections on the vessel regarding its construction and required safety appliances must be carried as per regulations.

Prior to commencement of operations, all relevant notices (e.g. Notifications to Mariners; Port Marine Notices) shall be provided to the Master, who will verify them for implementation.

### **4.4.2 Responsibilities and Duties**

All personnel are responsible for the safety of themselves and those they work with. They have a duty to take action to prevent accidents at all times, in accordance with accountability for HSE.



The Master of a vessel is responsible for the safety of the vessel and all those on board at all times. He has the authority to decide whether any operations affecting the vessel should proceed or be terminated, and should question any instructions issued to him that create a hazard to the vessel and all those on board.

Emergency response on an ISM certified vessel takes place in accordance with the Master Roll. The Master Roll shall show the duties assigned to the different members of the ship's crew.

#### **4.4.3 Onboard HSE Inductions**

All personnel joining the vessel for the first time or who have not been on board within the previous 6 months will be required to undergo HSE induction training ('Information at recruitment' resp. 'Familiarization') from the Captain or Chief Engineer.

Training shall include but not be limited to aspects of living and working on board a vessel or barge:

- Layout of the vessel;
- Housekeeping rules;
- Muster Stations;
- Emergency Alarms;
- Safety Equipment;
- PPE;
- Emergency Escape Routes;
- HSE Management; and
- Environmental Awareness.

Signed function descriptions and records of familiarization / information at recruitment shall be available onboard.

After boarding a vessel, visitors shall report to the Master who shall give a small induction on the particular dangers and rules on the vessel. Visitors shall always be guided during visits on deck.

#### **4.5 Site Basic Safety Rules**

The vessels shall make the necessary communication, depending on the type and operations of the vessel, with other vessels and/or with the Radio Room by means of the VHF channel that has been set up for the project.

Approaching or leaving a jetty or another vessel shall be done at a low speed, avoiding high waves and thus allowing safe boarding. Life jackets of the inflatable type or work vest type shall be worn in following situations:

- when boarding / disembarking a vessel / jetty;
- when working near or over the sides of a vessel;
- when there is a danger of falling into the water; and
- when working on other locations as specified by the supervisor or safety officer.

Other rules include:

- Reference is made to the specific SWP for PPE;
- Standards for housekeeping on the vessel (e.g. deck, galley, accommodation, etc.) shall be followed;
- The crew shall be competent and shall be made familiar with various emergency situations and hazardous applications through toolbox meetings and drills;



- Regular inspections shall be held by the Master, Safety Officer or Chief Engineer. The inspection and the frequency shall depend on the type of vessel;
- Mooring to other vessels or to jetties shall be done safely and with correct and sound mooring ropes;
- Fishing is not allowed on site;
- Smoking is only permitted in designated smoking areas;
- Drugs are not permitted on board. Persons taking medication are to advise the medic of their medical condition and show the prescription drugs they are taking; and
- All crew shall be in possession of a valid medical fitness certificate, correct seaman's book and correct STCW95 certificates for the function they have.

During periods of rough weather the following rules are to be observed:

- Crew shall not work in external areas of the vessel unaccompanied.
- Watertight closures are to be secured and shall be kept clear of obstructions.
- Watertight doors shall always be secured after passing through them (this should be observed in good weather conditions also).
- On vessels with low freeboard working decks such as anchor handlers and tugs where decks are easily awash the following precautions will be taken: personnel shall not work in external areas of the vessel unaccompanied; and personnel working on external decks shall wear a work vest.

When entering a Port, the vessel shall adhere to the specific Port Regulations, which could handle:

- Pilotage, navigation;
- Anchorage, berth, mooring, bunkering;
- Security measures; and
- Arrival and departure procedures

Prior to arrival at a Port, the SOPEP contact list must be available on the bridge. Reference is made to other SWP that could be applicable to vessel operations such as dredging and reclamation; PPE; hot work; and lifting.

During lifting operations on a vessel, particular attention should be paid to the following factors: wind speed; vessel motion; visibility; and suitability, certification and Safe Working Load (SWL) of equipment and rigging to be used.

All crane operators shall be competent and authorized. Rules for cabins include:

- Keep your cabin clean.
- Clean your toilet and shower area at regularly.
- Clean the drains very good on regular times.
- Use Biotal 2000 (or similar product) for your toilet and drains.
- When furniture is broken tell Captain or Chief mate.
- Do not smoke a cigarette on bed, and always use an iron ashtray.
- Do not keep food in your refrigerator.



## **4.6 Standard Safe Work Operations**

### **4.6.1 Mooring and Unmooring**

#### **General**

The deckhands shall be fully acquainted with the mooring procedure and the equipment. The deckhands shall check if the equipment is operational and tested. Mooring wires and ropes shall be replaced when they are damaged to a certain grade (i.e. when damage is more than 10% of the diameter; when a wire is badly kinked; etc.). The decks shall be well illuminated.

The deckhands that handle the ropes / wires shall always wear a hardhat, gloves and safety shoes. They shall be aware that standing in bights or near wires / ropes under tension is not allowed.

The crew shall be aware that, when working over / near water, a life vest needs to be worn. Means of communication shall be available during mooring activities.

#### **Mooring of Barges alongside dredger, crane barges or anchored pontoons**

Captains of barges approaching alongside dredger, crane barges or anchored pontoons shall be aware of treacherous currents and movements of the other vessel. Only EXPERIENCED skippers shall operate/sail the barges.

For the fastening of barge to the dredger, crane barges or anchored pontoons, the deckhands shall prepare at least 4 m of slack in the wire or use a pendant wire in order to prevent the deckhands on the other vessel from heavy pulling/lifting.

Stepping over wires or ropes when the barge is alongside, especially during rough weather conditions, must be avoided at all times.

#### **Towing**

The towing operation shall be in the charge of a competent tow Master and shall be properly planned and prepared in order that the voyage may be made in a safe and efficient manner without presenting a hazard to other shipping or offshore installations.

The selection of a towing vessel is based on its adequacy for the tow in the worst weather conditions to be encountered in the proposed area of operation. The type, specification and bollard pull (BP) of the vessel for a specific tow operation shall be defined. Prior to selection, a tow vessel will undergo suitability audit carried out by the technical department in order to ensure that the vessel is fit for the intended work scope.

If required, a Marine Warranty Surveyor shall check the sea fastening of cargo and the setup of the towing arrangements.

### **4.6.2 Engine and machinery room safety**

Some procedures for safe working practices in engine and machinery rooms are defined below. Mechanics, engineers and wipers shall be made familiar with these basic rules.

#### **General:**

- Think safety, try to predict, avoid and eradicate hazards.
- The following protection must be worn prior to entering a machine space: skin protection; protective clothing; footwear with slip and oil resistant soles; ear defenders; and if applicable, protective gloves and hard hat.





- Check where repair and maintenance work is in progress and ensure correct warning signs are in position.
- Do not run in a machinery space.
- Ensure visitors are suitably dressed, protected and familiar with E.R. procedures. Officers in charge must be informed of their presence.
- Asbestos holding items are removed from the vessel. Alternatively, possible asbestos holding items (of a none-dangerous type) are identified and crew is made aware of correct procedures regarding working with these items.

**Unmanned E.R. and machinery spaces:**

- Do not enter alone and always notify the officer in charge or the bridge.
- Before entering, ensure reporting and communication procedures are clearly understood.
- Safety procedures must be displayed at all entrances.
- Ensure adequate illumination is provided.
- Be aware that machinery may start and stop automatically.
- Do not attempt to rescue casualties alone, call for the Emergency Team.
- Be aware of toxic and explosive risks in certain machinery spaces.

**Main engines and auxiliaries:**

- When checking machinery, beware of moving parts and high temperatures.
- Be particularly observant in checking for oil and fuel leaks. These give the highest potential for fire.
- Be aware that some machines start and stop automatically.
- Ensure that all machinery is guarded correctly, especially after maintenance.
- During maintenance of machinery, ensure that all loose parts are securely stored.
- Engine room deck plates, grids and handrails must be securely fixed, clean and free from debris.
- All bilges and mud boxes must be kept clean and free from obstruction.

**Boilers:**

- All manufacturers' operating procedures must be clearly displayed and observed.
- Correct flashing up procedure must be followed to avoid risk of blowback.
- All escape routes from boiler fronts and firing spaces must be kept clear.
- Ensure uptakes are maintained free from gas leaks.

**Workshop and stores:**

- All loose items of equipment and spare gear must be securely stored.
- Workshop machinery must be suitably guarded with specific protective equipment available and mandatory signs displayed.
- All consumables must be correctly stored in accordance with suppliers' instructions and ship safety procedures.
- All wastes to be correctly packaged for disposal in accordance with MARPOL Annex V or project requirements.
- When using pneumatic or hydraulic equipment, ensure they are set at the correct working pressure and have been checked for serviceability.
- Use welding screens and head shields when arc welding and do not leave hot items unattended.
- Only trained personnel should use metal working machinery.
- Grinding wheel regulations must be observed.



#### **4.6.3 Hatches and doors closed at sea**

**The risks of open doors:**

- unwanted water flow could occur during sailing and stormy weather;
- the compartmentalization is no longer guaranteed during a calamity or collision.

**Prevention:**

- all watertight doors on deck must be closed and locked during sailing and working;
- doors shall be checked regularly during safety rounds;
- the importance of the closure and locking of doors shall be emphasised during toolbox-meetings.

**The risk of open horizontal hatches on deck an inside the ship:**

- because of overflow when dredging, water, silt and other (polluted) spoil could flow in rooms, resulting in major damage and pollution;
- unwanted water flow could occur during sailing and stormy weather;
- the compartmentalization is no longer guaranteed during a calamity or collision.

**Prevention:**

- all hatches must be closed and locked during sailing and working;
- check regularly during safety rounds;
- emphasize the importance of the closure and locking of hatches during toolbox-meetings.

Furthermore, condition of all automatic doors and hatches shall be checked regularly. As a minimum, the following items should be checked:

- warning signal (when opening/closing bell and/or revolving light);
- alarm signal to bridge or to engine room;
- availability operating instructions near the door;
- doors and hatches can be easily opened;
- emergency stop; and
- condition and watertight function of seals of doors and hatches.

#### **4.6.4 Shipboard food and hygiene**

Recommended procedures for health and safety in pantries, galleys and freezers are described below. Cooks and stewards shall be made familiar with these basic rules. Only authorized persons who have undergone food hygiene training and specific medical checks and vaccination shall carry out the preparation and handling of food.

**Health and hygiene:**

- Hands and fingernails must be kept clean at all times using hot water and anti-bacterial soap.
- Wash hands between handling meat, fish, fruit and vegetables or visiting the toilet or blowing your nose.
- Cuts, burns and abrasions must be covered with a suitably colored waterproof dressing.
- All illnesses to be reported immediately. If dysentery or diarrhea is suspected, stop work at once.
- No smoking, eating or drinking in food handling areas.
- Clean protective clothing and head covering must be worn at all times to protect food and handler.
- Do not cough or sneeze near food.

**Food preparation:**

- Do not use the same knife, chopping board or preparation surface for raw meat, fish, cooked food, fresh vegetables and fruit.
- Never use cracked or broken utensils.



- Use cleaning materials in accordance with manufacturer's instructions and never allow them to come into contact with food.
- All food must be thoroughly cooked to a safe internal temperature.
- Separate storage compartments must be used for raw and cooked foods.
- Do not handle food unnecessarily.
- Food must be washed properly where necessary.

**Galley and pantry equipment:**

- Extreme care must be taken when turning on stoves or deep-fat fryers, especially if oil or gas fired.
- Range guards must be used in rough weather.
- Microwaves must be used in accordance with manufacturer's instructions.
- Deep-fat fryers must have safety lids, which can smother a fire. Never use water to extinguish a fat fire.
- Knives, saws and choppers should be kept sharp and housed in secure racks or safely sheathed. Do not mix with other items when washing-up.
- Do not grab a falling knife.
- Faulty appliances must be reported and taken out of service. A 'do not use' notice must be displayed.
- When cleaning or unblocking, ensure equipment is switched off and isolated. All parts in contact with food must be washed, rinsed, sanitized and air-dried.
- Food wastes and other garbage must be immediately stored in designated containers and disposed of in accordance with MARPOL Annex V and with the project specific requirements.

**Temperature control:**

- It is the temperature of the food and not the air temperature of the holding unit that must be maintained.
- Always load the refrigerator in accordance with the manufacturer's instructions.
- Keep the thermometer in the coldest part of the fridge and check regularly that the temperature is between 0°C and 5°C.
- The coldest part of the fridge should contain the most perishable foods such as cold meats.
- All raw or uncooked food must be wrapped.
- Do not overload or put hot food in the fridge.

**Slips, trips and fall hazards:**

- Wear slip resistant footwear, which offers protection from hot fat or boiling water.
- Decks and gratings must be kept free of grease.
- All spills and breakages must be cleaned-up immediately.
- When using stairs and companionways, keep one hand free to use the handrail.
- Do not carry items in such a way as to obscure your view.
- Wherever possible, ensure all deck coverings are of the anti-slip type, especially outside refrigeration rooms.

**Refrigeration, freezer and store rooms:**

- All doors must be fitted with both means of opening and sounding alarm from inside.
- The alarm should be tested weekly.
- Personnel using refrigerated rooms must be familiar with operating alarms and handles in darkness.
- Always inform others when entering their areas and take the padlock and key with you.
- Refrigerant leaks must be reported immediately and warning notices posted on outside doors.
- Stores must be stowed securely to prevent movement in rough weather.



#### 4.6.5 Navigation

##### General

- Masters shall ensure that their vessels are navigated in full compliance with the International Regulations for Preventing Collisions at Sea, 1972 (COLREG), without exception.
- Prior to commencing any voyage Masters must ensure that a passage plan for the voyage has been developed and all Watch keeping / Navigating Officers are familiarized with it.
- Masters must ensure that all necessary charts and nautical publications for the area of operation are carried on board the vessel and that they are up to date with all the latest amendments and corrections. Where the area of operation will include subsea assets and platforms, the Master must also ensure that he has the latest field charts on board the vessel.
- Unless advised to the contrary or for safety reasons, vessels shall make best safe economical speed at all times.
- Vessels involved will be equipped with bathymetry maps showing areas of sensitivities. Furthermore, these areas will be marked in the dredge survey computer.
- Vessels shall anchor at anchoring areas indicated by the port. Alternatively, JAN DE NUL shall define designated safe anchoring zones outside sensitive areas. Vessels will not anchor outside designated anchoring areas unless in an emergency situation.
- Latest admiralty charts (ECDIS) will be provided of the working and sailing area to ensure that exclusion zones and subsea obstructions and installations are known to the officers.

##### Bridge Watchkeeping:

- A safe navigational watch must be kept at all times and every opportunity must be taken to physically check the vessel's electronic position referencing systems against visual observation and charts.
- A proper visual lookout shall be maintained at all times and the Officer of the Watch shall be responsible for taking timely action in order to avoid collision, grounding or close quarter situations.
- During periods of reduced visibility, Master's shall ensure that additional lookouts are posted, appropriate sound signals are made and a radar watch is maintained on both long range (12 nm) and short range (6 nm or less).

##### Preparing bridge before sailing

- Check compass error
- Compare gyro compass-reading with magnetic compass-reading
- Ascertain deviation by either adding or subtracting the variation and check outcome with deviation-table
- Put radars on stand by
- Start two steering-pumps
- Check if rudders are free of obstacles and then turn rudders full to SB and PS and check rudder-indicators
- Do this also with only SB and PS pump running
- Switch the Doppler-log on
- Check scanners of both radars and run the "Nucleus" radar and align gyro course, set the speed to log speed and adjust the screen brilliance / contrast. If the visibility is poor, then also do this with the second radar
- Test the ship's air whistle and its automatic signal blasting device
- Check if the bottom doors are fully closed and if the hydraulic pressure switch is set to "high"
- Check navigation-lights (including NUC-lights and X-mass tree) and leave the sailing lights burning





- Check communication with engine room by telephoning two ways with them and test the telegraph (you must go to the “engine room-control to do this) after this return to “bridge-control”
- Check portable radio sets on allowed channels only and hand them out to the fore- and aft mooring party or anchor hewing party
- Check if propellers are clear and when the control is the engine is on bridge-control than try to adjust the pitch slightly ahead and astern prior to unmooring the ship
- Switch on the VHF’s on the correct frequencies
- Put the correct nautical charts on the chart table
- Check if the DGPS position readout is correct
- Check if the echo sounder is operational and if the reading make sense
- Check the bow thruster by running it slowly PS/SB after you checked if there are no polypro ropes or rubble floating next to you
- Check window wipers
- Make sure standing orders are available
- Check on the navtex and check if anything important is on the printout
- Check searchlights and torches
- Check if everything is secured on the bridge and check with the dredge master if this is the case on deck
- Check if the pilot ladder is stowed away correctly or lowered to the correct height. In the latter case check if there is a life buoy and a deck light available
- Check the GMDSS radio equipment
- Place minimal two binoculars on the bridge console
- Hoist the appropriate flags for instance the “H” (Pilot on board) or show the appropriate lights if required by harbor rules and regulations (ask the pilot!)

#### 4.6.6 Weather

The Master and/or the Superintendent shall continuously monitor the weather conditions and shall restrict or even interrupt certain works when safe work is not possible.

##### Adverse Weather

Adverse Weather is defined as environmental conditions that may affect people, equipment or facilities, to such an extent those precautionary measures must be taken to safeguard the vessel or to maintain a safe system of work. Adverse weather includes, fog, hail, lightning, heavy rain, high winds, low cloud base, poor visibility, severe sea states and strong currents. In certain circumstances low/no wind can also be adverse weather. Weather conditions can change quickly and the effects of short-term variations such as wind gusts must be considered.

##### Weather Limits

Weather limits must consider the location and type of worksite, the nature of the work to be carried out, and the time required to secure the worksite before the onset of adverse weather. Weather limits should be identified in terms of the following categories as appropriate:

- Wind Speed
- Wind Direction
- Sea State
- Air Temperature



## **Weather Forecasts**

Weather forecasts should be obtained on a regular and frequent basis, at least every 12 hours and with a minimum coverage of 36 hours and a 5-day outlook. The forecasts as a minimum should provide the following information:

- Wind speed and direction
- Sig and max wave height
- Swell direction, period and height
- Visibility
- Significant temperature change
- Barometric pressure and tendency
- Risk of weather phenomena such as fog, thunderstorms, etc.

## **Movement of Personnel During Adverse Weather**

Site supervisors should carry out an assessment of the risk to personnel during adverse weather. In addition, supervisors responsible for the area should continue to frequently monitor external and other vulnerable areas throughout periods of adverse weather and put in place any necessary control measures to minimize risk to individuals. They should advise management of the need to review all other work in progress, to assess the impact of the adverse weather, and in particular access to and from modules and worksites. Personnel movement in external areas affected by adverse weather should be limited to the covered, sheltered or leeward areas of the location. Emergency Exit doors may have to be used for access to the leeward side of accommodation modules. Personnel should be made aware of restrictions or the alternatives to normal access routes, by the public address system and by the erection of safety barriers. Provision of guard/restraining lines may be necessary at areas such as walkway corners where wind effects are particularly severe, when such routes have to be used in adverse weather.

In severe weather, there may be occasions when all personnel will have to remain inside. Any operations, which cannot be continued without personnel access to weather affected areas, shall be suspended. 'Weather Watch Inspections' to look for loose items, carry out damage assessment, or perform meteorological observations should only be performed when it is safe to do so and should not be carried out by an unaccompanied individual.

## **4.7 Basic Safety Equipment**

### **General**

In essence, the safety equipment that is required to be onboard a vessel is reflected in the vessel's safety plan. This safety plan depends on the vessel's class, in compliance with SOLAS regulations, and is required to be approved by the Class surveyor. A copy of the safety plan can be found on various locations on the vessel.

ISM certified vessels have specific procedures and instruction regarding safety equipment within their ISM system. This project procedure provides some information on essential safety equipment onboard of vessels since not all vessels comply with SOLAS / ISM requirements, e.g. small or not self-propelled vessels, which are not sailing/working in international waters.

### **Inspection of life-saving and safety equipment**

The Captain/Senior Dredge Master must make a monthly inspection of all life-saving and safety equipment that it is compulsory to have on board ensuring that it is in the correct location and in good working order. If



the equipment is found to be defective, corrective action must be taken. All inspections must be recorded in the ship's log.

Safety equipment to be checked:

- All life rafts and lifeboats with their equipment. The engines of the motor lifeboats must be in good working order.
- All lifebuoys and attachments, such as flares and smoke signals.
- Line throwing appliances.
- Rockets for sending distress signals.
- Pilot ladder.
- Navigation lights.
- Safety lamps and signal lamps.
- Emergency shut-off valves on fuel lines.
- All fire extinguishing appliances and compressed-air breathing apparatus.

#### Survival and/or MOB craft

- The survival craft (lifeboat) will be used in case of an abandon ship emergency. The MOB boat will be used for rescuing a Man over Board victim. The crafts contain survival equipment as specified by the SOLAS convention.
- The master will ensure that the crafts are maintained in a fully operational condition. A regular inspection and maintenance schedule shall be executed and records kept for each craft. All officers and crew members shall be familiar with the operation of the crafts in accordance with their function as stipulated on the Muster List. Visitors must be informed on the location of the crafts by the master during their introduction.
- Launching, boarding and sailing have to be done following procedures which are defined in the Emergency Procedures Manual and the Vessel Operating Manual.
- The use of equipment on board of the lifeboat will be explained in Training Courses and safety briefings.

#### Life rafts

- In some emergency cases, it will be impossible to launch the lifeboats. In these cases life rafts will be used to abandon the ship. The SOLAS convention regulates the construction and the launching equipment of the rafts.
- A sufficient number of inflatable life rafts are mounted at convenient locations on the vessels. All officers and crew shall make themselves aware of the locations and operations of the rafts. Visitors must be informed to the master after boarding the vessel.
- Launching and boarding has to be done according the procedures which are defined in the Emergency Procedures Manual and Vessel Operating Manual.

#### Emergency Life jackets

- In every cabin there will be at least one SOLAS approved emergency life jacket (type: block vest) for each person staying in that cabin. Near the muster station there will be additional life jackets available.
- The SOLAS Convention defines the requirements for the amount of jackets, the type and their location on board.
- This type of life jackets must be worn when an emergency alarm sounds (e.g. Abandon Ship or Fire).
- Everybody on board shall be made familiar with the use of the jacket.



#### Work life jackets (work vest)

In normal conditions, a work vest shall be worn when work is being performed near the water side outside the protected area. However, in certain work conditions it is not practical to wear a work life jacket since it can hamper normal work. In this case, other means of protection (life line, net ...) shall be in place.

Sufficient work life jackets shall be available on board.

#### Life buoys

- Life buoys are constructed in accordance with the regulations stipulated by the SOLAS Convention.
- Location, configuration (i.e. with smoke, light and/or life line) shall conform to the safety plan.

#### Gangways, Accommodation ladders and Rope ladders

- Gangways and accommodation ladders are used for safe access of the vessel in normal conditions or at berth.
- The crew shall adhere to the rules of safe rigging and use of the gangway and accommodation ladder.
- The purpose of rope ladders is to provide means to board and disembark ships, even in difficult circumstances. When using the rope ladders, a life jacket shall be worn. A crewmember must be on standby below / above the rope ladder in order to assist for a safe transfer to and from the vessel.
- Places of boarding / disembarking shall be well lit at night.

#### Firefighting Equipment

Firefighting equipment shall be available in accordance with the SOLAS regulations. The type of firefighting equipment and the location is shown on the safety plan and fire plan. The equipment is subject to regular maintenance and inspection. The crew is trained in using the equipment through their STCW95 training as well as by regular drills.

The following firefighting equipment will be onboard:

- fixed firefighting system (CO2) in engine rooms
- fire flaps
- fire extinguishers
- fire reels and hoses
- hydrants
- fire pump & generator
- fireman's outfit
- emergency escape breathing devices
- fire / heat / smoke alarms
- fire axe

#### Lifesaving signals

Lifesaving signals shall be available in accordance with the SOLAS regulations. The type of life saving signals and the location is shown on the safety plan and fire plan. The equipment is subject to regular inspections. Officers are trained in using this equipment.

The following lifesaving signals shall be onboard:

- EPIRB
- Radar transponder
- VHF radio
- Pyrotechnics
- Signal lamp





- Flags

#### Safety signs

Safety signs shall be posted in accordance with the SOLAS regulations. Crew shall be familiar with the signs and adhere to them. The most important signs shall be explained to visitors during their introduction.

The following types of safety signs are posted onboard:

- Prohibition signs (e.g. 'no smoking')
- Mandatory signs (e.g. 'emergency exit: keep free')
- Direction signs (e.g. 'exit' or 'escape route')
- Hazard signs (e.g. 'danger: overhead working')
- Fire control / equipment signs (e.g. 'fire alarm')
- Space indicating signs (e.g. 'paint store')
- ISPS signs (e.g. 'restricted area')

#### Compressed-air breathing apparatus manner of testing:

Monthly:

- Open the bottle(s) a half turn and read the pressure on the gauge (must be at least 95% full).
- Close off the bottle(s) again.
- Wait one minute. Meanwhile affix the bracket.
- After one minute there should not have been an appreciable drop in the pressure; if there is, it means there is a leakage somewhere; trace the cause and solve the problem!
- Carefully reduce the pressure in the apparatus.
- Check that the (low pressure) withdrawal alarm is working

Every six months:

- Check the apparatus in accordance with the manufacturer's instructions;
- Pay special attention to all rubber components.
- Recharge the bottles with fresh air.

#### Entrances and emergency exits

- Escape routes and emergency exits must be clearly marked and well lit.
- Escape hatches and emergency exits must be marked on both sides with the words 'EMERGENCY EXIT - KEEP CLEAR'.
- Escape hatches and emergency exits must never be locked.
- Keep all means of access and emergency exits, all passageways, workshop floors, platforms, stairways and stairwells, gangways and scaffolding free from obstacles, grease, oil, snow, ice and mud. Never leave tools, ropes, wires and rubbish around but clear up immediately.
- Ensure (if possible) that provision is made for a second escape route wherever men are working.
- Paint all permanent fittings in a conspicuous color (black/yellow). Be mindful of obstructions such as eye plates on deck, lashing points, projections, raised edges and low ceilings.
- Raised work areas, (such as platforms), must be provided with railings.

#### Tanks Soundings

- The Captain or Chief Officer must ensure that all compartments and buoyancy tanks, including fore- and after- peaks, are sounded regularly.
- These soundings must be recorded in the ship's log and in the engine logbook (by the Chief Engineer)



#### Ballast tanks

- Ballast tanks must not be emptied or filled without prior permission from the Captain or Chief Officer.
- Adherence to the international ballast water requirements (IMO)

#### Fuel tanks

- Fuel tanks must be marked with the warning that naked flames and heat are dangerous and there must be safety devices in place to prevent 'overfill'.
- Engine exhausts in the vicinity must be fitted with spark arrestors.

#### Hatches and tank openings

- Hatches and tank openings must be clearly marked.
- A hatch that is open must be cordoned off.
- All permanent hatches must be fitted with safety devices to prevent them from closing of their own accord.

The following protocols of the prospective Contractor will be observed

- SWP General Marine Operations
- Training Requirements
- Navigational Aids and Equipment
- Adequate Personnel and Manpower

### **4.8 Oil Spills**

Oil Spills are considered the primary focus for Prevention and Emergency Responses. The following protocols related to this concern are provided as follows:

- Annex 4-A The Manila Bay Oil Spill Contingency Plan
- Annex 4-B Oil Pollution Prevention and Response Plan
- Annex 4-C Equipment, Devices and Materials for Containment of Oil Pollution

### **4.9 Natural Risks and Hazards**

- Seismic Risks
- Hydrological Risks
- Met Ocean Risks

These are discussed in Chapter 2.1. The mitigation measures for natural risks and hazards are through:

**Engineering Intervention-** By design and engineering using the applicable local and international building codes.

**Reclamation Methodology-** Application of the most appropriate technology and methodology. Complete and adequate soil stabilizations

**Chapter 1** provides discussions of the "Process Technology" indicating therein the various engineering and construction methodology to address natural risks. As an example, the containment structure is an effective reclamation component that addresses risks arising from seismic activities.



## Chapter 5. SOCIAL DEVELOPMENT PLAN (SDP) AND IEC FRAMEWORK

### 5 1 Social Development Plan (SDP)

#### Introduction

The SDP and IEC discussed in this Section are considered as “frameworks”.

Inasmuch as the proponent is the LGU, the official SDP will be formulated and/or finalized based on the protocol of the provincial government as well as of the host municipalities. This will not only ensure that the SDP responds to the needs and conditions of the concerned LGUs but equally important that the approval processes of the respective local governments are duly observed. The SDP also addresses the issues and concerns identified during public participation activities such as IEC, public scoping, perception survey, and public hearing, the latter to be undertaken when the EIS Report shall have substantially satisfied the requirements of the EIARC and the Resource Persons (RPs).

It is noted that the requirements of the Philippine Reclamation Authority (PRA) in granting the **Notice to Proceed (NTP)** which will be secured Post ECC to the Proponent LGU may likely impact on the details of the SDP and IEC.

#### 5 1.1 Responsibilities for the SDP and IEC

The responsible parties for the SDP and the funds for the SDP projects as well as the other components are herein spelled out in **Table 5-1**.

With respect to public funds/resources, these will be fully provided by the Private Sector / Project Developer and will not use government (national or local) sources. The LGU will eventually enter into a Consortium Agreement with a private sector and PRA for the proposed project. It will be necessary to formally establish the private sector partner (“Project Developer” of the Project Joint Venture so that the source of funds and resources could be ensured.

The estimated SDP fund will on a per annum basis will be subject to discussions not only among the LGUs concerned but likewise with the prospective private sector project partner.



Table 5-1. Preliminary Social Development Plan (SDP) for the Proposed Project

| CONCERN   | Responsible Community Member / Beneficiary  | Government Agency/ Non-government Agency and Services               | PROPONENT  | Indicative Timeline   | Source of fund  |
|---|---|---|--|---|-----------------|
| <b>FISHERIES (AFFECTED FISHERFOLKS &amp; THEIR FAMILIES)</b>  |   |   |  |   |                 |
| Sustainable livelihood programs<br>(e.g. fish processing & other aquaculture technology)  | <ul style="list-style-type: none"> <li>· Barangay Chairman</li> <li>· Barangay Kagawad for Agriculture/Fisheries</li> <li>· Registered fisherfolks]</li> <li>· Fisheries, women sector and other residents</li> </ul> | TESDA<br>Cavite Province LGU<br>Noveleta LGU<br>Rosario LGU<br>DSWD | Cavite Province LGU<br>Noveleta LGU<br>Rosario LGU | Formulation and Planning even prior to construction. Construction & Operation | Private Partner |
| Skill development training/livelihood seminars according to the need of affected parties & possible employment in the Proposed Project                            |   |   |  |   |                 |
| Technical & financial assistance in the marketing/sales/promotion of local products<br>(e.g., prominent display of ads in the public areas of the Island-Complex) |   | LGUs<br>DTI   |  |   |                 |
| Employment Assistance Program   | All stakeholders  | Cavite Province LGU<br>Noveleta LGU<br>Rosario LGU                  | Cavite Province LGU<br>Noveleta LGU<br>Rosario LGU | Construction & Operation  | Private Partner |
| Technical assistance (training/workshop) to fisherfolks in modern fishing methods and aquaculture technology  | <ul style="list-style-type: none"> <li>· Barangay Chairman</li> <li>· Barangay Kagawad for Agriculture/Fisheries</li> <li>· Registered fisherfolks]</li> <li>· Fisheries, women sector and other residents</li> </ul> | LGU<br>· Cavite Provincial Planning Office                          | Cavite Province LGU<br>Noveleta LGU<br>Rosario LGU | Construction & Operation  | Private Partner |
| Entrepreneurial and managerial assistance to fisherfolks  | <ul style="list-style-type: none"> <li>· Barangay Chairman</li> <li>· Barangay Kagawad for Agriculture/Fisheries</li> <li>· Registered fisherfolks]\</li> </ul>   | LGU<br>· Cavite Provincial Planning Office                          | Cavite Province LGU<br>Noveleta LGU<br>Rosario LGU | Construction & Operation  | Private Partner |





| CONCERN  | Responsible Community Member / Beneficiary   | Government Agency/ Non-government Agency and Services                             | PROPONENT   | Indicative Timeline             | Source of fund  |
|--|--|---|---|---------------------------------|-----------------|
| Credit assistance to farmers and fisherfolks   | · Barangay Chairman<br>· Barangay Kagawad for Agriculture/Fisheries<br>· Registered fisherfolks]\                              | LGU<br>· PPDO/MPDO<br>- BFAR<br>- Local Agriculture & Fisheries Office            | Cavite Province LGU<br>Noveleta LGU<br>Rosario LGU  | Construction & Operation        | Private Partner |
| Assistance in upgrading motorized boats (in view of longer routes for fishing) and provision of new fishing paraphernalia to enable affected small-scale fishers to move to deeper fishing grounds |  |   |   |                                 |                 |
| EDUCATION  |  |   |   |                                 |                 |
| Scholarship programs for qualified students  | Barangay Kagawad for Education<br>Teacher and/or Principal<br>Qualified & indigent students from the impact barangays          | DepEd<br>Barangay LGUs  | Cavite Province LGU<br>Noveleta LGU<br>Rosario LGU<br>Council member for Education/ / CRO | Construction & Operation        | Private Partner |
| Free school supplies and uniforms for indigent students and Scholarship programs for qualified students  | Barangay Kagawad for Education<br>Teacher and/or Principal<br>Grade 1 students from chosen/adopted public grade schools        | DepEd<br>Barangay LGUs  |   |                                 |                 |
| Annual assistance to the Education-related prograrm of the LGUs (the Province and/or the concerned City/Municipality)  | Barangay Kagawad for Education<br>PTA<br>Adopted public high schools & their students  | DepEd<br>Barangay LGUs  |   |                                 |                 |
| Technical/vocational education project;  |  | TESDA<br>Barangay LGUs  |   |                                 |                 |
| Training for advanced and appropriate technology, and strive to link with the economic strategies of the Province.   |  |   |   |                                 |                 |
| LIVELIHOOD   |  |   |   |                                 |                 |
| Provision of Livelihood Opportunities for Displaced Fisherfolks  | Barangay Chairpersons in the impact barangays<br>Chairperson or President of Fisherman's organization<br>Displaced Fisherfolks | PPDO, MPDO<br>Provincial & Municipal Agriculture & Fisheries Office<br>PSWD, MSWD | Concerned Council Member / CRO  | Pre-Construction & Construction | Private Partner |



| CONCERN  | Responsible Community Member / Beneficiary   | Government Agency/ Non-government Agency and Services                               | PROPONENT  | Indicative Timeline      | Source of fund  |
|--|--|---|--|--------------------------|-----------------|
| Provision for Gender-responsive Employment Opportunities / Training Programs for the elderly, men, women, and youth that are not employed. | Barangay Chairpersons<br>Residents of impact barangays   | PPDO, MPDO<br>Provincial/City/Municipal & Barangay LGUs<br>TESDA<br>PSWD, MSWD      | Concerned Council Member / MRO   | Construction & Operation | Private Partner |
| HEALTH   |  |   |  |                          |                 |
| Improvement of barangay health centers at impact areas as primary health care service providers.   | Barangay Chair<br>Barangay Kagawad for Health<br>Barangay Health Workers (BHWs)<br>Residents of impact barangays | LGUs<br>Provincial Health Office<br>Municipal Health Office<br>Barangay Health Unit | Provincial Health Office (PHO)<br>Municipal Health Office (MHO)<br>Community Relations Officer (CRO) | Construction & Operation | Private Partner |
| Medical missions and emergency relief programs   |  |   |  |                          |                 |
| Health information campaign  |  |   |  |                          |                 |
| Food assistance program for children of poverty-stricken families  |  |   |  |                          |                 |
| Control of communicable diseases   |  |   |  |                          |                 |
| HOUSING / URBAN SETTLEMENT   |  |   |  |                          |                 |
| Construction and maintenance of additional public toilets  | Barangay Chair<br>MPDO<br>Stall owners/sellers at the Public Market and/or Fish Port                             | PPDO, MPDO<br>Provincial Engineering<br>Municipal Engineering                       | PPDO, MPDO   | Construction             | Private Partner |
| SPORTS AND CULTURE DEVELOPMENT   |  |   |  |                          |                 |
| Provision of sports facilities such as balls, team uniforms, and the like  | · Barangay Chairman<br>· Barangay Kagawad for Sports and Cultural Development<br>- Youth                         | Provincial & Municipal Sports Commissions<br>Barangays                              | Cavite Province LGU<br>Noveleta LGU<br>Rosario LGU   | Construction & Operation | Private Partner |
| Integrate sports and cultural events with historical tour packages   |  |   |  |                          |                 |
| PEACE AND ORDER  |  |   |  |                          |                 |
| Provide drug addiction seminars, human rights violations and other related assistance  | Barangay Chair<br>Kagawad for Peace and Order  | PPDO<br>MPDO  | Cavite Province<br>PPDO  | Construction & Operation | Private Partner |



| CONCERN  | Responsible Community Member / Beneficiary   | Government Agency/ Non-government Agency and Services  | PROPONENT  | Indicative Timeline      | Source of fund  |
|--|--|--|--|--------------------------|-----------------|
| Sustain police mobility and visibility   | Barangay Police and Safety Officer (BPSO)<br>Residents of Noveleta & Rosario                           | Barangay Tanod<br>Local Police   | Noveleta MPDO<br>Rosario MPDO<br>CROs              |                          |                 |
| Conduct community-based preparedness programs to build on the “Ugnayan” with the barangays.    |  |  |  |                          |                 |
| Encourage the Barangay Intelligence Network  |  |  |  |                          |                 |
| SPIRITUAL  |  |  |  |                          |                 |
| Support on fund-raising activities relevant to religious programs and value formation programs | Barangay Assigned Catholic Priest, Pastor of different denomination                                    | Parish Priest<br>Pastor  | CROs   | Construction & Operation | Private Partner |
| ENVIRONMENT  |  |  |  |                          |                 |
| Manila Bay Marine Pollution Prevention and Coastal Clean up                                    | Barangay Chairman<br>Kagawad for Environment   | Municipal ENRO<br>Barangays<br>MBCO  | PG-ENRO<br>CENRO<br>Comrel<br>PCO                  | Construction & Operation | Private Partner |
| Mangrove reforestation & Nursery Establishment (As may be applicable)                          | Barangay Chair<br>Kagawad for Environment<br>Host Barangay (areas suitable for mangrove reforestation) |  |  | Operation                | Private Partner |
| SOCIAL SERVICES  |  |  |  |                          |                 |
| Community welfare program services   | · Barangay Chairman<br>· Barangay Kagawad for Social Welfare   | · Cavite Province Social Services<br>· Noveleta Social Services<br>· Rosario Social Services | Cavite Province LGU<br>Noveleta LGU<br>Rosario LGU | Construction & Operation | Private Partner |
| Outreach and consultation with the poor and underprivileged families;                          |  |  |  |                          |                 |
| DISASTER RISK REDUCTION / CLIMATE CHANGE ADAPTATION (in sync w IEC)                            |  |  |  |                          |                 |
| IEC on Disaster Risk Management  | · Barangay Kagawad for Environment<br>· Barangays and communities around the project area<br>· Workers | DENR-MGB, PHIVOLCS, PAGASA<br>PDRRMC<br>MDRRMC<br>Barangay Kagawad for Environment           | Cavite Province LGU<br>Noveleta LGU<br>Rosario LGU | Construction & Operation | Private Partner |
| Seminars/training on Disaster Risk Preparedness and Mitigation                                 |  |  |  |                          |                 |
| Provision of equipment and aid in response and recovery of affected communities                |  |  |  |                          |                 |



## Photos of Ongoing Social Development Programs at the Municipalities of Noveleta and Rosario

### Education



### Technical/Vocational programs of the TESDA school-based programs.



### Health

#### Medical/Dental Mission







## MEDICAL AND DENTAL MISSION FOR THE PEOPLE OF ROSARIO

### Livelihood Programs





**5.2 The IEC Framework.** *Target sector, key messages, scheme/strategy/methods, Information medium, timelines and frequency, cost (Annex 2-19 of RPM for DAO 2003-30)*

This is provided in **Table 5-2.**

**Table 5-2. Generic IEC Plan/Framework**

| Target Sector  | Major Topic/s of concern in Relation to Project   | IEC Scheme/ Strategy/ Method   | Information Medium   | Indicative Time/ Frequency                           | Indicative Cost           |
|--|---|--|--|--|---------------------------|
| Barangay Council/association and Municipal Officials | <ul style="list-style-type: none"> <li>Disaster Risk and Reduction and Management/ Emergency Plan</li> </ul>  | Municipal wide IEC Emergency Drills Participation by and NDRRMC and PHIVOLCS   | Visual Actual Drills (Fire, Earthquake, storm surges)  | From start of construction Semi-annual or as decided | To be determined          |
| Barangay and Municipal council members               | <ul style="list-style-type: none"> <li>Project Description</li> <li>Impacts on environment and health</li> <li>Risks</li> <li>Socio-Economic benefits</li> <li>Socio-Economic impacts particularly to fisher folks and vendors Climate Change Mitigation/Adaptation</li> </ul>  | Group Method Consultations with Stakeholders   | Roundtable Discussion Focus Group Discussion / Power Point Presentation Printed Materials Media releases | After receipt of NTP from PRA                        | To be determined          |
| Impact Barangays Senior Citizens                     | <ul style="list-style-type: none"> <li>Health and Safety</li> <li>Locally prevalent diseases</li> </ul>   | Group Method Consultations   | Roundtable Discussions   | Before start of construction                         | To be determined          |
| General Public                                       | <ul style="list-style-type: none"> <li>Drugs Awareness</li> </ul>   | Public Discussions PNP as guest  | Roundtable Discussions   | Before start of construction                         | To be determined          |
| The Impact Barangays                                 | <ul style="list-style-type: none"> <li>Garbage Management</li> <li>Plastic wastes</li> </ul>  | Technical Discussions Printed Materials  | Invite experts on solid wastes   | Before start of construction                         | To be determined          |
| NGOs and Religious Groups                            | <ul style="list-style-type: none"> <li>Nature of the Proposed Project</li> <li>Impacts on environment               <ul style="list-style-type: none"> <li>Floods</li> <li>Liquefaction</li> <li>Marine Ecology</li> </ul> </li> <li>Impacts on health</li> <li>Socio-Economic impacts and benefits to existing establishments</li> </ul> | Group Method Consultations <ul style="list-style-type: none"> <li>Send invitations to various barangay council members and impact sectors</li> <li>Continuous discussion and consultation with the stakeholders to know their issues and concerns</li> </ul> | Focus Group Discussion / Power Point Presentation Printed Materials                                      | Before construction Phase                            | Printing of IEC Materials |
| Professional society and individuals                 | Continuing consultation   | Group Method   | Focus Group Discussion Power Point Presentation  | To be determined                                     | To be determined          |
| Prospective MMT Members (if formed)                  | Environment and Health  | Group Method   | Focus Group Discussion   | Same   | Same                      |



| Target Sector           | Major Topic/s of concern in Relation to Project                   | IEC Scheme/ Strategy/ Method | Information Medium                           | Indicative Time/ Frequency | Indicative Cost  |
|-------------------------|---|------------------------------|--|----------------------------|------------------|
| PENRO                   |   |                              | Power Point Presentations                    |                            |                  |
| MMT Members (if formed) | The Project EIA<br>Water and Marine Ecology<br>Quality Management | Group method<br>Individual   | Printed materials<br>Focus Group Discussions | Same                       | To be determined |

Notes: The indicative time/frequency and indicative cost are noted in the above as "To be determined". These would be dependent not only on the LGUs internal programs/plans but on the inputs/requirements that may arise from the prospective JVAs as well as from the requirements of the PRA during the processing of the NTP for the Proponent LGU.

### 5.2.1 Public information on the Nature of the Project.

The completed "Public Participation" compliant with DAO 2017-15 sufficiently provides public information and includes among others the following matters/issues/concerns/perceptions of the public.

- Flooding/Storm Surges
- Liquefaction
- Land Subsidence
- Sea Level Rise
- Damage to Marine Life
- Incremental increase in Traffic Congestion

The report on "Public Participation" is provided in the Executive Summary and in the submission of the Public Scoping Report to the EIAMD.

The mandatory and prospective Public Hearing will further provide an important vehicle for Public Information and Dissemination.

### 5.2.2 Consultation with the Professional Sectors, Individuals and Experts

During the detailed design and engineering works, which will be undertaken post ECC, the proponent will consider consultations as maybe necessary and feasible with independent professionals, individuals, members of the academe, concerned governmental entities (e.g. the DOST PAGASA/PHIVOLCS) and of the civil societies concerning the application of technical/scientific/engineering knowledge and methodologies to address various perceived and real concerns on natural risks and hazards at the project site environs.

These perceived and real concerns relate to hazards/potentials on storm surges/waves, tsunamis, liquefaction, land subsidence and ground shaking. The National Academy of Science and Technology (NAST) in fact conducted a scientific forum on February 15, 2016 in Manila on the topic: **Policy Discussion on the Hazards, Risks and Profits of Reclamation**

### 5.2.3 Timeframes and Funding Support

The reclamation phase is separate and distinct from the operations phase and involves only the reclamation itself and horizontal development. This phase may be completed in between 2-3 years per phase after start of construction work. **Thus, the definitive timeframes for the SDP and IEC are necessarily tied in to the project timetable.**

The more definite timetable as well as source of funding will be better determined after the signing of the Province and the PRA with a Private Sector Project Developer which will undertake and fund the project.



## Chapter 6. ENVIRONMENTAL COMPLIANCE MONITORING (ECM)

### 6.1 Self-Monitoring Plan

Provided in **Table 6-1** is the Environmental Monitoring Plan (EMoP) with Environmental Quality Performance Levels (EQPLs) consistent with Annex 2-20 of the RPM for DAO 2003-30.

From this the definition of EQPL-Environmental Quality Performance Level is as follows:

- Alert or Red Flag: early warning
- Action Level: point where management measures must be employed so as not to reach the regulated threshold or limit level, or to reduce deterioration of affected environmental component to pre-impact or optimum environmental quality
- Limit Level: regulated threshold of pollutant (standard that must not be exceeded); point where emergency response measures must be employed to reduce pollutants to lower than standard limit.





Table 6-1. Summary of EMoP with EQPLs for the Project Cycle

| Activity   | Potential Impact | Parameter to be Monitored | Sampling & Measurement Plan   |           |   | Lead Person | Annual Estimated Cost                       | EQPL MANAGEMENT SCHEME |              |              |   |   |  |  |
|--|------------------|---------------------------|---|-----------|---|-------------|---|------------------------|--------------|--------------|---|---|--|--|
|  |                  |                           | Method  | Frequency | Location  |             |   | EQPL RANGE             |              |              | MANAGEMENT MEASURE  |   |  |  |
|  |                  |                           |   |           |   |             |   | ALERT                  | ACTION       | LIMIT        | ALERT   | ACTION  | LIMIT  |  |
| PRE-CONSTRUCTION PHASE   |                  |                           |   |           |   |             |   |                        |              |              |   |   |  |  |
| Not relevant survey works at site completed  |                  |                           |   |           |   |             |   |                        |              |              |   |   |  |  |
| CONSTRUCTION PHASE   |                  |                           |   |           |   |             |   |                        |              |              |   |   |  |  |
| WATER  |                  |                           |   |           |   |             |   |                        |              |              |   |   |  |  |
| Construction of containment structures<br>Filling of Materials<br>Transport of Materials | Water pollution  | TSS                       | Grab Sampling per DAO 2016-08 Water Quality Guidelines and General Effluent Standards of 2016 | Quarterly | 8 Stations - 2 stations per side elevation/direction (N, S, W, E) | PCO/ MMT    | Part of the monitoring fund of MMT PhP 400k | >35 mg/L               | >40 mg/L     | >45 mg/L     | Conduct investigation on the possible causes of exceedances as per standard Incident Accident Notification, Investigation and Reporting Procedure | Conduct investigation on the possible causes of exceedances as per standard Incident Accident Notification, Investigation and Reporting Procedure. Retesting to verify the exceedances. | -Remove oil from the Oil-Water Separator using oil sorbent pads.<br>- Conduct retesting to confirm result of action. Hire a 3rd party environmental monitoring team to conduct the testing to validate results. If exceedance persist operation in the area of concern will be temporarily stopped unless the exceedance is corrected. |  |
|  |                  | O & G                     |   |           |   |             |   | >1.5 mg/L              | >1.8 mg/L    | >1.9 mg/L    |   |   |  |  |
|  |                  | pH                        |   |           |   |             |   | <7.2 & >8.2            | <7.1 & >8.3  | <7 & >8.4    |   |   |  |  |
|  |                  | Color                     |   |           |   |             |   | No significant effect  |              |              |   |   |  |  |
|  |                  | Temperature               |   |           |   |             |   | 2.6°C rise             | 2.8°C rise   | 3.0°C rise   |   |   |  |  |
|  |                  | BOD                       |   |           |   |             |   | >15 mg/L               | >20 mg/L     | >25 mg/L     |   |   |  |  |
|  |                  | Cadmium                   |   |           |   |             |   | 0.001 mg/L             | 0.002 mg/L   | 0.0025 mg/L  |   |   |  |  |
|  |                  | Lead                      |   |           |   |             |   | 0.007 mg/L             | 0.008 mg/L   | 0.009 mg/L   |   |   |  |  |
|  |                  | Mercury                   |   |           |   |             |   | 0.0007 mg/L            | 0.0008 mg/L  | 0.001 mg/L   |   |   |  |  |
|  |                  | Chromium                  |   |           |   |             |   | 0.03 mg/L              | 0.04 mg/L    | 0.045 mg/L   |   |   |  |  |
|  |                  | Total Coliform            |   |           |   |             |   |                        |              |              |   |   |  |  |
|  |                  | Fecal Coliform            |   |           |   |             |   | 70 MPN/100mL           | 80 MPN/100mL | 90 MPN/100mL |   |   |  |  |
|  |                  | COD                       |   |           |   |             |   | >80 mg/L               | >90 mg/L     | >100 mg/L    |   |   |  |  |
|  |                  | Surfactants (MBAS)        |   |           |   |             |   | 0.2 mg/L               | 0.25         | 0.28 mg/L    |   |   |  |  |
|  |                  | Ammonia                   |   |           |   |             |   | 0.03 mg/L              | 0.04 mg/L    | 0.05 mg/L    |   |   |  |  |
|  |                  | Nitrate                   |   |           |   |             |   | 15 mg/L                | 17 mg/L      | 19 mg/L      |   |   |  |  |
|  |                  | Phosphate                 |   |           |   |             |   | 0.35 mg/L              | 0.4 mg/L     | 0.45 mg/L    |   |   |  |  |
|  |                  | Sulfate                   |   |           |   |             |   | 235 mg/L               | 240 mg/L     | 245 mg/L     |   |   |  |  |
|  |                  | Cyanide                   |   |           |   |             |   | 0.015 mg/L             | 0.017 mg/L   | 0.019 mg/L   |   |   |  |  |
|  |                  | Arsenic                   |   |           |   |             |   | 0.007 mg/L             | 0.008 mg/L   | 0.009 mg/L   |   |   |  |  |
|  |                  | Copper                    |   |           |   |             |   | 0.01 mg/L              | 0.015 mg/L   | 0.018 mg/L   |   |   |  |  |
|  |                  | Flouride                  |   |           |   |             |   | 1 mg/L                 | 1.2 mg/L     | 1.4 mg/L     |   |   |  |  |
|  |                  | Iron                      |   |           |   |             |   | 1 mg/L                 | 1.2 mg/L     | 1.4 mg/L     |   |   |  |  |
|  |                  | Zinc                      |   |           |   |             |   | 0.035 mg/L             | 0.04 mg/L    | 0.045 mg/L   |   |   |  |  |
| AIR  |                  |                           |   |           |   |             |   |                        |              |              |   |   |  |  |



| Activity  | Potential Impact  | Parameter to be Monitored              | Sampling & Measurement Plan         |             |                    | Lead Person | Annual Estimated Cost                        | EQPL MANAGEMENT SCHEME              |                                 |                                 |   |  |  |
|---|---|--|-------------------------------------|-------------|--------------------|-------------|--|-------------------------------------|---------------------------------|---------------------------------|---|--|--|
|   |   |  | Method                              | Frequency   | Location           |             |  | EQPL RANGE                          |                                 |                                 | MANAGEMENT MEASURE  |  |  |
|   |   |  |                                     |             |                    |             |  | ALERT                               | ACTION                          | LIMIT                           | ALERT   | ACTION   | LIMIT  |
| Hauling of filling materials                      | Noise generation  | Noise (Decibels dBA)                   | Portable Noise sampler NPCC Class C | Semi Annual | 2 station (hourly) | PCO         | Part of the monito ring fund of MMT PhP 10k  | Daytime - 60dB<br>Night time - 55dB | Daytime - 65<br>Night time - 58 | Daytime - 70<br>Night time - 60 | Survey sampling station verify complaints as per Noise Level Monitoring and Measurement Procedure. Check the sound level using sound meter. Determine possible cause. | If source of noise is from the site, inform the PM to provide mitigation measures. Conduct noise monitoring to verify if level is already w/in limits. If source of noise is not from the area, inform the MMT regarding possible source for MMT's investigation & coord w LGU.  | Noise sampling thru 3rd party firm. Inform the operation to stop activity unless mitigation measure has been installed or the source of noise has been corrected. Upon installation of measures, conduct noise monitoring to verify if the noise level is already w/in limits.   |
|   | Degradation of air quality<br>Dust pollution due to vehicle movements | SO2 (µg/Ncm)                           | DENR AO 2000-81, Rule XXVI, Sec.1   | Quarterly   | 2 station (hourly) | PCO/ MMT    | Part of the monito ring fund of MMT PhP 100k | 290 (1hr)                           | 305 (1 hr)                      | 340 (1 hr)                      | Check weather condition during sampling and if location is downwind of the area. Check possible source of pollution including external factors.                       | Check weather condition during sampling and if location is downwind of the area. Conduct site visit at said stations & hire 3rd party sampling firm to confirm. Adjust the unit's operation per operating manual. Temporarily stop certain aspect of operation unless the problem has been resolved. If the source is not from site, coordinate with LGU, DENR & MMT for appropriate action. | Check weather condition during sampling and if location is downwind of the area. Conduct site visit at said stations & hire a 3rd party sampling firm to confirm. Adjust the unit's operation per operating manual. Temporarily stop certain aspect of operation unless the problem has been resolved. If the source is not from site, coordinate with LGU, DENR & MMT for appropriate action. |
|   |   | NO2 (µg/Ncm)                           |                                     |             |                    |             |  | 220 (1hr)                           | 235 (1 hr)                      | 260 (1 hr)                      |   |  |  |
|   |   | PM10 (µg/Ncm)                          |                                     |             |                    |             |  | 170 (1hr)                           | 180 (1 hr)                      | 200 (1 hr)                      |   |  |  |
|   |   | TSP (µg/Ncm)                           |                                     |             |                    |             |  | 255 (1hr)                           | 270 (1 hr)                      | 300 (1 hr)                      |   |  |  |
| Compaction/Soil stabilization of the project area | Noise pollution due to heavy equipment operation                      | same as noise generation entries above |                                     |             |                    |             |  |                                     |                                 |                                 |   |  |  |



| Activity                              | Potential Impact  | Parameter to be Monitored  | Sampling & Measurement Plan  |                     |                               | Lead Person    | Annual Estimated Cost  | EQPL MANAGEMENT SCHEME   |   |  |   |  |  |
|---------------------------------------|---|--|--|---------------------|-------------------------------|----------------|--|--|---|--|---|--|--|
|                                       |   |  | Method   | Frequency           | Location                      |                |  | EQPL RANGE   |   |  | MANAGEMENT MEASURE  |  |  |
|                                       |   |  |  |                     |                               |                |  | ALERT  | ACTION  | LIMIT  | ALERT   | ACTION                                       | LIMIT  |
|                                       | Dust pollution due to heavy equipment operation including transport vessels | Same as degradation of air quality entries above                                       |  |                     |                               |                |  |  |   |  |   |  |  |
| LAND                                  |   |  |  |                     |                               |                |  |  |   |  |   |  |  |
| Construction of horizontal structures | Land pollution due to solid wastes and toxic substances                     | Volume of solid wastes   | Visual   | Weekly              | On site                       | PCCO           | Monitoring will be through visual count weekly of the number of garbage cans/containers picked up and coordinated to Cavite Solid Waste Management Office. |  |   |  |   |  |  |
| PEOPLE                                |   |  |  |                     |                               |                |  |  |   |  |   |  |  |
| Construction                          | Hiring  | Employment of local qualified residents  | Contractor records   | Construction period | Reclamation/construction site | MMT            | Included in Operation Cost   | Negative feedback to the Proponent                             | Formal complaint by the workers                                 | Formal complaint by the workers                | Formal complaint by the workers                                     | Complain to DOLE                             | Review the protocol and reconsider the complaint if applicable |
|                                       | Exposure of employees and the local community to construction activities    | Safe person-hours, injury, near miss and other safety performance indices Health stats | Incident reporting, survey, include in the H&S Plan  | Annually            | Reclamation/construction site | MMT            | Part of the monitoring fund of MMT   | No affected employee, injury, near misses and minor accidents. | One affected employee, injury, near misses and minor accidents. | Major accidents such as fires, explosion, etc. | Re-training of the workers on safety. Investigate.                  | Inspect the area of most accidents. Monitor. | Safety audit on site by 3rd Party                              |
|                                       | Residents   | Health, Income   | Surveys, medical examinations included in the H&S Plan, payment record, key informant interviews | Annually            | DIAs and IIAs                 | ComRel Officer | Part of SDP Budget   | Increased level of sickness per survey                         | All complaints lodged by residents                              | All complaints lodged by residents             | Talk with the locals to check their stand & to property address it. | Intensify IEC and ComRel                     | Conduct FGDs if needed.  |



## 6.2 Multi-Partite Monitoring Team (MMT)

Based on DAO 2017-15 in compliance to the ECC during the implementation of the project, it is imperative to ensure the implementation of Environmental Management Plan (EMP).

The MMT is to be composed of representative(s) from the concerned local environmental Non-Government Organization (NGO), PAGASA, DPWH, and other concerned government agencies, which shall be organized consistent with DAO 2017-15 and DAO 2018-18. The MMT shall primarily oversee and report to EMB Central Office, the proponents' compliance with its commitment and EMP/EMMoP as contained in the EIS documents.

The MMT is recommendatory to EMB. MMTs have the primary responsibility of validation of Proponent's environmental performance, with the following specific functions:

Per DAO 2003-30:

- i. Validate project compliance with the conditions stipulated in the ECC and the EMP;
- ii. Validate Proponent's conduct of self-monitoring;
- iii. Receive complaints, gather relevant information to facilitate determination of validity of complaints or concerns about the project and timely transmit to the Proponent and EMB recommended measures to address the complaint;
- iv. Prepare, integrate and disseminate simplified validation reports to community stakeholders;
- v. Make regular and timely submission of MMT Reports based on the EMB-prescribed format.

Per DAO 2017-15:

- vi. Continue to serve as a venue for promoting greater stakeholder vigilance and providing appropriate check and balance mechanisms in monitoring project impacts as well as a venue for empowering the communities in taking responsibility for environmental protection.
- vii. Conduct quarterly ocular site visit to validate the proponent's compliance with the ECC conditions and the EMoP including the requirement to conduct self-monitoring and submit corresponding reports regularly.
- viii. Discuss findings with the proponent.
- ix. May observe sampling activities conducted by the project proponent.
- x. Prepare and submit report to EMB-CO and EMB-RO concerned using EMB-prescribed format.
- xi. Institute an environmental emergency and complaints receiving and management mechanism, which shall include systems for transmitting recommendations for necessary regulatory action to EMB in a timely manner to prevent adverse environmental impacts.

The preliminary and proposed list of stakeholder members of the MMT, the basis of selection and proposed role is given in the **Table 6-2**.

**Table 6-2. List of MMT Stakeholders/Basis of Selection /Proposed Roles**

| Stakeholder Member                                       | Basis of Selection  | Proposed Roles  |
|--|---|---|
| EMB REG 4-A  | Per Annex 3.4 of RPM  | <ul style="list-style-type: none"><li>• Ensure adherence to policies and IRR of the MMT body</li><li>• When necessary refer items in conflict to EMB CO for resolution</li></ul>  |
| Project Proponent<br>(Provincial Government) –<br>Note A | Same as above<br>Main Responsible entity<br>Project Proponent | <ul style="list-style-type: none"><li>• Provide funds</li><li>• Provide relevant project information</li><li>• Allow MMT inspection of site and of pollution abatement facilities</li><li>• Participate in monitoring</li><li>• Assist and sign MMT Report</li><li>• Provide MMT with related Provincial Policies</li></ul> |





| Stakeholder Member  | Basis of Selection                     | Proposed Roles  |
|---|--|---|
| Host Barangays  | Most affected                          | <ul style="list-style-type: none"><li>• Participate in monitoring</li><li>• Assist and sign MMT Report</li></ul>  |
| NGO or PO registered and accredited in the Province or Municipality |  | <ul style="list-style-type: none"><li>• Assist in monitoring</li><li>• Assist in MMT report</li><li>• Provide relevant inputs on the sector represented</li></ul> |
| Philippine Reclamation Authority                                    | Authority for all reclamation projects | <ul style="list-style-type: none"><li>• Ensure compliance with the internal guidelines of the PRA</li><li>• Ensure compliance with Agreements with PRA</li></ul>  |
| Department of Tourism   | Tourism enhancement                    | <ul style="list-style-type: none"><li>• Ensure project aligned to Tourism</li><li>• Policy and Objectives</li></ul>   |
| Philippine Coast Guard  | In charge of Philippine Coasts         | <ul style="list-style-type: none"><li>• Ensure compliance with rules of PCG relative to marine environment</li></ul>  |
| Manila Bay Council  | Policy Making for Manila Bay           | <ul style="list-style-type: none"><li>• Ensure harmony with the MBC policies</li></ul>  |

**Note A:**

*Other than the Provincial Government, the Municipal Governments may also be made members of the MMT*

**Note B:**

*It should be noted that based on DAO 2017-15, EMB-DENR and the proponent shall no longer be a member of the MMT. The EMB-DENR shall provide oversight guidance to the MMT and consider its reports and recommendations in its impact and compliance evaluation. Moreover, the proponent shall provide funds for the MMT activities based on the Annual Work and Financial Plan approved by the EMB.*

**Section 16.2 of DAO 2017-15:**

*“The project proponents and EMB-DENR shall no longer be member of the MMT. The EMB-DENR shall provide oversight guidance to the MMT and consider its reports and recommendations in its impact and compliance evaluation. It shall conduct regular performance audit of the MMTs. The project proponent shall provide funds for the MMT activities based on the Annual Work and Financial approved by the EMB.”*

The above is a subject of challenge from some private sector and current members of the MMT.

**Section 15.4 of DAO 2017-15:**

*“In case that in this Environmentally Critical Project (ECP), the significant environmental impacts do not persist after construction phase or whose impacts could be regulated through the regular monitoring activities conducted by other government agencies, the MMT shall be terminated upon certification of completion by the lead government agency.”*

**6.3 Environmental Guarantee Fund**

A readily available and replenishable Environmental Guarantee Fund (EGF) to cover the following expenses:

1. For further environmental assessments, compensations and/or indemnification for whatever damages to life and property that may be caused by the project;
2. Rehabilitation and/or restoration of areas affected by the project's implementation; and
3. Abandonment/decommissioning of the project facilities related to the prevention of possible negative impacts; and as a source of fund for contingency and clean-up activities.

A replenishable Environmental Monitoring Fund (EMF) shall likewise be established to cover all costs attendant to the operation of the MMT.

**Proposed Amounts:**

1. Proposed EGF trust fund- Php 500,000 (estimate)
2. Proposed EGF cash fund- Php 500,000 (estimate)



### **3. Proposed EMF cash fund- Php 500,000 (estimate)**

The above will be discussed with the MMT upon its formation. It may be expected that the Proponent -LGU will also need to discuss this with the prospective private sector developer.

Note B above is expected to be deliberated during the formation of the MMT for this Project.

#### **Basis of the estimate**

**Annex 3-6** of the Revised Procedural Manual provides the guidelines for the determination of the EGF and is summarized hereunder. There is no explicit provision under DAO 2003-30 requiring valuation of potential impacts that may arise as a result of changes in the use of natural and environmental resources.

Procedures for arriving at such estimates in a more rational and systematic manner will have to be based on experiences that shall have been generated on Philippine examples and other developing countries. In the absence of such information, more recent experiences of projects of similar nature with provisions for EGF may be utilized.

The amount and mechanics of the EGF, EMF and the establishment of the MMT shall be determined by the EMB Central Office and the proponent in consultation with the EMB Region 4A Office through a Memorandum of Agreement (MOA), which shall be submitted to this Office one (1) year prior to project construction.

It should take into consideration the following factors in determining the appropriate amount for specific projects:

- The EIS committed programs
- The degree of environmental risk involved (based on number and extent of potential damage)
- Valuation of resources that would most likely to be affected
- The proponent's ability to provide funds for the EGF

At the end of the project life, a sufficient amount should be left from the EGF to ensure that rehabilitation, restoration, decommissioning, or abandonment shall be adequately financed. Such amount may be increased during the project life span to insure that the balance shall be sufficient for the abandonment phase. In such case, the EGF Committee may require an adjustment of such amount to cover inflation and other factors. The required submission to the DENR-EMB of the project's Abandonment Plan shall have a corresponding fund commitment subject to the approval of the DENR or the lead government agency with direct approving authority on the Abandonment/Decommissioning Plan of the project.

Draft MMT, EGF and EMF Memorandum Agreement is provided in **Annex 6-B**.

#### **Additional NOTES**

- MMT agreements and the details involving EGF EMF are developed post ECC for projects of all types
- Accordingly, the most appropriate time to provide meaningful entries is post ECC.



## **Chapter 7. DECOMMISSIONING/ ABANDONMENT/ REHABILITATION POLICY**

### **7.1 Statement on Proponent's policies and generic procedures for Rehabilitation/ Decommissioning/Abandonment will be submitted post-ECC, within a timeframe specified in the ECC.**

This will be submitted post-ECC, within a timeframe specified in the ECC. Abandonment/decommissioning may not be undertaken until after approval of the EMB of the submitted plans, which may include: a. Environmental Site Assessment to determine contaminants left by the construction; b. the monitoring of any residual effects and c. legal commitments, if any.

The proposed project is only intended for reclamation works and horizontal development, thus, decommissioning is only perceived as cessation of works in reclaimed land, which will be prepared before vertical development (construction of buildings etc.) or the establishment of the locators, which is not included in this ECC application. Once this Environmental Site Assessment (ESA) shall have been contemplated, it will be the responsibility of the proponent to coordinate with the EMB for the latter's guidelines on what are the needed activities including more in-depth monitoring as well as the decommissioning procedure.

The activities to be undertaken for the cessation of reclaimed land are:

- Sampling test for water to ensure that there are no leak oil and greases and more importantly metallic contamination and other substances that can affect the existing water quality of Manila Bay.
- General demobilization of equipment.
- In terms of alternatives for the future use of abandoned area, there will be no area to be abandoned, hence, this is not needed;
- Rehabilitation/ restoration plans, if any The project is consistent with the long-term zoning and land use development, noting that the proposed project is the Province itself.

### **7.2 General Abandonment/Decommissioning Scenario**

#### **Procedures for the decommissioning of the project components:**

Demobilization during post construction will be conducted by the contractors as per Provincial Government requirements, which include all activities and costs for transport of all construction equipment used, all excess materials, disassembly and transport of temporary facilities used during construction, removal and disposal of all construction debris and general clean-up of construction site.

The project components are largely the reclaimed land including the infrastructures therein constructed e.g. roads open spaces, viaduct, drainage culverts, electrical and water lines, etc.

#### **Transport/disposal of equipment and other materials used in the operation:**

The equipment and other materials used in the reclamation and dredging works would have been returned or claimed back by the contractors.

#### **Remediation of contaminated soil and water resources due to spills and leakage of chemicals and other materials used in the operation:**



There are no spills and leakages during the process of soil stabilization, and hence, this aspect is not relevant.

#### **Maintenance and Enhancement**

The reclaimed land itself and the operations phase of the project have no lifespan, hence, a continuing proper maintenance, enhancement and upgrading will be done to ensure high standard of the developed areas that is environmentally compliant, structurally-sound and safe. Structures will be assessed and monitored regularly to ensure the sustained integrity of the project development.

#### **Alternatives for the future use of abandoned area:**

The proponent can bid out the project to private sectors for their use; subject to the policies and approval of PRA and the NEDA.

#### **Consistency with long term zoning and land use development plan of the municipality:**

The project is consistent with the long term zoning and land use development, noting that the proposed project is the LGU itself.

### **7.3 Focus on the Decommissioning/Rehabilitation and Restoration Activities**

Focus will be made on the 267 hectare landform created for Island D.

Moreover, attention will be also be made on the rehabilitation and restoration needs, if any, for any residual impacts on the fishing structures and on the fishing grounds. Damage if any to the marine ecology will have to be compensated for including the rehabilitation of such damage.





## **Chapter 8. INSTITUTIONAL PLAN FOR EMP IMPLEMENTATION**

### **8.1 Organizational Scheme of the Proponent**

The Institutional Plan is the inception of an organizational body that will implement the proposed Environmental Management Plan (EMP) whose main thrust is to ensure that environmental, socio-economic, political and public health issues are properly address in a timely manner. It provides necessary mechanism that will strengthen the organizational relationship of the proponent with the private sector developer/partner, other concerned government agencies and other stakeholders.

The proposed project will be implemented by a group of the Cavite Provincial Government, PRA and a private sector project developer (through a Joint Venture Agreement), which will have shared responsibilities and liabilities.

- The Provincial Government of Cavite will enter into an Agreement with a private sector private developer (or a group of investors) that will ensure not only the implementation of the proposed project but also the faithful implementation of the EMP.
- The private sector member is expected to take direct responsibility for the reclamation phase in accordance with the agreements that will be made among the members of the consortium. The Project Developer will be awarding the reclamation/dredging works to qualified contractor(s).
- The line of command will be directly from the Project Developer through its Project Manager to the Contractor through the latter's Construction Manager.
- The delineation of total responsibilities for the implementation of the Project will be determined in the MOA. The Proponent will ultimately be responsible but is expected to delegate authority to the Private Sector Developer.

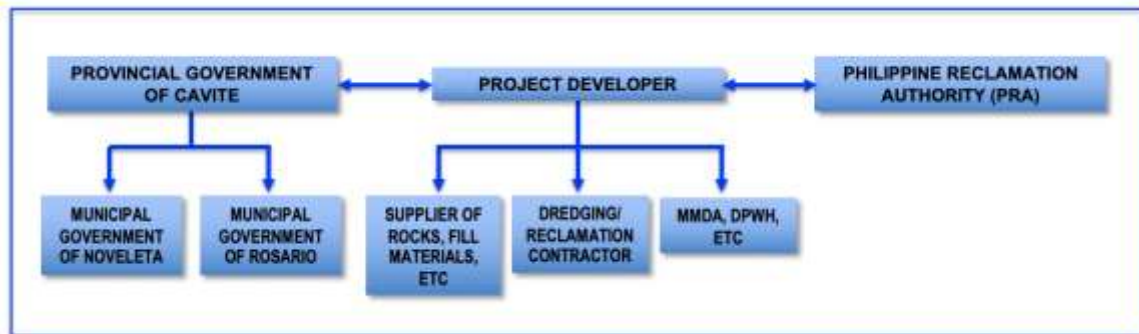
#### **During the Construction Phase**

The following key points are noted in respect of the organizational scheme:

| <b>Institutions</b>   | <b>Responsibilities</b>  |
|---|--|
| The Province of Cavite  | <ul style="list-style-type: none"><li>• Monitors compliance to EMP by contractors</li><li>• Coordinate and participate in monitoring compliance</li></ul>  |
| The City of Cavite  | Same as above as may be relevant to a particular Municipality and subject to arrangements with the Province  |
| Philippine Reclamation Authority/National Development Authority | The government agency with overall mandate over reclamation projects   |
| Private Sector Project Developer                                | <ul style="list-style-type: none"><li>• The private sector member of this consortium is expected to take responsibility for the reclamation phase in accordance with the agreements that will be made among the members of the consortium.</li><li>• The Project Developer will be awarding the reclamation/dredging works to qualified contractor(s). The manpower complement of the contractors will be determined by the Contractors themselves. The line of command will be directly from the Project Developer through its Project Manager to the Contractor through the latter's Construction Manager.</li></ul> |
| The Department of Works and Highways                            | <ul style="list-style-type: none"><li>• Participation in addressing flood problems</li><li>• Involvement in providing infrastructure support to the various projects</li></ul>   |
| The Philippine Coast Guard                                      | Stewardship of the Philippine marine waters  |
| Other Government Entities (e.g. BFAR, DOTr, DOT, etc)           | According to their Respective Mandates   |



**Figure 8-1** is an illustration of the Institutional Plan for the Construction/Reclamation Phase that may likely be adopted by the Project Consortium.



**Figure 8-1. Institutional Plan for Project Implementation – Construction Phase**

In compliance with the regulations of the EIS system, the Proponent shall establish an Environmental Unit (EU) to completely handle the environment-related aspects of the project in addition to the monitoring requirements as specified in the EMP / EMoP. The EU shall have the following functions:

- Monitor actual project impacts vis-à-vis the predicted impacts and mitigation measures in the EIS;
- Ensure that monitoring and submission of reports to EMB are carried out;
- Submit Demobilization Plan 1 year prior to the completion of reclamation activities, which will include clean-up plan; and
- Conduct a continuing consultaion with the stakeholders in updating the EMP/EMoP that may include baseline data, geohazard, disaster risk reduction and management, and ground settlement monitoring of the newly-reclaimed island.

### **The Organizational Chart for EMP Implementation**

The Pollution Control Officer (PCO) shall be responsible for the implementation of the recommended Environmental Management Measures and Environmental Monitoring Plan as stated in this report. He shall direct all contractors and sub-contractors in case they have observed the alert and action situation for immediate corrective measures. In addition, the PCO shall be responsible for monitoring of the Community Relations and Safety Officer.

He shall be responsible for the regular submission of the compliances report to the EMB Central Office and Regional Office.

### **The Organizational**

**Figure 8-2** Organizational Chart for the Construction/Reclamation Phase that may likely be adopted by the Project Consortium during the Implementation of the Environmental Management Measures.

#### ***Proponent***

Like in any other normal organization, the proponent Provincial Government of Cavite shall be responsible for planning, organizing, leading and controlling of the company thru its assigned Project Developer.

#### ***Project Developer***

The Project Developer shall report directly to the Provincial Government of Cavite who shall be responsible for the overall construction of the project as well as leading the management of the people and environment.



### ***Managing Head***

The Managing Head shall ensure compliance with the requirements of PD 1586, RA 6969, RA 8749, RA 9003, RA 9275,

### **Pollution Control Officer (PCO)**

The Pollution Control Officer (PCO) who shall be reporting directly to him and shall be responsible for the health and safety and implementation of the environmental management plan of the project. The Pollution Control Officer (PCO) shall see to it the safety of the people and the implementation of the Impact Management Plan (IMP) and at the same time lead assistant in the Multi-sectoral team.

### ***Health and Safety***

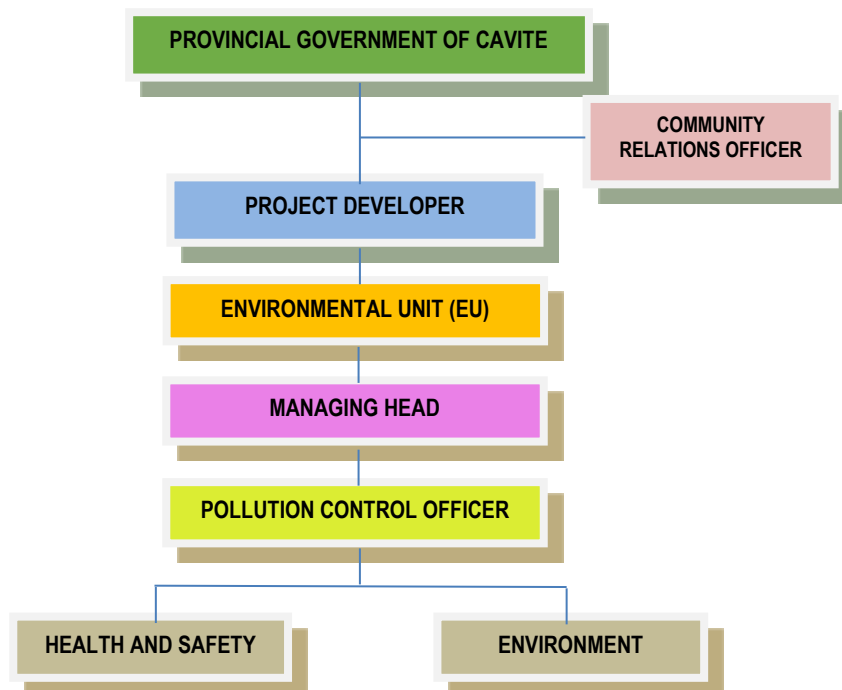
The health and safety shall include administration of the following:

- safety practices of the workers inside the plant
- point person in the disaster management plan
- emergency needs of the workers

### ***Environment***

The environment section functions the following:

- implementation and monitoring of the Impact Management Plan (IMP)
- implementation and monitoring of the Environmental Monitoring Plan (EMoP)
- reports from time to time to the Plant Manager and recommends action when necessary
- implementation of the Social Development Plan (SDP)
- implementation of the Information Education Communication (IEC)



**Figure 8-2 Organizational Chart of the Environmental Unit (EU)**



### **During Operations Phase (Distinct from the Construction Phase)**

The locators are expected to be organizing themselves into an Association which function involves among others the management of pollution abatement facilities.

It is understood that the body who will implement the EMP to be called Health, Safety, Environment and Community (HSEC) Department, shall follow the structure whereby these JV consortium 'members will be represented in the body to be organized.

During the reclamation phase, the Project Developer, through its Project Manager, shall be responsible in overseeing this institutional body in coordination with the representatives from the Department of Engineering & Public Works of the City of Paranaque and the PRA.

A Pollution Control Officer shall be designated among the project engineers who shall have the following functions for the implementation of the EMP:

- Monitor compliance of contractors' implementation of the EMP;
- Identify sources of pollution issues;
- Monitor the effectiveness of mitigating/enhancement measures;
- Based on monitoring results, find solutions/alternatives to enhance the EMP; and
- Coordinate with PRA, DPWH and other relevant oversight agencies and other stakeholders.

The PCO may concurrently act as Health and Safety Officer or a separate person may be designated. They shall report directly to the Project Manager or his designate who in turn will be responsible for the overall environmental management program. The PCO will have sufficient authority and competence on decision-making in terms of environmental management.

The Health and Safety Officer shall be responsible for the health and safety component, while the Security Officer shall be in-charge of Peace and order to include security risk management and emergency responses. The Community Relations Officer (Comrel) shall handle the implementation of social development programs and IEC activities.

Once the reclaimed land is established and turned over for vertical construction in the Operations Phase, a Project Management Office (PMO) may be established by the Estate Association of locators/business owners. The PMO head shall be supervising the new HSEC Department. The PMO shall report to the Association BOD, the

The PMO shall also function, among others, the overseeing of the maintenance of the common facilities such as the drainage system, the electrical/water distribution system and the communications facilities. It shall also manage the maintenance of the roads, drainage system as well as traffic management.

### **Contractor's Accountability**

Since the construction of the project will rely on the contractors, the proponents shall ensure that the contractors will strictly comply not only with all the technical specifications of the reclamation but likewise with all the health, safety, environment and community concerns in the execution of the development works. The contractors shall be held legally and financially liable to the EMP implementation. The contract may be terminated and or the contractor will be included in the blacklist if deemed to have acted inappropriately or did not abide by the rules set out clearly in the contract.





## 8.2 Framework on Grievance Mechanism

In general terms a “*grievance mechanism*” is a formal, legal or non-legal complaint process that can be used by individuals, workers, communities and/or civil society organisations that are being negatively affected by certain business activities and operations.

### Grievance Procedures For Reclamation Projects

Inasmuch as an LGU is the Project Proponent for reclamation projects, the Grievance Mechanism is lodged in the LGU set up.

Following procedures are based from the Local Government Code (Reference :RA 7160)

- The MPDO or CPDO will be responsible for receiving the complaints and grievances regarding the proposed reclamation project which relate to environmental, social and economic aspects (e.g. employment and livelihood). Following are the general procedures:
- The said Office will first verify the nature, correctness as well as the rationale for the complaints.
- Only formal complaints will be formally entertained.
- When verified, this Office will refer the complaints to the concerned unit or sub committee of the LGU, e.g. the environmental, employment, senior citizen, gender, peace and order, etc. unit or sub committee.
- The sub-committee will conduct an investigation or inquiry on the complaint and will call a face to face meeting with the complainant(s).
- The sub-committee will endorse the complaints and grievances to the Environment & Social Concerns Office or other unit(s) for advise and assistance.
- During the community meetings prior to the reclamation activities, the channels for complaints and grievances and related procedures shall be announced/publicized to the public including the PAFs in the form of hand-outs like pamphlets brochures/ leaflets.
- After the community meetings, all concerned institutions, including Barangay, LGU, PMO-GNP I, shall use the same hand-outs to explain the grievance redress procedures to those who come to them for filing their concerns.

Grievances from the PAFs related to the reclamation implementation or any related issues to the project will be handled, free of monetary charge, through negotiations and are aimed to have consensus decision following standard procedures.

Amicable and non-confrontational atmosphere will be observed during meetings and in the resolutions of complaints.

A timeline shall be set by the MPDO/CPDO for amicable resolutions of complaints. The complainants shall have the prerogative of elevating their complaints to the courts as they see fit.