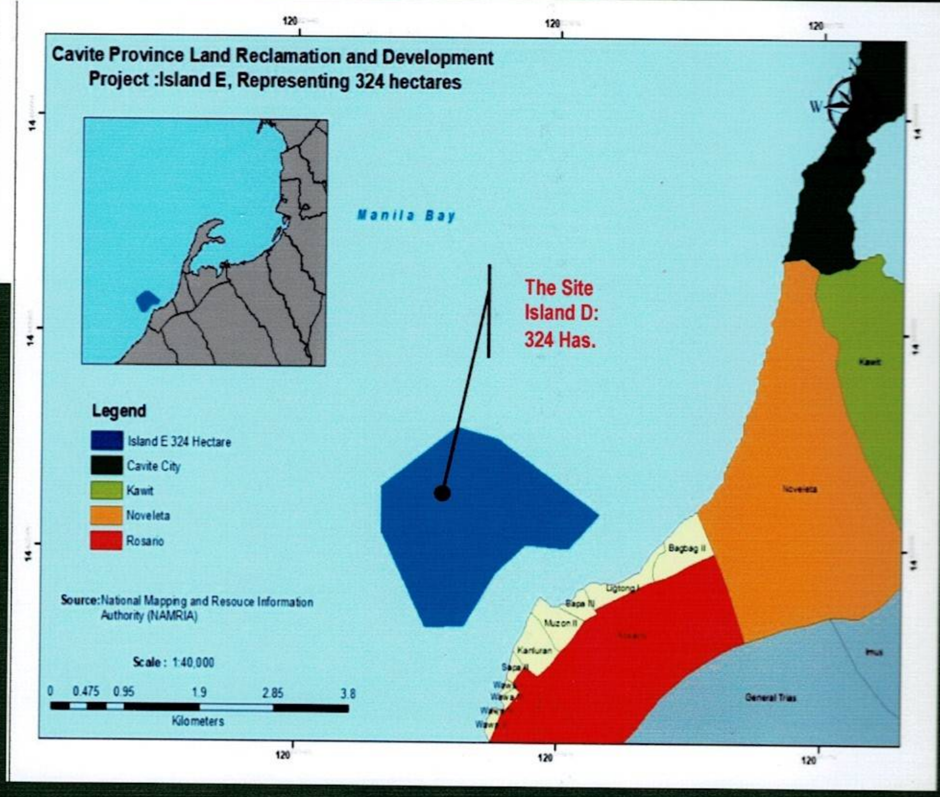
ENVIRONMENTAL IMPACT STATEMENT (EIS)

FOR THE PROPOSED

CAVITE PROVINCE LAND RECLAMATION AND DEVELOPMENT PROJECT

ISLAND E: 324 HECTARES

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



SUBMITTED BY:

CAVITE PROVINCIAL GOVERNMENT
OFFICE ADDRESS: PROVINCIAL CAPITOL OFFICE, TRECE MARTIRES CITY, PROVINCE OF CAVITE
SITE LOCATION: ALONG COASTAL WATERS OF ROSARIO WITHIN THE JURISDICTION OF CAVITE PROVINCE

FILE COPY
August 2020

SUBMITTED TO:

DEPARTMENT OF ENVIRONMENT AND NATURAL R
Environmental Management Bureau – Central Office
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AUGUST 2020

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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
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_4	Methane
CLUP	Comprehensive Land Use Plan
cm	Centimeter
cm/sec²	Centimeter per Square Second

Abbreviation/ Symbol	Meaning
cm/yr	Centimeter per Year
CO_2	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
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	Intergernmental 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

Abbreviation/ Symbol	Meaning
kg	kilogram
kh	Coefficient of lateral subgrade reaction unit
km^2	Square Kilometer
kms	Kilometers
kN	kiloNewton (Weight unit)
kN/m^3	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^2	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_2O	Nitrous Oxide
NAAQGV	National Ambient Air Quality Guideline Values
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

Abbreviation/ Symbol	Meaning
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	Oily 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
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

Abbreviation/ Symbol	Meaning
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

Name of Project	**PROPOSED CAVITE PROVINCE LAND RECLAMATION AND DEVELOPMENT PROJECT: ISLAND E (324 HECTARES)**	
Project Location	Along the Coastal Waters of Rosario, Within the Jurisdiction of Cavite Province	
Project Category per EMB MC 2014-005	Category A: Environmentally Critical Project (ECP) Major Reclamation Project ≥ 25 hectares	
Project Classification per EMB MC 2014-005	3.3 Reclamation and other land restoration project	
Scope of Project	Horizontal development Only Including Road Networks and Utilities *(Note: separate ECCs will be applied for the vertical development, source of reclamation materials, disposal of dredged materials and all connectors/bridges)*	
Project Area	324 Hectares	
Project Cost	PhP 21.400 Billion	
Summary of Major Components **(Only the "Construction" Phase covered in ECC application, i.e. dredging, reclamation and horizontal development works)**	**Major Components**	**Brief Description**
	One (1) Island	324 ha (Land area allocation for Saleable, Non-Saleable and Government Share)
	Internal Road Network	Composed of main roads, interior secondary roads, 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 Artificial block armor (Accropode) and Concrete Grid Plate.
	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 Water Supply Power Lines Telecommunication	Water supply will be connected to the Manila Water Service Inc. distribution system. Power shall be tapped from Meralco. 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
Project proponent	**CAVITE PROVINCIAL GOVERNMENT** **The Honorable Governor Juanito Victor C. Remulla** Office of the Governor Provincial Capitol Compound, Provincial Capitol Building, Trece Martires City Telephone No.: (046) 419-1919	
EIA Preparer / Consultant	**CEnSE Technical Consultancy Services** Unit 405 Yrreverre Square Building, 888 Mindanao Avenue, Quezon City Mobile No.: (0927) 511-6742; Landline: (02) 455-2022; Email add: cense_tech@yahoo.com.ph Contact Person: Engr. Venice Montemayor – Team Leader	

ES 1.1 Project Description Summary

The Environmental Impact Statement (EIS) Report has been prepared as requirement for an application for an Environmental Compliance Certificate (ECC) for the Proposed Project. The ECC application covers only the horizontal development or the reclamation of land, including the construction roads and utilities.The proposed reclamation project covers 324 hectares designated as **Island E** out of a total proposed reclamation area/project of the province of approximately 1,043.28 hectares.

The project will be situated along the coast of Manila Bay within the territorial jurisdiction of Cavite Province fronting the 9 coastal barangays namely Bagbag I, Kanluran, Ligtong I, Muzon II, Sapa II, Sapa III, Wawa I, Wawa II and Wawa III in the Municipality of 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-IA 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 Bacoor 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 Bacoor 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 withn 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.
Environmental Issues		
1	The proposed Cavite Reclamation Project consist of five (5) artificial islands to be constructed detached from the shoreline of Manila Bay. The frst four will be sited in succession parallell 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 maintsined 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, al 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 thru 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, draineg 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 structur4es may bring fort 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 tsunakis and othe 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-a-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 asses both requirements.	All possible hazards such such 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 is 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 quarts sands are to be preferred ideal materials. The proponent must therefore conduct extensive and comprehensive study as tot eh 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 in Table ES-2 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
Proponent's External Expertise			
• Arch. Armand Alli, EnP – Master Planning • Engr. Ricardo Yuson – Engineering • Engr. Jon Kasilag (AMH Philippines., Inc.) – Oceanography/Modeling • Engr. Lhyman Banganan (FF Cruz) – Topography/Bathymetry • Princess Camille Mercado (THEIDI) – Reclamation Methodology			

The accountability statements of the Prepares and Proponent in **Annex ES-B ans 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 18 February 2019 – 24 hr ambient air sampling
SOCIAL PREPARATION UNDERTAKEN	
IEC and Perception Survey (Public participation Documentation provided in **Annex ES-C**)	
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, Ligtong, Wawa I, Bagbag, Kanluran and Muzon II	January – March 2019

ES 2.3 EIA Methodologies

Table ES-4. EIA Methodology

<table>
<tr><th>Module</th><th>Baseline</th><th>Methodology</th></tr>
<tr><td colspan="3">LAND</td></tr>
<tr><td>Land Use Classification</td><td>Secondary data: Comprehensive Land Use Plan (CLUP) of Municipality of Rosario, Province of Cavite</td><td>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</td></tr>
<tr><td>Geology</td><td>Secondary data: Geologic, seismic, liquefaction, slope hazard maps and evaluation based on government data and maps.
Primary data: Borehole drilling by 3rd party</td><td>Identify and assess project impact in terms of the changed in topography including existing hazard as maybe aggravated

Conduct of EGGA.
MGB Methodology</td></tr>
<tr><td>Pedology / Soil</td><td>Primary data: Geotechnical Investigation</td><td>Physical and chemical properties relevant for design purposes</td></tr>
<tr><td colspan="3">WATER</td></tr>
<tr><td>Hydrology / Hydrogeology</td><td>Secondary data: Existing drainage system. Historical flooding occurrences</td><td>Identify and assess project impact on the change in drainage morphology, local drainage and resulting effects of flooding</td></tr>
<tr><td>Marine Water Quality</td><td>Primary data: Standard Methods for Water Quality Sampling and Monitoring.

Water Body Classification: DENR Class SB
Parameters Considered: 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)</td><td>Assess impacts on siltation of surface and coastal marine waters
DAO 2016-08
Analytical Methods: by CRL Laboratory, recognized by DENR.

Metals : Spectrophotometry AAS
Cold Vapour AAS for Hg
Coliform : Multiple Tube Fermentation
BOD : Azide Modification Winkler
O & G: Gravimetry (n-Hexane extraction)
DO : Winkler/Titrametric
pH : Electrometry
TSS : Gravimetry</td></tr>
<tr><td>Oceanography</td><td>Primary data:
Tide Measurements
Bathymetric data</td><td>Tidal Station

Echo sounder or equivalent</td></tr>
<tr><td>Marine</td><td>Primary data: Abundance / density / distribution of ecologically and economically important species, mangroves, benthism planktons, coral reefs, algae, seaweeds, sea grasses
Presence of pollution indicators</td><td>Transect, manta tow and spot dives surveys, marine resource characterization (e.g. city/municipal and commercial fisheries data), Key informant interview.

Microscopic Examination</td></tr>
<tr><td colspan="3">AIR</td></tr>
<tr><td>Ambient Air Quality</td><td>Primary data: Ambient air quality sampling and testing.

DENR Classification Ambient Air and Noise Classification: Class B – Commercial Area

Parameters Considered: TSP, PM10, SO_2, NO_2</td><td rowspan="2">Methodology: Standard Methods for Ambient Air Quality Sampling by Volume Sampler<table><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_2</td><td>Gas Bubbler Sampler</td><td>Pararosaniline</td></tr><tr><td>NO_2</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></td></tr>
<tr><td>Ambient Noise Quality</td><td>Primary data: Noise Meter</td></tr>
<tr><td>Contribution in terms of GHG</td><td>Data on Greenhouse Gases</td><td>Estimation of projected greenhouse gasses (GHG)</td></tr>
<tr><td colspan="3">PEOPLE</td></tr>
<tr><td>Demographic Profile / Baseline</td><td colspan="2">Primary data: Conduct of Public Perception Survey, Public Scoping
Secondary data: Comprehensive Land Use Plan (CLUP) of Rosario</td></tr>
</table>

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 Activiities**.

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

Sector or Representative Who Raised the Issue/ Suggestion	Issues/Suggestions Raised by Stakeholder	How it was Addressed in the EIS
Mr. Alex Maniago 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 Municipality of Rosario Resident of Barangay 8 Cavite City Councilor Cris Go of Municipality of Rosario	Impacts on Fisherfolks; near coast fihing areas will have to move further offshore	This is discussed under Chapter 2.2 Marine Ecology. 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. 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.
Ms. Vivian Tolentino Municipality of Kawit	Impacts on nearby municipalities	The various reclamation prjects 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. 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.
Representative from Philippine Coast Guard	Navigability of channels 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 Municipality of Rosario	Estimate Project 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 was conducted last October 13-19 2018 with a total of 270 respondents, to assess the socio-cultural economic situation of the communities that are to be affected by the proposed reclamation, particularly the 9 barangays in the Municipality of Rosario, namely: Bagbag II, Kanluran, Ligtong I, Muzon II, Sapa II, Sapa III, Wawa I, Wawa II and Wawa III.

For the perceived benefits, 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 after the IEC activities on January to March 2019 with a total of 3,095 respondents from 9 barangays in the Municipality of 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) stakehodlers and 21 November 2018 at Roof Top Noveleta, Public Market and Mount Sea Resort, Municipalaity 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

Sector or Representative Who Raised the Issue/ Suggestion	Issues/Suggestions Raised by Stakeholder	How it was Addressed in the EIS
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 Kap. Jomer M. Bumatayo 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 Resident of Tanza, Cavite	Impacts on nearby municipalities	The various reclamation prjects 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. 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

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
CONSTRUCTION PHASE- DREDGING ACTIVITY/OPERATION			
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

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	• Installation of silt curtains around the dredging vessel and/or dredging area	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 Increase of suspended solids affecting the settlement of marine species in the dredging and reclamation areas	• Provision of containment facility to prevent spillage • Provision of control measures when transporting filling materials	100% Compliant to RA 9275 and DAO 2016-08 standards 100% no proliferation of suspended solids
RECLAMATION ACTIVITY/OPERATION			
Construction of containment wall system/revetment structures 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	• 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. • Provision of geotextile membrane on the containment structures throughout the perimeters of the project area.	100% Compliant to RA 9275 and DAO 2016-08 standards 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 Delivery of filling and other construction materials through barges	Water pollution /Increase turbidity due to filling materials near reclamation areas	• 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. • Silt curtains shall be removed after filling inside the containment system. • Installation of silt curtains within the 50m away from the barge (for comments of the proponent) • Provision of permeable geotextile membrane to prevent sediments during high and low tide outside the project area	100% Compliant to RA 9275 and DAO 2016-08 standards
Hauling of filling materials	Increase in Noise generation	• 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. • Avoid use of heavy machinery during night hours. Activities should be strictly done from 8:00 AM to 5:00 PM only. • Installation of noise barriers along haul roads that will be used by heavy equipment.	100% compliant to Noise Standards
	Dust pollution due to vehicle movements: -Along the road leading to the reclamation area -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: ▪ 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. ▪ Covering all loaded trucks properly/fully using tarpaulin throughout the hauling period. • All trucks shall be road-worthy.	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
LAND DEVELOPMENT ACTIVITY/OPERATION			
	Land	• Liquefaction due to improper compaction	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	• 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. • Avoid use of heavy machinery during night hours. Activities should be strictly done from 8:00 AM to 5:00 PM only. • Installation of fences/noise barriers along the perimeter of the project area. Corresponding areas to be monitored shall be submitted to EMB.	100% compliant to RA 8749 in terms of air quality standards
	Air pollution emission of dust due to heavy equipment operation	• Sprinkling of water using water tanker at least four times a day within the project area especially during dry season. • Providing adequate water spraying device per hauling unit to water along all possible roads leading to the reclamation area.	100% compliant to RA 8749 in terms of air quality standards
Construction of horizontal structures such as follows: A. Road networks B. Drainage system C. Water distribution D. Power and telecommunication lines	Land pollution due to indiscriminate /improper dumping of solid wastes and toxic substances	The proponent shall ensure that its contractors shall practice on-site segregation and establish storage facility of the following: • Construction debris such as used drum, used tires, wood cuttings, iron bar cuttings, etc. • Hazardous wastes such as used oil, busted lamps, oily rags, etc. 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.	100% compliant to the following: • RA 9003 • DAO 1992-29 and DAO 2013-22 and its Revised Procedural Manual
	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	▪ Drainage system should to lead to settling ponds ▪ Provision of storm water collection system	100% Compliant to RA 9275 and DAO 2016-08 standards
	Dust pollution emanating from open areas	▪ Sprinkling of water along all possible routes leading to the reclamation area, at least four times a day, especially during dry season. ▪ Open areas should be covered with greeneries such as grass, shrubs, etc.	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 ▪ Implement SDP in terms of priority for local hirees	100% compliant to PPEs and Zero accident 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

Among the relevant Instrumentalities covering the Project is the Sangguniang Panlalawigan Resolution No. 1077, S 2018, dated November 19, 2018. This resolution grants the Provincial Governor the authority to award to Century Peak Corporation (CPC) and its consortium, the Cavite Reclamation Project Development covering 1,332 hectares (5 islands) within the territorial jurisdiction of the province. This also grants the Provincial Governor the authority to sign the Joint Venture Agreement for this purpose, pursuant to Provincial Ordinance No. 002-2-2012, otherwise known as “Provincial Government of Cavite’s PPP Code”. This also resolves to grant the Provincial Governor to apply for the necessary permits/clearancesbefore the appropriate agencies, and to enter ito agreement with such agencies, and if necessary, to sign, issue and submit documents in connection with the project. This resolution is provided as **Annex 1-A**.

This provincial resolution is backed by resolutions from the host municipalities stating no objection to the project. The Sangguniang Bayan of Rosario Cavite issued Resolution No. 10-2019 signed on January 28, 2019. The resolutions interposed no objection/opposition to the Cavite Reclamation Project and no objection/opposition to the authority of the Provincial Government to apply for the said project. These is attached as **Annex 1-B**.

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”.

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 C for application.

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

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

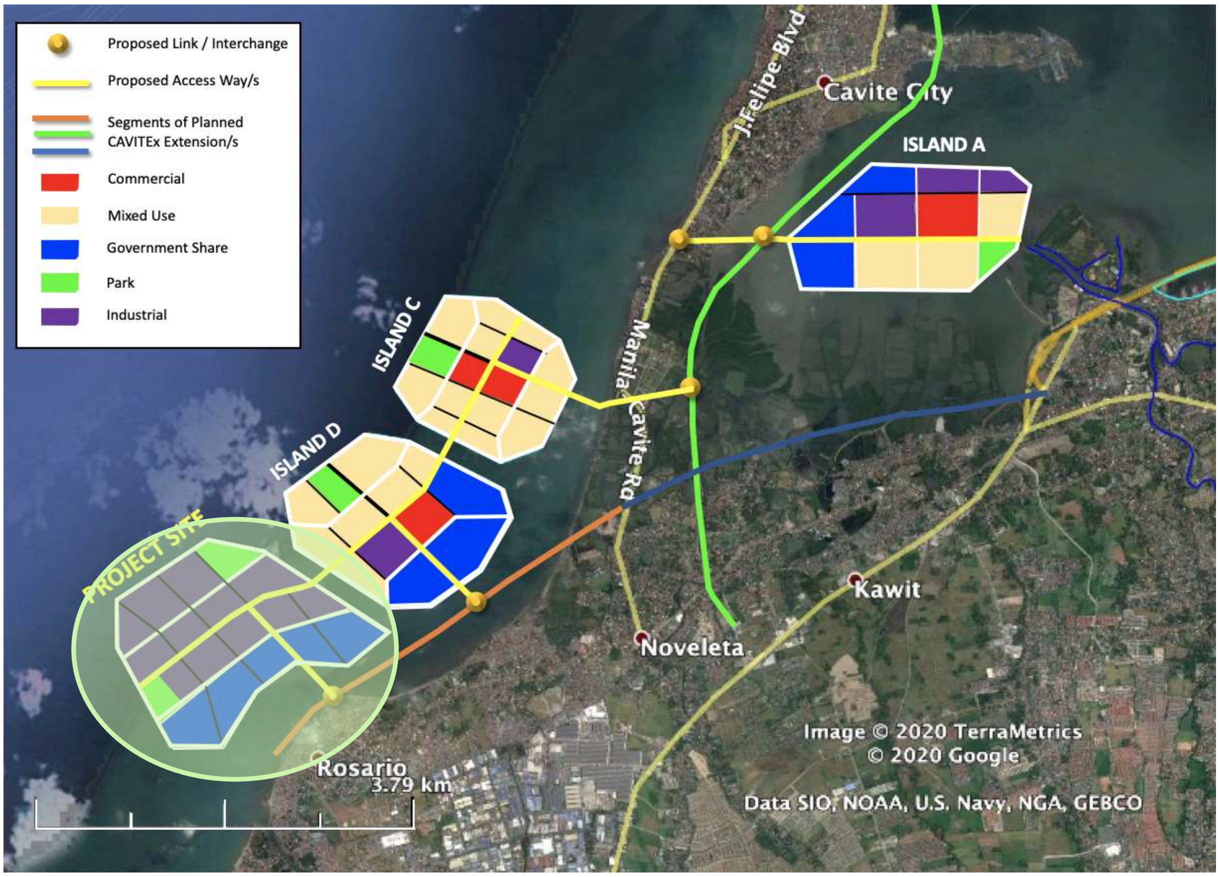


Figure 1-A Preliminary Overall Master Plan showing the location of Island E

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 **324 hectares**. The project is located in Manila Bay, along the coastline of the Municipality of Rosario, within the jurisdiction of Cavite Province.

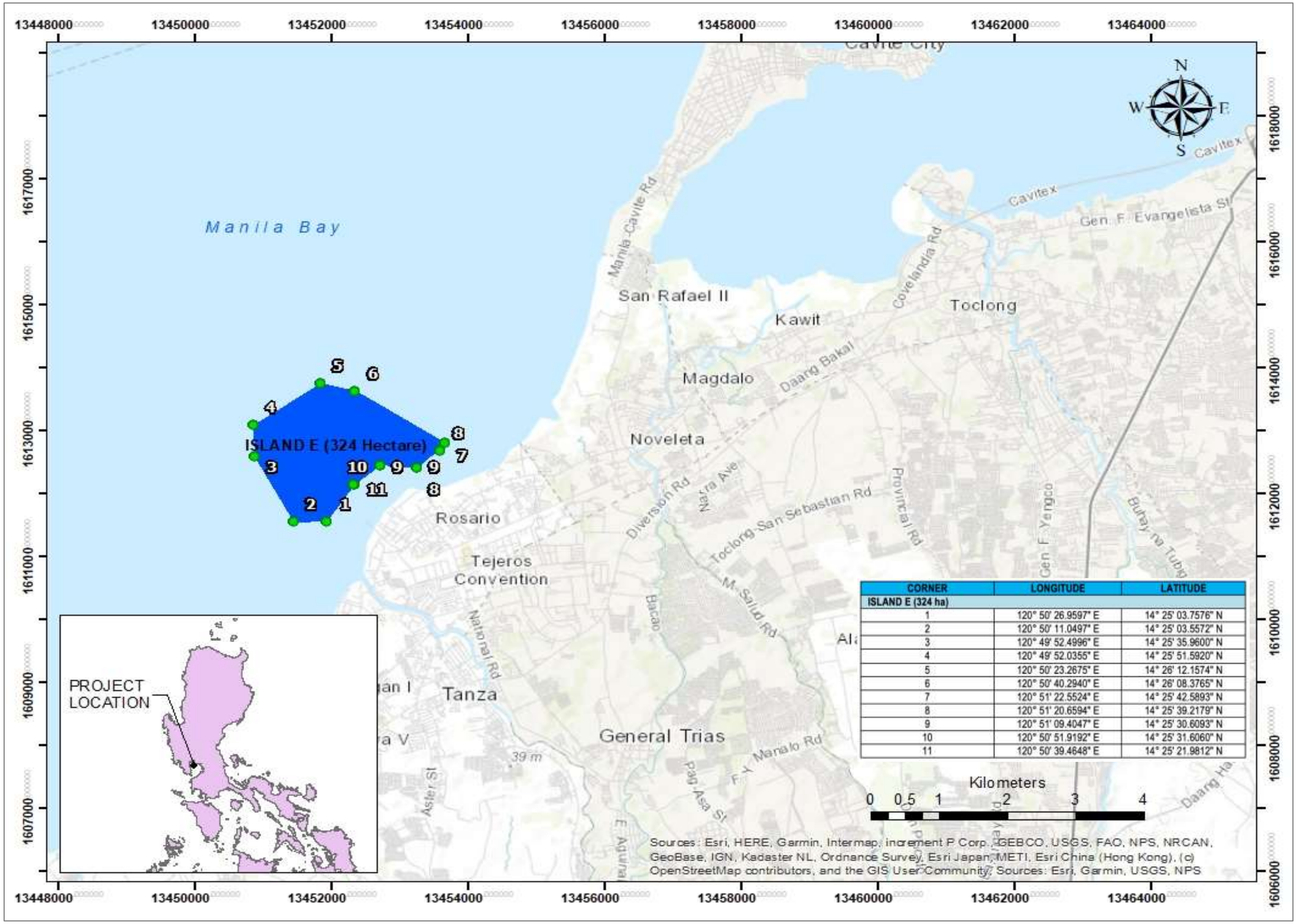
Provided in Figure 1-1 is the NAMRIA map and in Figure 1-2 the aerial satellite map of the proposed project site. The barangays/municipality adjacent to and fronting the project site (which are also the impact barangays) are shown in Figures 1-3 and 1-4**.**

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 1-1 and 1-2.

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

CORNER	LONGITUDE	LATITUDE
ISLAND E (324 ha)		
1	120° 50' 26.9597" E	14° 25' 03.7576" N
2	120° 50' 11.0497" E	14° 25' 03.5572" N
3	120° 49' 52.4996" E	14° 25' 35.9600" N
4	120° 49' 52.0355" E	14° 25' 51.5920" N
5	120° 50' 23.2675" E	14° 26' 12.1574" N
6	120° 50' 40.2940" E	14° 26' 08.3765" N
7	120° 51' 22.5524" E	14° 25' 42.5893" N
8	120° 51' 20.6594" E	14° 25' 39.2179" N
9	120° 51' 09.4047" E	14° 25' 30.6093" N
10	120° 50' 51.9192" E	14° 25' 31.6060" N
11	120° 50' 39.4648" E	14° 25' 21.9812" N



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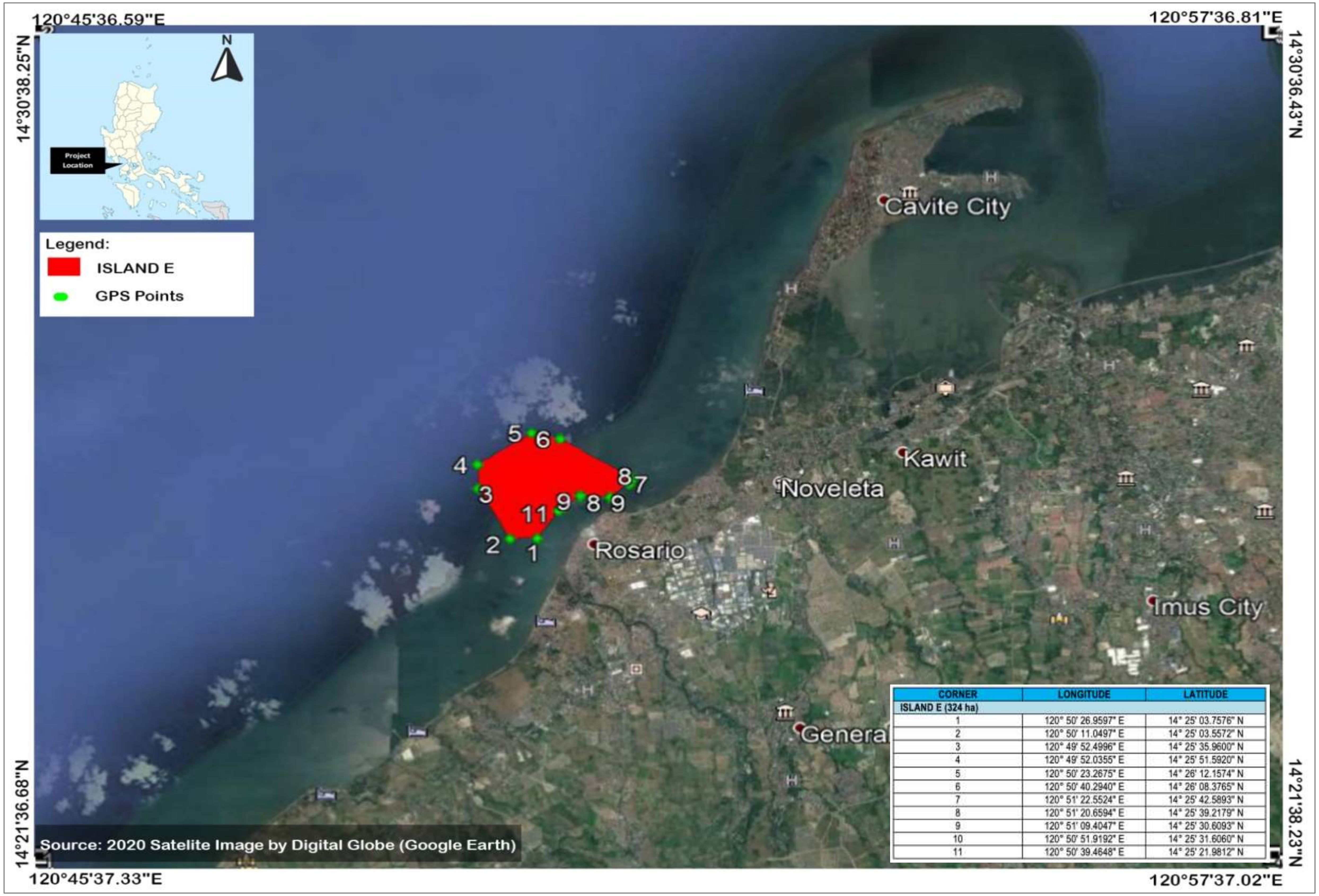
Source: NAMRIA Map Sheet 3129 1. July 2001

Figure 1-1 Proposed Project Location Map Indicating its Geographical Points (NAMRIA Map)



CORNER	LONGITUDE	LATITUDE
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11	120° 50' 39.4648" E	14° 25' 21.9812" N

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

Figure 1-2 Proposed Project Location Map 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 Rosario is the Manila-Cavite Road (NS orientation), approximately located at a range of 840 meters straight distance from the nearest corner of Islands E, shown in Figure 1-5. Another major road is the Marseilla Street, which runs almost parallel to the coast spanning the towns of Rosario, 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)*

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).* 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 E.

Access Ways

Preliminary design works are underway for the link from shore to the reclaimed land. In any case, the initial plan for Island E is for access ways/viaducts to be linked to the Marseilla Road and Magdiwang Highway (Figure 1-5). Should the CAVITEx expansion materialize, there are plans to connect Island E, as well as the other proposed islands, to the future CAVITEx (Figure 1-6).

Inter-island Connectivity

In the future when all the 4 islands of the Cavite Project are in place, Inter-island bridges will be built to connecting Islands 1 and 2 will be built. Furthermore, the access ways to island E 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 1-7. Important landmarks in the area are historical sites, old churches, industrial parks, and beach resorts. The nearest landmarks from the project site include:

- 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 1-8. These include the following:

Table 1-2. List of Nearby Reclamation Projects

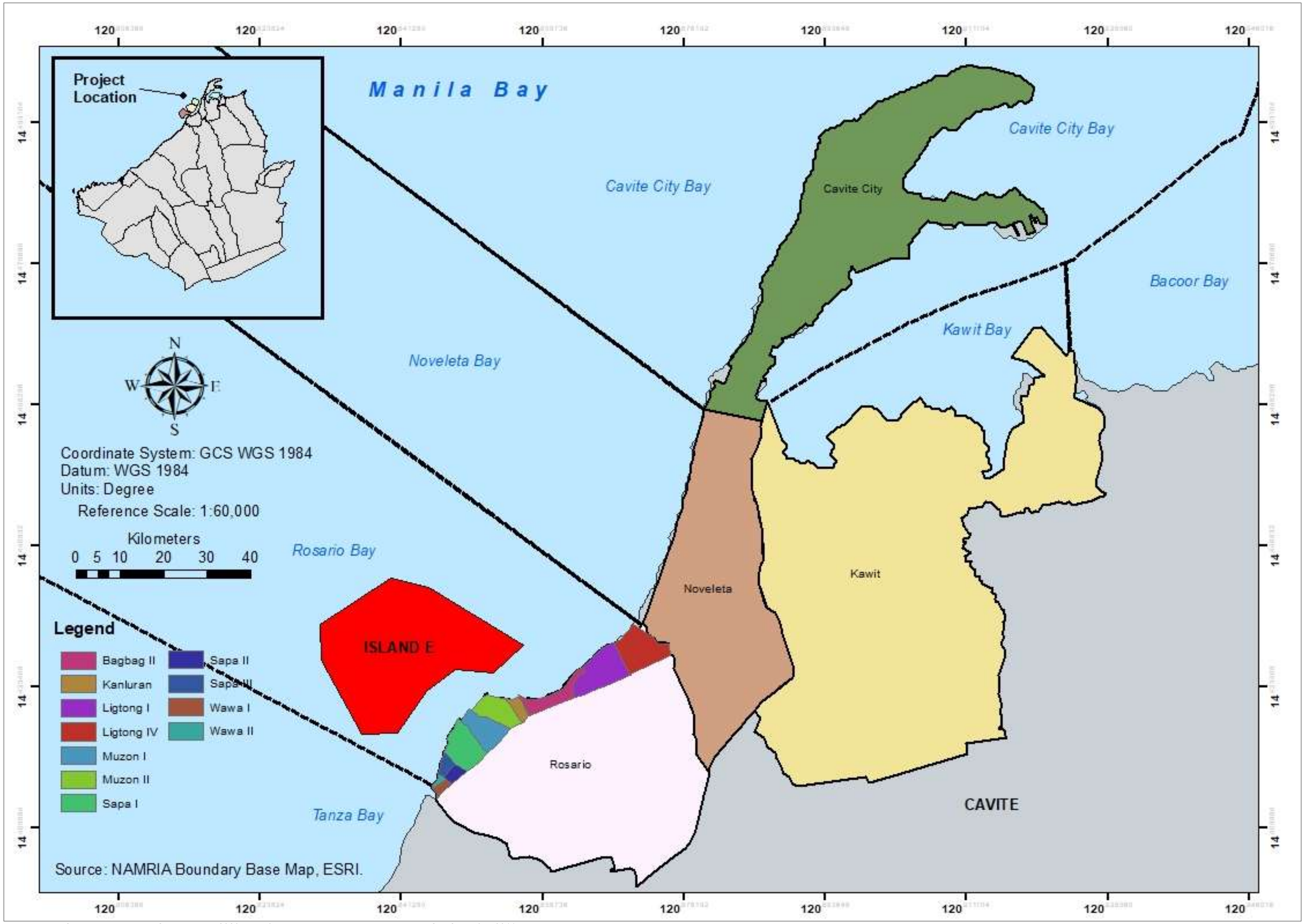
Project	Area (Hectare)	Status of ECC
Bacoor Reclamation and Development Project	320	With ECC
Diamond Reclamation and Development Project	100	With ECC
Sangley Point International Airport Project	>1,400	Planning stage
Philippine Navy Reclamation Project		Planning stage
Parañaque 286.86-ha Reclamation Project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

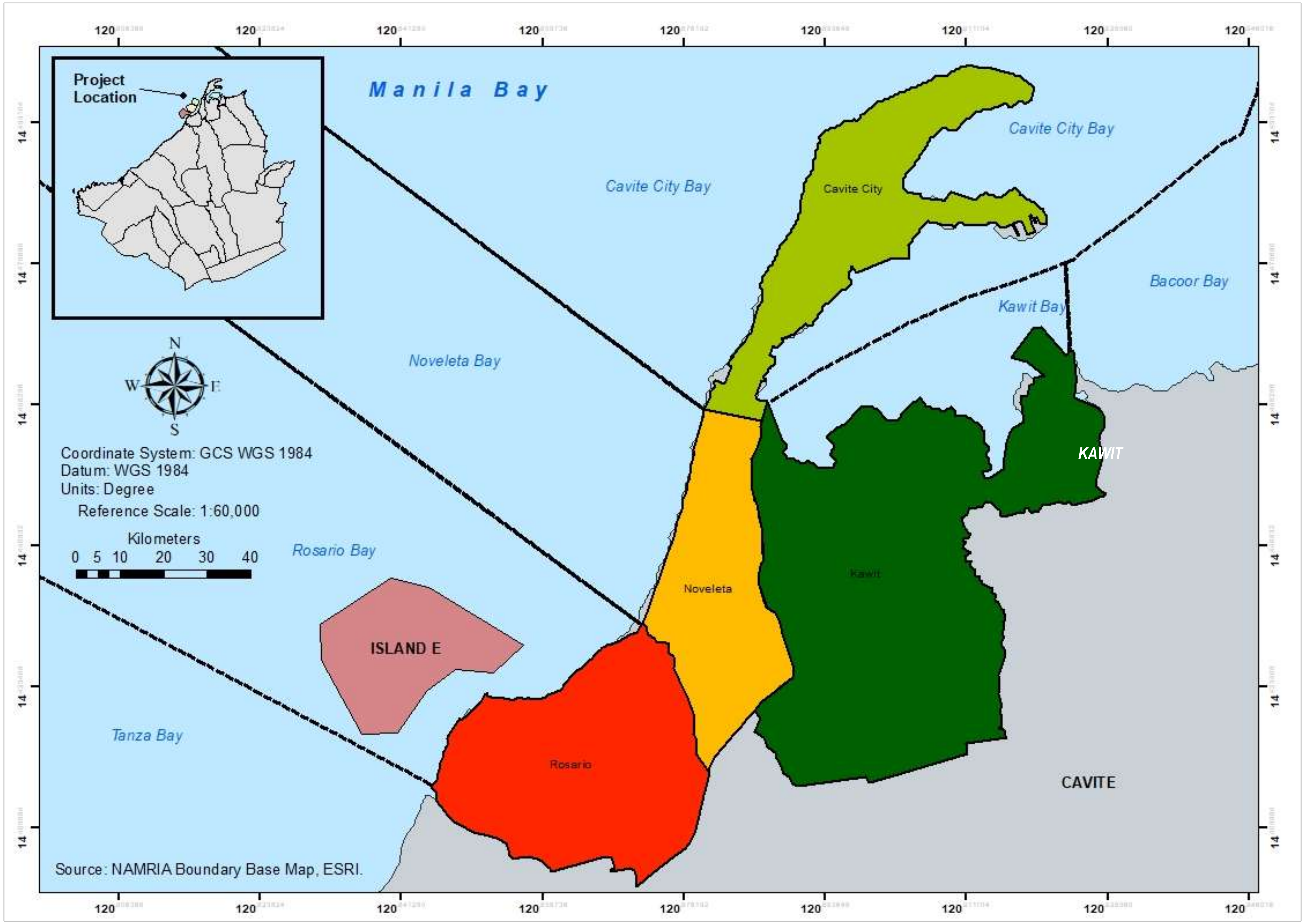
1.1.6 Relative Location of the Las Piñas-Parañaque Wetland Park (LPPWP)

The potential impact of the Project on LPPWP is well considered. Figure 1-9 shows the LPPWP being **14.5 km** away from the site a big distance to cause concern over potential impacts of the project.



Sources: Base Map –Google Earth. 2020; Data for Barangay Boundaries –NAMRIA, ESRI Shapefile. 2011

Figure 1-3 Geopolitical Map of Province of Cavite indicating the Proposed Project Site and Impact Barangays

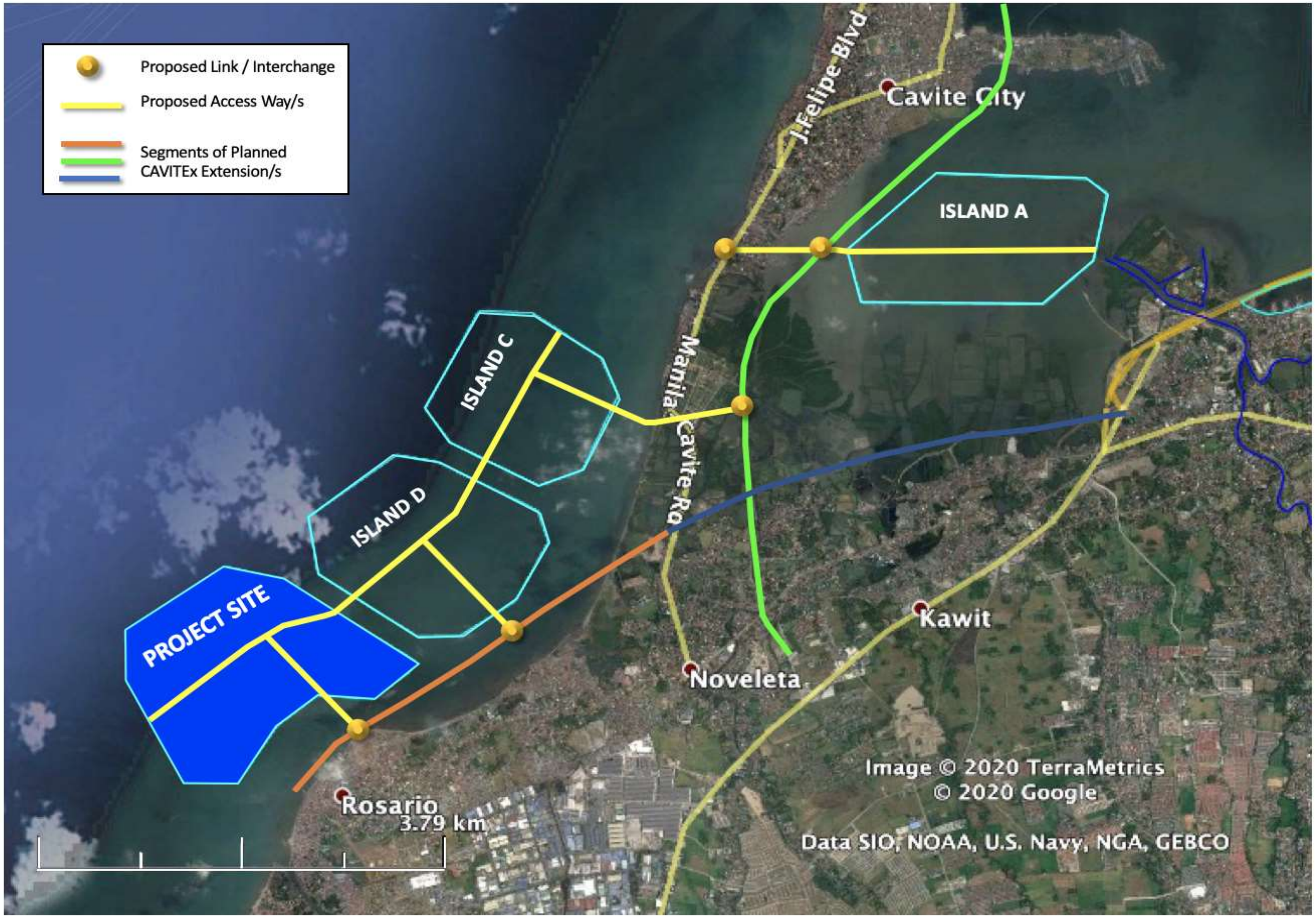


Sources: Base Map- NAMRIA Map Sheet 3129 1. July 2001; Data for Barangay Boundaries – NAMRIA, ESRI Shapefile. 2011

Figure 1-4 Geopolitical Map of the Province of Cavite Indicating the Project Site

Base Map: Satellite Image by Digital Globe, Google Earth. 2018

Figure 1-5 The Preliminary Conceptual Access Way of the Proposed Cavite Island E Reclamation Project



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

Figure 1-6 Initial Framework Plan for the Cavite Reclamation Projects Showing Conceptual Access Way to Future CAVITEx Expansion

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

Figure 1-7 Vicinity Map Showing the Important Landmarks

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

Figure 1-8 Nearby Reclamation Projects

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

Figure 1-9 Map Showing the Distance of the Project Site from the LPPWP

1.1.7 Impact Areas

The guidelines provided by the Revised Procedural Manual (RPM) for DAO 2003-30 relevant to this project are used for the delineation of the DIA and IIA. Moreover, it is also based on the critereia on Section 10.1 of DAO 2017-15 and the results of the hydrodynamic modelling.

Direct impact area (DIA) is … 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.

The direct impact areas (in terms of the physical environment) are those areas where all project components are proposed to be constructed/situated, which is the reclamation island itself covering 324 hectares. 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: Bagbag II, Kanluran, Ligtong I, Muzon II, Sapa II, Sapa III, Wawa I, Wawa II and Wawa III for Municipality of Rosario are considered DIAs as well, especially in terms of socio-economic aspects.

Another DIA are the nearest existing road where access way/s will be built.

Indirect Impact Area (IIA) …an IIA can be 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.

For the proposed project, the IIA are: the navigation lane of dredging vessel; and the other adjacent proposed reclamation project, which is the Sangley Point International Airport Reclamation Project, which is still in the planning stage.

The table below lists the DIAs and IIAs of the proposed project.

Table 1-3. Impact Areas

MODULE	MAJOR IMPACTS	DIRECT IMPACT AREA/S	INDIRECT IMPACT AREA/S
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: Bagbag II, Kanluran, Ligtong I, Muzon II, Sapa II, Sapa III, Wawa I, Wawa II and Wawa III for Municipality of Rosario. No land tenure issues related to project which is at sea.	
	Improper Solid Waste Management and Other related Impacts	At and vicinity of site	
	Inducement of natural hazards such as liquefaction, storm surge, tsunami, debris flow	Municipality of Rosario	Municipality of Rosario
	Soil Erosion	At and vicinity of site, Shoreline	
	Impacts on Las Piñas – Parañaque Wetland Park	-not applicable-	Las Piñas – Parañaque Wetland Park about 14.5 km.

MODULE	MAJOR IMPACTS	DIRECT IMPACT AREA/S	INDIRECT IMPACT AREA/S
Water	Change in drainage morphology	At and vicinity of site/onshore	
	Change in bathymetry	At and vicinity of site	
	Change in water circulation	Project site and vicinities	
	Degradation of freshwater and coastal water quality	Project site and adjacent water bodies. - The extent of water bodies where water quality are projected to exceed the ambient standards. - Coastal areas using groundwater that could possibly be contaminated by project activities. - Areas where there are existing users of the same source of water (e.g. fishing) that the proposed project will be using.	
		Nearshore coastal waters fronting the proposed project sites, i.e., coral reefs; seagrass meadows, mangrove habitats, macro-invertebrate habitats, and plankton communities	Offshore coral shoals within 1 to 3 km from the project site; mariculture zones (if any)
	Displacement of established fishing areas within the proposed site	Fisheries resources and practices occurring within the coastal area in front of the project site	
	Displacement of lifts and mussel farms		
	Potential Damage to fish cages due to Navigation of Vessel		Other fish lifts/sapras in the vicinity
	Potential damage to adjacent creeks and rivers		Adjacent freshwater bodies
Air	Areas with projected Ground Level Concentration (GLCs) of emissions higher than the ambient standard	Site of access way connecting points onshore	Roads outside project site
People	Positive impacts on employment and livelihood	Impact Barangays/ Municipality of Rosario	Province of Cavite
	Positive impacts on economic uplift of the Province of Cavite	Impact Barangays/ Municipality of Rosario	Province of Cavite
	Competition or otherwise enhancement of livelihood or businesses adjacent to site	Impact Barangays/ Municipality of Rosario	Municipality of Rosario and Province of Cavite
	Impacts on traffic in nearby existing roads		Adjacent areas onshore

The map of the DIA, and IIA is provided in Figure 1-10.

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 which is about 200 meters from from the shore. The buffer zone is also shown in Figure 1-10.

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

Figure 1-10 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 E 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 E of 324 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. The additional 9,310,000 square meters of building 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 Municipality of 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 9 impact barangays, the Municipality of 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 Municipal LGU 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.

With respect to territorial jurisdiction:
The most basic criterion in siting alternatives is that the site must be legally within the political jurisdiction of the LGU Proponent, which for this project is Province of Cavite. Conflict on jurisdiction with other LGUs should be avoided.

With respect to environmental/social impacts:
The severity of impacts is essentially the same for the feasible sites because the sites are essentially dictated by marine resources and bathymetry. Water depths have to be compatible with the dredging requirements and cost considerations, thus limiting the options to sites with depths of approximately 10 meters or shallower.

The perception of affected communities is considered neutral with respect to the site because the community concerns i.e. livelihood, employment, floods, storm surge and threats of earthquakes are essentially independent of the feasible site options.

With respect to risk factors:
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.

With respect to 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.

With respect to ECAs or Protected Areas:
The project site is not within the LPP Wetland Park nor does it infringe on the mangrove communities (see Figure 1-8).

With respect to other possible reclamation projects:
As planned, there will be sufficient buffer zone between the site and these other projects.

In addition, the site must not be in conflict with existing settlers, if any; and must be in reasonable distance from the source of filling materials i.e. the San Nicholas Shoal

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 in harmony;
- Configuration and site must be in conformance with the PLUP/CLUPs;
- Configuration must not be in conflict with existing and future reclamation plans of the host municipality/province; and
- The design of the viaduct will be influenced by the configuration and site inasmuch as the viaduct must connect to the shore and must be feasible in terms of length.

With respect to number of islands:

The choice on the number of islands must allow sufficient water circulation; sedimentation factors, passage of sea traffic, buffer zones for other users, overall aesthetics, must not result in prohibitive costs, and other factors. The choice of one island was arrived at because preliminary hydrodynamic modeling showed that such is sufficient and will not impede water circulation nor result in sedimentation issues and the result of the hazard assessment.

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 neotectonic 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.

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 m2/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 of 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 m2/hour with maximum conveying distance of 5km (soft soil characteristic). It has a capacity 5 times bigger than Grab Dredger (bucket capacity 16 m2).

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 m2 / hr and bucket capacity of 12.5 m2) has a lower dredging capacity when compared to that of a pump dredger with capacity of 6 m2 and 25 m2/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/Method

General Layout of Land Reclamation

The proposed project consists of Island E in which the island boundary areas of which is 324 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 31.93 Million cum.

1.3.2.3 Containment System

To form closed land formation region, dikes shall be built. Length of the dike for Island E is 7,043m. 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 ≤ 0.05m3/ (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/m3;
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

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 to100 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 100.33 Million cu.m. of which **31.93 million cu.m**. is the requirement for Island E.

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^3 on dry basis
- Rocks of the primary cover layer should be sound durable and hard and should be fee 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
Geologic Hazard		
Seismic Hazard *Ground Shaking/Acceleration* *Ground Rupture* *Differential Settlement* *Liquefaction* *Tsunami* *Landslide*	• The area investigated is prone to ground shaking hazards due to the presence of several earthquake generators in the region. • Reclaimed lands in general, are considered prone to liquefaction. • 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. • The project site may be affected by strong ground shaking • 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. • The proposed reclamation project will undergo backfilling and is considered to be highly susceptible to this hazard • The proposed project being a reclamation area located along the shoreline of the Manila Bay/Bacoor Bay is inherently susceptible to liquefaction • 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 • 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	Engineering Intervention
Mass Movement *Landslide* *Settlement/Subsidence*	• 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	Engineering Intervention
Volcanic Hazards		
Ash 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	Engineering Intervention
Hydrologic Hazards		
Flooding	• 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 could experience localized flooding especially if the drainage systems are inadequate.	Engineering Intervention
Coastal Hazards		
Storm Surges / Seiches / Storm Waves	• The reclaimed land will be in front of the existing coastline and therefore the reclaimed land will form	To prevent flooding engineering measures will be implemented in

	the new sea front. This makes it most vulnerable to storm surge and flooding from the sea. • 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.	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-C**.

1.3.6 Summary and Discussion of comparison of environmental impacts of each alternative for process/technology selection and resource utilization is presented in Table 1-4 to Table 1-4c.

Table 1-4 Summary of Comparison for Dredging Equipment

	Technology Option	Efficiency/Key Features	Advantage	Disadvantage	Impact to the Environment
1	**Dredging Equipment**				
	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.	• Not well applied for the area with low water level like the condition of the project area • Can work safely effectively, economically in rough and open waters • Does not interfere with or obstruct traffic • Ability to transport material over long sailing distances. Dredged material is discharged commonly via pipeline for land reclamation.	• Its deep draft precludes use in shallow waters • Cannot dredge continuously • Economic load is reduced when dredging a contaminate sediments • Difficulty dredging side banks	• Increases turbidity • Resuspension of sediments • Decreases in Dissolved Oxygen
	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	• 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 • Operates on an almost continuous dredging cycle resulting to economic and maximum economy and efficiency • Able to dredge rocklike formation	• Operation problems with areas with high waves • The pipeline from cutterhead can cause navigation problems in small, busy waterways and harbors	• Increases turbidity is much lesser • Resuspension of sediments • Decreases in Dissolved Oxygen

			• 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		
	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.	• Capability of dredging a level bottom topography; • Ability to work in narrow or restricted areas; • Versatility in handling a wide range of sediments; and • Side loaded barges are generally filled with a high solids-to-water ratio	• Limited dredging depth • Obstruction to navigation routes	• Increases turbidity • Resuspension of sediments • Decreases in Dissolved Oxygen
	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.	• Capabilities in blasted rock and compact materials are less • 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	• Barge is brought along side and moored into place by winches and cables • Dredge begins digging and placing the materials into the moored barge	• High turbidity • Resuspension of sediments • Decreases in Dissolved Oxygen
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 (b) Standard of wave protection is 100 years (c) Control standard of overtopping shall be ≤ 0.05 m3/(s.m)	(a) Load in land formation area: hydraulic sand fill, the bulk density is 16~20kN/m3 (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

Scheme Comparison

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: Construction Process	Wave Elimination	Soil Foundation Stability	Construction Cost	Structural Stability
Vertical Gravity Dike	(a) Return period for tide protection of the dike is 100 year (b) Standard of wave protection is 100 years (c) Control standard of overtopping shall be ≤ 0.05 m3/ (s.m)	(a) Load in land formation area: hydraulic sand fill, the bulk density is 16~20kN/m3 (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	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 construction process is convenient but not appropriate to project site since the water depth is not deep. 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 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. The construction is convenient and fast but the structure integrity is relatively not good.	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. The construction is convenient and the sloping structure is simple and applicable to different type of foundation.	Good wave elimination due to the trapezoidal shape of its section. It has a good capacity of wave and wind resistance.	This slopping structure is suitable to any type of foundation and the stability is good.	Low cost	Good

Scheme Comparison

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

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

Material of Sloping Dike			
	Criteria		
	Construction Process	Wave Elimination	Stability
Dike Body			
Sand Bag and Rock	The advantage of using sand bag for slopping dike structure is that the construction is convenient and quick.	Good wave elimination capacity and wind resistance	Good stability, good integrity of the dike body and durable.
Armor Structure			
Artificial Block Armor	The characteristics of artificial blocks are fixed effect between blocks which can make the construction convenient.	Good wave elimination capacity	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.	Poor wave elimination 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.	Poor wave elimination since natural stone armor is usually applied where the waves are relatively small.	Good Stability and the capacity to adapt to settlement
Scheme Comparison **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 in Table 1-5 are those associated with the various activities during the dredging/reclamation and horizontal development works only.

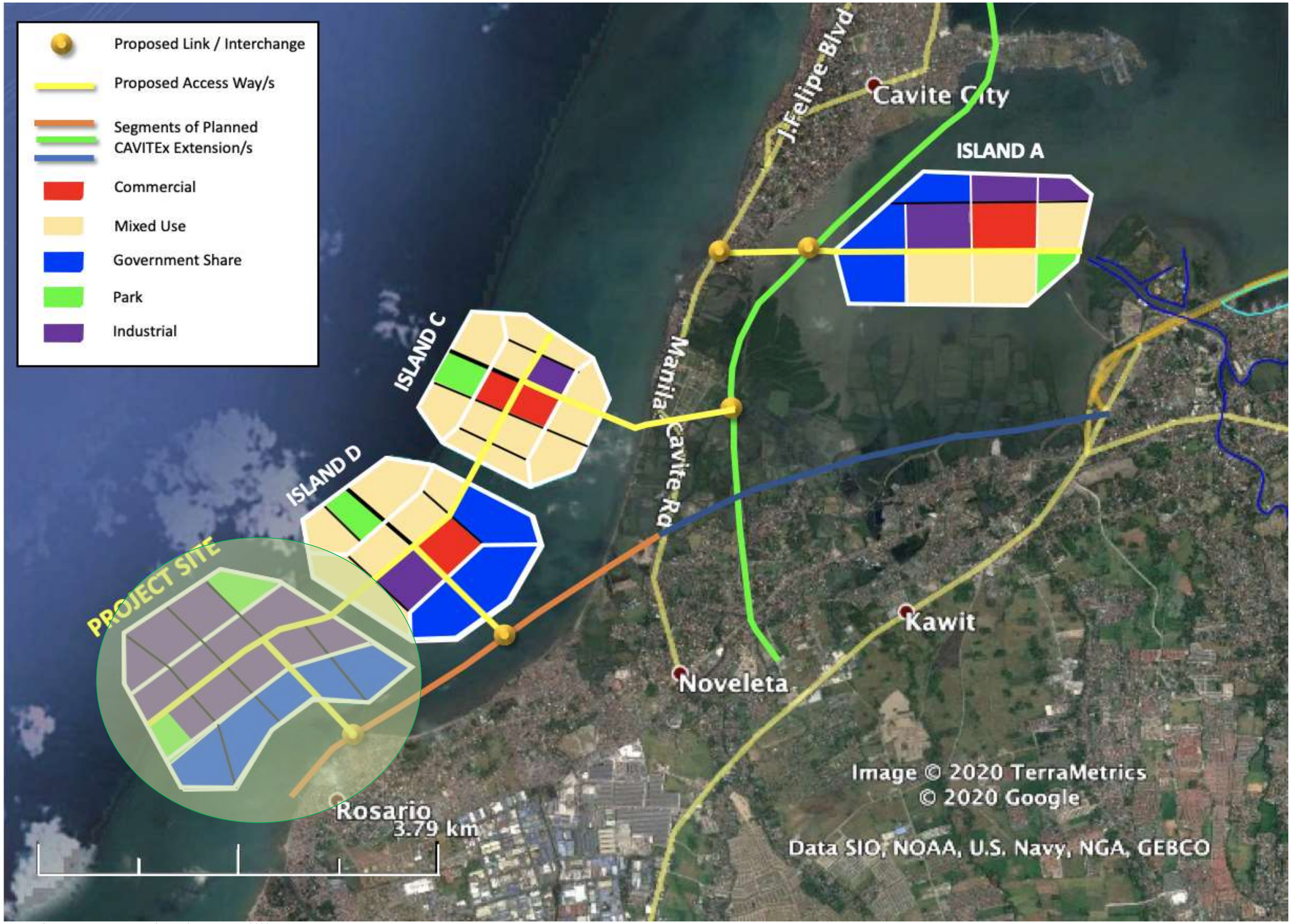
Table 1-5 Project Components

Facilities	Project Components		
	No. of units	Area (sq.m)/ Capacity	Specification/ Description/ Remarks
Project Area	**324.00 hectares**		
No. of Island	**One (1) Island**		
Volume of Earth Fill	**31.93 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 (Accropode) and Concrete Grid Plate**		
Soil Stabilization	**Vertical Drains Plus Surcharge**		
MAJOR COMPONENT			
Containment Wall System/Structures in a form of Sloping Dikes	1	7,043 linear meters	Considering that the wave is high in the area of Island E, it is recommended to use rock as the material for the dikes which faces the waves directly. Combination of rock dike, accropode wick drains, sand bag, and grid plate shall be used
Reclamation Method using Hydraulic Sand Fill Method	1	31.93 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 lots	13.59 Hectares	Commercial, high density superblocks and superblocks
Industrial Area	10 lots	175.31 Hectares	This is a the industrial area preprared for future locators
Government Share Area	5 lots	63.63 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	2 lots	20.96 Hectares	Area allocated for vast open areas including open spaces (parks), rotundas (place identifiers)
Road Connectivity Road-Right-of-Way (RROW)	1 lot	39.64 Hectares	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
Utility/Transportation Area	1 lot	10.55 Hectares	This is allotted for the transportation and utilities of the project.
SUPPORTING FACILITIES AND UTILITIES			
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	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. 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 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
POLLUTION CONTROL FACILITIES			
Silt Curtain	1	7,043 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 (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 (LPPWP) is located 14.5 km northeast of the proposed site.

Preliminary Master Development Plan is presented in Figure 1-11



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

Figure 1-11 Preliminary Master Development Plan Showing Proposed Access Ways

1.5 Process/Technology

a. The process flow chart involving the reclamation activity is presented in Figure 1-12.

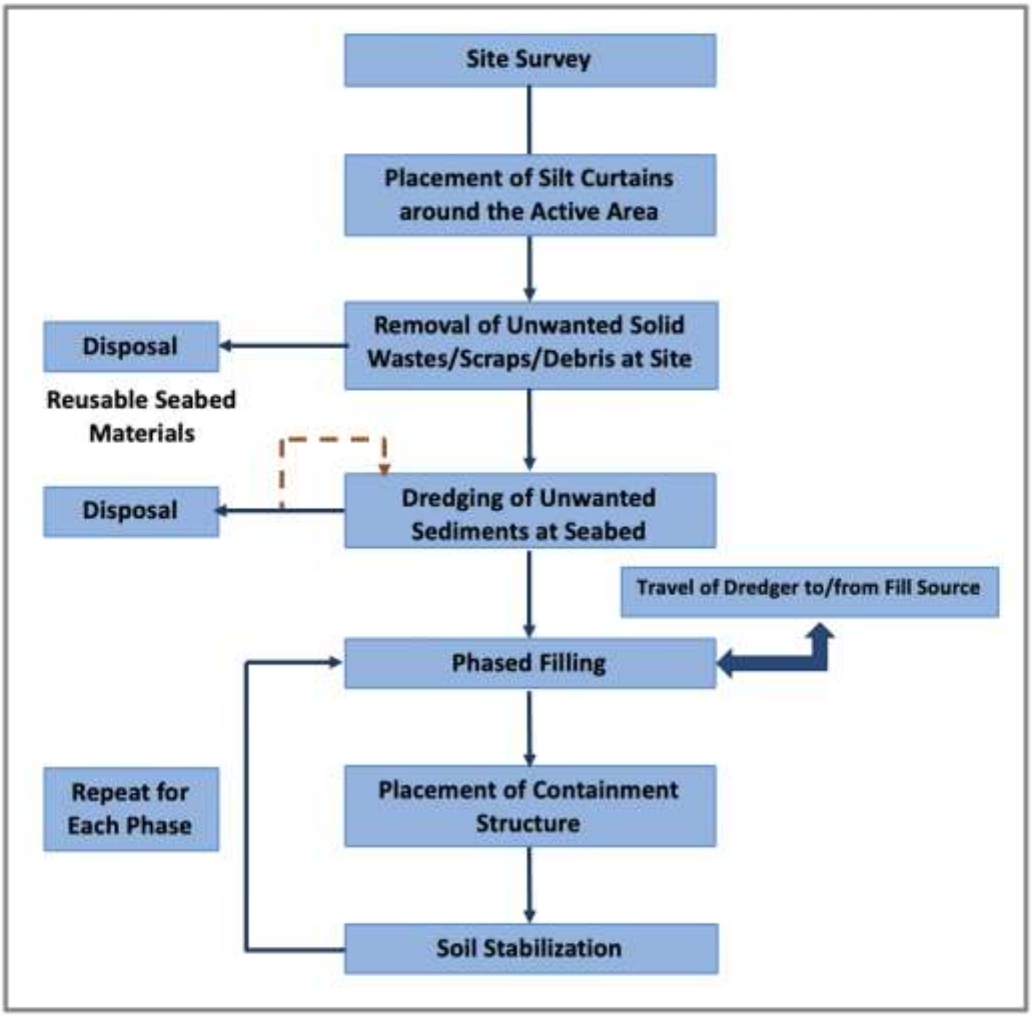


Figure 1-12 Process Flow" Diagram for Reclamation Projects

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. 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.

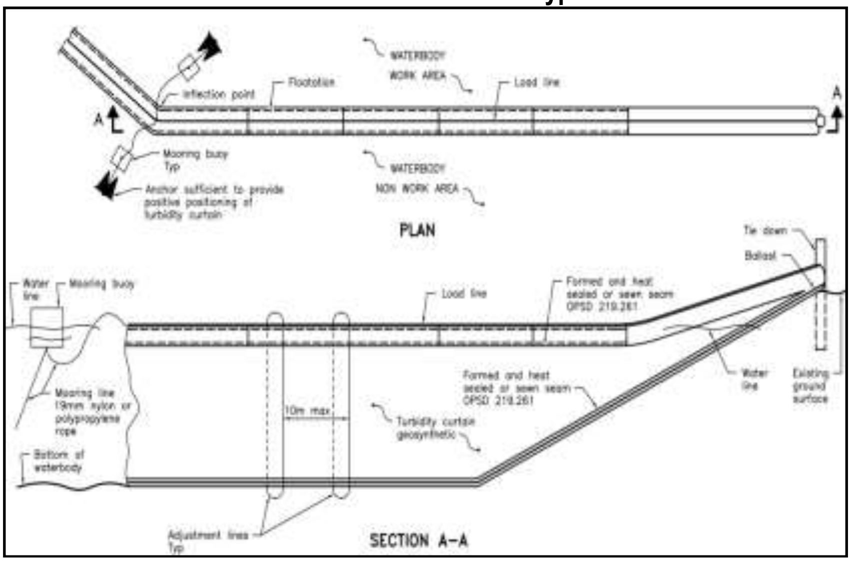
Locations of the Silt Curtains

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: Terrafix 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 warn 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 14.50 km northeast from LPPCHEA (LPPWP).

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 7,043 meters and construction of landforms with total fill volume 31.93 Million cubic meters sea sand land formation materials using Hydraulic Sand Fill Method.

1.5.5.1 Construction of Dikes

There are two (2) types of dikes to be constructed for Island E 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 1-13), Figure 1-13 shows the location of Dike I and Dike II for Island E. 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 E with total length of 4,965.11. 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 E 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 E. 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 E 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/m2 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.

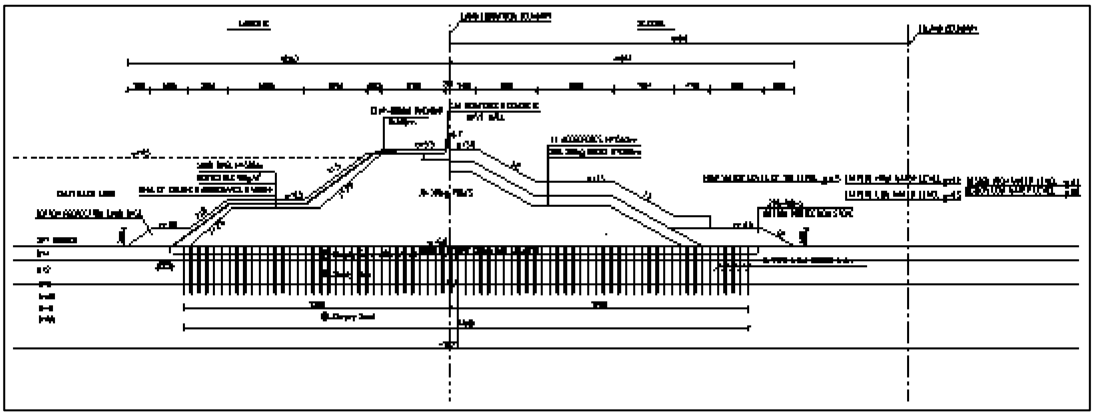


Plate 1-11. Rock riprap dike + Accropodes blocks + wick drains

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

This dike is applied in the southeast dike of Island E with total length of 2,077.53 meters.

Dike Ground Improvement

The thickness of soft soil under the dike of Island E 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 E is -2.0~-4.0m 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/m2 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/m2 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

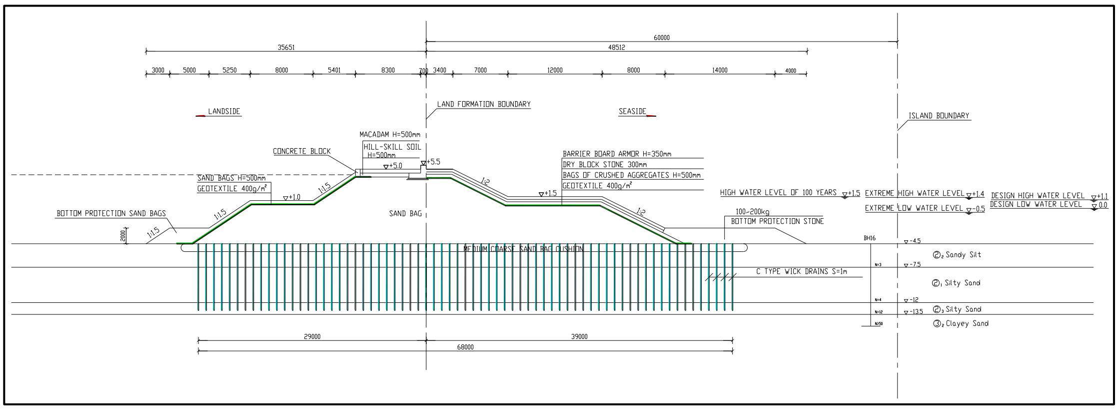
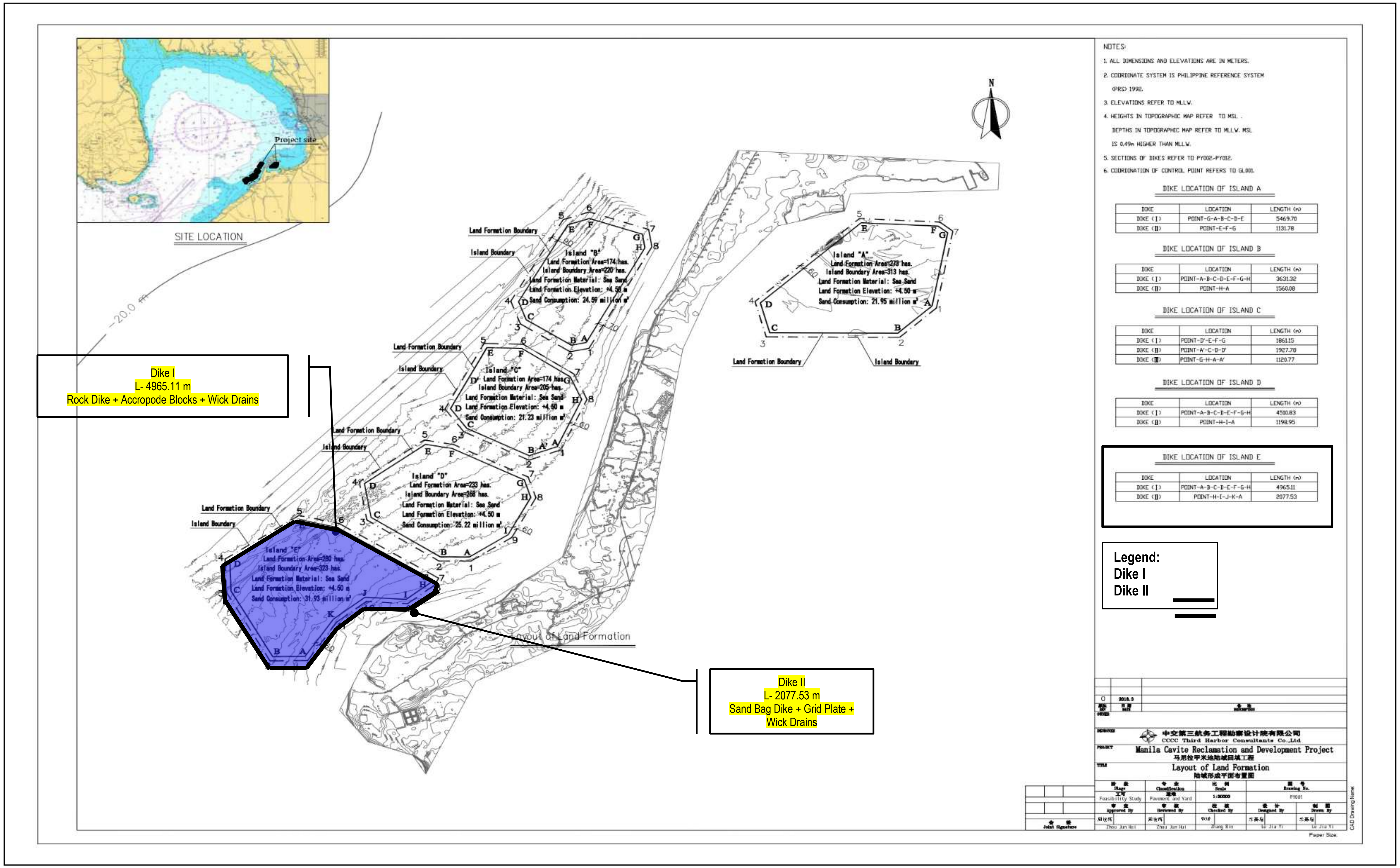


Plate 1-12. Sand bag + grid plate + wick drains



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

Figure 1-13 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 **31.93 million cubic meters** of fill materials from a reliable and feasible sand source. The reclaimed land of 324.00 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 1-14** 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.

Project Name:	**PRA Seabed Quarry Project**
Location:	San Nicolas Shoal (SNS) along coastal towns and the offshore areas of the barangays of Ternate, Naic, Tanza and Rosario of Cavite
Type of Project:	Offshore Quarrying Project
Project Size:	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, the volume of reserve at the SNS totals to **2,009,336,597 m^3**. It may therefore be concluded that the Project can well be provided by SNS with the required fill materials of approximately **100.33 M m^3 total for Island E and the other 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
Total Reserve		**2,009,336,597**

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 NOx 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 1-14:

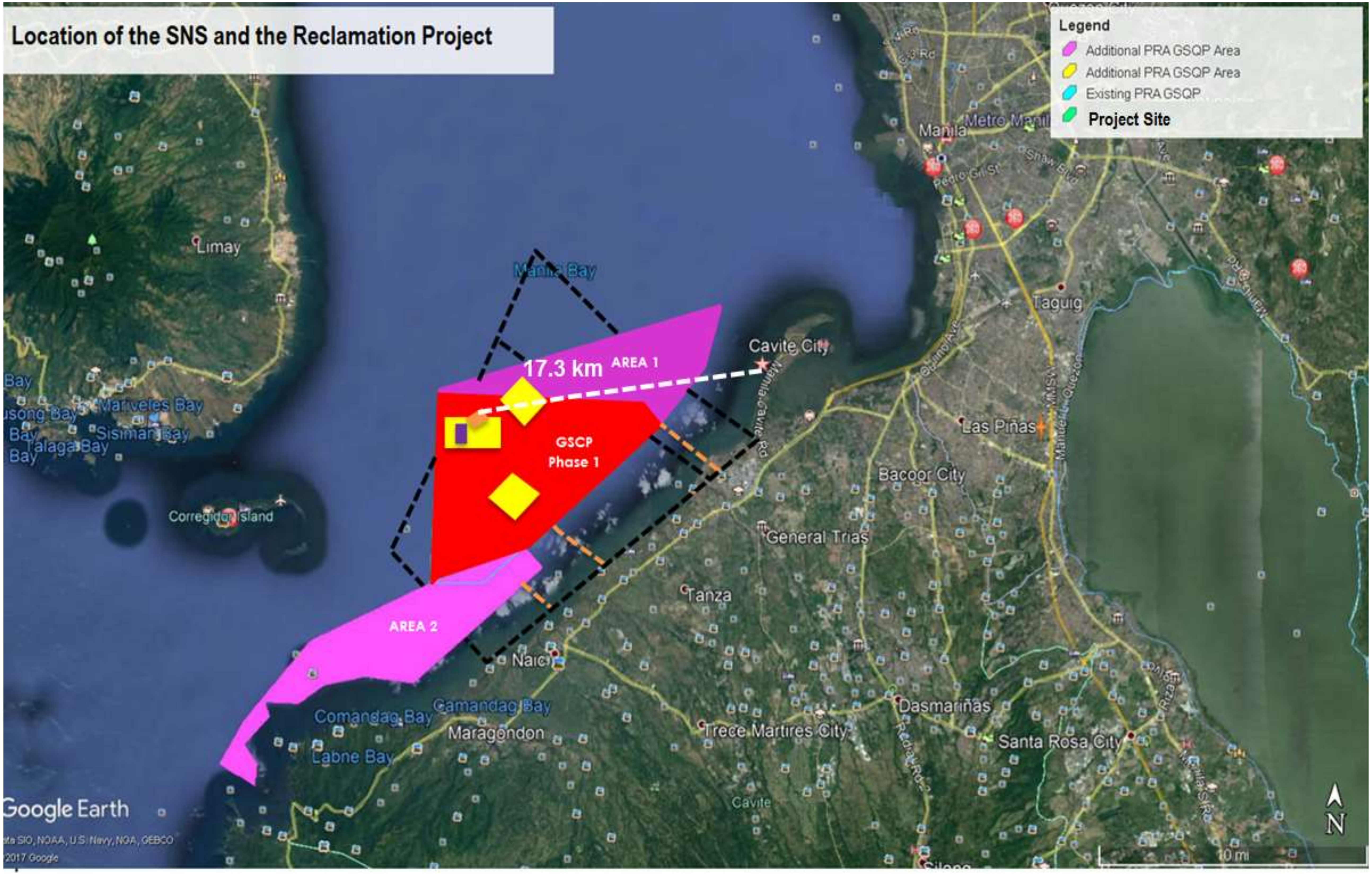
Plate 1-13. Illustration of the Principle of Wick Drains

Source: US Wick Drain. Wick Drain. Retrieved from [http://www.uswickdrain.com/faqs.htm. Retrieved on July 2017](http://www.uswickdrain.com/faqs.htm)

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 1-14 Relative Location of the SNS and the Cavite Province Land Reclamation and Development Project: ISLAND E

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	The Land	• Domestic solid, liquid and hazardous wastes generated	• 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
		The People	• Displacement of existing fish lifts	• Relocation and compensate affected fisherfolks
2	Removal of Unwanted Solids/ wastes	The Water	• Disturbance of the area Such as marine	• Coordinate with LGU for proper disposal • Transfer/scrape net marine lives
3	Dredging of Sediments/Seabed	The Water, Air and People	• Disturbance of the area Such as marine • Increase in Turbidity • Silt Dispersal • Emission of CO and NOx from dredging equipment • Domestic solid, liquid and hazardous wastes generated	• 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.
4	Disposal of unwanted seabed materials	The water	• Turbidity • Silt Dispersal	• Secure permit from National and Local agencies in terms of final disposal location • Implement Bilge Water Management • Compliance with the PCG Protocol • Compliance with MARPOL 73/78 • For Sea-based Operations-These are generally garbage

Item No	Activity	Environmental Component	Environmental Impacts	Pollution Control Device and Waste Management System
				from the crew and are segregated onboard, placed in bins and disposed onshore. • No disposal of liquid and solid wastes at the sea • Segregation of solid wastes • Compliance to Sections of the Philippine Clear Air Act, R.A. 8749 • Equipment shall be provided with muffler filter media.
5	Placement of Containment Wall/Dike	The Water and People	• Disturbance of the area • Increase in Turbidity • Emission of CO and NOx from dredging equipment • Domestic solid, liquid and hazardous wastes generated	• Provision for Silt curtain • Compliance R.A. 8749 • Compliance to RA 9003 • Installation of wave deflectors
6	Construction of Land Form	The Water, Air and People	• Possible silt Dispersal • Emission of CO and NOx from dredging equipment • 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
7	Development of Land form (Island) above the sea water level	The Land, Water, Air and People	• Possible Erosion • Dust and noise Pollution • Emission of CO and NOx from dredging equipment • Domestic solid, liquid and hazardous wastes generated	• Provision for temporary sedimentation pond • Immediate compaction of soil • No disposal of liquid and solid wastes at the sea • Compliance R.A. 8749 • Compliance to RA 9003 • Properly maintained equipment

Item No	Activity	Environmental Component	Environmental Impacts	Pollution Control Device and Waste Management System
8	Soil Stabilization	The Land, Water, Air and People	• Emission of CO and NOx from dredging equipment • Domestic solid, liquid and hazardous wastes generated • 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
9	Construction of Horizontal Development such as Road, Drainage and Water line system	The Land, Water, Air and People	• Emission of CO and NOx from dredging equipment • Domestic solid, liquid and hazardous wastes generated	• No disposal of liquid and solid wastes at the sea • Compliance R.A. 8749 • Compliance to RA 9003
3		Noise Pollution	• The mechanical noise caused by the operation of machines (such as hammers, bulldozers and concrete mixers, etc.). • The traffic noise caused by transport vehicles and ships.	• 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. • Choose the construction machines and trucks with low noise and vibration priority. Enhance the maintenance of them to make work smoothly. • 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

<u>Other Wastes</u>

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 warn 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 E** will occupy a total reclaimed land area of **324 hectares** along the coastal waters of 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. As maybe seen in Table 1-9 on Project Implementation Schedule, the activities are: design and engineering, technical plans and documentations, securing of permits and clearances.

Table 1-9 Required Clearances and Permits for the Reclamation Project

Item	Authorities Involved
ECC	DENR
NTP/Area Clearance	RED/DENR
Letters of No Objection (LONO)	a. Department of Tourism (DOT) b. Bureau of Fisheries and Aquatic Resources (BFAR) c. Philippine Navy d. Department of Energy (DOE) e. Regional Development Council (RDC) f. Philippine Reclamation Authority (PRA) g. Department of Public Works and Highways (DPWH) h. Department of Information and Communications Technology (DICT) i. National Headquarters Philippine Coast Guard (PCG) j. Philippine Ports Authority (PPA) k. National Commission for Culture and the Arts l. Department of Health (DOH)
Notice to Proceed (NTP)	Philippine Reclamation Authority (PRA)
Construction Permits	• LGU • DPWH • Philippine Coast Guard

1.7.2 Construction (e.g. dredging and reclamation phase)

There are two (2) types of construction activities, the landform preparation-structure and the horizontal development as discussed below:

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 31.93 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 56.39% is considered saleable, 25.17% is non-saleable and 18.44% 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 Initial Land Area Allocation for Island E

	Area (ha)	Percentage
A. Saleable		
Industrial	175.31	54.00
Commercial	13.59	4.00
Sub-total A (ha)	188.9	66.50
B. Non-Saleable		
Utility & Transportation	10.56	3.00
Parks & Open Spaces	20.96	6.00
RROWs	39.64	12.00
Sub-total B (ha)	10.55	3.71
C. Others		
Government Share	63.63	20.00
Grand Total (ha)	**324**	**100**

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 Road Safety and Traffic Dust Pollution and Increase in Noise Level	• Immediate compaction of the area to further mitigate the dust. • Implementation of traffic management that is appropriate for the area • Road signs shall be placed at appropriate locations to alert motorist along the highway. • Traffic warden shall be stationed at strategic locations to guide traffic. • Observed operating hours • Regular Maintenance of equipment and vehicles

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 E, the plan is to put up an approximately 1.1km viaduct going east to the Manila-Cavite Road. This is shown in Figure 1-6 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 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 1-15** presents the road network system for Island E 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

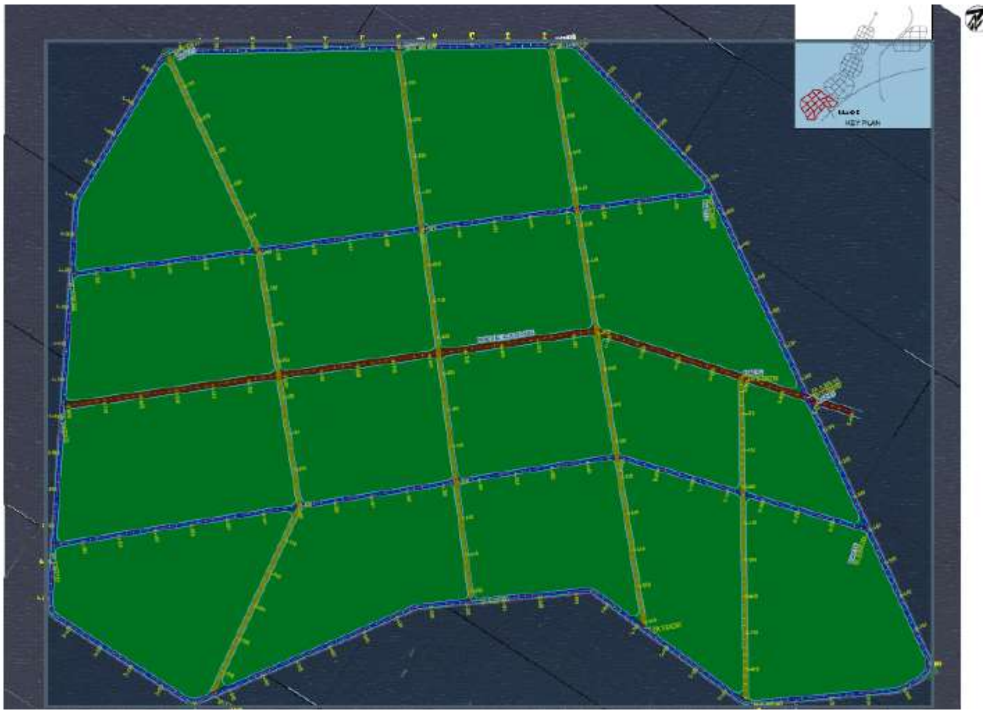


Figure 1-15 Road Network System Layout, Island E

Figures 1-16 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.

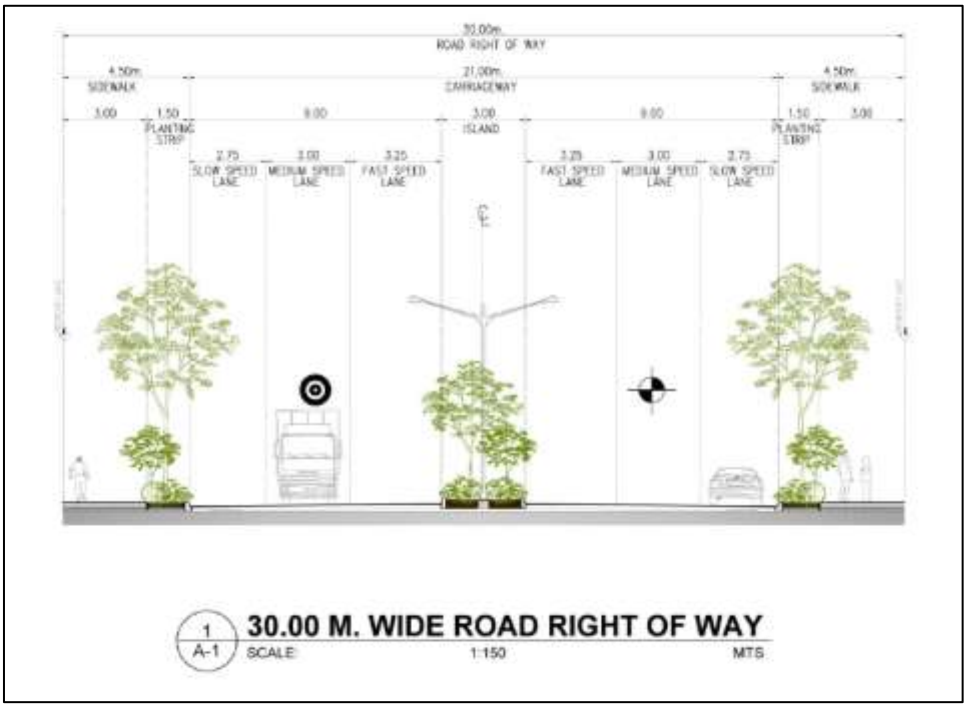


Figure 1-16 Illustration of 30.0-meter RROW and Road-side Tree Planting

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	Water - Possible Siltation of the sea Road Safety and Traffic Dust Pollution and Increase in Noise Level	• Immediate compaction of the area to further mitigate the dust. • Implementation of traffic management that is appropriate for the area • Road signs shall be placed at appropriate locations to alert motorist along the highway. • Traffic warden shall be stationed at strategic locations to guide traffic. • Observed operating hours • Regular Maintenance of equipment and vehicles

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.

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.

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 Road Safety and Traffic Dust Pollution and Increase in Noise Level Solid Wastes Generation	• Immediate compaction of the area to further mitigate the dust. • Implementation of traffic management that is appropriate for the area • Road signs shall be placed at appropriate locations to alert motorist along the highway. • Traffic warden shall be stationed at strategic locations to guide traffic. • Observed operating hours • Regular Maintenance of equipment and vehicles • Implement Solid Waste management plan such as segregation at source

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.

It is expected that the last three (3) years based on the preliminary project implementation shall remain for Island E completion of site development works. 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																
Cavite Island A = 247.27 has																
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																
Cavite Island C=205 has																
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																
Cavite Island D=267 has																
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																	
Cavite Island E=324 has																	
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																	

1.7.4 Operations (e.g. construction of horizontal structures)

The operations phase involves the construction of buildings and structures by various locators and the operation of their activities, e.g. food stores, convention centers, movie houses, etc. This phase is not included in the scope of this EIS and in the application for an ECC.

1.7.5 Decommissioning Phase

This refers to the permanent cessation of all activities involved through the formation of stable land forms.

Under this scenario, all the construction vessels and equipment shall be returned to the contractor. The Province of Cavite and the members of the Project Consortium will decide on how the reclaimed land will be used. Hence, remediation of the site will not be relevant.

1.8 Manpower

1.8.1 Construction (Reclamation Phase)

Dredging / Reclamation Works

The payment of statutory benefits of workers will be in accordance with the Contractor's policy but shall observe Philippine labor laws, particularly of the DOLE.

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
Pre-Construction Phase		
Technical Consultants	All Professionals and Experts (Local and Expats)	50
Construction Phase		
Sea-Based Crew	Professional	240
	Land Formation	
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
Horizontal Development		
Foreman	Skilled	50
Helper	Semi-skilled	250
Utilities	Semi-skilled	100
Estimated Number of Manpower During Construction Phase		**780**

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 21.40 Billion.**

The 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) would be divulged by the contractor during the competitive bidding process.

Proposed funding/ financing of the Project

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 2.1-0** below.

Table 2.1-0. Identification of Environmental Impacts

Impacts	Construction-Dredging and Reclamation	Consolidation and Stabilization	Site Development
LAND			
Land Use and Formation	✓		
Solid Wastes	✓	✓	✓
Hazardous Wastes	✓	✓	✓
Geologic Hazard		✓	✓
WATER			
Water (Marine) Quality	✓	✓	✓
Domestic Wastewater	✓	✓	✓
Hydrologic Hazard	✓		
Coastal Hazard	✓	✓	✓
Marine Ecology	✓		
Navigational Traffic	✓	✓	✓
AIR AND NOISE			
Air Quality	✓	✓	✓
Noise Quality	✓	✓	✓
PEOPLE			
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 Municipality of 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 Protection Framework Plan of Cavite (Figure 2.1-6). 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 implemented. There is also a plan to reclaim underwater lots for socialized housing and commercial purposes. (CLUP of Rosario, 2011-2020). In the Amended General Land Use Plan of Rosario 2020 (Figure 2.1-3), the coastal waters are not included. What is shown there are the mangrove zones in the estuarine areas. These will not be included in the reclamation.

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 existing and planned land use in the area include the following:

The Municipality of Rosario has a small 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)

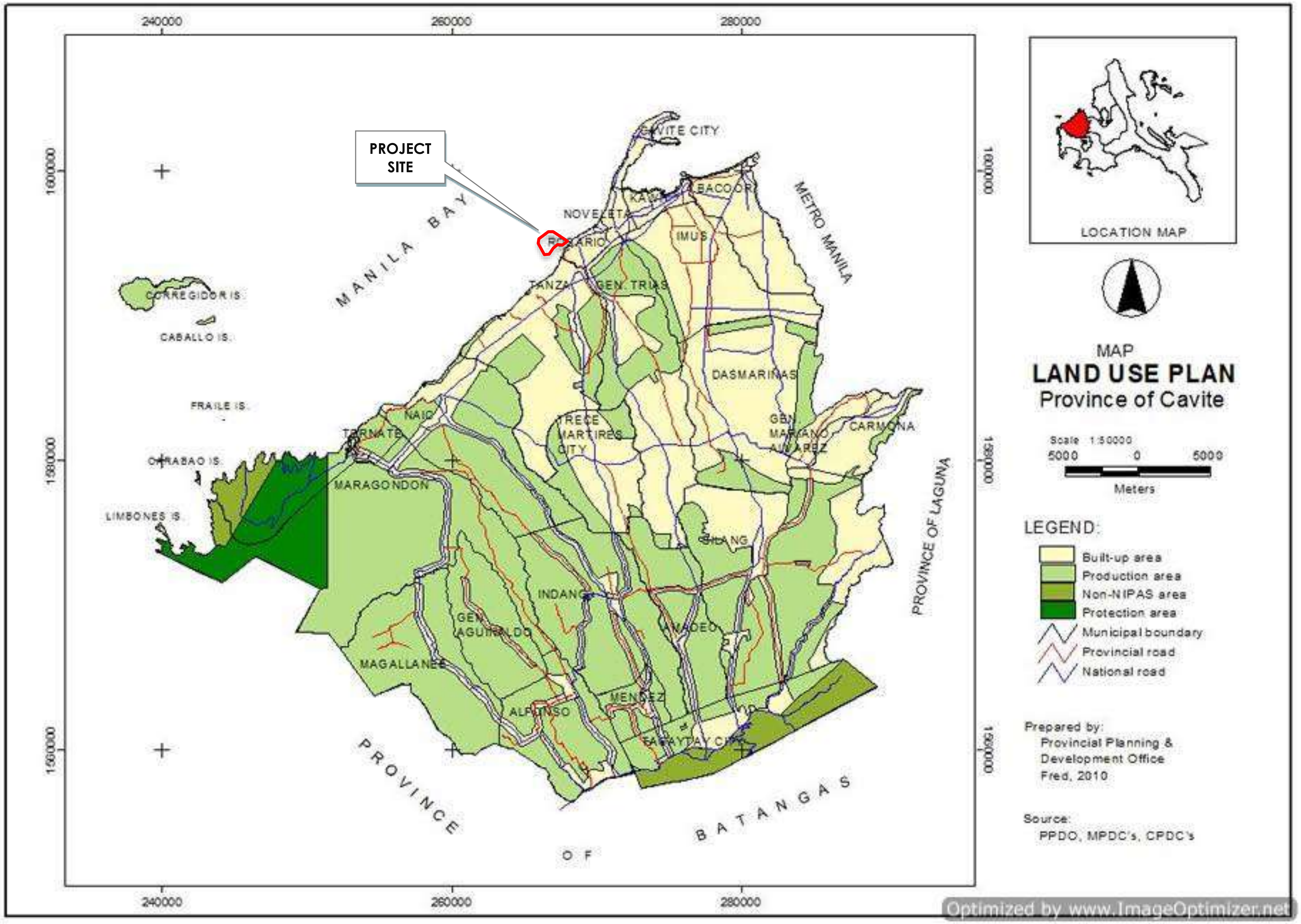
On the other hand, the industrial area of the PNOC property extends up to the coast of Rosario. The pipeline of the Oil Depot passes through the jurisdiction of Barangay Wawa II up to the territorial waters of Rosario. Mangroves can be found in the shore of Barangay Ligtong I and Barangay Wawa III.

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 the vicinity. 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-C**). The securing of the

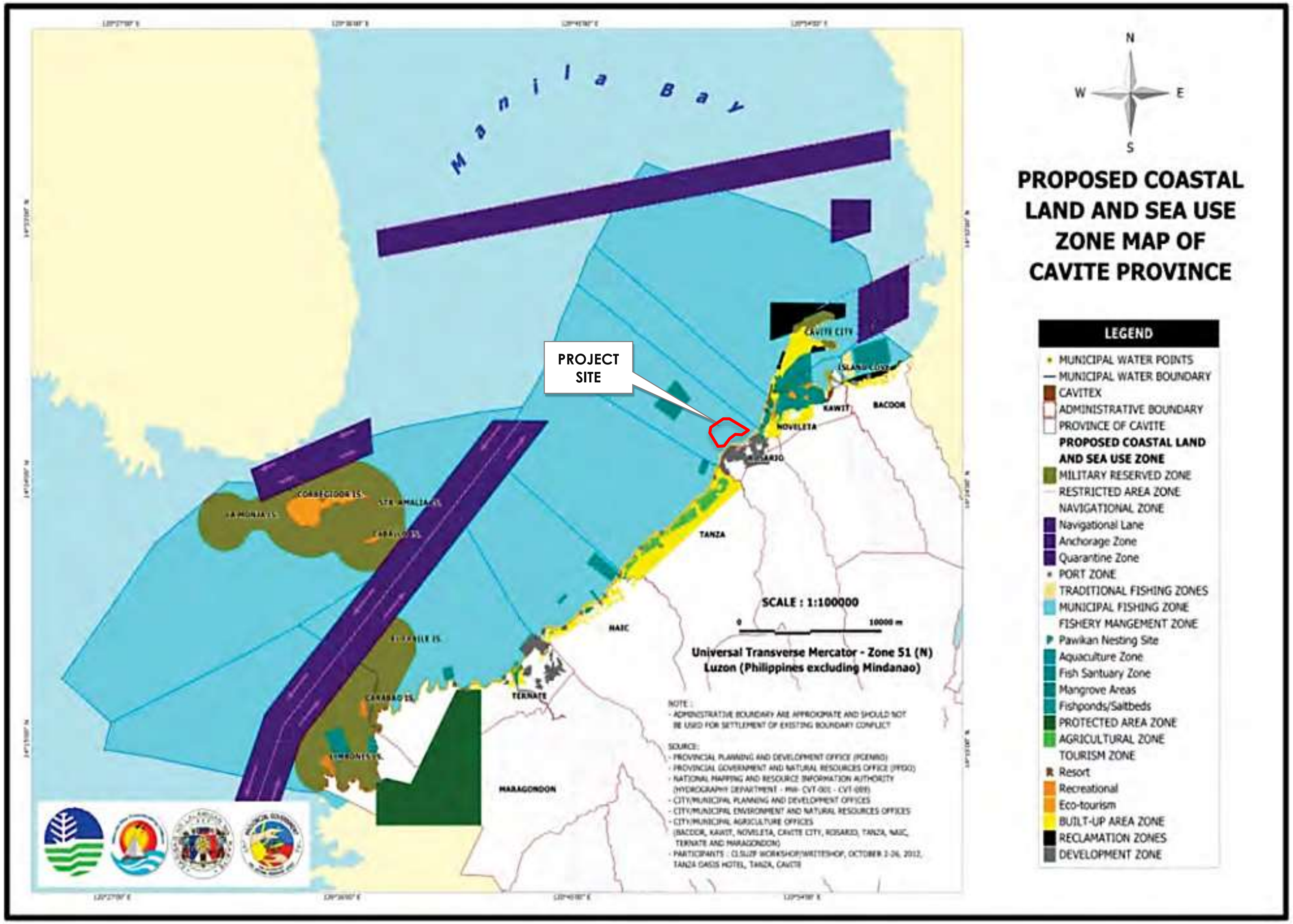
Letters of No Objection (LONOs) from the various concerned agencies, in support of the application for Area Clearance will reveal if there are conflicts with the Land Use and Classification of the proposed project (**Annex 2.1-A**). At present, the LONOs were already issued by the following stakeholder 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)



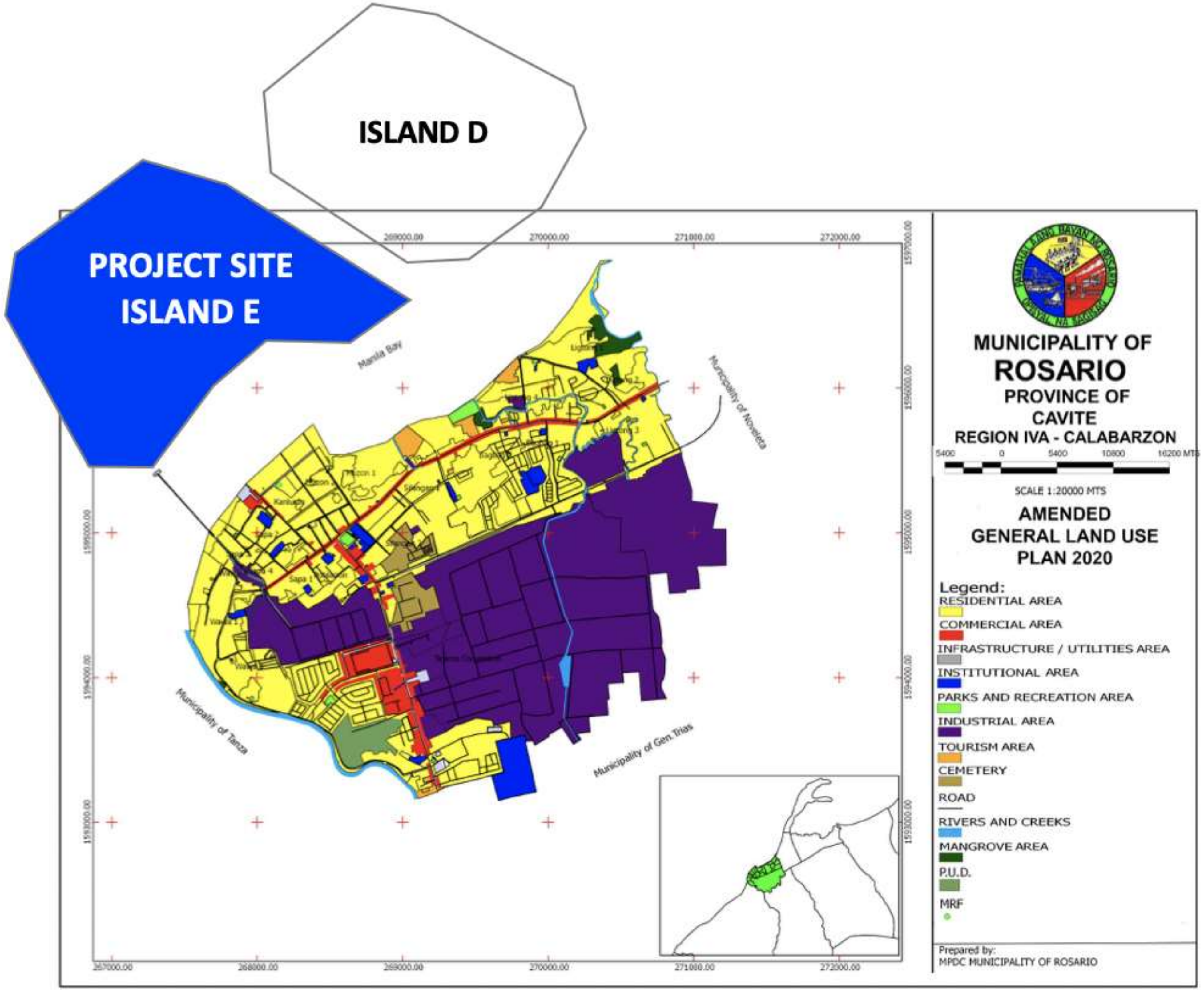
Source: Cavite PPDO 2016

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

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. 14.5km.
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 are 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 or the following conditions:	
	a. with primary pristine and dense young growth;	no primary pristine and dense young growth
	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 System (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 2.1-4 and 2.1-5. Figures 2.1-6 and 2.1-7 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).

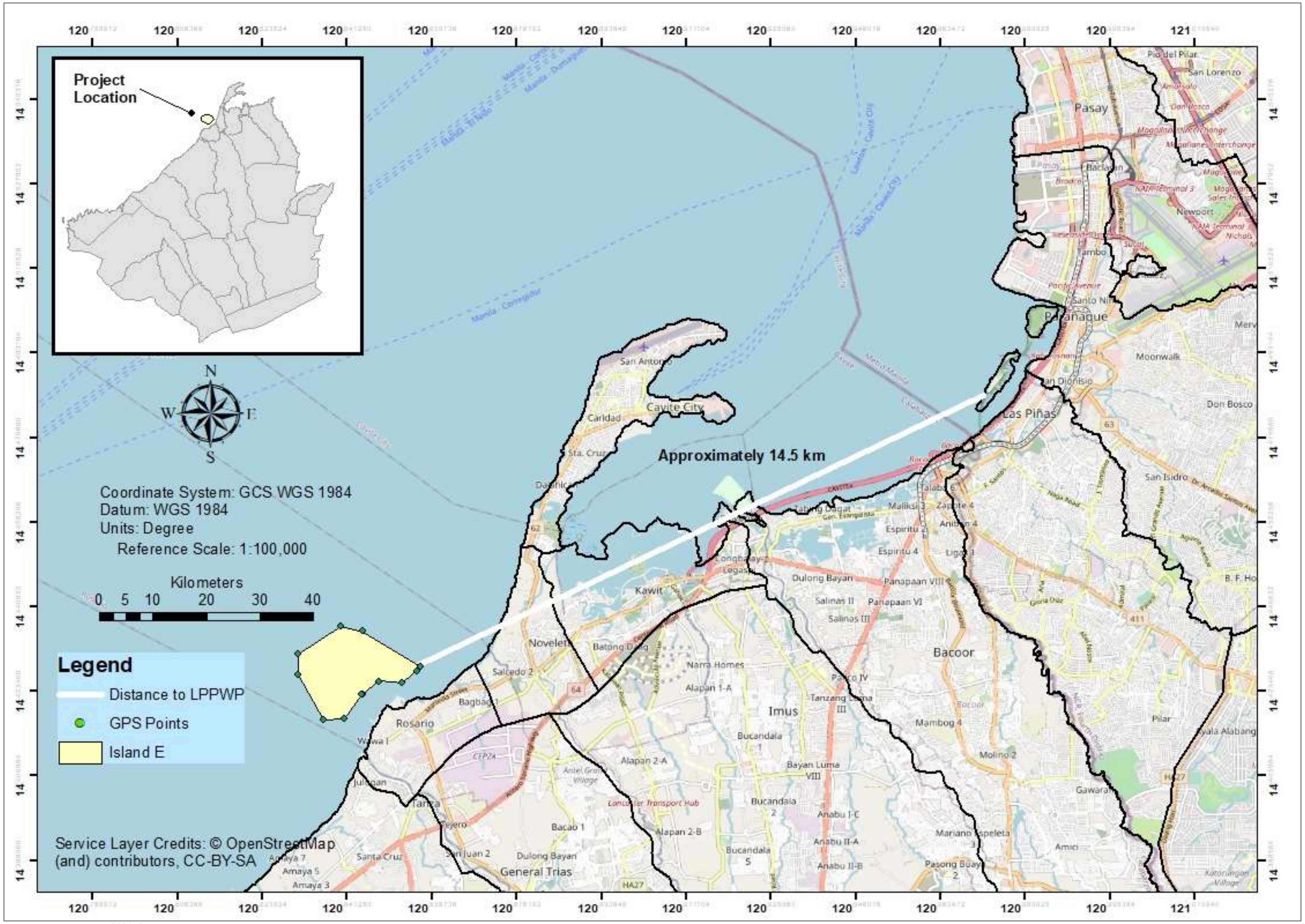
R.A. 11038 signed on June 22, 2018 is an amendment to R.A. 7586, which created 94 new protected areas in the Philippines including the LPPWP.

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 14.5 km northeast from the project site. Refer to Figure 2.1-4.

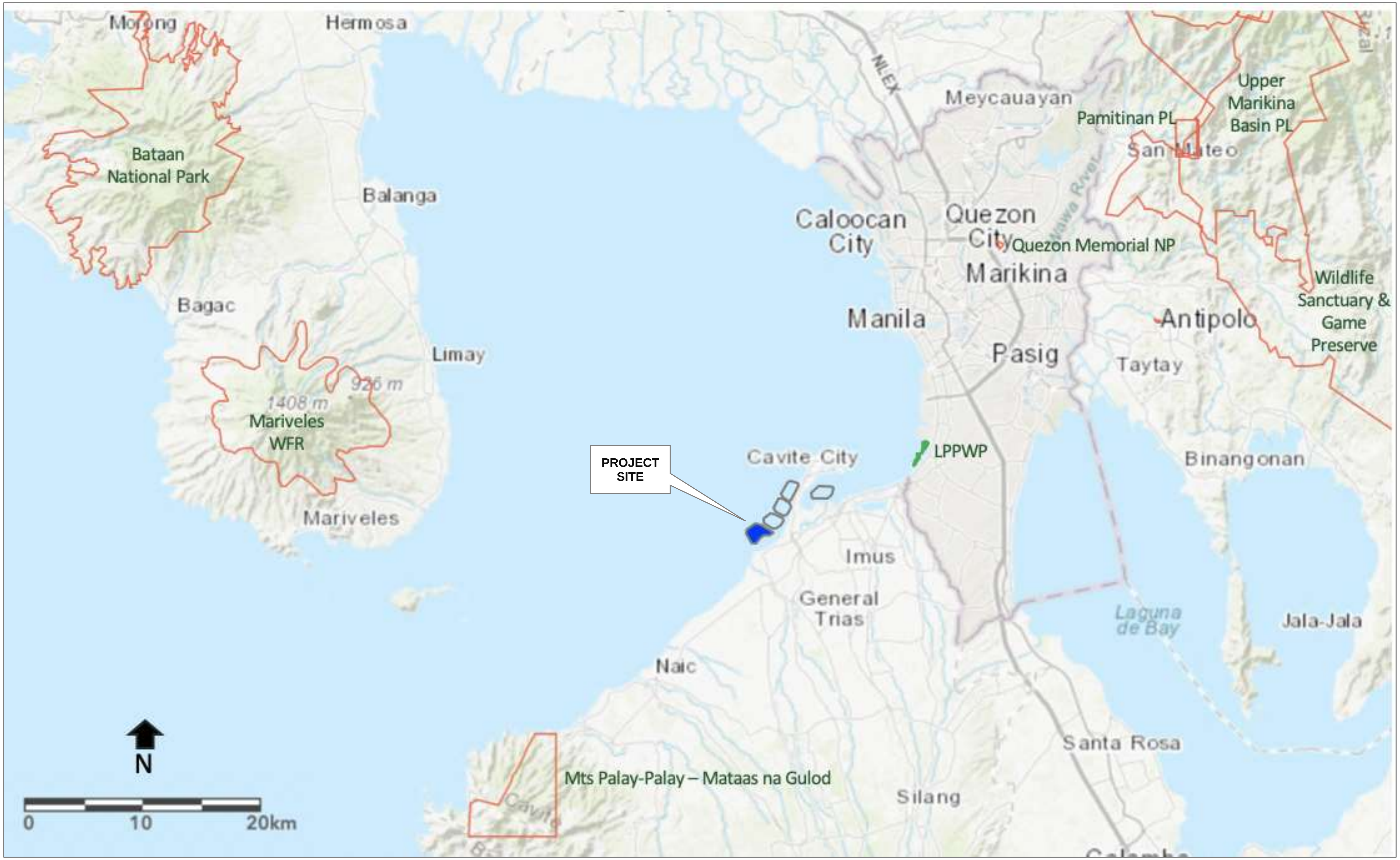
Sites under the Scope of the Ramsar Convention

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.



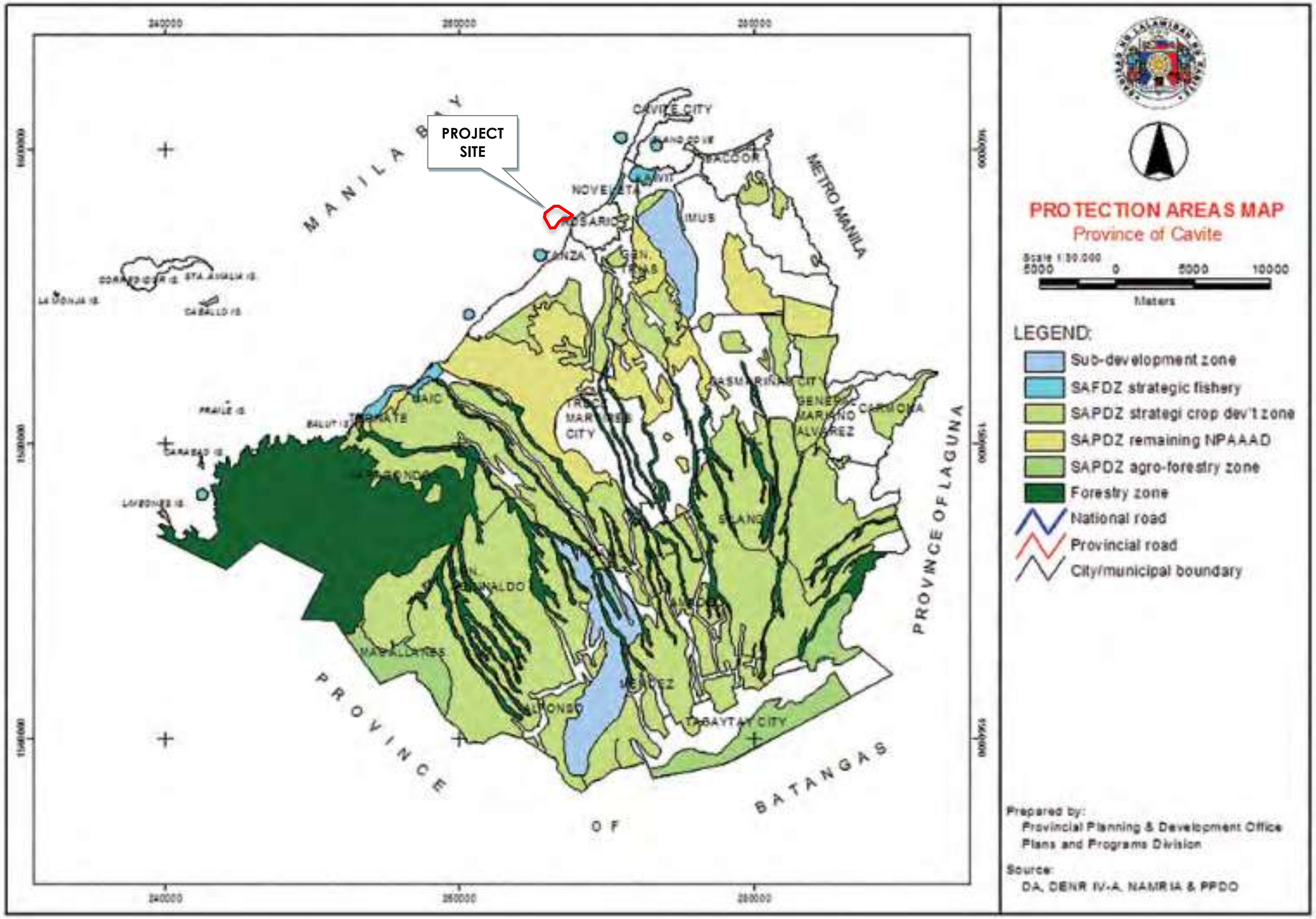
Base Map: 2020 Google Earth

Figure 2.1-4. Map of the LPPWP Relative to Project Site



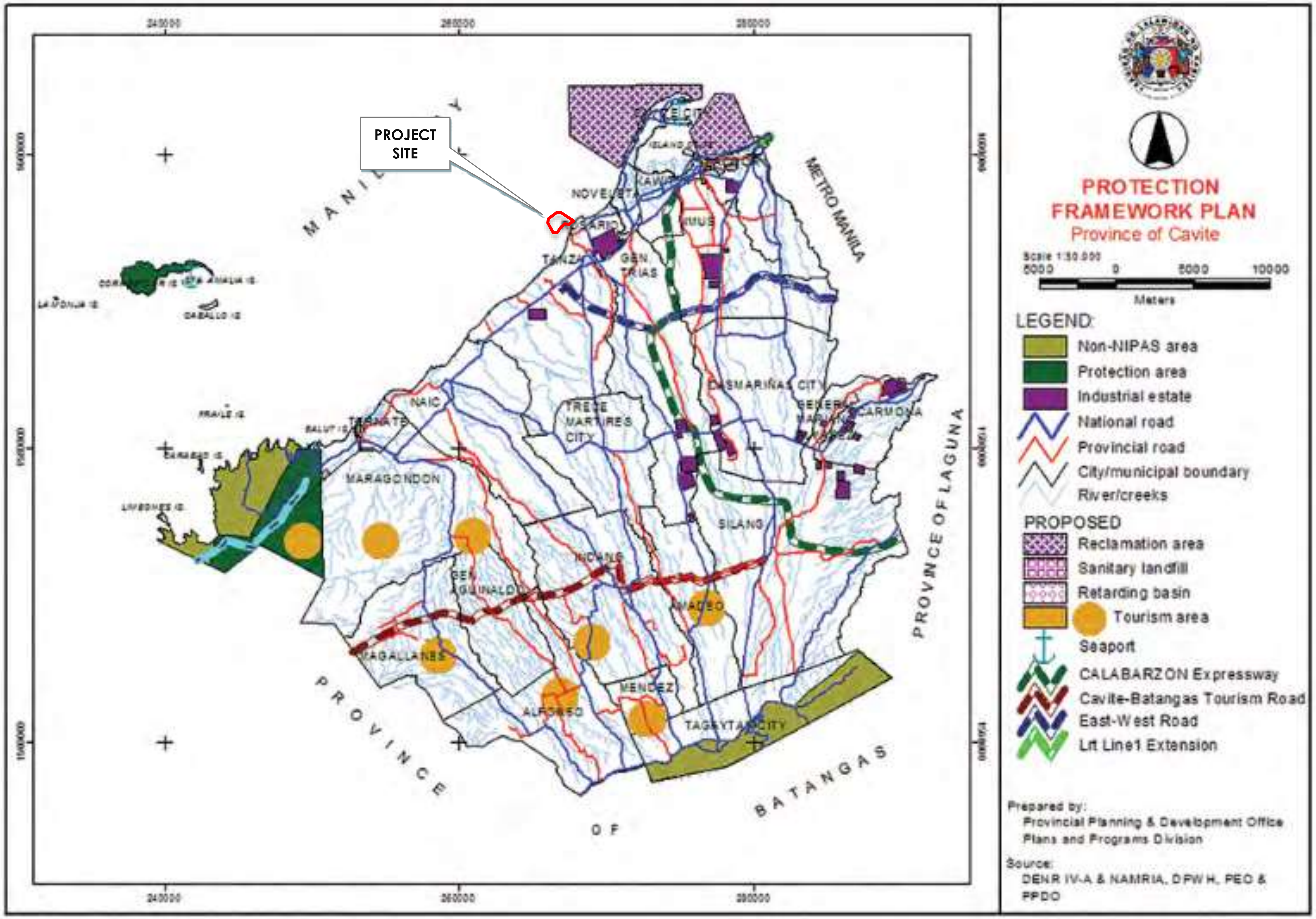
Source: ArcGIS Online, screen captured February 2020. https://www.arcgis.com/home/webmap/viewer.html?useExisting=1

Figure 2.1-5. Map of the Protected Areas in the Greater Manila Area



Source: Cavite PPDO 2016

Figure 2.1-6. Protection Areas Map of Cavite (not NIPAS-declared)



Source: Cavite PPDO 2016

Figure 2.1-7.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 City.
- The CLUP of the City 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 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 Mandamus itself does not directly restrict reclamation projects in Manila Bay

Areas Vulnerable/Susceptible to Natural Hazards

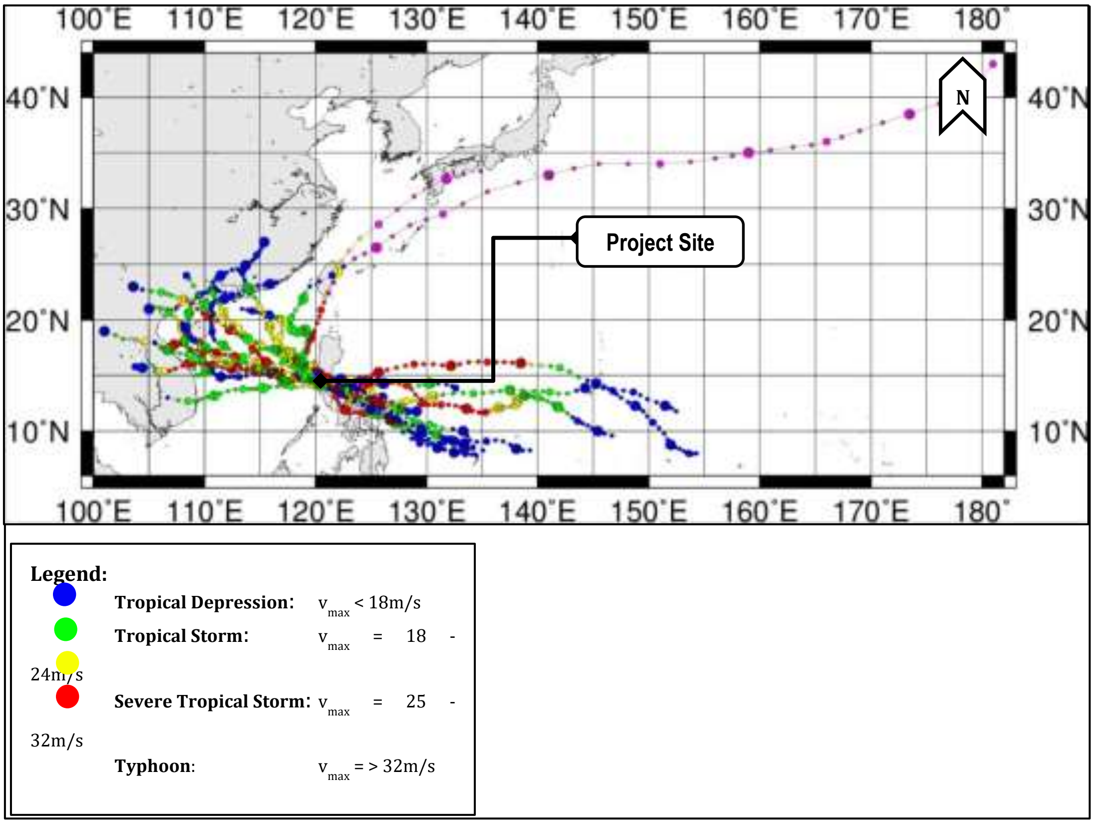
The project area being located within Manila Bay, is susceptible to various natural hazards such as earthquake-related hazards (i.e., ground shaking, liquefaction, tsunami and subsidence), flooding and storm surge. These are discussed in more detail under subsection 2.1.2.3. Inducement of subsidence, 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 Municipality of 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 2.1-8.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 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 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.

The proposed project will reclaim about 324 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 Municipality of Rosario, 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 1-8. 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

Project	Area (Hectare)	Status of ECC
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

Base Map: 2020 Google Earth

Figure 2.1-9. Nearby Reclamation Projects vis-à-vis Project Site and other Proposed Islands

Other 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 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 Rosario. 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. None of these were within proposed Island E, but two were near the coast fronting the island, and one along the river.

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 2.1-10. Location of Actual Fishing Operations Documented Across the Proposed Reclamation Islands

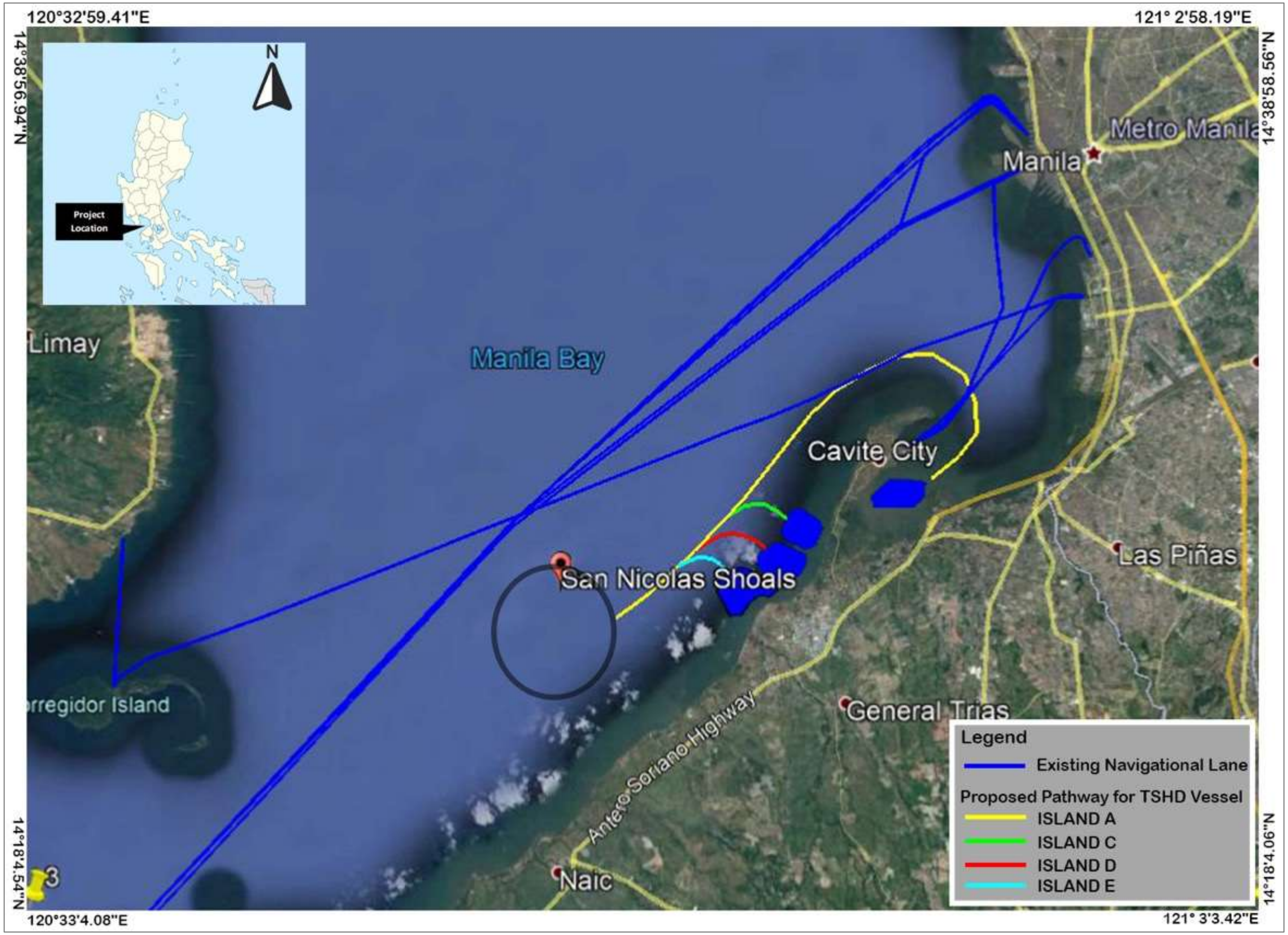
Port

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 (**Annex 2.1-A**) 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.



Base Map: 2020 Google Earth

Figure 2.1-11. Navigational Lanes of the PPA Relative to the Cavite Island E 324-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.

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:

a. The ship is discharging contaminated and disinfected/treated sewage at a distance of more than 5 nautical miles from the nearest shoreline;
b. 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;
c. 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
d. 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:

a. Hydrocarbons, including oil and their wastes;
b. Other noxious or hazardous matter transported by vessels for purposes other than dumping; and
c. 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.

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 Municipality of Rosario in Cavite Province and vicinities belong to the coastal lowlands, particularly the lowest lowland and the lowland areas (Figures 2.1-12 and 2.1-13).

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

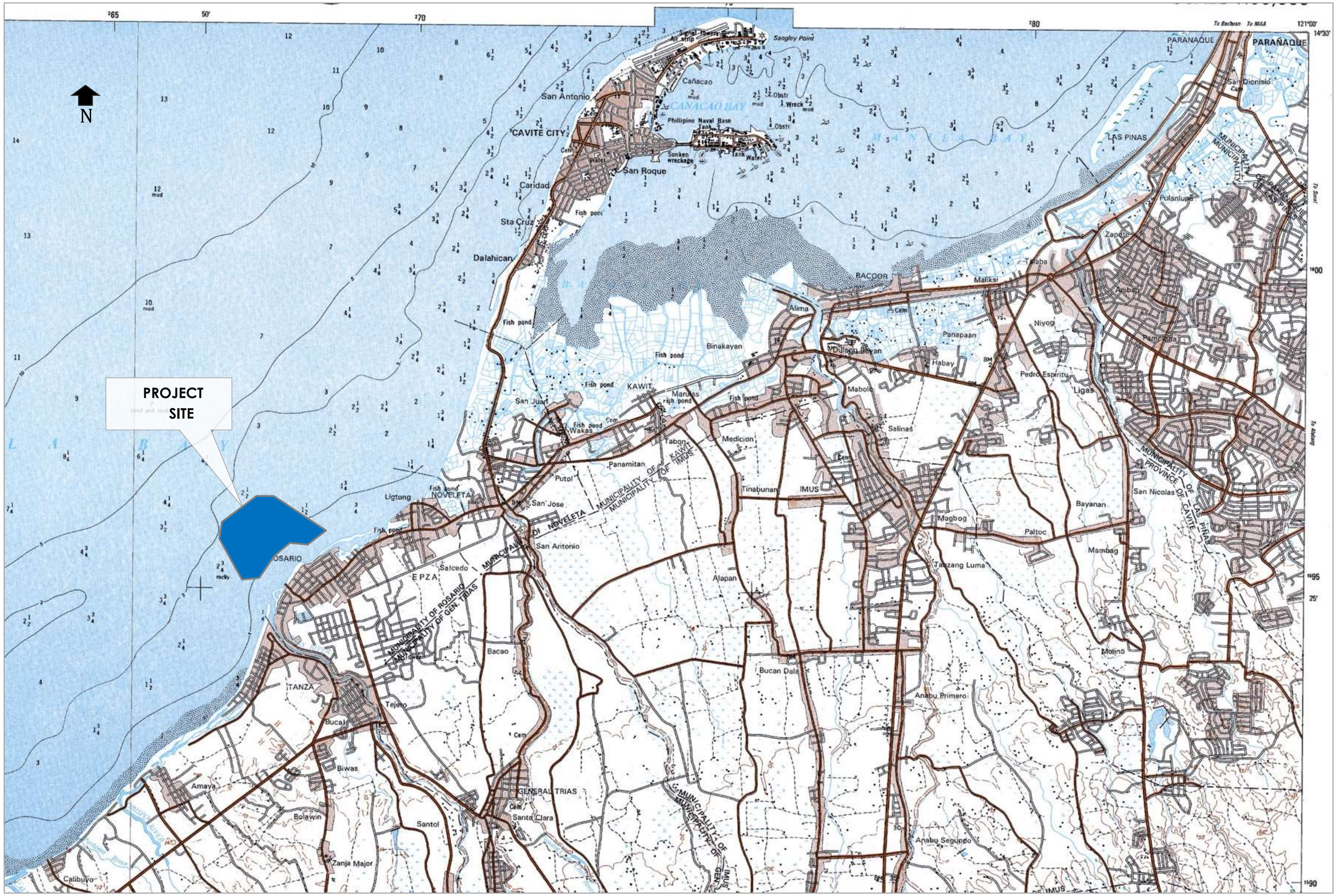
The lowland area consists of the coastal and alluvial plains. These areas have flat ground slope of less than 0.5 percent and low ground elevation of 2 to 30 meters elevation. The alluvial plain can be found in the municipality of Imus and southern part of General Trias. Within these municipalities forms the transition area between the coastal plain and the central hilly area. It also covers some areas of Bacoor, Kawit, Noveleta, Rosario and Tanza. (PDRRMO 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 E, which is located to the west of Cavite Spit, LPPWP is approximately 14.5 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)

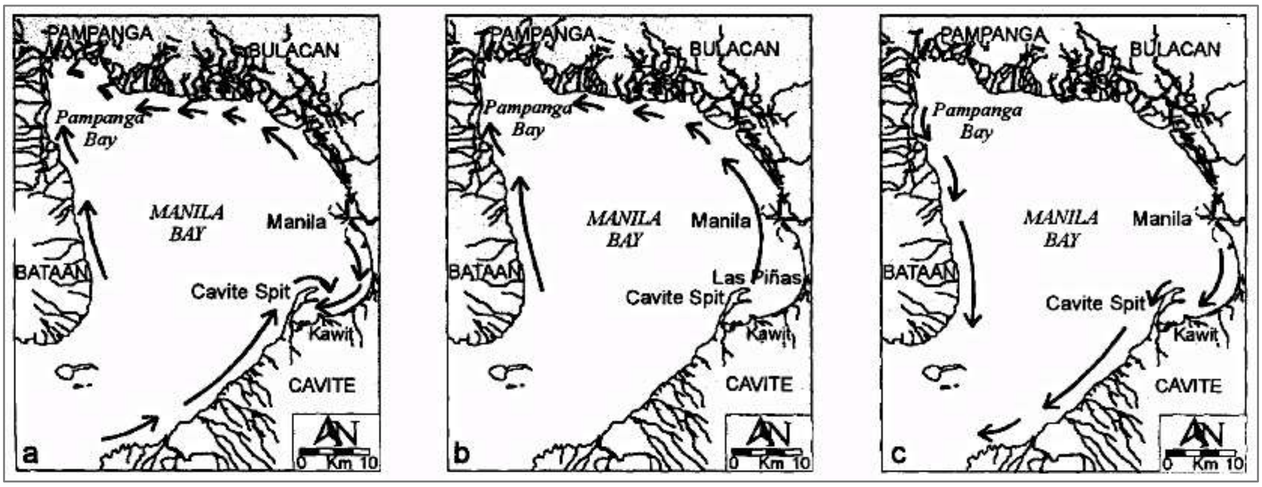
Figure 2.1-12. Topographic Map of Cavite - NAMRIA

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^3. 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^2), 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 Bacoor, 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 get transported in the northeastern Manila Bay (Figure 2.1-13). (Siringan and Ringor, 1997)



Source: Siringan and Ringor, 1997

Figure 2.1-13. Longshore currents associated with locally generated waves
a) south westerlies; b) south easterlies; c) north easterlies

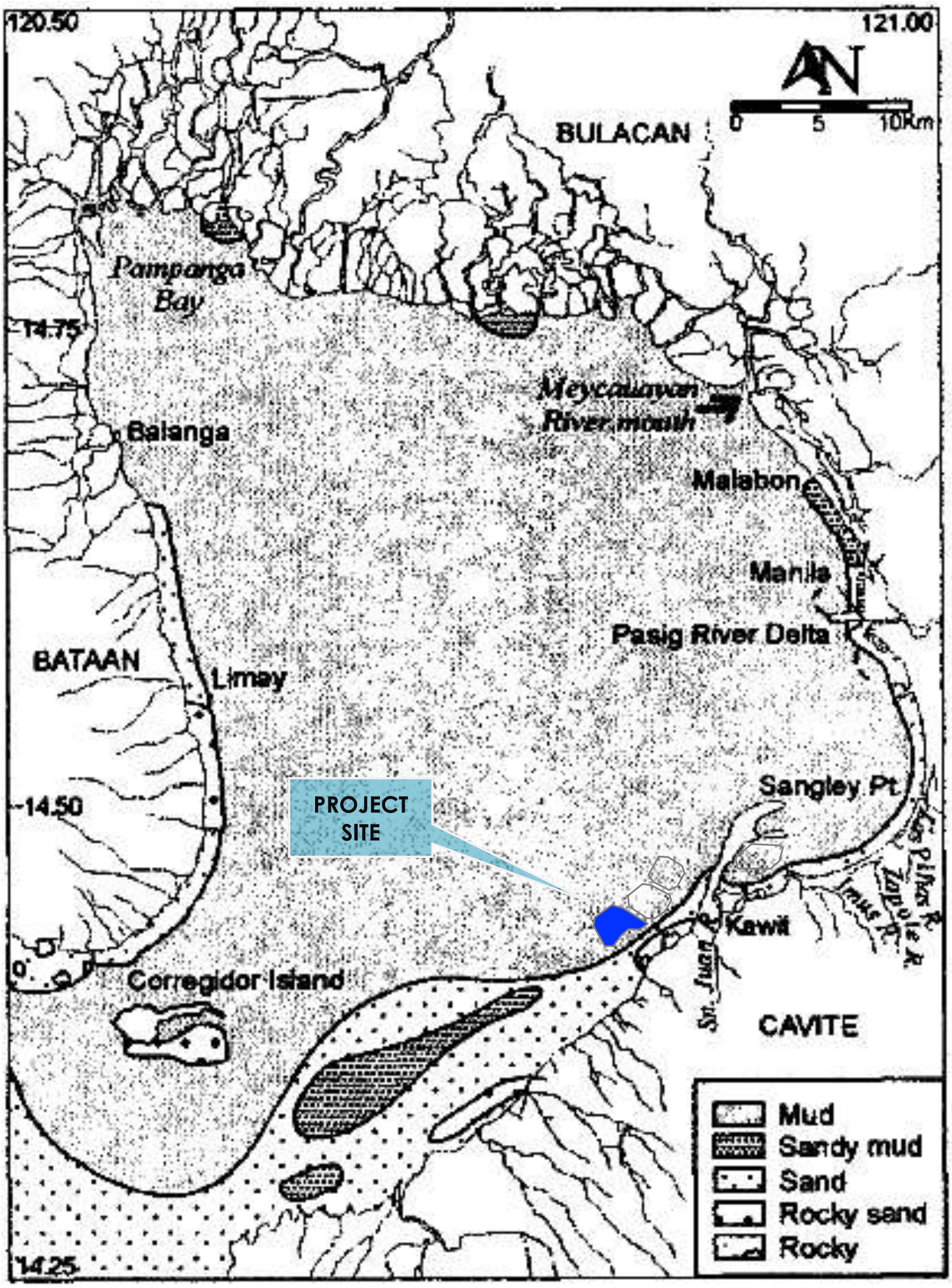
The Cavite Spit is a very prominent feature of the bay (Figure 2.1-13). It is 10km-long, 1.25km wide at its broadest portion, and has two recurved termination at its northeast end. It is approximately 30 km from the southern edge of the mouth of Manila Bay (Siringan and Ringor, 1997). The proposed Island E 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 2.1-14 shows the sediment distribution within Manila Bay.



Source: Siringan and Ringor, 1998

Figure 2.1-14. 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 14.5 km to the northeast – the LPPWP area.

There will be a change in the configuration of the coastline. Island E (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.

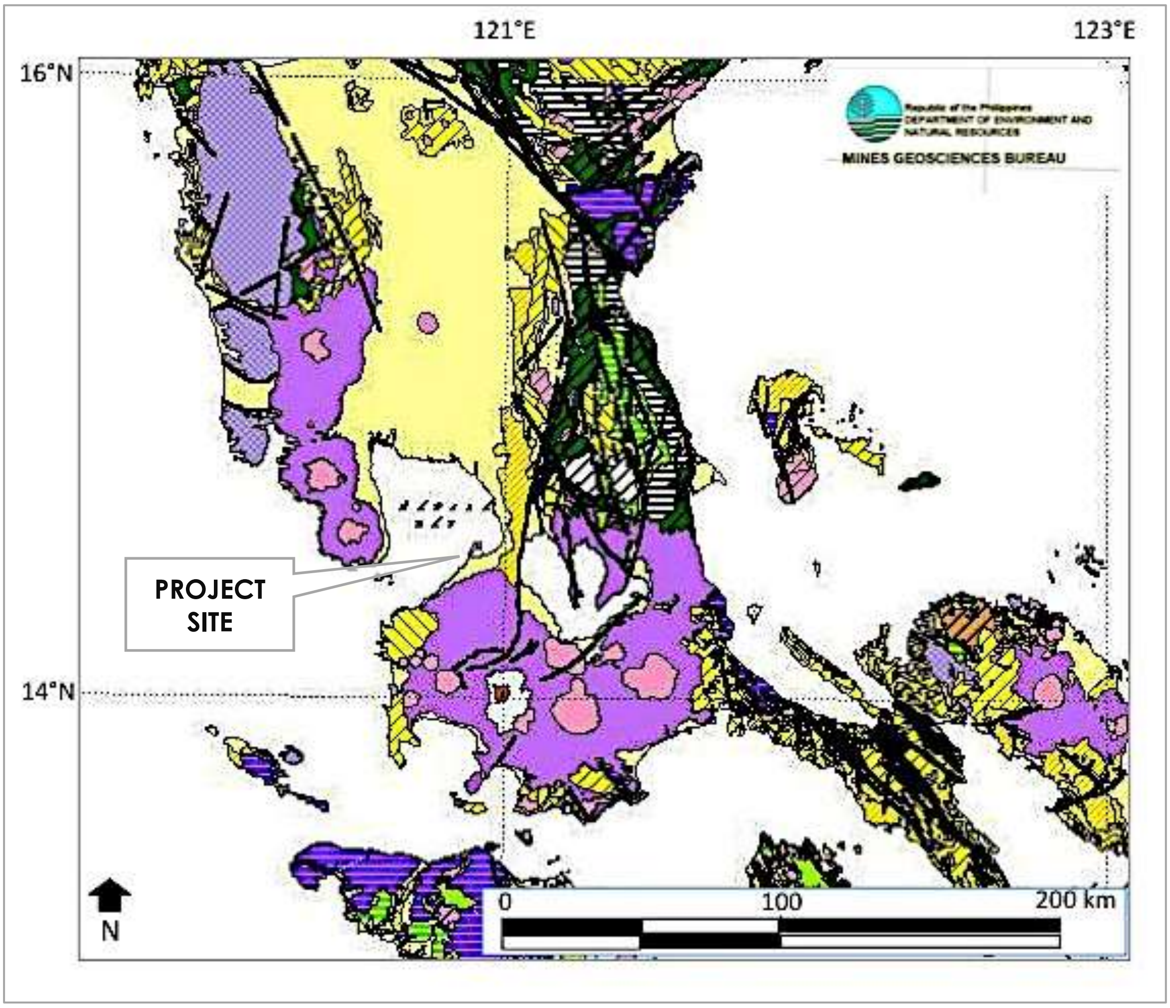
2.1.2.2 Changes in Subsurface Geology / Underground Conditions

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 2.1-15). 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 Peña (DENR-MGB) 2002

Figure 2.1-15. 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 2.1-16 and 2.1-17.

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 20.2 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.

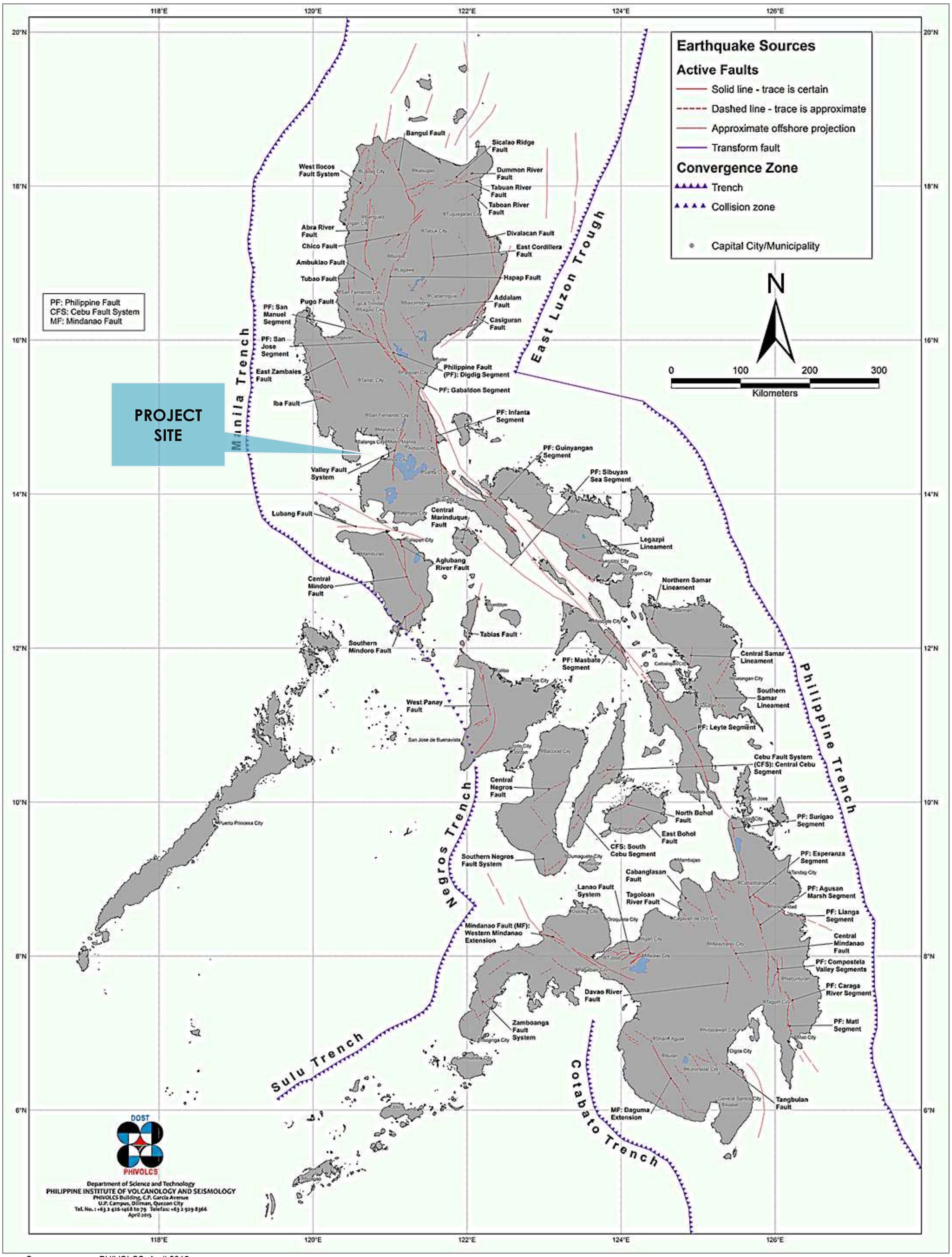
Manila Trench

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.

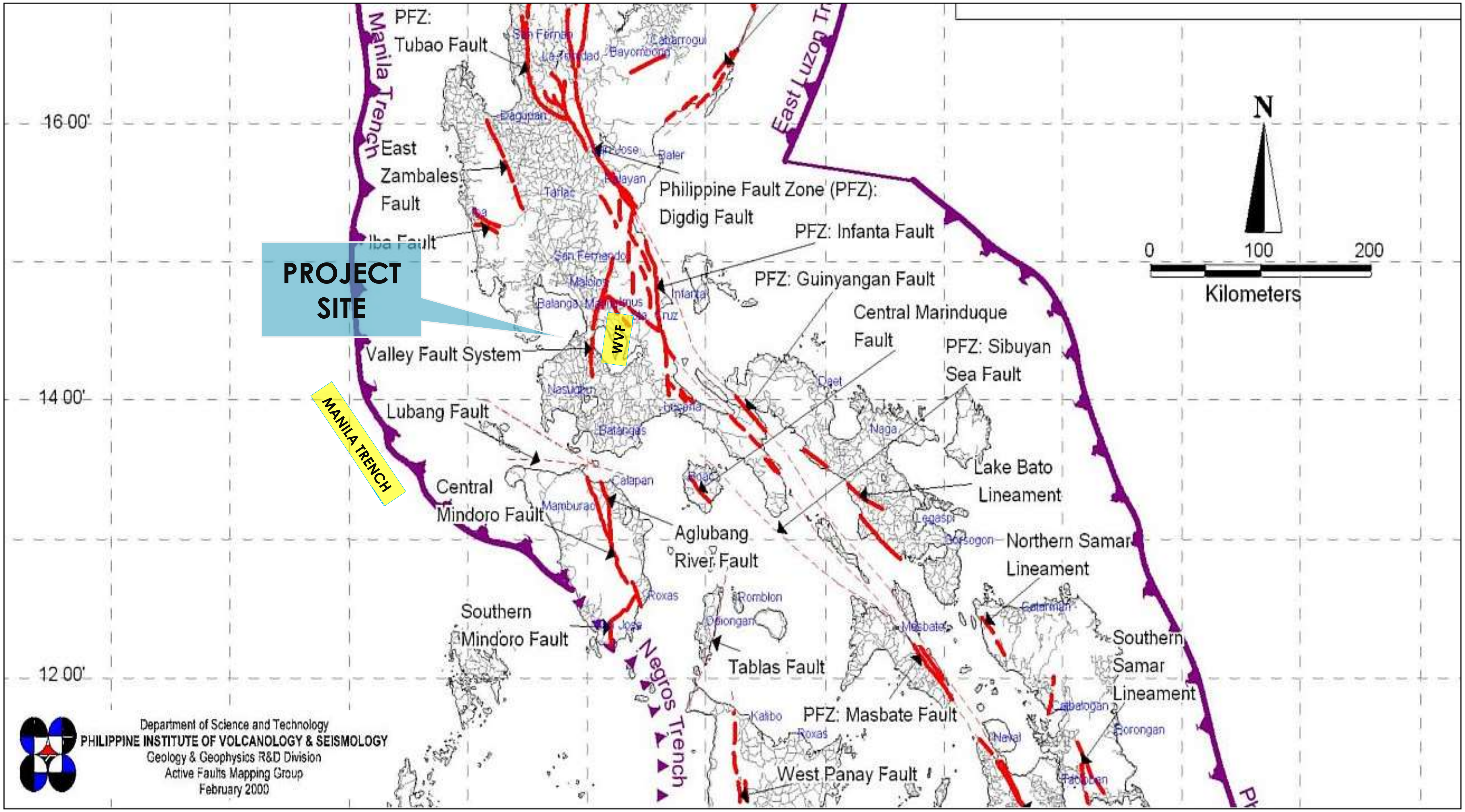
Macolod Corridor

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.



Source: PHIVOLCS, April 2015

Figure 2.1-16. Distribution of Active Faults and Trenches in the Philippines



Source: PHIVOLCS, February 2000

Figure 2.1-17. Distribution of Active Faults and Trenches in Western Luzon

2.1.2.2.4 Local Stratigraphy

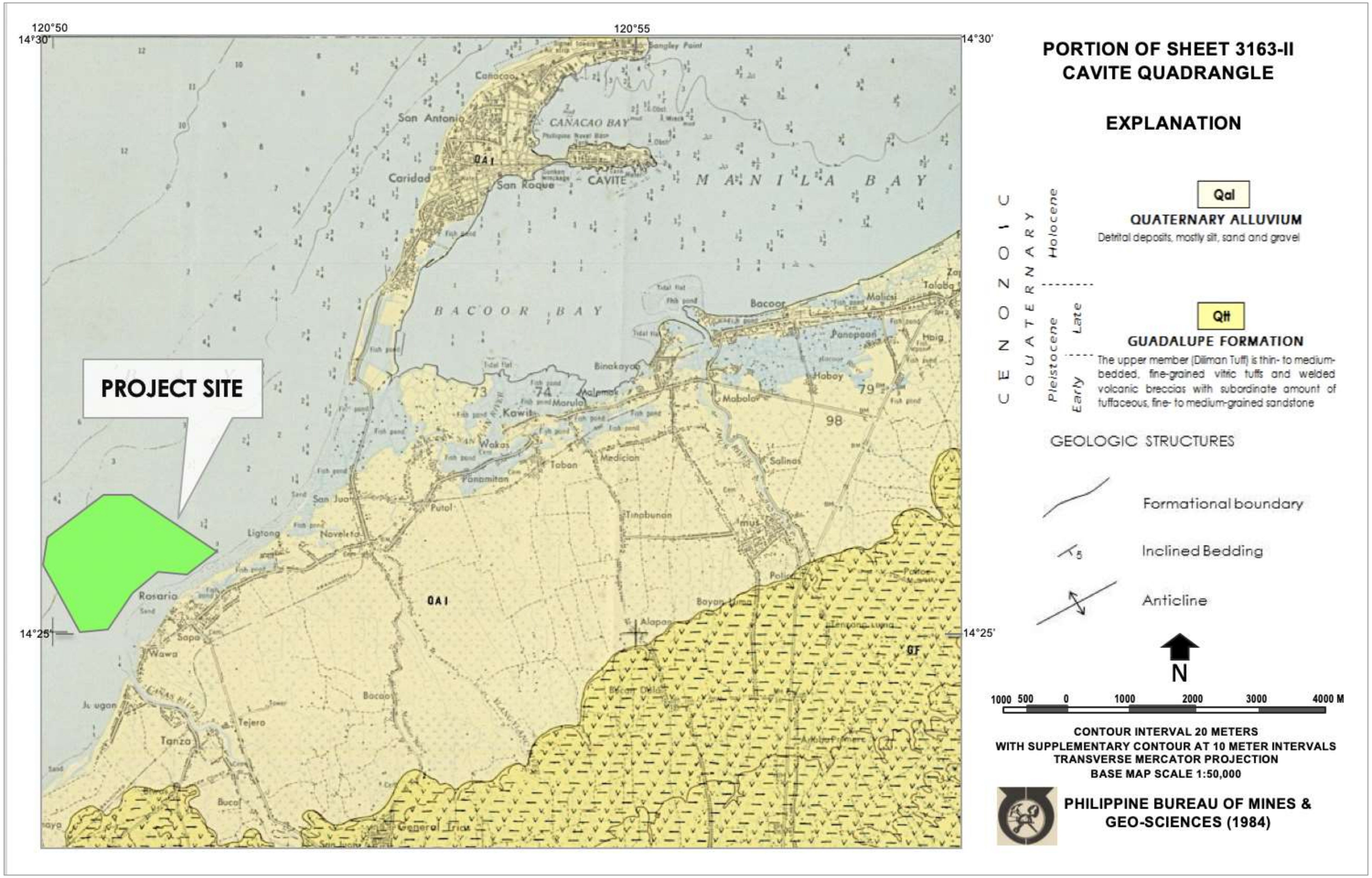
The most dominant rock formation in the area is the Guadalupe Formation (Pleistocene Age). It consists of an upper member, the Diliman Tuff, and a lower member, the Alat Conglomerate. Diliman Tuff, the most widespread rock in the area, is generally flat-lying (dips generally ranging from 3° to 10°) and 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 2.1-14). 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. Paleosoil 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 2.1-18.



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

Figure 2.1-18. 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 Detailed Engineering Design (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.**

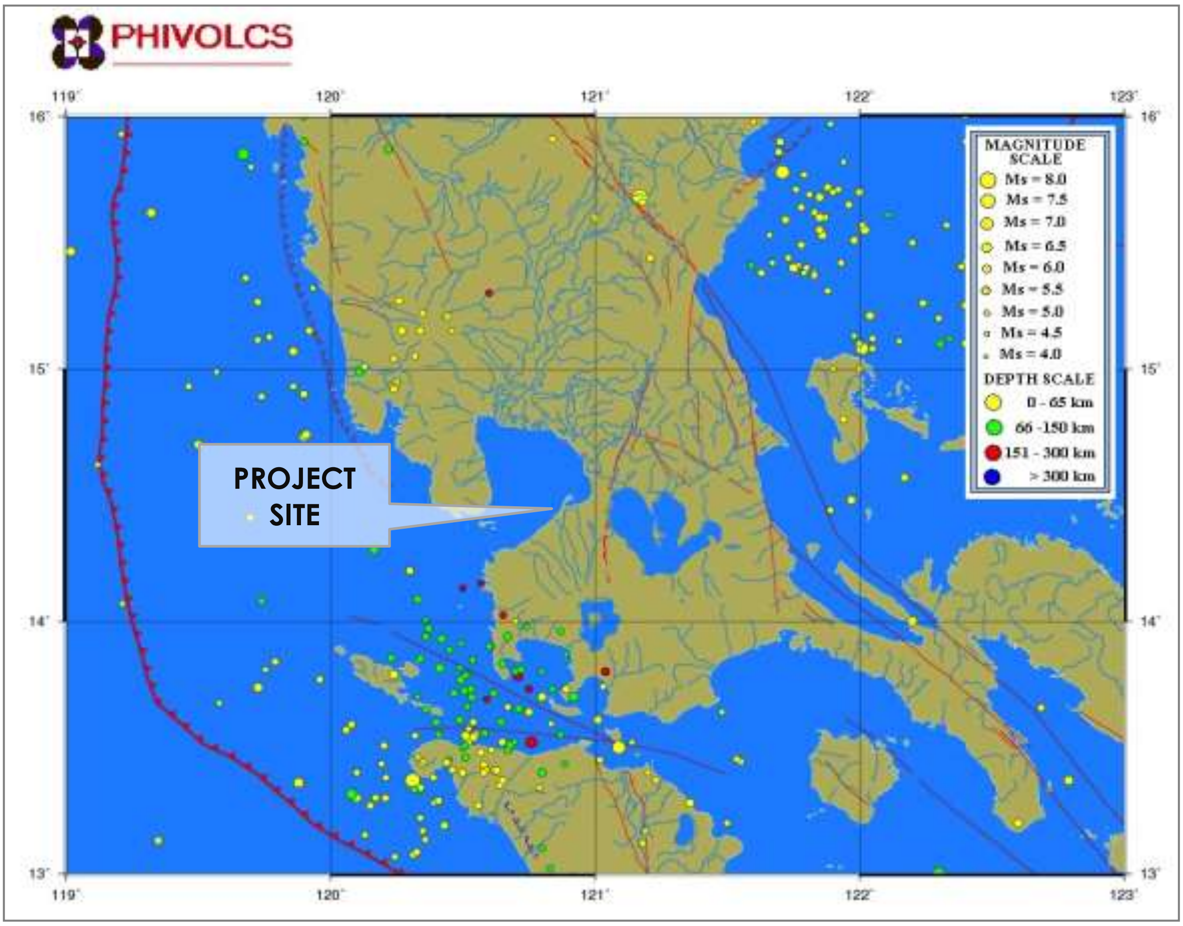
Observation stations shall be established in strategic locations within the reclaimed land. These will be used to monitor the degree of compaction and stability of the reclaimed land. These will record settlement/compaction rates.

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 2.1-19 and 2.1-20).

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.



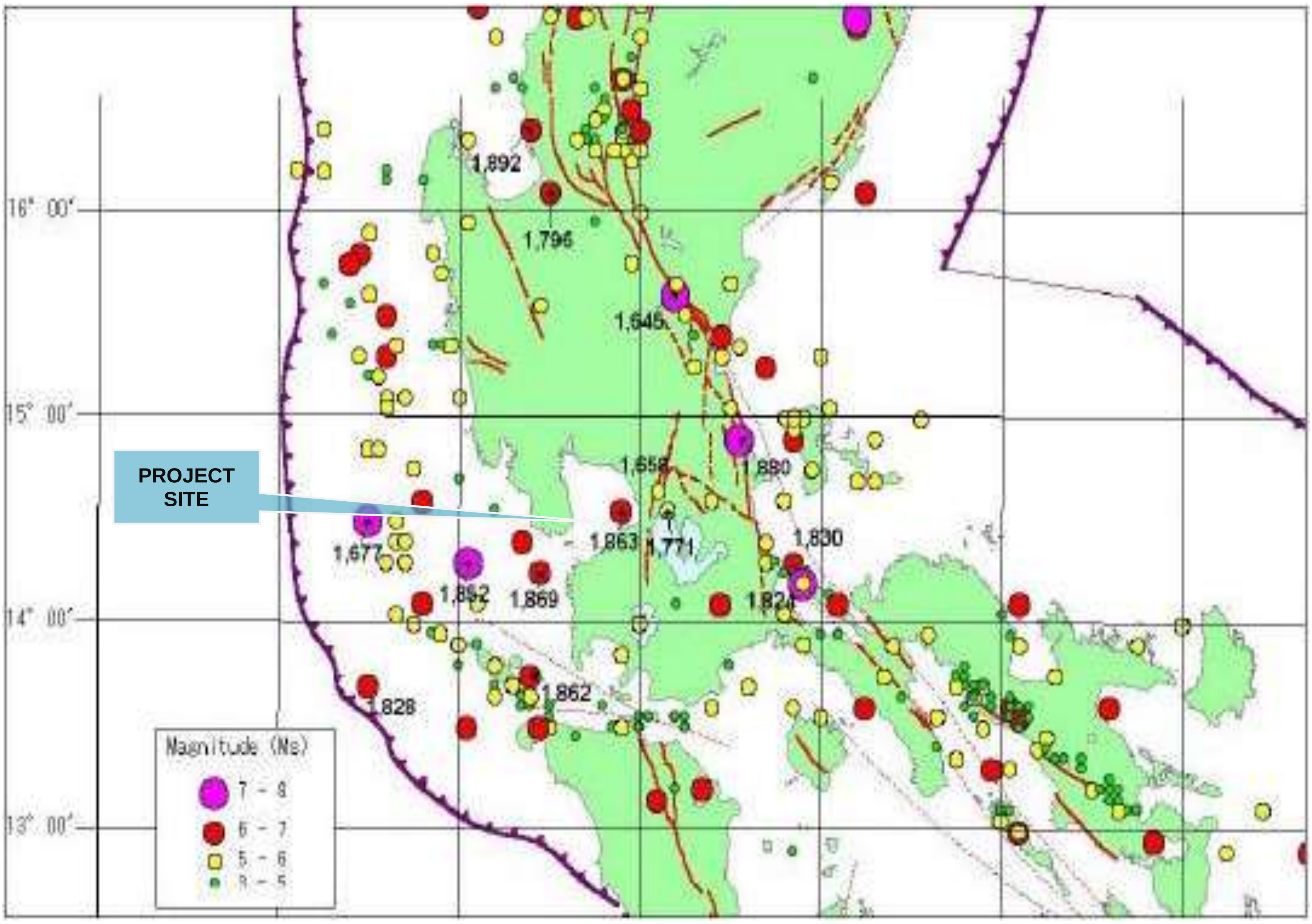
Source: PHIVOLCS, May 2017

Figure 2.1-19. 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 2.1-20. Distribution of Historical Earthquakes from 1608 to 1895

Source: PHIVOLCS 1999

Figure 2.1-21. 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 on February 18, 2019 and shown below. According to the report, the WVF is 20.2 km from the site of Island E, 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.

DOST
Republic of the Philippines
Department of Science and Technology
PHILIPPINE INSTITUTE OF VOLCANOLOGY AND SEISMOLOGY
PHIVOLCS

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HASS-EQ-04

HAS-Feb-19-197

DATE	18 February 2019
FOR	**TECHNOTRIX CONSULTANCY SERVICES, INC.**
REPRESENTED BY	**EDGARDO G. ALABASTRO**
PURPOSE	EIA requirement

EARTHQUAKE HAZARD ASSESSMENT

PROJECT NAME, LOCATION	GROUND RUPTURE	LIQUEFACTION	TSUNAMI	
Proposed Cavite Reclamation and Development Projects; 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 (Sagitarius), 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; Brgys. San Rafael 2, San Rafael 3 and San Rafael 4, Noveleta, Cavite; Brgys. Bagbag II, Kanluran, Ligtong I, Muzon II, Sapa II,				

d/b\db\TUFF\Volume_2\01 SERVICES_DATABASE\03 DRAFTS\Hazard Assessment Services\2019\February\HAS-Feb-19-197_Technotrix 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	**RENATO U. SOLIDUM, JR.**	**Undersecretary for DRR and CC, DOST** *and* **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.

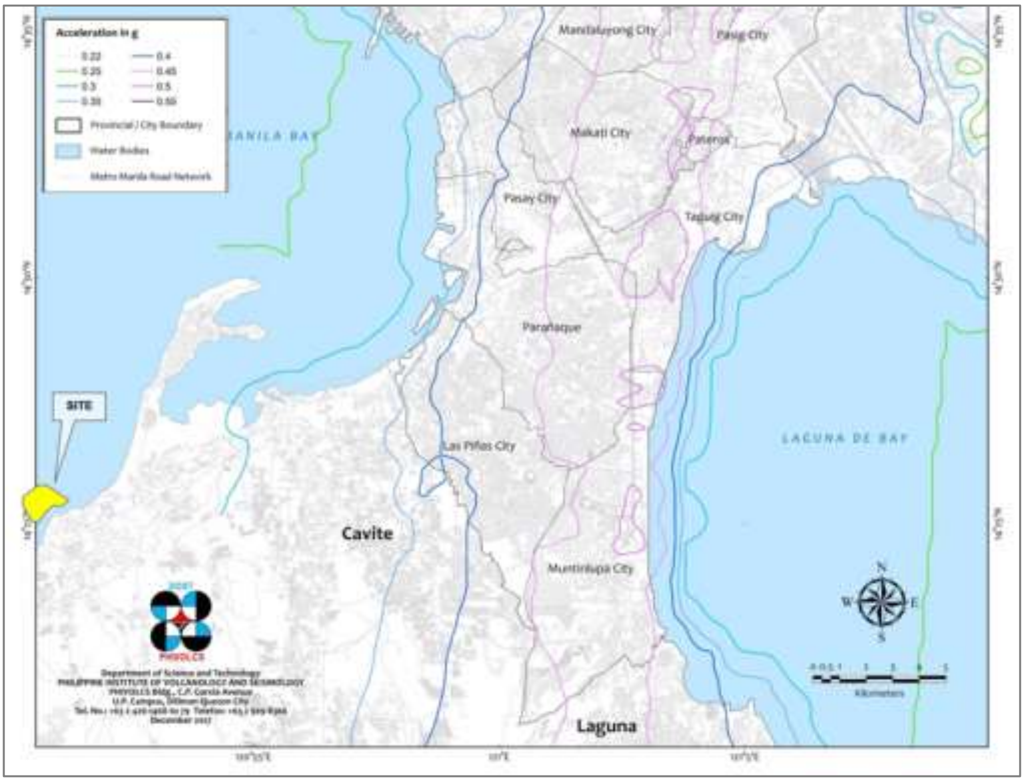
Factors that influence the intensity of ground shaking include the following: magnitude of the earthquake, distance of the site in relation to the earthquake generator, characteristics of the underlying rocks and the soundness of the buildings/structures.

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 2.1-22 to 2.1-24) 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.

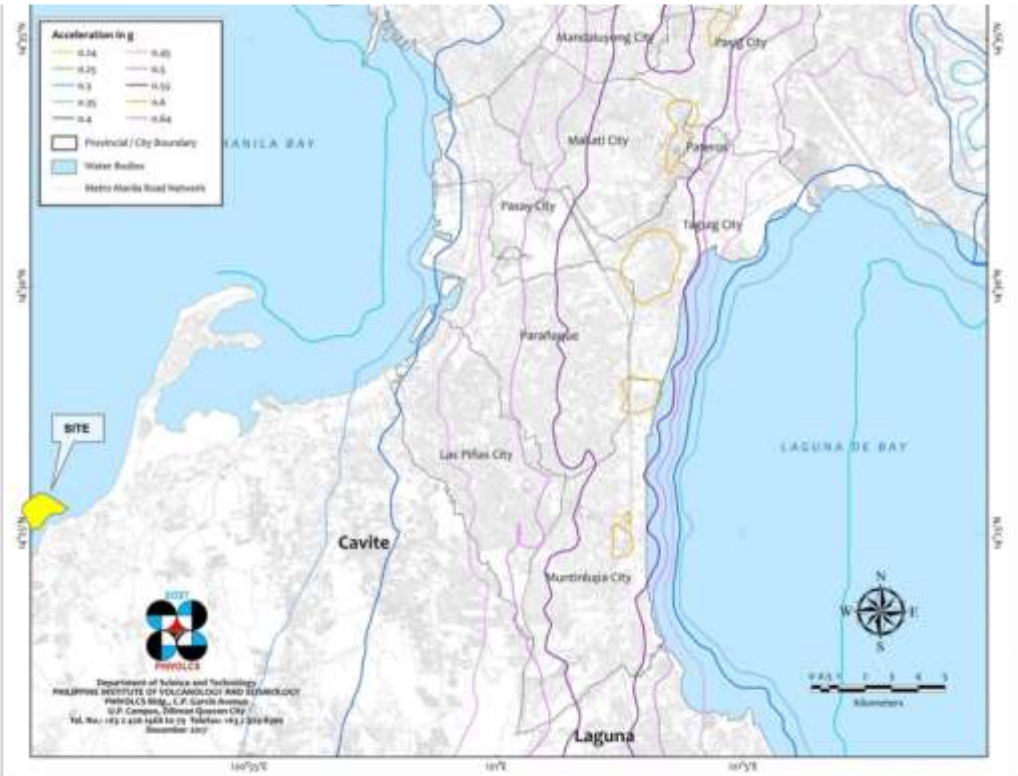
Based on these maps, the ground acceleration for 500 year return period at the project site for Vs30 site model is: 0.25; for 1,000 year return period is: 0.3; and for 2,500 year return period is: 0.35.

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.



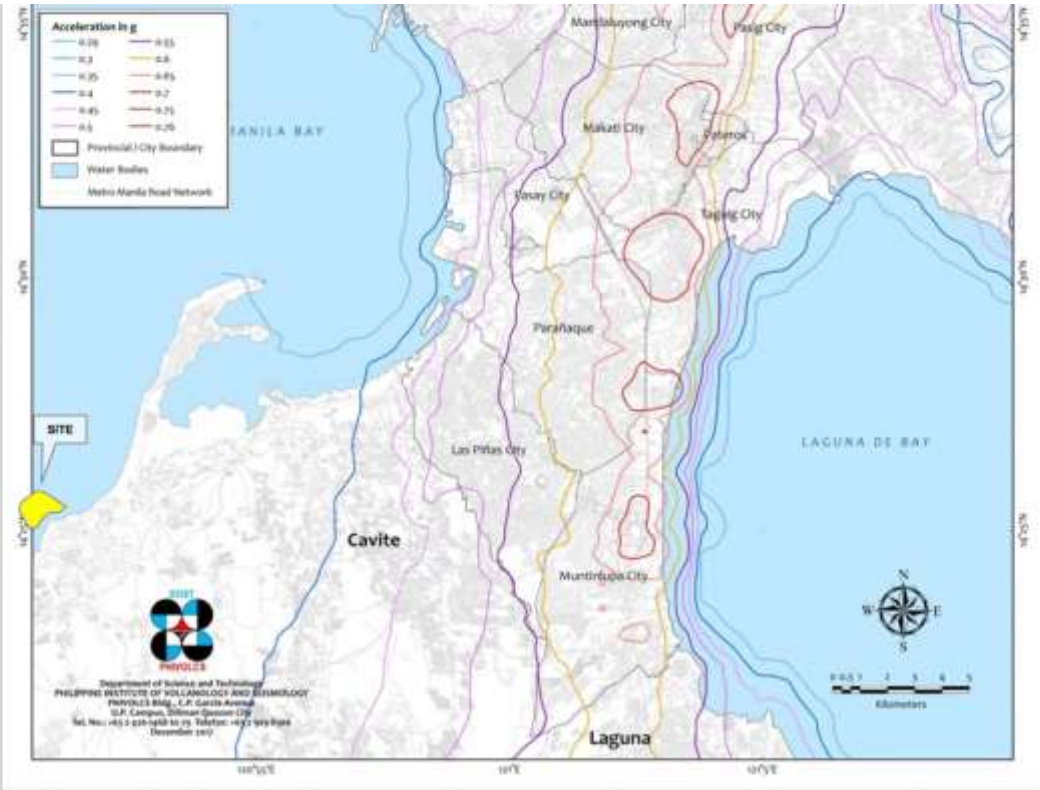
Source: PHIVOLCS 2017. The Philippine Earthquake Model

Figure 2.1-22. 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 2.1-23. Peak Ground Acceleration Map of Manila, 1,000-Year Return Period on VS_{30} Site Model with 10% Probability of Exceedance in 50 Years



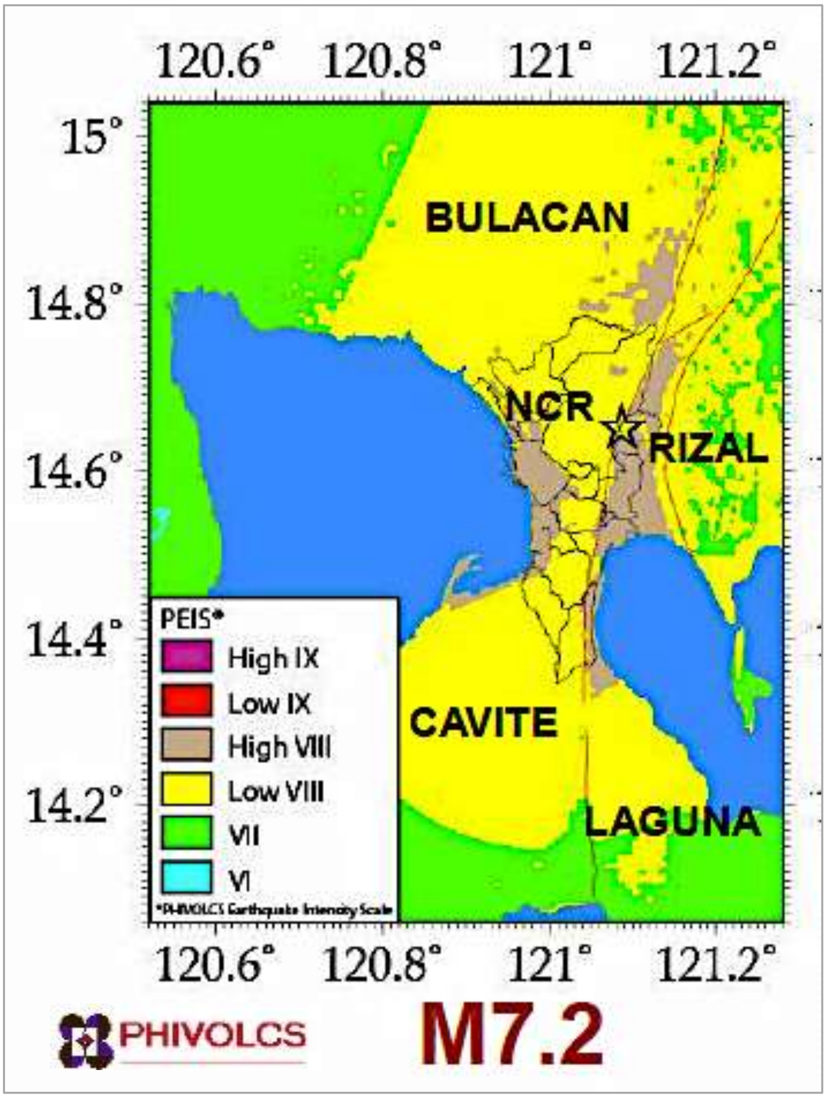
Source: PHIVOLCS 2017. The Philippine Earthquake Model

Figure 2.1-24. 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 20.2 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.

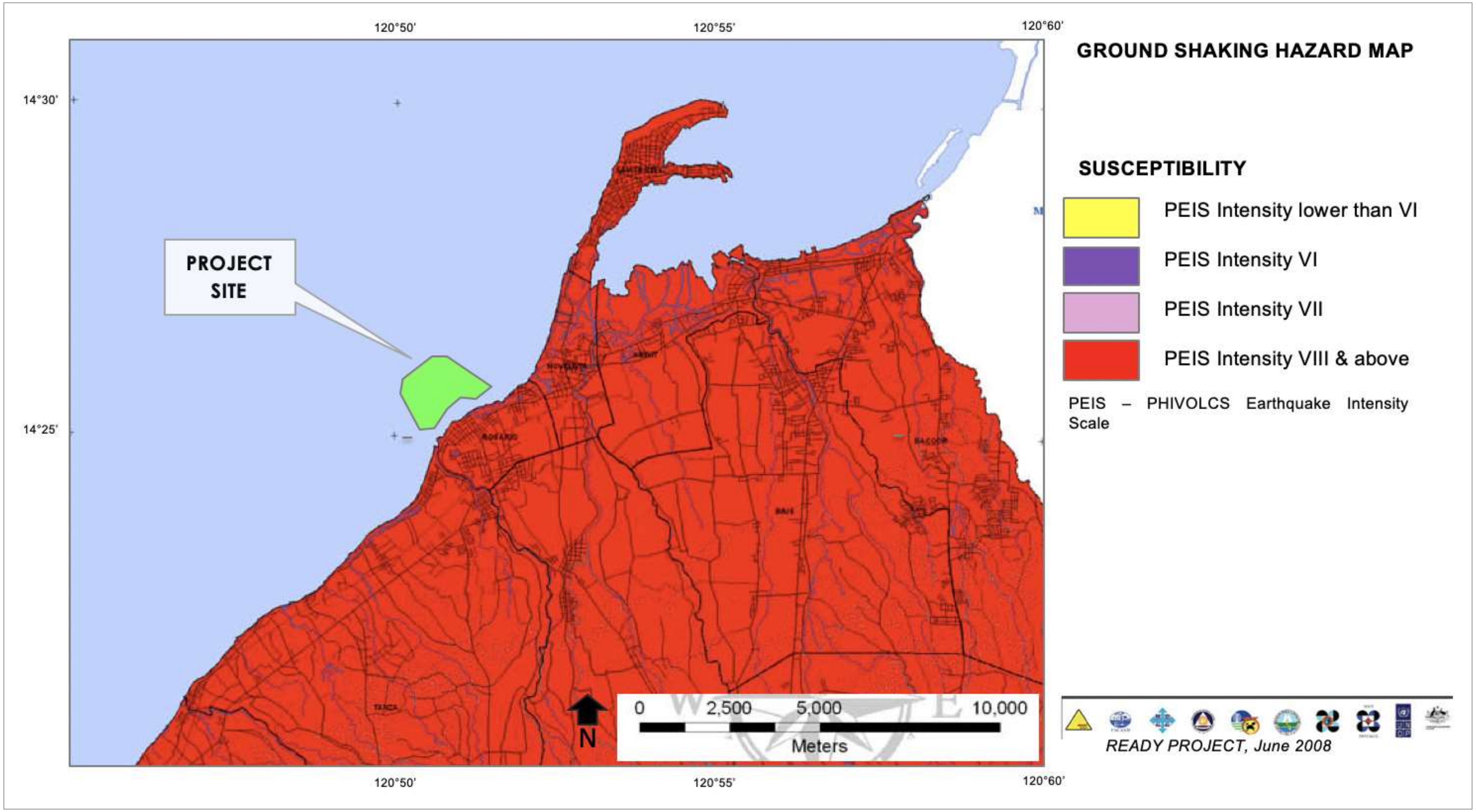
Figure 2.1-25 shows that in Model 08 (magnitude 7.2 from WVF), the PEIS is HIGH VIII (brown) or destructive in the vicinity of the project site.

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 2.1-26.



Source: Risk Analysis Project, 2013: PHIVOLCS

Figure 2.1-25. Ground Shaking in Greater Metro Manila and Vicinities (WVF Earthquake)



Source: READY Project, June 2008

Figure 2.1-26. Ground Shaking Hazard Map of Cavite

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

$$\mathbf{Log_{10}A = 0.41M - log_{10}\,(R + 0.032 \times 10^{0.41M}) - 0.0034R + 1.30}$$

Where: A= mean of the peak acceleration from two horizontal components at each site (cm/sec2)
R= shortest distance between site and fault rupture (km)
M= surface-wave magnitude

The following peak ground acceleration (PGA) values of 0.192g, 0.32g, and 0.449g for bedrock, medium soil and soft soil, respectively were computed. The project site being reclaimed land falls under soft soil and will experience 0.449g, which is slightly higher than the probabilistic estimates shown on PEM map (Figure 2.1-24). Thus, the recommended 'g' value to be used in seismic load evaluation and building design is 0.449g.

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	20.2	0.191	0.319	0.446
Manila Trench	7.9	179.9	0.022	0.037	0.051
PFZ: Infanta Segment	8	82.2	0.085	0.142	0.199
East Valley Fault	7	39.5	0.105	0.175	0.245
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 20.2 km east of the proposed project site. Still, the area and its vicinities are prone to ground acceleration. Ground acceleration caused by earthquakes may potentially result to great damage and destruction to property and infrastructure and maybe accompanied by loss of life.

Mitigating Measures

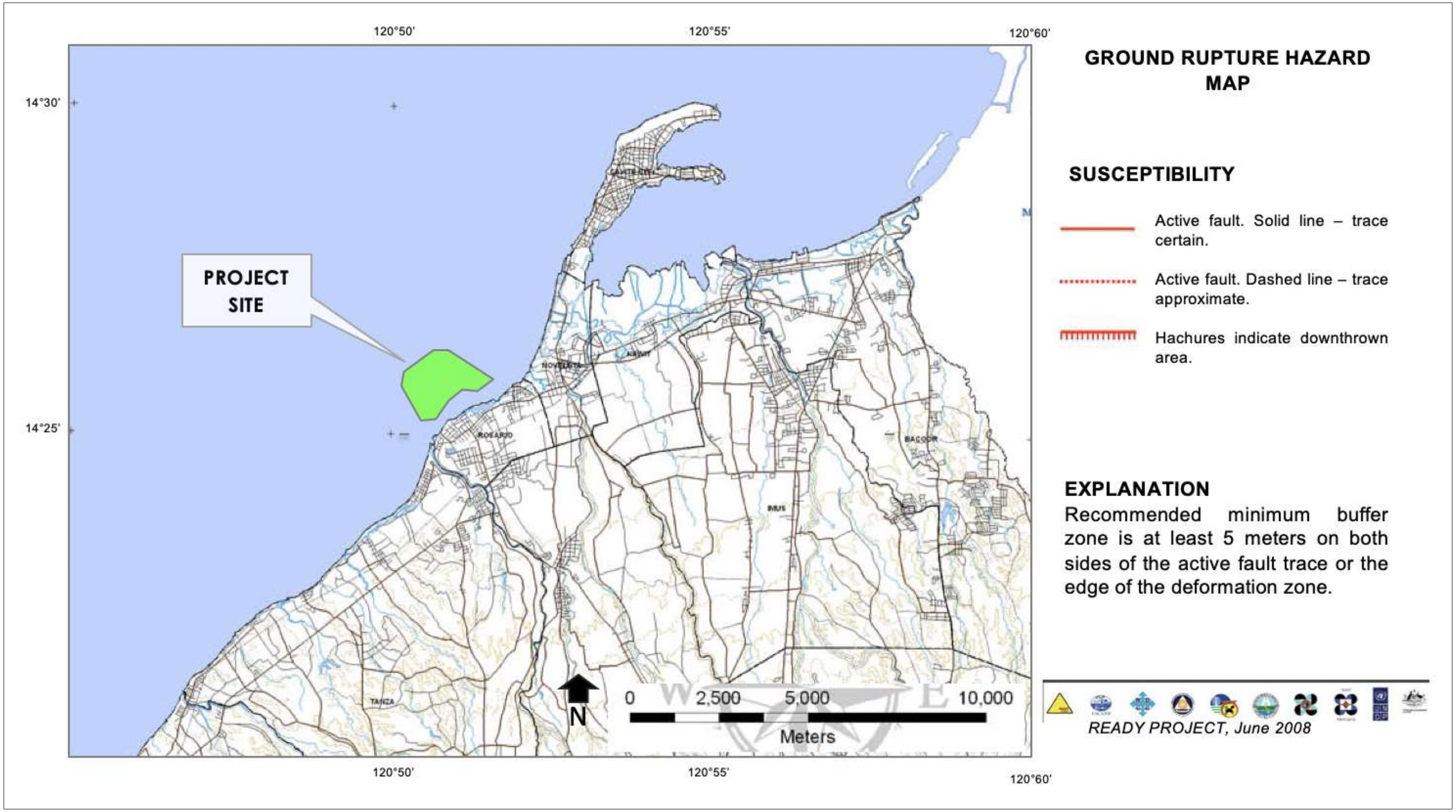
The buildings, infrastructure, wave deflectors, containment wall and other defense structures that would be constructed on the proposed reclamation site should conform to the National Structural Code of the Philippines. The computed “g” values of 0.449g must be utilized in the design of the structures. The retaining wall that will support the earth fill materials must be properly designed to resist the lateral and hydrostatic pressures.

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 2.1-27.

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.



Source: READY Project, June 2008

Figure 2.1-27. Ground Rupture Hazard Map of Cavite

2.1.2.3.1.3 *Differential Settlement*

In general, 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*

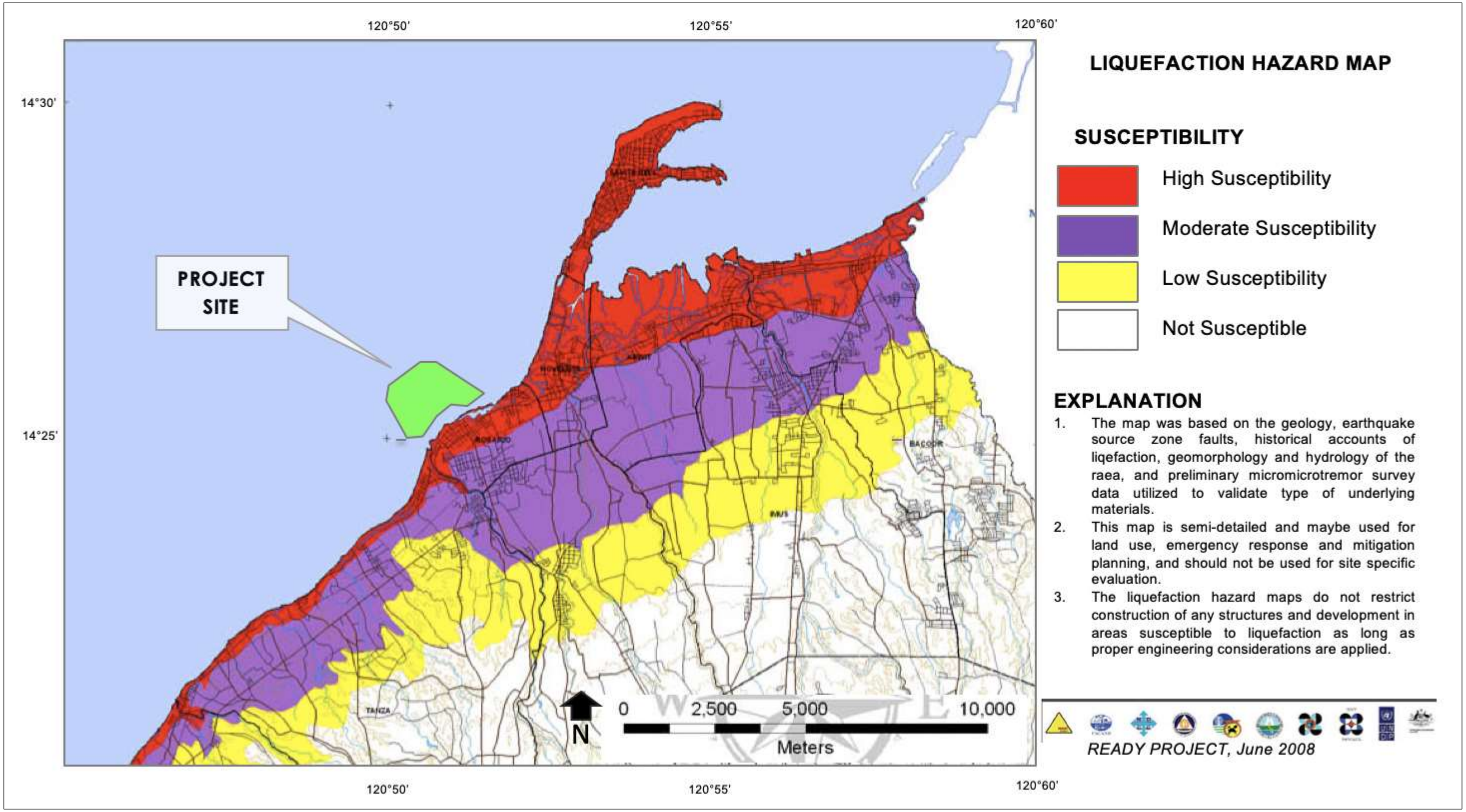
Liquefaction is the process that transforms the behavior of cohesionless water-saturated unconsolidated sediments from a solid to a liquid state usually caused by seismic stresses (Torres et al, 1994) that create ground shaking. Water saturated soils loose strength and liquefy and thus the material tends 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 2.1-28). However, the near-shore areas of Rosario are underlain by rocky to coarse sand substrata and is less susceptible to liquefaction compared to areas to the north.



Source: READY Project, June 2008

Figure 2.1-28. Liquefaction Hazard Map of Cavite

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

The near-shore areas of Rosario are generally underlain by rocky substrata. From the results of the initial analysis, all 3 boreholes in the proposed area (BH-31, BH-36, and BH-43) were not found to be susceptible to liquefaction since the subsoil condition is generally made up of silts and clays with significant amount of fines content. These types of soil material do not liquefy when subjected to earthquake loading. Hence, no mathematical analysis was done.

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.

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 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).

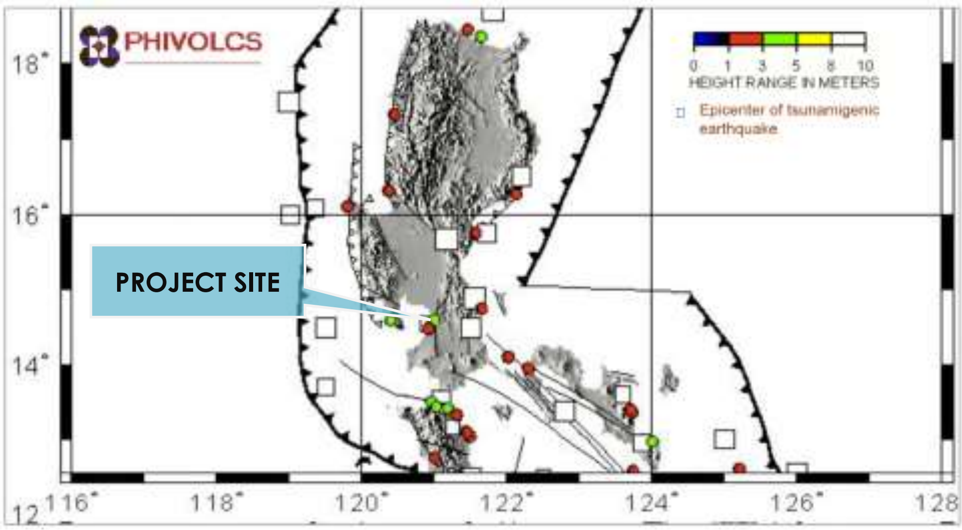
The platform level shall be above the extreme water level, securing a safe situation for future inhabitants. The required platform level will therefore be above the most extreme water level that can occur given the design life of the land reclamation, also considering the storm surge for the defined 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 2.1-29 below.

In PHIVOLCS' (2008) map of tsunami prone areas of Cavite Province, there are no marks of tsunami inundation area (red in Figure 2.1-30) in the immediate vicinity of the project site. However, in the 2014 READY Project map (Figure 2.1-31), 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 5.5m.

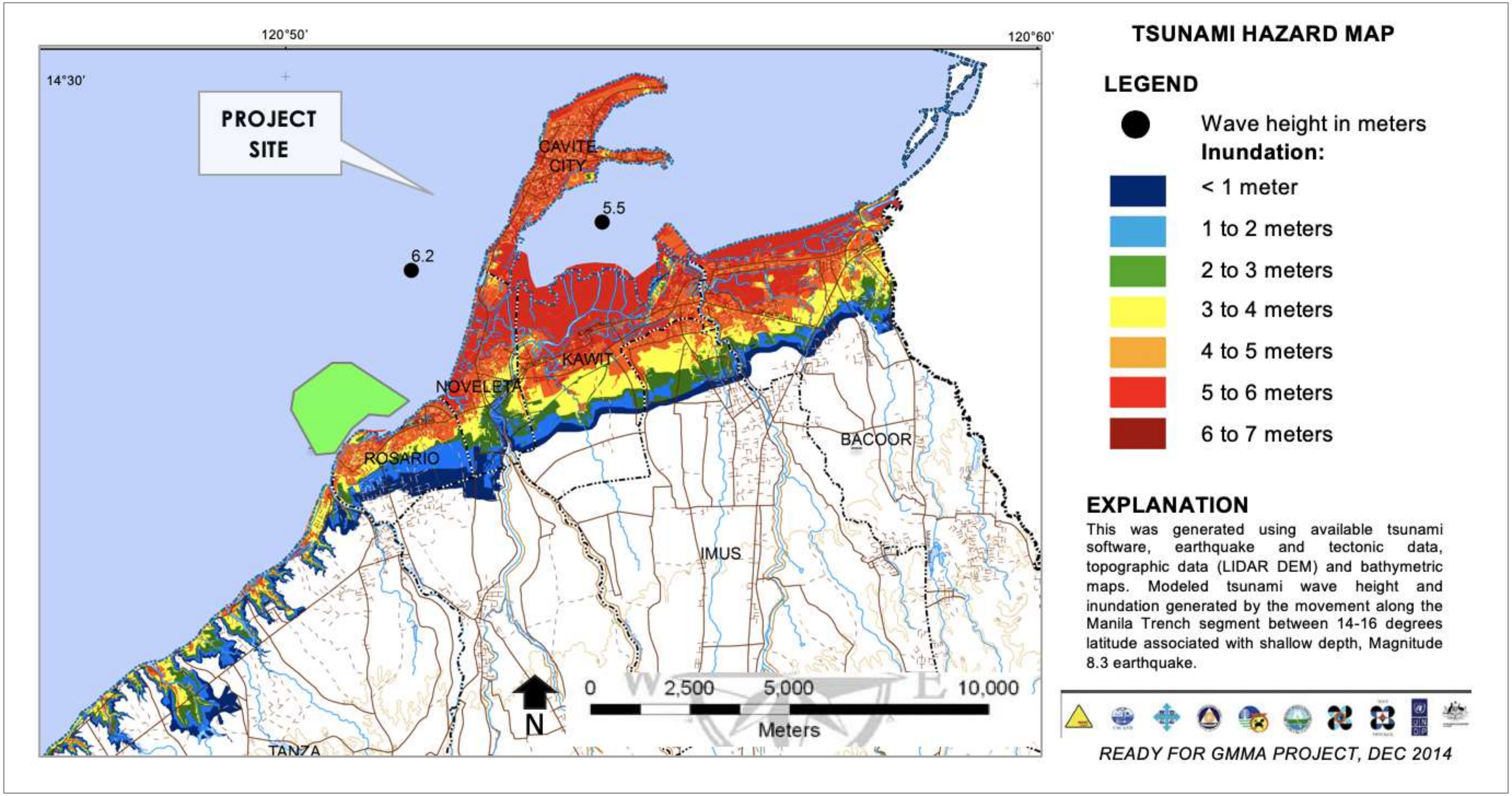


Source: PHIVOLCS (Bautista, B.), 2001

Figure 2.1-29. Map of Epicenters of Tsunamigenic Earthquakes in the Philippines

Source: PHIVOLCS, June 2008

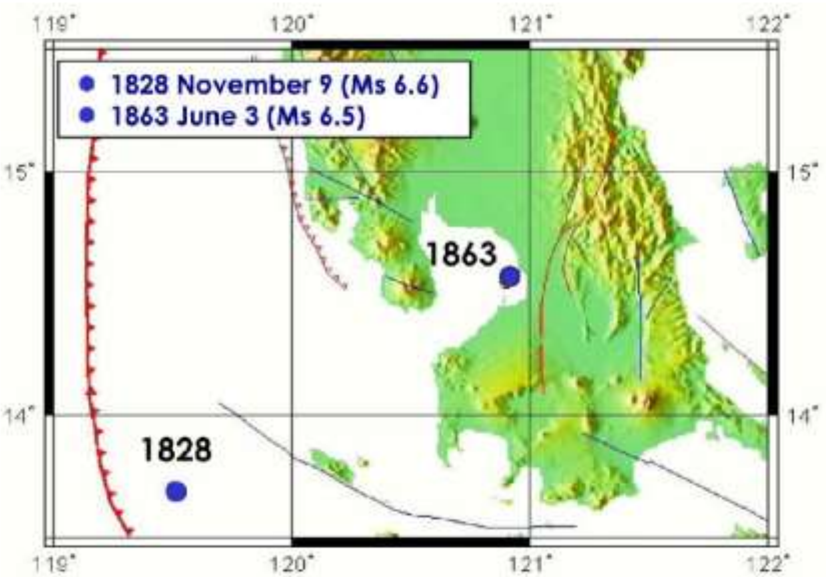
Figure 2.1-30. Tsunami Hazard Map of Cavite Province (PHIVOLCS)



Source: READY Project, December 2014

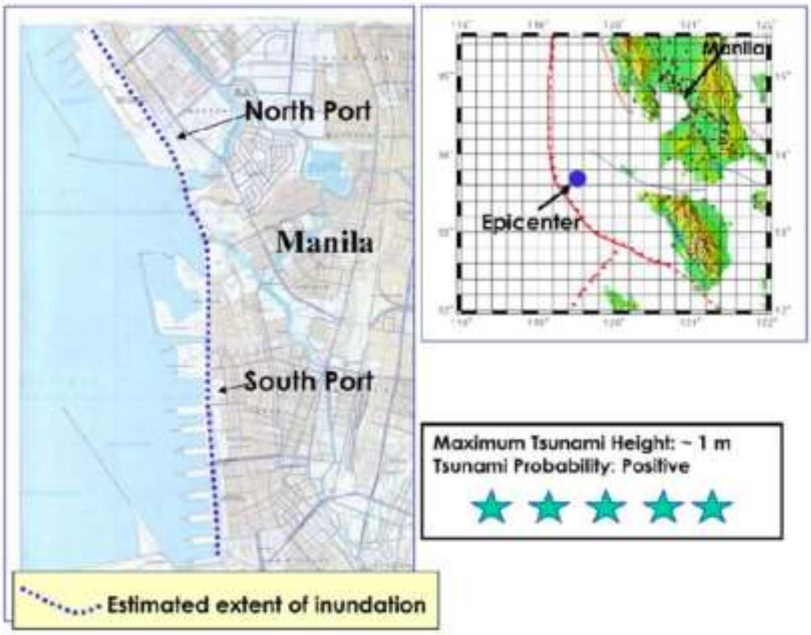
Figure 2.1-31. Tsunami Hazard Map of Cavite Province (READY Project)

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 2.1-32 to 2.1-34.



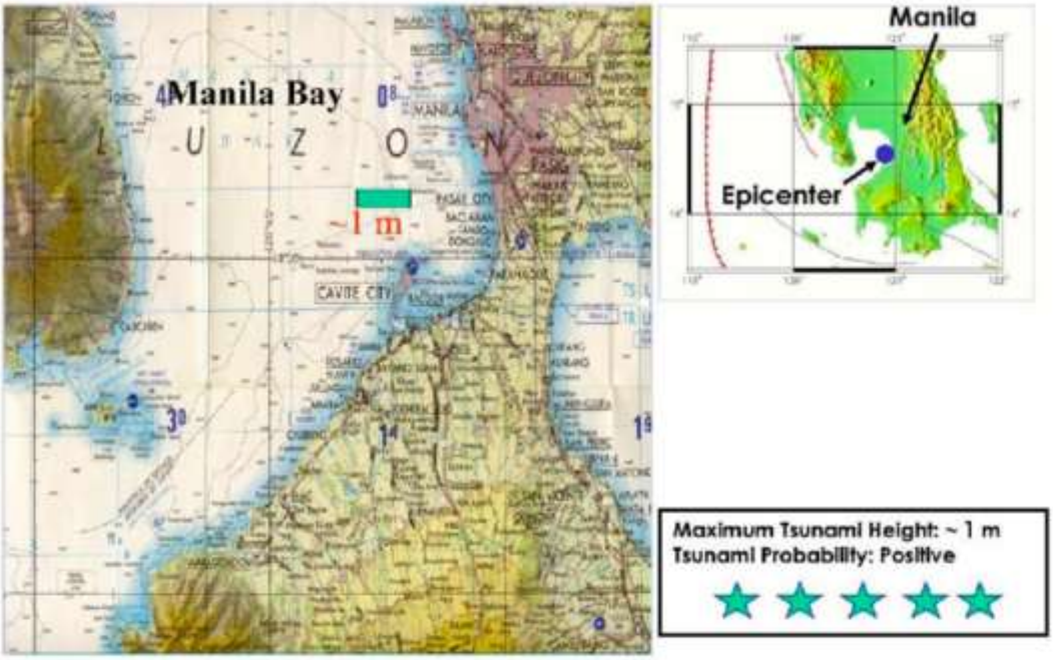
Source: PHIVOLCS 2014

Figure 2.1-32. Tsunamigenic Earthquakes that affected Metro Manila shores



Source: PHIVOLCS 2014

Figure 2.1-33. The November 9, 1828 Tsunami in Manila



Source: PHIVOLCS 2014

Figure 2.1-34. 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 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 2.1-35 and 2.1-36 for earthquake-induced landslide susceptibility maps and Figure 2.1-37 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

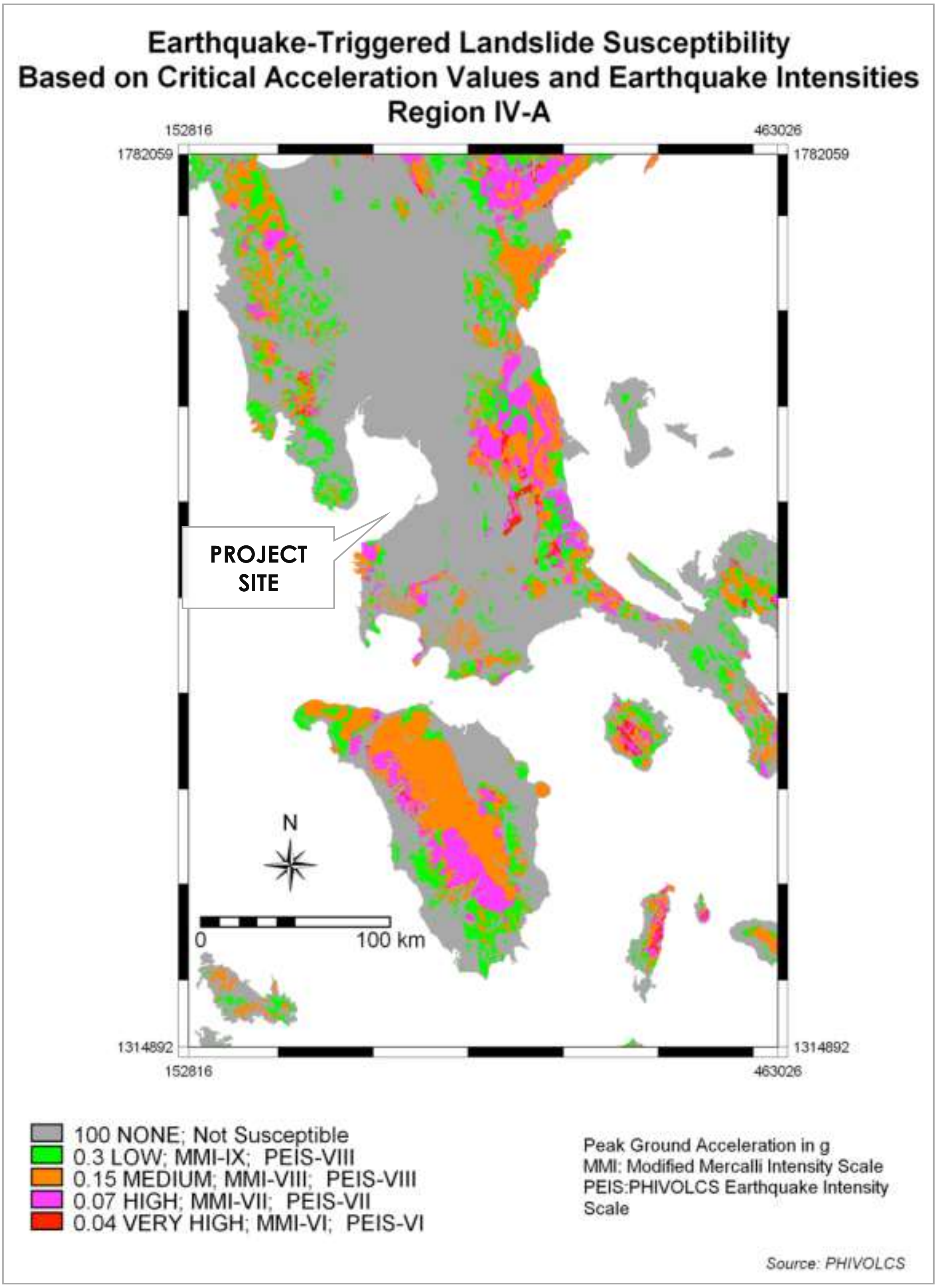
The project site has low susceptibility to landslide. That said, there is still a remote possibility of collapse of the fill materials in the reclamation area due to engineering/structural failures. Below is a numerical stability analysis for the containment structure of the island.

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

Mitigating Measures

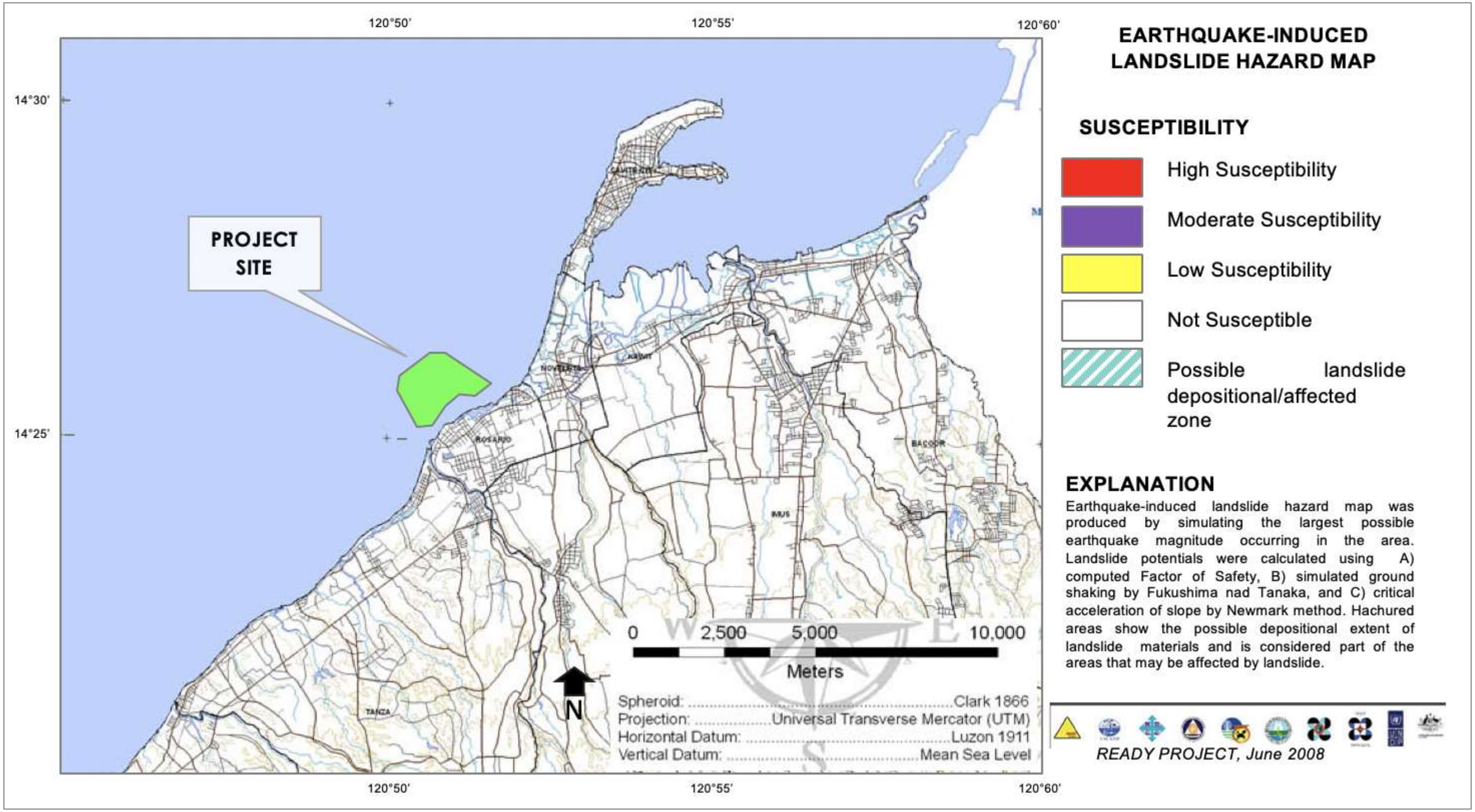
This hazard is seemingly absent in the project area and therefore no mitigation measures to be implemented.

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.



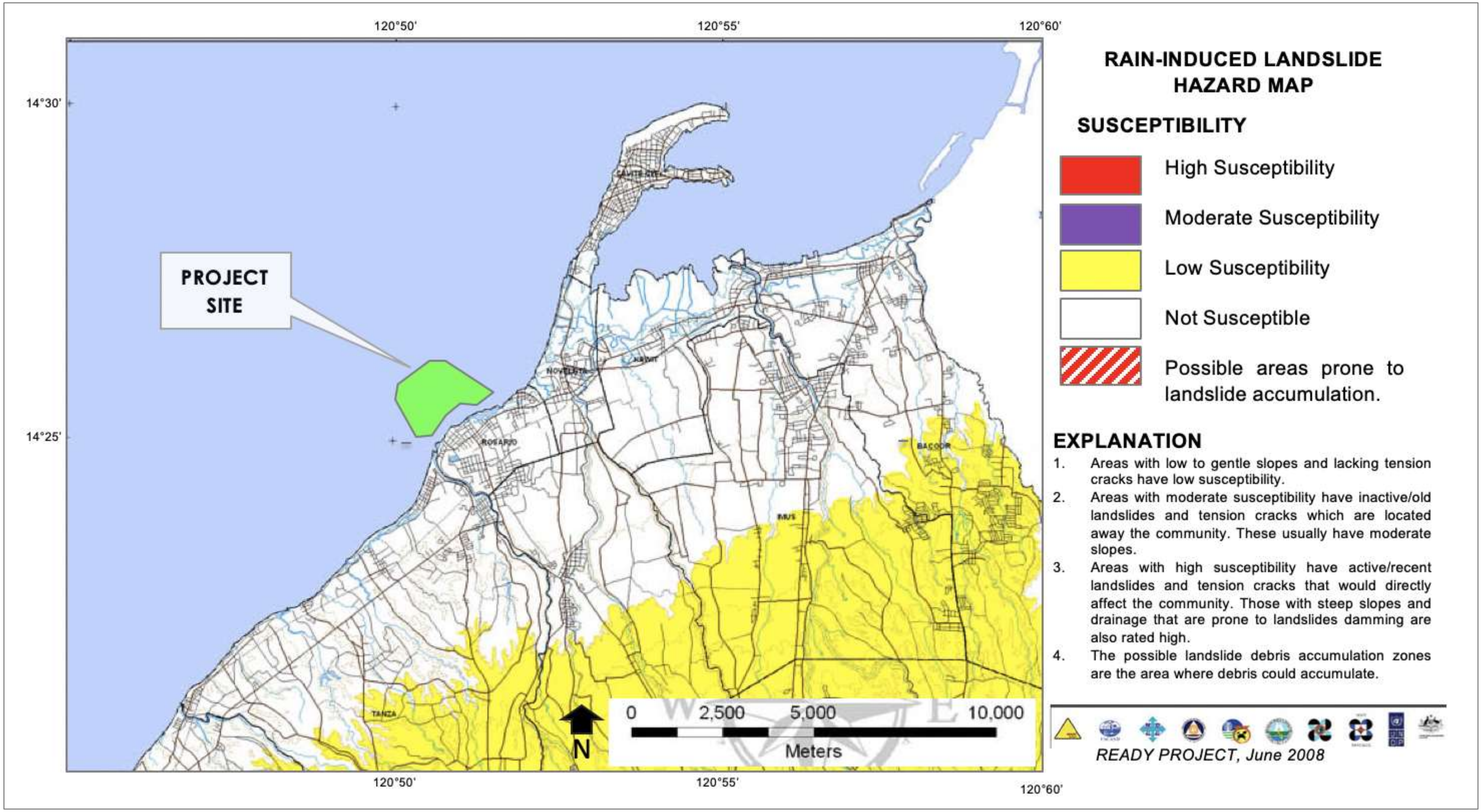
Source: PHIVOLCS, October 2008

Figure 2.1-35. Earthquake-Induced Landslide Susceptibility Map of Region IV-A



Source: READY Project, June 2008

Figure 2.1-36. Earthquake Induced Landslide Hazard Map of Cavite



Source: READY Project, June 2008

Figure 2.1-37. 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.

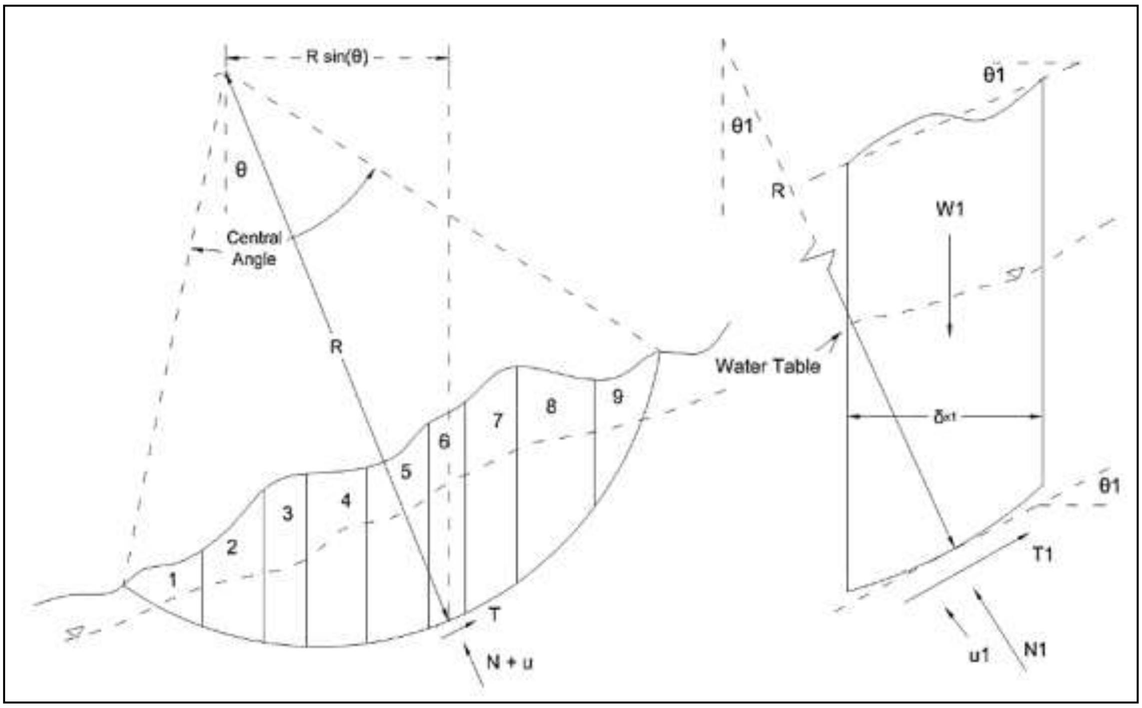


Figure 2.1-38. Stability Analysis by Limit-Equilibrium Methods

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

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

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)

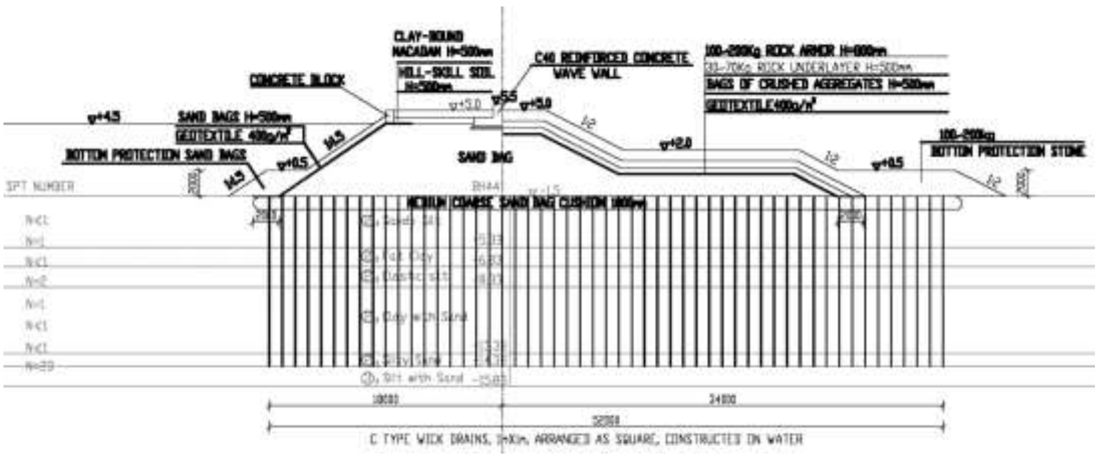
For this study, the following factors of safety were used:

- 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 2.1-39. Section of Island E Dike (I)

Geotechnical Parameters

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

Table 2.1-5. Geotechnical Parameters for Proposed Dike

Depth (m)	Soil Type	Relative Density	SPT N-value	Geotechnical Parameters		
				(kN/m^3)	c (kPa)	(^{0})
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.

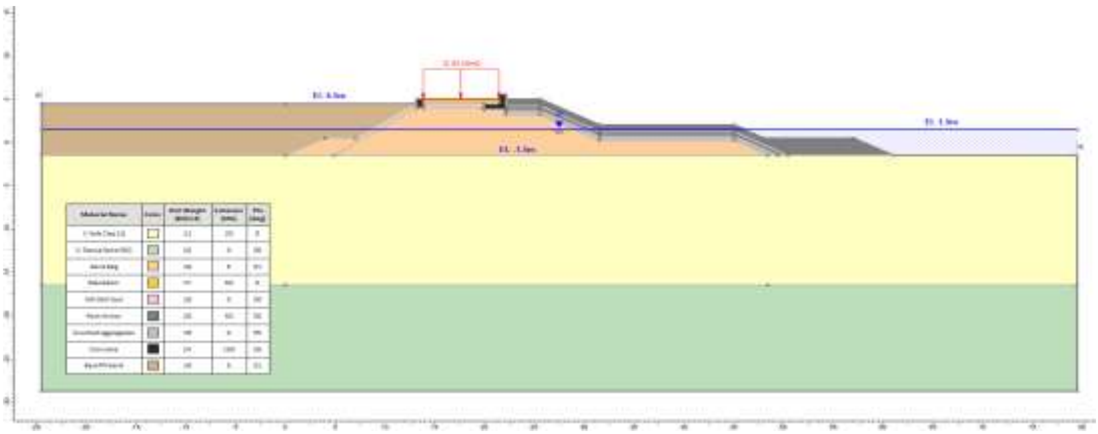


Figure 2.1-40. Slope Model of Island E Dike

Results of the Analysis

The following table presents the summary of the results of the slope stability analysis for Island E 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 2.1-42, 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 2.1-6. 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 ≈1.5 OK
2	Earthquake	0.20	0.10	0.542 < 1.1

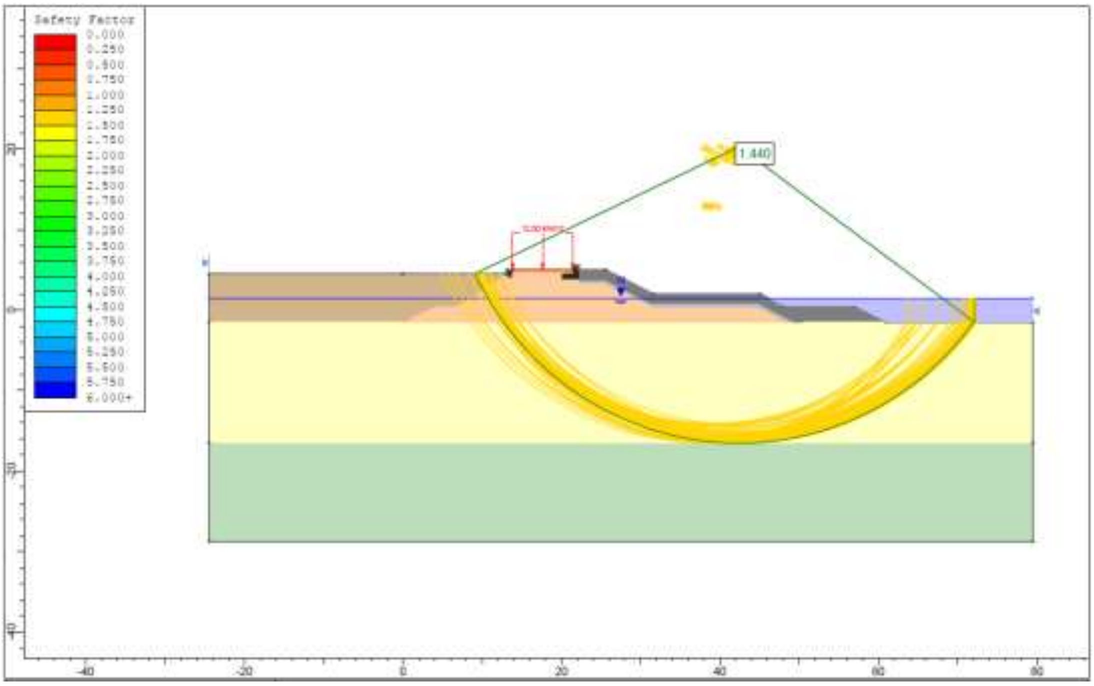


Figure 2.1-41. Case 1: Static (FoS=1.440)

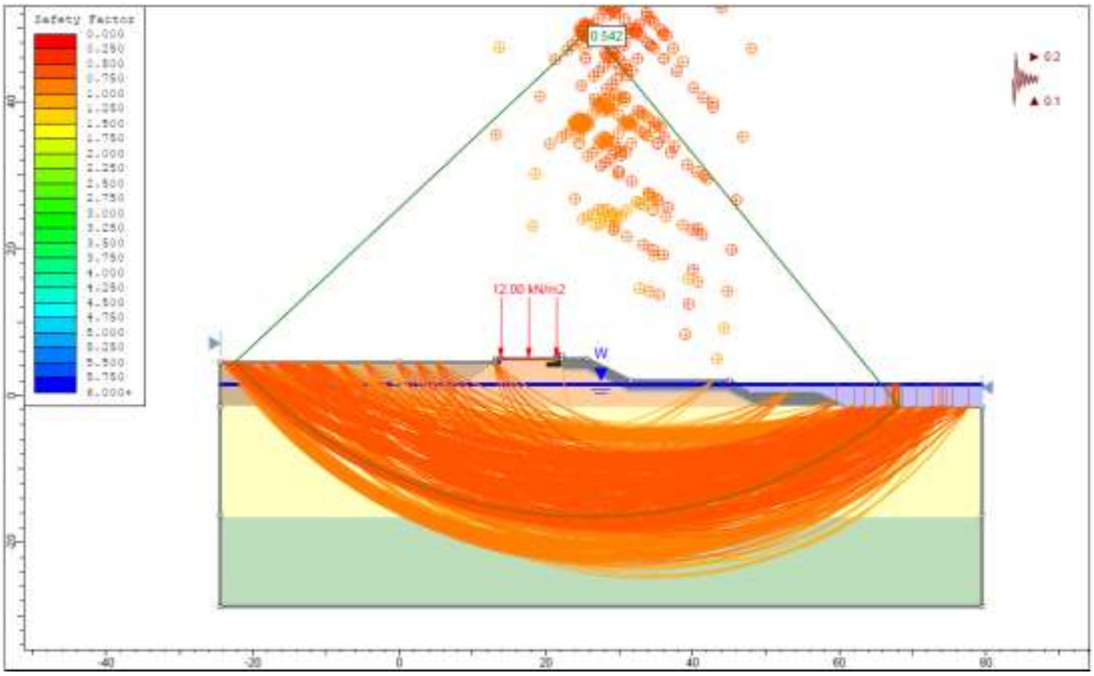


Figure 2.1-42. Case 1: Earthquake (FoS=0.542)

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.

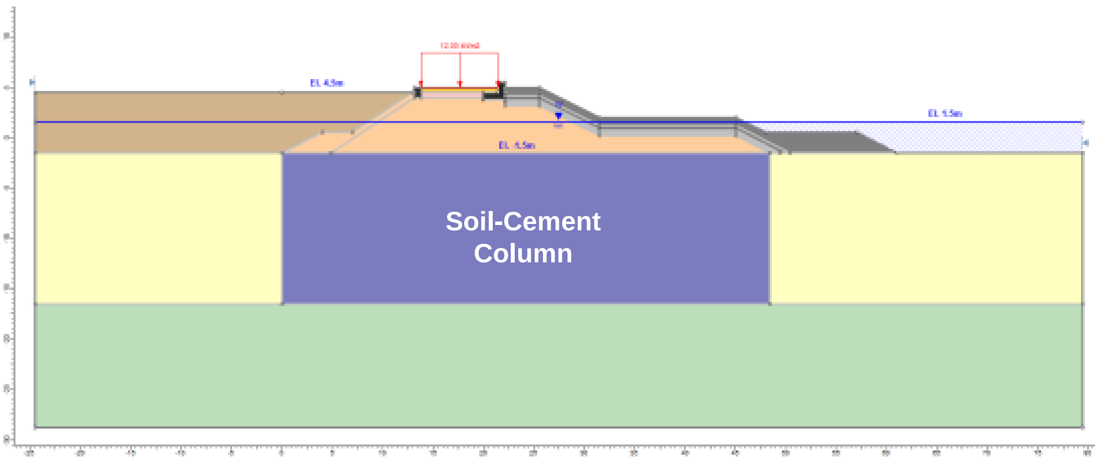


Figure 2.1-43. Slope Model with Soil Cement Column

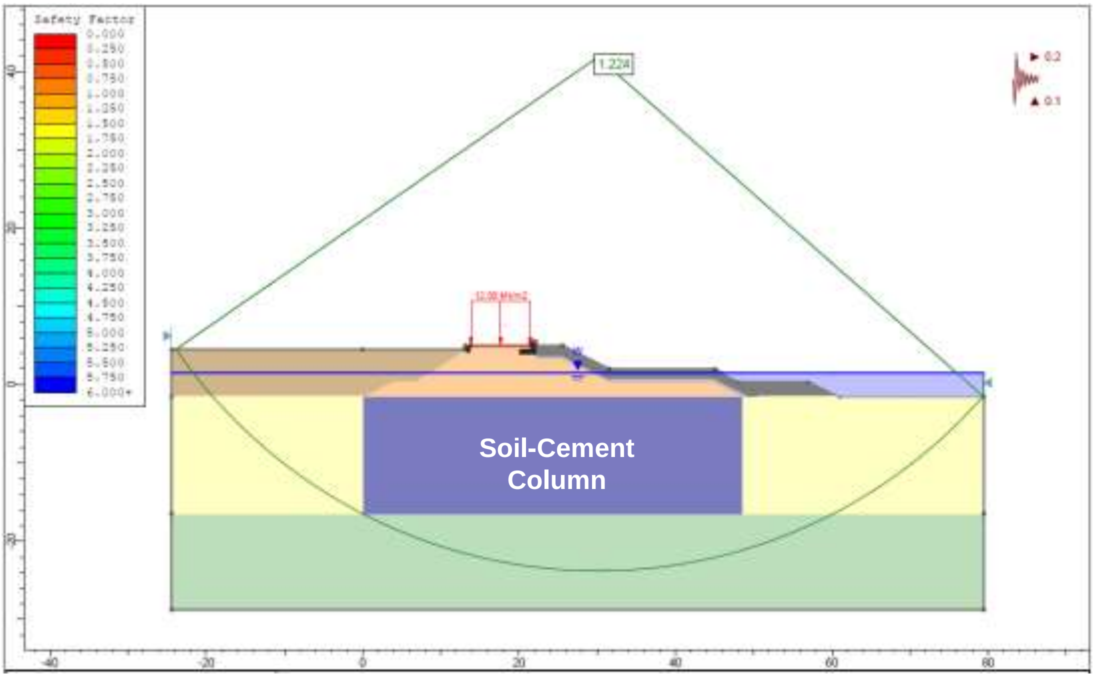


Figure 2.1-44. Case 2: Earthquake (FoS=1.224)

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.

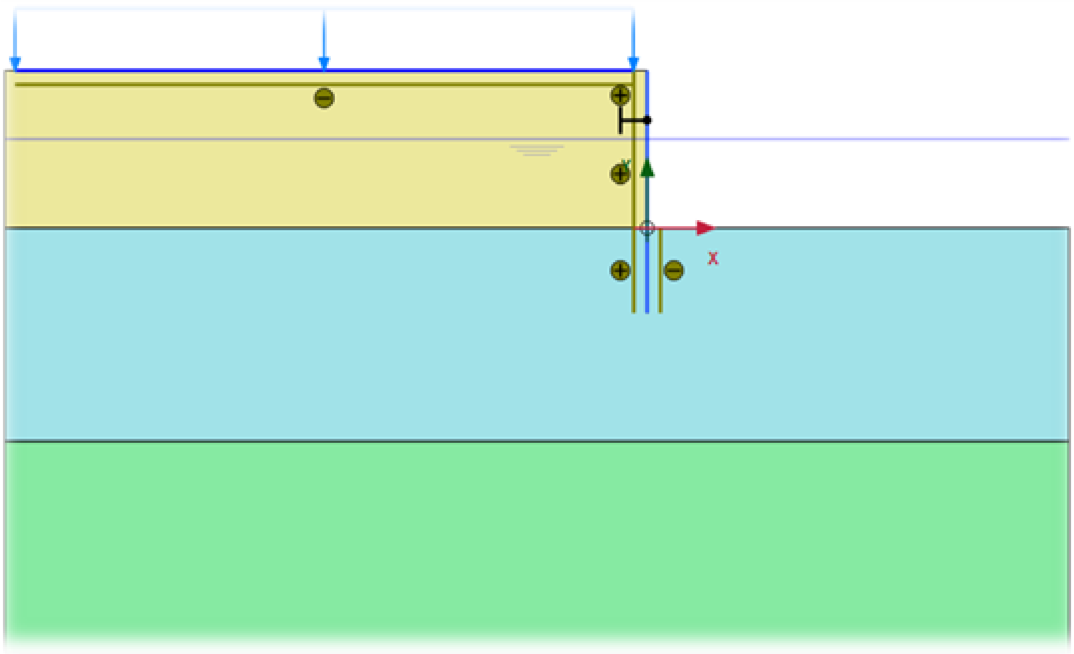


Figure 2.1-45. Plaxis Model

The following table summarizes the geotechnical parameters used:

Table 2.1-7. Geotechnical Parameters

Depth (m)	Soil Type	Unit Weight (kN/m^3)	Cohesion (kPa)	Angle of Friction (deg.)	Elastic Modulus (MPa)	Poisson's Ration (μ)
0.0 - 5.0	Clay	19	100	0	35	0.30
5.0 - 30.0	Sand	20	0	38	40	0.35

Results of Analysis

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

Table 2.1-8. 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?
12.50	19	57	PZC 37	13.80	95.9	Yes	552.673	Yes

**Displacement after compaction of backfill*

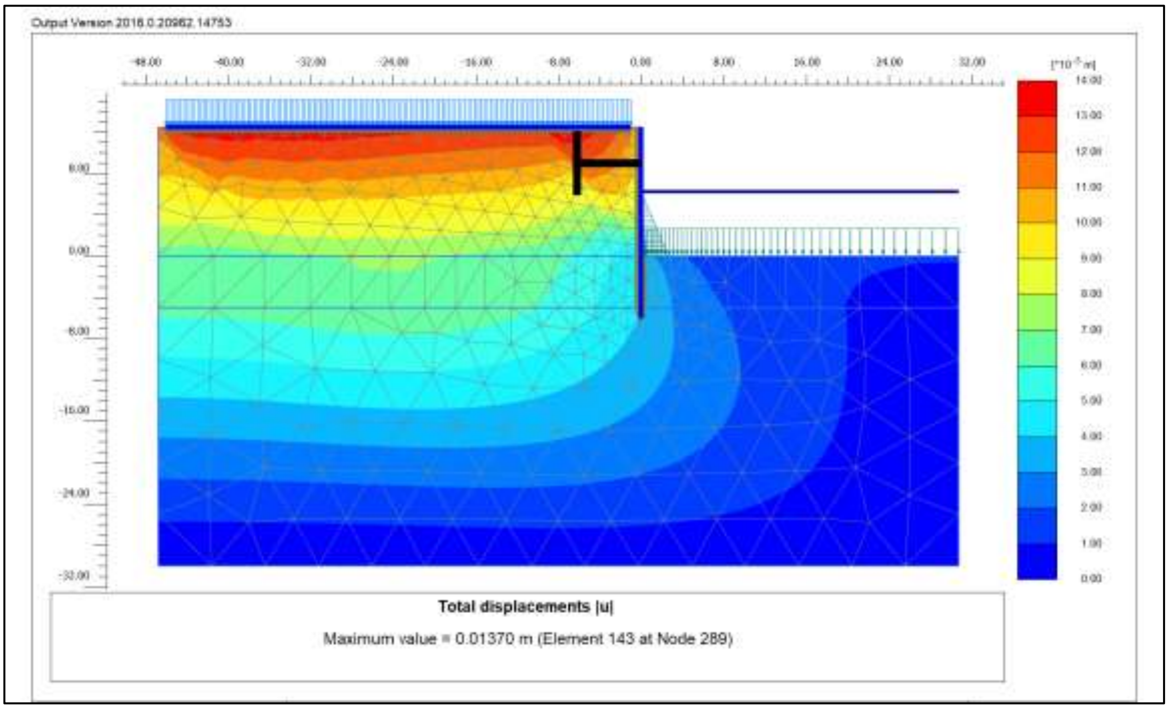


Figure 2.1-46. Plaxis Result – Total Displacement (Island E)

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 2.1-47. 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 is supposed to be 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. From the results of the soil investigation for Island E, the underlying soil consisted of hard clays (N-value > 30) and dense to very dense sands (N-value > 50). **Settlement (both immediate and long-term) for this type of soil is deemed negligible**. Thus, no numerical analysis was needed.

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 subsidence and 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 10 meters from the surface along the reclamation site makes the area a high-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).

As mentioned above, however, settlement (both immediate and long-term) for hard clays (N-value > 30) and dense to very dense sands (N-value > 50) that underlie the project site is deemed negligible.

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 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 there are no very loose to loose sands and very soft silts and clays (N-value < 10) inf the existing soil layer consist, deep foundation may not be much needed to carry the large loads and mobilize the high bearing capacities of the competent materials.

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. +4.00m 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 2.1-13 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 2.1-9. Summary of Allowable Pile Capacities for Concrete Bored Piles

Borehole No.	Width mm	Estimated Pile Length m	Compression kN	Uplift kN	Lateral kN
BH-31	600	13	525	410	210
		18	765	670	210
		23	1005	930	210
	800	13	775	580	375
		18	1095	935	375
		23	1415	1290	375
	1000	13	1060	765	590
		18	1220	950	590
		23	1860	1680	590

Borehole No.	Width mm	Estimated Pile Length m	Compression kN	Uplift kN	Lateral kN
BH-36	600	12	430	295	210
		17	965	520	210
		22	1270	715	210
	800	12	645	430	375
		17	1530	775	375
		22	2060	1110	375
	1000	12	900	580	590
		17	2155	1030	590
		22	2885	1500	590
BH-43	600	13	525	410	210
		18	765	670	210
		23	1005	930	210
	800	13	775	580	375
		18	1095	935	375
		23	1415	1290	375
	1000	13	1060	765	590
		18	1220	950	590
		23	1860	1680	590

Shallow Foundation Analysis

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 +4.00m (from MLLW) was considered. From the range of fill height required for the island, the depth of fill ranges from 6m to 9m, 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 2.1-10. Properties of sand fill for shallow foundation analysis

Ground Improvement	N-value	Unit Weight, g (kN/m^3)	Cohesion, c (kPa)	Friction Angle, ^{0}
Vibrocompacted sand fill	15	18	0	30

For the reclamation area, the safe bearing capacity is **90 kPa (≈1870 psf)** at a minimum foundation depth of 1.0m BGL (below ground level – reclaimed area at elev. +4.00m). For proportioning of various foundation widths and depths, allowable bearing capacity charts are presented in the graph below.

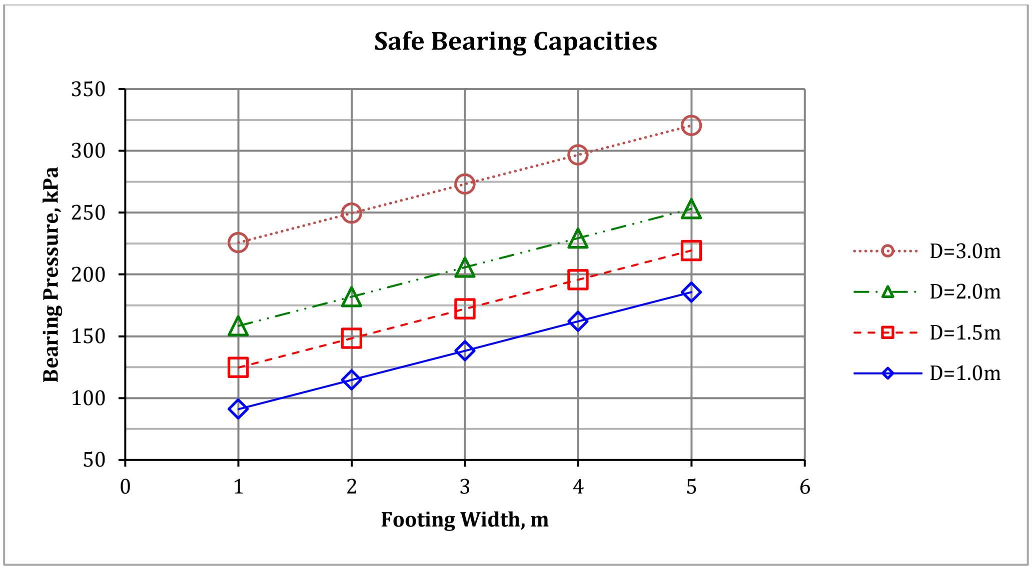


Figure 2.1-48. Safe bearing capacities for the reclamation area

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.

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 2.1-49 and 2.1-50) 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 2.1-51) by Project NOAH is consistent with the other two hazard maps. The whole Cavite Spit and the coastal areas from Bacoor 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: 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 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, Bacoor, 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)

The table below enumerates the recent typhoons that affected the Province of Cavite.

Table 2.1-11. 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	

Tropical Cyclone	Date of Occurrence	Maximum sustained winds (kt)	Population/Areas Affected	Impact
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 Ternate – 1 brgy, 64 fam, 315 Ind 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
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
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
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 PDH – 120
Typhoon Feria (Nangka)	June 22-27, 2009	45	3 mun, 8 brgy, 706 fam, 3,484 ind	TDH - 84 PDH - 5
Typhoon Frank (Fengshen)	June 18-26, 2008	95	12 mun, 166 brgy, 40,645 fam, 206,827 ind	TDH - 43 PDH –227
Typhoon Hana (Lekima)	Sep 30 - Oct 4, 2007	70	Rosario and Noveleta: 639 families.	TDH - 28 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
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
Typhoon Florita (Bilis)	13-Jun-06		7 mun, 45 brgy, 2,260 fam, 1,111 ind	TDH - 51 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	

Tropical Cyclone	Date of Occurrence	Maximum sustained winds (kt)	Population/Areas Affected	Impact
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.

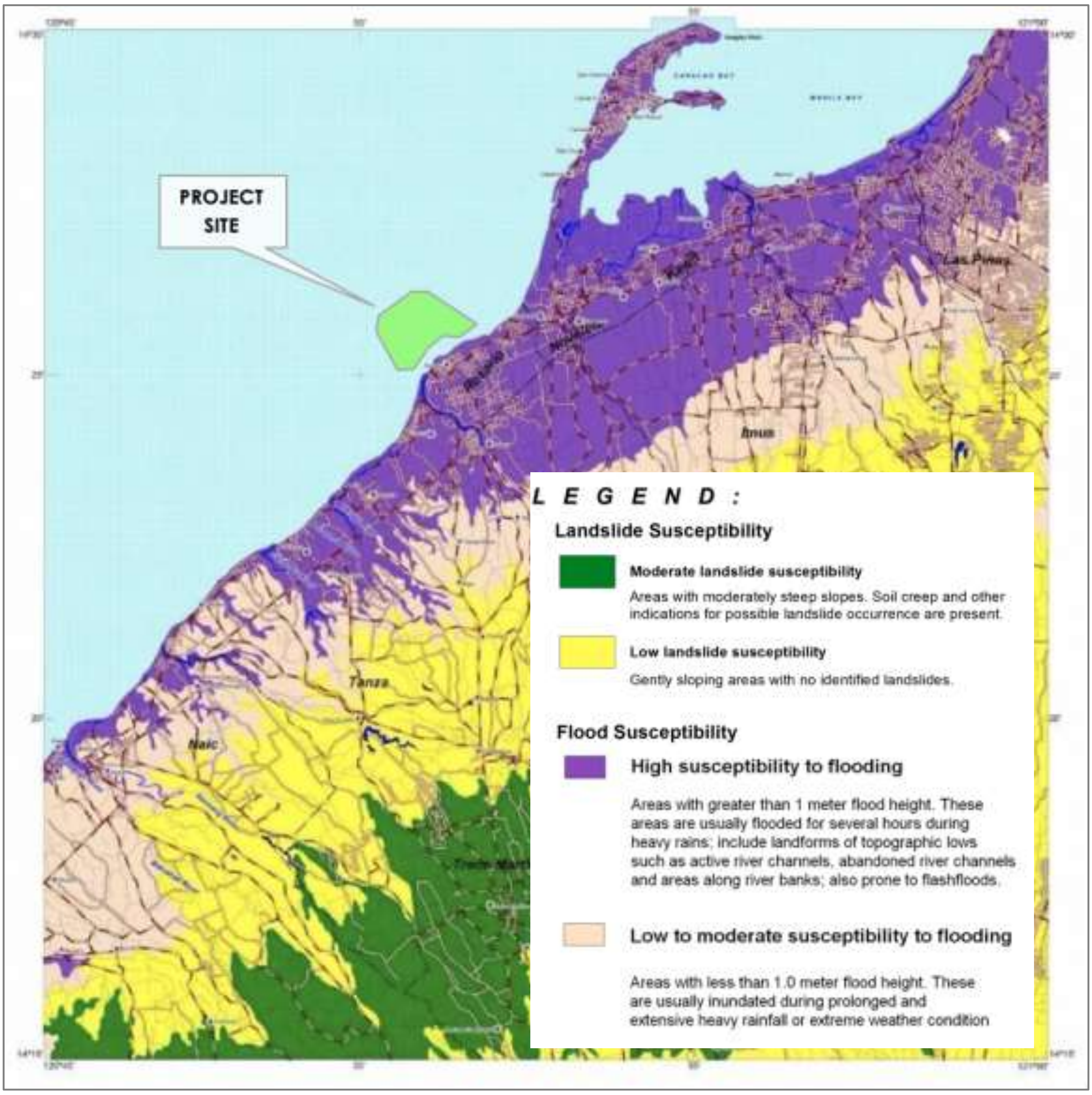
According to the PRA, well-designed and properly constructed reclamation projects will not cause flooding. On the contrary, they can prevent flooding by providing added protection, such as sea barriers to mitigate the effects of accelerated rising sea levels, which is a direct effect of global warming. 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

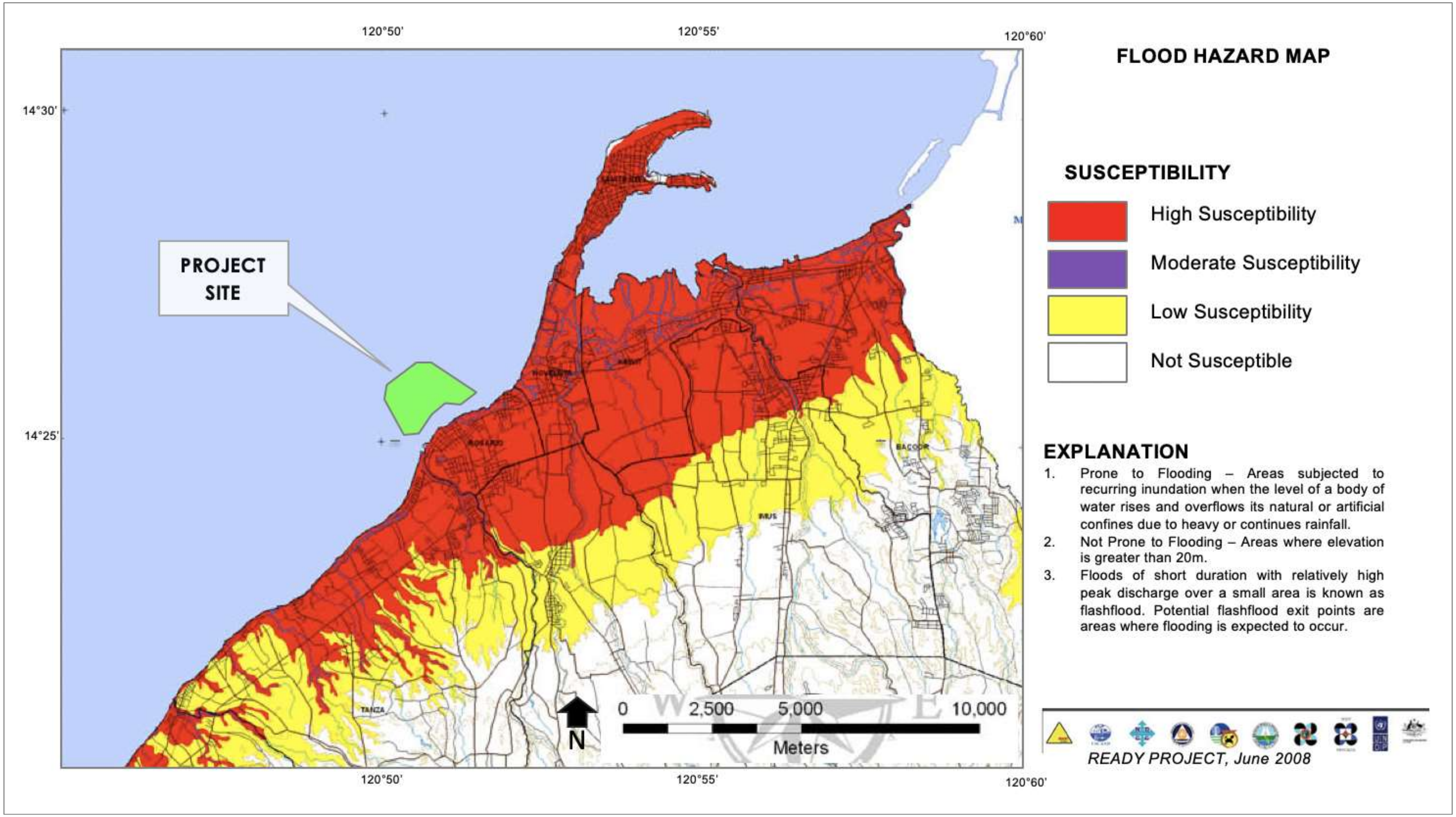
To help mitigate flooding, the engineering design of the reclamation should provide for adequate channels, drainages and runoff discharges to the open sea as well as non-blockage of river outfalls and other flood paths.

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.



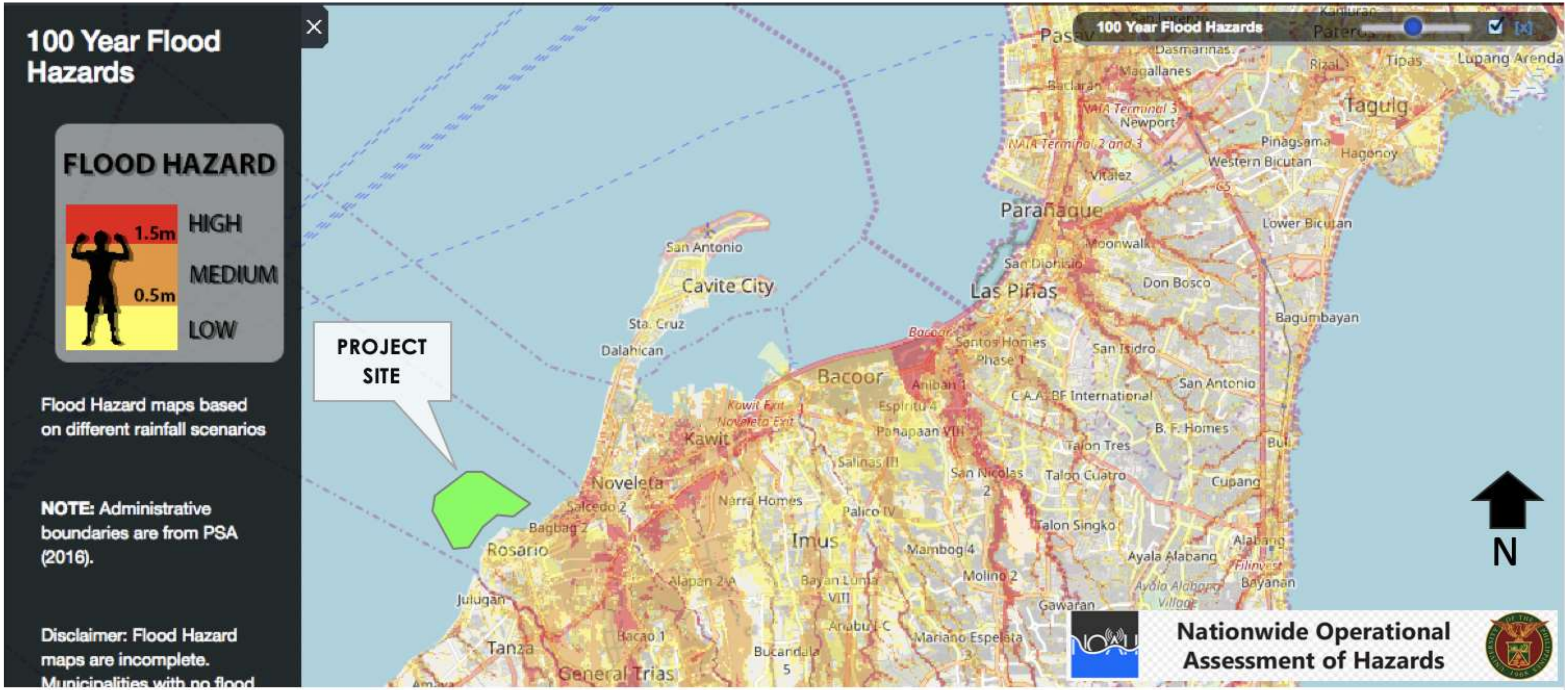
Source: MGB 2010 (from 1:50,000 base maps)

Figure 2.1-49. Landslide and Flood Susceptibility Map of Cavite City Quadrangle



Source: READY Project June 2008

Figure 2.1-50. Flood Hazard Map of Cavite



Source: UP Project Noah, screen captured on August 2017

Figure 2.1-51. 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 2.1-12 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.

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 Rosario 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 (PDRRMO, 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 2.1-12. Storm Surges in the Manila Bay Area and Vicinities

No.	Date of Occurrence	Associated Tropical Cyclone	Surge Height (m)	Affected Areas in Greater Manila Area	Casualties	Damage
1	June 29, 1589	Unnamed typhoon		Manila Bay		
2	Aug 29, 1863	Unnamed typhoon		Manila		Destroyed Bagumabayan 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

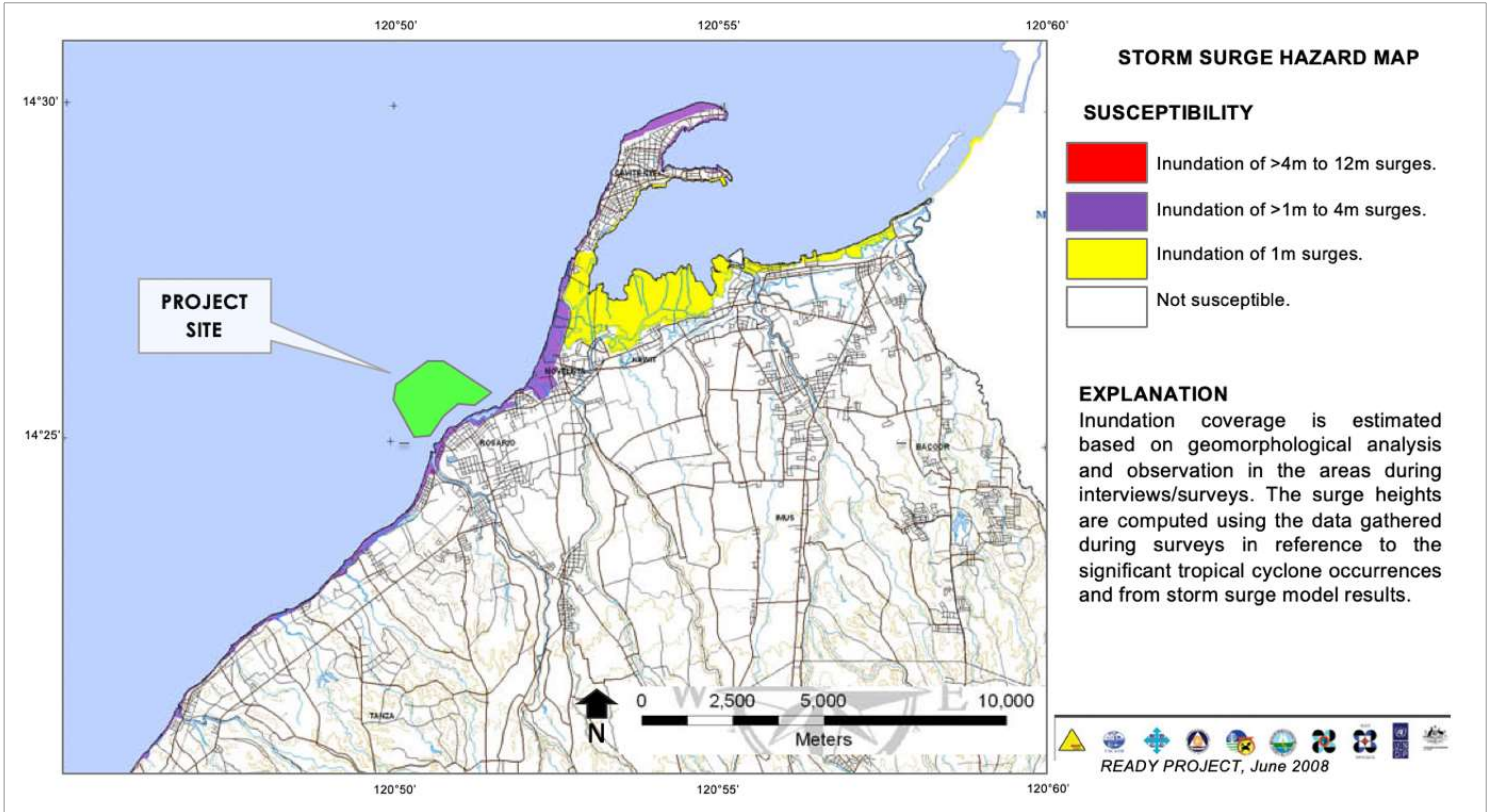
No.	Date of Occurrence	Associated Tropical Cyclone	Surge Height (m)	Affected Areas in Greater Manila Area	Casualties	Damage
7	Jun 23-25, 1972	Typhoon Konsing (Ora)		Manila Bay & Bicol region	1	Several ships washed ashore
8	Jul 2, 1983	Typhoon Bebeng (Vera)	4	Bataan & at least 10 villages in Manila Bay's 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	12	Damaged the breakwaters & seawall along Roxas Blvd
10	Jul 30-31, 2012	Typhoon Gener (Saola)		Ternate, Cavite		214 houses
11	Aug 22, 2013	Typhoon Maring (Trami)		Bgy Mabolo, Naic, Cavite		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 2.1-52 from READY Project while Figure 2.1-53 is the storm surge (advisory 2) map by UP NOAH.

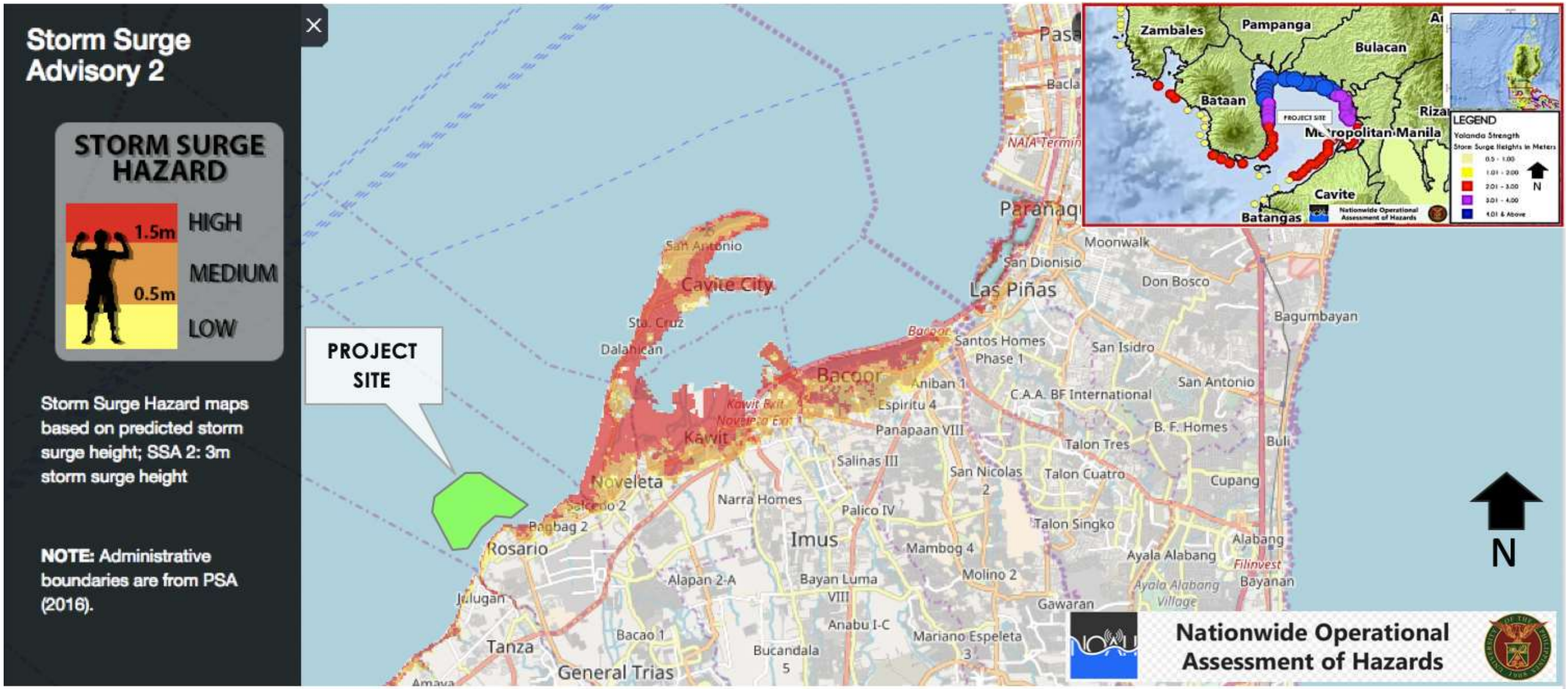
Climate change (global warming) has potential impacts on the frequency and strength of typhoons, and hence, on storm surge and storm waves. Rise in sea levels, spurred by climate change, will increase water depths and, by extension, wave heights in stormy weather. Even if the rise in sea level during 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 2.1-52. 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 2.1-53. Storm Surge Advisory 2 Hazard Map of Cavite and vicinities

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 2.1-53), it is clear that the areas behind MOA to CCP Complex are safe from this hazard.

For the proposed project site in Cavite, Island E will have a shielding effect on the coastal areas fronting the island. Reclaimed lands are in fact known to serve as massive breakwater.

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 **Section 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

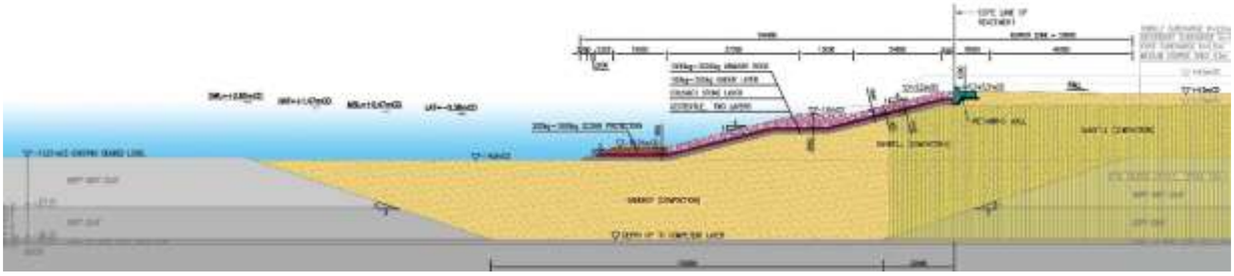
Structural defenses and infrastructure will be inspected periodically for integrity and soundness. Continuous monitoring of structural defenses should be implemented. Likewise, the Proponent should encourage awareness on all geohazards. Make use of the government’s alert systems such as those of PAGASA, MGB, PHIVOLCS, NOAH 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 project site has a competent seabed wherein very soft to soft silts and clays and very loose to loose sands (N-value < 10) are almost absent, and therefore, ground preparation may be limited to removal of solid wastes.

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 2.1-54.

The full factual report for the geotechnical drilling, including borehole logs is provided in **Annex 2.1-C**.

Base Map: 2020 Google Earth

Figure 2.1-54. 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 layer from 4.5m to 16.5m 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. It can be said that the seabed in the project site is generally stiff to dense without soft and loosed soil layers, and thus maybe considered as competent.

Table 2.1-13. Idealized Subsurface Conditions based on Results of Borehole Tests

Hole No.	Depth, m	Soil Description	SPT	Consistency / Relative Condition	γ	c (kPa)	ϕ (o)	k_h (kPa/m)
BH-31	0.0 – 4.5	ML / CL / MH	25	Very Stiff	19	155	0	18600/B
	4.5 – 30.0	SM / MH / CL / SC-SM / ML	39	Hard	20	192	0	23000/B
BH-36	0.0 – 16.5	ML / CL / MH	30	Very Stiff	19	192	0	23000/B
	16.5 - 21.0	SM	44	Dense	19	0	39	69300/B
	21.0 – 24.0	SM/MH	57	Very Dense	20	0	40	126000/B
	24.0 – 30.0	MH/ML	60	Hard	20	192	0	23000/B
BH-43	0.0 – 4.5	ML / CL / MH	25	Very Stiff	19	155	0	18600/B
	4.5 – 30.0	SM / MH / CL / SC-SM / ML	39	Hard	20	192	0	23000/B

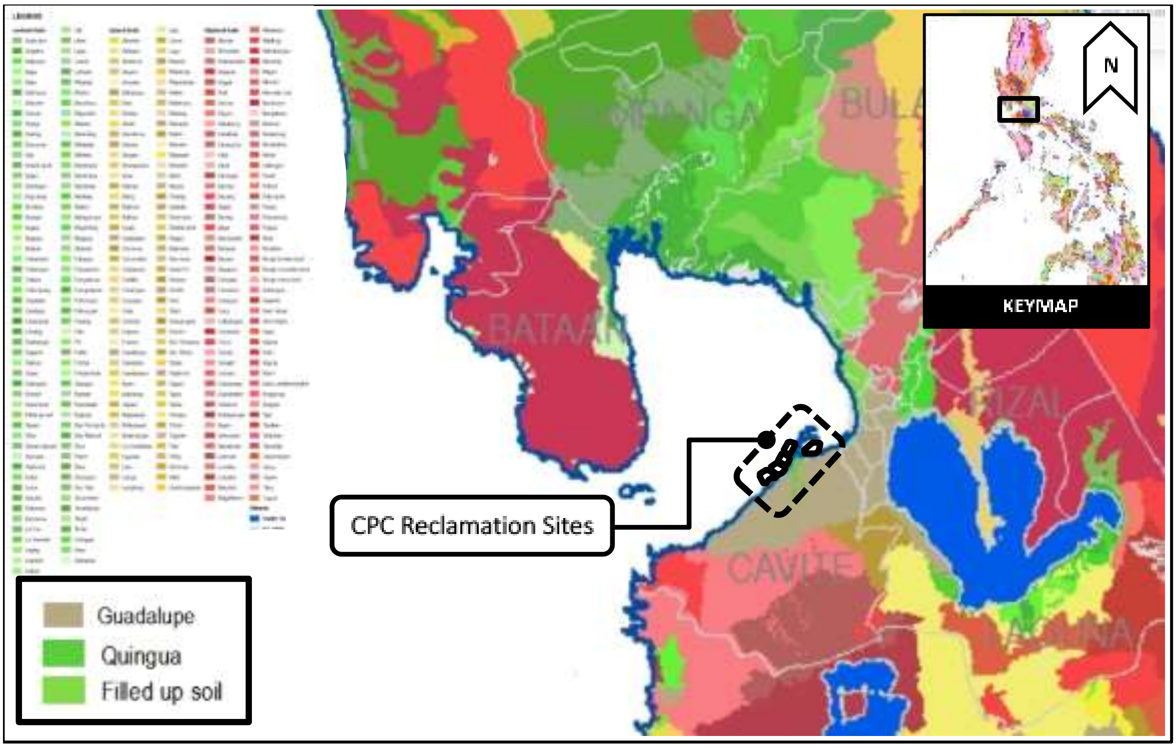
There is no soft soil layer in the project area. Therefore, the range of depth required to fill the reclamation area up to elevation +4.00m above Mean Low Low Water (MLLW) is **6 to 9 meters** only. Since there are no available data on elevations of the tide and seabed in the area of the project site, 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 residium, 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: BSWM

Figure 2.1-55. Clipped Philippine Soil Series Map

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 food plains or much of it is deposition 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^3 of soil or 1000 m^3 of ground water.

Table 2.1-14. The Dutch Target/Intervention Values

	EARTH/SEDIMENT (mg/kg dry matter)		
	National Background Concentration (BC)	Target Value (incl BC)	Intervention Value
Metals			
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 2018for the Bacoor Reclamation and Development Project of the Bacoor City LGU. The laboratory tests were done by CRL Environmental Corp. These samples are within Bacoor 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 Cavitex 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 2.1-57.

The test results from TCSI and Filipinas Dravo are listed in Table 2.1-18 while the IEMP-MB data are separately provided (Table 2.1-19).

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 2.1-57a below while the test results are in Table 2.1-17. Based on the quality of sediments for Island E, 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 2.1-56. Seabed Sediment Sampling Location Map

Table 2.1-15. 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
Test Methods	ICP-OES	Flame AAS	Flame AAS	Manual Cold Vapor AAS	DCM (SM3500-Cr-B)	EPA 9045D		
MDL	0.4	0.2	1	0.1	0.1	0.1		
BH-10	2	0.8	23	<0.1	<0.1	7.1	08/05/2018	10/15/2018
BH-11	2.3	0.8	26	<0.1	<0.1	6.8	08/07/2018	10/15/2018
BH-12	2.3	0.8	22	<0.1	<0.1	6.9	08/04/2018	10/15/2018
BH-14	5.5	0.8	9.9	<0.1	<0.1	7.7	07/29/2018	10/15/2018
BH-15	3.4	0.5	5.3	<0.1	<0.1	7.7	07/27/2018	10/15/2018
SS1	2	<0.2	15	<0.1	<0.1		06/12/2018	7/31/2018
SS2	1.9	<0.2	9.7	<0.1	<0.1		06/12/2018	7/31/2018
SS4	3.1	<0.2	22	<0.1	<0.1		06/12/2018	7/31/2018
1A	3	<0.2	30	<0.1	<0.1		06/12/2018	7/31/2018
2A	1.9	0.3	22	<0.1	<0.1		06/12/2018	7/31/2018
5A	1.7	0.6	19	<0.1	<0.1		06/12/2018	7/31/2018
10A	4.8	<0.2	28	<0.1	<0.1		06/12/2018	7/31/2018
16A	2.1	0.4	20	<0.1	<0.1		06/12/2018	7/31/2018
SED1		1.2	23		<0.1		08/03/2017	10/08/2018
SED2		0.8	28		<0.1	7.1	08/03/2017	10/08/2018
SED3		0.3	27		<0.1		08/03/2017	10/08/2018
SQ1	<0.10	<0.015	<0.05	<0.60			01/25/2018	2018
SQ4	<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, titatium, copper, aluminum and iron are the metallic elements that appear higher than in other areas.

To estimate the anthropogenic impact on sediments, Olivares et al (2019) calculated a normalized EF for metal concentrations relative to the reference environment (Table 2.1-17). The EFs obtained for many elements (< 2) fall under deficient or minimal enrichment, implying that these elements are depleted relative to crustal abundance in the area. However, some samples exhibited EF values classified to have moderate and significant enrichment (2 – 5 and 5 – 20, respectively) and may reveal sediment contamination. These values are highlighted accordingly in the said table. (*Olivares, R.R., et.al., June 18, 2019)*

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 2.1-57. Surface Sediment Sampling (Feb 10-11, 2005) Location Map

Table 2.1-16. Test Results for Seabed Sediments (2005)

Element Conc. (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

Element Conc. (ppm)	Sampling Station								
	1	2	3	4	5	6	7	8	9
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

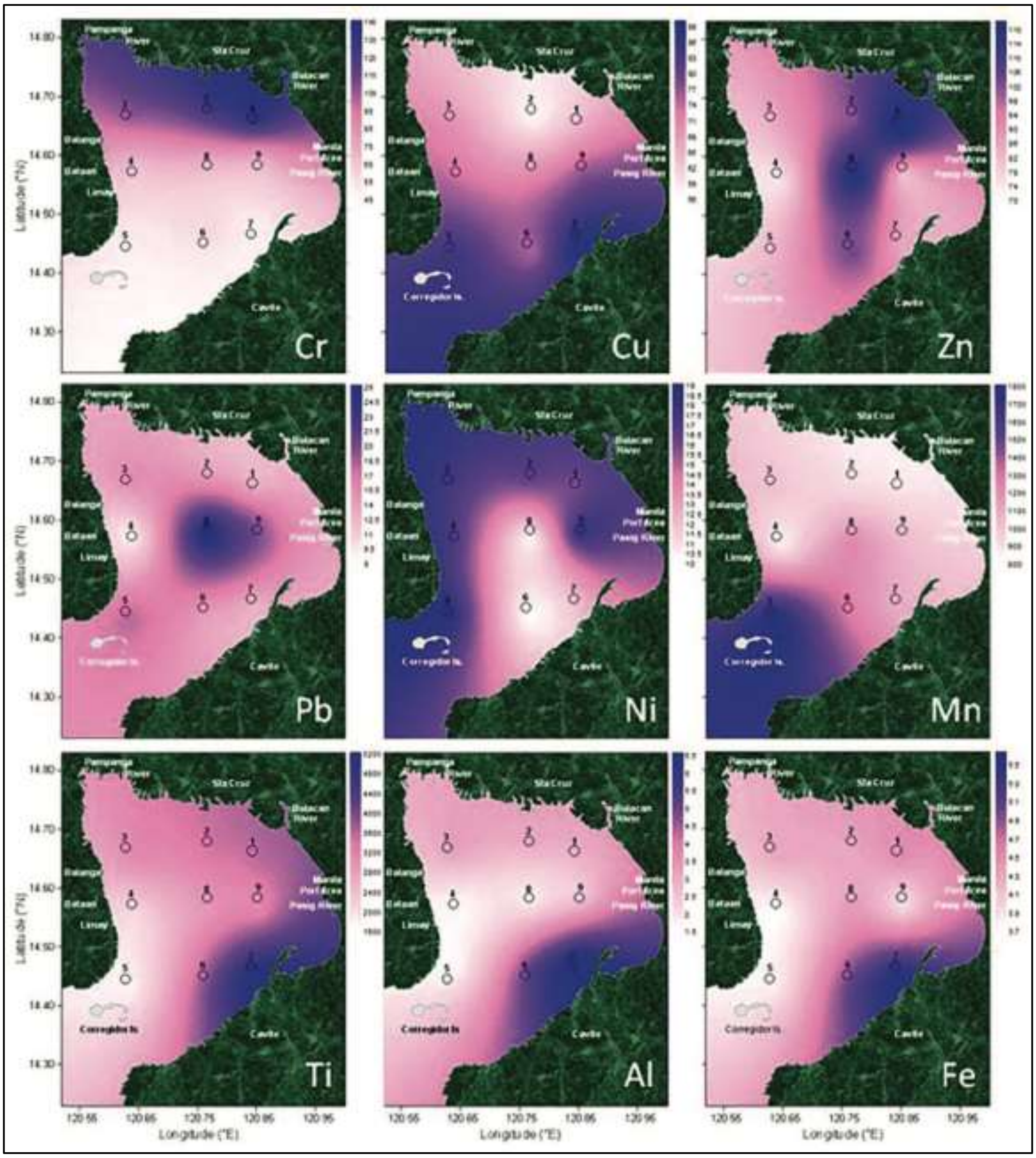
Table 2.1-17. Sediment Sampling Result, June 24, 2020

Sample ID	Arsenic (As) (mg/kg)	Cadmium (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	Cr +6 (mg/kg)	pH	Date Sampled	Date Reported
Test Method	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		
SE1 N 14°24’13.86” E 120°51’52.94”	6.1	1.0	10	ND	ND	8.1	06/24/2020	7/6/2020
SE2 N 14°25’35.36” E 120°50’28.73”	6.3	1.1	19	ND	ND	8.0	06/24/2020	7/6/2020

Source: CRL Environmental Corporation, July 6, 2020

Source: Base Map: 2020 Google Earth

Figure 2.1-57a Sediment Sampling Station, 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 2.1-58. 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 Ecology**.

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 onshore 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 2.1-18. Impact Management and Monitoring – Land Resources

IMPACTS	MANAGEMENT	MONITORING
PRE- CONSTRUCTION PHASE		
Not Applicable. The activities at sea which are largely survey works have been completed.		
CONSTRUCTION PHASE		
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 onshore according to RA 9003. No garbage disposal to the Manila Bay.	Inventory of solid wastes, principally garbage through records of amount of garbage disposed onshore.
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	

IMPACTS	MANAGEMENT	MONITORING
	reclamation fill from project handover to the end of 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.

SECTION 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 (GMMA)

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^2 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.

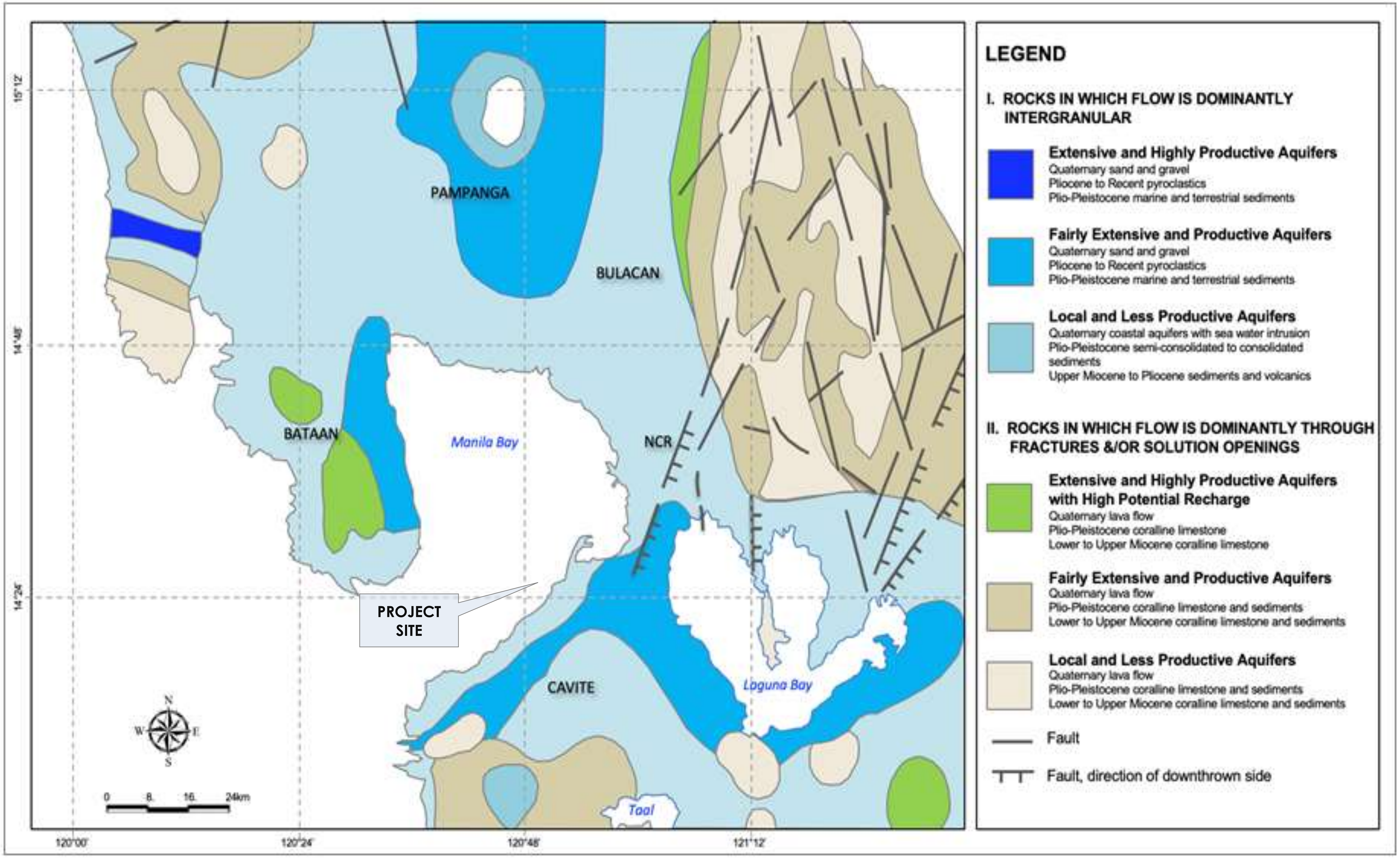


Figure 2.2-1. Regional Hydrogeologic Map

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

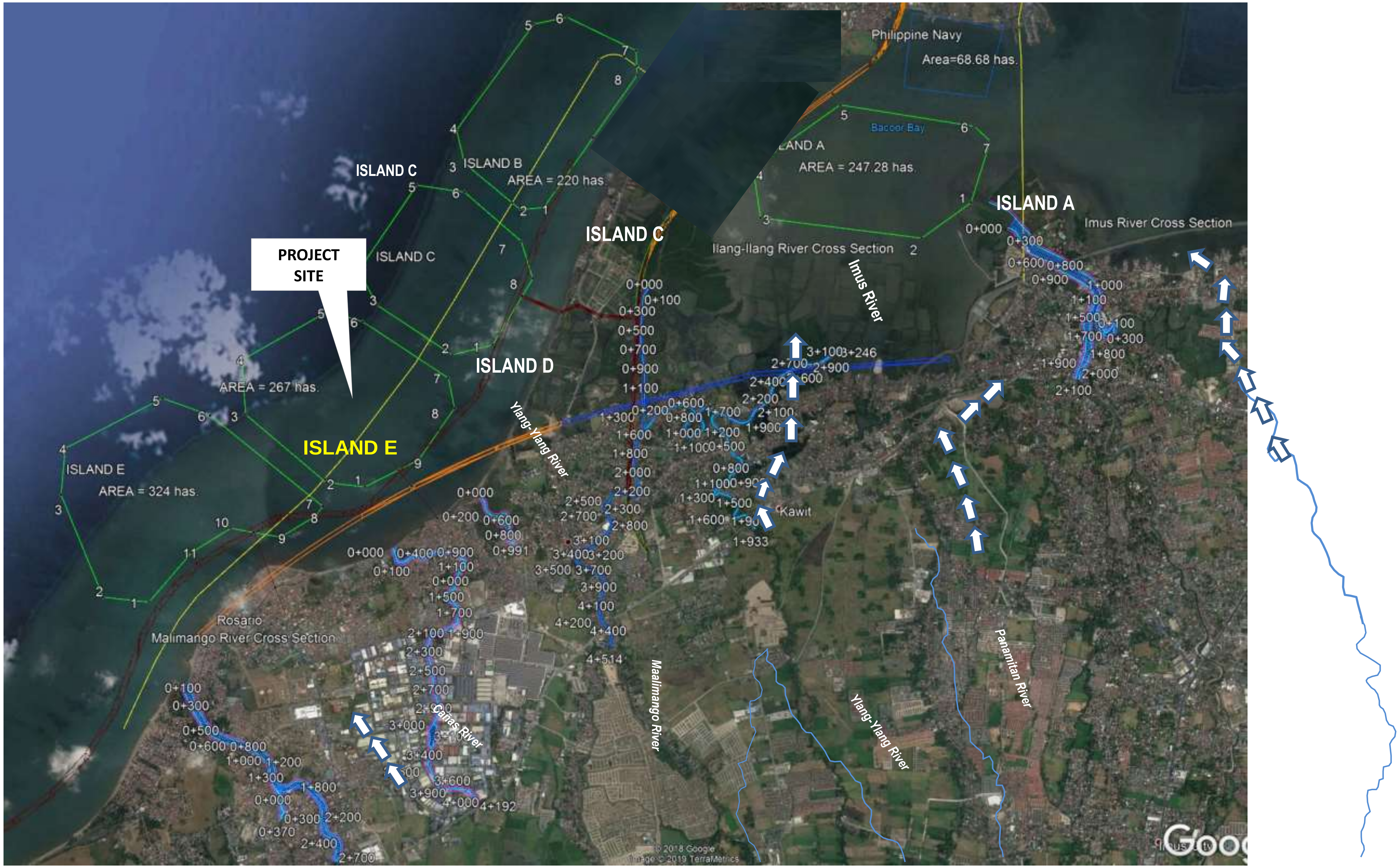
There are no bodies of freshwater, natural or manmade, the latter in the case of manmade drainage channels or canals that are located within Island E.

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 2.2-2 shows the rivers adjacent to Island E and to the other islands of the total project (islands A, C, and D) 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.

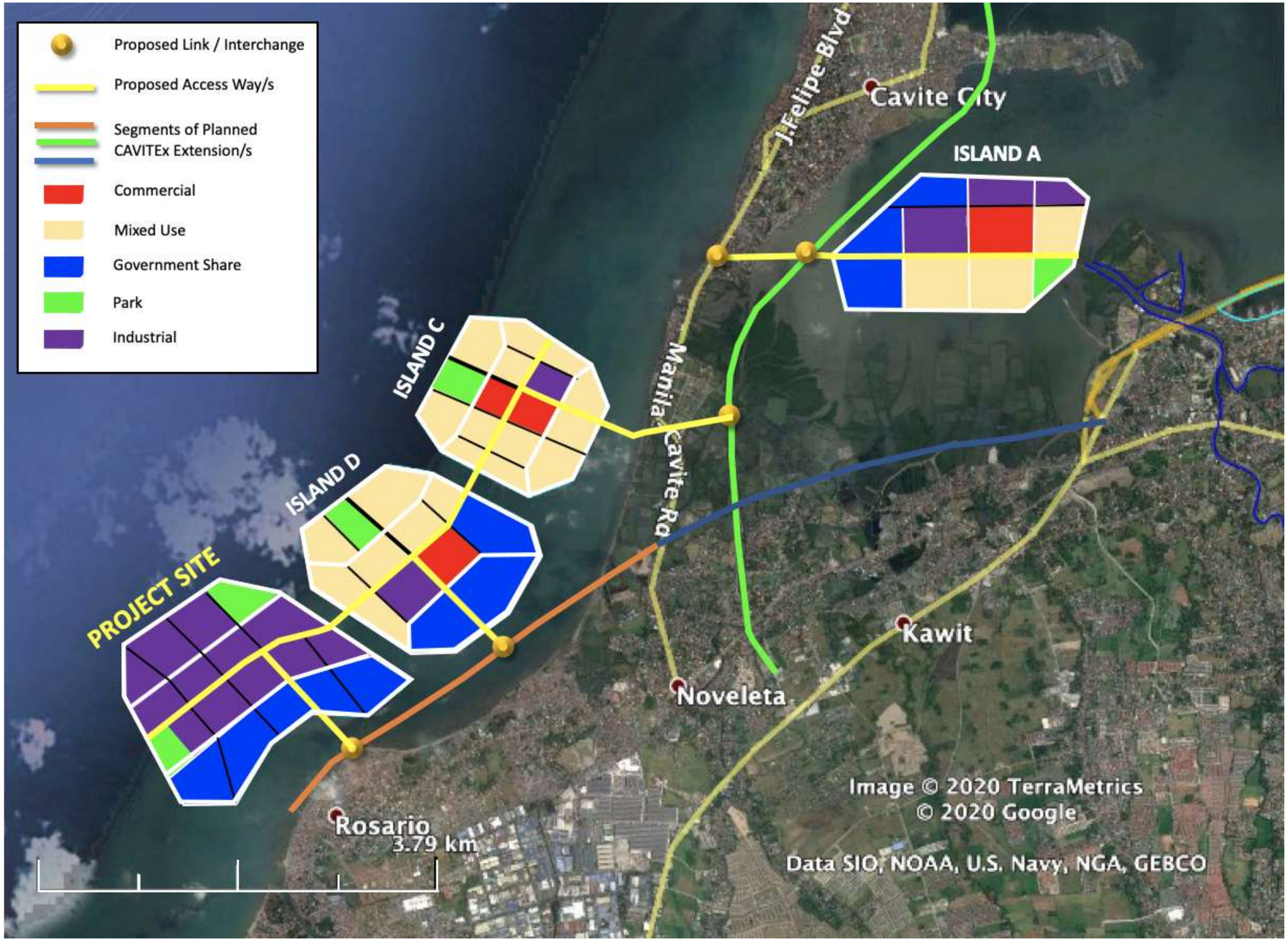
Plate 2.2-1 is an initial conceptual master development plan for Island E and all the other Islands wherein may be gleaned that the landform is distant from the shore at which the existing drainage systems are located.



Source: Actual survey of project sites and waterways plotted on Google Earth. Arrows indicate flow direction.

Figure 2.2-2. Map Showing the Project (Island E) as well as the adjacent other projects (Islands A to D) in relation to existing surface waters.

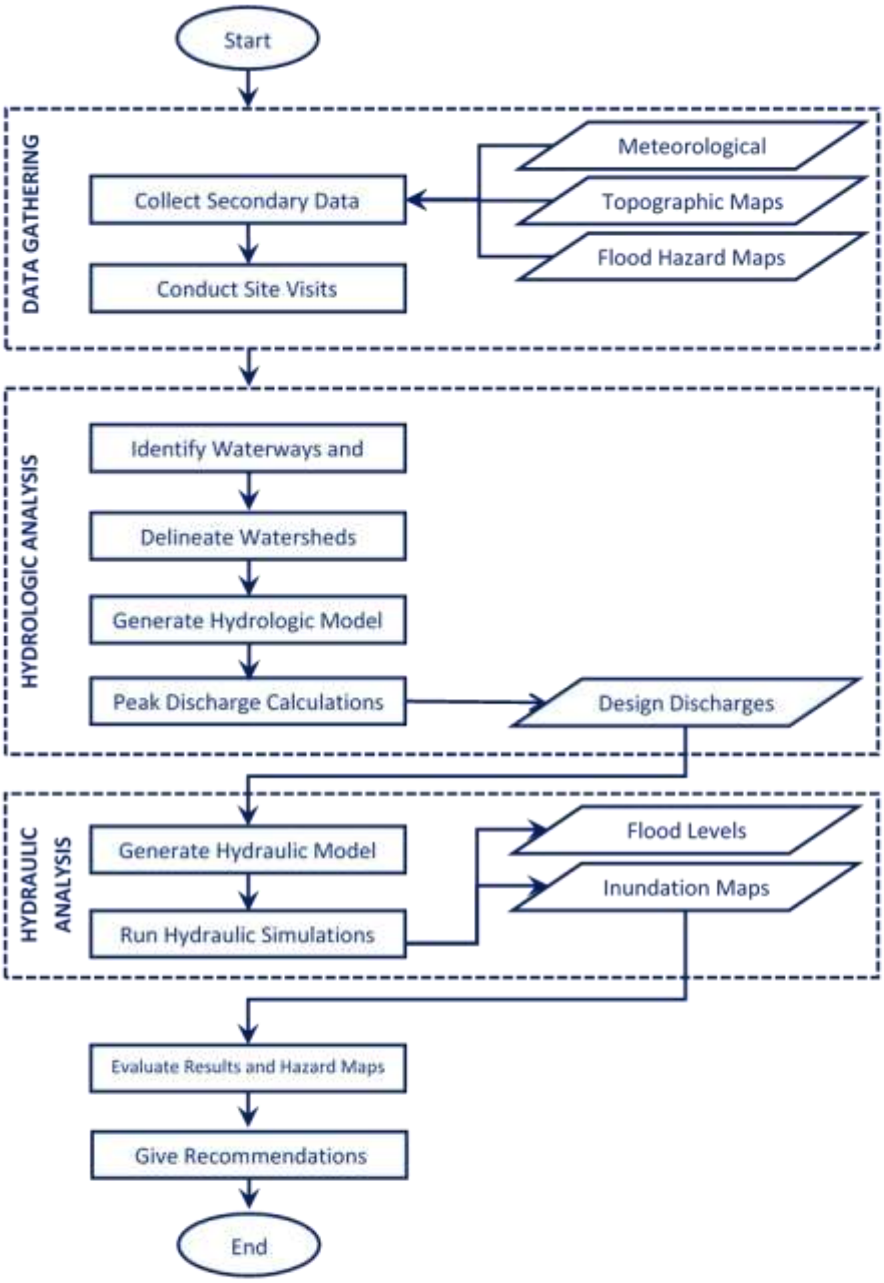
Plate 2.2-1. Initial Master Development Plan for Island E and other Islands (A, C & D)



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.

Existing Waterways

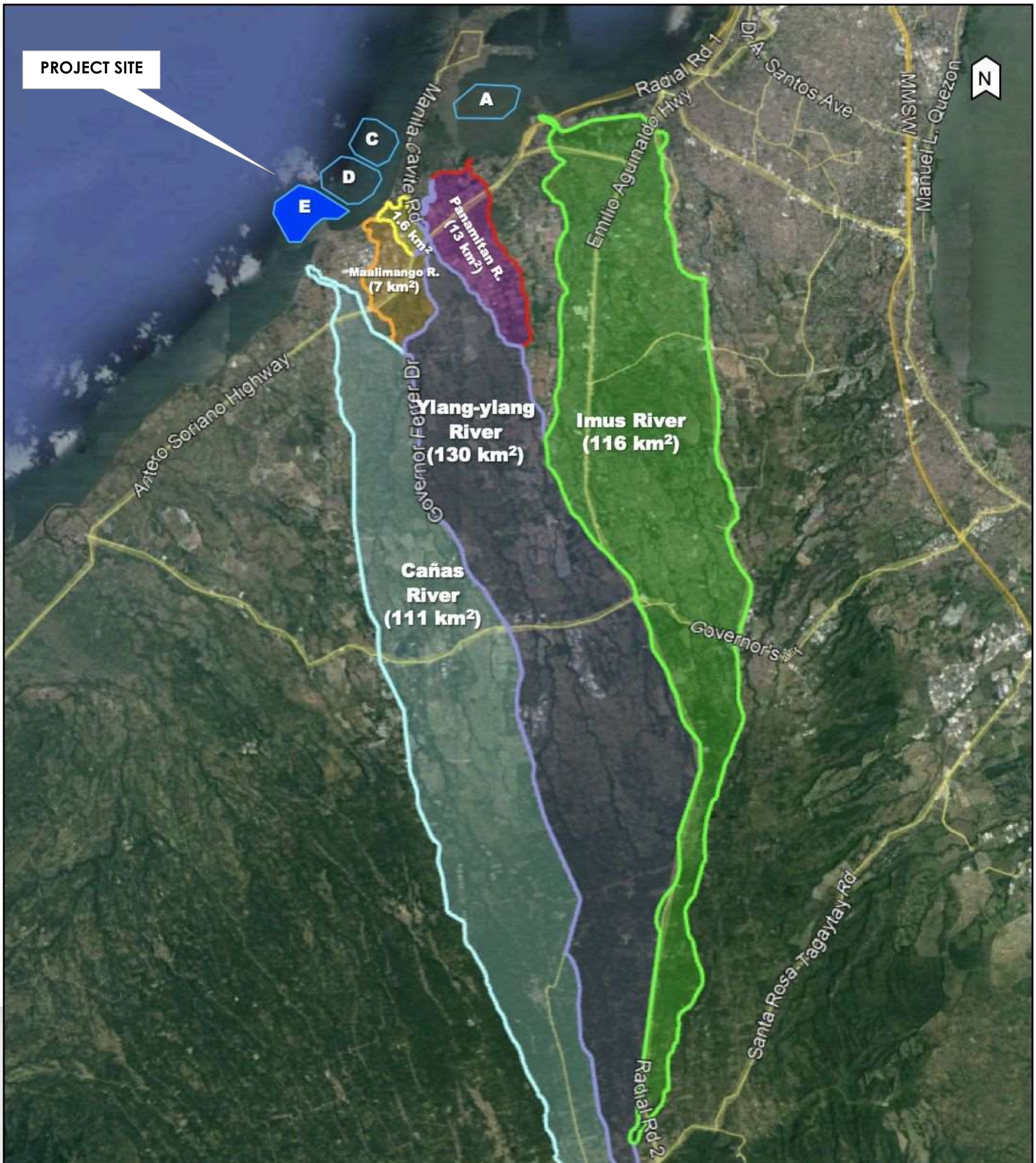
Cañas River drains to Manila Bay, and is about 850m to the south of Island E. Maalimango River and an unnamed tidal creek also drain into Manila Bay. The outfalls of Ylang-Ylang River, Panamitan River, and Imus River are located on the lee side of Cavite Spit, in Bacoor Bay near Island A. There are other small waterways which also drains to the coast near the same island, traversing the fishing pond areas south of the 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 2.2-3. Catchment Delineation of Waterway Discharge Points Near the Reclamation Site

Soil Map

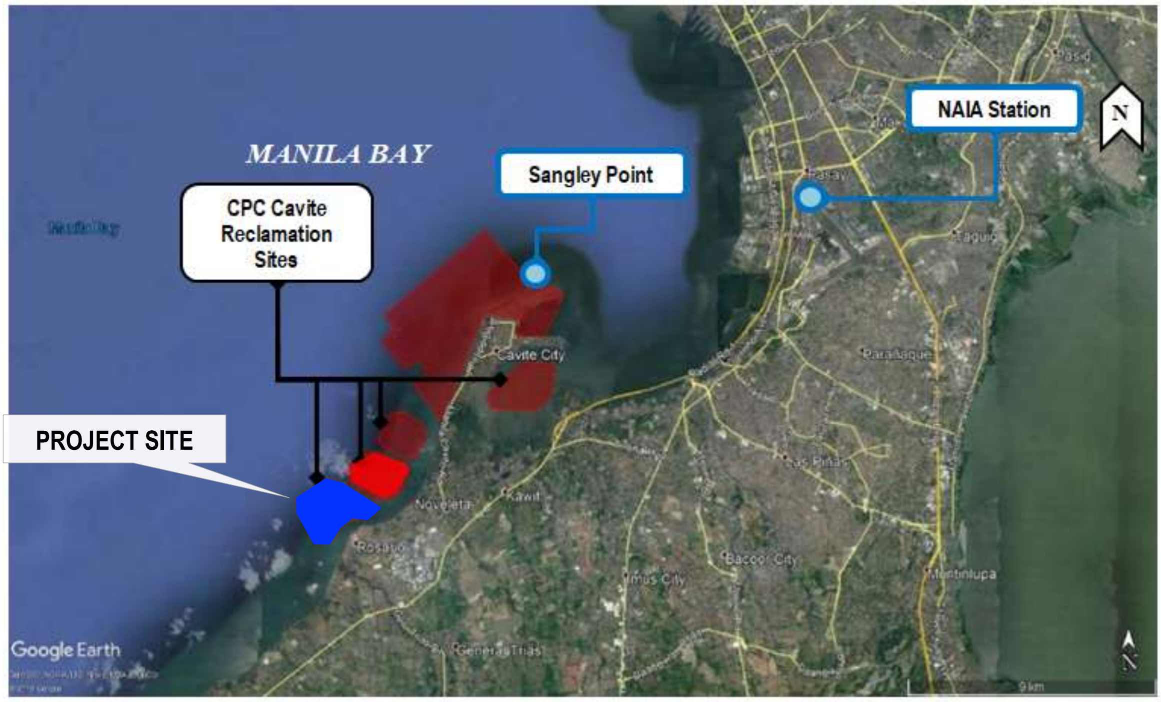
Discussion and maps for soil are presented under **Chapter 2.1.4. Pedology**.

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 residium, 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 2.2-4. Nearest RIDF Stations (Source: Google Earth)

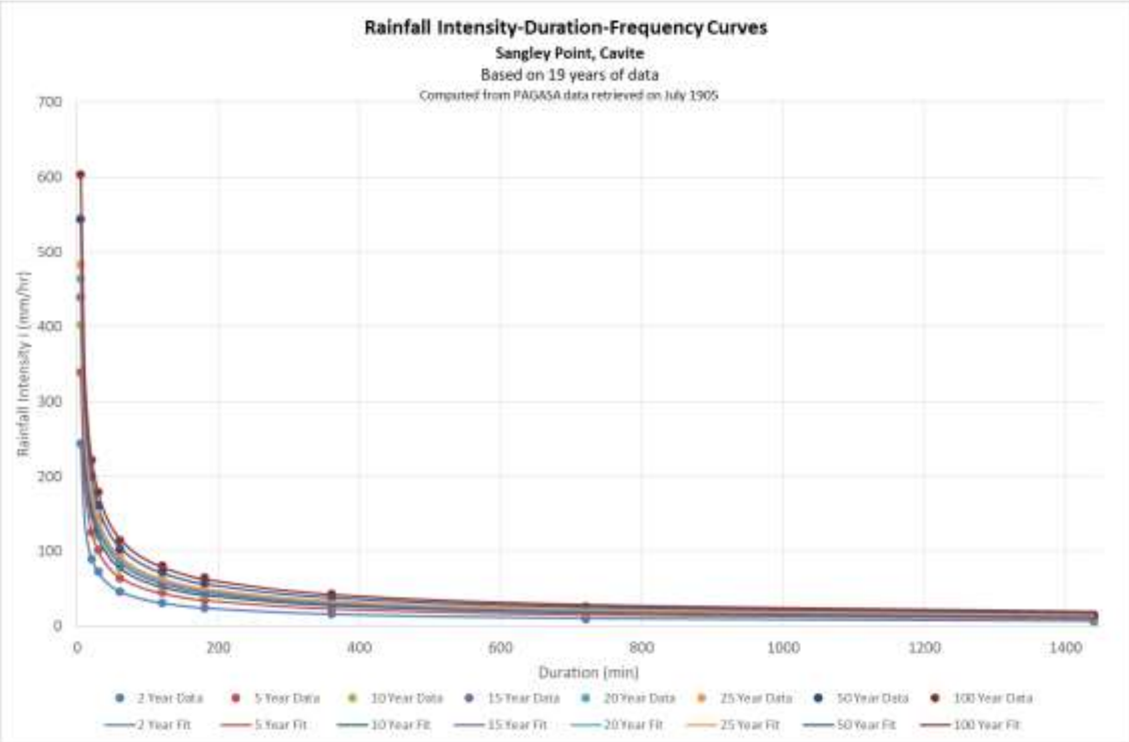
The RIDF Data (**Table 2.2-1**) is a tabulation of the rainfall depth (or equivalent rainfall intensity) corresponding to a selected storm duration and return period. These values are based on probabilistic analysis on the rainfall data collected for an extensive period of time.

Table 2.2-1. Recorded Extreme Values of Precipitation (in 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

Return Period (yr)	5 Min	20 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr
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



Source: PAGASA Sangley Point Station

Figure 2.2-5. 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.

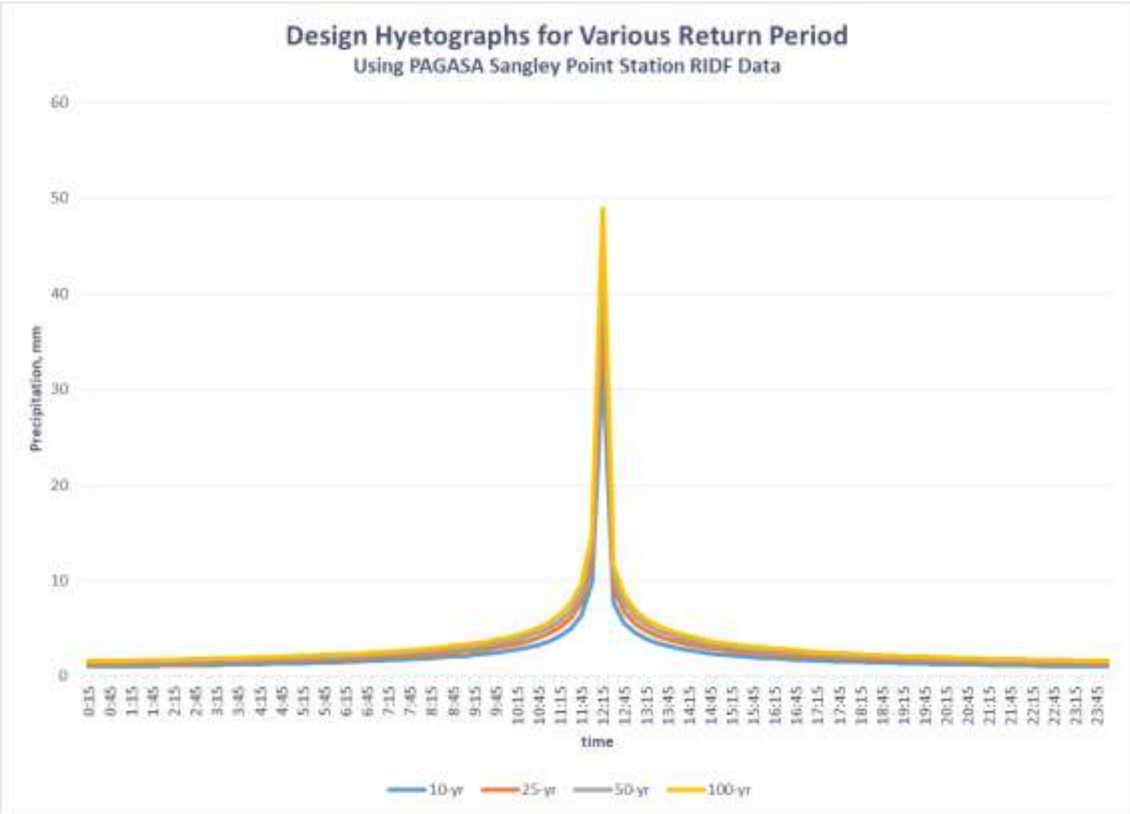
For large catchment areas, rainfall of an extreme precipitation event is unlikely to be distributed uniformly over all subbasins. An area reduction factor may be applied to reduce the point rainfall and use the value as the basin rainfall depth. This can be calculated using the Horton's Formula:

$$r = r_o e^{[-0.1(0.386A)^{0.31}]}$$

Where

r	=	basin mean rainfall (mm)
ro	=	point rainfall (mm)
A	=	catchment area (km^2)

The final design hyetograph for various return periods are presented in the figure below.



Source: PAGASA Sangley Point Station

Figure 2.2-6. 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 (mm)	No. of RD	Max (^0C)	Min (^0C)	Mean (^0C)	Dry Bulb (^0C)	Wet Bulb (^0C)	Dew Pt. (^0C)	Vapor Pressure (mbs)	Rel. Hum. %	MSLP (MBS)	DIR (16 pt)	SPD (mps)	Cloud (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	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	10-24-1988	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

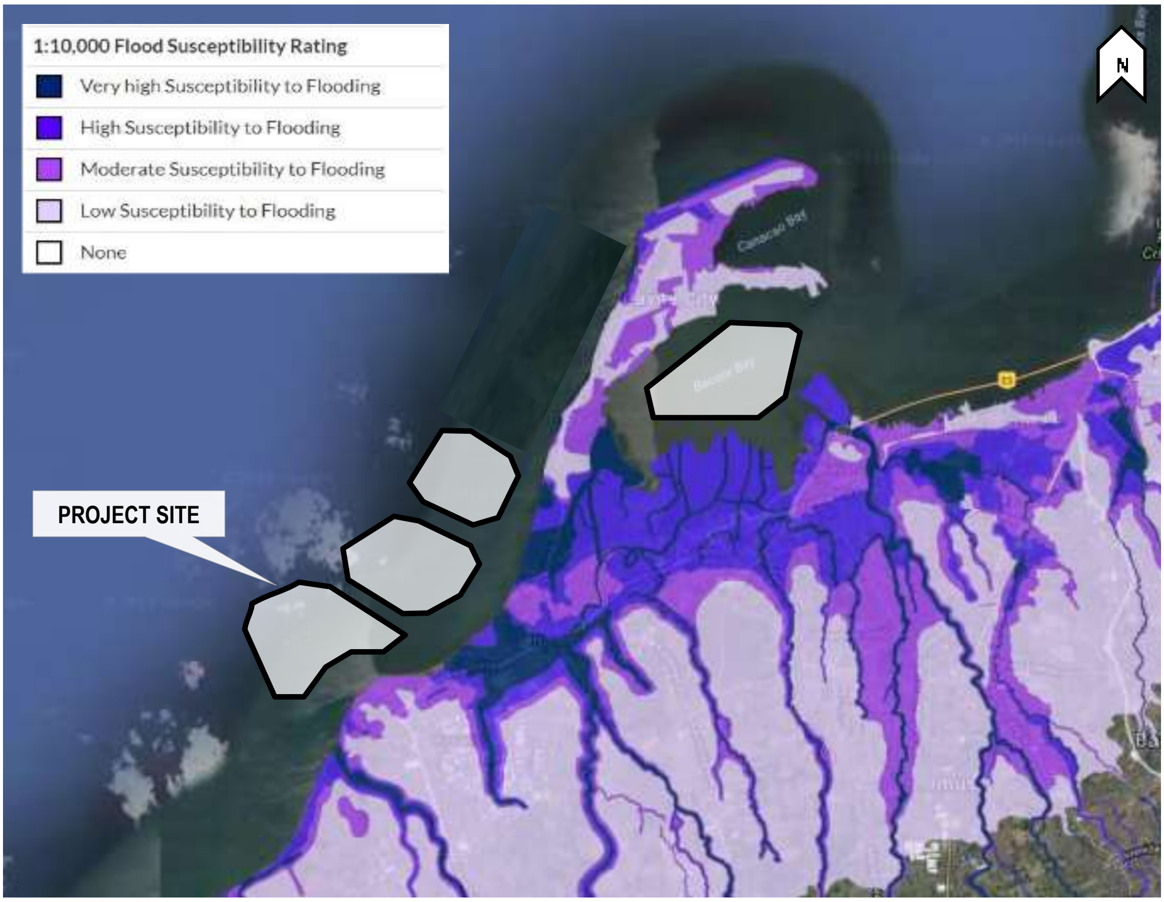
MGB Flood Hazard Map

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 2.2-7. 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 sections. Rational formula is used when a watershed (catchment area) is less than or equal to 20 km^2. The formula is defined by:

$$Q=KCiA$$

Where

Q = peak discharge (m3/s)

K	=	conversion factor (0.278)
C	=	runoff coefficient
i	=	rainfall intensity (mm/hr)
A	=	catchment area (km^2)

Base Map: 2018 Google Earth

Figure 2.2-8. 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^3/s
25-year Return Period (4%)	50 m^3/s
50-year Return Period (2%)	62 m^3/s
100-year Return Period (1%)	76 m^3/s

a. Hydraulic Analysis

The elevation data from the client-issued creek survey were used to generate the river sections of Maalimango River. Shown in **Figure 2.2-9** 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.

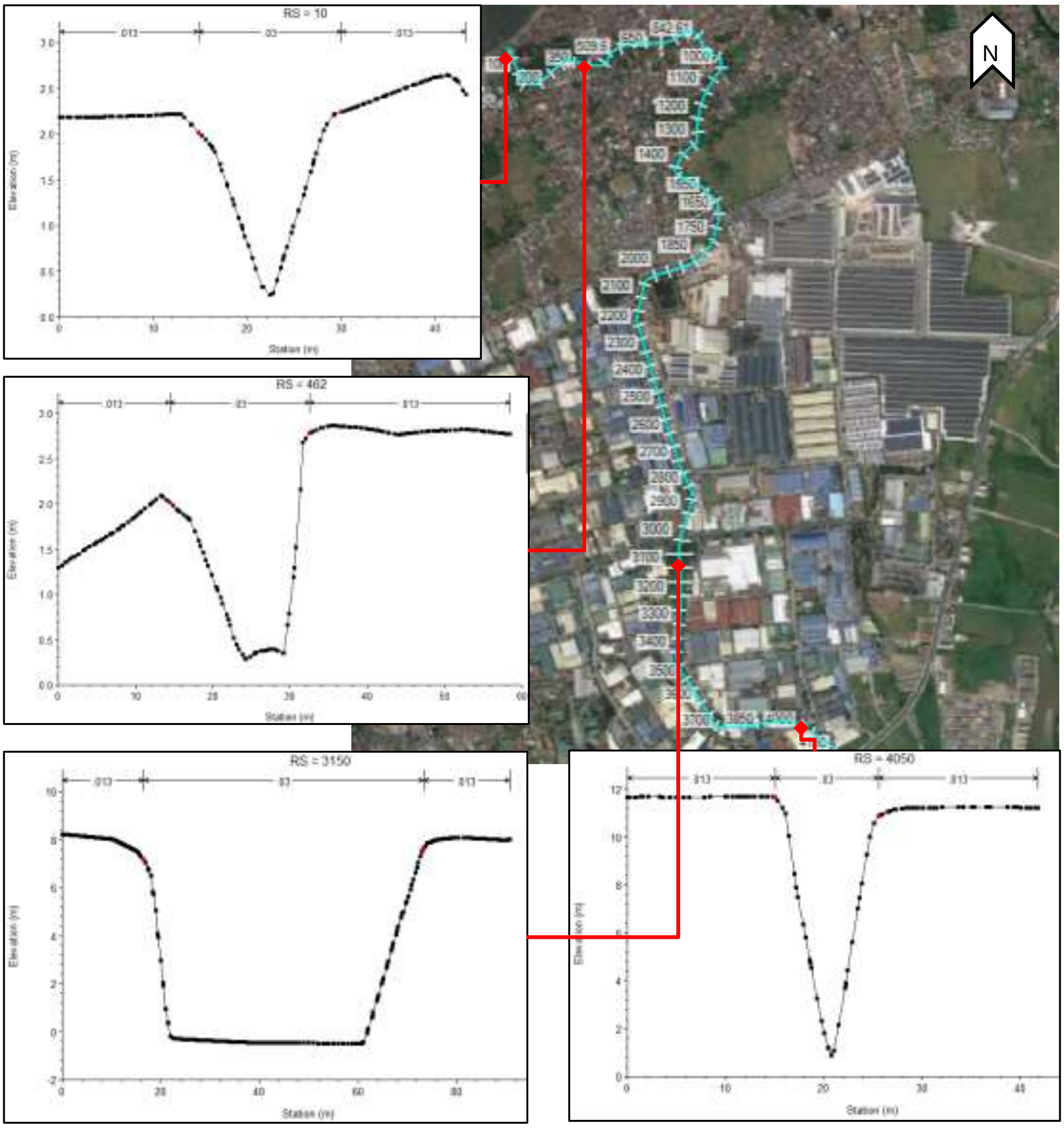


Figure 2.2-9. HEC-RAS model and sample sections for Maalimango River

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 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 2.2-5. HEC-RAS model parameters

Channel	Maalimango River
Flow Regime	Subcritical
Type of Flow	Steady
Downstream Control	Known Water Level (MSL) Extreme condition - Maximum Recorded Water Level = 1.48m Pre-development Conditions - Storm Tide Level = 1.2m* Post-development Conditions - Storm Tide Level= 1.2m* *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 2.2-10. Inundation Map of Maalimango River for 10-yr Return Period (based on Highest Historical Water Level at Manila South Tide Station)

Figure 2.2-11. Inundation Map of Maalimango River for 25-yr Return Period (based on Highest Historical Water Level at Manila South Tide Station)

Figure 2.2-12. Inundation Map of Maalimango River for 50-yr Return Period (based on Highest Historical Water Level at Manila South Tide Station)

Figure 2.2-13. Inundation Map of Maalimango River for 100-yr Return Period (based on Highest Historical Water Level at Manila South Tide Station)

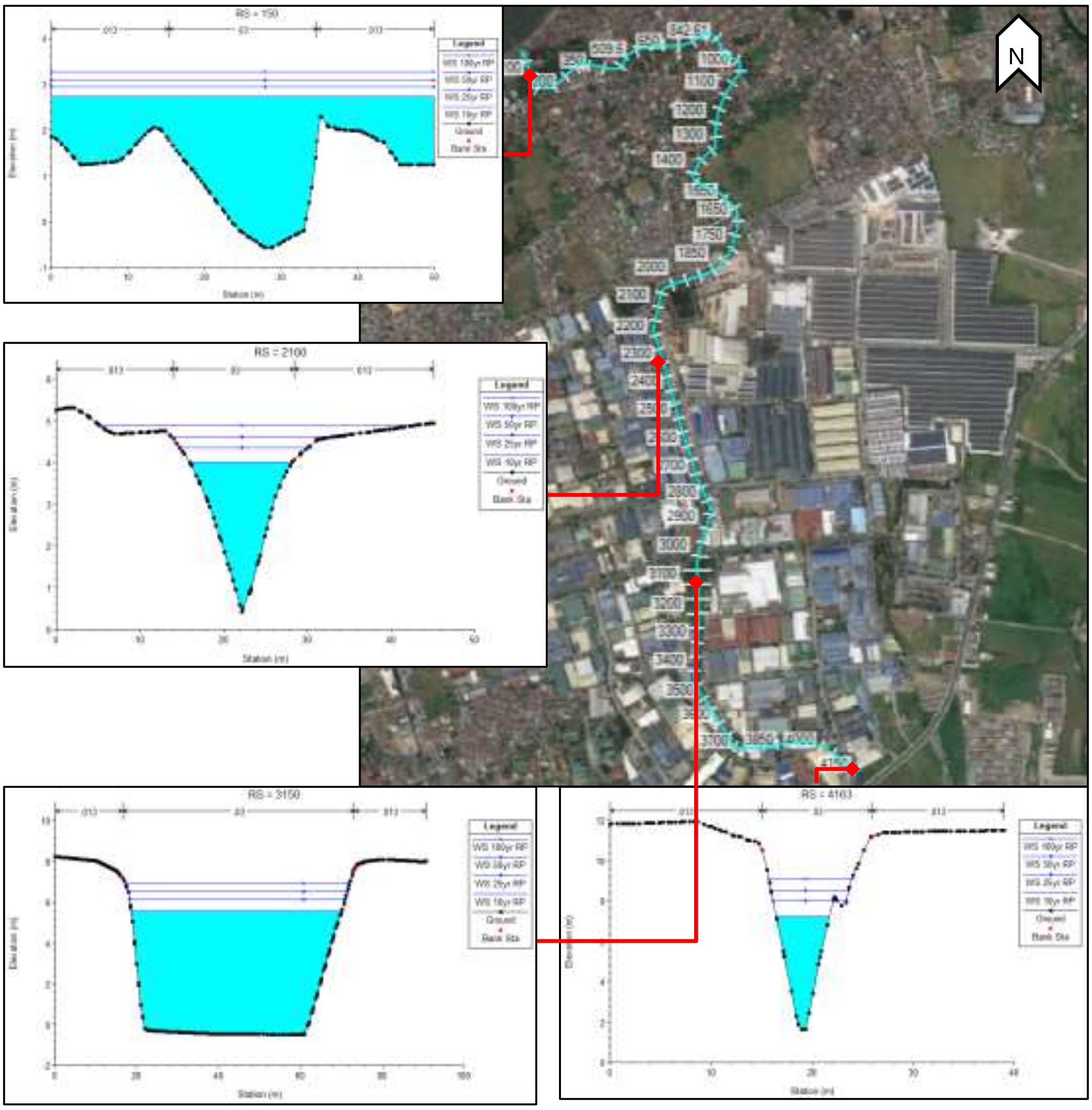


Figure 2.2-14. Sample Cross-Sections of Maalimango River (based on highest historical water level at Manila South Tide Station)

- 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 2.2-15. Inundation Map of Maalimango River for 10-yr Return Period (Pre-development and Post-development Condition)

Figure 2.2-16. Inundation Map of Maalimango River for 25-yr Return Period (Pre-development and Post-development Condition)

Figure 2.2-17. **Inundation Map of Maalimango River for 50-yr Return Period (Pre-development and Post-development Condition)**

Figure 2.2-18. **Inundation Map of Maalimango River for 100-yr Return Period (Pre-development and Post-development Condition)**

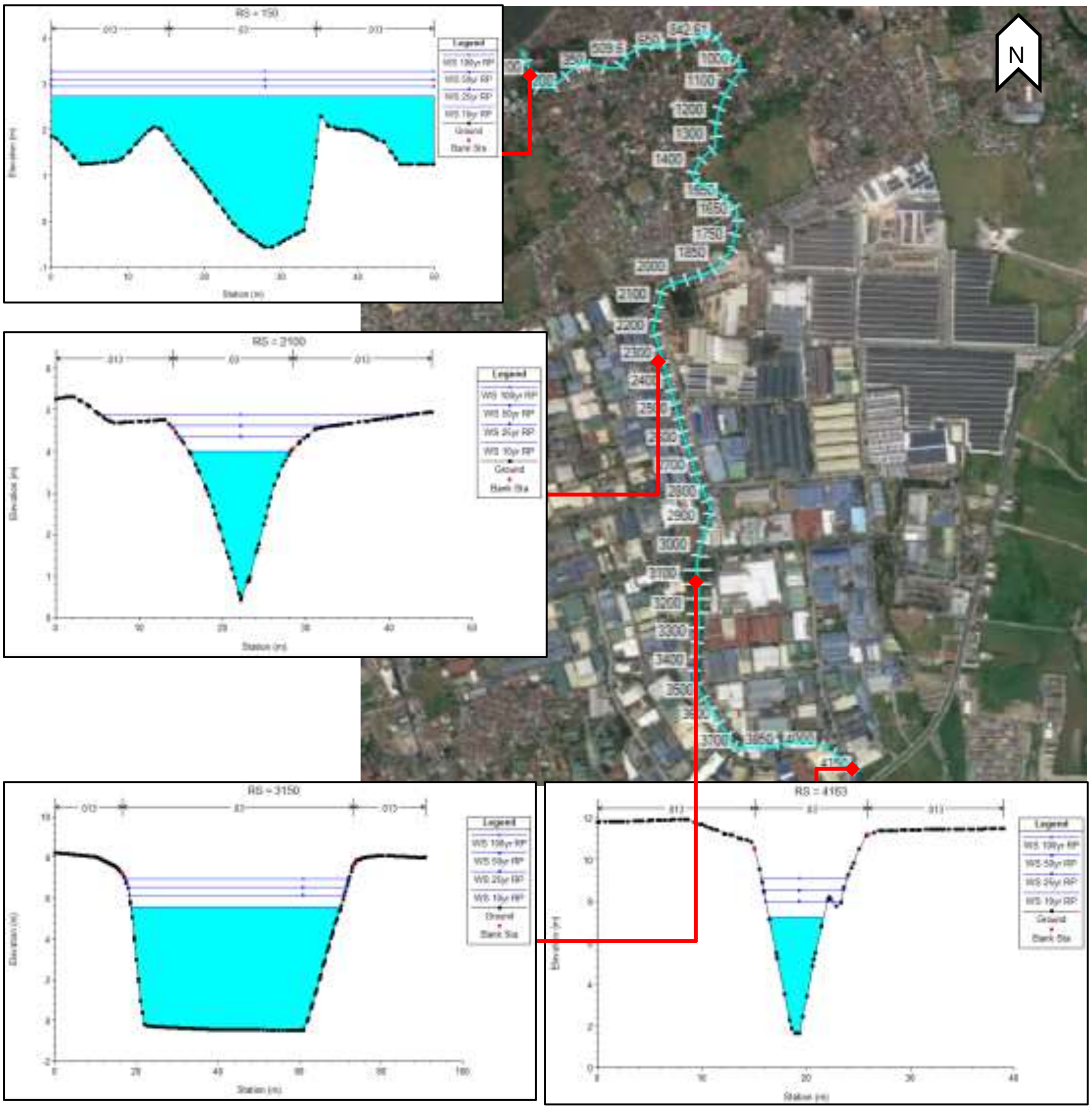


Figure 2.2-19. Sample Cross-Sections of Maalimango River (Pre-development and Post-development Condition)

- 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 2.2-20 shows the HEC-HMS model domain consisting of subbasins, reaches, and junction elements.

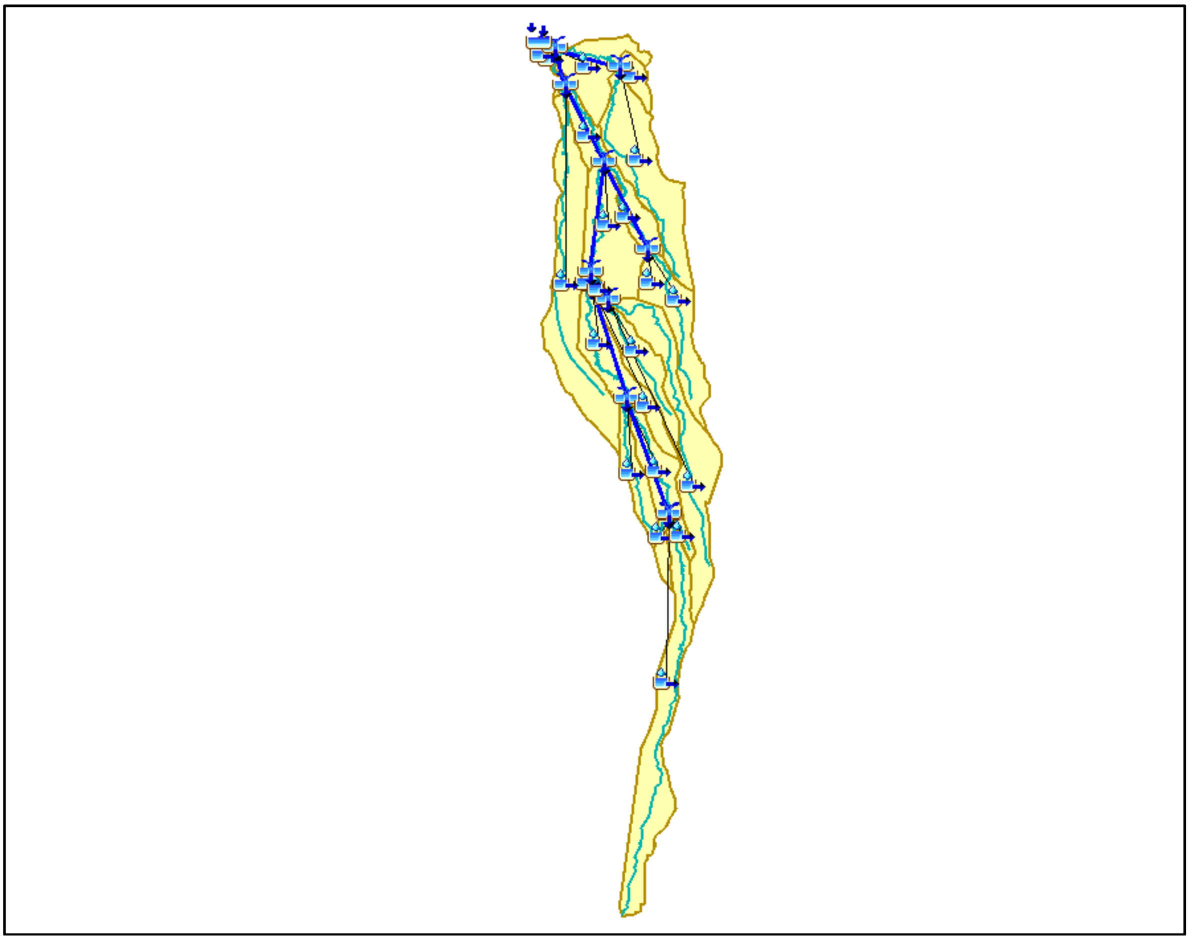


Figure 2.2-20. HEC-HMS Model for Cañas River

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
SB5	3.53	12.39	D

SUBBASIN	AREA (SQ.KM.)	BASIN SLOPE (%)	HYDROLOGIC SOIL GROUP
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^3/s
25-year Return Period (4%)	765 m^3/s
50-year Return Period (2%)	872 m^3/s
100-year Return Period (1%)	977 m^3/s

a. Hydraulic Analysis

The elevation data from the client-issued creek survey were used to generate the river sections of Cañas River. Shown in Figure 2.2-21 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.

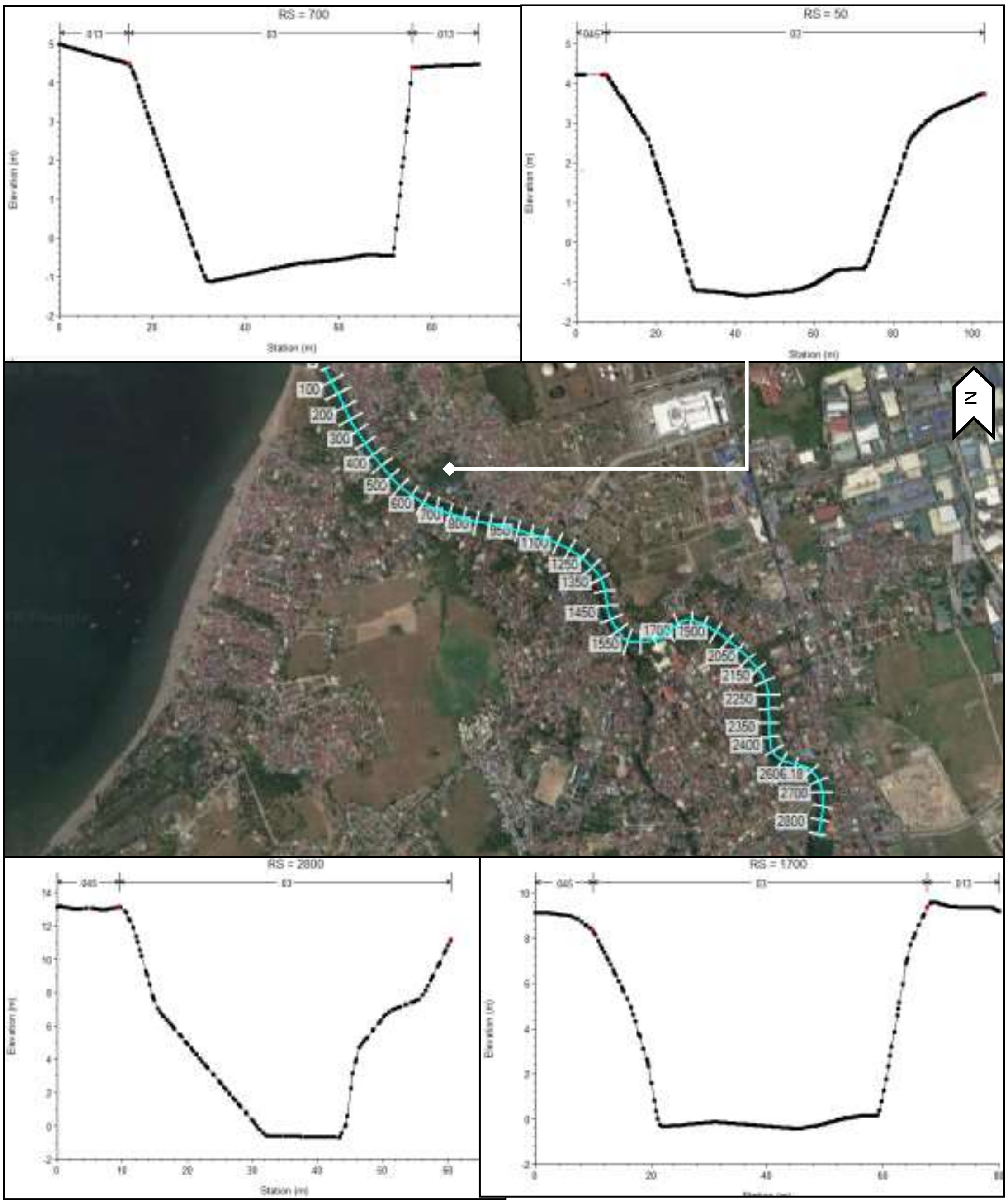


Figure 2.2-21. HEC-RAS model and sample sections for Cañas River

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) Extreme condition - Maximum Recorded Water Level = 1.48m Pre-development Conditions - Storm Tide Level = 1.2m* Post-development Conditions - Storm Tide Level= 1.2m* *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 2.2-22. Inundation Map of Cañas River for 10-yr Return Period (based on highest historical water level at Manila South Tide Station)

Figure 2.2-23. Inundation Map of Cañas River for 25-yr Return Period (based on highest historical water level at Manila South Tide Station)

Figure 2.2-24. Inundation Map of Cañas River for 50-yr Return Period (based on highest historical water level at Manila South Tide Station)

Figure 2.2-25. 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 with the upstream portion is not susceptible to flooding**.

Figure 2.2-26. Inundation Map of Cañas River for 10-yr Return Period (Pre-development and Post-development Condition)

Figure 2.2-27. Inundation Map of Cañas River for 25-yr Return Period (Pre-development and Post-development Condition)

Figure 2.2-28. Inundation Map of Cañas River for 50-yr Return Period (Pre-development and Post-development Condition)

Figure 2.2-29. Inundation Map of Cañas River for 100-yr Return Period (Pre-development and Post-development Condition)

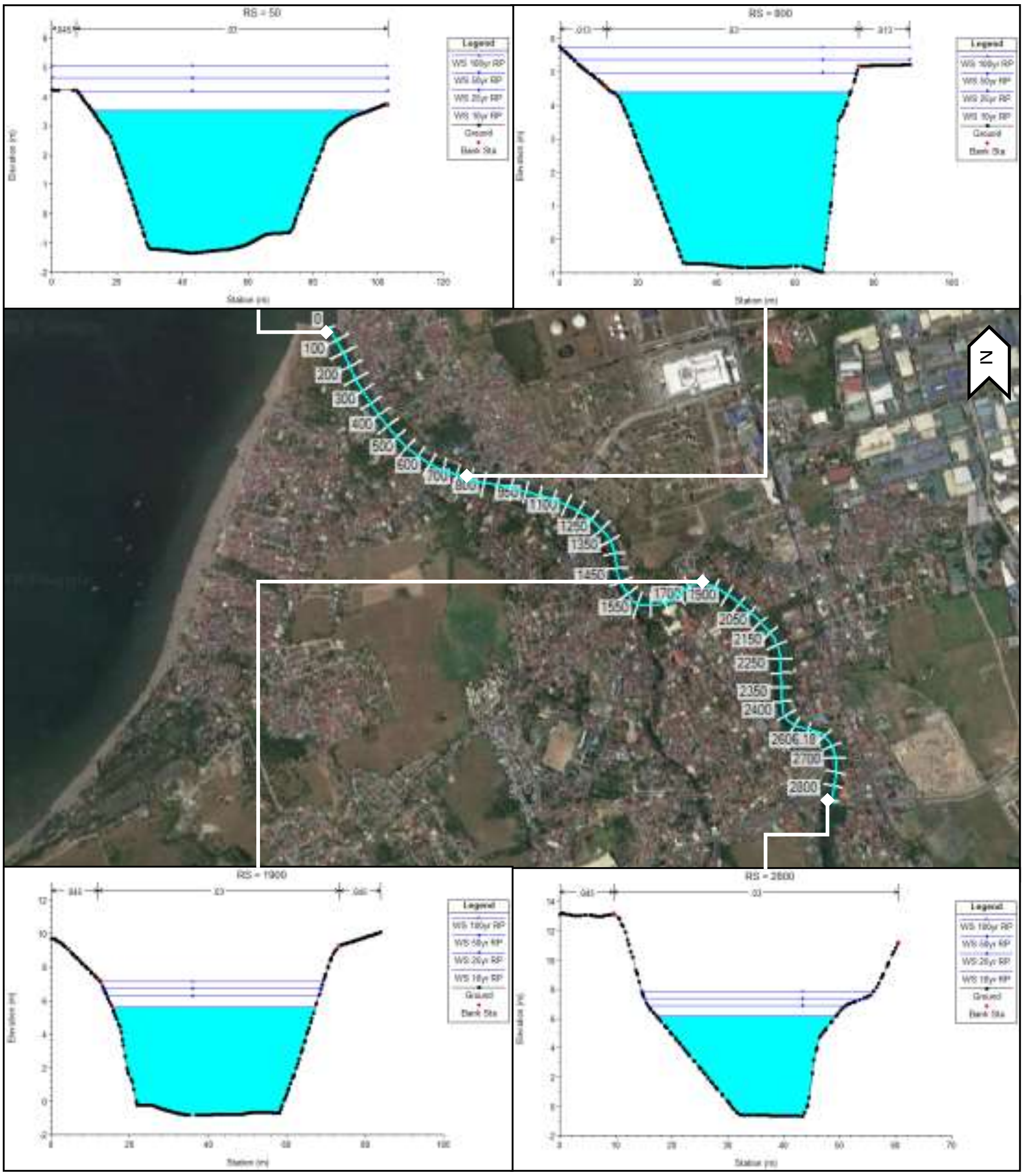


Figure 2.2-30. Sample Cross-Sections of Cañas River (Pre-development and Post-development Condition)

- 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).

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.

2) 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.

3) Site development and grading plan prepared for the project.
4) Land use map
5) Areal map (Google Earth etc.)
6) Updated tidal levels from the Bureau of Coast and Geodetic Survey or from Hydrographic Division of the NAMRIA

Design Discharge Estimates

i. 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:

Qi	=	The design discharge, m ^{3}/sec
C	=	The runoff coefficient C equal to 1 for mostly paved areas.

Ii = The rainfall intensity in minute
A = The catchment area in km^2

For Node 1 or Manhole 1, $Q_1 = CIA_1$; for Manhole 2, $Q_2 = CI(A_1+A_2)$ and so on $Q_n = CI(A_1+A_2+A_3…+A_n)$ 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 km2 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 2.2-31 below and 2.2-5 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 (yrs)	10 min	20 min	30 min	60 min	120 min	180 min	360 min	720 min	1440 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

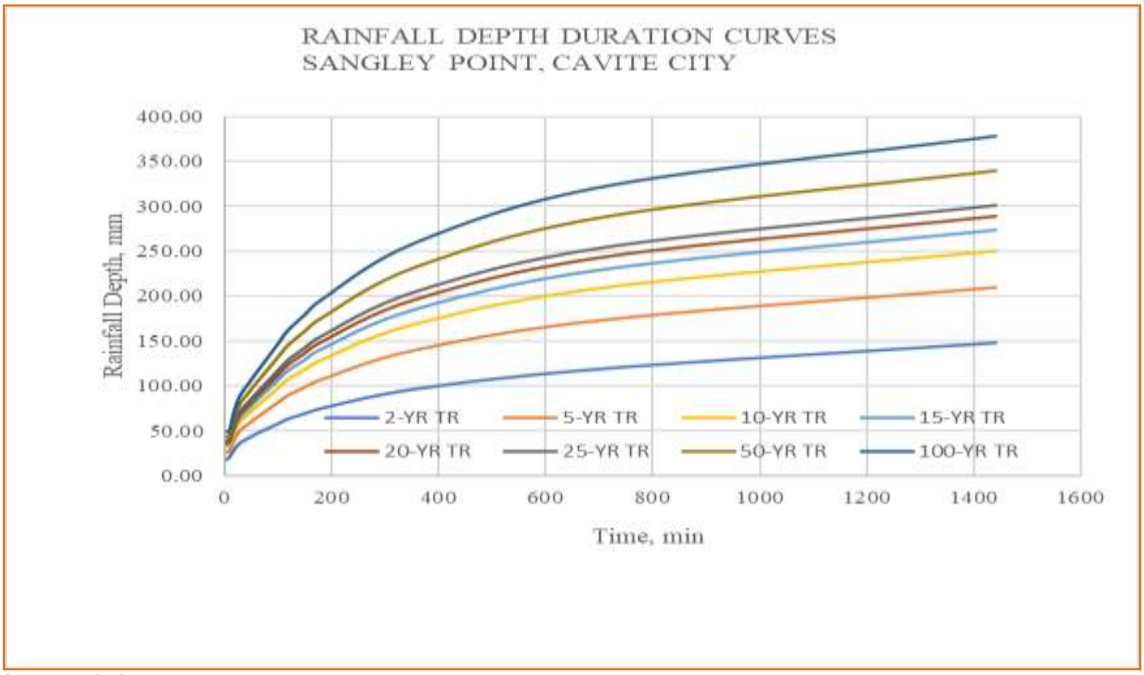
Source: PAGASA

Table 2.2-10. The Hydrometeorological Data Applications Section (HMDAS)

Equivalent Average Intensity (in mm/hr) of Computed Extreme Value

T (yrs)	10 min	20 min	30 min	60 min	120 min	180 min	360 min	720 min	1440 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



Source: PAGASA

Figure 2.2-31. 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^2)	100	-
Minor Bridges (CA<40km^2)	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 are

V = Mean Velocity, m/sec computed by Manning's Equation,

$$V = 1/n\ R^{2/3}\ S^{1/2}$$

Where :

V = Design Velocity, m/sec

n = Manning's Roughness coefficient n
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	
Natural river channels:		
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_W =	1.60	m		
		L =	1.00	m						L =	1.00	m		
Design Criteria		n =	0.015			Design Criteria				C =	0.80			
		K_u =	0.376							I =	421.08	m/hr		
Allowable Spread,		T =	2.00	m		Allowable Spread,				T =	2.00	m	If Qi > Q, PASSED	
Legends		HP =	High Point			Legends				HP =	High Point			
		LP =	Low Point							LP =	Low Point			
ROAD 2B			Road width	22	m	ROAD 2B			Road width	22	m			
Station		Length (m)	S_L m/m	S_X m/m	Q	Station		Spacing	Q	S_x	T	d	Q_i	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 width	30	m	ROAD 2G			Road width	30	m			
Station		Length (m)	S_L m/m	S_X m/m	Q	Station		Spacing	Q	S_x	T	d	Q_i	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 width	30	m	ROAD 2H			Road width	30	m			
Station		Length (m)	S_L m/m	S_X m/m	Q	Station		Spacing	Q	S_x	T	d	Q_i	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.

Cañas River is about 200m south of the project site and the alignment of the island to be reclaimed is such that its western boundaries will not block this river. For Maalimango (Lingatong) River, which is approximately 200m to the southeast of the northeastern side of the island, a 200m-wide channel shall be maintained between islands D and E to ensure that river flow will not be hampered. Thus, the project shall not bring changes to the stream depths of these 2 water bodies.

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^3/yr or 594,000 m^3/day. Much of this amount comes from precipitation over a 790 km^2 area (148 m m^3/yr). Induced flow from Laguna Lake is estimated at 22 m m^3/yr; inflow from the North, at 12 m m^3/yr; and inflow from the South, at 10 m m^3/yr. Recharge from MWSS pipeline leakage is estimated at 25 million m^3/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^3/day, of which 841,000 m^3/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^3/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^3 daily groundwater withdrawal, 973,000 m^3 is taken from the Guadalupe aquifer. The estimated recharged rate of the Guadalupe aquifer is 594,000 m^3/day, indicating an over-pumping rate of about 379,000 m^3/day (Haman, April 1996). In subsequent paper (dated October 1996), Haman adjusted this estimate of the over-pumping rate to about 307,000 m^3/day after accounting for the effect of induced infiltration potential in areas along Laguna Lake. Based on historical puming 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.

For Cavite Province, there are 12 water districts servicing the whole area, with 10 Maynilad pumping stations in the Rosario-Noveleta area. The average monthly production of these water districts is 5,624,184 cubic meters with 219,122 service connections. These are categorized as 200,120 for residential, 377 for government and 18,624 for commercial. Aside from these, numerous (1,962 in 1995) artesian wells are used by those who are not reached by the water districts.

Over-extraction of groundwater has been observed in the Municipality of Rosario, causing rapid lowering of water table level. In fact, this town is among the critical areas of subsidence in the GMMA (*Lapidez et al*).

2.2.2 Oceanography

2.2.2.1 Change in Water Circulation Pattern, Littoral Current, and Coastal Erosion/Deposition

Baseline Conditions

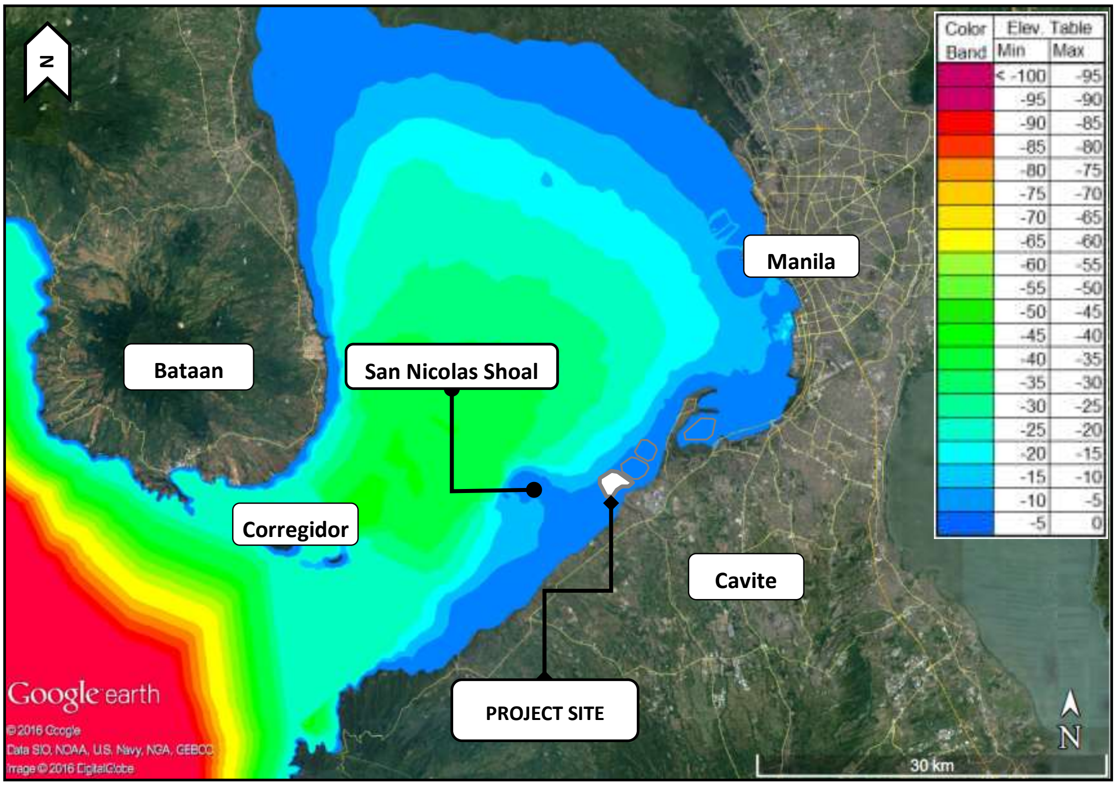
<u>Bathymetric Survey, measured bathymetry and bathymetric map</u>

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).

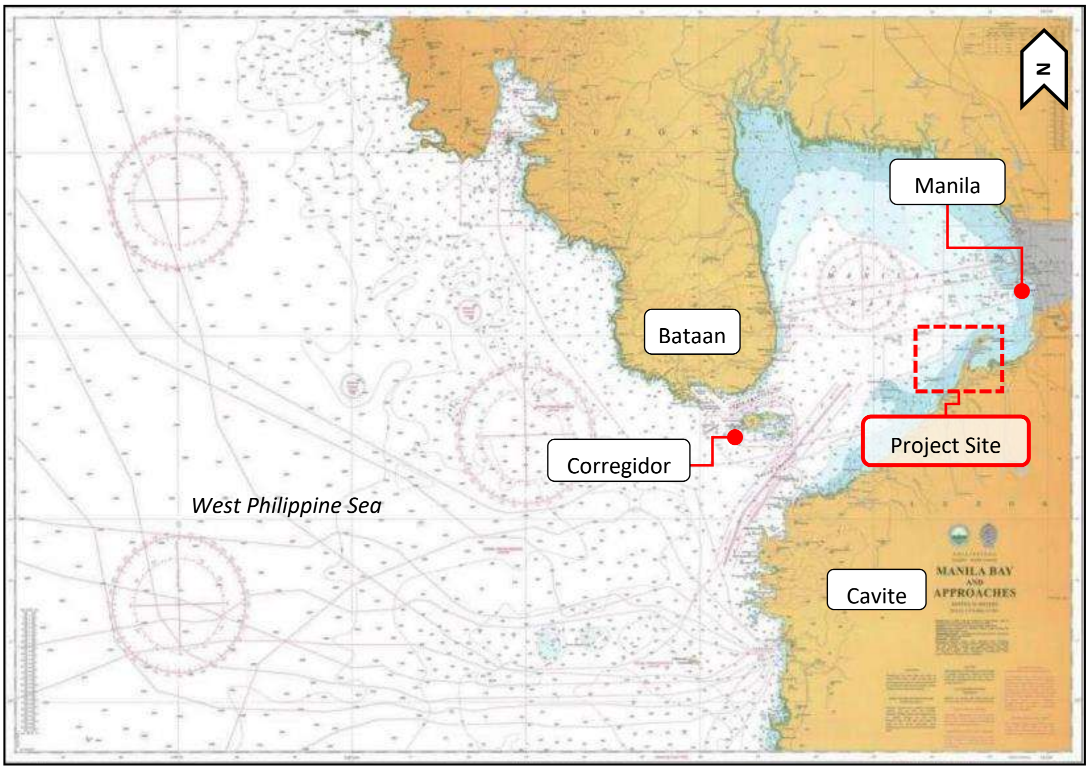
Figure 2.2-32 shows a Digital Elevation Model (DEM) of the bathymetry in the vicinity of the project area, overlain on Google Earth satellite imagery, derived from various Nautical Charts available for Manila Bay. Based on the NAMRIA topography and nautical map of Manila Bay and Approaches shown in Figure 2.2-33, 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.



Base Map: 2016 Google Earth and NAMRIA

Figure 2.2-32. Bathymetric Digital Elevation Model (DEM) of Project Area



Source: NAMRIA Chart#1501

Figure 2.2-33. Nautical Chart - Manila Bay and Approaches

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)**

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 2.2-34. 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)				GRATEST DAILY RAINFALL (mm)		STRONGEST WINDS (mps)			SEA LEVEL PRESSURES (mbs)			
	HIGH	DATE	LOW	DATE	AMT	DATE	SPD	DIR	DATE	HIGH	DATE	LOW	DATE
JAN	35.8	1/7/99	14.8	01-18-61	55.3	01-03-70	20	ENE	01-12-86	1022.3	01-27-87	1004.4	01-01-50
FEB	35.1	02-21-98	14.6	2/1/62	16.5	02-27-50	20	E	02-28-88	1021.4	02-01-98	1003.8	02-21-01
MAR	36.5	03-30-1978	16	3/3/63	36	03-07-11	26	E	03-29-92	1021.1	03-02-87	1002.4	03-06-99
APR	37.8	04-23-1948	18.7	4/1/94	63	04-04-92	22	ESE	04-06-86	1019.9	04-23-87	1002.4	04-21-01
MAY	38.2	05-18-14	19.1	5/11/50	229.1	05-27-60	31	SW	05-22-76	1015.9	05-09-57	992.2	05-17-89
JUNE	38	6/2/91	20	06-22-54	353.8	06/01/58	36	S	06-29-64	1016	06-07-97	974.6	06-29-64
JULY	36.4	07-26-16	18.3	07-28-48	472.4	07-20-72	36	W	07-08-86	1014.9	07-07-53	990.1	07-16-14

MONTH	TEMPERATURE (°C)				GRATEST DAILY RAINFALL (mm)		STRONGEST WINDS (mps)			SEA LEVEL PRESSURES (mbs)			
	HIGH	DATE	LOW	DATE	AMT	DATE	SPD	DIR	DATE	HIGH	DATE	LOW	DATE
AUG	35.2	08-29-89	17.4	8/9/49	401.8	08-10-47	30	WSW	08-16-84	1015.2	08-12-58	992.8	08-24-78
	35.2	08-19-14											
SEP	35.2	9/2/13	19.1	09-15-50	228.9	09-08-63	40	NNW	09-28-06	1016.2	09-18-05	986.7	09-30-95
OCT	36	10-24-76	18	10-23-81	274.5	10-09-78	27	W	10-18-85	1017	10-25-86	977.9	10-14-70
NOV	35.8	11-17-72	17.2	11-26-49	121.7	11-14-77	56	W	11-19-70	1019.4	11-03-89	899.4	11-06-95
DEC	34.2	12-29-78	16.3	12-18-55	125.5	12-15-15	25	NW	12-30-50	1020.9	12-06-60	955.5	12-02-04
ANNUAL	**38.2**	**05-18-69**	**14.6**	**02/01/62**	**472.4**	**07-20-72**	**56**	**W**	**11-19-70**	**1022.3**	**01-27-87**	**889.4**	**11-03-95**
Period	**1947-2016**				**1949-2016**		**1950-2016**			**1950-2016**			

Source: PAGASA

Table 2.2-16. Summary of Climatological Extremes of Sangley Point, Cavite

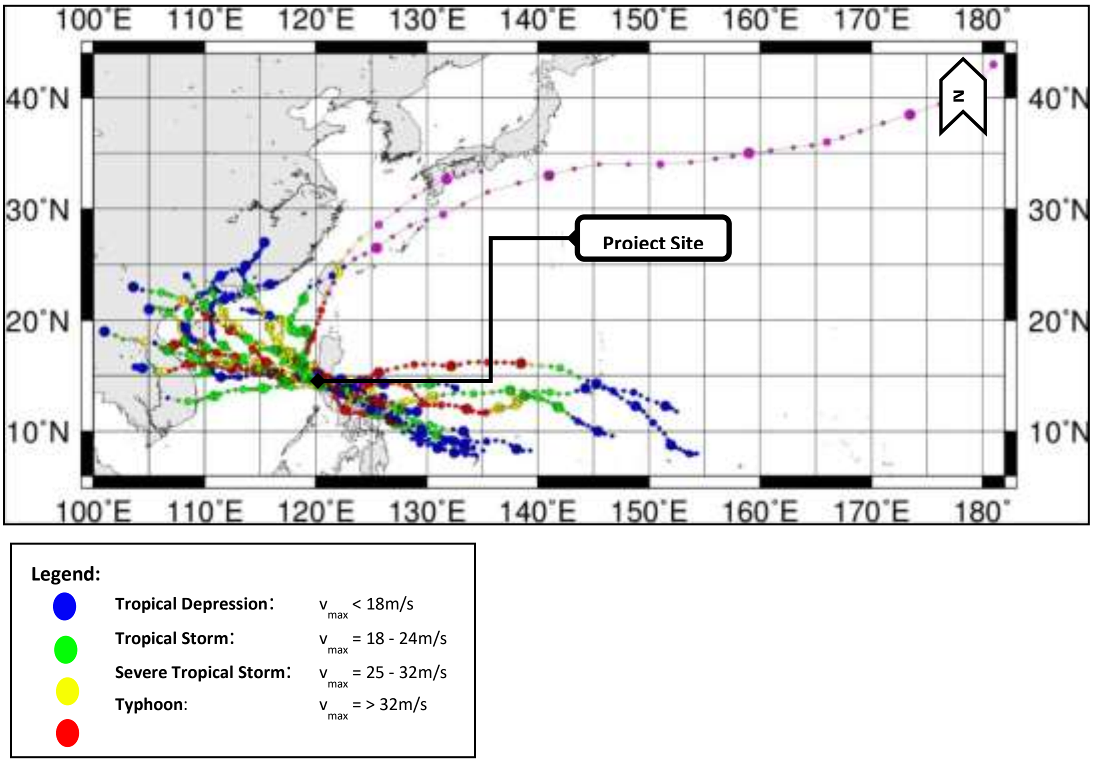
MO	TEMPERATURE (°C)				GRATEST DAILY RAINFALL (mm)		STRONGEST WINDS (mps)			SEA LEVEL PRESSURES (mbs)			
	HIGH	DATE	LOW	DATE	AMT	DATE	SPD	DIR	DATE	HIGH	DATE	LOW	DATE
JAN	34.8	01-25-99	19	01-03-82	94	01-12-77	17	ESE	01/19/10	1023.4	01/16/99	1001.9	01/31/01
FEB	35.2	02-28-98	18	02-01-82	45.8	02-06-16	15	ESE	02/27/92	1019.9	02/03/93	1005.4	02/21/01
MAR	36.6	03-29-81	19.1	03-25-80	52.4	03-22-13	24	ESE	03/23/98	1020.5	03/05/05	1003.9	03/06/99
APR	37.8	04-07-83	21.5	04-03-07	53.9	04-24-75	16	ESE	04-05-96	1017.5	04/14/93	1002	04/30/88
MAY	38.5	05-16-87	22	05-15-80	237.1	05-26-97	27	SW	05/22/76	1015.5	05/25/83	993.4	05/22/76
JUNE	38.4	06-04-87	22	06-16-81	172.4	06-27-85	25	SE	06-08-11	1014.3	06/08/97	997.6	06/28/04
JULY	36.3	07-25-07	21.2	07-15-82	231.4	07-20-02	54	E	07/13/10	1013.8	07/29/83	986.1	07/15/14
AUG	36.5	08-16-09	22	08-02-94	475.4	08-19-13	30	W	08/18/90	1014.5	08/13/05	998.1	08/17/90
SEP	35.6	09-02-96	21	09-16-79	275.4	09-22-13	44	NNW	09/28/06	1015.6	09/18/05	984.3	19/28/06
OCT	35.8	10-08-96	21	10-24-88	260.7	10-05-86	45	NW	10/21/94	1016.4	10/27/93	990.3	10/21/94
NOV	36.4	11-08-78	21.5	11-26-82	171.2	11-02-00	49	NW	11/03/95	1017.5	11/30/89	977	11/03/95
DEC	34	12-06-98	20	12-24-85	131.3	12-10-06	22	NNW	12/05/93	1019.1	12/31/92	997.9	12/02/04
ANNUAL	**38.5**	**05-16-87**	**18**	**02-01-82**	**475.4**	**08/19/2013**	**54**	**W**	**07/13-10**	**1022.3**	**01-16-99**	**977**	**11/03/95**
Period	**1974 - 2015**				**1974 - 2015**		**1974 - 2015**			**1974 - 2015**			

Source: PAGASA

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 (ΔPc), extreme gusts with sustained wind speed (Vmax), and some translational or forward speed of their centers (Vf). The size of typhoons is associated with the radius from the center (Rmax) to where the wind gusts reach their maximum speeds, while the strength of the typhoon is associated with both the maximum wind speed, Vmax, 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 2.2-35. 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 2.2-36.

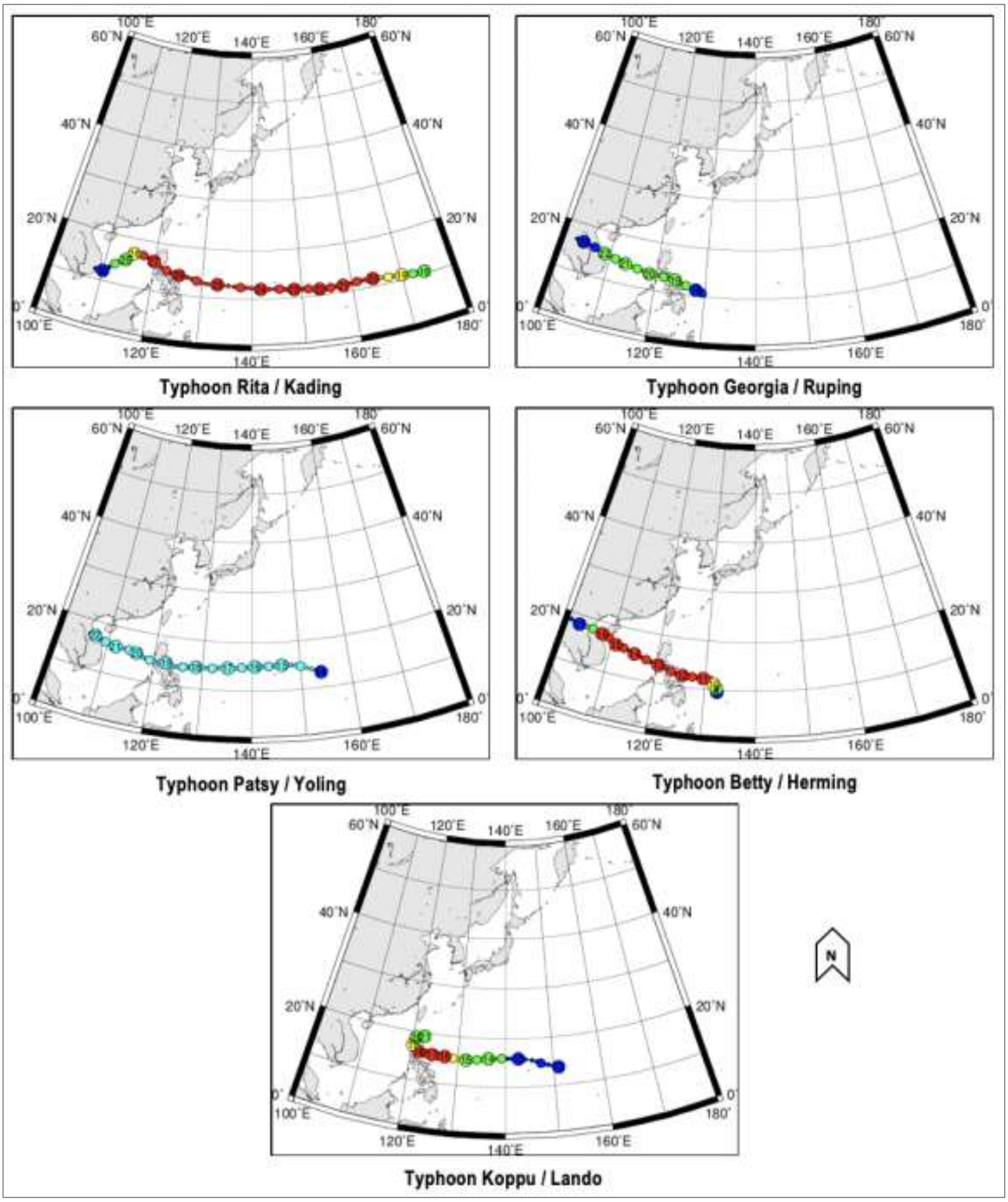


Source: Digital Typhoon

Figure 2.2-35. 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 2.2-36. Typhoon Koppu / *Lando*

Wind Rose Data

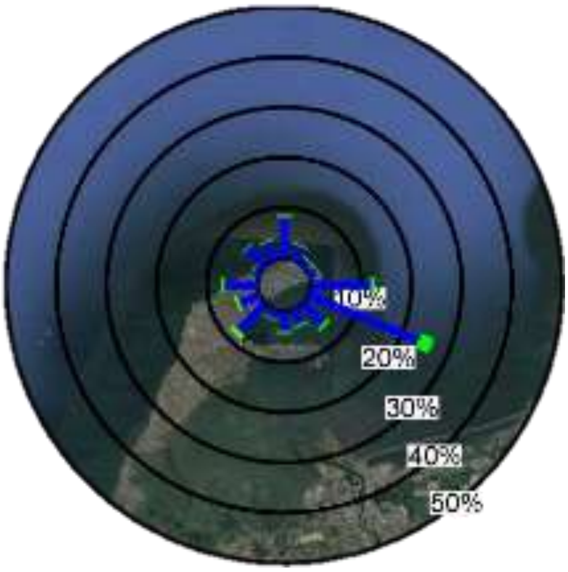
A wind rose diagram represents the frequency of winds blowing from particular directions. It uses sixteen (16) cardinal directions—North (N), North-northeast (NNE), Northeast (NE), East-northeast (ENE), East (E), East-southeast (ESE), Southeast (SE), South-southeast (SSE), South (S), South-southwest (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 2.2-37), 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 2.2-38) 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.

Color	Wind Speed Range (mps)	Description
	1 - 4	Light
	5 - 8	Moderate
	9 - 12	Moderate to Strong
	13 - 16	Strong
	17 - 20	Very Strong

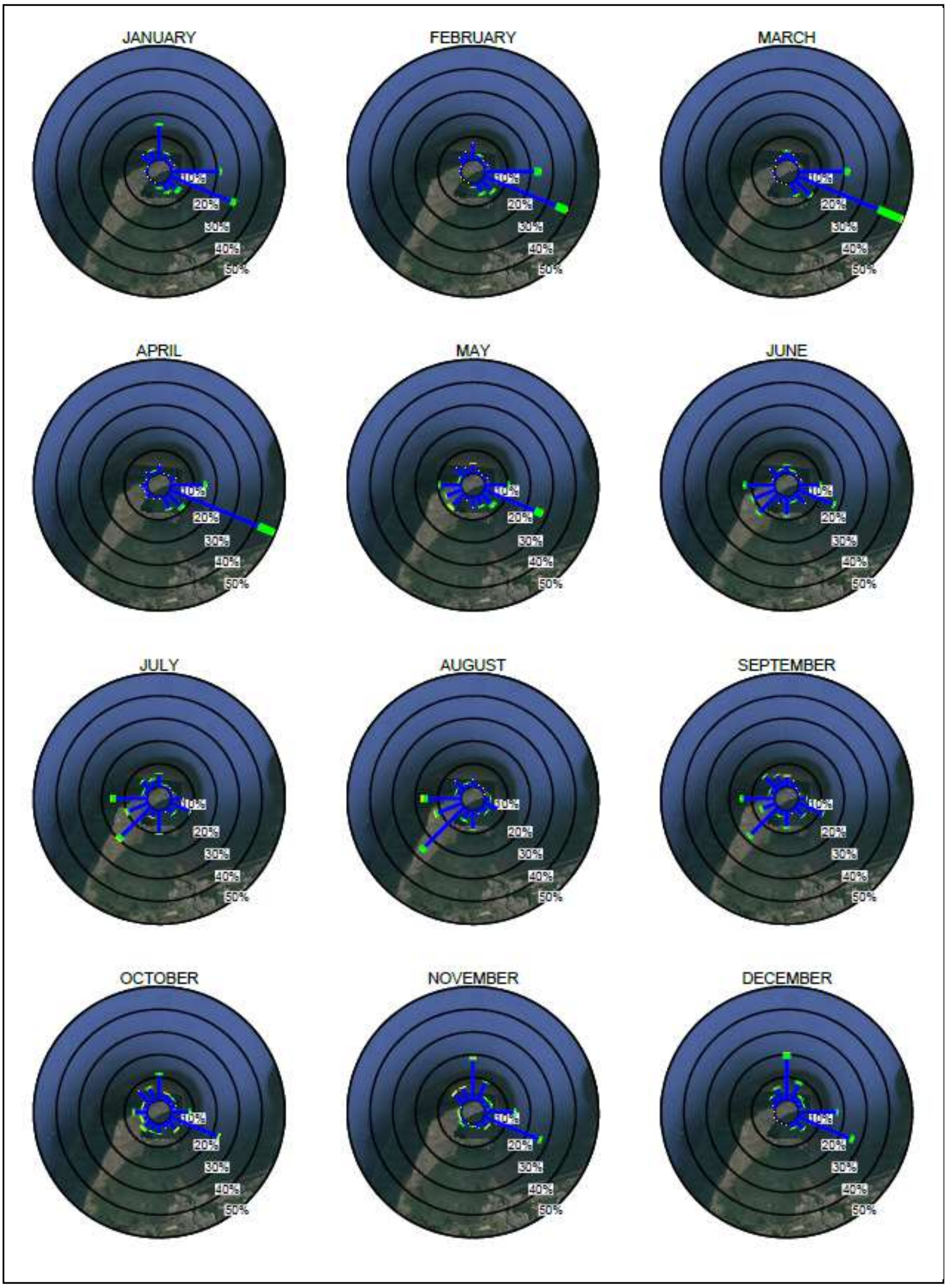
Source: PAGASA



Dir.	Freq. (%)	Dir.	Freq. (%)
N	15.7	S	2.0
NNE	3.4	SSW	0.1
NE	1.6	SW	0.1
ENE	1.7	WSW	0.1
ENE	21.9	W	0.9
ESE	30.9	WNW	0.2
SE	6.8	NW	5.0
SSE	4.7	NNW	4.9

Source: PAGASA

Figure 2.2-37. Annual Wind Rose Diagram at Sangley Point Wind Station



Source: PAGASA

Figure 2.2-38. Monthly Wind Rose based on the Sangley Point Wind Station

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 2.2-39. 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.

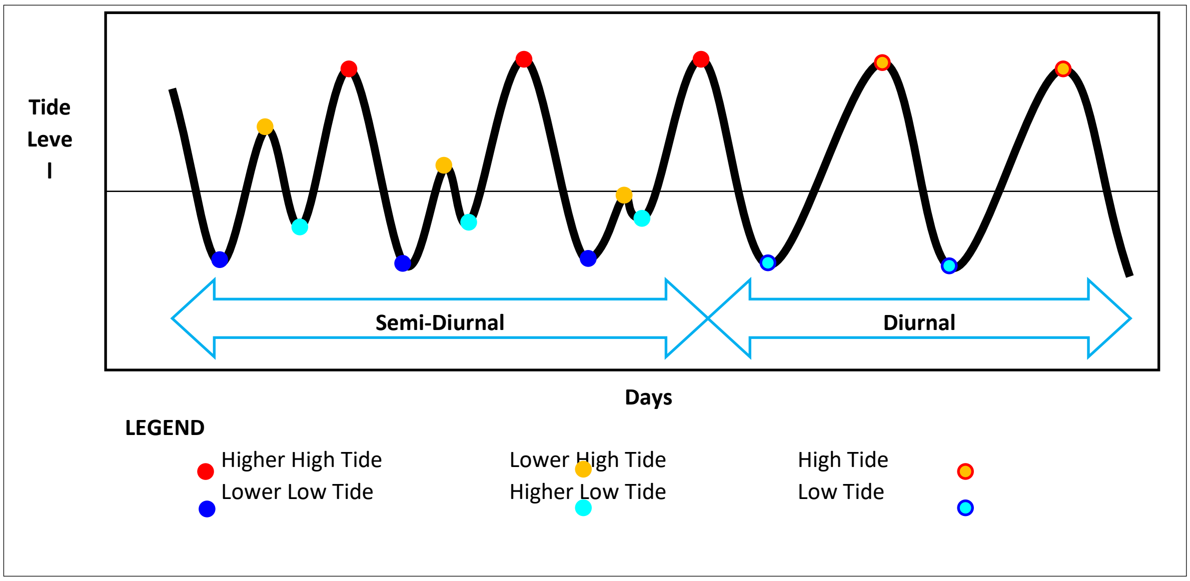


Figure 2.2-39. **Sample Tide Levels**

The location and data of nearby tide stations are shown in Figure 2.2-40 and Table 2.2-18, respectively. The nearby stations consist of one (1) primary station (Manila South Harbor) and two (2) secondary station (Puerto Azul & Mariveles).

Base Map: 2018 Google Earth

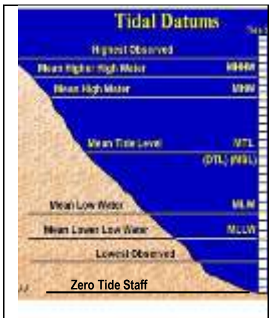
Figure 2.2-40. Tide Station Location

Table 2.2-18. Tide Station Information

NAME	TYPE	LAT	LONG	MUNICIPALITY	BM	EL. (MTL)
Manila South Harbor	Primary	14º35'N	120º58'E	South Harbor, Manila	BM 66	1.30
Mariveles Harbor	Secondary	14º26'N	120º30'E	Mariveles, Bataan	BM 1	2.696
Puerto Azul	Secondary	14º47'N	120º41'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



Station	Tide Elevation (m)						
	HHWL Highest Observed	MHHW Mean Higher High Water	MHW Mean High Water	MTL Mean Tide Level	MLW Mean Low Water	MLLW Mean Lower Low Water	LLWL Lowest 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

2.2.2.1.1 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.

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 2.2-41) encompassing the entire Philippine archipelago, and the local domain limited to Manila Bay alone (Figure 2.2-42). 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).

The two color-banded digital elevation model (DEM) with varying scales are shown in Figures 2.2-41 and 2.2-42.

- 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).

Summary of the Coastal Engineering Assessment

Table 2.2-22a presents the summary of the Coastal Engineering Assessment for the project.

Table 2.2-22a Presents the Summary of the Coastal Engineering Assessment

	Pre-Development	Post-Development	Impact
Development Scenarios	Assumes the existing coastline with no project in place	Includes Cavite Reclamation Island A,C,D and E and Sangley Point International Airport (SPIA)	NA
Effects of Prevailing Waves	Relatively Calm with wave heights at 0.70 meters in the tip of the Sangley Point	Induced lower waves heights in tis vicinity. Attributed to the significant amount of wave energy being blocked by the islands.	Calm wave may cause potential water stagnation issues
Effects on Storm Surge Storm tide levels of 3 critical typhoons, Rita, Patsy and Xangsane were simulated	Storm tide levels generated at an average of roughly 0.80 m – 0.90 m for all islands.	Typhoon Rita caused storm tide level of roughly 1.0 m – 1.1 m at reclaimed land SPIA to Island C to E, and 0.60 m – 0.80 m at Island A. Induced a slight increase of roughly 0.10 m in storm tide levels at the channel between Island E and the existing coastline. Typhoon Patsy cause storm tide levels of roughly 0.80 m – 0.90 m for all islands Typhoon Xangsane resulted lowest storm tide levels at roughly 0.80 m for all islands	Significant reduction in the storm tide levels in Bacoor Bay. Slight increase in storm tide level at the eastern portion of the proposed SPIA and Island A No significant change
Effect on Storm Wave	The storm wave heights induced ranges from 0 m to 3.0 m at the harbor and along the coastline	Will provide a sheltering effect on all shorelines leeward of the reclamations	Positive Impact to coastal barangays
Effects of Tidal Current	Maximum current for Island A is between 0.0 m – 0.20 m Maximum current for Island C,D and E is between 0.0 m – 0.25 m m/s Based on maximum current (January 29, 2019 to February 29, 2016)	Various changes in the maximum tidal-induced currents were noted, including an extreme increase if current speed at the gaps of Island A within Bacoor Bay. Moderate increase of current speed between the Islands C-E, and a significant increase of current speed on the leeside of Island E within the waterway	Impact or changes can be attributed to the constriction of flow in these areas
Effects of Tidal Circulation	Good circulation seawaters	Will still allow significant circulation of seawaters within both partially enclosed waterways and channelized waterways between the reclaimed islands.	No significant impact in terms of circulation of seawaters
Effects of Tsunami	Susceptible to tsunami with recorded tsunami run-up values that went as high as 6.14 m	Susceptible to tsunami with recorded tsunami run-up values that went as high as 6.14 m. This will serve as permanent protection or shield to costal barangays.	Tsunami height shall be considered in the design of the crest height of the coastal structures.

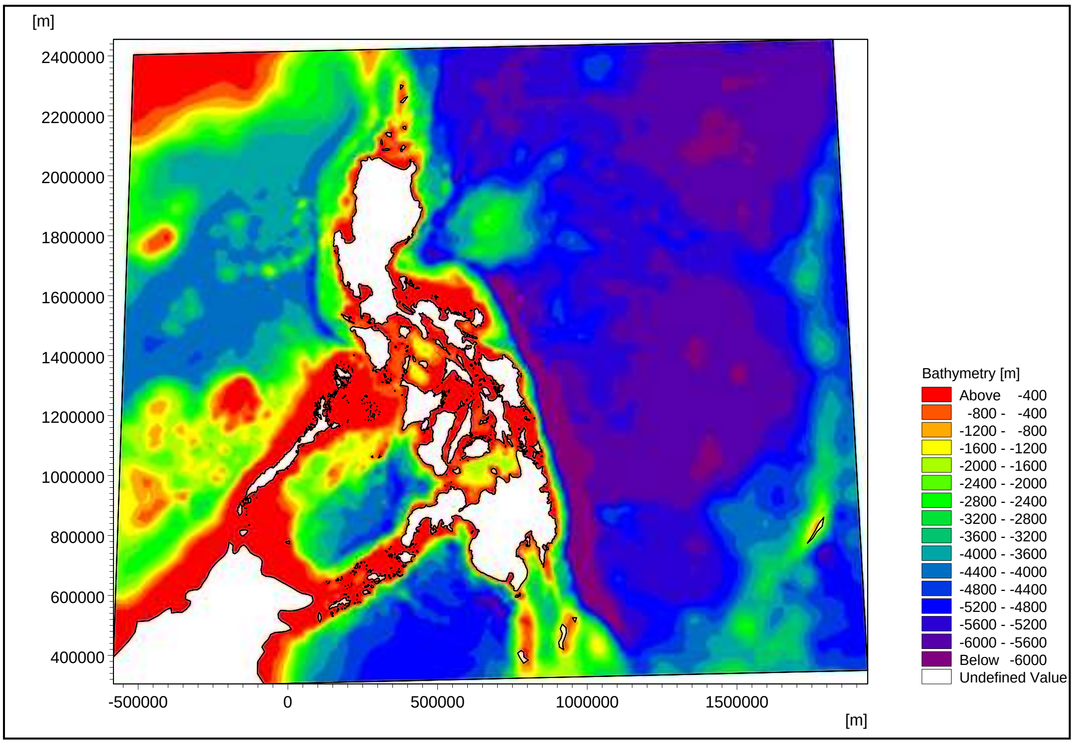


Figure 2.2-41. Domain Extents for the Hydrodynamic Computation of the Regional Model

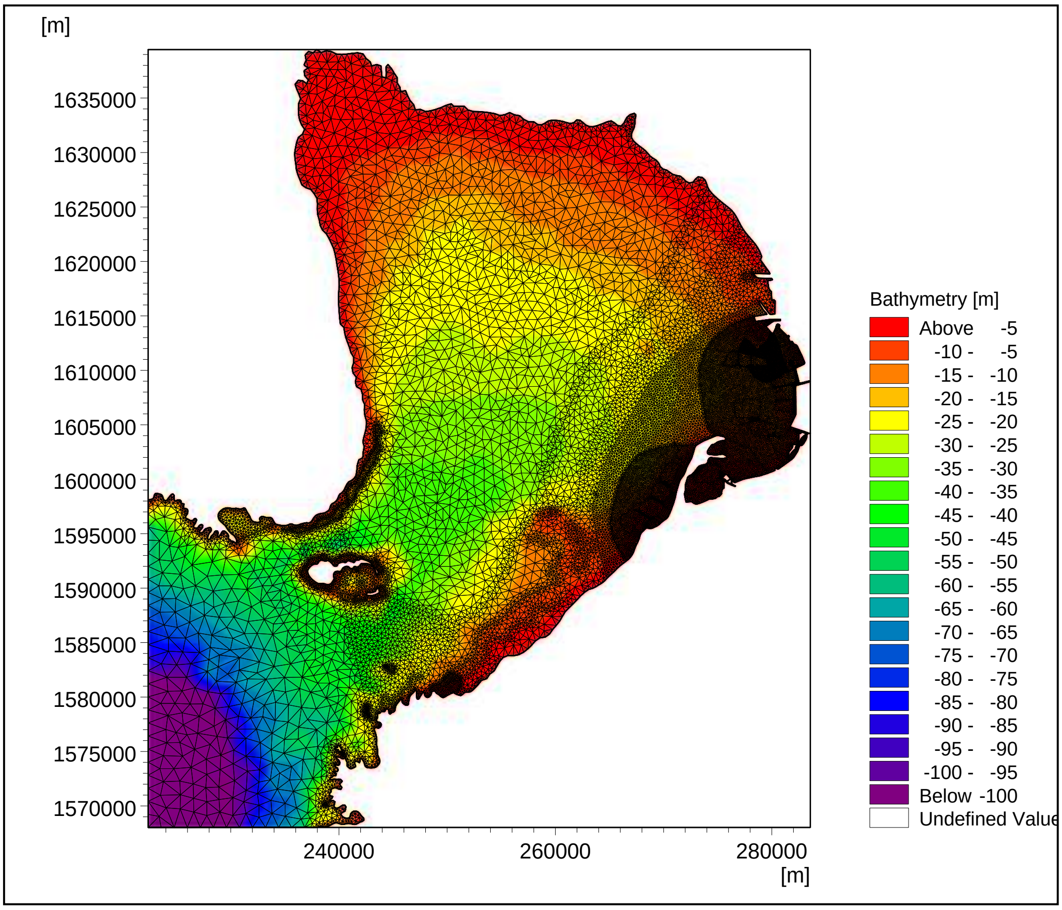


Figure 2.2-42. Flexible Element Mesh of the Local Model at Manila Bay

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 to D are covered in the separate EIS Applications
- 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 2.2-43 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.

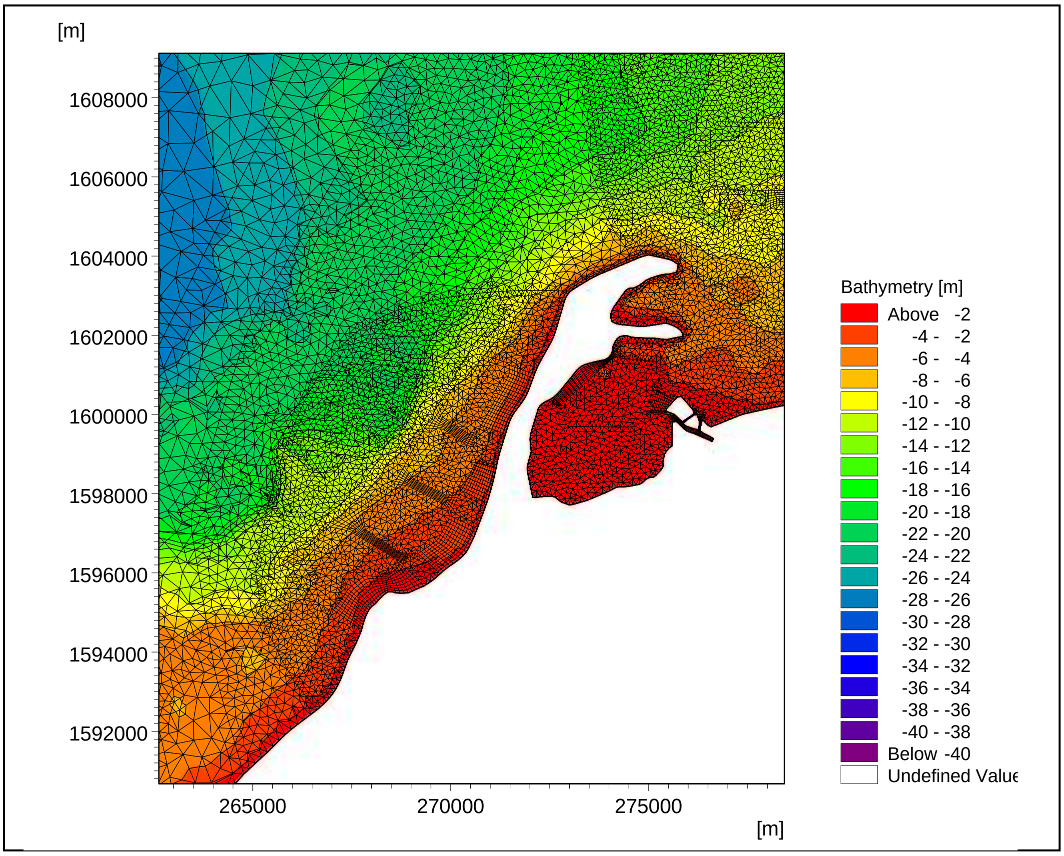


Figure 2.2-43. Flexible Element Mesh of the Local Model at the Project Site (Pre-Devt.)

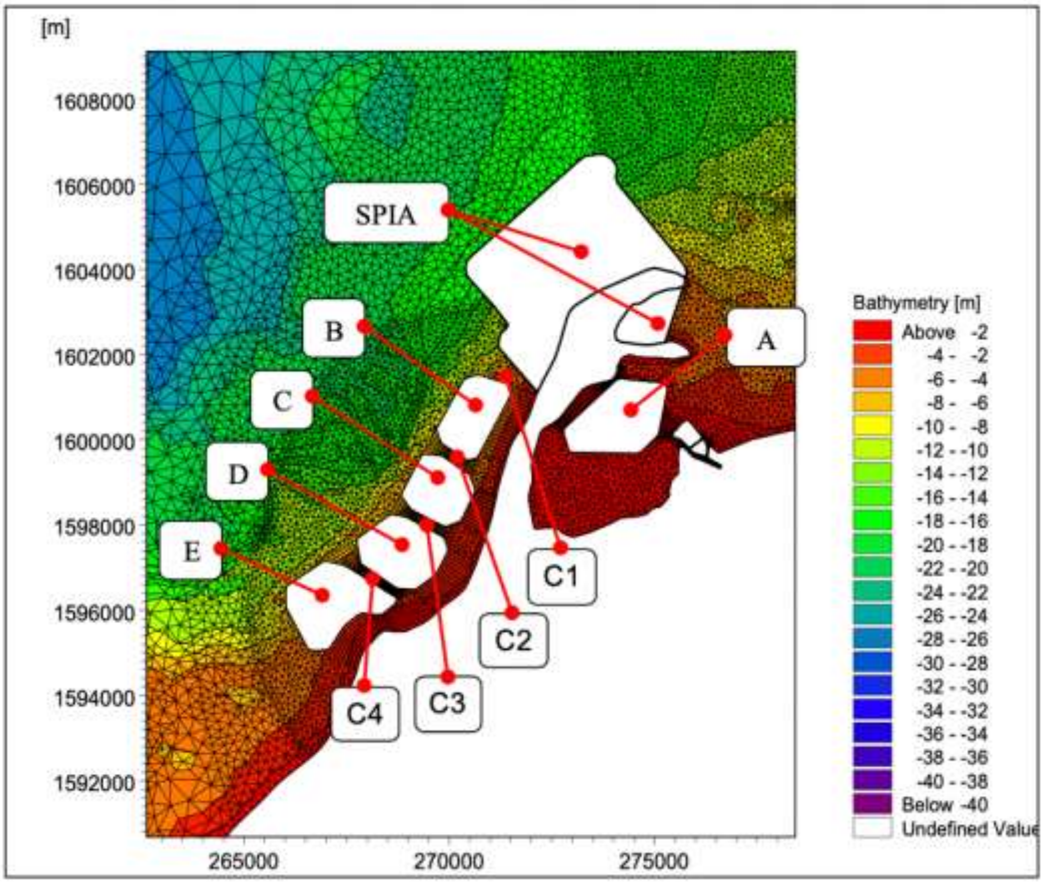


Figure 2.2-44. Flexible Element Mesh of the Local Model at the Project Site (Post-Devt.)

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 (R2) value of 0.91 at Manila South Harbor.

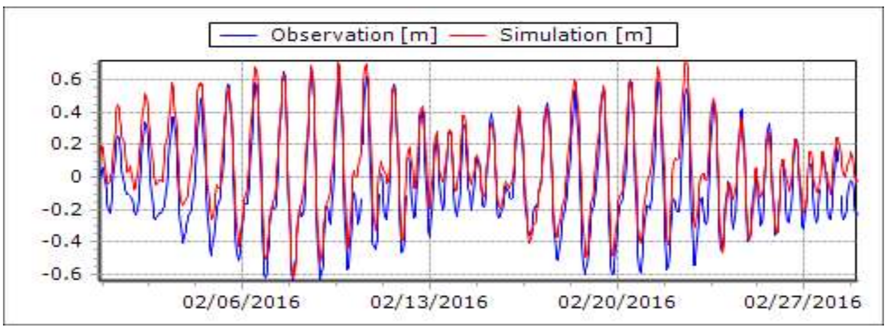


Figure 2.2-45. Simulated Tide Levels at Manila Bay South Harbor

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 2.2-23, with the results shown in Figures 2.2-46 to 2.2-63. The figures show the spatial distribution of the significant wave height (Hs) 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	3rd 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	2nd prevailing	n/a	n/a	2.2-54 & 2.2-55
	5-8	0.8				2.2-56 & 2.2-57
	9-12	0				
ESE	1-4	23.7	1st 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	6th 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	4th 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	8th 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	5th 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	7th prevailing	n/a	n/a	2.2-82 & 2.2-83
	5-8	0.1				2.2-84 & 2.2-85
	9-12	0				

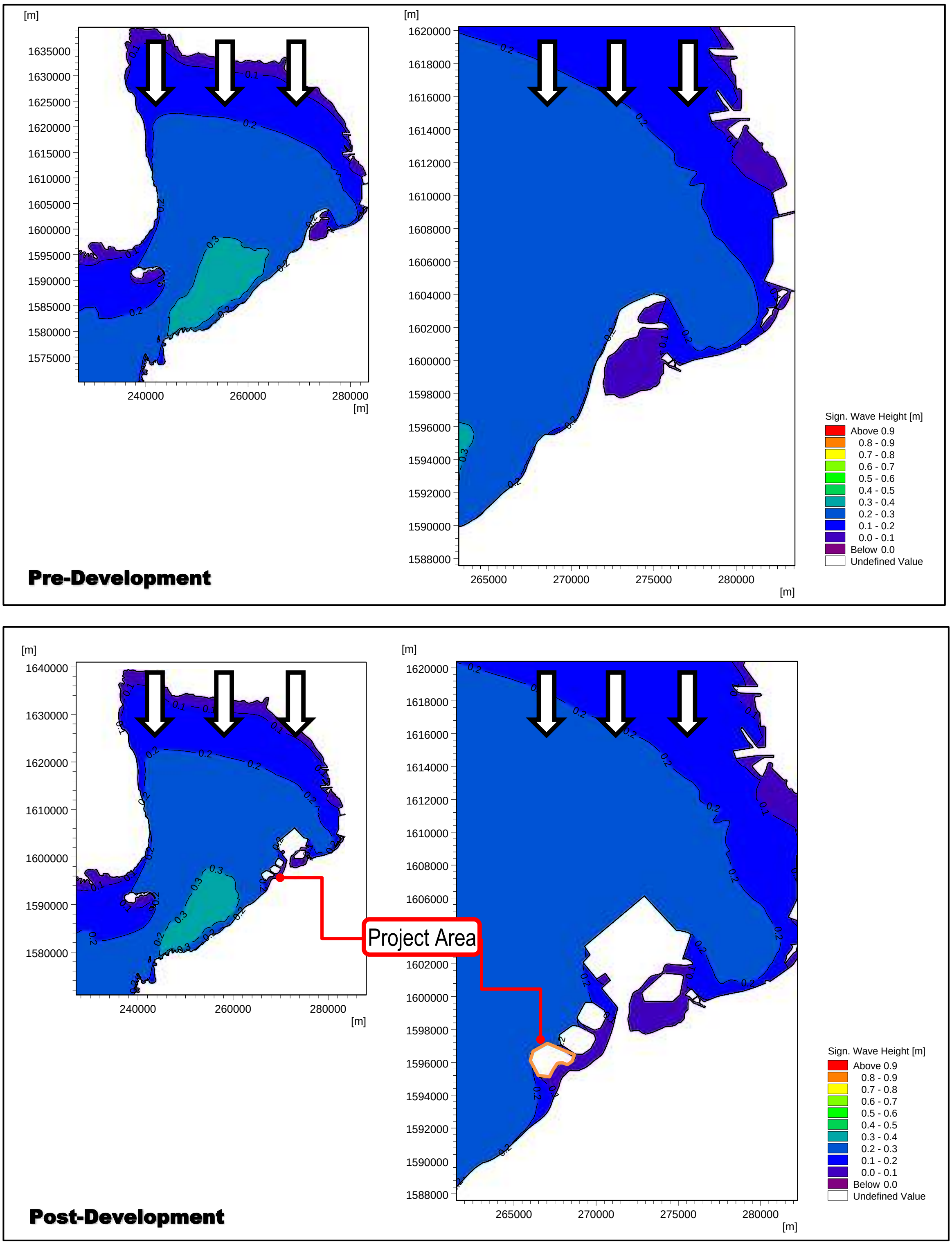


Figure 2.2-46. Wave Climate due to 1-4 mps Surface Winds & Offshore Waves from N at MHHW
(Pre- & Post-Devt.)

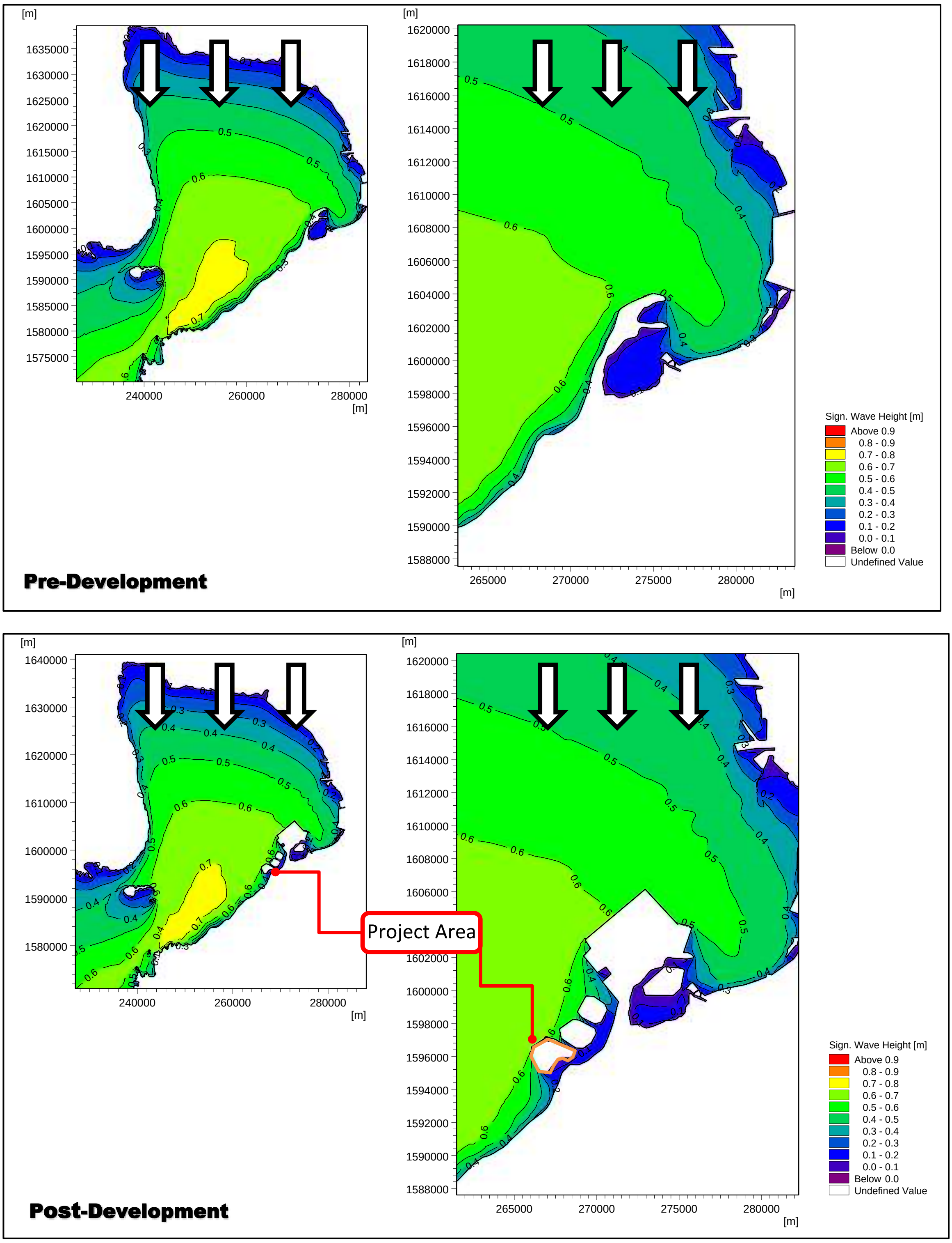
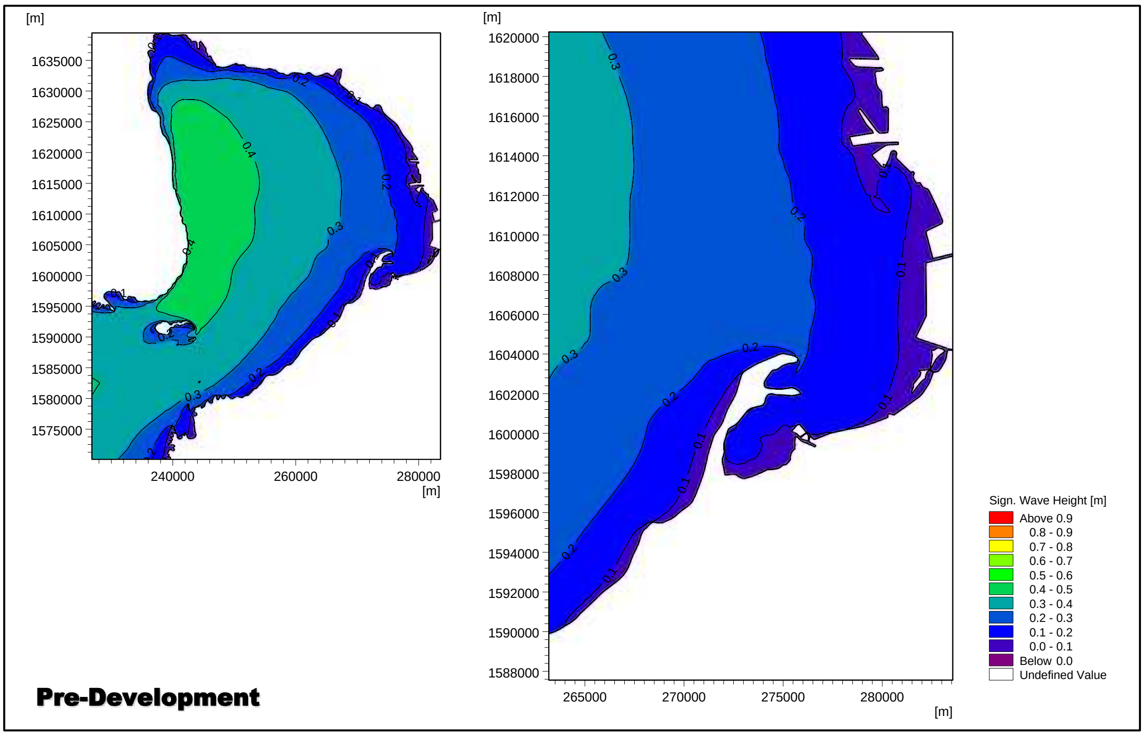


Figure 2.2-47. Wave climate due to 5-8 mps surface winds & offshore waves from N at MHHW
(Pre- & Post-Devt.)



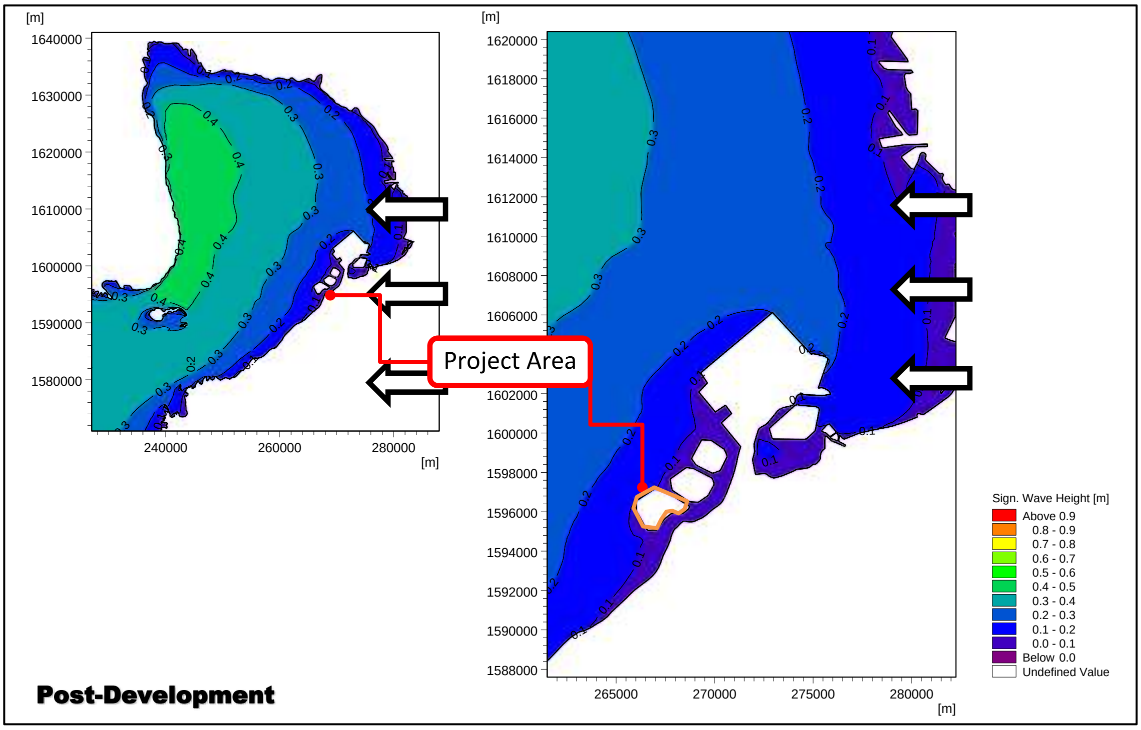


Figure 2.2-48. Wave climate due to 1-4 mps surface winds & offshore waves from E at MHHW (Pre- & Post-Devt.)

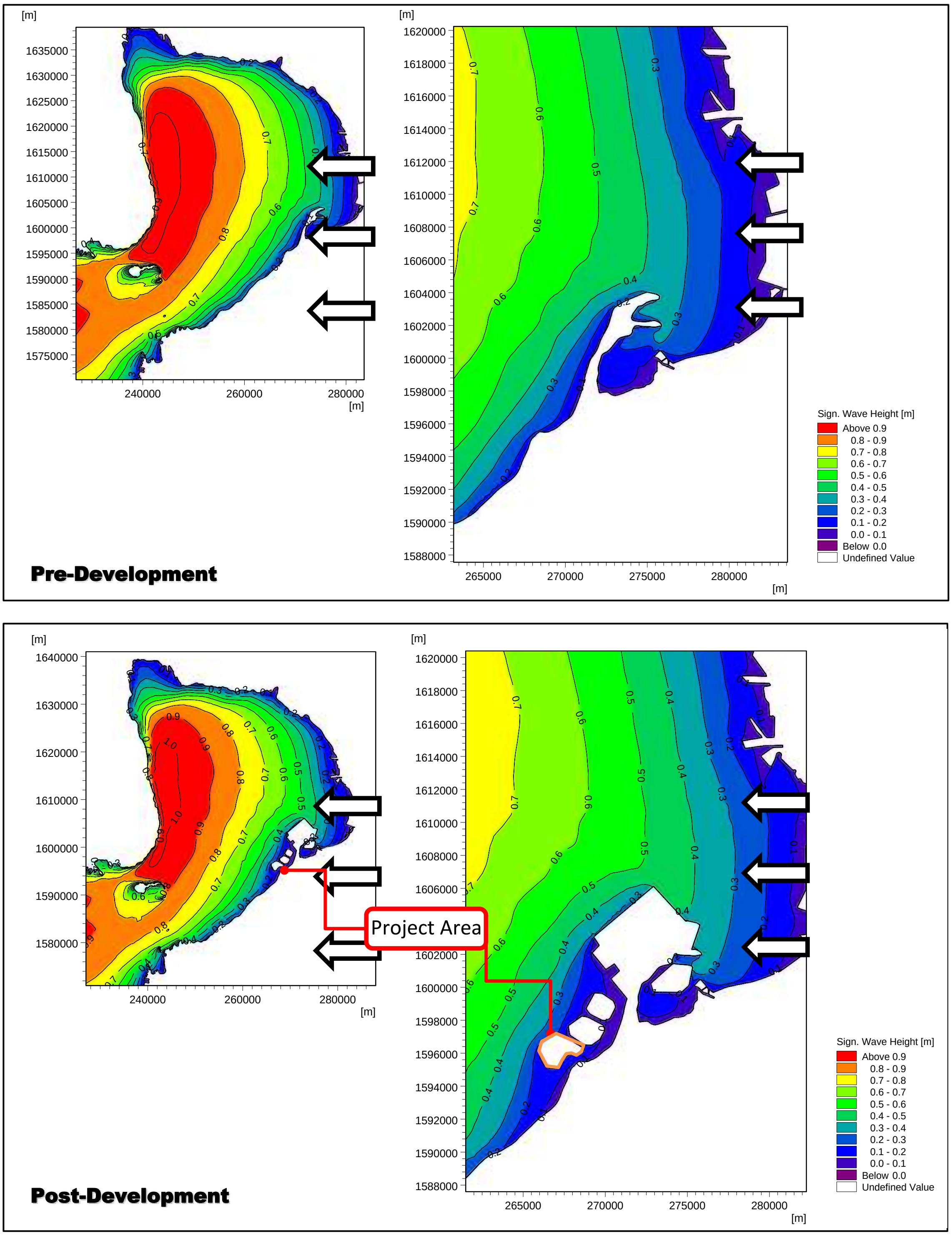


Figure 2.2-49. Wave climate due to 5-8 mps surface winds & offshore waves from E at MHHW
(Pre- & Post-Devt.)

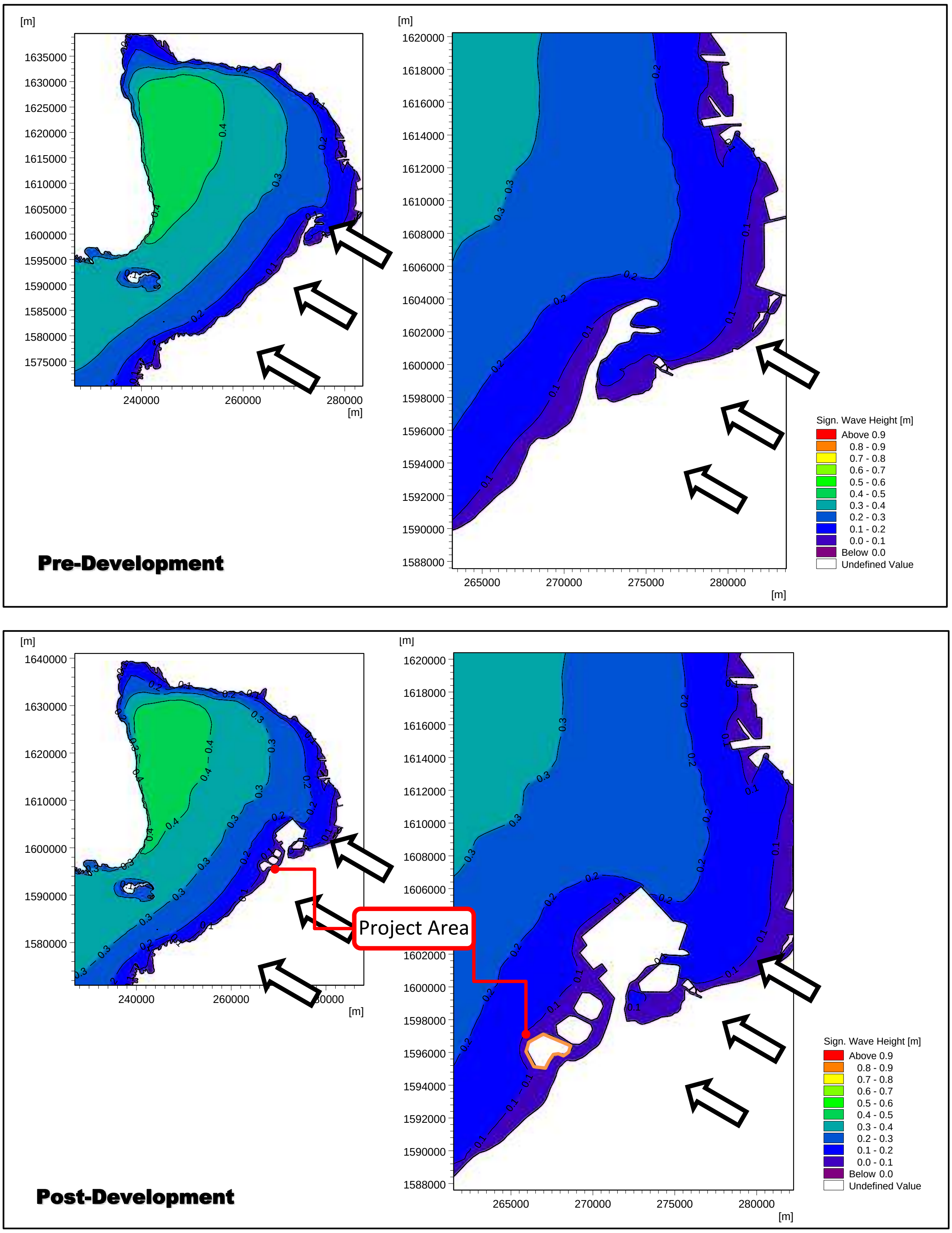


Figure 2.2-50. Wave climate due to 1-4 mps surface winds & offshore waves from ESE at MHHW
(Pre- & Post-Devt.)

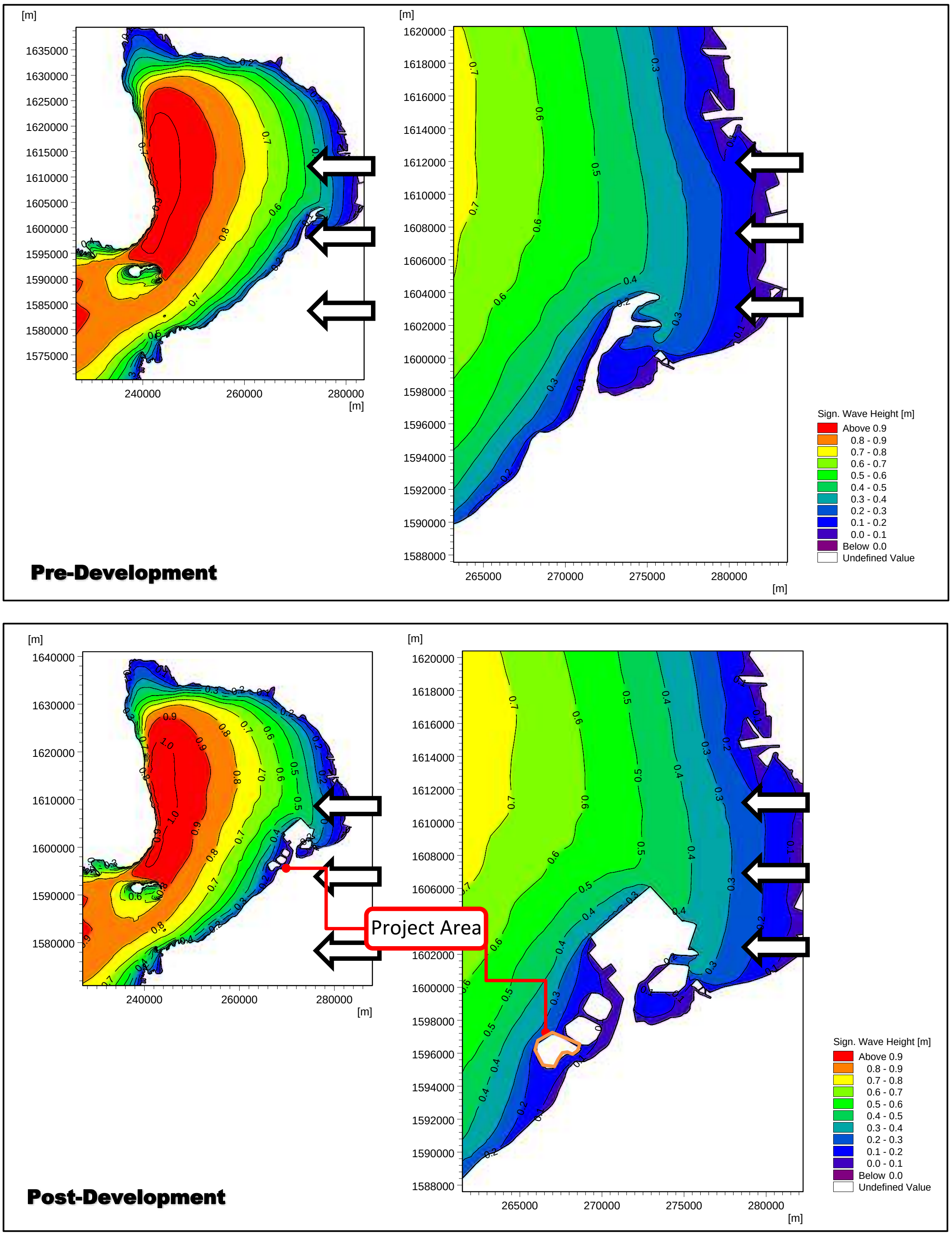


Figure 2.2-51. Wave climate due to 5-8 mps surface winds & offshore waves from ESE at MHHW
(Pre- & Post-Devt.)

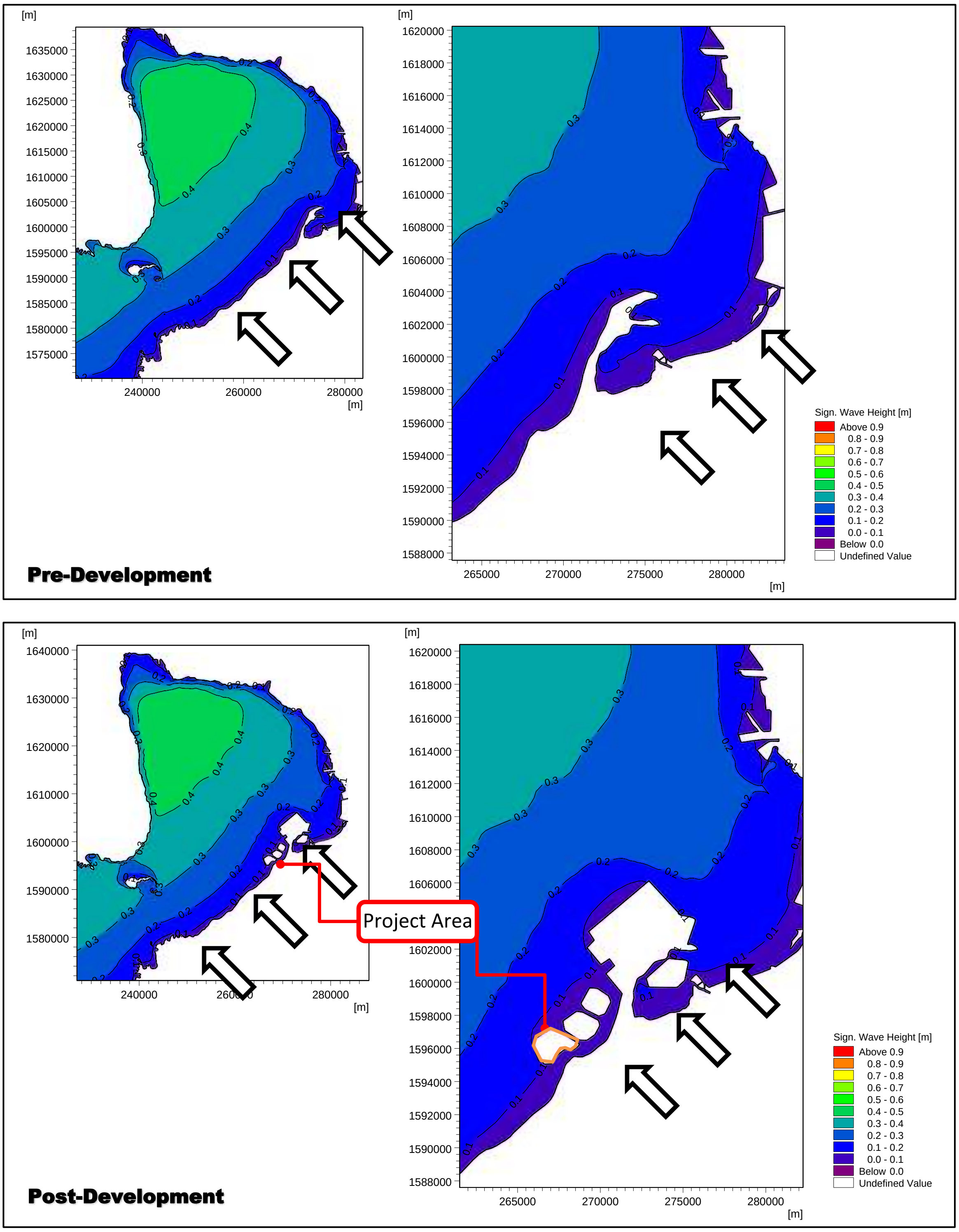


Figure 2.2-52. Wave climate due to 1-4 mps surface winds & offshore waves from SE at MHHW
(Pre- & Post-Devt.)

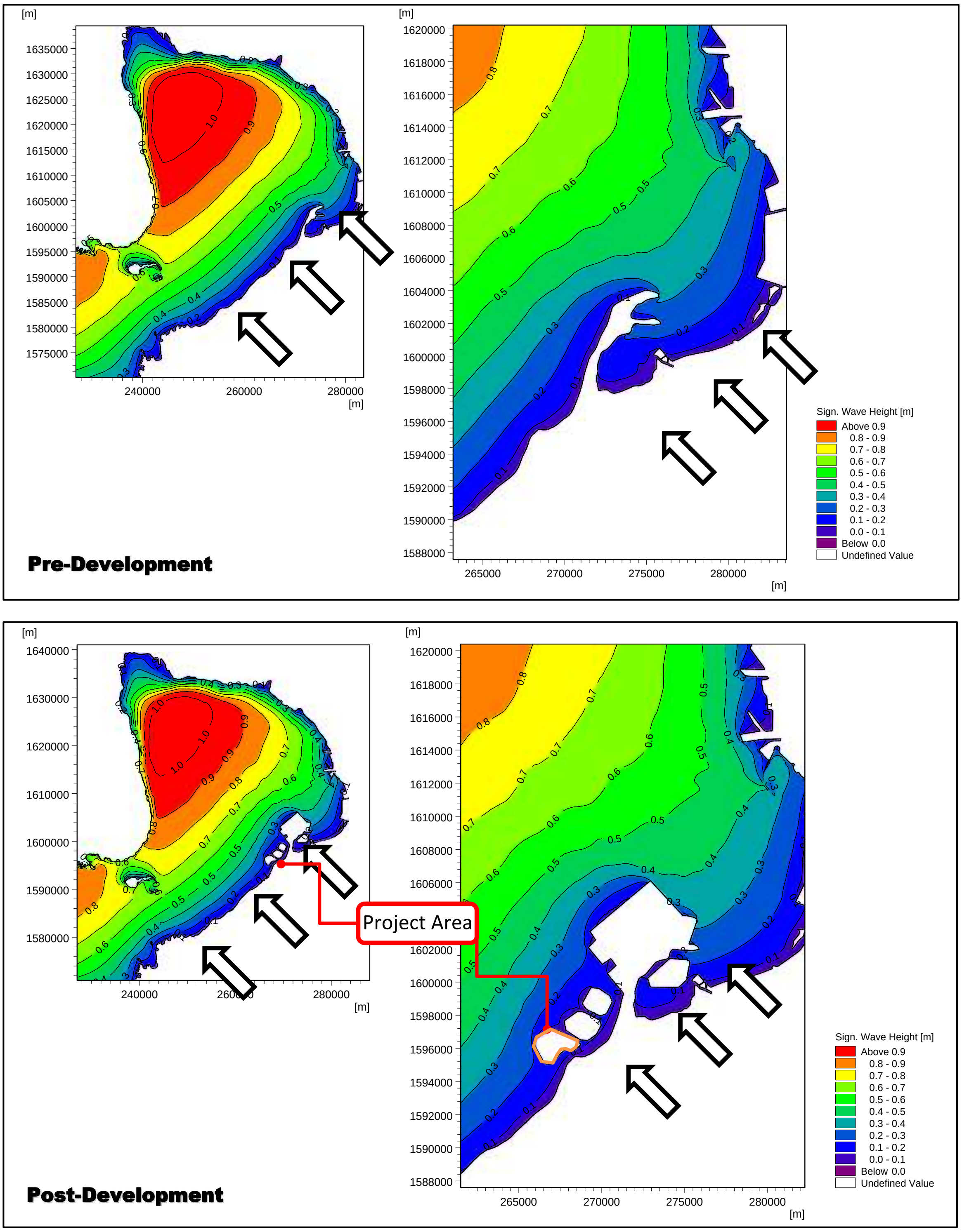


Figure 2.2-53. Wave climate due to 5-8 mps surface winds & offshore waves from SE at MHHW
(Pre- & Post-Devt.)

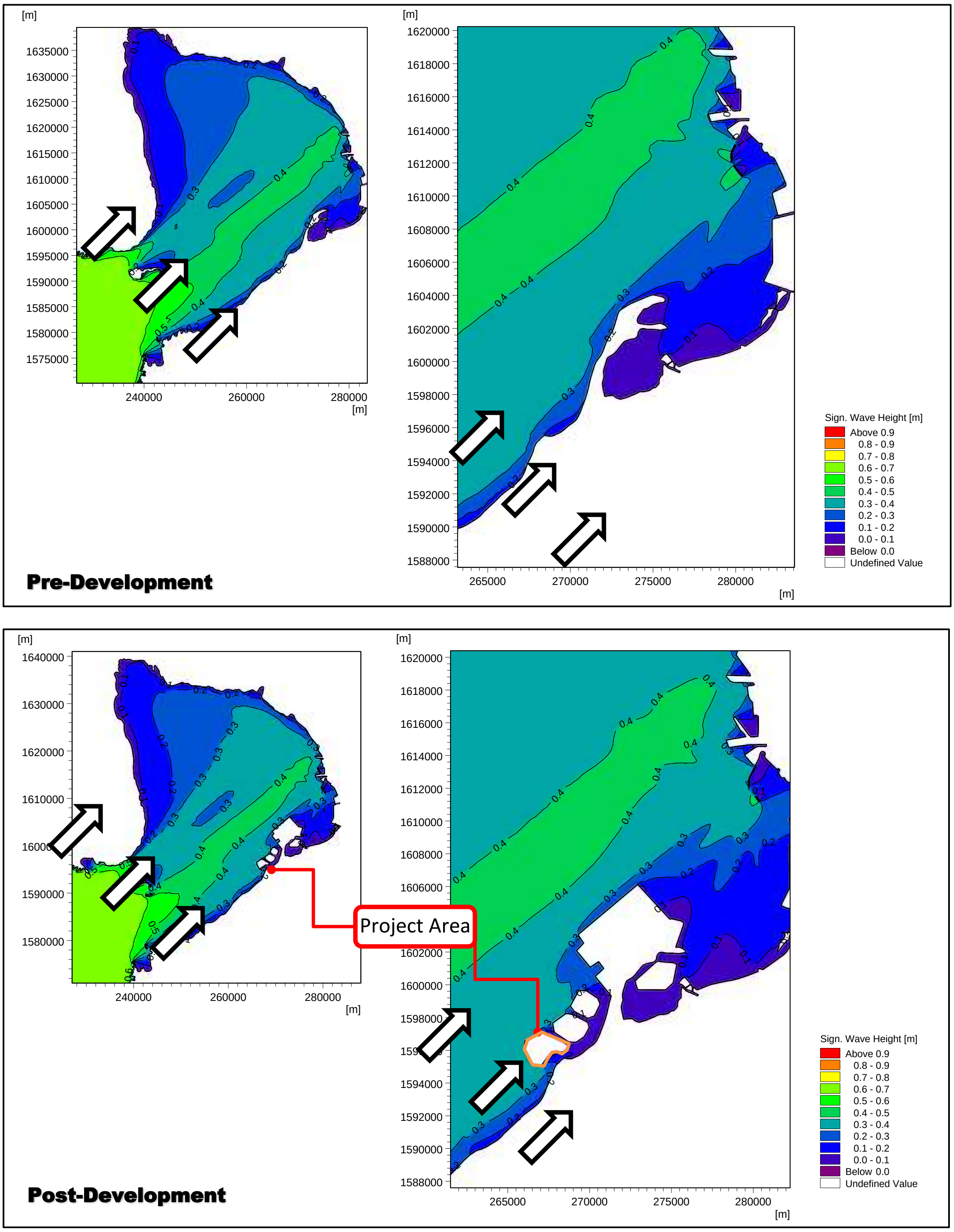


Figure 2.2-54. **Wave climate due to 1-4 mps surface winds & offshore waves from SW at MHHW**
(Pre- & Post-Devt.)

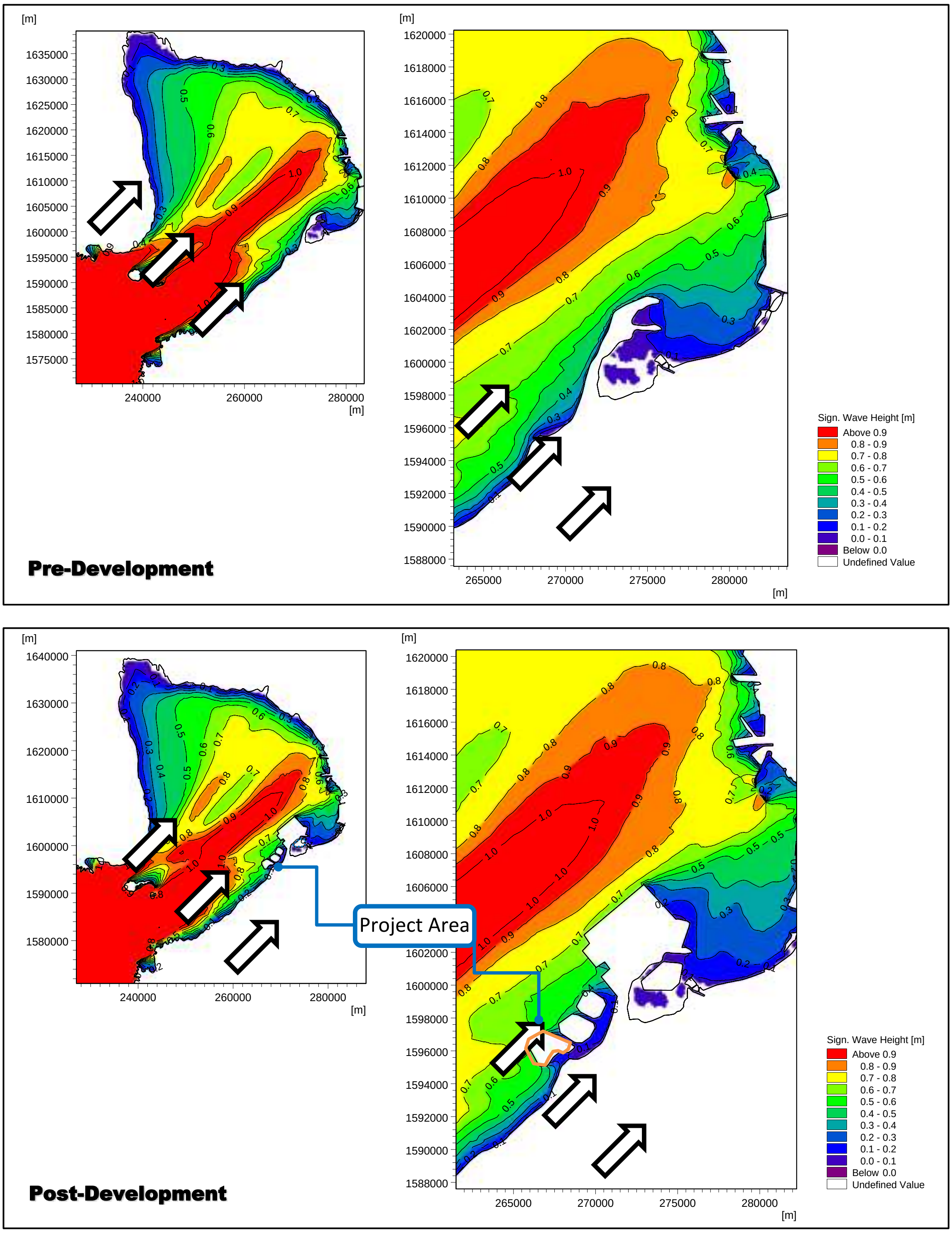


Figure 2.2-55. Wave climate due to 5-8 mps surface winds & offshore waves from SW at MHHW
(Pre- & Post-Devt.)

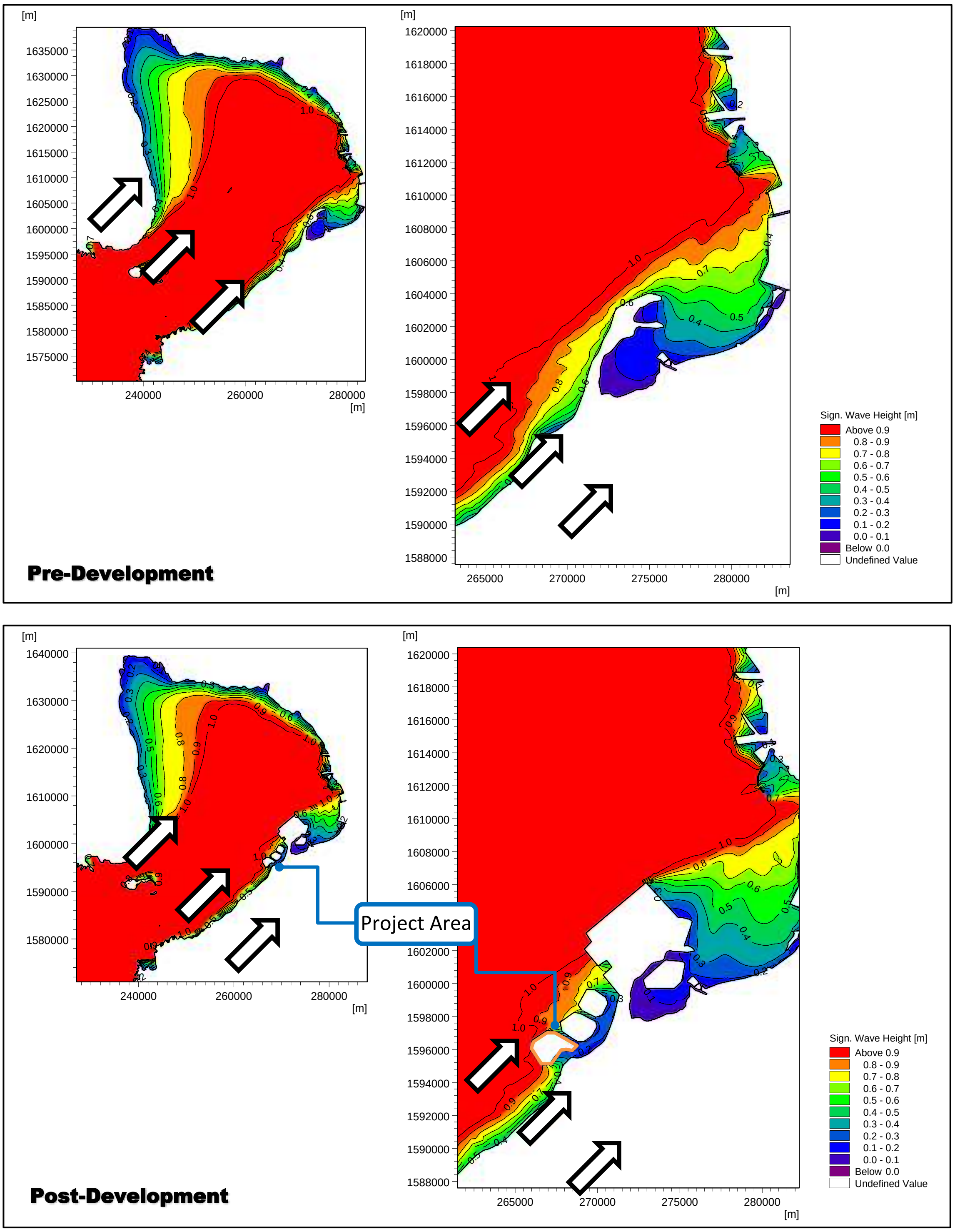


Figure 2.2-56. Wave climate due to 9-12 mps surface winds & offshore waves from SW at MHHW
(Pre- & Post-Devt.)

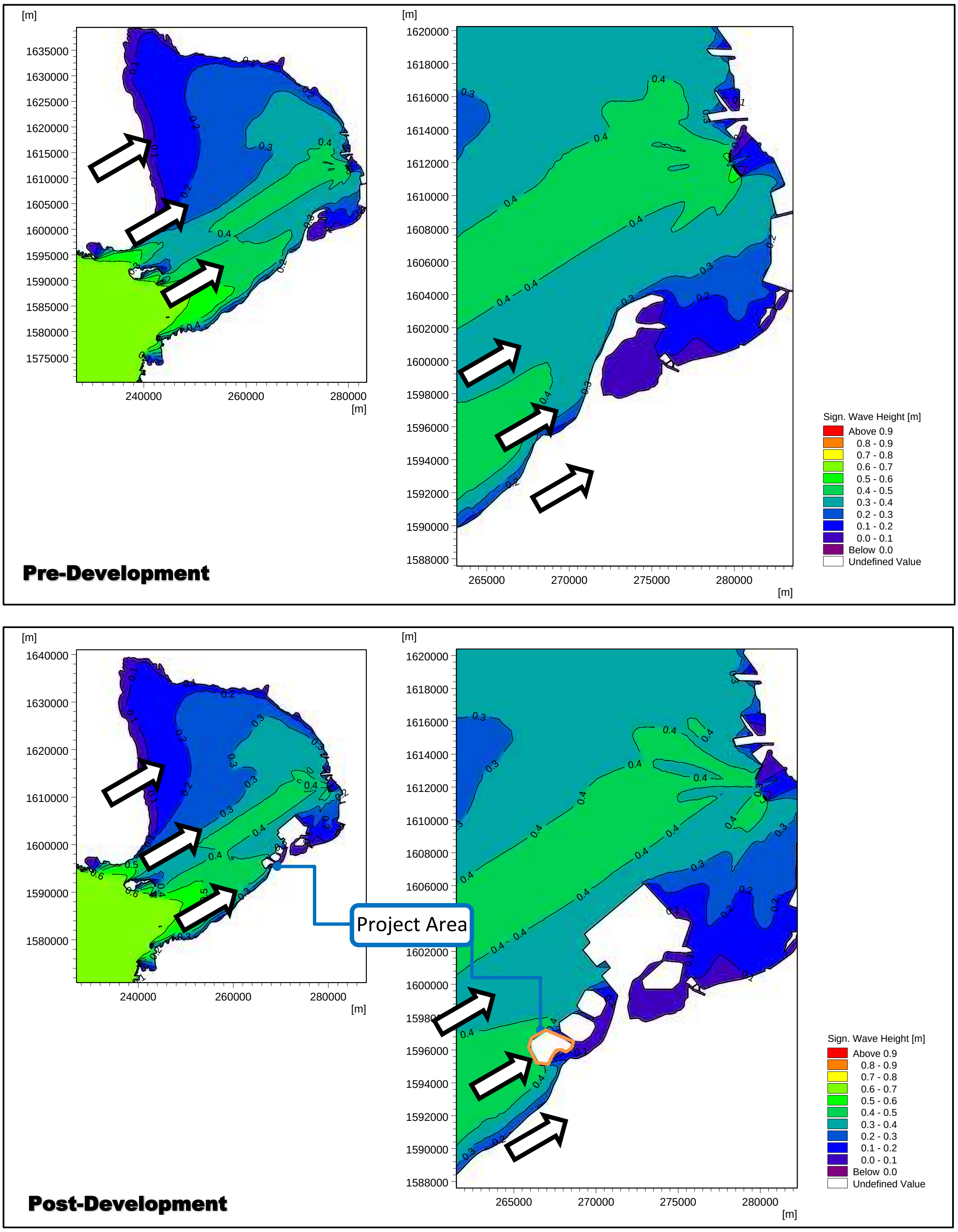
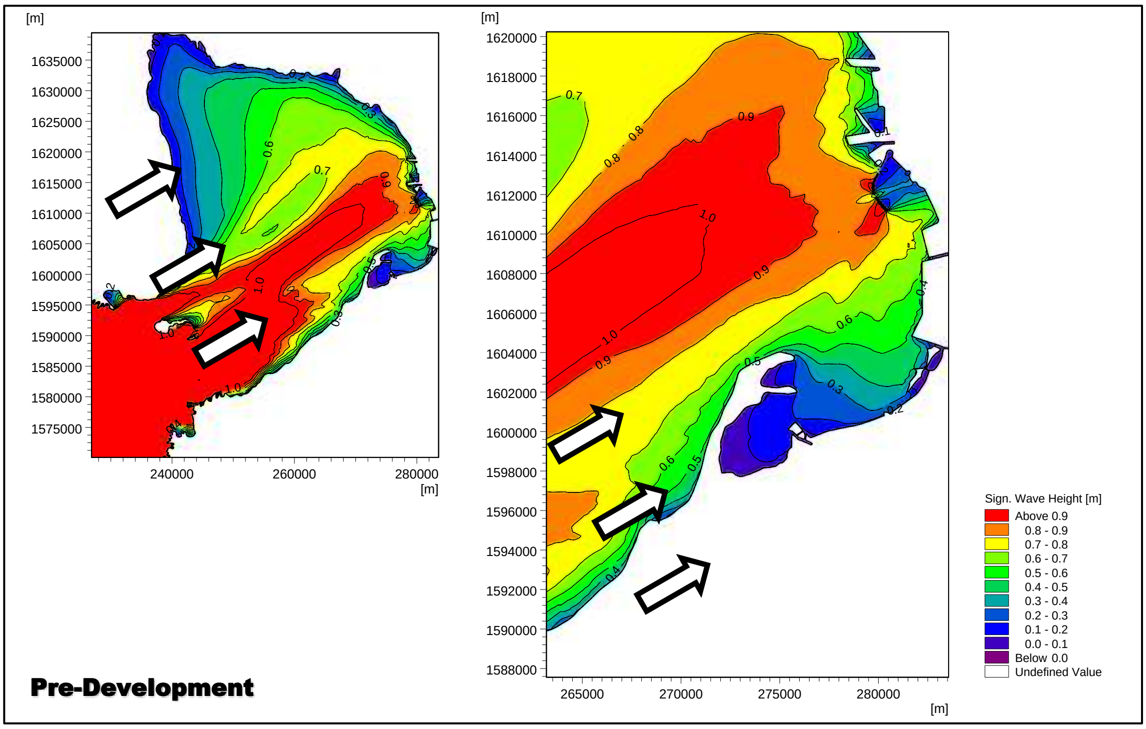


Figure 2.2-57. Wave climate due to 1-4 mps surface winds & offshore waves from WSW at MHHW
(Pre- & Post-Devt.)



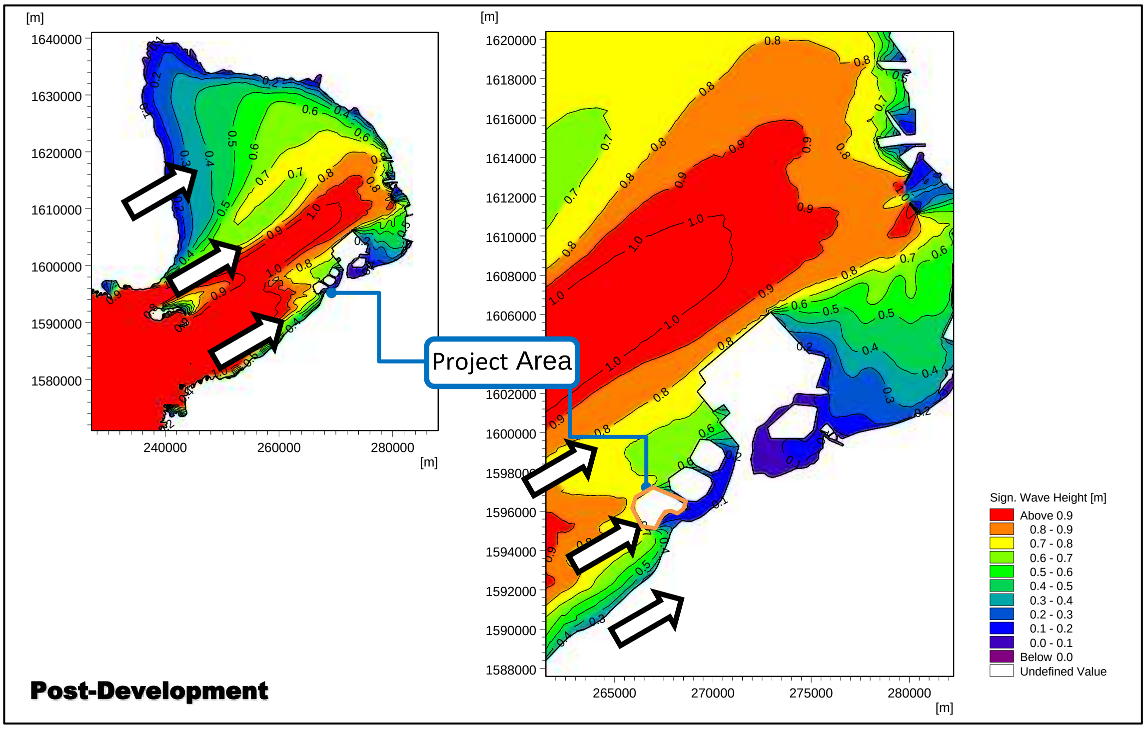


Figure 2.2-58. Wave climate due to 5-8 mps surface winds & offshore waves from WSW at MHHW (Pre- & Post-Devt.)

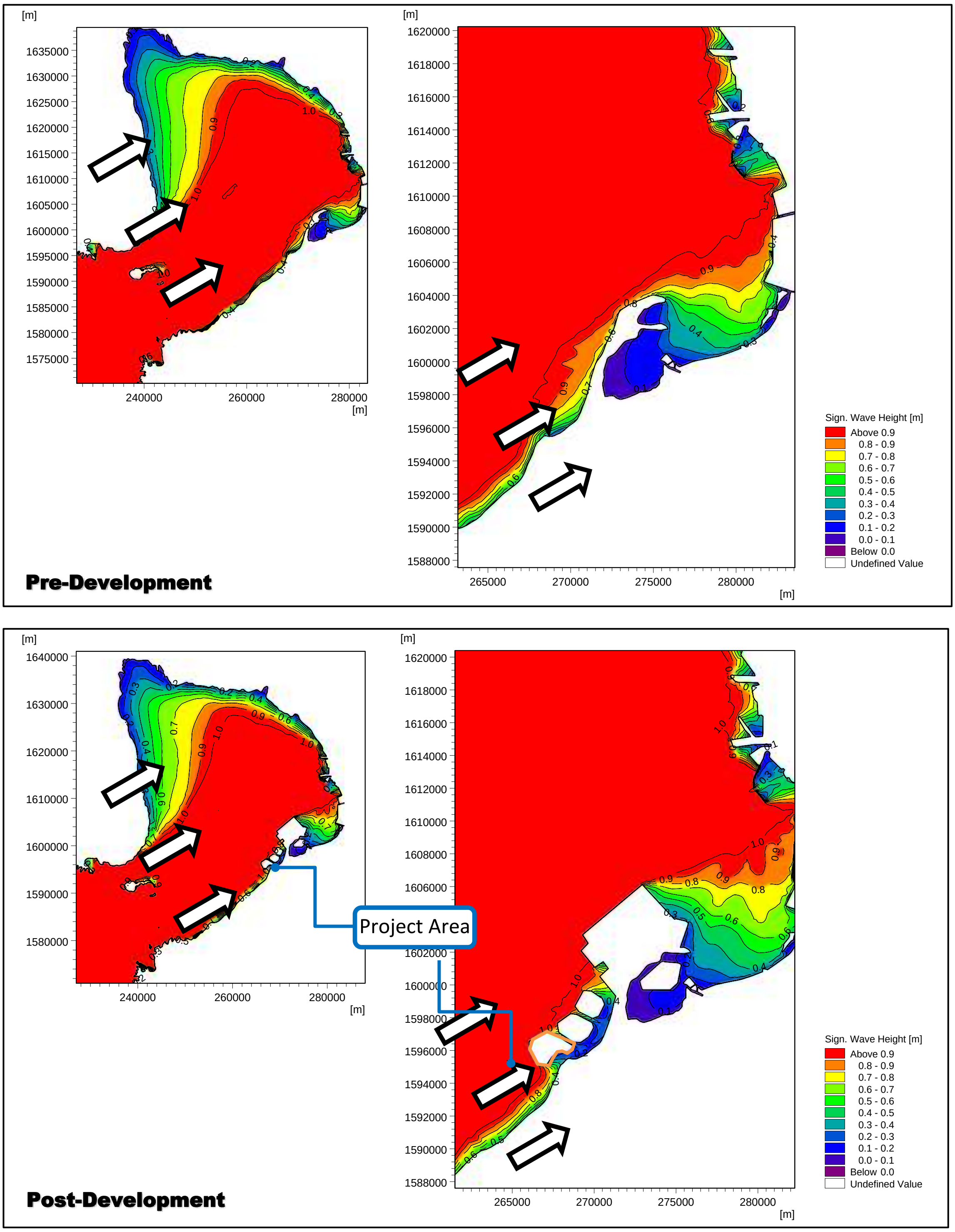


Figure 2.2-59. Wave climate due to 9-12 mps surface winds & offshore waves from WSW at MHHW
(Pre- & Post-Devt.)

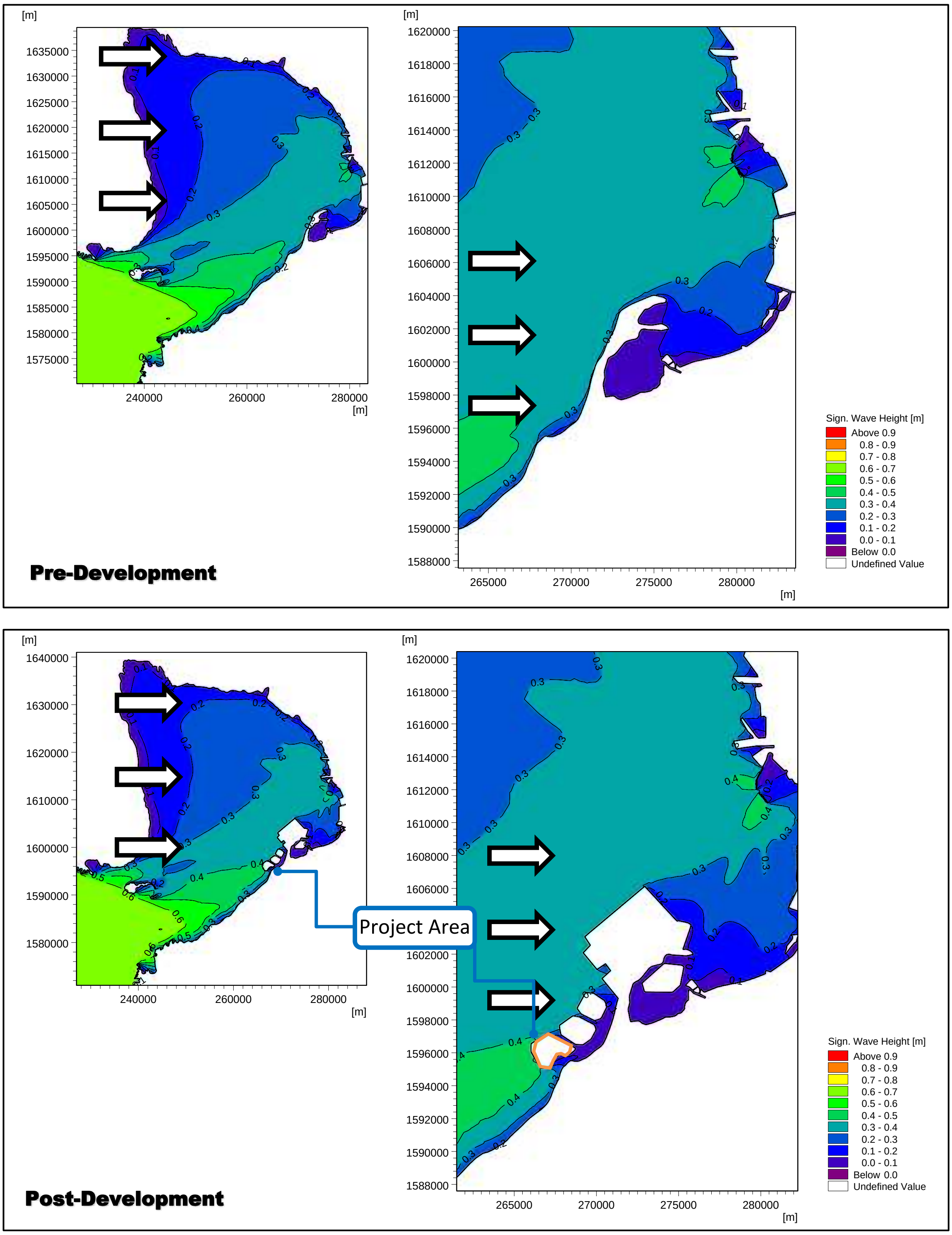


Figure 2.2-60. Wave climate due to 1-4 mps surface winds & offshore waves from W at MHHW
(Pre- & Post-Devt.)

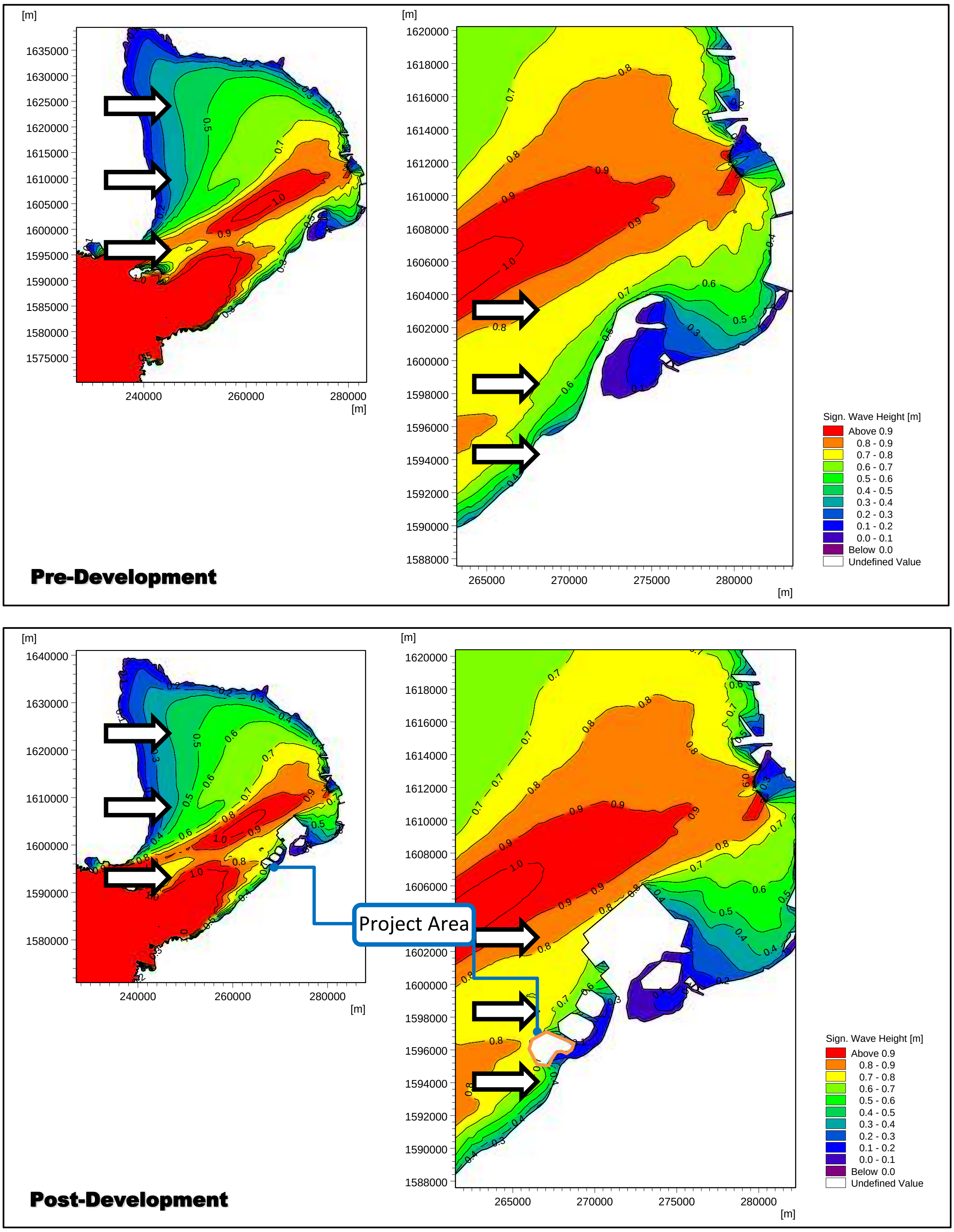


Figure 2.2-61. **Wave climate due to 5-8 mps surface winds & offshore waves from W at MHHW**
(Pre- & Post Devt.)

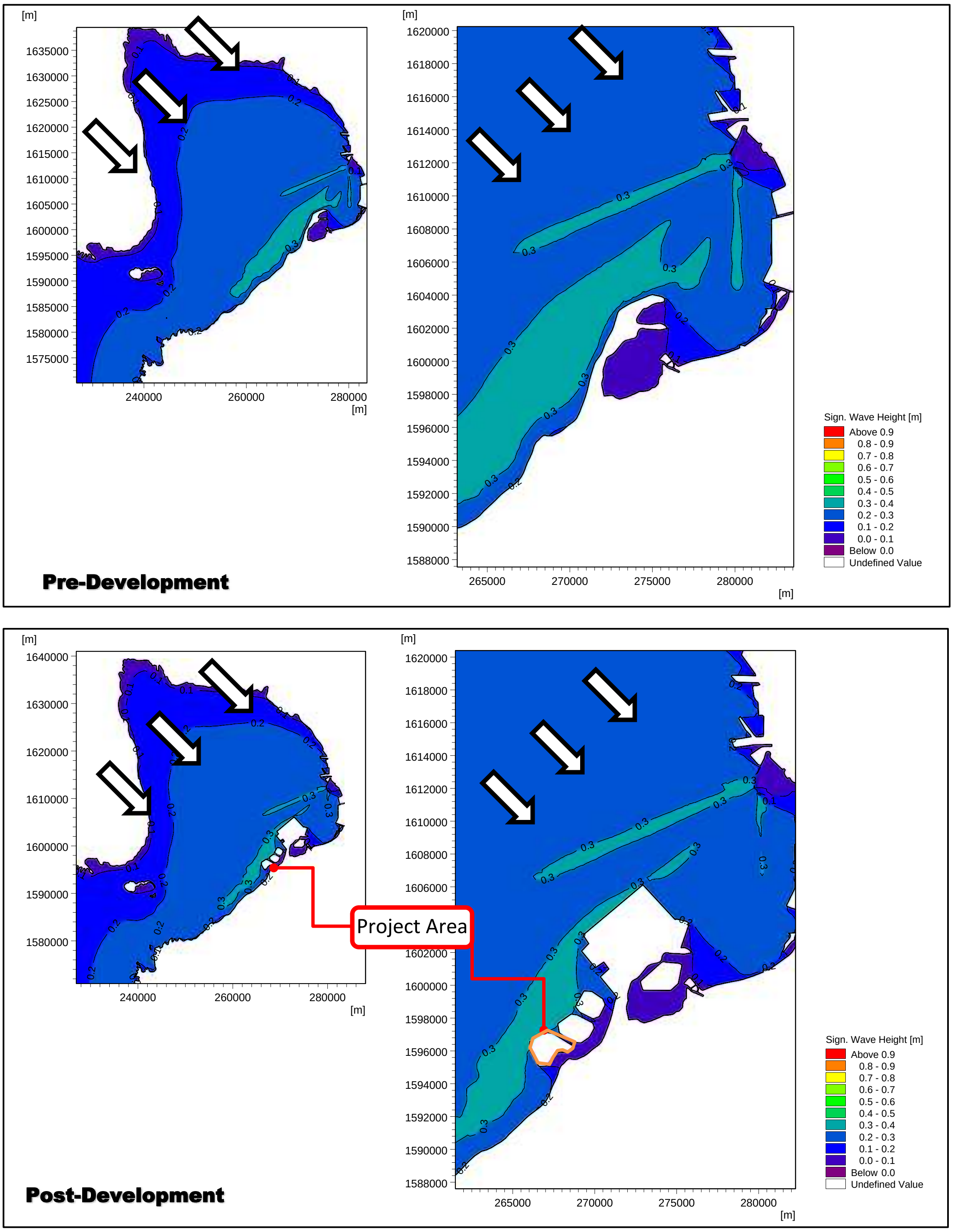


Figure 2.2-62. Wave climate due to 1-4 mps surface winds & offshore waves from NW at MHHW (Pre- & Post Devt.)

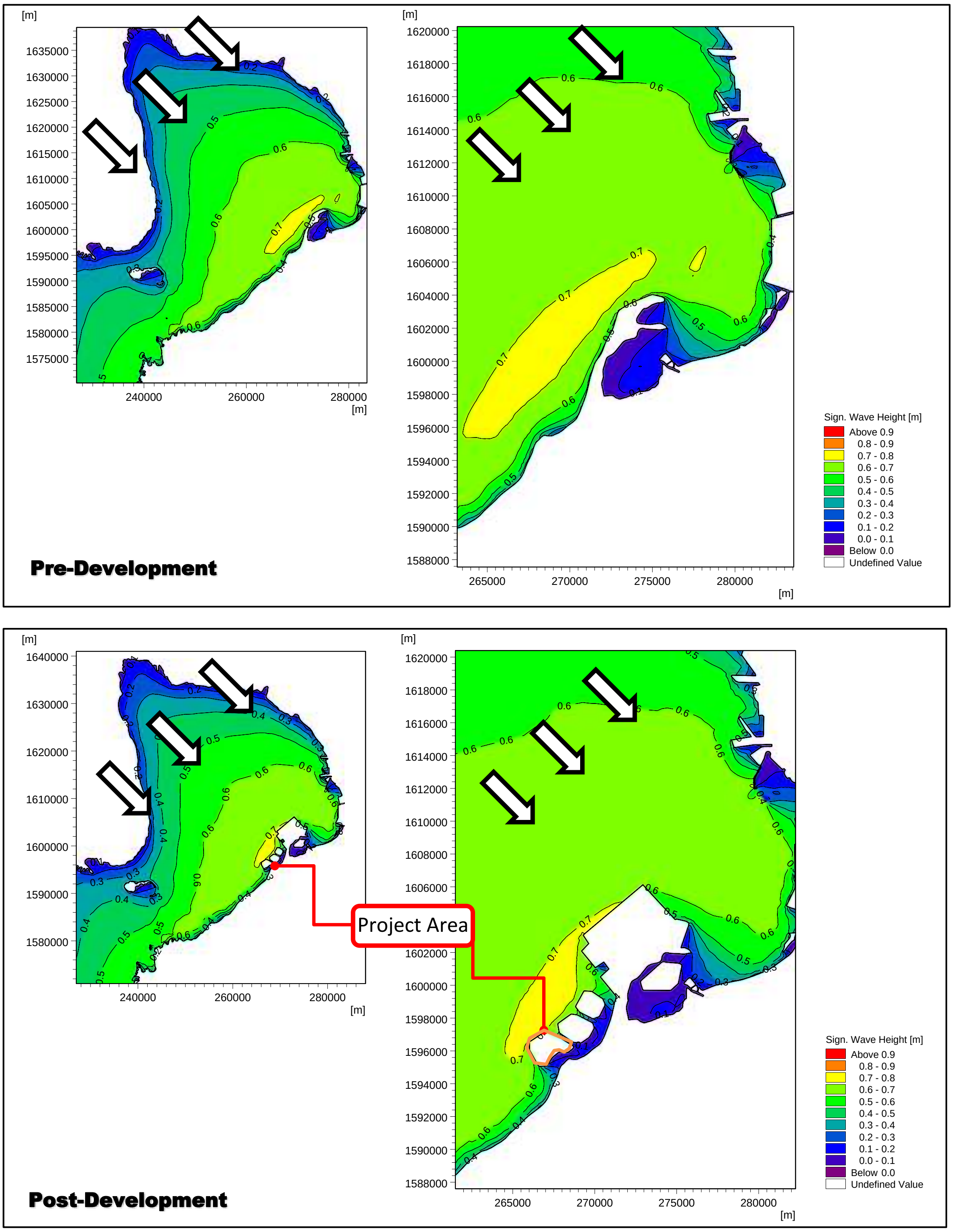


Figure 2.2-63. Wave climate due to 5-8 mps surface winds & offshore waves from NW at MHHW (Pre- & Post Devt.)

The hydrodynamic models derived for the project wer 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.

2.2.2.1.2 Tidal Current Analysis/ Changes/disruption in water circulation pattern Water Circulation Patterns Littoral Currents

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 2.2-64). 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 2.2-64. 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 (R2) value of 0.91 at Manila South Harbor.

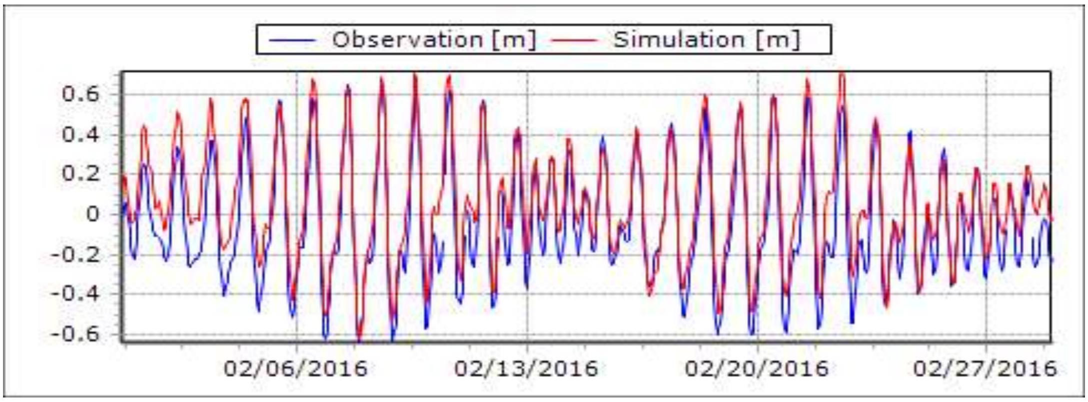


Figure 2.2-64. Simulated Tide Levels at Manila Bay South Harbor

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 2.2-65 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.

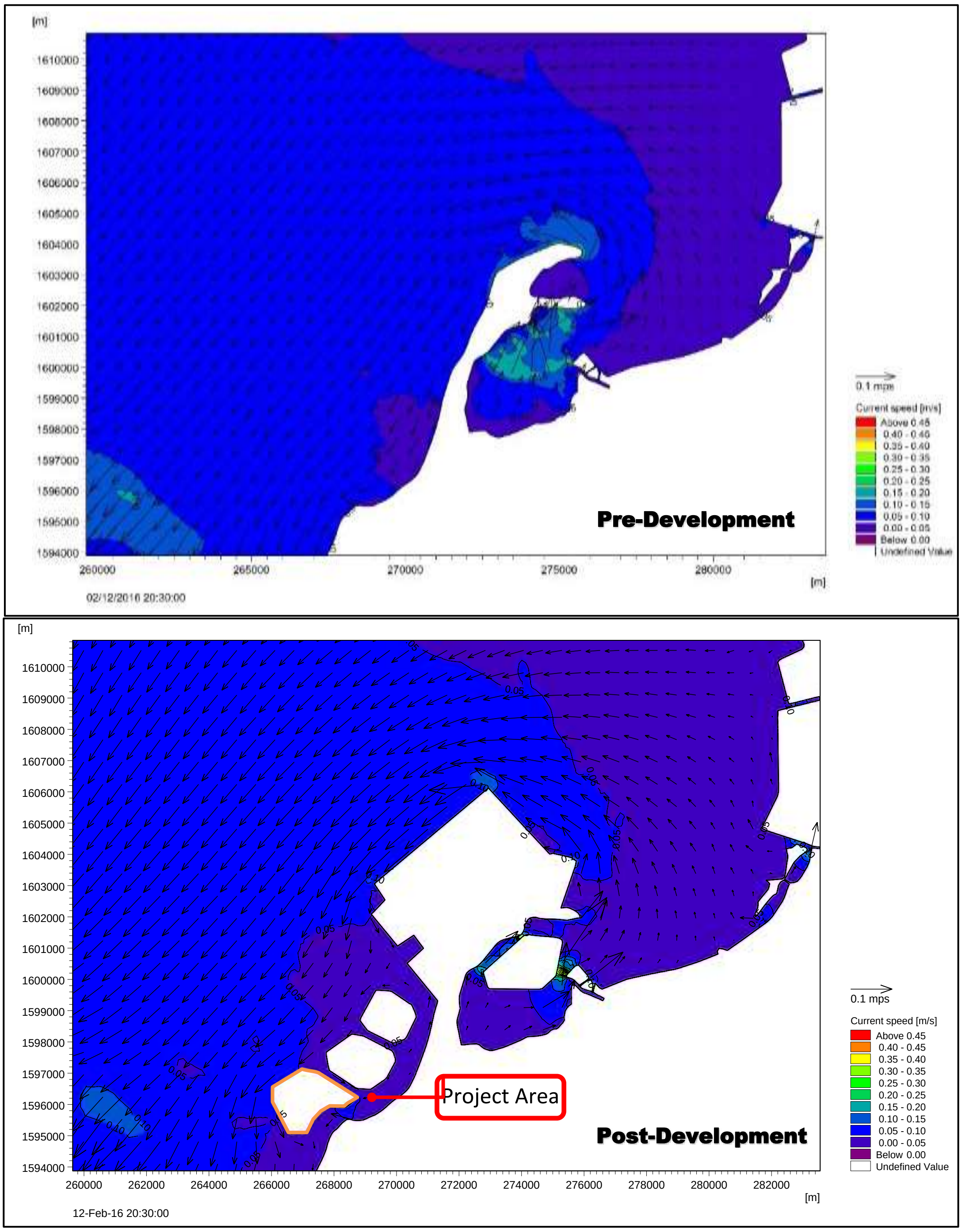


Figure 2.2-65. Snapshot of current magnitude & direction during ebb tide (20:30 Feb 12, 2016) Pre- & Post-Devt.

For the sample flow tide case, there is a **slight decrease** in current speed along the seaward side of Islands B-E, with a **slight increase** in the current speed on the leeside of **Island E**. Otherwise there are no macro changes in the current speeds and directions.

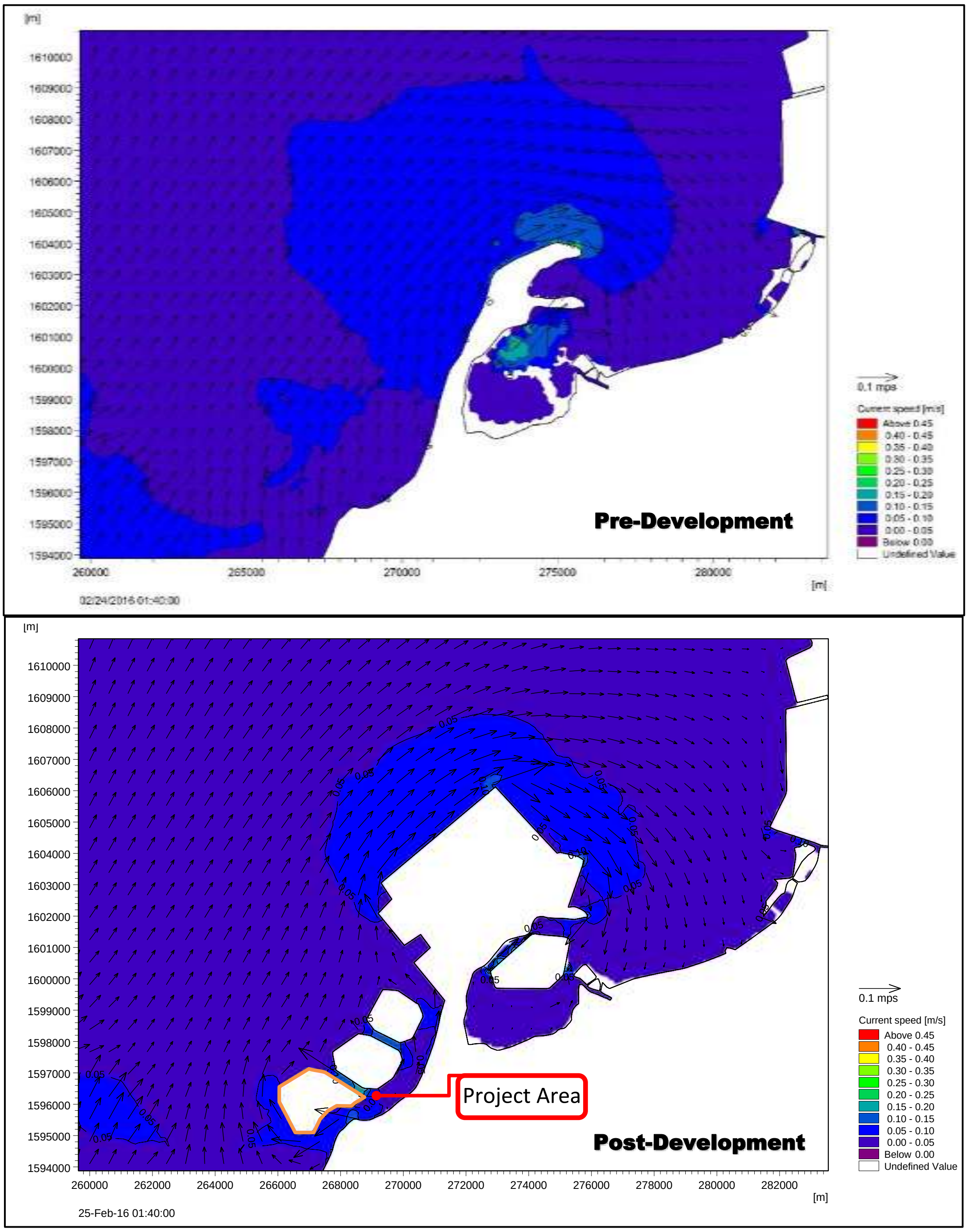


Figure 2.2-66. Snapshot of current magnitude & direction during flow tide (01:40 Feb 24, 2016) Pre- & Post-Devt.

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 2.2-66 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 Bacoor 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

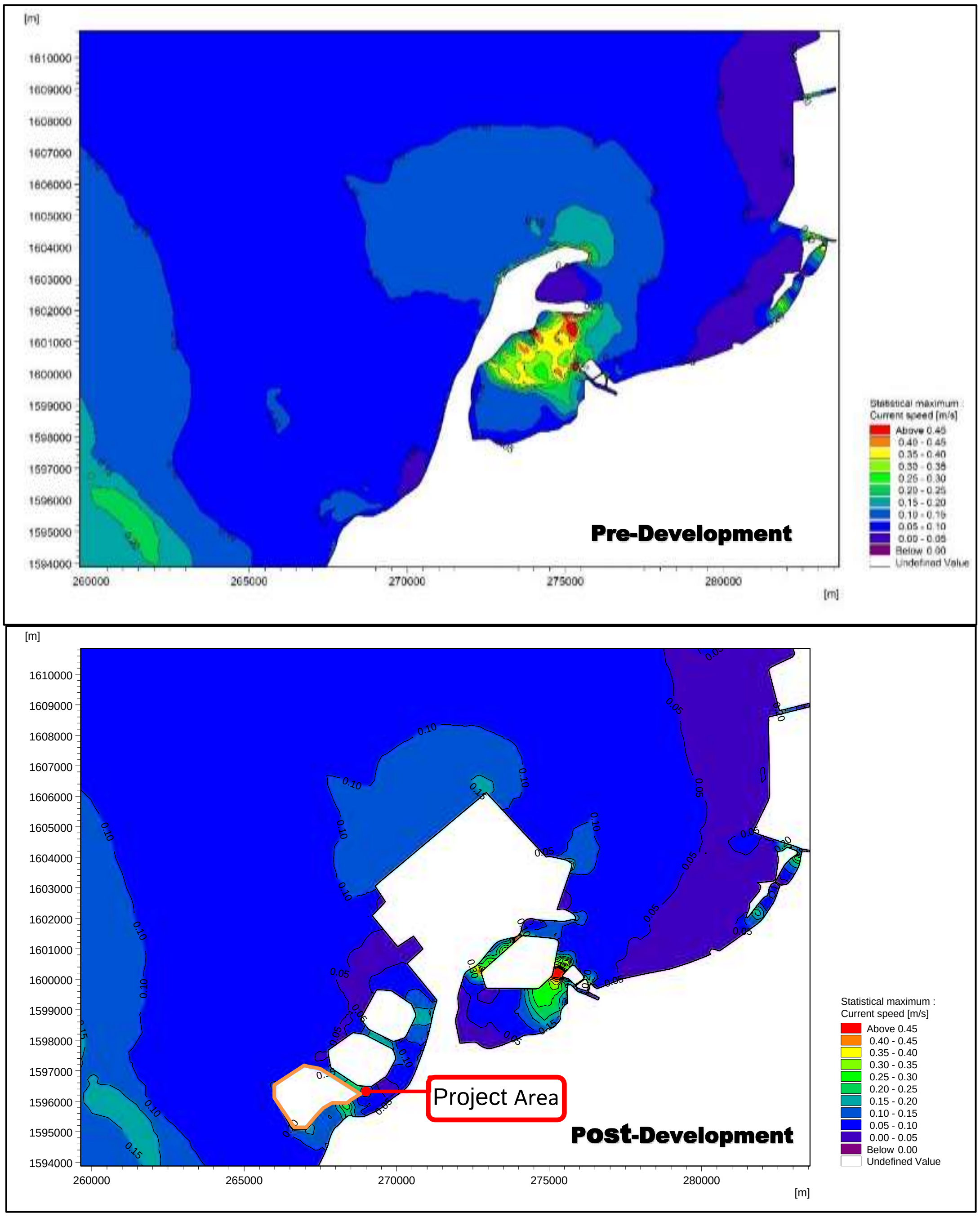


Figure 2.2-67. Maximum current (Jan 29, 2016 – Feb 29, 2016)
Pre- & Post-Devt.

2.2.2.1.3 Tidal Circulation Analysis

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 Bacoor 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 2.2-67. 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 shown 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 (C4 is the channel 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 2.2-68. 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 Bacoor Bay. The exterior flows around the reclaimed land F (Sangley 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.

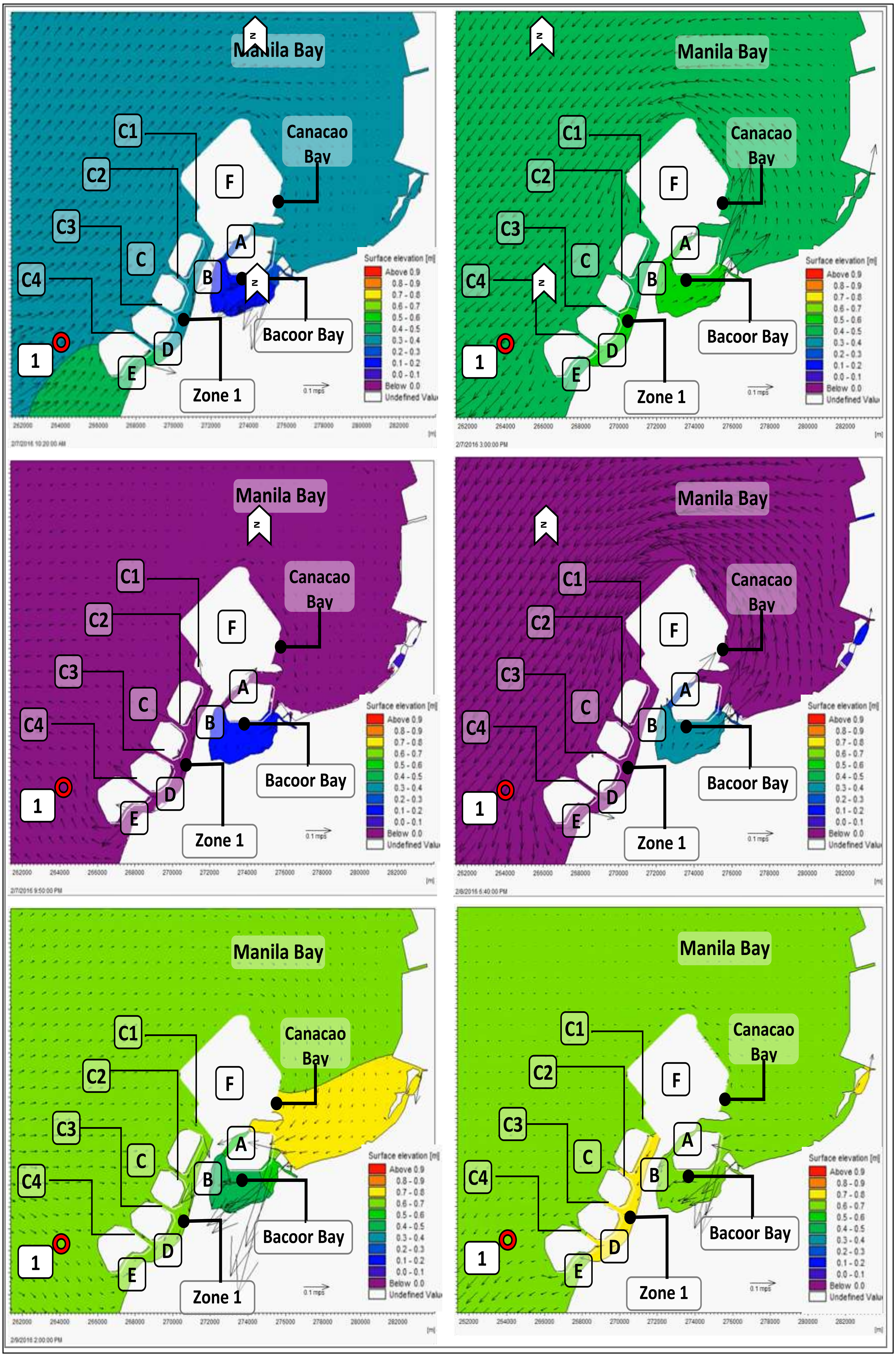


Figure 2.2-68. Chronological snapshots of tidal currents during Jan 29 – Feb 20, 2016

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 2.2-69. Over a tidal cycle of 15 days, Figures 2.2-70 and 2.2-71 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 (Bacoor 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.

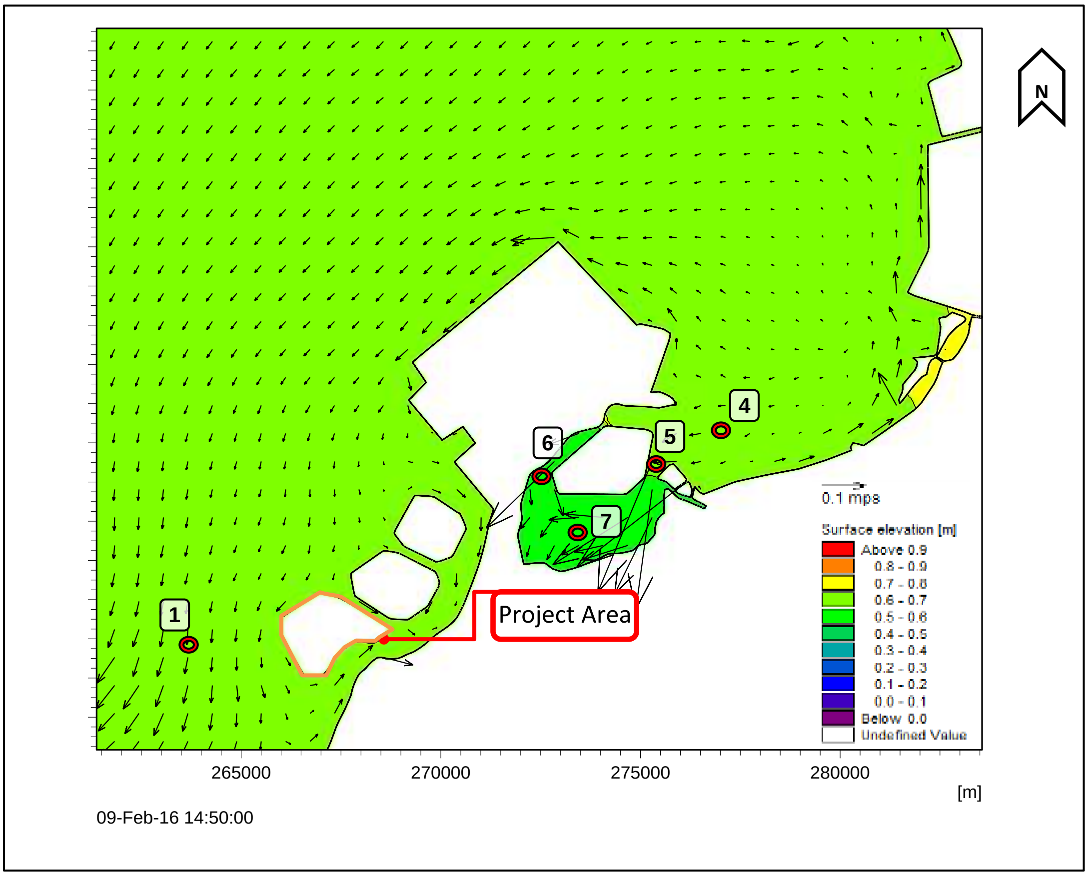


Figure 2.2-69. Location of Monitoring Points

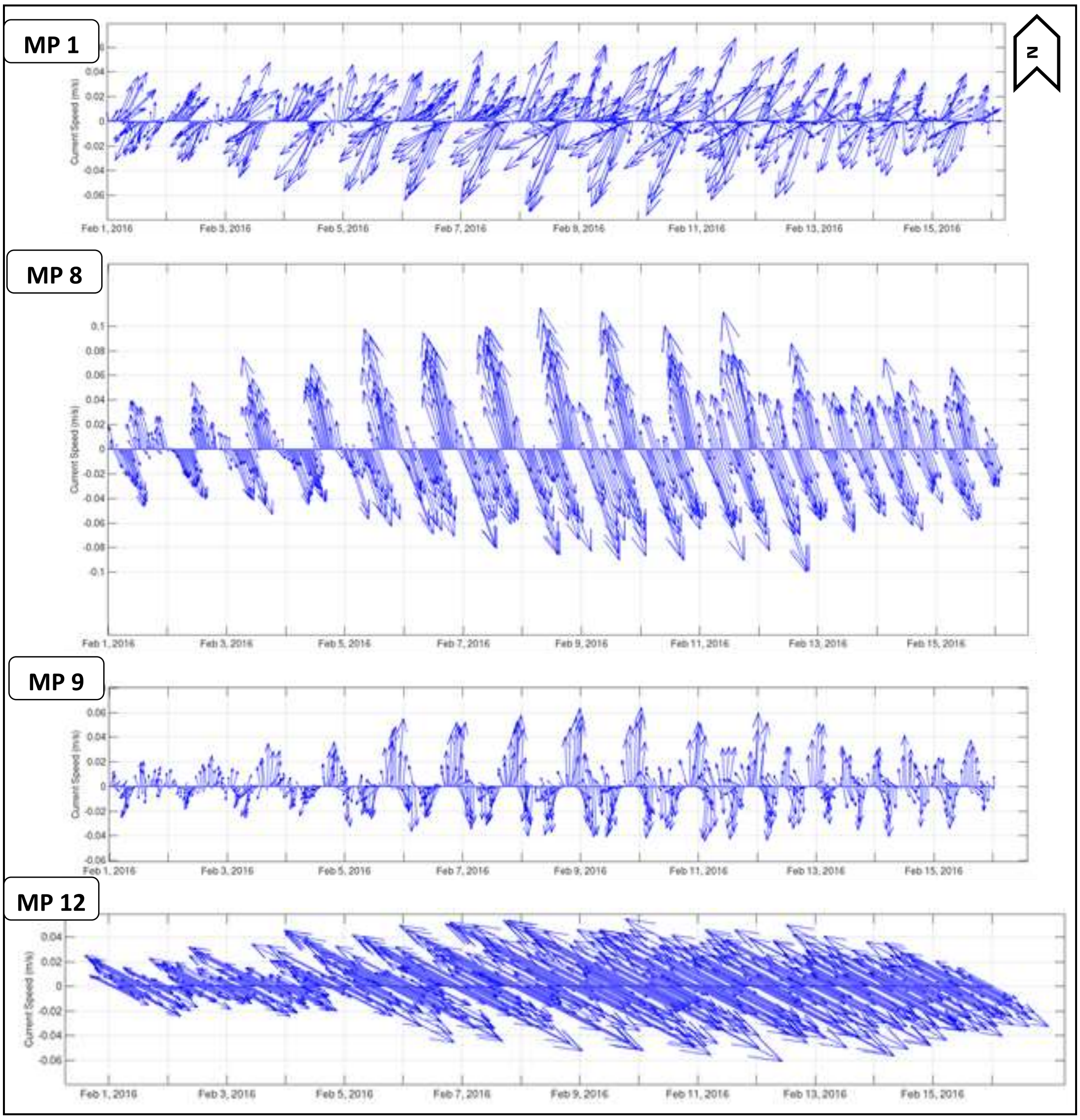


Figure 2.2-70. Tidal Current Time Histories over 15 days at MPs 1, 8, 9, & 12

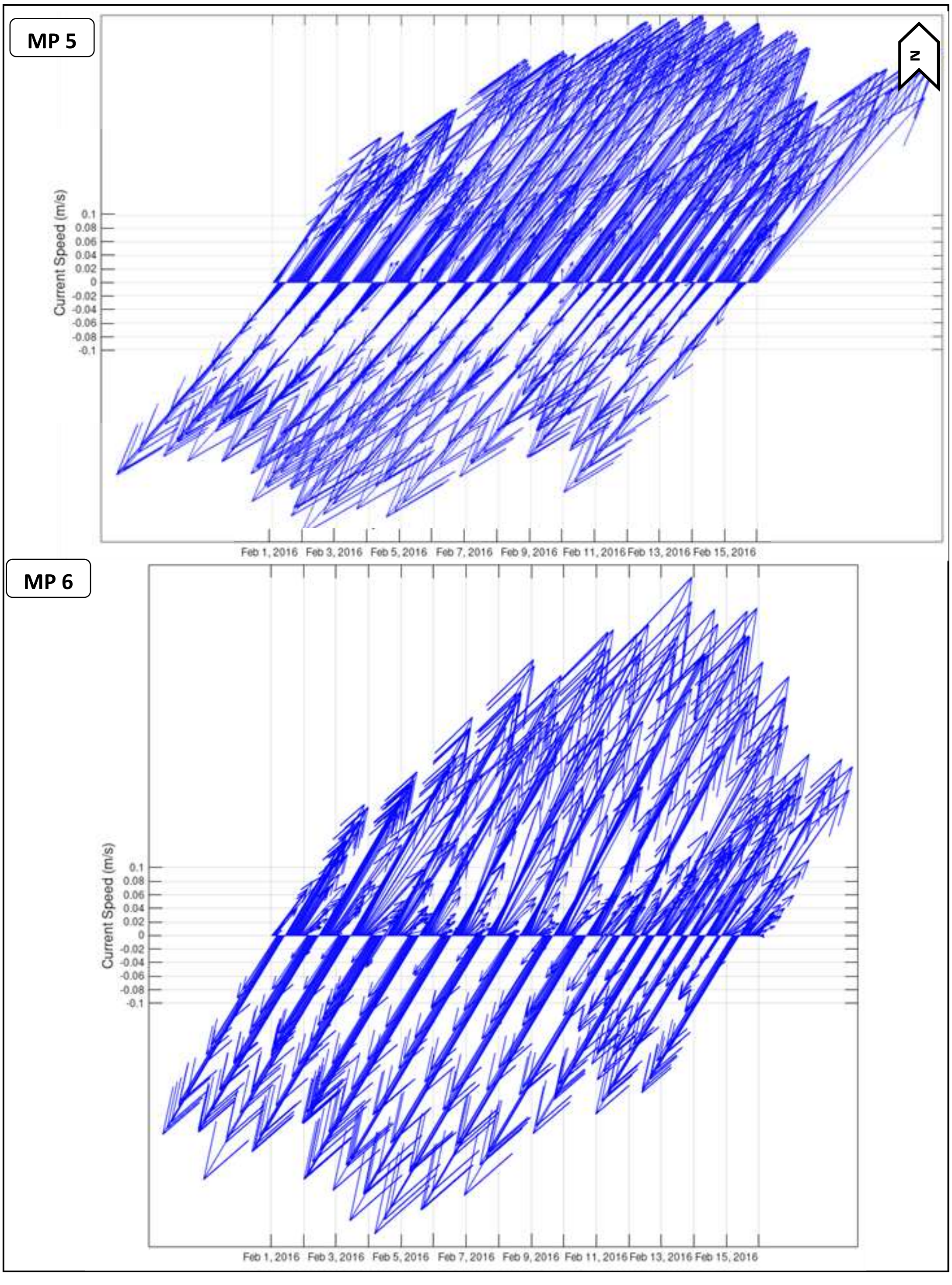


Figure 2.2-71. Tidal Current Time Histories over 15 days at MPs 5 & 6

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.

2.2.2.1.4 Storm Condition Analysis

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.

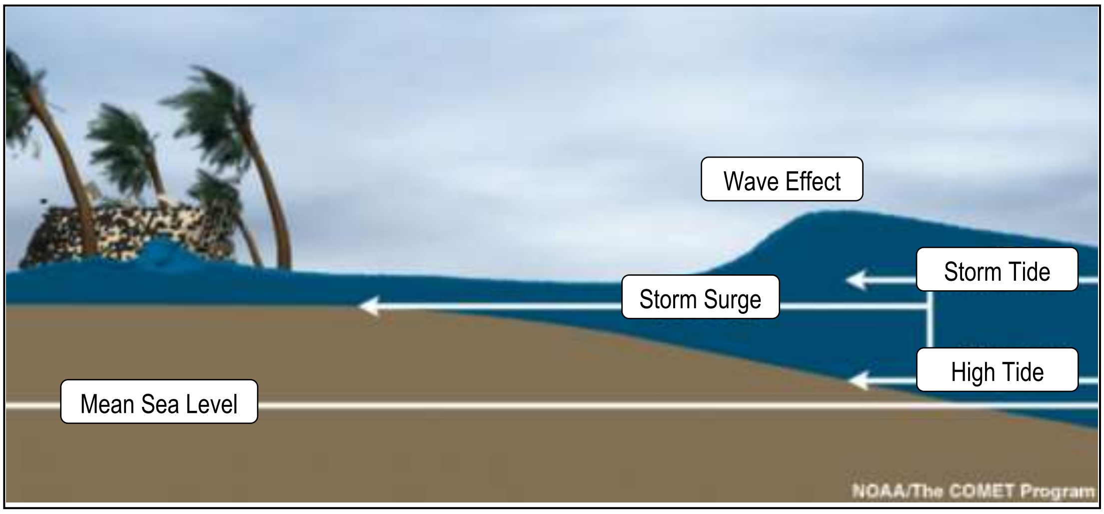
When the storm's center is in the oceans, these effects are generally small on account of the large depth of water to mobilize and the vast expanse of water. However, these effects are quickly amplified when the storm reaches the shallow water. As the storm reaches the coasts the small depth of water 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 2.2-37, 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 2.2-72), 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 2.2-72. Illustration of the Combined Effects of Astronomic Tide and Storm Surge

Synthesis of Storm Tide Levels

From the list of typhoons in Table 2.2-17, further analyses resulted in the narrowing down to three (3) potentially critical typhoons as shown in Table 2.2-43. The following figures (Figures 2.2-73 to 2.2-78) 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

Typhoon	Year	Vmax (kph)	Rmax (km)	Pc (hPa)	Relative Track to the Site
Rita (*Kading*)	1978	203	14	905	N
Patsy (*Yoling*)	1970	192	17	920	N
Xangsane (*Milenyo*)	2006	101	27	980	S

For the pre-development scenario (Figure 2.2-73) Typhoon Rita caused a storm tide level of roughly 1.0 m – 1.1 m at Islands C-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 Bacoor Bay. This range did not increase significantly for the post-development scenario (Figure 2.2-73), 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.

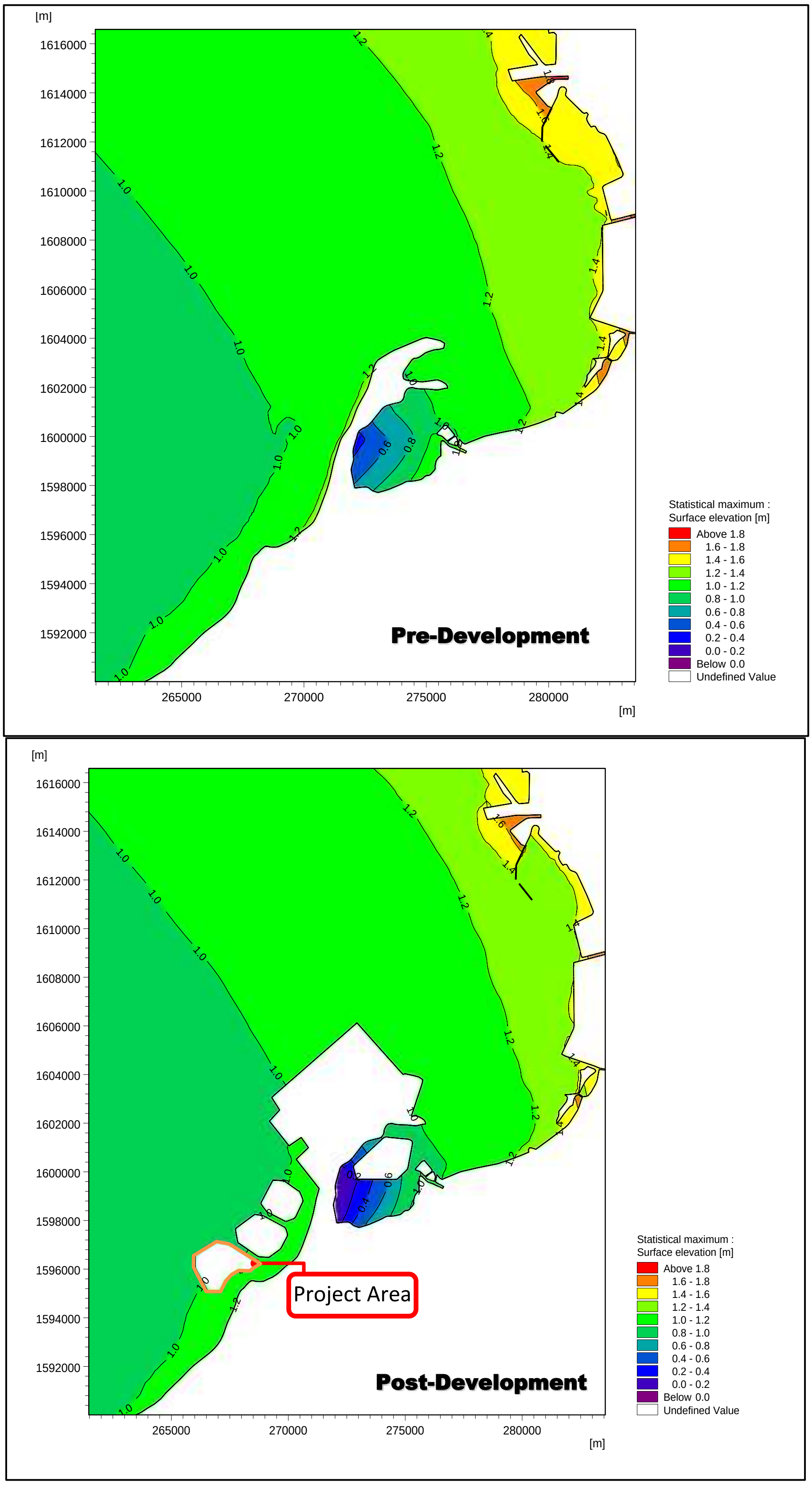


Figure 2.2-73. Simulated Storm Tide Level for Typh. Rita/Kading (1978) Pre- & Post-Devt.

For the pre-development scenario, the storm tide levels generated by Typhoon Patsy (Figure 2.2-74) 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 2.2-74) 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.

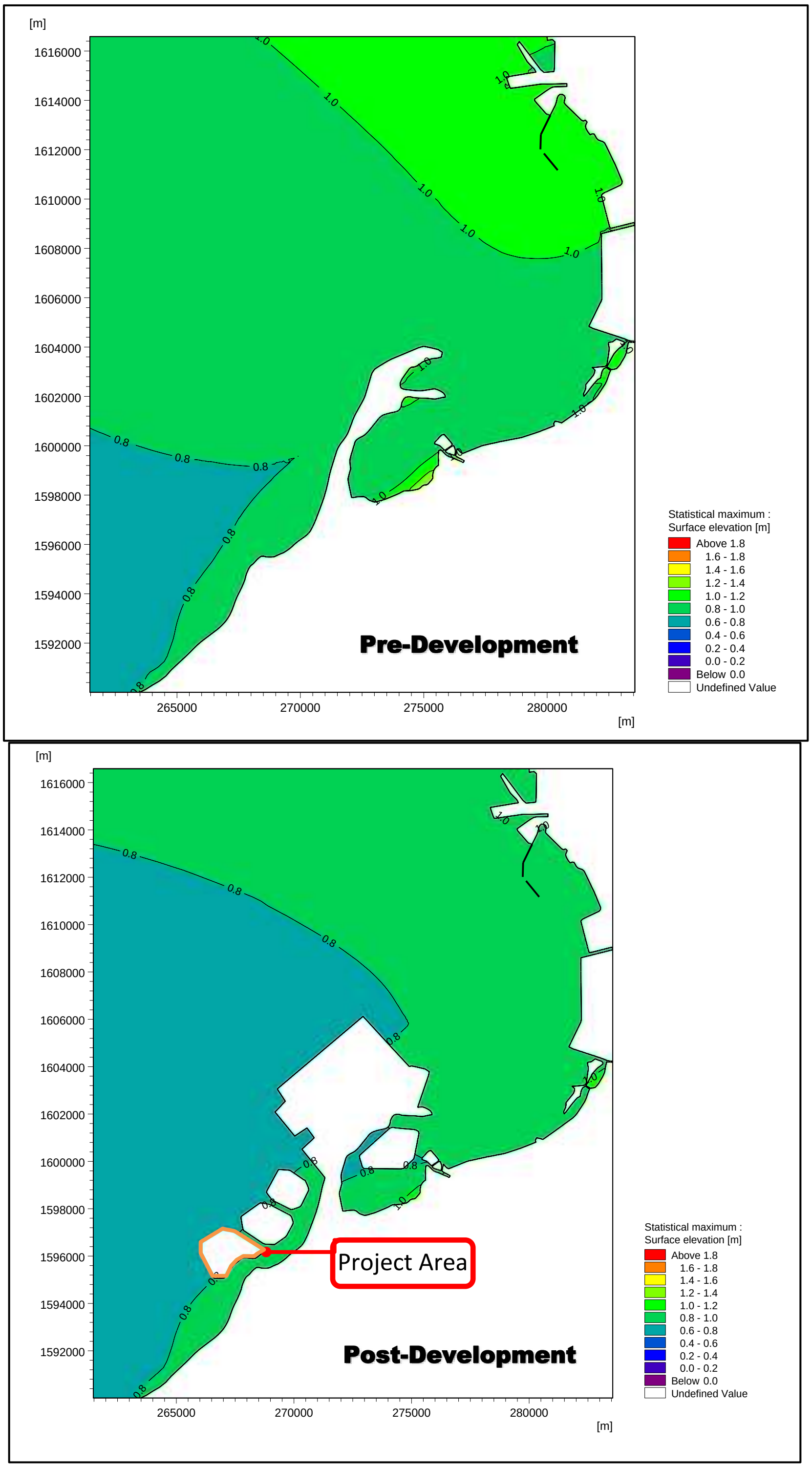


Figure 2.2-74. Simulated Storm ide Level for Typh. Patsy/Yoling (1970) Pre & Post Devt.

The storm tide for the pre-development scenario caused by Typhoon Xangsane (Figure 2.2-75) is significantly lower than the previous two typhoons, with the storm tide level averaging 0.8 m for all islands. Within Bacoor 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 Bacoor Bay, however, was noted to have been lowered to 1.2 m.

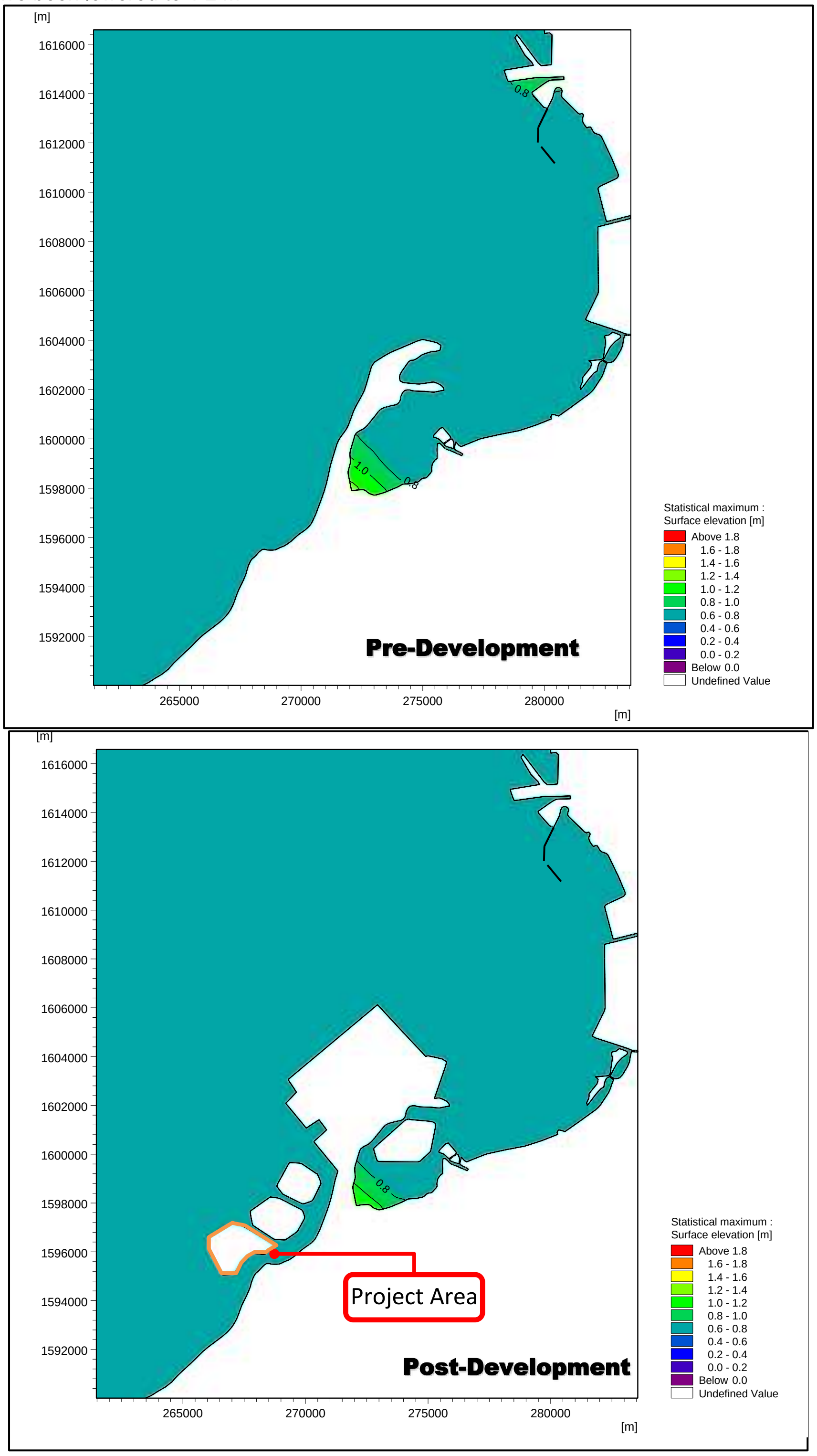
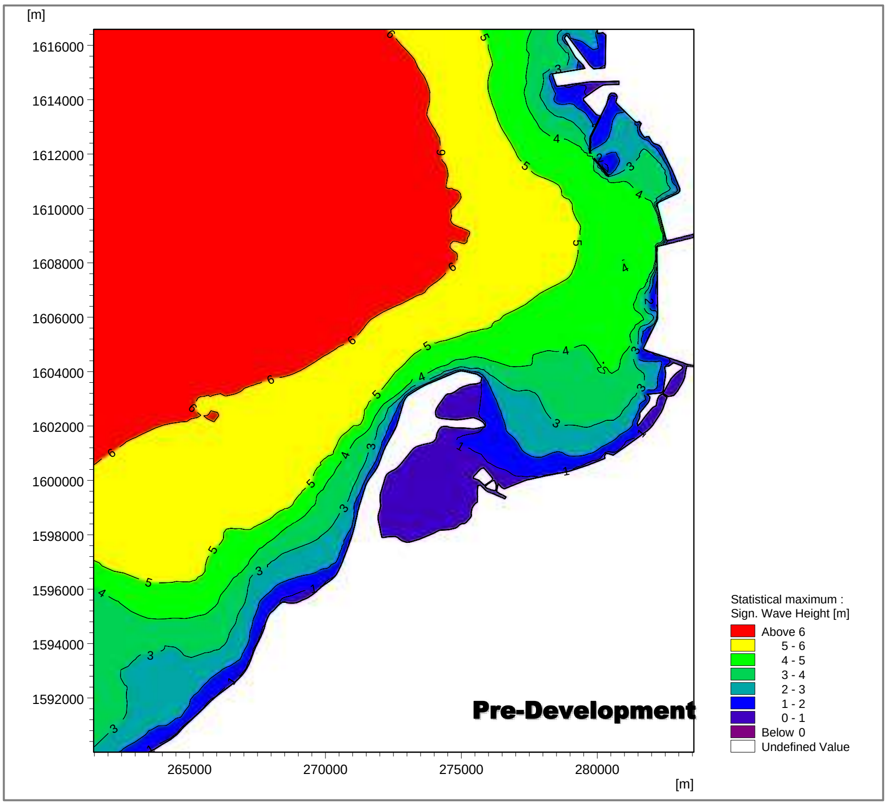


Figure 2.2-75. Simulated storm tide level for Typh. Xangsane/Milenyo (2006) Pre & Post Devt.

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 2.2-76 to 2.2-78). 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.



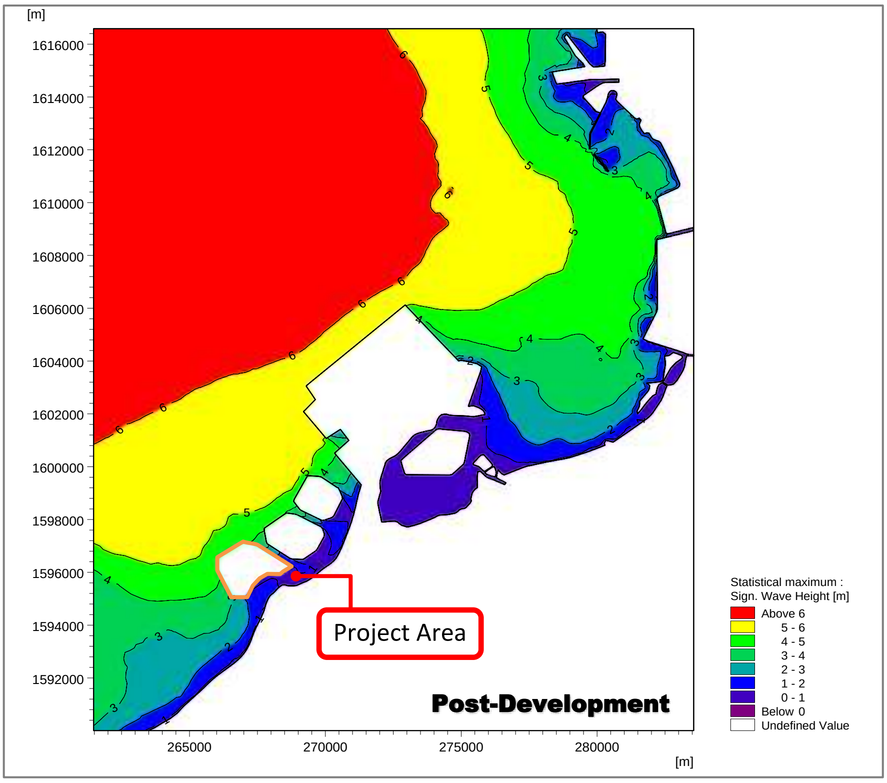


Figure 2.2-76. Simulated Maximum Significant Wave Heights for Typh. Rita/Kading (1978)
Pre- & Post-Devt.

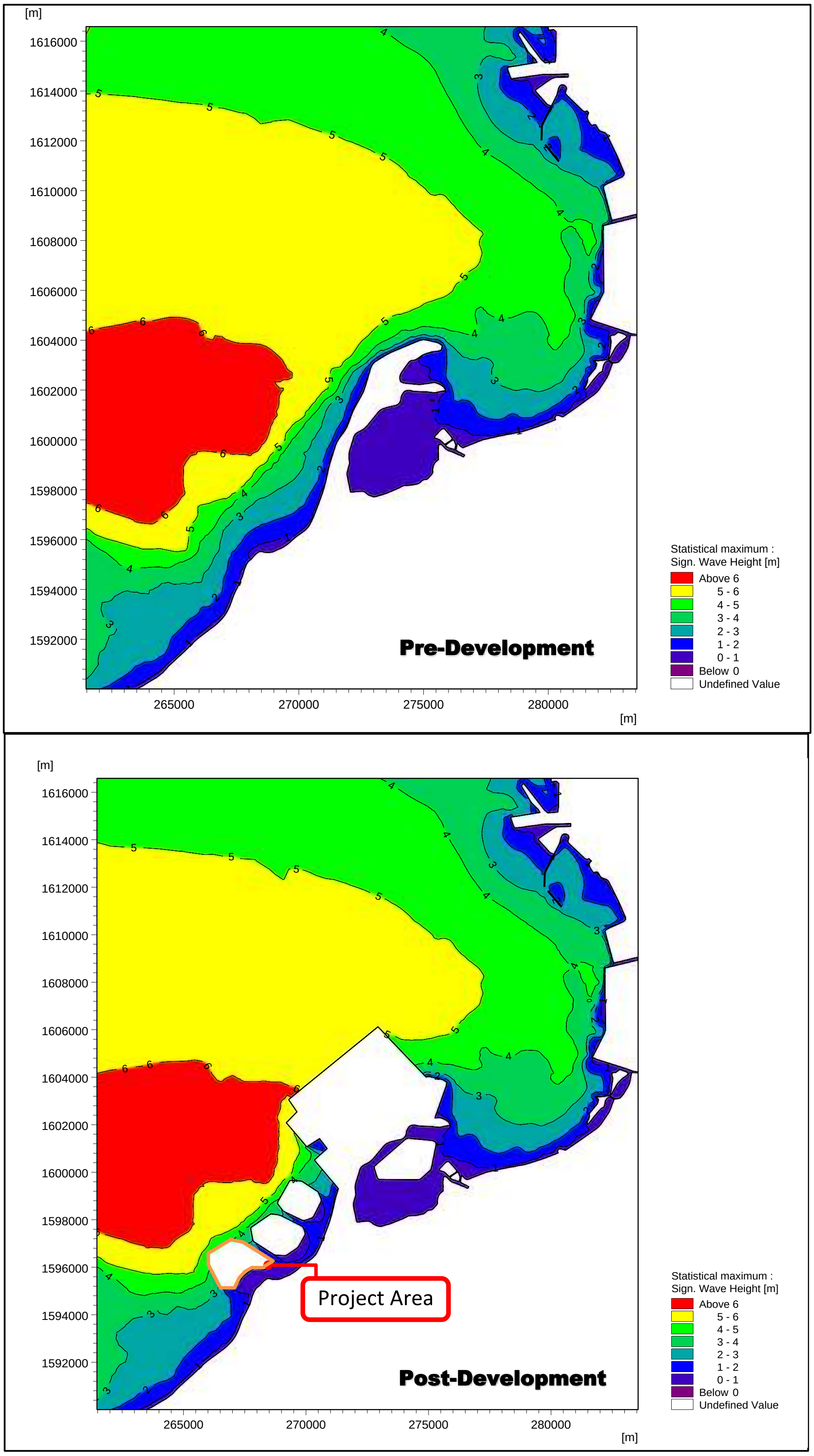


Figure 2.2-77. Simulated Maximum Significant Wave Heights for Typh. Patsy/Yoling (1970)
Pre- & Post-Devt.

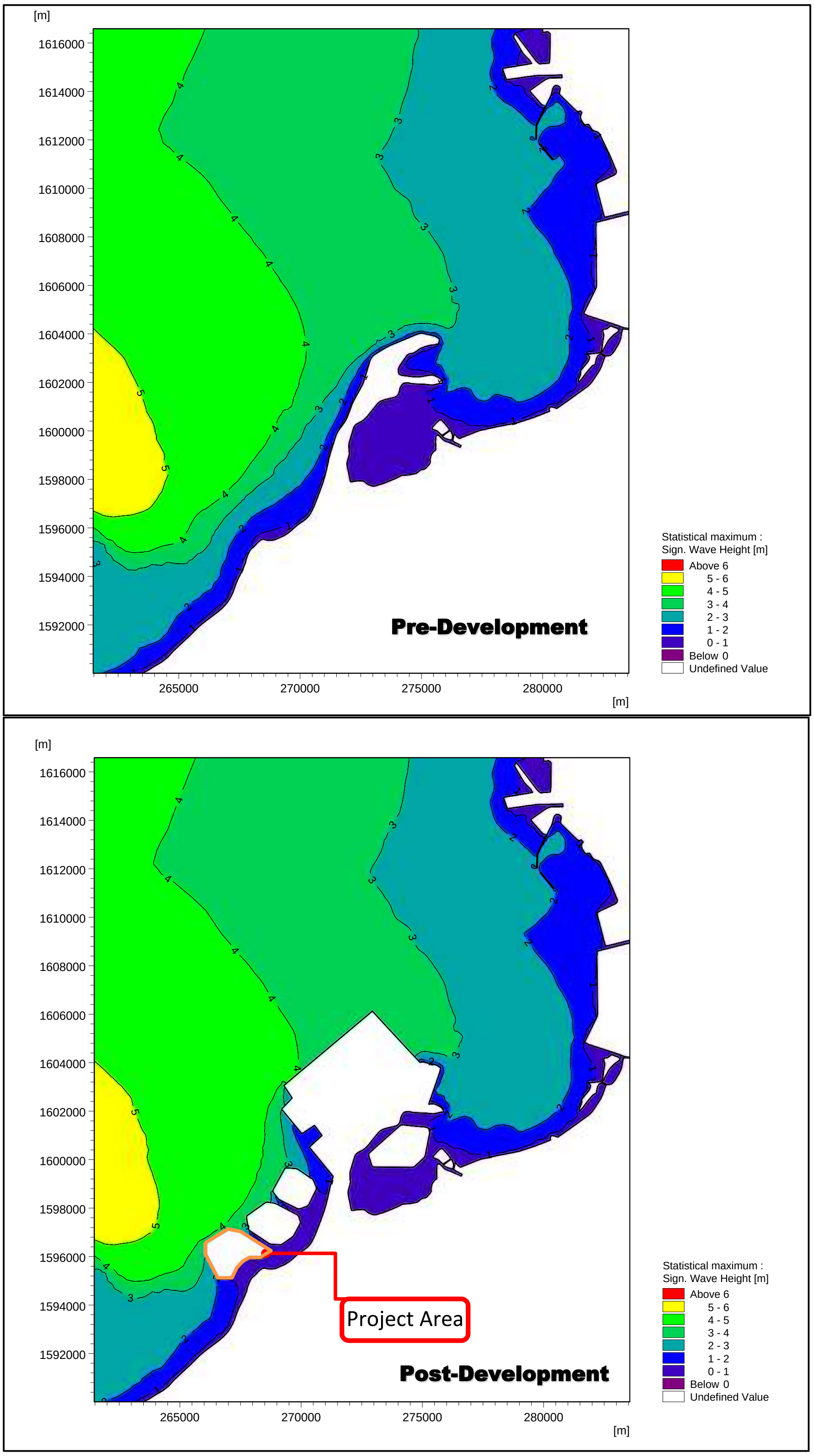


Figure 2.2-78. Simulated Maximum Significant Wave Heights for Typh. Xangsane/Milenyo (2006)
Pre- & Post-Devt.

2.2.2.1.5 Computation of Non-Overtopping Crest Elevation

Introduction

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.

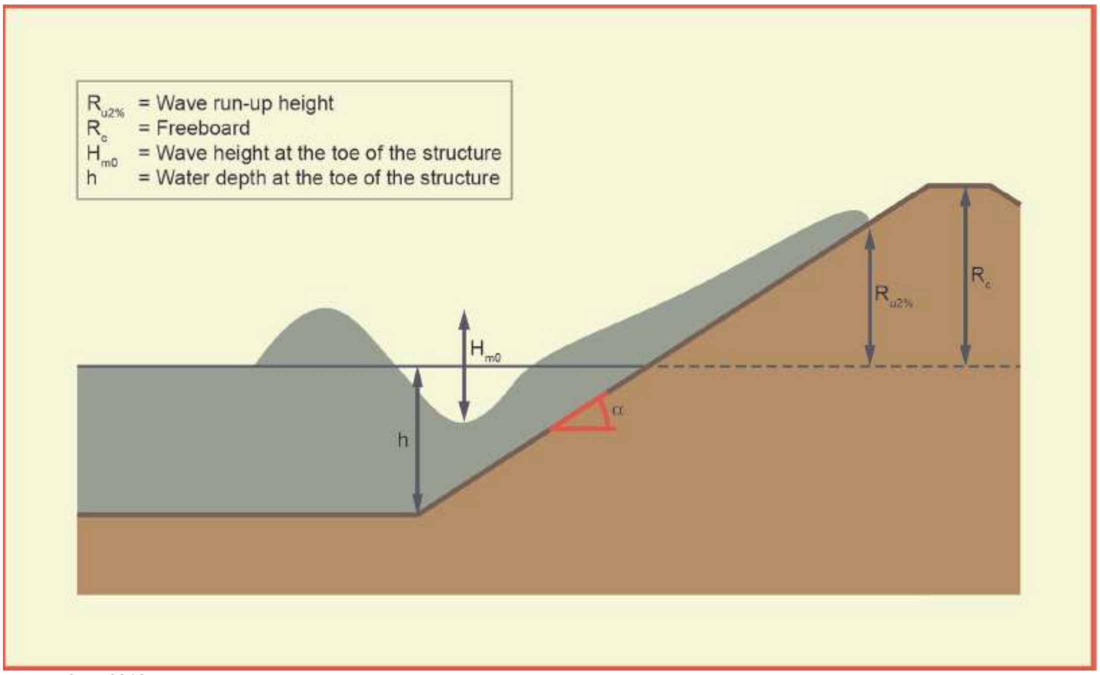
Wave runup is a complex phenomenon which considers the local water level, the characteristics of the incident wave, and the structure being run up. The computation of the runup is largely empirical; it is based on various laboratory measurements that relates runup to the breaking wave surf similarity parameter ξ 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:

$$\frac{R_u}{H_s} = \begin{cases} A\xi_{om}, & 1 < \xi_{om} \leq 1.5 \\ B(\xi_{om})^C, & 1.5 < \xi_{om} \leq (D/B)^{1/C} \\ D, & (D/B)^{1/C} < \xi_{om} \leq 7.5 \end{cases} \quad (2)$$

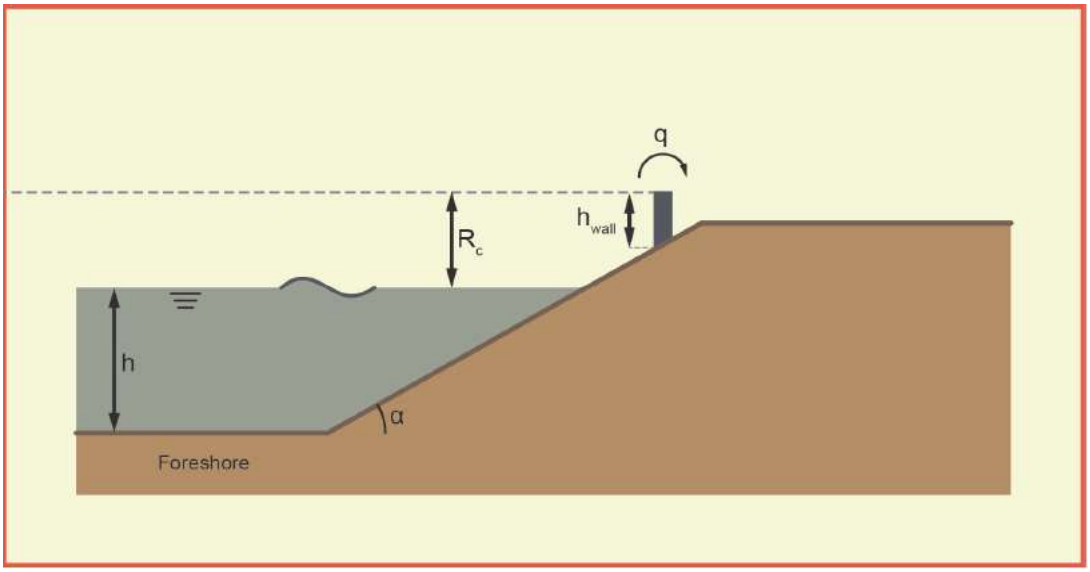


Source: EurOtop 2016

Figure 2.2-79. 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^3/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 2.2-80. Overtopping Discharge of a Slope with Storm Wall (Source: EurOtop 2016)

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:

$$\frac{q}{\sqrt{g \cdot H_{mo}^3}} = \frac{0.026}{\sqrt{\tan\alpha}} \gamma_b \cdot \xi_{m-1,0} \cdot exp\left[-\left(2.5\frac{R_c}{\xi_{m-1,0} \cdot H_{m0} \cdot \gamma_b \cdot \gamma_f \cdot \gamma_\beta \cdot \gamma_v}\right)^{1.3}\right]$$

(3)

with a maximum of:

$$\frac{q}{\sqrt{g \cdot H_{mo}^3}} = \frac{0.1035}{\sqrt{\tan\alpha}} \cdot exp\left[-\left(1.35\frac{R_c}{H_{m0} \cdot \gamma_f \cdot \gamma_\beta \cdot \gamma^*}\right)^{1.3}\right]$$

(4)

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 2.2-81. The computed non-overtopping crest elevations during maximum tide and maximum wave conditions are presented in the following tables.

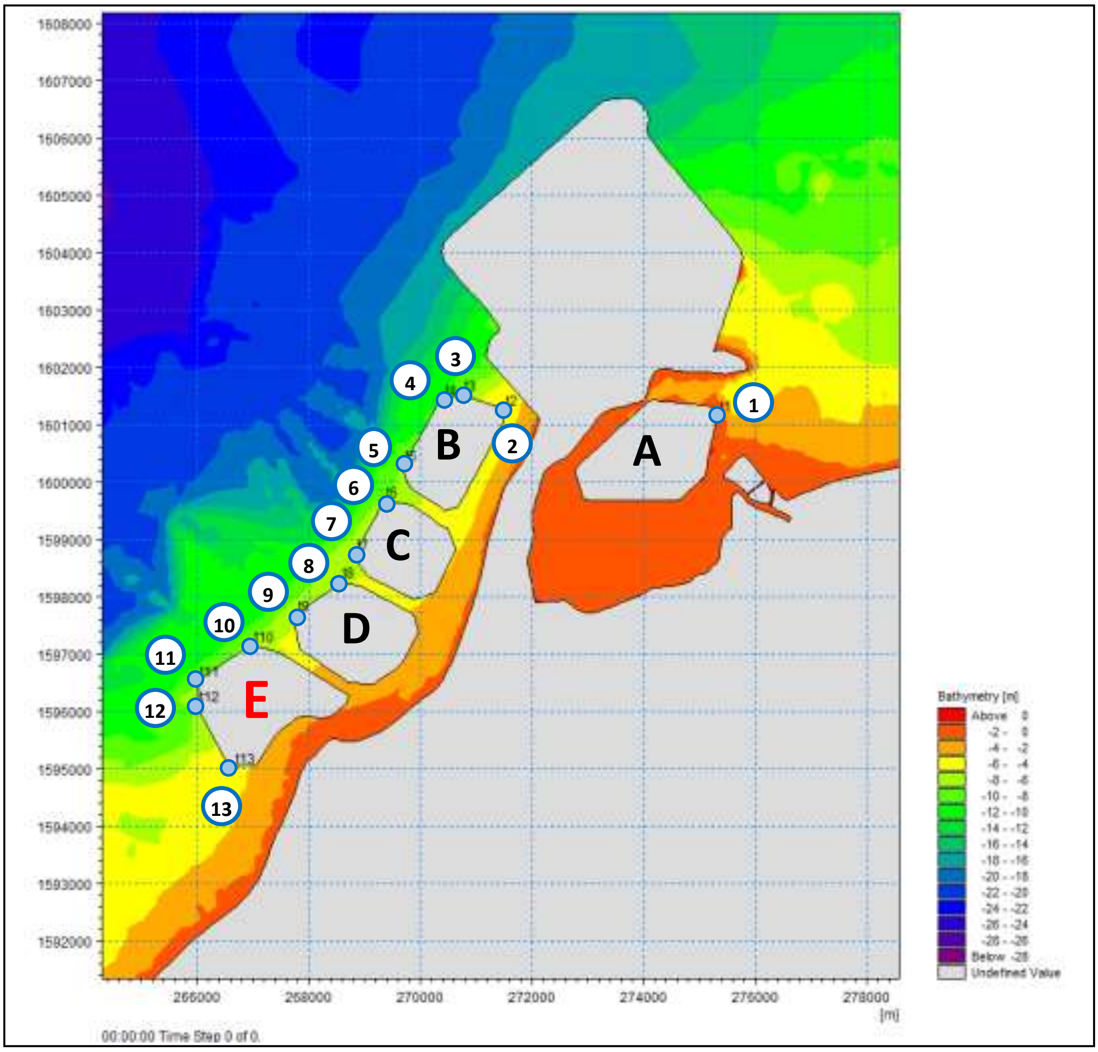


Figure 2.2-81. Location of Extraction Points

Table 2.2-25. Non-overtopping Crest Elevation Results During Maximum Tide Conditions

Typhoon	Point	Depth (m)	Time	Tide$_{max}$ (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

Typhoon	Point	Depth (m)	Time	$Tide_{max}$ (m)	Corresponding		NOCE Result (m)
					Wave (m)	Period (s)	
	Pt. 8	6.42	10/26/1978 18:50	1.01	3.56	6.81	6.36
	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	$Wave_{max}$ (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	$Wave_{max}$ (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-overtopping Crest Elevation Results

Typhoon	Point	NOCE Result (m)		Governing Case
		$Tide_{max}$	$Wave_{max}$	
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$_{max}$	Wave$_{max}$	
	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

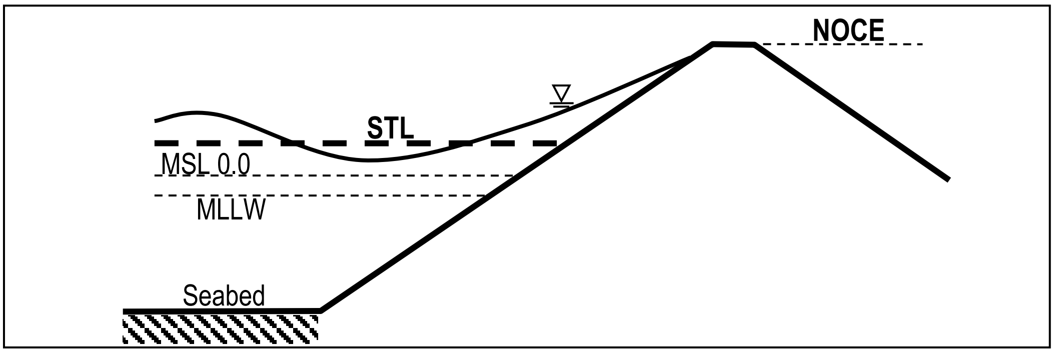


Figure 2.2-82. NOCE illustration

As shown in Table 2.2-27 above, 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, which is the northwestern corner of Island B. 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 reclamation islands are summarized in the table below.

Table 2.2-28. Synthesized NOCE of Island E.

Extraction Points	NOCE (maMSL)	Governing Condition
10, 11, 12, 13	7.04	Max Wave Height

Wave overtopping occurs when the structure crest elevation is lower than the wave runup 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 2.2-82. 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

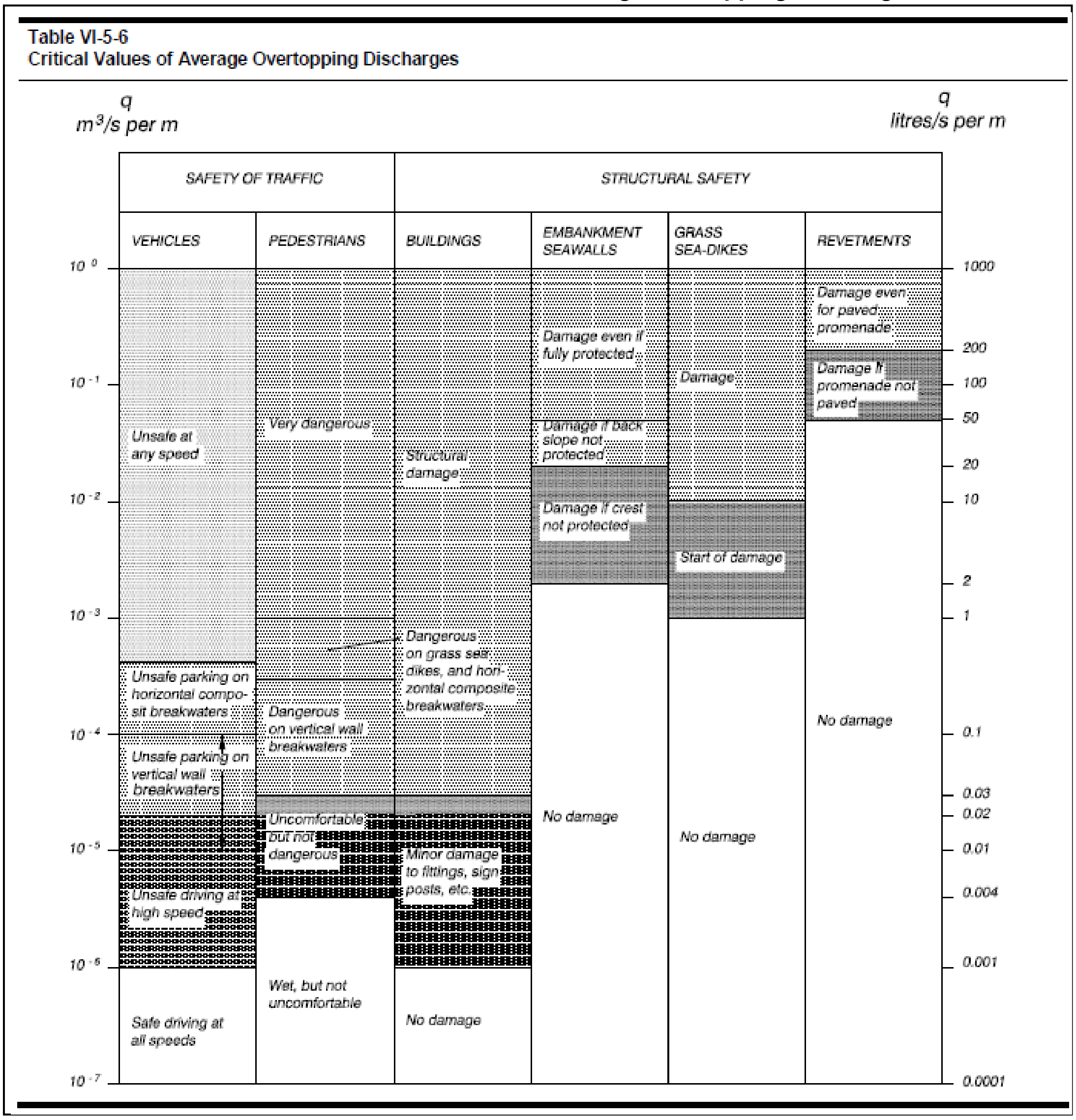
q ($m^3/s/m$)		Reclamation Backfill Elevation (maMSL)		
		+4.0	+4.5	+5.0
h_{wall} (m)	1.0	0.028	0.015	0.008
	1.5	0.010	0.005	0.003

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 2.2-31 summarizes the results of these computations based on Eq. (4) under the above conditions.

Table 2.2-30. Critical values of average overtopping discharges



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 E.

RBE (maMSL)	Required Minimum Wall Height (m)		
	q=0.02 cms/m	*q*=0.002 cms/m	*q*=0.000001 cms/m
4.0	0.759	1.690	4.304
4.5	0.449	1.391	4.027
5.0	0.133	1.087	3.745

2.2.2.1.6 Longshore Sediment Transport; Coastal Erosion and Deposition

Particle Dispersion Modeling

Knowledge of the movement and transport of **sediments (the terms "sediments" and "particles" are used interchangeably in these discussion**s) 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 Qn, can be positive or negative, and indicates the direction and magnitude of longshore transport. The total or gross transport rate Qt 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 Ho with offshore approach directions; and
- Annual occurrence frequencies of Ho.

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 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 2.2-34 summarizes the computed directional transport rates Q+ and Q-, net longshore transport rate Qn, and total longshore transport rate Qt, 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 Qn values of 1 to 19 tcm/yr, and Qt 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 Qn values of 2 to 50 tcm/yr, and an even higher Qt 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 Bacoor Bay.

The computed net transport rates for the baseline condition are plotted graphically and approximately to scale at the stations in Figure 2.2-83. 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 2.2-35 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. Figures 2.2-83 and 2.2-85 graphically plot the transport rates at the 58 stations.

Table 2.2-33. Annual longshore sediment transport rates – Baseline Condition

Shore-normal (deg, from N)	Station ID	Tributary length m	Q+ (to right) (1000m3 / yr)	Q- (to left) (1000m3 / yr)	Qn (net) (1000m3 / yr)	Qt (gross) (1000m3 / 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

Shore-normal (deg, from N)	Station ID	Tributary length m	Q+ (to right) (1000m3 / yr)	Q- (to left) (1000m3 / yr)	Qn (net) (1000m3 / yr)	Qt (gross) (1000m3 / yr)
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
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 2.2-34. Annual longshore sediment transport rates – Modified Condition

Shore-normal (deg, from N)	Station ID	Tributary length m	Q+ (to right) (1000m3 / yr)	Q- (to left) (1000m3 / yr)	Qn (net) (1000m3 / yr)	Qt (gross) (1000m3 / 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
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

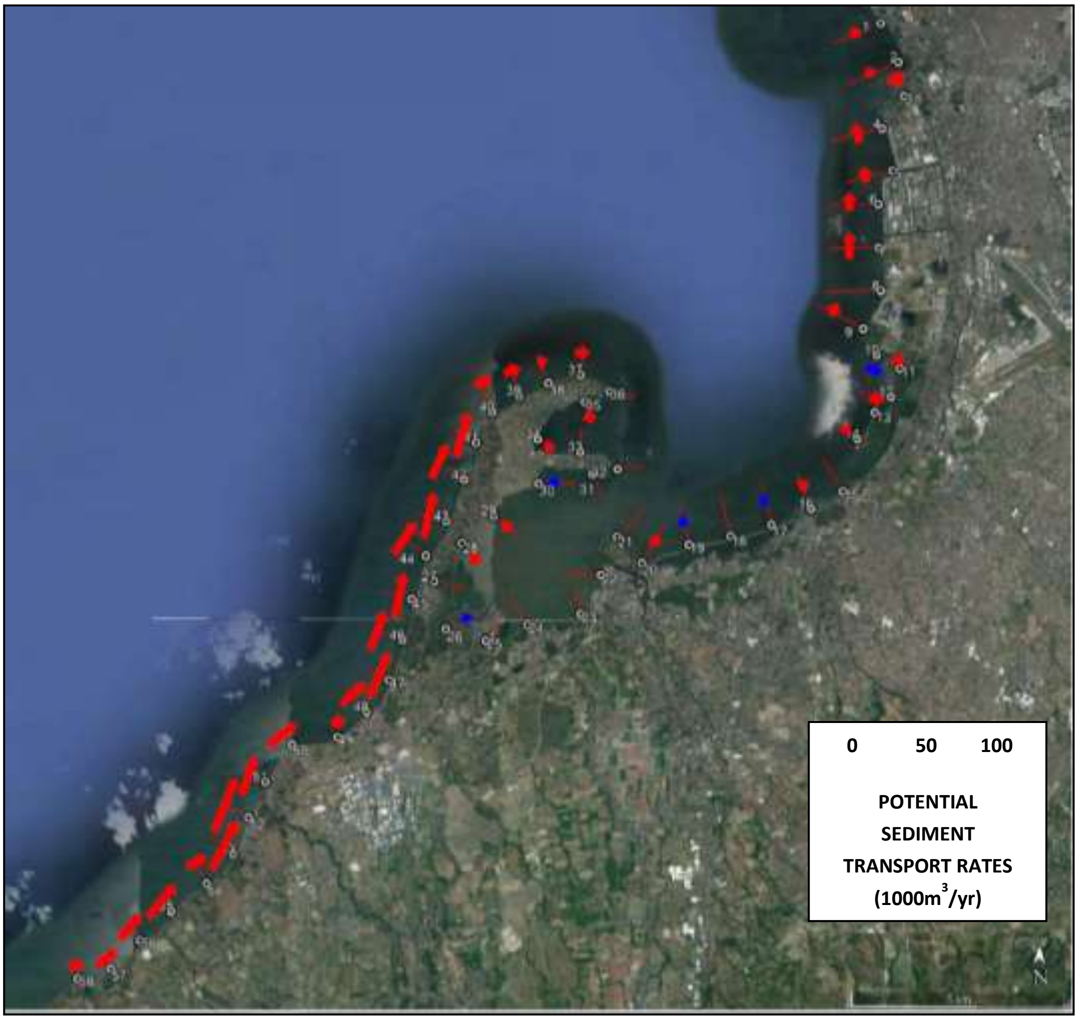
Shore-normal (deg, from N)	Station ID	Tributary length m	Q+ (to right) (1000m3 / yr)	Q- (to left) (1000m3 / yr)	Qn (net) (1000m3 / yr)	Qt (gross) (1000m3 / yr)
0	49	1000	0.12	0.13	-0.01	0.25
313	50	1000	10.77	0.08	10.68	10.85
282	51	1000	40.48	1.18	39.30	41.65
295	52	1000	61.65	5.95	55.70	67.60
308	53	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 2.2-36 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 ΔQn), except for the stations at the western stations which are not fronted by the proposed reclamation. The plot of Qn shown in Figure 2.2-85 indicates that local regions marked by dotted circle are potential accretion zones in the Modified Condition at the western stations.

Table 2.2-35. Differences of Transport Rates (Modified Condition-Baseline Condition)

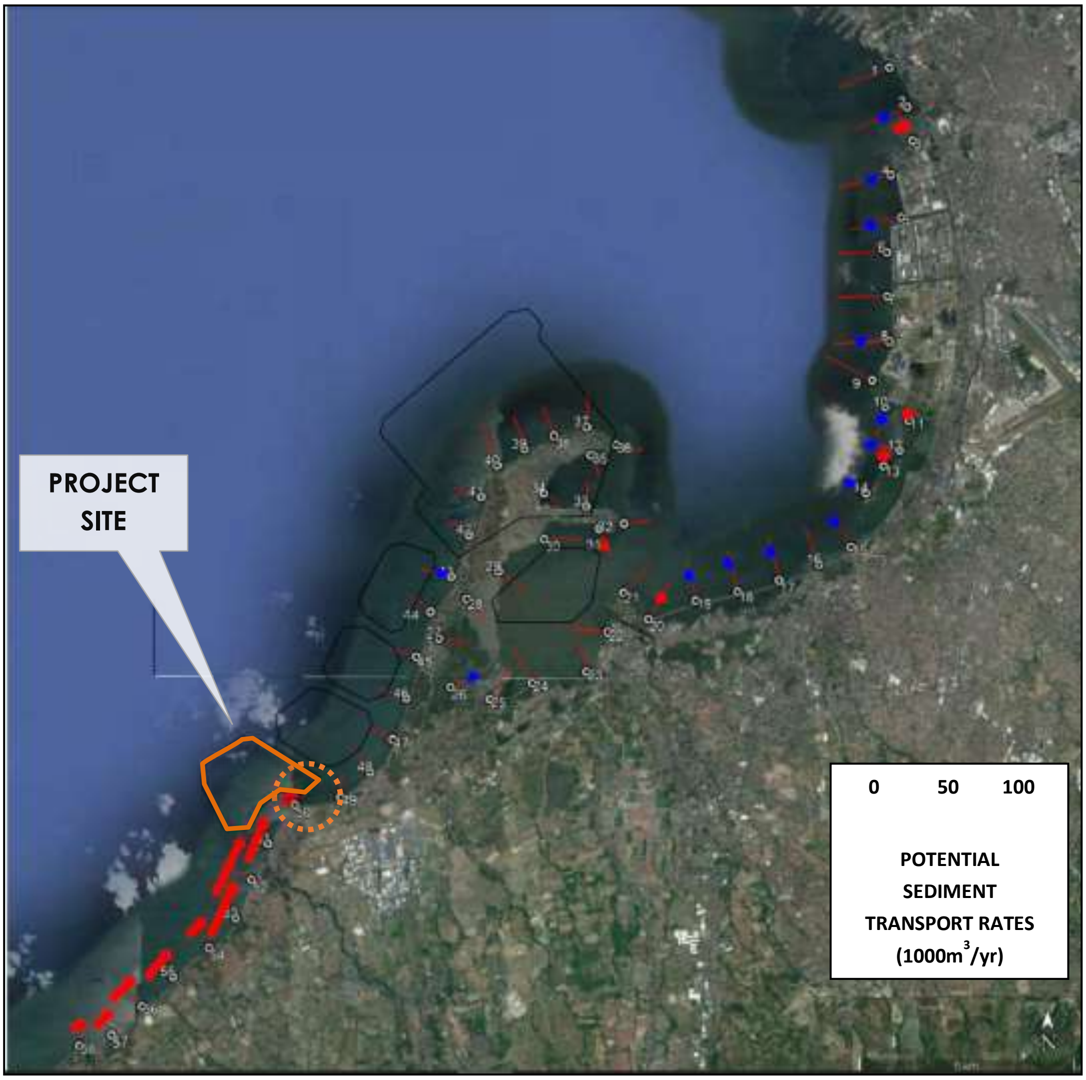
Shore-normal (deg, from N)	Station ID	Tributary length m	Q+ (to right) (1000m3 / yr)	Q- (to left) (1000m3 / yr)	Qn (net) (1000m3 / yr)	Qt (gross) (1000m3 / yr)
246	1	1000	-7.085	-4.013	-3.072	-11.098
246	2	1000	-11.098	-6.658	-4.439	-17.756
330	3	1000	-0.198	0.083	-0.281	-0.115
255	4	1000	-15.871	-3.552	-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
103	27	1500	-0.549	-0.331	-0.218	-0.879
139	28	1250	-3.194	-0.029	-3.165	-3.223

Shore-normal (deg, from N)	**Station ID**	**Tributary length** m	**Q+ (to right)** (1000m3 / yr)	**Q- (to left)** (1000m3 / yr)	**Qn (net)** (1000m3 / yr)	**Qt (gross)** (1000m3 / yr)
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 2.2-83. Directions and Magnitudes of Annual Net Longshore Transport Qn for Baseline Condition



Base Map: Google Earth

Figure 2.2-84. Directions and magnitudes of annual net longshore transport Qn for Modified Conditions

Figures 2.2-85 and 2.2-86 graphically show the total transport rates Qt at all stations under Baseline and Modified Conditions. It is clear that Qt 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 2.2-85. Directions and magnitudes of annual gross longshore transport Qt for Baseline Condition

Base Map: Google Earth

Figure 2.2-86. Directions and magnitudes of annual gross longshore transport Qt 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 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 results extend individually to Island E, which is the subject of this application.

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 Bacoor 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 m3/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 2.2-33). 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 E would need **+1.69m** 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.

Discussion of how the impacts may be affected by climate change especially sea level rise.

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.

Discussion of how the impacts may be affected by climate change especially sea level rise.

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.

Discussion of how the impacts may be affected by climate change especially sea level rise.

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.

2.2.2.2 Changes in Bathymetry

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.

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 it its adjacent areas.

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 mover 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

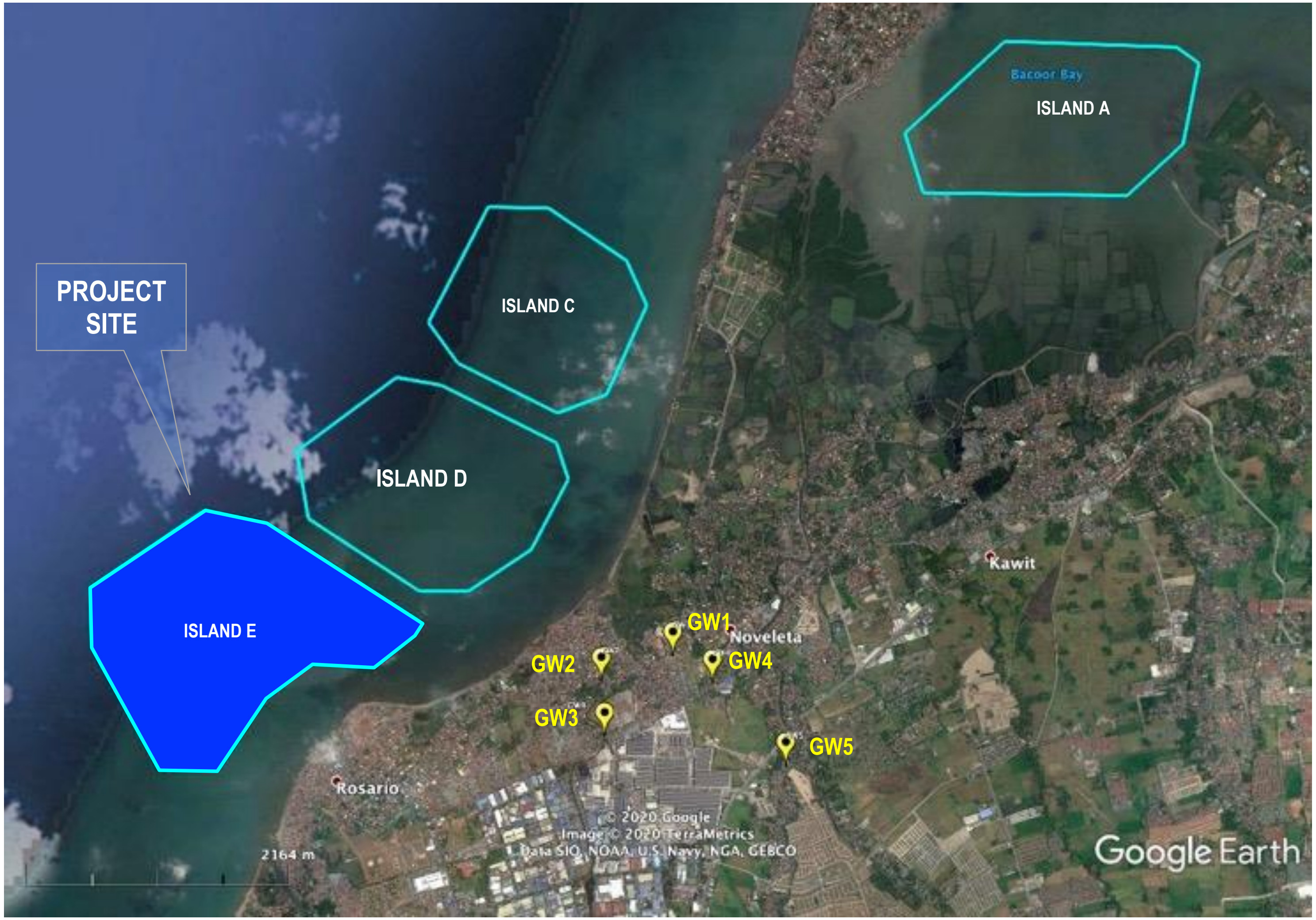
Although there will be no groundwater abstraction to be done for the project, secondary data on water quality is herein presented to characterize the baseline conditions. These were taken from the published EIS – Preparatory Survey for Cavite Industrial Area Flood Management Project prepared by KRC Environmental 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 2.2-36. Groundwater Quality Test Results (DPWH Data)

Parameter, unit	Sampling Station					PNSDW Limits
	GW1	GW2	GW3	GW4	GW5	
	Love Memorial Park Salcedo II, Noveleta	Marcella St. Brgy. Ligtong 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, ^{0}C	29	28.8	28.6	27.8	28	
Conductivity, ùS/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, undated

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, undated

Figure 2.2-87. 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 845m to the ESE from the easternmost corner of Island E, and Cañas (Wawa) River, which is 939m to the southwest from the southernmost corner (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

Island E is polygonally-shaped such that Cañas River is to its left or southwestern side (939 m), while Maalimango River is to its right or southeast (845 m).

Water quality baseline data were gathered for both rivers, including the tidal inlet to the northeast of Maalimango River, with a total of 7 samples 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 2.2-88, which also shows seawater sampling locations.

The primary data (Table 2.2-37) indicate that the dissolved oxygen content of all samples are all very low and do not pass the Class C standards, except for C-ER1 taken from Cañas R. Moreover, fecal coliform, total coliform, ammonia, and sulfate contents indicate standard exceedances. In terms of other parameters, all samples are within the limits, in fact, the arsenic, mercury, cadmium, chromium, lead, 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 1st 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 2.2-38 and 2.2-39. The sampling stations are shown in Figure 2.2-89.

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 Ligtong 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 (1st 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 1st Q 2018 and Jan 2020 only) are all beyond the limits while the ammonia and chloride contents (1st Q 2018) at the mouth of Cañas River and at Ligtong 1 along Maalimango River are higher than the limits as well. The nitrogen levels (Jan 2020 data only) all pass the standard.

There shall be freshwater sampling (mouths of Canas & Maalimango River) during the DED stage. The parameters to be tested are: Ammonia, Phosphate; Chlorides; Color; DO; BOD; pH; TSS; Total Coliform; and Fecal Coliform; and also to be added are the recommended parameters such as: COD; Chromium (+6); Surfactants; Sulfate, Boron; Cyanide; Mercury; Lead; Cadmium; Arsenic; Copper; Fluoride; Iron; Selenium; and Zinc. The results shall serve as the baseline for future monitoring.

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 2-36a which shows that all parameters tested for Ylang-ilang and Imus Rivers failed the DENR Standards exept for oil and grease which is below the reporting limit while Maalimango River failed for Nitrates, *Laboratory Result is attached Annex 2-2a*.

Table 2.2-36a Water Quality Results for Ylang-ilang, Imus and Maalimango River Rivermounts, June 24, 2020

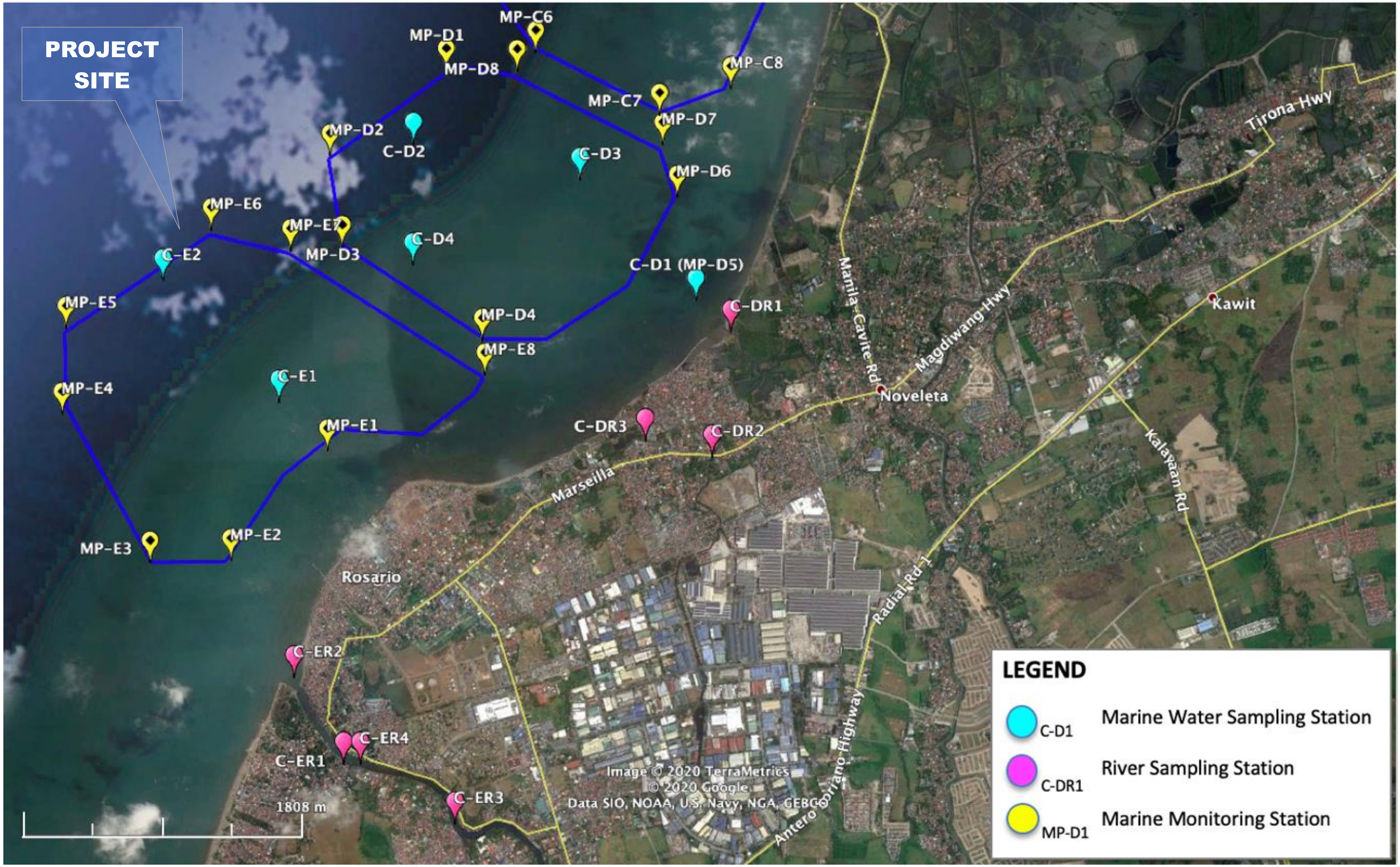
Station	Date of Samplinhg	NH_3, mg/L	BOD, mg/L	Nitrates, mg/L	O & G, MPN/100mL	Phosphate, mg/L	Surfactants, mg/L	TSS, mg/L	FC, MPN/100mL
DENR Class C Standard		0.007	1.0	0.003	1	0.006	1	2	1.8
Ylang-ylang N 14⁰27'44.01" E 121⁰53'13.16"	June 24, 2020	1.84	46	1.74	<1	0.959	0.2	85	$2.6x10^5$
Imus N 14⁰27'50.39" E 121⁰50'59.21"	June 24, 2020	2.51	52	0.575	<1	0.220	0.2	19	$7.9x10^4$
Maalimango N 14⁰24'42.81" E 121⁰50'38.39"	June 24, 2020	2.83	87	<0.003	3	1.64	0.2	7	$3.5x10^6$

Source: Elarsi, Inc., June 24, 2020

Table 2.2-37. Freshwater Quality Test Results (Primary Data)

Parameter	Test Methods	Class C Standard	Unit	Test Results						
				Maalimango River			Cañas River			
				C-DR1 (tidal creek)	C-DR2	C-DR3	C-ER1	C-ER2	C-ER3	C-ER4
				N 14.430917°	N 14.424159°	N 14.424787°	N 14.406250°	N 14.410472°	N 14.402008°	N 14.406339°
				E 120.871306°	E 120.870182°	E 120.866543°	E 120.848778°	E 120.845250°	E 120.855165°	E 120.848370°
Date of Sampling				**18-Oct-17**		**17-Feb-19**	**18-Oct-17**		**17-Feb-19**	
BOD	Azide Modification Winkler (SM 5210B)	7	mg/L	<1	-	-	1	2	-	
DO	Winkler, Titrimetric	5 (min)	mg/L	4	<2.0	<2.0	9	<2	<2.0	<2.0
TSS	Gravimetry (SM2540 D)	80	mg/L	11	25	20	45	51	20	31
Total Coliform	Multiple Tube Fermentation Technique	1,000	MPN/ 100mL	-	9,200	9,200,000	54,000	24,000	2,400	5,400
Fecal Coliform		200		-	9,200	9,200,000	24,000	24,000	2,400	5,400
Oil & Grease	Gravimetry (n-Hexane Extraction)	-	mg/L	0.3	0.67	0.44	0.3	51	0.44	0.44
pH	Electrometric Method	6.5 – 8.5	mg/L	8	-	-	7.6	7.7	-	
COD	Open Reflux Method (SM5220B)	-	mg/L	16	165	94	-	-	89	87
Arsenic	SDDC, Spectrophometry	0.02	mg/L	<0.01	<0.008	<0.008	<0.01	<0.01	<0.008	<0.008
Mercury	Manual Cold Vapor AAS	0.002	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Cadmium	Flame AAS-MIBK Extraction	0.005	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium +6	DCM (SM3500-Cr B)	0.05	mg/L	<0.005	<0.002	<0.002	<0.005	<0.005	<0.002	<0.002
Lead	Flame AAS-MIBK Extraction	0.05	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Selenium	ICP – OES	-	mg/L	-	<0.01	<0.01	-	-	<0.01	<0.01
Ammonia	Phenate Method (SM 4500-NH3 F)	0.05	mg/L	-	3	4.1	-	-	0.7	1.2
Sulfate	Turbidimetric Method	275	mg/L	-	685	826	-	-	1,350	1,870
Boron	Carmine Method	5	mg/L	-	2.4	2.9	-	-	2.9	2.7
Fluoride	SPADNS Method (SM4500-F D)	1.5	mg/L	-	1.1	1.1	-	-	1.1	1.1

Date Sampled: October 18, 2017 and February 17, 2019, Analyzed by: CRL Environmental Corporation; Red highlight indicates the sample is beyond DENR standards



Base Map: 2020 Google Earth

Figure 2.2-88. Water Quality Sampling Stations (Primary Data)

SECONDARY DATA

CAÑAS RIVER

Table 2.2-38. Results of Water Quality Analysis of Cañas River (DENR-4A)

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
CR-1 (Cañas River Mouth - 1												
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										
CR-2 (Cañas River Mouth - 2)												
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
CR-3 (Cañas River Mouth - 3)												
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
CR-4 (Julugan Wawa Hanging Bridge)												
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										
CR-5 (Tejero Bridge)												
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										
CR-6 (Paradahan Bridge)												
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
CR-7 (Mag-asawang Layon Bridge)												
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										
CR-8 (Patda Bridge)												
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										
CR-9 (Panaysayan Bridge)												
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). 1st Q 2020.
Note: Highlighted values are below/ exceedances in DAO 2016-08 Criteria for Class C waters.

MAALIMANGO (LIGTONG) RIVER

Table 2.2-39. Results of Water Quality Analysis of Maalimango/Ligtong River (DENR-4A)

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
MR-1 (Maalimango Bridge)												
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										
MR-2 (Mount Sea Resort)												
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										
MR-3 (Ligtong 1)												

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). 1st 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. 1st Quarter 2018

Figure 2.2-89. DENR-R4A Sampling Stations along Maalimango and Cañas Rivers

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

Water Quality Parameters and Test Results

The test results are shown in Table 2.2-40, while the sample locations are included in Figure 2.2-89 above.

The data indicate that seawater in the vicinity of the project site are mostly within the limits for Class SB waters except for total and fecal coliform and dissolved oxygen, wherein all values are beyond the standards. The metal contents (arsenic, mercury, cadmium, and hexavalent chromium) of the seawater samples are all below detection limits.

Additional Baseline Data Gathering

The three sampling stations are inside the proposed island itself, hence, such sites will be covered by fill/dredged materials. There shall be another round of water sampling during the DED stage wherein which, all of the monitoring stations shall be set along the perimeter, outside of the proposed island, with 2 stations on each side/direction (N, S, E, W). These stations (denominated as MP-E1 to MP-E8) are shown in the revised Figure 2.2-118 above. The results shall serve as the baseline for future monitoring during and after completion of construction phase.

Please note that during the DED stage, there may still be alterations in the final landform that may be required by concerned government agencies. This would also mean corresponding changes in the final location of the monitoring stations, which will also need concurrence of the MMT.

The WQ parameters to be tested are: Ammonia, Phosphate; Chlorides; Color; DO; BOD; pH; TSS; Total Coliform; and Fecal Coliform; and to be added are the recommended parameters such as: COD; Chromium (+6); Surfactants; Sulfate, Boron; Cyanide; Mercury; Lead; Cadmium; Arsenic; Copper; Fluoride; Iron; Selenium; and Zinc.

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 2.2-41b for the results. These stations (denominated as MP-E1 to MP-E4) 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 2.2-40. Seawater Quality Test Results (Primary Data)

Parameter	Test Methods	Class SB Standard	Unit	Test Results	
				C-E1	C-E2
			Date of Sampling	18-Oct-17	
DO	Winkler Titrimetric	6.0 (min)	mg/L	5	4
Total Coliform	Multiple Tube Fermentation Technique	100	MPN/100mL	-	540
Fecal Coliform		100	MPN/100mL	540	540
TSS	Gravimetry (SM2540 D)	50	mg/L	24	26
Oil & Grease	Gravimetry (n-Hexane Extraction)	2	mg/L	0.5	0.4
pH	Electrometric Method	7.0-8.5	mg/L	8	8.1
COD	Open Reflux Method (SM5220B)	NA	mg/L	38	47
Arsenic	SDDC, Spectrophometry	0.01	mg/L	<0.01	<0.01
Mercury	Manual Cold Vapor AAS	0.001	mg/L	<0.0002	<0.0002
Cadmium	Flame AAS-MIBK Extraction	0.003	mg/L	<0.01	<0.001
Chromium +6	Diphenylcarbazide, Colorimetric Method (SM3500-Cr B)	0.05	mg/L	<0.005	<0.005
Lead	Flame AAS-MIBK Extraction	0.01	mg/L	<0.005	<0.002

Date Sampled: Oct 18, 2017 and Sep 26, 2019
Analyzed by: CRL Environmental Corporation
Red highlight indicates the sample is beyond DENR standards

Table 2.2-41a Island E Marine Sampling Stations Coordinates

Point	Latitude	Longitude
Island E		
Monitoring stations		
MP-E1	14°26'15.45"N	120°50'25.85"E
MP-E2	14°25'1.45"N	120°50'29.98"E
MP-E3	14°25'34.23"N	120°49'51.05"E
MP-E4	14°25'40.77"N	120°51'25.60"E
Marine Sampling stations		
C-E1	14°26'1.89"N	120°50'15.06"E
C-E2	14°25'36.62"N	120°50'37.51"E

Table 2.2-41b Island E Marine Quality Test Results, June 24, 2020

Parameter	Test Methods	Class SB Standard	Unit	Test Results			
				North (MPE1)	South (MPE2)	West (MPE3)	East (MPE4)
Total Coliform	Multiple Tube Fermentation Technique	NA	MPN/100mL	33	23	23	3.5x10^3
Fecal Coliform	Multiple Tube Fermentation Technique	100	MPN/100mL	33	23	<1.8	3.5x10^3
Oil & Grease	Gravimetry (n-Hexane Extraction)	2	mg/L	<1	<1	<1	80
Arsenic	SDDC, Spectrophotometry	0.01	mg/L	<0.001	<0.001	<0.001	<0.001
Mercury	Manual Cold Vapor AAS	0.001	mg/L	<0.0003	<0.003	<0.003	<0.003
Chemical Oxygen Demand	Open Reflux Method (SM5220B)	NA	mg/L	56	54	10	14
Total Suspended Solids	Gravimetry (SM2540 D)	50	mg/L	16	46	10	19
Selenium	ICP – OES	0.01	mg/L	<0.001	<0.001	<0.001	<0.001
Ammonia	Phenate Method (SM 4500-NH3 F)	0.05	mg/L	0.039	<0.007	<0.438	<0.309
Sulfate	Turbidimetric Method	250	mg/L	527	500	1,148	275
Fluoride	SPADNS Method (SM4500-F D)	1.5	mg/L	0.9	0.9	0.9	0.9
pH	Electrometric	7.0-8.5	-	6.69	6.41	6.88	6.41
Temperature	Laboratory Method	26-30	^0C	20.0	20.0	20.0	20.0
Color	Visual Comparison	50	mg/L	5@pH 6.69	5@pH6.41	5@pH6.88	5@pH6.41
Chloride	Argentometric	n/a	mg/L	20,330	20,187	20,860	20,330
Phosphates	Stannous Chloride	0.50	mg/L	0.030	0.025	0.058	0.076
Nitrates	Brucine-Sulfanilic	10	mg/L	<0.003	<0.003	<0.003	<0.003
Surfactants	Methylene Blue	0.30	mg/L	<0.1	<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
Cadmium	Flame AAS-MIBK Extraction	0.003	mg/L	<0.003	<0.003	<0.003	<0.003
Copper	Flame AAS	0.02	mg/L	0.653	0.662	0.569	0.659
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	<0.01	<0.01	<0.01	<0.01

Date Sampled: June 24, 2020,
Analyzed by: Elarsi, Inc.;
Red highlight indicates the sample is beyond DENR standards

Figure 2.2-89a Map of the Marine Water Quality Sampling Station

Discussion of the Results

Based on the results, all stations failed the parameters of Total and Fecal Coliform, Sulfate and Copper, Oil and Grease yielded high results in East Station (MPE4) and while the rest of the parameters are within the allowable limits.

Impact Analysis. Discussion on Possible Increase in the Degree of Pollution Loadings Due to the Proposed Project.

The assessment of the degree of pollution loadings is reckoned from the perspective of the Scope of the Project, which is confined to the formation of 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 seabed materials will be likely disposed in deeper parts of Manila Bay 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).

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

Cañas River

Basic river parameters were measured in the Cañas River whose estuary is more or less a kilometer away from the western border of the last reclamation island (Island E) in Rosario, Cavite. River water is dark green due to turbidity and is not used for household purposes. The dominant resource use practice is fishing for Tilapia; with an estimated productivity of about 1 kg per hour using cast net. At the time of the survey, only two groups of fishers were fishing in the river. No mariculture activities were documented in 2 km of ocular survey pathway. Results are tabulated in Table 2.2-41 and featured in Figure 2.2-90.

Station 1 was established about 1km from the rivermouth. Both sides of the riverbank are occupied by households and concrete walls. Station 2 was located in a more open area 2km upstream. The southern flank of the river was occupied by households, while the northern side is open, with fishponds beyond the riverbank.

Table 2.2-41. River Parameters Measured along Cañas River in Rosario; Oct & Nov 2018

Station	Depth (m)	Width (m)	Flow Rate m/s	Color	Major Biota
Station 1, Cañas River, 1 km from rivermouth	3	25	0.12	Brown	Tilapia, shrimp (*Metapenaeus ensis),)*; long spined glass perchlet *(Ambassis inerrupta);* gobies *(Syciopterus sp),* mussel *(Perna viridis), river mullet (Mugil sp)*
Station 2 – 2 km upstream	2	23	0.24	Brown	Tilapia, shrimp (*Metapenaeus ensis),* long spined glass perchlet *(Ambassis inerrupta);* gobies *(Syciopterus sp)*

River biota is dominated by Tilapia which is being captured mostly by cast net by residents living along the riverbanks. Juveniles of the river mullet (*Mugil* sp; Banak) and shrimps of the species *Metapenaeus* sp. also enter the river. No fish traps, bathing establishments, small industries that utilize river water, were encountered in the river up to two kilometers upstream.

Plate 2.2-3. Cañas River at the border of Rosario and Naic, Cavite.

Maalimango River

The Maalimango River was inspected by the marine survey team on 17 February 2019. The river is extremely polluted with dark gray water (Plate 2.2-4, Figure 2.2-90). 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 2.2-4. 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.

Base Map: 2018 Google Earth Map

Figure 2.2-90. River Ecology Parameters Measured Along Cañas and Maalimango Rivers; Oct & Nov 2018.

2.2-5 Marine Ecology

2.2-5.1 Survey Area and Objectives

The proposed Cavite Reclamation and Development Project: Island E is located in the Municipality of Rosario, covering 324 hectares in nearshore coastal waters of outer Manila Bay (Figure 2.2-91): Island E traverses the coastline of Rosario, starting offshore of the Cañas River estuary and ending a short distance from the boundary of Rosario and Noveleta in Barangay Ligtong, Rosario.

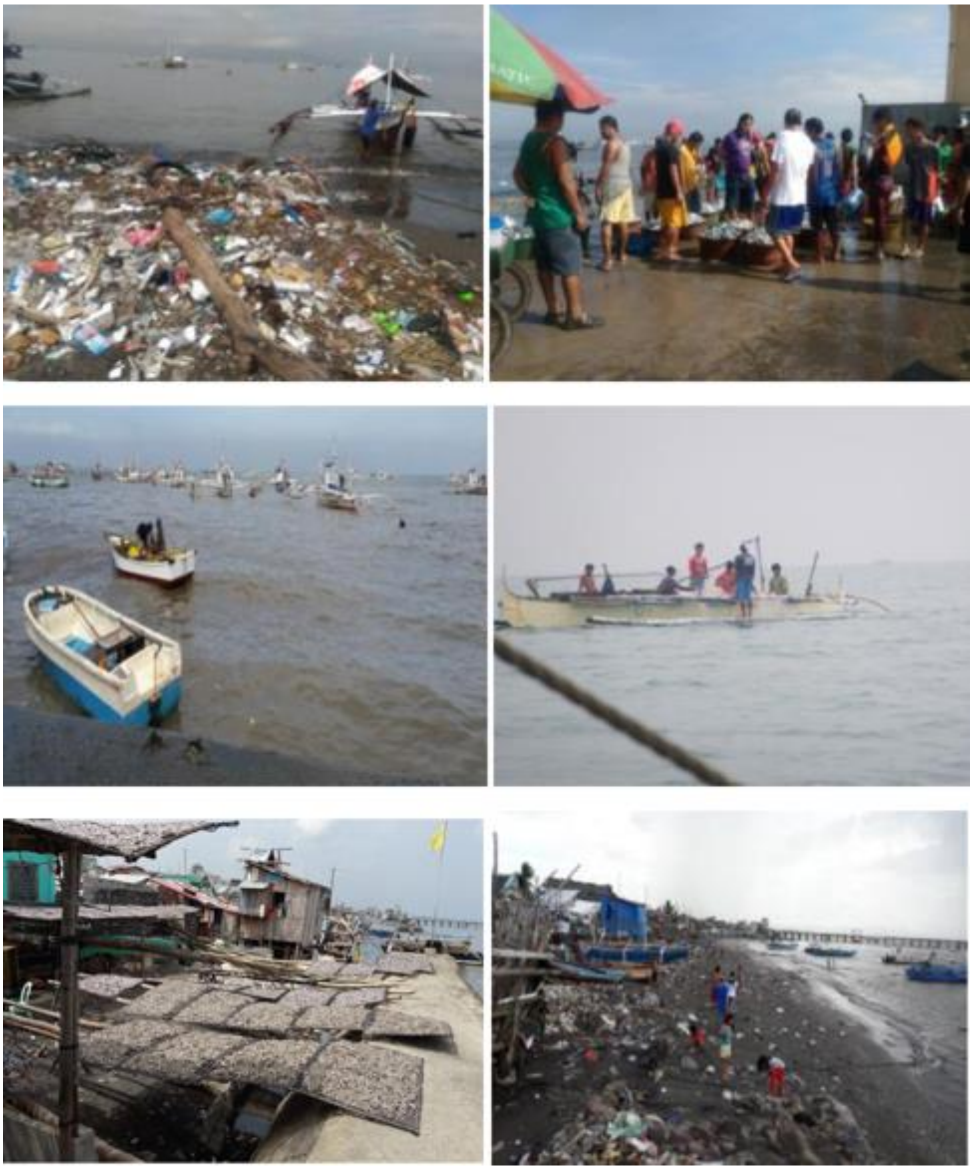
A comprehensive *in-situ* marine ecology baseline assessment in Island E of the proposed reclamation Project was conducted as part of the overall Environmental Impact Assessment (EIA) study associated with the establishment of the project by a team of fisheries biologists, a GIS specialist, a plankton/harmful algal bloom specialist and a marine biologist on various dates in October and November 2018 and February 16 to 18, 2019 (Plate 2.2-5). The survey was conducted inside and outside of the proposed reclamation Island E, focusing on identifying whether significant benthic habitats and resources are present in the proposed reclamation, and describe their distribution and susceptibility to reclamation activities and other 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.

In particular, the survey aimed to validate the absence of coral reef habitats or similar benthic life forms and resources as claimed by key informants and fishers. Survey pathways and plankton community sampling stations were distributed across the proposed island E, supplemented by spot dives in points outside of the proposed reclamation site.

The proposed Island E reclamation site is dominated by a sandy shelf perennially subjected to heavy deposition of sediments and domestic wastewaters from two river systems that receive domestic wastes from Rosario, Noveleta and Naic (Figure 2.2-92). 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 seabed 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. In view of this, coastal waters in the area proposed to be reclaimed are turbid and solid wastes are wantonly disposed into the Bay or carried through canals from communities and market halls in the surrounding municipalities (Plate 2.2-6). 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.

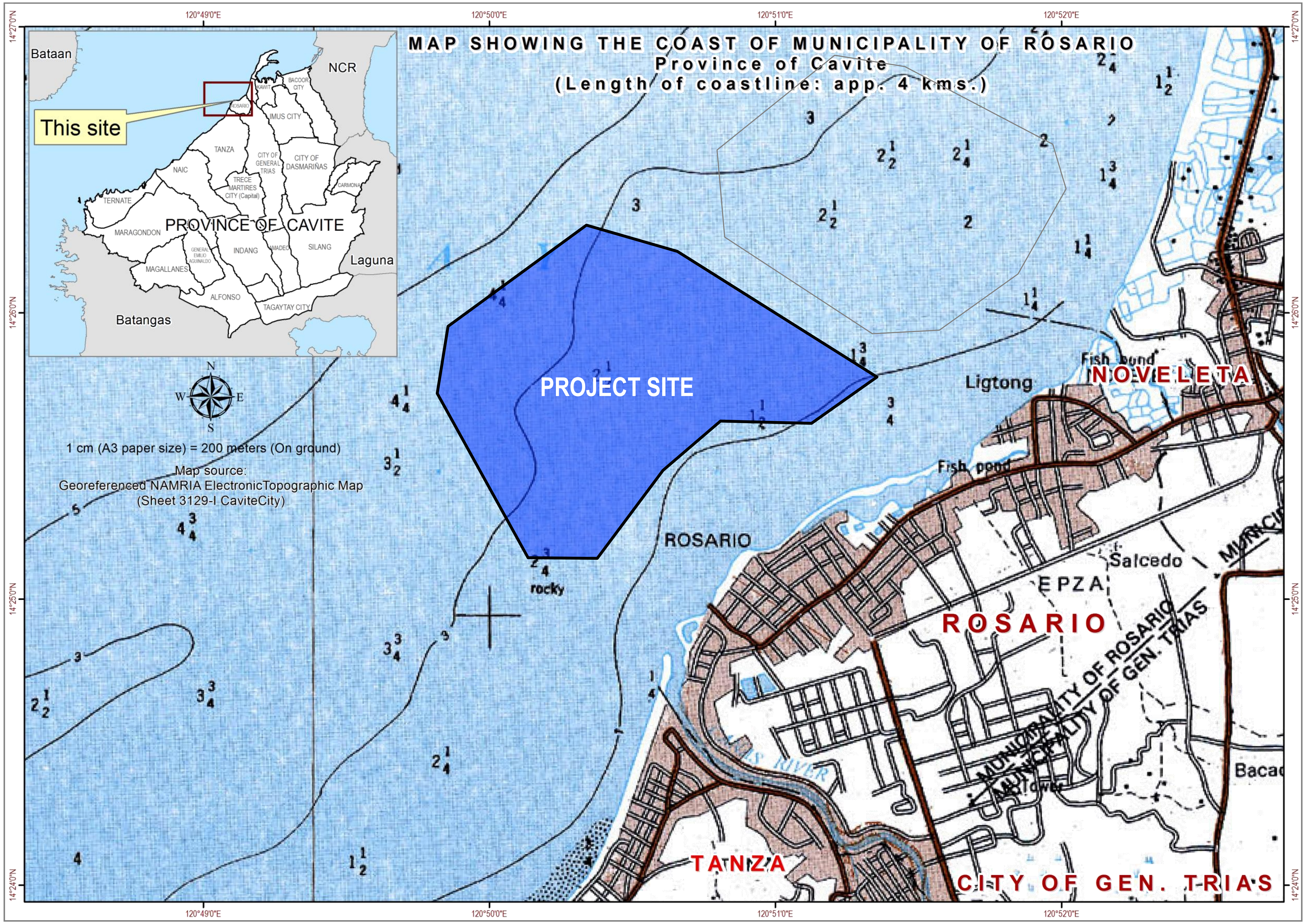
Plate 2.2-5. Survey team doing key informant interview at Rosario fish port, team preparing scuba gear and diver with substrate after spot dive.

Plate 2.2-6. Top: Trash in the coastline and fish traders in the Fish Port buying "Law-law" (Sardines); Middle: fishing boats docked in front of the fish port and s surrounding gill net being operated in fishing ground offshore; bottom: sardines being dried amidst shanties in Bgy. Pandawan, households and litter in the coastline of Rosario.



Base Map: 2017 Google Earth Map

Figure 2.2-91. Map of Marine Survey Area for the Cavite Reclamation Projects



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

Figure 2.2-92. Coastline and General Coastal Habitat Types in the vicinity of Island E

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:

2.2-5.2.1 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 using "tuck dives" and underwater torch were employed to determine the general benthic morphology in all of the proposed five islands. In turbid waters such as in Bacoor Bay, the seabed is difficult to discern clearly through manta tows and the survey had to resort to numerous tuck dives in the manta tow pathways, spot dives with scuba, and 'validation' dives to determine whether habitats and other benthic ecological attributes occur in the area. In areas where significant coral reefs occur, 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 will be undertaken. Verification of the nature of the seabed was also undertaken through key informant interviews, mostly with fishers and mussel farm crew.

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. In cases where water is turbid as in the case of Manila Bay, periodic spot dives were undertaken along the tow pathways to validate the nature of the bottom substrate. Overall, the manta tow survey in Island E consisted of eighteen (18) tow stations with tuck dives and validation free dives in shallow waters, covering a total linear distance of 4 km. The manta tow observation pathways are displayed in Figure 2.2-93; the coordinates of the stations surveyed is shown in Table 2.2-42.

Seabed and Substrate Spot Dives

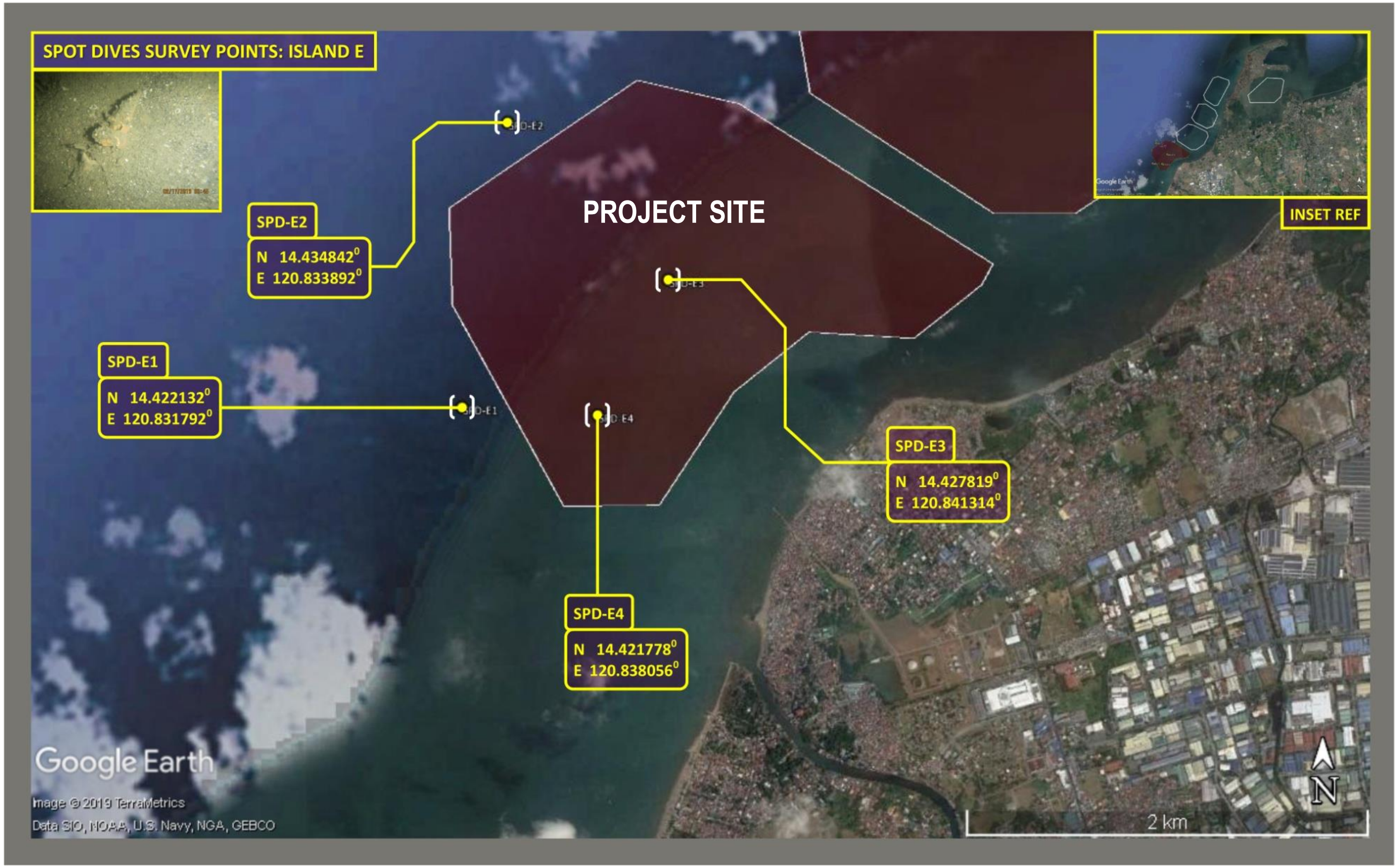
In as much as the coastal waters in study area are turbid, the survey team undertook periodic validation 'spot dives' aided with underwater torch in order to confirm that no other benthic fauna occur in the vicinity of the muddy substrates observed in the manta tow pathways. A total of four spot/validation dives were completed employing scuba were undertaken in strategic points in the proposed reclamation area in order to obtain samples of bottom sediments and to further check whether the seabed hosts other habitat attributes or structures that may be suitable for settlement of corals or growth of marine animals and crustaceans of economic and ecological importance. The spot dives involved the inspection of the benthic condition over a 10-meter diameter radius around the spot dive points (Figure 2.2-124). The coordinates of the stations are listed in Table 2.2-42. In the same stations, the nature of sediment and substrate were documented and samples were obtained.

Table 2.2-42. Coordinates of Spot Dive Stations; February 2019.

WP Code	LATITUDE	LONGITUDE	Remarks
SPDE1	N 14.422132°	E 120.831792°	Outside of reclamation area; western sector, side facing Ca River estuary.
SPDE2	N 14.434842°	E 120.833892°	Outside of reclamation area; northern sector seaward.
SPDE3	N 14.427819°	E 120.841314°	Inside reclamation Island 'E', central portion
SPDE4	N 14.421778°	E 120.838056°	Inside reclamation Island 'E', southern sector

Base Map: 2018 Google Earth Map

Figure 2.2-93. Manta Tow Pathways in Island E; October and November 2018 and February 2019.



Base Map: 2019 Google Earth Map

Figure 2.2-94. Location of Spot Dives for Bottom Sediment and Validation of the Nature of the Seabed in Island E; February 2019.

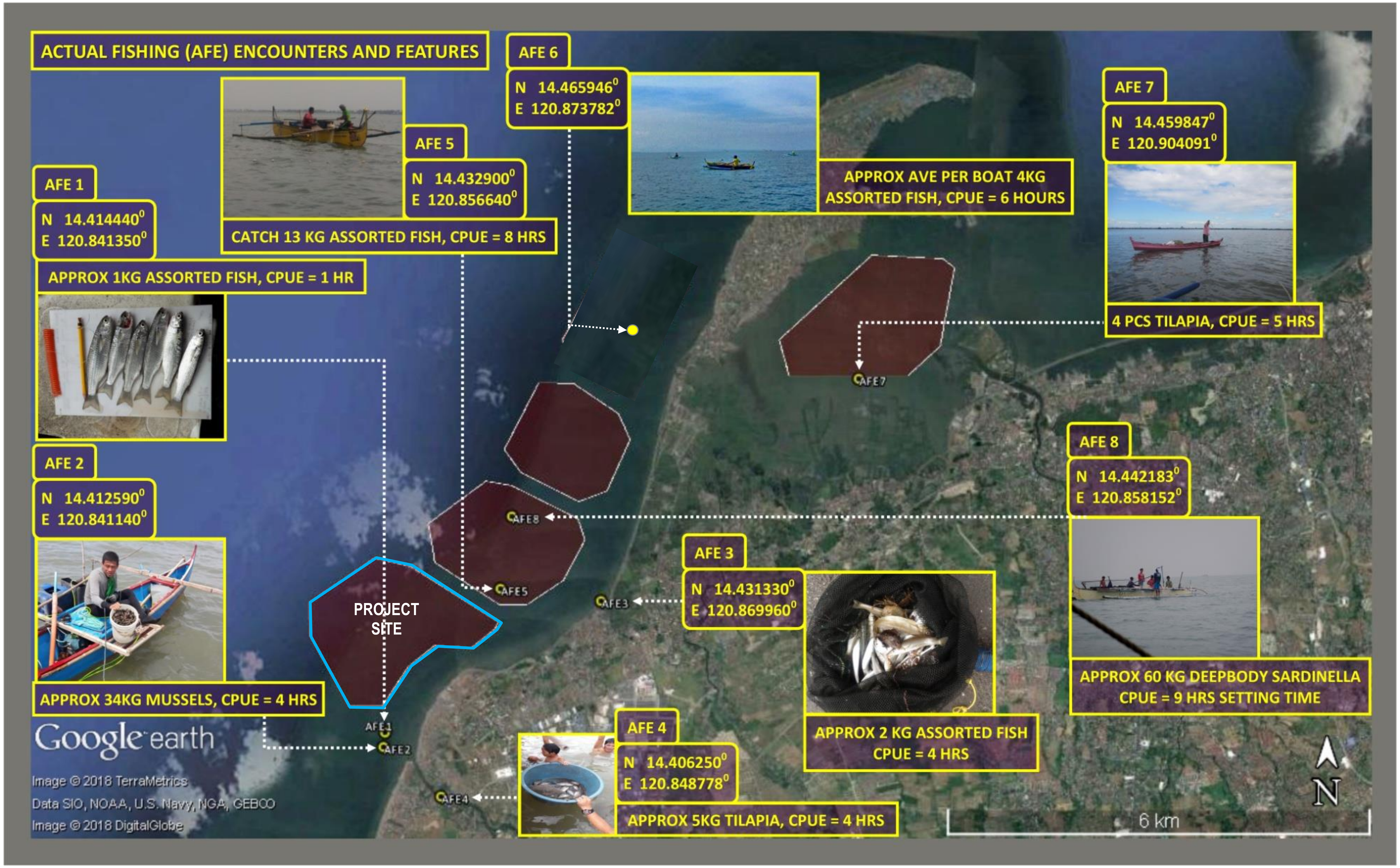
Fisheries and Fishing Practices

Fisheries statistics reported by the Philippine Statistics Authority revealed that the total volume of fish production in Cavite province declined by 21% in 2016 (11,584 MT) compared to the 2014 production (14,806 MT). Fisher informants in the Rosario fish port claim a steady decrease in catch rates for demersal and large pelagic species, but catch rates for “Law-law” (*Sardinela sp*) have remained largely constant, in fact increasing during surges of the sardine stock during peak spawning seasons. The fisheries situation is exacerbated by the use of illegal and ‘active’ fishing gears in offshore fishing grounds (e.g., sud-sod, commercial ring net) 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, hook and line 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. 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. A shellfish gleaner was observed in Island E. Fisheries profiling was reinforced with Key Informant (KI) interviews in the Rosario Fish Port to determine 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 2.2-43 and locations are shown in Figure 2.2-95.

Table 2.2-43. Coordinates of Actual Fishing Encounters (AFEs); Oct & Nov 2018

WP Code	LATITUDE	LONGITUDE	Remarks
AFE1	N 14.414440°	E 120.841350°	Gill net fisher operating approximately 1 km from the Cañas river estuary; south of Island ‘E’
AFE2	N 14.412590°	E 120.841140°	Fisher using compressor to harvest mussels in rocky substrate and “run-away” mussel bamboo poles; Island ‘E’
AFE4	N 14.406250°	E 120.848778°	Two fishers using cast net to catch Tilapia inside the Cañas River about 600 meters from river mouth.
AFE3	N 14.431330°	E 120.869960°	Lone fisher using cast net in Ligtong River estuary in the boundary of Rosario and Noveleta; Island ‘D’
AFE5	N 14.432900°	E 120.856640°	Two small-scale fishers operating in southern corner of proposed island ‘D’ using gill net
AFE6	N 14.465946°	E 120.873782°	Lone hook and line fisher in non-motorized boat fishing inside proposed island ‘B’ about 1 km from the shoreline
AFE7	N 14.442183°	E 120.904091°	Lone fisher in non-motorized boat fishing with gill net in shallow water with dense mussel farms; Island ‘A’.
AFE8	N 14.442183°	E 120.858152°	Six (6) fishers in motorized boat using surrounding gill net to catch sardines, approximately 1.6 km from shoreline inside proposed island ‘D’.



Base Map: 2018 Google Earth Map

Figure 2.2-95. Location of AFEs Documented Across the Cavite Reclamation Project Islands.

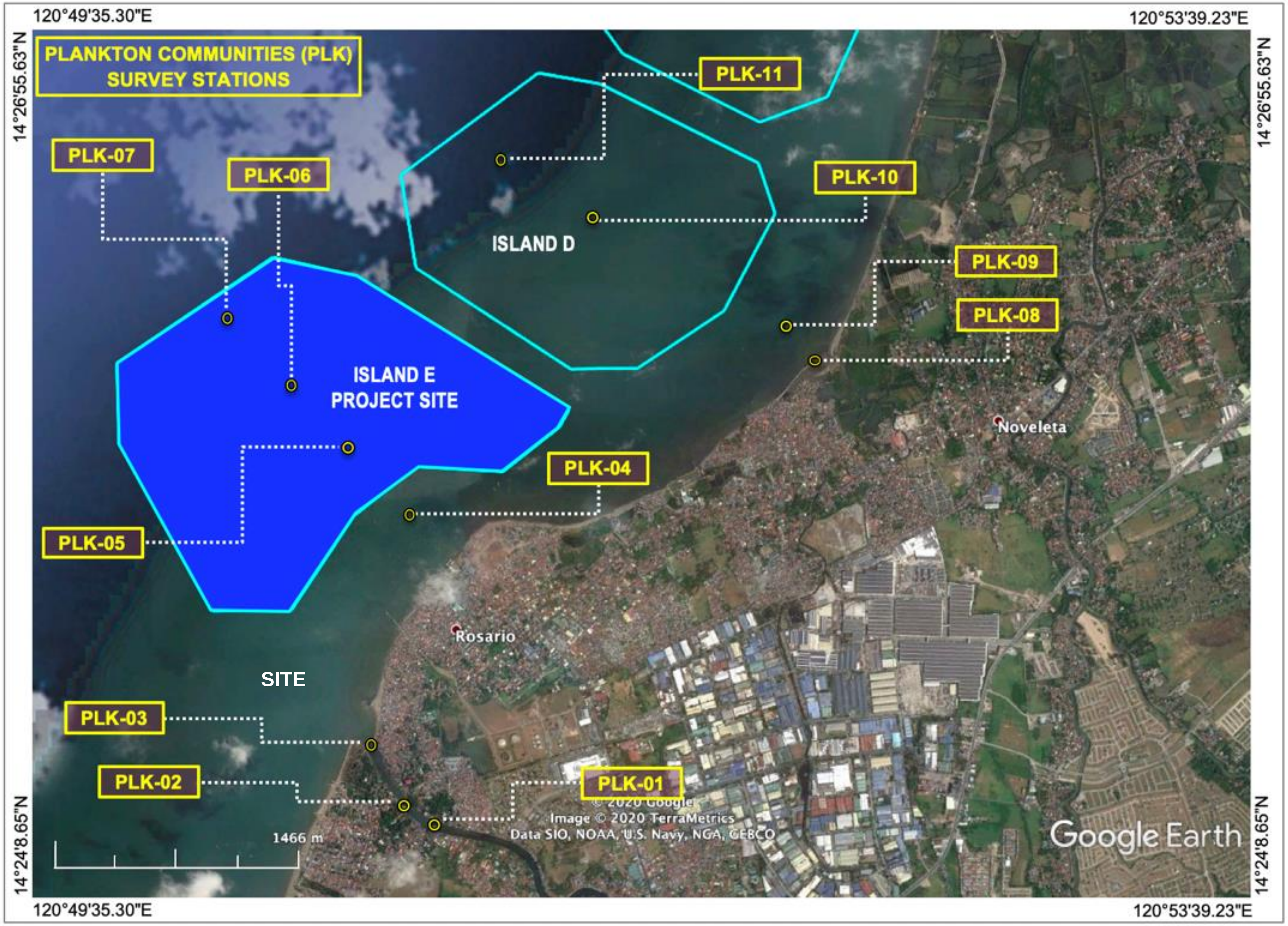
Plankton Community

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 2.2-44 and a map of station location is shown in Figure 2.2-96; also see Plate 2.2-6.

Table 2.2-44. Coordinates of Plankton Sampling Stations Surveyed in Island E and vicinities; February 2019

Island	Station	Northing	Easting	Remarks
Cañas R	PLK01	14.406250°	120.848778°	Dominant phytoplankton *Pseudonitzschia* spp. at 5,670 cells/L, while dominant zooplankton nauplius (larval form) at 23,100 indiv/m^3
Cañas R	PLK02	14.407306°	120.847111°	Dominant phytoplankton *Pseudonitzschia* spp. at 2,340 cells/L, while dominant zooplankton calanoid copepod (adult form) at 3,400 indiv/m^3
Cañas R	PLK03	14.410472°	120.845250°	Dominant phytoplankton *Chaetoceros* spp. and *Pseudonitzschia* spp. both at 456 cells/L each, while dominant zooplankton cyclopoid copepod (adult form) at 8,900 indiv/m^3
E	PLK04	14.422861°	120.847361°	Dominant phytoplankton *Chaetoceros* spp. at 453 cells/L, while dominant zooplankton nauplius (larval form) at 34,500 indiv/m^3
E	PLK05	14.426500°	120.843972°	Dominant phytoplankton *Skeletonema* spp. at 256 cells/L, while dominant zooplankton nauplius (larval form) at 35,600 indiv/m^3
E	PLK06	14.429778°	120.840833°	Dominant phytoplankton *Chaetoceros* spp. at 345 cells/L, while dominant zooplankton nauplius (larval form) at 46,700 indiv/m^3
E	PLK07	14.433472°	120.837278°	Dominant phytoplankton *Ceratium furca* at 76 cells/L, while dominant zooplankton nauplius (larval form) at 74,500 indiv/m^3

Plate 2.2-7. Plankton Sampling and Benthos Sorting



Base Map: 2020 Google Earth Map

Figure 2.2-96. Location of Plankton Community Sampling Stations in the proposed Cavite Reclamation Project; November 2018.

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 2.2-45 and shown in Figure 2.2-127.

Table 2.2-45. 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 Cañas 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 2.2-97. Location of Macro-invertebrate Stations in the Proposed Cavite Reclamation Project; October and November 2018.

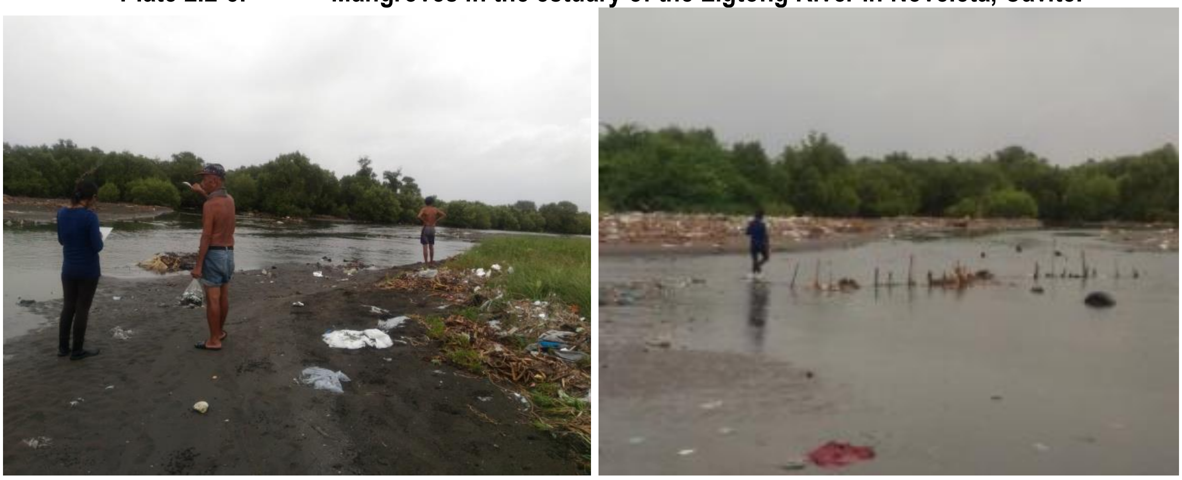
Seagrasses and Associated Macrobenthic Algae

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

There are no mangroves in the coastline fronting reclamation Island E. A small patch of mangrove exists along the estuary of the Ligtong River in the boundary of Rosario and Noveleta, Cavite (Plate 2.2-7); 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. These mangroves is nearest to island 'D".

Plate 2.2-8. Mangroves in the estuary of the Ligtong River in Noveleta, Cavite.

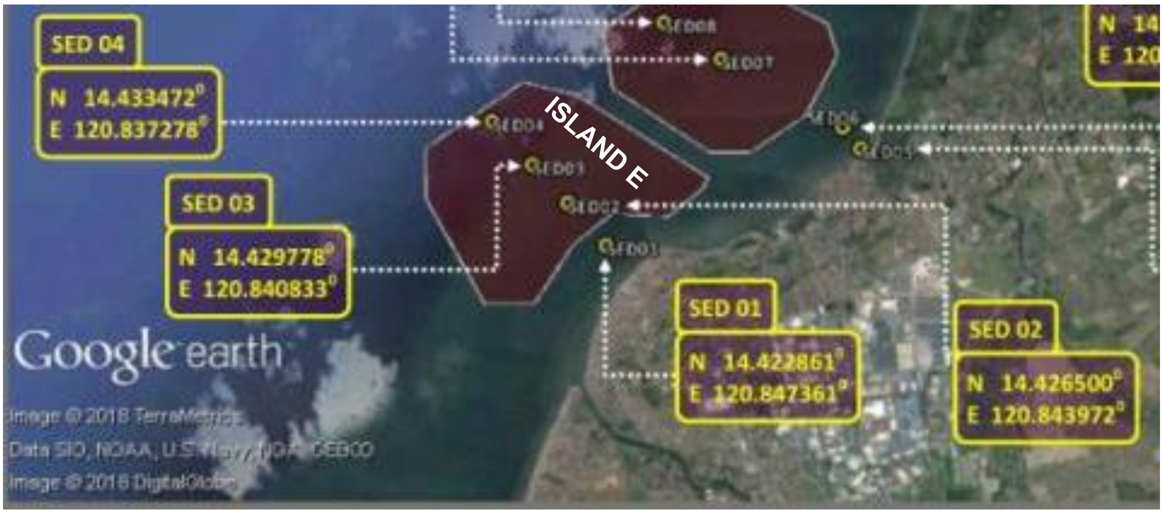


Sediment Collection

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 within Island E. The station coordinates and results are shown in the table below.

Table 2.2-46. Sediment Sampling Stations in Island E.

WP Code	LATITUDE	LONGITUDE	Remarks
SED01	N 14.422861°	E 120.847361°	Same coordinates as PLK04; dark gray silt/mud collected
SED02	N 14.426500°	E 120.843972°	Same coordinates as PLK05; dark gray silt/mud collected
SED03	N 14.429778°	E 120.840833°	Same coordinates as PLK06; dark gray silt/mud collected
SED04	N 14.433472°	E 120.840833°	Same coordinates as PLK07; dark gray silt/mud collected



Source: 2018 Google Earth Map

Figure 2.2-98. Location of Sediment Sampling Stations; Oct & Nov 2018

2.2-5.3 Results and Discussion

Benthic Profiling and Substrate Characterization

The broad survey covered a wide band of coastal waters with a total linear area of almost 30km in 108 manta tows and 'tuck dives' across the survey area. The benthic observation pathways were undertaken to locate, identify and characterize any benthic communities of corals, seagrass and algae beds, fish populations, submerged structures, and other benthic life forms such as anemones, gorgonians and sponges that can occur in the sandy seabed in the proposed reclamation sites. Elsewhere in the project site, extensive systematic snorkeling around tuck dive stations along the manta tow pathways and 4 spot dive surveys were completed in order to determine the nature of the seabed, collect sediments and verify existence of demersal species of fish.

Sandy substrate with a few scattering of rocks were recorded in 18 manta tow benthic observations across the proposed "Island E" reclamation site in Rosario. Profuse silt and sediment streams emanate from the Cañas River and Ligtong River estuaries, about 1km away from the northeastern edge of the proposed reclamation area. The seabed is essentially devoid of significant benthic habitats including soft and hard coral colonies, seaweed communities and associated algal assemblages or significant underwater rocky structures that can serve as habitats for demersal species of fish or support fish spawning aggregates.

However, fishers claim that 4 units of artificial reef structures (ARSs) have been placed around islands E and D. The survey team attempted to document the ARS using scuba but only the anchor line was seen at 30 feet under one of the buoy markers. Of the 4 ARs allegedly dispatched by the BFAR in Rosario, only 1 unit is inside the proposed reclamation area.

The results of manta tow surveys in Island E are shown in Table 2.2-47, Figures 2.2-99 and Figure 2.2-100, and Plate 2.2-8.

Plate 2.2-9. Muddy sediments and silt-encrusted sand dominate the seabed in the proposed reclamation Island E in Rosario, Cavite.

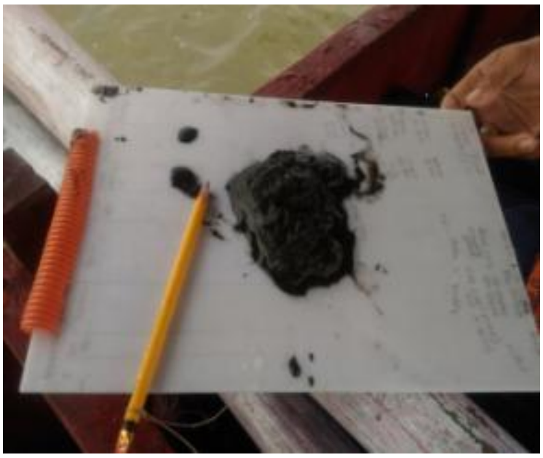


Table 2.2-47. Results of Manta Tow Benthic Life Form and Substrate Investigations; Nov 2018.

Tow Coverage	Location [DecDeg]	LHC	SC	DC	DCA	CR	S	Remarks
S00e	N 14.413360° E 120.84389°	-	-	-	-	-	-	**Start of Tow**
S00e-T01	N 14.413742° E 120.841484°	0	0	0	0	0	100	Turbid waters - tuck dive used; Substrate is sand and mud with shellfish grits
T01-T02	N 14.415136 ° E 120.839546°	0	0	0	0	0	100	Turbid water; Substrate is sand and mud (KI)
T02-T03	N 14.416959° E 120.837995°	0	0	0	0	0	100	Turbid waters - tuck dive used; Substrate is sand and mud with shellfish grits
T03-T04	N 14.418870° E 120.836790°	0	0	0	0	0	100	Turbid water; Substrate is sand and mud – KI
T04-T05	N 14.420927° E 120.836886°	0	0	0	0	0	100	Turbid waters - tuck dive used; Substrate is sand and mud with shellfish grits
T05-T06	N 14.422482° E 120.837661°	0	0	0	0	0	100	Substrate is coarse sand and silt – KI
T06-T07	N 14.423730° E 120.838740°	0	0	0	0	0	100	Substrate is coarse sand and silt –KI
T07-T08	N 14.425164° E 120.839986°	0	0	0	0	0	100	Tuck dive - Substrate is coarse sand and silt
T08-T09	N 14.426773° E 120.841148°	0	0	0	0	0	100	Turbid waters - tuck dive used; Substrate is coarse sand and silt
T09-T10	N 14.428221° E 120.842421°	0	0	0	0	0	100	Spot dive and KI - Rocks with mussels
T10-T11	N 14.429509° E 120.843750°	0	0	0	0	0	100	Tuck dive - Substrate is sand and mud with shellfish grits
T11-T12	N 14.430421° E 120.845577°	0	0	0	0	0	100	Turbid water - Substrate is sand and mud with shellfish grits – KI
T12-T13	N 14.431226° E 120.847404°	0	0	0	0	0	100	Turbid water - Substrate is sand and mud with shellfish grits (KI)
T13-T14	N 14.430744° E 120.849675°	0	0	0	0	0	100	Substrate is sand and mud with shellfish grits (KI)
T14-T15	N 14.429940° E 120.851558°	0	0	0	0	0	100	Tuck dive -Substrate is sand and mud with shellfish grits
T15-T16	N 14.428546° E 120.852998°	0	0	0	0	0	100	Free dive - Substrate is sand and mud with shellfish grits
T16-T17	N 14.426830° E 120.853718°	0	0	0	0	0	100	Free dive - Substrate is sand and mud with shellfish grits
T17-T18	N 14.424899° E 120.854106°	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**	

Tow Coverage	Location [DecDeg]	LHC	SC	DC	DCA	CR	S	Remarks

Site name:	Western coastal waters across Rosario Municipality, Province of Cavite	**Survey Team:**
Time / Date:	0910H-1220H / November 2018	1. Benjamin Francisco 2. Marivel Llavan 3. Liza Gobrin
Tow Speed:	4.0 kmh (ave)	
Visibility:	Varying from 30cm to 100cm due to mixing of seawater and sand/silt	
Weather:	Fair to Slightly Overcast	
Wave:	Rolling at 10cm crests	
Current:	None	
Tide:	Lowering @ 0.87m to 0.41m; as ref from Cavite –Manila Bay Tidal Station (WXTIDE32)	
Water Temp:	Varying from approx. ± 30°C	
Wind:	Beaufort Scale #2	
Cloud Type:	Cumulus and Nimbus Clouds	

Note: Tow area coverage are expressed in Decimal Degrees notation in reference to WGS84 Map Datum

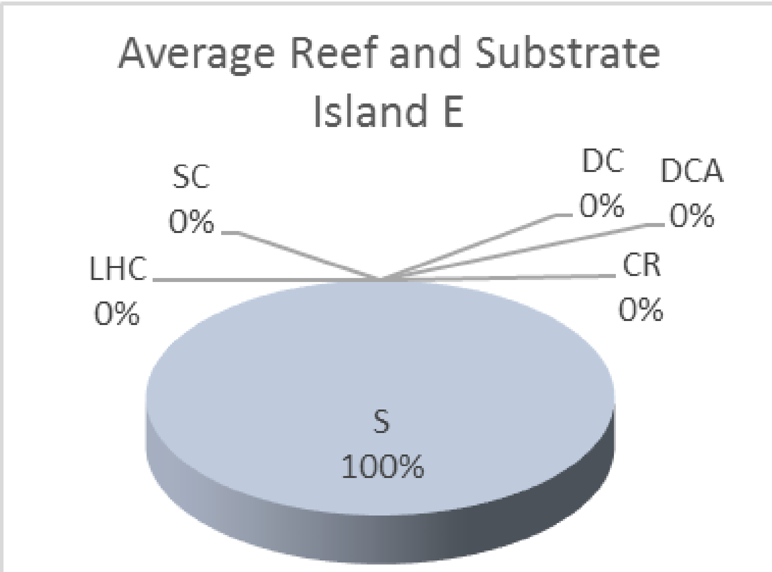


Figure 2.2-99. Results of Benthic Observations from 18 Manta Tow Pathways Across Island E; Nov 2018.

Note the 100% sandy substrate in Island E.

Four spot dives in water with depths ranging from 4.5 to 6.6 meters revealed that the substrate in the proposed Island E reclamation area is comprised of firm sand, rubble, small patches of rocks and grits of shellfish carapace. Patches of low relief algae were discerned in Spot dive SPDE1. A solitary anemone was seen in SPDE2. Photo documentation of the substrate seen from the spot dives is presented in Plate 2.2-10 below.

Plate 2.2-10. Photographs of substrate and sea bottom as seen from spot dives undertaken in several points inside and outside of the proposed Island E; Rosario, Cavite (February 2019).

Base Map: 2018 Google Earth Map

Figure 2.2-100. Results of Benthic/Substrate Surveys from 18 Manta Tow Pathways across Island E; Nov 2018 and Feb 2019.

2.2-5.4 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 2.2-48. 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			

**Source of data: Municipal Fisheries Profiles; 2018*

Capture Fisheries in the Vicinity of Island E

Capture fisheries is the dominant practice in Rosario and Noveleta, with the Rosario Fish Port as the main landing center. Mussels are also being harvested in Rosario and Noveleta in rocky structures along the coastline although the bivalves are not being farmed in these areas. Small-scale fishers using hook and line and bottom set gill nets are operating just outside of the proposed reclamation area about 1km away from the western side of the proposed reclamation area (Plate 2.2-11). The fishing ground is a small area where submerged rocks provide shelter to a few species of demersal fish, notably Nemipterids, Theraponids and the common whiting (*Asohos)*. During the survey on February 16, 2019, a total of 12 small fishing boats using hook and line were observed in the area. The catch consisted of bisugo (Threadfin bream – *Nemipterus japonicus*), and sap-sap (ponyfish – *Leiognathus sp*) averaging 3 kg per fishing boat in 5 hours of fishing time (Plate 2.2-11).

The main fishing operation in Rosario is the operation of encircling gill nets that capture “Law-law” (*Sardinella brachysoma*) in fishing grounds allegedly 10 km away from the Rosario Fish Port, in 18 fathoms of water. It should be noted that the encircling gill net, as well as other gears operated in Rosario and Noveleta such as ring net and motorized push nets are all considered as “active gear” and are therefore prohibited to be operated in the 15km municipal waters. Most of the fishing fleets are based in Barangays Sapa 2 and Sapa 4 in Rosario, Cavite. The deep-bodied herring (Law-law) occurs all year round with peak seasons during the months of April to October.

Plate 2.2-11. Top frame - Key informant interview of "law-law" fishers; a fleet of sardine gill netters docked inside the Cañas River; Bottom frames – a group of hook and line fishers operating 1km west of the proposed Island 'E' reclamation area, and a large boat transporting crab fish pots to an offshore fishing ground in the mouth of Manila Bay.

Fishery Resources

In the absence of coral reefs, fish visual census for recording of species richness of demersal, reef-associated fish communities cannot be undertaken. No significant aggregations of demersal fish species were encountered in the manta tows, spot dives and systematic snorkeling around the proposed reclamation site. The absence of ecologically significant benthic habitats and ecological functions that can support a viable level of demersal fish population and the prevalence of fishing gears that target pelagic species is a manifestation of the lack of demersal fish stocks.

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). 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 Bacoor Bay during its peak season from October to February and lesser in occurrence in Rosario waters. Mackerel scads (i.e. alumahan), swimming crabs and the lucrative diamond back squid (*Thysanoteuthis rhombus)* also constitute a minor portion of target species. The list of common species caught in the vicinity of the proposed reclamation areas is presented in Table 2.2-49 (please also see Plate 2.2-12).

Table 2.2-49. List of Fish Species Caught in Fishing Grounds of Rosario, Noveleta, Cavite City, Cavite

English Name	Local Name	Scientific Name
Deep bodied herring	Law-law	*Sardinella brachysoma*
Anchovy	Dilis	*Stolephorus sp*
Nile Tilapia	Tilapia	*Oreochromis nilotica*
Flathead mullet	Banak	*Mugil cephalos*
Long-arm mullet	Aligasin	*Valamugil cunnessius*
Gizzard shad	Kabansi	*Clupanodon thrissa*
Spotted mojarras	Latab	*Gerres filamentosus*
Caranx	Samin-samin	*Ulua mentalis*
Common whiting	Asohos	*Sillagos ihama*
Goat fish	Saramolyete	*Upeneus species*
Rabbitfish	Samaral/budas	*Siganus punctatus*
Rabbitfish	Danggit	*Siganus species*
Indian mackerel	Alumahan	*Rastrelliger kanagurta*
Mackerel scad	Galunggong	*Decapterus macarellus*
Diamondback squid	Pusit	*Thysanoteuthis rhombus*
Suahe	Pasayan	*Metapenaeus ensis*
Blue swimmer crab	Alimasag	*Portunus pelagicus*

Plate 2.2-12. Dominant target species in coastal waters around the proposed Cavite Reclamation Project in Rosario,Cavite: gizzard shad (kabansi), flathead mullet (banak), swimmer crab (alimasag), sardines (Law-law/tamban),

Fishing Practices

The surrounding gill net and ring net, both considered active gears, are operated in offshore fishing grounds, estimated to be 10km to 12km from the shoreline to catch schools of pelagic species. Operators of this gear claim that catches of sardines are better in deeper fishing grounds. At the time of the survey, there were 36 fishing boats docked at the Rosario Fish Port, majority of which were for "law-law" fishing. In nearshore areas, where other 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). In the shallow sandy shelf about 6 to 8 km from the shore, large boats with crab pots are operated to catch swimming crabs (*Portunus pelagicus*) 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 (Plate 2.2-13).

Plate 2.2-13. Large surrounding gill nets being loaded onto skiff boats (left); sardines fishing fleet docked in front of the Rosario fish port (middle) and tub of sardines unloaded in the port (right).

Catch Rates and CPUE

Information from the BFARMC of Kawit, fishers interviewed during actual fishing documentation and fishers unloading their catch in the Rosario Fish Port, 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. (Similar surges in sardine stocks have been reported by the BFAR in provinces where a sardine closed season have been imposed during the last five years, e.g., Zamboanga peninsula, central Visayas). A typical sardine fishing boat will have seven (7) fishers operating 9 hours a day with three net settings. The average catch is 4 to 10 bañeras/day, or a CPUE of more than 15 to 39 kg of sardine per fishing hour/boat. Each sardine tub is sold at the Rosario fish port at a common price of PhP 1500/bañera (35 kg).

Compared to fishing yields in the inner Manila Bay, the catch rate of small-scale fishers **off the shores of Cavite are relatively better**. According to the BFARMC of Kawit and fishers in the Rosario fish port, the catch rate averages 3 kg of Tilapia plus 1kg 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.

Results of Actual Fishing Operations

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 2.2-50, Figure 2.2-101 and Plate 2.2-14).

Table 2.2-50. Results of actual fishing encounters documented in Island E; October/November 2018.

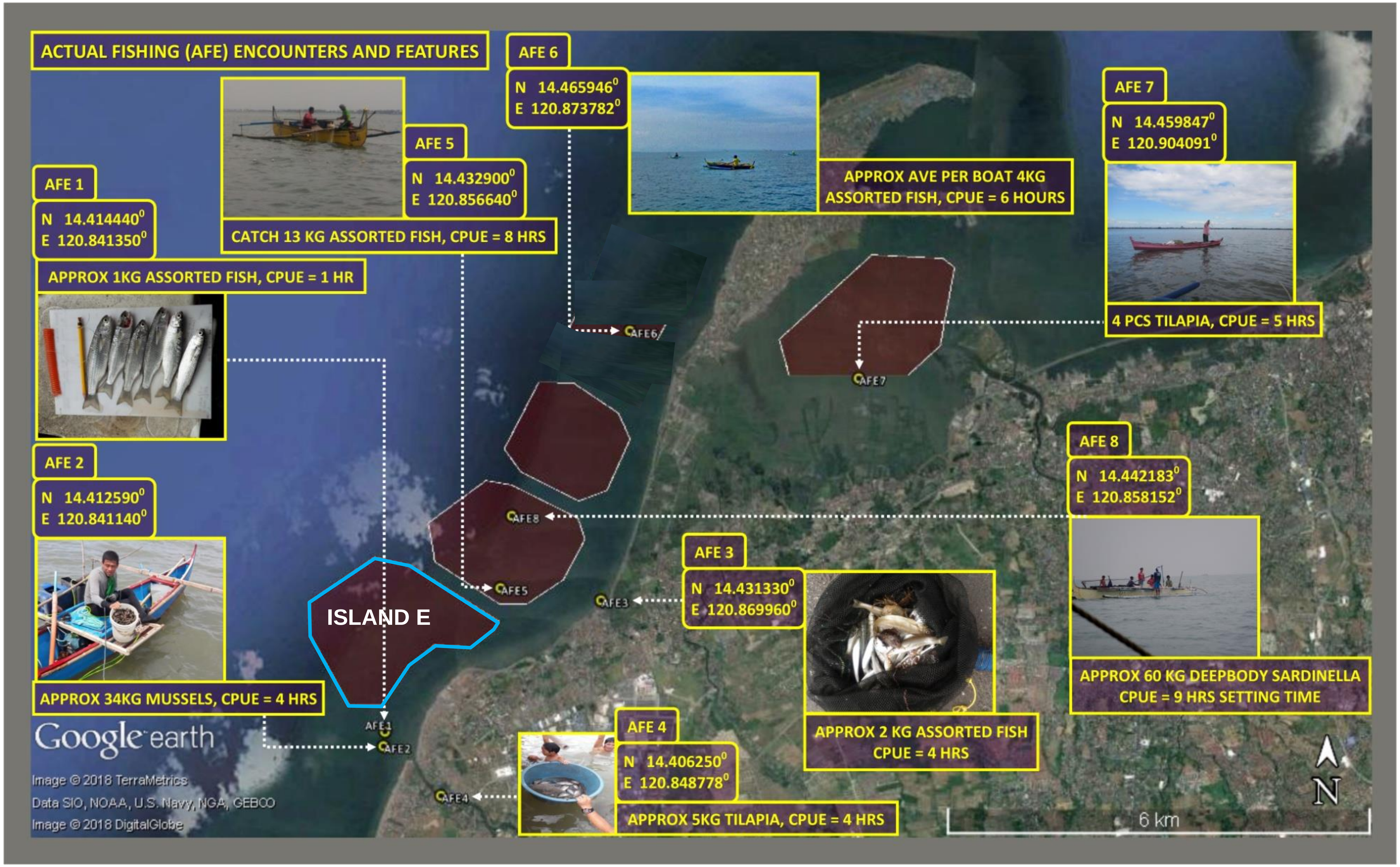
WP Code	Vicinity	Fishing Gear	Catch rate/catch composition/CPUE
AFE1	south of Island 'E'	Gill net	1 kg of small flathead mullet (*Mugil cephalus*); CPUE 1 kg/hr
AFE2	Island E	compressor	34 kg of mussel *Perna viridis*; CPUE 8.5 kg per hour with use of compressor (considered illegal)
AFE4	Near Island E; Cañas River	cast net	5 kg of Tilapia inside the Cañas river; CPUE – 1.25 kg per hour

Two fishers documented in the vicinity of Island E yielded a CPUE of 1kg/hr for bottom set gill net and 8.5kg of mussels harvested from bamboo poles that apparently drifted from Bacoor Bay. An additional actual fishing documentation on 16 February on the operation of two fishers aboard a small gill netter yielded 5kg of ponyfish and a few pieces of bisugo, all of which were extremely small juveniles, 9 hours fishing time (Plate 2.2-14). Offshore fishing grounds for *law-law*, approximately 10 km from the shoreline appear to be the most productive, employing 35-foot boats with a crew of seven fishers. The catch composition, at the time of the survey, seems 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.

Plate 2.2-14. Actual fishing documentation (16 Feb 2019) showing two fishers displaying catch consisting of two juvenile size threadfin bream (bisugo) and slipmouth (sap-sap) in coastal waters in the vicinity of Island E.

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 but are not being operated in Rosario particularly in the vicinity of the proposed Island E reclamation.



Source: 2018 Google Earth Map

Figure 2.2-101. Results of 8 AFEs during the Marine Survey; various dates in Nov 2018 and Feb 2019.

Mangroves

No mangroves occur in the greater vicinity of the proposed reclamation island E in the coastline of Rosario. The nearest mangrove is at the estuary of Ligtong (Maalimango) River 1.62km to the northeast of the easternmost corner of Island E.

Two mangrove stations were investigated in the estuary of the Ligtong River. The first station in 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 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 Ligtong River which actually hosted the main patch of mangroves (Table 2.2-51). 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 2.2-51 and Figure 2.2-102). *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 2.2-103 and 2.2-104).

Table 2.2-51. Mangrove Species Distribution in Station 1 in the Ligtong River Estuary, Noveleta

Location: Barangay Ligtong, Noveleta, Cavite — Date: November 2018
Observers: Marivel Llavan and Liza Gobrin — MGV1 Coordinates

Transect # 1	Tree #	Substrate	Species	Ht. (m)	Crown Diameter (m)			Observations
					Reading 1	Reading 2	Ave. C.Cover	
Quadrat # I	1	Muddy	*Avicennia marina (bungalon)*	4	0.5	0.5	0.5	- dump site
10mx10m	2		*Avicennia marina (bungalon)*	4	0.5	0.5	0.5	-migratory birds
	3		*Avicennia marina (bungalon)*	4	0.5	0.5	0.5	-coastal community bordering the mangroves
	4		*Avicennia marina (bungalon)*	4	.5	0.5	0.5	-old fishpond
	5		*Avicennia marina (bungalon)*	4	.5	0.5	0.5	
	6		*Avicennia marina (bungalon)*	4	.5	0.5	0.5	
	7		*Avicennia marina (bungalon)*	4	0.5	0.5	0.5	
	8		*Avicennia marina (bungalon)*	4	.5	0.5	0.5	
	9		*Avicennia marina (bungalon)*	4	.5	0.5	0.5	
	10		*Avicennia officinalis (api-api)*	4	0.5	0.5	0.5	
	11		*Avicennia officinalis (api-api)*	4	.5	0.5	0.5	
	12		*Avicennia officinalis (api-api)*	4	.5	0.5	0.5	
	13		*Avicennia officinalis (api-api)*	4	.5	0.5	0.5	
	14		*Avicennia officinalis (api-api)*	4	0.5	0.5	0.5	
Quadrat # 2 10x10m	1		*Avicennia marina (bungalon)*	3	1.0	0.5	0.75	Outside the transect another species was found - *Sonneratia alba* (pagatpat)
	2		*Avicennia marina (bungalon)*	3	1.0	0.5	0.75	
	3		*Avicennia marina (bungalon)*	3	1.0	0.5	0.75	
	4		*Avicennia marina (bungalon)*	3	1.0	0.5	0.75	
	5		*Avicennia marina (bungalon)*	3	1.0	0.5	0.75	
Quadrat #3 10mx10m	6		*Avicennia marina (bungalon)*	3	1.0	0.5	0.75	
	7		*Avicennia marina (bungalon)*	3	1.0	0.5	0.75	
	1		*Avicennia marina (bungalon)*	3	0.5	0.5	0.50	
	2		*Avicennia marina (bungalon)*	3	0.5	0.5	0.5	
	3		*Avicennia marina (bungalon)*	3	0.5	0.5	0.50	
	4		*Avicennia marina (bungalon)*	3	0.5	0.5	0.5	

Transect # 1	Tree #	Substrate	Species	Ht. (m)	Crown Diameter (m)			Observations
					Reading 1	Reading 2	Ave. C.Cover	
	5		*Avicennia marina (bungalon)*	3	0.5	0.5	0.5	
	6		*Avicennia marina (bungalon)*	3	0.5	0.5	0.5	
	7		*Avicennia marina (bungalon)*	3	0.5	0.5	0.5	
	8		*Avicennia marina (bungalon)*	3	0.5	0.5	0.5	
	9		*Avicennia marina (bungalon)*	3	0.5	0.5	0.5	
	10		*Avicennia marina (bungalon)*	3	0.5	0.5	0.5	
	11		*Avicennia officinalis (api-api)*	3	0.5	0.5	0.5	
	12		*Avicennia officinalis (api-api)*	3	0.5	0.5	0.5	
	13		*Avicennia officinalis (api-api)*	3	0.5	0.5	0.5	
	14		*Avicennia officinalis (api-api)*	3	0.5	0.5	0.5	
	15		*Avicennia officinalis (api-api)*	3	0.5	0.5	0.5	
		Summary Results:						
TOTAL AVERAGE CROWN COVER:		19.75						
TOTAL HEIGTH OF ALL TREES:		122						
AVERAGE HEIGHT:		122/ 36 trees = 3. 38 meters (fair condition)						
No seedlings found No saplings found								

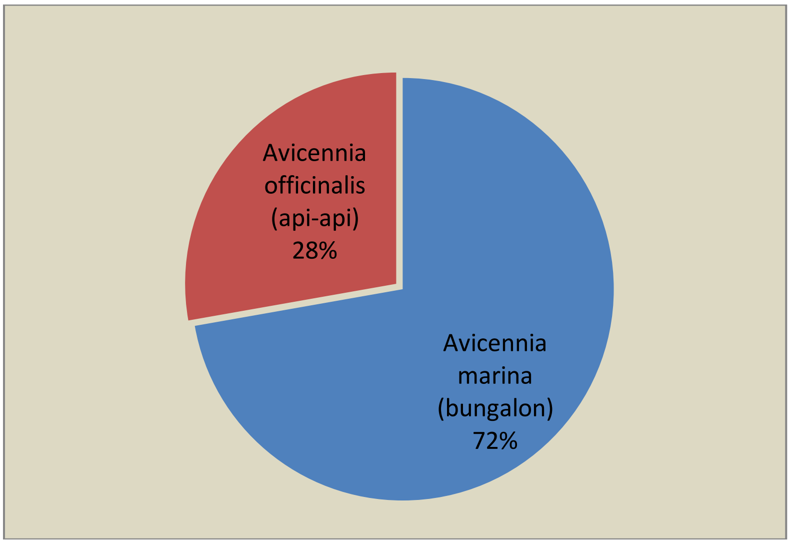


Figure 2.2-102. Relative Distribution of Mangrove Species in Station 1, Ligtong, Noveleta

Table 2.2-52. Relative Distribution of Mangrove Trees in Station 1 in Ligtong, Noveleta

Species	Local Name	Number of Trees	Relative distribution (% of total trees)
Avicennia marina	*Bungalon*	26	72
Avicennia officinalis	*Api-api*	10	28
		36	100%

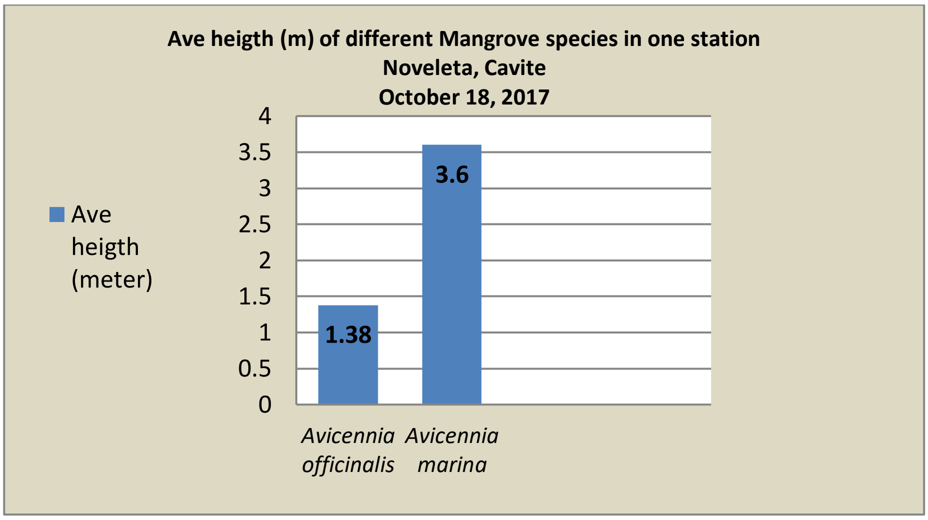


Figure 2.2-103. Relative Distribution of Height of Two Mangrove Species in Station 1, Ligtong

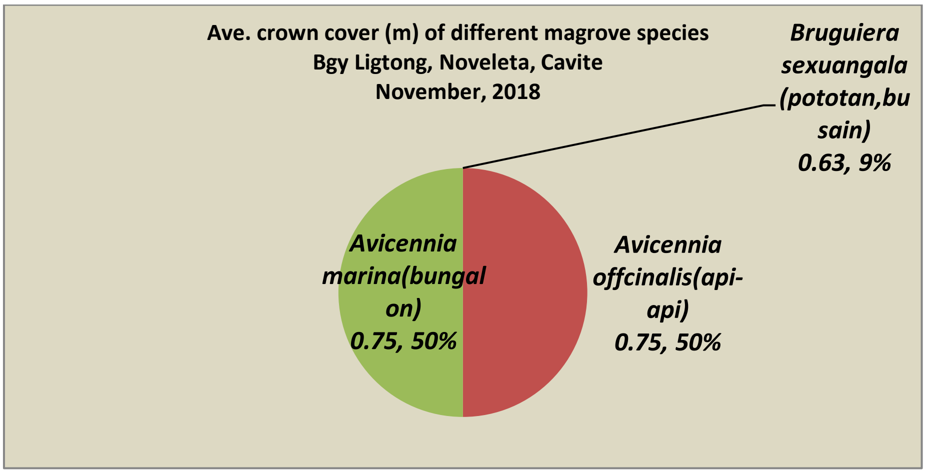


Figure 2.2-104. Average Crown Cover (% of total canopy) of 2 Mangrove Species in Station 1, Ligtong.

Plate 2.2-15. Mangroves in the Ligtong 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 2.2-53). The latter species dominated the community, comprising 57% of the community in two quadrats (Table 2.2-53 and Figure 2.2-105). *Avicennia alba* was much taller than the latte 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 2.2-106). As in station 1, there was a complete absence of seedlings and saplings. This indicates that both stations are in disturbed condition.

Table 2.2-53. Mangrove Species Distribution in Station 2 in the Ligtong River Estuary

Location: Barangay Ligtong, Noveleta, Cavite — Date: November 2018
Observers: Marivel Llavan and Liza Gobrin — MGV2 Coordinates

Transect # 2	Tree #	Substrate	Species	Ht. (m)	Crown Diameter (m)			Observations
					Reading 1	Reading 2	Ave. C.Cover	
Quadrat # I 10mx10m	1	Muddy	*Avicennia alba (api-api)*	4	0.5	0.5	0.5	- dump site - coastal community - migratory birds - old fishpond
	2		*Avicennia alba (api-api)*	4	0.5	0.5	0.5	
	3		*Avicennia alba (api-api)*	4	0.5	0.5	0.5	
	4		*Avicennia alba (api-api)*	4	0.5	0.5	0.5	
	5		*Avicennia alba (api-api)*	4	0.5	0.5	0.5	
	6		*Avicennia alba (api-api)*	4	0.5	0.5	0.5	
	7		*Avicennia alba (api-api)*	4	0.5	0.5	0.5	
	8		*Avicennia alba (api-api)*	4	0.5	0.5	0.5	
	9		*Avicennia alba (api-api)*	4	0.5	0.5	0.5	
	10		*Avicennia officinallis (bungalon)*	4	0.5	0.5	0.5	
Quadrat # 2 10x10m	1		*Avicennia alba (api-api)*	3	1	0.5	0.75	
	2		*Avicennia alba (api-api)*	3	1	0.5	0.75	
	3		*Avicennia alba (api-api)*	3	1	0.5	0.75	
	4		*Avicennia alba (api-api)*	3	0.5	0.5	0.5	
	5		*Avicennia officinallis (bungalon)*	3	0.5	0.5	0.5	
	6		*Avicennia officinallis (bungalon)*	3	0.5	0.5	0.5	
	7		*Avicennia officinallis (bungalon*	3	0.5	0.5	0.5	
	8		*Avicennia officinallis (bungalon*	3	0.5	0.5	0.5	
	9		*Avicennia officinallis (bungalon*	3	0.5	0.5	0.5	
	10		*Avicennia officinallis (bungalon*	3	0.5	0.5	0.5	
	11		*Avicennia officinallis (bungalon*	3	0.5	0.5	0.5	
	12		*Avicennia officinallis (bungalon*	3	0.5	0.5	0.5	
	13		*Avicennia officinallis (bungalon*	3	0.5	0.5	0.5	
TOTAL AVERAGE CROWN COVER		19.75						
TOTAL HEIGHT OF ALL TREES:		79						
AVERAGE HIEIGHT:		79/ 23 trees = 3.43meters (fair condition)						
		No seedlings found No saplings found						

Table 2.2-54. Relative Distribution of Mangrove Trees in Station 2 in Ligtong; Nov 2018

Species	Local Name	Number of Trees	Relative distribution (% of total trees)
Avicennia alba	*Api-api*	13	57
Avicennia officinalis	*bungalon*	10	43
		23	100%

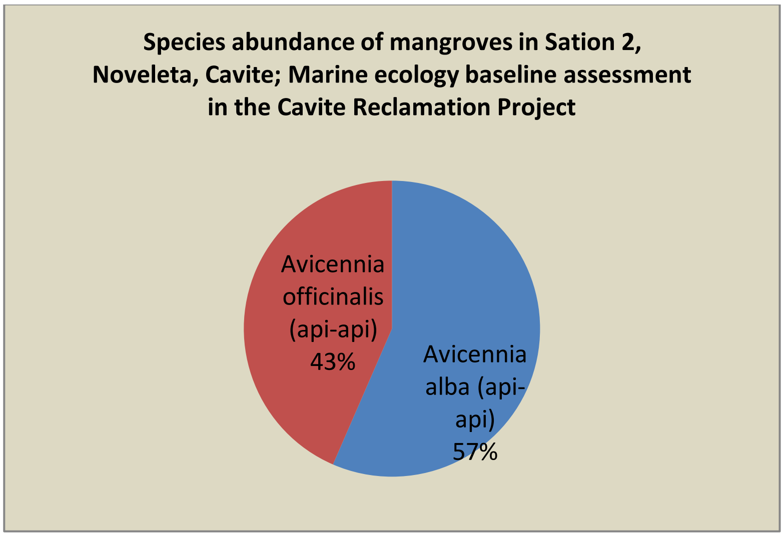


Figure 2.2-105. Relative Distribution of Mangrove Species in Station 2 in Ligtong, Nov 2018

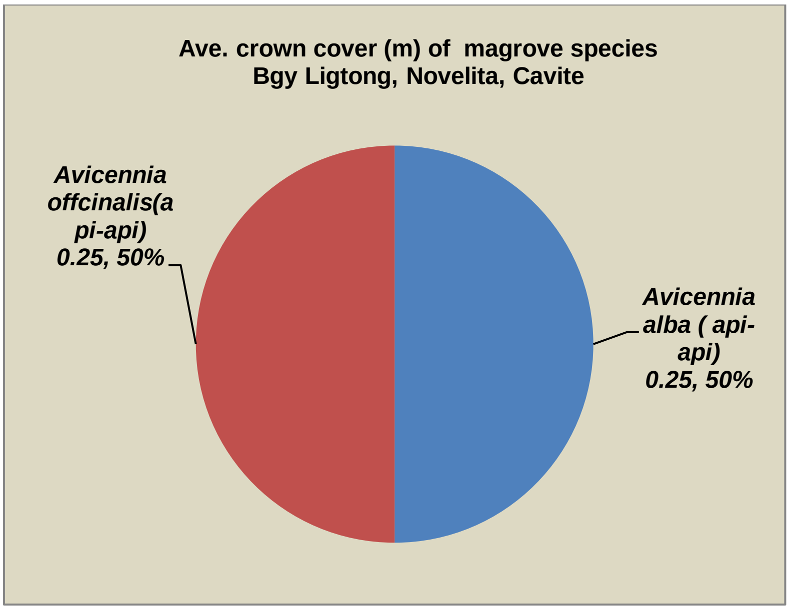
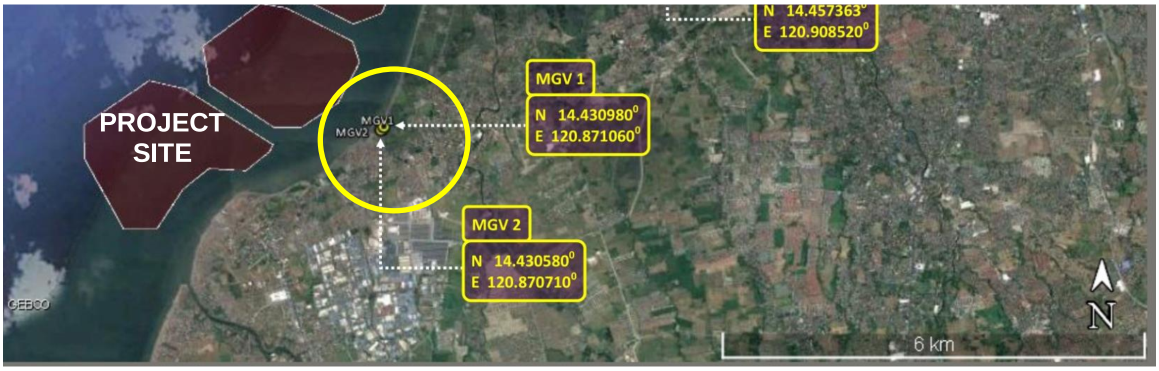


Figure 2.2-106. Average Crown Cover (in percentage of total canopy) of Two Species in Mangrove Station 2 in Ligtong, Nov 2018



Source: Google Earth Map

Figure 2.2-107. Location of Mangrove Area in Ligtong River Estuary

Plankton Community

<u>Zooplankton</u>

A total of 14 zooplankton groups (adult and larval forms) were identified in five stations sampled within proposed reclamation site in Island E (Table 2.2-55). These groups were copepod (calanoid, cyclopoid and harpacticoid), larvacean, polychaete, rotifer, bivalve veliger, decapod zoea, cnidarian larvae, gastropod veliger, copepod nauplius, polychaete trocophore. Of these, larval forms constituted for 53% while adult forms accounted for 47% of the total zooplankton count (Figure 2.2-108). Larval forms were mostly represented by copepod nauplius and copepodites with 47%. Among the adult zooplankton forms, cyclopoid copepods were the most abundant which constituted for 23%. Other important groups like gastropod veliger and decapod zoea only contributed for 3% and 0.85%. There was no rare or endemic zooplankton species found in the area and majority of the groups are common and cosmopolitan in distribution.

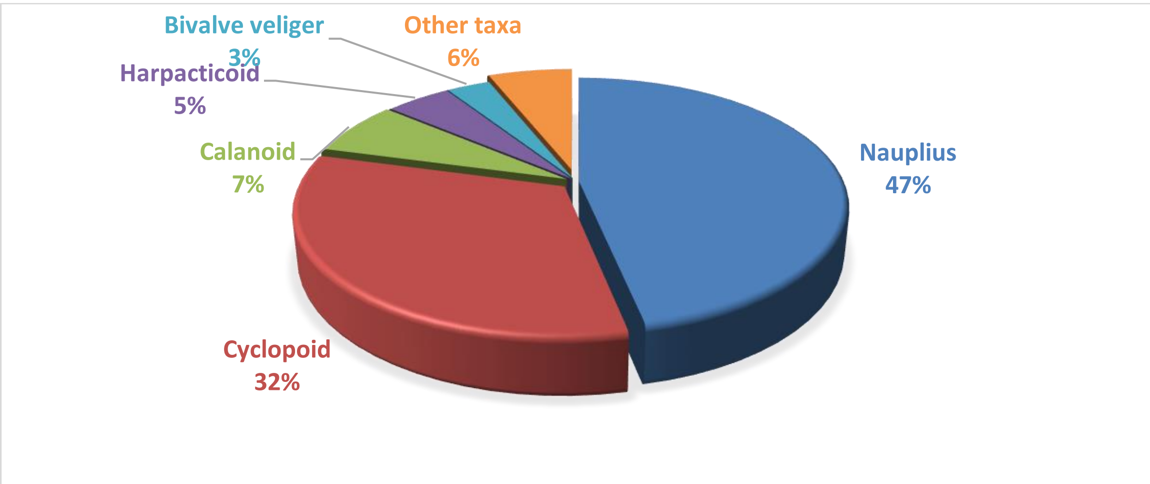


Figure 2.2-108. Percentage Composition of Major Zooplankton Groups in 4 Stations (Island E; Feb 2019)

Table 2.2-55. Zooplankton Composition and Abundance (ind/m³) in 4 stations (Island E, Feb 2019)

TAXA	ZP1	ZP2	ZP3	ZP4	Total	Rel Abund.
Adult forms	41,300	26,300	46,300	79,000	192,900	47.06
Calanoid	6,900	3,400	5,600	12,500	28,400	6.93

TAXA	ZP1	ZP2	ZP3	ZP4	Total	Rel Abund.
Chaetognaths	2,200	500	200	500	3,400	0.83
Cyclopoid	23,400	16,700	36,500	56,700	133,300	32.52
Harpacticoid	5,600	4,500	1,300	7,800	19,200	4.68
Larvacean	1,300	600	2,400	1,200	5,500	1.34
Polychaete	600		300	300	1,200	0.29
Rotifer	1,300	600			1,900	0.46
Larval forms	45,000	38,800	50,600	82,600	217,000	52.94
Bivalve veliger	4,500	1,500	2,300	4,500	12,800	3.12
Cnidarian larvae				700	700	0.17
Decapod zoea	700	700	800	1,300	3,500	0.85
Flatworm larvae	1,100	200		800	2,100	0.51
Gastropod veliger	3,400	0			3,400	0.83
Nauplius	34,500	35,600	46,700	74,500	191,300	46.67
Trocophore	800	800	800	800	3,200	0.78
Grand Total	86,300	65,100	96,900	161,600	409,900	100
Richness	13	11	10	12		
Evenness (I')	0.69	0.56	0.54	0.54		
Diveristy (H')	1.77	1.35	1.23	1.35		

The mean estimate abundance was 409,900 individuals/m^3 for all sampling stations collected in this area (Figure 2.2-109). Spatially, station ZP4 had the highest zooplankton abundance with 161,600 ind/m$^{3.}$ (Table 2.2-55, Figure 2.2-109). The lowest zooplankton abundance was observed in the station ZP2 with 65,000 ind/m$^{3.}$ recorded taxa. All diversity measurements were low (<2) with the highest values observed in station ZP1 with 1.77 while the lowest in station ZP3 with 1.35. The computed index of evenness was generally low ranging from 0.54 to 0.69. The low diversity and evenness value is due to the high density of copepod nauplius in all the stations.

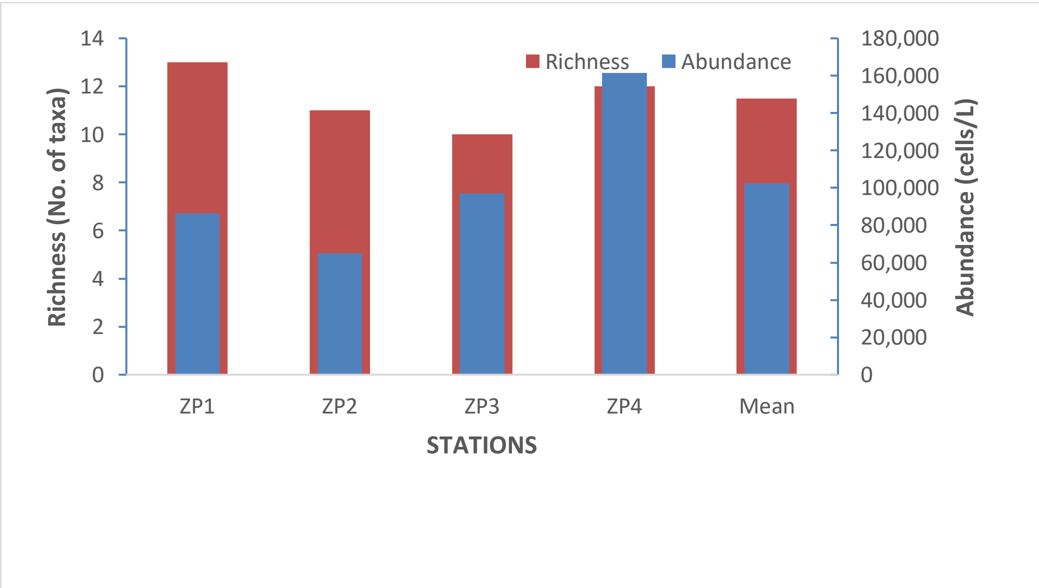
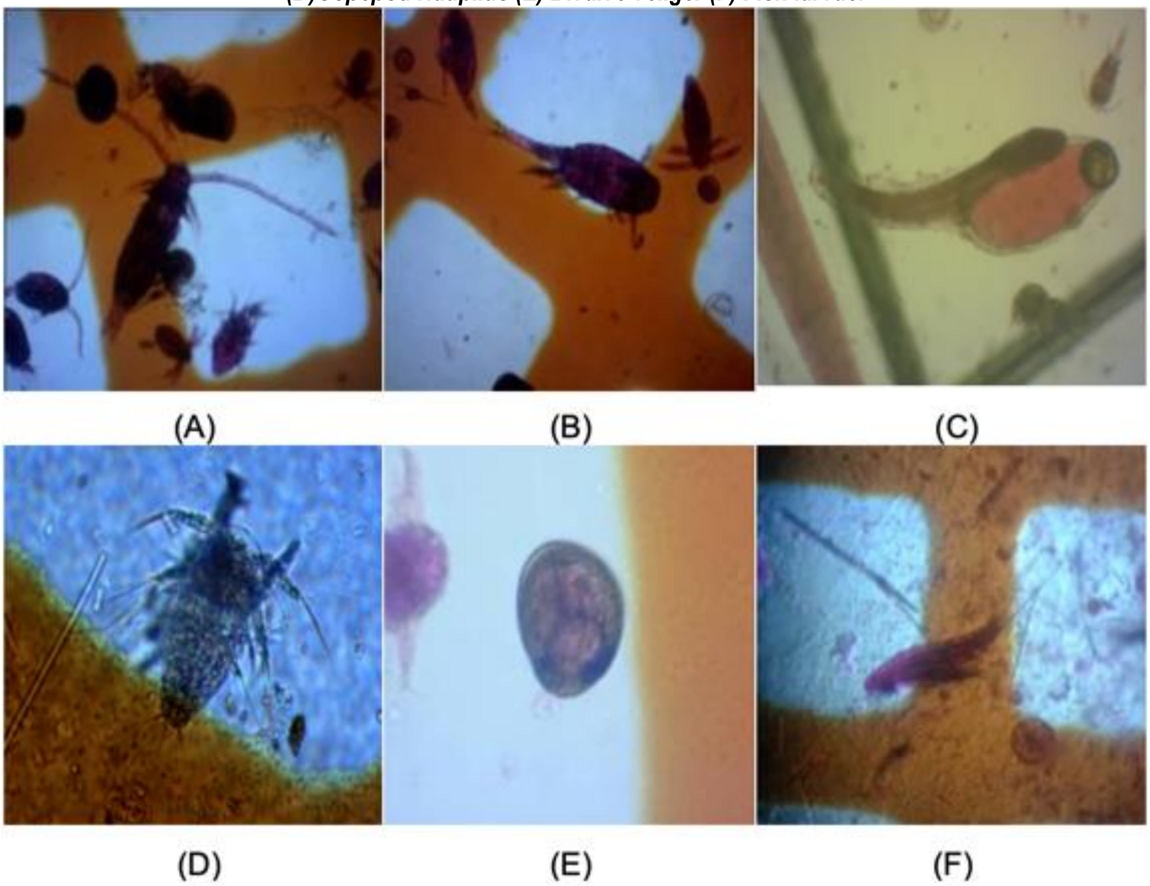


Figure 2.2-109. Zooplankton Abundance and Taxa Richness in 5 Stations (Island E; Feb 2019)

Plate 2.2-16. Photomicrographs of the dominant and important zooplankton groups
Calanoid copepod (B) Cyclopoid copepod (C) Harpacticoid copepod (D)Copepod Nauplius (E) Bivalve veliger (F) Fish larvae.



All diversity measurements were low (<3) with the highest values observed in station ZP2 and ZP3 with 2.25 and 2.22, respectively, while the lowest in station ZP9 with 1.02. The computed index of evenness was generally low ranging from 0.44 to 0.68 except for station ZP2 and ZP3 with vales ranging from 0.89 to 0.94. The low evenness and diversity values could be attributed to the high abundance of copepod in marine station as compared to the estuarine stations. In addition, these indices indicate that zooplankton communities in the area were low with the Wilhm criteria (1975) classifying the diversity index <3.0 as low in community stability.

<u>Phytoplankton</u>

A total of 28 phytoplankton species belonging to Bacillariophytes (diatoms) with 14 species and Dinophytes (dinoflagellates) with 10 species was recorded in four stations sampled in the proposed reclamation Island (Table 2.2-56). Diatoms totally dominated the phytoplankton community accounting for 80% while dinoflagellates constituted for 20% of the total phytoplankton count (Figure 2.2-110). Among the diatoms, the centric chain forming diatom, *Chaetoeros spp.* was the most abundant genus accounting for 30% of the total phytoplankton count. Another centric chain-forming diatom, *Skeletonema* also contributed with high density at 24% relative abundance. 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.

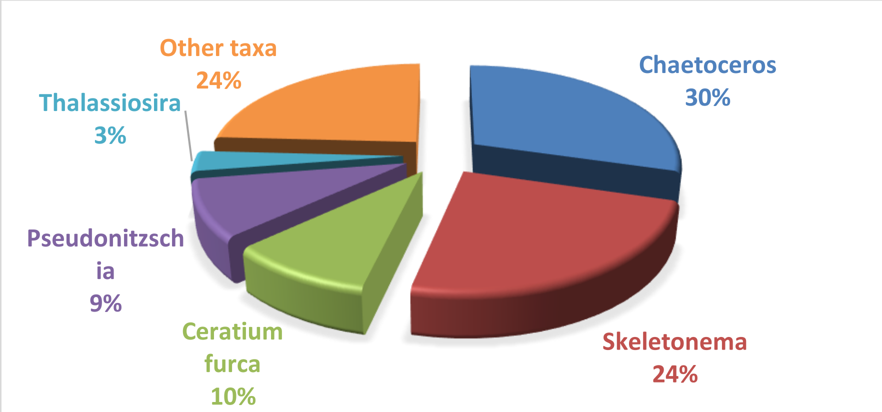


Figure 2.2-110. Percentage Composition of Major Phytoplankton Groups (Island E, Feb 2019)

Table 2.2-56. Phytoplankton Composition and Abundance (cells/L) in 4 stations in Island E

TAXA	Ph1	Ph2	Ph3	Ph4	Total	Rel Abund.
Diatoms	**921**	**876**	**904**	**262**	**2,963**	**80.30**
Bacteriastrum	14	78			92	2.49
Chaetoceros	453	235	345	57	1,090	29.54
Coscinodiscus	9	15	8	11	43	1.17
Guinardia		3	13		16	0.43
Lauderia		15	17		32	0.87
Leptocylindrus		27	22		49	1.33
Muniera	13	15	28		56	1.52
Odonetlla	12	34		5	51	1.38
Pleurosigma		9	17		26	0.70
Pseudonitzschia	77	134	67	67	345	9.35
Rhizosolenia	34	9	45	9	97	2.63
Skeletonema	245	256	342	45	888	24.07
Thalassionema	9	23		23	55	1.49
Thalassiosira	55	23		45	123	3.33
Dinoflagellates	**32**	**428**	**117**	**150**	**727**	**19.70**
Alexandrium		4			4	0.11
Ceratium furca		223	54	76	353	9.57
Ceratium fusus		18			18	0.49
Ceratium maroceros		12	8	9	29	0.79
Ceratium trichoceros		19			19	0.51
Ceratium tripos		45	2	13	60	1.63
Dinophysis caudata	11			8	19	0.51
Diplopsalis	9	17	13	4	43	1.17
Gonyaulax		12	9	13	34	0.92
Gymnodinium catenatum		13			13	0.35

TAXA	Ph1	Ph2	Ph3	Ph4	Total	Rel Abund.
Noctiluca		9			9	0.24
Prorocentrum micans		16	9	15	40	1.08
Protoperidinium	12	23	22	8	65	1.76
Scripsiella		17		4	21	0.57
Grand Total	**953**	**1,304**	**1,021**	**412**	**3,690**	**100**
Richness	**13**	**27**	**17**	**17**		
Evenness (I')	**0.63**	**0.77**	**0.67**	**0.86**		
Diveristy (H')	**1.60**	**2.55**	**1.89**	**2.42**		

Generally, the mean cell density of all the phytoplankton in four stations was 3,690 cells/L. In terms of spatial distribution, station PH2 had the highest phytoplankton abundance with 1,304 cells/L (Table 2.2-56, Figure 2.2-111). The most taxa rich station occurred in station PH2 with 27. The lowest total phytoplankton density and the most depauperate station was observed in station PH4 with 412 cells/L while the most depauperate station was observed in station Ph1 with 13 genera. The highest calculated diversity index based on Shannon Weiner is observed in station PH4 with 2.42 while the lowest was observed in stations PH4 with only 1.60 (Table 2.2-56).

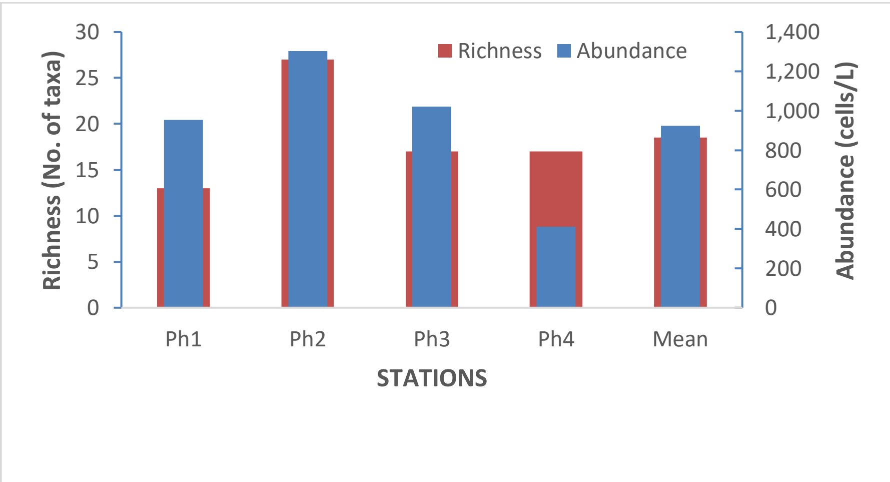


Figure 2.2-111. Phytoplankton Abundance and Taxa Richness in 4 Stations in Island E, February 2019.

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 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.

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. 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 coastaline 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-invetebrates encountered (Plate 2.2-16).

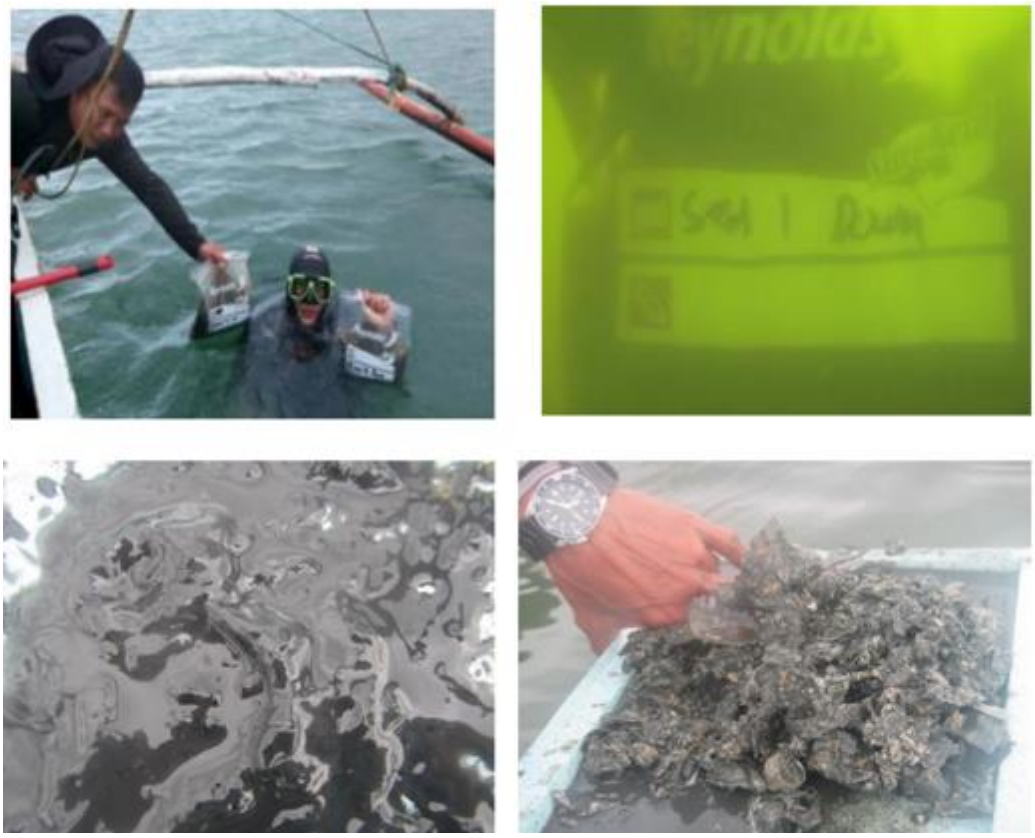
Unlike in Bacoor City where abundant ark shells ("halaan") are harvested, data gathered during the survey indicate the absence of significant macro-invertebrate population in the shoreline bordering the proposed reclamation project.

Plate 2.2-17. Few species of macro-invertebrate were found in three stations surveyed, dominated almost entirely by mussels, Perna viridis.

2.2-5.5 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 2.2-18).

Plate 2.2-18. Sediments collected from the proposed five islands of the Cavite Reclamation Project consisted entirely of mud, silt, discarded oyster shells and grits of other shellfish.



2.2-5.6 Probable Environmental Impacts

Sediment Fluxes and Re-suspension of Silt

The reclamation site is covered by loose silt 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 Pyrodiniumbahamense 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 Bacoor 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 Pseudinitzschia are known to produce domoic acid, a toxin associated with Amnesic Shellfish Poisoning (ASP). Dinophysis caudata are dinoflagellates associated to Diarhhetic 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 wastewater 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 Bacoor 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

There are no mangroves inside Island E, the nearest of which is 1.62km to the northeast, and is fronting proposed Island D. However, depressed tidal flow in the mangrove swamps in Ligtong 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.

2.2-5.7 Mitigation Measures

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

Any fishing gear that will be dislocated by reclamation filling and operations will be compensated through the provision of new mussel farming materials and fishing gear paraphernalia, as well as technical assistance in re-establishing fishing and mariculture operations. In particular, a new mussel and fish pen zone needs to be identified and delineated with collaboration from the local government of Rosario. Site suitability assessments – focusing on viability of mussel and oyster spat settlement in new areas - needs to be conducted and affirmed, supported by technical assistance of better farming techniques. Supplemental livelihood projects, through mariculture of full cycle aquaculture species will be promoted through collaboration with the Bureau of Fisheries and Aquatic Resources. Conservation of mussel stocks will be pursued through the establishment of spat collectors in areas past the proposed areas to be reclaimed. The spats will then be released in coastal waters after the reclamation is completed so that the shellfish juveniles can eventually repopulate rocky areas around the reclaimed site.

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

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.

A critical strategy is reforestation of mangrove forest trees along the Ligtong 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. Also, there will absolutely be no cutting of mangrove anywhere in the area.

In addition, fish larvae sampling will be undertaken in conjunction with annual water quality monitoring in coastal waters immediate to the reclamation site.

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 Ligtong River.

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 information, education and communication (IEC) campaigns to promote red tide awareness and to pinpoint sources of nutrient loading into the sea.

Table 2.2-57. Environmental Management Plan for Coastal and Fisheries Management

Project Activity CONSTRUCTION PHASE	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement
Reclamation, soil filling and compacting	Coastal water quality; Benthic communities of marine organisms; pelagic fish populations	Increase in siltation/sedimentation loading in coastal waters; increase in turbidity and suspended solids; Reduction in photosynthesis and primary productivity Suffocation of bivalve veliger in soft bottom benthos; Disruption of fish feeding and benthos larval growth; Impairment in fish and shellfish reproductive process. Disturbance to schools of sardines and mullets feeding in inshore waters	Provision of silt curtains where sediment streams are likely to occur and escape. Collection and trans-location of macro-invertebrates found within the reclamation area. Monitoring of sediment fluxes and application of more stringent control measures when necessary; or temporary cessation of activities. Sediment canals in reclaimed areas will be installed to divert sludge into filters and weirs that capture sediments and fugitive reclamation filling materials at source.
	Wastewaters emanating due to influx of reclamation workers can add to marine pollution and negatively affect benthic communities of macro-invertebrates; plankton community fish	Inadvertent spill of domestic wastewaters can cause coastal water pollution, loss of macro-invertebrate population, impairment in fish and shellfish reproductive physiology.	Install liquid waste management system ensuring modern waste retrieval and treatment system. Treatment and disposal of liquid waste at point source will involve collecting liquids of point source origin; directing waste into integrated multiple waste streams facilities or collecting vessels, and application of treatments. Any fluid effluent to be discharged at sea will be monitored and tested before discharging. Installation of latrines and waste receptacles; collection facilities; Adoption of clean practices by all project operating units and personnel; Efficient waste retrieval system;

Project Activity CONSTRUCTION PHASE	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement
			Greening of reclamation area
	Coastal waters	Oil and grease contamination	Adoption of an oil and grease recovery and treatment system; Implementation of rigid policies against indiscriminate disposal of oily waste and marine vessel bilge water.
	Fisheries and mariculture livelihood	Loss of mussel farms and fish pens/fish corrals. Loss of nearshore fishing grounds; dislocation of gill net and hook and line fishers	No mussel farms and fish pens in Island E area Provision of new fishing paraphernalia to enable affected small-scale fishers to move to deeper fishing grounds past the reclamation area; Provision of alternative livelihoodsto affected fishers.

Chapter 2.3 THE AIR

INTRODUCTION

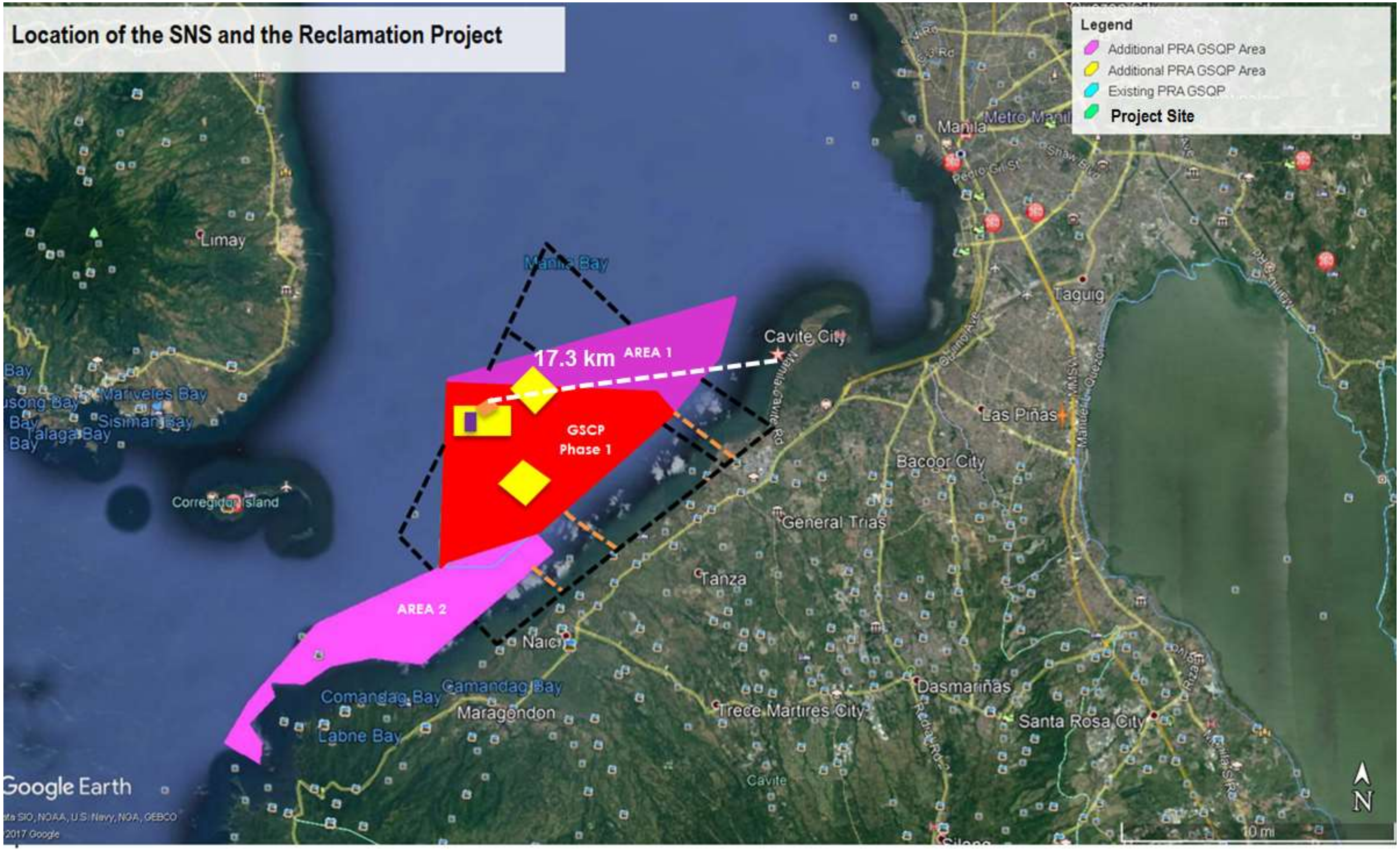
The potential impacts on the air environment and climate change phenomenon relative to the activities during the reclamation works are shown in Table 2.3-1.

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
Preparatory Works at Reclamation Site		
Dredging (To remove undesirable seabed materials)	Operation of dredging equipment, use of power generating sets involving combustion of fuel oils	• Distant from ESRs • Short term only • Fuel used in generating sets and heavy equipment will generate CO2 and other criteria pollutants
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 CO2 from combustion of Marine Diesel Oil (MDO) Loss of sea surface thus of GHG sequestration by ocean	• Deemed minimal because of small change (in percentage) in land form of the Manila Bay
Reclamation Proper		
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 (CO2)	• Pollution source is mobile in nature • Activity is short term; TSHD will operate for est. **54,600 hours** for the entire reclamation phase.
Filling/Land reclamation	Same as above	• Same as above
Installation of sub structures, e.g. containment sheets or silt curtains	Use of barges	• Minor generation of combustion products; relatively short term operation of barges
Leveling of reclaimed area to desired elevation	Use of compaction and other equipment, potential use of generating sets,	• Minor generation of combustion products • Potential fugitive dust generation.
Horizon works/Construction of support facilities, roadways, drainage system, etc.	Use of miscellaneous construction equipment, potential use of generating sets Temporary concrete mix batching plant may be opted.	• Minor and short generation of combustion products • Potential fugitive dust generation.
Soil Stabilization	Minimum use of heavy equipment; use of wick drains	• Essentially no significant air pollution discharges
All dredging, filling and horizontal development works	Noise generated by equipment	• Deemed not significant due to distance from noise generator to ESRs and short term activities

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.



Source: 2017 Google Earth Map; Adopted from PRA, PRA Seabed Quarry Project EIS

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; Sevruk 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

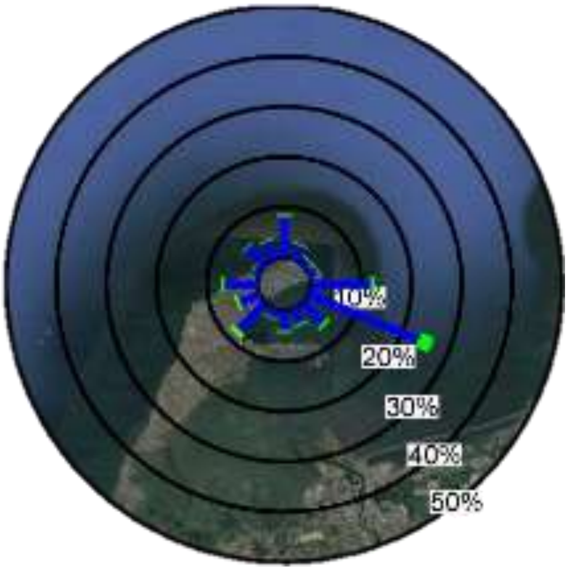
YEAR: AS OF 2016 LATITUDE: I4°30`25.75"N
ELEVATION: 21m LONGITUDE: 121°00`15.90"E

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	06-071997	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	0810-1947	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
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**	**889.4**	**11-03-1995**
Period of Record	**1947-2016**				**1949-2016**		**1950-2016**			**1950-2016**			

PREPARED BY: CADS/CAD/PAGASA

The monthly wind rose diagrams are provided in **Annex 2.3-1** while the annual diagram is shown in Figure 2.3-2.

	1 - 4	Light
	5 - 8	Moderate
	9 - 12	Moderate to Strong
	13 - 16	Strong
	17 - 20	Very Strong



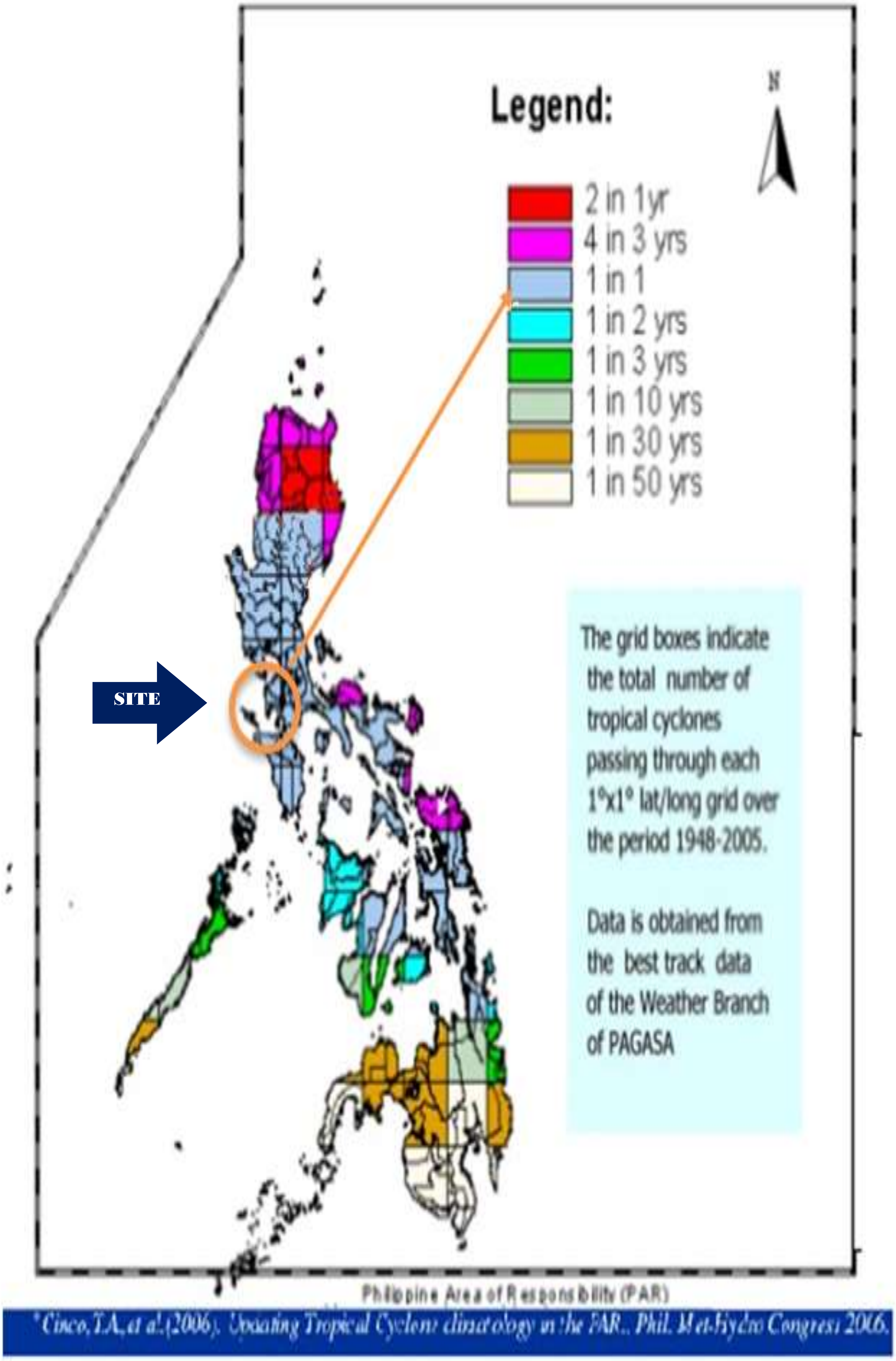
Source: PAGASA

Figure 2.3-2. Annual Windrose Diagram for the Project Site and Environs

Frequency of Tropical Cyclones

This is shown in Figure 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.



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_2 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_2 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^3
Volume Fill required for 5 islands	124,920,000 m^3
Total Number of cycles	7800
Total hours operating	54600 hours
Fuel carried by TSHD	2200 m^3
Total Oil Used	195,000 ton for the entire reclamation period

Estimation of GHGs (Order of Magnitude)

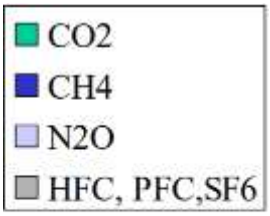
Estimated Heat Content = 42,700 kJ/kg,
www.effship.com/PartnerArea/MiscPresentations/Dr_Wild_Report.pdf

or:

195,000,000 kg x 41,700 kJ/kg = 8.132 x 10^{12} kJ or 7 707 648.822 x 10^{12} 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)

MMTCE (Million Metric Tons Carbon Equivalent) = (Btu/1000)(19.33MMTCE/Tbtu)(0.99)
Btu/1000)(19.33MMTCE/Tbtu)(0.99) = 2.53 x 10 $^{-6}$ MMTCE

Table 2.3-3 shows the official Philippine GHG Inventory.

Table 2.3-3. Officially Reported Philippine GHG Inventory

Category	In CO_2 Equivalent (kilotons) (2000)	In CO_2 Equivalent (kilotons) (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
TOTAL	**19,491**	**100,740.12**

References: 2nd 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 CO2 per gallon of biodiesel (Reference: USEPA)

Diesel Usage = 7.5 Ton/hour

CO2 generation (estimates only) = 420 tons/day

Loss of sequestration of CO2 by the displaced sea body/Disturbance of the sea surface

The ocean has a significant role in maintaining the concentration of CO2 in the atmosphere by absorbing the GHG.

It is reported that 2.3 Pg C yr^{-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 C + 0.9 C) = 26.0 C;
b. DJF rainfall = {827.7 mm + 827.7 (6.5%)mm} = (827.7-53.8) mm or 763.9mm;
c. Number of days with Tmax > 35 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 > 300mm in Casiguran during the 2006-2035 period (centered at 2020) = 20

Table 2.3-4. Seasonal temperature increase (in ^{0}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 (^{0}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^{0}c			No. of Dry Days			No. of Days w/Rainfall >200mm		
	OBS (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_2 and NO_2** is based on the Philippine Clean Air Act of 1999

a) For National Ambient Air Quality Guideline for Criteria Pollutants:

	Short Term[a]			Long Term[b]		
Pollutants	µg/NCM	ppm	Averaging Time	µg/NCM	ppm	Averaging Time
Suspended Particulate Matter[c] - TSP	230[d]		24 hours	90	--	1 year[c]
- PM-10	150[f]		24 hours	60	--	1 year[e]
Sulfur Dioxide[c]	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

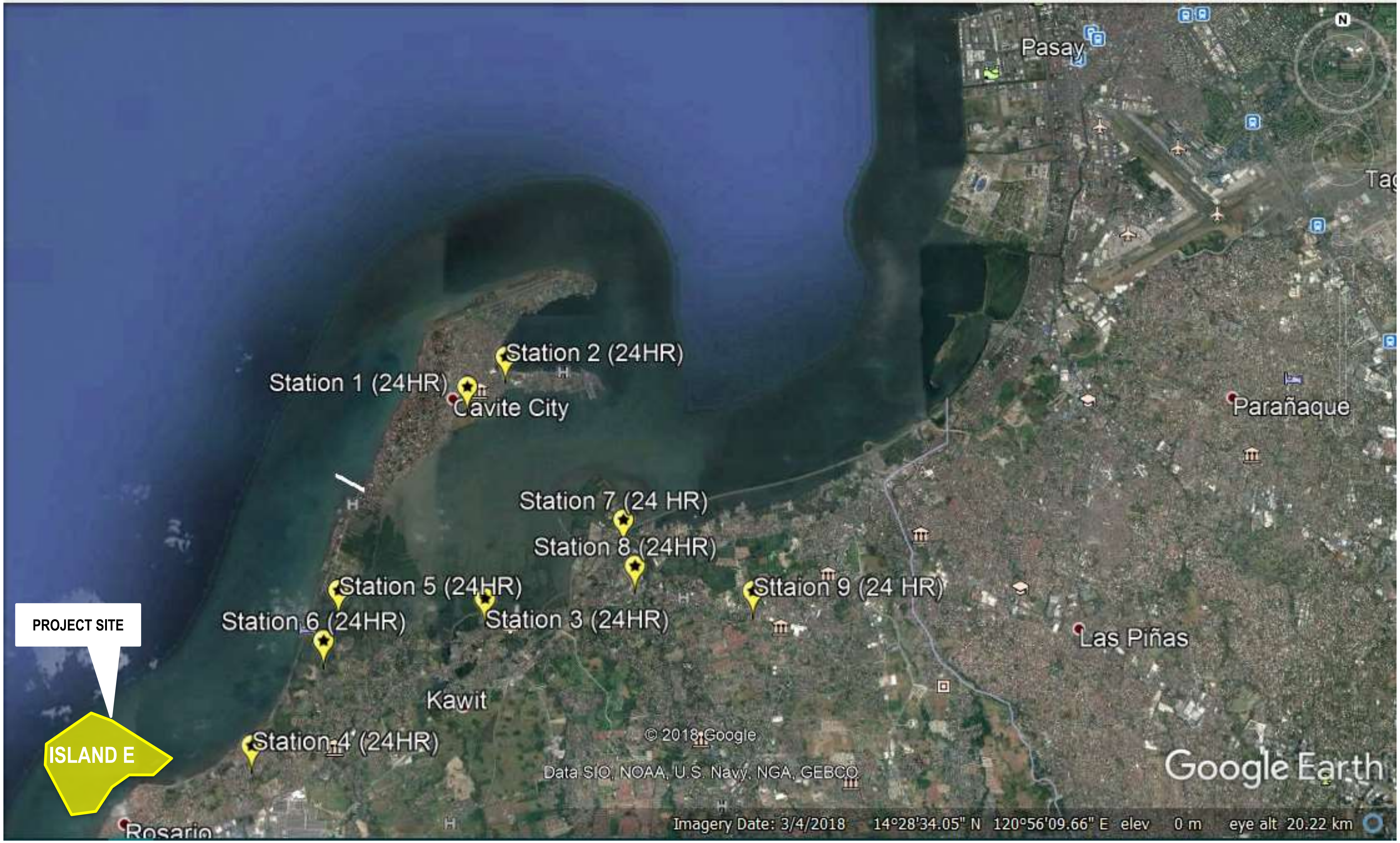
Sampling Stations

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

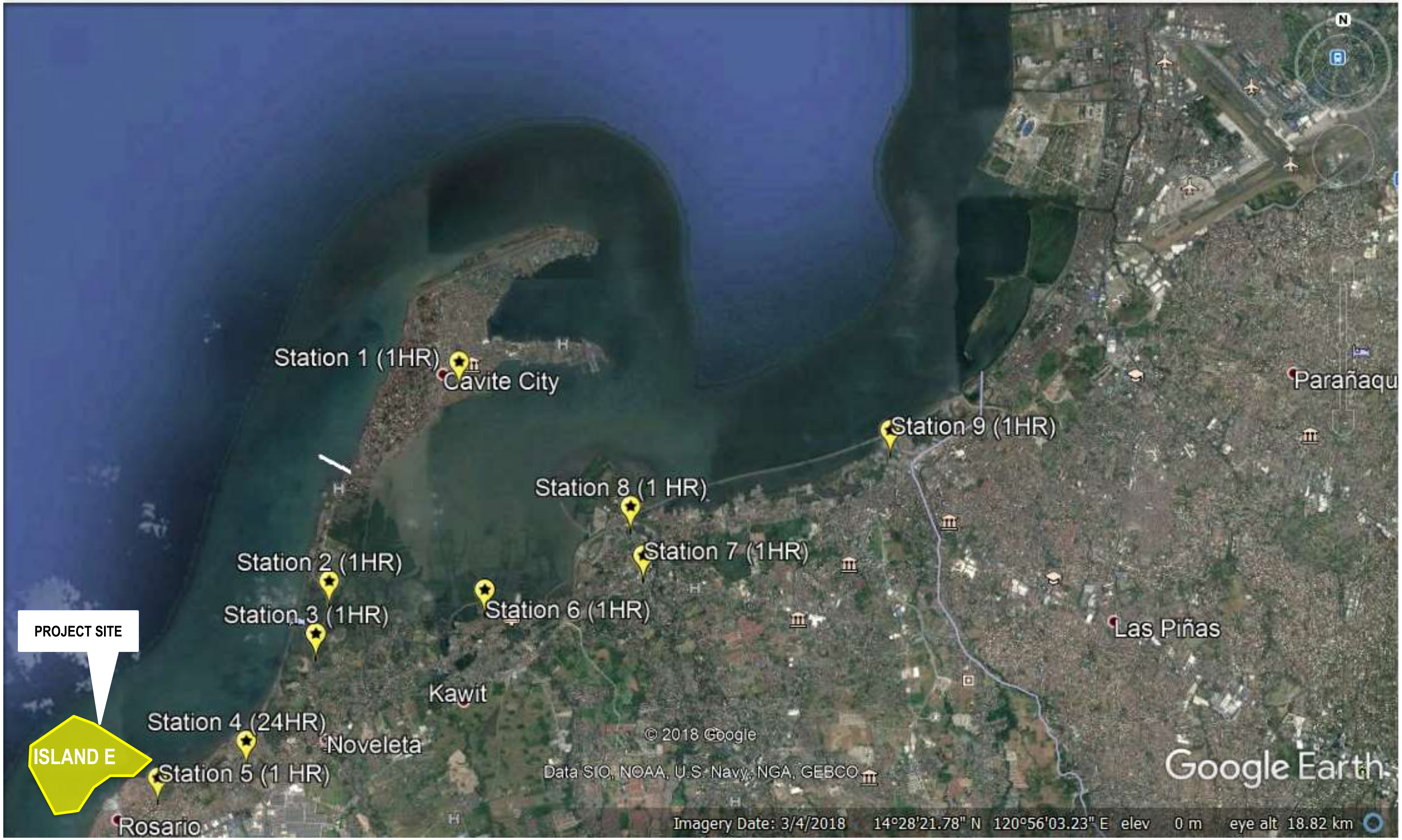
Figure 2.3-4. Map of the Ambient Air Sampling Station (24-HR)

Table 2.3-6. Results of the Ambient Air Quality Measurements (24-HR)

Stn	LOCATION	TSP µG/Nm³	PM10 µG/Nm³	PM2.5 µG/Nm³
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, Bacoor, Cavite	228.8	79.8	30.3
DENR NAAQSSAP		**230**	**150**	**50**

Table 2.3-7. Results of the Noise Level Measurements (24-HR)

Stn.	Period	Date	Time	Max. (dBA)	MIN (dBA)	Ave. (dBA)	MEDIAN (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 µG/Nm³	PM10 µG/Nm³	SO2 µG/Nm³	NO_2 µG/Nm³
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 Bacoor Cavite	335	727	8.51	4.92
9	Brgy. Dulong Bayan/Tirona *Highway Bacoor Cavite*	104	184	9.00	3.56
DENR NAAQSSAP		**300**	**200**	**340**	**260**

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

Category of the Area	Daytime (dBA)	Morning & Evening (dBA)	Nighttime (dBA)
A	55	50	45
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

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 2011-2020 Municipality of Rosario Comprehensive Land Use Plan as well as the 2015 Census of Population.

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. Nine (9) barangays were included in the perception survey namely: (1) Barangay Bagbag II, (2) Barangay Kanluran (3) Barangay Ligtong I (4) Barangay Muzon II (5) Barangay Sapa II (6) Barangay Sapa III (7) Barangay Wawa I (8) Barangay Wawa II (9) Barangay Wawa III- barangays directly affected by the proposed reclamation project. Sample Perception Survey Form attached in **Annex 2.4-A**.

On the other hand, secondary information was also gathered from existing websites of relevant government agencies such as the Philippine Statistics Authority. 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 Rosario, within the jurisdiction of Cavite Province.

The Municipality of Rosario, a town in the Province of Cavite occupies the northwestern section of the province along the western coast of Luzon. Its absolute location is within coordinates 120°50’30” to 120° 53’ 00” E and 14°4’00” to 14°26’00” N. It is bordered by the Municipalities of Noveleta to the northeast, General Trias to the southeast and Tanza to the southwest.

It lies 30km south of Manila, and 17km south-southwest of Cavite City. It is accessible by land and water (*sea*) transportation. With the continuous expansion of Metro Manila, the municipality is now included in Manila conurbation, which reaches Lipa City in its southernmost part. The Manila Bay and Corregidor Island are situated northwest of the town.

Land Area

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 favourably 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 768.3640 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;

Ligtong III (28.5870 ha); and Ligtong II (20.7914 ha). Other barangays with less than ten (10) include Sapa II and Sapa IV. See Table 2.4-1.

Table 2.4-1. Rosario 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
Ligtong I	4,674	23.3449	200
Ligtong II	2,055	20.7914	99
Ligtong III	6,821	28.587	239
Ligtong IV	2,893	12.4596	232
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	-
Total	**110,706**	**768.364**	**144**

Source: http://rosario-cavite.com/index.php/layout/innerleft-center-right/demography and POPCEN 2015

Demographic Profile

Population Size and Historical Growth

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 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 small 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 census done in 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% (Source: PSA 2010) which is due to displacement of worker in the Cavite Export Processing Zone. These data on population growth rate shows the uniqueness of demography characteristics in the Municipality.

Table 2.4-2. 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

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.

Age Sex Structure

Municipality of Rosario's population according to the 2015 census totalled 110,561. Out of these entirety, 54,738 are males (49.51%) and 55,823 are females (50.49%) or almost equal.

The municipality has a very young population as per Age Distribution. A population of 30,251 (27.36%) are 14 years old and under (non-working group). Those in the production age bracket (15-59 years old) registered a large 73,873 or 66.82% of the total population. The senior citizens (60 years and above) is the least 6,437 (5.82%).

Table 2.4-3. Household Population by Age Group and Sex: 2015

Age Group	Both Sexes	Male	Female
All Ages	110561	54738	55823
Under 1	2146	1118	1028
1 - 4	8345	4353	3992
5 - 9	10090	5200	4890
10 - 14	9670	4983	4687
15 - 19	10622	5353	5269
20 - 24	14078	6870	7208
25 - 29	12233	6036	6197
30 - 34	9238	4599	4639
35 - 39	8159	4014	4145
40 - 44	6400	3118	3282
45 - 49	5510	2702	2808
50 - 54	4384	2105	2279
55 - 59	3249	1564	1685
60 - 64	2519	1172	1347
65 - 69	1731	788	943

Age Group	Both Sexes	Male	Female
70 - 74	957	394	563
75 - 79	667	208	459
80 years and over	563	161	402

Source: POPCEN 2015

Age Group Dependency Ratio

Manifested by three (3) broad age groups, those that belong to 14 years old and under constitute 27.36%; the working age group 15 to 64 years old, 69.09%; while the seniors or 65 years old and above, 3.54%. Hence, the number of dependents (0-14 years old and 65 years old and over) or the dependency ratio reflected as to the working age (15 to 64 years old) is 30.91%. This dependency rate reflects that for every 100 working population, there are 31 dependents, in which 27 is coming from the young dependents and 4 comes from the old dependents.

Education

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 Rosario, 18,813 out of 19,760 children (or 95.2%) in this age group are attending school. (Table 2.4-3)

For the age group 15-24, 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 2.4-3)

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 2.4-4. 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
ROSARIO						
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

Literacy

The literacy rates in Rosario is vey high with 99.72% (see table below). This is almost equal across all age groups and for both sexes. In Rosario, a slight decrease to 98.94 % literacy exists among the seniors.

Table 2.4-5. Literacy of the Household Population 10 Years Old and Over: 2015

Age Group	Household Population 10 years old and over			Literate		
	Both Sexes	Male	Female	Both Sexes	Male	Female
Total	**89980**	**44067**	**45913**	**89729**	**43929**	**45800**
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

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.

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 Novelata 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 Rosario is located. It also shows that the number of unemployed gets lower in Region IV-A in the year 2018.

Table 2.4-6. 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 p
REGION II - CAGAYAN VALLEY												
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
Visibly [1]	124	130	116	94	154	143	176	155	69	172	271	205
Unemployed	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
REGION III - CENTRAL LUZON												
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	4,511	4,451
Underemployed	706	655	675	619	873	485	653	401	451	435	517	612
Visibly [1]	328	294	335	306	377	238	294	210	221	228	252	244
Unemployed	310	347	326	296	270	302	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	60.5	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	13.8
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
REGION IV-A - CALABARZON												
Household Population 15 Years Old and Over	9,539	9,479	9,537	9,520	9,618	9,787	9,733	9,721	9,840	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
Visibly [1]	430	523	437	325	434	412	432	420	362	435	418	363
Unemployed	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. Details may not add up to totals due to rounding.
2. Rates were computed based on actual figures.
3. Starting April 2016 round, the Labor Force Survey (LFS) adopted the 2013 Master Sample Design as well as the population projections based on the 2010 Census of Population and Housing (2010 CPH) while previous survey rounds were derived using the 2000 CPH population projections.
4. January 2016 data reflected were based on the 2010 CPH population projections to compute for the annualized data for 2016.
p Preliminary.
1 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.

The gainful workers of Rosario are slightly higher at 47.92% (50,053) of the 110,706 population or 45.27% of the 76,392 population within the working group age of 15-64 (See Table 2.4-3 above). Of these, 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 2.4-7)

Table 2.4-7. Gainful Workers 15 Years Old and Over by Major Occupation Group: 2015

Major Occupation Group	Total Gainful Workers 15 Years Old and Over	Percentage
TOTAL	**53,053**	**47.92**
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

Major Occupation Group	Total Gainful Workers 15 Years Old and Over	Percentage
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

The CEZ, considered the biggest/registered zone in the country, employs more than 79,000 management and production workers (2010 data). Aside from these, an estimated 4,500 are employed by brokers, banks, security agencies, canteens, subscribers and other offices. Most of these workers are residents of Roasrio while some are from Gen. Trias and other neighboring municipalities.

Due to its location as one of the lowland coastal municipalities, Rosario was noted for fishing and *"Tinapang Salinas"* processing. The presence of two fish ports, (i.e. Municipal Fish Port, and Ligtong Fish Landing) provides business opportunities and employment for the locals.

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 annual 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 of 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 324 hectares of land in Manila Bay. 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 in 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 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 E. 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.

The possibility of relocating the Rosario Bulungan (Fish Port) to Island E is being considered and being discussed among the LGUs, Private Partner, and the stakeholders. This can be an added attraction/feature of the Island, which can be popular not just among the locals but among the tourists as well. This can feature modern fish wharf that are popular tourist attractions in other countries. “Dampa” style food establishments can then be added and this will also feature the merchandising of value-added fish products like the famous “tinapa” or smoked fish of Rosario. In effect, this is a potential enhancement of the existing fish port, its structure, and exposure to a wider market, and ultimately, higher sales/income for the stakeholders.

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 2.4-1 shows the initial Framework Plan for the access ways. Avoidance of ROW conflicts is a key consideration for these access ways.

Figure 2.4-1. Initial Framework Plan showing Therein 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 Archaelogical 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 Municipality of 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, cultural sites, natural values, tourism and recreational values.

History and Culture

Rosario is renowned for its Patroness, *Nuestra Senora Virgen del Rosario* and the *"Karakol Dance"* in her honor. Located in Barangay Tejeros Convention is the Casa Hacienda, where the first Presidential Election (Revolutionary Government) was held and the First Philippine Army was established.

Geological and Archaeological Sites

There are no known geological and archaeological sites in the town of Rosario.

2.4.5 Threat to Delivery of Basic Services /Resource Competition

2.4.5.1 Water Supply

Groundwater is abundant in Rosario, which is the major sources both commercial and industrial uses. Water is supplied by Maynilad Warter Services Inc. (formerly Metropolitan Waterworks and Sewerage System), domestic deep well and shallow well are used to supply the needs of the populace.

At the construction stage of the project, 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 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

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.

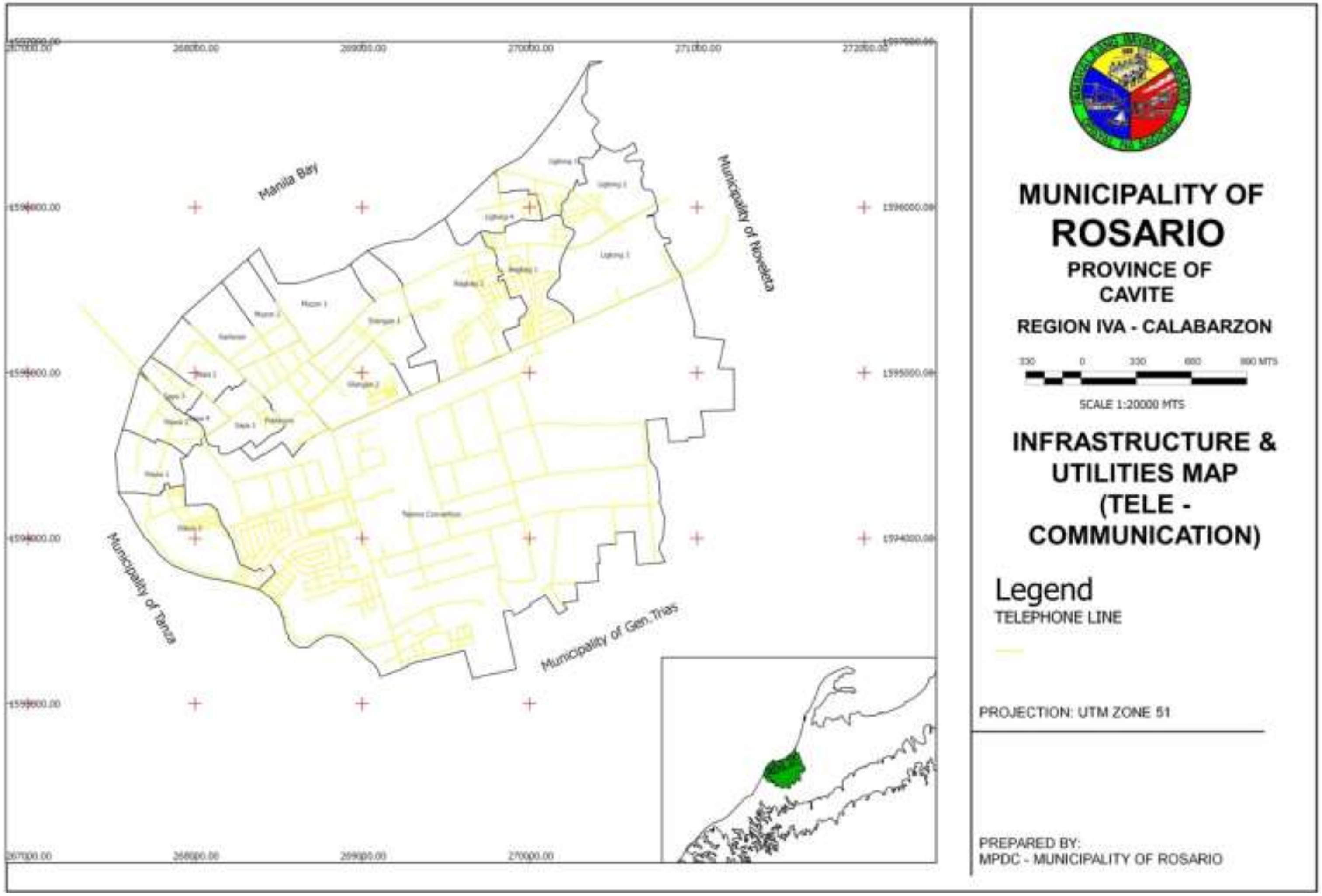
At present telephone requirements are provided by the Philippine Long Distance Telecommunications Company (PLDT), Globe Telecom, Digitel and cellular phone companies like Smart, Sun Cellular, Talk-and-Text Mobile for mobile phone services. Globe transmission towers are located in the whole municipality 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 Cignal.

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.



CLUP of Rosario, 2011-2020

Figure 2.4-2. Map of Infrastructure and Utilities Map

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.

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 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

The health service is provided by the Municipal Health Office. At present, there were about 21 public health stations with equivalent health workers to care for the needs of the populace. In the same way, a municipal lying-in clinic was established to provide pre and post natal services. The municipality also affords free laboratory test and x-ray in the Hospital on Wheels.

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 filing 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 2.4-8. Major Issues that May Affect the Communities In Case of Disaster/s

Hazard	Cause/Related Activities	Concerns/Issues	Mitigation Measure
NATURAL HAZARDS (not caused by the project)			
Met-Ocean Hazards			
Flood	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. Proper and adequate drainage system, island configuration and distance vis-à-vis mainland and other proposed islands
Storm Surge	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. The reclaimed island will serve as shield to mainland and its population.
Earthquakes and seismic related Hazards			
Tsunami	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. The reclaimed island will serve as shield to mainland and its population.
Subsidence	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

Hazard	Cause/Related Activities	Concerns/Issues	Mitigation Measure
Liquefaction	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
Ground Shaking	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.
ACCIDENTS			
Fire	Dredging/reclamation activties/ 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
Explosion	Dredging/reclamation activties/ movement of vessels	Loss of life and property; panic among residents and/or workers	MDO not explosive
Release of Toxic Substances	Dredging/reclamation activties/ movement of vessels	Loss of life and property; panic among residents and/or workers	Bilge water treatment No HAPs (Hazardous Air Pollutants) from exhaust of engines
Oil Spills from Dredging Vessels	Dredging/reclamation activties/ movement of vessels	Loos of marine life, environmental damage	a. Assurance of sea-worthiness of the sea vessel • Compliance with international and local (PCG) standards • Training of vessel crew and personnel • Possession of adequate navigational aids
			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 onboard oil spill containment and recovery equipment e.g. • Oil Spill Boom • Approved oil spill dispersant • Oil recovery equipment e.g. oil pump
Collission between marine vessels	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. 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. Rigid adherence to Marine Safety guidelines as discussed in Chapter 4.

Hazard	Cause/Related Activities	Concerns/Issues	Mitigation Measure
Failure/collapse of Structure	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. -Safety training of all personnel -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 Municipality of Rosario through tax payments will be flowed back to the residents in terms of development projects of the Province of Cavite.

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 Municipality of Rosario 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 Rosario

Transportation Network

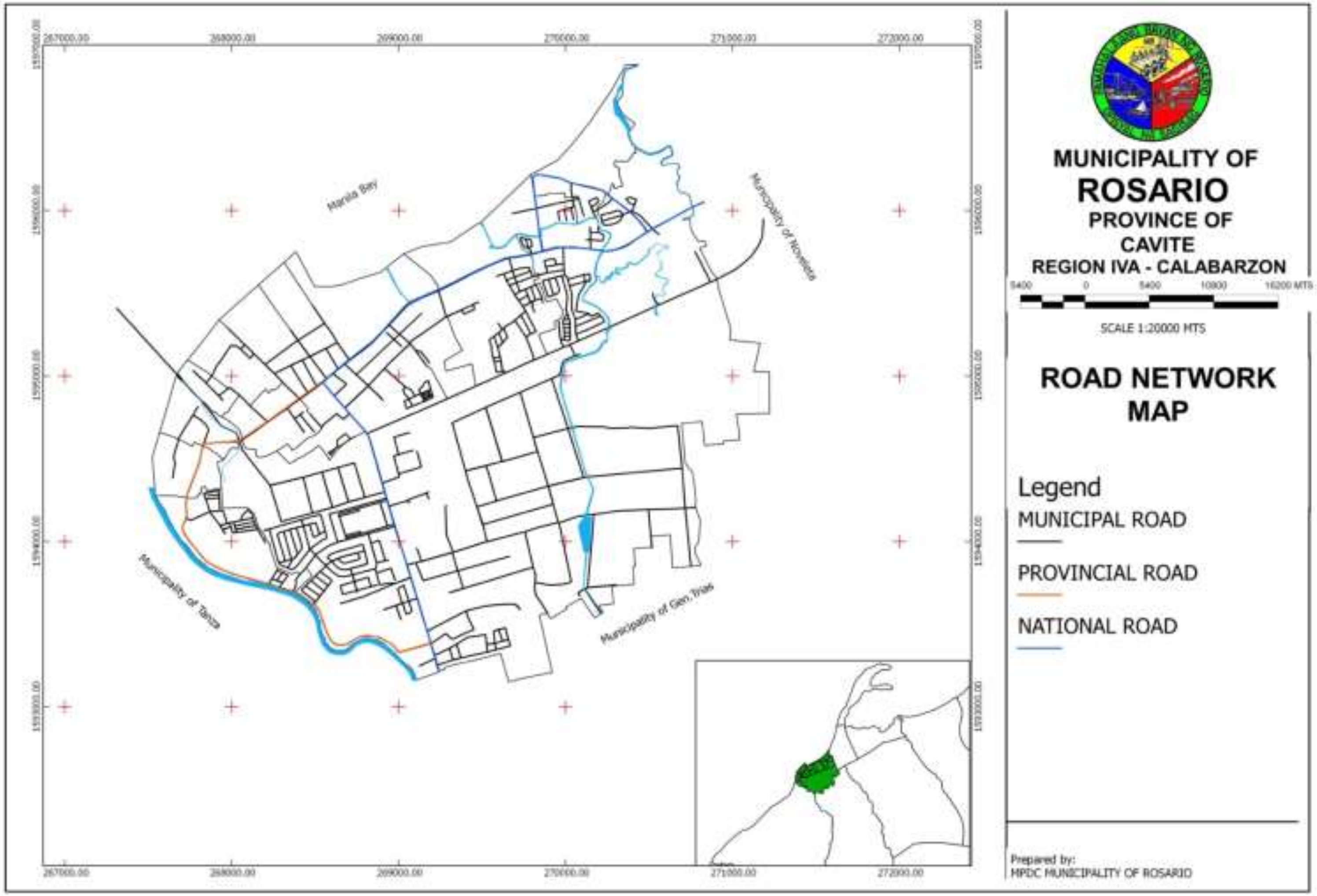
Land transportation is accessible from Metro Manila from the six (6) cities and from the other sixteen (16) municipalities of the province. Traffic volume in Rosario is moderate to heavy. Heavy traffics occur almost every day along the commercial areas extending up to the industrial zone (PEZA), especially during rush hours.

Transportation

Rosario is easily accessed by land means from neighbouring cities and towns. It is only 12 kms from the provincial capitol and 30 kms from Manila. Travelling is even more trouble-free as PEZA-Bacao Diversion Road is linked to Centennial Road towards 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 kms. All roads totalling more than 32.331 kms.lead to 20 barangays.

The municipality is likewise accessible by sea transportation passing through Manila Bay.



CLUP of Rosario, 2011-2020

Figure 2.4-3. Road Network Map of Municipality of Rosario

2.4.9 Public Perception Survey

The Preliminary Perception Survey conducted last October 13-19 2018 with a total of 270 respondents, to assess the socio-cultural economic situation of the communities that are to be affected by the proposed reclamation, particularly the three (9) barangays-namely: Barangays **Bagbag II, Kanluran, Ligtong I, Muzon II, Sapa II, Wawa I, Wawa II and Wawa III** 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 29.25% males and 70.74% females.

Table 2.4-9. 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	%		
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	**79**	**29.25**	**191**	**70.74**	**0**	**0**	**270**	**100**

Data Source: EIA Perception Survey 2018

Civil Status – Data coming from the EIA survey are used to present baseline condition of the impact barangays residents where majority or 61.48% of the respondents are married (or 166 out of 270 respondents) followed by single 17.77% and the rest are widower, lived in and separated.

Table 2.4-10. 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	%		
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	**48**	**17.77**	**166**	**61.48**	**21**	**7.77**	**12**	**4.44**	**23**	**8.52**	**270**	**100**

Data Source: EIA Perception Survey 2018

Religious Affiliations – Results of the conducted survey indicated that 93.33% of the total respondents interviewed are Roman Catholic followed by 2.22%, which are Protestant and followed by Iglesia Ni Cristo, Christian and Aglipayan.

Table 2.4-11. Impact Barangays: Religious Affiliation

Barangay	RELIGIOUS AFFILIATION										Total	
	Catholic		Protestant		Aglipayan		INC		Others		% of HH surveyed	%
	No. of HH surveyed	%	No. of HH surveyed	%	No. of HH surveyed	%	No. of HH surveyed	%	No. of HH surveyed	%		
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
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
Total	**252**	**93.33**	**6**	**2.22**	**1**	**0.37**	**3**	**1.11**	**8**	**2.96**	**270**	**100**

Data Source: EIA Perception Survey 2018

Ethnicity – The Municipality's dialect is mostly Tagalog (84.07%), there are migrants from other provinces that are also Tagalog speaking. Others are Waray, Cebuano and Bicolano.

Table 2.4-12. 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	%	
Bagbag II	27	90	1	3.33	0	0	0	0	2	6.67	30
Kanluran	26	86.67	0	0	4	13.33	0	0	0	0	30
Ligtong I	30	100	0	0	0	0	0	0	0	0	30
Muzon II	23	76.67	0	0	6	20	0	0	1	3.33	30
Sapa II	28	93.33	0	0	0	0	2	6.67	0	0	30
Sapa III	25	83.33	2	6.67	0	0	3	10	0	0	30
Wawa I	20	66.67	7	23.33	3	10	0	0	0	0	30
Wawa II	26	86.67	0	0	3	10	1	3.33	0	0	30
Wawa III	22	73.33	0	0	3	10	5	16.67	0	0	30
Total	**227**	**84.07**	**10**	**3.70**	**19**	**7.04**	**11**	**4.07**	**3**	**1.11**	**270**

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, vendor/family business and through contractual job/sub-contractor. On the other hand, 61.11% of the respondents stated that the husband is the primary earner in the household while 15.18% has the wife as primary eaner. See Table 2.4-13 and Table 2.4-14.

In terms of monthly income, Table 2.4-15 shows that most of the respondents or 24.44% earning between Php 1,001-P5,000, while respondents earning Php 10,001-20,000 make up 22.96% followed by 15.93% earning Php 1,000 below, 14.44% earning Php 5,001 – Php 10,000 and 5.93% earning Php 20,001 above.

Educational Attainment – Table 2.4-16 shows that the largest percentage or 57.77% of the respondents are high school graduate followed by 30.74% elementary graduate and 5.93% vocational course graduates.

Table 2.4-13. 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	%		
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	**111**	**41.11**	**36**	**13.33**	**22**	**8.15**	**49**	**18.15**	**52**	**19.26**	**270**	**100**

Data Source: EIA Perception Survey 2018

Table 2.4-14. Impact Barangays: Primary Earner

Barangay	Primary Earner										Total	
	Husband		Wife		Son		Daughter		Others		% of HH surveyed	%
	No. of HH surveyed	%	No. of HH surveyed	%	No. of HH surveyed	%	No. of HH surveyed	%	No. of HH surveyed	%		
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
Total	**165**	**61.11**	**41**	**15.18**	**17**	**6.29**	**18**	**6.67**	**29**	**10.74**	**270**	**100**

Data Source: EIA Perception Survey 2018

Table 2.4-15. 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 surveyed	%	No. of HH surveyed	%	No. of HH surveyed	%	No. of HH surveyed	%		
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
Total	**43**	**15.93**	**66**	**24.44**	**39**	**14.44**	**68**	**22.96**	**16**	**5.93**	**38**	**14.07**	**270**	**100**

Data Source: EIA Perception Survey 2018

Table 2.4-16. Impact Barangays: Educational Attainment

Barangay	EDUCATIONAL ATTAINMENT										Total	
	Wala (None)		Elementary		High School		Vocational		College		% of HH surveyed	%
	% of HH surveyed	%	% of HH surveyed	%	% of HH surveyed	%	% of HH surveyed	%	% of HH surveyed	%		
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**	**83**	**30.74**	**156**	**57.77**	**16**	**5.93**	**15**	**5.56**	**270**	**100**

Data Source: EIA Perception Survey 2018

Health

Sickness in the Family – Based on the survey conducted, 66.67% of the household respondents have experienced three (3) sick family members for the past five years. 17.78% of the household respondents have experienced four (4) sick family memebers for the past five years (Table 2.4-17). Common sickness in the barangay as indicated by the household respondets are fever, cold, gastrointestinal disease, skin disease and heart disease (Table 2.4-18).

Where do they Consult? – Based from the result of the conducted survey, 24.44% of the household respondents opted to consult in the existing Barangay Health Centers while 22.96% opted to consult in Private Clinic. See Table 2.4-19 on Where They Consult, for the survey data.

Table 2.4-17. 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	%		
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	**3**	**1.11**	**2**	**0.74**	**180**	**66.67**	**48**	**17.78**	**10**	**3.70**	**27**	**10**	**270**	**100**

Data Source: EIA Perception Survey 2018

Table 2.4-18. Common Illness in the Community

Barangay	Source of treatment for Illness of Respondents										Total	
	Gastrointestinal Disease		Cold		Fever		Others		No Answer		# of HH surveyed	%
	No. of HH surveyed	%	No. of HH surveyed	%	No. of HH surveyed	%	No. of HH surveyed	%	# of HH surveyed	%		
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**	**83**	**30.74**	**156**	**57.77**	**16**	**5.93**	**15**	**5.56**	**270**	**100**

Data Source: EIA Perception Survey 2018

Table 2.4-19. 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	%	
Bagbag II	**4**	13.33	**4**	13.33	**1**	3.33	**1**	3.33	**0**	0	**20**	66.67	**0**	0	30
Kanluran	**1**	3.33	**8**	26.67	**5**	16.67	**10**	33.33	**0**	0	**1**	3.33	**5**	16.67	30
Ligtong I	**6**	20	**13**	43.33	**7**	23.33	**4**	13.33	**0**	0	**0**	0	**0**	0	30
Muzon II	**17**	56.67	**7**	23.33	**1**	3.33	**1**	3.33	**0**	0	**4**	13.33	**0**	0	30
Sapa II	**5**	16.67	**15**	50	**7**	23.33	**1**	3.33	**0**	0	**1**	3.33	**1**	3.33	30
Sapa III	**3**	10	**1**	3.33	**7**	23.33	**18**	60	**0**	0	**0**	0	**1**	3.33	30
Wawa I	**2**	6.67	**8**	26.67	**3**	10	**15**	30	**0**	0	**0**	0	**2**	6.67	30
Wawa II	**0**	0	**5**	16.67	**7**	23.33	**13**	43.33	**0**	0	**1**	3.33	**4**	13.33	30
Wawa III	**5**	16.67	**5**	16.67	**1**	3.33	**5**	16.67	**0**	0	**11**	36.67	**3**	10	30
Total	**43**	**15.93**	**66**	**24.44**	**39**	**14.44**	**68**	**22.96**	**0**	**0**	**38**	**14.07**	**16**	**5.93**	**270**

Data Source: EIA Perception Survey 2018

Environmental Health and Sanitation - Based on the perception survey conducted, majority of the total respondents has access to sanitation facilities.

Table 2.4-20. 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	%	
Bagbag II	**1**	3.33	**4**	13.33	**23**	76.66	**1**	3.33	**1**	3.33	30
Kanluran	**0**	0	**29**	96.66	**0**	0	**0**	0	**1**	3.33	30
Ligtong I	**0**	0	**29**	96.66	**0**	0	**0**	0	**1**	3.33	30
Muzon II	**0**	0	**30**	100	**0**	0	**0**	0	**0**	0	30
Sapa II	**0**	0	**1**	3.33	**28**	93.33	**0**	0	**1**	3.33	30
Sapa III	**0**	0	**1**	3.33	**28**	93.33	**0**	0	**1**	3.33	30
Wawa I	**0**	0	**27**	90	**2**	6.66	**0**	0	**1**	3.33	30
Wawa II	**0**	0	**29**	96.66	**0**	0	**0**	0	**1**	3.33	30
Wawa III	**0**	0	**29**	96.66	**0**	0	**0**	0	**1**	3.33	30
Total	**1**	**0.37**	**179**	**66.29**	**81**	**29.99**	**1**	**0.37**	**8**	**2.96**	**270**

Data Source: EIA Perception Survey 2018

Perception of the Community

Knowlegde About the Proposed Project

Table below shows the frequency of the respondents who answered that they had prior knowledge and idea about the Proposed Cavite Province Land Reclamation and Development Project. Out of the 270 respondents, 138 or 51.11% of them answered Yes, while 81 or 29.99% answered No, and the remaining 51 or 18.88% had no responses.

Table 2.4-21. 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
Bagbag II	**8**	26.67	**12**	40	**10**	33.33	30
Kanluran	**6**	20	**5**	16.67	**19**	63.33	30
Ligtong I	**23**	76.67	**4**	13.33	**3**	10	30
Muzon II	**8**	26.67	**10**	33.33	**12**	40	30
Sapa II	**21**	70	**5**	16.67	**4**	13.33	30
Sapa III	**2**	6.67	**25**	83.33	**3**	10	30
Wawa I	**23**	76.67	**7**	23.33	**0**	0	30
Wawa II	**26**	86.67	**4**	13.33	**0**	0	30
Wawa III	**21**	70	**9**	30	**0**	0	30
Total	**138**	**51.11**	**81**	**29.99**	**51**	**18.88**	**270**

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 90 or 33.33% while 41 or 15.19% answered that they heard the project from their neighbor, 8 or 2.96% answered that they also heard the project from the media and through the IEC of the Proponent, and the remaining 123 respondents or 45.55% had no response. See Table 2.4-22.

Table 2.4-22. 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	%	
Bagbag II	**11**	36.67	**17**	56.67	**1**	3.33	**0**	0	**1**	3.33	30
Kanluran	**0**	0	**13**	43.33	**3**	10	**0**	0	**14**	46.67	30
Ligtong I	**2**	6.67	**8**	26.66	**1**	3.33	**0**	0	**19**	63.33	30
Muzon II	**12**	40	**12**	40	**1**	3.33	**1**	3.33	**4**	13.33	30
Sapa II	**0**	0	**5**	16.67	**1**	3.33	**4**	13.33	**20**	66.67	30
Sapa III	**2**	6.67	**7**	23.33	**0**	0	**2**	6.67	**19**	63.33	30
Wawa I	**12**	40	**12**	40	**1**	3.33	**1**	3.33	**4**	13.33	30
Wawa II	**2**	6.67	**12**	40	**0**	0	**0**	0	**16**	53.33	30
Wawa III	**0**	0	**4**	13.33	**0**	0	**0**	0	**26**	86.67	30
Total	**41**	**15.19**	**90**	**33.33**	**8**	**2.96**	**8**	**2.96**	**123**	**45.55**	**270**

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 Reclamation 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 2.4-23. Possible beneficial impacts of the Proposed Cavite Reclamation Project

Answers	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 2.4-24. Adverse Impacts of the Proposed Cavite Reclamation Project

Answers	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 nine (9) barangays are male. The data on age distribution are presented in Table 2.4-26.

Table 2.4-25. Impact Barangays: Sex Distribution

Barangay	FEMALE		MALE		NO ANSWER		TOTAL
	No. of HH surveyed	%	No. of HH surveyed	%	No. of HH surveyed	%	No. of HH surveyed
Wawa III	328	85	58	15	0	0	386
Sapa III	118	62	72	38	0	0	190
Wawa II	358	77	101	22	8	2	467
Sapa II	245	74	82	25	2	1	329
Ligtong	220	70	93	30	2	1	315
Wawa I	260	77	75	22	1	0	336
Bagbag	168	64	90	34	4	2	262
Kanluran	182	41	258	59	1	0	441
Muzon II	194	53	175	47	0	0	369
Total	**2073**	**67**	**1004**	**32**	**18**	**1**	**3095**

Data Source: EIA Perception Survey 2019

Table 2.4-26. Impact Barangays: Age Distribution

Barangay	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	%
Wawa III	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
Total	**93**	**3**	**424**	**14**	**544**	**18**	**526**	**17**	**410**	**13**	**175**	**6**	**57**	**2**	**877**	**28**	**3106**	**100**

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 57% (or 1734 out of the 3060 respodnents) are married and the rest are single, lived-in, single parents or widower.

Table 2.4-27. Impact Barangays: 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	%
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
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
Total	**499**	**16**	**1734**	**57**	**318**	**10**	**222**	**7**	**120**	**4**	**51**	**2**	**116**	**4**	**3060**	**100**

Educational Characteristics and Literacy - About 50% (or 1506 out of the 3011 respondents) are in secondary high school level, 21% (or 1506 out of the 3011 respondents) are in primary education level followed by 11% (or 335 out of 3011 respondents) tertiary education level. Only 5% (164 out of 3011respondents) opted not to answer while about 8% or 232 out of 3011 respondents have undergone vocational trainings.

Table 2.4-28. Impact Barangays: Educational Attainment

Barangay	NONE		ELEMENTARY		HIGH SCHOOL		VOCATIONAL		COLLEGE		POST GRADUATE		NO ANWER		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 Rosario																
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
Total	**57**	**2**	**636**	**21**	**1506**	**50**	**232**	**8**	**335**	**11**	**81**	**3**	**164**	**5**	**3011**	**100**

Data Source: EIA Perception Survey 2019

Socio-Cultural Profile

Place of Birth and Origin - Most of the respondents of barangays Wawa III, Sapa III, Wawa II, Sapa II, Brgy. Libtong, Wawa I, Bagbag, Kanluran, Muzon II were born outside the barangay/municipality while 32% of the total respondents of Barangay Wawa II were born within the barangay/municipality. It can be noted that majority of the respodnents are Tagalog. See Tables 2.4-29 and 2.4-30.

Table 2.4-29. Impact Barangays: Birth Place

Barangay	Born Outside the Municipality		Born Within the Municipality		No Answer		TOTAL	
	No. of HH surveyed	%	No. of HH surveyed	%	No. of HH surveyed	%	No. of HH surveyed	%
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
Ligtong	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
Total	**1058**	**38**	**712**	**25**	**1035**	**37**	**2805**	**100**

Data Source: EIA Perception Survey 2019

Ethnicity - The Municipality's dialect is mostly Tagalog (80%) there are migrants from other provinces that are also Tagalog speaking. Others are Visayan, Ilocano, Kapampangan, Bicolano and Waray.

Table 2.4-30. Impact Barangays: Ethnicity

Barangay	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	%
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
Total	**2573**	**80**	**426**	**13**	**40**	**1**	**20**	**1**	**7**	**0**	**77**	**2**	**93**	**3**	**3236**	**100**

Data Source: EIA Perception Survey 2019

Religious Affiliations - Results of the survey indicated that 90% or 2844 of the respondents are Roman Catholics followed byProtestant and the INC and affliates of the Islam, as presented in table below:

Table 2.4-31. Impact Barangays: Religious Affliations

Barangay	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	**2844**	**90**	**93**	**3**	**28**	**1**	**67**	**2**	**10**	**0**	**12**	**0**	**82**	**3**	**32**	**1**	**3168**	**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 employment. Most of the respondents are Jeepney driver, security guard, sales clerk, sales lady, vendor, sari-sari store vendor, cashier, bnk teller and entrepreneur.

Tables 2.4-32 - 2.4-33 presents the results on source of income of respodents, and monthly income, respectively.

Table 2.4-34 stated that the husband is the primar earner in the household.

Table 2.4-32. Impact Barangays: Occupation

Barangay	Pagsasaka		Pangingisda		Empleyado		Kontrakwal		Nagtitinda/nagbebenta		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	%
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
Total	**116**	**4**	**669**	**21**	**475**	**15**	**357**	**11**	**348**	**11**	**114**	**4**	**93**	**3**	**237**	**7**	**814**	**25**	**3223**	**100**

Data Source: EIA Perception Survey 2019

Table 2.4-33. Impact Barangays: Monthly Income of the Family

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	%
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

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	%
Bagbag	20	7	59	21	25	9	27	10	19	7	9	3	7	3	112	40	278	100
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
Total	**562**	**18**	**651**	**21**	**510**	**17**	**339**	**11**	**137**	**4**	**97**	**3**	**99**	**3**	**673**	**22**	**3068**	**100**

Data Source: EIA Perception Survey 2019

Table 2.4-34. Impact Barangays: Primary Earner of the Family

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	%
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
Total	**1345**	**44**	**401**	**13**	**223**	**7**	**149**	**5**	**73**	**2**	**42**	**1**	**124**	**4**	**669**	**22**	**3026**	**100**

Data Source: EIA Perception Survey 2019

Community Services

Water – Based on the survey, an accounted 10% of households are *"sariling patubigan"* for source of water supply. Athough 25% of the total respondents opted not to answer, it can also be noted that 17% of the respondents use deepwell 6% use other sources of water supply.

Table 2.4-35. Impact Barangays: Source of Water

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 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	%
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	**289**	**10**	**758**	**25**	**504**	**17**	**25**	**1**	**38**	**1**	**39**	**1**	**2**	**0**	**443**	**15**	**20**	**1**	**168**	**6**	**756**	**25**	**3042**	**100**

Data Source: EIA Perception Survey 2019

Power – Based on the survey conducted, majority of the households in the twelve (9) 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 69 percent. The data on Source of Electricity of respondents can bee seen in Table 2.4-36 below.

Table 2.4-36. 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	%
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 II	253	78	26	8	45	14	324	100
Ligtong	240	64	15	4	120	32	375	100
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
Total	**2120**	**69**	**141**	**5**	**815**	**26**	**3076**	**100**

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 2.4-37. 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	%
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
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
Total	**2010**	**69**	**247**	**8**	**669**	**23**	**2926**	**100**

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 two to three times in a week. Thus, it clearly shows that the Municipality has been collecting the garbage. See Table 2.4-38 and Table 2.4-39.

Table 2.4-38. Impact Barangays: Garbage Collection

Barangay	May nangungulikta		Hukay sa loob ng 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	%
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
Total	**1633**	**54**	**262**	**9**	**167**	**5**	**240**	**8**	**113**	**4**	**635**	**21**	**3050**	**100**

Data Source: EIA Perception Survey 2019

Table 2.4-39. 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	%
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
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
Total	**753**	**25**	**940**	**31**	**483**	**16**	**146**	**5**	**46**	**2**	**645**	**21**	**3013**	**100**

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 2.4-40. Impact Barangays: History of sickness for the past 3 years

Barangay	Oo		Wala		No Answer		Total	
	No. of HH surveyed	%	No. of HH surveyed	%	No. of HH surveyed	%	No. of HH surveyed	%
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

Barangay	Oo		Wala		No Answer		Total	
	No. of HH surveyed	%	No. of HH surveyed	%	No. of HH surveyed	%	No. of HH surveyed	%
Kanluran	213	66	63	20	45	14	321	100
Muzon II	76	26	35	12	181	62	292	100
Total	**1539**	**53**	**571**	**20**	**805**	**28**	**2915**	**100**

Data Source: EIA Perception Survey 2019

Table 2.4-41. 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	%
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
Total	**787**	**28**	**228**	**8**	**176**	**6**	**1631**	**58**	**2822**	**100**

Data Source: EIA Perception Survey 2019

Table 2.4-42. Impact Barangays: Number of family 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	%
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
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
Total	**675**	**22**	**412**	**14**	**204**	**7**	**117**	**4**	**112**	**4**	**370**	**12**	**1156**	**38**	**3046**	**100**

Data Source: EIA Perception Survey 2019

Table 2.4-43. Impact Barangays: Type of Disease in Rosario

BRGY	Gastrointestinal Diseases		Pag ubo/sipon		Lagnat		Skin Disease		Upper Respiratory Diseases		Hereditary Diseases		STD		Heart Diseases		Cancer		Others		No Answer		Total	
	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%
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
Total	**87**	**3**	**776**	**23**	**725**	**22**	**39**	**1**	**93**	**3**	**19**	**1**	**4**	**0**	**71**	**2**	**25**	**1**	**149**	**4**	**1384**	**41**	**3372**	**100**

Data Source: EIA Perception Survey 2019

Where do they Consult? – Based on the survey conducted, 28% of the household respondents opted to consult in the existing Barangay Health Centers. 17% opted to consult in Government Hospitals while 10% opted not to consult.

Table 2.4-44. Impact Barangays: Place of Treatment

Barangay	Bahay		Barangay Health Center		Goverment 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	%
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

Barangay	Bahay		Barangay Health Center		Goverment 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	%
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
Total	**347**	**10**	**971**	**28**	**603**	**17**	**218**	**6**	**18**	**1**	**32**	**1**	**1284**	**37**	**3473**	**100**

Data Source: EIA Perception Survey 2019

Perception of 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, 44% said that they are aware while 31% are not aware. Majority of the respondents or 22% knew about the proposed project from barangay officials. Others indicated that they knew the proposed project from their neighborhood or 20%, media (4%) and other people (3%). And the rest (49%) opted not to answer.

Table 2.4-45. 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	%
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. Ligtong	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
Total	**1384**	**44**	**998**	**31**	**793**	**25**	**3175**	**100**

Data Source: EIA Perception Survey 2019

Table 2.4-46. 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	%
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
Ligtong	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
Total	**583**	**20**	**647**	**22**	**44**	**2**	**119**	**4**	**74**	**3**	**1428**	**49**	**2895**	**100**

Data Source: EIA Perception Survey 2019

Perceived Impacts

The respondents were also asked on thier own view on the possible beneficial and adverse impacts of the proposed Cavite Province Land Reclamation and Development Project. As far as they benefits is 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 2.4-47. 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	
	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%
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

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	
	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%	HH surveyed	%
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
Total	**361**	**9.89**	**769**	**21.07**	**75**	**2.06**	**411**	**11.26**	**210**	**5.76**	**145**	**3.97**	**1,678**	**45.98**	**3,649**	**100**

Data Source: EIA Perception Survey 2019

Table 2.4-48. Impact Barangays: Disadvantages of the Project

Barangay	Kalusugan at siguridad		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	%
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
Total	**782**	**21.33**	**463**	**12.63**	**225**	**6.14**	**270**	**7.36**	**164**	**4.47**	**125**	**3.41**	**1,637**	**44.65**	**3,666**	**100**

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. Morover, 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 **Table 2.4-49.**

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 2.4-49. 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 guguho, 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 mapaguho na hindi natin nakikita na eventually ay lumilipas po yung time ay ganon po yung mangyayari kaya po kung may curtain yung mga itatayong isla then what will happen gaya po nyan di natin alam san kukunin ang panambak natin dyan.	**Ms. Nadia Conde:** 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. **Engr. Lene Ramboyong:** Kung hindi ako nagkakamali ay nabanggit na din yan ng PRA, Potential lang naman yung San Nicolas Shoal pero hindi pa nila maibibigay ng tuluyan , unang una nangangailangan pa muna yan ng permit at kung hindi ako nagkakamali ay ECC din. So ngayon po hindi rin sila makapag bitaw pa na sige pwede kayong kumuha dito. Kasi wala pa po silang ECC permits from other government pero potential lang po yun.	
	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.	**Ms. Nadia Conde:** 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		Yung sa Fishing grounds , di naman lingid sa inyo na madami po kaming nilagay na artificial coral reefs na nilagay dito sa	**Ms. Nadia Conde:** As to fishing grounds naman po, sabi ko nga po initial stage palang po wala pa po kaming ginagawang buong	

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
	Mr. Michael L. Del Rosario	municipal waters , papaanong recovery po ang gagawin natin? Panigurado pong tatamaan po iyon ng reclamation.	pag aaral , mag uumpisa po talaga kami right after ng technical 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. **Engr. Lene Ramboyong:** 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.	
	Congressman Michael Del Rosario	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	**Engr. Lene Ramboyong:** Any project must consider the drainage system. Hindi pwedeng maharangan ang daanan ng tubig.	
PEOPLE	**Mr. Alex Mañago Sr.**	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	**Ms. Nadia Conde:** 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	

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
		to, priority tayo na taga rito para magkaroon ng trabaho , yun po ang naisagot ko sa kanila. Ano po ba ang totoo? Pwede po ba sila na makapagtrabaho doon sa gagawing reclamation na iyan?	naman pupwede na magpagawa kayo ng bahay tapos sasabihin 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. **Engr. Lene Ramboyong:** 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 applikante bago kayo kumuha sa labas. **Congressman Michael Delrosario:** 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.	
	Ms. Devina M. Cenizal	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 .	**Ms. Nadia Conde:** 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 pababayaan 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	

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
			maging negative impact, and for the positive impacts naman 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. **Engr. Lene Ramboyong:** 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.	
	Kap. Jomer M. Bumatayo	Sa mga mamalakaya, pag na reclaim na po yung area saan po magkakaroon ng garahihan yung mga Bangka saan po ilalagay yung mga Bangka ?	**Ms. Nadia Conde:** 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. **Engr. Lene Ramboyong:** Hindi pa po natin malalaman yan ngayon hanggat hindi pa po sila nagsusubmit ng tinatawag nating EIS report. Doon po makikita nyo yung mga datus 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	

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
			katanungan.dapat maaddress lahat ng issues and concerns bago sila bigyan ng ECC.	
OTHERS	**Mr. Sergio Serico Nepomuceno** CPRD-National Museum	Naka attend na po kami 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 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 kami sa mga project developers na sila po ay mag-apply 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 continuous naman po ang monitoring ng cultural properties regulation division pati po yung aming maritime underwater division. At least 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.	**Engr. Lene Ramboyong:** Noted po	
	Kap. Ernesto "JonJon" V. Cupino Jr.	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 ?	**Ms. Nadia Conde:** Up to ECC issuance lang po kami. 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 doon.	

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
	Mr. Randy Legaspi	Potential Impact lahat kase may mitigation and enhancement ang accidental spoilage lang ang wala.	**Ms. Nadia Conde:** Hindi pa po kase final ang aming report maaari pong nung day na yon hindi pa naiinput ang data pero meron na po.	
	Message from Mayor Jose V. Ricafrente III	May proposed expansion po ang Cavitex dito din po sya mangyayari po sa ating dagat din po yung proposed expansion , kasama po ba yung daang gagawin from Cavitex to something? Dito din po kase yung development , baka po kase sa pag aaral magkaroon po ng problema kase baka mag conflict . 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. Gaano po kalayo yung distance ng shore sa reclaimed area po para sa kaalaman ng lahat. Kailan po masisimulan?	**Engr. Lene Ramboyong:** Noted po **Ms.Nadia Conde:** Lilinawin po namin pero ang alam po namin around 200 meters nga po siguro. **Engr. Lene Ramboyong:** 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.	

Chapter 3. KEY ENVIRONMENTAL MANAGEMENT PLAN (EMP)

Explanatory Notes:

The following explanatory notes are deemed relevant to the formulation of the EMP 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, the EMP also referred to as Impacts 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**.**

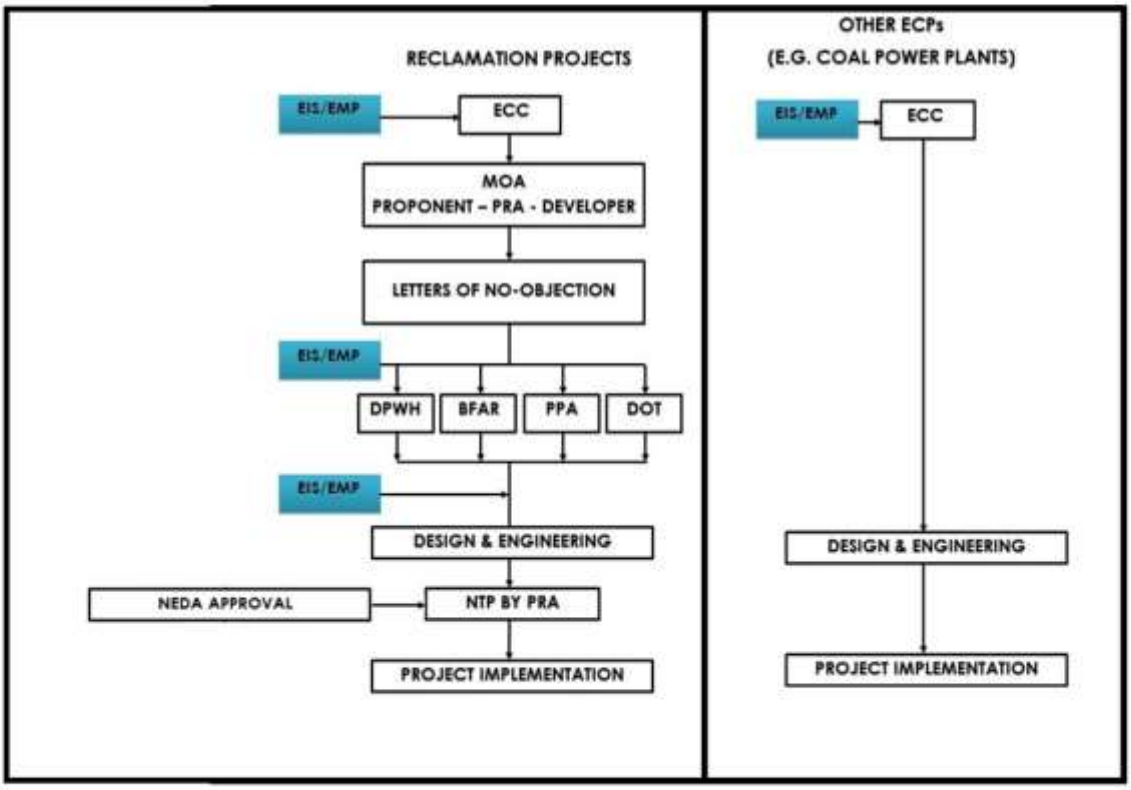


Figure 3-1. Post ECC Implementation of the IMP

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 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 EMP

The Environmental Management Plan (EMP) 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 EMP. 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
I. PRE-CONSTRUCTION PHASE							
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.							
II. CONSTRUCTION PHASE							
DREDGING WORKS ACTIVITY							
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 21.4 B	MOA among Consortium; ECC commitment
	People	Impact on the livelihood of fisherfolks that will be displaced	• 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. • 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. Collaboration with BFAR, the project will support diversification of fisher	100% Compliance to livelihood and Fish Aggregating Device (FAD)	MMT Members And Proponent's Self-Monitoring	Part of Project Development Cost Php 21.4 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
			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 21.4 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 21.4 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 21.4 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 Increase of suspended solids affecting the settlement of marine species in the dredging and reclamation areas	Provision of containment facility to prevent spillage Provision of control measures when transporting filling materials	Allowable Ambient Criteria or 100% Compliant to RA 9275 and DAO 2016-08 standards 100% No proliferation of suspended solids	MMT Members And Proponent's Self-Monitoring	Part of Project Development Cost Php 21.4 B	MOA among Consortium; ECC commitment
RECLAMATION ACTIVITY							

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
Construction of containment structures 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	• 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. • Provision of geotextile membrane on the containment structures throughout the perimeters of 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 Php 21.4 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 Php 21.4 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 Php 21.4 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 against tsunami/storm surge	MMT Members And Proponent's Self-Monitoring	Part of Project Development Cost Php 21.4 B	MOA among Consortium; 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 Php 21.4 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
		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 Php 21.4 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 Php 21.4 B	MOA among Consortium; ECC commitment
-Filling the project area with reclamation materials '-Delivery of filling and other construction materials through barges	Water Quality	Water pollution /Increase turbidity due to filling materials near reclamation areas	• 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. • Silt curtains shall be removed after all necessary components and materials are in place inside the revetment sections.	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 Php 21.4 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 Php 21.4 B	EIS / ECC Commitment
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 Php 21.4 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
	Air (Quality)	Dust pollution due to vehicle movements: -Along the road leading to the reclamation area -Within the project area activities	• 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. • Covering all loaded trucks properly/fully using tarpaulin throughout the hauling period. • All trucks shall be road-worthy.	100% Compliant to RA 8749 in terms of air quality standards	MMT Members And Proponent's Self-Monitoring	Part of Project Development Cost Php 21.4 B	EIS / ECC Commitment
LAND DEVELOPMENT							
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 Php 21.4 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 Php 21.4 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 And Proponent's Self-Monitoring	Part of Project Development Cost Php 21.4 B	EIS / ECC Commitment
	Air (Quality)	Noise pollution due to heavy equipment operation	• Use of efficient silencers on equipment and other noise dissipating device on all equipment to be used. • Observe allowable work hours to limit noise.	100% Compliant to Noise Standards	MMT Members And Proponent's Self-Monitoring	Part of Project Development Cost Php 21.4 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
		Dust pollution due to heavy equipment operation including transport vessels	• Sprinkling of water using water tanker at least four times a day within the project area especially during dry season. • Transport vessels/barges shall be fully and properly covered and load secured throughout the hauling period.	100% Compliant to RA 8749 in terms of air quality standards"	MMT Members And Proponent's Self-Monitoring	Part of Project Development Cost Php 21.4 B	EIS / ECC Commitment
Construction of horizontal structures such as follows: A. Road networks B. Drainage system (sewage and sewerage system) C. Water distribution D. Centralized wastewater treatment facility E. Power and telecommunication lines	Land	Land pollution due to indiscriminate /improper dumping of solid wastes and toxic substances	Ensure that its contractors shall practice onsite segregation and establish storage facility of the following: 1. Construction debris such as used drum, used tires, wood cuttings, iron bar cuttings, etc. 2. Hazardous wastes such as used oil, busted lamps, oily rags, etc. The above waste materials shall be hauled and disposed of by a DENR accredited hauler and treater. Composting facility will be provided to process biodegradable waste. Compost materials shall be used for greening activities.	100% compliance with the following: • RA 9003 • DAO 1992-29 and DAO 2013-22 and its Revised Procedural Manual	MMT Members And Proponent's Self-Monitoring	Part of Project Development Cost Php 21.4 B	EIS / ECC Commitment
	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 Collection and disposal will be done by a DENR accredited hazardous waste hauler and treater	Zero discharge of domestic waste to Bacoor Bay.	MMT Members And Proponent's Self-Monitoring	Part of Project Development Cost Php 21.4 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
	Water Quality	Water Pollution due Increase storm water run-offs surrounding the Areas	• Drainage system should to lead to settling ponds • Sewage and sewerage systems shall have dual piping (going to the wastewater treatment facility and for redistribution) • Provision of storm water collection system	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 Php 21.4 B	EIS / ECC Commitment
	Air (Quality)	Dust pollution emanating from open areas	• Sprinkling of water along all possible routes leading to the reclamation area, at least four times a day, especially during dry season. • Open areas should be covered with greeneries such as grass, shrubs, etc.	100% compliance with RA 8749 in terms of air quality standards	MMT Members And Proponent's Self-Monitoring	Part of Project Development Cost Php 21.4 B	EIS / ECC Commitment
	People	Health and Safety due to exposure to Construction Hazard	• Implement wearing of PPE's at all times when inside the project site	100% compliance to PPEs and Zero accident	MMT Members And Proponent's Self-Monitoring	Part of Project Development Cost Php 21.4 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 Php 21.4 B	MOA among Consortium; ECC commitment
III. ABANDONMENT PHASE							

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
Dismantling of equipment, clean-up, cessation of construction activities	People	Reduction and eventual termination of employment	• Promote alternative livelihood at early stage of project operation. • Pay employees termination pay and other payment mandated by laws.	100% compliance with SDP	MMT Members And Proponent's Self-Monitoring	Part of Project Development Cost Php 21.4 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.

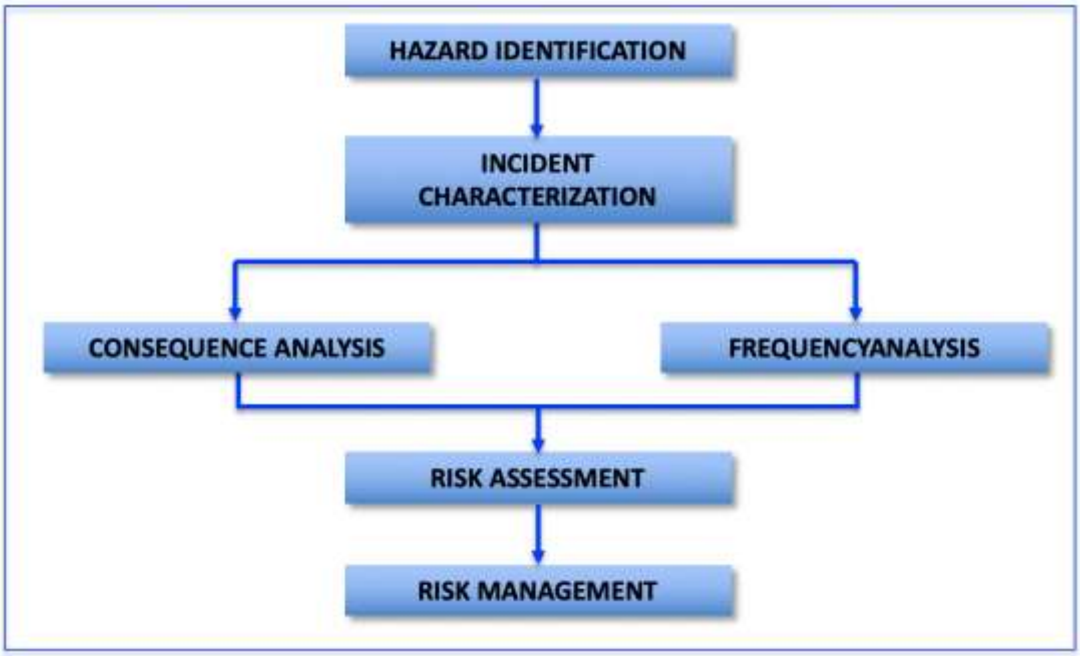


Figure 4-1. Risk Assessment Process

<u>Hazard identification</u> 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:

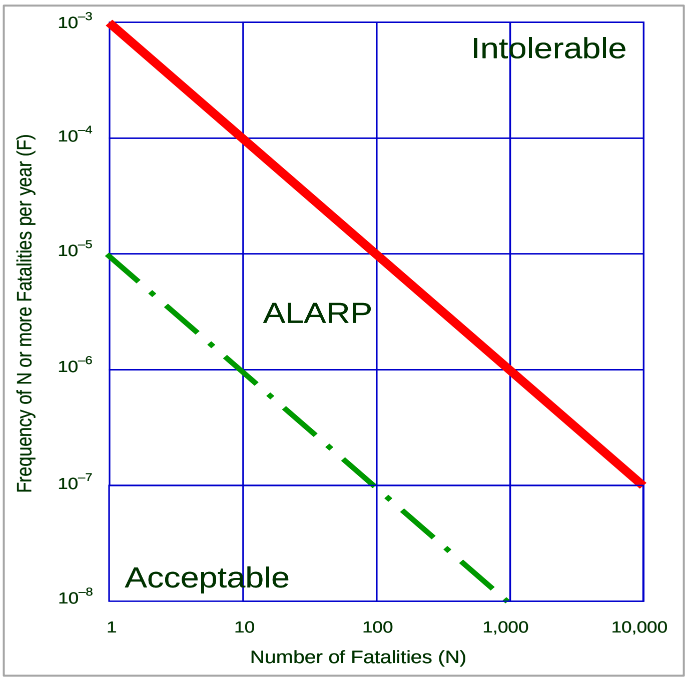
Table 4-1. Levels 1 and Level 2 Threshold Inventory

CATEGORY	LEVEL 1 (tons)	LEVEL 2 (tons)
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 (Reactivity)	1. A substance or preparation, which creates the risk of an explosion by shock, friction, fire, or other sources of ignition.
	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.
B. Flammable Substances (Highly flammable and extremely flammable substances)	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.
	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.
	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.
C. Oxidizing substances	Substances which give rise to highly exothermic reaction when in contact with other substances, particularly flammable substances.
D. Toxic Substances	Low, medium, high, very high and extreme toxicity of substances or preparation are classified as follows:
	1. A substance shall be considered as a liquid if vapor pressure is less than 1 bar at 20*C.
	2. A substance shall be considered as a gas if vapor pressure is greater than 1 bar at 20*C.
	3. The sum of (a) and (b) as provided in Tables 2 and 3 shall determine the toxicity class as contained in Table 1.
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^3
Volume Fill required for 5 islands	124,920,000 m^3
Total Number of cycles	7800
Total hours operating	54600 hours
Fuel carried by TSHD	2200 m^3
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 (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 > 60⁰ C
	Explosion	Nil	MDO not explosive
	Release of hazardous substances	Nil to insignificant Spent oil or on board leaks discharged to bilge not overboard	Bilge water treatment 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 > 60^0 C
	Explosion	Nil	MDO not explosive
	Release of hazardous substances	Nil to insignificant Spent oil or on board leaks discharged to bilge not overboard	Bilge water treatment No HAPs (Hazardous Air Pollutants) from exhaust of engines
Operation of Heavy Equipment (e.g. pumps, pile drivers)	Fire	Nil to Minimal	Marine Diesel Oil (MDO) used has high Flash Point > 60^0 C
	Explosion	Nil	MDO not explosive
	Release of hazardous substances	Oil sludge generated at vessel	Not discharged to bay, instead to onshore
Land Stabilization Soil stabilization	Fire	No Relevant Activity 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 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 Used or Waste Oils from operation of on board equipment	From food preparation of vessel crew Collected separately and disposed on shore or discharged to the bilge 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 filing 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

Nature of Substance	Source	Estimated Inventory
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
Reclaimed Land: 1 island with total land area = 324 ha		
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.
SUPPORT FACILITIES		
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.

Components	Specifications	Potentially Dangerous Substances or Organisms that Risk Release
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 Reclamation/Construction Activities	Not Applicable	Activities of Construction Workers will take place in work stations located at sea, e.g. in dredging vessel, in pile driving facilities, etc. 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. Waste materials classified as hazardous include spent lighting fixtures, computer inks and parts which are disposed on shore. No medical wastes, pathogens and harmful organisms involved or generated.
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.		

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	• Safety Training of Construction Crews • Safe worthy equipment
Filling	Accidents to Construction Personnel	Nil to insignificant	• Safety Training of Construction Crews • Safe worthy equipment
Operation of Heavy Equipment	Accidents to Construction Personnel	Nil to insignificant	• Safety Training of Construction Crews

Activities	Physical Risks	Probability of Incident	Prevention/Control Measures
			• Safe worthy equipment

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 / deboarding 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 of 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. Don 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, halls and trip 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.

<u>Survival and/or MOB craft</u>

- 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.

<u>Life rafts</u>

- 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.

<u>Emergency Life jackets</u>

- 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.

<u>Work life jackets (work vest)</u>

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 deboard 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 / deboarding 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 also consider the approval processes of the respective local governments. 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 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
1. Gender Responsive *Livelihood and Employment* • Provision of livelihood Opportunities for Displaced fisherfolks • Priority hiring of PAPs and local residents • Provision of alternative livelihood programs and or projects • Livelihood trainings and loan assistance for registered fisherfolks • Technical Assistance in marketing/sales/promotion of local products • Employment Assitance Program • Technical assistance or capacity development to fsherfolks in modern fishing methodas and aquaculture technology	• Barangay Chairman • Barangay Kagawad for Aquaculture/Fisheries • Qualified PAPs • Registered Fisherfolk Organization • Chairpenson from a registered organization in the concerned community	• Provincial Government of Cavite and concerned LGU • DSWD • BFAR	Provincial Government of Cavite and concerned LGU	• Pre-construction • Construction • Operation	Private Partner
2. Health and Safety • Heath and safety training for the employees • Construction work and road safety • Development of health and safety programs for the concerned community • Medical missions and emergency relief programs • Health information campaign	• Barangay Kagawad for Health • Barangay Municipal Health Workers	• Provincial Government of Cavite and concerned LGU	Provincial Government of Cavite and concerned LGU	• Pre-construction • Construction • Operation	Private Partner
3. Education and Recreation • Livelihood trainings for PAPs and concerned groups of the affected community • Provision of scholarship to qualified students	• Barangay Kagawad for Education • Barangay Elementary or primary School Principal	• Provincial Government of Cavite and concerned LGU	Provincial Government of Cavite and concerned LGU	• Pre-construction • Construction	Private Partner

CONCERN	Responsible Community Member / Beneficiary	Government Agency/ Non-government Agency and Services	PROPONENT	Indicative Timeline	Source of fund
• Assistance to the education-related programs of the concerned LGUs (Province/Municipal/City)	• Qualified students from the impact/host barangays	• DepEd		• Operation	
4. Environment and Sanitation • Mangrove reforestation program in the identified suitable mangrove areas for reforestation and use of dominant species of mangrove • Manila Bay Marine Pollution Prevention and Coastal Clean up • Implementation of Ecological Solid Waste Management (RA9003) and Toxic and Hazardous Waste Management (RA6969) • Implementation of Clean Water Act (RA 9275) and compliance to Manila Bay Supreme Court Mandamus for water quality. • Programs and projects for the host or impact community for environment and sanitation (i.e. wastewater and other related issues)	• Barangay Kagawad for Environment • Barangay and Municipal Fisheries and Aquatic Management Council (B/MFARMC)	• Provincial Government of Cavite and concerned LGU • DENR	Provincial Government of Cavite and concerned LGU	• Pre-construction • Construction • Operation	Private Partner
5. Peace and Order • Maintenance of peace and order • Management of migrants during construction • Sustain police mobility and visibility • Conduct of community-based preparedness programs to build "Ugnayan sa barangay".	• Barangay Kagawad for Peace and Order • Host barangays	• Provincial Government of Cavite and concerned LGU • PNP	Provincial Government of Cavite and concerned LGU	• Pre-construction • Construction • Operation	Private Partner
6. Spiritual Support on value formation programs	Barangay assigned Catholic priest and church pastors	Provincial Government of Cavite and concerned LGU	Provincial Government of Cavite and concerned LGU	• Pre-construction • Construction • Operation	Private Partner

CONCERN	Responsible Community Member / Beneficiary	Government Agency/ Non-government Agency and Services	PROPONENT	Indicative Timeline	Source of fund
7. Sports and Culture Development Integration of sports and cultural events with historical tour and other programs	• Barangay Chairman • Barangay Kagawad for Sports and Cultural Development • Youth Sector in the concerned LGU or community	• Provincial Government of Cavite and concerned LGU • DepEd	Provincial Government of Cavite and concerned LGU	Operation	Private Partner
8. Disaster Risk Reduction and Climate Change Adaptaton • IEC on Disaster Risk Management • Seminars/training on Disaster Risk Preparedness and Mitigation • Provision of equipment and aid in response and recovery of affected communities during disaster	• Barangay Kagawad on Environment Affected communities or host barangays	• Provincial Government of Cavite and concerned LGU • DENR-MGB • PHIVOLCS • PAG-ASA	Provincial Government of Cavite and concerned LGU	• Pre-construction • Construction • Operation	Private Partner

Photos of Ongoing Social Development Programs at the Munucipality of Rosario

Education

Technical/Vocational programs of the TESDA school-based programs.

Health
Medical/Dental Mission

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	• Disaster Risk Reduction and Management/ Emergency Plan	Municipal wide IEC Emergency Drills Participation by 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	• Project Description • Impacts on environment and health • Risks • Socio-Economic benefits • Socio-Economic impacts particularly to fisher folks and vendors Climate Change Mitigation/Adaptation	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	• Health and Safety • Locally prevalent diseases	Group Method Consultations	Roundtable Discussions	Before start of construction	TBD
General Public	• Drugs Awareness	Public Discussions PNP as guest	Roundtable Discussions	Before start of construction	TBD
The Impact Barangays	• Garbage Management • Plastic wastes	Technical Discussions Printed Materials	Invite experts on solid wastes	Before start of construction	TBD
NGOs and Religious Groups	• Nature of the Proposed Project • Impacts on environment ○ Floods ○ Liquefaction ○ Marine Ecology • Impacts on health • Socio-Economic impacts and benefits to existing establishments	Group Method Consultations • Send invitations to various barangay council members and impact sectors • Continuous discussion and consultation with the stakeholders to know their issues and concerns	FGD Power Point Presentation Printed Materials	Before construction Phase	Printing of IEC Materials
Professional society and individuals	Continuing consultation	Group Method	FGD Power Point Presentation	TBD	TBD
Prospective MMT Members (if formed) PENRO	Environment and Health	Group Method	FGD Power Point Presentations	Same	Same
MMT Members (if formed)	The Project EIA	Group method Individual	Printed materials FGDs	Same	TBD

Target Sector	Major Topic/s of concern in Relation to Project	IEC Scheme/ Strategy/ Method	Information Medium	Indicative Time/ Frequency	Indicative Cost
	Water and Marine Ecology Quality Management				

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 which 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 the 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					
								EQPL RANGE			MANAGEMENT MEASURE		
			Method	Frequency	Location			ALERT	ACTION	LIMIT	ALERT	ACTION	LIMIT
PRE-CONSTRUCTION PHASE													
Not relevant survey works at site completed													
CONSTRUCTION PHASE													
WATER													
Construction of containment structures Filling of Materials 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. - Conduct retesting to confirm result of action. Hire a 3rd party environme ntal 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 Night time - 55dB	Daytime - 65 Night time - 58	Daytime - 70 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 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.	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 monitori ng fund of MMT	No affected employee, injury, near misses and minor accidents.	One affected employee, injury, near misses and minor accidents.	Major accident s 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	• Ensure adherence to policies and IRR of the MMT body • When necessary refer items in conflict to EMB CO for resolution
Project Proponent (Provincial Government) – Note A	Same as above Main Responsible entity Project Proponent	• Provide funds • Provide relevant project information • Allow MMT inspection of site and of pollution abatement facilities • Participate in monitoring • Assist and sign MMT Report • Provide MMT with related Provincial Policies

Stakeholder Member	Basis of Selection	Proposed Roles
Host Barangays	Most affected	• Participate in monitoring • Assist and sign MMT Report
NGO or PO registered and accredited in the Province or Municipality		• Assist in monitoring • Assist in MMT report • Provide relevant inputs on the sector represented
Philippine Reclamation Authority	Authority for all reclamation projects	• Ensure compliance with the internal guidelines of the PRA • Ensure compliance with Agreements with PRA
Department of Tourism	Tourism enhancement	• Ensure project aligned to Tourism • Policy and Objectives
Philippine Coast Guard	In charge of Philippine Coasts	• Ensure compliance with rules of PCG relative to marine environment
Manila Bay Council	Policy Making for Manila Bay	• Ensure harmony with the MBC policies

Note A:
Other than the Provincial Government, the Municipal Government may also be made member 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

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 324 hectare landform created for Island E.

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 THE 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:

Institutions	Responsibilities
The Province of Cavite	• Monitor compliance to EMP by contractors; and • Coordinate and participate in monitoring compliance
The Municipality of Rosario	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	• 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; and • 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.
The Department of Works and Highways	- Participation in addressing flood problems; and - Involvement in providing infrastructure support to the various projects
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.

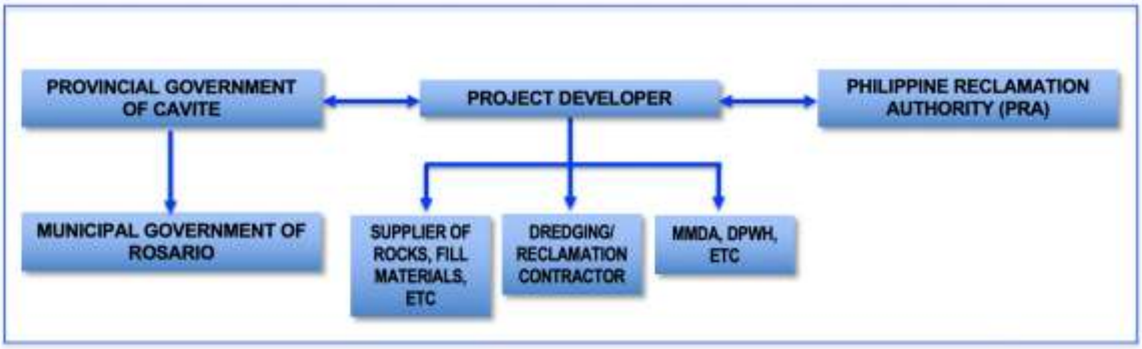


Figure 8-1. Institutional Plan for Project Implementation – Construction Phase

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 consultation 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 project
- 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 Project Manager and recommends action when necessary
- implementation of the Social Development Plan (SDP)
- implementation of the Information Education Communication (IEC)

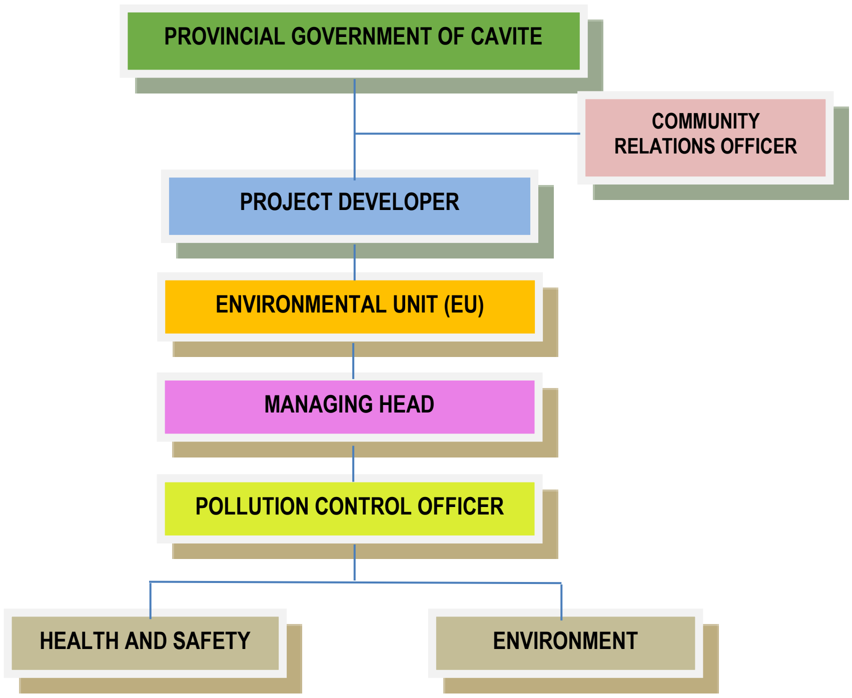


Figure 8-2 Organizational Chart of the Environmental Unit (EU)

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 organizations 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.