CHAPTER 6

EXISTING ENVIRONMENT

6.1 Zone Of Study

The future transformation in line for the Proposed Project site is the creation of an area for mixed development with related facilities and amenities on a new landmass which used to be the Jelutong Landfill (36.42 hectares or 90 acres) and reclamation land (28.33 hectares or 70 acres) covering a total area of 64.75 hectares or 160 acres of land. Rehabilitation for the Jelutong Landfill and reclamation of the new landmass will be conducted in tandem as outlined in earlier **Chapter 5** of this report.

6.2 Physical-Chemical Environment

A. Land Form And Topography

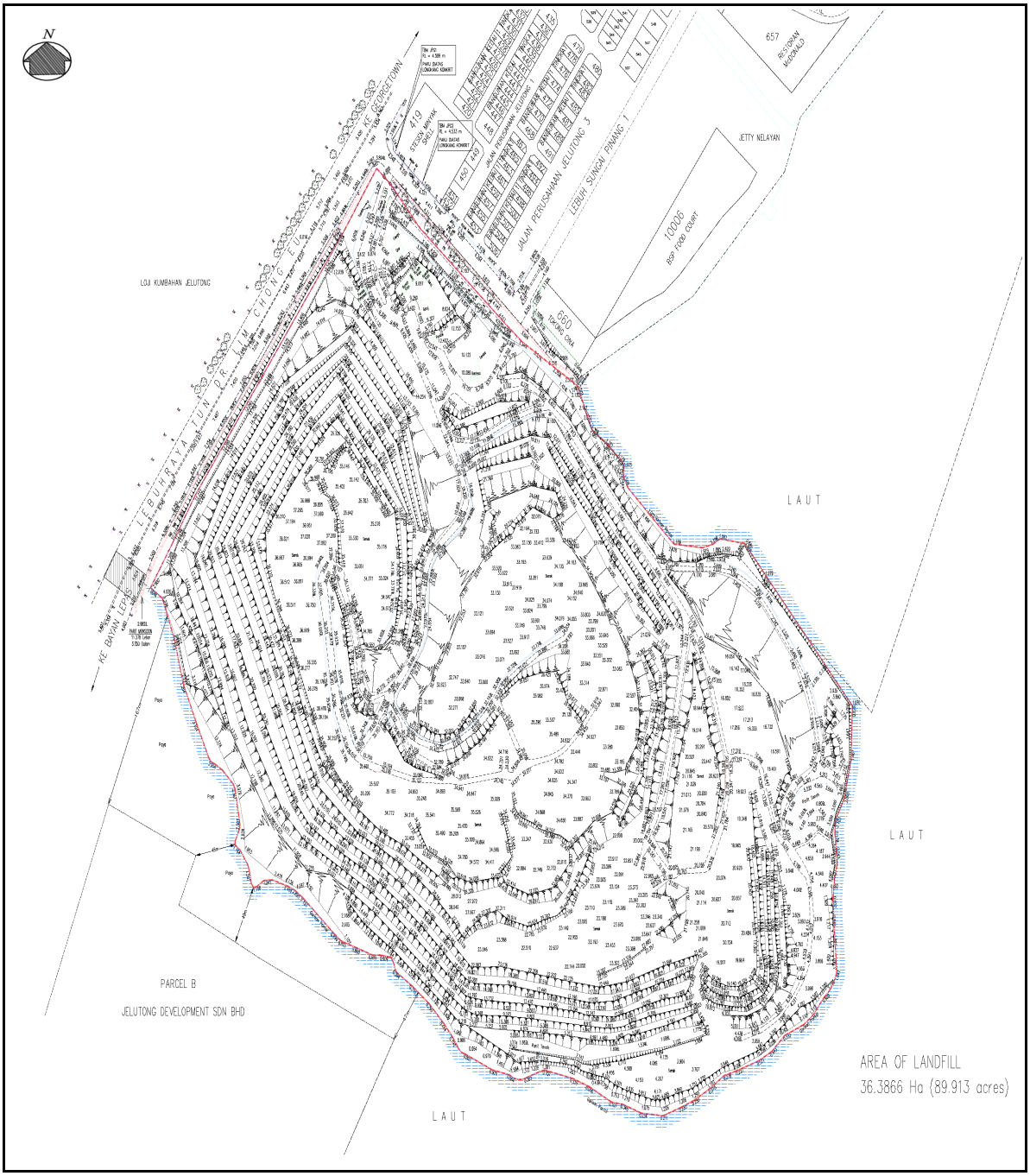
The Jelutong landfill is located adjacent to the Tun Dr. Lim Chong Eu highway while the area for the proposed reclamation is located north of the Jelutong Landfill and adjacent to Persiaran Karpal Singh.

The existing Jelutong Landfill located directly adjacent to Tun Dr. Lim Chong Eu Expressway stretches approximately 800m seaward. The existing level of the landfill is +37m NGVD (National Geodetic Vertical Datum) towards Tun Dr. Lim Chong Eu Expressway and +4m NGVD at its lowest further seaward and slopes into the sea as shown in **Figure 6.1.** The landfill is to be rehabilitated and suitable dump materials removed to be used at the reclamation site with final platform level of +4.35 m NGVD (National Geodatic Vertical Datum). An aerial view of the Jelutong Landfill is provided in **Figure 6.2.**

On the seaward side, according to the bathymetry survey dated July 2020 the seabed level towards the sea is approximately at -12.2 m NGVD at the deepest section as shown in **Figure 6.3** and further illustrated in **Appendix B-007.** The 3D seabed topographic image of the seabed profile and net fill height (difference between proposed platform level of +4.35 m NGVD and seabed level) contours are shown in **Figure 6.4 and Figure 6.5** respectively.

B. General Geology

A Geotechnical Design Report as illustrated in **Appendix B-008** for the Proposed Project is already in place and conducted by the Geotechnical Engineer from Global Water Consultants Sdn. Bhd. and submitted to the JK Pembangunan Tanah Berisiko. JKR as secretariat to the committee via letter reference PKR.PP(26)R/30/80/1 Jld.48 dated 5th April 2024 has approved the Geotechnical report for the Porposed Porject. Based on the soil investigation works prepared by M/S Soil Mechanic Sdn. Bhd. under the instruction of Sri & Sri's Associates Sdn. Bhd. as the consulting engineer for the Proposed Project.



Source: Jurukur Pinang

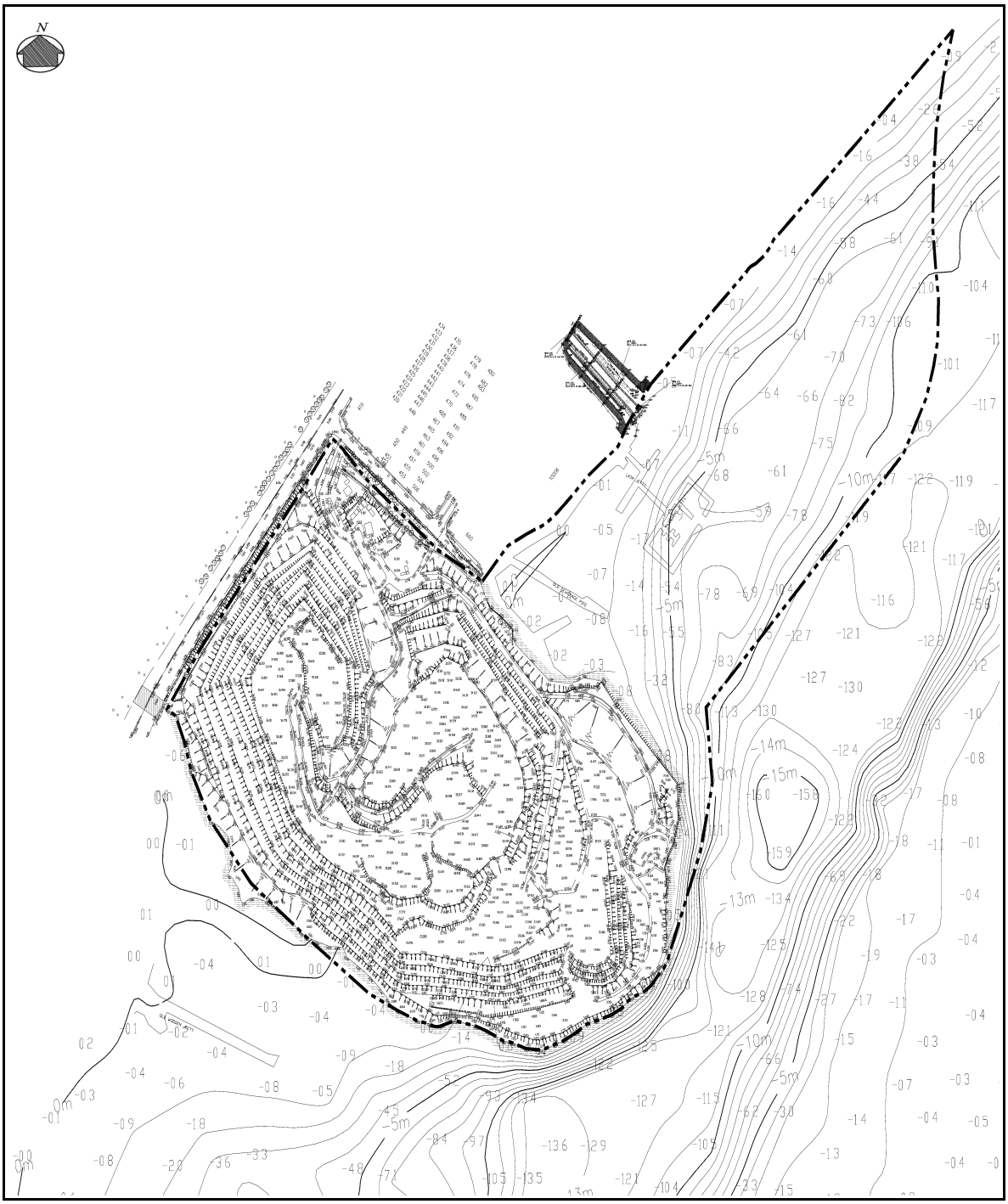
Not To Scale

Figure 6.1 Survey Plan Of Jelutong Landfill

Note: Refer **Appendix B-007**

Source: Aerial photo taken on 5th January 2024 Not To Scale

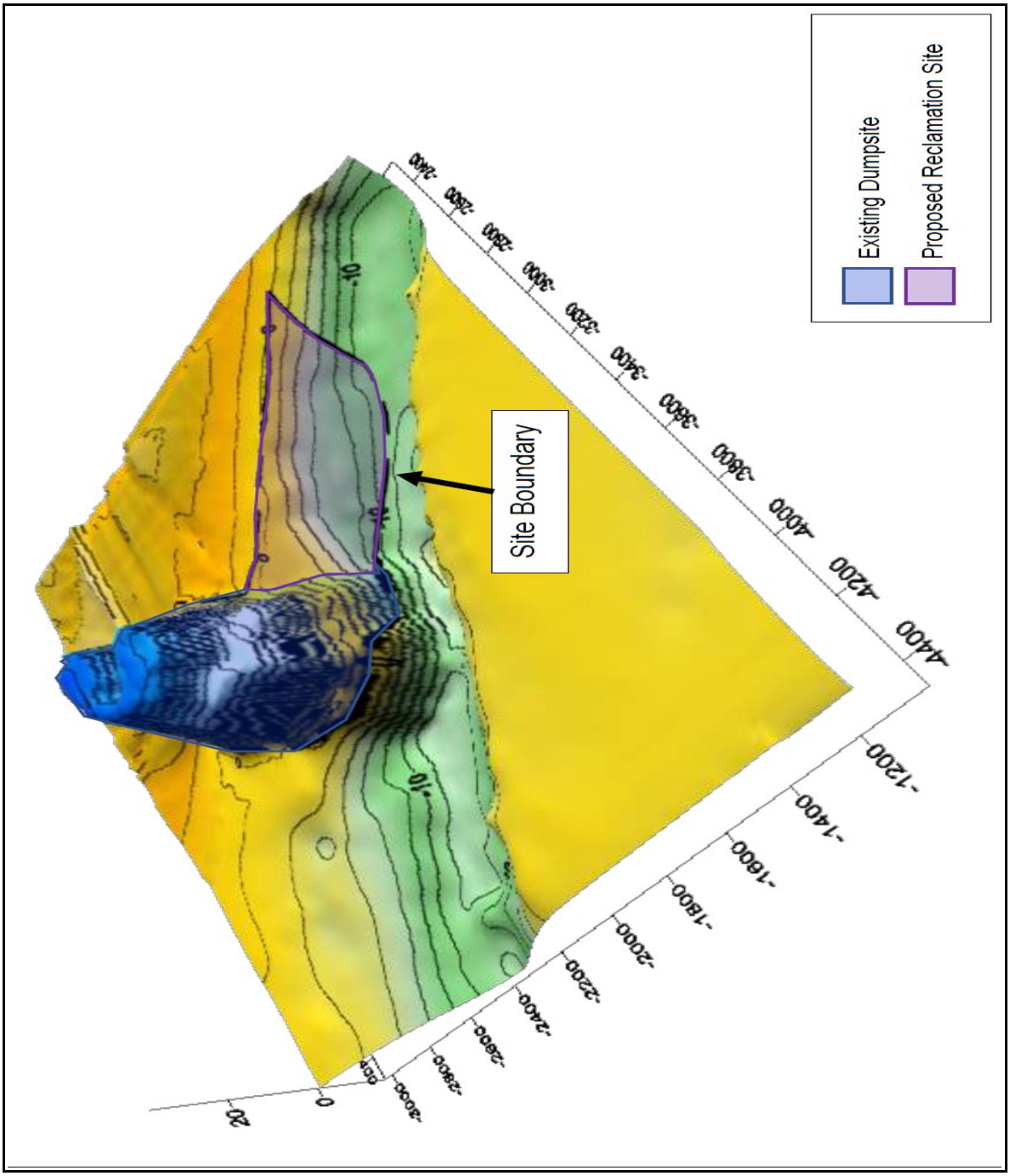
Figure 6.2 Aerial View Of Proposed Project



Source:Jurukur Perunding Services Sdn. Bhd. Not To Scale

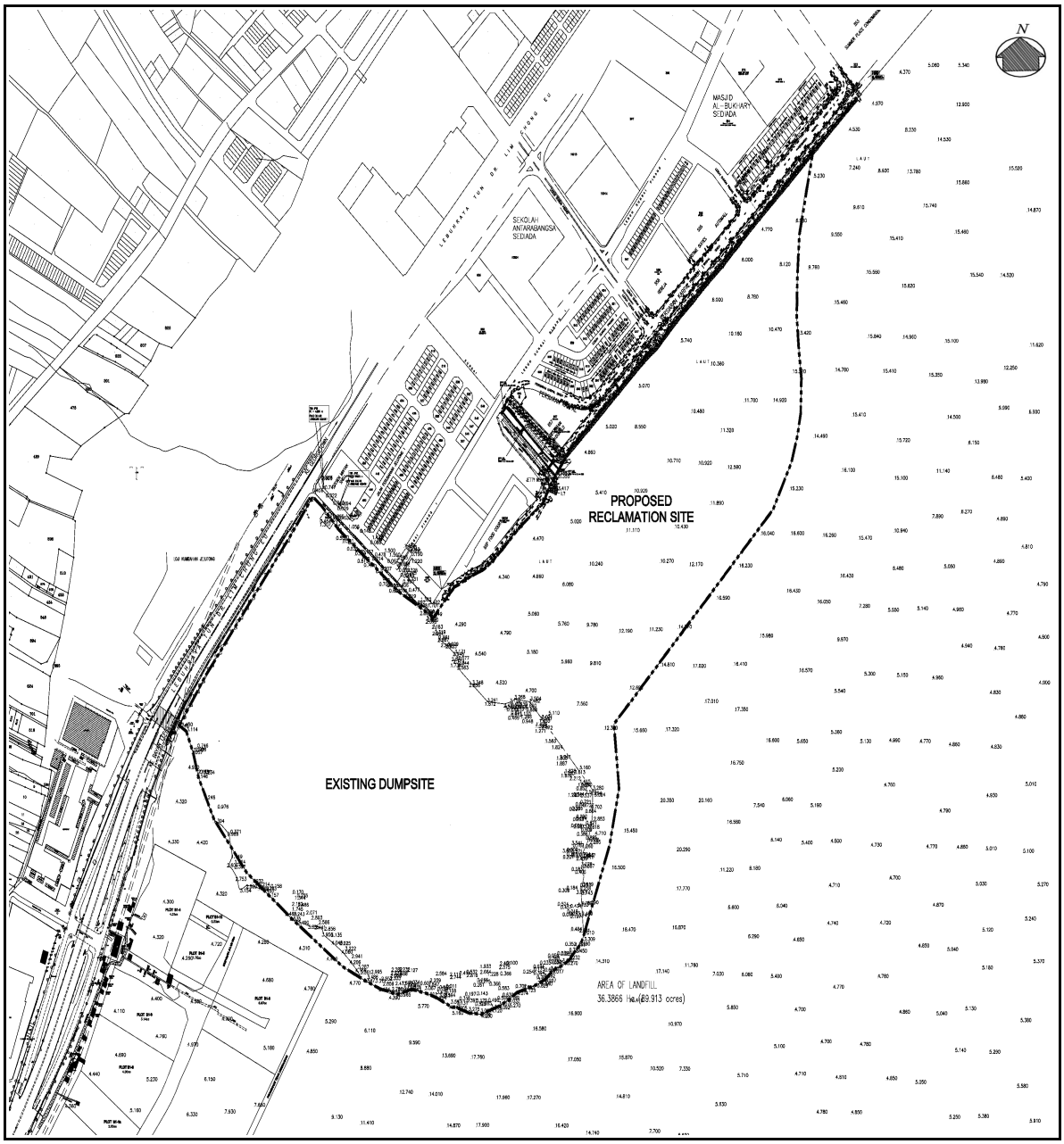
Figure 6.3 Bathymetry Survey Plan

Note: Refer **Appendix B-007**



Source: Geotechnical Design Report

Figure 6.4 3D Seabed Topography



Source: Geotechnical Design Report

Figure 6.5 Net Fill Height

JK Pembangunan Tanah Berisiko has approved the Geotechnial Design Report for the Proposed Project via JKR's letter reference PKR.PP.(26)R/30/80/1 Jld. 48 dated 5th April 2024. A copy given in **Appendix A-001.** Extract from the Geotechnical Design Report are provided below.

According to the Geotechnical Engineer's review of published Geological Map of Pulau Pinang, New Series L7010, Sheet 28, 2014 published by the Director-General, Minerals & Geoscience Department Malaysia, the Jelutong Landfill is likely within a previously reclaimed land underlain by Recent Alluvium.

Recent Alluvium is a marine deposite of Quaternary age and younger than Tanjung Bungah Granite which was formed during the Early Jurassic age. The coastal and fluviatile deposits in the main river valleys consists mainly of sand, silt and clay with traces of gravel. The geology underneath this soft alluvium may encounter granitic bedrock with various depths. The geological map of the area is shown in **Figure 6.6.**

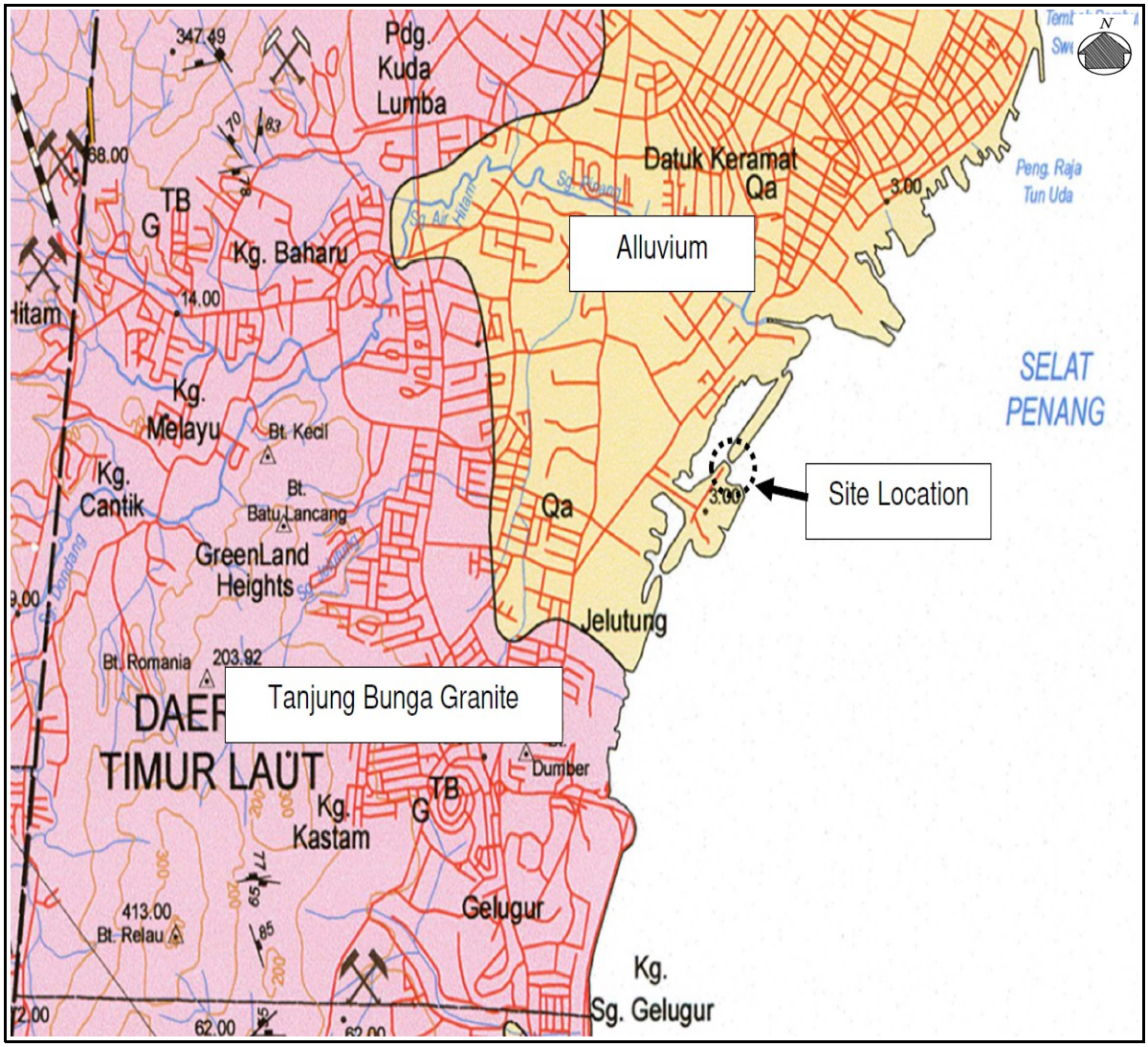
C. Subsurface Investigations

(i) General

Subsurface Investigation (SI) works planned by Sri & Sri's Associated Sdn Bhd consisting of nine (9) nos of boreholes (named as OBH series) are carried out at the existing Jelutong Landfill as provide in **Appendix B-009** to provide an indication of the thickness of dump material and the estimated original seabed level. **Figure 6.7** shows the location of the SI works previously carried out at the existing landfill.

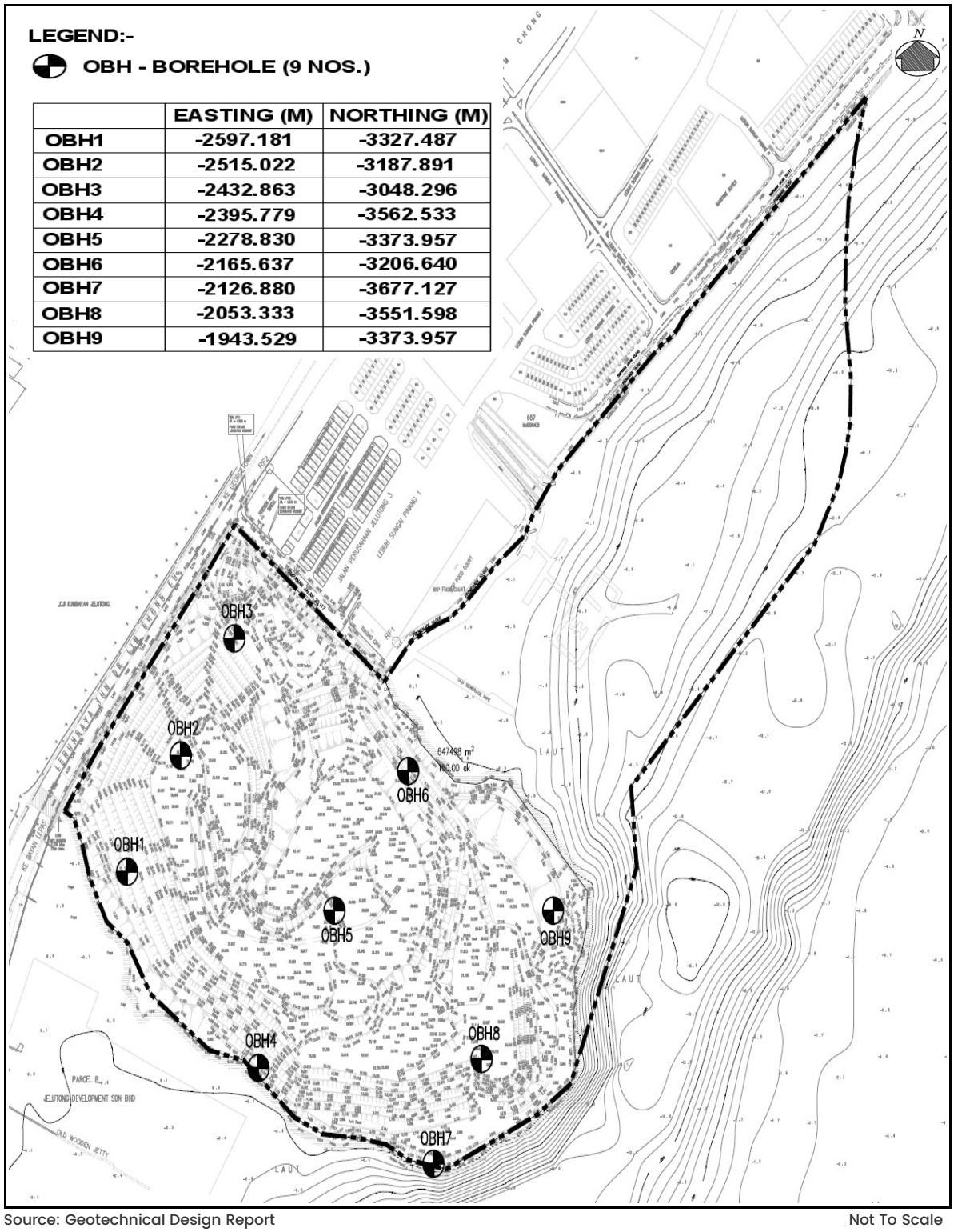
Additional SI works are carried out overwater (named as BH series) to acquire necessary subsoil parameters for planning and design of the reclamation works. The SI works are carried out in December 2022 by the SI contractor, Geolab (M) Sdn Bhd under full-time supervision of G&P's site representative. **Figure 6.8** shows the location of the additional SI works overwater and the following tests (field and laboratory) are carried out to acquire the representative subsoil parameter:-

- Boreholes — A total of nine (9) nos. of boreholes were sunk in to obtain the subsoil information and the necessary subsoil parameters for the design of settlement analyses and embankment stability analyses. Undisturbed soil samples were collected at various depths using thin wall sampler for laboratory tests. **Table 6.1 and Table 6.2** summarize the boreholes information;
- Piezocones — A total of three (3) nos. of piezocone test including 5 nos. dissipation test were carried out at soft soil areas to investigate the subsoil parameters such as soil type, soil strength, consolidation parameters (such as coefficient of consolidation in horizontal direction) and to determine sand layers (if any). **Table 6.3** summarize the piezocone information;



Source: Geotechnical Design Report

Figure 6.6 Geological Map

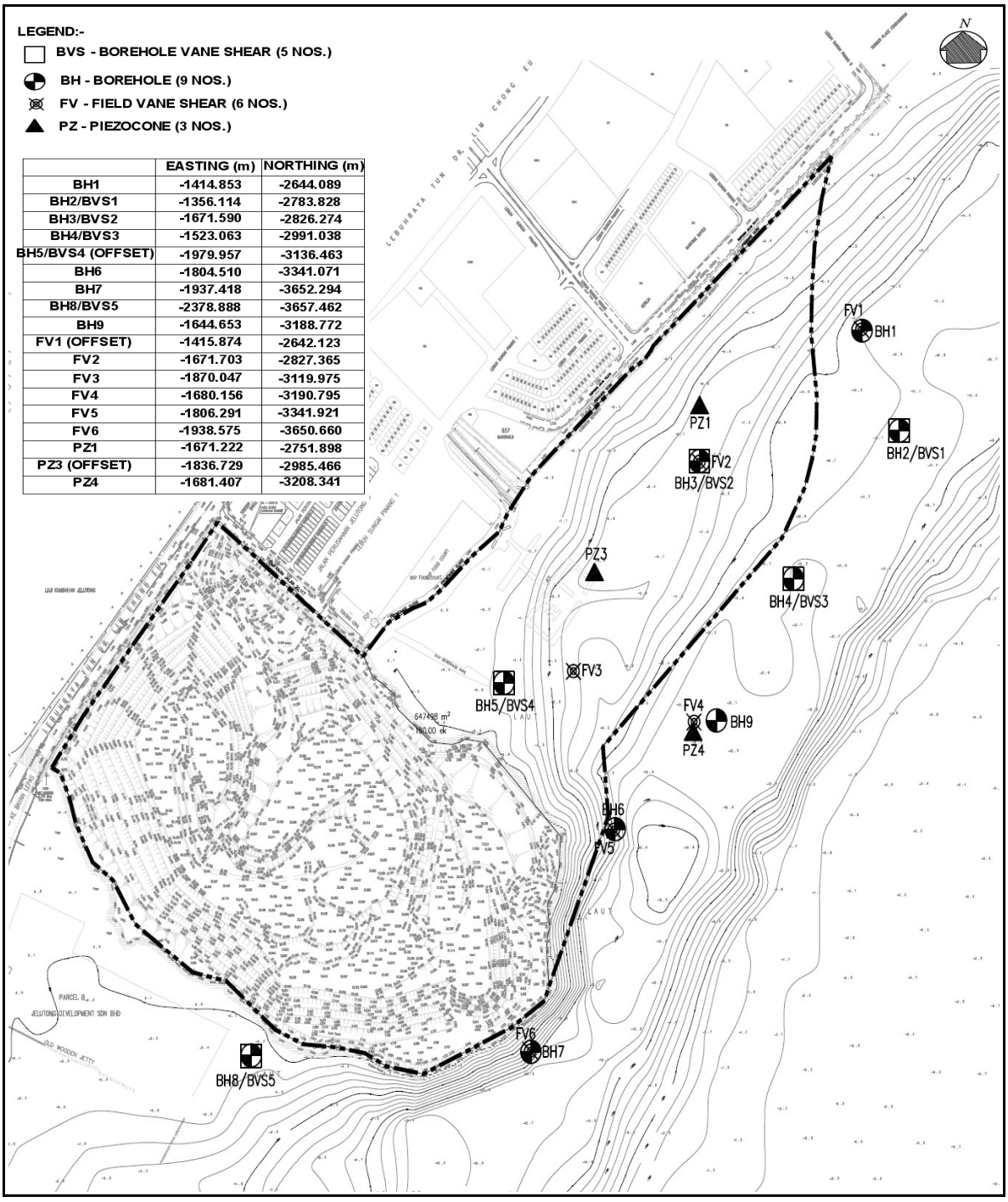


	EASTING (M)	NORTHING (M)
OBH1	-2597.181	-3327.487
OBH2	-2515.022	-3187.891
OBH3	-2432.863	-3048.296
OBH4	-2395.779	-3562.533
OBH5	-2278.830	-3373.957
OBH6	-2165.637	-3206.640
OBH7	-2126.880	-3677.127
OBH8	-2053.333	-3551.598
OBH9	-1943.529	-3373.957

Source: Geotechnical Design Report

Not To Scale

Figure 6.7 Subsurface Investigation Layout Plan At Rehabilitation Site



	EASTING (m)	NORTHING (m)
BH1	-1414.853	-2644.089
BH2/BVS1	-1356.114	-2783.828
BH3/BVS2	-1671.590	-2826.274
BH4/BVS3	-1523.063	-2991.038
BH5/BVS4 (OFFSET)	-1979.957	-3136.463
BH6	-1804.510	-3341.071
BH7	-1937.418	-3652.294
BH8/BVS5	-2378.888	-3657.462
BH9	-1644.653	-3188.772
FV1 (OFFSET)	-1415.874	-2642.123
FV2	-1671.703	-2827.365
FV3	-1870.047	-3119.975
FV4	-1680.156	-3190.795
FV5	-1806.291	-3341.921
FV6	-1938.575	-3650.660
PZ1	-1671.222	-2751.898
PZ3 (OFFSET)	-1836.729	-2985.466
PZ4	-1681.407	-3208.341

Source: Geotechnical Design Report

Not To Scale

Figure 6.8 Subsurface Investigation Layout Plan At Reclamation Site

- Penetration vane shear test — A total of six (6) nos. of penetration vane shear tests were carried out at soft soil area to obtain the undrained shear strength of the subsoil; and
- Laboratory tests — One dimensional One-dimensional Consolidation test, Isotropic Consolidated Undrained Triaxial Test with pore water pressure measurement (CIU) and Unconfined Compression Test (UCT) were carried out on the collected undisturbed soil samples to acquire the design parameters such as shear strength, compressibility, permeability, etc. Several direct shear box tests were carried out on the various collected disturbed samples for shear strength parameters. In addition, classification tests (i.e., Atterberg Limits, Particle Size Distribution, etc) and chemical tests (i.e., Organic Content, Chloride Content, Total Sulphate Content and pH Value) were carried out on various undisturbed and disturbed samples.

Table 6.1
Summary Of Borehole At Landfill Site

Borehole	Reduced Level (mNGVD)	Termination Depth	Remarks
OBH1	16.74	30.45	Dumping material at 0-20mbgl, no hard layer/rock encountered
OBH2	36.75	51.45	Dumping material at 0-41.7mbgl, no hard layer/rock encountered
OBH3	11.18	24.45	Dumping material at 0-14.7mbgl, no hard layer/rock encountered
OBH4	5.58	42.45	Dumping material at 0-29.7mbgl, no hard layer/rock encountered
OBH5	35.44	52.95	Dumping material at 0-43.2mbgl, no hard layer/rock encountered
OBH6	11.50	28.95	Dumping material at 0-19.2mbgl, no hard layer/rock encountered
OBH7	0.79	27.45	Dumping material at 0-16.2mbgl, no hard layer/rock encountered
OBH8	20.83	45.45	Dumping material at 0-36mbgl, no hard layer/rock encountered
OBH9	5.65	40.95	Dumping material at 0-19.2mbgl, no hard layer/rock encountered

Source: Geotcehnical Design Report, 2023

Note: Random dumping material sample collected at OBH5 and analyzed showed content consists of 66% concrete waste, 16% organic matter (0.425mm to 0.300 mm), 9% organic matter (0.15 mm to 0.075 mm), 7% glass and 2% organic matter (5.00 mm to 0.600 mm) as per analytical report issued by HTC Geoengineering Sdn. Bhd.

Table 6.2
Summary Of Borehole At Proposed Reclamation Site

Borehole	Reduced Level (mNGVD)	Termination Depth	Remarks
BH1	-11.49	60.45	No hard layer/rock encountered
BH2	-12.27	60.45	Intermediate hard layer at 49.5-54mbgl
BH3	-6.64	60.45	Encountered hard layer at 60mbgl
BH4	-12.50	60.45	No hard layer/rock encountered
BH5	-0.74	60.45	No hard layer/rock encountered
BH6	-14.15	60.45	Encountered hard layer at 58.5mbgl
BH7	-11.15	60.45	Intermediate hard layer at 58.5mbgl
BH8	-0.60	52.80	Encountered hard layer at 48m and rock at 49.8mbgl
BH9	-14.19	60.45	No hard layer/rock encountered

Source: Geotcehnical Design Report, 2023

Table 6.3
Summary Of Piezocone

Borehole	Reduced Level (mNGVD)	Termination Depth (m.b.g.l.)
PZ-1	-6.16	7.45
PZ-3	-6.48	9.88
PZ-4	-13.25	2.61

Source: Geotcehnical Design Report, 2023

(b) Subsoil Condition

The simplified borelogs showing the SPT-N values, major/minor classified subsoil components for the boreholes carried out at the existing landfill and over water are presented in **Figure 6.9 and Figure 6.10** respectively. According to the consulting engineers dumping material consist of either as shown in the footnote in **Figure 6.9.** The soil types at the existing landfill and over water are classified in accordance with the BSCS (British Soil Classification System for Engineering Purposes) obtained from soil laboratory classification tests. The borelog results (OBH series) at the existing landfill show that the thickness of the dump material ranges between 15m to 43m thick. On the other hand, the interpreted seabed levels beneath the landfill are between -3m NGVD and -24m NGVD. The seabed subsoil stratum here mainly consists of CLAY and sandy SILT/CLAY with SPT-N generally more than 4 blows.

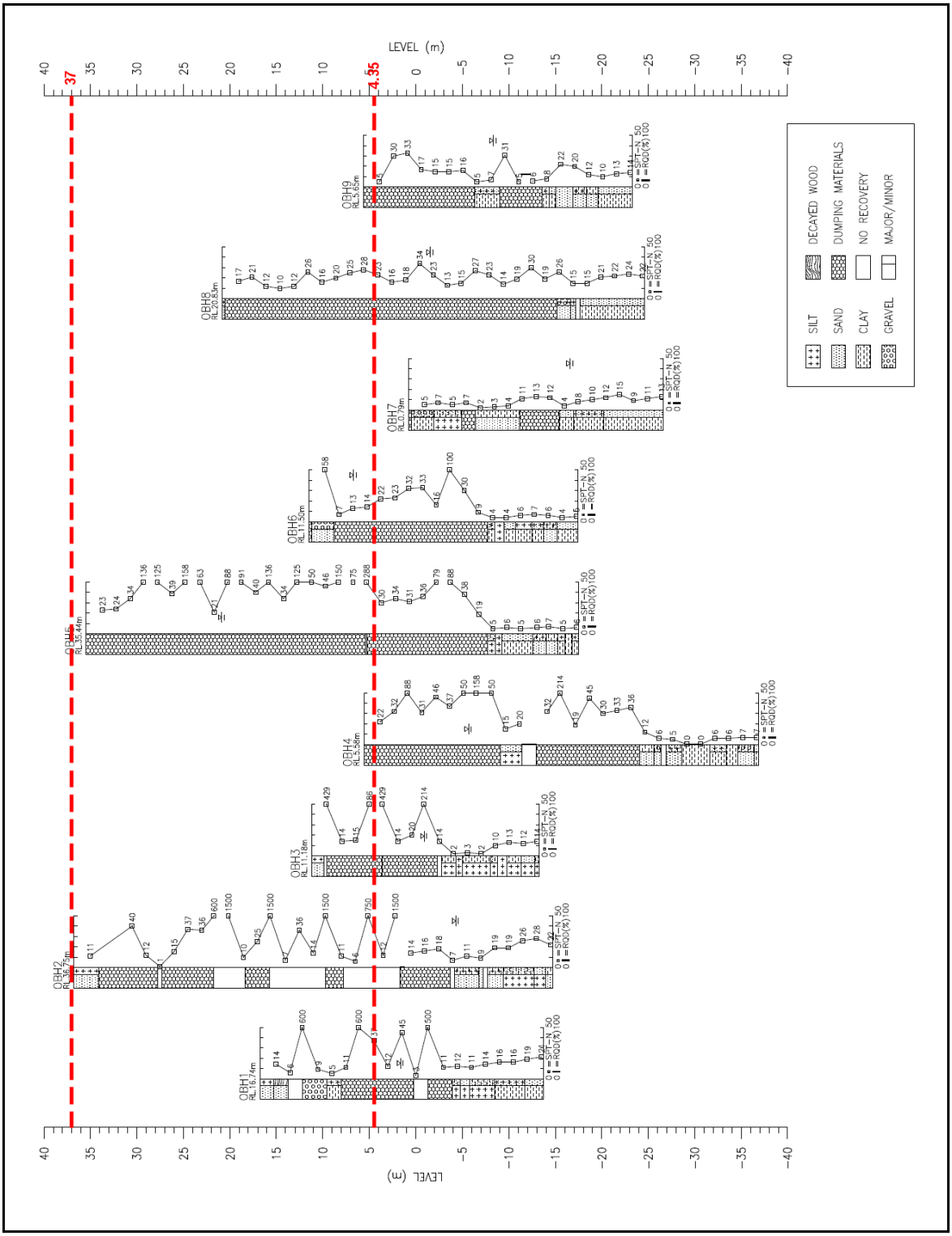
On the other hand, the borelog profile (BH Series) for overwater show that the seabed subsoil stratum mainly consists of CLAY and silty/clayey SAND. Soft compressible materials (SPTN <4) are found to be approximately 3m to 15m thick below the seabed. The piezocone profiles generally confirm the findings from the borelog profiles. Predominantly silty/clayey SAND underlain the soft compressible layers. During borehole drilling, in-situ Standard Penetration Test (SPT) was carried out at every 1.50m interval inside the boreholes as the boring progressed. It should be noted that BH8 encountered granite at 49.8m below the seabed.

(c) Engineering Properties Of Subsoil

i. Physical Properties

Majority of soil samples obtained for laboratory testing from the existing Jelutong Landfill is deemed to be recovered from the existing subsoil below the dumping materials which is also evident from the SI borelogs.

The Plasticity Chart of the SI information for the Jelutong Landfill and reclamation site are shown in **Figure 6.11 and Figure 6.12** respectively, the LL (Liquid Limit) of the soil samples generally range from 30% to 90% and 27% to 136% for samples retrieved from the landfill and reclamation respectively.

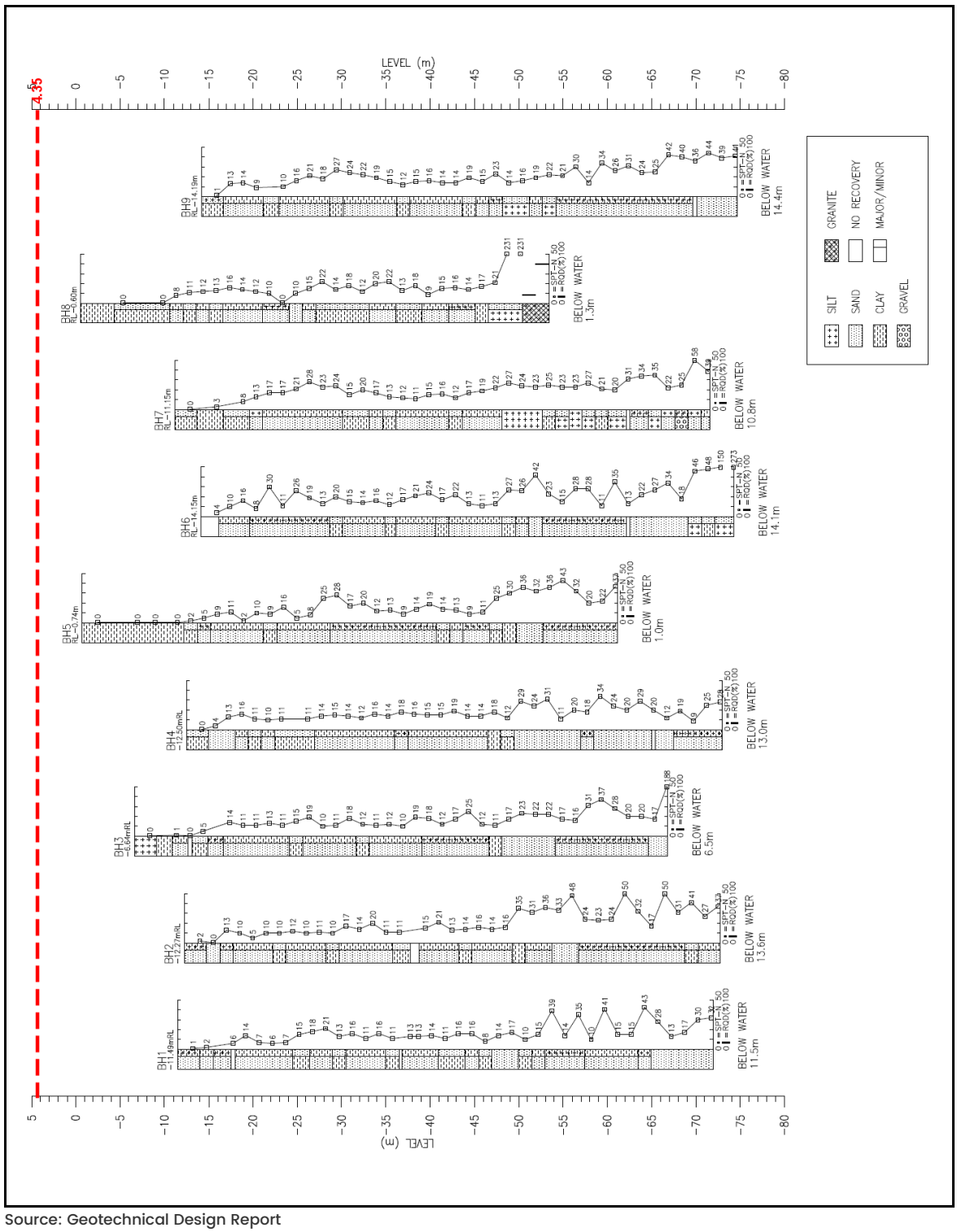


Source: Geotechnical Design Report

Note: Dumping material differs according to borehole:-

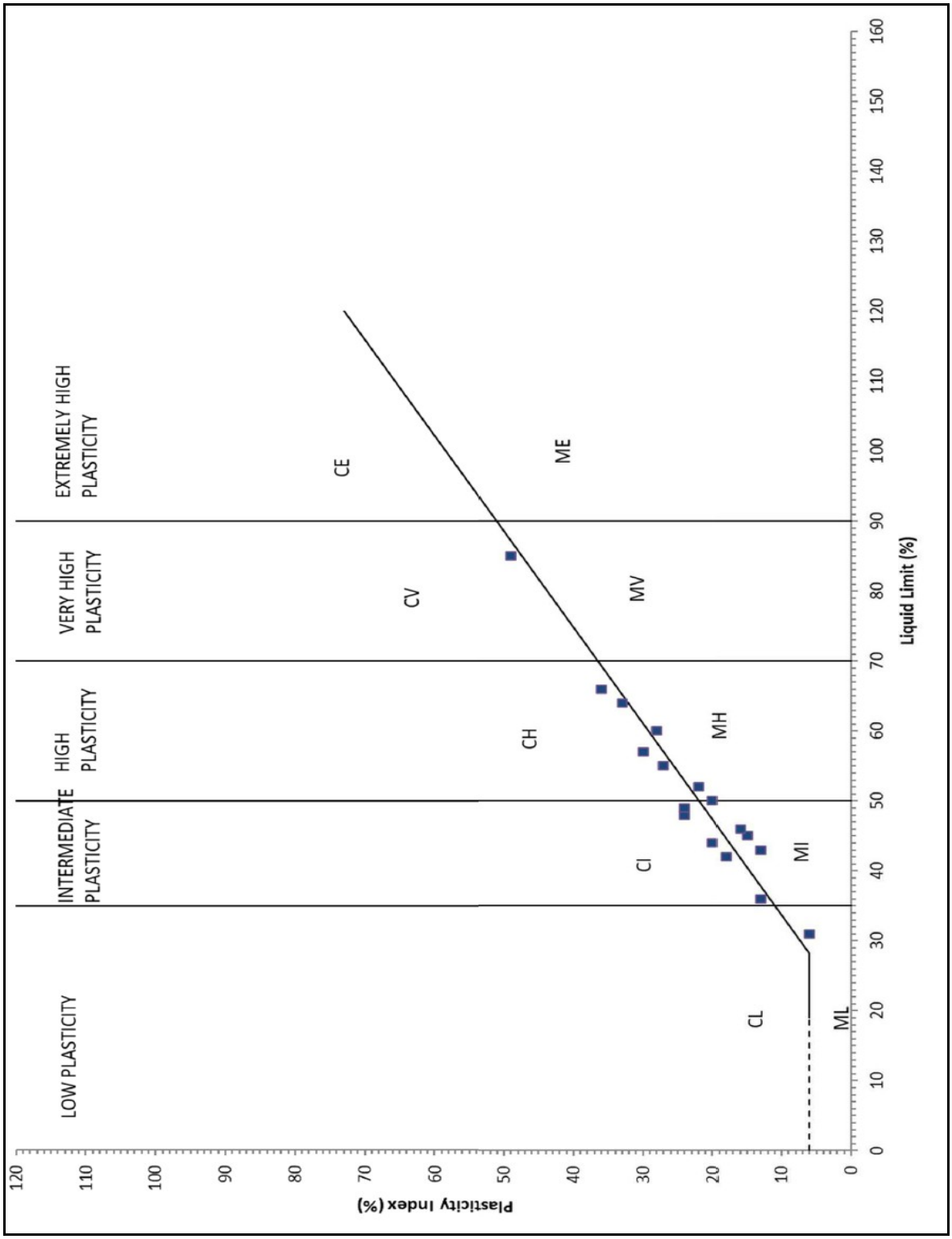
OBH1 – Demolition waste/soil	OBH4 – Demolition waste and waste soil	OBH7 – Demolition waste/soil
OBH2 - Demolition waste/soil	OBH5 – Domestic, waste, garden waste	OBH8 – Demolition and excavated waste
OBH3 - Demolition waste/soil	OBH6 - Bulk waste, waste soils, construction hardcore	OBH9 – Domestic waste, garden waste

Figure 6.9 Simplified Borelog (Rehabilitation Site)



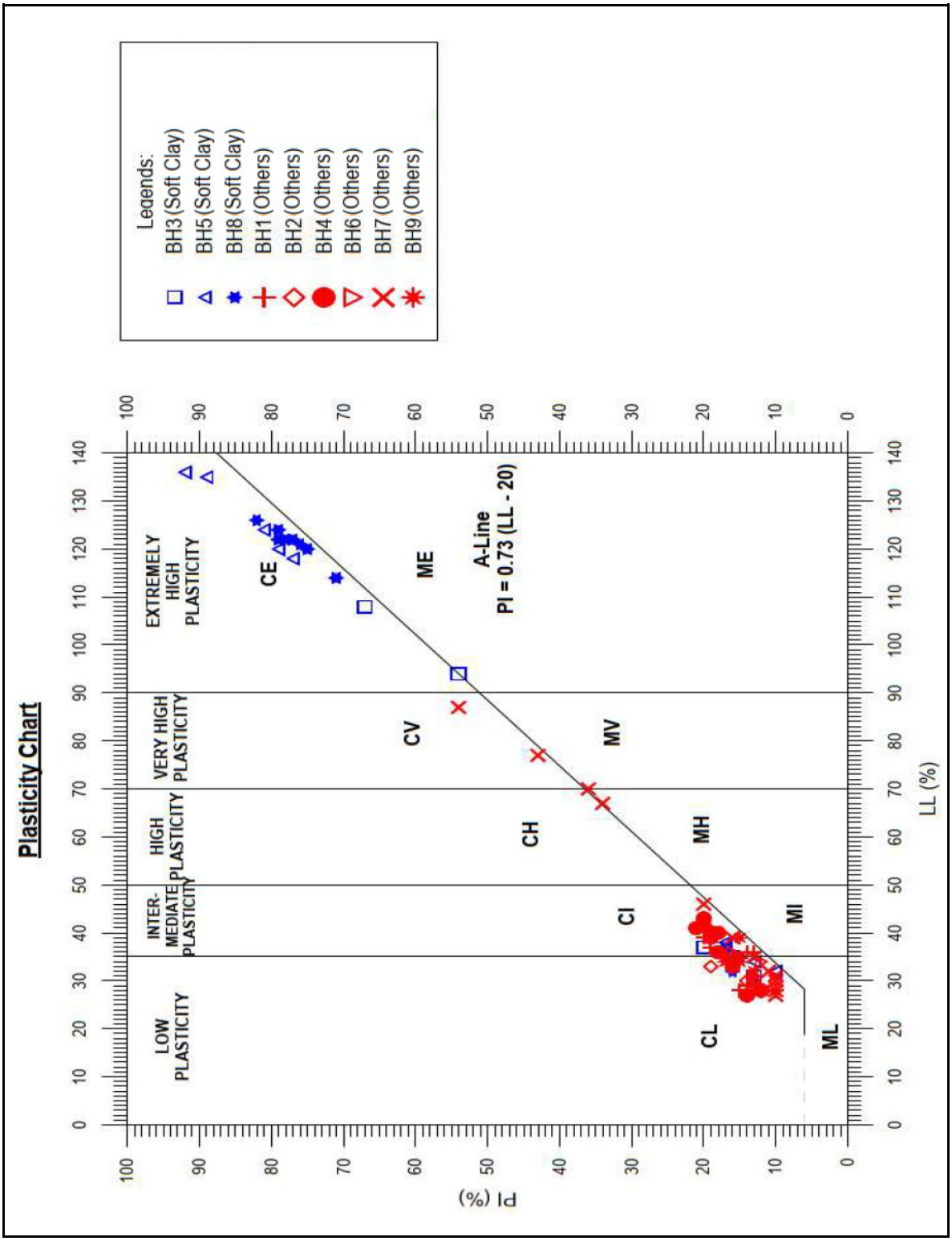
Source: Geotechnical Design Report

Figure 6.10 Simplified Borelog (Reclamation Site)



Source: Geotechnical Design Report

Figure 6.11 Plasticity Chart (Rehabilitation Site)



Source: Geotechnical Design Report

Figure 6.12 Plasticity Chart (Reclamation Site)

This indicates that samples range from low to extremely high plasticity. It is also observed that majority of the samples are scattered above the "A" line with fine components which are clayey in nature. Besides, some of the samples are found to be scattered below the "A" line with fine components which are silty in nature. The bulk unit weight of the collected samples beneath the Jelutong Landfill ranges from 14kN/m^3 to 19kN/m^3 as shown in **Figure 6.13.** Due to absence of dumping samples a unit weight of 12kN/m^3 is adopted for the dump materials which is within the range stated in literature. For the reclamation site bulk unit weight ranges from 10.5kN/m^3 to 15.5kN/m^3 for compressible clayey subsoil and 14kN/m^3 to 21.5kN/m^3 for sandy subsoil as shown in **Figure 6.14 and Figure 6.15.** Unit weight of 13kN/m^3 and 19kN/m^3 are adopted for clay and sand intrnals respective. **Table 6.4** provides the bulk unit.

Table 6.4
Bulk Unit Weight

Reduced Level (RLm)	Adopted Unit Weight (kN/m^3)
0-15 (clay material)	13
>15 (sand material)	19

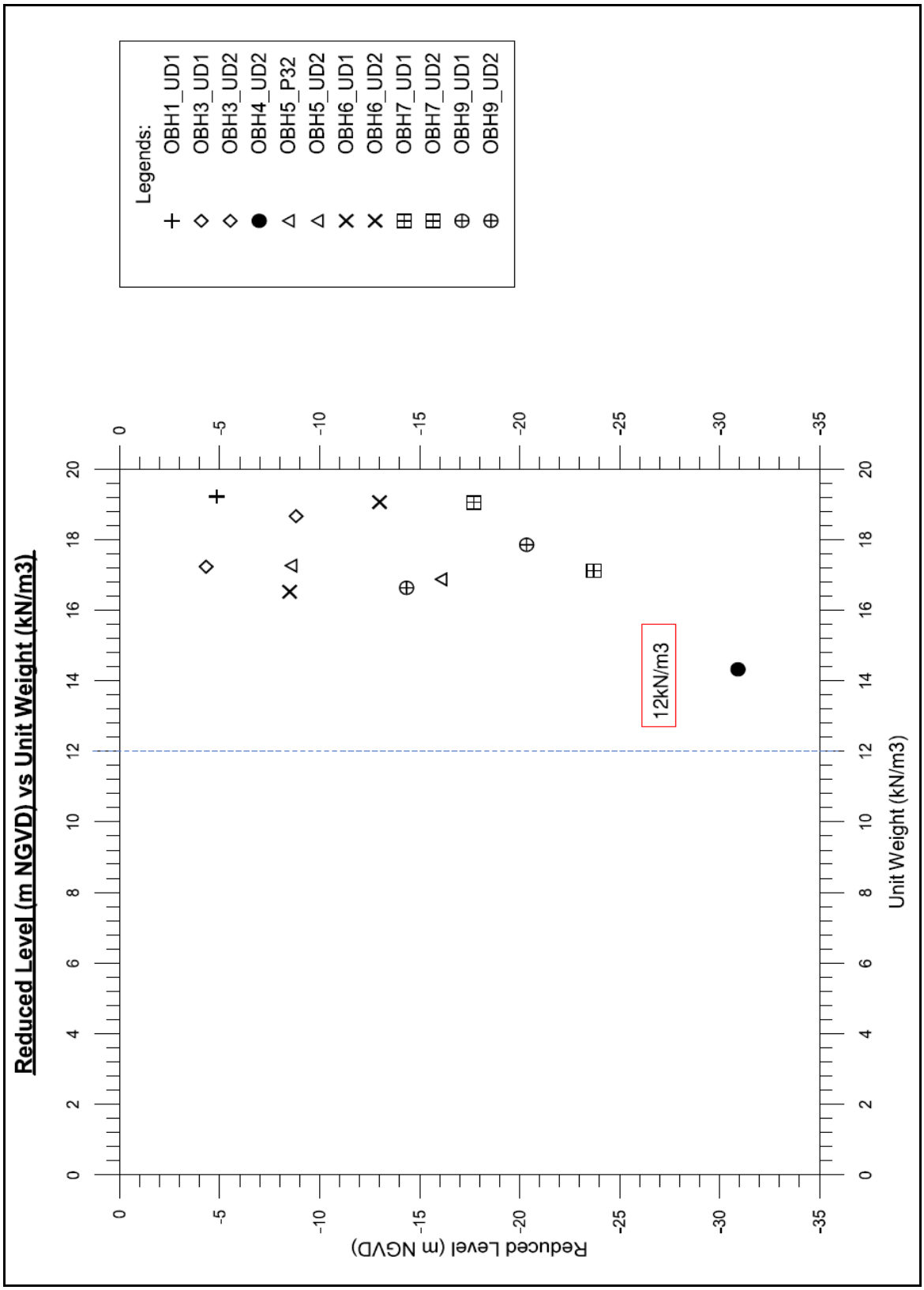
Source: Geotechnical Design Report

ii. Chemical Properties

Chemical tests are carried out to ascertain the amount of chloride content, pH value, total sulphate content and organic matter content in the subsoil which will react with construction materials such as concrete and steel. Soil samples from boreholes are tested at varying depths and results for the above mentioned chemical tests are presented in **Figure 6.16 to Figure 6.19.**

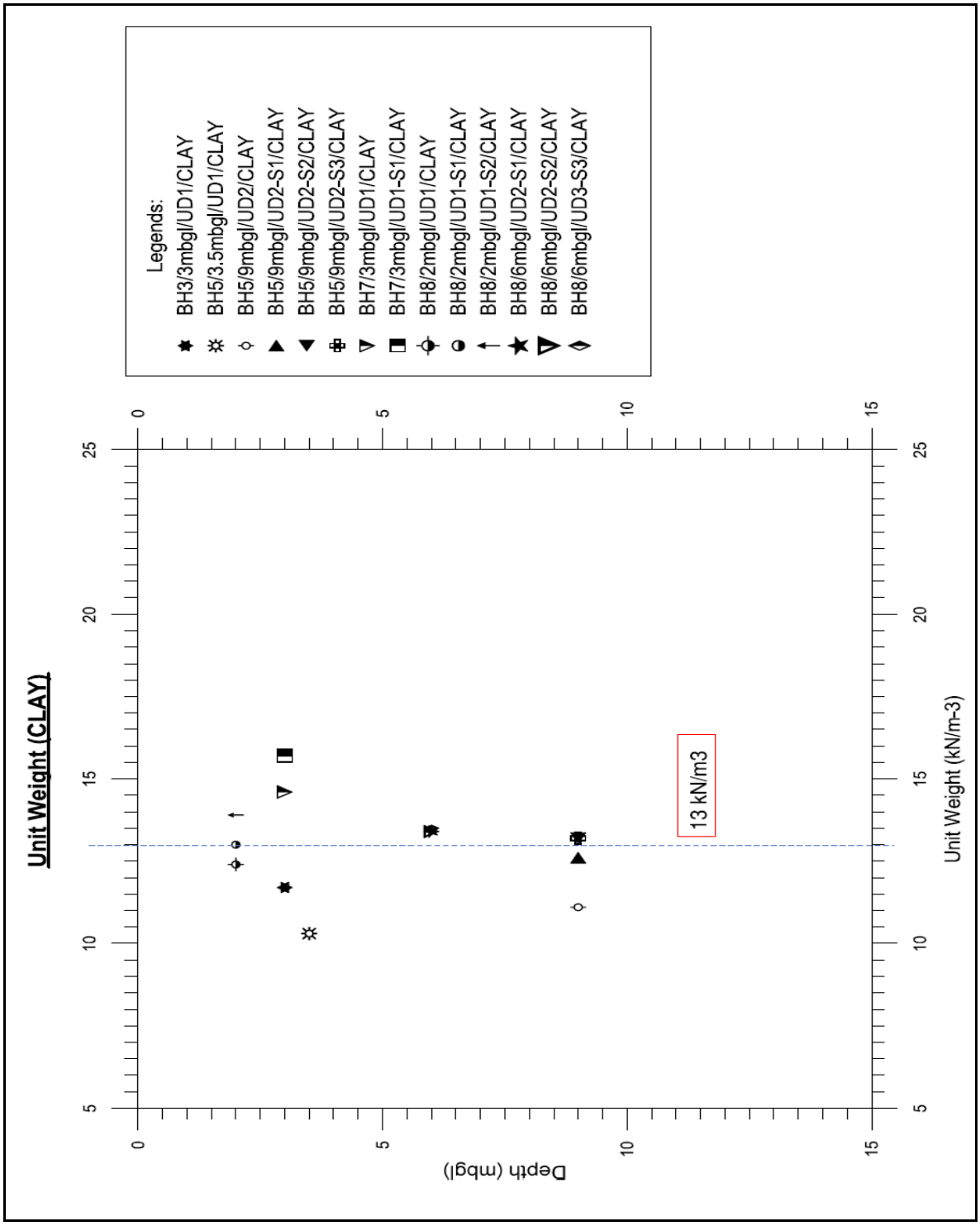
The subsoil is slightly acidic to slightly alkaline in nature with pH value range between 4.4-7.9. The subsoil also contains organic matter with content ranging from 0.1% to 5.6%. Based on Section 6, Clause 41.4.6, BS5930:1999, the subsoil is classified as slightly organic or organic.

Test results show that sulphate content (SO_3) ranges from 0.07% to 0.15% whereas chloride content ranges from 0.08% to 2.7%. The chemical test results for chloride content suggest that the subsoil is aggressive toward construction materials (>0.1% as per BS12:1996) and this has been expected as the influence of seawater and aquatic life have significant effects on the subsoil. As such, appropriate measures due to aggressive subsoil must be taken into consideration as per BRE Special Digest 1:2005 during design stage of building structures.



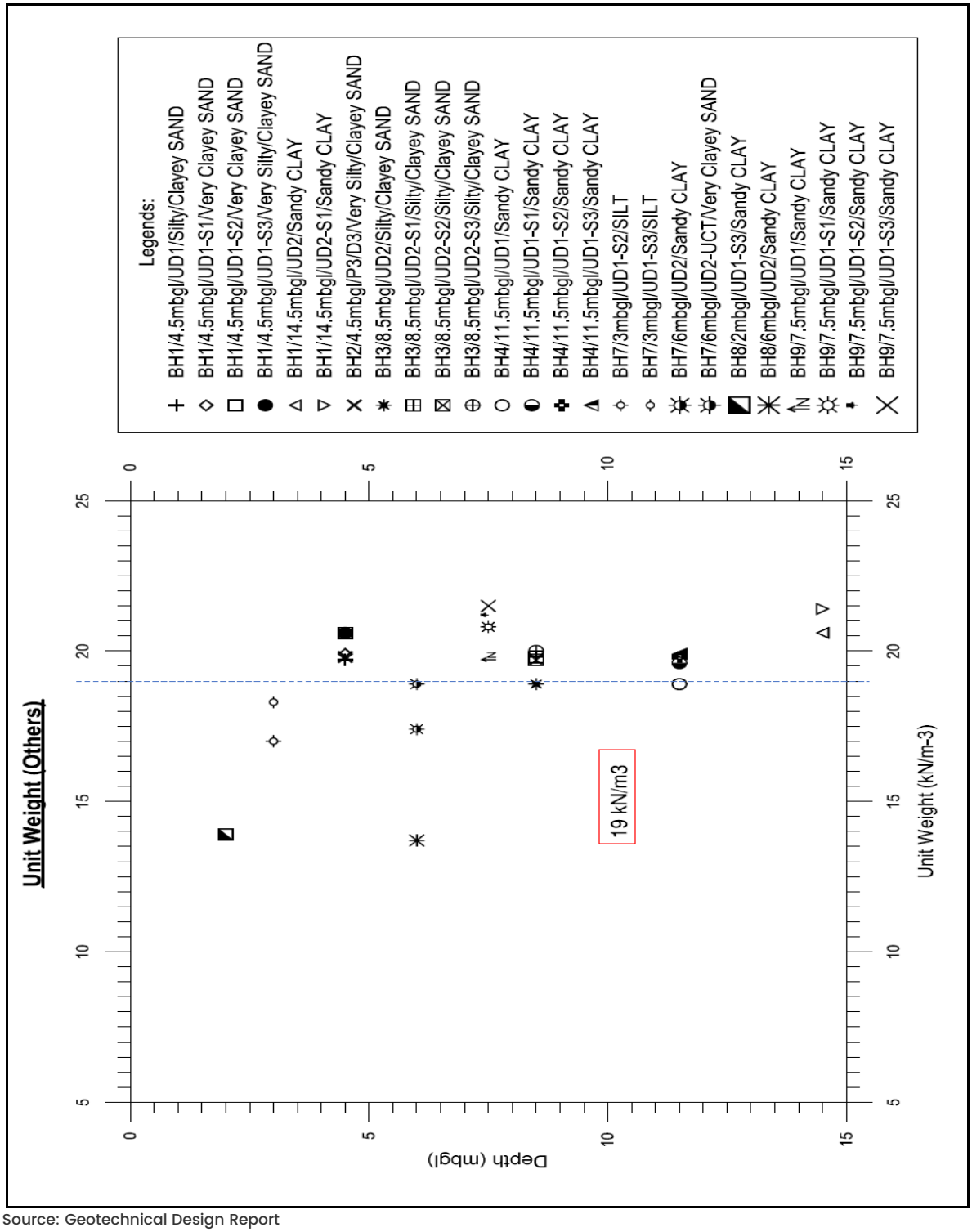
Source: Geotechnical Design Report

Figure 6.13 Unit Weight (Rehabilitation Site)



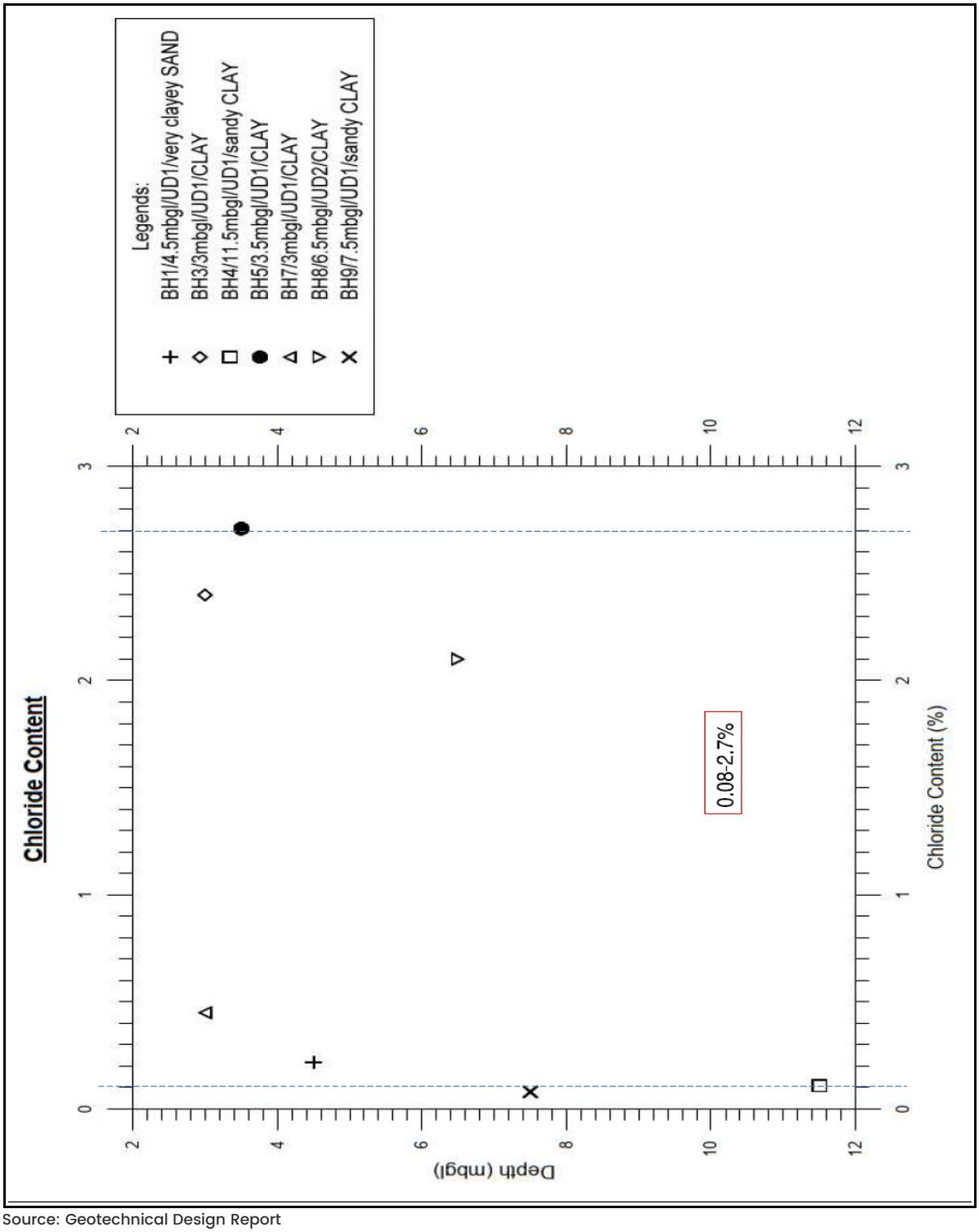
Source: Geotechnical Design Report

Figure 6.14 Unit Weight Of Clay (Reclamation Site)



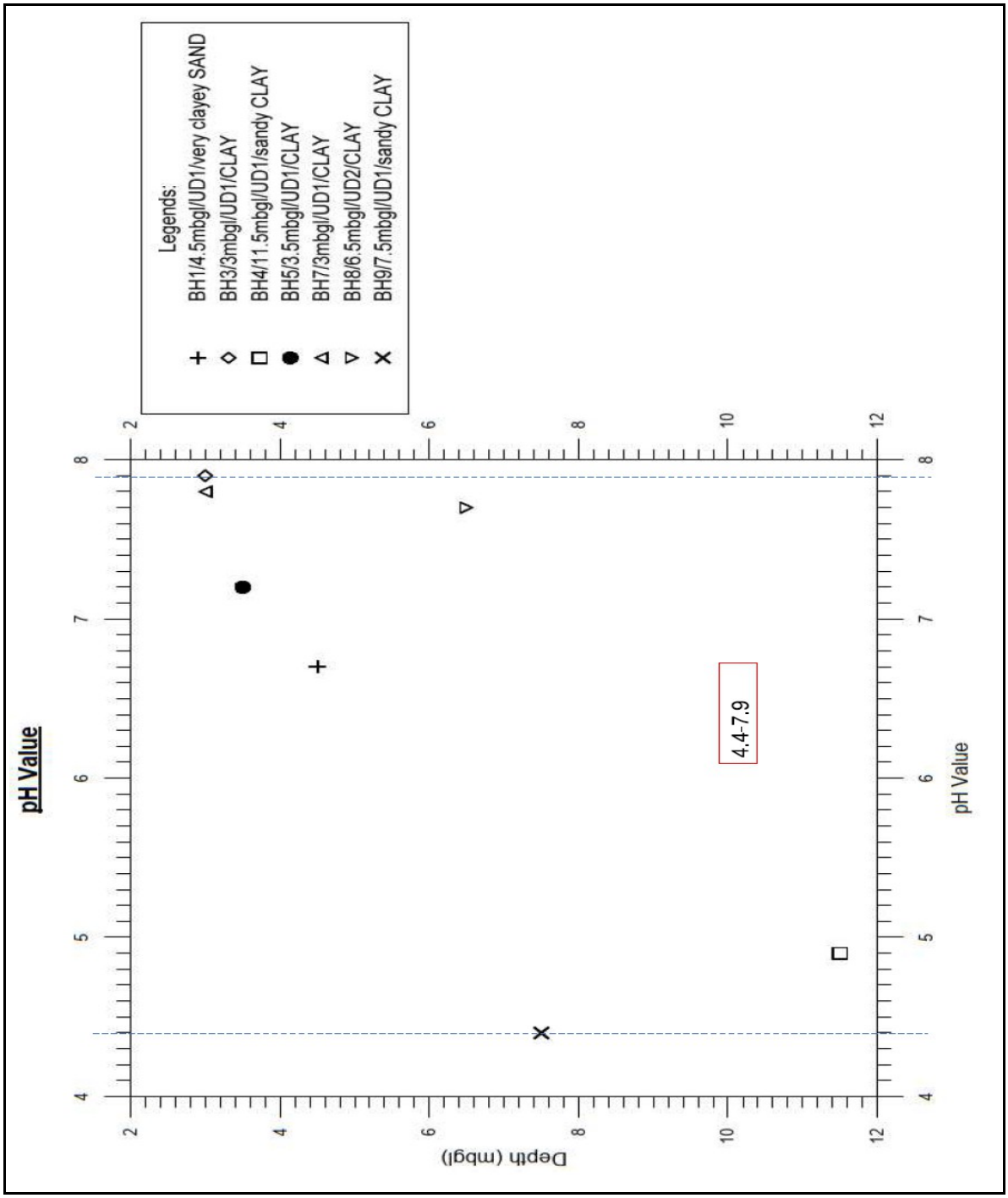
Source: Geotechnical Design Report

Figure 6.15 Unit Weight Of Sand (Reclamation Site)



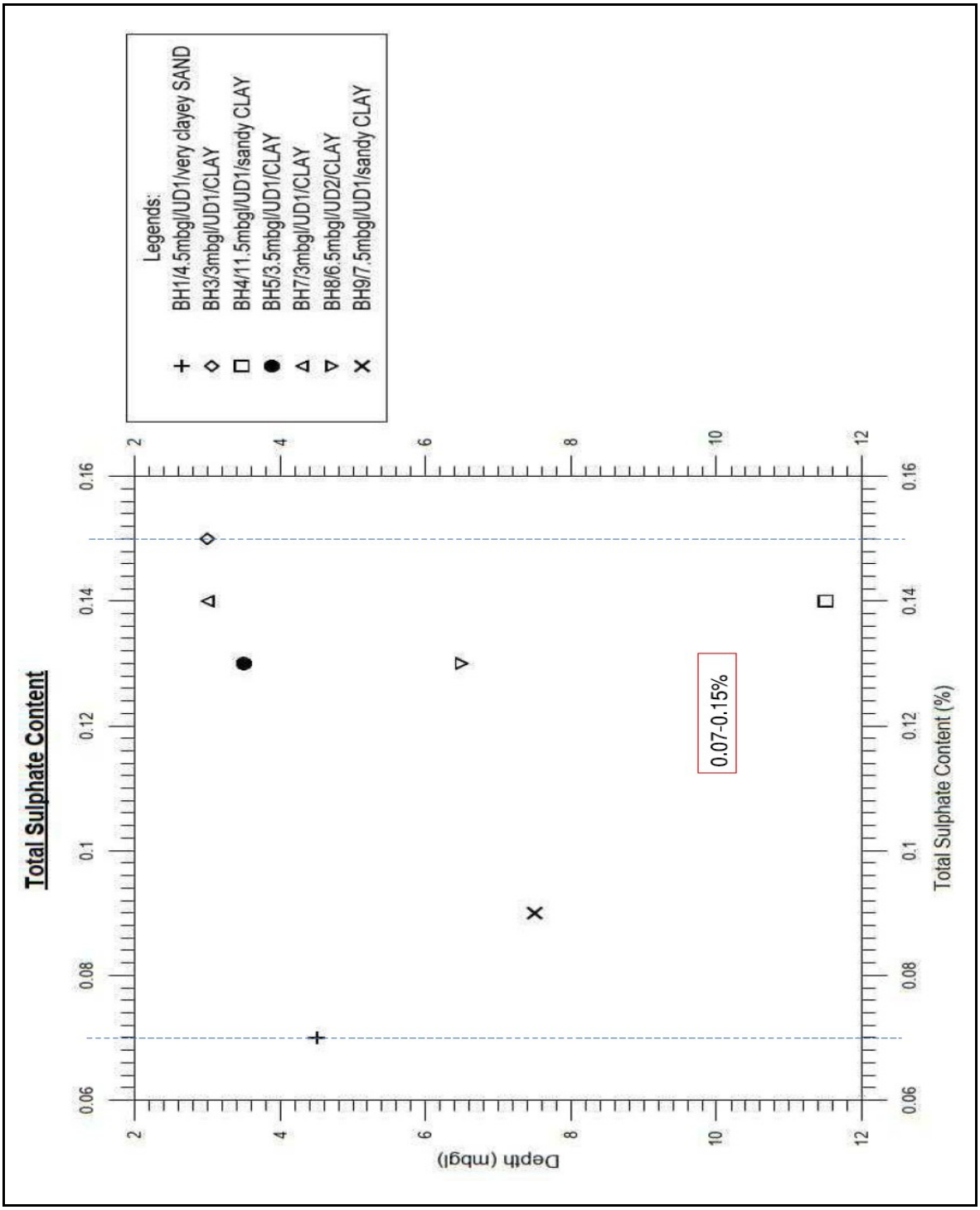
Source: Geotechnical Design Report

Figure 6.16 Chloride Content (Reclamation Site)



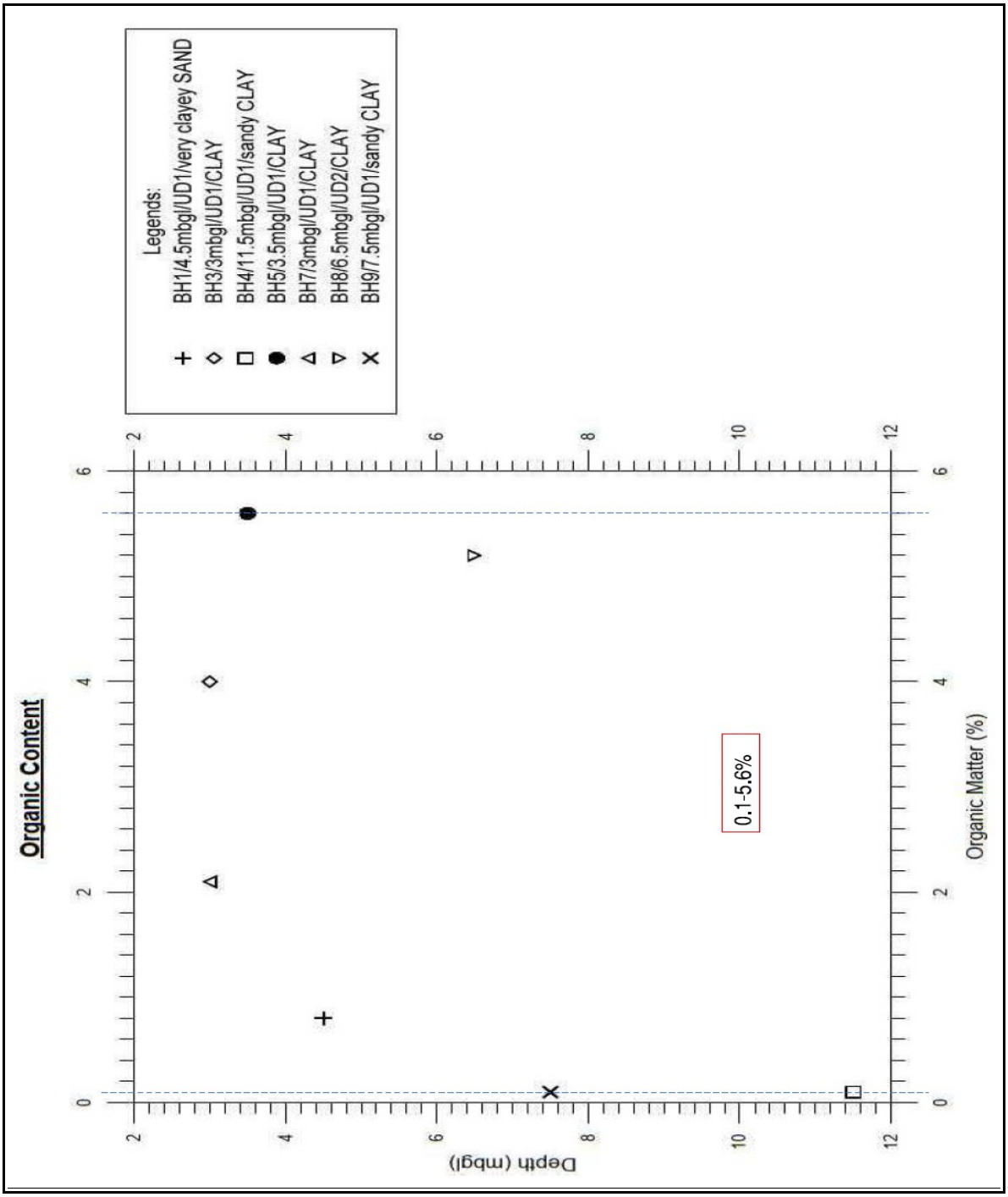
Source: Geotechnical Design Report

Figure 6.17 pH Value (Reclamation Site)



Source: Geotechnical Design Report

Figure 6.18 Total Sulphate Content (Reclamation Site)



Source: Geotechnical Design Report

Figure 6.19 Organic Content (Reclamation Site)

iii. Shear Strength Parameters

Generally, based on numerous SI information for reclamation in Penang, marine subsoil consists of weak cohesive material with low permeability. Hence, undrained shear strength of the subsoil is an important parameter for embankment stability analyses. su values adopted for the proposed reclamation design is based on penetration vane shear test, piezocones, UU (Unconsolidated Undrained) triaxial test) and UCT (Unconfined Compression Test) carried out at site during the SI works. **Figure 6.20** shows the interpreted undrained strength of the subsoil resulting from the above mentioned test, and the SU varies from 6kPa to 20kPa for predominantly clayey materials.

The effective stress shear strength parameters are deruved from the CIU (Consolidated Isotropic Undrained Traixial test) with pore pressure measurement and direct hsear box test. For design purposes, the effective stress friction angle, Ø and effective cohesion, C' of the subsoil are 30^0 and 1kPa respectively for predominantly sandy materials. For the existing dump materials, the effective shear strength parameters adopted are 26° for effective friction angle (f′) and 0kPa for effective cohesion (c'). This is in line with the recommendations stated in Waste Disposal by Landfill by Sarsby, R.W, Institution of Civil Engineers (ICE) Environmental Geotechnics Publishing.

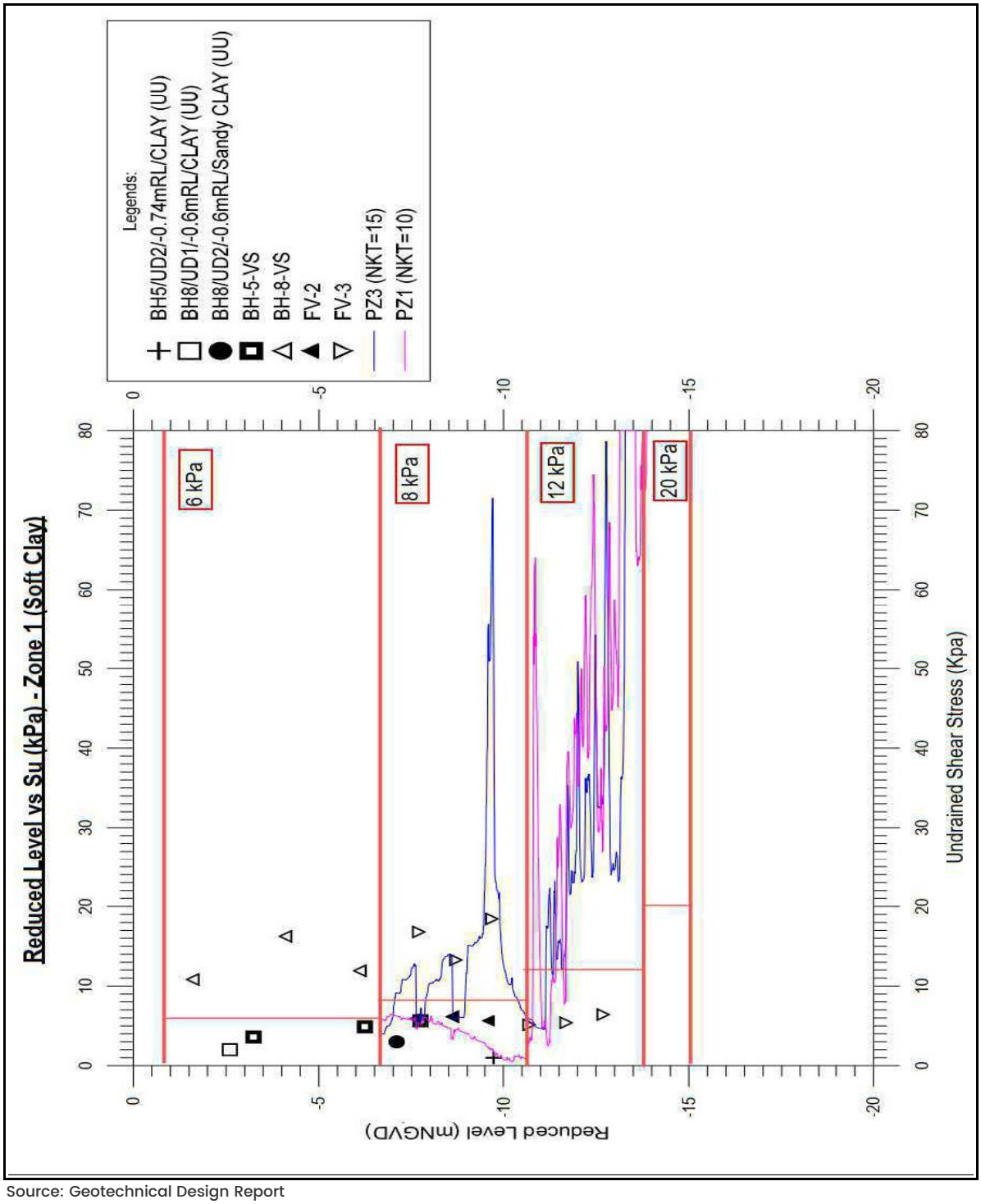
iii. Compressibility Parameters

Generally, subsoil settlement shall be the main geotechnical issue particularly for the proposed reclamation where consolidation of the soft compressible clay layers is expected. Compressibility parameters adopted for the settlement analysis in this report are derived from the 1D (One Dimensional) consolidation test using oedometer.

(ii) Subsurface Characterization using Electrical Resistivity

USAINS Holding Sdn. Bhd. was appointed to carry out subsurface characterization using electrical resistivity method at the Jelutong Landfill. A copy of this report is provided in **Appendix B-010.**

Electrical resistivity survey is often carried out to infer the subsurface condition from the electrical resistivity anomaly obtained from the electrical resistivity measurements. Electrical resistivity methods measure the earth materials resistivity to infer the kind of material beneath the surface. The differences in the earth materials resistivity will be used to identify and infer the different lithology and the hydrogeological condition. In general, huge areas can be covered by using this method.



Source: Geotechnical Design Report

Figure 6.20 Undrained Shear Strength (Reclamation Site)

5 survey alignments suing schlumbergen with max 400 m in length was carried out between 21st to 26th April 2021. each survey's length is based on the maximum allowable area to layout the cable at site. **Figure 6.21** provides the plan view of the 2D ground resistivity investigation area with the survey alignment at the Jelutong Landfill while the **Table 6.5** provides the electrical resistivity survey alignment point.

Table 6.5
Electrical Resistivity Survey Alignment Point

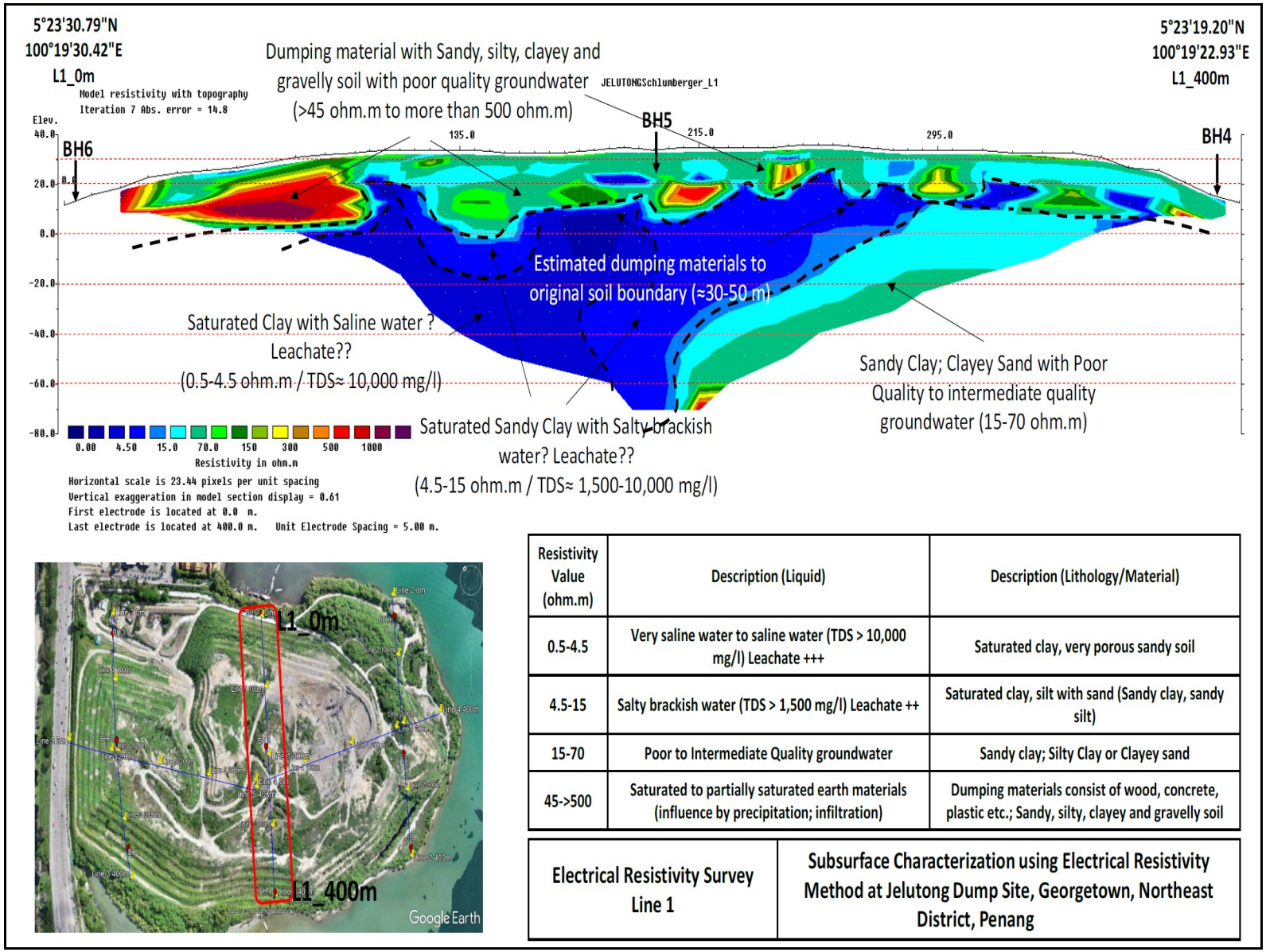
Line	POI	Latitude	Longitude
L1	L1_0m	5°23'30.79"N	100°19'30.42"E
	L1_400m	5°23'19.20"N	100°19'22.93"E
L2	L2_0m	5°23'26.36"N	100°19'30.42"E
	L2_400m	5°23'15.23"N	100°19'31.55"E
L3	L3_0m	5°23'36.86"N	100°19'22.39"E
	L3_400m	5°23'25.68"N	100°19'15.67"E
L4	L4_0m	5°23'19.90"N	100°19'37.41"E
	L4_400m	5°23'24.61"N	100°19'25.30"E
L5	L5_0m	5°23'33.70"N	100°19'16.30"E
	L5_400m	5°23'24.30"N	100°19'25.15"E

Source: Subsurface Characterization Using Electrical Resistivity Method At The Jelutong Dumpsite

Figure 6.22 to Figure 6.26 shows the 2D electrical resistivity image for survey Line 1 to 5. Based on the resistivity surveys carried out the following interpretation has been been suggested based on the resistivity values to earth materials which is highlighted in the earlier mentioned report.

Based on the geophysicist findings, the landfill site can be categorized into 2 distinct layers. The first layer is characterized as the fill layer with the landfill waste materials with thickness varying from 30-50 m in depths. The electrical resistivity of these layers are generally ranging from 45 ohm.m to more than 500 ohm.m with localized very low resistivity values of less than 30 ohm.m. The electrical resistivity values of this zone are strongly influence by the seasonal variation of the monsoon, where groundwater level fluctuation is affected by infiltration from precipitation. The subsequent layer consist of original soil mainly clayey/silty sand or sandy/silty clay with mix of saline seawater and leachate. This finding should be confirmed with borehole drilling with soil chemical/groundwater analysis. As a conclusion, the electrical resistivity results alone without integration with induced polarization methods cannot clearly differentiate/delineate the boundaries or the mix zones between saline seawater intrusion, leachate plume and clay to sand soil.

Figure 6.21 Electrical Resistivity Survey Alignment Point



Resistivity Value (ohm.m)	Description (Liquid)	Description (Lithology/Material)
0.5-4.5	Very saline water to saline water (TDS > 10,000 mg/l) Leachate +++	Saturated clay, very porous sandy soil
4.5-15	Salty brackish water (TDS > 1,500 mg/l) Leachate ++	Saturated clay, silt with sand (Sandy clay, sandy silt)
15-70	Poor to Intermediate Quality groundwater	Sandy clay; Silty Clay or Clayey sand
45->500	Saturated to partially saturated earth materials (influence by precipitation; infiltration)	Dumping materials consist of wood, concrete, plastic etc.; Sandy, silty, clayey and gravelly soil

Electrical Resistivity Survey Line 1	Subsurface Characterization using Electrical Resistivity Method at Jelutong Dump Site, Georgetown, Northeast District, Penang

Figure 6.22 2D Ground Resistivity Result For Line 1 Using Res2DINV Software

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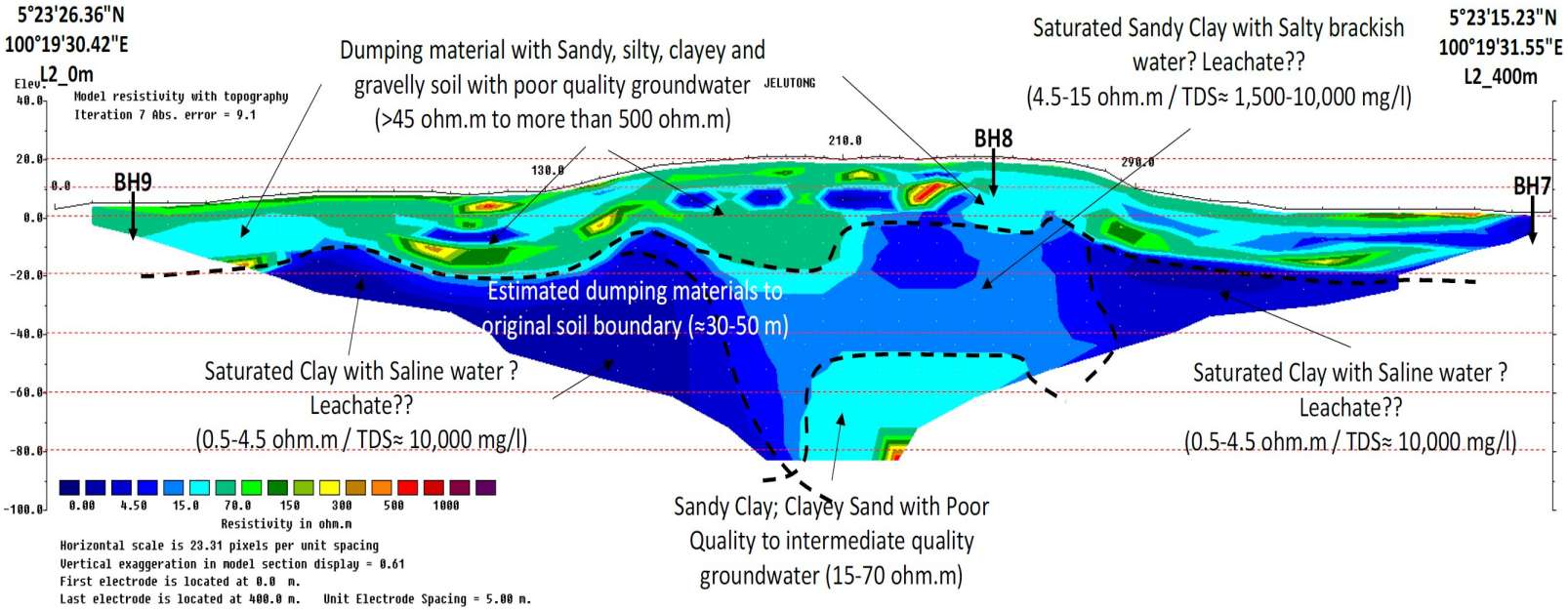
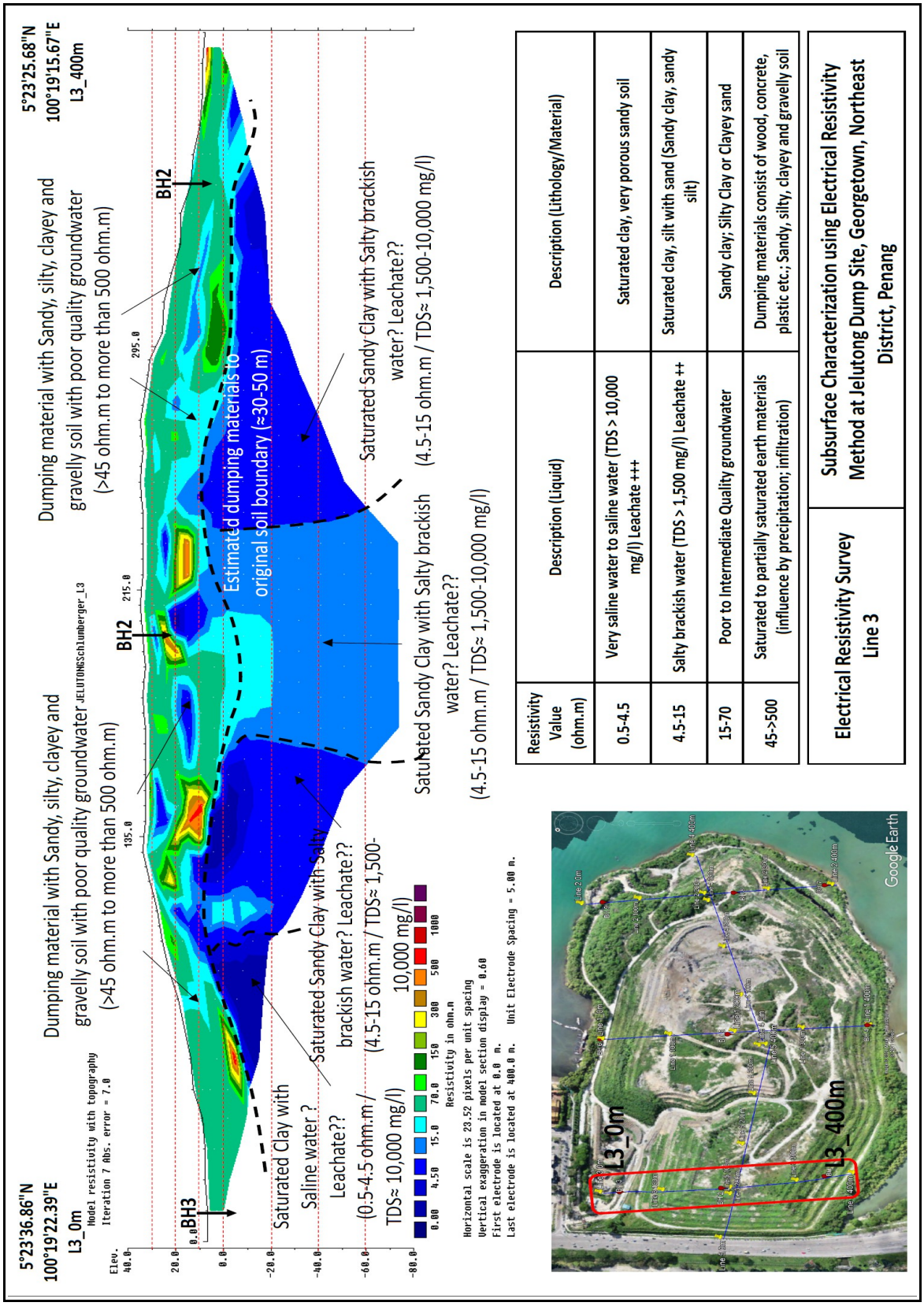
Figure 6.23 2D Ground Resistivity Result For Line 2 Using Res2DINV Software



Resistivity Value (ohm.m)	Description (Liquid)	Description (Lithology/Material)
0.5-4.5	Very saline water to saline water (TDS > 10,000 mg/l) Leachate +++	Saturated clay, very porous sandy soil
4.5-15	Salty brackish water (TDS > 1,500 mg/l) Leachate ++	Saturated clay, silt with sand (Sandy clay, sandy silt)
15-70	Poor to Intermediate Quality groundwater	Sandy clay; Silty Clay or Clayey sand
45->500	Saturated to partially saturated earth materials (influence by precipitation; infiltration)	Dumping materials consist of wood, concrete, plastic etc.; Sandy, silty, clayey and gravelly soil

Electrical Resistivity Survey Line 2	**Subsurface Characterization using Electrical Resistivity Method at Jelutong Dump Site, Georgetown, Northeast District, Penang**



Resistivity Value (ohm.m)	Description (Liquid)	Description (Lithology/Material)
0.5-4.5	Very saline water to saline water (TDS > 10,000 mg/l) Leachate +++	Saturated clay, very porous sandy soil
4.5-15	Salty brackish water (TDS > 1,500 mg/l) Leachate ++	Saturated clay, silt with sand (Sandy clay, sandy silt)
15-70	Poor to Intermediate Quality groundwater	Sandy clay; Silty Clay or Clayey sand
45->500	Saturated to partially saturated earth materials (influence by precipitation; infiltration)	Dumping materials consist of wood, concrete, plastic etc.; Sandy, silty, clayey and gravelly soil

Electrical Resistivity Survey Line 3

Subsurface Characterization using Electrical Resistivity Method at Jelutong Dump Site, Georgetown, Northeast District, Penang

Figure 6.24 2D Ground Resistivity Result For Line 3 Using Res2DINV Software

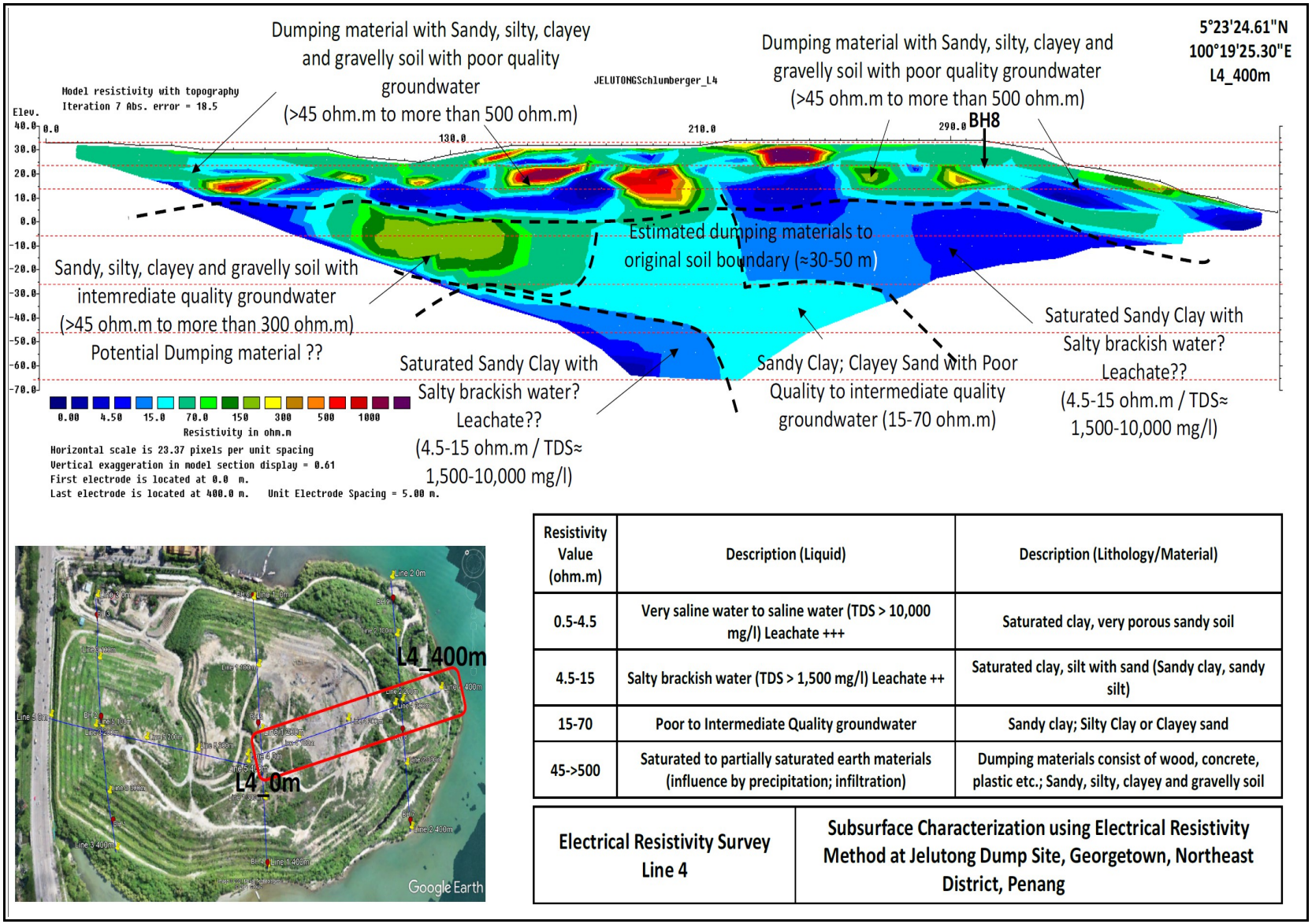


Figure 6.25 2D Ground Resistivity Result For Line 4 Using Res2DINV Software

Resistivity Value (ohm.m)	Description (Liquid)	Description (Lithology/Material)
0.5-4.5	Very saline water to saline water (TDS > 10,000 mg/l) Leachate +++	Saturated clay, very porous sandy soil
4.5-15	Salty brackish water (TDS > 1,500 mg/l) Leachate ++	Saturated clay, silt with sand (Sandy clay, sandy silt)
15-70	Poor to Intermediate Quality groundwater	Sandy clay; Silty Clay or Clayey sand
45->500	Saturated to partially saturated earth materials (influence by precipitation; infiltration)	Dumping materials consist of wood, concrete, plastic etc.; Sandy, silty, clayey and gravelly soil

Electrical Resistivity Survey Line 4	**Subsurface Characterization using Electrical Resistivity Method at Jelutong Dump Site, Georgetown, Northeast District, Penang**

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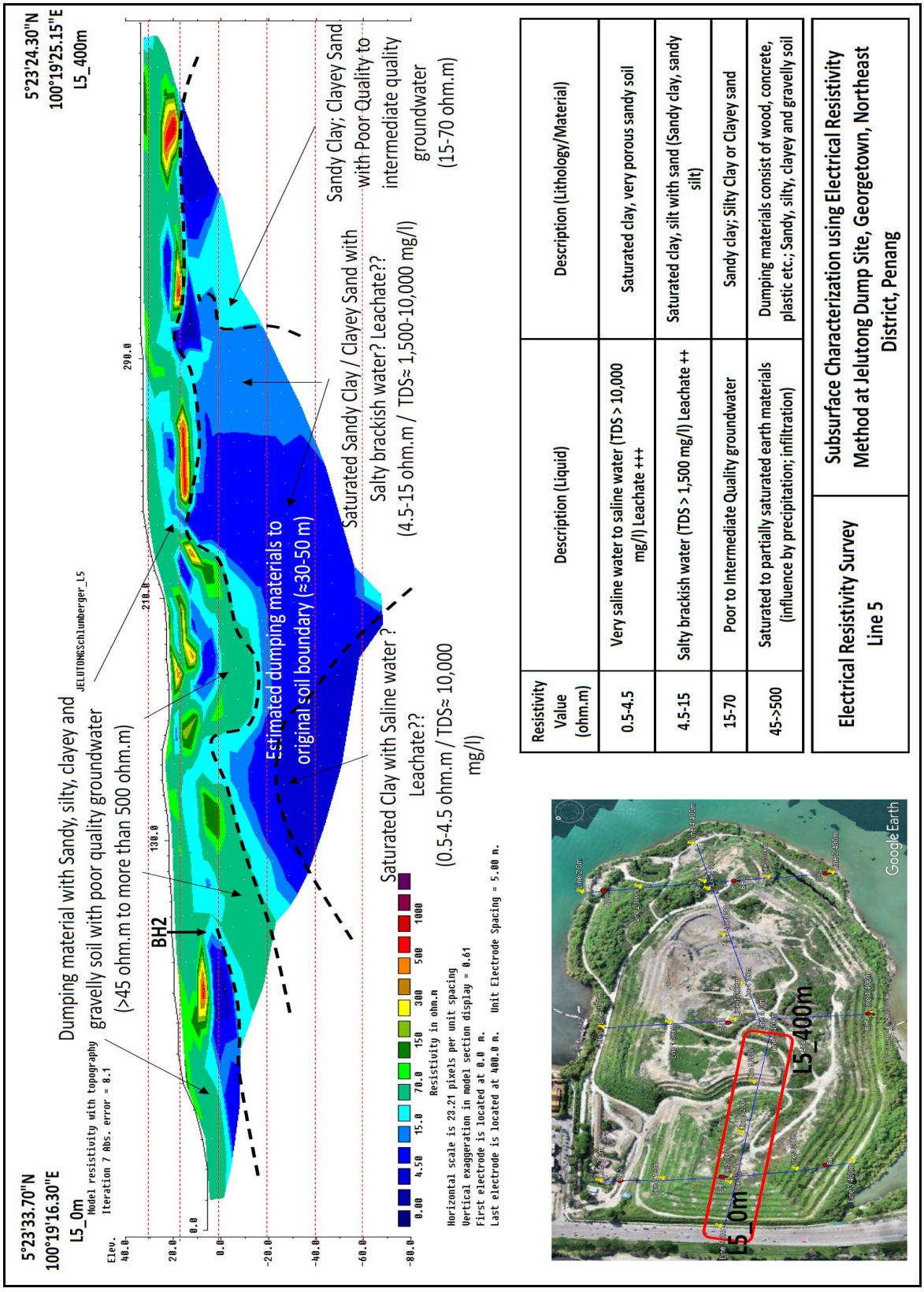


Resistivity Value (ohm.m)	Description (Liquid)	Description (Lithology/Material)
0.5-4.5	Very saline water to saline water (TDS > 10,000 mg/l) Leachate +++	Saturated clay, very porous sandy soil
4.5-15	Salty brackish water (TDS > 1,500 mg/l) Leachate ++	Saturated clay, silt with sand (Sandy clay, sandy silt)
15-70	Poor to Intermediate Quality groundwater	Sandy clay; Silty Clay or Clayey sand
45->500	Saturated to partially saturated earth materials (influence by precipitation; infiltration)	Dumping materials consist of wood, concrete, plastic etc.; Sandy, silty, clayey and gravelly soil

Electrical Resistivity Survey Line 5	Subsurface Characterization using Electrical Resistivity Method at Jelutong Dump Site, Georgetown, Northeast District, Penang

Figure 6.26 2D Ground Resistivity Result For Line 5 Using Res2DINV Software

(ii) Groundwater Table

The standpipe observation well installed in the boreholes (OBH) also measured the groundwater table in the boreholes. **Table 6.6** provides the water level monitoring data in the boreholes at the landfill. According to the borehole logs, the groundwater table ranged from RL+1.16m to RL7.27m.

Table 6.6
Water Level Monitoring Data

Borehole No.	OBH-6		OBH-8		OBH-4		OBH-5		OBH-2	
Reduced Level (RL)	Reduced Level: 6.76 m		Reduced Level: 26.07 m		Reduced Level: 9.43 m		Reduced Level: 35.04 m		Reduced Level: 36.44 m	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Date / Date Installed	01.06.2023		08.06.2023		15.06.2023		03.07.2023		07.07.2023	
29.05.2023										
30.05.2023										
31.05.2023										
02.06.2023	2.36	1.66								
03.06.2023	2.36	1.66								
04.06.2023	2.36	2.36								
05.06.2023	1.66	1.66								
06.06.2023	1.86	1.76								
07.06.2023	1.66	1.66								
08.06.2023	2.41	1.81	1.45	4.87						
09.06.2023	1.86	1.86	3.37	4.37						
10.06.2023	1.86	1.76	5.07	4.37						
11.06.2023	1.86	1.71	4.87	4.17						
12.06.2023	1.86	1.66	5.17	4.17						
13.06.2023	1.81	1.66	5.17	5.17						
14.06.2023	1.66	1.46	5.27	5.17						
15.06.2023	1.66	1.46	6.27	5.12	-9.47	-9.07				
16.06.2023	1.66	1.46	6.17	6.47	-9.47	-9.17				
17.06.2023	1.36	1.76	6.17	6.17	-10.47	-9.17				
18.06.2023	1.36	1.66	6.17	6.17	-10.27	-9.17				
19.06.2023	1.26	1.66	6.17	6.17	-10.27	-9.12				
20.06.2023	1.26	1.76	6.17	6.17	-10.47	-9.07				
21.06.2023	1.26	1.76	6.12	6.27	-10.27	-9.17				
22.06.2023	1.16	1.56	7.17	6.37	-10.27	-9.47				
23.06.2023	1.11	1.56	7.17	6.37	-10.32	-9.77				
24.06.2023	1.26	1.56	7.17	6.37	-10.27	-9.77				
25.06.2023	1.16	1.36	7.17	6.27	-10.37	-9.87				
26.06.2023	1.16	1.46	3.17	5.97	-14.72	-9.87				
27.06.2023	1.16	1.46	3.17	4.17	-15.22	-8.97				
28.06.2023	1.21	1.36	3.22	4.47	-10.97	-10.02				
29.06.2023	1.66	1.36	3.17	4.37	-11.07	-10.07				
30.06.2023	1.66	1.51	4.77	5.37	-11.27	-9.87				
01.07.2023	1.66	1.51	5.27	5.37	-11.07	-10.37				
02.07.2023	1.56	1.46	5.17	6.17	-10.67	-10.47				
03.07.2023	1.56	1.46	6.17	6.27	-10.47	-10.17	18.64	18.84		
04.07.2023	1.56	1.46	6.37	6.37	-10.27	-10.27	18.74	18.88		
05.07.2023	1.26	1.41	6.47	6.97	-10.07	-10.17	18.74	18.94		
06.07.2023	1.31	1.36	7.18	6.17	-10.27	-10.37	18.56	18.94		
07.07.2023	1.26	1.36	7.27	7.17	-10.27	-10.47	18.64	18.84	28.64	28.15

Source: SI Report, September 2023

(iii) Seismic Condition

The history of earthquake event in Malaysia is not well documented due to lack of recorded data, clear guidelines on adopted PGA (Peak Ground Acceleration) is not officially available. However, based on seismic hazard map produced by USGS in April 2008 as shown in **Figure 6.27** (based on the far field seismic impact), the anticipated PGA for project site shall be in the order of 4% to 5% of gravitational acceleration. In addition, the design of Penang 2nd Bridge (Sultan Abdul Halim Muadzam Shah Bridge) has considered PGA of 5.55%. Thus, a PGA value of 5.55% has been adopted in the seismic sensitivity assessment of reclaimed platform stability.

With seismic load considered, the reclaimed platform shall achieve a minimum FOS of 1.2 as suggested by NAVFAC (Naval Facilities Engineering Command) SM 7.01, 1986 for embankment subjected to transient loads, such as earthquake. Results from the stabuility analyses show that the minimum FOS (Factor Of Safety) is achieved for each construction stage and serviceability stage.

D. Surface Drainage

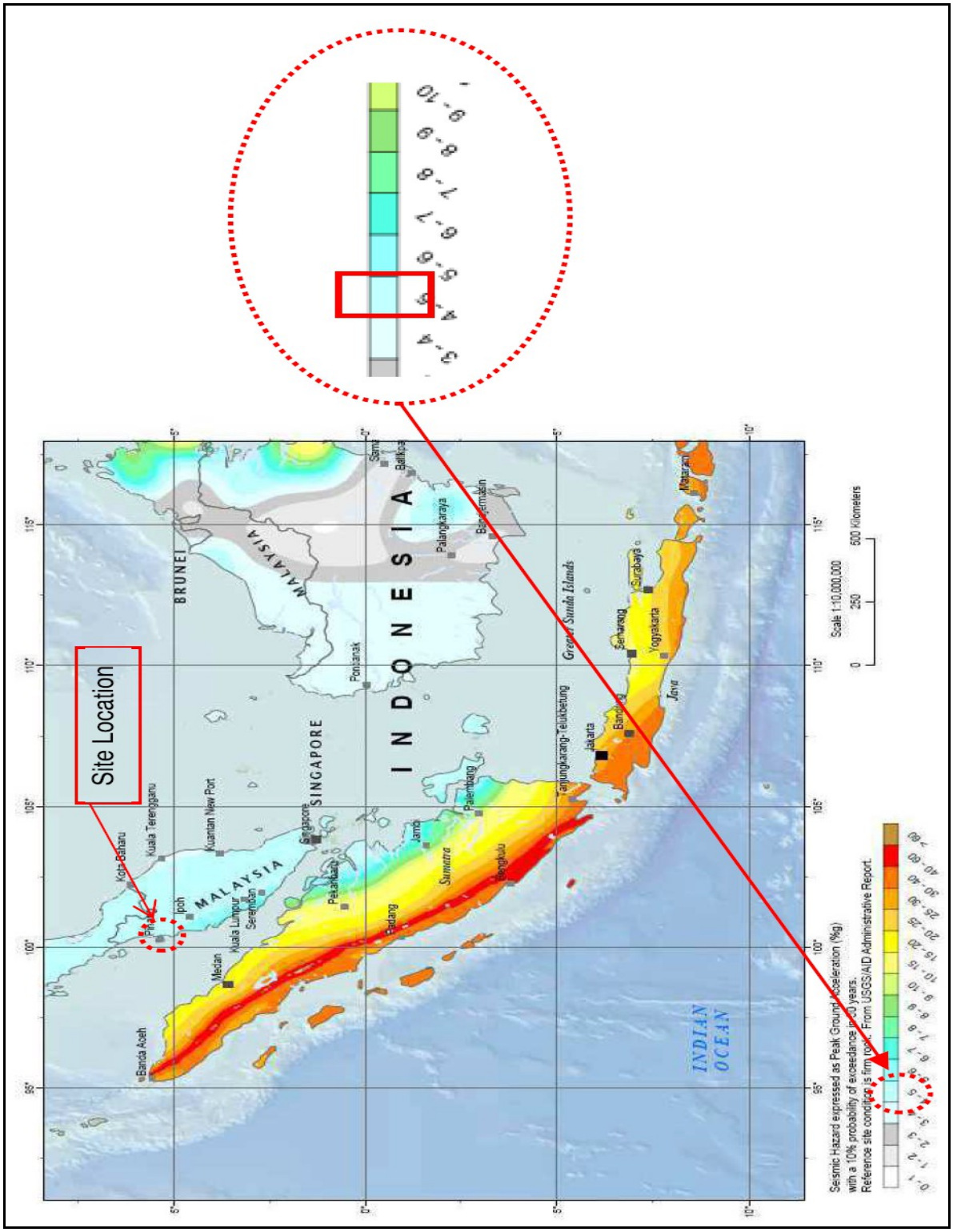
There are no streams at site on the Jelutong Landfill. The existing landmass adjacent to the Proposed Project site is within the Sungai Pinang river basin. Existing drainage in the vicinity as shown in **Figure 6.28**. A monsoon drain drains the area adjacent to the Proposed Project.

E. Coastal Morphology

The project site including the proposed reclamation area is located at the middle banks of Penang island which is about 2 km north of the Penang Bridge. The reclamation site will extend 820m seaward of the existing coastline.

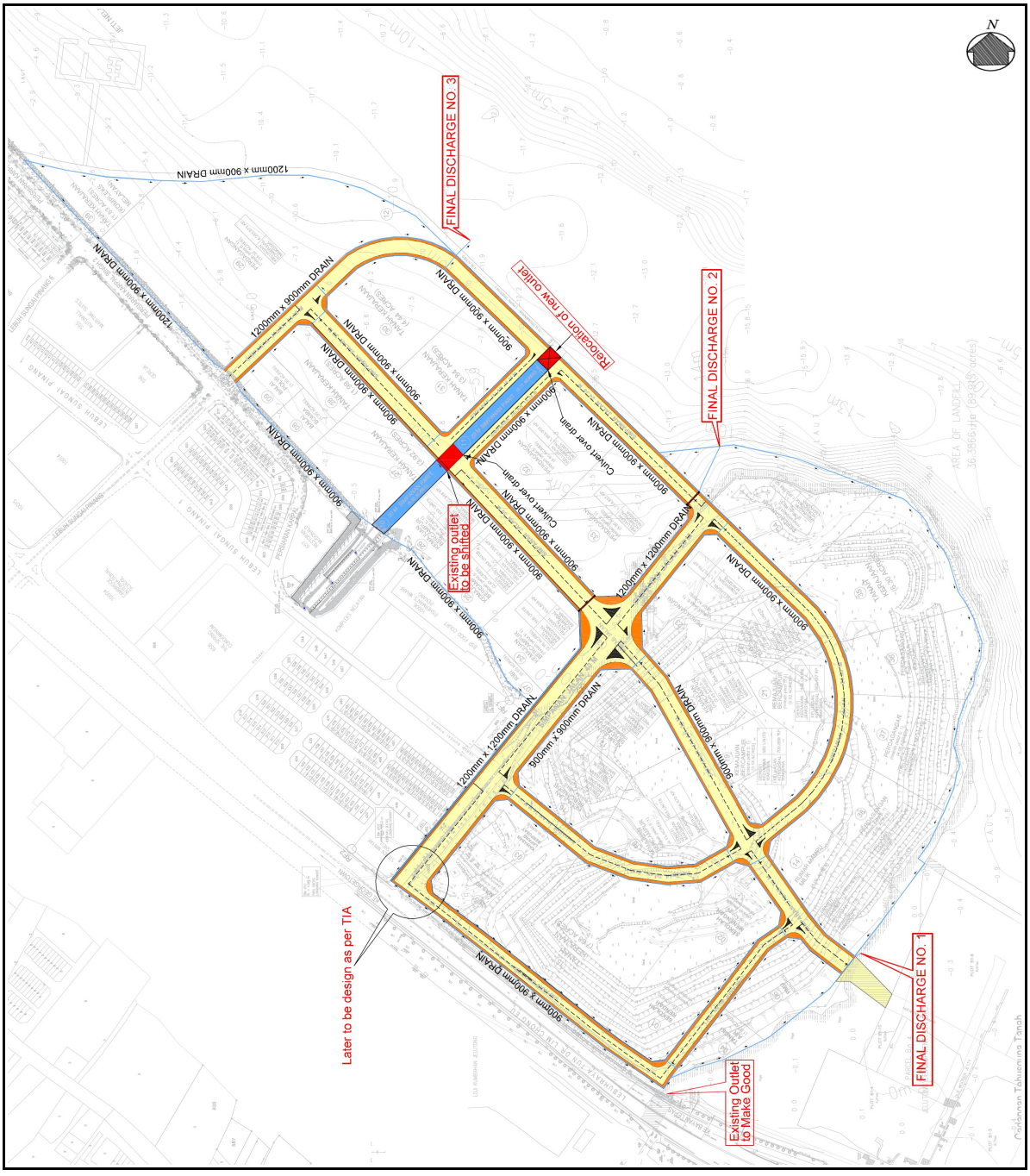
The coastline of the project site is characterized with a mixture of a narrow sandy/silty beach and tidal flats. The coastline both to the north and south of the Proposed Project site are protected by revetments. The coastline appears to be stable with little signs of either erosion or accretion as the water at this area is well sheltered from the offshore swells.

As the coastline of the existing landmass of the Proposed Project site is facing out directly into the sea of Penang Straits it is mainly affected by marine influences, such as tides, waves and the influx of saline water. The Proposed Project site is sheltered as it is located between Peninsular Malaysia and Penang island and thus the water at this area is relatively calm and the current velocity in this area is low.



Source: Geotechnical Design Report

Figure 6.27 Seismic Hazards Map



Not To Scale

Figure 6.28 Surface Drainage In The Vicinity

(i) Water Level and Tidal Range

Tides level at Kedah Pier Standard Port is adopted for the project area. The tidal levels are extracted from the Coastal Hydraulic Report based on the Royal Malaysian Navy Tide Table and shown in **Table 6.7**.

Table 6.7
Tide Level At Kedah Pier

Tidal Level	Chart Datum Level (CDm)	National Geodatic Vertical Datum Level (NGVDm)
Highest Astronomical Tide (HAT)	3.09	1.53
Mean High Water Spring (MHWS)	2.69	1.13
Mean High Water Neap (MHWN)	1.96	0.40
Mean Sea Level (MSL)	1.71	0.15
Mean Low Water Neap (MLWN)	1.45	-0.11
Mean Low Water Spring (MLWS)	0.72	-0.84
Lowest Astronomical Tide (LAT)	0.0	-1.56

Source : Coastal Hydraulic Report, G&P Water and Maritime

Due to the influence of tidal effects in the open sea (near-shore and off-shore), seawater level can vary considerably. As such, it is important to be aware of the seawater levels under the influence of tidal effects. **Table 6.8** summarises the above mentioned tidal levels at Standard Port at Kedah Pier, Penang.

Table 6.8
Tidal Chart

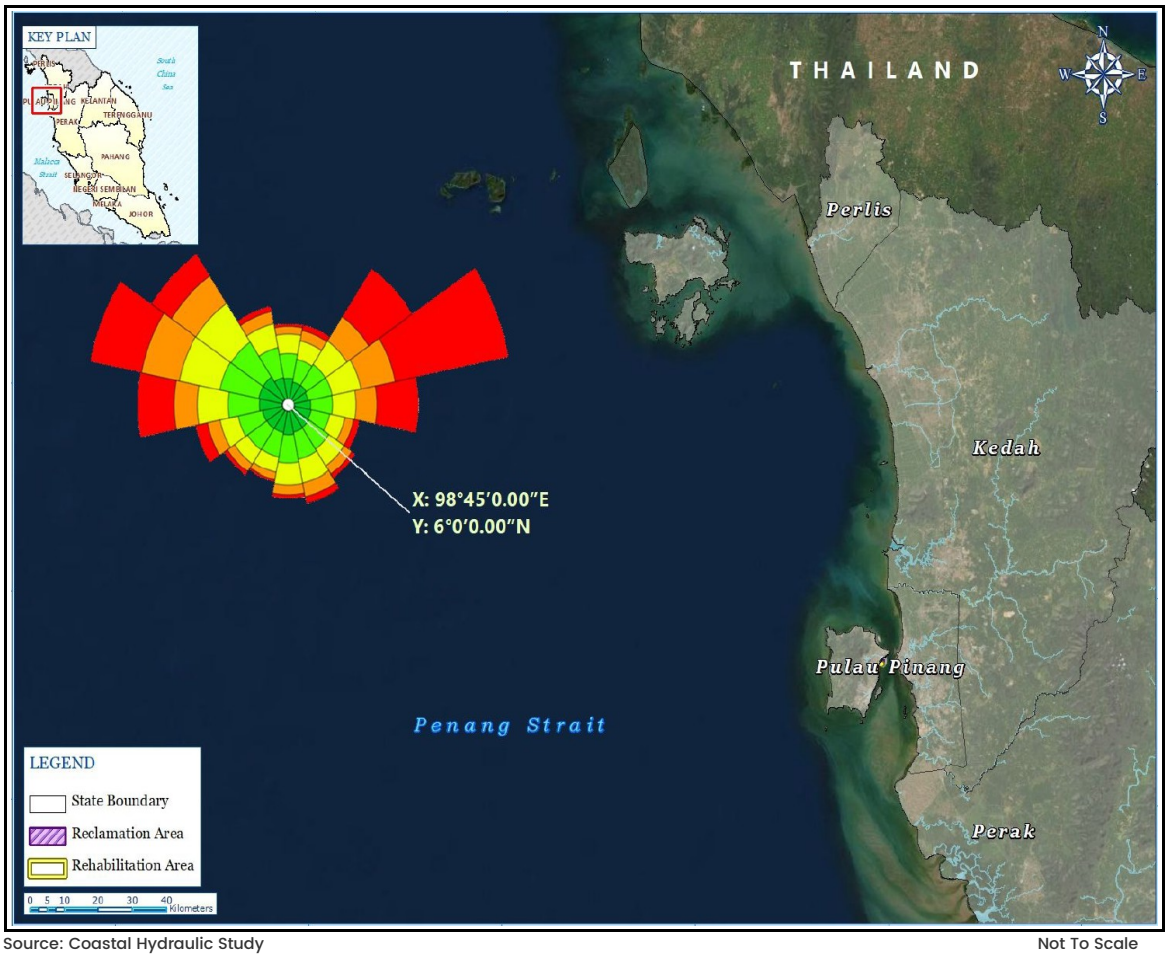
Tides	Chart Datum Level (CDm)	National Geodetic Vertical Datum Level (NGVDm)
Lowest Astronomical Tide (LAT)	0.00	-1.56
Mean Low Water Spring (MLWS)	0.72	-0.84
Mean Low water Neap (MLWN)	1.45	-0.11
Mean Sea Level (MSL)	1.71	0.15
Mean High water Neap (MHWN)	1.96	0.40
Mean High Water Spring (MHWS)	2.69	1.13
Highest Astronomical Tide (HAT)	3.09	1.53
Proposed Platform Level	5.91	4.35

Source : Geotechnical Design Report
Note: Tidal levels above are referenced to the Standard Port at Kedah Pier, Penang

According to the Tidal Tables Malaysia 2018, Volume 1 published by the National Hydrographic Centre, Royal Malaysian Navy and the Bathymetric Survey of the proposed site dated July 2020, the seawater level at the outermost region of the proposed reclamation is estimated to range from 9m to 13m above the seabed (based on Mean High Water Spring – MHWS at +1.13m NGVD).

(ii) Offshore Wind And Wave

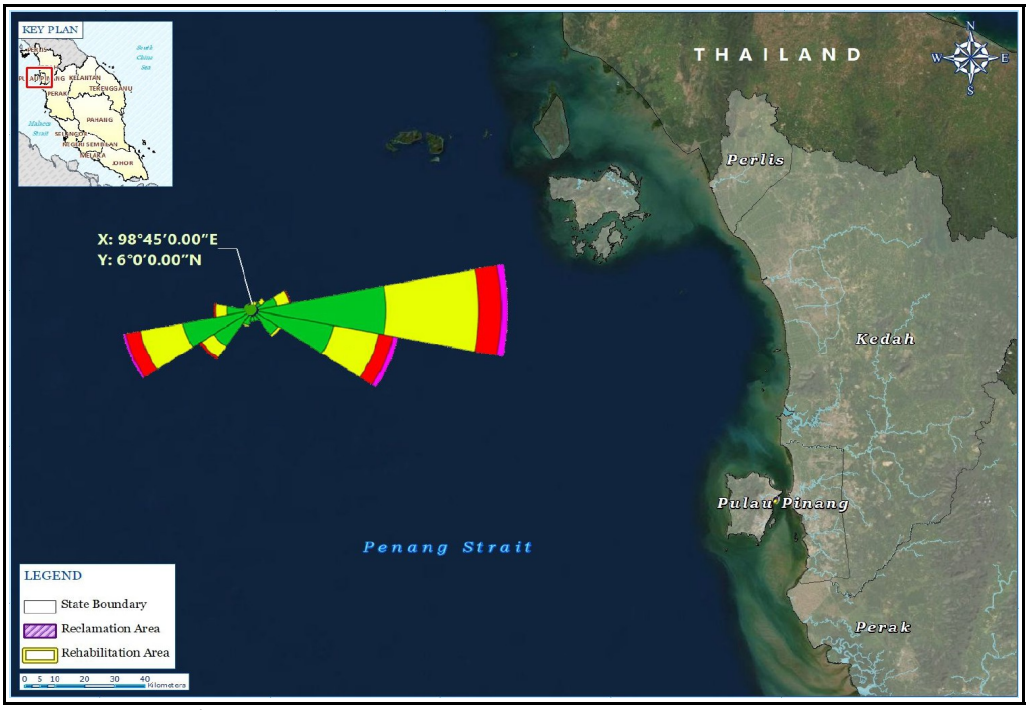
An offshore metocean station has been introduced for extraction of long-term hindcasted wind and wave data. Offshore wind and wave data within the northern part of Malacca Straits has been sourced from a global wind and wave data hindcasted model by BMT ARGOSS with a resolution of 1.25° (latitude) x 1° (longitude) located at 6°N and 98.75°E approximately 190 km northwest of the project area. The model is forced by the wind fields from the global numerical weather prediction model of NCEP (National Centre of Environmental Prediction) GFS Numerical Weather Prediction Model. This global hindcast provides 3-hourly time series of wave spectra covering a period of about 21 years (from the year 1992 to June 2013, inclusive). The hindcast wind and wave data are subjected to routine validation/ recalibration. Overview of the wind and wave rose and its location are shown in **Figure 6.29 and Figure 6.30.**



Source: Coastal Hydraulic Study

Not To Scale

Figure 6.29 Offshore Wind Rose (BMT) at (6°N, 98.75°E).



Source: Coastal Hydraulic Study

Not To Scale

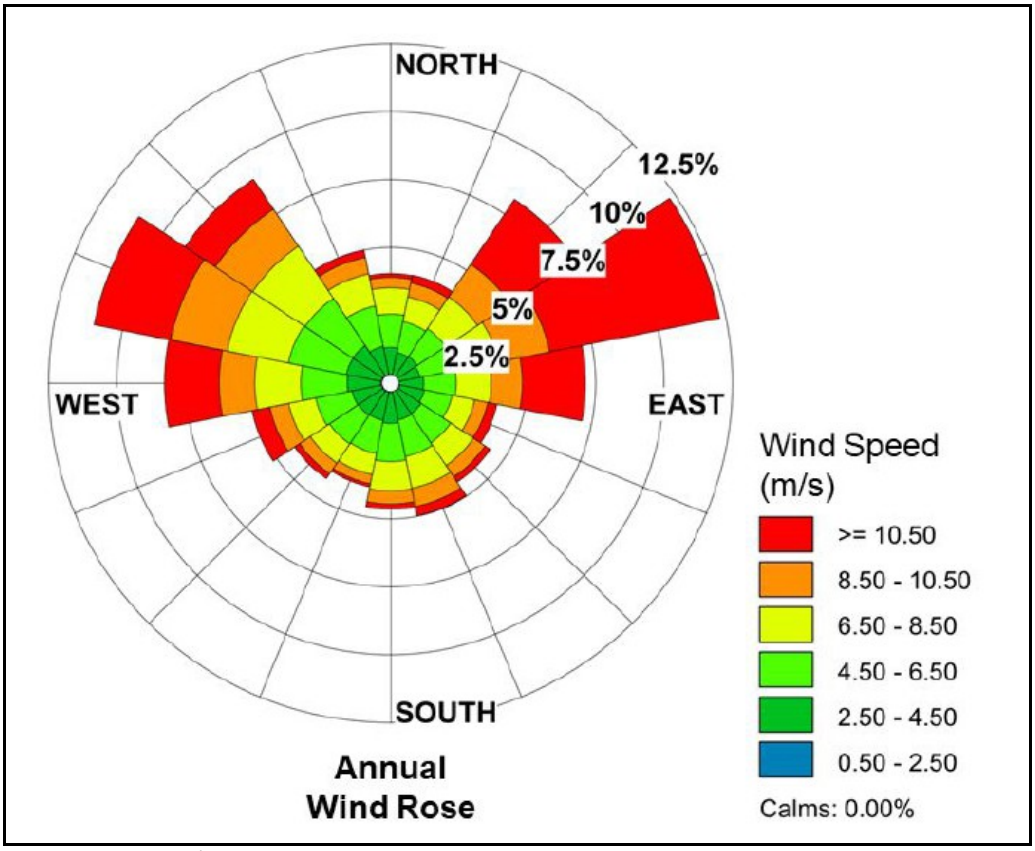
Figure 6.30 Offshore Wave Rose (BMT) At (6°N, 98.75°E). Direction Read As "Going To".

The climate pattern over Malaysia is governed by pressure system developed over the large landmass of the Asian and Australian Continents. A high-pressure system develops over the continents in the winter hemisphere while a low-pressure system develops over the continents in the summer hemisphere. Combined with the equatorial pressure, this drives the monsoon offshore winds that prevail over the region throughout long periods of the year. The NE (Northeast) monsoon season is from November to March and the SW (Southwest) monsoon is from May to September, whereas Intermonsoon period which described the transition between the NE and SW monsoons is often expected to take place independently in A pril and October. These monsoon seasons greatly influence the regional wind and wave climates of the country as deliberated in the following sections.

(a) Wind Climate

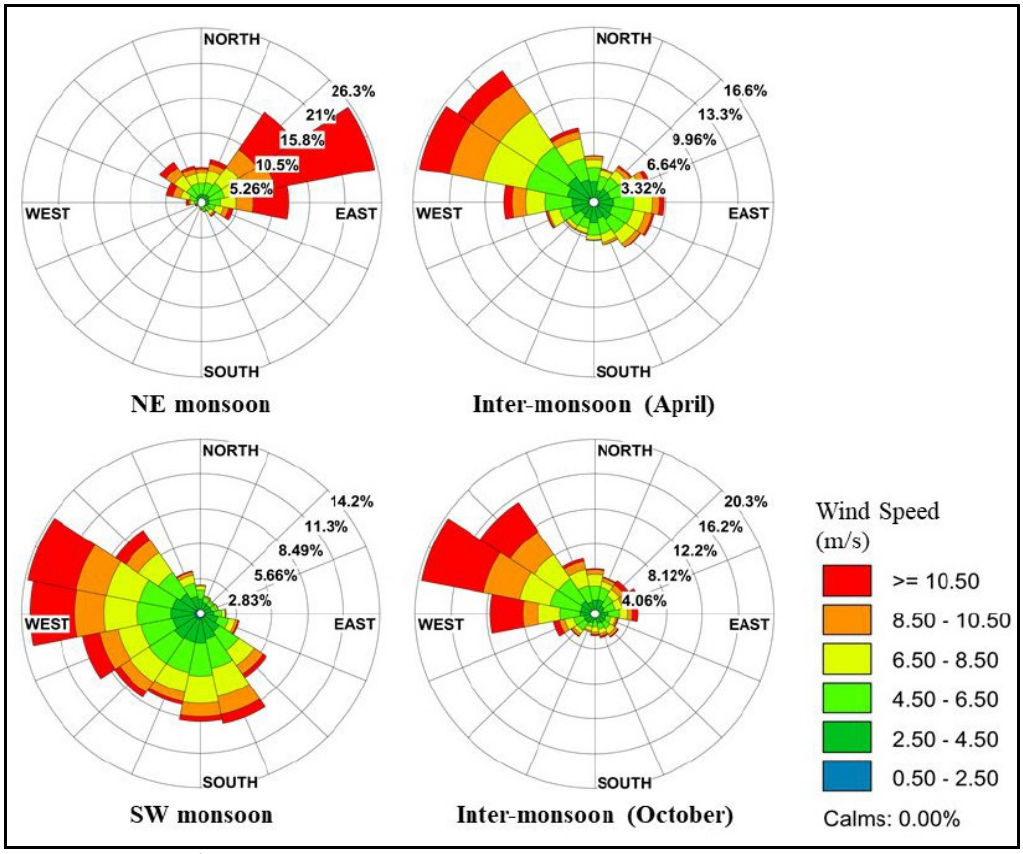
Figure 6.31 shows an overview of the annual wind trend at the offshore of northern Malacca Strait. Additionally, the annual offshore wind speed distribution for data covering from the year 1992 to 2013 as tabulated in **Table 6.9**. In the Strait of Malacca, the meteorological conditions are also governed by the NE and SW monsoon seasons, however the wind conditions are slightly different than in other areas due to lands effects which redirects the wind direction in the Strait. Thus, based on the hindcast offshore wind data, the following findings are deduced:-

- The annual wind rose diagram shown in **Figure 6.32** indicates that the wind blows from northwesterly and north-easterly;
- The annual occurrence of wind speed in the range of 2.5 m/s to 8.5 m/s was about 60% as described in **Table 6.9;**
- During NE monsoon season, prevailing wind was observed blowing north-easterly with annual frequency of about 55% with dominant wind class was in the range >= 10.5 m/s;
- During SW monsoon season, wind dominantly blowing north-westerly with yearly occurrence of about 27.34%, with dominant wind class during this monsoon phase was within the range of 2.5 m/s to 8.5 m/s;
- During the April inter-monsoon season, the wind generally blows north-westerly with dominant with wind class range of 2.5 m/s to 8.5 m/s;
- The prevailing wind blowing is observed from the same direction as in April inter-monsoon with the wind class range of 4.5 m/s to >= 10.5 m/s.



Source: Coastal Hydraulic Study

Figure 6.31 Detailed Annual Wind Rose Plot At The Offshore Of Northern Malacca Strait. Direction Read As "Coming From".



Source: Coastal Hydraulic Study

Figure 6.32 Wind Rose For Every Monsoon Seasons. Direction Read As "Coming From".

Table 6.9

Offshore Wind Speed Annual Distribution For Data Covering The Period From Year 1992 To 2013

Direction (°)	Wind Speed (m/s)						
	0.5 - 2.5	2.5 - 4.5	4.5 - 6.5	6.5 - 8.5	8.5 - 10.5	>= 10.5	Total (%)
348.75 - 11.25	0.30	1.02	1.23	0.96	0.38	0.14	4.03
11.25 - 33.75	0.29	0.87	1.15	0.93	0.52	0.29	4.05
33.75 - 56.25	0.30	0.88	1.24	1.40	1.44	2.87	8.13
56.25 - 78.75	0.28	0.82	1.33	1.59	1.90	6.32	12.24
78.75 - 101.25	0.32	0.89	1.19	1.27	1.14	2.30	7.11
101.25 - 123.75	0.35	0.91	1.03	0.84	0.48	0.34	3.96
123.75 - 146.25	0.33	1.02	1.29	1.00	0.51	0.23	4.37
146.25 - 168.75	0.29	1.09	1.37	1.19	0.69	0.35	4.97
168.75 - 191.25	0.34	1.14	1.40	1.07	0.48	0.18	4.62
191.25 - 213.75	0.33	1.06	1.24	0.79	0.34	0.11	3.88
213.75 - 236.25	0.36	1.06	1.26	0.85	0.47	0.22	4.21
236.25 - 258.75	0.34	1.09	1.35	1.00	0.70	0.66	5.15
258.75 - 281.25	0.35	1.23	1.70	1.67	1.30	2.00	8.25
281.25 - 303.75	0.35	1.29	2.16	2.28	2.10	2.85	11.03
303.75 - 326.25	0.34	1.32	2.09	2.30	1.64	1.33	9.01
326.25 - 348.75	0.32	1.06	1.51	1.20	0.62	0.28	4.99
Sub-Total	5.18	16.76	22.54	20.35	14.70	20.48	100.00
Calms							0.00
Total							100.00

Source: Coastal Hydraulic Study

The monsoon winds are generally not as strong in comparison to storm winds. However, during the monsoon seasons, especially over the open sea areas, the winds are proven to be quite consistent over the long period of time. This reflected in the wave climate, surface currents and variation in the mean sea level due to very large-scale wind set up.

(b) Wave Climate

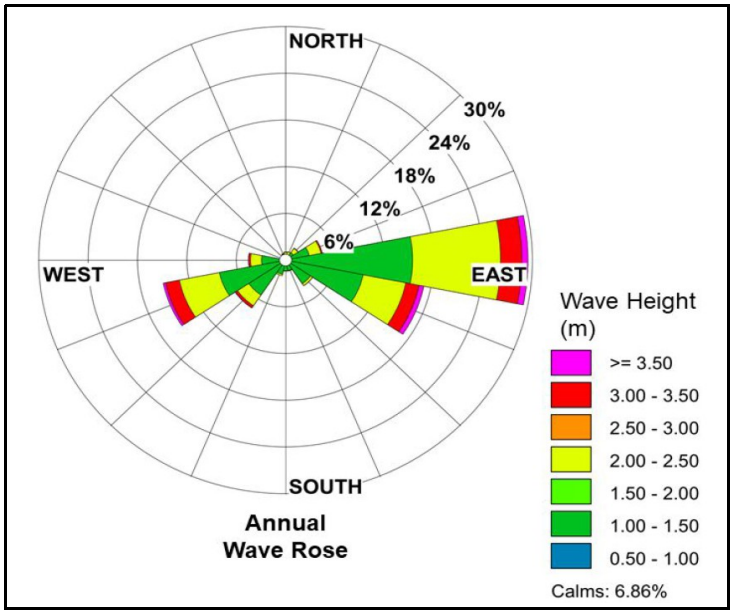
Ocean wave is generally generated by the shearing action of wind stress over the sea surface. Various factors which influence the wave magnitude and one of it related to the wind condition (i.e., speed, duration and fetch length). The wave climate off Penang Island is composed of locally generated wind waves and swells waves approaching Straits from the Indian Ocean and the Andaman Sea. The annual wave rose in **Figure 6.33** represents the wave resulting/combined wave conditions taking into account the sea and swell waves.

As no long-term wave data is found available at Penang area, thus, wave modelling has been conducted to determine wave conditions along Penang coast.

The Proposed Project area is located nearshore of the Penang Strait; therefore, it is protected against wave action. Very limited wave energy will be able to reach the Penang Strait and will have minimal impacts on the coastlines.

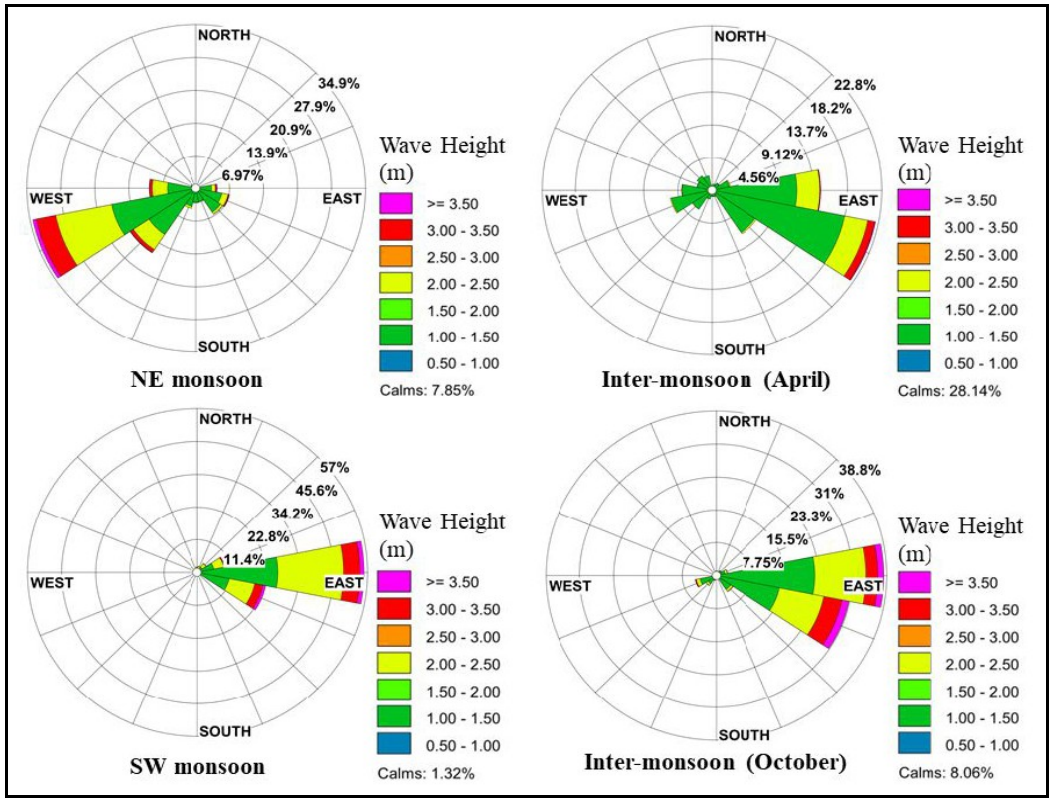
The key findings from the evaluated annual and seasonal wave climate as follow:-

- Annual wave rose diagram show in **Figure 6.34** indicates that the wave propagates mainly towards east quadrants;
- Annually, about 57% of the times the wave height was within 1.0 m to 1.5 m, with 6.9% of calm condition (i.e., the wave height below 0.1 m) as shown in **Table 6.10;**
- During NE monsoon period, the wave predominantly travels towards south-westerly corresponding to the dominant wind direction coming from northeast quadrant. The most common wave height observed during NE monsoon was in the class of 1 m to 1.5 m;
- During the SW monsoon season, the wave height travel to the east with the wave height in the class of 1.0 m to 1.5 m; and
- During April inter-monsoon period, the wave travels south-easterly with generally the wave height in the class of 1.0 m to 1.5 m. Same range and direction for wave height is observed during October inter-monsoon.



Source: Coastal Hydraulic Study Not To Scale

Figure 6.33 Detailed Annual Wave Rose Plot At The Offshore Of Northern Malacca Strait. Direction Read As "Going To".



Source: Coastal Hydraulic Study Not To Scale

Figure 6.34 Wave Rose For Every Monsoon Seasons. Direction Read As "Going To"

Table 6.10
Offshore Wave Height Annual Distribution
For Data Covering The Period From Year 1992 To 2013

Direction (°)	Wave Height (m)							
	0.5 - 1.0	1.0 - 1.5	1.5 - 2.0	2.0 - 2.5	2.5 - 3.0	3.0 - 3.5	>= 3.5	Total (%)
348.75 - 11.25	0.00	0.60	0.00	0.40	0.00	0.04	0.00	1.05
11.25 - 33.75	0.00	0.60	0.00	0.48	0.00	0.02	0.00	1.10
33.75 - 56.25	0.00	1.15	0.00	0.67	0.00	0.03	0.00	1.86
56.25 - 78.75	0.00	2.92	0.00	1.47	0.00	0.13	0.01	4.53
78.75 - 101.25	0.00	15.40	0.00	10.66	0.00	2.58	0.74	29.38
101.25 - 123.75	0.00	9.59	0.00	5.28	0.00	1.64	0.58	17.09
123.75 - 146.25	0.00	3.65	0.00	0.30	0.00	0.02	0.00	3.97
146.25 - 168.75	0.00	1.40	0.00	0.07	0.00	0.00	0.00	1.46
168.75 - 191.25	0.00	1.39	0.00	0.04	0.00	0.00	0.00	1.43
191.25 - 213.75	0.00	1.86	0.00	0.20	0.00	0.00	0.00	2.06
213.75 - 236.25	0.00	5.38	0.00	1.65	0.00	0.32	0.03	7.38
236.25 - 258.75	0.00	8.19	0.00	4.95	0.00	1.69	0.30	15.13
258.75 - 281.25	0.00	2.93	0.00	1.33	0.00	0.22	0.03	4.52
281.25 - 303.75	0.00	0.64	0.00	0.06	0.00	0.01	0.00	0.71
303.75 - 326.25	0.00	0.53	0.00	0.04	0.00	0.01	0.00	0.59
326.25 - 348.75	0.00	0.61	0.00	0.20	0.00	0.06	0.00	0.88
Sub-Total	0.00	56.84	0.00	27.80	0.00	6.79	1.71	93.14
Calms								0.00
Total								100.00

Source: Coastal Hydraulic Study

(iii) Water Level And Current Measurement

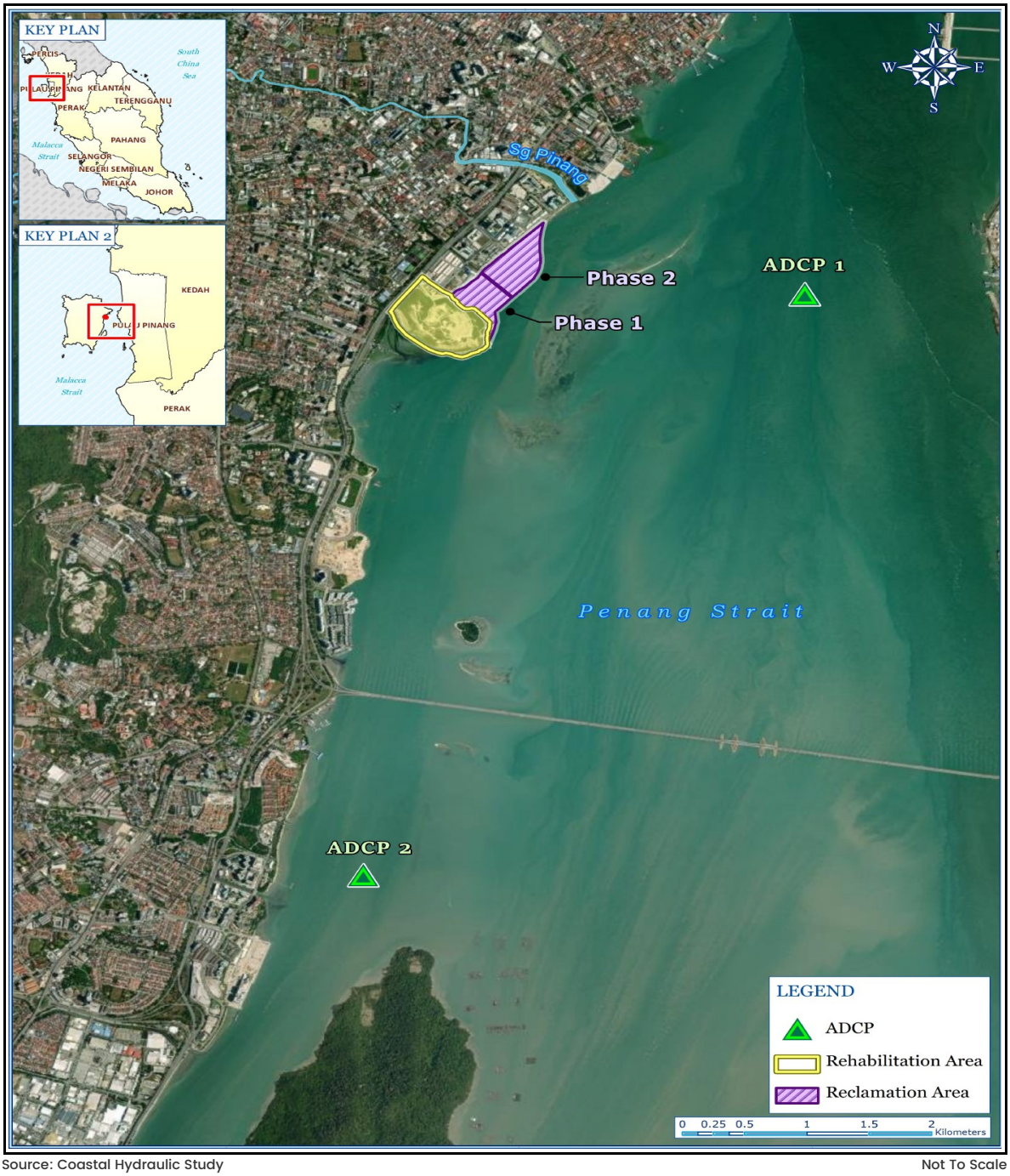
The water level and current measurements were carried out by using ADCPs (Acoustic Doppler Current Profiler) deployed in vicinity of Penang Strait. The water level and current flow were continuously recorded for 16-days, covering the spring and neap tide cycles. Details of the deployed ADCPs are tabulated in **Table 6.11 and Figure 6.35.**

Table 6.11
Detail Localities Of ADCP 1 And ADCP 2

ADCP	Longitude	Latitude	Depth (m MSL)	Deployment Period	Duration (days)
1	100°21'00.94"E	5°23'33.04"N	20.55	18th June – 04th July 2020	16
2	100°19'06.64"E	5°20'34.04"N	9.55		

Source: Coastal Hydraulic Study

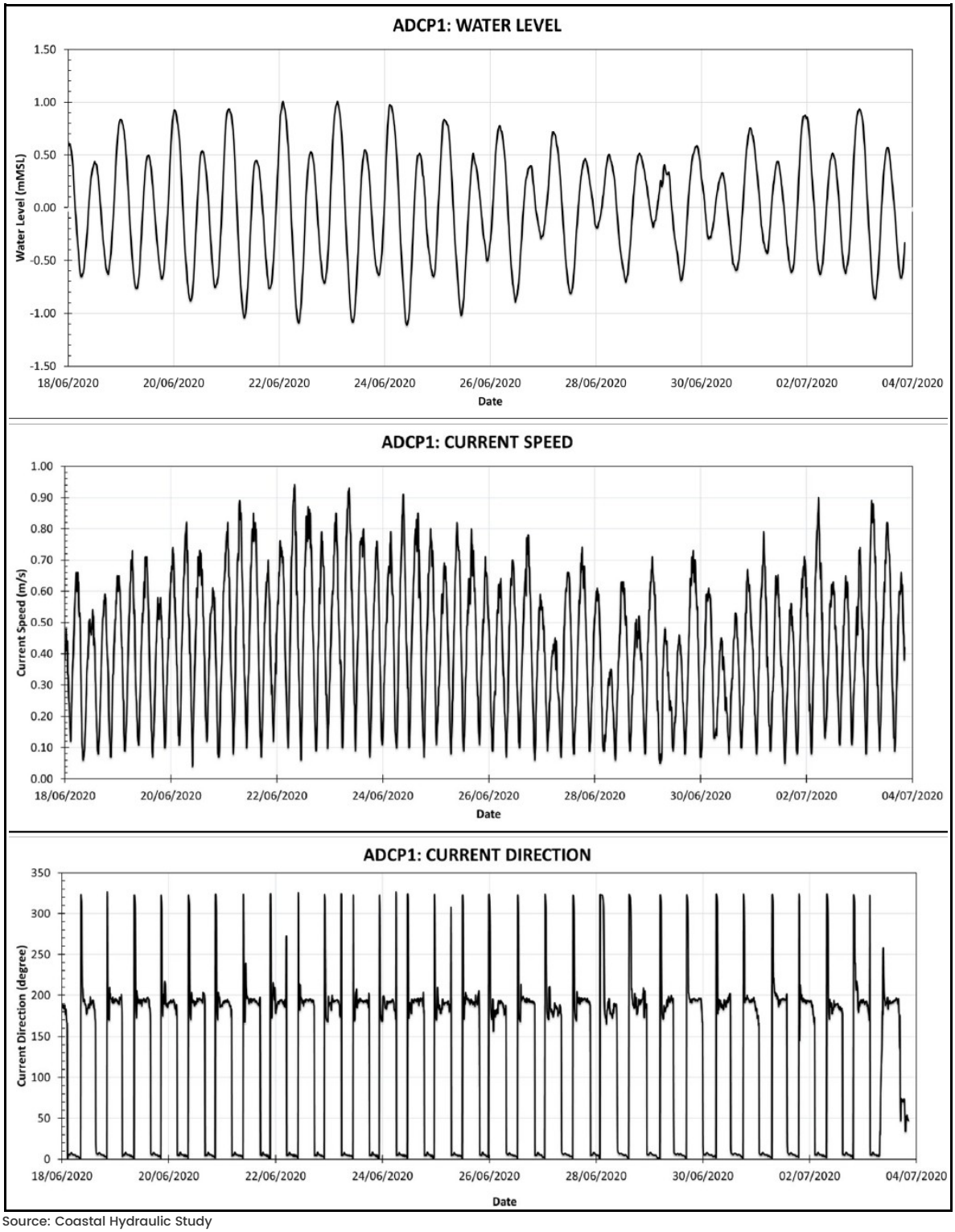
The water level and current velocity profile for both ADCP 1 and ADCP 2 are shown in **Figure 6.36 and Figure 6.37**, respectively. Based on the recorded water level, the tide surrounding the Penang Strait shows a prevailing semi-diurnal tide characteristic with two (2) high and low tide with almost similar amplitudes are observed within a day. The spring and neap tidal range for both ADCPs is generally at 2.0 m and 1.6 m, respectively.



Source: Coastal Hydraulic Study

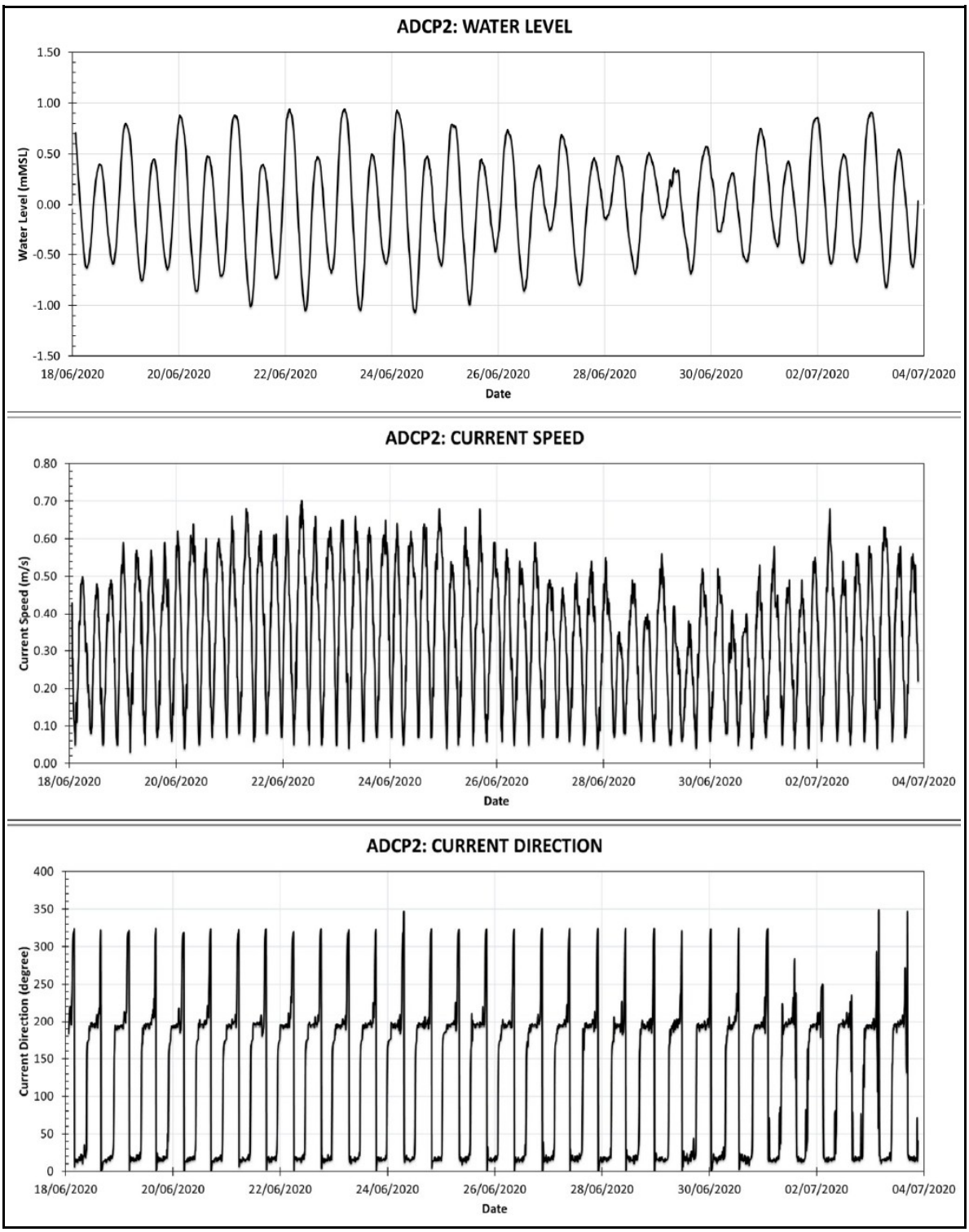
Not To Scale

Figure 6.35 Location Of ADCPs For Water Level And Current Flow Measurements



Source: Coastal Hydraulic Study

Figure 6.36 Recorded Measured Water Level, Current Speed And Direction For ADCP 1



Source: Coastal Hydraulic Study

Figure 6.37 Recorded Measured Water Level, Current Speed And Direction For ADCP 2

Meanwhile, for the measured current speed observed at ADCP 1 shows a maximum reading of 0.94 m/s with dominant current flow directions recorded towards northward and south-westward. During ebb tide, the current direction going to 360° to 22.5°, while during flood tide the current direction going to 225°. As for ADCP 2, the maximum current speed is 0.70 m/s with the prevailing current direction going to 22.5° during ebb tide and going to 202.5° during flood tide. It is noted that the dominant flow directions reflect the directions of the flooding and ebbing tides. The current rose plot for both ADCP 1 and ADCP 2 as shown in **Figure 6.38**, while the summary of flow characteristics measured at each ADCP are listed in **Table 6.12 and Table 6.13.**

Table 6.12
Summary Of Water Level Measured At ADCP 1 And ADCP 2

Description	Water Level		
	ADCP 1	ADCP 2	Unit
High Water Spring (HWS)	1.01	0.94	mMSL
High Water Neap (HWN)	0.78	0.75	mMSL
Low Water Spring (LWS)	-1.11	-1.07	mMSL
Low Water Neap (LWN)	-0.89	-0.86	mMSL
Spring Tidal Range	2.12	2.01	m
Neap Tidal Range	1.67	1.61	m

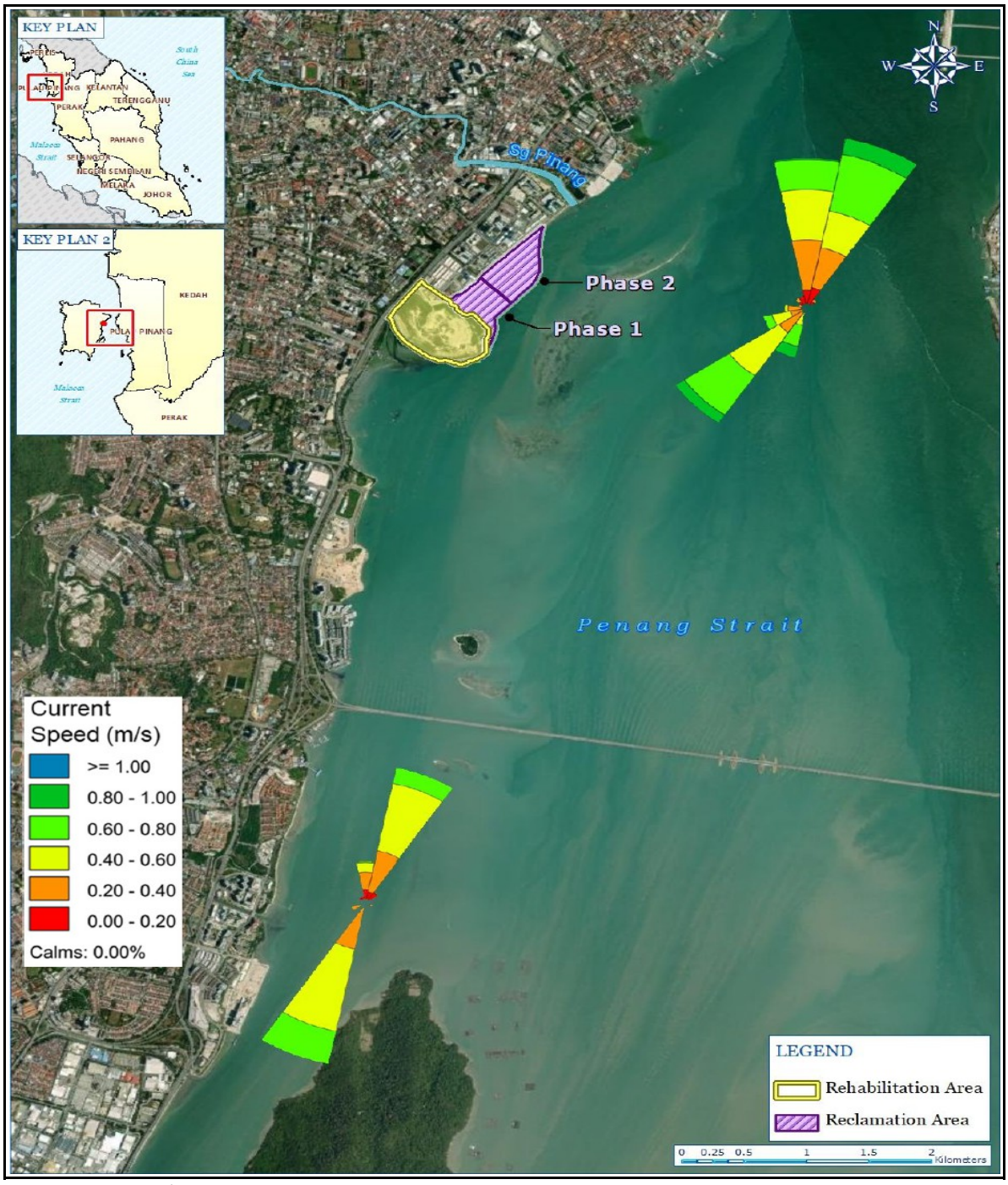
Source: Coastal Hydraulic Study

Table 6.13
Summary Of Currents Measured At ADCP 1 And ADCP 2

Description	Water Level		
	ADCP 1	ADCP 2	Unit
Mean Current Speed (Spring)	0.49	0.39	m/s
Mean Current Speed (Neap)	0.39	0.31	m/s
Maximum Current Speed (Spring)	0.94	0.70	m/s
Corresponding Current Direction (for maximum current speed - spring)	5.25	17.73	°
Maximum Current Speed (Neap)	0.80	0.68	m/s
Corresponding Current Direction (for maximum current speed - neap)	193.37	195.99	°

Source: Coastal Hydraulic Study

For reference purpose, the standard tide level at Kedah Pier as extracted from Malaysia Tide Table 2020 published by the National Hydrographic Centre of Malaysia, Royal Malaysian Navy (NHCM, RMN) is shown in **Table 6.14**.



Source: Coastal Hydraulic Study

Not To Scale

Figure 6.38 Rose Plot For Current Profile At ADCP 1 And ADCP 2 (direction read as "going to").

Table 6.14
Tide Level At Kedah Pier, Pulau Pinang Standard Port

Item		Port
		Kedah Pier, Pulau Pinang
Standard Tide Level (mCD)	Lowest Astronomical Tide (LAT)	0.00
	Mean Low Water Spring (MLWS)	0.72
	Mean Low Water Neap (MLWN)	1.45
	Mean Sea Level (MSL)	1.71
	Mean High Water Neap (MHWN)	1.96
	Mean High Water Spring (MHWS)	2.69
	Highest Astronomical Tide (HAT)	3.09
Authority (Observation)		DSM*
Authority (Constant)		RMN**
Authority (Prediction)		RMN**
Data Periods (Years)		13 years (1989 - 2003)

Source: NHCM, RMN, 2020

*DSM = Department of Survey and Mapping, Malaysia.

**RMN = National Hydrographic Centre, Royal Malaysian Navy.

G. Meteorology

All information pertaining to the meteorological conditions are enclosed in **Appendix C-001** of the report. Meteorology data for the site is obtained from the MMD (Malaysian Meteorology Department) in the Penang International Airport at Bayan Lepas. The meteorology data from 2012 to 2023 is given in **Appendix C-001.**

The site is in the central part of the state of Pulau Pinang which experiences tropical rain forest climate bounded on tropical monsoon climate.

This climate type features high temperatures with daily as well a annual variations due to the high humidity and cloud cover but over short durations and precipitate almost throughout the year. The dry season under `Ar' type climate is normally short.

The seasonal variation for Peninsular Malaysia is due commonly to monsoon seasons, which is attributed to the passage of the monsoon winds from the northeast and southwest, with two wetter seasons separated by two drier seasons in a year.

Malaysia is located to the north of the equator at latitude between 1° and 7° N and experiences a typical tropical humid climate via the `Ar' type under the climate classification system introduced by Trewartha (1980).

There are no meteorological data specific for the project area. Hence, these records were taken from the nearest meteorological station located at the Bayan Lepas International Airport whereby the MMD (Malaysian Meteorological Department) keeps a record on a number of the meteorological aspects.

(i) Humidity, Temperature And Evaporation

The records of relative humidity range from 67.3% to 85.0% monthly with monthly temperatures ranging from 26.2 to 29.9°C monthly. The records of daily evaporation at the Penang International Airport station are shown in **Appendix C-001.** The mean daily evaporation ranged from 2.2 to 5.9 mm per month.

(ii) Rainfall

Rainfall in Peninsular Malaysia is very much influenced by the seasonal monsoons, the northeast and the southwest monsoons. The north east monsoon is generally prevalent from November to March. This is followed by a transitional period in April and May. The south west monsoon is generally prevalent from June to September followed by another transitional period in October. The monthly rainfall ranges from 8.0 to 507.4 mm.

(iii) Number Of Rainday

Records for number of raindays obtained from the meteorological station in Bayan Lepas showed that rainday is between 2 to 28 days in a month.

(iv) Global Radiation

In general, the monthly global radiation range from year 2012 to 2023 is 7.09 to 25.03 Mjm^2.

(v) Winds

The mean surface wind speed ranges between 1.2 to 3.1 m/s. Winds are predominant in the northerly direction.

6.3 Biological Environment

A. Terrestrial Flora

There are limited flora on the Jelutong Landfill as it has been heavily used for the disposal of various wastes.

B. Terrestrial Fauna

There are no fauna of significance on the Jelutong Landfill as the nearby areas have been developed and disturbed. However stray dogs are observed at site.

C. Marine Fisheries

(i) General

A FIA (Fisheries Impact Assessment) has been submitted to the Department of Fisheries for comments on 5th May 2023. The comments issued by the Fishery Department via letters reference Prk.PP.SMPP/02/12-3( ) dated 12th December 2023, via letter reference DOF.PP 600-4/6/7(02) dated 27th December 2023 and via letter reference DOF.PP 600-4/6/3(07) dated 26th March 2024 are provided in **Appendix A-001.**

The fisheries impact assessment focused on the fisheries activities near the Proposed Project site in Jelutong coastal water located in Timur Laut District, Penang. The information on the fishing zone in Penang coastal water, number of licensed vessels and fishermen in Jelutong, fishing gear and aquaculture activities were gathered from the DOF (Department of Fisheries) on Perangkaan Perikanan Tahunan – Jilid 1, Perangkaan Perikanan Tahunan 2021. The number of fish landing jetty in Penang and data on the marine capture total at the Jelutong Fish Landing site from January 2019 to August 2022 were provided by LKIM (Fisheries Development Authority of Malaysia) Penang based on the data collected through 'Program Pengisytiharan Pendaratan Ikan LKIM'. The preliminary data is based on the sampling activities done on 5th, 6th and 12th October 2022 at the Jelutongs' Landing Site.

(ii) Fishing Zone, Number of Licensed Vessel and Fishermen and Aquaculture Activities in Penang and Near the Proposed Project Site

The conservation, management, and development of capture fisheries in Malaysia is governed under the Fisheries Act of 1985 (Act 317). The law outlines a rule-based approach for fishing within Malaysian waters that requires an application and maintenance of the correct license and observance to strict zoning in accordance to the operating license.

The intent of the law is to manage and limit fishing efforts across Malaysia through the control of license allocations per vessel and gear type, across zones.

The fishing zone consists Conservation Zone, Zone A, Zone B, Zone C, Zone C2 and Zone C3 as shown in **Figure 6.39.** Conservation zone (i.e. 0 – 1 nm from the coastline) which meant for aquaculture activities such as fish and cockles farming and fisherman community involvement (Figure 1.1). The Conservation Zone only applied to three (3) states in West Peninsular Malaysia i.e. Kedah, Perak and Selangor.

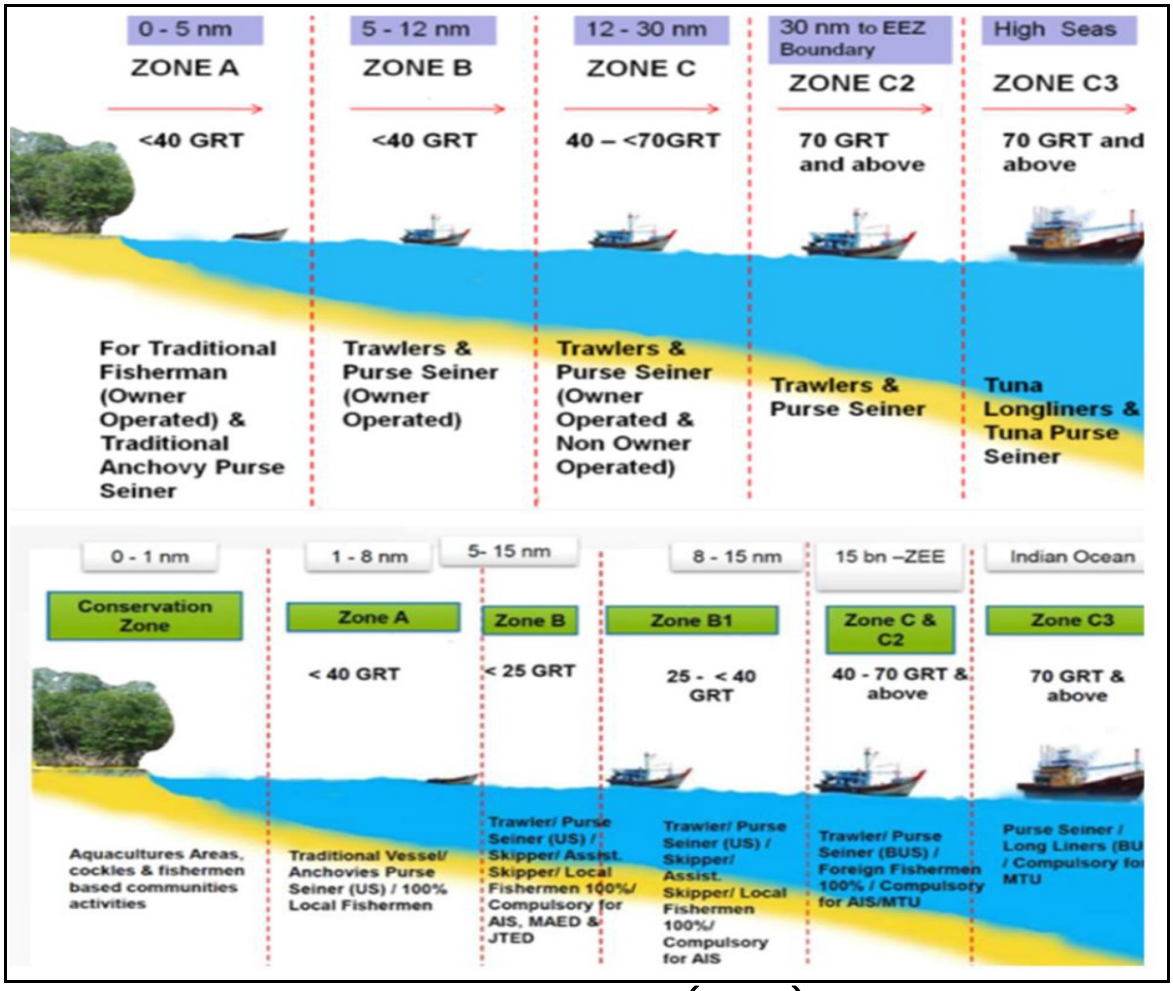


Figure 6.39 Zoning Under The Fisheries Act 1985 (Act 317) Whereby Below Is The New Fishing Zone That Comprises Only Kedah, Perak And Selangor

The fishing zone in Penang comprise Zone A, Zone B, Zone C, Zone C2 and Zone C3. Zone A (0 – 5 nm) is the main area of operations for local inshore fisherman with traditional vessels, sampan and anchovy purse seine. In this zone, only traditional fishermen who work on their own vessels are allowed to carry out fishing activities. Drift nets, portable trap, and fishhooks are the common equipment used by the fisherman in Zone A with load size, not more than 40 GRT. Zone B (5 – 12 nm), vessels operating in this area must be loaded less than 40 GRT, using commercial fishing equipment only i.e., dragnet and purse seine. Zone C (12 – 30 nm) usually trawlers and purse seine operated within this zone with vessel of 40 GRT but less than 70 GRT. Zone C2 (30 nm – EEZ boundary), vessels such trawlers and purse seine operating in this area must be loaded 70 GRT or more. Zone C3 (Indian Ocean and high sea), vessels operating in this area must be loaded above 70 GRT, using purse seine or tuna longline, and installation of MTU (Mobile Transceiver Unit) tool is compulsory for movement monitoring by DOF (Department of Fisheries).

In 2021 there were a total of 2,511 licensed vessels in Penang with 595 vessels licensed under the Timur Laut District. 577 vessels are licensed for outboard powered vessels, 11 vessels operating in Zone B and 7 vessels operating in Zone C + C2. total of 5,520 licensed fisherman working on fishing vessels in Penang for 2021, with 1,222 fishermen licensed are in Timur Laut District. The main fishing gear used by local fisherman is drift net (81.61%), others fishing gear include trawl nets, fish purse seines, kenka one boat, portable traps, hooks and lines, bag nets, shellfish collection, fish aggregate device, marine culture system and crab traps. The latest data up to August 10, 2022 from the Penang Department of Fisheries recorded, a total of 90 fishermen who are still have active fishing licensed in Zone A at Jelutong Fish Landing Site.

The aquaculture activity in Penang covers an area of 785,473.87 m^2 with 33,957 cages of brackish or marine cages in operations as of 2021. Fish species productions from brackish water or marine ponds in Penang includes golden pomfret, mangrove snapper, hybrid grouper, red snapper, threadfin. Seabass, red tilapia, tiger prawn and white shrimp with an accumulated amount throughout 2021 of 21,435.50 metric tons and a retail value of RM 378,302.78.

(iii) Secondary Data Of Marine Capture Total At Jelutong Fish Landing Jetty

For the year 2022, the most recent data provided by LKIM is only up to August 2022, hence data comparison for quantity, value, and number species landed in Jelutong is only done from January to August 2019 – 2022.

Figure 6.40 show quantity (kg) and value (RM) of marine species landed at Jelutong Fish Landing Site from January to August for 2019 to 2022. The year 2021 shows the highest number of catches and price values with 119,500.88 kg and RM 13,67188.99, the catches quantity (kg) drop by 40% in 2022 but there is not much change in price value. The number of species caught declined marginally over the years as shown in **Figure 6.41.** In 2022, catches of the high-value groups (e.g. ketam renjong and kerapu) is at their higher levels from the catches recorded previously as shown in **Table 6.15**, explaining the higher price recoded in 2022 despite low catches quantity (kg) recorded.

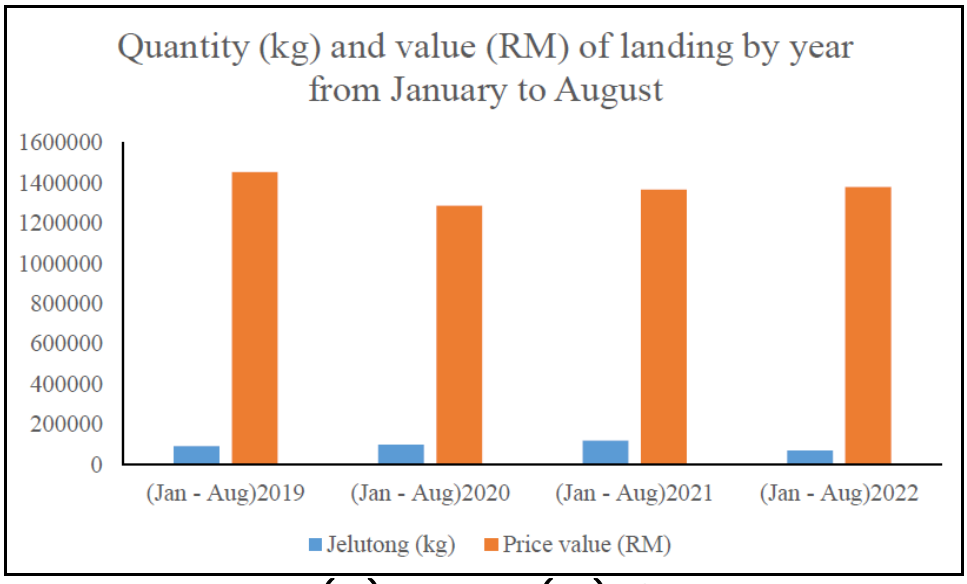


Figure 6.40 Quantity (kg) And Value (RM) Of Landing By Year From January To August From 2019 To 2022 At Jelutong Fish Landing Site

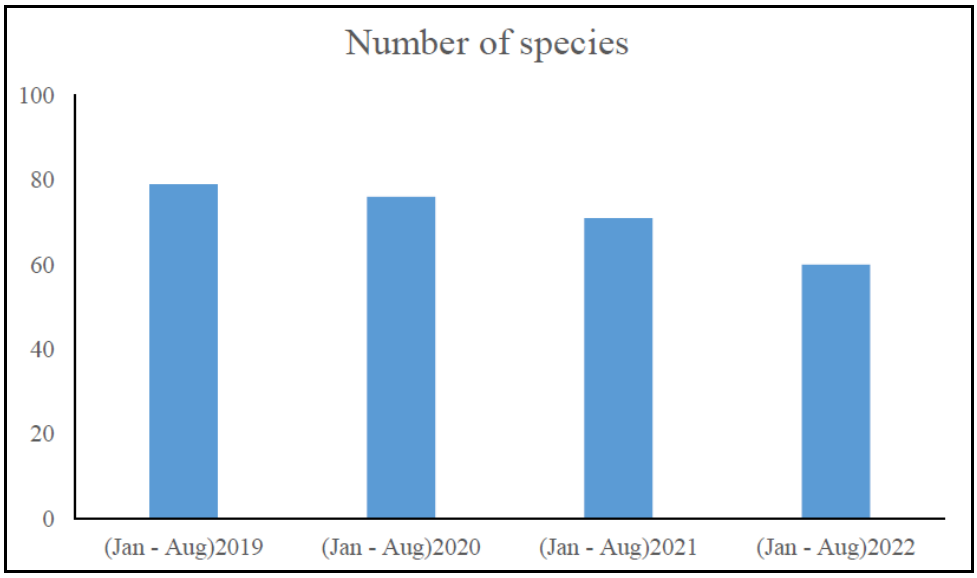


Figure 6.41 Number Of Marine Species Landed By Year From January To August From 2019 To 2022 At Jelutong Fish Landing Site

Table 6.15
Highest Landing According To Marine Species From 2019 To 2022

Species	2019	Species	2020
	Quantity (kg)		Quantity (kg)
Kerapu	3,103.6	Cencaru	3,229.67
Bawal putih	3,562.74	Jenahak	3,771.15
Semilang	3,907.35	Timah	4,100.00
Jenahak	4,596.19	Kembung	4,141.37
Kembung	4,990.21	Pelaling	5,858.00
Duri	5,588.86	Ketam Renjong	6,670.39
Talang	6,227.89	Talang	6,923.14
Ketam Renjong	6,960.57	Senangin	8,223.65
Senangin	8,932.49	Duri	9,146.3
Pari	20,417.71	Pari	17,815.29
Species	**2021**	**Species**	**2022**
	Quantity (kg)		**Quantity (kg)**
Daun Baru	3,199.37	Daun Baru	1,817.80
Semilang	3,688.44	Semilang	1,886.34
Talang	4,148.18	Kerapu	2,763.44
Kebasi	4,223.44	Kembung	2,958.64
Duri	5,255.81	Duri	3,585.35
Ketam Renjong	5,816.59	Jenahak	4,063.18
Cencaru	8,163.45	Talang	5,472.64
Senangin	8,219.89	Ketam Renjong	7,201.51
Pari	20,148.49	Senangin	8,066.70
Kembung	20,476.26	Pari	21,215.62

Source: LKIM Annual Fishery Statistic 2019, 2021 & 2022

(iv) Methodology

(a) Fish Sampling

Fish sampling was conducted on 5th, 6th and 12th October 2022 at Jelutong, Sungai Pinang and Batu Uban fish landing sites as shown in **Figures 6.42 and Figure 6.43**. Sampling was done based on each inshore boat that arrived at the landing sites. Fisherman used drift nets with various mesh size, lures and tali rawai, the fishing time was around 4 – 12 hours depending on the fishing gear used and tides. The fish caught was identified according to family and species level (Mohsin & Ambak, 1996; Mansor et al., 1998; Ambak et al., 2010). Fish species collected n≥30 specimens were measured its total length and weight to nearest cm and g, respectively. Data collected was calculated and analyzed for the species list, biomass and length-weight relationship.

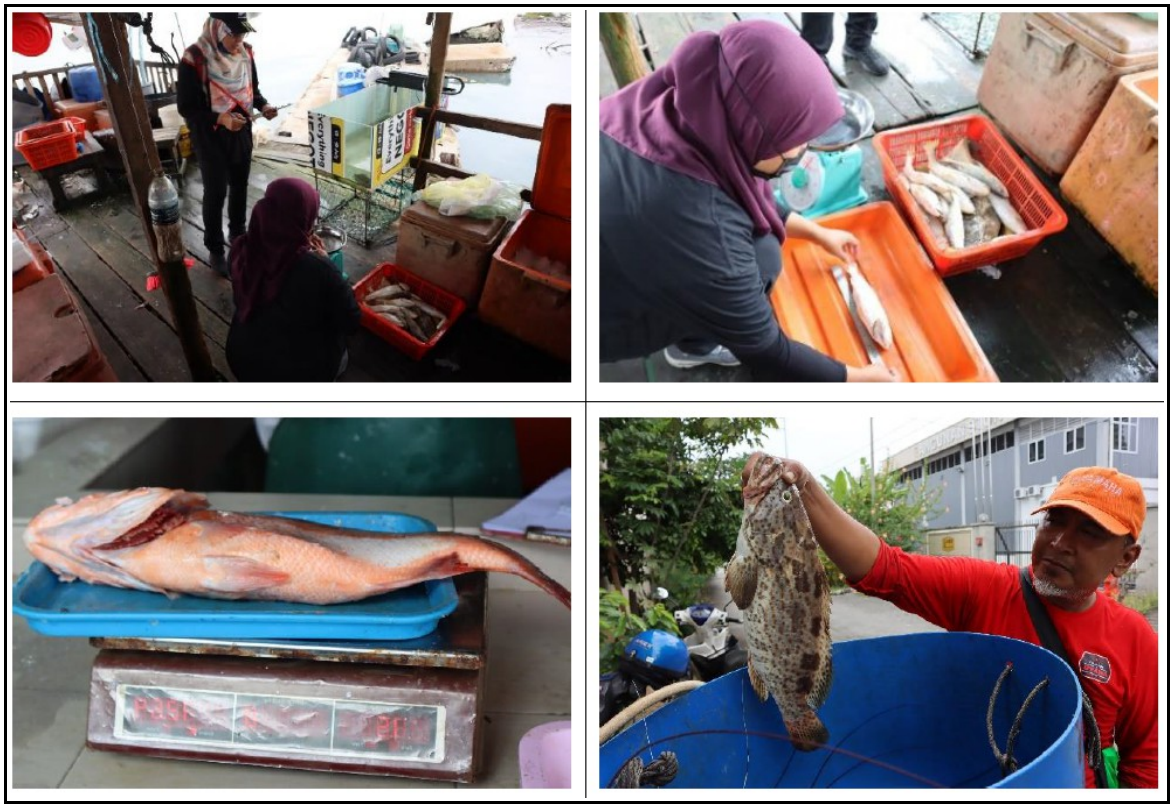


Figure 6.42 Fishing Survey At Fish Landing Sites

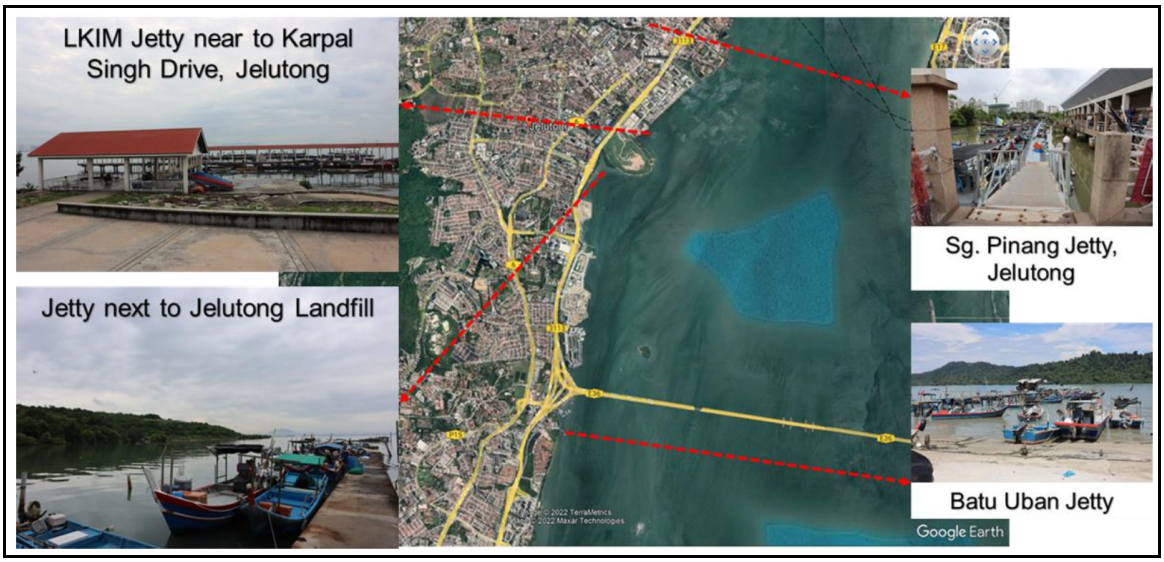


Figure 6.43 Fish Landing Jetty Near To The Proposed Project Site

(b) Length-Weight Relationship Of Fish Species

The fish collected were directly measured in cm using a ruler or measuring tape and weight in g using an electronic balance. Total length was measured from the tip of the snout to the end tip of the caudal fin as shown in **Figure 6.44.**

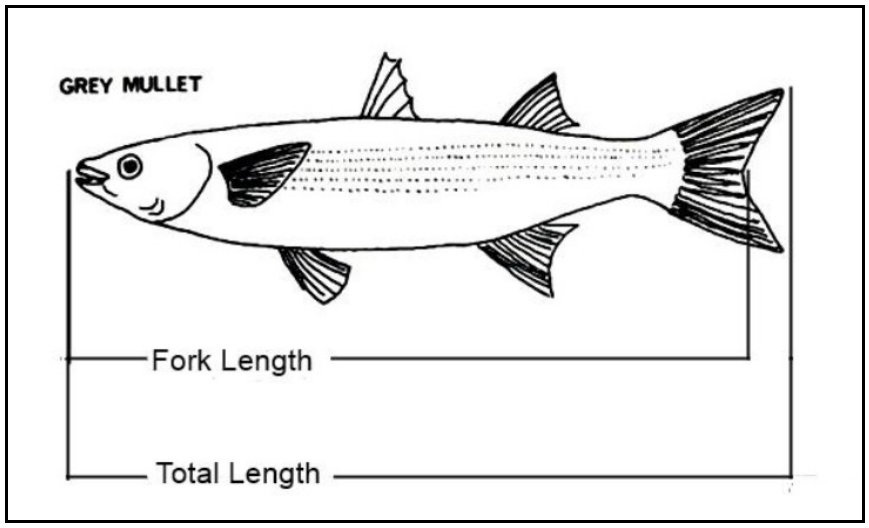


Figure 6.44 Fish Measurement

The length-weight relationships were estimated using the equation; (Le Cren, 1951; Froese, 2006).

□ ⊟□□□□□

W = body weight (g)
L = total length (cm)
a = constant proportionality (intercept value)
b = growth exponent (slope)

The power equation can be expressed in linear form using Log_{10} linear transformation as follows:-

□□□□□ BW=□□□□□ □⊞□□□□□□□ TL

Where *a* = constant, *b* = exponent, BW = body weight (g) and TL = total length (cm)

The b value defines the fish growth. The growth pattern i.e. Isometry (b = 3) or allometry (b ≠ 3) classify to positive allometry (b < 3) negative allometry (b < 3) was tested using Pauly's equation (Pauly 1984);

$$t = \frac{sd \ln L}{sd \ln W} \cdot \frac{|b-3|}{\sqrt{1-r^2}} \sqrt{n-2}$$

Where sd ln L and sd ln W are the standard deviations of the ln Length and Weight. The value of *b* is significantly different from the cubic law if the t calculated is greater than the t in the t distribution table for n – 2 degrees of freedom.

The confident limit for the *b* value calculated for the fish species caught was calculated based on formula by Zar (2010);

$$b \pm (1 - \alpha/2, n - 2) . \sqrt{S^2/(n-2)(SDTL)}$$

Where b is the slope calculated from length weight relationship, S^2 is the mean square error and SDTL is the standard deviation of total length.

(v) Findings

(a) Fish Landing Survey

A total of fish biomass of 168,985 g was caught during the three days of data collection which includes 18 species of fish, 1 species of crab, 1 species of octopus and 1 species of bivalve; represented from 17 families in total as shown in **Table 6.16 and Figure 6.45.** The species with the highest biomass caught was *Portunus pelagicus* (Flower crab) with 34,746 g (20.6%) of the total catch while *Drepane punctata* (Daun baru) was the lowest biomass caught with 229 g (0.1%) of the total catch. Most of the fishes caught by the fishermen are commonly found and under status either Least Concern or Data Deficient under ICUN Red List of Threatened Species. *Epinephelus fuscoguttatus* locally known as Kerapu Harimau is considered Vulnerable under IUCN.

Table 6.16
List Of Fishes During The Survey

Local Name	Genus	Scientific Name	Biomass (g)	Percentage (%)	IUCN
Tengkerong	Scianidae	Otolithes ruber	8,320	4.9	LC
Duri	Ariidae	Arius argyropleuron	7,843	4.6	-
Baji	Platycephalidae	Platycephalus indicus	4,380	2.6	DD
Merah/Bebara	Lutjanidae	Lutjanus argentimaculatus	2,991	1.8	LC
Daun baru	Drepanidae	Drepane punctata	229	0.1	-
Gerut-gerut	Haemulidae	Pomadasys kaakan	5,417	3.2	-
Gelama batu	Scianidae	Johnius belangerii	486	0.3	LC
Sembilang	Plotosidae	Plotosus canius	32,010	18.9	-
Senangin	Polynemidae	Eleutheronema tetradactylum	500	0.3	-
Jenahak	Lutjanidae	Lutjanus johnii	14,382	8.5	LC
Kebasi	Clupeidae	Anodontostoma chacunda	1,571	0.9	LC
Cencaru	Carangidae	Megalaspis cordyla	2,831	1.7	LC
Kaci	Haemulidae	Plectorhinchus pictus	1,910	1.1	LC
Singa	Batrachoididae	Batrachomoeus trispinosus	30,660	18.1	-
Longtan	Serranidae	Epinephelus lanceolatus	2,400	1.4	DD
Kerapu harimau	Serranidae	Epinephelus fuscoguttatus	14,400	8.5	VU
Puting damar	Sillaginidae	Muraenesox cinereus	361	0.2	-
Ketang	Siganidae	Siganus javus	587	0.3	LC
Crab	Portunidae	Portunus pelagicus	34,746	20.6	-
Octopus	Octopodidae	Octopus sp.	2,690	1.6	-
Green mussel	Mytillidae	Perna viridus	271	0.2	-
Total			168,985	100.0	

Note: LC = Least Concern; DD = Data Deficient; VU = Vulnerable; - = Status Not Available

Figure 6.45 List Of Fishes Identified

Figure 6.45 List Of Fishes Identified (Continued)

(b) Length-Weight Relationship Of Common Fish Species

LWRs (Length-weight relationships) and relative condition factor are of great importance in fishery assessment studies since it provides information about the growth of the fish, its general wellbeing, and fitness in a marine habitat.

Overall, sample from 18 different fish species belonging to 15 families were caught. Computation of relationship between TL (Total Length) and wet weight were limited to those 4 species that were represented by more than 30 individuals in the total sample.

Small sample size may lead to overestimation of the *b* value (slope) of the relationship between the width (cm) and weight (g) of samples (Frota et al., 2004). Length-weight relationship is presented for 4 species belonging to 4 families as shown in **Figure 6.46**.

The sample size ranged from 30 individuals *Megalaspis cordyla* and *Arius argyroplueron,* 30 samples for *Otolithes ruber* and 38 samples for *Anodontostoma chacunda*. The body size ranged from 23.4 – 33.2 cm for *Otolithes ruber*, 18.4 – 32.2 cm for *Megalaspis cordyla,* 17.5 – 35.0 cm for *Arius argyroplueron* and 12.7 – 15.5 cm for *Anodontostoma chacunda.* The body wet weights ranged from 150 – 360 g for *Otolithes ruber*, 61 – 122 g for *Megalaspis cordyla,* 75 – 469 g for *Arius argyroplueron* and 29 – 50 g for *Anodontostoma chacunda.*

The r^2 value of all 4 species were in significant positive relationship as shown in **Figure 6.46**, with all r^2 values being greater than 0.8. The calculated b value was within the suggested range of Froese (2006) i.e. in the range of 2.5 > b < 3.5 for all the four fish species. There are significant different detected for the b value of the fish species from the cubic law ($p < 0.05$) when tested with Pauly equation (Pauly, 1984). The result concluded that *Otolithes ruber, Arius argypleuron* and *Megalaspis cordyla* experienced negative allometric growth while *Anodontostoma chacunda* experienced positive allometric growth as shown in **Table 6.17.**

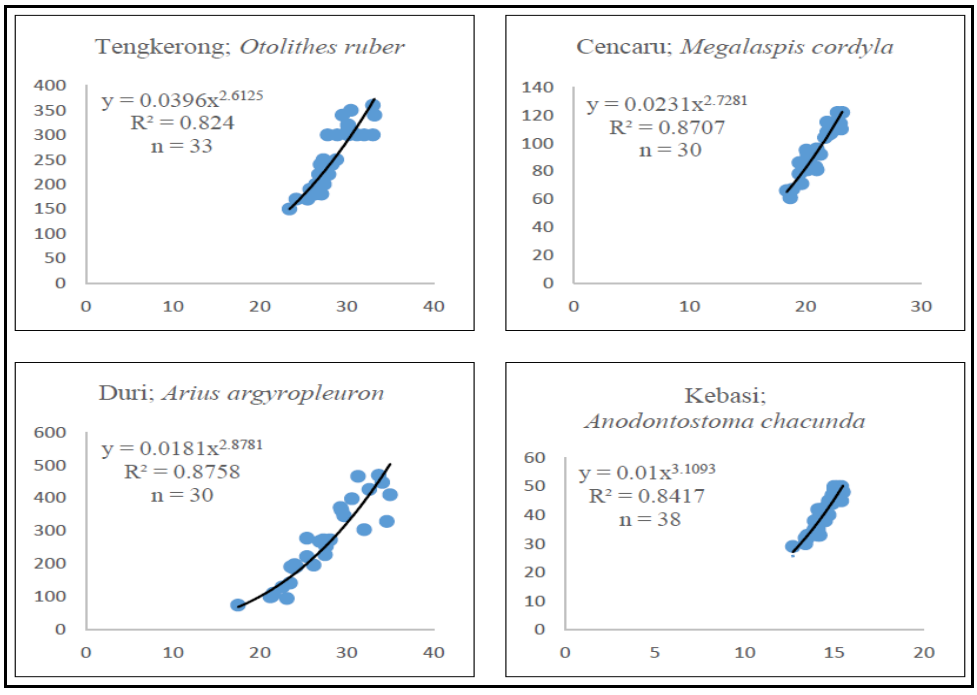


Figure 6.46 Length-Weight Relationship

Table 6.17

Length-Weight Relationship Of 4 Species Of Fish From Jelutong Fish Landing

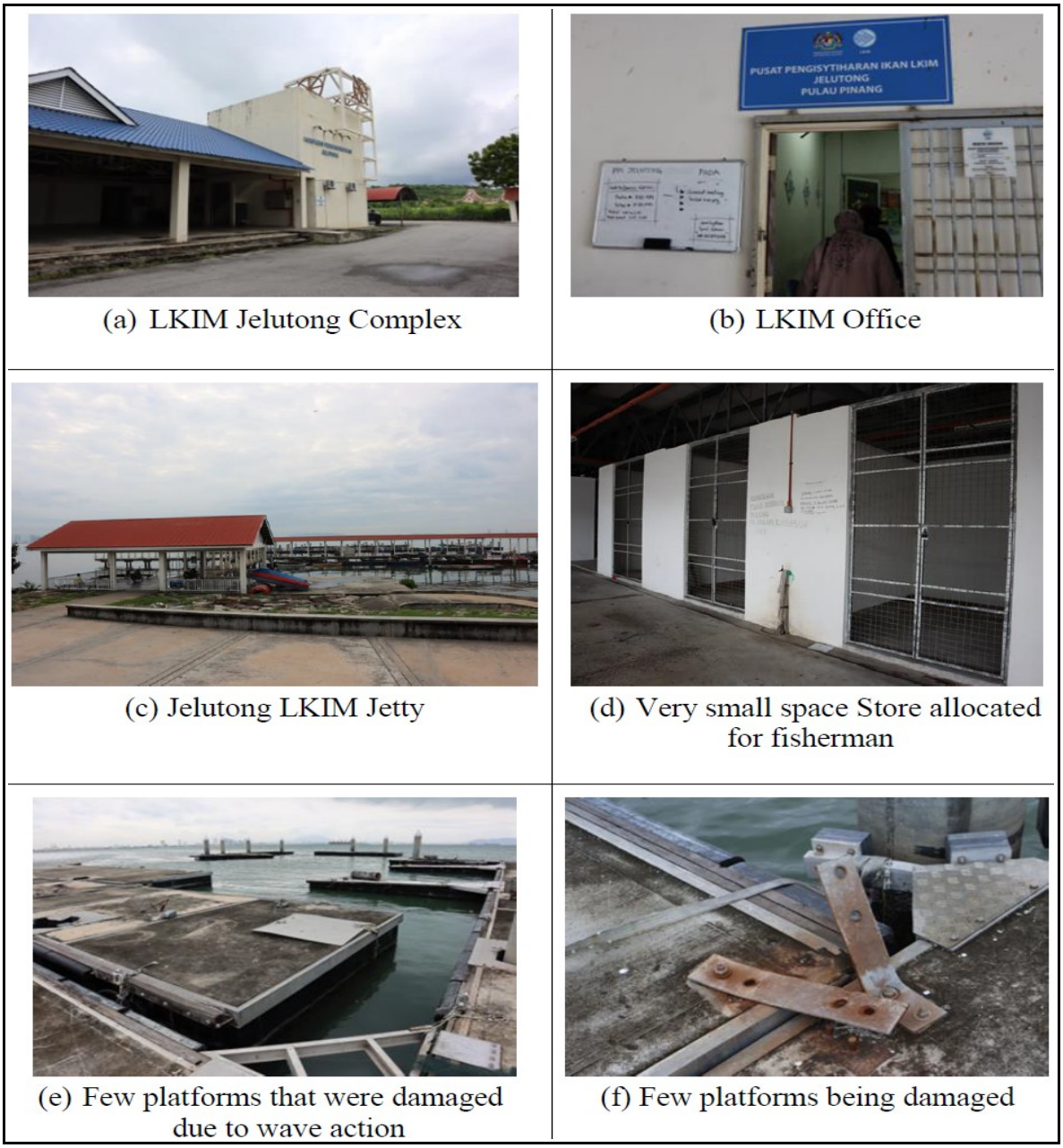
(n = sample size; *a* and *b* = *regression coefficient* and r^2 = determination coefficient)

Family	Species	n	Length (cm)		Weight (g)		Non-linear regression			Growth pattern
			Min.	Max.	Min.	Max.	a	±95% CI of b	r^2	
Scianidae	Otolithes ruber	33	23.4	33.2	150	360	0.0396	2.6125 ± 0.0260	0.824	Negative allometric
Carangidae	Megalaspis cordyla	30	18.4	32.2	61	122	0.0231	2.7281 ± 0.0212	0.871	Negative allometric
Ariidae	Arius argypleuron	30	17.5	35	75	469	0.0181	2.8781 ± 0.0275	0.876	Negative allometric
Clupidae	Anodontostoma chacunda	30	12.7	15.5	29	50	0.010	3.1093 ± 0.0124	0.842	Positive allometric

(vi) Jelutong Fisheries Landing Complex (Kompleks Pendaratan Ikan Jelutong)

Fisheries Development Authority of Malaysia Complexes (LKIM) are located in every state of Malaysia to function as a fish landing jetty complex to allow fishing vessels for fish handling operations. One LKIM complex that is near to the Proposed Project is located at Lebuh Sungai Pinang 1, Jelutong as shown in **Figure 6.47 and Figure 6.48.** However, this jetty seems to be under-utilized as most of the fishermen at this area expressed their concern about the limited space that was allocated to them to keep their fishing gears and other accessories. They also pointed out that the floating platform at the jetty experience easily damaged due to strong wave created by ship that pass by that area.

Figure 6.47 LKIM Complex Jetty At Jelutong Next To Proposed Project



(a) LKIM Jelutong Complex

(b) LKIM Office

(c) Jelutong LKIM Jetty

(d) Very small space Store allocated for fisherman

(e) Few platforms that were damaged due to wave action

(f) Few platforms being damaged

Figure 6.48 LKIM Complex At Jelutong

D. Aquaculture Activities

Aquaculture activities can be found mainly around Pulau Jerejak, Pulau Aman and areas close to the Sultan Abdul Halim Mu'adzam Shah bridge. **Table 6.18** provides the aquaculture data for year 2018 obtained from the Department of Fisheries. In this context, the project site is located more than 4.5 km north of these aquaculture farms.

Table 6.18
Aquaculture Data, 2018

Items	Data
Number of fisheries cultures	28,322 petak
Number of fishermen involve	195
Fish species breed	Kerapu, Jenahak, Merah, Siakap, Nyok-nyok, Senangin and others
Total production	22,340 metric ton
Retail value of catch	RM 506,470,191.00

Source: Department of Fisheries, Penang, 2018

E. Marine Ecology

(i) Marine Turtle

Marine turtle assessment is based on secondary data and desktop study. Recorded turtle landings and sightings were obtained from Department of Fisheries, Penang, reports and journals.

Four (4) species of marine turtles, i.e. the Leatherback (*Dermochelys coriacea*), Green Turtle (*Chelonia mydas*), Hawksbill Turtle (*Eretmochelys imbricata*) and Olive Ridley (*Lepidochelys olivacea*) nest along the coast of Malaysia. Two (2) species of turtles have been recorded in Penang waters, namely Green Turtle (*Chelonia mydas*) and Olive Ridley Turtle (*Lepidochelys olivacea*) (Department of Fisheries, 2018-unpublished, DHI Environment, 2014; Sarahaizad *et al*., 2012). Green Turtle (*Chelonia mydas*) is listed as Endangered, while Olive Ridley Turtle (*Lepidochelys olivacea*) is listed as Vulnerable in the IUCN (International Union for the Conservation of Nature) Red List. The major area for turtle landings located within the Penang National Park, particularly at Pantai Kerachut, Teluk Ketapang, Teluk Kampi and Muka Head beaches. Other areas at the northern part of island that recorded turtle landings have included Telok Aling, Telok Duyung, Telok Bahang, Moonlight Beach, Batu Ferringhi and Tanjong Bungah. As for the southern part of island, several beaches in Telok Kumbar, Gertak Sanggul, Pantai Medan, Telok Tempoyak and Pasir Belanda known as the area for turtle landing (DHI Environment, 2014). In addition, a Turtle Conservation Centre established to protect marine turtles, in Pantai Kerachut.

A study by Sarahaizad *et al.* (2012) undertaken at 13 beaches within Penang island i.e. Pantai Kerachut, Telok Kampi, Batu Ferringhi, Tanjong Bungah, Pantai Medan, Pasir Belanda, Teluk Kumbar, Gertak Sanggul, Moonlight Bay, Teluk Duyung, Teluk Aling, Teluk Bahang and Teluk Katapang. The most abundant species was Green Turtle (*Chelonia mydas*), where the major areas for their landings were Pantai Kerachut and Telok Kampi.

Tracks and nests of this species also have been recorded in Batu Ferringhi, Tanjong Bungah, Pantai Medan, Pasir Belanda, Teluk Kumbar, Gertak Sanggul, Moonlight Bay, Teluk Duyung, Teluk Aling, Teluk Bahang and Teluk Katapang. As for Olive Ridley Turtle (*Lepidochelys olivacea*), their tracks and nests have been found in Teluk Kumbar, Tanjung Bungah, Pantai Medan, Teluk Duyung and Gertak Sanggul (Sarahaizad *et al.,* 2012).

A more recent study of turtle landings in Penang is presented in **Table 6.19**. Landings fluctuated from 2010 to 2017, with the highest in 2013 (65 landings), while the lowest was in 2017 (30 landings) (*Department of Fisheries, Penang, 2018-unpublished*).

Table 6.19
Number of Turtle Landing Recorded in Penang, 2001-2017

Year	Turtle Species	
	Green Turtle (*Chelonia mydas*)	Olive Ridley (*Lepidochelys olivacea*)
2001[1]	66	-
2002[1]	39	1
2003[1]	47	-
2004[1]	62	1
2005[1]	42	1
2006[1]	71	-
2007[1]	62	1
2008[1]	44	3
2009[1]	73	2
2010[2]	51	-
2011[2]	60	-
2012[2]	50	-
2013[2]	63	2
2014[2]	35	-
2015[2]	60	1
2016[2]	55	-
2017[2]	30	-

Note: '–' = no data available
Source: [1]Sarahaizad et al. (2012), [2]Department of Fisheries, Penang (2018) – unpublished

(ii) Marine Mammals

Marine mammals assessment at South Penang Island is based on secondary data and desktop study. Recorded sightings of dolphins were from interview of fishermen and local community.

A total of 27 species of marine mammals known to occur in Malaysian waters. Of these, 17 species were recorded in Peninsular Malaysia (Ponnampalam, 2012). In the Penang Island, three (3) species that commonly present includes Common Bottlenose Dolphin (Tursiops truncatus), Irrawaddy Dolphin (Orcaella brevirostris) and Indo-Pacific Humpbacked Dolphin (Sousa chinensis) (Rajamani et al., 2014).

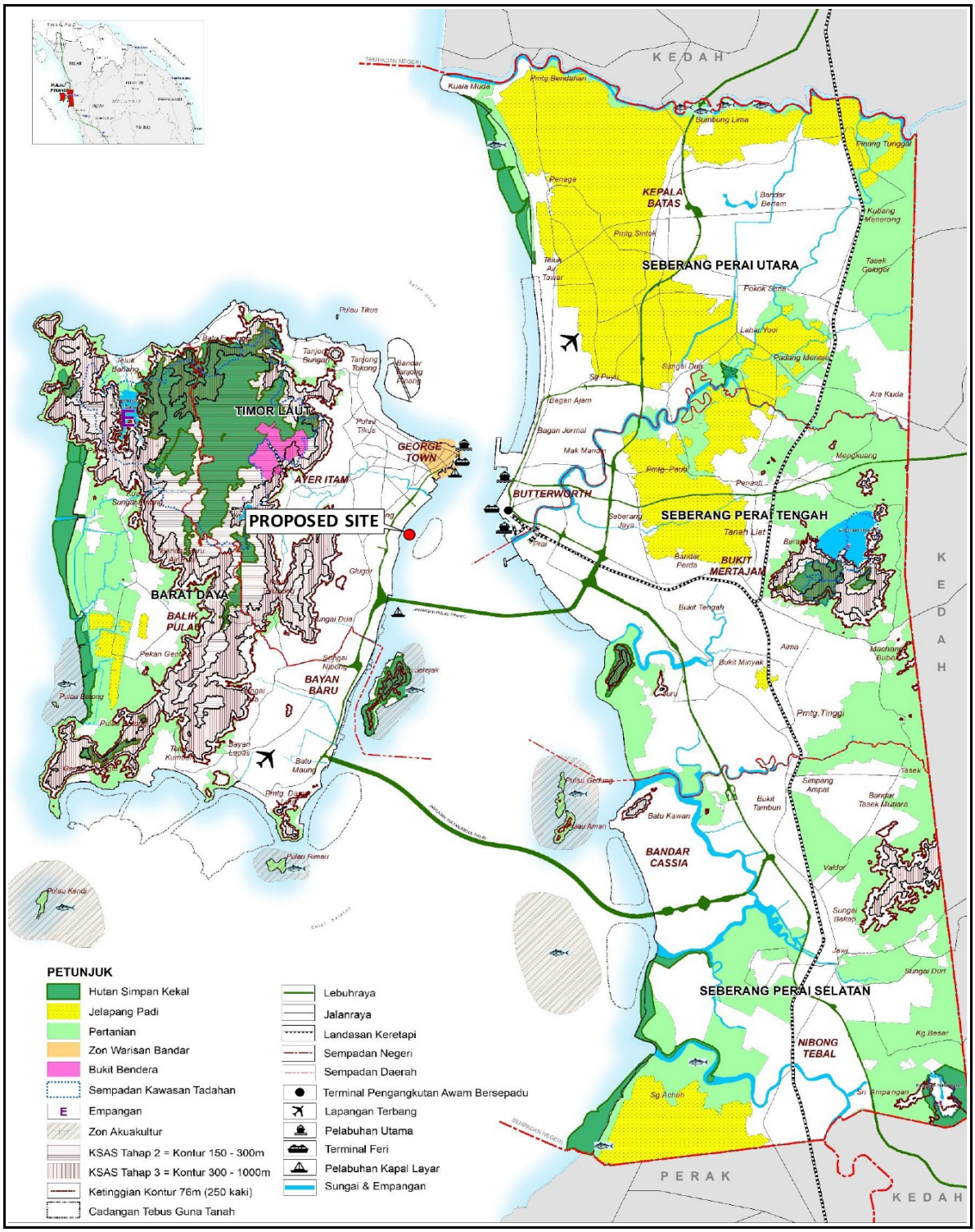
These species have been sighted by local fishermen adjacent to the rivermouth of Sg. Pinang, shallow waters near Batu Maung, Pulau Rimau, Kuala Teluk Kampi and Batu Buaya.

The local fishermen also reported that Irrawaddy Dolphin (O. brevirostris) generally appeared in small groups (5 – 10 individuals), while Common Bottlenose Dolphin (T. truncatus) present in larger groups (10 – 30 individuals).

Most fishermen believed that dolphins in Penang waters was declined due to several reasons such as increases in the number of trawlers, water pollution, decrease in fish available for dolphins, adverse weather and drift nets (Rajamani et al., 2014). In addition, strandings of Common Bottlenose Dolphin (T. truncatus), Irrawaddy Dolphin (O. brevirostris) and Indo-Pacific Humpbacked Dolphin (S. chinensis) was also recorded from 2008 - 2013 (excluding 2009 and 2010) (Rodríguez-Vargas, 2015).

F. Environmental Sensitive Areas

There are no marine parks and fisheries prohibited areas located within the impact zone of the study area and according to the RSN Pulau Pinang 2030 as shown in **Figure 6.49**, there are no environmental sensitive areas gazetted under the Town and Country Planning Act 1976. However environmental sensitive receptors within the coastal area that may be affected by any pollution issues are shown in **Figure 6.50**. The environmental sensitive receptors are located along South East of Penang shoreline.



Source: RSN, 2030

Not To Scale

Figure 6.49 Environmental Sensitive Areas In Pulau Pinang

Figure 6.50 Environmental Sensitive Receptors Surrounding The Project Site

6.4 Social And Economy Setting

A. Land Use

The land use within the surrounding areas are mainly residential and commercial use. **Figure 6.51** illustrates the photographs of the project site and activities surrounding the Proposed Project site. Land use immediately beyond the project site consists of mainly housing and commercial activities. Some of the residential areas include Fortune Park, Mutiara Idaman 1, Mutiara Idaman Apartment, Mutiara Idaman 2 & Artis 3 Condominium.

Figure 6.52 depicts the aerial view of the land use within 500 m land use surrounding the Proposed Project site which may also include the Middle Bank as the actual boundary of the Middle Bank has yet to be ascertain. During the EIA stuy cage culture can be found east of the project site near to the IJM reclamation site in Jelutong. Besides these housing schemes, institutional and commercial or mix commercial and residential land uses are apparent within the 5 km radius as shown in **Figure 6.53** and **Appendix C-002.** A fishermen's jetty can be found southwest of the existing Jelutong Landfill which will be relocated to a new site as outlined in **Chapter 5.** A summary of the 5 Km radius land use from the project site is shown in **Table 6.20.**

Table 6.20
5 Km Radius Land Use

Distance	North-West	South-West	South-East	North-East
0-0.5 Km	• Sewage Treatment Plant (IWK) • The H2O • Straits Garden Suite • SK Jelutong	• Artis 3 Condominium • Mutiara Idaman 1 • Mutiara Idaman Apartment • Mutiara Idaman 2 • Metro Avenue • Unit Nelayan Jelutong • Sea	• Sea	• Cage Culture • Shell • Fortune Park • McDonald • The Spring Condominium • Wesley Methodist School • Taman Serendah • Karpal Singh Drive • Residence Condominium • The Ocean View • Mosque • Desa Pinang Apartment • Pinang Court 2 Apartment • The Summer Place • Kolam Takungan Banjir • Middle Bank • Sea

Figure 6.51 Surrounding Activities

Not To Scale

Figure 6.52 500 m Radius Land Use Plan

Not To Scale

Figure 6.53 5 Km Radius Land Use Plan

Full Plan In **Appendix C-002**

Table 6.20 (Continue)

Distance	North-West	South-West	South-East	North-East
0.5 – 1 Km	• Jelutong • Taman Mutiara Vista • Taman Ara • Skyview Penang • Symphony Park • Taman Mutiara Vista • Taman Ara • Taman Continental	• Taman Continental • Jelutong Park • Mutiara Height • Cage Culture (near IJM Land)	• Sea	• Jelutong • Taman Serendah • Serina Bay Apartment • Desa Pinang 2 • Kolam Takungan Banjir • Pengkalan Weld • Sea
1 – 2 Km	• Jelutong • Taman Green Lane • Taman Desa Green • Skyview Penang • SJKC Beng Teik • Taman Jelutong Jaya • Sungai Pinang • Kg. Rawa • Kg. Makam	• Taman Greenview • Taman Island Glades • Taman Gelugur • Bukit Dumbar • Kg. Kastam • IPG Kampus • The Light City Plot C • Sea	• Sea	• Times Square Penang • Penang Street Art • Georgetown • Sea
2 – 3 Km	• Kg. Makam • Taman P. Ramlee • Taman Abidin • Taman Rampas • Taman Kampar • Taman Free School • Taman Sri Husin • Taman David Chen • SK Batu Lanchang • United Hokkien Cemeteries	• Taman Lembah Hijau • Taman Island Glades • Ashley Green • Taman Bukit Gambier • Taman Brown • Quarry • Minden Heights • Gelugor • Kompleks Belia & Sukan • The Light Linear • Penang Bridge • Sea	• Proposed Marine Sanctuary • Pulau Gazumbo • Penang Bridge • Sea • Dermaga Dalam	• Georgetown • Police Station • Penang Little India • Padang Kota Lama • Fort Cornwallis • Sea • Penang Port • Terminal Feri Butterworth • Penang Sentral
3 – 4 Km	• Taman Lalulintas • Taman Dhoby Ghaut • Taman Scotland • Desa Scotland • Taman Lumba Kuda • Taman Goh Guan Ho • Batu Gantung Cemetery • Riffle Range • Taman Bound • Taman Ria • Kg. Melayu Lama • Taman David Chen • Taman Pisang Awak • Taman Green Field	• Kg. Cantik • Farlim • Unoted Hokien Cemeteries • Taman Seri Rambai • Air Hitam • Paya Terubong • Iconic Hill View Point • Quarry • Taman Jade View Apartment • Taman Utama • Sunway Bukit Gambier • Universiti Sains Malaysia • Kg. Batu Uban • Taman Century • The Century • D Residence • Sea	• Penang Bridge • Sea • Dermaga Dalam	• New World Park • Georgetown • Sea • Terminal Kontena (NBCT) • Penang Port • Kg. Paya • Kg. Gajah • Bagan Jermal • Kg. Benggali • Kg. Siram • Taman Pantai • Kg. Nyiur • Taman Mewah • Taman Selat • Kg. Perlis • Bagan Dalam

Table 6.20 (Continue)

Distance	North-West	South-West	South-East	North-East
4 – 5 Km	• Kg. Syed • Taman Berjaya • Pulau Tikus • Taman Jesselton Height • Racecourse & Golf • Batu Gantung Cemetery • Riffle Range • Reservoir Garden • Taman Ria • Stesen Bukit Bendera • Air Itam • Taman Happy Valley	• Emerald Heights • Air Hitam • Paya Terubong • Taman Terubong Jaya 2 • Tama Terubong Indah • Iconic Hill View Point • Taman Pekaka • SMK Bukit Jambul • Desa Permai Indah • Kg. Dua Bukit • Sungai dua • Taman Jubilee • Sungai Nibong • Taman Saw Kit • Kg. Sg. Nibong • Tropicana Bay Residences • Putra Place Condominium • Bay Garden • Queens Waterfront • Sea • Pulau Jerejak	• Sea • Pulau Jerejak • Marine Cage Culture • Penang Bridge • TNB Prai Power Station • Ann Joo Steel • Taman Senangin • Taman Inderawasih	• Sea • Taman Molek • Kg. Buluh • Taman Jermal Indah • Kg. Kastam • Taman Riang • Kg. Gajah • Kg. Paya • Kawasan Perindustrian Mak Mandin • Taman Bagan • Seberang Jaya Industrial Estate • Kompleks Chain Ferry • Taman Inderawasih

B. Infrastructure And Public Amenities

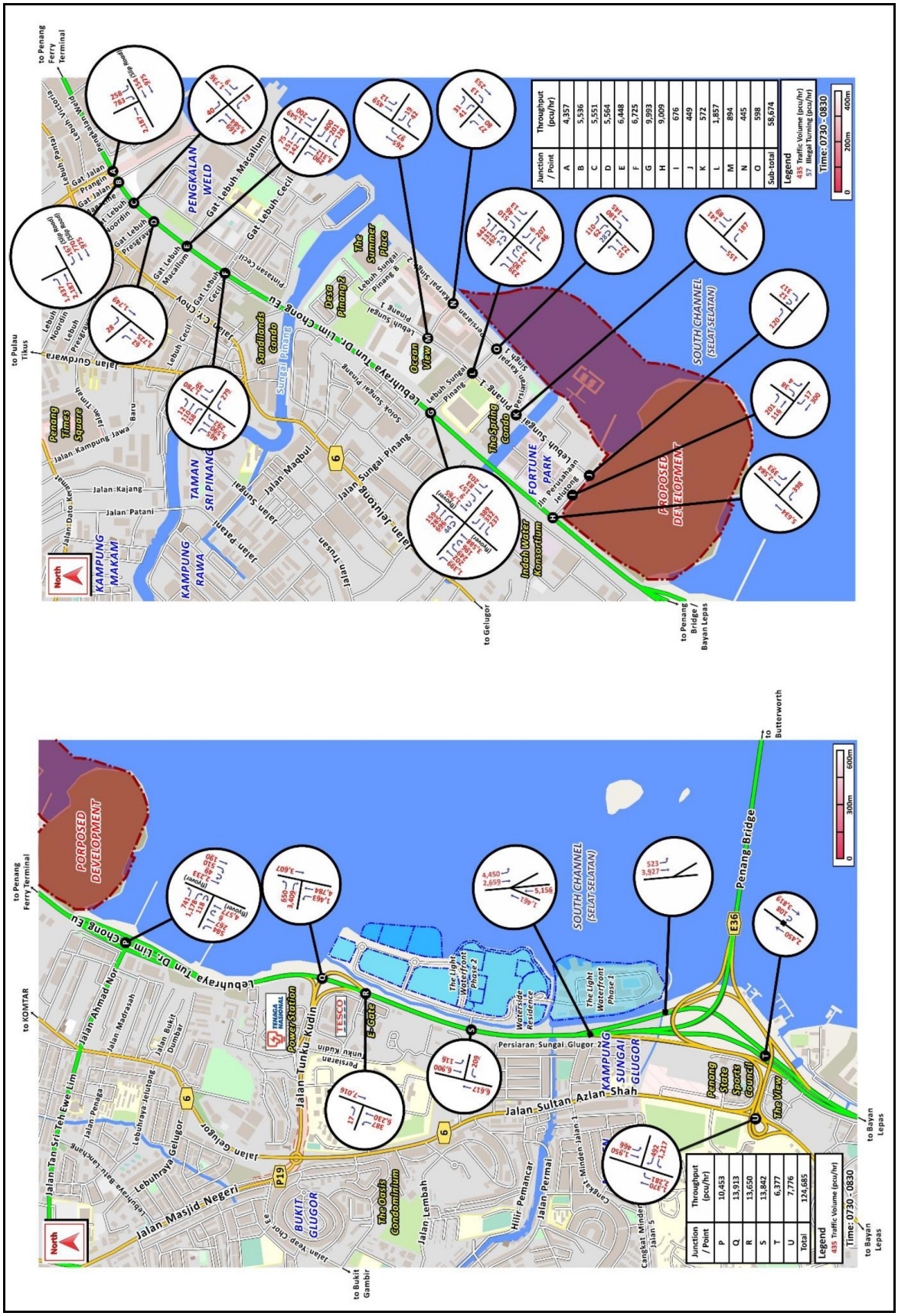
(i) Existing Traffic Conditions

The road network surrounding the project site consists of highways and local roads. Due to the high traffic generation/attraction in the study area, the existing traffic conditions extracted from the Traffic Master Plan Study report conducted by the traffic engineers are provided in this section to provide the existing traffic conditions in the area.

24 hour screenline traffic count data were conducted on 27th June 2018 at Persiaran Bayan Indah in order to record the fluctuations of the travel demand within the study area. The fluctuations of travel demands on Lebuhraya Tun. Dr. Lim Chong Eu are shown in **Figure 6.54 and Figure 6.55.**

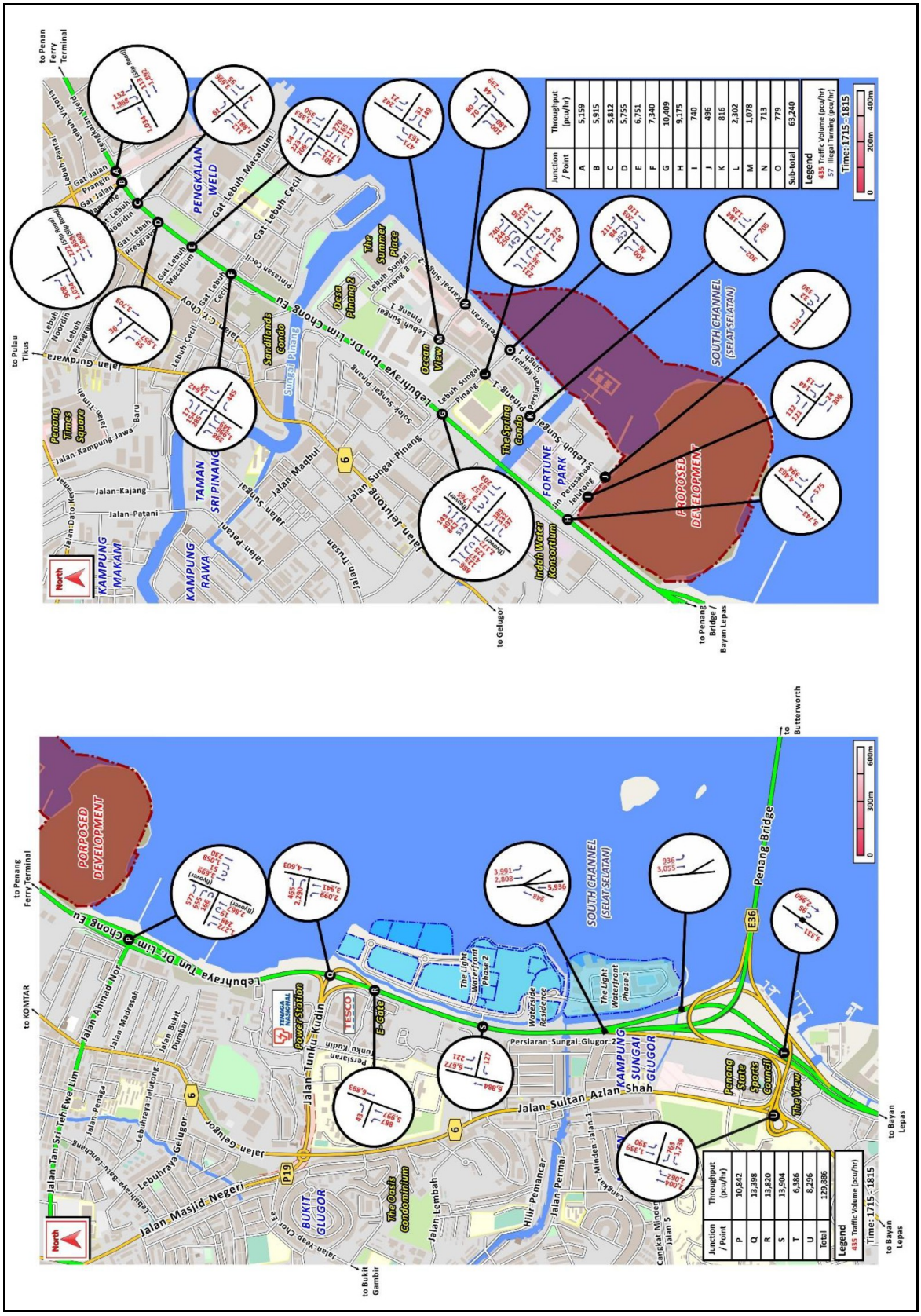
(ii) Water Supply

Water is supplied and distributed by Perbadanan Bekalan Air Pulau Pinang. The source of water supply to the area and its surrounding is from the Sungai Dua treatment plant in Seberang Perai.



Source: Perunding Trafik Bakti Sdn. Bhd.

Figure 6.54 Recorded Travel Demands During Morning Peak Hour In 2020



Source: Perunding Trafik Bakti Sdn. Bhd.

Figure 6.55 Recorded Travel Demands During Evening Peak Hour In 2020

A submarine pipe-line links the Sungai Dua treatment plant to the Bukit Dumbar installation on the island where water is pumped to the reservoir and distributed to the rest of the area. Water is distributed to the surrounding residents and users by a 6" diameter or 9" diameter A.C pipe.

(iii) Electricity Supply

Electricity is supplied and distributed throughout the neighbouring areas by TNB (Tenaga Nasional Berhad). The main intake is from Gelugor which is a 480 MVA station and later distributed to the rest of the island via sub-stations of 132/33 kW intake.

(iv) Telecommunications

TM (Telekom Malaysia Berhad) provides excellent telecommunication service, which are already existing in this area and this can be easily extended to cover the Proposed Project. The nearest exchange center is in Gelugor, which has a capacity of 40,000 lines.

(v) Sewage

George Town and its surrounding areas are connected to the George Town regional sewage reticulation network which conveys sewage for treatment to the regional sewage treatment plant in Jelutong (PEG 227). Besides the regional sewage treatment plant, other central public sewage treatment plants such as the Bayan Baru central sewage treatment are already operational under the IWK's maintenance.

(vi) Solid Waste Disposal

Garbage from the domestic and commercial sectors area collected and then transported to the MBPP's disposal site at the Pulau Burung sanitary landfill in Seberang Perai Selatan on a daily basis.

(vii) Public Safety

The police force is responsible in taking care of the public safety of the residents in the area. The nearest police station is available in George Town and in Jelutong.

(viii) Public Health

Health and medical services are easily available within this area. The residents in this area are serviced by several hospitals and clinics in George Town. The nearest Government hospital is the Penang Hospital whilst various private hospitals such as Gleneagles, Lam Wah Ee and other smaller maternity homes are also available in George Town.

(ix) Fire Services

Fire fighting services are available in George Town located at Jalan Perak.

(x) Postal Facilities

The postal communication services in the vicinity are provided in Jelutong and in the George Town central business district.

(xi) Recreational Facilities

Various recreational facilities are available in DTL especially in Tanjung Bungah and Batu Ferringhi which is in the tourist belt for Penang. Besides the beaches, other recreational facilities include the Botanical Gardens, the Butterfly Park, Bukit Jambul Golf Course and others.

C. Socio Economy And Perception

In order to provide the baseline socio economic status of the area, desks findings are conducted based on the Penang Structure Plan 2030 and the Laporan Tinjauan Kajian Semula Rancangan Struktur Negeri Pulau Pinang 2020. The following provides the baseline socio economic assessment conducted for the Proposed Project and its surrounding area.

(i) Demography

There are no specific demographic data for the area. Therefore, a general demographic profile for the DTL (Daerah Timur Laut) area is given for this purpose obtained from theRancangan Struktur Negeri Pulau Pinang 2030 which is shown in **Table 6.21**.

Table 6.21
Population Distribution In Pulau Pinang According To District ('000) Year 2012-2014 And Population Projected Per Year 2020 And 2030

District	2012	2013	Achievement 2014	Projection 2020	Projection 020 (Statistic Department)	Projection 2030 (RSNPP 2030)
DTL	529.4	531.4	533.3	625.3	Projection from Statistic Department is for internal use only and not to be publish for public use	643.1 (28%)
DBD	209.1	211.9	214.7	286.5		390.5 (17%)
SPU	303.0	305.6	308.1	351.9		367.5 (16%)
SPT	384.0	387.7	391.4	509.0		574.2 (25%)
SPS	185.6	191.9	198.2	284.3		321.5 (14%)
Total	1,611.1	1,628.5	1,645.7	2,057.00	1,980.00	2,296.80 (100%)

Source : Rancangan Struktur Negeri Pulau Pinang 2030

The population of Penang is projected to increase by 2.1% yearly whereby by year 2030, Penang's population will be 2,296.80. The population distribution showed that the population in DTL is higher than Daerah Barat Daya whereby by year 2030, it is projected that 643,108 people will be residing in DTL.

(ii) Employment

No specific data is available for the employment structure in the DTL. However, base on the population statistics outlined in the Laporan Tinjauan Rancangan Struktur Negeri Pulau Pinang 2020, the employment structure in Penang is mostly based on manufacturing as shown in **Table 6.22** which accounts for more than 31% of the employment structure in Penang.

Table 6.22
Human Resource Contribution In Penang According To Sector From 2012 To 2025

Industrial		2010		2011		2012	
		Number ('000)	%	Number ('000)	%	Number ('000)	%
Primary	Agriculture, Forestry, Fishery and Animal Husbandry	14.0	1.9	16.1	2.1	20.5	2.7
	Mining and Quarrying	0.2	0.0	0.0	0.0	0.5	0.1
Secondary	Manufacturing	231.6	31.7	244.1	32.5	236.1	31.2
	Electric and Water	1.7	0.2	2.3	0.3	0.9	0.1
	Water Supply, Sewage Service, Waste Management and Rehabilitation	4.0	0.6	5.1	0.7	4.1	0.5
	Construction	53.0	7.3	50.8	6.8	53.9	7.1
	Transport	119.3	16.3	115.2	15.3	123.1	16.2
	Transport and Storage	38.9	5.3	38.4	5.1	40.6	5.4
Tertiary	Commerce, Retail, Hotel and Restaurant	38.9	8.7	73.0	9.7	62.0	8.2
	Information and Communications	3.9	0.5	5.6	0.7	5.5	0.7
	Finance and Insurance	20.4	2.8	16.1	2.1	15.1	2.0
	Real Estate	5.5	0.7	4.5	0.6	3.6	0.5
	Professional Activities, Scientific & Technical	14.1	1.9	17.5	2.3	16.8	2.2
	Administrative and Support	26.1	3.6	24.5	3.3	39.5	5.2
	Administration, Defense, Social Service and Security	25.9	3.6	31.4	4.2	28.6	3.8
	Education	43.0	5.9	34.6	4.6	38.2	5.0
	Aktiviti Kesihatan Kemanusiaan dan Kerja Sosial	22.0	3.0	32.6	4.3	31.1	4.1
	Art Entertainment and Recreational	4.0	0.5	4.4	0.6	4.5	0.6
	Other Services	15.7	2.1	15.5	2.1	10.0	1.3
	Household as Employers	23.2	3.2	20.1	2.7	23.1	3.1
	Uniform bodies and Others	-	-	-	-	-	-
	Total	**730.0**	**100.0**	**751.8**	**100.0**	**757.7**	**100.0**

Source : Laporan Tinjauan Kajian Semula Rancangan Struktur Negeri Pulau Pinang 2020

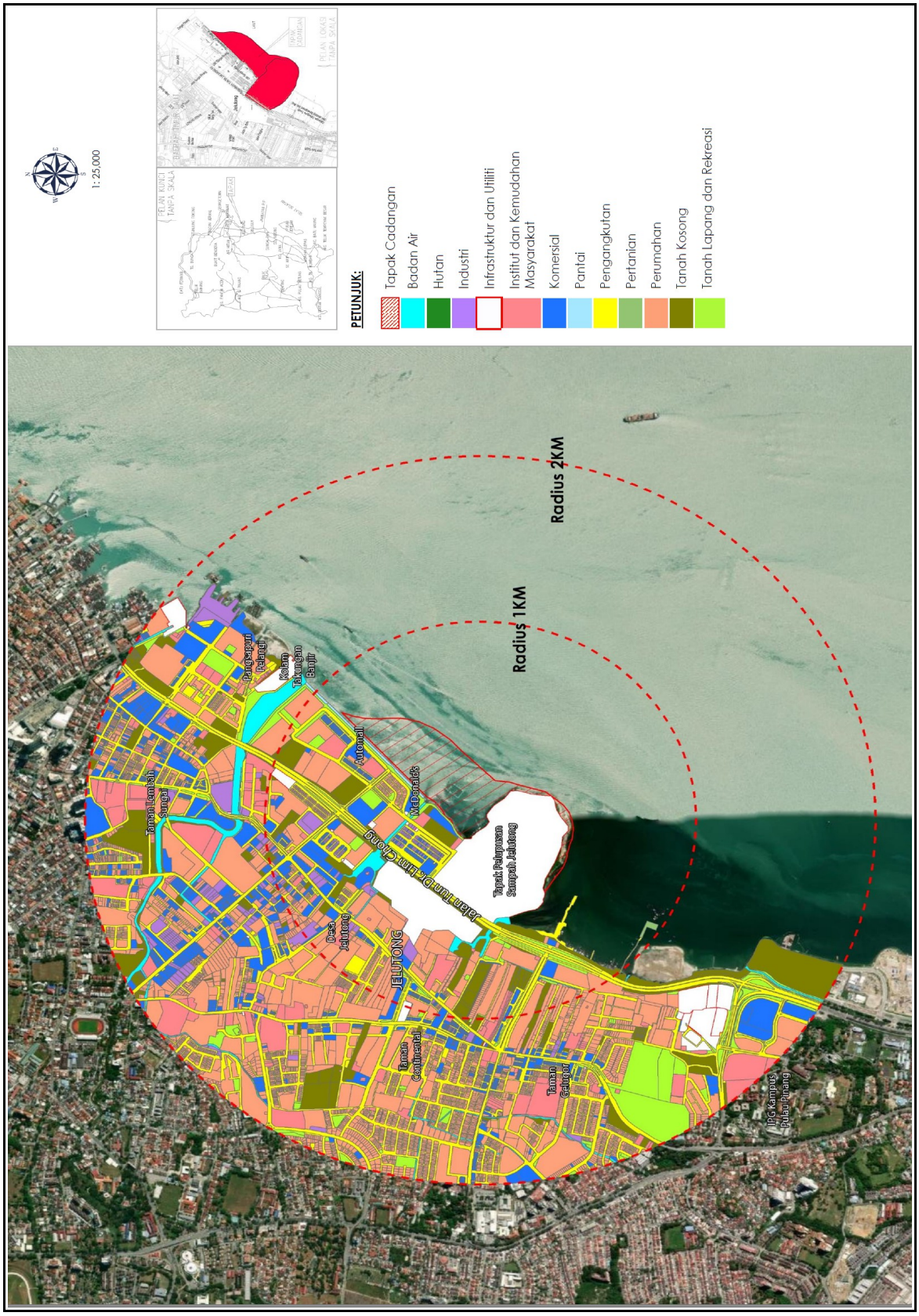
(iii) Social Perception

A SIA (Social Impact Assessment) study has been conducted for the Proposed Project to meet the requirements under the Town and Country Planning Act, 1976 which has been submitted to JPBD for approval as the land reclamation activities is classified as Category 3 SIA. JPBD via letter reference JPBD/01/0004/26 Jld 5(42) dated 15th November 2023 has approved the SIA report for the Proposed Project. A copy of this letter is provided in **Appendix A-001.** Extract from the SIA report is provided in this section to provide the social perceptions of the community staying in the nearby areas.

According to the SIA report, stratafied random sampling is conducted to determine the overall population required for the social survey. To ensure that the data obtain is significant to represent the residential and commercial communities wihin the 2 km radius ZOI (Zone Of Influence) as shown in **Figure 6.56.** The field study is conducted through a survey of housing, commercial, tourists/visitors and fishermen as shown in **Table 6.23, Table 6.24 and Table 6.25.**

Table 6.23
Number Of Housing And Commercial Respondents

Bil	Area	Sample No.	
		Housing	Commercial
Primary Zone (0KM-1KM)			
1	Persiaran Karpal Singh	3	-
2	Lebuh Sungai Pinang	10	35
3	Solok Sungai Pinang	17	17
4	Taman Pantai Tanjung	10	-
5	Mutiara Heights	35	-
6	Jelutong Park	35	-
7	Mutiara Idaman 1	20	-
8	Mutiara Idaman 2	10	-
9	Richmont Residence	10	-
10	Straits Garden	10	-
11	Kg. Loh Ban Kong	10	-
12	Kg. Tokong Batu	10	-
13	Kg. Kota Giam	10	-
14	Kg. Jalan Haji Md Taib	10	-
15	Kg. Masjid (Jelutong)	10	-
16	Kg. Jalan Madrasah	10	-
17	Kg. Lebuh Bakau	10	-
18	Fortune Park	-	50
19	Lebuh Bakau	-	6
20	Metro Avenue	-	12
	Jumlah	227	120



Source: SIA Report, 2023

Figure 6.56 Zone Of Influence (ZOI)

Table 6.23 (Continue)

Bil	Area	Sample No.	
		Housing	Commercial
Secondary Zone (1KM-2KM)			
1	Bukit Dumbar Permai Apartment	-	20
2	Bukit Dumbar Villa	-	-
3	Taman Bukit Dumbar	-	-
4	Morning Dew Tower	-	-
5	Sunshine Tower	-	-
6	Sea Breeze Tower	-	-
7	Edge 360 Executive Condo	-	-
8	Penang Sinar Bukit Dumbar Apartment	-	-
9	Villa Emas Ewani Apartment	-	-
10	Desa Bukit Dumbar Apartment	-	-
11	Vista Bukit Dumbar Apartment	3	-
12	Jelutong Park	3	-
13	Taman Selatan Apartment	3	-
14	Taman Medan Penaga	3	-
15	Taman Seri Damai	3	3
16	Mewah Court Apartment	3	-
17	Desa Green Apartment	3	-
18	Damai Vista Apartment	3	-
19	Suria Mutiara Apartment	3	-
20	Taman Seri Perak Apartment	3	-
21	Harmony View Apartment	3	-
22	Taman Sri Penawar	3	-
23	Sri Permai Apartment	3	-
24	Taman Sawang	3	-
25	Sri Tanjung	3	-
26	Taman Sin Chor Chit Apartment	3	-
27	Kota Emas	3	-
28	Taman Tampin Apartment	3	-
29	Taman Nusantara	3	-
30	Taman Jelutong Jaya	3	-
31	Sri Wangsa 1 & 2	3	-
32	Tingkat Nusantara Flat	3	-
33	Tampin Court Apartment	3	-
34	Kampung Makam	6	-
35	Rumah Pangsa Kampung Rawa	2	-
36	Desa Selatan Apartment	2	-
37	Taman Serina	2	-
38	Taman Sri Pinang	2	-
39	Sandilands Condominium	2	-
40	Taman Kilangin	2	-
41	Taman Lembah Sungai	2	-
42	Pinang Court 2	2	-
43	Desa Pinang 1 Apartment	2	-

Table 6.23 (Continue)

Bil	Area	Sample No.	
		Housing	Commercial
44	Desa Pinang 2 Apartment	2	-
45	Summer Place Condo	2	-
46	Pangsapuri Pelangi	2	-
47	Bayswater Condominium	2	-
48	Platino Luxury Condominium	2	-
49	Vertiq Condominium	2	-
50	Kg. Jalan Hajjah Rehmah	2	-
51	Kg. Sungai Pinang	2	-
52	Kg. Tong Ku	2	-
53	Kg. Pulau	2	-
54	Kg. Selut	2	-
55	Kg. Dodol	2	-
56	Kg. Masjid (Jalan Perak)	2	-
57	Kg. Rawa	2	5
58	Lintang Jelutong	-	4
59	Solok Jelutong	-	8
60	Jalan Selama	-	7
61	Solok Slim	-	6
62	Lintang Slim	-	7
63	Sri Permai	-	5
64	Sungai Pinang	-	9
65	Jalan Makloom	-	10
66	Gat Lebuh Cecil	-	2
67	Gat Lebuh Macallum	-	2
68	Lebuh Herriot	-	7
69	Lebuh Sandilands	-	8
70	Lebuh Tunku Kudin	-	2
	Jumlah	151	99
	Jumlah keseluruhan	378	219

Source: SIA Report, 2023

Table 6.24
Number Of Fishermen Respondents

No.	Area	Total
A.	Primary Zone (0-1 Km)	
1.	Unit Nelayan Jelutong	5
	Sub Total	**5**
B.	Secondary Zone (1-2 Km)	
1.	Unit Nelayan Sg. Pinang	7
	Sub Total	**7**
C.	Additional	
1.	Unit Nelayan Sg. Gelugor	1
2.	Unit Nelayan Batu Uban	7
	Sub Total	**8**
	Total	**20**

Source: SIA Report, 2023

Table 6.25
Number Of Visitor Respondents

Bil	Area	Sample No.
Primary Zone (0-1KM)		
1.	Pelawat di Persiaran Karpal Singh	100
	Jumlah	100

Source: SIA Report, 2023

The total number of samples that need to be taken for this study is 935 samples while the total sample obtained during the questionnaire is 717 respondents as shown in **Table 6.26.** The questionnaire study conducted has received good cooperation from respondents for residential, commercial and tourist areas. For the fishing community, only as many as 8% (20 respondents) who cooperated with the questionnaire study carried out. This small number of achievements of 8% has led to the need to hold a workshop session with representatives of fishing units, agencies, developers and consultant.

Table 6.26
Summary Of Sample Size

Bil.	Area	Number of Units	Number of Samples	Samples Obtained	Achievement
1.	Nelayan	238	238	20	8%
2.	Housing	20,784	378	378	100%
3.	Commercial	513	219	219	100%
4.	Tourist/Visitor at Persiaran Karpal Singh	100	100	100	100%
	Total		935	717	77%

Source: SIA Report, 2023

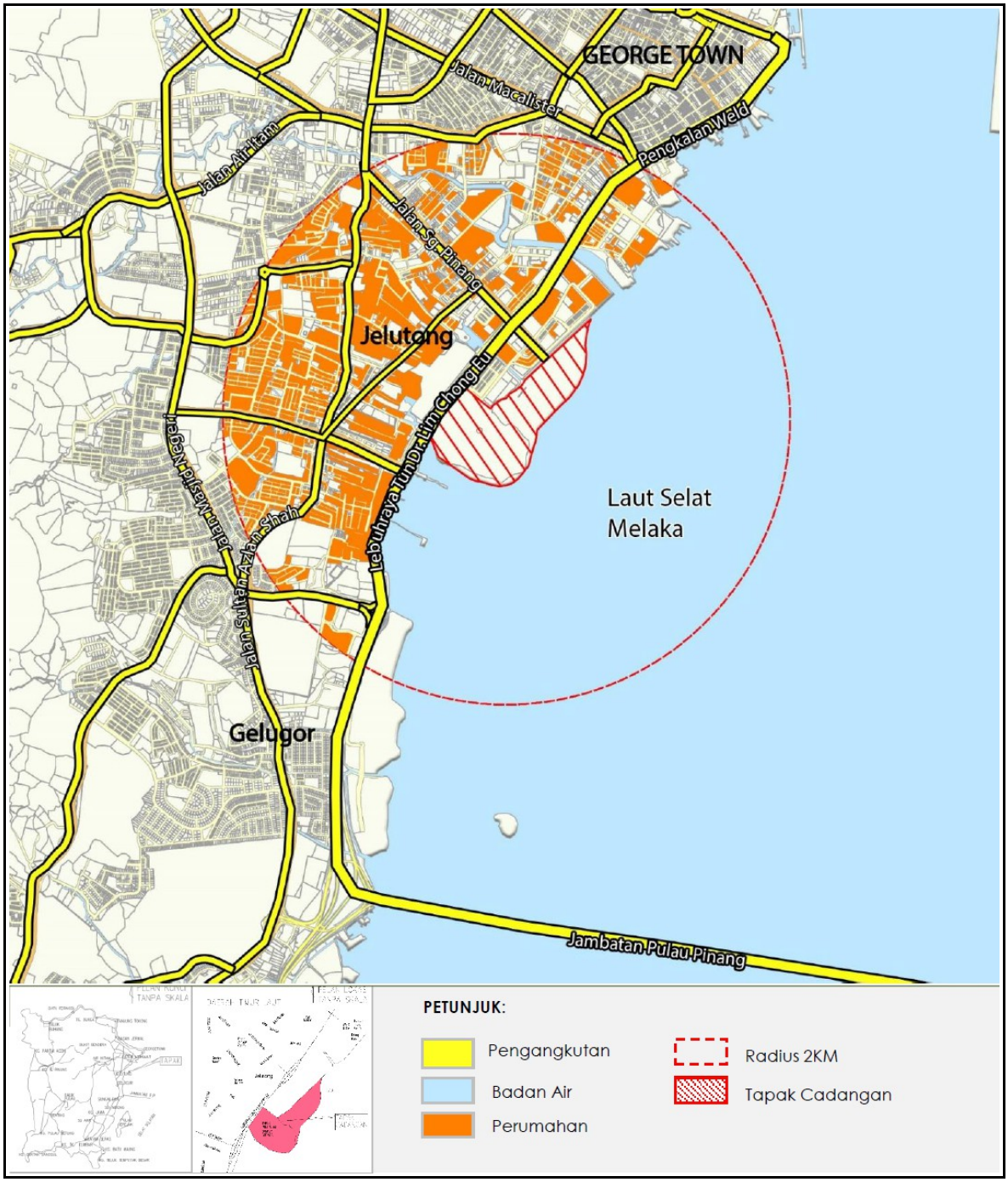
The survey area conducted for this fishing community covers 4 fishing units, namely Jelutong Fishing Unit, Sungai Pinang Fishing Unit, Gelugor River Fishing Unit and Fishing Unit Gray stone. **Figure 6.57** shows the directly impacted and impacted fishing pier indirectly for development proposals while **Figure 6.58** shows the distribution of housing and commercial located within a radius of 0-2 km from recommended site.

Visitors to Persiaran Karpal Singh are a community that will be indirectly affected with this proposed mixed development and trade. Redemptive activity the seashore in part of Persiaran Karpal Singh will affect recreational activities as well tourism in the area. **Figure 6.59** is the location conducted for the questionnaire survey at Persiaran Karpal Singh's.

Figure 6.60 shows the summary of the survey for the level of agreement of the respondents against development proposals. The following figure also shows a summary of the level of agreement according to each land use category.

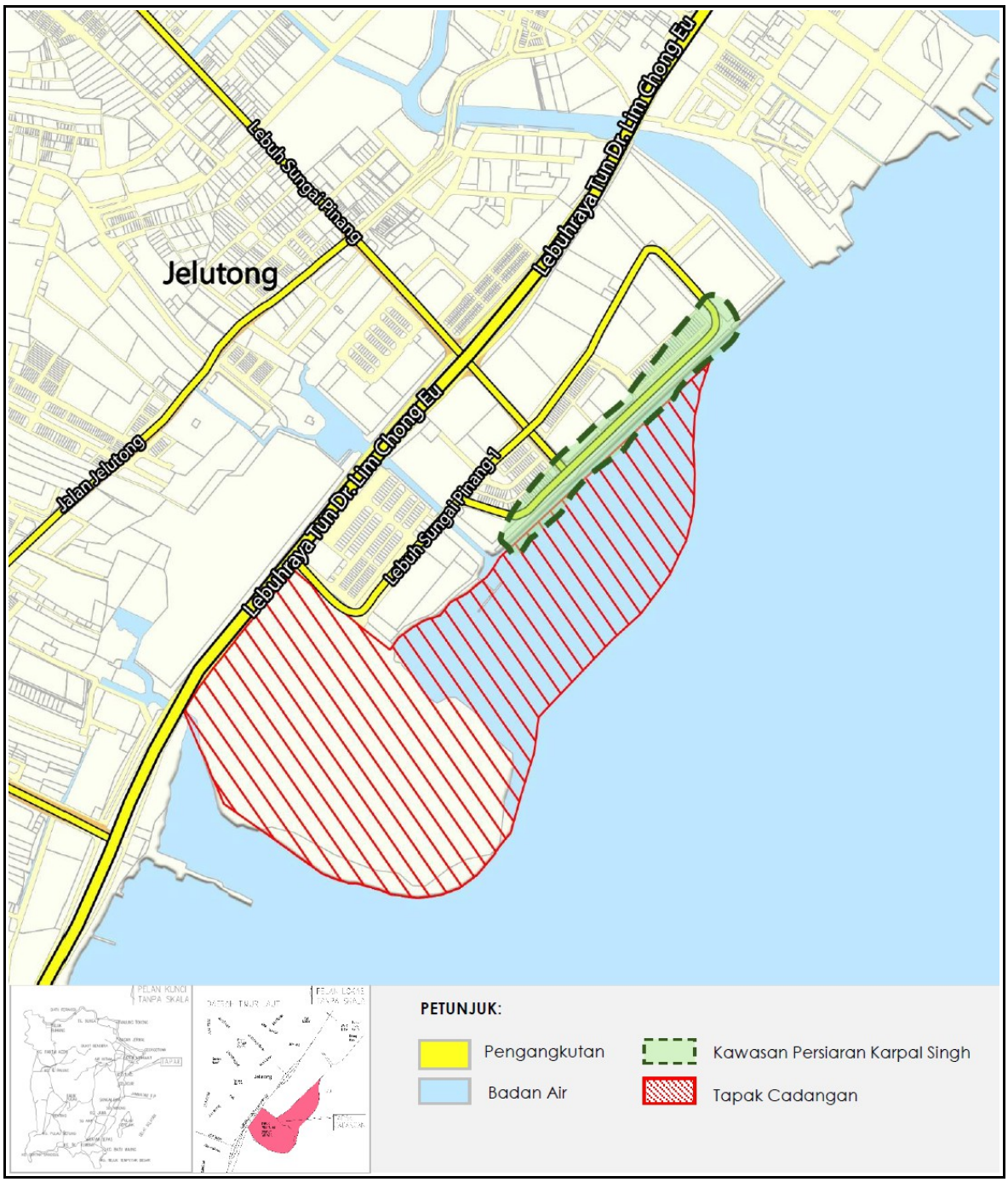
Source: SIA Report, 2023

Figure 6.57 Location Of Fishing Pier



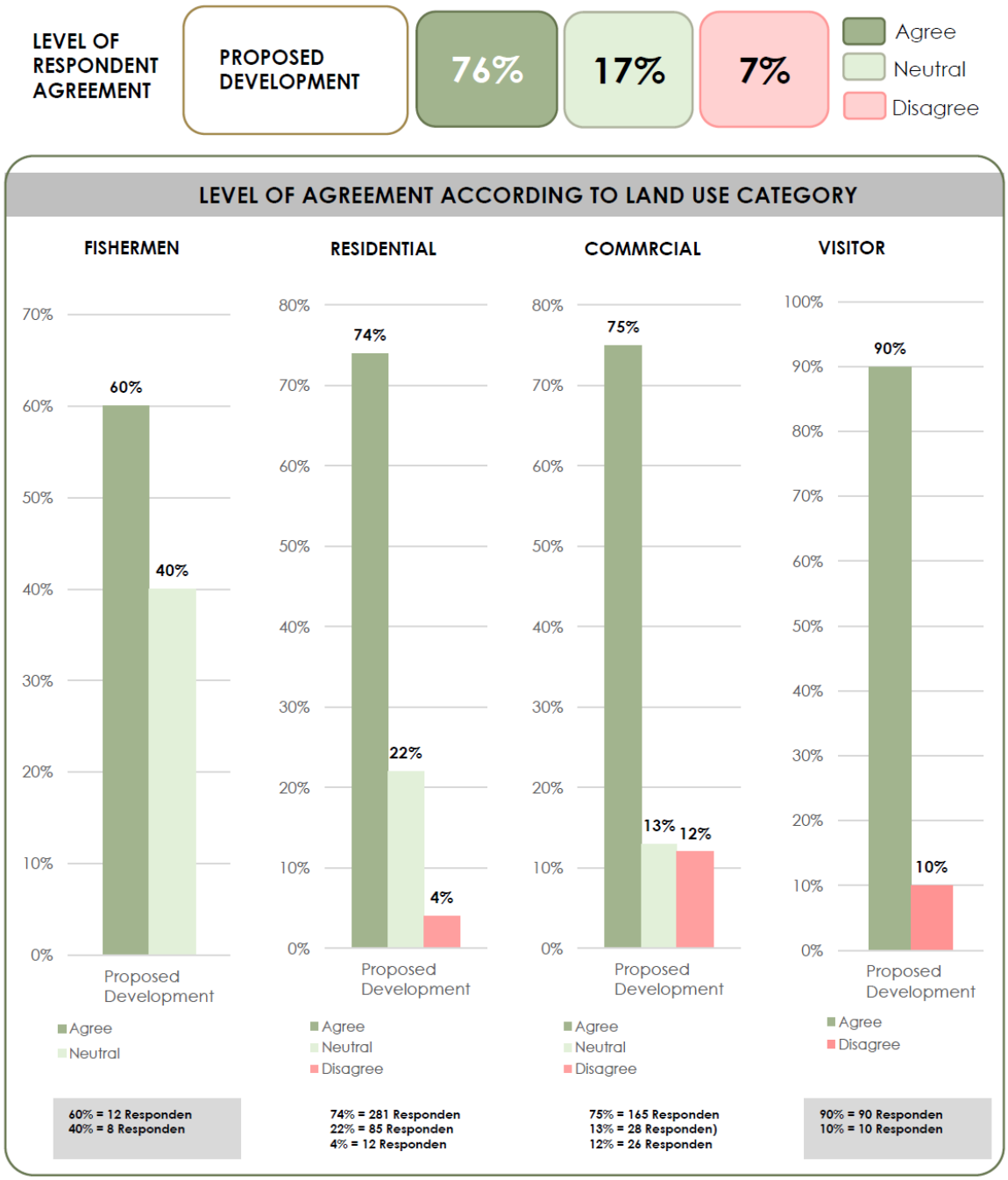
Source: SIA Report, 2023

Figure 6.58 Location Of Housing And Commercial Area Within 2 Km Radius



Source: SIA Report, 2023

Figure 6.59 Location Of Survey Area In Persiaran Karpal Singh



Source: SIA Report, 2023

Figure 6.60 Level Of Agreement

Based on the analysis that has been carried out, the majority of respondents do not object to the development which is proposed. Only 5% (37 respondents) did not agree with the proposed mixed development. For the Primary Zone, as much as 22% (100 respondents) strongly agree, as many as 46% (207 respondents) agree, as much as 14% (64 respondents) slightly agree, 11% (49 respondents) are neutral and only 7% (32 respondents) disagree with the proposed development. As for the Secondary Zone, as much 14% (37 respondents) strongly agree, 57% (145 respondents) agree, 18% (47 respondents) slightly agree, as many as 9% (23 respondents) are neutral and only as much 2% (5 respondents) do not agree with the proposed mixed development and this trade. In addition, there are also additional respondents from the fishing community namely respondents from Sungai Gelugor Fishing Unit and Batu Uban Fishing Unit. Additional respondents does not object to the development proposal because as many as 12% (1 respondent) agree, 38% (3 respondents) slightly agree and 50% (4 respondents) are neutral. **Table 6.27** provide a detailed summary of the acceptance of development proposals according to the ZOI.

Table 6.27
Summary Of Acceptance The Proposed Development According To ZOI

Acceptance of the Project	Respondent						Total	
	Primary Zone (0-1KM)	%	Secondary Zone (1-2KM)	%	Additional (Nelayan Sg. Gelugor dan Batu Uban)	%	Cumulative	%
Strongly Agree	100	22	37	14	0	0	137	19
Agree	207	46	145	57	1	12	353	49
Slightly Agree	64	14	47	18	3	38	114	16
Neutral	49	11	23	9	4	50	76	11
Disagree	32	7	5	2	0	0	37	5
Total	452	100	257	100	8	100	717	100

Source: SIA Report, 2023

There are 2 public engagement sessions held for the implementation of the SIA study for recommendations this mixed development and trade such as FGD (Focus Group Discussion) Sessions and Workshop session. This public engagement session has also been conducted through two methods, namely above online and physical. Cooperation that is not encouraging from the representatives of the MPKK (Majlis Pengurusan Komuniti Kampung), KRT, Jelutong Fishing Unit, Sungai Pinang Fishing Unit, Fishing Unit Gelugor River and Batu Uban Fishing Unit have led to the need for a workshop session. The implementation of the public engagement session is as per **Table 6.28.**

Public engagement sessions are held to get feedback from parties interested in the proposed mixed development and trade. The matters discussed during the public engagement sessions are shown in **Table 6.29.**

Table 6.28
Details Of Public Engagement Sessions

Sessions	Public Engagement	Date	Method	Number of Participants
FGD	Majlis Pengurusan Komuniti Kampung (MPKK) dan KRT	14 Disember 2022 (Sesi pagi)	Online	3
	Jabatan dan Agensi Teknikal	14 Disember 2022 (Sesi petang)	Online	21
Bengkel	Pihak Berkepentingan • Agensi • MPKK • KRT • Persatuan Pengguna Pulau Pinang	8 Januari 2023	Physical	17
	Pihak Berkepentingan • Agensi • Unit Nelayan Jelutong	16 Februari 2023 (Sesi pagi)	Physical	19
	Pihak Berkepentingan • Agensi • Unit Nelayan Sungai Pinang • Unit Nelayan Batu Uban • Unit Nelayan Sungai Gelugor	16 Februari 2023 (Sesi petang)	Physical	20

Source: SIA Report, 2023

Table 6.29
Issues Discussed During Public Engagement Sessions

No.	Issues
1.	Alert on mixed development and trade proposals.
2.	Consent with the proposed development of the Jelutong landfill.
3.	Consent with the proposed sea reclamation activities in part of Persiaran Karpal Singh.
4.	Agreement with mixed development and trade proposals.
5.	Current problems in the surrounding area faced by residents.
6.	The expected positive and negative effects will occur during the project under construction and operation.
7.	Consent if the proposed project is implemented.
8.	Additional comments and suggestions.

Source: SIA Report, 2023

FGD (Focus Group Discussion) and workshops are conducted to obtain data and information in the implementation of SIA. Overall, each issue and expected impact that stated by the representatives present during the FGD session, and this workshop needs to be paid attention to and should be addressed by the parties involved to avoid negative impacts against the population in the area around the proposed development site. **Table 6.30** is a summary of the expected positive and negative impact findings for the FGD Session and workshop for proposed mixed development and trade.

Table 6.30
Summary Of Expected Positive And Negative Impact Findings

Bil.	Issue /Expected Impact	Session	Phase			Impact
			F1	F2	F3	
1	Provide employment opportunities to locals.	FGD		/	/	Positive
		Bengkel			/	
2	Penang residents have the opportunity to own their own homes.	FGD				Positive
		Bengkel			/	
3	The facilities provided will enhance the safety of the local residents and ease the burden of the community.	FGD				Positive
		Bengkel			/	
4	The probability of the use of the circular economy concept is applied.	FGD		/		Positive
		Bengkel				
5	Improving the economy in coaching industry	FGD		/		Positive
		Bengkel				
6	Fish breeding will be affected as a result high slush	FGD				Negative
		Bengkel	/			
7	The existing jetty is not able to accommodate the membership of Jelutong fishermen.	FGD				Negative
		Bengkel	/			
8	Construction of a full-fledged fish landing complex.	FGD				Negative
		Bengkel	/			
9	The destruction of the Jelutong fishing community	FGD				Negative
		Bengkel	/			
10	It is necessary to create a fishing village as an attraction and economic opportunity.	FGD				Negative
		Bengkel	/			
11	Disagreement with the reserve of a new location of the fish landing complex and jetty in Plot 39.	FGD				Negative
12	Provision of temporary jetties for the use of impressed fishermen.	FGD				Negative
		Bengkel	/			
13	The absence of breakwater adversely affects fishermen.	FGD				Negative
		Bengkel	/			
14	Landfills are not suitable for operation due to pollution.	FGD	/			Negative
		Bengkel	/			
15	The existing Construction and Demolition (C&D) disposal operations will be affected.	FGD	/			Negative
		Bengkel	/			
16	Fishing issues will arise (income is affected, catch yield decreases, destruction of fish catch.	FGD	/			Negative
		Bengkel	/		/	
17	The road is damaged and dirty as a result of heavy vehicles coming in and out.	FGD		/		Negative
		Bengkel		/		
18	Affecting the recreational area at Persiaran Karpal Singh.	FGD				Negative
		Bengkel		/		
19	Soil erosion disrupts the stability of the slopes at the Jelutong landfill site.	FGD		/		Negative
		Bengkel		/		
20	Increase water pollution (water quality and leachate).	FGD		/		Negative
		Bengkel				
21	Increase air pollution (dust and dust).	FGD		/		Negative
		Bengkel				
22	The peace of the residents was disturbed due to the noise.	FGD		/		Negative
		Bengkel		/		

Table 6.30 (Continue)

Bil.	Issue /Expected Impact	Session	Phase			Impact
			F1	F2	F3	
23	Road congestion disrupts the flow of disrupted traffic.	FGD		/	/	Negative
		Bengkel		/	/	
24	Increase in solid waste	FGD		/	/	Negative
		Bengkel				
25	Sea catchment areas affected will interfere with fisheries activities.	FGD		/		Negative
		Bengkel		/	/	
26	The catch is reduced.	FGD				Negative
		Bengkel		/		
27	The cost of fisherman's activities is affected.	FGD				Negative
		Bengkel		/		
28	Risk of transmission of dengue outbreaks and infectious diseases.	FGD		/		Negative
		Bengkel				
29	Flooding in the upstream area as the proposed site is located close to the mouth of the river.	FGD		/	/	Negative
		Bengkel				
30	Affects existing drainage	FGD		/	/	Negative
		Bengkel				
31	Compatibility of landfills to be developed	FGD	/			Negative
		Bengkel				
32	Increased influx of foreigners	FGD		/		Negative
		Bengkel				
33	Environmental pollution	FGD		/		Negative
		Bengkel				
34	Disturbed marine life	FGD		/		Negative
		Bengkel				

Source: SIA Report, 2023

Based on the results of the questionnaire analysis, focus group discussions and workshops show that the proposed mixed development and trade received a positive response. Analysis obtained from questionnaires, FGDs and workshops shows the majority of representatives those involved agree with this development proposal. The Jelutong Fisherman's Unit is a community that is directly affected also does not object to the proposal development and hope that the developers take into account the views given by representatives of fishermen present at the workshop session. The agencies and technical departments involved with the FGD session also did not have any objection to this proposal.

However, they also voiced concerns about the proposed development and hope that issues or negative impacts will be given attention so development does not have a significant negative impact on the environment, activities fisheries, fishermen, safety and health. The conclusion that can be obtained from this study is, the majority of communities within the radius. The study area agrees with the proposed mixed development and trade but mitigation measures to solve the issues mentioned should be emphasized by the parties related.

D. Marine Traffic

The Terms of Reference for the conduct of the MRA (Marine Risk Assessment) by the appointed consultant has been submitted to Jabatan Laut Malaysia Wilayah Utara and the said authority has endorsed the TOR via letter (2)JLWU.BOM.600-00018 dated 19th December 2023. A copy of this letter is provided in **Appendix A-001.** However, due to recent requirements Jabatan Laut Malaysia via Malaysia Shipping Notice MSN 03/2024 has notify that the requirement for MRA (Marine Risk Assessment) are limited to the marine activities involving ship as listed below:-

- Mining including exploration and exploitation o oil & gas resources;
- Cable and pipe laying;
- Construction of new port, wharf and jetty within the main navigational channel;
- Ship to ship activity – liquid bulk cargo; and
- Any other activity as determined by the Director of Marine.

A copy of this notice is provided in **Appendix A-001.** Thus, MRA is no longer required for land reclamation activities.

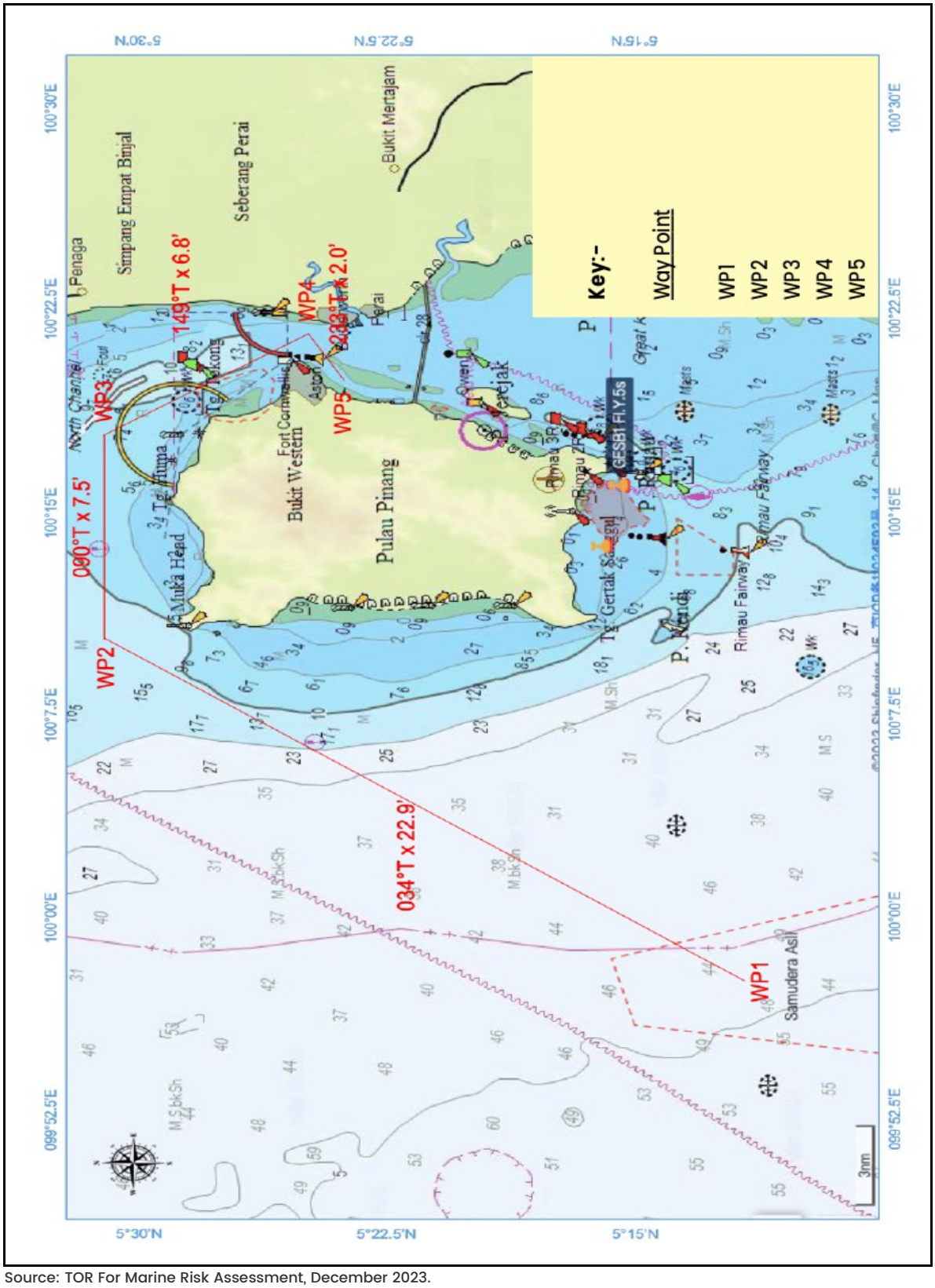
Data pertaining to the marine traffic in this section is obtained from the preliminary sources extracted from the appointed consultant for the marine risk as provided below:-

(i) Passage From Sand Source Area To Reclamation Site

Sand carriers en-route to the JDS reclamation site may access it via the northern channel of Penang Port as shown in **Figure 6.61.** Licensed harbour pilots are required to guide these sand carriers when navigating within the mandatory pilotage area of Penang Port. Sand carriers with a draft of less than 7 meters should remain outside the dredged channel at all times.

(a) North Channel – In Bound

The North Channel is entered at Latitude 05°35'N and Longitude 100°13'E, about 1.5 nautical miles southeast of the Fairway Buoy. It is marked by seven (7) pairs of IALA Region A lateral buoys. A maximum of 10% of draught as under keel clearance is needed at all times during the passage whilst transiting the channel. For deep draught vessels, due allowance for course alteration into the channel at buoy no. 1 should be given so as not to arrive at too acute an angle.



Source: TOR For Marine Risk Assessment, December 2023.

Figure 6.61 Passage Plan From Sand Source Area To Reclamation Site

Between buoy no. 1 and buoy no. 2, vessel will experience a bodily drift to the north or south depending on the prevailing tidal condition. This drift is especially pronounced during periods of spring tides. Upon reaching buoy no. 1, the course is 127°T thence course is altered to 145°T at buoy no. 5 to pass between no. 6 pair of buoys. Vessel drawing more than 10m draught are advised to pass through buoy no. 7 before leaving the channel. Inbound vessels with a draught of less than 7m may proceed without using the channel by staying close to the buoys. An alternative route for shallow draught vessels, upon reaching buoy no. 5 is to alter curse to 160°T, keeping buoy no. 6 and buoy no. 7 to port.

(b) North Channel – Out Bound

Table 6.31 provides the passage plan for sand carriers to reclamation site. Russian Wreck Buoy should be kept to port and upon reaching it, course is altered to 340°T direct to buoy No. 5, keeping Tokong Buoy and buoy No. 6 to starboard. For deep draft vessels, it is advisable to do dog leg upon reaching Tokong Buoys and steer towards buoy No. 6 to enter the channel.

Table 6.31
Passage Plan For Sand Carriers To Reclamation Site

Waypoint	Latitude	Longitude	Course	Distance	Remark
WP1	05°11.7'N	099°57.7'E	034°T	22.9 nm	Samudra Asli
WP2	05°30.8'N	100°10.4'E	090°T	7.5 nm	Muka Head
WP3	05°30.8'N	100°17.9'E	149°T	6.8 nm	Buoy 7
WP4	05°24.9'N	100°21.5'E	233°T	2.0 nm	Aston
			Total	39.2 nm	

Source: TOR For Marine Risk Assessment, December 2023.

(ii) Fishery Activities

The sand source area is situated within the fishing zones B and B1. A significant majority, over 80%, of the proposed sand mining area is located within zone B1, with the remaining portion falling under zone B. Zones B and B1 are classified as commercial fishing zones, meaning that fishing vessels operating in these zones and beyond are required to be equipped with commercial fishing gear. In accordance with the zonation established by the DOF (Department of Fisheries Malaysia), a total of 1055 licensed fishing vessels hailing from the Hilir Perak districts were reported to be active in Zones B and B1. **Table 6.32 to Table 6.34** provide details about the count of fishing vessels that were licensed by the Department of Fisheries in the areas of Hilir Perak, Timur Laut, and Barat Daya, Penang.

Table 6.32
Number Of Licensed Fishing Boats At Hilir Perak

Inboard								Outboard	Total
0-4.9 GRT	5-9.9 GRT	10-14.9 GRT	15-19.9 GRT	20-24.9 GRT	25-39.9 GRT	40-69.9 GRT	Above 70 GRT		
12	130	26	61	40	98	383	89	216	1055

Source: TOR For Marine Risk Assessment, December 2023.

Table 6.33
Number Of Licensed Fishing Boats At Timur Laut, Penang

Inboard								Outboard	Total
0-4.9 GRT	5-9.9 GRT	10-14.9 GRT	15-19.9 GRT	20-24.9 GRT	25-39.9 GRT	40-69.9 GRT	Above 70 GRT		
15	14	16	0	0	17	21	1	506	590

Source: TOR For Marine Risk Assessment, December 2023.

Table 6.34
Number Of Licensed Fishing Boats At Barat Daya, Penang

Inboard								Outboard	Total
0-4.9 GRT	5-9.9 GRT	10-14.9 GRT	15-19.9 GRT	20-24.9 GRT	25-39.9 GRT	40-69.9 GRT	Above 70 GRT		
1	12	2	0	2	24	25	19	598	683

Source: TOR For Marine Risk Assessment, December 2023.

Given the vastness of the fishing zones B and B1 where the sand source area is located, it is unlikely that sand extraction operations will hinder fishing activities, as fishermen could easily fish elsewhere within these zones. Thus, the sand mining activities will not affect the fishing activities in the vicinity of the proposed sand mining area.

(iii) Marine Traffic

Penang Port handled 3,555 arrivals of commercial ships in 2022 which almost all enter and leave through North Channel as shown in **Table 6.35.** The channel is only accessible for one-way traffic with total distance of 12 nm (from Pilot Boarding Ground to Buoy No. 7), width 185m and depth 11m. Traffic density along the route to north channel Penang Port is between 114 to 271 routes/0.31km^2/year. Barge carrying sand to reclamation site shall at all times give wide berth to vessels navigating within dredged channel and shall avoid obstructing the channel.

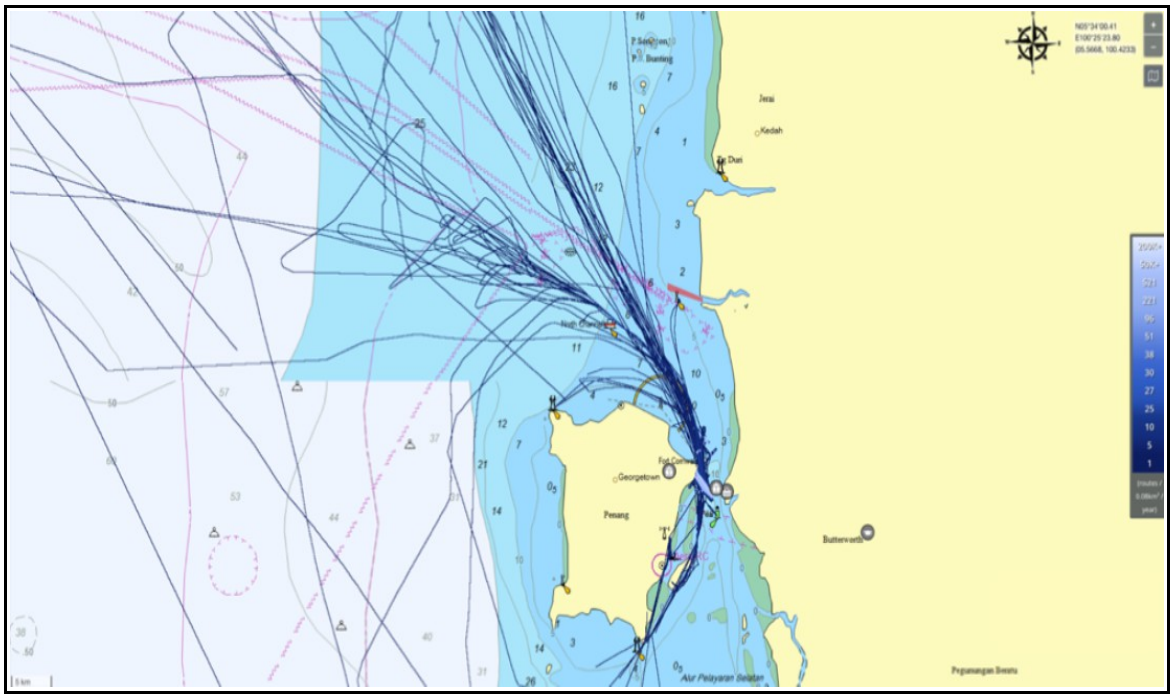
Table 6.35
Number Of Ship Calls By Types Of Ship In 2022

	Foreign Going							Coastal							Grand Total
	Container		Gen. Cargo	Tankers	Dry Bulk	Others	Total	Container		Gen. Cargo	Tankers	Dry Bulk	Others	Total	
	Main Line	Feeder						Main Line	Feeder						
1Q	208	140	73	146	33	514	**1114**	-	-	44	28	-	240	**312**	**1426**
2Q	228	109	54	114	37	55	**597**	-	-	21	35	-	58	**114**	**711**
3Q	94	230	30	153	43	40	**590**	-	-	34	34	-	82	**150**	**740**
4Q	187	117	29	142	46	64	**585**	-	-	8	30	-	57	**93**	**678**
2020	**717**	**596**	**186**	**555**	**159**	**673**	**2886**	**-**	**-**	**107**	**127**	**-**	**437**	**669**	**3555**

Source: TOR For Marine Risk Assessment, December 2023.

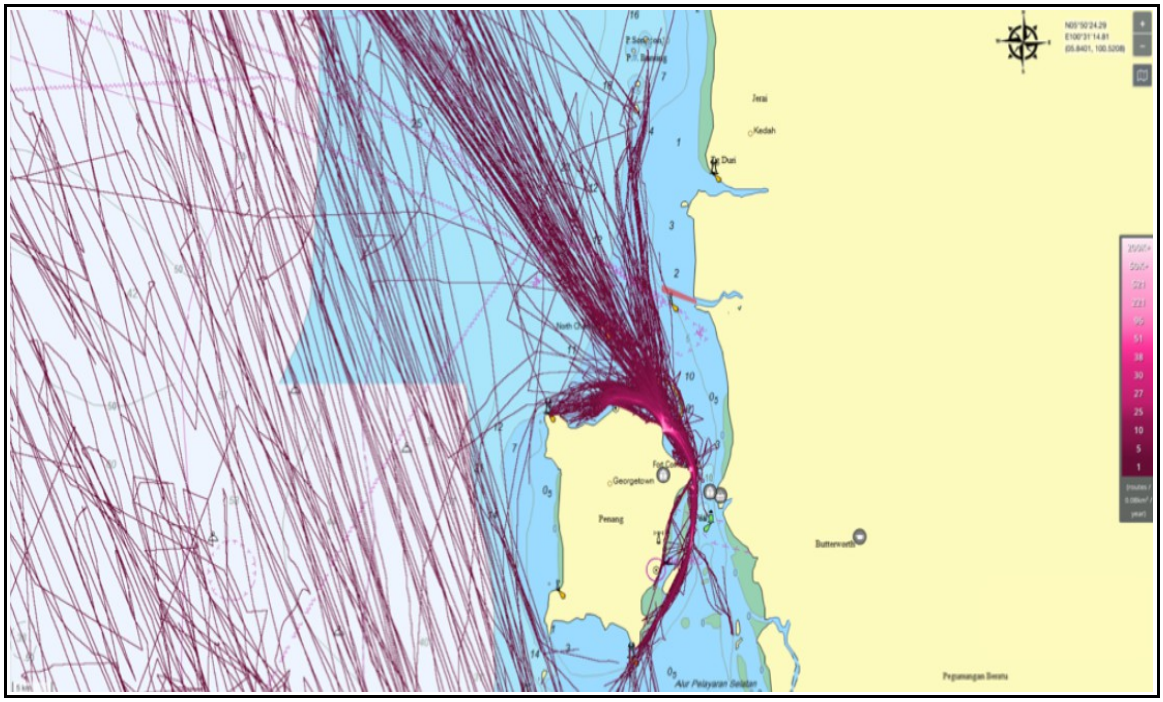
(iv) Common Navigational Routes

Figure 6.62 to Figure 6.68 provides the common navigational routes.



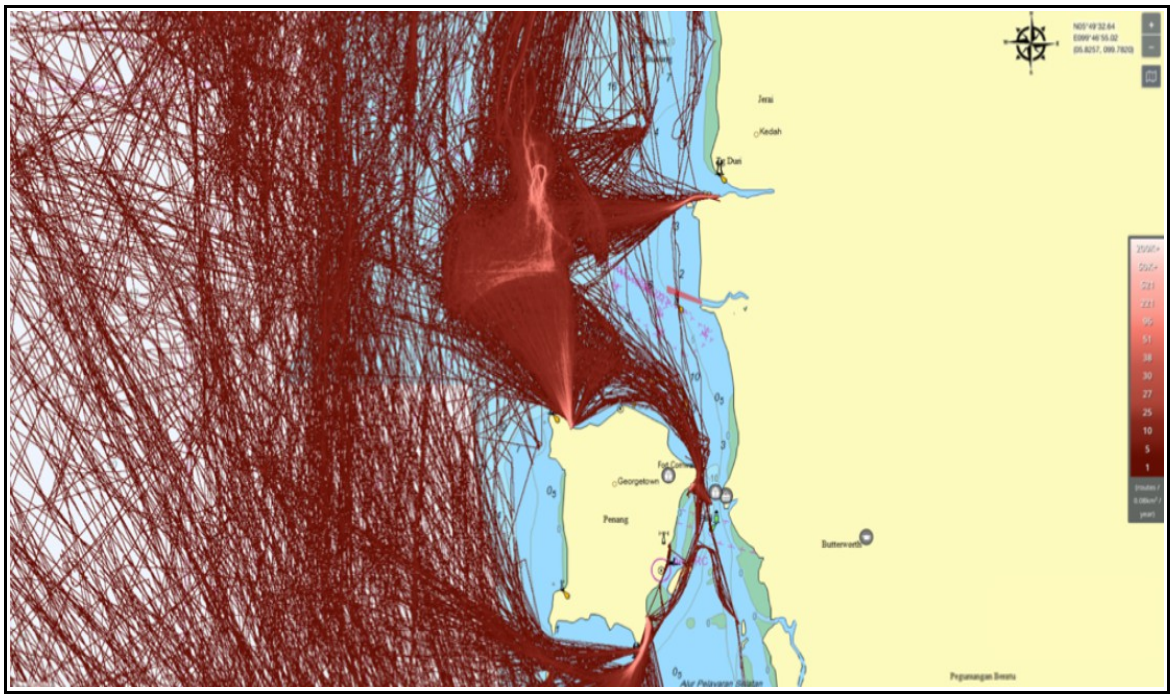
Source: TOR For Marine Risk Assessment, December 2023.

Figure 6.62 AIS Track Plot Of Passenger Vessels (2022)



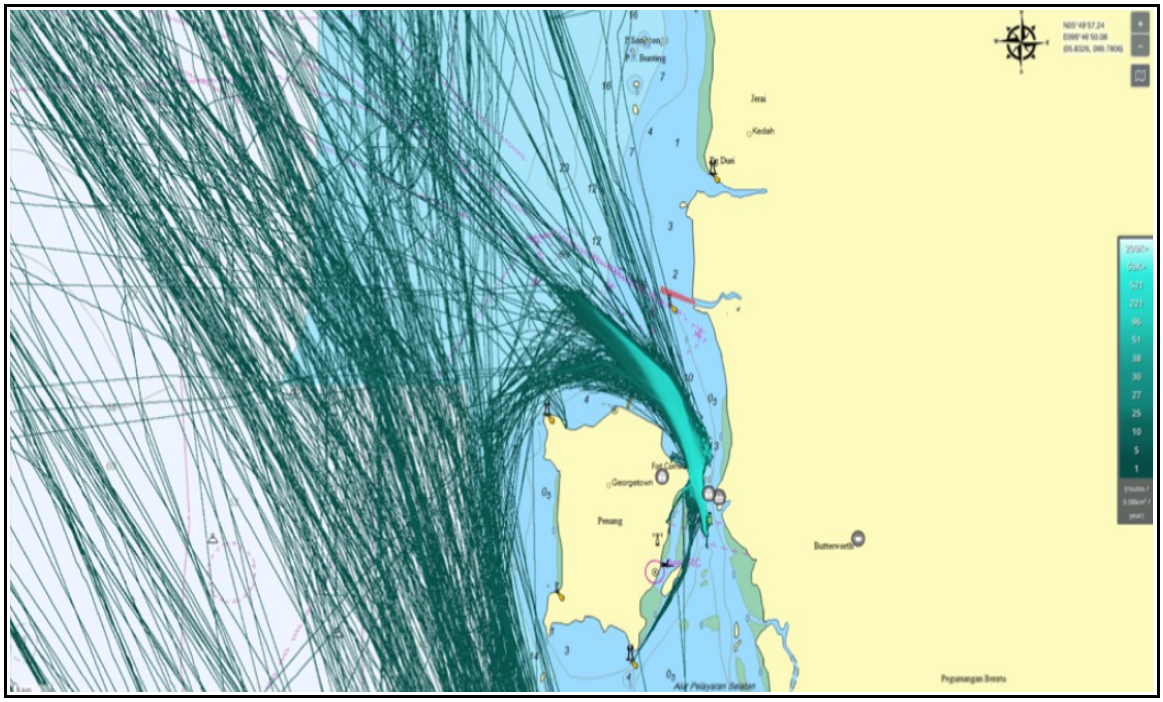
Source: TOR For Marine Risk Assessment, December 2023.

Figure 6.63 AIS Track Plot Of Pleasure Crafts (2022)



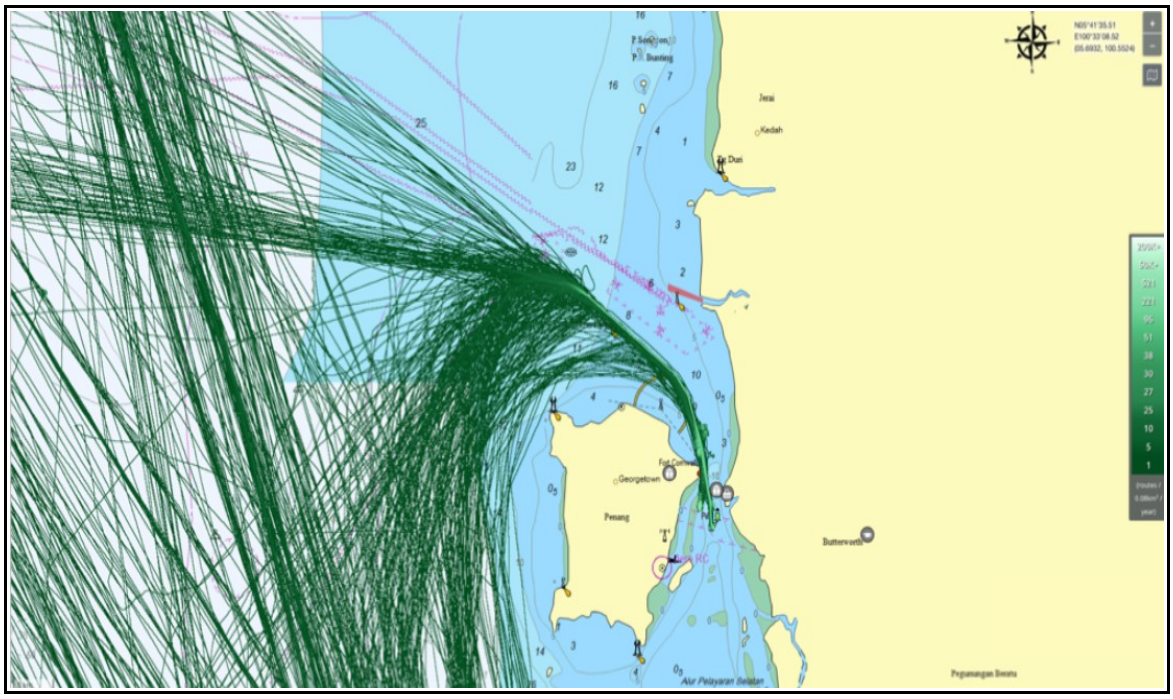
Source: TOR For Marine Risk Assessment, December 2023.

Figure 6.64 AIS Track Plot Of Fishing Vessels (2022)



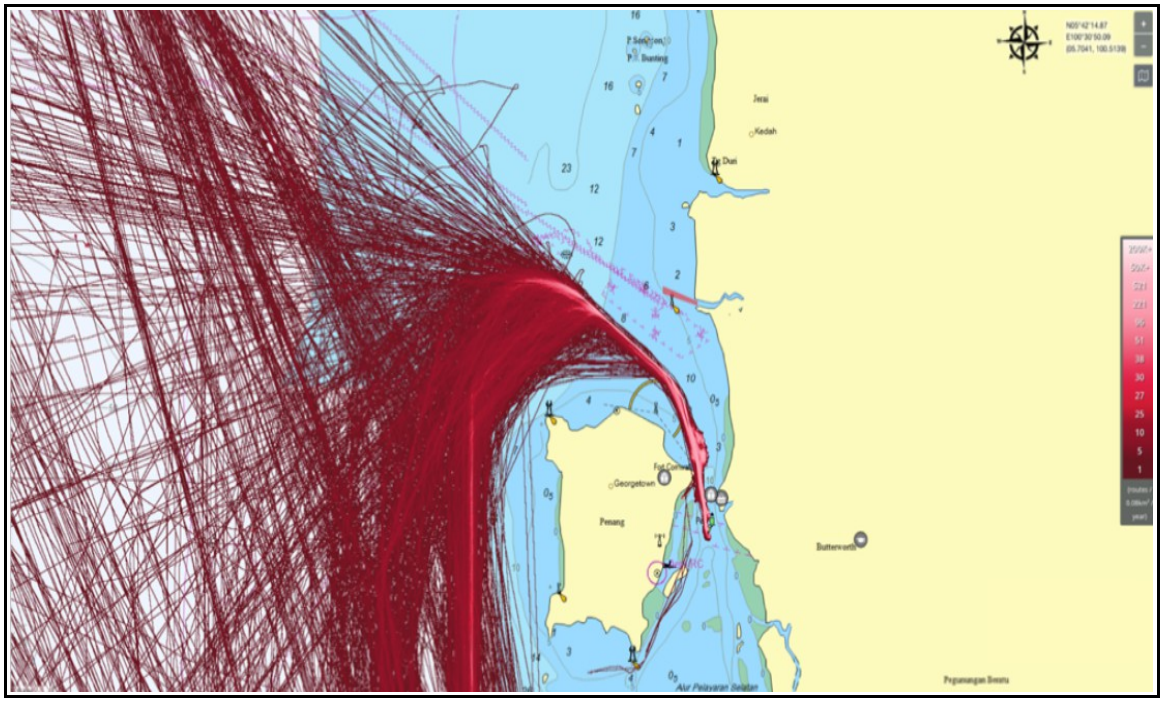
Source: TOR For Marine Risk Assessment, December 2023.

Figure 6.65 AIS Track Plot Of Tug And Tow (2022)



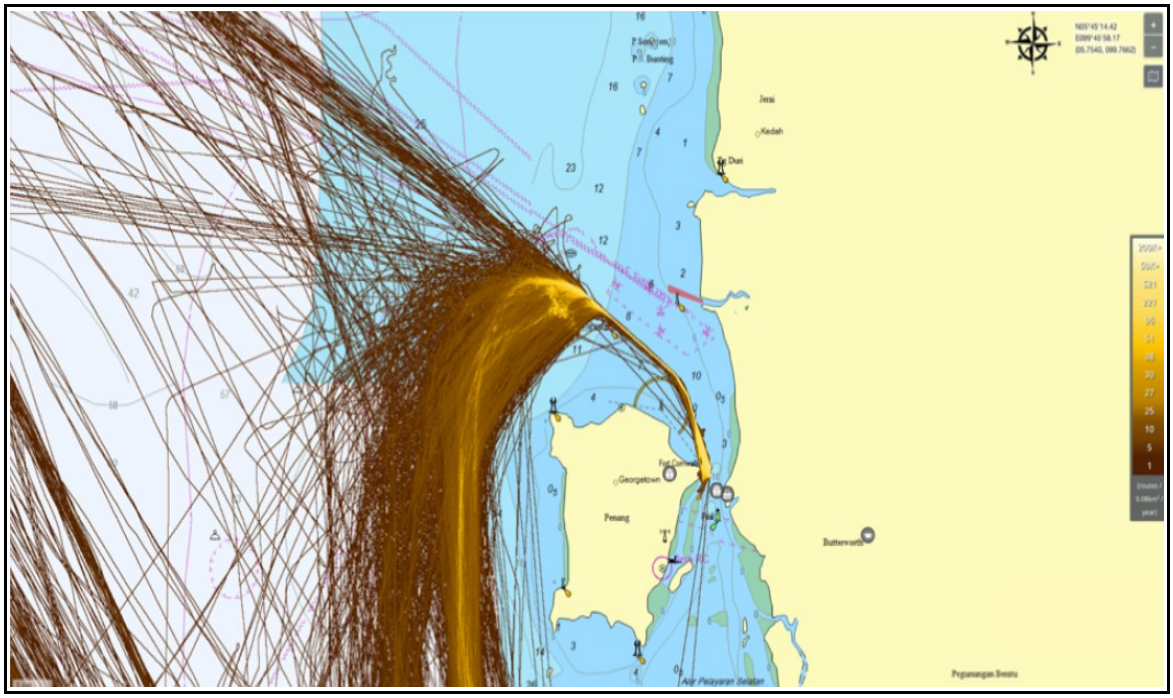
Source: TOR For Marine Risk Assessment, December 2023.

Figure 6.66 AIS Track Plot Of Bulk Carriers (2022)



Source: TOR For Marine Risk Assessment, December 2023.

Figure 6.67 AIS Track Plot Of Tankers (2022)



Source: TOR For Marine Risk Assessment, December 2023.

Figure 6.68 AIS Track Plot Of Container Vessels (2022)

6.5 Baseline Environmental Quality

A. Surrounding Environmental Quality

Baseline environmental quality for the study area are obtained from field sampling for air qaulity, noise and water quality. **Figure 6.69** depicts the locations of the baseline environmental monitoring stations while **Table 6.36** provides the description of the environmental monitoring stations. The following provides a discussion of the baseline monitoring conducted for the site.

Table 6.36
Description Of Baseline Environmental Quality Sampling Stations

Segment	Station ID	Georeferences	Location
Drain Water	DW1	N 5^0 23' 39.97" E 100^0 19' 21.49"	At upstream of drain adjacent to existing land mass in the south
	DW2	N 5^0 23' 34.38" E 100^0 19' 29.64"	At downstream of drain adjacent to existing land mass
	DW3	N 5^0 23' 29.15" E 100^0 19' 12.86"	At downstream of drain adjacent to existing land mass
Air Quality	AQ1	N 5^0 23' 28.87" E 100^0 19' 9.20"	At Mutiara Idaman 1
	AQ2	N 5^0 23' 42.31" E 100^0 19' 37.22"	At Persiaran Karpal Singh in front of Proposed Site
	AQ3	N 5^0 23' 59.59" E 100^0 19' 55.92"	At Persiaran Karpal Singh in the east near the Summer Place condominium
Noise Levels	NL1	N 5^0 23' 28.87" E 100^0 19' 9.20"	At Mutiara Idaman 1
	NL2	N 5^0 23' 42.31" E 100^0 19' 37.22"	At Persiaran Karpal Singh in front of Proposed Site
	NL3	N 5^0 23' 59.59" E 100^0 19' 55.92"	At Persiaran Karpal Singh in the east near the Summer Place condominium

Source : YES Bizs Sdn. Bhd.

(i) Drain Water Quality

The Proposed Project site is located within the Sungai Pinang catchment area. All stormwaters and surface runoffs from the site will enter the man made drainage system which discharges into the sea. Thus two sampling stations in the existing drains are identified for the sampling program.

For this purpose, three water samples are obtained on 4th January 2024 in the drain already available at the existing landmass. Grab samples are collected from each sampling location and analyzed in the laboratory to determine the pollution strength.

Figure 6.69 Location Of Baseline Environmental Quality Sampling Stations

The samples are analyzed in the laboratory to determine the pollution strength. Samples are tested for PO_4 (Phosphates), NH_3 (Ammonia), NO_2 (Nitrite), SS (Suspended Solids), Oil and Grease, DO (Dissolved Oxygen), Escherichia Coli, Faecal Coliform, Enterococci and NO_3 (Nitrates) instead of NO_2 is tested for the samples.

Earlier **Figure 6.69** depicts the ad hoc sampling stations where water sampling conducted in the drain. The water quality results and the variation of selected parameters are shown in **Table 6.37.** The following provides a discussion on the results of the parameters tested. Comparisons are made with the NWQS. The analytical results are depicted in **Appendix C-003** of the EIA report.

Table 6.37
Drain Water Quality Data

Parameters	Units	DW1	DW2	DW3	NWQS	
					Values	Class
Suspended Solids	mg/l	16.0	17.0	18.0	25	Class I
Oil & Grease	mg/l	ND<0.2	ND<0.2	ND<0.2	40	Class II
Dissolved Oxygen	mg/l	1.63	1.85	1.83	<3	Class IV
Phosphate	mg/l	2.3	2.4	1.8	-	-
Ammoniacal Nitrogen	mg/l	2.6	2.7	2.9	>2.7	Class V
Nitrate	mg/l	4.72	3.29	3.50	5	Class IV
Nitrite	mg/l	0.02	0.03	0.01	0.4 (0.03)	Class III
Lead	mg/l	ND<0.01	ND<0.01	ND<0.01	0.02* (0.01)	Class III
Cyanide	mg/l	ND<0.02	ND<0.02	ND<0.02	0.02	Class II
Zinc	mg/l	0.91	0.37	0.17	2	Class IV
Arsenic	mg/l	ND<0.001	ND<0.001	ND<0.001	0.05	Class II
Copper	mg/l	0.01	0.01	0.03	0.2	Class IV
Chromium	mh/l	ND<0.1	ND<0.1	ND<0.1	0.1	Class IV
Phenol	mg/l	ND<0.001	ND<0.001	ND<0.001	10	Class II
Mercury	mg/l	ND<0.001	ND<0.001	ND<0.001	0.001	Class II
Faecal Coliform	MPN/100mL	14000	14000	18000	5000 (20000)@	Class V

Source: YES Bizs Sdn. Bhd.
@ Maximum not to be exceed
DW1, DW2, DW3 sampled on 4th June 2024
DW4 sampled on __ August 2024

The following provides a brief discussion on the data obtained:-

(a) Physical Pollutants

The SS (Suspended Solid) concentration for the water samples are found to be wide ranging from 16.0 to 18.0 mg/l. The levels for SS are found to be comparable to Class I, NWQS.

DO ranging from 1.63 to 1.85 mg/l is detected in the water samples which are comparable Class IV, NWQS.

(b) Chemical Pollutants

Oil and Grease of less than 0.2 mg/l are detected in the water samples which are comparable to Class II, NWQS.

Metals in terms of Pb (Lead), Cn (Cyanide), Zn (Zinc), As (Arsenic), Cu (Copper), Cr (Chromium), and Hg (Mercury) are also tested in the water samples. Hg and Cyanide levels of <0.02 mg/l are detected at the detection limits.

Generally the metal concentrations are comparable to Class II, NWQS.

(c) Organic Pollutants

Organic pollutants in terms of AN (Ammonia) and Faecal Coliform are tested in the sampling exercise. AN ranging from 2.6 mg/l to 2.9 mg/l are detected in the water samples which are comparable to Class V, NWQS. Faecal Coliform on the other hand range from 14000 to 18000 MPN/100 ml which are comparable to Class V, NWQS. The high Faecal Coliform in the marine waters could be from the discharges from the RSTP operating in the area.

(ii) Air Quality

Air quality at the project site and surrounding area are also assessed to determine the ambient air quality of the project area. Initially three sampling stations are used for this purpose. A sampling station to the southwest of the project site at Mutiara Idaman 1 (AQ1), a location at the proposed site (AQ2) and one to the east at Summer Place condominium (AQ3). The locations of the air sampling stations are shown in earlier **Figure 6.69**.

A standard high volume air sampler is used to collect PM_{10} (Particulate Matter 10µ) and $PM_{2.5}$ (Particulate Matter, 2.5µ). The sampler is calibrated at a volumetric air flow rate of 10 m^3 for $PM_{2.5}$ corrected to 25°C and operated with a sampling duration of 24 hours. Sampling is conducted on 12th January 2024.

A 10 x 8 in glass fiber type filter media (Whatman GF/A) is used to collect the particulate samples. A glass type filter paper was used instead of cellulose type membrane in order to avoid any erroneous reading during weighing due to the hydroscopic nature of the filter media.

The filters are conditioned (in a desiccator for at least 24 hours) and weighted during pre and post sampling using an analytical balance. The calculated PM_{10} and $PM_{2.5}$ concentration is taken based on the particulate mass found on the filter media divided by the total volumetric flow of air sampled.

Air samples for NO_2 (Nitrous Oxides), SO_2 (Sulfurous Oxides), CO (Carbon Monoxide) and O_3 (Ozone) are also obtained at the sampling stations on 5th April 2023. For this purpose, the air samples are obtained with the use of an absorbing media which is fixed to a calibrated pump.

Air is drawn into the pump whilst the absorbing media absorbs the related pollutant to be tested. The pump is made to run for 1 hour and once completed brought back to the accredited laboratory for testing.

Table 6.38 depicts the air quality data obtained from the sampling exercise whilst the analytical results are shown in **Appendix C-003** of this EIA.

Table 6.38
Air Quality Data

Parameters	AQ1 (Mutiara Idaman 1)	AQ2 (Proposed Site)	AQ3 (Summer Place)	Guidelines*
$PM_{2.5}$ µg/Nm^3	24.2	27.1	20.0	35
PM_{10} µg/Nm^3	30.0	34.2	38.5	100
SO_2 µg/Nm^3	ND<0.01	ND<0.01	ND<0.01	250
NO_2 µg/Nm^3	ND<5.0	ND<5.0	ND<5.0	280
CO mg/Nm^3	4.70	4.47	4.58	30
O_3 µg/Nm^3	20	14	16	180

Source: Field Survey, YES Bizs Sdn. Bhd.

$PM_{2.5}$ levels at the sampling stations are detected to be 20.0 µg/Nm^3 to 27.1 µg/Nm^3. The $PM_{2.5}$ values are within the ambient air quality guideline of 35 µg/Nm^3 at the nearest receptors. PM_{10} levels are detected to be ranging from 30.0 µg/Nm^3 to 38.5 µg/Nm^3 which are found to be within the ambient air quality guidelines of 100 µg/Nm^3.

SO_2, NO_2 and CO are also tested from the air samples obtained from the sampling sites. SO_2 of less than 0.01 µg/Nm^3, NO_2 of less than 5.0 µg/Nm^3, CO values ranged from 4.47 to 4.70 µg/m^3 are detected in the air samples. O_3 values ranged from 14 to 20 µg/m^3 are detected at the sampling sites which are below ambient air quality guidelines.

(iii) Noise Levels

There are no major sources of noise in the vicinity except for traffic. Noise measurements are also conducted to assess the baseline noise levels in the area. Three sampling stations are identified for this purpose as shown in earlier **Figure 6.69.** The noise sampling stations are similar to the air quality sampling stations. Sampling is conducted between 12th to 13th January 2024.

Noise measurements are carried out with a SLM (Sound Level Meter). The sound level meter indicates minimum, maximum and equivalent values for noise levels at A rating.

Measurements are taken for a period of 24 hours covering the (daytime readings (7.00 am – 10.00 pm) and nighttime readings (10.00 pm – 7.00 am). The noise meter is placed on a stand at a height of about 1.2 m above the ground. For purposes of measurements care is taken to ensure that no reflections took place near the instrument. The analytical results are shown in **Appendix C-003** of this report.

Table 6.39 depicts the summary of the noise data from the measurements conducted at the sampling stations. Based on the noise monitoring study, the noise levels at the nearest residential areas ranged from 53.5 to 58.6 dB(A) Leq (daytime) and 45.1 to 53.4 dB(A) Leq (nighttime). The daytime noise levels are found to be below the guideline of 65 dB(A) Leq for urban residential use. The nighttime noise levels are found to be within the guideline of 60 dB(A) Leq. Traffic is the major contributor towards noise in the area. **Figure 6.70 to Figure 6.72** provides the noise output trend graphs for NL1, NL2 and NL3 respectively.

Table 6.39
Noise Levels

Station ID	Location	Period	Hour		Leq	L10	L90	Guidelines*
			Starting Time	Ending Time				
NL1	At Mutiara Idaman 1	Daytime	7:00:00	21:59:59	58.6	60.9	51.6	65
		Nighttime	22:00:00	6:59:59	53.3	54.6	43.8	60
		24 Hours	7:00:00	6:59:59	57.3	60.0	48.6	
NL2	At Proposed Site	Daytime	7:00:00	21:59:59	55.8	57.9	50.4	65
		Nighttime	22:00:00	6:59:59	53.4	55.5	44.3	60
		24 Hours	7:00:00	6:59:59	55.1	57.1	46.9	
NL3	At Summer Place	Daytime	7:00:00	21:59:59	53.5	53.2	40.6	65
		Nighttime	22:00:00	6:59:59	45.1	45.4	27.6	60
		24 Hours	7:00:00	6:59:59	51.8	51.9	31.5	

Sampling Date : 12th to 13th January 2024
Note: * Based on Guidelines for Environmental Noise Limits and Controls,2019 Third Edition

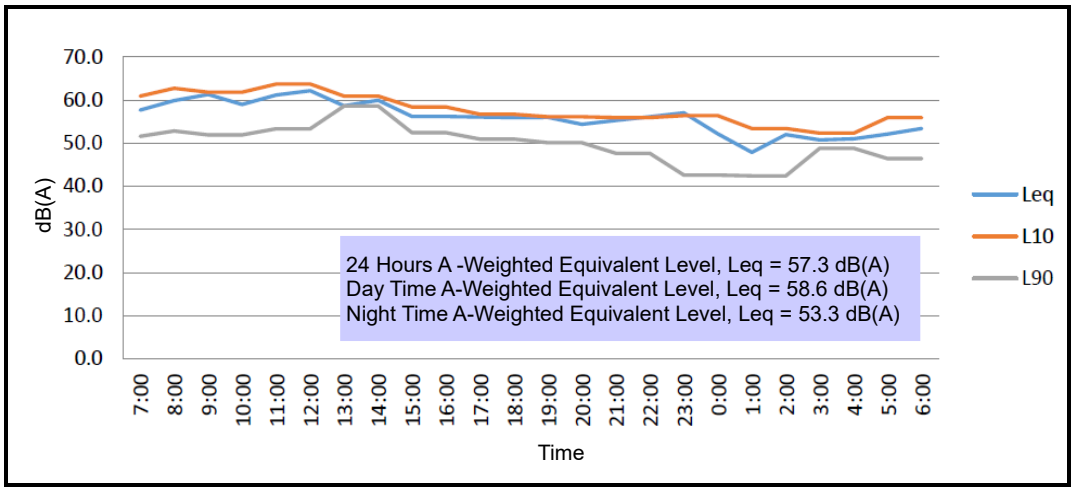


Figure 6.70 Noise Output Trend For NL1

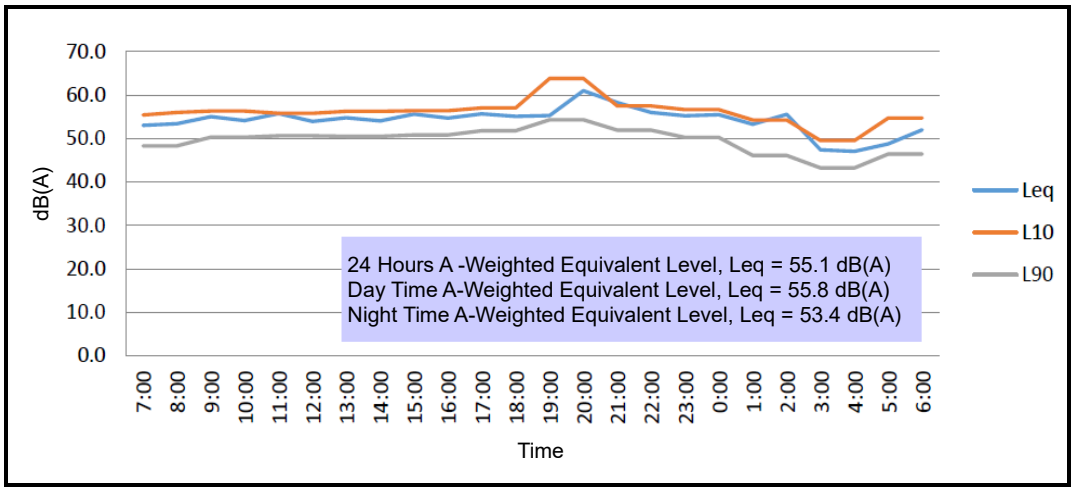


Figure 6.71 Noise Output Trend For NL2

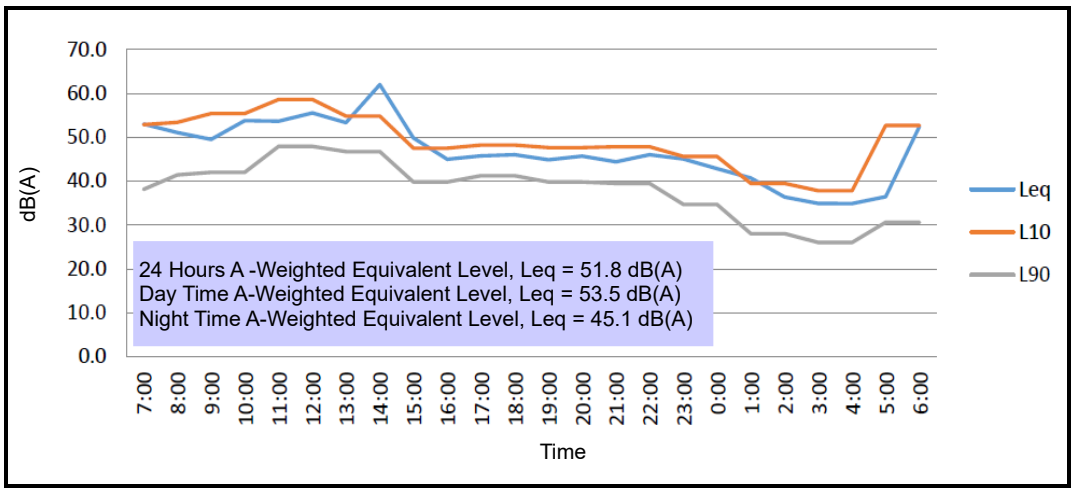


Figure 6.72 Noise Output Trend For NL3

(iv) Marine Water Quality

Discharge from the site will enter the proposed drainage system which will drain into the sea via two (2) discharge outlets as shown in earlier **Figure 5.5**. Thus the marine water quality in the nearby coastal environment receiving the discharges is assessed in this EIA study. The marine water quality sampling stations are shown in **Figure 6.73**.

Water samples are obtained at three sampling stations to assess the marine water quality on 18th June 2023. Two grab samples are obtained from each of the sampling locations one at high tide (0.8D) and the other at lowtide (0.2D) during the sampling period.

The samples are analyzed in the laboratory to determine the pollution strength. Samples are tested for Temperature, pH, Color, Turbidity, Salinity, NH_3 (Ammonia), N (Nitrate Nitrogen), TSS (Total Suspended Solids), DO (Dissolved Oxygen), Salinity, Faecal Coliform, Faecal Streptococi, PO_4 (Phosphate), Al (Aluminium), Mineral Oil, Phenol, Hg (Mercury), Cn (Cyanide), Cd (Cadmium), Pb (Lead), Cr^{6+} (Chromium), As (Arsenic), Cu (Copper) and Zn (Zinc).

The water quality results and variation of the selected parameters are shown in **Table 6.40**. Comparisons are made with Class 3, MWQS (Marine Water Quality Criteria and Standards) as the land use at the coastline comprise of comemrcial and human settelements with discussions provided below. The analytical results are shown in **Appendix C-003** of this report.

Table 6.40
Marine Water Quality Data

Parameters	Units	WS1		WS2		WS3		Class 3 MWQS
		0.2D	0.8D	0.2D	0.8D	0.2D	0.8D	
Temperature	°C	32.9	32.9	32.9	32.9	32.9	32.9	<2°C increase over max ambient
pH	-	7.9	7.8	7.8	7.9	7.3	7.3	6.5-9
Color	TCU	<1	<1	<1	<1	<1	<1	-
Turbidity	NTU	20	26.2	16.5	13	14	14	-
Total Suspended Solids	mg/l	35	28	8	21	25	28	100
Dissolved Oxygen	mg/l	8.5	7.9	7.6	7.3	4.2	4.6	>3.0
Salinity	mg/l	33.34	35.51	31.06	14,552	18.92	30.25	-
Nitrate Nitrogen	mg/l	14.3	9.99	5.39	4.34	2.67	2.51	-
Ammonia	mg/l	0.03	ND(<0.02)	ND(<0.02)	ND(<0.02)	0.05	ND(<0.02)	0.32
Phosphate	mg/l	3.49	4.47	3.65	4.38	3.65	2.24	0.067
Aluminium	mg/l	ND(<0.01)	ND(<0.01)	ND(<0.01)	ND(<0.01)	ND(<0.01)	ND(<0.01)	0.055
Faecal Coliform	MPN/100mL	Absent*	Absent*	Absent*	Absent*	6.8	1.8	70

Figure 6.73 Marine Water Sampling Stations

Table 6.40 (Continue)

Parameters	Units	WS1		WS2		WS3		Class 3 MWQS
		0.2D	0.8D	0.2D	0.8D	0.2D	0.8D	
Oil & Grease	mg/l	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	ND(<0.5)	-
Phenol	mg/l	ND(<0.001)	ND(<0.001)	ND(<0.001)	ND(<0.001)	ND(<0.001)	ND(<0.001)	0.1
Mercury	mg/l	ND(<0.001)	ND(<0.001)	ND(<0.001)	ND(<0.001)	ND(<0.001)	ND(<0.001)	0.00004
Cyanide	mg/l	ND(<0.01)	ND(<0.01)	ND(<0.01)	ND(<0.01)	ND(<0.01)	ND(<0.01)	0.014
Cadmium	mg/l	ND(<0.001)	ND(<0.001)	ND(<0.001)	ND(<0.001)	ND(<0.001)	ND(<0.001)	0.003
Lead	mg/l	ND(<0.01)	ND(<0.01)	ND(<0.01)	ND(<0.01)	ND(<0.01)	ND(<0.01)	0.012
Chromium	mg/l	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	ND(<0.005)	0.02
Arsenic	mg/l	ND(<0.001)	ND(<0.001)	ND(<0.001)	ND(<0.001)	ND(<0.001)	ND(<0.001)	0.003
Copper	mg/l	0.02	0.03	0.03	0.03	0.04	0.04	0.008
Zinc	mg/l	0.11	0.12	0.11	0.12	0.11	0.12	0.1
Faecal Streptococci	MPN/100mL	1.7x10	1.0x10	4.8x10	3.3x10	$1.3x10^2$	$2.8x10^2$	-

Source: Global Water Consultants Sdn. Bhd.
* Not Accredited ND – Not Detected
Class 3 – Industry, Commercial Activities & Coastal Settlements
Note: WS1, WS2 and WS3 sampled on 18th June 2023
WS4 sampled on __ August 2024

The following provides a brief discussion on the data obtained:-

(a) Physical Pollutants

The temperature of the water samples values at 32.9^{0}C. TSS (Total Suspended Solids) of 8 to 35 mg/l are detected at the sampling sites. The TSS levels are found to be within 100 mg/l for Class 3, MWQS. Dissolved Oxygen ranging from 4.2 to 8.5 mg/l are detected in the water samples. It is noted that during low tide, the DO values are extremely low as compared to the DO levels obtained during high tide. Turbidity values ranging from 13 to 26.2 NTU are detected in the water samples. Salinity values ranging from 18.92 to 14,552 mg/l are detected in the water samples.

(b) Chemical Pollutants

Oil & Grease of less than 0.5 mg/l are detected in the marine waters which is at the detection limits. N (Nitrate Nitrogen) levels ranging from 2.51 mg/l to 14.3 mg/l are detected in the water samples which are generally outside Class 3, MWQS of 0.7 mg/l in the MWQS.

Phenol of less than 0.001 mg/l are detected in the water samples. However theer are no standards for Phenols in the MWQS.

Metals in terms of Al (Aluminium), Pb (Lead), Cn (Cyanide), Zn (Zinc), As (Arsenic), Cu (Copper), Cr (Chromium), and Hg (Mercury) are tested in the water samples. Generally these metals are detected to be within Class 3, MWQS. Hg and Cyanide levels of <0.02 mg/l are detected at the detection limits.

Phosphates ranging from 2.24 to 4.47 mg/l which are outside Class 3, MWQS.

Metals in terms of Pb (Lead), Cn (Cyanide), Zn (Zinc), As (Arsenic), Cu (Copper), Cr (Chromium), and Hg (Mercury) are tested in the water samples. Generally these metals are detected to be within Class 3, MWQS except for Cu and Zn. Hg and Cyanide levels of <0.01 mg/l are detected at the detection limits.

(c) Organic Pollutants

Organic pollutants in terms of AN (Ammonia). Faecal Coliform and Faecal Streptococci are tested in the sampling exercise. AN of less than 0.02 mg/l to 0.03 mg/l are detected in the water samples which are within Class 3, MWQS. Faecal Coliform on the other are generally not detected in the water samples except for the sample obtained at WS1 and WS3 ranging from 1.8 to 7.8 MPN/100 ml. On the other hand Faecal Streptococci of 2.0 – 1700 MPN/100 ml are detected in the marine waters. The presence of Faecal Coliform and Faecal Streptococci in the marine waters may be due to the treated sewage discharges from the regional STP operating in Jelutong.

(d) Malaysia Marine Water Quality Index

The DOE's MMWQI (Malaysia Marine Water Quality Index) based on the following equation is used to classify the marine waters:-

$$MMWQI = qiDO^{0.18} \times qiFC^{0.19} \times qiNH_3^{0.15} \times qiNO_3^{0.16} \times qiPO_4^{0.17} \times qiTSS^{0.18}$$

Table 6.41 provides the summary of the qi for each parameter which is then used to calculate the MMWQI. The MMWQI is then compared to **Table 6.42.**

Table 6.41
Summary Of MMWQI

Parameters	qi for WS1	qi for WS2	qi for WS3
Dissolved Oxygen	2.08	2.07	1.83
Ammonia	2.29	2.29	2.29
F. Coliform	2.28	1	2.38
Total Suspended Solids	2.22	2.25	2.24
Nitrates	2.07	2.07	2.07
Phosphates	1.48	1.48	1.48
MWQI	**78.4 (Moderate)**	**31.68 (Poor)**	**68.4 (Moderate)**

Source: YES Bizs Sdn. Bhd.

Table 6.42
Marine Water Quality Classifications, Based On MMWQI

Category	Values
Excellent	90-100
Good	80-89
Moderate	50-79
Poor	0-49

Source : Department of Environment

Based on the calculations for MMWQI, it is observed that the marine water quality can be said to be moderate at WS1 and WS3 but poor at WS2 during the sampling period.

B. Landfill Site Environmental Quality

Table 6.43 provides the sampling stations identified for the baseline environmental quality at Jelutong Landfill site.

Table 6.43
Baseline Sampling Stations At Jelutong Landfill Site

Segment	Location	Reduce Level	Georeferences
Soil	BH2	36.44 m	N 5^0 23' 31.79" E 100^0 19' 17.88"
	BH4	9.43 m	N 5^0 23' 20.23" E 100^0 19' 21.24"
	BH6	6.76 m	N 5^0 23' 30.66" E 100^0 19' 29.79"
	BH8	26.07 m	N 5^0 23' 19.92" E 100^0 19' 33.88"
Groundwater	BH2	36.44 m	N 5^0 23' 31.79" E 100^0 19' 17.88"
	BH4	9.43 m	N 5^0 23' 20.23" E 100^0 19' 21.24"
	BH5	35.04 m	N 5^0 23' 26.32" E 100^0 19' 25.48"
	BH6	6.76 m	N 5^0 23' 30.66" E 100^0 19' 29.79"
	BH8	26.07 m	N 5^0 23' 19.92" E 100^0 19' 33.88"
Air	BH2	36.44 m	N 5^0 23' 31.79" E 100^0 19' 17.88"
	BH4	9.43 m	N 5^0 23' 20.23" E 100^0 19' 21.24"
	BH5	35.04 m	N 5^0 23' 26.32" E 100^0 19' 25.48"
	BH6	6.76 m	N 5^0 23' 30.66" E 100^0 19' 29.79"
	BH8	26.07 m	N 5^0 23' 19.92" E 100^0 19' 33.88"

Note: Sampling locations are similar to the borehole locations conducted during SI works in July 2023.

The locations of the sampling stations are shown in **Figure 6.74.** The locations identified are the exploratory boreholes identified during the SI studies for the Jelutong Landfill site. The following provides the environmental quality at Jeluong Landfill.

Figure 6.74 Location Of Soil, Groundwater And Air Quality Sampling Stations

(i) Soil Quality

Undisturbed soil samples were taken from the exploratory borehole using 50 mm diameter 600 mm long thin walled sampling tube at charge of strata in cohesive soils where necessary.

After extraction from the hole, the soil samples were immediately sealed with paraffin wax and sent to the laboratory for soil quality testing. The parameters tested for the soil quality include Al (Aluminium), Ag (Argentum), As (Arsenic), Ba (Barium), B (Boron), Cd (Cadmium), Ca (Calcium), Cr (Chromium), Co (Cobalt), Cu (Copper), Cyanide (Total), Cyanide (Free), F (Fluoride), Fe (Iron), Pb (Lead), Mg (Magnesium), Mn (Manganese), Hg (Mercury), Ni (Nickel), K (Potassium), Se (Selenium), Sn (Stabum), Sr (Strontium), Total Hydrocarbon, V (Vanadium) and Zn (Zinc).

Table 6.44 provides the soil quality obtained from the four sampling sites. Comparisons were made with the typical range of NOMC (Natural Occuring Metal Concentrations) in soil outlined in the Contaminated Land Management and Control Guidelines No. 1: Malaysian Recommended Site Screening Levels for Contaminated Land as well as the SSL (Site Screening Levels) for residential use as the reclaimed area will be use for mix development purposes. The analytical results are provided in **Appendix C-003.**

Table 6.44
Soil Quality Data

Parameter	Unit	Sample Marking					Residential Soil (mg/kg)	NOMC	
		BH-2/ UD 1	BH-2/ UD 2	BH-4/ UD 1 & UD 2	BH-6/ UD 1 & UD 2	BH-8/ UD 1 & UD 3		Max	Min
Aluminium	mg/kg	16,778	2,812	5,283	1,224	4,426	77000	53900	33500
Silver	mg/kg	3.77	0.23	<0.1	10.3	<0.1	390	<0.5	<0.5
Arsenic	mg/kg	26.6	10.8	<0.1	<0.1	1.78	0.39	43.0	1.1
Barium	mg/kg	101.6	3.12	12.1	7.61	15.9	15000	21.0	5.0
Boron	mg/kg	150.7	80.2	5.15	<0.1	8.00	16000	0.19	0.11
Cadmium	mg/kg	3.11	1.75	0.62	<0.1	0.90	NA	11.90	0.09
Calcium	mg/kg	56,205	1,907	4,357	802	6,396	NA	NA	NA
Chromium	mg/kg	223.2	26.8	7.75	1.45	6.20	280	14.40	0.02
Cobalt	mg/kg	146.1	1.17	3.81	<0.1	2.07	23	11.90	3.90
Copper	mg/kg	398.1	17.5	35.0	<0.1	5.21	3100	19.8	4.0
Cyanide Total Complex	mg/kg	ND<0.2	ND<0.2	ND<0.02	ND<0.02	ND<0.02	1600	NA	NA
Cyanide Total Free	mg/kg	ND<0.2	ND<0.2	ND<0.02	ND<0.02	ND<0.02	1600	NA	NA
Fluoride	mg/kg	0.92	1.10	0.34	1.77	1.16	NA	NA	NA
Iron	mg/kg	91,051	25,194	6,442	2,833	7,765	NA	44500	301
Lead	mg/kg	149.8	9.64	2.10	5.04	12.5	400	36.00	0.18
Magnesium	mg/kg	15,884	1,451	584	382.0	1,645	NA	507.2	0.9
Manganese	mg/kg	792	325.1	87.2	16.0	116.9	1800	3.99	3.95

Table 6.44 (Continue)

Parameter	Unit	Sample Marking					Residential Soil (mg/kg)	NOMC	
		BH-2/ UD 1	BH-2/ UD 2	BH-4/ UD 1 & UD 2	BH-6/ UD 1 & UD 2	BH-8/ UD 1 & UD 3		Max	Min
Mercury	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	6.7	0.42	0.02
Nickel	mg/kg	67.0	9.33	17.4	0.15	4.39	14000	28.90	0.70
Potassium	mg/l	5,923	996	466.3	184.3	584	NA	4.100	0.218
Selenium	mg/kg	<0.1	3.13	<0.1	<0.1	<0.1	390	NA	NA
Tin	mg/kg	867	44.5	<0.1	<0.1	<0.1	47000	8.5	3.5
Strontium	mg/kg	184.3	16.8	11.5	3.60	17.3	47000	7020	4940
Total Hydrocarbon	%	0.03	2.92	0.01	0.02	0.02	NA	NA	NA
Vanadium	mg/kg	37.1	18.5	1.66	<0.1	5.64	550	105.0	2.0
Zinc	mg/kg	775	64.2	79.0	51.1	42.6	23000	54.3	6.9

Source: Soil Investigation Report, September 2023
NA – Not Available

Based on the above data, the following can be inferred Ag (Silver), As (Arsenic), Cd (Cadmium), Cr (Chromium), Co (Cobalt), Cu (Copper), Fe (Iron), Pb (Lead), Mg (Manganese), Hg (Mercury), Sn (Tin) and Vanadium are classified as heavy metals due to their toxicity.

Generally As and Co (at BH2) values are detected to be high in relation to the SSL. However, As values is detected to be below the maximum range for the typical range of the natural occuring metal in soil.

Cn (Cyanide) levels of <0.02 mg/kg are also found to be within the SSL of 1606 mg/kg for residential soil. Fluorides ranging from 0.34 to 1.77 mg/kg and Total Hydrogen of 0.01 to 2.92% are detected in the soil samples. However there are no SSL for Fluorides and Total Hydrogen.

Thus base on the above, it can be inferred that the heavy metal containts in the soil obtained at the Jelutong Landfill are generally within the SSL for residential use except for As an Co (at BH2).

(ii) Groundwater Quality

The groundwater samples are obtained from the standpipe observation wells installed during the SI works. Water sampling from the discrete depths within each borehole is achieved by the use of a bailer sampler. The bailer sampler is put into this PVC standpipes. To collect the groundwater, the operator oscillates tubing up and down to bring groundwater sample to surface. Once the water enter the tube, the tubing balls will go up and the value close to open tube surface. Two to four samples are collected for every boreholes covering spring floodtide and during the neap floodtide. The groundwater are tested for various parameters as shown in **Table 6.45.** Sampling was conducted between 29th May to 7th July 2023 during the SI works. The Standard Methods for groundwater testing are tested based on the USEPA (United

States Environmental Protection Agency) (Standrads Methods for Examination of Water and Wastewater, American Public Health Association), 21st Edition 2005 and OSRMA (Official Standardised & Recommended Methods of Analysis, 2nd Edition 1973.

Table 6.45 provides the analytical results for the groundwater obtained at the 5 boreholes within the Jelutong Landfill site. Analytical results are provided in **Appendix C-003.** Comparisons are made with the ACFDL (Acceptable Conditions for Discharge of Leachate) under the Environmental Quality (Control of Pollution from Solid Waste Transfer Station and Landfill) Regulations 2009 as the groundwater at the Jelutong Landfill may also be 'leachate' which has percolated through solid waste or liquid discharged or release from the Jelutong Landfill site. The values are also compared to the NOMC (Natural Occuring Metal Concentrations) in groundwater based on the DOE's Contaminated Land Management and Control Guidelines No.1 – Malaysian Recommended Site Screening Levels for Contaminated Land. This is in line with the conclusion from the electrical resistivity results conducted by USAINS Holdings Sdn. Bhd. whereby the boundaries of the mix zones between saline seawater intrusion, leachate plume and clay to sand soil cannot be clearly differentiate. Due to this reasons comparison with the groundwater quality under the DOE's guidelines are not used. However to assess to groundwater quality, the IKAT (groundwater quality index) is calculated as discussed in this section.

Table 6.45
Groundwater Quality Data

(a) BH2, BH4 & BH5

Parameter	Unit	Sample Marking								ACFDL	NOMC	
		BH2		BH4				BH5			Max	Min
		Spring Flood Tide	Neap Flood Tide	Spring Flood Tide	Neap Flood Tide	Spring Flood Tide	Neap Flood Tide	Spring Flood Tide	Neap Flood Tide			
Sampling Date		**14/7/23**	**18/7/23**	**18/6/23**	**27/6/23**	**28/6/23**	**28/6/23**	**28/6/23**	**14/7/23**			
Aluminium	mg/l	0.982	0.582	191.92	83.16	30.27	68.23	0.388	2.338	NA	22.0	0.1
Ammonia	mg/l	137.41	124.03	56.47	20.30	116.53	73.37	315.87	234.47	NA	-	-
Ammoniacal Nitrogen	mg/l	250.57	226.18	102.68	37.01	212.50	133.40	576	427.57	5.0	-	-
Silver	mg/l	ND<0.001	ND<0.001	ND<0.001	ND<0.001	0.014	ND<0.001	ND<0.001	ND<0.001	0.1	-	-
Arsenic	mg/l	ND<0.003	ND<0.003	0.130	ND<0.003	0.077	0.074	0.194	ND<0.003	0.05	2.220	0.004
Barium	mg/l	0.213	0.366	0.653	0.140	0.821	0.382	0.676	0.437	1.0	-	-
BOD	mg/l	41	38	20	52	157	75	231	65	20	-	-
Boron	mg/l	0.915	1.388	0.662	1.614	1.696	0.653	2.609	3.504	1.0	<0.02	<0.02
Cadmium	mg/l	ND<0.001	ND<0.001	0.022	ND<0.001	0.004	0.008	ND<0.001	ND<0.001	0.01	0.011	0.005
Calcium	mg/l	213.72	322.18	256.70	331.03	175.76	171.23	221.76	160.65	NA	293.0	0.5
Chloride	mg/l	274.50	243.42	1,696	-	1.831	1,529	839	641	NA	-	-
Chromium	mg/l	ND<0.001	ND<0.001	0.758	ND<0.001	0.077	0.182	0.034	0.016	NA	0.100	0.002
Hexa-Chromium	mg/l	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	0.05	-	-
Tri-Chromium	mg/l	ND<0.02	ND<0.02	0.76	ND<0.02	0.08	0.18	0.04	ND<0.02	0.2	-	-

Table 6.45 (Continue)

Parameter	Unit	Sample Marking								ACFDL	NOMC	
		BH2		BH4				BH5			Max	Min
		Spring Flood Tide	Neap Flood Tide	Spring Flood Tide	Neap Flood Tide	Spring Flood Tide	Neap Flood Tide	Spring Flood Tide	Neap Flood Tide			
Sampling Date		**14/7/23**	**18/7/23**	**18/6/23**	**27/6/23**	**28/6/2 3**	**28/6/23**	**28/6/23**	**14/7/23**			
Cobalt	mg/l	0.002	ND<0.001	0.100	0.045	0.007	0.030	0.009	0.006	NA	0.30	ND
COD	mg/l	302	313	699	657	1,489	615	1,605	978	400	-	-
Color at Original pH	ADMI	99	119	111	234	248	241	553	655	100	-	-
Color at pH 7.0	ADMI	99	119	111	234	248	238	553	615	-	-	-
Conductivity	µS/cm	3,680	3.640	6,210	6,160	6,880	6,150	8,150	6,920	NA	-	-
Copper	mg/l	ND<0.001	0.216	0.783	ND<0.001	0.142	0.260	0.071	0.310	0.2	0.39	0.05
Cyanide	mg/l	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	0.05	-	-
Fluoride	mg/l	ND<0.04	0.31	0.88	1.36	1.26	0.96	0.55	0.04	2.0	-	-
Formaldehyde	mg/l	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	1.0	-	-
Hardness	mg $CaCO_3$/l	605	832	832	1,350	832	1,026	562	562	NA	-	-
Iron	mg/l	18.94	17.78	221.33	0.269	28.36	56.39	3.057	10.71	5.0	72.00	0.01
Lead	mg/l	ND<0.003	ND<0.003	0.468	ND<0.003	0.095	0.191	0.036	ND<0.003	0.10	1.00	0.01
Magnesium	mg/l	38.92	54.33	98.66	96.36	47.12	62.73	37.97	72.69	NA	675.0	0.2
Manganese	mg/l	0.657	0.462	3.585	0.102	0.772	1.354	0.155	0.230	0.2	5.00	0.01
Anionic Detergent	mg/l	ND<0.001	ND<0.01	ND<0.01	ND<0.01	ND<0.001	ND<0.001	ND<0.001	ND<0.001	NA	-	-
Mercury	mg/l	ND<0.001	ND<0.001	ND<0.001	ND<0.001	ND<0.001	ND<0.001	ND<0.001	ND<0.001	0.005	0.017	0.002
Mineral Oil	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	NA	-	-
Nickel	mg/l	0.013	0.012	0.298	0.024	0.045	0.095	0.028	0.035	0.2	0.40	0.01
Nitrate	mg/l	1.96	3.19	0.85	1.19	ND<0.02	0.34	ND<0.02	1.32	NA	-	-
Nitrite	mg/l	0.097	ND<0.005	0.052	0.072	0.096	0.134	0.214	0.185	NA	-	-
Oil & Grease	mg/l	6.2	2.0	5.4	7.8	7.2	5.2	6.0	5.2	5.0	-	-
pH	-	7.0	6.7	7.2	6.9	6.7	6.8	7.3	7.2	6.0-9.0	-	-
Turbidity	NTU	950	50	18,500	3,400	4,800	4,100	75	140	NA	-	-
Phenol	mg/l	0.008	0.005	0.016	0.010	0.012	0.027	0.079	0.076	0.001	-	-
Potassium	mg/l	220.71	264.22	614	369.38	248.60	273.48	309.59	493.33	NA	-	-
Selenium	mg/l	ND<0.004	ND<0.004	0.092	ND<0.004	0.100	0.077	0.045	ND<0.004	0.02	0.010	0.001
Sodium	mg/l	157.94	182.85	571	793	662	546	395.30	454.83	NA	-	-
Tin	mg/l	ND<0.020	ND<0.020	0.286	ND<0.020	ND<0.020	0.301	ND<0.020	ND<0.020	0.2	-	-
Strontium	mg/l	0.697	0.973	1.240	1.029	0.863	0.972	0.679	0.976	NA	6.10	0.01
Sulfate	mg/l	61.1	15.2	179.3	95.1	6.7	139.3	253.7	13.4	NA	-	-
Sulphide	mg/l	0.8	1.4	1.6	2.2	2.1	1.0	ND<0.2	ND<0.2	0.5	-	-
Temperature	°C	28.5	28.3	29.7	29.1	29.0	29.3	29.0	28.6	40	-	-
Total Dissolved Solid	mg/l	2,506	2,480	4,228	4,190	4,682	4,186	5,546	4,706	NA	-	-
Total Suspended Solids	mg/l	228	140	16,400	8,940	6,160	1,580	163	270	50	-	-

Table 6.45 (Continue)

Parameter	Unit	Sample Marking								ACFDL	NOMC	
		BH2		BH4				BH5			Max	Min
		Spring Flood Tide	Neap Flood Tide	Spring Flood Tide	Neap Flood Tide	Spring Flood Tide	Neap Flood Tide	Spring Flood Tide	Neap Flood Tide			
		14/7/23	18/7/23	18/6/23	27/6/23	28/6/2 3	28/6/23	28/6/23	14/7/23			
Zinc	mg/l	0.025	0.310	0.938	0.009	0.147	0.347	0.043	0.285	2.0	52.00	0.01
Vanadium	mg/l	0.003	0.005	0.008	0.003	0.030	0.006	0.006	0.010	NA	0.00	0.00
Salinity	$^0/_{00}$	7.6	10.8	14.2	13.6	9.6	12.9	7.9	7.3	NA	-	-
Dissolved Oxygen	mg/l	2.2	3.9	7.7	-	5.1	7.0	4.9	3.1	NA	-	-
Escherichia Coli	MPN/ 100ml	2.0	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	NA	-	-
Total Coliform	MPN/ 100ml	34	70	<1.8	17	4.5	26	79	2.0	NA	-	-
Gross α	Bq/L	-	-	-	-	0.21±0.78	0.22±0.08	<0.03	-	NA	-	-
Gross β	Bq/L	-	-	-	-	2.57±0.08	2.82±0.09	141±0.05	-	NA	-	-
Pesticides												
Aldrin	mg/l	ND<0.00002	ND<0.00002	-	-	ND<0.00002	ND<0.00002	ND<0.00002	ND<0.00002	NA	-	-
Chlordane	mg/l	ND<0.00002	ND<0.00002	-	-	ND<0.00002	ND<0.00002	ND<0.00002	ND<0.00002	NA	-	-
DDT	mg/l	ND<0.0002	ND<0.0002	-	-	ND<0.0002	ND<0.0002	ND<0.0002	ND<0.0002	NA	-	-
2,4-D	mg/l	ND<0.03	ND<0.03	-	-	ND<0.03	ND<0.03	ND<0.03	ND<0.03	NA	-	-
Dieldrin	mg/l	ND<0.00001	ND<0.00001	-	-	ND<0.00001	ND<0.00001	ND<0.00001	ND<0.00001	NA	-	-
Endosulfan	mg/l	ND<0.001	ND<0.001	-	-	ND<0.001	ND<0.001	ND<0.001	ND<0.001	NA	-	-
Heptachlor	mg/l	ND<0.00002	ND<0.00002	-	-	ND<0.00002	ND<0.00002	ND<0.00002	ND<0.00002	NA	-	-
Heptachlor Epoxide	mg/l	ND<0.00001	ND<0.00001	-	-	ND<0.00001	ND<0.00001	ND<0.00001	ND<0.00001	NA	-	-
Hexachloroben zene	mg/l	ND<0.00001	ND<0.00001	-	-	ND<0.00001	ND<0.00001	ND<0.00001	ND<0.00001	NA	-	-
Methoxychlor	mg/l	ND<0.0004	ND<0.0004	-	-	ND<0.0004	ND<0.0004	ND<0.0004	ND<0.0004	NA	-	-
Lindane	mg/l	ND<0.0001	ND<0.0001	-	-	ND<0.0001	ND<0.0001	ND<0.0001	ND<0.0001	NA	-	-
Chloroform	mg/l	ND<0.005	ND<0.005	-	-	ND<0.005	ND<0.005	ND<0.005	ND<0.005	NA	-	-
Bromoform	mg/l	ND<0.005	ND<0.005	-	-	ND<0.005	ND<0.005	ND<0.005	ND<0.005	NA	-	-
Dibromochloro methane	mg/l	ND<0.005	ND<0.005	-	-	ND<0.005	ND<0.005	ND<0.005	ND<0.005	NA	-	-
Bromodichloro methane	mg/l	ND<0.005	ND<0.005	-	-	ND<0.005	ND<0.005	ND<0.005	ND<0.005	NA	-	-

Source: Soil Investigation Report, September 2023

(b) BH6 & BH8

Parameter	Unit	Sample Marking								ACFDL	NOMC	
		BH6				BH8					Max	Min
		Spring Flood Tide	Neap Flood Tide	Spring Flood Tide	Neap Flood Tide	Spring Flood Tide	Neap Flood Tide	Neap Flood Tide	Spring Flood Tide			
Sampling Date		7/6/23	13/6/23	4/7/23	12/7/23	18/6/23	27/6/23	28/6/23	4/7/23			
Aluminium	mg/l	0.449	0.430	0.183	0.685	8.306	0.188	18.30	1.899	NA	22.0	0.1
Ammonia	mg/l	46.66	86.65	118.73	151.96	58.67	11.04	46.02	40.83	NA	-	-

Table 6.45 (Continue)

Parameter	Unit	Sample Marking								ACFDL	NOMC	
		BH6				BH8					Max	Min
		Spring Flood Tide	Neap Flood Tide	Spring Flood Tide	Neap Flood Tide	Spring Flood Tide	Neap Flood Tide	Neap Flood Tide	Spring Flood Tide			
Sampling Date		7/6/23	13/6/23	4/7/23	12/7/23	18/6/23	27/6/23	28/6/23	4/7/23			
Ammoniacal Nitrogen	mg/l	85.09	158.01	216.5	277.10	106.68	20.13	83.68	74.45	5.0	-	-
Silver	mg/l	ND<0.001	ND<0.001	ND<0.001	ND<0.001	ND<0.001	ND<0.001	ND<0.001	ND<0.001	0.1	-	-
Arsenic	mg/l	0.009	0.007	ND<0.003	0.027	0.054	ND<0.003	0.026	0.012	0.05	2.220	0.004
Barium	mg/l	0.197	0.204	0.206	0.348	1.399	0.332	1.562	0.278	1.0	-	-
BOD	mg/l	116	152	47	77	37	10	43	40	20	-	-
Boron	mg/l	1.962	1.927	2.536	3.594	1.208	1.554	1.169	1.994	1.0	<0.02	<0.02
Cadmium	mg/l	ND<0.001	ND<0.001	ND<0.001	ND<0.001	0.004	ND<0.001	0.003	ND<0.001	0.01	0.011	0.005
Calcium	mg/l	118.04	105.10	65.18	161.53	246.35	258.40	164.93	272.92	NA	293.0	0.5
Chloride	mg/l	-	-	707	588	3.275	-	2,804	2,303	NA	-	-
Chromium	mg/l	0.013	0.009	0.006	0.008	0.038	ND<0.001	0.022	0.005	NA	0.100	0.002
Hexa-Chromium	mg/l	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	0.05	-	-
Tri-Chromium	mg/l	ND<0.02	ND<0.02	ND<0.02	ND<0.02	0.04	ND<0.02	0.02	ND<0.02	0.2	-	-
Cobalt	mg/l	0.002	0.001	0.003	0.002	ND<0.001	ND<0.001	0.002	0.001	NA	0.30	ND
COD	mg/l	599	580	551	699	690	265	366	420	400	-	-
Color at Original pH	ADMI	550	550	580	530	1,220	-	112	201	100	-	-
Color at pH 7.0	ADMI	525	467	580	530	1,220	-	114	201	-	-	-
Conductivity	µS/cm	5,520	5,400	5,080	5,330	11,640	17,180	8,780	8,020	NA	-	-
Copper	mg/l	ND<0.001	0.010	0.072	0.551	0.049	0.012	0.039	0.056	0.2	0.39	0.05
Cyanide	mg/l	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	0.05	-	-
Fluoride	mg/l	0.77	0.70	0.50	0.68	0.54	0.75	0.62	0.48	2.0	-	-
Formaldehyde	mg/l	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	ND<0.02	1.0	-	-
Hardness	mg $CaCO_3$/l	1,026	750	572	680	1,890	2,376	1,037	1,166	NA	-	-
Iron	mg/l	1.599	2.547	1.651	2.933	55.12	0.213	29.76	2.885	5.0	72.00	0.01
Lead	mg/l	0.025	0.047	0.012	0.089	0.074	ND<0.003	0.067	0.006	0.10	1.00	0.01
Magnesium	mg/l	92.37	72.55	38.73	77.31	167.65	259.71	119.40	85.36	NA	675.0	0.2
Manganese	mg/l	0.018	0.101	0.115	0.175	1.036	0.493	0.753	0.538	0.2	5.00	0.01
Anionic Detergent	mg/l	ND<0.01	ND<0.01	ND<0.01	ND<0.01	ND<0.01	ND<0.01	ND<0.001	ND<0.001	NA	-	-
Mercury	mg/l	ND<0.001	ND<0.001	ND<0.001	ND<0.001	ND<0.001	ND<0.001	ND<0.001	ND<0.001	0.005	0.017	0.002
Mineral Oil	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	NA	-	-
Nickel	mg/l	0.020	0.021	0.013	0.027	0.013	0.004	0.026	0.004	0.2	0.40	0.01
Nitrate	mg/l	ND<0.02	0.19	0.03	1.18	0.98	0.55	0.78	ND<0.002	NA	-	-
Nitrite	mg/l	0.148	0.108	0.090	0.269	0.135	0.059	0.064	0.044	NA	-	-
Oil & Grease	mg/l	6.4	8.2	4.8	7.4	6.2	32.4	2.6	13.0	5.0	-	-
pH	-	7.5	7.5	7.5	7.4	6.8	6.5	6.8	7.0	6.0-9.0	-	-
Turbidity	NTU	35	23	10	32	400	380	650	120	NA	-	-
Phenol	mg/l	ND<0.001	ND<0.001	ND<0.001	ND<0.001	0.349	ND<0.001	ND<0.001	ND<0.001	0.001	-	-

Table 6.45 (Continue)

Parameter	Unit	Sample Marking								ACFDL	NOMC	
		BH6				BH8					Max	Min
		Spring Flood Tide	Neap Flood Tide	Spring Flood Tide	Neap Flood Tide	Spring Flood Tide	Neap Flood Tide	Neap Flood Tide	Spring Flood Tide			
Sampling Date		**7/6/23**	**13/6/23**	**4/7/23**	**12/7/23**	**18/6/23**	**27/6/23**	**28/6/23**	**4/7/23**			
Potassium	mg/l	422.95	396.57	274.76	372.00	237.83	225.20	180.70	194.22	NA	-	-
Selenium	mg/l	ND<0.004	ND<0.004	0.017	ND<0.004	ND<0.004	ND<0.004	ND<0.004	0.014	0.02	0.010	0.001
Sodium	mg/l	622	470.50	340.70	335.70	718	899	685	894	NA	-	-
Tin	mg/l	ND<0.020	ND<0.020	ND<0.020	ND<0.020	ND<0.020	ND<0.020	ND<0.020	ND<0.020	0.2	-	-
Strontium	mg/l	0.697	0.699	0.620	0.925	1.607	1.913	1.181	1.001	NA	6.10	0.01
Sulfate	mg/l	133.2	95.5	110.18	66.0	589	470.5	125.5	277.6	NA	-	-
Sulphide	mg/l	1.4	0.9	0.9	1.7	ND<0.2	0.2	0.5	0.8	0.5	-	-
Temperature	^{o}C	28.9	28.8	29.0	28.5	29.5	29.0	29.2	29.0	40	-	-
Total Dissolved Solid	mg/l	3,758	3,676	3,458	3,628	7,920	11,684	5,976	5,454	NA	-	-
Total Suspended Solids	mg/l	6	28	24	70	400	348	610	155	50	-	-
Zinc	mg/l	0.014	0.009	0.008	0.546	0.094	0.001	0.078	0.033	2.0	52.00	0.01
Vanadium	mg/l	0.007	0.006	0.004	0.008	0.007	ND<0.001	0.004	0.004	NA	0.00	0.00
Salinity	$^{o}/_{oo}$	8.2	5.5	8.2	8.5	11.4	17.5	11.6	6.8	NA	-	-
Dissolved Oxygen	mg/l	-	-	5.4	4.7	4.9	-	7.5	4.2	NA	-	-
Escherichia Coli	MPN/100 ml	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	NA	-	-
Total Coliform	MPN/100 ml	2.0	<1.8	<1.8	34	11	4.5	4.5	<1.8	NA	-	-
Gross α	Bq/L	-	-	0.20±0.07	-	-	-	0.16±0.08	<0.03	NA	-	-
Gross β	Bq/L	-	-	4.25±0.11	-	-	-	2.27±0.09	0.90±0.04	NA	-	-
Pesticides												
Aldrin	mg/l	-	ND<0.00002	ND<0.00002	ND<0.00002	-	-	ND<0.00002	ND<0.00002	NA	-	-
Chlordane	mg/l	-	ND<0.00002	ND<0.00002	ND<0.00002	-	-	ND<0.00002	ND<0.00002	NA	-	-
DDT	mg/l	-	ND<0.0002	ND<0.0002	ND<0.0002	-	-	ND<0.0002	ND<0.0002	NA	-	-
2,4-D	mg/l	-	ND<0.03	ND<0.03	ND<0.03	-	-	ND<0.03	ND<0.03	NA	-	-
Dieldrin	mg/l	-	ND<0.00001	ND<0.00001	ND<0.00001	-	-	ND<0.00001	ND<0.00001	NA	-	-
Endosulfan	mg/l	-	ND<0.001	ND<0.001	ND<0.001	-	-	ND<0.001	ND<0.001	NA	-	-
Heptachlor	mg/l	-	ND<0.00002	ND<0.00002	ND<0.00002	-	-	ND<0.00002	ND<0.00002	NA	-	-
Heptachlor Epoxide	mg/l	-	ND<0.00001	ND<0.00001	ND<0.00001	-	-	ND<0.00001	ND<0.00001	NA	-	-
Hexachlorobenzene	mg/l	-	ND<0.00001	ND<0.00001	ND<0.00001	-	-	ND<0.00001	ND<0.00001	NA	-	-
Methoxychlor	mg/l	-	ND<0.0004	ND<0.0004	ND<0.0004	-	-	ND<0.0004	ND<0.0004	NA	-	-
Lindane	mg/l	-	ND<0.0001	ND<0.0001	ND<0.0001	-	-	ND<0.0001	ND<0.0001	NA	-	-
Chloroform	mg/l	-	ND<0.005	ND<0.005	ND<0.005	-	-	ND<0.005	ND<0.005	NA	-	-
Bromoform	mg/l	-	ND<0.005	ND<0.005	ND<0.005	-	-	ND<0.005	ND<0.005	NA	-	-
Dibromochloromethane	mg/l	-	ND<0.005	ND<0.005	ND<0.005	-	-	ND<0.005	ND<0.005	NA	-	-
Bromodichloromethane	mg/l	-	ND<0.005	ND<0.005	ND<0.005	-	-	ND<0.005	ND<0.005	NA	-	-

Source: Soil Investigation Report, September 2023

The following provides the summary of findings for the groundwater:-

pH, Temperature, DO (Dissolved Oxygen), TDS (Total Dissolved Oxygen) and TSS (Total Suspended Solids), Salinity and Hardness are tested from the groundwater samples. General the pH of the water samples range from 5 to 7.3 which is within the range specified under the ACFDL. The temperature of the water samples range from 28.3^{0}C to 29.3^{0}C which is also within the temperature range outlined in the ACFDL.

DO range from 2.5 to 7.5 mg/l are detected in the water samples whilst TDS ranging from 2480 to 11,684 mg/l are detected in the water samples. Both the NOMC and ACFDL do not have values for DO and TDS.

TSS ranging from 140 to 16,400 mg/l are detected in the groundwater which indicaed to high presence of suspended solids in the groundwater, Turbidity vaues of 50-18,500 NTU are detected in the water samples while color values of 99-655 ADMI are generally found to be above the standards of 100 NTU outlined in the ACFDL.

The conductivity of the groundwater range from 3,640-17,180 µs/cm. Gross Alpha and Gross Beta are also testing in the water samples. Gross Alpha and Gross beta is a measure of radioactivity in a water sample attributable to the radioactive decay of alpha or beta emitting element. Alpha particles have great ionizing power. Based on the testing conducted the Gross Alpha values range from 0.21-0.03 Bq/L while the Gross Beta values range from 2.57-141 Bq/L. The Gross Alpha and Gross Beta values are important for screening levels for drinking water.

Biological parameters such as Total Coliform and E.Coliform are tested in the groundwater. E.Coli raging from 1.8 to 34 MPN/100 ml and E.Coli of 1.8 to 7.9 MPN/100 ml can be said to be low in the groundwater.

Marine Oil, BOD, Phenols and Oil & Grease and Ammonia Nitrogen are tested in the groundwater.

In general the BOD values ranged from 10-231 mg/l. Only two samples obtained (1 sample BH4 and 1 sample at BH8) showed values within the ACFDL while the rest of the samples obtained showed exceedence to the standards.

Oil and Grease ranging from 2.0 to 13.0 mg/l are generally found to be above the ACFDL except for 3 samples obtained at BH2 and BH8. Phenols values ranging from 0.0001 to 0.027 mg/l are found to be outside the ACFDL except for the samples obtained in BH6 and BH8.

Anionic compounds such as Fluorides, Sulphide and Sulfates are tested in the groudnwater.

Sulphides ranging from 0.2 to 2.2 mg/l detected in the water samples generally surpassed the ACFDL value of 0.5 mg/l except for 8 samples ontained at BH5 and BH8. Sulphates ranging from 7 to 253.7 mg/l are detected in the water samples. However there are no standards for this parameters. Anionic detergent of less than 0.001 to 0.01 mg/l are detected in the water samples. Again there are no standards for this parameter.

Various metals/heavy metals are tested in the groundwater. Amongst the parameters that do not meet the ACFDL include Boron, Fe, Cu and Mn. However, the values for Fe, Cu and Mn are within the maximum values for the typical range of Natural Occuring Metal Concentration in groundwater. Thus although these parameters exceeded the ACFDL, the metals concentration are within the maximum value for naturally occuring metals in groudnwater and thus should not be of concern. As the Jelutong Landfill in the past uses soil to cover the dump wastes, the natural occuring metals in the soil could have leached out contributing to the high metal contents.,

Nitrate, Nitrites, Ammonia and Ammoniacal Nitrogen are tested in the water samples. AN levels ranging from 11.04 to 151.96 mg/l are detected to be high. The high AN levels coud be due to the presence of the ammonia gases in the boreholes which is detected during the landfill gas testing described further in subsequent sections.

Nitrates ranging from 0.62 to 3.19 mg/l and Nitrites ranging from 0.005 to 0.185 mg/l are detected in the water samples. However, there are no standards for this parameters.

Cn and B are inorganic parameters, Cn of less than 0.02 mg/l are detected to be within the ACFDL of 0.09 mg/l. However B values ranging from 1,208 to 3,594 mg/l are detected to be above the standards and above the NOMC in groundwater.

COD ranging from 265-1,605 mg/l in the water samples are detected to b extremely high when compared to the ACFDL.

Hardness ranging from 572-2,376 mg$CaCO_3$/l are detected in the water samples. However teher are no standards for this parameters.

Pesticides such as Aldrin, Chlordane, DDT, Dieldrin, Endosulfan, Heptachlor, Hexachlorobenze, Lindane, Chloroform, Bronoform, Dibromochloromethane and Bromodichloromethane are tested in the groundwater samples.

The pesticides concentration are found to be low however there are no standards for these parameters in the Malaysian Recommended Site Screening Levels for Contaminated Land.

Conclusions

Based on the data obtained for the groundwater, it can be inferred that BOD, Ammonia Nitrogen, COD, Oil & Grease, Phenols, Boron, Fe and Mn are detected to be high in the groundwater samples when compared to the leachate standards. Nonetheless the concentration of the metals tested except for Boron are generally within the maximum values for the typical range of natural occuring metal concentration in groundwater and thus should not be a cause of great concern.

The groundwater quality is also assessed based on the IKAT. The index aims to provide simple and concise water quality information to all stakeholders to protect and preserve groundwater users. However for the TPSJ site, groundwater will not be used and as mentioned earlier, comparisons to its beneficial use is deemed not suitable. IKAT is built based on an arithmetic approach. IKAT includes selected water quality parameters that are most relevant to groundwater status. The selected water quality parameters for the national groundwater quality index include:-

- pH
- Fe
- E. Coli
- Total Dissolved Solids
- SO_4
- NO^{3-}
- Phenol

Since the selected parameters have different effects on various groundwater uses, weighting factors are introduced for each parameter. The weighting factor is based on the level of intensity for a particular use. IKAT is calculated as follows

$$IKAT = 0.13Si(pH)+0.17Si(Fe)+0.17Si(E.coli)+0.04Si(TDS)+0.09Si(SO_4^{2-}) +0.22Si(NO^{3-})+ 0.17Si\ (Phenol)$$

The IKAT scale is between 0 – 100. The index score is subject to the categories as tabulated in **Table 6.46.** The dumpsite groundwater quality is assessed using the IKAT method. Laboratory analysis results of groundwater samples are averaged for each sampling location.

Table 6.46
Groundwater Categories Based On Groundwater Quality Index IKAT Score

Index	Category	Potential Uses
0-15	Very Polluted	Research is required before use
13-39	Polluted	Irrigation / agriculture
40-69	Moderate	Raw water / industrial use
70-89	Good	Potential as drinking water, subject to compliance with all parameters listed in the drinking water quality standards under the ministry of health of Malaysia
>90	Very Good	High quality water for all forms of use, subject to water quality standards set for each form of use

The input parameters and calculation results of IKAT for the existing dumpsite are shown in **Table 6.47**. In general, the groundwater quality falls under Category of Moderate level. The groundwater quality at borehole BH2 even reaches the level of Good. This suggests that the potential contamination of the groundwater discharge to the sea could be modest.

Table 6.47
Input Parameters And Calculation Results Of IKAT For The TPSJ Groundwater

Parameter	Mean Analysis Results							
	BH2		BH5		BH6		BH8	
	Ci	Si	Ci	Si	Ci	Si	Ci	Si
PH -	6.9	100	7.3	100	7.5	100	6.8	100
Fe mg/l	18.4	0.0	6.9	0.0	2.2	56.4	21.2	0.0
E. Coli MPN/100ml	<1.8	100	<1.8	100	<1.8	100	<1.8	100
TDS mg/l	2493	16.9	5126	0.0	3630	0.0	7759	0.0
SO_4 mg/l	38.2	96.2	133.6	86.6	101.4	89.9	365.7	63.4
NO^{3-} mg/l	2.6	97.4	0.7	99.3	0.4	99.6	0.583	99.4
Phenol mg/l	0.0065	56.7	0.078	0.0	ND	0.0	0.088	0.0
IKAT	70.4		59.7		69.6		57.6	
Category	Good		Moderate		Moderate		Moderate	

(iii) Air Quality

Gas sampling at Jelutong Landfill site is also assessed to determine the ambient air quality of the project site. As many as 5 sampling stations are identified for this purpose. The locations of the gas sampling stations are shown in earlier **Figure 6.74**. The site sampling was conducted between 27th June 2023 to 29th July 2023.

Table 6.48 provides the result of the landfill gas sampling. Comparisons are made with the AAAQG (Arizona Ambient Air Quality Guidelines) and the USEPA AEGL (United States Environmental Protection Agency Acute Exposure Guidelines Limit).

Table 6.48
Landfill Gas Data

Parameter	Location					Guidelines	
	BH 2 (25.7.2023)	BH 4 (29.6.2023)	BH 5 (29.7.2023)	BH 6 (27.6.2023)	BH 8 (28.6.2023)	AAAQG	USEPA
Ammonia (µg/m³)	1.4	5.9	61.5	9.4	7.6	230	20900
Carbon Dioxide (mg/m³)	283000	677,000	26000	4,220	25,200	NA	NA
Hydrogen Sulfide (µg/m³)	<9.8	<11	<10	<13	<11	180	760
Methane (mg/m³)	237000	310,000	17200	<1,200	35,200	NA	NA
NMVOC (Halogenated Compounds) (mg/m³)	<0.017	<0.017	<0.017	<0.017	<0.017	NA	NA
NMVOC (Non-Halogenated Compounds) (mg/m³)@	<0.017	0.543	<0.017	0.152	0.038	170	167.71

@ Benzene

Ammonia levels are detected to be ranging from 1.4 µg/m³ to 61.5 µg/m³ which are found to be within the AAAQG on 230 µg/m³ and USEPA of 20900 µg/m³ as shown in **Figure 6.75**. Carbon Dioxide levels are detected to be ranging from 4,220 mg/m³ to 677,000 mg/m³ as shown in **Figure 6.76**.

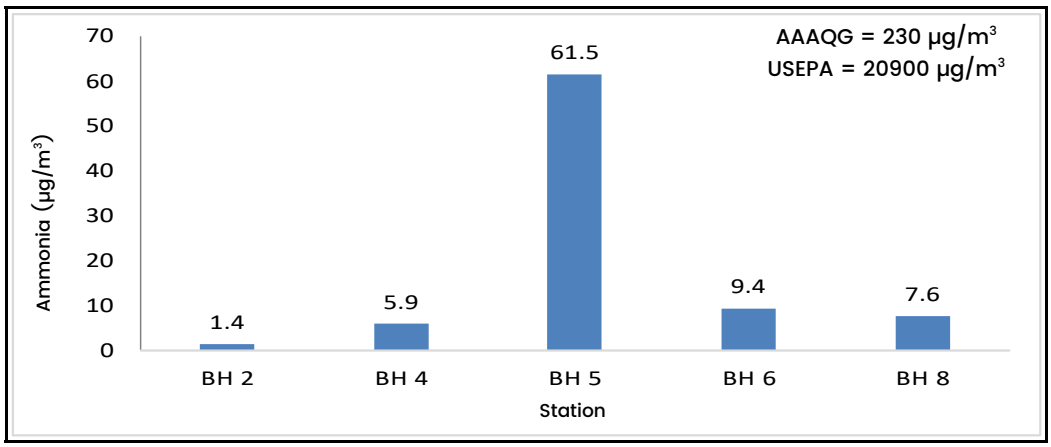


Figure 6.75 Ammonia

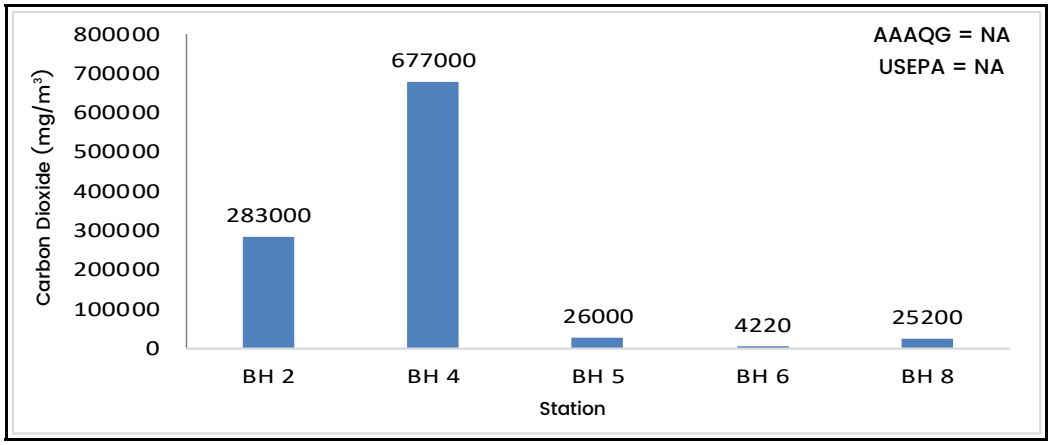


Figure 6.76 Carbon Dioxide

Hydrogen Sulfide levels are detected to be ranging from less than 9.8 µg/m³ to 13 µg/m³ which are found to be within the AAAQG of 180 µg/m³ and the USEPA Acute Exposure Limits of 760 µg/m³ as shown in **Figure 6.77**.

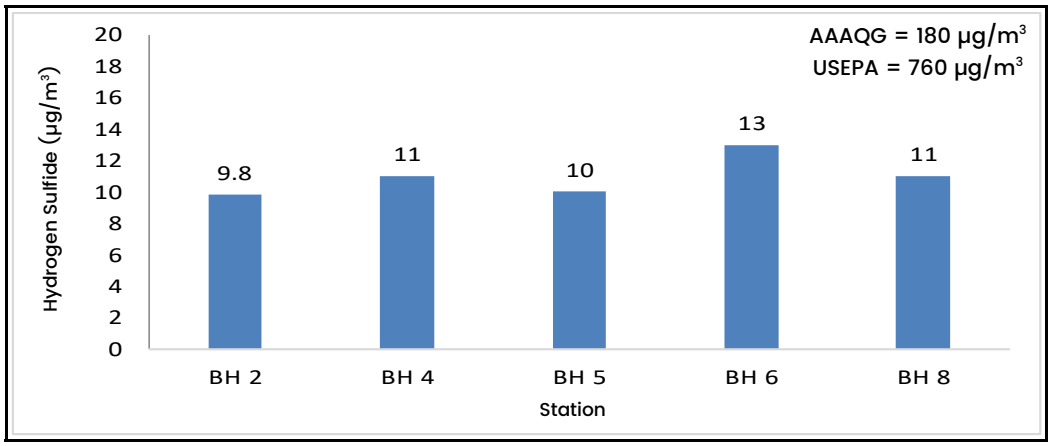


Figure 6.77 Hydrogen Sulfide

Methane levels are detected to be ranging from less than 1,200 mg/m³ to 310,000 mg/m³ as shown in **Figure 6.78.** High levels of both Carbon Dioxide and Methane at sampling points particularly BH2, BH4 and BH8 indicate the ongoing biodegration landfill activity.

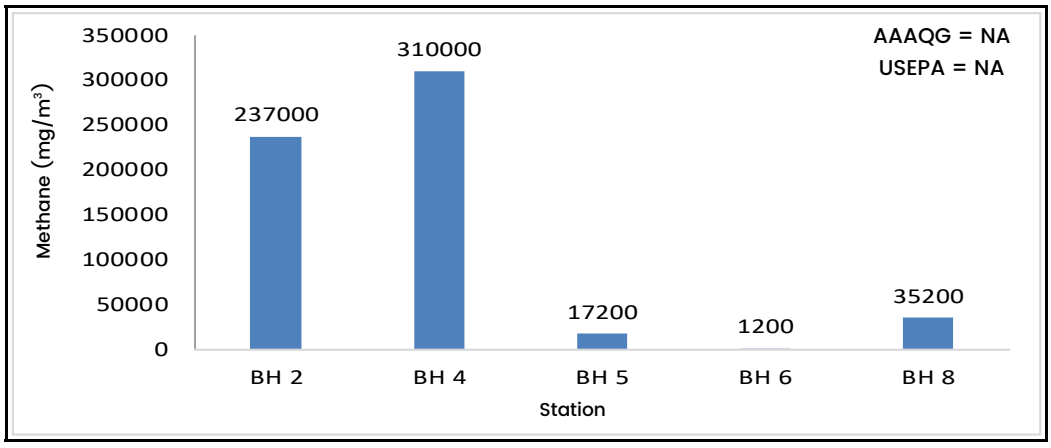


Figure 6.78 Methane

NMVOC (Halogenated Compounds) levels are less than 0.017 mg/m^3 while the NMVOC (Non Halogenated Compounds) levels at the sampling stations are detected to be less than 0.017 mg/Nm^3 to 0.543 mg/Nm^3 as shown in **Figure 6.79.** NMVOC (Non Halogenated Compounds) values are within the ambient air quality guideline of 170 mg/m^3 and USEPA Acute Exposure Limits of 167.7 mg/m^3 as shown in **Figure 6.80.**

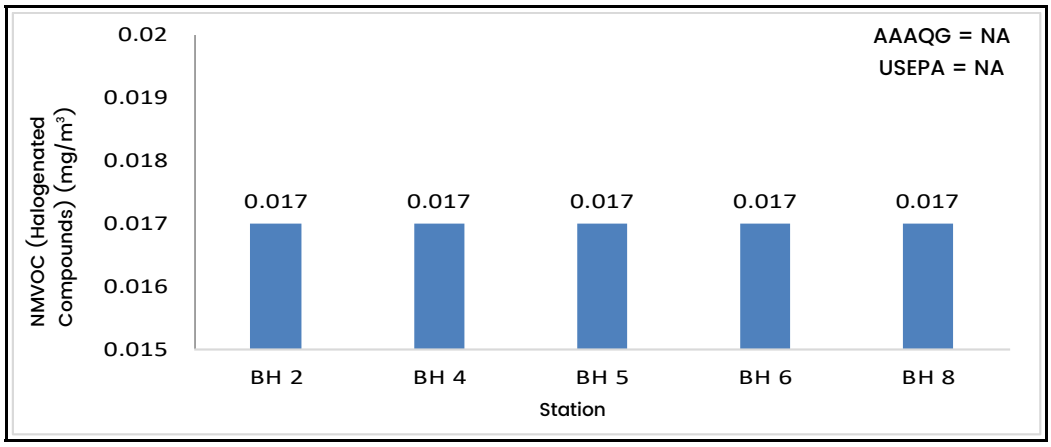


Figure 6.79 NMVOC (Halogenated Compounds)

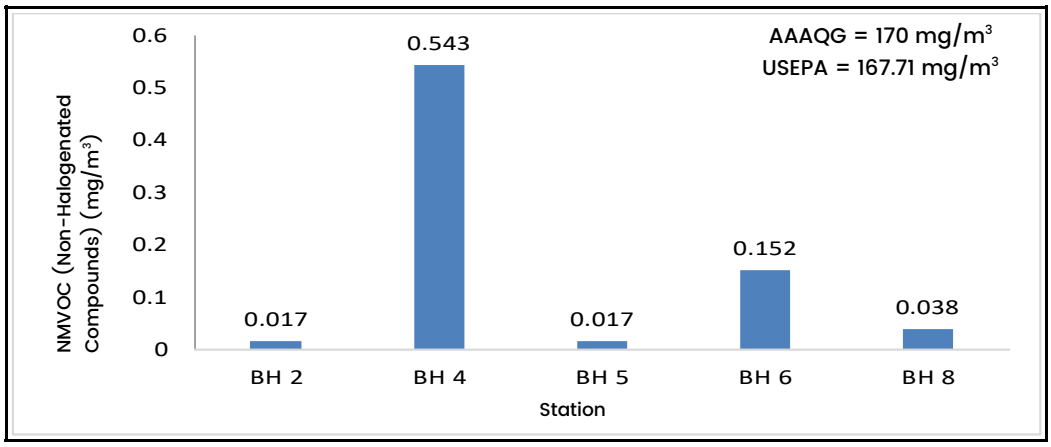


Figure 6.80 NMVOC (Non-Halogenated Compounds)

C. Coastal Environmental Quality

Baseline environmental quality for the coastal area are obtained from the field sampling of total suspended solid in marine water and seabed grab sampling. **Table 6.49** depicts the locations of the baseline of the coastal environmental monitoring stations.

Table 6.49
Decsription Of Coastal Environmental Quality Sampling Stations

Parameter	Station ID	Georeferences
Total Suspended Solid	S1	N 5°22'59.49" E 100°19'17.38"
	S2	N 5°23'04.30" E 100°19'03.21"
	S3	N 5°23'39.94" E 100°19'58.94"
	S4	N 5°23'40.20" E 100°19'37.80"
	S5	N 5°24'01.97" E 100°20'02.34"
	S6	N 5°22'02.75" E 100°19'06.38"
	S7	N 5°21'54.72" E 100°19'34.73"
	S8	N 5°20'15.54" E 100°19'34.78"
	S9	N 5°22'50.71" E 100°20'49.25"
	S10	N 5°22'54.36" E 100°21'58.25"
	S11	N 5°24'38.96" E 100°20'34.75"
	S12	N 5°25'01.49" E 100°21'10.94"
	S13	N 5°26'41.68" E 100°21'06.65"
Seabed Sediment	G1	N 5°23'06.31" E 100°19'10.56"
	G2	N 5°22'54.20" E 100°19'49.13"
	G3	N 5°23'58.04" E 100°20'05.13"
	G4	N 5°22'33.23" E 100°20'36.32"
	G5	N 5°21'58.54" E 100°19'41.92"
	G6	N 5°20'20.44" E 100°19'25.91"
	G7	N 5°22'48.85" E 100°21'46.99"
	G8	N 5°24'21.45" E 100°21'40.08"
	G9	N 5°24'34.70" E 100°20'33.06"
	G10	N 5°25'05.70" E 100°21'11.75"
	G11	N 5°25'58.31" E 100°19'56.45"
	G12	N 5°27'12.67" E 100°21'05.57"

Source: Coastal Hydraulic Study

(i) Total Suspended Solids Sampling In Marine Waters

Besides the baseline data outlined above, sampling for total suspended solid is also conducted by the coastal hydraulic consultants to assess the sediment characteristic in the study area.

TSS (Total Suspended Solids) is the total suspended solids in the water sample, which contain a large variety of material that could include clays, silts, inorganic matter, organic matter, vegetation, and living organisms that produce a large variety of particle sizes.

The water samples have been collected using a dedicated water sampler (Jabco Water Pump) and stored in 500mL HDPE bottles, on 21st June 2020 from thirteen (13) locations in the vicinity of Project area as shown in **Figure 6.81**.

Source: Coastal Hydraulic Study

Not To Scale

Figure 6.81 Location Of TSS Water Sampling Points

The samples were collected at one (1) depth (0.5D) for S2, S4 and S7 and three (3) different depths (0.2D, 0.5D and 0.8D) were collected for all the remaining points (S1, S3, S5, S6, S8, S9, S10, S11, S12 and S13). A total of 33 water samples were collected and sent to Soilpro Technical Services Sdn. Bhd. for laboratory analysis. The analysis was carried out in accordance to the APHA 2540D test method. Summary of the TSS results as tabulated in **Table 6.50**.

Table 6.50

Coordinates Of Water Sampling Locations And Results Of TSS Analysis From S1 To S13

ID	Longitude	Latitude	Sampling Depth	TSS (mg/L)	Average TSS (mg/L)
S1	100°19'17.38"E	5°22'59.49"N	0.2	28	98.7
			0.5	228	
			0.8	40	
S2	100°19'03.21"E	5°23'04.30"N	0.5	28	28.0
S3	100°19'58.94"E	5°23'39.94"N	0.2	34	36.0
			0.5	34	
			0.8	40	
S4	100°19'37.80"E	5°23'40.20"N	0.5	34	34.0
S5	100°20'02.34"E	5°24'01.97"N	0.2	40	58.7
			0.5	34	
			0.8	102	
S6	100°19'06.38"E	5°22'02.75"N	0.2	20	20.7
			0.5	30	
			0.8	12	
S7	100°19'34.73"E	5°21'54.72"N	0.5	42	42.0
S8	100°19'34.78"E	5°20'15.54"N	0.2	26	31.3
			0.5	28	
			0.8	40	
S9	100°20'49.25"E	5°22'50.71"N	0.2	50	47.3
			0.5	46	
			0.8	46	
S10	100°21'58.25"E	5°22'54.36"N	0.2	40	40.7
			0.5	44	
			0.8	38	
S11	100°20'34.75"E	5°24'38.96"N	0.2	34	40.0
			0.5	44	
			0.8	42	
S12	100°21'10.94"E	5°25'01.49"N	0.2	42	37.3
			0.5	36	
			0.8	34	
S13	100°21'06.65"E	5°26'41.68"N	0.2	34	25.3
			0.5	40	
			0.8	2	

Source: Coastal Hydraulic Study

Based on the analysed water sample result, higher TSS is identified at south of rehabilitation area (S1) with average TSS of 98.7 mg/L may be due to this sampling location near to aquaculture area. TSS results at S3 and S4 in the vicinity of proposed working platform area are less than 40 mg/L. While at Sg. Pinang river mouth, TSS concentration is 58.7 mg/L. The remaining sampling results show TSS concentration less than 50 mg/L.

(ii) Seabed Grab Sampling

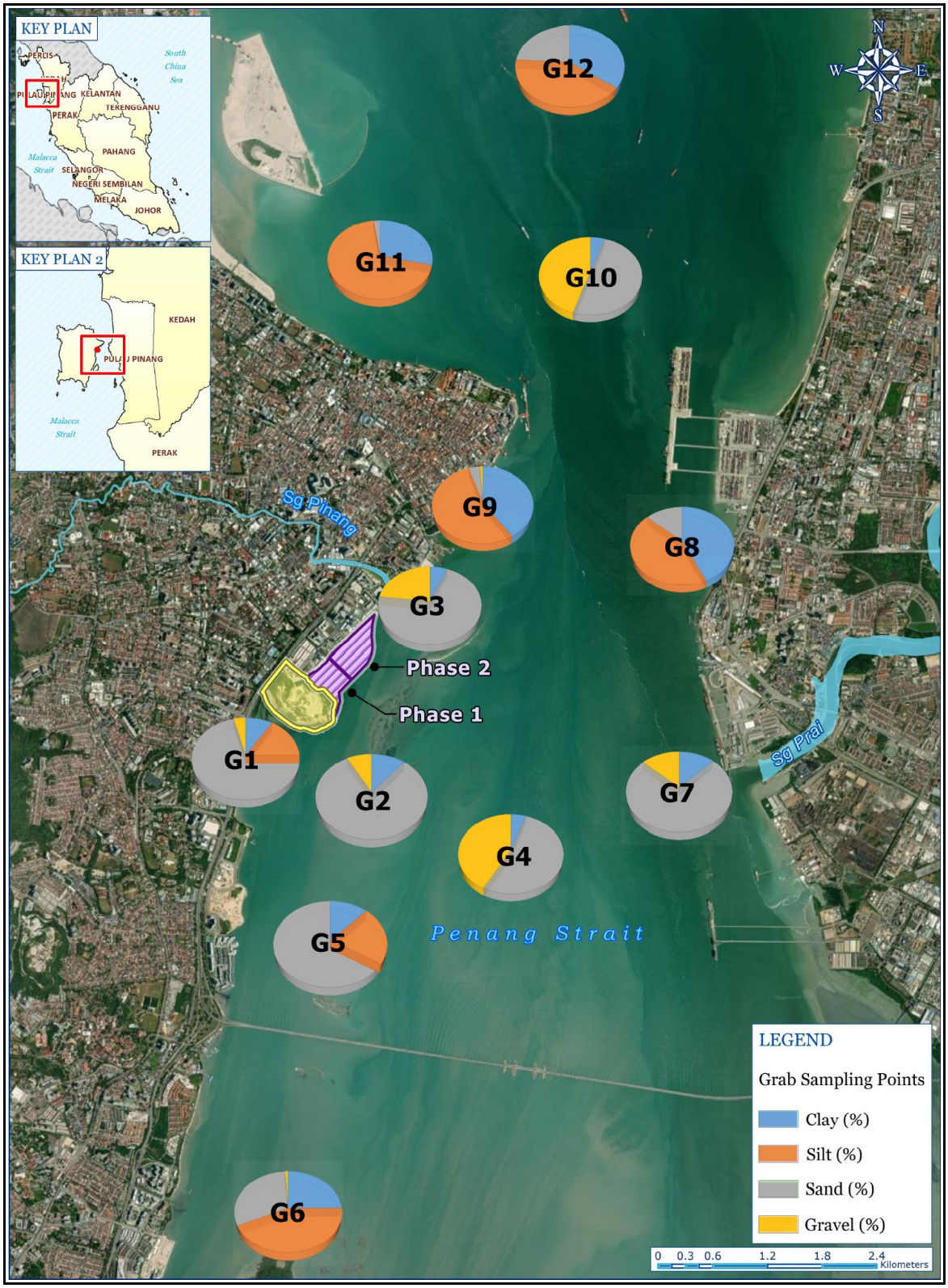
Seabed grab samples have been collected on 21st June 2020 for twelve (12) sampling locations as shown in **Figure 6.82** and details as tabulated in **Table 6.51.** All collected samples were sent to Soilpro Technical Services Sdn. Bhd. for PSD (Particle Size Distribution) analysis.

Table 6.51
Laboratory Results Of The Seabed Sediment At G1 To G12

ID	Coordinate		D50 (mm)	Grain Size Analysis (%)				Depth (m)	Remarks
	Longitude	Latitude		Clay	Silt	Sand	Gravel		
G1	100°19'10.56"E	5°23'06.31"N	0.14	9	16	71	4	2.91	Sand Mud
G2	100°19'49.13"E	5°22'54.20"N	0.722	11		81	8	1.85	Sandy
G3	100°20'05.13"E	5°23'58.04"N	0.907	6		71	23	12.65	Sand Mud
G4	100°20'36.32"E	5°22'33.23"N	1.585	5		53	42	9.6	Sandy
G5	100°19'41.92"E	5°21'58.54"N	0.127	12	22	66	0	2.59	Sandy
G6	100°19'25.91"E	5°20'20.44"N	0.018	25	43	31	1	2.79	Muddy
G7	100°21'46.99"E	5°22'48.85"N	0.440	12		75	13	15.52	Sand Mud
G8	100°21'40.08"E	5°24'21.45"N	0.003	43	44	13	0	12.54	Soft Mud
G9	100°20'33.06"E	5°24'34.70"N	0.003	41	54	4	1	7.76	Soft Mud
G10	100°21'11.75"E	5°25'05.70"N	1.764	5		50	45	25.12	Coarse Sand
G11	100°19'56.45"E	5°25'58.31"N	0.004	36	62	2	0	3.1	Muddy
G12	100°21'05.57"E	5°27'12.67"N	0.005	35	41	24	0	15.99	Muddy

Source: Coastal Hydraulic Study

Generally, the seabed material in the vicinity of the Project area is dominantly consists of sand with average D50 of 0.59 mm (G1 – G3). Higher portion of clayey silt is found near Pulau Jerejak (G6) and at north of Penang Strait (G8, G9, G11 and G12). Highest clayey silt composition of 98% is found at south of Sri Tanjung Pinang reclamation area (G11). Meanwhile, higher gravelly sand content is found at the middle of Penang Strait (G4 and G10).



Source: Coastal Hydraulic Study

Not To Scale

Figure 6.82 Particle Size Distributions At Sampling Stations