A COMPREHENSIVE HYDRAULIC STUDY - RECLAMATION PROJECT, IMPACTS ON SUNGAI LEREH AND MITIGATION MEASURES

1 Introduction

This study carried out to determine the optimum structural measures that will allow for safe during periods of strong wind and high wave activity and to enhance tourism and recreational potential in these areas. The current project comprises the impact of proposed reclamation work on hydrodynamic and morphological condition at Malacca, aims to create a model to represent the hydrodynamics, wave and mud transport patterns prevalent at the study site, using MIKE 21 developed by DHI. Present study represents the different scenario and state the period for reclamation work, impacts on Sungai Lereh and mitigation measures for the proposed study.

2 Modelling Scenarios

Table 5.3 shows the model simulation for different scenarios. With the below table, the model was simulated for a domain around Malacca for different scenarios viz., Scenario A – Baseline condition, Scenario B - Reclamation (with floating piles), Scenario C – Reclamation (with floating piles) + Breakwater (40m mouth distance) and Scenario D – Reclamation (with floating piles) + Breakwater (50m mouth distance) (Figure 1 to Figure 4). Two different monsoons were selected during this modelling study to assess the impact of proposed reclamation work at Malacca. These monsoons were selected based on the characteristics of wind and wave condition in the model boundaries.

Table 1: Model Simulation for Four Scenarios with Different Monsoon

Scenarios	Monsoon	Wind Speed (m/s) and Direction (º) Conditions
Scenario-A (Baseline Condition)	Northeast	5.5 m/s and 300º
	Southwest	4.5 m/s and 150º
Scenario-B (Reclamation with floating piles)	Northeast	5.5 m/s and 300º
	Southwest	4.5 m/s and 150º
Scenario-C	Northeast	5.5 m/s and 300º

(Reclamation with floating piles + Breakwater with 40m Mouth Distance)	Southwest	4.5 m/s and 150º
Scenario-D (Reclamation with floating piles + Breakwater with 50m Mouth Distance)	Northeast	5.5 m/s and 300º
	Southwest	4.5 m/s and 150º

3 Impact on Current

Current flows have been predicted in the study area, this is based on the calibrated model MIKE 21 FM. Current speeds are mainly induced by the tidal forcing and the bathymetry characteristics as well as by the wind action in the water surface. Table 2 and Table 3 shows current speed for different scenarios where speed can reach maximum up to 1.80 m/s and mean current speed falls between 0.00 m/s to 0.08 m/s during the study period. In general current speeds are lower in the shallow areas and the model prediction shows that the mean difference read approximately 0.000 m/s and maximum difference is 0.8 m/s in the vicinity of the reclamation site. A clear tidal pattern of the current can be observed, with two predominant current directions during flood conditions and ebb condition. Snap shots that illustrate the flow pattern around the reclamation area during different tidal conditions are shown in Figure 5 and Figure 8.

3.1 Current Speed Comparison

Comparison were based on the current speed changes with respect to the baseline condition at ten locations around the reclamation area. Figure 9 shows the extraction points around the project area. Current speed comparison are shown in Figure 10 and Figure 11. Comparison for mean and maximum current speeds at the extracted locations in project area are tabulated in Table 4 and Table 5.

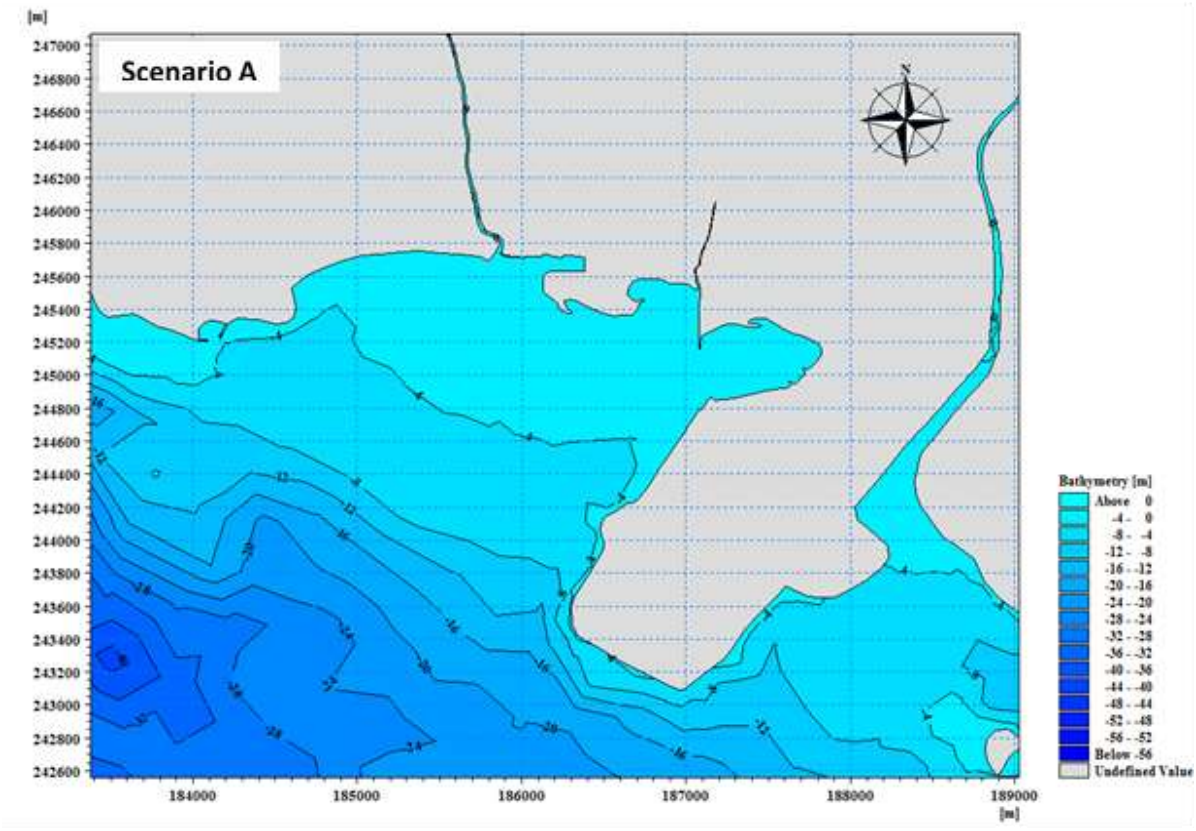


Figure 1: Scenario A with Bathymetry

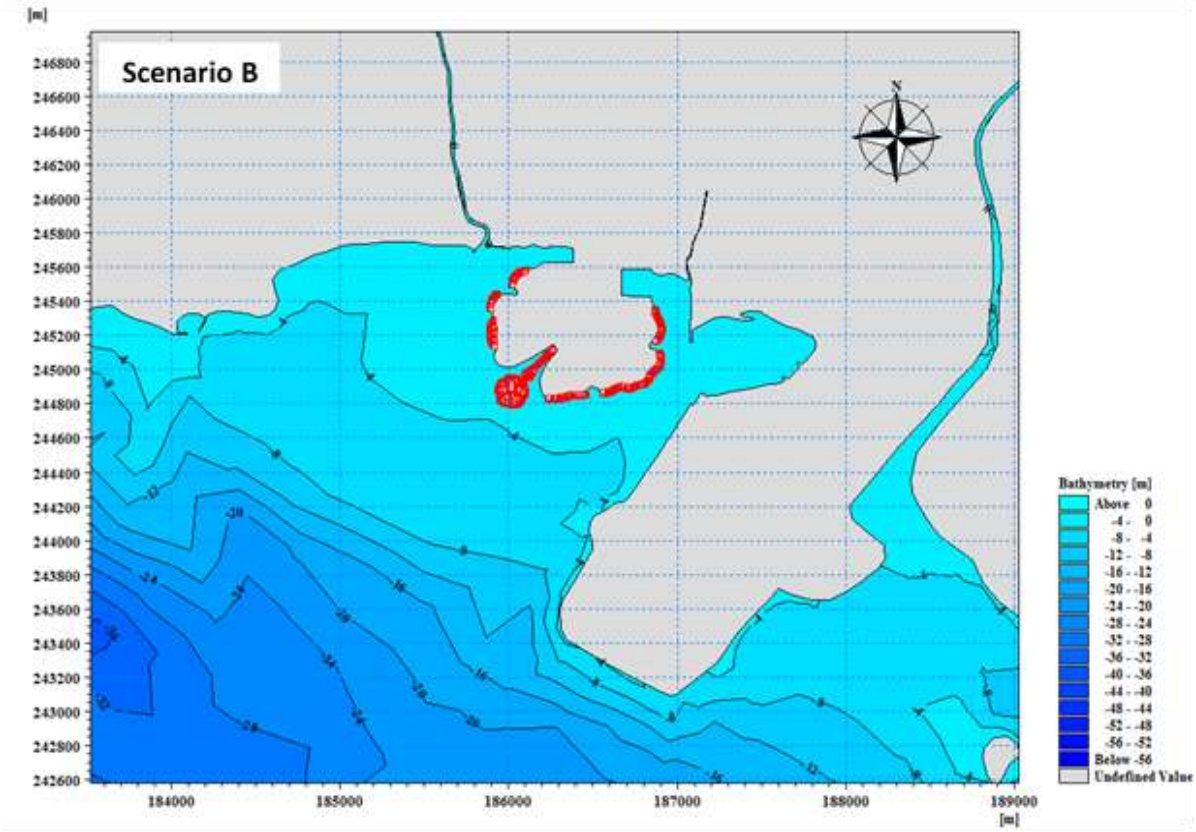


Figure 2: Scenario B with Bathymetry

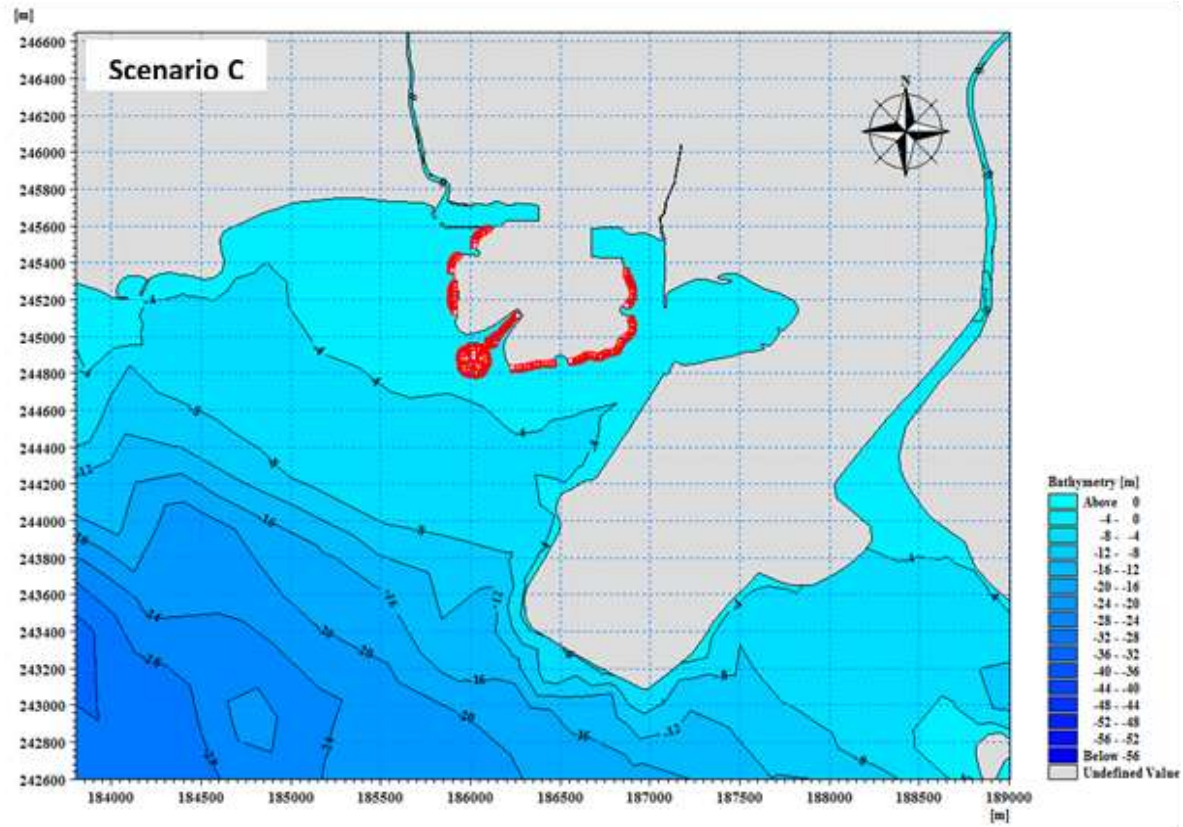


Figure 3: Scenario C with Bathymetry

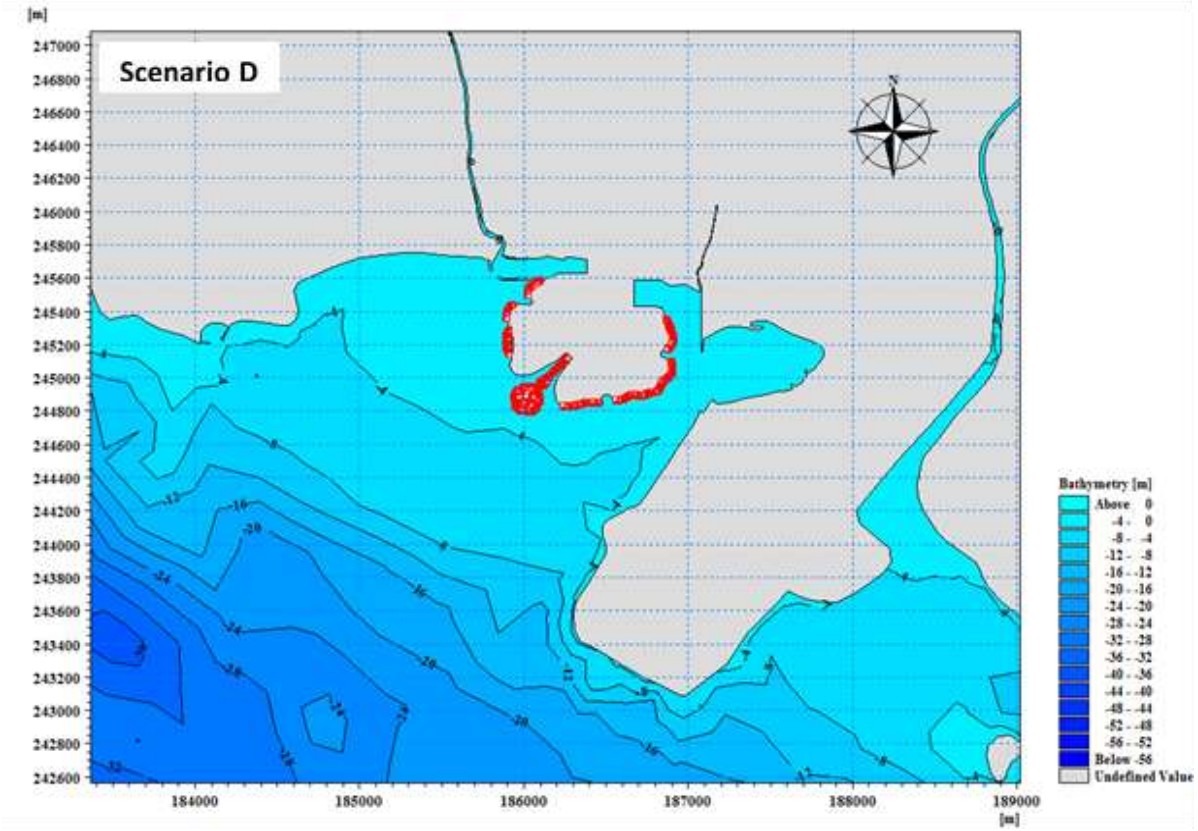


Figure 4: Scenario D with Bathymetry

Table 2: Summary of Simulation - Northeast Monsoon

Scenario	Monsoon	Current Speed		Water Level		Bed Thickness Change
		Mean (m/s)	Maximum (m/s)	Minimum (m)	Maximum (m)	(m/mth)
Scenario-A (Baseline Condition)	NE	0.00 to 0.08	0.00 to 1.20	- 1.4 to – 1.2	2.2 to 3.2	0.00 to 0.04
Scenario-B (Reclamation)	NE	0.00 to 0.08	0.00 to 1.20	- 1.4 to – 1.2	2.2 to 2.8	0.00 to 0.04
Scenario-C (Rec+Breakwater+40m)	NE	0.00 to 0.08	0.00 to 1.80	-1.4 to -1.2	2.2 to 2.8	0.00 to 0.04
Scenario-D (Rec+Breakwater+50m)	NE	0.00 to 0.08	0.00 to 1.65	-1.4 to -1.2	2.2 to 2.8	0.00 to 0.04
Scenario-A Vs Scenario-B	NE	-0.015 to 0.000	-0.4 to 0.00	-1.35 to 0.00	-0.50 to 0.00	0.00 to 0.00
Scenario-A Vs Scenario-C	NE	-0.015 to 0.000	-0.4 to 0.80	-1.20 to 0.00	-0.50 to 0.00	-0.02 to 0.00
Scenario-A Vs Scenario-D	NE	-0.015 to 0.000	-0.4 to 0.80	-1.20 to 0.00	-0.50 to 0.00	-0.02 to 0.00

Table 3: Summary of Simulation - Southwest Monsoon

Scenario	Monsoon	Current Speed		Water Level		Bed Thickness Change
		Mean (m/s)	Maximum (m/s)	Minimum (m)	Maximum (m)	(m/mth)
Scenario-A (Baseline Condition)	SW	0.00 to 0.08	0.00 to 1.20	- 1.4 to – 1.2	2.2 to 3.2	0.00 to 0.04
Scenario-B (Reclamation)	SW	0.00 to 0.08	0.00 to 1.20	- 1.4 to – 1.2	2.2 to 2.8	0.00 to 0.04
Scenario-C (Rec+Breakwater+40m)	SW	0.00 to 0.08	0.00 to 1.80	-1.4 to -1.2	2.2 to 2.8	0.00 to 0.04
Scenario-D (Rec+Breakwater+50m)	SW	0.00 to 0.08	0.00 to 1.65	-1.4 to -1.2	2.2 to 2.8	0.00 to 0.04
Scenario-A Vs Scenario-B	SW	-0.015 to 0.000	-0.4 to 0.00	-1.35 to 0.00	-0.50 to 0.00	0.00 to 0.00
Scenario-A Vs Scenario-C	SW	-0.015 to 0.000	-0.4 to 0.80	-1.20 to 0.00	-0.50 to 0.00	-0.02 to 0.00
Scenario-A Vs Scenario-D	SW	-0.015 to 0.000	-0.4 to 0.80	-1.20 to 0.00	-0.50 to 0.00	-0.02 to 0.00

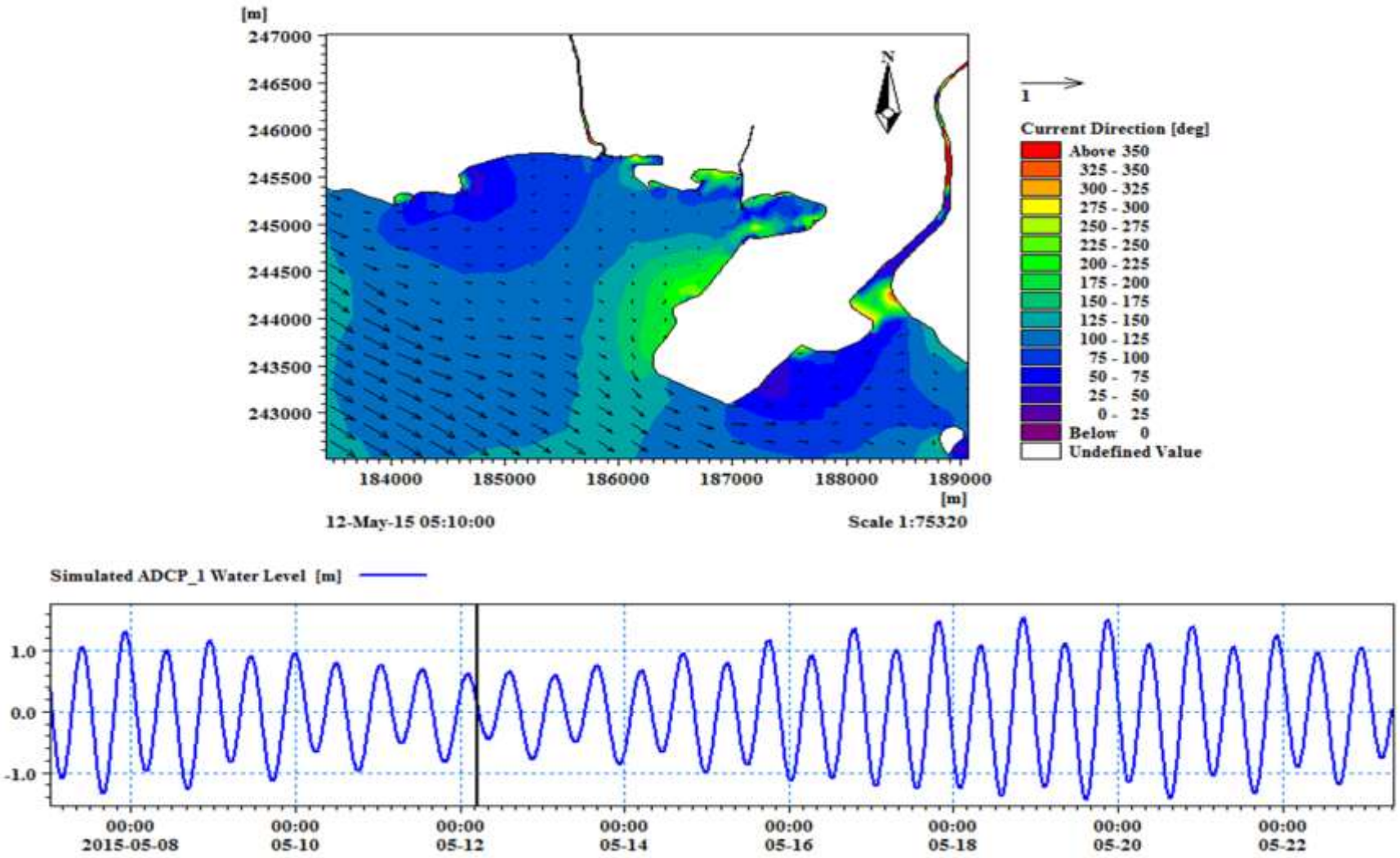


Figure 5: Northeast Monsoon : Details of Ebb Tidal Current Direction for Baseline Condition

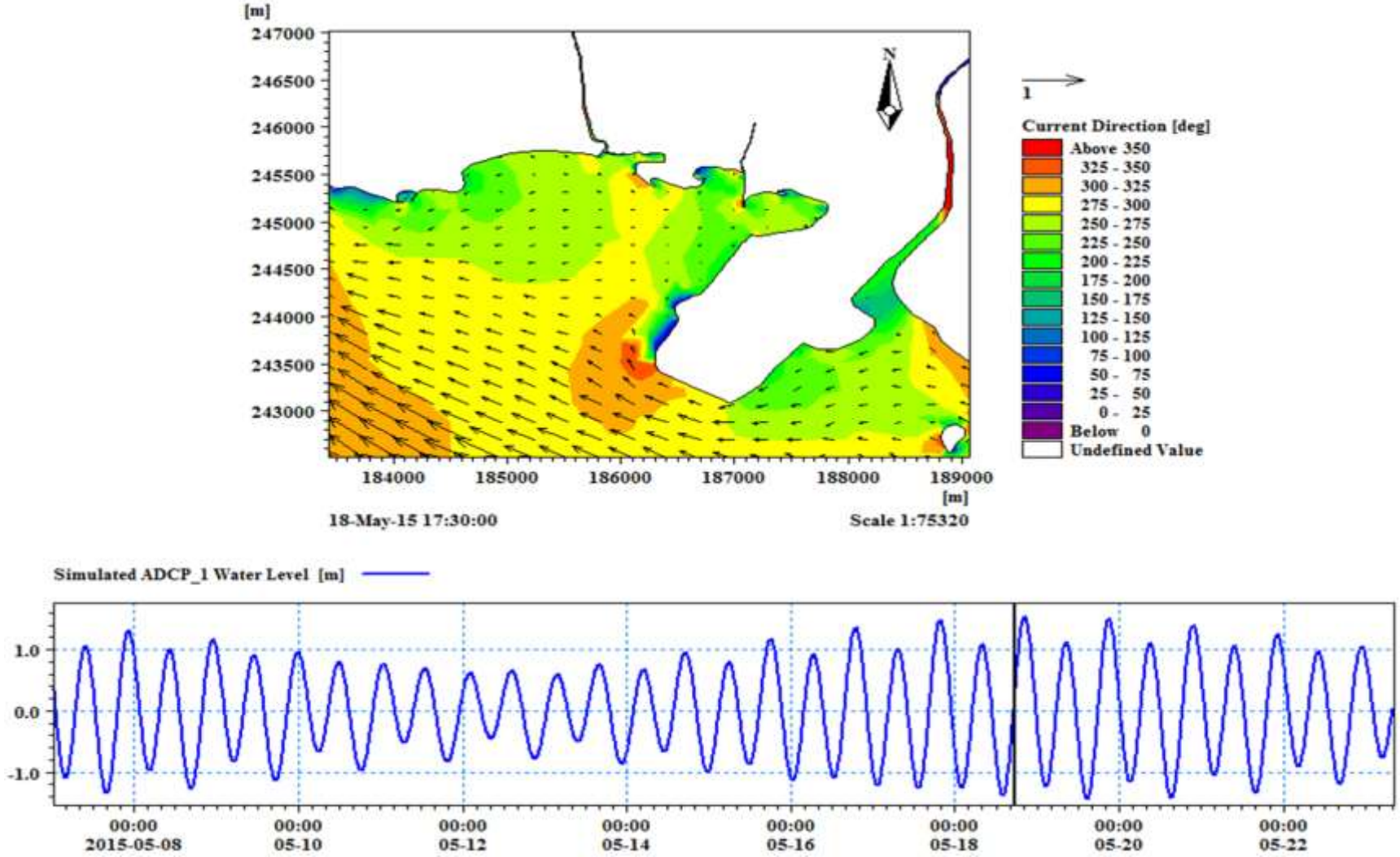


Figure 6: Northeast Monsoon : Details of Flood Tidal Current Direction for Baseline Condition

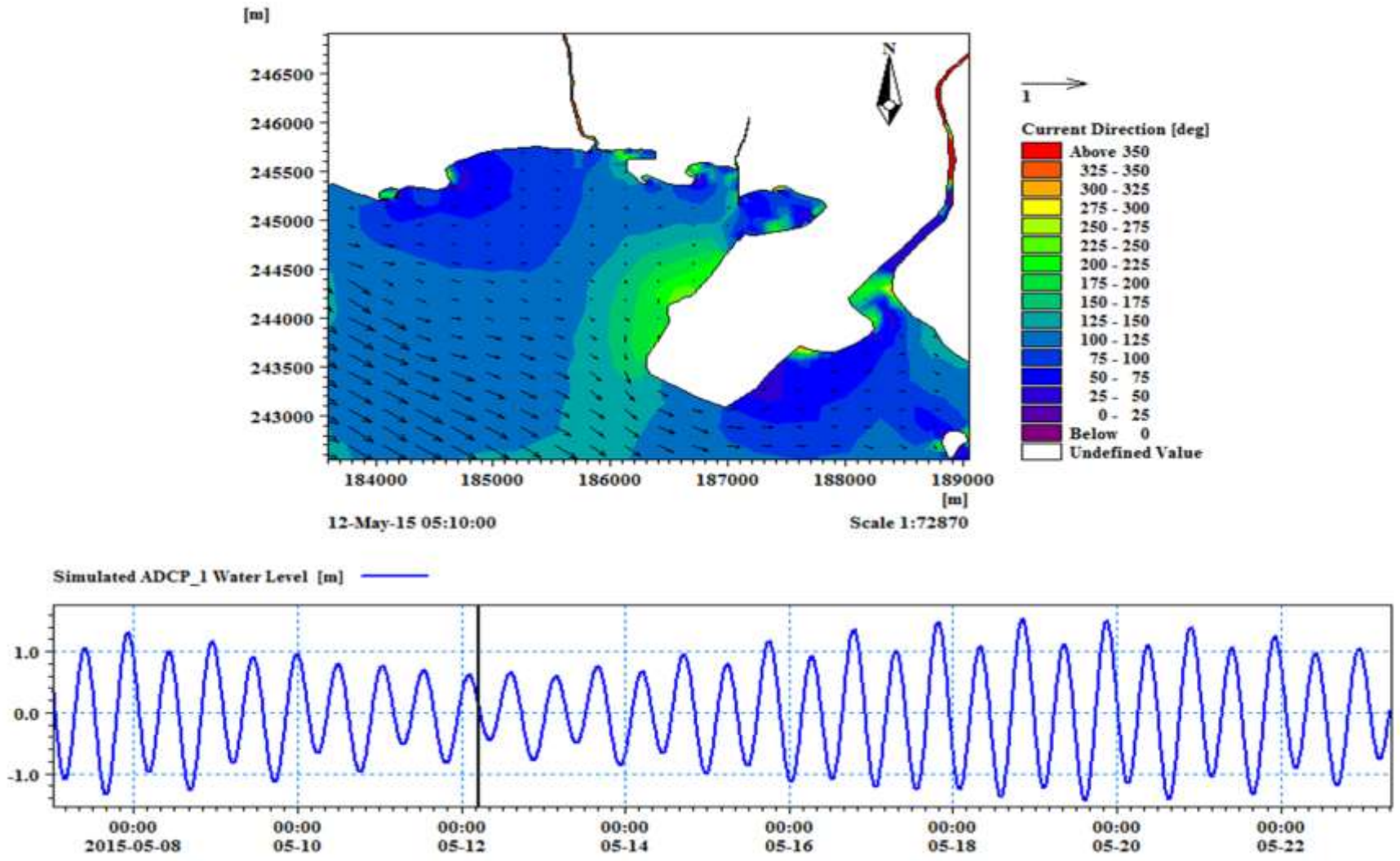


Figure 7: Southwest Monsoon : Details of Ebb Tidal Current Direction for Baseline Condition

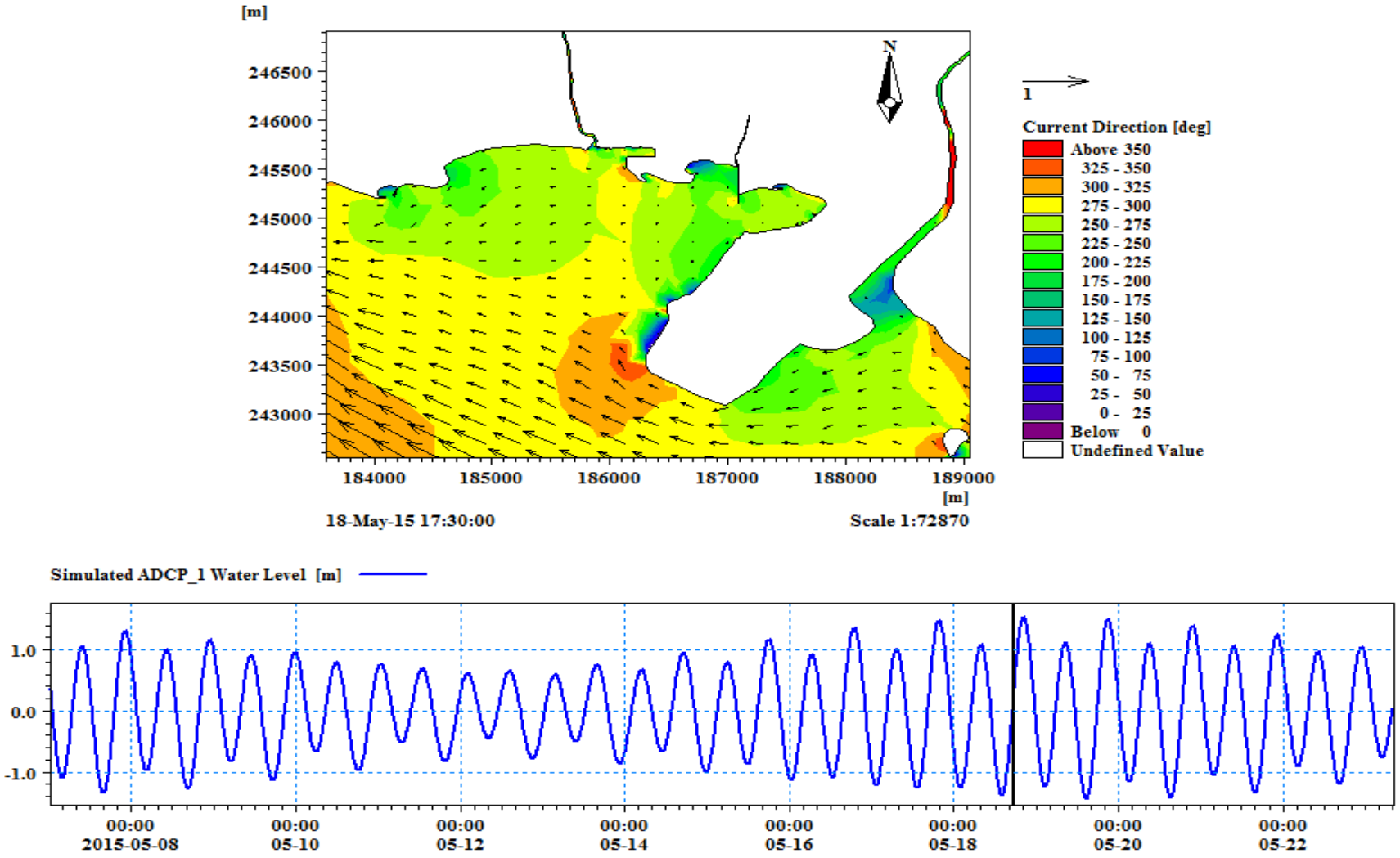


Figure 8: Southwest Monsoon : Details of Flood Tidal Current Direction for Baseline Condition

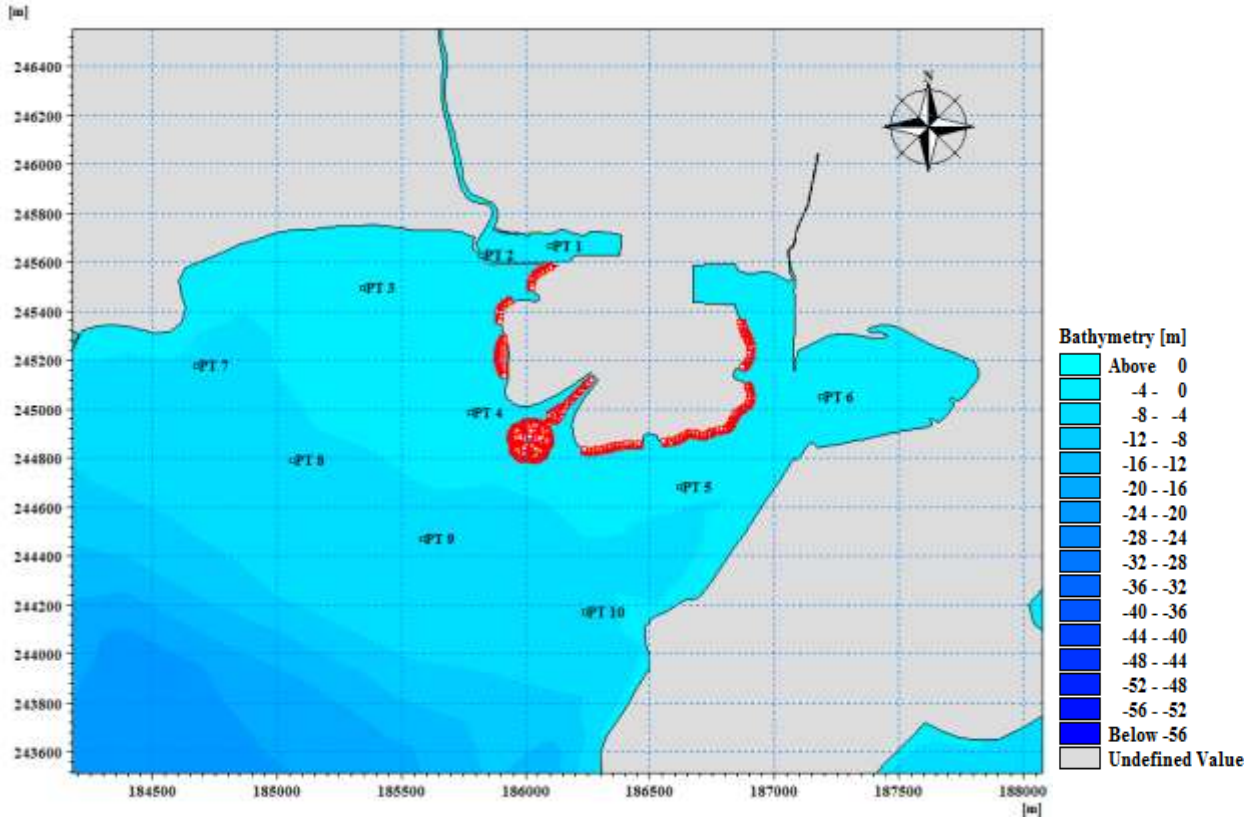


Figure 9: Extraction Points at Project Area

Locations:

PT 1	Within breakwater in front of Sungai Lereh
PT 2	Breakwater Mouth
PT 3	Left side of reclamation area
PT 4	Near floating piles
PT 5	Right side of reclamation area
PT 6	Around the bay at reclamation site
PT 7	Towards offshore (Northern side)
PT 8	Towards offshore (Northern side)
PT 9	Towards offshore (Southern side)
PT 10	Towards offshore (Southern side)

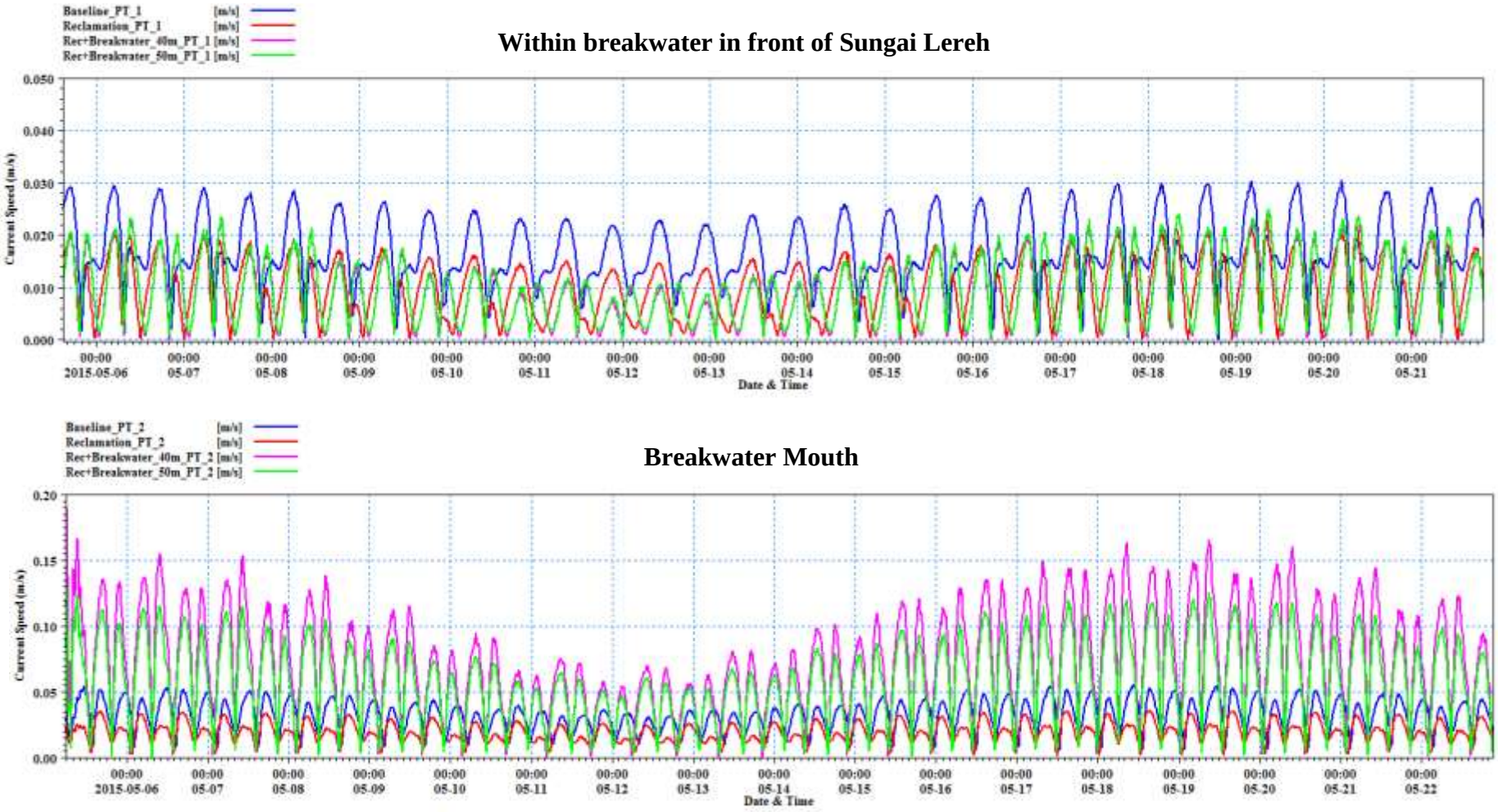
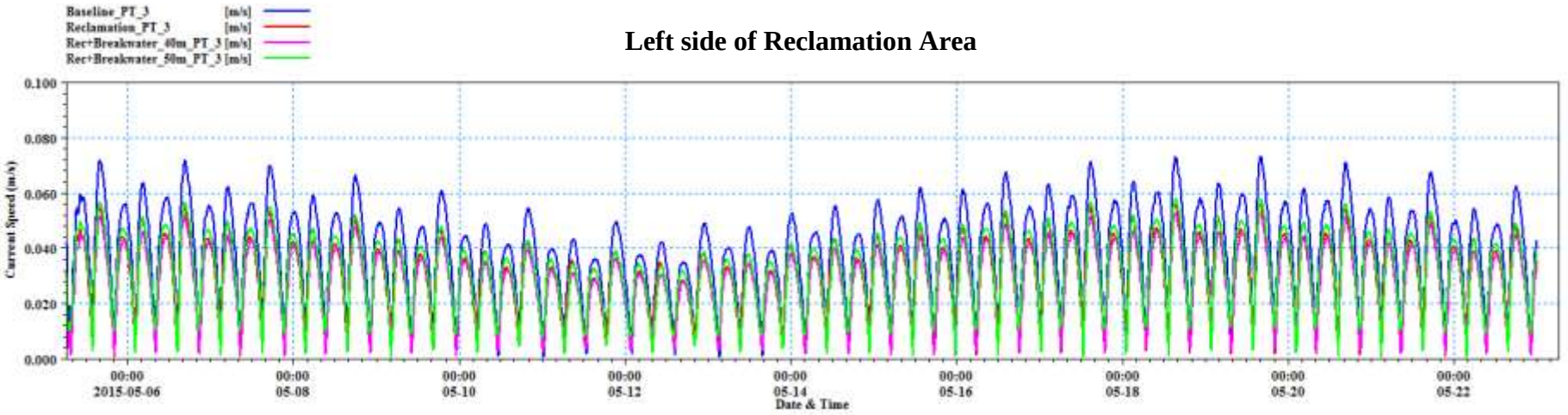
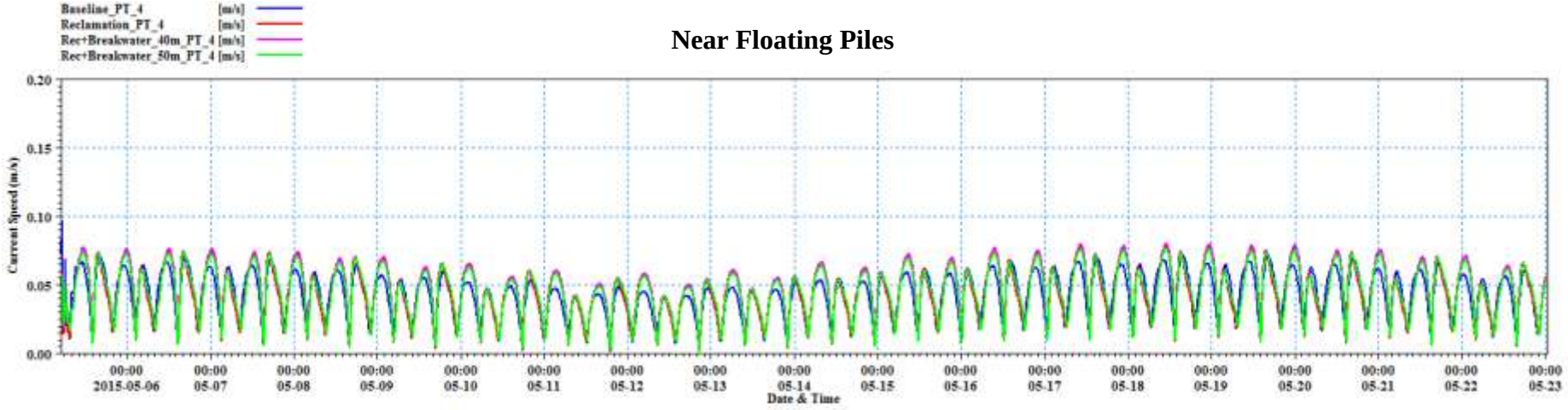


Figure 6.10: Northeast Monsoon: Comparison of Current Speed at Extraction Points around Project Site

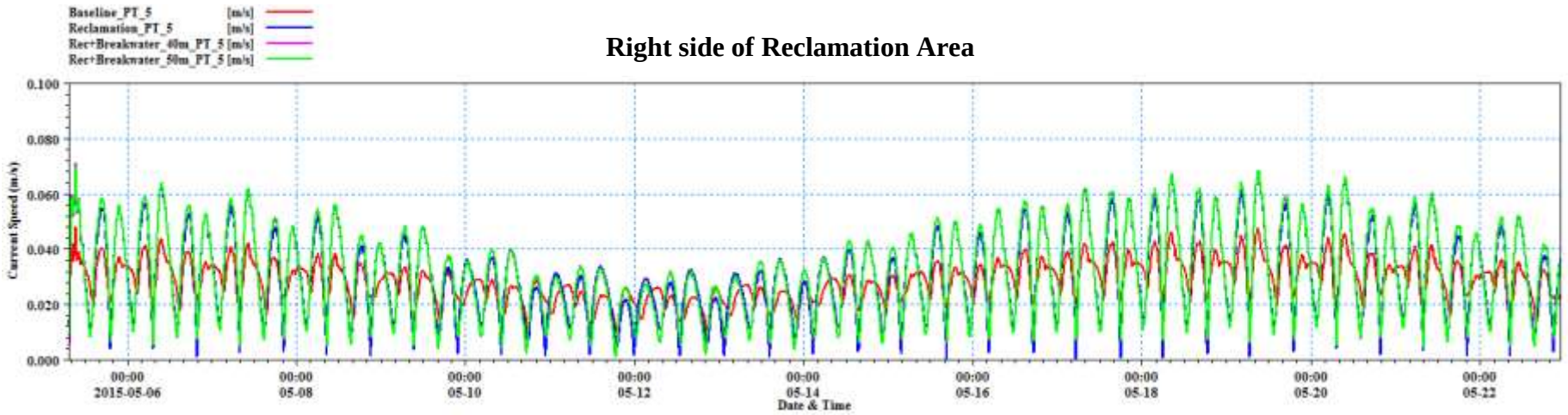


Left side of Reclamation Area

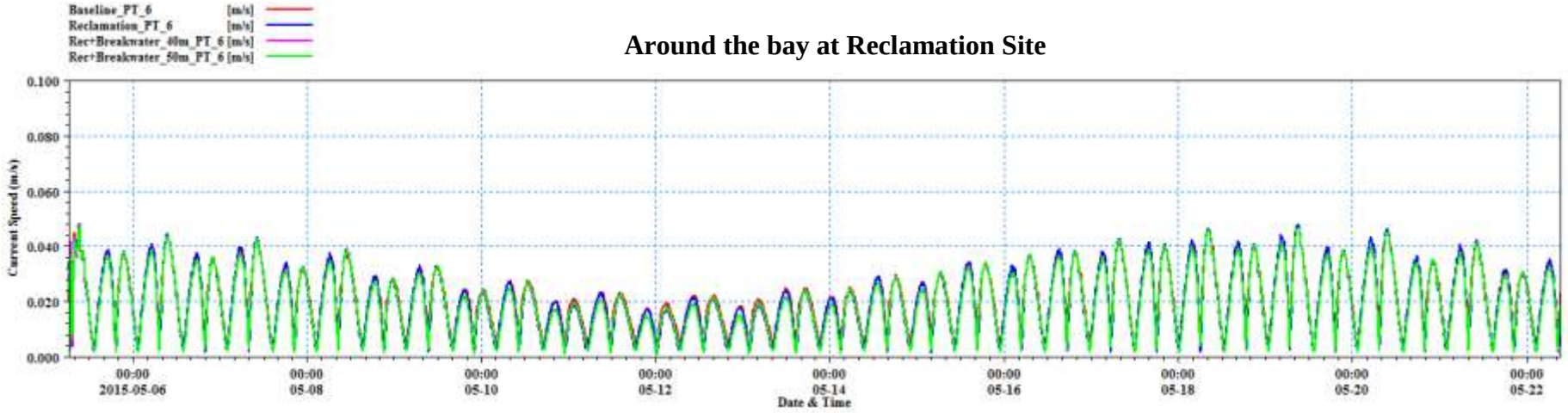


Near Floating Piles

Figure 6.10: (Cont'd)

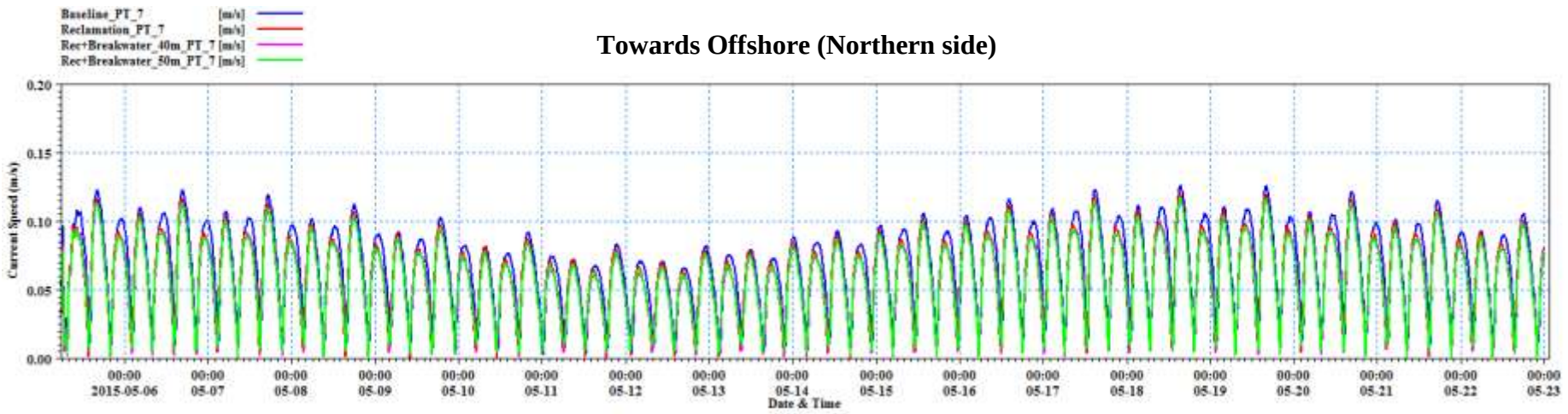


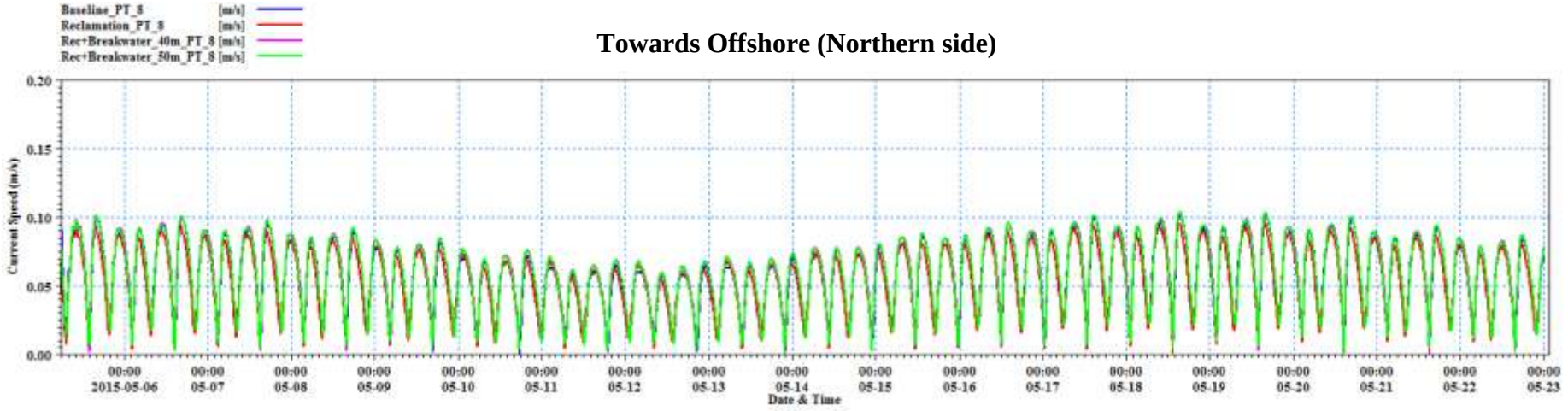
Right side of Reclamation Area



Around the bay at Reclamation Site

Figure 6.10: (Cont'd)





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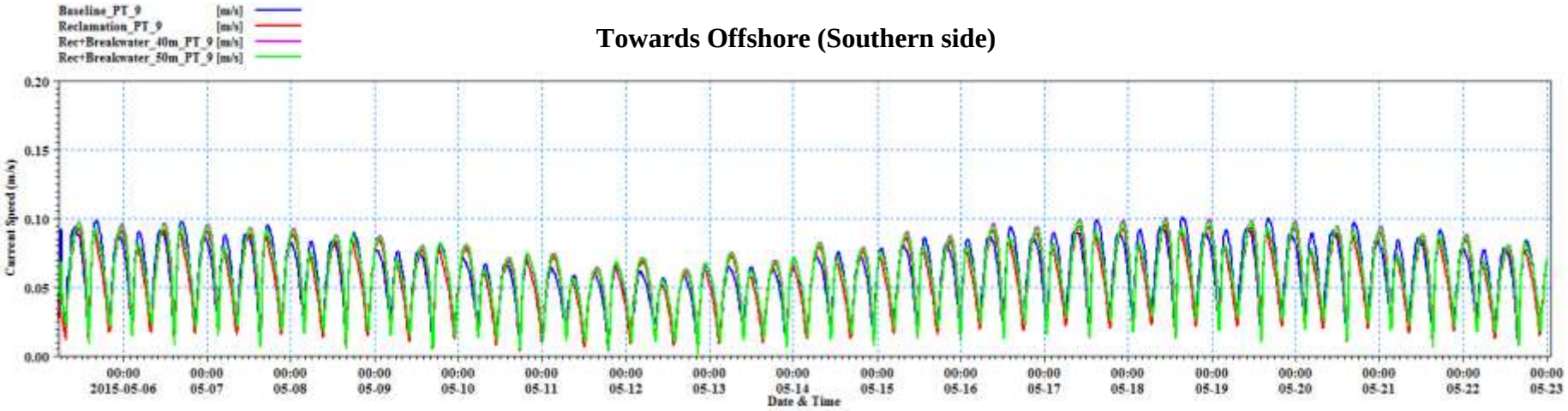


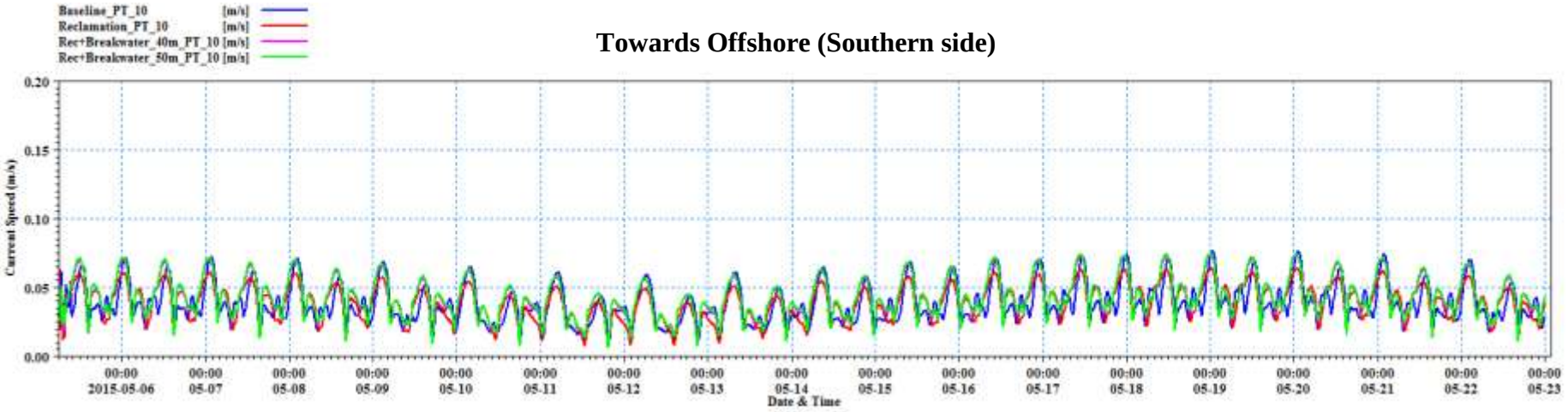


Figure 6.10: (Cont'd)

Table 4: Northeast Monsoon: Extracted Mean and Maximum Current Speeds at Project Site

Point	Location	Baseline Condition		Reclamation with Floating Piles		Reclamation with Floating Piles + Breakwater with 40m Mouth Distance		Reclamation with Floating Piles + Breakwater with 50m Mouth Distance		Scenario A Vs Scenario B		Scenario A Vs Scenario C		Scenario A Vs Scenario D	
		Mean (m/s)	Maximum (m/s)	Mean (m/s)	Maximum (m/s)	Mean (m/s)	Maximum (m/s)	Mean (m/s)	Maximum (m/s)	Mean (m/s)	Maximum (m/s)	Mean (m/s)	Maximum (m/s)	Mean (m/s)	Maximum (m/s)
PT 1	Within breakwater in front of Sungai Lereh	0.02	0.20	0.01	0.29	0.01	0.33	0.01	0.35	-0.01	0.09	-0.01	0.13	-0.01	0.15
PT 2	Breakwater Mouth	0.03	0.38	0.02	0.28	0.08	2.02	0.07	1.73	-0.01	-0.10	0.05	1.64	0.03	1.36
PT 3	Left side of reclamation area	0.04	0.65	0.03	0.60	0.03	0.49	0.03	0.58	-0.01	-0.05	-0.01	-0.17	-0.01	-0.07
PT 4	Near floating piles	0.04	0.90	0.05	0.91	0.05	0.74	0.05	0.92	0.00	0.00	0.01	-0.16	0.00	0.02
PT 5	Right side of reclamation area	0.03	0.80	0.03	0.72	0.03	0.67	0.03	0.67	0.00	-0.09	0.00	-0.14	0.00	-0.14
PT 6	Around the bay at reclamation site	0.02	0.69	0.02	0.50	0.02	0.51	0.02	0.50	0.00	-0.18	0.00	-0.18	0.00	-0.18
PT 7	Towards offshore (Northern side)	0.07	1.56	0.06	1.65	0.06	1.55	0.06	1.52	-0.01	0.09	-0.01	-0.01	-0.01	-0.04
PT 8	Towards offshore (Northern side)	0.06	1.30	0.06	1.35	0.06	1.36	0.06	1.38	0.00	0.05	0.00	0.06	0.00	0.08
PT 9	Towards offshore (Southern side)	0.06	1.32	0.06	1.21	0.06	1.20	0.06	1.19	0.00	-0.11	0.00	-0.12	0.00	-0.12
PT 10	Towards offshore (Southern side)	0.04	1.32	0.04	1.26	0.04	1.27	0.05	1.27	0.00	-0.06	0.00	-0.06	0.00	-0.06

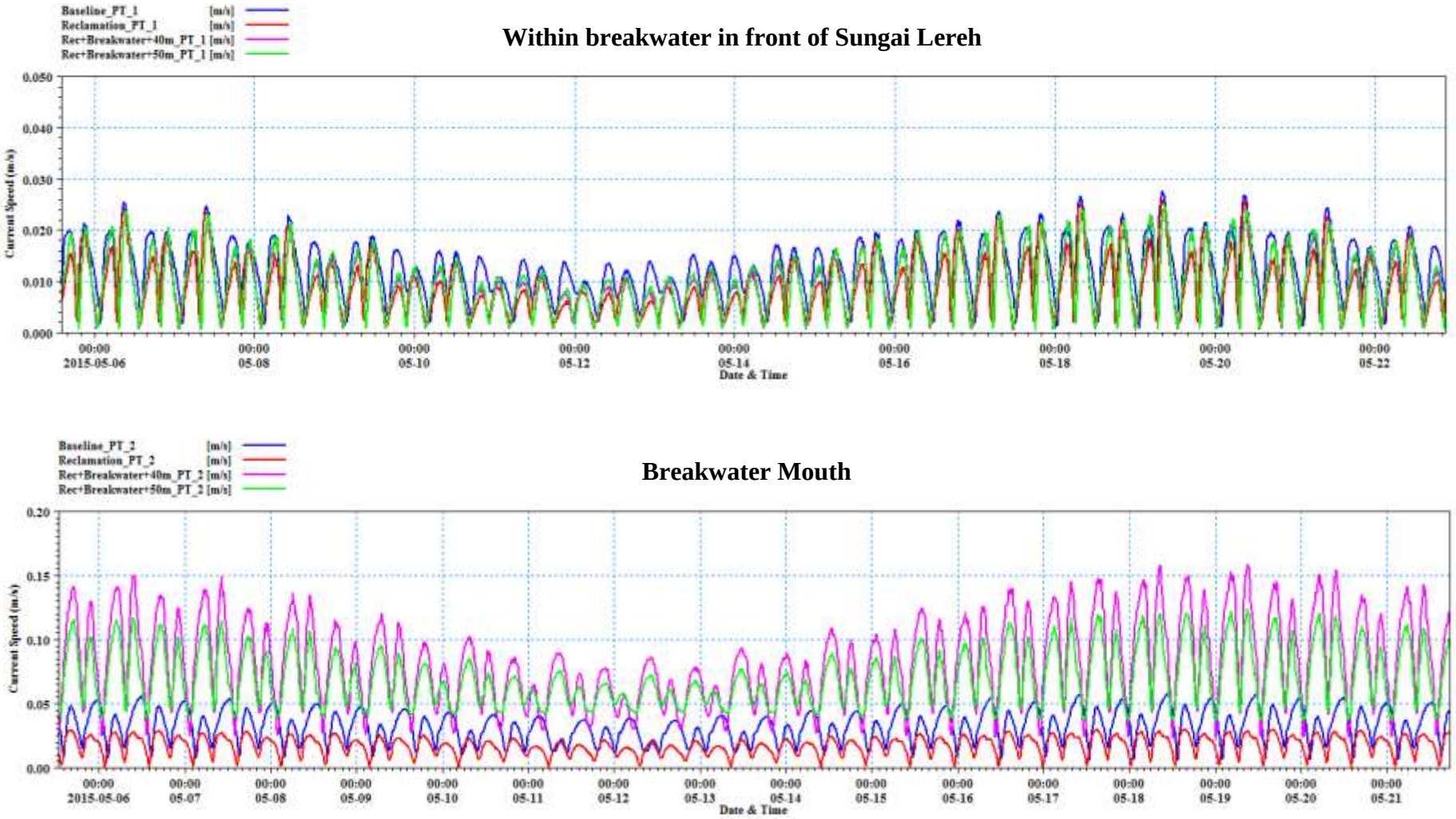
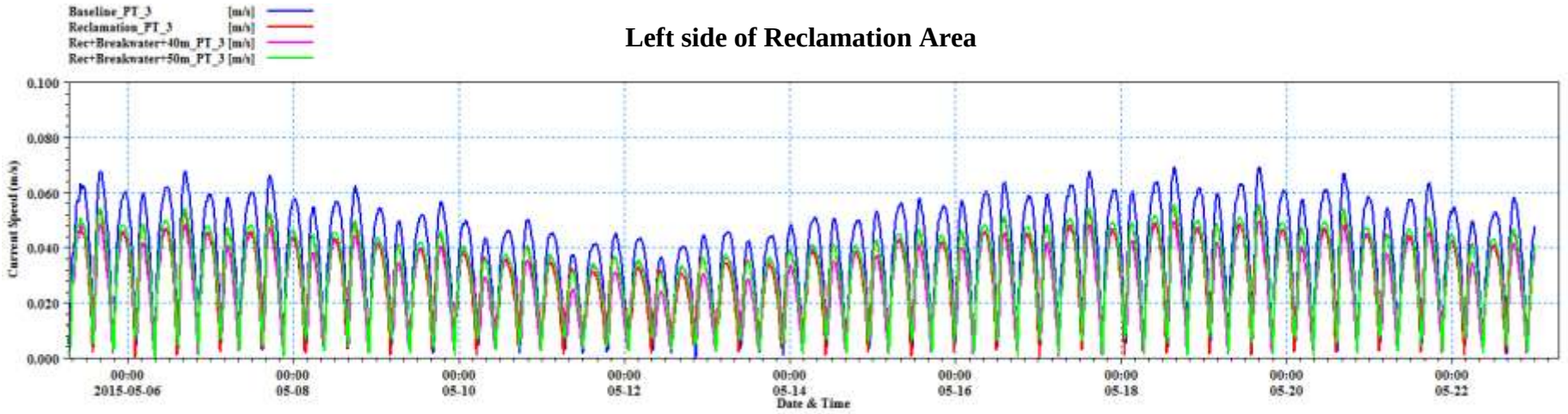


Figure 6.11: Southwest Monsoon: Comparison of Current Speed at Extraction Points around Project Site

Left side of Reclamation Area



Near Floating Piles

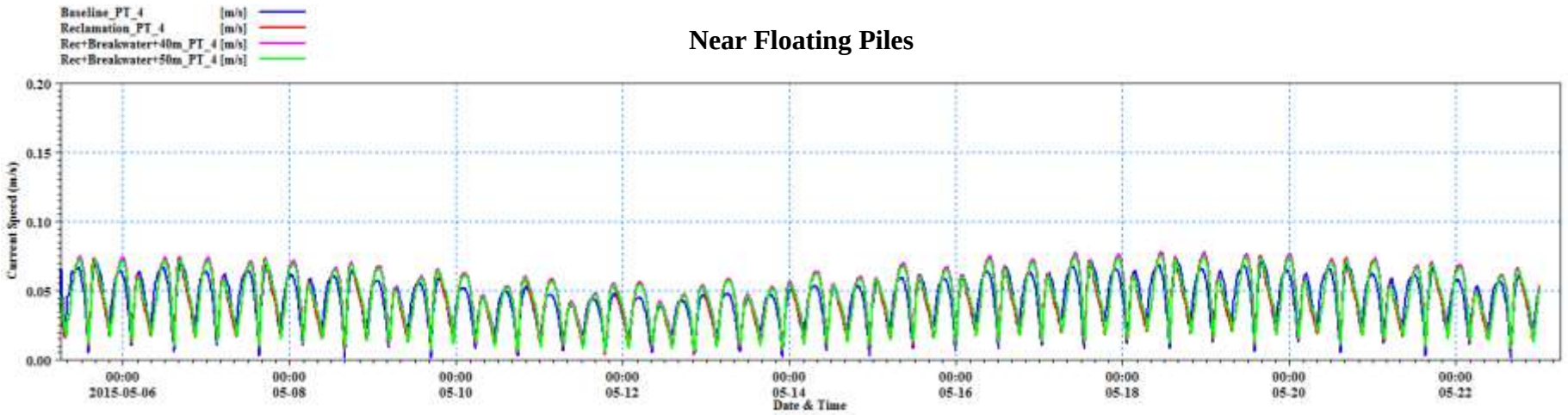
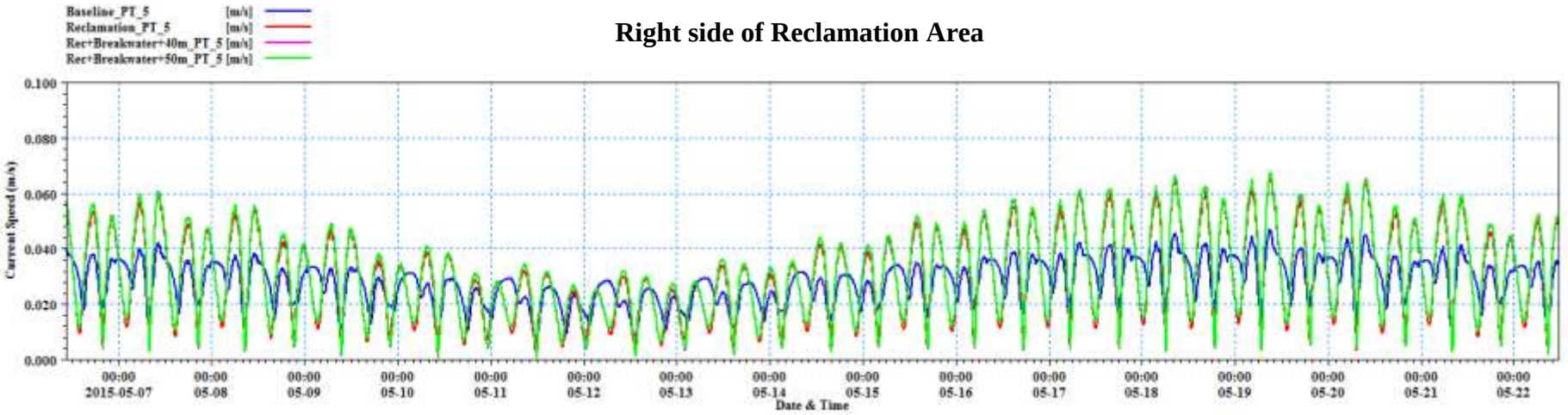
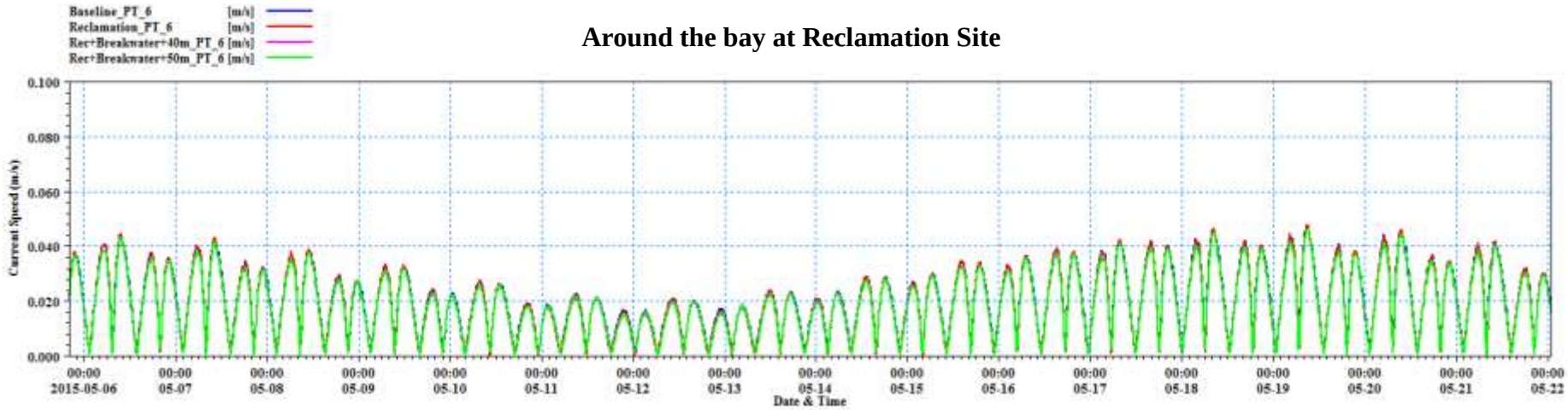


Figure 6.11: (Cont'd)

Right side of Reclamation Area



Around the bay at Reclamation Site



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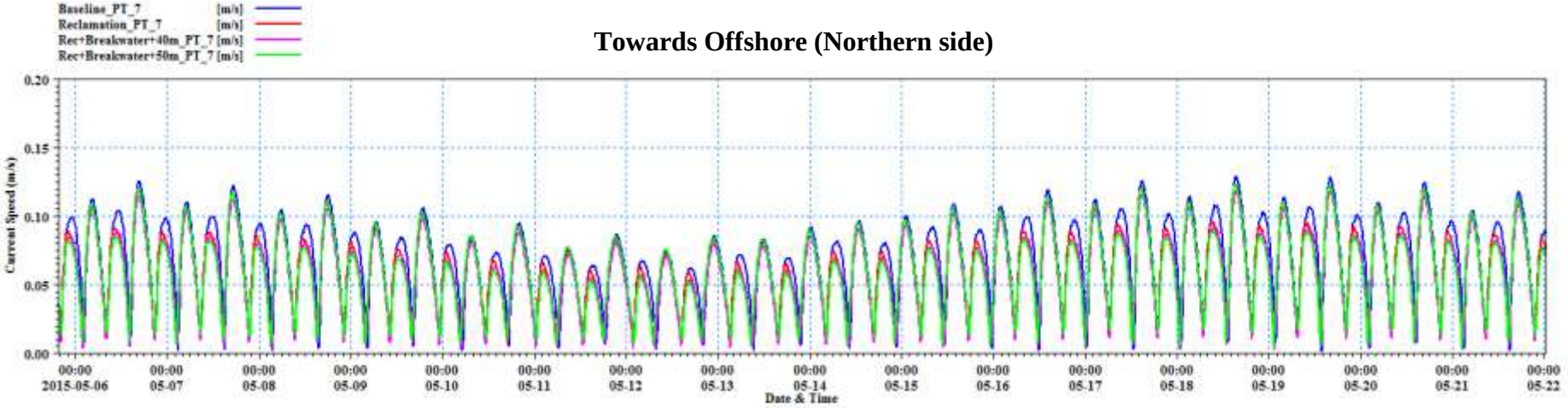

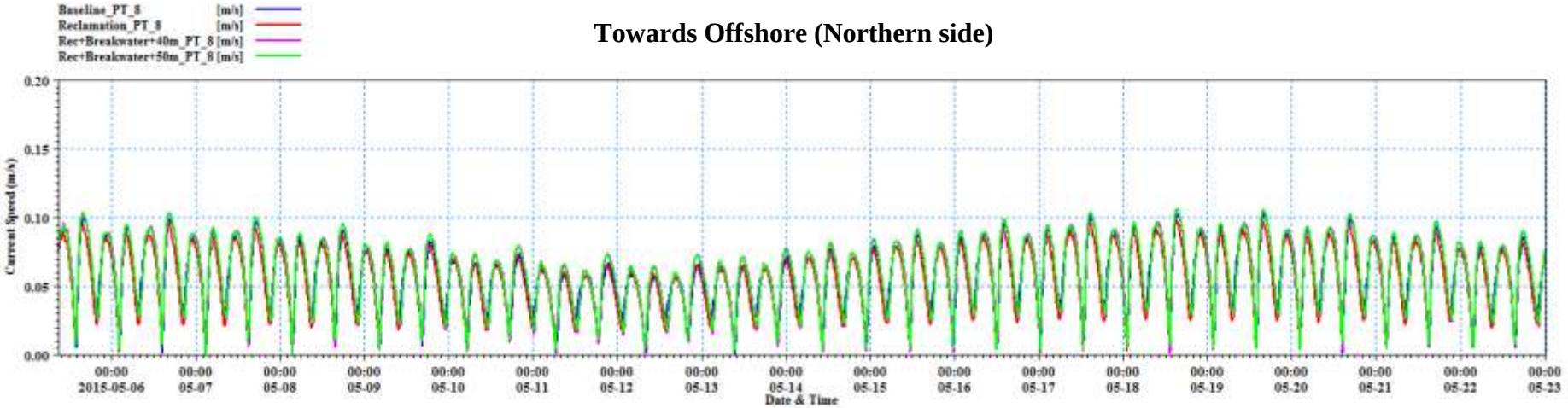

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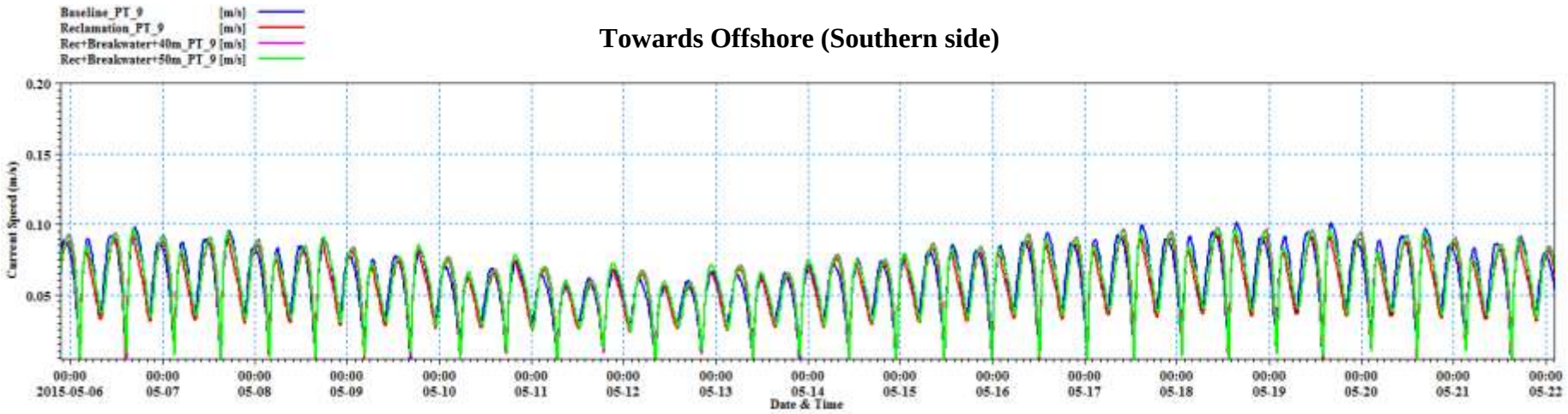


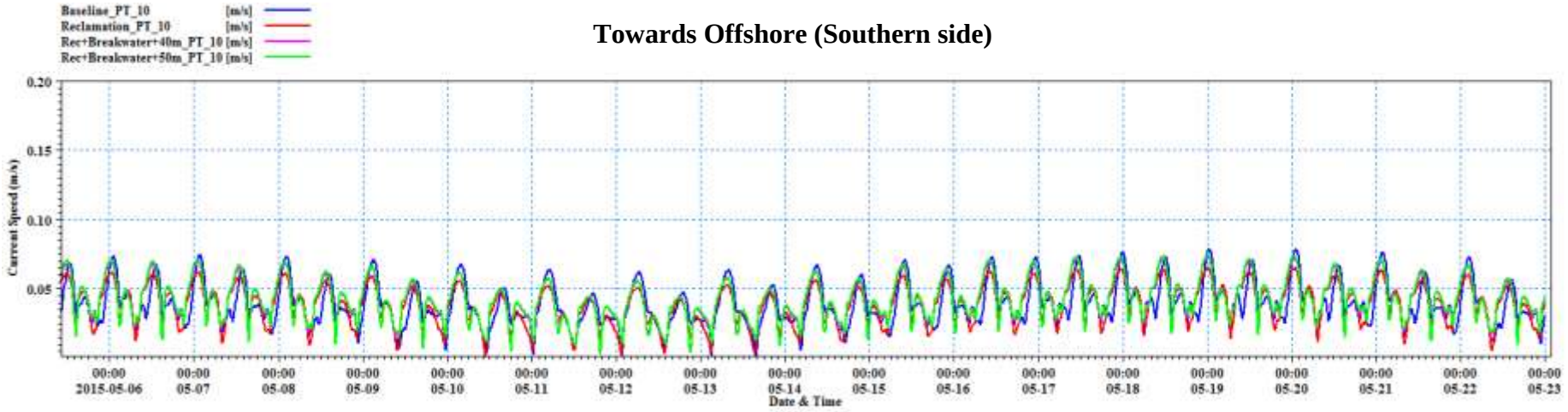


Figure 6.11: (Cont'd)

Table 5: Southwest Monsoon: Extracted Mean and Maximum Current Speeds at Project Site

Point	Location	Baseline Condition		Reclamation with Floating Piles		Reclamation with Floating Piles + Breakwater with 40m Mouth Distance		Reclamation with Floating Piles + Breakwater with 50m Mouth Distance		Scenario A Vs Scenario B		Scenario A Vs Scenario C		Scenario A Vs Scenario D	
		Mean (m/s)	Maximum (m/s)	Mean (m/s)	Maximum (m/s)	Mean (m/s)	Maximum (m/s)	Mean (m/s)	Maximum (m/s)	Mean (m/s)	Maximum (m/s)	Mean (m/s)	Maximum (m/s)	Mean (m/s)	Maximum (m/s)
PT 1	Within breakwater in front of Sungai Lereh	0.01	0.19	0.01	0.29	0.01	0.33	0.01	0.35	0.00	0.10	0.00	0.14	0.00	0.16
PT 2	Breakwater Mouth	0.03	0.38	0.02	0.28	0.09	2.04	0.08	1.73	-0.02	-0.10	0.05	1.66	0.04	1.36
PT 3	Left side of reclamation area	0.04	0.66	0.03	0.61	0.03	0.49	0.03	0.58	-0.01	-0.05	-0.01	-0.17	-0.01	-0.08
PT 4	Near floating piles	0.04	0.90	0.05	0.91	0.05	0.74	0.05	0.92	0.00	0.00	0.01	-0.16	0.00	0.02
PT 5	Right side of reclamation area	0.03	0.80	0.03	0.72	0.03	0.67	0.03	0.67	0.00	-0.09	0.00	-0.14	0.00	-0.14
PT 6	Around the bay at reclamation site	0.02	0.69	0.02	0.50	0.02	0.51	0.02	0.50	0.00	-0.18	0.00	-0.18	0.00	-0.18
PT 7	Towards offshore (Northern side)	0.07	1.56	0.06	1.65	0.06	1.55	0.06	1.52	-0.01	0.09	-0.01	-0.01	-0.01	-0.04
PT 8	Towards offshore (Northern side)	0.06	1.30	0.06	1.35	0.06	1.36	0.06	1.38	0.00	0.05	0.00	0.06	0.00	0.08
PT 9	Towards offshore (Southern side)	0.06	1.32	0.06	1.21	0.06	1.20	0.06	1.20	0.00	-0.12	0.00	-0.13	0.00	-0.13
PT 10	Towards offshore (Southern side)	0.04	1.32	0.04	1.26	0.04	1.27	0.04	1.27	0.00	-0.06	0.00	-0.05	0.00	-0.06

4 Impact on Water Level

Water levels are produced by a combination of forces of which the two major components are gravitation forces and climatic effects that induce a variation of the tidal levels due the shear effect of the winds and/or regional barometric pressure fields. An assessment of water levels has been carried out to provide additional information on water levels around the project area that can be used to verify if the proposed reclamation work levels at Malacca are acceptable.

For this project the water level was simulated for four scenarios considering the Table 2 and 3 assessed the minimum and maximum of water levels at project site. It is evident from the tables that the change in maximum water level is very less. Table 2 and 3 shows water level for different scenarios, whereas level can reach up to 3.2 m and minimum between -1.4 m to -1.2 m during the present study period.

4.1 Water Level Comparison

Comparison were based on the water level changes with respect to the baseline condition at ten locations around the project area. Results of the water level comparison are shown in Figure 12 and Figure 13. Comparison for minimum and maximum water levels at the extraction locations in project area are tabulated in Table 6 and Table 7.

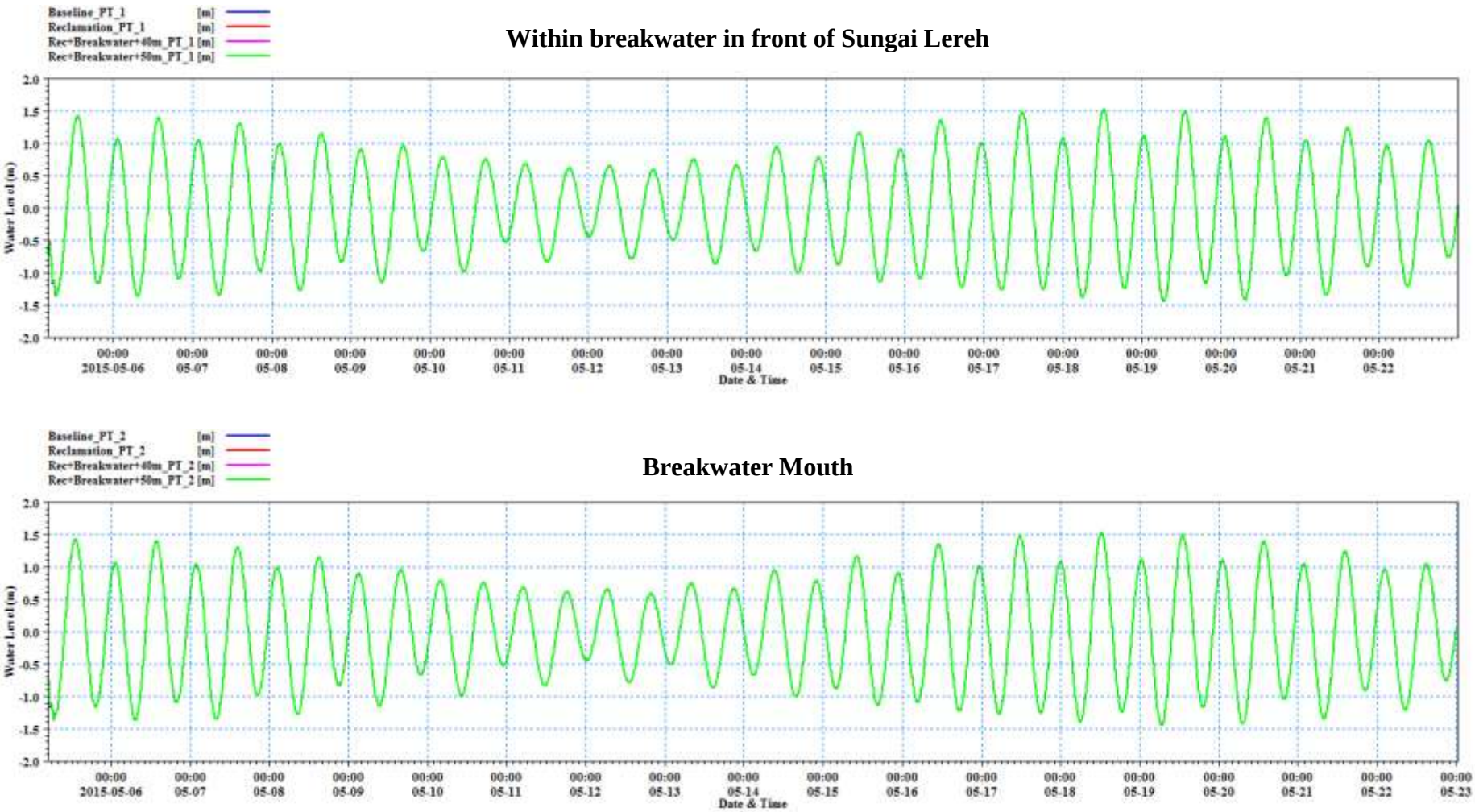
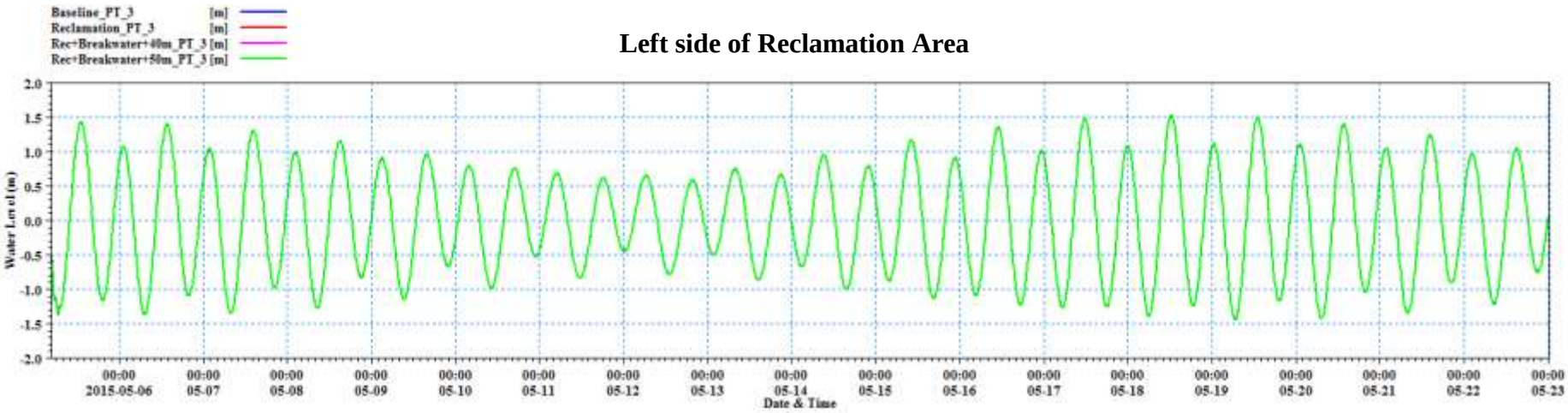


Figure 6.12: Northeast Monsoon: Comparison of Water Level at Extraction Points around Project Site



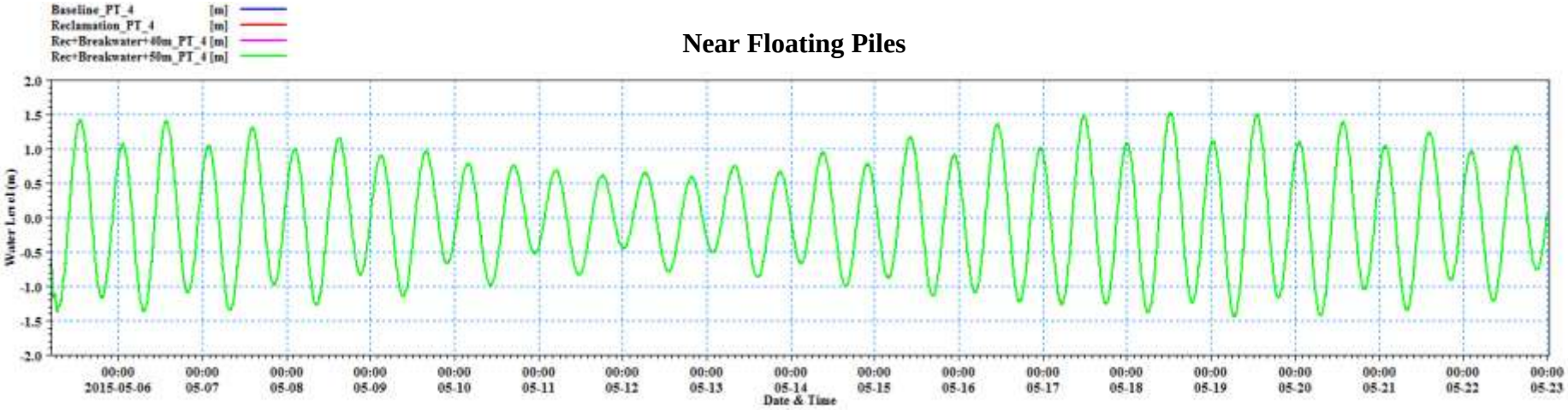
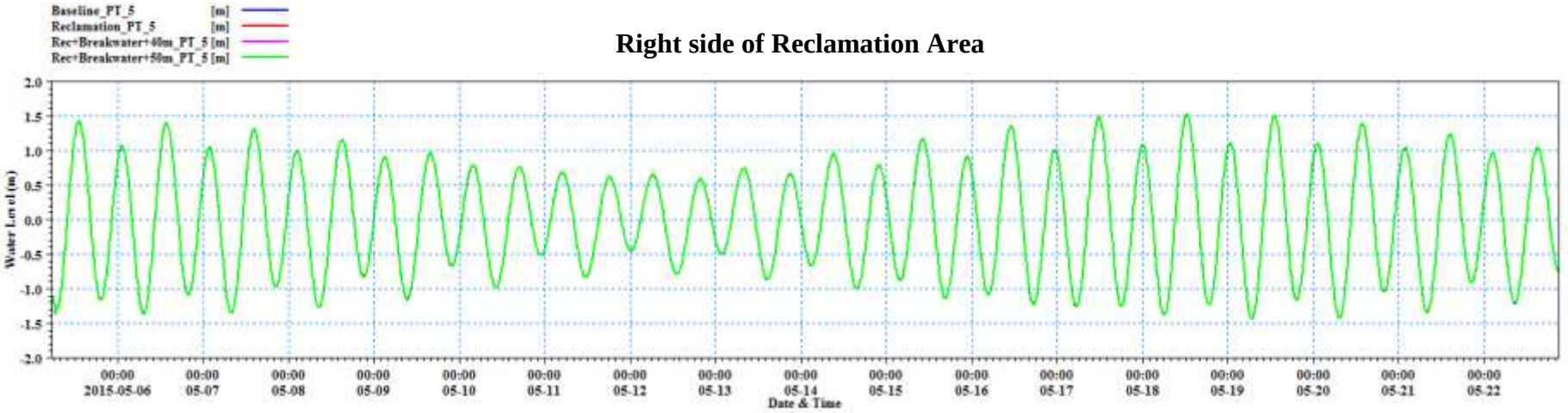
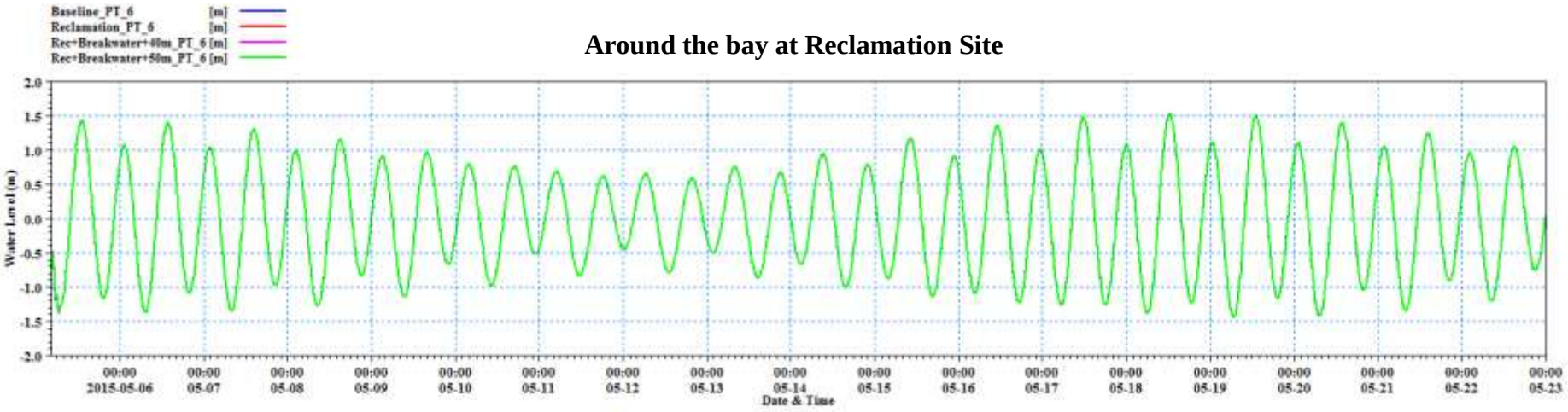


Figure 6.12: (Cont'd)

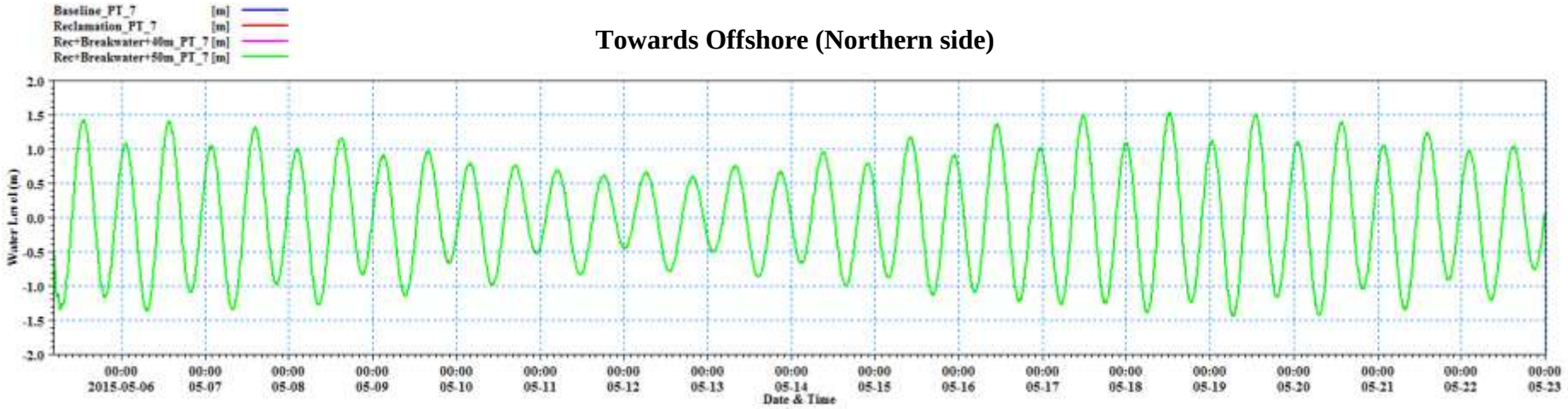


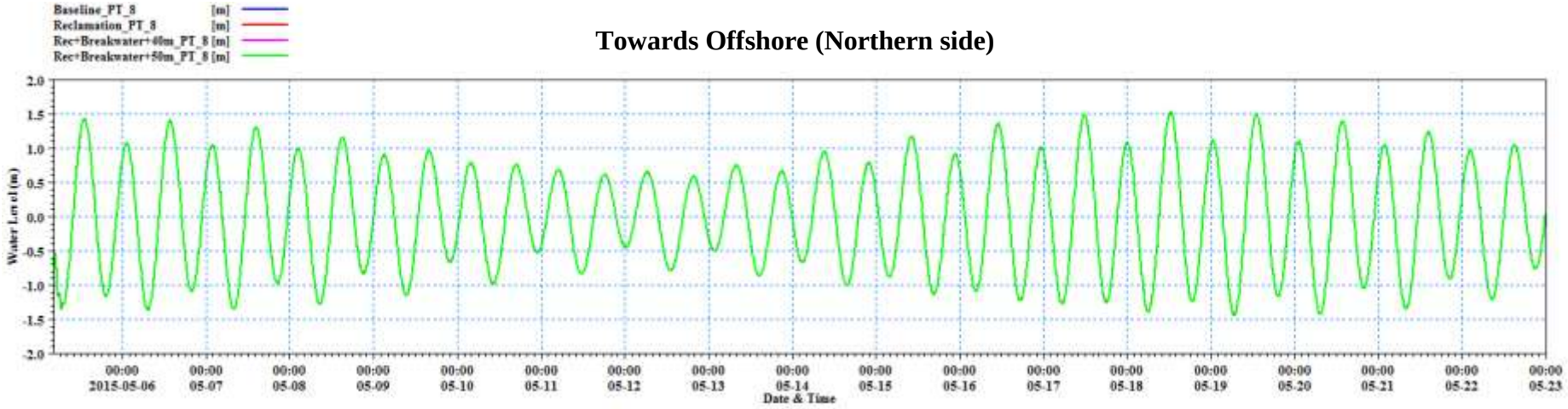
Right side of Reclamation Area



Around the bay at Reclamation Site

Figure 6.12: (Cont'd)





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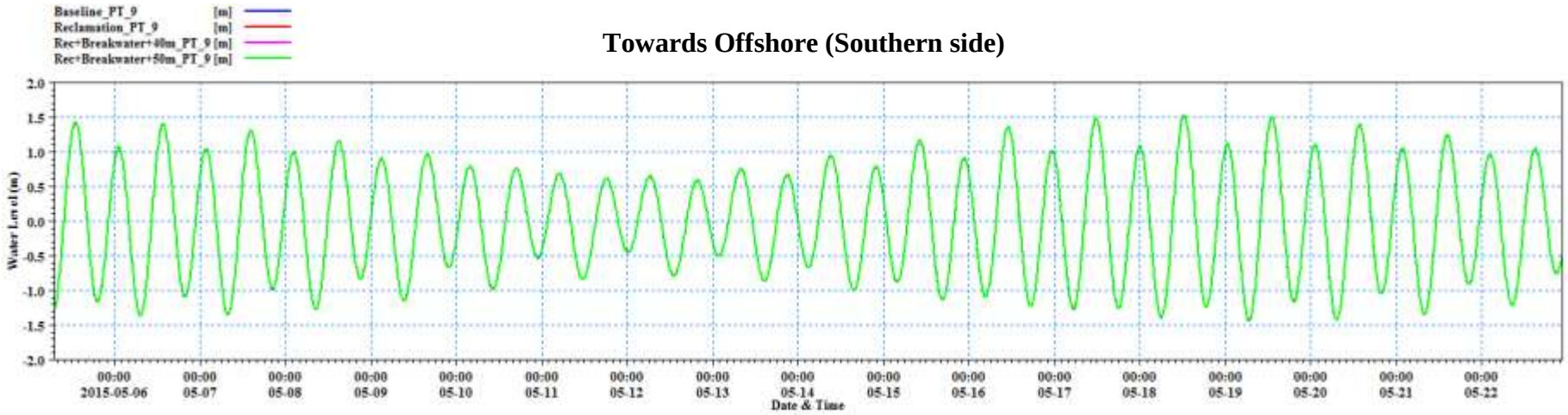


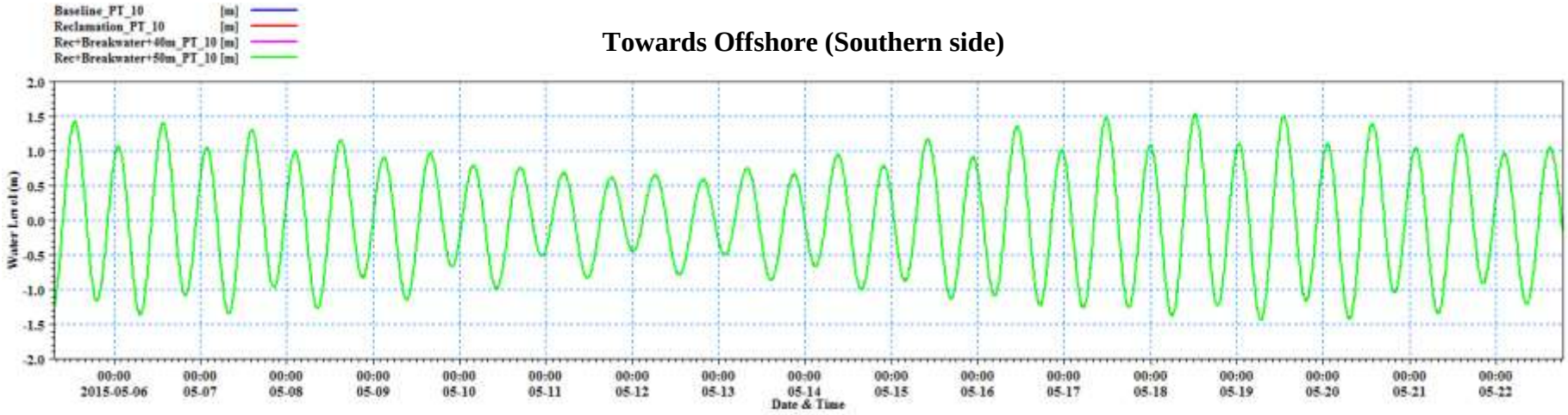


Figure 6.12: (Cont'd)

Table 6: Northeast Monsoon: Extracted Minimum and Maximum Water Level at Project Site

Point	Location	Baseline Condition		Reclamation with Floating Piles		Reclamation with Floating Piles + Breakwater with 40m Mouth Distance		Reclamation with Floating Piles + Breakwater with 50m Mouth Distance		Scenario A Vs Scenario B		Scenario A Vs Scenario C		Scenario A Vs Scenario D	
		Minimum (m)	Maximum (m)	Minimum (m)	Maximum (m)	Minimum (m)	Maximum (m)	Minimum (m)	Maximum (m)	Minimum (m)	Maximum (m)	Minimum (m)	Maximum (m)	Minimum (m)	Maximum (m)
PT 1	Within breakwater in front of Sungai Lereh	-1.44	2.35	-1.44	2.05	-1.44	2.47	-1.44	2.37	0.00	-0.30	0.00	0.12	0.00	0.02
PT 2	Breakwater Mouth	-1.44	2.33	-1.44	2.05	-1.44	2.14	-1.44	2.15	0.00	-0.28	0.00	-0.19	0.00	-0.18
PT 3	Left side of reclamation area	-1.44	2.22	-1.44	2.02	-1.44	2.04	-1.44	2.05	0.00	-0.21	0.00	-0.18	0.00	-0.17
PT 4	Near floating piles	-1.44	2.31	-1.44	2.04	-1.44	2.04	-1.44	2.05	0.00	-0.27	0.00	-0.27	0.00	-0.26
PT 5	Right side of reclamation area	-1.44	2.59	-1.44	2.27	-1.44	2.25	-1.44	2.25	0.00	-0.32	0.00	-0.34	0.00	-0.33
PT 6	Around the bay at reclamation site	-1.44	3.30	-1.44	2.80	-1.44	2.77	-1.44	2.76	0.00	-0.50	0.00	-0.53	0.00	-0.53
PT 7	Towards offshore (Northern side)	-1.44	2.07	-1.44	1.96	-1.44	1.94	-1.44	1.98	-0.01	-0.11	0.00	-0.13	0.00	-0.09
PT 8	Towards offshore (Northern side)	-1.44	2.14	-1.44	1.94	-1.44	1.95	-1.44	1.97	0.00	-0.20	0.00	-0.19	0.00	-0.17
PT 9	Towards offshore (Southern side)	-1.44	2.20	-1.44	2.00	-1.44	2.01	-1.44	2.02	0.00	-0.20	0.00	-0.19	0.00	-0.18
PT 10	Towards offshore (Southern side)	-1.44	2.34	-1.44	2.08	-1.44	2.06	-1.44	2.07	0.00	-0.26	0.00	-0.28	0.00	-0.28

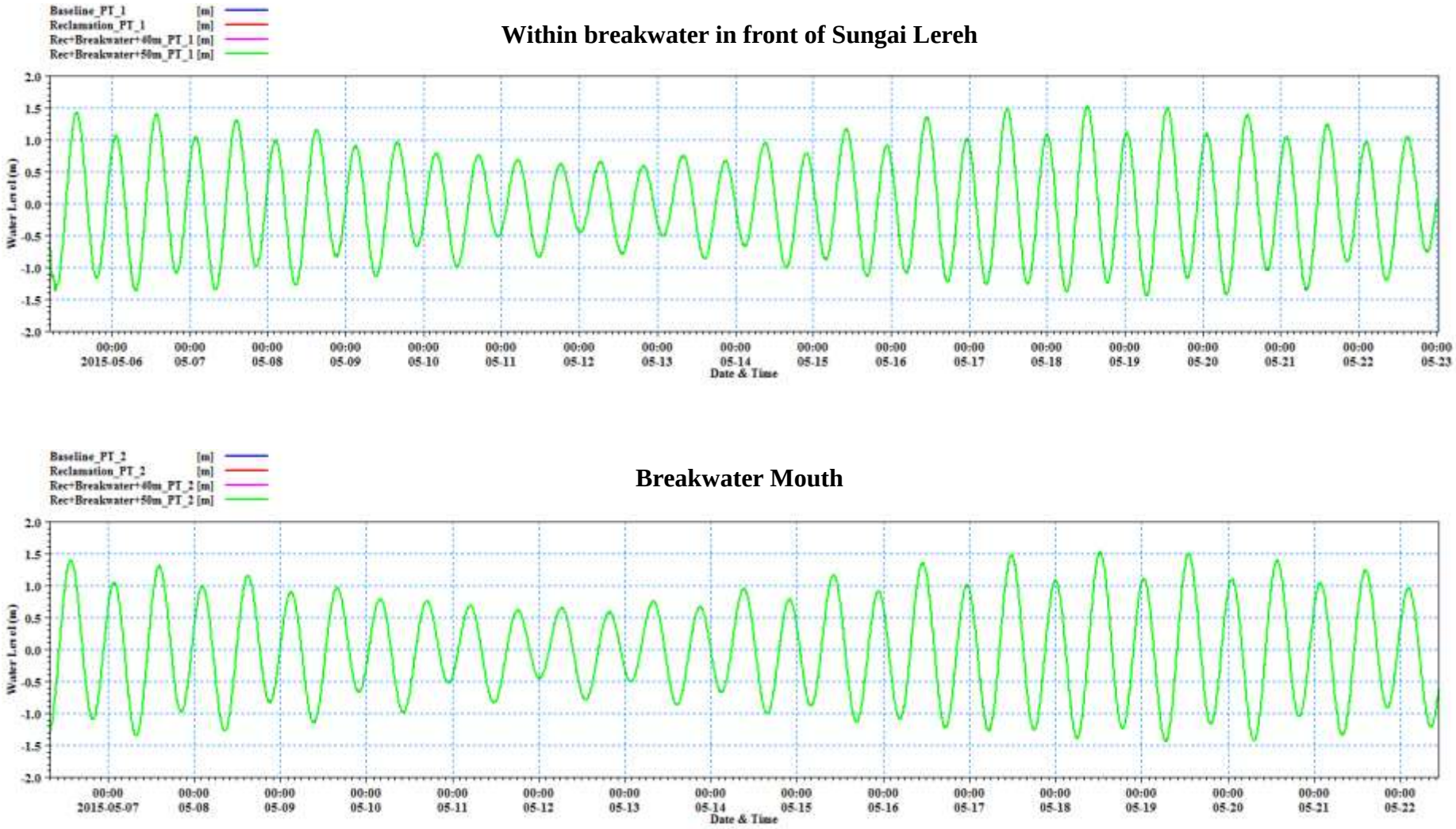
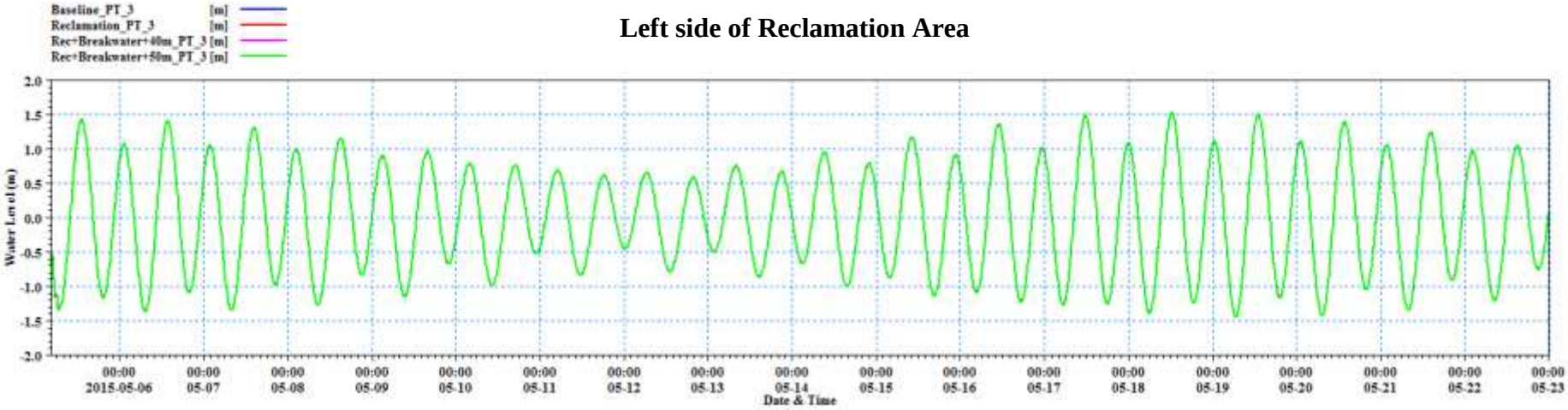


Figure 6.13: Southwest Monsoon: Comparison of Water Level at Extraction Points around Project Site

Left side of Reclamation Area



Near Floating Piles

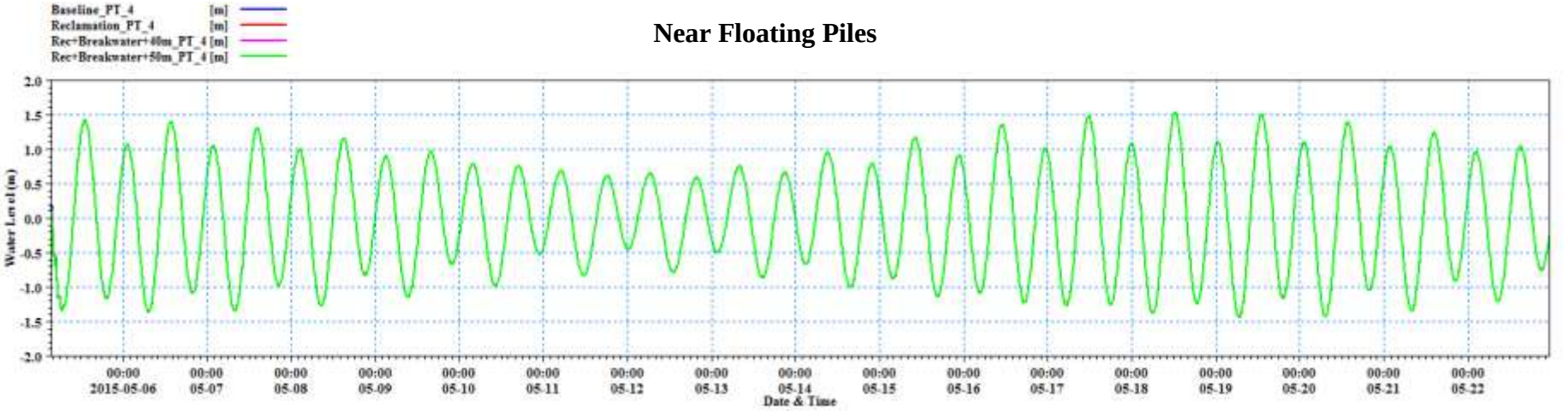
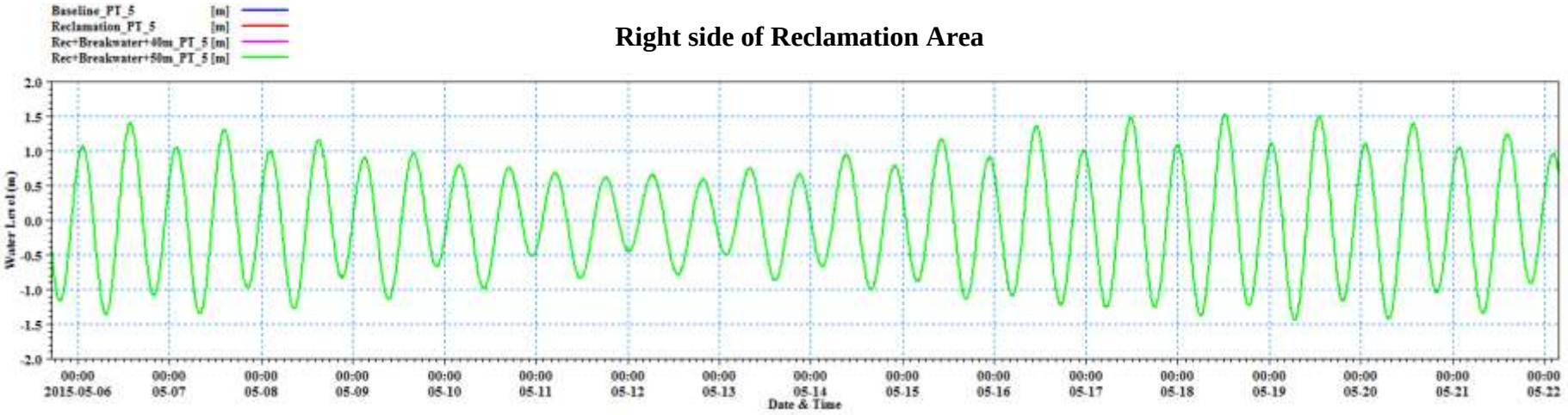


Figure 6.13: (Cont'd)



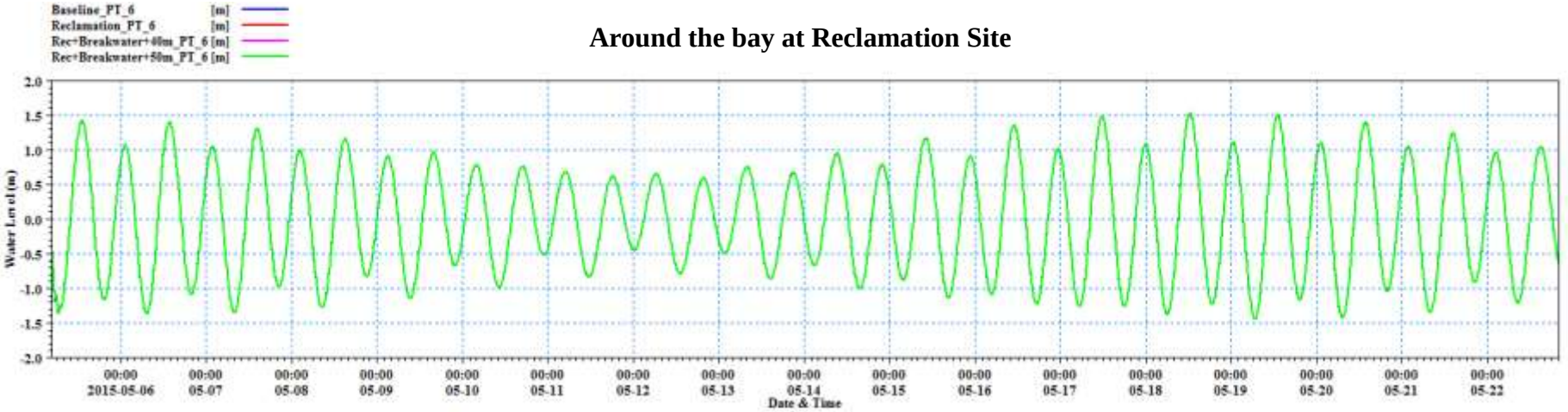
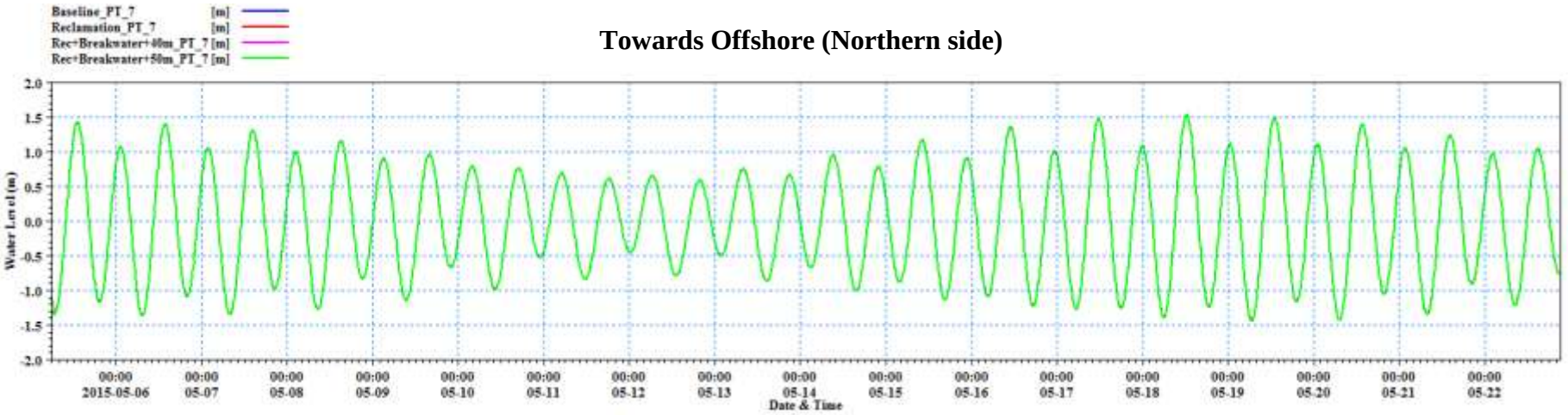
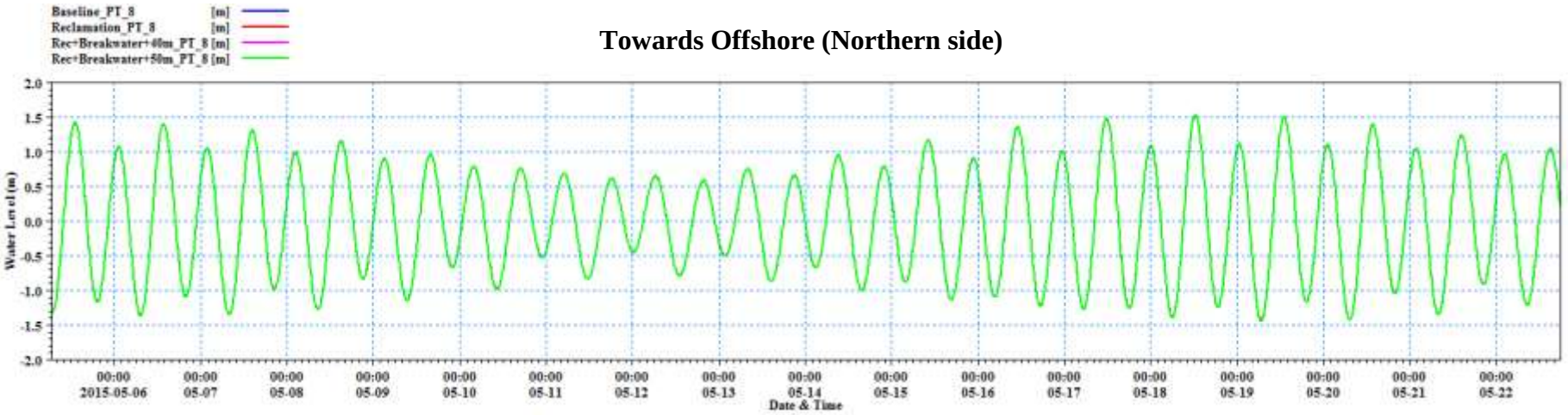


Figure 6.13: (Cont'd)





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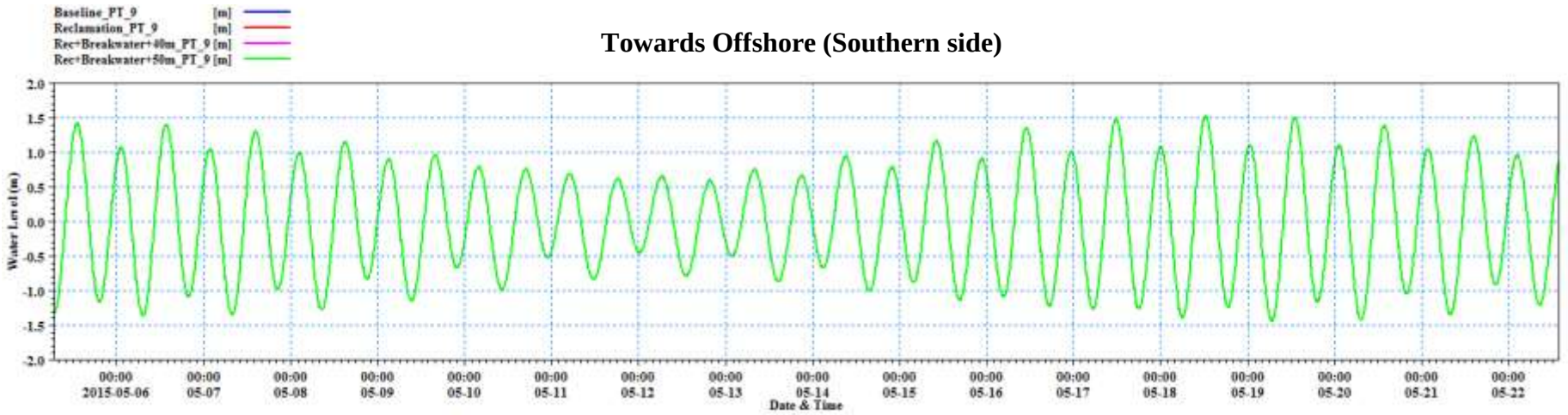

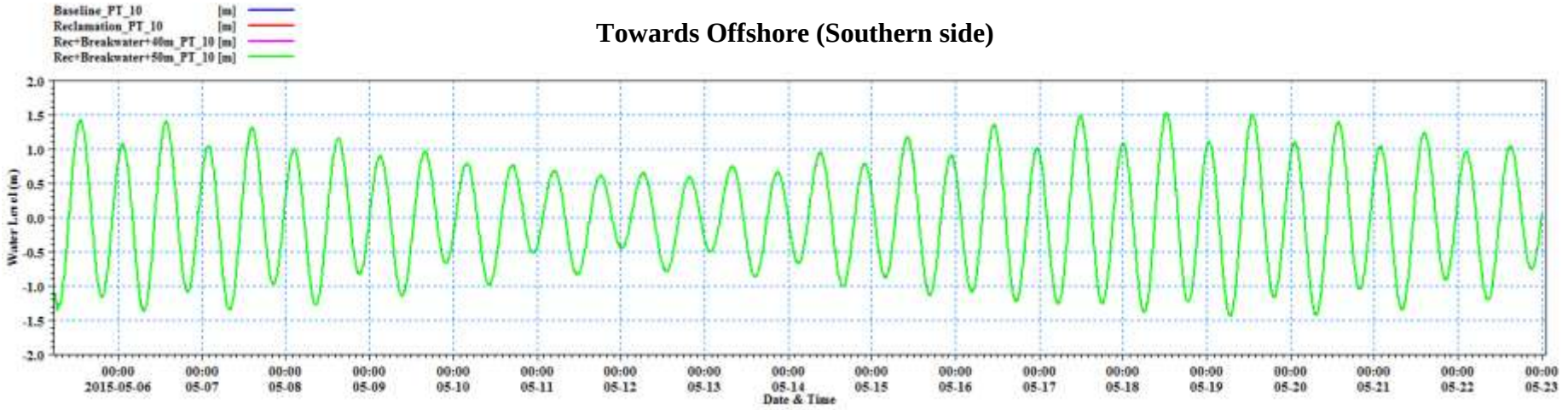

Figure 6.13: (Cont'd)

Table 7: Southwest Monsoon: Extracted Minimum and Maximum Water Level at Project Site

Point	Location	Baseline Condition		Reclamation with Floating Piles		Reclamation with Floating Piles + Breakwater with 40m Mouth Distance		Reclamation with Floating Piles + Breakwater with 50m Mouth Distance		Scenario A Vs Scenario B		Scenario A Vs Scenario C		Scenario A Vs Scenario D	
		Minimum (m)	Maximum (m)	Minimum (m)	Maximum (m)	Minimum (m)	Maximum (m)	Minimum (m)	Maximum (m)	Minimum (m)	Maximum (m)	Minimum (m)	Maximum (m)	Minimum (m)	Maximum (m)
PT 1	Within breakwater in front of Sungai Lereh	-1.44	2.35	-1.44	2.05	-1.44	2.47	-1.44	2.37	0.00	-0.30	0.01	0.12	0.00	0.02
PT 2	Breakwater Mouth	-1.44	2.33	-1.44	2.05	-1.44	2.26	-1.44	2.15	0.00	-0.28	0.00	-0.06	0.00	-0.18
PT 3	Left side of reclamation area	-1.44	2.22	-1.44	2.02	-1.44	2.05	-1.44	2.05	0.00	-0.21	0.00	-0.18	0.00	-0.17
PT 4	Near floating piles	-1.44	2.31	-1.44	2.04	-1.44	2.04	-1.44	2.05	0.00	-0.27	0.00	-0.27	0.00	-0.26
PT 5	Right side of reclamation area	-1.44	2.59	-1.44	2.27	-1.44	2.25	-1.44	2.26	0.00	-0.32	0.00	-0.34	0.00	-0.33
PT 6	Around the bay at reclamation site	-1.44	3.30	-1.44	2.77	-1.44	2.77	-1.44	2.75	0.00	-0.52	0.00	-0.53	0.00	-0.54
PT 7	Towards offshore (Northern side)	-1.44	2.07	-1.44	1.96	-1.44	1.94	-1.44	1.98	0.01	-0.11	0.00	-0.13	0.00	-0.09
PT 8	Towards offshore (Northern side)	-1.44	2.14	-1.44	1.94	-1.44	1.95	-1.44	1.97	0.00	-0.20	0.00	-0.19	0.00	-0.17
PT 9	Towards offshore (Southern side)	-1.44	2.20	-1.44	2.00	-1.44	2.01	-1.44	2.02	0.00	-0.20	0.00	-0.19	0.00	-0.18
PT 10	Towards offshore (Southern side)	-1.44	2.34	-1.44	2.08	-1.44	2.10	-1.44	2.07	0.00	-0.26	0.00	-0.24	0.00	-0.28

5 Impact on Wave Condition

The study of waves which would be experienced by the study area and with the proposed area is carried out using the Spectral Wave model. Wave modelling was carried out for the existing condition and different scenarios in this section. Four different scenarios were carried out for reclamation purposes. The results indicate that wave heights ranges between 0.06 m to 0.42 m depending on the wave directions. In order to provide an overview of the wave conditions at the reclaimed location, wave results have been extracted from regional wave conditions, as it can be observed maximum significant wave height is 0.42 m.

6 Impact on Mud Transport

Impact on bed thickness change is assessed for four different scenarios and provided in the Table 2 and Table 3. The scenario shows the bed thickness changes between ± 0.00 m/mth to ± 0.04 m/mth. It is found that the project site may experience absence of erosion and deposition during existing condition and after reclamation work. For each scenario, it has been calculated the mean values of the bed thickness change of the modeled area during the full period of simulation. The obtained map for the different scenarios exhibits very small differences. It is clear from the model result that after reclamation not have much impact on morphological changes due to the reclamation work around the project area.

6.1 Bed Thickness Change Comparison

Table 8 and Table 9 shows the bed thickness changes around project area. In order to compute the differences between before and after reclamation, the values are extracted at ten different points as shown in Tables. The annual bed thickness changes at proposed project area is shown in Table 10. As it can be observed, there are no changes in bed thickness changes due to the proposed reclamation work.

Table 8: Northeast Monsoon: Extracted Bed Thickness Change around Project Site

Point	Location	Baseline Condition	Reclamation with Floating Piles	Reclamation with Floating Piles + Breakwater with 40m Mouth Distance	Reclamation with Floating Piles + Breakwater with 50m Mouth Distance	Scenario A Vs Scenario B	Scenario A Vs Scenario C	Scenario A Vs Scenario D
		(m/mth)	(m/mth)	(m/mth)	(m/mth)	(m/mth)	(m/mth)	(m/mth)
PT 1	Within breakwater in front of Sungai Lereh	0.0000	0.0000	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
PT 2	Breakwater Mouth	0.0002	0.0000	-0.0408	-0.0289	-0.0002	-0.0410	-0.0291
PT 3	Left side of reclamation area	0.0018	0.0020	0.0010	0.0016	0.0002	-0.0007	-0.0002
PT 4	Near floating piles	0.0040	0.0037	0.0018	0.0022	-0.0002	-0.0022	-0.0018
PT 5	Right side of reclamation area	0.0004	0.0003	0.0003	0.0005	-0.0001	-0.0001	0.0001
PT 6	Around the bay at reclamation site	-0.0022	-0.0005	-0.0003	-0.0003	0.0017	0.0019	0.0019
PT 7	Towards offshore (Northern side)	0.0299	0.0211	0.0141	0.0175	-0.0089	-0.0158	-0.0125
PT 8	Towards offshore (Northern side)	0.0217	0.0357	0.0232	0.0318	0.0140	0.0015	0.0101
PT 9	Towards offshore (Southern side)	0.0156	0.0262	0.0155	0.0198	0.0106	-0.0001	0.0042
PT 10	Towards offshore (Southern side)	0.0090	0.0083	0.0082	0.0104	-0.0007	-0.0008	0.0014

Table 9: Southwest Monsoon: Extracted Bed Thickness Change around Project Site

Point	Location	Baseline Condition	Reclamation with Floating Piles	Reclamation with Floating Piles + Breakwater with 40m Mouth Distance	Reclamation with Floating Piles + Breakwater with 50m Mouth Distance	Scenario A Vs Scenario B	Scenario A Vs Scenario C	Scenario A Vs Scenario D
		(m/mth)	(m/mth)	(m/mth)	(m/mth)	(m/mth)	(m/mth)	(m/mth)
PT 1	Within breakwater in front of Sungai Lereh	0.0001	-0.0002	0.0000	-0.0002	-0.0003	-0.0002	-0.0003
PT 2	Breakwater Mouth	0.0003	0.0002	-0.0409	-0.0290	-0.0001	-0.0412	-0.0293
PT 3	Left side of reclamation area	0.0024	0.0025	0.0015	0.0018	0.0001	-0.0008	-0.0006
PT 4	Near floating piles	0.0045	0.0034	0.0022	0.0026	-0.0011	-0.0023	-0.0019
PT 5	Right side of reclamation area	0.0003	0.0002	0.0002	0.0004	-0.0001	-0.0001	0.0000
PT 6	Around the bay at reclamation site	-0.0023	-0.0005	-0.0003	-0.0003	0.0018	0.0020	0.0020
PT 7	Towards offshore (Northern side)	0.0321	0.0196	0.0126	0.0163	-0.0125	-0.0196	-0.0158
PT 8	Towards offshore (Northern side)	0.0216	0.0346	0.0232	0.0313	0.0131	0.0017	0.0097
PT 9	Towards offshore (Southern side)	0.0166	0.0284	0.0173	0.0219	0.0118	0.0007	0.0053
PT 10	Towards offshore (Southern side)	0.0076	0.0091	0.0093	0.0115	0.0016	0.0017	0.0039

Table 10: Annual Bed Thickness Change around Project Site

Point	Location	Reclamation with Floating Piles (m/y)	Reclamation with Floating Piles + Breakwater with 40m Mouth Distance (m/y)	Reclamation with Floating Piles + Breakwater with 50m Mouth Distance (m/y)
PT 1	Within breakwater in front of Sungai Lereh	**-0.0001**	**-0.0001**	**-0.0002**
PT 2	Breakwater Mouth	**0.0002**	**-0.0545**	**-0.0386**
PT 3	Left side of reclamation area	**0.0030**	**0.0017**	**0.0022**
PT 4	Near floating piles	**0.0047**	**0.0027**	**0.0032**
PT 5	Right side of reclamation area	**0.0003**	**0.0003**	**0.0006**
PT 6	Around the bay at reclamation site	**-0.0006**	**-0.0004**	**-0.0004**
PT 7	Towards offshore (Northern side)	**0.0271**	**0.0178**	**0.0225**
PT 8	Towards offshore (Northern side)	**0.0469**	**0.0310**	**0.0421**
PT 9	Towards offshore (Southern side)	**0.0364**	**0.0219**	**0.0278**
PT 10	Towards offshore (Southern side)	**0.0116**	**0.0117**	**0.0146**

7 Sediment Plume Dispersion Pattern

One of the main objectives of the present study is to determine the extent of the sedimentation dispersion pattern at the proposed reclamation work using the MIKE 21 models. The plume dispersion study were carried out for southwest monsoon. The purpose of the sediment dispersion study is to investigate the movement of suspended sediments during the filling process for reclamation. This is to simulate conditions during the period of the works being carried out. The levels of suspended sediment concentration are assessed to determine potential impact to the surroundings. Sediment plumes originating from the reclamation operation were simulated. Two scenarios were investigated, with silt curtain and without silt curtain during reclamation works. Silt curtain are able to control the dispersion of turbid water by diverting the flow under the curtain, thereby minimizing turbidity in the upper layer of the water column outside the silt curtain.

The spill rate and the total spill will be highly dependent upon work procedures, scheduling and reclaimed material characteristics. Each conveyor barge with a capacity of 1,250 m^3 is assumed to operate for 12 hrs (from 7 am to 6 pm) on a daily basis. Each barge has a pumping rate of 0.1 m^3/s. The spill concentration is 4.2 kg/m^3 for without silt curtain condition and 0.8 kg/m^3 for with silt curtain condition. Results from the spill are presented in maximum and minimum suspended sediment concentrations showing the extent and concentration over the simulation period for spring and neap tide. The plume patterns indicate that excess suspended sediment concentrations generated from the pilling work only at the project site and nearby. Figure 14 to Figure 17 shows the minimum and maximum sediment dispersion pattern during neap tide and spring tide. The maximum plume extent approximately up to 0.40 km during neap tide and 0.55 km at spring tide with silt curtain whereas without silt curtain the maximum plume reaches approximately up to 0.85 km for neap tide and plume travels 1.0 km in spring tide. Figure 18 to Figure 21 shows the time series sediment plume dispersion from the proposed reclamation work during neap and spring tide with silt curtain and without silt curtain.

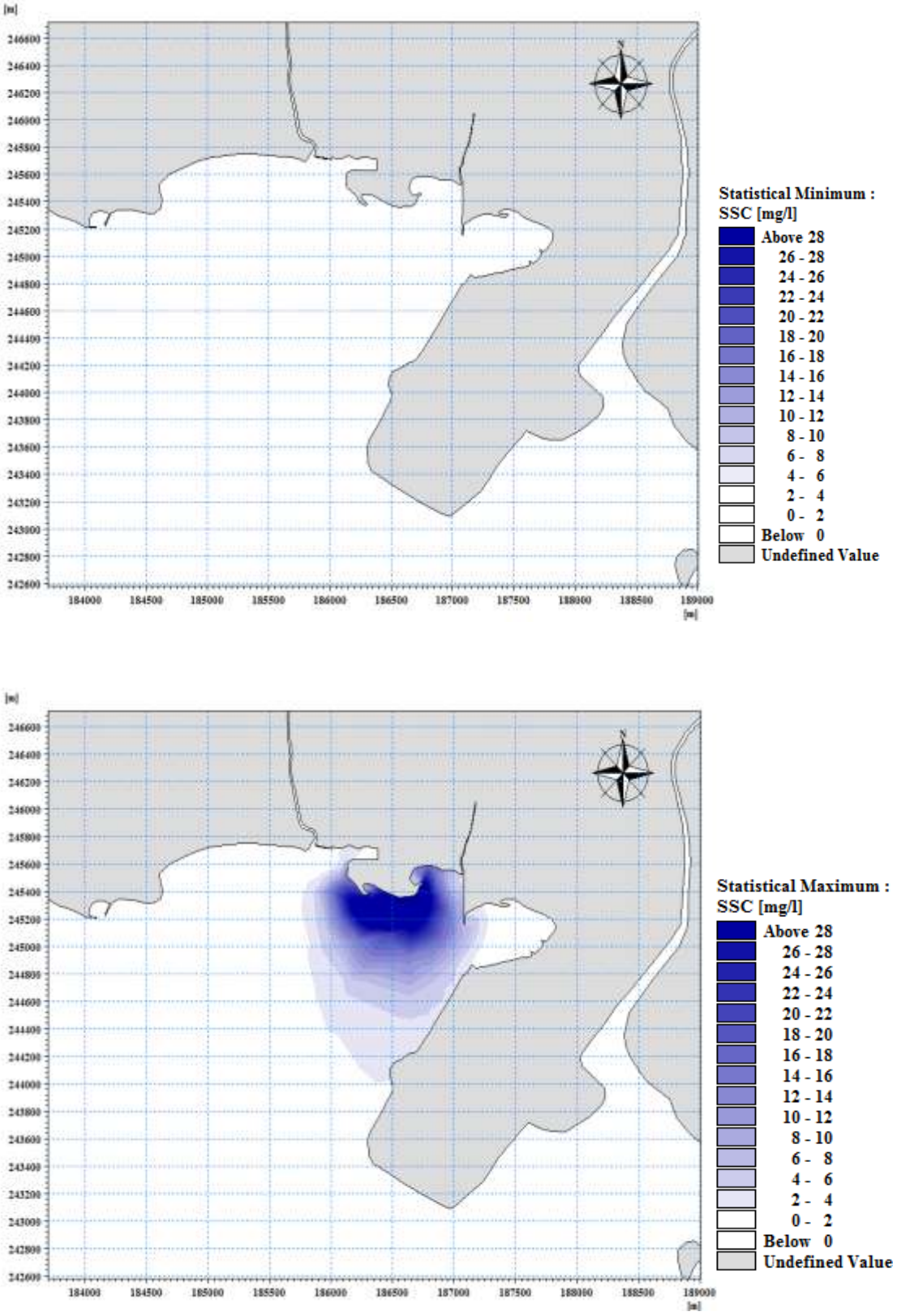

Figure 14: Minimum and Maximum Extent of Sediment Plume Dispersion from the Proposed Reclamation Work during Neap Tide without Silt Curtain

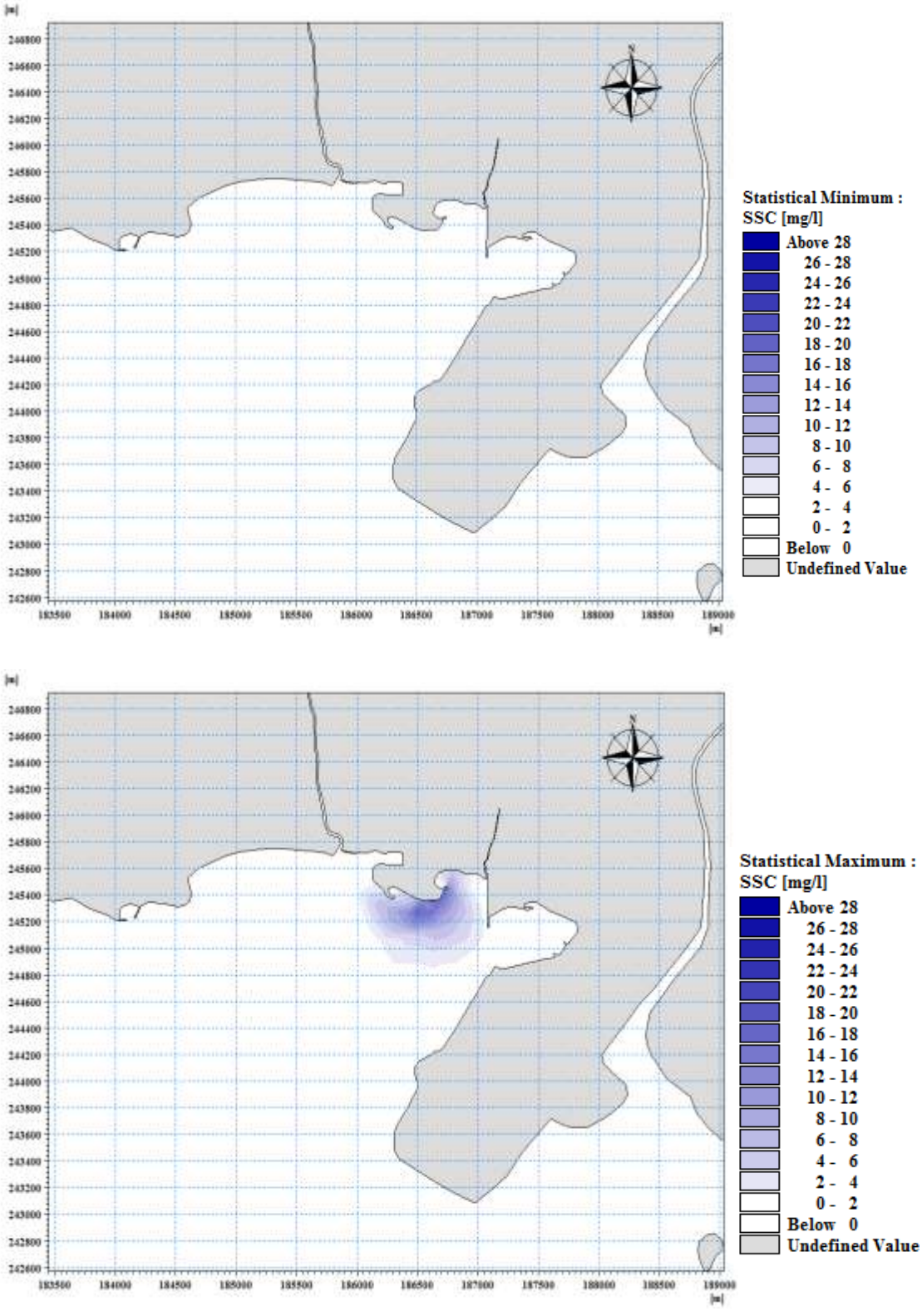

Figure 15: Minimum and Maximum Extent of Sediment Plume Dispersion from the Proposed Reclamation Work during Neap Tide with Silt Curtain

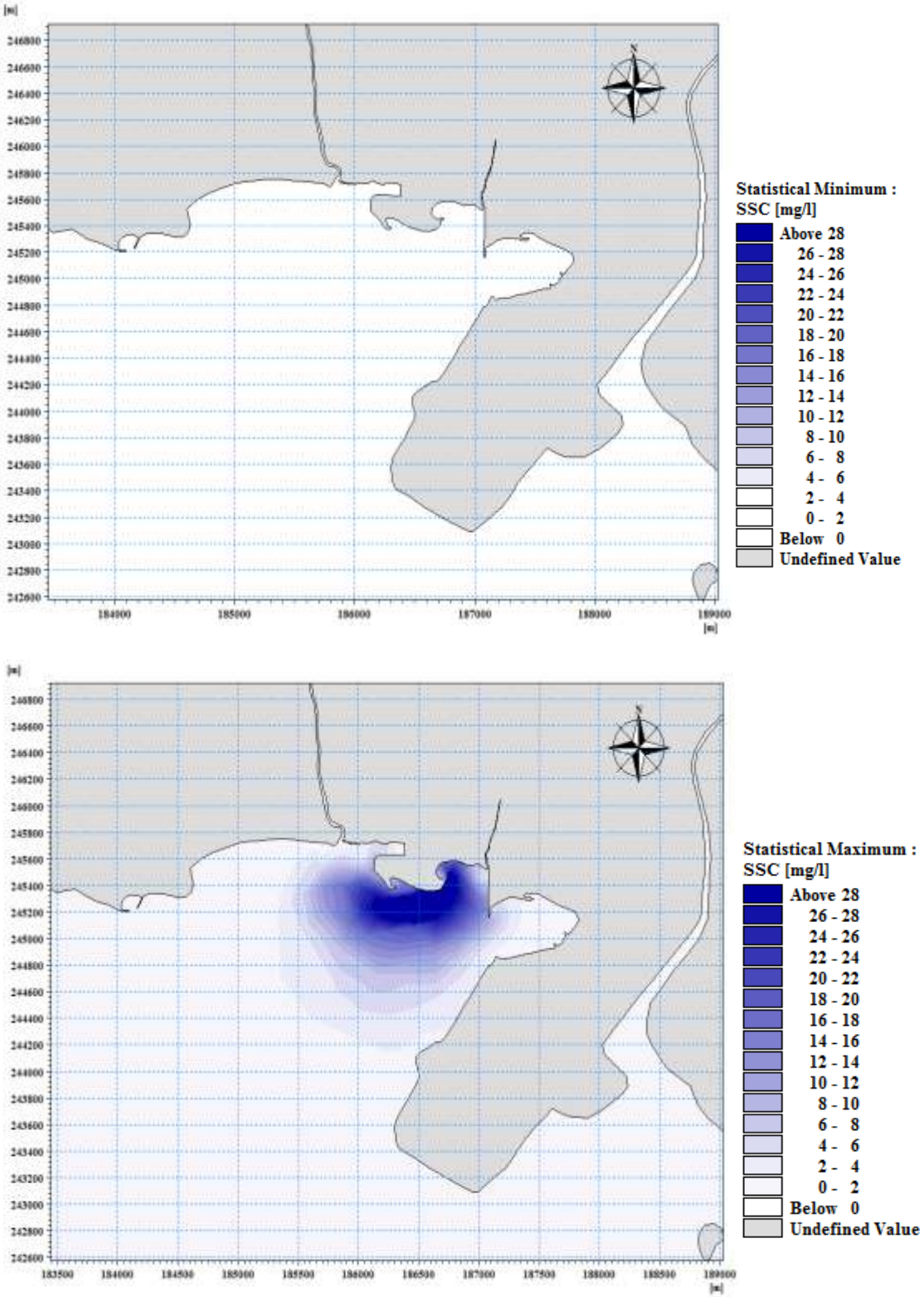

Figure 16: Minimum and Maximum Extent of Sediment Plume Dispersion from the Proposed Reclamation Work during Spring Tide without Silt Curtain

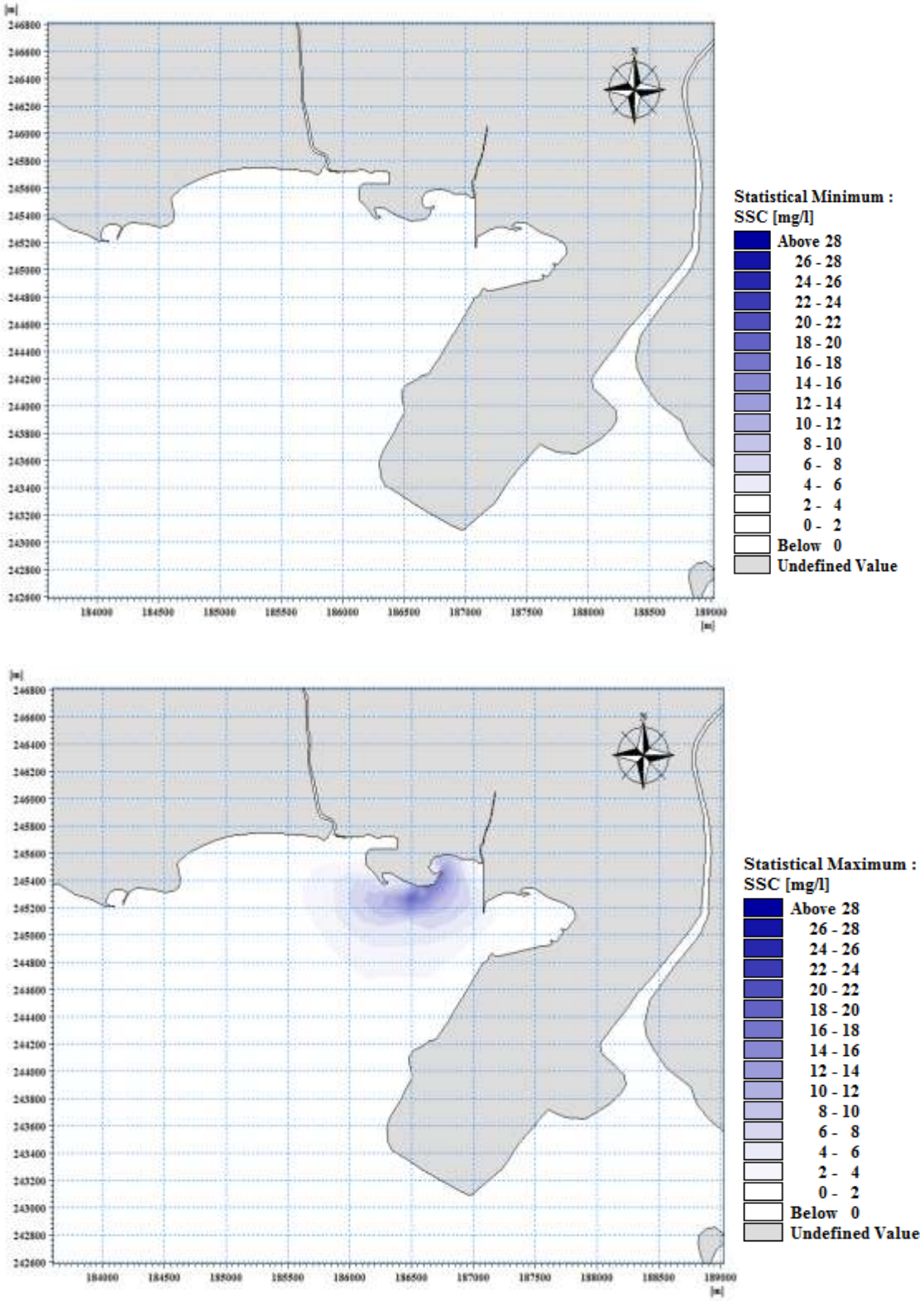

Figure 17: Minimum and Maximum Extent of Sediment Plume Dispersion from the Proposed Reclamation Work during Spring Tide with Silt Curtain

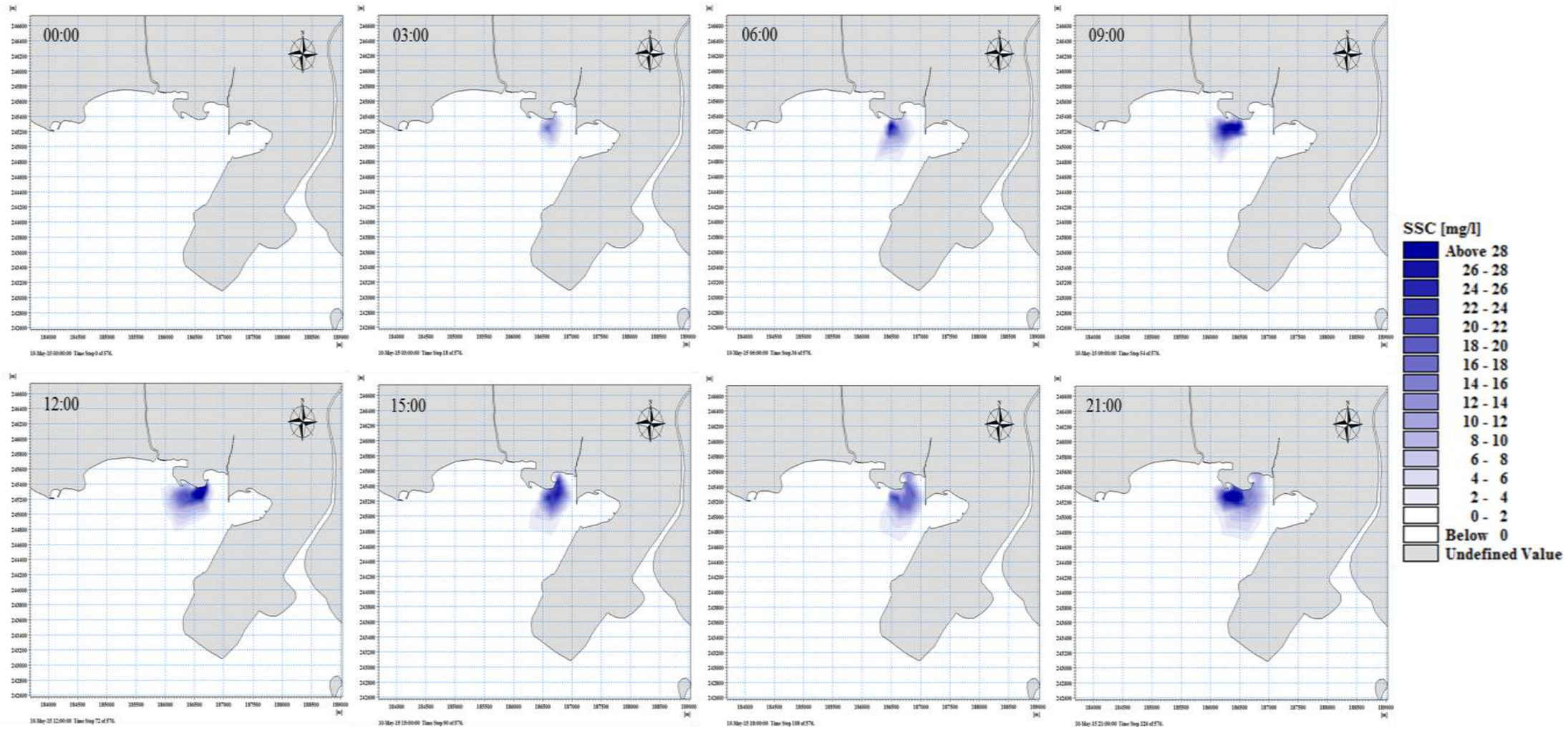

Figure 6.18: Time Series Sediment Plume Dispersion from the Proposed Reclamation Work during Neap Tide without Silt Curtain

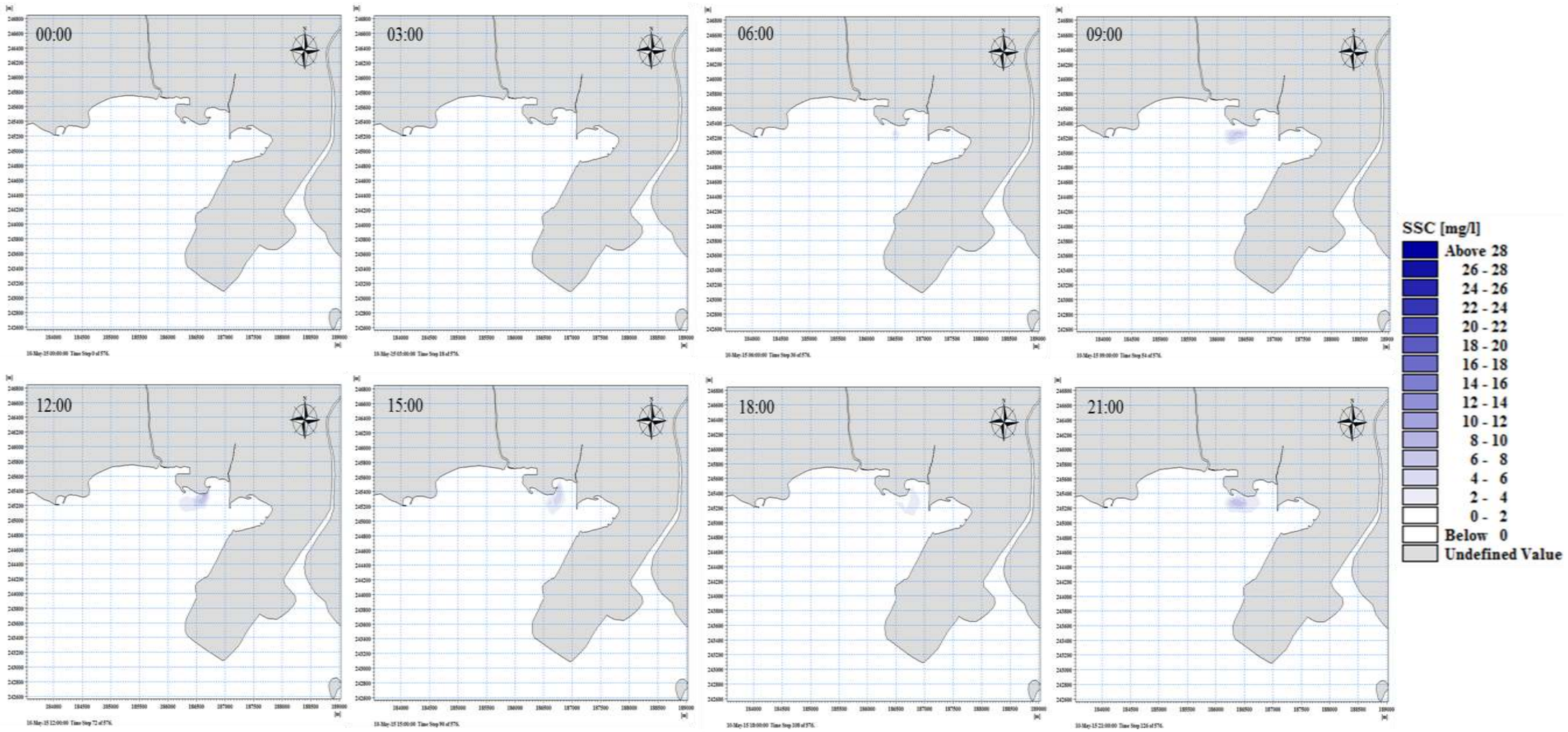

Figure 6.19: Time Series Sediment Plume Dispersion from the Proposed Reclamation Work during Neap Tide with Silt Curtain

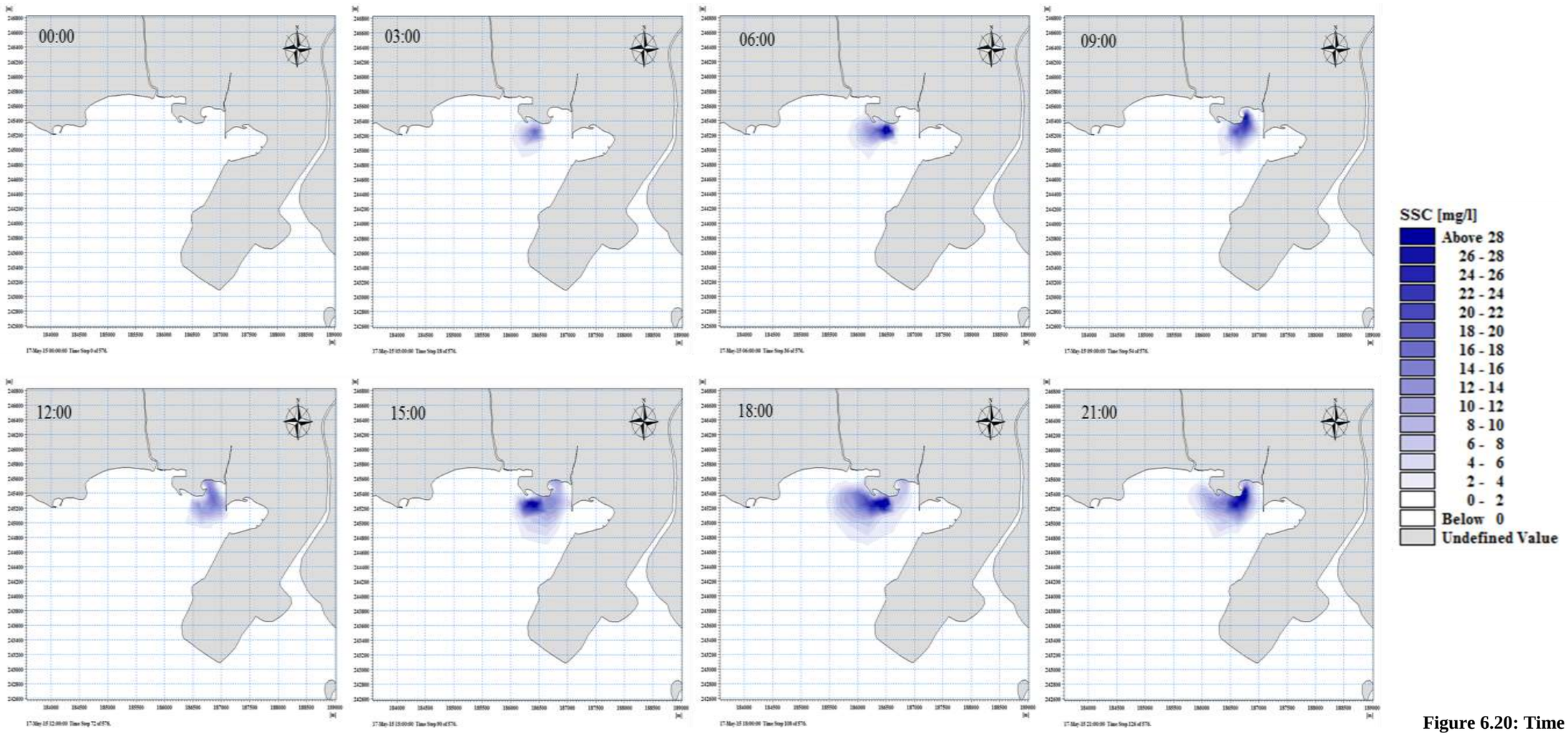

Figure 6.20: Time Series Sediment Plume Dispersion from the Proposed Reclamation Work during Spring Tide without Silt Curtain

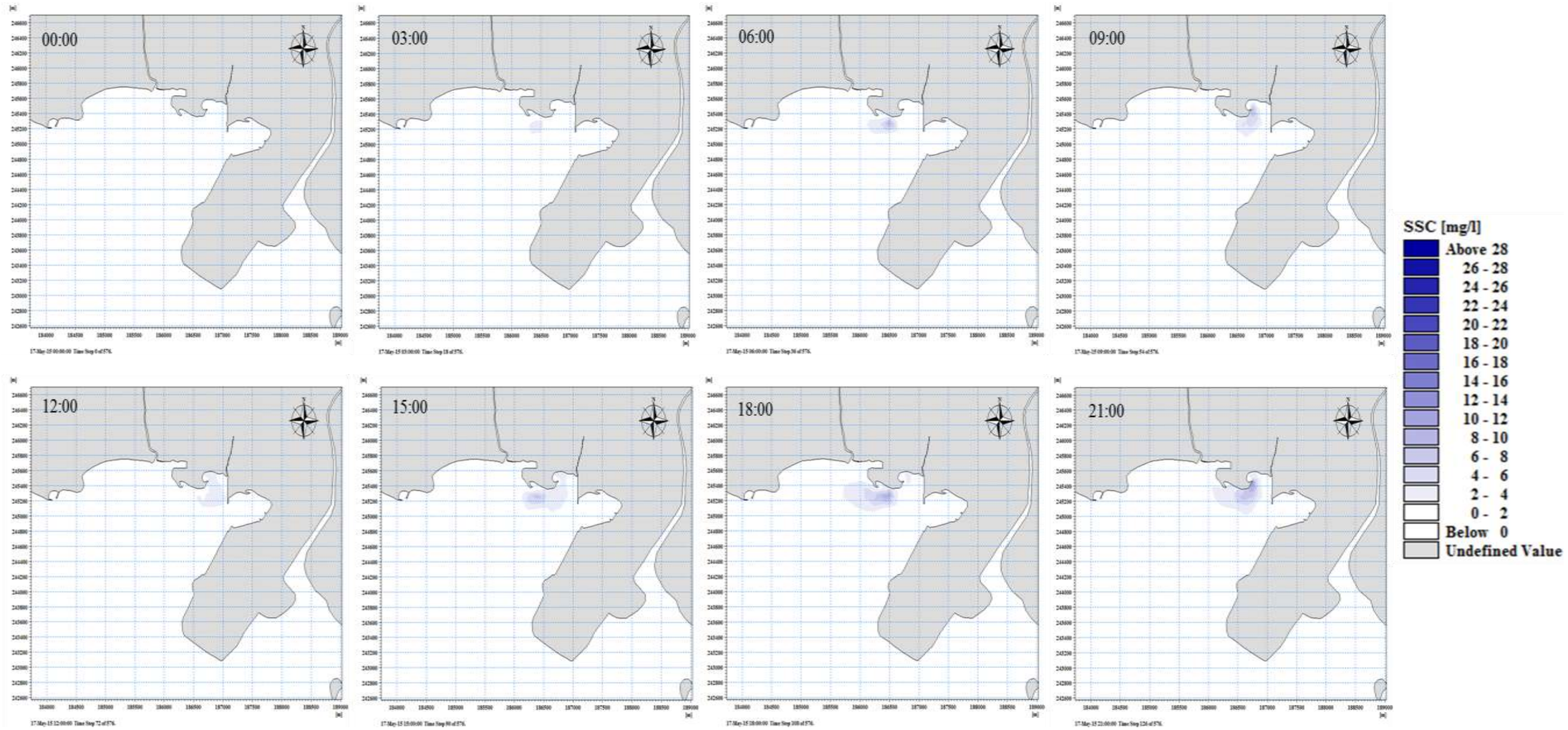

Figure 6.21: Time Series Sediment Plume Dispersion from the Proposed Reclamation Work during Spring Tide with Silt Curtain

7.1 Silt Curtain Position

Silt curtains are vertical barriers positioned within the water to contain fine material (sediment) introduced into the water column by dredging or other engineering construction activities (Figure 22). A definition of a silt curtain is “A floating geotextile material which minimizes sediment transport from a disturbed area adjacent to or within a body of water”. This barrier aims to prevent the fine grained suspended material from migrating by advection and diffusion from the point of generation at the work site and into the wider environment. This fine grained material may reduce water quality and impact upon sensitive receivers in the vicinity of the work site area. Figure 23 displays the silt curtain position during reclamation work. By installing single layer silt curtain, the sediment dispersion plume is restricted within the reclamation area.

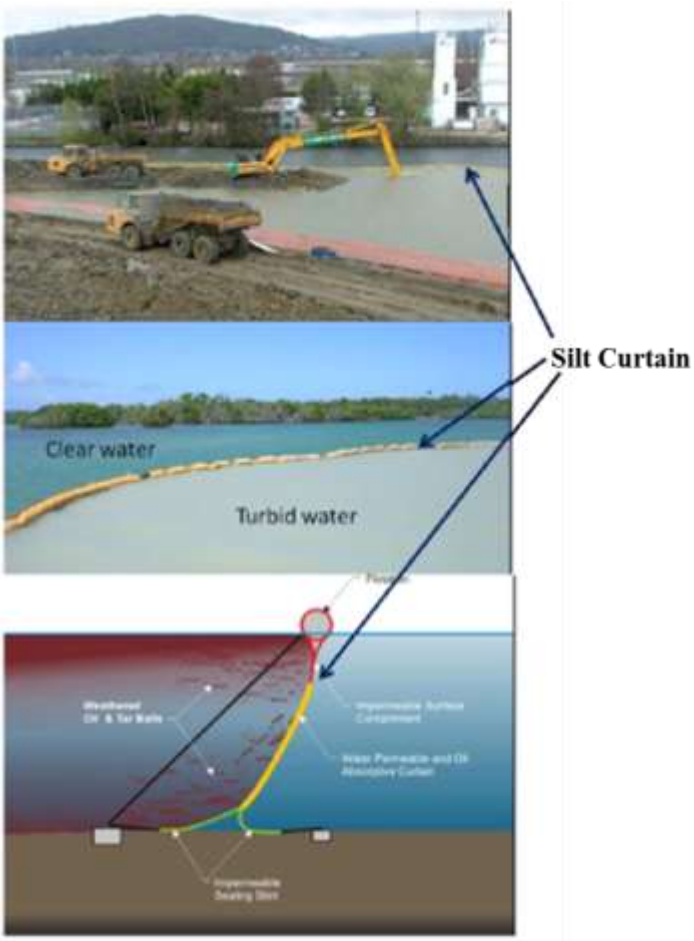

Figure 22: Application of Silt Curtain

Figure 23: Silt Curtain Position during Reclamation Work

8 Proposed Coastline Monitoring

Coastal monitoring program one of the component that required by Drainage and Irrigation Department (DID) for reclamation work. This proposed monitoring programme are important to draw a mitigation measures if needed after the reclamation works. Proposed shoreline monitoring works are based on reclamation project condition. Land survey and bathymetry survey are the main component for coastal monitoring programme. However 18 months duration required to carry out the monitoring works as per JPS requirement. This monitoring process required to ensure there is no changes in surrounding coastal environment due to the reclamation work. The survey lines are designed in two different intervals such as 100 meter intervals and 200 meter intervals. Erosion and deposition pattern of the coastal morphology need to be monitored using topographical and hydrographic survey. Random survey plan line is proposed throughout the monitoring period as per drawn in Figure 7.1. Monitoring period, at three months interval survey should be executed during the dredging and reclamation work at the project site and every 6 months for 3 years period after completion of reclamation work.

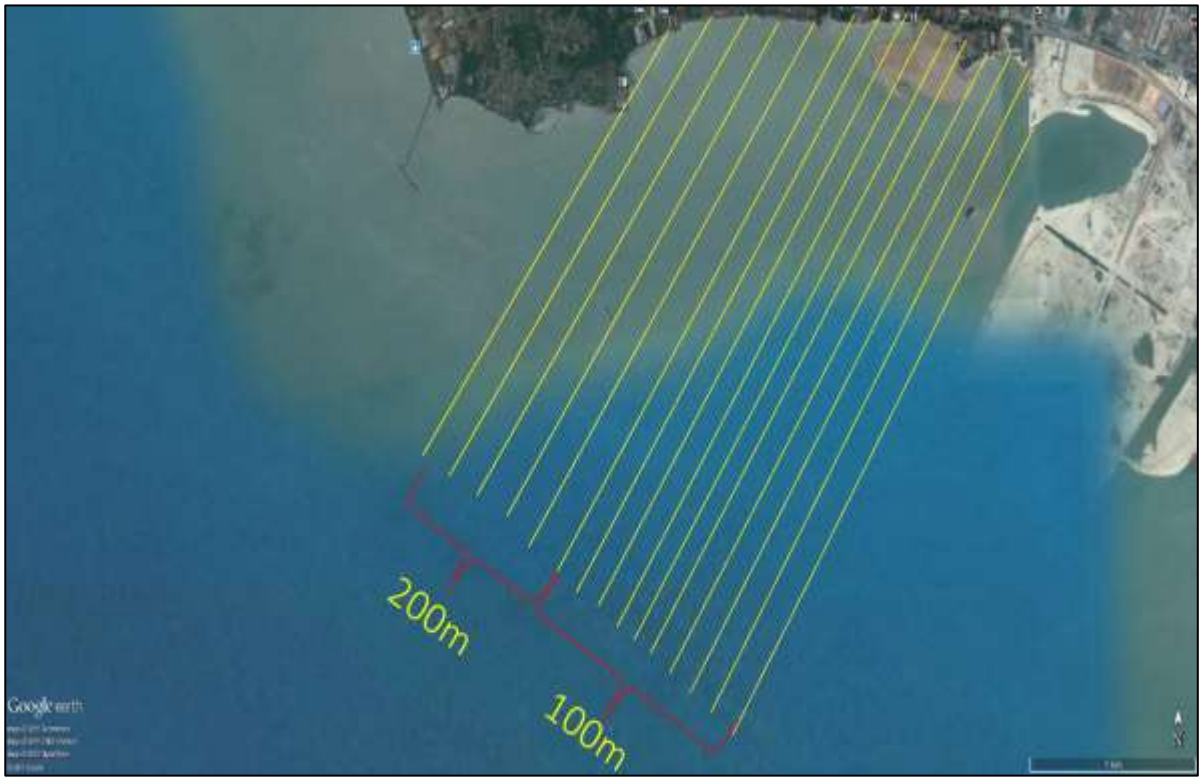

Figure 24: Proposed Monitoring Survey Line after Reclamation Work

9 Impact of Backwater

The backwater effect which is a barrier or construction will raising the surface water upstream from it. In the present project, the backwater effect were calculated for four different scenarios such as base condition, after reclamation, after reclamation with breakwater along 40 m mouth distance and after reclamation with breakwater along 50 m mouth distance. Due to the reclamation around coastal area the investigation of backwater effect is carried out by using numerical simulation. Three locations were identified to study the backwater effect around Sungai Lereh (Figure 25 and 26). Based on the simulation results, there is no significant backwater effect due to the reclamation at project site. The following Table 11 which shows the estimated discharge values for different scenarios.

Figure 25: Cross Section around Sungai Lereh

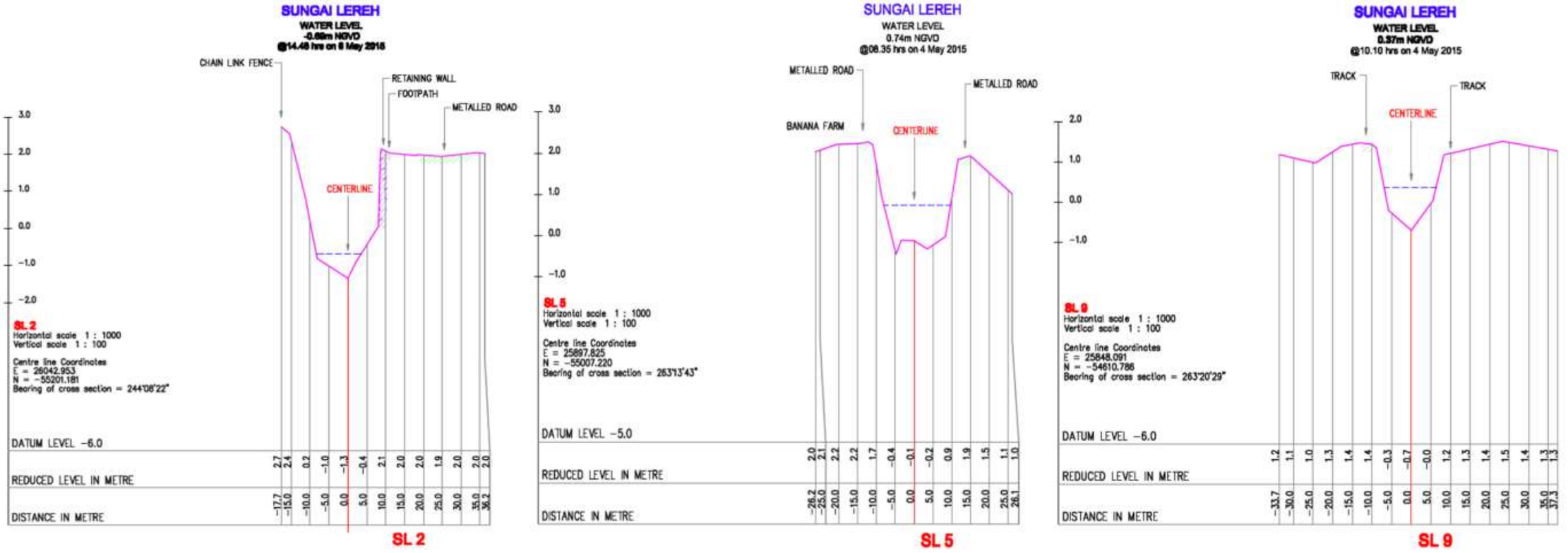

Figure 26: Drawing for Cross Sections around Sungai Lereh

Table 11: Estimated Discharge for Different Scenarios

Scenarios	Cross Section	Current Speed (m^3/s)		Percentage	
		Q Mean	Q Maximum	Q Mean (%)	Q Maximum (%)
Base Condition	SL_2	0.38	14.65	-	
	SL_5	0.34	25.29	-	
	SL_9	0.10	10.61	-	
After Reclamation	SL_2	0.31	14.81	-18	1
	SL_5	0.33	23.52	-1	-7
	SL_9	0.13	10.64	24	0
After reclamation + breakwater along 40 m mouth distance	SL_2	0.26	15.84	-31	8
	SL_5	0.40	32.00	17	27
	SL_9	0.12	10.86	12	2
After reclamation + breakwater along 50 m mouth distance	SL_2	0.26	15.84	-31	8
	SL_5	0.40	32.00	17	27
	SL_9	0.18	10.86	12	2

10 Confidence in Assessment

The main objective of the project is to assess the impact of reclamation work on the hydrodynamic and morphological condition at and around the project area. To accomplish the stated objective, state-of-art numerical model was developed, calibrated and validated. Hydrodynamic model was developed to assess the change in water level and current speed pattern during and after the completion of reclamation work. Whereas morphological model was developed to assess the change in erosion and deposition. Considering the pattern of wind and wave characteristics in the Malacca Strait, two different monsoon were devised**.** Both the hydrodynamic and morphological models and four scenarios were simulated for two monsoons to assess the impact of reclamation work. Models were also simulated with silt curtain to assess whether it is effective or not.

In term of hydrodynamic processes, we can conclude that the proposed reclamation at Malacca appears to have negligible impacts for proposed area. Based on the simulation it is clear that the reclamation work will not create any significant change nearby the project site. But it is evident from the study result that Reclamation work may cause no significant change in the pattern of mean and maximum current speed at and around the project site. It is also evident from the morphological model results that there will be no significant change in erosion and deposition if the reclamation work continues for a long duration for above scenarios. Based on the simulation results, there is no significant impact on Sungai Lereh and very less formation of siltation around the project area. Mitigation measures were carried out by installing single layer silt curtain, the sediment dispersion plume is restricted within the reclamation area. It indicates that a continuous monitoring is needed at some specific locations nearby the project site. This monitoring process required to ensure there is no changes in surrounding coastal environment due to the reclamation work. The survey lines are designed in two different intervals such as 100 meter intervals and 200 meter intervals. Monitoring period, at three months interval survey should be executed during the dredging and reclamation work at the project site and every 6 months for 3 years period after completion of reclamation work.