

ANNEX 3F WATER QUALITY IMPACT ASSESSMENT FOR CMPS DURING INITIAL YEARS OF THE PROJECT

3F.1 Introduction

While the change of coastline due to the proposed Kau Yi Chau Artificial Islands (KYCAI) development is not expected to be significant during initial years of construction and operation activities of the Project as the reclamation works of the proposed KYCAI development would be carried out gradually, the extent of sediment dispersion during initial years of construction and operation activities of the Project when the coastline of the proposed KYCAI development is yet to be formed, was further investigated. Two additional scenarios, Scenario C1B and Scenario C2B, which were not described in the *Method Statement for Water Quality Modelling Assessment (Annex 3A)*, were conducted to assess the potential water quality impact of concurrent dredging, backfilling and capping works at east of the Key Area, with hydrodynamic based on the existing coastlines without the KYCAI configuration. The adopted modelling assumptions for these two additional scenarios (C1B and C2B) are entirely the same as Scenarios C1 and C2, except for the absence of KYCAI configuration for the adopted hydrodynamic. These two scenarios are described below.

- Scenario C1B – assume three CMPs located at east of the Key Area (closer to Lamma Island) to be constructed and operated concurrently; hopper barge backfilling at the northernmost CMP, grab dredging (with 2 grab dredgers) at the middle CMP and hopper barge capping at the southernmost CMP as well as other concurrent projects; modelled coastline did not take into account the KYCAI configuration;
- Scenario C2B - similar to scenario C1B except dredging would be conducted by one Trailing Suction Hopper Dredger (TSHD).

3F.2 Impact Assessment on Changes in Water Quality due to Construction and Operation Activities

3F2.1 Suspended Solids (SS) Dispersion and Sedimentation

Scenario C1B

In this scenario, three CMPs located at east of the Key Area (closer to Lamma Island) are assumed to be constructed and operated concurrently. For this scenario, the coastline of potential artificial islands in the Central Waters has not been taken into account in the modelling. Concurrent backfilling in the northernmost pit at rate of 26,700 m³/day, grab dredging by two grab dredgers at the middle pit with rate of 50,000 m³/week per dredger, as well as capping at the southernmost pit at rate of 26,700 m³/day are modelled.

Predicted levels of maximum SS elevation and sedimentation flux at selected WSRs, which locate in the close proximity to Project site with notable predicted SS elevation shown in **Table 3.13**, are provided in **Table 3F.1** and **Table 3F.2**, respectively. Contour plots of predicted maximum depth-averaged SS elevation and sedimentation flux at dry and wet seasons are provided in **Figure 3F.1** and **Figure 3F.2**, respectively. To allow easy comparison, model prediction at the same WSRs under Scenario C1 (i.e. same sediment sources assumptions but with KYCAI configuration) are presented in **Table 3F.1** as well. The predicted levels of SS elevation were generally similar amongst Scenarios C1 and C1B. The difference of maximum SS elevation between the scenarios with and without KYCAI configuration at these WSRs around the proposed Project was in the order of 0.0 mg/L to 0.3 mg/L. Maximum SS elevation was predicted at MP1-C and the corresponding SS elevation were predicted to be 1.1 mg/L (Scenario C1) and 1.4 mg/L (Scenario C1B) respectively in dry season. The predicted maximum SS elevation were 0.8 mg/L at CR01 (Scenario C1) and 0.8 mg/L at MP1-B, MP1-C and CR23 (Scenario C1B) in wet season. Predicted maximum SS elevation at all identified WSRs under this Study, including those not listed in **Table 3F.1**, were below the corresponding assessment

criteria in both dry and wet seasons. The predicted levels of sedimentation flux under Scenario C1B were slightly different from those predicted under Scenario C1. The maximum sedimentation flux is predicted to occur at CR22 (Pak Kok) in wet season (54 g/m²/day) and CR23 (Shek Kok Tsui) in dry season (32 g/m²/day) (**Table 3F.2**), which are both below the assessment criterion. Unacceptable water quality impact associated with SS elevation and sedimentation flux from the proposed Project is not expected.

Scenario C2B

In this scenario, three CMPs located at east of the Key Area (closer to Lamma Island) are assumed to be constructed and operated concurrently. For this scenario, the coastline of potential artificial islands in the Central Waters has not been taken into account in the modelling. Concurrent backfilling in the northernmost pit at rate of 26,700 m³/day, TSHD dredging at the middle pit with rate of 256,200 m³/week, as well as capping at the southernmost pit at rate of 26,700 m³/day are modelled.

Predicted levels of maximum SS elevation and sedimentation flux at selected WSRs, which locate in the close proximity to Project site with notable predicted SS elevation shown in **Table 3.13**, are provided in **Table 3F.1** and **Table 3F.2**, respectively. Contour plots of predicted maximum depth-averaged SS elevation and sedimentation flux at dry and wet seasons are provided in **Figure 3F.1** and **Figure 3F.2**, respectively. To allow easy comparison, model prediction at the same WSRs under Scenario C2 (i.e. same sediment sources assumptions but with KYCAI configuration) are presented in **Table 3F.1** as well. The predicted maximum SS elevation were generally similar amongst Scenarios C2 and C2B. The difference of maximum SS elevation under between the scenarios with and without KYCAI configuration at these WSRs around the proposed Project was in the order of 0.0 mg/L to 0.2 mg/L. Maximum SS elevation was predicted at MP1-C and the corresponding SS elevation were predicted to be 1.1 mg/L (Scenario C2) and 1.3 mg/L (Scenario C2B) respectively in dry season. The predicted maximum SS elevation were 0.8 mg/L at CR01 (Scenario C2) and 0.8 mg/L at CR23 (Scenario C2B) in wet season. Predicted maximum SS elevation at all identified WSRs under this Study, including those not listed in **Table 3F.1**, were below the corresponding assessment criteria in both dry and wet seasons. The predicted levels of sedimentation flux under Scenario C2B were slightly different from those predicted under Scenario C2. The maximum sedimentation flux is predicted to occur at CR22 (Pak Kok) in wet season (52 g/m²/day) and CR23 (Shek Kok Tsui) in dry season (32 g/m²/day) (**Table 3F.2**), which are both below the assessment criterion. Unacceptable water quality impact associated with SS elevation and sedimentation flux from the proposed Project is not expected.

Overall, the model predictions showed that the construction and operation of the Project will not result in notable difference of water quality in terms of SS elevation and sedimentation flux at nearby WSRs with and without KYCAI configuration. The predicted levels of SS elevation and sedimentation flux at all the identified WSRs will be in compliance with the corresponding assessment criteria under the scenarios with and without KYCAI configuration.

Table 3F.1 Predicted SS Elevation at Selected WSRs

Description	Location	Model Output Location	EPD Station	Relevant Depth	Dry Season (WQO Allowable Change) (mg L ⁻¹)	Dry Season Max Increase (mg L ⁻¹)				Dry Season Compliance Time %	Wet Season (WQO Allowable Change) (mg L ⁻¹)	Wet Season Max Increase (mg L ⁻¹)				Wet Season Compliance Time %
						C1 Scenario	C2 Scenario	C1B Scenario	C2B Scenario			C1 Scenario	C2 Scenario	C1B Scenario	C2B Scenario	
Marine Ecological Sensitive Receivers																
Marine Park (MP)	Potential South Lamma MP	MP1-B ⁽²⁾⁽³⁾	SM6	Depth-averaged	3.7	0.6	0.6	0.6	0.6	100%	3.1	0.8	0.7	0.8	0.7	100%
		MP1-C ⁽²⁾⁽³⁾	SM6	Depth-averaged	3.7	1.1	1.1	1.4	1.3	100%	3.1	0.6	0.6	0.8	0.7	100%
Corals	Cheung Chau	CR01 ⁽¹⁾⁽³⁾	SM12	Bottom	6.6	0.0	0.0	0.0	0.0	100%	5.4	0.8	0.8	0.6	0.6	100%
		CR11 ⁽¹⁾⁽³⁾	SM12	Bottom	6.6	0.0	0.0	0.0	0.0	100%	5.4	0.5	0.5	0.4	0.4	100%
		B1 ⁽¹⁾⁽³⁾	SM12	Bottom	6.6	0.0	0.0	0.0	0.0	100%	5.4	0.6	0.5	0.4	0.4	100%
	Hei Ling Chau	CR02 ⁽¹⁾	SM11	Bottom	6.0	0.0	0.0	0.0	0.0	100%	5.1	0.2	0.1	0.1	0.1	100%
		CR03 ⁽¹⁾	SM11	Bottom	6.0	0.0	0.0	0.0	0.0	100%	5.1	0.3	0.2	0.2	0.2	100%
	Pak Kok	CR22 ⁽¹⁾	WM1	Bottom	4.8	0.8	0.8	0.7	0.7	100%	4.8	0.6	0.6	0.6	0.6	100%
	Shek Kok Tsui	CR23 ⁽¹⁾	SM7	Bottom	4.2	0.6	0.6	0.4	0.4	100%	5.4	0.7	0.6	0.8	0.8	100%

Notes:

1. The WSR also represents secondary contact recreation subzone.
2. The WSR also represents habitat for FP.
3. The WSR also represents nursery area and spawning ground for commercial fisheries resources.

Table 3F.2 Predicted Sedimentation Flux (g/m²/day) at the Selected Coral WSRs

Location	Model Output Location	EPD Station	Assessment Criterion (g/m ² /day)	Dry Season Max Increase (g/m ² /day)				Wet Season Max Increase (g/m ² /day)			
				Scenario C1	Scenario C2	Scenario C1B	Scenario C2B	Scenario C1	Scenario C2	Scenario C1B	Scenario C2B
Cheung Chau	CR01	SM12	100	0	0	0	0	33	43	24	24
	CR11	SM12	100	0	0	0	0	30	28	17	17
	B1	SM12	100	0	0	0	0	24	24	16	16
Hei Ling Chau	CR02	SM11	100	0	0	0	0	7	6	4	4
	CR03	SM11	100	0	0	0	0	10	9	7	6
Pak Kok	CR22	WM1	100	38	38	20	20	40	36	54	52
Shek Kok Tsui	CR23	SM7	100	29	29	32	32	50	48	39	37

Note: Sedimentation flux predicted by the model is instantaneous even though the output unit was based on daily. The values presented are the amount of sediment in gram settled on one square meter of area if the maximum sedimentation rate sustained for one day. In reality such instantaneous maximum would occur just once in the entire modelling period and would be far shorter than 1 day. Thus the presented results are conservative when interpreted based on the assessment criterion.

3F2.2 Dissolved Oxygen (DO) Depletion

As discussed in **Section 3.7.1.2**, the degree of DO depletion exerted by a sediment plume is a function of the sediment oxygen demand of the sediment, its concentration in the water column and the rate of oxygen replenishment. For Scenarios C1B and C2B, the predicted maximum SS elevation level is 1.4 mg L^{-1} at MP1-C and the corresponding level of DO depletion is calculated to be:

$$DO \text{ (mg O}_2 \text{ L}^{-1}) = 1.4 \text{ (g DW m}^{-3}) \times 28,000 \text{ (mg O}_2 \text{ kg}^{-1} \text{ DW)} = 39.2 \text{ (mg O}_2 \text{ m}^{-3}) = 0.0392 \text{ mg L}^{-1}$$

The maximum predicted DO depletion level is around 0.04 mg L^{-1} (at MP1-C, where allowable DO depletion is 1.2 mg/L), which is considered to be insignificant. DO depletion levels at other identified WSRs would be even lower due to insignificant SS elevation from the Project. Overall, no unacceptable water quality impact from DO depletion is anticipated and the predicted levels of DO will be in compliance with the corresponding assessment criteria under the scenarios with and without KYCAI configuration.

3F2.3 Release of Sediment-bounded Contaminants

As discussed in **Section 3.7.1.3**, the risk of release of sediment-bounded contaminants was assessed with the aid of computational modelling using Delft3D. Similar to the case of sediment dispersion modelling, two modelling scenarios were simulated, namely:

- Scenario C3B – assume three CMPs located at east of the Key Area (closer to Lamma Island) to be constructed and operated concurrently; hopper barge backfilling at the northernmost CMP and grab dredging (with 2 grab dredgers) at the middle CMP; modelled coastline did not take into account the KYCAI configuration; and
- Scenario C4B - similar to scenario C3B except the dredging would be conducted by one TSHD.

The model prediction under Scenarios C3B and C4B indicated the results of tracer dispersion were similar to those predicted under Scenarios C3 and C4. The WSR (CR03 in dry season), which was predicted to experience the highest conservative tracer concentration under Scenarios C3 and C4, was also predicted to have the highest conservative tracer concentration under Scenarios C3B and C4B. The results of estimated conservative tracer concentration at CR03 in dry season under Scenarios C3, C4, C3B and C4B are presented in **Table 3F.3**.

As shown in **Table 3F.3**, the predicted maximum tracer concentration as well as copper concentration at CR03 under dry season in both Scenarios C3B and C4B would be lower than those predicted under Scenarios C3 and C4, and would also be below the corresponding assessment criterion of $1.3 \text{ } \mu\text{g L}^{-1}$. Given CR03 is the WSR experiencing the highest level of conservative tracer concentration, the predicted levels of contaminant elevation at other WSRs would be lower and in compliance with the corresponding criterion. In addition, given copper is the most stringent parameter among all contaminants, compliance to criterion for copper would also imply compliance to criteria for all other contaminants considered. Therefore, no unacceptable water quality impact from release of sediment-bounded contaminants would be expected under the scenarios without KYCAI configuration.

Table 3F.3 Predicted Conservative Tracer Concentration and Corresponding Levels of Copper at CR03 in Dry Season under Scenarios C3, C4, C3B and C4B

Scenario	Dry Season Max. Concentration for Conservative Tracer (mg/L)								Dry Season Max Concentration for Copper (µg/L)				Assessment Criterion for Copper (µg/L)
	C3		C4		C3B		C4B		C3	C4	C3B	C4B	
	Tracer for Backfilling	Tracer for Dredging	Tracer for Backfilling	Tracer for Dredging	Tracer for Backfilling	Tracer for Dredging	Tracer for Backfilling	Tracer for Dredging					
CR03	5.5821	2.1394	5.5821	2.2421	4.9828	1.7793	4.9828	1.8569	0.7060	0.7104	0.6246	0.6280	1.3

3F2.4 Release of Sediment-bounded Nutrients

As discussed in **Section 3.7.1.4**, the release of sediment-bounded nutrient is estimated based on ammonia and organic nitrogen (Org-N) content. The predicted maximum SS elevation at the most impacted WSR (MP1-C) for both Scenarios C1B and C2B is only 1.4 mg L⁻¹. The corresponding Total Inorganic Nitrogen (TIN) elevation at this most impacted WSR is calculated to be 1.4 mg L⁻¹ × 270.32 mg kg⁻¹ = 0.00038 mg L⁻¹, which is less than 1% of the corresponding WQO in the Southern WCZ (as well as all other WCZs) and considered insignificant. The expected level of TIN elevation at other identified WSRs would be even lower. No unacceptable water quality impact from TIN elevation is anticipated under the scenarios with and without KYCAI configuration.

Similarly, the potential increase in unionized ammonia (UIA) is calculated to be 0.027 µg L⁻¹, which is below 1% of the corresponding WQO and is considered inconsequential at the most impacted WSR. The expected level of UIA elevation at other identified WSRs would be even lower. No unacceptable water quality impact from UIA elevation is anticipated under the scenarios with and without KYCAI configuration.

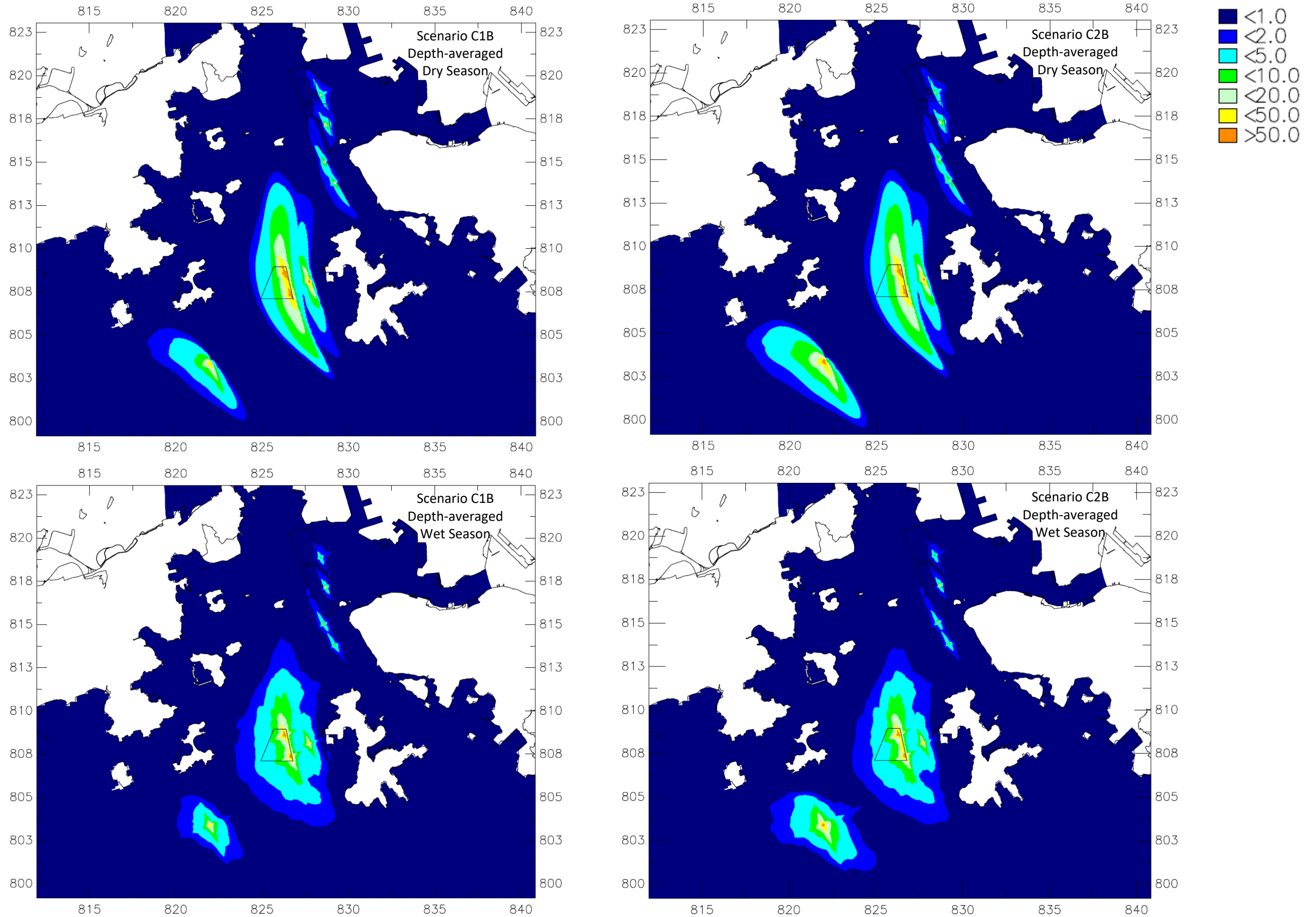


Figure 3F.1 Predicted Maximum Suspended Solids (SS) Elevation (mg/L)

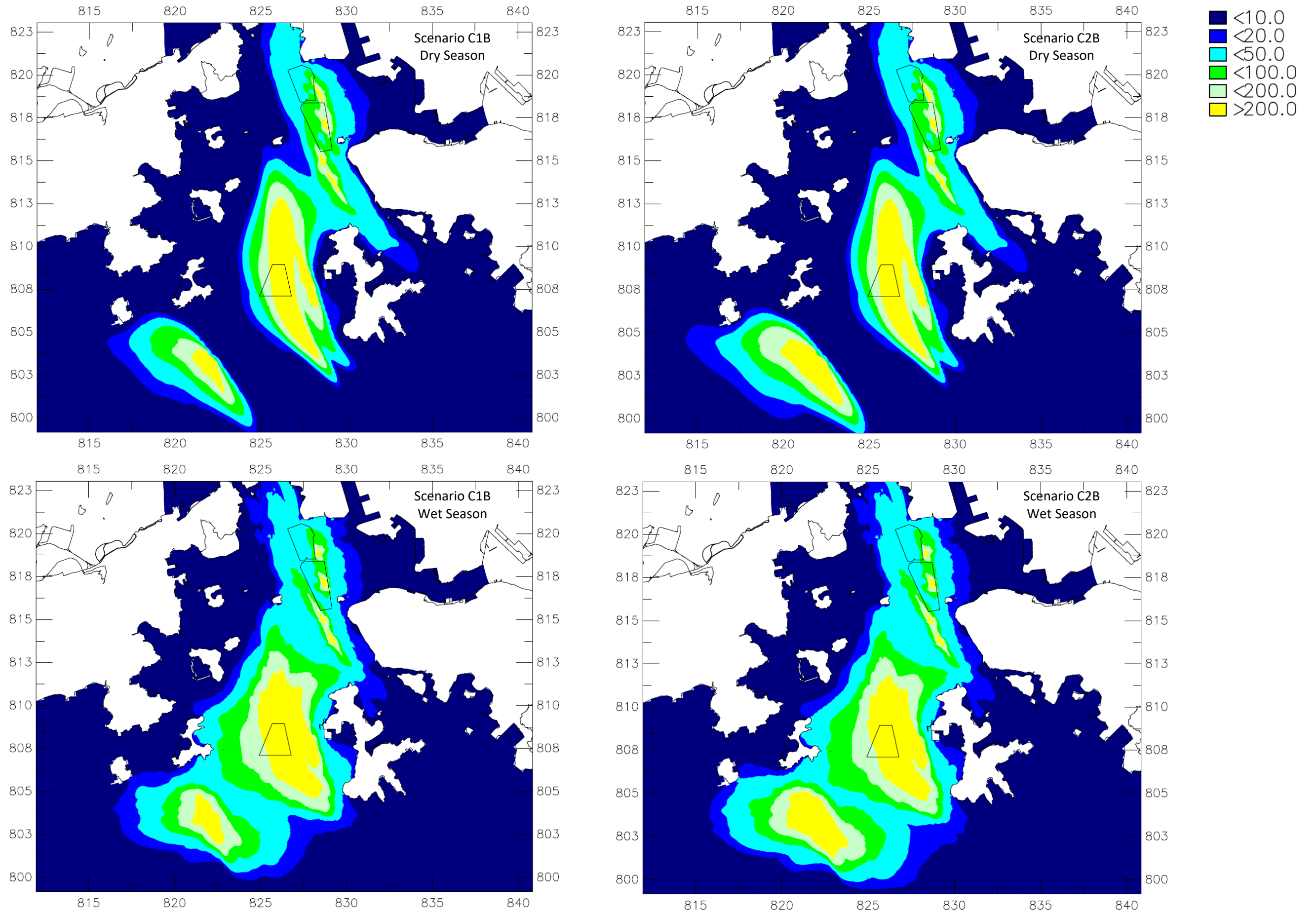


Figure 3F.2 Predicted Maximum Sedimentation Flux (g/m²/day)