Attachment 3: NRCan's January 2016 Assessment of the PNW LNG Supplemental Modelling Report - 3D Modelling Update (November, 2015)

These comments represent NRCan's final assessment of the Proponent's responses to the more significant issues raised in NRCan's October 16, 2015 submission. The provision of additional data, interpretation or clarification was required for NRCan to conduct a complete evaluation to verify that the modelled cases and results support the conclusions in the Proponent's 3D Modelling Update Report (November, 2015). The technical issues identified below do not impact NRCan's overall confidence in the Proponent's conclusions regarding sediment transport and morphological changes in the project area as described in our January 2016 cover letter. Comments are provided for consideration to better convey the comprehensiveness of the material presented in the report. Responses from the Proponent are not required. The comments are found below in two parts: A) Key considerations that would improve the comprehensiveness of the Proponent's 3D Modelling Update Report (November, 2015) and B) Comparison of NRCan's October and January , 2016 assessments of the Proponent's September and November, 2015 Modelling Reports.

A) Key considerations that would improve the comprehensiveness of the Proponent's 3D Modelling Update Report (November, 2015)

In NRCan's view, the following suggested changes and additions would have significantly improved the quality and comprehensiveness of the November 2015 Report, including:

1. Total erosion and deposition areas should have been listed and corrections of the computation of the averages of erosion elevation change and deposition elevation change should have been made in all tables listing area and volumetric changes (see comments on Table 6-1 on p. 3 of this submission).

2. In reviewing section 6.2 High-Resolution Modelling of the SW Tower and SW Anchor Block, NRCan requested that the revised report should provide estimates of the area over which the increase of the instantaneous total suspended solids (TSS) was respectively > 5 mg/l and >25 mg/l and the duration of these TSS increase events. The Proponent provided this information as Item 34 of the detailed responses Table 1 provided to NRCan in November, 2015. This additional information on TSS is important to assess the impact of the project on fish and fish habitat. In NRCan's view, the estimated durations of the TSS pulses should have also been included in Section 6.2.3.2 of the 3D Modelling Update Report (November, 2015).

3. The results of several key modelled cases were presented in the Appendices submitted by the Proponent in November, 2015. However, the 3D Modelling Update Report (November, 2015) was not consistent in referring to these. In NRCan's view, this affects the readers to link the various parts of the report and to appreciate the comprehensiveness of the material presented. The following are the modelling results presented in the appendices which should have been referred to in the 3D Modelling Update Report (November, 2015):
(1) The first paragraph in section 5.1.1: Storm Simulation Results on p. 56 could refer to the modelling results of the October 2012 storm in Appendix H to indicate that the impact of the proposed structures on waves, storm-induced currents, sediment transport and seabed morphology for a naturally occurring storm has also been modelled and the results are presented in Appendix H.
(2) At the end of second last paragraph on p. 80, the following statement could be added to refer to the modelled tide-dominant conditions: Additionally the impact of the marine structures on currents, sediment transport, and seabed morphology for typical tide-dominant conditions (28 days) was also modelled and the results are given in Appendix H (p. H-77).
(3) The first paragraph of section 6.1.4.1 could state that the impact on the net transport flux by the proposed structures was not assessed for the 3 month stormy period due to the coarse output intervals of the model. However, changes to the net transport flux for a storm in October 2012 was modelled and the results are presented in Appendix H. The impact of the marine structures on the net transport flux was also modelled in the 50-yr storm simulation.

(4) At the end of section 6.1.4.1, the following statement could be added on p. 126: The impact of the proposed structures on TSS for the 3 month stormy period were assessed for selected locations on Flora Bank in Appendix H (p. H-47).
(5) The first paragraph of section 6.1.4.1 could be revised to indicate that the impact on the net transport flux by the proposed structures was not assessed for the 4 month calm period due to the coarse output intervals of the model. However, changes to the net transport flux for the tide-dominant period was modelled and the results are presented in Appendix H (p. H-77). The impact of the marine structures on the net transport flux during the freshet was also modelled.
(6) At the end of section 6.1.4.2, the following statement could be added on p. 130: The impact of the proposed structures on TSS for the 4 month calm period were assessed for selected locations on Flora Bank in Appendix H (p. H-70).

B) Comparison of NRCan's October and January, 2016 assessments of the Proponent's September and November 2015 Modelling Reports:

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5 Key Questions Item 4 (p. xiv; also Item 4 of 8. Conclusions). Net sediment transport off of Flora Bank (last 2 paragraphs of p. xv)	In discussing sediment transport under typical conditions, the report states "… transport distances are generally limited with relatively little material transported off of Flora Bank". As for modelling results of extreme storms, the report makes a similar statement "even in very large events actual bed changes occur only during a portion of the storm and transport of fine to medium sand off Flora Bank is limited". While the net transport for the 50 year storm was low (Fig. 5-5), it did show net transport to the southeast and Table H-F-4 indicates a net sediment loss of 7,760 m3. Also the net transport flux from the 28-day freshet simulation in Fig. 5-16 shows net transport to the northwest. The report did not provide data on the net transport flux and volume changes for the 3-month stormy period or the 4 month calmer period. These values should be provided and be compared with the total volume of fine and medium sand on Flora Bank to derive quantitative estimates to substantiate that indeed little material is transported off of Flora Bank.	Net volume changes were given for the 3-month stormy period (Table 5-1) and the 4 month calmer period (Table 5-2). This is satisfactory to NRCan. However, NRCan notes that if the estimated net volume changes were compared against the total sand volume over Flora Bank (in the body of the Report), the volume changes as percentages of the total sand volume of Flora Bank would provide evidence to support the statement made by the Proponent in the September, 2015 Report ("transport distances are generally limited with relatively little material transported off of Flora Bank").
Simulations of the 50 year storm Sections 5.1 (p. 54).	Figure 5-4 (p. 58) shows snapshots of the total transport flux taken at three distinct times during the 50-year storm. The Proponent correctly interprets that the total transport fluxes generated before and after the peak of the storm are considerably smaller than at the peak of the storm. The report should include maps that show the total transport flux associated with peak flood and peak ebb during the peak of the storm. These figures will	A new Fig. 5-5 was added on p. 60. However, this figure shows total transport flux at the beginning of flood for the early, peak, and late stages of the storm. NRCan notes that it would be more effective for this figure to show maps of total transport flux for (a) peak flood and (b) peak ebb during the peak of the storm. The

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	corroborate the net flux patterns presented in Fig. 5-5.	early and late stages of the storm are of less importance.
Simulations of the 50 year storm Section 6.1.1 (p. 88)	The following additional data should be included in section 6.1.1: (1) Maps of sediment transport flux for peak flood and peak ebb during the peak of the storm for conditions with the marine structures; (2) Net sediment transport flux averaged over the duration of the storm for conditions with the marine structures.	(1) New Figures 6-4 and 6-5 were added to show total transport flux snapshots at the beginning of the ebb tide and flood tide. In NRCan's view, Figures 6-4 and 6-5 should have been replaced by maps of sediment transport flux for peak flood and peak ebb during the peak of the storm for conditions with the marine structures. (2) New Figure 6-6 was added to show net total transport flux for existing and proposed conditions. This response is satisfactory to NRCan.
Simulations of the 50 year storm Section 6.1.1 (p. 97), Table 6-1.	Table 6-1 presents volumetric and area changes over Flora Bank during the 50-year storm (p. 97). NRCan has the following comments: (1) The computation of Erosion Average Elevation Change, Deposition Average Elevation Change and Net Average Elevation Change values could be described. (2) The estimated total area of Flora Bank could be stated in the text to help quantify the relative percentage of the erosion and deposition areas relative to the total area of the bank. (3) The values listed in Table 6-1 are actually for the 100-year storm, not the 50-year storm. (4) Two tables listing the statistics of the areas for different erosion and deposition intervals for conditions with and without the marine structures (similar as Tables 4 and 5 of May 4, 2015 report Predicted Project Effects on Fish and Fish Habitat) should be added.	Additional information and corrections related to (2), (3) and (4) as described in column 2 (NRCan's October 2015 Assessment) were satisfactory to NRCan. Descriptions of computation methods as responses to #1 (as described in column 2), however, remain an issue. Computation methods were explained on p. 84 in referring to Table 5-1. There are issues with the calculations of Erosion Average Elevation Change and Deposition Average Elevation Change. The text on p. 84-85 indicates that the average elevation change was calculated by dividing both the erosion and deposition volumes by the total footprint area of Flora Bank (~3.25 million m^2). These values underestimate the average of erosion or deposition elevation changes for the areas over which erosion or deposition actually occurred. The average of erosional changes and the average of depositional changes over areas where these processes actually occurred should have been calculated by dividing both the erosion and deposition volumes by the erosion area and deposition area

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		respectively. Also the erosion and deposition volumes in Table 5-1 are the total values for all intervals of depth changes. However, the erosion and deposition areas in the Table are for those areas with changes greater than 5 cm. These erosion and deposition areas thus create discrepancy with the total erosion and deposition areas for all change intervals shown in Fig. 5-27. NRCan notes that in order to support the description of the computation methods, the total erosion and deposition areas should have been listed in the Table. For consideration, should further refinements occur, NRCan recommends that appropriate changes could be made in all tables showing volumetric and areal changes throughout the report. NRCan notes that these suggested corrections will not affect the findings related to the volumetric and area changes for the modelled 50-year storm. The statement "The area where change occurs is relatively similar between existing and proposed conditions" on p. 112 should have been revised as the erosion and deposition areas in Table 6-1 are the sum of those areas with changes greater than 5 cm. Fig. 6-10 and Table H-6 (pdf p. 334) indicate that the erosion and deposition areas for change intervals 0-5 cm slightly increased for the proposed conditions. However, the erosion and deposition areas decreased for the proposed conditions for all intervals with changes > 5 cm. This pattern of erosion and deposition area changes is similar for the 3-month stormy period and for the 1-year time series simulation. Respective corrections of interpretation could also be made for these simulations.
Freshet Simulations- 6.1.3 Freshet Simulations (with the marine structures)	Fig. 6-9 presents time series plots of TSS concentration at two locations for conditions without and with the marine structures (MS). The long duration of the time series plots makes it difficult to assess how often and by how much the TSS values with the MS are higher than that without the MS. Section 8.2 Long-	Fig. 6-15 was added to show that the TSS concentrations for existing and proposed conditions at two points were very similar. The percentage of time that TSS concentrations were above 25 mg/l for either the existing or proposed conditions, and the

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	Term Simulations of TSS With and Without Marine Structures (p. 167) of Hatch May 5 report, presented the percent of time that the TSS concentration with MS is higher for representative sites on Flora Bank in Table 8-2 and indicated that TSS values with the MS were sometimes higher for some sites. Also zoom-in time series plots showed that the TSS with MS at TSS3 site was ~100 mg/l higher than the values without MS. The update report should include tables and zoom-in time series plots in similar fashion to show if the MS will cause significant increase of TSS and if so, calculate the time% and the range and mean of the duration of the episodes of increased TSS.	maximum amount of consecutive hours that TSS concentrations were above 25 mg/l for both the existing and proposed conditions at selected points were described on p. 120. This response is satisfactory to NRCan.
Time Series Simulations of the 3-month stormy period Sections 5.3.3.1 and 6.1.4.1.	The Proponent only presented maps of the bed elevation change in assessing the impact for the modelled stormy period. Significant more results should be presented so that the marine structure impact on waves, storm currents, sediment resuspension, sediment transport and seabed morphology for the stormy winter season can be fully assessed. NRCan request of additional data: 1. For conditions without the marine structures: (1) A map of the net transport flux averaged over the stormy period is needed. (2) A table listing the statistics of erosion volume, deposition volume, net volume change, the area with erosion greater than 5 cm, the area with deposition > 5 cm, and net elevation change should be presented. (3) A table listing the area for various erosion and deposition intervals should be included.	(1) The net transport flux averaged over the 3 month stormy period cannot be provided because model outputs were saved at 12 hour intervals. However, net transport flux plots are presented in Appendix H (p. H-67) for a storm in October 2012. The 50-yr storm simulation also includes net transport flux plots. (2) Volumetric change statistics for the 3 month stormy period is presented in Section 5.3.4 (Table 5-1; Fig. 5-27). However, see comments on Table 6-1 on p. 3 of this submission related to the Simulations of the 50 year storm. (3) Information on the area for various erosion and deposition intervals is provided in Fig. 6-18. These responses are satisfactory to NRCan.
	2. Similar results as in #1 described above, could be presented for conditions with the marine structures and the structure impact could be assessed.	Volumetric change statistics for the 3 month stormy period is presented in Section 6.1.4.1 (Table 6-3; Fig. 6-18), and Appendix H. This response is satisfactory to NRCan.
	3. TSS (total suspended solids): (1) Time series of TSS (depth averaged or at selected heights above bottom) at representative locations on Flora Bank for conditions with and without the marine structures. Zoom-in time series plots over shorter time periods may be needed to better show the TSS increases with the MS. (2) Use the time series data at these locations to calculate (a) time% that TSS with the	TSS data are provided on p. H-47. The existing conditions produce larger TSS concentrations more often than the proposed conditions. This response is satisfactory to NRCan.

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	structures was respectively 5 mg/l and 25 mg/l above that of the existing conditions and (b) the histograms (or range and mean) of the duration of these TSS events exceeding the baseline conditions. (3) Statistics of areas over Flora Bank for which TSS with the marine structures was respectively at least once 5 mg/l and 25 mg/l above that without the marine structures.	
	4. Sections 5.1 and 6.1.1 address the impact on waves, storm-induced currents, sediment transport and seabed morphology for the artificially created 50-year storm. Similar results need to be presented so that the impact of the marine structures on these processes for naturally occurring storms can be determined. NRCan recommends that 1 or 2 of the largest storms (preferably coincident with strong spring tidal currents, e.g. the storm in mid-October 2012) should be selected from the modelled 3-month stormy period and the following information, for both conditions with and without the marine structures, should be presented for these selected storms: peak wave height, peak current coincided with peak flood and peak ebb respectively, peak suspended sediment concentration, peak sediment transport, net sediment transport flux averaged over the storm duration, and net bed elevation changes at the end of modelled storm duration. Wherever possible, changes due to the marine structures should be quantified.	Most of the requested data are presented for the October 2012 storm in Appendix H (pdf p. 351-365). This response is satisfactory to NRCan.
Time Series Simulations of the 4-month calmer period Sections 5.3.3.2 and 6.1.4.2.	The Proponent only presented maps of the bed elevation change in assessing the impact for the modelled less stormy period. Significant more results should be presented so that the marine structure impact on tidal current, sediment resuspension, sediment transport and seabed morphology for the quiescent late spring and summer season can be fully assessed. 1. For conditions without the marine structures: (1) A map of the net transport flux averaged over the calmer period is needed. (2) A table listing the statistics of erosion volume, deposition volume, net volume change, the area with erosion > 5 cm, the area with deposition > 5 cm, and net elevation change should be presented. (3) A table listing the area for various erosion and deposition intervals should be included.	1. Table 5-3 was added (p. 94) to list the volume changes for the 4 month calm period; Fig. 5-34 was added to show the histograms of erosion and deposition area and volume by intervals. 2. Table 6-4 (p. 130) was added to compare the volume changes for the existing and proposed conditions; Fig. 6-20 (p. 131) was added to provide distribution of area and volume changes organized by bed change intervals of 0.05 m. 3. Table H-11 (pdf p. 368) and Figures H-91 to H-95 were added (pdf p. 372) to show time series of TSS and TSS change statistics. The responses are satisfactory to NRCan.

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	2. Similar results as in 1 should be presented for conditions with the marine structures and the structure impact should be assessed. 3. TSS (total suspended solids): (1) Time series of TSS (depth averaged or at selected heights above bottom) at representative locations on Flora Bank for conditions with and without the marine structures. Zoom-in time series plots over shorter time periods may be needed to better show the TSS increases with the MS. (2) Use the time series data at these locations to calculate (a) time% that TSS with the structures was respectively 5 mg/l and 25 mg/l above that of the existing conditions and (b) the histograms (or range and mean) of the duration of these TSS events exceeding the baseline conditions. (3) Statistics of areas over Flora Bank for which TSS with the marine structures was respectively at least once 5 mg/l and 25 mg/l above that without the marine structures.	
	4. Impact of the marine structures on tidal currents, sediment transport and seabed erosion and deposition under tide-dominant conditions. The report did not present results to specifically demonstrate how the marine structures will change the currents, sediment transport and seabed erosion and deposition for tide-dominant conditions. Patterns of tidal current, sediment transport flux, and net sediment transport flux under tide-dominant conditions were discussed in Freshet Simulations. However, the background information on tidal elevation and current speed for the modelled period was not presented. Also the impact of the marine structures on the spatial distribution of currents, sediment transport flux and TSS was not presented in Freshet Simulations. Thus the following results under tide-dominant conditions should be added and the impact should be assessed: (1) Spatial maps of peak ebb and peak flood current, spatial maps of maximum TSS associated with peak flood and peak ebb, spatial maps of maximum transport associated with peak flood and peak ebb, a spatial map of the net transport flux for a tidal cycle under spring tide without and with marine structures. (2) The report should provide spatial maps of net currents, net sediment transport flux, and net bed elevation change averaged over one month (or 28 days) under tide-dominant	4. The following were included in Appendix H (pdf p. 373 – 388): (1) Maps of peak ebb and peak flood currents, maximum TSS associated with peak flood and peak ebb, and maximum transport associated with peak flood and peak ebb. (2) and (3) Maps of net current and net transport, and data on volumetric and area changes (in NRCan's view, Table H-13 should have listed total erosion and deposition areas and corrected values of the average of erosional elevation changes and depositional elevation changes). However, these responses are satisfactory to NRCan.

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	conditions for conditions without and with marine structures (3) A table similar to Table 6-2 to list volumetric and area changes over Flora Bank for the modelled one month under tide-dominant conditions.	
8 months and 1 year time series simulations Sections 5.3.3.3, 5.3.3.4 and 6.1.4.4	1. In discussing bed elevation changes predicted by the end of the 8-month stormy simulation (Fig. 5-25), the Proponent simply states (on p. 81): In general, erosional areas and depositional areas are similar to results from other simulations, but changes are greater in magnitude. The report should give quantitative estimates of the maximum erosion and deposition which reach ~0.8 m. These much greater erosion and deposition changes for the modelled 8 month period indicate that sediments on Flora Bank are quite dynamic.	The section "8-month Time Series of Stormy Period with 3-hour Wave-Flow Coupling" was replaced with section 5.3.4.3 1 year Time Series with 1-hour Wave-Flow Coupling. The sentence "Maximum bed elevation changes of up to 55-60 cm are predicted near Kitson Island which is a relatively energetic location with stronger waves and currents" was added on p. 93. This response is satisfactory to NRCan
	2. Issues with 3 hour wave-flow coupling: The report suggested that the 3 hour wave-current coupling likely caused artifacts of velocity spikes that then caused exaggerated bed elevation changes. Despite the exaggerated bed elevation changes, the report still used the 1-year time series modelling results based on 3 hour wave-flow coupling to assess the long-term impact on seabed changes by the marine structures. From Appendix I, we assume that this was due to the repeat crashes of model runs using 1 hour wave-flow coupling. NRCan's understanding is that at present a complete 1-year simulation was only available for time series runs using 3 hour coupling and that the predicted seabed changes from 3 hour coupling are conservative (greater than predictions from 1 hour coupling). Appendix I indicates that simulations of 1 year time series runs using 1 hour coupling are currently on going. NRCan would encourage that the Proponent complete their long-term time series runs using 1 hour wave-flow coupling. The time series run for the second year should also be completed to increase our confidence in the results of the first 1-year time series simulation and help assess that the seabed changes from these time series runs are accumulative net changes. The results from these time series runs using 1 hour coupling should be provided in an addendum report.	Results for the 1 year run with 1-hour wave-flow coupling were included in the Proponent's 3D Modelling Update Report (November, 2015). NRCan is satisfied that the time series modelling for a second year is underway. However, the results are not anticipated at this time for this stage of the assessment. As recommended previously by NRCan, the time series run for the second year should also be completed with one hour wave-flow coupling to increase our confidence in the results. This work could be completed in the longer term to inform the detailed design stage. Based on NRCan's recommendation (p. 3 of June 2015 NRCan review of PNW updated modelling workplan), the PNW Workplan for Updated Modelling (p. 12-13) has stated that the results of the storm event analyses and the one-year time-series analyses will be analytically and/or mathematically integrated as necessary to assess the potential long-term morphological changes due to the marine structures. The final report included a one year time series modelling with 1 hour wave-flow coupling from September 2012 to September 2013 and another one year time series modelling with 3 hour wave-flow coupling from May 2013 to May 2014. Results

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		for both simulations show slight decrease of erosion and deposition volumes on Flora Bank for the post construction conditions. Modelling results for most modelled extreme storms also show reduced local erosion and deposition for post-construction conditions. It is NRCan's view that these results from the 1-year time series runs and the modelled extreme storm cases suggest that the assessment of potential long-term morphological change by integrating the results of the storm case modelling and the one-year time-series modelling is no longer required.
	3. Missing information for 1 year time series simulation: The report only presented tables that show volumetric and elevation changes for the 1 year time series simulation. NRCan requests that the following information from the 1 year run for both existing and post-construction conditions should be included in the revised report, and wherever possible the impact of the marine structures should be assessed. (1) a map of the net transport flux (2) a map of spatial distribution of bed elevation changes (3) a table listing the area for various erosion and deposition intervals	(1) NRCan understands that the net transport map cannot be completed due to the fact that model outputs were saved at 12 hour intervals. (2) Maps of spatial distribution of bed elevation changes were added and compared in Fig. 5-33 (p. 93) and Fig. 6-21 (p. 133). (3) Table 6-5 (p. 134) was added to list volumetric changes and Fig. 6-22 was added (p. 135) to show the area and volume changes for various erosion and deposition intervals. More information of area and volume changes was also listed in Table H-15 (pdf p. 390). These responses are satisfactory to NRCan. NRCan notes it may have been more informative and accurate for Table 6-5 to list total erosion and deposition areas (to be consistent with the information presented in Fig. 6-22) and the averages of the erosional and depositional elevation changes in the Table be corrected as per NRCan comments related to Table 6-1 on p. 3 of this submission related to the Simulations of the 50 year storm.
6.2 High-Resolution Modelling of the SW Tower and SW Anchor Block	1. Figure 6-22 shows time histories of TSS without and with the marine structures at a location east of the SW Tower during the 28-day freshet simulation. The report states that the time histories shows that the elevated levels of TSS are episodic and occur around eelgrass areas only over a short period of time and only during peak flood currents. The	Fig. 6-34 (p. 156) was added to show areas for which the increase of instantaneous TSS due to the marine structures is respectively > 5 mg/l and 25 mg/l. The revised report indicates that only at the SW Tower the increases of 5 mg/L are predicted over the observed

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	results do show that with the marine structures in place, vortex shedding downstream produces more common short-term increases up to approximately 5 mg/L. Fig. 6-22 and also the animation of slide 32 in PNW LNG September 18 meeting presentation show that the increases of TSS by the marine structures are often > 5 mg/l. NRCan requests the following additional information and data: (1) The report should provide a spatial map that shows areas for which the increase of instantaneous TSS due to the marine structures is > 5 mg/l. (2) The report should provide estimates of (i) the area over which the increase of the instantaneous TSS was > 5 mg/l and the range and average of the duration of these events; and (ii) the area over which the increase of the instantaneous TSS was > 25 mg/l and the range and average of the duration of these events.	eelgrass areas in at least one instance during the simulation. These maps suggest that the episodic increases of TSS caused by the proposed structures are deemed insignificant as moderate increases of TSS rarely extend to the eelgrass areas. The Proponent provided estimates of the area over which the increase of the instantaneous TSS was respectively > 5 mg/l and >25 mg/l in Item 34 of the detailed responses shared with NRCan in November, 2015. The Proponent further estimated that for the ebb and flood current durations (approximately 6 hours), the pulses of TSS above 5 mg/L during the ebb and flood cycles usually last for roughly 4 hours and that the pulses of TSS above 25 mg/L at the SW Tower usually last for roughly 1 hour and dissipate fairly quickly. This additional information on TSS is satisfactory to NRCan. However, in NRCan's view, adding the estimated durations of the TSS pulses in the Report would provide useful information (in Section 6.2.3.2).
	2. Fig. 6-23 (now 6-36) shows that the maximum increase of currents by the marine structures in the 50-year storm can reach 30-50 cm/s. This was not reflected in Fig. 6-24 (now 6-37).	The response of the Proponent (Table 1 – item 55, provided to NRCan in November, 2015) explains what are presented in Figures 6-36 and 6-37 but does not address the comment. The comment points out that Fig. 6-36 shows that the proposed structures cause currents around the structures to be 30-50 cm/s higher than currents for the existing conditions as shown over areas far away from the structures, yet Fig. 6-37 shows the maximum velocity difference to be ~20 cm/s. In responding to NRCan comment, the Proponent replied that "larger increases in currents are present in the results, however the contouring in Figure 6-37 is not showing all of them. The contouring does not reach the highest level of change because the intent was to focus on changes near eelgrass beds" (Table 2 – item G1 of detailed responses provided to NRCan in November, 2015). NRCan was satisfied with this explanation, however it was not included in the final report.

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	3.Erosion and deposition patterns caused by the marine structures over a one-year period in Fig. 6-20 shows that the maximum erosion on the edge of Flora Bank (the -3.8 m contour) is ~12 cm. Fig. 6-26 indicates that the maximum increase of seabed erosion by the marine structures during the 50-year storm was ~24 cm. If the results of Fig. 6-20 are extrapolated to 5 years, the minimum estimated scour depth due to typical tidal and wave conditions will be ~60 cm. If the 50-year storm also occurs in that 5 years, the maximum erosion would be ~84 cm. Once the scour develops, its interaction with currents and waves and the likelihood of further expansion of the scour in the long term should be considered. Discussions in section 6.2.1 seem to suggest that equilibrium scour depth and extent will be reached and the equilibrium scour extent typically is a few diameters of the structure. NRCan requests that the report should specifically indicate that equilibrium scour will be reached. If so, information of how long does it take to achieve the equilibrium scour, the estimated extent and depth of the equilibrium scour should be provided.	The revised text on p. 168-169 indicates that all research fundamentally shows that equilibrium exists, and will be reached regardless of the coastal conditions or structure shapes. Several references were also given. The revised report also states that it is anticipated that equilibrium depths around the edges of the riprap scour protection are likely to be reached in time periods ranging from several months to a few years (p. 170). The response is satisfactory to NRCan.
7.5 Total Suspended Solids Concentrations	On p. 141, the report states: In direct connection to the transient current velocities discussed above total suspended solids concentrations are increased on the lee side of the structures when erosion is occurring (limited to a few structure diameters away), and quickly subsides as peak currents subside. Downstream outside of this area, no measurable difference in average suspended sediment concentration (TSS) is expected. This statement needs to be substantiated by providing additional time series data of TSS and statistics of frequency and duration of TSS events for relevant modelling cases.	The responses provided by the Proponent detailed in Table 1 Item 36 provided to NRCan in November, 2015 are satisfactory to NRCan.
5 Key Questions Item 4 (p. xiv; also Item 4 of 8. Conclusions)	(1) The report seems to suggest that the purpose of the time series model runs was to supplement results of weekly base simulations using MORFAC = 13.5. NRCan does not agree with this statement. DFO and NRCan reviews have consistently stated that the weekly case method did not fully simulate the real physical processes and	The Proponent concurs with NRCan's observations regarding the value of a time series modelling approach. However, no changes were made. NRCan notes the difference in opinion and acknowledges that further effort to resolve this is not critical.

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	the maximum magnitude of the tides and storms, and that the time series approach will most accurately capture the natural current, wave, and sediment transport processes and hence produces lest biased predictions of the long-term morphological change.	
5 Key Questions Item 5 (p. xiv; also Item 5 of 8. Conclusions)	The report states "Significant efforts have been undertaken to quantitatively review and present model results, particularly sediment flux and net sediment transport across a wide range of modelled conditions". This statement is not supported by the information presented in the September 16 Update Report. Sediment transport flux and net sediment transport flux data were not presented in several key modelled cases (impact of the marine structures on sediment transport flux peaks and net sediment transport flux for the 50-year storm; the net transport flux averaged over the 3 month stormy period; the net transport flux averaged over the 4 month calmer period; the net transport flux for the 1-year time-series simulation).	The revised report has made significant improvement and the changes include: (1) For the 50-year storm: Figure 5-5 was added on p. 60 to show total transport flux for the existing conditions. Maps of sediment transport flux for the proposed conditions were added as Fig. 6-4 and 6-5 on pages 104-105. Fig. 6-6 was added (p. 106) to demonstrate the impact on net sediment transport flux. (2) For the 3 month stormy period, the net transport flux averaged over the 3 month period cannot be provided. However, net transport flux plots for a storm in October 2012 are presented in Appendix H (p. H-67). (3) For the 4 month calmer period, the net transport flux cannot be provided. However, net transport flux is presented for the tides only case (Figure H–101, p. H-85 to 86) and freshet simulations (Fig. 6-12 p. 118). These responses are satisfactory to NRCan. In NRCan's view, adequate additional information on sediment transport flux and net sediment transport flux have now been presented in the revised report to support the cited statement.
<u>Changes in TSS (p. xix)</u>	The report presents the following summary points: "Changes in total suspended solids (TSS) relative to background levels are similarly focused around the southwest anchor block and southwest tower… TSS variances are transient, mobile and of limited magnitude". These points need to be substantiated by providing additional time series data of TSS and statistics of frequency and duration of TSS events for relevant modelling cases. See comments about TSS for 5.3.3.1 3-month Time Series of Stormy Period and for 5.3.3.2 4-month Time Series of Calmer Period.	The following data were added: - Time series plots of TSS at selected points and statistics of frequency and duration of TSS events for the 3-month stormy period were added (p. H-49 to H-55) - Time series plots of TSS at selected points and statistics of frequency and duration of TSS events for the 4 month calmer period were added (p. H-71 to H-76) These additional data and the response are satisfactory to NRCan.
<u>Conclusion 4 and net transport direction</u>	The report states that relatively symmetrical shape of the ripples in photo 1 indicates that this is an area of weak net sediment transport, i.e. levels of sediment transport are similar	Text on p. 19 was revised. The response is satisfactory to NRCan.

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inferred from ripple shapes (p. 19)	in both directions. The ripples are asymmetric in photo 2 and thus indicate net transport to the west. Ripples reverse their profile asymmetry in response to the direction of flood and ebb. Their asymmetry thus cannot be used to deduce long-term net transport direction. As the photos were taken at low tide after the ebb, the asymmetry of ripples in photo 2 only tells us that they were formed by the last westward ebb currents. Ripples in Photo 1 are not symmetrical but slightly asymmetric to the west with rounded crests. These characteristics of the ripples in photo 1 may suggest that the ebb currents at that location were not strong enough to completely reverse the easterly asymmetric ripples formed in the previous flood flow. The report should not draw conclusions about net transport direction based on ripple asymmetry at the end of an ebb cycle.	
Simulations of the 50 year storm Sections 5.1 (p. 54)	Fig. 5-3 (p. 57) shows the depth averaged current patterns during flood at the peak of the 50-year storm. It would be helpful that the report will compare this with magnitudes of peak tidal currents to quantify how storms significantly enhance the current intensity in the project area.	The response "Figure 6-2 and 6-3 compare ebb and flood currents with and without structures. These figures demonstrate instances of peak currents at these two tidal stages" did not adequately respond to NRCan's comment. In NRCan's view, it would be informative for the magnitude of peak currents during the 50-year storm in Fig. 5-3 be compared with the peak tidal currents under non-storm conditions in Figure 5-13 to provide quantitative estimates of how storms significantly enhance the current intensity in the project area.
	Fig. 5-5 (p. 60) shows the net total transport flux following the 50-year storm. The color scales in Figure 5-5 are skewed by the stronger transport in the deeper waters west of Flora Bank. A different color scale could be used for the close up in the bottom panel to better display the net transport flux patterns over Flora Bank. The caption of Fig. 5-5 states that different color scale was used for the bottom panel, however, the color scale was not changed.	The caption was revised, however, no changes were made in Fig. 5-6.
	In section 5.4: Summary of Existing Conditions Modelling Results (p. 87), the report states "the patterns of net total transport during the 50-year storm from 270 degrees True North are spatially homogeneous, indicating that material moves over Flora Bank but without	The response of the Proponent does not adequately respond to NRCan's comment (Item 48 of Table 1), however, further effort to resolve the difference is not critical as the quantification of erosion

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	strong spatial gradients in transport, little erosion or deposition occurs". Fig. 5-7 shows that maximum erosion and deposition reach about 0.1 m and thus the bed elevation changes cannot be defined as "little erosion or deposition occurs".	and deposition is subjective.
Simulations of the 50 year storm Section 6.1.1 (p. 88)	Impact of the marine structures on the wave height and depth-averaged currents is presented in Figs. 6-1 and 6-2 respectively (p. 89 and p. 91) (1) The report should provide quantitative estimates of the changes of wave height and currents by the marine structures. (2) Correction: "The depth-averaged current velocity patterns" at bottom of p. 88 should be "The significant wave height patterns".	Correction was made for (2), however, comment (1) was not adequately addressed. The Proponent responded that "Quantitative estimates can be taken from difference plots showing significant wave height values for existing and proposed conditions" (Tracking table 1, item 49). This not a critical issue, however, presenting this information in the report would have been more informative.
Freshet Simulations	Figure 5-16 shows the net transport flux computed over the duration of the 28-day freshet simulation. A close up map of net transport flux just over Flora Bank with a narrower color scale will be useful to show the details of net transport averaged over the modelled freshet period.	NRCan appreciates that a close-up map was added as new Fig. 5-16 on p. 74. The response is satisfactory to NRCan.
Time Series Simulations of the 4-month calmer period Sections 5.3.3.2 and 6.1.4.2	On p. 79, the report states "Water depths and velocities during this period are also shown for a location just north of Kitson Island in Figure 5-23" (should be 5-21). This simulation was performed from May 1, 2013 to August 31, 2013. However, water depth and current data for this period were not available as data in Fig. 5-21 are only for the period September 1, 2012 to April 30, 2013. Water depth and current data are important background information and should be presented in the report.	Time series plots of Fig. 5-24 and Fig. 5-25 were updated to show a full 12-month period. The response is satisfactory to NRCan.
	In discussing bed elevation changes predicted for the 4 month calmer period (top of p. 80), the report states "The bed changes shown here are less than approximately 5 cm in all areas of Flora Bank for the entire 4-month period, which are not likely to be measurable". Fig. 5-24 actually shows that net elevation changes can reach ~10 cm. The above statement that bed changes are less than approximately 5 cm in all areas of Flora Bank is not supported by this Figure.	The sentence was revised on p. 90. The response is satisfactory to NRCan.
8 months and 1 year time series simulations	5.3.4 Summary of Time Series Simulations Third paragraph on p. 87. The report states "Even over entire winter periods, erosion and	The statement was revised on p. 97. The response is satisfactory to NRCan.

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Sections 5.3.3.3, 5.3.3.4 and 6.1.4.4	deposition on Flora Bank is expected to be quite small (less than 20 cm), which is further evidence of the reported long-term stability of Flora Bank". Seabed changes from the 8-month stormy period simulation with 3-hour wave-flow coupling in Fig. 5-25 show that maximum seabed changes can reach 80 cm, although that value may be contaminated by the unrealistic spikes of currents and bed elevation changes caused by 3 hour wave-flow coupling. These contrast values of estimated maximum bed elevation changes emphasize the need of results of continuous 1-year time series runs based on 1 hour wave-flow coupling.	
7.3 Erosion and/or Deposition Affecting Eelgrass	In paragraph 3 on p. 140, the report states "It was found that net volume changes (the net difference between total erosion and total deposition within Flora Bank) are consistently smaller with the proposed structures included, as are the volumes of erosion and volumes of deposition." This statement is not completely correct. Tables H-F-4 and H-F-5 show that the net loss of sediments post the structures slightly increases for these extreme storms when waves approach from the western quadrants. The report should comment what is the implication of these increases to the long-term stability of Flora Bank.	The revised tables (H4 and H7) still show slight increases of net loss of sediments post the structures. Item 56 of the detailed response Table 1 states "Wording revised". NRCan found that the report still states "It was found that volume changes (total erosion and total deposition within Flora Bank) are consistently smaller with the proposed structures included". This not a critical issue, however, revising this statement would have made the report more informative and accurate.