Proposed Roberts Bank Terminal 2 Project

Coastal Geomorphology Technical Advisory Group

Summary Report

Prepared for

Port Metro Vancouver

Prepared on behalf of TAG Participants by

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Date

November 27, 2013

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Acronyms

CCIP	Container Capacity Improvement Program
Compass	Compass Resource Management
DoD	depth of disturbance
DTRRIP	Deltaport Terminal Road and Rail Improvement Project
EA	Environmental Assessment
IPCC	Intergovernmental Panel on Climate Change
LIDAR	Light Detection and Ranging
NHC	Northwest Hydraulic Consultants Ltd.
PMV	Port Metro Vancouver
PPRFFA&Ss	past, present, and reasonably foreseeable future actions and stresses
RBT2	Roberts Bank Terminal 2
SRKW	Southern Resident Killer Whales
TAG	Technical Advisory Group
TEU	Twenty-Foot Equivalent Units
YVR	Vancouver International Airport

1 Introduction

1.1 Purpose and Background

The Roberts Bank Terminal 2 (RBT2) project is a proposed new three-berth container terminal in Delta, BC that would expand existing port facilities by 2.4 million twenty-foot equivalent units (TEUs) of container capacity. The project is part of Port Metro Vancouver's (PMV) Container Capacity Improvement Program (CCIP), a long-term strategy to meet anticipated growth in demand for container capacity. The proposed RBT2 project entails the construction of a new three-berth marine terminal and associated road and rail infrastructure alongside the existing Westshore and Deltaport terminals at Roberts Bank. PMV has a mandate to support the growth of Canadian trade with other countries, and current demand forecasts anticipate container traffic to triple by 2030. Subject to regulatory approvals, the RBT2 project could be operational by the mid-2020s. Further information on the proposed RBT2 project can be found on the project's website, www.robertsbankterminal.com.

Figure 1. Artist's rendering of the proposed RBT2.

Image courtesy of PMV.

The proposed RBT2 project is subject to environmental assessment (EA) under federal and BC provincial laws. EA is a process whereby the potential effects of proposed projects on the environment are examined through a public process. While the scope and nature of the EA for RBT2 has not yet been determined by regulators, PMV expects the EA to be some form of joint review process. The proposed RBT2 project could potentially cause a variety of environmental effects, some of which are reasonably well understood, and some of which are less well understood due to their complexity and based on the current state of scientific knowledge.

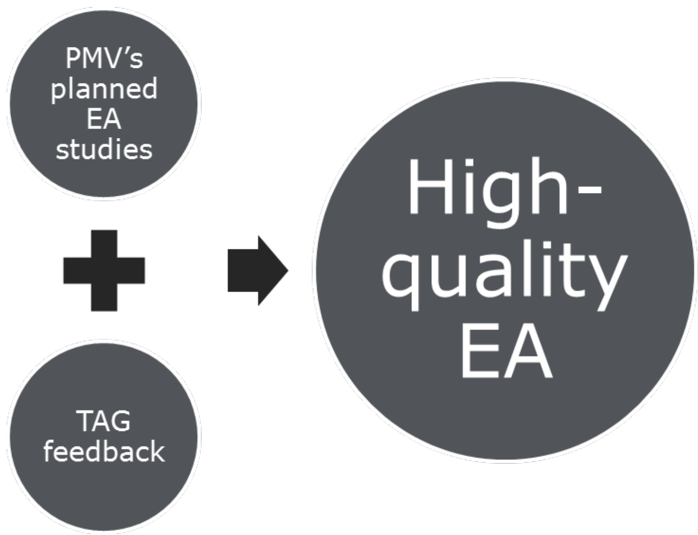
PMV has contracted Hemmera, a consulting firm specializing in EA, to conduct the EA studies for the proposed RBT2 project. Some of these studies, such as baseline studies that characterize the environment pre-construction, are currently underway. As part of its pre-EA work, PMV initiated a Technical Advisory Group (TAG) process to gather input from outside experts on four separate topics.

This report is written by Compass on behalf of the Coastal Geomorphology TAG and summarizes the proceedings and recommendations of that TAG.

1.2 Overview of the Technical Advisory Group Process

The purpose of the TAG process was to pro-actively gather input from scientific and technical experts prior to the formal initiation of the EA for RBT2 so as to enhance the relevance, quality, and rigour of EA studies for the project (Figure 2). Experts were invited from regulatory agencies, academia, First Nations and key non-government organizations based on their ability to contribute to technical discussions pertaining to the identified EA studies.

Figure 2. Role of TAG process in ensuring high-quality EA of the proposed RBT2 project.



The TAG process involved four separate TAGs:

1. Biofilm and Shorebirds;
2. Southern Resident Killer Whales (SRKW);
3. Coastal Geomorphology; and
4. Productive Capacity of Roberts Bank habitat.

The four TAGs each addressed topics that were considered by PMV and its consultants to require additional preliminary scoping in order to satisfy EA requirements.

Biofilm, shorebirds, and SRKW are likely to be recognized in the forthcoming EA as topics of particular importance to stakeholders and thus of the forthcoming EA process. These topics are discussed in companion reports on each of the individual TAGs.

Coastal geomorphology—the physical features and processes in the vicinity of the proposed project area at Roberts Bank—was chosen because any project-related geomorphic and physical oceanographic changes are expected to be the primary driver for marine biological and ecological changes. RBT2 infrastructure may cause changes to tidal currents and water movement associated with wind-generated waves, which could affect sediment settling and re-suspension, and which in turn could cause changes to local marine habitats, such as biofilm and eelgrass beds.

Similarly, the ability of habitat to support species of particular interest to stakeholders is critical to the health of those species. PMV sees merit in entering into technical dialogue on how the productive capacity of habitat is most appropriately defined at Roberts Bank. This topic is explored in a companion report on the Productive Capacity TAG.

Despite the different topic matter of each of the four TAGs, all four had a similar set of objectives:

- build a common understanding of the potential effects of RBT2 based on the best available information;
- provide input on appropriate methods for assessing potential adverse effects and their significance;
- identify priority information needs and related studies; and
- identify opportunities for collaboration.

Each TAG met face to face three or four times between November 2012 and May 2013. Meetings were held in Vancouver over full day periods. Each individual TAG process was designed and led by Compass, who acted as an external facilitator. In each meeting Compass and PMV consultants led discussions with TAG members. In addition, for all TAGs except Coastal Geomorphology, focus groups were created to investigate particular topics in greater depth with an additional set of experts relevant to each field.

1.3 Participants and Roles in the TAG Process

There were five main parties identified as potential participants in the TAG process: technical experts from government agencies, academia, non-governmental organizations, PMV and PMV consultants, and First Nations. First Nations did not participate in the TAG process, however PMV has committed to share TAG information and obtain input through a separate process.

TAG members were tasked with:

- providing input on current and planned EA studies;
- providing input on potential effects of the project on the environment;
- providing input on impact assessment methods;
- helping prioritize and scope key issues; and
- providing input from their organization.

PMV consultants – which for geomorphology included Hemmera and Northwest Hydraulic Consultants (NHC) – were tasked with:

- preparing material for TAG meetings, such as pre-reading packages, presentation slides, and discussion materials;
- managing schedules, scope, and budget for the TAG process;
- explaining current study plans to the TAGs;
- ensuring integration of people and discussions across TAGs where relevant;
- organizing meeting logistics; and
- where relevant, having representatives participate as TAG members in TAG meeting discussions.

PMV was tasked with:

- providing resources and meeting logistics;
- providing communications with TAG participants and the public;
- providing information about the proposed RBT2 project; and
- observing TAG meetings and considering input from each TAG.

The TAG process was *advisory* in nature, and so PMV sought to gather advice through the process in terms of how best it and its consultants conduct specific EA studies for RBT2.

Compass was tasked with:

- designing the TAG process and advising on implementation;
- facilitating TAG meetings;
- advising on how discussions and outputs of individual TAGs might be used by other TAGs;
- summarizing input, including areas of agreement and disagreement, in meeting notes; and
- producing a record of the process in this summary report.

1.4 About This Report

This report reviews the discussions and outputs of the Coastal Geomorphology TAG. This report does not attempt to follow the chronological order in which items were discussed during the meetings, but rather provides a thematically-organized synthesis of discussions that occurred over the course of the TAG meetings. The next section provides more background information on the Coastal Geomorphology TAG in terms of what meetings were held, who was involved, and what specific topics were explored. Section 3 examines methods of impact assessment related to coastal geomorphology and forms the bulk of the report. Section 4 examines several related issues that were less prominent in the TAG process. The reader is encouraged to review the reports for the other three TAGs to have a complete understanding of the RBT2 TAG process.

2 Background on the Coastal Geomorphology TAG

Coastal geomorphology in the context of RBT2 entails the study of the physical features of the shoreline, the Roberts Bank tidal flats, the Fraser River delta, and the processes that shape these features. The coastal geomorphology of Roberts Bank has a direct influence on the marine ecosystem, including species that are expected to be of particular importance to stakeholders. Therefore, PMV has chosen to better understand coastal geomorphological processes to help inform other studies in the environmental assessment for RBT2.

2.1 TAG Meeting Summary

The Coastal Geomorphology TAG met three times between November 2012 and March 2013 to discuss a variety of topics (Table 1). The Coastal Geomorphology TAG discussed how the proposed RBT2 project might affect the coastal geomorphology of Roberts Bank, how these effects might best be assessed, and what mitigation measures could potentially reduce the effects of RBT2 on the environment.

Table 1: Dates and key topics of Coastal Geomorphology TAG meetings.

Meeting Number	Meeting Date	Key Topics Covered
1	November 15, 2012	• overview of the TAG process • overview of the RBT2 project • how coastal geomorphology influences some marine species • overview of Roberts Bank geomorphology • potential ways in which RBT2 may affect the environment (i.e., key effect pathways) • current field studies and planned methods of EA • key questions for the TAG from PMV consultants • work plan for the TAG
2	January 31, 2013	• NHC's 'working conjectures' about the coastal geomorphology at Roberts Bank • how climate change is integrated into impact assessment

Meeting Number	Meeting Date	Key Topics Covered
		• factors affecting the formation of new tidal channels in mudflats
3	March 8, 2013	• methods of interpretive geomorphology • modeling methods for assessing the potential effects of RBT2 on coastal geomorphology • factors affecting the formation of tidal channels, and possible mitigation measures • cumulative effects baselines, including past, present, and reasonably foreseeable projects to be considered • wrap-up of TAG process and confirmation of key messages

2.2 TAG Participants

TAG participants included a variety of TAG members, observers, support staff, and facilitators, as summarized in Table 2.

Table 2: Participants in the Coastal Geomorphology TAG.

Name	Affiliation	Role	Participation
Juergen Baumann	Baumann Environmental Services Ltd	TAG member	Meetings 1,2, and 3
Dr. Doug Bright	Hemmera	TAG member	Meetings 1,2, and 3
Dr. Michael Church	University of British Columbia	TAG member	Meetings 2 and 3
Dr. John Clague	Simon Fraser University	TAG member	Meetings 1 and 2
Dr. Philip Hill	Pacific Geoscience Centre, Natural Resources Canada	TAG member	Meetings 1,2, and 3
Dr. Diane Masson	Department of Fisheries and Oceans	TAG member	Meetings 2 and 3
Dr. William McDougal	University of Florida	TAG member	Meetings 1 and 3
Dr. David McLean	Northwest Hydraulic Consultants	TAG member	Meetings 1,2, and 3
Derek Ray	Northwest Hydraulic Consultants	TAG member	Meetings 1,2, and 3
Dr. Terri Sutherland	Department of Fisheries and Oceans	TAG member	Meeting 2
Dr. José (Pepe) Vasquez	Northwest Hydraulic Consultants	TAG member	Meeting 3
Dr. Jeremy Venditti	Simon Fraser University	TAG member	Meetings 1,2, and 3
Edwin Wang	Northwest Hydraulic Consultants	TAG member	Meeting 3
Dr. André Zimmerman	Northwest Hydraulic Consultants	TAG member	Meetings 1 and 2
Jody Addah	PMV	Observer	Meetings 2 and 3
Rhona Hunter	PMV	Observer	Meeting 1
John Parker-Jervis	PMV	Observer	Meeting 1
Andrew Robinson	Canadian Wildlife Service	Observer	Meeting 3
Eriko Arai	Hemmera	Support	Meetings 1,2, and 3
Ben Wheeler	Hemmera	Support	Meetings 1 and 2
Marina Winterbottom	Hemmera	Support	Meeting 1
Mike Harstone	Compass	Facilitator	Meetings 1, 2, and 3
Chris Joseph	Compass	Facilitator	Meetings 1, 2, and 3

2.3 Selection of TAG Topics and Priorities

At the beginning of the TAG process, Hemmera and NHC identified a number of questions on which they asked the TAG to provide advice and input:

1. What are the most important pathways of potential effects on coastal geomorphic processes at the project site? What are the key uncertainties associated with these pathways?
2. Are the proposed studies appropriate and sufficient with respect to understanding the coastal geomorphology processes at the project site?
   a. What is an appropriate modeling methodology?
   b. In what ways can any weaknesses be addressed?
   c. How should the wave regime be characterized and measured?
   d. How should the potential effects of climate change on coastal geomorphic processes be incorporated into the modeling?
3. Are current data sufficient to support robust analyses on coastal geomorphic processes at the project site?
   a. What are the limitations of using historic data on morphological changes on Roberts Bank to forecast future project-related changes? Are there alternatives to using this historic data for the purposes of developing forecasts?
   b. What is the best approach to quantifying and describing changes to Roberts Bank tidal flats from projected climate change?
   c. Are there additional data available that should be considered?

These questions served to guide the development of initial agendas for the three TAG meetings.

In early discussions in the meetings, the TAG reviewed potential pathways of effects between the proposed project and specific marine species. In other words, the TAG discussed how the project's construction and operations might translate through cause-effect relationships into effects on the environment. The TAG identified numerous pathways, such as how the project may alter tidal currents which in turn might cause erosion or deposition of sediment, and how climate change may alter Fraser River water flows which in turn might compound with the effects of RBT2 on the tidal flats. TAG discussions highlighted the difficulty of disentangling the inter-related effects of development on tidal flat geomorphology. The TAG noted that coastal geomorphology science is associated with high uncertainty, and that viewing individual effects in isolation is problematic.

In the end, the TAG focused on the following topics during the process:

- underlying understandings and assumptions about the coastal geomorphology at Roberts Bank (what came to be known as NHC's 'working conjectures'); [1]
- how climate change is integrated into an impact assessment, including how sea level rise is factored into analyses;
- factors affecting the formation of new tidal channels in mudflats, and the effectiveness of mitigation;
- detailed issues with respect to modeling and interpretive geomorphology methods; and

[1] Note that despite being called 'working conjectures' NHC had come to these sets of understandings and assumptions based upon their considerable knowledge and experience.

- how cumulative effects on Roberts Bank coastal geomorphology, including consideration of environmental effects and the effects of other human projects should be considered in the analysis.

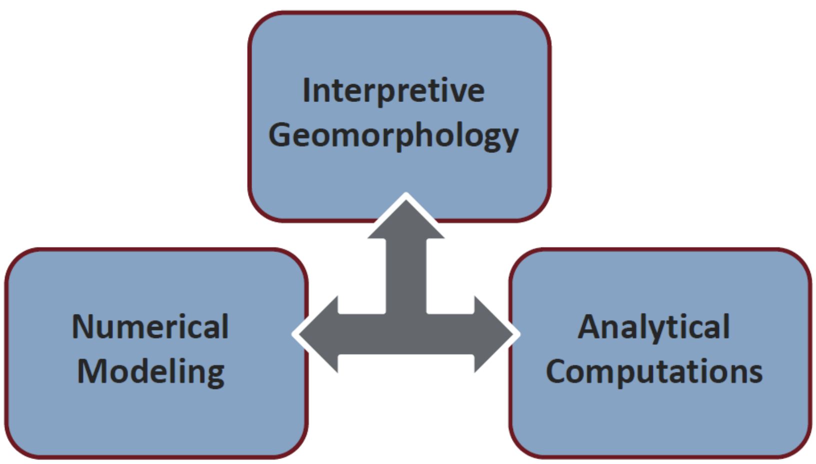
3 Assessing Effects on Coastal Geomorphology

An important part of Coastal Geomorphology TAG discussions was the review of possible methods for predicting the potential effects of RBT2 on coastal geomorphology. This section of the report explores these discussions. The first sub-section reviews the overall approach to impact assessment planned by NHC. The second sub-section examines methods related to assessing tidal channel initiation and propagation. The third sub-section examines TAG discussions pertaining to how to integrate climate change into the assessment.

3.1 Methodological Approach

NHC has proposed to use three inter-related sets of methods in its EA studies for RBT2 including (1) numerical modeling, (2) interpretive geomorphology, and (3) analytical computations (Figure 3). This 'three pronged' approach is expected to provide for a robust effect assessment study as the different methods are complementary and address the weaknesses of any single method used on their own.

Figure 3. NHC's proposed 'three-pronged' approach for EA of the potential effects of the proposed RBT2 project on coastal geomorphology.



Numerical modeling is the use of computer-based programs to solve the equations that describe the primary processes that shape coastal geomorphology. These processes – for instance, waves, tidal currents, sediments, etc. – can be described spatially and temporally and it is possible to relate the various processes using mathematical equations. Once the existing geomorphology conditions are represented in the model, such as tidal current velocity, it is possible to vary one or more parameters to allow for prediction of future conditions. For example, a numerical model could be used to estimate changes to wave heights in the vicinity of the proposed RBT2 project.

NHC is planning on using the TELEMAC model suite (composed of the TELEMAC hydrodynamic module, the TOMOWAC wave module, and the SISYPHE sediment transport module) in an integrated fashion to simulate interactions between water currents, waves, and sediments at Roberts Bank.

Analytical computational methods use empirical or theoretical relationships that describe processes in the natural system. For example, sediment transport, erosion and deposition processes can be described in general terms as a check on the numerical modeling approach. Analytical computational methods rely on the larger body of scientific knowledge regarding mathematical relationships between various system components (for example, between water velocities and the sediment particle sizes that can settle or become re-suspended).

Interpretive geomorphology is the analysis of existing coastal processes and landforms, both locally and around the globe. The patterns evident in coastal zones reflect the cumulative forces and dynamics of water, sediment, wind, and waves. An understanding of existing geomorphic processes and patterns both locally and globally provides the foundation for interpreting the processes underlying the geomorphology at Roberts Bank.

There are at least three reasons for using interpretive geomorphology methods. First, interpretive methods are often used to parameterize models and computations, e.g., data on river flow velocities can be input into models that predict future river flow velocities. Second, interpretative geomorphology helps to validate numerical modeling approaches by critically evaluating the degree of alignment between the current geomorphic state and what would be predicted from modeling. Third, interpretive methods can provide perspective on particular study sites by indicating what has happened, or is happening, elsewhere.

Some of the interpretive methods that NHC plans to use include:

- conducting inspections to observe processes in the field;
- analysing historical air photos for long-term changes and response to past disturbance;
- measuring sediment movement using instruments and monitoring stations in Canoe Passage and across Roberts Bank;
- assessing erosion and deposition on the tidal flats using depth of disturbance rods that show, over time, how much sediment in a location has been removed or collected (Figure 4);
- examining existing and historic tidal channels on Roberts Bank;
- measuring waves using sensors anchored temporarily on the seabed;
- analyzing data on sediment grain size; and
- reviewing and synthesizing experience from previous projects on the Fraser Delta and from similar environments in other regions relating to geomorphic impacts, methods of prediction, and methods of mitigation.

The following sub-sections describe the key issues, findings, and recommendations discussed by the TAG with respect to NHC's planned methods.

Figure 4. Schematic of a depth of disturbance rod (a) during placement, (b) with subsequent deposition of sediment over washer, and (c) following erosion (at which point washer drops down rod) and then subsequent deposition.

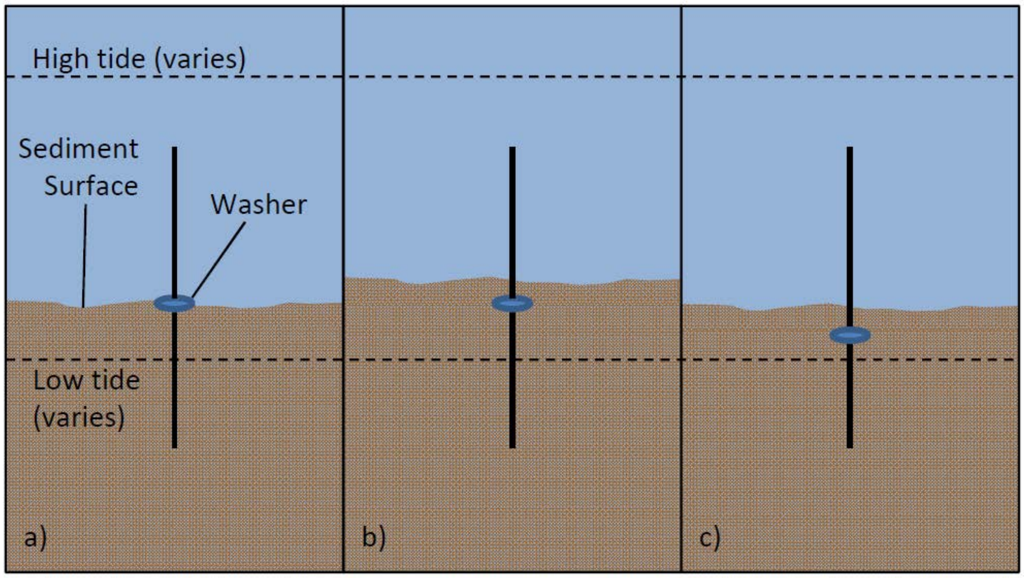


Diagram courtesy of Derek Ray, Northwest Hydraulic Consultants.

3.1.1 Key Issues

The key issues discussed in relation to NHC's proposed methods for predicting project-related effects included the following:

- underlying understandings and assumptions about Roberts Bank geomorphology (i.e., 'working conjectures');
- selection and limitations of models, and how to make the most effective use of available computing power; and
- the use of interpretative geomorphology methods to predict the future wave climate regime and evolution of the tidal flats at Roberts Bank.

3.1.2 Key Findings

In general, the TAG agreed with NHC's proposed three-pronged approach for assessing possible effects of RBT2 on coastal geomorphology. This section explores aspects of these discussions, including NHC's main working conjectures and their approach to numerical modeling and interpretative geomorphology. Section 3.1.3 reviews the TAG's recommendations in response to identified issues.

Working Conjectures

The TAG examined five 'working conjectures', or underlying understandings and assumptions, that NHC is using to form the basis of the EA work at Roberts Bank. These conjectures are based on existing scientific research and NHC's current understanding of the Fraser River delta. In general, the TAG agreed with the substance of the conjectures.

Conjecture #1: The contribution of sand from the main arm of the Fraser River to Roberts Bank is relatively small. Consequently, relatively little additional work is necessary to study sediment contributions from the main arm.

Sandy sediments carried by water flowing through the main arm of the Fraser River tend to remain in the channel and get deposited in the deeper waters of the delta front immediately off the river mouth. The historical pattern of deposition back and forth across the delta has changed as a result of the stability of the main channel imposed by human-made training structures that cause sediment entrainment and dredging. The tidal flats at Roberts Bank are primarily a relict feature that formed during previous stages of delta building and receive no sandy sediments from the main arm. At present, inputs of sandy sediments are limited to those delivered from Canoe Passage, which is a small distributary branch of the Fraser River that carries approximately 5% to 10% of the flow and sand load. Suspended sediments carried in the Fraser River plume are broadcast over Roberts Bank. However, in comparison to the historical sand load deposits, little material is delivered to Roberts Bank on an annual basis.

Conjecture #2: The amount of sediment that is transported to and from the tidal flats is low in comparison to the volume of sand stored in the flats.

The available evidence suggests that there is little change in sediment volumes in the study area.

First, a review of the historical data on the tidal flats (in combination with data gathered from an aerial (LIDAR) survey carried out in 2001 and 2011) indicates that while there has been deposition and erosion of sediment on the tidal flats, these changes are minor. In fact, except for the vicinity of Canoe Pass, where some channel migration is noted, the observed changes are within the accuracy of the survey measurement technique, and so observed 'changes' may not actually be real.

Second, data gathered from NHC's depth of disturbance (DoD) rods that have been placed in various locations across the tidal flats support the notion that there is little net erosion or accumulation of sediment on the tidal flats.

Third, the construction of the original PMV causeway did not trigger obvious drastic change in tidal flat morphology on either side of the causeway. In other words, by placing the original causeway along the tidal flats, the tidal flats on either side did not rapidly grow or diminish appreciably because of any sort of inhibition of sediment transport along the tidal flats.

The TAG discussed two consequences of all of this. One, this evidence lends credence to the notion that the tidal flats are in an approximate state of equilibrium over annual to inter-annual time scales. Two, any erosion caused by the project might become essentially permanent because of the lack of 'nourishment' from new sediment.

The TAG did note, though, that any movement and deposition of finer-grained (silt-clay) fractions (such as silt and clay) may affect species inhabiting Roberts Bank.

Conjecture #3: The majority of the lower Roberts Bank tidal flats consist of non-cohesive sediment, and the methods available for predicting the transport of non-cohesive sediments are well-described and accepted. Consequently, there is no need to consider transport, deposition, or erosion of cohesive sediment.

As the tidal flats are mostly composed of non-cohesive sediments, such as sand and silt, methods to assess how the project may affect sediment transport can be chosen accordingly. NHC plans to conduct sediment transport modeling using equations for non-cohesive sediments, and plans to ignore geomorphic processes related to sediment cohesion. This methodological strategy is conservative given that non-cohesive sediment is more vulnerable to erosion and re-suspension than cohesive sediment (such as clay), and because cohesive sediment settles more rapidly than non-cohesive sediment. In other words, by assuming that sediment on the tidal flats is non-cohesive, the worst-case scenario effects of RBT2 on coastal geomorphology will be predicted.

The TAG discussed how some portions of the upper flats are composed of cohesive mud, and that this mud is important biologically. There is also a shoreward band of elevated mud that wraps around the northern side of the Deltaport causeway. This band of mud appears to be an artefact from the construction activities. This mud supports biofilm, shorebirds, and fish, and it is therefore important for NHC to consider how not just sand and silt fractions may be affected by RBT2 but also the clay fraction. The TAG also discussed how RBT2 might lead to the formation of a new C-shaped mud beach behind the new terminal footprint but it was recognised that this could be assessed using an interpretive, rather than numerical, approach.

Conjecture #4: The primary morphologic changes induced by RBT2 will mainly be local erosion and deposition.

NHC has conducted preliminary modeling of changes that RBT2 may cause to the tidal flats. This preliminary modeling indicated that the proposed RBT2 project may cause some localized erosion of the seabed at the northwest corner of the new RBT2 terminal, and that this erosion may induce other changes on the tidal flats, such as the initiation of a new tidal channel (or the re-activation of a historical channel). While this modeling was only 'preliminary', the TAG agreed with the notion that this modeling work provides a sound basis for understanding the basic nature and scale of effects on tidal flat morphology from RBT2.

Conjecture #5: Mathematical models that examine how the shape of landforms may change over time are not very practical for examining whether or not small-scale tidal channels might form at Roberts Bank. Instead, an interpretive geomorphology approach is more effective for assessing whether such tidal channels might initiate or propagate, and how effective different mitigation measures may be for preventing initiation or curtailing expansion of channels.

NHC's preliminary modeling of changes that RBT2 may cause to the tidal flats is limited in its ability to predict what may eventually transpire at small spatial scales. As NHC pointed out to the TAG, the modeling that has been conducted to date is only preliminary in that it did not take into account the variety of grains sizes of sediment, amongst other issues. Consequently, as the TAG discussed, the results of such modeling cannot be viewed with sufficient confidence to base EA conclusions upon, and while NHC may be able to enhance the sophistication of subsequent modeling efforts, existing models still lack the capacity to consider channel initiation. Therefore, the TAG agreed that a complementary approach was to assess the project's potential to create new tidal channels using interpretative geomorphic methods.

NHC has begun using interpretive geomorphological methods to examine tidal channel initiation and propagation. This work has included examination of the historical depth of the portion of Canoe Passage crossing the tidal flats, and examination of this channel's response during the 2012 spring freshet. The data show that the position and shape of the channel has remained unchanged, despite the fact that the 2012 freshet was a large flood event. The TAG discussed how one implication of this finding is that storm events may be the principal influence on coastal landforms on Roberts Bank. This latter conclusion is supported by water turbidity data that suggest that the majority of sediment movement over the tidal flats occurs during larger wave events at lower tides.

Modeling

The TAG was generally supportive of NHC's proposed approach to modeling which includes the use of the TELEMAC model suite to assess wave – tidal current – sediment interactions. The TAG highlighted that what matters is not the specific model that is used, but whether the underlying physics of the chosen model are sound and appropriate in a given context, and whether the model is properly applied.

NHC's modeling approach is broken down into two parts: a coarse-grid model of the entire Strait of Georgia, and (ii) a fine-grid model providing more detail of Roberts Bank. The purpose of the coarse-grid model is to estimate the waves and currents at the outer boundary of the fine-grid model so that more detailed modeling (using the fine-grid model) is reflective of broader conditions in the Strait of Georgia.

One issue that arose in discussions was how the boundary conditions for the finer-grid, two dimensional (2D) model would be set, and whether the coarser-grid model could adequately capture the complex flow patterns in 2D or whether a 3D model would be required. In particular, the discussion explored the issue of horizontal layering in the water flowing through the Strait of Georgia and the potential for a 2D model to oversimplify the complex flow patterns that exist in the strait. One TAG member, for example, suggested that it is important to consider near-bottom currents when assessing sediment transport, and thus advocated 3D modeling. NHC agreed that they would explore both the 2D and 3D options for the large-area model to examine whether the improvements in terms of more accurate boundary conditions for the finer-scale model was worth the increased computational demands (and consequent limitations on what can be modeled) of the 3D large-area model.

Interpretive Geomorphology

NHC indicated that their interpretive geomorphology methods will involve examining landforms and processes at Roberts Bank, and analysing such things as turbidity levels of water, wave heights, and sediment grain size. The TAG supported these efforts and noted the dual role that these methods could take in terms of gathering data for use on its own but also to support modeling and analytical computations.

The TAG also discussed how best to characterize the wave climate at Roberts Bank (for instance the statistical patterns of wave heights during winter storms) so that waves and their effects on the tidal flats could be investigated while considering the overall regime of waves rather than the simpler approach that looks at the effects of a certain wave height at a certain tide height. NHC is gathering data on waves from sensors at monitoring stations around Roberts Bank, but sought advice from the TAG on whether this approach would be the most effective. In response, the TAG recommended several approaches (see below in s.3.1.3), but also considered how different species might be sensitive to waves – some vegetation may be limited by the long-term average characteristics of waves, whereas other vegetation might be limited by the characteristics of extreme wave events.

Sediment Dynamics and Evolution of the Tidal Flats

A key element of NHC's work is to understand how the tidal flats may change over time – both in response to the existing natural systems but also in response to future changes such as the RBT2 project and climate change. This topic is important because some species may be sensitive to seemingly minor changes in the shape, sediment characteristics, and/or depth of coastal landforms. Key to this topic, then, is how sediment, including fine sediment, may build up or erode over time on the tidal flats due to the erosion, transport, and deposition effects of tidal currents and waves. In the course of the TAG meetings NHC reviewed preliminary conclusions about how the project might affect the wave climate and sediment dynamics, and what this might mean for the evolution of the tidal flats over the long term. In response, the TAG discussed several interpretive geomorphology methods that might help fortify NHC's assessment as relayed in section 3.1.3 below.

3.1.3 Recommended Data Sources and/or Studies

The discussions highlighted above led to a variety of recommendations from the TAG:

- To complement modeling of the potential effects of RBT2 on the tidal flats, given the limitations of existing models, and to improve upon the interpretive geomorphology methods that NHC has planned, the TAG recommended that:
  - NHC draw inferences from development on Roberts Bank, Sturgeon Bank, and around the world (for instance the Bay of Fundy, the US west coast including San Francisco, and Brisbane (Australia) and Indonesia); and
  - PMV incorporate adaptive management strategies for RBT2, i.e., that PMV develop plans to address unforeseen consequences of development ahead of time in case such things do occur in the future.

- Given that modeling relies upon computer technology that has limitations in terms of computational power (i.e., the need to balance level of detail in the model against how long it takes for the model to run), the TAG recommended that NHC:
  - model conditions for summer and winter separately;
  - do short simulations if there is independence in geomorphological responses from year to year;
  - remove periods of calm weather to focus the wave modeling on storms and periods in which geomorphic processes are more likely to affect the tidal flats; and
  - 'leap frog' the modeling over time, i.e., time-stepping the models if there is evidence that year-to-year changes are small.

- To help understand the potential influence of waves on the tidal flats, the TAG recommended that NHC:
  - develop probability distributions of wave characteristics to build an understanding of the frequency with which waves capable of mobilising sediments on the tidal flats might occur; and
  - use scenario analysis to examine the potential effects of different types of storms on Roberts Bank (in lieu of forecasting the probability with which high energy storms might occur).

- Given that the response time for the tidal flats may be many decades, and the effects from human-made structures may only now, or may yet, be coming fully evident, the TAG recommended that NHC take core samples of sediment in the tidal flats and analyse tracers such as ^{210}Pb (lead 210) and silver to try and establish historical sedimentation rates.

- To help ensure that models are based upon accurate reflections of current conditions, and to help NHC determine whether 2D or 3D large-scale models are necessary to set boundary conditions for finer-scale modeling, the TAG suggested that NHC gather data from the Venus coastal network (a project of the Ocean Networks Canada Observatory at the University of Victoria).

3.2 Initiation and Propagation of Tidal Channels

Tidal channel initiation and propagation was an important topic for the Coastal Geomorphology TAG. This topic was discussed in all three meetings and concerned the state of science on the topic, methods of assessment, and mitigation measures.

Tidal channels were discussed under two broad categories: salt marsh tidal channels, and mud flat tidal channels.

Salt marsh tidal channels occur in the upper intertidal zone and are often associated with protected embayments where channels form within areas of vegetation growth. Channels emanating from a salt marsh do not necessarily persist across the tidal flats; such channels often become indistinct within a short distance of the marsh edge. Examples of this type of channel at Roberts Bank exist at Brunswick Point and throughout the upper intertidal zone northwest of the Deltaport causeway. Much of the existing research around the world on tidal channels has been carried out on this type of channel (but not at Roberts Bank).

Mud flat tidal channels are the more prevalent type of channels that have occurred at Roberts Bank in the area between the Deltaport and BC Ferries causeways (Figure 5). This type of channel occurs further down in the middle to lower inter-tidal zone and entails a distinct channel across the tidal flats that extend as far seaward as the low tide zone. The width and depth of mud flat channels tend to reflect the amount of water moving through them.

Figure 5. Aerial view from the northeast of the tidal channel that has formed between the BC Ferries terminal to the east (out of view) and Deltaport (in background).

Photo courtesy Derek Ray, Northwest Hydraulic Consultants.

The channels that have formed in the inter-causeway area are examples of what could potentially develop with the construction of RBT2. This type of channel will be a focus of the

RBT2 EA because of the proximity of the proposed project to an existing channel, the potential for the project re-initiate this channel, and the consequent changes that might occur to existing habitat on Roberts Bank. NHC has identified several alternative footprint designs for RBT2 and is examining those designs that are expected to be least likely to cause new tidal channel formation as occurred in the inter-causeway area.

3.2.1 Key Issues

In the 1950s, prior to construction of the Deltaport and BC Ferries causeways and terminals, there were almost no mud flat tidal channels on Roberts Bank. However, since construction of this infrastructure on Roberts Bank, tidal channels have formed, primarily in response to creation of a turning basin through dredging. This observation then raises the question of whether the mechanisms that triggered channel formation in the inter-causeway could occur in relation to the proposed RBT2 project.

As part of the TAG's exploration of this issue, the TAG discussed the current science on tidal channel formation. According to NHC, the three principal triggers of tidal channels seem to be:

1. head-cutting, where excavation of the tidal flats above the low tide mark leads to channel initiation upslope on the tidal flats, which leads to the channel extending landward through erosion;
2. water draining off uplands during a dropping tide in which seaward-advancing channels are produced by local drainage (from a stream or some other form of a reservoir) onto exposed tidal flats; and
3. a temporary storage of water upland of the tidal flats allows a flow of water to drain across the exposed tidal flats during a dropping tide.

Highlighting the uncertainties that exist with respect to understanding the mechanisms of tidal channel initiation at Roberts Bank, NHC presented the following lessons gathered through a review of the experience at Roberts Bank as well as the international experience of development and tidal flats:

- avoid excavation or eroding portions of the tidal flats that become exposed at low tide levels;
- avoid relying on crest protection structures, or other 'hard' engineering approaches, to control head cutting as they have not been demonstrated to work;
- head-cut channels are not expected to extend landward indefinitely and but are expected to ultimately reach equilibrium, though this equilibrium state may still affect some marine species (some positively, others negatively); and
- avoid increasing drainage onto exposed tidal flats as this may trigger seaward-advancing channels.

In short, NHC suggested that prevention is a key strategy to employ when developing in tidal flats.

3.2.2 Key Findings

The TAG noted that prediction of tidal channel formation is challenging since (i) the processes of interest are inherently non-linear, and (ii) much of the recent scientific research and model development is based on salt marsh channels in sheltered embayments as opposed to more exposed, lower elevation tide flats (i.e., the conditions at Roberts Bank). The overarching conclusion, therefore, was that developers should minimize disturbance of tidal flats.

In the course of discussions the TAG also identified a potential consequence of the proposed RBT2 project. NHC has begun to examine the potential for RBT2 to initiate tidal channel formation through preliminary modeling of sediment erosion and deposition around the new terminal. The results of this preliminary modeling suggest that the project may cause erosion at its northwest corner. The TAG discussed how this 'scour hole', if it should actually occur, might reactivate a relict tidal channel south of Canoe Passage, and if this happened, this relict channel might widen, deepen, and propagate upstream. An important question, then, is whether the channel would reach the wetland north of the existing relict channel at Brunswick Point (given the ecological importance of the salt marsh there) or link up with Canoe Passage. The TAG discussed how tidal channels can erode through eelgrass beds as they have in the inter-causeway area, a concern given the recognised ecological value of eelgrass. The TAG discussed that a tidal channel might not be initiated from the scour hole on the northwest corner if erosional forces could be limited to a narrow, deep area solely within the sub-tidal zone.

The TAG also discussed how numerical models have limitations in terms of predicting tidal channel impacts of development on tidal flats, partly because channel initiation occurs at a smaller scale than what can be modeled. The TAG mentioned that while modeling is not useful at predicting tidal channel formation, models can be used to give insight into where erosion might occur and where new channels might be triggered. This finding is consistent with NHC's planned approach to use models to identify potential locations for channel initiation, and then to rely on interpretive geomorphology methods, such as examining the historical experiences at Roberts and Sturgeon Banks, to estimate the potential scale of channels should they actually develop.

3.2.3 Recommended Data Sources and/or Studies

The TAG agreed with NHC that models should be used to help identify areas where erosion might occur and thus where tidal channels might be initiated, but that interpretive geomorphology methods should be used to help characterize the potential extent of tidal channels if they are initiated.

3.3 Characterizing Future Climate Change Scenarios

3.3.1 Key Issues

The potential effects of future climate change will need to be considered in the EA of the proposed RBT2 project. In a coastal context, this means that the assessment may consider the potential effects of climate change in terms of:

- the magnitude and rate of sea level rise that can be expected at Roberts Bank,
- the extent to which storms that send waves towards Roberts Bank might change,
- the extent of changes of Fraser River outputs (such as volume of flow and sediment load) at the river mouth, and
- the degree to which the tidal flats might change over the long-term to the above factors.

In addition, completion of the effects assessment will require the identification of an appropriate time horizon for analysis, i.e., the appropriate length of time over which EA forecasts are generated, given the long-term nature of climate change and the project. The TAG explored each of these five topics.

3.3.2 Key Findings

Sea Level Rise

There is considerable uncertainty and debate in the scientific community with respect to how high and how quickly sea levels will rise in the future from climate change. This topic was discussed by the TAG in terms of identifying what an appropriate range of sea level rise should be considered in NHC's analyses, given that sea level has an effect on the coastal geomorphology at Roberts Bank (for example, based on wave heights, which are in part a function of water depth).

A starting point was reviewing three scenarios for sea level rise proposed by NHC:

- a lower bound of 0.5m in 100yrs,
- a medium projection of 1m in 100 years (based on a BC Ministry of Environment guidance document (Ausenco-Sandwell 2011)), and
- an upper bound of 2.2 m in 100yrs (a value that is expected to be included in the next Intergovernmental Panel on Climate Change's (IPCC) report).

The TAG agreed that NHC should consider three scenarios consisting of lower and upper bounds and some middle, perhaps more probable, case. By examining the effects of each degree of sea level rise on coastal geomorphology, it may be concluded that, for example, there is little difference in the effect of lower levels of rise and that NHC can focus its efforts on understanding the effects of higher levels of rise.

The TAG further discussed how existing projections may underestimate actual rise. While the TAG noted that any upper bound for sea level rise should be grounded in rational argument, results of international studies on sea level rise continue to be refined, and recent publications suggest that existing projections do not sufficiently take into account some factors, such as melting of the Greenland ice cap and the volumetric expansion of the ocean relating to increased water temperature.

Second, the TAG discussed how there is local variation from the global-wide predictions reported by the IPCC's current projections for global sea level rise. The TAG discussed how sea level rise at Roberts Bank should be about 0.2 m lower than the average sea level rise across the globe predicted by the IPCC as a result of natural variation in sea surface elevation.

Third, the TAG discussed how NHC needs to factor in local changes in the elevation of the land surface relative to sea level caused by subsidence – i.e., lowering of the elevation of the sediments that form Roberts Bank due to settling and compaction. Available data that describe this effect provide poor spatial resolution with respect to the rate of subsidence that occurs at Roberts Bank, but it is known that subsidence in the immediate vicinity of existing structures such as Deltaport is higher than other areas.

Storminess

Climate change could result in changes in the frequency, magnitude, and/or duration of wind storm events which generate large waves at Roberts Bank. Both on its own and in relation to sea level rise, a change in the wave regime may have important implications for coastal geomorphology at Roberts Bank.

NHC reviewed the available scientific literature on the topic with the TAG. NHC explained that a report by Ausenco-Sandwell commissioned by the BC Ministry of Environment concluded that there is no evidence to suggest that future storms would be more frequent or more severe than existing storms. The TAG discussed whether this was a reasonable conclusion for NHC to follow in their EA work. One TAG member noted that there is general consensus in the literature towards more powerful storms with climate change, and therefore it's hard to support Ausenco-Sandwell's conclusion. A more conservative approach, according to this TAG member, would be to assume an increase in 'storminess'. Other TAG members noted that this effect may be less applicable to the temperate latitudes of the southern British Columbia coastal region and that an increase in storminess may be much less pronounced than in lower latitudes.

The TAG discussed how NHC might incorporate the assumption of increased storminess in their work. The TAG noted that it will be important for NHC to consider the frequency, duration, and severity of future 'extreme' storms, as these types of storms are the driving force for geomorphic change, though there is uncertainty of the extent to which Roberts Bank geomorphology depends upon extreme storms because their relative infrequency provides few examples to study. The TAG discussed how the tidal flats themselves might mitigate storm effects, as will the existing causeways. As well, the fetch for waves – i.e., the distance over which winds can blow and waves can form – limits wave heights within the Strait of Georgia, though wind speed is a key factor in determining wave height. The TAG also noted that it will be important to consider the effect of climate change on synoptic storms – storms on the order of 1,000 kilometres in size and commonly associated with weather fronts and intense low pressure centres – as storms of this scale may be the most important from the perspective of winds and waves at Roberts Bank.

The TAG also discussed how making overly conservative assumptions about future increases in storminess from climate change could actually result in an approach that downplays the predictions about the incremental effects of the project on the environment because the relative effect from the natural system is then assumed to be so great. For example, adopting an extreme 2.2m sea level rise over the next 100 years will mean that effects of RBT2 will be miniscule in comparison. Therefore, any use of extreme assumptions about climate change has to be done with caution.

Fraser River Outputs

Another potential effect of climate change is that the volumes of water flowing in the Fraser River and the amount of sediment carried in those flows might change, with consequent effects on the geomorphology at Roberts Bank. These types of changes can also be caused by more local human activities upstream, such as has occurred with the Nechako River diversion west of Prince George. A key question is whether either type of effect might be large enough to warrant consideration in the RBT2 EA – these effects may be so small that they are negligible relative to the potential effects of RBT2 on Roberts Bank's coastal geomorphology.

The TAG discussed how future Fraser River flows will likely be different than today with climate change. A likely scenario is that winter flows will probably be somewhat higher, but summer flows will probably be somewhat lower, while the magnitude of the largest floods will probably remain about the same.

The TAG generally agreed that there will likely be little change in sediment output to the project area with climate change. The TAG also discussed how it was unlikely that changes in land-use upstream of the project (such as pine beetle effects on forests) would substantially affect sediment production on a scale important for this EA. However, human-induced changes in closer proximity to the proposed project in Canoe Passage, such as dredging and channel deepening, or the removal of the George Massey Tunnel, are likely to be more important to Roberts Bank geomorphology than the effects of climate change.

Tidal Flat Adjustment

Adjustments to the cross-profile shape of the Roberts Bank tidal flats have previously been investigated. Hill et al. (2012) find that the tidal flats are likely to adjust due to a rise in sea level, increase in storminess (and consequent increase in wave energy), and changes in Fraser River outputs. These changes are expected to steepen the profile of the tidal flats, and as the TAG discussed, this steepening of slope might have substantial effects on some marine species. For example, many species and habitats (e.g., marshes) occupy a defined elevation range of the tidal flats, and so if the slope steepens the horizontal extent of the elevation band will be narrowed. This is a similar, though distinct, effect to the issue of 'coastal squeeze' that is expected to occur in conjunction with rising sea levels alone. The TAG discussed how the rate of sea level rise could outmatch the ability of the tidal flats to adapt.

Time Horizon for Analysis

All EA studies have a temporal boundary – the EA attempts to forecast the effects of a project on the environment over a given period of time, typically extended at least out to when a project is expected to be decommissioned. With RBT2, given that it may be used for many decades, and given that climate change may occur over centuries, a question arises as to the appropriate time horizon for EA studies. NHC proposed to conduct its assessment work over two time horizons: 50 and 100 years. In discussion the TAG did not contest these horizons, but noted that the further in time one attempts to forecast, the more uncertainty there is related to both a) the projected future conditions that are assumed (for example sea level rise), and b) the inherent uncertainty in making predictions in a complex natural system.

3.3.3 Recommended Data Sources and/or Studies

The TAG discussed a variety of ways in which NHC could improve its methods with respect to addressing climate change.

Sea Level Rise

NHC will need to complete their EA work before the next IPCC report will come out (2014). Since evidence suggests that sea level will rise further than projected in the last IPCC report (2007), the TAG recommended that NHC should adopt a high scenario that is at least as high as what might be forecast in the forthcoming IPCC report.

To help address the uncertainty in the degree to which sea level will rise, the TAG discussed two strategies that NHC could consider employing in its work. NHC could simply assume that the sea level will rise to certain levels (such as 0.5 m or 1 m) at some undetermined time and then to focus on the effects of these levels of rise on geomorphology. This approach focuses analytical efforts on understanding the potential effects of such a rise, and less on the challenging task of forecasting likelihood. Another approach is to gather 'probability of exceedance' of various degrees of sea level rise from experts, and to develop projections of sea level rise accordingly.

Storminess

The TAG identified three ways in which NHC could improve its methods with respect to addressing potential storms and waves under climate change:

1. increase the severity of storms, or their frequency (i.e., total number of storms in a year) to simulate increased storminess;
2. create a 'typical representative' winter season of storms and then model wind and waves from different storm directions; and

3. examine the sensitivity of Roberts Bank coastal geomorphology by altering variables or suites of variables in scenarios, and then adjust future studies if the results of these scenario analyses warrant.

Fraser River Outputs

The TAG did not make any specific recommendations with respect to potential changes to Fraser River outputs.

Tidal Flat Adjustment

The TAG suggested that NHC account for any climate change adaptation activities undertaken in the area as part of its forecasting of any tidal flat adjustment that might occur as a result of climate change, such as changes to coastal defence structures. The TAG also discussed how NHC might use equilibrium profile and wave field approaches to assess potential tidal flat changes.

Time Horizon for Analysis

Given the uncertainty around climate change, the TAG noted that it might be more useful to assess the potential effects of RBT2 under certain climatic conditions (such as particular sea level rise predictions) than to worry about when such conditions might occur. The TAG discussed how government policy may dictate the appropriate timeline for analysis.

4 Other Topics Explored by the Coastal Geomorphology TAG

4.1 Mitigation Options

The TAG did not discuss mitigation options at much length, though several ideas arose during meetings:

- The TAG discussed the tidal channel that formed in the area between the Deltaport and BC Ferries causeways in the past and the failure of attempts that have been made to prevent that channel's propagation. The TAG discussed how the best mitigation measure with respect to tidal channels is prevention.
- NHC explained that it is examining four potential design options for the proposed RBT2 project to minimize adverse geomorphology effects and address potential scouring issues.
- One TAG member wondered why NHC is not considering armouring the seabed where scouring is anticipated, such as through the use of a scour blanket. NHC explained that at this stage NHC is assessing different footprint options and will then look at possible other mitigation measures such armouring, if required.

4.2 Cumulative Effects

On numerous occasions the TAG discussed how other current and planned future human activities, such as future projects in the Fraser River, may have on the coastal geomorphology of Roberts Bank. Consideration of the cumulative effects of past, present, and reasonably foreseeable future actions and stresses (PPRFFA&Ss) on some important marine species is likely to be an important part of the RBT2 EA. Actions include such things as new port terminals, but also ongoing human activities such as routine dredging. Stresses include such things as climate change. A sound EA will forecast the effects of a project on important marine species in light of the pressures that PPRFFA&Ss will already be putting on the species. To assist NHC in such a cumulative effects assessment, the TAG discussed what PPRFFA&Ss might exist and be considered.

Tables 3 and 4 summarize the results of this discussion. The tables present a preliminary list of possible PPRFFA&Ss to include in a cumulative effects assessment for the proposed RBT2 project. The lists were reviewed and added to during the final TAG meeting and are considered a starting point. The TAG questioned the need to consider past and present actions and stresses; the TAG felt that what is likely most important to consider are future actions and stresses.

Table 3: Past and present actions and stresses for possible inclusion in the RBT2 EA.

Past or Present Action or Stress
Existing PMV terminal and causeway (including Westshore, Deltaport, dredging for Deltaport, dredged sediment disposal (at sea) for Deltaport and 3rd Berth, Deltaport expansion, Deltaport 3rd Berth, and Deltaport Terminal Road and Rail Improvement Project (DTRRIP))
BC Ferries (including original terminal and causeway, expansions, and habitat compensation projects)
shipping
Marine cables on south side of ferry terminal, including Vancouver Island Transmission Reinforcement Project
Lulu Jetty
Steveston bend training wall and jetty
Iona wastewater/sewage
Dredging programs of main arm, including Steveston 2013 major dredging project
Existing dykes, and dyke construction, Tsawwassen and Ladner
Port Mann bridge expansion including demolition of existing bridge
South Fraser Perimeter Road
Tsawwassen Gateway Logistics Centre
Tsawwassen First Nation Mixed Use Project
Fraser Surrey Docks Direct Transfer Coal Facility (Piles)
Southern Strait National Marine Conservation Area
Boundary Bay Airport Expansion
Existing sea dykes

Table 4: Future actions and stresses for possible inclusion in the RBT2 EA.

Future Action or Stress	Comments from the TAG
Massey Tunnel decommissioning/replacement	(none)
Vancouver Airport (YVR) fuel delivery project (including berths, dredging, and potential other activities in the water)	(none)
Steveston Harbour dredging project	• do not include: small effect on coastal geomorphology, and far away from Roberts Bank
Deepening of main channel of south arm of Fraser River	• some likelihood • may have an important effect on coastal geomorphology
Future BC Ferries projects	• no known projects planned
Artificial islands (e.g., Richmond) for habitat compensation	• no firm plans known • effects on coastal geomorphology will be location-dependent • potentially important
Ladner Harbour Redevelopment and side channel dredging per December 2012 funding announcement	• dredging might affect water flows into Canoe Passage • would have to be considered
Vancouver International Plaza on Duck Island	• vague plans at this point • unlikely to affect Roberts Bank coastal landforms
Climate change	(none)
Airport expansion of main runway onto Sturgeon Bank	• little effect on Roberts Bank, though depends how big/far it sticks out
Coastal defences against climate change	• highly likely • their form is uncertain, but various

Future Action or Stress	Comments from the TAG
	options are commonly used
Iona wastewater expansion	• unlikely to affect Roberts Bank coastal landforms

In the course of brainstorming PPRFFA&Ss the TAG identified several criteria that NHC and other PMV consultants might use in identifying PPRFFA&Ss:

- spatial proximity to RBT2 and Roberts Bank;
- likelihood of future actions and stresses happening (one needs to be reasonably certain that the action or stress will occur);
- the strength of effect(s) that the action or stress is expected to have;
- whether the action or stress will affect components of the environment of interest in the EA (such as marine species of particular importance to stakeholders); and
- whether the effects of the action or stress will occur over the time frame of the project.

The TAG discussed how Table 4 did not include future PMV projects. The TAG suggested that NHC maintain dialogue with PMV around what other projects are planned or might be envisioned in the foreseeable future, especially in the near vicinity of RBT2 such as Canoe Passage. The TAG discussed how it will be important that PMV understand any possible linkages between routine dredging actions and possible implications for Roberts Bank geomorphic changes.

4.3 Linkages to Other EA work

As noted in s.4.1 of this report, an understanding how the proposed RBT2 project may affect marine species rests upon a solid understanding of how the proposed project might affect the coastal geomorphology of Roberts Bank. Given this, on several occasions the TAG discussed how coastal geomorphology methods must have the spatial resolution – i.e., level of detail – to identify geomorphic changes that are of the scale of which some marine species are sensitive. In other words, from an EA perspective, it is not useful if coastal geomorphology studies cannot detect changes that matter to species. It was in this vein that there was interaction across TAGs during the TAG process. For example, Derek Ray of NHC presented at one of the Biofilm and Shorebird TAG meetings.

5 Conclusion

The Coastal Geomorphology TAG met three times over 2012 and 2013 to provide PMV and its consultants with feedback on appropriate methods to assess the potential effects of the proposed RBT2 project on the coastal geomorphology of Roberts Bank. This report catalogues this TAG process and the key findings and outputs of the process. Overall, the Coastal Geomorphology TAG endorsed NHC's planned approach and methods. At this point, PMV and its consultants are continuing their EA studies with the Coastal Geomorphology TAG's guidance in mind. Looking forward, PMV and its consultants will complete their EA studies, engage the provincial and federal governments in the formal EA process, and continue to consult with stakeholders and First Nations.

References

Hill, P. R., R. W. Butler, et al. (2012). Impacts of sea level rise on Roberts Bank (Fraser Delta, British Columbia). 57pp.

Ausenco-Sandwell (2011). Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use: Guidelines for Management of Coastal Flood Hazard Land Use. 45pp.

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