

22.0 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

Under CEAA, environmental assessments are required to include a consideration of the effect of the environment on projects. The following natural events and characteristics have been assessed for their ability to affect the construction and operation of the Deltaport Third Berth Project. These events and characteristics were selected from a review of the literature and from discussions in applicable study reports.

22.1 SEISMIC EVENTS

22.1.1 Background

British Columbia experiences over 1,200 earthquakes a year, 300 of which occur in the lower mainland and on Vancouver Island. Almost all of these earthquakes are too small to be felt. However, a stronger earthquake could occur at any time.

British Columbia is vulnerable to two types of earthquakes: those occurring within the earth's crustal plates and those occurring at the interface between crustal plates. Earthquakes that originate within a plate are seldom greater than magnitude 7.5. In contrast, earthquakes that originate between plates are usually larger than magnitude 8.0.

British Columbia is vulnerable to the largest type of earthquake called a "subduction" quake, which occurs between two plates. The Cascadia Subduction Zone is located approximately 100 kilometres west of Vancouver Island. The range of recurrence, however, varies from 200 years to 900 years. The last subduction earthquake was in January 1700 (304 years ago).

Since the Project is located in an area where seismic events have the potential to occur, the Project design included the consideration of seismic effects. The following sections describe how the Project has addressed seismic events, specifically in the wharf design, container yard design and building foundation design. Much of the information presented below has been discussed in **Chapter 2 Project Description**, however, it is summarised here for completeness.

22.1.2 Seismic Design Criteria and Site Geology

The Project will be designed in compliance with the current version of the National Building Code (1995 NBCC), which requires that new structures be designed to resist a 1:475 year seismic event without collapse in order to minimize risk of loss of life.

Table 22.1 summarises the ground motion parameters associated with the 1:475 year seismic event. These values were derived from the seismic hazard models and seismogenic zones used in the current 1995 NBCC.

Table 22.1 1:475 Year Seismic Event

Return Period	1:475
Probability of Exceedence per Annum	0.0021
Probability of Exceedence in 50 Years	10%
Peak Horizontal Ground Acceleration (g)	0.26
Peak Horizontal Ground Velocity (m/s)	0.23

The seismic criteria, along with the geological conditions at the project location, influence the geotechnical and structural design of the Project. Based on previous geotechnical investigations near the project location, the site geology throughout the general Deltaport area consists of deltaic deposits comprising of layers of silts and sands. The layers generally slope toward the southeast. A thick silt layer appears to be present at the north end of the existing container terminal in the area of the proposed berth extension. This layer will likely undergo deformation under a major earthquake event; possibly as deep as elevation –40 m CD at the south end of the berth extension. The thickness of this silt layer appears to decrease towards the north end of the berth extension to about elevation –30m.

22.1.3 Seismic considerations for the Wharf Structure

Geotechnical design considerations for the proposed caisson wharf structure (deck length of 427 metres and caisson width of 15.5 metres) have been compiled from information available from previous projects completed at Roberts Bank and are presented below:

- The loose silt and sand deposits that extend to elevation -40m at the south end of the extension and elevation -30m at the north end, are expected to liquefy during the 1:475 year seismic event.
- In-situ densification of the silt materials will not be sufficient to prevent liquefaction. To address this concern, the silt materials will be dredged and replaced with clean sand or gravel fills.
- The replacement fills will be densified to prevent liquefaction under the 1:475 year seismic event.

The required depths and extent of the soil improvements (dredging, replacement and densification of replaced material) are based on geotechnical information, including adjacent boreholes, available as of July 2004, and the conceptual level of engineering carried to date. An additional geotechnical investigation program is underway and the soil information collected will be used to refine soil improvements and foundation requirements as part of final engineering design.

The conceptual wharf design incorporates concrete caissons as the main support structure. Based on the 1:475 year seismic design criteria and the available geotechnical information, it was determined that 15.5 m wide caissons (wall to wall) with 18 m wide foundation slabs will be required. Local and global stability for the 1:475 seismic event will be maintained by improving soils along the wharf to prevent liquefaction and prevent the flow of weak soils located in the container yard area behind the caissons.

Soil improvements will include removal of any native clayey material, replacement with clean sand or gravel fill and installation of rock and granular berms. A thick rock mattress and levelling course will be placed as foundation material to support the heavy caisson gravity structures. The replacement fill, mattress rock, rock berms and all granular fill will be densified

over the full length of the caisson structures, extending approximately 40 m in front of the wharf face and 35 m to 40 m behind the back end of the caisson structure.

22.1.4 Seismic Considerations for the Container Yard, Structures and Buildings

The Project includes the construction of approximately 20 hectares (50 acres) of new land area for container operations and storage.

The proposed terminal area includes:

- Creation of approximately 20 hectares (approx. 50 acres) of new land area,
- Soil densification along the perimeter berm and under most new structures, and
- Rip-rap and tailings slope protection on the northern shoreline of the container yard.

The geotechnical review determined that specific foundation designs such as concrete raft foundations founded on piles will be adequate to support structures within the container yard area, and an extensive soil replacement program of the silty native soil (similar to the soil replacement program required for the caisson wharf structure) is not necessary for the container yard.

The container yard will be situated on pavement located on top of a dense sand fill and contained within the densified perimeter berm. The top sand fill surface will be graded and compacted to form a firm sub-grade overlain with asphalt pavement once all below grade site services and foundations have been installed.

The reefer towers will be supported on concrete raft foundations founded on steel piles. Similar to the reefer towers, foundations supporting the out-gate building will be constructed using concrete raft foundations resting on steel pipe piles driven into soils located below the liquefiable silt layer (approximate elevation – 30 m).

The International Longshore and Warehouse Union (ILWU) lunchroom building, the substation building and the small truckers shed may be founded on raft concrete foundations and

approximately 8 m of granular compacted sub-base material. The granular sub-base material for the structures will be installed during the placement of dredged fill material throughout the site.

The eight-lane out-gate bridge structure will be supported by four concrete foundation pedestals. High-mast lighting will be supported by reinforced concrete foundations.

22.1.5 Summary

Local and global stability under seismic events will be maintained by improving soils along the wharf to prevent liquefaction and prevent the flow of weak soils located to the west of the project area. Soil improvements will include removal of the native clay silt layer, replacement with clean sand or gravel fill and installation of rock and granular berms. A thick rock mattress and levelling course will form the foundation for the heavy caisson gravity structures. The replacement fills, mattress rock, rock berm and portions of the berm fill will be densified by vibro-densification. Lateral ground movements, including sliding of the caisson structures, can be expected during the design seismic event (1:475 year earthquake). However, overall collapse of the Deltaport Third Berth terminal extension is not likely to occur.

The geotechnical review determined that specific foundation designs such as concrete raft foundations founded on piles would be adequate to support structures within the container yard area, and an extensive soil replacement program of the silty native soil would not be necessary for the container yard. An additional geotechnical investigation program is underway and the soil information collected will be used to refine soil improvements and foundation requirements as part of final engineering design.

22.2 TSUNAMI

The coastal area of British Columbia has been identified at potential risk from tsunamis (Bornhold *et al.* 2003 and BC Province 2004). While the southern Strait of Georgia is sheltered from Pacific Ocean generated tsunamis by Vancouver Island (BC Province 2004), tsunamis generated in local waters by earthquakes, landslides or submarine landslides could have an impact (Bornhold *et al.* 2003). In particular the southern Strait of Georgia has been identified as an area at risk of tsunami generated by submarine landslides due to the large unstable sediment mass on Roberts Bank at the edge of the Fraser River delta (Rabinovich *et al.* 2003). A failure in

the cohesion of the sediment mass could allow a mass movement of sediment, which under the right conditions (volume of sediment, speed and location) could trigger a tsunami event. Such failures are not unknown in this area, and five slides have occurred since 1970 (Rabinovich *et al.* 2003). The Roberts Bank Port facilities have been in place since 1970.

Unconsolidated sediments naturally deposited off Roberts Bank by the Fraser River have produced the delta fore-slope, which is subject to failure in two ways: shallow, retrogressive flow slide failures, and deep-seated large-scale rotational failures (Rabinovich *et al.* 2003). Rapid failures may generate tsunamis with amplitudes exceeding several metres, and combined with high tide and storm surges these could cause coastal flooding.

Two failure scenarios were modelled for the edge of Roberts Bank (Rabinovich *et al.* 2003). Firstly a large (0.75 km³) failure at about 100m deep, where the zone of unstable material is present, and extending 7 km along the fore-slope between Canoe Passage and the B.C. Ferries terminal with a width of 3 km. Secondly, a smaller (0.23 km³) failure, also 100m deep, extending 4km from the Deltaport terminal to the B.C. Ferries terminal with a width of 2.6km. Both failures were modelled for high- and low-tide conditions.

Maximum wave height was generated on the opposite side of the Strait of Georgia from the source area (Galiano and Mayne islands) rather than near the failure zone on Roberts Bank (Rabinovich *et al.* 2003). This is due to waves reflecting off Roberts Bank, which acts to protect this part of the coastline. Tsunami wave amplitudes generated by the model range in height from 1 to 4 metres at the B.C. Ferries terminal (and the Project site), compared to up to 18m on the west side of the Strait of Georgia. Tsunami waves are 5 – 10 % higher at low-tide because the landslide is closer to the sea surface. However, high water levels during a high-tide create conditions that increase the destructive capacity of the tsunami waves (Rabinovich *et al.* 2003). Large volume slides create higher tsunami waves; for the large volume landslide waves were three times higher than for the small slide (Rabinovich *et al.* 2003).

The present freeboard at Deltaport and at the Project is 3.2 m (see **Figure 2.3** in **Chapter 2 Project Description**). Therefore, if the tsunami wave (maximum predicted amplitude of 4 m) were to occur at high tide there would be wave overtopping at the site. However, the existing Roberts Bank Port facilities, including Westshore Terminal and then the Deltaport Container

Terminal, have been in operation during all of the reported five previous submarine landslides at Roberts Bank and no large waves have been recorded that have overtopped the terminals.

22.3 CLIMATE CHANGE

It is widely accepted in the scientific community that the increased production of greenhouse gasses since the start of the Industrial Revolution in the early-1800s, has resulted in a general increase in global temperatures. This measured increase to the present is small compared to the potential increase of between 3°C and 6°C per century that is projected for the future. A general increase in global temperature is likely to affect the proposed Deltaport expansion at Roberts Bank through 1) sea level rise, and 2) an increase in extreme weather events, which means more storms and more severe storms.

22.3.1 Sea Level Rise

At a regional scale, sea level rise is measured relative to land and results from a combination of isostatic, tectonic, and eustatic factors that are not independently measured (Clague *et al.* 1982). Isostatic and tectonic factors are deformation of the earth's crust due to glacial loading, and down warping due to tectonic movements. Eustasy is the change in volume of the oceans as a result of the change of water stored in the earth's glaciers (glacial melt).

According to published reports, average global sea level has risen at around 2 mm/year during the last century. Most recent studies have concluded that the sea level will rise at a faster rate than in the last century due to the effects of global warming. The Inter-Governmental Panel on Climate Change (IGPCC) issued predictions of changes to sea level in 1990, 1995 and 2001 for a range of future scenarios. However, the range in projections has been very large. For example, the 1990 and 2001 forecasts indicated sea level could rise by 0.11 to 0.77 m by the year 2100.

The US Environmental Protection Agency (Titus and Narayanan 1995) has provided probability-based estimates for various future scenarios. For the median case, sea level was estimated to rise 0.15 m by the year 2050 and 0.34 m by 2100. For an extreme case, it was estimated that there is a 1% chance that global warming will raise sea level by 1 m by the year 2100. These figures represent only eustatic changes (glacial melt inputs) in sea level and do not include effects of local or relative sea-level change induced by factors such as ground subsidence or settlement. In

deltaic areas, such as at Roberts Bank, ground subsidence may affect local or relative sea-level differences.

Estimates of local sea-level rise in the region of Vancouver, based on analysis of long-term tidal gauge records (Point Atkinson), are in the order of 1 to 2 mm/yr (Clague et al. 1982). The recent tectonic history of the Fraser River delta area suggests that a combination of compaction and local down-warping has resulted in an average subsidence of approximately 1.2 mm/year (0.0012m/yr) (Mathews et al. 1970). Rates of subsidence in Boundary Bay of between 0.4 to 1.7 mm/year (0.0004m/yr to 0.0017m/yr) were reported (Kellerhals and Murray 1969), but these rates are relatively small compared to the projected eustatic changes (glacial melt inputs) that may occur.

Based on the predictions from these climate change studies, the projected relative sea-level rise in the Roberts Bank area will vary. For the purposes of this assessment, it is assumed that the projected sea level rise will be 0.5 m by the year 2100.

22.3.2 Extreme Weather Events

A rise in global temperature is expected to produce a complex response in the global circulation of weather, which may result in high temperature increases in the central portions of the North American continent, while coastal and southern regions may experience a more moderate rise in temperature. In addition, many researchers point to an increase in severe weather events as a likely outcome of global climate change (McBean 2004). Powerful storms with high winds are responsible for the largest wind generated waves at Roberts Bank. An increase in extreme weather events is expected to generate a greater frequency of large storms as well as an overall increase in the magnitude of storm intensity.

22.3.3 Effect of Climate Change on Deltaport Third Berth

Sea Level Rise

The present elevation of the Deltaport wharf as well as the Project wharf is +8.0 m CD. Current high water levels (HHWL²³) are at +4.8 m CD, which results in a 3.2 m freeboard at the wharf (see **Figure 2.3** in **Chapter 2 Project Description**). Therefore, with a 0.5 m rise in sea level predicted for year 2100, HHWL would be at +5.3 m CD, resulting in a Project freeboard of 2.7 m.

Quantitative assessments of expected impacts from the wave, current and sediment transport model projections (described in **Chapter 7 Coastal Geomorphology**) were not possible for year 2100 because of the uncertainty of the sea-level rise, which in turn affects the input parameters to the model. However, a qualitative assessment of impacts on the Project is provided below.

At the seaward end of the tidal flats, a 0.5 m rise in tide level would reduce the number of times a year that the tide drops below the edge of the crest protection. The higher water levels would reduce the velocities (and sediment movement) at the seaward ends of the existing tidal flat drainage channels and would probably end further seaward extension of the drainage channels.

Storm Events

With the projected sea level rise there is an increase in the frequency and magnitude of severe storms. The more severe storms would also be compounded by the projected increase in relative sea level. Larger and more frequent waves could result in waves overtopping the wharf, resulting in some terminal downtime and associated financial loss due to terminal shut down or repairs.

22.4 CONCLUSION

To address seismic risks to the Project, the Deltaport Third Berth Project has been designed to the current version of the National Building Code of Canada (1995 NBCC) to resist a 1:475 year seismic event.

²³ HHWL = high high water level

The Project may be affected by tsunami and global warming events (sea-level rise and storms). Both of these conditions could result in waves overtopping the wharf, resulting in some terminal downtime and financial loss. The existing Deltaport terminal was designed and constructed, as will the Project, at appropriate elevations above sea level (+8.0 m chart datum). This elevation provides adequate freeboard such that if the potential tsunami and global warming events were to occur there would be only a temporary disruption of terminal activities.

23.0 CUMULATIVE EFFECTS ASSESSMENT

This cumulative effects assessment layout is as follows:

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23.1 REASON FOR THE CUMULATIVE EFFECTS ASSESSMENT

The *Canadian Environmental Assessment Act* (CEAA) and the finalized Terms of Reference for the Deltaport Third Berth Project issued by the BC Environmental Assessment Office (EAO) on 24 September 2004 require that:

“A cumulative effects assessment will be included as a separate section in the Application, in accordance with the framework for addressing these effects pursuant to current CEAA guidelines.”

Cumulative environmental effects are defined as changes to the environment that are caused by an action in combination with other past, present and future human actions (Hegmann *et. al.* 1999). Cumulative environmental effects occur when:

- impacts on the natural and social environments take place so frequently or densely that the combined individual effects cannot be assimilated into the environment; or when
- the impacts of one activity combine with those of another in a synergistic manner creating a cumulative effect that is at least equal in intensity, or often greater than the total of the individual effects.

Assessment of cumulative environmental effects (often called cumulative effects assessment, CEA) considers effects that are likely to result from the project in combination with other projects or activities that have been or will be present in a reasonable temporal and spatial scale.

In general, a CEA addresses effects that:

- have a high level of certainty of proceeding;
- interact with other projects on the same Valued Ecosystem Component (VEC);
- extend over a larger spatial area; and
- extend into the future.

23.2 METHODOLOGY

This CEA for the Deltaport Third Berth Project will satisfy the requirements of the Act using guidance from the Canadian Environmental Assessment Agency (Hegmann *et. al.* 1999) as follows:

1. Scoping, to identify:
 - VEC, with ecosystem receptors for each;
 - Past present and future projects; and
 - Spatial and temporal boundaries for each VEC.
2. Analysis of effects on the ecosystem receptors for each VEC including:
 - Historic trends and existing conditions for each ecosystem receptor;
 - Contribution of Deltaport Third Berth and other projects;
 - Mitigation of effects on each ecosystem receptor; and
 - Significance of effects on the VEC.
3. Evaluate overall significance of cumulative effects.
4. Monitoring and follow-up recommended.

23.2.1 Scoping

VEC Appropriate to the Regional Issues and Other Projects

Scoping identified appropriate issues of concern, including VEC in the region. This was completed through an investigation of environmental issues raised in the published literature, environmental assessment documents (including the one for this project) and consultation with experts knowledgeable about the issues at Roberts Bank (including regulatory authorities). An earlier cumulative effects study (JWEL 2001), regional (GVRD 1996) and local (Corporation of Delta 1986) planning documents were also consulted.

Appropriate ecosystem receptors for each VEC

For each VEC, one or more ecosystem receptors were identified. Ecosystem receptors are the important environmental characteristics of the VEC that are affected by projects and activities. Ecosystem receptors are more specific than VEC, and often can be analysed using information that is, and has been, regularly collected in the appropriate study area. They are measurable and therefore quantifiable, and where possible this enables predictive analyses to be undertaken.

Other projects and activities that will be assessed

The CEA of the Deltaport Third Berth Project includes consideration of only projects and activities that have a high level of certainty of proceeding.

Spatial and temporal boundaries for each VEC

Appropriate spatial areas were defined for each VEC. Consultation with federal and provincial agencies was conducted on the rationale for the boundaries. A temporal boundary was also established based on the construction and fully operational timelines associated with the construction of the Deltaport Third Berth Project and available information.

23.2.2 Analysis of Effects

A separate effects analysis was conducted for each ecosystem receptor associated with the VEC. Data and or information for each ecosystem receptor, and relevant to the spatial and temporal boundaries set during CEA scoping, were collected. Due to the spatial and temporal scale of the ecosystem receptors the data collected is often more coarse than the impact assessment data.

An assessment of the project related effects, and the effects of all projects and activities, on the ecosystem receptors was conducted. These assessments used quantitative (statistics or modelling) analyses where possible, or qualitative analysis otherwise.

23.2.3 Mitigation Identification

Where possible, mitigation for the impacts of the identified cumulative effects on ecosystem receptors was identified. Due to scale, and the involvement of other projects and activities mitigation may be beyond the direct control of the proponent. Such mitigation may require cooperation of other companies and multiple federal and provincial agencies.

23.2.4 Significance Evaluation

Evaluation of the significance of cumulative effects was completed by comparing them against thresholds, standards, trends or objectives relevant to the ecological receptors.

The significance of each potential cumulative effect is discussed in the analysis of effects for each VEC (Sections 23.7 to 23.12), and a summary significance evaluation is also presented (**Section 23.13 Significance Evaluation**).

The terminology for assessing and reporting significance used in this CEA is presented below (**Table 23.1**). The significance assessment for some characteristics was appended with a qualifier, to indicate that under certain circumstances the outcome may be uncertain, or liable to change.

23.2.5 Follow-up

Suggested monitoring and follow-up for cumulative environmental effects in addition to those suggested for the Deltaport Third Berth Project.

Table 23.1. Significance criteria

Contribution of this Project	Extent	Magnitude	Duration	Reversibility	Ecological / Social Context	Probability	Frequency
Contribution of the residual effect of Deltaport to the overall cumulative effect (including other projects).	Geographic extent of the cumulative effects identified.	Size of the cumulative effect relative to baseline conditions.	Likely duration of the potential cumulative effect.	Potential for the cumulative effect to be reversed or naturally return to baseline level after effect over.	Ability for the social or ecological environment to absorb the change that the cumulative effect is causing.	Likelihood of cumulative effect occurring if the Project proceeds.	Nature of the occurrence of the cumulative effect.
<i>Negligible</i> –residual effect from this Project is a very small contribution to the cumulative effect.	<i>Local</i> – Project site and beyond to 2 km.	<i>Negligible</i> – no change over the baseline.	<i>Short</i> – less than 60 days.	<i>Reversible</i> – environment will return to baseline after effect is removed.	<i>Intact</i> – a near pristine ecological environment or social situation which will not absorb change un-noticed.	<i>Low</i> – up to 25 % chance of predicted cumulative effect occurring.	<i>Isolated</i> – the cumulative effect occurs infrequently.
<i>Low</i> –residual effect from this Project is a small contribution to the cumulative effect.	<i>Municipal</i> – Project site and beyond to 5 km.	<i>Low</i> – impact above baseline, but within accepted standards.	<i>Medium</i> – 60 to 90 days.	<i>Irreversible</i> - environment will not return to baseline after effect is removed	<i>Developed</i> – developed or altered landscape, ecological environment or social situation.	<i>Moderate</i> – 25 to 50 % chance of predicted cumulative effect occurring.	<i>Periodic</i> – the effect occurs occasionally, often in conjunction with other factors.
<i>Moderate</i> – residual effect from this Project is a moderate contribution to the cumulative effect.	<i>Regional</i> – Project site and greater than 5 km.	<i>Moderate</i> – impact considerably above baseline or could cause a change in environmental parameters.	<i>Long</i> – greater than 90 days.	<i>Change</i> – baseline will change after impact, but the effect on the environment will reverse to a new baseline.	<i>Well-developed</i> - Intensely modified, developed or altered landscape, ecological situation or social situation.	<i>High</i> - over 75 % chance of predicted cumulative effect occurring.	<i>Continuous</i> – the cumulative effect occurs at all times.
<i>High</i> –residual effect from this Project is a high contribution to the cumulative effect.	No further terminology used	High – impact will exceed accepted criteria and cause a measurable, non-natural change.	No further terminology used	No further terminology used.	No further terminology used	No further terminology used.	No further terminology used

23.3 SCOPING

23.3.1 Scoping the Valued Ecosystem Components

Although no significant impacts that could not be mitigated or compensated were identified in the impact assessment studies, it is the role of the CEA to consider the additive and synergistic environmental effects from all existing or known planned activities within the vicinity of the Deltaport Third Berth Project. Thus a number of VEC that are not affected by Deltaport, or that have non-significant effects are nonetheless addressed for completeness (**Table 23.2**).

Table 23.2 VEC and ecosystem receptors scoped for the cumulative effects assessment of the Deltaport Third Berth Project.

VEC	Ecosystem Receptor
Coastal Geomorphology / Marine Habitat	marine habitat types
Water Quality	marine eutrophication
Ecology	marine biota (fish / crabs / others) birds (esp. Pacific flyway) marine mammals
Noise	resident's perceptions
Traffic	traffic delays

Air quality was considered during the scoping of VECs, however the absence of any significant air quality effects (no residual effects) from the Project (as presented in **Chapter 13 Air Quality**) precluded it from the CEA analysis.

23.3.2 Scoping Historic and Existing Projects / Activities

In this cumulative effects assessment the contribution of, and the interactions between, specific historical and current development activities are explored to gauge the extent to which they have contributed to the existing environmental conditions. The following is a summary of the projects and activities in the surrounding region, which have contributed to creating the existing baseline conditions and trends of environmental change in the region. It is these existing projects and

activities, and likely future ones (**Section 23.5.3 Scoping Future Projects / Activities**) that will be assessed for their contribution to any identified cumulative environmental effects.

The projects and activities are arranged by types, which reflect that certain groups of projects and activities contribute similarly to specific effects on the VEC identified (**Section 23.5.1 Scoping the VECs**). The information used to complete this section is limited to publicly available documentation.

A brief description of each project or activity, including the known effects that are related to this cumulative effects assessment is presented. The related effects are limited to those that are known or suspected to interact with effects from the Deltaport Third Berth Project and potentially impact the identified VEC.

If applicable, any ongoing trend in environmental change or effects is explored in the relevant ecosystem receptor analysis. This is particularly pertinent when the effect has yet to reach equilibrium in the environment, and or when the effect is continuous.

Sea terminals

- The Roberts Bank Port Facility near Tsawwassen is a 115 ha offshore terminal connected to the mainland by a 4.1 km long artificial causeway. The facility was constructed in 1968, and since then it has been expanded to its existing size. It is owned by the Vancouver Port Authority who leases it to Westshore Terminals for their 50 ha coal loading facility, and Terminal Systems Incorporated (TSI) who operate the 65 ha Deltaport container terminal.

Westshore has two deep-sea berths, high-speed conveyors and other handling equipment enabling it to ship approximately 21 million tonnes of coal per annum.

Deltaport has 2 berths with a water depth of 15.85 m and a turning basin enabling it to service post-panamax sized vessels. It has container handling and storage capability, and rail link capacity, for over 900,000 TEUs per annum.

The construction of this port facility has altered coastal geomorphology processes. This in turn has altered the proportion of marine habitats in the vicinity of the terminal. These changes have altered the resources available to other marine

species: reduction in shallow sub-tidal habitat and consequent changes to invertebrates, fish and birds. These changes are ongoing and the area surrounding the terminal has yet to reach equilibrium.

This port facility has also introduced noise and sewerage inputs to the local area. These effects have not exceeded the relevant standards. There are also effects on marine mammals (noise and collisions) and birds (overhead utility lines and light).

- B.C. Ferries Corporation operates a ferry terminal with 5 berths for roll-on, roll-off vehicle ferries, parking and loading lanes near Tsawwassen. Like Deltaport, the B.C. Ferries terminal is connected to the mainland with an artificial causeway for road traffic and freight. The causeway and terminal was constructed in 1958.

The effects of this project are similar to that of the Roberts Bank Port Facility, and the two in concert have affected the inter-causeway area (the area between the causeways for each terminal). There are also noise and light effects from the B.C. Ferries terminal that are similar, though not as extended in duration, to those of the port facility. The B.C. Ferries terminal ceases operation between 10 and 11pm depending on the season. Marine mammal effects, traffic congestion, noise and air quality, particularly due to private vehicles travelling to and from the ferry terminal are the contributing effects from this facility.

- The Fraser River Port Authority operates Fraser Surrey Docks. It is located on the south bank of the Fraser River, approximately 25 km from the mouth, and 30 km from Deltaport. It accommodates vessels with a draft of 11.5 m, and has seven berths, with rail connections. In a typical year it handles over 400 deep-sea vessels with over 2 million tonnes of cargo, including over 250,000 TEU of container traffic.

This facility is regarded to be too distant for any synergistic or additive effects on ecosystem receptors to act in concert with Deltaport, and is not considered further.

Coastal / Riparian Modification

- Dykes have been constructed on the edge of the Fraser River for many years. Their purpose is to train the river and protect adjacent agricultural, residential and commercial land in the lower Fraser floodplain. Construction of dykes has limited the naturally dynamic nature of the river and maintained channels in one location. Previously the river has flowed in various locations across the floodplain between the Burrard Peninsula and Point Roberts. Limiting the lateral movement of the river reduces its diversity and can isolate it from large areas of habitat and resources. Reduced diversity and isolation from habitat negatively affect the river ecosystem including the fish that depend upon it (Church 2002).

The contribution of these developments to limiting fish habitat, and in turn affecting fish populations, in the lower stretches of the Fraser River is important, but they are unlikely to act in concert with effects from Deltaport and will not be considered further

- Dredging of the Fraser River began in 1885 because the main channel at the river mouth was not deep enough for vessel passage (NHC 2002). Sediment eroded from the catchment settles along the length of the Fraser River, but in the lower Fraser River the very wide channel and low gradients contribute to greatest accumulation. Demand by the shipping industry for navigation channel maintenance, and the increased need for dredged material by the construction industry have continued the requirement for dredging to the present day.

Dredging reached a maximum between 1975 and 1990 when volumes often exceeded 7 million m³ per year. Recent studies conclude that removing approximately 70% of the sediment inflow is an appropriate management target to maintain shipping channels and prevent flooding. Between 1997 and 2001 approximately 0.75 to 1.8 million m³ of material per year was removed, approximately 50% of sediment input. Sediment from dredging is either placed in an ocean disposal site, or is deposited in underwater transfer pits in the river, which are later removed by pumping onshore.

The lower Fraser River continues to adjust its morphology and sediment transport in response to the cumulative impacts of past dredging, river training and changes in flow regime. These adjustments appear to develop slowly and may be ongoing for decades.

The alteration to the sediment balance in the Fraser River is of relevance to this cumulative effects assessment as it affects the distribution of sediment by coastal processes.

Railways

- The mainline railway to Roberts Bank begins in Fort Langley 44 km to the east of Deltaport. Four different railways own this section of track: Canadian National, Burlington Northern Santa Fe, Canadian Pacific and B.C. Rail. The mainline ends at Gulf Siding adjacent to Deltaport Way where incoming or outgoing Roberts Bank Port trains are temporarily stored. On the causeway there are multiple tracks that are used to store cars and assemble trains.

With the current Roberts Bank port operations there are 18 train movements per day to service Deltaport and Westshore. This consists of three trains each way for the Deltaport Container Terminal and 12 trains arriving and departing Westshore.

The effects of this rail activity are in conjunction with the Project are noise and impacts to traffic congestion. Although there are acknowledged impacts to air quality from railways, there are insignificant inputs of air pollution from Deltaport Third Berth, thus there is little likelihood that these two projects will cumulatively affect air quality.

Roads

- Deltaport Way is a two-lane provincial highway that connects the Roberts Bank Port to Highway 17, and the remainder of the provincial highway network. Traffic on Deltaport Way is primarily destined for the port facilities and includes trucks with freight, employee vehicles, and service vehicles. Highway 17 south of the intersection with Deltaport Way services the community of Tsawwassen and the B.C. Ferries terminal. Other local roads service the communities of Tsawwassen

First Nation and Ladner, and rural housing and agriculture located adjacent to the Roberts Bank port.

Traffic congestion and noise from vehicles will be assessed by this cumulative effects assessment. Although there are acknowledged impacts to air quality from traffic, there are insignificant inputs of air pollution from Deltaport Third Berth, thus there is little likelihood that these two projects will cumulatively affect air quality.

Residential Developments

- The Tsawwassen First Nation is a community of 174 people who live adjacent to the causeway to Deltaport at Roberts Bank in Delta.
- Ladner, population 21,360, is 3 km to the east of Deltaport and south of the Fraser River. It is the closest large residential area to Deltaport and is the original fishing and agricultural village in Delta. Traffic congestion is the only interacting issue.
- Tsawwassen is a residential community with 21,330 people. Traffic congestion is likely to be the only issue where effects from this residential area interact with those from Deltaport.
- North Delta is the largest residential area in the municipality located on the forested hills north east of Deltaport and north of Mud Bay. Traffic congestion is the only issue that interacts with effects from Deltaport.

Adjacent Land Use

- On the land adjacent to Roberts Bank is an area of agricultural activity. This area would have formerly been wetlands, however land reclamation has converted it into farmland for a variety of crops and livestock. These activities produce organic (effluent) and inorganic (fertilisers, pesticides and herbicides) residues, some of which find their way through stormwater systems into the Roberts Bank area. The contribution of the organic residue to marine eutrophication in the inter-causeway area will be examined in this CEA.

Other

- Overhead power and telephone utility lines, usually on railway line and road rights of way, are common in the area. These can affect birds through collision risk, and potentially act cumulatively with the utility lines on the Roberts Bank port causeway.

23.3.3 Scoping Future Projects / Activities

Sea terminals

- The Roberts Bank Container Expansion Program is a Vancouver Port Authority initiative to expand container-handling facilities at the Roberts Bank port. The program will initially add a third berth to the existing Deltaport container terminal, followed by the development of a new three-berth container terminal, known as Terminal 2. Terminal 2 and Deltaport Third Berth are independent projects. Each will be subject to separate environmental assessment processes. The Third Berth Project has entered the assessment process under CEAA and BCEAA and is under consideration in this document. The Terminal 2 Project has not entered the CEAA process, though a letter of intent has been lodged with BCEAA.

The Third Berth project includes construction of 20 ha of land for container operations and storage, a wharf to accommodate a new ship berth, dredging to accommodate marine traffic adjacent to the terminal and a new tug mooring area.

The Terminal 2 Project proposes the development of another container terminal facility at Roberts Bank Port. The Terminal 2 project description has not been fully defined, as detailed environmental, technical and social studies are still being conducted. It is anticipated that the new terminal will include the construction of approximately 80 to 100 ha of new land for terminal infrastructure, the construction of a wharf to accommodate three additional ship berths, eight to ten gantry cranes and on-site container storage and intermodal facilities. Four possible terminal locations are being assessed, and a preferred location has been chosen. However, the terminal configuration has not been

established. The VPA will ultimately undertake an environmental assessment of the selected option.

The contribution of the Terminal 2 expansion to cumulative environmental effects is unknown because details for the development have yet to be finalised. It is likely that effects of the proposed Terminal 2 will impact on coastal geomorphology, and the flow-on from this to marine habitats and ecological components. Light and noise pollution may also be issues of concern. Although there are potential impacts to air quality from Terminal 2, there are insignificant inputs of air pollution from Deltaport Third Berth, thus there is little likelihood that these two projects will cumulatively affect air quality.

A separate environmental assessment will be conducted for the Terminal 2 expansion to consider these issues. However, until details of the size and nature of the development and its operation is known the cumulative effects analysis, like those for all proposed projects, will be speculative. The separate environmental assessment of Terminal 2 would consider that cumulative effects of Terminal 2 in combination with the Deltaport Third Berth Project, should the latter proceed.

- The B.C. Ferries terminal at Tsawwassen has no known expansion plans. However, they have announced the addition of three new super C-class (160 m long, 1650 passengers and 370 vehicle) ferries. Some of these, which are slightly larger than the existing C-class vessels, will use the terminal at Tsawwassen in addition to the existing ferries (BC Ferries 2004).

This could result in more ferry visits to the B.C. Ferries terminal, with a likely increase in impacts on noise (more frequent sailings) and possibly light if increased hours of operation are instituted. Although there are potential impacts to air quality (more vehicles and ferries), there are insignificant inputs of air pollution from Deltaport Third Berth, thus there is little likelihood that these two projects will cumulatively affect air quality.

- Fraser Surrey Docks announced an upgrade to its facilities in March 2004. This includes two new container gantry cranes, a large mobile harbour crane (certified for operation in July 2004) and the creation of a new intermodal yard. The 7.5 ha

intermodal yard and a 2.8 km extension adjacent rail holding yard are being built adjacent to the marine terminal on existing Fraser River Port Authority land in Surrey. The aim of these expansions is to boost container capacity to 415,000 TEUs and improve efficiency. A second phase, to take capacity to about 600,000 TEUs, could proceed if container growth continues.

Like the existing facility, the expansion is too distant for any shared effects on ecosystem receptors with Deltaport to act in concert, and it is not considered further in this assessment.

Coastal / Riparian Modification

- In conjunction with the potential Terminal 2 Project, there may also be a requirement for the expansion of the existing causeway to accommodate additional railway infrastructure. The extent of the proposed causeway widening is subject to engineering design and environmental impact assessment.
- Dredging activities will continue into the foreseeable future to maintain the existing Fraser River shipping channels while maintaining the environmental and structural integrity of the estuary. Dredging activities will be governed by dredge management guidelines released by the Fraser River Estuary Management Program (FREMP undated).

Railways

- Two existing tracks will be extended at the Gulf Siding east of 57B Street to 64th Street, and two additional railway tracks will be constructed on the causeway in association with the Deltaport Third Berth Project. These works are entirely contained within the existing railway right of way, and can be accomplished without widening the causeway. These developments are designed to accommodate the additional rail traffic predicted from the Third Berth Project.

Three additional trains per day are expected as a result of the Third Berth Project to accommodate additional container traffic associated with Deltaport.

- The potential Terminal 2 Project will require additional rail infrastructure, including storage tracks at Roberts Bank and mainline improvements. An

assessment of the rail needs for Terminal 2 is yet to be completed, but initial review indicates that the causeway may need to be widened to accommodate additional support track. An assessment of the mainline operations through Delta, Surrey and the City and Township of Langley will also be undertaken to assess future rail requirements associated with the Terminal 2 Project.

The effects of both these projects are likely to be increased noise and effects on traffic congestion at level crossings inland of the causeway.

Roads

- The B.C. Ministry of Transportation has proposed the South Fraser Perimeter Road (SFPR) project. This is a high standard (80 km/h) four-lane highway with grade-separated interchanges in the municipalities of Delta and Surrey. The proposed route is along the south bank of the Fraser River from the 184th Street in Surrey (with links to the new Fraser River Crossing project and Highway 1) west to Deltaport Way at Highway 17. The exact route of the SFPR in the vicinity of Ladner has yet to be determined.

The effects of the South Fraser Perimeter Road, which may act in concert with those of the Deltaport Third Berth terminal, include noise and traffic congestion related impacts. Although there are potential impacts to air quality from traffic, there are insignificant inputs of air pollution from Deltaport Third Berth, thus there is little likelihood that these two projects will cumulatively affect air quality.

- The Corporation of Delta in partnership with the VPA and the MOT are improving the intersection of 41B Street and Deltaport Way. This includes re-aligning the north leg of the intersection to allow for improvements to the east/west movements from 41B Street. When these improvements are completed intersection operations will be improved when trains occupy the south leg of the intersection.

Residential Developments

- The Corporation of Delta Official Community Plan indicates likely maximum long-term maximum population targets for communities in the area to be:
 - Tsawwassen; 23,672 people, a 10 % increase to the present population;
 - Ladner; 21,367 people, a 19 % increase to the present population; and
 - North Delta, 53,994, a 4 % increase to the present population.
- The TFN has identified long-term community requirements that would be developed on their proposed treaty lands. Details of this opportunity are still to be determined.

Most of these increases in population are expected to be infill housing in existing residential locations in Ladner and North Delta.

23.3.4 Scoping Spatial and Temporal Boundaries

All temporal boundaries were based on the current studies for this EA Application. Most of these were conducted between 2002 and 2004, however for standardisation all are indicated as 2003.

Coastal Geomorphology - Spatial and Temporal Boundaries

The spatial boundary of the coastal geomorphology study area is the tidal environments influencing and influenced by Deltaport. These are Roberts Bank from the top of the fore-slope to high water, and Canoe Pass to the B.C. Ferries causeway. The temporal baseline is conditions at Roberts Bank in 2003. This is the most recent data on pre-existing conditions.

This assessment acknowledges there have been changes in the coastal environment as a result of impacts from earlier developments (**Chapter 7 Coastal Geomorphology**). While setting the baseline condition as pre-development on Roberts Bank (pre 1958) may be desirable, this is not practical for two reasons. First, the required level of information about the coastal environment and geomorphic processes does not exist. For example there is little information about the tidal flats from before the mid 1970s, when studies of eelgrass growth, distribution and establishment were conducted (Triton 1996). Second, there is no ability to adequately discriminate between

changes from the terminal developments, and other changes such as alterations to the Fraser River channels and dredging activities.

Further complications to using a previous date as a baseline are due to the dynamic nature of the coastal environment at Roberts Bank. Even under natural conditions there would have been regular changes as a result of processes like shifting channels in the Fraser River, large unmitigated floods and regular freshets. For these reasons 2003 has been used as the baseline.

Water Quality - Spatial and Temporal Boundaries

The study area for potential cumulative effects on water quality and particularly circumstances that might lead to marine eutrophication is a 5 to 7 km radius from the existing Roberts Bank port. It is limited to the northwest by the main arm of the Fraser River, and the southeast by the B.C. Ferries causeway. The inter-causeway area is of particular interest because it is the only location on Roberts Bank where nutrient inputs in combination with reduced wind and tidal activity, which would otherwise mix and distribute nutrients causing eutrophication, could occur. The temporal baseline is conditions in 2003.

Ecology - Spatial and Temporal Boundaries

The study area for cumulative effects on ecology extend from Canoe Pass to the base of the B.C. Ferries causeway along the Brunswick and Tsawwassen marshes shoreline, seaward to the edge of the fore-slope of Roberts Bank and along the edge of the fore-slope to Canoe Pass. The marine mammal boundary is a 7.5km radius from the proposed Project site, but information for some species of marine mammals and birds from beyond the study area was also used.

Where possible this analysis of cumulative effects on ecology at Roberts Bank was informed by previous studies that indicate historical presence and distribution of biota. However, this was not possible for all biota, or the information was not reliable. As a result the temporal baseline for this assessment is taken as the time when the current studies were undertaken in 2003.

Noise - Spatial and Temporal Boundaries

The study area is the Deltaport facilities and causeway, residential communities adjacent to the B.C. Rail line east to 156th Street in Surrey, and residential areas in close proximity to the shoreline extending from the Roberts Bank causeway south to Tsawwassen Beach. Residential

communities to the east (Panorama Ridge, Colebrook, Woodward's Hill and Sullivan) were included because they overlook the rail line, which serves Roberts Bank almost exclusively. The temporal baseline for this study is the noise condition measured in 2003.

Traffic - Spatial and Temporal Boundaries

The study area is Deltaport Way, the Highway 17 corridor to the Highway 99 intersection, Highway 99 from Massey Tunnel to North Delta, River Road and rail lines leading to Deltaport. A smaller area was used for predictive modelling of Deltaport Third Berth effects. The temporal baseline is 2003 conditions.

23.4 ANALYSIS OF EFFECTS

Where there are interactions between ecosystem receptors for each VEC, and past, present or future projects there is potential for cumulative environmental effects. The following sections are the analysis of significance for each ecosystem receptor.

23.5 COASTAL GEOMORPHOLOGY ANALYSIS

Based on the significance criteria used in the effects assessment (**Chapter 7 Coastal Geomorphology**) there are no significant effects of the Deltaport Third Berth Project on the coastal environment or processes at Roberts Bank. Changes continue to occur as a result of earlier developments, but the impact assessment showed no increase in the magnitude or extent of these after the introduction of the Deltaport Third Berth Project.

While this would generally dictate that no cumulative effects assessment on coastal geomorphology processes is required, the role of these processes in shaping habitat for biota (**Section 23.9 Ecology Analysis**) is important enough to justify undertaking a cumulative effects assessment.

23.5.1 Coastal Geomorphology Ecosystem Receptors

Distribution of marine habitat is the ecosystem receptor assessed for cumulative effects on coastal geomorphology. The coastal environment, and by definition the processes that create it, dictate marine and intertidal habitats for biota. Characteristics like elevation (level of tidal inundation), salinity, substrate texture, sediment mobility, organic content and water clarity all

play a role in the distribution of marine and terrestrial biota. Alterations to the coastal environment are reflected in change in the distribution of habitat for particular biota.

23.5.2 Marine Habitats

Marine Habitats - Historic trends and conditions due to existing projects

Alteration in coastal processes governing tidal flat morphology and physical habitat such as tide direction and magnitude, waves and influx of the Fraser River sediment plume all caused by causeway development and dredging for the B.C. Ferries and Roberts Bank port terminals has resulted in the development of drainage (dendritic) channels. The key actions leading to this were dredging the ship turning basin, which triggered headcutting, and expansion of eelgrass over the flats, which promoted flow concentration.

Prior to dredging, the tidal flats extended at a nearly constant gentle slope before reaching the steep fore-slope leading to the sea floor. The slope of the tidal flats was in equilibrium with sediment erosion and deposition. Excavation of the ship turning basin created a step in the tidal flat profile that was above the lowest low water level. After the excavation, flow draining off the tidal flats near low tide intersected the edge of the excavation, and drainage channels were initiated by headcutting (**Figure 7.13**).

Eelgrass beds on Roberts Bank have expanded by approximately 33 % in area, from 377 ha in 1967 to 500 ha in 2003. The primary cause appears to be lowering of the tidal flats through altered sediment transport (net erosion), allowing the desiccation intolerant eelgrass to occupy more area of Roberts Bank (**Chapter 7 Coastal Geomorphology**). There are also a number of other inter-related reasons (Triton 1996):

- increase in water clarity and light penetration due to causeways preventing sediment-laden Fraser River water, which previously limited eelgrass growth;
- initiation of a positive feedback loop that promoted further expansion of eelgrass beds through ponding of water and stabilisation of the substrate (Triton 1996);
- introduction of the non-native eelgrass *Zostera japonica*, which occupies higher (and drier) habitat than the native *Z.marina*; and

- modification to tidal drainage pathways, which has likely accelerated the spread of eelgrass species by the spread of seeds and rhizomes.

The physical presence of eelgrass beds on the tidal flats appears to be playing a major role in the expansion and maintenance of the tidal-flat channels by increasing flow resistance. Increased flow resistance results in reduction in flow velocity within the eelgrass beds, and a drainage lag that causes a head differential between the tidal flats and the tide level in the open water.

Most of these long-term morphological changes were associated with tidal drainage channel formation in the inter-causeway area or channel shifting near the outlet of Canoe Passage. Future morphologic changes in the vicinity of Deltaport are expected to be minor. However, it is apparent that the network of drainage channels that formed after the earlier port developments is still evolving and has not reached equilibrium. In particular, the largest drainage channel is still extending in both seaward and landward directions. The large area of deposition near the head of the trunk channel also appears to be extending further landward and accreting to a higher elevation. Based on these studies, it appears the main trunk channel will continue to migrate landward. The zone of sand deposition at the head of the channel will also shift landward. There is also a chance that the smaller drainage channel to the east may also continue to grow, particularly if the outlet can by-pass the crest protection structure by joining with the larger channel along the creek.

Marine Habitats - Contribution of Deltaport Third Berth and other future projects

Of the projects and activities outlined in this assessment the existing terminals, the proposed Deltaport Third Berth and Terminal 2 developments, and dredging activities in the Fraser River affect marine habitats in the study area.

The proposed Deltaport Third Berth Project is not expected to initiate any new tidal channels because the planned excavation will be in deep water, well below the low tide line. As a result, there will not be further tidal flat erosion or triggering of headcutting. Furthermore, the main structures associated with the Deltaport Third Berth Project will not affect tidal current patterns or waves sufficiently to initiate scour or erosion.

The Terminal 2 development plan has not been finalised, and as a result an assessment of any potential effects on sediment distribution patterns, currents and waves has not been undertaken. However, an assessment of any interacting effects between the Deltaport Third Berth and a conceptual location for the proposed Terminal 2 development has shown that there is no synergistic interaction between the two projects.

Marine Habitats - Mitigation of Effects

The need for mitigation will be avoided if developments do not alter current and wave patterns such that sediment distribution patterns are changed. The Deltaport Third Berth achieves this by avoiding dredging in locations above the lowest low water tide level. Above this level dredging can initiate scour or erosion involved with headcutting on the tidal flats, potentially leading to the creation of dendritic channels and the alteration of sediment transport regimes. Such changes can be mitigated through the construction of coastal protection structures, though to date these have had limited success at Roberts Bank because they have not been planned and constructed in advance of dredging.

23.5.3 Coastal Geomorphology - Significance of Effects

There are no cumulative effects as a result of the Deltaport Third Berth on coastal geomorphology. However, the ongoing change in coastal geomorphology processes that has been brought about by existing projects and activities has caused a significant cumulative effect on landforms from marine habitats at Roberts Bank; these changes are unaffected by the development of the Deltaport Third Berth.

The contribution of future projects such as Terminal 2 on Roberts Bank is at present unknown because details such as site footprint and size, which are needed to undertake precise coastal process modelling, have not been determined. What is known is that there will be no synergistic effects between the existing Roberts Bank terminals with the Deltaport Third Berth in place and a conceptual design location for Terminal 2. When details for Terminal 2 are known, its potential effects on Roberts Bank will be the subject of an environmental impact assessment similar in scope to this one for Deltaport Third Berth.

23.6 WATER QUALITY ANALYSIS

No residual effects on water quality were identified in the assessment conducted for the EA Application (**Chapter 8 Water Quality**). However, there is sufficient concern for water quality, as it is the basis for marine life, so its inclusion in the cumulative effects assessment is justified. Discussion on marine eutrophication is also included in the marine environment chapter, specifically **Section 10.11.1 Marine Eutrophication**.

23.6.1 Water Quality Ecosystem Receptors

A number of parameters were quantitatively tested in the water quality assessment for the EA Application. For this assessment of potential cumulative water quality effects, a qualitative assessment of parameters that lead to marine eutrophication (dissolved oxygen – DO, phytoplankton biomass – chlorophyll *a*, and nutrients such as ammonia - NH₄-N) was conducted.

23.6.2 Marine Eutrophication

Construction of the B.C. Ferries terminal in 1958 and the subsequent development of the Roberts Bank port facilities, starting in 1968 with the port causeway and coal terminal, affected the Roberts Bank coastal environment. Concern has been raised over the potential for marine eutrophication in the intercauseway area (between the Roberts Bank port and B.C. Ferries terminal) due to the cumulative environmental effect of these structures and associated activities.

Marine eutrophication has no globally accepted definition, but a simple explanation is “an increase in the supply of organic matter” (Nixon 1995) caused by the direct effects of nutrient enrichment increasing productivity and organic material, which is not consumed by grazing insects and animals. The extreme and ultimate effects of eutrophication include growth of macroalgae, oxygen depletion and species mortality (Gray 1992). For this assessment, marine eutrophication is defined as an enrichment of nutrients in the intercauseway area that affects, or has the potential to affect, the health and stability of the marine ecosystem at Roberts Bank.

For marine eutrophication to arise, a number of factors and conditions have to occur. There has to be a source of increased nutrients in the ecosystem, nitrogen and phosphorous being the most problematic. The second is an impediment to tidal flushing, which would otherwise mix and

flush the system, and exchange the water/algal biomass accumulations with “new” marine water. Changes to tidal systems that decrease or increase flushing rates affect the marine eutrophication process. Slow moving or stagnant waters allow nutrient concentrations to rise in the water column, triggering the eutrophication process and reducing biological productivity. Increased tidal flushing dilutes nutrients and moves them away from aquatic plants, making them less available to trigger the marine eutrophication process.

Marine Eutrophication - Historic trends and conditions due to existing projects

A number of factors in the intercauseway area influence the potential for marine eutrophication: water quality; coastal geomorphology; and the marine environment.

Water Quality

Water quality parameters that indicate and or contribute to eutrophication were assessed.

- **Dissolved Oxygen (DO).** Eutrophication may give rise to an increased rate of oxygen consumption, decreased oxygen concentrations, and an increased frequency of oxygen depletion in the water column. In general, surface waters on Roberts Bank are more oxygenated than deeper waters. This is natural because oxygen enters the water column from the surface. During water quality studies on Roberts Bank (2004) 24 of 99 DO samples were below the chronic provincial Water Quality Objective (WQO) of 8.0 mg/L (mean of 5 samples collected in a 30-day period) (Swain *et al.* 1998), however none of the samples were below the instantaneous minimum objective of 5.0 mg/L. All of the low DO measurements were taken from deep water. Based these results, no harm to DO-sensitive species (salmonids) is expected.
- **Inorganic Nutrients (Nitrogen and Phosphorus).** Nitrogen is measured as ammonia nitrogen (NH₄-N), nitrate nitrogen (NO₃-N), and nitrite nitrogen (NO₂-N) and phosphorus as dissolved ortho-phosphorus (ortho-P). Input of nutrients such as nitrogen and phosphorus to the ocean is a natural phenomenon that becomes a problem when inputs are so high that ecosystem functions are affected. Ammonium in the form of nitrogen is taken up most readily by phytoplankton. Phosphorus is found in water bodies in dissolved and particulate forms. Dissolved phosphorus is

readily available for use by plants, and consists of inorganic orthophosphate and organic phosphorus-containing compounds.

Based on the water quality study conducted from May to October 2004 (spring and summer growing seasons), $\text{NH}_4\text{-N}$ and ortho-P concentrations were generally similar across Roberts Bank, and at all depths. Concentrations of $\text{NO}_3\text{-N}$ were up to five times higher closer to the Strait of Georgia than close to land. $\text{NO}_2\text{-N}$ concentrations were below detection limits in all samples. $\text{NO}_3\text{-N}$ concentrations were lowest southeast of the Deltaport terminal, whereas ortho-P concentrations appeared to decrease slightly from north to south. All measured ammonia-N ($\text{NH}_4\text{-N}$) concentrations were non-detectable or below half of the 30-day average WQO guideline therefore, ammonia related toxicity is not expected.

Based on the water quality data collected for nitrogen and phosphorus levels in the peak biomass period (growth of eelgrass), nutrient enrichment does not appear to be occurring in the intercauseway area. The potential for introduction of anthropogenic-derived nutrients could increase over the winter with increased rainfall and runoff.

- **Chlorophyll *a*** is a green pigment in plants that absorbs sunlight and converts it to sugar during photosynthesis. Chlorophyll *a* concentrations are an indicator of phytoplankton abundance and biomass. High levels of chlorophyll *a* can indicate poor water quality, chlorophyll *a* levels fluctuate naturally with the seasons; rainfall, and warm summer water temperatures and light levels lead to greater phytoplankton numbers, and therefore high chlorophyll *a*. However, long-term elevated concentrations of chlorophyll *a* can reflect an increase in nutrient loads and increasing trends can indicate eutrophication.

Based on the sampling to date (May to October 2004), chlorophyll *a* concentrations were consistently higher closer to land, particularly during June. However, no relationships between any of the individual nutrients concentrations and chlorophyll *a* concentration was observed as part of the water quality study.

Coastal Geomorphology

Nutrient loads alone cannot predict marine eutrophication because they vary as a function of nutrient loading and bio-availability of nutrients, and the extent to which hydrodynamic features (*e.g.* water volumes, residence times and extent of mixing) moderate the stimulatory effects of nutrients on plants and algae.

Studies undertaken for the Project (**Chapter 7 Coastal Geomorphology**) indicate that tidal flushing occurs in the intercauseway area. The eelgrass beds tend to retain water on the ebb tide reducing flow velocities over the tidal flats, but the dendritic channels or tidal creeks tend to concentrate flow, “flushing” the intercauseway area. The amount of flushing in the intercauseway area provides further evidence that marine eutrophication is unlikely to be occurring.

Marine Environment

Decline in eelgrass growth can be an indicator of marine eutrophication, because high numbers of phytoplankton and free-floating macroalgae reduce water clarity, shading eelgrass and leading to a decline in eelgrass distribution (Duarte 1995).

Roberts Bank and the intercauseway area have an abundance and diversity of marine species (**Chapter 10 Marine Environment**). The marine study identified over 32,000 individuals from at least 76 macroinvertebrate species on both sides of the Roberts Bank port causeway, and eelgrass habitat appeared more diverse than other marine habitats.

At Roberts Bank the health (increase in size) of eelgrass beds and high species diversity in the intercauseway area indicates that marine eutrophication is unlikely to be occurring.

Roberts Bank Nutrient Input Sources

The main source of nutrients for Roberts Bank is the Fraser River. In 1979, up to 60% of the municipal and industrial effluents of Vancouver were discharged to the Fraser River, and approximately 85% of the nutrients from the Fraser River end up on Roberts Bank (JWEL 2001). Discharges to the Fraser River have a long history of pollution, and include wastewater treatment plants and industrial effluent inputs, and agricultural and

urban runoff. More recent surveys indicate the nutrient loadings from the Fraser River meet relevant water quality objectives.

Additional nutrient inputs to the study area, with information on discharges, include:

- The Westshore Coal terminal has a wastewater plant to treat water used for coal dust suppression, and sewage. Discharges are not monitored for nutrients (oil, grease, suspended solids and toxicity are monitored), but an incidental nitrite and ammonia survey indicated the discharges were low and inconsequential (JWEL 2001).
- The existing Deltaport container terminal has a secondary sewage treatment plant approved by a Ministry of Water Land and Air Protection effluent permit to discharge treated effluent into the Deltaport ship berth area 12 m below mean low water. Discharges are monitored for 5-day biochemical oxygen demand (BOD₅), total suspended solids (non-filterable residue) and toxicity. The treatment plant treats water collected from domestic and industrial wastewater and wash down areas.
- The TFN wastewater treatment plant located in the intercauseway area provides secondary sewage treatment. In the past, the plant has not exceeded any water quality parameters, nor did it exceed background concentrations (IRC 1997 in JWEL 2001).
- The Brandrith pumping station on the north side of the B.C. Ferries causeway drains about 1,000 ha of urban and agricultural land adjacent to Roberts Bank. In the past phosphorous concentrations have exceeded objectives at this location (JWEL 2001).
- Non-point source surface water discharges from urban and agricultural land runoff (fertiliser, and animal waste) occur along the Roberts Bank foreshore. The water quality of these discharges is diverse and not well characterized.
- Liquid discharges from container and bulk cargo ships sewage treatment plants have the potential to release nutrient laden effluent. However, when in port or at

anchor ships routinely hold the treated effluent in ship-board tanks for discharge later when the ship is underway and away from land. This is a requirement under the International Convention for the Prevention of Pollution from Ships at Sea (MARPOL) Annex IV 73/78 and enforced locally by Transport Canada.

- Nitrogen can also return to the marine environment via nitrogen in air emissions that result from the burning of fossil fuels.
- Natural occurring sources of nutrients primarily include the decomposition of algal biomass in the intercauseway area. The Roberts Bank eelgrass beds represent a large source of algal biomass available for decomposition. Eelgrass beds at the Project site have expanded by approximately 33 % since 1967.

Prior to 1993 the B.C Ferries terminal discharged treated effluent to Roberts Bank, today it is connected to the Delta municipal wastewater system.

The water quality parameters tend to indicate that eutrophication is not likely occurring, but further monitoring of water quality indicators would provide a more definite indication on localized and short-term eutrophication processes.

Marine Eutrophication - Contribution of Deltaport Third Berth and other future projects

Construction and operation of the Deltaport Third Berth will generate a small increase in anthropogenic nutrients, which the existing sewage treatment facility can adequately process. Storm water from the expanded facility will pass through an oil interceptor and sedimentation tank for treatment before it is discharged to the ocean.

There is potential for increases in nutrient loadings from the Brandrith pumping station, the TFN wastewater treatment facility and non-point sources, as land uses change and population increases in the future. Any increase in population, particularly if the TFN seek to develop more residential use on their land, is at present unknown. Any such developments would be addressed by specific environmental impact assessments. However, monitoring of the existing point discharges should be considered by the applicable regulatory agencies to address any changes in nutrient loadings in the future.

The proposed Deltaport Third Berth Project is not expected to alter the tidal flushing that would result in hydrodynamic conditions that would trigger the eutrophication process.

Marine Eutrophication - Mitigation of Effects

There will be no effects from the development of the Deltaport Third Berth on water quality parameters that could lead to eutrophication; as a result no further mitigation is required. In addition, other existing and known future activities with nutrient inputs to the study area do not exceed thresholds that are likely to lead to eutrophication. Mitigation for such effects, such as existing treatment facilities and procedures, appear to be adequate for the current level of anthropogenic nutrient inputs.

23.6.3 Water Quality - Significance of Cumulative Effects

The indication is that there no cumulative effects on water quality parameters associated with the Deltaport Third Project that could lead to marine eutrophication in the intercauseway area. All discharges to the area are within water quality objectives, and understood to be under the threshold likely to cause a concern. Decomposition of eelgrass leading to nutrient enrichment and the triggering of macroalgae growth does not appear to be occurring as the intertidal areas appear to have adequate tidal flushing and mixing. The VPA will continue to monitor the water quality trends at Roberts Bank over the next year, including indicators of marine eutrophication.

23.7 ECOLOGY ANALYSIS

No significant residual environmental impacts from the Project to ecology (marine and terrestrial biota) were identified. This would ordinarily indicate no cumulative effects assessment is necessary. However, Roberts Bank is an important ecological area for the lower Mainland, and contributes ecologically to other areas, particularly in respect of providing resources for migrating birds on the Pacific flyway. As a result of the value of the area, the potential for cumulative effects on ecological components are addressed here.

23.7.1 Ecology Ecosystem Receptors

The ecosystem receptors chosen to represent the potential for cumulative effects on ecology are:

- marine biota;
- birds; and
- marine mammals.

The distribution and number of marine biota; macroinvertebrates (including Dungeness crabs), birds and fish (including salmonids) are dictated by the presence of their habitat. For both marine mammal and bird populations an assessment of presence and distribution was also undertaken.

23.7.2 Marine Biota

Marine Biota - Historic trends and conditions due to existing projects

Prior to intensive marine and coastal developments, Roberts Bank consisted of gently sloping, homogeneous sand and mud flats (including eelgrass areas) from near high water into and beyond low water. On the coastline were freshwater marsh and bog habitats. Construction of the causeways for the two terminals, introduction of non-indigenous species, dykes for agriculture and controls on the Fraser River have altered habitats at Roberts Bank (**Section 23.5 Coastal Geomorphology Analysis**), and the biota that depend on them. An assessment of the historic trends and existing conditions for each habitat type is presented below.

All the intertidal (brackish and salt) marshes at Roberts Bank have developed in the last 100 years after dykes for reclamation of agricultural land were constructed. Brackish marshes (exclusively around Brunswick Point) support a high diversity of vegetation fish and birds because the interplay between saline and fresh water allows biota that can tolerate both. Species supported by this habitat include juvenile salmonids and waterfowl, piscivorous and wading birds. Salt marshes are also relatively new at Roberts Bank having been either formed against the causeways, or after dyke construction. Salt marshes are important for primary production, providing food for other parts of the Roberts Bank ecosystem. They are particularly important year-round for the feeding, resting and roosting of dabbling ducks.

Intertidal sand and mud flats are distributed north of the Deltaport causeway, and in the inter-causeway area. They were the dominant habitat on Roberts Bank. However, intertidal sand and mud flats have decreased since: dyke construction initiated salt and brackish marsh formation; and causeway developments began the process of eelgrass invasion, dendritic channel formation and tidal flat erosion. Some of this habitat is now covered in eelgrass; the remainder supports filamentous algae, bivalves, Dungeness crabs

and other invertebrates and fishes such as sculpins, salmonids and flounder. These areas have the highest diversity of invertebrates, with 120 species being found there. The combination of good primary productivity and a nursery habitat for juvenile fish and invertebrates (cockles and crabs) makes these areas valuable for recruiting to adult stock and providing resources to other parts of Roberts Bank. They are also important habitat for migrating shorebirds; herons and gulls use tide pools to forage on invertebrates.

Eelgrass has expanded approximately 33 % in area, from 377 ha in 1967 to 500 ha in 2003, since the construction of the two causeways. This expansion has taken place at the expense of intertidal mudflat, and has been driven by the erosion of the intertidal mudflat, lowering the base level relative to tides, gradually creating an environment where the desiccation intolerant biota (eelgrass) are favoured over other species. This has provided more habitat for fish and invertebrates, and feeding areas for dabbling ducks, geese and swans, piscivorous birds and coastal seabirds. Some of the expansion of eelgrass has also been due to invasion by the exotic eelgrass species *Zostera japonica*, which occupies a higher, and hence drier, position on the intertidal flats than the native *Zostera marina*. Eelgrass elsewhere in North America is generally declining in extent.

Subtidal sand and mud have increased on Roberts Bank since causeway construction due to more areas of deeper water being created by dredging of ship basins and the creation of dendritic channels. These areas have limited amounts of eelgrass and seaweed (macrophytes) vegetation, and at greater depths macrophytes cease to be present. In shallow areas plover, dabbling ducks and shorebirds forage among the macrophytes on macroinvertebrates. Dungeness crabs are present, especially in areas with finer sediments, and anoxic conditions. Detritus in these areas provides food for crabs, clams and shrimp. English and Dover sole, flounder and lingcod are present here.

There were no areas of intertidal or subtidal rock on Roberts Bank prior to causeway construction or placement of marine protection devices. Rip rap and other hard substrate constructions have provided man-made habitat for fish, including salmonids, lingcod, copper rockfish and many other smaller fishes, that use it for refuge and foraging on the diverse algal cover. Piscivorous birds, diving ducks and shorebirds utilise this habitat,

particularly terns, cormorants and gulls feeding on the smaller fish living among the crest protection and rip rap structures.

Marine Biota - Contributions of Deltaport Third Berth and other future projects

The marine habitats on Roberts Bank continue to change as a result of the cumulative effects of the causeway developments, dredging on the Fraser River and coastal protection structures (dykes and stopbanks). Associated changes to marine biota that utilise these habitats has also not yet reached equilibrium. Eelgrass continues to expand at the expense of intertidal mud flats, intertidal mudflats are eroding and becoming deeper relative to sea level, and salt marshes may continue to develop against the causeways. The construction of the Deltaport Third Berth is not predicted to contribute further, as there are no alterations to waves and currents that manifest in changes to sediment movement or distribution.

There will be effects on habitat for marine biota as a result of the construction of the Third Berth because the footprint will remove some habitat (**Table 23.3**). These effects are adequately described in **Chapter 10 Marine Environment**, but a few of the pertinent features are repeated here. Dungeness crab habitat on intertidal mud flat will be lost, this is not considered to be significant as the habitat will be compensated for, and habitat will likely re-establish along the new Deltaport Third Berth shoreline. Further efforts will be made to relocate juvenile and adult crabs during construction to a suitable location. Loss of subtidal mud flats will not have an effect because the species depending on this are largely mobile (fish and crabs), and will likely relocate. In addition disturbance will only take place during non-critical times in the life cycles of these species. Salt marsh and eelgrass/mudflat habitat will be recreated in compensation for that lost under the footprint. Eelgrass/mudflat and saltmarsh habitat is regarded to be more productive than intertidal mudflats, and the habitat compensation proposed ensures no net loss of productive habitat. In addition the proportion of these habitat types lost are small in relation to the study area (**Table 23.3**). Intertidal rock habitat will be temporarily lost, but after construction of the Third Berth is complete this will be replaced with more habitat resulting in a net gain of 0.15 ha.

Table 23.3 Substrate Composition of the Deltaport Third Berth Project Footprint.

	Third Berth footprint area (ha)	Footprint as % of total study area
salt marsh	0.07	0.03%
sand flat (mud)	9.29	1.07%
Eelgrass (native) <i>Zostera marina</i>	2.92	0.46%
Eelgrass (exotic) <i>Zostera japonica</i>	1.13	0.22%
mud flat	7.15	2.52%
rocky habitats	1.18	3.46%
Total	21.74	

The exact footprint for the proposed Terminal 2 has not been determined, so the effects on marine biota as a result of the construction of this 80 to 100 ha terminal are unknown. For any practical location of Terminal 2 the effects will mostly be on intertidal sand and mudflats, with some proportion of eelgrass and saltmarsh habitats also affected. As was noted earlier there is no predicted interaction between the existing Roberts Bank port facility with the Deltaport Third Berth and proposed Terminal 2 (using a conceptual design and location). Therefore there are no synergistic cumulative effects of this interaction.

Marine Biota - Mitigation of Effects

Although the Deltaport Third Berth Project does not contribute to synergistic cumulative effects with the existing structures, there is no adequate way to mitigate for habitat changes on biota as a result of ongoing effects of terminals, causeways and other changes in and around Roberts Bank. An attempt was made to reduce dendritic channel formation through the construction of a crest protection structure, but this only stopped headcutting in two small channels, while the larger channel by-passed it and it continues to grow. The use of such structures to control erosion is regarded to be difficult, unless they are designed and placed prior to excavation.

Compensation for the loss of salt marsh, intertidal mudflat and eelgrass habitat under the footprint of the Deltaport Third Berth will be undertaken. This is similar to methods B.C.

Ferries undertook to mitigate for expansion at the Tsawassen Ferry Terminal. A salt marsh area was located to the north of the B.C. Ferries terminal. The compensation for footprint effects of the Deltaport Third Berth will introduce 3.7 ha of intertidal mudflat and eelgrass, and at a separate location 0.06 ha of salt marsh. Additional habitat to replace the intertidal rock that will be lost will be created around the outside of the Third Berth, and on the outside of the eelgrass/mudflat compensation area. There will be a net gain in intertidal rock habitat. Similar mitigation is likely to be applied for Terminal 2 developments at Roberts Bank. Other mitigation measures such as avoiding disturbing biota during critical times in their life histories and relocating species will be undertaken.

The continuation of VPA ballast water management program to prevent the introduction of non-indigenous species through ballast water exchange reduces the possibility of this occurrence.

23.7.3 Birds

Habitat availability and collision risk with overhead wires and other aerial structures are two issues that have been raised as potential cumulative effects for birds utilising the area around Deltaport. The two terminals on Roberts Bank contribute to effects on habitat availability, and overhead lines on the Roberts Bank port causeway and adjacent roads have an effect on birds. Discussion on the Roberts Bank Overhead Powerline Bird Impact Study is also included in **Chapter 11 *Waterfowl and Coastal Seabirds***; in addition, the interim Overhead Powerline Bird Impact Study report containing the results to date is included in **Technical Volume 6**.

Birds - Historic trends and conditions due to existing projects

Roberts Bank is an ecologically significant area, it is best known as a site where birds migrating seasonally on the Pacific flyway either overwinter, or stop on their way to other locations north or south. There are also resident coastal and terrestrial birds. The high biological productivity and diversity at Roberts Bank contributes to the value it offers to birds. However, the plant, invertebrate and fish components that also give it this high value are valuable in their own right (**Section 23.7.3 *Marine Biota***).

Foraging guilds (groups) of birds have been recognised to represent the high diversity of bird species utilising the Roberts Bank area.

- Dabbling ducks forage and rest in salt marsh, intertidal mudflats and eelgrass, utilising 17- 40% of favourable habitat available, depending on season and tides.
- Shorebirds forage rest and roost in salt marsh, intertidal mudflats and intertidal rock utilising 10 – 28 % of favourable habitat available, depending on the tide and the season.
- Diving ducks forage rest and roost in deeper water habitats such as eelgrass (including in dendritic channels), intertidal mudflats and intertidal rock, utilising 4 – 34% of favourable habitat available, depending on the tide and the season.
- Gulls scavenge (forage) opportunistically, rest and roost along the shorelines and the edge of the tide on salt marshes, intertidal mudflats, and in dendritic channels among eelgrass. They utilise 12 - 39% of favourable habitat available, depending on the tide and the season.
- Piscivorous (fish eating) diving birds forage and roost from intertidal rock, utilising the deeper water areas of eelgrass, subtidal and intertidal mudflats and intertidal rock. They utilise 20 - 44% of favourable habitat available, depending on the tide and the season.
- Geese and swans forage rest and roost in salt and brackish marshes utilising 1 – 22% of favourable habitat available, depending on the tide and the season.
- Other birds utilising terrestrial locations are not predicted to be affected by cumulative effects and are not considered further in this CEA.

Changes to bird habitats on Roberts Bank as a result of causeways and other developments have created diversity that may not have been present previously. The introduction of intertidal rock has allowed piscivorous birds to roost closer to their deeper water foraging habitat. The intrusion of deeper water into the intertidal mudflats and eelgrass has allowed birds that prefer or require deeper water (in dendritic channels) to forage closer to the shore. Unfortunately there is no historical information on the

distribution and presence of bird species that enable a comparison of those that have increased or decreased on Roberts Bank to be made.

Overhead powerlines and utility wires are on the causeway leading to the Roberts Bank Port facility, and along roads and railway rights of way on land adjacent to Roberts Bank. Overhead wires cause bird mortalities through collision. The risk to birds from these structures has only been present since about 1970 on the causeway, and before this on adjacent land.

Birds - Contributions of Deltaport Third Berth and other future projects

The impacts of the Deltaport Third Berth Project on birds are low, and relate mostly to the impacts on habitat from the footprint of the project. This affects 21.7 ha of intertidal and shallow subtidal habitat, which will no longer be available for use as habitat. This is approximately 6% of the resting roosting and or foraging habitat in the study area, though this is regarded as an overestimate because the study area is smaller than the total habitat available at Roberts Bank. In addition the habitats lost are not exclusive to the affected areas, they also occur at other locations in the study area. The footprint impacts from Terminal 2 will affect similar habitats, but with greater magnitude. The precise location for Terminal 2 is not presently known, and specific impacts are unable to be quantified.

Other effects of the Deltaport Third Berth, and Terminal 2 include construction noise, light and impacts on foraging (turbid water decreasing visibility) outside the footprint. These construction impacts are temporary, and after completion of the Project birds are expected to once again fully utilise these habitats. Birds utilising this area have become habituated to existing noise and other disturbances as a result of port operations. Many birds are likely to continue using the area during construction once they become acclimated to the additional effects. In operation the impacts from noise, light and other disturbances are not predicted to be greater than those from the existing facility, which many birds are already acclimated to.

Past studies have indicated that the overhead power lines that were constructed as part of the original Roberts Bank port development in about 1970 have impacted birds. Studies conducted between April and November 1983 identified 88 dead or injured birds on a

portion (40%) of the Roberts Bank causeway; 61 (70%) showed conclusive evidence of wire collisions, and cause of death for the remainder was inconclusive. Western sandpiper, a shorebird, was most susceptible (80% of observed mortalities). These mortalities are small in proportion to the birds observed utilising habitat on Roberts Bank at that time. During the 1983 survey 161,700 birds were observed in flight and 944,000 birds recorded on the ground or in the water (Roe and Williams 1984). In a survey that lasted one year from 1994 to 1995 approximately 710 birds were killed due to the overhead power lines on the Roberts Bank causeway, with the top wire presenting the greatest risk (Burger and Cassidy 1995). Shorebirds had the highest incidence of collision, followed by ducks and gulls.

In late 1996 a section of the upper overhead wire, on the Roberts Bank causeway was marked with spiral vibration dampers (or diverters) to make them more conspicuous to birds. A study jointly funded by the Vancouver Port Corporation and BC Hydro, with participation by the Canadian Wildlife Service, determined that the markers were effective, with fewer collisions on marked sections compared to unmarked (control) sections (Cassidy, Burger and Lemon 1998). Approximately 635 birds were estimated to have been killed in one year after the markers were installed. Fewer mortalities and less severe impacts were attributed to birds being able to see the dampers and react earlier, possibly avoiding collision risk. One of the recommendations from the study was to deploy the diverters/markers along the entire length of the causeway overhead wires and test the efficiency of the full deployment.

The diverters were installed on the upper overhead wires along the entire length of the Roberts Bank causeway; and the VPA is currently conducting a survey of its effectiveness in reducing bird mortality. This study addresses similar concerns as the previous reports, but the study area has been increased in size to include additional transmission lines installed after 1997 (i.e. following the latest study). The methodology incorporates the same protocol as the Burger and Cassidy (1995) study with adaptations from Cassidy, Burger and Lemon (1998). Initiated in May 2004, the current overhead power line impact assessment:

1. assesses whether the behavior of birds crossing the transmission wires at the different damper sectors varies from results of the previous reports;
2. estimates the number, species, chronology and spatial distribution of bird mortality by overhead wire collisions along the causeway through weekly searches for bird carcasses using adapted methodologies from the 1995 and 1998 reports; and
3. analyzes data collected from the surveys and the Coastal Seabird and Waterbird Surveys to assess the number and species of birds at risk (federal and provincial) that use the overhead wires.

Preliminary field observations of crossings by birds have been similar to the Cassidy, Burger and Lemon (1998) findings, in that for all weather conditions to date (May-October 2004), the diverters cause birds to cross the power lines higher above the upper wire. Species guilds that have been observed to avoid the overhead wires easily include gulls, ducks and passerines. The overhead power line bird impact assessment is an ongoing commitment by the VPA, is currently in progress and the year long study will end in the spring of 2005 (May 2004 to April 2005). The interim Overhead Powerline Bird Impact Study report containing the results to date is included in **Technical Volume 6**.

Birds – Mitigation of Effects

Effects from Deltaport Third Berth construction are being mitigated with the intercauseway eelgrass/mudflat compensation area to increase feeding areas and relocation of nesting birds (osprey nests). VPA will also work with the regulatory agencies and the members of the public to enhance pelagic cormorant nesting colonies.

Additional overhead power lines are not required for the Deltaport Third Berth Project. The placement of the diverters appears to provide some mitigation for the effects of the existing overhead power lines (Cassidy, Burger and Lemon 1998), and is under further assessment to test efficacy.

23.7.4 Marine Mammal populations

Marine mammals are considered in the CEA because their presence is an indicator of a viable ecosystem with abundant resources ranging from plankton utilised by baleen whales to fish used as killer whale prey.

Marine Mammals - Historic trends and conditions due to existing projects

Marine mammals are present to varying degrees, but killer whales (southern resident and transient), harbour porpoise, and humpback, fin and grey whales are the most vulnerable in the study area because they have a combination of low population size, and vulnerability to anthropogenic disturbance or habitat disruption. In addition many populations of these marine mammals are still recovering from earlier commercial hunting operations, or they have declining population numbers. All these species are identified as species at risk, either provincially (red- or blue-listed) federally (COSEWIC) or internationally (IUCN “red book”).

Health (size, fecundity and viability) of marine mammal populations in the study area varies according to the species under consideration. Some are considered at risk due to past predations and human activities, others are not because they are more common; usually because they are less susceptible to human activities. Trends of only those marine mammals that are either already at risk, or are likely to be affected by developments in the marine environment at Roberts Bank are considered in this CEA:

- southern resident killer whale - a small, declining red-listed population;
- transient killer whale - red listed, occurring locally in small numbers;
- grey whale - frequent visitors to the Southern Strait of Georgia;
- fin and humpback whales – usually seen offshore; and
- harbour porpoise - population under threat with declining numbers.

Marine mammals employ sound, in an active or passive manner, for a variety of purposes including navigation, communication, and foraging. Noise from human activities can affect marine mammal foraging, cause avoidance behaviour, and in extreme cases cause temporary and permanent losses in hearing. Ship movements and coastal developments

on Roberts Bank from Deltaport, Westshore and B.C. Ferries terminals, as well as Fraser River dredging and fishing and recreational vessels contribute to these effects.

These activities also contribute to the collision risk for marine mammals, and in this respect, faster and larger vessels pose a greater risk than slow moving ones. Risks are greater with vessels 80 m or longer, travelling at 14 knots or more. No severe or lethal injuries on marine mammals have been reported for vessels travelling at less than 10 knots. Most marine mammal collisions occur in open waters.

The number of ship movements from the B.C. Ferries terminal far exceed those of the Roberts Bank Port facility. Using a conservative estimate of B.C. Ferries ship movements during winter (considerably more in summer) there are 56 movements in and out of the terminal per day. Currently the Roberts Bank facility (Deltaport and Westshore) sees 3.1 ship movements per day (excluding tug boats). One incidence of injury to a marine mammal by a ferry has been reported (location unknown, but suspected in the Strait of Georgia), this incident severely injured a killer whale calf.

The existing collision risk as a result of the Roberts Bank Port operations is considered to be low. Existing ambient noise conditions in the area around Deltaport are unknown.

Marine Mammals - Contributions of Deltaport Third Berth and other future projects

The main effects of construction of the Deltaport Third Berth, and operation of the expanded facilities on marine mammals are additional noise, the potential release of environmental contaminants from dredging and the increased potential for collision with vessels. These effects are already present at Roberts Bank, and construction will temporarily increase noise, and operations will permanently raise potential for noise and collision risk impacts.

Sounds from dredging are likely to be audible to some marine mammals up to 25 km away, and these can elicit behavioural and physical responses at closer distances. The theoretical zone of audibility for killer whales is approximately 3.7 km. Noise from vibro-densification of fill material could also potentially affect marine mammals.

The magnitude and reversibility of any change in these effects is the key concern. Other ongoing activities in the area (dredging in the Fraser River and other vessels) are likely to have similar effects, and discriminating between the effects of other activities and the Deltaport Third Berth is difficult.

The potential for environmental contaminants, which can be concentrated in marine mammals at the upper end of the food chain, to be present in the sediments of Roberts Bank is unknown. However, a number of factors indicate the likelihood is low. Tests on indicator contaminants such as mercury, cadmium and PAH are within the Canadian standards for ocean disposal. These indicators were chosen to indicate potential effects on the food chain because they are initially taken up lower in the chain (in invertebrates). In addition the marine developments at Roberts Bank are fairly recent, and for much of this time controls on the contaminants of concern have been in place.

The expanded Deltaport facility will introduce some additional effects of noise and collision risk from additional ship visits. At the Roberts Bank Port, with the Third Berth expansion, ship movements are projected to increase from an average of 3.1 per day to 3.4 per day. Additional ferry movements are also likely, though the magnitude of the increase from the conservative estimate of 56 ferry movements per day is unknown. Terminal 2 in operation would also increase ship movements, though the magnitude of these additions is also unknown.

Marine Mammals – Mitigation of Effects

Mitigation to avoid effects on marine mammals during construction activities centre on avoiding activity above the noise thresholds for particular species when they are observed close enough for susceptibility. Deltaport Third Berth will adhere to these procedures.

The main mitigation measures to reduce effects on marine mammals during terminal operations is minimize the risk of boat collision, even though this risk is recognised to be low. The endangered listing of many of the cetaceans known to reside or transit through the Juan de Fuca and Haro straits is recognised. VPA will work with the BC Pilots to develop an education and awareness program about marine mammals and have pilots of

vessels transiting to Roberts Bank steer away from observed pods when vessel safety is not compromised.

23.7.5 Ecology - Significance of Cumulative Effects

There are cumulative effects on marine biota at Roberts Bank; ongoing changes to habitat have altered the biota that the area can support. As a result there are now more diverse habitats that support species that utilise salt marsh, intertidal rock and subtidal mud habitats. These include piscivorous birds, dabbling and diving ducks, salmonids and macroinvertebrates (crabs). The reduction in intertidal sand and mudflats has decreased habitat for shorebirds. The increase in eelgrass, particularly native *Zostera marina*, has potential to be a positive impact even though it has occurred at the expense of intertidal sand and mudflats. Eelgrass is a declining habitat around the world, including both the Atlantic and Pacific coastal areas of the U.S.A, and possibly also in British Columbia. The expansion of eelgrass beds at Roberts Bank goes against that trend.

The footprint impacts of proposed Deltaport Third Berth Project at Roberts Bank is not significant, as the effects can be mitigated, and the proportion of the area lost is small in relation to the study area on Roberts Bank. The actual proportion relative to the total area is even lower as there are parts of Roberts Bank that are not included in the study area.

Bird guilds are not limited by habitat availability; none utilise more than half of what is regarded to be the favourable habitat available to them during a tidal cycle, or at any one time in the season. In addition most guilds have physical (water depth and sediment characters) and biological (food resources) preferences that dictate where they can or will roost or forage. For a number of guilds these preferences can be met by a number of different habitats depending on the tide. There are for example very few species that have exclusive requirements for one particular habitat type.

There are no cumulative effects on marine mammals, as the risks appear to be relatively low in the area. Ship movements, while high from other activities than the Roberts Bank port facility, do not appear to be resulting in effects on marine mammals. In the surveys conducted for the Deltaport Third Berth expansion 143 marine mammals were observed, and 111 of these were from one species (harbour seals) that are not regarded to be at risk.

23.8 NOISE ANALYSIS

The analysis of noise undertaken for the impact assessment also takes into account ambient noise from existing projects and activities in the study area. The anticipated addition of noise associated with the Deltaport Third Berth is predicted, but the likely addition of other projects, which have yet to be assessed using a rigorous methodology (Terminal 2 and South Fraser Perimeter Road), has not been included. The viability of Terminal 2 depends on improvements to the road and rail network, and until these are planned any noise cumulative effects assessment is not known.

23.8.1 Noise Ecosystem Receptors

The predicted increase in average day night average noise level (dBA L_{dn}) normalized using a rating for particular types of noise associated with the Project (dBA L_{Rdn}) is used to calculate a quantitative value, the percentage of people that would be highly annoyed (%HA) due to noise. The % HA was used to assess potential cumulative effects of noise.

23.8.2 Resident's Perceptions

Some residents already consider ambient noise levels in the study area to be excessive. This included the noise from other projects and activities such as rail and road traffic, and B.C. Ferries terminal operation, for this reason noise is included in the CEA.

Resident's Perceptions - Historic trends and conditions due to existing projects

Ambient noise levels in all four measuring locations are considered excessive by a number of residents (**Table 23.4**). In these locations the noise is attributed to road and or rail traffic. These ambient conditions have been increasing over the years since measurements have been undertaken; noise analysis in 2000 showed no exceedances of noise (JWEL 2001). Numerous other studies on noise in and around the Roberts Bank Port between 1978 and 2001 collectively indicate that noise in the study area has increased over the past 25 years.

Resident's Perceptions - Contributions of Deltaport Third Berth and other future projects

The noise expected from both night and day construction activities for the Deltaport Third Berth is not predicted to increase enough that the changes will be evident to the human ear, therefore there are no significant impacts on residents in the study area. The

majority of the material imported to the site of the proposed project, such as sand, gravel and crushed rock, will be transported by barge so the degree of construction traffic, and their noise contribution, is anticipated to be low.

Table 23.4 Predicted changes in noise levels and percent of annoyed residents.

Location		L _{Rdn} (dBA)	Frequency of Occurrence	Likelihood of Impact	% HA (highly annoyed)
Location 1 – 41B Street	Existing	67	Continual	Probable ²	17
	Predicted	68			19
	Increase	1			2
Location 2 – Tsawwassen Drive North	Existing	61	Occasional	Possible ³	9
	Predicted	62			10
	Increase	1			1
Location 3 - Tsawwassen Beach Road	Existing	56	Occasional	Possible ⁴	5
	Predicted	57			5.5
	Increase	1			<1
Location 4 - Southridge Drive	Existing	63 ¹	Continual	Certain	11 ¹
	Predicted	65 ¹			14 ¹
	Increase	2 ¹			3 ¹

- 1 If remaining level crossings are automated or removed in the future, elimination of whistle noise would decrease the L_{Rdn} from its present value of 63 to 61.5 dBA and the %HA from its present value of 11% to 9%.
- 2 The predicted increases in noise levels at this location may not occur if the addition of new sidings results in fewer trains being broken up and reassembled.
- 3 The fact that night time noise levels at this location are much lower at night, even though the port normally operates 24 hours/day, suggests that noise from other non-port related sources may be predominant.
- 4 Noise levels at this location are relatively low and may not be controlled by sources associated with the port.

Trains, traffic, ships (including tugs) and container handling equipment likely to be used in the operation of Deltaport after the Third Berth extension will have a minimal contribution to ambient noise levels at local receptors. All measured locations had insignificant (imperceptible to the human ear) increases; one exception had minimal (>1 dBA) impact (**Table 23.4**). However, as noted above some residents already consider the ambient noise levels at many locations excessive. The major source of this excessive noise is from rail operations (trains and whistles). Other sources such as trucks serving the container terminal would have no significant impact (any change is inaudible) on residents in the study area. Alarms for the additional ship-to-shore gantry cranes may be perceptible at locations on the shoreline, but this increase in noise is still below the threshold that is considered significant.

The introduction of other projects that may also contribute to noise, such as the South Fraser Perimeter Road and Terminal 2 has the potential to further increase noise levels at these, and other locations. Detailed modelling for these has yet to be conducted, as parameters such as precise location and volumes of road and rail traffic are unknown. Both projects are likely to increase ambient noise levels further in the study area.

Resident's Perceptions – Mitigation of Effects

Rail noise is the biggest contributor to exceedances. Mitigation measures to address these effects primarily centre on the formation of a Roberts Bank Noise Management Committee with representatives of the VPA, terminal and railway operators, municipality and residents. The purpose would be to address the issue of noise generated from the rail lines. Particular initiatives have been identified for investigation. These include:

- reducing noise from idling locomotives and shunting operations
- changes to operational procedures including eliminating or reducing whistle requirements at grade crossings and reducing train speeds in certain areas,
- construction of noise barriers; and
- 24 hour environmental phone line to assist in identifying noise sources.

In addition to these initiatives, specific measures to ensure that there is no perceptible change in noise from the Deltaport Third Berth construction and operation will be put in place. These include:

- maximum allowable noise limits for construction machinery;
- training so construction and operation equipment operators are aware of noise issues;
- installation of bells, rather than alarms, that are inaudible to local receptors on operational equipment; and
- 24 hour environmental phone line to assist in controlling noise sources.

As part of the Deltaport Third Berth Project the proposed closure of the 57B Street at-grade rail crossing will potentially make some improvements to noise impacts; the siding

would be longer thereby reducing shunting operations, and the closure of the crossing will eliminate train whistle and crossing bell noise at this location

23.8.3 Noise - Significance of Cumulative Effects

Noise level increases as a result of the Deltaport Third Berth Project are predicted to be very small (between 1 dBA and 2 dBA), and not normally perceptible to the human ear. However, some residents already consider ambient noise levels in the study area excessive, and the increase will lead to more people being highly annoyed. While the increase as a result of Deltaport Third Berth is small, it nonetheless contributes to a cumulative environmental effect, which has developed from an increase in transport (particularly train) related activities over approximately the last 25 years. The addition of other projects with the potential to produce more noise seems likely to further exacerbate this trend, though no definitive comment can be made until details of these developments (Terminal 2 and the South Fraser Perimeter Road) are known. As indicated above, any assessment of the noise impacts from Terminal 2 would be speculative until details of the road and rail network improvements on which it depends are known. Both Terminal 2 and the South Fraser Perimeter Road will be subject to EA applications, which will assess their impacts on noise.

Mitigation measures specifically recommended to reduce the already low contribution of the noise from this Project, and measures to address more widespread issues, will go some way to reducing the number of residents that are highly annoyed by noise. These measures are indicated above, and further assumptions that may reduce noise levels are indicated in the notes to **Table 23.4**. However, it is clear from the assessment that excessive noise in the study area is due to rail operations and the VPA will continue to work with the railway companies to develop solutions based on a coordinated approach from all stakeholders.

23.9 TRAFFIC ANALYSIS

An assessment of current traffic levels has been undertaken, and traffic forecasts for the study area have been prepared to 2012. The additional traffic associated with the expanded Deltaport Third Berth has been identified both in absolute numbers as well as a percentage of total traffic on the regional network. This has enabled the cumulative effect of the Project to be assessed.

23.9.1 Traffic Ecosystem Receptors

Traffic delays can be measured as additional distance travelled or travel time, or reduced traffic speed. These factors have been assessed in this CEA, and are further described in **Section 2.9.4 Road Operations (Road Traffic)**.

23.9.2 Traffic Delays

Traffic Delays – Historic trends and conditions due to existing projects

Vehicle traffic has increased in the study area since the two sea terminals were constructed, and due to residential, commercial and agricultural development in the area. Deltaport Way was constructed in 1995 to service the Deltaport facility, which opened in 1997. This road connects to Highway 17, which in turn provides access to River Road and Highway 99 south and north (through George Massey Tunnel).

During the morning and afternoon peaks northbound traffic on Highway 99 towards Massey Tunnel is congested and exceeds available capacity in the tunnel. Most roadways between intersections are relatively free flowing, while intersection delays are significant; particularly at Highway 17 and Ladner Trunk Road and the Highway 99 on-ramps.

Current conditions show that overall Levels of Service (LOS) at major intersections on Highway 17 have acceptable levels of services, with only the Highway 17/Ladner Trunk Road intersection showing a marginally acceptable Level of Service “E” during morning peak periods (**Table 23.5**).

Table 23.5 Intersection level of service summary (2002).

Intersection	Level of Service		
	AM	MID	PM
Hwy 17 @ 56th Street	B	B	C
Hwy 17 @ Ladner Trunk Road	E	C	C
Hwy 17 @ Hwy 99	B	B	B

However, at the Highway 17/Ladner Trunk Road intersection there are three specific turning movements operating at a Level of Service “F” (Level “F” being defined as a “failing” intersection) during certain times of the day. This Level of Service is directly attributable to background and commuter traffic as Port traffic does not contribute to these turning movements (**Table 23.6**).

Table 23.6 Over-saturated movements summary (2002).

Period	Location	Movement*	LOS
AM	Hwy 17 @ Ladner Trunk Road	EBL	F
		NBT	F
PM	Hwy 17 @ Ladner Trunk Road	WBT	F

EBL = Eastbound left, NBT = Northbound through and WBT = Westbound through

Overall levels of service for the morning peak hour at the major intersections along River Road show that all critical intersections along River Road are good overall (**Table 23.7**).

Table 23.7 Levels of service for River Road intersections.

Intersection	Overall LOS
Nordel Way	B
Alexandra Road	A
Huston Road	A
76 Street	B
72 Street	A
68 Street	B
60 Avenue	A

Construction of Roberts Bank port facility in 1970 resulted in a new rail line from Langley to Roberts Bank. Since that time, rail traffic has increased on the Port Subdivision rail line to approximately 18 trains per day (9 inbound and 9 outbound). This traffic is comprised of 12 coal trains and 6 container trains per day and can result in delays at many of the 30 grade crossings that are located along the Port subdivision from Roberts Bank to the Township of Langley.

Traffic Volumes - Contributions of Deltaport Third Berth and other future Projects

Future traffic volumes were examined to assess the impact of the Third Berth Project. This was done by first determining future traffic volumes without the Project, and comparing these results to future traffic volumes that include the Project (**Section 2.9.4 Road Operations (Road Traffic)**) to illustrate the cumulative affect (**Tables 23.8 and 23.9**).

Table 23.8 Future (2011) Traffic Volumes without Deltaport Third Berth Project

Link	Morning			Afternoon		
	Total traffic	Port traffic	Port traffic as a % of total	Total traffic	Port traffic	Port traffic as a % of total
Highway 17 NB – North of Ladner Trunk Road	3349	99	3.0%	1805	94	5.2%
Highway 17 SB – North of Ladner Trunk Road	1085	225	20.7%	2613	51	2.0%
Highway 17 NB – South of Ladner Trunk Road	2053	99	4.8%	1476	94	6.4%
Highway 17 SB – South of Ladner Trunk Road	1176	253	21.5%	2244	58	2.6%

Table 23.9 Future (2011) Traffic Volumes with Deltaport Third Berth Project

Link	Morning			Afternoon		
	Total traffic	Port traffic	Port traffic as a % of total	Total traffic	Port traffic	Port traffic as a % of total
Highway 17 NB – North of Ladner Trunk Road	3415	164	4.8%	1840	138	7.5%
Highway 17 SB – North of Ladner Trunk Road	1228	369	30.0%	2636	73	2.8%
Highway 17 NB – South of Ladner Trunk Road	2124	164	7.7%	1526	138	10.0%
Highway 17 SB – South of Ladner Trunk Road	1337	414	31.0%	2250	147	3.6%

The difference between the predicted future traffic volumes with and without the Deltaport Third Berth in operation is small (with Third Berth – without Third Berth). For all intersection movements the Third Berth will increase traffic by less than 10%, and for most movements the increase is only 1 to 4%.

The majority of the traffic volume is a result of background commuter traffic from residential and agricultural communities and ferry traffic. The potential increase in residential population in the area, and the potential for increased ferry sailings is likely to continue to keep the contribution of these activities to traffic volumes in the area high.

When Deltaport way was built in 1996, the Land Reserve Commission required that an overpass be constructed at the 41B Street grade rail crossing when additional support track is built across this intersection. No additional tracks are being constructed at 41B Street for the purposes of the Deltaport Third Berth, and the number of train blockages will only increase from an average of 26 to 32 per day. In the meantime, a communication system is in place for the farming community to access information regarding train movements in the area. As well, improvements are currently being constructed with funding provided by VPA to improve traffic conditions at this location. Terminal 2 is likely to require additional support tracks across 41B Street and an overpass will be planned with the Land Reserve Commission at that time.

Traffic Delays – Mitigation of Effects

Several improvement options have been developed to mitigate the impact of the additional Project traffic. This includes amending the HOV lanes on Highway 17 to 2 or more people (previously 3 or more), extending the high occupancy vehicle (HOV) lanes on either side of Ladner Trunk Road, and undertaking signal modifications at the Highway 17 and Ladner Trunk Road intersection. When the Project reaches full capacity in 2012, these improvements will enable travel times on Highway 17 to be either be maintained at current levels or improved slightly, thereby providing an overall improvement to the existing situation. From a cumulative perspective, the impacts of the proposed traffic mitigation for the Project may also provide a small benefit to Highway 17 in terms of improved travel times.

To resolve the long-term transportation requirements, a regional plan is currently being prepared by the Gateway Program. This plan is examining a number of projects including the proposed South Fraser Perimeter Road, which ultimately could reduce congestion in Delta. This proposal is considering three alignments within Delta and, to date, no decision has been made on a preference as the options are still being assessed.

A detailed rail assessment for Terminal 2 will be completed in 2005 and the results of this study will be reviewed with the Corporation of Delta, the City of Surrey, and the Township and City of Langley. A coordinated road and rail plan will be prepared

together with input from the rail companies; all of which will be subject to a cumulative effects assessment.

23.9.3 Traffic - Significance of Cumulative Effects

While the improvement measures described above and in **Section 2.9.4 Road Operations (Road Traffic)** can mitigate the Project related effects, the issue of Delta wide traffic congestion remains, and ultimately requires a coordinated approach that involves local and provincial transportation providers. It is recognized that traffic congestion delays are common in the study area, and the road network is currently at, or close to, capacity at certain times of the day. Projections of future traffic confirm that the situation will continue to deteriorate, even without the Deltaport Third Berth Project. However, it is also noted that the additional traffic associated with the Project contributes to a relatively small percentage of the overall total daily traffic, does not add significantly to future traffic volumes, and its impacts can be mitigated.

To accommodate other future projects such as Terminal 2, will require a long-term transportation plan. While the improvements associated with the Deltaport Third Berth project may provide some overall benefit to both existing and future traffic conditions, they are clearly not sufficient to accommodate an additional container terminal development such as Terminal 2. Further, the VPA has indicated that until such time that a road solution and preferred alignment has been determined, an assessment of road infrastructure for Terminal 2 cannot be prepared. As a result, and given the uncertainty of the South Fraser Perimeter Road, a cumulative affect of Terminal 2 cannot be undertaken. In time both these projects will be the subject of separate environmental and cumulative effects assessments.

23.10 SIGNIFICANCE EVALUATION

Significant cumulative environmental effects have been identified in this assessment: change in marine habitat types and marine biota; proportion of residents highly annoyed by noise and increase in traffic delays (**Table 23.10**). For these the contribution of Deltaport Third Berth Project is low, or low to moderate, and for two (traffic and noise), the effects are reversible. While the potential adverse cumulative effects are a concern, the key driver is other projects or activities, not the proposed Deltaport Third Berth. Mitigation for the effects of these is required

to address the effects, and if mitigation were applied, for two, there is potential for the reversal of the effects.

Details for each of the identified significant cumulative effects deserve some consideration.

In the case of the significant cumulative effect on marine habitat types and marine biota it may be argued that despite the non-natural nature of the ongoing change caused by the combination of the existing Roberts Bank terminal and the BC Ferries terminal there are potentially positive elements. The increase in diversity of habitats; expansion of eelgrass, introduction of intertidal rock and increase in salt marsh has allowed a wider range of species to utilise the area. In addition the expansion of eelgrass goes against the North American trend of widespread decline.

While the proportion of residents highly annoyed by noise is predicted to increase due to the Project there are a number of conservative assumptions implicit in the assessment, that if altered may reduce the magnitude of the cumulative effect. Some of these assumptions are mitigation for the proposed Project (elimination of 57B Street rail crossing and increase in Gulf Siding length - less train shunting operations), and were not included in the analysis. Other mitigation may be achieved through the cooperative efforts of the community and VPA with the railway companies such as elimination of rail crossings, whistle noise and noise associated with train speed.

The potential for a significant cumulative effect on traffic delays is largely the result of a road network that is already at capacity, and the addition of additional background commuter traffic will make the existing situation worse. Deltaport Third Berth will add only a small additional amount of traffic to this situation. With the proposed mitigation improvements to Highway 17, the Project will not contribute to the traffic congestion. However, this is a short-term situation only, and long-term a regional solution is needed. The likely construction of the South Fraser Perimeter Road, a two-lane each way highway from south Delta (near Ladner) to Surrey will reduce the traffic congestion. Details of the exact location of the south Delta portion of the route are unknown, and as result this road has not been included in the cumulative effects analysis.

Table 23.10 Evaluation of significance of identified cumulative effects on each ecosystem receptor.

Potential Cumulative Effect	Third Berth Contribution	Extent	Magnitude	Duration	Reversibility	Ecological / Social Context	Probability	Frequency	Significance
Change in marine habitat types	low	local	moderate	long	Irreversible	developed	high	continuous	significant
Inter-causeway marine eutrophication	negligible	local	low	long	reversible	intact	high	periodic	non-significant
Change in marine biota	low	local	low	long	irreversible	developed	high	continuous	significant
Alteration to bird habitat	low	local	low	long	irreversible	developed	moderate	continuous	non-significant
Marine mammal population effect	negligible	municipal	negligible	long	reversible	developed	low	isolated	non-significant
Increase in 'highly annoyed' by noise	low	regional	high	long	reversible	well-developed	high	continuous	significant
Increased traffic delays	low-moderate	regional	moderate	long	reversible	well-developed	moderate	periodic	significant

23.11 FOLLOW-UP

Monitoring to ensure that the predictions in this assessment are accurate, and to ensure the mitigation is undertaken and effective is necessary. The fact that many of the cumulative effects are also a result of other projects and activities indicates that operators of these other activities, and the appropriate municipal, regional and provincial authorities need to participate in the appropriate monitoring programs.

Monitoring and follow-up to ensure that mitigation actions are undertaken is particularly important for those cumulative effects for which information is uncertain (eutrophication and nutrient inputs), where other projects may be about to be developed (noise and traffic congestion in respect of the South Fraser Perimeter Road) or where there are significant cumulative effects identified (marine habitat types and biota and residents annoyed by noise and traffic congestion).

24.0 SUSTAINABLE DEVELOPMENT

24.1 INTRODUCTION

Environmental assessment is commonly, and correctly, understood to be a planning tool used to help identify and avoid or mitigate potential environmental impacts, that may arise from development. Inherent in this definition of environmental assessment is the idea that social and economic costs and benefits, associated with proposed projects, must be considered against environmental costs and benefits. The idea that social, environmental and economic costs and benefits must be reconciled and in balance, is central to the concept of sustainable development.

Recent changes to CEAA have strengthened the requirement that consideration be given to how proposed projects may impact sustainability. The new Act is now a key legislative tool that is being used to help the Government of Canada "... *to achieve sustainable development by conserving and enhancing environmental quality and by encouraging and promoting economic development that conserves and enhances environmental quality.*"

CEAA defines sustainable development "*as development that meets the needs of the present, without compromising the ability of future generations to meet their own needs.*"

The section will consider – collectively - the range of social, economic and environmental costs and benefits associated with the proposed project, and present an overview of how the Project meets the intent and definition of sustainable development, as defined in the Act.

This section will:

- Describe the legislative requirements for sustainability assessments within the Act.
- Provide some background on the state of sustainability assessments in Canada and other jurisdictions.
- Consider the range of ecological, socio-community and economic values that are potentially influenced by the construction and operation of the proposed project.
- Identify which values are potentially impacted – either positively or negatively.

- Demonstrate that social, economic and environmental values – potentially influenced by the proposed project are not being impacted to the extent that “the needs of future generations to meet their own needs” are being compromised.

24.1.1 Legislative Requirement

CEAA requires that every Comprehensive Study consider the environmental sustainability of the development. Specifically Section 16(2)(d) states that every Comprehensive Study shall include consideration of “*the capacity of renewable resources that are likely to be significantly affected by the project to meet the needs of the present and those of the future*”.

While this requirement does not specifically mention sustainability or sustainable development, the definition of sustainable development in the Act is clearly very similar in scope. The definition of sustainable development given in the Act:

"means development that meets the needs of the present, without compromising the ability of future generations to meet their own needs".

This link between the requirements of section 16(2)(d) and sustainability is mirrored by the Terms of Reference for the Deltaport Third Berth Project. This document indicates the sustainability of renewable resources will be considered in the assessment. In particular the environmental assessment will consider:

“the sustainable use of renewable resources that may be significantly affected by the Project and whether their sustainable use will be affected.”

Presently there is little in the way of specific CEAA guidance or examples in order to achieve this requirement.

24.1.2 Background to Sustainable Use Assessments

Sustainability in development is traditionally taken to mean satisfying present needs without compromising the ability of future generations to meet their needs (UN World Commission on Environment and Development 1987). The idea of development that protects resources and the long-term integrity of ecosystems, while also improving well-being, especially for the

disadvantaged is based on the connection and interdependence of a number of components of the environment (Gibson 2000). These components include: ecological (biophysical), social, cultural, economic and political considerations. Most sustainability frameworks use a number of these components, often combining one or more of them. The most well known and widely used is the ecological, socio-cultural and economic framework that is also the basis for 'triple bottom line' accountancy reporting.

Traditional environmental component analyses (biophysical, socio-cultural and economic criteria) are widely used to assess sustainability in both policy development and environmental assessment (Skelton and Memon 2002 and Environment Canada 2004). Alternative approaches identify the changes in policies, assessment and human activities required to move toward sustainability, rather than just the components of the environment that we are concerned with (Gibson 2000). This alternative approach usually sets out principles (which are also the assessment criteria) for sustainable development. These principles have been enacted into legislation in some jurisdictions, such as in Australia (Dept. of Environment and Heritage 1992).

In Canada this alternative approach to adopting sustainability as the central decision criterion in environmental assessment has been explored, and a set of principles for the assessment of sustainability recommended (Gibson 2000). The principles are similar to those in the Australian legislation. In the future these principles may be a workable framework, but at this juncture they are not well developed for use in environmental assessment. For this sustainability assessment a traditional approach comparing the positive and negative implications to sustainability of biophysical, social / cultural and economic components of the environment has been adopted.

24.2 ASSESSMENT CRITERIA

Full and rigorous environmental, social and economic effects assessments were undertaken to understand the positive and negative effects of the Deltaport Third Berth Project on each of the environmental components. No quantitative analysis of the sustainability implications of the effects of each of these components is possible because there is no standard measure. Biophysical and socio-community impacts have no common measurement unit, and applying the recognised economic impact measure (dollars) to biophysical and socio-community factors is

fraught with difficulty. Obtaining a balance between them requires the merits of each to be qualitatively assessed.

This assessment, due to its qualitative nature, is a subjective one. There will, for example, be varying views on how sustainable different components of the environment are, and on the ability to balance different components off against each other. This attempt is not definitive, but its intention is to act as a starting point from which ongoing discussions can begin. The GVRD region is the area of consideration for sustainability.

24.3 SUSTAINABILITY ASSESSMENT

The provision of adequate international trade infrastructure contributes to the quality of life experienced by British Columbians. By improving efficiency and reducing cargo transport costs, exports are more competitive and the price of imported goods is reduced. This improves our position on the world trading market, and improved competitiveness generates employment and reduces the cost of living.

Balanced against this are the required activities for the construction and operation of port infrastructure, which involve a degree of environmental and social disturbance or effects. The balance or assessment of sustainability sets the environmental and social effects against likely detrimental effects from congestion and delays in cargo handling that result in cost increases to British Columbian businesses and consumers.

24.3.1 Existing Environmental Policies

The VPA has an environmental policy, which commits it to

“conduct its affairs in a responsible and sustainable manner to safeguard the environment, and the health and safety of its employees, customers and the public.”

In addition to this, TSI, the operator of Deltaport, has an environmental management plan providing procedures to ensure an environmentally sustainable operation. These include provisions to ensure accidents and malfunctions, contaminants, stormwater and effluent and other hazardous materials are handled and considered appropriately. The operating rail

companies also have environment management plans that they follow. Environmental management plans specific to the Third Berth Project are detailed in **Chapter 21** *Environmental Management Program*.

24.4 BIOPHYSICAL

The effects of the Deltaport Third Berth on marine biota will be addressed through mitigation that is designed to achieve no net loss of productive habitat capacity. The footprint of the proposed development will result in the loss of 21.7 ha of habitat of mudflat, eelgrass and salt marsh. This will be compensated by the creation of 3.55 ha of eelgrass and mudflat habitat. There will be no impact on the sustainability of the habitats, because notwithstanding that the Project will permanently remove some habitat, there remains much of every habitat type on the remainder of Roberts Bank.

There are also other impacts of the project that have implications on sustainability. Air quality, which is currently good in the area for most types of contaminants, will be affected by the Third Berth Project. The effects are not significant, and air quality objectives and risk to human health is within the appropriate Canadian objectives and standards. A number of existing measures undertaken at Deltaport contribute to keeping air quality emissions low. The continuation of these will aid in keeping the contributions to the airshed sustainable. New air quality initiatives have also been identified and are being pursued with the terminal operator as well as shipping, rail and truck industries.

The measures undertaken include:

- continuous improvements in operational efficiencies (new and improved machinery and procedures) at VPA terminals;
- providing auxiliary power for ships at berth;
- coordinating air quality improvement efforts with road and rail operators;
- use of low-sulphur fuel; and
- support for inter-governmental agreements to improve air quality

The ambient water quality at the Project site and at Roberts Bank in general is very good, meeting the provincial water quality objectives. During operation the Project could contribute to potential contaminant loadings with additional discharge of treated sewage effluent from the Deltaport terminal, as well as an increase in stormwater effluent. Mitigation measures have put in place to reduce the contribution of these discharges on ambient water quality, and no residual environmental effects are expected. In addition the VPA has implemented a number of environmental practices and procedures that further reduce contaminant loadings to the receiving waters ensuring ongoing sustainable operation of the Port facilities. These practices and procedures include:

- The loading of bunkers and bulk oils is not permitted under any circumstances for vessels berthed at Deltaport and Westshore Terminals at Roberts Bank. This prohibition is enforced by the Vancouver Port Authority and has been in effect since the expansion of the Roberts Bank port terminal in the early 1980's and was put in place to reduce the probability of oil spills at Roberts Bank.
- The Port of Vancouver Ballast Water Management Program implemented in 1998 applies to the Project to limit the possibility of transferring non-indigenous species into Canadian waters while protecting the safety of ships, and;
- The VPA Harbour Master's Patrol Staff seal the engine room bilge overside discharge valve(s) of all vessels calling on Roberts Bank to protect vessels and the environment from the accidental discharge of oil or oily water into the marine environment.

24.5 SOCIO-COMMUNITY

The impacts on the community social fabric during construction and operation of the Deltaport Third Berth Project are considered to be very low, and for some components of the socio-community environment there will be benefits. The project is expected to generate employment during construction and operation. This not only provides employment, and hence income, for those individuals, but further improves the income of the municipality and the region (see Section 24.6). However, with this growth comes the potential for impacts on the community. In this section the social and cultural sustainability of the projected growth is assessed. In particular

it assesses the potential for economic development to impair the ability of future generations to meet their needs.

The Deltaport Third Berth Project is expected to generate 640 jobs person years of employment during construction, and, on average, a further 356 full-time job equivalents (FTE's) per year during operation. Because most of these workers will come from outside of Delta and commute to the area there is expected to be little impact on community services such as emergency (police, ambulance and fire), medical and social services. These additional workers commuting to Deltaport will increase traffic on roads in the area, but the increase is regarded to be insignificant relative to existing, and projected future, traffic volumes. Proposed future road improvements will also mitigate this issue.

Some of the construction and operation workers may choose to locate closer to the Deltaport site if their job extends for the full construction period, or for long-term jobs created after the Third Berth is operational. Again this growth of permanent residents is not expected to significantly detract from the ability of community services to provide for the needs of the existing and future residents of the Corporation of Delta. The Corporation of Delta has recognised the potential for population growth in their municipality, and notwithstanding that most workers will likely commute from other municipalities, the total direct job creation can be accommodated within their projected long-term growth limits (approximately 9,000 people and 6,000 dwelling units).

Construction and operation of the Deltaport Third Berth adheres to many of the objectives in the local (Corporation of Delta Official Community Plan) and regional (GVRD Livable Region Strategic Plan) planning documents. The rationale for many of these objectives is to improve sustainability. Deltaport Third Berth will provide local job opportunities, which is one of Delta's OCP policies and one of the TFN community goals. Construction itself will have minimal impact on existing land uses in the local area as the Project is contained on existing Port and Provincial crown land and railway rights of way.

Efficiencies are gained by increasing the utilisation of existing port, rail and road transport facilities, especially those that are close to the major industrial areas of the lower mainland such as Annacis Island and others on the lower Fraser River. This adheres to policies in the Official Community Plan of the Corporation of Delta that encourages industrial activity in existing

industrial areas, and the GVRD Liveable Region Strategic Plan, which has an objective to protect existing green space and build complete communities.

Road and traffic congestion issues are a key concern for residents. The project will increase traffic in the area by 2011. However, the increase (600 truck and 500 car movements per day) is projected to be minimal compared to the volume of vehicle trips on Highway 17 due to background commuter traffic, and traffic to or from the B.C Ferries terminal. Deltaport Third Berth is not expected to prevent ongoing use of the road facilities, but it is one of the factors contributing to the increasing congestion problem. The Vancouver Port authority recognises this, and has made a commitments to specific road improvements in Delta required to support additional Project traffic. These include signal modifications at Ladner Trunk Road and Highway 17, extensions to HOV lanes on Highway 17, restrictions on commercial vehicles, geometric changes to highway ramps of the Ladner interchange, incident warning lights on Highway 17 and monitoring equipment on Deltaport Way (**Chapter 2 Project Description**). In addition the VPA encourages trucks destined for, or coming from Deltaport to utilise the designated routes. This policy will not change with Deltaport Third Berth in operation.

There is high potential for the existing road network to be unsustainable in the future, and there is a general recognition that this is a region wide issue that is not due to one project alone. Port operations at Roberts Bank will be one of the key beneficiaries of an improved road network and the Vancouver Port Authority is involved in discussions and contributes to the planning for a better road network in the area. In the meantime the VPA is advocating measures that will improve the situation in the short-term.

The visual amenity of the local area is not predicted to be impacted greatly by the further development of Deltaport as the Project will be visually absorbed into an existing port setting. In the future, residents of Delta and visitors to the area will view a port development that from the most proximal viewpoints is similar to that seen today.

Future generations will not inherit a degraded social environment as a result of Deltaport Third Berth. The effects on the majority of amenities and community facilities in the Corporation of Delta and the GVRD will be neutral, and will not prevent the ability of future generations to access the same resources.

24.6 ECONOMIC

The economic impacts of the Deltaport Third Berth are generally recognised to be positive; the project will add value to the local, regional and wider economies. Economic benefits mean added revenue to individuals, companies, municipalities and the provincial and federal governments. For individuals and companies, the benefits accrue as income, but for local, regional, provincial and federal government it is through tax revenues. This provides these entities with the ability to increase spending on items that enhance lifestyles. Governments for example can use the increased revenue to invest in more and better facilities and infrastructure to alleviate the effects of growth for their residents.

24.6.1 Construction Economic Impact

During construction significant capital will be invested in the building of the terminal, buildings, the container yard and equipment purchases. Capital expenditures, including related off-site road and rail infrastructure, are estimated at \$272 million. This expenditure will directly benefit local and regional economies.

New capital investment will also directly result in positive economic impacts due to contracts and purchases made for labour, goods and services as well as the associated taxes paid and corporate profits (**Chapter 17 Socio-community and Economics, Table 17.10**). Construction of the Deltaport Third Berth will generate significant economic benefits locally (\$13 million in Delta and \$117 million elsewhere in the GVRD), provincially (\$154 million in B.C.) and nationally (\$193 million in Canada) over the construction period. The relative significance of these economic benefits is high. The project will also provide many business opportunities locally and regionally.

24.6.2 Operations Economic Impact

The Deltaport Third Berth Project will generate significant economic benefits locally and regionally for an indefinite time in the future. The relative significance of these economic impacts is very high. Furthermore, the expanded container throughput as a result of the expansion will generate an increase in container business operations as cargoes move through the supply chain in greater volumes than would otherwise be the case.

Operation of the Deltaport Third Berth will generate a wide variety of employment and business opportunities, the majority of which will occur locally and regionally. The ongoing business operations associated with the Deltaport Third Berth Project will generate economic benefits through: employment creation and the resulting expenditures on wages, salaries and benefits; purchases of goods and services for operations; generation of corporate profits; and the payment of property and income taxes during ongoing company operations (**Chapter 17 Socio-community and Economics, Table 17.11**).

In addition when the Deltaport Third Berth Project is operational it will directly generate considerable new economic activity within the container industry supply chain. This will result in new economic benefits, which can be attributed to the project. Net new economic activity will be generated away from the container terminal itself as this new container traffic moves through Deltaport, the regional container handling network and the national supply chain (**Chapter 17 Socio-community and Economics, Table 17.12**).

24.6.3 Total Economic Impact

The economic impact from direct construction, operations and ex terminal business opportunities is \$86 million in Delta, \$1.5 billion elsewhere in the GVRD, \$328 million elsewhere in B.C. and \$932 million elsewhere in Canada. When secondary impacts are included (unavailable for Delta and the GVRD) the impact on the British Columbia and Canadian economies is \$1.7 billion and \$3.5 billion respectively (**Chapter 17 Socio-community and Economics, Table 17.14**).

24.7 CONCLUSION

The Vancouver Port Authority's first priority is to work with its terminal operators to increase the capacities of existing facilities through operating efficiencies and new equipment productivity. However, these improvements alone will not be sufficient to meet the container capacity requirements, and as a result, the VPA has an expansion strategy that includes the proposed Project at Roberts Bank.

The VPA has committed to ensuring that the Deltaport Third Berth Project will be socially and environmentally sustainable. From the above discussion on the sustainability of the ecological,

social and economic components of the environment, an interpretation of the overall contribution of each component to sustainability has been prepared.

The impact on the sustainability of biophysical, socio-community and economic components presents an overall balanced picture. There are strong positive economic contributions to overall sustainability; direct inputs to local, regional, provincial and national economies through job creation, spending and taxes is high. The secondary or flow-on effects of this will indirectly benefit the local, regional, provincial, and national economies. The effects of this are to allow greater ability to access goods and services, a clearly positive impact on the sustainability of future generations.

Effects on the sustainability of community infrastructure such as community and emergency services are considered to be neutral. However, for some socio-community issues such as air quality, noise and traffic the Deltaport Third Berth will contribute to the general trend where capacity of these resources to provide for the future is limited. The contributions of the Project are small in relation to the existing background conditions and the Project will provide mitigation for its direct effects so effects on sustainability are regarded to be neutral. Other factors contribute more to those issues, and the Deltaport Third Berth Project will not inhibit the community to access clean air, quiet or congestion-free roads, but it is widely recognised that broad community involvement and support is required to resolve the wider issues. Beyond the mitigation that VPA is proposing for the Deltaport Third Berth Project, the VPA continues to play a role in alleviating some of these wider community issues.

Access to biophysical environmental components will not be prevented by the construction of the Deltaport Third Berth Project. While there will be a loss of habitat under the footprint of the Project, there will be adequate mitigation applied for these effects, and none of the habitats affected are unique - other similar areas on Roberts Bank are available for plant, animal and human communities. These effects on sustainability are considered to be neutral.

Each of the components assessed for their contribution to sustainable development are considered to be either positive or neutral, leading to the interpretation that on balance the Deltaport Third Berth Project presents a sustainable development that does not prevent future generations from utilising renewable resources.