

4.2.1 - NAVIGATION IMPACT ASSESSMENT

FINAL REPORT

*Cascadia-Viterra **Capacity Improvement** Project - Ref.: 2019-PSHMM-0601*



June 18th, 2019

For: **HEMMERA**

By : Logistro Consulting International Inc. (LCI)

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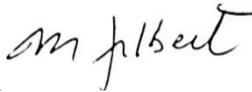
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Executive Summary

Hemmera mandated Logistro Consulting International to undertake a navigational risk, impacts and mitigation assessment regarding the “Cascadia-Viterra Capacity Improvement Project” (i.e. the project). The scope of the study was to review safety of navigation and operations related to the project in Vancouver Fraser Port Authority’s waters.

The project is the expansion of the Canadian Pacific tracks in order to enhance Viterra’s supply chain. The proposed track extension involves increasing the length of the existing third track by approximately 300 meters (m) to the East of the Cascadia Terminal. The track extension will require widening of the existing Canadian Pacific rail embankment within VFPA jurisdiction with the placement of clean, engineered, fill material extending into Burrard Inlet resulting in permanent loss of intertidal fish habitat and potentially subtidal fish habitat in the marine environment (6 phases).

The Project construction site is located East of the Second Narrows Bridge. The site is outside the main shipping channel. The proponent will establish in collaboration with the Port Authority, the different areas needed for marine work and storage of marine equipment (anchorage, spuds, etc.).

Work is presently scheduled outside of the fish habitat protection period (February 28 to August 16) and the work methodology will limit turbidity to levels that will not require silt curtains. If conditions were to change and construction overlaps with the protection period, installation of a silt curtain in the water would be required. The proponent will keep the Port Authority updated on any changes.

Vessel traffic in the Port of Vancouver comprises of deep-sea vessels, tugs and tows, barges (aggregate, chip, log, crane), dredges, ferries, tour boats, fishing vessels, pleasure craft, and log operations. Every year over 4000 vessels call Vancouver Fraser Port Authority to carry on their activities. Commercial vessels and tugs are required to have a functioning AIS system on board that enables the monitoring and control of their movements 24/7. The marine communications and traffic management services (MCTS) of the Canadian Coast Guard, monitors vessels’ movements within the navigation channels and keep mariners abreast of any relevant information pertaining to safety, security, environmental protection and emergency.

The marine construction work will be undertaken by a Marine Contractor to be selected. Marine navigation requirements will be the same as for all other commercial navigation in the Port. The construction will commence November 7th, 2019 and run until February 4th, 2020. The work will require the transportation of approximately 24,000 T of material. Generally, the barges used for this kind of project can carry between 500 T to 2500 T depending on their sizes. Assuming an average size of barge capable of transporting 1000 T, we anticipate:

- Phase 1 would be completed in 10 days with the movement of one barge per day;
- Phases 2,3,4 and 5 would be completed in 35 days with the movement of one barge every third day;
- Phase 6 would be completed in 10 days with the movement of one barge per day.

Hence, the project will bring in the worst case, the addition of one barge movement to the regular daily port’s traffic. In addition to existing VFPA’s marine requirements, specific working requirements will have to be met by the marine contractor (i.e. the Contractor will have to provide a Marine Activities & Operational Plan for approval before starting work).

Several mitigations are in place to ensure the safety and security of marine activities. Indeed, for the concerned project Contractor’s vessels working will be sailing through English Bay, Burrard Inlet and Indian Arm. These 3 locations are under VFPA’s jurisdiction who has developed practices and procedures to ensure safety of navigation. Bathymetry, tide and current information and data are critical to ensure the vessel navigation safety. VFPA in collaboration with the Canadian Hydrographic Services and the Canadian Coast Guard have in place programs and equipment (maintenance dredging, marine surveys, system to measure currents and water levels, etc.) to monitor and display updated information to mariners. Moreover, Vancouver Fraser Port Authority’s dredging/sounding program provides

accurate up to date bathymetries of port's different marine areas/locations that are shared with mariners. In case of a depth concern, Vancouver Fraser Port Authority will issue a "notice to mariners" to inform marine community and take actions to remediate the situation.

The navigation channel between English Bay and Indian Arm is marked with fixed and floating navigation aids managed by the Canadian Coast Guard. Range lights with leading beacons help mariners identify the channel centre line. The use of navigation marks and buoys is in accordance with the International Conventions on Buoyage. The Canadian Hydrographic Service regularly publishes hydrographic charts that clearly indicate channel fairways and navigational aids.

In 2010, Vancouver Fraser Port Authority asked the Canadian Coast Guard for a review and enhancement of existing Aids to Navigation in the Port Harbour. The results were the installation of several equipment and AtoN including water levels, air draft and currents measuring systems at the Second Narrows. The improvement of the overall navigation system enhanced the reliability, accuracy and redundancy of the Aids to navigation in the Port; hence mitigating navigational risks.

Vancouver Fraser Port Authority Harbour Master Office, through its Operational Centre operates 24/7 and provides expertise and skilled resources to support an/or respond to any issue, emergency or demands. The Harbour Master's officers can rely on sophisticated equipment and systems (cameras, IAS, radar feed, etc.) and water/land patrols to monitor Port's activities and enforce Port's Practices & Procedures. They work in collaboration with diverse organizations and regulatory agency to safeguard our waters.

The contractor is required to prepare a project specific Marine Activities & Operational Plan (MAOP) addressing all anticipated project's marine navigation/operations activities of its entire marine assets and equipment involved and have mitigation measures to alleviate impacts, including the following:

- **Safety Management System:** Ensure the marine Contractor has in place adequate safety and emergency plans and measures;
- **Management and Coordination of Marine Equipment/ Assets Movements:** As a mitigation measure, introduce planning tool/schedule identify and address in advance potential issues;
- **Protection of Contractor Personnel:** As a risk mitigation measure, remove personnel working in the cofferdam at least 15 minutes prior to scheduled barge moves;
- **First and second narrows transit restrictions:** Identify potential limitations and agree on Motus Operands;
- **Identified working area:** identify navigation exclusion zones (in the working site) and anchorage area;
- **Tug requirements:** specific requirements above Transport Canada regulations (if needed);
- **Barges requirements:** specific requirements above Transport Canada regulations (if needed);
- **Standby Tug:** The presence of a standby tug during the working hours in case of emergency;
- **Assist Tug:** Presence of a tethered assist Tug when transiting First and Second narrows;
- **Dry run:** organizing and coordinating a workshop before starting project in order to go through every aspects of the project with all pertinent actors and identify any gaps or opportunity to enhance the situation;
- **Regular meetings:** establish regular meeting in order to ensure alignment of objectives and actions.
- **Marine Communications Plan:** The contractor will submit a detailed Marine Communication Plan to the Vancouver Fraser Port Authority at least 10 days prior to the commencement of work. The Plan must be approved by the Authority.

The review and analysis of the overall regulatory framework (Transport Canada, Canadian Coast Guard, Port of Vancouver, Pilotage, etc.) indicates very high-level requirements presently in place to oversee marine safety, security and environmental protection in Canada in general and in the Port in particular.

As far as marine traffic management, monitoring and control, the Vancouver Fraser Port Authority, its stakeholders and users have state of the art equipment and systems to ensure safe navigation within Port's waters. The First and Second Narrows channels transit procedures are well established to ensure safety and security. Moreover, the marine infrastructures in both narrows are strong and with protection against vessel's striking

Definition

Chart datum (CD)

Chart Datum is the plane of vertical reference to which all charted depths and drying heights are related. In non-tidal waters, it is also the vertical datum for elevations and clearances. It is chosen to show the least depth of water found in any place under "normal" meteorological conditions; it shall be a plane so low that the water level will seldom fall below it. The surface of CD will vary from place to place with the range of tide or, in non-tidal waters, with the slope of the river at low stage. In non-tidal lakes, CD is normally a single level surface over the whole lake.

COLREGs

International Regulations for Preventing Collisions at Sea 1972 (COLREGs) are published by the International Maritime Organization (IMO) and set out, among other things, the "rules of the road" or navigation rules to be followed by ships and other vessels at sea to prevent collisions between two or more vessels. COLREGs can also refer to the specific political line that divides inland waterways, which are subject to their own navigation rules, and coastal waterways which are subject to international navigation rules.

Current

Generally, a horizontal movement of water. Currents may be classified as tidal and non-tidal. Tidal currents are caused by gravitational interactions between the Sun, Moon, and Earth and are part of the same general movement of the sea that is manifested in the vertical rise and fall, called tide. Tidal currents are periodic with a net velocity of zero over the particular tidal cycle. Non-tidal currents include the permanent currents in the general circulatory systems of the sea as well as temporary currents arising from more pronounced meteorological variability.

Clear Narrows

The term "Clear Narrows" is defined as the transit of a vessel through either First or Second Narrows, unimpeded and not met, overtaken or crossed ahead of by any other vessel.

Ebb current (ebb)

The horizontal movement of water associated with the falling tide. Ebb currents generally set seaward, or in the opposite direction to the progression. Also called ebb, ebb current or outgoing stream.

Ebb tide (Falling)

The portion of the tide cycle between high water and the following low water. The opposite is rising tide.

Flood current (stream)

The horizontal movement of water associated with the rising tide. Flood streams generally set toward the shore, or in the

	direction of the tide progression. Also called flood, flood current or in going stream.
Flood tide (Rising)	The portion of the tide cycle between low water and the following high water. Also called flood tide. The opposite is falling tide.
High tide (H.W.)	The highest level reached at a place by the water surface in one oscillation. Also called high water.
Higher high water large tide (HHWLT)	The average of the highest high waters, one from each of 19 years of predictions.
Higher high water mean tide (HHWMT)	The average from all the higher high waters from 19 years of predictions.
Knot	A division of the log line by which the ship's speed is measured. A nautical unit of speed. One knot is one nautical mile per hour. (1852.0 meters or 6076.115,49 international feet) per hour. The name is derived from the knots in the log line.
Lower low water large tide (LLWLT)	The average of the lowest low waters, one from each of 19 years of predictions.
Lower low water mean tide (LLWMT)	The average of all the lower low waters from 19 years of predictions.
Mean water level (MWL)	The average of all hourly water levels over the available period of record.
Tier 1 Vessel	Means any vessel which falls under the following categories: <ul style="list-style-type: none"> • All piloted vessels and tug and barge combinations when piloted, regardless of tonnage; • All non-piloted tug and barge combinations with a barge of 10,000 tonnes or more carrying capacity; • All non-piloted vessels including barges and articulated tugs and barges (ATBs) when in product.
Tier 2 Vessel	Means all other vessel traffic that is not Tier 1 operating in the TCZ-1 boundaries.
Traffic Control Zone 1 (TCZ1)	Area near Lions Gate Bridge established by the Port Authority for the purpose of promoting safe and efficient navigation or environmental protection in the waters of the port, with respect to ships or classes of ships.
Traffic Control Zone 2 (TCZ2)	Area near Iron Workers Memorial Bridge established by the Port Authority for the purpose of promoting safe and efficient

navigation or environmental protection in the waters of the port, with respect to ships or classes of ships.

VFPA

Vancouver Fraser Port Authority.

1. Introduction, Scope and Objectives

Hemmera mandated Logistro Consulting International to undertake a navigational risk, impacts and mitigation assessment regarding the “Cascadia-Viterra Capacity Improvement Project” project (i.e. the project).

The scope of the study is to review safety of navigation and operations related to the project in Port of Vancouver (VFPA)’s waters.

The Objectives are the followings:

- Review project information and data;
- Review and assess marine work plan;
- Provide a navigational assessment report (including impact and mitigation);

2. Project Definition

The project is the expansion of the Canadian Pacific tracks in order to enhance Viterra’s supply chain. The proposed track extension involves increasing the length of the existing third track by approximately 300 meters (m) to the East of the Cascadia Terminal. The track extension will require widening of the existing CP rail embankment within VFPA jurisdiction with the placement of clean, engineered, fill material extending into Burrard Inlet resulting in permanent loss of intertidal fish habitat and potentially subtidal fish habitat in the marine environment.

2.1. Construction Work Summary

The proposed construction activities are anticipated to occur from the marine side of the project area supported by a barge anchored immediately offshore. Granular and rock fill is anticipated to be transported to site via barge. A work pad will be temporarily constructed within the project site. The temporary working pad will serve as a material unloading area, the scow will be tied up adjacent to this pad. Marine work equipment is anticipated to be derrick with a track mounted crane containing a clam shell bucket for riprap placement and removal. Land based grading equipment will include rock trucks, excavators/or bulldozers and a packer. A salvage of the marine intertidal and subtidal areas will be conducted prior to fill placement. Following fill placement, the new track grade will be constructed followed by installation of the new track and switch infrastructure. A biophysical survey and geotechnical drilling program will be conducted to determine baseline environmental and soil conditions to support the environmental assessment and design.

The work will include the following:

Phase 1 – Toe Construction

The contractor will use the daily low tide window to:

- Excavate the required volume of material for disposal,
- Install the required geo textile,
- Install the rip rap toe material.

The remaining workday outside the low tide window will be used to manage on-site material and prepare for the next low tide window.

To facilitate barge access, a temporary work pad will be installed prior to slope construction to provide a stable working area for material unloading, temporary stockpiles, equipment setup and storage, etc. It is estimated that the work pad will require the following material specifications and volumes:

1. Well-graded structural fill (50 mm max) – (7,700 T) 6,800 m³
2. Rip rap – (1,500 T) 1,285 m³

The barging contractor will follow all applicable rules and regulations for marine operations inside the Burrard Inlet.

Phase 2 – Slope Construction (From Toe to HHWL)

The installation of construction fill from the installed toe to above HHWL, including the installation of slope armouring, will be limited to the linear limits of the tide window. The daily work will be left in a “slope protected” state.

Material delivered to site will be managed from the temporary work pad by the civil contractor; this includes placement of toe material, placement of the layers of structural fill, and the final placement of slope protective rip rap.

Slope construction will commence after contractor mobilization and will be staged in phases to minimize water turbidity. Material excavation and placement below the Highest High-Water Level (HHWL) will be limited by low tide windows. Material placement above HHWL will only be limited by the daily placement limits of the contractor.

The estimated slope expansion is currently broken up into the following material specifications and volumes:

1. Well-graded structural fill (50 mm max) – (10,900 T) 9,620 m³
2. Rip rap – (3,460 T) 3,057 m³
3. Sub ballast – (490 T) 436 m³

Phase 3 – Platform Construction (From HHWL to Sub-ballast)

The installation of this level will not be impacted by tide restrictions and will only be limited by the daily placement limits of the contractor.

Phase 4 – Installation of Sub-ballast

The installation of this level will not be impacted by tide restrictions and will only be limited by the daily placement limits of the contractor.

Phase 5 – Removal of Temporary Work Pad

The temporary work pad will be reduced in size, graded and rip rap placed subject to tide restrictions.

Phase 6 - Offsetting Construction

Fish habitat offsetting construction will be undertaken including the construction of intertidal and shallow rock reefs and riparian planting. Installation of the shallow rock reefs will include some in-water work (i.e., shallow subtidal reefs placed via barge mounted crane), however, work will be undertaken in the dry as much as feasible (i.e., intertidal reefs). This work will require 1000 m³ of rock for the reefs.

Note: The Project construction site is located East of the Second Narrows Bridge. The site is outside the main shipping channel. The proponent will establish in collaboration with the VFA Marine Operations, the different areas needed for marine work and storage of marine equipment (anchorage, spuds, etc.).



Figure 1- Location of work site (Source Google map)

2.2. Anticipated Schedule & Duration

Work is presently scheduled outside of the fish habitat protection period (February 28 to August 16) and the work methodology will limit turbidity to levels that will not require silt curtains. If conditions were to change and construction overlaps with the protection period, installation of a silt curtain in the water would be required. The proponent will keep the Vancouver Fraser Port Authority updated on any changes.

3. Marine Equipment & Activities

3.1. Equipment

The marine construction work will be undertaken by a Marine Contractor to be selected. Marine navigation requirements will be the same as for all other commercial navigation in the Port. However specific working requirements will have to be met by the marine contractor (see item 4.5.6. Contractor requirements).

The equipment used by the marine contractor will include cranes, barges, tugs, etc.

The marine activities will include the following:

- Mobilization,
- Vibratory driving of piles and sheeting,
- Excavation using clamshell bucket,
- Pile driving of piles within the cofferdam,
- Placement of rebar and concrete within the cofferdam,
- Demobilization

3.2. Marine Activity (estimated traffic related to project)

Although the marine contractor has not been yet identified, we can foresee minimum increase in marine traffic related to the project. Tugs and barges are required to follow VFPA's procedures and rules when they navigate on Port's waters.

<https://www.portvancouver.com/marine-operations/port-information-guide/>

The construction will commence November 7th, 2019 and run until February 4th,2020. The work will require the transportation of approximately 24,000 T of material. Generally, the barges used for this kind of project can carry between 500T to 2500 T depending on their sizes.

Assuming an average size of barge capable of transporting 1000 T, we anticipate:

- Phase 1 would be completed in 10 days with the movement of one barge per day.
- Phases 2,3,4 and 5 would be completed in 35 days with the movement of one barge every third day.
- Phase 6 would be completed in 10 days with the movement of one barge per day.

4. Marine Navigation Assessment, Impacts and Mitigation

4.1. Regulatory Authorities and Acts

4.1.1. Vancouver Fraser Port Authority

Vancouver Fraser Port Authority is a non-shareholder, for-profit corporate entity, established in January 2008, pursuant to the Canada Marine Act, subject to provisions of the act. The Port Authority is accountable to the Federal Minister of Transport, Infrastructure and Communities. The Port Authority's mandate under the Canada Marine Act is to facilitate safe and secure trade for the benefit of Canada. In order to achieve these objectives, the Act enables the port to develop and establish practices and procedures.

The Port's Harbour Master Office which operates 24/7 is responsible for the management, monitoring and control of all marine traffic and activities occurring within its jurisdiction. The Port has resources that ensure the application of Port's rules, practices and procedures on land or at sea. Since 2010, Vancouver Fraser Port Authority has established an Operational Center that facilitates ports operations including marine security, safety and emergency management.

In collaboration with a wide range of federal, provincial and municipal stakeholders and users the Vancouver Fraser Port Authority coordinates port's operations. Amongst the diverse communication platforms, Port of Vancouver (VFPA) has in place several Port Community Liaison Committees which are composed of First Nation, industry, Port users and community representatives to discuss and find solutions to port-related issues.

The Project is located within the VFPA's jurisdiction and requires a permit under the Port Authority's Project Environmental Review Process (PER). The permitting process enables the VFPA to ensure projects meet applicable standards and minimizes community and environmental impacts.

4.1.2. Canadian Coast Guard

The Canadian Coast Guard (CCG) is a Special Operating Agency of the Department of Fisheries and Oceans Canada (DFO), which owns and operates the federal government's civilian fleet and provides key maritime services to Canadians comprising aids to navigation (AtoN), marine communications and traffic management services (MCTS), icebreaking and ice-management services, channel maintenance, marine search and rescue and marine pollution response.

As the federal Organization responsible, under both the Ocean Act and the Canada Shipping Act, for ensuring safe and accessible waterways for Canadian, the CCG deploys important resources and equipment across Canada including aids to navigation. These AtoN are deployed in specific areas in order to help vessels navigate safely. The CCG has also marine assets available 24/7 to respond to an emergency within the Port's waters.

4.1.3. Transport Canada (Marine Safety)

Transport Canada (TC) is the federal entity that administers several international and federal Acts/laws including *Canada Shipping Act*, *Canada Marine Act* and the *Navigation Protection Act (NPA)*. Marine safety officers and other representatives manage these to ensure the safe operation, navigation, design and maintenance of ships, protection of life and property, and prevention of ship source pollution.

The Marine Safety program oversee several national programs including the following:

- Maintain a Canadian vessel registry;
- Deliver prevention-based programs to promote small vessel/recreational boating safety;
- Administer the navigable waters protection program;
- Promote safe practices and procedures;
- Develop and maintain regulations, examinations, and training standards for the certification of seafarers;
- Respond to marine occupational safety and health issues;
- Oversee pilotage matters.

As far as our project is concerned, Transport Canada provides regulatory framework and services that ensure Canadian seafarers and Canada's fleet of vessels meet national and international standards and requirements. Also, TC might be involved through the NPA in ensuring the public right of navigation in all Canadian waters and regulating the construction of works that have the potential to infringe this right.

4.2. Waterways Activities and Conditions

4.2.1. General

Port of Vancouver is the busiest port in Canada with over 170 million tons of cargo handled every year. With over 20 major terminals, the deep-water port is responsible for operation and development of assets and jurisdictions of the combined Fraser River Port Authority, North Fraser Port Authority and Vancouver Port Authority.

Vancouver Fraser Port Authority marine practices and procedures are established pursuant to Section 56 of the Canada Marine Act. Their purpose is to promote safe and efficient navigation in the waters of Vancouver Fraser Port, while striving to protect the environment. These Practices includes sections on general Information, Navigation, Fishing, Loading of Logs, Terminal Berth Activities, Mooring of Vessels, Floating Property and Booms, Towing, Dredging, Marine Events, Recreational Boating, Anchoring, Bridge Transits, Loading of Logs, Over Side Discharges, and Fuel Transfer Safety Checklist.

The marine activities in the Inner harbour/ Indian Arm are multiple and diverse including deep-sea vessels operations (cruise, bulk, general cargo, etc.), marine services (tugs, bunkering, water taxis, etc.), marine events (regatta, etc.), recreational boating and marine construction (pilings, dolphins, docks, etc.). The Harbour Master Office is responsible to develop and enforce these practices and procedures and have resources on land and at sea to oversee all marine activities within its jurisdiction.

4.2.2. Marine Traffic

Vessel traffic in the Port of Vancouver comprises of deep-sea vessels, tugs and tows, barges (aggregate, chip, log, crane), dredges, ferries, tour boats, fishing vessels, pleasure craft, and log operations. Every year over 4000 vessels call Vancouver Fraser Port Authority to carry on their activities. Commercial vessels and tugs are required to have a functioning AIS system on board that enables the monitoring and control of their movements 24/7. The marine communications and traffic management services (MCTS) of the Canadian Coast Guard, monitors vessels' movements within the navigation channels and keep mariners abreast of any relevant information pertaining to safety, security, environmental protection and emergency.

The vessel speed depends on location and situation and must abide to International Collision Regulations (COLREGS), Transport Canada and POV rules. For instance, vessels need to respect Port's speed limitations rule when they go through Second Narrows. Also, subject to Colregs rules 10 (Traffic separation Schemes), vessels must navigate accordingly in English Bay's Traffic Separation Scheme.

4.2.3. Bridges

4.2.3.1. General

Waterway crossings have different importance depending of their location and usage. In Canada, crossings are usually classified based on social/survival and strategic highway network considerations. The social/survival evaluation for bridge crossings is mostly concerned with the need to respond to an emergency that might exist on opposite sides of a crossing.

For infrastructures crossing navigable waterways, the Code requires that they be classified as either a Class I bridge (critical/essential) or a Class II bridge (regular) bridge as shown below:

- Class I bridges are of critical importance, including those that must remain open to all traffic after a vessel collision. The maximum annual frequency of collapse for the whole bridge shall be 0.0001, which is a return period of 1 in 10,000 years.
- Class II bridges are of regular importance, including those that must remain open to emergency and security vehicles after a vessel collision. The maximum annual frequency of collapse for the whole bridge shall be 0.001, which is a return period of 1 in 1,000 years.

For purposes of this study both the Lions Gate and the Iron Workers Bridges are classified as a Class I (Critical) bridge with a desired return period of 1 in 10,000 years for collapse due to potential vessel collision. It should be noted that the above- mentioned bridge collapse return period criteria does not imply that the bridge is expected to last 10,000 or 1,000 years, but rather that during the normal service life of the structure (typically 100 years) the risk of collapse due to a vessel collision will be very small.

<https://canada.constructconnect.com/joc/news/projects/2018/04/design-work-underway-lions-gate-ironworkers-memorial-bridges>

4.2.3.2. First Narrows (Lions Gate Bridge)

Opened in 1938, the Lions Gate Bridge is an 846m long suspension bridge spanning the First Narrows of the Burrard Inlet with a 472m main span supported by two main towers. The main towers are constructed of steel, each supported on reinforced concrete pedestals and foundation. The bridge carries three lanes of vehicular traffic and two multi-use paths for pedestrians and cyclists between Vancouver and the north shore municipalities of West Vancouver and North Vancouver



Figure 2 - Lions Gate Bridge (Source Internet)

The Lions Gate Bridge crosses the First Narrows entrance into Burrard Inlet and Vancouver Harbour. The First Narrows entrance is open to navigation all year around. The channel is maintained at 15 m (CD) and clearly defined by Aids to navigation. The fixed highway bridge has a vertical clearance under the center of 61m with a navigable width of 305m. Transit of commercial vessels (ships and barges) under the bridge are managed and monitored by the Port Authority and the MCTS. Fixed red lights are shown from tops of the main towers. Two fixed white lights are shown on the underside of the bridge to indicate channel limits. Fixed yellow lights are shown from the centres of bases of the two main towers.

4.2.3.3. Second Narrows (Iron Workers & CN Rail)

The Ironworkers Memorial Second Narrows Crossing, also called the Ironworkers Memorial Bridge and Second Narrows Bridge, is the second bridge constructed at the Second (East) Narrows of Burrard Inlet. Originally named the Second Narrows Bridge, it connects Vancouver to the North Shore of Burrard Inlet. The bridge is 1,292 m long with a center span of 335 m. The Iron Workers Memorial Second Narrows Bridge is a fixed span road bridge with a width of 315 m between supports over the channel. It has a minimum vertical clearance of 44 m over the 110 m wide shipping channel.

It was constructed adjacent to the older Second Narrows Bridge, which is now exclusively a rail bridge. The rail bridge was constructed in 1968 and replaced the original bascule rail/highway bridge built in 1925 which had been hit by vessels several times and collapsed twice due to vessel collision. The Second Narrows CN Rail Bridge across Burrard Inlet was struck by the cargo ship Japan Erica carrying logs in October of 1979 as it attempted to transit the harbour during heavy fog. The impact knocked an approach span adjacent to the main span section of the rail bridge into the water. The rail bridge remained closed until March 4, 1980. Subsequent to the 1979 accident, the VFPA in cooperation with the Coast Guard, PPA and other maritime stakeholders, imposed rigorous vessel operating restrictions for vessels transiting the Second Narrows waterway in the vicinity of the rail bridge. It has a vertical lift span over the navigable

channel. Limits of this channel, 137.1 m wide, are indicated by fixed red and green lights at the base of the piers supporting the lift span. Minimum clearance

4.2.4. Navigation

4.2.4.1. General

For the concerned project it is important to define the 3 main marine areas in the Port. Contractor's vessels working on the CP project will be sailing through English Bay, Burrard Inlet and Indian Arm. These 3 locations are under VFPA's jurisdiction who has developed practices and procedures to ensure safety of navigation.

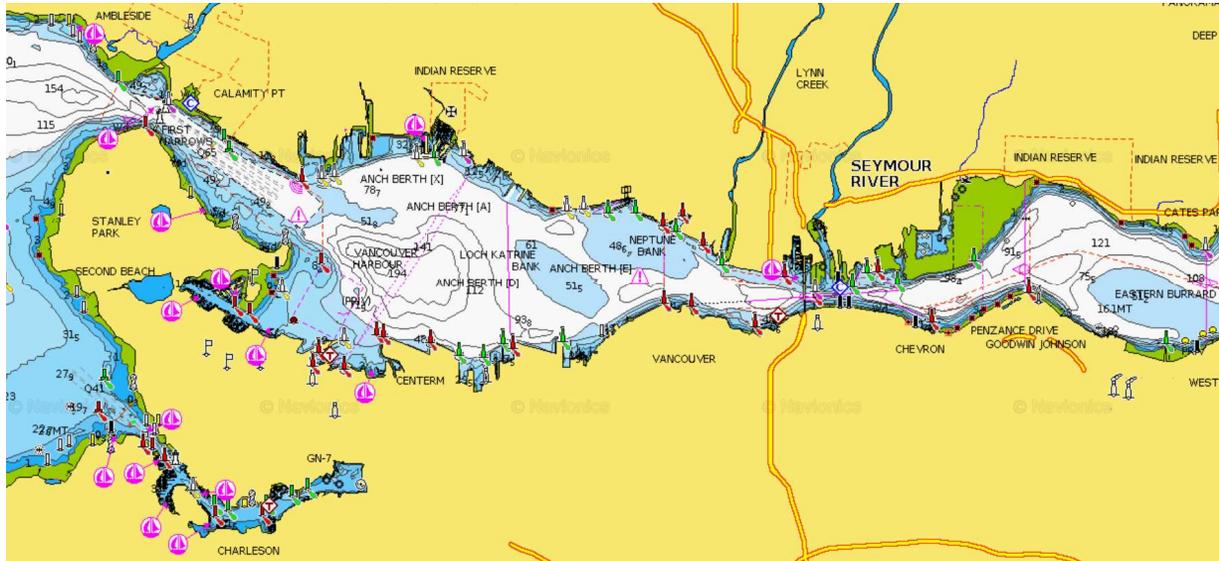


Figure 3 - English Bay, Burrard Inlet and Indian Arms areas (source AVIONICS)

4.2.4.2. English Bay

English Bay is a large marine sheltered area at the entrance of the Port where vessels can anchor and wait for the berth availability. Vessels calling Port of Vancouver arrive in English Bay (West of First Narrows) where there is a marine traffic separation scheme (TSS). The TSS is in place in order to separate the inbound and outbound vessels calling Vancouver. Vessels are subject to International Collision Regulations (COLREGs), Canadian regulations and VFPA's rules.

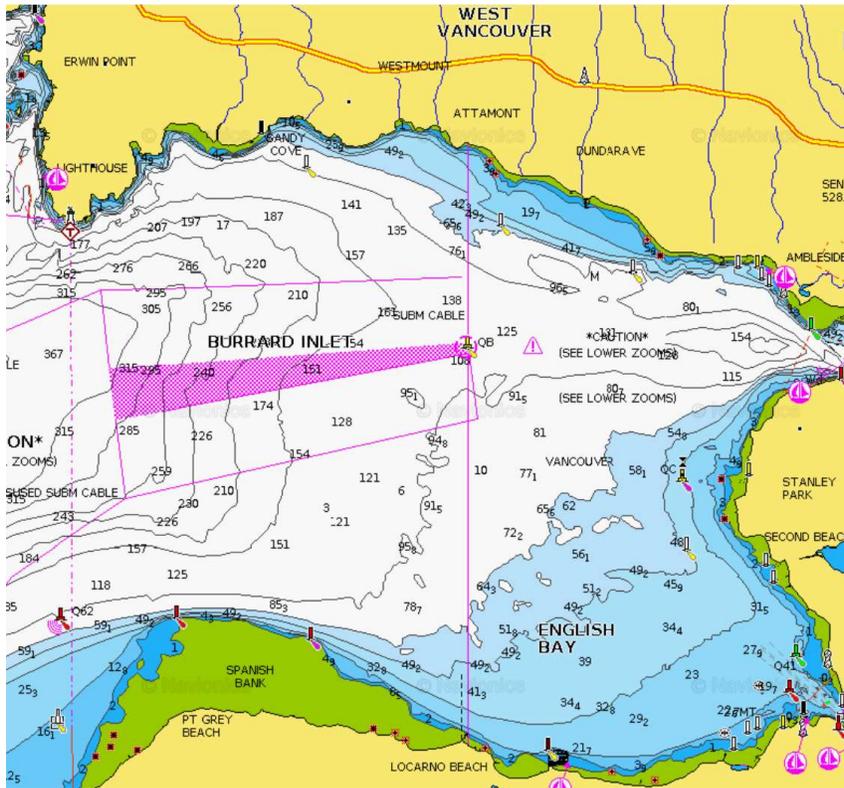


Figure 4 - Traffic Separation Scheme in English Bay (source AVIONICS)

Vancouver Fraser Port Authority manages all activities in English Bay including anchorages and marine events.

4.2.4.3. Burrard Inlet (BI)

Burrard Inlet is an area that hosts several important marine terminals that are located on both side of the body of water. Every day several vessels' movements occur in this busy marine area where several activities take place including a seabus service between North and South shores, dee-sea vessels' arrivals/departures, marine services to vessels at anchor and recreational marine activities.

In order to reach Burrard Inlet (BI), vessels transit through the First Narrows; Because of its intricacies, Vancouver Fraser Port Authority (VFPA) has developed special practices and procedures to ensure safe marine operations and movements. Vessels transiting the area must abide to VFPA's Traffic Control Zone 1 (TCZ1).

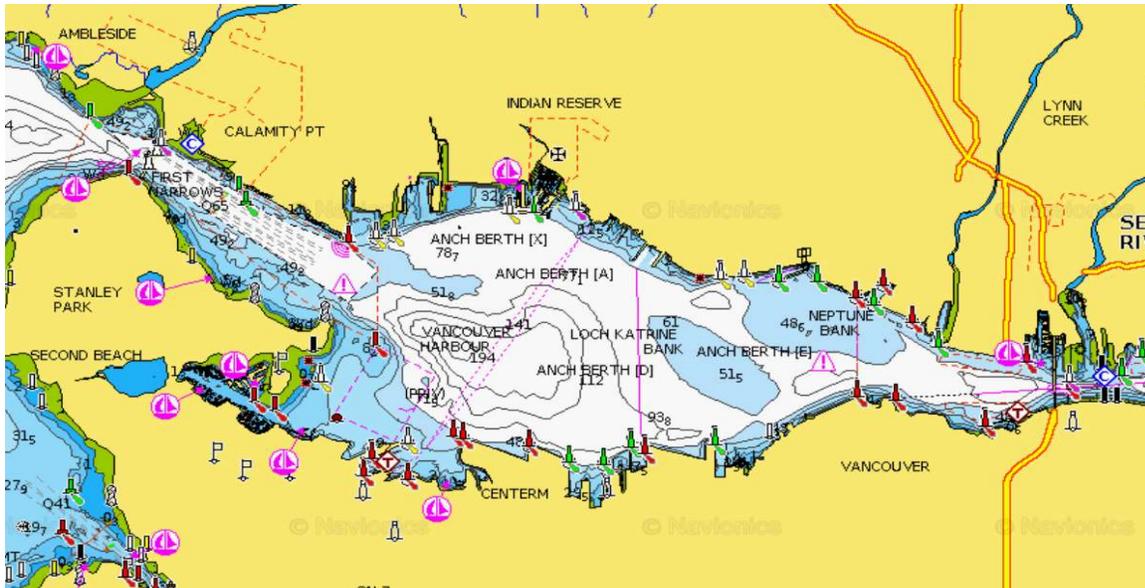


Figure 5 - Burrard Inlet (source AVIONICS)

4.2.4.4. Indian Arm

Indian Arm is situated in the most eastern part of the Port. Every day, tankers and other liquid/dry bulk carriers of different sizes transit the Second Narrows to reach the petrochemical and dry bulk terminals operating in the area.

In order to reach Burrard Inlet (BI), vessels transit through the Second Narrows; Because of its intricacies, Vancouver Fraser Port Authority (VFPA) has developed special practices and procedures to ensure safe marine operations and movements. Vessels transiting the area must abide to Vancouver Fraser Port Authority (VFPA)'s Traffic Control Zone 2 (TCZ2).

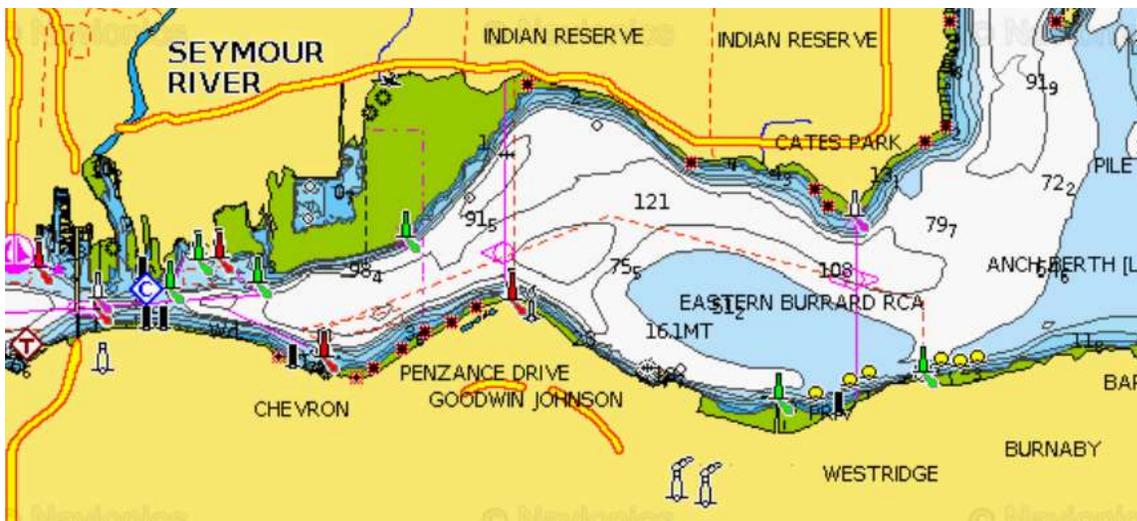


Figure 6 - Indian Arm (source AVIONICS)

As part of the BC Government's Lower Mainland Nature Legacy Program, Indian Arm has also seen the creation in 1995 of the Say Nuth Khaw Yum Heritage Park / Indian Arm Provincial Park. The Park is located within the core of the

Tsleil-Waututh Nation Traditional Territory. In 1998, a Management Agreement was signed between the Tsleil-Waututh Nation and the Government of British Columbia (BC). The Management Board has equal representation from the Tsleil-Waututh and the British Columbia Government to co-manage all aspects of the Park and Heritage Area.

4.3. Bathymetry, Tide and Currents

4.3.1. General

Bathymetry, tide and current information and data are critical to ensure the vessel navigation safety. VFPA in collaboration with the Canadian Hydrographic Services and the Canadian Coast Guard have in place programs and equipment (maintenance dredging, marine surveys, system to measure currents and water levels, etc.) to monitor and display updated information to mariners.

4.3.2. Bathymetry

Originally, bathymetry involved the measurement of ocean depth through depth sounding. Early techniques used pre-measured heavy rope or cable lowered over a ship's side. This old technique allowed the measure of the depth only at a singular point at a time and was subject to movements of the ship and currents moving the line out of true and therefore was not accurate. Today the technology is far more accurate with the use of echosounder or LIDAR that provide multibeam information and data.

Vancouver Fraser Port Authority's dredging/sounding program provides accurate up to date bathymetries of port's different marine areas/locations that are shared with mariners. In case of a depth concern, VFPA will issue a "notice to mariners" to inform marine community and take actions to remediate the situation.

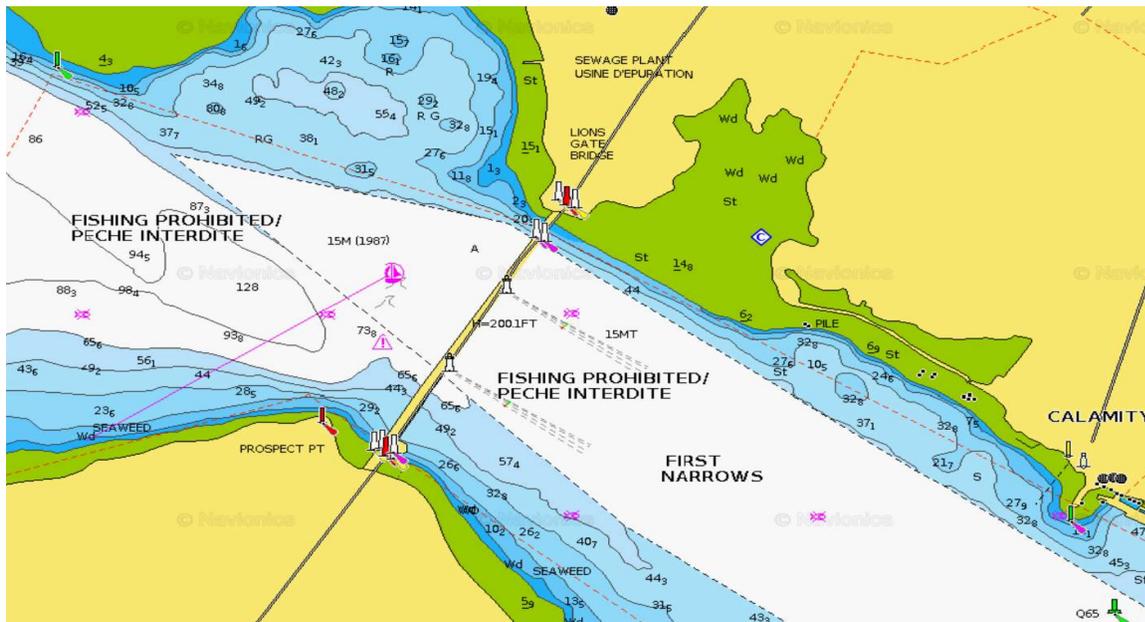


Figure 7 - First Narrows' maintained depth at 15m (CD)

Generally, beside the construction site (shoresides), the areas concerned by the project (i.e. transit through English Bay, Burrard Inlet and Indian Arm) are located in deep water where they would be no draft issues for the Contractor's marine equipment. However, for both First and Second Narrows, Vancouver Fraser Port Authority has established channel designed parameters to ensure safe transit under the bridges. The maintained depth in First Narrows is 15m (Chart Datum) and 12.5m (Chart Datum) for Second Narrows.

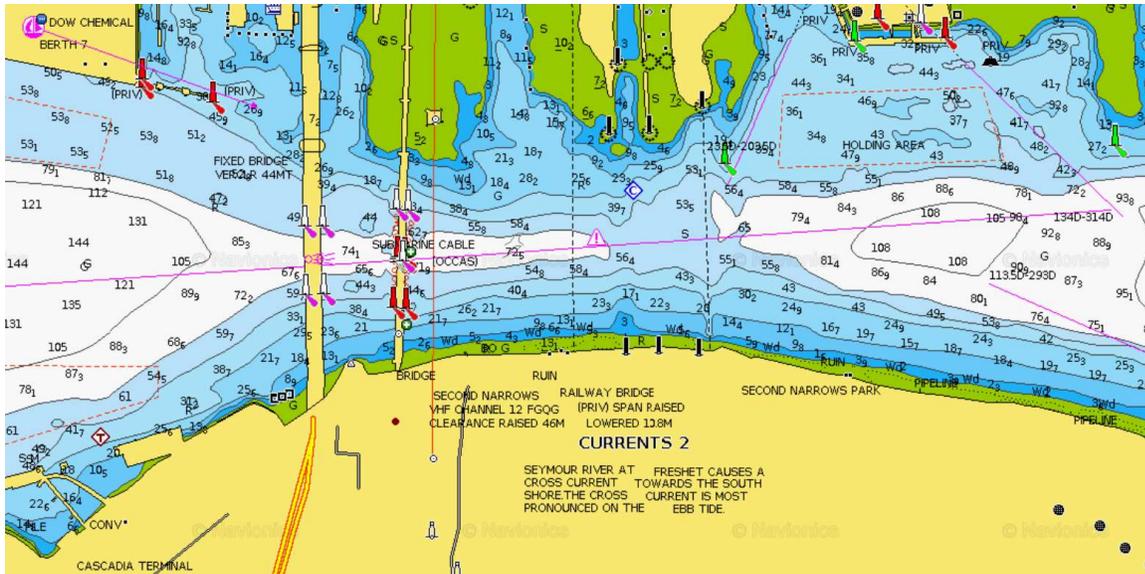


Figure 8 - Second Narrows' maintained depth at 12.5m (CD) (source AVIONICS)

4.3.3. Tides

The Vancouver Fraser Port Authority is within strong tidal influence area of the world. A mixed semidiurnal tide cycle (two high and two low tides of different size) occurs every day. The maximum tidal range in a cycle occurs during “spring tides” which occur twice per lunar month and can be as great as 5m.

Table 1- Vancouver Harbour Tidal Information (Source Canadian Hydrographic Services)

Tide type	Tide Level Elevation /depth (m)
Extreme Highest Water (EHHW)	5,6
Higher High Water Large Tide (HHWLT)	5,0
Higher High Water Mean Tide (HHWMT)	4,4
Mean High Water (MHW)	4,2
Mean Water Level (MWL)	3,1
Mean Low Water (MLW)	2,0
Chart Datum – CD	0,0
Lower Low Water Mean Tide (LLWMT)	1,1
Lower Low Water Large Tide (LLWLT)	(0,1)
Extreme Lowest Low Water (ELLW)	(0,3)

Tidal predictions and differences for the Port of Vancouver are in *Canadian Tide and Current Tables, Volume 5* (see link below). In the approach to Vancouver Harbour are given for Point Atkinson (7795) and tidal differences, referenced on Point Atkinson, are given for False Creek (7710). In the West portion of Vancouver Harbour, between First and Second Narrows, tidal predictions are given for Vancouver (7735). East of Second Narrows tidal differences referenced on Vancouver are given for Port Moody (7755), Deep Cove (7765) and Buntzen Lake (7771).

- Pointe Atkinson: http://www.tides.gc.ca/eng/data/table/2019/wlev_ref/7795
- Vancouver: http://www.tides.gc.ca/eng/data/table/2019/wlev_ref/7735
- Port Moody: http://www.tides.gc.ca/eng/data/table/2019/wlev_sec/7755

4.3.4. Currents

Real-time accurate information on currents is important for mariners as it could cause an accident if not taken into consideration when navigating especially in close distance from the shore (risks of groundings/ drifting). The major effects of currents are experienced in bottlenecks like First and Second Narrows where there is an increase of water flow's speed (Venturi effect). Another interesting aspect of currents is that their speed and direction can change dramatically depending of the depth. For instance, West of First Narrows, between the bridge and buoy *QB* 2.5 miles West of Lions Gate Bridge, the ebb current is preceded by a well-defined tide line. Surface currents West of the tide line are slack but at a depth of 10 m a strong West current in excess of 2 knots is usually present.

In First narrows, typical peak surface flows for both ebb (towards the West) and flood (towards the East) tides have peak surface currents across the body of water of 4 to 5 knots and moving in a direction roughly parallel to the vessel transit paths. On strong ebbs a distinct front exists along the junction of the mainstream, with the relatively weak currents to the South. It is often marked by a line of rips, dangerous to small craft, especially in the area near the mouth of Capilano River. Moreover, Vessels inbound or outbound in the vicinity of Prospect Point should exercise caution passing the mouth of Capilano River. If the river is in flood a considerable cross current can set the vessel off the course.

In Second narrows typical peak surface flows for both ebb (towards the West) and flood (towards the East) tides have peak surface currents across the body of water that can attain 6,5knots and moving in a direction roughly parallel to the vessel transit paths. Moreover, freshets from the Seymour River can cause a cross current toward the south shore that is most pronounced on the ebb tide.

Between First and Second Narrows strongest currents occur 3 hours before turn to ebb when velocities can attain 2 knots setting East-South-East off Centerm terminal on the south shore, then again 2 hours before the turn to flood when velocities can attain 2 knots setting West along the north shore.

Note: Inshore eddies within Vancouver Harbour are unpredictable. No reliance should be placed on anticipated direction of tidal stream alongside any wharf. Vessels berthing should have anchors in readiness.

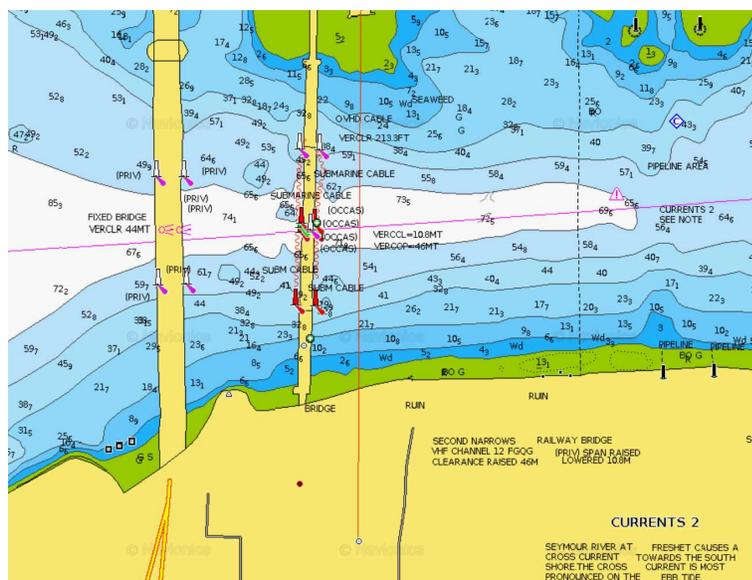


Figure 9 - Currents and cross current at Second Narrows (source AVIONICS)

Predictions of times and rates of maximum current and times of slack water are given for First Narrows (4000) and Second Narrows (4100) in *Canadian Tide and Current Tables, Volume 5*.

- First Narrows: http://www.tides.gc.ca/eng/data/table/2019/curr_ref/4000
- Second Narrows: http://www.tides.gc.ca/eng/data/table/2019/curr_ref/4100

4.3.5. Visibility

Although heavy precipitation and pollution can reduce visibility, fog is the primary visibility concern for navigation along the route for the Contractor's vessels. Fog is caused by relatively warm moist air blown over the colder land mass during the cooler months (i.e., September to March). Although fog can persist throughout the day or several days during colder weather periods, it typically dissipates during the warmer daytime.

As far as transiting First and Second Narrows, there are specific requirements for all Tier 1 vessels, including tugs and barges (also they may request the declaration by marine communications and traffic management services (MCTS) of a Clear Narrows during a TCZ-1 transit when restricted visibility of one mile or less is expected). However, the Master of a vessel has the final decision as far as undertaking a transit in reduced visibility.

Meteorological information from Vancouver International Airport are usually used for Vancouver Harbour.

4.3.6. Ice & Snow

The waters involved in the project are not subject to freezing and remain open all year round. Very seldom, there might be some thin ice in the northern extremity of Indian Arm (North of Deep Cove).

The mild climate of the British Columbia coast typically causes any snow fall to melt relatively quickly thereby limiting the amount and duration of snow accumulation.

4.4. Project Marine Impacts

Our assumption is that Cascadia-Viterra Capacity Improvement Project will involve a limited number of marine equipment (crane barge, delivery barges for construction materials, support tugs, small vessels for crew transit) that will have minimum impact on the overall Port's traffic. Moreover, the small vessel size and the type of handled material and products will put the marine equipment in the Tier 2 vessels reducing the transit requirements.

4.5. Mitigation

4.5.1. Practices & Procedures

The Port of Vancouver's Port Information Guide (<https://www.portvancouver.com/marine-operations/port-information-guide/>) is a living document that is updated on a regular basis to ensure its adequacy, accuracy and pertinence.

The continuous improvement of these rules is done taking into consideration world's best practices and in collaboration with stakeholders, government's representatives and other Port's users in order to address issues, needs and risks inherent to Port's operations and activities.

For the Cascadia-Viterra Capacity Improvement Project, Contractor’s vessels will navigate through two marine areas (First and Second Narrows) subject to specific transit procedure (Traffic Control Zone 1 and Traffic Control Zone 2). These detailed and comprehensive TCZ are in place to mitigate risks associated to navigation.

4.5.1.1. Traffic Control Zone 1

The TCZ1 procedures apply to all marine traffic in the TCZ1, except designated Port Authority vessels and vessels that are engaged in law enforcement and security, search and rescue or other emergency response vessels.

The TCZ1 Procedures do not relieve the Master from compliance with the *Canada Shipping Act, 2001* or other regulations, requirements or standards in respect of vessels operating in Canadian ports. For improved navigation safety, a single lane navigation channel has been established for 0.75 nautical miles both East and West of the First Narrows Lions Gate Bridge (highlighted in green below between the dashed black lines).

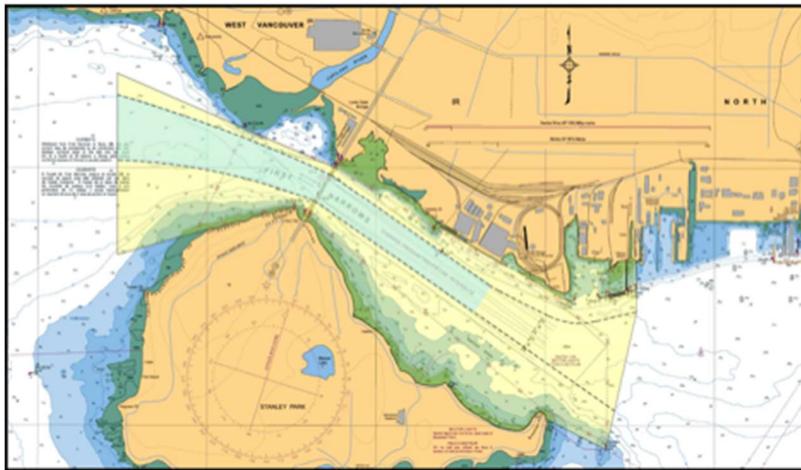


Figure 10 - TCZ1 (source VFPA’s Website)

Under the procedures, Tier 1 vessels must navigate at a safe speed, not to exceed 10 knots through the water when running free, seven knots through the water when tethered, except when safety of navigation requires otherwise. Tier 2 vessels within TCZ1 must navigate at a safe speed, not to exceed 15 knots through the water.

Moreover, a vessel engaged in towing operations within TCZ1, must limit the length of her towline to the least length that is safe and practical, taking account of weather, current and traffic conditions at time of transit but in any event must not exceed 80m. Such towline may not be lengthened until both vessels are completely clear of the bridge piers. Tugs engaged in towing or pushing barges, whether in ballast or in product, must be of adequate power.

4.5.1.2. Traffic Control Zone 2

In the same manner as for TCZ1, the TCZ2 procedures apply to all marine traffic in the TCZ2, except designated Port Authority vessels and vessels that are engaged in law enforcement and security, search and rescue or other emergency response vessels. The TCZ2 Procedures do not relieve the Master from compliance with the *Canada Shipping Act, 2001* or other regulations, requirements or standards in respect of vessels operating in Canadian ports.

The TCZ2 procedures encompasses a body of water including the Second narrows which forms a natural bottleneck of water in Burrard Inlet, between Burrard Inlet harbour to the West and the Indian Arm to the East.



Figure 11 - TCZ2 (source VFPA's Website)

As part of these procedures, VFPA has also established a "Clear Narrows" (CN) rule in order to ensure the transit of a vessel through either First or Second Narrows, unimpeded and not met, overtaken or crossed ahead of by any other vessel. The master of a vessel that requires a "Clear Narrows" (CN) must request it from the Canadian Coast Guard.

Tier 1 vessels must transit or maneuver within TCZ-2 at a safe speed not to exceed six knots through the water, except when safety of navigation requires otherwise. Tier 2 vessels within TCZ-2 must proceed at a safe speed which will allow them to properly respond to the prevailing circumstances and conditions.

Moreover, navigation in this area is challenging, particularly for small craft. Mariners must always exercise caution because of the important traffic and the weather conditions. A vessel towing another vessel through the Traffic Control Zones shall limit the length of her towline, measured from the stern of the towing vessel to the nearest portion of the vessel being towed, to not more than 60 meters. Such towline may not be lengthened until both vessels are completely clear of the bridge piers.

4.5.2. Wind Warning and restrictions

There are no standing wind restrictions for both Traffic Control Zones 1 and 2. However, when wind warnings are in effect, the master and/or pilot needs to take the proper action to ensure safe operations of the vessel.

In the event of high wind forecasts, Victoria Marine Communications and Traffic services will broadcast on CH12 a wind warning advisory for all vessels in the Port of Vancouver, under the following circumstances:

- 1) When winds reach or exceed 30 knots from any direction at First Narrows;
- 2) When winds are West to North West 20 knots or greater at First Narrows and a gale warning for North Westerly winds has been issued for Georgia Straight;
- 3) At the discretion of the Harbour Master or Victoria Marine Communications and Traffic Services Centre (MCTS).

The wind warning is cancelled when:

- 1) Winds have abated below 30 knots for over one hour (below 20 knots for over one hour if from the West or North West);
- 2) At the discretion of the Victoria Marine Communications and Traffic Services Centre (MCTS).

4.5.3. Aids to navigation

The navigation channel between English Bay and Indian Arm is marked with fixed and floating navigation aids managed by the Canadian Coast Guard. Range lights with leading beacons help mariners identify the channel centre line. The use of navigation marks and buoys is in accordance with the International Conventions on Buoyage. The Canadian Hydrographic Service regularly publishes hydrographic charts that clearly indicate channel fairways and navigational aids.

In 2010, Vancouver Fraser Port Authority (VFPA) asked the Canadian Coast Guard for a review and enhancement of existing Aids to Navigation in the Port Harbour. The results were the installation of several equipment and AtoN including water levels, air draft and currents measuring systems at the Second Narrows. The improvement of the overall navigation system enhanced the reliability, accuracy and redundancy of the Aids to navigation in the Port; hence mitigating navigational risks.

4.5.4. Monitoring and Control

The work, professionalism and dedication of the Harbour Master's team is a key navigational risk mitigation element as they ensure the overall safety, security and environmental protection of the Port.

Vancouver Fraser Port Authority (VFPA)'s Harbour Master Office, through its Operational Centre operates 24/7 and provides expertise and skilled resources to support an/or respond to any issue, emergency or demands. The Harbour Master's officers can rely on sophisticated equipment and systems (cameras, IAS, radar feed, etc.) and water/land patrols to monitor Port's activities and enforce Port's Practices & Procedures. They work in collaboration with diverse organizations and regulatory agency to safeguard our waters.

5. Conclusion

The review and analysis of the overall regulatory framework (Transport Canada, Canadian Coast Guard, Vancouver Fraser Port Authority, Pilotage, etc.) indicates very high-level requirements presently in place to oversee marine safety, security and environmental protection in Canada in general and in the Port in particular.

As far as marine traffic management, monitoring and control, the Port, its stakeholders and users have state of the art equipment and systems to ensure safe navigation within Port's waters. The First and Second Narrows channels transit procedures are well established to ensure safety and security. Moreover, the marine infrastructures in both narrows are strong and with protection against vessel's striking.

In order to further increase risk mitigation associated to the project, a specific Marine Activities & Operational Plan (MAOP) addressing all anticipated project's marine navigation/operations activities of its entire marine assets and equipment involved and their impacts will be required from the contracted marine Contractor.

Bibliography

Communications

Regulations

- Canada Marine Act (S.C. 1998, c. 10)
- Canada Shipping Act, 2001 (S.C. 2001, c. 26)
- Collision Regulations (C.R.C., c. 1416)
- Marine Transportation Security Regulations (SOR/2004-144)
- Pilotage Act (R.S.C., 1985, c. P-14)
- Navigation Protection Act (R.S.C., 1985, c. N-22)

Online Documents

Canadian Coast Guard: <http://www.ccg-gcc.gc.ca/eng/CCG/Home>

Transport Canada: <https://www.tc.gc.ca/en/transport-canada.html>

Western Canada Marine Response Corporation: <http://wcmrc.com>

Canadian Navigable Waters Act:

<https://www.canada.ca/en/services/environment/conservation/assessments/environmental-reviews/navigation-protection/guidebook.html>

Lions Gate Bridge: <https://canada.constructconnect.com/joc/news/projects/2018/04/design-work-underway-lions-gate-ironworkers-memorial-bridges>

Port of Vancouver, Port Information Guide: <https://www.portvancouver.com/marine-operations/port-information-guide/>

Lions Gate bridge: <https://www2.gov.bc.ca/assets/gov/driving-and-transportation/reports-and-reference/reports-and-studies/lower-mainland/2018-03-16-lions-gate-risk-assessment.pdf>