CONTEXT STATEMENT

June 8, 2012

Port Metro Vancouver commissioned the Fraser River Tanker Traffic Study in order to understand the logistical and operational impacts of liquid bulk cargo on the south arm of the Fraser River. We are sharing the results of the study to ensure that stakeholders and the wider community are aware of the findings and how they may contribute to our project evaluation process.

Recently, the Vancouver Airport Fuel Facilities Consortium (VAFFC) put forward a proposal that would include tankers carrying jet fuel to a new facility in Richmond. Although tankers have been coming to the Burrard Inlet for nearly 100 years and deep sea vessels regularly travel the Fraser River, there are currently no liquid bulk tankers on the River. Port Metro Vancouver needed more information to help determine how we would respond to this application or other similar proposals we might receive in the future. The findings of the study will feed into the environmental assessment and project permit review processes. They will help us understand the types of mitigation that can be put in place to ensure navigational safety.

In order to truly understand the results of the study, it is important to first be clear on its scope and limits. The study is but one part of the Port's comprehensive review process and does not constitute an approval of any of the scenarios contemplated within it. Some of the results are based on hypothetical scenarios, traffic patterns, and commodities that do not necessarily reflect what may actually take place. The study concentrates on logistics and operations, rather than detailed environmental effects, which would be required as part of the regular project evaluation. The findings are applicable only for the study area, which is the south arm of the Fraser River. And finally, the preliminary mitigation options identified in the study are a starting point and require further analysis of their effectiveness in reducing risk in different contexts.

Port Metro Vancouver's mandate is to facilitate trade. Although we do not decide what commodities Canada trades, we are responsible for the safe and efficient transportation of goods within our jurisdiction. We will continue to work with our partners to ensure safe navigation, to protect the environment and to thoroughly evaluate all projects. The results of this study will contribute to our knowledge of the issues and inform our assessment process.

Although there are no easy answers to the challenges of balancing the interests of trade with other considerations, Port Metro Vancouver has commissioned this study so we can be more aware of the implications. We hope that by sharing the results of the study, we contribute to a better understanding of the potential operational impacts of proposed increases to liquid cargo on the river, as well as the possible ways of mitigating those risks to acceptable levels.

DET NORSKE VERITAS™

SUMMARY OF

FRASER RIVER TANKER TRAFFIC STUDY

PREPARED FOR PORT METRO VANCOUVER

6TH JUNE 2012

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1 INTRODUCTION

1.1 Background

As part of its on-going business, Port Metro Vancouver (the Port) considers proposals for new facilities and activities along the South Arm of the Fraser River (hereafter called the Fraser River or the river). There has been increasing interest in siting possible bulk liquids handling facilities on the river downstream of New Westminster.

One specific proposal is from the Vancouver Airport Fuel Facilities Corporation (VAFFC) to use bulk tankers and coastal barges to deliver aviation fuel to a new terminal to be located close to Fraser Wharves at the southwest end of the Port's Richmond Properties. Although the Port has not yet received an application for this project, it is currently the first and only proposal for liquid bulk on the Fraser River.

As part of the process of evaluating the VAFFC proposal and in consideration of potential future liquid bulk shipments on the Fraser River, the Port commissioned the *Fraser River Tanker Traffic Study*. The goal of this study is to review current marine operations in the Fraser River and to conduct a risk assessment of possible future liquid bulk operations in order to inform the decision making process.

The study area for the risk assessment follows the South Arm of the Fraser River from Sand Heads to New Westminster as shown in Figure 1.

Figure 1 - Study Area

The Port hired Det Norske Veritas (Canada) Limited (DNV) to perform this risk assessment. The risk assessment work involved contributions from other organizations concerned with ensuring safe navigation in the Fraser River, including: Pacific Pilotage Authority; Fraser River Pilots; Council of Marine Carriers; Canadian Coast Guard; Chamber of Shipping of British Columbia; Western Canada Marine Response Corporation and Port Metro Vancouver.

This document is a summary of the "Fraser River Tanker Traffic Study, DNV Report No. PP017719, 6th June, 2012" conducted by DNV for Port Metro Vancouver

1.2 About Det Norske Veritas

Det Norske Veritas (DNV) is an independent, self-owned Norwegian foundation founded in 1864 with the objective of "safeguarding life, property and the environment." Originally a ship classification society, DNV now offers consultancy and certification services in addition to being one of the world's leading classification societies. The majority of DNV's consultancy work is centred round the theme of managing risk. In recent years, DNV has performed numerous navigational risk assessments and environmental risk assessments similar to the work performed for this study. Det Norske Veritas (Canada) Limited is a wholly owned subsidiary of Det Norske Veritas.

1.3 About Port Metro Vancouver

In 2008 the Vancouver Port Authority, the North Fraser Port Authority and the Fraser River Port Authority were amalgamated to form the Vancouver Fraser Port Authority, which operates as Port Metro Vancouver. The Port's operations are governed by the Port Authorities Operations Regulations, created pursuant to the *Canada Marine Act*. The Port is responsible for the operation and development of the assets and jurisdictions within its area of control. Along with abiding by all applicable international, federal, and provincial regulations, the Port provides guidelines for tanker operations in the Vancouver Harbour area, including the Fraser River.

2 THE STUDY

2.1 Purpose

The purpose of this study is three-fold:

1) To produce a comprehensive risk assessment of the possible introduction of liquid bulk shipments in the Fraser River area following the development of a new marine terminal by the Vancouver Airport Fuel Facilities Corporation.
2) To provide a traffic and risk baseline to be used in the review of future developments that requires liquid bulk shipments in the Fraser River area.
3) To identify the possible risk reduction options that could be implemented to ensure safety related to liquid bulk shipping operations.

To accomplish the above, DNV performed the following main tasks:

- A review of navigational practices, guidelines, legislation and regulatory requirements applicable to present-day vessel operations in the Fraser River.
- A risk assessment of current operations and possible future tanker operations, including the proposed delivery of aviation fuel oil to VAFFC and another hypothetical liquid bulk operation in the river.
- An identification and preliminary prioritization of potential additional risk reduction options that could reduce the risks of liquid bulk movements on the Fraser River.

This document summarises the work conducted and presents the main results. Detailed information is available in the main report "Fraser River Tanker Traffic Study, DNV Report No. PP017719-1, 6th June, 2012."

2.2 Methodology

All activities entail an element of risk. A risk assessment can be defined as the determination of the quantitative or qualitative value of risk related to specific situations and hazards. In practical terms, a risk assessment is a thorough examination and identification of the situations and processes that may cause harm to people, environment, business and property.

The risk assessment performed for this study followed the process shown in Figure 2:

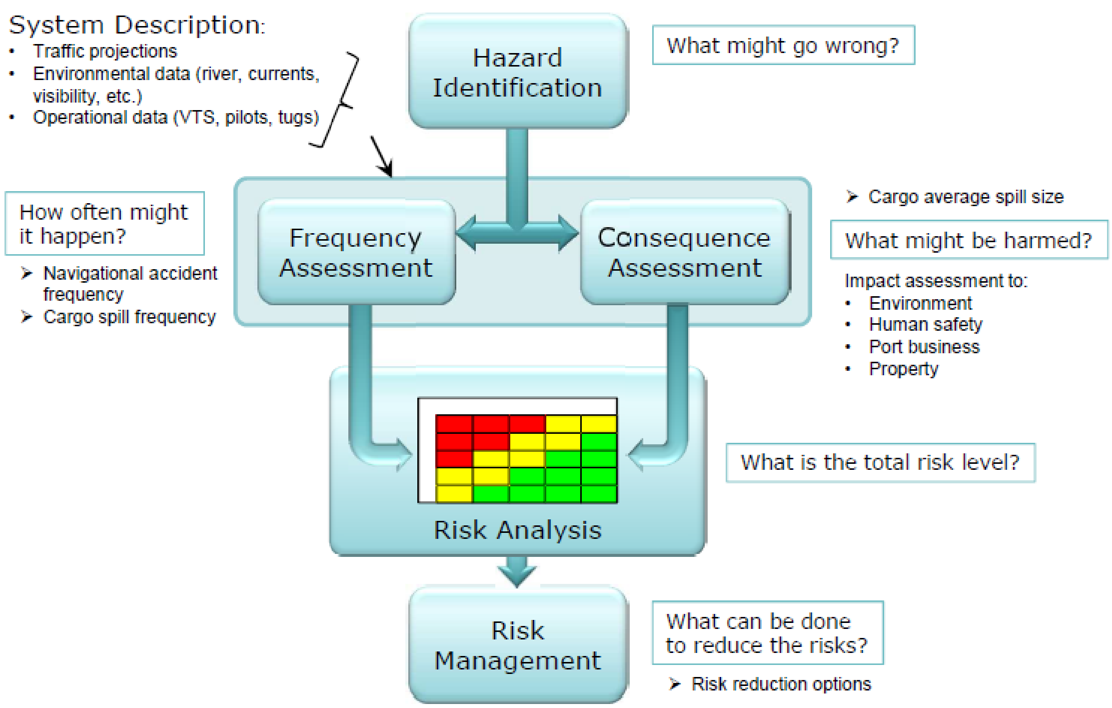

Figure 2 - Fraser River Tanker Traffic Study: Risk Analysis Process

- **System Description**: In this study, the system description consisted of detailed information about current and future marine traffic, the environment and the operations in the study area.
- **Hazard Identification**: What may go wrong with an operation?
- **Frequency Assessment**: How often might hazards occur?
- **Consequence Assessment**: What might be harmed (people, the environment, property and business) as a result of a hazard occurring and how severe is the harm likely to be?
- **Risk Analysis**: What is the total risk to the operation from all hazards?
- **Risk Management:** What can be done to reduce the risk? The identification of options that could reduce the frequency and/or consequence of hazards, and the coarse evaluation of their implementation.

A formal risk assessment is not an end in itself nor does it provide decisions. However, it is a basis for making informed choices about uncertain future events. It is important to recognize that zero risk is not a practical option.

2.3 The Fraser River Context

2.3.1 Operations in the Fraser River

DNV reviewed the operational controls and emergency preparedness in the Fraser River. They found that the present-day river management and operational controls are adequate to manage the safe and efficient transit of vessels in the river without any concerns expressed by the waterway users. In this context, “adequate” means that none of the waterways users could identify any deficiencies in the navigational aids, requirements or procedures provided.

The principal measures that control the level of navigational risk in the Fraser River today include:

- The river depth survey and dredging program and the distribution of up-to-date water depth information to pilots and/ or navigators.
- The use of compulsory pilotage.
- The provision of navigation surveillance and support information provided by the vessel traffic services centre.
- Adequate aids to navigation by the Canadian Coast Guard.

Although not exactly a risk control, the study notes that the river bottom in the study area is predominantly soft sand and thus would probably not damage a sea-going ship if contact with the river bottom were to occur. Finally any tankers introduced into the Fraser River would be required to have double hull construction. This is an effective risk control for reducing spills.

These present-day risk controls are taken into account in the risk assessment results described below.

2.3.2 Historical Marine Accident Records

DNV analysed the incidents that occurred on the South Arm of the Fraser River as reported to the Transportation Safety Board in accordance with mandatory reporting requirements. From 2006 to 2011 (October), only two of the 62 reported accidents involved deep water vessels. This accident rate can be considered as low. This low number of accidents involving deep water vessels is evidence to support the effectiveness of the risk controls in place on the river. In addition, representatives of the Fraser River pilots commented that in the past 10 years while averaging 1200 deep water ship movements per year, there has not been one serious deep water vessel accident leading to significant pollution or loss of life.

A quantitative risk assessment relies on statistical data to predict possible future risks. Although encouraging, the low number of accidents in the Fraser River does not represent a statistically significant basis to predict risks. It may skew the results and produce unsubstantiated risk calculations for future operations. Instead, to be cautious, the study combined worldwide accident data (where necessary) with Fraser River-specific data (where possible), which provided more conservative risk results compared to the historical experience data.

3 RISK ASSESSMENT

DNV assessed the operational risks related to several future marine traffic cases in the Fraser River. A comprehensive picture of 2011 marine traffic in the Fraser River was first developed by analysing the information provided by the vessels through the Automatic Identification System (AIS). Data includes the vessel type, position, trajectory and other useful information. These marine traffic data were verified and consolidated with the Port's traffic information. Then, various possible combinations of marine traffic, especially new types of traffic, were forecasted. Four cases were defined, (identified as Case 1 through 4) as shown in Figure 3.

Case 1 corresponds to the proposed VAFFC traffic in 2016, plus projected growth in other (non-liquid bulk) traffic types from the 2011 baseline traffic level. The three other cases are hypothetical scenarios that represent various configurations of traffic and cargo types. Although these three cases are not based on any actual proposals, they are important as they broaden the scope of the study.

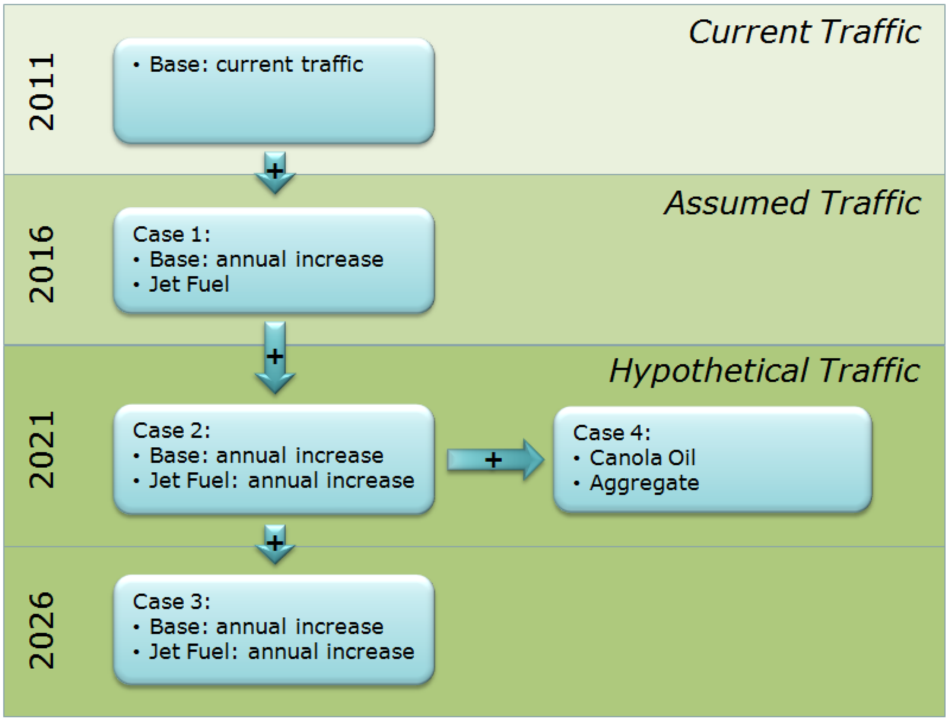

Figure 3 - Inter-relationships between the traffic cases

A computer-based risk model based on DNV's Marine Accident Risk Calculation System (MARCS) was tailored for the Fraser River to assess the potential risks from the following accident types:

- **Ship-ship collision**: A contact between two or more vessels under way.
- **Powered grounding**: Groundings that occur when the ship is under power and has the ability to navigate safely yet goes aground (e.g. due to human error).
- **Drift grounding**: Groundings that occur when the ship is unable to navigate safely, usually due to mechanical failure and is forced on to the shoreline by the action of wind, current or waves.
- **Fire or explosion** while a vessel is underway.
- **Structural failure or foundering** while a vessel is underway.
- **Impact**: An accident that typically occurs during approach or departure, when a ship impacts the berth with force sufficient to damage the ship or the berth.
- **Striking**: A contact between a navigating ship and a ship moored at the berth.

The risk model used data on local marine traffic movements, operation and navigation, environmental conditions, and present-day risk controls. This data was presented, discussed and validated by local stakeholders and waterway users. They were then combined with marine risk accident parameters previously derived by DNV through analysis of worldwide shipping accident data.

For each traffic case, the model estimated:

- The frequency of accidents for each ship type carrying liquid bulk.
- The frequency of cargo spill and the average spill size for each accident type.

The risk analysis was used to evaluate the overall risks of these accidents. This step relied on a risk acceptance matrix. The risk acceptance matrix shown in Figure 4 was developed based on the framework provided in the Pilotage Risk Management Methodology (PRMM) from Transport Canada. The frequency of each accident was categorized from Highly Probable (1) to Improbable (5). Their consequences were assessed with regards to their potential impact to:

- **Environment**: Refers to impacts to the quality of the water, air and ground as well as impacts to the wildlife and plants, in and around the river. The most major environmental consequence of tanker accidents comes from the type and quantity of cargo released in the event of a spill.
- **Human Safety**: Refers to injuries or fatalities to third parties (excluding employees of the Port or companies that make their living from the Fraser River) such as pleasure craft operators or passengers or people on the shoreline. Spilling or fire/explosion accidents are the most likely accident to have an impact on third parties.
- **Port Business**: Refers to events that could disrupt the partial or total use of the Fraser River waterway for a period of time.
- **Property:** Refers to the financial risk to the facility owner or operator not covered by other metrics. This would typically include impacts at a berth, which could render it unserviceable for a period of time.

The consequences were then rated from Extreme (A) to Low (E).

		Consequence				
		A-Extreme	**B-Very High**	**C-High**	**D-Medium**	**E-Low**
Consequence Metric	**Environment**	Sustained long term harm (i.e. damage lasts longer than a month).	Sustained medium term harm (i.e. damage lasts up to one month).	Medium term harm (i.e. damage lasts up to two weeks).	Short term harm (i.e. damage lasts no longer than a week).	Minimal harm (i.e. damage lasts no longer than a day).
	Human Safety	Multiple deaths and multiple people with serious long-term injury. Intensive Care.	Single death and multiple people with serious long-term injury. Intensive Care.	Some people with serious long-term injury and multiple minor injuries.	One person with serious long-term injury. Some minor injuries.	Single or multiple minor injuries requiring on site First Aid and\or off-site treatment.
	Port Business (Operational)	Sustained long-term disruption (longer than a month).	Sustained medium-term disruption (up to a month).	Medium-term disruption (up to two weeks).	Short-term disruption (no longer than a week).	Minimal disruption (no longer that a day).
	Property (Economic)	Damage to property is such that it ceases operations for a period of time exceeding one month or financial loss exceeds $10 million.	Damage to facilities is such that operations cease for up to one month or financial loss of $5 - $10 million	Damage to facilities is such that the operations cease for up to two weeks or financial loss of $1 - $5 million.	Damage to facilities cause operations to cease for up to one week or financial impact of $500,000 - $1 million.	Damage to facilities cause operations to cease for up to 72 hours or a financial impact up to $500,000.
		Risk Ranking				
Frequency Metric	**1-Highly Probable**	1A	1B	1C	1D	1E
	2-Probable	2A	2B	2C	2D	2E
	3-Possible	3A	3B	3C	3D	3E
	4-Unlikely	4A	4B	4C	4D	4E
	5-Improbable	5A	5B	5C	5D	5E

Frequency	Definition	Accident Return Period (Interpretation)
Highly Probable	Almost certain the event will occur OR at least once over a period of one year.	Less than or equal to one year
Probable	Expected that the event will occur OR at least once over a period of three years	Between one and three years
Possible	The event could occur over a period of 10 years	Between three and 10 years
Unlikely	It is not expected that the event will occur over a period of 10 years	Between 10 and 25 years
Improbable	It is not expected that the event will occur over any defined period.	Assumed greater than 25 years (once per career)

Figure 4 - Risk Acceptance Matrix used to Evaluate Risk Assessment Results (Based on the Pilotage Risk Management Methodology framework)

Each accident type was then mapped onto the risk matrix to provide its overall risk level as per the following scale:

- **Red** means that the risk is unacceptable and either further risk reduction options must be applied or the operation must be prohibited.
- **Yellow** means the risk is acceptable provided all justified risk reduction options have been applied.
- **Green** means the risk is broadly acceptable but any identified risk reduction options that are easy and financially reasonable should still be applied.

The risk assessment methodology requires DNV to use the average, or most likely, or reasonable worst case consequence in the risk assessment, not the most serious worst case. Often, DNV identified a range of consequence categories for any one accident, but used the most severe reasonable consequence to evaluate the corresponding risk class.

3.1 Risk Assessment Results

Figure 5 presents the detailed results of the risk assessment. For each of the four traffic cases, the frequency and possible consequences for each accident type were assessed using the risk acceptance criteria in Figure 4. Each result is colour-coded to show the risk level. The digit indicates the accident frequency predicted by the risk model, while the letter indicates the most reasonable highest accident consequence. A blank box indicates that the scenario is not applicable.
The main conclusion is that the risks have been evaluated as broadly acceptable (green) or occasionally acceptable with the implementation of the appropriate risk reduction measures (yellow). No risk has been evaluated as unacceptable (red).

	Case 1				Case 2				Case 3				Case 4			
Number of Deep Water Vessels	683				794				948				826			
Number of Tankers	60				90				120				114			
Total Liquid Cargo [ktons]	922				1382				1843				1982			
	Environment	Human Safety	Port Business	Property	Environment	Human Safety	Port Business	Property	Environment	Human Safety	Port Business	Property	Environment	Human Safety	Port Business	Property
Tanker Accident (Total risk)			3E	3E			3E	3E			2E	2E			2E	2E
Spilling Accident (Total risk)	5A	5D	5D	5D	5A	5D	5D	5D	5A	5D	5D	5D	5A	5D	5D	5D
Collision			5E	5E			5E	5E			5E	5E			5E	5E
Spilling Collision	5A	5D	5D	5D	5A	5D	5D	5D	5A	5D	5D	5D	5A	5D	5D	5D
Structural Failure/ Foundering			5E	5E			5E	5E			5E	5E			5E	5E
Spilling Structural Failure/ Foundering	5A	5D	5D	5D	5A	5D	5D	5D	5A	5D	5D	5D	5A	5D	5D	5D
Fire/ Explosion			5E	5E			5E	5E			5E	5E			5E	5E
Spilling Fire/ Explosion	5A	5D	5D	5D	5A	5D	5D	5D	5A	5D	5D	5D	5A	5D	5D	5D
Powered Grounding			5E	5E			4E	4E			4E	4E			4E	4E
Spilling Powered Grounding	5A	5D	5D	5D	5A	5D	5D	5D	5A	5D	5D	5D	5A	5D	5D	5D
Drift Grounding			5E	5E			5E	5E			5E	5E			5E	5E
Spilling Drift Grounding	5A	5D	5D	5D	5A	5D	5D	5D	5A	5D	5D	5D	5A	5D	5D	5D
Impact (all facilities)			5E	5E			5E	5E			4E	4E			4E	4E
Spilling Impact (all facilities)	5A	5D	5D	5D	5A	5D	5D	5D	5A	5D	5D	5D	5A	5D	5D	5D
Striking (all facilities)			4E	4E			3E	3E			3E	3E			3E	3E
Spilling Striking (all facilities)	5A	5D	5D	5D	5A	5D	5D	5D	5A	5D	5D	5D	5A	5D	5D	5D

Figure 5 - Summary of Risk Assessment Results

The study also shows that the frequency of some accidents types rises with increases in the concentration of marine traffic and average length of the transit on the river.

Looking at the various cases and taking into account the configuration of the river and the operational controls in place, the most frequent accident type that could occur on the river, in order of importance, are:

- Striking.
- Powered grounding.
- Impact.
- Drift grounding.

Figure 6 presents the higher values of the range of possible risk levels for Case 1 to 4 regarding environment, human safety, port business, and property. The risks to port business and property were assessed as of lower consequence. The more frequent hazards (e.g. accidents with or without spill) have lower average consequences than the less frequent hazards (e.g. accidents with spill). In terms of risks to human safety, the scenarios indicated that hazards were Improbable, and the range of consequences fell between Low and Medium. As shown in Figure 5, risks to environment and human safety were only evaluated for cargo spilling scenarios. For environment they were assessed as Improbable, and the possible consequences ranged between Medium and Extreme.

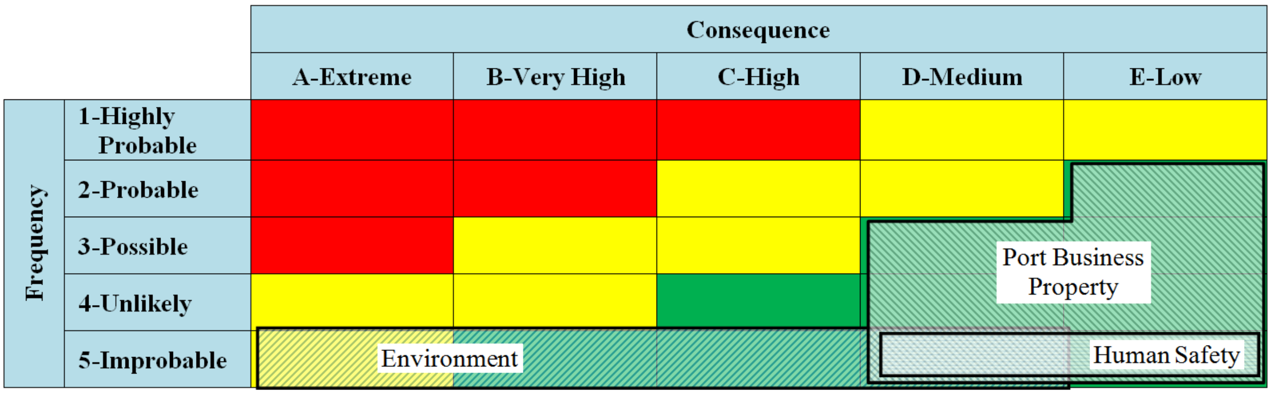

Figure 6 - Overall Risk Levels

4 RISK REDUCTION

Although most risks were assessed as broadly acceptable, the study looked at possible risk reduction options that could be implemented. The panel of stakeholder experts, with the help of DNV, reviewed the accident types outlined above that contribute most to total risk: striking and powered grounding, followed by impact, drift grounding and collision. They identified options that would either lower the frequency of such accidents and/or reduce their impact if such accidents were to occur. The options were then evaluated and coarsely ranked for effectiveness, practicality, and cost. Over 40 potential risk reduction options were identified as part of this study. The following options are recommended for further consideration:

- **Enhance waterways management safe practices**: More formalized management of the Fraser River waterway should be considered. This might include the definition of parts of the river where overtaking of deep water ships is not allowed, other parts of the river where only one-way traffic is allowed (no passing traffic), and parts of the river where exclusion zones around ships with hazardous cargo should be applied. These measures would reduce collision risk. Other possible waterways management measures would be to restrict vessel movements and operations (e.g. transit, berthing and unloading) depending on certain environmental conditions such as wind, current or visibility. The environmental limits that restrict operations would have to be carefully evaluated. Finally, the river could be surveyed and marked so that smaller draft ships can use shallower parts of the river, thus moving some traffic out of the deep water channel. These measures are expected to mainly reduce collision and powered grounding risks.

  The river survey and dredging program should also be continued, as well as the dissemination of the most up-to-date information on water depths to navigators (river pilots and officers with pilot waivers). There is an implicit assumption in the risk assessment process that there is no uncharted shallow water in the Fraser River. Powered grounding was identified as a significant risk for all cases considered.

- **Evaluate Dynamic Under Keel Clearance (DUKC):** Ship squat or squat effect is a hydrodynamic phenomenon during which a vessel moving through shallow water creates an area of lowered pressure under its bottom that causes the ship to "squat" lower in the water. The dynamic behaviour of the squat of different ship types should be evaluated taking into account the river`s actual hydrodynamic conditions and the ships' design, speed and draft. Detailed, location-specific knowledge of under keel clearances would reduce the frequency of powered grounding accidents which were identified as significant for all cases considered.
- **Develop and implement E-navigation:** E-navigation, a group of measures which improve and organise available information, should be further developed. Real-time now-casts and short term forecasts of current, wind and visibility could be made available via a single information portal. Current data would be provided by tide gages and current sensors in the river. Information would be sent to ship systems and portable pilotage units. This measure would reduce powered grounding risks.
- **Deploy tanker operation warning system:** Information systems in the Fraser River should be enhanced to notify ships of hazardous operations, such as loading/unloading and berthing at the side of the river. This may be done by putting lights near the berths, providing information through the Vessel Traffic Service (VTS), or by other means. Ships striking at their berth and ships impacting upon approach of the berth were evaluated as significant risks for all cases considered.
- **Require escort tugs for tankers with hazardous cargo:** Escort tugs should be provided for tankers laden with hazardous cargo. To be truly effective, escort tugs, pilots and navigators need to have a clear plan of how the escorts will be used and what should happen in emergency situations, including a possible failure of the escort tug. The optimum configuration of an escort would need to be developed - such as one tug or two, whether to tether, whether it should be tethered to the bow and/or the stern - and validated by simulator training and practice runs. This measure is expected to reduce the frequency of drift grounding.
- **Further develop spill and emergency response capability:** An enhanced and formalized emergency response plan, to include spill response, firefighting and salvage options, should be developed appropriate to the materials that might be spilt. This should include the siting of appropriate spill response equipment at terminals handling new liquid bulk, the carriage of spill response equipment by escort tugs (if implemented) and the availability of spill response equipment to address spills anywhere along the navigation channel in the Fraser River - not only at the terminal(s). The purchase of equipment should be augmented by operating procedures and emergency response exercises. Spills could result from any accident type and could take place at either the terminal(s) or elsewhere along the river. While the goal of the other risk reduction options is to prevent accidents, the goal of this one is to respond effectively to the accidents if they occur.

- **Separate facility from main traffic flow:** The tankers unloading at a facility, such as the proposed VAFFC facility, should be separated from ships in the main channel to minimize the probability of striking. Alternately, an energy-absorbing fender-like structure would both provide a visual cue to keep clear and provide some protection. Striking was identified as a significant risk for all cases considered.

The merit of each identified risk reduction option should be re-evaluated in the light of the specific characteristics of each project, as subtle changes can have a significant effect.

5 CONCLUSION

DNV reviewed the navigational and operational controls in the Fraser River and found that the river's management is well governed by international, national, regional and local regulations, rules and guidelines. The operational risk controls currently implemented include pilotage requirements, aids to navigation, vessel traffic services, waterway maintenance operations and practices required by the Port. The river management and operational controls are adequate, without any concerns expressed by waterway users.

The risk assessment produced a profile of operational risks for various liquid bulk cargo and traffic level scenarios - proposed and hypothetical - that could potentially develop in the Fraser River. This analysis indicated that striking and powered grounding, followed by impact, drift grounding and collision are the main risks. Further, the assessment concluded that the great majority of the risks identified were acceptable against the defined risk acceptance criteria. The risk to the environment was found to be acceptable with all justified mitigations applied. None of the risks were assessed as unacceptable.

The final step of the study was to look at measures that would increase safety or reduce the potential consequences in case of an accident. Appropriate risk reduction options were identified and ranked by conducting a coarse evaluation of their effectiveness and potential for implementation. The identified options ranged from regulatory to non-regulatory (i.e. development and adoption of best practice/voluntary standards to reduce risk and improve compliance levels) to design-stage improvements for risk reduction. These options offer starting points for further consideration. Their merit would need to be reassessed in light of the specific characteristics of each liquid bulk project. This requires more detailed and focused analysis, with sufficient details and data quality to allow more robust decisions on the selection, design and implementation of the best risk control measures.

Despite the complexity of the system and the open-ended nature of the issue, the study concludes that the risks due to the introduction of liquid bulk traffic in the south arm of the Fraser River are either acceptable or can be made acceptable by applying additional risk controls. A number of candidate risk reduction options are identified and coarsely evaluated. These risk reduction options, and possibly others not identified in this report, should receive more specific and detailed consideration as part of any actual project proposal.

Det Norske Veritas:

DNV is a global provider of knowledge for managing risk. Today, safe and responsible business conduct is both a license to operate and a competitive advantage. Our core competence is to identify, assess, and advise on risk management, and so turn risks into rewards for our customers. From our leading position in certification, classification, verification, and training, we develop and apply standards and best practices. This helps our customers to safely and responsibly improve their business performance.

Our technology expertise, industry knowledge, and risk management approach, has been used to successfully manage numerous high-profile projects around the world.

DNV is an independent organisation with dedicated risk professionals in more than 100 countries. Our purpose is to safeguard life, property and the environment. DNV serves a range of industries, with a special focus on the maritime and energy sectors. Since 1864, DNV has balanced the needs of business and society based on our independence and integrity. Today, we have a global presence with a network of 300 offices in 100 countries, with headquarters in Oslo, Norway.

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