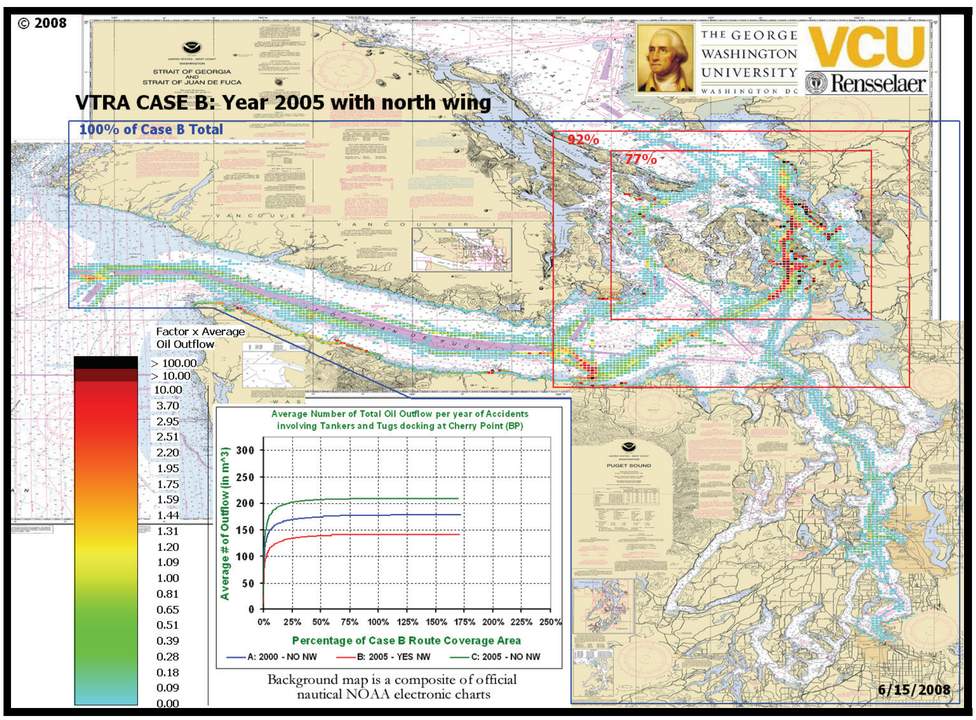
FINAL REPORT ADDENDUM:
A response to 23 comments from the Corps



Assessment of Oil Spill Risk due to Potential Increased Vessel Traffic at Cherry Point, Washington

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AD-1. Introduction

In June 2006, BP West Coast Products, LLC contracted a consortium of universities (GWU, VCU and RPI) to conduct a vessel traffic study. GWU was the prime contractor and VCU and RPI were sub-contractors to GWU. The approach for this vessel traffic study was to build on the maritime risk assessment methodology involving dynamic risk simulations developed for tanker operations in Prince William Sound, Alaska (1995-96), estimation of passenger risk for the Washington State Ferries (WSF) Risk Assessment (1998-1999) and the dynamic exposure simulation methodology for the San Francisco Bay Exposure Assessment (2002) also with a passenger safety focus. This methodology is described in the journal papers Van Dorp et. al (2001) , Merrick et. al (2002), Merrick et. al (2003) and Szwed et. al (2006) that have been reviewed by our academic peers.

Over the course of two years that this vessel traffic study was conducted, it became to be known as the Vessel Traffic Risk Assessment (VTRA) and the consortium of universities (GWU,VCU and RPI) were referred to as the VTRA Team. The VTRA team engaged the VTRA maritime community while conducting this vessel traffic study by presenting their progress over the course of one and a half year (from November 2006 till May 2008) to the Puget Sound Harbor Safety Committee (PGHSC), which held public meetings every two months at the Army Corps of Engineers building, East Marginal Way South, Seattle. The focus of the vessel traffic study was to evaluate oil spill risk associated with potential traffic increases related to the Cherry Point Pier of the Cherry Point refinery in Washington State. The vessel traffic study was tasked to include an impact analysis that will describe the outcomes of accidents as described by their location and size of oil outflows, but stop short of examining the fate and effects of these oil spills. Examining the fates and effects of an oil spill leads to an analysis of environmental risk. The VTRA oil spill analysis results by location and size serve as an input to that analysis. The oil outflows to be evaluated were limited to accidents involving those vessels that dock at the BP Cherry Point dock. These vessels involve both tankers, articulated tug barges (ATB) and integrated tug barges (ITB) docking at BP Cherry Point. These classes of vessels are herein and in the VTRA Final Report (or vessel traffic study final report) referred to as the BPCHPT vessels.

Around the same time frame that the VTRA vessel traffic study commenced, the Army Corps of Engineers (CORPS) contracted separately with ENTRIX to conduct an Environment Impact Assessment (EIS) of the construction of the North-Wing Pier of the Cherry Point Pier. ENTRIX opted to incorporate the oil spill results from the vessel traffic study into their EIS. A coordination was agreed upon between the CORPS, ENTRIX and the VTRA team to facilitate the seamless integration of the vessel traffic study oil spill results into a fates and effect analysis of the EIS to be conducted by ENTRIX.

The vessel traffic study conducted by the VTRA Team supports the EIS via its oil spill analysis results and its final report. The vessel traffic study final report describes the VTRA analysis methodology and a synthesis of the vessel traffic study oil spill analysis results. To further support the EIS, the VTRA team coordinated with the CORPS and ENTRIX to provide separate oil spill results for persistent (crude oil and heavy-fuel) oil spills and non-persistent (refined products and diesel fuel) oil spills from accidents involving BPCHPT vessels. While the VTRA team analyzed these oil spill results in terms of their origin, i.e. whether the oil spill originated from the BPCHPT vessel or an interacting vessel that potentially collides with it, it was further coordinated with ENTRIX and the CORPS[1] that ENTRIX only needed a separation into persistent and non-persistent oil by location and size for their fates and effect analysis.

On September 1, 2008 the VTRA Team submitted the vessel traffic study final report deliverable of their contract agreement with BP West Coast Products, LLC that had a contract end-date of August 31, 2008. After the submission of the vessel traffic study final report (or VTRA final report), the CORPS, BP and ENTRIX indicated collectively that they would submit a comprehensive set of comments regarding the VTRA final report. On October 1, 2008 the VTRA Team received 23 comments that were submitted by the CORPS assisted by ENTRIX. The VTRA Team assessed these 23 comments in terms of their "totality". The purpose of this VTRA Final report addendum is to respond to those 23 comments. However, this addendum to the vessel traffic study final report written by VTRA Team is provided to the CORPS, ENTRIX and BP as a professional courtesy, not as a requirement of the contract agreement of the VTRA team with BP West Coast Product, LLC since this contract ended on 8/31/08. The 23 comments provided by the CORPS and the accompanying letter from the CORPS are included in this addendum as Appendix A.

We shall provide a detailed response below to these 23 comments in the same order as they are listed in Appendix A. Eighteen comments of these 23 fall in the category of report comments dealing with clerical errors or misunderstandings of the content of the vessel traffic study final report and these are addressed with the additional explanation provided in this addendum. Of these 23 comments, Comments 1, 2, 3, 4 and 22 ask for additional work

[1]During a meeting at the CORPS with ENTRIX on May 13, 2008

that goes beyond the project scope of the contract agreement between GWU and BP West Coast products, LLC that ended August 31, 2008. With the appropriate financial arrangements in place the VTRA Team could continue to support ENTRIX and the CORPS with their analysis capabilities to assist in completion of this additional work related to Comments 1, 2, 3, 4 and 22.

Before we commence with our responses to these 23 comments, we shall provide in Section AD-2 a more detailed explanation of the VTRA analysis of incremental risk to enhance its understanding. In Section AD-3, we shall explain that evaluating system wide risk in a dynamic maritime transportation requires aggregation of risk as a function of time over an extended period. Comparisons of various VTRA Cases are based in the VTRA study on a comparison of their aggregated system wide risk levels and changes in the risk levels from VTRA Case to VTRA Case are explained through the use of geographic profiles. Following VTRA responses to these 23 comments, the VTRA Team shall take the opportunity in this addendum to address some other additional clerical errors that have come to their attention prior to the October 1, 2008 CORPS letter and that were not listed in the accompanying 23 comments.

AD-2. The VTRA analysis of incremental risk

The VTRA Team was tasked to evaluate the incremental risk of (1) an accident (collision, grounding or other scenario) involving a tank vessel, (2) resulting in a discharge of crude oil or petroleum products, (3) associated with reasonably foreseeable increases in vessel traffic through calendar year 2025 to and from both wings of the Cherry Point Refinery Pier, (4) as compared with the baseline traffic that the pre-North Wing pier could accommodate. The study was to included an impact analysis that describes the outcomes of an accident as described by the location and size of oil outflows, but stop short of examining the fate and effects of an oil spill.

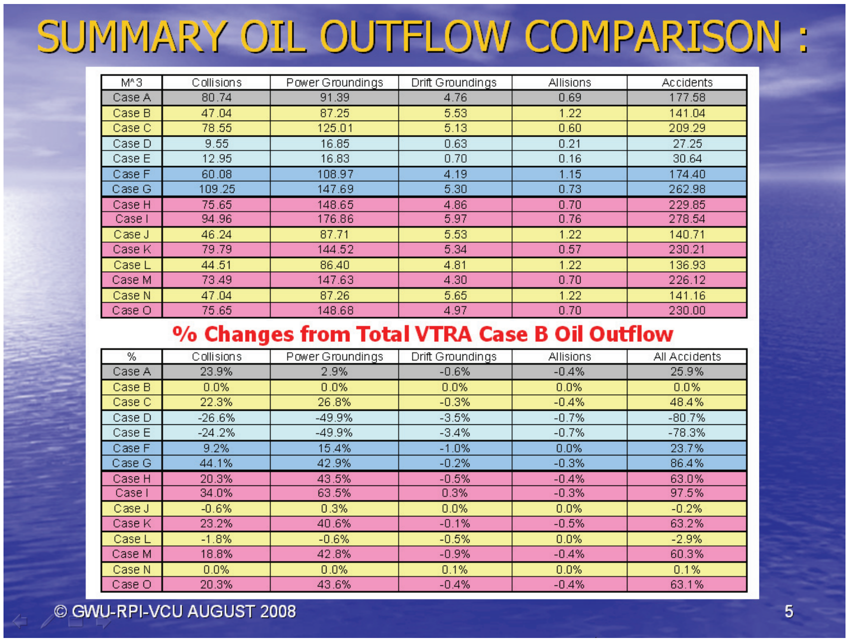
Table AD-1 contains a description of 15 VTRA scenarios that were developed as per the scope of the VTRA and in coordination with the CORPS and ENTRIX. Table AD-1 was included in the VTRA final report as Table 1 of the main report and Table G-1 in Technical Appendix G. In case of VTRA Case B in Table AD-1, the maritime simulation that was constructed (described in more detail in Technical Appendix C of the VTRA final report) effectively replays the movement of vessels of a full year of a complete set of traffic movement data that was collected with the assistance of the United States Coast Guard. Hence, the VTRA CASE B scenario was the natural scenario for incident and accident frequency calibration. This calibration step is explained in more detail in Technical Appendix D of the VTRA final report.

Progress related to preliminary VTRA CASE B analysis results was presented in a geographic format (also further explained in the final report) to the PGHSC as early as October 2007 and oil spill analysis results related to VTRA Case B as early as April 2008. In May of 2008, the VTRA Team gave their last presentation to the VTRA maritime community by presenting a synopsis of the VTRA analysis methodology and preliminary oil spill results of VTRA Case B during the National Harbor Safety conference also held in Seattle at that time. Given that VTRA Case B was the calibration scenario and given that the maritime community had become familiar with VTRA Case B over the course of a series of presentations to the PGHSC, VTRA Case B was selected as the natural scenario for comparison purposes of the other VTRA scenarios in Table AD-1.

Table AD-1. The 15 VTRA Cases
(Table 1 in the main report of the VTRA final report)

	Case	CP Traffic	Other Traffic	North Wing?	Saddlebags?	Extend Escorting?	Neah Bay?	Gate Way?
1	A	2000	2000	No	Yes	No	Yes	No
2	B	2005	2005	Yes	Yes	No	Yes	No
3	C	2005	2005	No	Yes	No	Yes	No
4	D	2025 Low	2025 Low	Yes	Yes	No	Yes	Yes
5	E	2025 Low	2025 Low	No	Yes	No	Yes	Yes
6	F	2025 Medium	2025 Medium	Yes	Yes	No	Yes	Yes
7	G	2025 Medium	2025 Medium	No	Yes	No	Yes	Yes
8	H	2025 High	2025 High	Yes	Yes	No	Yes	Yes
9	I	2025 High	2025 High	No	Yes	No	Yes	Yes
10	J	2005	2005	Yes	No	No	Yes	No
11	K	2025 High	2025 High	Yes	No	No	Yes	Yes
12	L	2005	2005	Yes	Yes	Yes	Yes	No
13	M	2025 High	2025 High	Yes	Yes	Yes	Yes	Yes
14	N	2005	2005	Yes	Yes	No	No	No
15	O	2025 High	2025 High	Yes	Yes	No	No	Yes

For each of the 15 VTRA scenarios in Table AD-1, the total annual average of oil spill volume (in cubic meters) for the VTRA study area was evaluated. The incremental oil spill risk was evaluated for each VTRA Case as a percentage change from the total annual average oil spill for the entire VTRA study area for VTRA Case B. Figure AD-1 is a figure included in the VTRA final report in Section G-3 of the Technical Appendix. Section G-3 was also



SUMMARY OIL OUTFLOW COMPARISON :

M^3	Collisions	Power Groundings	Drift Groundings	Allisions	Accidents
Case A	80.74	91.39	4.76	0.69	177.58
Case B	47.04	87.25	5.53	1.22	141.04
Case C	78.55	125.01	5.13	0.60	209.29
Case D	9.55	16.85	0.63	0.21	27.25
Case E	12.95	16.83	0.70	0.16	30.64
Case F	60.08	108.97	4.19	1.15	174.40
Case G	109.25	147.69	5.30	0.73	262.98
Case H	75.65	148.65	4.86	0.70	229.85
Case I	94.96	176.86	5.97	0.76	278.54
Case J	46.24	87.71	5.53	1.22	140.71
Case K	79.79	144.52	5.34	0.57	230.21
Case L	44.51	86.40	4.81	1.22	136.93
Case M	73.49	147.63	4.30	0.70	226.12
Case N	47.04	87.26	5.65	1.22	141.16
Case O	75.65	148.68	4.97	0.70	230.00

% Changes from Total VTRA Case B Oil Outflow

%	Collisions	Power Groundings	Drift Groundings	Allisions	All Accidents
Case A	23.9%	2.9%	-0.6%	-0.4%	25.9%
Case B	0.0%	0.0%	0.0%	0.0%	0.0%
Case C	22.3%	26.8%	-0.3%	-0.4%	48.4%
Case D	-26.6%	-49.9%	-3.5%	-0.7%	-80.7%
Case E	-24.2%	-49.9%	-3.4%	-0.7%	-78.3%
Case F	9.2%	15.4%	-1.0%	0.0%	23.7%
Case G	44.1%	42.9%	-0.2%	-0.3%	86.4%
Case H	20.3%	43.5%	-0.5%	-0.4%	63.0%
Case I	34.0%	63.5%	0.3%	-0.3%	97.5%
Case J	-0.6%	0.3%	0.0%	0.0%	-0.2%
Case K	23.2%	40.6%	-0.1%	-0.5%	63.2%
Case L	-1.8%	-0.6%	-0.5%	0.0%	-2.9%
Case M	18.8%	42.8%	-0.9%	-0.4%	60.3%
Case N	0.0%	0.0%	0.1%	0.0%	0.1%
Case O	20.3%	43.6%	-0.4%	-0.4%	63.1%

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Figure AD-1. Total average annual oil spill volume per year (in cubic meters) for the VTRA Study Area by accident type and by all accidents for the 15 VTRA case scenarios in Table AD-1. The incremental risk changes are listed as a percentage of the total VTRA Case B oil outflow by accident type and by all accidents.

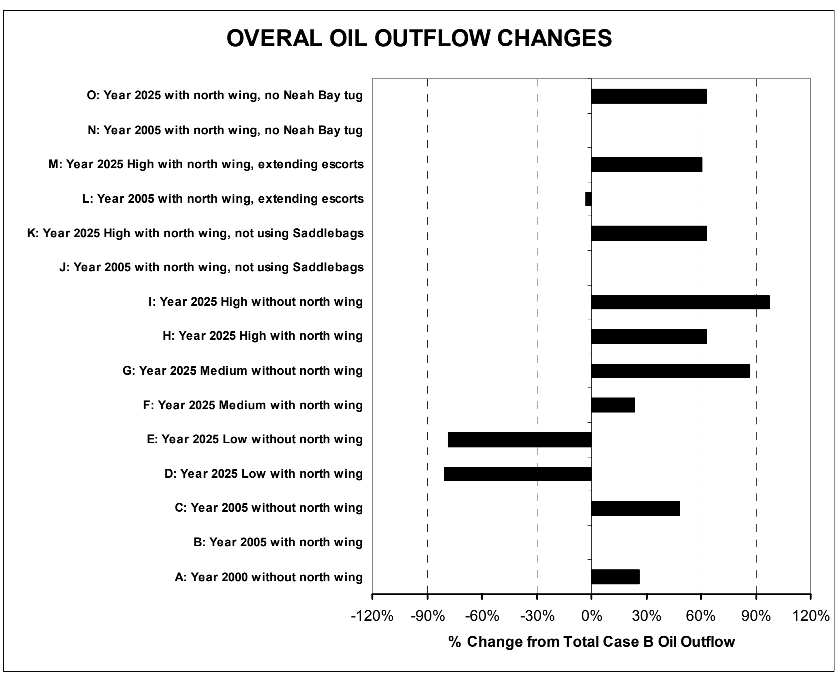

Figure AD-2. The overall incremental oil spill volume changes for the 15 VTRA Scenarios in Table AD-1 presented as a percentage change from total VTRA Case B oil outflow volume by accident type and by all accidents.

submitted as a Microsoft Power Point presentation electronically[2]. Figure AD-2 presents these percentage changes from VTRA Case B in a tornado diagram format. Figure AD-2 is also included in the VTRA final report in Section G-3 of Technical Appendix G. From Figures AD-1 and AD-2 one immediately observes, for example, an increase of about 48% in aggregated oil spill volume from VTRA Case B to VTRA Case C.

AD-2.1. Explanation format of incremental risk in our prior maritime risk studies

The format of presenting overall incremental risk changes in Figure AD-2 is consistent with the format that was used in prior maritime studies that the VTRA team was involved in. Figure AD-3A present a similar format for the Prince William Sound (PWS) Risk Assessment (see, e.g., Merrick et. al (2002) completed in 1996 and Figure AD-3B presents the format that was used in the Washington State Ferry (WSF) Risk Assessment (see, e.g., Van Dorp et al. (2003)) completed in 1999. Both Figures AD-3A and AD-3B depict the percentage increment (or decrement) in risk for different analysis scenarios that were considered in those studies.

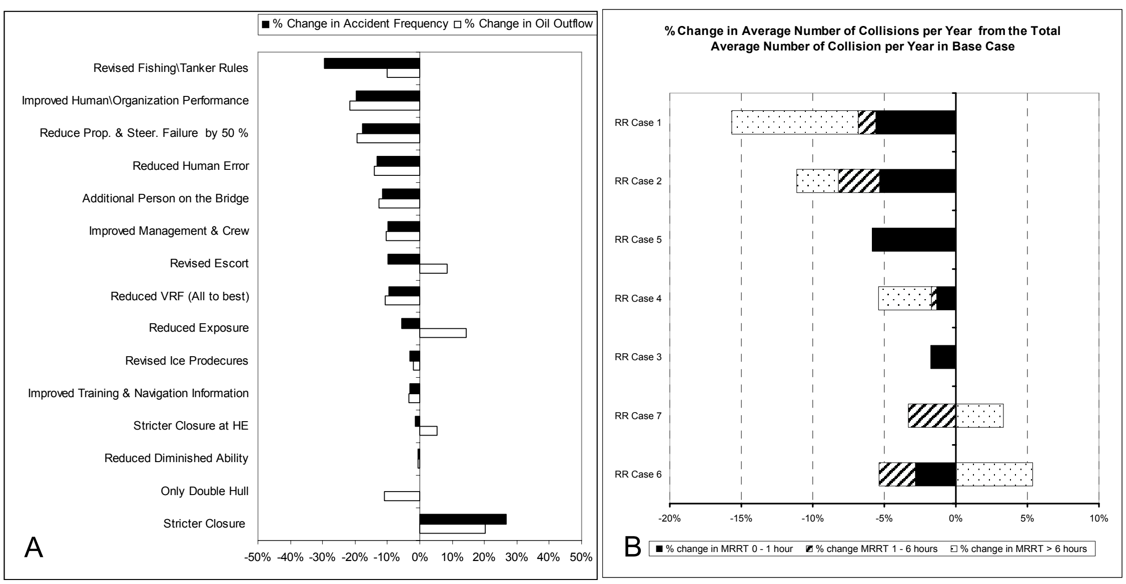

Figure AD-3. Format of incremental changes in other VTRA Team Maritime Risk Studies A: Format in Prince William Sound Risk Assessment (Merrick et al. (2002); B: Format in Washington State Ferry Risk Assessment (Van Dorp et. al. (2001)).

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[2] The footer of the Microsoft Power Presentation in Section G-3 of the VTRA final report inadvertantly lists "© GWU-RPI-VCU AUGUST 2007" which should read "© GWU-RPI-VCU AUGUST 2008". This was corrected in Figure AD-1

A negative increment in Figures AD-3 and Figure AD-2 implies a percentage decrease in the quantity of interest relative to the base case scenarios in each study. Recall that in the VTRA study, VTRA Case B was selected as the scenario for such a comparison.

To further understand changes in risk, risk profiles were produced in both the PWS Risk Assessment and WSF Risk Assessment by location and size for each scenario. Figure AD-4A displays a profile result from the Prince William Sound Risk Assessment with on the y-axis the percentage of outflow volume relative to the base case and on the x-axis the different possible combinations of accident types and locations in that study. The seven different locations were separately defined as displayed in Figure AD4-B. Figure AD-5A present the average collision frequency per year by location in case of the WSF Risk Assessment, where a location was defined as a particular WSF Ferry Route. The different ferry routes considered in the WSF Risk Assessment are displayed in Figure AD-5B.

While the display of analysis results by location and size in Figures AD-4 and AD-5 was the VTRA Team's state of the art at that time, it had the disadvantage that no distinction could be made with in terms of an analysis results distribution within a particular location in Figure AD-4B or along a particular ferry route in Figure AD-5B. The different sizes of locations in Figures AD-4B and the different lengths of the Ferry Routes in Figures AD-5B complicates a risk comparison from location to location in Figure AD-4B and from ferry route to ferry route in Figure AD-5B.

In 2002 GWU and VCU jointly participated in a project as a subcontractor to ABS consulting for the San Francisco Bay Water Transit Authority. While the focus in that study was also on passenger risk, GWU and VCU were only tasked to develop a maritime simulation model that could estimate the impacts on vessel to vessel interactions of proposed increased ferry service alternatives on San Francisco Bay and surrounding waters. Over the course project of this GWU and VCU developed a novel method to display vessel to vessel interactions (or congestion) geographically on a map using a fine color scale. Figure AD-6 displays the exposure results for a ferry service expansion scenario in San Francisco Bay. The graphical format of analysis results in Figure AD-6 is called a geographic exposure profile. Exposure results are displayed in Figure AD-6 in grid cells of the same size and the color of each grid cell indicates the relative congestion within a grid cells as explained by the color legend. Darker colors exhibits a busier traffic pattern within that cell than those cell with a lighter color. The advantage of a display of analysis results in this manner over that in

Figures AD-4 and AD-5 is that it allows for a more detailed presentation of analysis results by location and size.

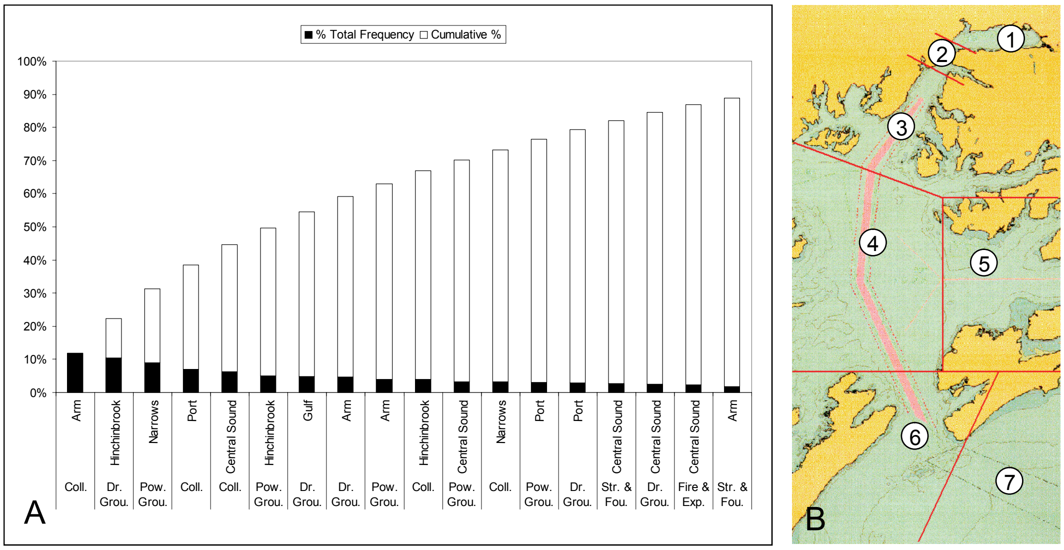

Figure AD-4. Format of base case oil spill results by location and size used in Prince William Sound (PWS) Risk Assessment (RA) (see, e.g., Merrick et al. (2002)) A: % Oil spill volume results by location and accident type B: Location definition in (PWSRA).

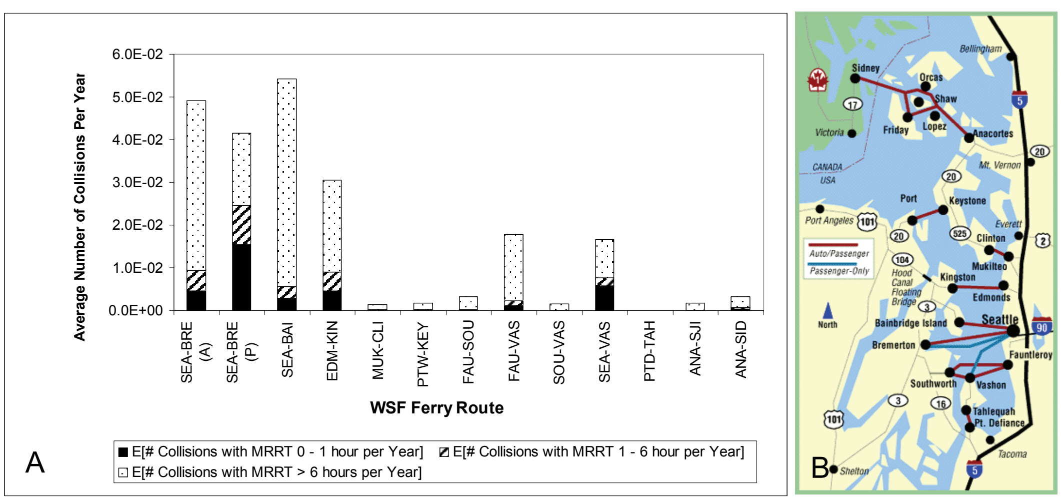

Figure AD-5. Format of base case passenger risk results by location and size used in the Washington State Ferry (WSF) Risk Assessment (RA) (see, e.g, Van Dorp et. al. (2001)) A: Average annual frequency of collisions by ferry route B: Location definition in WSFRA.

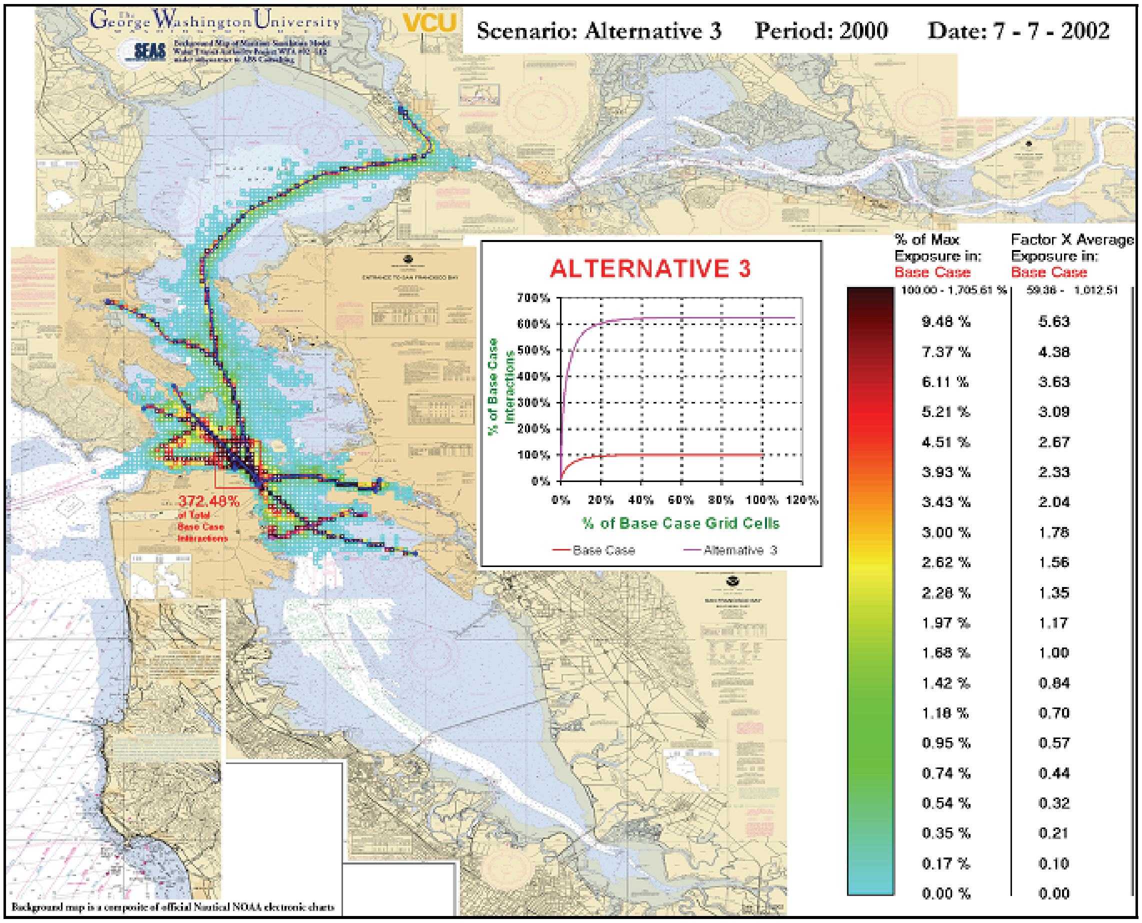

Figure AD-6. Format of Exposure (traffic congestion) results for a year 2000 Base Case Scenario in the San Francisco Bay Exposure Assessment (Merrick et. al. (2003)).

Another advantage of the display format of Figure AD-6 is that it allows for a direct visual assessment of the distribution of the exposure analysis results. For example, we immediately observe from Figure AD-6 a larger congestion and convergence of ferry to vessel interactions at the approaches towards the ferry terminal at Pier 1 in San Francisco Bay.

In addition to providing for a direct visual assessment of the analysis results, the graphic in the middle of this geographic exposure profile in Figure AD-6 allows for more detailed analysis conclusions. In effect the plot in the middle of Figure AD-6 (combined with the color scale) enhances the role of Figure AD-4A used in the PWS risk assessment. The horizontal axis list the percentage of grid cells that have color (and thus interactions) in

Figure AD-6 and the vertical axis displays the percentage of interactions relative to the total number of interactions in the base case scenario. The curves in this plot displays the progression in the cumulative number of interactions when ordering the grid cells by the number of interactions from largest to smallest. Hence we can conclude from this plot in Figure AD-6 that the top 20% of the grid cells that have interactions in the Base Case and Alternative 3, account for almost all of the interactions in both cases. Moreover these 20% are also assigned darker colors on the color scale which provides for a more detailed identification by location of relative "hot spots" displayed in such a geographic profile.

The curves in the middle of these geographic profiles also allow for more detailed conclusions regarding incremental risk between alternatives. For example, one derives the following additional conclusions from Figure AD-6:

(1) The total number of interactions in Alternative 3 increases overall by more than about factor of 6.2 (in other words we have an increment in Alternative 3 of more than 5.2 times the interactions in the Base Case),

(2) the top 20% of grid cells that have interactions in Alternative 3 account for about 6 times the total number of interactions in the base case and

(3) From the end-points of both graphs in Figure AD-6 it follows that Alternative 3 spreads the interactions over a slightly larger area than the Base Case (about a factor 1.18 larger).

AD-2.2. Explanating incremental risk changes in the VTRA study

Exposure, accident frequency and oil outflow analysis results in the VTRA study are geographic profiles of a similar presentation format as Figure AD-6. Technical Appendix G contains a complete set of geographic profiles for exposure, accident frequency and oil outflow for all 15 VTRA cases described by Table AD-1. Figure AD-7 and AD-8 below provide example geographic profiles in terms of average annual oil outflow for VTRA Case B and VTRA Case C listed in Table AD-1. Figures AD-7 and AD-8 are part of the VTRA final report and are included in Section G-5 of Technical Appendix G. They provide for a visual assessment by VTRA Case of oil outflow analysis results by location and size using the color scale in these figures. It is important to note that the color scales in these figures are identical and as a result one can visually compare the analysis results in Figures AD-7 and AD-8. Similar to Figure AD-6, detailed incremental changes in oil outflow analysis results from one VTRA Case to another are displayed visually using the plot in the middle of the geographic profile. The plot in the middle of Figure AD-7 and AD-8 compares VTRA Case A, B and C. As an illustration, we shall focus below on the oil outflow results comparison of VTRA Case B and VTRA Case C.

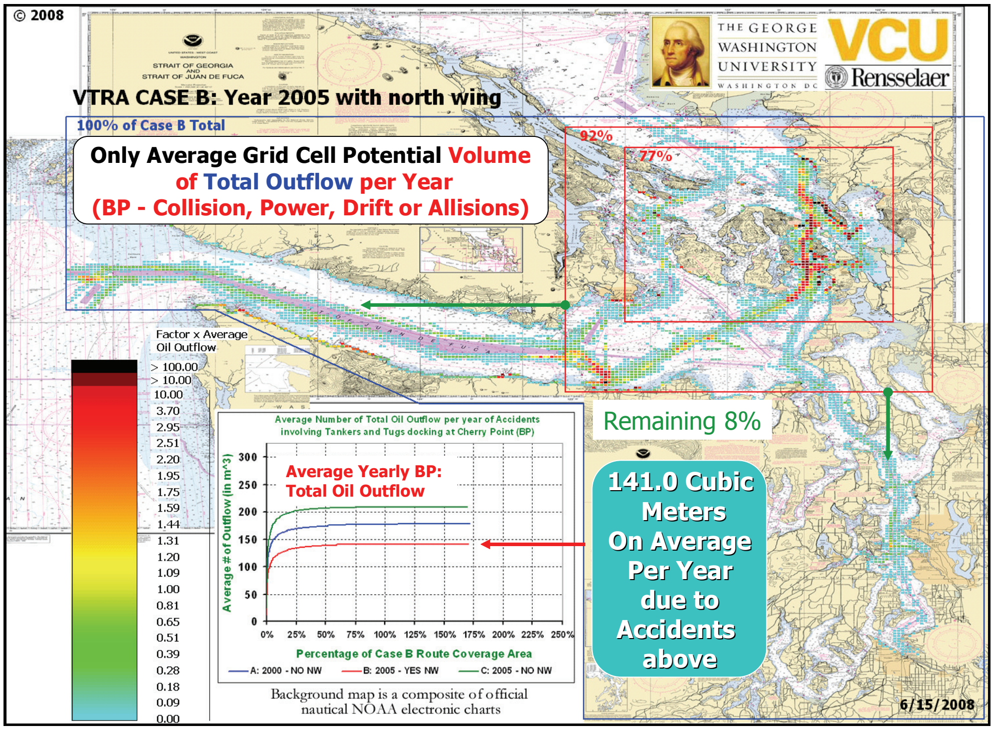

Figure AD-7. Geographic profile of average annual oil spill volume results for VTRA Case B with an incremental volume comparison between VTRA Cases A,B and C.

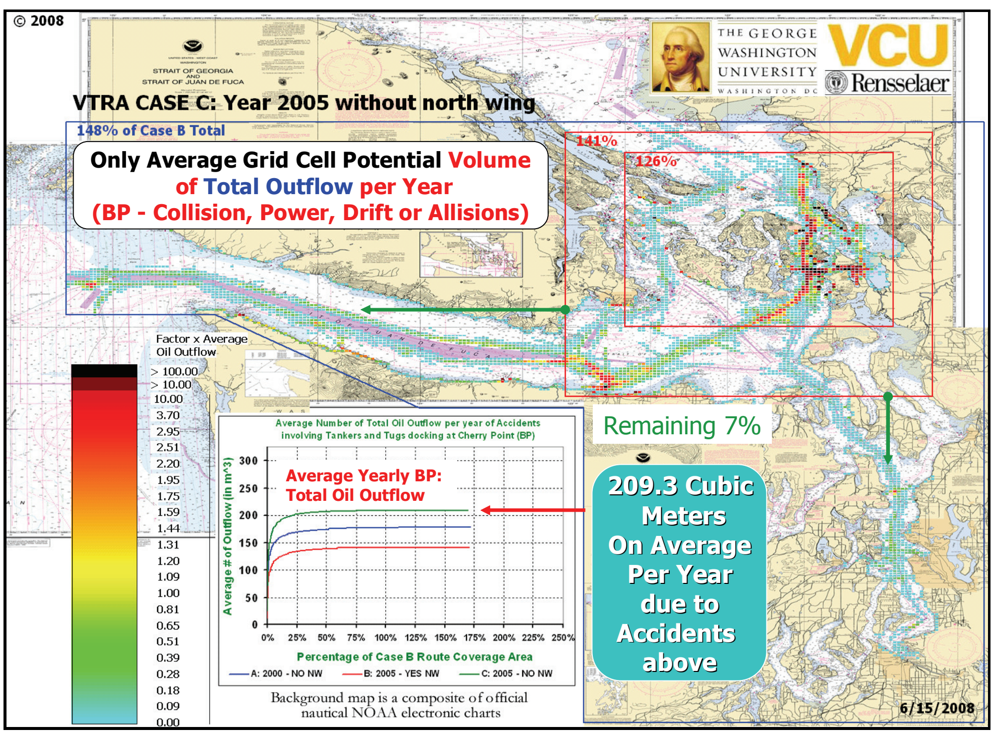

Figure AD-8. Geographic profile of average annual oil spill volume results for VTRA Case C with an incremental volume comparison between VTRA Cases A,B and C.

Those grid cells in Figures AD-7 and AD-8 with a darker color exhibit higher average annual oil outflows than those with a lighter color. Next to the beginning of the yellow color in this color scale we observe the number 1.00. The color next to the number 1.00 indicates the average oil outflow per grid cell averaged over all grid cells that have color. In other words, those grid cells that have a color from the yellow color on and upward along the color scales in Figures AD-7 and AD-8, exhibit a larger than average oil outflow and those grid cells with a green color and light blue color exhibit a smaller than average oil outflow. Hence, when visually inspecting these geographic profiles from an oil outflow results perspective, one might be particularly interested in those colors that are yellow and higher.

Shifting our attention to the plot in the middle of Figure AD-7 and Figure AD-8, we note that end-point of the red curve (VTRA Case B) in Figure AD- 7 indicates a total annual average oil outflow for VTRA Case B of about 141.0 cubic meters. The end-point of the green curve (VTRA Case C) in Figure AD- 8 indicates a total annual average oil outflow for VTRA Case C of about 209 cubic meters. Both these cumulative amounts are also included in Figure AD-1 and are provided in Technical Appendix G of the VTRA final report. Hence, we have an increment in oil spill risk from VTRA Case C to VTRA Case B of approximately $209.3 - 141.0 \approx 68.3$ cubic meters. This amounts to a percentage increase in oil outflow of

$$\frac{209.3 - 141.0}{141.0} \approx 48\%.$$

This percentage increase is also listed in the top left corner of the VTRA study area border of Figure AD-8. It lists that overall in VTRA Case C the total annual average oil outflow over the entire VTRA study area equals 148% that of VTRA Case B. Please note that the Figure AD-7 lists the number 100% in the same corner. Hence, percentages in Figure AD-7 and Figure AD-8 are calculated as a percentage of the total annual average oil outflow of VTRA Case B.

Moreover, from the same plots in Figures AD-7 and Figure AD-8 and the vertical distance between the green and red curve while moving from the right towards the left, it follows that only a rather small percentage of the grid cells that have color are responsible for this increase of 48%. Indeed, we observe from the x-axis in this plot that this percentage would certainly be less than 25% and possibly even less than 12%. Percentages along the x-axis are measured relative to the total annual number of grid cells that BPCHPT vessels traverse through. The plots in Figure AD-7 and AD-8 are aggregate plots in the sense that those grid cells that have color in these figures, observed either shore and allision interactions of

BPCHPT vessels (as explained in Technical Appendix D) or vessel to vessel interactions of BPCHPT vessels and those vessels that interact with them. This total area naturally covers a larger area than the route coverage alone of BPCHPT vessels and hence the colored curves in the middle of Figures AD-7 and AD-8 have an end-point along the x-axis beyond the 100% value. However, we do observe that both VTRA Case B and VTRA Case C have about the same coverage of interactions across the VTRA study area.

Shifting our attention to the two smaller red squares[3] and in particular their percentages in the top right corners, we observe From Figure AD-8 (VTRA Case C) in the larger red square 141% of all the oil outflow in VTRA Case B (and in the smaller red-square 126% of all the outflow in VTRA Case B) over the entire study area. Similarly, we observe from Figure AD-7 a 92% of all the outflow in VTRA Case B in the larger red-square (and a 77% in the smaller red-square). Hence as a percentage of the total outflow in VTRA Case B we observe the following increments in these larger and smaller red-squares:

Relative Increase in Larger Red Square	:	$141\% - 92\% \approx 49\%$
Relative Increase in Smaller Red Square	:	$126\% - 77\% \approx 49\%$

Realizing that results are rounded to whole percentages and since the smaller red-square is completely contained within the larger one, one immediately observes that the lion-share (if not all) of the increase in the larger red-square occurs in the smaller red-square. Moreover, one sees a 49% increase within the larger red-square, whereas one only observes a 48% increase over the entire study area. Hence, this implies that outside the larger red-square (but-within the VTRA Study area) one observes approximately a 1% decrease in aggregate oil spill risk when going from VTRA Case B to VTRA Case C. Indeed, this 1% reduction also follows from the percentages indicated in Figures AD-7 and Figure AD-8 underneath the lower left corner of this larger red-square. In Figure AD-7 it is indicated that the remaining 8% of the total oil outflow of VTRA Case B falls outside this larger red-square and in Figure AD-8 this amounts to 7% in VTRA Case C (also evaluated as percentage of total VTRA Case B oil outflow). Hence, once more a decrease of 1% outside the larger red square is observed when going from VTRA Case C to VTRA Case B.

Summarizing, the geographic profiles in Figure AD-7 and Figure AD-8 provide for a detailed explanation of the incremental risk changes between VTRA Case B and VTRA Case

[3]Strictly speaking they are rectangles.

C. While we have concluded that the oil outflow increases occur almost entirely in the smaller red-square, we observe utilizing the common color scale that these increases occur predominately in Guemes Channel and its anchorage areas and the approaches of Rosario strait. This observation follows from Figures AD-7 and AD-8 since within these areas we observe a darkening of color when going from VTRA Case B to VTRA Case C. Finally, via a careful visual inspection of Figure AD-7 and Figure AD-8 one observe a slight lightening of color along the Olympia coast in Figure AD-8 as compared to Figure AD-7. This suggests that the lion share of the 1% decreases outside the larger red-square (when going from VTRA Case B to VTRA Case C) could occur along this coast line.

AD-3. Risk in an maritime transportation system is a dynamic quantity.

Figures AD-9 and AD-10 are screen shots of the Prince William Sound maritime simulation (see, e.g., Merrick et. al 2002) and the San Francisco Bay maritime simulation (see, e.g., Merrick et. al 2003). Figure AD-9 contains a time-series plot of the exposure of Prince William Sound tankers over a 96 hour simulation period and Figure AD-10 contains a time-series plot of the exposure of San Francisco Bay Ferries over a 96 hours simulation period. Note that the time series in Figure AD-10 displays periodicity since SFB Ferries run on a schedule and do not run at night, whereas the time series in Figure AD-10 does not display such a periodicity. Hence, from these time-series plots we observe that exposure (of which risk is a function) changes over time and thus oil spill risk (in the case of the PWS study) and passenger risk (as in the case of the San Francisco Bay study and Washington State Ferry Risk Assessment study) as it emerges from moving traffic, is a dynamically changing quantity over time as well.

Hence, to evaluate system risk for either the PWS, the WSF and the San Francisco Bay maritime transportation simulations, one evaluates aggregate risk over an extended time period of such a time series for the entire study area. Results in all three prior maritime risk studies were presented as annual averages and analysis by location and size resulted in the output results as displayed in Figures AD-4 and AD-5. Risk intervention measures were evaluated in these studies by a comparison of aggregated annual system wide risk measures. To explain changes by location and size similar plots as those in Figures AD-4 and AD-5 were produced for each risk intervention scenario.

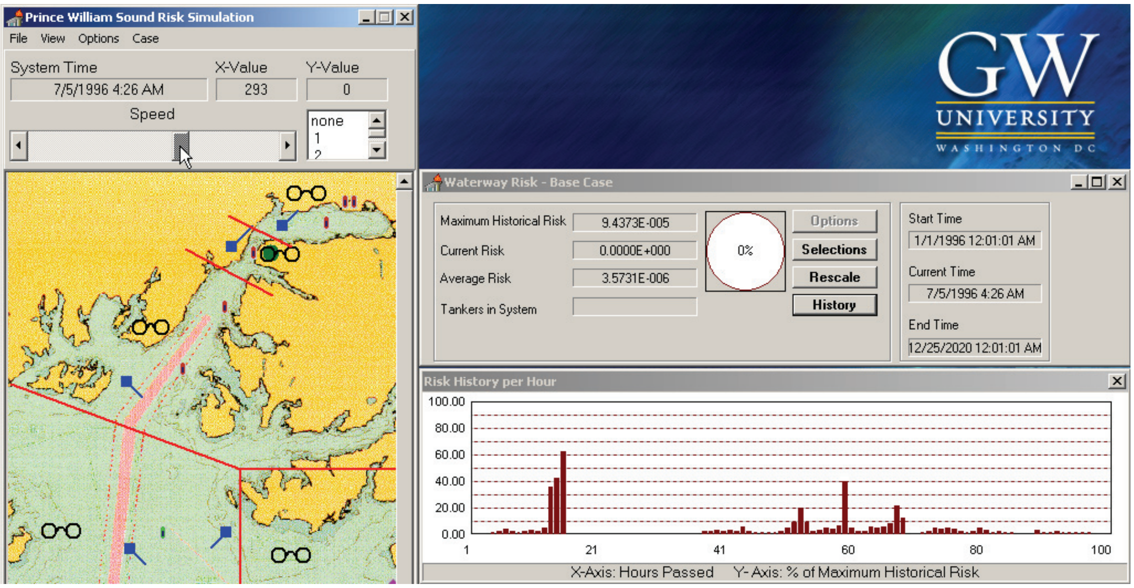

Figure AD-9. An example time series of exposure of Prince William Sound Tankers vessels over a 96 hours simulation period in the PWS maritime simulation.

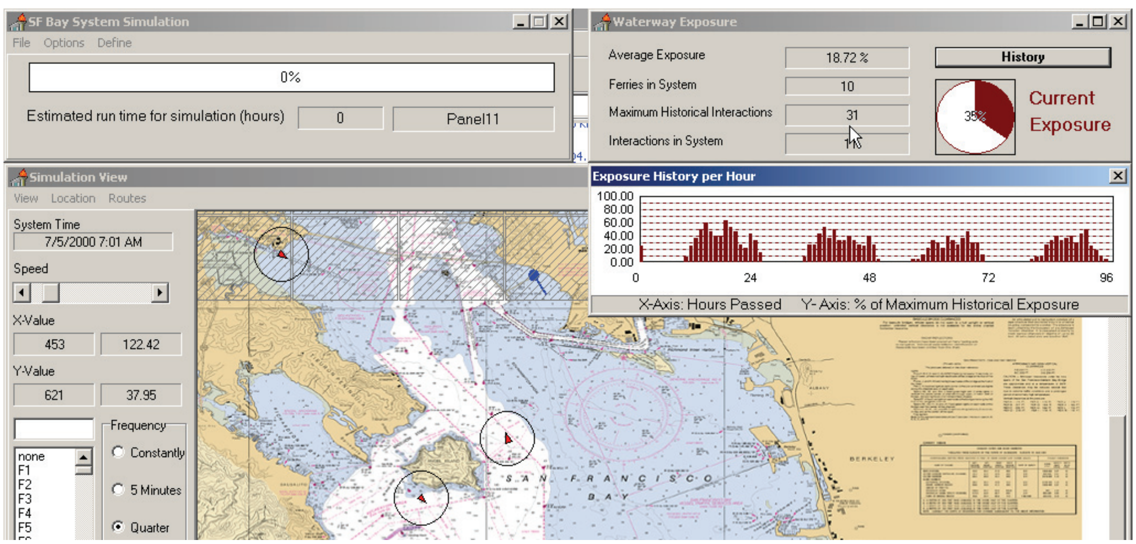

Figure AD-10. An example time series of exposure of San Francisco Bay Ferries over a 96 hours simulation period in the San Francisco Bay maritime simulation.

AD-3.1. VTRA system risk evaluation requires aggregation over a time period.

Figure AD-11 displays a similar screen shot of the VTRA maritime simulation. Similar to Figures AD-9 and AD-10, it also contains a time-series of the exposure of BPCHPT vessels over a 96 hours period. Hence, analogous to our prior studies, system risk for a particular scenario over the entire study area is evaluated by aggregating the results of such a time-series over an extended period of time. A full years worth of VTOS traffic data was collected for VTRA Case B and hence this time period was used for the VTRA Case to VTRA Case comparisons. VTRA Case B vessel traffic movement of traffic is predominantly a replay of the observed arrival steam from this VTOS traffic data base for the various different vessel types in the VTRA Study area. This is explained in more detail in Technical Appendix C of the VTRA final report.

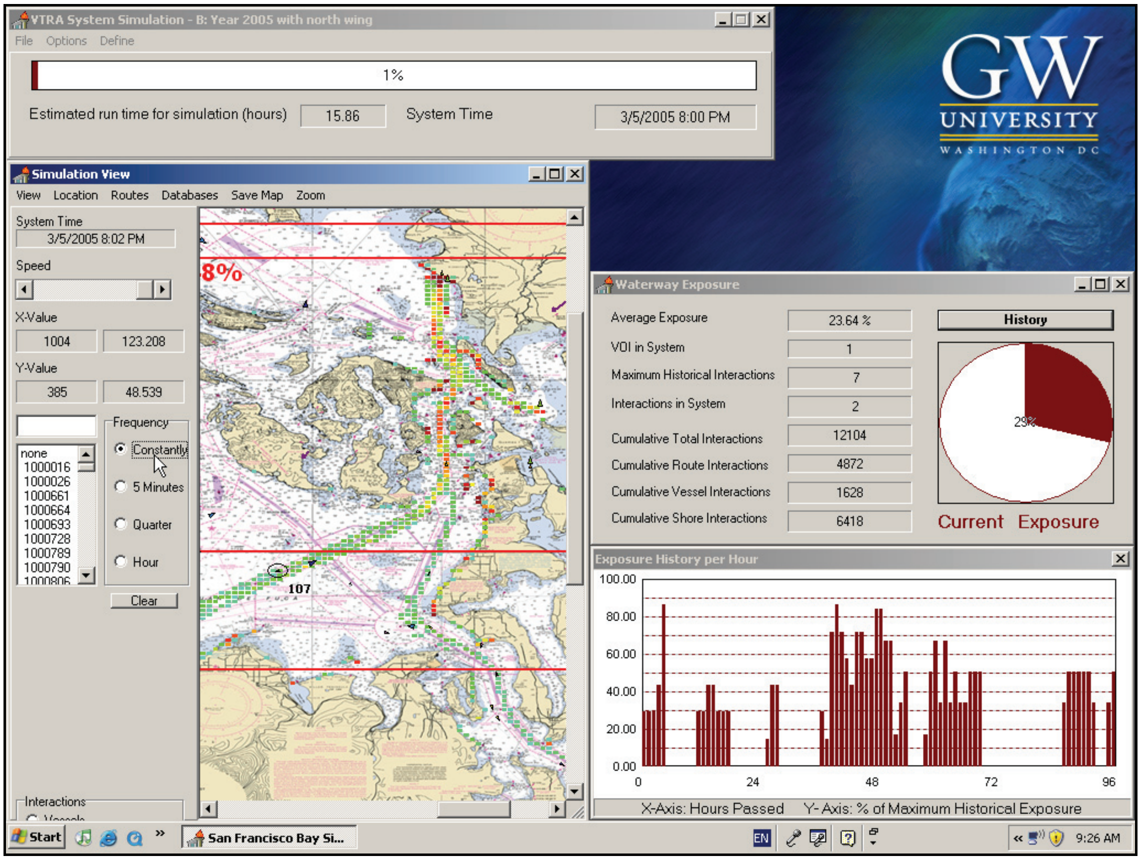

Figure AD-11. An example time series of exposure of BPCHPT vessels over a 96 hours simulation period in the VTRA maritime simulation.

In the VTRA study, system wide analysis results for all 15 VTRA Cases (listed in Table AD-1) were aggregated in terms of annual total average oil outflow, annual total average accident frequency and annual total number of interactions. These cases were constructed by increasing or decreasing the arrival stream of a particular vessel type to a level as explained in Technical Appendix F of the VTRA final report. Those vessel types whose arrival stream did not need modification to describe a particular VTRA Case, were continued to be replayed as they appeared in their full years worth of VTOS data. Comparison of incremental risk across these VTRA Cases is, similar to our prior studies, based on these system wide annualized results. Figure AD-1 (also provided in Technical Appendix G of the VTRA final report) provides these system wide statistics for the annual total average oil outflow. Similar tables have been provided for accident frequencies by accident type and interactions by type in Section G-3 of Technical Appendix G. Geographic profiles in terms of all these statistics provide for a more detailed explanation of incremental changes across VTRA Cases along the lines of the presentation in Section AD-2 (and play a similar role as Figures AD-4 and AD-5 did in the PWS and WSF risk assessments) .

Summarizing, the fact that risk in a dynamic maritime transportation system (MTS) is a dynamic quantity (that is, it changes over time) dictates that a comparison of different VTRA Cases ought to be based on aggregated or averaged system wide results over an extended simulation period. In the VTRA study the period of one year was selected as the period for comparison of VTRA cases, since only one continuous full year of VTOS traffic data was available.

AD-3.2. When changing a dynamic maritime transportation system, risk migrates across the entire area experiencing vessel movements.

To further explain the migration of risk in the PWS Sound study (see, e.g. Merrick et al. (2002)) and the WSF Study (see, e.g. Van Dorp et al. (2001)) results of the form in Figures AD-4 and AD-5 were developed for various risk intervention scenarios in those studies. In the San Francisco Bay study a more detailed description of changes in risk across a study area was provided through the generation of geographic profiles (as displayed in Figure AD-6) for various expansion alternatives , while keeping the color scale the same from one geographic profile to another.

From our prior studies we have observed that maritime risk in dynamic maritime transportation system has a tendency to migrate when changes are made to such a system. For example, migration of risk behavior was the primary reason that a lowering of wind closure conditions in Valdez Narrows (Location 2 in Figure AD-4) ended up resulting in a system wide increase of risk. Even though this particular risk intervention measure targeted a risk reduction in Valdez Narrows (Location 2 in Figure AD-4), the closure of Valdez Narrows resulted in an increased congestion in Valdez Arm (Location 3 in Figure AD-4) and an increase in the number of trips from Tankers to the PWS Anchorages (Location 5 in Figure AD-4) from inbound tankers. Hence, risk migrated from Valdez Narrows to elsewhere and at the same time resulted in an amplified affect when evaluating system wide risk across the entire PWS study area. Hence, this risk migrating behavior required that system wide risk interventions be evaluated in the PWS study by considering the net aggregate change across all seven locations in the entire study area (indicated in Figure AD-4).

To explain the migration in risk by location and size in the VTRA study, the VTRA team has provided geographic profile results both in terms of exposure, accident frequency and oil outflow for all 15 VTRA cases in Table AD-1. Figure AD-7 and AD-8 provide these results in terms of oil outflow for VTRA Cases B and C[4]. In Section AD-2.2 we have explained in detail how these geographic profiles contain an explanation of incremental risk changes when going from VTRA Case B to VTRA Case C. We concluded for this example comparison that going from VTRA Case C to VTRA Case B the larger increases occur in Guemes Channel and the approaches to Rosario Strait. Similar to the example of the Prince William Sound Risk Assessment in the previous paragraph, this appears to be a direct result of anchorages filling up as a result of the south-wing dock being occupied more frequently in VTRA Case C with as a result an increased use of all anchorages areas in that case. This also results in an increased use of the March Point anchorages by approaching laden tankers that cannot use the other more northern anchorages when approaching Rosario Strait because these are occupied at that time during the simulation run.

While we synthesized in the VTRA final report and through a further explanation in this addendum in Section AD-2.2 that the lion share of this migration when going from VTRA Case B to VTRA Case C resulted in an increase of oil spill risk of 49% (as a percentage of average annual total oil outflow) in the smaller red square, it is quite likely that one may in fact observe increases in one grid cell and similar decreases immediately adjacent to it, also as a result of risk migration. This occurs, since when altering a traffic scenario (for example from VTRA Case B to VTRA Case C) one not only changes the timing and location of vessel to vessel interactions throughout the entire VTRA study area, but also the interaction of vessels with varying environmental variables such as wind, current and visibility. As a result, each area throughout the VTRA study area may exhibit grid-cells where increases in risk occurs in some and decreases in risk occurs in others, and these grid-cells may be adjacent to one another. Hence, only when one aggregates the grid-cell to grid-cell information over a larger area, one can conclude if overall these changes in grid-cell to grid-cell behavior leads to an increase or decrease in risk for that larger area. In the system wide

[4]These profiles were also provided in Section G.5 of Technical Appendix G. Geographic profiles displaying oil outflow results, accident frequency results and exposure results of VTRA Case B were also provided in the Main Report of the VTRA Final report as Figures 31, 30 and 28, respectively.

risk evaluation for the VTRA Case, this aggregation occurred over the entire VTRA study area.

To further illustrate the potential grid-cell to grid-cell migration, we are providing two additional geographic profiles in Figures AD-12 and Figure AD-13. In Figure AD-12 we are displaying those grid-cells that have an increase in oil outflow when subtracting from the oil outflow results in a grid cell in VTRA Case C, the oil outflow results in that grid-cell from VTRA Case B. In Figure AD-13 we are displaying those grid-cells that have a decrease in oil outflow when subtracting from the oil outflow results in a grid cell in VTRA Case C, the oil outflow results in that grid-cell from VTRA Case B. We are displaying these increases and decreases separately in Figures AD-12 and AD-13, but are using the same color scale as the one used in Figures AD-7 and AD-8. Thus the color scales in Figures AD-12 and Figures AD-13 are the same and hence those grid cells with the same color in Figures AD-12 and Figures AD-13 represent the same absolute change in grid-cell analysis result, except that the change in Figure AD-12 is an increase and the change in Figure AD-13 is a decrease. From Figures AD-12 and AD-13 we do observe explicitly that grid cells that experience increases are spread throughout the entire study area and also grid cells that experience decreases are spread throughout the entire study area. In fact, from the x-axis of the plots in the middle of Figures AD-12 and Figures AD-13 one observes about the same amount of grid-cells with increases as the amount of grid-cells with decreases. The net aggregate effect however of all these migrations is the earlier stated 68.3 cubic meters[5] increase in outflow going from VTRA Case B to VTRA Case C.

Shifting our attention to the plots in the middle of Figures AD-12 and AD-13, one observes from Figure AD-12 that the total amount of oil outflow increases over all grid cells that experience increases, amounts to 95.5 cubic meters. From Figure AD-14 we observe that the total amount of oil outflow decreases over all grid cells that experience decreases, amounts to 27.2 cubic meters. Hence, the net increment in total annual average oil outflow going from VTRA Case B to VTRA Case C also follows here as the previously stated 68.3 cubic meters as explained in Section AD-2.2. From Figure AD-12 we observe in the top-right hand corner that the total amount of oil outflow increases over all grid-cells that have increases, amounts to an increase of 68% of the average total annual oil outflow of VTRA Case B.

[5]on Page AD-20 in Section AD-2.2

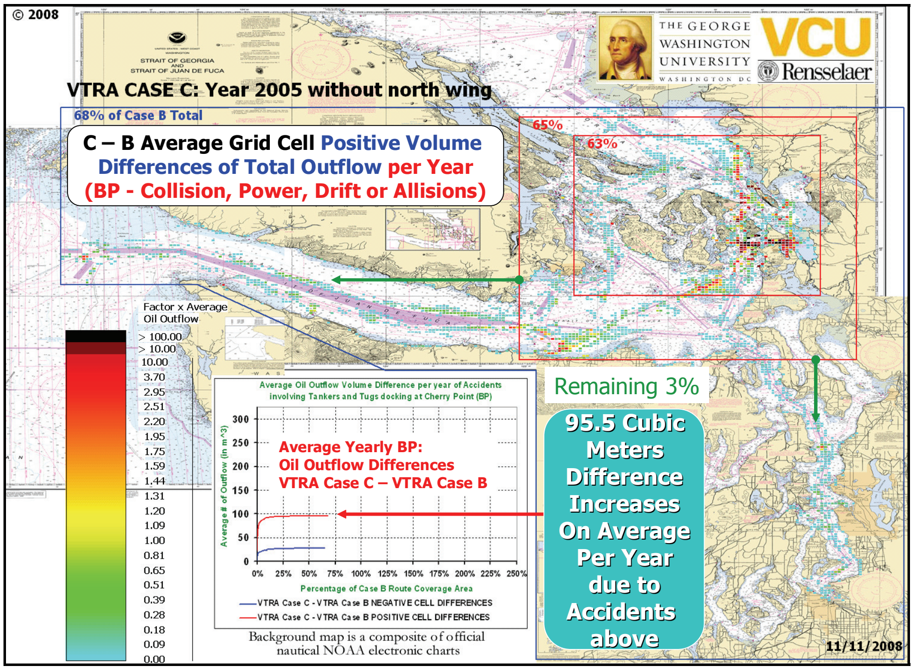

Figure AD-12. Geographic profile of grid-cells that have an increase in oil outflow when subtracting from the oil outflow results in a grid cell off VTRA Case C, the oil outflow results in that grid-cell from VTRA Case B.

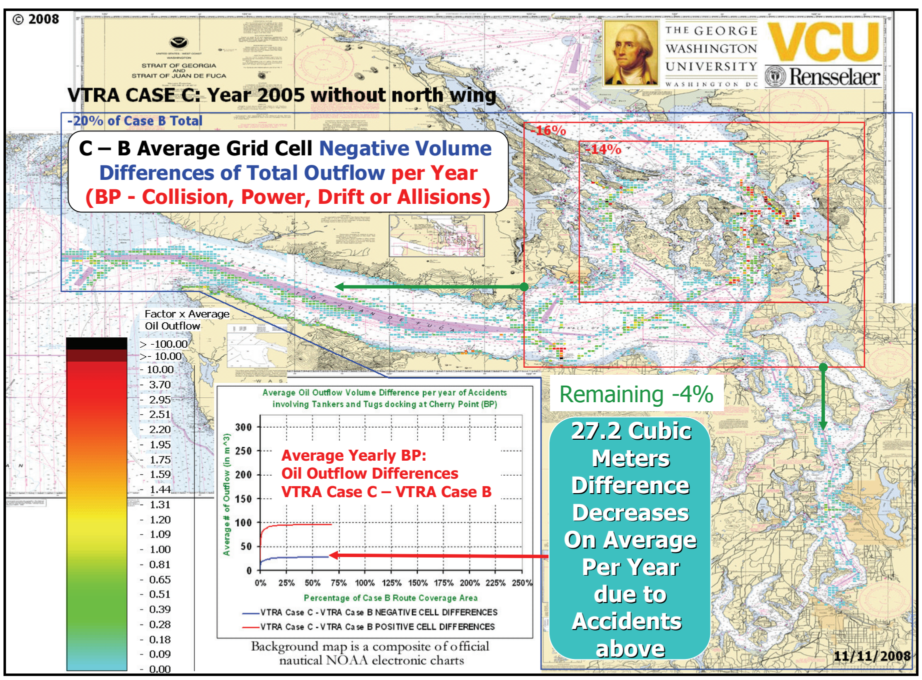

Figure AD-13. Geographic profile of grid-cells that have an decrease in oil outflow when subtracting from the oil outflow results in a grid cell of VTRA Case C, the oil outflow results in that grid-cell from VTRA Case B.

From Figure AD-13 we observe in the top-right hand corner that the total amount of oil outflow decreases over all grid-cells that have decreases, amounts to a reduction of 20% of the average total annual oil outflow of VTRA Case B. Hence, similar to the conclusion in Section AD-2.2[6] we have overall about a 48% increase in oil outflow when going from VTRA Case B to VTRA Case C. Analogously, we arrive at the conclusion that in the larger red-square we have an overall increase of about a $65\% - 16\% = 49\%$ increase of oil outflow and a $63\% - 14\% = 49\%$ increase of oil outflow in the smaller red-square[7]. Hence, one arrives at exactly the same conclusions as in Section AD-2.2 when comparing Figures AD-12 and Figure AD-13 as opposed to comparing Figures AD-7 and AD-8. That is, the lion share (if not all) of the aggregate oil outflow increase occurs in the smaller red-square when going from VTRA Case B to VTRA Case C. Moreover, one also arrives at the same conclusion from Figures AD-12 and AD-13 that we have a decrease of $4\%\text{-}3\% = 1\%$ outside the larger red-square when going from VTRA Case B to VTRA Case C. Finally, we observe from Figure AD-12 that the larger increases occur in Guemes Channel and the approaches to Rosario Strait.

Summarizing, even though Figures AD-12 and Figures AD-13 separate the respective increases and decreases across grid-cells, one arrives at exactly the same conclusions when comparing the geographic profiles of oil outflow results per VTRA Case B and VTRA Case C as displayed in Figures AD-7 and AD-8. This ought not be a surprise, since the ingredient information of Figures AD-12 and AD-13 are derived from the results displayed in Figures AD-7 and AD-8.

AD-4. Comment 1

1. **The study results incompletely describe the incremental risk of accident and oil outflow.** The scope of work listed on pages 21 and 22 note that the study is to determine incremental risk and to describe changes in risk geographically. The report results include a number of "Geographic Profiles", however each of these profiles is for a single case (year). the report does not include any mapped displays or outputs showing the differences in risk between cases (for example the change in risk from Case B – 2005 with North Wing and Case C - without North Wing). Since the underlying simulation model output is geographic based, the study team should be able to simply subtract Case B from Case C using a GIS system and produce the desired result.

[6] on page AD-20.

[7] Which was also concluded on page AD-20

> Since none of the geographic profiles show the difference in risk of accident or oil outflow, geographically the reader must view two profiles and interpret the pattern difference visually. Such comparisons are difficult on three counts; 1) in the Draft Report the profiles for Case B and Case C are shown on the front and back of one page making direct comparison impossible, 2) the displays are at a small scale making interpretation difficult and 3) the displays have been normalized making direct reading of results impossible.

AD-4.1. Response to Comment 1

The VTRA Team was tasked to evaluate the incremental risk of (1) an accident (collision, grounding or other scenario) involving a tank vessel, (2) resulting in a discharge of crude oil or petroleum products, (3) associated with reasonably foreseeable increases in vessel traffic through calendar year 2025 to and from both wings of the Cherry Point Refinery Pier, (4) as compared with the baseline traffic that the pre-North Wing pier could accommodate. The study was to include an impact analysis that describes the outcomes of an accident as described by the location and size of oil outflows, but stop short of examining the fate and effects of an oil spill. The VTRA Team has completed these tasks and their completion have been described in the VTRA final report. A further explanation of the analysis format of incremental risk in the VTRA study is described in Section AD-2 of this addendum. Examining the fates and effects of an oil spill leads to an analysis of environmental risk. The VTRA oil spill analysis results by location and size serve as an input to that analysis.

In May of 2008, the VTRA team coordinated with the CORPS and ENTRIX on a numerical non-graphical format of the VTRA oil spill analysis result in addition to the graphical geographic profile display of the VTRA oil spill analysis results. The numerical results were provided to ENTRIX to allow for the integration of the oil spill analysis results into a numerical fates and effect analysis to be conducted by ENTRIX. An example snapshot of these analysis results for the accident type collisions is provided in Table AD-2 below. These results were provided to ENTRIX by accident types considered in the VTRA, i.e. collisions, powered groundings, drift groundings and allisions in the format of comma separated text files for all 15 VTRA Case Scenarios listed in Table 1 of the final report (and Table AD-1 in this addendum). Hence, a total of 60 comma separated text files were generated and delivered. We shall refer to these files as the VTRA interface files.

The LAT and LONG columns in each VTRA interface files exemplified in Table AD-2 describe the latitude longitude coordinates of the midpoint of a grid cell of one half of a nautical mile by one half of a nautical mile. The FREQUENCY column describe the average annual frequency of that accident type associated with that file in that grid cell. The AVERAGE PERS OIL describes the average persistent oil outflow volume (in cubic meters) per accident in that grid cell and the AVERAGE NON-PERS OIL describes the average non-persistent oil outflow volume (in cubic meters) per accident in that grid cell. ENTRIX demonstrated[8] the ability to import our output analysis results from the interface files into a Geographic Information System (GIS) of their choice and correctly display the location and the size of the grid-cells on a nautical map.

Table AD-2. A snap-shot of non-graphical VTRA output analysis results. Comma separated text files of this type were provided to ENTRIX for the accident types collisions, power groundings, drift groundings and allisions and for all 15 VTRA Cases in listed in Table 1 of the final report and Table AD-1 of this addendum.

LAT	LONG	FREQUENCY	AVERAGE PERS OIL	AVERAGE NON-PERS OIL
4.85E+01	1.25E+02	2.03E-05	2.47E+02	5.06E+02
4.85E+01	1.25E+02	2.06E-05	2.13E+01	3.06E+00
4.85E+01	1.25E+02	3.01E-05	8.96E+01	4.00E+01
4.84E+01	1.25E+02	2.12E-06	1.58E+01	1.33E+00
4.85E+01	1.25E+02	1.73E-05	5.14E+01	4.20E+02
4.85E+01	1.25E+02	2.07E-05	7.18E+01	3.11E+00
4.85E+01	1.25E+02	2.57E-05	1.45E+01	2.25E+01
4.84E+01	1.25E+02	9.79E-07	8.15E+00	1.10E+00
4.84E+01	1.25E+02	2.59E-06	1.17E+01	1.14E+00

While the original geographic scope of the VTRA was modified and expanded in February 2007 the VTRA Team were informed[9] by ENTRIX that the geographic scope of the EIS was not modified in February 2007 and still excludes the Puget Sound and the extension westward beyond Buoy "J". However, since the geographic scope of the EIS is contained within that of the VTRA, the VTRA output analysis results provided in the VTRA interface files continue to support the EIS and continue to allow for their seamless integration into ENTRIX's EIS fates and effect analysis.

For the purpose of their fates and effect analysis ENTRIX produced[10] a manipulation of the information in VTRA interface files as they suggested in this Comment 1 of the October 1, 2008 CORPS letter, included in this addendum as Technical Appendix A. ENTRIX provided the VTRA Team with sample graphical output on a nautical map that excludes the Puget sound seemingly confirming the smaller geographic scope for the EIS than the VTRA. ENTRIX produced these results for the purpose of their fates and effect analyses utilizing

[8]In June 2008
[9]During a conference call with ENTRIX in June of 2008.
[10]In July of 2008

the comma separated VTRA oil spill volume results as input. The VTRA team responded with concern in part since (1) ENTRIX produced an output which was a direct manipulation of VTRA analysis results (i.e. not analysis result that reflect an additional fates and effects analysis layer) in a different geographical format than the geographical profiles that were submitted[11], (2) it appeared that ENTRIX was evaluating grid cell differences of average oil outflow per accident rather than of average oil outflow per grid cell[12], and (3) because differencing at a grid-cell level, rather than at a higher aggregate level, did not seem to lead to a meaningful integration of the VTRA oil outflow analysis results into ENTRIX's fates and effect analysis. Our complete response dated July 16, 2008 to the grid-cell to grid-cell differencing analysis that ENTRIX conducted is provided as Sub-Appendix B of this Addendum. We did not receive any further comments from ENTRIX after this response until the response from the CORPS, dated October 1, 2008, to which we are responding herein.

While the VTRA Team was not tasked to conduct a fates and effect analysis of oil spills in any of their prior studies nor were they in the VTRA study, it would seem that the fates and effect of a difference in oil spill results from VTRA Case to VTRA Case would be a function of the level of outflow from which that difference is calculated[13]. If that were to be the case, this would contradict the need for a fates and effect analysis of only differences of VTRA oil spill results, but rather asks for a fates and effect analysis of each VTRA Case in Table AD-1 separately, after which differencing of system wide fates and effects could occur by VTRA Case. Furthermore, even if this were not the case (i.e. fates and effects at a location are only a function of a difference in oil out flow results at that location) a differencing of oil outflow results by grid-cell would only be meaningful, if a fates and effect analysis would be conducted for that difference in each grid-cell and next a system-wide fates and effect analysis of these differences would be evaluated by aggregating the grid-cell fates and effect analysis over all grid cells. To the best of our knowledge, the later approach is not the approach ENTRIX was taking towards their fates and effect analysis. However, in all fairness, we have not been given a formal presentation of ENTRIX's analysis methodology for their fates and effect analysis over the two-year span of the entire VTRA project.

[11]Representing the information imbedded in the analysis results but in a different manner will not change the overall conclusions. Our geographic profile format has been developed over time and uses a fine color scale as opposed to a very coarse and therefore less accurate color scale used by ENTRIX while using a GIS system of their choice.
[12]Which would ignore the accident frequency completely.
[13]This further explains the VTRA response dated July 16, 2008 in Sub-Appendix B.

In the spirit of coordination, the VTRA team assisted ENTRIX by suggesting an alternative procedure[14] towards a fates and effect analysis that utilizes the information in VTRA interface files exemplified in Table AD-2 involving a sub-area partitioning of the VTRA study area. The VTRA Team recommended to ENTRIX that such a sub-area definition ought to take environmental sensitivities into account. Regardless, the numerical VTRA oil spill volume result provided to ENTRIX in the VTRA interface files exemplified in Table AD-2 provide for a flexibility in the sense that they supports all the approaches described above towards a fates and effect analysis.

In a further spirit of coordination between ENTRIX, the CORPS and the VTRA Team, and to make sure their could be no further misunderstanding about the content of VTRA interface files, the VTRA Team provided ENTRIX with four Microsoft Excel spreadsheets constructed from the VTRA interface files with a comparison of VTRA Case A, B and C listen in Table 1 of the final report and Table AD-1 of this addendum by accident type. These Microsoft Excel spreadsheets demonstrate to ENTRIX how to aggregate the output analysis results in the VTRA interface files for the entire VTRA study area. Figure AD-14 displays a screen shot of one of the Microsoft Excel files for the accident type collision. Please observe from Figure AD-14 that the evaluated total average annual volume of outflows equals about 80.7, 47.0 and 78.6 in cubic meters for VTRA Cases A, B and C, respectively. Note that these values coincide with the total average annual volume of outflow for collisions in Figure AD-1, but also provided in Technical Appendix G of the final report. The same method of aggregation as exemplified in these Microsoft Excel files should be employed when aggregating the grid-cell by grid-cell information in Table AD-2 for a sub-area partitioning of the VTRA study area. If the VTRA Team is provided with ENTRIX's sub-area partitioning of the VTRA study area, the VTRA team could further assist ENTRIX in the aggregation of grid-cell analysis results, provided the appropriate financial arrangements are in place.

The remainder of Comment 1 list three observations regarding the comparison of geographic profiles. A three hole binder with a one-sided print out of the report would allow a reader to look at two pages at the same time addressing Observation 1. The geographic profiles in the presentation in Technical Appendix G cover a full page addressing the small scale concerns listed in Observation 2. Moreover, these presentations have also been submitted electronically in Microsoft Powerpoint presentations to allow for a back and forth

[14] In our response dated July, 16 2008 and provided in Sub-Appendix B in this addendum.

animation of VTRA Case geographic profiles in full screen mode on a large computer screen or even larger presentation screen, further addressing both Observations 1 and 2. To even further address the small scale concern listed in Observation 2 we shall include with this addendum our larger resolution bitmap files that were used to develop the Microsoft Powerpoint presentations in Technical Appendix G of the final report.

	A	B	C	D	E
1		**CASE A**	**CASE B**	**CASE C**	
2	**Collisions**				
3	Total Annual Frequency	0.111	0.091	0.132	
4	Average Per Grid Cell	5.218E-05	4.622E-05	6.503E-05	
5	Min	5.109E-08	3.916E-08	3.965E-08	
6	Max	5.988E-03	2.911E-03	6.098E-03	
7					
8	**Persistent Oil (m^3)**				
9	Total Average Annual Volume	65.515	32.250	60.780	
10					
11	**Non- Persistent Oil (m^3)**				
12	Total Average Annual Volume	15.230	14.800	17.780	
13					
14	**Combined Oil (m^3)**				
15	Total Average Annual Volume	80.744	47.049	78.559	
16					

Figure AD-14. Screen shot of Microsoft Excel files explaining the methodology for aggregation of grid-cell information for the entire VTRA Study Area and larger sub-areas.

While we do not fully understand what is meant by the term "normalized" displays mentioned in the third observation, perhaps Observation 3 still arises from some remaining misunderstandings of the information provided by VTRA geographical profiles. We hope that the additional explanation that we are providing now in Section AD-2.2 helps alleviate such misunderstandings. We imagine that the normalization remark relates to the common color scale in the presentation of geographic profiles of VTRA analysis results of the same type across VTRA Cases listed in Table AD-1 and Table 1 of the final report. A common color scale is used to allow for a visual geographic profile comparison from VTRA Case to VTRA Case. A numerical comparison of the 15 VTRA Cases listed in Table 1 of the VTRA final report is provided in a numerical aggregate results presentation for the entire VTRA study area in Technical Appendix G of this report.

AD-5. Comment 2

2. **Conclusions based on average point estimates over the study area do not adequately link change in risk to affected resources.** The purpose of the VTRA in the context of the Environmental Impact Statement is to determine the change in "environment risk" that results from operation of the Cherry Point Dock North Wing. Thus changes in the risk of accident and oil outflow derived by the VTRA simulation model must be directly linked to potentially affected environmental resources which vary significantly throughout the study area.

   The simulation model results displayed as geographic profiles do show the probability of accident and oil outflow geographically. However these displays only offer the reader a general impression of the geographic context of the results (see further discussion below). No useful statistical results linked to geographic areas are available in the report.

   The report states that "Quantitative results in our study are presented as average point estimates commonly used for the evaluation of alternatives in a decision analysis context" (page 81). The purpose of the VTRA is to support an environmental impact analysis of the incremental difference in environmental risk, not a decision analysis of alternatives. Please explain how average single point estimates are to be used to evaluate variable geographic effects to environmental resources.

AD-5.1. Response to Comment 2

The VTRA Team was tasked to included an impact analysis that describes the outcomes of an accident as described by the location and size of oil outflows, but stop short of examining the fate and effects of an oil spill. The VTRA Team has completed that task. Examining the fates and effects of an oil spill leads to an analysis of "environmental risk". The VTRA oil spill analysis results by location and size serve as an input to that analysis. Changes in VTRA oil spill analysis results that follow from the operation of the Cherry Point Dock North Wing thus indirectly influence the change in "environment risk". A complete set of comparisons presentations of geographic profiles of VTRA oil outflow analysis results for the VTRA cases in Table AD-1 have been provided in Technical Appendix G of the VTRA final report. A separate presentation of aggregate changes in oil outflow risk is presented in Section G-3 of that same appendix. Moreover, we have provided an augmented explanation of the VTRA analysis of incremental risk in Section AD-2 of this addendum.

In addition to providing these oil outflows by location and size, the VTRA Team went above and beyond the scope of the contract agreement with BP and coordinated with ENTRIX and the CORPS to provided these oil outflow results by persistent oil outflows (i.e. crude oil and heavy fuel) and non-persistent oil outflow (i.e. diesel fuel and refined petroleum products). Initial coordination[15] led the VTRA team to evaluate these results by their origin, i.e. whether the oil outflow originated from a BPCHPT vessel or an interacting vessel that potentially collided with the BPCHPT Vessel. In retrospect, however, we were informed by ENTRIX[16] that the origin of the oil outflow was not needed for their fates and effect analysis. Being good partners, the VTRA team provided the requested additional analysis detail in oil outflow results to further facilitate the fates and effect analysis to be conducted by ENTRIX. The VTRA team provided these results in a non-graphical format in 60 comma separated text VTRA interface files. Their content is exemplified in Table AD-2.

The VTRA team was not tasked to link their oil outflow results to potentially affected environmental resources. In fact, during the same communication[17] related to the Microsoft Excel files exemplified in Figure AD-14, it was the VTRA team who recommended to ENTRIX that: (1) ENTRIX divide the VTRA study area into a partitioning that takes environmental sensitivities into account and (2) ENTRIX use the electronic information in the VTRA interface files exemplified in Table AD-2 to aggregate oil outflow results for the sub-areas of such a partition. However, if the VTRA Team is provided with ENTRIX's sub-area partitioning of the VTRA study area, the VTRA team could further assist ENTRIX in the aggregation of grid-cell analysis results, provided the appropriate financial arrangements are in place.

This comment further asserts that no useful statistical results linked to geographic areas are available in the report. We disagree. We have provided in Technical Appendix G aggregate results presentations across the 15 different VTRA cases listed in Table AD-1 in terms of exposure (interactions), accident frequency and oil outflow by the different accident types collisions, powered grounding, drift grounding and allisions. In addition, we have provided aggregate geographic profile presentations in Technical Appendix G also in terms of exposure, accident frequency and oil outflow that contain various useful numerical analysis results relevant to the entire VTRA study area, but also relevant to the interior of two smaller red squares also identified, for example, in Figures AD-7 and AD-8 within the VTRA study area and their exterior. Section AD-2.2 in this addendum further explains how these numerical statistics included in these presentations provide for a numerical explanation of incremental risk across these three different geographic areas.

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[15]In a letter dated May 6, 2008
[16]During a meeting in Seattle dated May 13, 2008
[17] In our response dated July, 16 2008 and provided in Sub-Appendix B in this addendum.

For example, in Section AD-2.2 we demonstrated that essentially all of the increase of 49% of the annual average oil outflow, when going from VTRA Case B to VTRA Case C, occurs within the smaller red-square. Moreover, since the entire VTRA study area has a 48% increase, it was explained that a 1% decrease in overall annual average oil outflow occurs outside the larger red-square (which covers the Strait-of Juan de Fuca and the Puget Sound) when going from VTRA Case B to VTRA Case C. Without a doubt that level of geographic detail in numerical oil outflow analysis results is very useful for the comparison of VTRA Case B to VTRA Case C from an oil transportation risk perspective. We have further explained in Section AD-2.2 that the use of a common color scale in, for example, Figures AD-7 and AD-8 allow for a direct visual evaluation of the changes in oil outflow when going from VTRA Case B to VTRA Case C. Such a visual evaluation leads to the same conclusion that a predominant darkening of color (and hence increase of oil outflow) occurs within the smaller red-square when comparing Figure AD-8 (VTRA Case C) to Figure AD-7 (VTRA Case B).

With respect to the last paragraph of Comment 2, the VTRA team never suggested that ENTRIX's analysis of geographic effect to environmental resources (which is part of ENTRIX's fates and effect analysis) should only use the point estimates of the VTRA system wide risk evaluations as input (see, Figure AD-1 for an example of system wide risk in terms of oil outflow across the 15 different VTRA Case listed in Table AD-1). We would like to once again refer to the VTRA interface files that we have provided ENTRIX and of which their content is exemplified in Table AD-2. The VTRA team did however suggest[18] to ENTRIX that they use the information in the VTRA interface file to evaluate aggregate oil outflow results for a partitioning of the VTRA study area into sub-areas, where ENTRIX's partitioning should take environmental sensitivities into account. Moreover, we have suggested to ENTRIX an approach towards a fates and effect analysis using this partitioning in our complete response to them (provided in Sub-Appendix B of this addendum).

On the other hand, should ENTRIX choose to evaluate the fates and effect per grid cell, the information in the VTRA interface files also support such an analysis, since each grid cell is identified in these VTRA interface files by their latitude and longitude coordinates. We have provided the numerical oil outflow results per grid cell in term of persistent (crude oil and heavy fuel) and non-persistent oil outflow (diesel fuel and refined petroleum products) in

[18] In our response dated July, 16 2008 and provided in Sub-Appendix B in this addendum.

coordination with ENTRIX and the Corps and to further facilitate and support ENTRIX with their fates and effect analysis.

AD-6. Comment 3

3. **Sensitivity analysis is required to assess the stability of the results.** The report does not describe whether the simulation model is deterministic (i.e. the same inputs always produce the same outputs) or stochastic (i.e. it includes some random elements). It also does not include any discussion of the sensitivity of the results to variability in the primary simulation model inputs including the AIS track data, the various other traffic data sets, expert judgment, future traffic forecasts, etc.

AD-6.1. Response to Comment 3

The VTRA Team was tasked to evaluate the sensitivity of their results with respect to low, medium and high traffic scenarios. Specifically, the VTRA team was tasked to evaluate incremental oil spill risk associated with reasonably foreseeable increases in vessel traffic through calendar year 2025 to and from both wings of the Cherry Point Oil Spill Risk Assessment due to increased vessel traffic calling at Cherry Point Dock Refinery Pier. VTRA Case D, E, F, G, H and I listed in Table AD-1 evaluate the sensitivity with respect to these future traffic forecasts. To create the traffic arrival pattern for these VTRA Cases, the arrival stream of vessels of VTRA Case B were minimally modified to account for those vessel types that needed a lower or higher number of arrivals. Through a time series analysis those vessel types were identified whose annual transits remained constant over the period of the time series data. These vessels arrivals continue to follow their arrivals as in VTRA Case B. Technical Appendix F in our main report describe the construction of the various sensitivity cases with respect to low, medium and high future traffic scenarios and a further explanation is provided in our response in to Comment 8 in Section AD-11 of this addendum.

The sensitivity of the analysis results relative to high, medium and low future traffic scenarios has been reported in our main report and the results presentations in Technical Appendix G. It is important to note that for all the paired comparisons of cases with the north Wing being operational (for example, VTRA Case B) and the north wing not being operational (for example, VTRA Case C) the analysis displayed robustness throughout and favored the case with the north wing being in operation. However, even with the north wing being operational we have analyzed that oil transportation risk could increase above the levels enjoyed by VTRA Case A (the 2000 VTRA Case) as a result of traffic increases.

The maritime simulation of VTRA Case B is partly a deterministic simulation of vessel movements in its arrivals of the larger vessel types that report to the VTS, but also partly stochastic in terms of their behavior throughout the VTRA study area while adhering to established vessel traffic protocols. Technical Appendix B provides a detailed system description that was used in the construction of the VTRA maritime simulation and Technical Appendix C discusses elements of its construction in terms of traffic, but also in terms of the weather simulation modeling, current modeling. The main source for the weather modeling is hourly data from the national climatic data center which is replayed in the simulation as it occurred. Current tables for 2005 for 140 current stations were used to model the current behavior as a function of time for these 140 current stations as described in Technical Appendix C of the main report. A further explanation of the deterministic/ stochastic nature of the VTRA analysis is provided below.

Summarizing, the VTRA Team completed the sensitivity analysis relative to high, medium and low future traffic scenarios as tasked. With the appropriate financial arrangements in place the VTRA Team could continue to support ENTRIX and the CORPS with their analysis capabilities to assist in completion of additional sensitivity analysis if requested. The discussion that follows may be helpful in making such considerations and in formulating such a request.

The VTRA study team was tasked not to evaluate vessel traffic risks at locations other than those routes used by vessels traveling to and from Cherry Point. Hence, the VTRA team was specifically tasked not to evaluate sensitivity of analysis results with respect to routes that BPCHPT vessels have not traveled on in the past. The VTRA study team was tasked to investigated risks associated with the Haro Strait and Huckleberry-Saddlebag approaches to and from Cherry Point and the use of Rosario Strait and Guemes Channel instead of the Huckleberry-Saddlebag traverse. We have completed this investigation and a separate comparison presentation of VTRA Cases A, B, J and K has been provided in Technical Appendix G, Section G-9.

One full years of traffic data was collected for those vessels that report to the various vessel traffic services within the VTRA study area. The VTOS database was the main data source for this type of traffic. A total of 1834 different representative traffic routes were constructed from this data set and traffic arrivals in VTRA Case B and VTRA Case C occur in these cases as they occurred within the VTOS database (which contains a combination of

AIS and radar data of vessel movements over this year). These vessel traffic routes represented those routes that vessels of various types most commonly travel on when going from a specific A to B combination. We were not tasked to evaluate the sensitivities of the other 1834 different representative traffic routes that were constructed from the VTOS database.

VTRA Case B and VTRA Case C effectively replay the vessel traffic arrivals from the VTOS database as they occurred. However, typical vessel speeds differ from one vessel type to another within this database. From the VTOS database vessel speeds distributions were determined by vessel type and upon the arrival of a vessel its constant speed was randomly assigned from these constructed distributions by vessel type. Figure AD-15 displays the vessel speed distributions for RORO Cargo / Container Ships and the Deck Ship Cargo vessel type. Hence, RORO Cargo / Container ships typically travel at a higher speed than the Deck Ship Cargo vessels in both the VTOS database and the VTRA maritime simulation. Similar speed distributions were determined from the VTOS database for the other vessel types within the VTRA simulation.

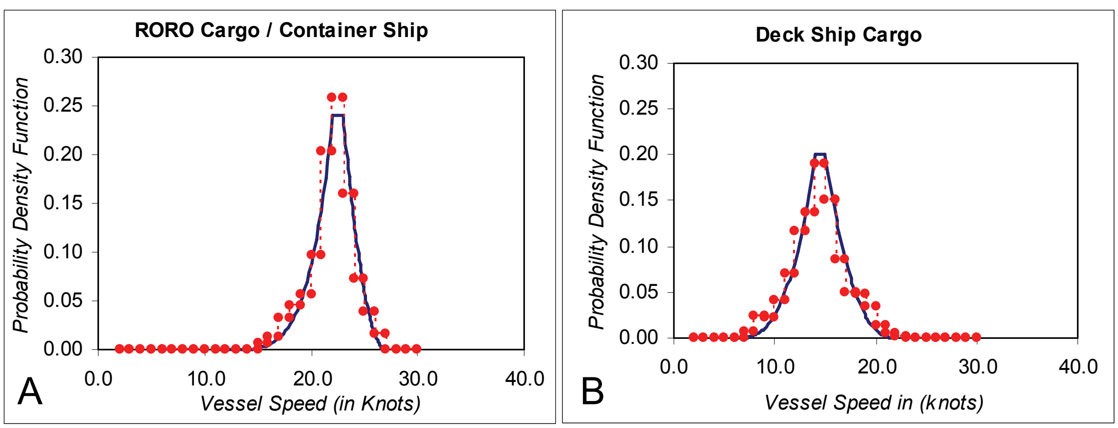

Figure AD-15. Two example speed distributions estimated from the VTOS database. The dotted lines represents the empirical PDF and the solid line is a fitted Generalized Trapezoidal Uniform PDF (see, e.g., Van Dorp et al. 2007), A: RORO Cargo / Containerships (4920 observations) B: Deck ship Cargo (7093 Observations)

Other random elements within VTRA Case B and VTRA Case C are movements of regatta events, whale watching boats and the various commercial and tribal fishery movements that are modeled within the simulation. These vessels do not report to the VTS (which was explained in Technical Appendix B of our main report) and no movement data similar to that of the VTS reporting traffic is available as described in the VTOS database. For these events only the typical number of boats and their general areas could be established as well as their port of origin from various data sources as described in Technical Appendix C of the VTRA final report. Hence, when, for example, a fishing opener occurs, boats leave their port of origin and travel via a route to their fishery location (which is defined as a collection of grid cells) and boats move randomly through this regions at their typical vessel speed (which sometimes involves following the speed of currents while they are fishing). On the other hand, for regatta events their typical routes were constructed from US Coast guard data regarding the permitting of these events.

Finally, we have applied the variance reduction technique of selecting the randseed of the pseudo random number generator in the simulation for its random elements. This technique has the distinct advantage that differences observed across simulation scenarios are not a function of the specific random number stream but rather are a results of their systemic behavior throughout the simulation. As a result different simulations runs of the same VTRA Case produce the same analysis results.

The discussion above responds to the sensitivity comments with respect to AIS track data, the various other traffic data sets and the future traffic forecasts. Below we shall respond to the comment with respect to the sensitivity to the expert judgment. Our accident data collection process[19] recorded 4 reported accidents for BPCHPT vessels (1 collision, 1 grounding and 2 allisions). This number of accidents is of the same order of magnitude as the number of accidents collected in the PWS Risk Assessment (see, e.g., Merrick et al. 2002) and the number of accidents collected in the Washington State Ferry Risk assessment (see, e.g., Van Dorp et al. 2001). Hence, similar to both these prior studies the VTRA team had to rely on expert judgment to evaluate the effect of multiple accident attributes, such as vessel type, traffic scenario, wind, visibility and current etc., on the accident probability per vessel or system interaction. Technical Appendix D in our report provides a detailed discussion of our expert judgment procedure and analysis.

A representative analysis of the uncertainty in the expert judgment has also been presented in Section D-3 of Technical Appendix D of the VTRA final report. The average posterior values of the accident parameters were used to evaluate accident probabilities in the VTRA analysis results. Thus, Technical Appendix D acknowledges the uncertainty of the expert

[19] Described in Technical Appendix A for the time period from (1995-2005)

judgment. One should bear in mind, however, that no sufficient data was available to arrive at similar detail in VTRA analysis results using only BPCHPT accident and incident data. Hence, the use of expert judgment in the VTRA study actually reduces the uncertainty of an analysis with similar detail that would have followed from a study that used only the BPCHPT vessels accident and incident data.

From the uncertainty in the expert judgment as discussed in Technical Appendix D of the VTRA final report, it immediately follows that if a higher (lower) accident probability were to have been used for an accident scenario[20] that the oil outflow results for that accident scenario would increase (decrease) by the same percentage. Hence, the acknowledgement of the uncertainty in the expert judgment in Technical Appendix D, de-facto means that the VTRA oil spill analysis are uncertain as well, as a result of that uncertainty. However, since a change in accident probability levels does not change the dynamics of the maritime transportation system and would affect all accident scenarios generated in the maritime simulation in a similar manner, a robustness can be expected in terms of the ranking of the paired comparison of the cases with the North Wing being operational (for example, VTRA Case B) and the north wing not being operational (for example, VTRA Case C) relative to the uncertainty in the expert judgment.

The VTRA team was not tasked to propagate the uncertainty in the expert judgment throughout our analysis model. A quote from "The Last Lecture" by Randy Pausch, a professor of Carnegie Mallon University, may perhaps be in order here: *"Engineering is not about perfect solutions, but is about doing the best you can with limited resources"* (Pausch and Zaslow, 2008). As stated above, we expect that VTRA case comparisons will show robustness even with expert judgment uncertainty and will be similar to that of the scenario comparisons in Merrick et al. (2006). Specifically, we believe a stochastic dominance of analysis results would follow for those VTRA Cases with the north wing being operational over those VTRA cases with the north wing not being operational, leading to the same overall analysis conclusions. That being said, only an actual propagation of expert judgment uncertainty could allow for such a conclusion. With the appropriate financial arrangements in place the VTRA team could attempt to propagate expert judgment uncertainty through their analysis results. We should caution however that the complexity of the VTRA maritime simulation is much higher than that of the analysis conducted in Merrick et al. (2006). It is quite possible that computation times alone would prevent us from being able to conduct such an uncertainty

[20]Than resulting from the average posterior accident parameters.

analysis and a project of this size should be thought of as similar or larger in size to that of the National Science Foundation project that led to the publication Merrick et al. (2006). This latter project was a joint project between VCU and GWU and covered a two-year period by itself.

AD-6. Comment 4

4. **Rectangular "Window" used to summarize change in risk is arbitrary.** The geographic profiles shown in the report include a rectangular window generally covering the San Juan Islands group, Haro Strait, Rosario Strait and the Anacortes area. The area depicted by the rectangle is held constant from one profile to the next with a statistic showing the percentage of the variable displayed by the geographic profile that occurs within the rectangle. The report does not describe the purpose of reporting statistics for the rectangular area or the basis for the specific area covered. The rectangle selected does not incorporate the specific and unique environmental habitats for which summarizing environmental risk would be useful in the EIS.

Table A-2 of Appendix A lists 10 geographic sub-regions which are named "Waters of the VTRA". At the April 4, 2008 review meeting Jason Merrick presented preliminary findings summarized by the Waters of the VTRA and indicated that the simulation results would be reported by the sub-areas which are less arbitrary that the rectangular window. (See also comment No. 19.)

AD-6.1. Response to Comment 4

The rectangular windows in Figures AD-7 and AD-8 are not "arbitrary" but were selected keeping in mind certain accident probability aspects across these regions. For example, the lower left corner of the larger rectangle commences at a point that Puget Sound Pilots board the laden inbound vessels, whereas both the upper right corners of both rectangles continue to include the Cherry Point terminal. The lower left corner of the smaller rectangle in Figured AD-7 and Figure AD-8 were chosen in such a manner such that the smaller rectangle covers the more congested waterways within the larger red rectangle. The congestion of waterways does not only have an effect on the accident probability but also on the residual speed of a tanker when potentially running aground after potential drifting has occurred.

Both the main report and Technical Appendices D and E have described the use of these smaller red rectangles in the geographic profiles to enhance understanding of the overall distribution of exposure, accident frequency and oil outflow across the VTRA study area per

VTRA case. In Section AD-2.2, we augment this explanation and have further discussed their use for VTRA Case comparisons.

All percentages across VTRA cases reported in these geographic profiles are in terms of percentages of VTRA Case B aggregate results. Hence, the percentages in the left top corner of the VTRA study area or these two smaller red rectangles allow for a direct numerical comparison of exposure, accident and oil outflow results across the VTRA cases. Indeed, in our additional explanation of the comparisons of Figures AD-7 and AD-8 in Section AD-2.2, it was concluded that of the about 48% overall increase in oil outflow going from VTRA Case C to VTRA Case B, an about 49% increase occurred within the smaller rectangle and an about 1% decrease occurred outside the larger red-square.

With respect to the comment that "the rectangle selected does not incorporate the specific and unique environmental habitats for which summarizing environmental risk would be useful in the EIS" we would like to refer back to our response to Comment 2.

With respect to the comment related to 10 geographic sub-regions in Appendix A, we note that these locations were used for data gathering and classifications purposes. Location definitions for the nine geographic location used in the expert judgment elicitation were provided in Figure D-7 of Technical Appendix D of the VTRA final report. Hence, for accident probability calculations with BPCHPT vessels (which do not cross through the San Juan Islands) these nine locations are recorded by the VTRA maritime simulation. GWU[21] was not present during the April 4th presentation and did not commit to that level of analysis detail. However, GWU, VCU and ENTRIX were all present during a meeting and a presentation made by GWU at a later date on May 13, 2008 in which it was coordinated with ENTRIX and the CORPS to provide numerical analysis detail in the format of the VTRA interface files as exemplified by Table AD-2. The detail in these analysis results allow ENTRIX to aggregate grid cell analysis results in the VTRA interface files using a partitioning of the VTRA Study area that takes environmental sensitivities into account. However, if the VTRA Team is provided with ENTRIX's sub-area partitioning of the VTRA study area, the VTRA team could further assist ENTRIX in the aggregation of grid-cell analysis results, provided the appropriate financial arrangements are in place. For a further response we would like to refer back to our response to Comment 2.

[21]GWU is the prime contractor and VCU and RPI are sub-contractors to GWU.

AD-8. Comment 5

5. **Conclusions are not adequately explained.** The conclusions section (starting on page 77) recites a number of summary statistics without explanation of the source or derivation of the statistics. If they are taken from specific geographic profiles, the specific profiles should be referenced. In addition, the conclusions are expressed inconsistently in three different terms; recurrence interval, fractional and percentage.

AD-8.1 Response to Comment 5

The statistics in the conclusions section are taken either directly from Technical Appendix G: Geographic Exposure, Accident and Oil Outflow Profiles, or through some minor additional evaluation using their results. Technical Appendix G in the VTRA final report is a compilation of the various analysis results that were generated over the course of the VTRA project. The introduction of Technical Appendix G briefly describes a roadmap for a reader to enlarge his or her understanding of the VTRA study analysis results.

We have presented risk analysis results in commonly used numerical formats in the field of risk communication such as absolute values, fractions, percentages and recurrence intervals for accidents. The VTRA team used these different terms to provide for a detailed presentation of risk. Aggregate results in the PWS study (see, e.g. Merrick et al. (2002)), the WSF Risk Assessment Study (see, e.g. Van Dorp et al. (2001)) and the San Francisco Bay Exposure Assessment (see, e.g. Merrick et al. (2003)) were presented using similar formats.

Below we shall elaborate on the source for the summary statistics and the analysis conducted to arrive at the summary statistics in the conclusions section (starting on Page 77) by there headings:

- **2005 analysis system context conclusions - north wing operational:**
  Source: Technical Appendix G, Section G-2, System context presentation.
  The summary statistic results in this section follow directly from the presentation in Section G-2 of Technical Appendix G.

- **2005 analysis aggregate VTRA study area conclusions - north wing operational:**
  Sources: 1. Technical Appendix G, Section G-3, Summary Aggregate Results Presentation.

2. Technical Appendix G, Section G-4, VTRA Case B Presentations.

Table AD-3. VTRA CASE B accident frequency summary statistics by accident type calculations for the conclusion section of the main report.

	Collisions	Powered Grounding	Drift Grounding	Allisions	All Accidents
Inside Red Square	73%	93%	92%	93%	88%
Outside Red Square	27%	7%	8%	7%	12%
Total	100%	100%	100%	100%	100%

	Collisions	Powered Grounding	Drift Grounding	Allisions	All Accidents
Inside Red Square	0.066	0.074	0.011	0.169	0.320
Outside Red Square	0.025	0.006	0.001	0.013	0.044
Total	0.091	0.079	0.012	0.182	0.364

As % of All Accidents	Collisions	Powered Grounding	Drift Grounding	Allisions	All Accidents
Inside Red Square	18.2%	20.3%	3.0%	46.5%	88.0%
Outside Red Square	6.7%	1.5%	0.3%	3.5%	12.0%
Total	25.0%	21.8%	3.2%	50.0%	100.0%

Table AD-4. VTRA CASE B oil outflow summary statistics by accident type calculations for the conclusion section of the main report.

	Collisions	Powered Grounding	Drift Grounding	Allisions	All Outflow
Inside Red Square	87%	98%	57%	100%	92%
Outside Red Square	13%	2%	43%	0%	8%
Total	100%	100%	100%	100%	100%

	Collisions	Powered Grounding	Drift Grounding	Allisions	All Outflow
Inside Red Square	40.8	85.2	3.1	1.2	130.3
Outside Red Square	6.3	2.1	2.4	0.0	10.8
Total	47.0	87.3	5.5	1.2	141.0

As % of All Outflow	Collisions	Powered Grounding	Drift Grounding	Allisions	All Outflow
Inside Red Square	28.9%	60.4%	2.2%	0.9%	92.4%
Outside Red Square	4.5%	1.5%	1.7%	0.0%	7.6%
Total	33.4%	61.9%	3.9%	0.9%	100.0%

Tables AD-3, AD-4 and AD-5 further detail the calculations that led to the summary statistics conclusions in this section on page 77 of the main report. The analysis results in the first gray row of Table AD-3 follow directly from the geographic profiles in Sections G-4.3, G-4.4, G-4.5, G-4.6 and G-4.2, respectively. The analysis results in the second gray row in Table AD-3 are read directly from Section G-3 in Technical Appendix G.

From the second row in Table AD-3 one evaluates next, for example, that collisions amount to $0.091/0.364 \approx 25\%$ of the total average annual frequency of accidents, etc. From Table AD-3 it follows, for example, that the average annual frequency of accidents inside the largest red square totals to ≈ 0.320, which amounts to 88% of the total average annual frequency of 0.364. Similarly we observe from Table AD-4 that 92% of the total average annual oil outflow of 141.0 cubic meters can be attributed to inside this largest red-square. From Table AD-5 it follows that if we add 122.1 cubic meters of persistent oil from BPCHPT vessel to 15.3 cubic meters of non-persistent oil-out flow, one arrives at a total of 137.4 cubic meters from these vessels, which amounts to 97.5% of the average 141.0 cubic meters of average annual oil outflow volume, etc. .

Table AD-5. VTRA CASE B oil outflow summary statistics by BPCHPT Vessel and Interaction Vessel (IV) calculations for the conclusion section of the main report.

	BP CHPT Persistent	BP CHPT Non-Persistent	IV Persistent	IV Non - Persistent	All Outflow
Inside Red Square	94%	80%	62%	81%	92%
Outside Red Square	6%	20%	38%	19%	8%
Total Accidents	100%	100%	100%	100%	100%

	BP CHPT Persistent	BP CHPT Non-Persistent	IV Persistent	IV Non - Persistent	All Outflow
Inside Red Square	115.2	12.3	0.6	2.1	130.3
Outside Red Square	6.9	3.0	0.4	0.5	10.8
Total	122.1	15.3	1.0	2.6	141.0

As % of All Outflow	BP CHPT Persistent	BP CHPT Non-Persistent	IV Persistent	IV Non - Persistent	All Outflow
Inside Red Square	81.7%	8.7%	0.4%	1.5%	92.4%
Outside Red Square	4.9%	2.1%	0.3%	0.3%	7.6%
Total	86.6%	10.9%	0.7%	1.8%	100.0%

- **2005 analysis conclusions inside largest rectangular area - north wing operational:**

  Sources: 1. Technical Appendix G, Section G-3, Summary Aggregate Results Presentation.

  2. Technical Appendix G, Section G-4., VTRA Case B Presentations.

Tables AD-3, AD-4 and AD-5 further detail the calculations that led to the conclusions with the section heading above. The results in the gray rows in these tables are provided in the sources in Technical Appendix G as specified above. Minor evaluations using these results yield the summary statistics in this conclusion section. For example, 73% of the total annual frequency of collisions of 0.091 inside the larger red square equals 0.066, which in turn amounts to 18.2% of the total number of accidents per year 0.364, etc.. Some minor round-off errors are present in the main report on page 78 in this section. For example, it lists on page 78 in this section an outflow of about 85.5 cubic meters for inside the largest red-square due to powered grounding, which is corrected in Table AD-4 to be 85.2 cubic meters.

- **2005 analysis conclusions outside largest rectangular area - north wing operational:**

Sources: 1. Technical Appendix G, Section G-3, Summary Aggregate Results Presentation.
2. Technical Appendix G, Section G-4., VTRA Case B Presentations.

Tables AD-3, AD-4 and AD-5 further detail the calculations that led to the conclusions with the section headings above. The results in the gray rows in these tables are provided in the sources in Technical Appendix G as specified above. Minor evaluations using these results yield the summary statistics in this conclusion section. For example, 27% of the total annual frequency of collisions of 0.091 equals 0.025, which in turn amounts to 6.7% of the total number of accidents per year 0.364, etc.. Some minor round-off errors are present in the main report on page 78 in this section. For example, it lists on page 78 in this section an outflow of about 7 cubic meters for outside the largest red-square due to collisions, which is corrected in Table AD-4 to be 6.3 cubic meters (i.e. about 6 cubic meters).

- **2000-2005 comparison derived from VTRA analysis results**

Sources: 1. Technical Appendix G, Section G-3, Summary Aggregate Results Presentation.

The conclusion in the first bullet followed directly from the VTRA maritime simulation. When comparing VTRA Case B (year 2005) to VTRA Case C (year 2005), which run the same arrivals of vessels from the VTOS database, the maritime simulation results indicated that in VTRA Case C (without the north-wing being operational) 96% of the BPCHPT vessels that were served in VTRA Case B (with the north-wing being operational), were served in VTRA Case C[22]. This reduction of 4% in VTRA Case C is a direct results of the South-wing being occupied at the time of arrival of a BPCHPT vessels and that vessel having to be delayed or diverted to one of the anchorage areas until the south-wing dock would become available (see also our response to Comment 10 below). The remainder of the conclusions follow directly form the results provided in Section G-3 of the Technical Appendix G. Table AD-6 details these summary statistics calculations.

The second bullet items states that despite serving more BPCHPT vessels in VTRA Case B, accident frequency are down 112% − 91% = 21% and down 118% − 79% = 39%[23] in outflows from VTRA Case C, where % are evaluated in terms of VTRA Case A (year 2000) absolute accident frequency and oil outflow levels.

The third bullet items states that going from VTRA Case A to VTRA Case B, accident frequency are down 100% − 91% = 9%[24] and down 100% − 79% = 21% in outflows from VTRA Case C, where % are evaluated in terms of VTRA Case A (year 2000) absolute accident frequency and outflow levels.

The fourth bullet items states that going from VTRA Case A to VTRA Case C, accident frequency are up 112% − 100% = 12% and up 118% − 100% = 18% in oil outflows from VTRA Case A, where % are evaluated in terms of VTRA Case A (year 2000) absolute accident frequency and outflow levels.

Table AD-6. VTRA CASE A, B and C accident frequency and oil outflow summary statistics calculations for the conclusion section of the main report.

	2000	2005	2005
	VTRA Case A	VTRA Case B	VTRA Case C
Accident Frequency per year	0.402	0.364	0.450
% of VTRA Case A	100%	91%	112%
	VTRA Case A	VTRA Case B	VTRA Case C
Oil Outflow (in m^3) per year	177.577	141.044	209.286
% of VTRA Case A	100%	79%	118%

[22]Page 79 reads "had restricted operations to the south wing ..." should read "had restricted operations to the north wing ..."
[23]Page 79 lists 38% due to round-off error, but should read 39%.
[24]Page 79 lists 10% due to round-off error, but should read 10%.

- **2000-2025 comparison derived from VTRA analysis results**

  Sources: 1. Technical Appendix G, Section G-3, Summary Aggregate Results Presentation.

  The conclusion in the first bullet follows directly from the aggregate results Section G-3 of the Technical Appendix G of the VTRA final report. Table AD-7 details the summary statistics calculations for the second and third bullet.

  The second bullet items states that going from VTRA Case A to VTRA Case C, the oil outflow reduced from 177.6[25] to 174.4, which are quite similar in size and only a reduction of 100% − 98.2% = 1.8%, where % are evaluated in terms of VTRA Case A (year 2000) absolute oil outflow levels.

  The second bullet items states that going from VTRA Case A to VTRA Case H, the oil outflow reduced from 177.6[26] to 229.9, an increase of 129.4% − 100% = 29.4%, where % are evaluated in terms of VTRA Case A (year 2000) absolute oil outflow levels.

Table AD-7. VTRA CASE A, F and G accident frequency and oil outflow summary statistics calculations for the conclusion section of the main report.

	2000	2025	2025
	VTRA Case A	VTRA Case F	VTRA Case H
Oil Outflow (in m^3) per year	177.6	174.4	229.9
% of VTRA Case A	100.0%	98.2%	129.4%

- **Risk intervention conclusion derived from VTRA Analysis results**

  Sources: 1. Technical Appendix G, Section G-3, Summary Aggregate Results Presentation.

  As before the numbers in the gray rows in Table AD-9 can be read directly from Section G-3 in Technical Appendix G of the VTRA final report.

  Table AD-8 further details the summary statistics calculations for the first bullet item. Most notable of the analysis in Table AD-9 is that when going from VTRA Case H (year 2025) to VTRA Case K (year 2025), which is equivalent to removing

[25] Page 79 lists 177.7 due to round-off error, but should read 177.6 cubic meters
[26] Page 79 lists 177.7 due to round-off error, but should read 177.6 cubic meters

the Saddle Bag option in 2025, the average annual accident frequency increases by 102.3% − 100% = 2.3% or about a 2% increase. Oil outflows go down by 0.2% when going from VTRA Case B to VTRA Case J, but goes up by 0.2% when going from VTRA Case H to VTRA Case K. No doubt, neither of these changes in oil outflow qualify as appreciable changes.

Table AD-8. VTRA CASE B, J, H and K accident frequency and oil outflow summary statistics calculations for the conclusion section of the main report.

	2005	2005
	VTRA Case B	VTRA Case J
Accident Frequency per year	0.364	0.364
% of VTRA Case B	100.0%	100.0%
	VTRA Case B	VTRA Case J
Oil Outflow (in m^3) per year	141.0	140.7
% of VTRA Case B	100.0%	99.8%

	2025	2025
	VTRA Case H	VTRA Case K
Accident Frequency per year	0.682	0.697
% of VTRA Case H	100.0%	102.3%
	VTRA Case H	VTRA Case K
Oil Outflow (in m^3) per year	229.9	230.2
% of VTRA Case H	100.0%	100.2%

Table AD-9 further details the summary statistics calculations for the second bullet item. For example, when going from VTRA Case B (year 2005) to VTRA Case L (year 2005), which is equivalent to adding continuous escorting in the West Strait of Juan de Fuca in 2005, the average annual accident frequency reduces by 100.0% − 98.5% = 1.5% or and oil outflow reduces by about 100.0% − 97.1% = 2.9% or about 3%. In a year 2025 comparison these percentage are given by 1% and 1.6%[27] respectively.

Table AD-10 further details the summary statistics calculations for the third bullet item. For example, when going from VTRA Case B (year 2005) to VTRA Case N (year 2005), which is equivalent to removing the NEAH Bay Tug, the average annual oil outflow from BPCHPT Vessels reduces by 100.1% − 100% = 0.1%. A similar increase in oil outflow is observed in 2025. Hence, relative to the entire VTRA study

[27]Page 80 lists 1.5% due to round-off erro, but should read 1.6%.

area no appreciable effect is observed. This partly follows from the observations that 88% of the overall accident frequency and 92% of the oil outflow potential in VTRA Case B is experienced inside the largest red square (see Tables AD-3 and AD-4). If one couples this with (1) the information that outside this red-square (which includes the Puget Sound) drift grounding only constitutes 0.3% of the overall accident potential (see Table AD-3) and 1.7% of the overall oil outflow potential and (2) with the information that the NEAH bay tug targets drifting tankers but covers of this area outside the largest red square only the entrance of the West Strait of Juan de Fuca, one arrives at the conclusion that the NEAH Bay Tug cannot have an appreciable effect on accident frequency reduction or oil outflow reduction across the VTRA Study area from BPCHPT Vessels.

Table AD-9. VTRA CASE B, L, H and M accident frequency and oil outflow summary statistics calculations for the conclusion section of the main report.

	2005	2005
	VTRA Case B	VTRA Case L
Accident Frequency per year	0.364	0.358
% of VTRA Case B	100.0%	98.5%
	VTRA Case B	VTRA Case L
Oil Outflow (in m^3) per year	141.0	136.9
% of VTRA Case B	100.0%	97.1%

	2025	2025
	VTRA Case H	VTRA Case M
Accident Frequency per year	0.682	0.675
% of VTRA Case H	100.0%	99.0%
	VTRA Case H	VTRA Case M
Oil Outflow (in m^3) per year	229.9	226.1
% of VTRA Case H	100.0%	98.4%

The fourth bullet item followed from additional sensitivity analysis that the VTRA Team performed by assuming a 100% save capability of the Neah Bay Tug, if it could get to a drifting BPCHPT Vessel in time. Even in that case, the risk reduction effect of the NEAH Bay Tug on BPCHPT Vessel relative to the overall system risk within the VTRA Study area is small. This fourth bullet items list an accident frequency reduction of 0.03% and an oil outflow reduction of 0.75%[28]. However, since BPCHPT vessel only comprise 1.1% of the total traffic picture a limited effect of the NEAH bay Tug with respect to BPCHPT vessels does not does not warrant a

[28]Which is about 44% of the 1.7% oil outflow attributed to drift grounding outside the red-square.

similar conclusion with respect to the total traffic picture (as we have explained at the end of the conclusion section of the main report of the VTRA final report).

Table AD-10. VTRA CASE B, N, H and O accident frequency and oil outflow summary statistics calculations for the conclusion section of the main report.

	2005	2005
	VTRA Case B	VTRA Case N
Accident Frequency per year	0.364	0.364
% of VTRA Case B	100.0%	100.0%
	VTRA Case B	VTRA Case N
Oil Outflow (in m^3) per year	141.0	141.2
% of VTRA Case B	100.0%	100.1%

	2025	2025
	VTRA Case H	VTRA Case O
Accident Frequency per year	0.682	0.682
% of VTRA Case H	100.0%	100.0%
	VTRA Case H	VTRA Case O
Oil Outflow (in m^3) per year	229.9	230.0
% of VTRA Case H	100.0%	100.1%

AD-9. Comment 6

6. **The report's conclusion, that risk will be reduced is not placed in a relevant context.** Risk (both accident and oil outflow) are primarily described in the report as percent change without reference to the absolute value of risk or absolute value of change in risk. Without a discussion of the actual probability of accident, the reader has no means to understand the significance of the percent change in risk that the model forecasts.

AD-9.1 Response to Comment 6

Risk is described throughout the VTRA final report in a variety of ways. We have provided a further explanation of the analysis of incremental risk in Section AD-2 of this addendum.

That being said, the VTRA report does provide through it geographic profiles in the main report and Technical Appendices D, E and G of the VTRA final report absolute references for risk in addition to the percentage change evaluations. For example, Figure 30 in the main report of the VTRA final report provides "4 accidents in 11 years of data" for VTRA Case B which is equivalent to an average return time of $11/4 \approx 2.75$ years (also indicated in Figure 30). The vertical axis of the plot and the title of the plot in the middle of Figure 30 also provides its dimension in terms of "Average numbers of accidents per year" of BPCHPT vessels. Figure 31 in the main report of the VTRA final report provides "141.0 cubic meters on average per year" due to accidents involving BPCHPT vessels for VTRA Case B. The vertical axis of the plot and the title of the plot in the middle of Figure 31 also provides its dimension in terms of "Average # of Oil Outflow (in m^3)". Percentages in the text and percentages in Figures 30 and 31 are evaluated in terms of these aggregate overall results for VTRA Case B.

Figures 32, 33, 36 and 37 in the main report of the VTRA final report that follow shortly after Figures 30 and 31 also provide the reader an evaluation of absolute risk in terms of average number of accidents per year and in terms of average oil outflow per year (in m^3). These figures, however, could have benefited from a dimension description of the vertical axis. On the other hand, the purpose of Figures 32 and 33 is primarily to describe visually the aggregate build-up of absolute accident risk and oil outflow risk by accident type across VTRA Cases A, B and C. Similarly, the purpose of Figures 36 and 37 is to provide a visual comparison of absolute aggregate risk in terms of accident frequency and oil outflow for VTRA Cases A, B, C, D, E, F, G, H and I. Despite the lack of a dimension specification for the y-axis in these figures, we believe that these figures still accomplish their purpose.

Other percentage change evaluations in the geographic profile figures throughout the main report, Technical Appendix D, E and G of the VTRA final report are evaluated with respect to VTRA Case B aggregate results, as presented in Figures 30 and Figures 31 in the main report. Hence, all consistently allow for an absolute risk evaluation in terms of annual average frequency of accidents per year, an absolute value of average oil outflow volume per year and percentage change evaluations as compared to the calibration case VTRA Case B. For example, 141% oil outflow volume in the larger red-square in Figure 35 of the main report of the VTRA final report implies an average oil outflow volume for VTRA Case C in this red-square of $\approx 141 \times 1.41 \approx 199$ (m^3). This is about 48 cubic meters more than evaluated for the entire VTRA study area in VTRA Case B. Even without this evaluation, one would imagine that a reader would appreciate the significance that this read-square alone has 141% of the oil outflow potential experienced throughout the entire VTRA study area for VTRA Case B. It is also important to note here that Section G-3 in Technical Appendix G provide for both a presentation in terms of aggregate absolute risk values and aggregate percentage changes relative to VTRA Case B.

AD-10. Comment 7

7. **Calibration of oil outflow values** - Are oil outflow losses worst case values? Were the results compared to actual losses in Puget Sound? Why are oil outflow values stated in cubic meters rather than the more common values of oil barrels or gallons used by industry and regulatory agencies?

AD-10.1 Response to Comment 7

The oil outflow analysis of the VTRA project is limited to oil outflows that follow from an accident involving a BPCHPT vessel. The VTRA maritime simulation is calibrated at the accident level to the average number of accidents per year and at the incident level at the average number of incidents per year for BPCHPT vessels. These averages were obtained after a very careful and comprehensive analysis of 1995-2005 accident and incident data. This data collection process is described in Technical Appendix A of the VTRA final report. The Section "Error-Analysis - BP Cherry Point Calling Fleet Accident and Incidents" on page A-58 in Technical Appendix A of the VTRA final report lists the data set that was distilled from this data collection process and used for calibration. At the accident level one collision, one grounding and two allisions were observed. Neither of these four accidents involving BPCHPT vessels in the calibration data set resulted in an oil outflow. Hence, if a calibration at the oil outflow level would have been conducted, the VTRA analysis would have predicted zero oil outflow since none was attributed to BPCHPT vessels accidents over the data collection period from 1995-2005. Hence, a descriptive oil outflow model was constructed to analyze average oil outflow per a potential accident to assess non-zero oil outflow levels. Technical Appendix E of the VTRA final report details the construction of this descriptive oil outflow model used in the VTRA analysis.

The Transportation Research Board (TRB) from the National Academies of Sciences (NRC, 2001) arrived at the similar conclusion that a descriptive oil outflow model is needed to evaluate the differences in tanker design performance of single hull and double hull tankers in collisions and grounding accidents. Here too, the primary reason for arriving at this conclusion is a lack of data of double hull tanker accidents. In 1995, the International Maritime Organization (IMO) developed a standard for the probabilistic comparison of tanker hull designs. However, this method of probabilistic comparison relied primarily on 100 historical collision and grounding accidents from the period 1980-1990 which involved only single hull tankers. Probability density functions (pdf) (see, Figure E-1 in Technical Appendix E of the VTRA Final Report) were created from this data set for longitudinal and transverse penetration, but neither of these probability density function were able to take into account the specifics of a particular accident scenario such as point of impact, vessel sizes, vessel speeds and their interaction angle. This lack of specificity led the Transportation Research Board to the conclusion that a different model was needed than the IMO (1995) model to evaluate and compare single and double hull tanker designs.

A study was conducted by TRB which resulted in The National Academies Special Report 259 publication (see, Figure E-2 in Technical Appendix E for the cover of this report). A total of 80,000 physical simulation accident scenarios were conducted in this study linking input parameters such as point of impact, vessel mass, vessel speed and vessel compartments to oil outflow values. These physical simulation scenarios are computationally intensive on their own and do not allow from a computational point of view for their direct integration with such tools as the VTRA maritime simulation model. However, the VTRA team was able to develop an explicit model linking the input parameters above to oil outflow values through a careful study of these 80,000 physical simulation accident scenarios via statistical data analysis techniques. The construction of this oil outflow model is described in detail in Technical Appendix E of the VTRA final report.

Tank volume data of the single hull and double hull tanker designs used in the Special Report 259 publication were provided in cubic meters, which is the primary reason that absolute average oil outflow volumes in the VTRA study are also expressed in terms of cubic meters. The following table is included to assist ENTRIX in the conversion of cubic meters to gallons or barrels.

Table AD-11. Conversion Constants for Cubic Meters (m^3) to U.S. Gallons and U.S. Barrels (Oil).

	1 Cubic Meter (m^3)
U.S. Gallons	264.172 gal
U.S. Barrels (Oil)	6.290 bbl

The impact location and damage extend in the SR 259 model and the VTRA Oil outflow model determines what tanks in the tank vessel configurations are penetrated. It is assumed in the VTRA oil outflow model that all contents of a penetrated tank is lost, which is a worst case assumption. However, one input parameter that the VTRA maritime simulation does not provide for is the actual location of impact on the struck vessel needed in this descriptive oil outflow model. Hence, the VTRA analysis evaluates the average oil outflow over 100 different impact locations across a vessel's length and averages them, for each accident scenario. Next, since multiple interactions may occur over the course of a one year simulation within a single grid cell, which covers a half a nautical mile by half a nautical mile, the VTRA analyses aggregates these average oil outflows for these grid cells taking into account the accident frequency of each scenario. Hence, the oil outflows per grid cell plotted in the VTRA geographic profiles are the annual average oil outflows per grid cell.

The VTRA interface files provided to ENTRIX and exemplified in Table AD-2 provides the latitude and longitude coordinates of each grid cell, the average annual frequency of accidents in that grid cell (averaged over the different accident scenarios that occurred in that grid cell) and the average oil outflow in that grid cell per accident (also averaged over the different accident scenarios that occurred in that grid cell). The Microsoft Excel spreadsheets in Figure AD-14 were provided to ENTRIX to enhance their understanding of the content of the VTRA interface files and to provide them with the methodology for aggregating grid cell oil outflow results for larger sub-areas (defined as a collection of grid cells).

AD-11. Comment 8

8. **Use of appropriate BP Vessel Traffic Forecast.** – The original forecast of vessels calling at Cherry Point provided by BP in response to the Corps data request was updated by BP and submitted to the Corps who subsequently transmitted it to the GWU team. Please verify that the revised forecasts were used in the simulations. Description of vessel traffic to the Cherry Point dock seems inconsistent with the revised forecast.

AD-11.1 Response to Comment 8

The revised forecasts were used in the simulations. The following is an explanation of the manner in which these forecasts were used to achieve low, medium, and high traffic scenarios in the simulation used in the analysis of VTRA Cases as described in Table AD-1.

BP provided an initial estimate of crude and product traffic levels to the Corps. This information is provided in the Table AD-12 below. While Table AD-12 does not actually directly supply the request to provide low, medium, and high scenarios of traffic levels in 2025, we chose to use the lowest numbers in this table for the low scenario, the growth based on historical demand for the medium scenario and the highest numbers in the table for the high scenario. This provides the greatest range to reflect the uncertainty about traffic levels in 2025. From this table, the low scenario would then have included 15 crude vessels and 155 product vessels, the medium scenario would have been the mid-point of the range for historical market demand or 177.5 crude vessels and 177.5 product vessels (decimals points kept for % change calculations), and the high scenario would have included 185 crude vessels and 260 product vessels. BP subsequently provided an update to the forecast in Table AD-12 based on deviations from the short-term forecasts. These revised forecasts are provided in Table AD-13 below.

The numbers for the "increased crude oil deliver by pipeline" scenario remained the same and were used for the low scenario. The "current range of operations" and the "potential future growth" scenarios were updates. The "potential future growth" scenario did not match any of the previously defined scenarios. We need three 2025 scenarios to get low, medium, and high scenarios. We used the "potential future growth" scenario numbers to replace the "growth based on high market demand" scenario numbers since BP's update justification discussed reasons for the decrease in transits and this was the only scenario that would involve a decrease. This gave us Table AD-14 that was included in Technical Appendix F of the VTRA Final report as Table F.1.

Table AD-12. Initial traffic level forecasts provided by BP

Vessel Traffic Scenario	Annual Total Vessel Range					Probability of Occurrence	
	crude vessels	product vessels		crude vessels	product vessels	within 10yrs	by 2025
Increased Crude Oil Delivery by Pipeline from Canada	170		to	220		very low	low
	15	155		20	200		
Current Range of Operations	290		to	340		low	medium
	145	145		170	170		
Growth Based On Historical Market Demand	340		to	370		medium	low
	170	170		185	185		
Growth Based On High Market Demand	370		to	410		very low	very low
	160	210		150	260		

Table AD-13. Revised traffic level forecasts provided by BP

Vessel Traffic Scenario	Annual Total Vessel Range 2006-2025				
	crude vessel %	product vessel %		crude vessel %	product vessel %
Increased Crude Oil Delivery by Pipeline from Canada	170		to	220	
	5-10	90-95		5-10	90-95
Current Range of Operations	320		to	400	
	40-50	50-60		40-50	50-60
Potential Future Growth	350		to	450	
	30-40	60-70		30-40	60-70

Table AD-14. Merged traffic level forecasts that follows from Table AD-3 and AD-4.

Vessel Traffic Scenario	Annual Total Vessel Range					Probability of Occurrence	
	crude vessels	product vessels		crude vessels	product vessels	within 10yrs	by 2025
Increased Crude Oil Delivery by Pipeline from Canada	170		to	220		very low	low
	15	155		20	200		
Current Range of Operations	320		to	400		low	medium
	150	170		180	220		
Growth Based On Historical Market Demand	340		to	370		medium	low
	170	170		185	185		
Growth Based On High Market Demand	350		to	450		very low	very low
	120	230		150	300		

With this update, we now reach the following numbers of vessels. The low scenario now includes 15 crude vessels and 155 product vessels, the medium scenario is the mid-point of the range for historical market demand or 177.5 crude vessels and 177.5 product vessels, and the high scenario is 185 crude vessels and 300 product vessels. Thus only the high scenario's number of product vessels was actually impacted by the updated information from BP.

To achieve these numbers of vessels calling at BP Cherry Point, the VTRA team minimally modified the traffic arrivals as described in the VTOS database used for the traffic arrivals of VTRA Case B and C. Separate arrival, shift frequency and route models were developed for those vessel types that needed arrival modification for future scenario development, including the traffic arrivals of BPCHPT vessels. The parameters of these models were then modified and calibrated to ensure that the correct numbers of vessel transits were observed in the simulation of the low, medium, and high future scenarios. Obviously, in the medium case, either 177 or 178 arrival calls was considered acceptable. The remaining numbers were achieved precisely. Percentage calculations of transits in Table F-3 in Technical Appendix F of the VTRA final report as deviations from the VTRA Case B number of transits were provided in the main report as an indication only. These percentages were not used in the construction of future scenarios. The actual numbers of transits as described above were used in the analysis to calibrate the future scenario VTRA Cases.

AD-12. Comment 9

9. **Page 9 and Appendix A.** The accident incident database is limited to 1995-2005. Why is earlier and later data not included? What is the basis for limiting the database to these years?

AD-12.1 Response to Comment 9

Data collection for the accident-incident database on the Puget Sound Vessel Traffic Risk Assessment project began in July 2006. Because of the lag time associated with data captured, coding and digitization, 2005 was the last calendar year for which complete accident and incident records were available. Data collection continued until June 2007; during this time, in addition to the large volume of electronic records collected, paper data records were collected from U.S. Coast Guard Headquarters. During the data collection period, it became clear that complete data records for years after 2005 would not be available in time for data collection and analysis activities to conclude. In fact, 2005 data was still be processed and entered into the source records during 2007. Inclusion of data records for selected events in 2006 and 2007 was not effected, as complete data records for a calendar year were required for inclusion in the database. Thus, 2005 was chosen as the last year during which complete accident and incident data were available for inclusion in the database. This parameter was briefed to BP, the Corps, the Coast Guard, and the Puget Sound Harbor Safety Committee during meetings and presentations in September 2006 and in February, April, June, October and December 2007.

A primary requirement with the accident incident database was to develop a set of descriptive statistics showing patterns of events, accidents and incidents in Puget Sound over a sufficiently long period of time to demonstrate data and event stability. Traditionally, a decade-long period has been used as an analysis window for accident-incident database analyses (Harrald, et al., 1998; Merrick, et al., 2000; Grabowski, et al., 2000; van Dorp et al., 2001; Merrick, et al., 2002); this period allows sufficient time preceding the base year of analysis to allow comparison of risk events, and sufficient time to allow patterns in data and event variances to stabilize. In addition, the contractors had previous experience developing and analyzing an accident-incident database for Puget Sound in an earlier time period, 1989-1999 (van Dorp, et al., 2001); the time period adopted for the earlier Puget Sound database analysis proved robust, complete and representative of events in the domain, and therefore, the 1995-2005 time period was adopted as the period of analysis.

The 1995-2005 period of analysis also permitted analysis on either side of the issue that generated the risk assessment. A question in the VTRA project was determining the incremental changes in risk associated with building the north dock at Cherry Point in 2001. Pre- and post-2001 analyses were an essential element of the VTRA study. Use of the 1995-2005 analysis period allowed equitable distribution of events and analysis for pre- and post-2001 time periods, using a complete calendar year of data records that were available at the time of data collection.

Accident and incident frequencies developed with the database analysis were input to the vessel traffic simulation. As a result, establishing a baseline year for risk analysis, and a baseline accident-incident period, were important early tasks for the contracting team. Transit data to normalize the accident and incident data were required; the transit data were also a critical input to the simulation. Thus, the 1995-2005 accident-incident database period of analysis was established early as a fundamental parameter for the VTRA simulation, and that parameter, and its associated rationale, were discussed on multiple occasions in meetings with and briefings to BP, the Corps, the Coast Guard, and the Puget Sound Harbor Safety Committee.

AD-13. Comment 10

10. **Page 11 – First bullet.** The text in the first bullet says, "If BP had restricted operations to the south wing in 2005, …" Said differently, the simulation model did not allow 4% of the vessels that actually visited at Cherry Point in 2005 to land if only the South dock had been available. What is the explanation for this conclusion?

AD-13.1 Response to Comment 10

First, it should be noted that the sentence above contains a typographical error. The text within quotation marks should refer to the north wing, not the south wing. However, even with this edit, the question above may still remain, thus we provide the following explanation.

The traffic numbers in 2005 in the VTOS database were observed in a system that included an operational north wing. There was a certain time between calls to the study area by each crude vessel and each product vessel and a pattern of shifts while within the system. While not traversing through the VTRA study area the vessels were essentially "busy" elsewhere. This overall pattern and timing is used in the arrivals of VTRA Case B, a simulation of the year 2005 with the north wing in operation.

To model VTRA Case C without the north wing being operational during 2005, one must make the following assumption: the same pattern of vessels will arrive to the VTRA study area and make shifts in the system, but none of these vessels can use the north wing. Under this assumption, each vessel will still spend the same amount of time out of the VTRA study in 2005, but while within the study area, some of the vessels will be delayed or redirected first to anchorages as the north wing is not operational. Thus some vessels will leave the system later than they actually did in 2005 with the north wing operational. This reduces the number of vessels that call at BP Cherry Point in VTRA Case C by 4% as compared to VTRA Case B.

Summarizing, using the same arrival stream of tankers in VTRA Case B and VTRA Case C the number of BPCHPT vessels that docked at the Cherry Point terminal within the VTRA maritime transportation system (MTS) simulation decreased by 4% going from VTRA Case B to VTRA Case C. This follows from BPCHPT vessels having to spend overall more time in the VTRA Case C MTS simulation than in the VTRA Case B MTS simulation. It is important to keep in mind here that the BPCHPT terminal is one component in a complex maritime transportation system that includes a one way zone and multiple anchorages that serve multiple customers. Regardless of the arrival stream of tankers that one uses to compare the one dock MTS simulation to the two dock MTS simulation, one effect of having one dock as opposed to two docks at the BPCHPT terminal is that BPCHPT vessels have to spend more time in the MTS simulation with one dock, which in turn results in a reduction of the numbers of tankers that can pass through this version of the MTS simulation per unit time.

AD-14. Response to Comment 11

11. **Page 25 – Graph and text.** The graph is not consistent with the last sentence of text above the graph.

AD-14.1 Response to Comment 11

The sentence referred to in the comment reads: "It is noteworthy that this higher number of transits is actually reached before the north wing went in to operation." The figure referred to in the comment is provided in Figure AD-16 below. The figure supplied by BP shows that the increase in crude vessel calls started around April 2000 after the merger of BP with ARCO as that is where BP placed the red line. The north wing becampe operational in September 2001. Thus the number of transits had increased before the north wing went in to operation.

AD-15. Comment 12

12. **Page 26, 38 – Consistency of Tanker Routes.** Figure 7 on page 26 and Figure 22 on Page 38 are both labeled to show the routes of Cherry Point destined traffic. The two figures appear to be inconsistent.

AD-15.1 Response to Comment 12

Figure 7 (shown below in Figure AD-17) shows routes (single transit paths from point A to point B) that either begin or end at BP Cherry Point. Figure 22 (shown below in Figure AD-18) shows movements of vessels that call at BP Cherry Point during a visit to the system. This includes transits of BPCHPT vessel that visit the Cherry Point terminal at some point during their visit (and includes transits that do not begin or end at the Cherry Point terminal specifically). Thus the reflection in Figure 22 (shown below in Figure AD-18) includes more routes than the reflection in Figure 7 (shown below in Figure AD-17).

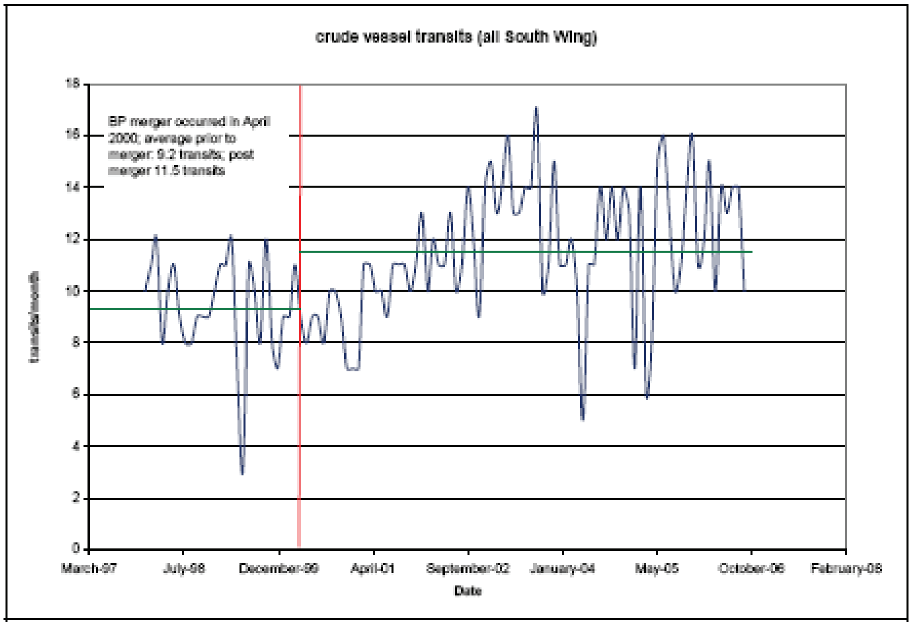

Figure 5. Crude oil tankers calling at BP Cherry Point per month.

Figure AD-16. Figure 5 included in the main report of the VTRA final report.

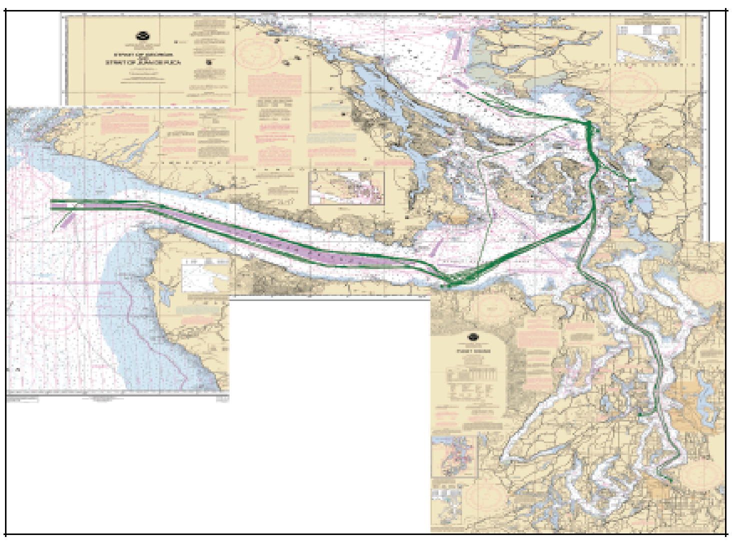

Figure 7. Representative Routes Used by Tankers Calling at BP Cherry Point.

Figure AD-17. Figure 7 included in the main report of the VTRA final report.

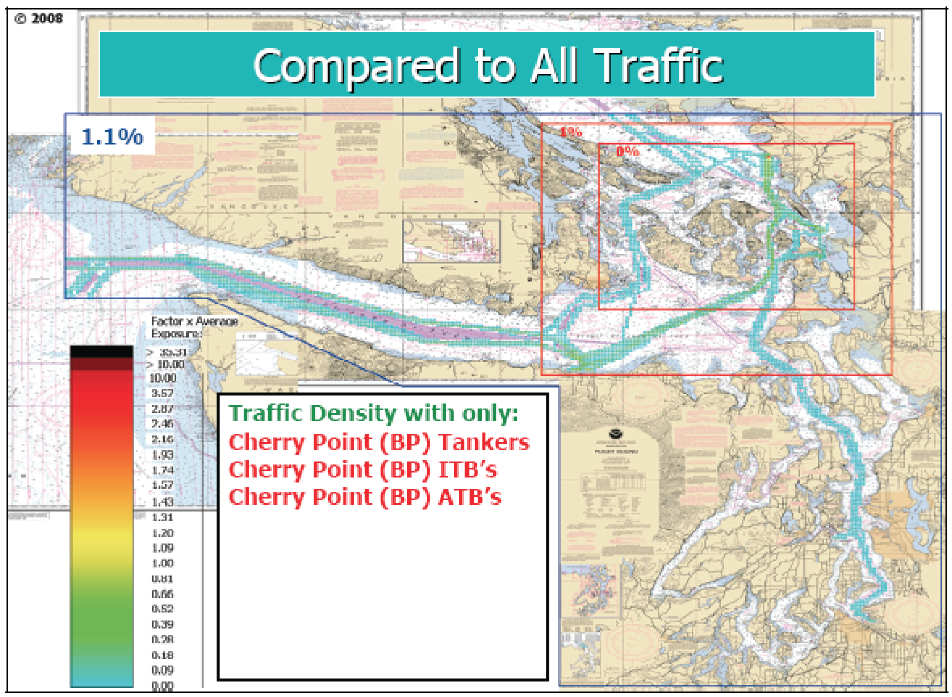

Figure 22. The density of BP Cherry Point traffic across the region.

Figure AD-18. Figure 22 included in the main report of the VTRA final report.

AD-16. Comment 13

13. **Page 39.** The term "Wind Fan" is not defined.

AD-16.1. Response to Comment 13

A weather vane, also known as a wind vane or weathercock, is a device for showing the direction of the wind. The VTRA final report mistakenly referred to wind vanes as "wind fans" which is a typographical error. Hence, throughout the VTRA report when the word "wind fan" is used, the VTRA team intended to use the wording "wind vane". For example, on page 38 of the main report of the VTRA final report we refer to seven weather stations in Figure 23 for which the VTRA team obtained hourly wind speed and direction for the year 2005. On page 39 we refer to these weather stations in Figure 23 as "wind fans". We should have referred to them as "wind vanes".

AD-17. Comment 14

14. **Page 52, 54 – Basis for 2000 Traffic.** The discussion of the methodology used to back cast the 2005 traffic forecast to create Case A is unclear. Are conclusions given regarding the difference between 2000 and 2005 crude and refined product traffic based on the pre- and post North Dock operation averages or the averages for years 2000 and 2005 respectively? Inspection of Figures 5 and 6 do not seem consistent with the discussion on page 54.

AD-17.1. Response to Comment 14

We note that the first full sentence on page 54 includes a typographical error. The word "product" should read "crude". The changed word is underlined in the revised sentence below:

"The traffic levels reflect operations in the year 2000; much of the traffic has been consistent from 2000 to 2005, but crude traffic at BP Cherry Point was 20% less in 2000 than 2005, while other tanker traffic was 23% higher in 2000."

The VTRA Case B 2005 numbers were based on actual transits in 2005 obtained from the VTOS database. VTOS data was not available for the year 2000. Aggregate counts for various types of vessels were made available by the USCG and the Marine Exchange and a time series analysis was conducted using this data as explained in Technical Appendix F of the VTRA final report. However, none of these counts were broken down to the level of crude or product tankers calling at BP Cherry Point; the nearest count was for all tank vessels. Thus we used the changes supplied by BP for before and after the north wing, namely 9.2 crude vessel visits per month before the north wing and 11.2 crude vessel visits per month thereafter. This calibration step resulted in VTRA Case A having a 20% lower level of crude traffic (in terms of transits) than VTRA Case B. It is important to recognize here that a single visit or call to the VTRA study area may result in multiple transits, where a transit within the VTRA study area is defined as a departure from a point A to a point B. The remainder of VTRA Case A arrivals were consistent with the number of visits for these vessels types provided by the USCG and Marine Exchange numbers for that year.

AD-18. Comment 15

15. **Page 56 – Labeling on Figures 32 and 33.** Figures are incomplete; units for the vertical axis of the graphs are missing.

AD-18.1. Response to Comment 15

Figure 32 shows accident potential as indicated in the figure caption. The units would be average number of accidents per year as for all other references to accident potential in the VTRA final report. Figure 33 shows oil outflow potential as indicated in the figure title. The units would be average cubic meters of oil outflow per year as for all other references to oil outflow potential in the VTRA final report.

AD-19. Comment 16

16. **Page 57 – Source for conclusions.** A number of conclusions are given in the discussion on this page. If these conclusions are based on Figure 33, no geographic context or explanation for the changes in accident potential or oil outflow are apparent. What are the explanations for the changes described in the text and the sources of these explanations?

AD-19.1. Response to Comment 16

Differences in aggregate oil outflows from VTRA Case to VTRA Case by location and size are provided in Technical Appendix G of the VTRA final report. Technical Appendix G also contains a number of geographic comparison presentations in terms of exposure, accident frequency and oil outflow. Hence, the location of these increases and decreases can be observed from these presentations. To further understand and explain the observed differences and the locations of oil outflow results in Section G-5 of Technical Appendix G (which compares VTRA Cases A, B and C) the VTRA Team conducted additional analyses by querying the simulation analyses results that led to the geographic profiles of VTRA Case A, B and C. The explanations provided on Page 57 of the VTRA main report follow from these additional analysis queries. Hence, these explanations are not based on the results on Figures 32 and 33 which display aggregate analysis results for the entire VTRA Study area.

AD-20. Comment 17

17. **Page 71, 72.** The argument given in the second paragraph concerning tug escorts is unclear and difficult to follow. i.e. "There is a larger effect on a reduction of collision potential due to the external vigilance effect as there is more collision potential that draft grounding potential". What does this sentence aim to say?

AD-20.1. Response to Comment 17

Escort tugs can save a drifting tanker and, thus, reduce the potential for drift groundings when they are escorting a vessel. However, they also serve as a source of external vigilance and so can point out navigational errors to the vessel and, thus, reduce the potential for collisions and powered groundings as well.

The discussion on page 71 and 72 concerns the effect of extending escorts through the Straits of Juan de Fuca west ward to near Buoy J. The overall estimated effect of such an extension on the potential for drift groundings is small. We attempt to explain this by pointing out that this extension will only affect the drift grounding potential in the Straits of Juan de Fuca and that drift grounding potential here is lower than elsewhere in the transit as the tanker has a longer drift time before running ashore. Thus such an extension of escorts is only affecting the relative small piece of the total drift grounding pie.

Moreover, drift groundings are only a relatively small part of total accident potential. There is a higher potential for allisions, collisions, and powered groundings. There is a higher potential for oil outflow from collisions and powered groundings. The extension of escorts does have some effect on the potential for collisions and powered groundings and their associated oil outflow. In fact, the evaluated reduction in collisions is larger than the reduction in drift groundings. As this analyzed reduction in collisions is due to the external vigilance of the tug crew, the external vigilance effect of extending escorts (reduction in collisions) is larger than the analyzed effect of tugs performing saves (reduction in drift groundings) although the latter is the main intent of adding escorts.

AD-21. Comment 18

18. <u>**Technical Appendix A, Page A-3.**</u> What is the intended purpose of the sub-areas listed in Table A-2? How are they used in the development of the data base, operation of the simulation model, reporting of the results or development of study conclusion?

AD-21.1 Response to Comment 18

Data in the accident-incident database was characterized by date, time, location, weather, vessel(s) involved, latitude, longitude, as well as other attributes; thus, analysis of events, accidents and incidents by location, as indicated by the areas defined in Table A-2 was part of the descriptive statistics developed in the database analysis reported in Technical Appendix A of the VTRA final report. Page A-38 of this Technical Appendix A reports significant trends associated with the event analysis by location undertaken using the areas outlined in Table A-2. These trends involves reported accidents and incidents of all vessels.

The simulation was calibrated at an aggregate level to accidents and incidents involving BPCHPT vessels. These incidents are further described on Page A-58 and A-59 of Technical Appendix A. The VTRA analysis results and conclusions by location and size, as described and derived from the geographic profiles, follow from the VTRA maritime risk simulation analysis results and not from the sub-areas listed in Table A-2.

AD-22. Comment 19

19. **Technical Appendix B – Figure B-1.** Should this figure also include the sub-area "San Juan Islands"?

AD-22.1. Response to Comment 19

Location definitions for the nine geographic locations that were used in the expert judgment elicitation were provided in Figure D-7 of Technical Appendix D of the VTRA final report. Hence, for accident probability calculations with BPCHPT vessels (which do not cross through the San Juan Islands) these nine locations are recorded by the VTRA maritime simulation. The San Juan Islands are surrounded by the Rosario Strait, Haro Strait - Boundary Pass, East Strait of Juan de Fuca and Cherry Point locations displayed in Figure D-7 of Technical Appendix D of the final report. BPCHPT vessels do travel through these latter location definitions.

AD-23. Comment 20

20. **Technical Appendix F –Refinery Capacity.** We are not aware that BP provided any specific refinery capacity values in response to data requests. Please provide the source or describe the derivation for the refinery capacity of 250,000 bbl/day quoted on page F-7

AD-23.1. Response to Comment 20.

The VTRA Team already responded to this comment prior to the receipt of the 23 comments collected by the CORPS in a letter dated October 1, 2008 and provided in Sub-Appendix A of this addendum. This earlier response was provided in a direct communication to BP in an e-mail dated September 19, 2008. The text of this e-mail is provided in Sub-Appendix D of this addendum. As explained in that e-mail, the information regarding a maximum refinery capacity of 250,0000 bbl/day mentioned on Page F-7 in Technical Appendix F of the VTRA final report was obtained through a personal communication with BP. That being said, it was not used to construct the future scenario VTRA Cases or anywhere else in the VTRA study and hence it does not affect the VTRA analysis results.

AD-24. Comment 21

21. **Technical Appendix F- Table F-2** – How were the values included in this table derived? Please provide the reference to the source information.

AD-24.1. Response to Comment 21

These construction of this table is discussed in our response to Comment 8, Section AD-11.

AD-25. Comment 22

22. **Map presentations are difficult to read and interpret.** The geographic profiles used to present simulation results are difficult to read and interpret. As a report associated with and supporting the EIS, effective communication of these graphics is of significance importance.
    a. **Size and Scale** – The maps are small (8.5 x 11) and of low resolution making them difficult to read and interpret. The graphics shown starting on page 65 of the draft report and in the appendices are of inadequate scale to show meaningful results.
    b. **Color Scale** – Continuous gradient color scale makes interpretation of map information very difficult. Both the orange-red and green-blue ranges are so broad that interpreting the value of an individual grid cell or group of cells with any precession is difficult and may result in an error of as much as an order of magnitude.
    c. **Sub-area Statistics** – The explanation for the information contained on the geographic profiles given on page 58 does not include a description of the sub-areas for which statistics are reported or the basis for defining the sub-areas.
    d. **Labeling and Notations** – Labels and other notations are incomplete and/or confusing.

AD-25.1. Response to Comment 22

The geographic profile format of our analysis results and their rational were presented on multiple occasions in meetings with and briefings to BP, ENTRIX, the Corps, the Coast Guard, and the Puget Sound Harbor Safety Committee. Each of these meetings involved a discussion regarding their format and provided the audience the opportunity to provide feedback regarding their format. The first exposure geographic profile was provided to ENTRIX on August 17, 2007 and presented to the Puget Sound Harbor Safety Committee meeting in October, 2007. Since then every two months the updated format of the geographic profiles was updated and presented to Puget Sound Harbor Safety committee with finally an accident frequency geographic profile presentation and their format being presented to BP, ENTRIX, the Corps in February, 2008. The rationale behind the development of the geographic profile method of displaying risk was also presented during this Puget Sound Harbor Safety committee meeting at which ENTRIX, the Corps and BP were present.

In April 2008, the first oil outflow geographic profiles were presented to the Puget Sound Harbor Safety Committee, ENTRIX, BP and the Corps. In May 2008, all three geographic profile formats were presented at the National Harbor Safety Conference held in Seattle as well. Over the course of these presentations, spanning a period of nine months, feedback regarding the use of only a singular rectangular window in early geographic profiles led to the use of two rectangular windows in the geographic profile presentations. Feedback regarding the solid black color used at the upper part of the color scale in the early geographic profiles format led to a further refinement of the color scale in its upper ranges. In Section AD-2 of this appendix we have provided an additional explanation of the use of geographic profiles to supplement the explanation already provided during the presentations mentioned above and their descriptions in the VTRA final report and its Technical Appendices.

We have addressed in our response to Comment 1 of this addendum the concern regarding size and scale of these figures. The VTRA Team shall provide with this addendum our larger resolution bitmap files of the geographic profiles that were used to develop the presentations of Technical Appendix G of the VTRA final report. These larger bitmaps files allow ENTRIX to reproduce these graphics at a higher graphical resolution. Section AD-2 explains that the color scale does not serve the purpose of providing a reader with the numerical value of an individual grid cell or group of grid cells, but rather provide the reader with a visual assessment of the distribution of exposure, accident frequency and oil outflow across the VTRA study area. In our response to Comment 4, we have explained the rationale behind the rectangular "windows" included in the geographic profiles. Section AD-2 provides an additional explanation regarding their use and Section AD-2 also further explains the labeling and notations used in the geographic profile presentations. All percentages in the geographic profiles are evaluated relative to the aggregate results of VTRA Case B. Hence, the absolute values of these percentages allow for a direct comparison of exposure, accident and oil outflow risk across all VTRA Cases in Table AD-1 not only for the entire VTRA study area, but also for the two smaller rectangular areas included in these geographic profiles of the VTRA analysis results.

Finally, as explained in our response to Comment 1, we have provided ENTRIX with numerical grid cell analysis result which we refer to in our response to Comment 1 as the VTRA interface files. The numerical format of the VTRA interface files were coordinated with ENTRIX and the CORPS, and ENTRIX has demonstrated the ability to represent the information contained within the VTRA interface files in a Geographic Information System (GIS) platform of their choosing, using a geographic format of their choosing and a color scale of their choosing. With the appropriate financial arrangements in place, and with a more specific direction from ENTRIX on how they would like to change the geographic profile presentations, the VTRA team could further assist ENTRIX to enhance the VTRA geographic profile presentations. However, the additional explanation provided in Section AD-2 of this addendum should further facilitate their interpretation and the communication of the risk information imbedded in the VTRA geographic profile presentations.

AD-26. Comment 23

23. **Graphs** – The graphs overlain on individual geographic profiles include information that is not part of the geographic profile and is not referenced or described.

AD-26. Response to Comment 23

The graphs referred to in this comments are an integral part of the geographic profiles. Not only provide these graphs the absolute value of the total average accident frequency per year and total average oil outflow volume per year, they also provide information regarding the progression of these aggregate values over those grid cells that do have the potential for oil outflow or accidents. Moreover, these plots provide for a direct comparison of different VTRA Cases. For example, the geographic profiles for VTRA Case A include in their plots the cumulative curves for VTRA Case B and VTRA Case C. Hence, these curves provide an immediate visual comparison across particular VTRA Cases not only in terms of the absolute aggregate value of risk, but also in terms of its cumulative progression. It is quite noteworthy that neither of the curves of different VTRA cases in these plots cross[29] and hence the ordering amongst VTRA Cases not only apply to the aggregate value, but also in terms of a percentage of grid cells that experience the highest accident frequencies or oil outflows, regardless of the specific percentage (for all percentages).

In Section AD-2 of this addendum we have expanded upon the explanation of the geographic profile risk presentation beyond what was already provided in the VTRA Final Report and we explain how the VTRA team have evolved their manner of presentation of

[29]Although some plots are drawn nearly drawn on top of one another when only small differences are observed. This is for example the case when comparing VTRA Case B to VTRA Case J.

risk by location and size over the course of their prior maritime risk projects ultimately leading to their geographic profile presentation by location and size used in this project, but previously used within the San Francisco Bay Exposure Assessment project (see, e.g., Merrick et. al (2003)). Section AD-2 exemplifies the additional conclusions that can be drawn from this geographic profile format by taking advantage of both the red rectangular window information provided in these profiles, but also the plot information provided in these geographic profiles.

AD-27. Corrections of other clerical errors in the VTRA Final Report

The following first paragraph after the Section 4.2 heading on Page 44 in the VTRA Final Report[30];

Incidents are the events that immediately precede the accident. The types modeled include total propulsion losses, total steering losses, loss of navigational aids, and human errors. The impact of each of these types of triggering events on the occurrence of accidents is estimated by examining the records of each accident that occurs inside the study's geographic scope. An exhaustive analysis of all possible sources of relevant accident, near miss, incident, and unusual event data was performed. The tanker fleet calling at BP Cherry Point has experienced ***xx propulsion failures, xx steering failures, and xx navigational aid failures*** *while within the study area over the 11 year period from 1995 to 2005. The ATB and ITB fleet that call at BP Cherry Point have not been operating for as long as the tankers, just 7.5 years. Over this period they have experienced* ***34 propulsion losses, 13 steering losses, and 12 navigational aid failures*** *while within the study area. These counts are used to find the probability of a propulsion failure, steering loss, or navigational aid failure during each interaction that is counted in the simulation.*

should read:

Incidents are the events that immediately precede the accident. The types modeled include total propulsion losses, total steering losses, loss of navigational aids, and human errors. The impact of each of these types of triggering events on the occurrence of accidents is estimated by examining the records of each accident that occurs inside the study's geographic scope. An exhaustive analysis of all possible sources of relevant accident, near miss, incident, and unusual event data was performed. The tanker fleet calling at BP Cherry Point has experienced ***31 propulsion failures, 11 steering failures, and 10 navigational aid failures*** *while within the study area over the 11 year period from 1995 to 2005. The ATB and ITB fleet that call at BP Cherry Point have not been operating for as long as the tankers, just 7.5 years. Over this period they have*

[30]For additional clarity the changed sentence sections are indicated in Bold Italic Font.

experienced ***3 propulsion losses, 2 steering losses, and 2 navigational aid failures*** *while within the study area. These counts are used to find the probability of a propulsion failure, steering loss, or navigational aid failure during each interaction that is counted in the simulation.*

For a more detailed description of the incidents above please see pages A-58 and A-59 of Technical Appendix A of the VTRA final report.

References

J.R.W. Merrick, J. R. van Dorp, T. Mazzuchi, J. Harrald, J. Spahn and M. Grabowski (2002). "The Prince William Sound Risk Assessment". Interfaces, Vol. 32 (6): pp.25-40.

J.R.W. Merrick, J.R. van Dorp, J.P. Blackford, G.L. Shaw, T.A. Mazzuchi and J.R. Harrald (2003). "A Traffic Density Analysis of Proposed Ferry Service Expansion in San Francisco Bay Using a Maritime Simulation Model", Reliability Engineering and System Safety, Vol. 81 (2): pp. 119-132.

Randy Pausch and Jeffrey Zaslow (2008). The Last Lecture, Hyperion, New York, NY.

Merrick, J. R. W. and J. R. van Dorp (2006). "Speaking the Truth in Maritime Risk Assessment". Risk Analysis, Vol. 26 (1), pp. 223 - 237.

National Research Council (2001). "Environmental Performance of Tanker Designs in Collision and Grounding", Special Report 259, Marine Board, Transportation Research Board, The National Academies.

P. Szwed, J. R. van Dorp, J.R.W.Merrick, T.A. Mazzuchi and A. Singh (2006). "A Bayesian Paired Comparison Approach for Relative Accident Probability Assessment with Covariate Information", European Journal of Operations Research, Vol. 169 (1), pp. 157-177.

J. R. van Dorp, S. C. Rambaud, J. G. Pérez, and R. H. Pleguezuelo (2007). "An Elicitation Procedure for the Generalized Trapezoidal Distribution with a Uniform Central Stage", Decision Analysis Journal, Vol. 4, pp. 156 - 166

J.R. van Dorp, J.R.W. Merrick , J.R. Harrald, T.A. Mazzuchi, and M. Grabowski (2001). "A Risk Management procedure for the Washington State Ferries", Journal of Risk Analysis, Vol. 21 (1): pp. 127-142.

SUB-APPENDIX A:

October 1, 2008 Letter from the Army Corps of Engineers with attached 23 comments prepared by ENTRIX.

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

OCT - 1 2008

Regulatory Branch

Dr. John R. Harrald, Director
Institute for Crisis, Disaster, and Risk Management
The George Washington University
1776 G Street, NW, Suite 101
Washington, DC 20052

Reference: BP Environmental Impact Statement
(NWS-1992-00345)
Vessel Traffic Risk Assessment Draft Report

Dear Dr. Harrald:

This letter provides the U.S. Corps of Engineers' comments on the draft Vessel Traffic Risk Assessment Draft Report (VTRA), dated July 31, 2008.

The enclosed Memorandum for Record (MFR) contains the combined comments from U.S. Coast Guard (USCG), BP, Entrix and U.S. Corps of Engineers (Corps).

Since the VTRA Study is an important element of the Environmental Impact Statement (EIS) and the settlement agreement, the Corps, as lead federal agency, requests a meeting with the VTRA Study Team to discuss our comments and to reach an agreement on how the VTRA study and report can be modified to support the EIS. We would like to meet with the Study Team as soon as possible, either in October or early November 2008. BP is aware of this request and travel funding will be provided.

Copies of this letter with the MFR will be furnished to LCDR Diana J. Wickman, Chief, Waterways Management Division, U.S. Coast Guard Sector Seattle, 1519 Alaskan Way South Seattle, WA 98134-1192 and Scott McCreery, Environmental Manager, Dock EIS BP Cherry Point Refinery,4519 Grandview Road, Blaine, WA 98230. Please contact me to schedule our meeting or if you have any questions, at (206) 764-6960 or via email at olivia.h.romano@usace.army.mil.

Sincerely,

Jeffrey F. Dillon,
Chief, North Puget Sound Section

Enclosure

CENWS-OD-RG

US Army Corps of Engineers
Seattle District

MEMORANDUM FOR RECORD

Date: September 26, 2008

RE: Comments on the Draft VTRA Report

Prepared by ENTRIX, Inc for the U.S. Army Corps of Engineers, U.S. Coast Guard, and BP Cherry Point Refinery.

Comments are divided into three sections; 1) general comments on the approach and characterization of the results, 2) detailed comments on specific elements of the draft report and 3) comments on presentation graphics.

GENERAL COMMENTS

1. **The study results incompletely describe the incremental risk of accident and oil outflow.** The scope of work listed on pages 21 and 22 note that the study is to determine incremental risk and to describe changes in risk geographically. The report results include a number of "Geographic Profiles", however each of these profiles is for a single case (year). the report does not include any mapped displays or outputs showing the differences in risk between cases (for example the change in risk from Case B – 2005 with North Wing and Case C - without North Wing). Since the underlying simulation model output is geographic based, the study team should be able to simply subtract Case B from Case C using a GIS system and produce the desired result.

   Since none of the geographic profiles show the difference in risk of accident or oil outflow, geographically the reader must view two profiles and interpret the pattern difference visually. Such comparisons are difficult on three counts; 1) in the Draft Report the profiles for Case B and Case C are shown on the front and back of one page making direct comparison impossible, 2) the displays are at a small scale making interpretation difficult and 3) the displays have been normalized making direct reading of results impossible.

2. **Conclusions based on average point estimates over the study area do not adequately link change in risk to affected resources.** The purpose of the VTRA in the context of the Environmental Impact Statement is to determine the change in "environment risk" that results from operation of the Cherry Point Dock North Wing. Thus changes in the risk of accident and oil outflow derived

by the VTRA simulation model must be directly linked to potentially affected environmental resources which vary significantly throughout the study area.

The simulation model results displayed as geographic profiles do show the probability of accident and oil outflow geographically. However these displays only offer the reader a general impression of the geographic context of the results (see further discussion below). No useful statistical results linked to geographic areas are available in the report.

The report states that "Quantitative results in our study are presented as average point estimates commonly used for the evaluation of alternatives in a decision analysis context" (page 81). The purpose of the VTRA is to support an environmental impact analysis of the incremental difference in environmental risk, not a decision analysis of alternatives. Please explain how average single point estimates are to be used to evaluate variable geographic effects to environmental resources.

3. **Sensitivity analysis is required to assess the stability of the results.** The report does not describe whether the simulation model is deterministic (i.e. the same inputs always produce the same outputs) or stochastic (i.e. it includes some random elements). It also does not include any discussion of the sensitivity of the results to variability in the primary simulation model inputs including the AIS track data, the various other traffic data sets, expert judgment, future traffic forecasts, etc.

4. **Rectangular "Window" used to summarize change in risk is arbitrary.** The geographic profiles shown in the report include a rectangular window generally covering the San Juan Islands group, Haro Strait, Rosario Strait and the Anacortes area. The area depicted by the rectangle is held constant from one profile to the next with a statistic showing the percentage of the variable displayed by the geographic profile that occurs within the rectangle. The report does not describe the purpose of reporting statistics for the rectangular area or the basis for the specific area covered. The rectangle selected does not incorporate the specific and unique environmental habitats for which summarizing environmental risk would be useful in the EIS.

   Table A-2 of Appendix A lists 10 geographic sub-regions which are named "Waters of the VTRA". At the April 4, 2008 review meeting Jason Merrick presented preliminary findings summarized by the Waters of the VTRA and indicated that the simulation results would be reported by the sub-areas which are less arbitrary that the rectangular window. (See also comment No. 19.)

5. **Conclusions are not adequately explained.** The conclusions section (starting on page 77) recites a number of summary statistics without explanation of the

source or derivation of the statistics. If they are taken from specific geographic profiles, the specific profiles should be referenced. In addition, the conclusions are expressed inconsistently in three different terms; recurrence interval, fractional and percentage.

6. **The report's conclusion, that risk will be reduced is not placed in a relevant context.** Risk (both accident and oil outflow) are primarily described in the report as percent change without reference to the absolute value of risk or absolute value of change in risk. Without a discussion of the actual probability of accident, the reader has no means to understand the significance of the percent change in risk that the model forecasts.

7. **Calibration of oil outflow values** - Are oil outflow losses worst case values? Were the results compared to actual losses in Puget Sound? Why are oil outflow values stated in cubic meters rather than the more common values of oil barrels or gallons used by industry and regulatory agencies?

8. **Use of appropriate BP Vessel Traffic Forecast.** – The original forecast of vessels calling at Cherry Point provided by BP in response to the Corps data request was updated by BP and submitted to the Corps who subsequently transmitted it to the GWU team. Please verify that the revised forecasts were used in the simulations. Description of vessel traffic to the Cherry Point dock seems inconsistent with the revised forecast.

DETAILED COMMENTS

9. **Page 9 and Appendix A.** The accident incident database is limited to 1995-2005. Why is earlier and later data not included? What is the basis for limiting the database to these years?

10. **Page 11 – First bullet.** The text in the first bullet says, "If BP had restricted operations to the south wing in 2005, …" Said differently, the simulation model did not allow 4% of the vessels that actually visited at Cherry Point in 2005 to land if only the South dock had been available. What is the explanation for this conclusion?

11. **Page 25 – Graph and text.** The graph is not consistent with the last sentence of text above the graph.

12. **Page 26, 38 – Consistency of Tanker Routes.** Figure 7 on page 26 and Figure 22 on Page 38 are both labeled to show the routes of Cherry Point destined traffic. The two figures appear to be inconsistent.

13. **Page 39.** The term "Wind Fan" is not defined.

14. **Page 52, 54 – Basis for 2000 Traffic.** The discussion of the methodology used to back cast the 2005 traffic forecast to create Case A is unclear. Are conclusions given regarding the difference between 2000 and 2005 crude and refined product traffic based on the pre- and post North Dock operation averages or the averages for years 2000 and 2005 respectively? Inspection of Figures 5 and 6 do not seem consistent with the discussion on page 54.

15. **Page 56 – Labeling on Figures 32 and 33.** Figures are incomplete; units for the vertical axis of the graphs are missing.

16. **Page 57 – Source for conclusions.** A number of conclusions are given in the discussion on this page. If these conclusions are based on Figure 33, no geographic context or explanation for the changes in accident potential or oil outflow are apparent. What are the explanations for the changes described in the text and the sources of these explanations?

17. **Page 71, 72.** The argument given in the second paragraph concerning tug escorts is unclear and difficult to follow. i.e. "There is a larger effect on a reduction of collision potential due to the external vigilance effect as there is more collision potential that draft grounding potential". What does this sentence aim to say?

18. **Technical Appendix A, Page A-3.** What is the intended purpose of the sub-areas listed in Table A-2? How are they used in the development of the data base, operation of the simulation model, reporting of the results or development of study conclusion?

19. **Technical Appendix B – Figure B-1.** Should this figure also include the sub-area "San Juan Islands"?

20. **Technical Appendix F –Refinery Capacity.** We are not aware that BP provided any specific refinery capacity values in response to data requests. Please provide the source or describe the derivation for the refinery capacity of 250,000 bbl/day quoted on page F-7

21. **Technical Appendix F- Table F-2** – How were the values included in this table derived? Please provide the reference to the source information.

PRESENTATION COMMENTS

22. **Map presentations are difficult to read and interpret.** The geographic profiles used to present simulation results are difficult to read and interpret. As a report associated with and supporting the EIS, effective communication of these graphics is of significance importance.

a. **Size and Scale** – The maps are small (8.5 x 11) and of low resolution making them difficult to read and interpret. The graphics shown starting on page 65 of the draft report and in the appendices are of inadequate scale to show meaningful results.
b. **Color Scale** – Continuous gradient color scale makes interpretation of map information very difficult. Both the orange-red and green-blue ranges are so broad that interpreting the value of an individual grid cell or group of cells with any precession is difficult and may result in an error of as much as an order of magnitude.
c. **Sub-area Statistics** – The explanation for the information contained on the geographic profiles given on page 58 does not include a description of the sub-areas for which statistics are reported or the basis for defining the sub-areas.
d. **Labeling and Notations** – Labels and other notations are incomplete and/or confusing.

23. **Graphs** – The graphs overlain on individual geographic profiles include information that is not part of the geographic profile and is not referenced or described.

SUB-APPENDIX B:

July 16, 2008 E-mail from VTRA TEAM to ENTRIX in response to their E-mail dated July 7, 2008.

AD-B.1. VTRA Team e-mail text dated July 16, 2008.

John:

In response to your e-mail and to make sure there is no misunderstanding about the content of electronic interface files that we have provided you, we have prepared four spreadsheets for you from these files with a comparison of VTRA Cases A, B and C by accident type. In addition, to assist you with your fates and effects analysis we have prepared a Microsoft Power Presentation of aggregate results using the geographic profiles of the VTRA Cases A, B and C. By flipping back and forth between the profiles of two cases on can observe the migration and changes in accident frequency or oil outflow since the profiles of like geographic profiles are drawn with the same color scale.

You can download these Excel Spreadsheets and Powerpoint presentations from:
http://www.seas.gwu.edu/~dorpjr/downloadENTRIX_MENU_071608.html

To further assist you with your fates and effect analysis, we shall also provide you with similar powerpoint presentation for other relevant comparisons of VTRA cases by the anticipated delivery date of our draft final report of 7/31/08.

We have looked at the GIS plots that you have provided us. We have some concerns with respect to the comparisons that you make using the electronic files that we have provided you. These concerns are explained more fully in the attached word document. In the attachment, we have suggested two alternative approaches that one could take to conduct a fates and effect analysis using the electronic files that we have provided.

We ask that any additional questions will be held in obeyance until our final draft VTRA report is finished. We hope that this reponse will provide with the insight that you are seeking for your study.

Best, Rene van Dorp
--
Johan Rene van Dorp - Associate Professor
http://www.seas.gwu.edu/~dorpjr/
Engineering Management and Systems Engineering Department
School of Engineering and Applied Science
The George Washington University
(P) 202-994-6638 (F) 202-994-0245

AD-B.2. Content VTRA Team MS Word attachment to e-mail dated July 16, 2008.

John,

1. This e-mail is in response to your e-mail dated: 7/7/08. Just to make sure there is no misunderstanding about the content of electronic interface files that we have provided you, we have prepared four spreadsheets from these files with a comparison of VTRA Case A, B and C by accident type. As you are aware (and per

your request during our May 13th meeting in Seattle), your fates and effects files contain for each grid cell the average annual accident frequency by accident type and for each accident type the average oil outflow of persistent oil and non-persistent oil. We are providing, as per our May 6th letter, additional detail by providing geographic profiles detailing persistent and non-persistent oil outflow by BPCHPT vessel and by interacting vessels that potentially collide with a BPCHPT Vessel.

2. The attached spreadsheets illustrates how you can evaluate the overall accident frequency by accident type for the entire VTRA study area and the overall average oil outflow for the entire VTRA study area per VTRA case by accident type.
3. Following a similar procedure one could also evaluate for a subsection of the VTRA study area the average annual frequency per subsection by accident type and the average oil outflow per subsection by accident type.
4. Comparisons between VTRA cases by subsection should be based on an evaluation of average oil flows that follow by multiplying per grid cell the average accident frequency by accident type and the average oil outflow per accident and summing these values over the grid cells within such a subsection. Comparisons between VTRA cases per subsection should not be based on the average oil outflow per accident since this would complete ignore the average annual frequency of accidents in this subsection.
5. We will compare VTRA cases by aggregate results for the entire VTRA study area and we use our geographic profiles to further understand possible increases or migration of by accident frequency and by oil outflow. To further assist you with your fates and effects analysis we have prepared a Microsoft Power Presentation of aggregate results using the geographic profiles of the VTRA Cases A, B and C. By flipping back and forth between the profiles of two cases on can observe the migration and changes in accident frequency or oil outflow since the profiles of like geographic profiles are drawn with the same color scale. The color scales for all our Case by Case comparisons are set by the calibration case VTRA Case B. You can download the excel spreadsheet that we prepared and mentioned under bullet 1 and the comparison presentation of VTRA Case A-B-C from: http://www.seas.gwu.edu/~dorpjr/downloadENTRIX_MENU_071608.html
6. To further assist you with your fates and effects analysis we will provide similar comparisons Microsoft PowerPoint presentations for: A-B-C, B-D-E, B-F-G, B-H-I, B-J-H-K, B-L-H-M and finally B-N-H-O. These presentations are compiled from all the most recent geographic profiles that have already been available for downloading

from the following link:
http://www.seas.gwu.edu/~dorpjr/downloadENTRIX_MENU_061608.html.

7. The remaining presentations under bullet item 6 will be available as Appendix G of our draft final report that we anticipate to submit on 7/31/08 together with a system context presentation, an overview presentation providing aggregate results by case in terms of exposure, accident frequency and overall outflow and finally a detailed presentation of the calibration case VTRA Case B.

8. We have worked with you since our May 13th meeting to make sure that you are able to plot the results of the electronic fates and effects files in a GIS system as per your choosing. While we have expressed concern about the reproduction of our results on a map using a different color scale than the one we use (as per our e-mail to you date on : INSERT DATE[31]), we understand it is important that you have this capability for the type of partitioning of the VTRA Study area as described under bullet 3.

9. One approach to use of the information in the electronic interface files that we have provided your for a fates and effect analysis is as follows: First use the accident frequencies per grid cell to probabilistically sample one grid cell for the location of an accident and next look up the average oil flow for that accident in that grid cell. Next, perform a fates and effect analysis for that sampled average oil outflow for that accident in that grid cell. Executing this procedure for a large enough sample and next aggregating these fates and effect results for the entire study area would provide the average fates and effects results for a certain VTRA case. Next, one could compare the average fates and effects of one VTRA case to another in this manner.

10. In the event that the above approach is too computationally intensive, one alternative approach could be to first partition the VTRA study area in subsections (as collections of grid cells). Next, evaluate as per bullet item 3 the average accident frequency by subsection and evaluate the average oil outflow per subsection as per bullet item 3. Next, one should evaluate a fates and effect analysis by subsection by sampling an accident location in a subsection and next evaluate the fates and effect analysis using the average oil outflow per accident for that subsection. Aggregating the fates and effects results for all samples generated in this manner provides an approximation of the average fates and effects for one VTRA Case. As before, one could compare the average fates and effects of one VTRA Case to another in this manner.

[31]The date of that e-mail was May 8, 2008.

11. We would like to offer the following observations with respect to the plots that you have generated thus far from the electronic files that we have provided you:

a) As we have pointed out to you before, VTRA cases comparisons should not be based on a grid cell by grid comparison, but by larger subsections. Our comparisons are conducted over the entire study area and the geographic profiles are only used to observe patterns of changes and general tendencies of migration of results from one area to another.

b) A comparison from VTRA case by VTRA case by grid cell is not a meaningful use of our electronic results. When going from VTRA case to VTRA case there could be a natural fluctuation in either average accident frequency or average oil outflow from grid cell to grid cell to the extend that no apparent pattern may emerge when producing the Case by Case difference plots that you have. One could see increases in one grid cell and decreases immediately adjacent to it. Indeed, even though we have over 60000 vessel to vessel interactions for the calibration VTRA Case B, on average we have 18 interactions per grid cell for collisions over the year. Hence, on average this is too small of a number and a natural fluctuation per grid cell will occur from VTRA Case to VTRA Case. This effect will be more pronounced in grid cells that have fewer interactions. Overall, these changes are a natural result of the dynamic nature of the VTRA maritime transportation area.

c) This fluctuation effect will be further exacerbated in difference plots of average oil outflow per accident per grid cell (which you may have done) since one naturally observes a larger fluctuation in oil outflows per accident (which does not take the accident frequency into account) than in expected oil outflows (which does take the accident frequency into account by multiplying it with the oil outflow per accident).

d) It is important to emphasize that difference plots of average oil outflow per accident over a larger subsection would also ignores the average probability of an accident in such a subsection as stated in bullet item 4. Naturally, the average probability of an accident per subsection should be taken into account when making VTRA Case by VTRA Case comparisons.

e) We would like to reiterate our concern about a reproduction of our analysis results on a map using a different coloring scale than we have used in our geographic profiles. Our color scales are non-linear and have been designed with a risk perception in mind. A coarse color scale with only nine colors at arbitrary selected thresholds (as you have in your plots) rather than a more continuous changing scale of color (as we have in our geographic profiles) may over-emphasize the difference from one grid cell to another. For example, a red cell and a light brown or dark brown cell adjacent to one another may have in fact a very small difference in oil outflow from adjacent cell to cell, but one happens to be red because it is above the threshold and the other is light brown because it is below the threshold. However, the difference in color between the red color and the light or dark brown colors may from a perception perspective suggest in fact the largest change in the red cell, even though the darkest brown cell indicates by your coarse color scale design the largest difference.

f) We have spend quite a bit of time over the course on the development of our geographic profiles methodology on the construction of a refined color scale that shows subtle changes from grid cell to grid cell when comparing VTRA Case to VTRA Case. We understand that the plots that ENTRIX have produced from our electronic results are for their internal use and are to assist them in the definition of a partitioning of the VTRA study area into subsections as explained under bullet item 3. Naturally, such a partitioning should not only follow from the electronic results that we have provided but also take into account the various geographic sensitivities over the VTRA study area from a fates and effects perspective.

12. We would be happy to answer any questions you have regarding this response after 7/31/08 which is when our draft final report is due.

SUB-APPENDIX C:

July 7, 2008 E-mail from ENTRIX to VTRA Team

AD-C.1. ENTRIX e-mail text dated July 7, 2008.

Rene, Jason:

We are in the process of setting up the oil spill fate/effects analysis and I wanted to review with you our approach to this task because it is based on our initial understanding of the VTRA results:

1) *We have downloaded all Case A, B, C, H and I accident and outflow files and attached them to ArcInfo shape files so they can be plotted.*

2) *Shruti Mukhtyar of our staff worked with you to develop a grid cell file to fit the geographic coordinates (cell centroids) used in the VTRA. This grid layer was used to display the comparisons we have developed.*

3) *We made a composite file for each case (A, B, C, H and I) by comparing the four individual accident types within each case and retaining for each cell the highest probability of accident found. We also retained the corresponding oil outflow associated with the highest probability value and changed the oil outflow units from cubic meters to gallons (could be barrels).*

4) *For the first comparison we subtracted Case A (Existing without the North Dock) from Case B (2005 with the North Dock). For a second comparison we subtracted Case C (2005 w/o ND) from Case B. Preliminary results of these comparisons are illustrated as both scatter plots and maps (see attached files,)*

5) *On the scatter plots and maps negative values indicate a reduction in probability of outflow volume for a specific cell, positive values indicate an increase in the probability or outflow volume increases with operation of the North Dock.*

6) *The scatter plots of probability show that for most cells the change was close to zero. They also show that the magnitude of increased probability was much smaller than the magnitude of reduced probability.*

7) *The scatter plots for oil outflow show that the magnitude of increased predicted outflows is similar to declines. It also shows that a much higher number of cells were found to have increases of decreases.*

8) *We noted that your geographic profiles indicate an approximate 30% drop in average outflow (for the 2005 w/ and w/o case). Based on this graph, we expected that the area under the curve shown on the corresponding scatter plot would show a similar dramatic bias on the negative side to create to 30% average reduction but the scatter plot seems to shown a generally equal area under the curve. We are unclear why this difference occurs*

9) *As a first approximation we established the maps scales intervals by dividing the number of cells past the start of the knee in the curve onthe scatter plot into ranges or approximately equal number of cells (or area). We also assume that differences on the order of 1E-5 in probabilities of the same order must be within the noise of the model; therefore we placed all of these cells in the middle gray range.*

10) *The general result of this comparison for probability of accident as viewed on the maps shows a similar pattern for both the 2000 w/o ND -2005 w/ ND and the 2005 w/ or w/o ND. That is, there is a general increase in the probability of accident at Cherry Point and in Saratoga Passage. There is a reduction of the probability of accident in Guemes Channel and the other passages into Padilla Bay (Anacortes). There are a few single cells showing increased probability, most notably in Haro Strait and near Port Angeles. Since these cells sit by themselves we are wondering if they are an artifact of some special circumstance at each location? We also found it interesting that the pattern of cells with increases in Saratoga Passage was less dense (fewer cells) in the 2005 w/ and w/o comparison when contrasted to the 2000-2005 comparison. One general observation is that while on average the probability of accident declines over the routes analyzed, there are some locations (Cherry Point and Saratoga Passage) where the probability of accident clearly increases.*

11) *We need to slelect one of the two comparisons as the basis for the oil spill modeling. To do this we need ot better understand the differences between the 2000 w/o ND and the 2005 w/o ND and would request some discussion on this issue. We assume that the pricipal chages are the Chery Pont traffic whcih yo have actiual data for and the hindcast of general traffic from 2005 to 2000.*

12) *The oil outflow plots show a much greater number of locations where outflow volume changes with the North Dock in operation. All cells with increases/decreases of approximately 1,000 bbl., or less, an often used threshold in oil spill modeling analysis, have been colored gray. All other colored cells have increases or decreases greater than 1,000 bbl. We observe that many of the cells with the greatest increase in outflow, along the Olympic Peninsula shoreline for example have accident probabilities of zero or are in the lowest range of change in accident probability. In other words the probability of an accident occurring didn't change but the size of the spill did. We have a number of questions about the oil outflow maps as they don't intuitively relate tot he change in probability maps.*

In general, there are increased release volumes along all general routes except in portions of the center section of the Strait of Juan de Fuca. In many of the areas where spill volumes increased there was little or no change in the probability of spill. If the spill probability at a location is virtually the same what circumstances are leading to a large increase in the outflow volume. This occurs in both the 200 to 2005 and the 2005 comparisons.

Since all CP bound vessels travel the same route from the entrance of the Strait of Juan de Fuca to approximately Port Angeles it would seem that there should be no change in probability or oil outflow volume when comparing Case B & C yet there are a number of cells that show a significant increase in outflow volume, especially along the coast of the Olympic Peninsula and at the entrance to the Strait. There are also some reductions in spill volumes in the traffic lanes. We would like to better understand the circumstances that lead to a much broader pattern of oil outflow increases in view of the very limited pattern of locations where accident probability increases.

We also observe an area of increased outflow volumes on the Haro Strait-Boundry Pass Route without a corresponding increase in spill probability. Can you help us understand these results ?

13) *Perhaps a two stage response to the aforegoing would be most efficient as we know that you are working diligently to produce a draft of your report. It would be most useful to us if you first comment on our approach to constructing the comparisons. this will allow us to complete the 2005-2025 comparisons. On the other issues perhaps we could organize a conference call to include the*

> *COE. We might schedule the conference call i n a week or so to give you time to consider our questions. I realize that after 2 years you can see the light at the end of tunnel and step away from what has become a major effort . . . we'll try not to impede your progress but understanding the VTRA results is a key link in the preparation of the Draft EIS.*

I will separate the attachments into several e-mails to make them easier to send.

Best regards, and congratulations on getting to this point in the process.

John

SUB-APPENDIX D:

September 19, 2008 E-mail from VTRA Team to BP

AD-D.1. VTRA team e-mail text dated September 19, 2008.

Scott,

I am sorry, but I have to point out to you that the date of your e-mail in which you asked a question about "maximum permitted capacity" (referred to in our final report that was submitted on 9/1/08) was dated 9/18/08 and not 8/18/08 as you state in the e-mail that I am now responding to. As per your specific need to have an answer to this question to allow you to frame other questions and comments related to the VTRA report, please see the explanation below:

I recently spoke to Jason about this since he was the main author of Technical Appendix F which contains the statement you are referring to. It is my understanding that he obtained the information regarding "maximum permitted capacity" through personal communication during lunch with you and Matt Cohen on Wednesday February 6-th, from about 12:30 till 13:30 after the HSC meeting on that day, but prior to our afternoon meeting with you, Matt Cohen, ENTRIX and the CORPS. Since he obtained the information through personal communication directly with you and Matt Cohen, Jason felt there was no further need for verification. However, Jason said that this particular statement was not used in the development of the VTRA Analysis Scenario's and thus it did not affect our final analysis results discussed in the final report submitted on 9/1/08.

Best, Rene