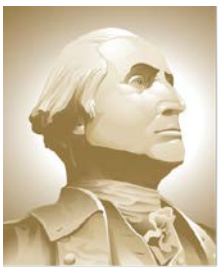
VTRA 2015 PROPOSAL

Phase I + Phase II

Submitted by: Jason R.W. Merrick (VCU) and J. Rene van Dorp (GW)



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WASHINGTON, DC

VCU

February 3rd, 2016

Introduction

This proposed scope of work is written by J. Rene van Dorp (GW) and Jason Merrick (VCU) for the Washington State Department of Ecology to be shared with the former VTRA 2010 Steering Committee. It has been revised based on comments received from the former VTRA 2010 Steering Committee during an October 2015 meeting and a September 2015 meeting. This proposed scope of work consists of two Phases. Phase I consists of 5 main tasks of which only 4 can be completed within the time and budget anticipated. Phase II consist of 2 main task that can only be completed pending funding availability. Completion of tasks will follow the same collaborative analysis approach as the VTRA 2010 project involving the maritime stakeholder community. A body similar to the VTRA 2010 steering committee will serve as the VTRA 2015 steering committee[1] in an advisory role through meetings following the Puget Sound Harbor Safety Committee meetings. The numbering of the tasks are as follows Task 1-I, Task 2-I, Task 3-I, Task 4-I and Task 5-I for Phase I and Task 3-II, Task 4-II for Phase II. This numbering system is chosen to keep track of Task numbering over the different versions of this scope of work that were provided and over the two Phases. Task 1-I, 2-I, 3-I and 4-I were included in the first version. Task 5-I was added to the second version of this proposed scope of work. Task 3-II and Task 4-II were added following the Department of Ecology announcement that an additional 65K may be available on top of the original budget 100K. Thus, Task 3-II and Task 4-II can only be executed if the indeed the availability of those funds materializes.

VTRA 2015 Project Description

Task 1-I, 3-I and 4-I from the first version of this proposed Scope of Work are selected for completion. Following the completion of Task 1-I, it will be decided by the Washington State Department of Ecology, in consultation with the VTRA 2015 Steering Committee, whether Task 2-I (from the first version) or Task 5-I (added after the first version) will be completed. Task 1-I involves the development of a VTRA 2015 base case; Task 2-I revisits/updates the VTRA 2010 What-If scenarios; Task 3-I defines a new VTRA 2015 What-if Case, in consultation with the VTRA 2015 Steering Committee, adding additional planned projects to the VTRA 2010 Case T[2]. Task 3-II will be completed conditioned on the availability of additional funds and will evaluate prioritized planned projects individually, in consultation with the VTRA 2015 committee, added under Task 3-I on top of the VTRA 2015 Base Case. Task 4-I deals with the development of a new Risk Mitigation Measure (RMM) Case in which a portfolio of RMM's will be evaluated. This portfolio will contain VTRA 2010 RMM's and additional RMM's selected in consultation with the VTRA 2015

[1] To be termed Puget Sound Harbor Safety Committee VTRA 2015 working group

[2] It is envisioned that a similar number of projects will be added in Task 3 as was the case during the VTRA 2010 (say, three). If more than three projects are added under Task 3a, three to four projects will be selected for further individual analysis under Task 3-II prioritized in consultation with the VTRA 2015 Steering Committee.

Steering Committee[3]. Task 4-II will be completed conditioned on the availability of additional funds and will evaluate prioritized individual RMM's added under Task 4-I individually on top of the VTRA 2015 Base Case. Task 5-I involves a Sensitivity Analysis Case on VTRA 2010 incident rates by the VTRA 2010 focus vessel classes: Oil Barges, Tankers, Chemical Carriers, ATB/ITB's, Bulk Carriers, Container Ships and Other Cargo Vessels.

A total of three meetings are envisioned throughout the project: a kick-off meeting, a progress meeting and a final meeting. Pending a VTRA 2015 Start date in November 2015, the kick-off meeting will follow the Puget Sound Harbor Safety Committee meeting in December 2015. The progress meeting, envisioned to take place in April 2016, shall take a workshop format where input will be solicited from the VTRA 2015 Steering Committee with the selection of the additional planned projects for inclusion to the What-If Case under Task 3-I and the design of the Risk Mitigation Case to be evaluated under Task 4-I. It is envisioned that this workshop will start Wednesday afternoon following the Puget Sound Harbor Safety Committee in April 2016 and will be continued the next Thursday morning following it. A VTRA 2015 final result presentation is envisioned during the VTRA 2015 final meeting, which is anticipated to take place in August 2016. A draft final report delivery is planned for July 31, 2016. Completion of the VTRA 2015 is scheduled for August 31, 2016. The deliverable for this project will be the VTRA 2015 final report and the analysis result presentations developed for each of the What-If Cases and RMM Cases analyzed under this scope of work.

All case analyses shall be compared to the VTRA 2015 Base Case using geographic profiles by oil spill size communicated via a May 26 e-mail (APPENDIX A) to the maritime stakeholder community. The generation of these geographic profiles by oil spill size is particularly informative for the consideration of additional potential risk mitigation measures under Task Four. Geographic profiles by oil spill size were not available during the VTRA 2010. A copy of the e-mail and the attached presentation is attached to this proposed scope of work for clarification. In addition to the generation of the geographic profiles by Oil Spill Sizes $1m^3$ – 1000 m^3, $1000m^3$ – 2500 m^3, $2500m^3$ – More, a by waterway zone comparison will be conducted for the 15 VTRA 2010 waterway zones in terms of these oil spill size categories. Below Tasks 1-I, 2-I, 3-I, 3-II, 4-I, 4-II and 5-I are described in more detail through the description of sub-tasks.

Additional background information is provided for Task 5-I in terms of an e-mail communication to the maritime stakeholder community on April 24, 2015 (APPENDIX B) detailing the VTRA 2010's approach toward incident rate per hour modeling by focus vessel class. Moreover, APPENDIX C provides page 62 (and Figure 35) from the Puget Sound Partnership VTRA 2010 final report. The VTRA 2010 Steering Committee would like to investigate the sensitivity to individual

[3] Implementation of a RMM measure in the VTRA 2015 model will be discussed with the VTRA 2015 Steering Committee provided the VTRA 2015 model is suited to evaluate it. The number of RMM's that can be added is limited by time and the availability of budget. It is envisioned that potentially three to four RMM's can be added to the VTRA 2015 model. Only three to four RMM's shall be selected for individual evaluation on top of the VTRA 2015 Base Case under Task 4-II, prioritized in consultation with the VTRA 2015 Steering Committee.

incident rates per hour for Oil Barges, Chemical Carriers, Bulk Carriers, Container Ships and other Cargo. In the VTRA 2010 the **incident rates per hour** were set equal to the **incident rates per hour** of ATB/ITB's. The **incident rates per hour** for Chemical Carriers, Bulk Carriers, Container Ships and Other Cargo vessel were set equal to the **incident rates per hour** for Tankers (Panel A in Figure 35). Panel C in Figure 35 details the number of **potential incident rates per year** evaluated in the VTRA 2010 model. Observe from Panel C in Figure 35 that the VTRA 2010 model did model **the highest number of potential incident rates per year for the Bulk Carrier focus vessel group** (about four times more per year than the number of **potential incident rates per year** for tankers). Finally, the attachment to e-mail in April 24, 2015 (Appendix B) details that the VTRA 2010 modelled **the highest incident density factor in the Haro-Strait/Boundary Pass waterway zone for Cargo Focus Vessels** and **the highest incident density factor in the Rosario Strait and Guemes waterway zones for Tank Focus Vessels**. The definition of VTRA 2010 waterway zones is provided in APPENDIX D. Should TASK 5-I be selected for completion over Task 2, multiplication factors for **the incident rates per hour** for Oil Barges, Chemical Carriers, Bulk Carriers, Container Ships and Other Cargo for Task 5-I will be provided to GW/VCU with source documentation by the Puget Sound Harbor Safety Committee working group.

Task 1-I: Development of VTRA 2015 Base Case

- **a.** Perform a crossing line analysis of 2010 - 2015 AIS data for crossing lines: WSJF, Admiralty Inlet, Entrances Haro-Strait/Bound Pass, Entrances Rosario Strait, Saddle Bags and Point Roberts. The crossing line analysis will "tease out" the various traffic streams by cargo focus vessel and tank focus vessel category to evaluate changes in traffic volume over these traffic streams over that time period. The crossing line counts will be provided to GW/VCU for the years 2010 through 2015 at no charge.
- **b.** Use the analysis results of Task 1a to "rebalance" the focus vessel traffic in the VTRA 2010 analysis model such that rebalancing will result in VTRA model annual crossing line counts similar to the 2015 AIS crossing line counts by cargo focus vessel and tank focus vessel.
- **c.** Use the model developed under Task 1b to develop a VTRA 2015 Base Case analysis by generating geographic profiles by Oil Spill Size Categories: $1m^3$ – 1000 m^3, $1000m^3$ – 2500 m^3, $2500m^3$ – More. Compare the VTRA 2015 Base Case Analysis to the VTRA 2010 Base Case Analysis in terms of these geographic profiles (see VTRA 2010 Geographic Profile by Potential Spill Size – Supplement May 26, 2015 attachment).
- **d.** Use the model developed under Task 1b to compare the VTRA 2015 Base Case results to the VTRA 2010 Base Case Results by the 15 VTRA waterway zones and by Oil Spill Size Categories: $1m^3$ – 1000 m^3, $1000m^3$ – 2500 m^3, $2500m^3$ – More.

Task 2-I: Revisit/Update VTRA 2010 What-if Cases and compare to VTRA 2015 Base Case

a. Revisit the VTRA 2010 definition of What-If Cases Q, R, S and T and update their definitions if necessary.

b. Use the model developed under Task 1b and the What-If Case definitions revisited under Task 2a to generate geographic profiles by Oil Spill Size Categories: 1m^3 – 1000 m^3, 1000m^3 – 2500 m^3, 2500m^3 – More. Compare the Case Q, R, S and T results to the VTRA 2015 Base Case Analysis in terms of these geographic profiles.

c. Use the model developed under Task 1b and the What-If Case definitions revisited under Task 2a to compare Case Q, R, S, and T results to the VTRA 2015 Base Case Results by the 15 VTRA waterway zones and by Oil Spill Size Categories: 1m^3 – 1000 m^3, 1000m^3 – 2500 m^3, 2500m^3 – More.

Task 3-I: Definition of VTRA 2015 What-if Case and compare to VTRA 2015 Base Case

a. With the Puget Sound Harbor Safety Committee VTRA 2015 working group, collaboratively define a new What-If Case U using the VTRA 2010 Focus Vessel categories reflecting additional planned projects that have come to light following the VTRA 2010 completion, including the potential impacts of crude-by-rail on vessel traffic. Add the additional potential traffic to the What-If Case T from Task 2a. This case will designated What-If Case U.

b. Use the model developed under Task 1b and the What-If Case U defined under Task 3a to generate geographic profiles by Oil Spill Size Categories: 1m^3 – 1000 m^3, 1000m^3 – 2500 m^3, 2500m^3 – 1000 m^3 for Case U. Compare the What-If Case U results to the VTRA 2015 Base Case Analysis in terms of these geographic profiles.

c. Use the model developed under Task 1b and the What-If Case U defined under Task 3a to compare What-If Case U results to the VTRA 2015 Base Case Results by the 15 VTRA waterway zones and by Oil Spill Size Categories: 1m^3 – 1000 m^3, 1000m^3 – 2500 m^3, 2500m^3 – More.

Task 3-II: Definition of VTRA 2015 What-if Case and compare to VTRA 2015 Base Case

a. Evaluate separate What-If Cases for each added planned project defined in What-If Case U under Task 3a by adding them individually to the VTRA 2015 Base Case, using the VTRA 2010 Focus Vessel categories. If three or more projects where added in the creation of What-If Case U under Task 3, prioritize in consultation with the VTRA 2015 Steering Committee which three shall be selected for further analysis.

b. Use the model developed under Task 1b and the individual What-If Cases defined under Task 3-IIa to generate geographic profiles by Oil Spill Size Categories: 1m^3 – 1000 m^3, 1000m^3 – 2500 m^3, 2500m^3 – 1000 m^3 for these What-If cases. Compare the What-If Cases results to the VTRA 2015 Base Case Analysis in terms of these geographic profiles.

c. Use the model developed under Task 1b and the individual What-If Cases defined under Task 3-IIa to compare What-If Cases results to the VTRA 2015 Base Case Results by the 15 VTRA waterway zones and by Oil Spill Size Categories: 1m^3 – 1000 m^3, 1000m^3 – 2500 m^3, 2500m^3 – More.

Task 4-I: Definition of VTRA 2015 RMM Case and compare to VTRA 2015 Base Case

a. With the Puget Sound Harbor Safety Committee VTRA 2015 working group, collaboratively define a new RMM Case using the VTRA 2010 Focus Vessel categories reflecting a portfolio of RMM's selected from VTRA 2010 RMM's, existing RMMs that have been introduced since 2010, and potentially other RMM's to be defined based on insights gleaned from the results under Task 1 and 3.

b. Use the model developed under Task 1b to perform an analysis combining the RMM Case defined under Task 4a with What-If Case U defined under Task 3a. Designating this as the U-RMM Case generate for this case geographic profiles by Oil Spill Size Categories: 1m^3 – 1000 m^3, 1000m^3 – 2500 m^3, 2500m^3 – 1000 m^3. Compare these U-RMM results to the What-if Case U geographic profile results generated under Task 3b.

c. Use the model developed under Task 1b and the U-RMM Case defined under Task 4b to compare the U-RMM Case results for the 15 VTRA waterway zones and by Oil Spill Size Categories: 1m^3 – 1000 m^3, 1000m^3 – 2500 m^3, 2500m^3 – More to the What-If Case U by waterway zone results generated under Task 4c.

Task 4-II: Definition of VTRA 2015 RMM Case and compare to VTRA 2015 Base Case

a. Evaluate separate RMM Cases for each RMM defined in the U-RMM under Task 4a by adding them individually to VTRA 2015 Base Case, using the VTRA 2010 Focus Vessel categories. If three or more RMM's where added in the creation of Case U-RMM under Task 4, prioritize in consultation with the VTRA 2015 Steering Committee, which three shall be selected for further analysis.

b. Use the model developed under Task 1b and the individual RMM Cases defined under Task 4-IIa to generate geographic profiles by Oil Spill Size Categories: 1m^3 – 1000 m^3, 1000m^3 – 2500 m^3, 2500m^3 – 1000 m^3 for these RMM cases. Compare the RMM Cases results to the VTRA 2015 Base Case Analysis in terms of these geographic profiles.

c. Use the model developed under Task 1b and the RMM Cases defined under Task 4-IIa to compare RMM Case results to the VTRA 2015 Base Case Results by the 15 VTRA waterway zones and by Oil Spill Size Categories: 1m^3 – 1000 m^3, 1000m^3 – 2500 m^3, 2500m^3 – More.

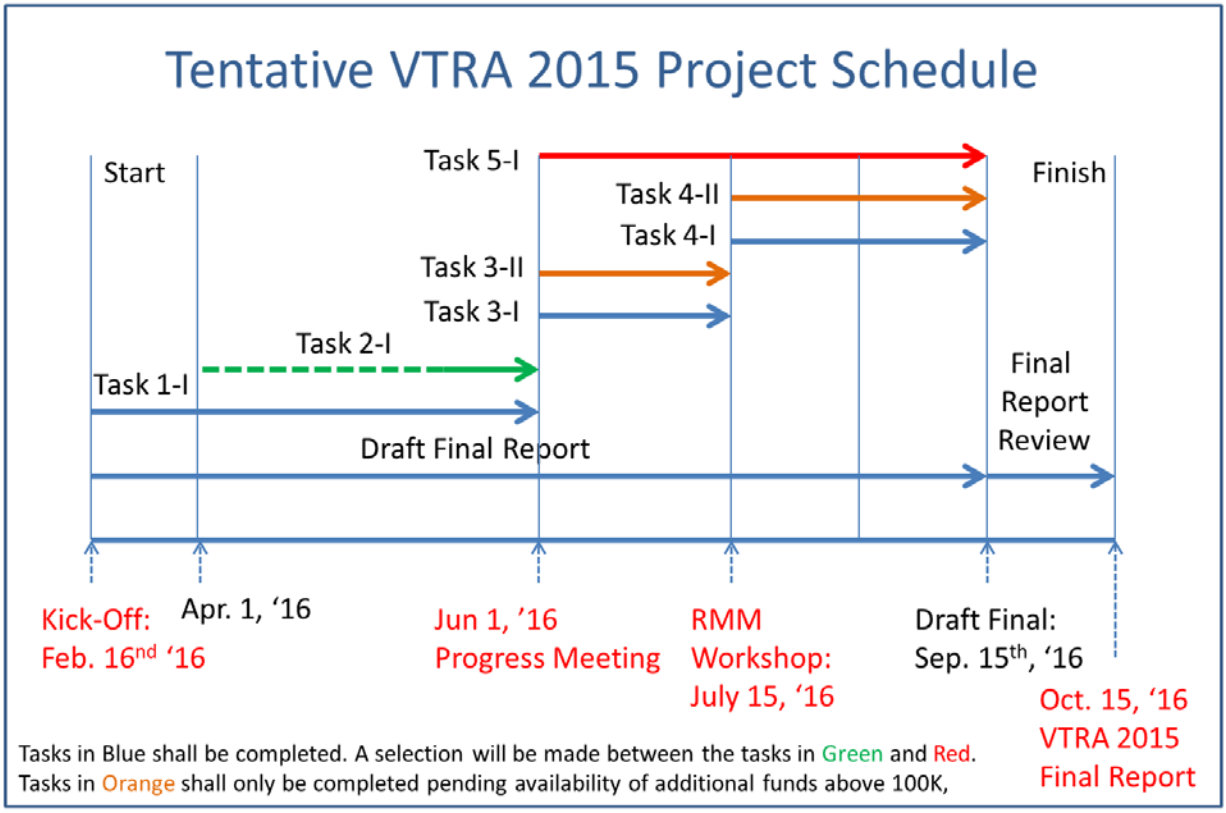
Task 5-I: Definition of VTRA 2015 Sensitivity Case on VTRA 2010 incident rates and compare to VTRA 2015 Base Case

a. With the Puget Sound Harbor Safety Committee VTRA 2015 working group provided multiplicative factors for incident rates per hour for incident rates per hour for ATB/ITB's and incident rates per hour for tankers, define a new Sensitivity Case using the VTRA 2010 Focus Vessel categories.

b. Designating the case under Task 5a as Case V, use the model developed under Task 1b to perform a sensitivity analysis by generating for this case geographic profiles by Oil Spill Size Categories: 1m^3 – 1000 m^3, 1000m^3 – 2500 m^3, 2500m^3 – 1000 m^3. Compare these Case V results to the 2015 Base Case geographic profile results generated under Task 1c for all Focus Vessels, Cargo Focus Vessels and Tank Focus Vessels

c. Designating the case under Task 5a as Case V, use the model developed under Task 1b to perform a sensitivity analysis by for the 15 VTRA waterway zones and by Oil Spill Size Categories: 1m^3 – 1000 m^3, 1000m^3 – 2500 m^3, 2500m^3 – More to the 2015 Base Case by waterway zone results generated under Task 1d.

VTRA 2015 Project Schedule



Appendix A:
E-MAIL COMMUNICATION MAY 26, 2015

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van Dorp, Johan <dorpjr@email.gwu.edu>

VTRA 2010 Base Case Geographic Profiles by Oil Spill Size

60 messages

Johan van Dorp <dorpjr@gwu.edu> Tue, May 26, 2015 at 9:10 AM
Reply-To: dorpjr@gwu.edu
To: "Hass, Todd (PSP)" <todd.hass@psp.wa.gov>, John Veentjer <jeveentjer@marexps.com>, "Bowechop.chad@centurytel.net" <Bowechop.chad@centurytel.net>, "McFarland, Robert E" <Robert.E.McFarland@uscg.mil>, "Kauffman, Meridena D LCDR" <Meridena.D.Kauffman@uscg.mil>, Jason R W Merrick <jrmerric@vcu.edu>, "Edwards, Matt CDR" <Matt.Edwards@uscg.mil>, "Mark.Homeyer@crowley.com" <Mark.Homeyer@crowley.com>, Mike Moore <MMoore@pmsaship.com>, "vince_sup@msn.com" <vince_sup@msn.com>, "Jeffrey.P.Shaw@conocophillips.com" <Jeffrey.P.Shaw@conocophillips.com>, Fred Felleman <felleman@comcast.net>, Tom Leschine <tml@u.washington.edu>, JD Ross Leahy <jdross@uw.edu>, "frank@wspa.org" <frank@wspa.org>, Mike Doherty <mdoherty@co.clallam.wa.us>, "Sawicki, David A" <david.sawicki@bp.com>, "Teutschel, Nicole (Cantwell)" <Nicole_Teutschel@cantwell.senate.gov>, "McCreery, Scott L" <scott.mccreery@bp.com>, "lprovince@wslc.org" <lprovince@wslc.org>, "todd.w.malloy@gmail.com" <todd.w.malloy@gmail.com>, "salmon@whidbey.com" <salmon@whidbey.com>, "paulm@pgst.nsn.us" <paulm@pgst.nsn.us>, "Bolger, Jim (PSP)" <jim.bolger@psp.wa.gov>, "Graham.Knox@gov.bc.ca" <Graham.Knox@gov.bc.ca>, Jostein Kalvoy <jkalvoy@pspilots.org>, "dsclark@uw.edu" <dsclark@uw.edu>, "wishart.bruce@gmail.com" <wishart.bruce@gmail.com>, "Patrick.Higgins@international.gc.ca" <Patrick.Higgins@international.gc.ca>, "Harkiran.Rajasansi@international.gc.ca" <Harkiran.Rajasansi@international.gc.ca>, Lovell Pratt <lovelpratt@gmail.com>, "darylwilliams@tulaliptribes-nsn.gov" <darylwilliams@tulaliptribes-nsn.gov>, John Robinson <john.robinson@cardno.com>, Keith Ledford <keithledford@hotmail.com>, Eleanor Nick Kirtley <enkirtley@glosten.com>, Clark George <gclark4@clearwire.net>, "Michael O'Leary, NWF" <michael@nwfpacificregion.org>, Cecilia Gobin <cgobin@nwifc.org>, Stephanie Buffum <stephanie@sanjuans.org>, Charlie Costanzo <ccostanzo@vesselalliance.com>, Kevin <kdcampion@hotmail.com>, "Copeland, Lisa (ECY)" <lcop461@ecy.wa.gov>, Tom Gunton <tgunton@shaw.ca>, "Janice Rose (Janice@esquimaltnation.ca)" <Janice@esquimaltnation.ca>, jon.neel@psp.wa.gov, Dagmar Etkin <etkin@environmental-research.com>, Sean Broadbent <sbroadbe@sfu.ca>, "Helker, Alice (ECY)" <adru461@ecy.wa.gov>, "Ferguson, Scott (ECY)" <scfe461@ecy.wa.gov>, tom@dykesehrlichman.com, barbara@dykesehrlichman.com

Dear All,

The VTRA 2010 analysis has focused in the past on providing relative risk comparisons between a Base Case 2010 vessel traffic year and traffic levels if future planned projects come to fruition in the context of potential oil spills. In this context, following the VTRA 2010 final report submission in March 2014, absolute risk levels were reported in terms of event average return times by oil spill size during the January 2015 Salish Sea Workshop held at Bellingham, WA. The VTRA 2010 average return time analysis was conducted to specifically allow for comparisons, during this workshop, with other risk studies using that same risk metric and studying the same future planned projects. Unfortunately, however, average return times are fraught with misinterpretation hampering risk communication (see the VTRA Bellingham workshop presentation):

http://www.seas.gwu.edu/~dorpjr/tab4/publications_VTRA_Update_Presentations.html

To better communicate a measure of absolute risk in the VTRA 2010 oil spill context, we are now able to evaluate the probability of spill occurrence in 25 years by spill size category. The communication of the probability of event occurrence in 25 years as a measure of absolute risk is advocated in Kousky and Kunreuther [2009] for risk communication (reference included below). We now evaluate for the VTRA 2010 Base Case scenario, for example, that:

- The probability of a potential spill in the next 25 years in the VTRA 2010 study area with a spill size larger than 2,500 cubic meters equals about 3% with an average potential spill size of 6,641 cubic meters per potential event.

- The probability of a potential spill in the next 25 years in the VTRA 2010 study area with a spill size in the range from 1 to 1,000 cubic meters equals about 85.5% with an average potential spill size of 65 cubic meters per potential event.

One of our goals of the Salish Sea Bellingham Workshop presentation was to also draw attention to the potential of the latter more frequent but "smaller spill" events. In contrast, the Kinder Morgan study has focused on "Worst Case Credible Spills" with a spill size of 16,500 tonnes which converts to about 18,644 cubic meters (depending on the oil density). Perhaps the different ways in which volumes of oil are commonly reported (barrels, gallons, tonnes, liters and cubic meters) hampered this goal. So we decided to look at the oil spills that **have happened** in the VTRA study area **over the past 25 years** and convert their reported spill sizes to cubic meters. The two main spill events that come to mind are:

1991 Collision Spill : Tenyo Maru – Spilled 361,000 gallons = 1,367 cubic meters (m3)
1994 Grounding Spill: Barge 101 – Spilled 993 gallons = 3.76 cubic meters (m3)

In fact, the most recent spills drawing our attention in the news today that **happened outside the VTRA Study area** also fall in this "smaller spills" category:

April '15 English Bay bunker fuel spill: More than 2,700 liters = 2.70 m3 of bunker fuel

May '15 California Pipeline spill: About 21,000 gallons in the ocean = 79.5 m3 of crude

Now going back to the VTRA 2010, about 32% of the potential annual oil losses evaluated for the base case 2010 year are attributed to spill sizes between 1 and 1,000 cubic meters that account for about 80% of the potential annual accident frequency (with an average spill size of 65 cubic meters = 17,771 gallons per potential accident). On the other hand, in the VTRA 2010, about 10% of the evaluated potential annual oil losses are attributed to spill sizes of 12,500 cubic meters or more, whereas they account in the VTRA 2010 for only 0.1% of the evaluated annual potential accident frequency. But, this accident category has

an average spill size of 16,281 cubic meters = about 14,409 tonnes (depending on oil density) per potential accident in the VTRA 2010 base case. While the imbalance in these VTRA 2010 evaluations may be overstated, this imbalance clearly highlights the challenge in managing potential oil spill risk, i.e.:

How does one prevent/prepare for the less likely but larger spill sizes while keeping the more likely but smaller spill sizes in mind?

While we do not have a definite answer to this question, it would be preferred to have a geographically distributed approach towards spill response/accident prevention as opposed to, for example, concentrating all assets in a single location.

We continued to ponder after the Salish Sea Bellingham workshop presentation in January 2015 how to enhance the VTRA 2010 model capabilities to better inform this important question. We have since January 2015 enhanced the VTRA 2010 analysis capability to be able to produce geographic risk profiles by potential oil spill size while calibrating the VTRA 2010 model to the two spills above that have happened over the past 25 years in the VTRA 2010 study area. In light of these accidents, we chose the following categories for geographic risk profiles by oil spill size:

(a) 1 – 1000 cubic meters: 31.8% of VTRA 2010 potential annual average oil loss
(b) 1000 – 2500 cubic meters: 14.6% of VTRA 2010 potential annual average oil loss
(c) 2500 or more cubic meters : 53.6% of VTRA 2010 potential annual average oil loss

These supplemented VTRA 2010 geographic profiles by oil spill size category are provided in the attached adobe acrobat file to provide a geographic sense of oil spill risk by spill size category.

We hope you will find the attached presentation with these geographic profiles useful. Needless to say, these results only apply to the VTRA 2010 Base Case modeled traffic bearing in mind that perhaps since then traffic levels may have changed. More importantly, these results do not reflect potential oil spill risk by spill size if any of the three What-If Scenarios modeled in the VTRA 2010 come to fruition or a combination thereof.

Regards,

Jason Merrick and Rene van Dorp

C. Kousky and H. Kunruether (2009). Improving Flood Insurance and Flood Risk Management, Discussion Paper, Resources for the Future, RFF DP-09-07, http://www.rff.org/documents/RFF-DP-09-07.pdf

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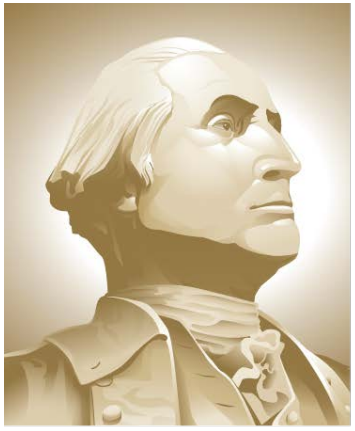
Johan Rene van Dorp - Professor
http://www.seas.gwu.edu/~dorpjr/
Engineering Management and Systems Engineering
School of Engineering and Applied Science
The George Washington University

800 22nd Street NW, Suite 2800
(P) 202-994-6638 (F) 202-994-0245

VTRA 2010 Geographic Profile by Potential Spill Size - Supplement.pdf
2057K

ATTACHMENT TO E-MAIL COMMUNICATION MAY 26, 2015

VTRA 2010 – BASE CASE GEOGRAPHIC PROFILES BY POTENTIAL SPILL SIZE– SUPPLEMENTAL ANALYSIS



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Jason R.W. Merrick (VCU) and Rene van Dorp (GW)

May 26, 2015

VESSEL TRAFFIC RISK ASSESSMENT (VTRA) 2010

BASE CASE 2010 PERCENT CONTRIBUTION TO ANNUAL POTENTIAL OIL SPILL AND ANNUAL POTENTIAL ACCIDENT FREQUENCY

	OIL_2500_MORE	OIL_1000_2500	OIL_1_1000	OIL_0_1
% Potential Annual Oil Loss	53.6%	14.6%	31.8%	0.0%
% Potenial Annual Accident Frequency	1.3%	1.4%	79.6%	17.7%
Average potential spill size per accident (in m^3)	6,641	1,697	65	0.13
Probability of an accident in next 25 years by spill size	3.1%	3.4%	85.5%	34.9%

3.1 % Probability of an Accident in the next 25 years with a Potential Spill Size of **more than 2500 m^3** (and an average of **6641m^3 per potential spill**)

85.5% Probability of an Accident in the next 25 years with a Potential Spill Size **between 1 m^3 - 1000 m^3** (and an Average of **65m^3 per potential spill**)

VESSEL TRAFFIC RISK ASSESSMENT (VTRA) 2010

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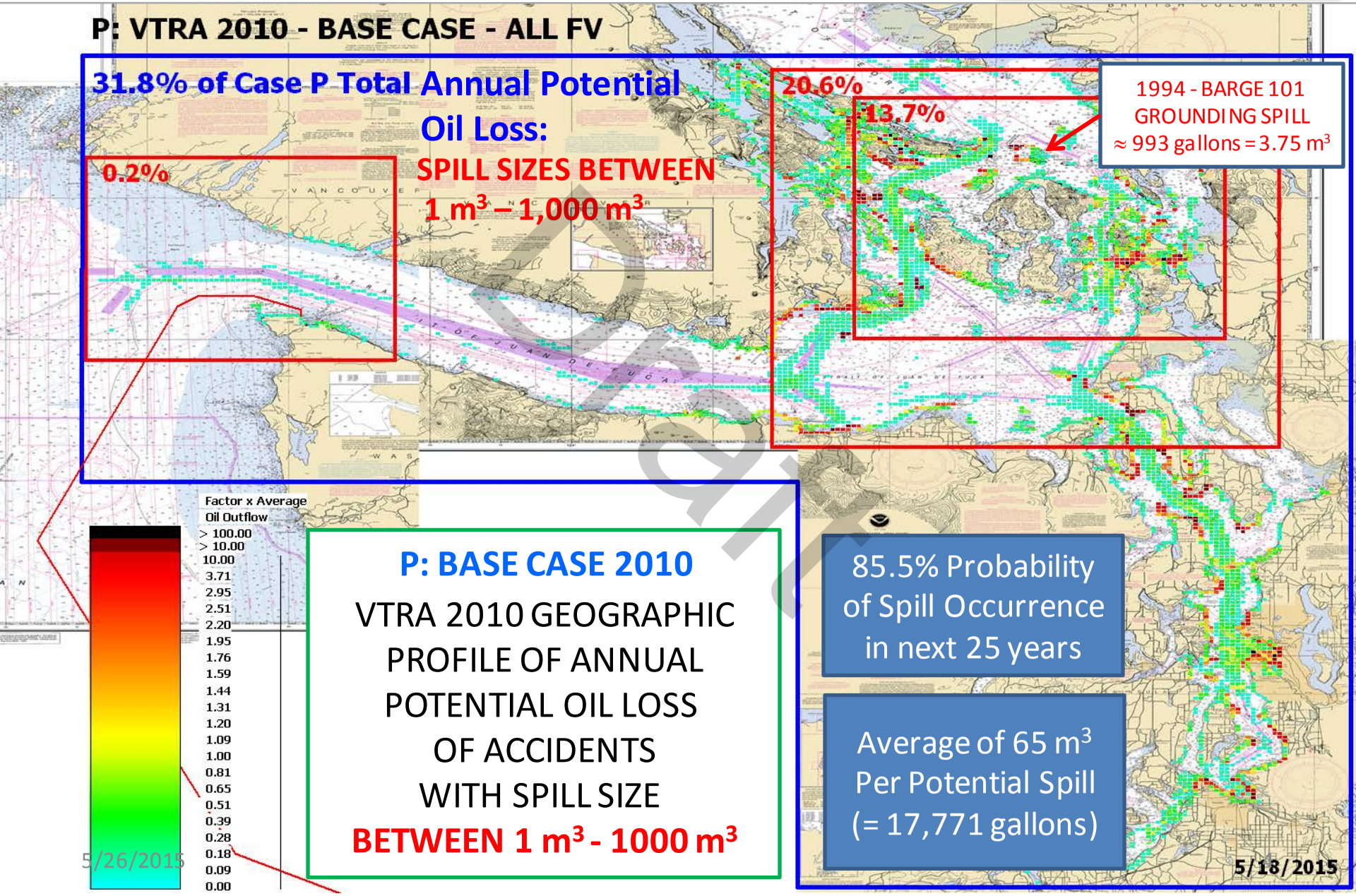

VESSEL TRAFFIC RISK ASSESSMENT (VTRA) 2010

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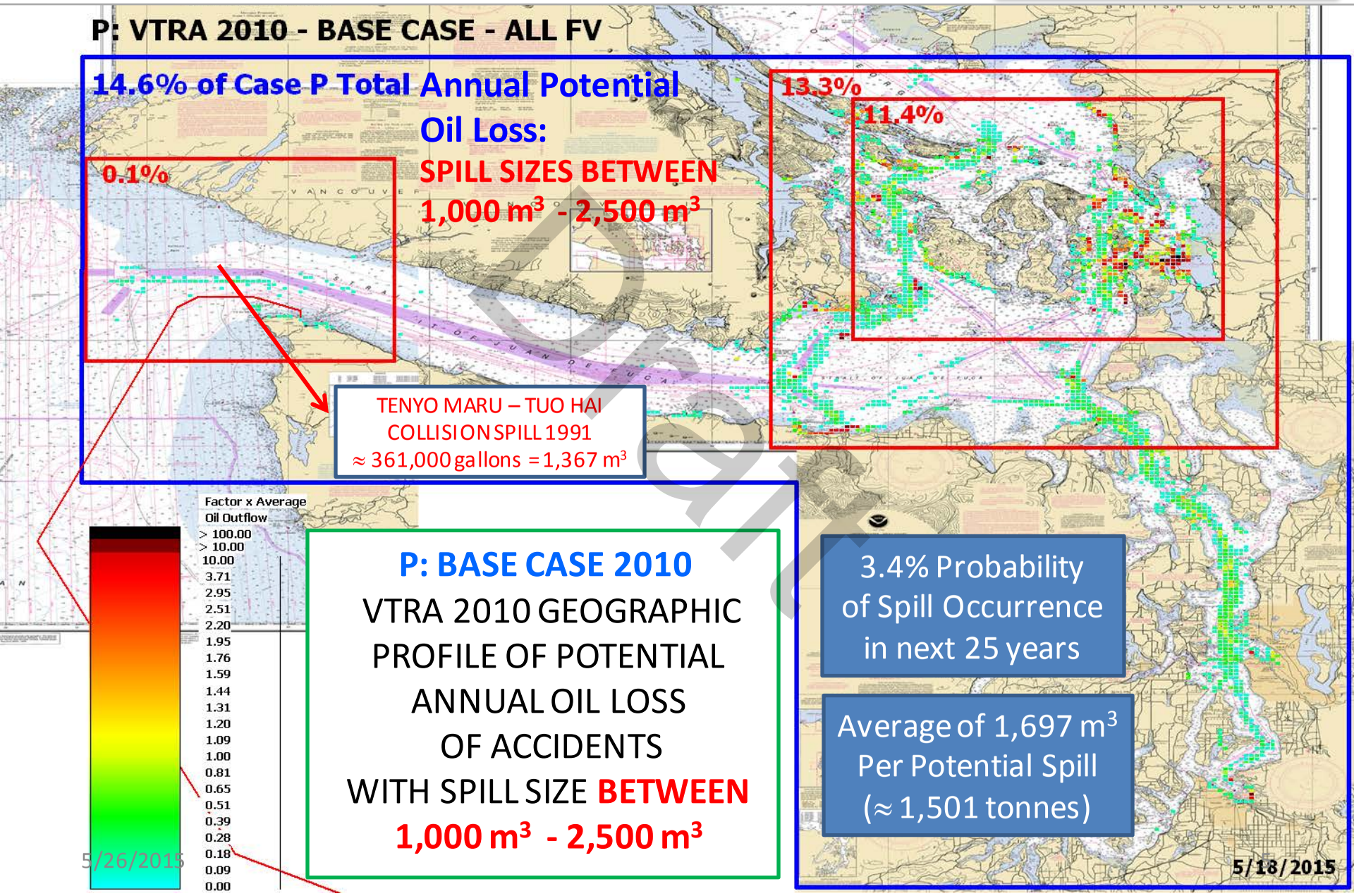

VESSEL TRAFFIC RISK ASSESSMENT (VTRA) 2010

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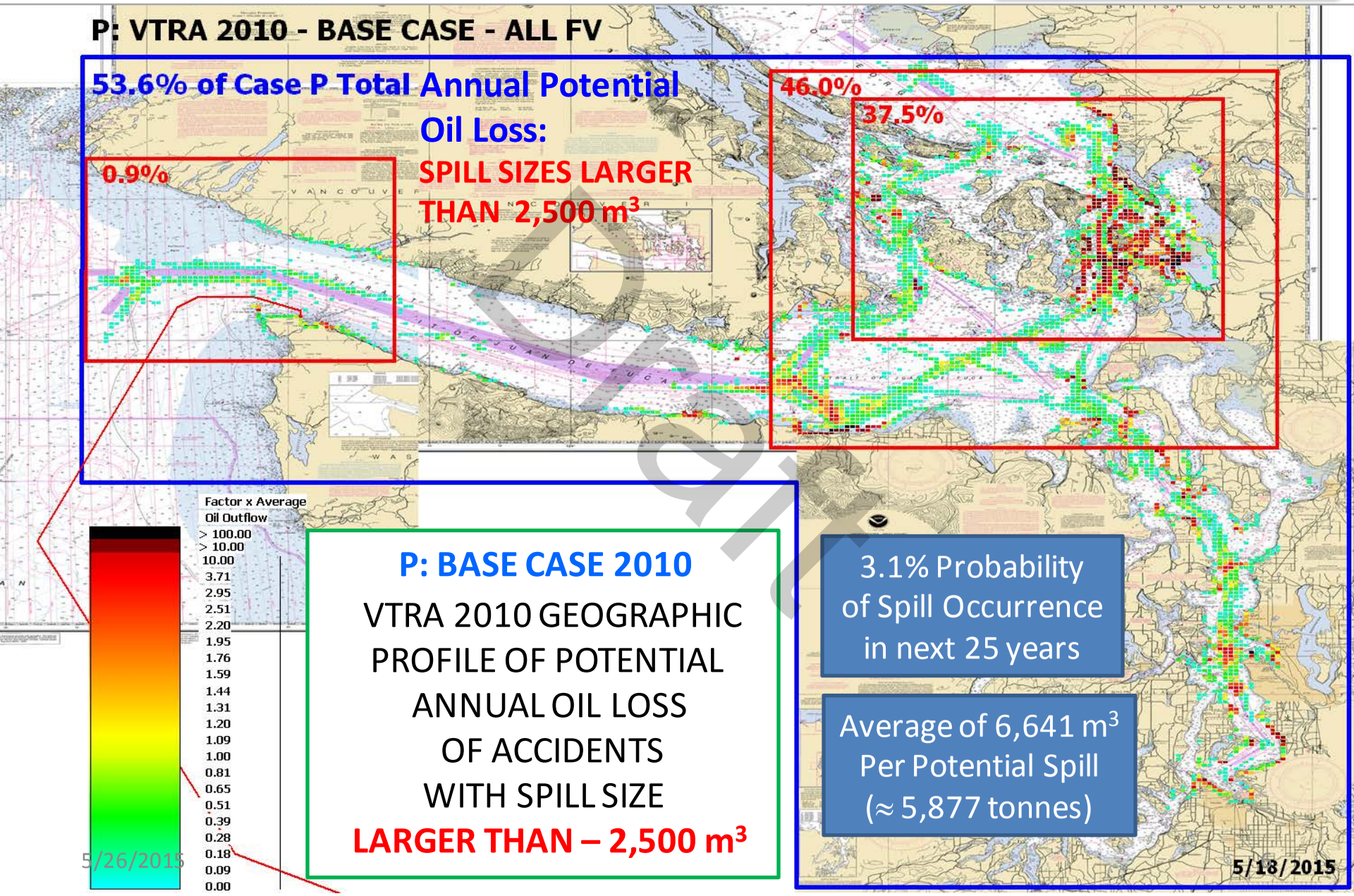

Appendix B:
E-MAIL COMMUNICATION APRIL 24, 2015

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van Dorp, Johan <dorpjr@email.gwu.edu>

Updated VTRA 2010 Bellingham Workshop presentation

Johan van Dorp <dorpjr@gwu.edu> Fri, Apr 24, 2015 at 4:48 PM
Reply-To: dorpjr@gwu.edu
To: Todd Hass <todd.hass@psp.wa.gov>
Cc: John Veentjer <jeveentjer@marexps.com>, "Bowechop.chad@centurytel.net" <Bowechop.chad@centurytel.net>, "jnee461@ECY.WA.GOV" <jnee461@ecy.wa.gov>, "McFarland, Robert E" <Robert.E.McFarland@uscg.mil>, "Kauffman, Meridena D LCDR" <Meridena.D.Kauffman@uscg.mil>, Jason R W Merrick <jrmerric@vcu.edu>, "Edwards, Matt CDR" <Matt.Edwards@uscg.mil>, "Mark.Homeyer@crowley.com" <Mark.Homeyer@crowley.com>, Mike Moore <MMoore@pmsaship.com>, "vince_sup@msn.com" <vince_sup@msn.com>, "Jeffrey.P.Shaw@conocophillips.com" <Jeffrey.P.Shaw@conocophillips.com>, Fred Felleman <felleman@comcast.net>, Tom Leschine <tml@u.washington.edu>, JD Ross Leahy <jdross@uw.edu>, "frank@wspa.org" <frank@wspa.org>, Mike Doherty <mdoherty@co.clallam.wa.us>, "Sawicki, David A" <david.sawicki@bp.com>, "Teutschel, Nicole (Cantwell)" <Nicole_Teutschel@cantwell.senate.gov>, "McCreery, Scott L" <scott.mccreery@bp.com>, "lprovince@wslc.org" <lprovince@wslc.org>, "todd.w.malloy@gmail.com" <todd.w.malloy@gmail.com>, "salmon@whidbey.com" <salmon@whidbey.com>, "paulm@pgst.nsn.us" <paulm@pgst.nsn.us>, "Bolger, Jim (PSP)" <jim.bolger@psp.wa.gov>, "tom@salishcommunity.org" <tom@salishcommunity.org>, "barbara@salishcommunity.org" <barbara@salishcommunity.org>, "Graham.Knox@gov.bc.ca" <Graham.Knox@gov.bc.ca>, Jostein Kalvoy <jkalvoy@pspilots.org>, "dsclark@uw.edu" <dsclark@uw.edu>, "wishart.bruce@gmail.com" <wishart.bruce@gmail.com>, "Patrick.Higgins@international.gc.ca" <Patrick.Higgins@international.gc.ca>, "Harkiran.Rajasansi@international.gc.ca" <Harkiran.Rajasansi@international.gc.ca>, Lovell Pratt <lovelpratt@gmail.com>, "darylwilliams@tulaliptribes-nsn.gov" <darylwilliams@tulaliptribes-nsn.gov>, John Robinson <john.robinson@cardno.com>, Keith Ledford <keithledford@hotmail.com>, Eleanor Nick Kirtley <enkirtley@glosten.com>, Clark George <gclark4@clearwire.net>, "Michael O'Leary, NWF" <michael@nwfpacificregion.org>, Cecilia Gobin <cgobin@nwifc.org>, Stephanie Buffum <stephanie@sanjuans.org>, Charlie Costanzo <ccostanzo@vesselalliance.com>, Kevin <kdcampion@hotmail.com>, "Copeland, Lisa (ECY)" <lcop461@ecy.wa.gov>, Tom Gunton <tgunton@shaw.ca>, "Janice Rose (Janice@esquimaltnation.ca)" <Janice@esquimaltnation.ca>, jon.neel@psp.wa.gov, Dagmar Etkin <etkin@environmental-research.com>, Sean Broadbent <sbroadbe@sfu.ca>, "Helker, Alice (ECY)" <adru461@ecy.wa.gov>, "Ferguson, Scott (ECY)" <scfe461@ecy.wa.gov>

Dear All,

I have been receiving questions regarding the incident model and results in the VTRA 2010 model. In particular, one appears to be interested in incident rates modeled for Canadian waters and in particular Haro-Stait/Boundary Pass.

I am attaching a VTRA 2010 supplemental incident model and results presentation by waterway zone and would like to share these results with all of you. The presentation evaluates an incident density factor which evaluates potential VTRA 2010 incident rates per square mile. This was done to account for the different sizes of the waterway zones in the VTRA 2010. Incidents considered in the VTRA 2010 include potential propulsion, steering, navigational aid failures and human errors.

From the presentation one concludes that in the VTRA 2010 base case analysis:

1. When including all focus vessels (bulker, containter, other cargo, oil barge, tanker, ATB, Chemical carrier) the waterway zones West Strait of Juan De Fuca and Haro Strait/Boundary Pass have the highest incident density factors in the VTRA 2010.
2. When including only Cargo Focus Vessels (bulker, containter, other cargo) the waterway zone Haro Strait/Boundary Pass has the highest incident density factor in the VTRA 2010.
3. When including only Oil Focus Vessels (oil barge, tanker, ATB, Chemical Carrier) the waterway zones Rosario Strait and Guemes have the highest incident density factors in the VTRA 2010.

It is important to note that conclusions above only apply to the VTRA 2010 Base Case and not to the other What-If and Bench-Mark scenarios modeled in the VTRA 2010.

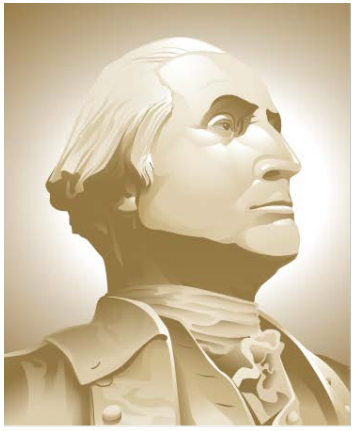
Best, Rene

[Quoted text hidden]

VTRA 2010 Incident Model - Supplement.pdf
1362K

ATTACHMENT TO E-MAIL COMMUNICATION APRIL 24, 2015

VTRA 2010 - POTENTIAL INCIDENT RATES BY WATERWAY ZONE – SUPPLEMENTAL ANALYSIS



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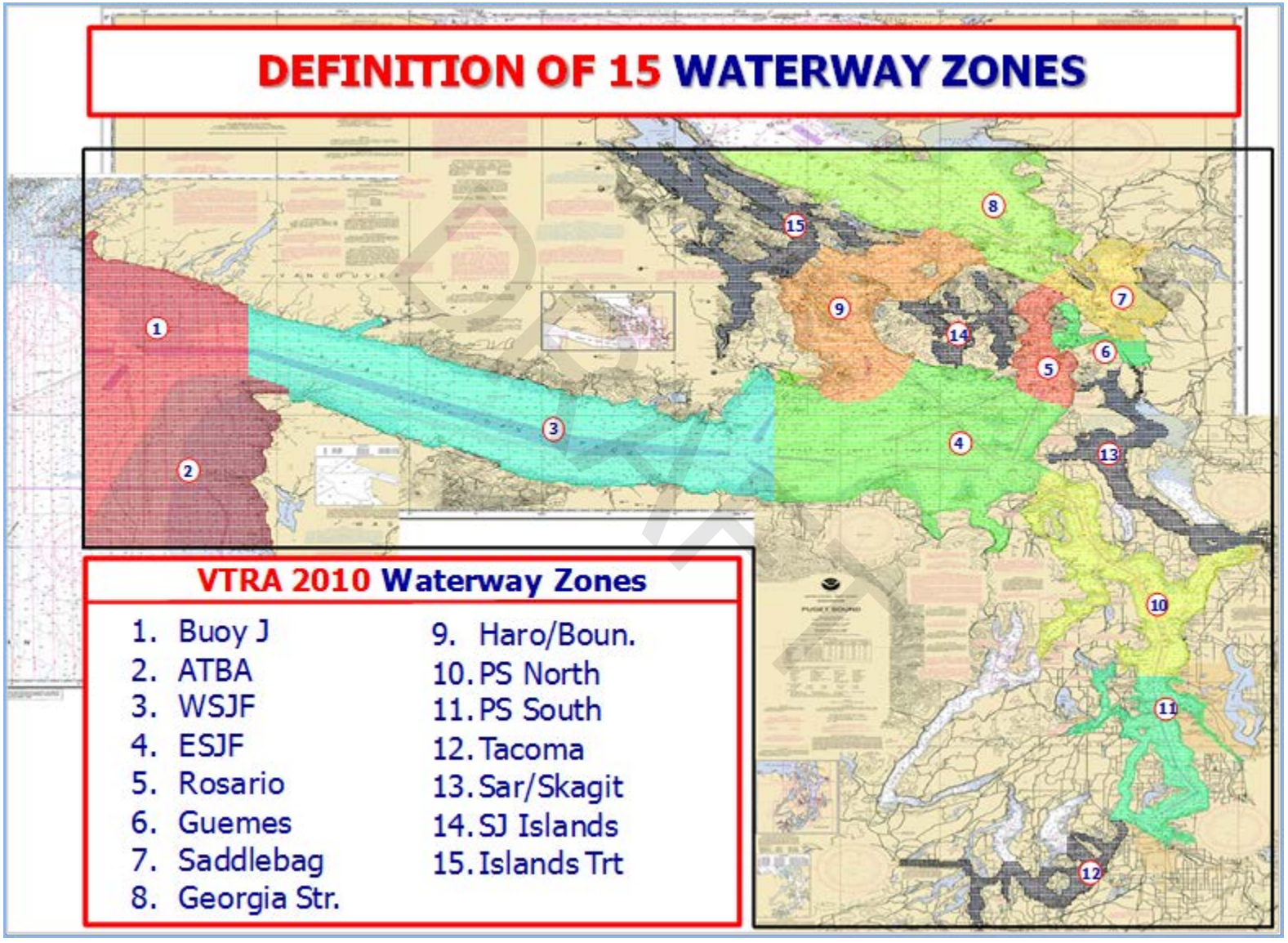
VCU

Jason R.W. Merrick (VCU) and Rene van Dorp (GW)

Presented by: J. Rene van Dorp

VESSEL TRAFFIC RISK ASSESSMENT (VTRA) 2010

VESSEL TRAFFIC RISK ASSESSMENT (VTRA) 2010



POTENTIAL INCIDENT RATE: The average number of incidents per year as modeled by the VTRA 2010.

These are not historical incident rates!

Incidents considered: Propulsion, Steering, Navigational Aid Failures and Human Errors

Modeling approach:

1. Historical yearly average numbers of incidents per year for Tankers, Tugs and ITB were converted to incident rates per moving hour using VTRA 2010 simulation yearly time on the water (in #hours) estimates for these vessel types.
2. These incident rates per moving hour were extrapolated to other focus vessel (FV) classes due to lack of vetted yearly incident data for these other FV classes.

Also see Page 61 – 63 in VTRA 2010 Final Report:
http://www.seas.gwu.edu/~dorpjr/tab4/publications_VTRA_Update_Reports.html

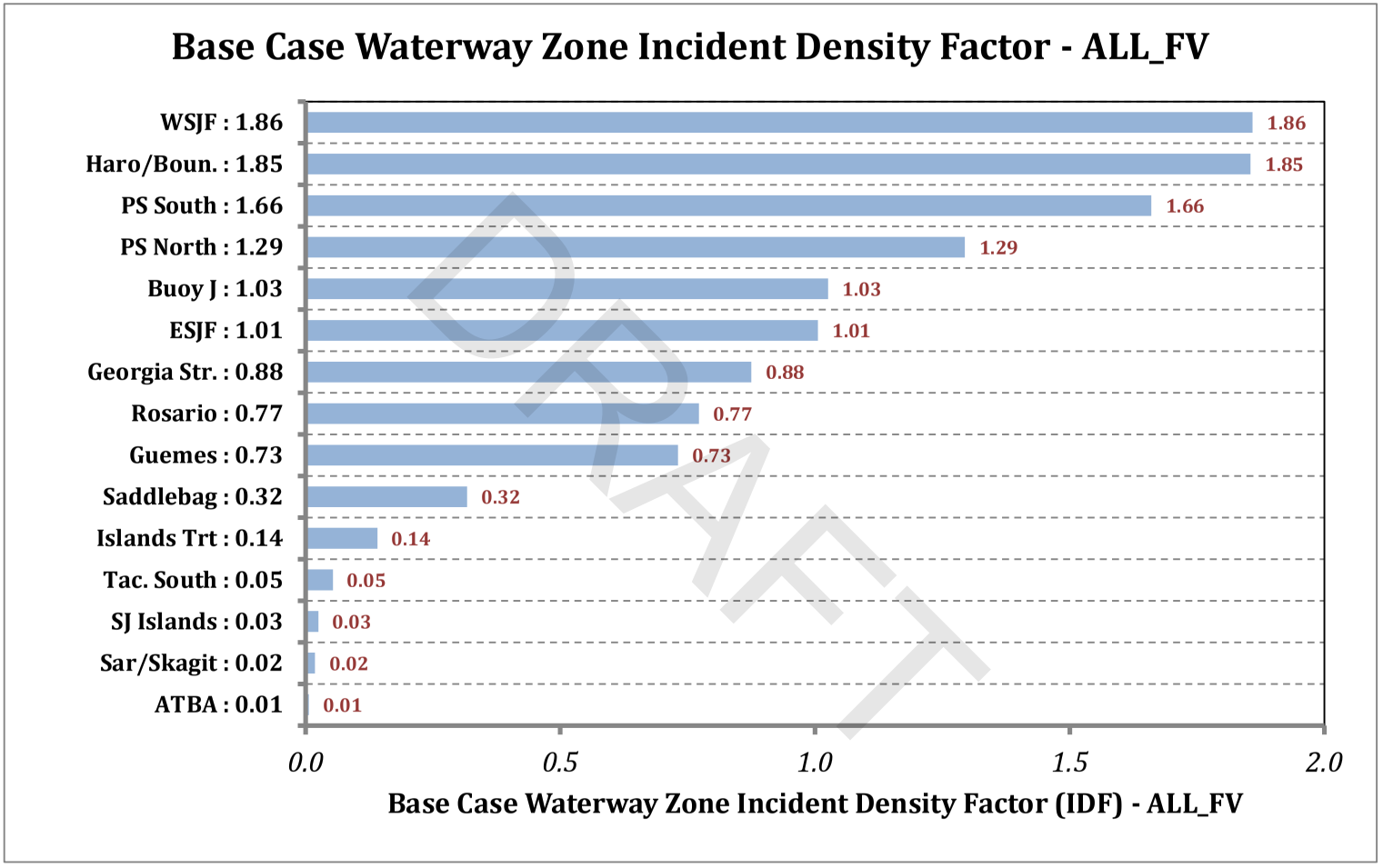
VESSEL TRAFFIC RISK ASSESSMENT (VTRA) 2010

ALL FV ANALYSIS:
Bulk Carrier
Container Ship
Other Cargo
Oil Barge
Tanker
ATB
Chemical Carrier

Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*
WATERWAY ZONE	**# Grid Cells**	**% Area**	**VTRA 2010 Potential # FV Incidents per Year**	**Incident Density Factor (IDF) ALL_FV**
WSJF	2901	18.2%	172	1.86
PS South	749	4.7%	40	1.66
Guemes	149	0.9%	3	0.73
ESJF	2079	13.1%	67	1.01
Georgia Str.	1470	9.2%	41	0.88
PS North	1152	7.2%	48	1.29
Saddlebag	449	2.8%	5	0.32
Haro/Boun.	1151	7.2%	68	1.85
Rosario	357	2.2%	9	0.77
Buoy J	1512	9.5%	50	1.03
ATBA	1518	9.5%	0	0.01
Tac. South	499	3.1%	1	0.05
SJ Islands	349	2.2%	0	0.03
Sar/Skagit	597	3.8%	0	0.02
Islands Trt	979	6.2%	4	0.14
Total	**15911**	**100.0%**	**508**	**1.00**

INCIDENT DENSITY FACTOR (IDF): IDF =1.00 when incident rate per year per square mile equals the average for the entire VTRA Study AREA <u>including all FV</u>

VESSEL TRAFFIC RISK ASSESSMENT (VTRA) 2010



INCIDENT DENSITY FACTOR (IDF): IDF =1.00 when incident rate per year per square mile equals the average for the entire VTRA Study AREA <u>including all FV</u>

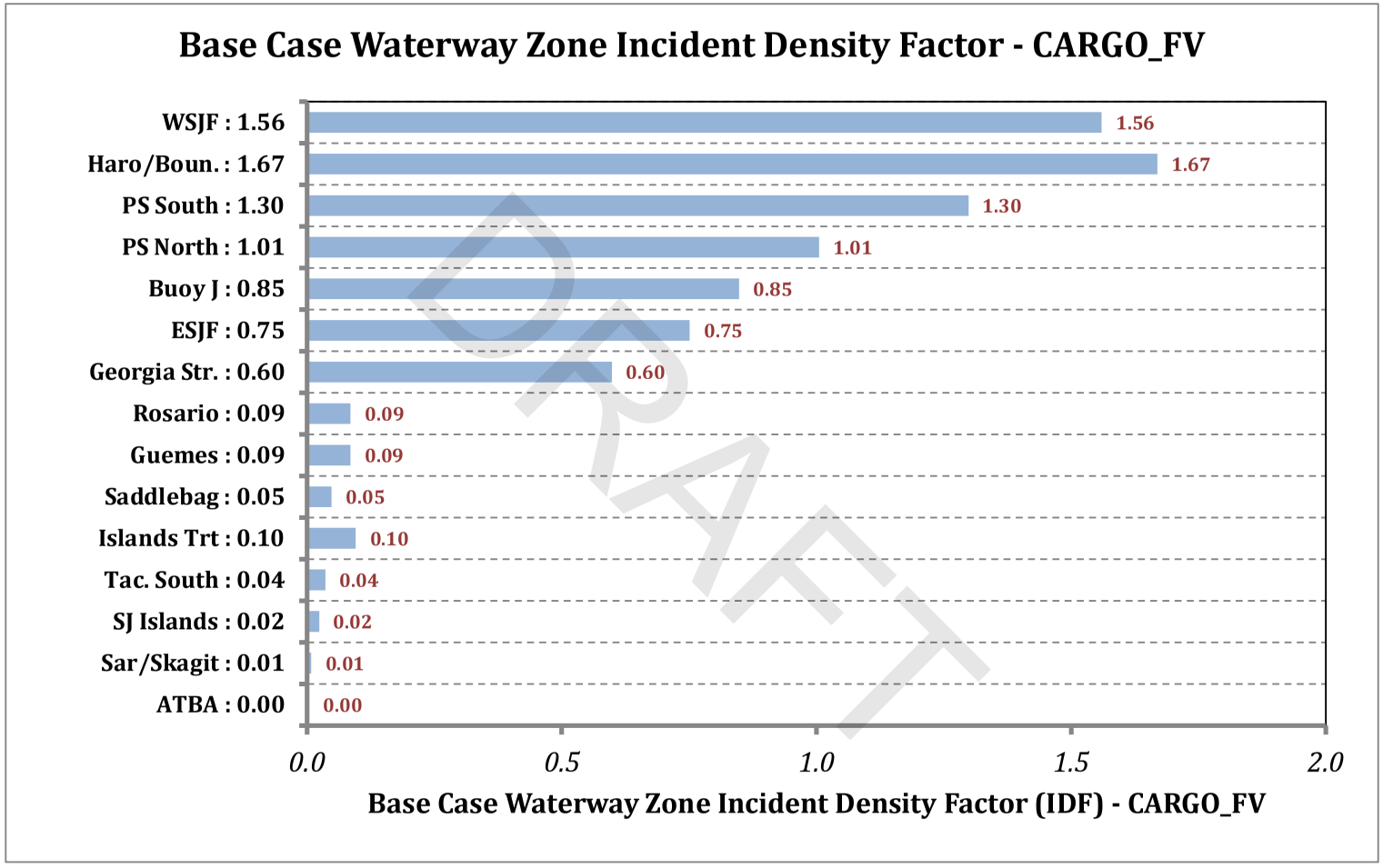
VESSEL TRAFFIC RISK ASSESSMENT (VTRA) 2010

CARGO FV ANALYSIS:
Bulk Carrier
Container Ship
Other Cargo

Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*
WATERWAY ZONE	**# Grid Cells**	**% Area**	**VTRA 2010 Potential # FV Incidents per Year**	**Incident Density Factor (IDF) CARGO_FV**
WSJF	2901	18.2%	144	1.56
PS South	749	4.7%	31	1.30
Guemes	149	0.9%	0	0.09
ESJF	2079	13.1%	50	0.75
Georgia Str.	1470	9.2%	28	0.60
PS North	1152	7.2%	37	1.01
Saddlebag	449	2.8%	1	0.05
Haro/Boun.	1151	7.2%	61	1.67
Rosario	357	2.2%	1	0.09
Buoy J	1512	9.5%	41	0.85
ATBA	1518	9.5%	0	0.00
Tac. South	499	3.1%	1	0.04
SJ Islands	349	2.2%	0	0.02
Sar/Skagit	597	3.8%	0	0.01
Islands Trt	979	6.2%	3	0.10
Total	**15911**	**100.0%**	**399**	**0.79**

INCIDENT DENSITY FACTOR (IDF): IDF =1.00 when incident rate per year per square mile equals the average for the entire VTRA Study AREA including all FV

VESSEL TRAFFIC RISK ASSESSMENT (VTRA) 2010



INCIDENT DENSITY FACTOR (IDF): IDF =1.00 when incident rate per year per square mile equals the average for the entire VTRA Study AREA <u>including all FV</u>

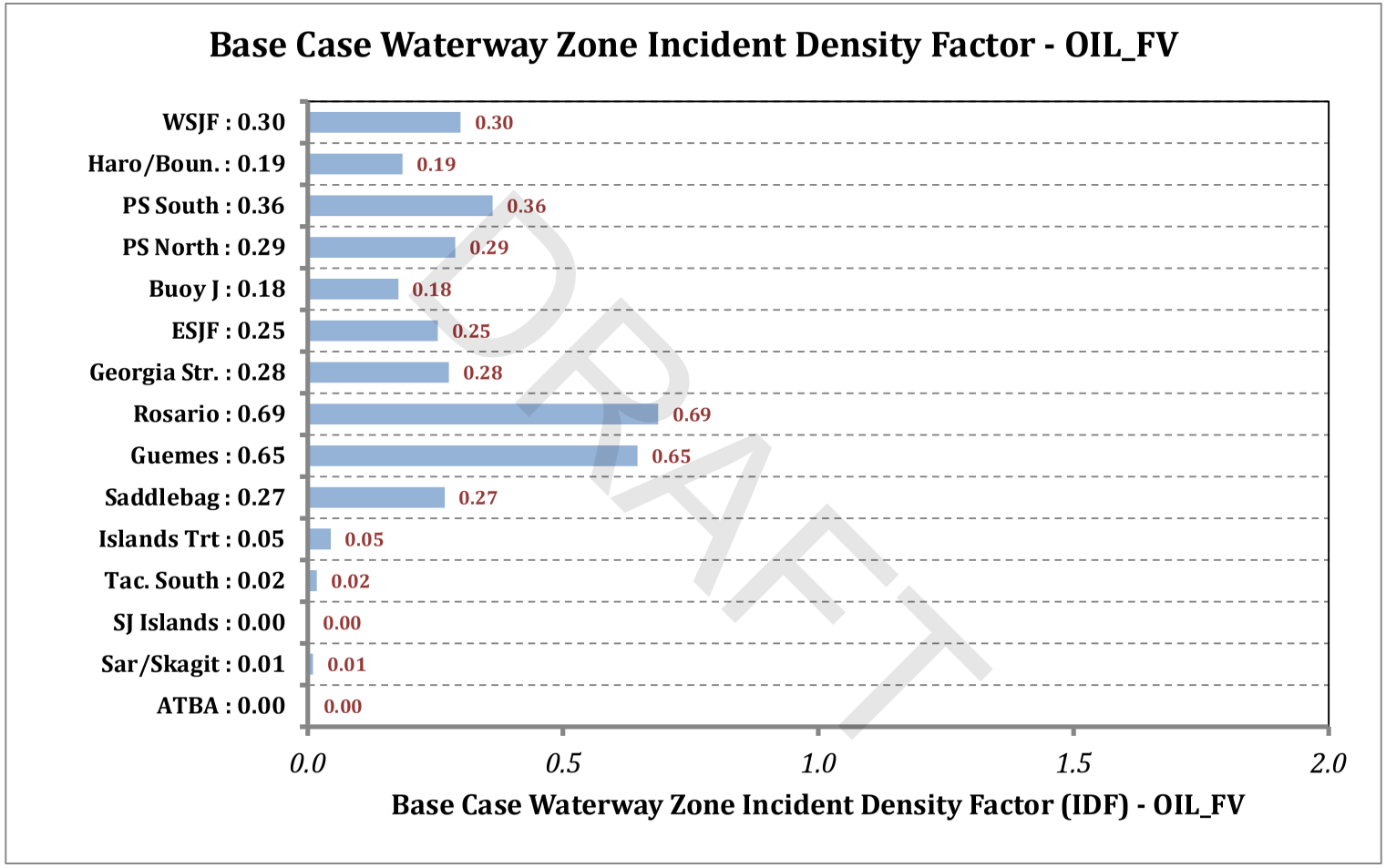
VESSEL TRAFFIC RISK ASSESSMENT (VTRA) 2010

ALL FV ANALYSIS:
Oil Barge
Tanker
ATB
Chemical Carrier

Column 1	*Column 2*	*Column 3*	*Column 4*	*Column 5*
WATERWAY ZONE	**# Grid Cells**	**% Area**	**VTRA 2010 Potential # FV Incidents per Year**	**Incident Density Factor (IDF) OIL_FV**
WSJF	2901	18.2%	28	0.30
PS South	749	4.7%	9	0.36
Guemes	149	0.9%	3	0.65
ESJF	2079	13.1%	17	0.25
Georgia Str.	1470	9.2%	13	0.28
PS North	1152	7.2%	11	0.29
Saddlebag	449	2.8%	4	0.27
Haro/Boun.	1151	7.2%	7	0.19
Rosario	357	2.2%	8	0.69
Buoy J	1512	9.5%	9	0.18
ATBA	1518	9.5%	0	0.00
Tac. South	499	3.1%	0	0.02
SJ Islands	349	2.2%	0	0.00
Sar/Skagit	597	3.8%	0	0.01
Islands Trt	979	6.2%	1	0.05
Total	**15911**	**100.0%**	**109**	**0.21**

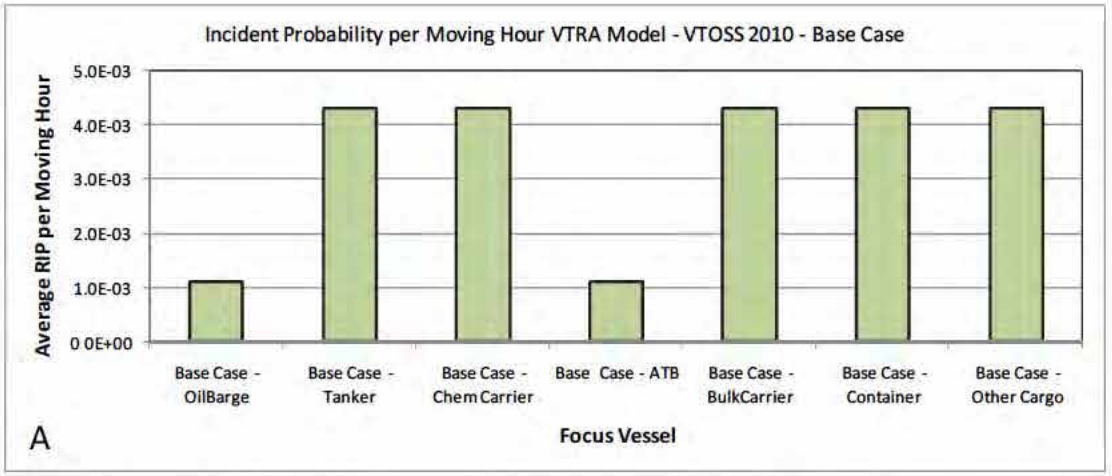
INCIDENT DENSITY FACTOR (IDF): IDF =1.00 when incident rate per year per square mile equals the average for the entire VTRA Study AREA including all FV

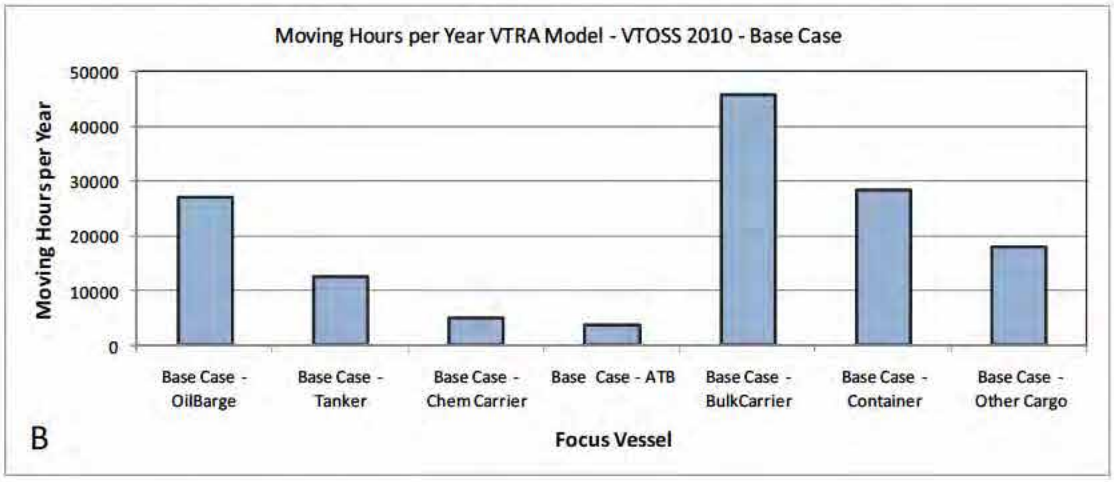
VESSEL TRAFFIC RISK ASSESSMENT (VTRA) 2010



INCIDENT DENSITY FACTOR (IDF): IDF =1.00 when incident rate per year per square mile equals the average for the entire VTRA Study AREA <u>including all FV</u>

Appendix C:
Page 62 from Puget Sound Partnership VTRA 2010 Final Report





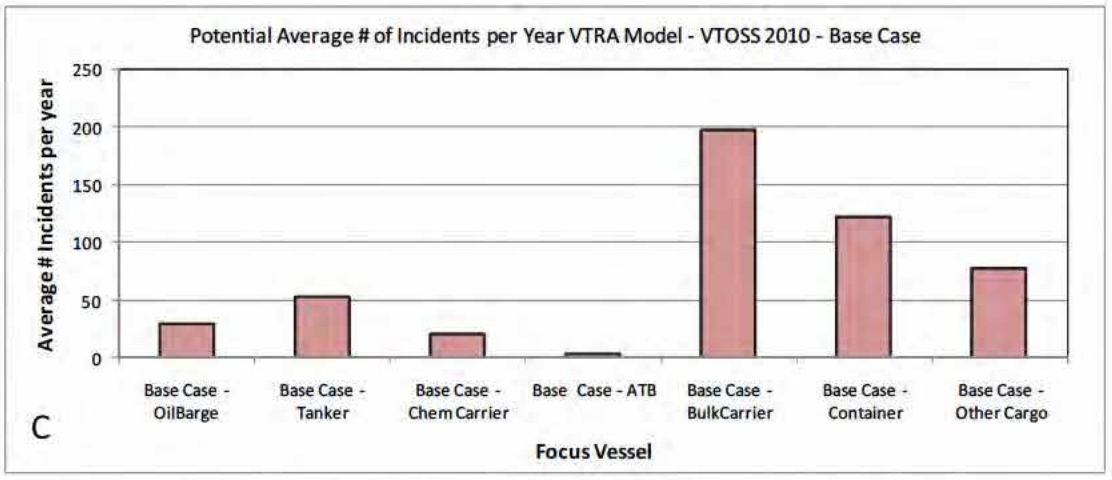


Figure 35. A: Incident rate per moving hour by focus vessel; B: Moving hours in VTRA 2010 model by focus vessel; C: Potential number incidents per year by focus vessel

Appendix D: Definition of the fifteen VTRA 2010 Waterway Zones

VESSEL TRAFFIC RISK ASSESSMENT (VTRA) 2010

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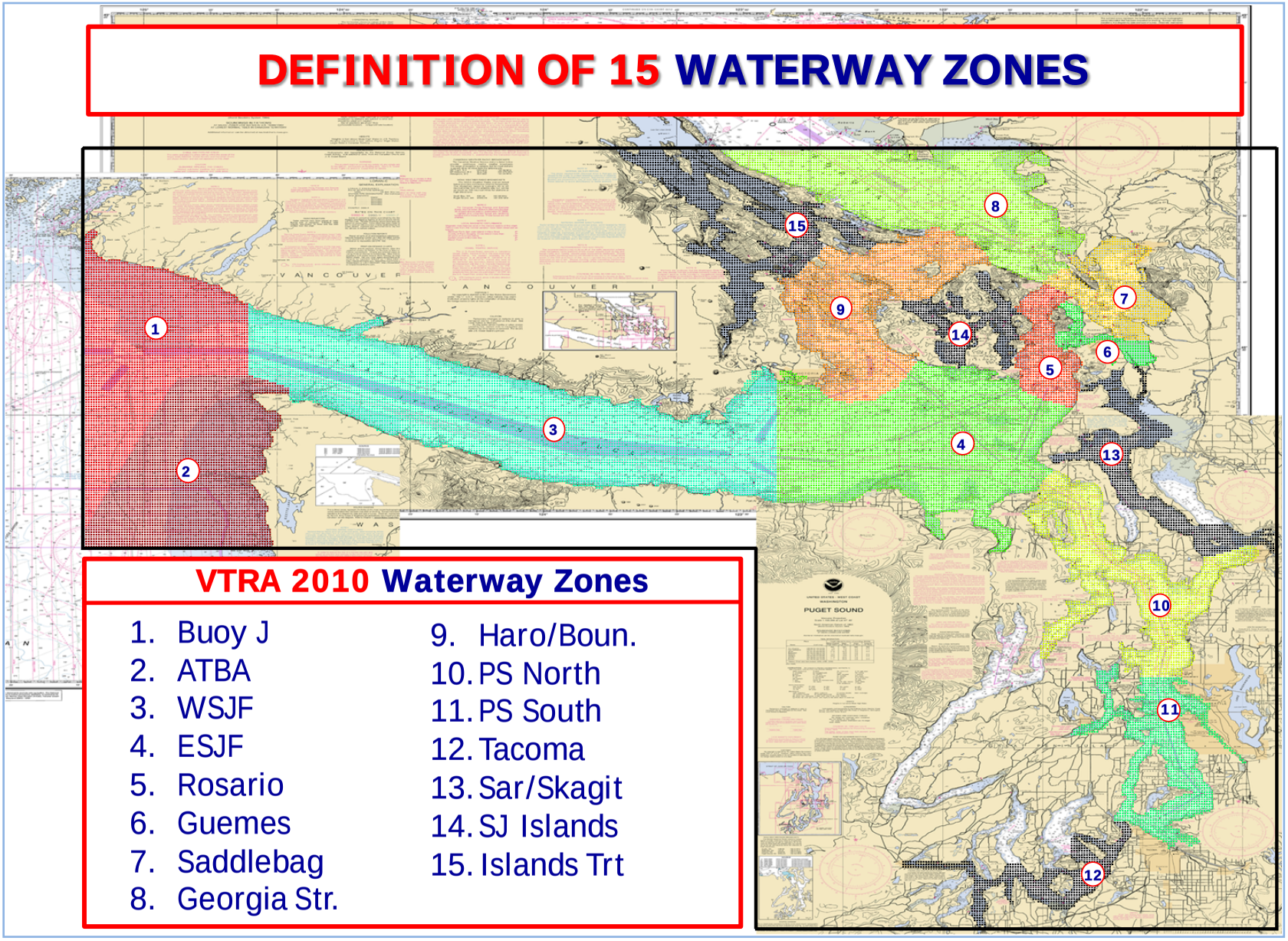
DEFINITION OF 15 WATERWAY ZONES



VTRA 2010 Waterway Zones

1. Buoy J
2. ATBA
3. WSJF
4. ESJF
5. Rosario
6. Guemes
7. Saddlebag
8. Georgia Str.
9. Haro/Boun.
10. PS North
11. PS South
12. Tacoma
13. Sar/Skagit
14. SJ Islands
15. Islands Trt