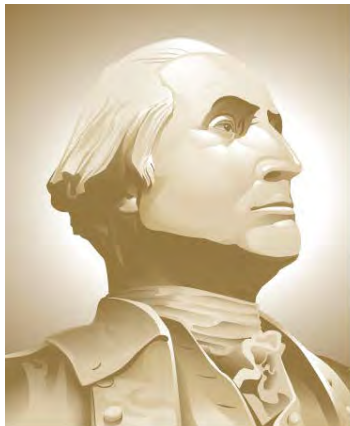


VTRA 2010 TRAFFIC DENSITIES BY CARGO – FV and TANK- FV

Presentation by: J. Rene van Dorp



THE GEORGE
WASHINGTON
UNIVERSITY

WASHINGTON, DC

VCU

CASE T: Gateway, Kinder Morgan, Delta Port

GWU Personnel: Dr. J. Rene van Dorp

VCU Personnel: Dr. Jason R. W. Merrick

OCTOBER 9, 2013

PRELIMINARY

Table. Focus Vessel (FV) Classification for the 26 VTOSS vessel type classification used in the GW/VCU MTS simulation model.

- NON – FV** : Those vessels that Interacting Vessels (IV) with Focus Vessels (FV)
- BASE CASE CARGO – FV** : Bulk Carriers, Container Vessels, Other Cargo Vessels that travel in VTRA 2010 Base Case
- BASE CASE TANK – FV** : Oil Barge, Oil Tankers, Chemical Carrier, ATB 's that travel in VTRA 2010 Base Case
- WHAT IF – FV** : CARGO AND TANK FV'S added to VTRA 2010 Base Case to model What-If Scenario

Note: Focus Vessels (FV's) are also considered as Interacting Vessels (IV's) when interacting with another Focus Vessel.

#	VESSEL TYPE	FOCUS VESSEL?	#	VESSEL TYPE	FOCUS VESSEL?
1	BULKCARRIER	CARGO - FV	14	PASSENGERSHIP	NO
2	CHEMICALCARRIER	TANK - FV	15	REFRIGERATEDCARGO	CARGO-FV
3	CONTAINERSHIP	CARGO - FV	16	RESEARCHSHIP	NO
4	DECKSHIPCARGO	CARGO - FV	17	ROROCARGOSHIP	CARGO-FV
5	FERRY	NO	18	ROROCARGOCONTSHIP	CARGO-FV
6	FERRYNONLOCAL	NO	19	SUPPLYOFFSHORE	NO
7	FISHINGFACTORY	NO	20	TUGTOWBARGE	NO
8	FISHINGVESSEL	NO	21	UNKNOWN	NO
9	LIQGASCARRIER	TANK - FV	22	USCOASTGUARD	NO
10	NAVYVESSEL	NO	23	VEHICLECARRIER	CARGO-FV
11	OILTANKER	TANK - FV	24	YACHT	NO
12	OTHERSPECIALCARGO	CARGO - FV	25	ATB	TANK - FV
13	OTHERSPECIFCSERV	NO	26	OIL BARGE	TANK - FV

IMPORTANT:

THE OPERATIVE WORD IN PRESENTING THESE ANALYSIS RESULTS IS THE USE OF THE WORD

POTENTIAL

TO INDICATE THAT THESE ANALYSIS RESULTS DO NOT FOLLOW FROM AN HISTORICAL DATA ANALYSIS, BUT THROUGH THE USE OF AN ANALYSIS TOOL THAT EVALUATES SUCH **POTENTIAL**.

THE 2010 YEAR IS CONSIDERED **THE BASE CASE YEAR** AND A BASE CASE YEAR POTENTIAL IS EVALUATED.

NEXT, **WHAT-IF SCENARIOS** ARE DEVELOPED FROM THE BASE CASE BY ADDING ADDITIONAL HYPOTHETICAL TRAFFIC AND A WHAT-IF POTENTIAL IS EVALUATED AND COMPARED **RELATIVE TO THE BASE CASE** TO INFORM **RISK MANAGEMENT**.

CASE T: GW 487, KM 348, DP 348 and 67:

**BASE CASE 2010 TRAFFIC WITH
FOLLOWING WHAT-IF FOCUS VESSELS**

487 Gateway Bulk Carriers + Bunkering Barges

348 Kinder Morgan Tankers + Bunkering Barges

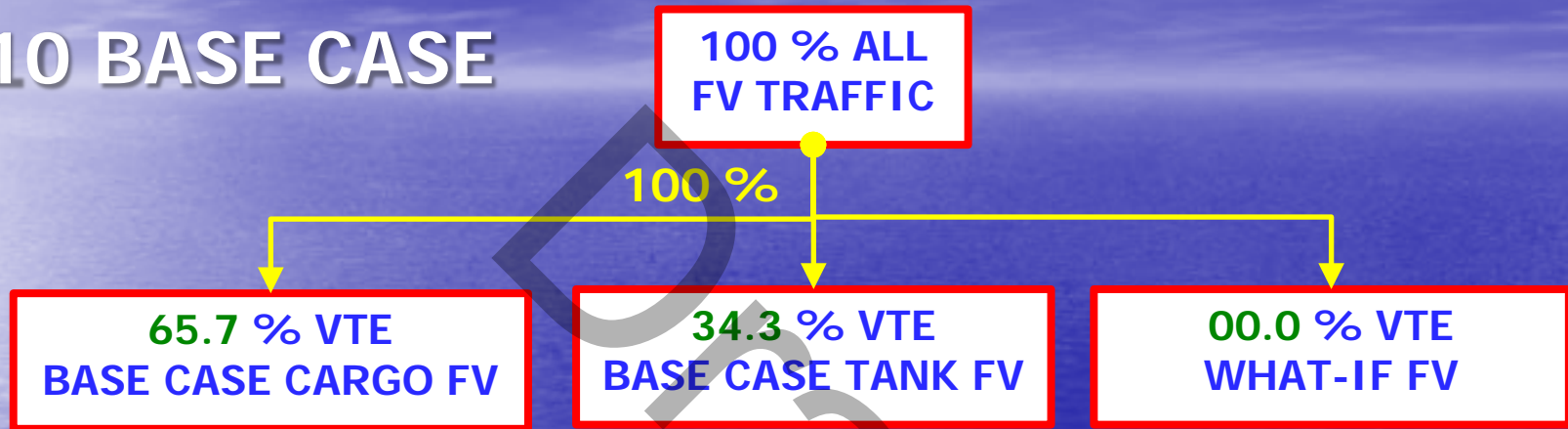
348 Delta Port Bulk Carriers + Bunkering Barges

67 Delta Port Container Ships+ Bunkering Barges

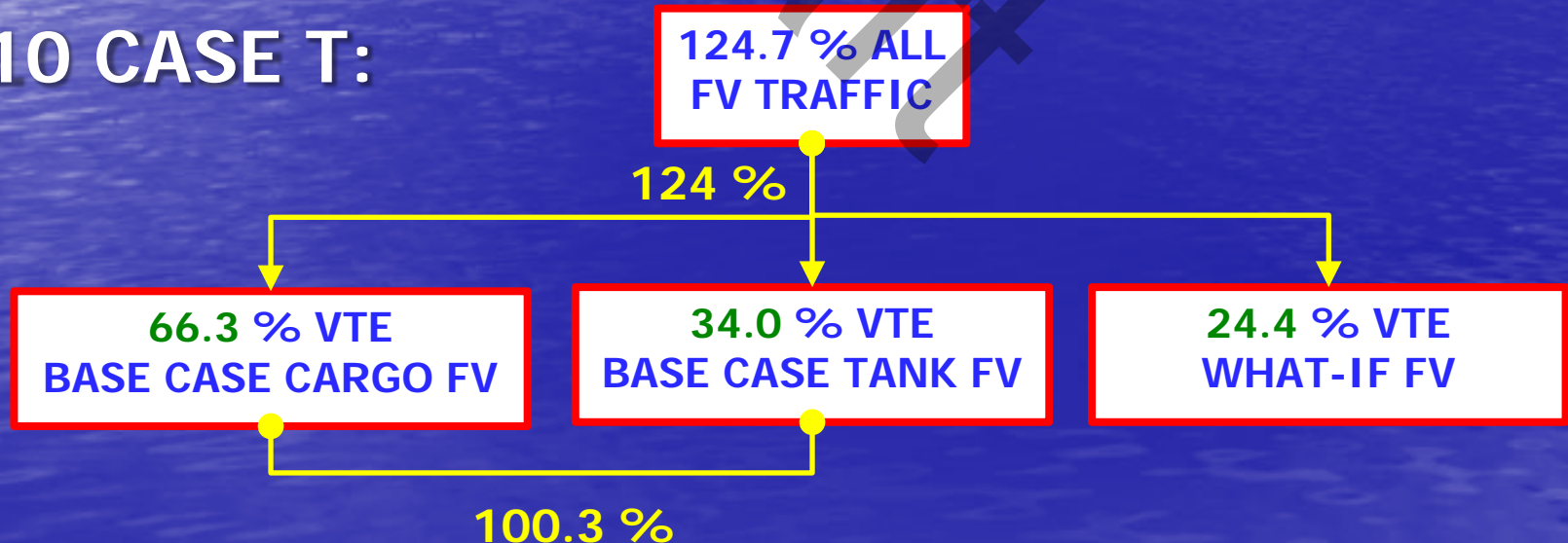
A TAXONOMY OF 2010 FOCUS VESSEL POTENTIAL TOTAL TIME OF EXPOSURE

VTE : TOTAL TIME OF EXPOSURE - PER YEAR

2010 BASE CASE

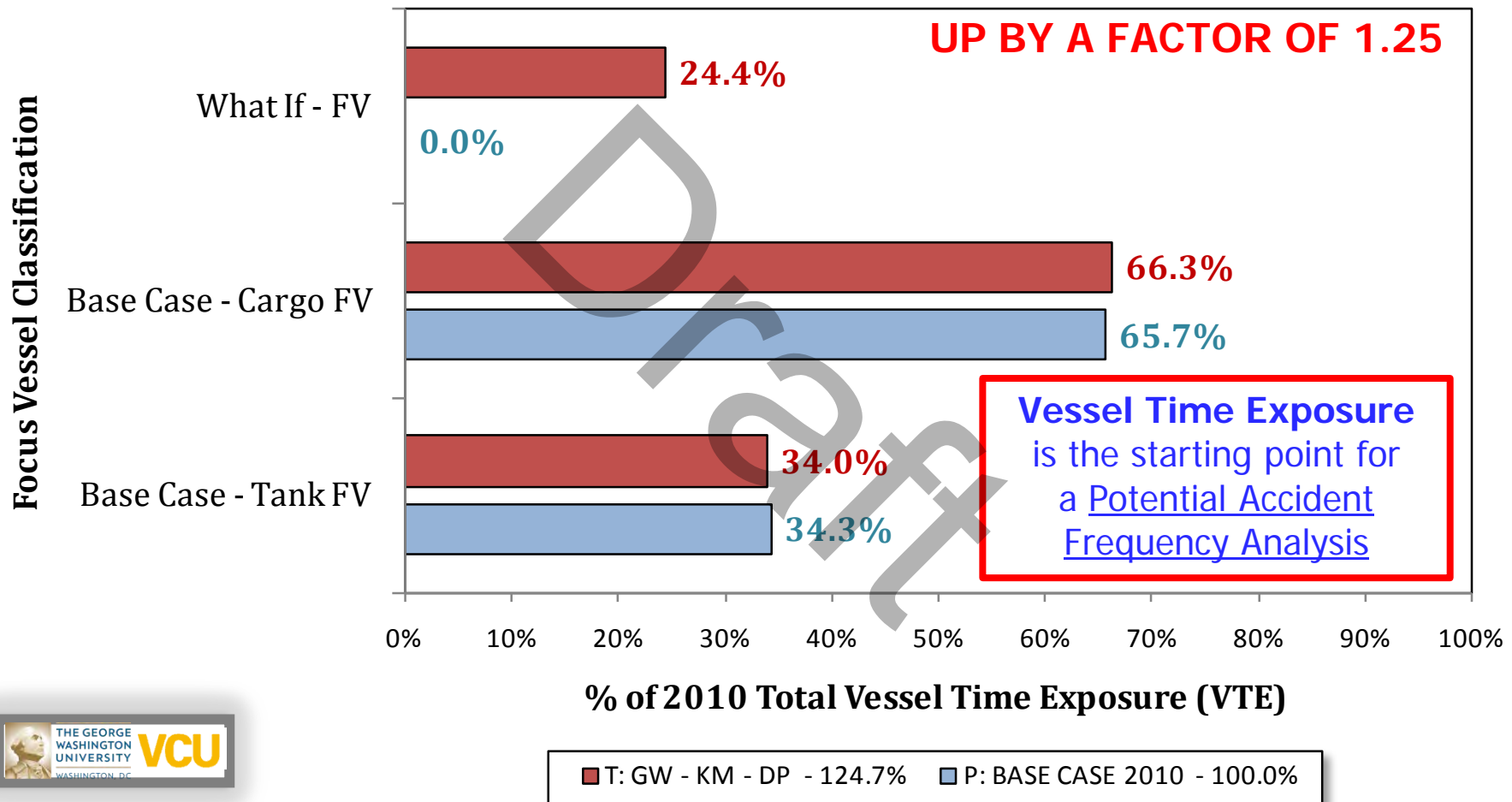


2010 CASE T:



CASE T: GW 487, KM 348, DP 348 and 67:

VTRA 2010 - Total Vessel Time of Exposure (VTE)



VTE = VESSEL TIME EXPOSURE:

TOTAL AMOUNT OF ANNUAL TIME A FOCUS VESSEL IS MOVING IN THE VTRA STUDY AREA

CASE T: GW 487, KM 348, DP 348 and 67:

FINDINGS - VTE:

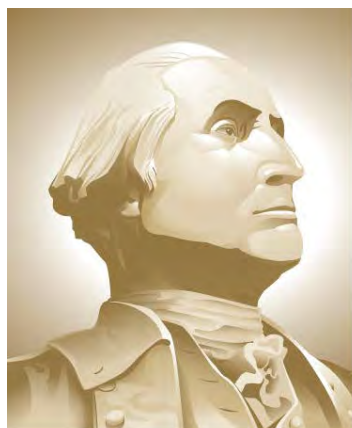
1. Base Case Cargo Focus vessels travel about same amount of time when including additional Gateway, Kinder Morgan and Delta Port Vessels.
2. Base Case Cargo Focus vessels travel about same amount of time when including additional Gateway, Kinder Morgan and Delta Port Vessels.
3. Case T What-If Focus Vessels add about 24.7% of Focus Vessel Traffic to the 2010 – Base Case.

VTE = TOTAL TIME EXPOSURE:

TOTAL AMOUNT OF ANNUAL TIME A VESSEL IS MOVING IN THE VTRA STUDY AREA

VTRA 2010 TRAFFIC DENSITIES BY CARGO – FV and TANK- FV A WATERWAY BY LOCATION ANALYSIS

Presentation by: J. Rene van Dorp



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WASHINGTON, DC

VCU

CASE T: Gateway, Kinder Morgan, Delta Port

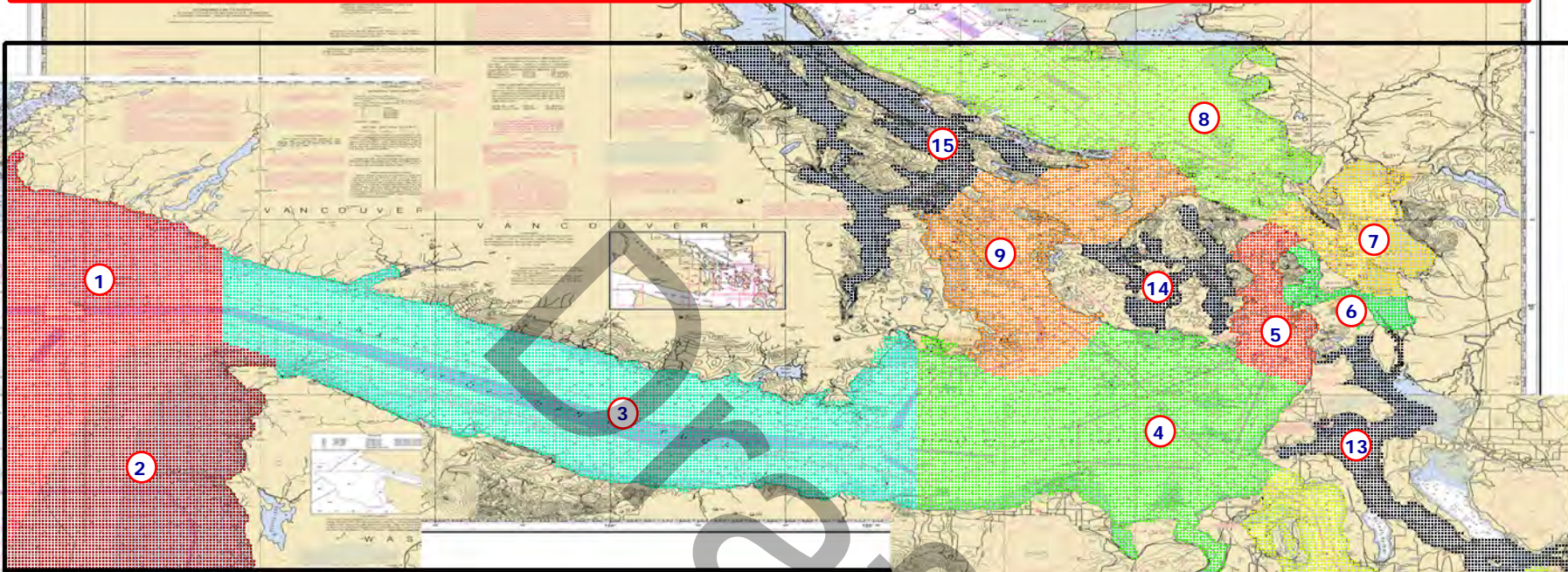
GWU Personnel: Dr. J. Rene van Dorp

VCU Personnel: Dr. Jason R. W. Merrick

OCTOBER 9, 2013

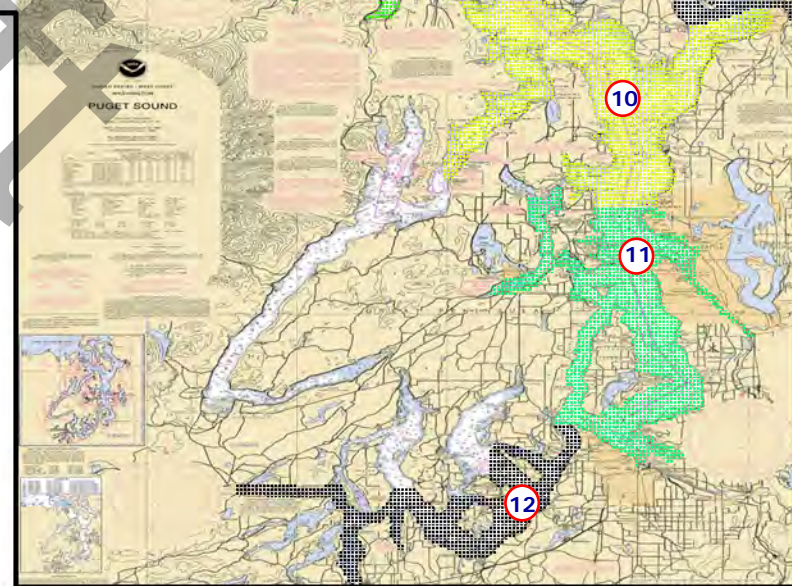
PRELIMINARY

DEFINITION OF 15 WATERWAY LOCATIONS



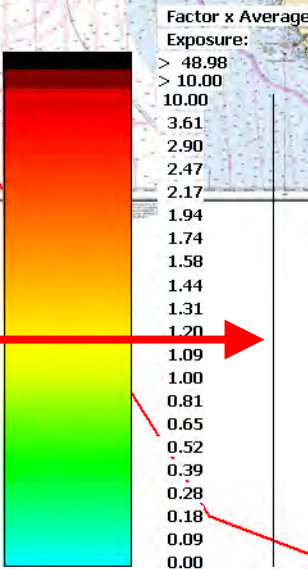
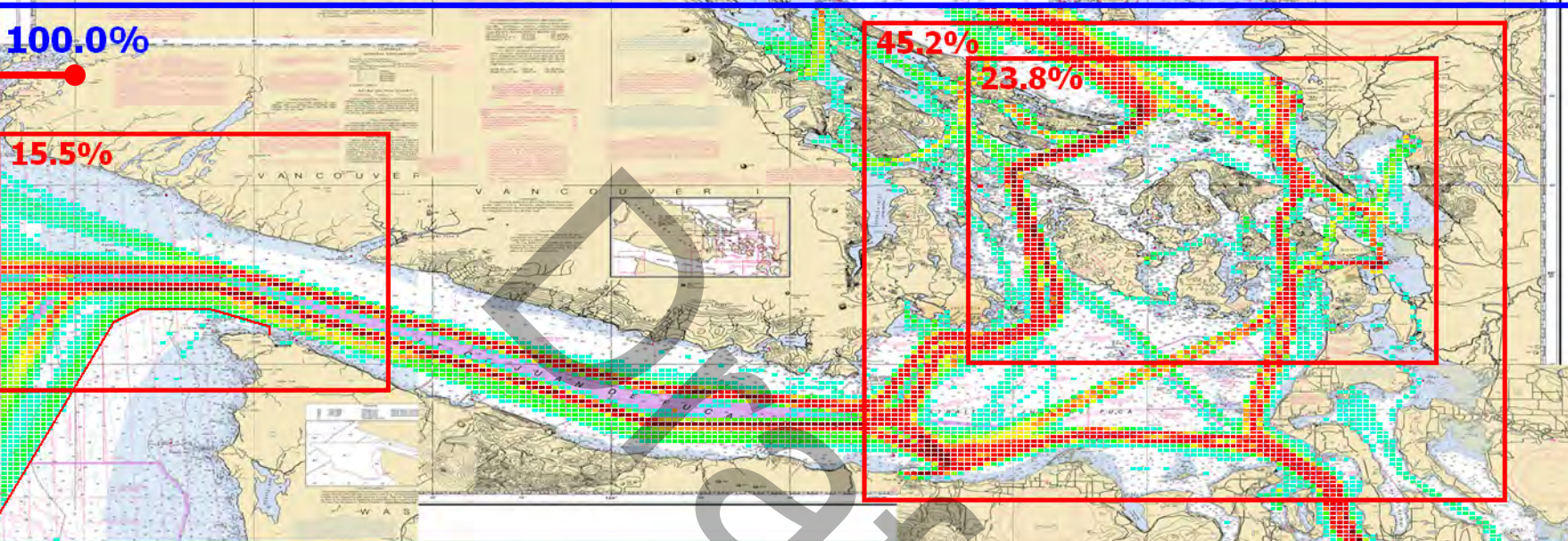
VTRA 2010 Waterway Locations

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



P: ALL FV Traffic Density

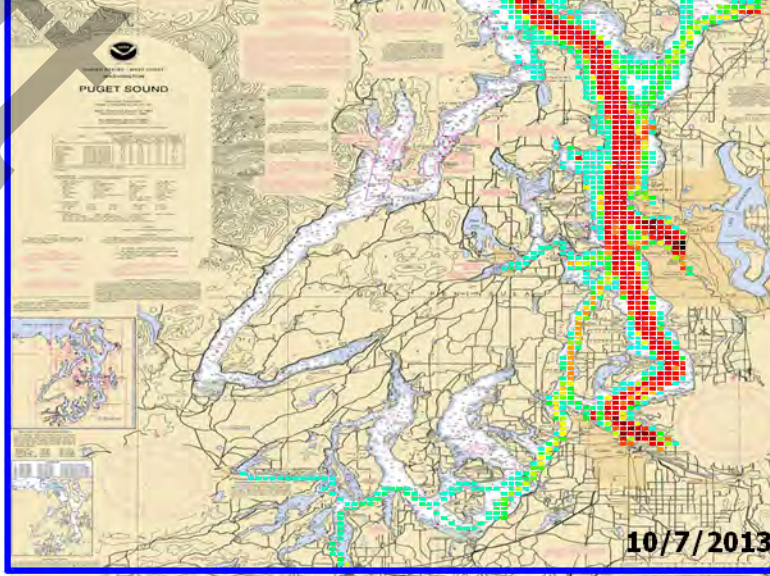
P: VTRA 2010 - BASE CASE - All FV



CASE P – ALL FV TRAFFIC DENSITY

65.7% - CARGO Focus Vessel
34.3% - OIL Focus Vessel
00.0% - WHAT-IF Focus Vessel

+
**100.0% of 2010 Base Case
ALL FV - VTE**



T: ALL FV Traffic Density

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348 - All FV

124.7%

19.9%

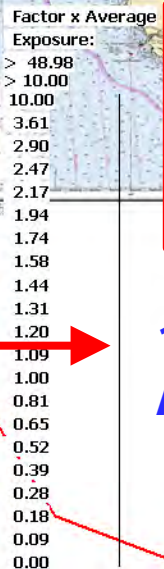
59.2%

33.5%

CASE T – ALL FV TRAFFIC DENSITY

- 66.3% - CARGO Focus Vessel
- 34.0% - TANK Focus Vessel
- 24.4% - WHAT IF Focus Vessel

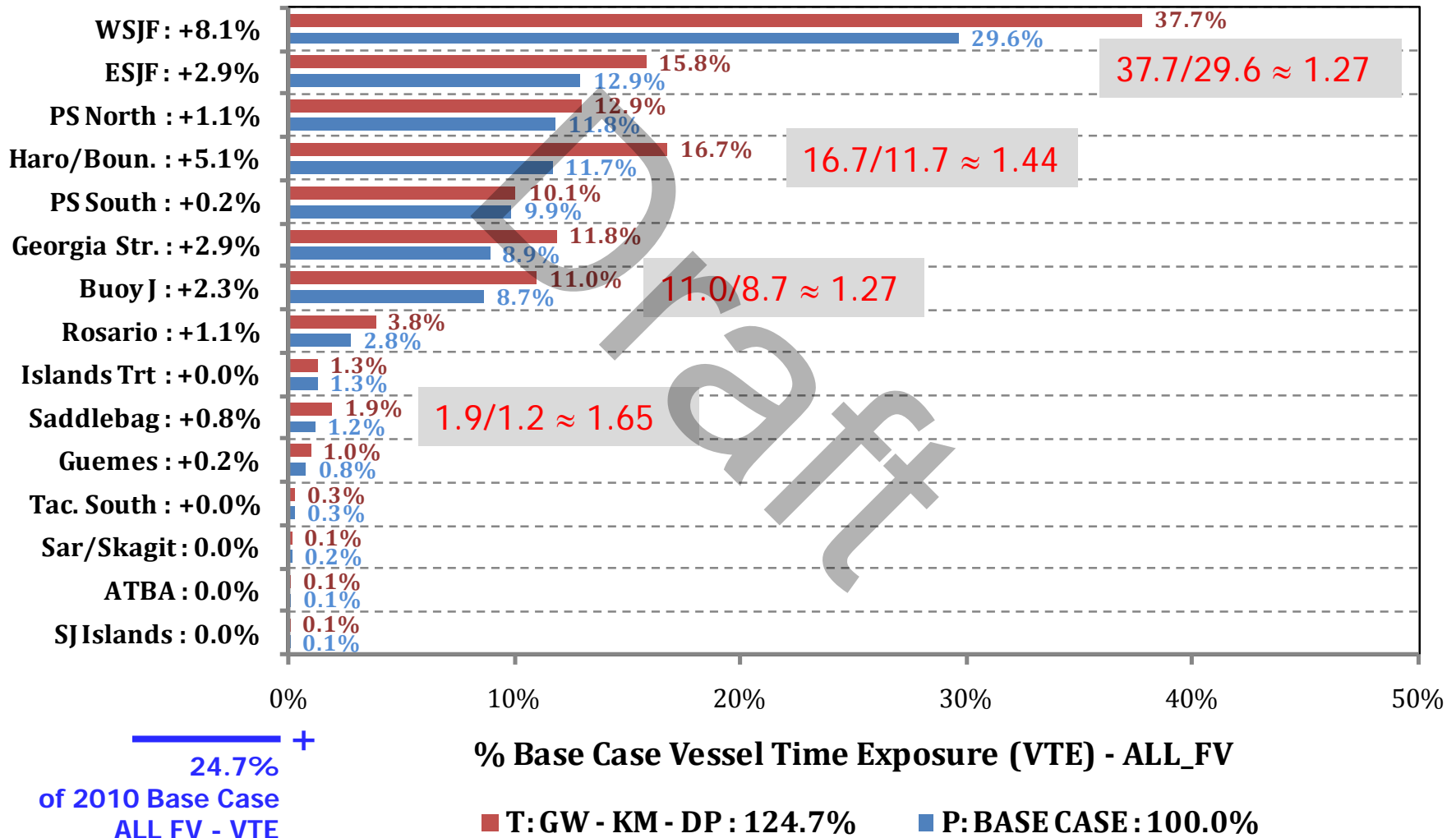
— +
124.7% of 2010 Base Case
ALL FV - VTE



WATERWAY LOCATION

VESSEL TIME EXPOSURE ANALYSIS – ALL FOCUS VESSELS

% Base Case Vessel Time Exposure (VTE) - ALL_FV



T: WHAT-IF FOCUS VESSEL Traffic Density



T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348

24.4%

4.5%

13.5%

9.2%

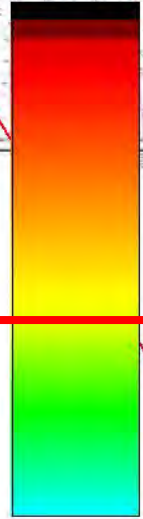
T : WHAT-IF FV TRAFFIC DENSITY

- 12.5% - BULK CARGO
- 01.8% - CONTAINERSHIP
- 07.3% - TANKER
- 02.7% - OILBARGE

**24.4% of 2010 Base Case
ALL FV - VTE**

Factor x Average Exposure:

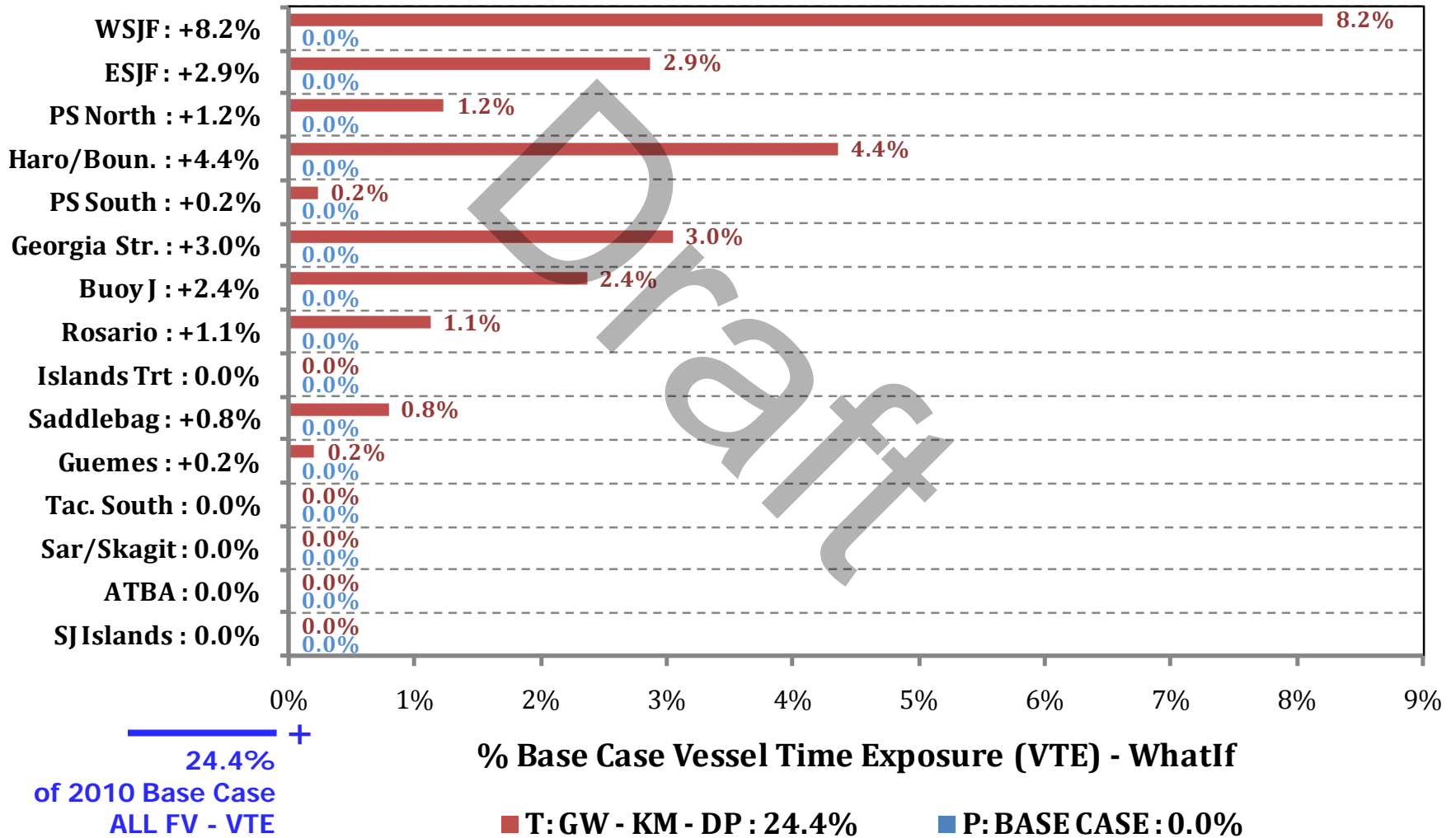
- > 48.98
- > 10.00
- 10.00
- 3.61
- 2.90
- 2.47
- 2.17
- 1.94
- 1.74
- 1.58
- 1.44
- 1.31
- 1.20
- 1.09
- 1.00
- 0.81
- 0.65
- 0.52
- 0.39
- 0.28
- 0.18
- 0.09
- 0.00



WATERWAY LOCATION

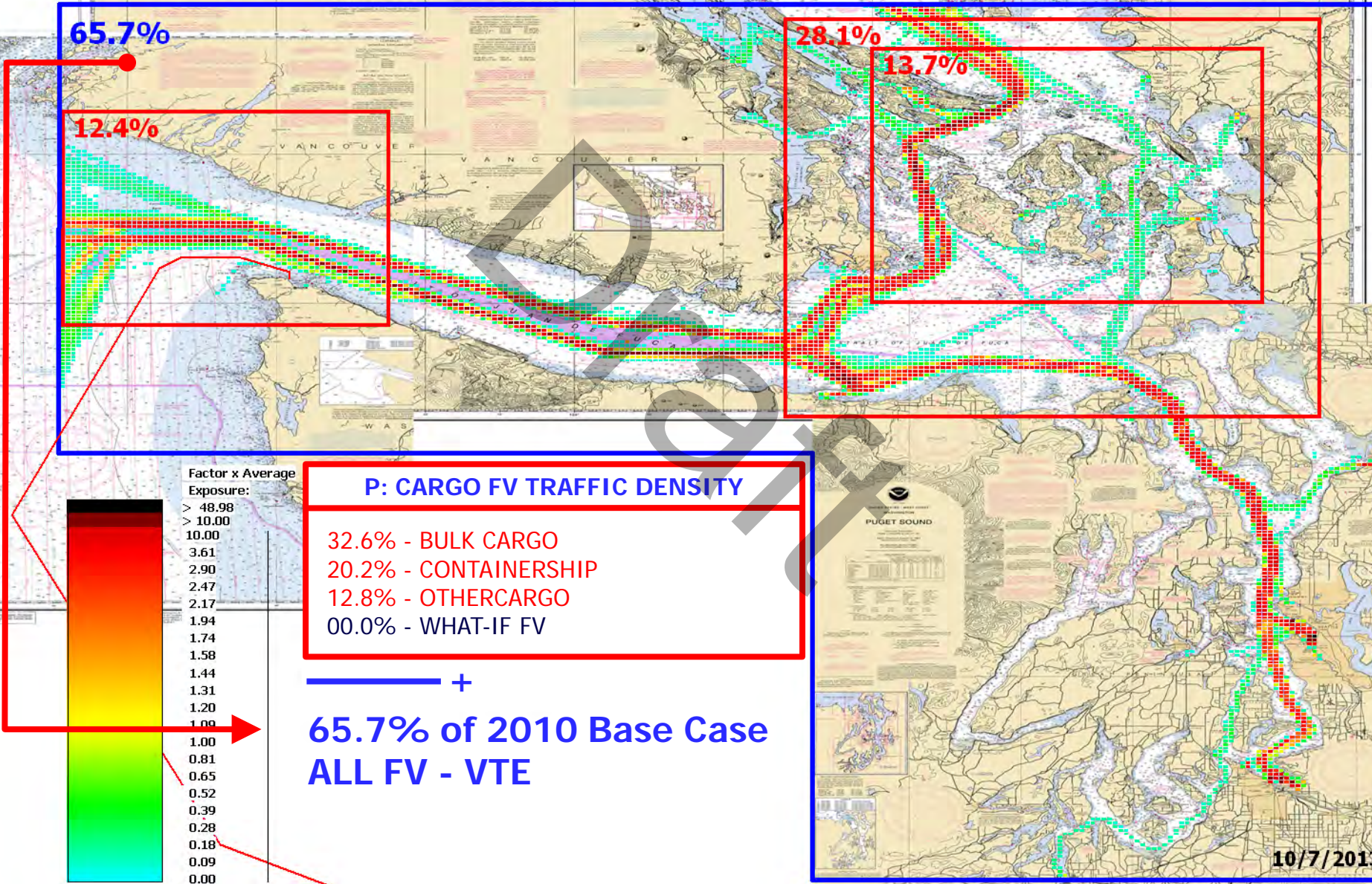
VESSEL TIME EXPOSURE ANALYSIS – What If FV

% Base Case Vessel Time Exposure (VTE) - WhatIf



P: BASE CASE CARGO FV
Traffic Density

P: VTRA 2010 - BASE CASE - Cargo FV



65.7%

12.4%

28.1%

13.7%

Factor x Average Exposure:

> 48.98
> 10.00
10.00
3.61
2.90
2.47
2.17
1.94
1.74
1.58
1.44
1.31
1.20
1.09
1.00
0.81
0.65
0.52
0.39
0.28
0.18
0.09
0.00

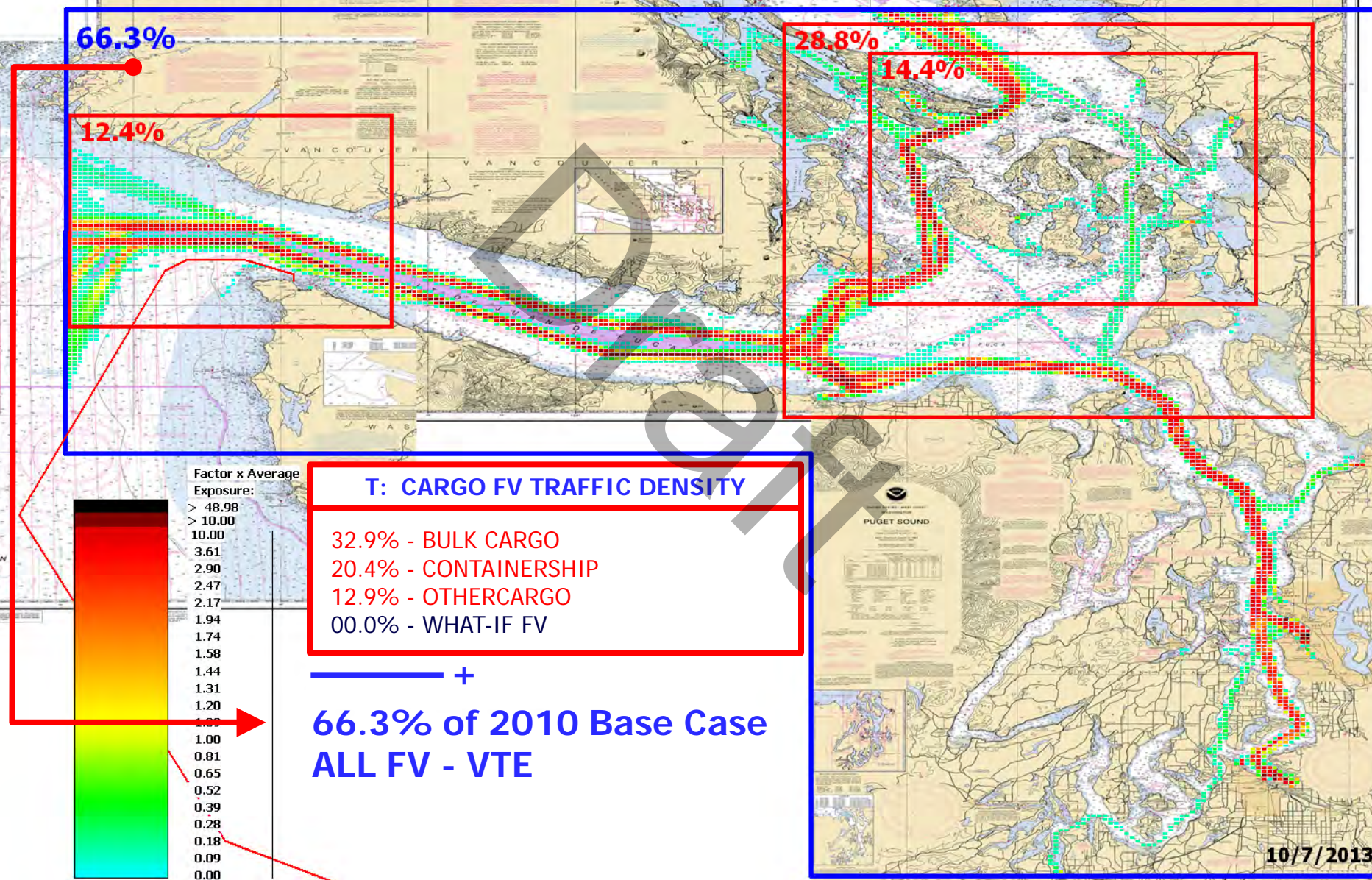
P: CARGO FV TRAFFIC DENSITY

- 32.6% - BULK CARGO
- 20.2% - CONTAINERSHIP
- 12.8% - OTHERCARGO
- 00.0% - WHAT-IF FV

— +
65.7% of 2010 Base Case
ALL FV - VTE

T: BASE CASE CARGO FV Traffic Density

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348 - Cargo FV

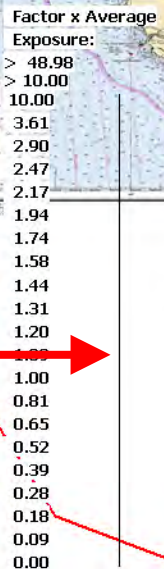


66.3%

12.4%

28.8%

14.4%



T: CARGO FV TRAFFIC DENSITY

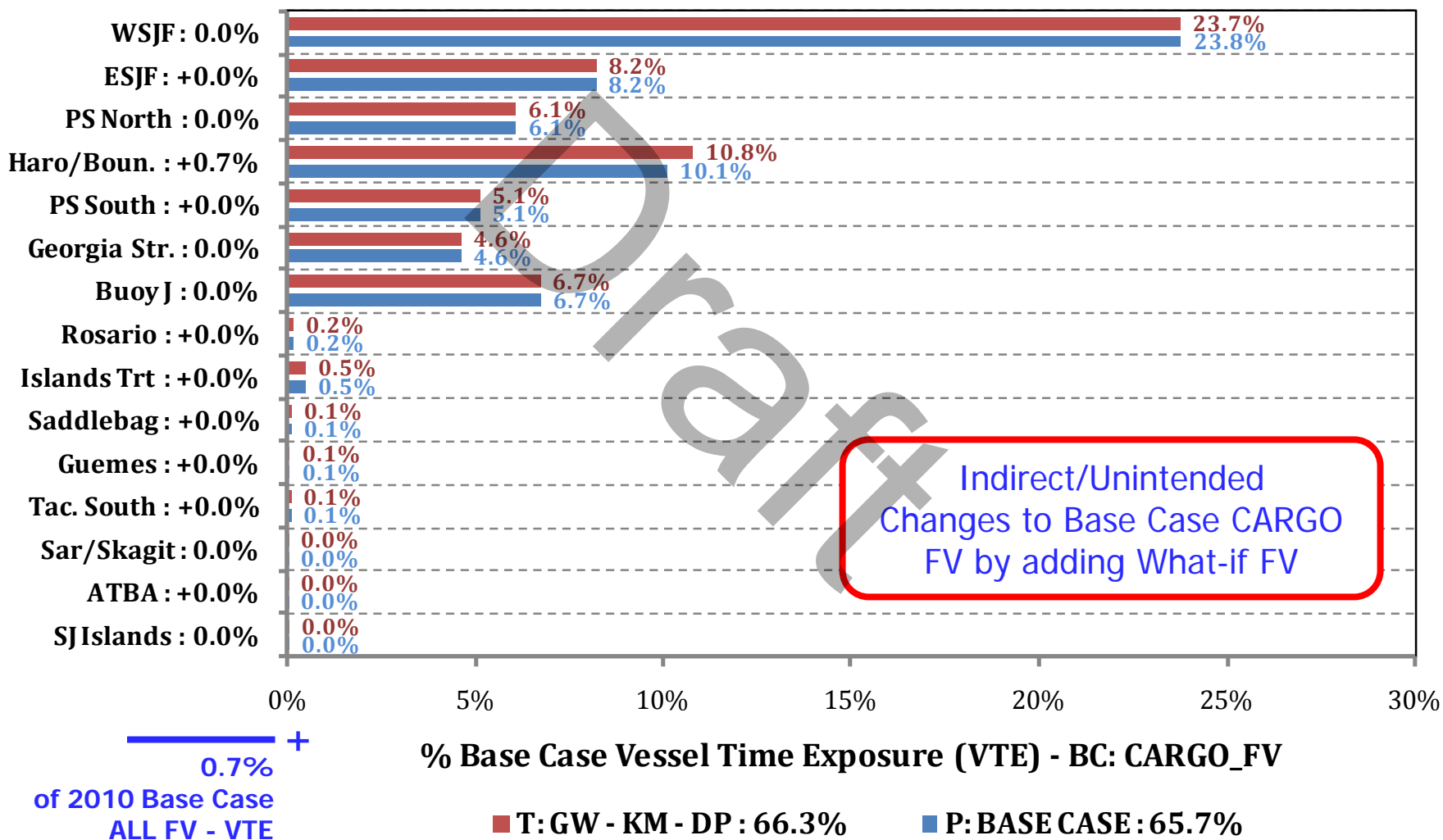
- 32.9% - BULK CARGO
- 20.4% - CONTAINERSHIP
- 12.9% - OTHERCARGO
- 00.0% - WHAT-IF FV

+
66.3% of 2010 Base Case
ALL FV - VTE

WATERWAY LOCATION

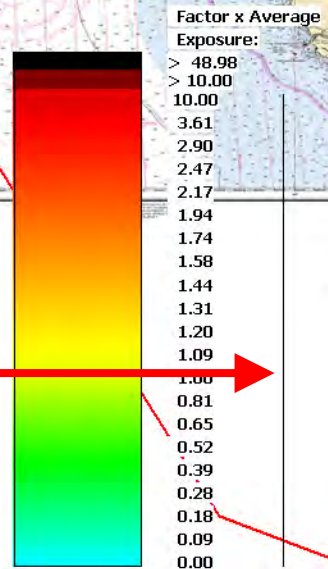
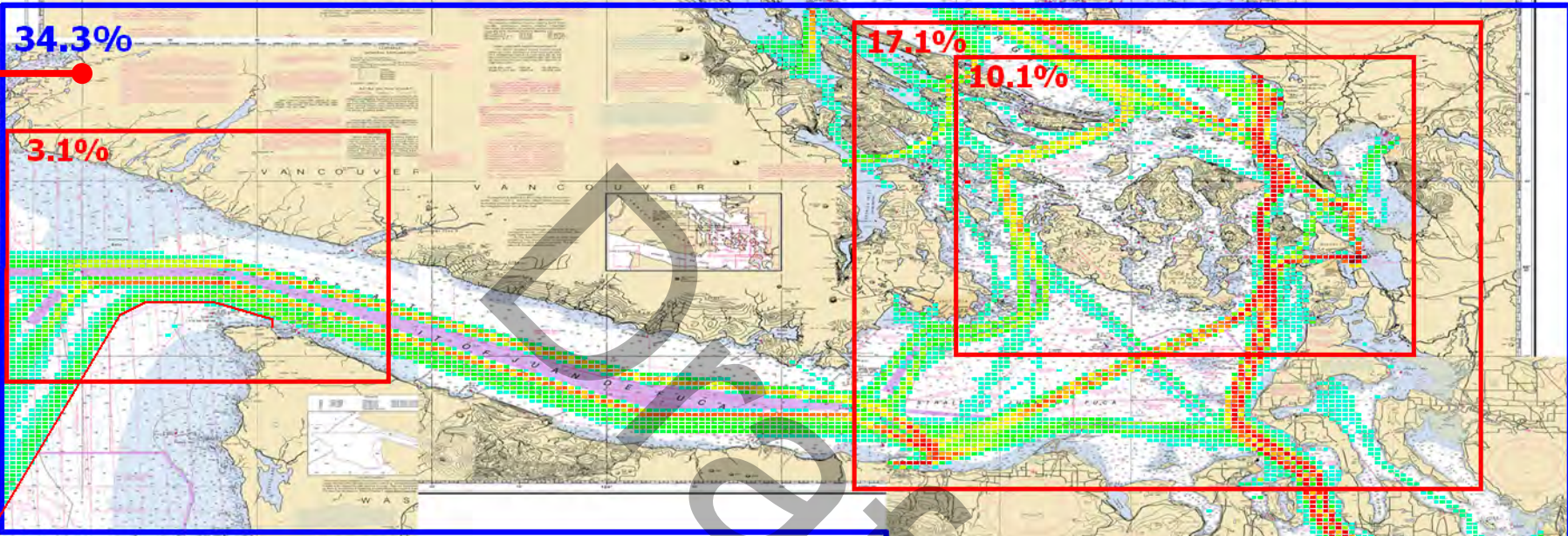
VESSEL TIME EXPOSURE ANALYSIS – BC CARGO FV

% Base Case Vessel Time Exposure (VTE) - BC: CARGO_FV



P: BASE CASE TANK FV
Traffic Density

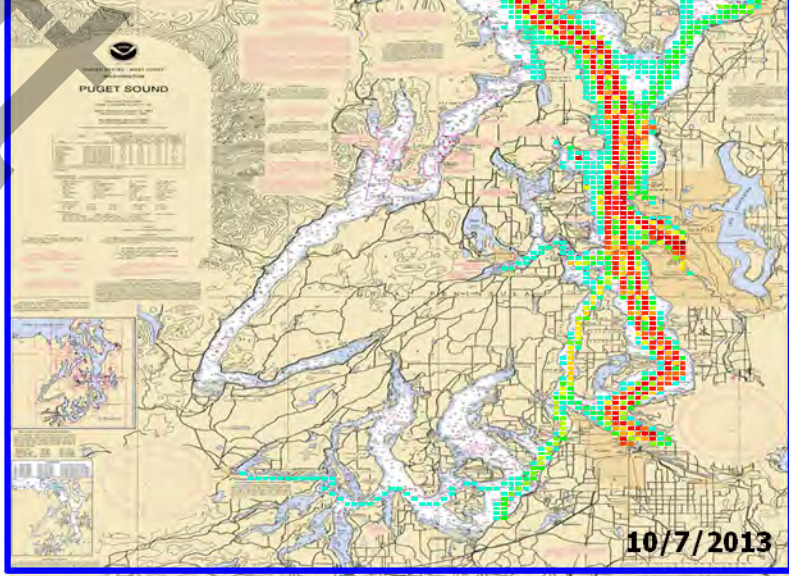
P: VTRA 2010 - BASE CASE - TANK FV



P: TANK FV TRAFFIC DENSITY

- 19.3% - OILBARGE
- 08.8% - OILTANKER
- 03.5% - CHEMICALCARRIER
- 02.7% - ATB
- 00.0% - WHAT-IF FV

+ 34.3% of 2010 Base Case ALL FV - VTE



T: BASE CASE TANK FV Traffic Density

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348 - TANK FV

34.0%

3.1%

16.9%

10.0%

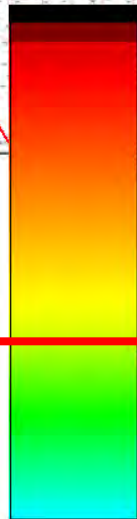
T: TANK FV TRAFFIC DENSITY

- 19.1% - OILBARGE
- 08.7% - OILTANKER
- 03.6% - CHEMICALCARRIER
- 02.6% - ATB
- 00.0% - WHAT-IF FV

— +
34.0% of 2010 Base Case
ALL FV - VTE

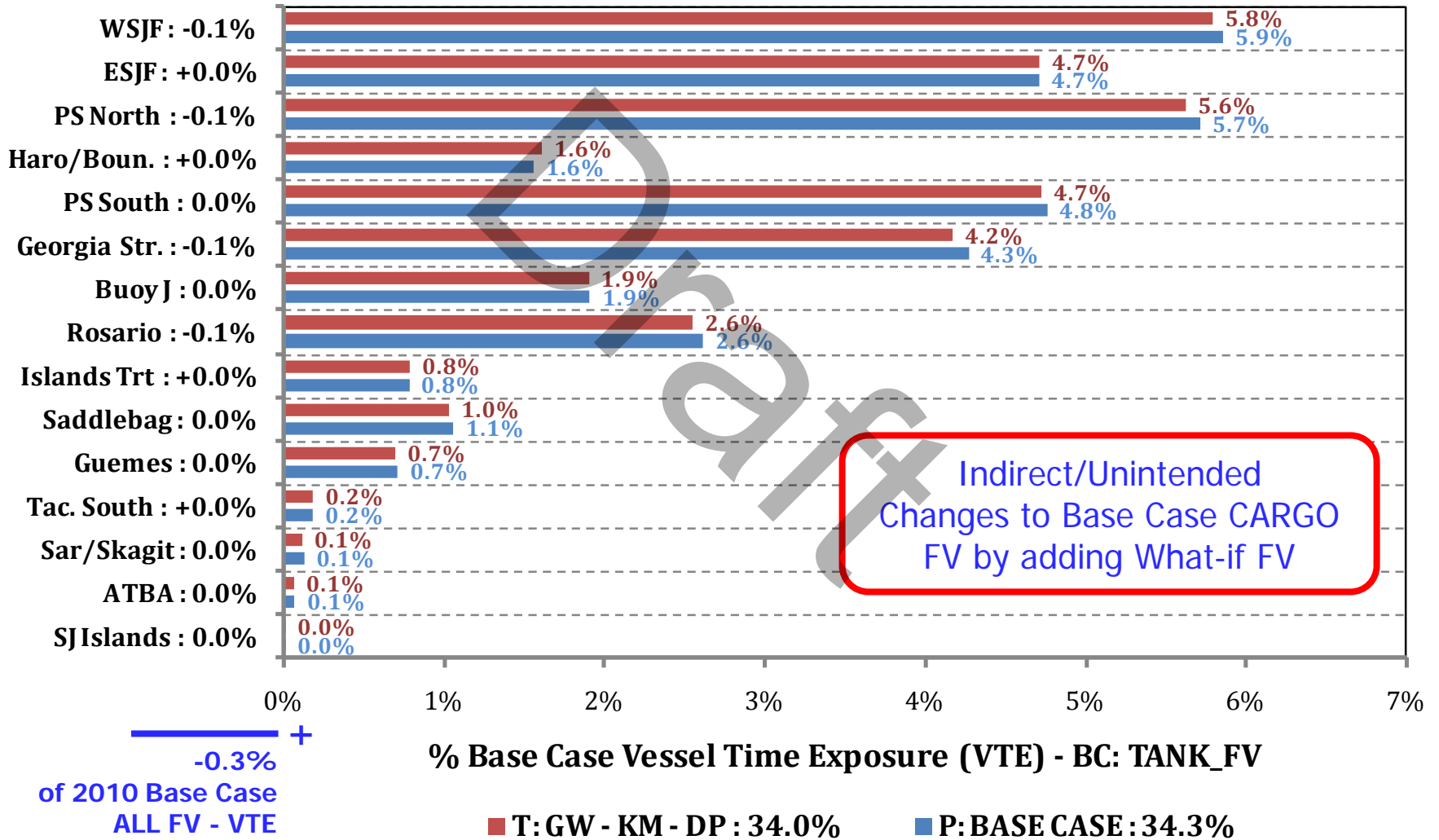
Factor x Average Exposure:

- > 48.98
- > 10.00
- 10.00
- 3.61
- 2.90
- 2.47
- 2.17
- 1.94
- 1.74
- 1.58
- 1.44
- 1.31
- 1.20
- 1.09
- 1.00
- 0.81
- 0.65
- 0.52
- 0.39
- 0.28
- 0.18
- 0.09
- 0.00



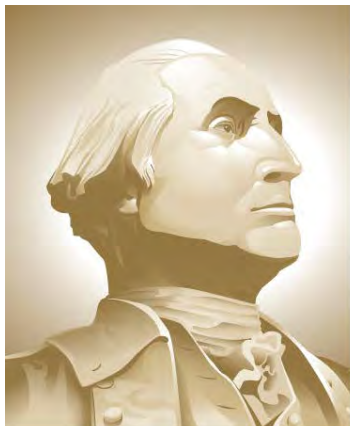
WATERWAY LOCATION VESSEL TIME EXPOSURE ANALYSIS – BC TANK FV

% Base Case Vessel Time Exposure (VTE) - BC: TANK_FV



VTRA 2010 OIL MOVEMENT DENSITY BY CRUDE, PRODUCT AND FUEL

Presentation by: J. Rene van Dorp



THE GEORGE
WASHINGTON
UNIVERSITY

WASHINGTON, DC

VCU

CASE T: Gateway, Kinder Morgan, Delta Port

GWU Personnel: Dr. J. Rene van Dorp

VCU Personnel: Dr. Jason R. W. Merrick

OCTOBER 9, 2013

PRELIMINARY

Table. Focus Vessel (FV) Classification for the 26 VTOSS vessel type classification used in the GW/VCU MTS simulation model.

NON – FV : Those vessels that are only considered as Interacting Vessels (IV) with Focus Vessels (FV) in this study

CARGO – FV : Bulk Carriers, Container Vessels, Other Cargo Vessels

TANK – FV : Oil Barge, Oil Tankers, Chem-Carrier, ATB

Note: Focus Vessels (FV's) are also considered as Interacting Vessels (IV's) when interacting with another Focus Vessel.

#	VESSEL TYPE	FOCUS VESSEL?	#	VESSEL TYPE	FOCUS VESSEL?
1	BULKCARRIER	CARGO - FV	14	PASSENGERSHIP	NO
2	CHEMICALCARRIER	TANK - FV	15	REFRIGERATEDCARGO	CARGO-FV
3	CONTAINERSHIP	CARGO - FV	16	RESEARCHSHIP	NO
4	DECKSHIPCARGO	CARGO - FV	17	ROROCARGOSHIP	CARGO-FV
5	FERRY	NO	18	ROROCARGOCONTSHIP	CARGO-FV
6	FERRYNONLOCAL	NO	19	SUPPLYOFFSHORE	NO
7	FISHINGFACTORY	NO	20	TUGTOWBARGE	NO
8	FISHINGVESSEL	NO	21	UNKNOWN	NO
9	LIQGASCARRIER	TANK - FV	22	USCOASTGUARD	NO
10	NAVYVESSEL	NO	23	VEHICLECARRIER	CARGO-FV
11	OILTANKER	TANK - FV	24	YACHT	NO
12	OTHERSPECIALCARGO	CARGO - FV	25	ATB	TANK - FV
13	OTHERSPECIFICSERV	NO	26	OIL BARGE	TANK - FV

IMPORTANT:

THE OPERATIVE WORD IN PRESENTING THESE ANALYSIS RESULTS IS THE USE OF THE WORD

POTENTIAL

TO INDICATE THAT THESE ANALYSIS RESULTS DO NOT FOLLOW FROM AN HISTORICAL DATA ANALYSIS, BUT THROUGH THE USE OF AN ANALYSIS TOOL THAT EVALUATES SUCH **POTENTIAL**.

THE 2010 YEAR IS CONSIDERED **THE BASE CASE YEAR** AND A BASE CASE YEAR POTENTIAL IS EVALUATED.

NEXT, **WHAT-IF SCENARIOS** ARE DEVELOPED FROM THE BASE CASE BY ADDING ADDITIONAL HYPOTHETICAL TRAFFIC AND A WHAT-IF POTENTIAL IS EVALUATED AND COMPARED **RELATIVE TO THE BASE CASE** TO INFORM **RISK MANAGEMENT**.

FOCUS VESSELS MOVE OIL: Crude, Product and Fuel

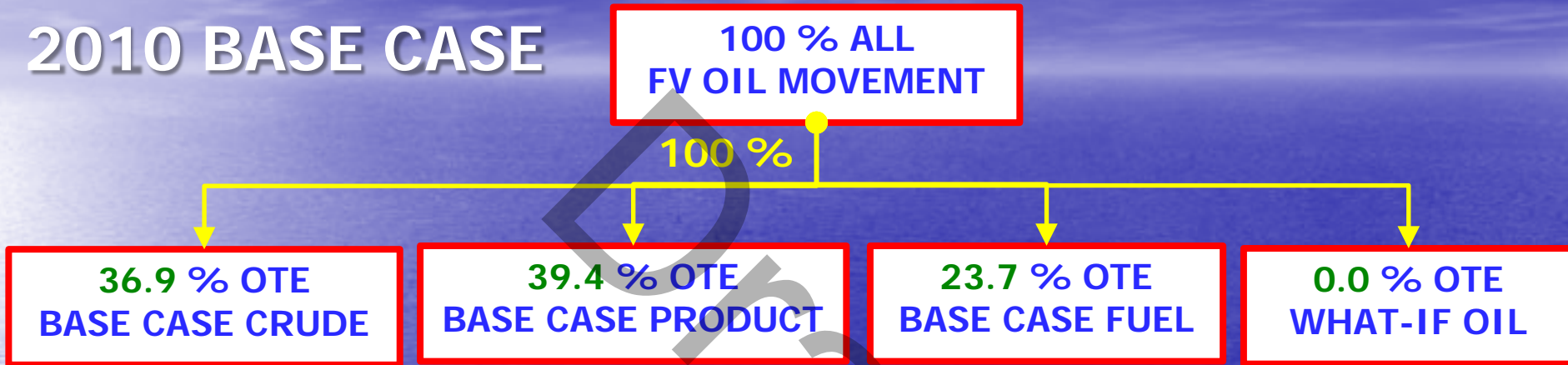
Disclaimer: No information is available on volume of oil or type of oil on board a vessel and we have to rely on overarching assumptions regarding movement of amount and type of oil as focus vessels move through the study area.

- Assumption 1 : Tankers are classified as crude or product carriers by name
- Assumption 2 : Chemical carriers transport product.
- Assumption 3 : Oil barges are assumed to transport product.
- Assumption 4 : All Focus Vessels fuel tanks are 50% full
- Assumption 5 : US bound crude tankers are assumed fully laden as they arrive in study area, drop of equal amounts at their stops and leave empty.
- Assumption 6 : Canadian bound crude tankers are assumed empty as they arrive and fully laden as they depart.
- Assumption 7 : Product Tankers and ATB's are assumed fully laden as they depart study area, empty as they arrive.
- Assumption 8 : Chemical carriers are assumed fully laden as they arrive in the study area, empty when they leave the study area.
- Assumption 9 : When ATB's go back and forth between two destinations within the study area they are assumed 50% full
- Assumption 10: Oil barges are assumed fully laden as they travel through study area.
- Assumption 11: Tank Focus Vessels not covered by 1-10 are assumed fully laden.

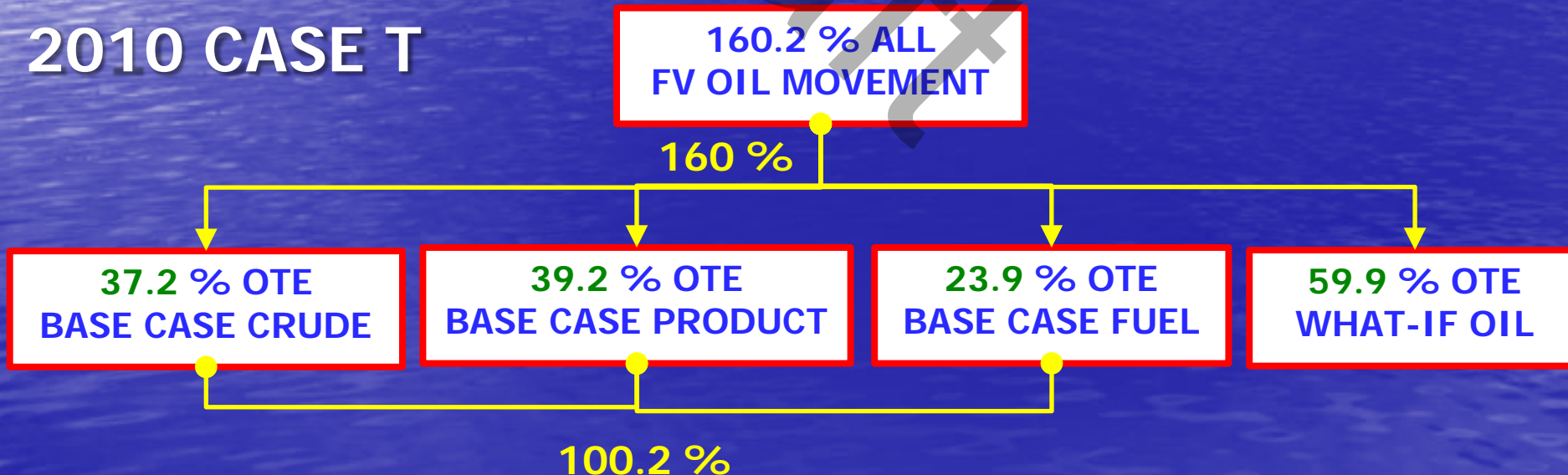
A TAXONOMY OF 2010 FOCUS VESSEL POTENTIAL TOTAL TIME OF EXPOSURE

VTE : TOTAL TIME OF EXPOSURE - PER YEAR

2010 BASE CASE

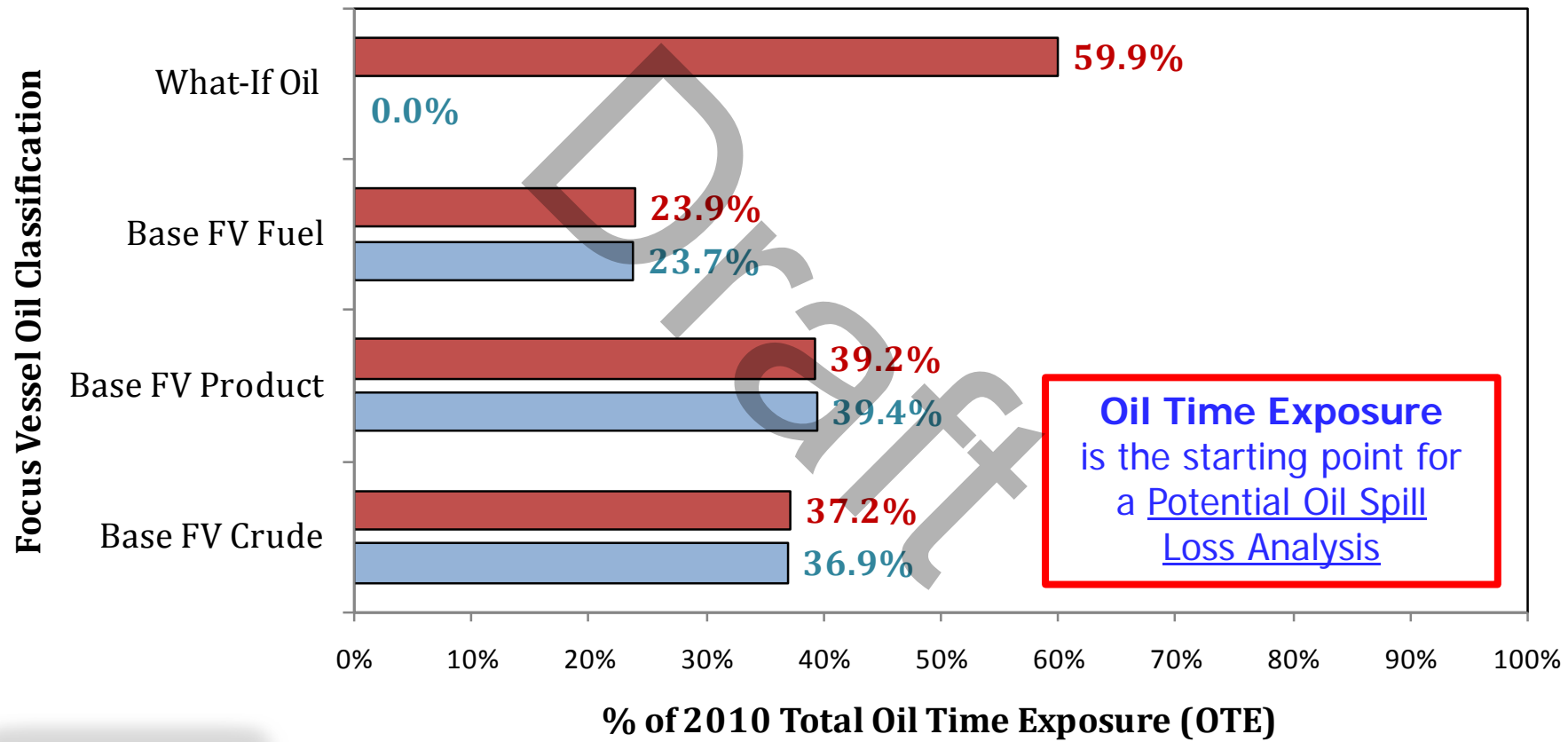


2010 CASE T



CASE T: GW 487, KM 348, DP 348 and 67:

VTRA 2010 - Total Oil Time Exposure (OTE)



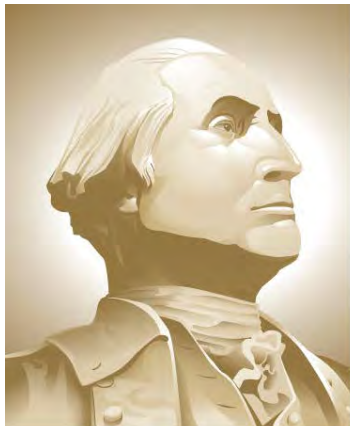
Oil Time Exposure
is the starting point for
a Potential Oil Spill
Loss Analysis



■ T - GW - KM - DP - 160.2% ■ P: BASE CASE 2010 - 100.0%

VTRA 2010 OIL MOVEMENT DENSITIES BY CARGO – FV and TANK- FV A WATERWAY BY LOCATION ANALYSIS

Presentation by: J. Rene van Dorp



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CASE T: Gateway, Kinder Morgan, Delta Port

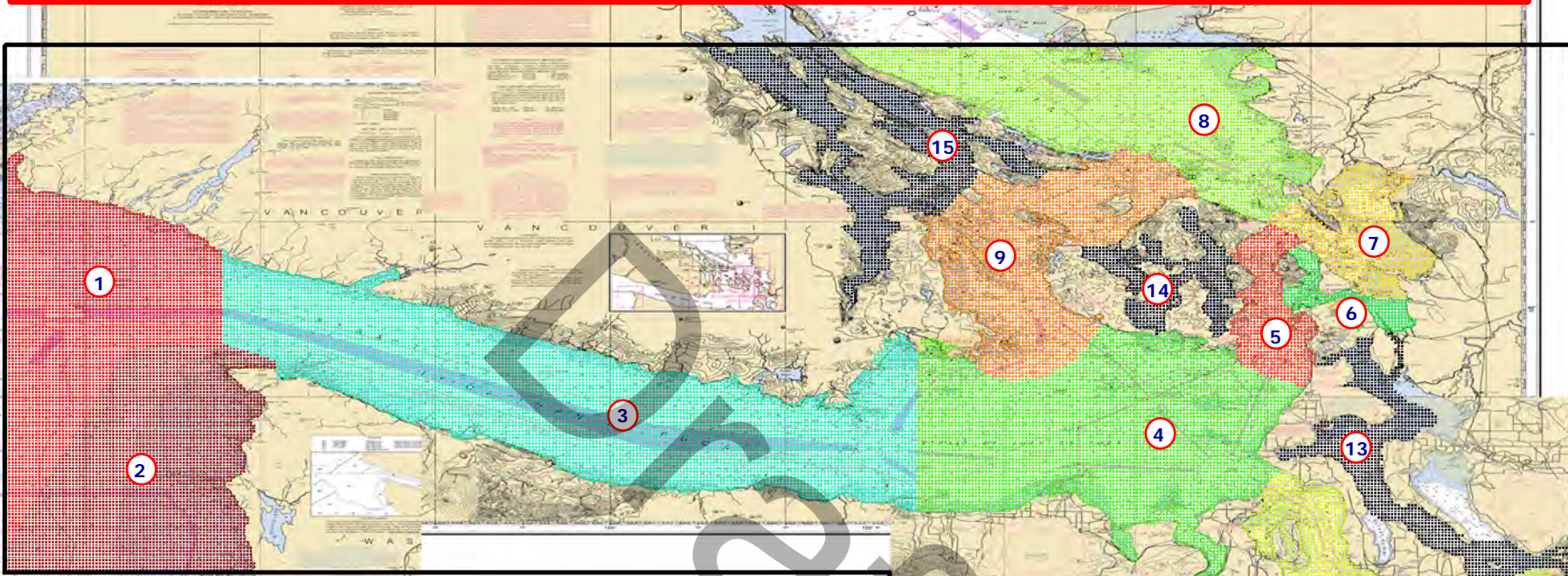
GWU Personnel: Dr. J. Rene van Dorp

VCU Personnel: Dr. Jason R. W. Merrick

OCTOBER 9, 2013

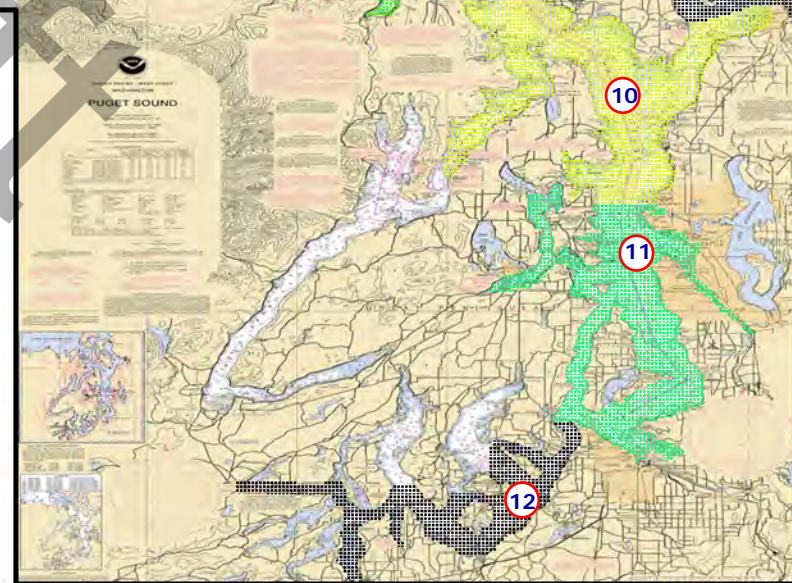
PRELIMINARY

DEFINITION OF 15 WATERWAY LOCATIONS



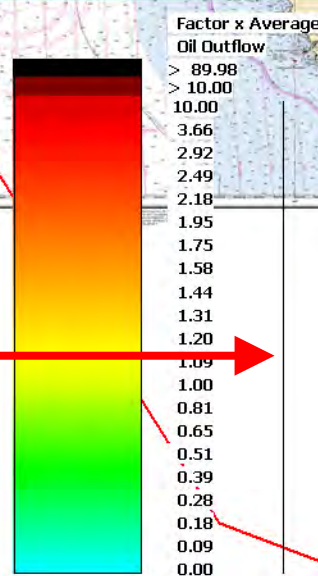
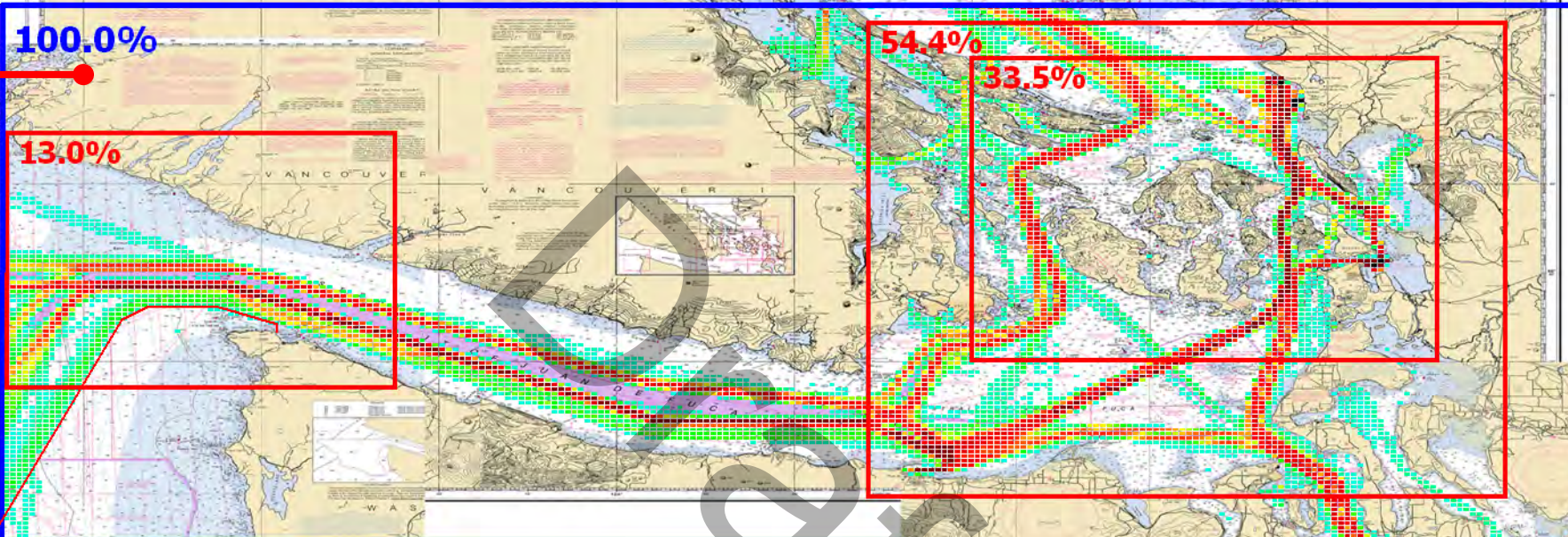
VTRA 2010 Waterway Locations

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



P: ALL FV ALL OIL MOVEMENT

P: VTRA 2010 - BASE CASE - All FV



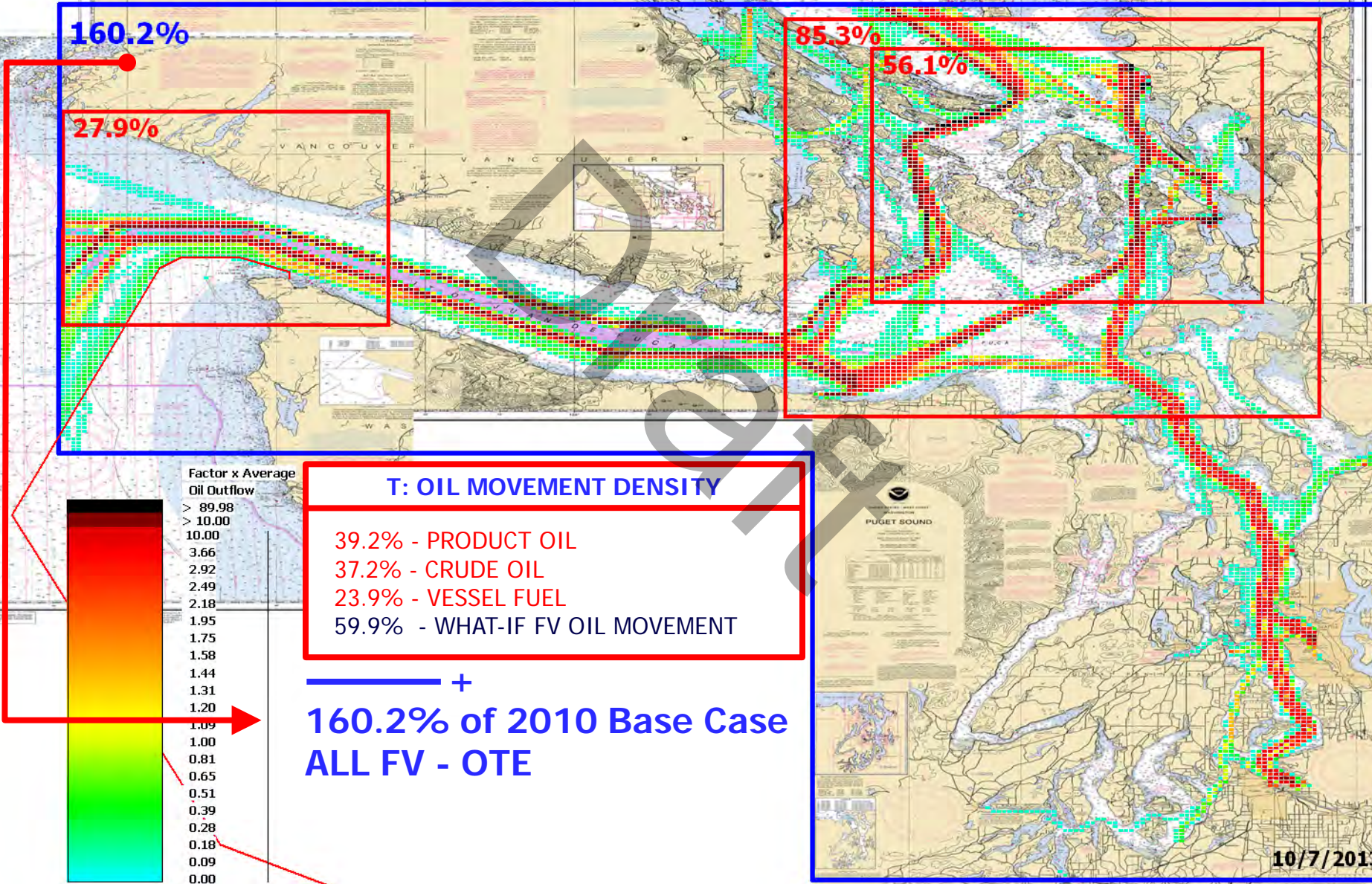
P: OIL MOVEMENT DENSITY

- 39.4% - PRODUCT OIL
- 36.9% - CRUDE OIL
- 23.7% - VESSEL FUEL
- 00.0% - WHAT-IF FV OIL MOVEMENT

+
**100.0% of 2010 Base Case
ALL FV - OTE**

T: ALL FV ALL OIL MOVEMENT

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348 - All FV



160.2%

27.9%

85.3%

56.1%

T: OIL MOVEMENT DENSITY

- 39.2% - PRODUCT OIL
- 37.2% - CRUDE OIL
- 23.9% - VESSEL FUEL
- 59.9% - WHAT-IF FV OIL MOVEMENT

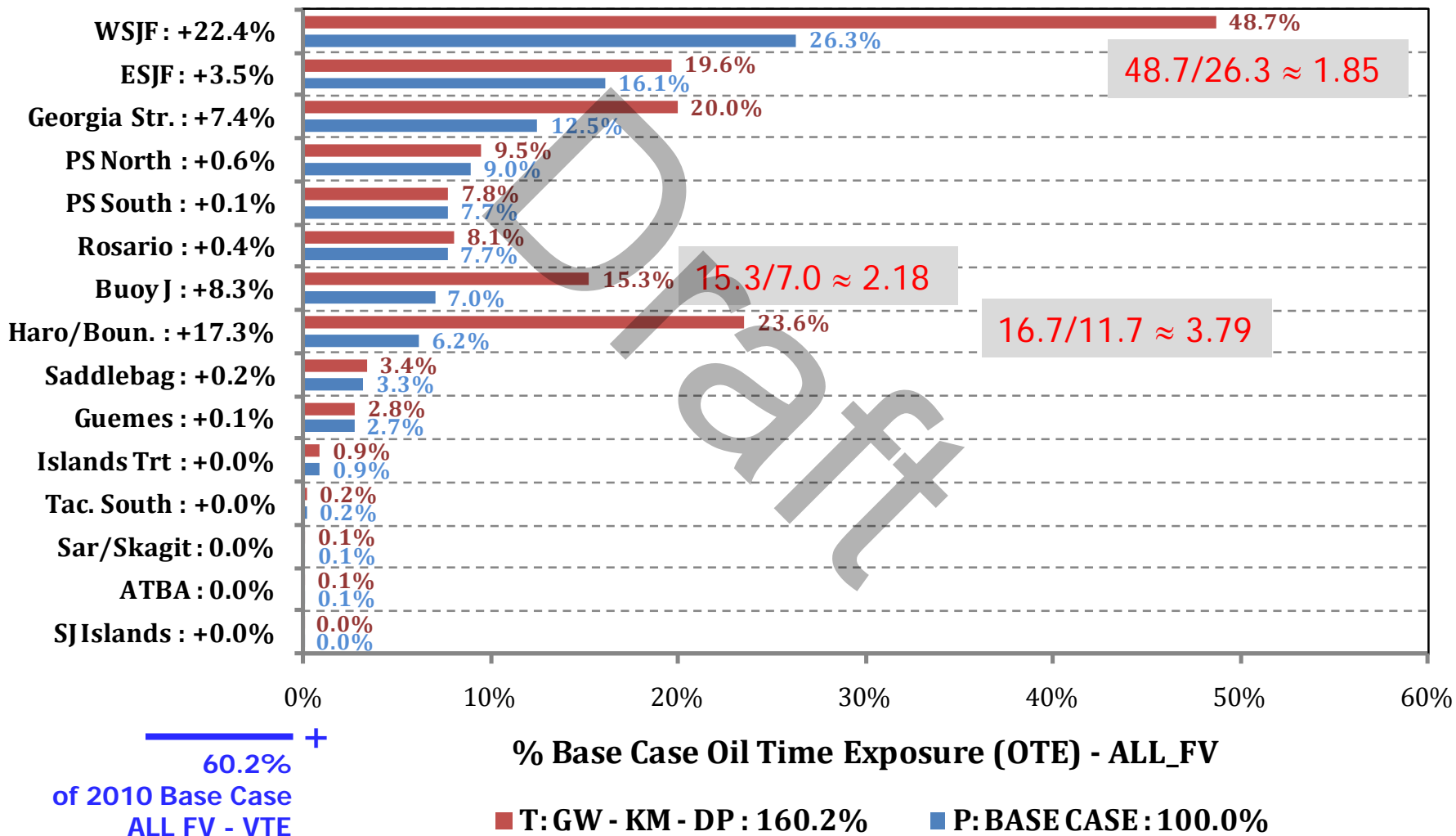
— +
160.2% of 2010 Base Case
ALL FV - OTE

Factor x Average Oil Outflow

> 89.98
> 10.00
3.66
2.92
2.49
2.18
1.95
1.75
1.58
1.44
1.31
1.20
1.09
1.00
0.81
0.65
0.51
0.39
0.28
0.18
0.09
0.00

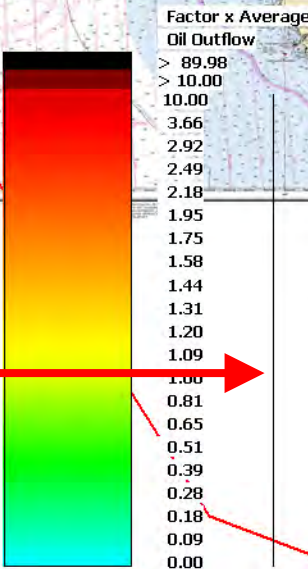
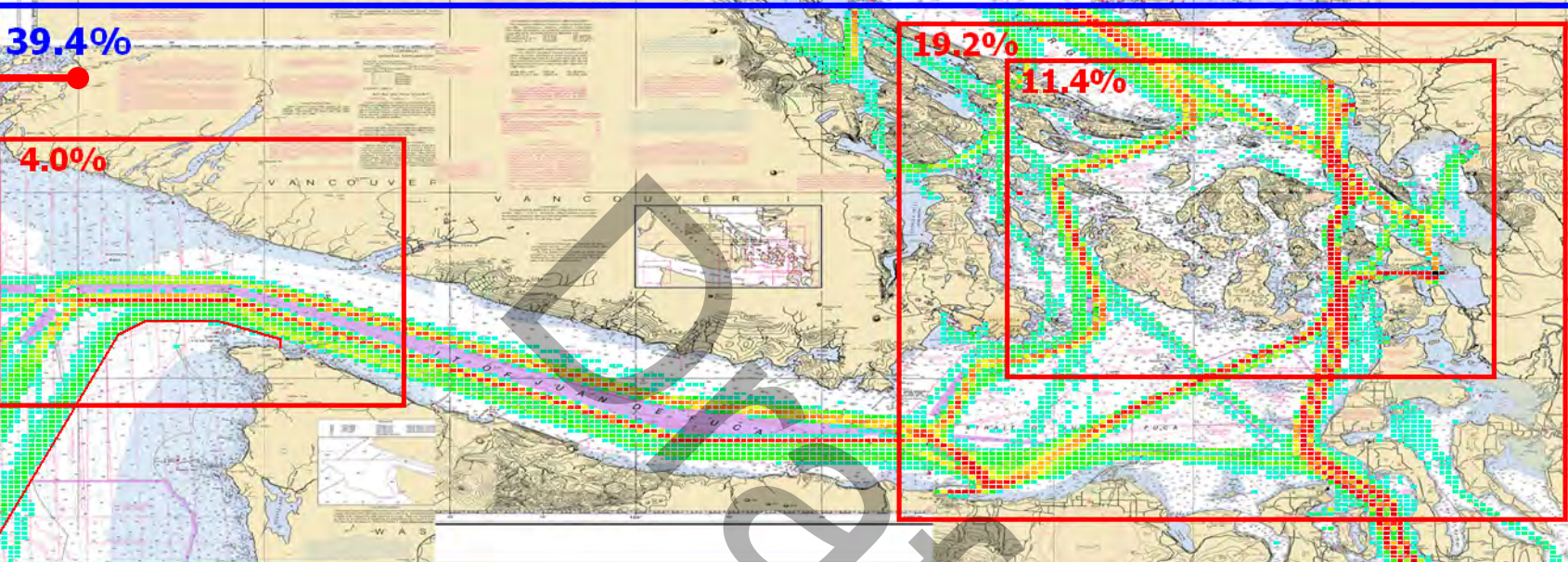
WATERWAY LOCATION OIL TIME EXPOSURE COMPARISON (P+C+F)

% Base Case Oil Time Exposure - ALL_FV



P: ALL FV PRODUCT OIL MOVEMENT

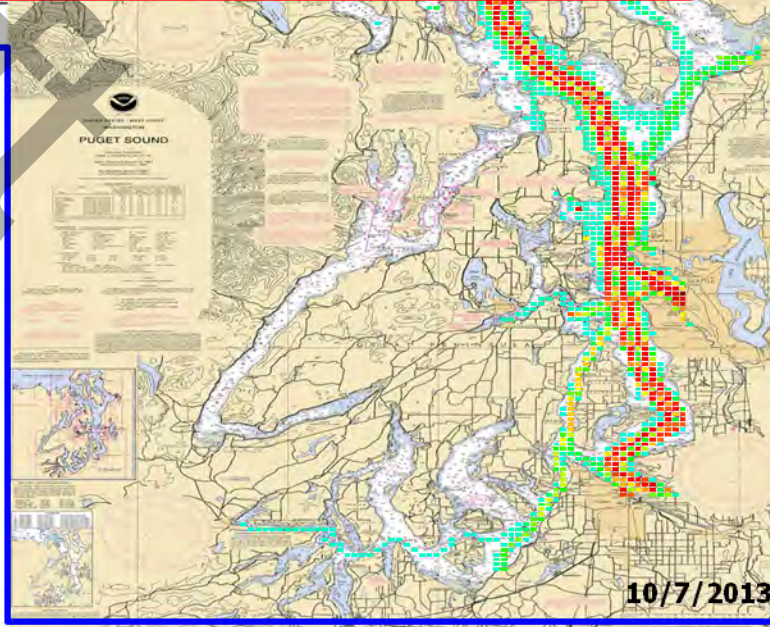
P: VTRA 2010 - BASE CASE - All FV



P: PRODUCT OIL MOVEMENT DENSITY

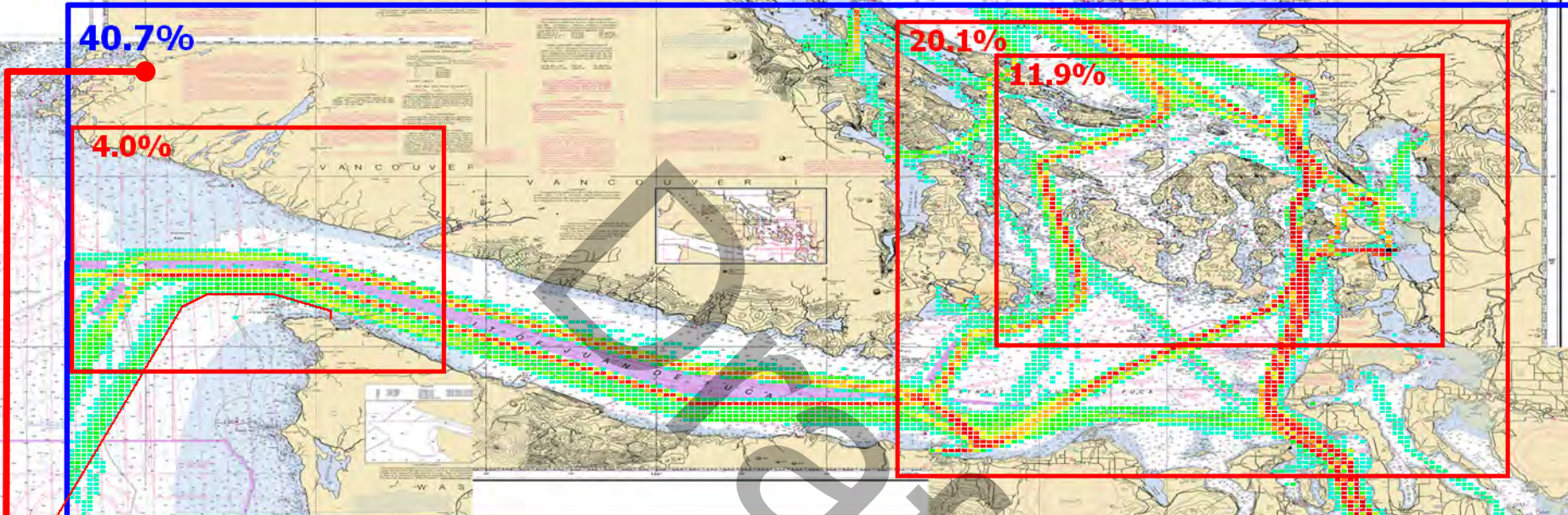
- 20.3% - OILBARGE
- 08.3% - PRODUCT TANKER
- 07.9% - CHEMICALCARRIER
- 02.8% - ATB
- 00.0% - WHAT-IF FV PRODUCT OIL

+
39.4% of 2010 Base Case
ALL FV - OTE



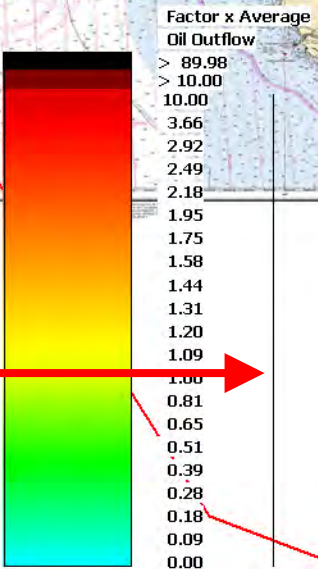
T: ALL FV PRODUCT OIL MOVEMENT

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348 - All FV



T: PRODUCT OIL MOVEMENT DENSITY

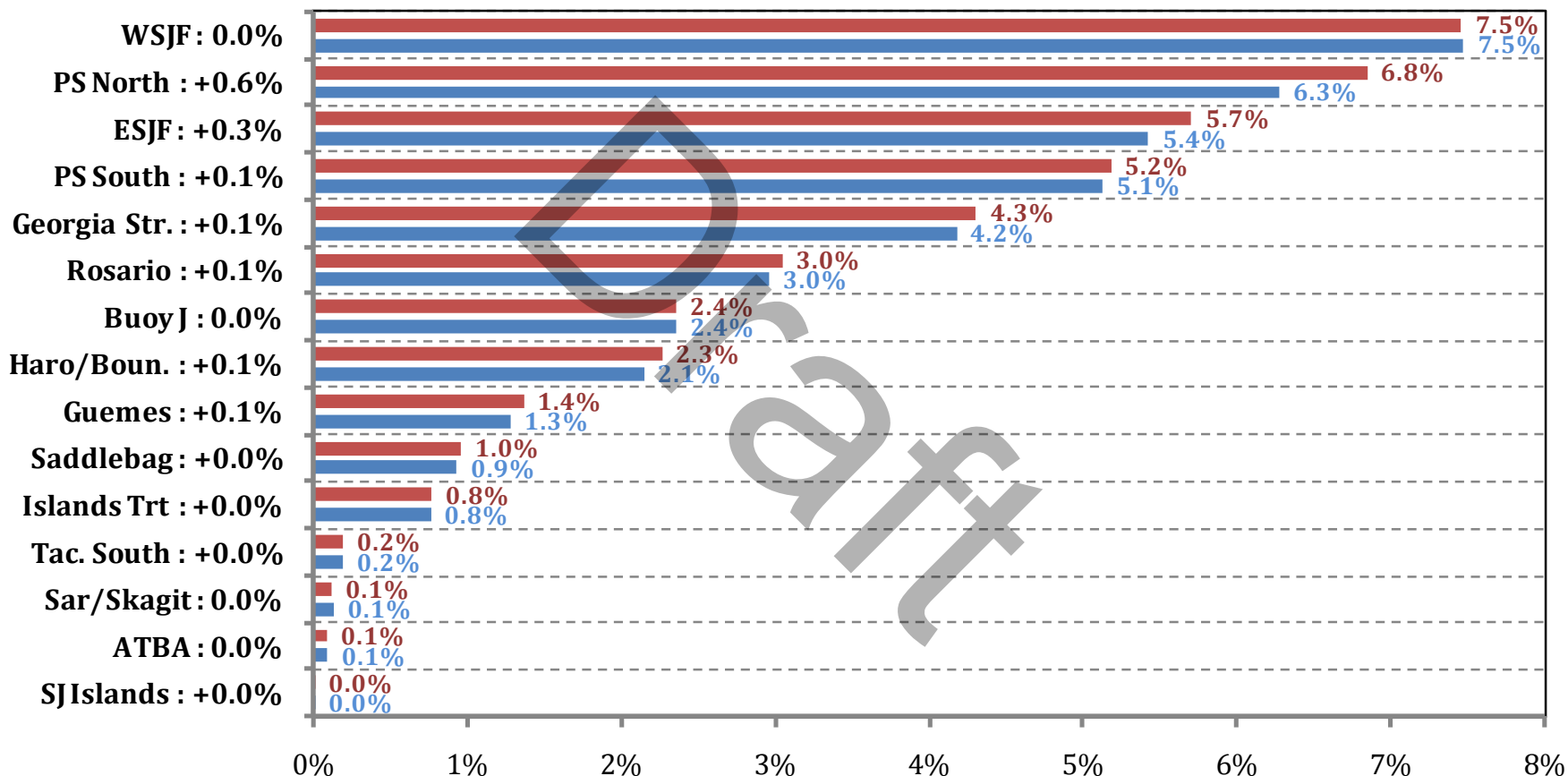
- 20.0% - BC OILBARGE
- 08.3% - BC PRODUCT TANKER
- 08.0% - BC CHEMICALCARRIER
- 02.8% - BC ATB
- 01.5% - WHAT-IF FV PRODUCT OIL



+
40.6% of 2010 Base Case
ALL FV - OTE

WATERWAY LOCATION PRODUCT OIL TIME EXPOSURE COMPARISON

% Base Case Product Time Exposure - ALL_FV



■ +
 1.3%
 of 2010 Base Case
 ALL FV - OTE

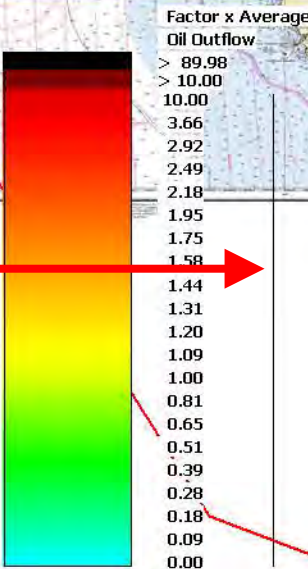
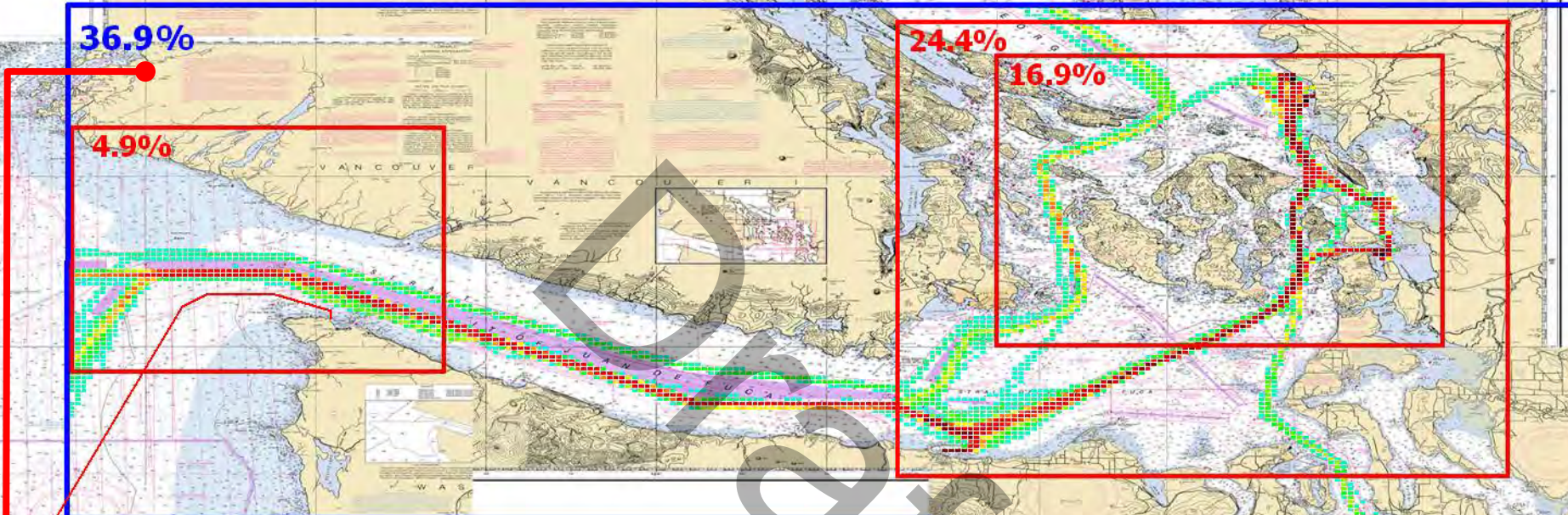
% Base Case Oil Time Exposure (OTE) - ALL_FV

■ T:GW - KM - DP : 40.7%

■ P:BASE CASE : 39.4%

P: ALL FV CRUDE OIL MOVEMENT

P: VTRA 2010 - BASE CASE - All FV

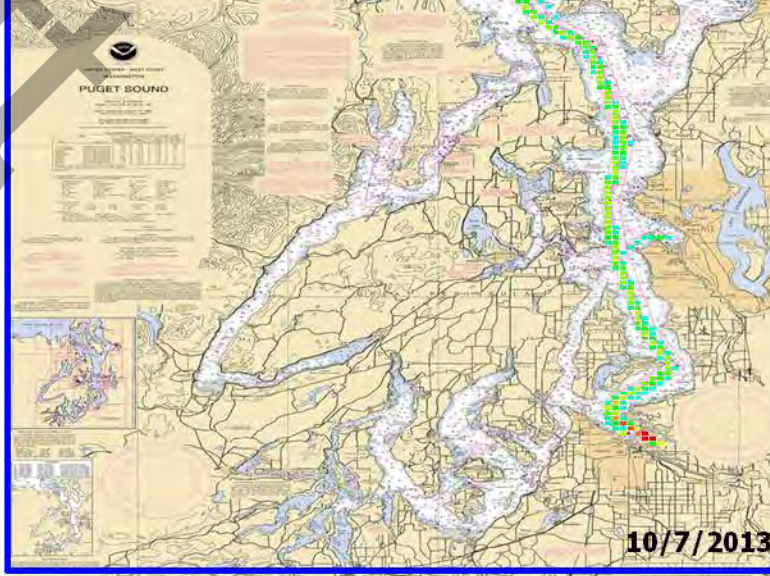


P: CRUDE OIL MOVEMENT DENSITY

36.9% - BASE CASE CRUDE TANKER
0.0% - WHAT-IF FV CRUDE

+

36.9% of 2010 Base Case ALL FV - OTE



T: ALL FV CRUDE OIL MOVEMENT

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348 - All FV

86.5%

18.0%

49.3%

35.4%

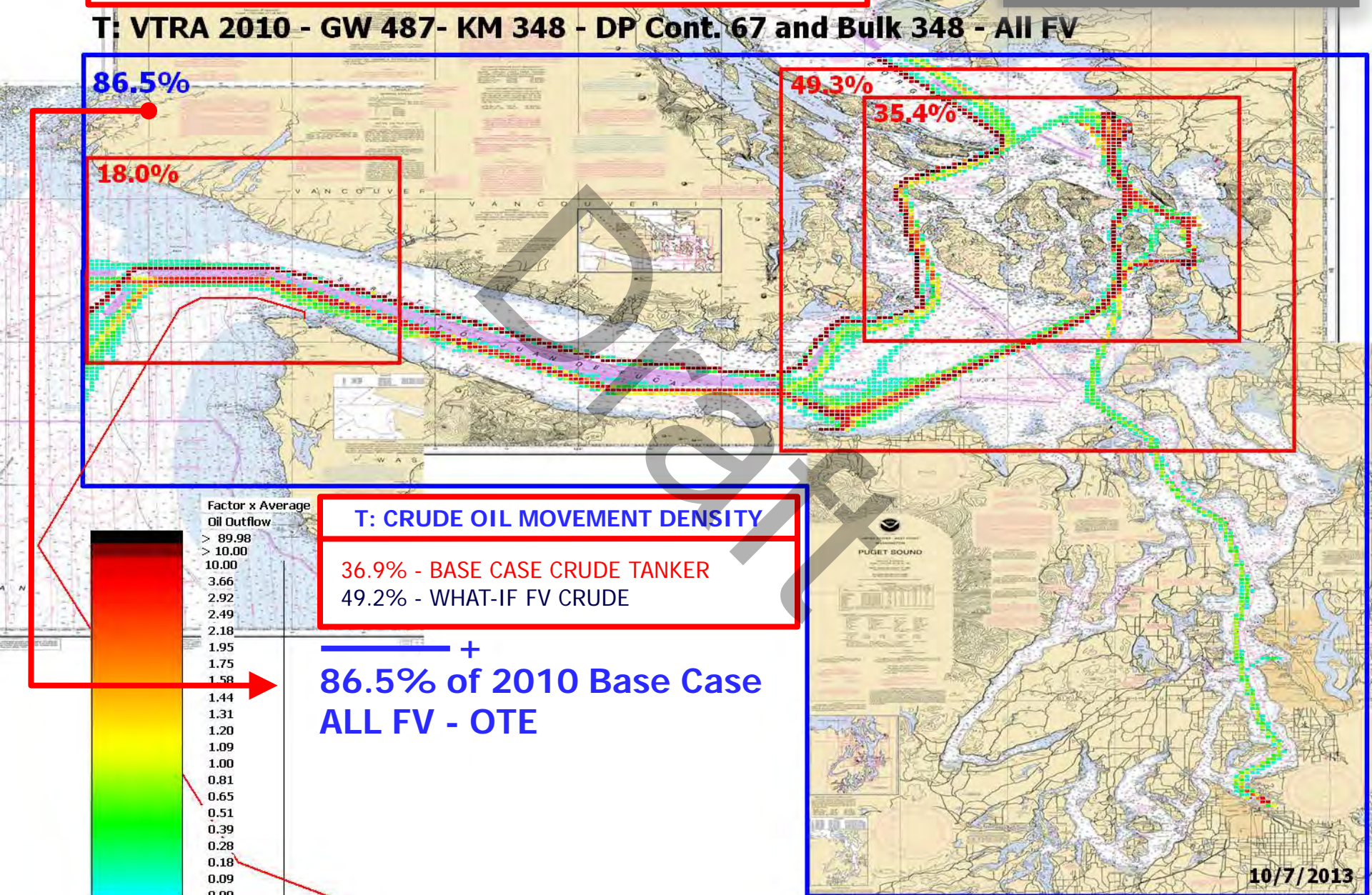
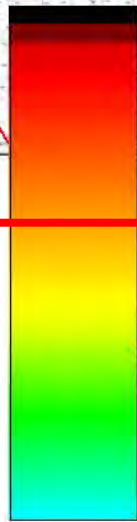
T: CRUDE OIL MOVEMENT DENSITY

36.9% - BASE CASE CRUDE TANKER
49.2% - WHAT-IF FV CRUDE

+
86.5% of 2010 Base Case
ALL FV - OTE

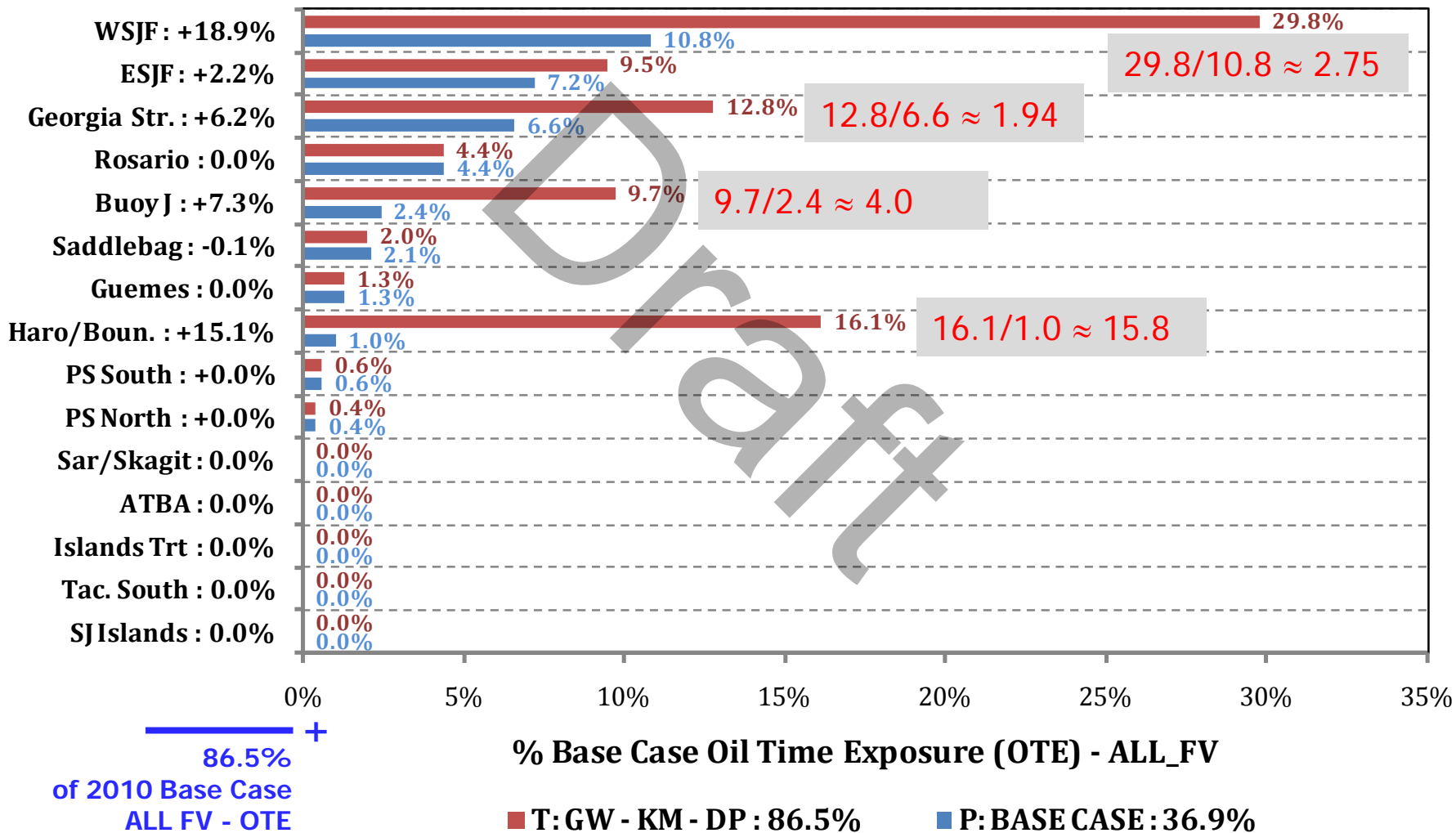
Factor x Average
Oil Outflow

- > 89.98
- > 10.00
- 10.00
- 3.66
- 2.92
- 2.49
- 2.18
- 1.95
- 1.75
- 1.58
- 1.44
- 1.31
- 1.20
- 1.09
- 1.00
- 0.81
- 0.65
- 0.51
- 0.39
- 0.28
- 0.18
- 0.09
- 0.00



WATERWAY LOCATION CRUDE OIL TIME EXPOSURE COMPARISON

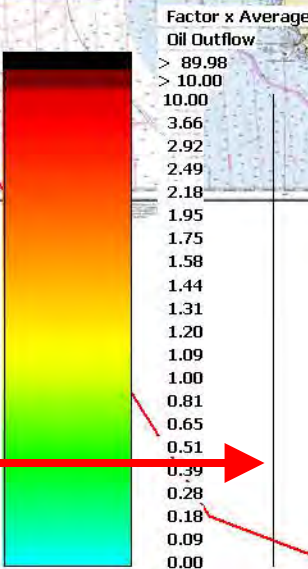
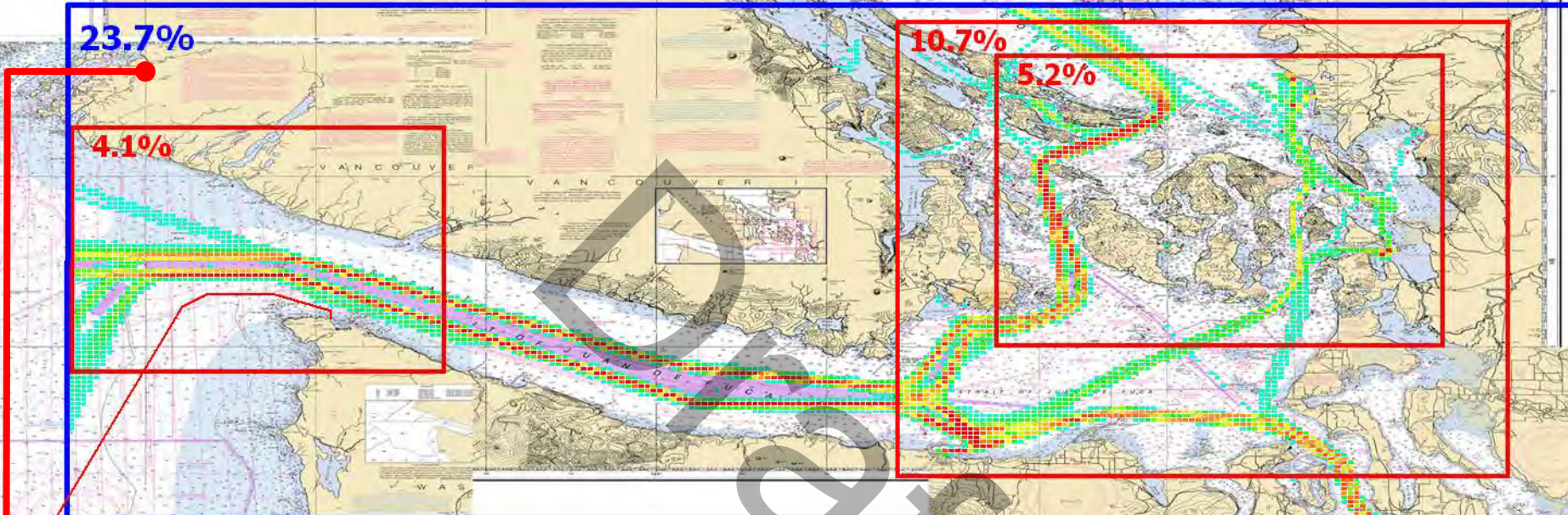
% Base Case Crude Time Exposure - ALL_FV



86.5/36.9 ≈ 2.34

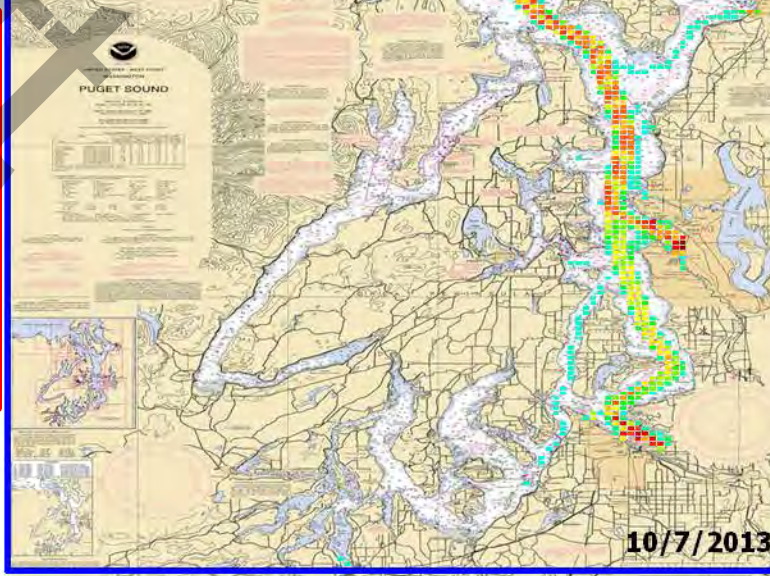
P: ALL FV FUEL OIL MOVEMENT

P: VTRA 2010 - BASE CASE - All FV



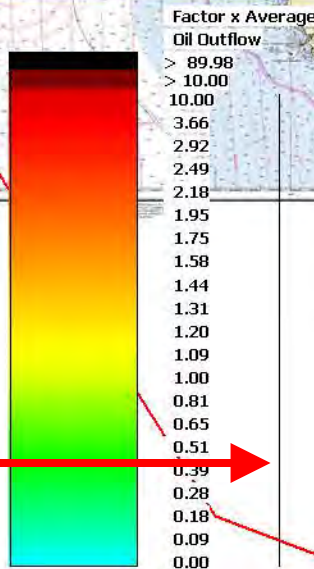
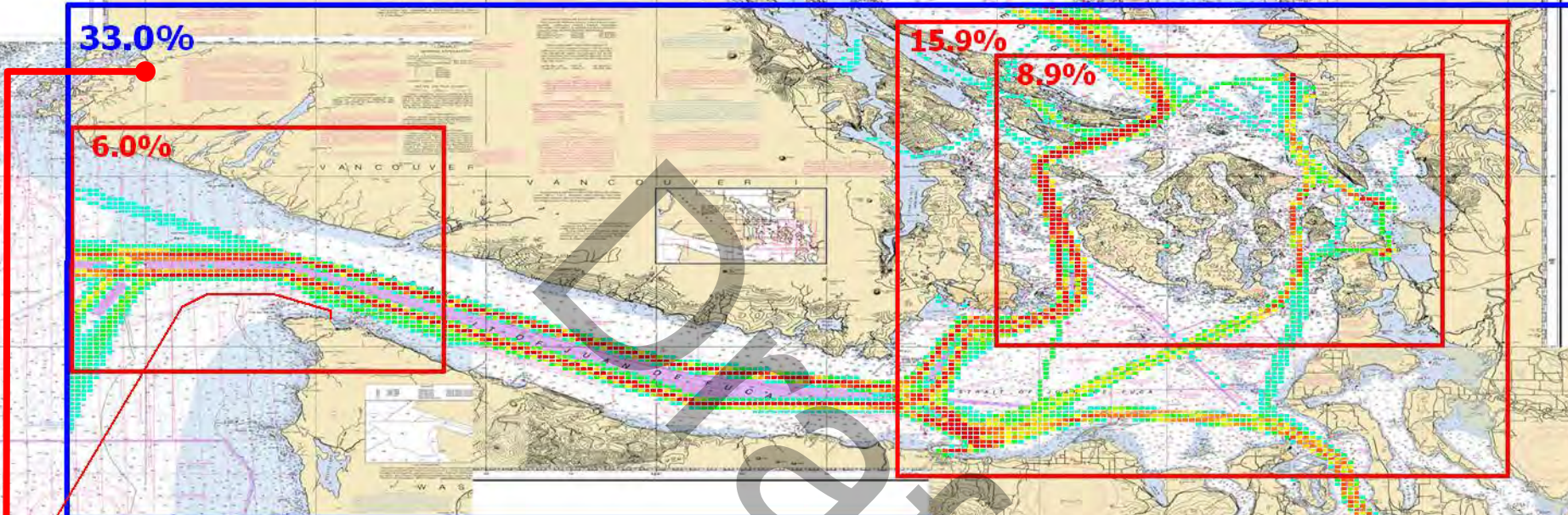
- ### P: FUEL OIL MOVEMENT DENSITY
- 7.8% - BULK CARRIER
 - 8.9% - CONTAINER SHIP
 - 3.0% - OTHER CARGO
 - 0.3% - OIL BARGE
 - 2.9% - OIL TANKER (CRUDE OR PROD.)
 - 0.5% - CHEMICALCARRIER
 - 0.4% - ATB
 - 0.0% - WHAT-IF FV FUEL MOVEMENT

+
23.7% of 2010 Base Case
ALL FV- OTE



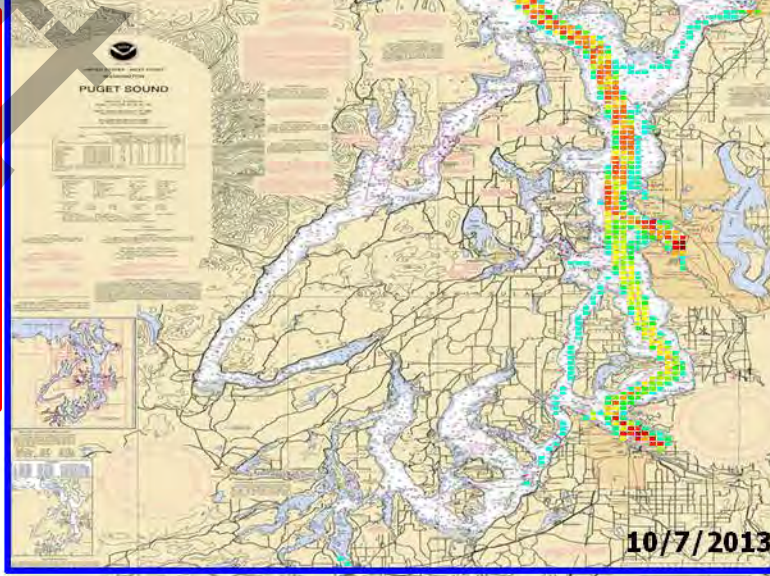
T: ALL FV FUEL OIL MOVEMENT

T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348 - All FV



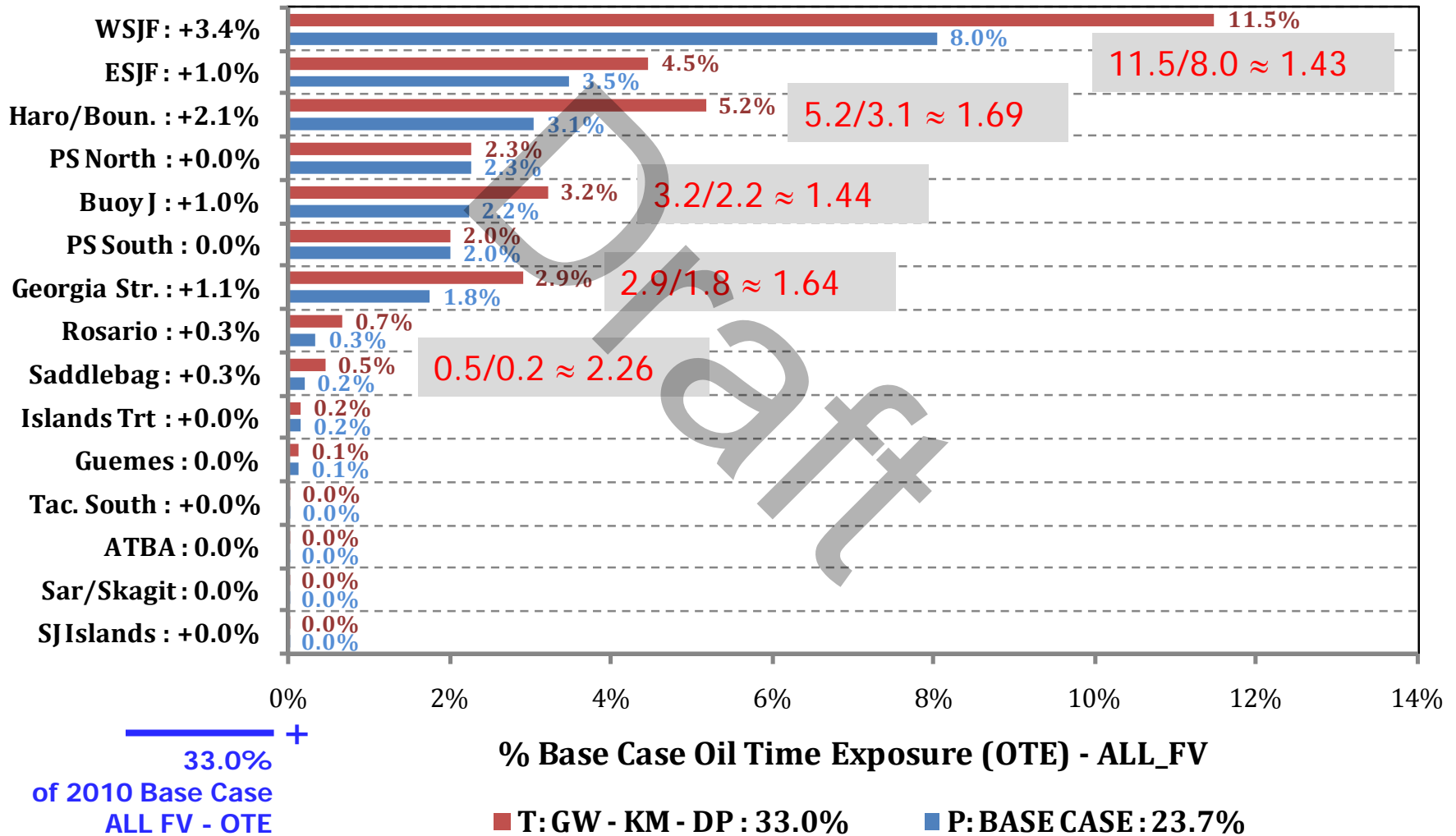
- ### T: FUEL OIL MOVEMENT DENSITY
- 7.9% - BULK CARRIER
 - 8.9% - CONTAINER SHIP
 - 3.0% - OTHER CARGO
 - 0.3% - OIL BARGE
 - 2.8% - OIL TANKER (CRUDE OR PROD.)
 - 0.5% - CHEMICALCARRIER
 - 0.4% - ATB
 - 9.1% - WHAT-IF FV FUEL MOVEMENT

+
32.9% of 2010 Base Case
ALL FV- OTE



WATERWAY LOCATION FUEL OIL TIME EXPOSURE COMPARISON

% Base Case Fuel Time Exposure - ALL_FV



33.0/23.7 ≈ 1.39