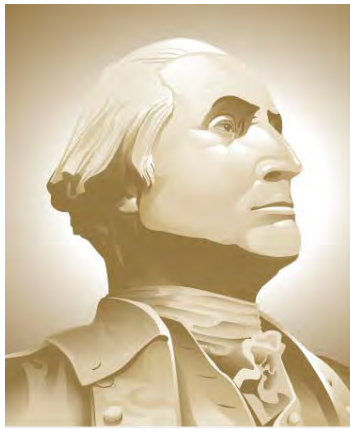


VTRA 2010 POTENTIAL COLLISION FREQUENCY BY ALL FV, CARGO – FV, TANK- FV AND WHAT-IF FV

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

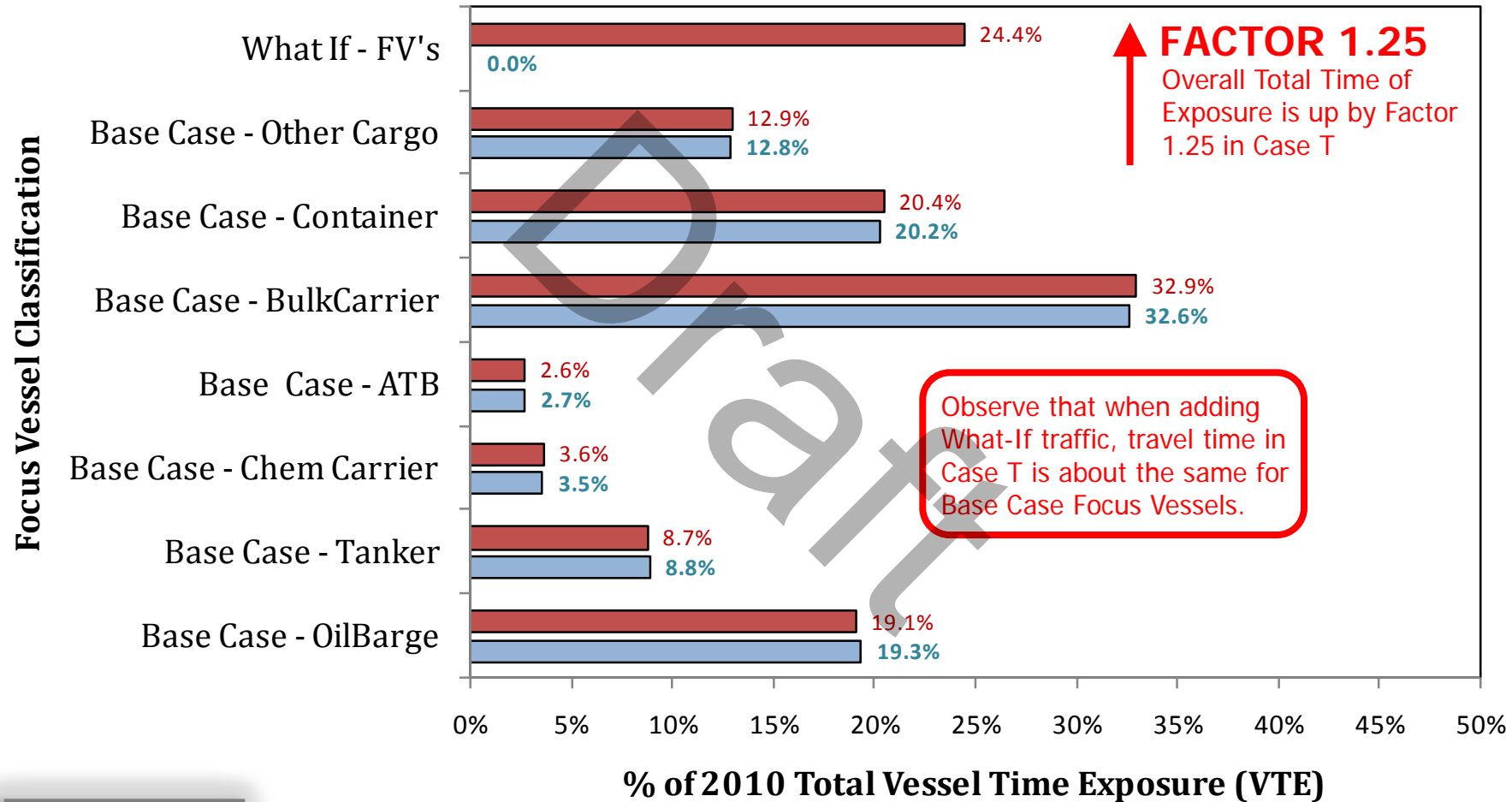
348 Kinder Morgan Tankers + Bunkering Barges

348 Delta Port Bulk Carriers + Bunkering Barges

67 Delta Port Container Ships+ Bunkering Barges

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

VTRA 2010 - Total Vessel Time of Exposure (VTE)

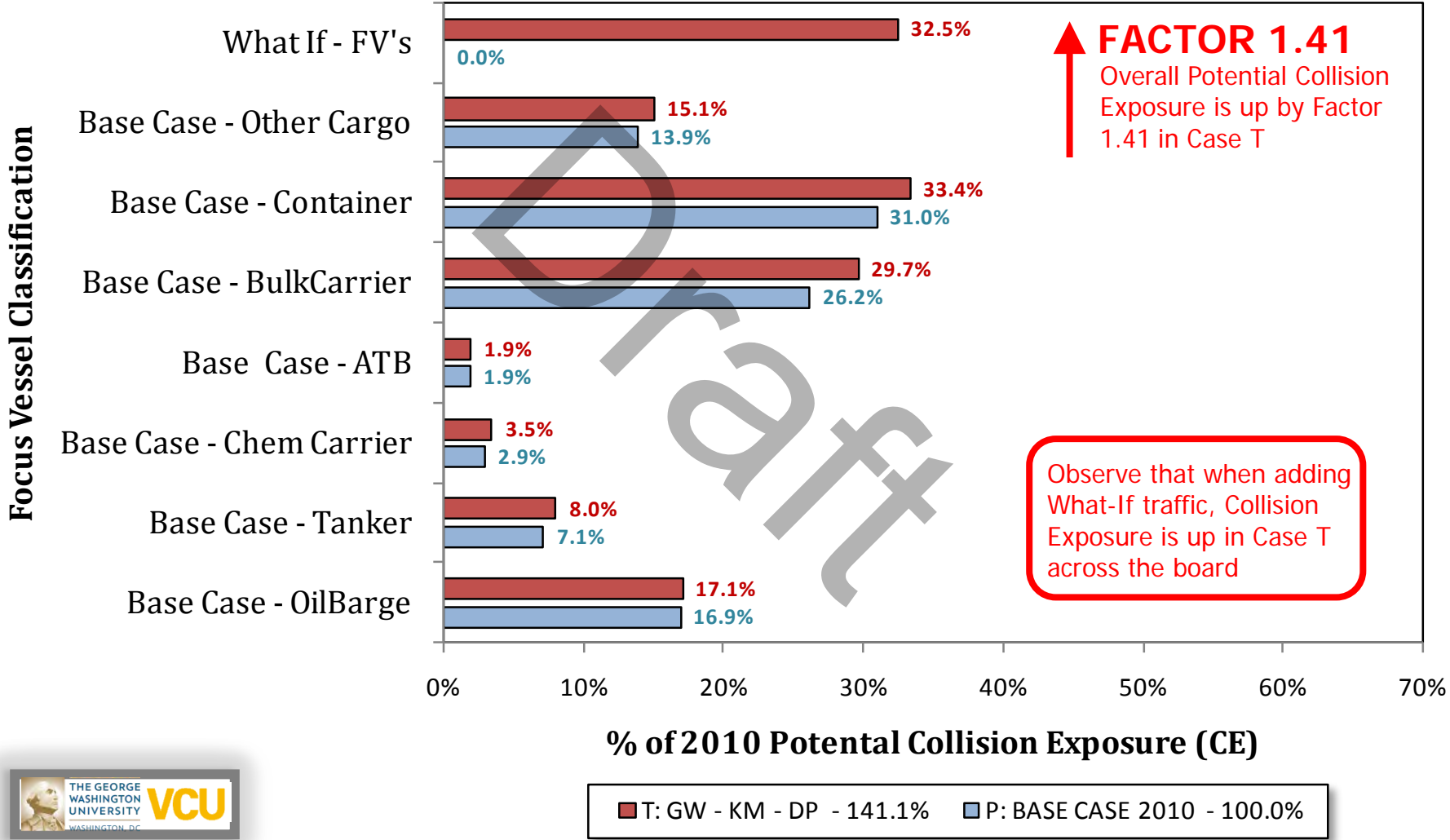


■ T: GW - KM - DP - 124.7% ■ P: BASE CASE 2010 - 100.0%



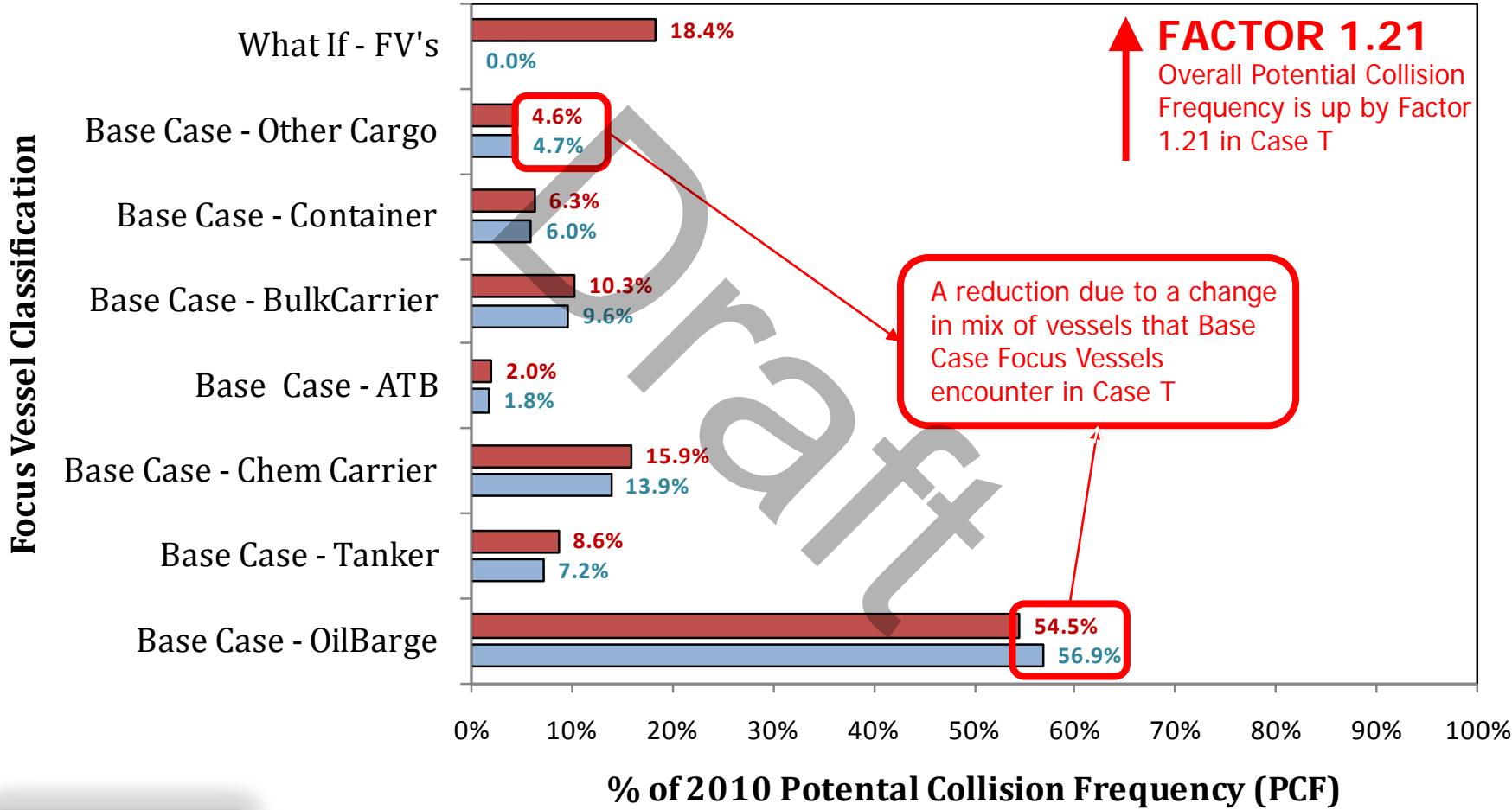
CASE T: GW 487, KM 348, DP 348 and 67:

VTRA 2010 - COLLISION EXPOSURE



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

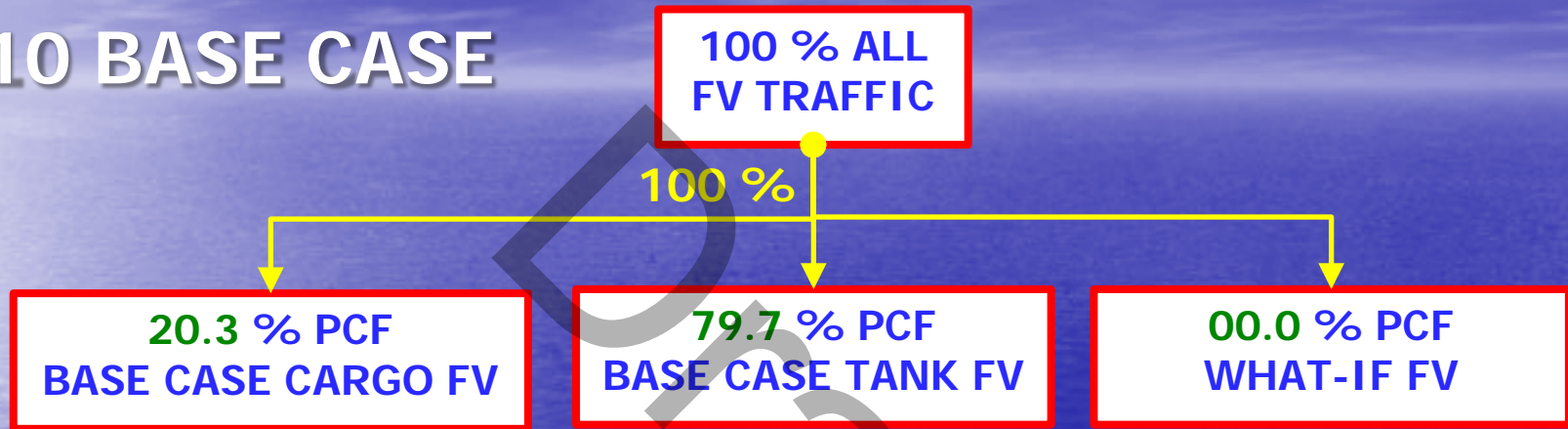
VTRA 2010 - COLLISION FREQUENCY



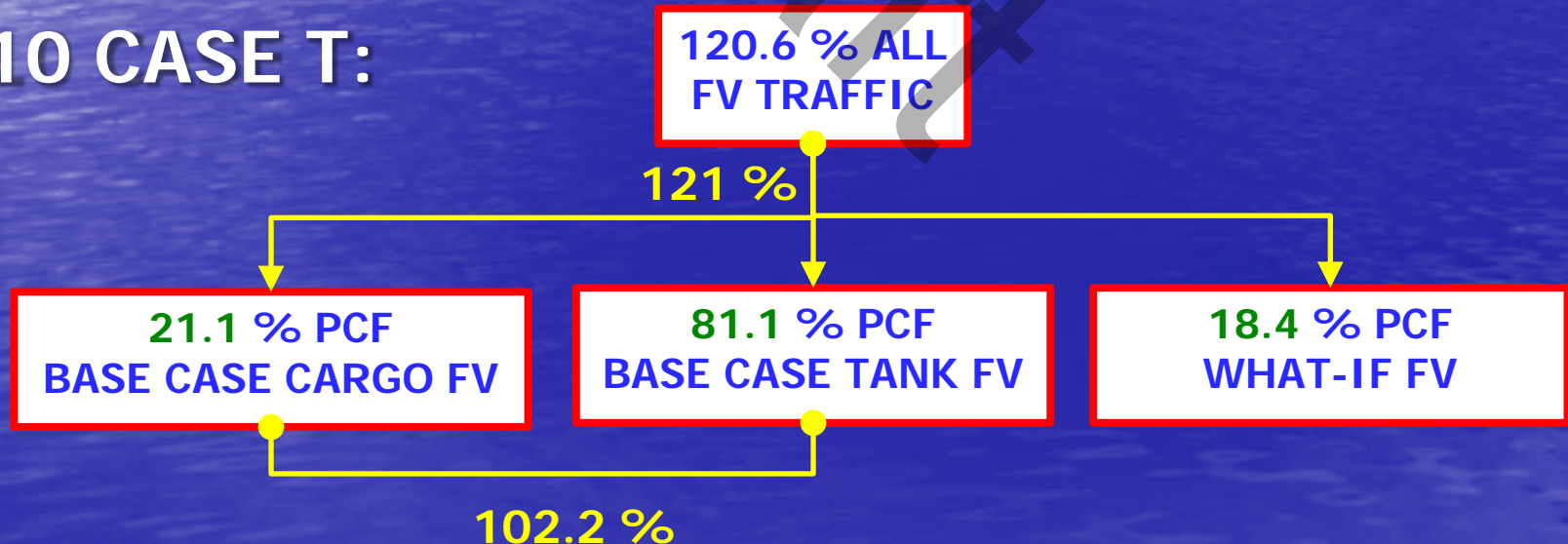
A TAXONOMY OF 2010 FOCUS VESSEL POTENTIAL ANNUAL COLLISION FREQUENCY

PCF : POTENTIAL COLLISION FREQUENCY - PER YEAR

2010 BASE CASE

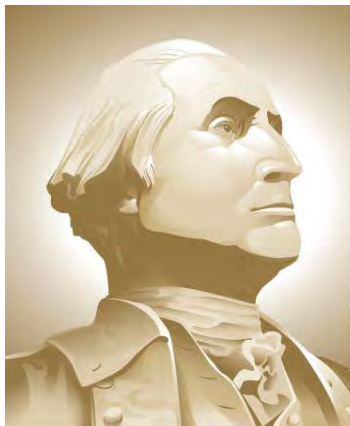


2010 CASE T:



VTRA 2010 COLLISION FREQ. BY CARGO – FV and TANK- FV A WATERWAY BY LOCATION ANALYSIS

Presentation by: J. Rene van Dorp



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VCU

CASE T: Gateway, Kinder Morgan, Delta Port

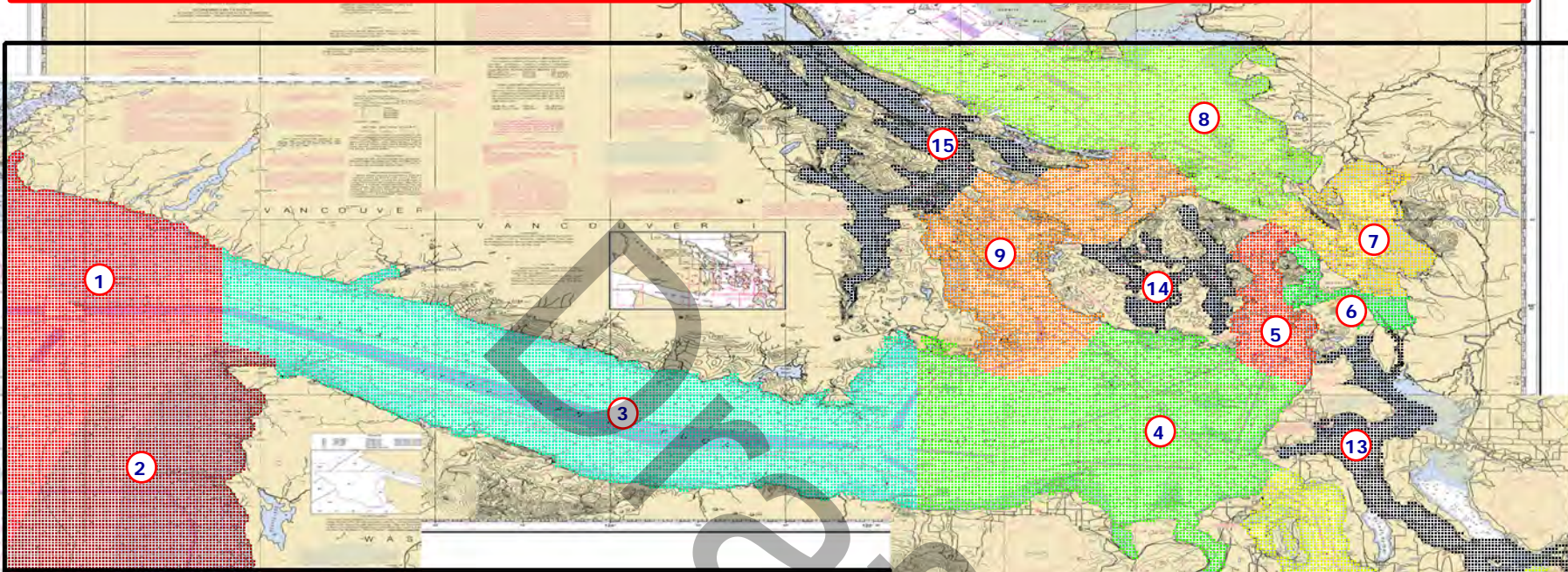
GWU Personnel: Dr. J. Rene van Dorp

VCU Personnel: Dr. Jason R. W. Merrick

OCTOBER 9, 2013

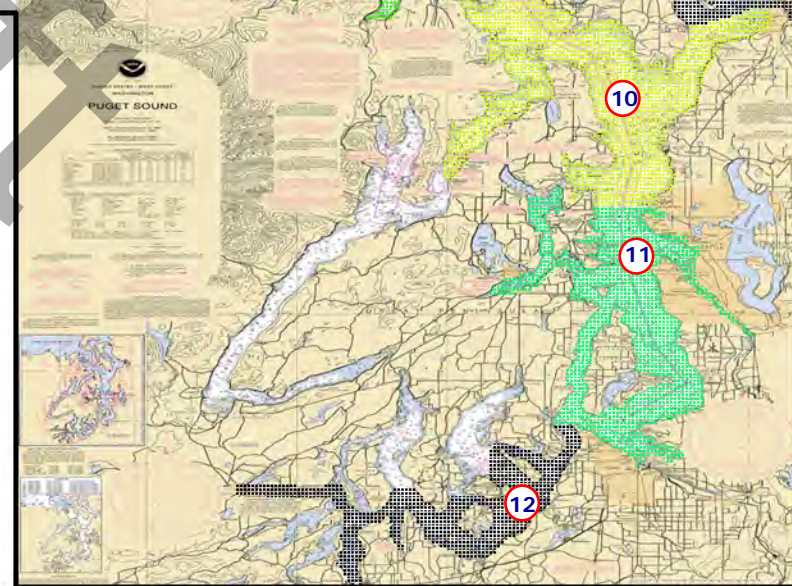
PRELIMINARY

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 POTENTIAL COLL. FREQUENCY (PCF)

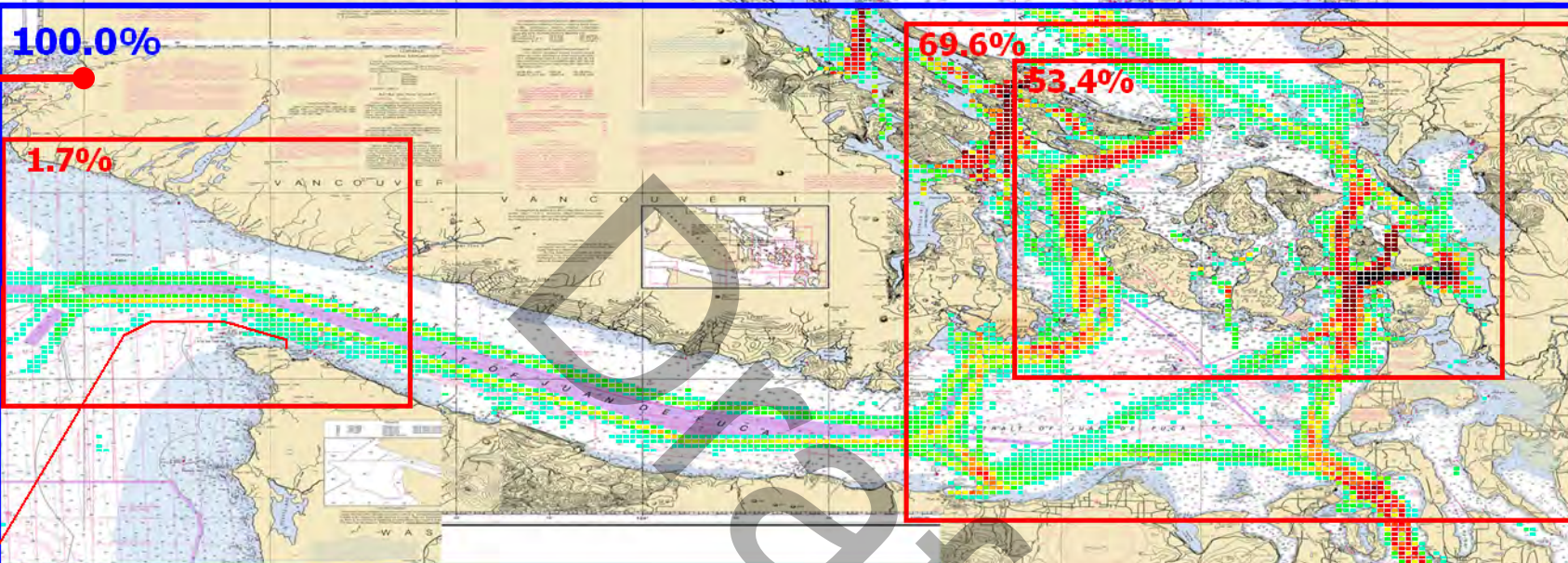
P: VTRA 2010 - BASE CASE - All FV

100.0%

1.7%

69.6%

53.4%



Factor x Average
of Accidents

- > 100.00
- > 10.00
- 10.00
- 3.69
- 2.95
- 2.51
- 2.19
- 1.95
- 1.75
- 1.59
- 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

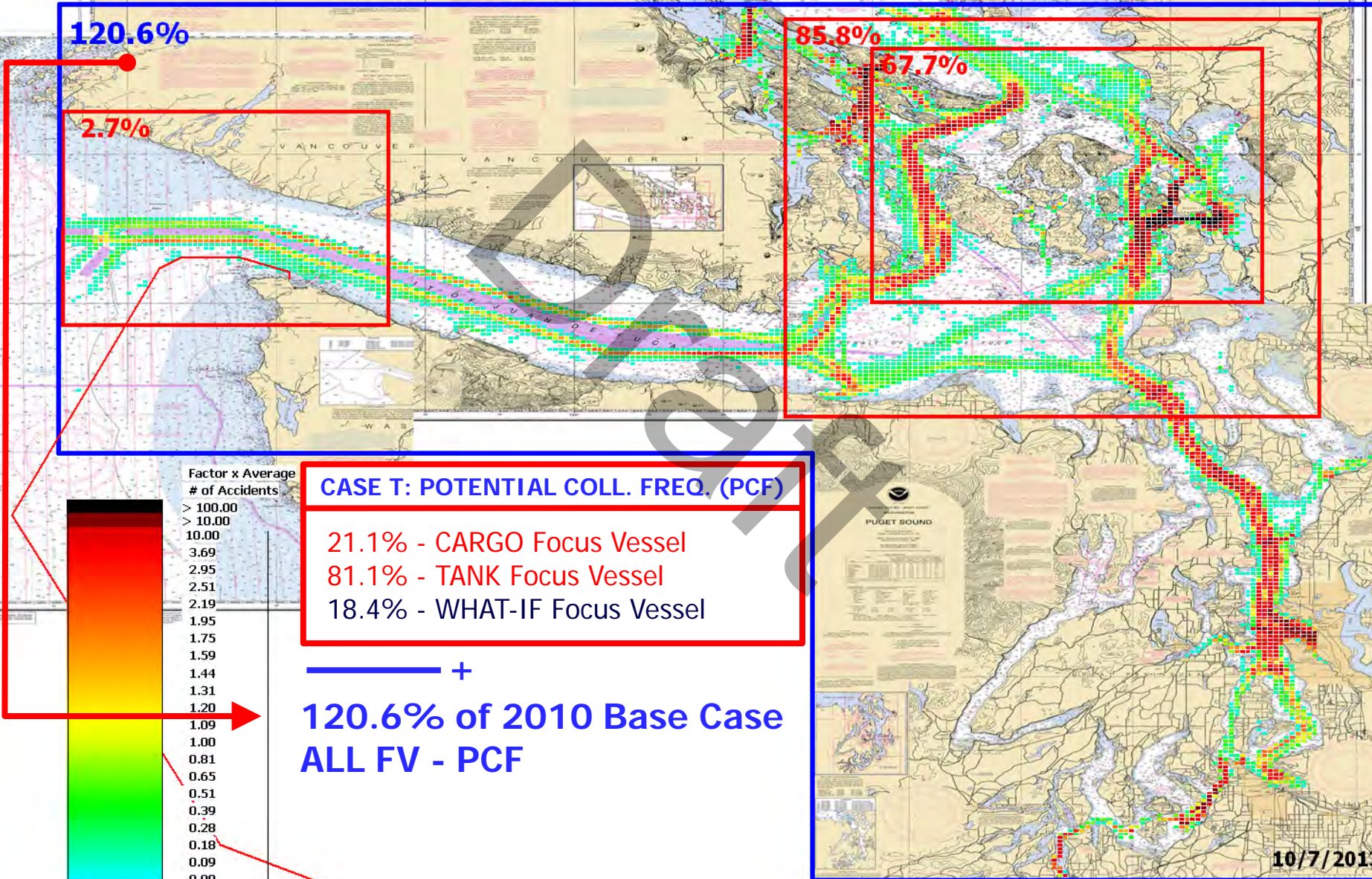
CASE P: POTENTIAL COLL. FREQ. (PCF)

- 20.3% - CARGO Focus Vessel
- 79.7% - TANK Focus Vessel
- 00.0% - WHAT-IF Focus Vessel

— +
100.0% of 2010 Base Case
ALL FV - PCF

T: ALL FV POTENTIAL COLL. FREQUENCY (PCF)

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



120.6%

85.8%

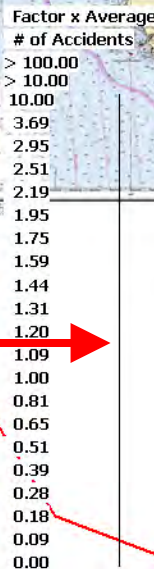
67.7%

2.7%

CASE T: POTENTIAL COLL. FREQ. (PCF)

21.1% - CARGO Focus Vessel
81.1% - TANK Focus Vessel
18.4% - WHAT-IF Focus Vessel

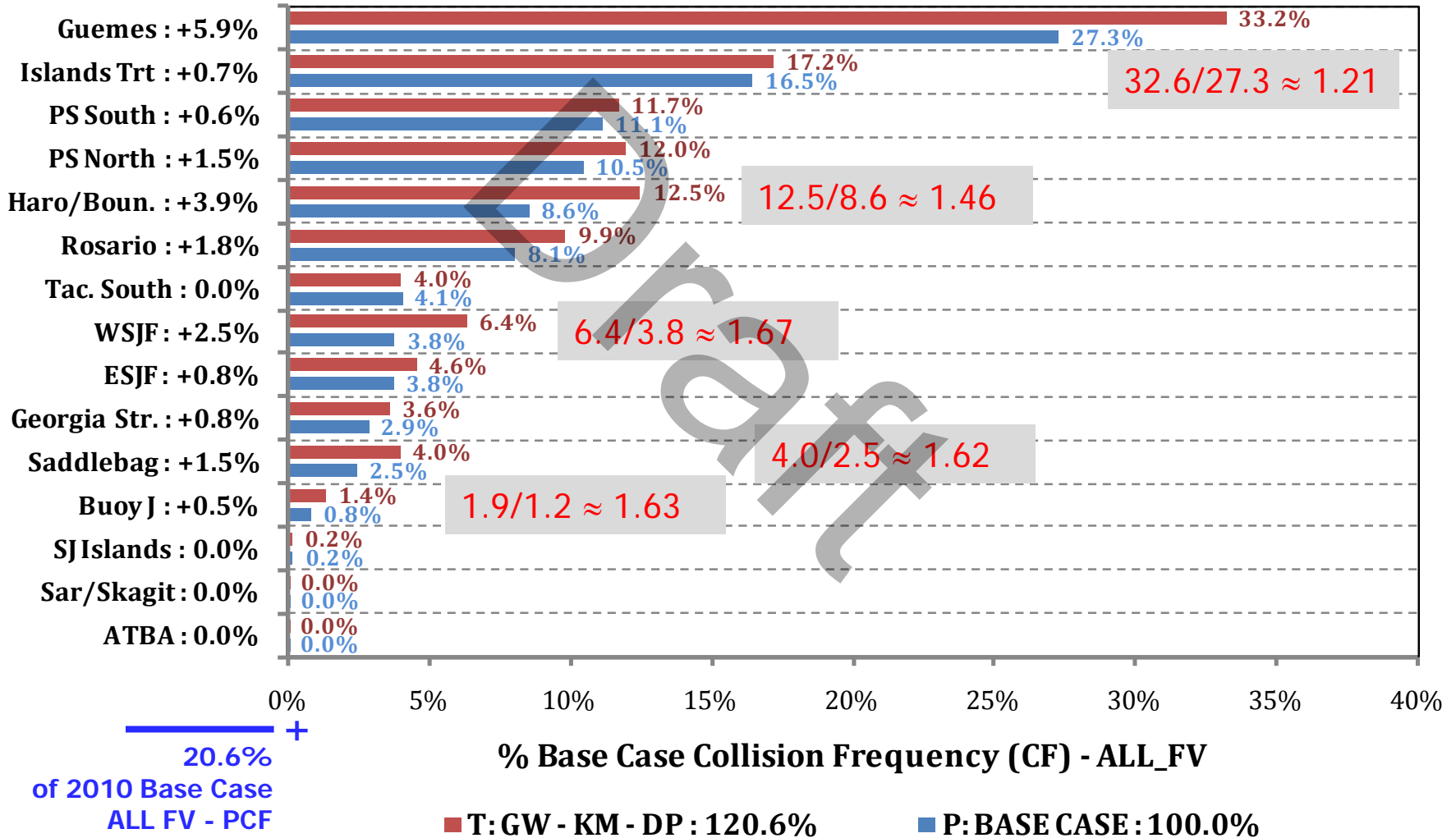
— +
**120.6% of 2010 Base Case
ALL FV - PCF**



WATERWAY LOCATION

Potential Collision Freq. Comparison – ALL FV

% Base Case Collision Frequency - ALL_FV



T: WHAT-IF FV POTENTIAL COLLISION FREQUENCY (PCF)

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

18.4%

0.7%

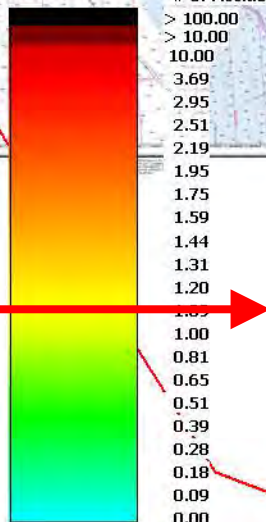
14.6%

13.1%

CASE T: POTENTIAL COLL. FREQ. (PCF)

- 03.6% - BULK CARGO
- 00.7% - CONTAINERSHIP
- 03.1% - TANKER
- 10.9% - OILBARGE

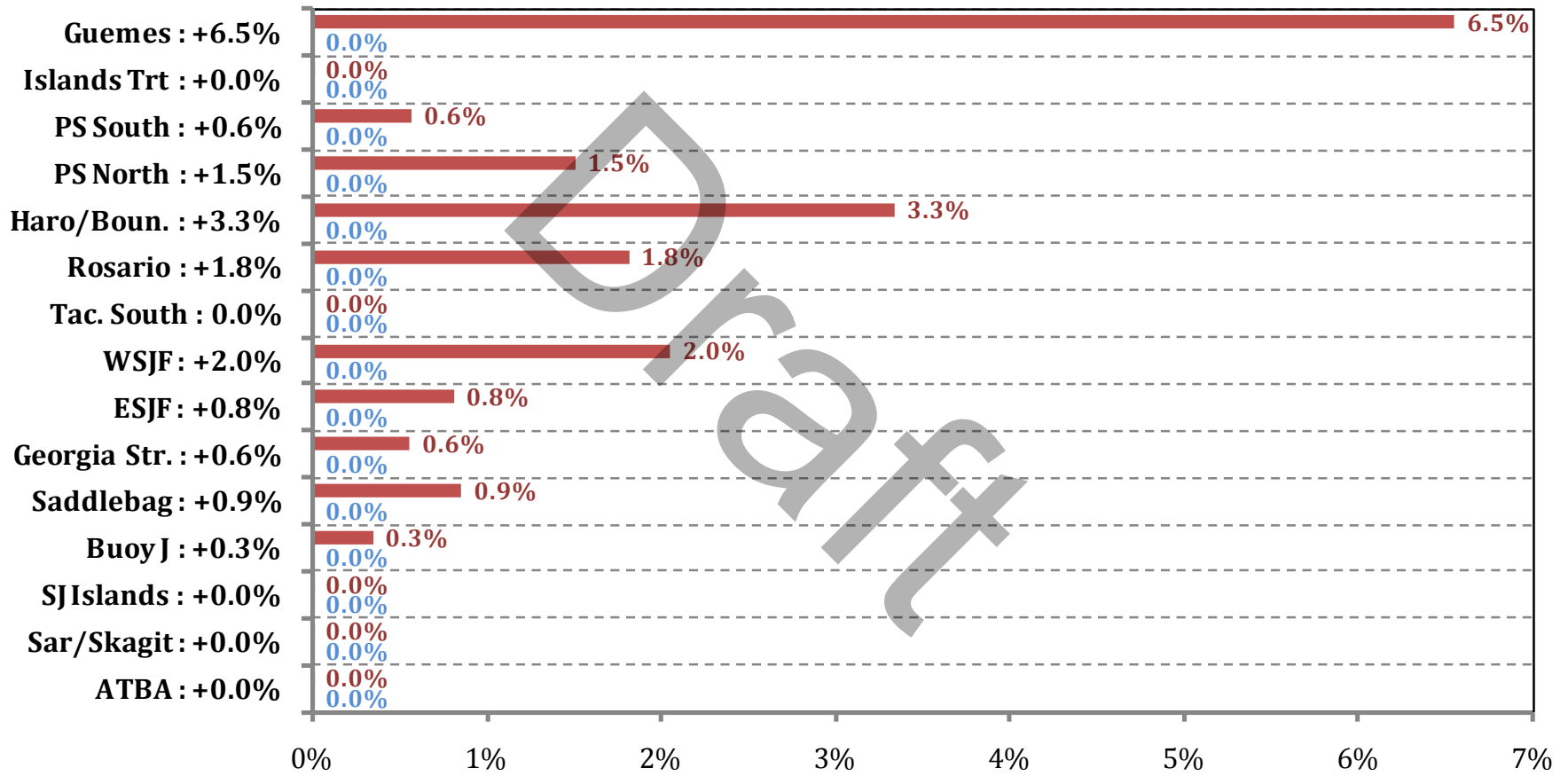
**18.4% of 2010 Base Case
WHAT-IF FV - PCF**




WATERWAY LOCATION

Potential Collision Freq. Comparison – WHAT-IF FV

% Base Case Collision Frequency - WhatIf





 18.4%

 of 2010 Base Case

 ALL FV - PCF

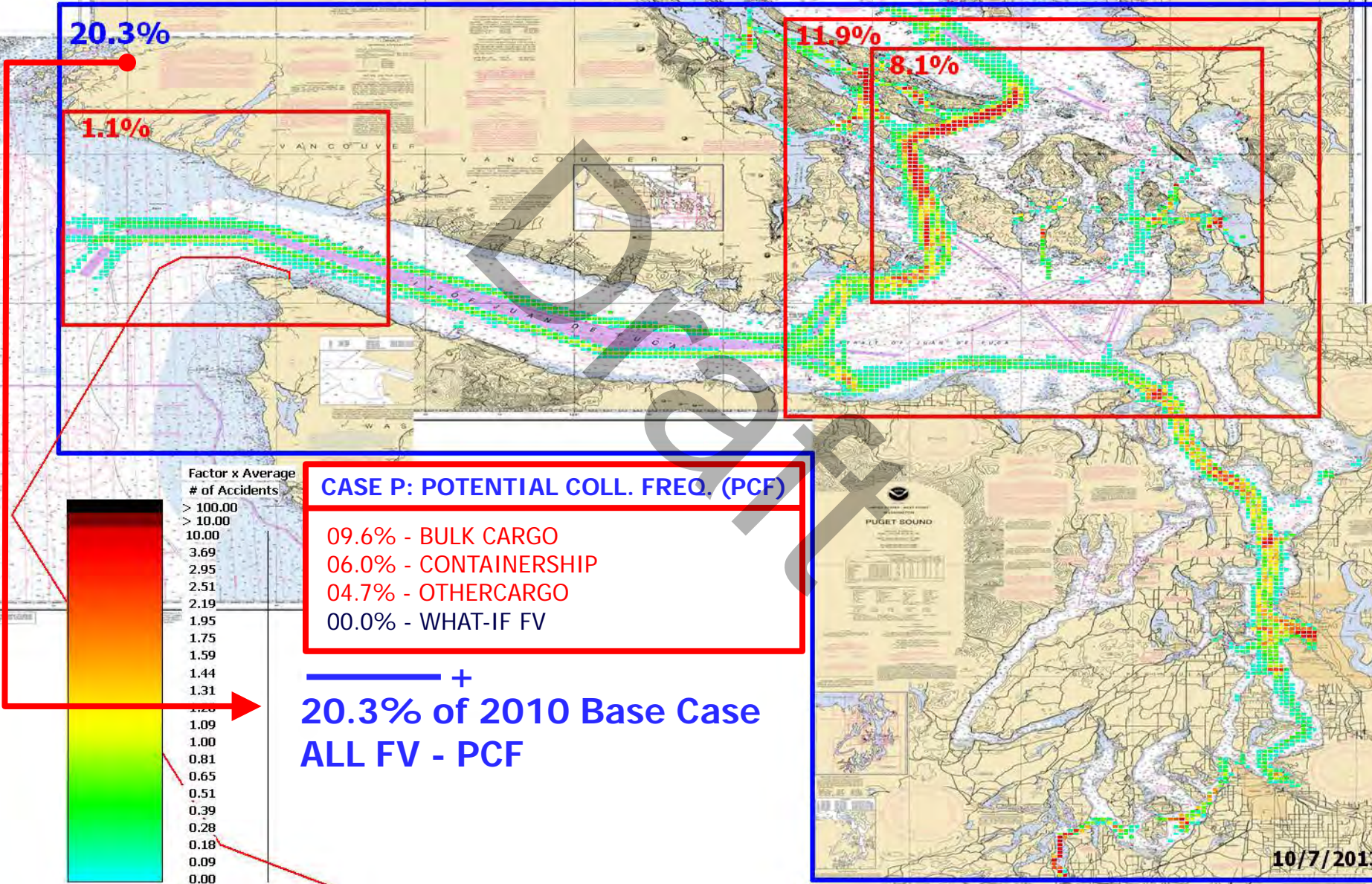
% Base Case Collision Frequency (CF) - WhatIf

 T: GW - KM - DP : 18.4%

 P: BASE CASE : 0.0%

P: BASE CASE CARGO FV POTENTIAL COLLISION FREQUENCY (PCF)

P: VTRA 2010 - BASE CASE - Cargo FV



20.3%

1.1%

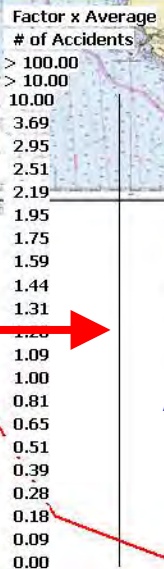
11.9%

8.1%

CASE P: POTENTIAL COLL. FREQ. (PCF)

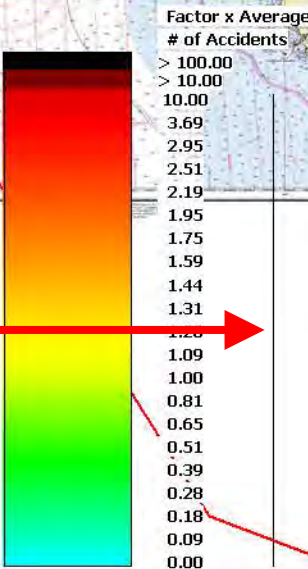
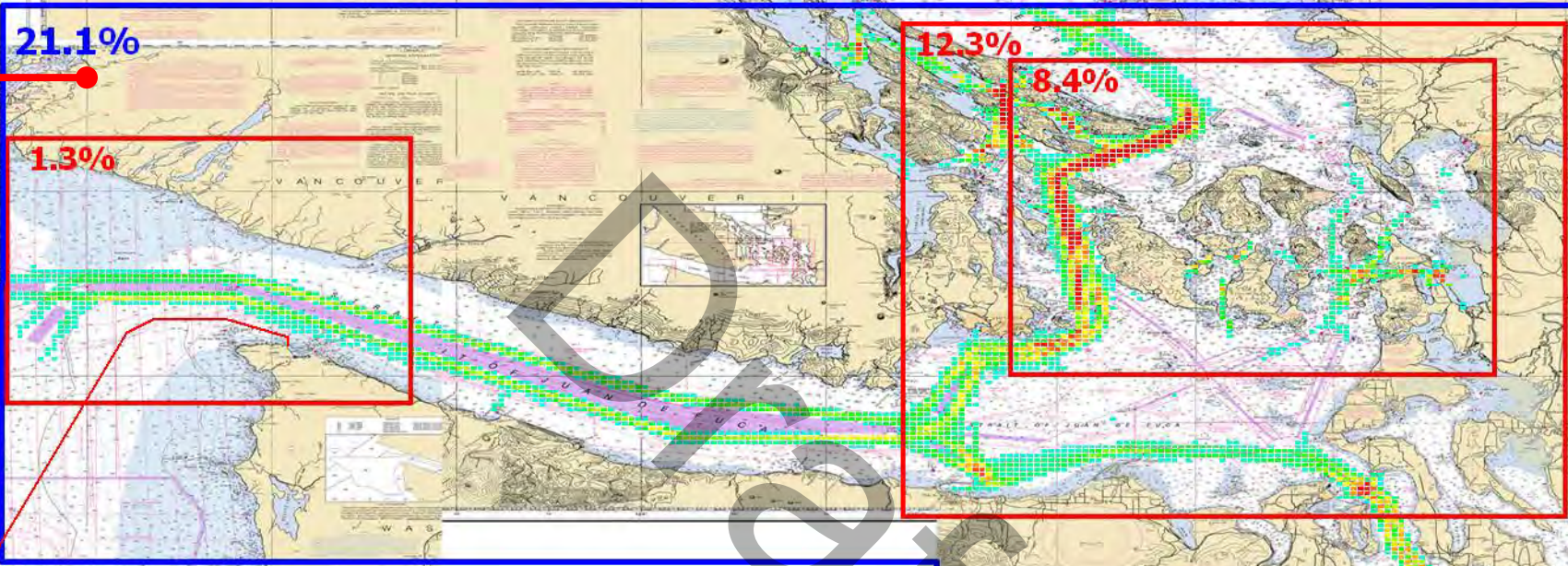
- 09.6% - BULK CARGO
- 06.0% - CONTAINERSHIP
- 04.7% - OTHERCARGO
- 00.0% - WHAT-IF FV

+
20.3% of 2010 Base Case
ALL FV - PCF



T: CASE T CARGO FV POTENTIAL COLLISION FREQUENCY (PCF)

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



CASE T: POTENTIAL COLL. FREQ. (PCF)

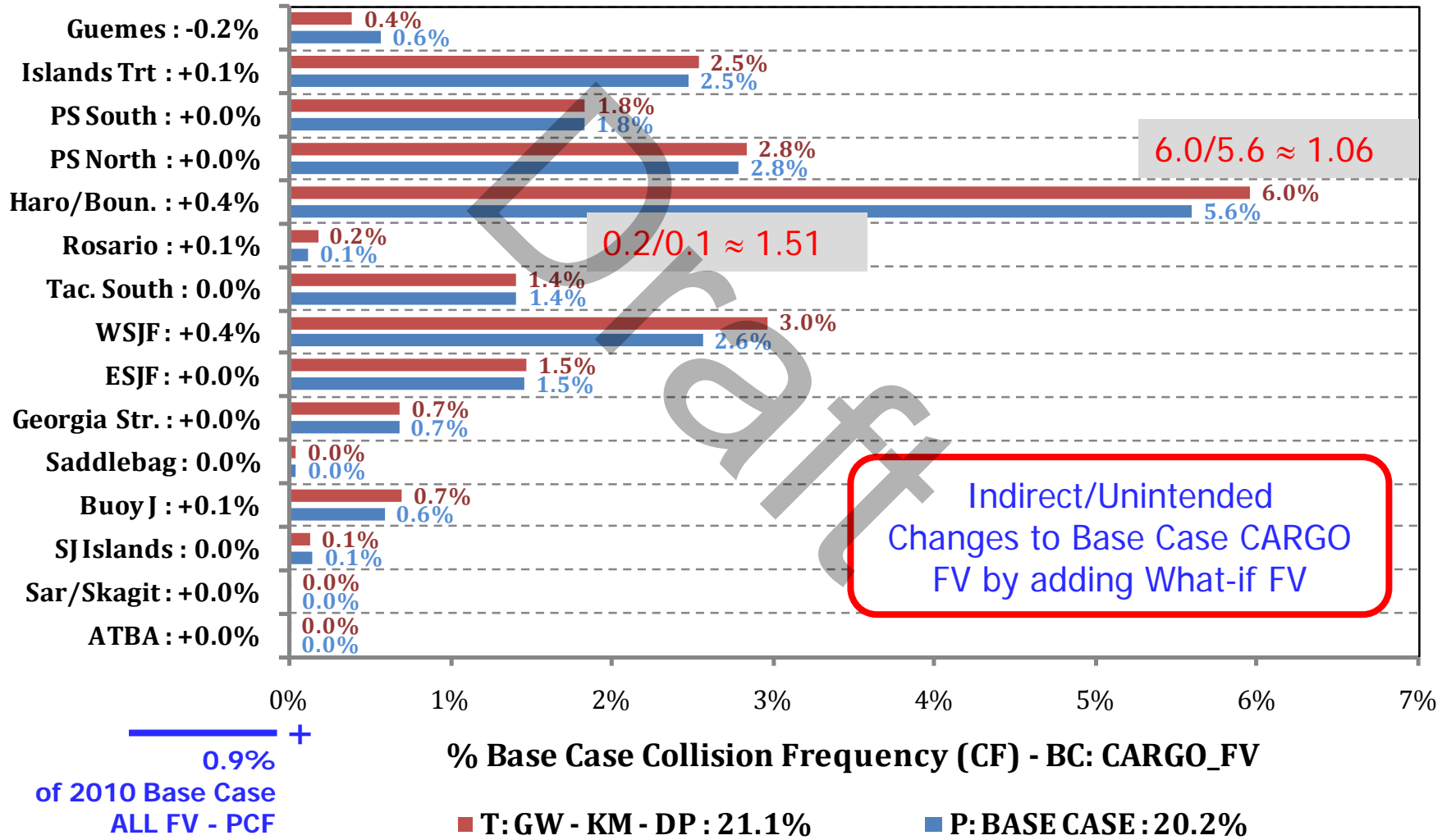
- 10.3% - BULK CARGO
- 06.3% - CONTAINERSHIP
- 04.6% - OTHERCARGO
- 00.0% - WHAT-IF FV

+
21.1% of 2010 Base Case
ALL FV - PCF

WATERWAY LOCATION

Potential Collision Freq. Comparison – CARGO FV

% Base Case Collision Frequency - BC: CARGO_FV

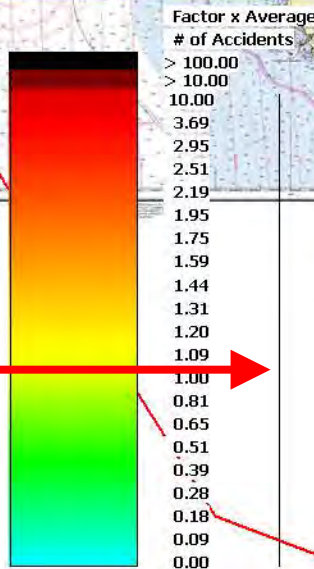
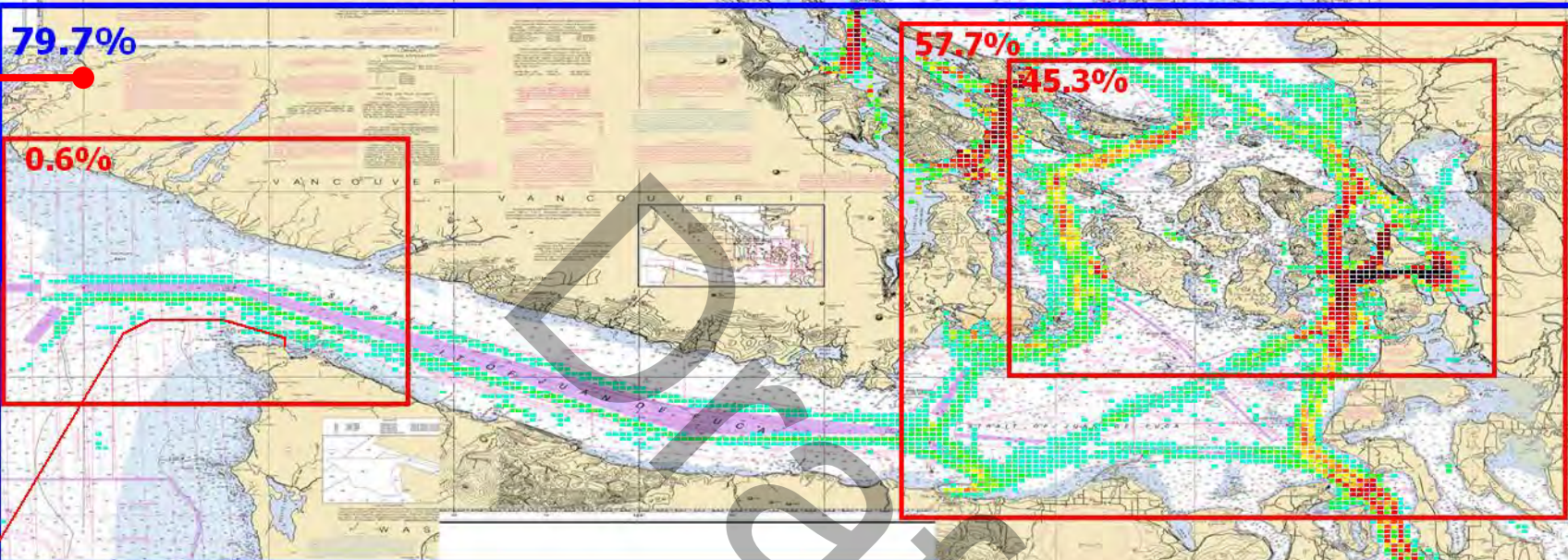


Indirect/Unintended
Changes to Base Case CARGO
FV by adding What-if FV

21.1/20.2 ≈ 1.04

P: BASE CASE TANK FV POTENTIAL COLLISION FREQUENCY (PCF)

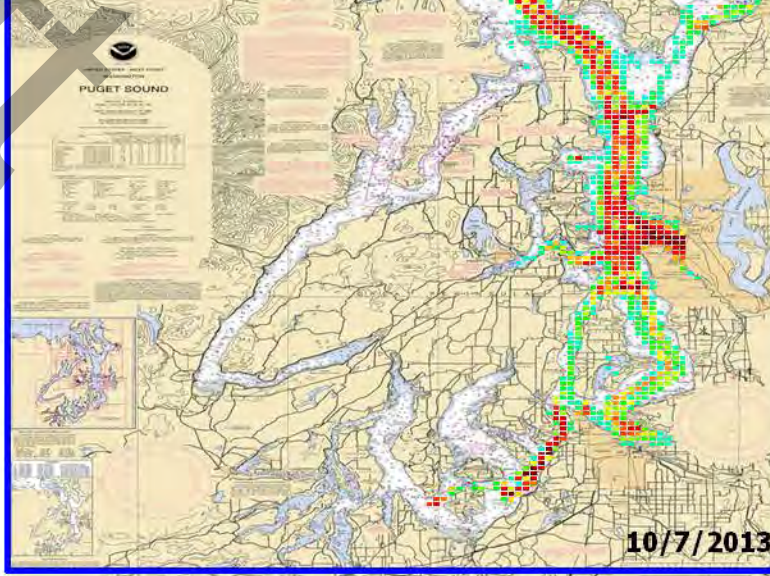
P: VTRA 2010 - BASE CASE - TANK FV



CASE P: POTENTIAL COLL. FREQ. (PCF)

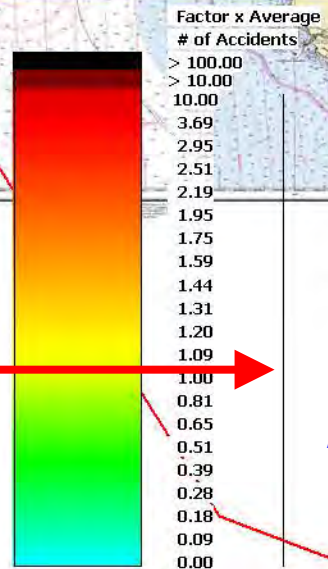
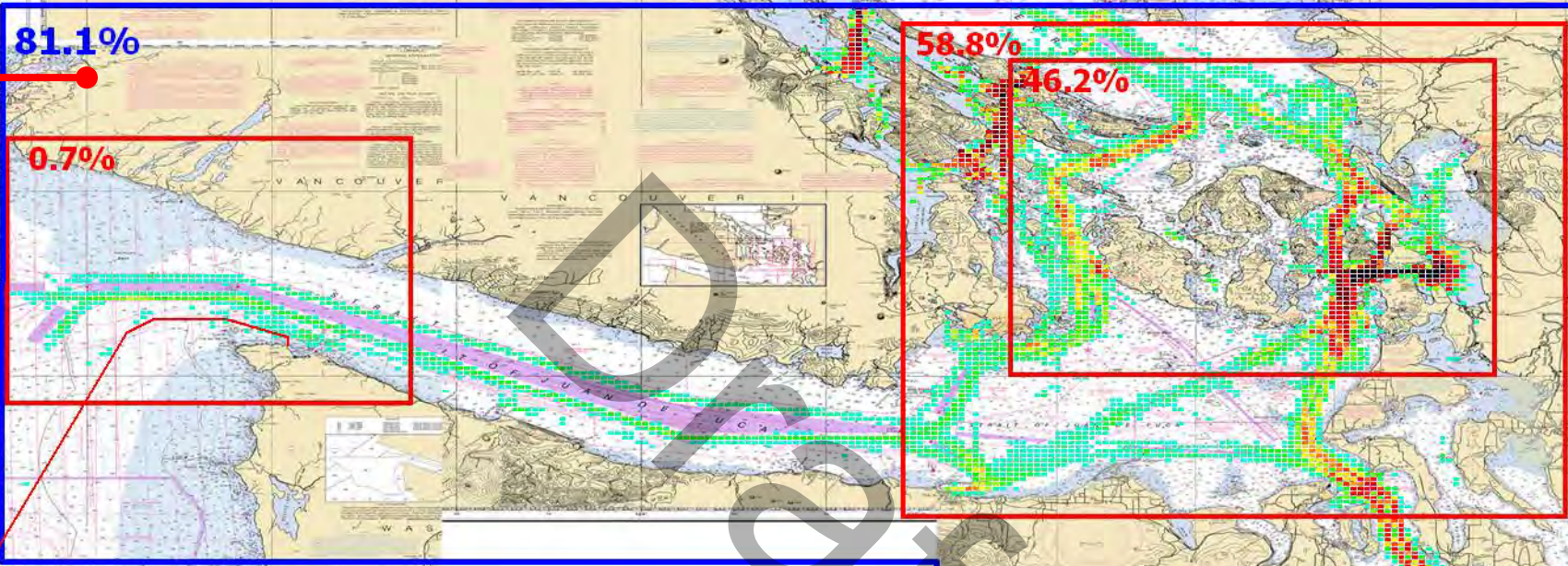
- 56.9% - OILBARGE
- 07.2% - OILTANKER
- 13.9% - CHEMICALCARRIER
- 01.8% - ATB
- 00.0% - WHAT-IF FV

79.7% of 2010 Base Case ALL FV - PCF



T: BASE CASE TANK FV POTENTIAL COLLISION FREQUENCY (PCF)

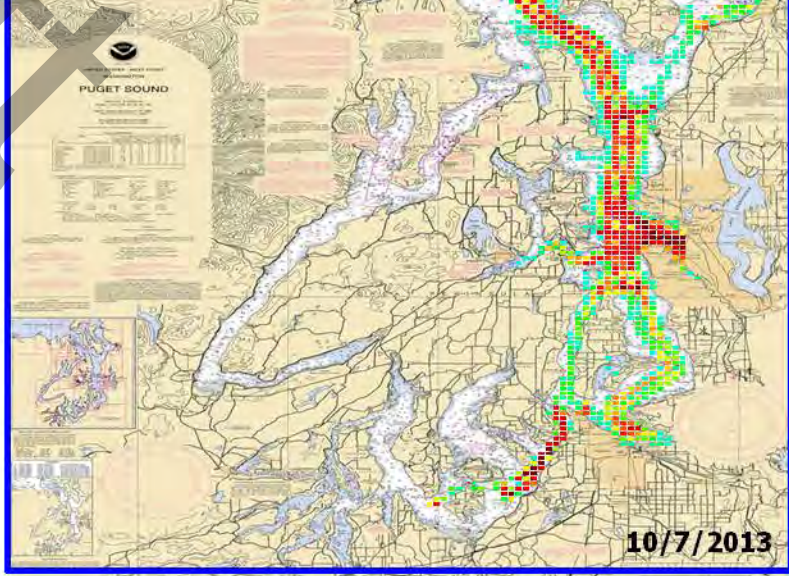
T: VTRA 2010 - GW 487- KM 348 - DP Cont. 67 and Bulk 348 - TANK FV



CASE T: POTENTIAL COLL. FREQ. (PCF)

- 54.5% - OILBARGE
- 08.6% - OILTANKER
- 15.9% - CHEMICALCARRIER
- 02.0% - ATB
- 00.0% - WHAT-IF FV

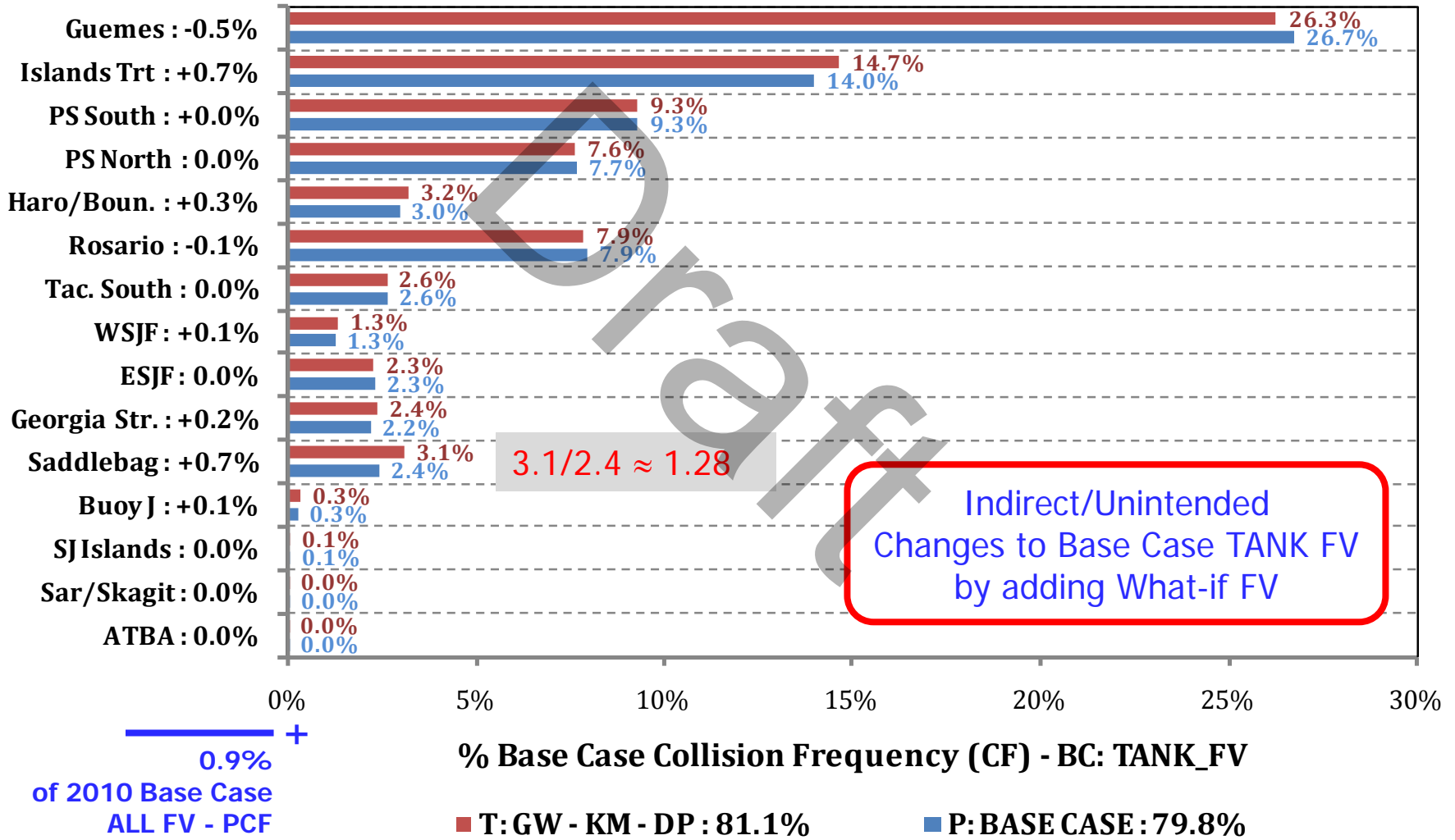
**+
81.1% of 2010 Base Case
ALL FV - PCF**



WATERWAY LOCATION

Potential Collision Freq. Comparison – TANK FV

% Base Case Collision Frequency - BC: TANK_FV



3.1/2.4 ≈ 1.28

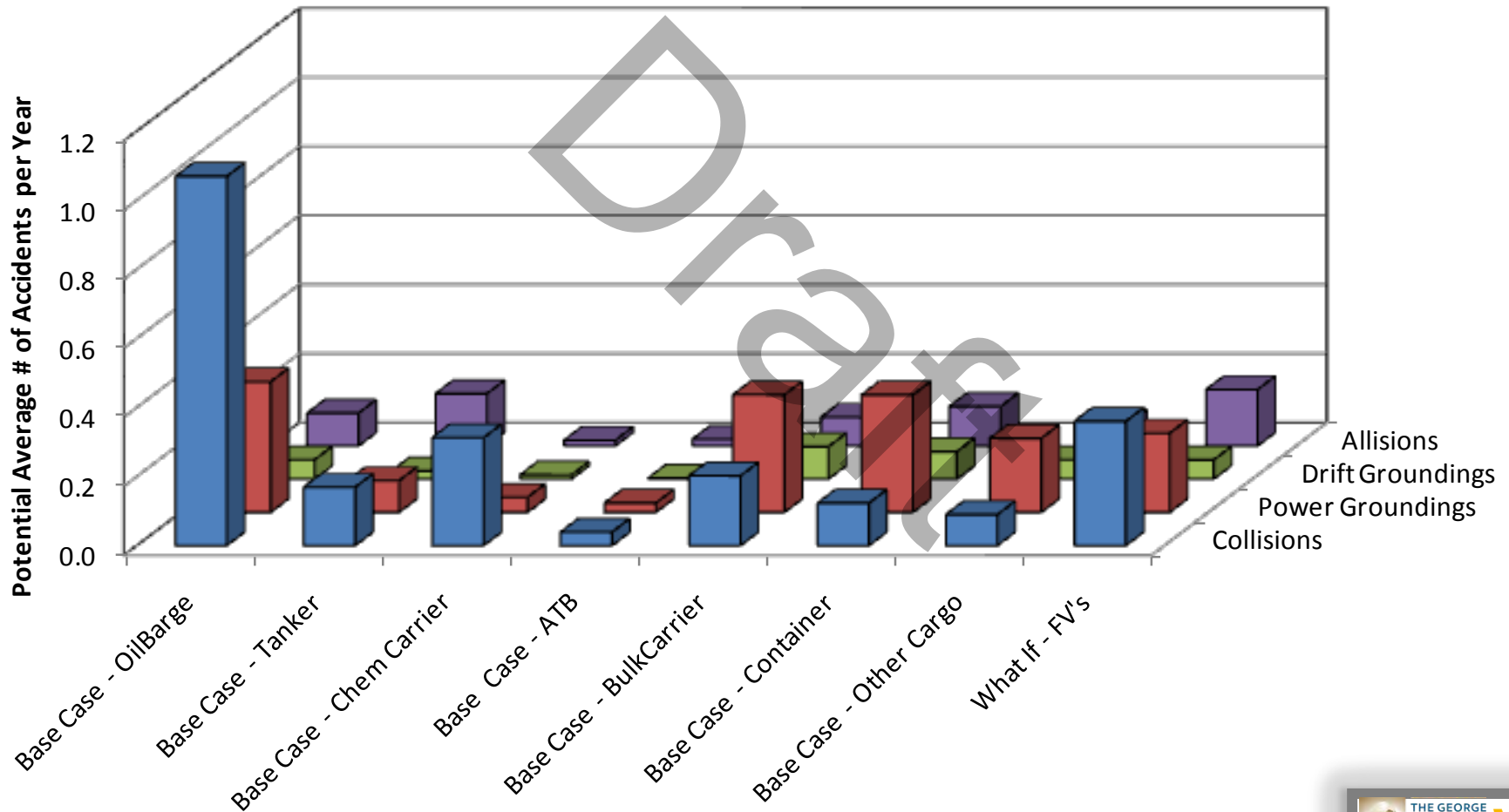
Indirect/Unintended
Changes to Base Case TANK FV
by adding What-if FV

81.1/79.8 ≈ 1.02

A TAXONOMY OF 2010 FOCUS VESSEL POTENTIAL ACCIDENT FREQUENCY AND ACCIDENT TYPE

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

T - VTRA 2010 : Potential Average # of Accidents per Year



T - VTRA 2010 : Potential Average # of Accidents per Year					
Focus Vessel	Collisions	Power Groundings	Drift Groundings	Allisions	Total
Base Case - OilBarge	54.5%	25.5%	17.1%	17.3%	37.0%
Base Case - Tanker	8.6%	6.2%	7.1%	27.6%	10.1%
Base Case - Chem Carrier	15.9%	2.9%	3.6%	2.9%	8.9%
Base Case - ATB	2.0%	1.8%	1.0%	3.5%	2.1%
Base Case - All Tank FV's	81.1%	36.5%	28.8%	51.4%	58.0%
Base Case - BulkCarrier	10.3%	23.0%	28.5%	15.2%	16.7%
Base Case - Container	6.3%	22.9%	24.1%	20.8%	15.2%
Base Case - Other Cargo	4.6%	14.5%	17.1%	12.0%	9.9%
Base Case - All Cargo FV's	21.1%	60.4%	69.7%	48.1%	41.7%
Base Case - All FV's	102.2%	96.9%	98.4%	99.4%	99.8%
What If - FV's	18.4%	15.5%	16.8%	29.8%	18.7%
Total - Base Case + What- IF	120.6%	112.4%	115.2%	129.2%	118.5%

T - VTRA 2010 : Potential Average # of Accidents per Year					
Focus Vessel	Collisions	Power Groundings	Drift Groundings	Allisions	Total
Base Case - OilBarge	1.07	0.38	0.06	0.09	1.60
Base Case - Tanker	0.17	0.09	0.02	0.15	0.44
Base Case - Chem Carrier	0.31	0.04	0.01	0.02	0.38
Base Case - ATB	0.04	0.03	0.00	0.02	0.09
Base Case - All Tank FV's	1.59	0.54	0.09	0.28	2.51
Base Case - BulkCarrier	0.20	0.34	0.09	0.08	0.72
Base Case - Container	0.12	0.34	0.08	0.11	0.66
Base Case - Other Cargo	0.09	0.21	0.06	0.07	0.43
Base Case - All Cargo FV's	0.41	0.89	0.23	0.26	1.80
Base Case - All FV's	2.00	1.44	0.32	0.54	4.31
What If - FV's	0.36	0.23	0.06	0.16	0.81
Total - Base Case + What- IF	2.36	1.66	0.38	0.71	5.11

