Oil Spill Analysis
Shell Crude Tank Replacement Project (CTRP) EIR
Martinez, CA

1. Introduction

The following Technical Memorandum describes analysis performed for Alameda County in support of the Crude Tank Replacement Project (CTRP) EIR, Shell Oil Facility, Martinez, California. Coast & Harbor Engineering, Inc.'s (CHE) Scope of Work included spill analysis using the NOAA Trajectory Analysis Planner II (TAPII) software. The Shell Martinez Terminal is located in the Carquinez Straight, immediately west of the Benicia-Martinez Bridge, as shown in Figure 1.

Figure 1. Shell Martinez Terminal project site location

2. Spill Evaluation

CHE performed analysis of potential spills at the Shell Martinez Terminal and in transit to assist the project team in evaluation of potential environmental impacts. CHE did not perform modeling of spill propagation; rather, CHE utilized statistical data summarizing spill modeling results already included within the NOAA Trajectory Analysis Planner II (TAPII) software (NOAA, 2000). The software consists of a database of spill modeling results for various materials, time periods, volumes and physical conditions. The TAPII system database is generated using a large set of individual spill trajectory modeling runs performed with NOAA's "On-Scene Spill Model (OSSM)." Each run consists of a randomly-chosen start time with its corresponding wind/tide/current conditions and a spill location of interest, then spill trajectories are calculated with subsequent calculation of spill volumes that accumulate within each segmented shoreline impact area (called "shoreline zones") over a 5-day simulation period (Barker, 2009).

The results obtained from the TAPII system on the Shell Martinez Terminal EIR include probabilities of spill volumes within the shoreline zones resulting from a spill of a certain material and volume at the terminal and also at one in-transit location at the Carquinez Bridge.

2.1. Modeling Scenarios and Approach

Spill scenarios were developed by the project team prior to the analysis using United States Coast Guard (USCG) spill response spill volume planning protocols and following consultation with Shell personnel (Gordon Johnson, Shell, personal communication, 2011). Two locations were selected for the origin of modeled accidental oil spills that included the Shell Martinez Terminal (MT) and Carquinez Bridge. Table 1 shows the spill analysis scenarios, consisting of different spill locations, times of year that the spill would occur and spill volumes.

Table 1. Spill Analysis Scenarios

Scenario	Location	Season	Volume (bbl)	Type of Spill
1	Shell Martinez Terminal	Summer	1,680	Reasonable Worst Case MT Spill
2	Shell Martinez Terminal	Winter	1,680	Reasonable Worst Case MT Spill
3	Shell Martinez Terminal	Summer	168	Maximum Most Probable MT Spill
4	Shell Martinez Terminal	Winter	168	Maximum Most Probable MT Spill
5	Shell Martinez Terminal	Summer	50	Average Most Probable MT Spill
6	Shell Martinez Terminal	Winter	50	Average Most Probable MT Spill
7	Carquinez Bridge	Summer	20,000	Reasonable Worst Case Tanker Spill
8	Carquinez Bridge	Winter	20,000	Reasonable Worst Case Tanker Spill

Winter and summer time periods differ presumably due to larger tidal ranges and river flows during the winter; however, insufficient detail regarding the simulations used to develop the TAPII database was available from NOAA to confirm these assumptions. Results generally indicate wider spread of higher probabilities of material during the winter. The results from the TAPII modeling system consist of probabilities that a certain number of barrels of spill material will be present within each shoreline zone. Shoreline zones are pre-defined within the TAPII system (185 different zones), and consist of areas approximately 8,200 ft long (on average), that extend approximately 1,650 ft offshore (on average).

Spill transport was evaluated at multiple times during a five-day simulation period (nine times were available, from six hours to five days after each spill), and the maximum probabilities of spill volumes exceeding a critical threshold value (level of concern) in each shoreline zone were determined. The TAPII system assumes that spill materials do not mix, but are all present on the surface as a sheen.

The approach to material volume calculation within each shoreline zone was coordinated and approved by the project team prior to final spill analysis. The level of concern in each shoreline zone, defined in TAPII as the volume of material present in each shoreline zone, was determined based on the shoreline zone area (8,200 by 1,650 ft) and reported thickness of crude oil sheen (Wikipedia 2011). Oil sheen thickness information for different appearance criteria were available ranging from "barely visible" to "colors are much darker". Crude oil sheen thickness for a "silvery sheen" (herein chosen as the level of concern for oil spill impact analysis) is such that 50 gallons are typically present in one square nautical mile. Based on this reported sheen thickness, a volume of 0.6 barrels per shoreline zone was determined to be the

level of concern upon which probabilities of impact were calculated in the TAPII system.

2.2. Modeling Results

The TAPII database was used to analyze the scenarios described in Section 2.1 and the results were analyzed in coordination with the project team. Appendix A shows plan view plots of the TAPII results of the maximum probabilities of spill volumes present in each shoreline zone on a rectified satellite image of San Francisco Bay, San Pablo Bay, and Suisun Bay for each modeling scenario. Sections 2.2.1 to 2.2.8 describe the results of the maximum probabilities of spill volumes along the shorelines of San Francisco Bay, San Pablo Bay, and Suisun Bay for each modeling scenario.

2.2.1. Scenario 1

Scenario 1 consists of 1,680 barrels of crude oil spill at the Shell Martinez Terminal (Reasonable Worst Case MT Spill) during summer. Results indicate that probabilities of exceeding the levels of concern range from 75 to 100 percent along the shorelines west of the terminal past the Carquinez Bridge and east of the terminal to Chipps Island and Mallard Island. Probabilities of exceedance up to 40 percent can be found in San Pablo Bay to Point San Pablo and Point San Pedro. Probabilities of exceedance up to 15 percent can be found to Tiburon. Probabilities of exceedance drop to values less than 5 percent south of Tiburon.

2.2.2. Scenario 2

Scenario 2 consists of 1,680 barrels of crude oil spill at the Shell Martinez Terminal (Reasonable Worst Case MT Spill) during winter. Results indicate that probabilities of exceeding the levels of concern range from 75 to 100 percent along the shorelines west of the terminal past the Carquinez Bridge and east of the terminal to Chipps Island and Mallard Island. Probabilities of exceedance of up to 50-60 percent can be found in San Pablo Bay to Point San Pablo and Point San Pedro. Probabilities of exceedance up to 25 percent can be found to the Golden Gate. Probabilities of exceedance drop to values less than 5 percent south of Alameda.

2.2.3. Scenario 3

Scenario 3 consists of 168 barrels of crude oil spill at the Shell Martinez Terminal (Maximum Most Probable MT Spill) during summer. Results indicate that probabilities of exceeding the levels of concern range from 75 to 100 percent along the shorelines west of the terminal past the Carquinez Bridge (north shoreline) and east of the terminal to Seal Islands/Roe Island. Probabilities of exceedance up to 50 percent can be found along the shorelines east of the terminal to Chipps Island and Mallard Island. Probabilities of exceedance drop to values less than 5 percent outside Suisun Bay.

2.2.4. Scenario 4

Scenario 4 consists of 168 barrels of crude oil spill at the Shell Martinez Terminal (Maximum Most Probable MT Spill) during winter. Results indicate that probabilities of exceeding the levels of concern range from 75 to 100 percent along the shoreline west of the terminal past the Carquinez Bridge (north shoreline) and east of the terminal to Seal Islands/Roe Island. Probabilities of exceedance up to 40 percent can be found along the shoreline east of the terminal to Chipps Island and Mallard Island. Probabilities of exceedance of up to 30 percent can be found in San Pablo Bay to Point San Pedro. Probabilities of exceedance drop to values less than 10-15 percent south of San Pablo Bay with peaks at Tiburon and Angel Island. Probabilities of exceedance drop to values less than 5 percent south of Angel Island.

2.2.5. Scenario 5

Scenario 5 consists of 50 barrels of crude oil spill at the Terminal (Average Most Probable MT Spill) during summer. Results indicate that probabilities of exceeding the levels of concern range from 75 to 100 percent west of the terminal to Port Costa/Crockett along the south shoreline and up to approximately one mile east of the Carquinez Bridge along the northern shoreline. Probabilities of exceedance range from 75 to 100 percent for approximately 2.2 miles east of the terminal along the south shoreline. Probabilities of exceedance up to 50 percent can be found along the shoreline west of the terminal past the Carquinez Bridge (north shoreline) and east of the terminal to the shoreline area north of Port Chicago. Probabilities of exceedance up to 30 percent can be found along the shoreline east of the terminal to Chipps Island and Mallard Island. Probabilities of exceedance drop to values less than 5 percent outside Suisun Bay.

2.2.6. Scenario 6

Scenario 6 consists of 50 barrels of crude oil spill at the Shell Martinez Terminal (Average Most Probable MT Spill) during winter. Results indicate that probabilities of exceeding the levels of concern range from 75 to 100 percent west of the terminal all the way to Port Costa/Crockett along the south shoreline and past the Carquinez Bridge along the north shoreline. Probabilities of exceedance range from 75 to 100 percent for approximately 3.2 miles along the south shoreline east of the terminal. Probabilities of exceedance up to 50 percent can be found along the south shoreline west of the terminal past the Carquinez Bridge, and east of the terminal to the shoreline area north of Port Chicago. Probabilities of exceedance up to 20 percent can be found along the shoreline east of the terminal to Chipps Island and Mallard Island. Probabilities of exceedance drop to values less than 5 percent outside San Pablo Bay.

2.2.7. Scenario 7

Scenario 7 consists of 20,000 barrels of crude oil spill at Carquinez Bridge (Reasonable Worst Case Tanker Spill) during summer. Results indicate that probabilities of exceeding the levels of concern range from 75 to 100 percent along the shoreline west of the Carquinez Bridge into San Pablo Bay and east of the Carquinez Bridge to the shoreline area north of Port Chicago. Probabilities of

exceedance up to 40-50 percent can be found in San Pablo Bay to the Richmond-San Rafael Bridge and east of the Carquinez Bridge to Chipps Island and Mallard Island. Probabilities of exceedance of up to 30 percent can be found at Richmond, and up to 20 percent can be found to the Golden Gate and to Alameda. Probabilities of exceedance drop to values less than 5 percent south of Alameda.

2.2.8. Scenario 8

Scenario 8 consists of 20,000 barrels of crude oil spill at Carquinez Bridge (Reasonable Worst Case Tanker Spill) during winter. Results indicate that probabilities of exceeding the levels of concern range from 75 to 100 percent along the shoreline west of the Carquinez Bridge, into San Pablo Bay to Point San Pablo and Point San Pedro, and east of the Carquinez Bridge to the shoreline area north of Port Chicago. Probabilities of exceedance of up to 50 percent can be found at Richmond, to the Golden Gate and to Treasure Island. Probabilities of exceedance up to 30 percent can be found along the shoreline east of the terminal to Chipps Island and Mallard Island. Probabilities of exceedance drop to values less than 5 percent south of Hunters Point.

3. Conclusion

Oil spill dispersion predictions were provided using the NOAA TAPII system in support of environmental impact analysis for the Shell Martinez Crude Tank Replacement Project (CTRP) EIR, Martinez, California. Oil spill analysis results in the form of probabilities of spills exceeding levels of concern were provided to the project team for environmental analysis.

4. References

Barker, C. 2009. The NOAA Trajectory Analysis Planner: TAP II. Downloaded from NOAA website.

Johnson, G. 2011. Personal Communication with Gordon Johnson, Shell.

Wikipedia. 2011. http://en.wikipedia.org/wiki/Oil_spill.

National Oceanic and Atmospheric Administration (NOAA). January 2000. TAPII 1.1 User Manual, U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Office of Response and Restoration.

APPENDIX A

**Plan Views of Maximum Probabilities of Spill Volumes above
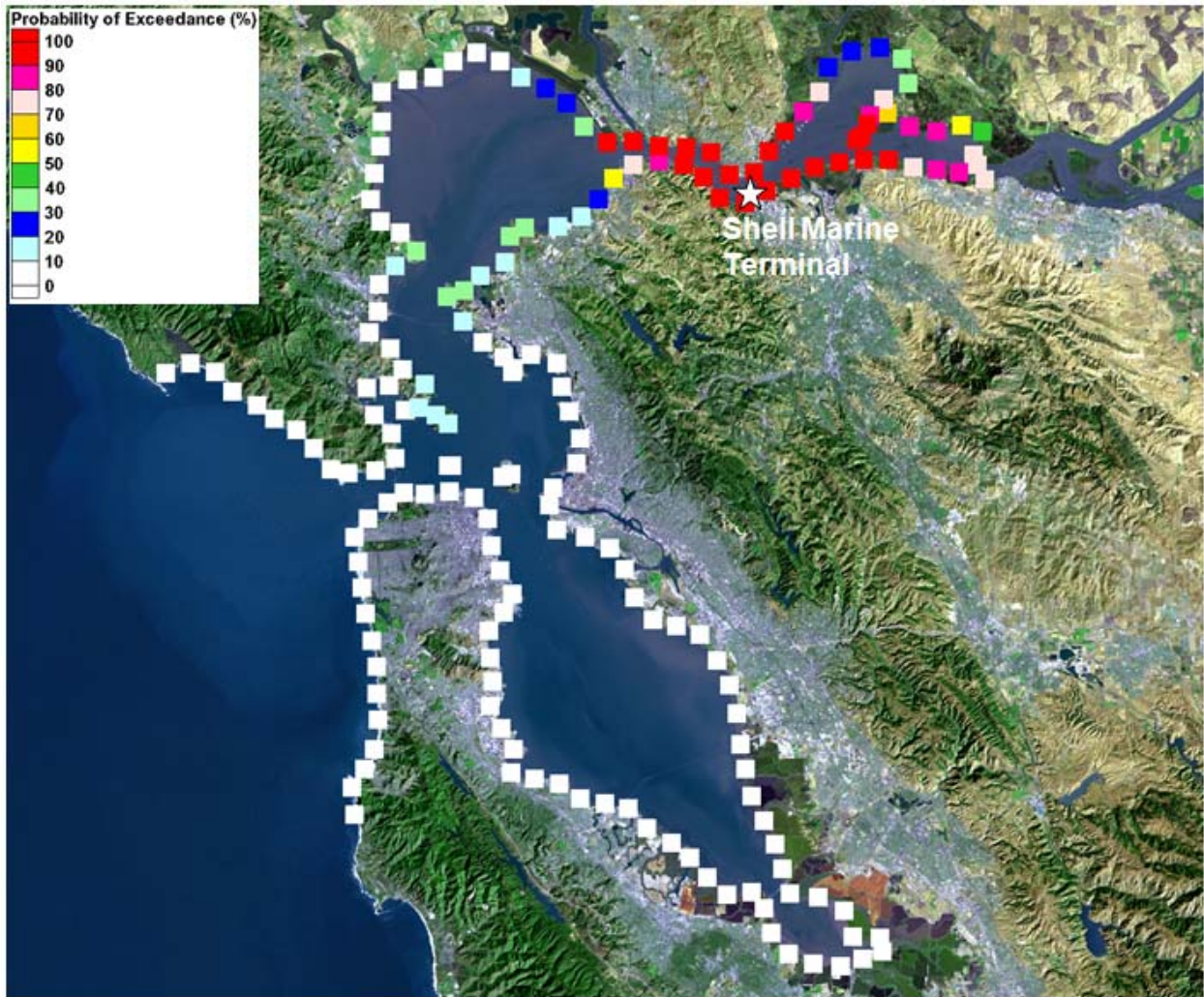Level of Concern in Each Shoreline Zone**

Figure A1. Scenario 1, Reasonable Worst Case MT Spill, 1,680 Barrels, Shell Martinez Terminal, Summer
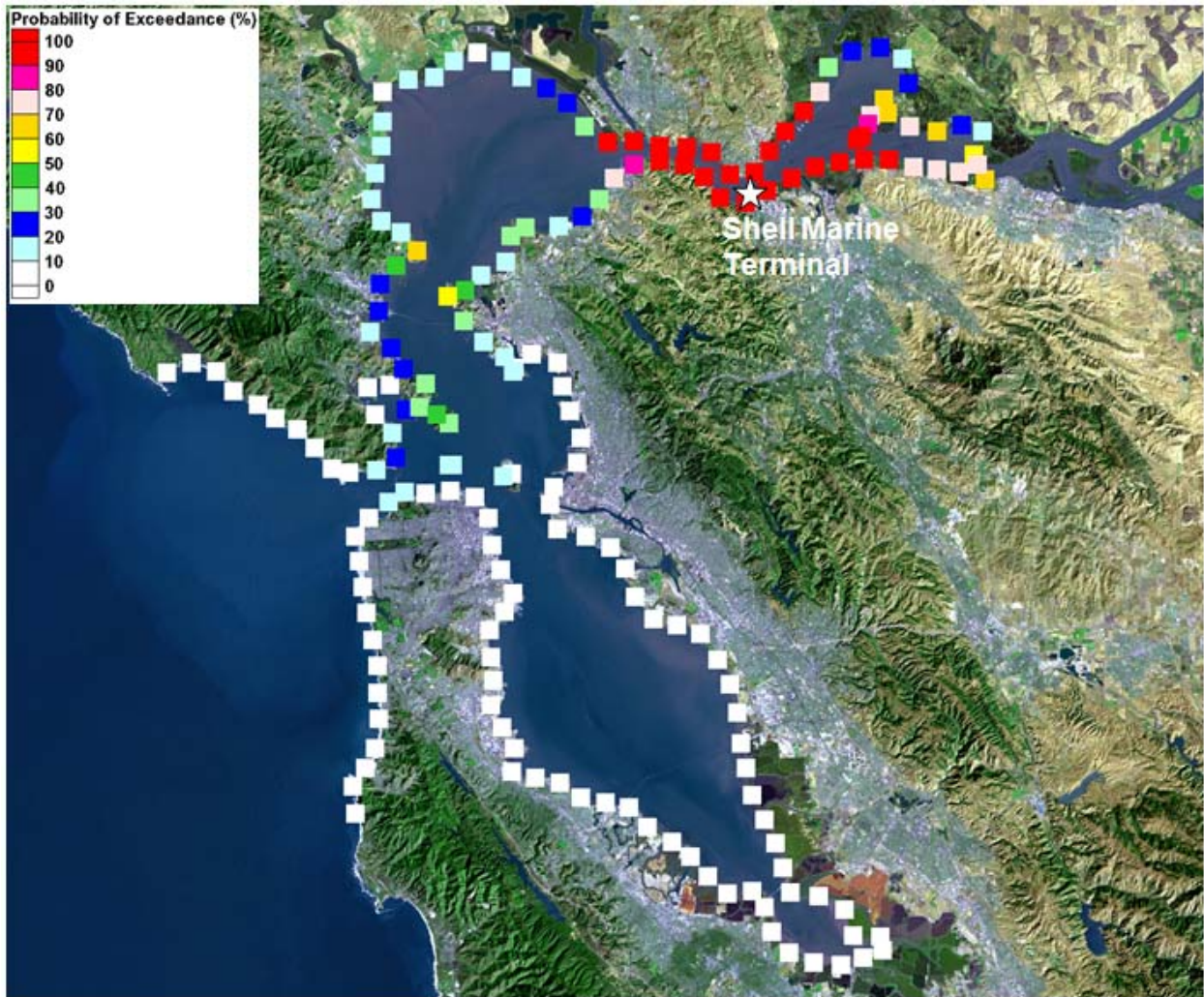
Figure A2. Scenario 2, Reasonable Worst Case MT Spill, 1,680 Barrels, Shell Martinez Terminal, Winter

Figure A3. Scenario 3, Maximum Most Probable MT Spill, 168 Barrels, Shell Martinez Terminal, Summer
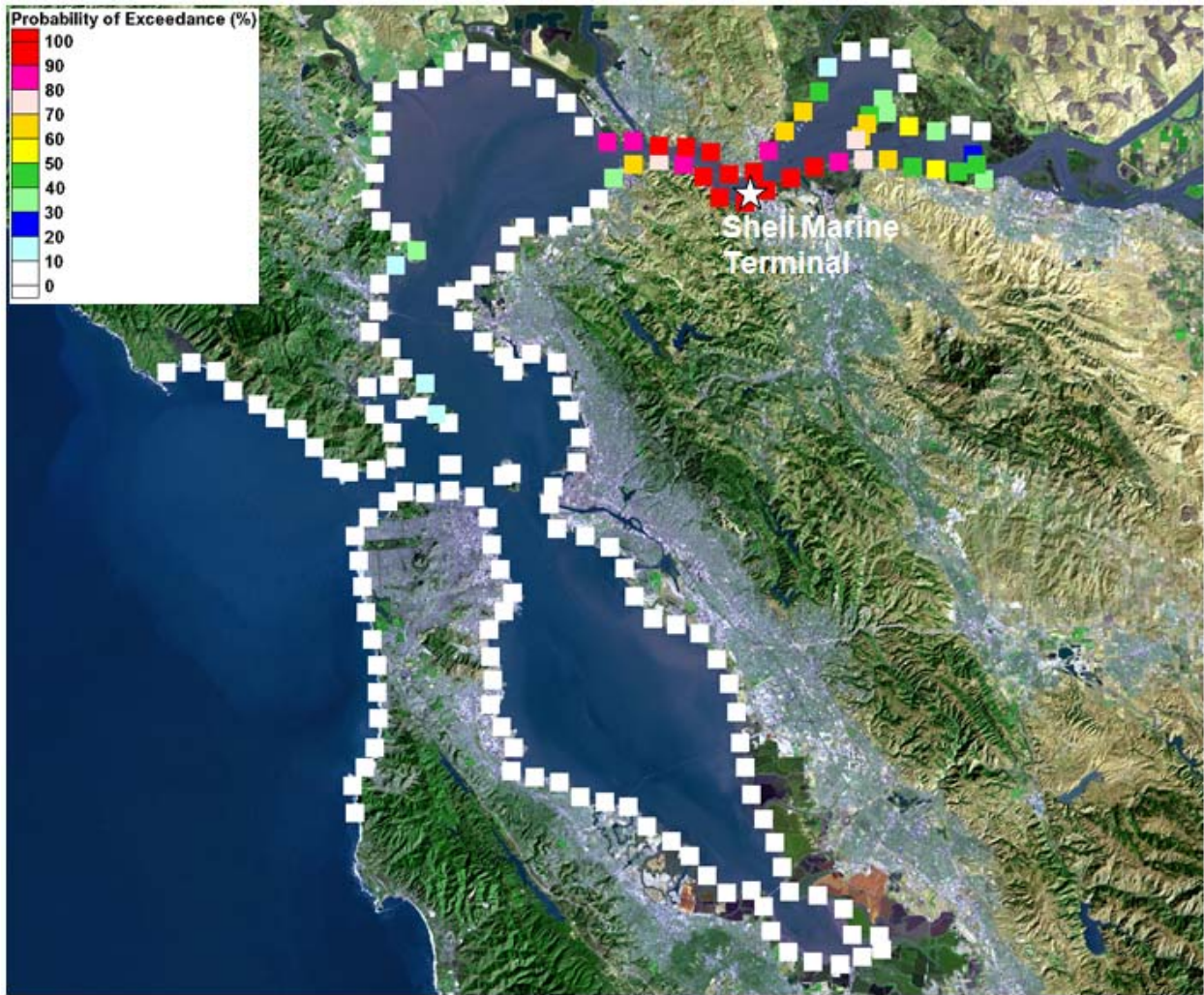
Figure A4. Scenario 4, Maximum Most Probable MT Spill, 168 Barrels, Shell Martinez Terminal, Winter

Figure A5. Scenario 5, Average Most Probable MT Spill, 50 Barrels, Shell Martinez Terminal, Summer

Figure A6. Scenario 6, Average Most Probable MT Spill, 50 Barrels, Shell Martinez Terminal, Winter
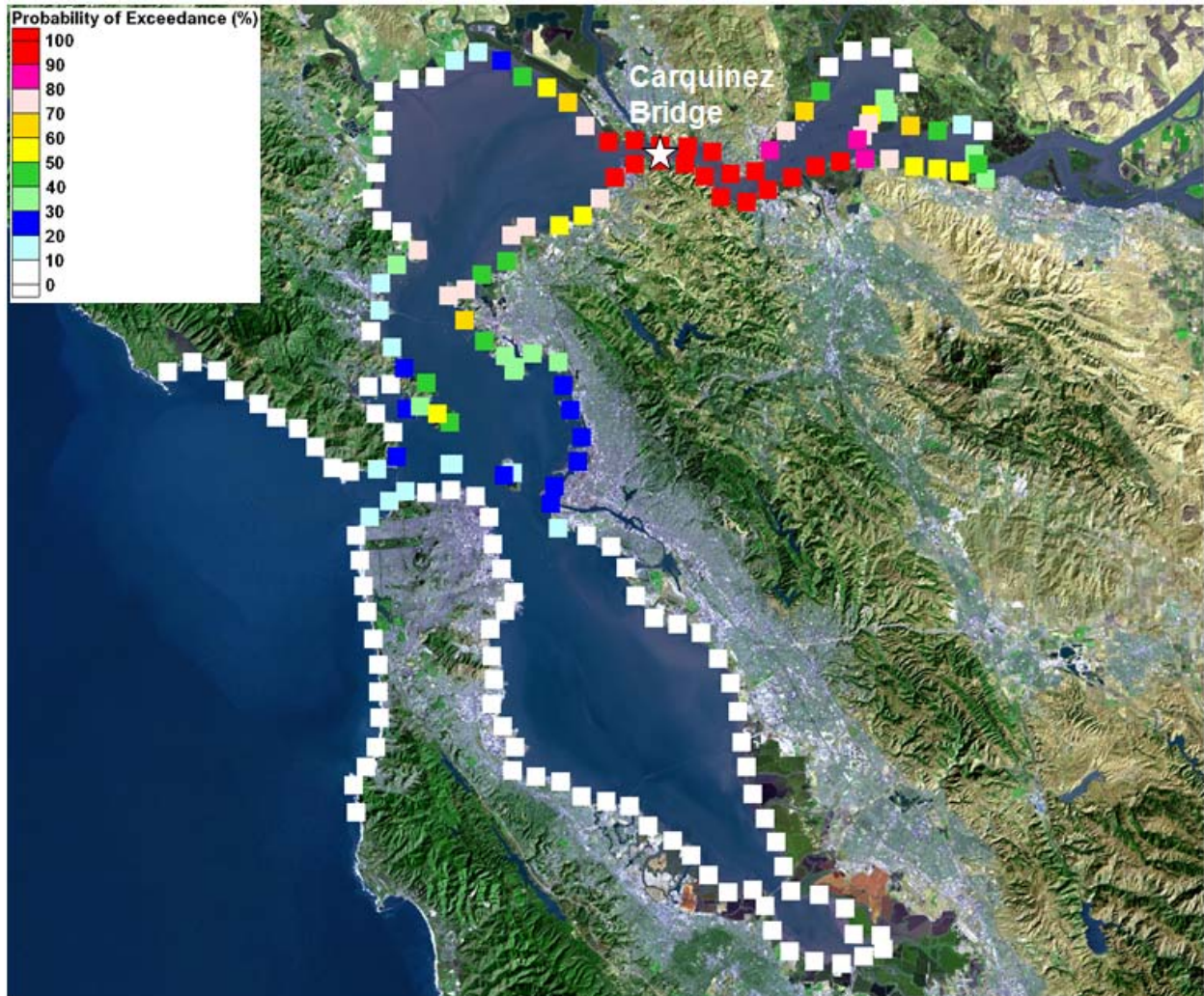
Figure A7. Scenario 7, Reasonable Worst Case Tanker Spill, 20,000 Barrels, Carquinez Bridge, Summer

Figure A8. Scenario 8, Reasonable Worst Case Tanker Spill, 20,000 Barrels, Carquinez Bridge, Winter