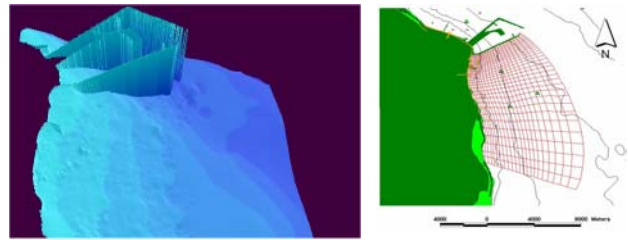


Transport and Fate of Chlorine-treated Cooling Water

Ras Laffan Liquefied Natural Gas, Arabian Gulf, Qatar



Situation

RasGas operates a liquefied natural gas (LNG) facility on the northeast coast of Qatar, north of Doha. The facility discharges cooling water into the Arabian Gulf through an open canal. RasGas added a third LNG train that increased cooling water flow rates to 90,000 tonne/hr, increasing the size of the mixing zone. A residual chlorine discharge limit of 0.15 mg/L at the outfall was previously permitted by the Supreme Council for the Environment (SCE). At the edge of the mixing zone the residual chlorine concentration is not to exceed 0.01 mg/L limit.

The ERM Surfacewater Modeling Group was tasked to create a model simulating the chlorine plume discharged from the facility under these new conditions to verify compliance with standards.

Approach

Three dimensional thermal and chlorine plume modeling of the RasLaffan LNG facility's cooling water outfall was performed using ERM's 3-D hydrodynamic and water quality model, GEMSS® (Generalized Environmental Modeling System for Surfacewaters).

The physico-chemical reactions in the water column were modeled to estimate chlorine concentrations using a first-order decay law. First, the model tested if the permitted discharge concentration (0.15 mg/L) would pass water quality standards at the edge of the mixing zone under the new flow conditions. The three-train scenario was run with a maximum temperature rise of 10°C at 15 mg/L chlorine. Concentration plume maps describing the areas in which there was a 95% probability of exceeding 0.01 mg/l chlorine

at the surface and at the bottom were obtained showing exceedances of the 0.01 mg/L limit for surface concentrations. A second scenario was run to determine what maximum concentration would be allowable at the outfall under the new flow conditions to meet the 0.01 mg/L limit.

Results

Since the currently allowable discharge limit for residual chlorine (0.15 mg/L) would cause an exceedance in chlorine standards at the edge of the mixing zone, the new maximum allowable chlorine concentration at the outfall was determined to be 0.05 mg/L.

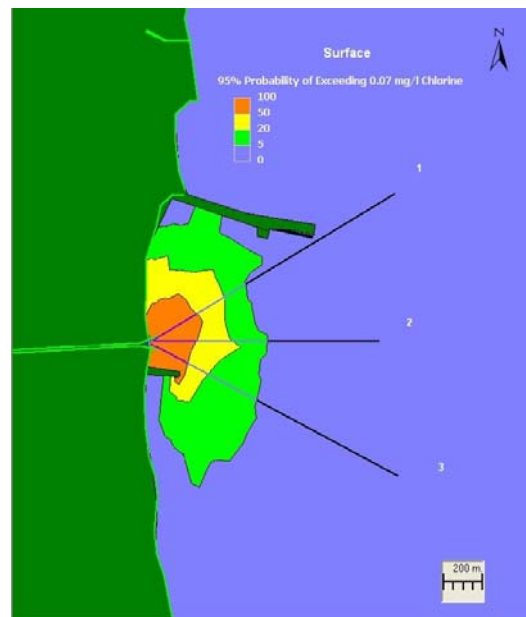


Figure 1 Probability plume contour plot of 0.07 mg/l chlorine concentration at the surface for summer conditions