Assessing the Effects of a Desalinization Facility on the Palmer River

CLIENT:

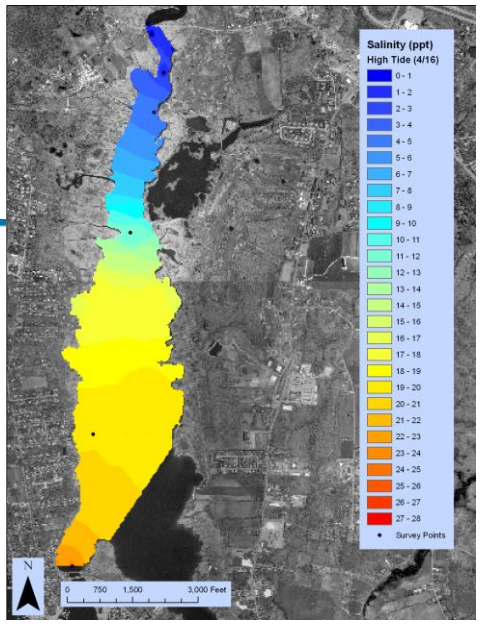
Town of Swansea, MA (through Epsilon Associates, Inc.)

PROJECT #:

2003-150

PROJECT ELEMENTS:

- Hydrodynamic modeling using BFHYDRO and WQMAP
- Three-dimensional Updated Merge (UM3) modeling
- Field program



PROBLEM. PURPOSE.

In order to address growing demand for water, the city of Swansea, MA is investigating the feasibility of locating a desalination facility on the Palmer River, a small estuary that joins with the Barrington River to form the Warren River, which in turn empties into upper Narragansett Bay. ASA was contracted to assess the effects of desalination operations on the hydrography of the Palmer River and to provide feedback on the design of the desalination facility to minimize these effects.

SCIENCE. SERVICES. SOLUTIONS.

A field program was initiated to characterize the current hydrography of the river and the use of analytic and computer models to evaluate both the near field flows associated with the intake and discharge from the facility and the far field flows associated with tidal forcing and freshwater runoff.

The purpose of this study was to determine what effects, if any, the withdrawal of water from the Palmer River for desalination treatment and the discharge of the resulting concentrated brine into the river, would have on the hydrography and ultimately the biological communities resident there. The study featured an extensive field program in the river. Analytic and computer models were used to assess the potential effects of water withdrawal and brine discharge on the river.

The field program consisted of four components: 1) a bathymetric survey of the Palmer River; 2) stream gaging surveys to measure freshwater flow into the Palmer River; 1) long term monitoring of temperature and salinity at the proposed water intake location; and 4) intensive field surveys of the longitudinal structure of salinity and water temperature. These surveys were designed to capture both spatial and temporal (i.e., seasonal) variations in the hydrography, and particularly both high and low freshwater flow conditions.

Modeling the effects of the discharge on the hydrography of the Palmer River was accomplished in two steps. First, a far field model was developed to characterize ambient flow velocities in the vicinity of the discharge throughout the tidal cycle. This was accomplished using ASA's boundary fitted hydrodynamic (BFHYDRO) model, a component of ASA's WQMAP. The model was applied to the Palmer River and calibrated to data from the field program. Velocities from the far field model were then used as inputs into the near field plume model, which was used to characterize the discharge plume.

The three-dimensional Updated Merge (UM3) model was used for simulating submerged brine discharge into the Palmer River. Discharge during three different ambient tidal conditions (neap high tide – slack flow, mean high tide – maximum flow and spring low tide – slack flow) was modeled. Neap high tide - slack flow was found to be the most restrictive of these three conditions. Several diffuser geometries were simulated using UM3 by varying the port angle, port diameter, port spacing, and port depth so that the excess salinity of the plume in the mixing zone is minimized.

PRODUCTS. RESULTS.

The modeling showed the plume initially rose toward the surface before angling back towards the bottom, staying well within the mixing zone and the analysis was provided to the Town of Swansea, MA.