



## Mixing Zone and Thermal Modeling

**NPDES permitting authorities allow an allocated impact zone for dischargers—an area near the outfall where higher pollutant concentrations, temperatures, or suspended solids are allowed before water quality standards must be met. Permit conditions are established through mixing zone analysis that considers the size, position within the receiving stream, constituents of concern, dilution capabilities, and sensitive ecological communities.**

**Mixing zone analyses allow dischargers to confidently evaluate receiving water effects based on different discharge/treatment scenarios, defining the appropriate balance between water quality protection and necessary level of treatment.**

LimnoTech has helped numerous industrial and municipal clients resolve NPDES permit problems, and helped others obtain Section 316(a) thermal discharge variances through mixing zone analysis. LimnoTech also has a unique and authoritative understanding from providing national guidance and training to both the regulatory and regulated communities, on the proper application of mixing zone analysis.

### LimnoTech Services

LimnoTech has extensive experience in both theoretical development and practical application of models used to evaluate mixing zone issues. Our mixing zone services include:

- Dye surveys to measure the dilution occurring in receiving waters
- Thermal plume studies to define mixing zones for excess heat
- Application of simple screening models to estimate dilution, with and without field data
- Application of existing mixing zone modeling packages (CORMIX, Visual Plumes, and others)
- Development and application of detailed, multi-dimensional, finite-element mixing zone models
- Technical guidance for mixing zone assessment and modeling
- Workshop training for mixing zone assessments and modeling

### LimnoTech's Experience

LimnoTech has performed mixing zone and thermal plume analyses related to NPDES permits at more than 100 sites worldwide. Receiving waters have ranged from small, intermittent streams to coastal areas.

- For private industry, LimnoTech has:
  - Conducted field studies to define mixing processes.
  - Reviewed site-specific modeling performed by regulators.
  - Applied mixing zone models in support of permit negotiations and Section 316(a) variances.
  - Developed technical guidance for mixing zone assessment.
- For regulators, LimnoTech has:
  - Contributed to guidance manuals on mixing zone modeling.
  - Conducted more than 40 modeling workshops attended by EPA staff from all 50 states and all 10 Regions.
- For both regulators and regulated clients, LimnoTech has:
  - Developed mixing zone models with user-friendly output graphics.
  - Developed mixing zone guidance for a regional consortium of regulators and dischargers to the Ohio River, to ensure consistent application of mixing zone analyses throughout the basin.



*Many problems require a multi-disciplinary approach involving collaboration between water resource engineers, hydrologists, geologists, computer modelers, and others.*

The following selected descriptions demonstrate our experience in mixing zone and thermal plume project work.

**Analysis of Thermal Stratification, Velocity, and other Measurements Offshore of the Donald C. Cook Nuclear Plant.**

The Donald C. Cook Nuclear Plant is evaluating the potential benefits of moving its plant cooling water intake further offshore so that it would be located in cooler water, below the thermocline in critical summer months. To evaluate the benefits and feasibility of relocating the cooling water intake, LimnoTech collected temperature data along a transect extending offshore of the Cook Plant over several years. Early field investigations focused on collecting high spatial resolution temperature profiles every several weeks during the summer and fall seasons. This data-gathering effort provided information about the depth of the thermocline and the extent to which the thermocline controls bottom temperature. Combined datasets also showed the importance of wind direction and storm activity, which can result in significant migration or disruption of the thermocline and changes to intake water temperature. Thermal data from the surveys provided a focus for additional offshore investigation work, and laid the groundwork for an expanded thermal study. Efforts are still underway, with an expanded scope that includes collection of data on water velocity, turbidity, sediment character, sediment accumulation rates, and algal growth, in addition to thermal data. These characteristics are being studied at eight different offshore locations to support costing evaluations and design of a proposed intake.

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**Hydrodynamic Analysis and Dilution Modeling to Evaluate Municipal Wastewater Discharge to the Napa River, Napa, California.**

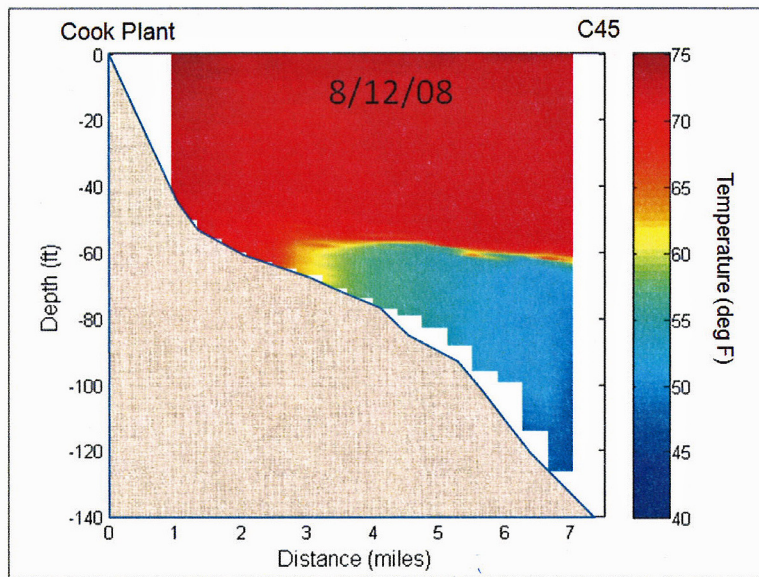
The Napa Sanitation District (NSD) operates a municipal wastewater treatment plant on the Napa River, south of the City of Napa, California. This plant is permitted under the National Pollutant Discharge Elimination System. To ensure that aquatic life is protected and State water quality standards are not violated, NSD was seeking to demonstrate that their permit should include a

mixing zone provision. LimnoTech was retained to provide engineering support and modeling services to facilitate permitting of the Napa Sanitation District's discharge. LimnoTech developed a hydrodynamic model of the Napa River to simulate river stage and velocity under a range of tidal conditions.

**Evaluation of Thermal Impacts, Indian Point Nuclear Power Plant Discharge.**

As consultant to the New York State Department of Environmental Conservation (NYSDEC) in relicensing negotiations, LimnoTech reviewed documents

pertaining to the thermal discharge from the Indian Point Nuclear Energy Center Units 2 & 3, and evaluated the impacts of the thermal discharge. The objectives of this evaluation were to determine compliance with New York State Environmental Regulations, specifically concerning thermal discharge criteria; and to evaluate whether the discharges ensure a "balanced and indigenous population" of aquatic organisms, in accordance with Section 316(a) of the Federal Clean Water Act.



*Thermal mixing zone studies help determine compliance with environmental regulations and evaluate the effects of thermal discharges on aquatic life.*

LimnoTech reviewed data and analyses submitted to NYSDEC in support of previous operating and thermal discharge permits, with particular attention to compliance with thermal discharge criteria; assessment of thermal modeling; and assessment of Section 316(a) requirements. LimnoTech concluded that the Indian Point facility's discharge did not comply with New York State Criteria Governing Thermal Discharges, based upon the modeling analysis reviewed. LimnoTech identified significant uncertainties in the analyses that had been used to demonstrate that the discharge would ensure the presence of a balanced and indigenous population of aquatic organisms. These uncertainties related to the modeling conducted to estimate the temperature increases in the river, as well as the biological assessment of the impacts of those temperature increases.