

**Tennessee Valley Authority (TVA) Projects  
Using PHOENICS**

**Example 1:**

**Colbert Fossil Plant Skimmer Wall**

## Barge Collecting Debris at COF, 2001



# Debris Impact on COF



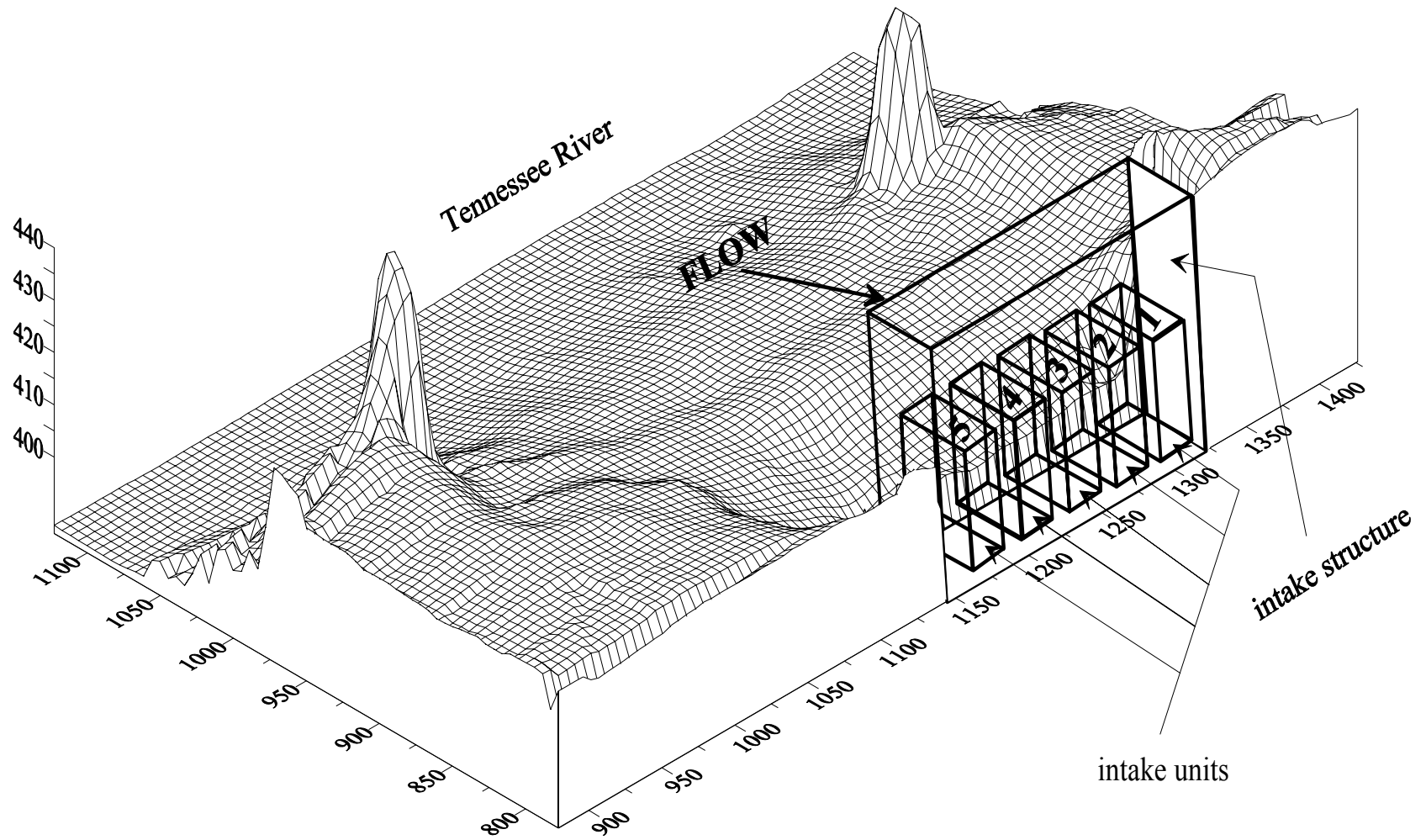
(June 1999)

- TVA lost 16,030 MWh from 1994-2000 due to debris.
- After 2000, trash boom deteriorated at COF.
- TVA lost 80,000 MWh due to debris buildup at COF in 2001.

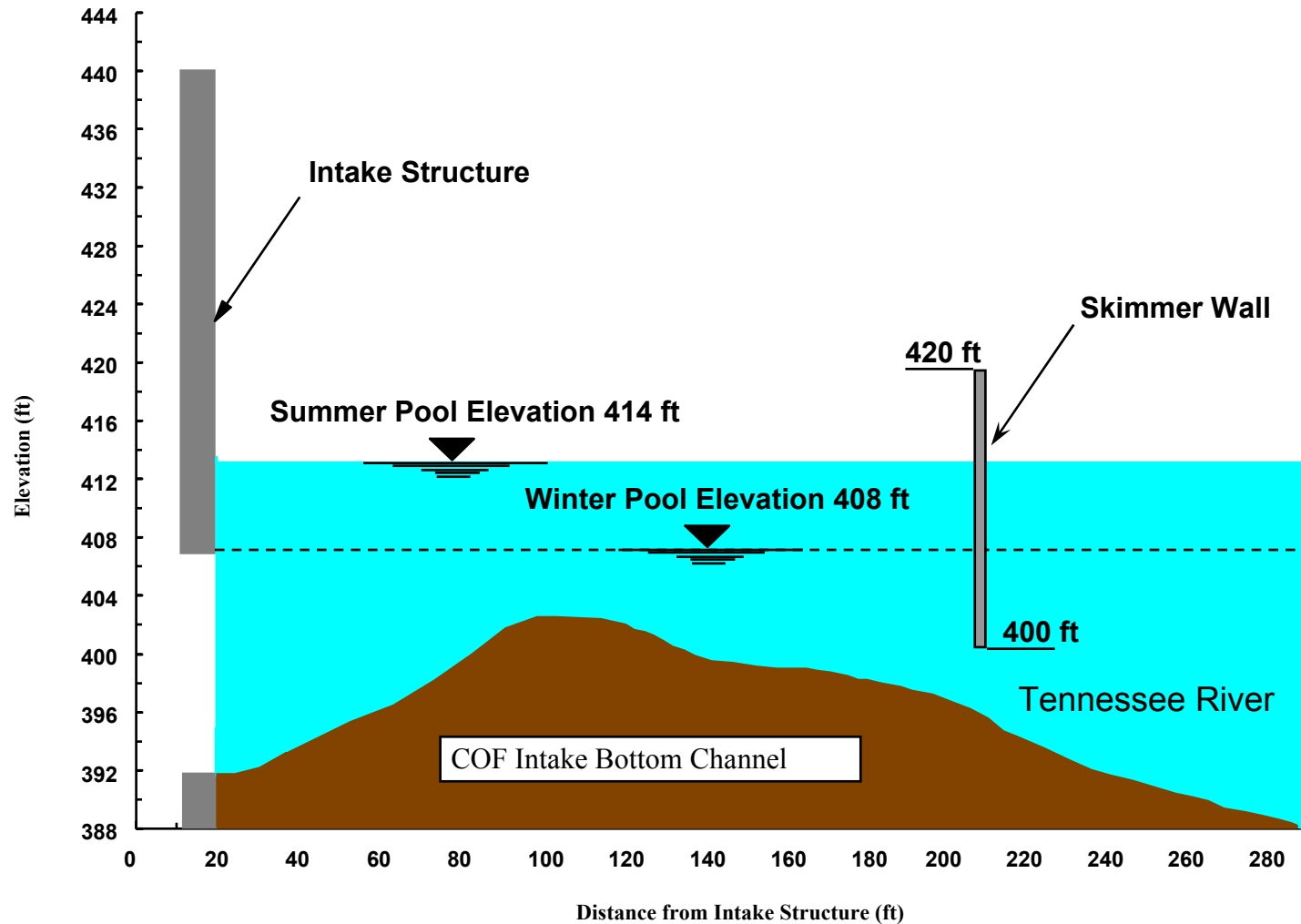
# COF Skimmer Wall Objectives

- **Reduce intake temperatures**
- **Minimize debris at pumping station**
- **Minimize Fish impingement**
- **Improve plant efficiency**

# Colbert Intake Channel Bottom Surveyed September, 1996



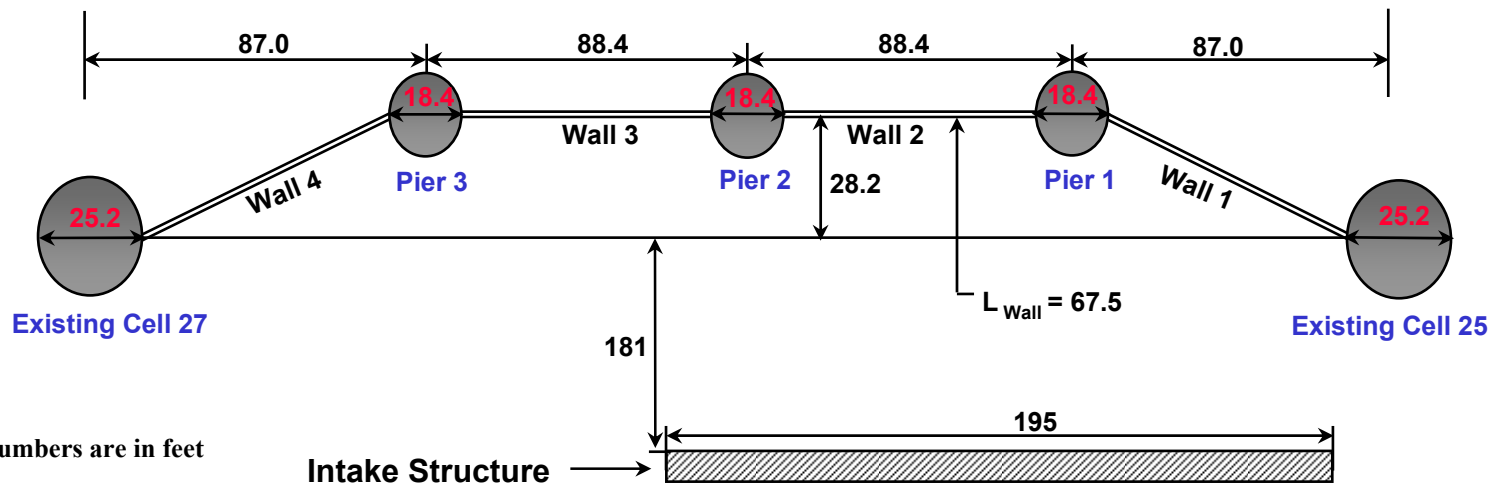
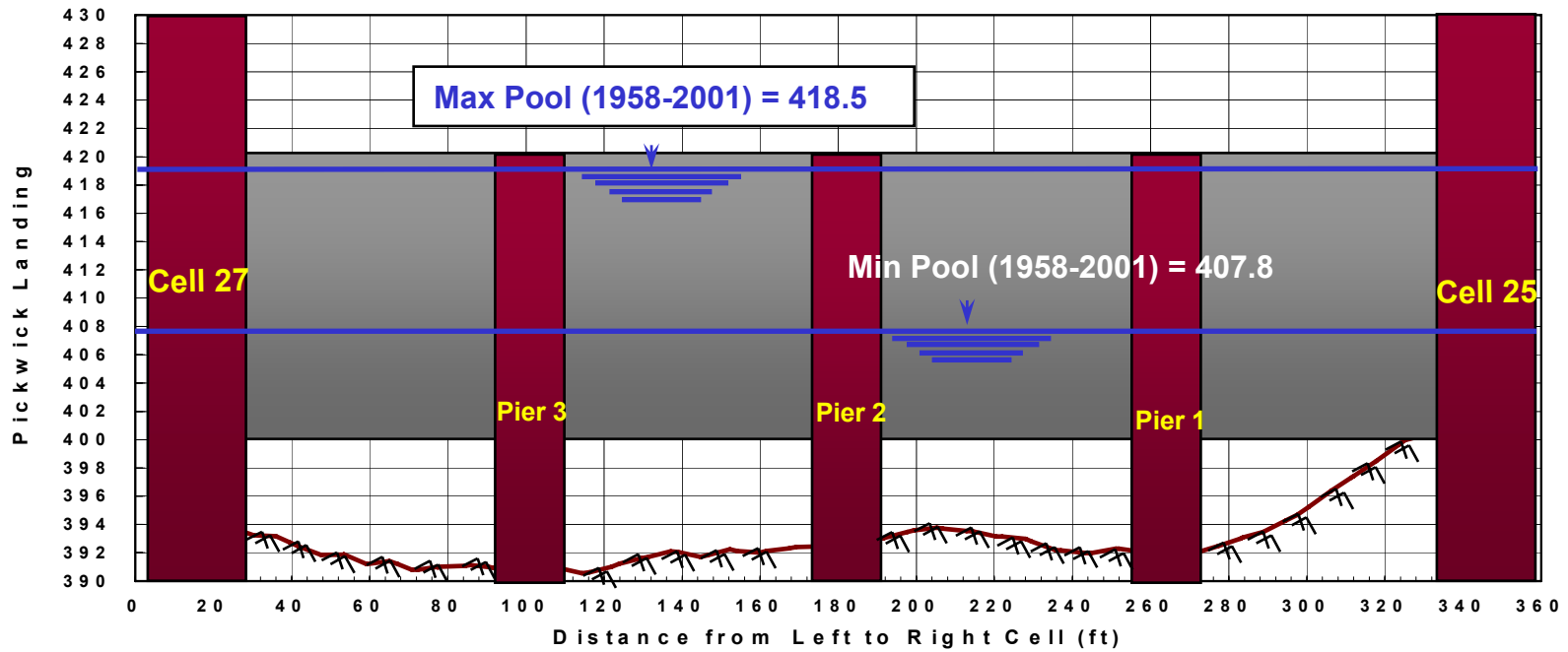
# New skimmer wall brings cool water to plant, keeps warm water and Debris in the reservoir.





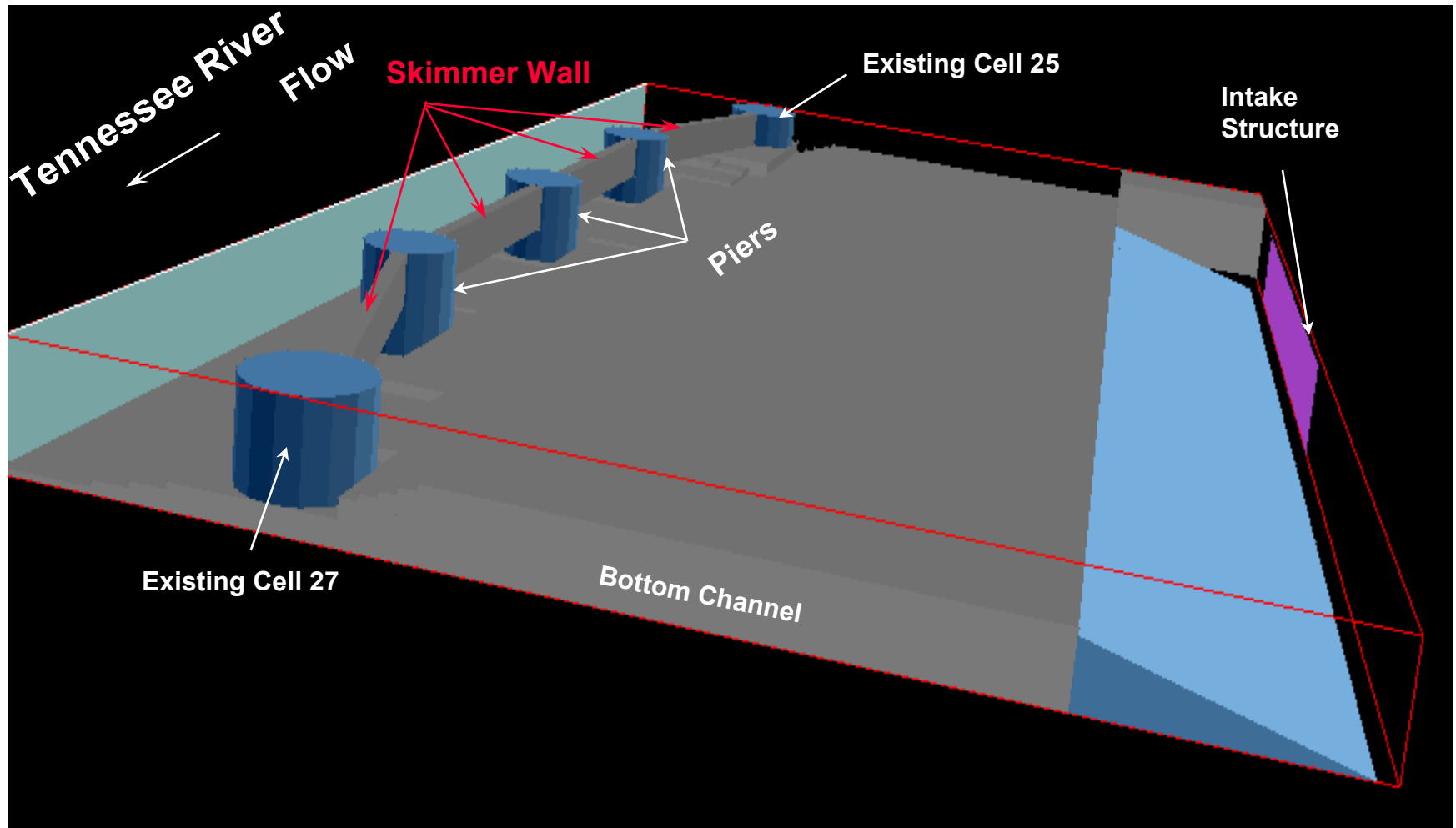
# Schematic Potential Layout of COF Skimmer Wall, Option 2 (Preferred Design)

**Cost = \$1,313,000**

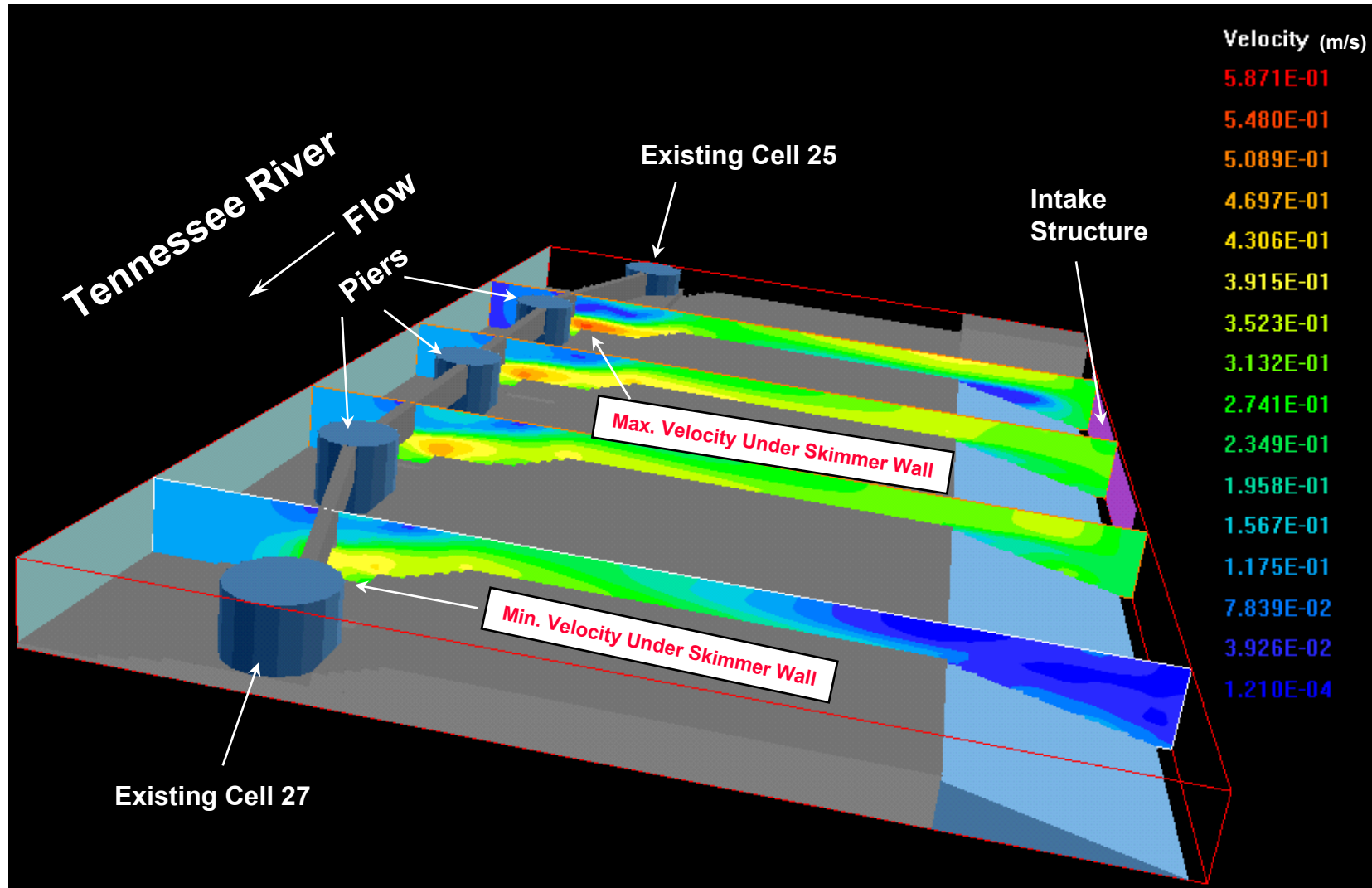




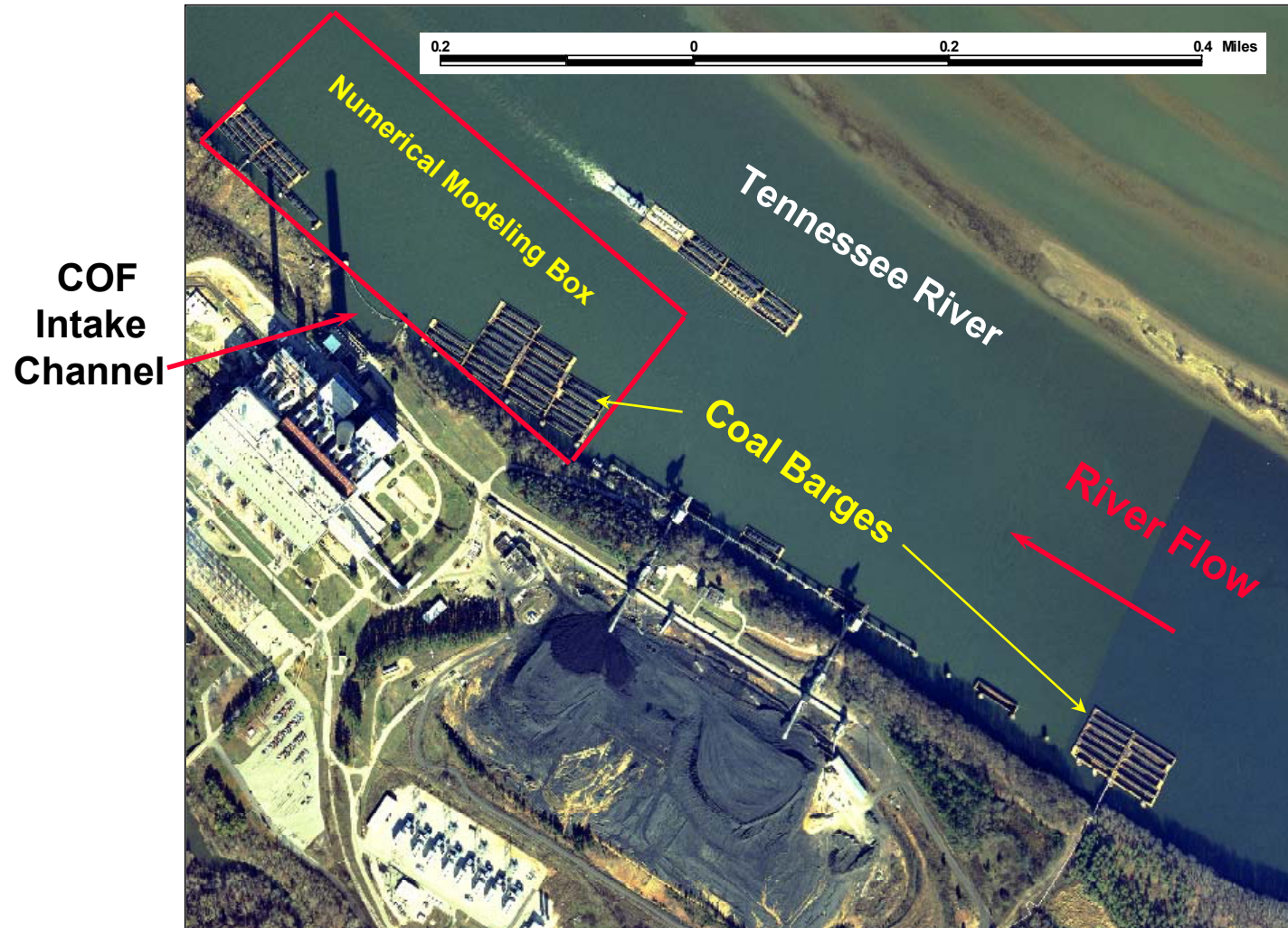
## Intake Channel Numerical Representation in CFD



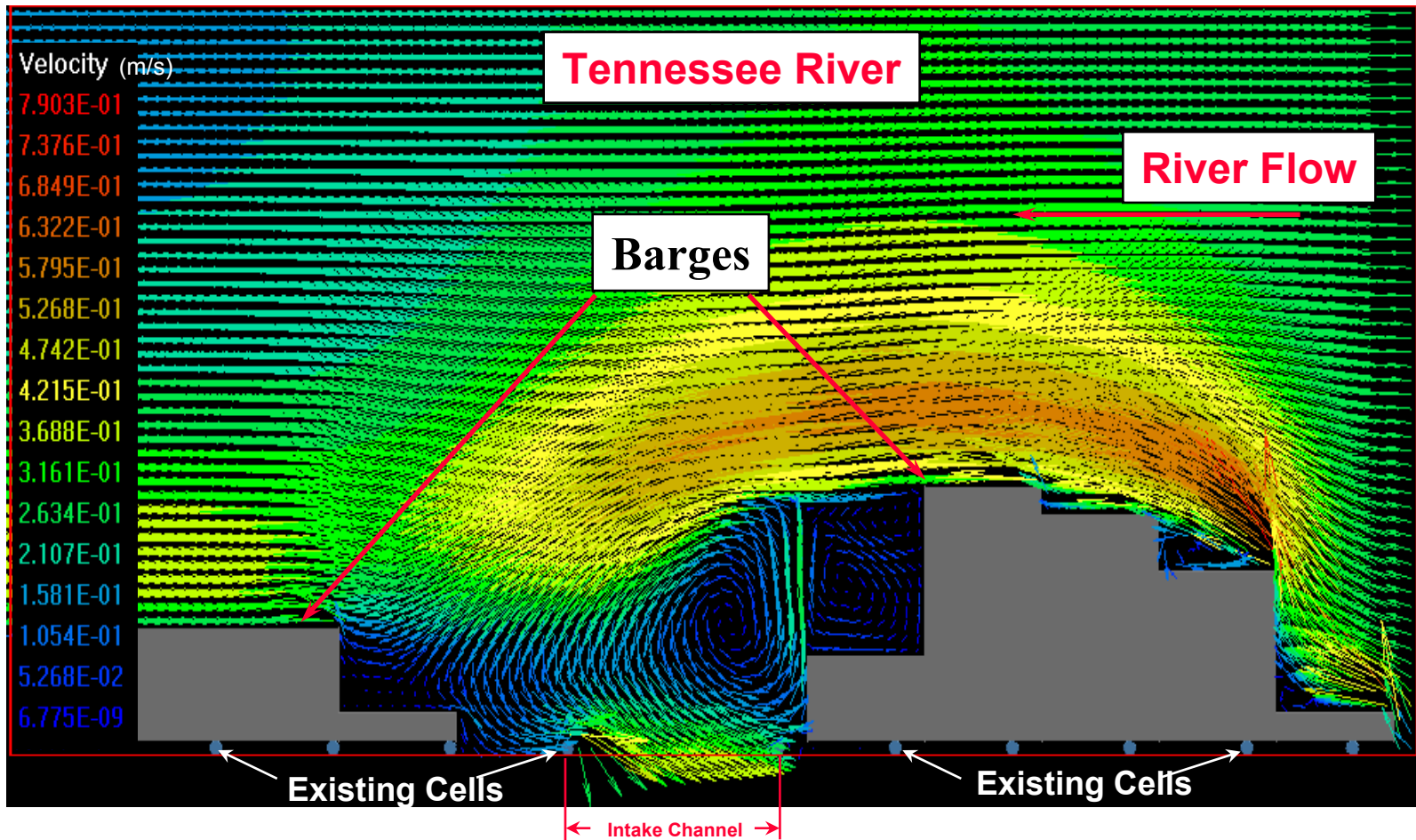
# Computed Velocity Profile Contours at Several Locations of the Skimmer Wall



## Aerial View of COF and Tennessee River

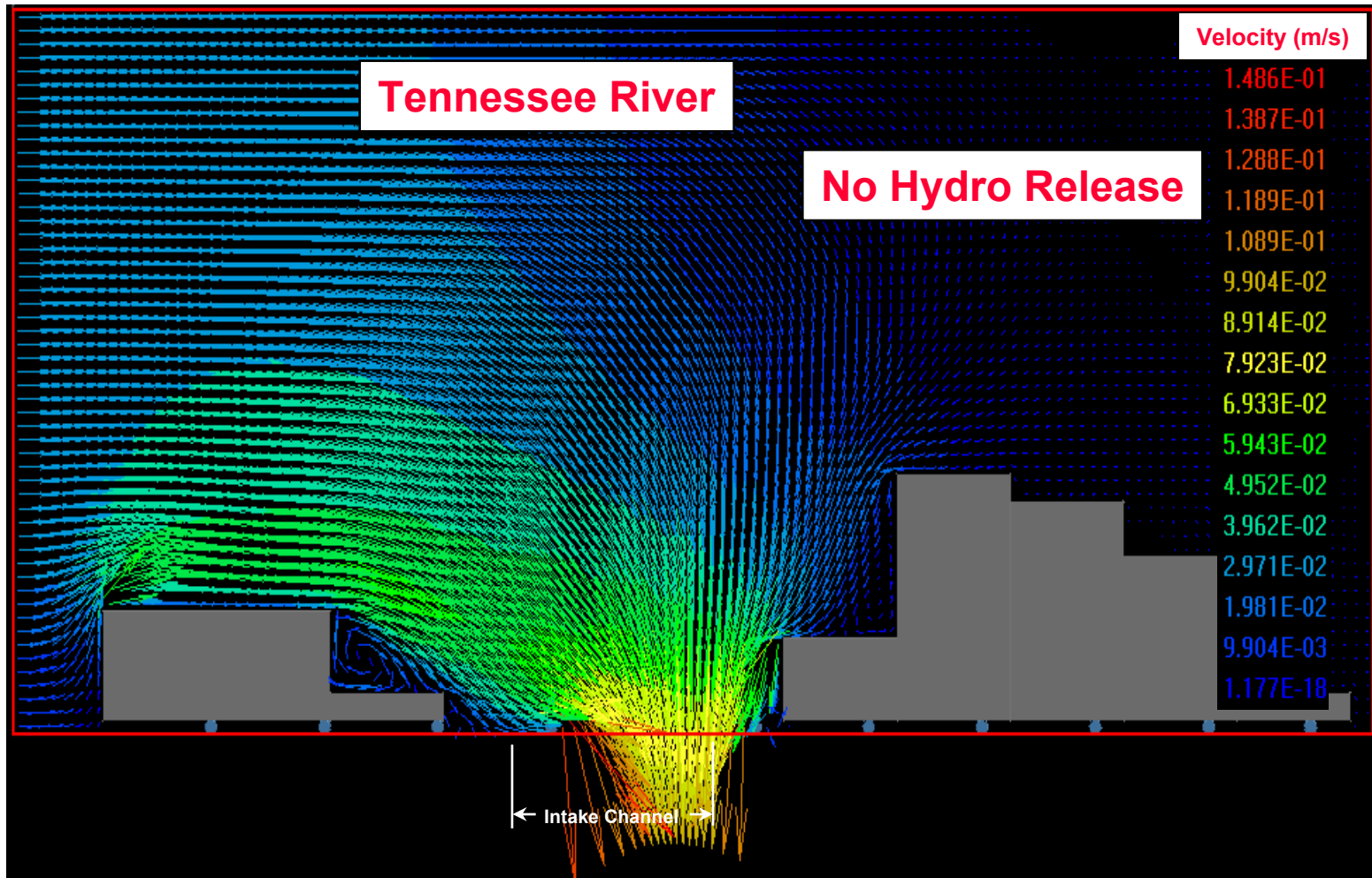


# Computed Flow Field at COF Intake Channel Vicinity with Hydro Release, (Existing Conditions)





# Computed Flow Field at COF Intake Channel Vicinity with No Hydro Release, Existing Conditions



# COF Skimmer Wall During and After Construction

During Skimmer Wall Construction  
04-2002



Potential Saving  
about \$20 Millions  
for the next 25 years

Wall Construction Finished  
07-2002  
Cost = \$1.4 Millions

## Results

- No debris cleaning since the construction of the wall.
- TVA lost 0 MWh due to debris buildup at COF since construction.
- An average improvement of about 0.25 °F in intake water temperature.
- Lower Base line 316(b) ruling

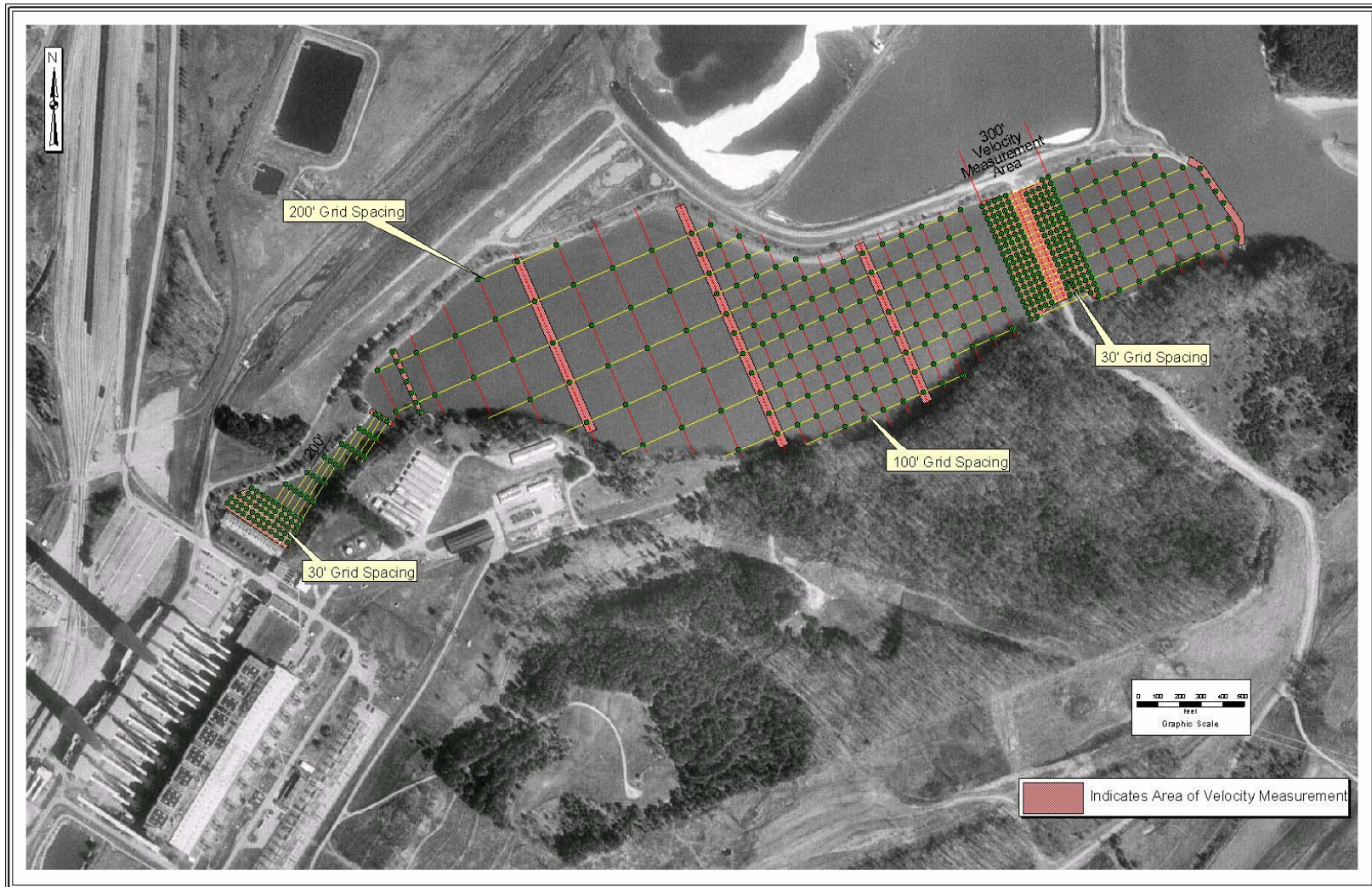


**Example 2:**

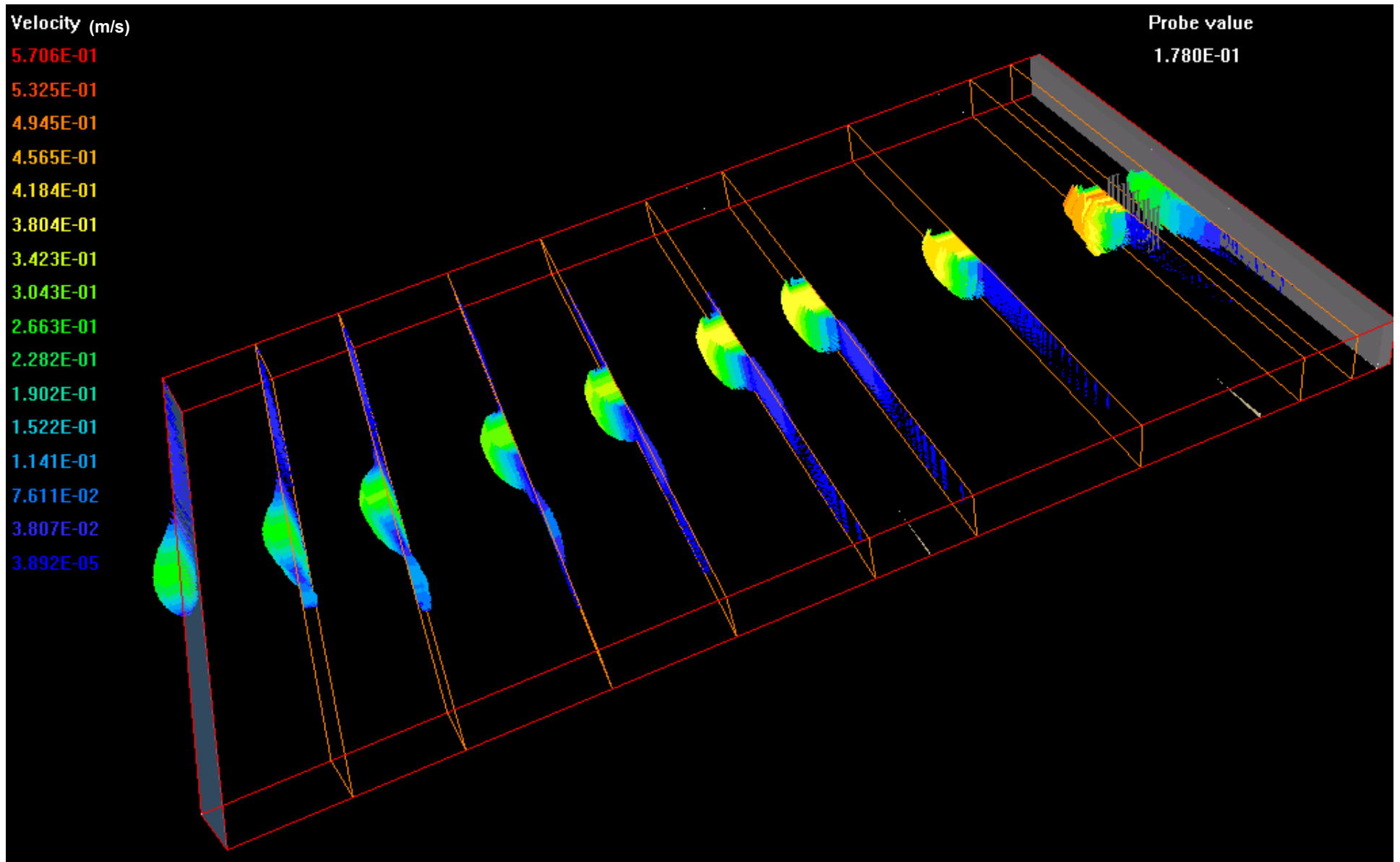
**Multi-Port Diffuser Kingston Fossil Plant**



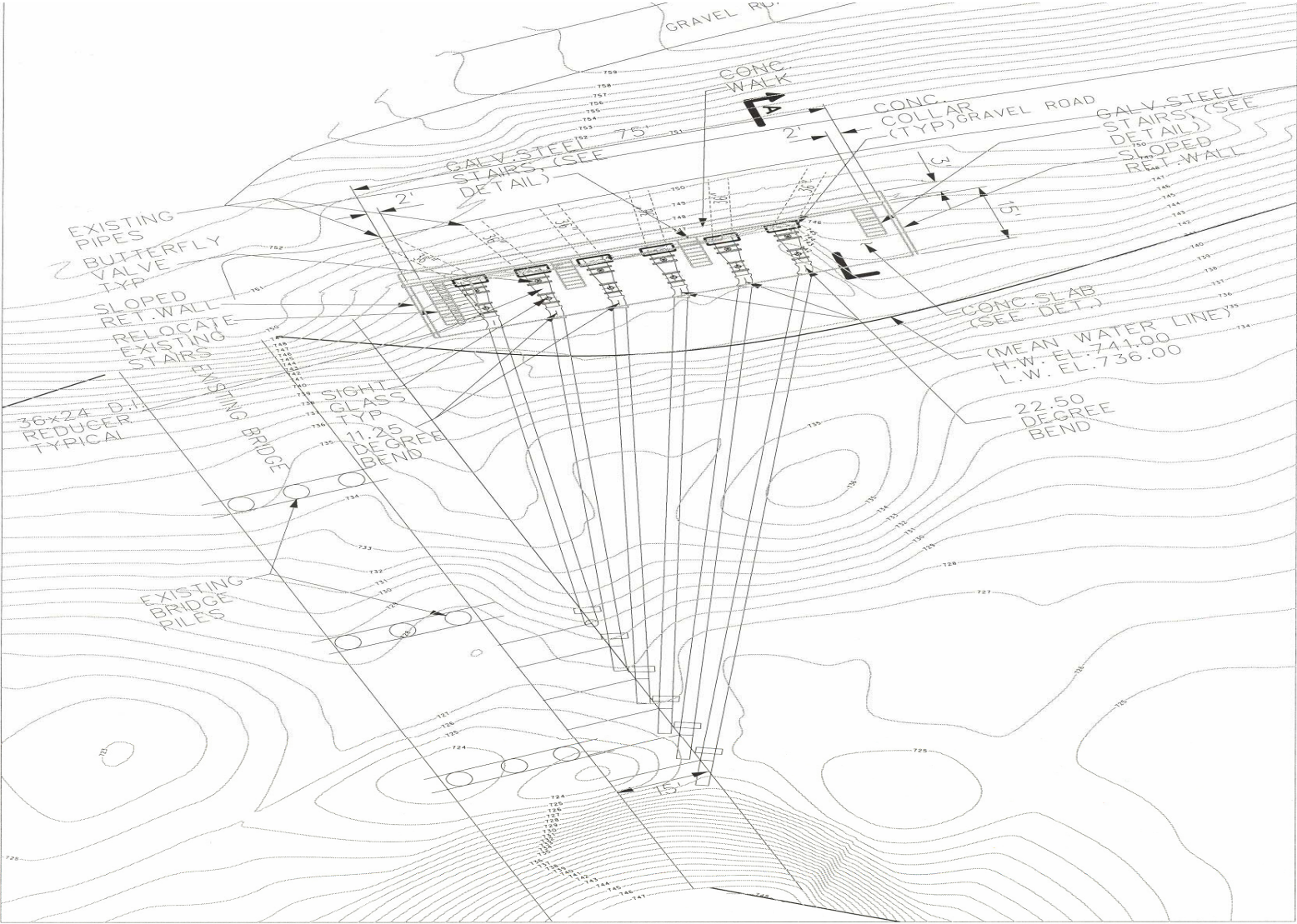
# Survey at KIF intake Channel



## Velocity Vector taken at Several Intake Channel Sections

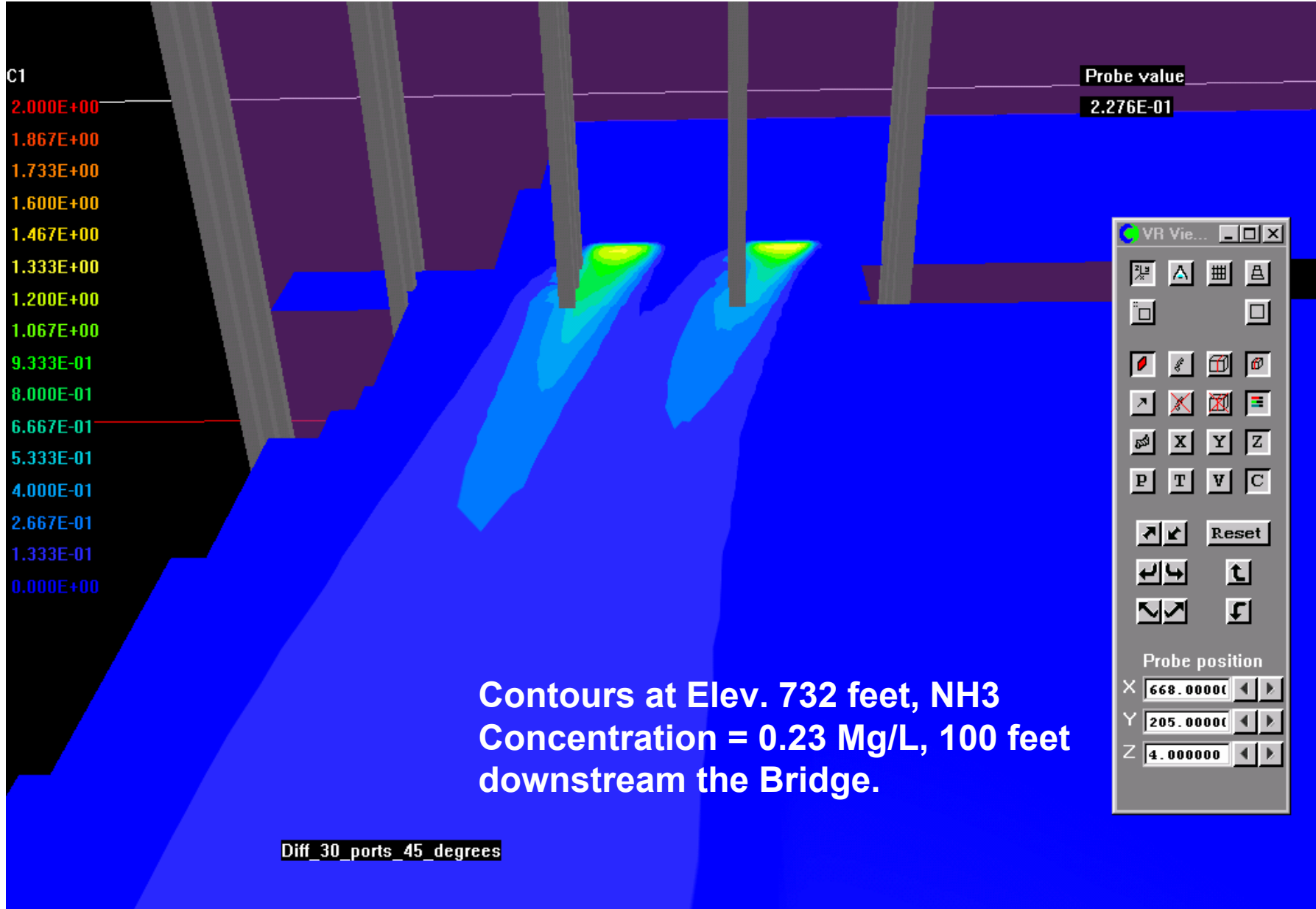


# Plan View of the Recommended Diffusers Design

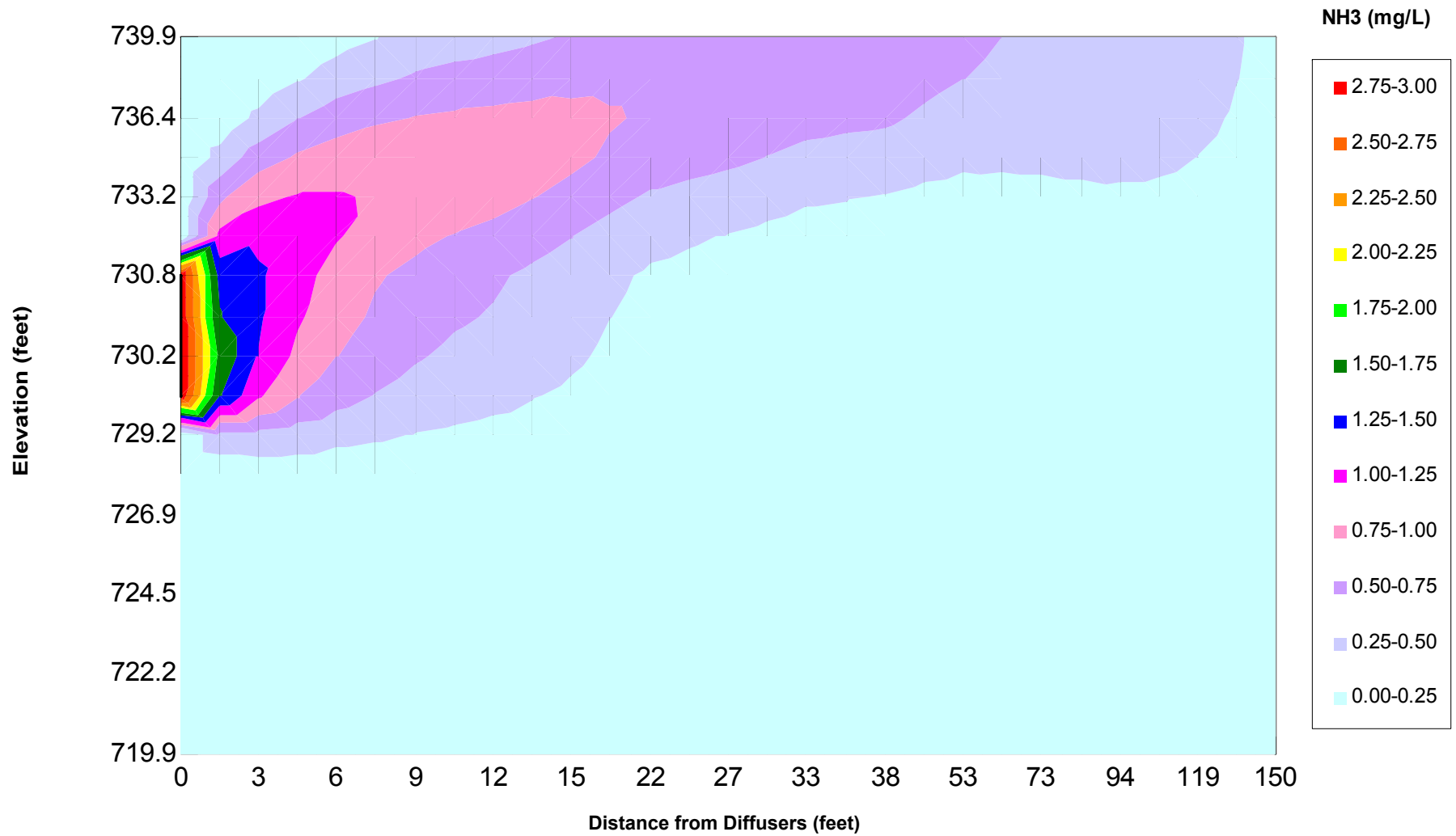




# Diffusers Angled at 45 degree, Instantaneous Mixing



# Computed NH<sub>3</sub> Concentrations Downstream of KIF Diffusers



# Construction Started in October 2003

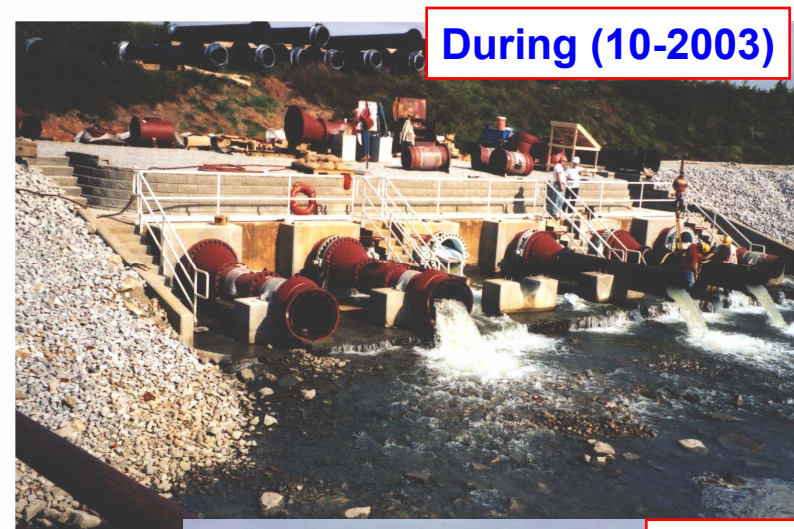




**Before (11-2002)**



**During (10-2003)**



**After (01-2004)**



**“At an estimated price of \$500,000, Deskins (KIF plant Manager) says the main advantage of this proposal, besides being environmentally friendly, is the cost savings — \$7.5 million at most or at least \$3.5 million”. (Inside TVA, August 2003)**



**Example 3:**

**Surface Water Pumps at Tims Ford Reservoir**

## **Example 3:**

# **Surface Water Pumps at Tims Ford Reservoir**

**Objective:** Evaluate surface water pumps performance under several configuration layouts, pump sizes, and initial propeller velocities.

**Goal:** Determine an optimum design that maximizes the improvement of water temperature and dissolved oxygen (DO) content in hydropower plant releases without disturbing reservoir bottom sediment.

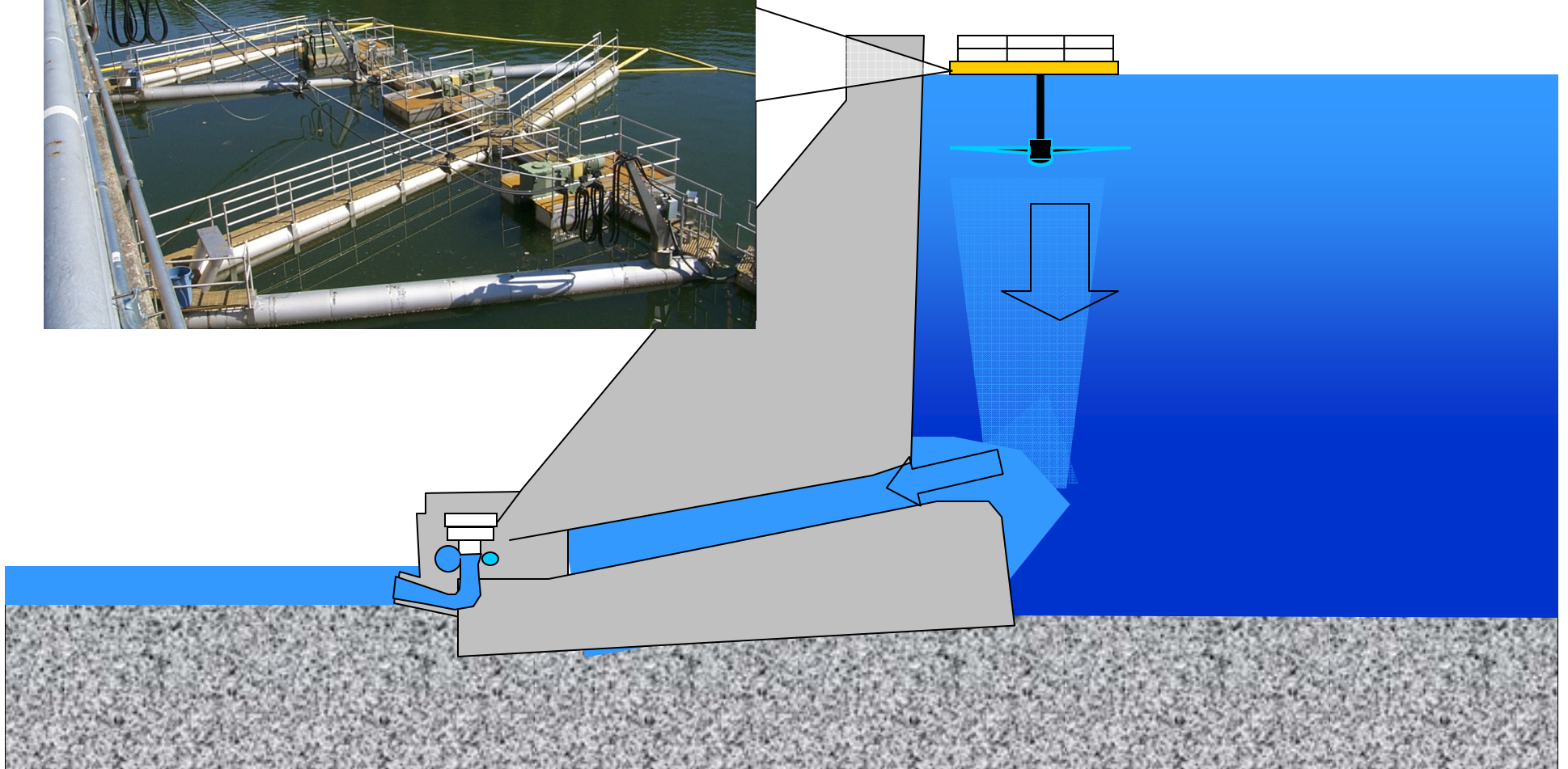
**Tools:** A 3-dimensional Computational Fluid Dynamics (CFD) model, PHOENICS.

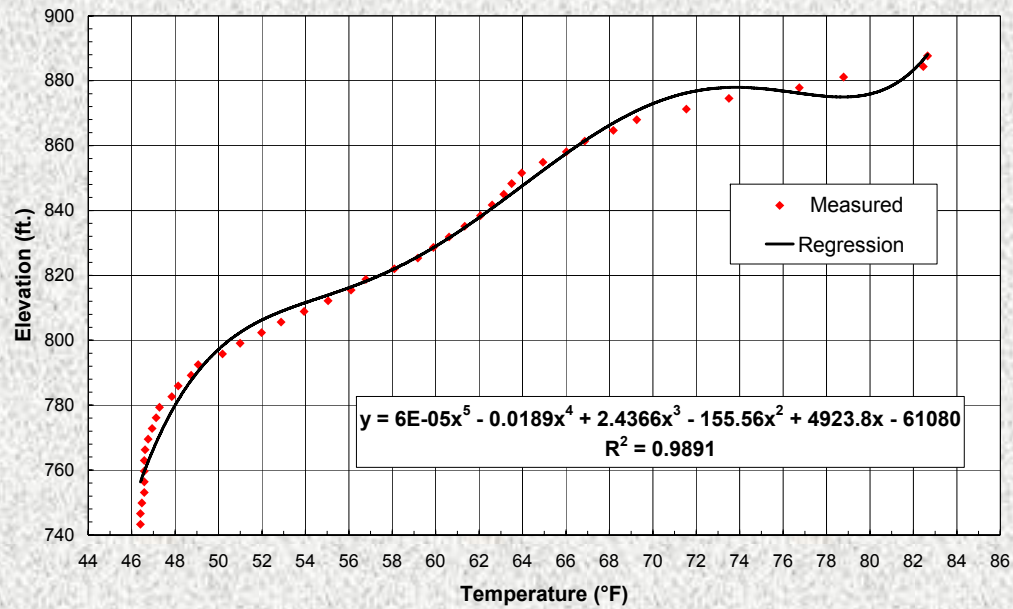
**Alternatives:** Several modeling analysis for different locations, operating speed, with three and six pump layouts.

# surface-water pumps are being Used at Douglas and Cherokee Reservoirs

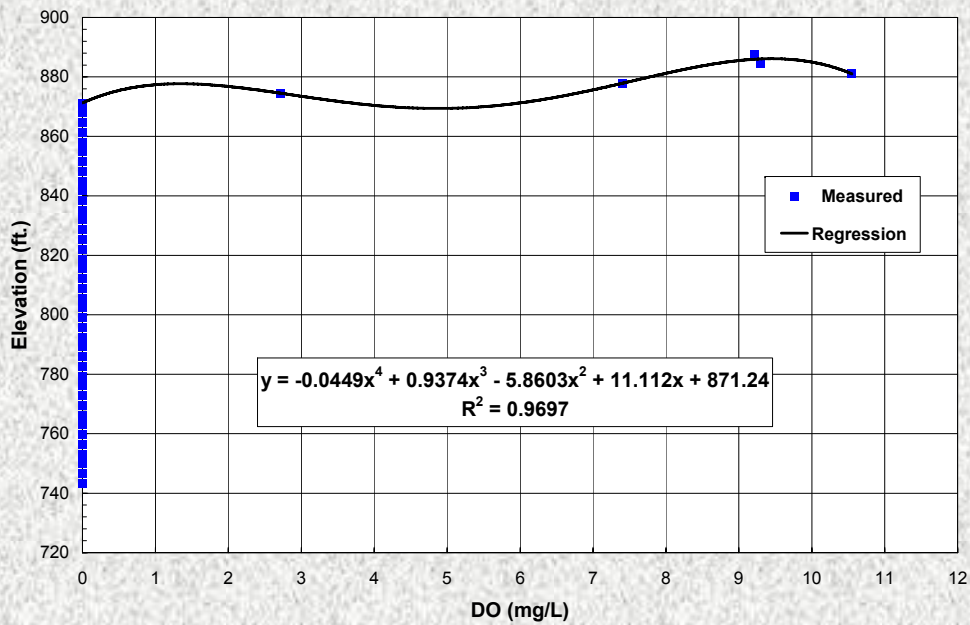


Impeller forces higher DO and warmer water at the surface down to the turbine intake





Forebay Measured Temperature



Forebay DO Profiles (6-26-03)

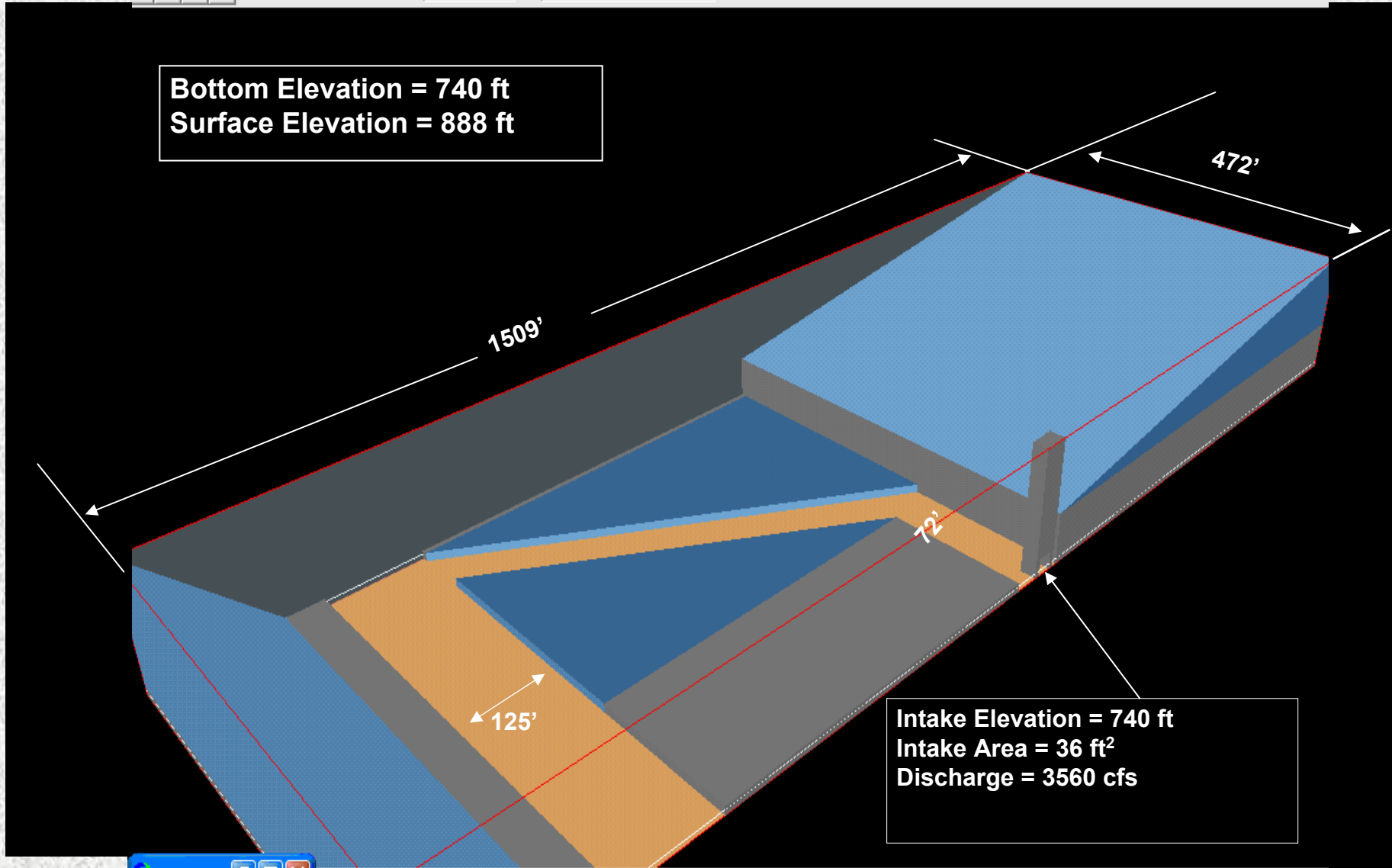
# Model Layout (Base Case)



CHRM

DOMAIN

Bottom Elevation = 740 ft  
Surface Elevation = 888 ft

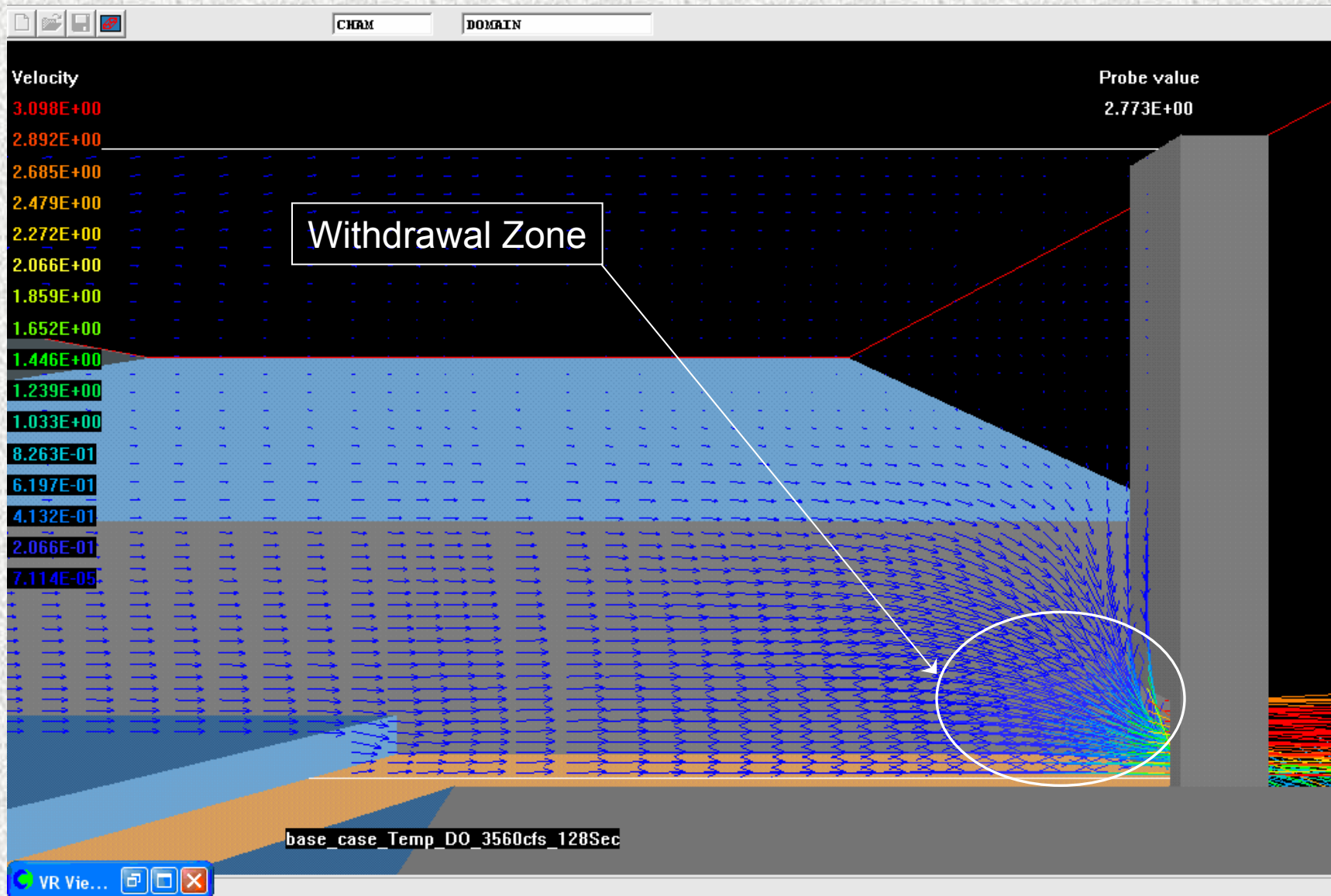


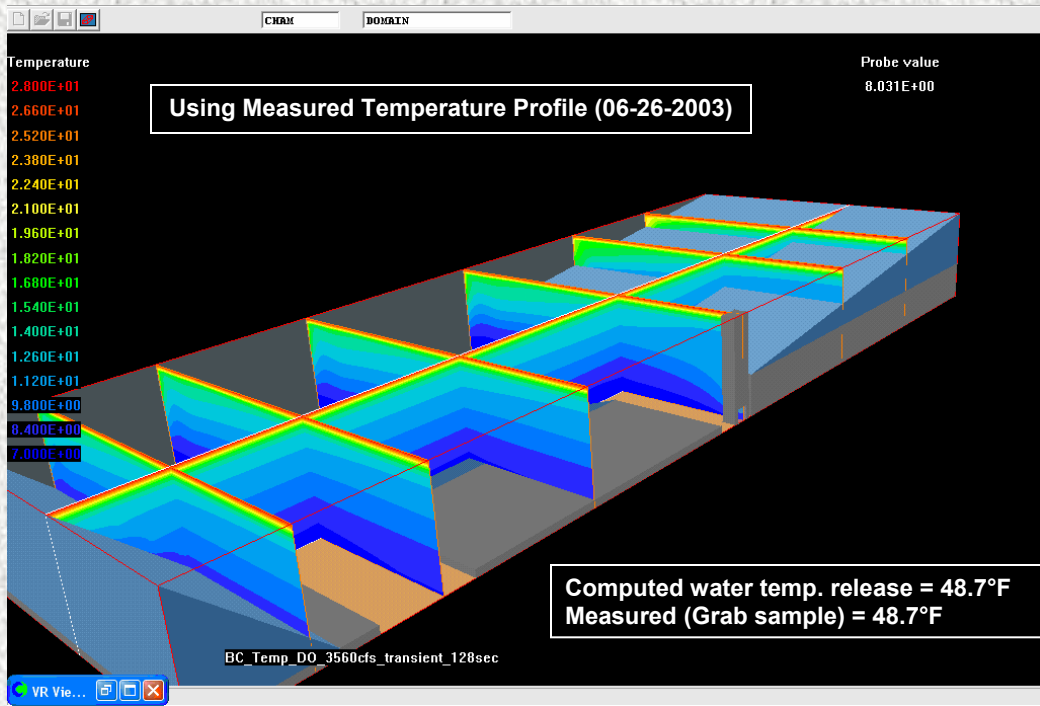
Intake Elevation = 740 ft  
Intake Area = 36 ft<sup>2</sup>  
Discharge = 3560 cfs



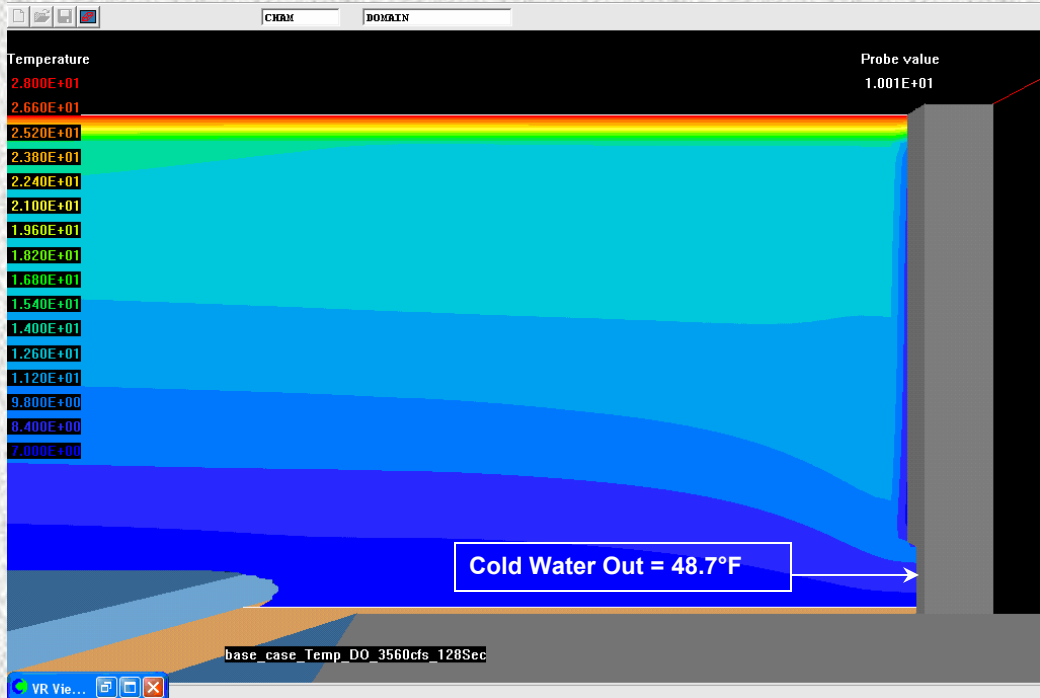


# Velocity Vectors (Base Case)





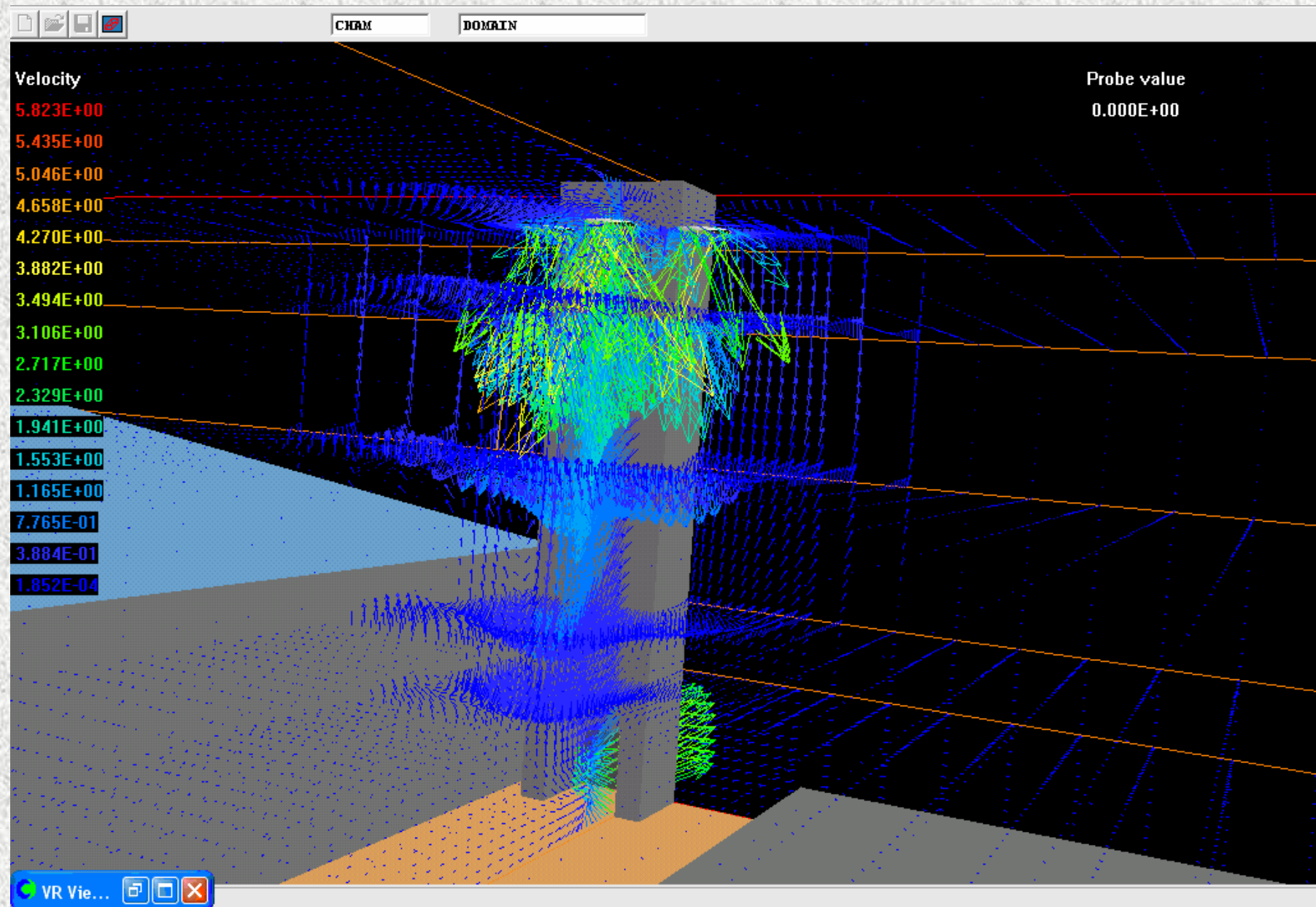
**Numerical Domain**

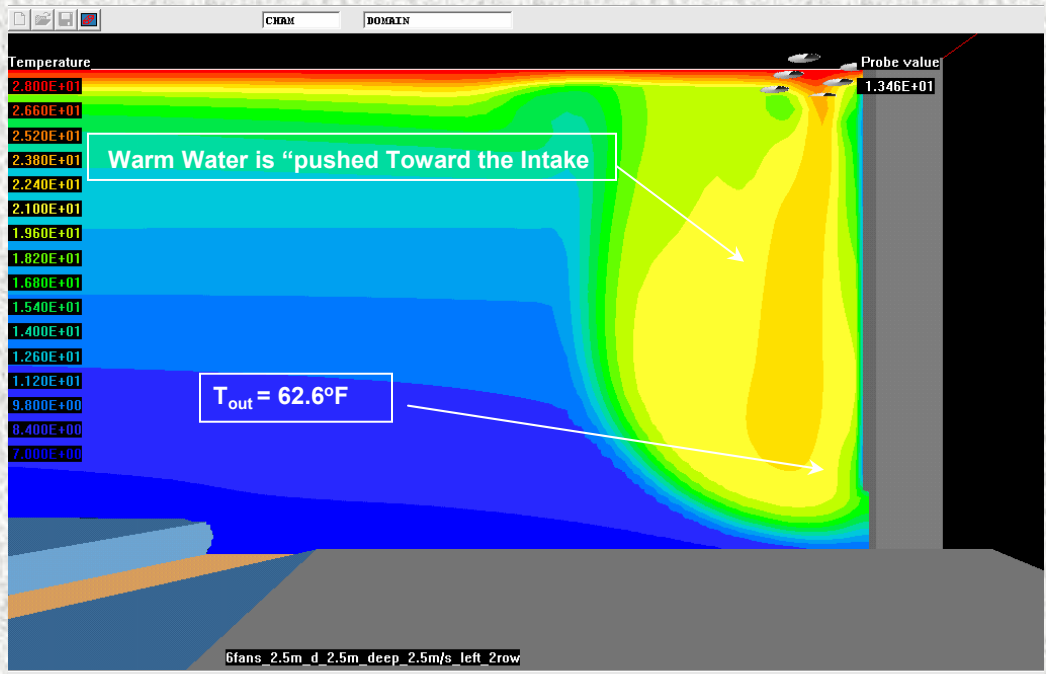


**Close-Up**

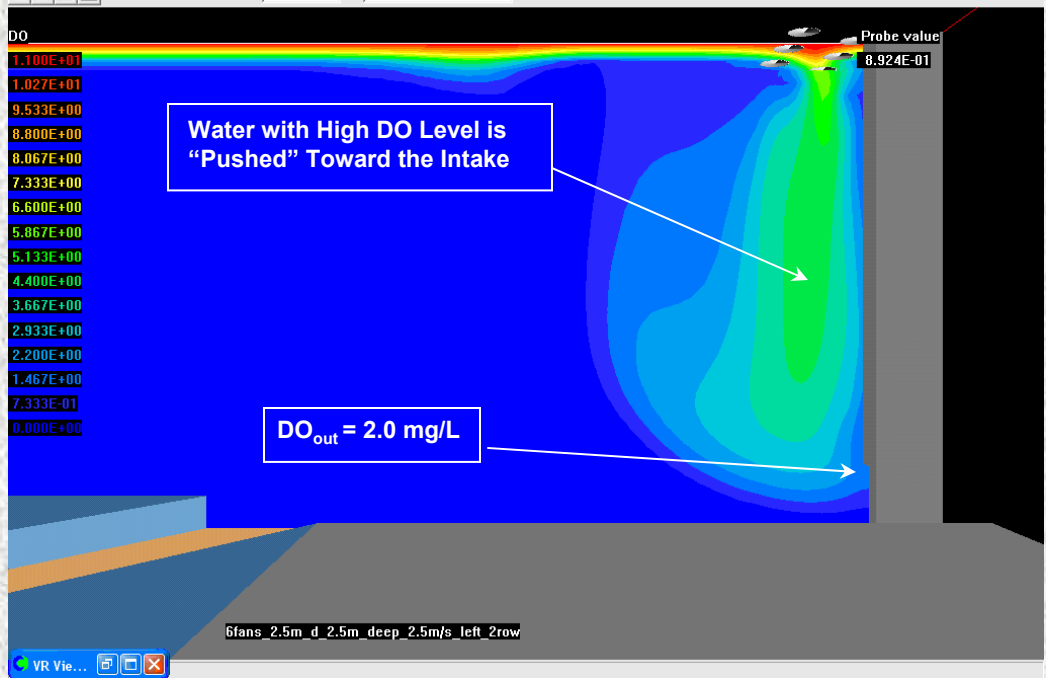


# Velocity Vectors with Three Pumps





**Computed Temperature at Intake Vertical Centerline (Six Pumps)**



**Computed DO at Intake Vertical Centerline (Six Pumps)**

# Recommendation

The option recommended is six 8-ft pump layout. Under the June 26, 2003, forebay profile, the water temperature release was improved by 10.3°F and the DO by 2.0 mg/L.