CHARACTERIZATION OF CONTAMINANT MIGRATION POTENTIAL THROUGH IN PLACE SEDIMENT CAPS

SERDP Project ER-1370

BRIEFING TO USEPA REGION 10
and
USACE - SEATTLE DISTRICT

MARCH 1 – 2, 2006

Performers

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Technical Objectives

- Establish fundamental principals that influence contaminant mobility through native sediments and sediment caps
- Understand the influence of porewater flux via groundwater advection and tidal pumping on contaminant migration
- Investigate particle-scale mechanisms that contribute to sorption and attenuation of contaminant transport in native and cap sediments
- Measure contaminant partitioning and sorption/-desorption rates to establish methods for quantifying rates for DoD sites
- Develop model principles to predict cap performance at other sites
- Identify characteristics of a site that make capping a successful option

Technical Approach

<u>Task 1</u>: Examine contaminant mobility through existing sediment caps using core samples

<u>Task 2</u>: Measure in situ porewater flux due to groundwater flow and tidal pumping

<u>Task 3</u>: Evaluate fundamental in-cap sorption processes that influence contaminant transport

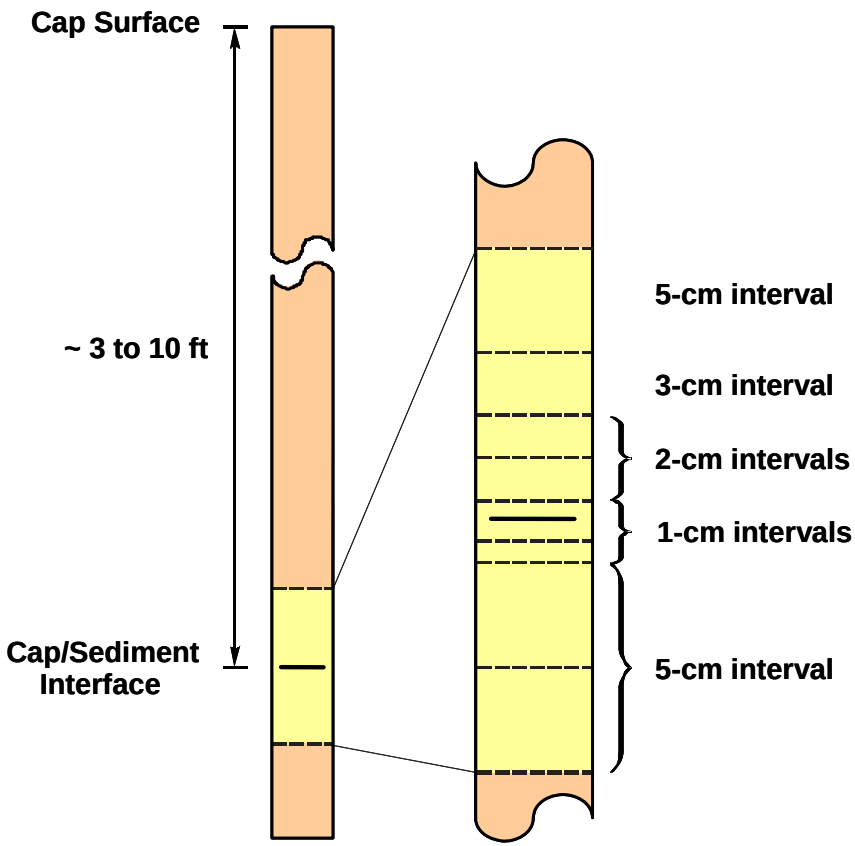
<u>Task 4</u>: Simulate and measure vertical contaminant transport using laboratory columns

<u>Task 5</u>: Study the role of natural organic matter level and sorptive additives on cap performance

<u>Task 6</u>
Model contaminant migration through sediment caps

Task 1 – Sediment Coring

Measure vertical contaminant distributions in the cap



- Vertically profile contaminant distributions, PSD and TOC
  - 1-cm intervals at the sediment/cap interface
  - Larger intervals toward cap/water interface
- Two coring events, tentatively scheduled for Years 1 and 3
  - Chemical forensics may be used to identify contaminant migration over time
  - Evaluate laboratory results to reevaluate time of and need for the 2nd event

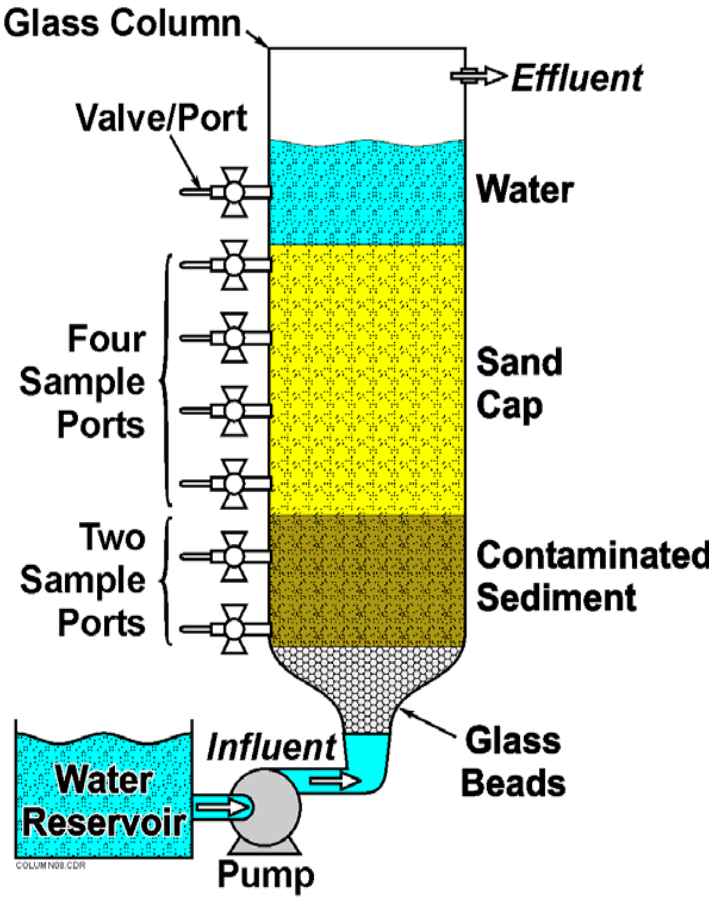
Task 2 - Techniques for Measuring Advective Transport

Understand the nature and extent of porewater transport & tidal pumping

- Transport of contaminants from the sediment into the water, as often seen by sheens, is a major concern near the Wyckoff Site. This SERDP study will complement other investigative work taking place at the West Beach.
- Deploy and monitor (~1 year) vertically arrayed piezometers
  - Two-piezometer array per location
  - One upgradient on-land well
  - One tidal gauge
- Compare porewater velocities from piezometer array against ultrasonic seepage meter
- Measure changes in temperature and ionic conductivity in the cap as additional indicators of upwelling due to tidal fluctuations

Task 3, 4, 5 – Laboratory Tests

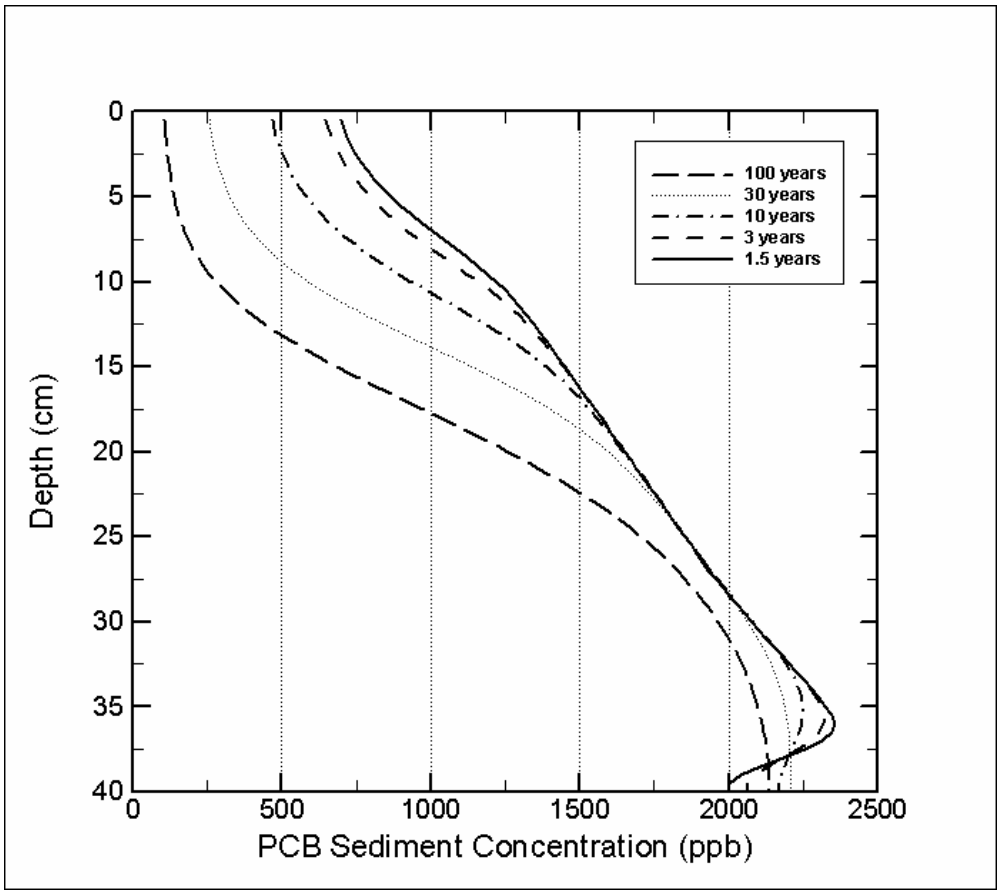
Continuous flow columns to simulate advective transport and batch experiments for measuring sorption equilibrium



- Native sediment and cap material to simulate field conditions
- Examine the role of NOM on cap performance. Can additives predictably enhance performance?
- Monitor contaminant migration with time
- Improve predictive capabilities for contaminant mobility by examining fundamental site-specific mechanisms that control cap performance; Measure sediment desorption rates and equilibrium partitioning coefficients in native sediments and with clean and amended cap materials

Task 6 – Predicting Future Cap Performance

Develop the ability to predict cap performance based on measured site-specific parameters



1. Refine the Lick/Jones model to evaluate sediment caps to capture essential contaminant transport processes
2. Apply the model using the field, lab, and literature supported data
3. Conduct multiple simulations

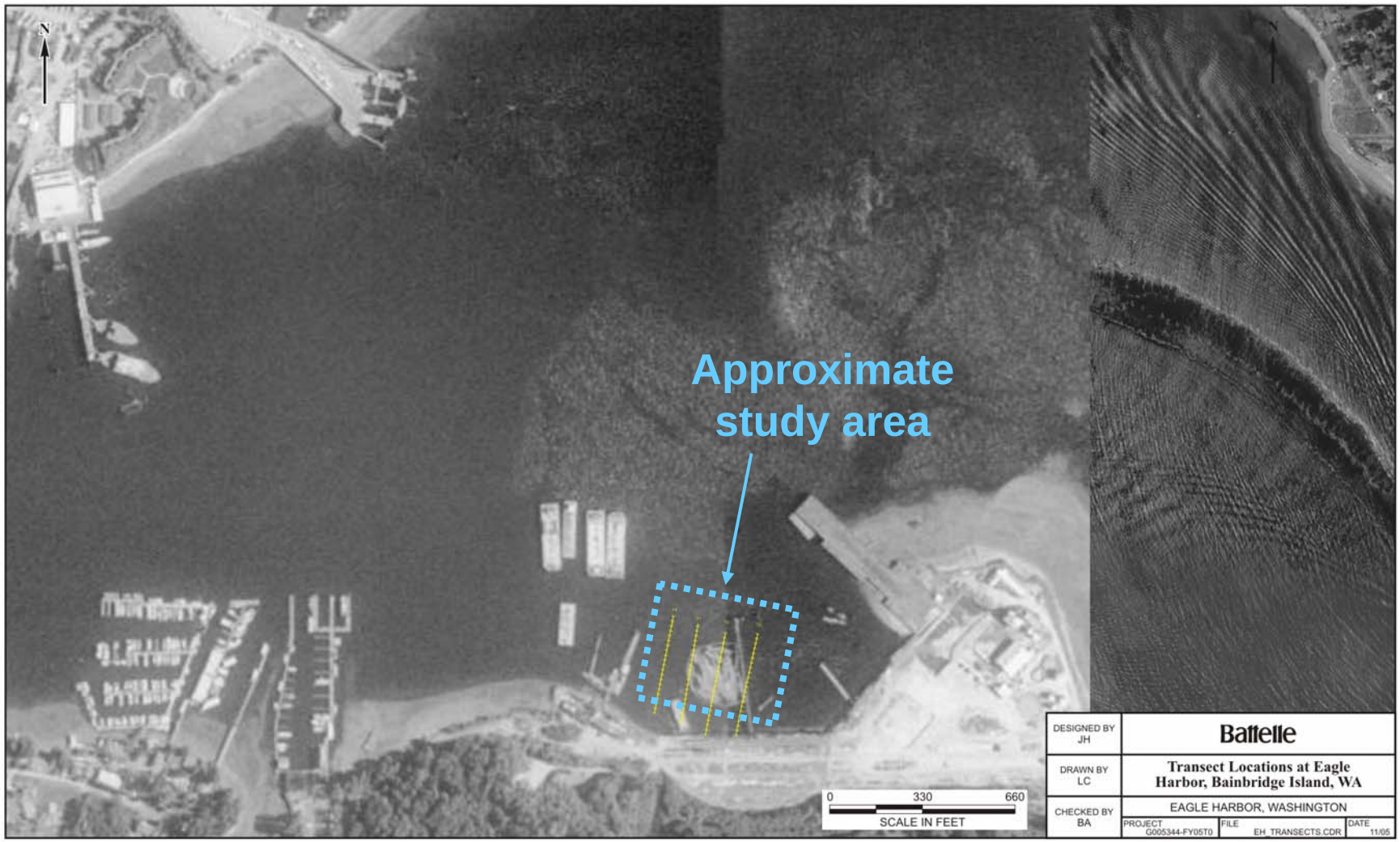
Project Field Schedule

First sediment core for contaminant profiling	April 2006
Laboratory analysis for PAHs and TPH	April-June 2006
Sediment and cap material collection for lab testing	April 2006
Verification of conductivity at site	June 2006
LTC and communication network installation	June 2006
Deployment and testing using ultrasonic seepage meter	July-August 2006
Second sediment core for contaminant profiling	March 2008

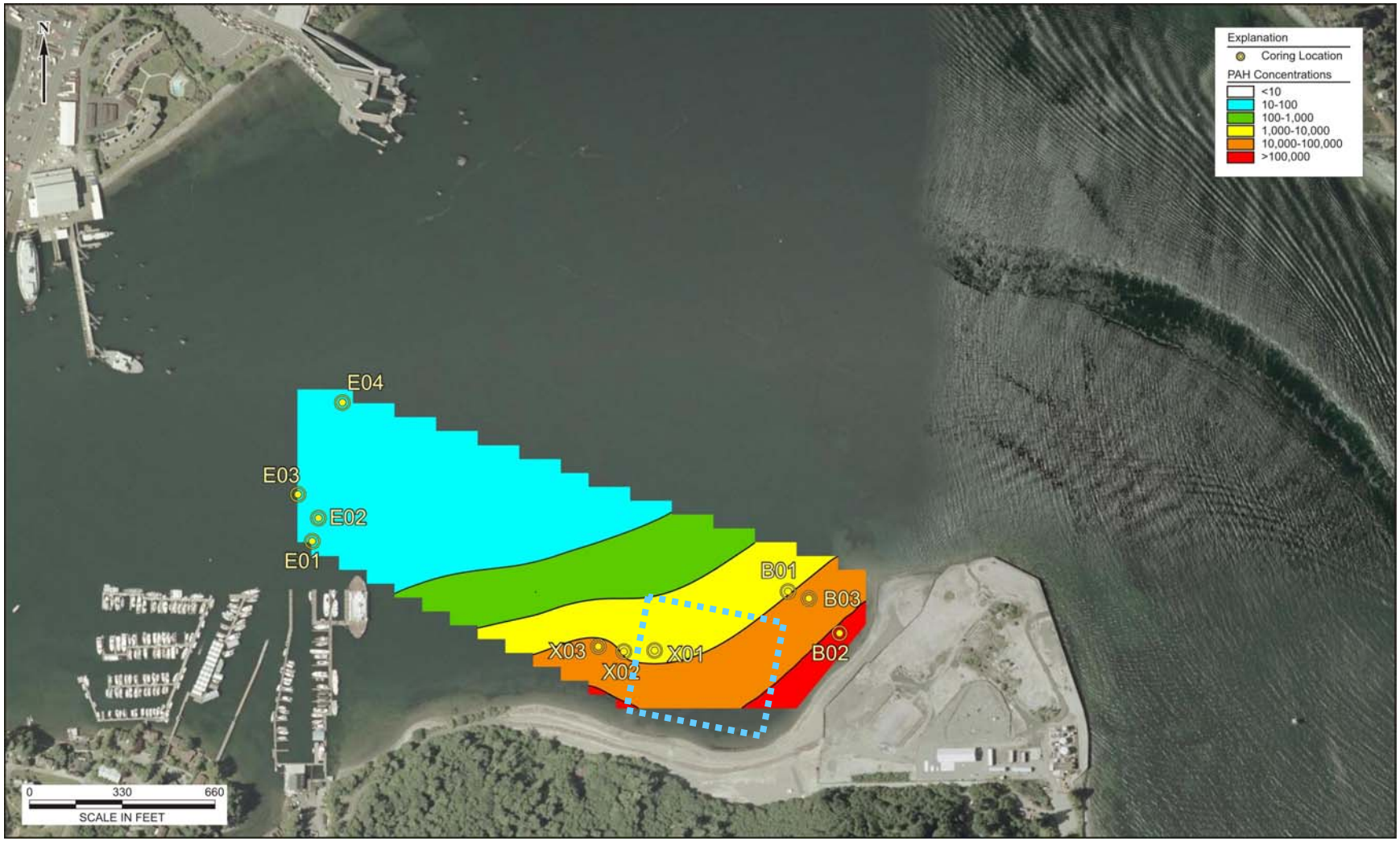
Criteria for Selecting a Study Area within the West Beach Site

- Area of primary interest is the capped area off-shore from the West Beach
- Study area must be of appropriate scale for this investigation
  - Plan is to investigate areas with different porewater fluxes, not to characterize variability.
- The following selection criteria were used:
  - High contaminant levels present in the underlying sediment
  - Indications of fresh water upwelling
  - Cap thickness is close to nominal (3 ft)

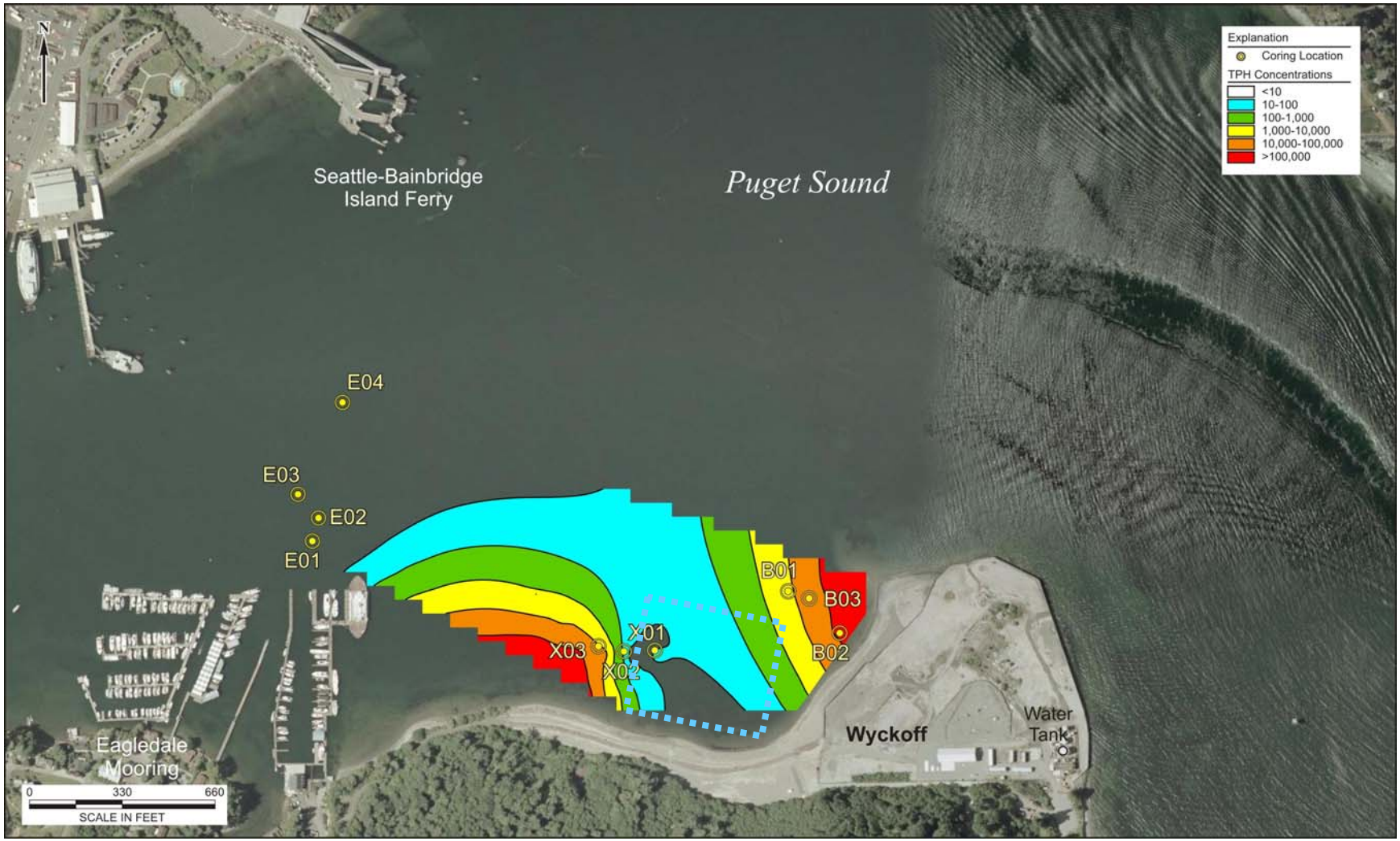
Preliminary Study Area Relative to Original Facility



Sediment Contaminant Profile
Total PAHs

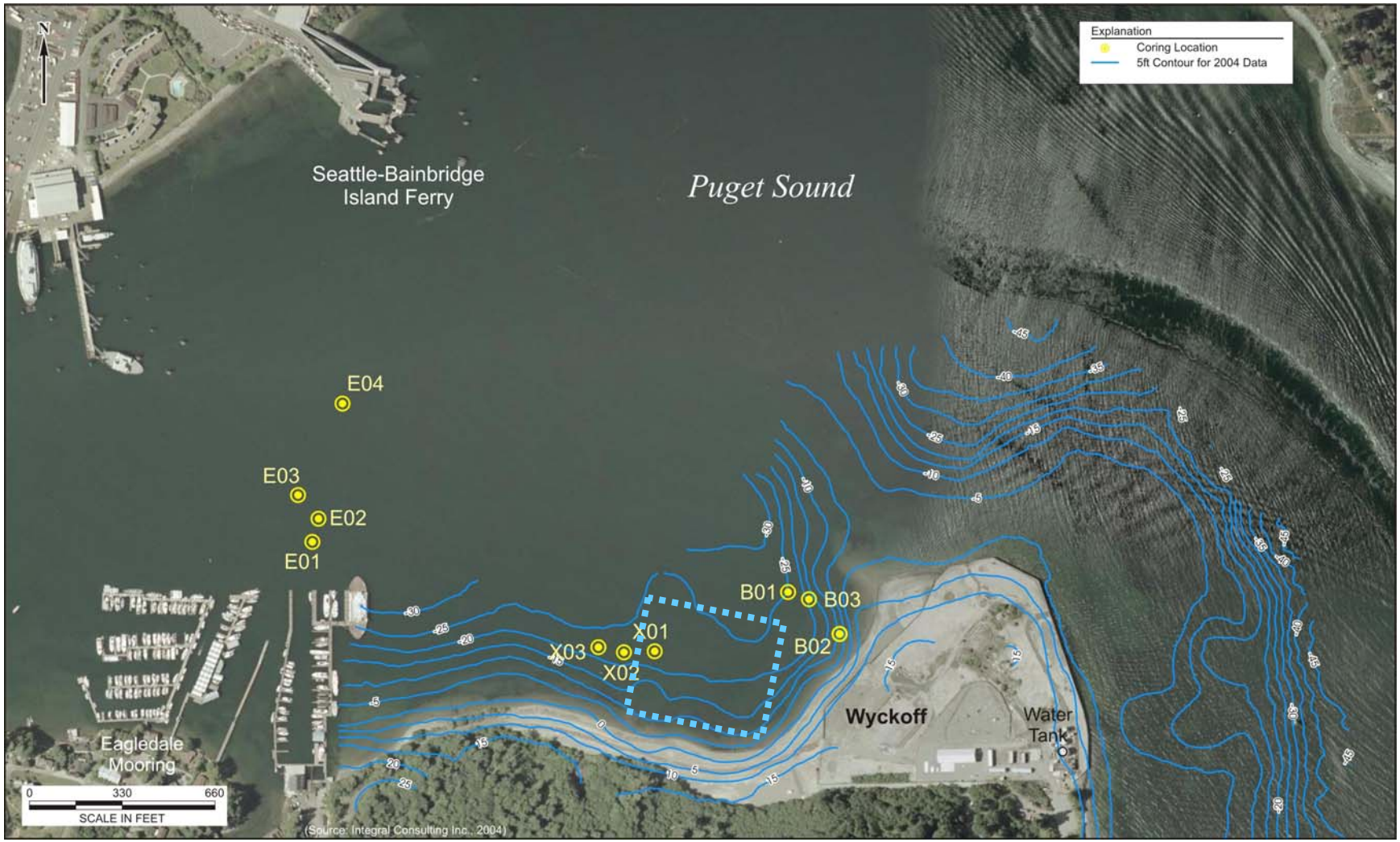


Sediment Contaminant Profile
Total Petroleum Hydrocarbons (TPH)



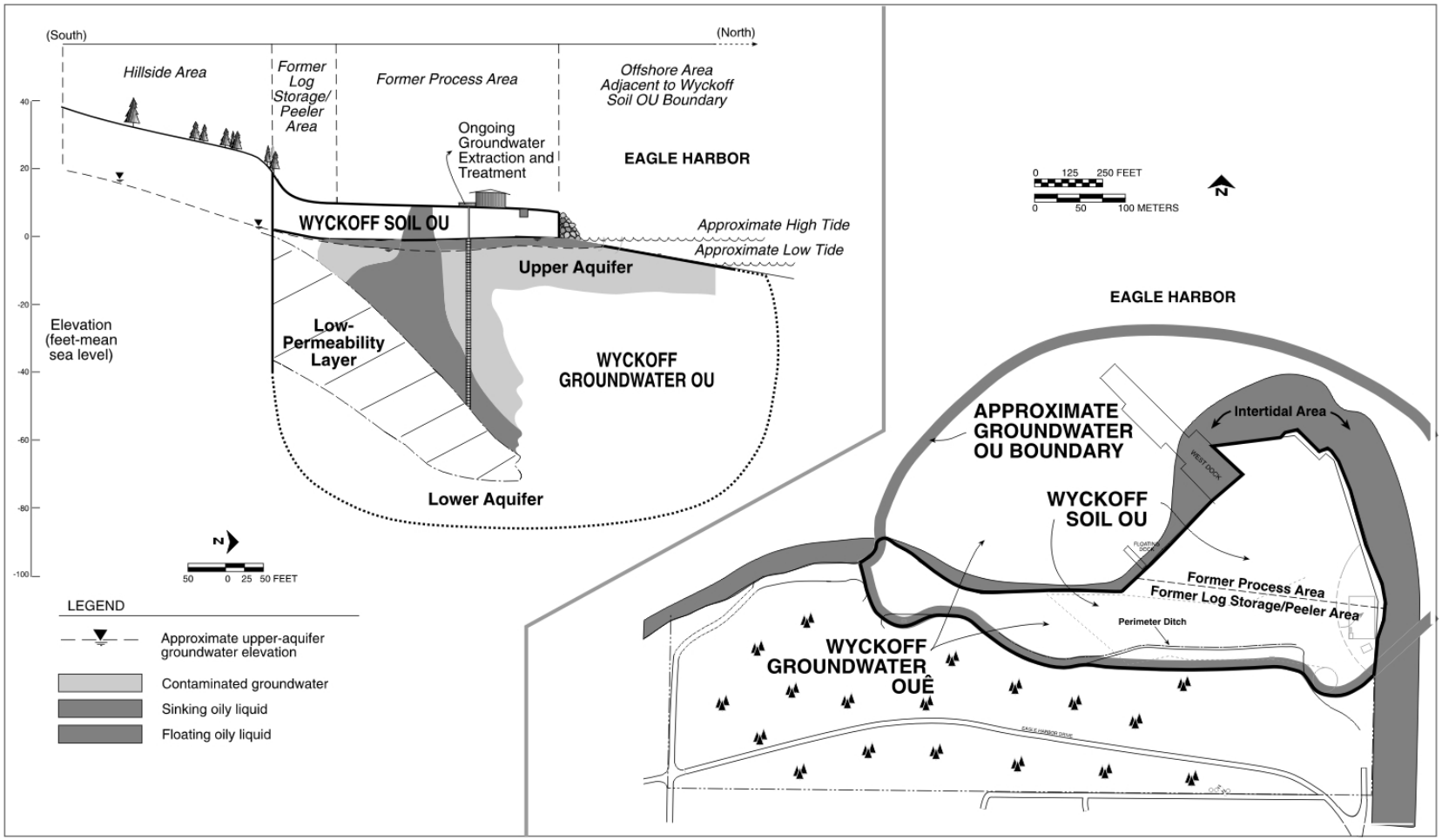
Preliminary Conductivity Mapping Results

Bathymetry of Study Area (2004)



Source; USACE/Integral Year 8 Environmental Monitoring Report

Eagle Harbor Hydrologic Setting

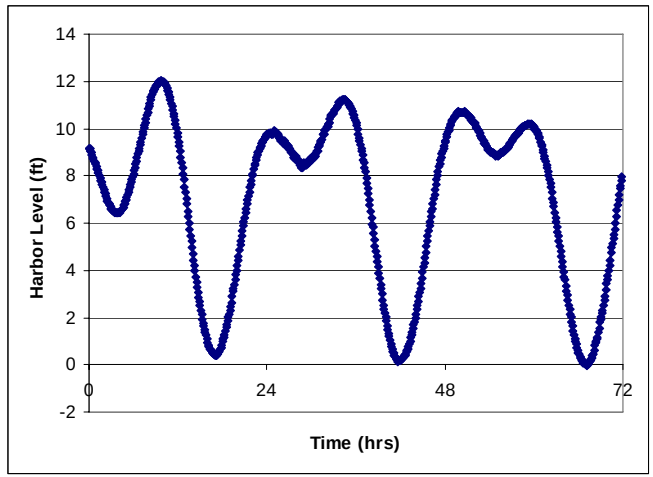


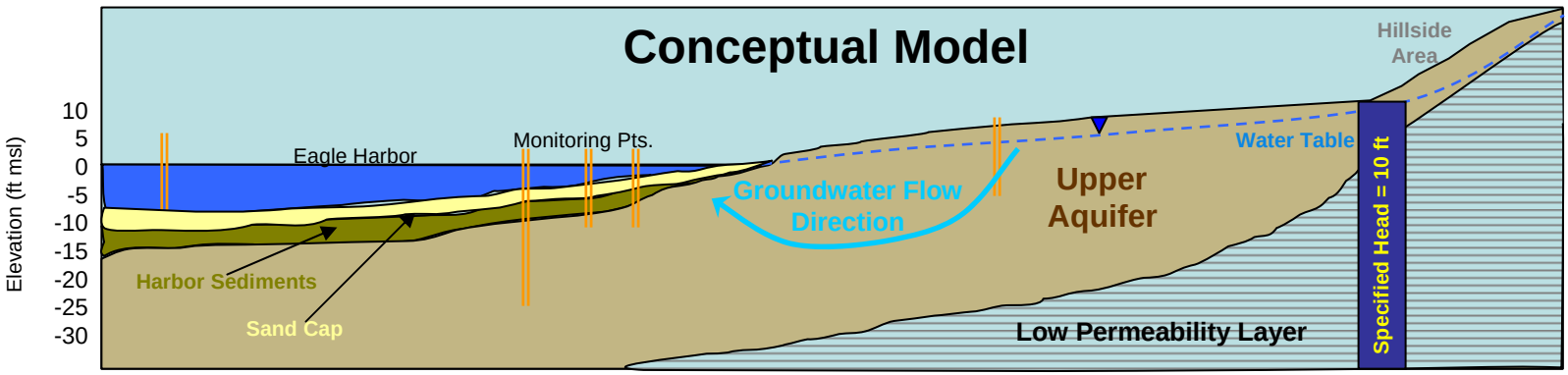
Source: USEPA. 1997. Superfund Fact Sheet

Eagle Harbor Groundwater Flux Modeling

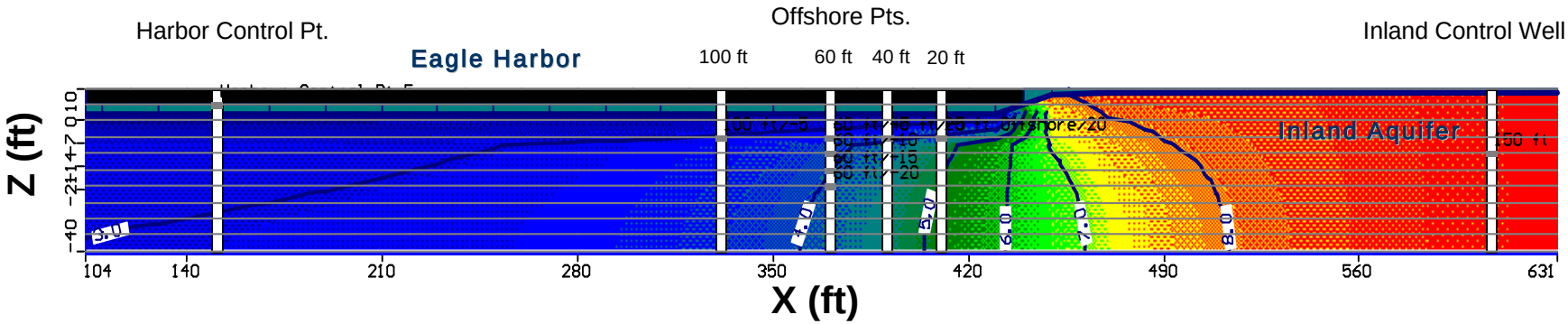
- Objective = understand interaction between Harbor and aquifer, analyze water level variations, estimate flux.
- Simplified MODFLOW groundwater model set up to analyze discharge to harbor.
- Eagle Harbor simulated as transient boundary based on typical tidal harbor water levels.

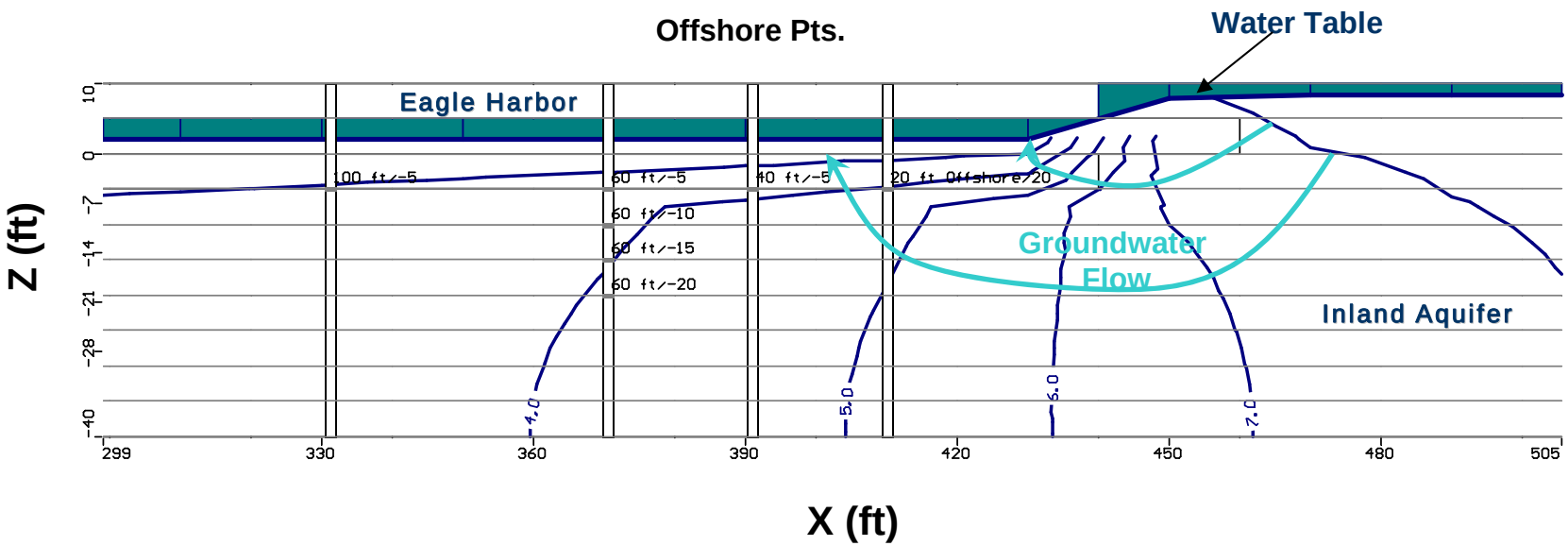
Typical Tidal Pattern in Eagle Harbor (Source = NOAA)



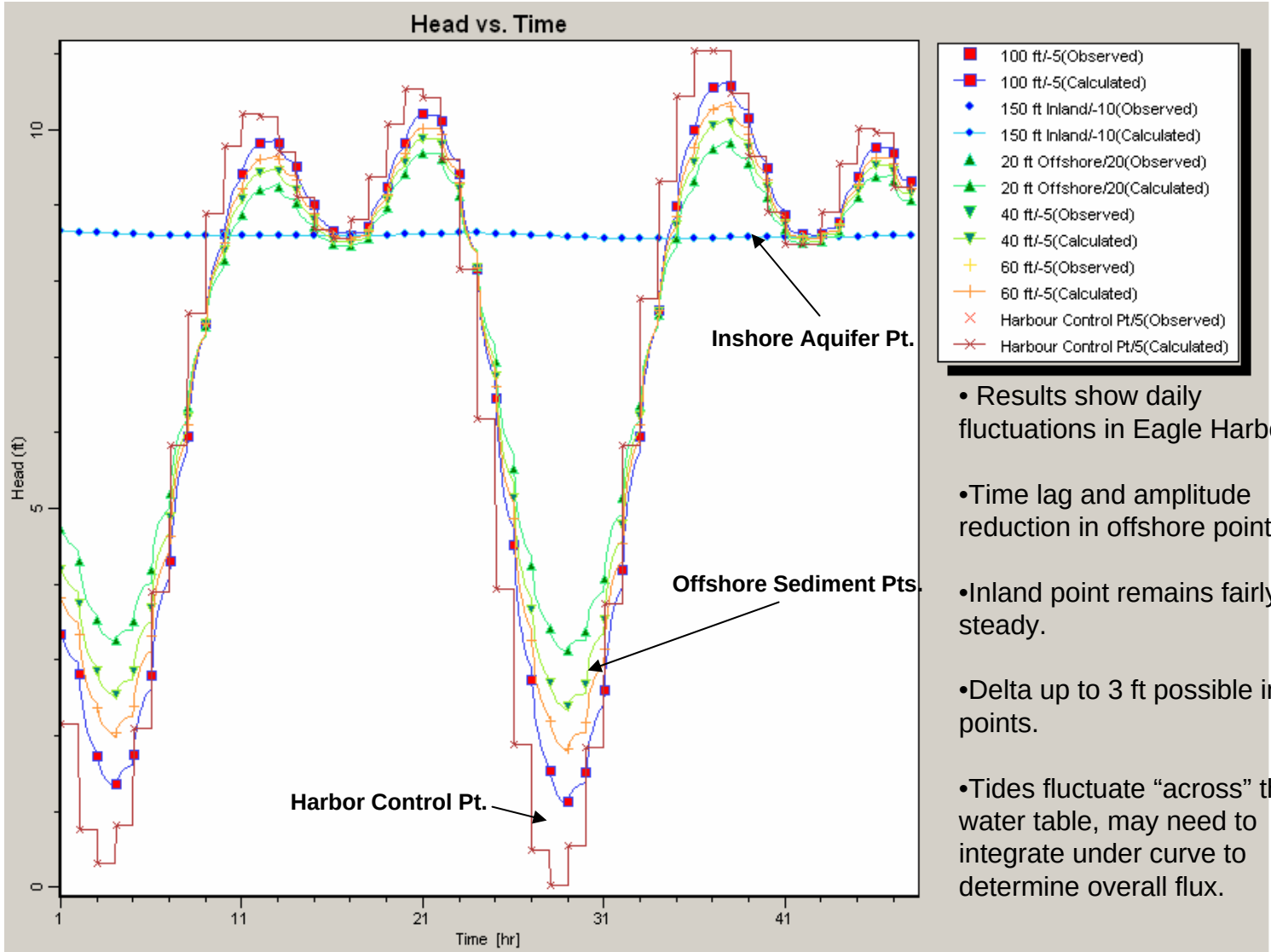


Eagle Harbor Sediment Flux Model Results



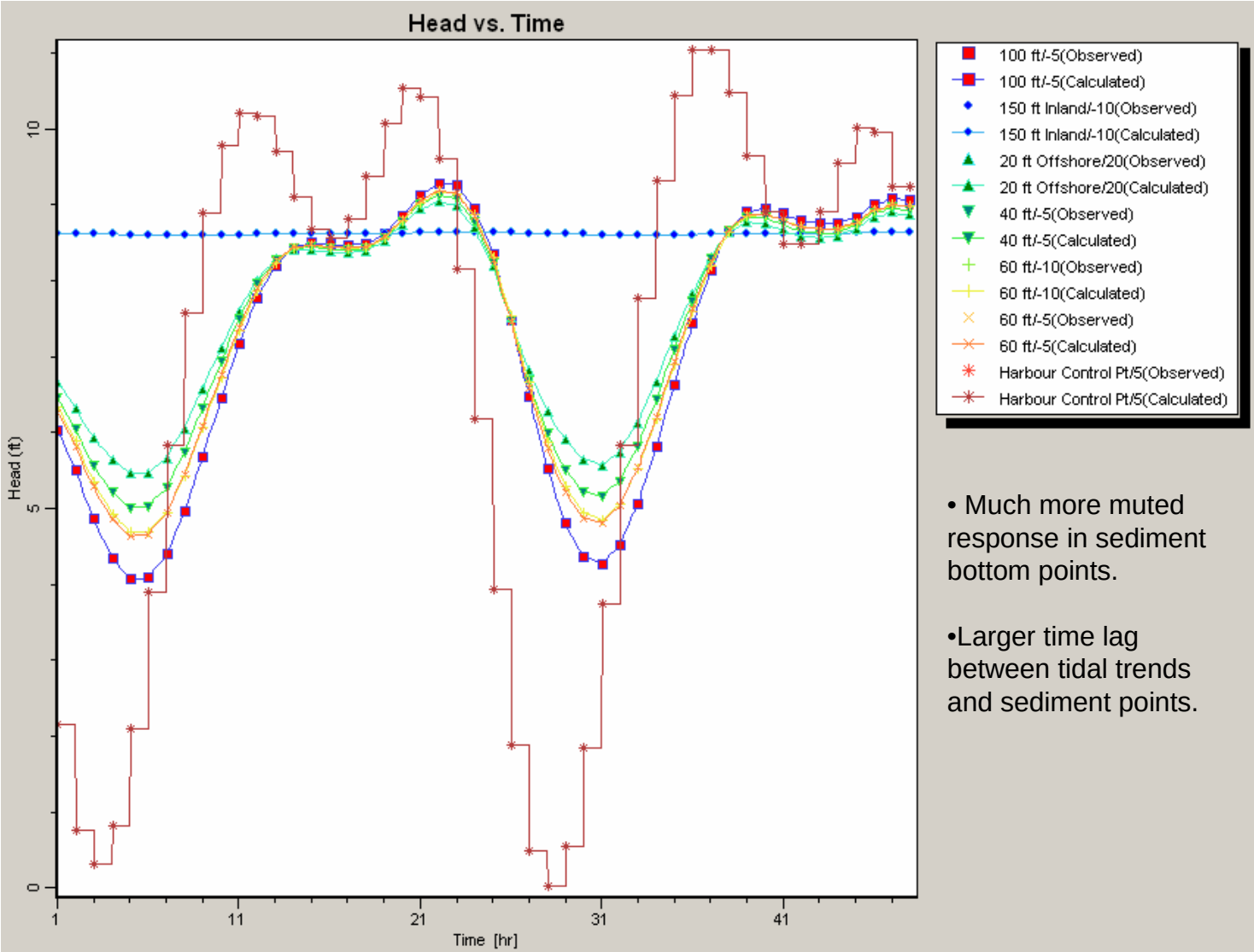


Simulated Heads over Time at Monitoring Points- Medium K Harbor Sediment Scenario (K = 1.0 ft/d)



- Results show daily fluctuations in Eagle Harbor.
- Time lag and amplitude reduction in offshore points.
- Inland point remains fairly steady.
- Delta up to 3 ft possible in points.
- Tides fluctuate “across” the water table, may need to integrate under curve to determine overall flux.

Simulated Heads over Time at Monitoring Points- Low K Harbor Sediment Scenario (K = 0.1 ft/d)

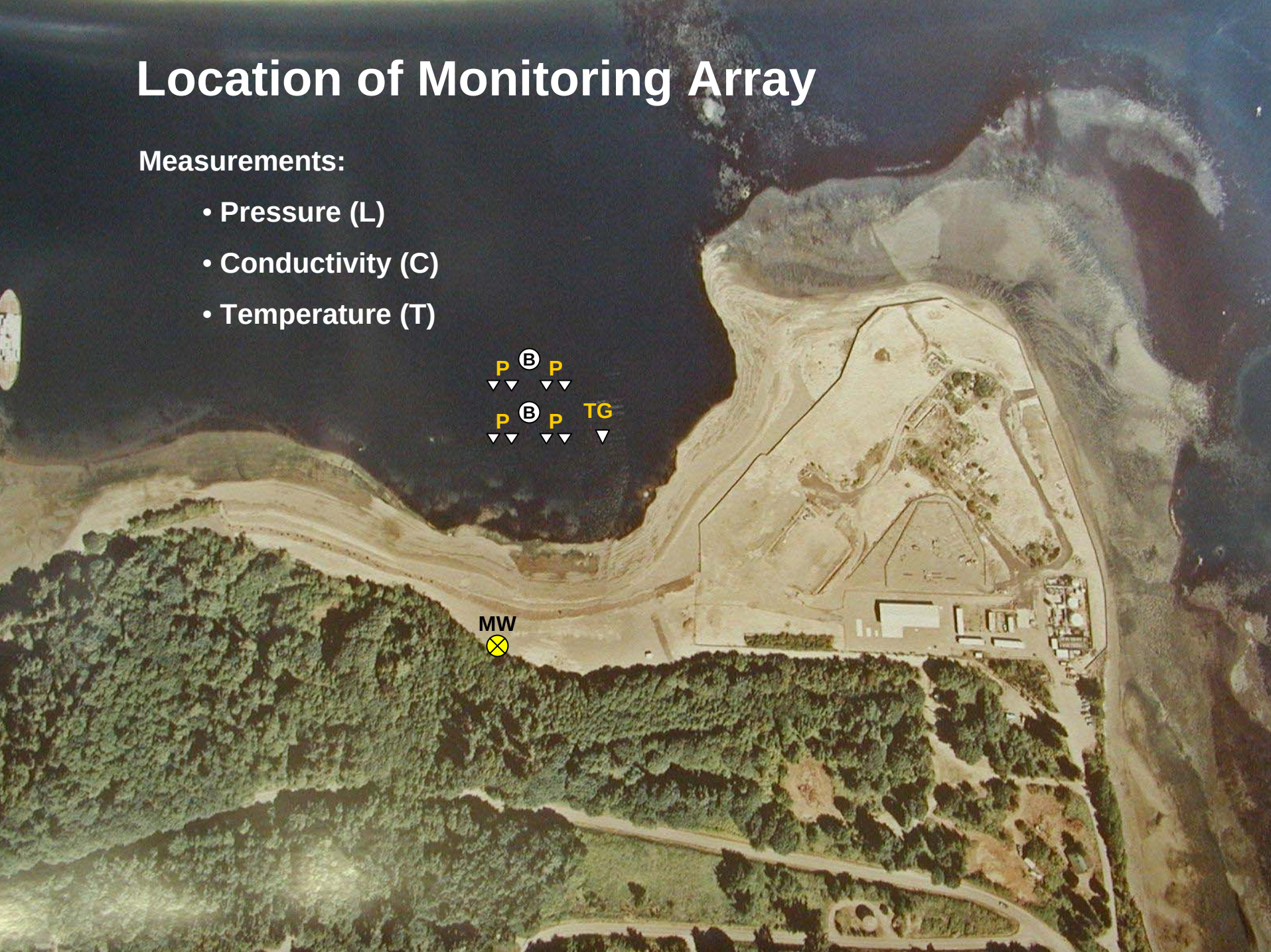


- Much more muted response in sediment bottom points.
- Larger time lag between tidal trends and sediment points.

Location of Monitoring Array

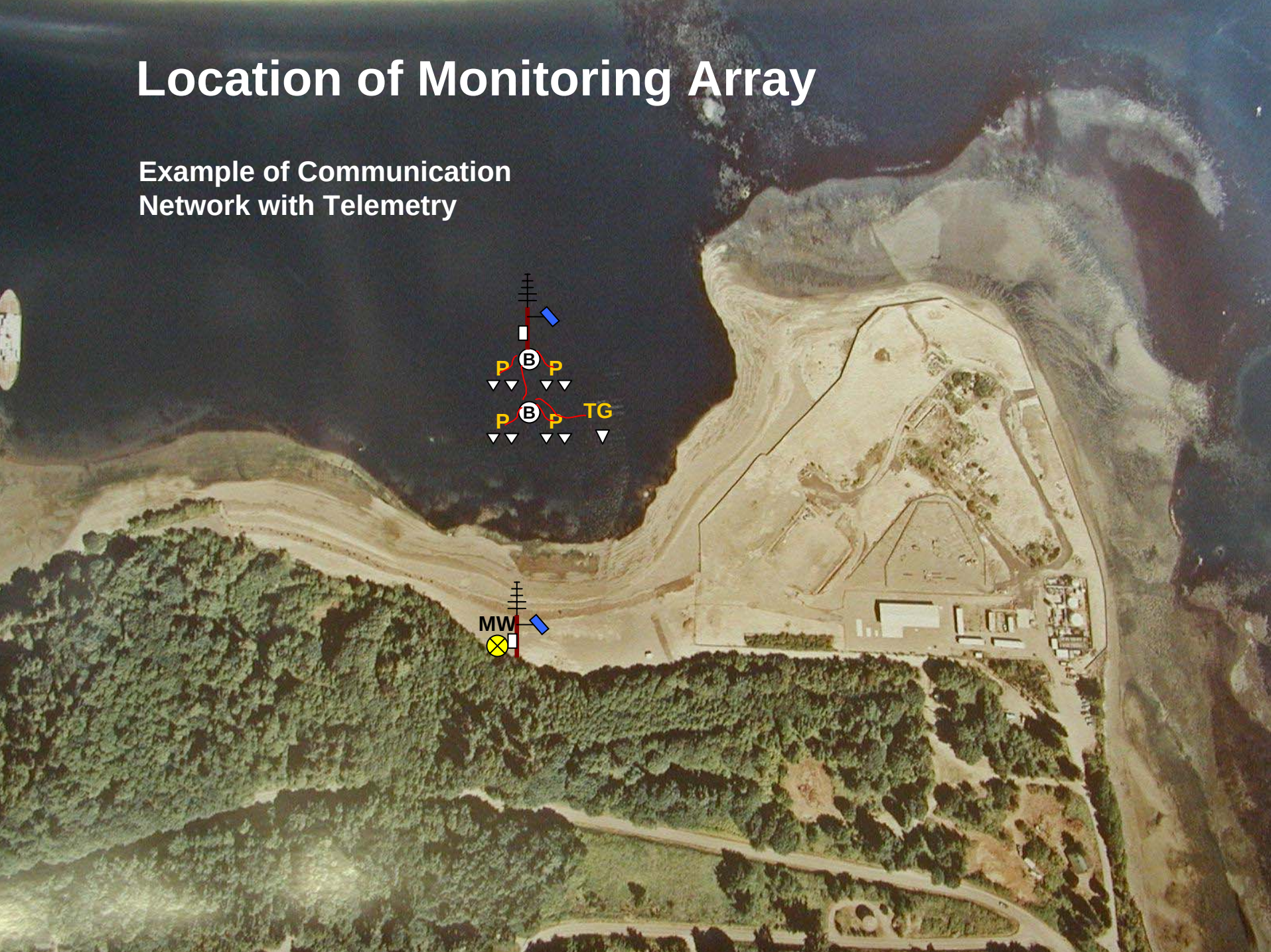
Measurements:

- **Pressure (L)**
- **Conductivity (C)**
- **Temperature (T)**

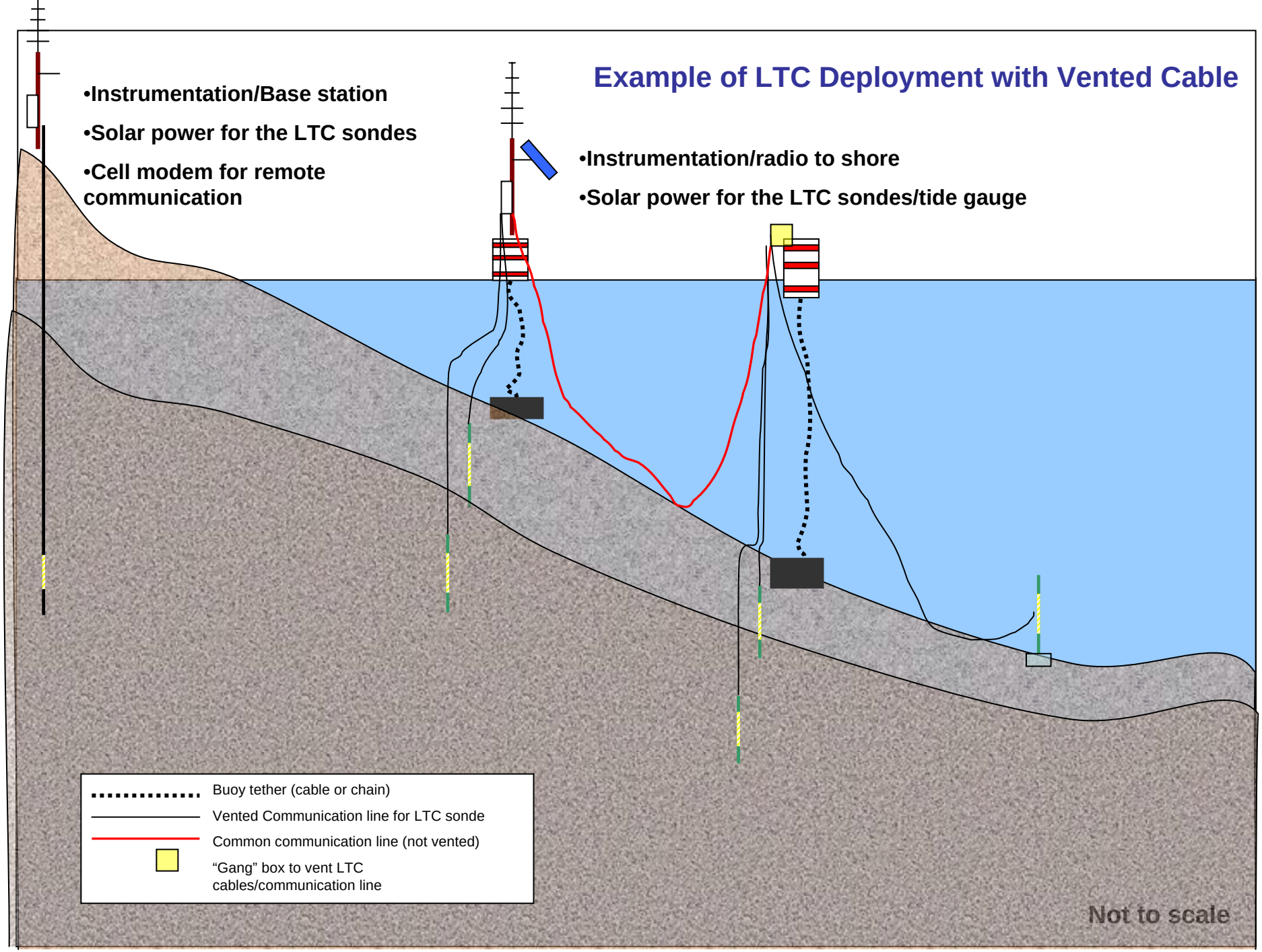


Location of Monitoring Array

Example of Communication Network with Telemetry



Example of LTC Deployment with Vented Cable



Project/Data Needs

- Cap interval thickness in GIS format
- Hydrologic model for groundwater flow in aquifer system and shallow sediment.
- Concurrence on sediment contaminant distribution
- Permit requirements for new upland wells (if needed)
- Permit requirements for harbor activities (buoys, boat and diving operations, core collection)
- Site logistics (utilities, telephone, site access)
- Can the site provide a student worker for downloading logger data and related tasks?
- Requirements at conclusion of project (abandon monitoring devices)

EPA Leveraged and In-Kind Projects

Marc Mills

EPA/ORD/NRMRL

United States Environmental Protection Agency
Office of Research and Development