Environmental Risk Assessment at Philadelphia Naval Reserve Basin

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(1)Abstract

Multibeam bathymetry coverage was achieved throughout the basin except within 50' of the bulkheads and below naval vessels. Casting lead lines at bulkheads, then interpolating with a tension spline filled near-bulkhead gaps in coverage. Kriging was used to fill gaps caused by naval vessels. These grids were joined in areas of dense multibeam coverage to generate a seamless union. Using a dredge depth of 32' the basin was broken up into cells requiring 8,000 yd^3 of material removed. Chemical analyses on vibracores, at representative cells, were required to determine if dredging is a hazard to aquatic or human health. Historic drill logs were examined for depth to sand and a grid was generated to estimate the depth of vibracore need to achieve this depth at core locations throughout the basin. Chemical analyses were preformed on the vibracores to assess the potential risks.

(2)Introduction

The Reserve Basin is a mooring basin in an industrial area located in the western portion of the Philadelphia Naval Business Complex (PNBC). The basin opens to the Schuylkill River approximately 0.5 km north of the confluence of the Schuylkill and Delaware Rivers (Figure 2-1). The Reserve Basin covers approximately 40 hectares with water depths ranging from 20 to 50 ft Mean Lower Low Water (MLLW).

The Reserve Basin continues to serve as a moorage for the Navy's inactive ships (Figure 2-1). The sediments of the Reserve Basin contain elevated concentrations of contaminants including metals and PAHs from several sources. Ship moorage in the Reserve Basin has the potential to release contaminants. The antifoulant paint on ships' hulls may act as a source of contaminants, especially for copper and zinc. Additional sources of contamination to the Reserve Basin are the Girard Point Landfill and influx from the Schuylkill River.

(3)Bathymetry and Dredging Cell Creation

The presence of large numbers of moored ships throughout the basin limited the access of the multibeam survey vessel to some areas of the basin. To provide depths along those areas of the bulkhead where multibeam soundings could not be obtained, lead line soundings were acquired along the bulkhead (Figure 3-1). These lead line soundings were geo-referenced and converted to MLLW based on the same tide station used to convert the multibeam data. A tension spline filled near-bulkhead gaps in coverage and kriging was used to fill gaps caused by naval vessels. These grids were joined in areas of dense multibeam coverage to generate a seamless union.

The lead line measurements were necessary to augment the multibeam dataset so that a reasonable picture of the seafloor directly below the ships could be estimated. Data points from the lead line and the multibeam survey were merged to enable the creation of a continuous surface covering the entire basin floor (Figure 3-2). Dredge volume calculations were generated based upon this surface.

The project required that chemical analyses were preformed on every 8,000 cubic yards of material that will be removed from the basin. These cells were created using SAIC designed DMSMART Hydrographic Tools. These tools used the bathymetry grid (described in the previous paragraph) and a cutting grid, which was the planned dredge depth for the area. Using the depth difference option under DMSMART Hydrographic Tools, the appropriate grids were selected (Figure 3-3). Next polygons were drawn and the tool calculates the difference and created a polygon and a difference grid. The polygon feature contained the volume and max dredging depth. Snapping was used during polygon creation to prevent gaps from forming. The polygons were then adjusted through an iterative process to achieve the desired 8,000 cubic yards of volume. Once the entire basin was finished, the polygons were merged together to create the dredging cells (Figure 3-4).

(4)Depth to sand

A continuous raster image was created of the basin showing depth to sand (from MLLW). Additionally, the individual cores and borings values (of depth to sand) have been included (Figure 4-1). This data was created from a compilation of SAIC 2000 cores and boring records. Two of the points were not used in gridding, as they did not penetrate the sand layer. Note that the entrance channel doesn't have any historic cores or borings that penetrate the sand layer and thus the basin data has been extrapolated into the channel. This extrapolation may not provide the desired precision as we have moved from a basin to a channel feature and there may be more slope effect near the banks.

For each proposed core location data necessary for coring was queried including: water depth, minimum core penetration to reach below 32', and minimum core penetration to reach sand. All of the minimum core penetrations are well within SAIC/OSI capabilities to achieve except RB-25 and RB-27. Both of these cores are near the entrance channel. As was stated earlier this area is where the gridded depth to sand becomes least robust.

(5)Chemical Analysis

The goal of this work is to determine if there is contaminated sediment in the basin, if so where it is and how much will have to be removed to remediate the basin. After a preview of chemical analysis it was determined that the chemicals of concern were copper and PCBs. Instead of interpolating the chemical data, thiessen polygons were utilized. In this approach, the area of the entire polygon is assumed to take on the concentration at the sampled location, assuming that proximity is the best predictor of conditions most likely to occur at the unsampled location. Therefore the objective was to develop the Theissen polygon map for the basin based on the most current sampling locations, apply the calculated preliminary remediation goals (PRGs) to the measured concentrations assigned to each polygon, and sum the areas of polygons above PRGs to determine the spatial extent of PRG exceedance. The footprints exceeding PRGs are presented in Figure 5-1.

(6)Possible Dredging Concerns

The wharf around the Philadelphia Naval Reserve Basin is comprised of long-standing pilings that are somewhat delicate in nature. In order not to degrade the pilings, dredging operations should not remove any material critical in the support of these pilings. For this aspect of the study we created a piling buffer zone of 3 times the height of the portion of the piling below the sediment/water interface. Dredging in the area outside of this buffer zone should not affect the structural integrity of the pilings, and therefore will not have depth restrictions. The area inside this buffer zone may be dredged but must preserve the 3:1 ratio (see figure 6-1 below). In order to facilitate the preservation of the 3:1 ratio maps will be produced showing the acceptable dredging depths within the buffer zone. In addition, volumetric calculations were made (using 3-D Analyst) to determine the amount of material available for dredging and its distance from the pilings.

(7)Future Work Products

Cores will be sampled and described in order to create a 3-dimensional model that defines stratigraphic layers, specifically the clean sand and contaminated mud layers. The stratigraphy will be based on the core description logs and incorporated into a stratigraphy table. During the process of building the solid model, we will create a grid for the upper and lower surface of each of the active stratigraphic layers using the best-suited modeling algorithm. The completed solid model will be composed of a 3-dimensional interpolated grid (see examples figure 7-1 and 7-2). Volume and mass of each formation can then be easily extracted from the model. Since the contamination is not present in all strata types, chemical modeling and volume estimation will be constrained to contaminated stratigraphy. This will reduce the required number of chemical analyses. Additionally, 2-dimensional vertical profiles of stratigraphic sections will "slice" through the models vertically along the selected section lines.

Figure 2-1. The Philadelphia Naval Business Complex (PNBC) opens to the confluence of the Schuylkill and Delaware Rivers.

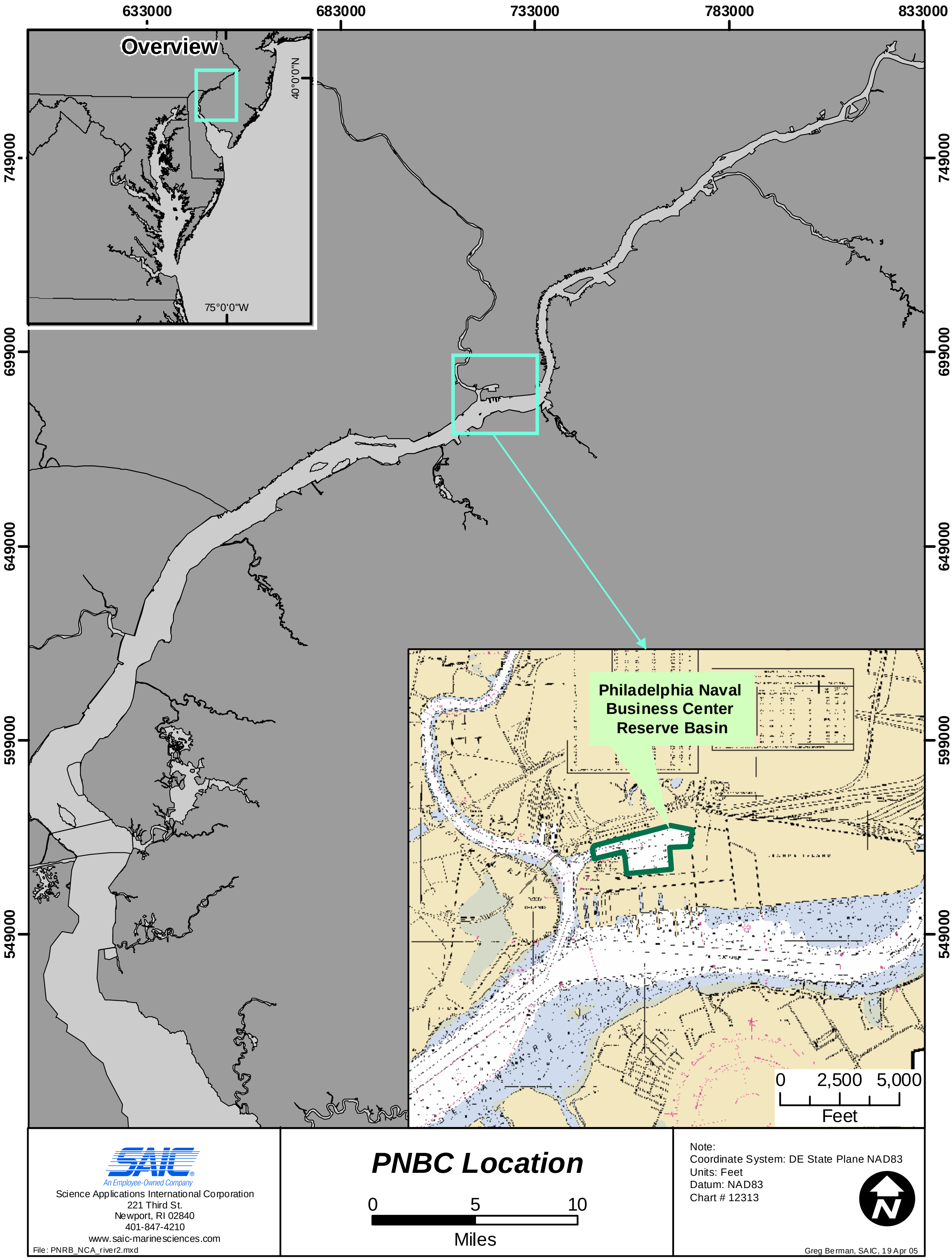


Figure 2-2. The Philadelphia Naval Business Complex (PNBC) still contains moored US Navy ships in various degrees of readiness.

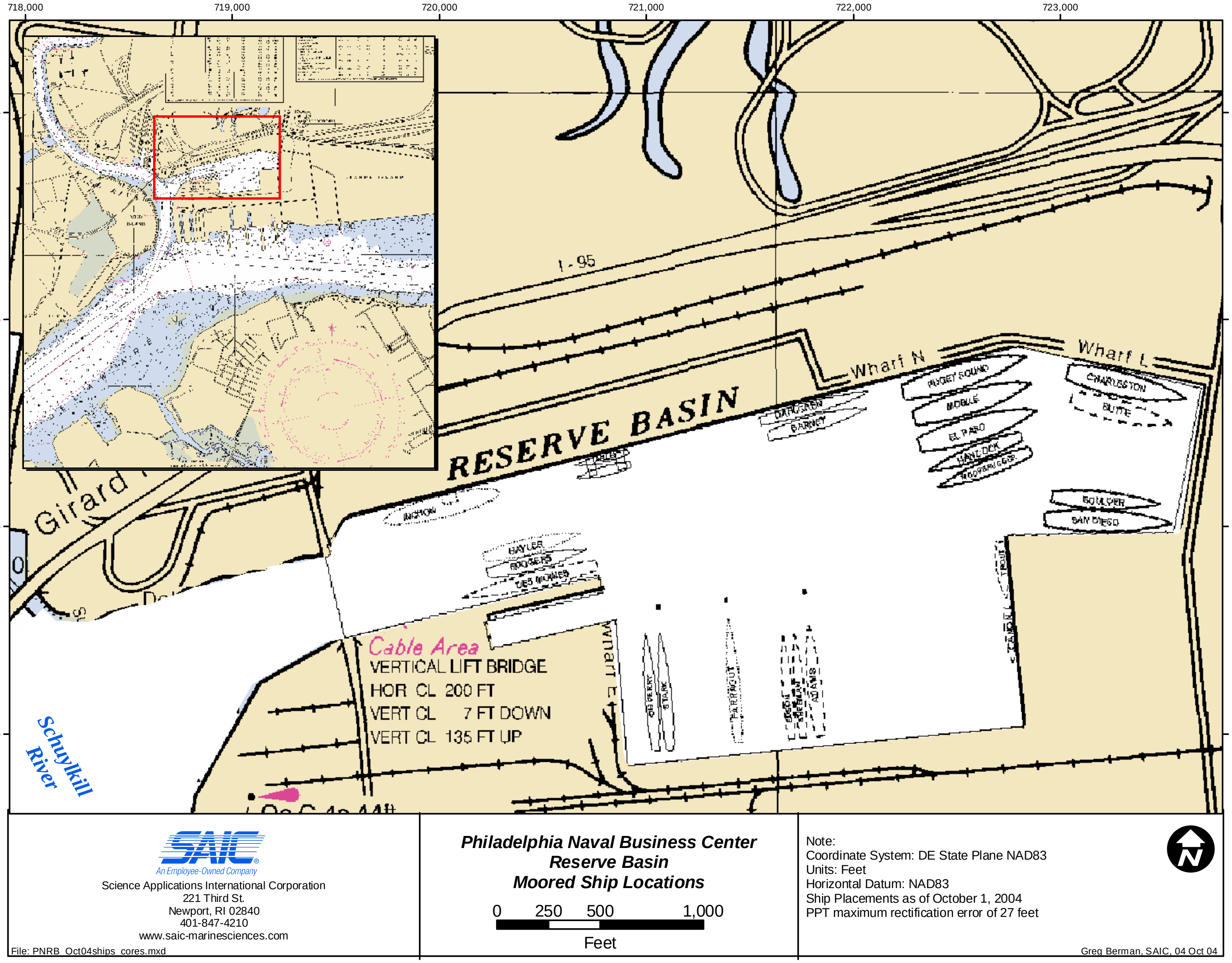


Figure 3-1. The black dots indicate individual bathymetry points. The points along the edge of the basin are lead line soundings. Gaps were caused by moored ships and shallow bathymetry in the channel.

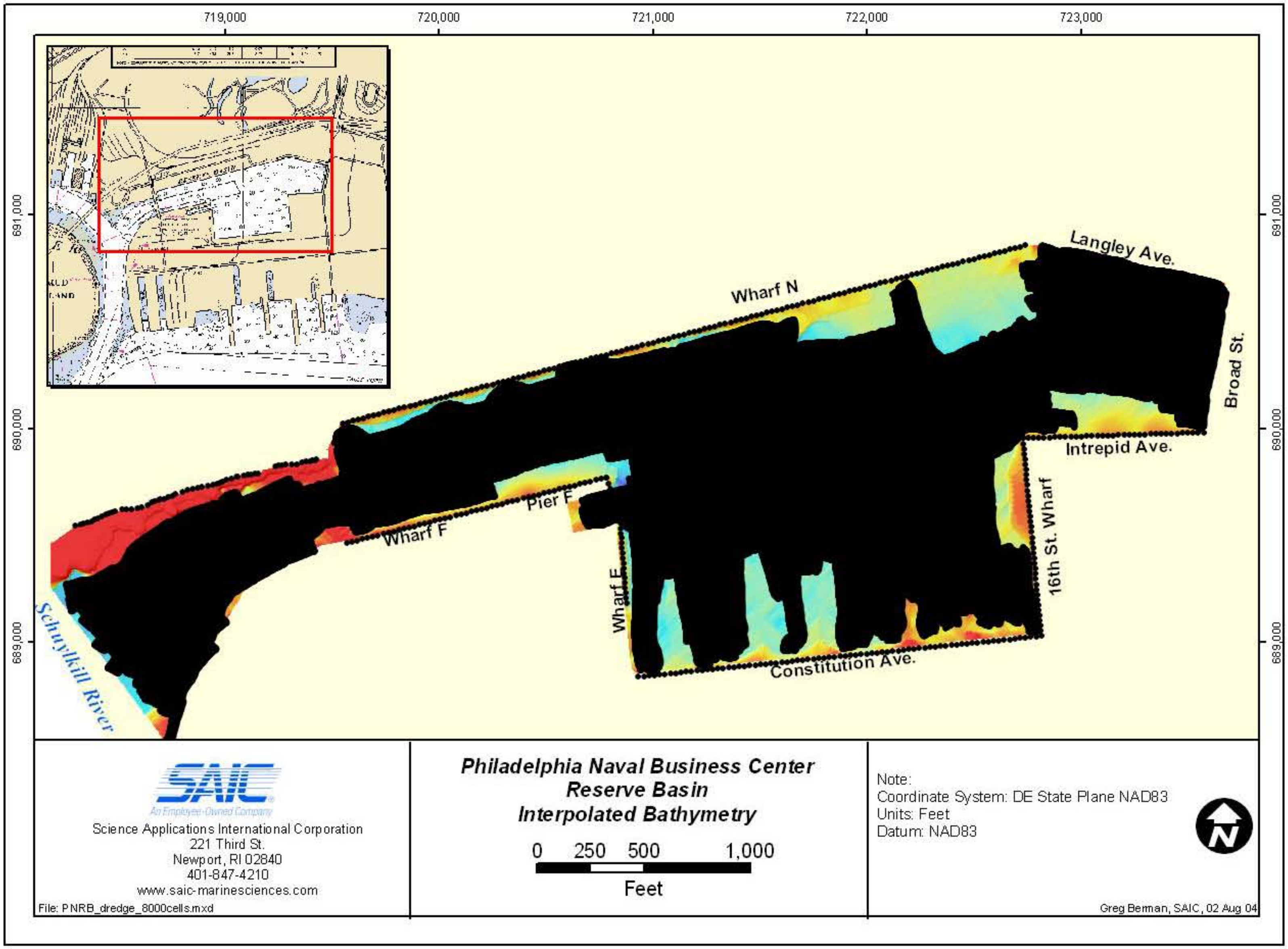


Figure 3-2. A tension spline filled near-bulkhead gaps in coverage and kriging was used to fill gaps caused by naval vessels. These grids were joined in areas of dense multibeam coverage to generate a seamless union.

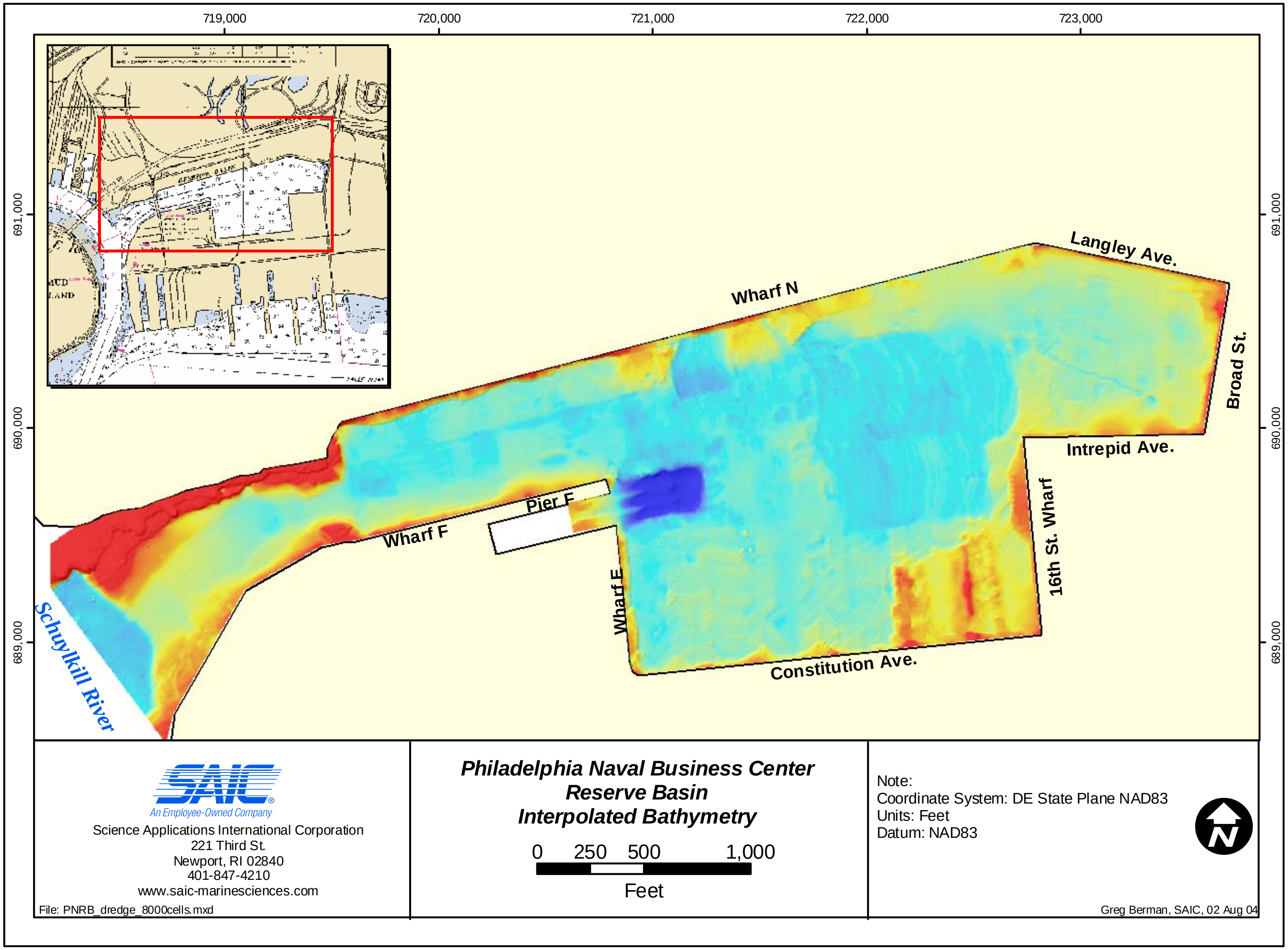


Figure 3-3. A screen-shot of SAIC designed DMSMART Hydrographic Tools that were used to design the 8,000 cubic yard dredging cells.

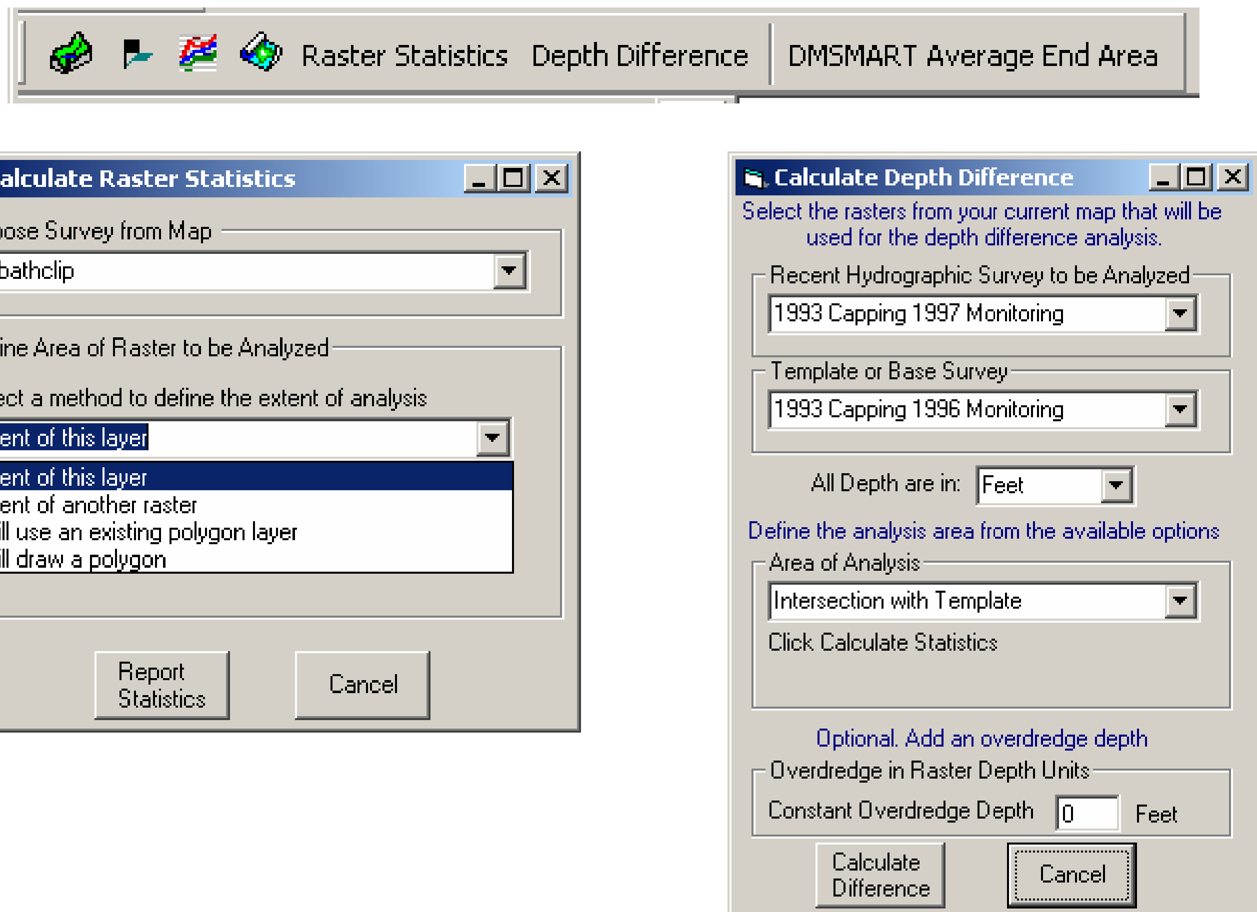


Figure 3-4. The finished 8,000 cubic yard dredging cells overlain on the PNBC basin. Note that there is an offset from the bulkhead to preserve stability.

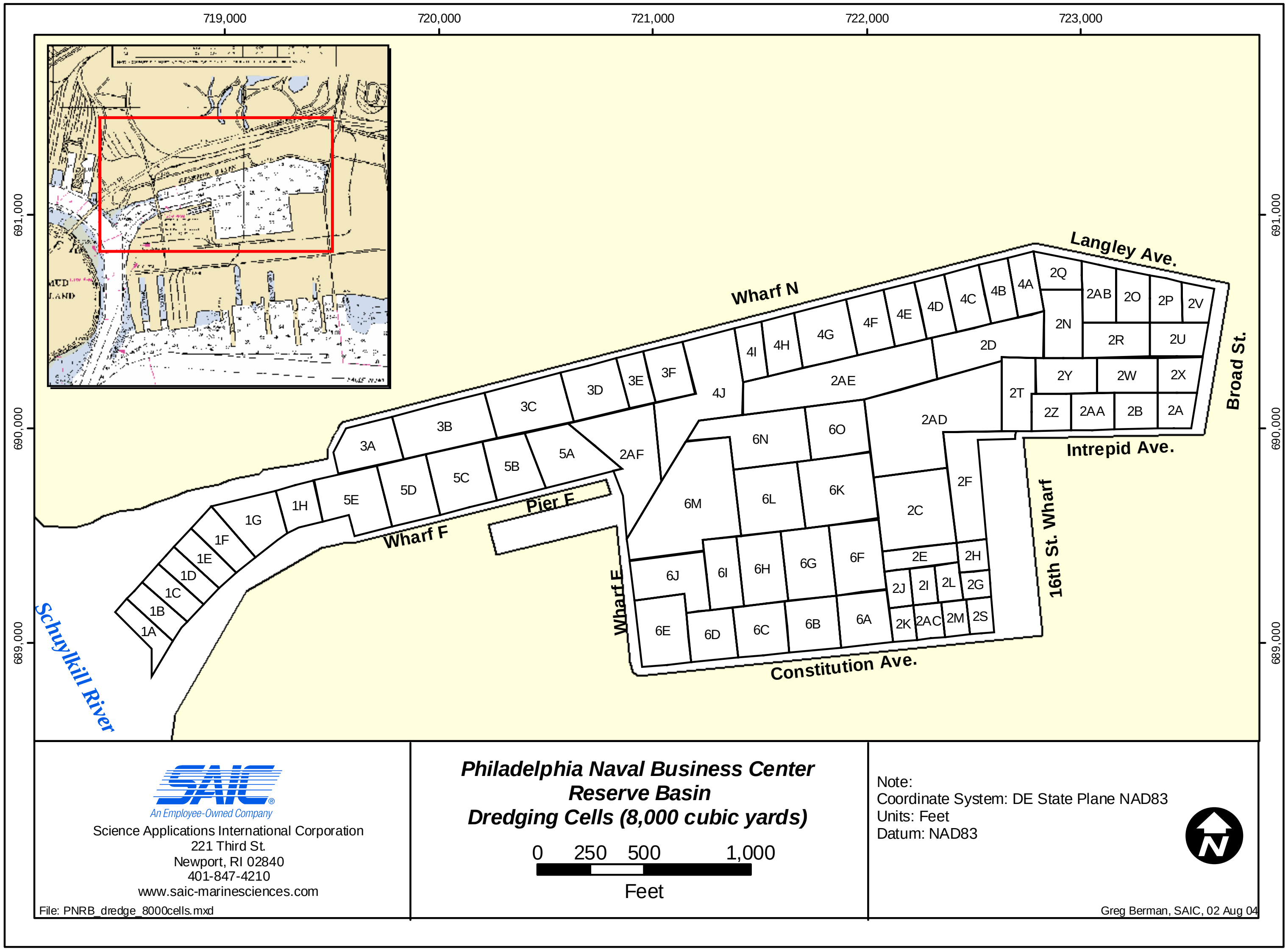
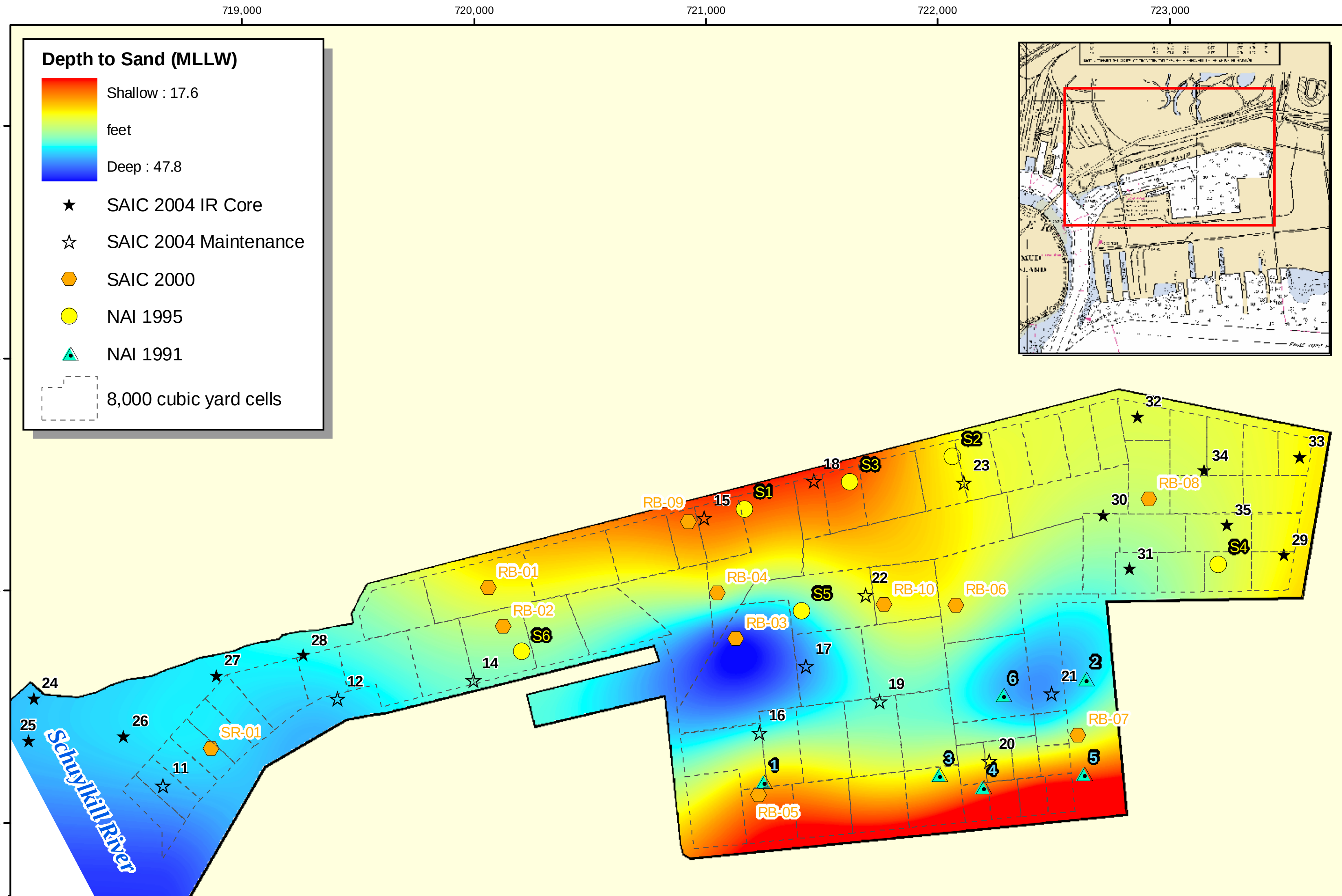


Figure 4-1. A continuous raster image was created of the basin showing depth to sand



Philadelphia Naval Business Center
Reserve Basin
Depth to Sand

0 250 500 1,000
Feet

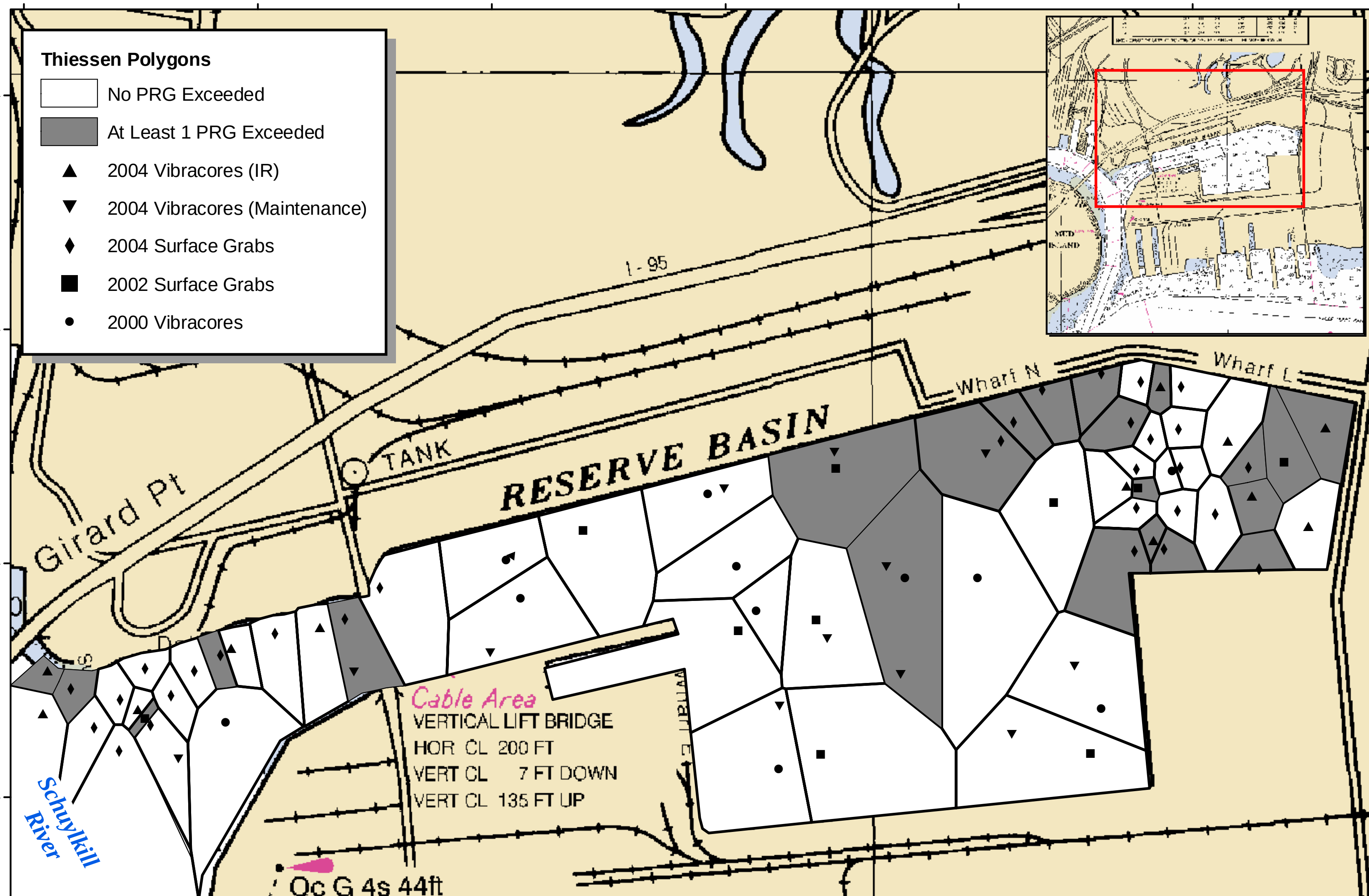
Science Applications International Corporation
221 Third St.
Newport, RI 02840
401-847-4210
www.saic-marinesciences.com

Note:
Coordinate System: DE State Plane NAD83
Units: Feet
Horizontal Datum: NAD83
Vertical Datum: MLLW

File: PNRB_depth2sand_cores_v3.mxd

Greg Berman, SAIC, 16 Feb 05

Figure 5-1. Thiessen polygons were created from recent chemical data to determine which areas exceed the PRG for copper or PCBs.



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File: PNRB_HH_and_AQ_thiessen.mxd

Philadelphia Naval Business Center
Reserve Basin
PRG Exceedence

0 250 500 1,000
Feet

Note:
Coordinate System: DE State Plane NAD83
Units: Feet
Horizontal Datum: NAD83

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Greg Berman, SAIC, 21 Apr 05

Figure 6-1. Cartoon of 3:1 ratio maps that were produced showing the acceptable dredging depths within the buffer zone.

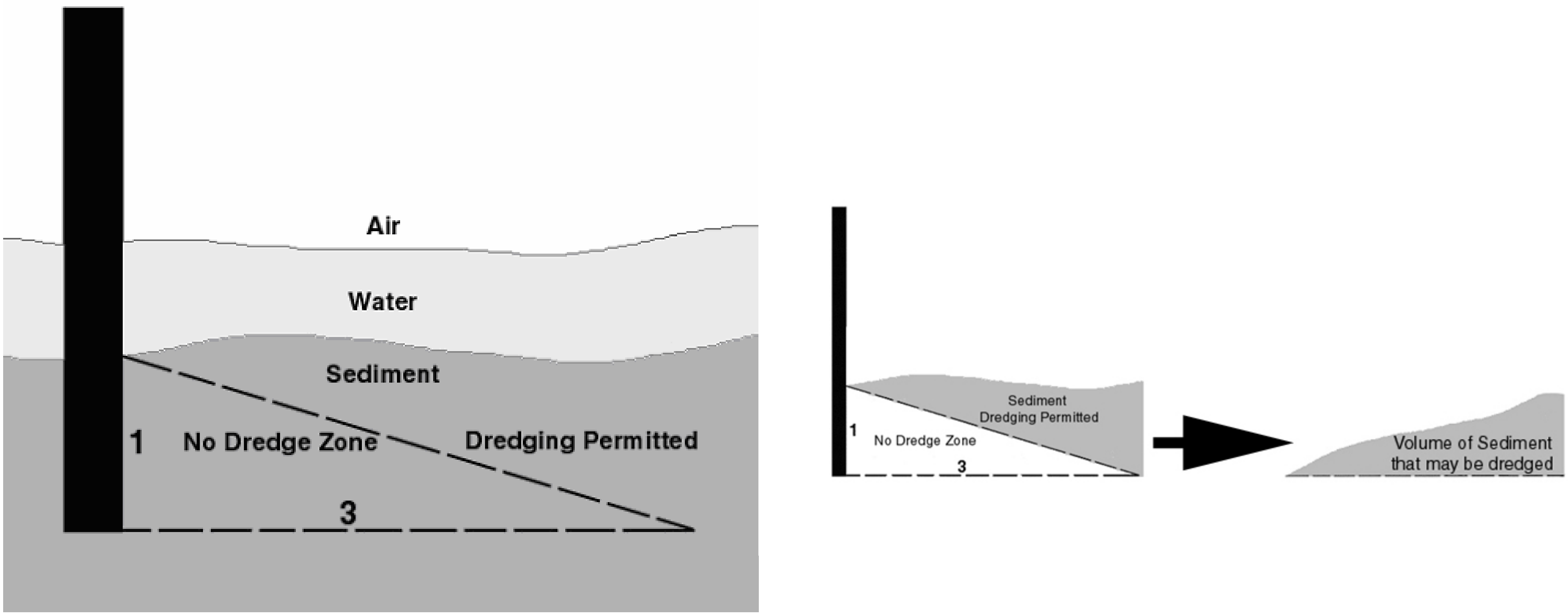


Figure 7-1. Example of a 3-dimensional depth to sand surface overlain on the existing bathymetry for the basin.

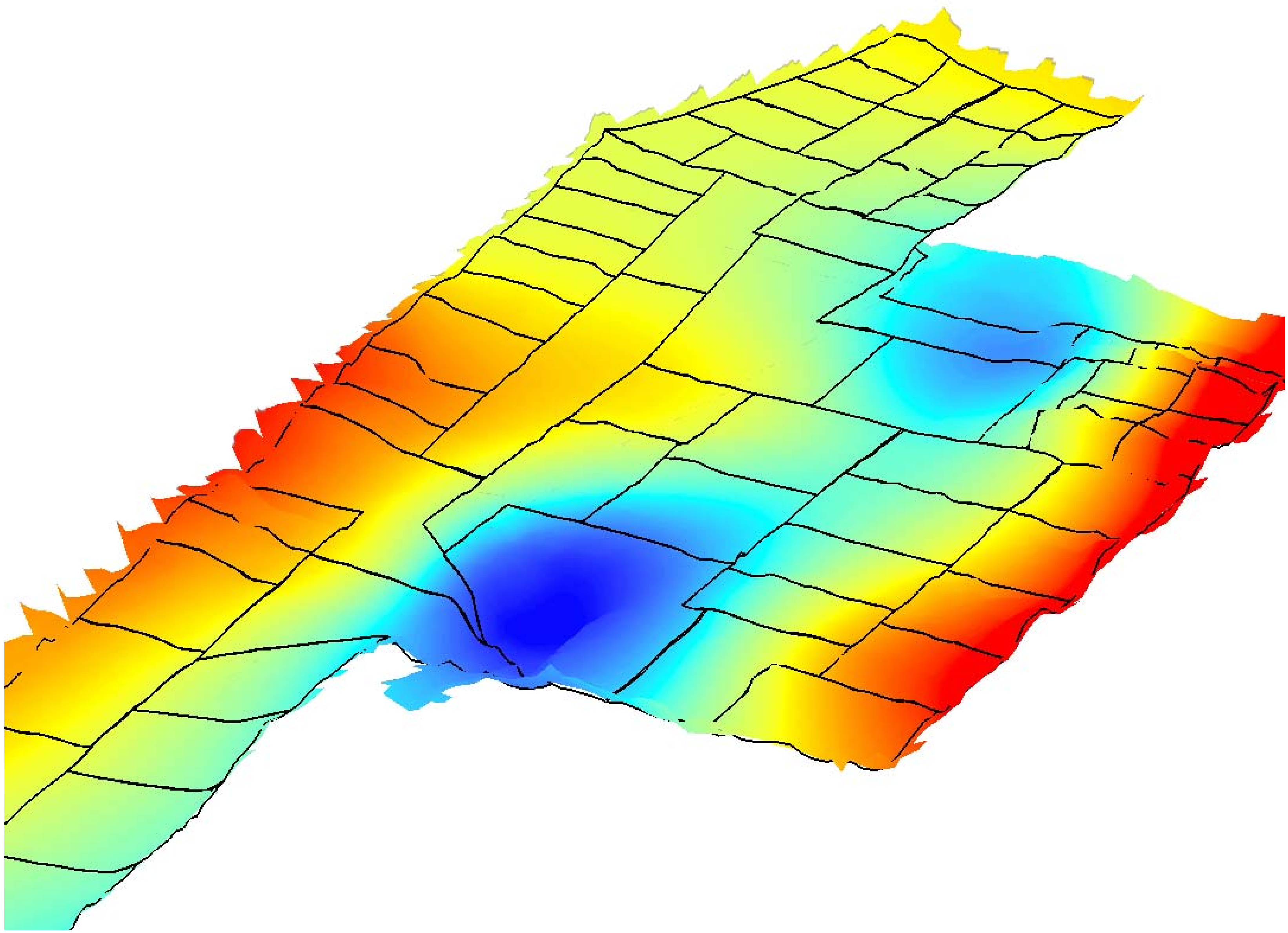
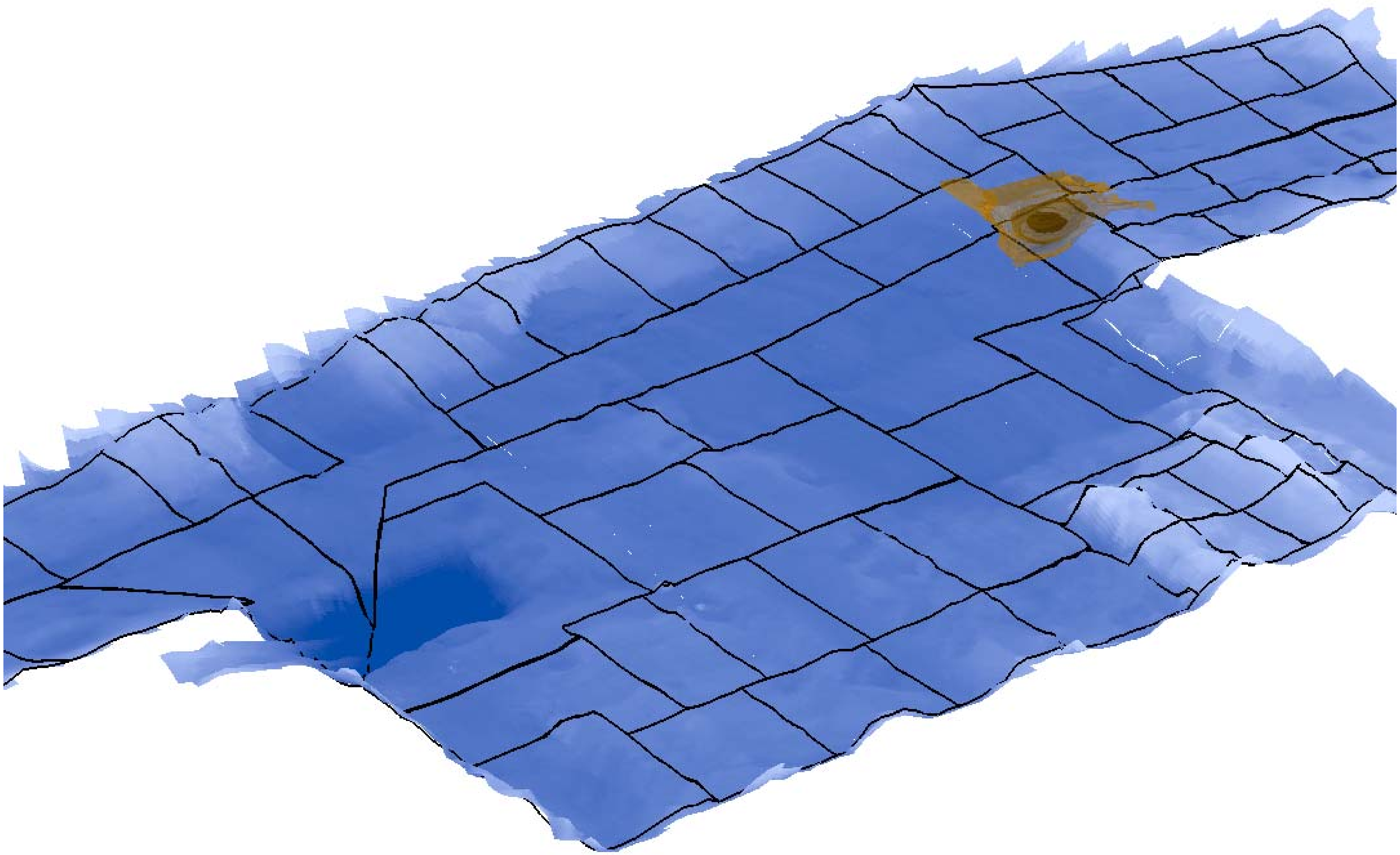


Figure 7-2. Example of what a 3-dimensional contaminant plume would look like after extraction from the solid model.



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