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DRAFT MEMORANDUM

To:	Todd Slater
From:	Erik Strandhagen, Eron Dodak, David Livermore, Mark Herrenkohl
Date:	July 23, 2007
Subject:	Data Gap Analysis
Project No.:	C167.0101

This memorandum summarizes the methods and results of the Environmental Visualization System (EVS) data gap analysis tool that was used to focus on the uncertainty in the three-dimensional (3D) kriged model of DDx (sum of total DDT, total DDD, and total DDE) mass in sediments at the Arkema site. This tool can be used to supplement other data gaps analyses that are conducted to identify key data needs for data collection for the Arkema site engineering evaluation/cost analysis (EE/CA).

OBJECTIVE

The objective of this analysis is to identify data gaps by identifying areas of higher uncertainty in the 3D kriged model that are located in the areas near the "breakpoint" in the DDx mass removal analysis for the Arkema site sediments. The target sample locations identified in this analysis should be used in conjunction with other data gaps analyses to identify potential target locations for further EE/CA investigation.

SUMMARY OF DDX MASS KRIGING ANALYSIS

The model developed for the DDx mass removal approach used kriging to interpolate the DDx sediment data at the Arkema site. Kriging is a geostatistical method that minimizes the estimated variance of a predicted point with the weighted average of its neighbors. Kriging uses a semivariogram graph, which plots one-half of the square of differences between samples versus distance. The semivariogram describes the weighting factors applied for the kriging interpolation. Unlike inverse distance weighting, another

interpolation method, kriging provides a measure of the error and associated confidence and uncertainty in the estimates at each point in the model.

For the DDx mass removal analysis, EVS software kriging algorithms were used to estimate DDx masses and concentrations in the analysis area (Figure 1). Sample stations with chemical results for DDx have 100% confidence in the 3D kriged model. DDx concentrations at every other location in the analysis area are predicted by the kriging algorithm. The kriging algorithm computes the standard deviation from the semivariogram for each estimated value in the analysis area. This standard deviation allows the assessment of the confidence and uncertainty of the estimated values within the analysis area.

DATA GAPS IDENTIFICATION METHOD

A process called "Drill Guide" in the EVS software was utilized to identify areas of high uncertainty. Drill Guide identifies trends in the kriged sediment data to determine the optimal locations for additional sampling. The Drill Guide can be used to focus on specific areas of the site.

The Drill Guide was run on two-dimensional kriged data using the highest total DDx concentration from each sample station[1]. The highest concentration was used because the data gaps associated with the higher concentrations of DDx are of greatest interest for the mass removal approach analysis. For this analysis, the Drill Guide was used to analyze uncertainty associated with each of three specified total DDx target concentrations, 1 mg/kg, 5 mg/kg, and 10 mg/kg. The 5 and 10 mg/kg total DDx concentrations bracket the breakpoint in the DDx mass removal analysis; the 1 mg/kg total DDx concentration provides a supplemental buffer for evaluating target sample locations outside of the 5 mg/kg target range. The Drill Guide was set to identify 20 locations for each of these target concentrations where the predicted concentration confidence is low.

[1] The EVS software developers recommend the 2D analysis because of the complexities of examining uncertainty in three dimensions. There is no differentiation between surface and subsurface samples in this 2D analysis and both surface and subsurface samples are equally weighted. As a result, the 2D model will yield similar results to the 3D model with the exception that the 3D model will also in some cases identify multiple sample depths at a single sample station that have higher uncertainty. The latter aspect of the 3D analysis is not lost, however, because it is assumed that the 2D drill guide will be used to identify borings that will be advanced to depth (i.e., bedrock or equivalent depths).

RESULTS

The drill guide results for 1 mg/kg, 5 mg/kg, and 10 mg/kg are shown on Figures 1 through 3, respectively. The locations are shown in relation to the corresponding mass removal boundaries for the 1, 5, and 10 mg/kg DDx mass removal areas and also the existing sediment sample stations. The combined locations for all three boundary concentrations are shown on Figure 4. This analysis identifies potential target areas for additional investigation, but not the specific number of boreholes or sample points that will be required to complete the EE/CA investigation. Some of the identified target locations for different boundary analyses (i.e., 5 mg/kg and 10 mg/kg) are located close enough together (and in a few cases at the same location) such that a single borehole could be used to fill data gaps for both areas (Figure 4).

CONCLUSIONS

The EVS Drill Guide analysis is a method for evaluating data gaps derived from the 3D kriging algorithm for the Arkema site. This analysis should be used in conjunction with other tools to identify data gaps and specific data needs for EE/CA investigation. The greatest value of this analysis is in defining areas of the Arkema site where additional chemical analysis may further refine the delineation of the potential DDx sediment mass removal area boundaries.

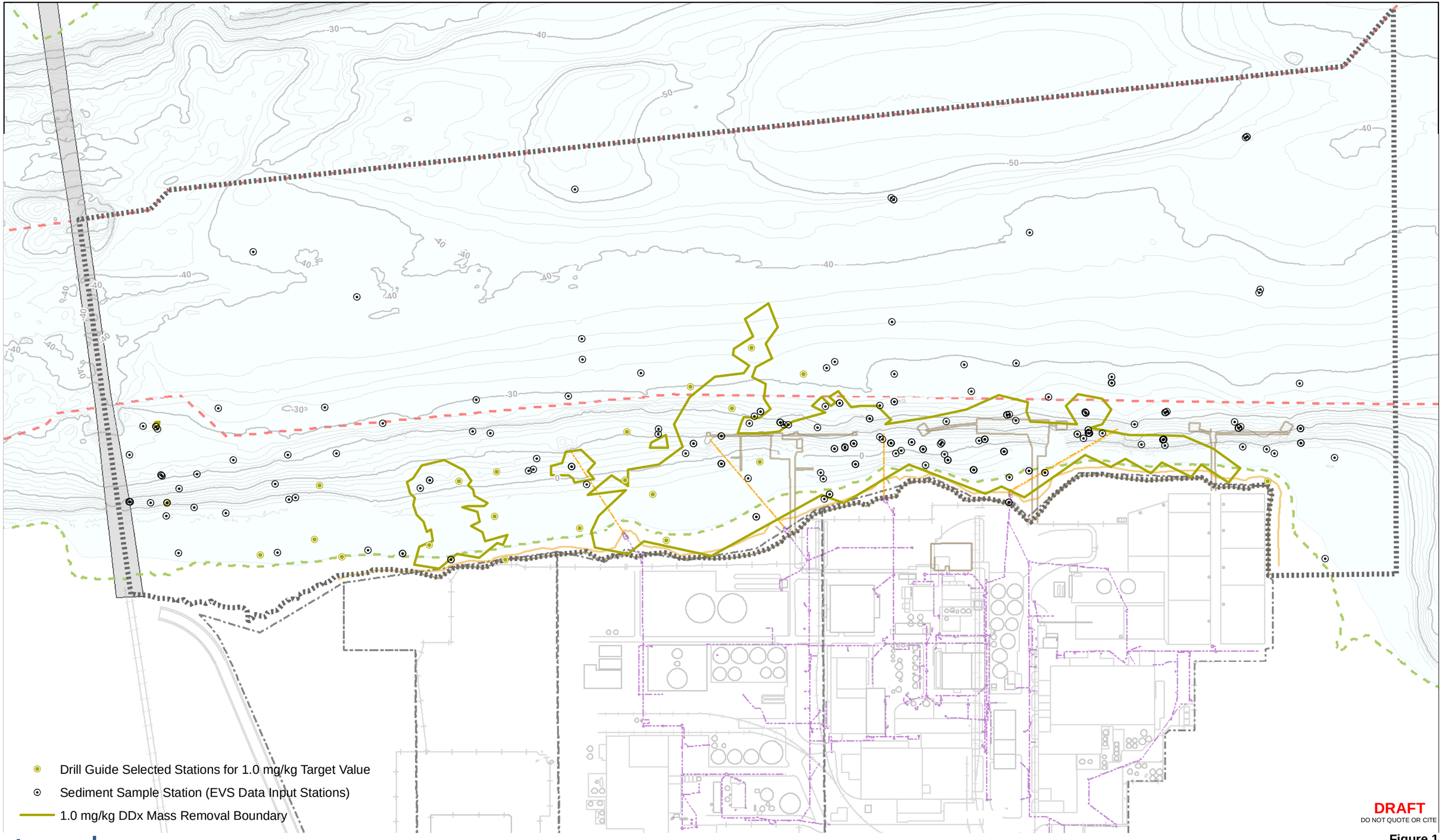

Figure 1
Data Gaps Identified Using Drill Guide for 1.0 mg/kg Target Value

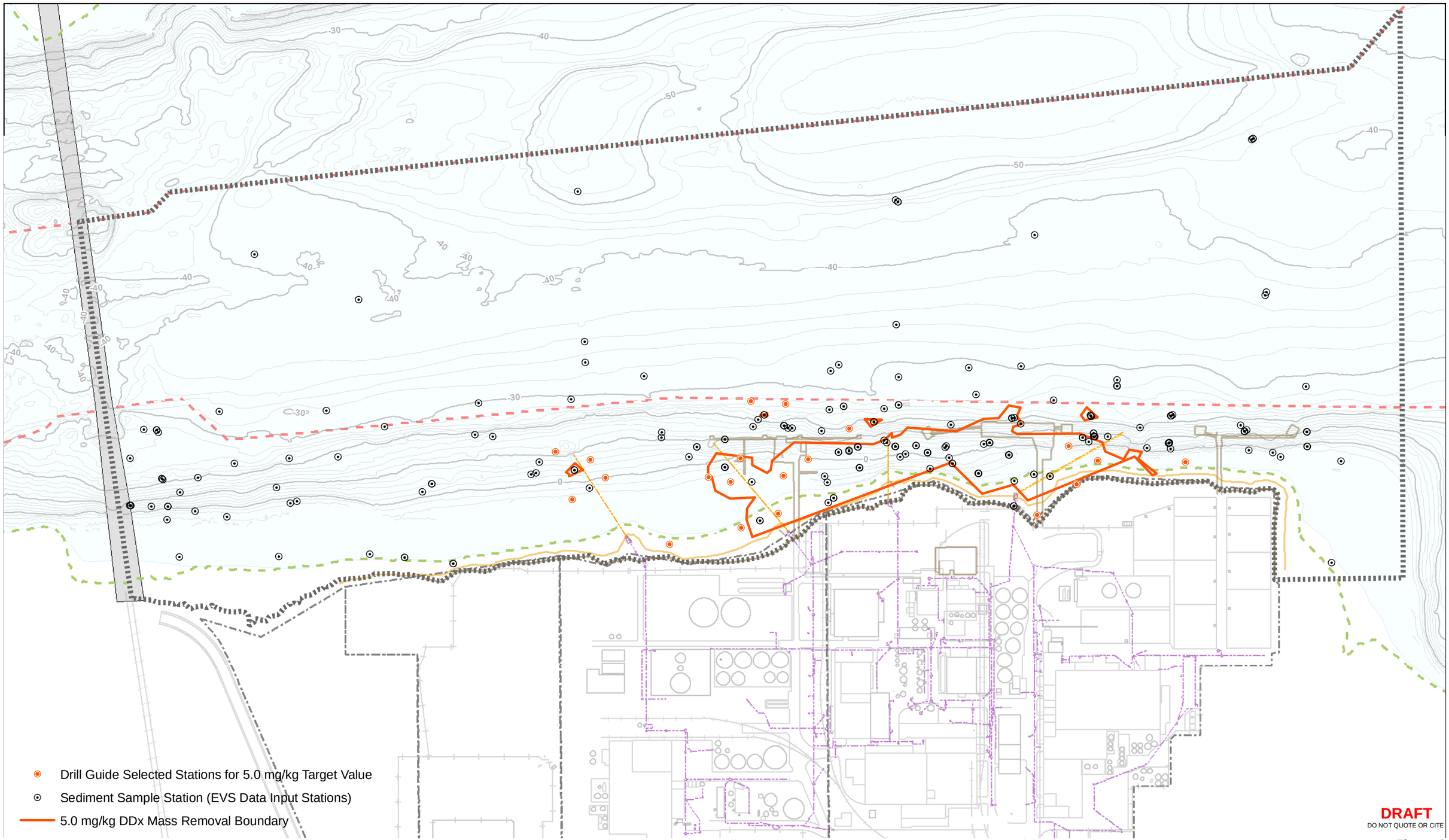

Figure 2
Data Gaps Identified Using Drill Guide for 5.0 mg/kg Target Value

Drill Guide Selected Stations for 10.0 mg/kg Target Value

Sediment Sample Station (EVS Data Input Stations)

10.0 mg/kg DDx Mass Removal Boundary

Analysis Area Boundary

Ordinary High Water

Top of Bank

12ft Contour

Navigation Channel

Storm Drain

E-Sewer-L

integral consulting inc.

0 100 200

Feet

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Figure 3
Data Gaps Identified Using Drill Guide for 10.0 mg/kg Target Value

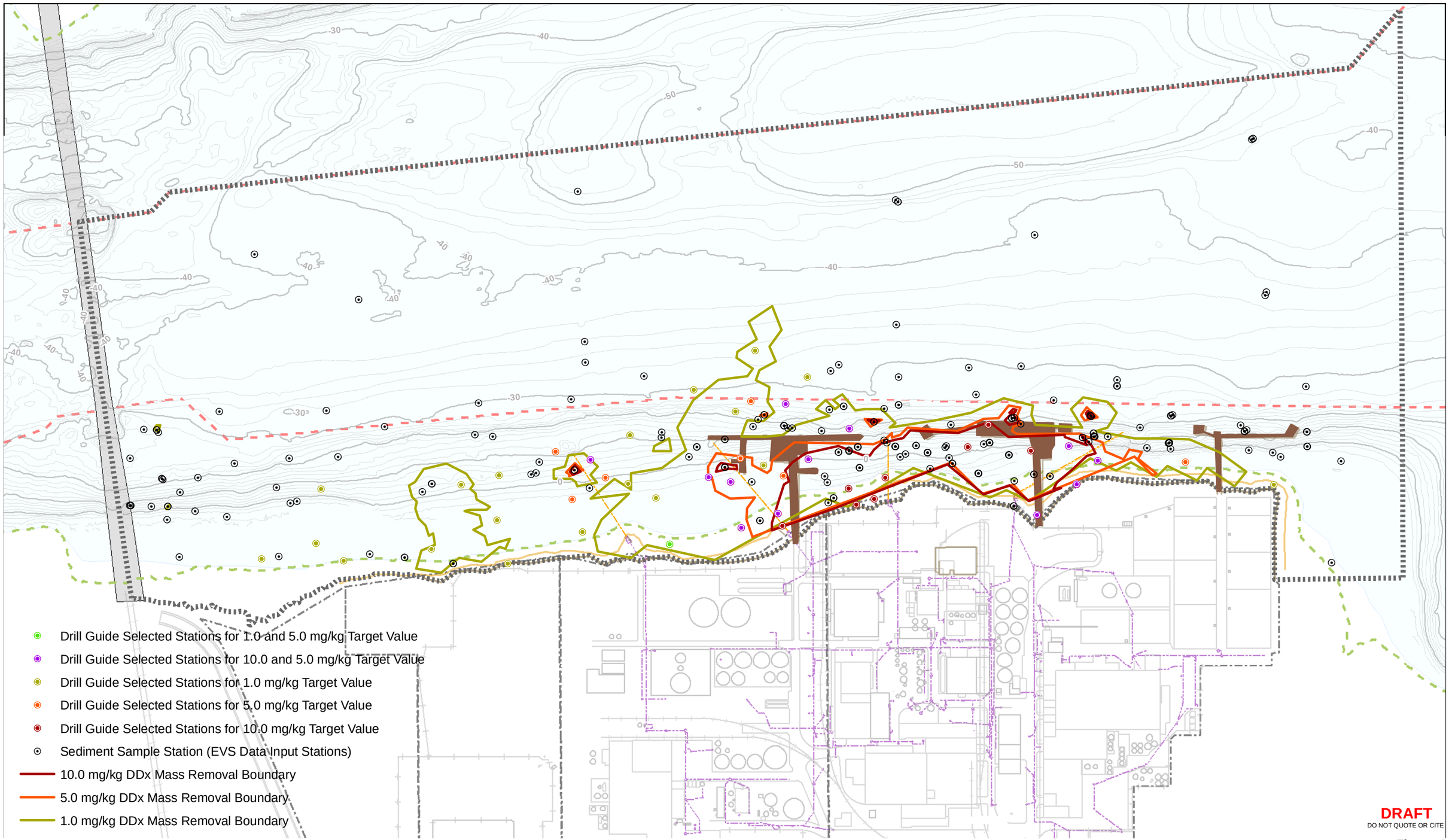

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Figure 4
Data Gaps Identified Using Drill Guide for 1.0, 5.0, and 10.0 mg/kg Target Value