Lower Fox River OU1 2005 RA Summary Report
Response to Agency/Boldt Oversight Team Comments
Summary Report Dated March 2006

October 2006

GMS Modeling and SWAC Calculation Methodologies

Modeling efforts to support the development of the dredge prisms for OU1 sediments have been extensive. The methods for development of the dredge prisms have been detailed in the GMS-SED white paper, which was included as an appendix to the OU1 Basis of Design Report.

The main goal of earlier modeling work was to develop the prism, and to interpret the volumes of sediment that would be needed to be removed to achieve the OU1 RAL of 1.0 ppm PCBs. Here the model is utilized to a much fuller extent, including modeled percent solids in conjunction with modeled PCB concentrations and sediment depth to provide estimates of in-situ PCB mass.

The sediment bed model is essentially a three-dimensional mesh, constructed from a network of multiple triangulated layers. Horizontal mesh node spacing is typically on the order of 30 feet. Vertically the mesh is divided into layers, the number of which ranges from 16 to 53 depending on sub-area. Data interpolations to the three-dimensional mesh for each sub-area exclusively utilized the inverse distance weighting (IDW) algorithm with Shepards method. Further detailed information of model development is given in the BODR white paper.

The post-dredge sediment bed model is a combination of the pre-dredge model for areas not dredged, and newly interpolated post-dredge data for areas that were dredged. Newly interpolated areas utilize post-dredge data, and are interpolated under the same parameter settings as for the BODR. For regions not dredged, the post-dredge model retains mesh node values from the pre-dredge model. For dredged areas, mesh node values are based on interpolations exclusively using post-dredge data.

Given the three-dimensional meshes of interpolated PCB and percent solids data, a custom post-processing algorithm was constructed to generate two-dimensional triangulated irregular networks (TINs). These two dimensional TINs, or layouts, summarize sediment characteristics over depth at a given horizontal location. The post-processing algorithm was written utilizing Igor Pro software developed by WaveMetrics.

The post-processing algorithm allows rapid and accurate evaluation of metrics for all TIN nodes (all XY locations for which modeling results are reported) including:

a. Maximum PCB concentration
b. Average percent solids associated with dredge cut
c. Area and volumes of sediment
d. PCB mass
e. Total dry and wet tonnage of sediment for the depth of dredge cut
f. Mass of PCBs per unit area (grams PCBs per square meter)
g. Mass of PCBs per unit volume (kg PCBs per CY)

There are four main steps to the post-processing algorithm:

1. Calculate influence areas (Theissen polygon areas) for all XY locations reported by the model (TIN nodes). Figure 1 shows the triangulated irregular network (TIN) nodes, the triangulation, and the resulting Theissen polygons.

2. Load the three-dimensional mesh data from the sediment bed model. The three-dimensional mesh data for PCBs and percent solids are input, and the two-dimensional TINs of soft sediment thickness, polygon areas, and top-of-sediment elevations are also input.

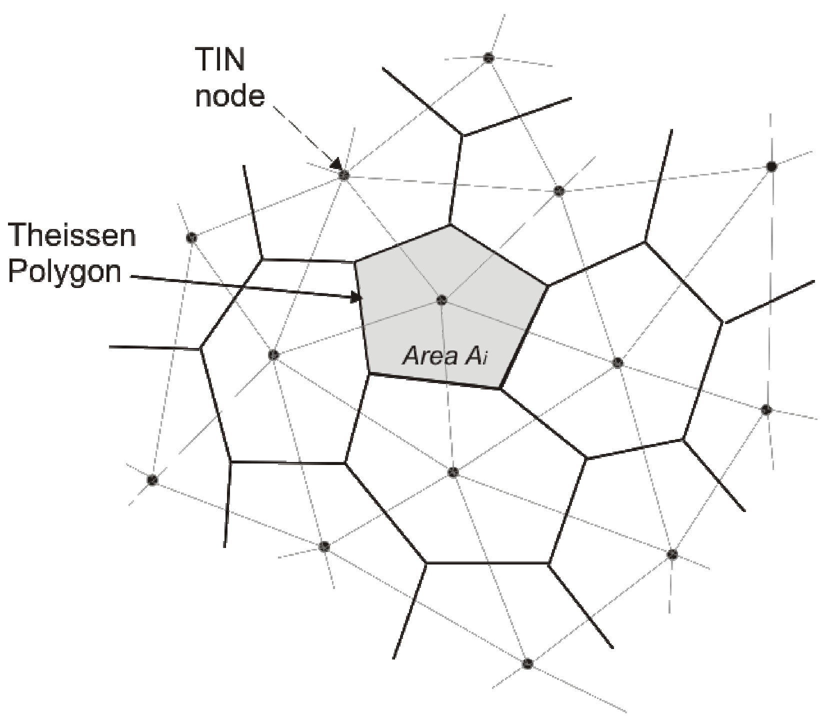

Figure 1. Top view of triangulated irregular network (TIN). GMS-SED model provides data (PCBs, % solids, elevation) and coordinates of each TIN node. A mapping application is used to develop Theissen polygon areas.

3. The three-dimensional mesh data are analyzed to generate the isopach prism (the isopach to meet a specific RAL with a prescribed overcut). This is done through linear interpolation of PCB concentrations over the vertical profile of the mesh. Figure 2 shows the vertical profile, determination of the dredge cut, and application of the overcut. Sediment volume is determined as the product of the (Theissen) polygon area and the dredge cut. Then mesh data for percent solids and PCBs are analyzed to account for the sediment volume, PCB mass, maximum and average PCB concentration, and other metrics at each TIN node.

4. The summary results from each TIN node are aggregated and analyzed further (summary statistics). Total volumes, dry tons, bulk densities, average percent solids, average PCBs, PCB mass, and other measures are computed for all sub-areas and sub-area regions used in the post-processing set.

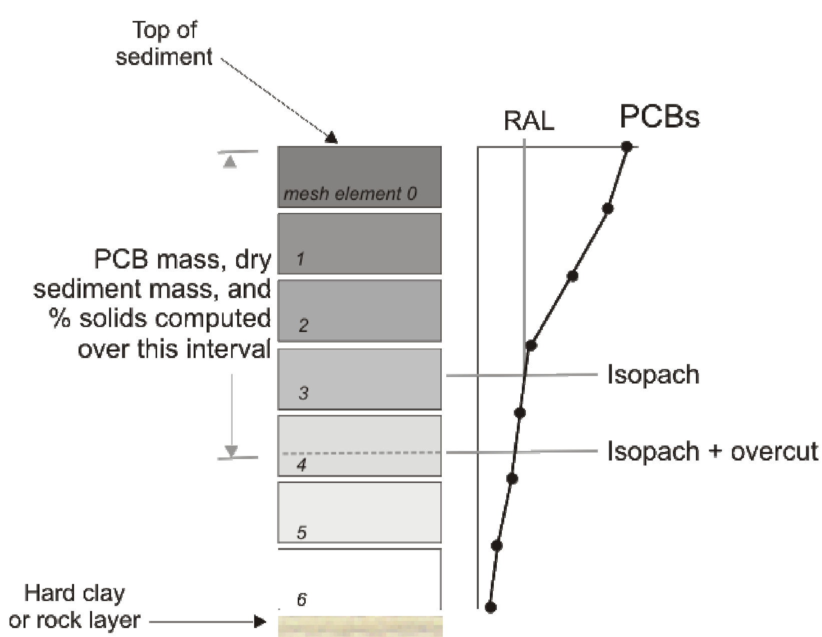

Figure 2. Profile view of soft sediment layers at a TIN node and orientation 3D mesh elements used for post-processing GMS-SED modeling results for PCBs and percent solids. Post-processing includes determination of cut thickness, volume (with known Theissen polygon area), dry and wet weights, average percent solids, average PCB concentration and other metrics.

An example of a two-dimensional layout constructed from the post-processing algorithm is the maximum PCB concentration over depth to 1 ppm with a 4-inch overcut. Here the algorithm looks vertically at the three-dimensionally interpolated PCB mesh, and identifies the depth to 1 ppm plus overcut at each horizontal location. In this column, the maximum interpolated concentration to the specified depth is then chosen.

Another example is construction of a two-dimensional layout representing PCB mass. At each three dimensional mesh node, a representative volume is calculated as the Thiessen polygon area (horizontal) multiplied by the mesh layer thickness (vertical). For each mesh node volume, the PCB mass in Kg was found through multiplying the volume by the interpolated mesh node PCB concentration and sediment dry density, and multiplying by an appropriate conversion factor. The PCB mass values were then summed vertically to the specified depth to give total PCB mass in Kg at a horizontal location.

Layouts of percent solids give average percent solids in a vertical column to the isopach depth plus a specified overcut. Specifically, at each horizontal location, average percent solids as reflected by the mesh nodes vertically to the 1 ppm cutline plus a 4-inch overcut to clay are presented. Percent solids as presented in the figures illustrate modeled average percent solids as contours. Core locations and numeric values of the arithmetic average of actual discrete core sample intervals are also presented. In certain instances, the arithmetic average of discrete core samples may not exactly match the contoured average, since the contours are derived by averaging the mesh nodes.

SWAC calculations

Surface weighted average concentration SWAC are generated as follows:

1. The post-processing algorithm is used to calculate the average PCB concentration in the top four inches from the three-dimensional PCB mesh. A two-dimensional “surface PCB” layout is created.

2. At each two-dimensional TIN node, the surface PCB concentration is multiplied by the corresponding Thiessen polygonal area. For all TIN nodes in the region of interest, the multiplied results are summed.

3. The corresponding Thiessen polygonal areas in the region of interest are also summed.

4. The SWAC for the region of interest is then given by the sum in Step 2 divided by the Sum in Step 3.

An example is given below for the post-dredge SWAC of the entire Sub-area A, which includes un-dredged regions and Sub-area A regions outside the 1.0 ppm RAL:

TIN Node Id	Surface PCB (ppm)	Thiessen Polygon Area (ft)	Product
1	0.504	275.991	139.014
2	20.374	247.993	5052.585
3	20.774	304.812	6332.195
4	18.162	306.517	5566.839
5	12.105	214.249	2593.484
6	16.637	252.445	4199.826
7	16.888	260.437	4398.182
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4523	0.345	109.581	37.818
Sum	12756	3127166	6839176
SWAC	6839176/3127166 = 2.187		