Foth & Van Dyke

Memorandum

August 17, 2006

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FR: Jerry Eykholt, Foth & Van Dyke
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RE: OU1 Sub-Area POG2 Revisions To Dredge Prism

Introduction

The purpose of this memo is to present modeling revisions for OU1 Sub-area POG2, scheduled for dredging during the 2006 RA Project. Sub-area POG2 encompasses the man-made navigational channel immediately downstream from the Menasha Lock. The channel has much thicker sediment deposits than other OU1 areas dredged to date. The POG2 dredge prism from the BODR showed deep dredge cuts within and along the POG2 Sub-area boundary, with no cuts or much smaller cuts proposed for the sediments on the other side of the boundary (in adjacent sub-areas). In addition, dredging in POG2 during the 2004 RA complicates the understanding of current conditions. The main driver behind the POG2 dredge prism revisions described herein, is to better characterize and communicate the transition in soft sediment thickness that occurs within the POG2 channel, along the side-slopes, and near the lock and southern shoreline.

The revisions for the POG2 model are addressed with the following sections:

- Change in Approach for Modeling Channel
- Poling of Soft Sediment to Define Channel and Southern Shoreline Area
- Development of Representative Sediment Thickness Dataset
- GMS-SED Interpolation Procedures
- Quantities
- Quality Assurance
- Implementation

As detailed below, the main outcomes from 2006 changes to the POG2 dredge prism, compared to the BODR set, are reductions in the steepness of cuts along the channel sides and the target volume to the 1 ppm isopach.

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Change in Approach for Modeling Channel

The Basis of Design Report (BODR, March 2005) describes the processes and settings (specific for each sub-area) used to generate dredge prisms. In general, the top of sediment surface was treated by the model as a flat surface, and the soft sediment thickness was used to develop the vertical domain of the model. Soft sediment thickness data included both poling data and sample core data. The soft sediment thickness data at a given poling or coring location was either associated with the bottom of the deepest sample interval or the thickness found from poling, whichever led to the greatest sediment thickness. For POG2, only poling and sediment thickness data (61 points) from within the channel boundary were used, and sediment thickness was effectively extrapolated to a vertical channel wall along the boundary.

There were several goals for the approach to revise the model for POG2:

1. Greatly expand the amount of poling to better define the channel. The focus was on regularly spaced poling cross-sections across the channel.
2. Include sediment thickness data from poling and sample core locations in areas outside the POG2 channel, to better describe the transition of sediment thickness along the side-slopes.
3. Refine the horizontal boundaries, especially along the southern shoreline near the Menasha Lock.
4. Improve the horizontal resolution of the model, especially along shorelines and channel side-slopes.[1]
5. As much as possible, use methods and interpolation settings consistent with those described in the BODR.

All of these goals were achieved, and details of the modeling approach are described below.

Poling of Soft Sediment to Define Channel and Southern Shoreline Area

An extensive poling survey of Sub-area POG2 was conducted by Foth & Van Dyke in April and July 2006 to better delineate the Sub-area POG2 boundaries and soft sediment thickness. The April 2006 survey also included poling of other 2006 RA areas, Sub-areas C/D2S, POG3, and POG4.[2] The April 2006 survey in POG2 included 17 poling transects across the channel, adding roughly 200 new poling points to the area within and around POG2. Another 63 points located within 400 ft. of POG2 were used from the BODR point set.[3] The July 2006 poling survey added another 64 points along the southern shoreline of POG2. The dataset for sediment thickness expanded greatly, from 61 points used for the BODR to 397 points. The points used

[1] Horizontal resolution of the model increased. Although the total area of the sub-area increased by 1%, the number of horizontal nodes used to model the 2D surfaces (TIN nodes) increased from 800 to 1135 (42%).

[2] The April 2006 Survey Plan was described in a memo from Jerry Eykholt to GW Partners, "Planning for additional poling in OU1 Sub-areas C/D2S, POG2, POG3, and POG4," March 2, 2006. This memo was shared with the Agencies and Oversight Team (A/OT).

[3] Although within 400 ft. of POG2, points from POG1 and some points from southern POG4 were not used because there were regions of shoreline/ land between the points and POG2.

for the POG2 model are shown in Figure 1. The points obtained from the July 2006 survey in southern POG2 are shown in Figure 2. The southern shoreline boundary was adjusted to better fit the July 2006 data.

Development of Representative Sediment Thickness Dataset

Some adjustments were needed to the poling and sample datasets to provide a representative sediment thickness for the model. The model characterization needed to be relevant to the sediment sampling conditions from 2004, prior to the dredging of portions of POG2 for the 2004 RA. Some adjustments were needed for the sediment thickness dataset, in order to consider the different sampling times and pre- and post-dredge data.

The ONYX 2004 top of sediment surface was used as the reference top elevation. For the BODR set, the 1.0 ppm isopach thickness was translated to a target elevation using the ONYX 2004 top of sediment elevation data. One strategy of the model revision work was to preserve the bottom of soft sediment elevations from the dataset. So, to get thickness, the ONYX elevation (interpolated to the poling or coring location) was subtracted by the expected or measured bottom of sediment elevation. For a few points, the sediment thickness found this way was negative or less than 0.1 ft. So, for these points, the actual poled thickness was used. This was a conservative measure that generally increased the domain volume of soft sediment. Similarly, some points collected before dredging in 2004 did not have elevation data associated with them, so the actual poled thickness was used for these points.

GMS-SED Interpolation Procedures

There were two main interpolation steps applied in the GMS-SED model for POG2. The first interpolation step used was to estimate the soft sediment thickness at every TIN node, and, after the formation of a revised 3D mesh, the sample PCB data were interpolated to the mesh in order to develop the target dredge prism at the 1.0 ppm RAL.

The interpolation for the soft sediment thickness was based on the Shepard's inverse distance weighting (IDW) method. The settings included selecting the nearest 6 points, a horizontal anisotropy of 2.0 with an azimuth of -6.3 degrees (along main channel direction), with truncation to the minimum and maximum of the data set. The horizontal anisotropy provided some data elongation in the direction of the channel, which was needed to appropriately model the side-slopes between the poling transects. Due to the irregular spacing of poling locations, especially in southern POG2, the BODR interpolation settings (IDW Quadratic with 48 nodal points and 48 nearest points) did not provide a suitable characterization. Like the BODR method, the sediment thickness interpolation included truncation to the minimum and maximum of the dataset. This avoided extrapolation to very large thicknesses and maintained a minimum sediment thickness of 0.1 ft.

The remaining modeling steps were consistent with the steps used for the BODR. The 3D mesh was generated (31 layers) and the 1.0 ppm isopach was found using the BODR interpolation settings (Shepard's IDW, 4 pts., z-factor of 0.02125) and the same sample PCB dataset. A summary of settings and outcomes from the revised model are shown in Table 1. The 1 ppm isopach is shown in Figure 3.

Quantities
As a result of modeling revisions for POG2, the total area of POG2 expanded by 1%. However, the 1.0 ppm area dropped 0.4% to 497,914 sq. ft. and the 1.0 ppm isopach volume dropped by 7.2% to 65,339 cy. The main reason for the decrease in 1.0 ppm area and volume was the recharacterization of the sediment bottom, especially along the channel side-slopes. Remaining quantities to be dredged in 2006, considering the 2004 removal volume (7,240 cy) are also shown in Table 1. Since the 2004 removal did not accomplish the 1 ppm target elevation in the region of dredging, no adjustment to the 1 ppm area was made. Using a simple subtraction of the 2004 removal volume, the remaining estimated volume to the 1.0 ppm target elevation in POG2 is 58,099 cy (without overcut). Although a uniform, 4 inch overcut will likely be difficult to obtain (because of a hard bottom at the base of the target elevation in some areas), the 1.0 ppm RAL volume with 4" overcut would be 64,245 cy. Actual dredge volumes will vary depending on the pre-dredge bathymetry, overcut, and adjustments needed for implementation, such as shoreline corrections.

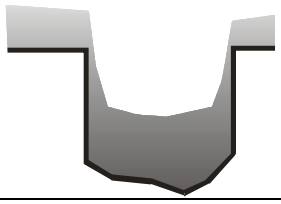
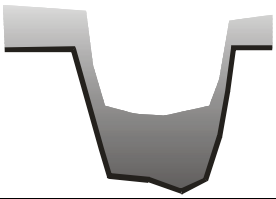
Quality Assurance
Internal QA was done to check the agreement of the model top and bottom elevation surfaces with the poling data obtained for the 17 poling transects. Cross-sections were prepared as a visual check of model agreement and are provided in Figures 4A and 4B. Except for regions of dredging from the 2004 RA, agreement is excellent.

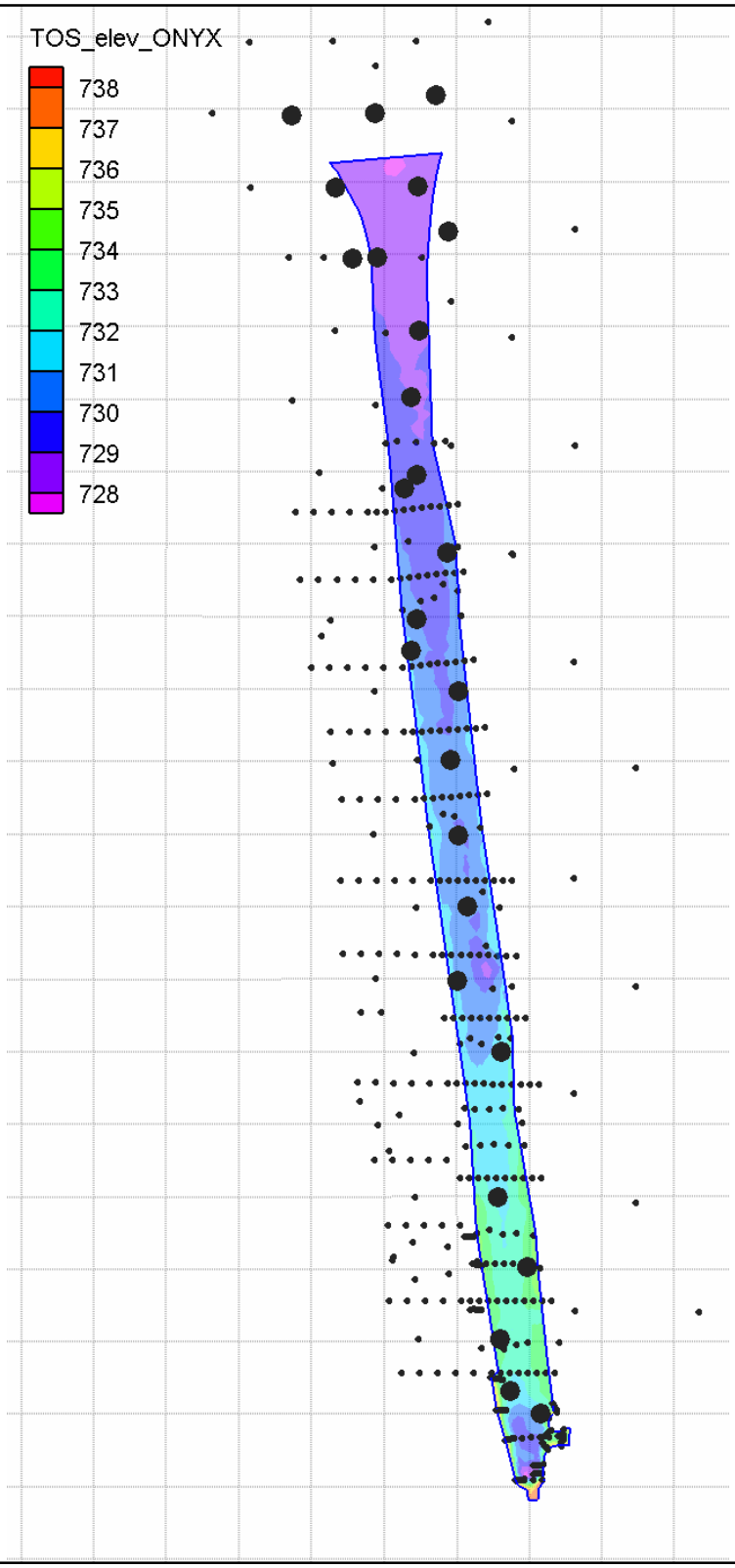
Second party QA was conducted by CH2M HILL. The 1.0 ppm isopach was confirmed to provide adequate capture of all samples with PCB concentrations greater than the 1.0 ppm RAL. The 1.0 ppm area and volumes were also confirmed within 0.1%. The QA team identified three small areas of southern POG2, near the outlet of the Menasha Lock, where the model outcome showed no dredge cut. The largest of these three areas was located directly downstream of the lock outlet and the other two smaller areas were along the shoreline. The QA team suggested that alternative modeling settings could be applied to capture these areas. After close review of sampling and bathymetric data near the excluded areas, it became apparent that there was a lack of sampling data in the far southern area, the closest samples showed low-level PCB concentrations at depth with shallower samples less than 1.0 ppm. The main area downstream of the lock was likely erosional and not contaminated, and the small areas excluded along the shoreline had thin sediment thicknesses. For these reasons it was agreed that the interpolation settings would be maintained.

The QA team also identified irregularities in the presentation of the sample poling set. These irregularities, which did not affect modeling outcomes, have been corrected.

Implementation
Further discussions with the Brennan, GW Partners, and the Agencies and Oversight Team may be needed to identify constraints associated with implementing the targeted dredge cuts in POG2. In particular, an easement may be applied near the Menasha Lock and setbacks or slope limits may be applied near shorelines, channel side-slopes, and pipelines by CH2MHILL (Engineer for RD), or by Brennan. However, these adjustments are commonly done with CADD and applied after the GMS-SED model has been completed. Once these modeling revisions are approved by the Agencies and Oversight Team, the shapefiles and xyzz point files, necessary for dredge control to the 1.0 ppm RAL, will be provided by Foth & Van Dyke to Brennan in time for the scheduled dredging in POG2 on or about August 24, 2006.

Table 1
Summary of Modeling Revisions and Outcomes for OU1 Sub-area POG2.

Version		March 2005 BODR	Revision, August 2006
Summary of Method		GMS-SED, soft sediment thickness based on limited poling data, channel sides may be vertical. ONYX bathymetry defines top of sediment.	GMS-SED, soft sediment thickness based on extensive poling data, channel bottom is more continuous with adjacent subareas. ONXY bathymetry defines top of sediment.
Schematic of Typical Cross-Section			
Interpolation Settings			
Bottom of soft sediment		IDW Quad 48/48. Data set did not include soft-sediment thickness data outside sub-area.	Classic IDW, 6 points, y-anisotropy = 2 with azimuth of -6.3 degrees (along channel). Data set included sediment thickness data outside of channel
1 ppm isopach		Classic IDW (with 4 nearest pts., with vertical anisotropy factor of 0.02125 (1 ft. vertical = 47 ft. horizontal).	Same – no changes to settings or sample dataset
Pre-dredge Conditions	Units		
Area –Sub-area	(ft.^{2})	551,859	556,104
Area – 1 ppm footprint	(ft.^{2})	500,113	497,914
Volume – total soft sediment	(cy)	105,802	100,355
Volume – 1 ppm target	(cy)	70,400	65,339
PCB mass – total	(kg)	155.6	144.0
PCB mass – 1 ppm target	(kg)	152.8	141.8
2004 Remedial Action			
Area – dredge footprint (est.)	(ft.^{2})	108,009	99,163
Volume removed (CADD)	(cy)	7240	7240
PCB mass removed (model)	(kg)	5.9	6.1
Conditions after 2004 RA			
Area – 1 ppm footprint	(ft.^{2})	500,113	497,914
Volume – total soft sediment	(cy)	98,562	92,160
Volume – 1 ppm target	(cy)	63,160	58,099
PCB mass – total	(kg)	149.7	137.9
PCB mass – 1 ppm target	(kg)	146.9	135.7



Legend

- Poling Locations
- Sample Core Locations

Note: Poling and sample core stations used to model the soft sediment thickness and PCB concentration of Sub-area POG2. Contours show top of sediment elevation (ft.) from 2004 Onyx Survey. 200 ft. grid.

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FIGURE 1

SUB-AREA POG2

POLING AND SAMPLING CORE STATIONS

Date: August 17, 2006	Revised:	
Drawn By: DAT	Checked By: SGL	Scope: 04G007

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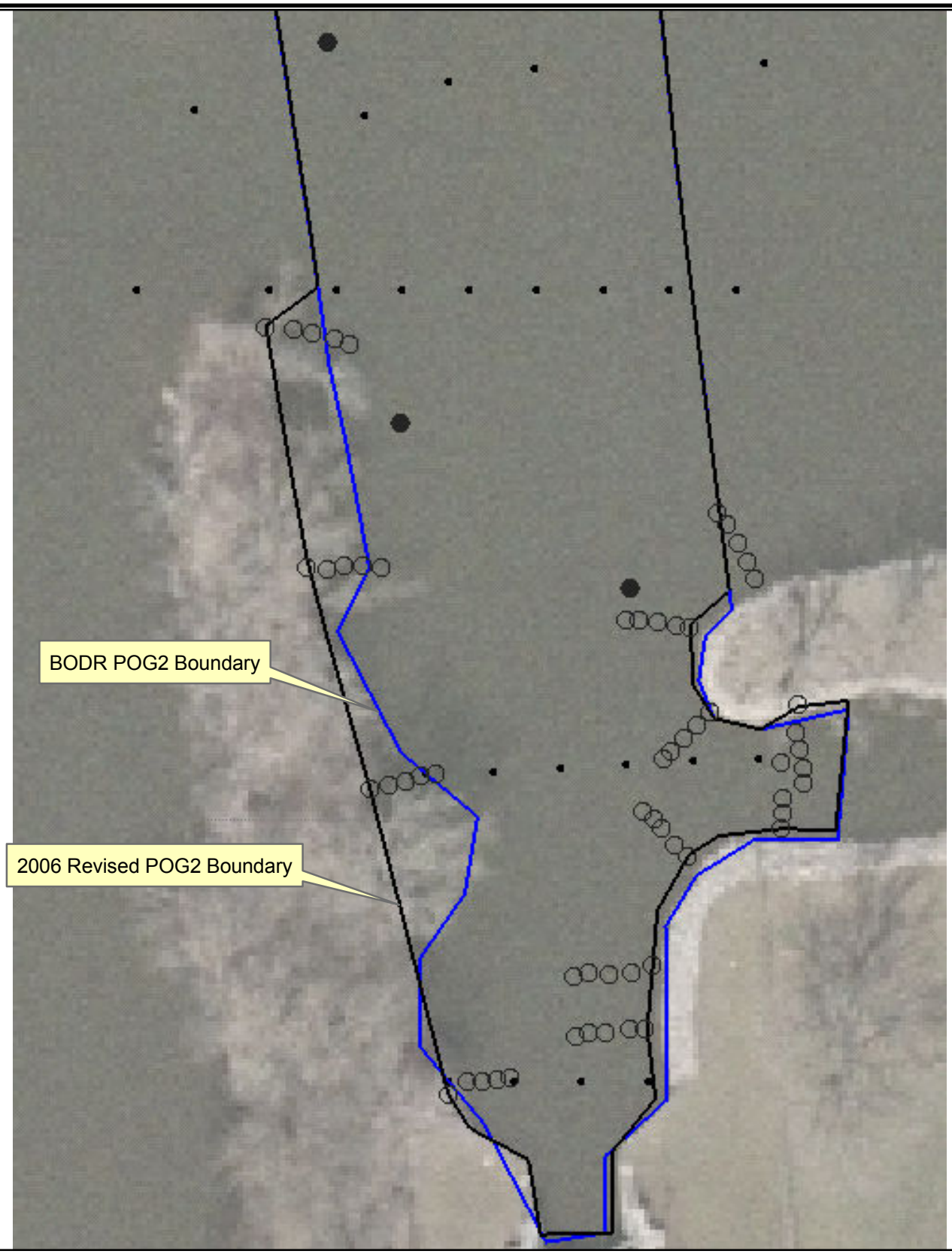

Legend

- Poling Locations
- Sample Core Locations
- July 2006 Poling Locations
- 2006 Revised POG2 Boundary
- BODR POG2 Boundary

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FIGURE 2

SUB-AREA POG2
SOUTHERN BOUNDARY REVISION

Date: August 17, 2006	Revised:	
Drawn By: DAT	Checked By: SGL	Scope: 04G007

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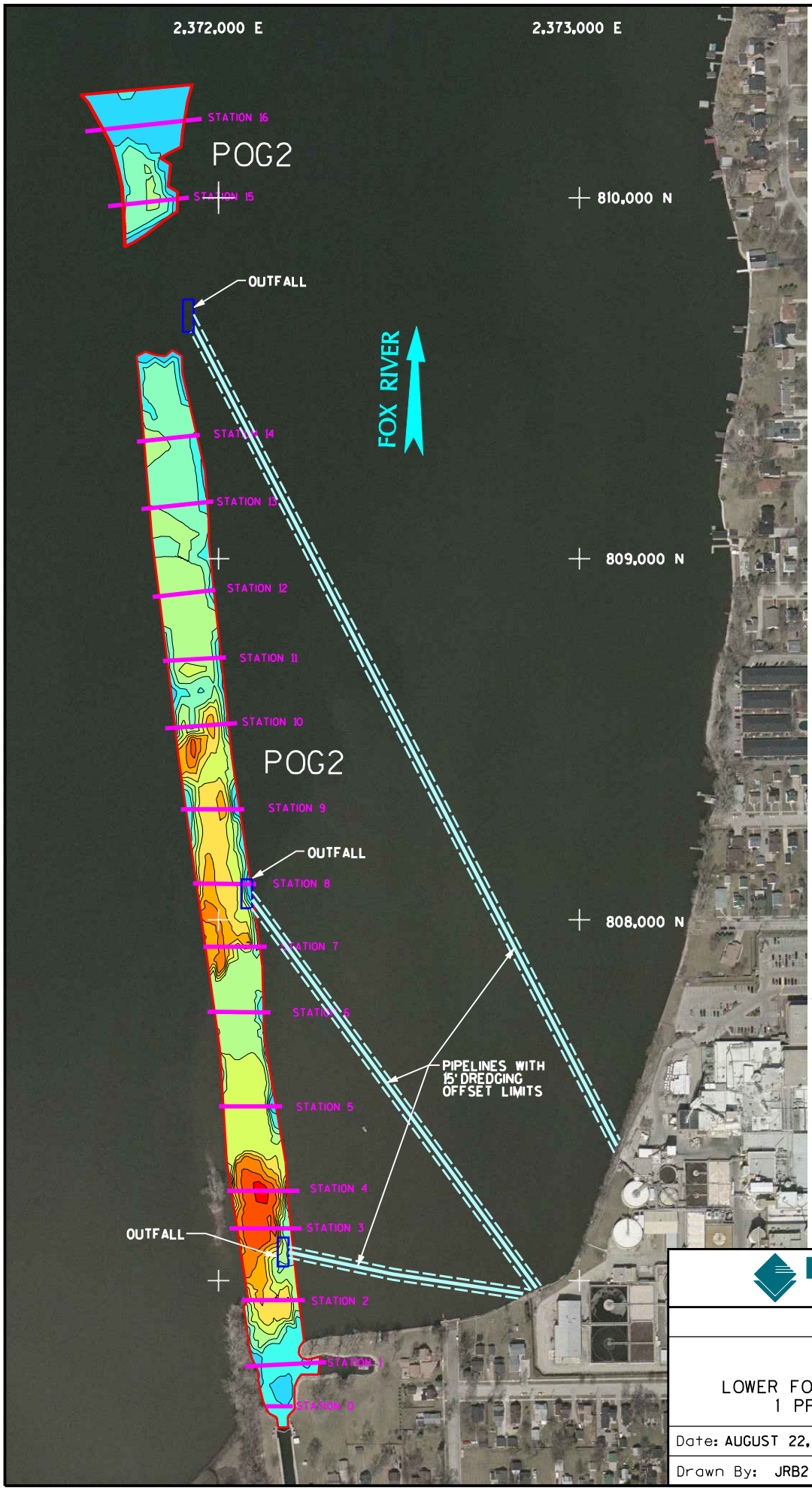

1 PPM SEDIMENT THICKNESS INTERVALS

- 0' - 1' THICKNESS
- 1' - 2' THICKNESS
- 2' - 3' THICKNESS
- 3' - 4' THICKNESS
- 4' - 5' THICKNESS
- 5' - 6' THICKNESS
- 6' - 7' THICKNESS
- 7' - 8' THICKNESS
- 8' - 9' THICKNESS
- 9' - 10' THICKNESS

LEGEND

2006 RAWP PRE-DREDGE 1.0 PPM SEDIMENT BOUNDARY

NOTES:

1. THE HORIZONTAL CONTROL IS REFERENCED TO THE NAD83 WISCONSIN STATE PLANE COORDINATE SYSTEM (WISCONSIN SOUTHERN ZONE). THE VERTICAL CONTROL IS REFERENCED TO NAVD 88.
2. THE 1 PPM ISOPACH IS A GMS-SED MODELING OUTCOME AFTER REVISIONS TO THE MODELING APPROACH AND AFTER INCORPORATIONG DATA OBTAINED FROM APRIL 2006 AND JULY 2006 POLING SURVEYS.
3. PIPELINE INFORMATION SUPPLIED BY J.F. BRENNAN CO., INC., AUGUST, 2006.

0 200' 400'
BAR SCALE

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FIGURE 3

LOWER FOX RIVER - SUB AREA POG2
1 PPM SEDIMENT ISOPACH

Date: AUGUST 22, 2006	Revision Date:	
Drawn By: JRB2	Checked By: DMR	Scope: 04G007

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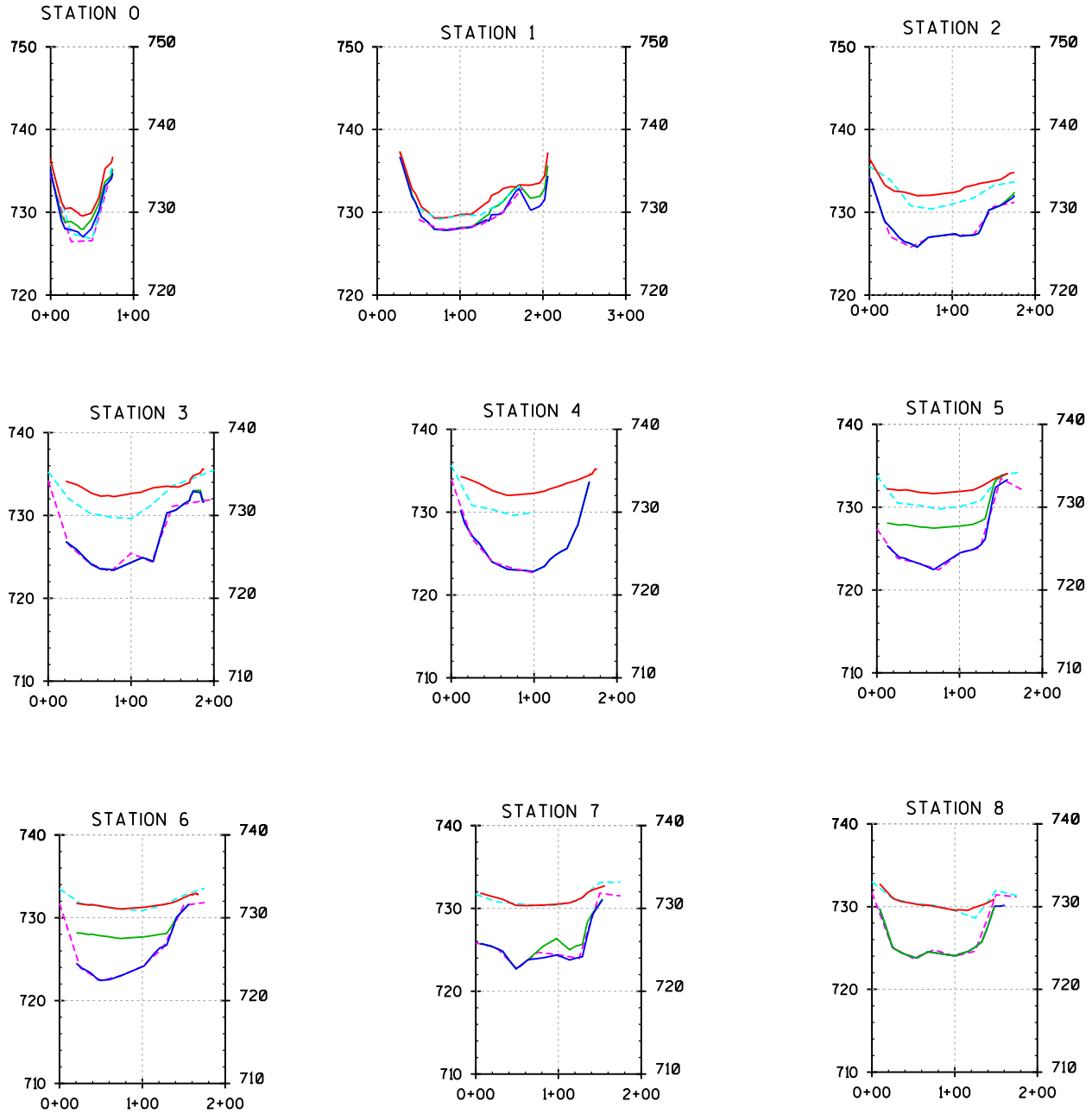
8/22/2006 jrb2



LEGEND

- APRIL 2006 TOP OF SEDIMENT POLING ELEVATIONS
- APRIL 2006 BOTTOM OF SEDIMENT POLING ELEVATIONS
- ONYX TOP OF SEDIMENT ELEVATIONS
- UPDATED JULY 2006 1 PPM TARGET ELEVATIONS
- UPDATED JULY 2006 GMS BOTTOM OF SOFT SEDIMENT ELEVATIONS

NOTES:

1. THE HORIZONTAL CONTROL IS REFERENCED TO THE NAD83 WISCONSIN STATE PLANE COORDINATE SYSTEM (WISCONSIN SOUTHERN ZONE). THE VERTICAL CONTROL IS REFERENCED TO NAVD 88.
2. THE 1 PPM RAL ELEVATION IS A GMS-SED MODELING OUTCOME AFTER REVISIONS TO THE MODELING APPROACH AND AFTER INCORPORATIONG DATA OBTAINED FROM APRIL 2006 AND JULY 2006 POLING SURVEYS.

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FIGURE 4A

LOWER FOX RIVER - SUB AREA POG2
CROSS SECTIONS

Date: AUGUST 17, 2006	Revision Date:	
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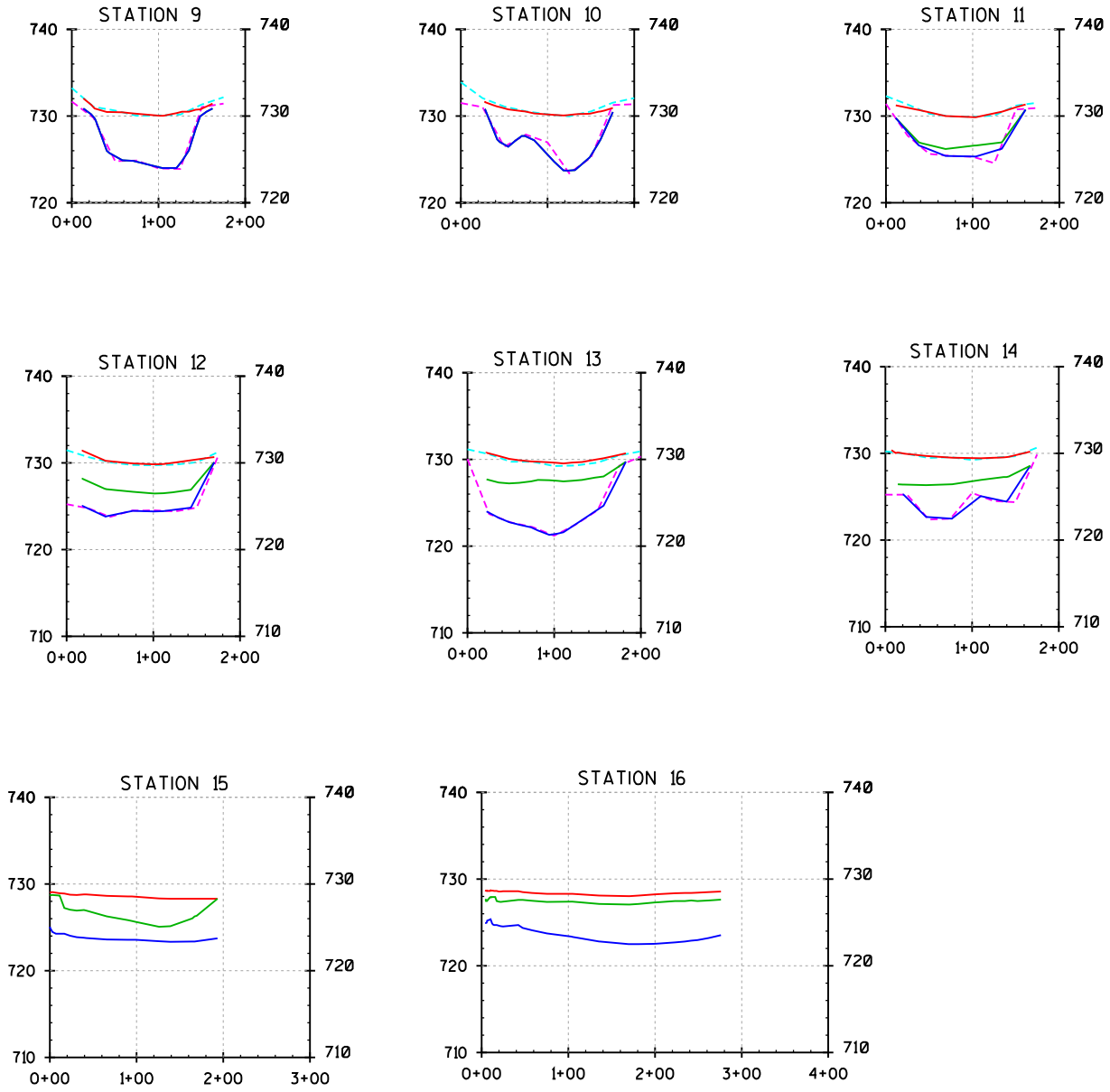

LEGEND

- APRIL 2006 TOP OF SEDIMENT POLING ELEVATIONS
- APRIL 2006 BOTTOM OF SEDIMENT POLING ELEVATIONS
- ONYX TOP OF SEDIMENT ELEVATIONS
- UPDATED JULY 2006 1 PPM TARGET ELEVATIONS
- UPDATED JULY 2006 GMS BOTTOM OF SOFT SEDIMENT ELEVATIONS

NOTES:

1. THE HORIZONTAL CONTROL IS REFERENCED TO THE NAD83 WISCONSIN STATE PLANE COORDINATE SYSTEM (WISCONSIN SOUTHERN ZONE). THE VERTICAL CONTROL IS REFERENCED TO NAVD 88.
2. THE 1 PPM RAL ELEVATION IS A GMS-SED MODELING OUTCOME AFTER REVISIONS TO THE MODELING APPROACH AND AFTER INCORPORATIONG DATA OBTAINED FROM APRIL 2006 AND JULY 2006 POLING SURVEYS.

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FIGURE 4B

LOWER FOX RIVER - SUB AREA POG2
CROSS SECTIONS

Date: AUGUST 17, 2006	Revision Date:	
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