Milltown Reservoir Sediments Volume Comparison

TO: Russ Forba/EPA

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Introduction

In late July and August 2002, EPA conducted additional measurement, sampling and testing activities at the Milltown Reservoirs Sediments Site to assist in making better decisions regarding a final remedy. Work was focused principally in the arsenic ground water source area being considered for removal actions (Sediment Accumulation Area I), and on the existing Clark Fork River Channel area sediments (Area III). Area I had sediment thicknesses measured at twenty-one strategically placed locations. The CFR channel sediments were cored to depth at five additional locations. This additional sediment thickness information was evaluated to check sediment volume calculations currently being utilized. The purpose of this memorandum is to convey the results of that evaluation.

Area I Volume Calculation Check

A spreadsheet was generated which included survey measurements for 15 piezometer and 6 geoprobe locations. For each of these locations, the following information was included:

- Easting
- Northing
- Surface Elevation
- Bottom Elevation
- Sediment Thickness

Using this database, each point was mapped using ArcView GIS. At each data point the surveyed sediment thickness was compared with the sediment thickness utilized by EMC^2 to estimate their most recent sediment volume calculation for Area I (April 17, 2002). The values used by EMC^2 are based on the sediment thickness isopach map presented as Figure B-16 in the Milltown RI. EMC^2 used the isopach to create a 1-foot grid of Area I with ArcView GIS to represent the sediment thickness. This grid file was provided to CH2M HILL by EMC^2 and was used to make the comparison.

The following table presents a comparison of the sediment thickness at each of these surveyed data points.

ID	Type	Sept 02 Measured Sediment Thickness (ft)	EMC^2 Utilized Sediment Thickness (ft)	Difference (ft)
PZ1	Piezometer	14.20	14.02	0.18
PZ2D	Piezometer	19.80	16.00	3.80

ID	Type	Sept 02 Measured Sediment Thickness (ft)	EMC^2 Utilized Sediment Thickness (ft)	Difference (ft)
PZ3D	Piezometer	18.90	18.00	0.90
PZ4D	Piezometer	19.60	18.24	1.36
PZ5D	Piezometer	22.80	21.97	0.83
PZ6D	Piezometer	21.00	22.00	-1.00
PZ7D	Piezometer	20.30	15.82	4.48
PZ8D	Piezometer	20.10	17.76	2.34
PZ9D	Piezometer	17.60	16.31	1.29
PZ10D	Piezometer	17.90	17.51	0.39
PZ11D	Piezometer	15.80	16.26	-0.46
PZ12S	Piezometer	17.20	18.00	-0.80
PZ13D	Piezometer	19.80	21.92	-2.12
PZ14D	Piezometer	23.80	21.42	2.38
PZ15D	Piezometer	16.50	13.61	2.89
3024	Geoprobe	22.42	24.00	-1.58
3025	Geoprobe	28.33	22.11	6.22
3026	Geoprobe	25.75	21.02	4.73
3027	Geoprobe	20.33	18.88	1.45
3028	Geoprobe	20.00	20.19	-0.19
3029	Geoprobe	18.50	22.95	-4.45

As shown in the table, 14 of the measured values (67%) are greater than the values utilized by EMC^2 and 7 of the measured values (33%) are less than the utilized values. It should be noted that the thickness grid at each of the comparison points is an interpolated value from the locations shown on Figure B-10 in the Milltown RI. An exact comparison could only be made if the new survey data points and the locations on Figure B-10 were in identical locations, which they are not.

Values of the difference in measured and utilized thicknesses (column 5 of the table) were used to generate a 1-foot grid with ArcView GIS. Using this grid, differences in the sediment volume calculations were estimated as follows:

- Added volume (approximately 73% of Area I) = 127,714 CY
- Reduced volume (approximately 27% of Area I) = 32,,087 CY
- Net difference in volume = 95,627 CY

The net difference in volume of 95,627 CY indicates an approximate volume of additional sediment for Area I that would be calculated if the isopach was revised to reflect the latest

sediment thickness measurements. The total volume estimate for Area I prepared by EMC[2] indicates 2.6 million CY. This additional volume would increase the estimate by 3.7 percent. In summary, given the data available and accuracy of methods used to prepare these estimates, the incremental additional volume is likely within the error band of the measurement methods. Therefore, it is recommended that the latest EMC[2] calculation of Area I volume of 2.6 million currently being utilized by EPA not be changed.

CFR Channel Sediment Volume Calculations

The CFR channel was cored in five additional locations to determine contaminant concentrations by depth interval, and to better define total sediment thickness. Contaminant concentration data, by sediment depth interval, are summarized in the following table.

		Sediment Contaminant Concentrations (mg/kg)				
Core Location	Depth Interval (ft)	As	Cd	Cu	Pb	Zn
1B	0-2'	8.3	0.8	88.1	15.2	224
	2'-bottom	7.4	0.8	77.2	14.7	229
2A	0-2'	12.5	1.3	148	24.0	277
	2'-bottom	21.0	0.5	50.7	10.2	104
3	0-2'	11.0	1.1	115	19.9	271
	2'-7'	25.3	2.0	373	44.7	454
	7'-bottom	89.7	2.8	1130	94.6	624
4	0-2'	11.3	1.0	126	20.4	289
	2'-7'	263	7.9	2150	189	2240
	7'-bottom	500	13.7	3650	392	3730
5	0-2'	16.3	1.4	204	31.6	315
	2'-7'	398	11.5	3090	290	3050
	7'-bottom	214	7.2	2050	175	1480

Using the average sediment arsenic and copper concentrations established for Area I found in Figure 1-4 of the Milltown OU Combined Feasibility Study (320 and 2,300 mg/kg respectively) as benchmark criteria *to* define "contamination", it was logical to consider sediment depth intervals deeper than 2 feet for cores 4 and 5 (locations nearer the dam) as "contaminated" and likely zones for potential removal as suggested by MDEQ. Of course, to remove the volumes below the 2-foot depth range would involve also removing clean sediments above the 2-foot interval so the total depth of sediments for both cores 4 and 5 would have to be removed.

The following methodology was used to re-determine the volume of sediment in the Clark Fork River channel targeted for potential removal.

- For the purpose of this evaluation, that portion of Area III extending along the active Clark Fork channel from the Duck Bridge abutments north to the northeast corner of the Power House comprised the Clark Fork River Channel study area.
- The map noted as Figure 1-4 from the Milltown OU Combined FS was used to define the boundaries between Areas I, II and III. Recently obtained, additional depth of sediment data along the southern boundary of Area I parallel to the Clark Fork Channel were also used to better define thickness of the channel sediments.
- The Land and Water (L&W) Reports of 1997 and 1998 utilized survey transects which were used to create channel cross sections at multiple locations through the study reach. Sediment core locations were used to define the depth of the channel sediments throughout the reach. Where more that one boring at a single location occurred, sediment thickness was averaged, and the average was used to calculate an elevation of the pre-reservoir bottom. Relevant depth information from the recent core and piezometer data were also interpolated with the L&W transects to create a bottom profile through the study reach.
- To estimate sediment volumes at each cross section, it was assumed that the interface between Area I and Area III sediments was vertical to the pre-reservoir bottom. The interface between Area II and Area III (southwest CFR channel bank) was delineated by a 5:1 slope extending to the pre-reservoir bottom. Along each transect comprising a channel cross section, the width of the top of the channel at low pool was measured from the aerial photo serving as a base map for Figure 1-4 in the CFS. This information was entered into the ArcView GIS data base with the L&W data and a cross section of the channel was generated.
- To estimate sediment volume, cross-sectional area for each cross section was integrated by ArcView with a length of influence. Length attributed to each cross section is bounded by the mid-point between the cross sections. This method is often referred to as a double end-area calculation.
- The results of the volume estimate, by cross-sectional area, are presented in the following Table. Volumes are separated into contaminated and uncontaminated categories. As previously described, the analytical data from the cores illustrate an area of As and Cu contamination that encompasses sediment below 2 feet in the vicinity of cores #4 and #5. The upstream boundary of this contaminated zone was interpolated between Cores #3 and #4 . The volume of sediment associated with L&W transect F is assumed to be contaminated. It is assumed the contamination extends to the face of the dam.

TABLE
Milltown Clark Fork River Sediments (Area III)

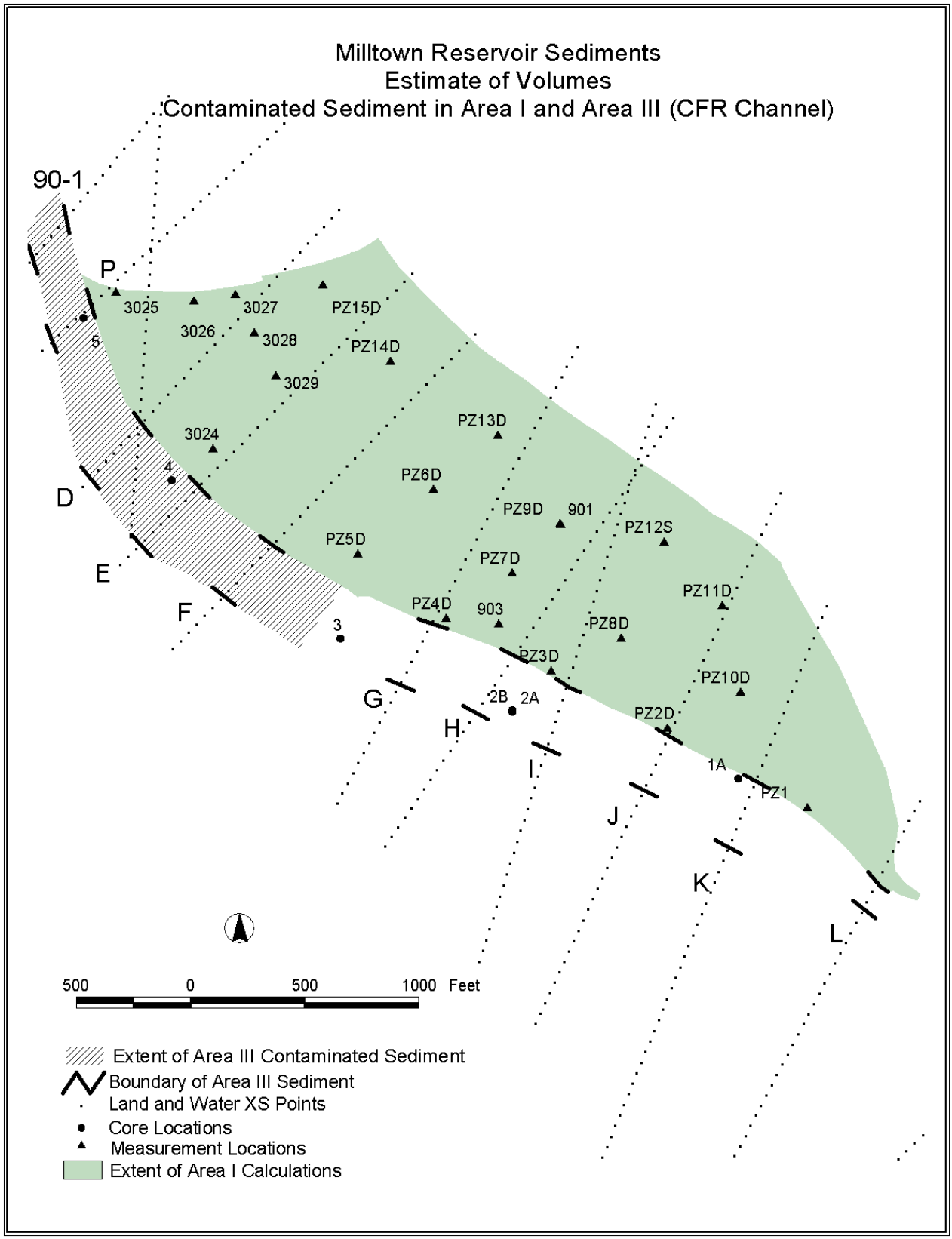
Land & Water Cross Section ID	Bottom of Sediment Elevation	Cross-Section Area (ft^2)	Influence Length (ft)	Sediment Volume (yd^3)	
90-1	3231.1	1,610	240	14,309	
P	3231.2	3,287	462.5	56,307	***43,274 CY* Uncontaminated (zero to 2 feet)**
D	3231.4	5,289	467.5	91,584	
E	3231.4	6,011	395	87,937	***316,746 CY* Contaminated (below 2 feet)**
F	3230.8	4,805	617.5	109,884	
G	3235.4	4,201	595	92,580	
H	3241.3	2,539	340	31,970	
I	3243.1	2,319	395	33,920	
J	3243.7	2,042	460	34,797	
K	3244.2	2,521	560	52,283	***257,011 CY* Uncontaminated**
L	3245.0	711	435	11,461	
				617,031	***Total Sediment Volume***

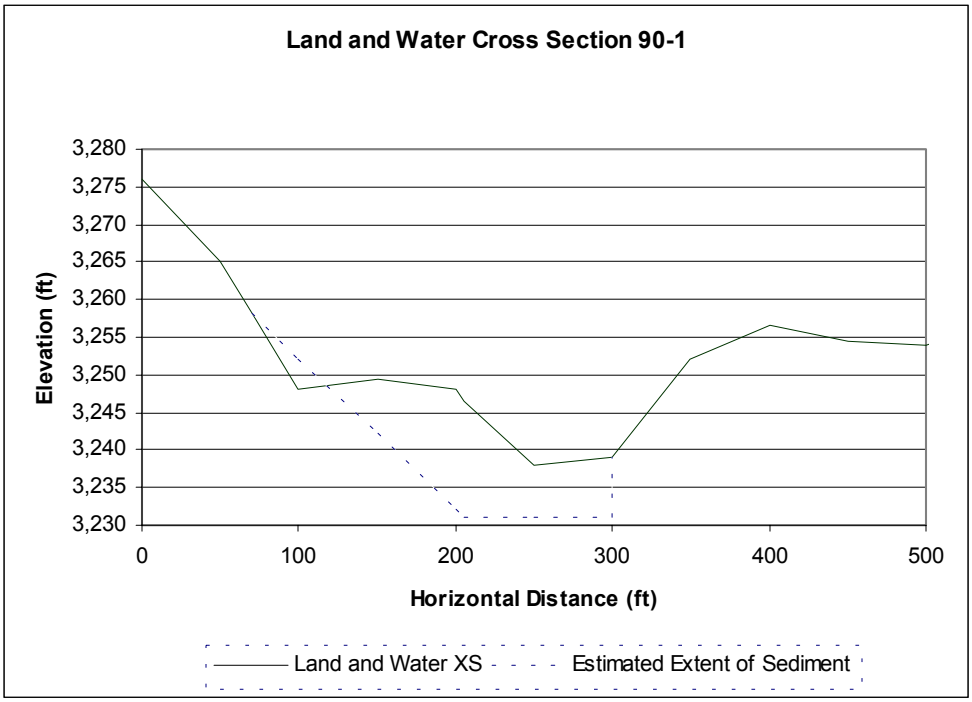
Please note that the areas and volumes delineated by this evaluation are based on relatively few channel cores and nearby interpolated sediment depth locations and, as such, they should be considered approximate. To better define these areas and subsequent sediment volumes, additional survey data, depth of sediment data and additional aerial photography would be necessary.

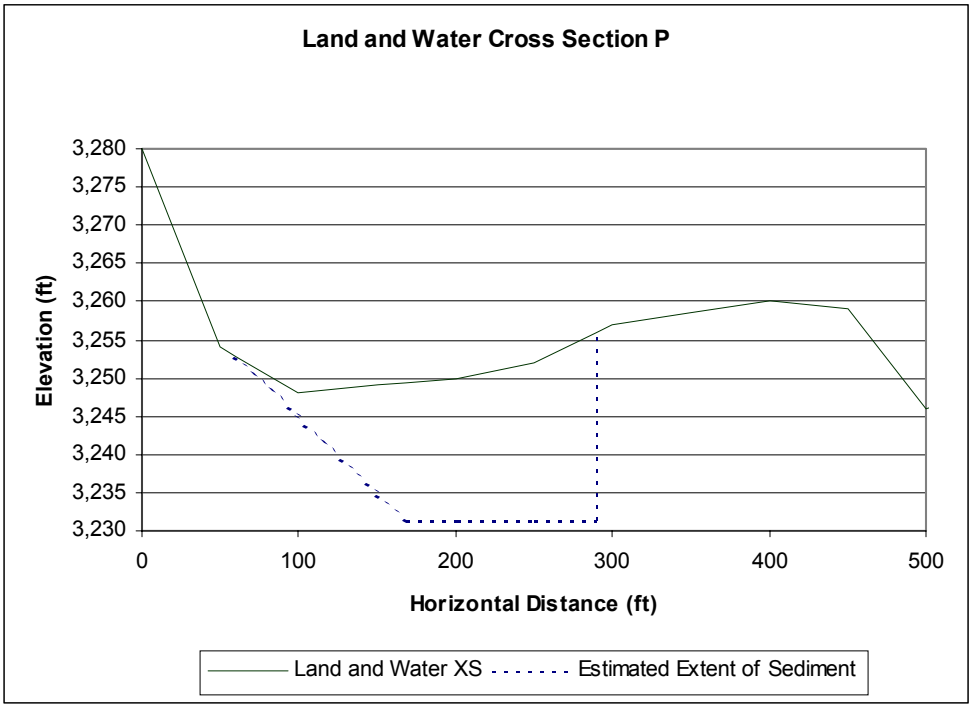
The total sediment volume for the CFR channel from Duck Bridge to the dam was estimated by this technique at approximately 617,000 cubic yards (CY) of which 317,000 CY may be considered "contaminated". Given the assumptions and limited hard data associated with this estimate, the total sediment volume is again fairly comparable to the recent calculations by EMC[2] (April 2002), who estimated a sediment volume for all of Area III at about 1.01 million CY. Our estimate excluded the Blackfoot River arm of Area III (I-90 to the Milltown Dam).

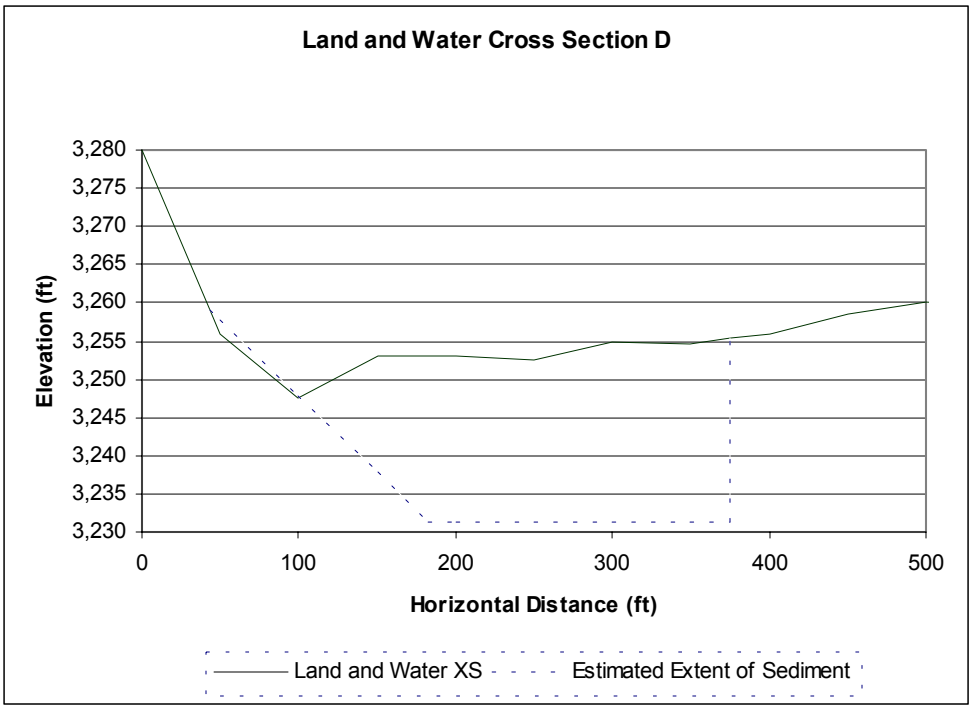
Attachments

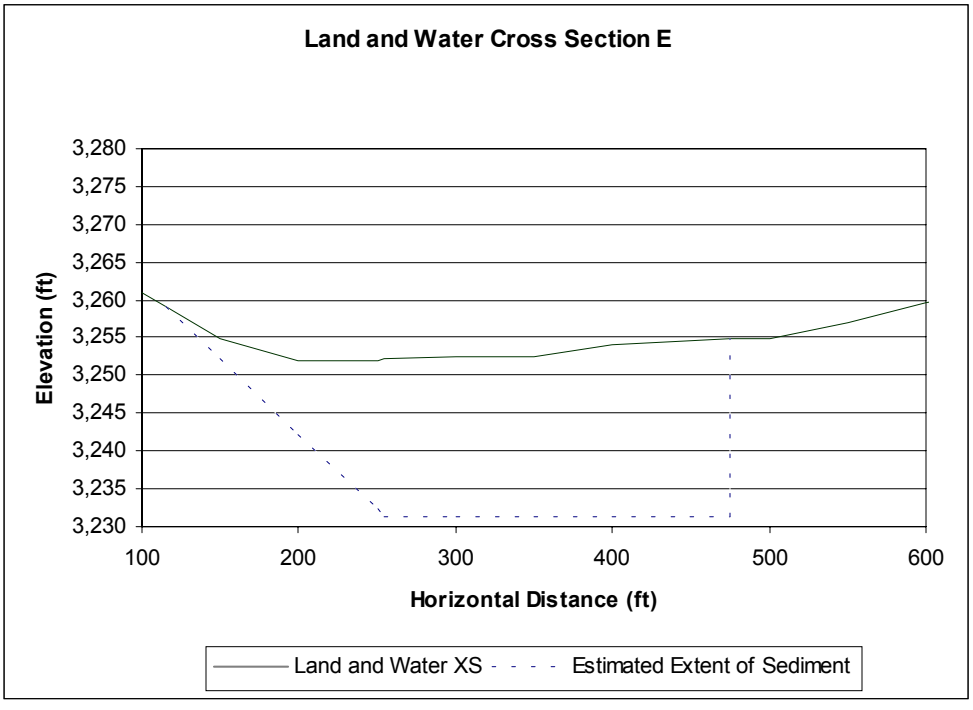
Plan View of the Study Area with Land & Water Transects
Channel Cross Sections with Volume Estimates

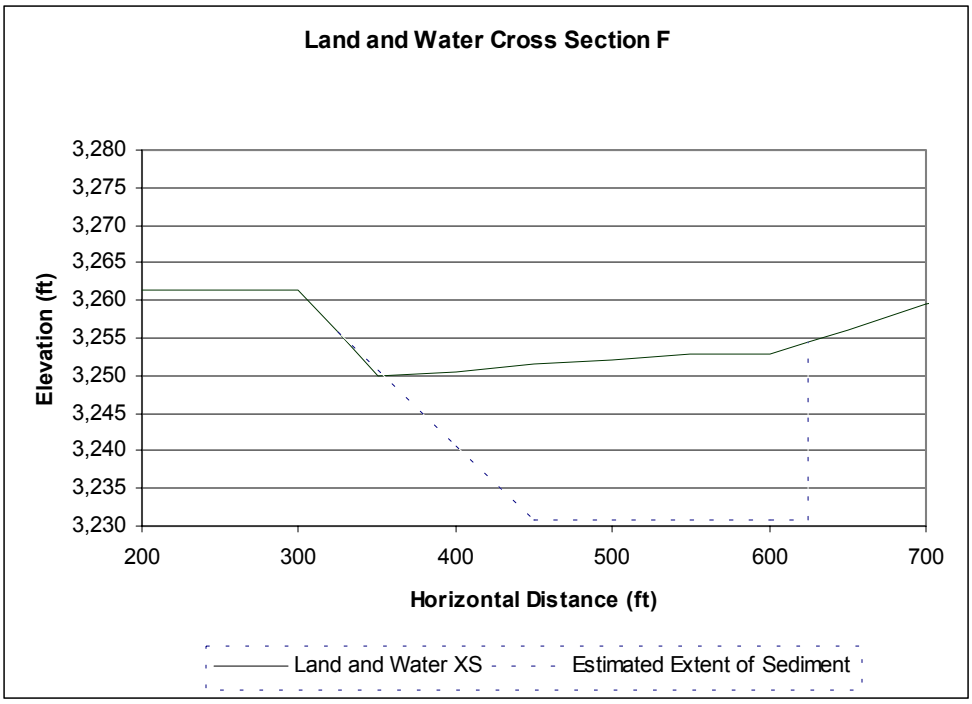

Milltown Reservoir Sediments
Estimate of Volumes
Contaminated Sediment in Area I and Area III (CFR Channel)
90-1
P
3025
3027
PZ15D
3026
3028
PZ14D
5
3029
3024
PZ13D
4
PZ6D
D
PZ9D
901
PZ12S
PZ5D
PZ7D
E
PZ11D
PZ4D
903
F
3
PZ8D
PZ3D
PZ10D
G
2B
2A
PZ2D
H
1A
PZ1
I
J
K
L
500
0
500
1000
Feet
Extent of Area III Contaminated Sediment
Boundary of Area III Sediment
Land and Water XS Points
Core Locations
Measurement Locations
Extent of Area I Calculations

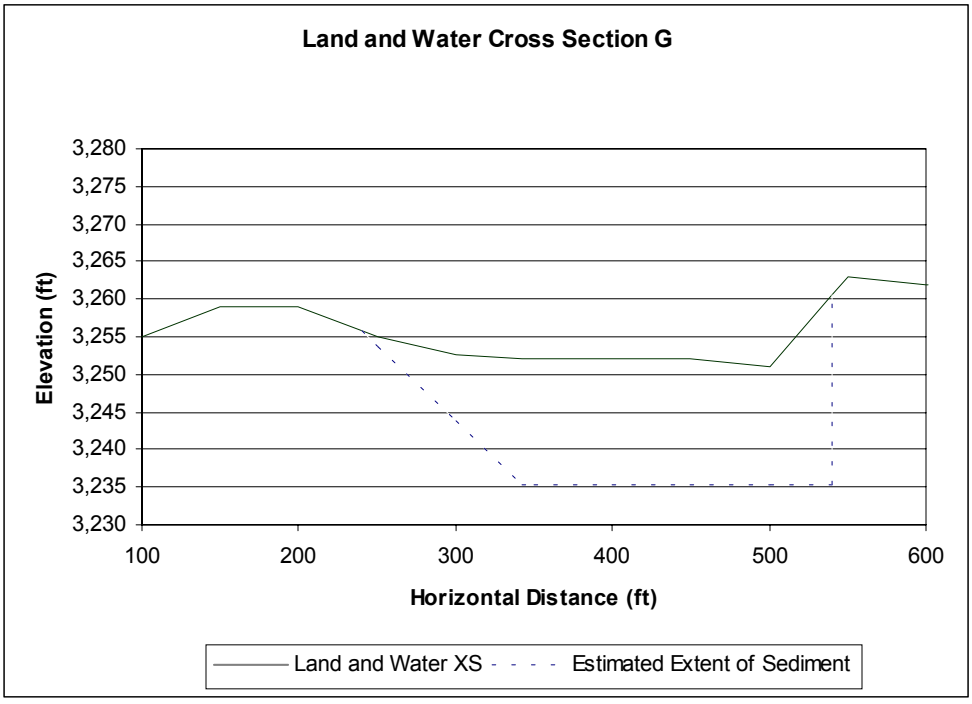

Land and Water Cross Section 90-1
Elevation (ft)
3,280
3,275
3,270
3,265
3,260
3,255
3,250
3,245
3,240
3,235
3,230
0
100
200
300
400
500
Horizontal Distance (ft)
Land and Water XS
Estimated Extent of Sediment

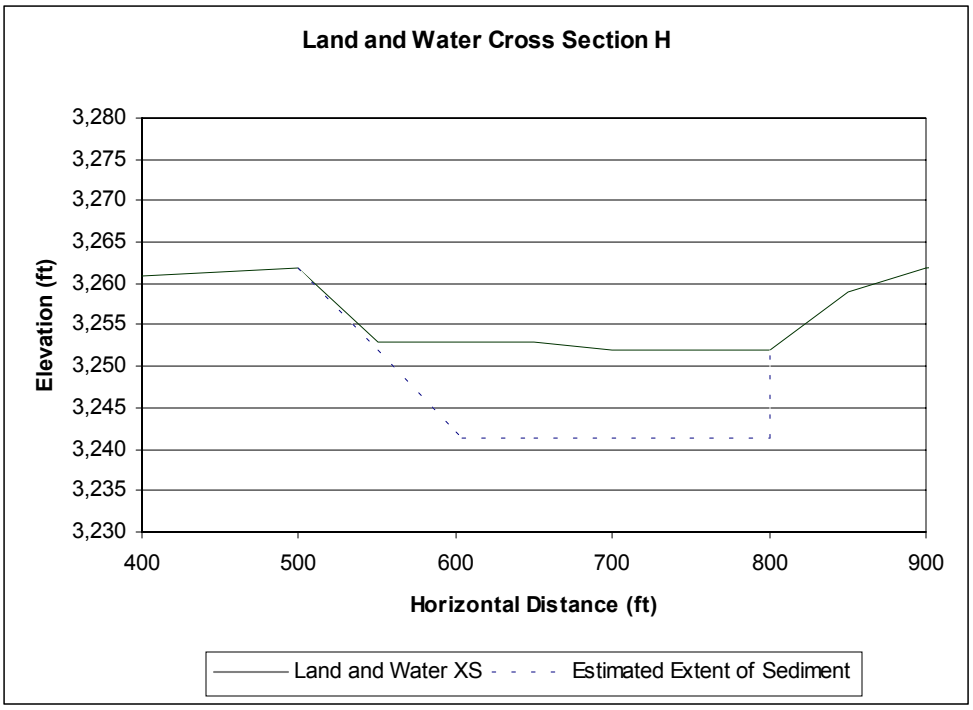

Land and Water Cross Section P
Elevation (ft)
3,280
3,275
3,270
3,265
3,260
3,255
3,250
3,245
3,240
3,235
3,230
0
100
200
300
400
500
Horizontal Distance (ft)
Land and Water XS
Estimated Extent of Sediment

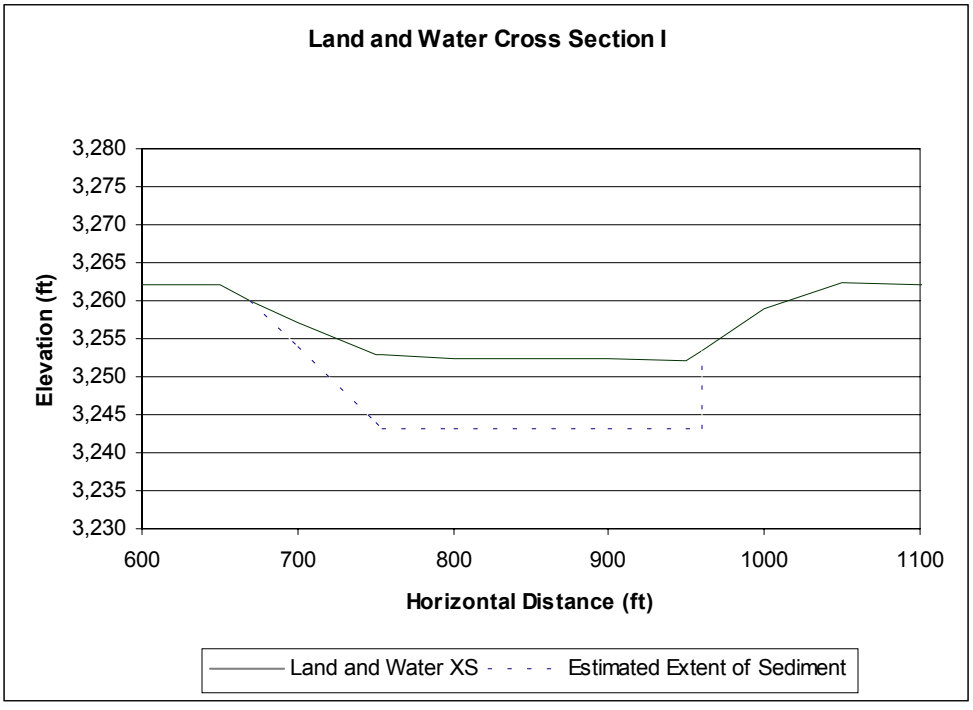

Land and Water Cross Section D
Elevation (ft)
3,280
3,275
3,270
3,265
3,260
3,255
3,250
3,245
3,240
3,235
3,230
0
100
200
300
400
500
Horizontal Distance (ft)
Land and Water XS
Estimated Extent of Sediment

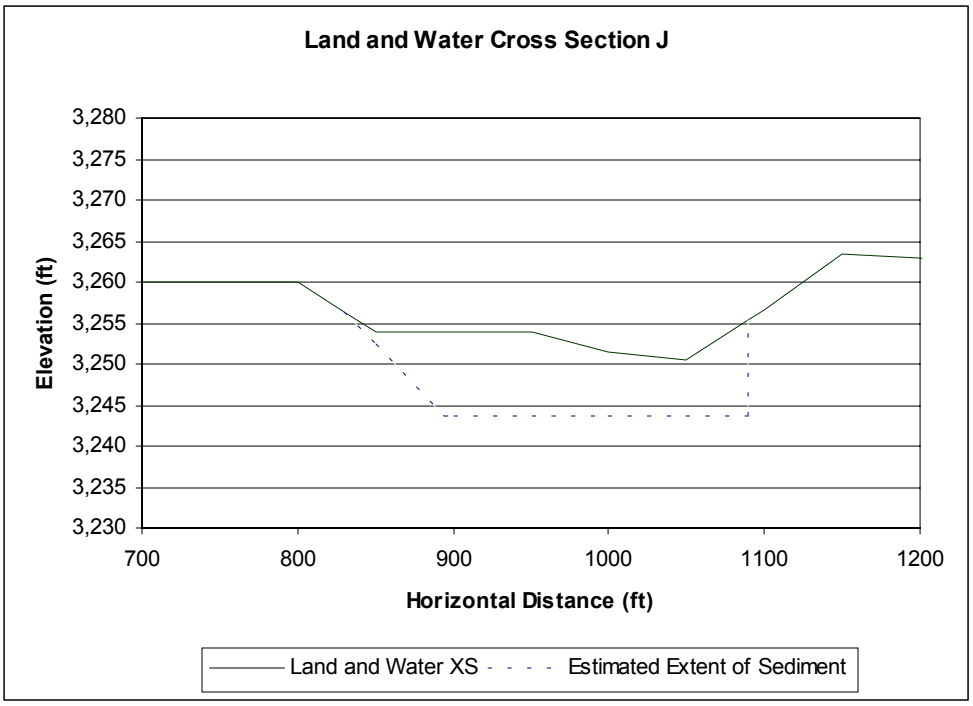

Land and Water Cross Section E
Elevation (ft)
3,280
3,275
3,270
3,265
3,260
3,255
3,250
3,245
3,240
3,235
3,230
100
200
300
400
500
600
Horizontal Distance (ft)
Land and Water XS
Estimated Extent of Sediment

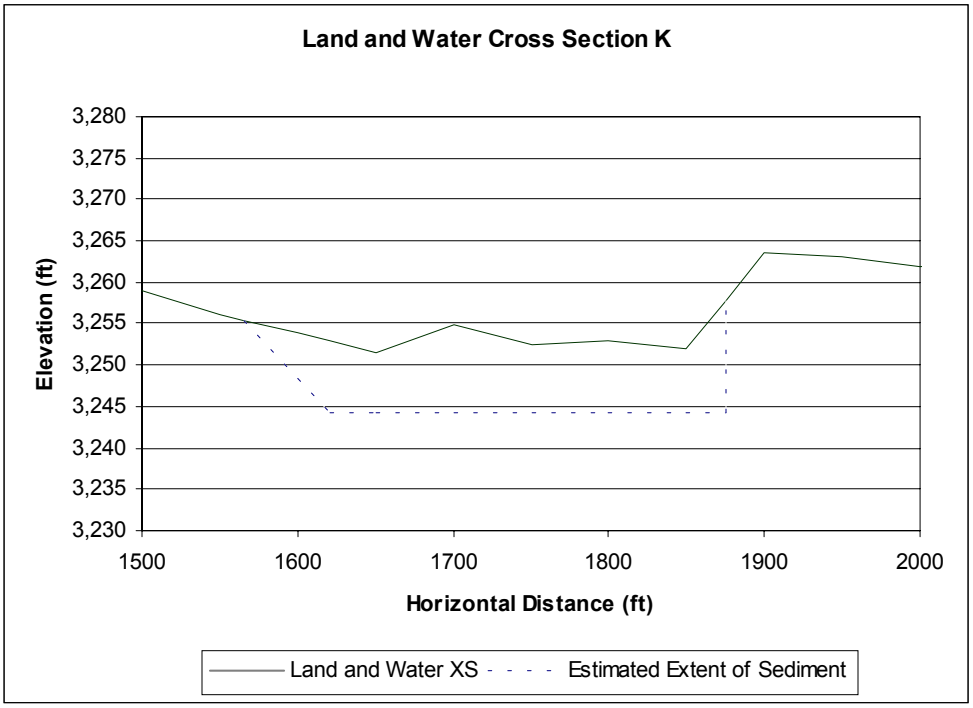

Land and Water Cross Section F
Elevation (ft)
3,280
3,275
3,270
3,265
3,260
3,255
3,250
3,245
3,240
3,235
3,230
200
300
400
500
600
700
Horizontal Distance (ft)
Land and Water XS
Estimated Extent of Sediment

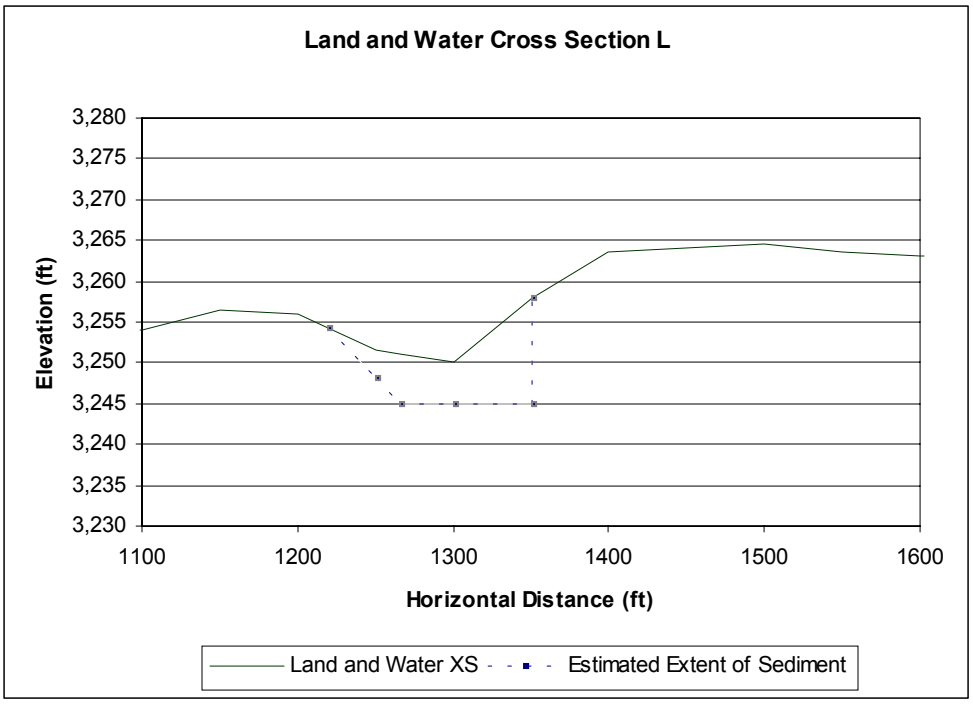

Land and Water Cross Section G
Elevation (ft)
3,280
3,275
3,270
3,265
3,260
3,255
3,250
3,245
3,240
3,235
3,230
100
200
300
400
500
600
Horizontal Distance (ft)
Land and Water XS
Estimated Extent of Sediment


Land and Water Cross Section H
Elevation (ft)
3,280
3,275
3,270
3,265
3,260
3,255
3,250
3,245
3,240
3,235
3,230
400
500
600
700
800
900
Horizontal Distance (ft)
Land and Water XS
Estimated Extent of Sediment


Land and Water Cross Section I
Elevation (ft)
3,280
3,275
3,270
3,265
3,260
3,255
3,250
3,245
3,240
3,235
3,230
600
700
800
900
1000
1100
Horizontal Distance (ft)
Land and Water XS
Estimated Extent of Sediment


Land and Water Cross Section J
Elevation (ft)
3,280
3,275
3,270
3,265
3,260
3,255
3,250
3,245
3,240
3,235
3,230
700
800
900
1000
1100
1200
Horizontal Distance (ft)
Land and Water XS
Estimated Extent of Sediment


Land and Water Cross Section K
Elevation (ft)
3,280
3,275
3,270
3,265
3,260
3,255
3,250
3,245
3,240
3,235
3,230
1500
1600
1700
1800
1900
2000
Horizontal Distance (ft)
Land and Water XS
Estimated Extent of Sediment



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