Attachment J-2:
Cost Documentation "Factsheets" and Summary Table of Costs

Lower Susquehanna River Watershed Assessment
Summary of Representative Sediment Management Alternatives

	Innovative Reuse	Open Water Placement			Upland Placement			
	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3A	Alternative 3B	Alternative 3C	Alternative 3D
Physical Description								
Sediment to be removed, cubic yards	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Sediment to be removed, tons	810,000	810,000	810,000	810,000	810,000	810,000	810,000	810,000
Type of dredging	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Mechanical	Hydraulic	Hydraulic
Transportation method	Pipeline	Pipeline + barge	Pipeline	Pipeline	Pipeline	Barge + transfer + trucking	Pipeline + dike + trucking	Pipeline + discharge pipe
Distance to be transported, miles	10	8+32	3	3	13	0+0+14	3+0+12	14 + 4
Location/type of containment site	Bainbridge, slurry screened, water returned, solids stockpiled	Drying/transfer site near Susquehanna State Park, with dike construction	N/A	N/A	Will need dike construction at quarry for dewatering to extend project life	Shoreline transfer site	Nearby drying site required with dike construction	Will need dike construction at quarry for dewatering to extend project life
Final destination of material	Concrete block market	Pooles Island	Susquehanna River, approximately 1 mile d/s of Conowingo Dam	Susquehanna River, approximately 1 mile d/s of Conowingo Dam	Stancills Quarry	Mason-Dixon Quarry (Belvidere site)	Mason-Dixon Quarry (Belvidere site)	Mason-Dixon Quarry (Belvidere site)
Number of dredging cycles that facility could be used before capacity is reached	Facility has a useful life of more than 40 years	Unknown, due to local sediment transport	No limitation	No limitation	5	29	23	23
Land to be purchased, acres	100	420	1-2	1-2	2-5	15	420	2-5
Production Calculations								
Volume to be removed, cubic yards	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
Volume in pipeline, cubic yards	4,000,000	4,000,000	4,000,000	4,000,000	4,000,000	N/A	4,000,000	4,000,000
Volume to be disposed of, cubic yards	N/A	1,500,000	N/A	N/A	1,500,000	1,200,000	1,500,000	1,500,000
Number of dredges	1	1	3	2	1	8	1	1
Number of pipelines	1	1	3	2	1	0	1	1
Number of barge loads per day	N/A	2	N/A	N/A	N/A	10	N/A	N/A
Number of truck loads per day	N/A	N/A	N/A	N/A	N/A	400	500	N/A
Dike volume, cubic yards	N/A	140,000	N/A	N/A	140,000	N/A	140,000	140,000
Booster pumps required	3	7	6	4	12	0	2	14
Months of operation	Year-round	Year-round	October-February (5 months)	July-March (9 months)	Year-round	Year-round	Year-round	Year-round
Actual operational time, days per year	330	250	83	125	250	250	250	250
Total sediment removal capacity, cubic yards per day	4,000	4,000	12,000	8,000	4,000	4,000	4,000	4,000

	Alt 1 Low	Alt 1 High	Alt 2A Low	Alt 2A High	Alt 2B Low	Alt 2B High	Alt 2C Low	Alt 2C High	Alt 3A Low	Alt 3A High	Alt 3B Low	Alt 3B High	Alt 3C Low	Alt 3C High	Alt 3D Low	Alt 3D High
One-Time Investment Costs	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Real estate/land purchase	$0		$4,200,000	$8,400,000	$10,000	$40,000	$10,000	$40,000	$20,000	$100,000	$150,000	$300,000	$4,200,000	$8,400,000	$20,000	$100,000
Legal and financial services	$27,600,000		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Design and study costs	$13,300,000		$2,000,000	$5,000,000	$2,000,000	$5,000,000	$2,000,000	$5,000,000	$2,000,000	$5,000,000	$2,000,000	$5,000,000	$2,000,000	$5,000,000	$2,000,000	$5,000,000
Booster pump construction	$2,300,000		$2,100,000	$2,100,000	$1,800,000	$1,800,000	$1,200,000	$1,200,000	$3,600,000	$3,600,000	$0	$0	$600,000	$600,000	$4,200,000	$4,200,000
Permanent pipeline construction	$1,800,000		$1,300,000	$2,100,000	$1,400,000	$2,300,000	$1,000,000	$1,600,000	$2,100,000	$3,400,000	$0	$0	$500,000	$800,000	$2,900,000	$4,700,000
Transfer site/dike construction	$0		$1,100,000	$2,200,000	$0	$0	$0	$0	$1,100,000	$2,200,000	$0	$0	$1,100,000	$2,200,000	$1,100,000	$2,200,000
Dredging and dewatering plant	$28,600,000		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Reuse manufacturing plant	$108,200,000		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal	$181,800,000		$10,700,000	$19,800,000	$5,210,000	$9,140,000	$4,210,000	$7,840,000	$8,820,000	$14,300,000	$2,150,000	$5,300,000	$8,400,000	$17,000,000	$10,220,000	$16,200,000
Annualized, $/year	Costs to be offset by generated revenues		$456,000	$844,000	$222,000	$390,000	$179,000	$334,000	$376,000	$610,000	$92,000	$226,000	$358,000	$725,000	$436,000	$691,000
O&M/Removal Costs	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Tipping fee (costs reduced by any generated revenues)	$39,000,000	$50,000,000	$0	$0	$0	$0	$0	$0	$1,500,000	$7,500,000	$12,000,000	$18,000,000	$15,000,000	$22,500,000	$15,000,000	$22,500,000
Dredging + transportation	$0	$0	$15,000,000	$20,000,000	$10,000,000	$15,000,000	$5,000,000	$10,000,000	$20,000,000	$25,000,000	$40,000,000	$70,000,000	$20,000,000	$30,000,000	$20,000,000	$25,000,000
Manufacturing processing	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Construction design and management	$0	$0	$1,000,000	$2,000,000	$1,000,000	$2,000,000	$1,000,000	$2,000,000	$1,000,000	$2,000,000	$1,000,000	$2,000,000	$1,000,000	$2,000,000	$1,000,000	$2,000,000
Subtotal	$39,000,000	$50,000,000	$16,000,000	$22,000,000	$11,000,000	$17,000,000	$6,000,000	$12,000,000	$22,500,000	$34,500,000	$53,000,000	$90,000,000	$36,000,000	$54,500,000	$36,000,000	$49,500,000
Cost per Cubic Yard (assumes yearly removal)	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
One-time investment cost, $/cy	$182		$11	$20	$5	$9	$4	$8	$9	$14	$2	$5	$8	$17	$10	$16
Annualized investment cost, $/cy/year	$0	$0	$0	$1	$0	$0	$0	$0	$0	$1	$0	$0	$0	$1	$0	$1
Annual removal cost, $/cy/year	$39	$50	$16	$22	$11	$17	$6	$12	$23	$35	$53	$90	$36	$55	$36	$50
Total annual cost, $/cy/year	$39	$50	$16	$23	$11	$17	$6	$12	$23	$35	$53	$90	$36	$55	$36	$50
Major Limitations	Substantial commitment to continual use would be required		Currently not allowed by law; large parcels adjacent to the river may be very difficult to find		Environmental impacts; NMFS concerns		Environmental impacts; NMFS concerns				Large parcels adjacent to the reservoir may be difficult to find		Large parcels expected to be difficult to find nearby		Effluent from dewatering will need to be pumped back to the Susquehanna River	

General Assumptions:

These are concept-level costs for planning purposes only. Detailed design and cost estimate would be required for any future studies investigation implementation of any of these alternatives.
All alternatives assume the dredging of a location in Conowingo Reservoir which currently has the highest amounts of deposition in the entire lower Susquehanna reservoir system; similar costs could be developed for the other lower Susquehanna reservoirs.

Technical Assumptions:

Real estate cost = farmland cost in Harford/Cecil County, MD; range of cost = $10,000 to $20,000 per acre; based on Internet search of agricultural land June 2013; assume large tracts of land available.
Annualization factor = 23.456 for interest = 3.500% and project life of 50 years Rounding factor for annualization = 3
Each hydraulic dredge has its own separate pipeline and associated booster pump system, with a production capacity of 4,000 cubic yards per day; cost per booster pump = $300,000
Hydraulic dredging process will add a signficant amount of volume to the pipeline; assume pipeline will contain 4 times the dredging volume.
Drying process will be able to remove a signficant amount of the water that is pumped in with the dredged material; assume that material to be transported after drying is 1.5 times the original dredging volume.
Production capacity for one mechanical dredge = 500 cubic yards per day; material volume is increased by 20%, a factor of 1.2 (compared to original dredged volume), during dredging process
Barge capacity varies; for transport to Pooles Island, each barge is expected to hold 2,500 cubic yards; for in-reservoir dredging, the capacity would be much smaller, only 500 cubic yards/barge.
Permanent pipeline cost = $160,000 to $260,000 per mile ($30-50 per linear foot).
Transfer site/dike construction cost = 5-foot high dike for 3 feet of material, assume 2 cycles per year, $8-16/cy construction cost
Tipping fee for Stancils Quarry is assumed to be $1-5/cy with a total volume available of 9Mcy; tipping fee for Mason-Dixon Quarry is based on $10-15/cy and a total volume available of 35Mcy; the tipping fees are applied to the dredged amount for pipeline delivery and to the trucked amount for truck delivery; outright purchase of quarry could be another option to tipping fees.
Universal conversion factor; 1 cubic yard of dredged material = 0.81 tons of sediment based on bulk density value of 1600 kilograms/meter ^{3}.

Lower Susquehanna River Watershed Assessment
Summary of Representative Sediment Management Alternatives

	Innovative Reuse	Open Water Placement			Upland Placement			
	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3A	Alternative 3B	Alternative 3C	Alternative 3D
Physical Description								
Sediment to be removed, cubic yards	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000
Sediment to be removed, tons	2,430,000	2,430,000	2,430,000	2,430,000	2,430,000	2,430,000	2,430,000	2,430,000
Type of dredging	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Mechanical	Hydraulic	Hydraulic
Transportation method	Pipeline	Pipeline + barge	Pipeline	Pipeline	Pipeline	Barge + transfer + trucking	Pipeline + dike + trucking	Pipeline + discharge pipe
Distance to be transported, miles	10	8+32	3	3	13	0+0+14	3+0+12	14 + 4
Location/type of containment site	Bainbridge, slurry screened, water returned, solids stockpiled	Drying/transfer site near Susquehanna State Park, with dike construction	N/A	N/A	Will need dike construction at quarry for dewatering to extend project life	Shoreline transfer site	Nearby drying site required with dike construction	Will need dike construction at quarry for dewatering to extend project life
Final destination of material	Concrete block market	Pooles Island	Susquehanna River, approximately 1 mile d/s of Conowingo Dam	Susquehanna River, approximately 1 mile d/s of Conowingo Dam	Stancills Quarry	Mason-Dixon Quarry	Mason-Dixon Quarry	Mason-Dixon Quarry (Belvidere site)
Number of dredging cycles that facility could be used before capacity is reached	Facility has a useful life of more than 40 years	Unknown, due to local sediment transport	No limitation	No limitation	2	10	8	8
Land to be purchased, acres	100	1,250	1-2	1-2	2-5	44	1,250	2-5
Production Calculations								
Volume to be removed, cubic yards	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000	3,000,000
Volume in pipeline (4X), cubic yards	12,000,000	12,000,000	12,000,000	12,000,000	12,000,000	N/A	12,000,000	12,000,000
Volume to be disposed of, cubic yards	N/A	4,500,000	N/A	N/A	4,500,000	3,600,000	4,500,000	4,500,000
Number of dredges	3	3	8	4	3	24	3	3
Number of pipelines	3	3	8	4	3	0	3	3
Number of barge loads per day	N/A	7	N/A	N/A	N/A	29	N/A	N/A
Number of truck loads per day	N/A	N/A	N/A	N/A	N/A	1,200	1,500	N/A
Dike volume, cubic yards	N/A	420,000	N/A	N/A	420,000	N/A	420,000	420,000
Booster pumps required	9	21	16	8	36	0	6	42
Months of operation	Year-round	Year-round	October-February (5 months)	July-March (9 months)	Year-round	Year-round	Year-round	Year-round
Actual operational time, days per year	330	250	94	188	250	250	250	250
Total sediment removal capacity, cubic yards per day	12,000	12,000	32,000	16,000	12,000	12,000	12,000	12,000

	Alt. 1 Low	Alt. 1 High	Alt. 2A Low	Alt. 2A High	Alt. 2B Low	Alt. 2B High	Alt. 2C Low	Alt. 2C High	Alt. 3A Low	Alt. 3A High	Alt. 3B Low	Alt. 3B High	Alt. 3C Low	Alt. 3C High	Alt. 3D Low	Alt. 3D High
One-Time Investment Costs	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Real estate/land purchase	$0		$12,500,000	$25,000,000	$10,000	$40,000	$10,000	$40,000	$20,000	$100,000	$440,000	$880,000	$12,500,000	$25,000,000	$20,000	$100,000
Legal and financial services	$65,700,000		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Design and study costs	$21,600,000		$2,000,000	$5,000,000	$2,000,000	$5,000,000	$2,000,000	$5,000,000	$2,000,000	$5,000,000	$2,000,000	$5,000,000	$2,000,000	$5,000,000	$2,000,000	$5,000,000
Booster pump construction	$6,800,000		$6,300,000	$6,300,000	$4,800,000	$4,800,000	$2,400,000	$2,400,000	$10,800,000	$10,800,000	$0	$0	$1,800,000	$1,800,000	$12,600,000	$12,600,000
Permanent pipeline construction	$5,400,000		$3,800,000	$6,200,000	$3,800,000	$6,200,000	$1,900,000	$3,100,000	$6,200,000	$10,100,000	$0	$0	$1,400,000	$2,300,000	$8,600,000	$14,000,000
Transfer site/dike construction	$0		$3,400,000	$6,700,000	$0	$0	$0	$0	$3,400,000	$6,700,000	$0	$0	$3,400,000	$6,700,000	$3,400,000	$6,700,000
Dredging and dewatering plant	$56,600,000		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Reuse manufacturing plant	$212,000,000		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal	$368,100,000		$28,000,000	$49,200,000	$10,610,000	$16,040,000	$6,310,000	$10,540,000	$22,420,000	$32,700,000	$2,440,000	$5,880,000	$21,100,000	$40,800,000	$26,620,000	$38,400,000
Annualized, $/year	Costs to be offset by generated revenues		$1,194,000	$2,098,000	$452,000	$684,000	$269,000	$449,000	$956,000	$1,394,000	$104,000	$251,000	$900,000	$1,739,000	$1,135,000	$1,637,000
O&M/Removal Costs	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Tipping fee (costs reduced by any generated revenues)	$87,000,000	$117,000,000	$0	$0	$0	$0	$0	$0	$4,500,000	$22,500,000	$36,000,000	$54,000,000	$45,000,000	$67,500,000	$45,000,000	$67,500,000
Dredging + transportation	$0	$0	$45,000,000	$60,000,000	$30,000,000	$45,000,000	$15,000,000	$30,000,000	$60,000,000	$75,000,000	$120,000,000	$210,000,000	$60,000,000	$90,000,000	$60,000,000	$75,000,000
Manufacturing processing	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Construction design and management	$0	$0	$1,000,000	$2,000,000	$1,000,000	$2,000,000	$1,000,000	$2,000,000	$1,000,000	$2,000,000	$1,000,000	$2,000,000	$1,000,000	$2,000,000	$1,000,000	$2,000,000
Subtotal	$87,000,000	$117,000,000	$46,000,000	$62,000,000	$31,000,000	$47,000,000	$16,000,000	$32,000,000	$65,500,000	$99,500,000	$157,000,000	$266,000,000	$106,000,000	$159,500,000	$106,000,000	$144,500,000
Cost per Cubic Yard (assumes yearly removal)	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
One-time investment cost, $/cy	$123		$9	$16	$4	$5	$2	$4	$7	$11	$1	$2	$7	$14	$9	$13
Annualized investment cost, $/cy/year	$0	$0	$0	$1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1	$0	$1
Annual removal cost, $/cy/year	$29	$39	$15	$21	$10	$16	$5	$11	$22	$33	$52	$89	$35	$53	$35	$48
Total annual cost, $/cy/year	$29	$39	$16	$21	$10	$16	$5	$11	$22	$34	$52	$89	$36	$54	$36	$49

	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3A	Alternative 3B	Alternative 3C	Alternative 3D
Major Limitations	Substantial commitment to continual use would be required	Currently not allowed by law; large parcels adjacent to the river may be very difficult to find	Environmental impacts; NMFS concerns	Environmental impacts; NMFS concerns		Large parcels adjacent to the reservoir may be difficult to find	Large parcels expected to be difficult to find nearby	Effluent from dewatering will need to be pumped back to the Susquehanna River

General Assumptions:

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Hydraulic dredging process will add a signficant amount of volume to the pipeline; assume pipeline will contain 4 times the dredging volume.
Drying process will be able to remove a signficant amount of the water that is pumped in with the dredged material; assume that material to be transported after drying is 1.5 times the original dredging volume.
Production capacity for one mechanical dredge = 500 cubic yards per day; material volume is increased by 20%, a factor of 1.2 , during dredging process
Barge capacity varies; for transport to Pooles Island, each barge is expected to hold 2,500 cubic yards; for in-reservoir dredging, the capacity would be much smaller, only 500 cubic yards/barge.
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Tipping fee for Stancils Quarry is assumed to be $1-5/cy with a total volume available of 9Mcy; tipping fee for Mason-Dixon Quarry is based on $10-15/cy and a total volume available of 35Mcy; the tipping fees are applied to the dredged amount for pipeline delivery and to the trucked amount for truck delivery; outright purchase of quarry could be another option to tipping fees.
Universal conversion factor; 1 cubic yard of dredged material = 0.81 tons of sediment based on bulk density value of 1600 kilograms/meter^3.

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Physical Description								
Sediment to be removed, cubic yards	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Sediment to be removed, tons	4,050,000	4,050,000	4,050,000	4,050,000	4,050,000	4,050,000	4,050,000	4,050,000
Type of dredging	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Mechanical	Hydraulic	Hydraulic
Transportation method	Pipeline	Pipeline + barge	Pipeline	Pipeline	Pipeline	Barge + transfer + trucking	Pipeline + dike + trucking	Pipeline + discharge pipe
Distance to be transported, miles	10	8+32	3	3	13	0+0+14	3+0+12	14 + 4
Location/type of containment site	Bainbridge, slurry screened, water returned, solids stockpiled	Drying/transfer site near Susquehanna State Park, with dike construction	N/A	N/A	Will need dike construction at quarry for dewatering to extend project life	Shoreline transfer site	Nearby drying site required with dike construction	Will need dike construction at quarry for dewatering to extend project life
Final destination of material	Concrete block market	Pooles Island	Susquehanna River, approximately 1 mile d/s of Conowingo Dam	Susquehanna River, approximately 1 mile d/s of Conowingo Dam	Stancills Quarry	Mason-Dixon Quarry	Mason-Dixon Quarry	Mason-Dixon Quarry (Belvidere site)
Number of dredging cycles that facility could be used before capacity is reached	Facility has a useful life of more than 40 years	Unknown, due to local sediment transport	No limitation	No limitation	1	6	5	5
Land to be purchased, acres	100	2,080	1-2	1-2	2-5	72	2,080	2-5
Production Calculations								
Volume to be removed, cubic yards	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000	5,000,000
Volume in pipeline (4X), cubic yards	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000	N/A	20,000,000	20,000,000
Volume to be disposed of, cubic yards	N/A	7,500,000	N/A	N/A	7,500,000	6,000,000	7,500,000	7,500,000
Number of dredges	5	5	12	7	5	40	5	5
Number of pipelines	5	5	12	7	5	0	5	5
Number of barge loads per day	N/A	12	N/A	N/A	N/A	48	N/A	N/A
Number of truck loads per day	N/A	N/A	N/A	N/A	N/A	2,000	2,500	N/A
Dike volume, cubic yards	N/A	700,000	N/A	N/A	700,000	N/A	700,000	700,000
Booster pumps required	15	35	24	14	60	0	10	70
Months of operation	Year-round	Year-round	October-February (5 months)	July-March (9 months)	Year-round	Year-round	Year-round	Year-round
Actual operational time, days per year	330	250	104	179	250	250	250	250
Total sediment removal capacity, cubic yards per day	20,000	20,000	48,000	28,000	20,000	20,000	20,000	20,000

	Alt. 1		Alt. 2A		Alt. 2B		Alt. 2C		Alt. 3A		Alt. 3B		Alt. 3C		Alt. 3D	
One-Time Investment Costs	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Real estate/land purchase	$0		$20,800,000	$41,600,000	$10,000	$40,000	$10,000	$40,000	$20,000	$100,000	$720,000	$1,440,000	$20,800,000	$41,600,000	$20,000	$100,000
Legal and financial services	$88,000,000															
Design and study costs	$26,100,000		$2,000,000	$5,000,000	$2,000,000	$5,000,000	$2,000,000	$5,000,000	$2,000,000	$5,000,000	$2,000,000	$5,000,000	$2,000,000	$5,000,000	$2,000,000	$5,000,000
Booster pump construction	$11,300,000		$10,500,000	$10,500,000	$7,200,000	$7,200,000	$4,200,000	$4,200,000	$18,000,000	$18,000,000	$0	$0	$3,000,000	$3,000,000	$21,000,000	$21,000,000
Permanent pipeline construction	$9,000,000		$6,400,000	$10,400,000	$5,800,000	$9,400,000	$3,400,000	$5,500,000	$10,400,000	$16,900,000	$0	$0	$2,400,000	$3,900,000	$14,400,000	$23,400,000
Transfer site/dike construction	$0		$5,600,000	$11,200,000	$0	$0	$0	$0	$5,600,000	$11,200,000	$0	$0	$5,600,000	$11,200,000	$5,600,000	$11,200,000
Dredging and dewatering plant	$78,200,000															
Reuse manufacturing plant	$298,800,000		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal	$511,400,000		$45,300,000	$78,700,000	$15,010,000	$21,640,000	$9,610,000	$14,740,000	$36,020,000	$51,200,000	$2,720,000	$6,440,000	$33,800,000	$64,700,000	$43,020,000	$60,700,000
Annualized, $/year	Costs to be offset by generated revenues		$1,931,000	$3,355,000	$640,000	$923,000	$410,000	$628,000	$1,536,000	$2,183,000	$116,000	$275,000	$1,441,000	$2,758,000	$1,834,000	$2,588,000
O&M/Removal Costs	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Tipping fee (costs reduced by any generated revenues)	$130,000,000	$195,000,000	$0	$0	$0	$0	$0	$0	$7,500,000	$37,500,000	$60,000,000	$90,000,000	$75,000,000	$112,500,000	$75,000,000	$112,500,000
Dredging + transportation	$0	$0	$75,000,000	$100,000,000	$50,000,000	$75,000,000	$25,000,000	$50,000,000	$100,000,000	$125,000,000	$200,000,000	$350,000,000	$100,000,000	$150,000,000	$100,000,000	$125,000,000
Manufacturing processing	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Construction design and management	$0	$0	$1,000,000	$2,000,000	$1,000,000	$2,000,000	$1,000,000	$2,000,000	$1,000,000	$2,000,000	$1,000,000	$2,000,000	$1,000,000	$2,000,000	$1,000,000	$2,000,000
Subtotal	$130,000,000	$195,000,000	$76,000,000	$102,000,000	$51,000,000	$77,000,000	$26,000,000	$52,000,000	$108,500,000	$164,500,000	$261,000,000	$442,000,000	$176,000,000	$264,500,000	$176,000,000	$239,500,000
Cost per Cubic Yard (assumes yearly removal)	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
One-time investment cost, $/cy	$102		$9	$16	$3	$4	$2	$3	$7	$10	$1	$1	$7	$13	$9	$12
Annualized investment cost, $/cy/year	$0	$0	$0	$1	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1	$0	$1
Annual removal cost, $/cy/year	$26	$39	$15	$20	$10	$15	$5	$10	$22	$33	$52	$88	$35	$53	$35	$48
Total annual cost, $/cy/year	$26	$39	$16	$21	$10	$16	$5	$11	$22	$33	$52	$88	$35	$53	$36	$48

	Alternative 1	Alternative 2A	Alternative 2B	Alternative 2C	Alternative 3A	Alternative 3B	Alternative 3C	Alternative 3D
Major Limitations	Substantial commitment to continual use would be required	Currently not allowed by law; large parcels adjacent to the river may be very difficult to find	Environmental impacts; NMFS concerns	Environmental impacts; NMFS concerns		Large parcels adjacent to the reservoir may be difficult to find	Large parcels expected to be difficult to find nearby	Effluent from dewatering will need to be pumped back to the Susquehanna River

General Assumptions:

These are concept-level costs for planning purposes only. Detailed design and cost estimate would be required for any future studies investigation implementation of any of these alternatives.

All alternatives assume the dredging of a location in Conowingo Reservoir which currently has the highest amounts of deposition in the entire lower Susquehanna reservoir system; similar costs could be developed for the other lower Susquehanna reservoirs.

Technical Assumptions:

Real estate cost = farmland cost in Harford/Cecil County, MD; range of cost = $10,000 to $20,000 per acre; based on Internet search of agricultural land June 2013; assume large tracts of land available.
Annualization factor = 23.456 for interest = 3.500% and project life of 50 years Rounding factor for annualization = 3
Each hydraulic dredge has its own separate pipeline and associated booster pump system, with a production capacity of 4,000 cubic yards per day; cost per booster pump = $300,000
Hydraulic dredging process will add a signficant amount of volume to the pipeline; assume pipeline will contain 4 times the dredging volume.
Drying process will be able to remove a signficant amount of the water that is pumped in with the dredged material; assume that material to be transported after drying is 1.5 times the original dredging volume.
Production capacity for one mechanical dredge = 500 cubic yards per day; material volume is increased by 20%, a factor of 1.2 , during dredging process
Barge capacity varies; for transport to Pooles Island, each barge is expected to hold 2,500 cubic yards; for in-reservoir dredging, the capacity would be much smaller, only 500 cubic yards/barge.
Permanent pipeline cost = $160,000 to $260,000 per mile ($30-50 per linear foot).
Transfer site/dike construction cost = 5-foot high dike for 3 feet of material, drying time of 2 months per cell, $8-16/cy construction cost
Tipping fee for Stancils Quarry is assumed to be $1-5/cy; tipping fee for Mason-Dixon Quarry is based on $10-15/cy; the tipping fees are applied to the dredged amount for pipeline delivery and to the trucked amount for truck delivery; outright purchase of quarry could be another option to tipping fees.
Universal conversion factor; 1 cubic yard of dredged material = 0.81 tons of sediment based on bulk density value of 1600 kilograms/meter ^{3}.

SCREENING LEVEL ESTIMATE

1 - Innovative Reuse

HarborRock Light Weight Aggregate

Logistics and Assumptions to Remove: 1 Million CY, 3 Million CY, and 5 Million CY of Sediment from Conowingo Reservoir

SCENARIO

Hydraulic dredges will be used to remove sediment from the Conowingo Reservoir. It is envisioned the slurry from the dredge will be pumped to a site along the shore line where it will pass over a series of screens to remove large debris or rocks, items nominally greater than 1 inch in diameter or length. This large material will be sold or disposed. The slurry will fall into a sump where it will be pumped downstream in a pipeline to a HarborRock placement site located at the Bainbridge property west east of Port Deposit. The HarborRock site will be 100 acres. The slurry from the pipeline will again pass over a series of screens to seperate the solids by size fractions that will be segreated and stored on site for subsequent drying and use. Some of water will be stired and used on site for process applications and the remainer will flow by seperate pipeline down to the Susquehanna River for discharge. The LWA will use the silts and clay material to make its lightweight aggreagte (LWA) product. For each CY dredged nominally 0.7 tons of LWA will be produced. The LWA will be distributed for sale by truck and by barge.

ASSUMPTIONS/BASIS FOR ESTIMATE:

This fact sheet makes a number of assumptions and qualifications in regards to removing sediment behind the Conowingo Dam via dredging and pumping the dredged sediment thru pipes to a location where a industrial plant can mechanical dewater the piped sediment. Once dewatered the dry sediment can be placed into a gas fired kiln to create Light Weight Aggregate (LWA) for construction material.

First – This initial effort only includes dredging for the Conowingo Dam in the Conowingo Reservoir. In the future other fact sheets could be developed for dredging Safe Harbor and Holtwood Dams.

Second – A CY of sediment is estimated to contain 0.81 tons of solid matter. harborRock has also assumed that a CY of sediment will contain debris or other materials, such as large stones, that are unsuitable for making LWA and that this fraction amounts to 5% of the weight in solids or 0.04 tons per CY of sediment. Therefore, a CY of sediment contains 0.77 tons of dry solid matter suitable to make LWA. In a rotary kiln, a bone dry ton of input material (sediment) yields nominally 0.9 tons of Light Weight Aggregate (LWA). Therefore, 1 CY of sediment will yield 0.69 tons of bone dry LWA, 0.7 tons for simplicity. Alternatively, 1 million CYs of sediment will yield 700,000 tons of LWA.

Rotary kilns may be sized to match the annual throughput need. For this project it would be easy to design a kiln to process 1 .0 million CY per year of sediments, therefore necessitating 1, 3 or 5 kilns as the project grows. This is perfectly acceptable and the modularity allows for project expansion and expenditure of funds as needed. This method however does increase the number of operating systems and total cost. Alternatively, if it were known that 3 million CY per year were required to be processed, 2 kilns, each rated to process 1.5 million CYs per year would be selected or 3 kilns each rated for nominally 1.67 million CYs per year if the goal was to process 5.0 million CYs per year. For purposes of this analysis 1 kiln will be used for 1 MCY, 2 kilns for 3 MCY and 3 kilns for 5 MCY and the corresponding ancillary systems.

Fourth - HarborRock's Sediment Management Fee, in addition to the revenue earned from the sale of its LWA product, is the amount needed to offset their cost "All – In" capital and operating costs for the LWA plant and provide a return on equity to its investers. these costs include operating all the equipment necessary to remove the sediments from the reservoir through pumping them to a location, producing and selling the lightweight aggregate product.

Description of Site and/or dewatering Locations and Processing Facility Where Applicable

This alternative consists of acquisition of **100 acres** of land the where a Light Weigh Aggregate (LWA) Plant will be constructed, which converts sediment behind the Conowingo Dam into light weight aggregate. The beneficial use of the dredged material is the creation of Light Weight Aggregate (LWA), which can be used for construction purposes. Suitable sites would be **100 acres and will** need access to roads, rail, and or barge infrastructure. One or more dredges would be needed in addition a pipeline and pumps to move the dredged material to the processing plant. The Plant will comprise of DM Slurry Storage tanks , Filter Press's and Flash Dryers, Pellet Extruders, Thermal Processing Kilns, Coolers, smoke stacks, Air Emission Control, Turbines for electrical generation, and a structure to house said equipment. The representative site would be located in the area 15 miles between Conowingo Dam and Holtwood dam and up to 5 miles inland from the river, or could be further downstream and up to 5 miles inland from the river in the 10 mile area between Havre De Grace and Conowingo Dam. The area available for a facility is only limited the hydraulic pumping distance. At the plant, the dredged material will be unloaded, stocked in the DM Slurry Tanks, and then Processed. Additional area will be needed to stockpile the light weight aggregate that is produced. It is assumed that the water from the dewatering process will be pumped back the Susquehanna river.

Evaluation of Available Capacity:

Total Amount of Material to be dredged (CY)	Sediment to be Removed Tons @ 0.81 tons per Cubic Yard	Number of Dredges at (400 CY/hr solids at 10 hour days or 4000 CY/day or 1000000 CY/yr) per Dredge	Actual CY of Sediment Plus Water Volume Hydraulically Dredged (water adds 4 times the original volume)	Distance to be Piped (miles)	
1,000,000	810,000	1	4,000,000	10	
3,000,000	2,430,000	3	12,000,000	10	
5,000,000	4,050,000	5	20,000,000	10	

Total Amount of Material to be dredged (CY)	Number of Pipes	Number of Booster pumps	Acreage Needed for Factory (acres)	Acreage Needed for Storage of Hydraulically Dredged Material (acres)	Total Acreage Neededl (acres)
1,000,000	1	3	80	20	100
3,000,000	3	9	80	20	100
5,000,000	5	15	80	20	100

Total Amount of Material to be dredged (CY)	Number of Slurry Screening Operations	Number of Rotary Dryers	Number of Flash Dryers	Number of Pellet Extruders	
1,000,000	2	1	1	4	
3,000,000	4	2	2	8	
5,000,000	6	4	4	16	

Ideally, there would be a site of approximately 2 acres size on-shore at the Conowingo Resevoir to allow for slurry screening to remov debris and a collection station of the outputs from the multiple dredges to allow for uniform and consisnet pumping of the slurry downs Removing large debris from the slurry initially will improve reliability, save time and cost.

Total Amount of Material to be dredged (CY)	Number of Kilns	Number of Coolers	Number of Smoke Stacks	Number of Air Emission Controllers	
1,000,000	1	1	1	1	
3,000,000	2	2	2	2	
5,000,000	3	3	3	3	

Multiple stacks are proposed to allow for maximum reliability and up time for operations. The loss of a kiln or other device in a single t would then only affect that train.

COSTS

One-Time Investment Costs

Total Amount of Material to be dredged (CY)	Design and study costs (includes development, permitting and engineering)	Legal and Financial services (includes capitalized interest, debt service and major maintanence reserve funds and fees)	Booster pump construction	Permanent pipeline construction	Dredging & dewatering plant	Reuse manufacturing plant, buildings & shipping equipment	TOTAL
1,000,000	13,339,450	27,645,057	2,250,000	1,800,000	28,553,813	108,239,629	$181,827,948
3,000,000	21,599,677	65,652,691	6,750,000	5,400,000	56,637,522	212,015,378	$368,055,267
5,000,000	26,099,677	88,044,244	11,250,000	9,000,000	78,196,230	298,780,385	$511,370,536

O&M/Removal Costs

Total Amount of Material to be dredged (CY)	Manufacturing processing	Management and financial repayment (30 yrs.)	TOTAL
1,000,000	$43,136,320	$17,095,261	60,231,581
3,000,000	$120,478,090	$31,758,675	152,236,765
5,000,000	$203,180,414	$42,499,175	245,679,589

Sales Revenue

Total Amount of Material to be dredged (CY)	Net LWA Rrevenue (gross sales minus profit)
1,000,000	$11,907,480
3,000,000	$42,461,770
5,000,000	$67,780,000

Tip Fee Range - Privately financed

Total Amount of Material to be dredged (CY)	Expected	Low	High
1,000,000	$48	$46	$50
3,000,000	$37	$34	$39
5,000,000	$36	$32	$39

Tip Fee Range - Publically financed

Total Amount of Material to be dredged (CY)	Expected	Low	High
1,000,000	Unknown	$39	$40
3,000,000	Unknown	$29	$33
5,000,000	Unknown	$26	$33

Note:

If the total quantity to be dredged annually is known at start of design, then there may be fewer total systems, stacks etc. used.
Elimination of Booster pumps and pipeline one-time investment costs lowers Tip Fee by $1.00 - 2.00/CY
There is 1 pipeline and associated booster pumps per 1 MCY.
Economies of scale would result if pipeline were designed to maximum flow, eliminating multiple pipes. It would appear a good size for the pipeline would be 3.42 MCY. At this size, increasing operational days from 250 to 365 increases annual flow by a factor
Private Finance = 80% debt finaced over 30 years at 5.25% per annum.
Public Finace = 100% debt finaced at 3.75% per annum for 50 years

SCREENING LEVEL ESTIMATE

2A - Open Water Placement

Pooles Island Open Water Placement

Logistics and Assumptions to Remove: 1 Million CY, 3 Million CY, and 5 Million CY of Sediment from Conowingo Reservoir

SCENARIO

Hydraulic dredges will be used to remove sediment from the Conowingo Reservoir, then using a pipeline from the dredge the removed sediment will be pumped downstream to a temporary placement site that is available near Port Deposit. At this location material can be dewatered and loaded into barges. Once the dredged material is placed onto the barges it will be moved to a placement site at Pooles Island, Md.

ASSUMPTIONS/BASIS FOR ESTIMATE:

1) The Pooles Island placement area is assumed to be 350 acres, the expansion of the Pooles Island site connects G-West to Site 92. Allowable fill would be to a depth to -11' MLLW.

2) The 350 ac site is identified as having 4.7 mcy of capacity which would result in an 8.3 ft placement thickness (4,700,000cy x 27cf/cy /350 ac / 43560 cf/ac = 8.32 ft thick). The assumption holds that Pooles Island capacity to handle new material recharges yearly allowing for 4.7 CY of material to be placed every year.

3) Assume 1 cy of sediment contains 0.81 tons of solids.

4) An initial estimate and sizing of a dredge for Conowingo reservoir placement indicated that a dredge such as the Jet Dragon 870 should be suitable for dredging the Conowingo Reservoir at 400 CY / hr. A Jet Dragon 870 Dredge costs 1.5 million. (Based on discussion and materials from Ellicott Dredging Company who have dredges such as the dragon cutter head line which can dredge from 100 to 1000 CY/hr)

5) This estimate will be based on the assumption that there are 250 work days per year and up to 10 work hours days.

6) Approximately 7 boosters per pipe at $300,000 per booster will be needed to get hydraulically dredged material to a temporary placement site that is assumed to be available across the river from Port Deposit (circled in green in the picture below) the dredge will push the sediment for the first mile then booster pumps are needed every mile thereafter.

7) The Legislative restrictions for open water placement at Pooles Island would be lifted or suspended. Opposition from the fishing community will be assuaged.

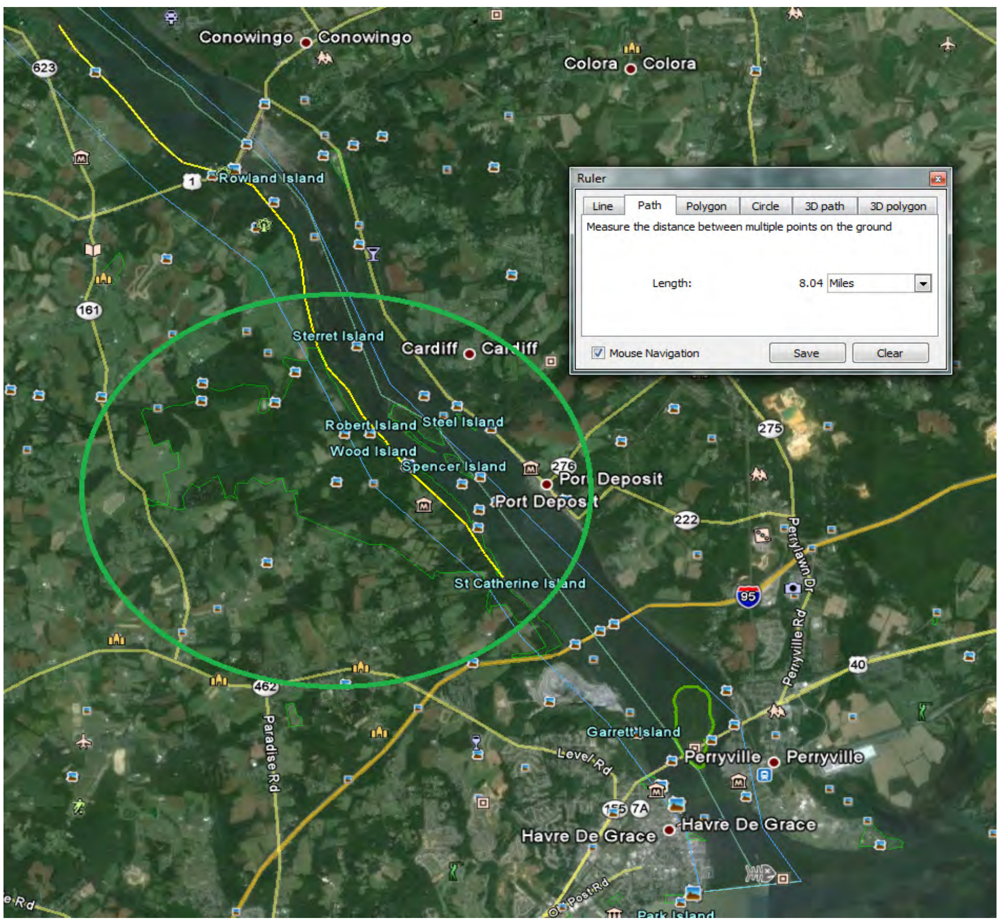
8) Dredged material would first be removed from the reservoir via hydraulic dredging and pumped to a temporary holding site near Port Deposit. This site would be a number of acres surrounded by a sediment holding dike which will contain the dredged material while it is dewatered by working and trenching the material with bulldozers. Drying the material will take approximately 4 months per cell.

9) After the sediment is dewatered the material will then be mechanically loaded into barges via clam shell dredge or large excavators and transported to the Pooles Island placement site ~30 Miles by barge The material would then be pumped from the barge into the Pooles Island open water site.

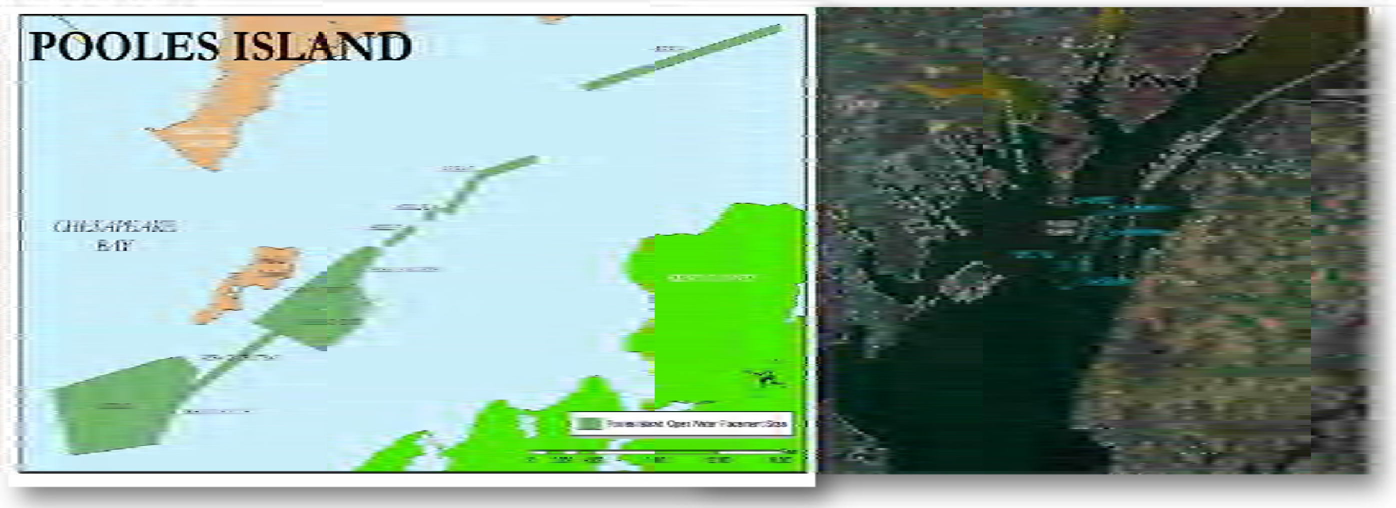
10) We are assuming a 2500 cy / barge will have access to transfer sites at our temporary dewatering site

11) Equipment needed: Dredge's, Pipe, Booster Pumps, Excavators (enough to remove the same amount of material that the dredge pumps per hour), Bulldozers (to trench and move material for drying), Barges.

Potential temporary placement sites across river from Port Deposit in the Susquehanna St Park with access to River.



Location of Pooles island



Evaluation of Available Capacity:

Total Amount of Material to be dredged (CY)	Number of Dredges at (400 CY/hr solids at 10 hour days or 4000 CY/day or 1000000 CY/yr) per Dredge	Number of days to dredge amount at given number of dredges.	Actual CY of Sediment Plus Water Volume Hydraulically Dredged	Distance to be Piped (miles)	Number of Pipes	Number of Booster pumps	Equivalent Acreage of Hydraulically Dredged Material @ 3 ft or 1 yd depth
1,000,000	1	250	4,000,000	8	1	7	800
3,000,000	3	250	12,000,000	8	3	21	2,500
5,000,000	5	250	20,000,000	8	5	35	4,100

Total (CY) of Sediment Plus Water Volume Placed into Temporary Holding Cells During One Year	Equivalent Acreage of Hydraulically Dredged Material @ 3 ft or 1 yd depth	Acreage needed for 6 drying Cells which are used 2 times per year for temporary placement	Area of one Drying Cell (acres)	Dike Length in Feet for 6 cells	Dike Volume in CY for 6 cells at 5 ft elevation	Dewatered Volume of Material (1.5 times original amount dredged)
4,000,000	800	420	70	33,200	140,000	1,500,000
12,000,000	2,500	1,250	210	99,600	420,000	4,500,000
20,000,000	4,100	2,080	350	166,000	700,000	7,500,000

Temporary Dewatering Sediment Cells and Associated Months of Handling

	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	
Pump	1	2	3	4	5	6	Cycle 1
Dry	2,3,4,5	3,4,5,6	4,5,6,7	6,7,8,9	7,8,9,10	8,9,10,11	
Remove	6	7	8	9	10	11	
Pump	7	8	9	10	11	12	Cycle 2
Dry	8,9,10,11	9,10,11,12	10,11,12,1	11,12,1,2,	12,1,2,3	1,2,3,4	
Remove	12	1	2	3	4	5	

Volume of Material to be barged to Pooles Island After Drying (CY)	Volume of Dried Material per Drying Cell (CY)	Area of one Drying Cell (acres)	Transfer pads and associated 400 Cy/hr transfer excavators per Drying Cell	Number of barge loads per day	Number of loads per year at 2500 cy/barge	Percentage of Material Dredged per year that Pooles island can Handle per year (%)	# of dredging cycles that facility could be used before capacity is reached
1,500,000	130,000	70	1	2	600	100	Unknown
4,500,000	380,000	210	4	7	1,800	100	Unknown
7,500,000	630,000	350	7	12	3,000	63	Unknown

SCREENING LEVEL ESTIMATE

2B - Open Water Placement

5 Months of Sediment Bypassing

Logistics and Assumptions to Remove: 1 Million CY, 3 Million CY, and 5 Million CY of Sediment from Conowingo Reservoir

SCENARIO

Hydraulic dredges will be used to remove sediment from the Conowingo Reservoir, then using a pipeline from the dredge the removed sediment will be pumped past Conowingo Dam downstream to a release point bypassing sediment over 5 months from October - February.

ASSUMPTIONS/BASIS FOR ESTIMATE:

1) Assume 1 cy of sediment contains 0.81 tons of solids.

2) An initial estimate and sizing of a dredge for Conowingo reservoir placement indicated that a dredge such as the Jet Dragon 870 should be suitable for dredging the Conowingo Reservoir at 400 CY / hr. A Jet Dragon 870 Dredge costs 1.5 million. (Based on discussion and materials from Ellicott Dredging Company who have dredges such as the dragon cutter head line which can dredge from 100 to 1000 CY/hr)

3) This estimate will be based on the assumption that there are approximately 105 work days in five months and up to 10 work hours days.

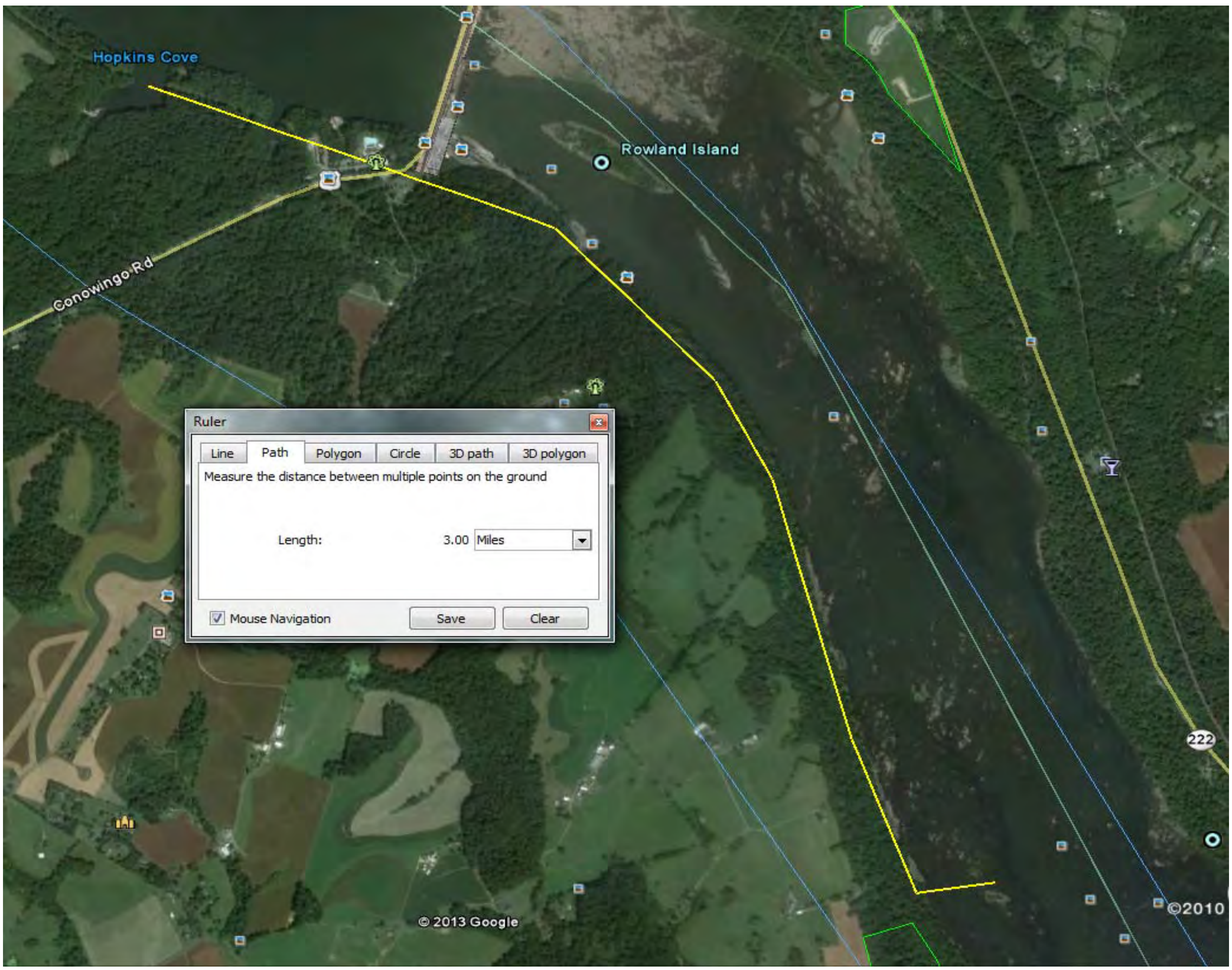
4) A sediment release point can be found down stream of the dam where channel hydraulics would promote sustainable sediment transport.

5) Approximately 2 boosters per pipe at $300,000 per booster are needed to get hydraulically dredged material past Conowingo Dam. The dredge will push the sediment for the first mile then booster pumps are needed every mile thereafter.

6) The Legislative restrictions for open water placement would be lifted or suspended. Opposition from the fishing community will be assuaged.

7) Equipment needed: Dredge's, Pipe, Booster Pumps.

Sediment Pipe around Conowingo Dam and location of Down Stream Release point in the Susquehanna River.



Evaluation of Available Capacity:

Total Amount of Material to be dredged (CY)	Number of Dredges at (400 CY/hr solids at 10 hour days or 4000 CY/day per Dredge at 21 days per month or 84000 CY per month	Number of days to dredge amount at given number of dredges.	Actual CY of Sediment Plus Water Volume Hydraulically Dredged	Distance to be piped (miles)	Number of Pipes	Number of Booster pumps	Percentage of Material Dredged per year that can be Bypassed per year (%) (No Total Capacity Limit)
1,000,000	3	83	4,000,000	3	3	6	100
3,000,000	8	94	12,000,000	3	8	16	100
5,000,000	12	104	20,000,000	3	12	24	100

SCREENING LEVEL ESTIMATE

2C - Open Water Placement

9 Months of Sediment Bypassing

Logistics and Assumptions to Remove: 1 Million CY, 3 Million CY, and 5 Million CY of Sediment from Conowingo Reservoir

SCENARIO

Hydraulic dredges will be used to remove sediment from the Conowingo Reservoir, then using a pipeline from the dredge the removed sediment will be pumped past Conowingo Dam downstream to a release point bypassing sediment over 9 months from July-March.

ASSUMPTIONS/BASIS FOR ESTIMATE:

1) Assume 1 cy of sediment contains 0.81 tons of solids.

2) An initial estimate and sizing of a dredge for Conowingo reservoir placement indicated that a dredge such as the Jet Dragon 870 should be suitable for dredging the Conowingo Reservoir at 400 CY / hr. A Jet Dragon 870 Dredge costs 1.5 million. (Based on discussion and materials from Ellicott Dredging Company who have dredges such as the dragon cutter head line which can dredge from 100 to 1000 CY/hr)

3) This estimate will be based on the assumption that there are approximately 190 work days in nine months and up to 10 work hours days.

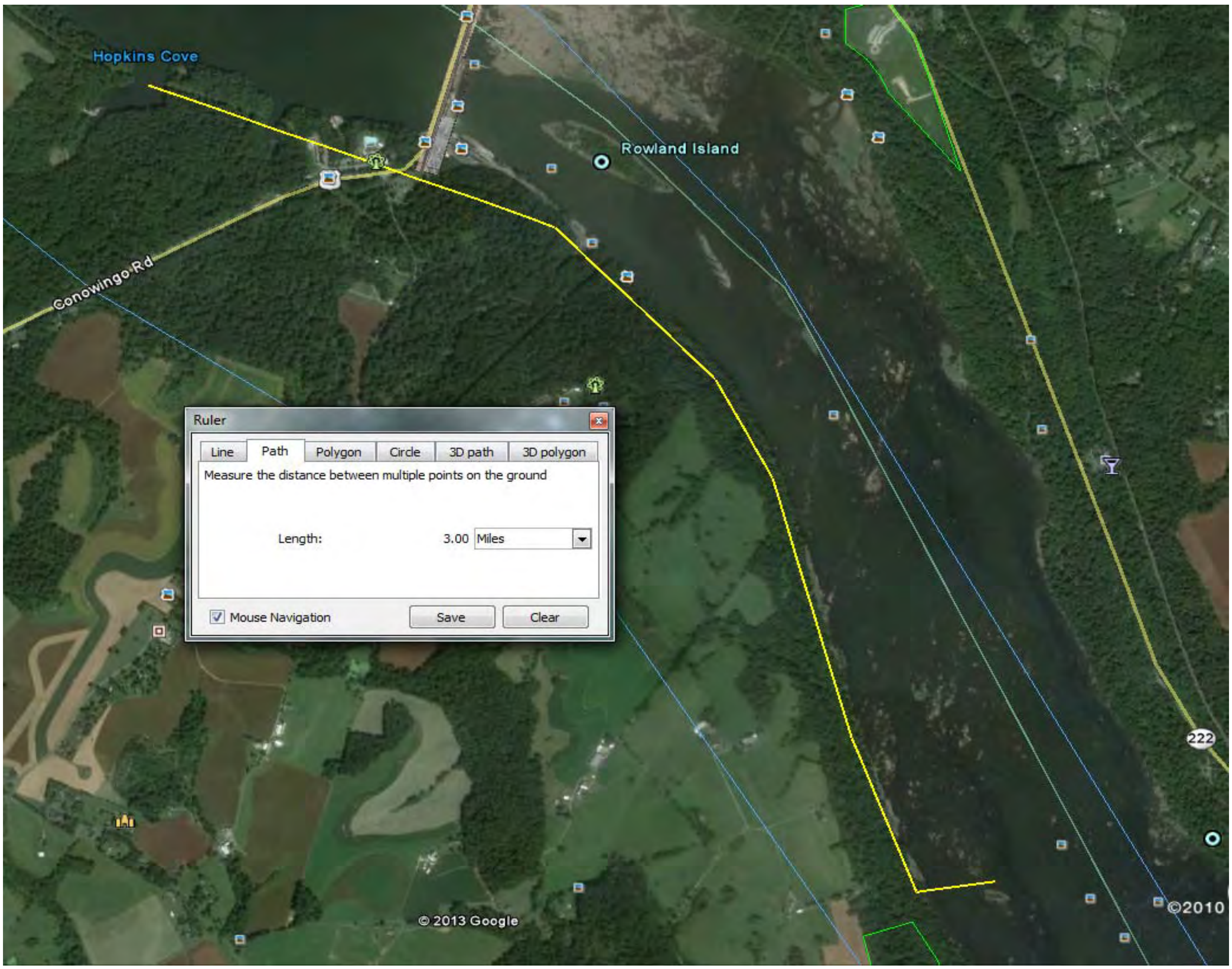
4) A sediment release point can be found down stream of the dam where channel hydraulics would promote sustainable sediment transport.

5) Approximately 2 boosters per pipe at $300,000 per booster are needed to get hydraulically dredged material past Conowingo Dam. The dredge will push the sediment for the first mile then booster pumps are needed every mile thereafter.

6) The Legislative restrictions for open water placement would be lifted or suspended. Opposition from the fishing community will be assuaged.

7) Equipment needed: Dredge's, Pipe, Booster Pumps.

Sediment Pipe around Conowingo Dam and location of Down Stream Release point in the Susquehanna Rive



Evaluation of Available Capacity:

Total Amount of Material to be dredged (CY)	Number of Dredges at (400 CY/hr solids at 10 hour days or 4000 CY/day per Dredge at 21 days per month or 84000 CY per month	Number of days to dredge amount at given number of dredges.	Actual CY of Sediment Plus Water Volume Hydraulically Dredged	Distance to be piped (miles)	Number of Pipes	Number of Booster pumps	Percentage of Material Dredged per year that can be Bypassed per year (%) (No Total Capacity Limit)
1,000,000	2	125	4,000,000	3	2	4	100
3,000,000	4	188	12,000,000	3	4	8	100
5,000,000	7	179	20,000,000	3	7	14	100

SCREENING LEVEL ESTIMATE

3A - Upland Placement

Stancil Quarry Upland Placement

Logistics and Assumptions to Remove: 1 Million CY, 3 Million CY, and 5 Million CY of Sediment from Conowingo Reservoir

SCENARIO

Hydraulic dredges will be used to remove sediment from the Conowingo Reservoir, then using a pipeline from the dredge the removed sediment will be pumped downstream to a dewatering site at Stancil Quarry before it is placed in a permanent site that is available at Stancil Quarry.

ASSUMPTIONS/BASIS FOR ESTIMATE:

1) Assume 1 cy of sediment contains 0.81 tons of solids.

2) An initial estimate and sizing of a dredge for Conowingo reservoir placement indicated that a dredge such as the Jet Dragon 870 should be suitable for dredging the Conowingo Reservoir at 400 CY / hr. A Jet Dragon 870 Dredge costs 1.5 million. (Based on discussion and materials from Ellicott Dredging Company who have dredges such as the dragon cutter head line which can dredge from 100 to 1000 CY/hr)

3) This estimate will be based on the assumption that there are 250 work days per year and up to 10 work hours days.

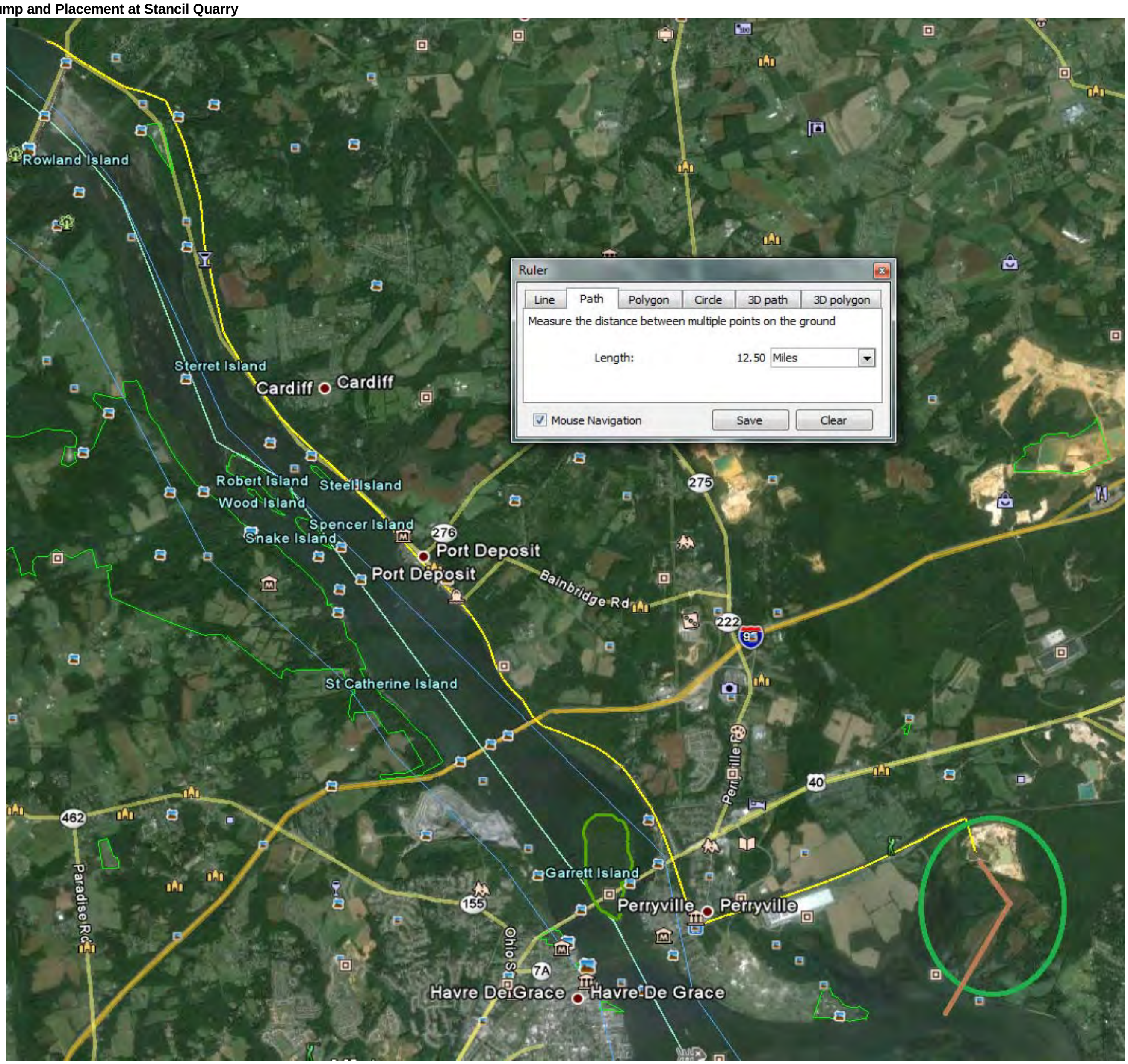
4) Approximately 12 boosters per pipe at $300,000 per booster will be needed to get hydraulically dredged material to Stancil Quarry. The dredge will push the sediment for the first mile then booster pumps are needed every mile thereafter.

5) Dredged material would first be removed from the reservoir via hydraulic dredging and pumped 13 miles to a holding area at Stancil Quarry where it can be dewatered to the Susquehanna flats. Once the material is dewatered it can be placed perminantly in final fill areas at the quarry. The dewatering site at the quarry would be a number of acres surrounded by a sediment holding dike which will contain the dredged material while it is dewatered by working and trenching the material with bulldozers. Drying the material will take approximately 4 months per cell.

6) After the sediment is dewatered the material will then be pushed and moved via bulldozer and excavator to a final fill location within Stancil Quarry.

7) Equipment needed: Dredge's, Pipe, Booster Pumps, Excavators, Bulldozers (to trench and move material for drying).

Pump and Placement at Stancil Quarry



Evaluation of Available Capacity:

Total Amount of Material to be dredged (CY)	Number of Dredges at (400 CY/hr solids at 10 hour days or 4000 CY/day or 1000000 CY/yr) per Dredge	Number of days to dredge amount at given number of dredges.	Actual CY of Sediment Plus Water Volume Hydraulically Dredged	Distance to be Piped (miles)	Number of Pipes	Number of Booster pumps	Equivalent Acreage of Hydraulically Dredged Material @ 3 ft or 1 yd depth
1,000,000	1	250	4,000,000	13	1	12	800
3,000,000	3	250	12,000,000	13	3	36	2,500
5,000,000	5	250	20,000,000	13	5	60	4,100

Total (CY) of Sediment Plus Water Volume Placed into Temporary Holding Cells During One Year	Equivalent Acreage of Hydraulically Dredged Material @ 3 ft or 1 yd depth	Acreage needed for 6 drying Cells which are used 2 times per year for temporary placement	Area of one Drying Cell (acres)	Dike Length in Feet for 6 cells	Dike Volume in CY for 6 cells at 5 ft elevation	Dewatered Volume of Material (1.5 times original amount dredged)
4,000,000	800	420	70	33,200	140,000	1,500,000
12,000,000	2,500	1,250	210	99,600	420,000	4,500,000
20,000,000	4,100	2,080	350	166,000	700,000	7,500,000

Temporary Dewatering Sediment Cells and Associated Months of Handling

	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	
Pump	1	2	3	4	5	6	Cycle 1
Dry	2,3,4,5	3,4,5,6	4,5,6,7	6,7,8,9	7,8,9,10	8,9,10,11	
Remove	6	7	8	9	10	11	
Pump	7	8	9	10	11	12	Cycle 2
Dry	8,9,10,11	9,10,11,12	10,11,12,1	11,12,1,2,	12,1,2,3	1,2,3,4	
Remove	12	1	2	3	4	5	

Volume of Material for Permanent placement at Stancil Quarry After Drying (CY)	Volume of Dried Material per Drying Cell (CY)	Area of one Drying Cell (acres)	Percentage of Material Dredged per year that Stancil Quarry can Handle per year (%)	# of dredging cycles that facility could be used till capacity is reached
1,500,000	130,000	70	Unknown	6
4,500,000	380,000	210	Unknown	2
7,500,000	630,000	350	Unknown	1

SCREENING LEVEL ESTIMATE

3B - Upland Placement

Mason Dixon Quarry Upland Placement - Mechanical Dredge

Logistics and Assumptions to Remove: 1 Million CY, 3 Million CY, and 5 Million CY of Sediment from Conowingo Reservoir

SCENARIO

Mechanical dredges will be used to remove sediment from the Conowingo Reservoir and place that sediment into barges, then the barges will circulate between the dredges and the southern shoreline where their contents will be offloaded via excavators. The southern shoreline was chosen due to the rail line on the northern shoreline, which would make offloading the barges too expensive or potentially unfeasible. There will be staging areas on the southern shoreline for the transfer of dredge material from each barge to the trucks An excavator at each transfer site will then place the wet material into trucks able to hall 12 cy of wet material. Each staging area will have one excavator which will unload the barge and transfer its contents to the trucks at a assumed rate of one truck every 10 minutes. The trucks will then cross the Conowingo Bridge and drive to Mason Dixon Quarry where they will unload their contents, and return to be filled again.

ASSUMPTIONS/BASIS FOR ESTIMATE:

1) Assume 1 cy of sediment contains 0.81 tons of solids.

2) An initial estimate of the sizing of a mechanical dredge for Conowingo reservoir suggested a mechanical dredge capable of removing remove 500 CY / day would be the minimum size dredge needed..

3) This estimate will be based on the assumption that there are 250 work days per year and up to 10 work hours days.

4) Pipes or pumping of sediment infrastructure are not needed for the logistics of this example.

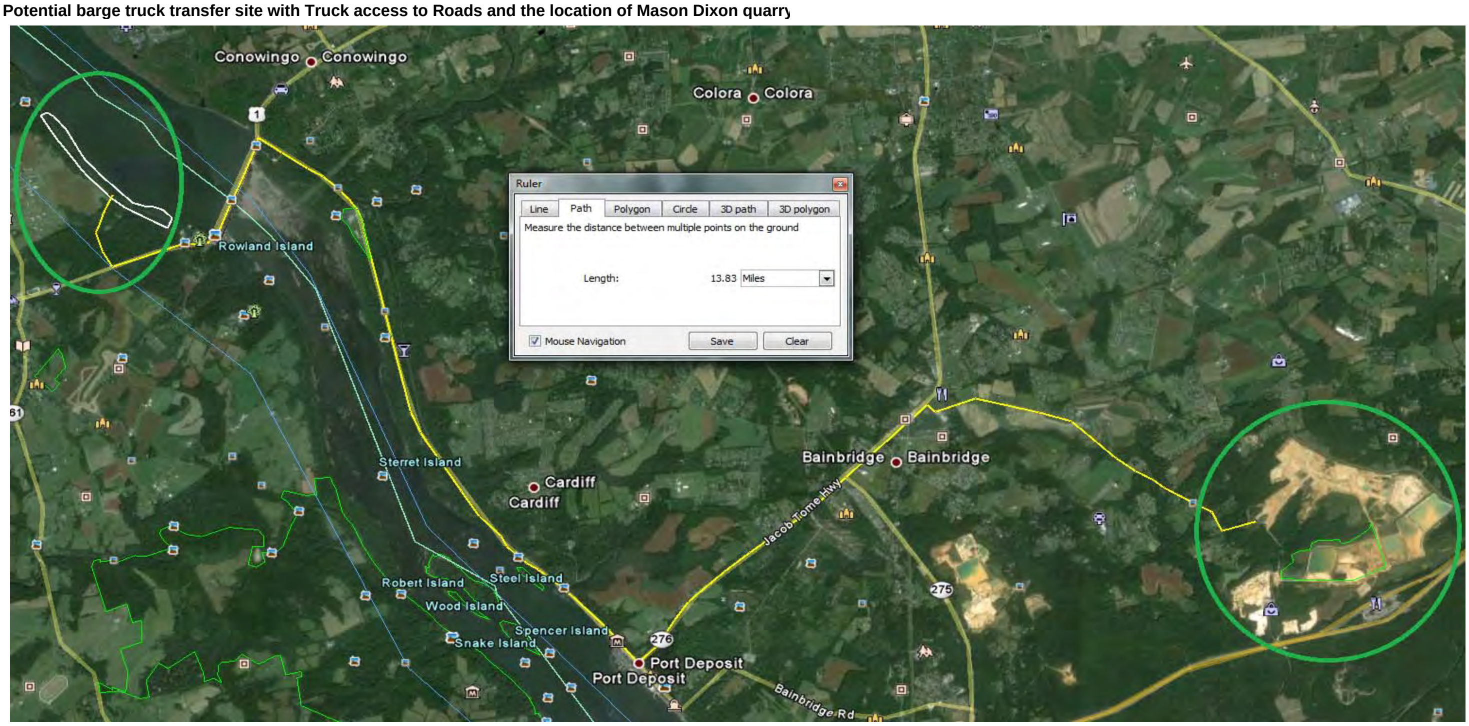
5) Dredged material would first be removed from the reservoir via mechanical dredging and barged to a transfer sites on the Conowingo Reservoir southern shore. There the wet material will be transferred to trucks via excavators. The material will then be trucked to Mason Dixon Quarry for final placement.

6) The depth necessary to move the required number of 500 CY barges is present or can be dredged, and the dock structure to allow excavators to transfer sediment from barge to truck will be able to be constructed.

7) Any temporary to permanent road structures to allow sediment trucks to access state, or county roads and highways will be built, and all road access for the large number of trucks will be approved.

8) Equipment needed: Mechanical Dredge, Barges, Trucks, Excavators, and Bulldozers (to move material at Mason Dixon Quarry).

Potential barge truck transfer site with Truck access to Roads and the location of Mason Dixon quarry



Evaluation of Available Capacity: Based on Mechanical Dredging

Total Amount of Material to be dredged (CY)	Number of Dredges at 500 CY/day per Dredge	Number of days to dredge amount at given number of dredges.	Actual CY of Sediment Plus Water Volume Mechanically Dredged (1.2 times original amt.)	Number of Barge Loads per day at 500 CY per barge	~ Total Number of Truck Loads Per Day @ ~42 Truck Loads per Barge	~ Total Number of Truck Loads Per Year	Number of Transfer sites at 6 trucks per hour per transfer site
1,000,000	8	250	1,200,000	9.6	400	100000	10
3,000,000	24	250	3,600,000	28.8	1200	300000	29
5,000,000	40	250	6,000,000	48.0	2000	500000	48

Transfer Area Acreage needed at 1.5 acres per Transfer Site	Volume of Material for Permanent placement at Mason Dixon Quarry (CY)	Percentage of Material Dredged per year that Mason Dixon can Handle per year (%)	# of dredging cycles that facility could be used till capacity is reached
15	1,200,000	Unknown	29
44	3,600,000	Unknown	10
72	6,000,000	Unknown	6

SCREENING LEVEL ESTIMATE

3C - Upland Placement

Mason Dixon Quarry Upland Placement - Hydraulic Dredge

Logistics and Assumptions to Remove: 1 Million CY, 3 Million CY, and 5 Million CY of Sediment from Conowingo Reservoir

SCENARIO

Hydraulic dredges will be used to remove sediment from the Conowingo Reservoir, then using a pipeline from the dredge the removed sediment will be pumped downstream to a dewatering site that is across the Susquehanna River from Port Deposit. At this location material can be dewatered then once dried the material can be placed onto the trucks via excavators to be moved to a final placement site at Mason Dixon Quarry.

ASSUMPTIONS/BASIS FOR ESTIMATE:

1) Assume 1 cy of sediment contains 0.81 tons of solids.

2) An initial estimate and sizing of a dredge for Conowingo reservoir placement indicated that a dredge such as the Jet Dragon 870 should be suitable for dredging the Conowingo Reservoir at 400 CY / hr. A Jet Dragon 870 Dredge costs 1.5 million. (Based on discussion and materials from Ellicott Dredging Company who have dredges such as the dragon cutter head line which can dredge from 100 to 1000 CY/hr)

3) This estimate will be based on the assumption that there are 250 work days per year and up to 10 work hours days.

4) Approximately 2 boosters per pipe at $300,000 per booster will be needed to get hydraulically dredged material to past Conowingo Dam 3 miles to a temporary placement site assumed to be available (the area outlined in white in picture below) across the Susquehanna River from Port Deposit . The dredge will push the sediment for the first mile then booster pumps are needed every mile thereafter.

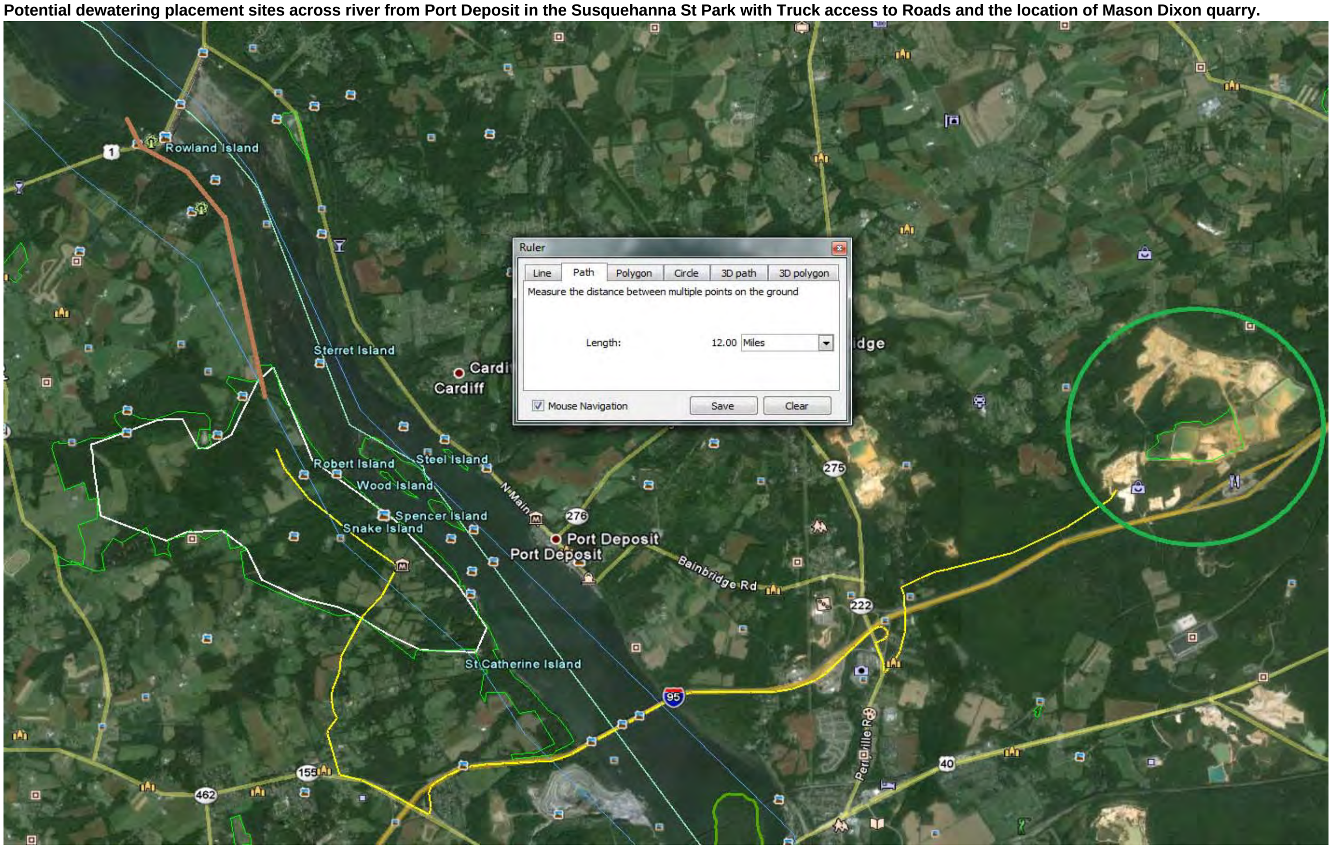
5) Dredged material would first be removed from the reservoir via hydraulic dredging and pumped 3 miles to a holding area across the river from Port Deposit, where it can be dewatered. Once the material is dewatered it can be loaded onto trucks to be transported to Mason Dixon Quarry. The dewatering site would be a number of acres surrounded by a sediment holding dike which will contain the dredged material while it is dewatered by working and trenching the material with bulldozers. Drying the material will take approximately 4 months per cell.

6) After the sediment is dewatered the material will then be mechanically loaded into trucks via excavators and transported to the Mason Dixon Quarry final placement site ~12 Miles by truck and going over the Millard E. Tydings Bridge which is part of interstate 95 and driving on other state and Local Roads roads and some temporary roads created for this project. The material would then be offloaded from the trucks to the final placement site at the quarry.

7) Any temporary to permanent road structures to allow sediment trucks to access state, or county roads and highways will be built, and all road access for the large number of trucks will be approved.

8) Equipment needed: Dredge's, Pipe, Booster Pumps, Excavators, Bulldozers (to trench and move material for drying), and Trucks.

Potential dewatering placement sites across river from Port Deposit in the Susquehanna St Park with Truck access to Roads and the location of Mason Dixon quarry.



Evaluation of Available Capacity:

Total Amount of Material to be dredged (CY)	Number of Dredges at (400 CY/hr solids at 10 hour days or 4000 CY/day or 1000000 CY/yr) per Dredge	Number of days to dredge amount at given number of dredges.	Actual CY of Sediment Plus Water Volume Hydraulically Dredged	Distance to be Piped (miles)	Number of Pipes	Number of Booster pumps	Equivalent Acreage of Hydraulically Dredged Material @ 3 ft or 1 yd depth
1,000,000	1	250	4,000,000	3	1	2	800
3,000,000	3	250	12,000,000	3	3	6	2,500
5,000,000	5	250	20,000,000	3	5	10	4,100

Total (CY) of Sediment Plus Water Volume Placed into Temporary Holding Cells During One Year	Equivalent Acreage of Hydraulically Dredged Material @ 3 ft or 1 yd depth	Acreage needed for 6 drying Cells which are used 2 times per year for temporary placement	Area of one Drying Cell (acres)	Dike Length in Feet for 6 cells	Dike Volume in CY for 6 cells at 5 ft elevation	Dewatered Volume of Material (1.5 times original amount dredged)
4,000,000	800	420	70	33,200	140,000	1,500,000
12,000,000	2,500	1,250	210	99,600	420,000	4,500,000
20,000,000	4,100	2,080	350	166,000	700,000	7,500,000

Temporary Dewatering Sediment Cells and Associated Months of Handling

	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6	
Pump	1	2	3	4	5	6	Cycle 1
Dry	2,3,4,5	3,4,5,6	4,5,6,7	6,7,8,9	7,8,9,10	8,9,10,11	
Remove	6	7	8	9	10	11	
Pump	7	8	9	10	11	12	Cycle 2
Dry	8,9,10,11	9,10,11,12	10,11,12,1	11,12,1,2,	12,1,2,3	1,2,3,4	
Remove	12	1	2	3	4	5	

Volume of Material for Permanent placement at Stancil Quarry After Drying (CY)	Volume of Dried Material per Drying Cell (CY)	Area of one Drying Cell (acres)	~ Total Number of Truck Loads Per Year	Number of Transfer sites at 6 trucks per hour over 10 hours per transfer site	Percentage of Material Dredged per year that Mason Dixon Quarry can Handle per year (%)	# of dredging cycles that facility could be used till capacity is reached
1,500,000	130,000	70	125000	9.0	Unknown	23
4,500,000	380,000	210	375000	25.0	Unknown	8
7,500,000	630,000	350	625000	42.0	Unknown	5

SCREENING LEVEL COST ESTIMATE

3D - Upland Placement

Mason Dixon Belvidere Quarry Upland Placement - Hydraulic Dredge

Logistics and Assumptions to Remove: 1 Million CY, 3 Million CY, and 5 Million CY of Sediment from Conowingo Reservoir

SCENARIO

Hydraulic dredges will be used to remove sediment from the Conowingo Reservoir, then using a pipeline from the dredge the removed sediment will be pumped downstream directly to the Mason Dixon (Belvidere Plant) Quarry in Cecil County Md., where it can be dewatered and permanently placed at the site.

ASSUMPTIONS/BASIS FOR ESTIMATE:

1) Assume 1 cy of sediment contains 0.81 tons of solids.

2) An initial estimate and sizing of a dredge for Conowingo reservoir placement indicated that a dredge such as the Jet Dragon 870 should be suitable for dredging the Conowingo Reservoir at 400 CY / hr. A Jet Dragon 870 Dredge costs 1.5 million. (Based on discussion and materials from Ellicott Dredging Company who have dredges such as the dragon cutter head line which can dredge from 100 to 1000 CY/hr)

3) This estimate will be based on the assumption that there are 250 work days per year and up to 10 work hours days.

4) Approximately 13 boosters per pipe at $300,000 per booster will be needed to get hydraulically dredged material to Mason Dixon Belvidere Quarry. The dredge will push the sediment for the first mile then booster pumps are needed every mile thereafter.

5) Dredged material would first be removed from the reservoir via hydraulic dredging and pumped over 13 miles to a holding area at Mason Dixon Belvidere Quarry where it can be dewatered to ***the Susquehanna River or to the Susquehanna flats approximately 5 miles away.*** Once the material is dewatered it can be placed permanently in final fill areas at the quarry. ***The dewatering site will be a number of acres surrounded by a sediment holding dike which will contain the dredged material while it is dewatered by working and trenching the material with bulldozers. Drying the material will take approximately 4 months per cell.***

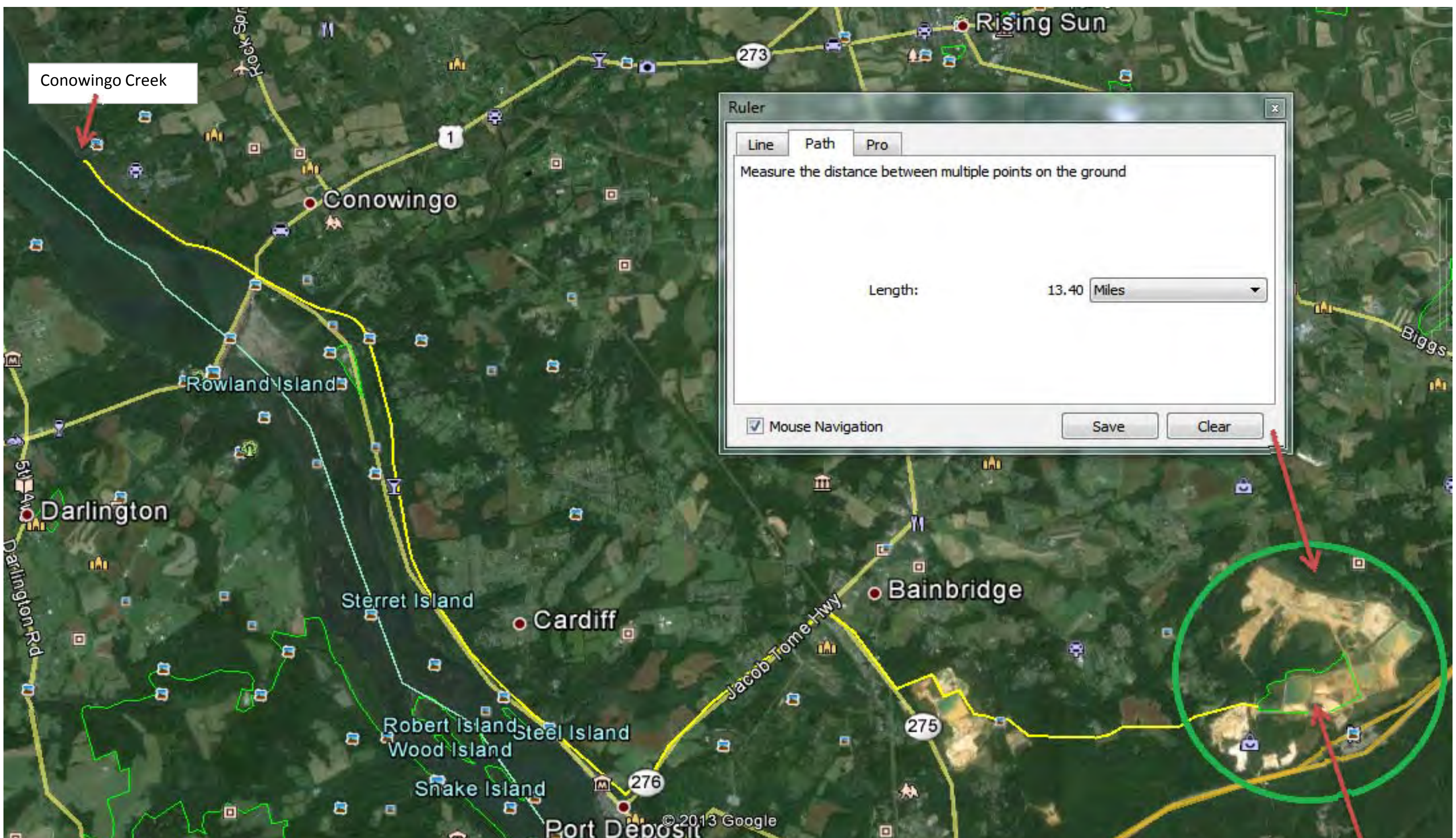
6) Where needed the pipeline can be constructed along roads, rail lines and thru areas of farm land or forest.

7) Initially the dredges will pump sediment under the train trestle on Old Conowingo Creek in order to cross under the rail lines, and move the material in the pipeline from water to land.

8) Cells will be set up to dewater the sediment at the Quarry and Effluent will be pumped back to the Susquehanna River or the Susquehanna Flats area 5 miles away. After the sediment is dewatered the material will then be pushed and moved via bulldozer and excavator to a final fill location within the Quarry.

9) Equipment needed: Dredge's, Pipe, Booster Pumps, Excavators, Bulldozers (to trench and move material for drying).

Location of Proposed Pipeline and Mason Dixon Belvidere Quarry in Cecil County Md.



Belvidere Quarry

Evaluation of Available Capacity:

Total Amount of Material to be dredged (CY)	Number of Dredges at (400 CY/hr solids at 10 hour days or 4000 CY/day or 1000000 CY/yr.) per Dredge	Number of days to dredge amount at given number of dredges.	Actual CY of Sediment Plus Water Volume Hydraulically Dredged	Distance to be Piped (miles)	Number of Pipes	Number of Booster pumps	Equivalent Acreage of Hydraulically Dredged Material @ 3 ft. or 1 yd. depth
1,000,000	1	250	4,000,000	***14***	1	***13***	800
3,000,000	3	250	12,000,000	***14***	3	***39***	2,500
5,000,000	5	250	20,000,000	***14***	5	***65***	4,100

Total (CY) of Sediment Plus Water Volume Placed into Temporary Holding Cells During One Year	***Equivalent Acreage of Hydraulically Dredged Material @ 3 ft. or 1 yd. depth***	***Acreage needed for 6 drying Cells which are used 2 times per year for temporary placement***	***Area of one Drying Cell (acres)***	***Dike Length in Feet for 6 cells***	***Dike Volume in CY for 6 cells at 5 ft. elevation***	***Dewatered Volume of Material (1.5 times original amount dredged)***	***Distance to Pipe Effluent from Dewatering Operation (miles) using 2 pumps***
4,000,000	***800***	***420***	***70***	***33,200***	***140,000***	***1,500,000***	***5***
12,000,000	***2,500***	***1,250***	***210***	***99,600***	***420,000***	***4,500,000***	***5***
20,000,000	***4,100***	***2,080***	***350***	***166,000***	***700,000***	***7,500,000***	***5***

Temporary Dewatering Sediment Cells and Associated Months of Handling

	Cell 1	***Cell 2***	***Cell 3***	***Cell 4***	***Cell 5***	***Cell 6***	
Pump	***1***	***2***	***3***	***4***	***5***	***6***	***Cycle 1***
Dry	***2,3,4,5***	***3,4,5,6***	***4,5,6,7***	***6,7,8,9***	***7,8,9,10***	***8,9,10,11***	
Remove	***6***	***7***	***8***	***9***	***10***	***11***	
Pump	***7***	***8***	***9***	***10***	***11***	***12***	***Cycle 2***
Dry	***8,9,10,11***	***9,10,11,12***	***10,11,12,1***	***11,12,1,2,***	***12,1,2,3***	***1,2,3,4***	
Remove	***12***	***1***	***2***	***3***	***4***	***5***	

Volume of Material for Permanent placement at Mason Dixon Belvidere Quarry After Drying (CY)	***Volume of Dried Material per Drying Cell (CY)***	***Area of one Drying Cell (acres)***	Percentage of Material Dredged per year that Mason Dixon Belvidere Quarry can Handle per year (%)	# of dredging cycles that facility could be used before capacity is reached
1,500,000	***130,000***	***70***	Unknown	23
4,500,000	***380,000***	***210***	Unknown	8
7,500,000	***630,000***	***350***	Unknown	5

SCREENING LEVEL ESTIMATE

4 - Watershed Management Strategy

Implement "E3" Scenario

Logistics and Assumptions to Reduce Sediment Yield: 243,000 CY from Conowingo Reservoir

SCENARIO DESCRIPTION

Total maximum daily loads (TMDLs) have been established for nutrients (phosphorus and nitrogen), which will be met through watershed implementation plans (WIPs). After meeting the nutrient TMDLs there will still be available sediment reduction by implementing the "E3" scenario (everyone doing everything technically feasible everywhere in the watershed) beyond the WIPs.

ASSUMPTIONS/BASIS FOR ESTIMATE:

1) Assume 1 CY of sediment contains 0.81 tons of solids.

2) Model runs that were used to develop the "E3" scenario will result in the sediment reductions described in the scenario.

3) The unit costs to implement the "E3" scenario will not change greatly over time.

4) Jurisdictions will be able to secure adequate funding and political support.

Description of POTENTIAL SITE/Locations/Include PHOTOS, FIGURE, MAP

Best management practices will be implemented in the Susquehanna River watershed in areas of New York, Pennsylvania, and Maryland above Conowingo Dam.

Description of POTENTIAL BMPs PHOTOS, FIGURE

Two examples of best management practices that could be implemented in urban areas are pervious pavers and rain gardens, which allow overland flow generated during storms to slowly infiltrate. This will reduce runoff and erosion and help to reduce sediment loads.

Two examples of agriculture best management practices are cover crops and covered manure sheds. Cover crops help to reduce erosion and sediment loads and manure sheds reduce nutrient inputs to local water systems and ultimately the Bay.