APPENDIX A

Trout Creek Watershed Study –BMP Selection Technical Memorandum

Trout Creek Watershed Study - BMP Selection

PREPARED FOR: Paul DeBarry and Len Smith, Borton-Lawson
Steve Burgo, Tredyffrin Township
PREPARED BY: Brian Marengo, CH2M HILL
DATE: July 2, 2008
PROJECT NUMBER: 362362

Introduction and Purpose

The purpose of this technical memorandum is to document the BMP screening and selection process applied for the Trout Creek Watershed Study conducted for Tredyffrin Township by Borton-Lawson Engineers. To support the watershed planning process and to plan for the development of effective stormwater retrofits to mitigate stormwater problems in Tredyffrtin, CH2M HILL developed several tools to develop effective BMP concepts, provide and initial screening to 10 BMPs to be evaluated in detail with the watershed model developed by Borton-Lawson, and to provide a final ranking of the most effective projects according to criteria that were jointly developed with the township staff.

Google Earth Mapping Tool

Pertinent GIS data was collected from the Township and exported to keyhole markup language (.kml) to create an interactive planning environment using Google Earth. The Google Earth tool was used during various workshops with the township and board of supervisors to provide insight into the various factors governing the selection of viable sites for evaluating the benefits of retrofitting stormwater best management practices. Figure 1 illustrates the use of the tool to show the watershed boundary, road network, areal photos, and possible BMP locations. Figure 2 shows proposed BMP locations and size footprints along Devon Park Drive. Table 1 provides a list of the features that were included in the interface and the sources of the original GIS mapping data. The files are posted on the project FTP.

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

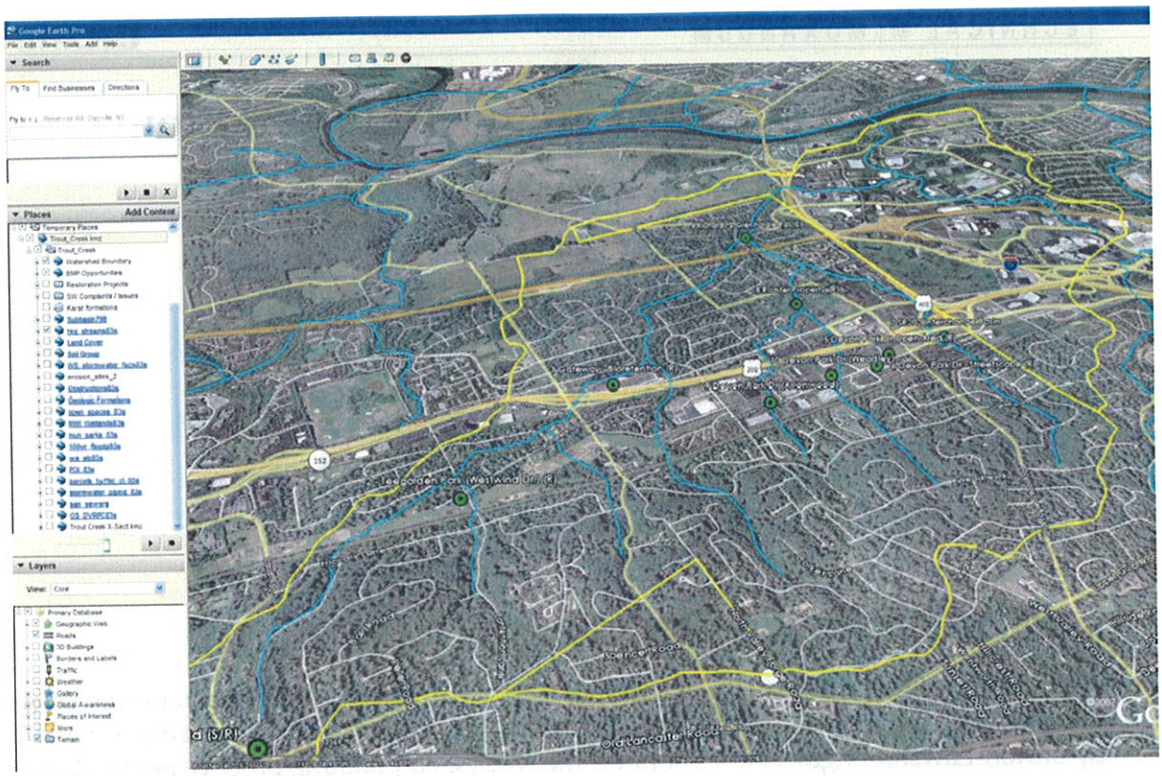


Figure 1 - Google Earth Mapping Tool for Interactive Stormwater Planning

Figure 2 - Google Earth Visualization of BMP Footprints

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

TABLE 1 - FEATURES INCLUDED IN THE GOOGLE EARTH STORMWATER PLANNING TOOL

Feature Name	Feature Type	Description	Source
Watershed Boundary	Polygon	Watershed Boundar with Municipal Boundary	Township GIS
BMP Opportunities			Workshop Meetings
Footprint Polys	Polygon	Approximate BMP Footprints from Borton Lawson	Borton Lawson
Footprints	Image	Superimposed footprints of BMPs	Borton Lawson
Top 10	Point	List of 10 Top Ranked BMPs	Workshop Meetings
Secondary Opportunties	Point	17 additional BMP opportunities defined in the study	Workshop Meetings
BMP Polygons-Misc	Mixed	Miscellaneous BMP planning data and concepts from meetings	Workshop Meetings
Restoration Projects	Line	Restoration Project Location - FX Browne	Workshop Meetings
Stormwater Complaints/Issues	Mixed	Stormwater Issues Identified by the Township at the study outset	Township List
Karst Formations	Image	Image map of Karst formation density	Kochanov & Reese, 2003
Subbasin798	Polygon	Model sub-basin boundaries	Borton Lawson
reg_streams83s	Line	Streams	Borton Lawson
Land Cover	Polygon	Land Cover Classification	www.PASDA.org
Hydrologic Soil Group	Polygon	Hydrologic soil groups as reported in the State Soil Survey	www.PASDA.org
WS_stormwater_facs83s	Point	Existing Stormwater Facilities	Township GIS
erosion_sites_2	Point	Erosion Sites	Township GIS - Ratsep, 2004
Obstructions83s	Point	Stream Obstructions	Township GIS - Ratsep, 2004
Geologic Formations	Polygon	Geologic Formations	www.PASDA.org
Open_spaces_83s	Polygon	Designated open spaces	www.PASDA.org
NWI_Wetlands	Polygon	Wetlands identified in National Welands Inventory	www.PASDA.org

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

TABLE 1 - FEATURES INCLUDED IN THE GOOGLE EARTH STORMWATER PLANNING TOOL

Feature Name	Feature Type	Description	Source
Watershed Boundary	Polygon	Watershed Boundar with Municipal Boundary	Township GIS
mun_parks_83s	Polygon	Township maintained parks	Township GIS
100yr_flood83s	Line	100yr FEMA flood plain	www.PASDA.org
POI_83s	Point	Various Points of local interest	
parcels_buffer_cl_83s	Polygon	Township parcels	Township GIS
stormwater_piping_83s	Line	Stormwater conduit locations	Township GIS
san_sewers	Line	Sanitary Sewer Locations	Township GIS
OS_DVRPC	Polygon	Open Space	DVRPC
Trout Creek X-Sect	Point	Locations where field cross sections were measured for use in model calibration	Approximated from Field

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

Cross Section Data

To Support the development and calibration of the of the watershed developed by Borton-Lawson, CH2M HILL collected measurements (Table 2 from selected cross-sections shown in Figure 3)

TABLE 2 – SUMMARY OF CHANNEL BOTTOML WIDTH AND SIDE SLOPES AT SELECTED CROSS SECTIONS

			Left Side Slope				Right Side Slope			
Section	**Name**	**Bottom Width (B)**	**X**	**Y**	**Left Side Slope (x:y)**		**X**	**Y**	**Right Side Slope (x:y)**	
3	**50ft Upstr - Thomas Rd**	17.5	11.2	4.5	2.5	:1	12.0	5.4	2.2	:1
4	**1000ft E. Old Eagle School Rd**	14.0	15.0	5.0	3.0	:1	13.0	5.5	2.4	:1
4a	**E of Old Eagle School Bridge Culvert**	18.0	9.0	6.7	1.3	:1	9.0	7.2	1.3	:1
5a	**Walker Rd Bridge Culvert**	20.0	0	1.5	vertical	:1	0	1.8	vertical	:1

Notes - All Sections looking Downstream and Measurements in feet

Figure 3 - Locations of Physical Cross-section measurements

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

Analysis and Prioritization of Potential Stormwater BMP Retrofits

Utilizing existing Trout Creek Watershed Study documents, realistic solutions to the issues and problems identified in Task were identified. Generally, the solutions identified as opportunities to address flooding, streambank erosion, and water quality impairment in the watershed. Working with the township staff and EAC, the team conducted a workshop meeting to define goals for the retrofit program and reviewed the Township Stormwater Issues List. An opportunity inventory was generated and primary and secondary BMP concepts developed for each site. An assessment was conducted that evaluated each concept for the potential to have a regional flood control benefit and also to impact a dry stream reach downstream if recharge could be achieved in the BMP design. These factors, land ownership information, and other anecdotal information gathered from the township staff was recorded in Table 3. From this table, the ten most promising concepts were selected in consultation with township staff.

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

Table 3 – Opportunity Inventory and Preliminary Screen of Trout Creek Watershed Potential Best Management Practice / Stormwater Retrofit Projects

Top 10 Site ID	New ID	Branch	Location	Primary Project Type	Secondary Project Type	Regional Benefit (Y/N)	Dry Stream Dnstream (Y/N)	Land Ownership	Land Acquisition Approach	Project Source	Other Considerations:
1	1	M	Old States Road Road (Cassatt (PADOT) to Hickory & Orchard Way	S	R	Y	N	Twp/Private	Consider Options within Twp ROW & Private Residents	W	Upper Watershed is Main Branch - Twp has already identified areas in need of storm sewer and infrastructure modifications, possible BMPs, and stabilization near numerous eroded areas. Residential house flooding from runoff and groundwater, bank erosion near roadway in several locations.
2	2	M	Westwind Dr. (Teegarden Park)	R	ED, P, B,	Y	N	Twp/PECO	$0	T	Township Park along Main Branch of Trout Creek. PECO has aerial ROW in Park. Drains to residential areas with bank erosion and localized flooding issues. Site of GG Grant Stream Stabilization Design by FX Browne
	3	M	Coldstream Drive	C	R	Y	N	Twp/Private	Work with private property owners	W	Private Ballfield and Residential properties outside Twp roadway ROW. Area located withing FEMA floddplain and experiences localized flooding and bank erosion.
	4	C	PECO Right of Way (E of N. Valley Forge Rd)	R	S, B, M	Y	N	PECO/FMOB Associates C/O J Leow Prperty Mangagment	Work with PECO/ Private Property Owners	T	Existing Basin in Area, Old Forge Crossing experiences existing issues
	5	D	PECO Right of Way (W of N. Valley Forge Rd)	R	B, Ed	Y	Y	PECO/ Norm Duncan	Work with PECO	T	Duncan Farms has lots of debris in area around stream.
	6	H	PECO Right of Way (Contention Lane)	R	B, W	Y	N	PECO/ T. Horgan	Work with PECO	T	Site of GG Grant Stream Stabilization Design by FX Browne
	7	H	Gateway Shopping Center (rear)	R	G, P, S	N	N	AZCO Properties - All Star Investments	Work with Owner	T	Groundwater Pollution (TCE - from Gateway Cleaners) ? Large amount of impervious coverage with parking and buildings with little to no SWM. Trout Creek on 3 sides of developed area. High public exposure site potnetially work with store owners trader joes
3	8	H	Gateway Shopping Center (Parking lot BMP)	R	P, B, S	N	N	AZCO Properties - All Star Investments	Work with Owner	T	Groundwater Pollution (TCE - from Gateway Cleaners) ?
	9	M	Tributary Between East Swedesford Road and Anthony Wayne Drive	C	S	Y	N	AZCO Properties - All Star Investments/ Private Residential	" "	W	Gateway Greenspace - along stream corridor to Walker Rd. Floodplain.
	10	M	Valley Forge Middle School	M	Ed, G, P, R, B	N	N	T/E School District	Work with T/E School District	W	School Approval - Provide recommendations to T/E School District for their consideration for potential future retrofit projects for Basin retrofit, Green Roof, Bioretention, Porous Pavement , etc.
	11	M	Walker Rd between (Prussian Lane and Anthony Wayne Drive)	C	S	Y	N	Twp/ Chester Co.	County Bridge	W	Chester County is to replace in '08 or '09
	12	M	Thomas Road (between Park Ridge and Colonel Dewees)	C	S	Y	N	Twp/ Chester Co.	County Bridge	W	Chester County Bridge - Bank Erosion on both sides of structure.
4	13	M,T	Richards Road and Glenhardie Road	C	S	Y	N	Tredyffrin Twp	$0	W	Serious Area of Flooding, sediment deposition, and routine and emergency maintenance and road closures. Could new bridge design provide measureable benefit vs. cost, reduce Twp maintenance expenditures, and reduce flooding ? ? Public works has to clear sediment several times / year
5	14	W	Devon Park Dr Open Area	R	P, B, Ed	Y	Y	Chester Co. Ind. Dev.	Work with property owners	T	drains to key problem areas
6	15	W	Devon Park Dr. Streetscape BMP	B	R, Ed	N	Y	Tredyffrin Twp	$0	T	Reduction of roadway width (impervious) combined with BMP Retrofit (Bioretention area) in center of street. Short term vs long term workin with redevelopment through new comprehensive plan to encourage developments to include recommendations for Devon PArk Drive to either reduce width and impervious coverage, add Green space , and incoporate SWM BMPs. need to define base cross section for model
7	16	T	S.R. 202 Basin Interchange	R	Ed, W	Y	Y	PECO/ PADOT	Work with PECO/PADOT	T	drains to key problem areas
	17	W	Wembley Drive near East Swedesford Road	R	Ed, M	N	Y	California State Teachers/ Lend Lease Investments	Work with private property owners	W	drains to key problem areas. Encourage property owners to do BMP retrofits maybe work to identify Grants to foster this work to better address SWM and reduce peak flows, especially small storms, and add WQ benefit
8	18	W	Richter Property	R	W, Ed, C	Y	Y	Private	$?, Depends on Acreage	T	Twp needs to consider all alternatives and Benefits vs. Costs for Land Acquisition as well as culvert and BMP design and construction. southern parcel for sale (10.47ac). Northern parcel is focus. Look at range of storms

COPYRIGHT 2008 BY CH2M HILL, INC. - COMPANY CONFIDENTIAL

Top 10 Site ID	New ID	Branch	Location	Primary Project Type	Secondary Project Type	Regional Benefit (Y/N)	Dry Stream Dnstream (Y/N)	Land Ownership	Land Acquisition Approach	Project Source	Other Considerations:
	19	T	Glenhardie Country Club	S	B, R, Ed	N	Y	Private/Various Owners	Work with property owners	W	drains to key problem areas Need to discuss with propety owenr and identify areas for BMP retrofit
	20	T	Drummers Lane Apartments/ Offices	R	B, P, R, Ed	N	Y	Private/Various Owners	Work with property owners	T	drains to key problem areas
9	21	A	Devon Park Dr. Natural area north of adjacent to Avonwood Branch	R	S	Y	Y	PECO	Work with PECO	T	drains to key problem areas - Green areas adjacent to Creek possible BMP areas
10	22	W	Devon Park Dr. Natural area north of adjacent to Weadley Branch	R	S	Y	Y	PECO	Work with PECO	T	drains to key problem areas - Green areas adjacent to Creek possible BMP areas

Project Source

- W Ratsep Watershed Plan
- T Township Workshop / Field Visit 10/31/2007

Stream Branches

- T Treyburn
- W Weadley Rd
- A Avonwood Branch
- H Hammer Hollow
- D Devon State Rd
- C Contention Lane
- M Main Stem

Potential BMP Project Types

- R Structural BMP Retrofit (extended detention / retention / swale)
- S Stream Restoration
- B Bioretention / Streetscaping
- G Green Roof
- P Porous Pavements
- C Conveyance Improvement (e.g. increase culvert capacity)
- M Modify Existing Basin (e.g. outlet structure / vegetate for water quality)
- Ed Educational

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

Evaluation Criteria and Weights

A set of evaluation criteria were explored in conjunction with township staff and weighting factors assigned as a means of quantifying the relative importance of the evaluation criteria. These weighting factors and the basis of assessing the performance are summarized in Table 4.

TABLE 4 - BMP EVALUATION CRITERIA AND WEIGHTS

Criteria		Performance Criteria	Criteria Weight
Public Health & Safety (Quantity)	1	Reduction in Flood Peak Flow / Stage	98%
Water Quality - Volume	2	Volume Control (Recharge / ET)	84%
Water Quality - Erosion	3	Erosion (TSS) Control (Channel Protection)	92%
Public Amenity	4	Public Amenity (Aesthetics, Acceptance, Education)	70%
Constructability	5	Accessibility / Conflicts / Permitability	85%

Performance Ranking Scores

Each project was evaluated with respect to the above criteria based upon a scoring system that assigned a score of 0-10 to each project criteria combination. The scores for criteria 1-3, were determined based upon the output of the watershed model and the simulation of each BMP under a range of flow conditions. This analysis was performed by Borton Lawson and the Flood Reduction, Channel Protection and Volume Control evaluation with model were normalized over the range of performance values and a score assigned to each project.. This analysis is summarized in Table 5.

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

TABLE 5 – BMP PERFORMANCE EVALUATION AND RATING SCORES FOR PRIORITIZATION

Site ID	Site Name	BMP Type	Flood Reduction (100-year event)			Channel Protection (2-year event)				Rating Scores for BMP Ranking		
			Reduction in Peak Flow from Site (%)	Weighted Reduction in Peak Flow from Site	Downstream Reduction in Peak Flow	Channel Protection at the Site (%)	Weighted Reduction in Peak Flow from Site	Channel Protection Downstream from the site (%)	Volume Control Rating	Flooding	Erosion	Volume
1	Old State Road	na	1	**0**	0	14	**0**	0	**34**	0.0	0.0	4.2
2	Teegarden Park	Online	5	**7**	0	0	**0**	0	**43**	0.9	0.0	5.3
	Teegarden Park	Offline	92	**19**	2	67	**4**	0	**48**	2.5	0.4	5.9
	Teegarden Park	Diversion	39	**15**	0	0	**0**	0	**43**	2.0	0.0	5.3
3	Gateway Shopping Center	na	0	**0**	0	0	**0**	0	**42**	0.0	5	9
4	Richards Road Culvert	na	0	**0**	0	0	**0**	0	**23**	0.0	0.0	2.8
5	Devon Park Drive Open Area	na	21	**75**	0	67	**46**	0	**52**	10.0	4.6	6.4
6	Devon Park Drive Streetscape	na	23	**4**	0	44	**15**	0	**50**	0.5	1.5	9.0
7	S.R. 202 Interchange	na	37	**48**	5	73	**99**	10	**32**	6.4	10.0	4.0
8	Richter Property	Config. A	24	**58**	6	18	**66**	2	**58**	7.7	6.7	7.2
	Richter Property	Config. B	20	**47**	4	5	**17**	0	**58**	6.3	1.7	7.2
9	Devon Park Drive (Avonwood)	Online	3	**2**	0	0	**0**	0	**30**	0.3	0.0	3.7
	Devon Park Drive (Avonwood)	Offline	83	**22**	0	71	**33**	0	**45**	2.9	3.3	5.6
	Devon Park Drive (Avonwood)	Diversion	43	**7**	0	0	**0**	0	**30**	0.9	0.0	3.7
10	Devon Park Drive (Weadley)	Online	6	**6**	0	0	**0**	0	**33**	0.8	0.0	4.1
	Devon Park Drive (Weadley)	Offline	68	**37**	0	49	**33**	0	**36**	4.9	3.3	4.4
	Devon Park Drive (Weadley)	Diversion	60	**14**	0	20	**2**	0	**33**	1.9	0.2	4.1

Notes –

- A weighted flood reduction capacity and channel protection capacity at the site was determined by multiplying the percentage of the reduction in the peak flow at the site by the fraction of the site flow with respect to the overall watershed flow and then multiplying it by ten.
- Volume control was not determined by the hydrologic model but was evaluated as the potential for achieving the intended volume control based upon a weighted rating considering physical site characteristics, drainage area to BMP footprint ratio, BMP size and the percentage of contributing impervious area.
- Site Numbers 1, 3, 4 and 6 were not included in the watershed model.

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

Criteria 4 and 5 were somewhat more subjective in their determination. Table 6 and 7 provide a set of general guidelines that were followed in assigning a score to each project for their value as a public amenity, a visible educational opportunity, and overall constructability. The assigned ranking scores for each project are summarized in Table 8.

TABLE 6 – PUBLIC AMENITY AND EDUCATION RANKING SCORES

Score	Public Amenity	Visible Education
10	Significant Recreational & Public Space Benefits	Defined Linkages to Education
9		
8	Preserves Natural Open Space	Potential Educational Linkages
7		
6		
5	Neutral Public Benefit	Neutral Educational Benefit
4		
3		
2	Unknown	Unknown
1		
0	Likely to be avoided	Example of what not to do

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

TABLE 7 – CONSTRUCTIBILITY RANKING SCORES

Score	Access	Utility Conflict	Ease of Acquisition / Coordination	Permitting
10	Readily Accessable - no barriers	No other utilities in area	None - Township is land owner	Readily permittable in 30 days
9		single indirect conflict		
8	Single Moderate barrier			60 days
7		multiple indirect	One private landowner	
6	Multiple moderate barriers			90 days
5		single direct	One other public agency	
4	Multiple difficult barriers (steep slope, stream crossing…)			Over 6 months permitting
3		Multiple moderate conflicts	Public and Private Coordination	
2	Unknown	Unknown	Unknown	Unknown
1				
0	Inaccessible (cranes needed for bulldozers)	Multiple Large (transmission) Direct Utility Conflicts	Coordination Required between Multiple Private / Public Parties	Requires significant non-standard permitting with indefinite approval timeframe

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

Table 8 – Summary of Rating Scores for the top 10 projects

Site ID	Site Name	BMP Type	Rating Scores for BMP Ranking				
			Flooding (98%)	Erosion (84%)	Volume (92%)	Public Amenity (70%)	Constructability (85%)
1	Old State Road	n/a	0.0	0.0	4.2	3.0	3.0
2	Teegarden Park	Online	0.9	0.0	5.3	8.0	6.0
	Teegarden Park	Offline	2.5	0.4	5.9	8.0	9.0
	Teegarden Park	Diversion	2.0	0.0	5.3	8.0	9.0
3	Gateway Shopping Center	n/a	0.0	5	9	9.0	8.0
4	Richards Road Culvert	n/a	0.0	0.0	2.8	2.0	3.0
5	Devon Park Drive Open Area	n/a	10.0	4.6	6.4	6.0	7.0
6	Devon Park Drive Streetscape	n/a	0.5	1.5	9.0	9.0	10.0
7	S.R. 202 Interchange	n/a	6.4	10.0	4.0	5.0	8.0
8	Richter Property	Config. A	7.7	6.7	7.2	6.0	3.0
	Richter Property	Config. B	6.3	1.7	7.2	6.0	3.0
9	Devon Park Drive (Avonwood)	Online	0.3	0.0	3.7	7.0	6.0
	Devon Park Drive (Avonwood)	Offline	2.9	3.3	5.6	7.0	7.0
	Devon Park Drive (Avonwood)	Diversion	0.9	0.0	3.7	7.0	7.0
10	Devon Park Drive (Weadley)	Online	0.8	0.0	4.1	7.0	6.0
	Devon Park Drive (Weadley)	Offline	4.9	3.3	4.4	7.0	7.0
	Devon Park Drive (Weadley)	Diversion	1.9	0.2	4.1	7.0	7.0

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

Planning Level BMP Cost Estimates

Planning level costs were developed for each BMP based upon literature values from three sources and an average value used to estimate the capital costs in the development of net present value (or life cycle) cost estimates. The net present value determination

Capital Cost Estimates

Heaney (1999) developed a relationship (Equation 1) relating construction costs for stormwater detention facilities to the overall storage volume of the basin. A 15% contingency was added to this cost to represent the planning, design, and permitting costs

$$C = 55{,}000V^{0.69} \quad \text{(Equation 1)}$$

Similarly Shuler and Brown (1997) developed a similar relationship (Equation 2) that included planning design and permitting. This equation was used to provide a second estimate.

$$C = 12.4V^{0.760} \quad \text{(Equation 2)}$$

The third capital cost estimate was derived from the Water Environment Research Foundation using the life-cycle cost templates provided in the final research report for detention basins. An average of the three capital costs estimates was used to represent the capital cost of construction in the whole life cost analysis. A discount rate of 4.9% was assumed per the Office of Management circular A-94 for long term (30-yr) cost estimating horizons. In addition, costs were updated to 2007 costs based upon the Engineering News Record (ENR) Construction Cost Index (CCI) as shown in Table 9.

TABLE 9 – ENR CONSTRUCTION COST INDEX VALUES USED TO UPDATE COSTS TO 2007

Year	ENR CCI
2007	7966
1999	6059
1997	5826

Land Acquisition Cost Estimates

Land Acquisition costs were estimated using the township GIS parcel data, which contained assessed values for each parcel. The land area for all parcels containing an assessed value was summed and a unit assessed value per acre computed for the 3,269 acres with data. A

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

market value was determined by applying the 1.93 multiplier and the results are shown in Table 10. As the land ownership was not clear for each BMP evaluated, land acquisition costs were left of the BMP ranking discussed later.

Table 10 Land acquisition cost estimates

	Assessed Value	Market Value
Total	$ 1,249,090,340	$2,410,744,356
Per acre	$ 382,104	$ 737,461

Market Value = Assessed Value X 1.93.

Operation and Maintenance Costs

Operation and Maintenance Costs were estimated using the WERF Life Cost spreadsheets assuming a medium level of maintenance. Detailed Cost estimates for the BMPs simulated with the watershed model are provided in Attachment 1 and represent conceptual costs based on other facilities that are not located in Tredyffrin Township.

A summary of the cost analysis is provided in Table 11.

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

TABLE 11 – SUMMARY OF COST ESTIMATES FOR BMPS SELECTED FOR EVALUATION WITH THE TROUT CREEK WATERSHED MODEL

							Capital Cost						Whole Life Costs		
Site ID	Site Name	Basin Foot Print (acre)	Type	% Impervious	Volume (ft³)	2007 Construction Cost (Heaney) [3]	2007 Capital Cost (Heaney) [3]	2007 Capital Cost (Schuler) [4]	Capital Cost WERF [5]	Avg Capital Cost	Land Cost [1]	Total Capital Cost	Net Present Value (NPV)	Annual O & M Cost	Equivalent Uniform Annual Cost (EUAC)
2	Teegarden Park	1.0	on-line	24.87	229,997	$105,143	$120,915	$201,465	$ 191,000	**$154,631**	$ -	$ 154,631	$ 263,012	$ 6,916	$ 15,256
2	Teegarden Park	1.0	off-line	19.36	229,997	$105,143	$120,915	$201,465	$ 191,000	**$154,631**	$ -	$ 154,631	$ 263,012	$ 6,916	$ 15,256
2	Teegarden Park	1.0	diversion[1]	24.87	229,997	$105,143	$120,915	$201,465	$ 191,000	**$154,631**	$ -	$ 154,631	$ 263,012	$ 6,916	$ 15,256
5	Devon Park Drive Open Area	2.25	off-line	47.94	1,045,440	$298,889	$343,723	$636,735	$ 720,000	**$499,837**	$900,000	$ 1,399,837	$ 887,792	$ 25,793	$ 52,751
7	S.R. 202 Interchange	5.25	on-line	29.01	1,624,788	$405,176	$465,953	$890,219	$ 1,119,000	**$720,087**	$ -	$ 720,087	$ 1,306,662	$ 39,204	$ 78,040
8	Richter Property	8.0	on-line	44.26	1,934,064	$456,940	$525,481	$1,016,271	$ 1,332,000	**$832,673**	$3,200,000	$ 4,032,673	$ 1,900,081	$ 46,363	$ 116,579
8	Richter Property	8.0	on-line	44.26	3,027,420	$622,493	$715,867	$1,428,587	$ 2,085,000	**$1,212,987**	$3,200,000	$ 4,412,987	$ 2,280,431	$ 71,673	$ 137,092
9	Devon Park Drive (Avonwood)	0.75	on-line	29.53	139,392	$74,425	$85,589	$137,693	$ 129,125	**$106,708**	$300,000	$ 406,708	$ 184,005	$ 4,818	$ 10,573
9	Devon Park Drive (Avonwood)	0.75	off-line	57.31	139,392	$74,425	$85,589	$137,693	$ 129,125	**$106,708**	$300,000	$ 406,708	$ 184,005	$ 4,818	$ 10,573
9	Devon Park Drive (Avonwood)	0.75	diversion[1]	29.53	139,392	$74,425	$85,589	$137,693	$ 129,125	**$106,708**	$300,000	$ 406,708	$ 184,005	$ 4,818	$ 10,573
10	Devon Park Drive (Weadley)	1.5	on-line	32.21	326,700	$133,954	$154,048	$263,054	$ 237,625	**$197,170**	$600,000	$ 797,170	$ 338,717	$ 9,156	$ 19,790
10	Devon Park Drive (Weadley)	1.5	off-line	49.36	326,700	$133,954	$154,048	$263,054	$ 237,625	**$197,170**	$600,000	$ 797,170	$ 338,717	$ 9,156	$ 19,790
10	Devon Park Drive (Weadley)	1.5	diversion[1]	32.21	326,700	$133,954	$154,048	$263,054	$ 237,625	**$197,170**	$600,000	$ 797,170	$ 338,717	$ 9,156	$ 19,790

Notes

[1] Land Cost not included in Total Capital and NPV Costs

[2] O & M Cost from WERF BMP SUDS 2007 Medium Level Maintenance

[3] Heaney, 1999 $C=55{,}000\ V^{0.69} + 15\%$ Planning, Design, Permitting

[4] Schuler & Brown, 1997 $C = 12.4\ V^{0.760}$

[5] WERF BMP SUDS LifeCycle Costs - Detention, 2007

COPYRIGHT 2008 BY CH2M HILL, INC. - COMPANY CONFIDENTIAL

Project Prioritization

CH2M HILL developed and applied a multi-attribute, utility assessment tool to evaluate the top ten BMP project in relation to the overall stormwater program goals. This tool was used to rank the top 10 projects in terms of the total overall benefit in meeting the evaluation criteria. For each project, the tool multiplies the ranking score for each criterion by the criteria weight as determined through the workshop meeting. A total benefit score is calculated and the tool provides several options for ranking the projects. The projects are ranked by benefit-cost score (total benefit score / net present value) in Table 12 and Figure 4 provides a graphic depiction of the factors that contribute to the total benefit score and ranks the projects by their total benefit score irrespective of costs.

Funding Opportunities

CH2M HILL located a funding opportunity for the project for which the township is well positioned. Excelon, Inc. provides annual funding for watershed restoration projects and introduced a new stormwater project category in 2008. A draft letter of intent that is required for all applicants was prepared and a copy in included in attachment 2 along with a description of the grant opportunity.

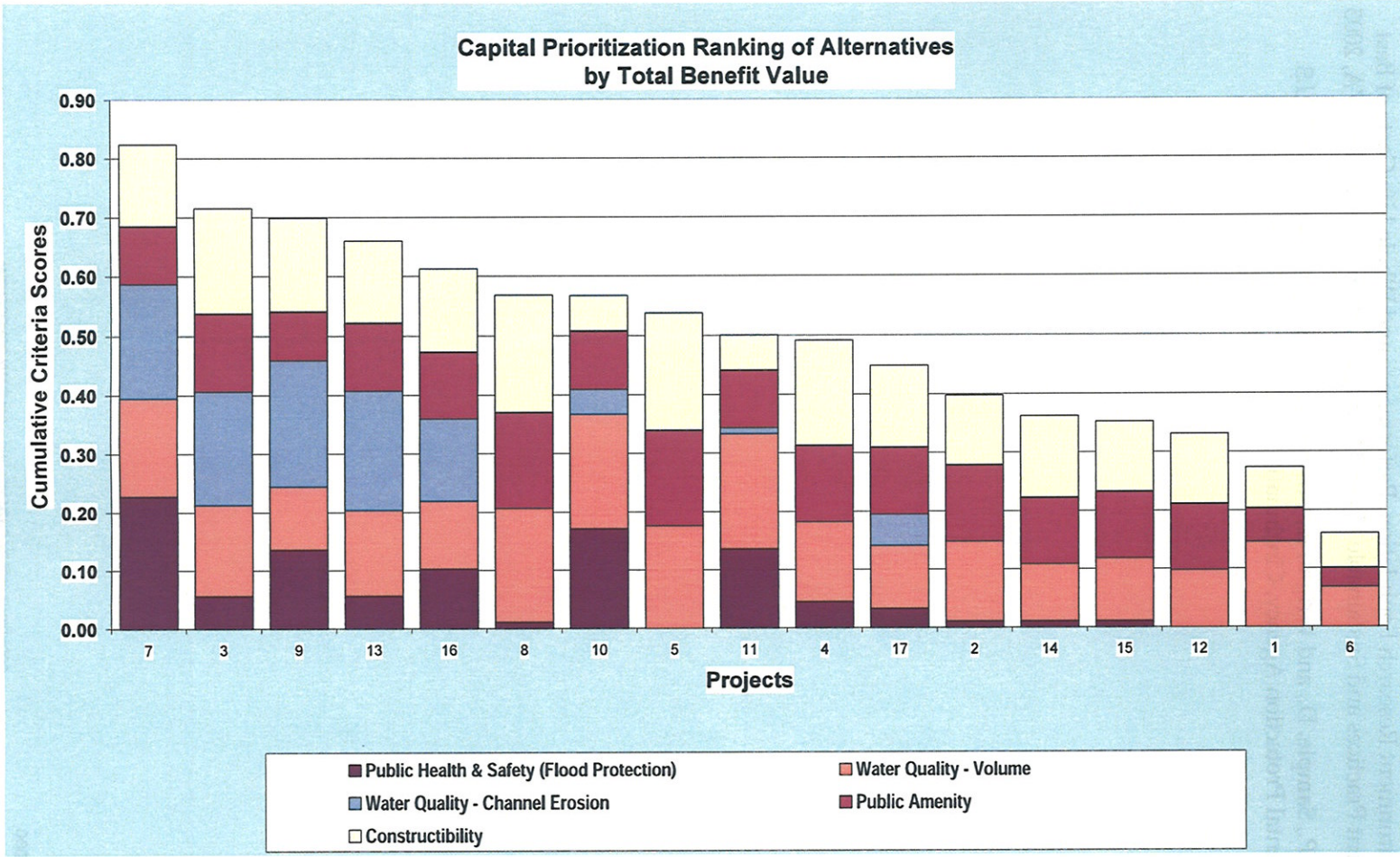
COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

TABLE 12 - RANKING OF PROJECTS BY BENEFIT COST SCORE

CIP Project ID	Project ID	Project Description	Total Benefit Score	Benefit - Cost Score	Project Cost (NPV)	Cumulative Cost
1	1	Old State Road (Homeowner Retrofits) [1]	27	9,110	$3,000	$3,000
5	3	Gateway Mall Bioretention Demo [1]	54	1,920	$28,000	$31,000
8	6	Devon Park Drive Streetscape [1]	57	430	$132,238	$163,238
13	9B	Devon Park Dr. (Avonwood) (Offline)	66	359	$184,005	$347,243
3	2B	Teegarden Park (Offline)	72	272	$263,000	$610,243
14	9C	Devon Park Dr. (Avonwood) (Div)	36	197	$184,005	$794,248
4	2C	Teegarden Park (Div)	49	187	$263,000	$1,057,248
16	10B	Devon Park Dr. (Weadley) (Offline)	61	181	$338,717	$1,395,965
12	9A	Devon Park Dr. (Avonwood) (Online)	33	180	$184,005	$1,579,970
2	2A	Teegarden Park (Online)	40	151	$263,000	$1,842,970
17	10C	Devon Park Dr. (Weadley) (Div)	45	132	$338,717	$2,181,687
15	10A	Devon Park Dr. (Weadley) (Online)	35	104	$338,717	$2,520,404
7	5	Devon Park Drive Open Area	82	93	$887,792	$3,408,196
9	7	S.R. 202 Interchange	70	54	$1,306,662	$ 4,714,858
6	4	Richards Road Culvert Re-design	16	45	$354,000	$5,068,858
10	8A	Richter Property (Config A)	57	30	$1,900,081	$6,968,939
11	8B	Richter Property (Config B)	50	22	$2,280,431	$9,249,371

[1] - Special Weighting Criteria Applied - Projects have site level benefits only and do not contribute to regional benefits

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL



CIP Project ID	Project Description
1	Old State Road (Homeowner Retrofits) [1]
5	Gateway Mall Bioretention Demo [1]
8	Devon Park Drive Streetscape [1]
13	Devon Park Dr. (Avonwood) (Offline)
3	Teegarden Park (Offline)
14	Devon Park Dr. (Avonwood) (Div)
4	Teegarden Park (Div)
16	Devon Park Dr. (Weadley) (Offline)
12	Devon Park Dr. (Avonwood) (Online)
2	Teegarden Park (Online)
17	Devon Park Dr. (Weadley) (Div)
15	Devon Park Dr. (Weadley) (Online)
7	Devon Park Drive Open Area
9	S.R. 202 Interchange
6	Richards Road Culvert Re-design
10	Richter Property (Config A)
11	Richter Property (Config B)

Figure 4 - Capital Project Prioritization by Total Benefit Value (independent of cost)

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

References

Water Environment Research Foundation, Performance and Whole Life Costs of Best Management Practices and Sustainable Urban Drainage Systems, Alexandria, VA, 2005

Heaney, J. P., Sample, D., and Wright, L., Costs of Urban Stormwater Control, U.S. Environmental Protection Agency, Cincinnati, OH, 2002

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

Attachment 1 – Estimates of Operation and Maintenance Costs for each BMP

Projects and cost estimates are conceptual and based on cost curves from literature studies and do not reflect specific engineering cost estimates for the facilities evaluated in this report.

COPYRIGHT 2008 BY CH2M HILL, INC. • COMPANY CONFIDENTIAL

Extended Detention Basin

Site Name: 2-Teagarden
Site Location:

Cost Summary

CAPITAL COSTS	Included in WLC Calculation			Total Cost	
	Model	User	Chosen option		
Total Facility Base Cost	Y		Y		$152,800
Total Associated Capital Costs (e.g., Engineering, Land, etc.)	Y		Y		$38,200
Capital Costs	Y		Y		**$191,000**

REGULAR MAINTENANCE ACTIVITIES	Included in WLC Calculation			Years between Events	Cost per Event	Total Cost per Year
	Model	User	Chosen option			
Inspection, Reporting & Information Management	Y		Y	3	$140	$47
Vegetation Management with Trash & Minor Debris Removal	Y		Y	1	$480	$480
Vector Control	Y		Y	3	$200	$67
add additional activities if necessary	Y		Y	0	$0	$0
add additional activities if necessary	Y		Y	0	$0	$0
Totals, Regular Maintenance Activities						**$593**

CORRECTIVE AND INFREQUENT MAINTENANCE ACTIVITIES (Unplanned and/or >3yrs. betw. events)	Included in WLC			Years between Events	Cost per Event	Total Cost per Year
	Model	User	Chosen option			
Intermittent Facility Maintenance (Excluding Sediment Removal)	Y		Y	1	$1,000	$1,000
Sediment Removal	Y		Y	10	$53,232	$5,323
add additional activities if necessary	Y		Y	0	$0	$0
add additional activities if necessary	Y		Y	0	$0	$0
add additional activities if necessary	Y		Y	0	$0	$0
add additional activities if necessary	Y		Y	0	$0	$0
Totals, Corrective & Infrequent Maintenance Activities						**$6,323**

Total O&M	**$6,916**

Extended Detention Basin

Site Name: 2-Teagarden

Site Location:

Design & Maintenance Options

WATERSHED CHARACTERISTICS	Unit	Model Default	User	Chosen option
Drainage Area (DA)	ac	10.00	126.70	126.70
Drainage Area Impervious Cover (IC)*	pct	40%		40%
Watershed Land Use Type *("R"-Residential; "C"-Commercial; "Ro"-Roads; "I"-Industrial)*		R		R

* Included since frequently used to calculate storage volume.

FACILITY STORAGE VOLUME	Unit	Model Default	User	Chosen Option
Water Quality Volume (WQV)*	ft^3	229,961		229,961
Flood Detention/Attenuation Volume	ft^3			0
Channel Protection/Erosion Control Volume**	ft^3			0
Other Volume (e.g., Recharge Volume)	ft^3			0
TOTAL FACILITY STORAGE VOLUME	ft^3		0	229,961

* Model default is 1/2-inch of capture over drainage area; actual volume will depend on regional regulatory requirements and site-specific characteristics, etc.

** For example, 24-hour extended detention storage.

DESIGN & MAINTENANCE OPTIONS	Unit	Model Default	User	Chosen Option
Choose Level of Maintenance *("H"=high; "M"=medium; "L"=low)*	-	M		M
Main Pool Volume	yd^3	8,517		8,517
Pct. Full when sediment removed from Basin*	pct	25%		25%
Quantity of Sediment Removed from Basin	yd^3	2,129		2,129

* Can adjust to be higher if expect heavy soils/sediment deposition to basin.

WHOLE LIFE COST OPTIONS	Unit	Model Default	User	Chosen Option
Discount Rate	%	5.50	4.9	4.9

Extended Detention Basin

CAPITAL COSTS

Site Name: 2-Teagarden
Site Location:

Choose Capital Costing Option

A	Total Facility Cost	$ 191,000

"A" - Simple Cost based on Drainage Area
"B" - User-Entered Engineer's Estimate

Method A: Simple Cost based on Drainage Area

Cost based on Drainage Area	Cost per Acre of DA Treated		(Chosen option)
	Model Default	User	
Drainage Area (DA) (acres)	126.70		126.70
Base Facility Cost per acre DA*	$ 1,000		$ 1,000
Default Cost Adjustment for Smaller Projects**	1.21		1.21
Resulting Base Cost per acre DA	$ 1,205		$ 1,205
Base Facility Cost (rounded up to nearest $100)	$ 152,800		**$ 152,800**
Engineering & Planning (default = 25% of Base Cost)	$ 38,200		$ 38,200
Land Cost	$ 0		$ 0
Other Costs	$ 0		$ 0
Total Associated Capital Costs (e.g., Engineering, Land, etc.)			**$ 38,200**
Total Facility Cost	**$ 191,000**		**$ 191,000**

*** Base Facility Cost guidelines (circa Year 2005)**
Very High = $15,000/acre
High = $5,000/acre
Medium = $3,000/acre
Low = $1,000/acre
** Smaller projects generally incur higher unit costs for many components; factor added to adjust.
Suggestion: Use higher or lower Base Costs to reflect higher or lower regional construction costs.
Some jurisdictions already have cost relationships established; check to see if any available.

Method B: User-Entered Engineer's Estimate

Select from the following list, as applicable to the project or facility type; add items where necessary

Total Facility Base Costs	Unit	Unit Cost	Quantity	Cost
Mobilization	LS			$ -
Clearing & Grubbing	AC			$ -
Excavation/Embankment	CY			$ -
Dewatering	LS			$ -
Haul/Dispose of Excavated Material	CY			$ -
Sediment Pretreatment Struct. (e.g., inlet sump)	LF			$ -
Trash Rack	LF			$ -
Inflow Structure(s)	LS			$ -
Energy Dissipation Apron	LS			$ -
Outflow Structure	LS			$ -
Overflow Structure (concrete or rock riprap)	CY			$ -
Dam/Embankment	CY			$ -
Impermeable Liner	SY			$ -
Site Landscaping (e.g., trees)	LS			$ -
Maintenance Access Ramp/Pad	LS			$ -
Revegetation/Erosion Controls	SY			$ -
Traffic Control	LS			$ -
Amenity Items (e.g. recreational facilities, seating)	LS			$ -
Signage, Public Education Materials, etc.	LS			$ -
Other				$ -
Other				$ -
Other				$ -
Total Facility Base Cost				**$ -**
Associated Capital Costs	**Unit**	**Unit Cost**	**Quantity**	**Cost**
Project Management				$ -
Engineering: Preliminary				$ -
Engineering: Final Design				$ -
Topographic Survey				$ -
Geotechnical				$ -
Landscape Design				$ -
Land Acquisition (site, easements, etc.)				$ -
Utility Relocation				$ -
Legal Services				$ -
Permitting & Construction Inspection				$ -
Sales Tax				$ -
Contingency (e.g., 30%)				$ -
Total Associated Capital Costs				**$ -**
Total Facility Cost				**$ -**

Extended Detention Basin

M User entered MEDIUM maintenance level in Sheet 1.

** Change on Sheet 1 if desired/applicable **

Site Name: 2-Teagarden

Site Location:

Maintenance Costs

User may enter lump sum here

ROUTINE MAINTENANCE ACTIVITIES (Frequent, scheduled events)

Cost Item	Frequency (months betw. maint. events)			Hours per Event			Average Labor Crew Size			Avg. (Pro-Rated) Labor Rate/Hr. ($)			Machinery Cost/Hour ($)			Materials & Inciden-tals Cost/Event ($)			Total cost per visit ($)		
	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input
Inspection, Reporting & Information Management	36		36	2		2	1.0		1.0	40		40	30		30	0		0	140		140
Vegetation Management with Trash & Minor Debris Removal	12		12	4		4	2.0		2.0	30		30	60		60	0		0	480		480
Vector Control	36		36	0		0	1.0		1.0	40		40	200		200	200		200	200		200
add additional activities if necessary			0			0			0.0			0			0			0	0		0
add additional activities if necessary			0			0			0.0			0			0			0	0		0

CORRECTIVE AND INFREQUENT MAINTENANCE ACTIVITIES (Unplanned and/or > 3 yrs. betw. events)

Cost Item	Frequency (months betw. maint. events)			Hours per Event			Average Labor Crew Size			Avg. (Pro-Rated) Labor Rate/Hr. ($)			Machinery Cost/Hour ($)			Materials & Inciden-tals Cost/Event ($)			Total cost per visit ($)		
	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input	Model	User	Input
Intermittent Facility Maintenance (Excluding Sediment Removal)	12		12			0			0.0			0			0			0	1,000		1,000
add additional activities if necessary			0			0			0.0			0			0			0	0		0
add additional activities if necessary			0			0			0.0			0			0			0	0		0

Cost Item	Frequency (months betw. maint. events)			Sediment Quantity (yds3) [from Sheet 1]			Cost per yd3 to Remove, Dispose of Sediment												Total cost per visit ($)		
	Model	User	Input	Model	User	Input	Model	User	Input										Model	User	Input
Sediment Removal	120		120	2,129		2,129	25.0		25.0										53,232		53,232
add additional activities if necessary			0			0			0.0										0		0
add additional activities if necessary			0			0			0.0										0		0

Note: For facilities judged to require larger or smaller amounts of maintenance (due to land area, etc.), consider multiplying the Model output in Column U by a multiplier (e.g., 120%) in Column V. Another quick means of adjustment would be to multiply the number of Hours per Event by a multiplier in the User Input field.

Extended Detention Basin

Site Name: 2-Teagarden
Site Location:

Whole Life Costs

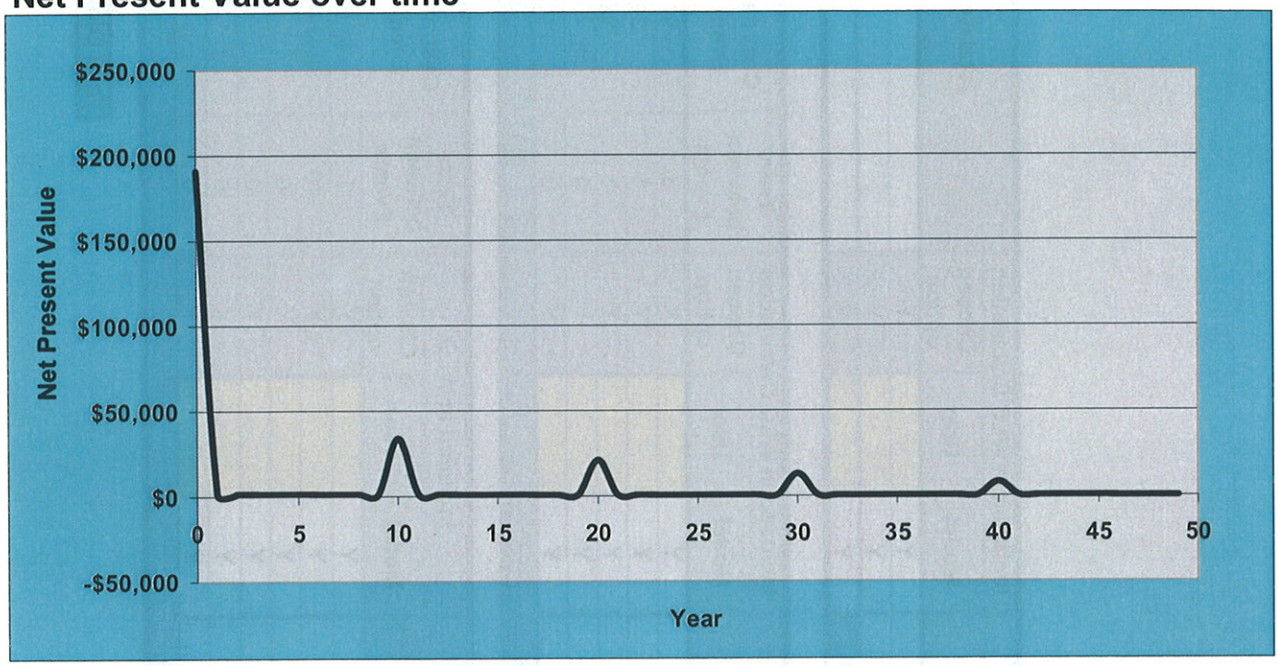
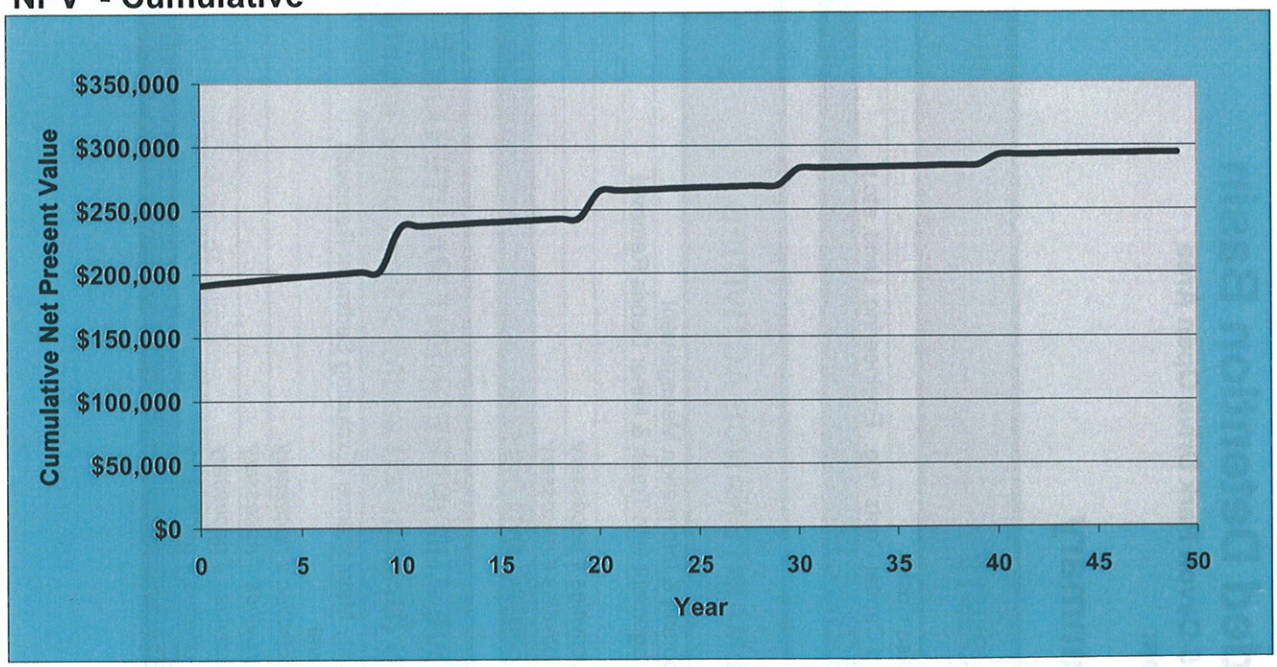
EUAC $ 5,887

Year	Discount Factor	Capital & Assoc. Costs	Regular Maint. Costs	Corrective & Infrequent Maint. Activities: Intermit. Facility Maint.	Sediment Removal	Other [User Entered]	Total Irregular Maint.	Total Costs	Present Value of Costs	Cumulative Costs: Cash	Present Value
Cash Sum ($)								$ 482,000	$ 294,367		
0	1.000	$ 191,000						$ 191,000	$ 191,000	$ 191,000	$ 191,000
1	0.953	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 1,519	$ 192,593	$ 192,519
2	0.909	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 1,448	$ 194,187	$ 193,967
3	0.866	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 1,380	$ 195,780	$ 195,347
4	0.826	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 1,316	$ 197,373	$ 196,663
5	0.787	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 1,254	$ 198,967	$ 197,917
6	0.750	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 1,196	$ 200,560	$ 199,113
7	0.715	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 1,140	$ 202,153	$ 200,253
8	0.682	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 1,087	$ 203,747	$ 201,340
9	0.650	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 1,036	$ 205,340	$ 202,376
10	0.620	$ -	$ 593	$ 1,000	$ 53,232	$ -	$ 54,232	$ 54,825	$ 33,980	$ 260,165	$ 236,356
11	0.591	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 941	$ 261,758	$ 237,297
12	0.563	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 897	$ 263,352	$ 238,195
13	0.537	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 856	$ 264,945	$ 239,050
14	0.512	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 816	$ 266,538	$ 239,866
15	0.488	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 777	$ 268,132	$ 240,643
16	0.465	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 741	$ 269,725	$ 241,384
17	0.443	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 707	$ 271,318	$ 242,091
18	0.423	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 674	$ 272,912	$ 242,764
19	0.403	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 642	$ 274,505	$ 243,406
20	0.384	$ -	$ 593	$ 1,000	$ 53,232	$ -	$ 54,232	$ 54,825	$ 21,060	$ 329,330	$ 264,467
21	0.366	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 583	$ 330,923	$ 265,050
22	0.349	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 556	$ 332,517	$ 265,606
23	0.333	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 530	$ 334,110	$ 266,137
24	0.317	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 505	$ 335,703	$ 266,642
25	0.302	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 482	$ 337,297	$ 267,124
26	0.288	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 459	$ 338,890	$ 267,583
27	0.275	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 438	$ 340,483	$ 268,021
28	0.262	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 417	$ 342,077	$ 268,439
29	0.250	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 398	$ 343,670	$ 268,837
30	0.238	$ -	$ 593	$ 1,000	$ 53,232	$ -	$ 54,232	$ 54,825	$ 13,053	$ 398,495	$ 281,890
31	0.227	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 362	$ 400,088	$ 282,251
32	0.216	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 345	$ 401,681	$ 282,596
33	0.206	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 329	$ 403,275	$ 282,925
34	0.197	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 313	$ 404,868	$ 283,238
35	0.187	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 299	$ 406,461	$ 283,537
36	0.179	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 285	$ 408,055	$ 283,821
37	0.170	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 271	$ 409,648	$ 284,093
38	0.162	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 259	$ 411,241	$ 284,352
39	0.155	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 247	$ 412,835	$ 284,598
40	0.148	$ -	$ 593	$ 1,000	$ 53,232	$ -	$ 54,232	$ 54,825	$ 8,090	$ 467,660	$ 292,688
41	0.141	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 224	$ 469,253	$ 292,912
42	0.134	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 214	$ 470,846	$ 293,126
43	0.128	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 204	$ 472,440	$ 293,330
44	0.122	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 194	$ 474,033	$ 293,524
45	0.116	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 185	$ 475,626	$ 293,709
46	0.111	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 176	$ 477,220	$ 293,886
47	0.106	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 168	$ 478,813	$ 294,054
48	0.101	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 160	$ 480,406	$ 294,214
49	0.096	$ -	$ 593	$ 1,000	$ -	$ -	$ 1,000	$ 1,593	$ 153	$ 482,000	$ 294,367
50	0.091	$ 1	$ 593	$ 1,000	$ 53,232	$ -	$ 54,232	$ 54,826	$ 5,014	$ 536,826	$ 299,381

Extended Detention Basin

Site Name: 2-Teagarden
Site Location:

Net Present Value over time



NPV - Cumulative