VII. Pollutant Loading

The purpose of the pollutant loading calculation in a watershed management plan is to standardize the progress reporting so water quality impacts and state wide advancements can be systematically represented. Calculations were conducted according to the Pollutant Controlled Calculation and Documentation for 319 Watersheds Manual (DEQ 1999). It is recognized that this system has limitations, but does provide a uniform system of estimating relative pollutant loads. In the following section we have provided pollutant loading calculations for sediment and sediment-borne phosphorus and nitrogen. This method doses not account for nutrients that are dissolved in solution and transported by runoff.

During the physical inventory of the Swartz Creek Watershed, specific locations were identified where pollutants are entering the stream. Those sites that were included in the calculations for pollutants controlled include:

1. Gully Erosion Sites
2. Eroding Stream Banks
3. Over Falling Culverts/Outfalls
4. Broken/Eroding Outfalls

Gully Erosion Methods:

Forty-two gully erosion sites were identified during the physical inventory portion of the Swartz Creek Planning Process. The Gully Erosion Equation (GEE) was used to calculate the amount of sediment that is being delivered from those locations.

Gully Erosion Equation:

$$\text{Sediment Reduction} = \frac{\text{Top Width(ft.)} + \text{Bottom Width(ft.)}/2 * \text{Depth(ft.)} * \text{Length(ft.)} * \text{Soil Weight(tons/ft}^3\text{)}}{\text{Number of Years}}$$

The gully erosion equation requires us to know or estimate several variables including the volume of the gully, the dry density weight of the soil eroded and the number of years a gully took to form. In inventorying gully erosion sites, a system was developed to rank them depending on their size and delivery of sediment to the stream channel. The system consisted of giving gullies a ranking between 1-3, with 1 representing the lowest and 3 the highest sediment delivery. Below is a description of each of the three classes of gully erosion sites and their average dimensions.

- Gully 1 - Gullies with a 1 ranking are small partially vegetated gullies that appear to be delivering sediments eroded from the uplands to the stream during rain events. These small gullies are the lowest priority for mitigation. Mitigation at these sites would likely require only minimal effort to install BMPs such as grassed waterways to trap sediments eroded from the uplands. The average size of these gullies were estimated to be 1ft wide at bottom, 2ft wide at the top, 7 ft in length and formed over the course of 3 years.

- Gully 2 - Gullies with a 2 ranking are more severe then those with a rank of 1. These gullies would require some earth moving and or forest removal to install BMPs. The average dimensions of these were estimated to be 2ft wide at the bottom, 3ft wide at the top, 10ft in length and formed over the course of 3 years.

- Gully 3 - These gullies are similar to those with a ranking of a 2 but are more severe in that active sedimentation within the stream immediately below the gulley was clearly visible. Several of these gullies were large enough for inventory workers to walk into. These gullies are of the highest priority and should be mitigated in the earliest phases of implementation. The average dimensions of these were estimated to be 4ft wide at the bottom, 5ft wide at the top, 15ft in length and formed over the course of 5 years.

In order to calculate the sediment loadings the dry density of the eroded soil must be known. To identify the dry density of the eroded soils, a geographic information system was used to overlay the known gully location with a soil layer. This overlay allowed for the identification of the specific soil type and associated soil class texture. Dry density soil weights were interpreted based on the soil texture class according to the MDEQ procedures (MDEQ 1999). Microsoft Excel was used to conduct the calculations and produce a table of the loadings. According to our calculations displayed in Table 9 gully erosion sites are responsible for depositing approximately 86 tons of sediment per year while broken tiles and over falling culverts are contributing approximately 10 tons of sediment to the Swartz Creek per year.

Bank Erosion Method
Approximately 8500ft of stream bank were identified for erosion mitigation in the Swartz Creek Watershed. Several specific locations were identified as in need of erosion mitigation totaling approximately 5500ft. An additional 3000ft of stream bank erosion was included for areas that were not inventoried but have the general hydrologic and morphologic characteristics as the areas that were identified.

The Channel Erosion Equation (CEE) was used to calculate the annual average sediment delivery associated with stream bank erosion.

$$\textbf{CEE = Length(ft.) * Height(ft.) * LRR * Soil Weight (tons/}^{\textbf{ft3}}\textbf{)}$$

The CEE requires us to know or estimate several variables including the length, height, lateral recession rate, and dry density soil weight for the segments of stream bank. The length and height of the areas in need of stream bank mitigation were based upon field observation and the use of aerial photography and GIS measuring tools. The lateral recession rate was estimated as severe according to the MDEQs field observation guidance. Soils were dominated by a sandy loam texture with dry density soil weights of .0525 tons/ft^3. An average channel height was estimated between four and five feet. According to our calculations in Table 9 approximately 70 tons of sediment are entering the Swartz Creek from stream bank sources.

Nutrients
The amount of attached phosphorus and nitrogen is calculated using information collected by USDA-ARS researchers (Frere et al., 1980). The estimate starts with an overall phosphorus concentration of 0.0005 lbP/lb of soil and a nitrogen concentration 0.001 lbN/lb of soil. Then a general soil texture is determined, and a correction factor is used to better estimate nutrient holding capacity. A loamy soil has a correction factor of 1.0, while clay and muck soils are greater than 1.0 and sandy soils are less than 1.0. This correction factor reflects the fact that soils with higher clay and organic matter contents have a higher capacity to hold nutrients, while sandier soils have a lower nutrient capacity. The phosphorus reduction is calculated by multiplying the phosphorus concentration by the sediment reduction and correcting for the soil texture. The same method is used to calculate the nitrogen reduction. A soil phosphorus concentration of 0.0005 lbP/lb soil, and a soil nitrogen concentration of 0.001 lbN/lb soil (Frere et al., 1980) were used in our calculations.

Nutrient reduced (lb/yr) =
Sediment reduced (T/yr) x Nutrient conc. (lb/lb soil) x 2000 lb/T x correction factor

According to our calculations on Table 9 sediment is responsible for contributing 166 tons of phosphorus per year and 333 tons of nitrogen per year.

Gully Erosion Loadings

Site #	Site Type (Gully 3, Gully 2, Broken Tile, etc)	Soil Type	Soil Texture Cass	Dry Density Tons/Cubic Ft	Top Width (ft)	Bottom Width	Depth	Legenth	Number of Years (3 years assumed)	(Top + Bottom /2)	Total Numerator	Reduction
19	Gully1	Bw	loam	0.045	2	1	2	7	3	1.5	0.945	0.315
7	Gully1	Cn	sandy loam	0.0525	2	1	2	7	3	1.5	1.1025	0.3675
22	Gully1	DrA	silt loam	0.0425	2	1	2	7	3	1.5	0.8925	0.2975
23	Gully1	DrA	silt loam	0.0425	2	1	2	7	3	1.5	0.8925	0.2975
24	Gully1	DrA	silt loam	0.0425	2	1	2	7	3	1.5	0.8925	0.2975
21	Gully1	Le	silty claly loam	0.04	2	1	2	7	3	1.5	0.84	0.28
1	Gully1	Le	silty clay loam	0.04	2	1	2	7	3	1.5	0.84	0.28
2	Gully1	Le	silty clay loam	0.04	2	1	2	7	3	1.5	0.84	0.28
3	Gully1	Le	silty clay loam	0.04	2	1	2	7	3	1.5	0.84	0.28
4	Gully1	Se	loam	0.045	2	1	2	7	3	1.5	0.945	0.315
25	Gully2	Cn	sandy loam	0.0525	3	2	3	10	3	2.5	3.9375	1.3125
26	Gully2	Cn	sandy loam	0.0525	3	2	3	10	3	2.5	3.9375	1.3125
27	Gully2	Cn	sandy loam	0.0525	3	2	3	10	3	2.5	3.9375	1.3125
34	Gully2	DrA	silt loam	0.0425	3	2	3	10	3	2.5	3.1875	1.0625
30	Gully2	DrB	sandy loam	0.0525	3	2	3	10	3	2.5	3.9375	1.3125
6	Gully2	Gd	sandy loam	0.0525	3	2	3	10	3	2.5	3.9375	1.3125
20	Gully2	Le	silty claly loam	0.04	3	2	3	10	3	2.5	3	1
31	Gully2	Le	silty claly loam	0.04	3	2	3	10	3	2.5	3	1
33	Gully2	Le	silty claly loam	0.04	3	2	3	10	3	2.5	3	1
0	Gully2	Le	silty clay loam	0.04	3	2	3	10	3	2.5	3	1
28	Gully2	Le	silty clay loam	0.04	3	2	3	10	3	2.5	3	1
5	Gully2	Se	loam	0.045	3	2	3	10	3	2.5	3.375	1.125
15	Gully3	Bw	loam	0.045	6	4	5	15	5	5	16.875	3.375
16	Gully3	Bw	loam	0.045	6	4	5	15	5	5	16.875	3.375
17	Gully3	Bw	loam	0.045	6	4	5	15	5	5	16.875	3.375
18	Gully3	Bw	loam	0.045	6	4	5	15	5	5	16.875	3.375
8	Gully3	Cn	sandy loam	0.0525	6	4	5	15	5	5	19.6875	3.9375
9	Gully3	Cn	sandy loam	0.0525	6	4	5	15	5	5	19.6875	3.9375
10	Gully3	Cn	sandy loam	0.0525	6	4	5	15	5	5	19.6875	3.9375
11	Gully3	Cn	sandy loam	0.0525	6	4	5	15	5	5	19.6875	3.9375
12	Gully3	Cn	sandy loam	0.0525	6	4	5	15	5	5	19.6875	3.9375
37	Gully3	Cn	sandy loam	0.0525	6	4	5	15	5	5	19.6875	3.9375
38	Gully3	Cn	sandy loam	0.0525	6	4	5	15	5	5	19.6875	3.9375
14	Gully3	CvA	loam	0.045	6	4	5	15	5	5	16.875	3.375
13	Gully3	CvA	loam	0.045	6	4	5	15	5	5	16.875	3.375
35	Gully3	DrA	silt loam	0.0425	6	4	5	15	5	5	15.9375	3.1875
36	Gully3	DrA	silt loam	0.0425	6	4	5	15	5	5	15.9375	3.1875
32	Gully3	Le	silty claly loam	0.04	6	4	5	15	5	5	15	3
29	Gully3	Le	Silty clay loam	0.04	6	4	5	15	5	5	15	3
39	Gully3	Le	silty clay loam	0.04	6	4	5	15	5	5	15	3
40	Gully3	Le	silty clay loam	0.04	6	4	5	15	5	5	15	3
41	Gully3	Le	silty clay loam	0.04	6	4	5	15	5	5	15	3
											Total	85.9475

Stream Bank Erosion Loadings

Location	Sediment Source	Soil Type	Soil Texture Class	Dry Density	Legenth (ft)	Height	Lateral Recession Rate	Sediment Load (tons/year)
Swartz Creek Golf Course	Bank Erosion (Known)	Cn	Sandy loam	0.0525	3000	5	0.04	31.5
Genesee Medows Golf Course	Bank Erosion (Known)	Cn	Sandy loam	0.0525	2500	4	0.04	21
Various	Bank Erosion (Suspected)	Multiple	Multiple	0.05	3000	4	0.03	18
							Total	70.5

Overfall / Broken Tile Erosion Loadings

Site #	Erosion Cause	Soil Type	Soil Texture	Dry Density	Radius of Pool	Depth of pool	Cubic Ft	Numerator	Estimated age	Sediment Load
12	Overfalling Culvert	Cn	Sandy Loam	0.0525	4	5	251.2	13.188	3	4.396
51	Overfalling Culvert	Cn	Sandy Loam	0.0525	3	4	113.04	5.9346	3	1.9782
57	Overfalling Culvert	Cn	Sandy Loam	0.0525	3	4	113.04	5.9346	3	1.9782
58	Overfalling Culvert	Cn	Sandy Loam	0.0525	NA	NA	NA		Total	8.3524
59	Overfalling Culvert	Cn	Sandy Loam	0.0525	NA	NA	NA			

	Erosion Cause	Soil Type	Soil Texture	Dry Density	Top Width (ft)	Bottom Width	Depth	Legenth	Number of Years (3 years assumed)	(Top + Bottom /2)	Total Numerator	Reduction
	Broken Tile	Cn	Sandy Loam	0.0525	2	1	2	7	3	1.5	1.1025	0.3675
	Broken Tile	Cn	Sandy Loam	0.0525	4	2	4	8	3	3	5.04	1.68
											Total	2.0475

Total Sediment Reduction = **166.8474**

Nutrient Reduction Calculaions

Nutrient Load Reductions	Sediment Reduced (Tons)	Nutrient Concentration	Correction Factor	Nutrient Reduction (lb/year)
Phosphrous Reductions	166.8474	0.0005	1	166.8474
Nitrogen Reductions	166.8474	0.001	1	333.6948

Table 9. Pollutant Loadings for the Swartz Creek Watershed

Implementation

VIII. Goals and Objectives

The previous sections of this watershed management plan provide information necessary for the development of a strategy to protect the water quality of the Swartz Creek Watershed. The remainder of this document is focused on the activities that need to be implemented to protect the designated uses of the SCW and mitigate the pollutants identified in the previous sections. Included in the implementation sections are sections that set the overarching goals and objectives of the watershed management plan and outline the specific tasks, BMPs, responsible parties and estimated costs associated with the protection effort. This implementation section also contains an education plan necessary to achieve the goals and recommendations of the plan. Finally the implementation plan provides guidelines to evaluate progress and encourage the sustainability of the plan.

Watershed Goals

The development of goals, objectives and implementation tasks is an extremely important step in the watershed planning process. The use of this framework ensures that there is a direct linkage between the numerous tasks outlined in the WMP and the achievement of the water quality goals. This framework provides numerous opportunities to measure achievements and provide opportunities for program monitoring and evaluation. The goals for the implementation of the Swartz Creek Watershed Management Plan include:

1. Protect and restore the Warm Water Fisheries

   Objectives

   a. Reduce sedimentation from gully erosion sites
   b. Reduce sedimentation from stream banks
   c. Reduce sedimentation from road/stream crossings
   d. Reduce Sedimentation from broken/elevated outfall

2. Protect and restore the Aquatic Life and Wildlife designated use

   Objectives

   a. Reduce sedimentation from gully erosion sites
   b. Reduce sedimentation from stream banks
   c. Reduce sedimentation from road/stream crossings
   d. Reduce sedimentation from broken/elevated outfall

3. Protect the Partial and Total Body Contact recreation designated use

   Objectives

   a. Reduce the presence of pathogens

4. Implement activities to attain other desired uses

   Objectives

   a. Provide increased public access to Swartz Creek
   b. Use stream corridor in "green way" system
   c. Reduce the presence of oil and grease

5. Positively affect water quality by implementing a public education campaign

   Objectives

   - Build and retain stakeholder awareness of the Swartz Creek Watershed
   - Educate stakeholders about the linkage between human activity and water quality
   - Motivate individuals to take actions to protect, preserve and restore water quality in the Swartz Creek Watershed

The above goals and objectives are intended to serve as a guide and assessment tool for the implementation and periodic review of the Swartz Creek Watershed Management Plan. Table 10 in the next section identifies the specific tasks necessary to achieve objectives and the key stakeholders in implementing the tasks.

X BMPs

Best Management Practices or BMPs are practices that when adopted or implemented function to protect water quality. BMPs include managerial policies, vegetation management and structural improvements/modifications to stream channels. Table 10 identifies the series of BMPs that need to be implemented to meet the goals set forth in the previous section. The table provides information about the targeted pollutant, example BMP needed, known and suspected number of sites requiring implementation, key stakeholders, estimated cost, financial sponsor and timeline.

Best Management Practices for Swartz Creek Watershed Plan										
Watershed Plan Goal		**Pollutant Target**	**Objective**	**BMP/Management Measure**	**Timeline Short-term = 1-2 years Mid-term = 2-4 years Long-term > 5 years**	**Example BMP**	**Number of Sites/Location (Maps of locations = Figure 11)**	**Key Stakeholders**	**Estimated Cost**	**Sponsor / Financial Assistance**
1& 2	Protect and Restore the Warm Water Fisheries and Aquatic Life Designated Uses	Sediment, Nutrients	Reduce erosion from gully erosion sites	Mitigate half of all known Gully2 and Gully 3 erosion sites	Short-term	Grassed waterway, catch basin, drop structure, grade stabilization structures	15	GCDC, City of Flint, USDA, Property Owners	$45,000 - $60,000	Drain Assessments, USDA Cost Share
		Sediment, Nutrients		Mitigate remaining known Gully2 and Gully 3 erosion sites	Mid-term	Grassed waterway, catch basin, drop structure, grade stabilization structures	15	GCDC, City of Flint, USDA, Property Owners	$45,000 - $60,000	Drain Assessments, USDA Cost Share
		Sediment, Nutrients		Mitigate all suspected Gully 2 and Gully 3 erosion sites	Long-term	Grassed waterway, catch basin, drop structure/grade stabilization structures	15	GCDC, City of Flint, USDA, Property Owners	$45,000- $60,000	Drain Assessments, USDA Cost Share
		Sediment, Nutrients	Reduce erosion from broken/elevated culverts	Repair known and suspected broken tiles	Short-term	Repair tile, outlet stabilization	12	GCDC, City of Flint, USDA, Property Owners	$20,000 - $30,000	Drain Assessments,
		Sediment, Nutrients		Install energy dissipaters at known elevated outfall locations	Short-term	Outlet stabilization, riprap	8	GCDC	$12000 - $20,000	Drain Assessments
		Sediment, Nutrients		Install energy dissipaters at suspected elevated outfall locations	Mid-term	Outlet stabilization, riprap	10	GCDC	$20,000 - $30,000	Drain Assessments
		Sediment,Nutrients,Thermal	Reduce erosion from stream banks	Assist known landowners in re-establishing riparian vegetation	Mid-term	Trees, shrubs, ground covers, biologs	11	FRWC, GCCD, USDA, DEQ	$35,000- $45,000	319, CMI
		Sediment, Nutrients		Assist suspected landowners in re-establishing riparian vegetation	Long-term	Trees, shrubs, ground covers, biologs	20	FRWC, GCCD, USDA, DEQ	$45,000- $50,000	319, CMI
		Sediment, Nutrients		Assess feasibility of stream bank stabilization at Genesee Meadows and Swartz Creek Golf Course	Short-term	NA		DEQ	$50,000	Need to Identify
		Sediment, Nutrients		Stabilize known eroding stream banks at Genesee Meadows and Swartz Creek Golf Courses	Mid-term	Stream bank stabilization	Approximately 5000 Meters known	City of Flint, Genesee Meadows Golf Course	Study Dependant	319, CMI, Landowner
		Sediment, Nutrients		Stabilize stream banks at suspected locations	Long-term	Stream bank stabilization	5,000 Meters (Suspected)	Landowners, Contractor, DEQ,	Study Dependant	319, CMI, Landowner
		Sediment, Nutrients	Reduce erosion at Road/Stream crossings	Replace or repair known undersized crossings	Mid-term	Culvert replacement/upgrade	6	GCDC, GV Meadows Golf Course	$60,000 (Grant for Private Crossings) $200,000 (Road Commission)	Road Commission, 319, CMI
		Sediment, Nutrients		Replace or repair suspected undersized crossings	Long-term	Culvert replacement/upgrade	4	GCRC	$150,000 (Road Commission)	Road Commission
		Sediment, Nutrients		install mitigation measures at dirt road stream crossings	Mid-term	Check dams		GCRC	$45,000	Road Commission, 319, CMI
		Sediment, Nutrients	Reduce Soil erosion form construction sites	Conduct soil erosion training for developers with incentive program	Short-term	IE	NA	SESC, GCDC, FRWC,	$4,500	Phase II
		Sediment, Nutrients	Reduce sediment from Roadways and parking lots	Develop Street Sweeping Program along Miller and Fenton Road Corridors	Long-term	Street Sweeping	NA	City of Flint, Flint Township	Need to research	319, CMI, Phase II
3	Protect the Partial and Total Body Contact Recreation designated uses	Pathogens	Reduce the presence of Pathogens	Fully implement illicit discharge elimination program under Phase I and Phase II of NPDES	Mid-term	NA		City of Flint, GCDC	NA (Phase I and II)	Phase II
		Oil, Grease	Reduce the presence of Oil and Grease	Install two demonstration storm water retrofits to remove oil and grease from parking lot runoff	Mid-term	Oil girt separator	2	Flint Township, Landowner, Design Firm	$100,000	319, CMI
4	Implement Activities to attain other desired uses	ALL	Provide Increased public Access to Swartz Creek	Develop trail system along West and South Branch to connect City of Flint to City of Swartz Creek and Munday Township	Long-term	Trail system		Local Govt's, GLS Greenlinks, FRWC, CAER	$500,000	Local Foundation, Natural Resources Trust Fund
5	Positively affect water quality by implementing a public education campaign	ALL	See Education plan							

Table 10. BMPs, Timeline, Estimated Costs for Implementation