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I. Introduction

Concerns about the water quality and impacts of current and historic land use practices in the Swartz Creek Watershed (SCW) led stakeholders in the watershed to initiate the development of a watershed management plan. The following plan was created through a collaborative effort between local units of government, Flint River Watershed Coalition, the University of Michigan - Flint's Center for Applied Environmental Research (CAER), concerned citizens and several other partners. The plan includes information gleaned from reviews of previous research, a public involvement process, and field investigations. The plan that follows is intended to address the current and potential future water quality conditions in the watershed. Funding and grant administration was provided by the Michigan Department of Environmental Quality.

II. Planning Process

The management of water resources is a complex and difficult task that requires the coordination of numerous individuals, organizations and various technical and or policy issues. As the lead agency involved with the development of the Swartz Creek Watershed Management Plan (SCWMP), CAER inevitably had a significant influence on the planning process and its outcomes. Because of that influence we felt it is important to take a moment to briefly identify several of our guiding principles in the management of the Swartz Creek Watershed.

Guiding principles:

- Watershed planning must be done using an iterative and adaptive approach
- Providing public access to the river resource is critical to protection of water quality
- Watershed planning should be integrated into master planning, parks and recreation planning, and infrastructure planning
- Land use within the watershed is a major consideration because of its effects on the hydrology of the watershed
- Source control is key to protection of water quality
- Protection of streams is more cost-effective than restoration of degraded streams
- BMPs should consist of a blend of structural, vegetative and managerial BMPs
- Public involvement and education are crucial to water resource sustainability

III. Public Involvement

Water resources, like all natural resources, are held in the public trust and require public input when management decisions are being made. This principle is especially important when dealing with water resources and non-point source (NPS) pollution because of the voluntary nature of NPS pollution mitigation. Involving the public in the development of the management plan provides advantages by identifying alignment between community visions and research goals. An open planning process ensures those responsible for implementation are comfortable with responsibilities and provides watershed managers with important information about the community's understanding of their water resources and its management. The public was involved in this project through public meetings and communication with individual residents and decision makers.

Public Concerns & Desired uses

Public concerns and involvement were the catalysts that began the process of seeking funding to develop the SCWMP. Over the course of the project various organizations and individuals played instrumental roles in defining how the project was to be managed, used and evaluated. Concerns involving the condition of the watershed were identified through several methods including formal public meetings and informal conversations among committee members and stakeholder groups. During the planning process three public meetings were conducted to both educate the public and gather information about the public's concerns. The three meetings were conducted with a total attendance of 41 individuals. The public identified several specific water quality concerns that were the focus of the physical inventory phase of the project. These concerns included:

- Poor fishing
- Flooding
- Low flows
- Aesthetics
- Bacteria from human waste
- Eroding stream banks

In addition to concerns expressed by individuals about the historic and current problems within the watershed, efforts were made to facilitate the identification of a vision for the future of the watershed and to establish desired uses. These concepts and desires were incorporated into the planning process and final plan.
The desired uses included:

- Preserve rural character in portions of the watershed
- Encourage economic sustainability of watershed communities
- Protect drinking water
- Use stream corridors in a greenways system
- Use SCW as an education tool for school aged children
- Improve public access to the stream
- Develop organizational capacity for watershed planning efforts in the Flint River Watershed

- Recreation
- Develop a stewardship ethic among citizens and local government about local water resources

Public Involvement Observations

During the planning process, CAER strived to document successful strategies and areas/issues that need significant improvements relating to public involvement. During the planning process, the following observations were by made by CAER staff and will be used and/or addressed in the implementation plan for the SCW.

- There was a need for increased public outreach and education
- Local elected officials were able to generate citizen turnout to watershed planning sessions
- There was a lack of understanding about water pollution and the role local governments and individuals play in watershed management

Steering Committee

The Center for Applied Environmental Research at the University of Michigan-Flint led the planning initiative and provided project coordination services. In an effort to ensure the planning process was representative of the community, a SCWMP steering committee was established that included:

- Michigan State Univeristy Extension (Genesee County)
- Flint River Watershed Coalition
- Genesee County Drain Commissioner
- Genesee County Health Department
- University of Michigan-Flint
- Mundy Township
- Flint Township
- Michigan Department of Environmental Quality
- Michigan Department of Natural Resources
- USDA-NRCS
- Genesee County Conservation District
- City of Swartz Creek

The above members of the steering committee did not meet on a regular schedule but were consulted throughout the project for input on elements of the project that impacted them. These steering committee members also were instrumental in the three public meetings that were held during the planning process.

Stakeholders

The geographic nature of a watershed is such that it crosses numerous political and social boundaries. In beginning the watershed planning process, efforts were made to include as many stakeholders of the community as possible. This public process was conducted to ensure that a common vision for the watershed was identified. Communication with this group yielded information about a range of issues from watershed wide concerns to site specific problems. Increased involvement by these organizations and additions to this group of stakeholders should be a goal in following iterations of the watershed management planning process.

The key stakeholders included:

Flint Township
Gaines Township
Mundy Township
Genesee County Drain Commissioner
City of Swartz Creek
Michigan State University Extension
Michigan Department of Natural Resources
Oakland County Road Commission
Saginaw Bay Watershed Initiative Network
Natural Resources Conservation Service
Citizens Disposal
Genesee Valley Shopping Center
Greater Flint YMCA
Carman-Ainsworth Schools
Grand Blanc Schools
Genesee County Land Bank
City of Flint
Grand Blanc Township
Holly Township
Fenton Township
Flint River Watershed Coalition
North Oakland Land Conservancy
Genesee County Road Commission
Swartz Creek Schools
Bishop Airport
Baker College
Seven Lakes State Park
General Motors
Genesee Institute
Holly Schools

IV. Watershed Description

Methods

The SCW is the area of land that drains to the Swartz Creek and its tributaries. Identifying priority pollutants, source areas, and specific causes of pollution affecting the watershed requires an understanding of the physical characteristics of a watershed. The following section of the watershed management plan is intended to provide specific information about the historic, current and future physical condition of the watershed. In order to characterize the physical condition of the SCW, CAER and its partners engaged in several activities during the planning effort. These activities included:

1. Conducting literature reviews of historic studies of the watershed and its tributaries
2. Soliciting public input about the watershed's physical condition
3. Conducting road/stream crossing data collection
4. Wading channels in specific areas of concern
5. Reviewing aerial photography and other GIS data
6. Conducting reviews of existing and future land use within the watershed
7. Conducting reviews of local community ordinances
8. Identifying specific areas of concern and specific sites for BMP implementation

Study Area

The Swartz Creek Watershed (SCW) is a 129 mi^2 area of land located in southern Genesee and northern Oakland Counties. (Figure 1.) The stream flows north approximately 15 miles from its headwaters in Oakland County into Genesee County and ultimately to its confluence with the Flint River in the City of Flint. The SCW is comprised of seven sub-watersheds (Figure 2.) and contains a number of small lakes (Table 1). The headwaters are primarily dominated by forest and wetlands and appear to exhibit relatively good water quality and natural channel forms. As the stream flows north into southern Genesee County, water quality reduces significantly as the landscape changes from forest and wetland land uses and to agricultural and urban land uses. The watershed includes ten municipalities including: City of Flint, City of Fenton, Flint Twp, Gains Twp., Mundy Twp., Grand Blanc Twp, Fenton Twp., in Genesee County and Holly Twp., Groveland, Twp, in Oakland County. (Figure 3.)

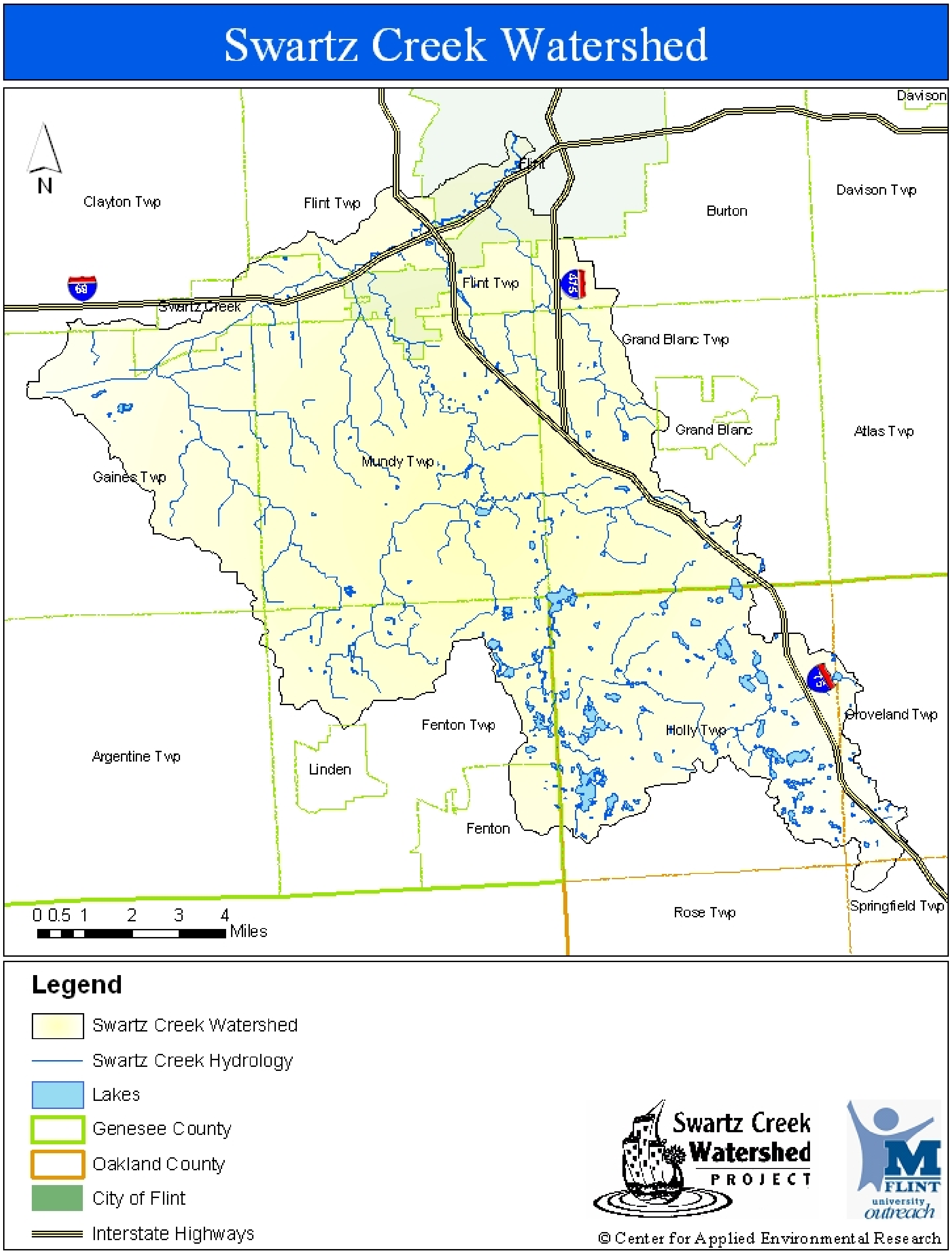
Swartz Creek Watershed
N
Davison
Clayton Twp
Flint Twp
Flint
Burton
Davison Twp
Swartz Creek
Flint Twp
Grand Blanc Twp
Grand Blanc
Atlas Twp
Mundy Twp
Gaines Twp
Fenton Twp
Holly Twp
Groveland Twp
Argentine Twp
Linden
Fenton
Rose Twp
Springfield Twp
0 0.5 1 2 3 4
Miles
Legend
Swartz Creek Watershed
Swartz Creek Hydrology
Lakes
Genesee County
Oakland County
City of Flint
Interstate Highways
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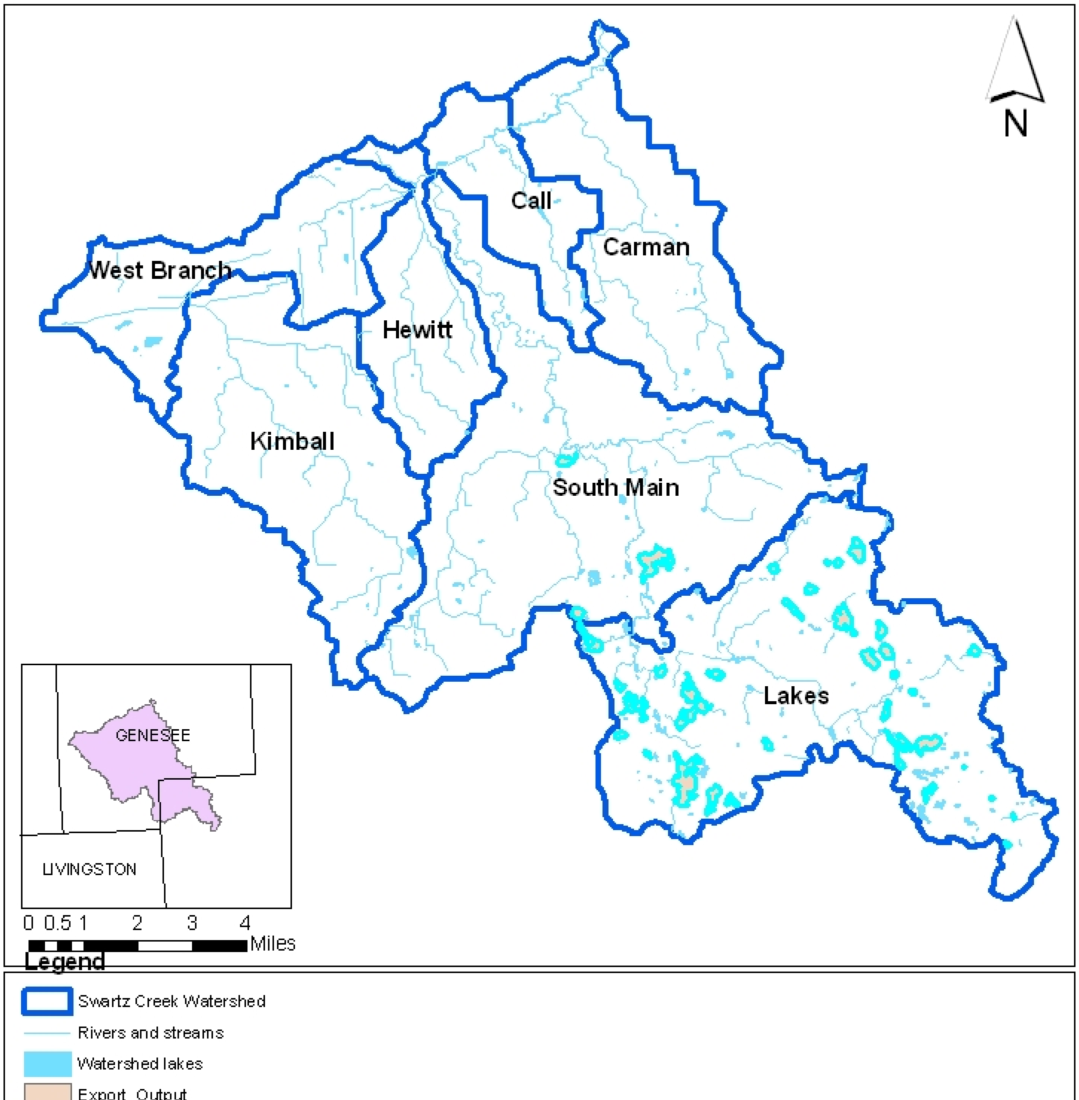
Figure 1 8

Sub-Watersheds of Swartz Creek



Swartz Creek Subwatersheds	AREA (Sq. Miles)
Carman	15.753
Call	6.713
South Main	34.589
Kimball	20.074
Lakes	32.180
West Branch	11.542
Hewitt	9.082
TOTAL	129.933

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Figure 2

Case Lake	Little Lake
Slack Lake	Pine Lake
Copneconic Lake	Holdridge Lakes
Barnum Lake	Lake Iroquois
Little Long Lake	Marl Lake
Dollar Lake	Cady Lake
McCully Lake	Crotched Lake
Crooked Lake	Little Crotched Lake
Petts Lake	Spring Lake
Nichols Lake	Minnock Lake
Slack Lake	Seven Lakes
Bloat Lake	Burns Lake
Martin Lake	Crystal Lake
Kennedy Lake	Dickinson Lake
Baldwin Lake	Spring Lake
Mitchell Lake	Minnie Lake
Fagan Lake	Mud Lake
Mud Lake	Pier Lake
Round Lake	Halstead Lake
Strawberry Lake	Oyster Lake
Horton Lake	Hollyshire Lake
Gravel Lake	

Table 1. Lakes of the Swartz Creek Watershed

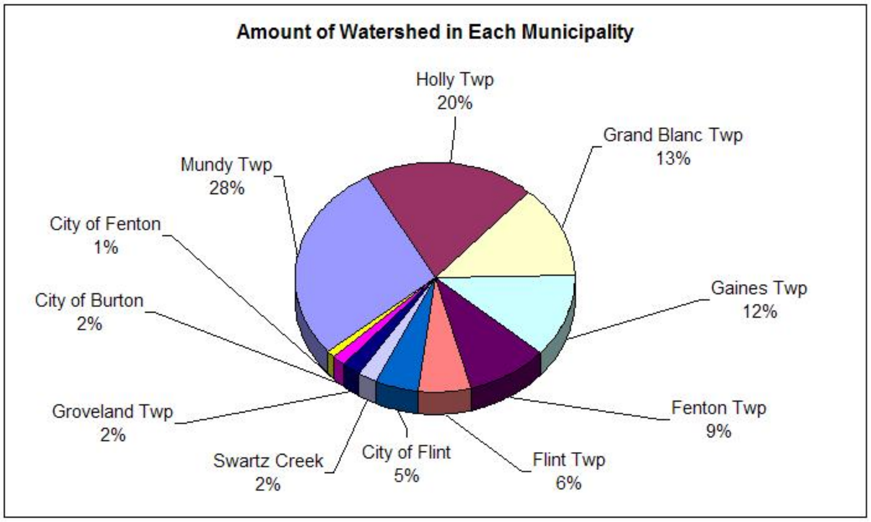

Figure 3. Percentage of Swartz Creek Watershed by Municipality

Climate

The Swartz Creek Watershed is located in the Lansing Ecoregion which has the following climate characteristics. The growing season is 140 to 150 days, generally decreasing to the north (Eichenlaub *et al*. 1990). Danger of late spring frosts is great due to numerous lowland depressions (outwash and kettle lakes). Average snowfall is 40 to 50 inches; greatest amounts are in the extreme north and extreme south. Annual precipitation is 30 to 32 inches, with highest amounts in the south. Extreme minimum temperature ranges from -22½F to -28½F, while highs range from 63F to 101F.

Geology

Understanding the geology of the SCW is important because of its implications for understanding how the drainage system works. This includes identifying areas that have the greatest potential for infiltration and understanding the capabilities and constraints upon any planned BMPs.

The geology of the SCW is dominated by landforms associated with the Wisconsinan glacial period. The glacial landforms found in the Swartz Creek Watershed are derivatives of the Laurentide ice sheet that reached its maximum at the Ohio River Valley approximately 18,000 years ago. Specifically, the local formations are associated with the glacier's Saginaw lobe that advanced from the Chesapeake Bay and retreated through the Lake Huron Basin. The glacial structures found in the Swartz Creek Watershed primarily include end moraines, outwash plains, till plains, and lake bed deposits. Each one of these forms is described briefly below.

End moraines - are depositional structures formed at the head of a glacier at undulating ice positions due to fluctuations in climate. The end moraines were formed as the retreat of the Saginaw Lobe stalled at various positions in the Swartz Creek Watershed. They are comprised of unsorted glacial till with large amounts of sand and gravel as well as lesser amount of clay and silt. These areas are important to increasing infiltration in the watershed.

Outwash plains are formed as a result of the glacial drainage system and collect when the glacier is stalled. They are comprised of well sorted sands and gravels and they typically slope downstream from the moraine. These areas are important to increasing infiltration in the watershed.

Till plains are formed as a glacier deposits materials in its path. They are composed of unsorted glacial till that has large amounts of clay and lesser amounts of sands, silts, and gravels. These areas are limited in their ability to infiltrate water in the watershed.

Lake bed deposits occur when melt water collects behind a previously formed end moraine. They consist of till that has localized deposits of clays and silts associated with underwater environments. These areas are limited in their ability to infiltrate water in the watershed.

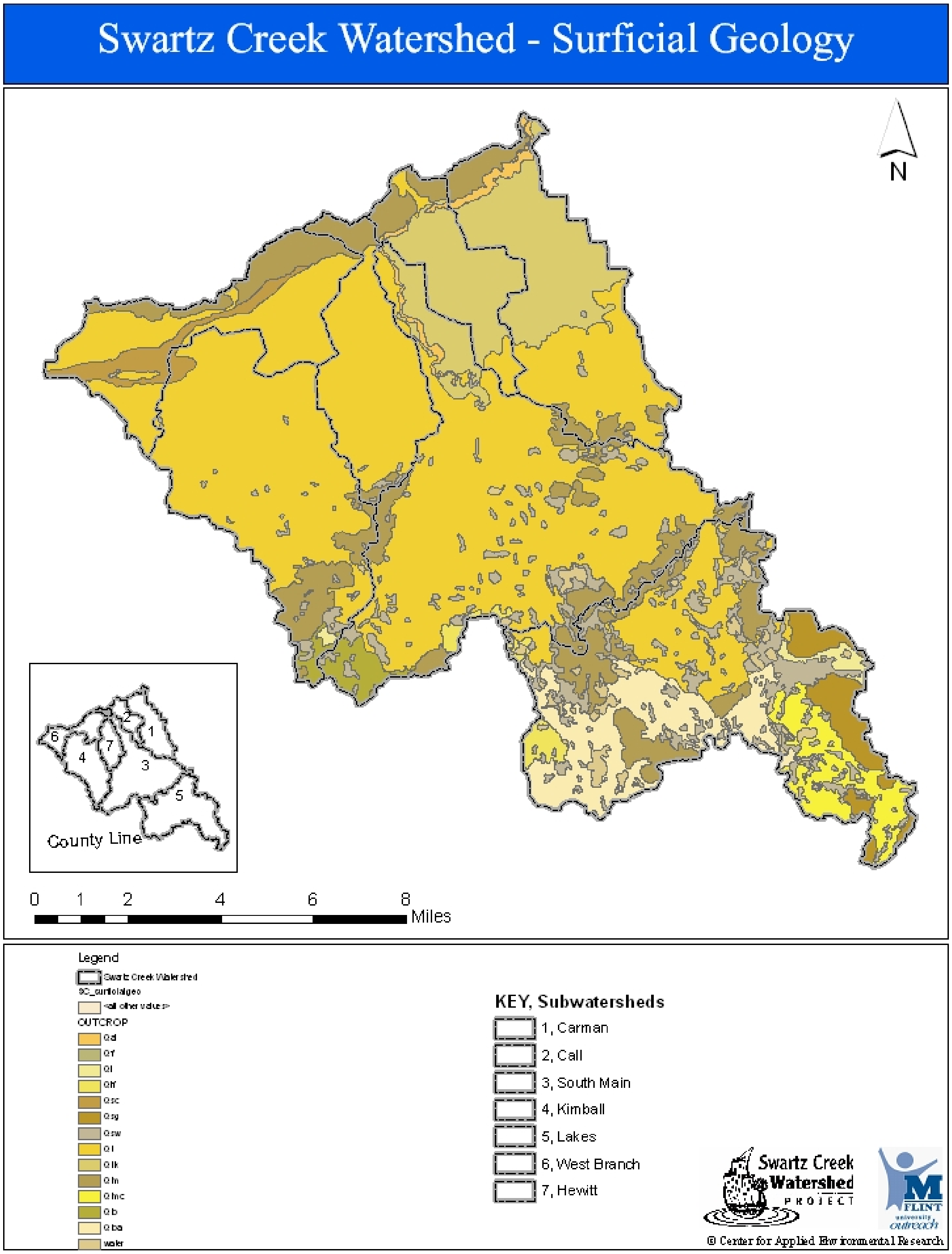

Figure 4

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Soils

Soils of the Swartz Creek Watershed are described as sandy loam moraines interspersed with clay-rich loam depressions. Soil associations of the SCW are shown in Table 2 and hydrologic soil groups in Table 3. A review of the hydrologic soil groups reveals that approximately 50% if the soils in the watered are rated as "C" type soils. These soils are generally limited with regards to their infiltration capacity. There are, however, pockets of soils that have increased capacity for infiltration. (Figure 5.)

Soil Association	Acres
BOYER-OAKVILLE-COHOCTAH (MI024)	122,351
CONOVER-BROOKSTON-PARKHILL (MI025)	464,108
LENAWEE-DEL REY-KIBBIE (MI009)	61,259
LENAWEE-TOLEDO-FULTON (MI008)	152,545
MARLETTE-CAPAC-PARKHILL (MI035)	716,259
MIAMI-CONOVER-BROOKSTON (MI017)	554,756
MIAMI-MARLETTE-LAPEER (MI016)	302,252
MIAMI-SPINKS-OAKVILLE (MI015)	23,632
SPINKS-HOUGHTON-BOYER (MI014)	1,045,162

Table 2: Soil Associations within the SCW

Entire Watershed	Area (Sq. Miles)	Percentage
A	2.8178	2.17%
B	30.4676	23.45%
C	62.8782	48.40%
D/A	7.7883	5.99%
D/B	17.6888	13.62%
D/C	0.1069	0.08%
Unknown	3.5245	2.71%
No data	4.6470	3.58%
Total	**129.9192**	**100.00%**

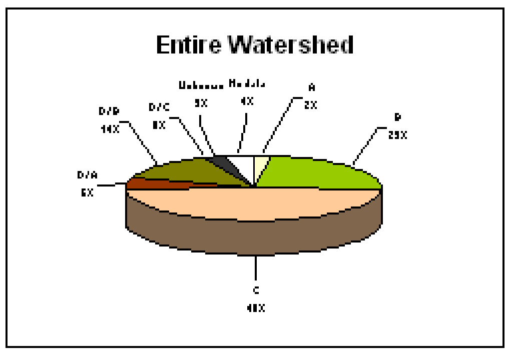

Table 3. Hydrologic Soil Groups of the Swartz Creek Watershed

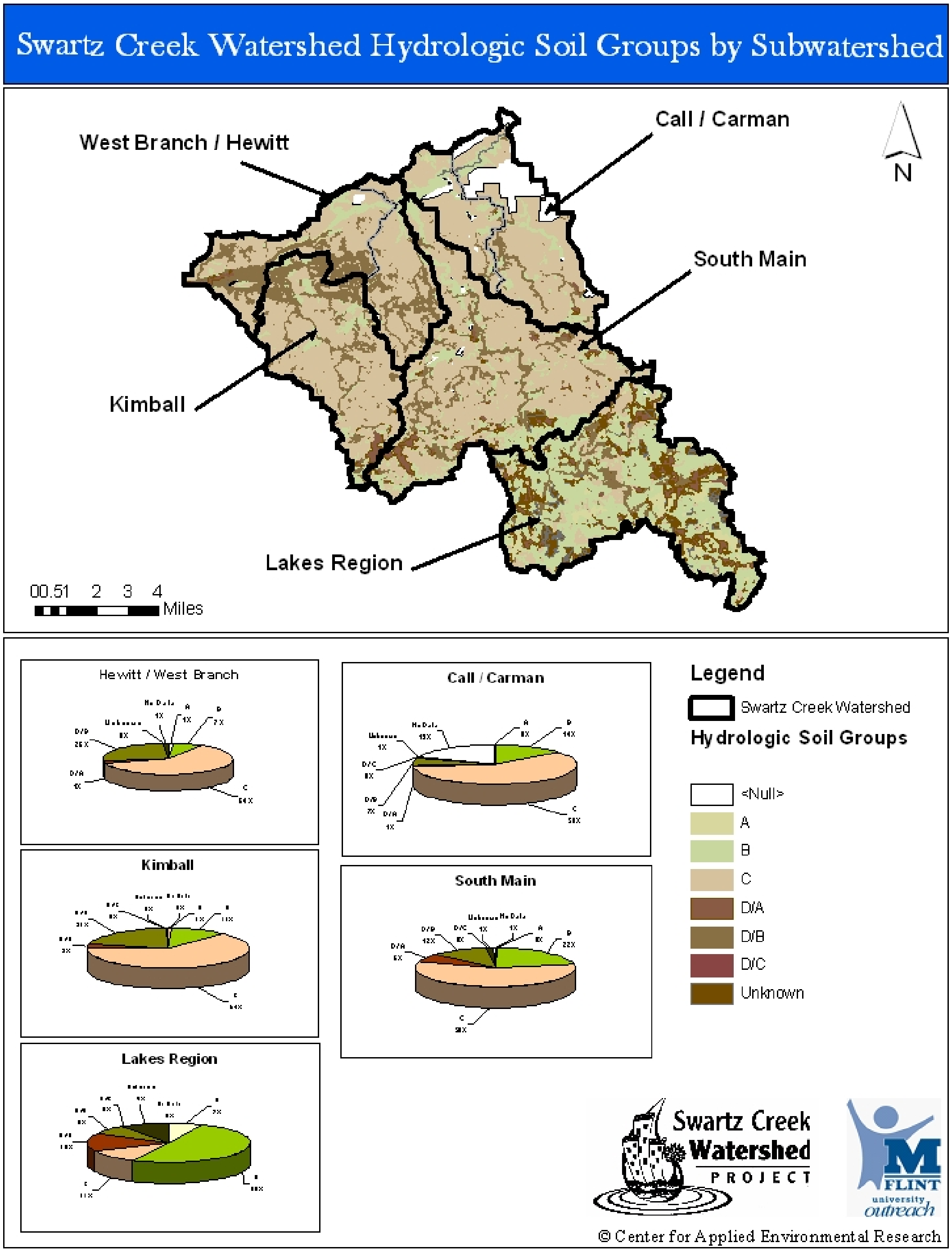
Swartz Creek Watershed Hydrologic Soil Groups by Subwatershed
West Branch / Hewitt
Call / Carman
South Main
Kimball
Lakes Region
N
0 0.5 1 2 3 4
Miles
Hewitt / West Branch
Call / Carman
Kimball
South Main
Lakes Region
Legend
Swartz Creek Watershed
Hydrologic Soil Groups
<Null>
A
B
C
D/A
D/B
D/C
Unknown
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Figure 5

Upland Habitat

Historically, the Swartz Creek Watershed consisted of Oak-Hickory forests in the southern portions and Beech-Sugar Maple forests in the north. Patches of mixed hardwood swamp, wet prairie, and black ash swamp existed in areas where the water table was in close proximity to the surface. In the south patches of mixed oak savannas, black oak barrens existed, with small patches of mixed conifer swamp, wet prairie, and mixed hardwood swamp in areas with a high water table.

Biological and Aquatic Habitat Assessments

Assessment of the biological and physical habitat of the Swartz Creek Watershed was determined to be necessary to characterize water quality and to make recommendations on the management of the watershed. Existing biological and habitat assessments conducted by state agencies were reviewed and evaluated. The combination of these assessments with field investigations conducted in the physical inventory process provided sufficient information to identify implementation activities. However, a more complete biological and chemical assessment should be conducted based upon the findings of our physical inventory.

Macro invertebrate and Mussel Community Assessments

MDEQ 1998 Assessment

The MDEQ Surface Water Quality Division conducted biological and chemical sampling at four locations in the Swartz Creek Watershed between July and September of 1998. Sampling was conducted on the Western Branch near the Miller Rd and US-23 interchange, Grand Blanc Rd and Main Branch crossing, Cook Road and Indian Creek Crossing and the Fenton Rd and Main Branch Crossing.

Macroinvertbrate communities at all sampling locations were rated as acceptable but near the low range of acceptable results. Little narrative or qualitative information regarding habitat and or hydrologic cues were present in the report. Water chemistry samples were also included within the report. Only one notable anomaly was identified in the report, which consisted of high arsenic levels at the Cook Road Crossing south of the Citizens Disposal Landfill. According the report these high arsenic levels were localized and no source was identified. (MDEQ 2001)

MDEQ 2003 Assessment

The MDEQ Surface Water Quality Division conducted biological sampling at four stations in the Swartz Creek between June 30th and August 8th 2003. The stations were located at the crossings of Cook Road and Indian Creek, Baldwin Road and Dawe Drain south of Citizens Disposal landfill, Reid Road and Kimball Drain and on the West Branch near Dye Road. The Western Branch Station was typical of heavily modified system with evidence of hydrologic dysfunction. The stream was extremely turbid on both sampling dates and substrates were limited and heavily embedded in a layer of clayey slit. The macro invert community was dominated by taxa that are indicative of poorer water quality and scored at the lower end of the acceptable rating. (Cooper 2004)

Water chemistry samples were taken in Indian Creek upstream and down stream of Dawe Drain (stations 46 and 47 respectively). Station 46 contained dense communities of algae and Cladophora on July 1, indicating chronically high nutrient concentrations. However this portion of the channel was dry in August and not sampled for macroinvertebrates. Macroinvertebrate communities at station 47 were rated as acceptable while nutrient concentrations, especially phosphorus were highly elevated (Cooper 2004)

Chemistry and macroinvertertbrate sampling was conducted in the Kimball Drain Subwatershed. This low gradient stream has been degraded along its entire length and heavily influenced by agricultural land uses. The overall riverine habitat at this station was rated as good and supported macro invertebrate community that, although acceptable, contained very low densities. There was almost no discernable flow on the date sampled. Stream banks were relatively stable with numerous undercut banks that provided ample fish cover. Upstream portions of the stream had little to no canopy and are intermittent in nature. Chemistry sampling indicated that soluble reactive phosphorous made up approximately 75% of the total phosphorous found in the stream indicating that there may be little assimilative capacity left within the stream channel. (Cooper 2004)

Fisheries Assessments

MDNR Fisheries classifies the Swartz Creek and its tributaries as a second quality warm water stream. Second quality warm water streams are those that have limited sport fish populations due to pollution, competitions, inadequate reproduction, or lack of suitable habitat. No fisheries management has occurred in on the Swartz Creek or any of its tributaries. Prior to 1997 no fisheries assessment records were collected for the Swartz Creek.

Flint River Community assessment March 1997

In 1997 MDNR collected fisheries information on the Swartz Creek near its confluence with the Flint River. According to Leonardi the fish community at the sampling location appears to be slightly influenced by the proximity to the Flint River. The presence of sand, spotfin, and emerald shiners and gizzard shad suggest these species are migrating into the Swartz Creek from the Flint River. High species diversity in relatively high abundance and the presence of intolerant species suggest that fair to good water quality and habitat conditions exist. These conditions are influenced by good in stream cover and good water level. Fish community structure in the upper reaches of the Swartz Creek tributaries where water levels are low and dredging has occurred are most likely less diverse and dominated by tolerant species. Spawning migration of carp, suckers, and northern pike are known to occur in the Swartz Creek. High sediment load is most likely affecting egg development of certain species (northern pike) (Leonardi 2001).

MDNR Fisheries Status and Trends Monitoring Program 2003
A single site was selected for sampling that was located along the entrance road to Camp Copneconic, approximately three miles east of Holly and two miles north of Fenton. This sampling site was selected as a representative site for the upper Swartz Creek aquatic ecosystem. The fish community found at this site is typical of warm water stream in Lower Michigan where water quality may be considered good but other factors limit species presence and abundance. The most significant limiting factor at this site appeared to be lack of suitable habitat due to low water levels. Although low stream conditions at this site appear to be more stable than downstream stretches.

A review of fishers information from the Swartz Creek indicates that a total of 28 species have been collected from the Swartz Creek. Sport fish constitute a small potation of the fishery and little recreational angling opportunities are available. Species diversity and abundance are higher in the lower portions of the watershed due to greater flow, better habitat and movement from the Flint River. (Leonardi 2003)

Human Population Trends
The communities of the Swartz Creek Watershed have experienced increased growth due to immigrations from the Detroit suburbs of Oakland County and from the northern Flint area. U.S. Census data from years 1990 and 2000 show all communities gaining in population with the exception of Flint Township. (Table 4) Population data was summarized from the Middle Flint Watershed Storm Water Management Plan.

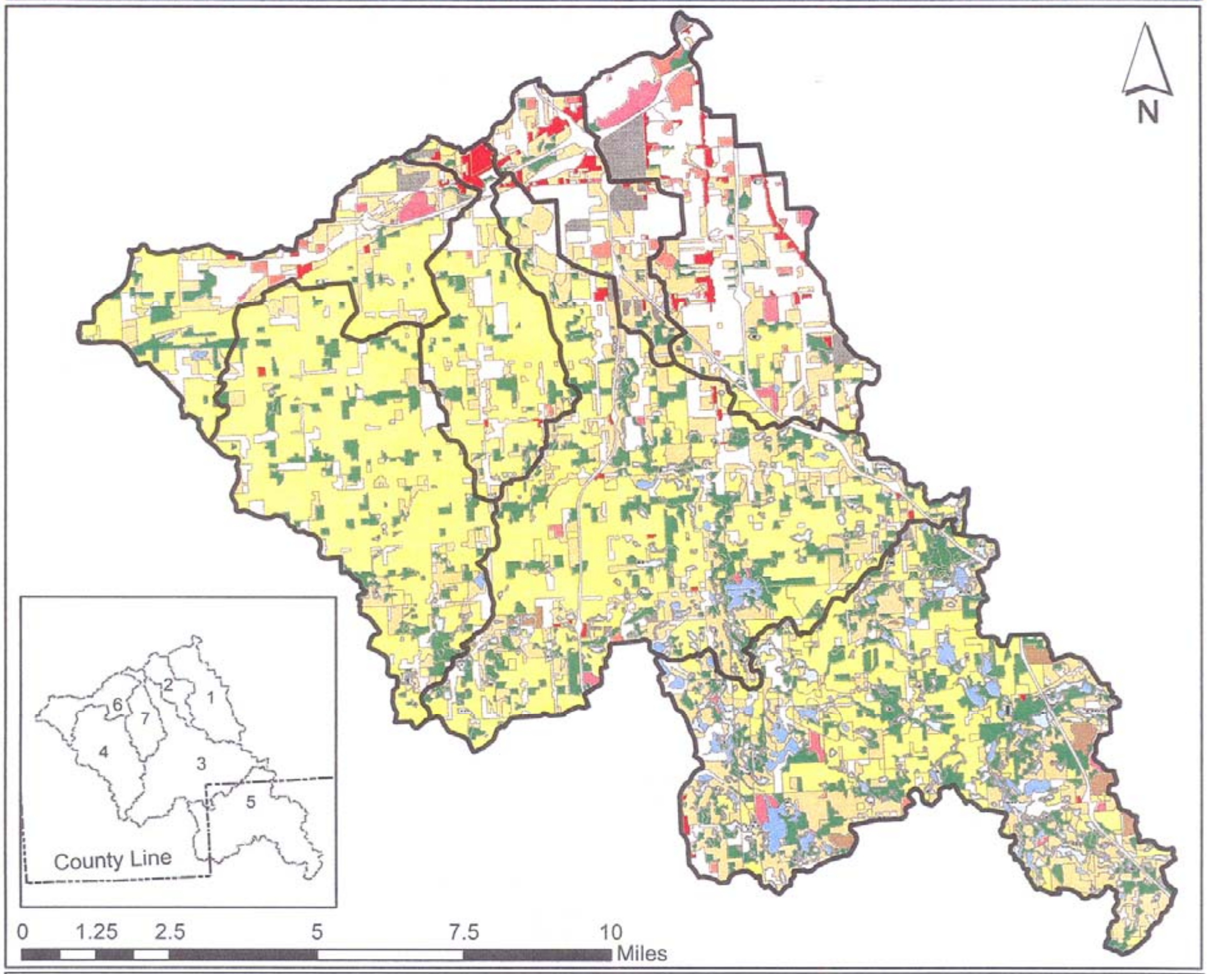
Community	1990 Population In Watershed	2000 Population In Watershed	% Change
Gaines Township	2171	2614	20.4
Grand Blanc Township	25392	29827	17.5
Holly Township	2998	3400	13.4
Mundy Township	11511	12191	5.9
Fenton Township	3718	4796	29
Flint Township	10228	10115	-1.1
Total	**56018**	**62943**	**12.36**

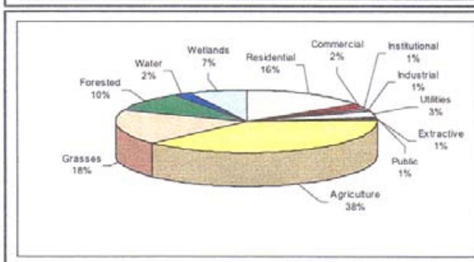
Table 4: Population in the SCW

Land use
By definition a watershed is the area of land that drains to a particular water body. Given that definition, it is understandable how the way the land is used within a watershed will have a tremendous impact upon the water quality of a river and on how that river should be managed for future generations. Because of the importance of linkages between land use and water quality the planning team felt it important to examining the historic, current and future potential land use makeup of the SCW. This examination will allow better planning decisions to be made in the SCW.

Historic Urbanization (pre 1978)
Historically land development has taken place in the lower portions of the watershed including the Call and Carman Drain Watersheds and the I69/Miller Road Corridor in the Western Branch Watershed (Figure 6). This initial urbanization that took place prior to 1978, has primarily impacted only the furthest downstream portions of the watershed. The most intensive impacts are from large commercial and residential land uses in these areas of the watershed. These land uses have resulted in a large amount of impervious cover from roof tops, parking lots and roadways. The remainder of the watershed has historically been dominated by rural land uses including agricultural, forest, wetland and rural residential. These areas have seen some water quality reductions associated with agricultural land uses and drain maintenance but have historically not been impacted by high percentages of impervious coverage.

Swartz Creek Watershed - 1978 Land Use / Cover





Entire Watershed	Area (sq mi)	Percent
Residential	20.4980	15.78%
Commercial	2.0520	1.58%
Institutional	1.2780	0.98%
Industrial	1.7230	1.33%
Utilities	4.1300	3.18%
Extractive	0.7410	0.57%
Public	1.4420	1.11%
Agriculture	49.6850	38.24%
Grasses	23.6000	18.16%
Forested	12.9980	10.00%
Water	2.3090	1.78%
Wetlands	9.4720	7.29%
Total Area	129.9280	100.00%

Legend

Class

- Residential
- Commercial
- Institutional
- Industrial
- Utilities
- Extractive
- Public
- Agricultural
- Grasses
- Forested
- Water
- Nonforested Wetlands
- Barren

Watershed Boundaries Key, Sub watershed

- 1, Carman
- 2, Call
- 3, South Main
- 4, Kimball
- 5, Lakes
- 6, West Branch
- 7, Hewitt

Data Sources:
2003 Land Use Data produced by CAER in 2005 from 2003 AirPhoto USA true color aerial photos with a 1 acre minimum mapping unit.

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Figure 6

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Current Land use (1978-2003)

In the more recent past, urbanization has begun to expand into other portions of the watershed. During the planning process for the SCW, CAER was engaged in updating land use for portions of the Genesee County including those areas in the Swartz Creek Watershed. The new data set generated by CAER has given us the ability to make direct comparisons about the changes in land use within the watershed over the past three decades. In addition, this information provides a basis for evaluating the success of land use strategies implemented to protect and restore the water quality of the Swartz Creek Watershed. An examination of the current land use presented in Tables 5 & 7 reveal several key trends that should be of consideration in regards to the management of the Swartz Creek Watershed including:

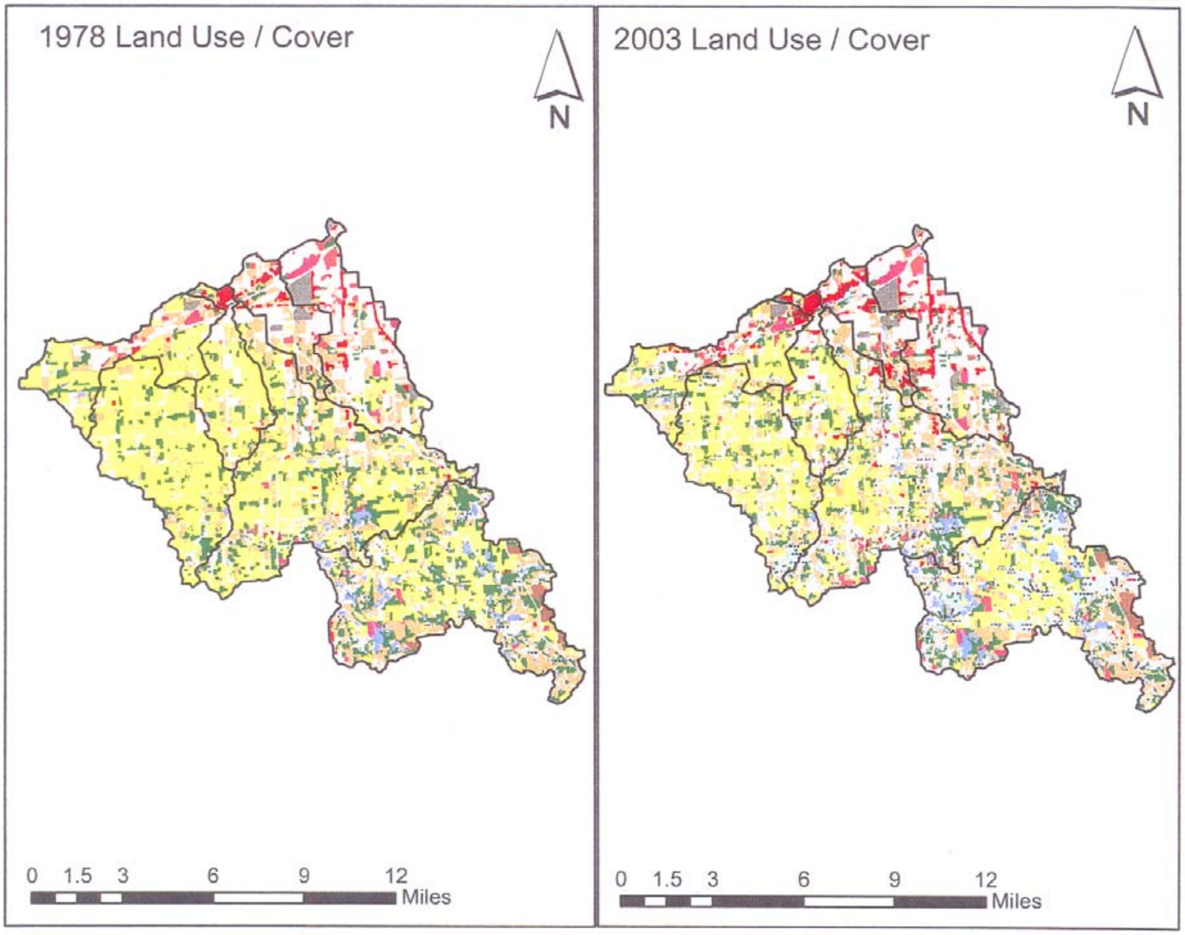
1. The land uses within the major tributaries of the Swartz Creek are transitioning from rural/agricultural to residential. Since 1978 Hewitt, Kimball and the South Main Branch all experienced losses of agricultural land above 45% and increases in residential land uses ranging from 22 to 26 percent. The Swartz Creek Watershed as a whole experienced a loss of over 44% of its agricultural lands.

2. There appears to be a net increase in the amount of wetlands in the watershed. It is speculated that this increase in wetland is a result of reductions in the drainage of agricultural lands. Some increases are due to improved image/mapping techniques allowing for a one acre minimum mapping unit for the 2003 data. The 1978 data was generated with a 2.5 acre minimum mapping unit.

Class	West Branch	Call Drain	Carman	Hewitt	Kimball	Lakes	South Main	Entire Watershed
Agriculture	-38.20%	-7.27%	-22.53%	**-45.13%**	**-48.95%**	- 24.11%	**-48.93%**	**-44.20%**
Barren					0.05%			.01%
Commercial	7.20%	20.16%	7.62%	6.52%	0.27%	1.26%	1.51%	4.14%
Extractive			1.07%			1.65%	-0.71%	0.12%
Forested	5.08%	5.58%	9.31%	5.40%	-0.47%	-3.92%	3.64%	2.92%
Grasses	-11.72%	-40.86%	-27.55%	-4.72%	12.06%	-22.06%	6.53%	-5.45%
Industrial	1.08%	-1.20%	8.48%	-1.47%		2.63%	0.90%	1.53%
Institutional	1.87%	1.96%	4.31%	2.65%	0.33%	1.63%	2.60%	2.31%
Public	1.96%	5.31%	1.42%	1.86%	0.04%	5.12%	0.96%	2.07%
Residential	23.11%	2.99%	15.54%	24.60%	26.00%	19.29%	22.20%	23.80%
Utilities	-0.21%	2.01%	-0.16%		-0.70%	-0.03%	2.34%	0.81%
Water	0.80%	0.58%			0.53%	0.88%	1.32%	0.89%
Wetlands	8.77%	12.09%	2.01%	7.67%	10.65%	17.42%	8.37%	11.04%

Table 5: Land use change in the SCW from 1978 - 2003

Swartz Creek Watershed
1978/2003 Land Use / Cover Change



Swartz Creek Watershed Land Use Change 1978-2003

Entire Watershed

Class	1978	2003	Change (Sq mi)	Change (Acres)	Percent Change
Agriculture	49.69	32.44	-17.25	-11038.08	-44.20%
Barren		0.00	0.00	2.56	0.01%
Commercial	2.05	3.67	1.61	1032.96	4.14%
Extractive	0.74	0.79	0.05	28.80	0.12%
Forested	13.00	14.14	1.14	729.60	2.92%
Grasses	23.60	21.48	-2.13	-1360.00	-5.45%
Industrial	1.72	2.32	0.60	382.08	1.53%
Institutional	1.28	2.18	0.90	576.64	2.31%
No Data		0.28	0.28	181.76	0.73%
Public	1.44	2.25	0.81	515.84	2.07%
Residential	20.50	29.78	9.29	5943.04	23.80%
Utilities	4.13	4.45	0.32	202.88	0.81%
Water	2.31	2.66	0.35	222.08	0.89%
Wetlands	9.47	13.78	4.31	2758.40	11.04%
Total Drainage Area	-	130.1999			

Legend

Class

Residential	Public
Commercial	Agricultural
Institutional	Grasses
Industrial	Forested
Utilities	Water
Extractive	Nonforested Wetlands
	Barren

Data Sources:
2003 Land Use Data produced by CAER in 2005 from 2003 AirPhoto USA true color aerial photos with a 1 acre minimum mapping unit.

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Figure 7

Future estimates

In addition to examining historic and current land uses within the watershed, the planning team examined information that provides some insights into the future land use makeup of the Swartz Creek Watershed. This was facilitated by examining future land use information from community master plans, zoning maps and ordinance manuals. This method has significant limitations that need to be considered but can provide information about the general future land use goals of the community.

The process used to estimate future land use assumes that full build out will occur of the existing land use plan. This examination fails to account for partial build out or for variances granted by agencies charged with making land use decisions. It should also be stated that this examination of land use was conducted at the watershed scale and therefore does not reflect nor should it be used for making site specific recommendations. Rather the information reflects the general intentions of the community with regards to future land uses.

During the investigation of community master plans and zoning ordinances it became apparent that there was the need to develop a uniform zoning classification system that could be applied to the entire watershed. In order to facilitate this comparison, CAER reviewed the zoning criteria of the municipalities within the watershed and developed a uniform system. Specifics about how the classification system was developed are included in the appendix. Once the master plans and zoning maps of the communities were uniformly classified they were examined at a watershed and sub-watershed scale (See figure 8).

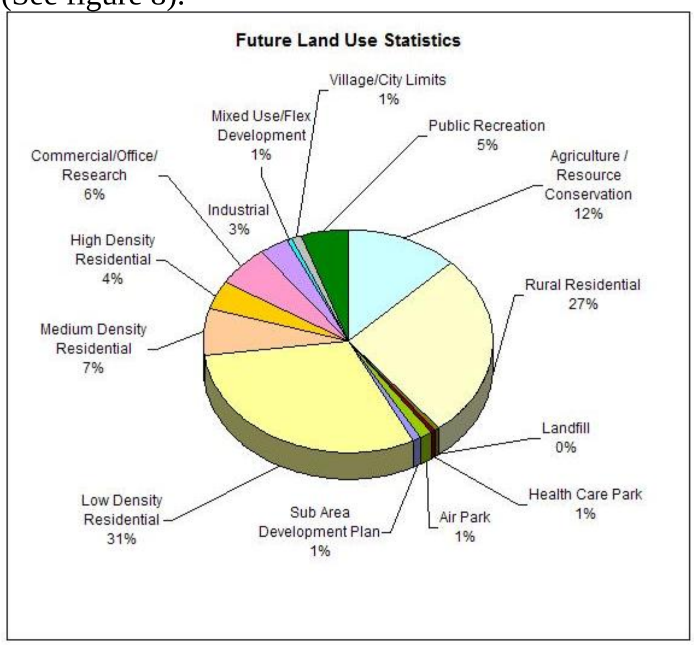

Figure 8. Hypothetical future land use of the Swartz Creek Watershed

A review of “future” land use information illustrates that a large percentage of the watershed is classified as “transitional”, which includes agricultural and residential land uses. It appears that the headwaters portion of the watershed including Kimball Drain, Sever Drain, Indian Creek and Hewitt will likely continue to see significant increases in residential construction. These areas are made up largely of Gaines, Mundy and Holly Townships. These transitional areas are identified as having the highest development pressure because of their large parcel size and prices.

Local ordinance reviews and policies

Home Rule is at the heart of land use decisions and local building ordinances in the State of Michigan. This traditional local control of land use decisions by local planning commissions and township boards will play a major role in determining the success or failure of the Swartz Creek Watershed Plan. Local policies are directly related to and/or responsible for determining future land uses within the SCW. As a result the planning team examined the local land use policies and ordinances that influence land use and storm water management within the watershed. This examination was conducted to uncover opportunities for improvements in local policies and practices that will assist in protecting and restoring water quality in the Swartz Creek Watershed. Each community’s zoning and building policies were entered into a matrix and awarded points for policies that are considered positive for water quality (Table 5.)

Community Zoning Ordinances and Stormwater Management

(0 = hinder 1 = help)

Community	Landscaping Standards	Buffer Zones Required Near Sensitive Lands	Parking Lot Runoff Controls	Required Parking Lot Vegetation	Open Space Cluster Options	Lot Grading	Floodplain Development	Paving Options / Shared Driveways	Curb / Swale Options	Feedlot / Animal Waste Control	Fertilizer Controls (Golf)	Septic Controls	Totals
Fenton Twp.	1	1	1	1	1	1	0	0	0	0	0	1	7
Flint	0	0	0	1	1	0	0	0	0	0	0	0	2
Flint Twp	1	1	1	1	1	1	1	0	0	0	0	0	7
Grand Blanc Twp.	1	0	1	1	1	0	0	0	0	0	0	1	5
Holly Twp.	1	0	1	1	1	1	0	0	0	1	0	0	6
Mundy Twp.	0	0	0	0	1	1	0	0	0	0	0	1	3
Swartz Creek	1	1	1	1	1	0	1	1	0	0	0	0	7
Totals	5	3	5	6	7	4	2	1	0	1	0	3	

Table 5.

Implementing progressive policies to protect water quality is most important in those areas identified in the future land use examination, mainly Mundy, Gaines and Holly Townships. Based on our review of the matrix containing existing policies and information gathered from communications with township residents and leaders several key findings were identified:

1. Little consistency exists across jurisdictional lines regarding zoning classifications.
2. Current ordinances within the Swartz Creek watershed revealed that most attention to water resources followed traditional zoning concerns, such as density and open space.
3. Local policies fail to recognize the linkage between water quality and water quantity.
4. Mundy Township's ordinances are the weakest with regards to protecting water quality. Specifically the township has no ordinances regarding landscaping standards, buffer zones near sensitive lands, parking lot runoff controls, parking lot vegetation, flood plain development or fertilizer controls. This fact in combination with its large area in the watershed makes it a high priority municipality to work with in strengthening water related policies.
5. Watershed planning is not currently incorporated into other township planning efforts (parks, master, transportation etc).
6. Mundy, Holly, Grand Blanc and Flint Twp. should consider implementing natural features setback ordinances. This finding is also supported by the physical inventory portion of the planning process which found significant need for this policy change.

These findings are important to consider in the management of the Swartz Creek Watershed. The lack of consistency in the communities zoning policies presents a significant hurdle in attempting to manage land use to protect water quality. The weakness of Mundy Township's ordinances, its continued growth and its location within the watershed make it a top priority for new policy development and implementation specifically with regards to stormwater management and riparian land management. Holly Township is the second highest priority township in the watershed because of its relatively good water quality and expected continued development. Holly Township's policies are relatively good when companied to the other municipalities including the requirement for parking lot vegetation and runoff controls. The focus of new policy development in Holly Twp should be focused on the development of natural feature setbacks and standards that allow for the use of low impact development such as no curb/swale options, road narrowing, etc. These findings directly influenced the development of several education and managerial BMPs identified in the implementation portion of the watershed plan.

Future land use/policy research

Several opportunities exist in the watershed for land use and policy research and/or work. During the watershed planning process no examination of the enforcement of the communities' policies was conducted. Future research should be conducted to examine the performance of the communities with regards to zoning ordinance and code enforcement.

IIV Hydrology

Hydrology General Concepts

To understand the hydrology of the Swartz Creek Watershed one needs to know how water moves through the drainage system. Reviewing information about the volume and rate at which water travels through the system before, during and after rain events can help us understand how the hydrology of the SCW affects water quality.

Streams receive water in two general ways including overland flow (runoff) from the earth's surface and from base flow (infiltration that seeps directly into the stream channel). Land use changes in a watershed redistribute the amount of water that is delivered to the stream by these two processes. In most cases human interactions tend to increase the amount of water entering the stream from direct runoff while reducing the water available for base flow. This change in the hydrology is measured by two variables: the coefficient of runoff (amount) and the concentration time (speed). Landscape changes including land clearing, deforestation and the introduction of impervious surfaces increase the coefficient of runoff. Concentration time is shortened by activities such as installing ditches, constructing storm sewers and removing wetlands. Figure 9 is a graphic representation of how natural and urban river systems react to rainfall events. This figure contains two hydrographs representing hypothetical urban and natural streams. Time is plotted along the horizontal axis while the amount of water (discharge) is plotted along the vertical axis. A review of this figure demonstrates drastic differences between natural and urbanized watersheds. Most important to notice are the increases in peak flow and reduction of base flow associated with the urban watershed.

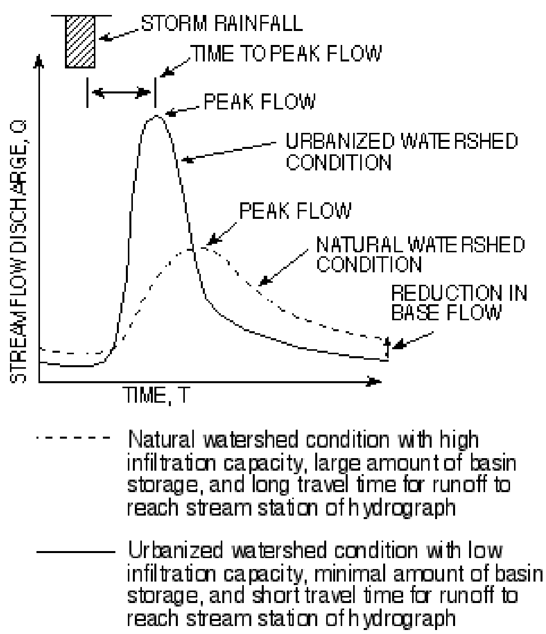

Figure 9. Hypothetical urban and natural hydrographs

Hydrology's affects on water quality

The increase of runoff coefficients and concentration times associated with land use changes and channel alterations result in significant impacts on water quality. Changes in these two variables directly impact the aquatic habitats of the stream system. In addition they affect the magnitude and frequency of flooding events and function to increase the delivery of non-point source pollutants to the stream and other receiving waters. The reduction in base flow negatively impacts the stream by reducing the water available for human and animal uses.

Swartz Creek Watershed Hydrology

Because of the major role that hydrology has on stream water quality, the steering committee wanted an understanding of the general hydrologic conditions of the watershed. Based on resources available to the investigation hydrology characteristics were determined by activities including:

1. A review of existing hydrologic information
2. An investigation into the historic modifications made to the stream channel
3. Observing and recording hydrologic clues (channel form, substrate, habitat structure, geomorphic units)

Hydrology findings

The Swartz Creek Watershed is similar to many watersheds in the southern Lower Peninsula of Michigan that are dominated by stormwater runoff. The Swartz Creek system has been highly altered from the pre-settlement state by stream channel straightening, flood plain removal, increases in drainage associated with ditches and tiles, and the introduction of large areas of paved surfaces. The combination of these factors has resulted in the Swartz Creek Watershed taking on a flow regime that is characteristically urban.

The United States Geologic Survey (USGS) gauging station located four miles upstream from its confluence with the Flint River averages an annual discharge of 78 cfs (cubic feet per second) with extremes of 0.3cfs to 1300cfs. Flow patterns tend to be flashy due to landuse, channel alterations and storm water runoff. Figure 10 is an actual hydrograph generated by the USGS for the Swartz Creek Watershed during a recent storm event.

A review of this hydrograph unquestionably illustrated the urban nature of the watershed. The ascending limb of the hydrograph illustrates a relatively short concentration time. The abrupt and sharp recession limb of the hydrograph illustrates the relative inability of the watershed to retain water for longer periods of time before releasing it to the stream channel.

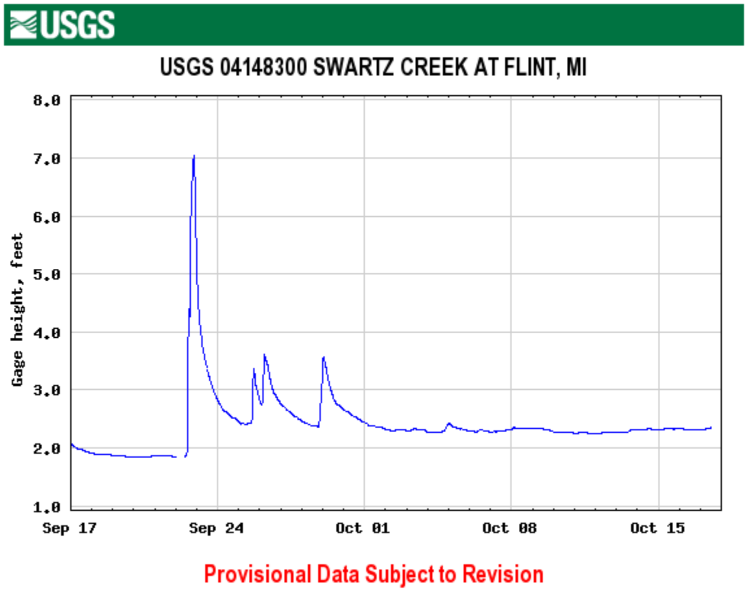

Figure 10: Stream gauge near the Ballenger Highway Bridge, Flint, MI.

In addition to direct measures of river discharge, the physical condition of the stream can provide insights into the hydrologic conditions of the watershed. In order to examine the physical condition or "hydrologic cues" of the watershed, we divided the SCW into five stream segments: 1) Lakes Region 2) South Main Branch, 3) Kimball Drain, 4) Western Branch/Hewitt Drain, 5) Call/Carman Drain. The Western Branch is further divided into three sections because of its complexity. Table 6 summarizes the narrative descriptions of each of these segments highlighting the hydrologic descriptions and land use.

Stream segment	**General hydrology descriptors/hydrologic cues**	**Landuse**
Lakes	Stable hydrology/continual flow Numerous wetlands, lakes and ponds High infiltration soils Vegetated stream banks	Rural residential, dominated by wetlands, woodland Low Impervious cover
Main Branch	Upper reaches are intermittent Wide floodplain downstream from Fenton Rd. Crossing Logjams affecting flow upstream of airport (site specific) Moderate stream bank erosion (site specific)	Transitioning from agricultural to residential Numerous proposed residential developments Existing Zoning will facilitate continued trends
Kimball Drain	Partially recovered modified stream channel Low but stable base flow Large stormwater flows from agricultural sources Relatively stable undercut banks	Transitioning from agricultural to residential Less development pressure then other portions of watershed
West Branch	**See stretch descriptions below**	**See stretch descriptions below**
City of Swartz Creek to Genesee Meadows Golf course	Highly modified/straightened stream channel Excessive sedimentation upstream of dam location Wide slow channel Floodplain removal Debris jams at road stream crossings Eroding Outfalls	Largely residential and agricultural including Kimball Drain contributions Riparian corridor dominated by Interstate and railroad corridor
Dam to Howard	Large Scale Flood Plain removal	Largely Commercial

Johnson	Large scale stream bank erosion Fast channelized flow	Large transportation land uses including I-69 and Miller Rd. Corridor
Howard Johnson to Thread Creek	Highest order stream segment in watershed Well connected floodplain Active Channel migration Out flooding common Few channelized sections	Complex (entire watershed) Riparian Corridor is largely natural
Carman and Call Drains	Entirely dependant upon stormwater runoff Extensive stream bank and road stream crossing erosion	Heavily urbanized High density residential

Table 6 Summary of the hydrologic conditions and land use for each segment of the Swartz Creek Watershed

VI. Water Quality

The following section presents information about the water quality of the Swartz Creek Watershed. Presented here is information about water quality in general, a brief review of information gathered about water quality in the Swartz Creek Watershed, the identification of priority pollutants in the watershed, and a water quality summary. BMPs to protect water quality from the pollutants described here are presented in the implementation section of this plan.

The management of water quality involves identifying the status of designated uses of that particular water body. In Michigan, rivers are supposed to meet eight designated uses including:

1. Agriculture
2. Industrial water supply
3. Public water supply at point of intake
4. Navigation
5. Warm water fishery
6. Other indigenous aquatic life and wildlife
7. Partial body contact recreation
8. Total body contact recreation (between May 1st and October 31st)

Identifying the designated uses not being met and those uses that are threatened by activities on the land is a critical part of all watershed management plans. In assessing the use attainment of the Swartz Creek Watershed, several sources of information were consulted including: reviews of county health department records, DNR fisheries reports, DEQ water quality assessments, physical inventory road stream crossing surveys and observation of use by stakeholders.

Review of previous research

A review of both the macrointertrabrate and fish community assessments indicate that the Swartz Creek is at the low end of designated use attainment or slightly impaired. Pollutants cited for the impairments included: sediment, nutrients and PCB's. According to the research review, water quality within the watershed is generally the highest in the headwaters region and declines downstream towards the more developed areas of the watershed. The only exception to this trend is that fish populations are healthier in the lower portions of the watershed primarily due to upstream migration from the Flint River.

Physical Inventory

In addition to a review of previous research related to the use attainment of the Swartz Creek Watershed, the planning team engaged in several other activities to identify the water quality condition of the Swartz Creek. These included data collection at road stream crossing, critical area investigations, public input sessions, and observation of uses within the watershed.

A review of the road stream crossing inventory information and critical area investigations confirmed the results of both MDEQ and MDNR's previous research.

In-stream habitat is negatively impacted by large amounts of sediment. Human generated erosion was present throughout the entire watershed with sources including both upland and in stream areas. The removal of riparian vegetation was identified at sites throughout the entire watershed and is responsible for exacerbating stream bank erosion and increasing stream temperatures. The presence of oil sheens on the stream was common throughout the entire Western Branch after storm events. These oil sheens originated at large expanses of impervious cover in the sub-watershed.

Prioritization of pollutants, sources, causes and identification of critical areas
Prioritization of the pollutants affecting the Swartz Creek Watershed is important to achieve the greatest reduction of pollutants with the least input of resources. Pollutants along with sources and causes were prioritized for each of the impaired designated uses. This prioritization was based upon the significance of the impact upon the watershed and designated uses, the amount of pollutant and the potential of the pollutant to impact the watershed in the future.

Based upon those criteria and the professional judgments of the planning team, sediment was determined to be the highest priority pollutant. This was followed by sediment born nutrients (phosphorus) and suspected pollutants including thermal, bacteria, and oil/grease from road runoff respectively. The pollutants, sources causes and critical areas are discussed briefly here and identified in Table 7.

Sediment
Sediment is a priority pollutant because of its affects upon both warm water fisheries and other indigenous aquatic life designated uses. Sediment increases turbidly of the water affecting reproduction of eggs, respiration and feeding of aquatic life. Sediment fills pore spaces between gravel substrates reducing their viability for spawning. Sediment also covers woody debris that is critical for protection of both fish and other aquatic life from predation.

Sedimentation from both upland and in stream sources is affecting life stages of fish and other aquatic life. Sediment is entering the Swartz Creek from specific upland sites including gully erosion from agricultural, residential construction and commercial areas. These sites are primarily caused by improper management of stormwater and sediment before it enters the stream channel. Additional sediment from stream banks is entering the channel at a number of locations. Stream bank erosion is primarily a result of improper riparian land management, local hydrologic conditions (i.e. culverts/tree falls) and system wide hydrologic alterations (dredging/channelization). Significant erosion also is present at several elevated or broken outfalls. See Figure 11 for a map of the specific locations.

Sediment Critical areas
Active erosion to the stream channel was witnessed at various sites across the entire watershed. Several stretches of stream were identified as contributing the largest amounts of sediment from upland areas and stream banks including the West Branch, Kimball Drain, Indian Creek and Hewitt Drain.

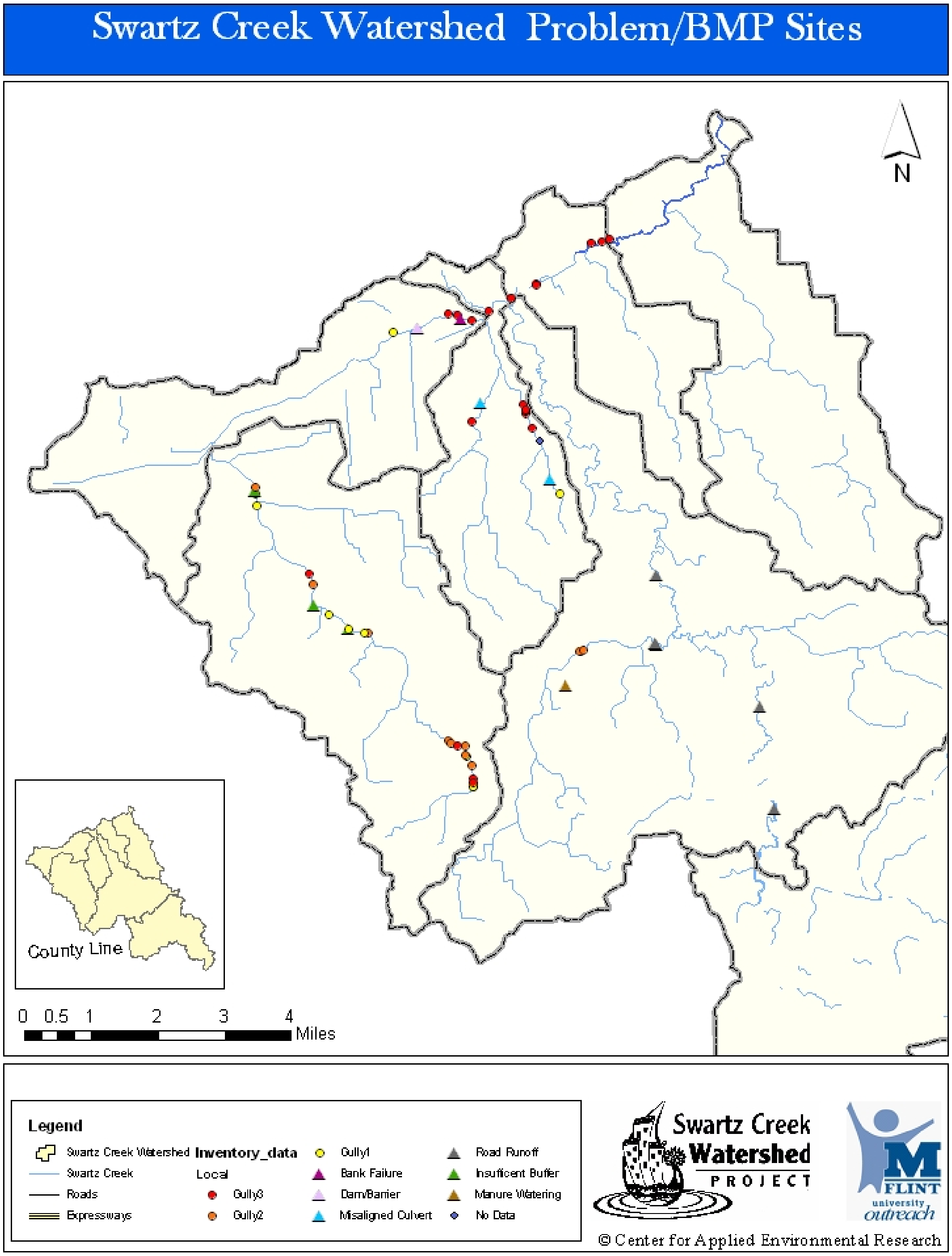
Swartz Creek Watershed Problem/BMP Sites
N
County Line
0 0.5 1 2 3 4
Miles
Legend
Swartz Creek Watershed
Swartz Creek
Roads
Expressways
Inventory_data
Local
Gully3
Gully2
Gully1
Bank Failure
Dam/Barrier
Misaligned Culvert
Road Runoff
Insufficent Buffer
Manure Watering
No Data
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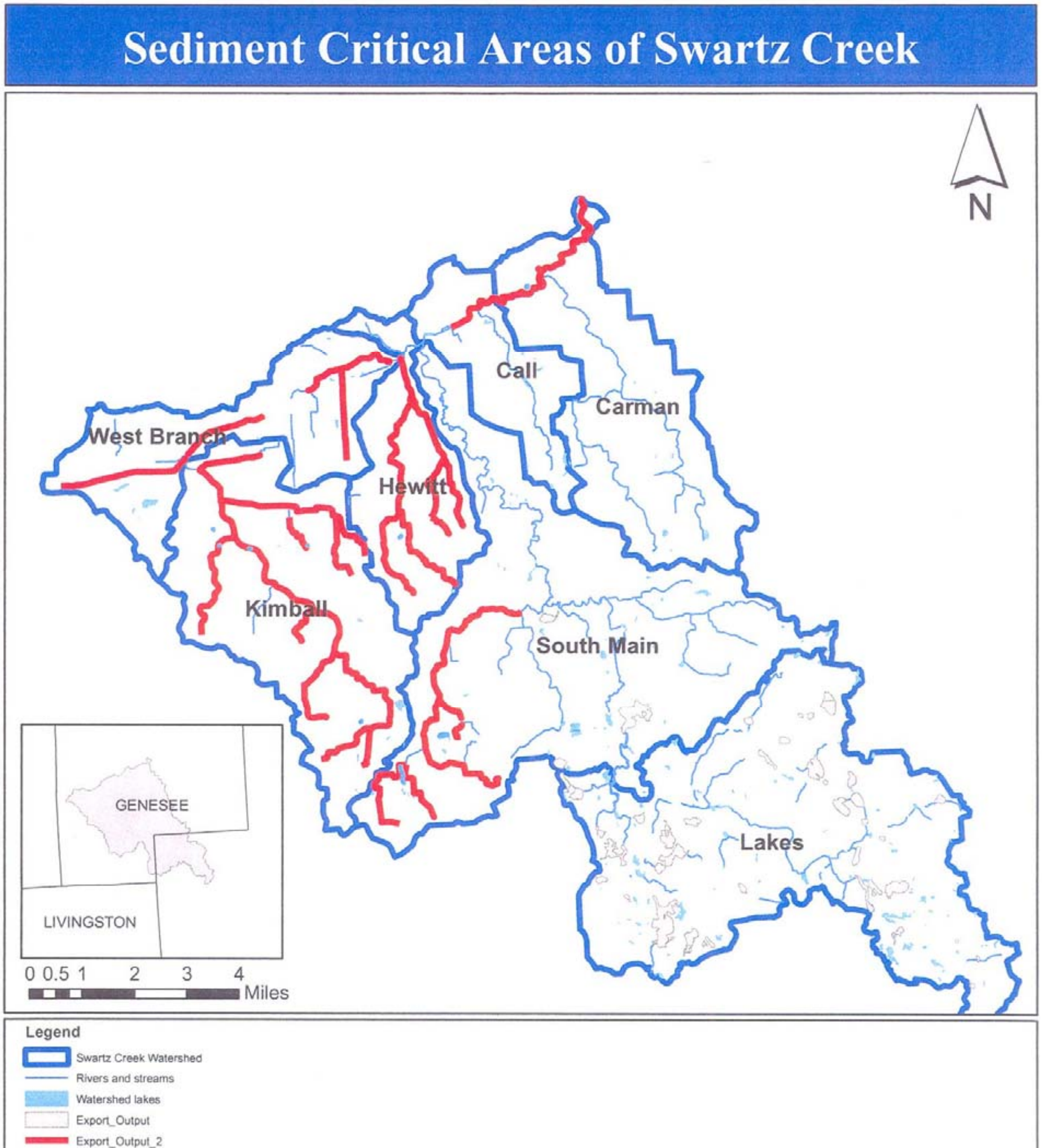
Figure 11

34



Swartz Creek Subwatersheds	AREA (Sq. Miles)
Carman	15.753
Call	6.713
South Main	34.589
Kimball	20.074
Lakes	32.180
West Branch	11.542
Hewitt	9.082
TOTAL	129.933

Figure 13

Sedimentation
Erosion of sediment into the stream channel provides the material that will periodically settle out of suspension and cover the streambed destroying aquatic habitat. Several areas within the watershed were identified as being inundated with excessive sediment and embedded stream beds. As portions of the watershed management plan are implemented these areas should be monitored for reductions in stream embeddedness.

The location of a small dam on the Western Branch is creating the most significant sedimentation in the Swartz Creek Watershed. Upstream of this dam approximately one mile of streambed is entirely covered in sediment carried from the Kimball Drain and Western Branch Sub-Watersheds. Sources of sedimentation include primarily agricultural runoff from Kimball Drain which flows into Swartz Creek upstream of the dam. The scale of the sedimentation and any efforts to restore this section of the stream will require additional research. A second location of excessive sedimentation is located just below the Hammerberg Rd. stream crossing in the Happy Hollow Recreation area. Localized sedimentation also is present periodically behind log jambs throughout the lower portions of the Southern Branch and Western Branch Watersheds. It is expected that as reductions in sediment loadings across the entire watershed are achieved embeddedness in these areas will be reduced.

Sediment Born Nutrients
Nutrients within the stream channel were identified as a priority pollutant because of their impact on warm water fisheries and aquatic habitat. Phosphorus was identified by DEQ as a pollution problem throughout the entire basin with the Kimball Drain Watershed being the most impacted. (Cooper 2004) The identification of Kimball Drain as severely impacted appears to be a result of the large agricultural makeup of this sub watershed. The identification of biological indicators such as algae blooms and extensive aquatic vegetative growth were not present during the physical inventory portion of the watershed planning process. This was largely due to the intermittent nature of the watershed and the lack of water in stream channels in mid to late summer.

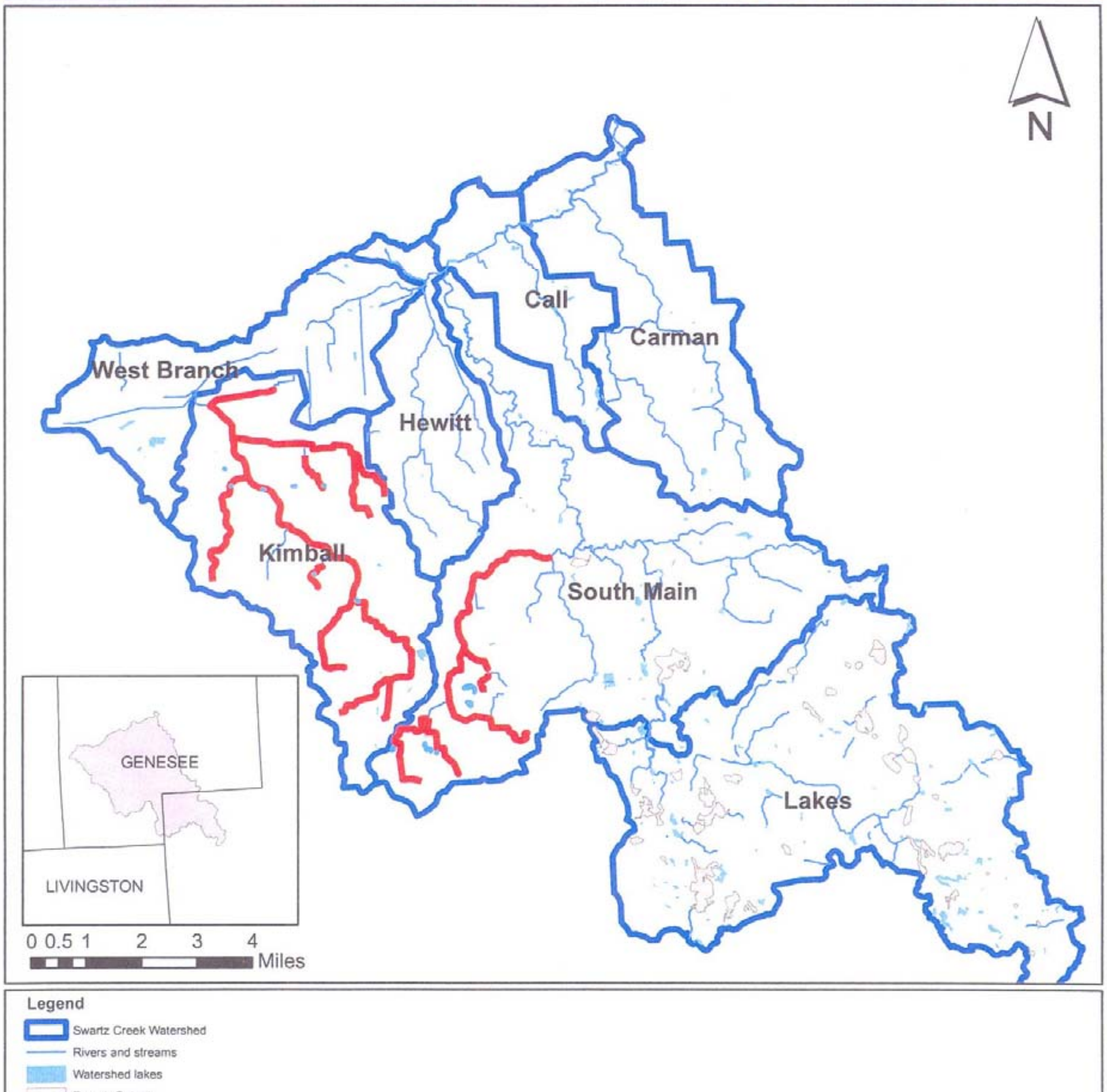
Based upon research reviews and field observations sediment borne nutrients, specifically phosphorous, need to be controlled to achieve water quality goals and protect/restore designated uses. Addressing sediment as a pollutant is expected to reduce the presence of phosphorous in the stream system to sufficiently protect/restore designated uses.

Phosphorous Critical Areas
Both DNR Fisheries and DEQ identified the presence of excessive phosphorus as contributing to water quality impairments within the watershed. During field investigation several locations in the Kimball Drain and Indian Creek Watersheds were identified as being impacted by excessive nutrients. However low flow in the creek during mid to late summer often resulted in dry stream channels that did not support algae growth. A majority of the phosphorus appears to be entering the stream attached to sediment particles eroded from various sites across the Kimball Drain and Indian Creek watersheds. As erosion/sediment BMP's are implemented phosphorous monitoring should be conducted to confirm reductions in phosphorous loadings. If phosphorous

loading are not reduced significantly to restore/protect the designated uses the watershed management plan will need to be reviewed to address additional sources of nutrients.

Two specific sites were identified where nutrients including phosphorus and nitrogen were entering the stream directly from runoff. These included a site on Indian Creek near the Jennings Rd Bridge and near the confluence of Kimball and Lum Drains. Investigations into the Indian Creek site identified a dairy operation nearby that was contributing manure runoff to the creek. The USDA-NRCS was contacted and is currently working to mitigate the problem. No quantification of this source was conducted. The source of increased nutrients near the mouth of Lum Drain was not determined but is likely from residential land uses in several neighborhoods directly upstream of the site. Further investigations are needed to determine the exact source and quantity of the nutrient inputs at this location.

Nutrients Critical Areas of Swartz Creek



Swartz Creek Subwatersheds	AREA (Sq. Miles)
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West Branch	11.542
Hewitt	9.082
TOTAL	129.933

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Figure 16

Suspected Pollutants

The remaining pollutants are suspected and not currently classified as priority pollutants affecting the designated use status of the stream system. After the implementation of BMP's to address the priority pollutants an examination of the designated use status of the stream system should take place. If it is found that the stream is not in full attainment watershed management the plan should be reviewed and potentially altered to include these non-priority pollutants. Continued investigation into the extent of these pollutants would be necessary to include them as priority pollutants. Coordination between the Swartz Creek Management Team and state and local agencies should take place to achieve this.

Thermal Pollution

Increases in water temperature in the Swartz Creek are suspected to be impacting the warm water fishery and other aquatic habitat designated uses. An increase in the temperature is primarily a problem because it reduces the dissolved oxygen available to fish and other aquatic organisms for respiration. Runoff from impervious surfaces, removal of riparian vegetation and an impoundment are contributing to this problem.

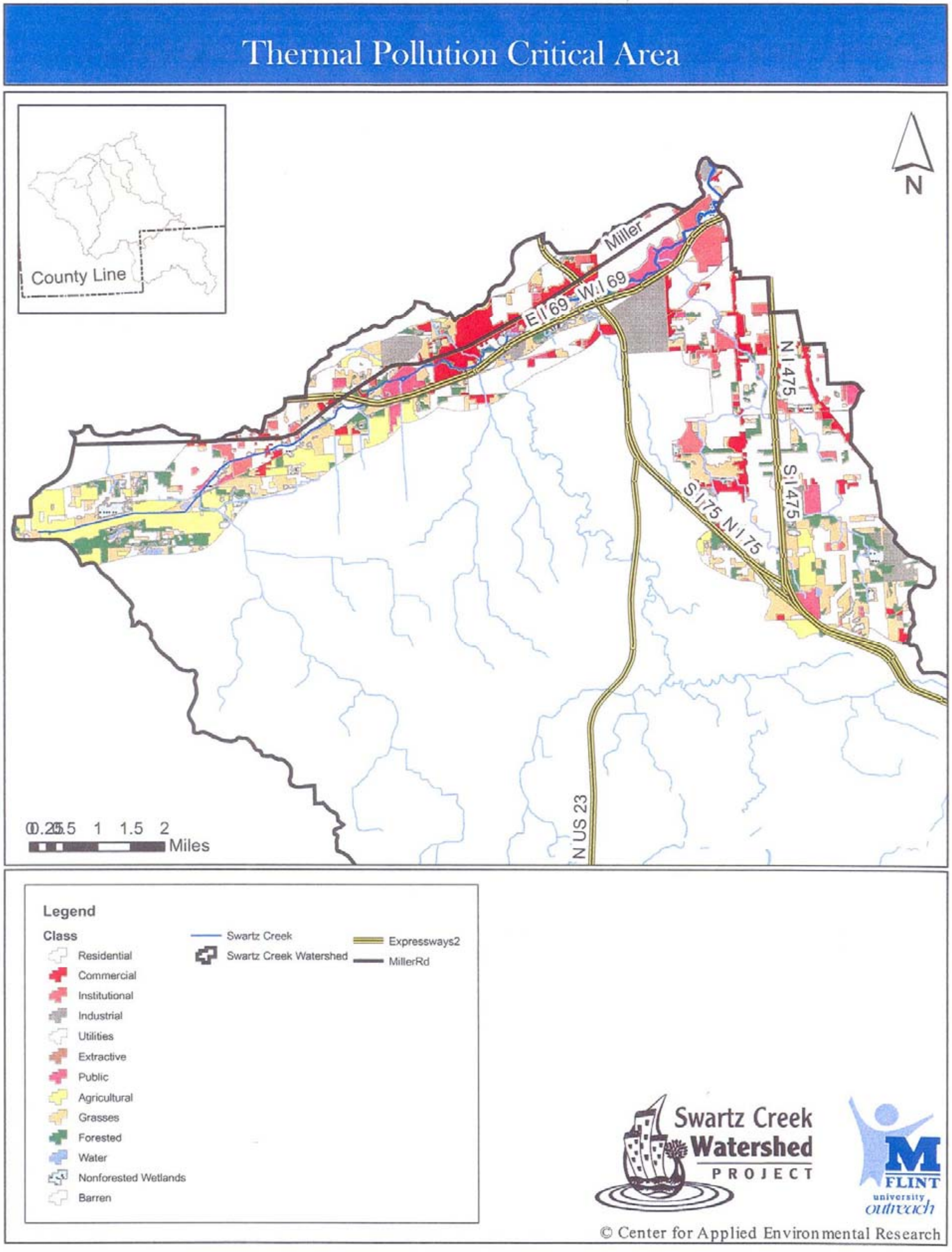
A large amount of impervious surfaces in the lower portion of the watershed is directly connected to the Swartz Creek. This area is a contributor of thermal pollution to the stream system. Rainfall that lands upon heated rooftops and pavement in this area is directly discharged to the lower portion of the watershed during summer storm events. Removal of riparian vegetation and exposure the stream to direct sunlight is present at locations throughout the entire watershed. This condition is worst along the area upstream of the impoundment on the Western Branch and along two golf courses in the West Branch Sub-Watershed.

Thermal monitoring was not conducted as part of the planning effort. This is reflected by the identification of thermal pollution as a suspected pollutant. Monitoring of stream temperatures is a relatively inexpensive process and should be done in the short and long term monitoring of Swartz Creek. Education related to stormwater management and reductions in thermal pollution are included in the education plan for Swartz Creek.

Thermal Pollution Critical Areas (Insert Critical Area map of West Branch/Carman Drain and Riparian Corridor)

Increases in thermal inputs into the Swartz Creek are primarily suspected from stormwater and direct solar radiation. The presence of directly connected impervious cover is most abundant in the Western Branch and Carmen Drain sub-watershed. These areas constitute the critical areas of existing storm water inputs and associated thermal inputs. These two areas are distinctly different in their land use make up. The Western Branch and Call Drain's land use is dominated by commercial and transportation land uses while the Carmen Drain sub-watershed is dominated by storm water runoff from high density residential development with high road densities.

Suspected temperature increases in the Swartz Creek Watershed are also associated with the removal of riparian vegetation. The removal of riparian vegetation was present throughout the watershed and was highly dependant upon landowner. Several specific locations were identified that will constitute the area for riparian corridor management in implementation. The most critical area is located upstream of the small impoundment located on the Genesee Meadows Golf Course and the stretch of river along the Swartz Creek Golf Course.



Thermal Pollution Critical Area
County Line
N
Miller
E I 69
W I 69
N I 475
S I 475
S I 75
N I 75
N US 23
0 0.25 0.5 1 1.5 2
Miles
Legend
Class
Residential
Commercial
Institutional
Industrial
Utilities
Extractive
Public
Agricultural
Grasses
Forested
Water
Nonforested Wetlands
Barren
Swartz Creek
Swartz Creek Watershed
Expressways2
MillerRd
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Figure 17

Pathogens
Pathogens are suspected to be negatively impacting the water quality of the Swartz Creek Watershed. Limited monitoring conducted by the Genesee County Health Department for E.coli indicated that water quality standards were being exceeded. The infrequent nature of the monitoring program and the limited sampling sites lead the planning team to to identify pathogens only as a suspected pollutant in the river system at this time. Future watershed planning efforts should conduct a more robust monitoring program for pathogens in the watershed. Suspected sources of pathogen contamination included illicit connection to storm sewers in the West Branch and Carman Drain sub watersheds and failing septic systems and natural sources in the remainder of the watershed.

Pathogens Critical Areas
Many potential sources exist for pathogen contamination of the surface waters in the Swartz Creek Watershed. The identification of critical areas for pathogen is not feasible at this time. Future sampling programs will need to be conducted to identify the areas critical to pathogen mitigation.

Oil/Grease from road runoff
Oil and grease from road and parking lot runoff are threatening the warm water fishery and other aquatic life designated uses. The presence of oil sheens in the western branch is common at locations where flow is restricted by culverts, log jams, or other obstructions. These oils are entering the stream from direct road runoff at road stream crossings and from storm drains that service the commercial areas along the Miller Rd/I-69 corridor in the West Branch. Implementing education activities and stormwater management techniques that reduce/retrofit the direct connections between roadways and the stream are required to minimize this threat.

Oil and Grease Critical Areas
Based upon our inventory the source area for oil and grease is concentrated along the Miller Rd. and I-69 corridor. This area is dominated by commercial and transportation land uses which are contributing oil and grease to the stream channel. See Figure 16 for a map of the oil/grease critical area.

Pollutant	Source	Cause
Sediment (K)	Stream banks (K)	Insufficient upland stormwater management (urban and agricultural gully erosion) (K) Riparian Vegetation Removal (K) Elevated Outfalls(K)
	Road Stream Crossings (K)	Undersized crossing (K) Erosive road or shoulder surfaces (K)
	Agricultural Lands (K)	Insufficient riparian vegetation buffers (K) Insufficient runoff and sediment management (K)
	Developed and developing areas (K)	Insufficient riparian Buffers (K) Inadequate soil erosion practices (S)
	Roads, parking lots (K)	Inadequate storm water mgt in commercial & industrial parking lots (K)
Nutrients (S)	Agricultural application (S)	Lack of comprehensive nutrient management planning (K)
	Residential Septic Systems	Failing septic systems (S)

	(S) Residential Lawns (S)	Over application of Fertilizer (S)
Thermal (S)	Roads & Parking Lots (K) Direct solar radiation (K)	Insufficient storm water mgt. practices (K) Removal of overhanging vegetation (K)
Bacteria (S)	Human Waste (S) Pet Waste(S)	Illicit connections to storm sewers (S) Failing Septics(S) Lack of concern/knowledge on part of home owners (S)
Oil/Grease (K)	Parking lots (K) Roadways (K)	Inadequate storm water mgt techniques (K) Lack of auto maintenance Lack of auto maintenance

Table 7. Pollutant, Source and Cause of NPS for Entire Swartz Creek Watershed

K = known source of pollution
S = suspected source of pollution

Water Quality Summary:
Based on the information gathered through previous research, our completed field investigations and professional judgment, we present the following water quality summary for the Swartz Creek Watershed.

The water quality of the Swartz Creek Watershed is negatively impacted by the effects of non-point source pollutants. The impact of these pollutants becomes progressively worse from the headwaters to the mouth of the stream. Water quality within the watershed will continue to worsen if a coordinated and watershed-wide plan is not implemented.

Urban development in the lower reaches of the watershed and has caused the most severe degradation to the system. This dramatic degradation is generally still confined to lowest portions of the watershed. However, as increased growth continues in the relatively healthy portion of the watershed (i.e. the headwaters) it is likely we will see larger reductions in water quality than we have experienced in the past. The management of the Swartz Creek will require implementing primarily preventative measures in the headwaters (Kimball, South Main and Lakes area) and restorative measures in the lower stretches of the watershed (West Branch, Carman and Call Drains).

The Swartz Creek Watershed has **two impaired designated uses: warm water fisheries and other indigenous aquatic life.** The partial and full body contact uses are threatened. Table 8 details the status of each of the designated uses and the known and suspected pollutants affecting each use. The designated use attainment table below excludes several areas upstream of the Ray Road stream crossing over the Southern Branch in Section 1 of Fenton Township. Upstream of this crossing the watershed appears to currently be meeting all designated uses.

Designated use	Status	Pollutants
Agricultural	Attaining	NA
Navigation	Attaining	NA
Industrial Water Supply	Attaining	NA
Public Water Supply at point of water intake	NA	NA
Warm Water Fisheries	Impaired	Sediment (K) Nutrients "Phosphorus" (K) Thermal (S)
Other indigenous aquatic life and wildlife	Impaired	Sediment (K) Nutrients "Phosphorus" (K) Thermal (S)
Partial Body Contact	Threatened	Pathogens (S)
Total Body Contact	Threatened	Pathogens (S)
		K = known presence in watershed S = suspected presence in watershed

Table 8. Designated Use Attainment/Threats below Ray Road

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:

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

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			

					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.

Insert table 10. Work plan with Goals. Objectives and BMPs   (See Excel File)

IX. Education Plan

Introduction

An effective community outreach and education plan is important to implementing the Swartz Creek Watershed Management Plan. A successful education plan is important because reducing the pollutants affecting water quality in Swartz Creek will require increases in knowledge by the community and voluntary behavior changes by residents and decision makers. The Swartz Creek Education Plans goals focus on watershed **awareness**, watershed **education** and the encouragement of stakeholders to take **action** to improve and sustain water quality in the Swartz Creek Watershed**.** The Swartz Creek education plan consists of the following components:

- A review of existing watershed education activities
- Swartz Creek education plan goals, objectives and actions to implement the plan and identification of audiences and pollutants targeted in education activities
- Watershed education tool kit
- Potential funding sources

Existing watershed education efforts

Currently, there are several watershed education efforts ongoing in the Swartz Creek Watershed and/or adjoining watersheds. A brief discussion of these programs is provided here to identify opportunities and to minimize duplication of efforts.

Phase II Stormwater Education

The Genesee County Drain Commissioner's (GCDC) office has been working with the municipalities of Genesee County to develop and implement a Public Education Plan (PEP) as required under Phase II of the NPDES program. The focus of this broad campaign is on basic watershed education topics including defining a watershed and illustrating the impacts of storm water pollution. The plan also focuses on several topics required under the NPDES program including:

1. The encouragement of people reporting the presence of illicit discharges or improper disposal of materials into separate storm water systems
2. Education of the public regarding the proper disposal of household hazardous waste, travel trailer waste, chemicals, grass clippings, leaf litter, animal waste and motor vehicle fluids
3. Acceptable application and disposal of pesticides and fertilizers
4. The use of preferred cleaning materials and procedures for car washing
5. Education of the public regarding the ultimate discharge point and potential impacts of separate storm water drainage systems serving their place of residence
6. Stewardship of local watersheds

7. Education of the public regarding management of riparian lands to protect water quality

Implementation of the Phase II public education program will use a number of methods and techniques to educate the public concerning the topics outlined above. These formats will include radio and television announcements, speaker circuits, billboards, newspaper articles and other mass media promotions. The implementation of the Phase II Stormwater Education program is scheduled to begin in 2006.

The Phase II program provides many of the basic elements required for the implementation of a public education program for the Swartz Creek Watershed. The education activities associated with Phase II programs, however, do not address specific issues identified as affecting designated uses within the Swartz Creek Watershed. The program outlined here will complement the Phase II program by providing specific education activities based on target audiences and specific pollution problems identified in the planning process.

Other Watershed Education Activities
In addition to the activities underway as part of the Phase II storm water program, education activities will also be underway in the Kearsley Creek and Gilkey Creek Watersheds. These watersheds are currently undergoing watershed planning and watershed education plan development. Efforts will be made to coordinate the sub-watershed management plans to ensure that learning and collaboration can continue over the course of the projects.

Education of individuals and organizations about aspects of the Swartz Creek Watershed is extremely important in order to protect the water quality of the watershed. There are several education activities identified in the goals and objectives portion of the watershed plan. The activities were presented in earlier portions of the WMP because of the close relationship they have to other specific BMPs.

Swartz Creek Education Plan

The Swartz Creek Planning Team developed the following campaign to focus on specific problems identified in the physical, hydrologic and policy analysis conducted during the planning phase. This program targets primarily specific audiences, pollutants, sources and causes that are impacting water quality in the Swartz Creek Watershed.

The Swartz Creek Watershed Education Plan will focus on three primary categories of activities including increasing stakeholder's **awareness** of the watershed, **educating** them about the watershed and finally **motivating** them to actively participate in protecting, preserving and restoring the watershed. In order to be successful in implementing the plan a set of goals, objectives and specific activities was developed. Using this framework ensures focus in the education plan and provides a means for evaluating the success or failure of the education efforts. The team also identified responsible parties and recommendations on how to evaluate the success or failure of each action item. Below is a description of the three general goals recommended by the Swartz Creek Steering Committee. This is followed by Table 11, which includes the objectives, tasks, measures, tools, responsible party and estimated cost /year.

Swartz Creek Education Plan Goals

Goal 1. Build and retain stakeholder awareness of the Swartz Creek Watershed.
The first goal of the plan focuses on general awareness of the Swartz Creek and the condition of water quality in the watershed. The objectives detailed under this goal will ensure that watershed stakeholders become familiar with the Swartz Creek project, the physical location of the watershed, and the NPS issues facing the watershed. This portion of the plan does not entirely focus on specific pollutants identified in the plan. This section addresses several observations made during stakeholder meetings regarding the public's awareness of watersheds and their management. The recommendations put forth here combined with the ongoing Storm Water Education program should ensure a solid understanding of the basics of watersheds and their protection.

Goal 2. Educate stakeholders about the linkage between human activity and water quality in the watershed.
The focus of goal 2 is to provide more specific information about the non-point source pollution issues facing stakeholders of the Swartz Creek Watershed. This goal focuses on specific target audiences and causes of pollution identified in the planning process. This goal also includes objectives to promote the benefits of personal stewardship and responsibility of municipal officials to protect water quality.

Goal 3. Motivate individuals to take action to protect, preserve and restore water quality in Swartz Creek Watershed.
Active involvement in watershed protection by a diverse group of stakeholders is the key to sustainable water resource protection. Goals one and two set the basis of our education plan and facilitate the achievement of goal three. This goal focuses largely on assisting citizens and decision makers in implementing voluntary BMPs, policy changes and participating in stewardship activities.

Table 10 See attached Excel File

Watershed Education Tools and Responsible Parties

Conducting a public education campaign requires the use of numerous tools and educational aids. This section provides a description of the tools that have been mentioned in the education plan.

Proposed Swartz Creek Watershed Logo

Information Brochure (Not developed): A brochure that contains general information about the watershed (location, definition of watershed, practices) will be developed to use with various audiences. The brochure will include graphics of a hypothetical watershed, the Swartz Creek Watershed logo and contact information about the project. (Steering Committee)

Riparian Stewardship Brochure (Not developed): Riparian residents were identified as a primary target audience during the physical inventory of the SCW. A brochure will be developed that focuses on retaining and restoring vegetative buffers, improving shoreline habitat, and reducing run-off pollution from the landscape. (FRWC/CAER/MSUE)

Riparian Stakeholder list (Developed): A riparian stakeholder list will be generated using a Geographic Information System. This GIS system will inexpensively produce a mailing list of residents who own property adjacent to Swartz Creek. These stakeholders were identified in the physical inventory as a primary target audience. This list will provide an effective way to disseminate information to this key target audience. (GCDC)

Business Stakeholder List (Not developed): Including business in the implementation of the watershed management plan will be important to the success of the education plan. A list can be divided into two categories including a general business group and those that directly impact water quality. (CAER /County equalization data)

> **General business:** This list will provide several potential assets to the Swartz Creek Project for information dissemination and for potential sponsorship of education activities such as Project Green Adopt-A-School. These locations will generally consist of businesses that require individuals to wait for a service such

as local offices, barber shops, oil change locations, restaurants, etc. Disseminating information at these locations will provide an increased chance of individuals reading relevant information while they wait for services. (CAER)

Direct Impact List: This list will identify businesses that are engaged in activities that have the potential to positively or negatively impact water quality. These could include businesses like septic companies, fertilizer retailers, auto repair, local nurseries, car washes etc. Partnerships should be developed between local watershed advocates and these businesses to promote the responsible use of their products. (CAER)

Swartz Creek Interstitials (Developed): During the development of the public education program for the SCW two, three minute interstitials were developed to be used for education purposes.

The first interstitial, titled **Whispers of a Watershed** presents various concepts about watersheds and watershed management. This piece is intended to be used as an introduction to watersheds and why an individual should behave responsibly in a watershed.

The second interstitial, titled **Field of Dreams** presents a number of activities that individuals can participate in to protect their local watershed. Activities range from restoring a wetland, participating in HHW recycling, to joining your local watershed organization. This interstitial will be used to provide specific information about "things people can do" to assist in protecting water quality.

Water Quality Report (Not developed): A water quality report based on the findings of the Swartz Creek Watershed plan will be developed to be used with watershed stakeholders. This report will summarize the findings of the management plan in a format that will be more user friendly than the long and complex watershed plan. Key information will include:

A map of the watershed
Summary of the findings
Contact information about the plan
Photos and descriptions of critical areas
How to get engaged in present activities

Watershed Tours (Not developed): A series of tours of the Swartz Creek watershed will be conducted for local planning and elected officials. The purpose of these tours will be to familiarize local officials with the geographic location, physical appearance and water quality of various parts of the watershed. These tours will also provide opportunities for stakeholders to visit various BMP implementation sites. (FRWC/CAER/Conservation District)

Watershed Maps (Partially developed) : The ability to identify one's location within a watershed is fundamental to understanding individual impacts on the watershed and the impacts the watershed has on individuals and communities. A series of simple maps will be generated that identify the location of municipal boundaries, watershed divide, cultural landmarks such as township offices, historical locations etc. (GCDC/CAER)

Swartz Creek Watershed Display (Not developed): A permanent display about the watershed including information about general watershed principles and Swartz Creek specific problems and solutions. This permanent display will be used on a rotating basis at school, libraries and public spaces such as shopping centers. (FRWC Education Committee)

Swartz Creek Stewardship Certificate/Seal (Not developed): Use the Swartz Creek Watershed logo in the development of certificates/seals to present to governments. (FRWC/UM-Flint)

Ordinance Policy Matrix (Developed): During the planning process, a review of local ordinances was conducted. The results of this review are presented in a matrix that identifies the degree to which individual municipalities have policies in place to protect water quality. This matrix also illustrates the individual policies that are being or not being used across the watershed. This matrix will allow decision makers to understand how their municipality is "doing" with regards to water resource protection and identify ways in which they may improve their policies.

Filling the Gaps (Developed): Filling the Gaps is a document produced by the Michigan Department of Environmental Quality to assist local governments in protecting their natural resources. This document provides a comprehensive overview of relevant enabling legislation, example ordinances and case studies of their application. This tool will be extremely useful in most education activities involving local elected and appointed officials.

Slide Library (Developed): A PowerPoint slide library will contain a wide variety of slides that can be used to develop presentations for target audiences. These slides will include a wide range of topics and will incorporate the Swartz Creek Watershed logo.

Watershed Signage (Not developed): These signs will be designed and developed in coordination with the Genesee County Road Commission and be placed around the watershed to increase identification of the Swartz Creek Watershed.

In addition to applying for education grant dollars from MDEQ, several other sponsors have been identified that would likely fund portions of the education plan for the Swartz

Creek. Below are several other sources that should be used in the education plan implementation.

Local Foundations

The Ruth Mott Foundation services the greater Flint community by providing funding for projects that range in focus. As part of the Foundation's Beautification Program several watershed planning activities have been funded that include educational components. Concept papers are accepted by the foundation three or four times a year.   A proposal that focuses on the aesthetic value of watershed education should be submitted to the foundation in the early phases of a project.

The Community Foundation of Greater Flint has recently shifted some of its program focus to include land use education. The details of this program area are still to be published but should be monitored for developments that may assist in the education of residents about land use impacts upon the Swartz Creek.

EPA-Five Star Program

The Five Star Restoration Program brings together students, conservation groups, other youth groups, citizen groups, corporations, landowners and government agencies to provide environmental education and training through projects that restore wetlands and streams. The program provides challenge grants, technical support and opportunities for information exchange to enable community-based restoration projects. Funding levels are modest, from $5,000 to $20,000, with $10,000 as the average amount awarded per project. However, when combined with the contributions of partners, projects that make a meaningful contribution to communities become possible. At the completion of Five Star projects, each partnership will have experience and a demonstrated record of accomplishment, and will be well-positioned to take on other projects. Aggregating over time and space, these grassroots efforts will make a significant contribution to our environmental landscape and to the understanding of the importance of healthy wetlands and streams in our communities.

Great Lake Aquatic Habitat Network Fund (GLAHNF)

The mission of the Great Lakes Aquatic Habitat Network and Fund (GLAHNF) is to foster and support a vital, effective grassroots sector working locally to protect aquatic habitats throughout the Great Lakes Basin. GLAHNF provides financial resources, shares information, and fosters communication between citizens and organizations working to protect aquatic habitats. The GLAHNF grants program is designed to increase the ability of grassroots groups and individuals to succeed in advocacy projects to protect rivers, lakes, and wetlands in their areas.

The goal of GLAHNF's grants program is to provide financial support to advocacy activities that strengthen the role of individuals and community groups working locally to protect and restore shorelines, inland lakes, rivers, wetlands, and other aquatic habitats in the Great Lakes Basin. Advocacy work, as defined here, involves local community members actively promoting aquatic habitat protection by influencing community and/or individual behavior or opinion, corporate conduct, and/or public policy.

XI. Monitoring and Evaluation Plan

Program Process and Goals-

The primary goal of the Swartz Creek Watershed Planning Project was to development a plan that will protect and restore the designated uses of Swartz Creek Watershed. A comprehensive watershed management process involves working though a number of phases that ultimately lead to water quality protection. This watershed management process can be generally divided into three phases including watershed planning, plan implementation, and effectiveness assessment. Figure 17 illustrates the relationship between the three phases of watershed management.

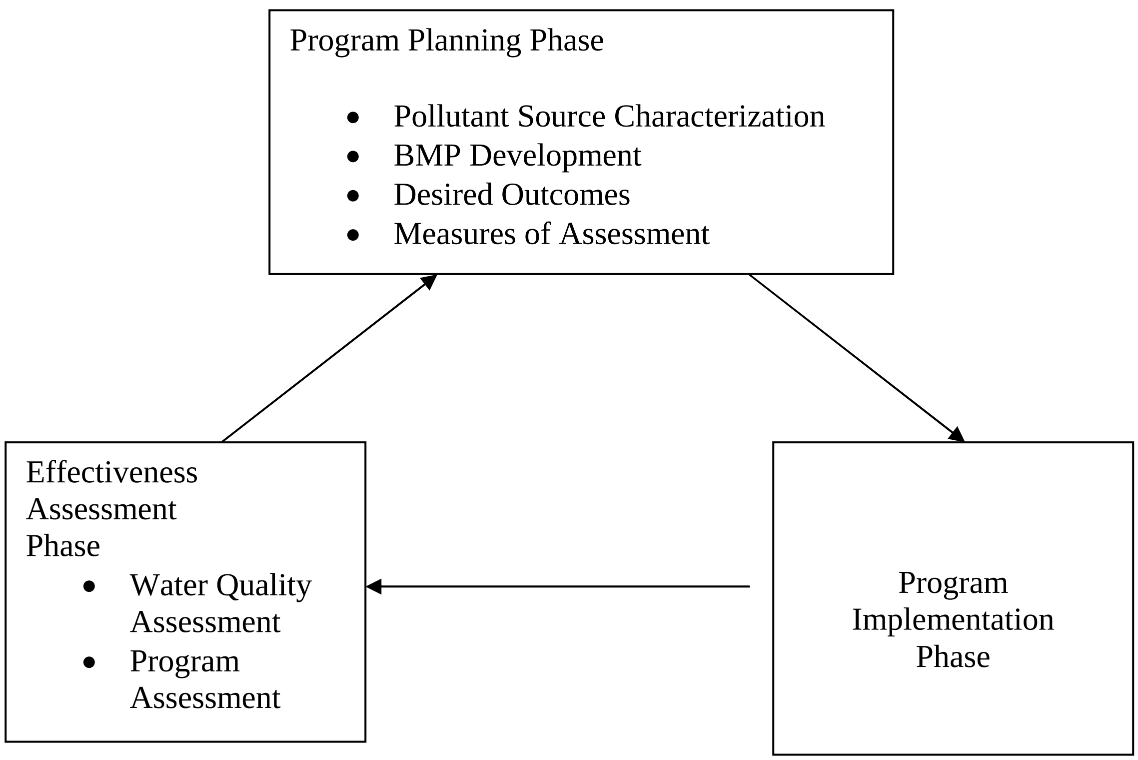

Figure 17 . Watershed Management Cycle taken from the Genesee County Phase II Middle Flint River Watershed Plan.

Currently the Swartz Creek Watershed Planning team has completed the steps associated with the program planning phase including:

1. The identification of known and suspected pollutants, source areas and causes of non-point source pollution
2. The identification of Best Management Practices that need to be implemented to protect water quality
3. The identification of specific desired outcomes related to water quality
4. The identification of measures of assessment

With the Swartz Creek planning process complete, the next step in watershed management involves implementing the watershed plan. As such, activities will need to begin that provide information to evaluate the watershed plan. Figure 18 is a theoretical hierocracy of levels of program evaluation. These levels are intended to provide a conceptual framework that will be reviewed periodically to assess the Swartz Creek Watershed Plan. Below is a short description of each of these levels of evaluation and specific instruction on how the levels are to be used in the evaluation. Several of these levels, including the needs assessment and program theory levels are relatively unimportant at the current iteration of the watershed planning process. The upper two levels including assessment of the program process/implementation and assessment of program outcome/impact are our primary focus in this evaluation plan.

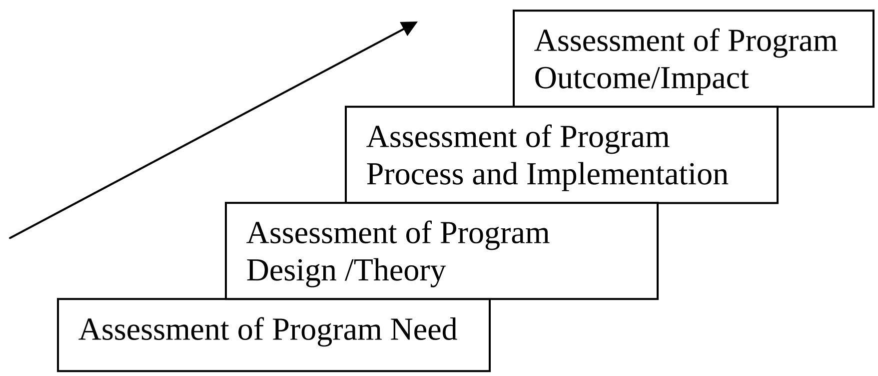

Figure 18 Hierarchy of program Evaluation

Program Need - The assessment of the program need is simply the determination of the necessity of the program. This portion of the evaluation can be conducted by answering the evaluation question: **Do non-point source pollutants impact or threaten the designated use status of the Swartz Creek Watershed?** A response of yes to this question should prompt the evaluator to discontinue the needs assessment and focus evaluation efforts on assessing the program design/theory aspects of the project.

Program Design/Theory – The assessment of the underlying theory that watershed planning and watershed management lead to improved water quality and protection of designated uses is the focus of this step in the evaluation hierarchy. It is currently accepted by the MDEQ based upon their Developing a Watershed Management Plan for Water Quality document, that the planning process and methods undertaken in the Swartz Creek are the most effective way to protect water quality. As continued advancements are made in the academic disciplines focused on natural resources or with techniques used by watershed managers, adjustments to the underlying theory should be made.

Program Process – The assessment of the program process is the first step in the assessment hierarchy that will be addressed in any detail in this evaluation plan. This step in the evaluation process assesses what the program is doing and if it is delivering the services as it was intended to do. The assessment of program process generally falls into two domains including service utilization and program organization (Rossi, Lipsey, Freeman 2004). This portion of the evaluation should focus on two primary question including: 1) **Is the program reaching the intended target audiences?** and 2) **Are the program services consistent with the program as designed?** Periodic reviews of the implementation documents including meeting attendance, bmp worksheets and the goals, objectives, and task table should be sufficient to make judgments about the success or failure of the program process.

Program outcome/impact – Assessing the program outcome and program impacts of the Swartz Creek Watershed Plan is the most critical and likely most complicated evaluation task. The difficulty in assessing program outcomes is primarily a result of the complex interactions between watersheds, land use, water quality and human society. What is intended by watershed management is that continual steps are made towards protecting water quality in a number of ways using a variety of methods, techniques and BMP's. In order to evaluate the success of these activities, a series of "levels of success" were developed (See figure 19). The remainder of the evaluation plan will use these levels of success to answer the primary evaluation question: **Are advancements towards protecting the designated uses of the Swartz Creek Watershed being made?**

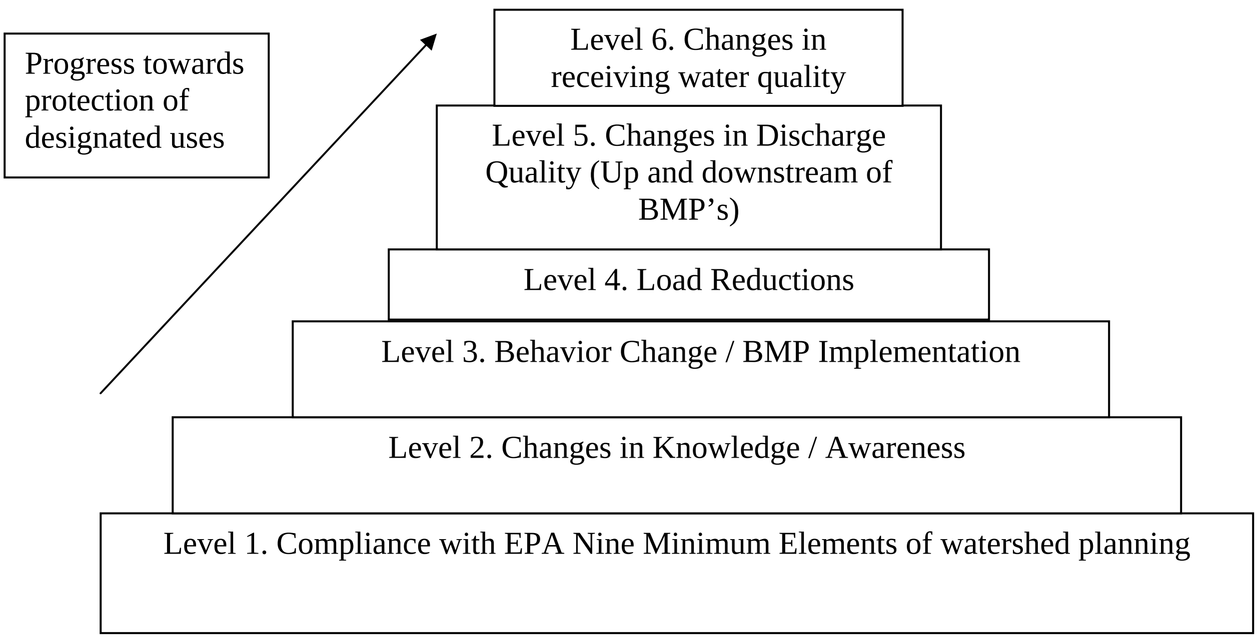

Figure 19. Levels of success necessary to protect the designated uses of the Swartz Creek Watershed (Modified from the Middle Flint River Watershed Plan, Genesee County Drain Office spring, 2004)

In attempting to answer the primary evaluation question its necessary to ask several additional questions that, when answered collectively, will provide an answer to the primary question proposed above. These additional "sub questions" are directly related to the levels of success described above and provide specific measures that can be evaluated to gauge the success or failure of portions of the watershed management plan. The sub questions include:

- Is the watershed plan in compliance with EPA requirements of watershed plans?

- Are changes in knowledge taking place because of the watershed plan?
- Are behavioral changes taking place as a result of the watershed plan?
- Are reductions in the amount of pollution delivered to the stream a result of the watershed plan?
- Are changes in the water quantity of the Swartz Creek being achieved because of the watershed plan?

Measures of success are critical to assessing of the effectiveness of the Swartz Creek Watershed planning effort. Identification of quantifiable measures provides measurability and accountability throughout the six levels of the program. Data collection and analysis will be developed for each of the levels of success necessary to protect the water quality of the watershed. In the next section standards, measures and data gathering methods will be developed and detailed for each level of success.

Level one: Compliance with EPA nine minimum elements of watershed planning-
Compliance with the EPAs minimum standards to watershed planning is a requirement of all watershed plans funded using federal dollars. This is achieved by including several key elements in all watershed plans. Compliance with the requirements is expected to positively impact water quality because inclusion of these elements has been proven to increase the success of watershed planning efforts. The standard for this level of success will simply be that the Swartz Creek Watershed Plan meets these requirements. Measures that apply to this level of success will be directly related to the ability of the plan to remain in compliance with EPA standards as they change. Data gathering for this indicator will simply be conducted by reviewing the most recent copy of the watershed plan and comparing it to the current requirements of the EPA.

Level two: Changes in Knowledge / Awareness-
Changes in knowledge of watershed residents are targeted through the information and education campaign. Measures and data collection for this level of success would likely take place in two ways including a social survey and pre and post testing targeting individuals involved in education activities. Focus should also be on identifying changes in knowledge related to specific issues targeted in the Swartz Creek Education Plan. The standards for changes in knowledge should be based on statistical significance that will need to be established.

Additional measures of knowledge change should be conducted on individuals who are specific targets of the Education Plan. Data collection methods with these target individuals will primarily include pre and post tests at conferences or workshops focused on specific water quality issues in the Swartz Creek Watershed. Again, standards of improvement would need to be established regarding the specific policy or group of individuals.

Level Three Behavior changes / BMP Implementation-
The intended outcome of this level of success is a change in behaviors as a result of changes in knowledge. Similar to level two, changes in behavior across a population will

be relatively difficult to monitor because of the other ongoing education campaigns in the area. The same approach used above with a control group outside of the watershed and an experimental group in the watershed could be used and measures of statistical variation between the groups measured.

Changes in behavior can also be identified in conjunction with BMP installation. This portion of the evaluation design should focus on identifying and tracking individuals who are known to be involved in the planning process and instrumental in implementing BMPs. Tracing changes in behavior related to structural BMPs is more feasible then changes in behavior related to managerial BMPs. This is the case because the implementation of Structural BMPs is tied directly to individual property owners, municipal governments and specific locations within the watershed. Data about the implementation of BMP can be gathered simply through tracking the number of BMPs installed as a result of the plans implementation. Data gathering should be done by project implementers with specific individuals as behavior changes and BMP installations are identified. An example of this may include documenting behavior changes of a local planning commission with regards to a particular policy after an educational seminar (managerial BMP) or by mapping the location of structural and vegetative BMPs. Standards for evaluation the success of these efforts are based on the specific measurable objectives outlined in the plan including the number of sites identified for BMPs or the number of policy changes recommended.

Level Four: Reduction in pollutant loadings to the Swartz Creek-

A pollutant loading is a quantifiable amount of pollution that is being deposited in a river. Pollutant loads are based on an amount of pollutant that enters a stream in a given unit of time. An example could include a statement such as 500 pounds of nitrogen enter the stream per day from a specific site. Pollutant loads can be calculated based on the ability of an installed BMP to reduce the targeted pollutant. Loading are best used at specific sites where detailed data about the reduction of pollutants can be gathered. Pollutant load reductions should be calculated for each installed BMP. Standards for pollutant loads are generally calculated on a cost-effectiveness basis. These are expressed in terms of the dollars spent to reduce a particular unit of pollution. MDEQ has specific standards that are established for BMPs and pollutants. These standards would serve as the standards for this evaluation design.

Level Five and Six Changes in water quality-

The evaluation of achievements in level five and six include activities that directly measures the water quality the Swartz Creek and the Flint River. The monitoring of water quality in these systems is an extremely complex task that involves gathering data from a number of sources. Periodic assessments of the water quality of the Swartz Creek and Flint River are conducted as part of several federal and state water quality monitoring programs. These programs use both randomized and purposeful sampling based on recommendations from local water quality experts. The data gathered from these sampling procedures are compared to the State of Michigan Water Quality Standards.

This complex set of standards is based on both quantitative and some qualitative standards. Data analysis is conducted and published by experts at MDEQ and USEPA. The combining of data gathered under these programs with periodic water quality assessments conducted as part of the watershed planning will provide the best picture of existing water quality in the watersheds. In addition, specific monitoring activities will need to be coordinated with agencies to ensure implementation targets are being met. In order to monitor the affects of the watershed management plan CAER staff and the Flint River Watershed Coalition will work with state and local agencies

Level Five Monitoring-Monitoring of Discharge (Up and downstream of BMP's)
Discharge monitoring will be focused on monitoring the affects of BMP implementation. Monitoring should be targeted to address the warm water fisheries and other aquatic life designated uses. This monitoring will be conducted using GLEAS procedure 51 to assess the in stream habitat conditions. Coordinating with the MDEQ and MDNR is critically important to provide the quality control and quality assurances needed for such monitoring. This monitoring should be conducted during the MDEQ five year rotating basin monitoring.

In addition to using procedure 51 monitoring, the Flint River Watershed Coalition is considering changes to its volunteer monitoring program. FRWC is focusing on increasing the number of professionally trained volunteers and increasing the use of technology in the monitoring program. If increases in the technical expertice of volunteers in this program are achieved these volunteers may be used during those years when DEQ is not conducting monitoring in the basin.

Level Six-Water Quality Monitoring

In addition to monitoring upstream and downstream of BMP's, monitoring of reference sites within the watershed should also take place to provide information about trends in water quality. MDEQ and MDNR currently monitor several reference sites within the watershed. The location of these reference sites appears to be sufficient to evaluate overall water quality within the watershed. Periodic review of these locations should be conducted in order to provide opportunities to monitor newly discovered water quality issues or large scale changes in water quality. If after the implementation of the watershed management plan no increases in water quality trend are noted the watershed plan should be reviewed and altered to address suspected and any new pollution sources.

XII. References

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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, 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

Swartz Creek Education Plan

	Goal	Objective	Pollutant Targeted	Actions	Timeline	Measures	Tools	Responsibility	Cost/Year
1	Build and retain stakeholder awareness	Raise awareness of the results of the Swartz Creek planning efforts	All	Conduct presentations to local planning and elected officials	Short-term	Number of presentations completed	Brochure, Slide Show, Sw	FRWC,CAER,GCCD	$1,500
			All	Distribute copies of Swartz Creek Watershed Management plan	Short-term	Number of Copies distributed	Brochure	FRWC, CAER	$1,500
			All	Distribute media releases of the completion of the Swartz Creek Planning Process	Short-term	Number of stories published	Brochure, WMP, Slidesho	FRWC, CAER	N/A (Match)
			All	Participate in community events	Mid-term	Number of events displayed at	Watershed Display, Watershed Maps, Swartz Creek Interstitials	FRWC, CAER	NA (Match)
		Build Awareness of the Geographic location of the Swartz Creek Watershed	All	Conduct watershed tours for Township Trustees Planning Commissioners Municipal Councils (1/year for 3 years)	Short-term	Tours conducted, number of attendees, pre/post test	Map series,	CAER, FRWC, GCCD	$2,500
			All	Develop and distribute watershed map series to municipa officials, interested residents and school children	Short-term	Maps distributed	Map series	CAER	$5,000
			All	Place signage on major roads around drainage divide and at road/stream crossings	Short-term	Number of signs, Number vehicles passage of signs	Signage	GARS	$4,000
		Build awareness of Land use and Non-Point source impacts on water quality in Swartz Creek	All	Conduct storm drain stenciling outreach program	Mid-term	Number of students participating, # of drains stenciled	Stencils	FRWC, CAER	$5,000
			All	Publish and distribute Swartz Creek specific riparian landowners outreach guide	Short-term	Number of guides distributed,	Riparian Landowner Guide to Swartz Creek	FRWC, CAER	$10,000
2	Educate stakeholders about linkage between human activity and water quality in watershed	Educate target audiences about priority pollutants and causes of water quality reduction in Swartz Creek	All	Distribute information about proper Riparian Vegetation/Flood Plain Management	Short-term	Number of guides distributed	Riparian Landowner Guide to Swartz Creek	FRWC, CAER, GCCD	$3,000
			Sediment	Conduct outreach to riparian landowners identified with gull erosion and eroding outfalls	Short-term	Number of BMPs installed	Special Communications	FRWC,CAER,GCCD	$5,000
			Thermal, Sediment, Nutrients	Conduct workshops for riparian landowners on the use of native vegetation to enhance riparian corridor	Mid-term	Number of workshops conducted, number of participants, number of locations where corridor enhancements were made, pre/post test	Needs to develop	Wildones, GCCD	$1,500
			Sediment, Nutrients	Conduct incentive based soil erosion and sedimentation education training for developers in watershed	Mid-term	Number of trainings, number of participants, number of incentives received	Needs to develop	GCDC, Phase II	NA (Phase II)
			Nutrients	Conduct nutrient management plannin assistance for agricultural producers in watershed	Mid-term	Number of nutrient management plans developed	See USDA	USDA, GCCD	$10,000
			Sediment	Conduct alternative road design workshop for county roac commission employees and crews	Mid-term	Number of participants, pre/post test	Need to develop	MDOT, GCRC, CAER	$3,000
			All	Conduct training for municipal officials and developers on alternative storm water management techniques	Short-term	Number of participants, pre/post test number of policy changes	Need to develop	CAER, FRWC, MDEQ	$3,000
			Thermal, Sediment, Nutrients	Conduct trainings for reducing runoff from high density residential areas (rain gardens, etc)	Short-term	Number of participants, Number of Rain gardens installed	Need to develop	CAER, Applewood Esta	$3,000
			Oil, Grease	Conduct outreach program focus on regular automobile repairs	Short-term	Done under Phase II	Phase II	GCDC, Phase II	NA (Phase II)
		Educate residents about personal benefits of watershed stewardship	All	Coordinate River Cleanups	Mid-term	User Friendly WMP, Riparian Stakeholder Guide	NA (FRWC already conducts cleanups)	FRWC	NA (Match)
		Promote the physical and psychological benefits of using Swartz Creek as a recreational resource	All	Conduct educational hiking trips along Swartz Creek from City of Flint to Happy Hollow Recreation Area	Short-term	Number of participants, pre/post test	Brochure, User friendly WMP, Map Series, Watershed Certificate	FRWC, Sierra Club, CAER	NA (Match)
3	Motivate individuals to take actions to protect, preserve and restore water quality in the Swartz Creek Watershed	Encourage participation in FRWC by SCW Stakeholders	All	Focus annual membership drive in strategic neighborhoods and commercial districts in watershed	Short-term	Number of memberships generated	Business stakeholder list,	FRWC, CAER	NA (Match)
			All	Develop and advertise "adopt a creek" committee under FRWC	Long-term	Formation of citizen committee, Number of participants, hours met, actions taken		FRWC, CAER	NA (Match)
			All	Promote participating of residents in FRWC benthic monitoring program	Mid-term	Number of participants involved, number of sites sampled on Swartz Creek	Riparian stakeholder list	FRWC, CAER	NA (Match)
		Conduct education program on benefits of land preservation with land conservancies	All	Contact high priority landowners to gauge interest in lan conservation	Mid-term	Landowners contacted	Riparian stakeholder list	FRWC, CAER, GCCD	NA (Match)
			All	Facilitate meetings between land preservation specialist and land owners	Mid-term	Number of meetings held, number of conservation easements established		FRWC, CAER, Land co	NA (Match)
		Work with municipal officials to adopt water quality related ordinances	All	Provide technical assistance to municipalities interested in adopting natural features setback, storm water ordinance, local wetland protection ordinance	Mid-term	Number of ordinances adopted	Filling the Gaps, User Friendly WMP, Swartz Creek Interstitials, Ordinance/Policy matrix	CAER, FRWC	$15,000

Table 11. Swartz Creek Education Plan