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.

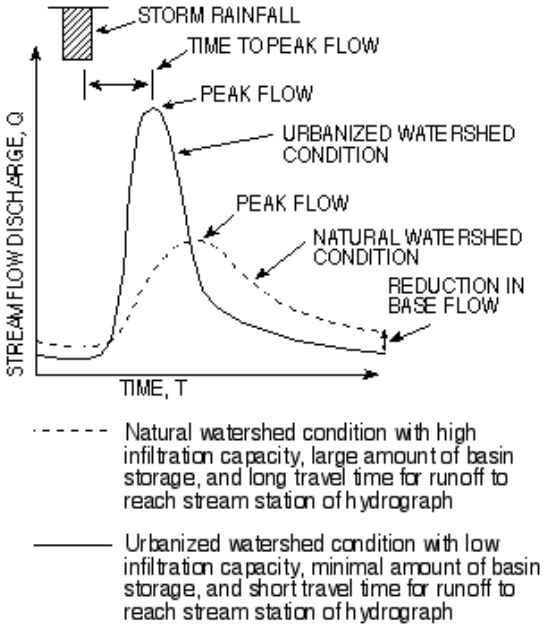

Figure 9. Hypothetical urban and natural hydrographs

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.

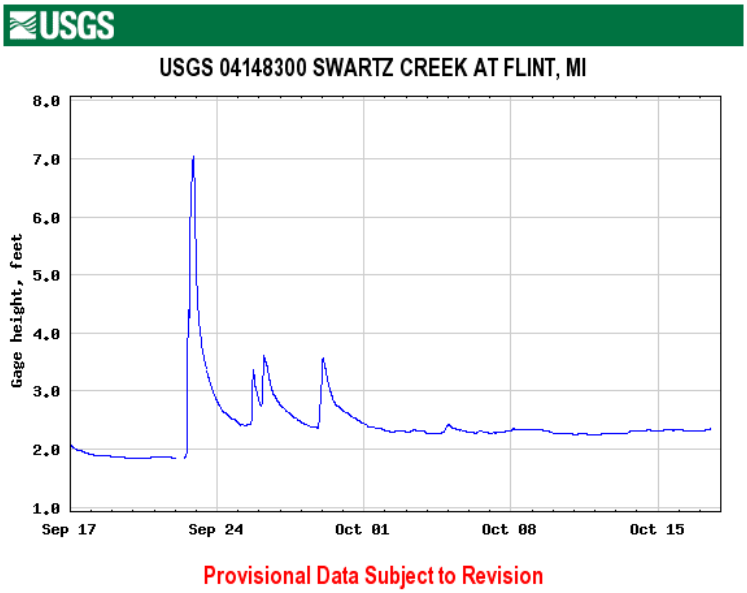

Figure 10: Stream gauge near the Ballenger Highway Bridge, Flint, MI.

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.

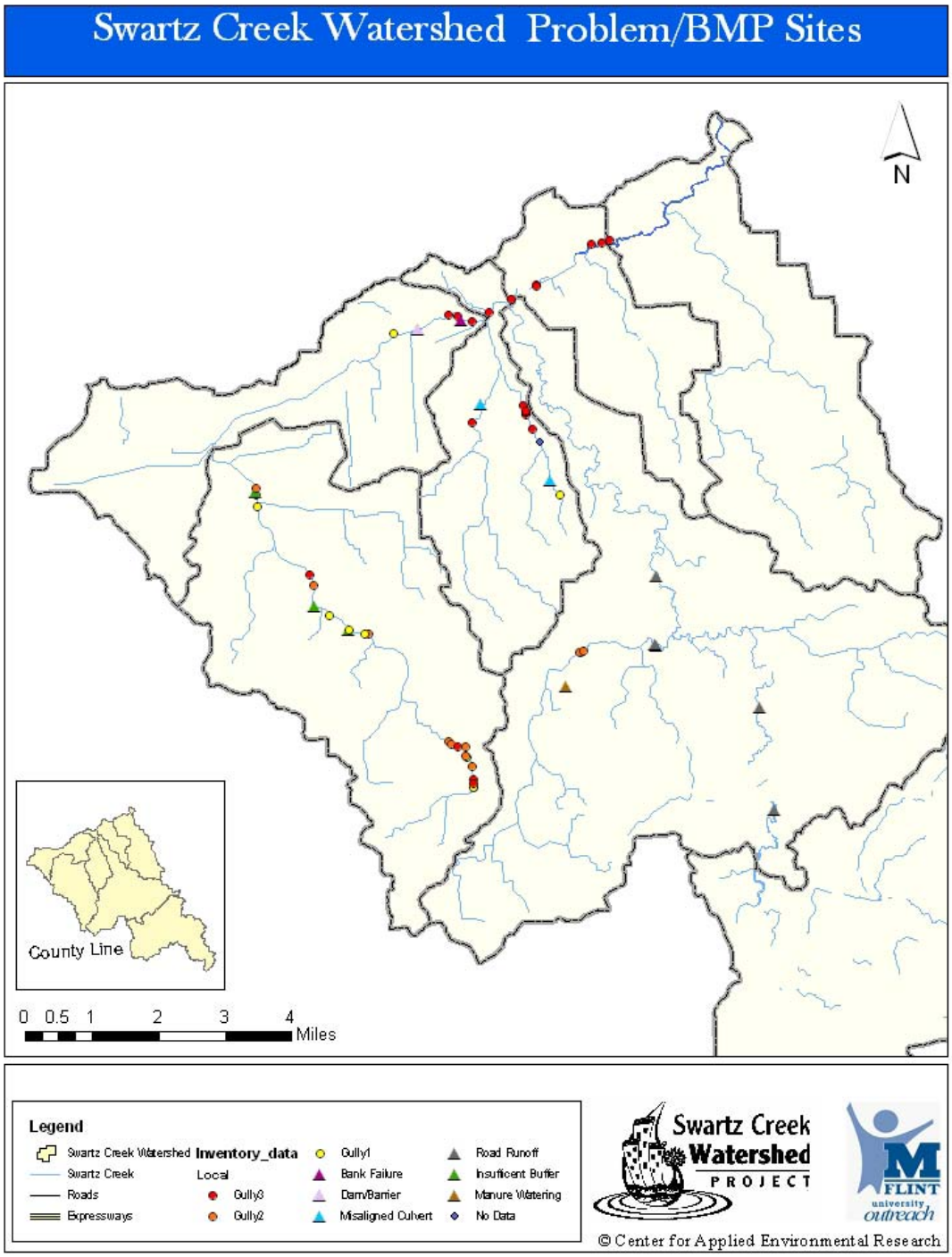
Swartz Creek Watershed Problem/BMP Sites
N
County Line
0 0.5 1 2 3 4
Miles
Legend
Swartz Creek Watershed
Swartz Creek
Roads
Expressways
Inventory_data
Local
Gully3
Gully2
Gully1
Bank Failure
Dam/Barrier
Misaligned Culvert
Road Runoff
Insufficent Buffer
Manure Watering
No Data
Swartz Creek Watershed PROJECT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

34

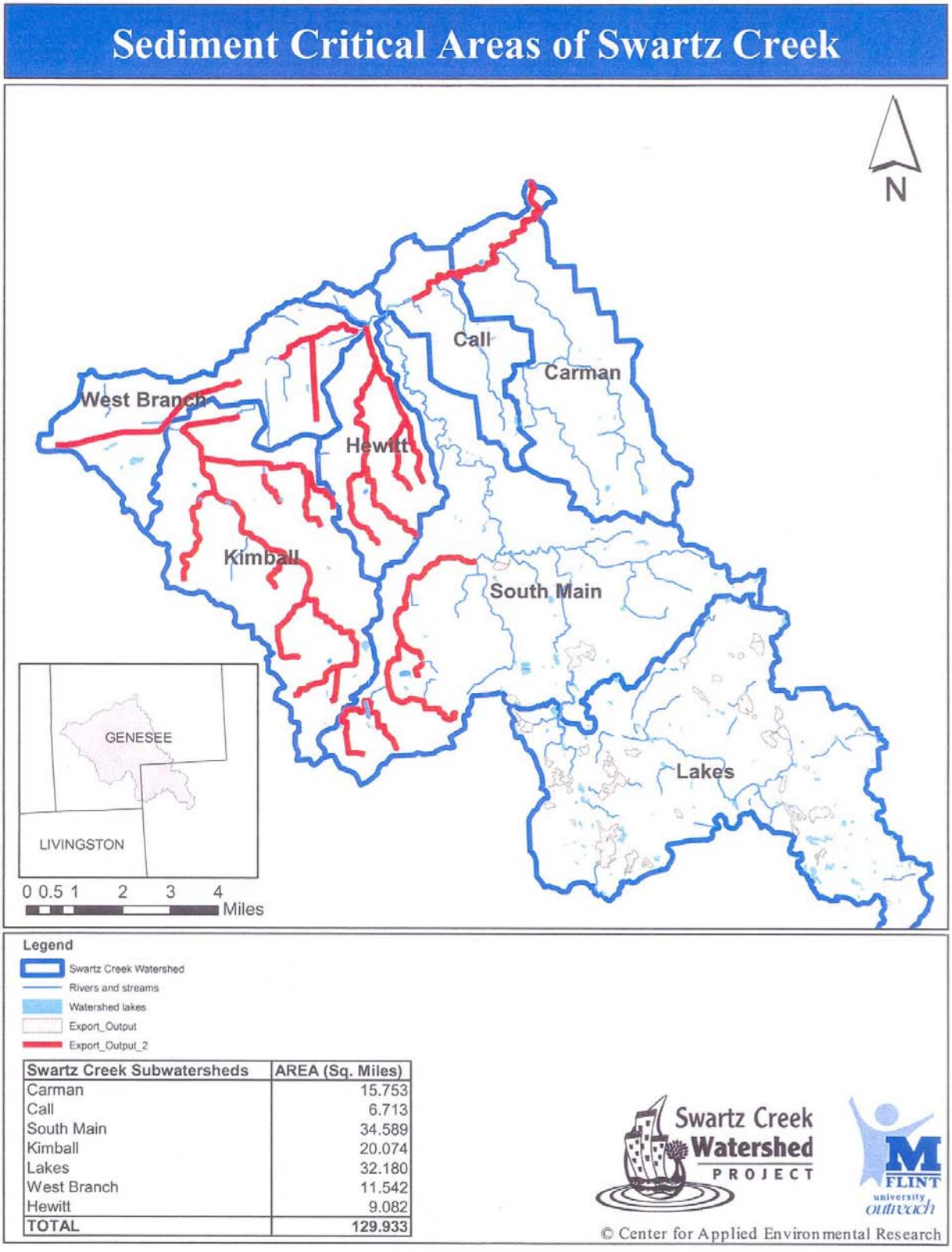
Sediment Critical Areas of Swartz Creek
N
Call
Carman
West Branch
Hewitt
Kimball
South Main
Lakes
GENESEE
LIVINGSTON
0 0.5 1 2 3 4
Miles
Legend
Swartz Creek Watershed
Rivers and streams
Watershed lakes
Export_Output
Export_Output_2
Swartz Creek Subwatersheds | AREA (Sq. Miles)
Carman 15.753
Call 6.713
South Main 34.589
Kimball 20.074
Lakes 32.180
West Branch 11.542
Hewitt 9.082
TOTAL 129.933
Swartz Creek Watershed PROJECT
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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.

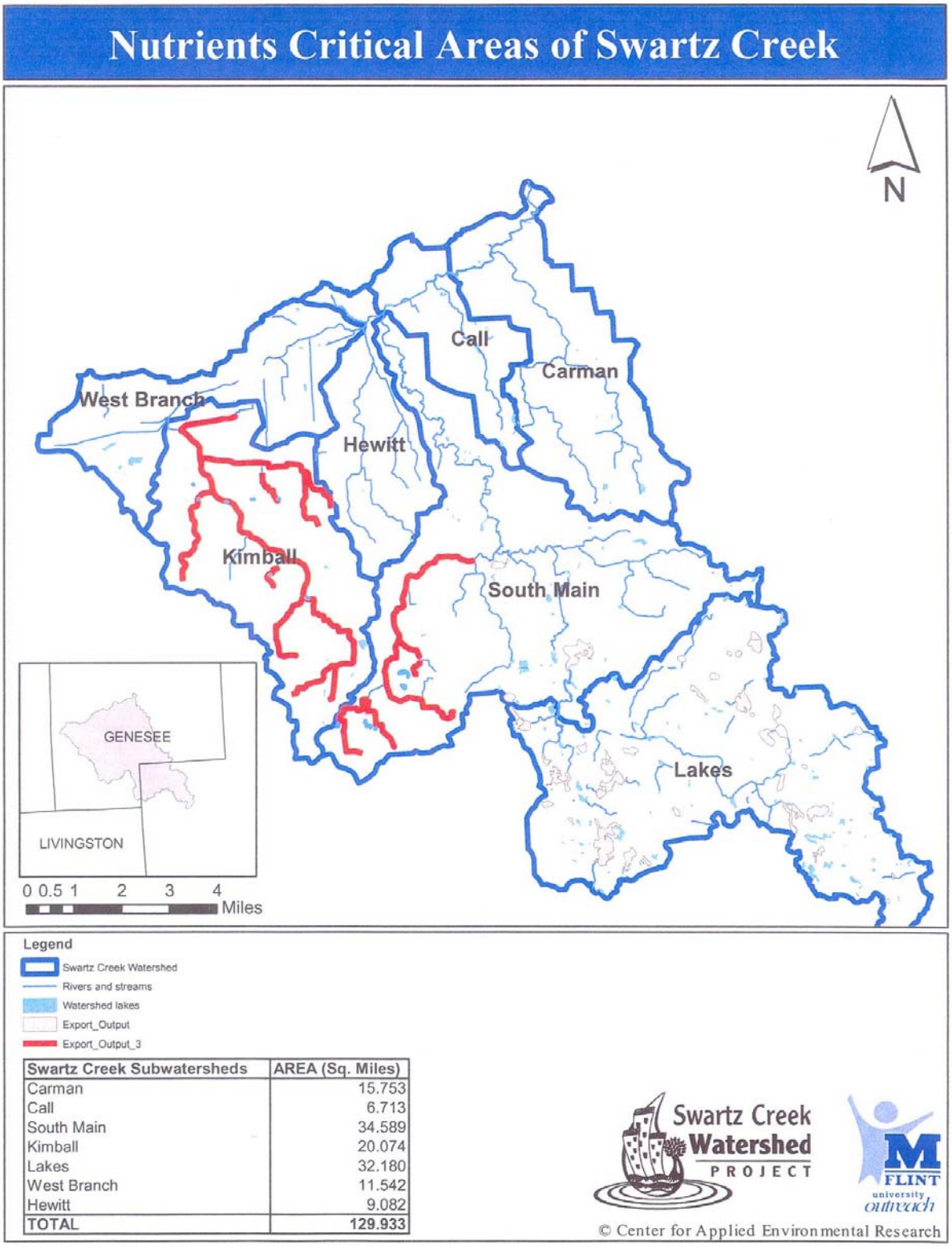
Sediment Born Nutrients
Nutrients within the stream channel were identified as a priority pollutant because of their impact on warm water fisheries and aquatic habitat. Phosphorus was identified by DEQ as a pollution problem throughout the entire basin with the Kimball Drain Watershed being the most 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.



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 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.

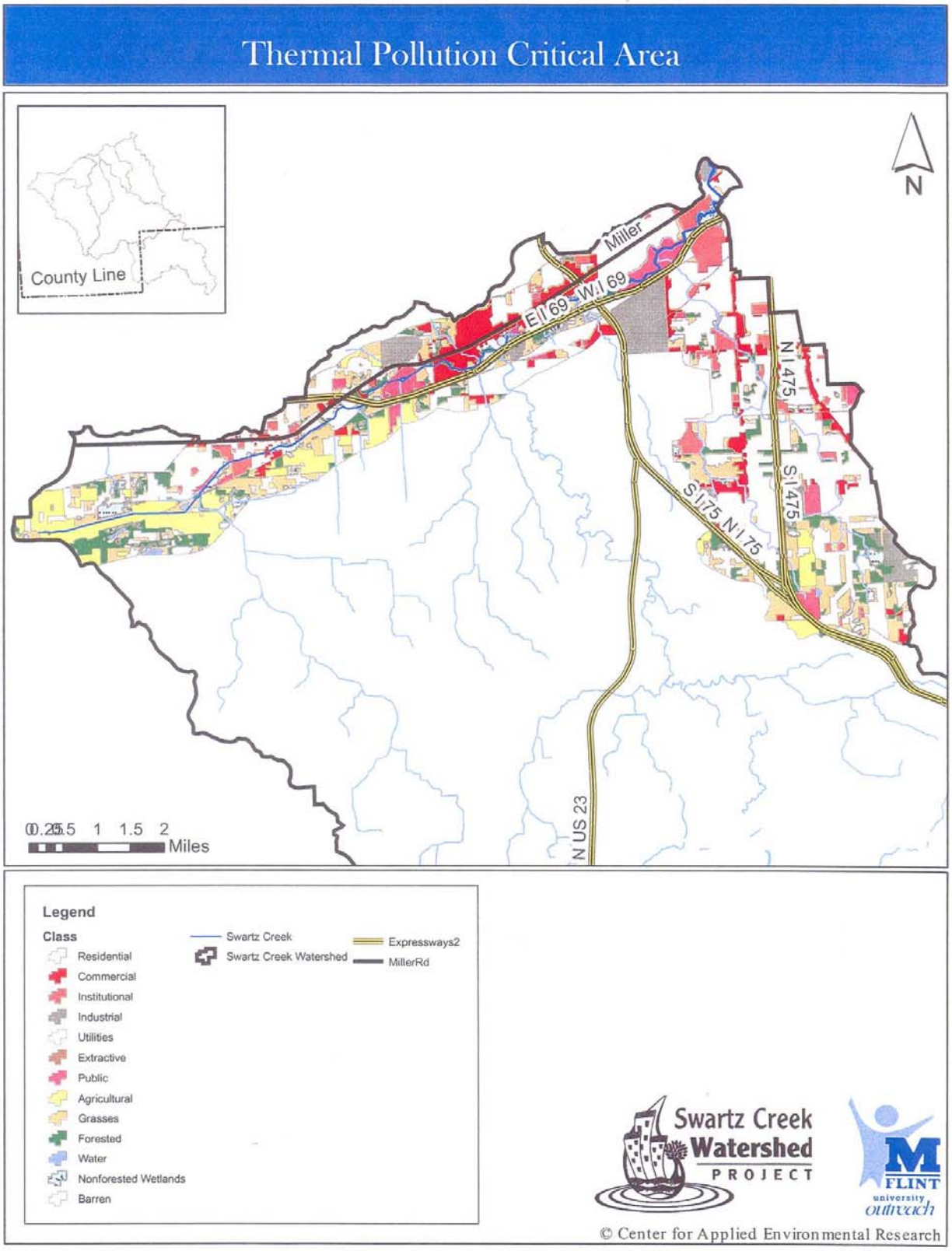

Thermal Pollution Critical Area
County Line
N
Miller
E I 69
W I 69
N I 475
S I 475
S I 75
N I 75
N US 23
0 0.25 0.5 1 1.5 2
Miles
Legend
Class
Residential
Commercial
Institutional
Industrial
Utilities
Extractive
Public
Agricultural
Grasses
Forested
Water
Nonforested Wetlands
Barren
Swartz Creek
Swartz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