CHAPTER FOUR:
THUNDER BAY RIVER PHASE TWO NONPOINT SOURCE INVENTORY

INTRODUCTION

Nonpoint source pollution can find its way into a water system through various means. When streambanks and shorelines erode, sediments are deposited into lakes and rivers. Sediments and other pollutants can be washed into streams at road/stream crossings. Agricultural and residential areas contribute fertilizers and pesticides. Several inventories, including streambank, road/stream crossing, and agriculture were conducted during spring through autumn of 2003 to gather information regarding the state of the watershed. Materials used in the assessment of the watershed included topographic maps, MIRIS land use maps, plat books, aerial photographs, watershed maps, and county road maps. Water quality data and zoning ordinances were also used to supplement the spatial data. The field inventories were conducted by car, boat, canoe and/or by walking the watershed. The resulting data sets were used to determine which pollutants are threatening or impairing the watershed's designated and desired uses.

STREAMBANK EROSION INVENTORY

METHODOLOGY

An inventory of streambank erosion sites was conducted in summer 2003. The streambanks were inventoried using a variety of methods, including topographical map review, soils studies analysis, and where navigable, various watercraft were used. For the field inventory, each erosion site was given an identification number, condition of the site was documented, and photographs were taken of the streambank. Information collected at each site included length and slope of the eroded embankment, soil type and amount of vegetation present, the condition of the bank, and the extent and causes of the erosion (**Appendix B** is a sample data collection form; **Appendix C** is the severity scoring sheet used to determine site rank). Using this data, best management practices were then determined for each site inventoried. In order to identify the most critical erosion sites, a ranking system that evaluates the collected data was used, and each erosion site was determined to be either a *Mino*r, *Moderate*, or *Severe* environmental concern. Evaluation of the streambanks in the watershed is critical in determining not only which sites need immediate attention, but also in identifying sites that may pose potential sedimentation problems in the future.

Maps 8-10 indicate sites where streambank erosion is occurring. For more detailed information on erosion sites, see *Support Document: Thunder Bay River Watershed Initiative, Phase Two.*

Map 8 Streambank PI & AIp

Map 9 Streambank Maple Ridge

Map 10 Streambank Ossineke and Caledonia

RESULTS

A total of twenty-seven sites displaying significant amounts of streambank erosion were located within the watershed. Five of the sites show minor amounts of erosion, twenty have moderate erosion, and two sites were considered severe. Three of the minor sites were located on the North Branch of the Thunder Bay River; two were on the Lower South Branch. Four of the moderate sites were located on the North Branch, and the remaining sixteen were located on the Lower South Branch. Both of the Severe sites were located on the Lower South Branch. The causes of erosion varied from site to site. Several of the erosion sites were naturally occurring from a bend or an obstruction in the river. The erosion at many of the sites, however, was the result of human activities. In particular, fishing and boat launch sites, and sites where livestock had access to streams often showed moderate to severe signs of erosion. **Table 15** is a brief summary of the streambank inventory.

Table 15: SUMMARY OF STREAMBANK EROSION INVENTORY				
Site ID	**County**	**Township**	**Stream**	**Site Score**
Minor Sites				
SB04	Alpena	Wilson	Lower South Branch	24
SB05	Alpena	Wilson	Lower South Branch	21
NB01	Presque Isle	Long Rapids	North Branch	23
NB02	Alpena	Posen	North Branch	23
NB05	Alpena	Long Rapids	North Branch	26
Total Minor Sites 5				
Moderate Sites				
SB01	Alpena	Caledonia	Lower South Branch	32
SB02	Alpena	Ossineke	Lower South Branch	31
SB03	Alpena	Wilson	Lower South Branch	33
SB06	Alpena	Wilson	Lower South Branch	33
SB07	Alpena	Wilson	Lower South Branch	32
SB08	Alpena	Wilson	Lower South Branch	35
SB09	Alpena	Maple Ridge	Lower South Branch	32
SB10	Alpena	Maple Ridge	Lower South Branch	32
SB11	Alpena	Maple Ridge	Lower South Branch	32
SB12	Alpena	Maple Ridge	Lower South Branch	32
SB14	Alpena	Maple Ridge	Lower South Branch	36
SB15	Alpena	Maple Ridge	Lower South Branch	32
SB16	Alpena	Maple Ridge	Lower South Branch	34
SB17	Alpena	Maple Ridge	Lower South Branch	33
SB18	Alpena	Maple Ridge	Lower South Branch	33
SB19	Alpena	Maple Ridge	Lower South Branch	34
NB03	Alpena	Long Rapids	North Branch	31
NB04	Alpena	Long Rapids	North Branch	30
NB06	Alpena	Long Rapids	North Branch	30
NB07	Alpena	Long Rapids	North Branch	34
Total Moderate Sites 20				
Severe Sites				
SB13	Alpena	Maple Ridge	Lower South Branch	36
SB20	Alpena	Maple Ridge	Lower South Branch	38
Total Severe Sites 2				
Watershed Total 27				

SHORELINE INVENTORY

A shoreline survey to identify locations of Cladophora growth and other shoreline features was conducted jointly by the Huron Pines RC&D Council and the Northeast Michigan Council of Government in the spring of 2003. Hubbard Lake was the primary focus of the survey, as it is an oligotrophic lake with excellent habit for Cladophora growth, and is almost fully developed with households on septic systems.

Cladophora is a branched, filamentous green algae that occurs naturally in small amounts in Northern Michigan Lakes. Specific environmental requirements for temperature, substrate, nutrients and other factors govern its occurrence. It is found most commonly in the wave splash zone and shallow shoreline areas of lakes, and can also be found in streams. It grows best on stable substrates such as rocks and logs. Artificial substrates such as concrete or wood seawalls are also suitable. The preferred water temperature is 50 to 70 degrees Fahrenheit. This means that late May to early July, and September and October are the best times for its growth in Northern Michigan lakes.

The nutrient requirements for Cladophora to achieve large, dense growths are greater than the nutrient availability in lakes with high water quality, such as Hubbard Lake. Therefore, the presence of Cladophora can indicate locations where relatively high concentrations of nutrients, particularly phosphorus, are entering a lake (it has less usefulness as an indicator of nutrient pollution in streams). Sources of these nutrients can be due to natural conditions, including springs, streams, and artesian wells that are naturally high in nutrients due to the geologic strata they encounter; as well as wetland seepage which may discharge nutrients at certain times of the year. However, past experience has shown that the majority of Cladophora growths can be traced to cultural sources such as lawn fertilization, malfunctioning septic systems, poor agricultural practices, soil erosion, and wetland destruction. These nutrients can contribute to an overall decline in lake water quality. Additionally, malfunctioning septic systems pose a potential health risk due to bacterial and viral contamination.

A shoreline survey can be a valuable lake management tool. Coupled with follow up on-site visits and questionnaires, controllable sources of nutrients to the lake, serious erosion sites, the presence and condition of shoreline greenbelts, and the intensity of algae growth along the waterfront can be identified and documented. Subsequently, a reduction in nutrient loading and other forms of pollution can often be achieved by working with homeowners to solve problems. These solutions are often simple and low cost, such as regular septic system maintenance, proper lawn care practices, and preservation or establishment of a greenbelt along the shoreline. Prevention of problem situations can also be achieved through the publicity and education associated with the survey.

Although the shoreline inventory does not replace the need for more detailed water quality studies, it is a good starting point and a useful tool for watershed management. Data generated by this inventory must, however, be carefully interpreted and is intended only to help characterize the current condition of the lake, help predict future impacts to the lake from shoreline practices, and to serve as an educational tool.

METHODOLOGY

The shoreline inventory for Hubbard Lake was conducted in May 2003 by staff from Huron Pines RC&D and NEMCOG. Using kayaks and generally paddling within 30 ft of the shoreline, technicians documented the entire shoreline of the lake, noting erosion, intensity of Cladophora growth, and greenbelt condition on a parcel by parcel basis.

Parcel data was not available from the County Equalization Department at the time of this study. However, through the use of aerial photographs, county plat books, on-the-lake observations, and using the Geographic Information System (GIS), it was possible to plot the information with accuracy. Shoreline information was entered into a database and used to generate maps depicting areas of vulnerability in Hubbard Lake.

A total of 942 distinct shoreline property parcels were identified around the lake. These were numbered sequentially, starting with the boat launch/township park on the north end of the lake and running counterclockwise around the lake. Parcels included both undeveloped and developed areas. In a few instances there was a relatively long stretch of undeveloped shoreline that was considered one parcel based on the apparent ownership and development status of the parcel. **Table 16** is a general summary of the results of the survey. Maps and specific parcel information are located in *Support Document: Thunder Bay River Watershed Initiative, Phase Two.* **Appendix D** provides a sample Hubbard Lake Shoreline Inventory Form.

Table 16: Hubbard Lake Shoreline Inventory Results: General Summary	
Number of shoreline miles	21.02
Number of shoreline miles undeveloped	2.8
Number of property parcels	942
Percent of shoreline undeveloped	13.3%
Number of parcels with good to excellent greenbelts	128
Number of parcels with poor or no greenbelts	796
Number of parcels with moderate to heavy shoreline erosion	27
Percent of parcels with Cladophora habitat	73%
Cladophora habitat parcels with light, moderate, or heavy growths	68%

RESULTS

Cladophora Habitat and Growth
This form of filamentous green algae requires a hard surface (rock, seawall, or log) to attach to. If this surface is not available, there is no Cladophora habitat and the algae will not be present. In summary, 73.4% (691) of the property parcels exhibited suitable habitat for Cladophora growth.

The survey noted whether Cladophora was present or absent, and whether it was found in light, moderate or heavy growths. In nutrient poor (low productivity) lakes like Hubbard, Cladophora is a reliable indicator of possible nutrient pollution. Of the parcels with habitat, 474 parcels (68%) showed visible signs of growth. Significant (heavy) growths of Cladophora were observed on 127 (18%) of parcels.

Shoreline Erosion
While erosion is a natural process, it can be accelerated by human activities and lead to both property loss and environmental problems. This survey noted only visible erosion, such as bare soil on steep slopes, gullies, undercut banks, and slumping. Erosion was classified as slight, moderate, or severe. Twenty-seven (2.8%) of the 942 sites exhibited significant shoreline erosion, considered to be moderate or heavy.

Shoreline Greenbelts
Greenbelts were scored on a scale of 0 to 3, with *3* being an undeveloped shoreline. A *0.5* signifies removal of all vegetation except for turfgrass, 1 represents some vegetation, but not enough to qualify as a greenbelt zone, and *2* or above is considered "good." Good greenbelts

will have significant areas of natural vegetation that remain, particularly adjacent to the shoreline. Homes with good to excellent greenbelts can often be difficult to observe from the water. This may be the most subjective of the inventory categories; however, maintaining natural vegetation is perhaps the most significant action a lakefront property owner can take to preserve high water quality. Greenbelts minimize overland runoff, remove nutrients from the soil, minimize the need for intensive lawn maintenance, provide important riparian habitat for wildlife, hold shoreline soils in place and buffer the shoreline from erosion. While 128 parcels were scored good to excellent; 796 scored 1.9 or below.

In addition to Hubbard Lake, shoreline surveys were completed for Ess Lake, Rush Lake, Long Lake and Beaver Lake. None of these lakes had any significant amounts of erosion, and none had good Cladophora habitat. All four of the lakes have quite a bit of development for their size, and are on septic systems. A study of the impacts from wastewater treatment practices should be considered for a future project. **Table 17** compares findings for all five lakes inventoried. Two other lakes important to the watershed, Grass Lake and Fletcher Pond, did not meet the criteria for the survey, due to lack of shoreline development.

Table 17: Shoreline Survey Summary

Lake	Total Number of Parcels	Parcels With Good to Excellent Greenbelts	Parcels With Poor or No Greenbelts	Parcels With Moderate to Heavy Shoreline Erosion	Parcels With Cladophora Habitat	Parcels With Cladophora Present (Light, Moderate or Heavy)
Hubbard	942	128	796	27	691	474
Ess	68	34	22	2	2	0
Rush	81	20	53	3	13	0
Beaver	214	32	171	9	68	0
Long	143	64	68	0	12	1

ROAD/STREAM CROSSING INVENTORY

A road/stream crossing site exists wherever a road or street and a stream intersect. Road/stream crossings can be major contributors of sediments and other pollutants to the water system. Dirt and gravel from shoulders of the roads, and from unpaved roads, can be washed into a stream. The resulting build up of sediments in the stream is called *sedimentation*. Although sedimentation is a natural process, excess amounts of sediments can wreak havoc on the aquatic environment. Some detrimental effects of sedimentation are:

- Destruction of aquatic habitat and the extermination of aquatic wildlife
- Negative impacts on birds and mammals dependent on the aquatic environment
- Restriction of plant productivity due to reduction of sunlight penetration
- Warming of waters, which can lead to destruction of coldwater fisheries
- Release of nutrients into the water system, causing the stimulation of algae growth
- Introduction into the water body of harmful pesticides, toxic metals and bacteria which may adhere to the grains of sediment
- Disruption of fish life cycle (affects fish's ability to feed, spawn, and inhibits gill function.)
- Reduction of stream channel width and depth, and the potential increase in flooding events

Sediment loading occurs when a net import of sediment exceeds annual export, and the consequences of such loading can be detrimental to the biology and structure of the system. Such a situation can lead to the overall degradation of the system. Sediment loading gradually fills in a stream channel, and under the more stable flow regimes associated with northern Michigan trout streams, the water is most typically displaced laterally. Lateral spread of the channel results in an overall decrease in depth with the variability in depth being nearly eliminated, resulting in a homogeneous stream channel. A change in the stream channel can also result in increased streambank erosion thus compounding the problem. The amount of sedimentation experienced by a waterbody depends on several factors, such as the length and slope of the approaches, steepness of the embankment, whether or not the road is paved, the amount of vegetative cover along shoulders and ditches at the site, and the runoff path.

Other components that influence channel morphology, such as large woody debris, cease to function as they become buried with sediment. When these types of structures become covered the result is a loss of scour holes and plunge pools. Additionally, the overall use of large woody debris as cover for fish may be severely reduced depending on the degree of sedimentation that has occurred. Other aspects of habitat are also directly affected, such as riffle areas that are normally dominated by rock and cobble. As sand becomes deposited valuable substrate for invertebrates and fish spawning is lost. Populations of fish are almost always affected more noticeably than the invertebrates, as angling represents one of the more common recreational uses of these types of systems. The reasons for the direct effects on the fishery are twofold; the food resource can be diminished to such an extent as to stunt growth, and unavailable spawning substrate results in poor fish recruitment.

METHODOLOGY

The road/stream-crossing inventory for the Thunder Bay River Watershed Initiative: Phase Two was conducted in the spring and summer of 2003. The inventory was completed using county road maps and topographic maps to identify potential sites. At each site, photographs were taken of upstream, downstream, and left and right approaches. Physical condition and measurements of the culvert and roadway, the length and slope of approach, road width and surface type, stream depth and current, amounts and causes of erosion, and extent of vegetation were recorded. (A sample inventory sheet is included in **Appendix E**.) One of the key functions of an inventory is to aid in the prioritization of sites for improvement. A sample ranking sheet can be found in **Appendix F,** and terms used in ranking and data collection are defined in **Appendix G**. Using the data collected, each site was assigned a ranking of minor, moderate or severe based on the point system found below:

Point Score Total	Severity Category
0-15	Minor
16-29	Moderate
>30	Severe

The ranking system is designed to reflect the relative severity of existing and potential erosion conditions at each site. Severity rankings are useful as a quick reference to sites that fall within a specific category. Generally, the severity ranking will be only one of several considerations for improvement decisions. Other variables such as cost, access, funding sources, and logistics will strongly affect implementation decisions. It is expected that resource managers will look carefully at candidate sites' individual scores before selecting sites for improvement.

Cost estimates were developed based on the severity rank and the extent of erosion of each site. To serve as a general guideline the following table (**Table 18**) was created. On certain sites minimal or no repair work was recommended, in this case the cost estimate was adjusted accordingly.

Table 18: Cost Estimate Table	
Rank	**Cost Estimate**
0-10	$0
11-18	$5,000
19-25	$10,000
26-29	$30,000
30-35	$60,000
36-40	$120,000
41-47	$300,000

The technical committee identified several sites as being *priority* (those contributing the most pollutants to the river) and a second site evaluation of those sites was conducted. Site designs were then drafted and more detailed cost estimates were calculated for these high priority road/stream crossings. (See *Chapter 7: Watershed Goals and Recommendations*) Costs and plans should be refined prior to implementing the recommended improvements.

RESULTS

A total of 199 road/stream crossing sites were inventoried for the Thunder Bay River Watershed Initiative, Phase Two. **(**See **Map 11)** The sites were ranked as *Minor, Moderate* or *Severe* contributors of sediments to the river system. A total of 41 sites received a ranking of Minor, the majority of which were found in Alcona and Alpena Counties. Over half of the sites inventoried (135) received a ranking of Moderate; the majority of these sites were located in Alpena County. Only six sites were ranked severe; two in each of Montmorency and Alcona Counties and one in each of Montmorency and Alpena Counties.

Sediment was determined to be the pollutant having the most detrimental effect on water quality in the watershed, and road/stream crossings contribute significantly to the sedimentation process. **Table 19** lists each crossing by site ID, followed by an estimated cost to repair or remediate that site. Where no action was deemed necessary, only the site ID is listed. The table lists sites by county and severity ranking, and includes county and watershed totals.

Road/stream crossing sites assessed during the inventory are identified in a series of maps (***Maps 6-10***) located in *Support Document: Thunder Bay River Watershed Initiative, Phase Two.* Inventoried sites are listed by county and township on **Table 20,** which was developed to simplify locating specific road/stream crossing sites.

Map 11 Road/Stream Crossing Sites

Table 19: ROAD/STREAM CROSSING INVENTORY SUMMARY WITH COST ESTIMATIONS			
Alcona County			**Total**
MINOR	**16**	ALC01 ALC04 ALC06 ALC17 ALC18($3000) ALC19($7000) ALC21($2000) ALC23 ALC24 ALC32 ALC33($2000) ALC34($5000) ALC35($5000) ALC38 ALC40 ALC43	**$24,000**
MODERATE	**35**	ALC02 ALC03($1000) ALC05 ALC07 ALC08($1500) ALC09($5000) ALC10($10,000) ALC11($30,000) ALC13 ALC14 ALC15($30,000) ALC16($5000) ALC20($5000) ALC22($5000) ALC25($5000) ALC26($2000) ALC27 ALC28($5000) ALC30($10,000) ALC31($5000) ALC36 ALC37($2000) ALC39($30,000[$150,000 with bridge replacement]) ALC41 ALC42($10,000) ALC44($2000) ALC45 ALC46 ALC47($1000) ALC48 ALC49($500) ALC50($2000) ALC51 ALC52($1000) ALC53	**$168,000 ($288,000 with bridge replacement)**
SEVERE	**2**	ALC12($60,000) ALC29($30,000)	**$90,000**
TOTAL	**44**	**($402,000 with bridge replacement)**	**$282,000**
Alpena County			**Total**
MINOR	**15**	ALP04($1000) ALP07($5000) ALP08 ALP14 ALP16 ALP18($5000) ALP22 ALP24($5000) ALP28 ALP56 ALP59 ALP77($5000) ALP84 ALP87	**$21,000**
MODERATE	**75**	ALP01($30,000) ALP02($1000) ALP03($10,000) ALP05 ALP06($5000) ALP09($5000) ALP10($2000) ALP11 ALP12($5000) ALP13 ALP15($5000) ALP17 ALP19 ALP20($10,000) ALP21($30,000) ALP23 ALP25($10,000) ALP26($10,000) ALP27($10,000) ALP29 ALP30 ALP31($10,000) ALP32($10,000) ALP33($10,000) ALP34($10,000) ALP35($5000) ALP36($5000) ALP37($5000) ALP38($10,000) ALP39 ALP40 ALP41($10,000) ALP42($1000) ALP43($10,000) ALP44($10,000) ALP45($5000) ALP46($5000) ALP47 ALP48($5000) ALP49 ALP50($10,000) ALP51($30,000) ALP52 ALP53 ALP54($5000) ALP55($5000) ALP57 ALP58 ALP60($5000) ALP61($5000) ALP62 ALP63($5000) ALP64($10,000) ALP66($10,000) ALP67 ALP68($5000) ALP69($5000) ALP70($5000) ALP71($5000) ALP72($10,000) ALP73 ALP74($5000) ALP75($10,000) ALP76 ALP78 ALP79($30,000) ALP80($30,000) ALP81 ALP82($10,000) ALP83($10,000) ALP85($20,000) ALP86($10,000) ALP88($5000) ALP89($10,000) ALP90($10,000) ALP91	**$509,000**
SEVERE	**1**	ALP65($30,000)	**$30,000**
TOTAL	**91**		**$560,000**
Montmorency County			**Total**
MINOR	**1**	MO15($10,000)	**$10,000**
MODERATE	**15**	MO01($30,000) MO02 MO03 MO04($10,000) MO05($50,000) MO06($2000) MO07($10,000) MO08($5000) MO09 MO10 MO11 MO12($10,000) MO16($5000) MO17($5000)	**$137,000**
SEVERE	**2**	MO13($60,000) MO14($10,000) MO18($5000)	**$65,000**
TOTAL	**18**		**$212,000**
Oscoda County			**Total**
MODERATE	**1**	OS02	**$30,000**
SEVERE	**1**	OS01($30,000)	**$0**
TOTAL	**2**		**$30,000**
Presque Isle County			**Total**
MINOR	**9**	PI01 PI03($5000) PI09($2000) PI16 PI17($500) PI18 PI121($10,000) PI124 PI125	**$17,500**
MODERATE	**18**	PI02($20,000) PI04 PI05($5000) PI06($5000) PI07($20,000) PI08 PI10 PI11($20,000) PI12 PI13 PI14 PI15 PI19 PI120 PI122($5000) PI123($2000) PI126 PI127($1000)	**78,000**
TOTAL	**27**		**$95,000**
WATERSHED TOTALS			**Total**
MINOR	**41**		**$72,000**
MODERATE	**144**		**$922,000 ($1,042,000 with ALC39 bridge replacement)**
SEVERE	**6**		**$215,000**
TOTAL SITES	**199**		**$1,175,000 ($1,325,000 with ALC39 bridge replacement)**

Table 20: Road /Stream Crossing Sites by Township

ALCONA COUNTY

Mitchell		Caledonia		Alcona	Hawes	
ALC01	ALC07	ALC12	ALC19	ALC22	ALC25	ALC31
ALC02	ALC08	ALC13	ALC20	ALC23	ALC26	ALC39
ALC03	ALC09	ALC14	ALC21	ALC24	ALC27	ALC40
ALC04	ALC10	ALC15	ALC32	ALC36	ALC28	ALC41
ALC05	ALC11	ALC16	ALC33	ALC37	ALC29	ALC42
ALC06	ALC44	ALC17	ALC34	ALC38	ALC30	ALC43
		ALC18	ALC35			

ALPENA COUNTY

Wellington		Green			Long Rapids		Maple Ridge		Alpena	
		(west)	(east)							
AL01	AL11	AL07	AL24	AL30	AL17	AL22	AL39	AL44	AL48	AL54
AL02	AL12	AL08	AL25	AL31	AL18	AL35	AL40	AL45	AL49	AL55
AL03	AL13	AL09	AL26	AL32	AL19	AL36	AL41	AL46	AL50	AL56
AL04	AL14	AL23	AL27	AL33	AL20	AL37	AL42	AL47	AL51	AL57
AL05	AL15		AL28	AL34	AL21	AL38	AL43		AL52	AL58
AL06	AL16		AL29						AL53	AL59
AL10										

MONTMORENCY COUNTY

Vienna	Albert	Loud		Hillman		Briley		Montmorency	Avery	Rust
				(west)	(east)					
MO01	MO03	MO29	MO36	MO18	MO53	MO04	MO11	MO61	MO17	MO54
MO02	MO08	MO30	MO37	MO19	MO58	MO05	MO12	MO69	MO21	MO55
	MO24	M031	MO38	MO20	MO59	MO06	MO13	MO70	MO22	MO56
	MO25	MO32	MO39	MO46	MO60	MO07	MO14	MO71	MO23	MO57
	MO26	MO33	MO40	MO47	MO62	MO09	MO15	MO72	MO43	
	MO27	MO34	MO41	MO49	MO63	MO10	MO16		MO44	
	MO28	MO35	MO42	MO50	MO64				MO45	
					MO65				MO51	
					MO66				MO52	
					MO67					
					MO68					

OSCODA COUNTY	PRESQUE ISLE COUNTY			
Clinton	Metz	Bismarck	Posen	Belknap
0S01	PI01	PI02	PI20	PI24
OS02	PI11	PI03	PI21	PI25
	PI12	PI04	PI22	
	PI13	PI05		
	PI14	PI06		
	PI15	PI07		
	PI16	PI08		
	PI17	PI09		
	PI18	PI10		
	PI19	PI23		
	PI26			
	PI27			

AGRICULTURE INVENTORY

The welfare of fish and wildlife depends on water quality and the availability of habitat. Public concern over environmental water quality grows as declining populations of fish and wildlife in the Thunder Bay River watershed are noticed. Extensive land use by farmers for agricultural purposes has a direct impact on wildlife habitat and water quality in the watershed. Public desires to protect the lands from extensive farming have been expressed through legislation, including the Clean Water Act, the Endangered Species Act and the Farm Bill.

Sedimentation from agricultural activities can be a sign of nonpoint source pollution in a watershed. Wind and water flowing across the land allows sediment to detach and provides transportation of sediment into a water body, causing a loss of topsoil to the farmer and adding excess sediment to a lake, stream, or river. The loss of topsoil is usually countered by the addition of nutrients into the soil, leading to an excess of nutrients that disturb the natural balance of an ecosystem around a watershed as nutrients collect in the water.

Animal manure also contributes to an excess of nutrients that can be easily transported by water and concentrated into lakes and streams. Nutrient loading has the affect of disturbing the sensitive ecosystem of fish and wildlife while at the same time creating the loss of valuable habitat. Excesses of nutrients can impair the quality of drinking water, aquatic habitat, and the recreational quality of watercourses.

Nonpoint source pollution is a serious issue, but one readily brought under control with proper management of land and resources. The use of Best Management Practices (BMPs) is cost effective in the long run and benefits members of the community as well as wildlife. Healthy fish and wildlife populations are the result of good watershed management and a concerted community effort. Understanding and acting upon the need to correct present, and prevent future, nonpoint source pollution in the watershed, community members and farm operators can cooperatively maintain mutually beneficial high water quality and efficient, well managed agricultural operations. Increased crop and livestock yields for farmers, abundant wildlife habitat, and aesthetically pleasing vistas can be the by-products of a high quality, well-maintained watershed.

METHODOLOGY

An inventory of agricultural operations within the watershed was completed in summer 2003. The inventory was conducted by USDA-NRCS staff and the Montmorency County Conservation District. Agricultural sites within the defined critical area were identified using a variety of maps and aerial photos. Sites were located using topographical maps and county plat books were consulted to identify property owners. A database was then developed to include township, range and section numbers, and landowner addresses. Utilizing the skills of USDA-NRCS personnel, high priority agricultural sites were determined, and field inventories were conducted. Agricultural sites were evaluated on an Agricultural Inventory Field Data Form, such as the one shown in *Appendix H*. Data collected at each site includes location, number of acres, type of operation, pollutant sources, recommended treatments and a site sketch. Field checks were used to establish a list of potential problem areas related to agricultural practices. High priority sites were photographed and a document complete with photos, field data, BMPs, and a cost estimate was developed for each site. This combined form can be found in *Support Document: Thunder Bay River Watershed Initiative, Phase Two.* A series of maps that show locations of agricultural sites is included with this document.

RESULTS

Four counties within the Thunder Bay River Watershed (Alpena, Alcona, Montmorency and Presque Isle) were surveyed for nonpoint source pollution originating from agricultural operations. Of the 157 sites inventoried, 39 sites ranging from *minor* to *severe* were determined to be contributing pollution to the watershed critical area. (For a summary of the agricultural inventory see **Table 21.**) Unrestricted livestock access was cited as the number one source of agriculture-related pollution; other significant sources include improper management of animal waste and improper/overuse of fertilizers and pesticides. Inappropriate agricultural practices are currently threatening several of the state mandated designated uses, as well as negatively impacting economic, aesthetic, and recreational aspects of the watershed.

Table 21 lists agricultural sites of concern by township and severity ranking, and includes cost estimations for each township.

Table 21: SUMMARY OF AGRICULTURAL INVENTORY AND ESTIMATED COSTS			
Total Sites of Concern	**39**	**Total Cost:**	**$535,590**
MINOR SITES	**Township**	**Number of Sites**	**Cost for Township**
Alcona County	Mitchell	1	$3,350
Alcona County Totals		***1***	$3,350
Alpena County	Green	2	$3,765
	Ossineke	6	$32,340
	Wilson	7	$13,860
Alpena County Totals		***15***	***$49,965***
Montmorency County	Rust	1	$150
	Montmorency	3	$20,330
Montmorency County Totals		***4***	***$20,480***
Presque Isle County	Posen	4	$24,095
Presque Isle County Totals		***4***	***$24,095***
Total Minor Sites Inventoried/Total Cost		**24**	**$97,890**
MODERATE SITES	**Township**	**Number of Sites**	**Cost**
Alcona County	Caledonia	1	$3,780
	Mitchell	3	$91,185
Alcona County Totals		***4***	***$94,965***
Alpena County	Ossineke	1	$1,725
	Wilson	3	$135,780
Alpena County Totals		***4***	***$137,505***
Montmorency County	Montmorency	2	$6,600
Montmorency County Totals		***2***	***$6,600***
Presque Isle County	Posen	2	$17,275
Presque Isle County Totals		***2***	***$17,275***
Total Moderate Sites Inventoried/Total Cost		**12**	**$256,345**
SEVERE SITES	**Township**	**Number of Sites**	**Cost**
Alcona County	Mitchell	1	$132,580
Alcona County Totals		***1***	***$132,580***
Alpena County	Ossineke	1	$31,950
	Wilson	1	$16,825
Alpena County Totals		***2***	***$48,775***
Montmorency County	*No Sever Sites*		
Presque Isle County	*No Severe Sites*		
Total Severe Sites Inventoried/Total Cost		**3**	**$181,355**

LAND USE INVENTORY

One of the most important components to the development of a nonpoint source pollution management plan for the Thunder Bay River Watershed is an analysis of land use and the land use planning process. The type and intensity of land use has a direct impact on water quality, and if adequate pollutant controls are not incorporated during the land development phase, costly remediation measures are often required to repair damaged caused by erosion, sedimentation, stormwater runoff or nutrient overload.

METHODOLOGY

The NEMCOG Geographic Information System was used to produce the maps in this report. The digital land use polygons were placed over the 1998 digital aerial photo images and were then modified to reflect the current land use at the time that the aerial photos were taken. The categories of land use were updated using the Michigan Resource Inventory System (MIRIS) classifications. Those classifications were then merged into 10 categories for map display purposes: Residential, Commercial, Industrial, Institution/Recreational, Agricultural, Nonforest, Upland Forest, Lowland Forest, Wetlands, and Surface Water. **Table 22** lists categories of land use in number of acres and percentage of the critical area for the Thunder Bay River Watershed, Phase two. **Map 12** displays current land use for the watershed.

In addition to the general watershed land use inventory, a detailed inventory of three blocks of land within the critical area was conducted in summer 2003. Each of the three blocks covered approximately six sections, and was selected to represent one of the major land use categories in the Thunder Bay Watershed, Phase Two. One of the blocks, consisting of primarily *Residential land* was located in Alcona County, another block highlights the *Agricultural land* predominate in Alpena County, and the third, representing *Upland and Lowland Forests* was surveyed in heavily forested Presque Isle County. The information gathered indicates trends in general land use changes for the watershed, and will be discussed in the appropriate land use categories below.

RESULTS

Data from the land cover/use inventory shows that over 65 percent of the Watershed's 505,412 total acreage was forested, with another 14 percent in agriculture, 8.5 percent non-forest land, 5.2 percent wetlands and 4.3 percent surface water (see **Table 22**). Less than three percent of the watershed's land was used for urban-type purposes in 1998, which included commercial, industrial, institutional/recreational and residential uses.

Residential

Residential land use includes residential dwelling structures such as single family or duplexes, multi-family low-rise residential, multi-family medium & high rise residential, and mobile home parks. According to the MIRIS Land Cover/Use update, 7677 acres (1.5%) of the watershed's critical land area was used for residential purposes. For the most part, residential development found in the watershed consists of single-family dwellings; however, single family duplexes, multi-family residential, condominiums, mobile homes and mobile home parks are also included in this category. Residential uses are concentrated around the rivers and lakes of the watershed, particularly Hubbard Lake. In addition to new dwellings being built on waterfront property, many of the once seasonal and weekend developments have undergone a transition to year-round residences. Residential development is also occurring along county roads throughout the watershed as larger parcels are split into ten-acre and smaller parcels.

A land use survey covering six sections (sections 1,2,3,10,11,12 and 14, of central Caledonia Township, Alcona County) in the heavily residential area of Hubbard Lake was conducted in 2003. When compared to the 1993 land use data, the updated 2003 data shows a 5.2% increase of residences for that area. This increase coincides with a 13.9% decrease in *Agricultural Land.* The impact of development was illustrated even more strongly in two other areas included in the study. Posen Township (Presque Isle County) and Ossineke Township (Alpena County) show large increases in residential land use, while at the same time showing significant losses of agricultural land. (See **Maps 13** and **14,** and **Table 23**.) Development of forests, agricultural lands and open land is a trend that can be seen not only in the Thunder Bay River Watershed, but also throughout the state.

Map 12 Land Use

Map 13 & 14 Residential

Commercial

Commercial land uses include merchandise and services provided in primary/central business districts, shopping center/malls, and secondary/neighborhood business districts, including commercial strip development. This category includes compact groups of neighborhood stores and parking areas related to the commercial businesses. The 1998 land use inventory identified 211 acres (0.4%) in commercial use in the watershed. While there are no heavily commercial areas in Phase Two of the Thunder Bay River Watershed; commercial service facilities are found clustered in the more urbanized sections of Alpena, Alcona, Presque Isle and Montmorency Counties.

Industrial

Due to the discoveries of new oil and gas reserves and the changes in availability and cost of foreign oil in the 1970s, national attention turned to Michigan's oil and gas industry. The extraction of oil and gas from deep gas reserves has been replaced in recent years by the development of the shallow Antrim shale reserves.

One of the major concerns of well drilling is ground water contamination. A well can serve as a conduit for surface contamination to directly enter the ground water without passing through any natural filter systems.

Another concern is the road access construction and site clearing. Many miles of primitive roads are built that may require extensive topographic changes to the land. In addition, miles of pipeline must be laid to transport the product to a processing and shipping facility. In order to place the drilling rig, an area of one to three acres must be cleared of trees and other vegetation to reduce the fire hazard. These activities can increase the amount of runoff in the watershed as well as the number of road stream and pipeline crossings. **Map 15** shows the location of oil and gas wells within the Thunder Bay River System.

In addition to industrial and extractive development (oil & gas drilling, quarry operations, etc.) this land use category includes transportation, communication and utility facilities, manufacturing and industrial parks, light industries, production facilities, lumber mills, chemical plants, brick-making plants, waste product disposal areas, and areas of stockpiled raw materials. Development falling under this category made up only 0.28 percent (1,418 acres) of the total watershed land area. Much of the industrial development is located near the main community centers.

Table 22: Land Use Classifications

Land Use	Number of Acres	Percentage
Residential	7,677.38	1.52%
Commercial	210.70	0.04%
Industrial	1,418.84	0.28%
Institution/Recreational	1,375.42	0.27%
Agriculture	71,265.05	14.10%
Nonforest	43,141.36	8.53%
Upland Forest	229,406.10	45.39%
Lowland Forest	102,676.08	20.32%
Wetlands	26,465.96	5.24%
Surface Water	21,775.77	4.31%
Total	**505,412.70**	**100%**

Source: 1998 update of 1978 MIRIS Land Cover/Use Inventory

Map 15 Oil & Gas

Institution/Recreational

Land devoted specifically for institutional and recreational purposes amounted to approximately 0.27 percent, or about 1,375 acres of the watershed. Land uses included in this category are public parks and campgrounds, golf courses, schools, churches, cemeteries, correctional and military facilities, and public buildings. Buildings, parking areas, and immediate grounds of these facilities are included in this category, however all surface water, forest, barren land, and wetlands associated with the industrial/recreational sector are entered into their own respective categories.

Open Land

Open-land is defined as areas supporting a "pioneer" stage of plant succession, land that is in transition to forestland. Open land consists of plant communities characterized by grasses or shrubs, and classifications such as barren land, herbaceous open land, and shrub land are included in the *Open Land* category. One type of opening was created by turn of the century logging operations and subsequent wildfires. Other Open Land areas consist of abandoned or idle farm land. Herbaceous open land is often subjected to continuous disturbance such as mowing, grazing, or burning. Typical Open Land grass species are quack grass, Kentucky bluegrass, upland and lowland sedges, reed canary grass and clovers. Shrub species include blackberry and raspberry briars, dogwood, willow, sumac and tag alder. The watershed supports over 4,000 acres of open land (8.5 percent), and the majority of these areas are located within active agriculture lands and upland forests.

Agricultural

The agricultural land use category includes land that is used for the production of food and fiber, and for non-food livestock such as horses. Types of agricultural operations fall into a variety of classes: cropland, orchards (including vineyards and ornamental horticulture), confined feeding operations for livestock, pasture lands, farmsteads, greenhouse operations, and horse training areas. With some 71,265.05 acres (14 percent) classified as farm land, agriculture is one of the watershed's largest land use categories, second to only forested lands. While the bulk of agricultural land is found in Alpena and Presque Isle Counties, significant amounts of land used for agricultural purposes can be found in all of the watershed's counties.

A six-section area (sections 2, 3,4,9,10, and 11) in Ossineke Township, R7E, Alpena County, was updated in 2003, and the results were compared to the 1978 land use update for the same six sections. Although the increase in lands used for residential purposes was slight, agricultural lands experienced a significant 18.4 percent decrease. This apparent discrepancy can be explained when the 8.8 percent increase in Forested land is taken into consideration. In many cases once active farms have ceased operating, and the land has since reverted to it's original forested state. **Maps 13** and **14** below show the land use changes for this updated six-section block experienced the past twenty-five years. (In the 1978 Land Use update, less detailed counts were taken for residential lands than in has been the practice in later updates. This fact should be taken into consideration when comparing 1978 residential land use to the 2003 update.)

Maps 16 & 17: Agricultural update

Upland Forest

Upland forests comprise the majority of land use in Thunder Bay River Watershed critical area, with a total of 229,406 acres, or 45.4 percent of the land area. The following species predominate areas classified as upland forests: sugar and red maple, elm, beech, yellow birch, cherry, basswood, white ash, all aspen types, white, red, jack and scotch pines and any managed Christmas Tree plantations. Other upland conifers include white or black spruce, balsam, or Douglas fir, along with areas covered by larch and hemlock.

Lowland Forest

The land use inventory shows that 102,676 acres, or 20.3 percent of the watershed's surface area consists of lowland forests. Lowland forest areas are dominated by tree species that grow in very wet soils, and contain such species as ash, elm and soft maple, along with cottonwood and balm-of-Gilead. Lowland conifers, such as cedar, tamarack, black and white spruce and balsam fir stands are also included.

The upland and lowland forests combine to encompass 332,082 acres, or 65.7 percent of the watershed's total surface area. Forests, therefore, constitute the largest single land use category for the Thunder Bay River Watershed. Large tracts of forested land can be found throughout the watershed, with especially high concentrations in Alcona County. Of the total forests, 69 percent are upland forests, while 31 percent are lowland forests.

Presque Isle County has 19,510 acres of upland forests, as well as over 10,000 acres of lowland forest. Land use for a six-section block (sections 26, 27, 28, 33, 34, and 35) within Posen Township was updated in 2003, and compared to the 1995 land use patterns for those same six sections (see **Maps 18** and **19**). During the eight years between land use updates, the six sections lost less than one percent of its forests due to changing land uses, this despite a significant increase in residential uses for the area. No Commercial or Institutional/Recreational land uses were recorded during the 1995 survey, however the 2003 survey indicates 1.4 acres of land are being used for commercial purposes, and 3050 acres have been classified Institutional/Recreational. Not surprisingly, the most significant decrease for the updated area (2.1 percent in eight years) was found in the agricultural sector.

Maps 18 & 19 Forested Sections

Table 23 shows changes in residential, forest, and agricultural land uses for three six-section blocks between 1978 and 2003. From these sample sections, it is possible to determine a slow but steady change from agricultural and forested lands to increased residential uses in the watershed.

Table 23: Sample Land Use Changes			
	Percent Change Residential Land Use	**Percent Change Agricultural Land Use**	**Percent Change Forested Land Use**
Caledonia Sections 1993-2003	5.2% Increase	13.9% Decrease	0.4% Decrease
Ossineke Sections* 1978-2003	1471.4% Increase	18.4% Decrease	8.8% Increase
Posen Sections 1995-2003	49.4% Increase	2.1% Decrease	0.1% Decrease

* The sections updated in 2003 were compared to the most current available data of that county. When comparing land use changes for the various sections, please note the update of the Ossineke sections covers a span of 25 years, while the Caledonia and Posen sections cover a period of ten and eight years, respectively. It should also be noted that land use was tracked in less detail in 1978 than in more recent years.

Wetlands

As can be noted from **Table 22**, 26,465 acres or about 5.2 percent of the Watershed's land area was identified as non-forested wetlands. Wetlands are those areas between terrestrial and aquatic systems where the water table is at, near, or above the land surface for a significant part of most years. The hydrologic regime is such that it permits the formation of hydric soils or it supports the growth of hydrophytic vegetation. Examples of wetlands include marshes, mudflats, wooded swamps and floating vegetation situated on the shallow margins of bays, lakes, rivers, ponds and streams. Wetland categories include shrub wetlands, fresh-water marshes, wet meadows, open bogs, emergent wetlands and aquatic bed wetlands.

In some situations, lands classified as lowland forests are treated as wetlands. Combining the land use types of wetlands and lowland forests for the Thunder Bay River Watershed, Phase Two, reveals that 129,141 acres (over 25 percent of the surface area) could be considered to be wetland types.

It is important to note that existing land use statistics used in this report are based on Michigan Resource Information System (MIRIS) data. Forested and wetland information contained in the MIRIS data was not verified by field inspection when the data was compiled. Thus, areas shown as wetlands on the MIRIS system may not actually meet State and Federal criteria for legally regulated wetlands. However, the information is still valuable for general land use planning decisions.

Surface Water

The Thunder Bay River Watershed Initiative, Phase Two is the home of two significant inland lakes; Hubbard Lake and Fletcher Pond, and is covered by an extensive network of rivers and tributaries. In fact surface water makes up over 4 percent of the watershed's land use types (about 21,776 acres). The combination of wetland types (including lowland forests) and surface water makes up approximately one third of the watershed's surface area.

Land Use Summary

Large amounts of upland forests (45.4%) and lowland forests (20.3%) dominate the critical area of the Thunder Bay River Watershed, Phase Two. **Tables 3** and **7** (Population Trends) and **Tables 4** and **8** (Total housing Units) in Chapter One, show that there has been a steady increase in both population and total housing units in all five counties of the watershed. Compared to past land use maps much of the increase in seasonal and year-round homes has occurred along the riparian corridor and around lakes within the watershed. Much of the population growth has occurred in Montmorency and Oscoda Counties. Montmorency County has experienced a 219% population increase over the past hundred years, with a 38% increase just since 1980. Oscoda County, with a 542% increase since 1900 (37% since 1980) shows the largest percent population increase in the watershed. Although the rate of population growth appears to have slowed considerably since 1980 for Alcona (+20%), Alpena (-3%), and Presque Isle (+1%) Counties, historical data shows that these counties had significant increases over the past century (106%, 72%, and 75%, respectively). As development continues, it is likely that there will be an increase in riparian and wetland development, which in turn will negatively impact water quality in the watershed. Considering the large areas of surface water contained within the watershed, protecting the water and wetland resources should be a major priority in land use planning. Implementing best management practices now will help reduce the amount of stress placed on the Thunder Bay River Watershed in the future

SEPTIC SYSTEM INVENTORY

The health of a watershed can be influenced by the state of the septic and sewer systems within its boundaries. When a septic system malfunctions or overflows, bacteria and nutrients are released and may contaminate the lakes, streams or groundwater of the watershed. Poorly installed, improperly sited or overused systems, and older systems that were installed prior to the adoption of current zoning ordinances are potential contributors of this type of non-point pollution. Another potential problem for the watershed is seasonal homes that are converted for year round use without updating and expanding existing systems. The increased load may cause a septic system failure and as a result, contaminate area wells and waterbodies.

METHODOLOGY

A general survey of septic systems within the Thunder Bay River Watershed Initiative, Phase Two was conducted by NEMCOG in the summer of 2004. Information on septic systems was compiled using data obtained from various sources such as the District Health Department #2, District Health Department #4, the U.S. Bureau of Census, The Environmental Protection Agency, and the Department of Environmental Quality. By comparing data from these various sources and **Map 4: Septic System Constraints,** it was possible to discern generally which areas tend to have the oldest systems, which areas are being heavily developed and areas that are most susceptible to septic problems and therefore least suitable for increased development.

RESULTS

Nearly the entire watershed, and all of the critical area, is under severe constraints for septic systems. The cause for severity varies from section to section, and even from parcel to parcel. Constraints due to wetness and soils that *percolate* (perc) slowly dominate much of the watershed. Percolation is the downward movement of water through the soil. In the western portion of the watershed, particularly in Rust Township, constraints are due mainly to large areas covered by hydric soils. Hydric soils are saturated for most of the year, and when soils are too wet, oxygen is not available for organisms that break down waste. Septic systems constructed in hydric soils therefore may not operate properly during wet seasons, resulting in groundwater contamination.

Hydric soils and areas of wetness also impact the effectiveness of septic systems in the northern portion of the watershed. In addition, this section contains areas of bedrock and large rocks, particularly in Metz Township, Presque Isle County. In the northwestern portion of the watershed (Montmorency Township in particular) poor filtering soils dominate the landscape. Poor filtering materials such as sand and gravel allow liquids to pass through too quickly to filter out effluents, increasing chances of associated bacteria coming in contact with groundwater. Compounding the problem is the fact that nearly 40 percent of the homes in Montmorency Township (and 35 percent of homes for the county) were built before 1960. Even though a small percentage of these older homes undoubtedly have had their septic systems upgraded due to expansion or system failure, most are using systems that are over forty years old. While the efficiency and effectiveness of a system tends to decrease over time, a well maintained older system is not necessarily on the verge of failure. Many older systems, however, were installed at a time before current water protection requirements were in effect.

The southern portion of the watershed, including parts of Alpena, Oscoda, and Alcona Counties, consists of a hodge-podge of severe limitations such as steeply sloped areas, poor filtering soils, soils that perc slowly, and wet soils (see **Map 4**). This area has seen steady development over the last thirty years. In addition, **Table 24** Shows that the region has a substantial number of homes that were built prior to 1960, before current sanitary codes were in place. Continued development combined with a large number of older systems creates a potential risk to the future health of the watershed.

The Thunder Bay River Watershed, Phase Two area falls under the jurisdiction of two health departments. Alcona and Oscoda Counties are regulated by District Health Department #2, and District Health Department #4 oversees Alpena, Montmorency, and Presque Isle Counties. District #2 has issued approximately 1000 new permits over the last ten years, mostly residential (DEQ writes permits for commercial systems discharging 10,000 gallons or more per day). Health Departments are required to submit to the DEQ an annual report on failed systems. For District #2, 25-30 percent of the permits written each year are for replacement of failed systems. The most common reasons for failure include systems that are too old, too small, have too many people using them, or systems that have been damaged by excavation or driving over them.

Alcona County (which includes the heavily developed Hubbard Lake area) in particular should be monitored closely. In addition to having a large number of septic systems that were installed prior to 1960, Alcona has had a population increase of over 15 percent and a housing increase of nearly 13 percent in the last 25 years. This increase in population and housing development combined with a substantial number of older systems, hydric soils, steep slopes and poor filter material create a potential threat to water quality for the Thunder Bay River Watershed. At this time, the District #2 Health Department is in the process of re-writing its sanitation code to require larger, compartmentalized tanks for new or replacement systems.

TABLE 24: Age Distribution of Homes in the Watershed

County	Total Homes	Built 1960-2000	Built Before 1960
Alcona	14,520	9493	5027
Alpena	8854	6110	2744
Montmorency	5408	3535	1873
Oscoda	1750	1209	541
Presque Isle	1964	1238	726
Total	**32,496**	**21585**	**10911**

Nearly all of the lands designated residential or agricultural for the watershed lie within areas of severe septic constraints due to soils that are hydric, wet, or poor filtering, or that perc slowly, as can be seen when **Map 4: Septic Constraints** is compared to **Map 3: Land Use**. If the trend of expanding residential areas continues as more and more agricultural lands are parceled out for development, increased potential for contamination to the water supply is inevitable. Septic system and soil constraints will need to be considered carefully in any future development in these areas and great care will need to be taken to ensure the continued health of the Thunder Bay River Watershed.

GROUNDWATER INVENTORY

There is a direct link between surface water and groundwater contamination. For the Thunder Bay River Watershed, as well as virtually all of northeast Michigan, groundwater is the only source of drinking water. It is therefore imperative that groundwater be protected from contamination. It is far less costly to use contamination preventative measures than it is to restore a contaminated ground water site to a potable state. Along with pollutants carried into the water system via stormwater drains, road/stream crossings and residential/agricultural runoff, contamination from abandoned wells, leaking underground storage tanks and other industrial sources may also find its way into ground water. Also, portions of the watershed exhibit karst topography and special care needs to be taken in these sensitive areas. The porous geology of limestone bedrock can allow for direct contamination from the surface to ground water resources.

METHODOLOGY

In order to determine the presence and extent of chemical contaminants in the watershed, DEQ and EPA documents were reviewed to identify Leaking Underground Storage Tanks (LUST) and other sites of contamination.

RESULTS

According to the Michigan Department of Environmental Quality Leaking Underground Storage Tank (LUST) Database*, there are twenty LUST sites in Alcona County, one of which is located within the phase two portion of the Thunder Bay River Watershed. In Alpena County there are sixty-three LUST sites, six located within the watershed. Presque Isle, Montmorency, and Oscoda Counties have thirty-six, twenty-eight, and ten sites, respectively. None of the contamination sites of Montmorency County are within the watershed boundary; seven of Presque Isle's contamination sites and six of Oscoda's are located within the watershed critical area. The majority of pollutants from LUST’s are either gasoline or diesel fuel.

TABLE 25: WATERSHED CONTAMINATION SITES

COUNTY	Sites with Arsenic	Sites with Nitrates	Sites with VOC	Total Contaminated Sites
Alcona	6	78	1	**85**
Alpena	4	145	10	**159**
Montmorency	1	10	0	**11**
Presque Isle	3	37	3	**43**
Oscoda	8	31	2	**41**
WATERSHED	**22**	**301**	**16**	**339**

*The database, which is updated weekly, was consulted in 2004

The Contamination Investigation Unit of the Department of Environmental Quality (DEQ) conducts a drinking water contamination investigation program, which includes groundwater contamination from sources other than LUST sites. According to the DEQ WaterChem Database, 1983-2003 samples, contamination has been found at 339 sites tested within the watershed. Pollutants include Arsenic, Nitrates, and Volatile Organic Chemicals (VOC). Some common sources of these pollutants are landfills, refuse systems, metal processing, auto repair, petroleum products, private households, agricultural services and chemical product manufacturing. **Table 25** indicates contamination sites for the watershed, listed by county and type of contaminant.

ARSENIC
Arsenic is a known carcinogen, and has been linked to other health-related problems such as central nervous system disorders, heart damage, birth defects and skin problems. Earth materials such as bedrock, sand, and gravel may contain arsenic bearing minerals, and may enter water from these natural deposits in the earth, from industrial and agricultural operations, or as a by-product of copper smelting, mining or coal burning. In this country, thousands of pounds of arsenic are released into the environment every year by industry alone. Arsenic was found at twenty-two sites within the Thunder Bay River Watershed, Phase Two area. None of the sites exceeded the EPA's Maximum Contaminant Level (MCL) of 0.010mg/L for arsenic in drinking water, and if pollution control measures are strictly adhered to, this dangerous pollutant need never become a threat to the watershed.

NITRATES
Nitrate, one of the most widespread contaminants, can get into water from sources such as livestock waste, septic tank/drainfield effluent, crop and lawn fertilizers, municipal wastewater sludge application, and natural geologic nitrogen. As well as posing health risks to infants and young children, the excessive levels of nitrates in drinking water may indicate potential for the presence of other contaminants. In the Thunder Bay River Watershed, Phase Two , 301 sites tested positive for nitrates. The EPA has established the MCL for nitrates at 10 mg/L. Two of the sites in the watershed were found to have nitrate levels between 10-20 mg/L, and four sites showed levels of over 20 mg/L.

VOLATILE ORGANIC CHEMICALS
This group of contaminants includes a wide range of chemicals found to have detrimental effects on both the environment and the life forms (including humans) that it supports.

TABLE 26: VOLATILE ORGANIC CHEMICALS

Chemical	MCL*	Chemical	MCL	Chemical	MCL
Benzene	0.005 mg/L	Dichloromethane	0.005 mg/L	Ethylbenzene	0.7 mg/L
Carbon Tetrachloride	0.005 mg/L	Monochlorobenzene	0.1 mg/L	o-dichlorobenzene	0.6 mg/L
1,2-dichloroethane	0.005 mg/L	St`yrene	0.1 mg/L	Tetrachloroethylene	0.005 mg/L
Cis-1,2-dichloroethylene	0.07 mg/L	Trichloroethylene (TCE)	0.005 mg/L	Trans-1,2-dichloroethylene	0.1 mg/L
1,1,1-trichloroethane	0.20 mg/L	Toluene	1 mg/L	1,2-dichloropropane	0.005 mg/L
Para-dichlorobenzene	0.075 mg/L	Vinyl Chloride	0.002 mg/L	Xylenes (Total)	10 mg/L
1,1-dichloroethylene	0.007 mg/L	1,2,4-trichlorobenzene	0.07 mg/L	1,1,2-trichloroethane	0.005 mg/L

Sources of Volatile Organic Chemicals (VOC's) include improper storage and waste disposal; solvents; leaking underground fuel storage tanks; petroleum refining; cigarette smoke; several types of fumigants; fire extinguishers; cleaning agents; dry cleaning solvents; metal degreasers; adhesives; varnish; gasoline additive; agricultural runoff; industrial waste; leaking gas tanks;

* The MCL for each of the chemicals listed varies from 0.002 mg/L (Vinyl Chloride) to 10 mg/L (Xylenes). Only the presence of a volatile organic chemical is noted; information concerning the level of contamination for each site is not available.

styrene production; industrial metal; and the manufacture of fluorocarbons, chloro-fluoromethane, plastics, synthetic rubber, insulators, pesticides, resins and solvents. **Table 26** lists each chemical found in the watershed, as well as its MCL as established by the EPA.

The discharge of hazardous substances into water bodies presents one of the serious health threats to the community. Contaminated drinking water contains many substances that cause cancer and interfere with the function of several body organs, including the heart, liver, brain and skin. Contamination of water resources by hazardous substances such as benzene, nitrates, arsenic, mercury, cadmium and petroleum products can affect the health of anyone, but children are especially susceptible. Because their bodies are still developing, children tend to retain more of these substances.

In 1972, Congress passed the Federal Water Pollution Control Act (commonly known as the Clean Water Act) aimed at halting large-scale pollution of the country's lakes and rivers. The Act made it illegal for anyone to discharge pollutants into navigable water bodies without obtaining a permit. There is no question that the Clean Water Act has had a positive impact on the health of the nation's rivers and streams. However, small amounts of pollution from nonpoint sources that enter rivers and streams during a storm event can seriously degrade a water system over time. In order to maintain a high level of water quality, measures such as rain gardens, detention/retention basins, filter strips and effective stormwater ordinances are needed to impede this indirect flow of contaminants to the Thunder Bay River and its tributaries.