Section G: Threats, Problems, and Concerns Related to Protected and Desired Uses

The threats, problems, and concerns identified by stakeholders are grouped into six main categories: Human Pathogens (protection of public health); Ecosystem Health (excessive nutrients and habitat alterations); Hazardous Materials (contaminants that threaten fish, wildlife, and aquatic organisms, and generate fish consumption warnings); Groundwater (threats to domestic water supplies and groundwater); Invasive Species; and Other Concerns (aesthetics, storm water, riparian rights, public use of natural resources, coordinated local planning, etc.). Obviously the categories overlap in many respects and have been selected to help organize the information to provide appropriate emphasis to the concerns identified.

HUMAN PATHOGENS

The highest priority to protect water users from potential human disease threats associated with human or animal waste is to monitor the areas with relatively high-density development around the lake and adjacent to streams that are currently dependent upon onsite wastewater treatment systems (OWTS). This includes all of Bear Lake as well as the riparian properties along Bear Creek and its tributaries. The age, number of people served, size of the drainage field, soil type, depth of groundwater, and the waste volume entering the systems are all factors in determining the effectiveness of existing systems to prevent pathogens from entering surface waters. Cottages once used as residences for a few weeks a year have been converted to year-round homes. More residences have been constructed in recent years. Dishwashers, washing machines, and garbage disposals formally limited or non-existent in homes adjacent to surface waters in the watershed are now commonplace.

Bear Lake

The capacity of existing OWTS, particularly those over 30 years of age, to treat increased waste loads for both human pathogens and nutrients (e.g., phosphorus and nitrogen) is limited. Two separate reports were prepared by Bear Lake residents and members of the Bear Lake Property Owners Association in 2005 and 2006 to determine the number of residences and businesses on the shores of and adjacent to Bear Lake that have upgraded their OWTS since 1973 (Bear Creek Property Owners Association 2005; Bear Creek Property Owners Association 2006). The reports were based upon information obtained from the Manistee County Health Department, the Manistee County Equalization Department and the Special Assessment District (SAD), that was proposed to fund a public sewer disposal system as developed by the Bear Lake-Pleasanton Areas Utilities Authority. The first report (2005) concluded that only 36 percent of the residences and businesses in Bear Lake Township within the SAD had obtained a permit since 1973 to upgrade their OWTS and only 42 percent in Pleasanton Township had done so. The second report (2006) indicated that in the Village of Bear Lake, 51 percent of the residences and businesses obtained a permit to upgrade their OWTS since 1973. The reports make clear that the vast majority of OWTS adjacent to Bear Lake riparian property, including those on back lot property within the SAD, are more than 30 years old and fewer than half have upgraded in the period from 1973 to 2005.

Bear Creek and Tributaries

There is no similar systematic analysis of OWTS for residences and businesses along Bear Creek and tributaries. Riparian lot sizes are bigger and the density of homes along Bear Creek and tributaries is lower than that found near Bear Lake. While the potential for pathogens and nutrients to reach the water in Bear Creek and tributaries from OWTS is less of a threat than it is in Bear Lake, areas where residences are clustered and close to the river may constitute a potential localized source of nutrients or human pathogens. Agricultural practices involving the grazing of farm animals and the application of

chemicals, fertilizers, and manure in close proximity to Bear Creek and tributaries has been observed and may represent a threat to the health of stream users and create the potential for excessive nutrient loadings.

ECOSYSTEM HEALTH

The primary threats to water quality essential to the protection of existing fish and wildlife populations and related fishing opportunities are primarily related to changes in the trophic status or productivity (nutrient) level in Bear Lake. Alterations in the remaining natural habitat essential to reproduction, survival, and growth of fish and wildlife and related food organisms are also a significant threat in both Bear Lake and Bear Creek and tributaries. The following describes the ecosystem health concerns, threats, and problems identified in the Greater Bear Watershed.

Nutrient Loadings

Bear Lake

Phosphorus is the limiting nutrient in Bear Lake. Incremental increases in phosphorus loading over time can significantly alter the productivity of Bear Lake and result in changes in water chemistry (such as decreased dissolved oxygen below acceptable levels), increased algal and aquatic plant growth (e.g., nuisance algal blooms and excessive rooted aquatic plant growth), and decreased quality of fishing, boating, swimming, and other water-related activities. Increases in urbanization and other significant land use changes have been shown to be a significant factor in the eutrophication or increased productivity in other inland lakes. Future growth around Bear Lake, including expanded use of existing residences (i.e., the addition of appliances that generate wastewater, expanded period of occupancy, and increased number of household members), is a potential concern since no central wastewater system is available. However even without significant new growth around Bear Lake, as noted in the previous section on Human Pathogens, existing uses, particularly OWTS, pose a significant threat that needs to be monitored and corrective action must be taken as needed.

Models are useful in determining the annual phosphorus loadings to a lake. Although models are based upon estimates, they can be used to identify controllable sources of phosphorus where nutrient levels are of concern. There are several potential sources of phosphorus entering a lake including groundwater, inflowing rivers and streams, surface runoff from surrounding land draining directly to the lake, rainfall and snow falling on the lake surface, direct point source discharges from wastewater treatment facilities, and leachate from commercial and residential OWTS such as septic tanks and tile fields. Estimates from each of these sources can be used to determine the annual phosphorus loading to a lake. In the case of Bear Lake, there are no significant streams or rivers entering the lake and there are no point source discharges from commercial, industrial, or municipal wastewater treatment facilities. The primary sources of phosphorus loadings to Bear Lake are from groundwater, leachate from OWTS, runoff from adjacent lands that drain directly to the lake, and precipitation. In some lakes, phosphorus accumulated in sediments can be released to the water column above, particularly when anoxic (dissolved oxygen concentration near zero) conditions occur near the lake bottom. Re-suspension of phosphorus from bottom sediments is not likely a significant source of phosphorus in Bear Lake.

Because OWTS are of great concern in the watershed, high and low estimates for phosphorus loading in Bear Lake were developed. Many factors need to be considered in order to approximate phosphorus loading from Bear Lake OWTS, including soil type, age of system, condition of system, and proximity of the system to ground and surface water. A rough estimate can be calculated using U.S. Census information and data from previous studies (see Appendix 3 for additional information on the methods used to estimate phosphorus loading from OWTS as well as the high and low estimates).

In 2005, a group of local citizens reviewed records at District Health Department #10 for parcels located within the proposed SAD around most of Bear Lake (BLPOA 2005). That assessment district excluded the Village of Bear Lake but included the majority of parcels directly adjoining Bear Lake and some parcels up to about three-quarters of a mile away from the lake in areas adjacent to the proposed sewer.

A 2006 study by the same group of property owners included a review of requested permits for well and OWTS between 1973 and 2005 (BLPOA 2006). The group then compared the list of requested permits to parcels of property with residential or commercial dwellings to determine the number of parcels that had updated their OWTS and those that had not. Few OWTS are designed to last more than 30 years without substantial renovation that would likely require a permit from the health department. Thus, OWTS on developed properties for which there is no record of a OWTS between 1973 and 2005 were determined to be potentially lower functioning systems. The review found 308 properties with a house or business within the proposed SAD that did not have a permit on file. These 308 properties likely have lower functioning OWTS.

A summary of the high and low estimates in Bear Lake along with a comparison to nearby Portage Lake in Manistee County and Red Cedar Lake in Wisconsin is included in Exhibit 79. The annual phosphorus loading contribution from atmospheric sources to Bear Lake was estimated based upon a range of concentration values for phosphorus in rainfall reported for Beaver Island and Silver Lake, Michigan (USEPA 1975). The contribution of phosphorus from groundwater sources was estimated based upon the volume of Bear Lake (32,690,970 kiloliters) divided by the hydraulic residence time (2.19) multiplied by the average concentration of phosphorus (0.01mg/l) in groundwater reported for rural areas (Nolan and Hitt 2003). The estimate for the phosphorus contribution from immediate runoff (nearshore) was calculated using the land area approximately 1,300 feet from the shore of Bear Lake and applying the U.S. Environmental Protection Agency (USEPA) Spreadsheet Tool for Estimating Pollutant Load (STEPL) model for projecting phosphorus runoff from that area based upon land uses – 50 percent urban (cottages, homes, and businesses), 25 percent forested, and 25 percent cropland. The model was designed by Tetra Tech, a private consulting company, for the USEPA.

The methods used in estimating the total annual phosphorus loading for each of the three lakes included in Exhibit 79 were similar. Each estimated the contribution of OWTS based upon annualized per capita phosphorus discharges from literature-reported values, similar to those used for Bear Lake in Appendix 3. The contributions from other sources were estimated using either literature- reported values or actual measurements. In the case of Bear Lake, available data on the age of OWTS and the date of the last upgrades were used to classify systems that were assumed to be effective (upgraded in the last 30 years) in removing phosphorus at a rate of 85 percent, while the systems that had not been upgraded in the last 30 years were estimated to be 50 percent efficient (low estimate) or 15 percent efficient (high estimate) in removing phosphorus. Data on the age of OWTS on the other two lakes were not available. The efficiency of OWTS in removing phosphorus in these other two other lake studies were assumed to be 85 percent for Portage Lake and 70 percent for Red Cedar Lake based upon then reported values in the literature available at the time the reports were prepared.

There are significant differences among the three lakes. Bear Lake and Portage Lake are classified as mesotrophic lakes (P = 7.6 to 11.4 µg/l) while Red Cedar Lake is classified as a eutrophic lake (30.2 µg/l mean P level). Both Red Cedar Lake and Portage Lake have significant inflowing rivers and streams while Bear Lake has no significant inflowing surface watercourses. Bear Lake has the highest number of OWTS adjacent to the lake and the highest estimated phosphorus loading from OWTS. Despite the differences, the three lakes have similar total yearly phosphorus loading per capita results that range from 0.21 to 0.67 kilograms/year. The groundwater contribution of phosphorus to Red Cedar Lake is relatively high due to the presence of larger bodies of water and development immediately upstream that contribute to the groundwater inflow.

The estimated total phosphorus loading by sources in Bear Lake indicates that a substantial reduction in phosphorus inputs could be achieved by providing municipal wastewater service to the homes and businesses located adjacent to the lake. Reductions can also be achieved by application of best management practices (BMPs) to reduce phosphorus in storm water runoff from properties that drain directly to Bear Lake. Together, OWTS and storm water runoff from adjacent lands represent over 80 percent of the estimated phosphorus loadings to Bear Lake. Atmospheric deposition and groundwater, while contributing to the total annual phosphorus loading of Bear Lake, are either from natural occurring sources or, in the case of air depositions, from distant sources beyond local control.

Exhibit 79 compares estimates of P inputs and levels for Bear Lake, Portage Lake (both in Manistee County, Michigan), and Red Cedar Lake in Wisconsin. A high and low estimate was generated for Bear Lake. The figures for Portage Lake show the highest estimate of phosphorus entering the lake. The study in Red Cedar Lake reported only single numerical estimates for phosphorus loading from various sources.

EXHIBIT 79. Comparison of Phosphorus Loading and Other Parameters for Bear Lake (Manistee Co., Mich.), Portage Lake (Manistee Co., Mich.), and Red Cedar Lake (Barron and Washburn Co., Wisconsin)

	Bear Lake		Portage Lake[a]	Red Cedar Lake[b]
	High Estimate	Low Estimate	High Estimate	Estimate
Loadings (kilograms phosphorus/year)				
Extended Runoff (inflowing streams)	None	None	1,054	7,235
Immediate Runoff (nearshore)	554	554		1,147
Groundwater	149	149		653
Septic Loading Estimate	445	280	884	88
Atmospheric	92	39	261	53
Sub-Total Non-Point Source Phosphorus	1,240	1,022	2,199	9,176
Sub-Total Point Source Phosphorus (state permitted discharges)	None	None	None	None
Total Annual Phosphorus Loadings (kilograms phosphorus/year)	**1,240**	**849**	**2,199**	**9,176**
Other Lake Parameters				
Lake Area (hectares)	745.84	745.84	815.85	744.62
Maximum Depth (meters)	7.32	7.32	18.29	16.15
Mean Depth (meters)	4.39	4.39	5.79	7.83
Hydraulic Residence Time (years)	2.19	2.19	3.50	0.21
Lake Volume (kiloliters)	32,690,970	32,690,970	48,659,626	58,343,692
OWTS (number of septic systems)	507	507	570	348
OWTS Capita/yr (full-time equivalent residents/year)	1,033	1,033	1,311	418
Total Yearly Phosphorus/Capita from OWTS (kilograms)	**0.43**	**0.27**	**0.67**	**0.21**
OWTS Annual Phosphorus Loading/Hectare (kilograms)	0.60	0.38	1.08	0.12
OWTS Capita Year / Hectare (number)	1.39	1.39	1.61	0.56
Micrograms/Liter of Phosphorus Measure (µg/l)	**High[c]**	**Low (mean)[c]**	**Reported Mean**	**Reported Mean**
Phosphorus Concentration (µg/l)	10.00	7.60	11.40	30.20

SOURCE: PSC 2011 with data from ASI Environmental Technologies, 2007b; Bear Lake Property Owners Association, 2005; Bear Lake Property Owners Association, 2006.
[a] Public Sector Consultants, 2008.
[b] Robertson 2003
[c] Michigan Clean Water Corps., 1976–2010.

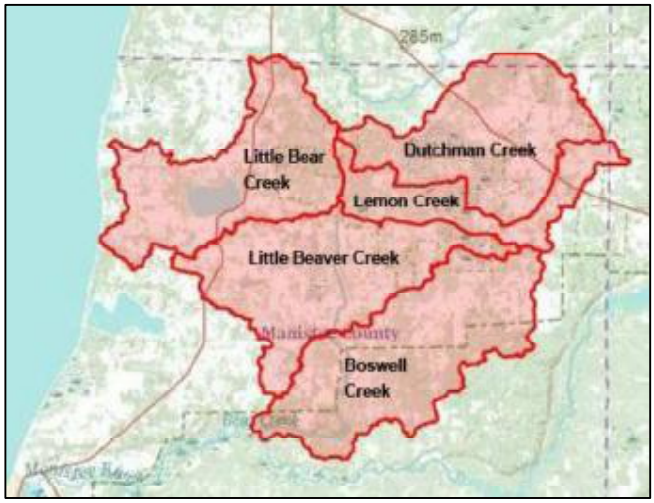
Bear Creek and Tributaries

The application of agricultural fertilizers and manure and the grazing of livestock on lands immediately adjacent to Bear Creek and tributaries may be a concern specifically where no vegetative buffer strips separate tilled or grazed land from the adjacent stream. Bear Creek and its tributaries are less vulnerable to nutrient loadings as a whole from OWTS. Although there are relatively few households and businesses adjacent to these waterways, there is the potential for impairments to stream sections where homes and cottages are relatively close together on Bear Creek or in Little Bear Creek immediately downstream of the outlet of Bear Lake. Because of the predominance of permeable sand and gravel glacial deposits, surface water runoff into Bear Creek is minimal and the length and size of tributary streams reflects the fact that most water entering Bear Creek and its tributaries is from groundwater sources. Significant land use changes in the Bear Creek watershed could pose a threat if increased storm water runoff is conveyed directly to surface waters. The application of agricultural BMPs for existing and future farming activities, and routine maintenance or replacement of failing OWTS adjacent to the streams, can effectively control nutrient loadings to Bear Creek and its tributaries.

Because water from Bear Lake flows into Bear Creek, an overall watershed runoff analysis was completed using the STEPL model. Expected nonpoint source pollution loadings to waterbodies in the Greater Bear Watershed were estimated using the STEPL model which is based on annual precipitation, land uses, agricultural practices, OWTS use, and soil conditions. Common sources of nutrient loading include riparian OWTS, fertilizer uses, livestock wastes, and storm water runoff.

Exhibit 80 shows the location of the five subwatersheds used for this analysis and the estimated phosphorus and sediment loads for these subwatersheds used by the STEPL model[1] and the Greater Bear Watershed as a whole.

EXHIBIT 80. STEPL Model Estimated Phosphorus and Sediment Loads



[1] The number of subwatersheds within a broader watershed can differ depending on the scale of analysis. The local Greater Bear Watershed Steering Committee developed four subwatersheds for analysis. The STEPL model uses five subwatersheds.

EXHIBIT 80. STEPL Model Estimated Phosphorus and Sediment Loads (cont.)

STEPL Subwatershed	Acres	Hectares	P Load			Sediment Load		
			lb/year	kg/year	lb/acre/year	ton/year	kg/year	ton/acre/year
Little Beaver Creek-Bear Creek	29,999	12,140	6,972	3,162	0.23	1,103	1,000,625	0.04
Lemon Creek-Bear Creek	12,459	5,042	2,135	968	0.17	367	333,028	0.03
Dutchman Creek-Bear Creek	25,099	10,158	4,263	1,934	0.17	791	717,946	0.03
Boswell Creek-Bear Creek	33,555	13,580	6,461	2,930	0.19	910	825,085	0.03
Little Bear Creek	26,575	10,755	6,010	2,726	0.23	865	784,624	0.03
Total	**127,686**	**51,675**	**25,840**	**11,721**	**0.20**	**4,036.0**	**3,661,398**	**0.03**

SOURCE: Calculations generated using the STEPL model.
NOTE: Different sources that estimate the total acreage of the Greater Bear Watershed vary slightly (less than 1 percent difference among estimates used in this report) based on different underlying data sets used to estimate watershed boundaries. Additional differences can occur due to rounding of figures.

The STEPL model estimated phosphorus load for the Greater Bear Watershed is almost 25,840 pounds per year or 0.2 pounds per acre per year.

The STEPL model estimated sediment load is 0.03 tons per acre per year or approximately 0.078 tons per hectare per year (t/ha/yr). A study of 226 mixed use watersheds (combination of forestland, cities, and other land uses) in the eastern United States found a mean sediment load of 0.35 t/ha/yr and a range of loads between 0.02 and 4.42 t/ha/yr (Brooks 2003). The same study also analyzed 65 forested watersheds within the eastern United States and found a mean sediment load of 0.17 t/ha/yr and a range of 0.02–2.44 t/ha/yr. It should be noted that sediment loading occurs naturally as a result of erosion; sediment loading in the Greater Bear Watershed based upon the model is relatively low when compared to these other watersheds. However, the general model used does not consider sedimentation that occurs in areas with bare eroding sand banks that are a legacy from the historical logging practices in the Greater Bear Watershed in the late 1800s and early1900s

Habitat Alterations

Shoreline Vegetation—Bear Lake

Bear Lake, like many other inland lakes in Michigan, has undergone significant habitat alterations over the last 150 years. The most significant changes have been the alteration of shoreline and nearshore habitat due to the construction and use of homes, cottages, and businesses. The wetlands areas adjacent to the lake have been reduced; shoreline vegetation has been physically removed and in some areas replaced with hardened breakwalls. Naturally occurring large woody debris, at least in nearshore areas, has been removed to accommodate recreational uses. All these natural elements of the shoreline or nearshore areas are essential habitat for the reproduction, survival, and growth of fish, wildlife, and aquatic food organisms. In addition, shoreline vegetation of native plants and wetlands serve as filters for runoff of nutrients and contaminants from nearby impermeable services such as roads, driveways, and roofs. Protecting remaining wetlands, reducing the use of hardened breakwalls, and protecting or reestablishing native plants in shoreline areas, including the use of rain gardens, are steps that can be taken to mitigate the impairments that have already occurred to the valuable shore and nearshore habitat and related protected uses.

Water Levels—Bear Lake

The level of Bear Lake is currently controlled by a structure constructed at the outlet of the lake when the last major improvements were made to U.S. 31 at the bridge crossing of Little Bear Creek. In the past, the level of Bear Lake has fluctuated based upon both natural precipitation rates and the historical modifications at the outlet. The lake does not have a legally established lake level, and unless boards are placed in the slots in the concrete structure at the bridge crossing, the maximum height is controlled by the elevation of the fixed concrete structure at the bridge. Some residents would prefer higher lake levels at particular times of the year and others prefer lower levels depending on their location on the lake, the setback of their home or cottage, and their intended use. The unauthorized placement of boards at the lake outlet structure has occurred in the past in an attempt to raise the level and the boards have been subsequently removed to restore the outlet to the normal fixed level.

Although it is possible to maintain Bear Lake at a constant level or range of levels to accommodate various property owners or uses, natural fluctuations in lake levels are an important component of maintaining wetlands and other nearshore vegetation that are essential cover, food, and reproduction areas for important aquatic species including fish. In addition, property owners downstream of the Little Bear Creek outlet are affected and their uses impacted when lake levels are artificially manipulated. In general, lake residents have learned to live with the levels maintained by the current fixed level outlet structure and recognize that natural precipitation and evaporation rates will normally reduce lake levels during the late summer period. Nonetheless, preserving the ability to temporarily block the lake outlet to respond to emergencies could be important. Accidental releases of hazardous materials into the lake (such as oil, grease, gasoline, etc.) from highway accidents could be prevented from entering Little Bear Creek through temporary blocking of the outflow while cleanup activities contain and remove the contaminants from the lake.

Habitat—Bear Creek and Tributaries

Bear Creek and its tributaries have undergone considerable change since the mid-1800s when logging of the area began. Bank destruction and sand and silt erosion from the cleared land during and following extensive timbering activities in the latter part of the 1800s and early 1900s are still evident today. Historical evidence and physical alterations of the river banks indicate that the logging practices have had severe habitat impacts in the watershed. Grayling were the dominant species prior to the beginning of the twentieth century. Early logging practices and associated habitat degradation has been cited as the primary reason for the extirpation of grayling in Michigan's Lower Peninsula. The regeneration of the forested land and the conversion of land to agricultural crop production have allowed stream systems, such as Bear Creek, to slowly recover. However, remaining severe historical bank erosion sites (see Exhibit 82), current road crossings (see Exhibit 83), and the related erosion of sand and silt into the river system remain a concern. Historical logging practices removed tress that once provided streamside cover – a source of large woody debris – and prevented stream widening. Although bank restoration activities in the last decade have addressed many of the most serious erosion sites, increased stream temperatures, the lack of in-stream woody debris habitat, and sand deposition still limit trout and salmon reproduction, survival, and growth in some areas. Residential and agricultural practices have also reduced natural streamside vegetation and increased the rate of storm water and snow melt runoff resulting in accelerated erosion and increased stream temperatures.

Road Crossings and Barriers to Fish Migration—Bear Creek and Tributaries

Construction, repair, and maintenance of road crossings over Bear Creek and its tributaries remain a concern for area residents and visitors (see Exhibit 83). The use of culverts for road crossings can block the free movement of fish species and prevent access to upstream habitat. The bottom elevation, particularly in older road crossing culverts, can be significantly higher than the downstream water level creating an upstream barrier to fish passage during most of the year. Enlargement of the culvert and/or

lowering the bottom elevation of the culvert have been completed in some locations and, while fish passage has been improved, the former eroded pool below the improved crossing is eliminated. While the public has expressed concern over the loss of these accessible "fishing holes" below road crossings where these improvements have been made, the stream is actually returning to a natural condition that would have existed prior to the construction of the original road crossing.

Inadequately maintained road crossings, both at culverts and bridges, can be a source of eroding sand and soil resulting in increased sedimentation in downstream areas. Public use of stream crossings for public access, inadequate design or maintenance, and major precipitation events can accelerate erosion of disturbed soils that contribute to the sediment loading of Bear Creek and tributaries. Erosion at these sites can be reduced by increasing the number and location of managed public access sites other than at road crossings and placing erosion control devices such as steps at popular public access road crossings. The use of bridges rather than culverts can also reduce erosion, address fish passage concerns, and lower erosion control maintenance cost; the additional capital expense to replace a culvert with a bridge, however, is significant.

HAZARDOUS MATERIALS

Aside from the fish consumption warnings that currently apply to fish populations in Bear Lake and Bear Creek and tributaries that are attributed to sources ***outside*** of the watershed, there are no known sources of hazardous waste within the watershed that are currently affecting the surface waters within the Greater Bear Watershed. In August each year, a county-wide program operated by the Manistee County Conservation District and various local partners provides for the drop-off and disposal of household hazardous waste including automotive products and fuels, paint products, yard and garden products, household cleaners, electronic products, and pharmaceuticals (Manistee County Conservation District 2011). In addition, state and federal regulations control the use, storage, and disposal of hazardous materials used in industrial and commercial facilities. In spite of these protections, citizens remain concerned about potential surface and groundwater contamination through the storage, use, and disposal of hazardous materials from households, public agencies, and commercial, industrial, and agricultural sources.

Storm Water Discharges

Storm water runoff from the surface of the riparian lands and through drainage systems can transport litter, yard waste, fertilizer, pet waste, hazardous chemicals, and an array of other materials deposited on the land and roads into surface waters. Bear Lake is more susceptible to storm water discharges from urban uses while Bear Creek is more likely to be affected by agricultural runoff. While storm water discharges can include threats related to human health (pet and livestock waste), ecosystem health (fertilizers and yard waste), habitat degradation (eroded sand and silt), and aesthetics (litter and discarded metal, paper, and plastic), the greatest threat in many instances is the accidental release of hazardous chemicals from road accidents or poor handling, storage, or disposal practices by homeowners, commercial and industrial operators, and farmers.

Storm Water—Bear Lake

In 2008, the BLPOA, Surface Water Subcommittee, prepared a Storm Drain Report (BLPOA 2008). In the absence of a readily available printed record of the storm drain systems that discharged into Bear Lake, the subcommittee members visually inspected grated storm drain locations, probable storm water drainage ways, retention ponds, and open fields and ditches which drained into Bear Lake. The report identified 36 grated storm drain entrances, and a number of under-the-road drainages, retention ponds, culverts, and pipes that drained toward Bear Lake. The report contained hand drawn maps of the grated storm drain locations as well as the sites of the 12 lake exit drains and one road-run, lake exit into Bear

Lake. The report ,and mapping of the storm drainage system revealed the vulnerability of Bear Lake to storm water pollutants coming from residences, businesses, and transportation corridors served by or connected to the storm drain system surrounding the lake. Additional analysis is needed to determine the exact location of these drains and the stormwater collection boundaries.

Many of the property owners served by the grated storm sewers in the Village of Bear Lake may not be aware that the drains – where they might dispose of household waste material – lead directly to the lake. More important, a busy state highway (U.S. 31) parallels Bear Lake for some distance and the storm water runoff from this area of roadway flows into Bear Lake. Normal automobile contaminants found on the highway, as well as potential accidental spills of hazardous materials routinely being transported on U.S. 31, represent a potential threat to Bear Lake.

Educational materials targeted for homeowners and businesses served by storm drains discharging to the lake would be helpful in preventing inappropriate disposal of polluting substances and encouraging practices that properly contain areas used for the storage, handling, and use of hazardous materials. The current household hazardous waste collection and disposal program operated by the Manistee County Conservation District can help residents find a safe and acceptable method to dispose of hazardous materials. Storm drain stenciling of grated storm water drains can help residents understand that how they use the land and dispose of waste affects the lake. Vegetated retention basins and rain gardens placed near the outlets of exit drains can reduce the amount of litter, nutrients, and other waste that enters the lake. Most important, local first responders to road accidents need to have contingency plans that avoid, to the extent possible, washing or sweeping of hazardous materials into drains leading directly to the lake.

Storm Water—Bear Creek and Tributaries

In addition to the potential threat of nutrient loadings from adjacent farm lands and failing domestic OWTS outlined in earlier sections, storm water runoff from agricultural lands can include pesticides and other chemicals commonly used to produce crops. The application of best management agricultural practices, including the use of natural vegetative buffer strips between active row crop, grazing, orchard, and tree nursery areas, as well as adjacent watercourses, can reduce the potential for transport of these chemicals to Bear Creek and tributaries. In general, road accidents do not pose as great a risk to Bear Creek and tributaries since the only areas of likely runoff would be from road accidents involving the release of hazardous materials at or in close proximity to stream road crossings. Still, first responders should be made aware that clean-up of hazardous materials from accidents should avoid discharges to nearby waterways whenever possible.

GROUNDWATER

Existing regulations protect groundwater from permitted waste discharges, leaking underground storage tanks, and other discharges from land uses involving the storage, disposal, transportation, and use of hazardous materials that threaten the groundwater resources in the watershed. Groundwater is virtually the only source of potable water in the watershed and it is a major contributor of cool clean water to Bear Lake, Bear Creek, and its tributaries. Groundwater pollution is not only a threat to drinking water but potentially to protected uses of surface waters. Residents of the watershed express concerns about past and current practices that they feel may impact the quality of both drinking water supplies and water quality of area lakes and streams.

Recently reported contamination of domestic water wells by the application of paper waste materials to agricultural properties in the county has heightened concern that closed township dump sites, former food processing sites, abandoned gas stations, hydrocarbon extraction facilities, or the unconfined storage of agricultural soil enhancement materials in the watershed may represent potential sources of groundwater

contamination that threaten water supplies or surface water quality. Since many of the older water wells serving domestic homes in the watershed are shallow, failing OWTS also pose a risk to nearby shallow-well domestic water supplies.

There is no information to indicate that any of the potential groundwater contamination sources identified are having a negative impact on *surface waters* of the watershed. The two municipal water supplies, in the villages of Bear Lake and Kaleva, engage in regular testing of their domestic water supplies for a range of contaminants and have instituted groundwater protection programs to protect against surface or subsurface uses that could contaminate their water supply aquifers. Individual domestic wells near sites of known sources of contamination such as the paper waste land applications have been evaluated as part of an investigation by the Michigan Department of Environmental Quality (MDEQ), in cooperation with the local health department. Investigation of individual sites of potential groundwater contamination, such as areas that may contain spills or leaks from commercial operations, are routinely evaluated by the MDEQ and scored for follow-up investigation according to their potential for contaminating nearby water wells or surface waters.

Packaging Corporation of America Land Application of Sludge

From 1986 to 1997, cardboard manufacturing waste sludge from Packaging Corporation of America's Filer City, Michigan, facility was used to enhance soils at golf courses, gardens plots, farm fields, and nurseries in Mason and Manistee counties. Under the MDEQ's Program for Residual Management (PERM), the paper waste was approved for limited application as an organic matter supplement to poor soils. Groundwater contamination from the application of this paper sludge was first suspected at a site in Filer Township in Manistee County when a former resident tried to sell their home and their water well test came back with levels of nitrates considerably above the state safe drinking water standards. The suspected source of the nitrate contamination was a nearby tree farm that had routinely received waste sludge from the Packaging Corporation of America. A civil lawsuit involving the nitrate contamination issue was settled in 2002, but the concern soon spread to other sites where the sludge had been deposited.

Under the direction of the MDEQ, the local health department sampled water wells within one-quarter mile of 52 sites, some of which are within the Greater Bear Watershed, which received 100 or more truckloads of the paper sludge. Of the 114 wells tested, seven showed nitrate levels at or above the drinking water standard of 10 milligrams per liter (10mg/l). MDEQ investigations have been unable to establish that the application of the low concentration of nitrates found in the paper waste was responsible for nitrate contamination of groundwater at the numerous sites examined. Nitrate contamination of groundwater has been noted in other rural areas throughout Michigan and the nation and it has been attributed to the widespread use of nitrogen fertilizers, runoff from livestock holding areas, infiltration from sewage treatment lagoons, and various manufacturing waste disposal practices. The state has provided funds for both temporary bottled water for affected Manistee County residences and the cost of new wells where deeper protected water supplies are available. While the disposal of paper mill waste in Manistee and Mason counties has received considerable attention in the local press, MDEQ investigators found that the most likely source of the high nitrates found in groundwater is from the application of high nitrate fertilizers.

Uncovered Storage of Lime for Agricultural Soil Enhancement

The public has expressed concern about outside stockpiling of lime in the watershed prior to its application to farm fields as a soil conditioner. There is perhaps some confusion between agricultural lime (calcium carbonate) and other products such as quick lime (calcium oxide). The latter, calcium oxide, is extremely caustic and potentially harmful to humans through direct contact. Agricultural lime is routinely stockpiled for later application to farm fields for a variety of purposes including reduction of soil acidity, increasing soil calcium levels, and enhancement of nutrient uptake. Unless stockpiled on the ground

immediately adjacent to a watercourse, agricultural lime does not represent a risk to surface water or groundwater.

Closed Township Dump Sites

Hundreds of former township dump sites throughout the state were closed in the 1970s and early 1980s following the passage of new solid waste management laws at the state and federal levels. Former local dump sites used by nearby industrial or commercial businesses for the disposal of large quantities of hazardous solid or liquid waste have been investigated and cleanups implemented where migrating contaminated groundwater posed a human health or environmental threat. For the most part, closed township dumps that served primarily rural communities contained mostly domestic waste and were isolated from nearby domestic water supplies and surface waters. No additional action has been taken and no further remedial actions are planned at closed rural dump sites unless new problems are discovered or the site is disturbed. The former, closed township dump sites in the Greater Bear Watershed fall into this category.

Hydrocarbon Development

Manistee County has had extensive oil and natural gas exploration and development over the last 25 years (see Exhibit 21, Description of the Greater Bear Watershed). Recent increased interest in hydraulic fracturing of natural gas wells in Michigan has prompted public concerns over the safety of this practice and the use and disposal of water used in the process. In Michigan, more than 12,000 wells have been hydraulically fractured, primarily in the Antrim Shale Formation gas wells in the northern Lower Peninsula. While horizontal drilling technology has been available since the 1980s, it has seldom been used for the extraction of natural gas. The combination of hydraulic fracturing and horizontal drilling has increased the interest in producing natural gas from shale formations where the tightly locked gas can only be commercially produced by hydraulic fracturing or fracking.

Concerns over fracking for natural gas focus on five primary issues: (1) migration of gas or fracture fluids to the surface or into freshwater aquifers, (2) water use, (3) management of produced water (i.e., water that is returned to the surface and must be disposed), (4) surface spills of drilling liquids and produced water, and (5) hazards associated with chemical additives (Michigan Department of Environmental Quality 2011).

- **Migration of fluids:** Michigan has regulations to prevent the migration of gas or fluids that require intermediate casing; wells must be set 100 feet into bedrock and 100 feet from any fresh water zones and cemented from the bottom of the casing to the ground surface. The production casing is required to be set and cemented at the gas reservoir depth before fracking can occur. Prior to drilling, the state inspects the area to assure that no nearby abandoned or production wells provide a conduit for migration of gas or drilling fluids.
- **Water use and withdrawals**: Fracking of Antrim Shale gas formations typically requires approximately 50,000 gallons of water. The Utica/Collingwood Shale gas formations may consume 5,000,000 gallons or more when fracked. While oil and gas operations are exempt from Michigan's new water withdrawal laws, state oil and gas regulations require owners/operators to conduct the same water withdrawal impact assessment as they would for other proposed large quantity water withdrawals and prohibit fracking operations that are likely to cause a significant adverse impact to groundwater or surface water. The regulations also require the installation and monitoring of an observation well if there is a freshwater supply well within one-quarter mile of the production well.
- **Management of produced water:** The water used during the fracking process is either left in the deep gas producing formation or recovered at the surface and disposed of in a deep injection well disposal site approved by state and federal authorities. The produced water containing salts from deep formation and chemicals used to facilitate the extraction of gas from the shale ranges from 25 to 75 percent of the water injected into the formation. Under Michigan oil and gas regulations, all the

produced fluids must be contained in steel tanks and disposed of at an MDEQ and USEPA approved deep well disposal location.

- **Surface spills:** Secondary containment is required under tanks, wellheads, and other areas where spills may likely occur. Under state requirements, spills must be reported immediately and actions taken to promptly recover and clean up impacted areas.
- **Chemical additives:** All chemical additives in the fracking and production of gas must be reported to the state with specific information on Material Safety Data Sheets (MSDS) such that the state can appropriately respond to concerns related to production operations and can prepare potential spill responses. The MDEQ posts information from the MSDS on its website for public review.

Michigan is considered a national leader in the development and implementation of model regulations for hydraulic fracking of natural gas and as such has avoided the problems encountered by other states where such exploration and production has occurred. While fracking of deep shale gas such as that found in the Utica/Collingwood Shale requires significant amounts of water, the MDEQ is proposing well spacing density of up to 640 acres per well versus the 40–80 acre spacing historically required for oil and gas development, which means that many fewer wells will be needed.

AQUATIC INVASIVE SPECIES

Despite the apparently successful control of Eurasian milfoil in Bear Lake through the annual application of selective, approved aquatic plant herbicides, the residents who live around and use Bear Lake are concerned about both the long-term impacts and costs of annual chemical treatments. Biological controls offer a potential defense against Eurasian milfoil in the future, but for now the carefully managed chemical control program represents the best available technology to assure that this invasive species does not expand to the point that it materially interferes with the various recreational uses of the lake. There is some evidence from other lakes in Michigan that long-term application of chemicals, specifically those containing copper sulfate, has reduced the abundance of certain sensitive invertebrate organisms that are important food sources for fish A broad spectrum of herbicides and algaecides are now approved for use in Bear Lake under a permit issued by the state. Since the herbicide 2, 4, D has been demonstrated to be an effective chemical for the control of Eurasion Milfoil, the authorization for the use of other chemicals should be removed from the annual state permit until a demonstrated need has been established. Two additional invasive plant species—phragmites (*Phragmites australis*) and purple loosestrife (*Lythrum salicaria*)—are a concern in Bear Lake. An organized effort to identify and eradicate these two species when they are first identified in wet areas adjacent to the lake is seen by residents as an essential activity to protect the remaining wetlands adjacent to Bear Lake.

Zebra mussels (*Dreissena polymorpha*) are already established in Bear Lake and the residents and users are concerned that the changes that have occurred in Bear Lake related to food chain disruptions caused by this invasive species may be exacerbated if a closely related organism, the quagga mussel (*Dreissena rostriformis bugensis*), finds its way into Bear Lake from the Great Lakes or other inland lake sources. Anecdotal evidence from residents suggests that zebra mussels in Bear Lake have reached their peak abundance and are now declining. Some residents have observed that the number of zebra mussel shells found on the beaches and live mussels attached to domestic irrigation intake pipe laid nearshore on the lake bottom have significantly decreased in the last few years.

OTHER CONCERNS

Public Use of Bear Creek and Conflict with Riparian Owners

Preceding the initiation of the Greater Bear Watershed planning effort, a number of conflicts occurred and continue to this day between public users of Bear Creek and Bear Creek riparian property owners. Public use of the river increased with the introduction of Pacific salmon in the mid-1960s and recent state-targeted enforcement to minimize illegal salmon snagging (hooking a fish anywhere other than in the mouth) on the nearby Manistee River at Tippy Dam has apparently increased snagging on the less visible stretches of Bear Creek. The vast majority of the shoreline property on either side of Bear Creek from 13 Mile Road downstream to Coates Highway is in private ownership with public access limited to public bridge crossings. Following the increase of snagging in Bear Creek and the attendant trespassing, littering and boisterous and sometimes threatening behavior of some fishermen, the Bear Creek property owners began to question the public's right to navigate and fish the river. Some attempts have been made by property owners to place fences or other barriers in the river to prevent boating or wading anglers from using the river. In 2011, a property owner was fined for harassing an angler fishing the river from a guide boat.

Formation of Special Bear Creek Access Subgroup

Recognizing this conflict, the Greater Bear Steering Committee formed a special subgroup representing a private fishing guide service that uses the river, Bear Creek property owners, the MDNR, and other interested members of the Greater Bear Steering Committee. One of the first tasks undertaken by the subgroup was to determine the status of Bear Creek as a navigable and therefore public river open to public boating and fishing. The subgroup reviewed various legal opinions by Michigan courts on whether or not Bear Creek is a navigable stream and finally settled on the most recent decision of the Michigan Supreme Court, which determined that a crucial test for whether or not a stream is navigable is evidence that the stream was used for the historical transport of logs. The subgroup invited Steven Harold, Curator for the Manistee Historical Museum, to present evidence available on logging activities in the late 1800s and early 1900s adjacent to and in the proximity of Bear Creek in Manistee County.

Mr. Harold provided historical information on lumber camps and lumber staging areas adjacent to Bear Creek upstream of 13 Mile Road and at other locations within the Bear Creek watershed. This information led him to conclude that there is strong evidence that Bear Creek and tributaries were used to transport logs to saw mills located at the mouth of the Manistee River in the City of Manistee, since neither roads nor rail were available to transport logs during the early logging period. Mr. Harold had recently testified as an expert on historical logging operations in the upper Boardman River, where the court subsequently determined that the river was indeed navigable based upon the evidence of it being used for the floating of logs. The observation that Bear Creek shows signs even today of stream bank log rollaways at several locations would appear to confirm Mr. Harold's conclusion that Bear Creek was used for the transport of logs and is therefore a navigable river available to the public for floating, wading, and fishing.

MDNR Purchase of New Bear Creek Public Access

Between meetings of the subgroup, the MDNR completed the final purchase of private property on Bear Creek to increase long-sought-after increased public access to Bear Creek. At a public meeting in Kaleva on the Greater Bear Watershed Plan, several Bear Creek property owners expressed dismay at the prospect of even more public use of Bear Creek based upon the litany of existing unresolved conflicts.

Despite reaching the conclusion that Bear Creek is indeed navigable, subgroup members expressed support for developing and advocating solutions to the legitimate issues facing the Bear Creek property owners. The subgroup asked the Bear Creek Watershed Council to prepare a comprehensive list of the

issues that Bear Creek property owners believe should be addressed and pledged its support to help find solutions for legitimate problems.

The Bear Creek Watershed Council surveyed its members and other property owners along Bear Creek and the following concerns were identified related to the potential increase in public use due to the state's recent purchase and future development of a new public access site on the river

In-stream and Streamside Habitat Changes

- Accelerated bank erosion at road crossing sites where no managed egress/ingress is provided
- Expanded illegal tree cutting and bank brush removal on public and private riparian properties
- Damage to in-stream bottom habitat from use of larger vessels during low water conditions

Uses at New Access Site and Expanded Uses at Related Bridge Crossings Access Points

- Overnight partying at site and dumping of trash
- Decreased value of private properties adjacent to site
- Lack of enforcement and site maintenance on site due to shortfalls in funding
- Increased shoulder parking, congestion, and related traffic hazards at Milks, Johnson, and Kerry road bridge crossings due to expected increase in dropoff and pickup of watercraft/anglers

Value of Private Riparian River Properties and Enjoyment by Residents

- Accelerated trespass issues with boaters and wading anglers leaving the river and using private property between ingress and egress points
- Increased amount of loud, vulgar, and threatening behavior of groups using the river both during the day and at night that reduce the quality of life and land values for those who reside on private property adjacent to the river
- More trash and litter on stream banks and in the river from careless river users

Fishing Violations and Over-fishing for Resident Trout

- Increased opportunity for snagging of salmon and steelhead and increased difficulty of enforcement
- Increased fishing pressure on resident trout populations resulting in potential decline in the number of trout available to anglers

Recommendations

There are several mechanisms and tools available to address the legitimate concerns of Bear Creek property owners without excluding or severely restricting the public from reasonable use of the river. Some involve better information to public users, such as signage at the new public access site about the fact that the property on both sides of the river is private and that removal of tree limbs or brush or trespassing on private property is unlawful. Formal rules and effective enforcement of restrictions on the use of public access sites (such as prohibitions on overnight use, partying, camping) as well as enforcement of the prohibitions on salmon snagging can discourage use by those individuals and groups that have been the source of major conflicts with property owners. Improved bank stabilization and or stairs on pathways at bridge crossings can reduce stream bank erosion caused by launching or retrieving vessels and foot traffic. The acquisition of public property to provide additional parking at strategic points may also be needed to reduce congestion and road hazards. Voluntary agreements with guide services that use the river on the size of guide boats, frequency of use, and assistance in litter control and river stewardship can help reduce conflicts as well and have been effective in other rivers in Michigan. Special fishing regulations can be used to minimize the number of those who come to the river to illegally snag

salmon in the fall, or to reduce the pressure on resident trout should population monitoring indicate further harvest limitations are needed.

The best combination of these tools that will be most effective in reducing conflicts will take some time to develop, implement, and evaluate. As a minimum, three divisions of the MDNR (Parks and Recreation, Fisheries, and Law Enforcement), representatives of commercial fishing guides and kayak and canoe rental services, members of the current Greater Bear Steering Committee, and interested Bear Creek property owners need to be involved in the selection and implementation of alternatives to help minimize conflicts between public users and private property owners on Bear Creek. A permanent subgroup of the Greater Bear Watershed implementation team should be identified to take the steps needed to assemble an advisory group so that actions can be taken soon by the appropriate agencies in anticipation of expanded public use of the river. In the event that some proposed actions will require additional funding (such as printed informational materials for public users, signage, acquisition of property for off-road parking at strategic locations, bank stabilization/steps at critical bridge crossings), priority should be placed on seeking grants or other contributions needed to implement those improvements.

Aesthetics

Two aesthetic concerns were voiced by the public during the development of this plan. Residents of the watershed expressed concern over what they believe are the growing number of blighted properties in the watershed and the effect these properties have on the quality of life and property values of area residents and the perception of visitors who come to the area to recreate, buy vacation homes, or retire. A significant number of people in the watershed have also expressed concerns about proposals to locate clusters of large-tower wind turbines in the area that could change the natural scenic vistas that attract many to buy homes or recreate in the area.

Urban and Rural Blight

A number of people attending the public hearings on development of the plan expressed concern about the lack of uniform local regulation or the uneven enforcement of existing regulations to control the accumulation of inoperable vehicles, broken machinery, unused trailers, and other large discarded materials on residential and commercial properties. They also expressed concerns about abandoned residences and commercial structures. They believe that blight in both the small villages and rural areas in the watershed can affect nearby property values and undermines community efforts to encourage people to live, locate, and operate businesses and recreate in the watershed. The public cited this issue as an example of the need for better coordination between local units of government to develop and implement cooperative and consistent development goals, plans, and regulations to better serve the current and future residents of the Greater Bear Watershed.

Wind Turbines

Growing interest in the development of alternative and sustainable energy sources in Michigan and government incentives to encourage investments in these new renewable energy sources has fostered new investments in wind turbines. The sites with sustained winds needed to support this emerging electric energy source in Michigan are limited, and some are found within the Greater Bear Watershed. A proposal by a major energy company to erect 100 or more utility-scale wind turbines in Benzie and Manistee counties has created significant conflict among residents. Those seeking employment opportunities or leasing income to preserve their family farming operations, and supporters of renewable energy in general are set against those opposed to the project because of negative visual impacts to the area and other concerns.

Because of the concerns expressed by residents about the potential negative impacts of large clusters of tall wind turbines, Manistee County Alliance for Economic Success has sponsored a number of public

meetings where citizens have been able to express their concerns or support or ask questions, and were provided information on the planned development of wind turbine energy. While there is broad support for the development of renewable energy sources and economic development in general by residents, many are seeking more information before endorsing the large proposed wind turbine development. More information on the subject of wind energy and the specific proposal in Manistee and Benzie counties is available from the Manistee County Alliance for Economic Success (Manistee County Alliance for Economic Success 2011).