Uses, Threats, Sources, Causes

A comprehensive watershed plan examines whether or not waterbodies in the watershed meet designated, protected uses specifically identified in water pollution control statutes and promulgated rules, and evaluates compliance with water quality standards adopted to protect those uses. It also identifies desired uses within the watershed.

DESIGNATED, PROTECTED USES

Under the Michigan water pollution control statute (Natural Resources and Environmental Protection Act, Public Act 451 of 1994), discharges to surface waters are unlawful if they may become injurious to

- public health, safety, or welfare;
- domestic, commercial, industrial, agricultural, recreational, or other uses that are being made or may be made of such waters;
- the value or utility of riparian lands;
- livestock, wild animals, birds, fish, aquatic life, or plants, or to their growth or propagation; or
- the value of fish and game.

Promulgated Michigan water quality rules based on this state law and the federal Clean Water Act establish, as a minimum, that all waters of the state are designated and protected for the following uses:

- Agriculture
- Navigation
- Industrial water supply
- Warmwater fishery
- Other indigenous aquatic life and wildlife
- Fish consumption
- Partial body contact
- Total body contact from May 1 to October 31

Under state rules, both numerical and narrative water quality standards are established for designated and protected uses. In all cases where waters are designated for more than one of these protected uses, the most restrictive water quality standards apply.

In addition to the above protected uses, additional protected uses include the following if identified by the state:

- Coldwater lakes, trout lakes, and trout streams
- Migratory routes for anadromous salmonids (a family of soft-rayed fishes including the trouts, salmons, whitefishes, and graylings, that live in lake environments but spawn in rivers and streams)
- Public water supply intakes

In the case of the Portage Lake, watershed *migratory routes for anadromous salmonids* and designated *trout streams* would apply as additional protected uses. Portage Lake is not a designated cold water or trout lake, and there are no surface water public water supply intakes in the watershed.

Groundwater is also protected under Michigan law and rules. Under state regulations groundwater discharges must essentially meet a non-degradation standard to protect existing or potential uses such as domestic water supplies, irrigation, stock watering, etc. Groundwater flow to trout streams tributary to Portage Lake and to Portage Lake itself is critical to maintaining existing protected uses. New water withdrawal laws in Michigan provide significant measures to regulate groundwater and surface water uses intended to protect groundwater quantity, particularly where such withdrawals may impact trout streams.

EXISTING CONDITIONS COMPARED TO STATE STANDARDS

The Clean Water Act requires Michigan to prepare a biennial report on the quality of its water resources. This report, called the Section 303(d) list, constitutes the principal means of conveying water quality protection/monitoring information to the USEPA and the U.S. Congress. The Section 303(d) list includes Michigan waterbodies that are not attaining one or more designated use and require the establishment of total maximum daily loads (TMDLs) to meet and maintain water quality standards. The Portage Lake watershed is attaining its designated uses currently. A summary of this information can be found in Exhibits 43 and 44. Exhibit 43 details (1) **existing** activities and uses; (2) the categories of designated, protected uses under statute and regulations; (3) the water quality standards that apply to each designated, protected use; and (4) the existing conditions compared to the water quality standard, including the date for the latest information available. Exhibit 44 details (1) **potential future** activities and uses; (2) the categories of designated, protected uses under statute and regulations; and existing conditions.

EXHIBIT 43

Portage Lake Watershed State Designated Uses for Existing Uses, Associated, Applicable Water Quality Standards, and Existing Conditions

Designated, protected uses (Part 31 of Act 451, §324.3109)	Water quality standards (MDEQ 2006)	Existing activities and uses[1]	Existing condition compared to standard[2] (year of most recent data collection)
Total body recreational contact	Counts of 130 or less for *Escherichia coli (E. coli*) per 100 ml monthly average and 300 or less for *E. Coli* per 100 ml at any time	Swimming, SCUBA, snorkeling, water skiing, tubing, kneeboarding, and related full body contact activities	Meets standard based on historical data and tests at major beach areas (2007)
Partial body recreational contact	Counts of 1,000 or less for *E. coli* counts per 100 ml	Canoeing, kayaking, cruising, sailing, and related boating activities	Meets standard based on historical data and tests at major beach areas (2007)
Fish consumption	Fish consumption advisory trigger levels for toxic heavy metals and organic compounds	Fishing	Fish consumption warnings for Portage Lake are limited to PCBs and mercury in certain species due to sources outside of watershed (2007)[3]
Warmwater fish populations and seasonal migratory pathways for anadromous trout and salmon (Portage Lake)	Dissolved oxygen (DO) not less than 5.0 mg/L during summer stratification in the epilimnion (uppermost layer of the lake). Not less than 5.0 mg/L for the rest of the year in entire lake area.		Meets standard based upon historical data and recent summer testing for dissolved oxygen during summer stratification (2007*)*
Coldwater fish populations (tributary streams)	DO not less than 6.0 mg/L in any 24-hour period during summer minimum flow period and not less than 7.0 mg/L rest of the time		Benthos sampling indicates diverse, stable coldwater bottom organisms (2003)[4]. Presence of trout and salmon in tributary streams would indirectly indicate that standard is being met (2007). No direct data to confirm standard.

Designated, protected uses (Part 31 of Act 451, §324.3109)	Water quality standards (MDEQ 2006)	Existing activities and uses[1]	Existing condition compared to standard[2] (year of most recent data collection)
Protection of wild animals, birds, fish, aquatic life, or plants, and of their growth or propagation	Numerous numeric chemical limits such as pH, ammonia, toxic metals, and organic compounds, as well as narrative limits such as for nutrients (nuisance algal growths) and physical properties (color, temperature, clarity, etc.)	Hunting, wildlife observation, ecosystem protection, plant and animal diversity	pH (1992), ammonia (1992), phosphorus (2007), physical properties all within acceptable ranges for mesotrophic lakes (1992). No toxic substances reported above levels of concern (1992). No nuisance algae blooms reported, some concerns over excessive weed growth and invasive species (1992–2007).
Navigation	No interference or increased cost to navigation	Access to and from Lake Michigan through Portage Lake Channel	Water quality standards for other protected uses sufficient to protect this designated use

SOURCE: Public Sector Consultants Inc., 2007.
[1] From cited, previous studies, and focus groups, public meetings, and telephone surveys conducted during 2007.
[2] From cited previous studies and information recently provided by Onekama Township and MDNR Fisheries Division.
[3] See Fish Consumption Advisory section below for species and sizes covered by recommended fish consumption advisories for Portage Lake
[4] From cited, previous studies from MDEQ Water Bureau, 2007d.

EXHIBIT 44

Portage Lake Watershed State Designated Uses for Potential Future Use, Likelihood of Future Use, and Existing Condition

Designated, protected uses (Part 31 of Act 451, §324.3109)	Potential future use	Likelihood that designated/surface water use may be made in the future	Ability of existing water quality to support use
Public water supply	New public water supplies from surface waters	Adequate quality and quantity of groundwater in watershed for expected domestic water demand. Surface water sources other than Portage Lake are small. Municipal supply, if from surface water, most likely would be taken from Lake Michigan.	Drinking water quality standards higher than existing water quality and further treatment would be required to meet state drinking water requirements.
Industrial water supply	New industrial/commercial surface water supplies	Future demand unknown, but likely major industrial use would be either from groundwater or Lake Michigan.	Most industrial/commercial uses could be accommodated by existing water quality.
Agriculture	New agricultural surface water uses (possible existing, small quantities used for lawn and garden watering by riparians)	Tributary streams too small to support significant agricultural withdrawal and there are no expected significant agricultural uses riparian to Portage Lake.	Agricultural uses could be supported by existing water quality.

SOURCE: Public Sector Consultants Inc., 2007.

Full and Partial Body Contact

Five popular swimming areas on Portage Lake were sampled on two occasions during 2007 to verify that bacteria levels as measured by the presence of *E. coli* still meet state standards for both full and partial body contact. All results indicated that water quality standards are being met. Historical sampling in Portage Lake has on occasion shown that the bacteria levels have at times exceeded state standards. Many of the problem areas were addressed, however, when the sanitary sewer system was constructed and operated for homes and businesses within the Village of Onekama in the early 1990s. Further testing for *E. coli* would be prudent to assure that the water quality standards for bacteria associated with human and animal waste are being met throughout the year and in locations where potential sources are concentrated near the shoreline of Portage Lake and tributary streams.

Fish Consumption Advisories

According to testing conducted by the state, only polychlorinated biphenyls (PCBs) and mercury (Hg) are being detected at levels of concern for human consumption of fish from the lake (MDEQ 2007e). PCB levels in fish from Portage Lake are declining, consistent with similar trends elsewhere in the state following controls on the use and disposal of this chlorinated hydrocarbon. Mercury levels in Portage Lake fish are lower than those commonly found in inland lakes within Michigan. The source of mercury and PCB contamination is likely atmospheric deposition from sources outside of the watershed or the result of Lake Michigan fish that had accumulated contaminants from other locations entering Portage Lake. (For more detail on fish contaminants in Portage Lake, please see pages 58–59 of this report.)

All Other Numerical and Narrative Water Quality Standards

Historical and recent test results from Portage Lake and tributary streams do not indicate that there are any current exceedances of state water quality numeric or narrative standards intended to protect designated uses. Data collected in 2006 and 2007 by Onekama high school for dissolved oxygen, chlorophyll *a*, water transparency, and phosphorus show no significant change in the productivity level of Portage Lake, and the information collected is consistent with a mesotrophic lake. Additional testing of DO may be warranted to determine whether the state standard is being met throughout a 24-hour period and whether oxygen depletion at the deeper portions of the lake during stratification are existing for a longer period of time. Further monitoring of both exotic plant species and algae may be appropriate to determine whether further actions are needed to protect existing uses of the lake.

DESIRED USES

Desired uses of the watershed are those values identified by the community for protection. These uses expand beyond the uses specifically protected under surface water pollution-control laws and regulations that could be incorporated as part of the watershed plan. In the Portage Lake watershed, the following desired uses were identified by stakeholders through interviews, focus groups, and public meetings:

- Maintain existing undeveloped shoreline habitat

- Preserve diverse upland ecotypes
- Maintain scenic vistas
- Preserve examples of historic agricultural practices
- Identify, protect, and preserve culturally and/or historically significant buildings and sites

These uses are listed in Exhibit 45, along with the location and purpose of the use, existing protections and programs, and potential additional protection and preservation approaches that can be expanded and/or documented with more detail as specific goals, objectives, and actions are identified as priorities.

EXHIBIT 45

Additional Desired Uses Not Protected Under Water Quality Regulations and Location, Purpose, and Additional Protections under Consideration to Preserve and Protect These Uses

Desired use	Location	Purpose	Applicable laws/regulations/ programs	Potential additional protections
Maintain existing undeveloped shoreline habitat	Riparian properties adjacent to Portage Lake and major tributaries	Preserve critical fish habitat, provide filter for land-based storm water–runoff, maintain biological diversity/stability	State wetlands and inland lakes and streams laws and regulations	Education of owners, fee purchase, acquisition of conservation easements, local ordinance adoption related to new development, control of invasive plant species
Preserve diverse upland ecotypes	Need to identify	Maintain ecological diversity; habitat for endangered, rare, and threatened species; study sites for understanding natural ecological functions/processes	State/federal endangered and threatened species laws; state/ local property tax exemption status for certain properties and land conservancy acquisitions/ easements	Education of owners, fee purchase, acquisition of conservation easements, local ordinance adopted related to new development
Maintain scenic vistas	Selected areas or zones	Continue to provide aesthetically pleasing landscape views for residents and visitors to the area	State and local highway rest areas, picnic areas and scenic turnouts, local parks, private land conservancies	Public information on scenic road touring, information/education to landowners, promotion with local and state highway departments
Preserve examples of historic agricultural practices	Selected areas or zones	Maintain examples of cultural heritage of region for the education/enrichment of residents and visitors	MDA Centennial Farm Recognition Program, Farmland Preservation Act, land conservancy programs, accommodation of local zoning requirements	Promotion of locally grown agricultural products through markets days, farm roadside products tour information, featuring of locally produced food at nearby restaurants and markets
Identify, protect and preserve culturally and/or historically significant buildings and sites	Selected areas or zones	Increase awareness and understanding of Native American occupation and use of the area in pre-settlement period; maintain and develop historical examples of significant buildings and locations of interest to area residents and visitors	Need to identify	Partnering with Little River Band of Ottawa Indians and local historical groups to identify, interpret, and map sites of significance

SOURCE: Public Sector Consultants Inc., 2007.

MOST LIKELY THREATS TO PROTECTED USES IN THE FUTURE

In many watershed plans in Michigan and elsewhere in the country there is a focus on restoration of protected use impairments due to water pollution sources, as indicated by non-attainment of water quality standards. In the Portage Lake watershed, water quality standards are being met based upon the information available, and additional monitoring is planned to fill remaining information gaps. The focus of this watershed plan is thus to protect the existing high water quality of the lake and associated protected uses by closely monitoring priority threats to address sources of detected problems *before* they cause significant impairments.

The last column of Exhibit 46 identifies such potential threats based on the review of available information both for the Portage Lake watershed and through the examination of information from other watersheds that have experienced water quality problems and impairment of protected uses. The Portage Lake stakeholders have the opportunity to prevent major impacts on existing uses rather than having to confront the often difficult and costly efforts to restore the quality of the environment after it has been degraded. Not all preventive measures are inexpensive and a case must be established for any costly prevention activities. This initial watershed plan is intended to identify actions that are justified based on current information and building a database so that any future recommendations can be established based on information that clearly demonstrates what further actions are needed to protect the uses valued by the watershed stakeholders.

EXHIBIT 46

Portage Lake Watershed Existing Uses and Associated Designated Protected Uses, Existing Conditions, Sources/Causes of Threat

Designated, protected uses (Part 31 of Act 451, §324.3109)	Existing condition compared to standard[1] (year of most recent data collection)	Most likely source and cause of threat to meeting standard in the future[2]
Total body recreational contact	Meets standard based on historical data and tests at major beach areas (2007)	Pathogens coming from failed septic systems, uncontrolled runoff from farm-raised animals, household pets, and waterfowl
Partial body recreational contact	Meets standard based on historical data and tests at major beach areas (2007)	Same as above
Fish consumption	Fish consumption warnings for Portage Lake are limited to PCBs and mercury in certain species due to sources outside of watershed (2007)[6]	Air deposition of toxic, bioaccumulative heavy metals and persistent organic compounds; potential, but undocumented, historical industrial releases contained in Portage Lake sediments
Warmwater fish populations and seasonal migratory pathways for anadromous trout and salmon (Portage Lake)	Meets standard based upon historical data and recent summer testing for DO during summer stratification (2007)	Over-enrichment due to septic tile field leachate, riparian lawn fertilization, storm water discharges, agricultural practices and resulting excessive plant and algal growth, decomposition, and oxygen consumption
Coldwater fish populations (tributary streams)	Presence of trout and salmon in tributary streams would indirectly indicate standard is being met; no direct data to confirm standard (2007)	Streamside development that would remove natural vegetative cover, large land use changes creating direct, polluted runoff to coldwater trout streams, bank erosion due to stream crossings and adjacent upland uses, riparian agricultural food and animal production
Protection of wild animals, birds, fish, aquatic life, or plants, and their growth or propagation	pH (1992), ammonia (1992), phosphorus (2007), physical properties all within acceptable ranges for mesotrophic lakes (1992). No toxic substances reported above levels of concern (1992). No nuisance algae blooms reported; some concerns over excessive weed growth and invasive species (1992–2007)	There are no known continuous, direct or indirect discharges resulting in violations of water quality standards designed to protect aquatic life and wildlife in Portage Lake and tributaries. However, accidental spills of hazardous substances related to improper storage or use and/or inadequate contingency plans related to transportation, storage, and use do pose a threat through storm drainage systems
Navigation	Water quality standards for other protected uses sufficient to protect this designated use	Unlikely, but potential increase is cost of Portage Lake Channel dredging due to presence of contaminants

SOURCE: Public Sector Consultants Inc., 2007.

[1] From cited previous studies, information recently provided by Onekama Township and MDNR Fisheries Division.

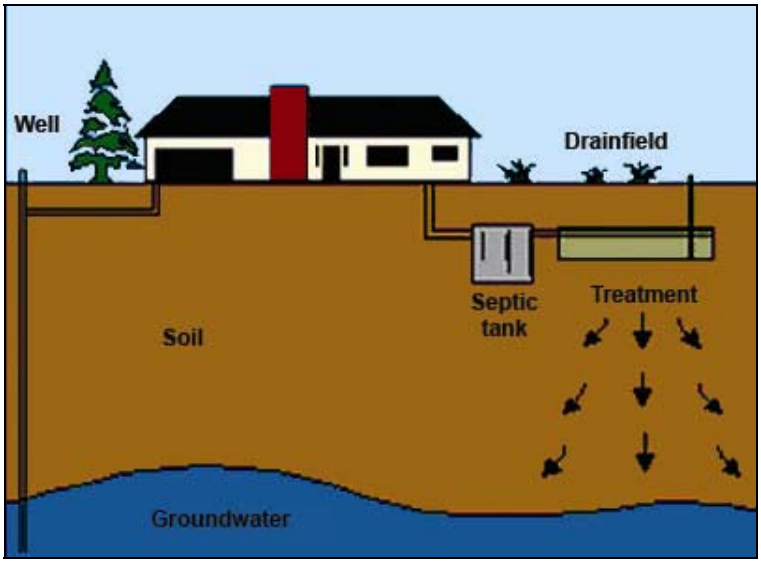
[2] Conclusions of this study by Public Sector Consultants Inc. endorsed by the Portage Lake Watershed Forever Technical Advisory Committee.

Public Health

Pathogens

While there are many potential sources of pathogens (bacteria) in the Portage Lake watershed, including storm water runoff and waterfowl, septic systems (on-site disposal systems or OSDSs) pose the largest threat. OSDSs provide a means of treating household waste in areas that do not have access to public sewers or where sewering is not feasible. They typically consist of two components: a septic tank designed to intercept and hold partially treated solids and a drainfield that disperses wastewater to surrounding soils (see Exhibit 47). OSDS effluent is the substance that passes through the tank to the drainfield and eventually filters through the soils. This effluent contains pathogens and nutrients (nitrogen and phosphorus) that are harmful to ground and surface waters when found in excessive amounts.

EXHIBIT 47
Typical Septic System



SOURCE: MSU, Institute for Water Research, 2007.

When properly designed, sited, constructed, and maintained, a conventional on-site septic system effectively reduces or eliminates most human health or environmental threats posed by pollutants during the course of its design life (typically 30 years). Previous studies cite that approximately 99 percent to 99.99 percent of fecal coliforms that pass through conventional septic systems are removed (USEPA 2002).

OSDSs fail to meet human health and water quality objectives for many reasons, including improper siting (too close to drinking water supply or water table), outdated and under-performing technologies, inadequate maintenance, and systems exceeding

design life[9] (USEPA 2002). Surface water may eventually be affected as groundwater seeps into adjacent streams, lakes, rivers, and wetlands. Surface waterbodies may also be directly affected if a nearby system fails and the effluent ponds on or just below the soil surface.

Septic systems fail at a rate that ranges between 10 and 20 percent each year (USEPA 2002). This means that of the 570 homes with septic systems in the watershed, about 114 may currently be failing, and the threat of failing systems will continue to increase. As the land use projection maps in the Watershed Description section suggest, demand to build homes along Portage Lake and other surface waters in the watershed will continue to increase. Residents will also continue the trend of converting existing waterfront part-time dwellings to permanent residences. Many of these homes were built with septic tanks/tile fields that were adequate for limited summer use but not for year-round residence. Small waterfront lots with a high water table and/or poor soil conditions are not well suited to septic systems in any case. When a cottage once used only a few weeks a year becomes a permanent home, the addition or increased use of automatic dishwashers, garbage disposals, and washing machines can overload the system. Systems will also age, exceeding their design life and increasing the failure rate.

Identifying and eliminating these possible failing septic systems will help control pathogenic bacterial contamination of ground and surface water supplies in the watershed from untreated wastewater discharges. The highest priority for protecting water users from potential human disease threats associated with human or animal waste is monitoring of the areas with relatively high-density development around the lake and adjacent to streams that are not currently served by a sanitary sewer system.

This includes virtually all of Portage Lake and the near lake outlets of significant tributary streams, with the exception of the area served by the Village of Onekama sanitary sewer system. The density, age, number of people served, size of the drainage field, soil type, depth of groundwater, and the waste streams entering septic tank/tile fields are all factors in determining the effectiveness of existing systems to prevent pathogens from entering surface waters.

The capacity of existing OSDSs to treat increased waste loads to control both pathogens and nutrients, particularly phosphorus, is limited. This plan calls for a series of iterative steps, starting with providing better information to property owners on the proper maintenance and use of OSDSs; systematic monitoring of *E. coli*, phosphorus, and nearshore algal growth; and advocacy for time-of-sale OSDS inspections to determine the effectiveness of existing systems and the need to repair/upgrade failed systems. These initial steps will provide the information needed over time to determine if and when a sanitary sewer system is needed for all or portions of the more densely developed areas adjacent to Portage Lake and tributary streams, in order to both ensure the protection of public health and reduce nutrient loadings to surface waters.

[9] Tanks and pipes buried in the ground can be expected to last 20 to 30 years before they begin to deteriorate and require repair or replacement. The soil itself does not "wear out," but its capacity to absorb and assimilate pollutants can become inadequate.

A secondary priority is to begin to monitor land uses that can contribute human or animal waste such as storm water discharges from the Village of Onekama and nonpoint runoff from agricultural animal operations.

Contaminants in Fish

Based upon state testing of contaminants in fish from Portage Lake in 1990 and again in 2004, air deposition from sources outside of the watershed represents the greatest threat to increases in contaminants found in Portage Lake fish (MDEQ 2007e). While PCB contaminant levels in fish have declined statewide following state and federal controls on the use and disposal of this industrial chemical, mercury levels have remained high. Support for regional efforts to control sources of mercury emissions, particularly related to the burning of coal, is a high priority.

Historical industrial operations adjacent to Portage Lake may have resulted in the discharge of toxic materials that could result in the contamination of fish and/or direct exposure to recreational users. While no specific information was uncovered during the development of this plan, residents of the area have suggested that the operation of a tannery, railroad spills of hazardous materials, and/or chemicals associated with wood processing facilities need to be investigated using a more thorough examination of historical information.

Ecosystem Health

The threats to water quality essential to the protection of existing fish and wildlife populations and related angling and hunting opportunities are primarily related to changes in the trophic status, or productivity level of Portage Lake. Alterations in the remaining natural habitats essential to reproduction, survival, and growth of fish and wildlife and related food organisms are also a significant threat in both Portage Lake and its tributaries. Cool, high-quality groundwater is an essential factor in maintaining current protected uses related to coolwater fish species in both Portage Lake and in the coldwater tributaries to the lake. Any significant changes in the quantity or quality of groundwater are a threat to existing uses.

Eutrophication (Increased Phosphorus Loadings)

Phosphorus is the limiting nutrient in Portage Lake. Incremental increases in phosphorus loading over time can significantly alter the productivity level of Portage Lake and result in changes in water chemistry (e.g., decreased dissolved oxygen below acceptable levels) and increased algal and rooted plant growth (e.g., nuisance algal blooms and excessive rooted aquatic plant growth), thus decreasing the 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. The application of best management practices to control nutrient loadings, as well as sediments and other pollutants contained in runoff, is an important long-range strategy to reduce this threat. Based on land use change and population growth estimates, phosphorus will continue to be a significant threat that needs to be monitored and for which corrective action must occur as needed.

An overall watershed runoff analysis was completed using the Long-Term Hydrologic Impact Assessment (L-THIA) model (*http://cobweb.ecn.purdue.edu/~sprawl/LTHIA7*). The model was designed by Purdue University with cooperation from the USEPA. Based on average annual runoff, soil conditions, land use type, and impervious cover, the L-THIA model was used to estimate expected nonpoint source pollution loadings to waterbodies in the Portage Lake watershed. The model was also used to determine the pollutant loading if predicted future land use trends come to fruition.

To determine runoff and pollutant loading for current conditions, the most current land use figures in the watershed from the National Land Cover Database (MRLCC 2001) were used. To estimate potential future loads, a land transformation model developed by the Computational Ecology and Visualization Lab and Michigan State University Land Policy Institute was used for the year 2040. Exhibit 48 shows the estimated phosphorus loading on a watershed-wide scale. This information was derived from the existing land use types and projected increase in development based on modeling. Common sources of nutrient loading include riparian septic systems, fertilizer use, livestock wastes, and storm water runoff.

EXHIBIT 48

Estimate of Phosphorus Loading to Surface Water in the Portage Lake Watershed (pounds per year) 2001 and 2040

Source	Current conditions (based on 2001 existing land use)		Future runoff (based on projected land use in 2040)		Runoff % change
	Acres	Runoff volume (lbs/yr)	Acres	Runoff volume (lbs/yr)	
Commercial	59	38	193	124	226.3%
High-density residential	672	367	2,194	1,199	226.7
Low-density residential	1,043	142	3,403	464	226.8
Forestland	5,494	2	3,408	1	(50.0)
Wetlands	2,938	0	2,314	0	0.0
Grassland/pasture	1,946	1	1,532	1	0.0
Agriculture	3,593	1,774	2,701	1,334	(24.8)
Atmospheric	2,155	576	N/A	576	0.0
Total	15,745	2,900	15,745	3,699	31.2%

SOURCE: Public Sector Consultants Inc., 2007, with data from MRLCC, 2001 (current land use), the MSU CEVL and LPI (future land use), 2007, and SEG, 1993 (atmospheric loading).
NOTE: Atmospheric source area is the water surface area in the watershed.

The current annual phosphorus loading (2001 land use data) is similar to the estimated loading figures calculated in the Phase I study, which estimated an average in-lake phosphorus concentration of 14 ug/L. This estimate is consistent with 2007 sampling results. While phosphorus runoff will increase by more than 31 percent if land use trends continue, it is not expected that this will result in the lake exceeding the range of a mesotrophic lake (10–20 ug/L).

Because septic systems are of great concern in the watershed, an additional loading calculation was made for this particular source. It is difficult to estimate pollutant loading

from septic systems. Many factors need to be considered, including soil type, age, condition, use of system, and proximity of system to ground and surface water. A rough estimate, however, can be calculated using Census information and data from previous studies.

In the Portage Lake Watershed, 60 percent (570) of the occupied housing units are outside the public sewer "envelope" of the Village of Onekama, and an average of 2.3 people live in each household (U.S. Census Bureau 2000). The USEPA estimates average daily wastewater flows of approximately 50 to 70 gallons per person per day (2002). The USEPA has also documented studies that estimate residential septic effluent pollutant levels (2002). The highest value documented among these studies was used to estimate the maximum estimated phosphorus pollutant load in the Portage Lake watershed (see Exhibit 49). If, based on USEPA estimates, 20 percent of the septic systems in the watershed fail, and the functioning systems are 85 percent effective in removing phosphorus, a maximum of 884.17 Kg could be released from OSDSs annually (see Exhibit 49). If even half of that amount reaches Portage Lake, septic systems are a significant source of phosphorus in the watershed. As systems age, homes expand, and amenities such as washing machines and dishwashers are added, this source must be addressed in the future.

EXHIBIT 49

Residential, Conventional Septic System Pollutant Load Estimates, Phosphorus, 2000

Variable	Failed septic systems[1]	Functioning septic systems[1]	Total
Households on septic	114	456	570
Residents on septic[1]	262	1049	1,311
Total effluent generated in watershed[2]	25,359,269 L/yr (6,699,210 gal/yr)	101,456,418 L/yr (26,801,950 gal/yr)	126,796,343 L/yr (479,976,371 gal/yr)
Effluent phosphorus concentration	21.8 mg/L	21.8 mg/L	21.8 mg/L
Total phosphorus in effluent	552,410,368 mg/yr (552.41 Kg/yr)	2,211,749,908 mg/yr (2,211.75 Kg/yr)	2,764,160,276 mg/yr (2,764.16 Kg/yr)
Maximum estimated pollutant load[3]	552,410,368 mg/yr (552.41 Kg/yr)	331,762,486 mg/yr (331.76 Kg/yr)	884,172,854 mg/yr (884.17 Kg/yr)

SOURCE: Public Sector Consultants Inc., 2007, with data from USEPA (pollutant load, average gallons of wastewater generated/person/day), 2002 and U.S. Census Bureau (number of households, average household size), 2000.
[1]Assumes 20 percent failure rate, USEPA, 2002.
[2]Assumes 70 gallons/person/day (265 L), USEPA, 2002.
[3]Assumes failed systems are 0 percent and functioning are 85 percent effective in reducing phosphorus, USEPA, 2002.

The first priority for nutrient control, as it is for protection of human health, is prevention of increased phosphorus loadings from existing septic tank/tile field onsite disposal systems. The iterative approach outlined in the previous section as a priority to address public health threats will also address the threat of nutrient loadings from these OSDSs. A second priority for phosphorus control is reduction in the use and subsequent runoff of fertilizers applied to lawns and gardens adjacent to lakes and streams. Education for riparian landowners on the use of low- or zero-phosphorus fertilizers to maintain lawns can result in reduced nutrient loadings. A third priority for phosphorus control is the

application of best management practices to reduce loadings from point source storm water in the Village of Onekama and other storm water systems that discharge directly to the lake or its tributaries.

Finally, previous studies have identified agricultural runoff as a contributor of animal waste and potentially phosphorus in the lower portion of one tributary to Portage Lake. Because of the predominance of permeable sand and gravel glacial deposits, surface water runoff in the Portage Lake watershed is minimal and the length and size of tributary streams reflect the fact that most water entering Portage Lake and its coldwater tributaries is from groundwater sources rather than from surface water runoff. While significant changes in agricultural practices or other land use changes could pose a threat if storm water runoff were conveyed directly to surface waters, agricultural sources of nutrients in the Portage Lake watershed are significantly fewer than those found where agricultural drains are constructed to move water off poorly drained soils for discharge to surface waterways. In the Portage Lake watershed, agricultural land uses—and for that matter, land use changes that occur significant distances from surface water courses—are not likely to be a significant source of phosphorus loadings to Portage Lake. Nevertheless, potential agricultural sources that are adjacent to waterways need to be monitored.

Habitat Degradation

The shoreline of Portage Lake and the downstream sections of some tributaries have been significantly altered since development first occurred in the late 1800s. The remaining undeveloped shoreline and wetlands are critical to sustaining resident, self sustaining populations of warmwater and coolwater fish populations in the lake, and the trout and salmon in the coldwater tributaries. The number one priority for habitat protection is preservation and enhancement of the remaining wetlands and undeveloped riparian lands that support a diverse habitat for various species and help capture nutrients and sediments from storm water and snow melt coming from adjacent impervious upland areas. The second priority is protection of the undeveloped areas riparian to Portage Lake and tributaries to preserve to the extent possible the nearshore littoral zone in the lake and a vegetated buffer strip along tributaries.

Invasive plant species within Portage Lake (i.e., Eurasian milfoil) and in contiguous wetlands (i.e., purple loosestrife and *Phragmites sp.*) threaten the biological diversity needed to support fish and wildlife populations and surface water recreational uses. Physical, biological, and/or chemical controls may be appropriate if future monitoring indicates that the spread of these species currently present in Portage Lake threatens existing uses.

Sedimentation has not been reported as a major, recurring problem in the lake or in its tributaries. However, lake access areas, bridge crossings, and similar activities that disturb the shoreline have the potential to cause erosion and add sediments and, at least in localized areas, impair benthos habitat. Increases in storm water runoff volumes can also have an impact. Monitoring of lake access areas, stream road crossings, and other shoreline disturbance activities to detect significant erosion problems and encouraging

the application of best management practices by responsible land owners/managers can help to minimize the threat of sedimentation and resulting impairment to aquatic habitats.

Increased storm water runoff can also pose a threat to the health of the Portage Lake watershed ecosystem by causing increased stream bank erosion and degradation of in-stream habitat. An overall watershed runoff analysis was completed using the L-THIA model. Exhibit 50 depicts estimated runoff amounts and pollutant loading for phosphorus for current and future conditions.

EXHIBIT 50
Average Annual Total Runoff Volume (acre-feet), 2001 and 2040

Land use	Current conditions (based on 2001 existing land use)		Future runoff (based on Projected land use in 2040)		Runoff % change
	Acres	Runoff volume (acre-ft.)	Acres	Runoff volume (acre-ft.)	
Commercial	59	31	193	101	118.6%
High-density residential	672	112	2,194	366	226.8
Low-density residential	1,043	18	3,403	59	227.8
Forestland	5,494	5	3,408	3	(40.0)
Water/wetlands	2,938	0	2,314	0	0.0
Grassland/pasture	1,946	6	1,532	5	(16.7)
Agriculture	3,593	176	2,701	132	(25)
Total	**15,745**	**348**	**15,745**	**666**	**91.4%**

SOURCE: Public Sector Consultants Inc., 2007, with data from MRLCC, 2001 (current land use), and MSU CEVL and LPI (future land use), 2007.
NOTE: Acre-ft. = the volume of water necessary to cover one acre to a depth of one foot (1 acre-ft. = 43,560 cu. ft.).

Recreational and Fishing Access

The Portage Lake Channel provides a major attraction to residents and visitors who use Portage Lake as an access point to fish and boat on Lake Michigan. Traditionally the Portage Lake Channel has been maintained by the U.S. Army Corps of Engineers (USACE). However, recent federal budget reductions have threatened the maintenance dredging and breakwater pier upkeep in all Great Lakes harbors with the exception of a limited number of commercially important Great Lakes ports. State and local funding mechanisms are being sought to assure that safe, sustained access through the Portage Lake Channel can be maintained for access to Lake Michigan from Portage Lake. Surface water recreation in Portage Lake is dependent upon adequate and safe boat launching and docking facilities and public swimming and recreational areas. Recent low water conditions have limited the use of some facilities and new or improved shore-based recreational facilities are needed to support existing and potentially expanded use.

Contaminated sediments that require special handling and disposal can increase the cost of navigational dredging. There is no evidence, however, of contaminated sediments in the Portage Lake Channel. If actions called for in this plan are implemented to prevent

hazardous materials from entering surface waters, there should be no increased costs associated with dredging sediments from the channel.

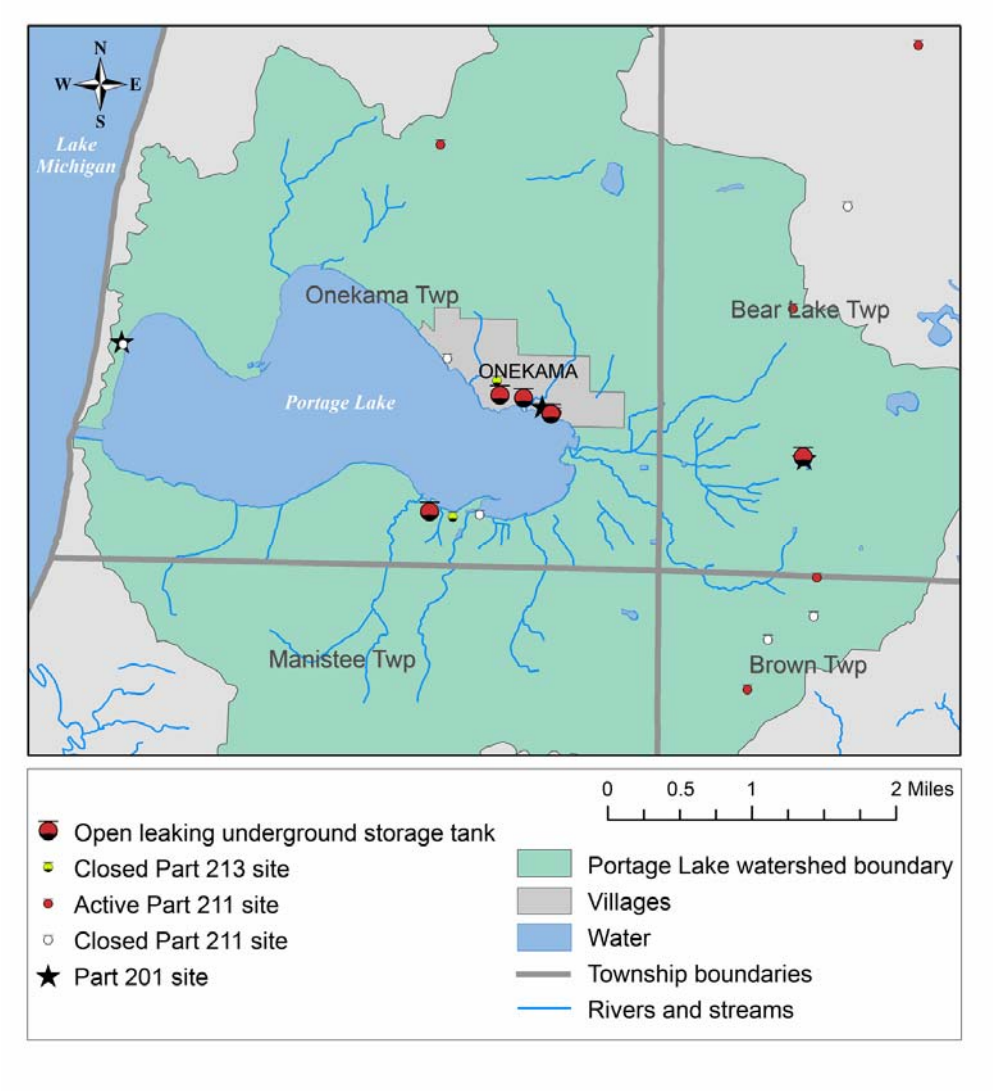
Groundwater

The greatest threats to groundwater in the watershed are related to the unlawful releases of contaminants already identified in this watershed plan, and to the potential release of contaminants from spills and discharges to the surface that either gain direct access to groundwater or enter otherwise protected groundwater aquifers through improperly plugged and/or abandoned hydrocarbon and mineral wells or domestic water wells.

While existing regulations protect groundwater from permitted waste discharges, leaking underground storage tanks and other nonpoint discharges from land uses involving the storage, disposal, transportation, and use of hazardous materials 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 Portage Lake and tributary streams. Groundwater pollution is not only a threat to drinking water but to protected uses in surface waters.

Exhibit 51 shows the distribution of hazardous substance releases, leaking underground storage tanks (LUST), and underground storage tanks (UST) in the Portage Lake watershed. Closed LUST and UST sites are potential or past sites of contamination that have been addressed. Active UST sites are locations where there is at least one tank at the facility that is not closed in place or removed, but there is no leaking.

EXHIBIT 51
Groundwater Contamination Sites in Portage Lake Watershed



SOURCE: MDEQ, 2007b.

The sites of concern are the open LUST sites and Part 201 sites. Open LUST sites are those where a release has occurred and corrective actions have not been completed to meet the appropriate land use criteria. Part 201 sites are those where there has been a release of a hazardous substance(s) in excess of the Part 201 of the Michigan Natural Resources and Environmental Protection Act (Public Act 451 of 1994) residential criteria, and/or where corrective actions have not been completed under Part 201 to meet the applicable cleanup criteria for unrestricted residential use. Exhibits 52 and 53 provide details about open LUST and Part 201 sites in the watershed.

EXHIBIT 52
Open LUST Sites in the Portage Lake Watershed

Site	Municipality	Release date	Substance
Spirit of Onekama (Formerly Wesco)	Village of Onekama	Oct. 2, 1991	Unknown
Pete's Repair Service	Village of Onekama	Jun. 19, 1995	Unknown
Onekama Marine Inc	Village of Onekama	Oct. 29, 1998	Diesel
Portage Lake Marina	Village of Onekama	Dec. 1, 1998	Gasoline
Portage Lake Marina	Village of Onekama	Nov. 29, 1993	Gasoline

SOURCE: MDEQ, 2007b.

EXHIBIT 53
Part 201 Sites in the Portage Lake Watershed

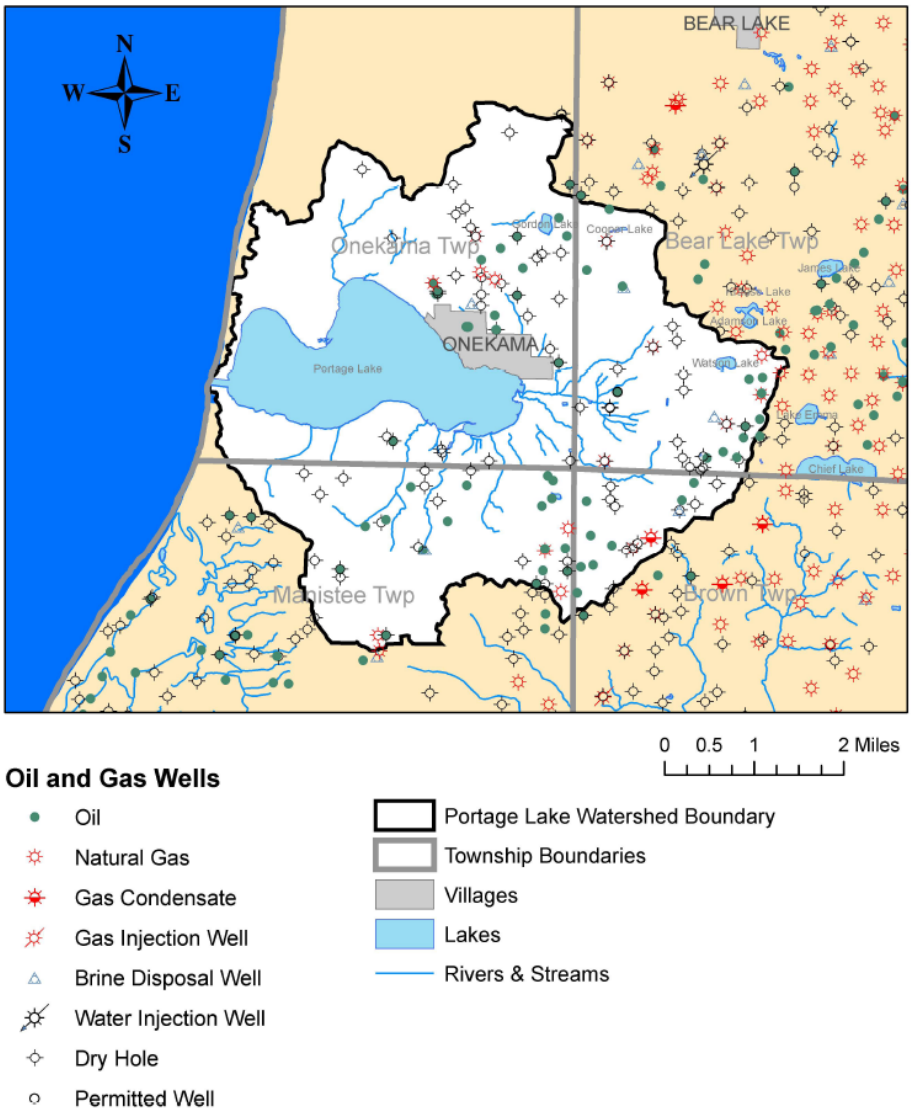
Site	Municipality	Substance	Status
Residential well, Eight Mile Road	Village of Onekama	1,2-Dichloropropane DCP	Interim response conducted—no further activities anticipated
Residential well, Farr Road	Village of Onekama	Chloride	Interim response conducted—no further activities anticipated
Residential spill, Main Street	Village of Onekama	Fuel oil	Inactive—no actions taken to address contamination
Portage Pointe Inn	Village of Onekama	Benzene; Ethylbenzene; Toluene; Xylenes; PNAs	Delisted*

SOURCE: MDEQ, 2007b.
*A delisted site has been removed from the Part 201 list because response actions have reduced the levels of contaminants to concentrations that meet or are below the criteria for unrestricted residential use.

It is important to note that the Part 201 list does not include all of the sites of contamination that are subject to regulation under Part 201 because owners are not required to inform the MDEQ about the sites and can pursue cleanup independently. Sites of environmental contamination that are not known to the MDEQ are not on the list, nor are sites with releases that resulted in low environmental impact.

Contaminants from spills and discharges to the surface can gain direct access to groundwater or enter otherwise protected groundwater aquifers through improperly plugged and/or abandoned hydrocarbon and mineral wells or domestic water wells. This is a considerable threat, given the fact that Manistee County ranks second in the state in the total production of both oil and natural gas that began in Michigan in 1925. Exhibit 54 shows the large number of wells drilled in the Portage Lake watershed.

EXHIBIT 54
Location of Wells Drilled in Portage Lake Watershed



SOURCE: Public Sector Consultants Inc., 2007, with data from MDEQ 2000, Locations – Oil and gas wells.

Pollution prevention education programs targeted to commercial and public facilities that store, handle, and use hazardous materials can be an effective means to protect groundwater. Providing free or subsidized household hazardous waste disposal options for homeowners can reduce unacceptable disposal on the land. Inventorying and the proper closure of abandoned domestic and industrial wells can reduce the potential direct access to groundwater aquifers from contaminated surface runoff. A quick response and cleanup of leaking underground storage tanks and other known groundwater contamination sites can minimize the threat of groundwater pollution. Alerting watershed property owners of low-cost or free water supply testing for various contaminants can also help detect and address potential threats to groundwater.