



**MAINE PUBLIC DRINKING WATER  
SOURCE WATER ASSESSMENT PROGRAM  
PORTLAND WATER DISTRICT  
SEBAGO LAKE WATERSHED**

**MARCH 2003**

prepared for



**Source Water Assessment Program  
Drinking Water Program  
Maine Department of Human Services**

prepared by



**Drumlin Environmental, LLC  
Portland, Maine**

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11 State House Station  
Augusta, Maine 04333



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# **PORTLAND WATER DISTRICT SEBAGO LAKE WATERSHED**

## **EXECUTIVE SUMMARY**

The Portland Water District provides drinking water from Sebago Lake to more than 190,000 people in the Portland metropolitan area. Sebago Lake has a surface area of approximately 30,500 acres and is fed by water from a direct watershed of more than 142,000 acres. The lake lies within the towns of Windham, Standish, Sebago, Naples, Casco, Frye Island and Raymond. Portions of the towns of Harrison, Otisfield, Norway, Waterford, Albany Township, Greenwood and Bethel lie within the Crooked River watershed, which drains into the Songo River and then to the lake at its northern end. The watershed is more than 50 miles long from Bethel to Standish and more than 13 miles wide. Approximately 86 percent of the watershed is undeveloped woodland. Agricultural land occupies approximately 6 to 7 percent of the watershed. Residential, commercial and industrial development occupies 7 to 8 percent of the watershed, but increases in density closest to the lake.

The Portland Water District owns approximately 2,500 acres of land along the southern shore of the lake, near its intakes. Sebago Lake State Park and a portion of the White Mountain National Forest are located in the central and northern portions of the watershed, along with several privately held conservation easements. However, the majority of the land in the watershed is privately owned. Approximately half of the towns in the watershed control development with municipal zoning ordinances. The remaining towns have not adopted specific zoning to control development. All towns have, however, adopted the state-mandated Shoreland Zoning, which influences development within 250 feet of the lake and the Crooked River.

The reconnaissance of the watershed for the SWAP identified existing non-residential land uses that could impact water quality. These activities include the handling and storage of petroleum and other chemicals, gravel pits, human and animal waste storage and disposal and waterfront recreational facilities. In addition to stationary land uses, a variety of sensitive materials are transported along major roadways in the watershed including US Routes 302, 114, 35 and 5, which pass through the watershed near Sebago Lake and/or the Crooked River.

The Portland Water District has determined that there are approximately 4,000 developed or developable parcels of land along the approximately 100 miles of Sebago Lake shoreline. Shorefront development poses a threat to the quality of the lake from subsurface wastewater disposal, lawn fertilizers, gravel roads and driveways and increased recreational access. Local and state laws relating to Sebago Lake give the Portland Water District authority to review certain aspects of development proposals within 200 feet of the shore. The Portland Water District has also developed productive working relationships with the Planning Boards and Codes Enforcement Officers of the seven towns around the lake as a means of monitoring development along the shore. Nevertheless, development pressure is very high for this waterfront property and significant future development is likely.

Sebago Lake serves the dual function as the source of supply for the Portland Water District and the dominant recreational resource for the area. There are public boat launches around the lake,

including one in the southern end of Lower Bay in Standish. There are also numerous private and association access points to the lake. All recreational uses are permitted on the lake, except within the designated protection areas granted to the Portland Water District. No recreational activity that involves bodily contact with the water is permitted within two miles of the Portland Water District's intakes. However, small, motorized vehicles (e.g., snowmobiles and four-wheelers) do go on the ice within two miles of the intakes during ice fishing season. No trespassing of any kind is permitted within 3,000 feet of the intakes. These restricted zones are marked by buoys and enforced by Portland Water District staff and volunteers.

Water quality data collected by the Portland Water District classify Sebago Lake as oligotrophic, which suggests minimal nutrient enrichment from the watershed area. The data show that the lake has low phosphorous and bacteria counts, high dissolved oxygen concentrations and good clarity. The data also indicate that the quality of the lake has remained stable over time.

The Portland Water District regularly collects water quality data from tributaries and the major rivers flowing into the lake. Elevated concentrations of phosphorous and coliform counts have been noted at certain sampling points.

The density of development in the direct watershed of Sebago Lake ranges from low in the upper watershed to high near the lake. The Portland Water District has developed and is implementing a dynamic Watershed Control Program to monitor water quality and improve conditions that pose a potential threat to the water quality of the lake. However, residential development pressure around the lake is high. The area will also continue to experience pressure to develop commercial and industrial projects along the Route 302 corridor. Based on these factors, the overall susceptibility of the Sebago Lake water supply to degradation of its water quality is considered to be moderate.

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## **1.0 INTRODUCTION**

The operation of public water systems in Maine is governed by the federal Safe Drinking Water Act (SDWA), which was first passed in the 1970s and later amended in 1986 and 1996. The federal government delegated authority for enforcing the SDWA to the state under the Maine Department of Human Services (DHS) Drinking Water Program (DWP). In 1998, the Source Water Protection Section was established in the DWP to implement the Maine Public Drinking Water Source Water Assessment Program (SWAP). The SWAP process is being conducted through a cooperative effort between the DWP staff, Portland Water District staff and Drumlin Environmental, LLC (Drumlin), the environmental consulting firm contracted through DHS to provide technical assistance for the project.

The purpose of the SWAP evaluation for the Portland Water District (District) is to assess the susceptibility of its Sebago Lake drinking water supply (PWSID 91300) to potential threats of contamination. The long-term goal is to protect the water supply source. To do this, the SWAP process has compiled information to assist the Portland Water District in future planning that will help to control potential threats to the water quality of Sebago Lake.

This Report describes the SWAP for the Portland Water District and is organized as follows:

- **Section 2.0** summarizes the physical characteristics of the water supply at Sebago Lake;
- **Section 3.0** describes the variety of conditions and activities that could pose a threat to water quality;
- **Section 4.0** provides an assessment of the threats within the Sebago Lake watershed; and,
- **Section 5.0** ranks the susceptibility of the water quality at Sebago Lake and provides recommendations for future protection of water quality.

## **2.0 WATER SUPPLY SOURCE**

### **2.1 Description**

The source of supply for the Portland Water District is Sebago Lake, which is located approximately 10 miles to the northwest of the City of Portland. Sebago Lake lies within the towns of Windham, Standish, Sebago, Naples, Casco, Frye Island and Raymond. Sebago Lake is fed by the Songo and Crooked Rivers, which combine to flow into the lake at its north end. For the purpose of this SWAP assessment, the direct Sebago Lake watershed has been defined as

land that drains directly to the lake or its tributary rivers (e.g., the Muddy River, Jordan River, etc.). Land that drains into another lake or pond before feeding the tributary rivers (i.e., the indirect watershed) has not been included in this SWAP assessment. Sebago Lake and its direct watershed are depicted in Figure 1. In addition to the seven towns directly bordering the lake, land within the watershed lies in the towns of Harrison, Otisfield, Norway, Waterford, Albany Township, Greenwood and Bethel. The components and description of the Portland Water District water source are summarized in Table 1.

**TABLE 1**  
**SEBAGO LAKE SUPPLY**

<b>Category</b>	<b>Description</b>
Water System Name:	Portland Water District
Surface Water Source:	Sebago Lake
Water System Type:	Non-transient, community system
Watershed Location:	Windham, Standish, Sebago, Naples, Casco, Frye Island, Raymond, Harrison, Otisfield, Norway, Waterford, Albany Township, Greenwood and Bethel
Source Surface Water Area:	30,512 Acres
Source Watershed Area:	142,009 Acres
Maximum & Average Depths	316 ft Max. 101 ft Ave.
Water Volume in Storage	995 Billion Gallons
Population Served (customers):	Services: 47,000 +/- Population: 190,000 +/-
Type of Treatment:	Ozonation, Chloramination, Fluoridation, Corrosion Control
Filtration:	Filtration Waiver
Estimated Daily Water Use:	24 MGD average, 42 MGD peak

Sebago Lake covers more than 30,500 acres and is the second largest lake in Maine. There are three primary regions of the lake. The largest region of the lake, located in the northwest, is referred to as Big Bay. The northeast region of the lake is referred to as Jordan Bay. Big Bay and Jordan Bay are separated by Raymond Neck and the Town of Frye Island. The southern (and smallest) region of the lake is referred to as Lower Bay. According to Portland Water District staff, water circulates throughout the entire lake in a counterclockwise direction. The three bays do not have distinct circulation characteristics.

The direct Sebago Lake watershed is more than 50 miles from north to south and approximately 13 miles from east to west at its widest point near the north end of the lake. The lake is fed by small streams or brooks originating in the towns surrounding the shoreline. However the primary tributary to the lake is the Songo and Crooked Rivers, which combine approximately one mile north of the lake and flow into its north end. The combined flow in these rivers contributes an estimated 66 percent of the annual surface water flow into the lake.

The Songo River originates at the southern end of Long Lake in Naples and drains a series of lakes to the north. Land area above the headwaters of the Songo River has not been included in this assessment because it does not drain directly into Sebago Lake. The Crooked River drains an extensive area of land to the north of Sebago Lake, including land in Harrison, Otisfield, Norway, Waterford, Albany Township, Greenwood and Bethel.

The Portland Water District draws water from two intakes located at the southern end of Sebago Lake near the bottom of Lower Bay.

## **2.2 Land Use**

Land use around Sebago Lake and in the Sebago Lake watershed includes a mixture of commercial, industrial and residential development as well as farmland and undeveloped woodlands. The Portland Water District provides drinking water to developed land in a portion of the eastern watershed. Developed land in the remainder of the watershed draws drinking water from private wells. All developed land in the watershed relies upon private, subsurface systems for disposal of wastewater. The principal land use characteristics described in this section have been grouped by location within the watershed.

**Intake Watershed Area:** The majority of land closest to the intakes is owned by the Portland Water District and is managed to protect and preserve the water quality in the lake. With the exception of a small office and its ozonation treatment plant, land owned by the Portland Water District is primarily undeveloped. Land along the southeast shore of Sebago Lake, closest to the intakes, is also largely undeveloped.

The southern part of the watershed, near the intakes, is crossed by Route 35 and Route 114, which are heavily traveled state roads. A primary business center in Standish is located near the intersection of Routes 35 and 114 and includes several small businesses that provide automotive services. There is also a heavily used boat launch at the southern end of Lower Bay in Standish, where as many as 4,000 boats launch annually.

**Western Watershed Area:** The western shore and watershed lies within the towns of Standish and Sebago. The primary route of access to this part of the watershed is via Route 114. Route 114 passes close to the lakeshore (within 100 feet) at several locations in the Town of Sebago. East Sebago village is located close to the lake and includes several small stores, a marina and town public works facilities. The west shoreline is also characterized by several locations with dense residential development (e.g., Long Beach and Harmons Beach) and several boys and girls camps, including Camp Sebago and Camp O-AT-KA.

**Eastern Watershed Area:** The eastern shore and watershed lies within the towns of Windham, Raymond, Frye Island and Casco. Route 302 is the major road serving this area and is heavily traveled. The Route 302 corridor is heavily developed with retail and commercial development through most of the eastern watershed. Businesses in the watershed along Route 302 include gasoline stations and other automotive service facilities, marinas, small and moderately sized manufacturing facilities and hotel and resort development. This development is generally set



back from the lake, although Route 302 does pass close by the lakeshore in several locations. The eastern shoreline also includes several areas of moderate to dense residential development.

**Northern Watershed Area:** The northern shore of the lake is dominated by Sebago Lake State Park, which provides camping and recreational access to Sebago Lake. There are also several other large-scale recreational and resort developments in the watershed near the north end of the lake, including Point Sebago and Point Sebago Golf Resort. These facilities provide attractive recreational opportunities for local residents and tourists and are heavily used in the summer. These facilities, as well as private residential development in the Kettle Cove area, rely on subsurface wastewater disposal systems rather than a sanitary sewer system.

**Crooked River Watershed Area:** Land draining to the Crooked River and then to Sebago Lake is characterized by moderately dense mixed development south of Route 11 in Casco and lower density development to the north. Route 11 crosses the Crooked River in Casco approximately four miles north of the lake. Land along Route 11 and the other primary roads to the south has been developed with retail and service-related businesses, including several convenience stores, gasoline stations, auto service shops and gravel pits. Land in the Crooked River watershed north of Route 11 is primarily rural, with occasional non-residential development. Former or active solid waste handling facilities are located in the watershed in Norway, Harrison, Otisfield and Waterford. Farms that spread ash or sludge as soil amendments are present in Casco, Otisfield and Waterford. Regional sand and gravel deposits are common along the Crooked River valley. As a result, there are a number of gravel pits in the upper portion of the watershed, including pits in close proximity to the Crooked River in Albany Township, Waterford, Harrison and Naples.

There are a number of land parcels in the Sebago Lake watershed that are owned for conservation purposes and maintained in an undeveloped or limited development state. This land serves to protect water quality in the watershed and lake by limiting areas where development can take place and by providing natural habitat to preserve and enhance water quality.

Areas of significant conservation ownership or easements in the watershed are depicted in Figure 2 and described below.

- **Portland Water District:** The Portland Water District owns approximately 2,500 acres of land on the south and southeast side of the lake, near the intake.
- **Steep Falls Wildlife Management Area:** Two wildlife management parcels include portions of the western watershed in Sebago.
- **Sebago Lake State Park:** Sebago Lake State Park borders the Songo River where it flows into Sebago Lake. The majority of this land is undeveloped and in its natural state. Portions of the land are used for camping and recreation along the lakeshore.
- **Jug-Town Easement:** Hancock Lumber Company has placed a conservation easement on approximately 3,200 acres of land in the lower Crooked River watershed.

- White Mountain National Forest: A large area of the White Mountain National Forest lies within the watershed in Albany Township.

An overview of land use characteristics in the Sebago Lake watershed is presented in Figure 3, derived from the Multi-Resolution Land Characterization database. This database shows that the majority of the watershed (86 percent) is forested. Approximately 7 to 8 percent of the land in the watershed is developed for residential use. Approximately 6 to 7 percent of the land is used for agricultural purposes. Less than one percent of the land is used for commercial, industrial and transportation purposes.

Future land use (and to a lesser extent, current land use patterns) within the Sebago Lake watershed is also influenced by zoning and planning review in the watershed towns. An overview of the zoning in the 14 towns in the direct Sebago Lake watershed is provided in Table 2.

**TABLE 2**  
**ZONING SUMMARY FOR THE SEBAGO LAKE WATERSHED**

<b>Town</b>	<b>Status of General Zoning</b>	<b>Shoreline Zoning Overlay</b>	<b>PWD Review in Shoreland Zone</b>
Sebago	No Specific Zoning	Yes	Yes
Standish	Specific Zoning Adopted	Yes	Yes
Windham	Specific Zoning Adopted	Yes	Yes
Raymond	Specific Zoning Adopted	Yes	Yes
Frye Island	No Specific Zoning	Yes	Yes
Casco	Specific Zoning Adopted	Yes	Yes
Naples	Village District Only	Yes	Yes
Harrison	No Specific Zoning	Yes	No
Otisfield	No Specific Zoning	Yes	No
Norway	No Specific Zoning	Yes	No
Waterford	No Specific Zoning	Yes	No
Albany Twp	LURC zoning	Yes	No
Greenwood	No Specific Zoning	Yes	No
Bethel	No Specific Zoning	Yes	No

Towns that have not adopted specific zoning districts are predominantly rural in nature. Future development in these towns is most likely to consist of low-density residential or agricultural development, although commercial or industrial development would not be precluded. In towns that have adopted specific zoning districts, the majority of the land within the watershed is zoned for residential or rural development. However, land within the watershed along the Route 302 corridor in Casco, Raymond and Windham is specifically zoned for commercial development. There is also land in the watershed surrounding the intersections of Routes 114 and 35 in Standish that is zoned as a Village Center and permits a variety of commercial development.

All of the watershed towns have adopted Shoreland Zoning Districts that restrict development within 250 feet of Sebago Lake or the Crooked River. In those towns where no general zoning

exists, shoreland zoning controls the configuration of proposed development (e.g., typical minimum setbacks of 100 feet from the Sebago Lake or Crooked River), rather than the type of development. In towns where specific land use zones have been adopted, the specific zoning district controls the type of development that is permitted, and the shoreland zoning overlay influences the configuration of the allowable development.

In the seven towns that border the lake, all shoreline development is reviewed by a Water Resource staff member from the Portland Water District. Staff are in regular contact with the Codes Enforcement Offices in each town, review copies of Planning Board agendas and provide regular comment on development proposals near the lake.

### **3.0 INVENTORY OF POTENTIAL WATER QUALITY CONCERNS**

#### **3.1 Background**

The Source Water Assessment Program (SWAP) is intended to assist water districts and suppliers in protecting the quality of their surface water supply by identifying potential threats to water quality. Two factors have been considered in identifying and assessing the potential risk posed by a threat: (a) location in relation to the intake and (b) the nature of a potential threat.

This SWAP assessment looks for potential threats to water quality in three zones:

1. The intake zone within 1,000 feet of the intake;
2. The shoreline zone, within 250 feet of the shoreline of the surface water body; and,
3. The watershed zone, extending to the limits of the surface watershed.

Activities in each of these zones have a different potential effect on the quality of water in the surface supply.

Within each of the three zones, the SWAP assessment examines a variety of conditions, land uses and practices that have a potential to influence water quality. These features generally fall into one of the following categories:

- Physical characteristics of the watershed, for example the presence of wetlands, steep topography or erodible soils;
- General land uses and development patterns, for example the percentage of developed versus undeveloped land and controls to guide future development; and,
- Specific activities that involve chemical handling or may release pathogens (e.g., fecal coliform) with the potential to degrade water quality.

The SWAP assessment also considers available water quality data from the surface supply as an indicator of existing conditions. Appendix A describes specific guidance used during the SWAP to inventory potential factors influencing water quality. Appendix A also lists specific activities included in the SWAP assessment. Table 3 lists general sources of information consulted during SWAP research.

**TABLE 3**  
**SOURCES OF SWAP INFORMATION**

<b>Information Type</b>	<b>Information Source</b>
Watershed Characteristics	US Geological Survey (Topography, Hydrology), Soil Conservation Service (Soils), Maine Geological Survey (Geology)
Raw Water Quality	Water District Monitoring, PEARL
Potential Contamination Sources	DEP Databases, Water District Survey Database and Municipal Contacts
Land Use and Zoning	Water District and Municipal Records
Other Analyses	Other DEP Databases

### 3.2 Source Sensitivity to Land Use

The key watershed features that define the sensitivity of the water supply source to land uses are briefly described below:

- **Natural Features:** The watershed has a significant percentage of undeveloped forestland. There are shoreline segments of Sebago Lake that are susceptible to erosion. There are also potentially erodible sand and gravel deposits in close proximity to the Crooked River along certain reaches. The watershed is more than 45 miles long from north to south and this length provides an opportunity for natural processes to buffer and attenuate potential contaminants entering Sebago Lake. This buffering and attenuation process is further enhanced by the large size and volume of the lake itself.
- **Man-made Features:** Historical development patterns have resulted in moderate- to high-density development along the lakeshore and major roadways that pass close to the lake. There is a well-developed infrastructure that has supported and is likely to continue to attract increased development near the lake. The upper watershed is much less densely developed than the land near the lake. However, significant primary roads such as Routes 5/35 follow the Crooked River and tend to support development in areas that have the potential to pose a risk to water quality in the river.
- **Specific Activities:** The Sebago Lake water supply is potentially sensitive to a variety of activities that occur in the watershed. These activities include handling and use of petroleum and other industrial chemicals, handling and disposal of human or animal wastes and related byproducts, disturbance of soil material in gravel mining or general development, transportation along the primary and secondary road corridors and on-water

recreational activities. These activities are found in a greater density in the southern part of the watershed. However, many of these activities also occur in the northern portions of the watershed.

#### **4.0 ASSESSMENT OF SEBAGO LAKE**

Sebago Lake is used directly by the Portland Water District as its source of supply after disinfection and pH adjustment for corrosion control. Available data and information provided by the Portland Water District staff indicate that drinking water derived from the lake has historically been of high quality. The Sebago Lake water supply was granted a waiver from filtration by the Department of Human Services after demonstrating that this source has consistently low turbidity and bacterial counts and that the Portland Water District had developed a management plan to preserve water quality in the watershed.

##### **4.1 Watershed**

Sebago Lake is the second largest lake in Maine and is located north of the Portland metropolitan area. The direct watershed of the lake is approximately 45 miles long from north to south and approximately 13 miles wide at its widest point, near the north end of the lake. Around the lake, the distance from the edge of the watershed to the shore varies from less than 1,000 feet, at the southern end of Lower Bay, to more than five miles, northwest of the lake in the Town of Sebago. The northern part of the direct watershed extends north from the lake along the Crooked River and its associated drainages.

The Portland Water District estimates that the Crooked and Songo Rivers contribute approximately 66 percent of the surface water inflow to Sebago Lake. This inflow occurs at the north end of the lake, nearly 12 miles to the north of the Portland Water District intakes. The distance from the Crooked/Songo Rivers to the Portland Water District intakes serves as a buffer to attenuate potential pollutants from the upper portion of the watershed.

The southern part of the watershed is drained by a number of smaller streams that flow directly into the lake. The Portland Water District estimates that these tributaries contribute close to 20 percent of the surface water inflow to the lake. Many of the tributaries flow into the lake at a significant distance from the intakes. However, the Sticky River, Rich Mill Pond, and Standish Brook flow into Lower Bay within several miles of the intakes, increasing their potential for source water impact.

The Sebago Lake watershed is dominated by undeveloped forestland. The upper portion of the watershed lies within the towns of Harrison, Otisfield, Norway, Waterford, Albany Township, Greenwood and Bethel. The White Mountain National Forest extends across a large tract of land in the watershed in Albany Township. Hancock Lumber's Jug-Town easement preserves forested land and prevents future development in a significant area in the upper watershed. The towns in the upper watershed are rural in nature and do not generally have densely developed land uses. In addition to low-density residential development, the most common activities in these towns include timber management and harvesting, agriculture, and mineral extraction such

as gravel pits. Due to existing geologic conditions, many of the gravel pits in the upper watershed are located along the Crooked River valley, within 1,000 feet of the river.

In the lower watershed, the towns of Sebago, Standish and Naples include significant portions of rural land with low-density development. In contrast to the towns in the upper watershed, these towns do have some areas of moderate- to high-density development, particularly near the lake. The highest development density in these towns is found in East Sebago village and Standish village, as well as locally dense residential development along the lakeshore.

The densest development in the watershed occurs on the eastern side of the lake and along the Route 302 corridor in the towns of Windham, Raymond and Casco. This portion of the watershed includes high-density residential development near the shoreline and mixed commercial and retail development along Route 302. Non-residential development in the watershed in Windham, Raymond and Casco includes municipal facilities (e.g., public works), recreational facilities (e.g., golf courses, marinas), retail (e.g., grocery, hardware, automotive) and light industrial (e.g., boat manufacturing).

In anticipation of the SWAP process, the Portland Water District conducted a detailed inventory of non-residential land uses that pose a potential threat to water quality in the seven towns that surround the lake. Databases maintained by the Maine Department of Environmental Protection have also been reviewed to identify regulated activities in the entire watershed. Finally, observations were made during a May and June 2002 reconnaissance of the watershed to identify both point and non-point sources of potential contamination that may pose a concern to the water supply.

In conducting its survey, the Portland Water District grouped sites into six categories:

- Petroleum Hydrocarbon Storage and Uses;
- Gravel Pit;
- Herbicide/Pesticide Use;
- Marina;
- Human or Animal Waste Storage/Disposal; or,
- Other.

As part of its inventory process, the Portland Water District interviewed facility owner/operators to assess materials that were present as well as the management measures in practice at each facility. Using this information, Drumlin, the Drinking Water Program staff and the Portland Water District staff reviewed conditions at many facilities and removed certain ones from the potential threat category because the material and practices employed effectively minimized risk to water quality.

The location and classification of potential threats identified within the watershed by the SWAP review and the Portland Water District are included in Figure 4. Figure 4 also shows the location of a corridor containing oil and natural gas pipelines that pass through the watershed for approximately 30 miles, from Bethel to Casco. In addition to these specific activities noted above and shown on Figure 4, a potential threat to the water supply is posed by transportation of

commercial products along roads in the watershed, including US Route 302, Route 114, Route 5 and Route 35.

The Portland Water District has developed a multi-component plan to monitor development and protect water quality in the watershed. Its Watershed Control Program consists of four principal activities including:

1. Water Quality Monitoring and Surveillance;
2. Direct Action;
3. Environmental and Water Quality Education; and,
4. Advocacy for Source Protection.

Water quality monitoring and surveillance activities are described in greater detail in Section 4.3. Direct Action activities are described in greater detail in Section 4.2. A brief summary of the education and advocacy components is provided below.

**Environmental and Water Quality Education:** The Portland Water District employs several staff members whose primary responsibility is environmental and water quality education. The Portland Water District undertakes a variety of educational efforts throughout the watershed and its service area.

- The District posts informational signs along the major roads to notify motorists as they enter the Sebago Lake watershed. Informational signs are also posted at boat launches around the lake.
- The District publishes Watershed News twice yearly to provide information about watershed protection activities and services offered by the District.
- The District has established a school-based educational program (HydroLogics) that is offered to supplement the curriculum at 20 schools in the watershed and service area towns.
- The District also runs a week-long nature camp for children to expand on the HydroLogics curriculum.

A variety of scientific and educational materials are available to visitors at the District's Sebago Lake Education Center in Standish.

**Advocacy for Source Protection:** As the largest water district in Maine, the Portland Water District plays an active role in a variety of local and state-wide legislative and policy-making forums. The staff participates in educational and legislative initiatives of the Maine Water Utilities Association. The staff also assists local planning and code enforcement officials in the towns surrounding the lake, to review proposed development projects that have a potential to influence water quality in the lake. The Portland Water District has cultivated a close relationship with municipal planning and enforcement staff in the seven towns that surround the lake. Through this relationship, the Portland Water District is influential in all new development along the lakeshore.

## 4.2 Shoreland

Sebago Lake has a shoreline of approximately 100 miles in the towns of Standish, Sebago, Naples, Casco, Raymond, Frye Island and Windham. As shown in Figure 2, the Portland Water District owns a significant length of shoreline along Lower Bay, including the land closest to the intakes. Approximately 1.25 miles of the northern shoreline lies within Sebago Lake State Park. The State of Maine also owns a small parcel of land at Tassel Top Beach in Raymond. The remainder of the land along the shoreline of Sebago Lake is privately owned.

Towns surrounding the lake experienced a rate of growth during the 1990s that ranged from more than 14 percent in Naples to nearly 30 percent in Raymond according to recent census data. These growth rates were among the highest in Maine. Sebago Lake is an attractive recreational resource for the area and growth during the 1990s and into the future is likely to put pressure on shoreland for development.

According to the Portland Water District, there are more than 4,000 developed or developable parcels of land along the shore of the lake. Dense residential development is present along segments of the shoreline in each of the towns surrounding the lake. Areas with the densest residential development include the western lakeshore (e.g., Harmon Beach to Long Beach and North Sebago), Kettle Cove in Casco, the northern end of Frye Island, several areas of Raymond Neck and the Windham shore of Jordan Bay. Development is lowest along the shore owned by the Portland Water District on the eastern side of Lower Bay. There are also significant shoreline areas developed with recreational beaches, resorts and marinas.

The majority of the shoreline development is served by municipal or private (homeowner association) roadways constructed of gravel. Frequently these roadways pass close to the lake. The frequency and quality of maintenance on these roads varies considerably. Poorly maintained gravel roads pose a risk to the lake from erosion of soil material and the associated introduction of phosphorous into the lake. A recent survey by the Portland Water District identified 51 gravel camp roads as highly prone to soil erosion.

There are a few segments of major roadways, including Route 302 in Raymond, Route 35 in Standish and Route 114 in Standish and Sebago, which pass close to the lake. These areas pose the greatest transportation-related threat to the lake. There are also inactive tracks of the Mountain Division Line Railroad that lie along the shoreline in Standish. According to the Portland Water District, this rail line is inactive and being considered for conversion to a recreational trail.

In addition to the development patterns around the Sebago Lake shoreline, there are natural features of the shoreline, particularly soil characteristics, which have the potential to affect water quality. In conjunction with the Portland Water District, the Maine Geological Survey has compiled data classifying the type of shoreline around the lake. This classification identifies approximately 57 percent of the shoreline as having soils derived from till, a heterogeneous mixture of gravel, sand, silt and clay. Compared to other soil types, till tends to be resistant to erosion. More than 20 percent of the shoreline is characterized by sandy beaches, some stabilized with artificial seawalls or groins. These areas are susceptible to erosion, which



introduces phosphorous into the lake. Figure 5 shows the portions of the shoreline with the highest potential for erosion and phosphorous loading. This information was derived from a phosphorous hotspot model run by the Portland Water District that combined soil type, land use, slope and proximity to the lake as indicators of potential erosion and phosphorous export.

The Portland Water District recognizes the impact that shoreline development can have on the water quality of the lake and plays an active role in monitoring existing activities and reviewing proposed new activities. The legal jurisdiction of the Portland Water District includes land within 200 feet of Sebago Lake. As a result of this, shorefront landowners must get a permit from the Portland Water District before installing a septic system. The Portland Water District also maintains close contact with the Planning Board and Codes Enforcement offices in all shoreline towns so that it can review and comment on all potential shoreline development. The Portland Water District's review of proposed activities within 250 feet of the lake enhances local shoreland zoning adopted by the towns surrounding the lake.

As part of its Watershed Control Program, the Portland Water District undertakes surveys and specific construction projects (Direct Action) intended to protect and improve the water quality of the lake. While not all of the Portland Water District's actions are along the shoreline, many projects are targeted for the shoreline areas because of the beneficial nature of shoreline improvements. Examples of Direct Action that the Portland Water District has undertaken recently in the shoreland zone include the following.

- The District conducted a survey of 461 camp roads around the lake, to assess their condition and whether improvements would provide increased protection to the lake's water quality. The survey identified 51 camp roads as high priorities for repair. This survey will guide future efforts and outreach by the District.
- Over the past several years the District has worked with citizens and homeowner associations to construct demonstration Best Management Practice (BMP) projects in the Kettle Cove area of the shoreline. Projects included construction of diverters, settling pools and vegetated buffers to prevent soil erosion from reaching the lake.
- The District continues its ongoing program of reviewing, permitting and assisting in maintenance of residential septic systems. From October 2000 to 2001, the District was involved in permitting and/or inspecting more than 100 new septic systems around the lake. The District also provided coupons to 22 landowners to assist in the cost of pumping and maintaining their existing systems.

The Portland Water District does not have jurisdictional authority along the Songo or Crooked River shorelines, like it does around Sebago Lake. Shoreland development along these rivers is typically low-density in nature, although there are several road crossings with moderate to dense residential development. The resulting impact of development along the river is monitored indirectly by the Portland Water District through its Water Quality Monitoring activities described in Section 4.3.

### 4.3 Intake

Portland Water District draws water from two intakes located in the southeastern part of Lower Bay near the bottom of the lake. As part of the charter authority of the Portland Water District, the Maine legislature has established two restrictive zones on Sebago Lake around the intakes:

- 3,000-Foot Zone: No trespassing is permitted within 3,000 feet of the intakes; and,
- 2-Mile Zone: No bodily contact in the lake is permitted within two miles of the intakes.

Both restrictive zones are marked with buoys maintained by the Portland Water District. The District also owns the land along the shoreline closest to the intakes and so controls shoreline activities in the intake zone.

The Portland Water District staff is very active in educating the public about restrictions protecting their intakes. In addition to the buoys, staff patrols Lower Bay by boat 8 hours per day 7 days per week during the summer. Boaters entering the restricted areas are informed of the applicable restrictions and, if necessary, asked to leave the “No Trespassing” area or end their water contact activities. Staff monitors the Standish boat launch site, located within the 2-mile no contact zone, 8 hours per day, 7 days per week during the summer. Staff educates boaters, hands out educational literature and monitors violations of the no contact law. Staff at the Standish Boat Launch also monitors trailers and boats for invasive aquatic plants such as Eurasian Milfoil. At other boat launches on the lake, the Portland Water District has posted informational signs to educate the public about the water supply and invasive plants.

During the winter, the Portland Water District continues to enforce the limitation on activities within the 3,000-foot and 2-mile zones. Staff monitors ice fishing in these areas and hands out educational information to users on Lower Bay.

The Portland Water District has a multi-component water quality-monitoring program that includes testing in Lower Bay, near the intake, as well as strategic locations around the lake and throughout the watershed. These programs generate data throughout the watershed to assess possible trends in water quality and to identify areas of potential impact. The principal water quality monitoring programs conducted by the Portland Water District include the following.

- Lower Bay Monitoring: Bacteria samples are collected in 12 locations out to the 2-mile limit on a monthly basis from ice-out until fall turnover. These data have been collected for more than 40 years.
- Standish Boat Launch Monitoring: Bacteria and volatile organic compounds (VOCs), including methyl-tert-butyl ether (MTBE), samples are collected around the boat launch and at several other locations in Lower Bay to assess the impact from activities originating from this boat launch.
- Lake Profiles: Water quality profiles including temperature, dissolved oxygen, secchi disk, phosphorous and chlorophyll-a are collected at the deepest point in Lower Bay, Big Bay and Jordan Bay. These profiles are conducted monthly from ice-out through fall turnover. These samples provide data to evaluate the Trophic State Index (TSI) of the lake.

- **Tributary Monitoring:** The District has collected data from tributaries around the lake for the past 22 years. Currently, 10 tributaries are sampled monthly for fecal coliform, phosphorous, turbidity and flow.
- **Crooked River Monitoring:** The District collects samples from 7 sites along the Crooked River on a quarterly basis and analyzes the samples for fecal coliform, phosphorous, turbidity and flow.

Data from these monitoring programs have been reviewed for the SWAP. An overview of the water quality near the intakes in Lower Bay, the lake as a whole and the tributaries is provided below.

**Lower Bay Water Quality:** The Lower Bay of Sebago Lake has good water quality based on recent and historic water quality profiles. Over the past 20 year period, total phosphorous concentrations have ranged from 3 to 7 parts per billion (ppb); chlorophyll-a concentrations have ranged from 1 to 3.5 ppb; secchi disk transparency has ranged from 7 to 12 meters. The secchi disk data show a slight trend of increasing clarity, but no trends are discernable in the phosphorous and chlorophyll-a data. Bacteria counts in open water and near the intakes in Lower Bay are generally very low (0 to 1 colony forming unit (CFU) per 100 milliliters of water).

Water quality samples collected near the Standish boat launch and Standish Brook contained several samples with bacteria concentrations of greater than 100 CFUs per 100 milliliters of water. Petroleum-related VOCs have also been detected close to the boat launch. According to the Portland Water District, the concentrations of MTBE near the boat launch dropped after the use of this additive was reformulated in the late 1990s. VOCs have not been detected in the open water in Lower Bay or at the intake.

Lakes normally experience an aging process known as eutrophication caused by various natural processes. This process can be accelerated by development and other man-made influences. Phosphorus from runoff, fertilizers, sewage and other sources is a primary factor affecting lake eutrophication since phosphorus nourishes plant and algae growth in the lake. The amount of algae productivity in the lake is characterized in terms of three Trophic States: (1) Oligotrophic = low, (2) Mesotrophic = moderate, and (3) Eutrophic = high. The Trophic State can be determined using chlorophyll-a and phosphorus data or using secchi disk transparency data, which measures the clarity of the lake water. Available raw water quality data collected by the Portland Water District indicate that Sebago Lake is oligotrophic. This indicates that the lake is not enriched in nutrients. The data also indicate that the Trophic State of Sebago Lake is generally stable.

**Lake-Wide Water Quality:** Water quality profile data from Big Bay and Jordan Bay show that both bays are also oligotrophic. Data since 1993 show total phosphorous concentrations have ranged from 3 to 6 parts per billion (ppb); chlorophyll-a concentrations have ranged from 0.75 to 2.3 ppb; secchi disk transparency has ranged from 8 to 13 meters.

**Tributary Water Quality:** Data from 10 tributaries to Sebago Lake plus the Crooked River and Songo River show higher concentrations of coliform and phosphorous than are measured in the

open water of the lake. Mean fecal coliform concentrations ranged from 1 CFU to more than 100 CFUs per 100 milliliters of water, with the highest concentrations measured in Standish Brook and in the Songo River at the State Park. Average phosphorous concentrations ranged from 5 ppb to more than 25 ppb.

Data from the Crooked River show fecal coliform concentrations in individual samples ranging from less than 5 CFUs to more than 300 CFUs per 100 milliliters of water. The 1999 coliform data reviewed for the SWAP also showed significant variation between the spring and fall data along the Crooked River. Crooked River phosphorous data ranged from 5 ppb to more than 45 ppb during 1999. Seasonal trends were not as evident in the phosphorous data as they appeared in other data.

Using the phosphorous and flow data from the 1999 tributary sampling, the Portland Water District has estimated that the Crooked River, Panther Run and Songo River supply the greatest quantity of phosphorous to the lake on an annual basis (8,100 lbs./yr., 4,700 lbs./yr. and 2,900 lbs./yr., respectively).

## 5.0 SWAP RANKING AND RECOMMENDATIONS

### 5.1 Ranking of Susceptibility

The SWAP assessment factors indicate that overall susceptibility of the water quality in Sebago Lake is moderate. This conclusion is based on the general conditions observed, including the density of development, current and anticipated future development pressure, the type and location of activities in the watershed that handle materials that can lower water quality and historical and recent water quality data. Specific factors considered in assessing the overall risk are summarized in Table 4.

**TABLE 4**  
**SEBAGO LAKE SURFACE WATER ASSESSMENT**

<b>Zone</b>	<b>Measure</b>	<b>Findings</b>	<b>Risk Level</b>
Watershed	Ambient Water Quality	Class GPA, in full compliance for trophic status. Lake water quality is high. Certain tributaries have water with elevated phosphorous and coliform bacteria.	Low-Moderate
	Existing Conditions	Watershed is predominantly forested but includes high-density residential, commercial and industrial uses. The intensity of development increases close to the lake.	Low-Moderate
	Future Development	Varying zoning control on future development. Approximately half of the towns in the watershed have no zoning, including two shoreline towns. Growth and development	Moderate

	Overall	pressure is high.	Low-Moderate
Shoreland	Lake Classification	Oligotrophic	Low
	Soils	Erodible soils are present along certain shoreline segments. Camp roads also contribute to erosion.	Low-Moderate
	Activities Posing a Threat	The shoreline includes several areas with high-density residential development and many shoreline beaches, resorts and marinas.	Moderate
	Potential for Future Threats	Future shoreland development controlled by zoning. Project review includes the Portland Water District. However, there are approximately 4,000 developed or developable shoreland lots around the lake.	Moderate
	Overall		Moderate
Intake	Raw Water Quality	Lake quality is good and stable. Filtration waiver granted.	Low
	Ownership/Control	District owns shoreline at intake but there is little conservation ownership along other portions of the shore. District has comprehensive Watershed Control Program.	Low-Moderate
	Activities Posing a Threat	Recreation (boat launch, motorized vehicles, parking, ice fishing) adjacent to intake zone.	Low-Moderate
	Potential for Future Threats	Increased recreation in unrestricted areas, persistent contaminants (e.g., MTBE), invasive plants and increased shoreline development pose a risk that degraded water quality will encroach into the District's restricted intake zone.	Moderate
	Overall		Low-Moderate
<b>Overall</b>			<b>Moderate</b>

## 5.2 Recommendations

The overall ranking for the susceptibility of Sebago Lake to threats of contamination is moderate. At present, the watershed has limited development and the forested land serves to protect water quality. The large size of the lake is also an important buffer that attenuates nutrients and contaminants from the surrounding watershed. However, the intensity of the current development and the pressure for future development increase with proximity to the lake. While new stormwater management and other regulations may mitigate some impacts from future development, it will continue to pose a threat to the ability of the lake to maintain its high water quality in the future.

The Portland Water District has a Watershed Control Program to monitor water quality, improve existing practices and guide future development in the watershed. Based on discussions with the staff, the program is implemented in a dynamic manner, with annual review of the component activities and periodic alterations, as appropriate. The Watershed Control Program is a strong base for protecting the quality of the lake. In addition to the current activities conducted in the Watershed Control Program, the Portland Water District and watershed towns may also want to consider the following actions to provide added protection to the source water quality for the future.

- Protection of land from development will also protect and improve the quality of water flowing into Sebago Lake. **To this end, the Portland Water District should foster more land conservation in the watershed.** While it may not be feasible for the District to purchase significant new tracts of land for conservation, the District could facilitate communication and coordination among the many existing land trusts and large landowners within the watershed. Currently there appears to be enthusiasm from several groups, but coordination among the groups is limited.
- Currently the towns of Sebago and Frye Island have no land use zoning and the Town of Naples has village zoning. As development pressure increases, towns without zoning may be vulnerable to poorly planned, high-density growth. Development may also be attracted to these towns because there are fewer restrictions, making the transactional cost of development lower than in the surrounding communities. **All shoreline towns should consider zoning that incorporates protections for the lake.**
- The Portland Water District benefits from the 3,000-foot and 2-mile statutory limits granted in its charter. However, the location of the current boat launching area in Standish forces a significant amount of recreational boating traffic to cross close to the District's intakes to enter the northern portion of the lake. Water quality monitoring data collected near the boat launch document that fuel-related compounds are being discharged into the lake at this location. **The Portland Water District and the Town of Standish should continue to work together to locate an alternative boat launch site that provides users with better access to the lake without encroaching on the District's intakes.**
- The upper portion of the direct watershed, along the Crooked River, is an important source of water to the lake. Water quality monitoring data along the Crooked River included several data sets with elevated phosphorous and coliform counts. **The Portland Water District should work closely with the Lakes Environmental Association to monitor activities in the upper watershed and to advocate for land use practices that are protective of high water quality in the Crooked River and its smaller tributaries.**

## **APPENDIX A**

### **SWAP ASSESSMENT GUIDELINES**

**MAINE PUBLIC DRINKING WATER  
SOURCE WATER ASSESSMENT PROGRAM  
PORTLAND WATER DISTRICT  
SEBAGO LAKE WATERSHED**

**APPENDIX A  
ASSESSMENT GUIDELINES**

<b>Assessment Item/Threat</b>	<b>Low</b>	<b>Moderate</b>	<b>Significant</b>
Physical Characteristics of the Watershed			
Watershed boundary, area	Smaller	>>	larger
Area of water body	Smaller	>>	larger
Tributaries	Few	>>	many
Watershed topography	Low	moderate	steep, rugged
Wetlands	Many	>>	few
Water body depth	Deep	>>	shallow
Sand and gravel aquifers	Few	some	many
Soil types (erodibility and slope)	Low	moderate	high
Raw Water Quality			
Secchi Disk Transparency	> 8 M	4-8 M	< 4 M
Turbidity	< 1 NTU	< 5 NTU	> 5 NTU
pH	6.5-8.5	N/A	< 6.5 or > 8.5
Phosphorus	< 10 ppb	< 20 ppb	> 30 ppb
Pesticides and herbicides	ND	N/A	detected
Color	< 5	5-15	> 15
Total Coliform and E. Coli	> 29/100 ml	occasional	> 142/100 ml
Dissolved Oxygen	>7 mg/L	5-7 mg/L	< 5 mg/L
Temperature	ambient		> 10° C ambient
VOCs	absent	N/A	detected
Chlorophyll-a	< 2 ppb	2-6 ppb	> 6 ppb
Total Organic Carbon	< 4 mg/L	4-8 mg/L	> 8 mg/L
Potential Contamination Source Inventory			
UST/AST leak sites	Absent from watershed or actively monitored and controlled or fully remediated.	Present in watershed, some operational deficiencies and/or remediation is underway.	Present and unmonitored and/or unremediated.
Municipal/Comm/Special Landfill			
Compost sites			
Demolition debris sites			
Ash/septage storage/utilization			
Superfund site			
Sand/salt storage sites			
Petroleum spill sites			
Hazardous waste sites			
Wastewater treatment facilities			
Food residuals utilization sites			
Uncontrolled hazardous sites			
Tank farms			
Industrial complexes			



Assessment Item/Threat	Low	Moderate	Significant
Potential Contamination Source Inventory Non-point pollution sources Transfer stations Sludge utilization sites Automobile graveyards Engineered subsurface systems Woodyards Underground injection wells Surface impoundments Mining/mineral processing sites Overboard discharges to rivers Active UST sites Roadways Railroads Utility Rights-of-way Boat launches Commercial farms CAFOs Commercial forest operations Private septic systems Home heating oil tanks Airports Bathing beaches Combined sewage overflows	If present, at low density, properly installed and operated. In compliance with applicable local, state and federal regulations.	>>>>	High density, little evidence of active management, documented incidence of problems and failures.
Land Uses and Zoning Residential density Percent of watershed Owned by PWS Public lands or conservation Forested With protective zoning Agricultural Impervious cover Industrial/commercial Waterbody uses: Restricted areas Ice fishing Boating Swimming Recreational vehicles	> 2 Ac/lot  total > 80% for all protected uses  < 20 % total < 20 % total < 20 % total  large, posted  limited to absent	1-2 Ac/lot  intake and shoreland protected, others developed 20-30% total 20-30% total 20-30% total  intake zone  moderate, well-managed	< 1 Ac/lot  critical areas (intake, shoreland) unprotected or developed > 30% total of 3 > 30% total of 3 > 30% total of 3  small to none  prevalent, uncontrolled
Other Analyses Trophic State Index Vulnerability Index Build-out Analysis	< 25 low fully developed	25-60 moderate >>>	> 60 high high potential for development