CITY OF MOSES LAKE

SHORELINE INVENTORY AND CHARACTERIZATION

FINAL DRAFT

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1. INTRODUCTION

In 2004, the City of Moses Lake obtained a grant from the Washington State Department of Ecology (DOE) to conduct a characterization of its shoreline jurisdiction as defined by the state's Shoreline Management Act (RCW 90.58). The purpose of this study is to conduct a baseline inventory of abiotic, biological and cultural conditions in the City of Moses Lake's shoreline jurisdiction to provide the basis for the City's Shoreline Master Program update. This characterization will help the City identify existing conditions, determine functions and values of shoreline resources, and explore opportunities for conservation and restoration of ecological functions within the shoreline jurisdiction. These findings will help provide a framework for future updates to the City's shoreline environment designations and shoreline management policies and regulations.

Methodology

Following DOE (2004) protocols, this shoreline inventory and analysis attempts to integrate findings in an accessible manner through narrative and associated maps to inform SMP planning decisions and to provide a baseline for adaptive management and cumulative impact assessment. The resulting shoreline characterization indicates management opportunities for protection of ecological functions, restoration of degraded habitat, improving public access, and supporting water-dependent use.

Using existing reports, the protocol begins with providing a regional context, including a vicinity map, which describes the regional setting, climate, topography and land uses, and indicates the extent of shorelines that are under SMA jurisdiction. This regional context sets the stage for the characterization of ecosystem-wide processes that are influencing the ecological functions within the shoreline jurisdiction, focusing on upland and adjacent land uses that affect the flow of water, sediment, nutrients and materials. This characterization uses existing regional plans, as well as data and information from existing, studies, data and technical information, to identify management issues and determine the relationship of ecosystem-wide processes to shoreline functions, the health of those functions, and measures to protect or restore healthy processes and functions. Management issues addressed include flooding, erosion and sedimentation, loss and fragmentation of habitat, water pollution, and exotic species.

Following the characterization of ecosystem-wide processes, the protocol requires the characterization of the shoreline jurisdiction's ecological functions, which first requires mapping preliminary reach boundaries and documenting the rationale used. By overlaying the lake shoreline, land use, and aerial photos, reach boundaries are created by considering changes in land use and zoning, vegetation cover, and/or geomorphic units (e.g. notable changes in slope, soils, fetch, shoreline geometry, surficial geology).

After determining reach boundaries, assessment of the ecological function of each reach begins with overlaying biological features and critical physical areas, including fish and conservation areas, wetlands, riparian and aquatic vegetation, frequently flooded areas, and geologically hazardous areas, such as areas of slope instability or erosion. Next, possible impacts to ecological functions are determined by overlaying shoreline modifications, including structures (e.g. bulkheads, docks, storm drains), facilities cutting across the shoreline (e.g. roads and bridges), and land uses (e.g. agriculture, impervious surfaces). The results of these overlays are provided in a narrative summary and tables describing existing shoreline functions as evidenced by the mapped physical, biological and modification features.

The final step in the shoreline characterization is to overlay cultural and regulatory constraints to future use of the shoreline, and combine that analysis with the analysis of ecological functions to identify opportunities for shoreline protection and use. Cultural resources, public access, and regulatory designations that define and/or constrain future uses are mapped and summarized in both narrative and tables. These include archaeological and historic sites, public access, and zoning designations. Ecological protection and restoration opportunities are then identified through the physical, biological and cultural modification synthesis map overlays, while public access and cultural resource protection needs and opportunities are identified through the cultural jurisdiction synthesis maps. Preliminary shoreline environmental designation boundaries are also determined for each reach, based on existing use patterns and the biological and physical characteristics of the shoreline.

Principal Data Sources

A number of Grant County, State, and federal agency data sources, and technical reports were reviewed to characterize overall watershed conditions and to assess the ecological function of the City of Moses Lake's shorelines in this watershed context. Sources reviewed for this report include:

1) <u>Reports and Maps</u>:

Comprehensive Plan (City of Moses Lake 2000)

Park, Recreation, & Open Space Plan, Moses Lake, Washington (City of Moses Lake 2001).

Water System Plan for the Year 2000 (City of Moses Lake 2001).

Sewer System Plan (City of Moses Lake 1994).

Shoreline Management Master Plan (City of Moses Lake 1988)
Moses Lake Total Maximum Daily Load Groundwater Study. Washington Department of Ecology 2003)

Moses Lake Clean Lake Project. Irrigation Water Management Final Stage 3 Report (Moses Lake Irrigation and Rehabilitation District 1987).

Moses Lake Clean Lake Project. Irrigation Water Management Final Report (Moses Lake Irrigation and Rehabilitation District 1990).

Moses Lake Area: Water Quality Monitoring Report. (Moses Lake Irrigation and Rehabilitation District 1997).

Moses Lake Total Maximum Daily Load Phosphorous Study (Washington Department of Ecology 2002)

Shoreline Habitat Characterization and Analysis for the Moses Lake Project (Geo-Ecology Research Group, 2004)

2) Digital Databases

In addition, the following digital databases were also used as part of the inventory and analysis process:

- Washington State Department of Natural Resources. (2000). Digital 1:100,000-scale Geology of Washington.
- United States Department of Agriculture, Natural Resources Conservation Services. (2003). Soil Survey Geographic (SSURGO) Database.
- Washington State Department of Ecology. (1995). Lake Bathymetry of Washington.
- Federal Emergency Management Agency Flood Insurance Program Maps.
- United States Fish and Wildlife Service. (2003). National Wetlands Inventory Data.
- Washington Department of Fish and Wildlife (2002). Priority Habitats and Species and Natural Heritage Site databases
- Washington State Department of Fish and Wildlife. (1997). GAP Species Data.
- Interior Columbia Basin Ecosystem Management Project. (1995). Potential Natural Vegetation.
- Washington State Department of Natural Resources. (1996). Digital 1:24,000-scale Transportation (Roads and Railroads) of Washington.
- United States Census Bureau. (2000). Census TIGER® 2000/ Line Data; Railroads. Data retrieved 2004 from www.geographynetwork.com.
- Washington Department of Ecology. (1998). 303(d) Listings.
- Washington State Department of Ecology. (1998). DOE Facilities.
- Washington State Department of Ecology. (2004). Leaking Storage Tanks.
- Storm sewer outlets (City of Moses Lake)
- Grant County Zoning (Grant County)
- City parcels and land use (City of Moses Lake)

3) Data Sources Developed by Geo-Ecology Research Group

The following digital datasets were developed from a variety of sources:

- Soil permeability, runoff, erosion characteristics. Reclassified soil data from United States Department of Agriculture, Natural Resources Conservation Services [NRCS] Soil Survey Geographic (SSURGO) Database through cross reference of digital data and the NRCS Grant County Soil Survey information (1984). Data Acquired January 2004.
- Slopes > 15%. Developed using ESRI Spatial Analyst and U.S. Geological Survey 10-m DEM.
- Nearshore exposure due to lake drawdown, fish communities, and substrate type. Developed from data collected and analyzed for Washington Department of Fish and Wildlife (2004)
- Fishing “hot spots”. Digitized from Fish-n-Map Co. map.
- Riparian tree cover. Digitized from 2002 1:24,000 Washington Department of Transportation (DOT) aerial photographs rectified using 1996 DOT 1:24,000 black and white orthophotos.
- City of Moses Lake zoning. Digitized from pdf image Comprehensive Plan maps
- Imperviousness estimated from land use, based on Total Imperviousness Area Method (NRCS, 1986)
- Parks and boat launches. Digitized from Park, Recreation & Open Space Plan (City of Moses Lake, 2001).
- Archaelogical or historical resources as identified by the Washington State Department of Archaeology & Historic Preservation.Archaeological properties are of a sensitive nature and can be subject to vandalism. Records, maps, or other information identifying the location of archaeological sites are exempt from public disclosure per RCW 42.17.310 (1)(k). Sites are given as approximate positions, using offset polygons the width of the shoreline jurisdiction and 500 m in length.
- Shoreline environmental designations. Digitized from hard copy SMP maps for Grant County and the City of Moses Lake.

We also conducted a field survey of the City’s shoreline jurisdiction in 2004 to collect information on riparian vegetation conditions and land use, as well as map the following information using a Garmin 3+ GPS unit:

- bulkheads
- docks
- emergent vegetation

Report Organization

The report is divided into three principal sections. After Section 1, the Introduction, Section 2 provides the regional context and characterization of watershed conditions and ecosystem-wide processes. Section 3 provides the inventory and analysis of ecological functions in the shoreline jurisdiction by reach. This section includes a presentation and discussion of the shoreline reach breaks used, and separate discussions of the physical, biological, and cultural modification, and jurisdictional characteristics of each reach. These discussions are augmented by several tables in the appendix, as well as synthesis maps included in the accompanying DVD map portfolio. Each reach-level inventory and analysis includes a summary of shoreline conditions, including draft environmental designations and identification of potential opportunities for protecting and restoring ecological functions. Again, accompanying maps are included in the DVD map portfolio.

Use of Map Portfolio

To provide final synthesis maps at appropriate viewing scales that will inform the analysis report and illustrate findings, we chose to use an electronic map portfolio accessed through ESRI ArcReader, a free, easy-to-use mapping application that allows users to view, explore, and print maps. ArcReader © is a great way to deliver interactive mapping capabilities that access a wide variety of dynamic geographic information. Using ArcReader ©, anyone can view high-quality maps created using the ArcGIS© software (ESRI 2005).

Included on the DVD are 8 main folders:

- an ArcReader90 folder
- 7 data/map folders
    - Physical (physical.pmf)
    - Biological (biological.pmf)
    - Cultural Modifications (cultural_modification.pmf)
    - Cultural Jurisdictional (cultural_jurisdiction.pmf)
    - Protection Opportunities (opp_protection.pmf)
    - Restoration Opportunities (opp_restoration.pmf)
    - Environmental Designations (Env_Desig.pmf)

To begin using ArcReader to view maps, install ArcReader by navigating to the folder 'ArcReader90'. Click on Setup.exe and follow on-screen instructions.

Once ArcReader has been successfully installed, navigate to one of the data/map folders. Each of these folders contains two other folders called 'data' and 'pmf'. Ignore the data folder. Open the pmf folder and double click the pmf file with the same name as the parent folder.

If ArcReader has been installed properly (note – ArcReader will not install on PCs running Windows 98.) the ArcReader map will open up. The table of contents has intentionally been disabled in each of these ArcReader maps. Upon opening, a warning will flash on screen telling you as much, click OK. You are now ready to view and print ArcReader map files.

Two different versions of maps published into ArcReader have been delivered to the City of Moses Lake:

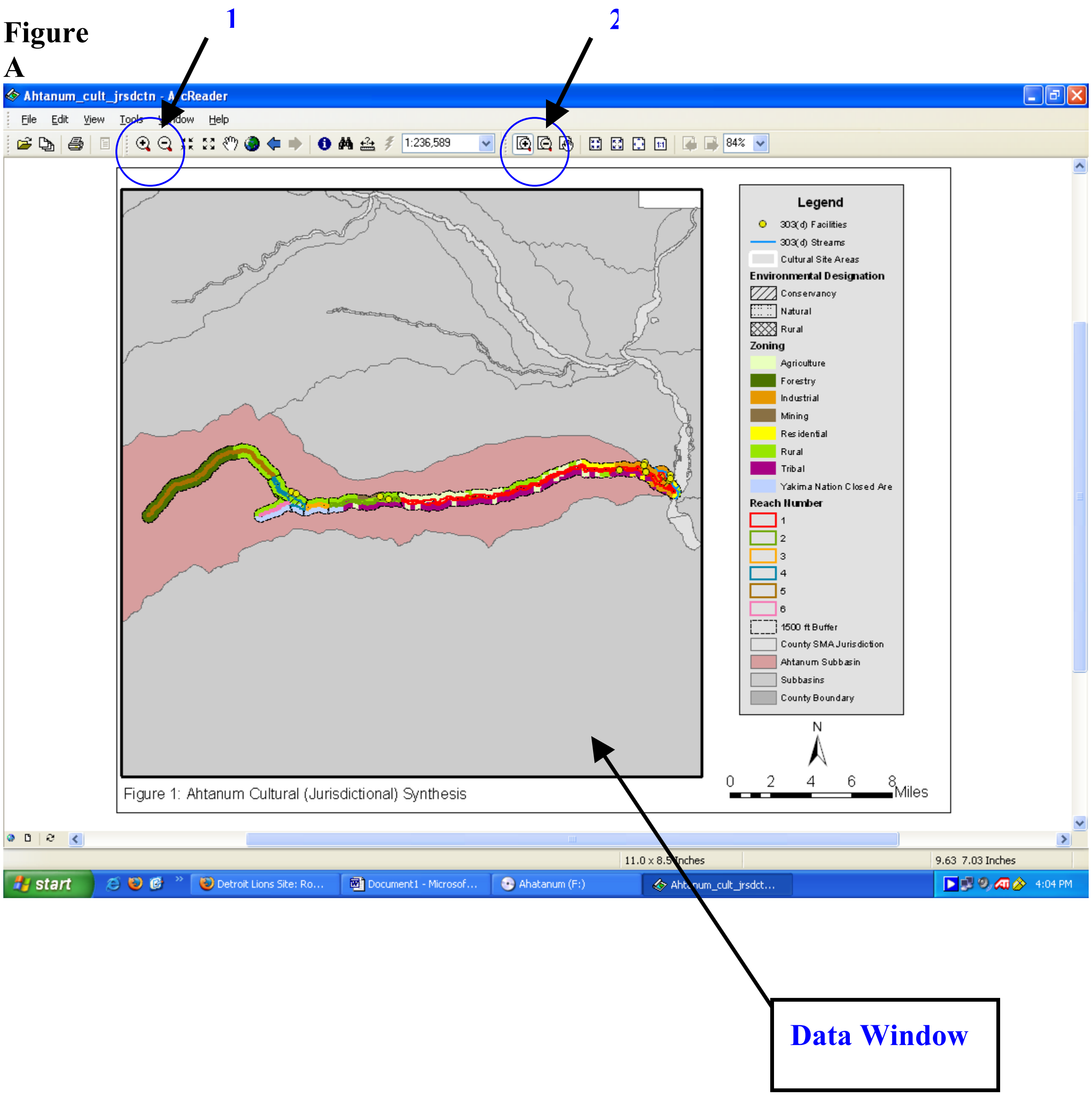
1. **Maps displaying biological information** (biological.pmf): data layers may be activated or deactivated on the map;
2. **All other map files**: Ability for user to manipulate data has been deactivated to simplify the viewing of maps.

Each of the map files opens to the full extent of a SMA jurisdiction. If the user navigates to **VIEW → BOOKMARKS,** then they can zoom the map to each individual reach or to the extent of the entire jurisdiction. This option is always available to the user. The user may also explore the map data using the zoom tool. There are two sets of zoom tools in ArcReader ©. One tool (#1) is used to zoom within the data window and the second tool (#2) is used to zoom in on the entire map document (Figure A). In most cases the user will want to use the first zoom tool.

When viewing biological data, it may be necessary to navigate to **VIEW→ TABLE OF CONTENTS** to open the **Table of Contents** window. The individual data layers can be activated and deactivated from the **Table of Contents** (Figure B).

The user may also use the software to print maps by navigating to **FILE → PRINT** on the main menu.

Figure A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2
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Cultural Site Areas
Environmental Designation
Conservancy
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Ahtanum Subbasin
Subbasins
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0 2 4 6 8 Miles
Figure 1: Ahtanum Cultural (Jurisdictional) Synthesis
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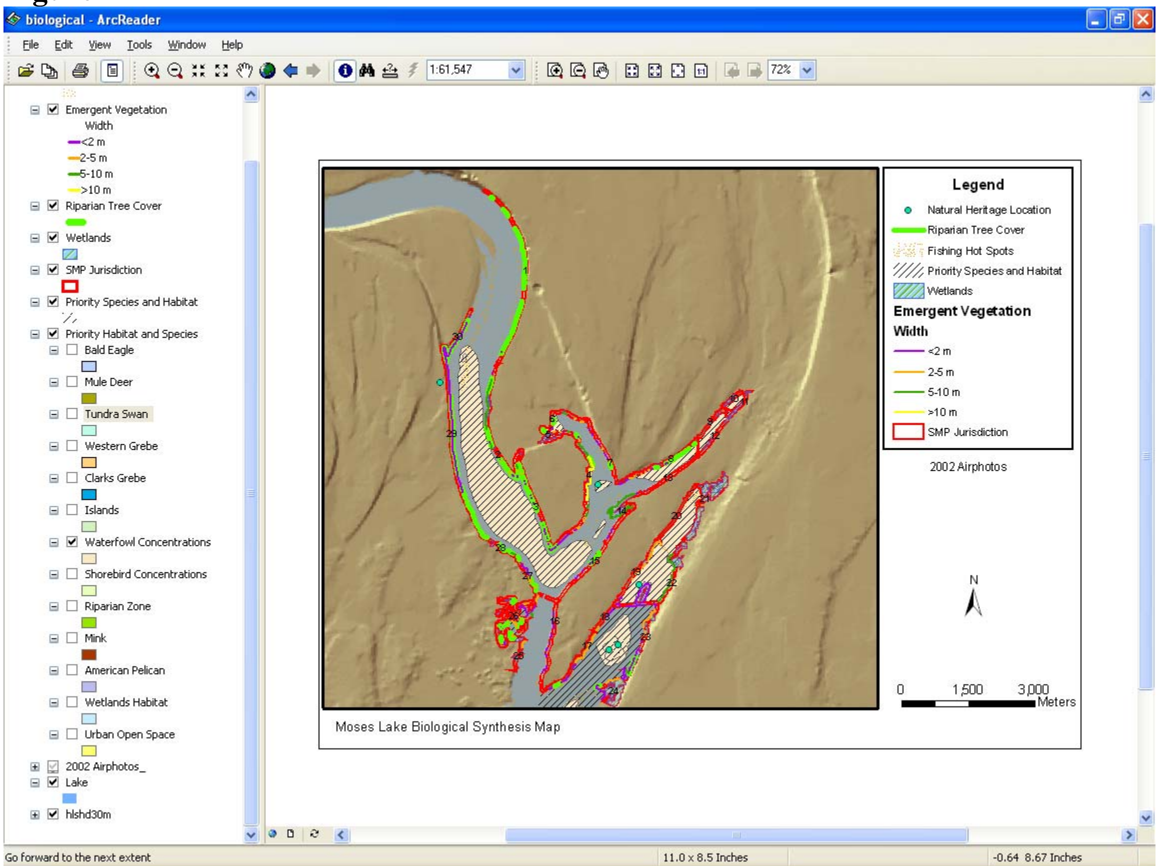
Data Window

Figure B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Riparian Tree Cover
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Priority Species and Habitat
Priority Habitat and Species
Bald Eagle
Mule Deer
Tundra Swan
Western Grebe
Clarks Grebe
Islands
Waterfowl Concentrations
Shorebird Concentrations
Riparian Zone
Mink
American Pelican
Wetlands Habitat
Urban Open Space
2002 Airphotos_
Lake
hlshd30m
Legend
Natural Heritage Location
Riparian Tree Cover
Fishing Hot Spots
Priority Species and Habitat
Wetlands
Emergent Vegetation Width
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Moses Lake Biological Synthesis Map
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11.0 x 8.5 Inches
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2. ECOSYSTEM-WIDE SUMMARY

Regional Setting and Topography

The City of Moses Lake is located along the southern portion of a 6800 acre fresh water coulee lake in the central Columbia Plateau region in Washington. The surrounding topography is characterized by relatively flat depositional terraces and cross-cutting, abandoned erosional channels, and surface drainage is generally toward Moses Lake (Fig. 1). These terraces step steeply down to the lake shoreline in several areas where cut banks were eroded by floodwaters, exposing thick sequences of the flood gravels along the lake shoreline (Grolier and Foxworthy, 1961).

Climate

The climate of Moses Lake is semiarid to arid with hot, dry summers, and moderately cold winters. The Cascade Mountain range, approximately 58 kilometers to the west of the lake acts as a precipitation barrier and funnels hot dray air in the summer and cold arctic air in to the Columbia Basin in the winter. Mean temperatures in the area range from a high of 88 degrees Fahrenheit in July to a low of 35 degrees in January. Average annual precipitation is about 9 inches, with approximately 80 percent falling from October through March.

Geology

Throughout much of the Moses Lake area, basalts are directly overlain by fine-grained deposits of the late Miocene to Pliocene-age Ringold Formation (Pitz, 2003)(Fig. 2). In the Moses Lake area Ringold sediments are primarily comprised of lacustrine clay, silt, and fine sand. Overlying the Ringold sediments are a sequence of Pleistocene-age flood deposits that mantle the ground surface around the majority of the lake. These unconsolidated glacio-fluvial deposits are largely comprised of massive to well-stratified boulder to granule-sized basaltic gravel, with lesser deposits of sand, silt, and non-basaltic gravel. These coarse sediments were deposited as a result of repeated, high-energy catastrophic floods that occurred with the rapid release of water from glacial-age Lake Missoula in Montana. Localized Quaternary deposits of eolian, lacustrine, and alluvial sediments have subsequently accumulated within low-lying portions of the study area.

Soils

Surface soils in the Moses Lake area are largely from the Ephrata and Malaga series. These soils are typically characterized by very deep profiles of well-drained to excessively well-drained material formed on glacial flood deposits (Bain, Jr., 1990). The grain size profile with depth is normally characterized by a shallow-horizon gravelly sandy loam (Ephrata) or cobbly sandy loam (Malaga) grading to deep-horizon extremely gravelly and cobbly coarse sand (USDA, 1984; Bain, 1990). Soil permeability is moderately rapid within the upper horizons, and very rapid in the lower most portion of the soil profile, reflecting the coarse-grained nature of the underlying parent deposits. Wind-born deposits of loess may be incorporated into the upper soil profile, and calcium carbonate coatings on particles are often present (Pitz, 2003).

Hydrology

Moses Lake is a shallow warm water lake that was created as a result of ice age glaciers and ancient floods that moved across eastern Washington (City of Moses Lake, 2001a). Moses Lake is an extended natural impoundment that was formed due to the deposition of dune sands across a channel system cut as a result of the ancient floods (Bain, Jr. 1990). The lake is over 20 miles in total length, approximately 11 square miles in total area, and has a mean depth of 18.5 feet. Rocky Ford Creek and Crab Creek are two SMA streams that drain into the lake, part of the 2,450 square miles of watershed that contribute runoff the Moses Lake (Fig. 1). Crab Creek drains approximately 84% of the watershed, including discharges from the Rocky Coulee Wasteway, a drainage conduit for major irrigation return flows. The lake drains into the Potholes Reservoir to the south.

Surface discharge from the lake is controlled by two US Bureau of Reclamation-operated dams located at the southern end of the lake, which manipulate lake surface elevation throughout the year for irrigation management as part of the Columbia Basin Project, serving as a supply route for water passing from the East Low Canal to the Potholes Reservoir (Pitz, 2003)(Fig. 2). In mid-March, the lake level is set to a relatively high and constant elevation, where it remains throughout the summer. In October, the lake level is lowered by approximately 1.5 m to create storage capacity for winter/early spring runoff, and to protect and allow maintenance of shoreline structures.

The lake is segmented into three major arms or horns (Bain, Jr., 1990)(Fig. 3). The main arm extends north, draining Rocky Ford Creek. The southern end of the lake includes Parker and Pelican Horns, which are separated by a peninsula. A smaller embayment, called Lewis Horn, is connected to Parker Horn, which is fed by Crab Creek. While flooding is normally not an issue, Crab Creek can exceed channel capacity in the upper reaches of Parker Horn during flash flood conditions (City of Moses Lake, 2001a).

The groundwater hydrology of the region primarily consists of several complex aquifers comprised of basalt formations and overburden deposits (Pitz, 2003). The majority of groundwater that interacts with Moses Lake moves through the unconfined, high permeability flood deposits, with limited direct interaction from the basalt system. Groundwater interacting with the lake along the southeastern shoreline of Pelican Horn (as well as in the area of the big bend), is presumably transported through the finer grained Ringold deposits present above and adjacent to the lake. There is no evidence that basalts are in direct contact with the lake. Depth to groundwater over the study area tends to relate directly to topography; depth to groundwater is routinely less than 20 feet in low relief areas adjacent to the lake shoreline (e.g. along the peninsula between Parker and Pelican Horns), while the depth to the water table on high bluffs around the lake may be over 100 feet.

Due to the extremely coarse character of the flood deposits, infiltration rates at the surface are considered to be very rapid, with limited attenuation capacity for pollutants (Pitz, 2003). Recharge to the local aquifer system originates from a combination of precipitation, infiltration of groundwater and surface water derived irrigation, and groundwater injection. Discharge from the aquifer system is primarily from water-supply withdrawals, discharge to local surface waterbodies, including the lake and Crab and Rocky Ford Creeks.

The majority of the groundwater that discharges into the lake moves through the unconfined, highly permeable gravels, cobbles, and boulders of the Missoula Flood deposits (Pitz, 2003)(Fig. 2). This discharge is likely concentrated in the nearshore areas of the lake bottom along the northwestern and eastern shorelines. Similarly, lake water recharges surficial aquifers along the southwestern and far southern shorelines.

Land Uses

Much of the land in the Crab Creek watershed is devoted to agriculture, including rangeland (630,000 acres), irrigated cropland (130,500 acres in the lower watershed), and dryland farming (781,500 acres in the upper watershed)(Bain, Jr., 1990)(Fig. 1). Extensive irrigated cropland is present to the west, southeast, east and northeast of the lake. Dry range and shrubland is the primary land use adjacent to the northern shorelines of the lake, which also include low density rural development and irrigated agricultural land. Urban and suburban shoreline residential development is occurring along much of the lake shoreline, especially the southern shorelines of the lake, concentrated along the peninsula between Parker and Pelican Horns, and on the northern shoreline of upper Parker Horn (Fig. 3). In total, more than 27,000 people live around the lake, with the majority concentrated in and around the city (Carroll et al., 2000). Rapid development has occurred over the last 15 years in several unincorporated areas beyond the city boundaries. The lake is primarily used for recreational purposes such as boating, fishing, jet skiing, and swimming.

Management Issues

<u>Alterations to hydrology</u>**:** Although Moses Lake was natural in origin, a dam was installed at the tributary of Crab Creek to control water levels. The lake is heavily influenced by irrigation and return flows – it is hyper-eutrophic with a flushing rate ~2x per year. The outlets are regulated by the Bureau of Reclamation and the Moses Lake Irrigation District. The combination of dam regulation and a low average annual precipitation of approximately 7.8 inches results in significant annual drawdown of approximately 5 feet in late summer. Several freshwater courses have also been altered in Moses Lake by filling or piped diversions (City of Moses Lake, 2001a).

<u>Water quality and sediment</u>: Water quality issues have been identified beginning in the 1960s when excessive nutrient loads began resulting in nuisance algal growth. The lake

has been classified as "hyper-eutrophic", which indicates that it is receiving excessive nutrient loading. Moses Lake is presently a 303(d) listed water body for exceeding set criteria for phosphorous. In the past, during certain years, Crab Creek has delivered total phosphorous loads to Moses Lake during large winter/spring runoff events greater than 500 cfs. Nitrate trends in some surface waters in the Columbia Plateau Agricultural Initiative (CPAI) area, such as Crab Creek, have also increased due to an increase of irrigated acreage.

Water quality in Moses Lake is of concern both to local residents and downstream users of Potholes Reservoir waters. A primary water quality problem is overproduction of algae, particularly blue-green algae, which form unsightly, floating mats during the summer recreation season (Bain, Jr., 1990). Development along the shoreline has also increased the amount of impervious surfaces, leading to increased stormwater runoff and the possibility of contaminants. Additional risks include agriculture runoff and septic failures. The primary sources of wastewater likely impacting local groundwater include leachate from septic systems, municipal waste lines, and infiltration of municipal wastewater (Pitz, 2003).

High nutrient loads also have contributed to excessive aquatic weed growth covering over half of the Moses Lake shoreline, which can impede boat traffic and swimming along the more developed shorelines such as along Parker Horn., as well as impede streamflow in Rocky Ford Creek (Bain, Jr., 1990). Water quality issues such as turbidity and release of nutrients is further aggravated by carp feeding and spawning activity, especially in Pelican Horn and lower Rocky Creek.

<u>Riparian and wetland habitat</u>**:** The lake, once a premier crappie, bass, bluegill, sunfish and trout fishery in central Washington, began to decline in the late 1970s. Annual drawdown of the lake may affect fish habitat by dewatering aquatic vegetation and exposing root structures to wave erosion and freezing. Residents along the shoreline have also been identified as removing aquatic vegetation. Development activities also affect the quality of freshwater habitat through removal of upland and wetland vegetation and increasing silt, organic debris, and other stormwater contaminants that enter the natural drainage system.

Good riparian habitat is primarily found along undeveloped shoreline of Moses Lake and Crab Creek, as well as undeveloped islands in the lake, while wetlands, typically ranging in 1-3 acres in size, are scattered throughout the Moses lake urban growth area, totaling approximately 610 acres (City of Moses Lake, 2001a)(Fig. 3). Significant wetlands are located in the northern tip of Pelican Horn and the eastern lakeshore, as well as along the Crab Creek shoreline. Small pockets of urban natural open space are also found along the shoreline. The greatest risk to these habitats is the continued pace of urban land conversions-particularly land development patterns that remove riparian cover and erode productive topsoil. Urban tolerant species, like raccoons and crows, invade the remaining habitat from the urban edges, supplanting and driving out remaining native species. Exotic species can become a nuisance when they reduce the amount of habitat and resources used by native species. In addition, stabilization methods such as bulkheads often associated with residential development disconnect the critical ecological linkages between the water and land environments.

The wetlands, riparian zones, and urban natural open spaces may support a variety of mammals (e.g. beaver, muskrat, mink, raccoon, weasel) and waterfowl (e.g. mallards, American widgeons, green-wing teal, blue heron, common merganser, and Canadian goose)(City of Moses Lake, 2001a). Portions of Moses Lake may also provide habitat for the bald eagle and osprey.

Species of Concern: A number of species of concern to federal and state agencies have been reported in the Moses Lake area. While data sufficient to map the areas used by most of those species have not been collected, it is reasonable to expect that some or all of the following species may be found within the City's shoreline jurisdiction, based on anecdotal information and biophysical characteristics of the shoreline area.

Species	**Federal Status**	**State Status**
American White Pelican	None	State Endangered
Bald Eagle	Threatened	Threatened. Breeding areas, communal roosts, regular and regular large concentrations, regularly-used perch trees in breeding areas are on PHS list
Burrowing Owl	Species of concern	Candidate; breeding areas, foraging areas, regular concentrations are on PHS list
Great Blue Heron	None	Monitor species; breeding areas on PHS list
Merlin	None	Candidate; breeding sites are on PHS list
Western Grebe	None	Candidate; breeding sites are on PHS list (1/04 addendum)
Yuma Myotis	Species of concern	None; breeding areas, foraging areas, regular concentrations are on PHS list
Townsend's Big-Eared Bat	Species of concern	Candidate; any occurrence is on the PHS list
Northern Leopard Frog	Species of concern	Endangered

The Washington Department of Fish and Wildlife (2002) has also classified certain habitats as Priority Habitats for protection along the Moses Lake shoreline. These include wetlands and riparian areas, as well as habitats for mink and mule deer, wintering bald eagle and Tundra swan, as well as breeding and nesting habitat for waterfowl, shorebirds, and Western and Clark's grebe.

Management Measures to Protect Ecosystem-Wide Processes

● **Hydrology issues:** Permits for new development and setback legislation can be used to mitigate stormwater flows. New developments should be required to use Stormwater Best Management Practices (BMPs).

● **Water quality issues** Wetlands and riparian vegetation within SMP jurisdiction can be protected to mitigate effects of upland sources. Public education on fertilizer and pesticide impacts may be useful, especially for shoreline residents. Slow runoff from construction sites with proper erosion controls. Avoid development on hydric or highly erodible soils. Identify neighboring jurisdictions for coordination of water quality management plans.

● **Riparian habitat issues:** New development can be regulated to ensure protection of riparian habitat and migration corridors. Use zoning and shoreline regulations to prevent encroachment of riparian and wetland habitat by new development within the SMP jurisdiction, including the use of buffers and adequate shoreline setbacks for new construction. Protect wetland and riparian vegetation within SMP jurisdiction to mitigate effects of upland nonpoint pollution sources, both by maintaining natural shoreline and aquatic plants as well as preventing their removal. Work with conservation districts and irrigation districts to institute livestock fencing along riparian areas. Prevent protection of shoreline with hard structures.

Management Measures to Restore Ecosystem-Wide Processes

- **Hydrology issues**: Work with Bureau of Reclamation and irrigation districts to alter dam and irrigation operations, such as timing drawdown to limit impacts to aquatic vegetation.
- **Water quality issues:** Effects on lake from upland developments can be addressed through integration with GMA planning. Direct storm runoff away from waterways or install containment ponds. Highlight locations for most effective stormwater retrofitting. Work with conservation districts and irrigation districts to institute BMPs for agriculture, including efficient use of irrigation water and fertilizer, control of animal waste and sediment, as well as livestock fencing along riparian areas. Develop public education programs to reduce fertilizer use on residential land near the shoreline.
- **Riparian habitat issues:** Implement a program to protect lakeside terrestrial and emergent vegetation. Retrofit shore protection structures with bioengineered approaches to help restore riparian vegetation and function. Maintain vegetative buffer along shoreline zones to help limit nonpoint source pollution. Maintain and enhance the biological and physical functions and values of wetlands. Provide for reasonable buffers around wetlands in order to provide a local habitat for wetland plant and animal communities, and to reduce or minimize intrusions from humans and domestic animals. Stewardship strategies should be implemented for the long

term management of wetlands. Maintain the natural value of wetlands to control and filter storm water runoff.