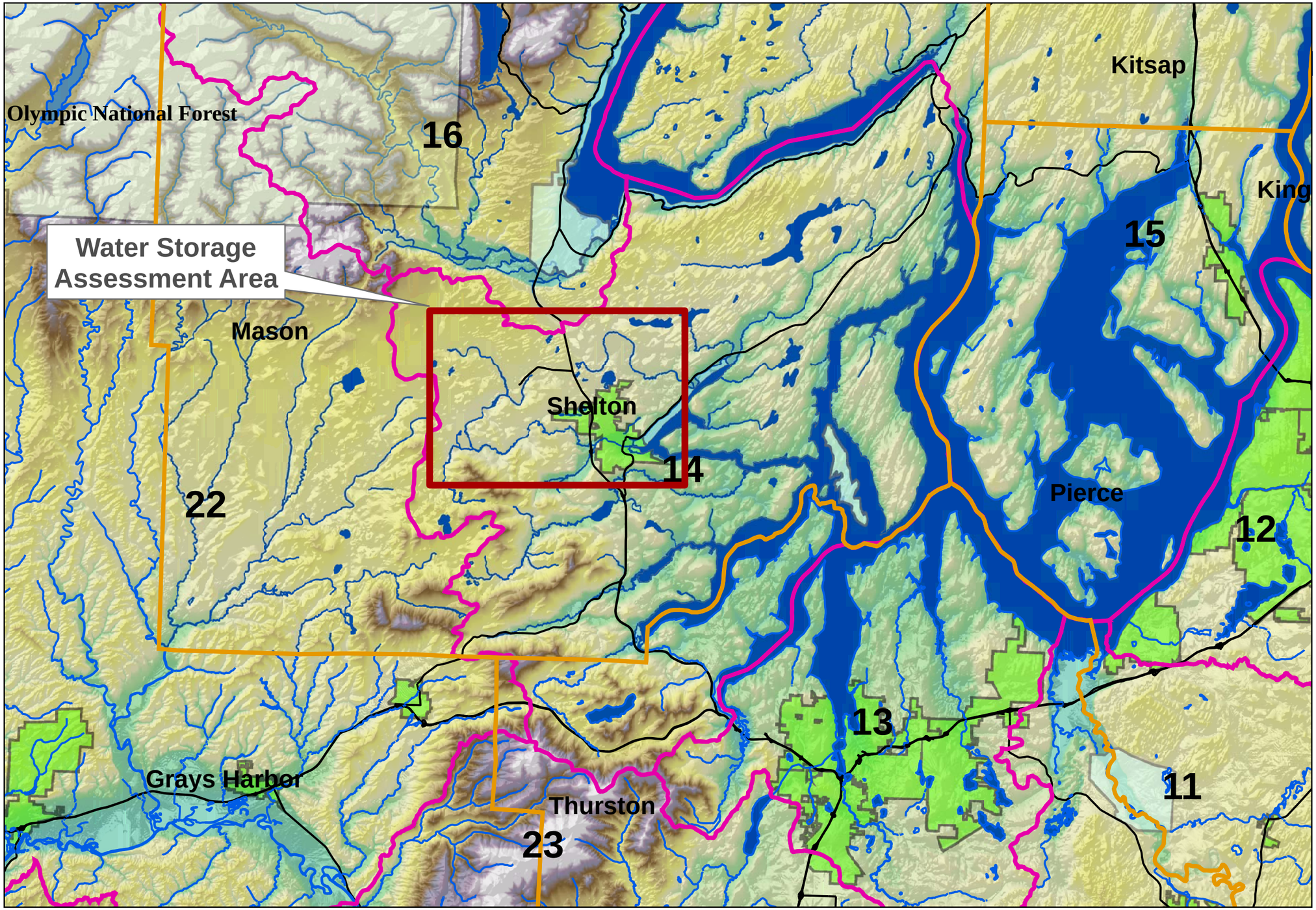

Figure 1.1
WRIA 14

Legend

- Cities
- National Forests
- County
- WRIA 14 Boundary
- Indian Reservations
- State Roads
- Water Bodies

Elevation

Height

High : 1550

Low : 0

LIDAR elevation data was obtained from Puget Sound LIDAR Consortium. Other data sources include WSDOT, WDNR, and WDOE.

N

Miles

0 4

1:250,000

RH2 ENGINEERS PLANNERS SCIENTISTS

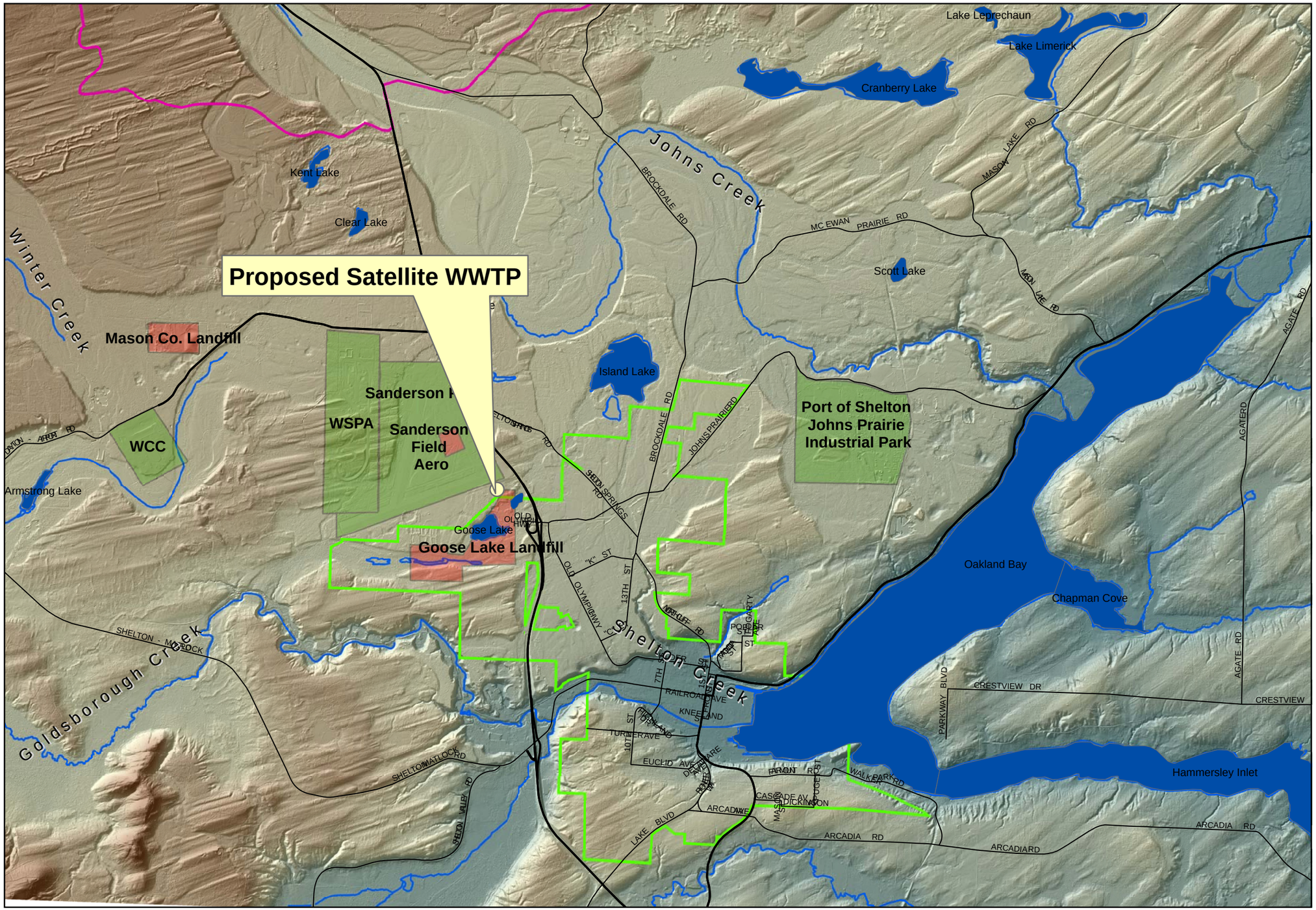

Figure 1.2 Water Storage Assessment Area

Legend

- WRIA 14 Boundary
- City of Shelton
- Hazardous Waste Site
- Regional Facility

Elevation

Value

- High: 870 ft
- Low: 0 ft
- Water Bodies

LIDAR elevation data was obtained from Puget Sound LIDAR Consortium. Other data sources include WSDOT, WDNR, and WDOE.

RH2 ENGINEERS PLANNERS SCIENTISTS

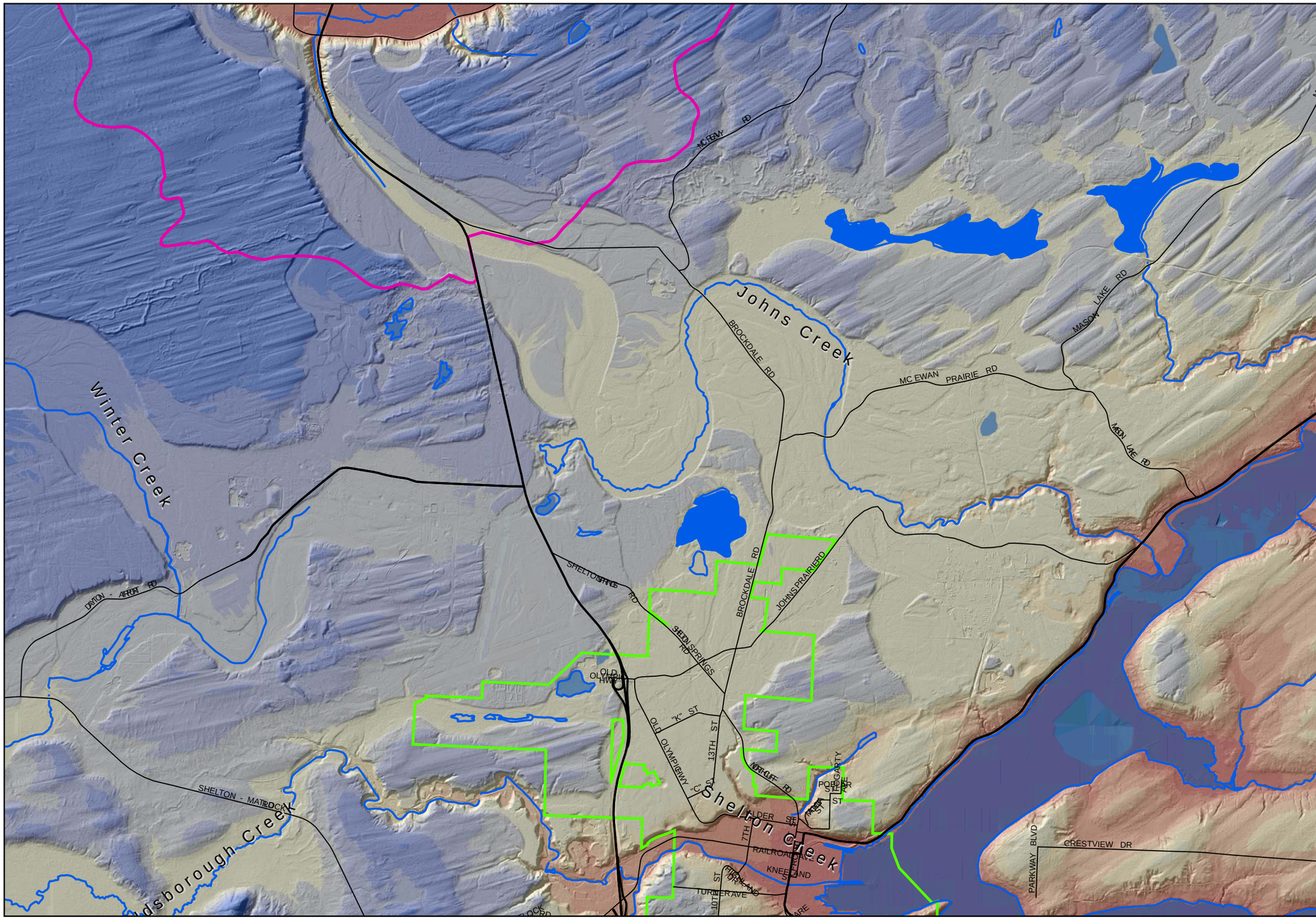

Figure 1.3 Topography: LIDAR and Elevation Scheme

Legend

- WRIA 14 Boundary
- City of Shelton

Elevation

<VALUE>

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- 300 - 350
- 350 - 400
- 400 - 500

LIDAR elevation data was obtained from Puget Sound LIDAR Consortium. Other data sources include WSDOT, WDNR, and WDOE.

N

Feet
0 4,000

1:48,000

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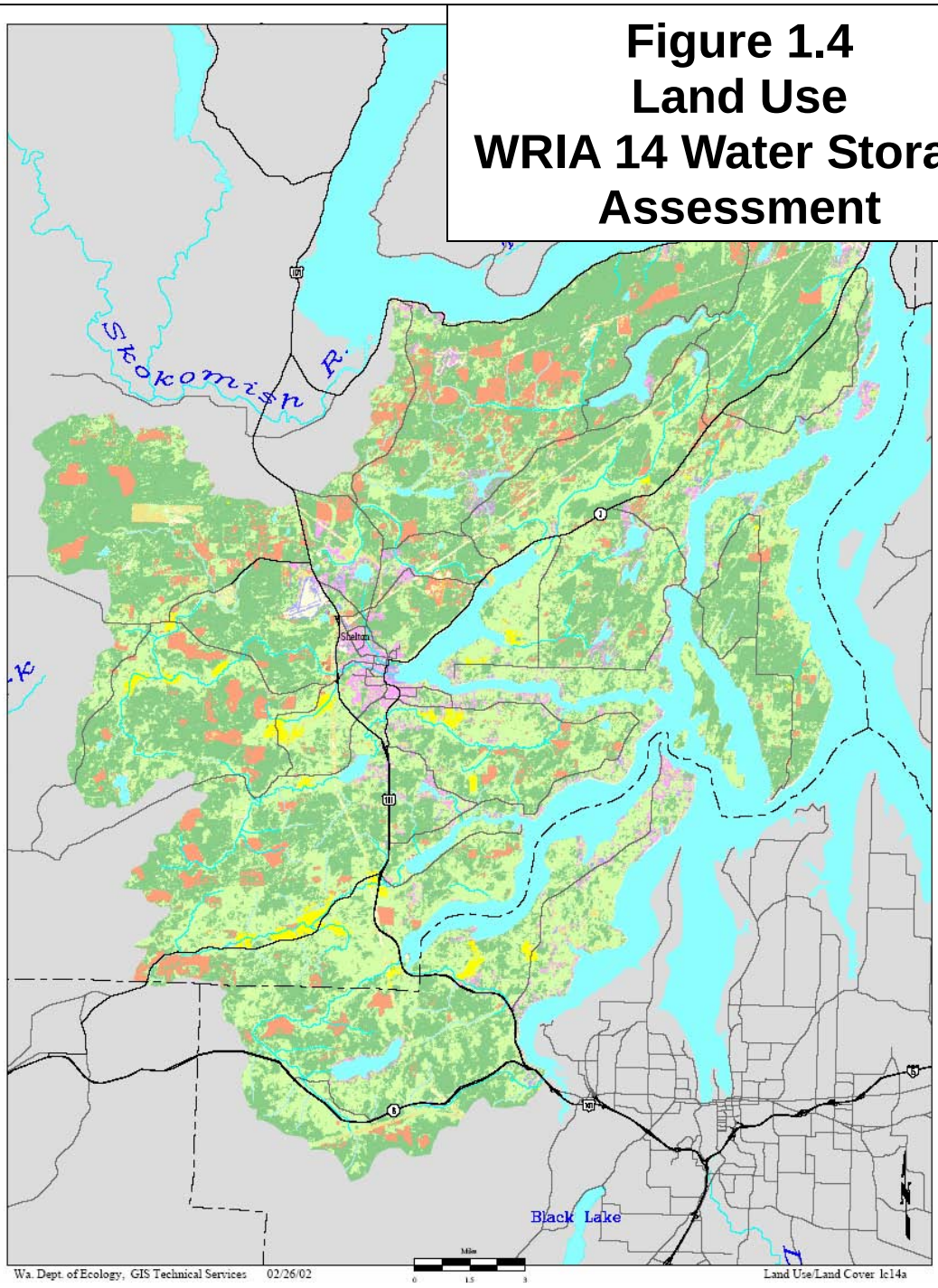
Figure 1.4
Land Use
WRIA 14 Water Storage Assessment



Water Resource Inventory Areas and Land Use/Land Cover

- Agriculture
- Forest (evergreen)
- Forest (mixed)
- Transitional
- Shrub
- Grass (herbaceous)
- Barren
- Urban (commercial)
- Urban (residential)
- Glacier
- Water
- Federal/State Highway
- Secondary Route
- Rivers/Streams
- WRIA Boundary
- County/State Boundary

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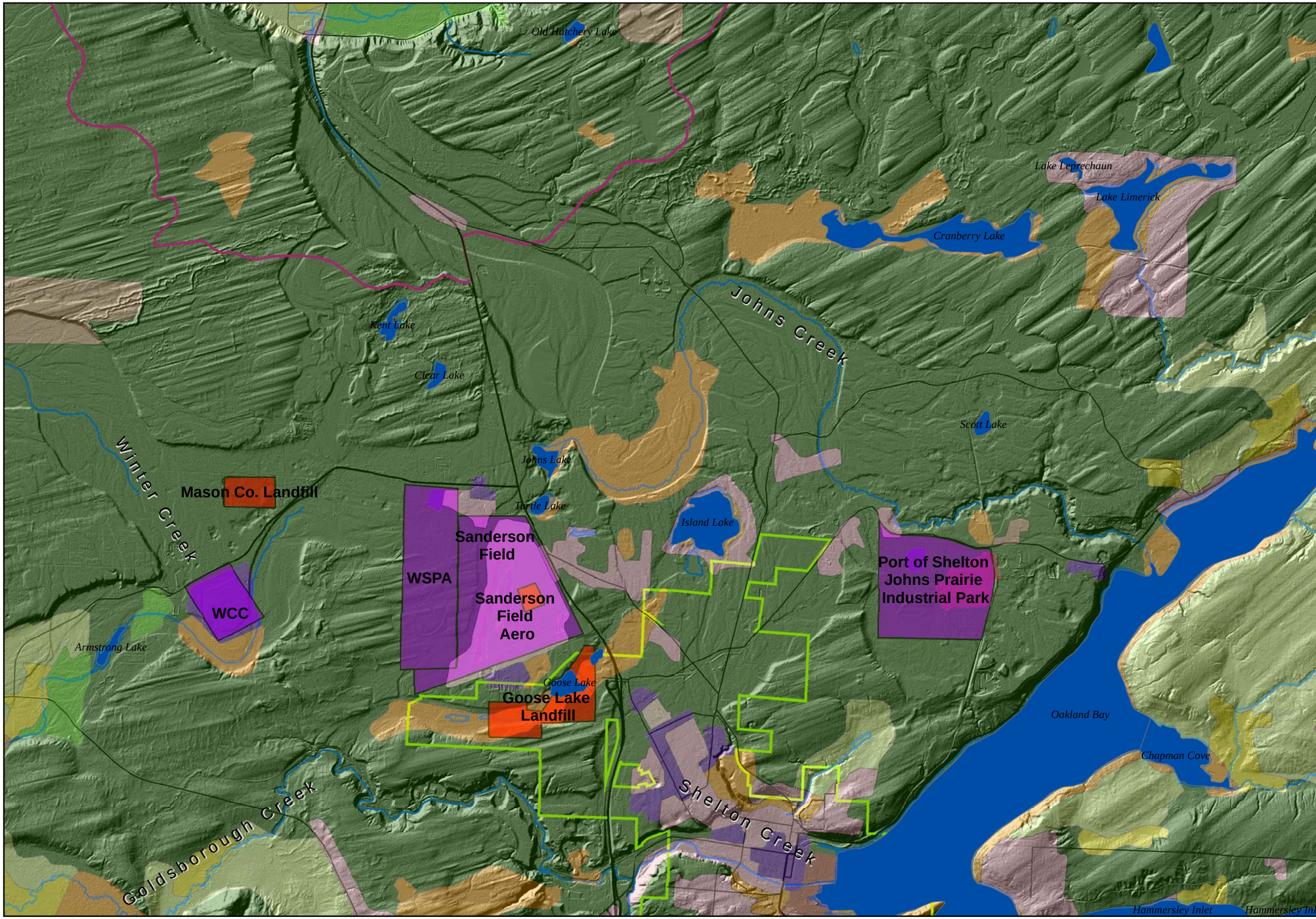


Figure 1.5 Land Use in Assessment Area

Legend

- Water

Major Facilities

- Hazardous Waste Site
- Regional Facility
- City of Shelton

Land Use

- Other
- Shrub
- Forest (Mixed)
- Forest (Evergreen)
- Forest (Deciduous)
- Agriculture
- Grass
- Wetland
- Urban (Commercial)
- Urban (Residential)

LIDAR elevation data was obtained from Puget Sound LIDAR Consortium. Other data sources include WSDOT, WDNR, and WDOE.

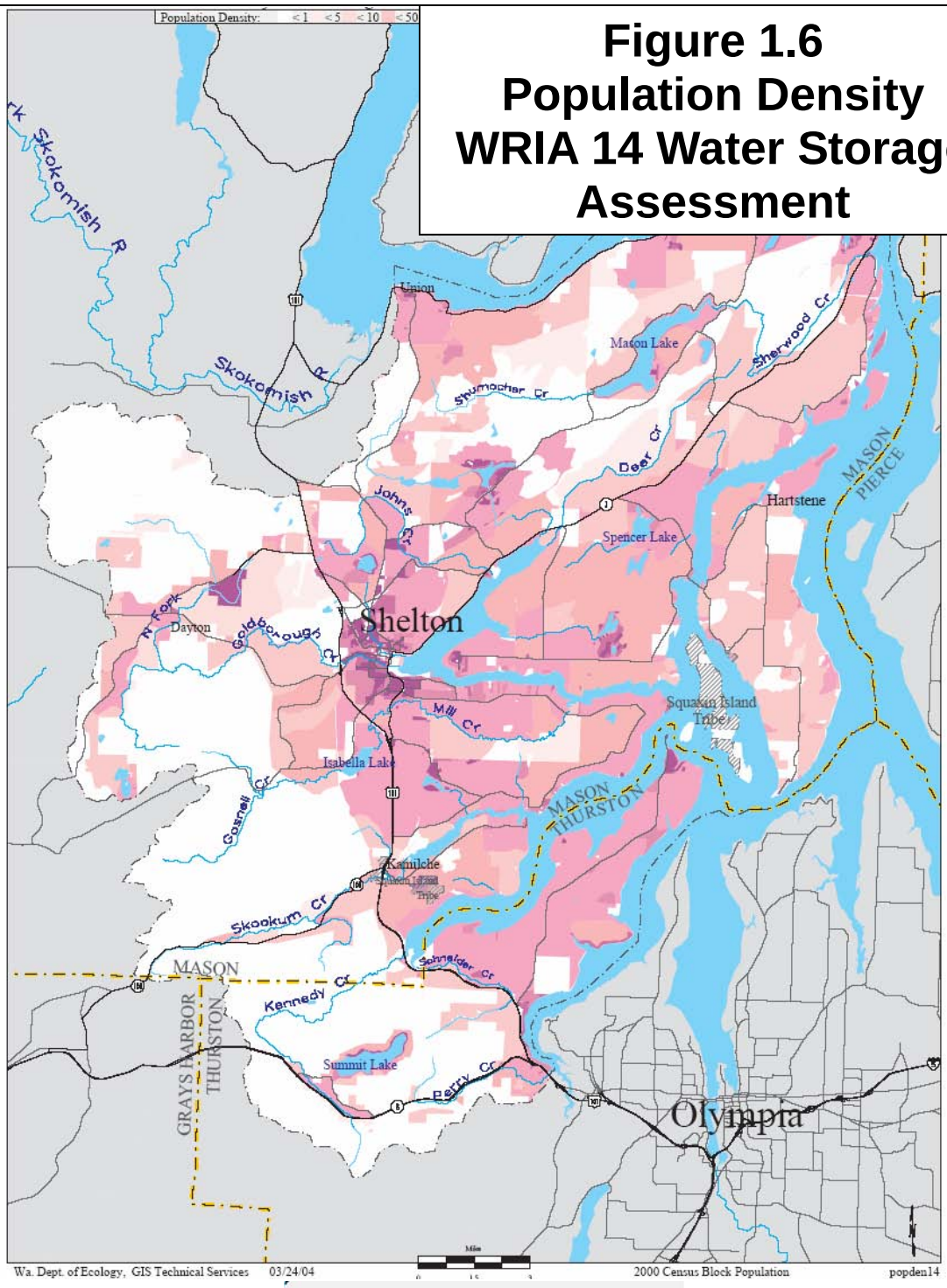
N

0 4,000 Feet

1:48,000

RH2 ENGINEERS PLANNERS SCIENTISTS

Figure 1.6
Population Density
WRIA 14 Water Storage Assessment



People per sq.mi.
- < 1
- 1-5
- 5-10
- 10-50
- 50-100
- 100-500
- 500-1000
- 1000-1500
- > 1500

- Public Land/Private Forest
- Tribal Reservation
- WRIA Boundary

TIGER Census 2000 Block population. Statistical areas bounded on all sides by man-made, geographical features or jurisdictional boundaries. Data resolution scale 1:100,000 US Bureau of Census/WOFM

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Figure 1.7
Average Daily Flow Goldsborough and Johns Creek
WRIA 14 Water Storage Assessment

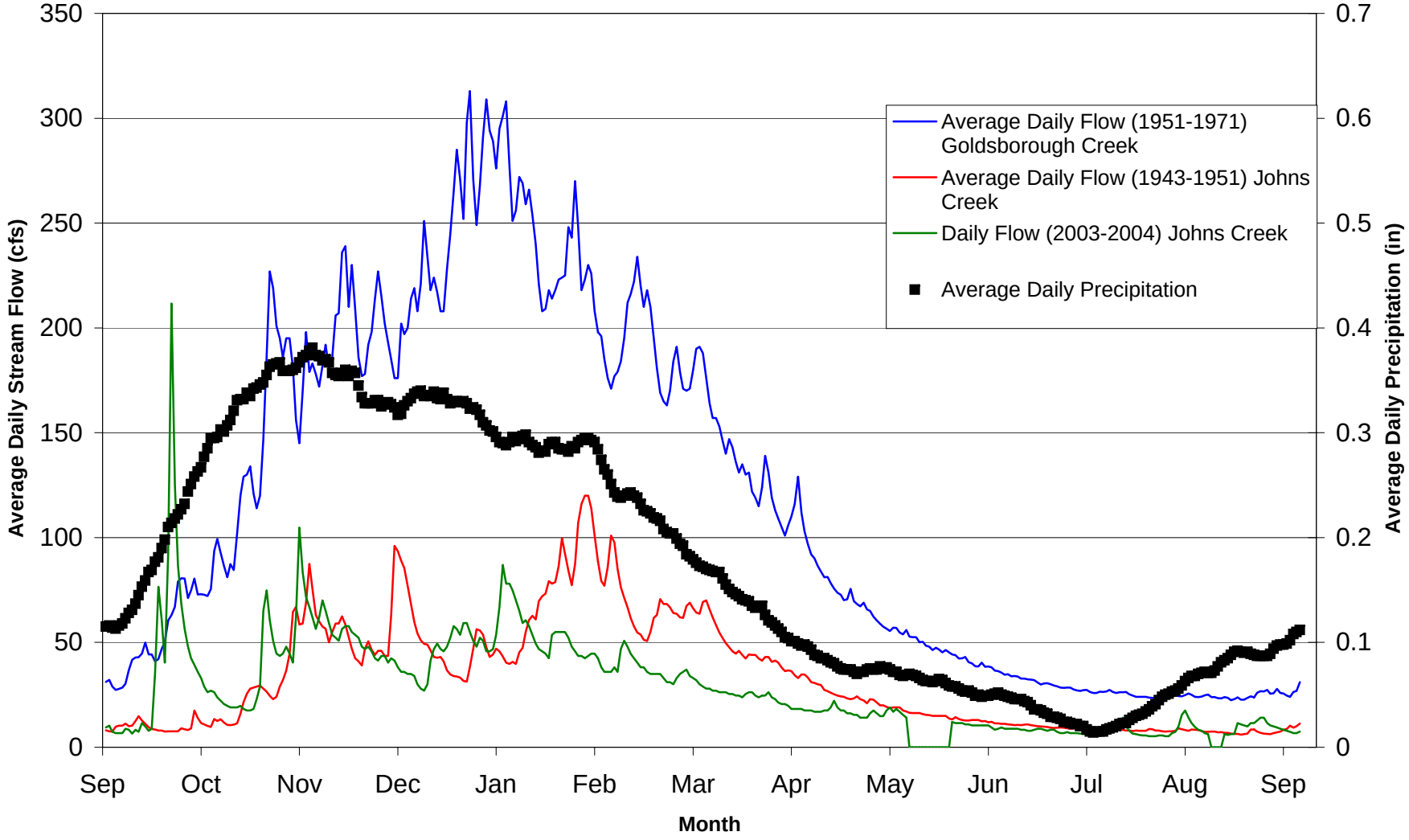
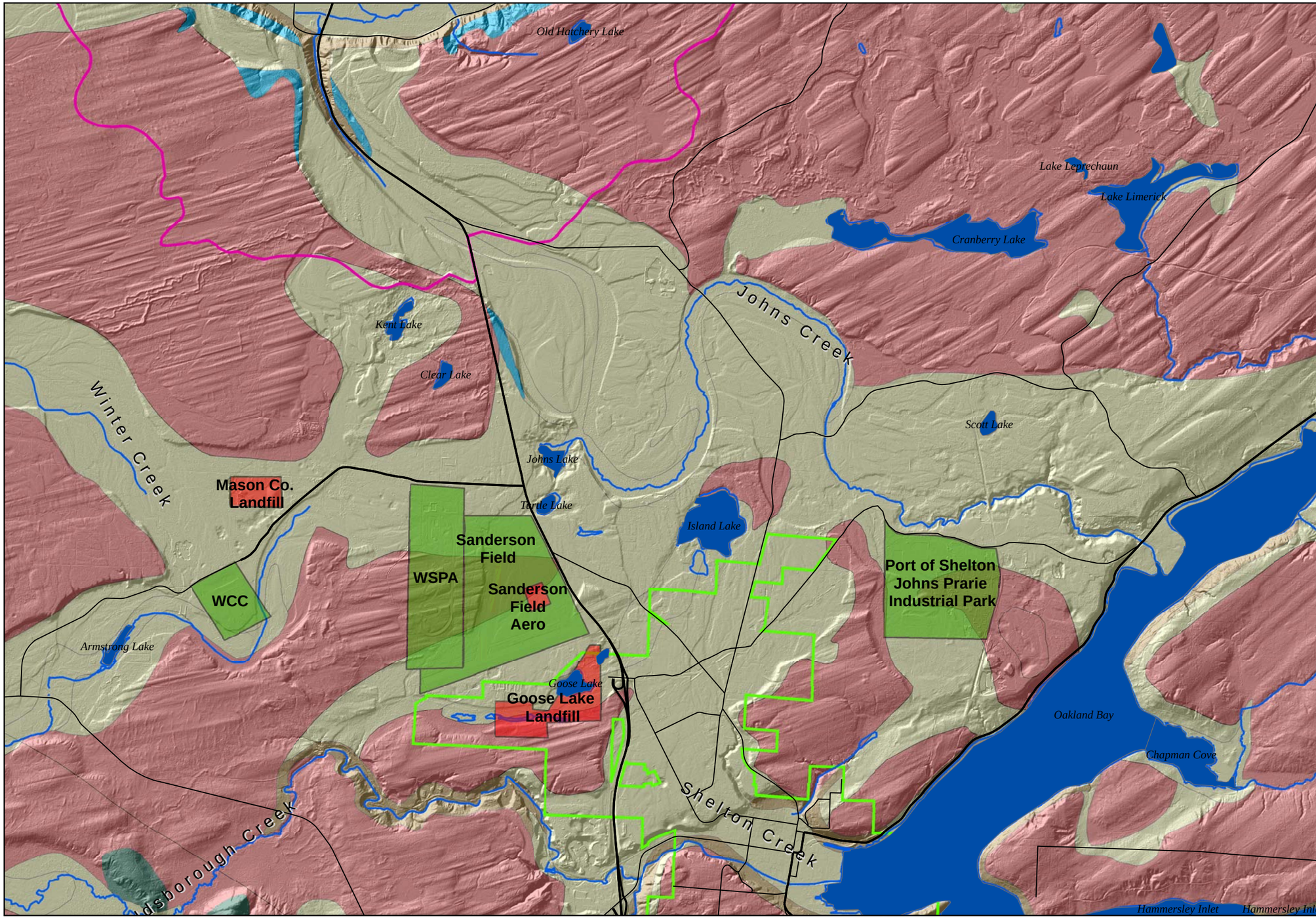


Figure 2.1 Geologic Map



Legend

- WRIA 14 Boundary
- City of Shelton
- Water Bodies

Major Facilities

- Hazardous Waste Site
- Regional Facility

Surface Geology

- Unit A
- Unit B and C
- Unit D
- Deeper Units
- Bedrock

LIDAR elevation data was obtained from Puget Sound LIDAR Consortium. Other data sources include WSDOT, WDNR, and WDOE.

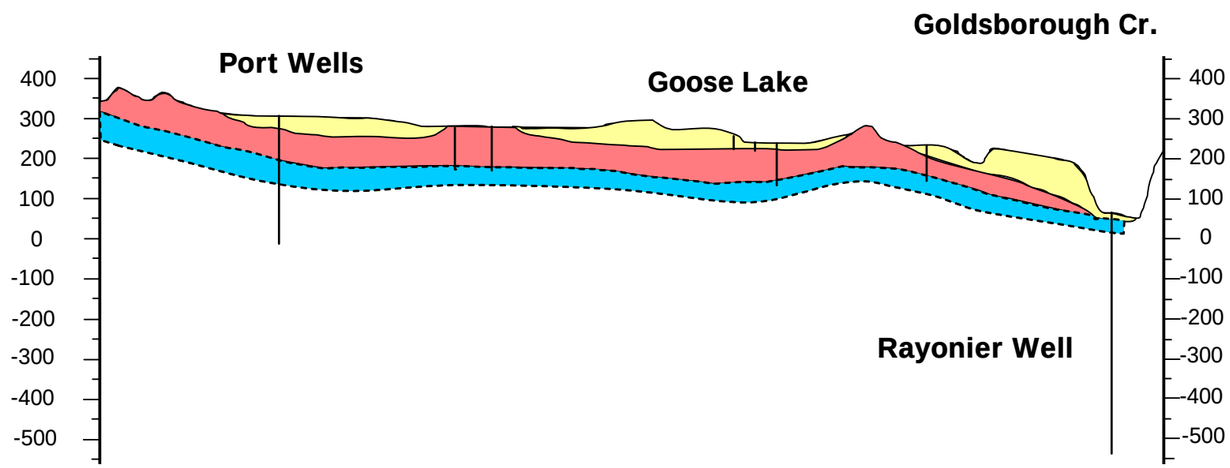
N

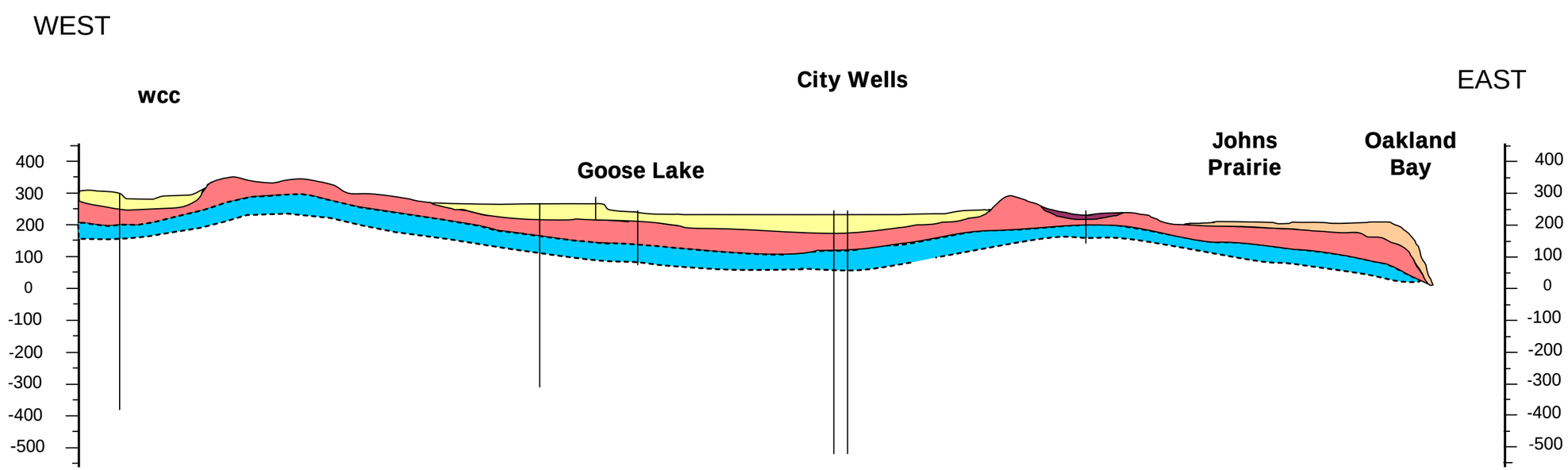
0 4,000 Feet

1:48,000

RH2 ENGINEERS PLANNERS SCIENTISTS

Figure 2.2 Geologic Cross Sections





Legend

Surface Geology

- Unit A
- Unit B and C
- Unit D
- Deeper Units
- Bedrock

0 5,000 Feet

1:48,000

RH2 ENGINEERS PLANNERS SCIENTISTS

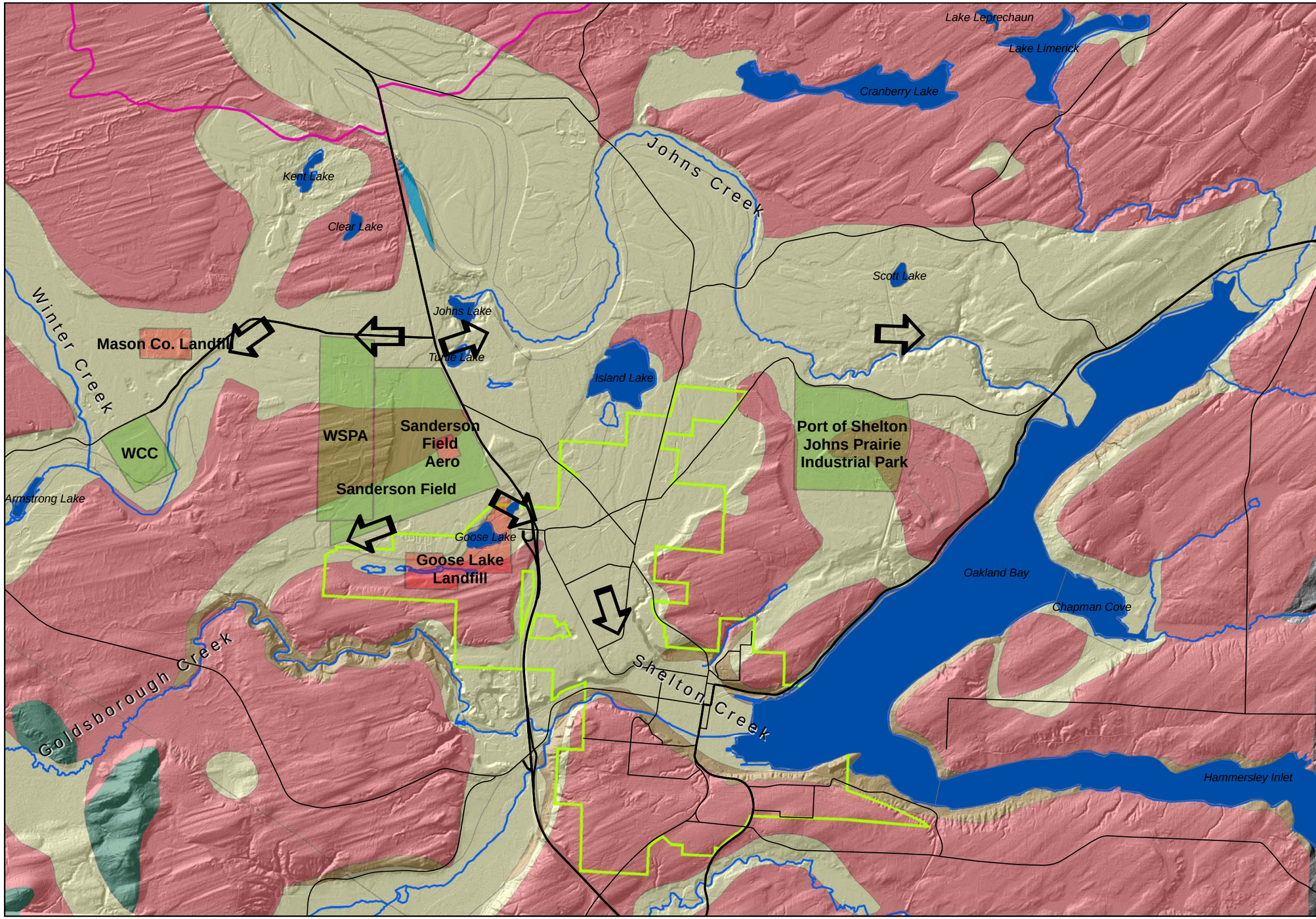


Figure 2.3 Generalized Shallow Groundwater Flow Directions

Legend

- City of Shelton
- WRIA 14 Boundary
- Water Bodies

Major Facilities

- Hazardous Waste Site
- Regional Facility

Surface Geology

- Unit A
- Units B and C
- Unit D
- Deeper Units
- Bedrock

LIDAR elevation data was obtained from Puget Sound LIDAR Consortium. Other data sources include WSDOT, WDNR, and WDOE.

N

0 4,000 Feet

1:48,000

RH2 ENGINEERS PLANNERS SCIENTISTS

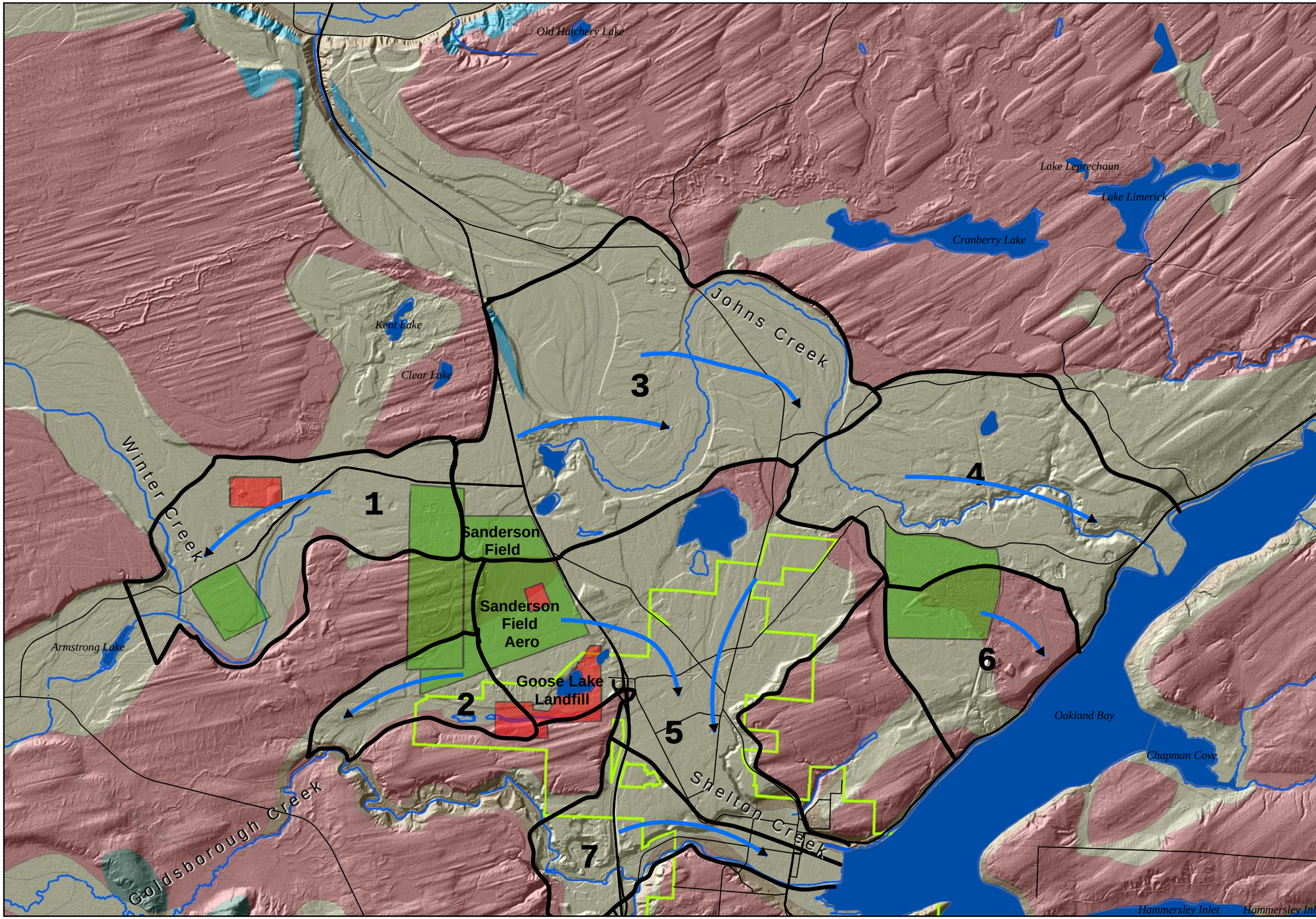


Figure 3.1 Infiltration Sub-Basins

Legend

City of Shelton

Surface Geology

- Unit A
- Units B and C
- Unit D
- Deeper Units
- Bedrock
- Water Bodies

Infiltration Sub-Basins
1. Upper Goldsborough Creek
2. Fairgrounds
3. Upper Johns Creek
4. Lower Johns Creek
5. Shelton Creek
6. South Johns Prairie
7. Lower Goldsborough Creek

Generalized Groundwater Flow

LIDAR elevation data was obtained from Puget Sound LIDAR Consortium. Other data sources include WSDOT, WDNR,

N

Feet
0 4,000

1:48,000

RH2 ENGINEERS PLANNERS SCIENTISTS

APPENDIX A
WRIA 14 HYDROGEOLOGIC INVESTIGATION AND INFILTRATION TESTING

A. Investigation of Satellite WWTP Region

Test Pit Investigation

In August 2004, SLR International Corp. investigated shallow subsurface conditions south and east of Sanderson Field to confirm the geologic characteristics of shallow soil in these areas (**Figure A1**). The Regional Plan tentatively identified these areas for possible infiltration sites. An SLR hydrogeologist directed Port staff to excavate shallow test pits approximately 12 feet deep at four locations: Port property and TSAI property east of Highway 101, and Port property and Kneeland property west of Highway 101 and south of Sanderson Field (**Figure A1**).

Findings

Test pit exploration encountered sand and gravel units in all of the areas and dense sandy silt and gravel (glacial till) at the Port property east of Highway 101. Only a thin layer (less than 2 feet) of sand and gravel was encountered at the east Port property and it was determined that the area did not have sufficient sand and gravel thickness for infiltration. The sand and gravel layer at the TSAI property was at least 10 feet thick, but groundwater levels encountered at a depth of 9 feet below ground surface indicated insufficient receptor capacity to temporarily store the reclaimed water without significant mounding and potential impacts to adjacent wetlands. Rise in water levels in the wetland areas near the TSAI property would likely exceed maximum allowable water level increases at wetlands specified in RCW Chapter 90.46, precluding the use of the TSAI property as an infiltration site.

The sand and gravel encountered at the Kneeland property exhibited excellent infiltration potential. Exploration test pits encountered at least 12 feet of permeable sand and gravel. Lithologic logs for monitoring wells completed at the property, indicate sand and gravel thickness ranges from 30 to 40 feet. Geologic mapping indicates that the sand and gravel extends throughout the Kneeland property. Land use (Goose Lake hazardous waste site) and site conditions (Goose Lake wetlands, steep slopes), however, may limit the site for infiltration.

The western Port property, which comprises Sanderson Field, the access road to the fairgrounds and property south of the access road, also exhibited excellent infiltration potential. Conditions encountered during test pit exploration at the western Port property resemble those of the Kneeland property, although some organic material was encountered in the upper 2 to 4 feet of several test pits. The proximity to the airport and public access related to use of the fairgrounds would require specific designs to meet permitting requirements.

Hydrogeologic concept model and feasibility review

The findings of the initial investigation and a description of a hydrogeologic conceptual model of the assessment area which reviewed the feasibility of infiltrating reclaimed water in the assessment area were submitted to the WRIA 14 planning committee. The committee members reviewed and accepted the findings and recommended additional

assessment of the local hydrogeologic characteristics of the Sanderson Field-Fairgrounds area and the Johns Prairie area at the Port of Shelton Industrial Park.

A brief assessment of the hydrogeologic characteristics of the Johns Prairie Industrial Park using available environmental and geotechnical reports confirmed the potential for infiltration and storage at the Industrial Park. The planning committee approved additional hydrogeologic characterization of the Sanderson Field/Mason County Fairgrounds area and for the Port of Shelton Industrial Park.

Hydrogeologic Site Characterization

Activities

The hydrogeologic site characterization assessed infiltration rates, groundwater storage potential, and groundwater mounding potential at the two sites (**Figure A1**). The assessment at both locations consisted of:

- drilling and completing one groundwater monitoring/aquifer test well;
- excavating a temporary infiltration trench; and
- pilot infiltration testing.

These field activities combined with the available data from other hydrogeologic investigations in the two areas provided sufficient information to evaluate the potential performance of infiltration and storage system at both sites. Short-term aquifer testing was conducted at the Johns Prairie site.

Drilling

On July 1, 2005, Cascade Drilling Inc., (Cascade) installed a 4-inch diameter PVC well at both sites. The Sanderson Field (SF-1) and the Johns Prairie Industrial Park (JPIP-1) wells were completed at depths of 41.5 feet and 31.5 feet, respectively. Cascade constructed both wells using 25 feet of 0.020-inch slot well screen according to WAC 173-160 *Well Construction*. Well completion logs are attached at the end of this Appendix.

Pilot Infiltration Testing

Port of Shelton personnel constructed the infiltration trenches using a backhoe. The Sanderson Field-Fairgrounds trench was completed at a depth of 4 feet bgs and with dimensions of approximately 20 by 4 feet. The Johns Prairie trench was completed at a depth of 3 feet bgs and with dimensions of approximately 20 by 2 feet. The midpoints of both trenches were approximately 25 feet from the respective monitoring well. **Figures A2** and **A3** show the locations of the infiltration testing sites. A pre-existing monitoring well (MW-1) at the Johns Prairie site provided an additional location for site monitoring. Well MW-1 is approximately 40 feet south of JPIP-1 and was approximately 15 feet south of the south end of the infiltration trench.

The pilot infiltration testing at the two sites consisted of discharging potable water from a Port hydrant into the trench until the water level in the trench stabilized, then adjusting the flow into the trench until both the discharge into the pit and the water level in the pit remained steady. Steady infiltration rates of 16 gpm and 115 gpm were attained at the Sanderson Field and Johns Prairie sites, respectively, after approximately 4 to 5 hours of infiltration. The Sanderson Field test was conducted on July 7, 2005, and the Johns Prairie test was conducted on August 10, 2005. No response to infiltration was observed

at the test well at the Sanderson Field site. A rise of 0.2 feet was observed at both wells at the Johns Prairie site. **Figures A4** and **A5** illustrate testing results at the two sites.

Aquifer testing

Short-term pumping tests were intended for the two sites site, but after infiltration testing, it was determined that industry-available 4-inch diameter pumps would not have sufficient capacity (greater than 100 gpm) to apply sufficient stress to the shallow aquifer for useful testing. Instead, aquifer testing consisted of injecting potable water from the hydrant into the 4-inch test well at the Johns Prairie site at rates ranging from 25 to 75 gpm and measuring steady-state water levels in the well. Water levels stabilized within seconds of injection rate increase. The water level rose by 1 foot under the maximum 75 gpm injection rate, which indicates a hydraulic conductivity value in the range of 0.25 to 0.4 cm/sec.

No aquifer testing was performed at the Sanderson Field site; no groundwater response was observed during infiltration testing, indicating high permeability aquifer materials at the site. Inspection of the soil samples retrieved from the test well borings indicated that the permeability of the shallow aquifer at the Sanderson Field-Fairgrounds site is equal to or greater than the permeability of the shallow aquifer at the Johns Prairie site. A similar response to pumping and injection was assumed for the Sanderson Field-Fairgrounds site as observed at the Johns Prairie site.

The infiltration and testing results indicate that the hydrogeologic characteristics of Unit A at either of the two locations would accommodate reclaimed water infiltration with acceptable levels of groundwater mounding. Additional longer-term hydrogeologic characterization is recommended at the site selected for the infiltration and storage facility.

PROJECT	WRIA 14	BORING JPIP-1	FIELD LOCATION
PROJECT #	105-082	DATE BEGAN 7/1/2005	
OBSERVER	Nelson	COMPLETED 7/1/2005	South end of E Production Road near ballfields
CONTRACTOR	Cascade	TOTAL DEPTH 30	Shelton, WA
METHOD	Hol Stem	SHEET 1 of 1	

Other	Well Details	Sample Method	Sample #	Blows/ Foot	Sample/ Recovery	DEPTH	SOIL SYMBOL	LITHOLOGIC DESCRIPTION
	Flush Mount in							
	asphalt							
	4-in diam PVC							
	Blank riser	SS		10	X	5	SW	Brown, fine to coarse sand with subrounded fine gravel
	0 to 15 feet			20	X			to 3 inches, dense, moist (outwash)
				25	X			
	med bent chips							
	2 to 13 feet							
		SS		14	X	10	SW	Brown, fine to coarse sand with subrounded fine gravel
	10 x 20 CSS			10	X			to 3 inches, dense, moist (outwash)
	sand filter			14	X			
	13 to 30 feet							wet at 13 feet
	Well Screen	SS		5	X	15	SW	Brown, fine to coarse sand with subrounded fine gravel
	15 to 30 feet			7	X			to 3 inches, dense, wet (outwash)
	0.020 in slot			13				
		SS		50-6	X	20	SW	Brown, fine to coarse sand with subrounded fine gravel
				50-6				to 3 inches, dense, few fines, wet (outwash)
		SS		100-	X	25	SW	Brown, fine to coarse sand with subrounded fine gravel
								to 3 inches, dense, few fines, wet (outwash)
		SS		38	X	30	SW	Brown, fine to coarse sand with subrounded fine gravel
				50-6	X			to 3 inches, dense, few fines, gravel size increasing, wet,
								(outwash)

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Remarks:

PROJECT	WRIA 14	BORING SF-1	FIELD LOCATION
PROJECT #	105-082	DATE BEGAN 7/1/2005	
OBSERVER	Nelson	COMPLETED 7/1/2005	300 feet north of Mason County Fairgrounds entrance gate
CONTRACTOR	Cascade	TOTAL DEPTH 40	Shelton, WA
METHOD	Hol Stem	SHEET 1 of 1	

Other	Well Details	Sample Method	Sample #	Blows/ Foot	Sample/ Recovery	DEPTH	SOIL SYMBOL	LITHOLOGIC DESCRIPTION
	Flush Mount in							
	gravel					3	SW-	Dark brown, organic gravelly sand with few fines, moist (fill)
							SM	
	4-in diam PVC							
	Blank riser	SS		15	X	5	SW	Brown, gravelly sand with few fines, few organics, moist (outwash)
	0 to 15 feet			9	X			
				6	X			
	med bent chips							
	2 to 13 feet							
		SS		11	X	10	SW	Brown, fine to coarse sand with subrounded fine med gravel
	10 x 20 CSS			12	X			to 4 inches, dense, moist (outwash)
	sand filter			20	X			
	to 13 feet							
	Well Screen	SS		13	X	15	SW	Brown, fine to coarse sand with subrounded fine gravel
	15 to 40 feet			13	X			to 3 inches, dense, wet (outwash)
	0.020 in slot			22	X			
	10 x 20 CSS							
	sand filter	SS		15	X	20	SW	Brown, fine to coarse sand with subrounded fine to med gravel
	to 13 feet			21	X			to 4 inches, dense, few fines, moist to wet (outwash)
				23	X			
								wet at 24 feet
		SS		16	X	25	SW	Brown, fine to coarse sand with subrounded fine gravel
				23	X			to 3 inches, dense, few fines, wet (outwash)
				16	X			
		SS		50-6	X	30	SW	Brown, fine to med sand with subrounded fine gravel
								to 3 inches, dense, few fines, gravel size increasing, wet,
								(outwash)
				16	X	35	SW	Brown, fine to coarse sand with subrounded fine gravel
				24	X			to 3 inches, dense, few fines, wet (outwash)
				20	X			
				10	X	40	G W	Brown, fine to med gravel, fine to coarse sand, dense, few fines
				15	X			wet, (outwash
				18	X			

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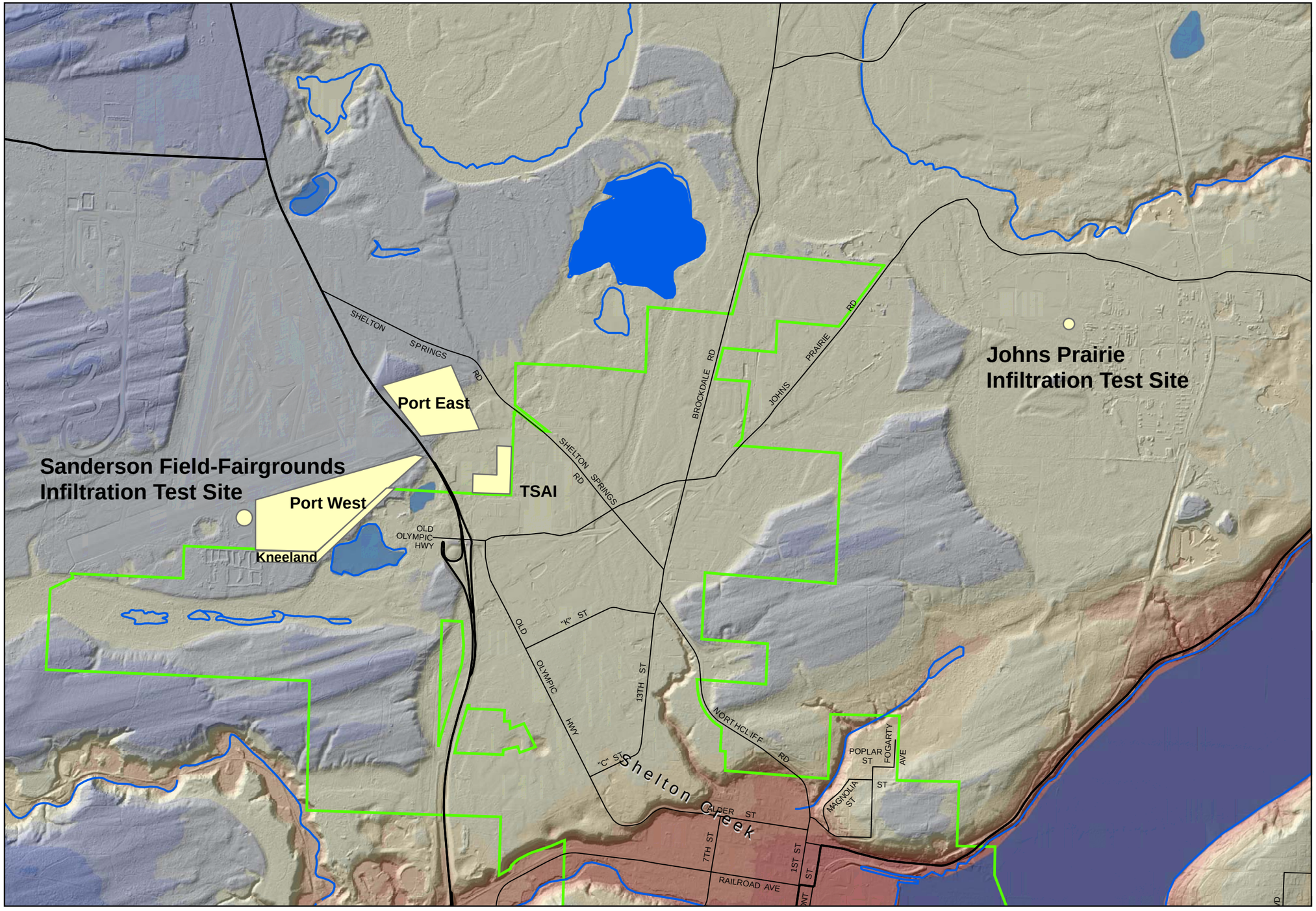
Remarks:

Figure A-1
Hydrogeologic Investigation Locations



Legend

- WRIA 14 Boundary
- City of Shelton

Elevation

<VALUE>

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- 300 - 350
- 350 - 400
- 400 - 500

LIDAR elevation data was obtained from Puget Sound LIDAR Consortium. Other data sources include WSDOT, WDNR, and WDOE.

N

0 2,000 Feet

1:24,000

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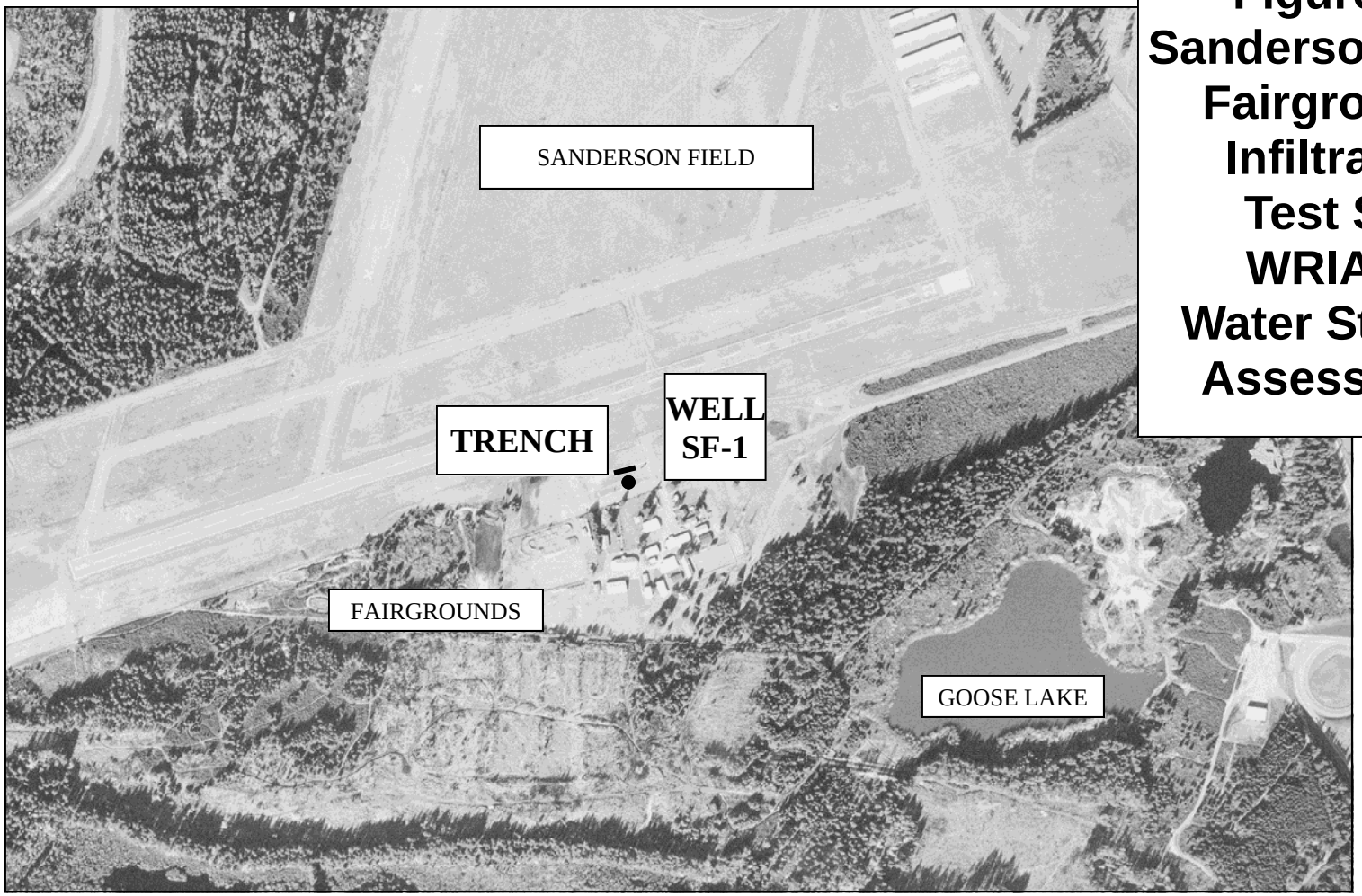
Figure A2
Sanderson Field-Fairgrounds Infiltration Test Site
WRIA 14 Water Storage Assessment



N

0 1,000 5,000 FEET

Figure A3
Port of Shelton Johns Prairie Industrial Park Infiltration Test Site WRIA 14 Water Storage Assessment

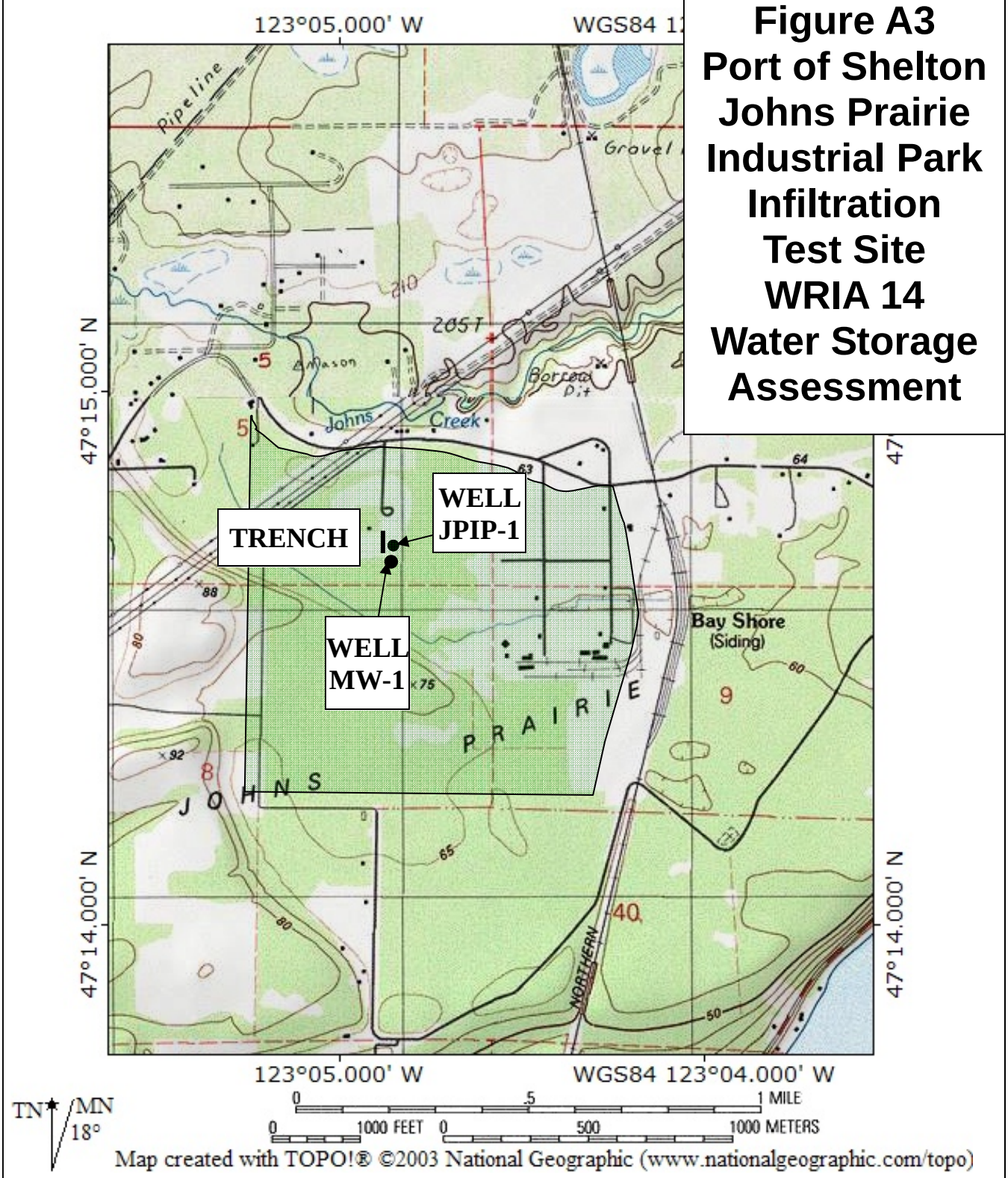


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Figure A-4
Sanderson Field - Fairgrounds Infiltration Testing Results
Groundwater Mounding due to 16 gpm Infiltration Rate
WRIA 14 Water Storage Assessment

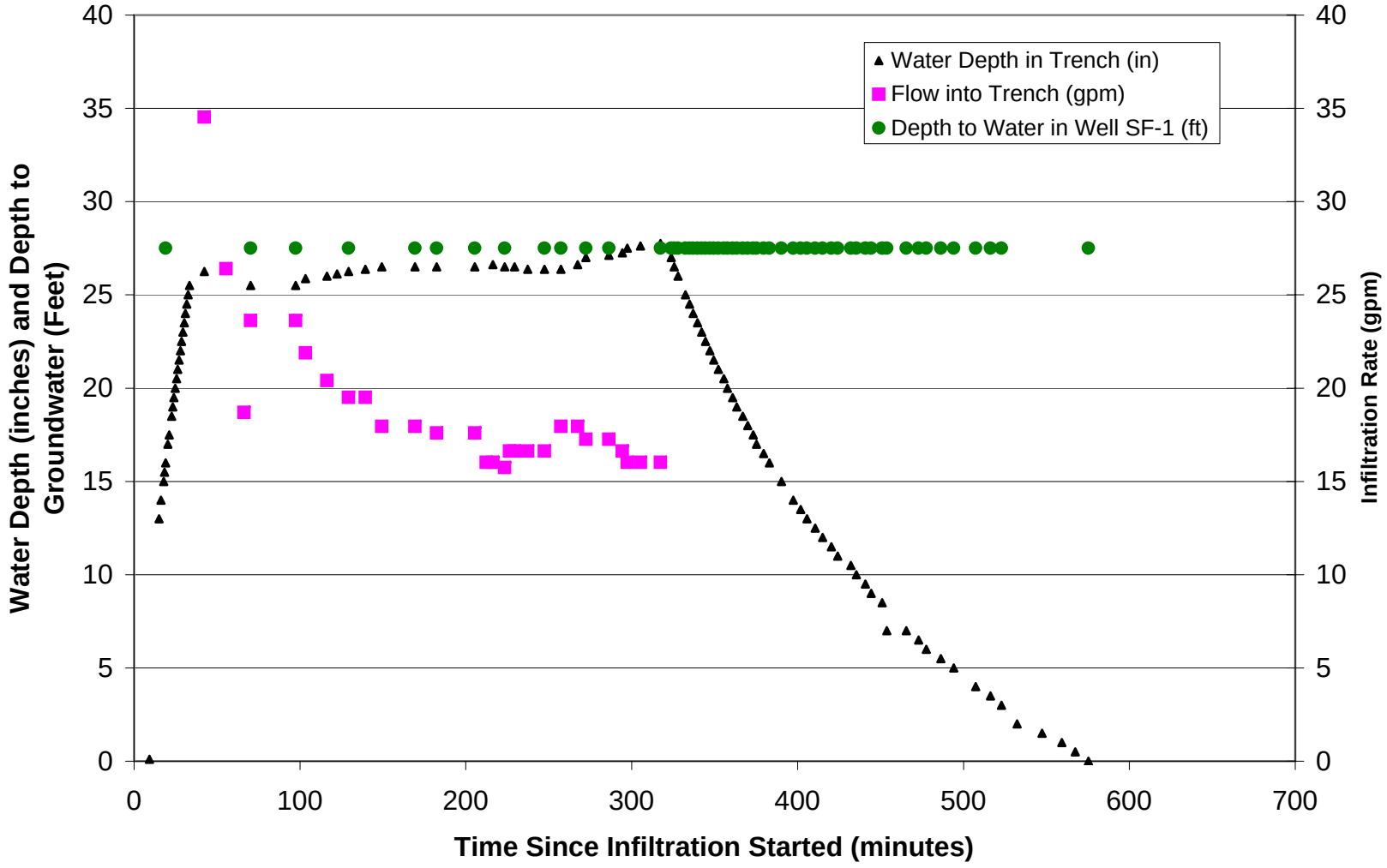
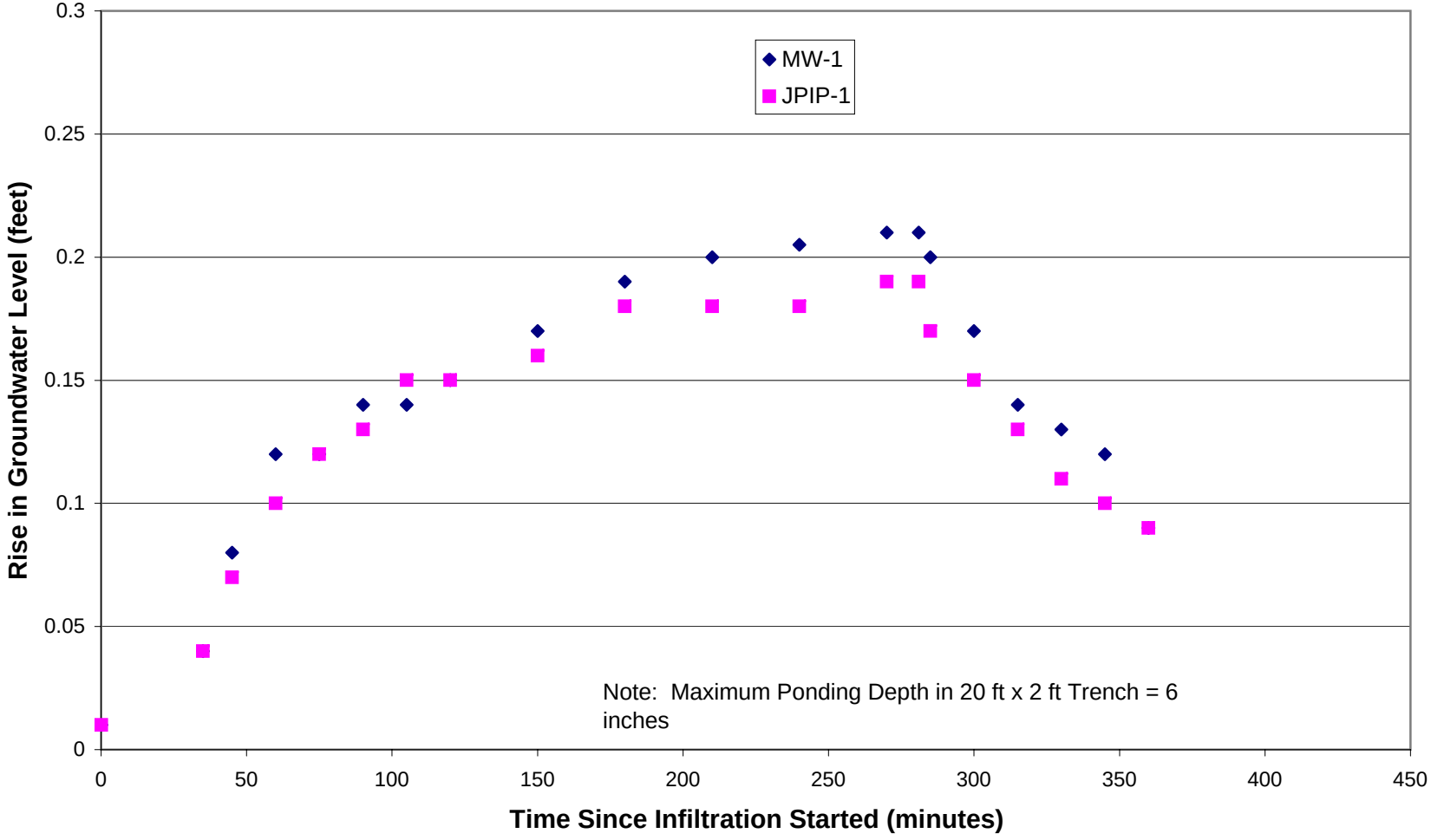
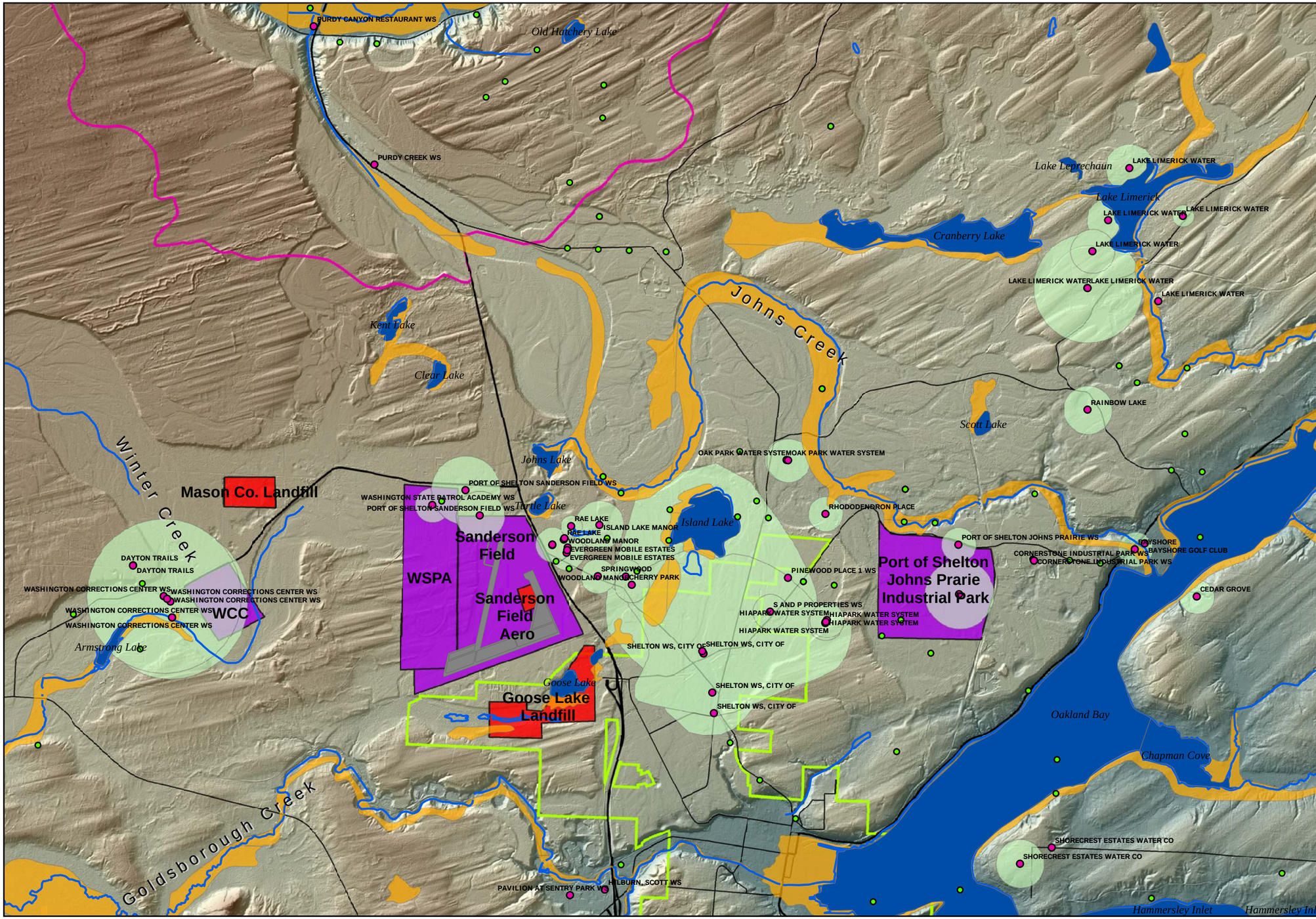


Figure A-5
Port of Shelton Johns Prairie Industrial Park Infiltration Testing Results
Groundwater Mounding due to steady 115 gpm Infiltration Rate
WRIA 14 Water Storage Assessment





Appendix B Wellhead Protection Areas and Floodplains WRIA 14

Legend

- Water
- 5 Year TOT WHPA
- Floodplain

Major Facilities

- Hazardous Waste Site
- Regional Facility
- City of Shelton
- Airfield
- Group B Sources
- Group A Sources

LIDAR elevation data was obtained from Puget Sound LIDAR Consortium. Other data sources include WSDOT, WDNR, and WDOE.

N

0 4,000 Feet

1:48,000

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IV.4 CRITICAL AREAS

Geologically Hazardous Areas

Geologically hazardous areas include areas susceptible to landslide, erosion, earthquake or other geological events. In many cases, hazards can be reduced or mitigated by engineering, design or modified construction practices. Because of their susceptibility however, some of these areas may not be suitable for new development.

Mason County's Interim Resource Ordinance identifies three types of Geologic Hazard Areas: 1) Landslide Hazard Areas; 2) Seismic Hazard Areas; and 3) Erosion Hazard Areas. Landslide Hazard Areas are lands that have an increased potential for landslides and other earth movement. Seismic Hazard Areas are lands that are particularly susceptible to damage from earthquakes and other seismic activity. Lastly, Erosion Hazard Areas are lands that are more susceptible to excessive erosion.

Landslide Hazard Areas

A landslide is a rapid down slope movement of a mass of material such as rocks, soil, or other debris. The speed and distance of movement, as well as the amount of material, vary greatly and depend on a combination of geologic, topographic and hydrologic factors. Especially susceptible to landslide hazards are marine bluffs and unconsolidated glacial deposits on steep hillsides (greater than 40 percent).

Potential Landslide Hazard Areas are areas that meet the following criteria:

1. Areas with indication of earth movement such as debris slides, earth flows, slumps and rock falls; or

2. Areas with artificial over steepened or unengineered slopes, i.e. cuts or fills;

3. Areas containing soft or potentially liquefiable soils;

4. Areas unstable as a result of stream incision, stream bank erosion, and undercutting by wave action;

5. Slopes greater than 15% (8.5 degrees), except areas composed of consolidated rock, and having either of the following:

    a. Steep hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock; or
    b. Springs or groundwater seepage.

A key indicator of potential landslide areas is slope of the land. Approximately 10% of the landscape in Mason County (excluding Olympic National Forest and Olympic National Park areas) has a slope of 15-30%, and approximately 3% has steeper slopes of 30-45% (see FIGURE IV-4.1, Landslide Hazard Map).

The risk of landslide occurrence depends on a number of factors including soil vulnerability, slope, and the degree of water saturation. Development activities can increase the risk by exposing soil through clearing, altering natural drainage patterns, excavating the "toe" of slopes, or increasing soil moisture content.

An important measure of potential risk for landslide when development occurs is land clearing and alteration for development. Potential impacts to Mason County can be assessed based on the relative amount of land converted to urban uses during the 20-year planning under each of the alternatives.

In addition to the critical area regulations, the comprehensive plan minimizes the amount of land cleared for development by directing up to 70 percent of the County's growth into Urban Areas. Further, options such as Working Rural Areas and Resource Conservation Master Plans require clustering and open space. Both techniques reduce the amount of land disturbed by development while maintaining overall rural densities.

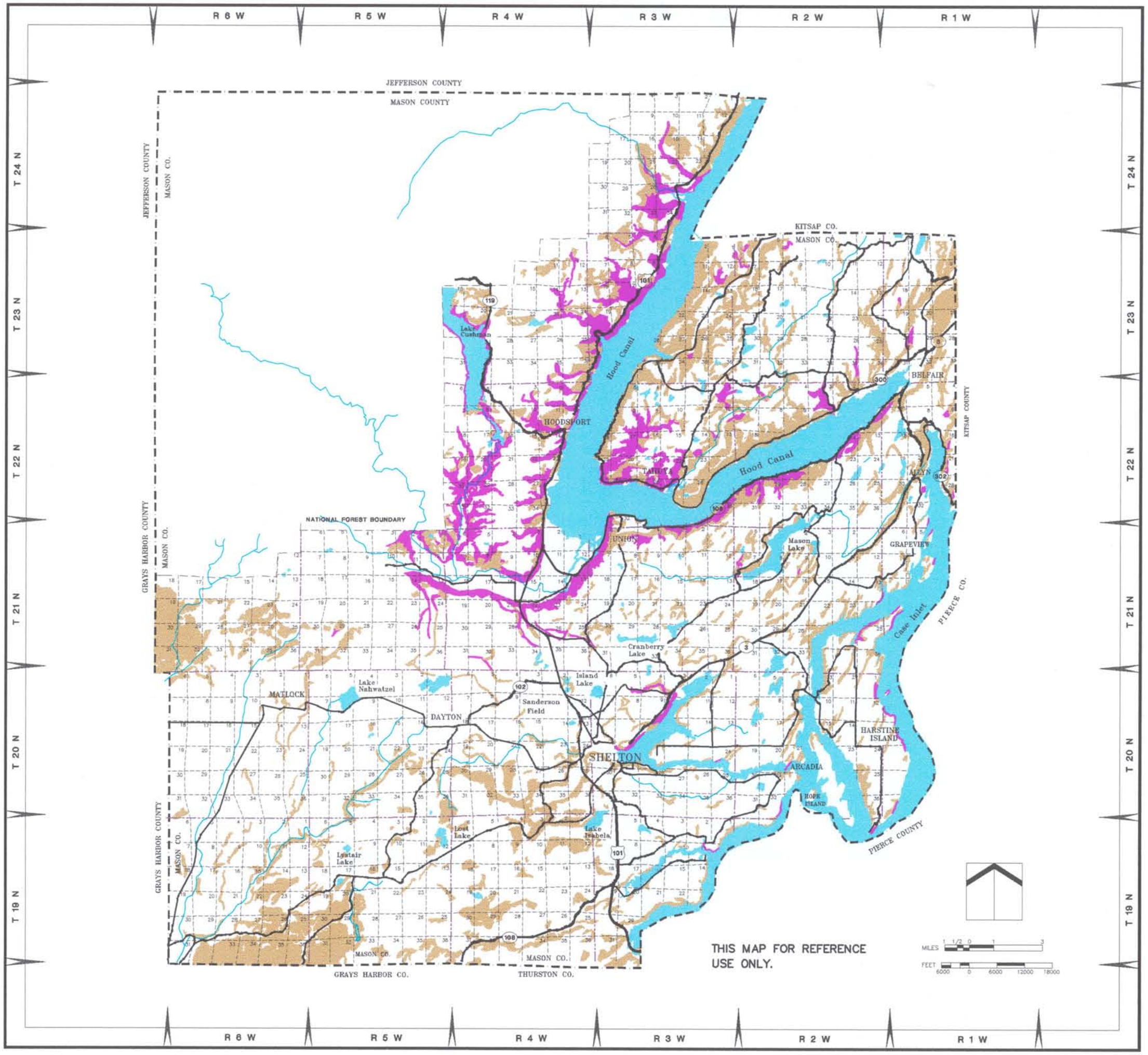
Seismic Hazards

Seismic Hazards occur in areas subject to severe risk of earthquake damage as a result of seismic induced settlement or soil liquefaction. These areas include soils containing high organic content (e.g., wetland soils), areas of loose sand and gravel, artificial fills, landslide deposits, and fine-grained soils with high water tables.

Seismic Hazard Areas are areas susceptible to ground failure, including the following:

1. Mapped geologic faults;
2. Areas of poorly compacted artificial fill;
3. Areas with artificially steepened slopes;
4. Post-glacial stream, lake or beach sediments;
5. River Deltas;
6. Areas designated as potential Landslide Hazard Areas;
7. Bluff areas;
8. Deep road fills and unsupported fills.

Seismic Hazard Areas are shown on the Mason County Seismic Hazards Map (FIGURE IV-4.2), as documented by the *Coastal Zone Atlas of Washington* and *Geology and Related Groundwater Occurrence, Southeastern Mason County, Washington, Water Supply Bulletin 29*.



MASON COUNTY

COMPREHENSIVE PLAN

CRITICAL AREAS

LAND SLIDE HAZARDS

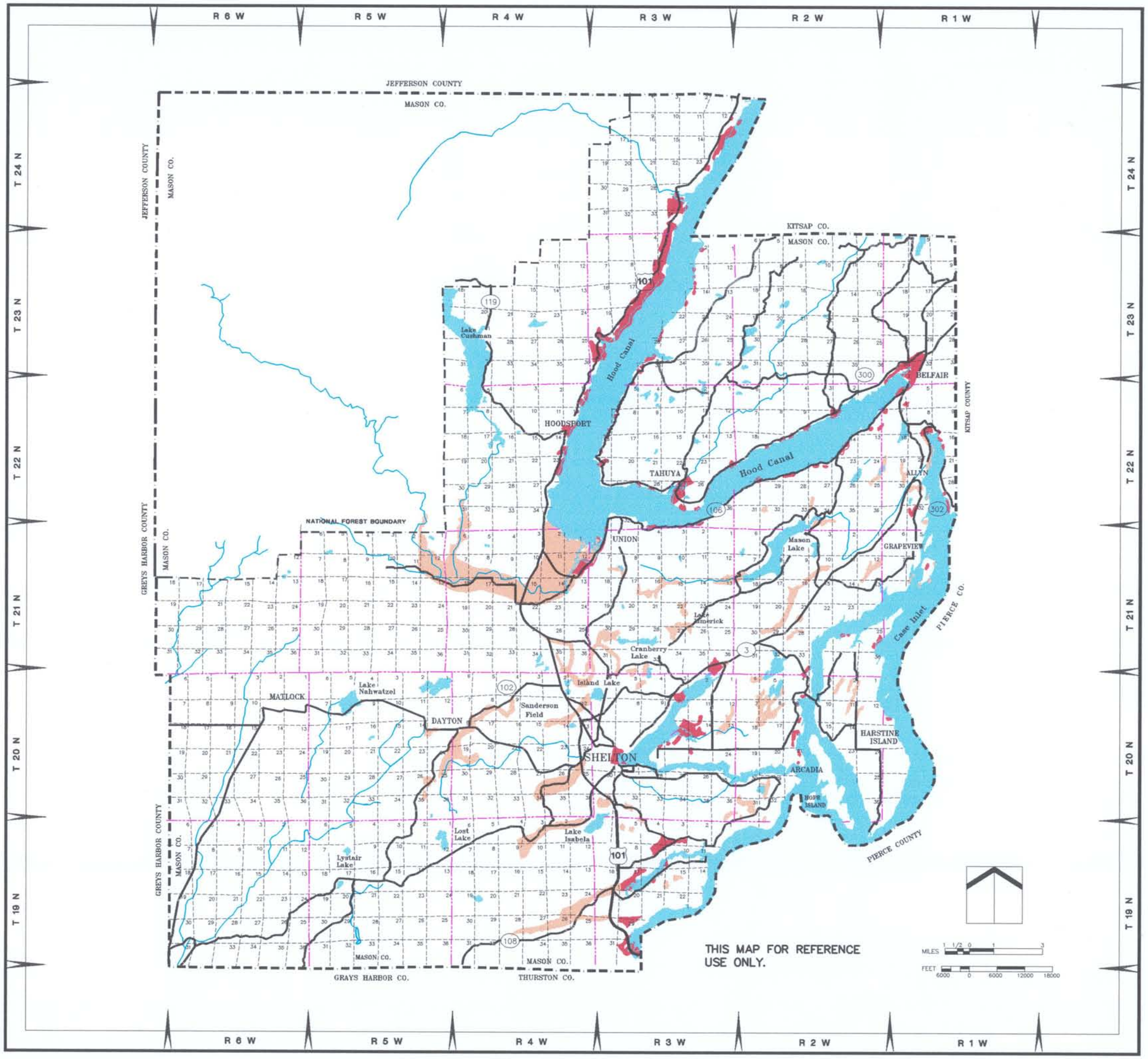
LEGEND:

- 15% – 30% SLOPES
- 30% – 45% SLOPES

MASON COUNTY
Department Of Community Development

Shelton, WA
March, 1996

FIGURE IV-4.1



MASON COUNTY

COMPREHENSIVE PLAN

CRITICAL AREAS

SEISMIC HAZARD AREAS

LEGEND

- FROM COASTAL ZONE ATLAS OF WASHINGTON
- WATER SUPPLY BULLETIN

MASON COUNTY
Department Of Community Development

Shelton, WA
November, 1995

FIGURE IV-4.2

All structures in Mason County are subject to the engineering and design requirements of the Uniform Building Code for earthquakes. Seismic hazards focus on effects to buildings and other facilities from intense ground shaking and/or liquefaction. Seismically-induced landslides could also cause structural damage to buildings, particularly on steeper slopes and shoreline bluffs. In addition, the critical area regulations do not allow significant public buildings in seismic hazard areas; and the future land use plan directs most growth away from these areas.

Erosion Hazard Areas

Erosion is a natural process in which the land surface is worn away by the action of water, wind, ice or other geologic processes. The most common cause of erosion is water falling or flowing across the land. Factors contributing to erosion hazard are soil type and slope. Erosion hazards generally occur on erosive soils where slopes exceed 15 percent.

The Mason County Interim Resource Ordinance classifies Erosion Hazard Areas as areas that have an Erosion Index of 8 or greater as determined by methodologies found in the United States Department of Agriculture, Soil Conservation Service "Food Security Act Manual, Title 180, Second Edition, August, 1988".

The erosion process can be accelerated by development activity that exposes and disturbs soils so they are more vulnerable to erosive forces. Further, increased areas of impervious surfaces reduce the infiltration of rainfall, increase stormwater runoff, and result in even greater erosion potential. Increased runoff, erosion, and sedimentation may adversely affect the physical and biological characteristics of streams and other water resources.

Erosion Hazards are similar to Landslide Hazards in that they are both often created by, or aggravated by development activities such as clearing and grading. The comprehensive plan controls the hazards through the critical areas regulations and by concentrating development in suitable areas.

Mason County Planning Policies

The recommended policies contain several policies intended to mitigate the impacts of development in geologically hazardous areas. The policies focus on:

1. Adoption of a permanent Critical Areas Ordinance to identify and designate geologically hazardous areas.

2. Identifying areas in which development should be prohibited or restricted due to geological hazards.

3. Adopting new standards for effective erosion control.

4. Requiring a geotechnical report for proposal located on Landslide Hazard Areas.

5. Development standards such as vegetative management, drainage, and buffers.

Wetlands

Wetlands are natural ecosystems that serve a number of important beneficial functions. They assist in reducing erosion, siltation, flooding, and ground and surface water contamination. Wetlands provide habitat for wildlife, plants, and fisheries. They may also assist in recharging groundwater supplies. In addition, wetlands provide opportunities for recreation and education.

In wetlands, the soil is at least periodically saturated or covered with water. These water conditions support special kinds of plants called *hydrophytes* (Greek for "water loving"). Soils that have been saturated for a sufficient length of time certain properties and are referred to as hydric soils. An area must exhibit all three of the following characteristics in order to be classified a wetland:

1. Inundation or saturation of the soil by water;

2. The presence of wetland plants (hydrophytes); and

3. The presence of hydric soils.

Wetlands are generally divided into five classes: *Riparian* wetlands are associated with rivers and streams; *Marine* wetlands are found along ocean shores; *Estuarine* wetlands occur where fresh water and salt water meet; *Lacustrine* wetlands are associated with lakes; and *Palustrine* wetlands include upland freshwater wetlands fed by ground or surface water. The wetlands identified within Mason County include all of these classes.

For the purposes of protection and regulation, wetlands are designated as Category I, Category II, Category III, or Category IV. The Washington State Department of Ecology established these categories.

Category I applies to the most valuable wetlands. These wetlands include a particularly rare plants or animal species, represent a high quality, rare wetland type, are regionally rare, or provide irreplaceable functions and values.

Category II applies to wetlands that provide habitat for very sensitive or important plants or animals, are difficult to replace, or provide very high functions and values, particularly for wildlife habitat.

Category III applies to wetlands that support a variety of wildlife species and occur more commonly throughout Mason County than either Category I or II wetlands.

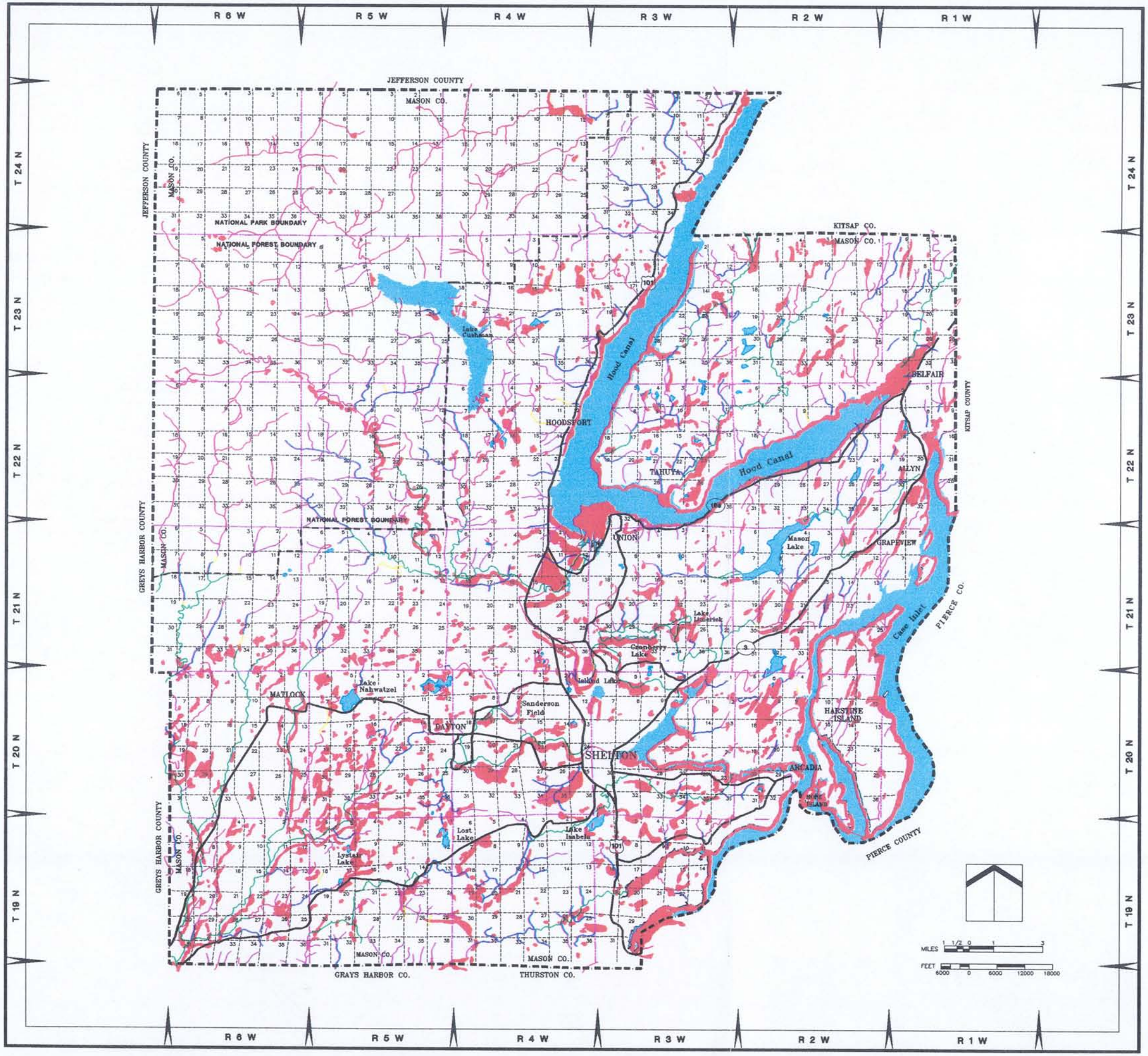
Category IV applies to smaller, isolated wetlands that have less diverse vegetation but provide important functions and values.

Mason County includes an abundance of wetland areas. Most of these areas are associated with larger freshwater and saltwater systems. The Natural Heritage Program identifies only high quality native wetlands, category 1 under the Western Washington Rating System. As of 1992, there were approximately 20-25 Category I wetlands documented in Mason County.

In total, however, approximately 38,290 acres in the County have been mapped as wetlands as documented by the National Wetland Inventory (see FIGURE IV-4.3, Mason County Generalized Wetland Inventory Map. Agricultural wetlands and isolated wetlands under one acre in size are exempt from most of the regulatory requirements of the Mason County Critical Area Ordinance.

The alteration or destruction of wetlands can eliminate or reduce the variety of biological and hydrological functions that wetlands perform. Direct impacts may result from clearing, grading or filling in advance of development. Of equal potential are indirect impacts from new development which may alter surface water flows, or interrupt the infiltration of groundwater.

New development may increase volumes of sediment-laden runoff entering wetlands. This may inhibit the wetlands' natural capacity to remove nutrients and process chemical and organic wastes. In addition, increased sedimentation within wetlands may reduce their ability to temporarily store flood waters and increase the risk and magnitude of downstream impacts.



MASON COUNTY

COMPREHENSIVE PLAN

CRITICAL AREAS

GENERALIZED WETLANDS INVENTORY

LEGEND

WETLAND AREAS

Stream Types

- TYPE 1
- TYPE 2
- TYPE 3
- TYPE 4
- TYPE 5

MASON COUNTY
Department Of Community Development

Shelton, WA
September, 1995

Wetlands may also often provide groundwater recharge. Development activities in areas near or hydrologically connected to wetlands in recharge areas could interrupt infiltration to the groundwater system.

The comprehensive plan concentrates growth, allocating as much as 73 percent of the County's population growth to Urban Areas. It also provides for permanent open space and designated natural resource areas in development allowed within Rural Areas.

Countywide Planning Policies

The *Countywide Planning Policies* call for Mason County and the City of Shelton to:

1. Encourage the retention of open space; and

2. Protect the environment and enhance the County's quality of life; including air and water quality, and the availability of water.

Mason County Planning Policies

The recommended policies contain several policies intended to mitigate the impacts of development on wetlands. The policies focus on:

1. Avoiding impacts to wetlands due to development and ensuring that no net loss of wetlands in terms of acreage, function and value occurs.

2. Adopting permanent regulations for wetland protection which provide for: restrictions on clearing, grading and filling; stormwater runoff controls; construction practices; sufficient buffers to sustain wetland functions; and mitigation and/or restoration.

Mason County has adopted interim regulations to protect critical areas, including wetlands. The Western Washington Growth Management Hearing Board has ordered the county to re-assess those regulations, but until that can be done, the current regulations will remain in effect.

Fish and Wildlife Habitat

Mason County contains an abundance of marine, freshwater and upland habitat for fish and wildlife. Preservation of fish and wildlife habitat is critical to protecting suitable environments for animal species, and in providing an important part of the local quality of life for County residents and visitors.

One of wildlife's most important functions is in maintaining the health and diversity of

ecosystems. Each species has its role in an ecosystem. When a species is eliminated, the ecosystem loses the functions it performed. As a result, the balance of the ecosystem is sometimes irreversibly lost or diminished. Given the inter-relation of all species in an ecosystem, species elimination may result in unpredictable consequences, though some consequences of habitat impact are known in advance. For example, a loss of marine invertebrates and kelp from over-harvesting ultimately affects the quality of habitat for larger fish, mammals and birds.

Fish and wildlife also provide important in providing recreational and economic benefits such as hunting and fishing opportunities. The continued prosperity of the commercial and recreational fish and shellfish industries depends on maintenance of excellent water quality and unpolluted habitats for fish, shellfish, and their food sources.

Fish and wildlife habitat also provide significant social benefits. Mason County residents are accustomed to occasional encounters with wildlife such as bald eagles, great blue heron and elk. Wildlife provides the opportunity to educate the public about biological and ecological processes. Other less quantifiable benefits include wildlife viewing, and maintaining the historical, cultural, and spiritual values of Native American Tribes and the general public.

The Mason County Interim Resource Ordinance guides management of the County's Fish and Wildlife habitat. It divides critical fish and wildlife habitat areas into two classes: 1) Aquatic Management Areas; and 2) Terrestrial Management Areas.

Aquatic Management Areas

Mason County includes three principal river systems and numerous lakes, small rivers, and streams. The Skokomish and Hamma Hamma rivers are swiftly flowing, deeply incised rivers that originate high in the Olympic Mountains and empty into Hood Canal. The East and Middle Forks of the Satsop River originate in the Olympic Mountains, converge at the southwestern corner of the County and flow southward into the Chehalis River. All of the eastern part of the County is drained by smaller streams which flow only short distances before reaching outlets to Puget Sound. Many of the small streams, as well as the larger systems, support significant fisheries, including anadromous fish. Other surface waters are made up of numerous lakes and wetland areas, some of which include Cushman, Mason, Nahwatzel, Lost, Isabella, Island, Cranberry, Limerick and Spencer lakes.

The waters and shorelines of Mason County are an important resource. In addition to their natural beauty, and cultural value, they provide the base for a sizable shellfish industry, aquaculture, fish and wildlife habitat.

Aquatic Management Areas as classified and designated include the following:

Class I Management Area

All areas under the jurisdiction of the Mason County Shoreline Master Program; except State designated Harbor Areas pursuant to RCW 79.90.020 and Article XV of the Washington State Constitution.

Class II Management Area

All areas defined as Type 2, 3, 4, or 5 waters as established in WAC 222-16-030, including all naturally occurring lakes and ponds not considered wetlands and not under the jurisdiction of the Mason County Shoreline Master Program; and all lands within:

a. 200 feet of the ordinary high water mark of Type 2 waters;
b. 100 feet of the ordinary high water mark of Type 3 waters;
c. 50 feet of the ordinary high water mark of Type 4 waters; or
d. 25 feet of the ordinary high water mark of Type 5 waters.

The water typing system has been established by the Department of Natural Resources and is based on the size and character of the water body. Type 1 waters are the larger water bodies and rivers which have been classed as Waters of the State, such as the Hood Canal and the Skokomish River. As the size of the river or lake is reduced, the water type becomes a 2, 3, or 4, until a type 5 water is identified. Type 5 waters may be dry beds most of the year, providing only winter flows.

Marine Habitat Areas include the following:

1. All kelp beds (members of the brown algal family Laminariales including *Alaria marginata*, *Alaria nana*, *Alaria tenuifolia*, *Egregia menziesii*, *Eisenia arborea*, *Pterygophora californica*, *Agarum cribosum*, *Agarum fimbriatum*, *Costaria costata*, *Cymathere triplicata*, *Hedophyllum sessile*, *Laminaria spp.*, *Pleurophycus gardneri*, *Dictyoneuropsis reticulata*, *Dictyoneurum californicum*, *Lessioniopsis littoralis*, *Macrocystis integrifolia*, *Nereocystis luetkeana*, and *Postelsia palmaeformis*) and all eelgrass beds (*Zostera spp.*). These areas are important salt water habitats that support valuable species, providing habitat for plants, fish, shellfish, sea birds and sea mammals.

   Recent maps of the location of kelp and eel grass beds in Mason County were not available for inclusion in this Plan. The Washington State Department of Natural Resources reports that floating Bull kelp occurs off of the west shore to the

southwest tip of Squaxin Island. The location of eel grass beds can change over time, making the locations of eel grass beds, particularly the deeper, subtidal species hard to track. Eel grass has been found throughout Hood Canal in the past (*1995 Mason County Shoreline Inventory*).

2. Priority shellfish areas including:

   a. All public and private tidelands or bedlands which are approved or conditionally approved by the Washington Department of Health for shellfish harvest;

   b. Any Shellfish Protection District created under RCW 90.72; and

   c. Areas with all of the following attributes: broad intertidal areas, bays with geographically restricted wave action and circulation, poor or limited flushing, warmer water temperatures, seasonally reduced salinity, and increased potential for algae bloom.

3. All identified smelt spawning areas (these are mapped in the *1995 Mason County Shoreline Inventory*).

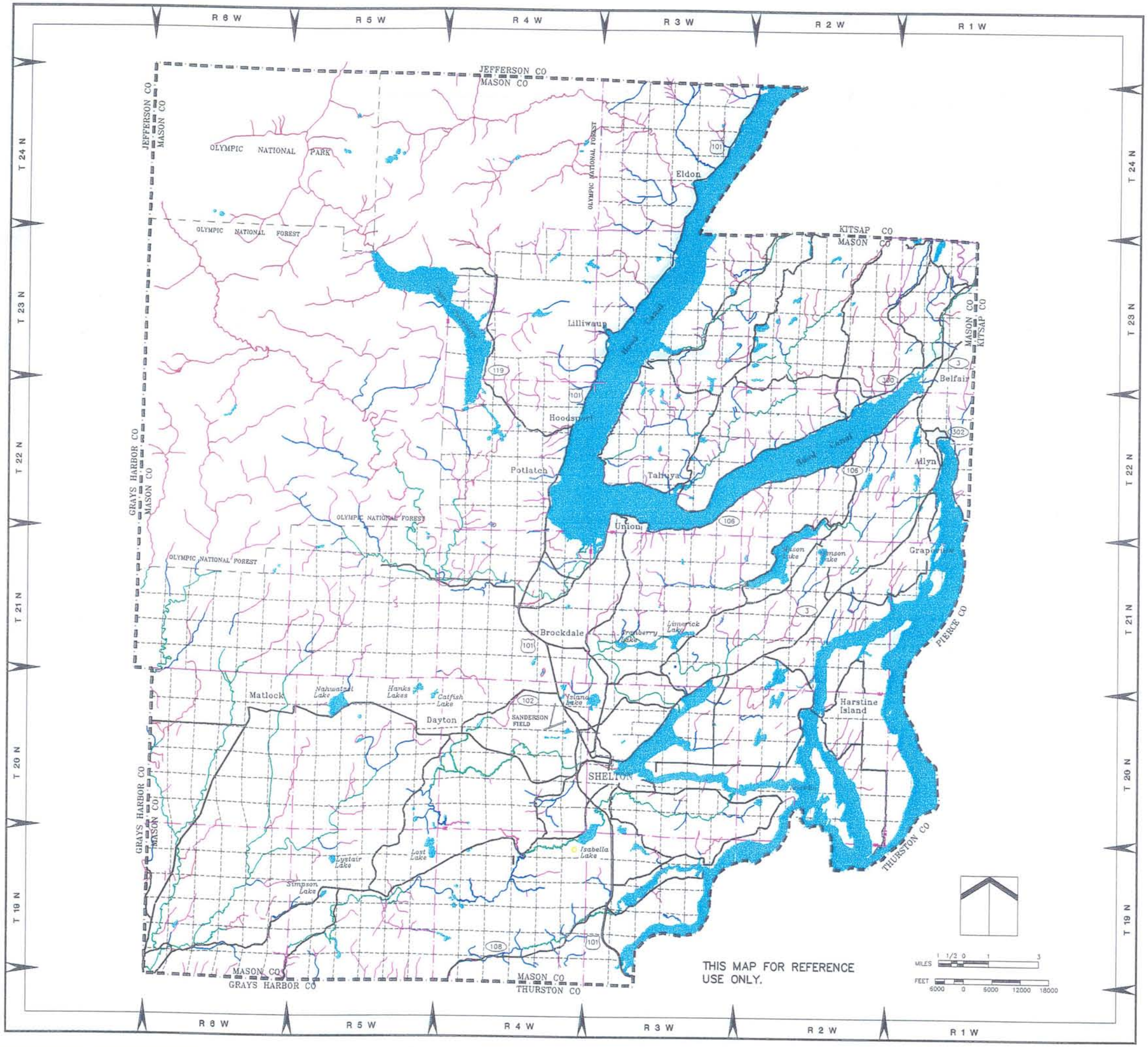
To protect and preserve aquatic resources, the County has designated the following areas as Aquatic Management Areas:

1. All areas under the jurisdiction of the Mason County Shoreline Master Program; except State designated Harbor Areas pursuant to RCW 79.90.020 and Article XV of the Washington State Constitution;

2. All Type II, III, IV waters as established in WAC 222-16-030, including all naturally occurring lakes and ponds not considered wetlands and not under the jurisdiction of the Mason County Shoreline Master Program, and all lands within (see FIGURE IV-4.4, Mason County Stream Type Map):

   a. 200 feet of the ordinary high water mark of Type II waters;
   b. 100 feet of the ordinary high water mark of Type III waters;
   c. 50 feet of the ordinary high water mark of Type IV waters.
   d. 25 feet of the ordinanry high water mark of Type 5 waters.

These areas not only protect the aquatic habitats, but they provide preserved areas for habitat for non-aquatic species and establish wildlife corridors between the larger areas of habitat and open space.



MASON COUNTY

COMPREHENSIVE PLAN

CRITICAL AREAS

STREAM TYPES

LEGEND

- TYPE 1 STREAMS
- TYPE 2 STREAMS
- TYPE 3 STREAMS
- TYPE 4 STREAMS

DATA SOURCE:
Washington State Department Of Natural Resources.
Mason County Department Of Community Development

MASON COUNTY
Department Of Community Development

Shelton, WA
November, 1995

FIGURE IV-4.4

Terrestrial Management Areas

All development activities have the potential to impact native plant and animal species. Terrestrial Management Areas are those areas where the presence of state endangered or state threatened terrestrial species have been identified. The Mason County Critical Area Ordinance specifies that all development in these areas shall be consistent with State and Federal law.

TABLE IV-4.1 is a compilation of the Priority Habitats and Species and Special Non-Game Species in Mason County. It is summarized from data provided by the Washington State Department of Fish and Wildlife (then the Department of Wildlife) in June, 1991.

There are also a number of publicly and privately managed natural areas in Mason County that have been designated as preserves or refuges. These areas are important for fish and wildlife habitat, scenic vistas, protection of sensitive plant species, and preservation of open space.

The Washington State Department of Natural Resources manages three Natural Area Preserves in Mason County. They include 17 acres at Oak Patch Lake, 28 acres on Skookum Inlet, and a 56 acre site on Totten Inlet. The Washington State Department of Fish and Wildlife manages a number of properties in the County, including the 172-acre Skokomish River Tidelands Wildlife Area and the 122-acre Union River Wildlife Area.

Mason County also includes a number of properties managed by the Hood Canal Land Trust (HCLT). HCLT is a non-profit organization that either owns properties outright or manages them under the terms of conservation easements. Key HCLT sites include the Klingall and Jimmy Bryan Wetland Preserves, 88 acres on the north side of Lynch Cove and 140 acres along the Union River under a conservation easement.

TABLE IV-4.1	
Priority Habitats and Species and Special Non-Game Species in Mason County*	
BIRDS	**BUTTERFLIES**
Great Blue Heron	**Hoary Elfin Butterfly**
Pileated Woodpecker	**American Painted Lady**
Osprey	**Oreas Angelwing**
Bald Eagle	**Sonnora Skipper**
Band-Tailed Pigeon	
Common Golden Eye	**FISH**
Shorebird Concentrations	**Olympic Mudminnow**
Wood Ducks	
Waterfowl Concentrations	**REPTILES**
Mountain Quail	**Pacific Gopher Snake**
Golden Quail	
Western Bluebird	**AMPHIBIANS**
Purple Martin	**Tailed Frog**
	Van Dyke's Salamander
MAMMALS	**Olympic Salamander**
Elk	**Cope's Giant Salamander**
Fisher	
Shelton Pocket Gopher	**HABITATS**
	Urban Natural Open Space
	Cliffs
	Wetlands
Source: Washington Department of Wildlife, June 1991 (as documented by the 1992 Mason County Growth Management Background Report.) *** As defined by WDW data from June 8, 1991.**	

Sensitive Plants and Plant Communities

The existence of rare and sensitive plants and plant communities is increasingly threatened by the intensive development created by the County's population growth. One of the primary objectives of the GMA is to protect the natural environments that are required to support these communities.

The following is a list of rare and sensitive plant species for Mason County provided by the Washington State Department of Natural Resources, Natural Heritage Program (*1995 Mason County Shoreline Inventory*).

Scientific Name	Common Name	State Status
Botrychium ascendens	**Triangular-lobed moonwort**	**Sensitive**
Carex buxbaumii	**Buxbaum's Sedge**	**Sensitive**
Carex circinata	**Coiled sedge**	**Sensitive**
Carex interrupta	**Green-fruited sedge**	**Monitor**
Carex pauciflora	**Few-flowered sedge**	**Sensitive**
Chrysolepis Chrysophylla	**Golden chinquapin**	**Sensitive**
Claytonia lanceolata var pacifica	**Pacific lanceleaved springbeauty**	**Sensitive**
Cochlearia officinalis	**Scurvygrass**	**Sensitive**
Lindernia dubia var anagallidea	**False-pimpernel**	**Sensitive**
Ophioglossum pulsillum	**Adder's-tongue**	**Threatened**
Parnassia palustris var neogaea	**Northern grass of parnassus**	**Sensitive**
Potamogeton obtusifolius	**Blunt-leaved pondweed**	**Sensitive**
Woodwardia fimbriata	**Chain-fern**	**Sensitive**

In addition to monitoring rare plants, DNR also maintains a data base of sensitive native plant communities and native wetland areas in the County. The Mason County Sensitive Plants Map, presented in the *1995 Mason County Shoreline Inventory* shows the general locations where these natural features exist. Because of the sensitive nature of these areas, only the general area (section to quarter-quarter section) where these features are known to occur is shown on the map as documented in Appendix F of the *1995 Mason County Shoreline Inventory*.

The impacts of development to habitat include the replacement of woodlands, pastures and other undeveloped areas with buildings, roads, parking lots, landscaping, and other structures. Depending on the location, density and intensity of uses, this may result in the removal and displacement of habitat and cause some wildlife species to relocate to other areas. Since most habitats are currently assumed to be at or near their carrying capacity, displaced animals may perish.

Loss of wetlands, riparian areas and adjacent fields may affect the overall number and variety of wildlife and waterfowl. Loss of riparian vegetation could also affect migrating or nesting areas. Plant and animal species can also be affected by erosion and sedimentation of streams, coastal waters, and wetlands. Shoreline and related over-water development can harm valuable kelp and eelgrass beds.

In addition to the critical areas protections adopted by the county, the comprehensive plan concentrates development, allocating approximately 66 percent of the County's population growth and associated development to Urban Areas. The Urban Area will, however, account for less than 1.3 percent of the County's land area. The comprehensive plan also provides for permanent open space and designated resource areas in development within Rural Areas. These features will promote the protection, preservation, and enhancement of fish and wildlife habitat.

County-Wide Planning Policies

The *County-Wide Planning Policies* call for Mason County and the City of Shelton to conserve fish and wildlife habitat.

Mason County Planning Policies

Mason County's Comprehensive Plan policies intended to mitigate the impacts of development on habitat. The policies focus on:

1. The County providing fish and wildlife habitat information to the public as part of the development process;

2. Adopting new regulations for habitat protection which are consistent with the *Mason County Shoreline Master Program*; and

3. Managing site development activity to reduce/minimize off-site erosion, siltation or other reductions in water quality.

Critical Aquifer Recharge Areas

The State of Washington's definition of aquifer recharge areas for GMA planning purposes focuses on existing areas of supply which are vulnerable to contamination: *Areas with a critical recharging effect on aquifers used for potable water are areas where an aquifer that is a source of drinking water is vulnerable to contamination that would affect the potability of the water* (WAC 365-190-030).

Groundwater exists in underground layers of porous rock or soil called *aquifers*. Water stored in aquifers reaches the ground surface through springs, wells, or by seepage into surface water features, including wetlands. Surface waters replenish, "recharge", aquifers through seepage from streams, lakes, and wetlands, and from precipitation that percolates through soil or rock.

Potable water means water suitable for drinking. Groundwater provides virtually all of Mason County's potable water. Protecting aquifers and aquifer recharge areas, therefore, is critical to maintaining Mason County's water supply. Aquifers exist throughout the County. The groundwater supplying most of the County's water is obtained from the aquifers running through the coarser and more permeable glacial and fluvial sedimentary deposits. The older, undifferentiated sedimentary deposits provide large quantities of water for industrial and municipal wells. Bedrock forms the bottom of the groundwater layer although fractures and joints in the relatively impermeable rocks may yield small quantities of water. Most of Mason County enjoys an abundance of good quality water, however, the state Department of Ecology has identified some areas such as the Kennedy and Goldsborough drainages where this may not be the case. There is no prohibition on new water rights in these drainages, but, further surface water appropriations have been stopped (WAC 173-514). According to the Department of Ecology, the ground water in these areas is hydrologically connected to these

streams. If ground water is withdrawn, the stream flows may be impacted. This can form a basis for the denial of new water rights in the area.

Precipitation provides the primary source of recharge for Mason County's groundwater. Precipitation within the County averages 64 inches annually. It increases rapidly towards the Olympic Mountains where, at Lake Cushman, precipitation is in excess of 100 inches per year. Water levels in wells are typically within 125 feet of the land surface. The quality of groundwater in an aquifer is inextricably linked to its recharge area. Approximately 24,970 acres have been mapped as Critical Aquifer Recharge Areas in Mason County (see FIGURE IV-4.5, Critical Aquifer Recharge Areas).

All Critical Aquifer Recharge Areas in Mason County are classified as having either an Extreme, High or Moderate recharge potential, as defined by the County's Interim Resource Ordinance (Mason County Ordinance No. 77-93).

Urban development has two potential impacts on groundwater resources: 1) increases in impervious surfaces reduce the volume of precipitation available to recharge groundwater, and 2) urban development may introduce pollutants into the groundwater system. When groundwater recharge is reduced, groundwater supplies may be depleted. In many instances, this is coupled with withdrawals of groundwater in excess of recharge capacity. Potential long term impacts include reduced capacity of water wells, reduced flows in groundwater-fed streams, and depletion of water supplies to lakes or wetlands.

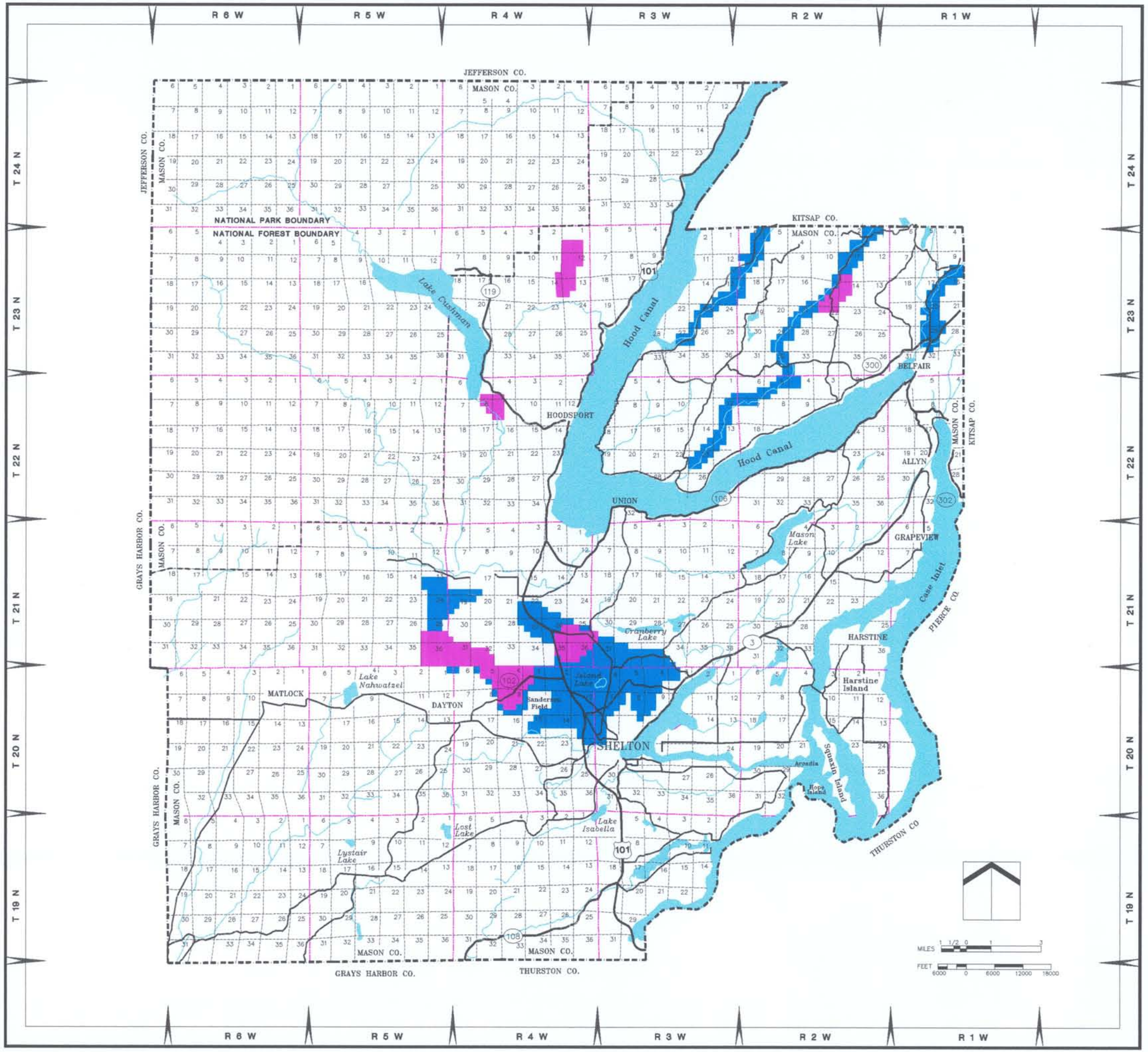
Pollutants can be introduced into the groundwater system through a variety of means. They include failing septic systems, agricultural chemicals and animal waste, urban runoff, solid waste disposal, and leaking underground storage tanks.

County-Wide Planning Policies

The *County-Wide Planning Policies* call for Mason County and the City of Shelton to:

1. Protect Resource Lands and Critical Areas.

2. Protect the environment and enhance the County's quality of life; including air and water quality, and the availability of water.



MASON COUNTY

COMPREHENSIVE PLAN

CRITICAL AREAS

AQUIFER RECHARGE AREAS

LEGEND

- HIGHLY CRITICAL
- EXTREMELY CRITICAL

MASON COUNTY
Department Of Community Development

Shelton, WA
April, 1996.

FIGURE IV-4.5

Mason County Planning Policies

The planning policies contain several policies intended to mitigate the impacts of development on aquifer recharge areas. The policies focus on identifying and regulating land uses which could have a potential significant impact on groundwater quality or quantity.

The Natural Systems, On-Site Sewage Disposal, Clearing and Grading, and Stormwater and Surface Water Elements of the Harstine Island Sub-Area Plan contain policies for the protection of groundwater quality and quantity.

The Shoreline, On-Site Sewage, Groundwater Management, Monitoring and Education Elements of the North Mason Sub-Area Plan contain policies for the protection of groundwater quality and quantity.

The Commercial and Industrial Land Uses, Natural Systems, On-Site Sewage Disposal and Treatment, Clearing and Grading, and Stormwater and Surface Water Elements of the Southeast Mason Sub-Area Plan contain policies for the protection of groundwater quality and quantity.

In addition, Mason County has adopted interim regulations to protect critical areas, including aquifer recharge areas. As part of the joint planning effort to be made by the City of Shelton and Mason County, the county will continue to examine whether additional protections are needed within the urban growth areas to adequately protect the critical areas.

Flood Hazard Areas

Flood hazard areas are lands subject to a one percent or greater chance of flooding in any given year. In Mason County they include areas identified as potential or historic flood areas in the Department of Ecology's *Coastal Zone Atlas* or areas identified as "Zone A" flood areas on the National Flood Insurance Program Flood Insurance Rate Maps Mason County.

Flooding in Mason County generally occurs from November through April. The greatest cause of flooding is heavy rainfall combined with snow melt. The Mason County Flood Insurance Study lists four areas as most susceptible to flooding. Those areas include the Skokomish, Tahuya and Union Rivers, and Goldsborough Creek.

The Skokomish River Valley floods several times annually. In recent history there have been large flood events in 1955, 1972, and 1990. Many homes, pastures and personal property were damaged in those years as well as lessor damage on a more frequent basis. Flooding on the Tahuya River and Goldsborough Creek have been known to cause some damage, whereas the Union River tends to have high flows, but minimal overbank flooding.

Flooding of marine shorelines is caused by a number of factors which can occur individually

or in combination. They include extreme high tides, waves generated by winds, tsunamis of distant origin, and locally generated seismic waves or boils. Wind-driven waves, superimposed on extreme high tides, represent the most common form of coastal flooding in Mason County.

Floodways, floodplains and coastal flood areas are identified by the Mason County Federal Flood Insurance Study FEMA maps.

The comprehensive plan protects Flood Hazard areas because it concentrates urban development on the least amount of land, considers the suitability of the land for development through the use of performance standards, and provides for significant open space and resource use areas in development within the Rural Area.

The *County-Wide Planning Policies* call for Mason County and the City of Shelton to protect Critical Areas.

APPENDIX D
EVALUATION OF THE WASHINGTON CORRECTIONS CENTER SPRAYFIELD AREA FOR RECLAIMED WATER APPLICATION

Introduction

This technical memo evaluates using the existing sprayfield area at the Washington Corrections Center (WCC) wastewater facility (the facility) as the site for Regional Plan discharge from the satellite WRP. The WCC discharges an average of 0.18 MGD of treated wastewater effluent to the sprayfield. WCC periodically monitors water quality at the point of discharge and in groundwater monitoring wells, and monitors groundwater levels in the same wells. WCC has operated the sprayfield system since 1997 and has reported no environmental impacts from the application of treated wastewater at the facility.

This evaluation describes the setting and operation of the facility, the environmental conditions of the local area, the current impacts and benefits to the environment, two alternatives for discharging reclaimed water from the Regional Plan satellite WWTP at the sprayfield area and the potential impacts and benefits of these alternatives. This summary of hydrogeologic conditions is based on a review of water level data collected by WCC during the past several years, in compliance with the wastewater permit, and reviews of *Hydrogeologic Evaluation, Proposed Land Application Site*, by HongWest Assoc., (1996) and *Wastewater Treatment Plant Improvements, Engineering Report, Phase 2*, by Gray & Osborne, 1996. Site maps of the facility are found in both reports.

Setting

The WWC sprayfield facility (the facility) comprises 52 acres of relatively flat terrain covered by second-growth Douglas-fir and hemlock forest. Several small, 10 to 30-foot-deep topographic depressions (glacial kettles) are scattered throughout the facility. The facility is approximately 500 feet from the North Fork of Goldsborough Creek.

Facility Operation

The 31.5-acre sprayfield within the facility consists of five irrigation zones constructed with parallel discharge lines that distribute treated effluent into five different areas of the facility. Treated wastewater is discharged into each zone for one day followed by four days of dormancy and recovery. The maximum infiltration capacity of the sprayfield was estimated at 36 to 40 inches per week (*Design Criteria Report, Wastewater Land Treatment,* Earth Systems Assoc., 1996), a substantially higher rate than precipitation rates of 65 inches per year. The *Design Criteria Report* concluded that the maximum hydraulic assimilative capacity of the facility is 4 inches per week, equivalent to 490,000 gallons per day (gpd). This assimilative capacity is the maximum rate at which the sprayfield could attenuate effluent constituent concentrations without impairing the performance of the sprayfield. Therefore, the current system could attenuate current effluent constituent concentrations at a maximum rate of 0.5 MGD, but the soil beneath the sprayfield area has the capacity to infiltrate clean water at a rate 10-times greater.

Geology

Two upgradient groundwater monitoring wells (WCC-2, MW-6) and two downgradient monitoring wells (WCC-1, MW-9) are used by WCC to monitor environmental conditions in

the uppermost groundwater zone beneath the facility. The wells are completed at depths of 48 to 57 feet below grade. Copies of well logs are attached in HongWest (1996).

The shallow geologic unit underlying the entire facility consists of sand and gravel with minor amounts of silt to a depth of at least 57 feet. HongWest reported a maximum depth of 150 feet for the unit near the facility. This uppermost unit corresponds to Unit A encountered throughout the WRIA 14 Storage Assessment area. Well logs completed in the area indicate that low permeability silt, sand and gravel, which corresponds to Unit B and described as glacial till and lacustrine (lake bed) silt, underlies Unit A throughout the local area. HongWest concluded that the till unit may be absent at the site and to the north at the Mason County landfill; fine to medium sand in the deepest borings (57 feet) underlies the coarse sand and gravel of Unit A. HongWest interpreted this sand unit as advance outwash, which corresponds to Unit C of the water storage assessment.

Groundwater

During 2004-2005, groundwater levels measured at the facility ranged in depth from 30 to 50 feet below ground surface. Water levels in individual wells fluctuated by 12 to 15 feet during 2004. The fluctuation coincided with seasonal precipitation. HongWest reported a 7 to 16-foot seasonal range of groundwater levels at the Mason County landfill and a 20-foot seasonal fluctuation at well WCC-2 in 1995. Water levels reported in well logs for WCC-1 and WCC-2 and by HongWest indicate that water levels (28 to 31 feet below grade) were approximately 7 to 11 feet higher in March 1995 than in March 2004 (35 to 42 feet).

Aquifer Characteristics

The average saturated thickness of the aquifer beneath the sprayfield is 10 feet based on a 2004-2005 average groundwater level of 267 feet and an aquifer base at 257 feet (see Figure 4 in HongWest, 1996). The thickness will vary seasonally with precipitation. The maximum potential thickness, assuming a groundwater elevation of 290 feet or 12 to 20 feet below grade, is 33 feet.

Groundwater levels measured at the four monitoring wells in 1995 and 2004-2005 indicate that groundwater in the sand and gravel beneath the facility flows generally southeast towards Goldsborough Creek under a gradient of 0.003 to 0.004 feet per foot. HWA estimated a hydraulic conductivity value of 0.3 cm/sec for the sand and gravel unit. Using this value and the hydraulic gradient, HWA estimated a horizontal groundwater velocity of 8 feet per day. HWA estimated a 63-day travel time from the sprayfield to Goldsborough Creek, a distance of 500 feet.

Surface Water

The North Fork of Goldsborough Creek lies 500 feet south of the facility and flows to the southwest. No data are available on the stream flow of the reach near the facility, although HongWest reported that the Creek may become dry during summer months. The North Fork joins Winter Creek, a spring-fed stream, and flows west and south before combining with the South Fork and discharging into Oakland Bay at Shelton.

Wastewater Application Rates

In 2004-2005, treated wastewater discharged at the facility ranged from 80,000 to 250,000 gpd, and averaged 180,000 gpd. Application rates fluctuated according to variables

of water consumption and wastewater generation at the corrections center, and not according to season. The total water loading at the facility (sprayfield application plus rainfall), however, changes with the seasonal water balance. Total water loading at the facility increases with wet season precipitation and decreases with dry season evapotranspiration. Daily precipitation rates during the wet season may equal or exceed current wastewater application rates.

Current Sprayfield Impacts and Benefits

The high infiltration rates of the sand and gravel unit beneath the sprayfield promote rapid infiltration and transmission of the treated wastewater. Current application rates do not result in obvious water quantity impacts such as flooding of Goldsborough Creek or ponding at the surface in the sprayfield. The water migrates towards and ultimately discharges into Goldsborough Creek, which augments stream flow.

Groundwater quality testing results indicate that the concentrations of wastewater effluent constituents, such as TSS, BOD, and nitrate (1 to 20 mg/L), are lower in groundwater samples collected downgradient of the facility (e.g., nitrate is less than 2 mg/), indicating that natural filtration and treatment attenuates these constituents in the subsurface.

Potential Changes under Regional Plan

Reclaimed water from the satellite WRP could be applied at the WCC sprayfield under two different alternatives. Alternative 1 would discharge all of the effluent above ground using existing or similar sprayfield equipment, and Alternative 2 would discharge all of the effluent below ground in a subsurface infiltration system constructed in the sprayfield area. Both alternatives would increase current loading to the subsurface, as the current average application rate of 0.18 MGD is substantially lower than the anticipated satellite WRP discharge rate of 0.3 to 0.6 MGD. Applying higher quality Class A reclaimed water from the satellite WRP, however, would improve groundwater quality beneath and downgradient of the facility. Applying water to the subsurface (Alternative 2) would result in greater stream flow augmentation of Goldsborough Creek, as significantly less water would be lost to evapotranspiration compared to sprayfield application.

Current application rates appear to have less influence on the fluctuation of groundwater levels than seasonal precipitation (see attached graph). However, increasing the application rate from 0.18 MGD to either 0.3 or 0.6 MGD would likely increase groundwater levels beneath the facility. Insufficient pre-sprayfield groundwater level data exist to determine the degree of groundwater mounding resulting from current sprayfield application. Using the average aquifer characteristics described above, the 10-foot thick, 2,000-foot-wide, saturated portion of Unit A beneath the facility currently transmits approximately 0. 38 MGD of water towards the southeast. The maximum available saturated thickness is approximately 33 feet, and the maximum rate of groundwater flow through the aquifer beneath the facility would be 1.2 MGD. The sand and gravel unit beneath the facility has the capacity to transmit substantially greater groundwater flow.

Seasonal Fluctuation

Alternative 2 increase the potential for groundwater mounding beneath the facility. However, the potential for unacceptable groundwater mounding is low. Current loading at the sprayfield is 0.28 MGD, based on an average application rate of 0.18 MGD and average

rainfall of 0.10 MGD. The projected average discharge rate from the satellite WRP ranges from 0.3 to 0.6 MGD. Increasing the total loading up to 0.4 MGD (0.3 MGD plus 0.10 MGD rainfall) would increase the aquifer thickness by 43 percent, or from 10 feet to 14 feet thick. A 4-foot rise in average groundwater elevation from 267 feet to 271 feet would not result in an unacceptable groundwater mound beneath the facility or result in ponding at the surface (see attached figure).

Increasing the total loading up to 0.70 MGD (0.60 MGD plus 0.10 MGD rainfall) would increase the aquifer thickness by approximately 150 percent, or from 10 feet to 25 feet. A 15-foot rise in groundwater levels would result in a groundwater mound beneath the facility at an elevation of 282 feet. This projected groundwater elevation is approximately 20 to 30 feet below ground surface, and would not result in unacceptable groundwater mounding or ponding at the surface, except possibly at the bottom of the glacial kettles at the facility.

These estimates assume average groundwater levels and precipitation for the facility. Should a prolonged period of rainfall in one or successive years substantially increase groundwater levels, then groundwater mounding potential will increase proportionally to the cumulative precipitation and groundwater recharge.

Conclusion

The sand and gravel unit underlying the existing sprayfield has the infiltration capacity to accommodate an increase of effluent discharge from the current annual average rate of 0.18 MGD to the projected discharge rate from the satellite WRP of 0.3 or 0.6 MGD without excessive groundwater mounding or surface ponding. Stream flow in the North Fork of Goldsborough Creek potentially would be augmented due to increased discharge rates at the sprayfield. Anecdotal information indicates that the reach of the stream near the facility is dry during the summer, indicating the potential environmental benefit of applying Class A reclaimed water to the sprayfield area. The reclaimed water could be applied either using existing or similar aboveground spraying equipment or by subsurface infiltration.