SURFACE WATER STORAGE AND GROUNDWATER RECHARGE INVESTIGATION, MIDDLE SPOKANE RIVER WRIA 57
WETLAND RESTORATION & RECHARGE OPPORTUNITIES WRIA 55 & 57

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1.0 INTRODUCTION

This document presents the results of an evaluation of surface water storage and associated groundwater recharge options for the Water Resource Inventory Area (WRIA) 57 (Middle Spokane River) in support of watershed planning activities. The area covered by WRIA 57 is shown on **Figure 1-1**. PBS&J completed this evaluation under contract with the Spokane County Division of Utilities (Spokane County Utilities), and it is one component of a larger study of wetland restoration and recharge opportunities in WRIA 55 and WRIA 57. All of the studies are designed to identify actions that could improve summer flow conditions in the Little Spokane and Spokane Rivers. The other components of the larger study include:

- An assessment of wetland restoration opportunities in both WRIA 55 and 57; and
- An investigation of surface water storage options for the West Branch Little Spokane River portion of WRIA 55.

In 1998 the Washington State legislature passed the Watershed Planning Act (Chapter 90.82 RCW) to set a framework for developing local solutions to watershed issues on a watershed basis. The law is administered by the Washington Department of Ecology (Ecology) in the form of grants. The current watershed planning effort for WRIA 55/57 was initiated in late 1998. Spokane County is the Lead Agency and one of the initiating governments in completing these watershed planning efforts for the Middle Spokane and Little Spokane watersheds. The WRIA 55/57 Planning Unit and Watershed Implementation Team (WIT) committee oversee watershed planning development within WRIA 55/57.

1.1 Purpose and Scope

The purpose of this evaluation was to identify non-wetland surface water storage options in the Middle Spokane River area of WRIA 57. The surface water storage options would be used to store water during periods of excess capacity for use during periods of limited capacity to mitigate current or future impacts to streamflows, provide new water supply, and to potentially improve habitat. The evaluation included the potential for new surface water storage and also for expanding existing surface storage. The primary goal of this effort was to determine if feasible surface water storage projects exist or if future efforts should emphasize wetland options.

The identification of surface water storage opportunities was accomplished through a combination of existing information review, site visits, and consultation with the Watershed Implementation Team (WIT) and other stakeholders and interested parties. Once potential sites were identified each site was ranked using various criteria above into sites with a high, medium and low potential for surface water storage and in-stream flow increases.

This document includes the following:

- A review of previous investigations;
- Identification of potential surface water storage options for WRIA 57;
- Feasibility screening of the identified surface water storage options; and
- Recommendations regarding additional detailed evaluation.

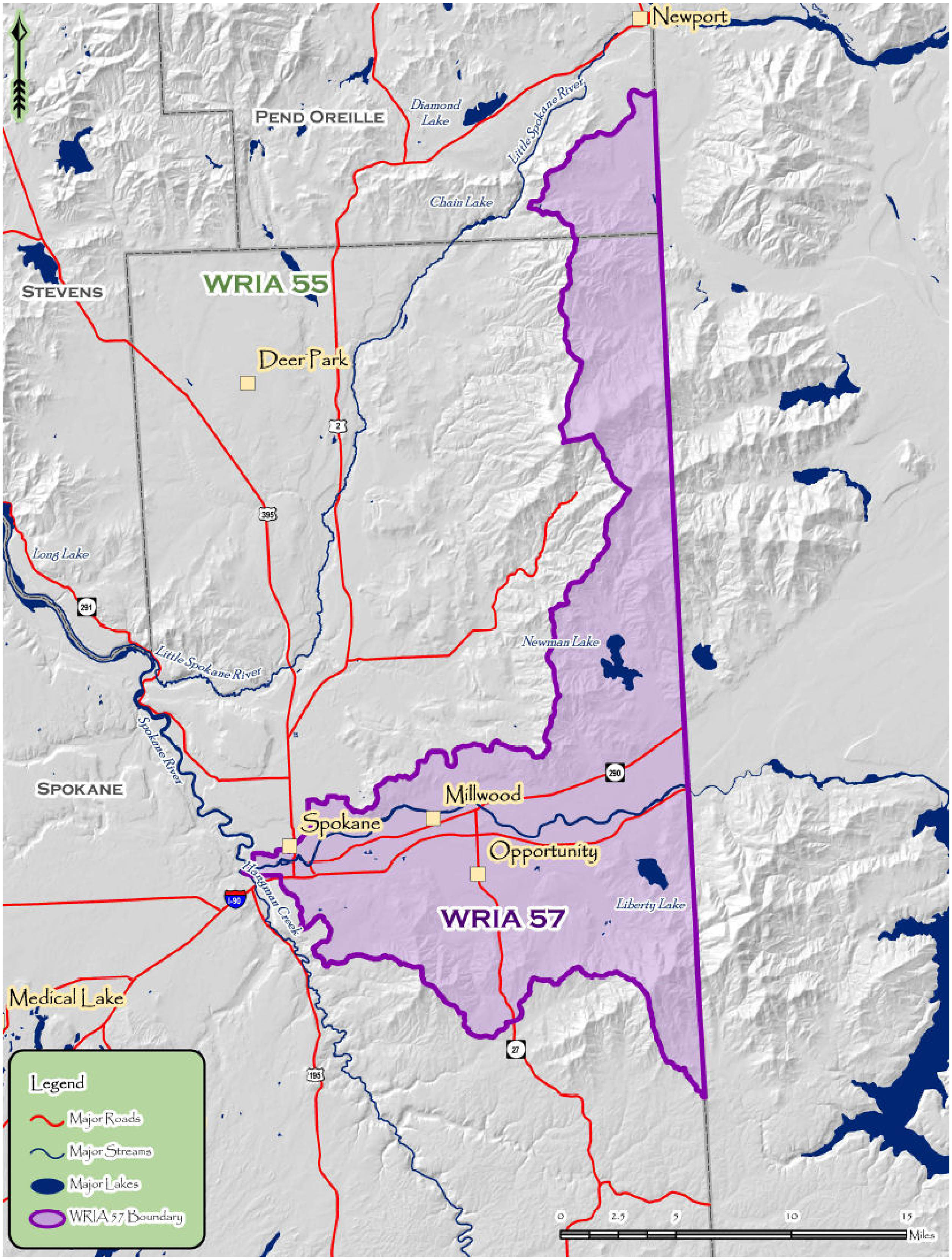

Figure 1-1. WRIA 57 Area

A list of objectives for storage assessment was previously developed (Golder, 2004) based on results of Watershed Planning work completed in WRIA 57 and conversations with Spokane County Utilities staff. These objectives were incorporated into the evaluation for this study and include:

- Offset potential impacts on streamflow from future water supply development under existing water rights;
- Offset potential impacts on streamflow from future water allocations (new water rights);
- Potential use of reclaimed water;
- Improve aquatic habitat through increased flows (examples include flows to facilitate aquatic organism passage and improve redd coverage) where flow is a potentially limiting factor; and
- Improve flow-related surface water quality problems.

1.2 Previous Investigations and Documents

Previous investigations and documents relevant to the evaluation of surface water storage options in WRIA 57 include:

- Water Storage Task Force Report (Washington Department of Ecology, 2001): This document addressed potential water storage alternatives and is intended to provide support to development of a watershed plan. Additional SEPA compliance (checklist or EIS) may be needed for implementation of specific projects. Alternatives specified included:
    - Alternative WP19: Construct and operate new on-channel storage facilities. Under this alternative, a water storage facility would be created by impounding a river or stream. On-channel storage facilities could include large reservoirs on the mainstem of major rivers as well as small reservoirs on tributary streams. Construction could involve creation of an earthen dam or a concrete dam.
    - Alternative WP 20: Raise and operate existing on-channel storage facilities. Under this alternative the capacity of an existing on-channel reservoir would be increased by raising or enlarging the impoundment structure.
    - Alternative WP 21: Construct and operate new off-channel storage facilities. Under this alternative, an impoundment structure, either earthen or concrete, would be created in an upland location. Water would be diverted or pumped from a river to an off-channel location for storage.
    - Alternative WP 22: Raise and operate existing off-channel storage facilities. Under this alternative the capacity of an existing off-channel reservoir would be increased by raising or enlarging the impoundment structure.
    - Alternative WP 23: Use existing storage facilities for additional beneficial uses. Operation of a storage facility constructed to provide water for one beneficial use or group of uses could be modified to provide water for additional beneficial uses. For example, use of a storage facility originally constructed for municipal water supply could be expanded to supply water for irrigation or to provide additional flows for fish during critical life stages.

- WRIA 55/57 Watershed Planning, Phase II – Level 1 Assessment (Golder, 2003). This document presents a preliminary assessment of existing information for WRIA 55 and 57. The information was used to describe the major characteristics of the watersheds and to identify data gaps. The Level 1 work was a precursor to the development of a hydrologic model under Level 2.

- Final Storage Assessment, Little and Middle Spokane Watersheds (Golder, 2004). This study included an appendix summarizing a preliminary evaluation of surface water storage options for both WRIA 55 and WRIA 57. The only surface water storage option reviewed in any detail for

WRIA 57 was raising the dam at Newman Lake, which was ultimately eliminated in favor of wetland restoration at that location. This current evaluation follows a similar approach to that used by Golder in examining potential surface water storage options and contains some of the information presented by Golder for the Newman Lake option.

- Ground-Water Flow Model for the Spokane Valley-Rathdrum Prairie Aquifer (Hsieh et al, 2007). This investigation represents a culmination of several previous investigations of the Spokane Valley Rathdrum Prairie (SVRP) aquifer. The USGS, working with Washington and Idaho representatives, developed a groundwater flow model of the SVRP aquifer.

- Watershed Management Plan for WRIA 55/57 (Spokane County, 2006). This document was prepared by the Little Spokane River and Middle Spokane River Planning Unit under the lead of Spokane County. Two of the key recommendations relevant to this evaluation were to "Continue site identification and feasibility analysis for use of surface runoff storage in existing lakes as means of augmenting base flow in the Little Spokane Watershed (VI.A.02.a.)" and "Continue site identification and feasibility analysis for use of surface runoff storage in new artificial lakes or ponds as means of augmenting base flow in the Little Spokane Watershed. (VI.A.02.b)."

- Detailed Implementation Plan for WRIA 55/57 (WIT, 2008). This document provides specific actions and implementation details to address a variety of issues including strategies for river baseflow, reclamation and reuse, instream flow needs, and water rights and claims. Relative to this evaluation, the document specifies that "Spokane County will hire consultants to do two feasibility analyses of the use of surface runoff storage in 1) existing lakes (medium-high benefit to the watershed according to WIT) and 2) new reservoirs, manmade ponds, or wetlands as a means of augmenting base flow in the Middle Spokane Watershed (medium benefit to the watershed). The feasibility analyses will include an engineering analysis of the feasibility of surface water flow augmentation at one or more sites, a wetlands delineation and assessment, and an explanation of the legal issues, including water rights, and identification of all needed permits."

2.0 POTENTIAL SURFACE WATER STORAGE OPPORTUNITIES

Potential surface water storage alternatives include on-channel and off-channel reservoirs, small impoundments, and wetlands. An evaluation of wetland options is being conducted under a separate effort and is not included in this document.

On-channel reservoirs are situated on the main stem of a river or stream and are filled by the flow from an upstream watershed. Off-channel reservoirs are located completely off of stream channels and are filled by overland flow or pumped from a nearby source. Small impoundments in natural depressions, oxbows, or small surface ponds would need to be implemented on a basin-wide basis in order to provide the greatest benefit.

The total number of potential surface water storage options considered by Golder (2004) for WRIA 57 during preliminary screening is not clear. However, the only option evaluated in any detail was that of increasing storage at Newman Lake.

Potential storage options are divided into the following categories:

- Existing Dams;
- Natural Lakes; and
- Infiltration Using Existing Lakes or Depressions.

A fourth potential storage option, that from new dams, was not included in this study. Not only would costs be very high and permitting very complex, but potential locations would be limited to the Spokane River in the valley center due to the general lack of tributary drainages. As such, there has been no apparent interest in this approach. New dams at higher elevations would present the added problem of addressing dam safety issues. Other surface water storage alternatives that involve wetland or stream restoration are addressed in a separate document and are not provided here.

Water data presented below are in units of acre-feet (AF) or cubic feet per second (cfs). To put these units in perspective, 1,000 AF/yr of water would equate to an annual flow of about 1.4 cfs, or 8.4 cfs for a 60 day period.

2.1 General Site Conditions

Key physical characteristics of WRIA 57 have been described in previous investigations (Golder 2003, Golder 2004, Kahle and Bartolino 2007, and Hseih et al 2007) and much of the details presented in these studies are not repeated here. Some of the factors critical to understanding the feasibility of various surface water options evaluated below include geology, hydrology, and land use.

The geology of the study area is important in that it controls how effective surface water storage can be. A highly permeable subsurface will allow water to rapidly infiltrate and recharge the groundwater, while less permeable material will slow groundwater recharge and allow for a more controlled release of stored water, increasing the chances for improving summer flows. A general geologic map of the area is shown on **Figure 2-1.** The map is from a study of the SVRP aquifer (Kahle and Bartolino, 2007) and does not show the geology of the entire WRIA 57 area; however, the missing portions are general extensions of the crystalline bedrock shown fringing the catastrophic flood deposits comprising the SVRP aquifer. A cross-section from the study is also shown on **Figure 2-1**. The geologic map and cross-section show that lowland portions of the area are underlain by coarse flood deposits, while upper portions of the area are marked by less permeable crystalline basement rock. The latter setting is more conducive to surface water storage efforts because leakage into the subsurface at these locations would be slower.

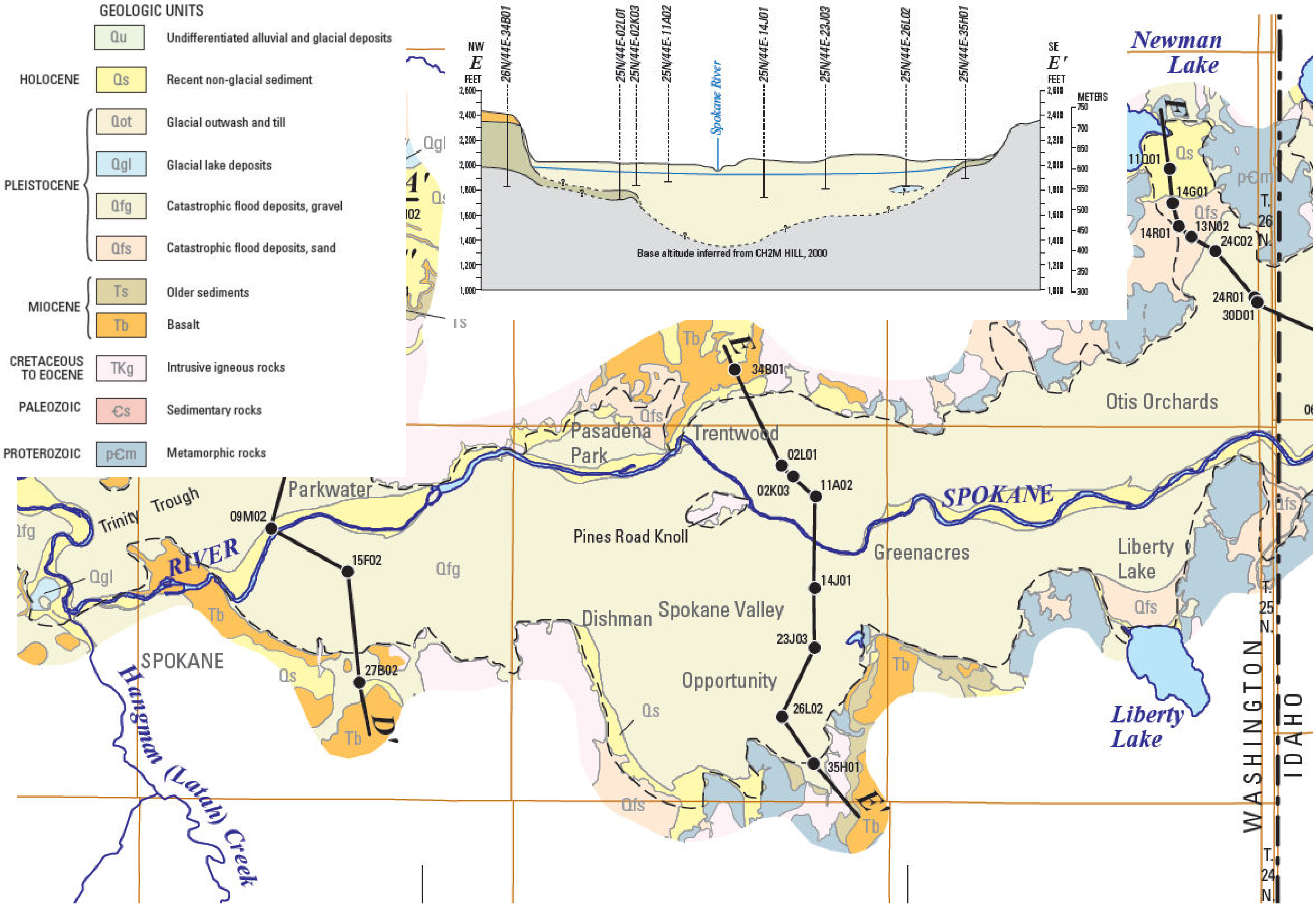

Figure 2-1. Generalized Geologic Map of WRIA 57

Flow data exist for the Spokane River from gaging stations at locations shown on **Figure 2-2**. Historical flow data for the stations are sporadic with the most complete and continuous datasets being for the Spokane and Post Falls stations. August and September are generally the lowest flow months of the year with an average discharge at the Spokane station of roughly 26% of the mean annual flow of 6,685 cfs (EES, 2007). Minimum flow requirements for the Spokane River are still being determined, but it is generally recognized that summer flows are problematic in terms of water quality and aquatic life support.

Figure 2-2. Spokane River Gaging Station Locations (from Hsieh et al 2007)

Land cover and land use in the study area are illustrated on **Figure 2-3**. The dominant land use in the area is classified as urban in the Spokane River valley, with agriculture being more prevalent in the eastern portion of the valley. Away from the valley, dominant use is urban in the west, agriculture in the north, and forest in the south and northeast.

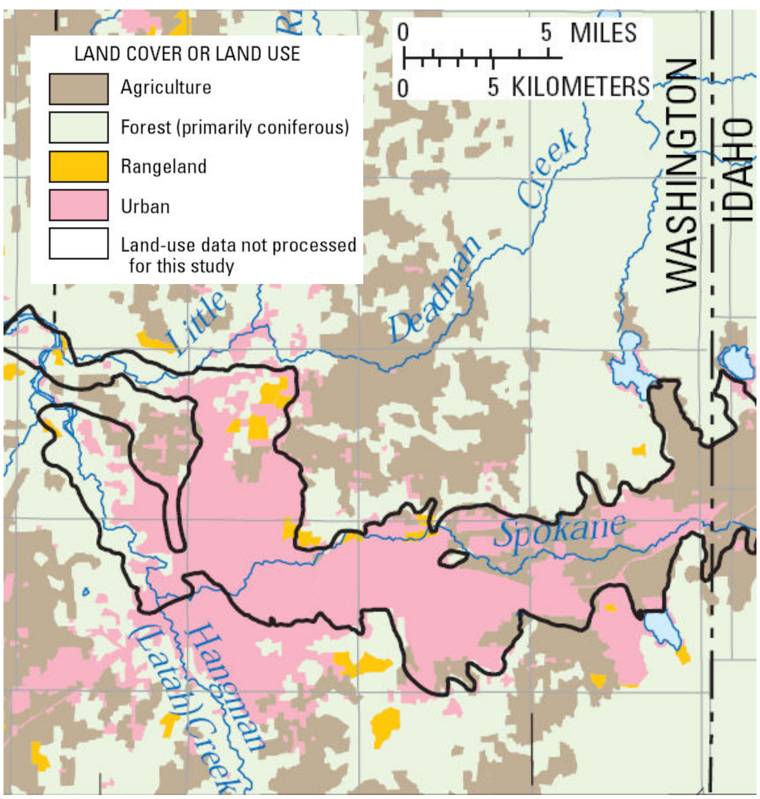

Figure 2-3. Land Cover or Land Use Map of WRIA 57 (from Kahle and Bartolino, 2007)

2.2 Existing Dams

There are ten existing dams in WRIA 57, shown on **Figure 2-4**, that were identified in an earlier study by Golder (2004). Only one of the dams, the Newman Lake Flood Control Dam, holds any potential feasibility for increasing storage in WRIA 57.

Three of the dams are on the Spokane River and they do not present good opportunities for additional storage. Room for expansion of the reservoirs is restricted by existing land use along the banks and the costs of dam revision and permitting would be very expensive in return for little gain in storage. Four other dams are small earthen dams in an area known as Saltese Flats which is being evaluated under a separate study by Spokane County Utilities in coordination with Ecology. Two dams (Warner and Martin) located in uplands are small (25 AF and 55AF of storage, respectively) and were not visited for this study. Due to their location in small tributary drainages, the amount of potential additional storage would likely be minor, and dam safety issues due to a large downstream population could be problematic.

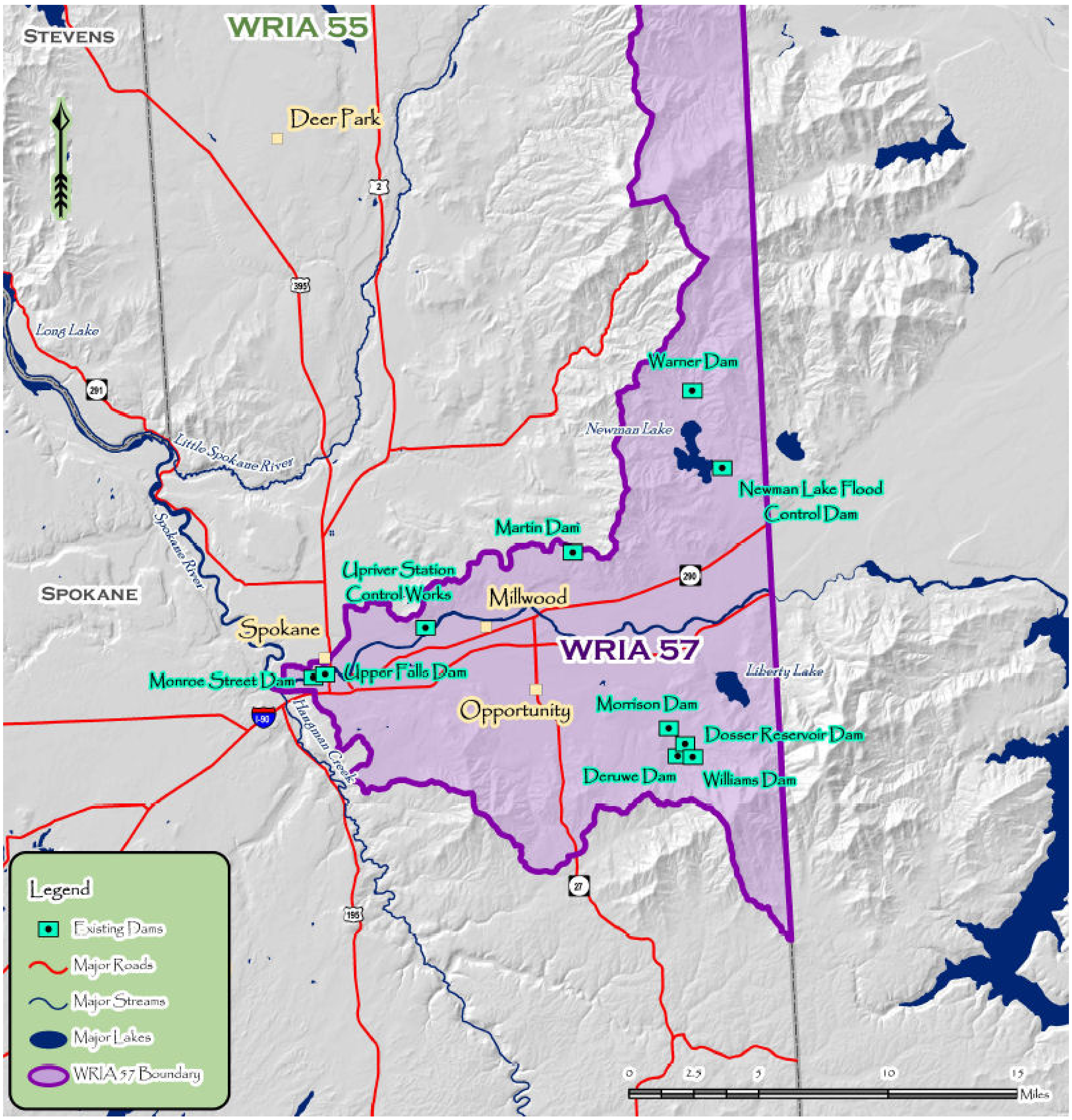

Figure 2-4. Existing Dams in WRIA 57

2.2.1 Newman Lake

Newman Lake (**Figure 2-5**) is a 1,200 acre lake in the northeast corner of WRIA 57 with a maximum storage capacity of about 21,200 AF (Ecology, 2007). The lake is fed from the north by Thompson Creek which originates at Mount Spokane. Discharge from the southeast end of the lake is controlled by a dam called the Newman Lake Flood Control Dam. A spillway sends water into an artificial channel leading to a sump roughly four miles to the south near Trent Road, where the water infiltrates. Maximum infiltration in the sump area is reported to be 425 cfs. The dam on Newman Lake is 10 ft in height with a crest length of 8,400 ft. Dam construction material consists of native peat soils except near the outlet structure. The peat material is prone to settling and leakage.

Normal operation of the dam is to hold the water surface at 2,123 ft until mid March or early April when the lake is free of ice and the peak of watershed snowmelt has passed. The water level is then gradually increased to the maximum storage goal elevation of 2,125.6 feet by the end of May. The water level is subsequently allowed to drop, which occurs primarily due to evaporation and groundwater losses, until early October when the lake level is drawn down to 2,123 ft. Spring releases are made as needed to reduce flooding. Flooding has been reported by residents when the lake level is above 2125.6 ft.

A previous study of the potential for increasing storage at Newman Lake was completed by Golder Associates (2004). Their study concluded that raising the dam by 20 feet would allow an additional 35,000 AF of additional storage. They also calculated that a controlled release of water stored by a 20 ft dam raise could provide a flow of 200 cfs for 3 months and that previously drained wetlands might be partially restored.

Potential impediments to raising the dam at Newman Lake that were previously identified still hold true. These include the fact that, like many large lakes near an urban area, the land surrounding lake is developed, though not extensively. Raising the lake level would likely encounter resistance from lakeshore property owners and require complicated negotiations. Also, leakage from lake appears to be significant which would reduce the ability to hold high lake levels leading into the low flow summer months. Lastly, the existing dam, which is comprised of native peat soils would likely have to be replaced to provide a solid foundation. In addition to these limitations, our evaluation revealed that raising the lake level would serve to flood existing and potential wetlands to the north of the lake which otherwise could be used as alternative water storage opportunities in the area. Areas of potential wetland restoration identified as part of a companion study are shown on **Figure 2-5**.

An alternative to raising the dam height at Newman Lake would be to implement operational changes that would maintain higher lake levels for a longer period of time and then release water during the summer months. Current dam operations provide for a difference of 2.6 feet between high and low levels, or roughly 2,000 AF of water. That volume of water equates to a flow of roughly 17 cfs for 60 days. While this may be a relatively simple adjustment to implement, the actual benefit may be less than suggested from the calculations. This is because there appears to be potentially significant leakage that could limit the ability to maintain a high lake level when inflow from Thompson Creek diminishes leading into the summer months. Nevertheless, this may be worth pursuing from an overall watershed management perspective; even if the gain is nominal.

As part of this current evaluation, a presentation was made to the WRIA 55 & 57 WIT. Our summary of the Newman Lake potential was discussed along with the conclusion that a dam raise did not appear worth studying further but revising dam operations might bring some slight benefit. At that presentation there was no indication that further review of this potential storage opportunity was of interest. One committee member raised the question of potential dredging to increase lake storage. While dredging would serve to increase total storage in the lake, the increase would occur below the control structure outlet and that increased storage would therefore not be available for release to increase downstream flows.

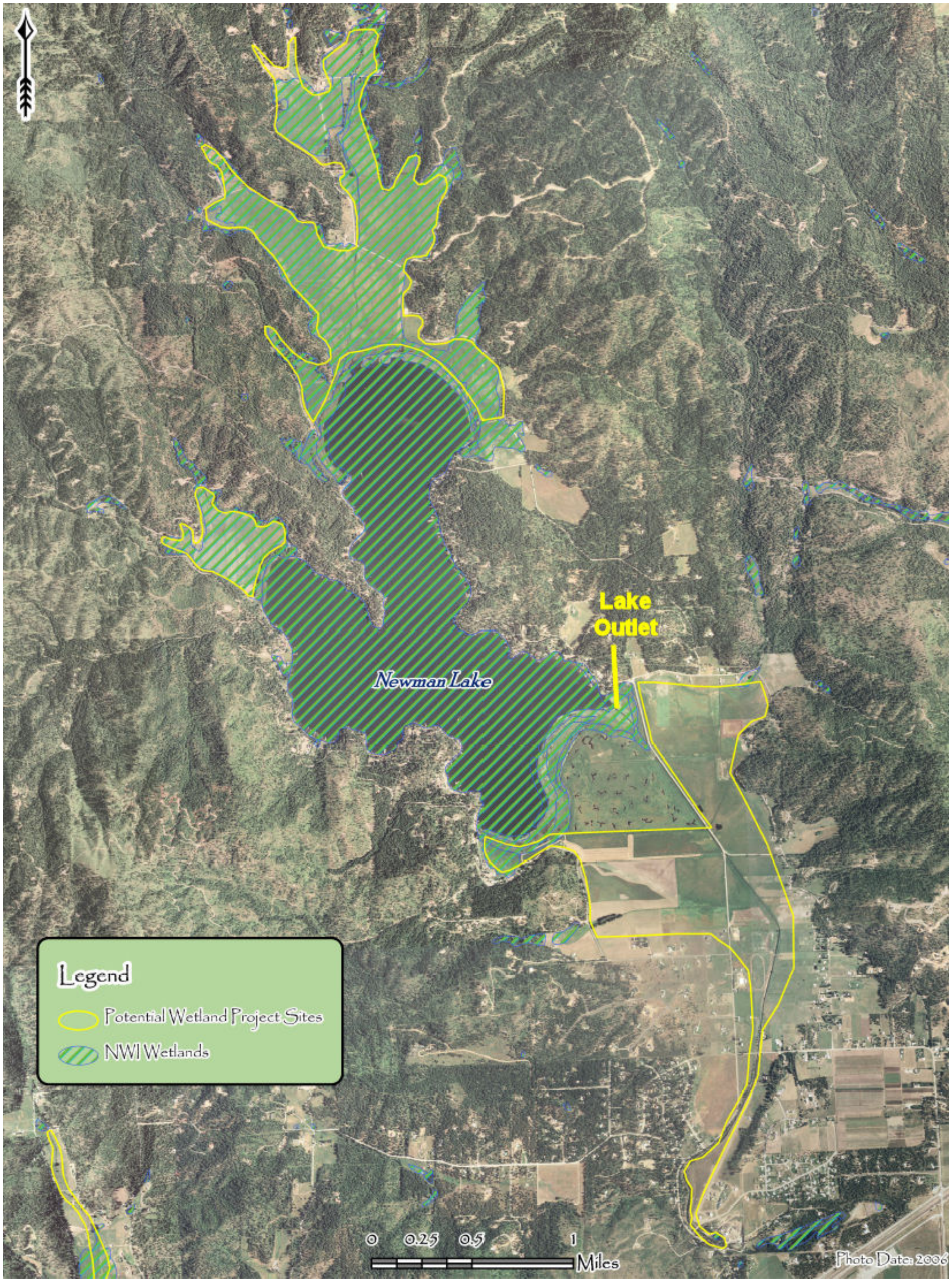

Figure 2-5. Newman Lake

In lieu of modifying Newman Lake storage by raising the dam level and even if the potential benefits from modified operation are realized, it appears that the best option for increasing storage in the area is through wetland restoration which is being evaluated in a companion study to the one presented in this document. Areas of potential wetland restoration near Newman Lake are shown on **Figure 2-5**.

2.3 Natural Lakes

The potential for expansion of water storage in natural lakes in WRIA 57 was also evaluated for this study. The occurrence of natural lakes in WRIA 57 is limited and those of sufficient size to offer any significant storage volume increase potential are limited to Shelley Lake and Liberty Lake.

Shelley Lake is roughly 21 acres in size and is located about three miles west of Liberty Lake in the eastern portion of WRIA 57. Flow into the lake comes from Saltese Creek which originates at Mica Peak to the south and is joined by flow from Quinnamose Creek, which drains an area between upper Saltese Creek and Liberty Creek, the input to Liberty Lake. Shelley Lake overlies the SVRP aquifer and has no outlet. Drainage from the lake is through infiltration into the aquifer. Potential modification of the Shelley Lake watershed to enhance summer infiltration into the SVRP aquifer is currently being evaluated as part of a separate study into the restoration of wetlands at Saltese Flats which lie along Saltese Creek upgradient from the lake.

2.3.1 Liberty Lake

Liberty Lake lies on the eastern boundary of WRIA 57. The lake, shown on **Figure 2-6**, is fed by Liberty Creek to the south which drains an area of 13 square miles. The lake covers an area of roughly 708 acres with a volume of 16,750 AF. Drainage from the lake is through a fabricated outlet structure and channel on the northwest corner leading to infiltration basins.

Because of the large size of Liberty Lake, the potential for increasing water storage in the lake with a nominal increase in lake level is significant. Increasing the lake level by as little as five feet would result in an increased storage exceeding 4,000 AF. Spring lake levels are controlled at the adjudicated maximum level of 2049.5, which then drop in late June-early July to winter lows of roughly 2046.5.

There is extensive development around the lake, especially around the northern half. Development is evident along the eastern and western banks. The southeast portion is classified as FEMA floodplains and has been identified as a potential wetland restoration and water storage opportunity in a companion study to this one, with the area of potential wetland restoration outlined on **Figure 2-6**.

Although increasing storage by raising the lake level would equate to a significant volume of water, the feasibility of accomplishing this appears to be poor. The degree of development along the lakeshore and established maximum lake level present very complicated impediments in addition to the cost of properly designing, permitting, and constructing an appropriate control structure. An evaluation of the potential for wetland restoration to the south seems to be a more efficient and promising avenue to pursue.

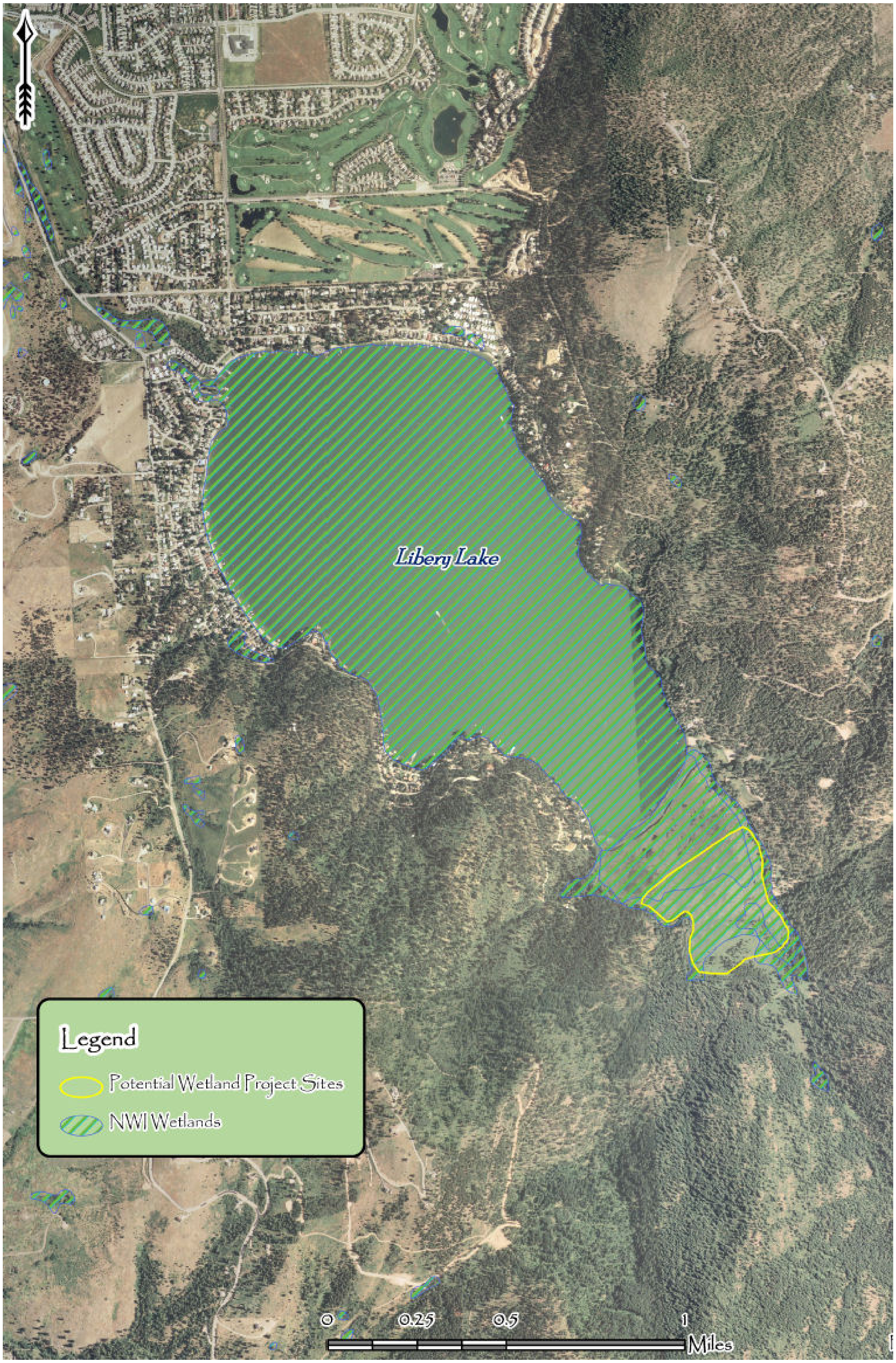

Figure 2-6. Liberty Lake

2.4 Infiltration Using Existing Lakes or Depressions

Potential storage options included in this category would generally involve transferring water from an existing location, such as from a lake into a created reservoir or existing depression to allow infiltration into the groundwater. In areas underlain by coarse material, the infiltration would be relatively rapid and unless the areas of recharge were placed some distance from surface water, there would be little delay between the timing of infiltration and recharge to surface water. In the northern portion of the basin where finer grain basement rock underlies the surface, infiltration would be slower and this could be a viable area for delayed infiltration.

The major downside to this approach is that, in order to create significant storage, either a number of small locations would be needed or large reservoirs would need to be constructed. For those reasons this approach apparently holds little promise to provide an economically feasible method to increase water storage in the watershed with the intent of measurably increasing summer flows in the Spokane River. One potential method in this category, using gravel pits, is discussed briefly below.

2.4.1 Gravel Pits

Abandoned gravel pits provide ready-made depressions that could be utilized to route water into underlying aquifers. The water would eventually find its way into the Spokane River. The number and location of abandoned gravel pits in WRIA 57 was not determined for this study, but considering the nature of the SVRP aquifer matrix in the valley and a cursory review of the area, there are many.

The major impediment to utilizing these artificial depressions is twofold. First, because the nature of gravel mining is to find coarse material, the pits are located in areas where infiltration is rapid. Second, although the number of pits may be large, the actual size of any one pit is small in terms of the potential for a large volume of storage. The first limitation could be overcome with creative engineering approaches to reduce the infiltration, such as lining the pit bottoms either with fine grained fill or even other types of available organic debris to slow water movement into the subsurface. However, the second limitation, that of individual size, suggests the potential cost and number of locations required to measurably increase river flow would be prohibitive.

3.0 CONCLUSIONS AND RECOMMENDATIONS

In conclusion, a number of potential options have been evaluated, or in some cases revisited, that could increase water storage in WRIA 57 with the overall intent of increasing or slowing the decline of summer low flow conditions in the Spokane River. These potential storage options include the following categories:

- Existing Dams;
- Natural Lakes; and
- Infiltration Using Existing Lakes or Depressions.

There are ten existing dams in WRIA 57 but only one of them holds any potential feasibility for increasing storage in WRIA 57. Three dams lie on the Spokane River where expansion is constricted by land use, would be expensive, and would likely include complicated permitting. Four of the dams are smaller earthen dams at Saltese Flats, which is being evaluated under a separate study. Two dams are in upland areas and would likely offer small additional storage potential and present dam safety issues.

The dam at Newman Lake could potentially be enlarged with a resulting storage increase of up to 35,000 AF. Impediments include existing development along the lake, infiltration that would reduce effectiveness, the cost of replacing the existing dam, and potential flooding of existing wetlands. Alternatively, operational changes at the dam could result in smaller increased summer releases that would reach the Spokane River.

There are only two existing lakes large enough to provide any potential for significantly increased storage in WRIA 57. Shelley Lake lies near Saltese Flats and potential revisions to watershed management there are under review in a separate study. Liberty Lake covers 708 acres and increasing lake levels by as little as 5 ft would increase storage by over 4,000 AF. However, this is not likely feasible due to extensive development along the lake and would require modifying the existing control structure.

It is not feasible to use existing lakes or depressions for infiltration to create significant storage potential to increase summer flows. First, rapid travel of groundwater through the SVRP aquifer means there would be little delay from the time of infiltration, which would be greatest during high spring flows and would therefore not improve summer conditions. Second, in order to create significant storage, either a number of small locations would be needed or large reservoirs would need to be constructed. For these reasons this approach holds little promise for providing an economically feasible method to increase water storage in the watershed with the intent of increasing summer flows in the Spokane River.

Based on this evaluation there do not appear to be any obvious or highly attractive options for significantly increasing water storage in WRIA 57, although there are options that could increase storage nominally. It appears that the most viable option for attaining the desired goals of this study would be to pursue wetland restoration options, which are being evaluated under a separate study.

4.0 REFERENCES

Ecology, 2007. Newman Lake Total Phosphorus Total Maximum Daily Load Water Quality Improvement Report. Wa State Department of Ecology Publication # 06-10-045. November

EES, 2007. Final Technical Report, Spokane River Instream Flow Studies. Prepared by EES Consulting for Spokane County Public Works Department and WRIA 54 & 57 Watershed Planning Units. May.

Golder, 2003a. Little Spokane (WRIA 55) and Middle Spokane (WRIA 57) Watershed Planning, Phase II – Level 1 Assessment, Data Compilation and Preliminary Analysis. Prepared by Golder Associates for Spokane County and the WRIA 55 and 57 Planning Unit. June.

Golder, 2003b. Little Spokane River Basin (WRIA 55) Instream Flow Needs Assessment. Prepared by Golder Associates. December

Golder, 2004a. Draft Baker (Ponderosa) Dam Site Visit Results and Suggested Direction. Memorandum included in Final Storage Assessment, Little and Middle Spokane Watersheds. August 31.

Golder, 2004. Final Storage Assessment, Little and Middle Spokane Watersheds. Prepared by Golder Associates Inc. for Spokane County and WRIA 55 and 57 Planning Unit. December 2004. 77p.

Hsieh, P.A., Barber, M.E., Contor, B.A., Hossain, M.A., Johnson, G.S., Jones, J.L., and A.H. Wylie, 2007. Ground-Water Flow Model for the Spokane Valley-Rathdrum Prairie Aquifer, Spokane County, Washington, and Bonner and Kootenai Counties, Idaho. USGS Scientific Investigations Report 2007-5044.

Kahle, S.C., Caldwell, R.R., and J.R. Bartolino, 2007. Hydrogeologic Framework and Ground-Water Budget of the Spokane Valley-Rathdrum Prairie Aquifer, Spokane County, Washington, and Bonner and Kootenai Counties, Idaho. USGS Sci Invest Report 2007-5041, Plate 2.

Spokane County. 2006. Watershed Management Plan: Water Resource Inventory Area 55-Little Spokane River & Water Resource Inventory Area 57-Middle Spokane River. 120p.

Washington Department of Ecology, 2001. Water Storage Task Force Report to the Legislature. Publication Number 01-11-002. February.

Washington Department of Ecology. 2008. Progress on Watershed Planning and Setting Instream Flows. 2007 Report to the Legislature. Washington Department of Ecology Publication No. 08-06-002. June.

WIT, 2008. Detailed Implementation Plan, Little and Middle Spokane River Basins, Water Resource Inventory Area 55/57. Developed by the Watershed Implementation Team. February 20.