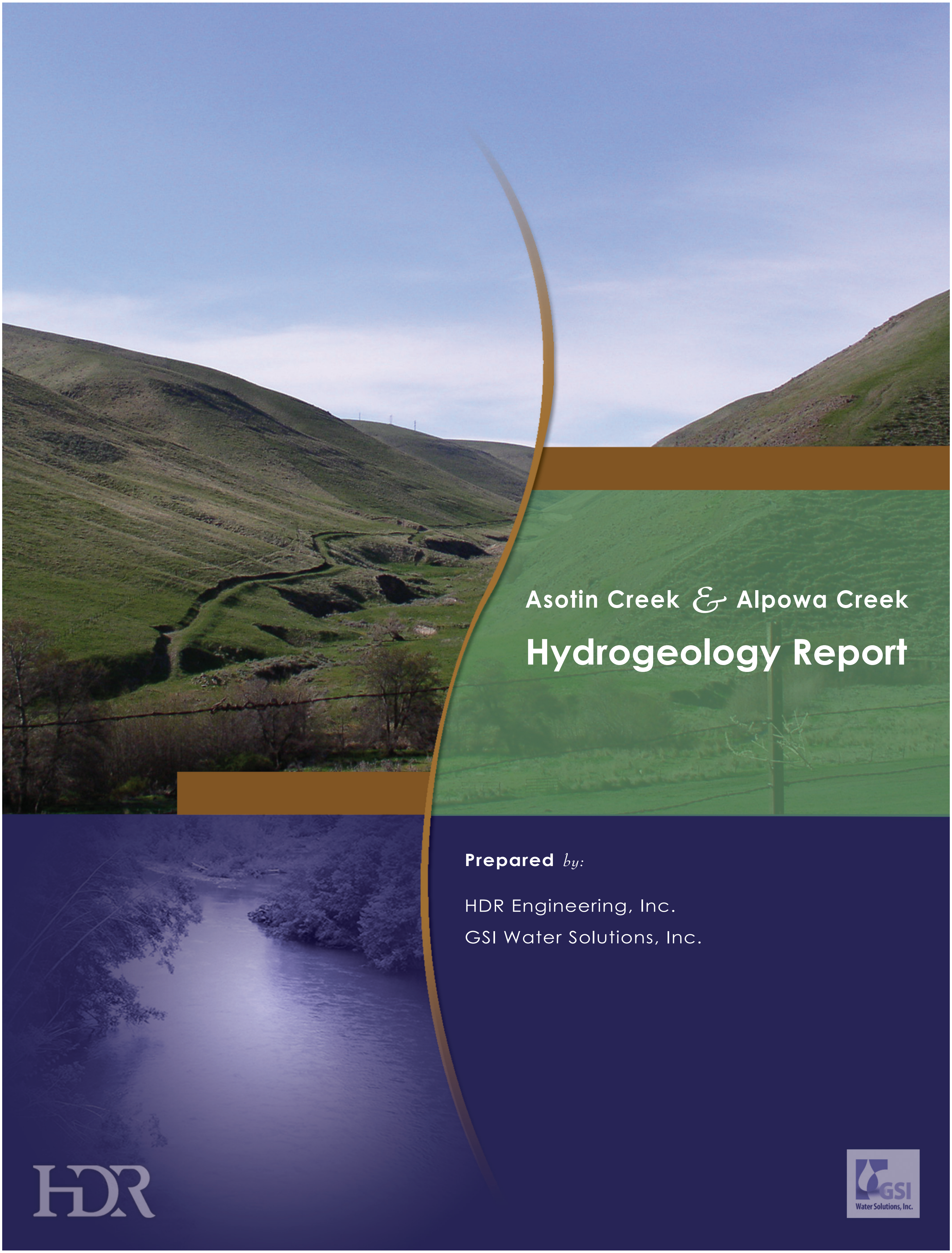

Asotin Creek & Alpowa Creek

Hydrogeology Report

Prepared *by:*

HDR Engineering, Inc.
GSI Water Solutions, Inc.

Asotin Creek and Alpowa Creek
Hydrogeology Report

Grant Number: G0800148

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for

WRIA 35 Planning Unit

Washington State Department of Ecology

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Executive Summary

A field investigation, hydrogeologic evaluation and water use analysis was conducted for the Alpowa Creek and Asotin Creek sub-basins. The study area included the Alpowa and Asotin Creek sub-basins as well as the Town of Anatone and Tenmile and Mill Creek sub-basins.

Field Investigation

The field investigation included a physical reconnaissance of the study area, interviews with residents residing outside the boundary of Asotin Public Utility District to determine water used characteristics such as irrigated lawn size, household population and irrigation practices, interviews with other landowners and with persons familiar with the area to determine irrigated acreage and livestock within the project area, groundwater level measurements permit exempt wells and a seepage run.

An average of 2.4 persons per household and an average lawn size of 2,500 square feet were identified during the survey. A total of about 1,900 livestock are located in the basin during the year. Ground water level measurements were recorded at about 59 wells in the fall of 2008 and spring of 2009. Twenty six of the wells were measured once during the fall and again in the spring. Creek flow measurements were taken during the September of 2008 to determine groundwater gains and losses (seepage run) for Asotin Creek (North Fork, South Fork and Mainstem), George Creek, Charley Creek, Alpowa Creek, Mill Creek and Tenmile Creek.

Hydrogeologic Evaluation

Geology

The predominant geologic formation in the project area is the Columbia River Basalt Group (CRBG), a thick sequence of flood basalt prevalent throughout the region. The project area is within the western half of the Lewiston Basin, which is a structural basin bounded by folded and faulted CRBG. The CRBG formations on the western edge of the basin down-dip to the east to the center of the basin. The western edge of the basin and the formation anticline runs through the Town of Anatone and the northern portion of the town is on the northeastern limb of the anticline and the area south of the town is on the southwestern limb of the anticline. The structural dip (to the east) ranges from 2 to 10 degrees and the CRBG formations found exposed in the project area highlands are well below the Snake River in the center of the basin. The strong down-dip in the CRBG formations cause over one mile of structural relief in the project area. There is significant faulting on the western portion of the Lewiston basin in the project area. A number of generally east-west oriented faults are mapped in associated with the anticline on the southern edge of the project area and generally north-south faults occur from the mouth of Alpowa Creek south to the lower portion of Asotin Creek. Faulting is also evidenced in many areas throughout the upper portions of the basins. The Asotin and Alpowa Creek and their tributaries have eroded steep canyons which have truncated and divided the CRBG formations. Canyon depths are in excess of 1,500 feet.

The oldest geologic formation evaluated for this project in the study area is the CRBG. The CRBG is classified by a vertical sequence of mappable formations including (from youngest to oldest), the Saddle Mountains Basalt, Wanapum Basalt, Grande Ronde Basalt and Imnaha Basalt. The Saddle Mountain and Wanapum basalt units are the upper units and are present in eastern portion of the Asotin Creek sub-basin (they are eroded from the western portion of the basin). The creek valleys completely truncate and erode these units in most areas. The Grande Ronde Basalt forms the deeper basalt unit in the study area. This unit is exposed in the deeper canyons in the upper portion of the sub-basins and because of down-dip and structural relief they are buried below the bottom of the canyons in the middle and lower portions of the basin.

The CRBG is overlain by younger Pleistocene deposits in the valley bottoms mostly composed of alluvial sand, gravel and cobbles ranging from less than 20 feet deep in the upper basin to 50 to 100 feet deep in the middle areas of the valleys and from 50 to over 150 feet deep in the lower valley. Asotin Creek and Alpowa Creek flow directly on these alluvial deposits. More recent silt overbank deposits are located atop the alluvial sand and gravel deposits in the middle and lower portions of the valleys.

Hydrogeology

The sand and gravel alluvial deposits present in most of the valleys form a shallow unconfined aquifer ranging from less than 50 to over 150 feet in thickness that is in direct hydraulic-continuity with the creeks flowing in the valley bottoms. Few wells are completed in this aquifer.

The principal groundwater supply aquifers in the study area are the confined, shallow and intermediate basalt hydrostratigraphic unit (SBHU and IBHU) aquifers. The SBHU is intersected and eroded by the tributary and mainstem creek canyons and the aquifer discharges to springs in the upper portion of the Alpowa and Asotin Creek sub-basins. The IBHU displays characteristics of both the shallow and deep units, depending on location. In the Alpowa Creek and upper Asotin Creek areas, the unit is deeply incised by canyons; aquifers likely display limited lateral continuity, water production is low, and many water-bearing zones discharge to springs in the headwaters areas of these streams. In the Lower Asotin Creek area this unit is generally at or below most canyon bottoms.

The lateral continuity of the SBHU and IBHU units is controlled by faults, feeder dikes and other geologic features in the formation and the deeper canyons which partially to completely truncate these units. Most faults are expected to form flow barriers in basalt aquifers. Most of the groundwater flow from these aquifers to surface water appears to be within the upper portions of the basin and small springs are observed emanating from the basalt in the headwaters. There is little hydrologic evidence that the basalt aquifers are in continuity with surface water in the middle and lower portions of the sub-basins. An exception is Alpowa Creek, where seepage run data indicate a cumulative gain in flow from groundwater of about 5 to 6 cfs, which is the vast majority of flow in the creek.

Most of the basalt wells are located in the middle and lower areas of the sub-basins and are completed in the SBHU or IBHU aquifers. In the mainstem Asotin Creek basin and in George and Charley Creek there is no evidence to suggest that basalt aquifers are discharging to or providing flow to the creeks. Ground water levels measured in wells vary significantly for wells completed within the same geologic unit indicating a high degree of discontinuity within a single formation. The available geologic information also indicates that the structure of the shallow basalt (faulting, erosion, truncation, pinch outs) causes the aquifers to be hydraulically discontinuous between wells and surface water drainages.[1] Pumping by individual wells at low rates needed for household or small

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[1] The shallow basalt aquifer near the Town of Anatone is an exception and groundwater levels in wells show a continuous groundwater flow gradient that suggests a hydraulic connection within the aquifer.

agricultural use at relatively few households spread over a large area is unlikely to impact surface water flow. This is especially the case since the basalt aquifers that supply the water are not expected to be hydraulically-connected to stream flow in the middle and lower portion of the Asotin Creek sub-basin where most groundwater wells and usage occurs.

There is little evidence to suggest that the deep basalt hydrostratigraphic unit (DBHU) is in hydrologic connection with streams based on hydrostratigraphic mapping. Very few wells (less than 15 percent) are exclusively completed in the deep basalt hydrostratigraphic unit (DBHU). This is probably due to the high cost of drilling into deep basalt and the availability of water from the more-shallow basalt aquifers. The available data shows that the DBHU is present well below the bottom of the canyon bottoms and is not in hydrologic connection to mainstem and tributary creeks. Most of these wells are located in the lower portion of the basin and probably use water that would eventually flow into the Snake River and are not hydraulically-connected to the Asotin or Alpowa Creeks or their tributaries. Therefore, we can conclude that the few wells that are pumping from the deep aquifer are not affecting creek flow in the project area.

Water Use Estimate

A water use estimate was conducted for the project area. The water use estimate included residential use, public supply use and agricultural use components.

Residential use was based on population estimates and household use rates. The current-day population was estimated from a count of households (365 residences) and assuming 2.5 persons per household (which is consistent with the 2.4 person per household estimate from the field survey) indicating a total current population of about 900 persons. The 50-year future population was estimated at 640 residences and 1,600 persons using a conservative estimate of 1 percent growth. An estimate of the development of the lots in the lower portion of the basins where residential growth is most likely to occur yielded an estimate of 8,400 residences with 21,000 persons. This is very conservative because it assumes that all lots in these areas will be developed with individual wells, whereas in reality, development at this level would likely involve connection to a public water supply system supplied from deep wells that would likely not be hydraulically-connected to the creeks in the sub-basin. We estimated an annual residential use rate of 381 gpd/household and a summer use rate of 571 gpd/household. This estimate is higher than national and regional averages, but is lower than the household meter record use within the Asotin PUD water service area. This is reasonable considering the arid climate and the fact that most of the lawns in the project area are much smaller than residences in the Asotin PUD service area and are irrigated at less than the irrigation demand.

Public water supply use is a minor component of total water use. There are only 38 households or businesses served by public water supply systems not counting the Town of Asotin. The Town of Asotin is served by a deep basalt well near the Snake River and the source of the water is not within the project area so it was not included in the water use estimate.

Agricultural groundwater use was estimated based on water rights, a field survey, interviews with persons knowledgeable about the irrigation practices in the area and a count of irrigated lands and stock in the sub-basins. A total of about 91 acres are irrigated for agriculture with an estimated annual water use of about 245 AF/yr. Stock watering was estimated based on a count of stock and assuming 27 gpd for cattle and 18 gpd for horses. The estimated 1,900 stock in the basin are estimated to use about 29 AF/yr assuming full consumptive use.

The Alpowa Creek sub-basin water use for current-day population in the summer is about 0.48 cfs (28.8 acre-feet per month) with 0.09 cfs (5.3 afm) return flow and the annual water use is about 0.26 cfs (15.6 afm) with about 0.05 cfs (3.3 afm) return flow. The Asotin Creek sub-basin water use for current-day population in the summer is about 0.38 cfs (23.1 afm) with 0.10 cfs (6.3 afm) return flow and the annual water use is about 0.26 cfs (15.6 afm) with about 0.08 cfs (5.1 afm) return flow. This information shows that current-day water use is not a significant factor with regards to the potential for stream flow depletion from water use.

The 50-year projected future growth scenario shows that in the Alpowa Creek sub-basin the annual and summer groundwater use rate increases to about 0.29 cfs or 17.6 afm (0.07 cfs or 4.3 afm return flow) and 0.53 cfs or 31.8 afm (0.11 cfs or 6.4 afm return flow), respectively. For the Asotin Creek sub-basin the 50-year projected future growth scenario shows that the annual and summer groundwater use rate increases to about 0.34 cfs or 20.4 afm (0.13 cfs or 7.7 afm return flow) and 0.50 cfs or 30 afm (0.15 cfs or 9.2 afm return flow), respectively. This information shows that water use is not a significant factor with regards to the potential for stream flow depletion from water use for the projected 50-year growth scenario.

The partial build-out growth scenario shows that in the Alpowa Creek sub-basin the annual and summer groundwater use rate increases to about 0.5 cfs or 30.2 afm (0.18 cfs or 10.7 afm return flow) and 0.84 cfs or 50.7 afm (0.22 cfs or 13.5 afm return flow), respectively. For Asotin Creek sub-basin the 50-year projected future growth scenario shows that the annual and summer groundwater use rate increases to about 2.9 cfs or 176 afm (1.7 cfs or 101 afm return flow) and 4.0 cfs or 246 afm (1.8 cfs or 109 afm return flow), respectively. This is a very conservative future growth scenario because it assumes that all lots in these areas will be developed with individual wells proving a water supply. In reality, if development at this scale occurred in the middle and lower Asotin Creek sub-basin the residences would be served by a public water supply system supplied from deep basalt aquifer wells that are not hydraulically-connected to Asotin Creek.

Chapter 1
Introduction

This report describes an investigation of the hydrogeology, water use and potential for stream flow depletion in the Asotin Creek and Alpowa Creek sub-basins. The goal of the study is to quantify current and projected future ground water use and to evaluate the effects on surface water resources in the project area. The project area, shown on **Figure 1-1**, is located in Garfield and Asotin County, Washington. Individual maps showing of the Alpowa and Asotin Creek sub-basins are presented on **Figures 1-2** and **1-3**. The project was conducted according to the scope of services described in the January 18, 2008 and June 25, 2008 proposals authorized by the Asotin Public Utility District on behalf of the WRIA 35 Planning Unit. The project was funded by Grant # G0800148 from the Washington State Department of Ecology (Ecology). This report was prepared by HDR Engineering, Inc. and GSI Water Solutions, Inc.

A Phase I report was previously prepared, dated June 28, 2008, that described the results of a hydrogeologic analysis based on a review of well logs, geologic reports and a field reconnaissance. Phase II of the project involved additional field investigations, including a seepage run analysis to quantify gaining and losing creek reaches, two rounds of ground water level measurements and a water use survey and analysis of this information. This report presents combined information for both Phase I and Phase II of the project.

The technical information and findings in the report are presented in the following four chapters.

Chapter 2 Field Investigations

Chapter 2 summarizes the methods and results of field investigations conducted during fall of 2008 and spring of 2009. A water use inventory was conducted involving interviews with residents of approximately 52 households in the project area to identify the number of persons per household, lawn size and irrigation and stock watering practices. Ground water wells were identified in the project area and the top of casing elevation was measured using a high-precision GPS instrument. About 78 wells were located and the depth to the ground water table was measured in about 59 wells using a decontaminated ground water level probe. A stream gaging seepage run flow profile was completed to quantify the amount of ground water flowing into or out of reaches of eight major creeks in each sub-basin in the project area.

Chapter 3 Hydrogeologic Evaluation

Chapter 3 presents the results of a hydrogeologic evaluation of the occurrence and distribution of the principal ground water supply aquifers in the project area and assesses, to the extent possible based on available data, ground water flow direction within the aquifer system and the extent of hydrologic connection between the different portions of the aquifer system and surface water (springs, tributaries and mainstem creeks). The hydrogeologic evaluation was based on examination of well logs, field reconnaissance, regional geologic reports and the authors' experience with the Columbia River Basalt Group (CRBG) aquifers. Chapter 3 shows that the primary ground water supply aquifers in the project area currently being tapped by water wells are shallow and intermediate basalt hydrostratigraphic units (SBHU and IBHU). The SBHU is interpreted to be hydrologically-connected to tributary and mainstem creeks throughout much of the project area, although this connection may be more extensive in the upper portions of the drainages, than the lower. The available data is interpreted to indicate that the IBHU is hydrologically-connected in the upper portion of the basin and may be connected in the lower portion of the basin. The deep basalt hydrostratigraphic unit (DBHU) has very limited use in the lower portion of the basin (less than 15 percent of all wells are solely completed in the DBHU), where it is located well below canyon bottoms and therefore probably has limited hydrologic connection with surface water in the lower portion of the Asotin Creek and Alpowa Creek basin. There are few wells and limited data to establish the degree of hydrologic connection for the IBHU and DBHU. The alluvial aquifer present in creek valley bottoms generally has a high degree of hydrologic connection with streams but it is not used for ground water supply.

Chapter 4 Water Use Analysis

Chapter 4 presents the results of a ground water use assessment. This assessment was completed to estimate the extent and seasonal nature of ground water use in the project area. Three types of ground water use were examined: (1) domestic use by permit-exempt wells for residences with septic tanks, (2) public supply use and (3) agricultural use. Growth projections were evaluated to determine the current ground water use, projected future ground water use (over the next 50 years), and future ground water use assuming a partial build-out of developable lots in the lower portion of the sub-basin. The results of the assessment show that ground water use and depletion of surface water flows in each of the sub-basins is relatively small (less than about 0.5 cfs) for both current and future (50-year) growth projections assuming a 1 percent annual growth rate. Another growth scenario (partial build-out) was completed to examine the effects of additional population growth and further build-out of developable lots. The partial build-out scenario assumes that development in the lower portion of the basins expands to the amount allowed under current zoning regulations. The resulting higher population increases groundwater use significantly (up to 0.8 cfs and 4 cfs for Alpowa and Asotin Creek Sub-Basins, respectively).

Chapter 5 Summary and Conclusions

Chapter 5 presents a summary and conclusions for the project. The information presented on the hydrogeologic evaluation in Chapter 3 and the water use analysis in Chapter 4 is compared to provide an evaluation with respect to the potential for adverse stream flow depletion at the level of future development anticipated for the basin.

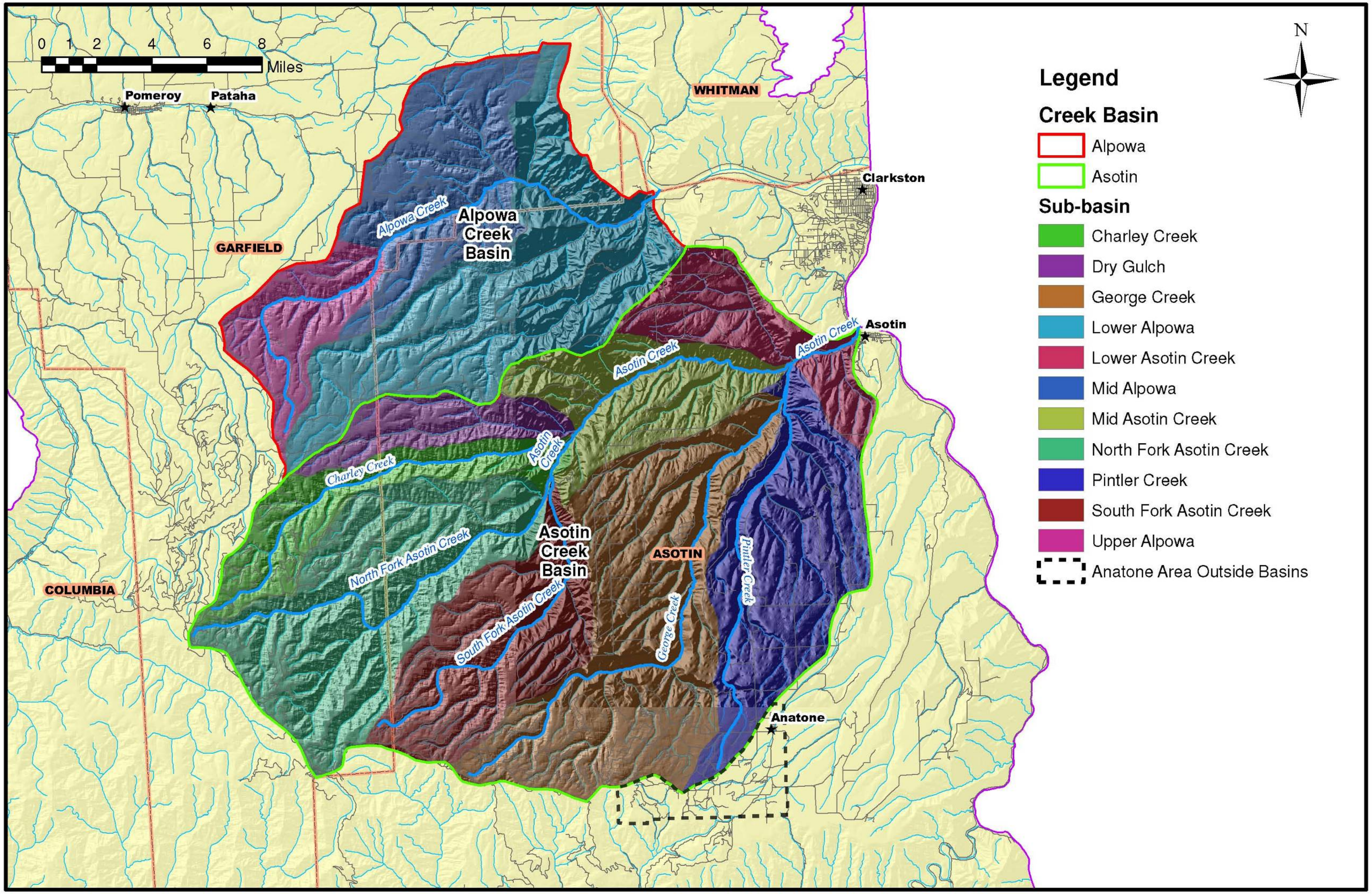


Figure 1-1 Map of Project Area

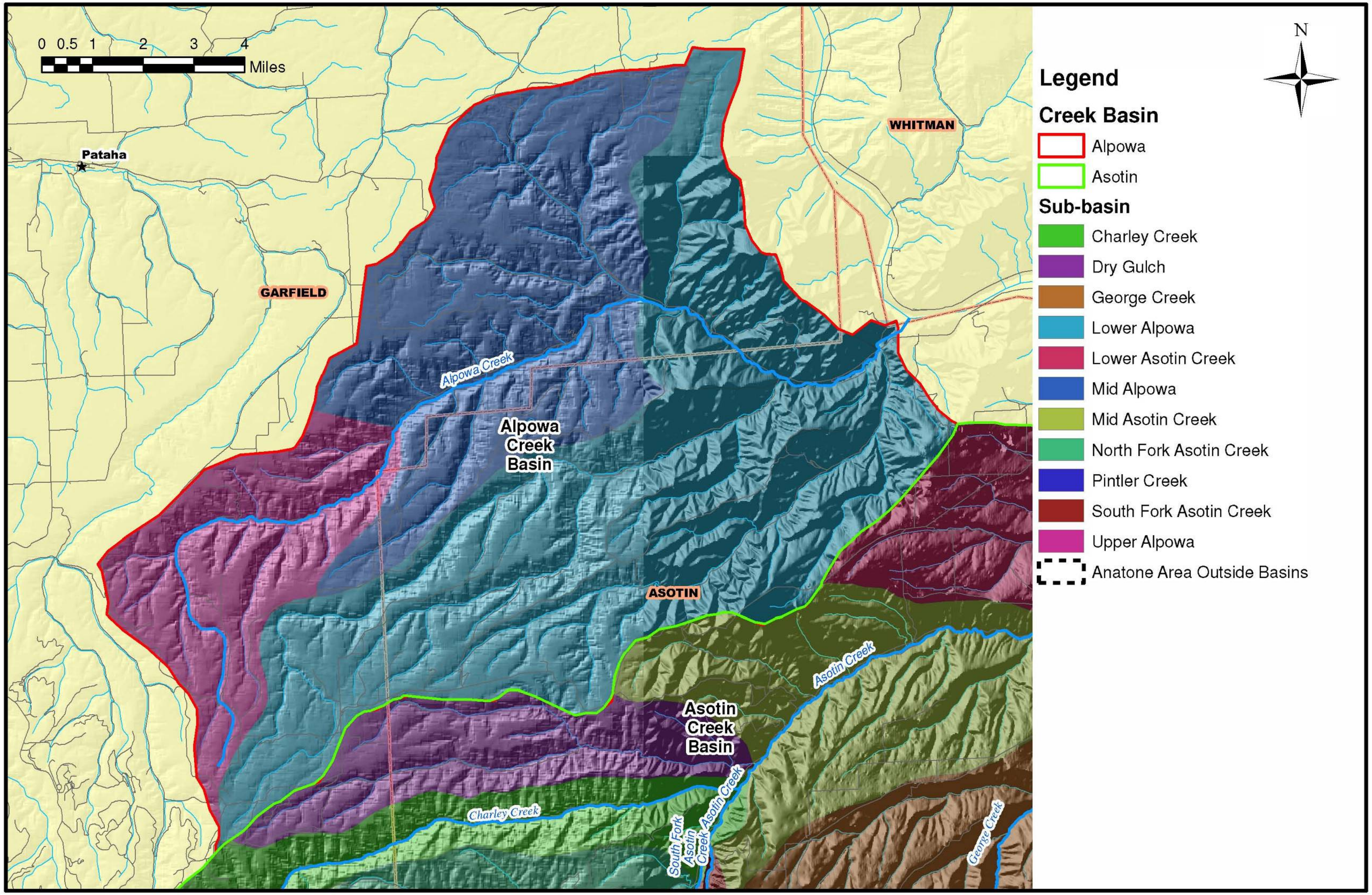


Figure 1-2 Map of Alpowa Creek Sub-Basin

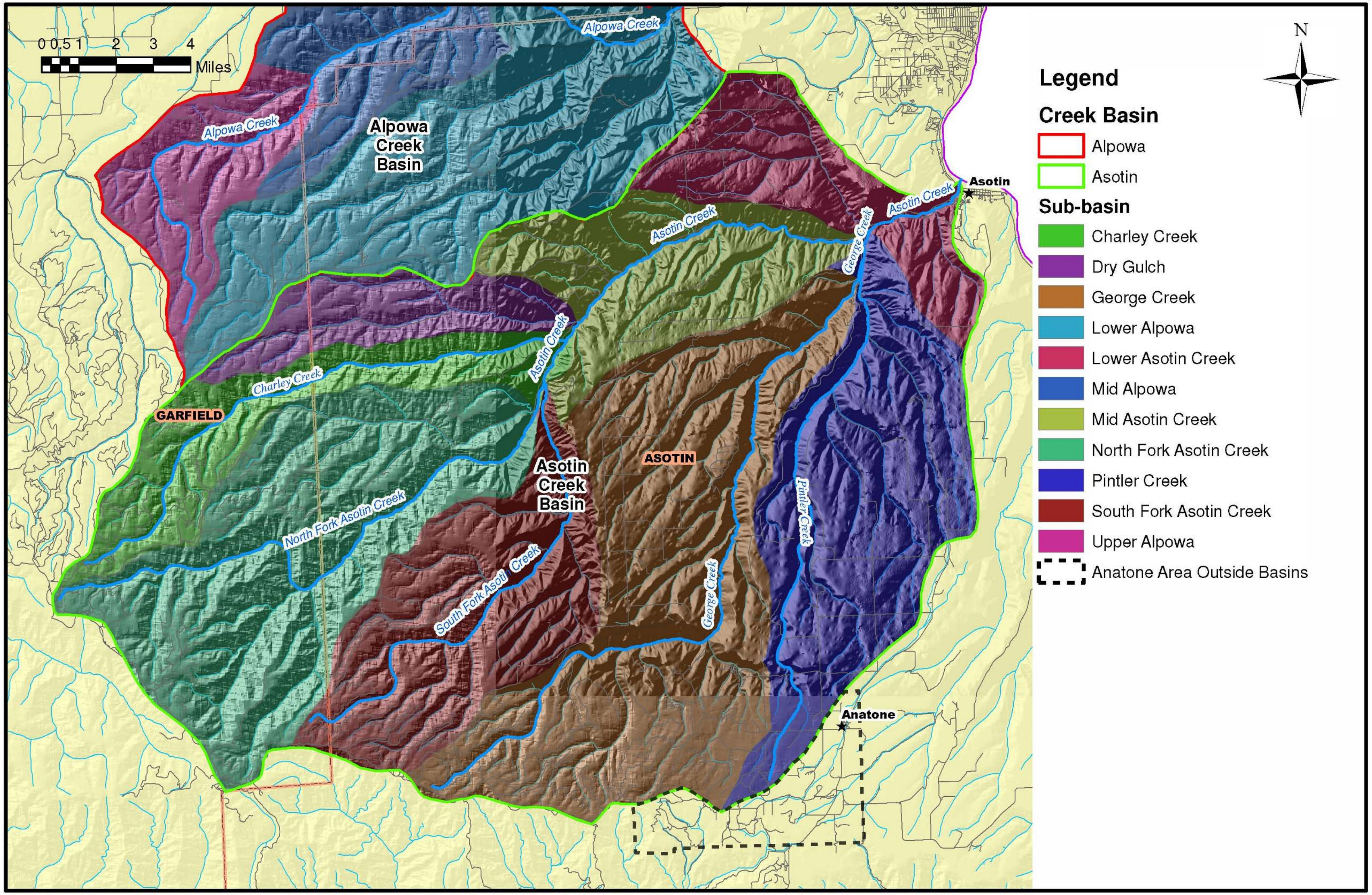


Figure 1-3 Map of Asotin Creek Sub-Basin

Chapter 2
Field Investigations

2.1 Introduction

The objective of this chapter is to describe the results of the field data collection efforts within the Alpowa Creek and Asotin Creek sub-basins of Water Resources Inventory Area (WRIA) 35. This chapter identifies the methods and results of field work performed in the basins.

This chapter is subdivided into several sections that describe or summarize:

1. Household water use survey
2. Ground water level measurements
3. Seepage run

2.2 Water Use Survey

A water use survey was conducted in the project study area. The water use survey was conducted concurrently with the groundwater level measurements during October 27 - November 5 and December 8-11 of 2008. The purpose of the survey was to identify water use information. Data were collected to determine the following water use components:

- Household population
- Residential lawn size
- Irrigation practices
- Number of stock

2.2.1 Water Use Survey Methods

Residents were asked to complete a household water use survey during groundwater level field measurements. Information on household water use was collected from those residents that were home during the survey and agreed to participate. The survey included questions about number of well users, quantity of stock watered from well, lawn size and irrigation practices. Irrigated lawn size was provided by the owner, estimated by field crew or measured from the 2006 National Agricultural Imagery Program (NAIP) orthophotos of the project area. The survey form used to interview well owners is included in **Appendix A**.

2.2.2 Water Use Survey Results

A total of 52 households and residents were interviewed. All of the households surveyed were residential except for three (WSDOT Highway Department in Anatone, WDFW and Headgate County Park). The 52 households surveyed are approximately 14 percent of the estimated 365 households in the project area. **Table 2-1** provides a summary of the residential household data collected and used in this analysis. The results of the survey are shown in **Table 2-2**.

2.2.2.1 Average Household Population

Based on visual observations, and interviews and conversations with persons knowledgeable about the area, most houses in the upper Asotin and Alpowa Creek Basins are retirement homes or are used seasonally. Most of the households were occupied by two residents, which is consistent with retirees and seasonal homes. Six households indicated they are occupied on a seasonal basis, while 39 households are occupied year round. The remaining four homes are currently being constructed or are for sale. The average household population calculated from the water use survey was 2.4 residents per household. **Figure 2-1** provides the frequency distribution of residential population. Household populations ranged from 1 to 10 people.

2.2.2.2 Average Residential Lawn Size

The average irrigated lawn size in the project area was approximately 2,500 square feet or 0.06 acres. **Figure 2-2** shows the range of irrigated lawn size from the water use survey. Lawn size ranged from no lawn to 0.32 acres and nine owners indicated they did not irrigate a lawn at all. Lawns in the Anatone area that received no irrigation typically were shaded and covered with pine needles (**Figure 2-3**). Other lawns were landscaped so no irrigation was required (**Figure 2-4**). Eleven owners indicated they irrigated less than 1,000 sq. ft. of lawn. The small lawns usually consisted of dry landscaping and/or small gardens. **Figure 2-5** provides an example of a small yard typical of houses in Clarkston Heights. Examples of lawns that received irrigation are shown in **Figure 2-6**.

Hoses and sprinklers were the two main methods used by residents to water their lawns. Residents hand watered lawns by using a hose, soaker hose or attaching a small sprinkler to the hose. Other residents had small underground irrigation systems installed that irrigated using a programmed schedule.

Factors affecting lawn irrigation included availability and cost of pumping groundwater. Those with deep wells indicated that watering lawns resulted in a higher electricity bill. When asked how often residents watered their lawns in the summer, the responses ranged from “No irrigation” to “Everyday.” On average, residents watered their lawns approximately 3 times a week (**Figure 2-7).** Other responses included “as needed” or “only as a means of fire protection.” The results of the irrigation survey indicate that deficit irrigation (under watering) is a common practice in the study area.

2.2.2.3 Livestock

Brad Johnson of Asotin Public Utility District and Duane Bartels of the Pomeroy Conservation District conducted a telephone survey to determine the amount of stock in the study area. A total of 1900 livestock were identified. Over 95 percent were cattle and the remainder were horses. Most of the cattle do not reside in the project area for the entire year; rather they are only present during the winter months. Cattle are moved out the basins, typically to Idaho, during the summer because the basins do not support enough productive rangeland to feed all stock. In Asotin County the predominant livestock is beef cattle and there are no dairy cattle (Courtney Smith, Rangeland Management Specialist, NRCS personal communication). Most of the cattle do not remain in the project area for the entire year; rather they are only present during the late fall, winter and early spring months. A majority of cattle are moved out of the basins to higher elevation ranges outside the project area during the late spring, summer and early fall months.

2.3 Groundwater Level Measurements

The purpose of the groundwater level measurements was to obtain data necessary to understand the direction of subsurface water movement in the project area. Ground water levels in wells in the project area were measured in the fall of 2008 between October 27 -November 5 and from December 8-11. A second round of groundwater level measurements was conducted in the spring of 2009 during May 12-15. Select wells were revisited to document how the groundwater level had changed since the initial 2008 measurement.

2.3.1 Groundwater Level Measurement Methods

Before going into the field, private wells in the project area were identified from the Ecology online well database. The well logs were downloaded and prioritized based on location, completeness of well log information and potential aquifer completed.

The owners listed on the well logs are the original well owners. For this reason, it was difficult to match well logs to current owners. Brad Johnson, of the WRIA 35 Planning Unit, was able to provide insight about many of the current owners because he has personally worked with many of the residents located in the rural areas of the project. Other data sources used to correlate well logs to current owners included phone books, parcel records and the county tax rolls.

Well owners were also located by canvassing populated areas that were not serviced by Asotin PUD or a smaller public water system. These areas included Anatone, Cloverland, Jerry and Peola. Knocking on doors, distributing fliers and calling potential well owners were techniques used to locate well owners.

Once a private well was located and access granted, the following methodology was used to perform the groundwater level measurement. Measurements were only collected at wells in good working order that could be accessed from the surface.

1. Request permission to enter property and access well.
2. Verify the well log with the owner. If the log is not a match, ask the well owner if they have the correct log or any information that may helpful when looking for the log. Such information included previous property owners(s), well depth, well driller and date of well installation.
3. Photograph the well casing with cap in place. Remove the well cap and photograph.
4. Disinfect the groundwater level probe with bleach solution.
5. Verify with well owner that the well is off. Once off, lower the disinfected probe into the well. Record the distance from the top of well casing to the groundwater surface. Record the distance from top of well casing to ground surface.
6. Remove and disinfect probe with bleach solution.
7. Fill out remainder of well survey information. The survey form used has been included in **Appendix A**. Information collected included depth to groundwater level, distance from top of well casing to ground surface and well depth.
8. Measure the spatial location and elevation (x, y and z) of the ground surface at the well. A Trimble GeoXT was used to occupy the well location for at least 10 minutes.

9. Replace well cap and photograph. Remind well owner to restore power to well.

After the field data collection was completed, the GPS data was differentially corrected to maximize vertical and horizontal precision. The differential correction was performed using GPS Pathfinder Office software and base files downloaded from the Trimble reference station in Grangeville, ID.

2.3.2 Groundwater Level Results

We visited 77 private wells during the fall 2008 sampling. At 19 of the wells a groundwater level measurement was not able to be recorded because the probe would not go down the well, usually becoming trapped at locations where the casing diameter changed or the well was dry. Some owners have multiple wells for stock watering or other purposes. **Figure 2-8** shows the location of the surveyed wells from 2008. During May of 2009, 27 wells were surveyed, 26 of which had been visited during fall of 2008 (**Figure 2-9**). Ground water levels were recorded in 26 of the wells. **Table 2-3** provides the groundwater level measurement and elevation results from both surveys.

2.4 Seepage Run

This section provides information regarding the seepage run collection efforts and data analysis conducted. The results of the seepage run are summarized below for the following:

- River and tributary flow
- Irrigation diversions
- Ground water inflow/outflow from the river channel

2.4.1 Seepage Run Methods

2.4.1.1 River and Tributary Flow

Field measurements were collected at 101 locations during September 16 to September 22, 2008 in the Asotin Creek Basin at the following creeks: Asotin Creek (North Fork, South Fork and Mainstem), George Creek and Charley Creek, in Alpowa Creek and in Mill and Tenmile Creeks, which are located to the south of Asotin Creek Basin. The locations of the flow measurement stations are shown in **Figure 2-10.**

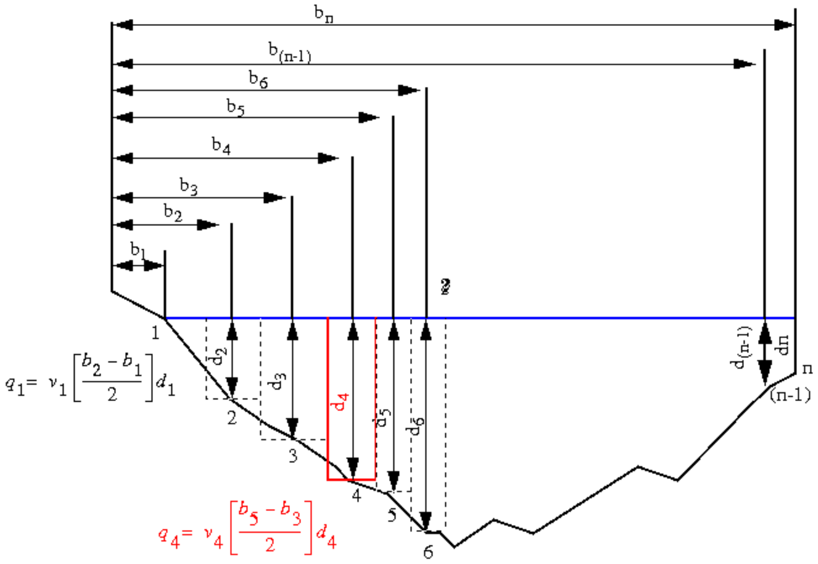
Stream velocities were measured in the field using a Marsh-McBirney Flow-Mate 2000 electromagnetic flow meter and a top-setting wading rod. Techniques used to obtain stream velocity were in accordance with the United States Geological Society (USGS) methods of measuring stream flow (Buchanan 1969). The following methodology was used:

1. Flow data were collected about every mile along the creeks where feasible. Flow data was also collected for tributary flow into the creeks. Landowner permission to access desired creek stations for velocity measurements was obtained prior to entering the field.
2. Flow measuring sites were chosen based on the characteristics (Buchanan 1969) listed below.
    - A straight reach 300 feet upstream and downstream of station with uniform flow
    - No side channel areas.

    - Stable banks high enough to contain flood
    - Banks free of brush and overhanging vegetation as to not interfere with flow measurements

3. A measuring tape was fixed across the channel perpendicular to the flow to measure the channel width.
4. Time-averaged point velocities were measured along the tape, starting at one bank and ending at the opposite. When measuring the velocity, the crew members maintained the maximum distance downstream of the flow meter to avoid influencing the flow field in the immediate vicinity of measurement.
5. At each measurement location, the lateral stationing along the tape, depth of the wading rod and time-averaged velocity were recorded. Velocity was measured at a depth of 0.6 of the total depth. Velocity readings were averaged over at least 30 seconds and were recorded when the flow meter displayed values that were constant or only fluctuated by +/- .01 ft/s.
6. Water temperature and GPS location were recorded. Photos of the station were collected.

The stream flow was calculated using the velocity area method (also known as the midsection method) as described by USGS (Rantz 1982). The velocity-area method calculates a flow based on the depth, width and velocity of the interval, as shown below. The total flow for the river station is calculated by summing each of the intervals flow.



Explanation

1,2,3 ....n --Observation verticals

b_1, b_2, b_3, ...b_n --Distance from initial point to observation vertical

d_1,d_2,d_3,.....d_n --Depth of water at observation vertical

Dashed lines --Boundaries of subsections

Sketch of velocity area method for computing discharge (Nolan 2007)

2.4.1.2 Irrigation Diversions

A single irrigation diversion located at river mile 9.63 on Alpowa Creek was operating during field measurements. It was assumed that irrigation occurring in close proximity to the creek was diverting water from the creek. Observations were made of system type (i.e. handline, lateral wheel lines, center pivots, etc), number of irrigation heads, estimated irrigated acres, and spatial location using GPS. In addition, photographs were taken of the irrigation system in action. Diversion flow rates were estimated by multiplying assumed sprinkler rate by the number of sprinkler heads. It was assumed that irrigation sprinklers heads used for crop irrigation discharged at about 7 gpm[1] (Ley 1992). Total instantaneous irrigation diversion rate was estimated to be 0.31 cfs.

2.4.1.3 Groundwater Inflow/Outflow

A flow balance was estimated for each of the creeks using the flow calculated from the velocity measurements. Beginning with the most upstream station to the farthest downstream station, flow between stations was compared. Inflows from tributaries, springs, and outflows due to irrigation diversions were accounted for in the balance. Any remaining loss or gain was assumed to be a result of groundwater interaction.

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[1] Based on assumption of a 3/16" nozzle size and operating pressure of 45 psi from Table 1 in "Sprinkler Irrigation – Application Rates and Depths" by Thomas W. Ley, 1992.

2.4.2 Example Seepage Run

An example calculation is outlined below. Assume two stations exist on a creek: Station A (upstream) and Station B (downstream). The respective flow at stations A and B are 15 cfs (Q_a) and 27 cfs (Q_b). Between stations A and B, a small tributary enters the mainstem flowing at 8 cfs (Q_{trib}). In addition, a field located in close proximity to the creek between stations A and B is applying water at a rate of 3 cfs ($Q_{irrigation}$). The water balance at station B is calculated as follows:

$$Q_b = Q_a + Q_{trib} - Q_{irrigation} + Q_{groundwater} \qquad \textbf{(1)}$$

$Where:$

$Q_b = Flow\ at\ downstream\ station\ B$

$Q_a = Flow\ at\ upstream\ station\ A$

$Q_{trib} = Flow\ from\ tributary$

$Q_{irrigation} = Flow\ diverted\ for\ irrigation$

$Q_{groundwater} = Flow\ due\ to\ ground\ water\ exchange$

Solving for groundwater interaction ($Q_{groundwater}$).

$$\begin{aligned} Q_{groundwater} &= Q_b - Q_a - Q_{trib} + Q_{irrigation} \qquad \textbf{(2)} \\ Q_{groundwater} &= 27cfs - 15cfs - 8cfs + 3cfs \\ Q_{groundwater} &= 7cfs \end{aligned}$$

The flow rate is 7cfs, which represents a groundwater gain. If $Q_{groundwater}$ was negative, then water is lost due to groundwater interaction between stations A and B.

2.4.3 Flow Variability during Seepage Run Measurements

The seepage run results are shown below for each of the measured reaches. The flow in Asotin and Alpowa Creek is monitored by Department of Ecology flow gages. Appendix D provides a detailed discussion and interpretation of the flow gage data. The 15 minute flow data was obtained from Ecology on the days of the seepage run for Asotin (September 16-17, 2008) and Alpowa Creek (September 18, 2008) and is shown in **Figures 2-11** and **2-12** respectively. No rainfall was observed during these measurements. The fluctuation was about 1.5 cfs during the seepage run on all reaches of Asotin Creek. The fluctuation on Alpowa Creek was about 0.5 cfs. This number reflects the change in flow from the start of first measurement to the end of the last measurement. The change in flow between individual measurements was almost always 0.1 cfs or less and consequently it was not necessary to consider flow fluctuations in the seepage run calculations.

2.4.4 Seepage Run Results

2.4.4.1 Asotin Creek Mainstem

The reach on the mainstem Asotin Creek surveyed for this analysis started just downstream of the confluence with the North and South Forks of Asotin Creek at river mile (RM) 15.27 and ended at Chief Looking Glass Park in Asotin (RM 0.43). Velocities were measured at 17 stations along the mainstem of Asotin Creek. Tributary flow entered Asotin Creek from the North and South Forks (RM 15.28), Charley Creek (RM 13.74) and George Creek (RM 3.18). The maximum flow calculated for Asotin Creek was 35.8 cfs and occurred at RM 2.88. The minimum flow of 26.0 cfs was located at the most upstream station (RM 15.27). **Table 2-4** provides the flow data for each station along Asotin Creek. **Figure 2-13** shows two typical stations.

The flow balance calculated on the mainstem of Asotin Creek shows a cumulative gain attributed to groundwater interactions of 0.6 cfs (**Figure 2-14**). The largest groundwater gain occurred between RM 8.99 and 10.93. The largest loss to groundwater was 5.5 cfs and occurred between RM 3.20 and 4.80.

2.4.4.2 North Fork Asotin Creek

The reach of the North Fork of Asotin Creek starting at RM 4.67 and ending at the confluence with Asotin Creek was measured for stream velocities at five stations. The flow calculated for the North Fork ranged from 19.3 cfs at RM 4.67 to 23.6 cfs at RM 0.02 (**Table 2-5**). **Figure 2-15** shows the station at RM 0.96. No tributaries or irrigation existed along the North Fork.

The flow balance performed on the North Fork indicates a cumulative groundwater gain of 4.2 cfs (**Figure 2-16**). The largest groundwater gain occurred between the two most upstream stations, RM 3.33 and 4.67, and was calculated at 3.2 cfs. The largest loss to groundwater was 1.7 cfs and occurred in the reach between RM 1.85 and 3.33.

2.4.4.3 South Fork Asotin Creek

The most upstream station of South Fork was at RM 5.81, while the most downstream station was located at RM 0.02 (**Figure 2-17**), just upstream of the confluence with the North Fork and mainstem of Asotin Creek. Seven stations were measured along the South Fork. The lowest calculated flow of 2.5 cfs occurred at RM 0.02, while the maximum flow of 3.4 cfs occurred at multiple stations (**Table 2-6**). No irrigation diversion or tributaries occurred along the measured reach of South Fork Asotin Creek.

A cumulative loss to groundwater of 0.7 cfs occurred on the lower 5.81 miles of South Fork Asotin Creek (**Figure 2-18**). The largest groundwater loss between stations was 0.9 cfs and occurred between RM 0.02 and 1.07. The largest groundwater gain of 0.6 cfs occurred between RM 1.07 and 1.95.

2.4.4.4 Charley Creek

Charley Creek is a tributary to Asotin Creek. Ten stations were measured along Charley Creek from RM 0 to RM 7.42. The largest flow calculated was 7.4 cfs (RM 6.82) while the smallest flow calculated was 4.4 cfs (RM 7.42), as shown in **Table 2-7**. No irrigation diversions or tributaries were observed within the surveyed reach of Charley Creek. **Figure 2-19** shows two station photographs along Charley Creek.

In the lower 7.2 miles of Charley Creek, cumulative gains attributed to groundwater interactions totaled up to 1 to 2 cfs (**Figure 2-20**). The largest groundwater gain of 3.1

cfs occurred in the most upstream reach (RM 6.82 to 7.42). A maximum of 1.8 cfs was lost to groundwater between RM 6.15 and 6.82.

2.4.4.5 George Creek

George Creek is also a tributary to Asotin Creek. George Creek had velocity measured at 14 stations from RM 0 to RM 5.60. Portions of George Creek were dry and the largest flow calculated was 1.7 cfs, located just upstream of the confluence with Asotin Creek (**Figure 2-21)**. Pintler Creek and an unnamed tributary provide negligible inflow to George Creek. No irrigation was observed along George Creek. **Table 2-8** presents the flow calculated at each of the stations on George Creek.

A cumulative gain of 1.1 cfs from groundwater was calculated for the first 5.60 miles of George Creek (**Figure 2-22**). The peak groundwater loss of 0.9 cfs occurred between RM 0.54 and 1.01. The maximum groundwater gain of 1.7 cfs occurred between RM 0.54 and the confluence with Asotin Creek mainstem.

2.4.4.6 Alpowa Creek

Alpowa Creek was the only creek measured in the Alpowa Creek Basin. The survey started downstream near the historic bridge marker on US highway 12 (RM 1.00) and continued upstream to RM 17.13. A total of 19 stations were measured along Alpowa Creek. Typical stations on Alpowa are shown in **Figure 2-23**. The lowest flow calculated was 2.7 cfs and occurred at RM 17.11. The highest flow of 7.6 cfs occurred at RM 4.69. **Table 2-9** provides all the calculated flow in Alpowa Creek. A single irrigation diversion was observed at RM 9.63, totaling a diversion of 1.2 cfs. The irrigation system consisted of a lateral line with 20 elevated heads and provided irrigation to approximately 5 acres (**Figure-24**). No measurable tributary flow was observed entering Alpowa Creek.

Alpowa Creek gained 4.6 cfs due to groundwater interactions from RM 1.00 to 17.13 (**Figure 2-25**). The largest groundwater gain and loss, respectively, were 1.9 cfs and 1.0 cfs. The max gain occurred between RM 8.89 and 9.93 and the largest groundwater outflow occurred between RM 5.62 and 6.57.

2.4.4.7 Tenmile Creek

Velocity measurements were recorded at 14 stations along Tenmile Creek, starting at RM 0.25 and ending at RM 15.83. Tenmile creek ran dry at multiple stations (**Figure 2-26**). A maximum flow of 1.1 cfs was observed at RM 1.06 (**Table 2-10**). Two tributaries, Mill Creek and an unnamed spring entered Tenmile Creek. No irrigation diversions were observed during the time of measurements.

In the lower 16 miles of Tenmile Creek, 0.2 cfs was lost to groundwater interactions (**Figure 2-27**). The largest groundwater gain was 0.3 cfs and occurred between RM 5.73 and 7.03. The largest loss occurred between RM 4.97 and 5.73 and was calculated as 0.3 cfs.

2.4.4.8 Mill Creek

Mill Creek is a tributary to Tenmile Creek. Mill Creek had velocity measured at 8 stations located between RM 0.06 and 7.70. Similar to Tenmile Creek, stations with no flow were observed (**Figure 2-28**). The largest flow occurred at RM 2.86 and was calculated to be 0.30 cfs (**Table 2-11**). A single unnamed spring with no measurable flow entered Mill Creek at RM 6.28. No irrigation diversions were located along Mill Creek.

The results of the flow balance on Mill Creek indicate a gain of 0.1 cfs from groundwater interactions (**Figure 2-29**). The largest groundwater gain was 0.2 cfs and occurred between multiple stations. The peak loss to groundwater of 0.3 cfs occurred between stations at RM 0.06 and 0.44.

Table 2-1 Summary of household water use results.

Household	Household Population	Irrigated Lawn Size (sq ft)	Head of Stock
Betty Koch	1	4,800	25
Bob Chance	2	4,000	14
Bob Kennedy	2	400	0
Brad Forgey	3	2,500	150
Buck and Leeann Hostetler	2	400	90
Chad Johnson	4	3,500	Unknown
Dale and Stacey Dyer	3	2,500	2
Dallas Vantilbury	1	Under Construction	0
Darrell and Sheryl Andrews	2	0	0
Dave and Vonda Gittens	2	0	0
Derek	2	Unknown	0
Dick Allen	2	0	3
Gene Thiessen	2	6,500	150
Gerry and Claudia Winkler	2	0	0
Grady and Jeri Burnam	2	600	5
Graeson "Buster" Parsons	4	0	0
Jay Holzmiller	2	300	Unknown
Jeff and Debbie Allen	2	2,925	0
Jeff and Denise Hammrich	2	450	3
Jim Hollenbeck	1	5,000	2
Joe Lillard	2	400	0
John and Molly Larson	2	Unknown	0
Jon Schlee	2	Unknown	Unknown
Justin and Leah Petty	4	Unknown	0
Keith Ausman	2	0	125
Kenny Weiss	2	2,000	0
Laura Hostetler	4	5,500	3
Leo Bausch	1	4,000	4
Mark Greene	2	4,200	0
Matt Seibly	6	14,000	100
Patty Parks	1	400	0
Paul and Sally Knapp	2	Under Construction	0
Phil and Debbie Zembas	2	500	1
Phil Fowler	2	0	0
Rod Hostetler	2	1,200	465
Rod Reeves	4	Unknown	0
Rolf Wolff	2	350	0
Ron Scheibe	2	Unknown	70
Ron Simpson	2	0	0
Sam and Linda Heitstuman	10	900	900
Sam Ledgerwood	2	Unknown	450
Sandy Cunningham	1	Under Construction	5
Steve and Dawn Boyea	4	4,000	0
Steve and Dawn Smith	2	13,500	50
Stewart Keith	2	0	0
Sue Parks	1	75	5
Tim Lynch	Unknown	6,000	6
Tom and Kim Hendrickson	2	Unknown	100
Tom Petty	2	2,700	0
Average	**2.4**	**2,463**	
Total	**115**	**93,600**	**2,728**

Table 2-2 Water use survey results.

	Result
Average Household Population (persons)	2.4
Average Irrigated Lawn Size (acres)	0.06
Average Irrigated Lawn Size (sq ft)	2,463
Estimated Head of Stock	1,900

Table 2-3 Results of ground water level measurements (continued on next page).

Well ID	Current Well Owner	Fall 2008[4]			Spring 2009[5]			Ground Water Elevation Change (ft)	Vertical Precision (ft)
		Ground Water Level (ft below top of well)	Ground Water Elevation (ft, NGVD 1929)	Measurement Date	Ground Water Level (ft below top of well)	Ground Water Elevation (ft, NGVD 1929)	Measurement Date		
ASO0267	Matt Seibly	18.1	3,532	10/29/08	17.5	3,533	05/12/09	0.6	5.5
ASO0277	Washington State Department of Highways at Anatone	NA	NA	10/30/08					5.1
ASO0281	Tom Petty	136.7	3,258	12/10/08					6.0
ASO0284	Betty Koch	31.4	1,752	10/28/08	30.8	1,752	05/13/09	0.6	5.2
ASO0286	Chad Johnson	268.0	2,493	12/10/08	267.9	2,493	05/15/09	0.1	4.6
ASO0293	Justin and Leah Petty	140.5	2,863	12/10/08					3.3
ASO0294	Justin and Leah Petty	125.3	2,876	12/10/08					5.2
ASO0298	Jeff and Denise Hammrich	Dry	Dry	11/01/08					4.0
ASO0299	Jeff and Denise Hammrich	352.5	2,009	11/01/08					3.2
ASO0302	Tim Lynch	494.8	2,313	12/11/08					3.7
ASO0305	Jim Hollenbeck	149.3	1,263	11/03/08	133.3	1,279	05/13/09	16.1	4.9
ASO0310	Sandy Cunningham	Dry	Dry	12/10/08					3.1
ASO0315	Tom and Kim Hendrickson	9.0	1,182	10/28/08					2.8
ASO0341	Laura Hostetler	NA	NA	10/29/08					6.7
ASO0344	Leo Bausch	520.2	1,188	11/03/08					4.5
ASO0524	Don Nuxoll				90.1				
ASO0563	Phil Fowler	98.7	3,878	11/01/08	98.5	3,879	05/14/09	0.2	6.6
ASO0565	Dick Allen	45.5	3,993	11/04/08	36.8	4,001	05/14/09	8.8	3.2
ASO0571	Stewart Keith	41.1	3,833	10/31/08	38.5	3,835	05/12/09	2.6	3.6
ASO0610	Keith Ausman	246.3	1,219	11/04/08					6.3
ASO0649	Dale and Stacey Dyer	357.8	1,160	11/05/08	344.9	1,172	05/15/09	12.9	4.7
ASO0651	Dave and Vonda Gittens	242.9	1,442	11/03/08	241.6	1,443	05/15/09	1.3	4.0
ASO0663	Gerry and Claudia Winkler	334.8	812	12/09/08	335.0	811	05/15/09	-0.3	2.9
ASO0670	Jeff and Debbie Allen	564.7	931	11/03/08					3.8
ASO0672	Joe Lillard	129.8	1,449	11/02/08					4.0
ASO0673	Derek	52.5	757	11/01/08	52.3	757	05/13/09	0.2	6.8
ASO0682	Paul and Sally Knapp	196.7	1,442	11/02/08	197.5	1,441	05/13/09	-0.8	5.3
ASO0683	Phil and Debbie Zembas[1]	215.3	1,477	11/01/08	218.0	1,474	05/15/09	(-2.7) See note 1	4.0
ASO0686	Ron Simpson	583.0	819	12/11/08	580.5	821	05/15/09	2.5	4.5
ASO0690	Sue Parks[2]	113.2	1,273	11/02/08	85.9	1,300	05/13/09	(27.3) See note 2	3.7
ASO0801	Rod Hostetler	422.0	1,747	10/29/08					4.9
ASO0802	Jon Schlee	NA	NA	11/05/08					5.0
ASO0803	Bob Kennedy	61.0	3,613	11/04/08	60.2	3,613	05/14/09	0.8	3.0
ASO0804	Kenny Weiss	91.5	2,604	11/05/08					3.0
ASO0805	Mark Greene	162.0	2,589	11/05/08					7.1
ASO0806	Dallas Vantilbury	NA	NA	10/31/08	31.8		05/15/09		5.4
ASO0807	Brad Forgey	NA	NA	10/29/08					2.9
ASO0808	Brad Forgey	10.0	3,476	10/29/08					4.1
ASO0809	Brad Forgey	7.4	3,476	10/29/08					4.2
ASO0810	Brad Forgey	6.5	3,478	10/29/08					4.2
ASO0811	WDFW	3.4	1,822	10/28/08					4.0

Table 2-3 Results of ground water level measurements (continued from previous page).

Well ID	Current Well Owner	Fall 2008[4]			Spring 2009[5]			Ground Water Elevation Change (ft)	Vertical Precision (ft)
		Ground Water Level (ft below top of well)	Ground Water Elevation (ft, NGVD 1929)	Measurement Date	Ground Water Level (ft below top of well)	Ground Water Elevation (ft, NGVD 1929)	Measurement Date		
ASO0812	Gene Thiessen	NA	NA	10/28/08					2.5
ASO0813	Headgate Park	8.2	1,340	10/28/08					3.5
ASO0814	Headgate Park	6.4	1,341	10/28/08					3.5
ASO0815	Keith Ausman	NA	NA	10/29/08					4.9
ASO0816	Steve and Dawn Smith	NA	NA	10/30/08					4.4
ASO0817	Graeson "Buster" Parsons	79.3	3,071	12/10/08					4.7
ASO0818	Graeson "Buster" Parsons	Dry	Dry	12/10/08					NA
ASO0819	Graeson "Buster" Parsons	185.5	3,008	12/10/08					6.5
ASO0820	Sandy Cunningham	NA	NA	12/10/08					3.1
ASO0821	Rod Reeves	NA	NA	12/10/08					4.0
ASO0822	Rod Reeves	219.0	3,228	12/10/08					3.1
ASO0823	Chad Johnson	251.0	3,035	12/10/08					2.9
ASO0824	Rolf Wolff[3]	160.0	1,296	12/09/08	180.0	1,276	03/17/09	(-20.0) See Note 3	4.4
ASO0825	Darrell and Sheryl Andrews	51.4	3,907	10/29/08	44.5	3,914	05/14/09	6.9	5.1
ASO0826	Keith Ausman	62.6	4,071	11/04/08	63.0	4,071	05/12/09	-0.4	3.4
ASO0827	Patty Parks	496.0	919	11/02/08	500.0	915	05/13/09	-4.0	3.6
ASO0828	Steve and Dawn Boyea	NA	NA	11/04/08					3.8
ASO0829	Grady and Jeri Burnam	15.4	938	11/05/08					2.6
ASO0830	Buck and Leeann Hostetler	186.6	2,907	11/05/08	186.8	2,906	05/14/09	-0.2	2.8
ASO0831	Bob Chance	NA	NA	12/11/08					5.0
ASO0832	Ron Scheibe	81.4	3,465	11/04/08	80.4	3,466	05/14/09	1.0	2.6
ASO0833	John and Molly Larson	NA	NA	12/09/08					5.1
ASO0834	Rod Hostetler	350.0	1,897	10/29/08					4.5
ASO0835	Chad Johnson	NA	NA	12/10/08					NA
ASO0836	Gene Thiessen	13.7	1,413	10/28/08					2.6
ASO0837	Gene Thiessen	11.9	1,487	10/28/08					3.0
ASO0838	Rolf Wolff	172.0	1,283	12/09/08					6.0
GAR0133	Sam Ledgerwood	211.0	1,952	12/09/08					5.5
GAR0134	Sam Ledgerwood	31.2	1,445	12/09/08					4.8
GAR0407	Sam Ledgerwood	NA	NA	12/09/08					2.7
GAR0418	Sam and Linda Heitstuman	NA	NA	11/03/08					5.0
GAR0419	Sam Ledgerwood	27.6	1,267	12/09/08					3.2
GAR0600	Sam Ledgerwood	12.0	1,313	12/09/08					3.8
GAR0601	Sam Ledgerwood	43.5	1,446	12/09/08					6.3
GAR0602	Sam Ledgerwood	39.8	1,265	12/09/08					3.1
GAR0603	Sam Ledgerwood	38.6	1,834	12/09/08	38.3	1,834	05/13/09	0.3	4.4
GAR0604	Sam Ledgerwood	35.0	1,649	12/09/08	33.5	1,650	05/13/09	1.5	4.5

Notes:
1) Well ASO06683 was running prior to the spring 2009 measurement. While running, the water level was at 238.25 ft. After 2 hours and 40 minutes, the water level was at 218 ft.
2) Well ASO0690 was running prior to the fall 2008 measurement. The owner indicated the well recharged slowly.elevations between measurements.
3) Well ASO0824 was deepenend inbetween ground water level measurements.
4) Well measurements were taken from Oct. 27 - Nov. 5 and from December 8-11 of 2008.
5) Well measurements were taken from May 12 - May 15 of 2009.

Table 2-4 Results of mainstem Asotin Creek seepage run.

	River Mile	Creek Flow (cfs)	Tributary Flow (cfs)	Tributary Name	Irrigation Diversion (cfs)	Gain (+)/Loss (-) (cfs)	Cumulative Gain (+)/Loss (-) (cfs)
ASOTIN CREEK MAINSTEM	0.43	34.8	0.0		0.0	-1.0	0.6
	2.88	35.8	0.0		0.0	3.8	1.6
	3.17	32.0	0.0		0.0	2.1	-2.1
	3.18	-	1.4	George Creek	0.0	-	-
	3.20	28.5	0.0		0.0	-5.5	-4.3
	4.80	34.0	0.0		0.0	2.0	1.2
	5.99	32.0	0.0		0.0	-0.7	-0.8
	6.71	32.7	0.0		0.0	0.5	-0.1
	8.13	32.3	0.0		0.0	-3.2	-0.5
	8.99	35.5	0.0		0.0	4.1	2.7
	10.93	31.4	0.0		0.0	-2.6	-1.4
	11.62	34.0	0.0		0.0	-1.1	1.2
	12.61	35.0	0.0		0.0	1.2	2.3
	13.69	33.9	0.0		0.0	-1.0	1.1
	13.74	-	4.9	Charley Creek	0.0	-	-
	13.76	30.0	0.0		0.0	1.2	2.1
	14.28	28.8	0.0		0.0	2.8	0.9
	15.27	26.0	0.0		0.0	-1.9	-1.9
	15.28	-	25.4	N. Fork Asotin Creek	0.0	-	-
	15.28	-	2.4	S. Fork Asotin Creek	0.0	-	-

Table 2-5 Results of North Fork Asotin Creek seepage run.

	River Mile	Creek Flow (cfs)	Tributary Flow (cfs)	Tributary Name	Irrigation Diversion (cfs)	Gain (+)/Loss (-) (cfs)	Cumulative Gain (+)/Loss (-) (cfs)
NORTH FORK ASOTIN CREEK	0.02	23.6	0.0		0.0	1.9	4.2
	0.96	21.6	0.0		0.0	0.8	2.3
	1.85	20.8	0.0		0.0	-1.7	1.5
	3.33	22.5	0.0		0.0	3.2	3.2
	4.67	19.3	0.0		0.0	-	-

Table 2-6 Results of South Fork Asotin Creek seepage run.

	River Mile	Creek Flow (cfs)	Tributary Flow (cfs)	Tributary Name	Irrigation Diversion (cfs)	Gain (+)/Loss (-) (cfs)	Cumulative Gain (+)/Loss (-) (cfs)
SOUTH FORK ASOTIN CREEK	0.02	2.5	0.0		0.0	-0.9	-0.7
	1.07	3.4	0.0		0.0	0.6	0.2
	1.95	2.7	0.0		0.0	-0.7	-0.5
	2.99	3.4	0.0		0.0	0.0	0.2
	3.61	3.4	0.0		0.0	0.3	0.2
	4.85	3.1	0.0		0.0	-0.1	-0.1
	5.81	3.2	0.0		0.0	-	-

Table 2-7 Results of Charley Creek seepage run.

	River Mile	Creek Flow (cfs)	Tributary Flow (cfs)	Tributary Name	Irrigation Diversion (cfs)	Gain (+)/Loss (-) (cfs)	Cumulative Gain (+)/Loss (-) (cfs)
CHARLEY CREEK	0.00	4.5	0.0		0.0	-0.5	0.1
	0.99	5.0	0.0		0.0	-1.0	0.6
	1.90	6.0	0.0		0.0	0.0	1.6
	2.87	6.0	0.0		0.0	-0.1	1.6
	3.85	6.1	0.0		0.0	0.3	1.7
	5.23	5.7	0.0		0.0	1.2	1.4
	5.61	4.5	0.0		0.0	-1.1	0.2
	6.15	5.7	0.0		0.0	-1.8	1.3
	6.82	7.4	0.0		0.0	3.1	3.1
	7.42	4.4	0.0		0.0	-	-

Table 2-8 Results of George Creek seepage run.

	River Mile	Creek Flow (cfs)	Tributary Flow (cfs)	Tributary Name	Irrigation Diversion (cfs)	Gain (+)/Loss (-) (cfs)	Cumulative Gain (+)/Loss (-) (cfs)
GEORGE CREEK	0.00	1.7	0.0		0.0	1.7	1.1
	0.54	0.0	0.0		0.0	0.0	-0.7
	1.01	0.0	0.0		0.0	-0.9	-0.7
	1.22	0.9	0.0		0.0	0.0	0.3
	1.44	-	0.0	Pintler Creek	0.0	-	-
	1.81	0.9	0.0		0.0	0.9	0.3
	2.39	-	0.1	Unknown Tributary	0.0	-	-
	2.42	0.0	0.0		0.0	0.0	-0.6
	2.79	0.0	0.0		0.0	0.0	-0.6
	2.95	0.0	0.0		0.0	-0.4	-0.6
	3.36	0.4	0.0		0.0	-0.2	-0.1
	3.87	0.6	0.0		0.0	0.3	0.0
	4.30	0.3	0.0		0.0	-0.1	-0.3
	4.92	0.4	0.0		0.0	0.0	-0.2
	5.12	0.4	0.0		0.0	-0.2	-0.2
	5.60	0.6	0.0		0.0	-	-

Table 2-9 Results of the Alpowa Creek seepage run.

	River Mile	Creek Flow (cfs)	Tributary Flow (cfs)	Tributary Name	Irrigation Diversion (cfs)	Gain (+)/Loss (-) (cfs)	Cumulative Gain (+)/Loss (-) (cfs)
ALPOWA CREEK	1.00	6.5	0.0		0.0	-0.9	3.7
	1.54	7.4	0.0		0.0	-0.2	4.6
	3.53	7.6	0.0		0.0	0.3	4.8
	4.69	7.3	0.0		0.0	1.1	4.5
	5.62	6.2	0.0		0.0	-1.0	3.4
	6.57	7.2	0.0		0.0	1.0	4.5
	7.48	6.2	0.0		0.0	-0.3	3.5
	8.89	6.5	0.0		0.0	1.0	3.7
	9.63	-	0.0		0.3	-	-
	9.93	5.8	0.0		0.0	-0.2	2.7
	11.16	6.1	0.0		0.0	0.3	3.0
	12.46	5.8	0.0		0.0	0.2	2.7
	13.78	5.5	0.0		0.0	1.5	2.5
	13.93	4.0	0.0		0.0	-0.1	0.9
	14.19	4.1	0.0		0.0	-0.1	1.0
	14.20	4.2	0.0		0.0	0.3	1.1
	14.96	3.9	0.0		0.0	1.3	0.8
	17.11	2.7	0.0		0.0	-0.4	-0.4
	17.13	3.1	0.0		0.0	-	-

Table 2-10 Results of the Tenmile Creek seepage run.

	River Mile	Creek Flow (cfs)	Tributary Flow (cfs)	Tributary Name	Irrigation Diversion (cfs)	Gain (+)/Loss (-) (cfs)	Cumulative Gain (+)/Loss (-) (cfs)
TENMILE CREEK	0.25	0.9	0.0		0.0	-0.2	-0.2
	1.06	1.1	0.0		0.0	-0.1	-0.1
	1.09	-	0.9	Unnamed Spring	0.0	-	-
	1.16	0.2	0.0		0.0	0.2	0.0
	2.37	0.0	0.0		0.0	0.0	-0.2
	3.60	0.0	0.0		0.0	0.0	-0.2
	4.75	0.0	0.0		0.0	0.0	-0.2
	4.97	0.0	0.0		0.0	-0.3	-0.2
	5.73	0.3	0.0		0.0	0.3	0.1
	7.03	0.0	0.0		0.0	-0.1	-0.2
	7.09	0.1	0.0		0.0	0.1	-0.1
	8.12	0.0	0.0		0.0	0.0	-0.2
	10.79	0.0	0.0		0.0	-0.2	-0.2
	10.85	-	0.2	Mill Creek	0.0	-	-
	10.86	0.0	0.0		0.0	0.0	0.0
	15.83	0.0	0.0		0.0	-	-

Table 2-11 Results of the Mill Creek seepage run.

	River Mile	Creek Flow (cfs)	Tributary Flow (cfs)	Tributary Name	Irrigation Diversion (cfs)	Gain (+)/Loss (-) (cfs)	Cumulative Gain (+)/Loss (-) (cfs)
MILL CREEK	0.06	0.2	0.0		0.0	0.2	0.1
	0.44	0.0	0.0		0.0	-0.3	0.0
	2.86	0.3	0.0		0.0	0.2	0.3
	5.01	-	0.0		0.0	-	-
	5.11	0.1	0.0		0.0	0.0	0.1
	5.47	0.1	0.0		0.0	0.1	0.1
	5.95	0.1	0.0		0.0	0.0	0.0
	6.28	-	0.0	Unknown Tributary	0.0	-	-
	7.70	0.1	0.0		0.0	-	-

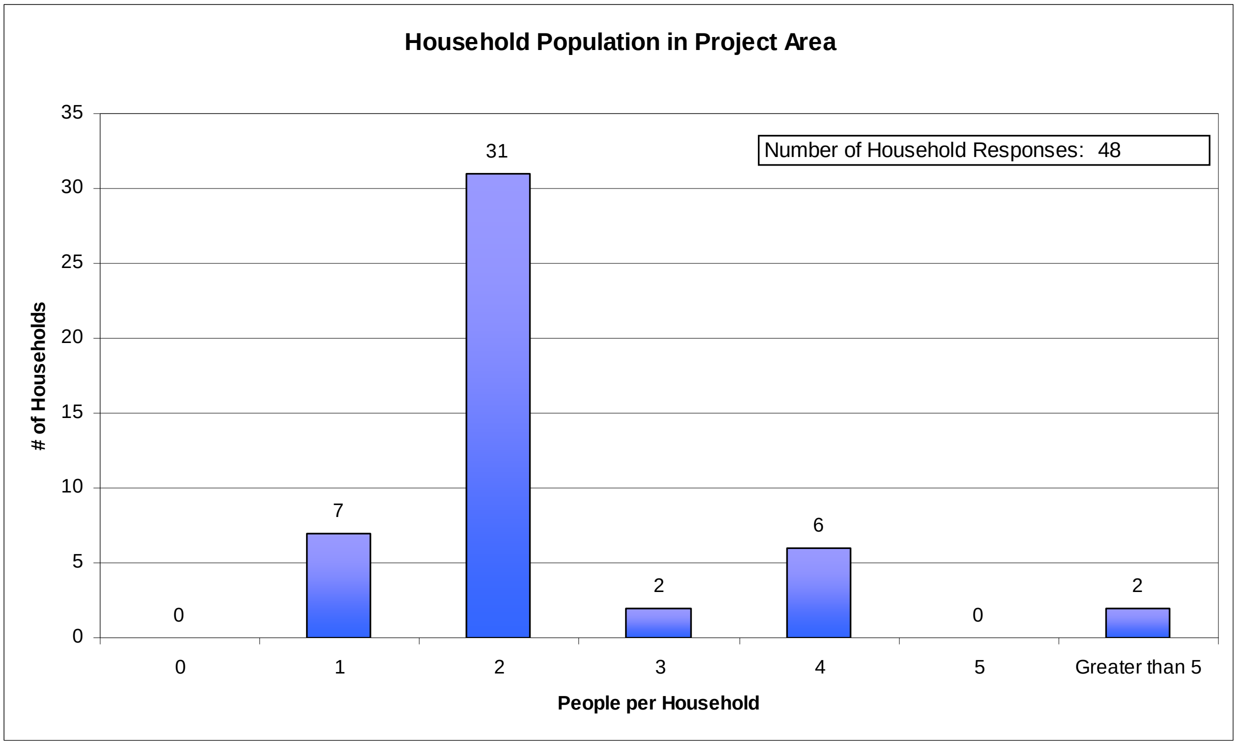


Figure 2-1 Household population in the unincorporated project area.

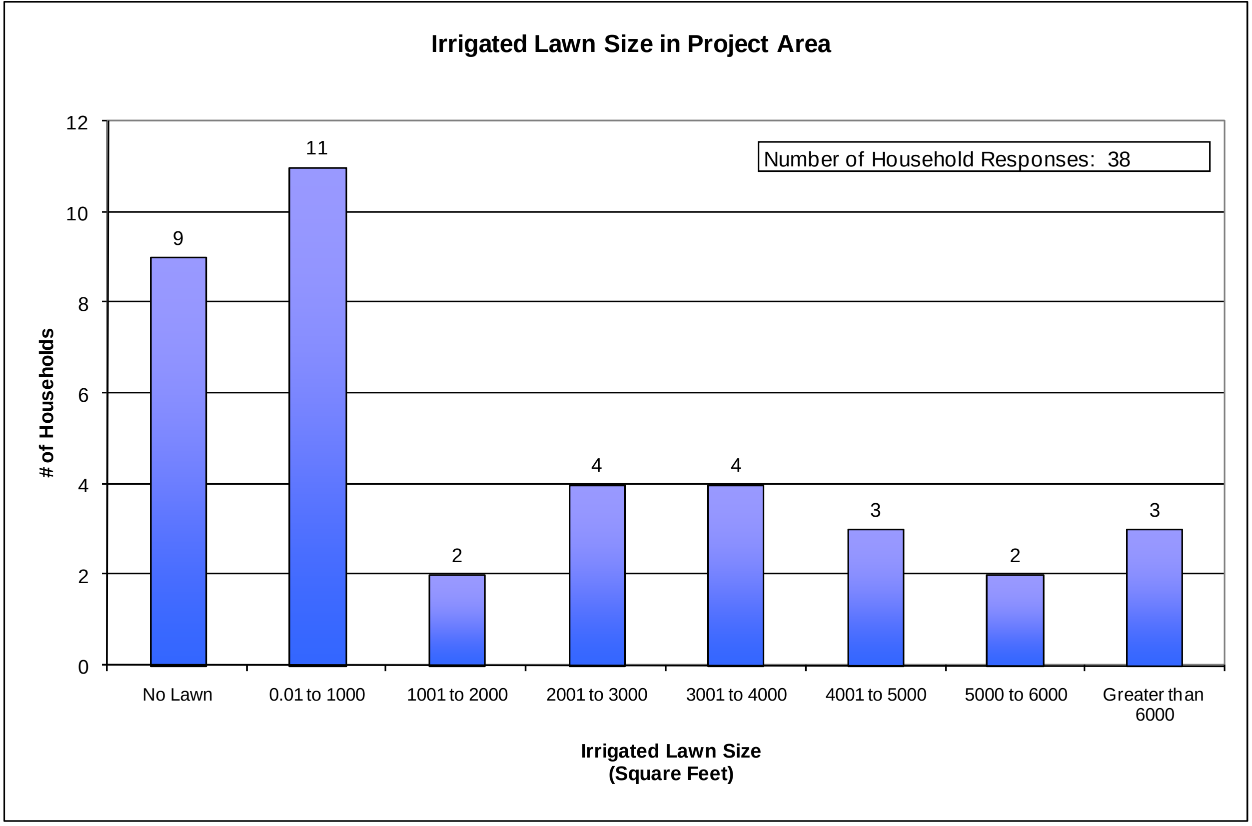


Figure 2-2 Irrigated lawn size in the unincorporated project area.

Figure 2-3 Typical lawns receiving little or no irrigation in the Anatone area.

Figure 2-4 Typical residences with no lawn in the Clarkston Heights area.

Figure 2-5 An example of a small lawn (less than 1,000 SF) with garden and landscaping.

Figure 2-6 Examples of irrigated lawns by Cloverland (left) and Alpowa (right).

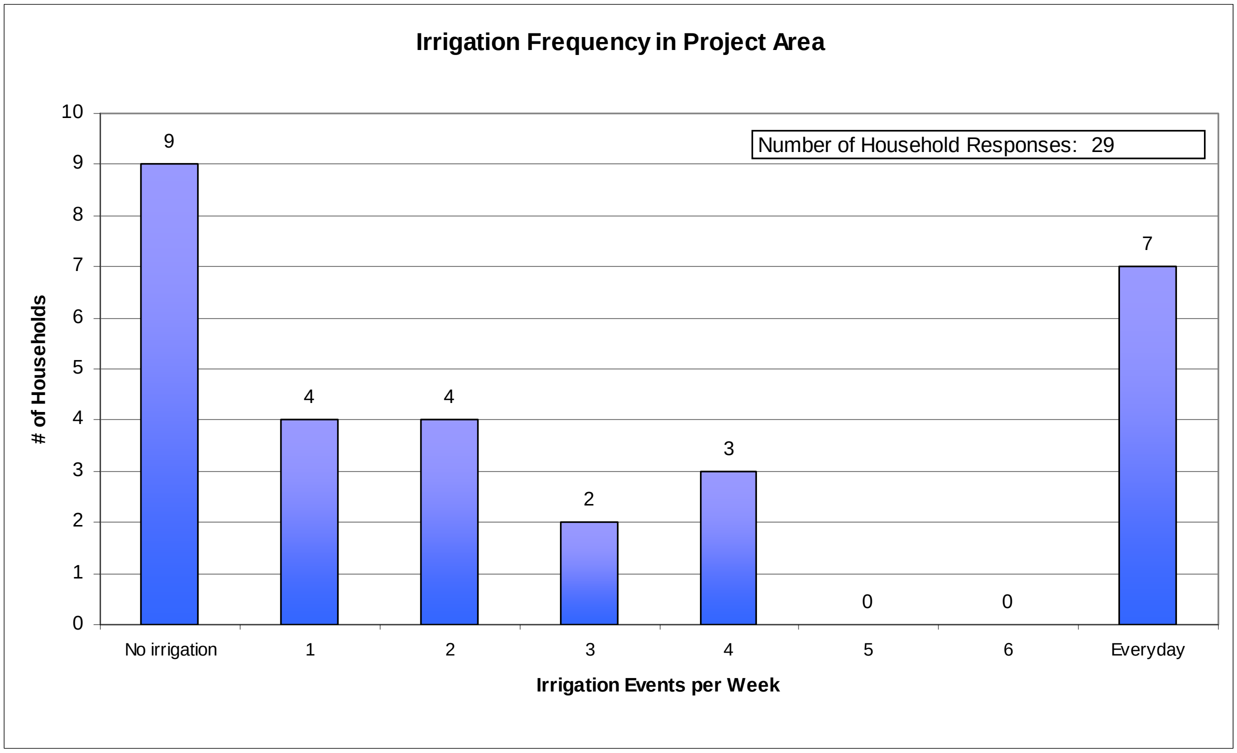


Figure 2-7 Frequency of irrigation per household.

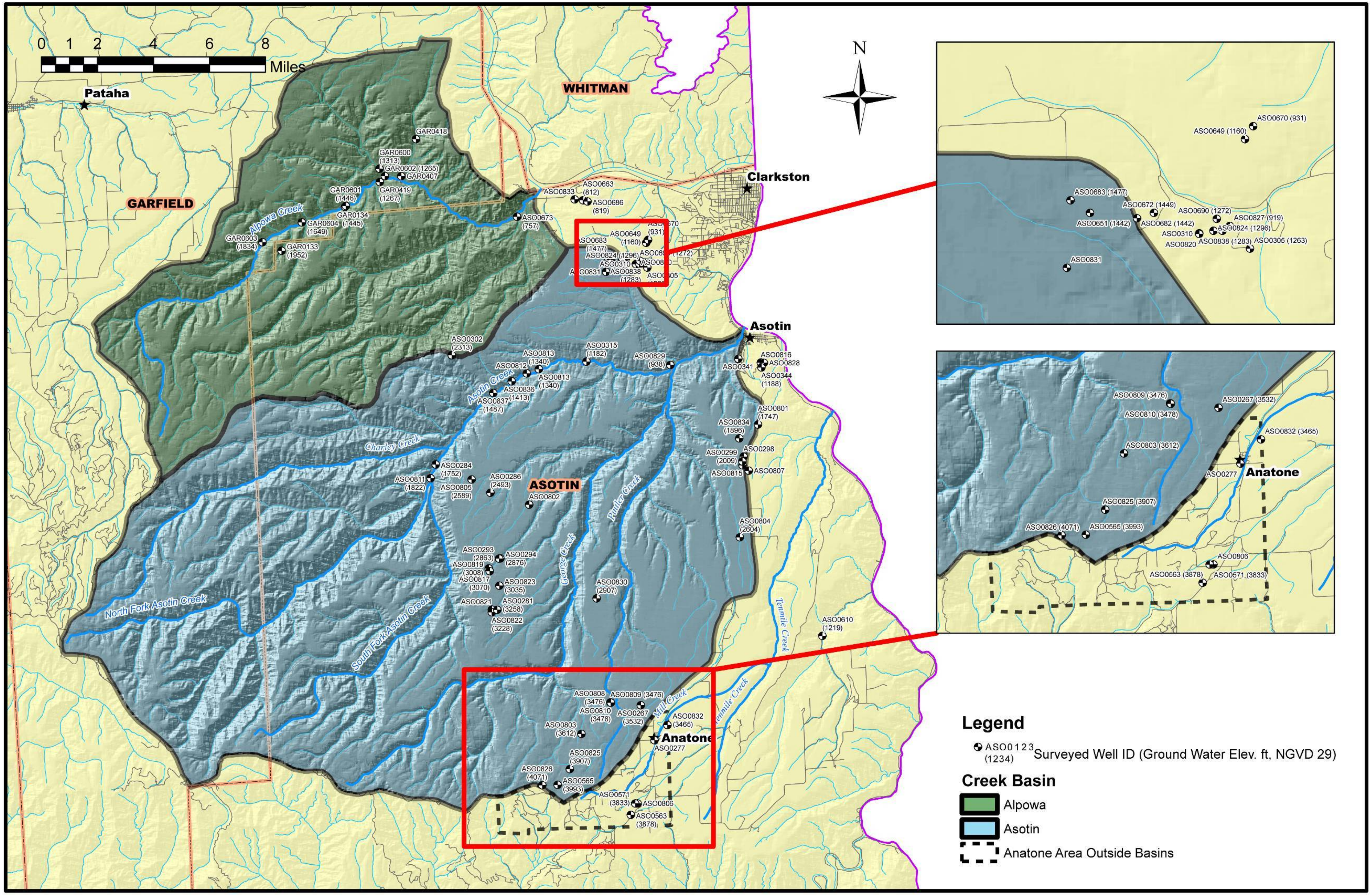


Figure 2-8 Location and ground water elevation (ft, NGVD 29) of wells surveyed during October 27-November 5 and December 8-11 of 2008.

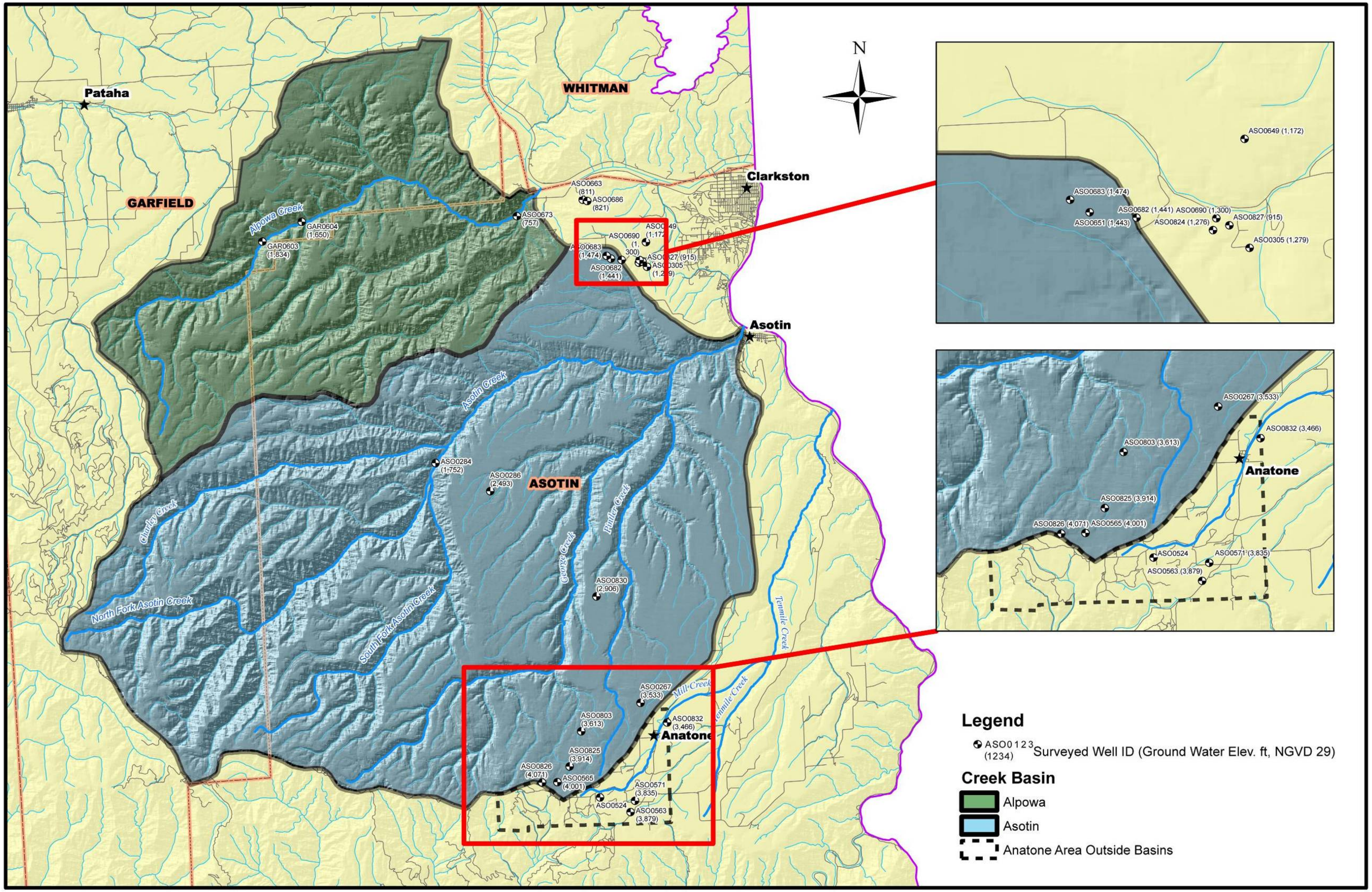


Figure 2-9 Location and ground water elevation (ft, NGVD 29) of wells surveyed during May 12-15 of 2009.

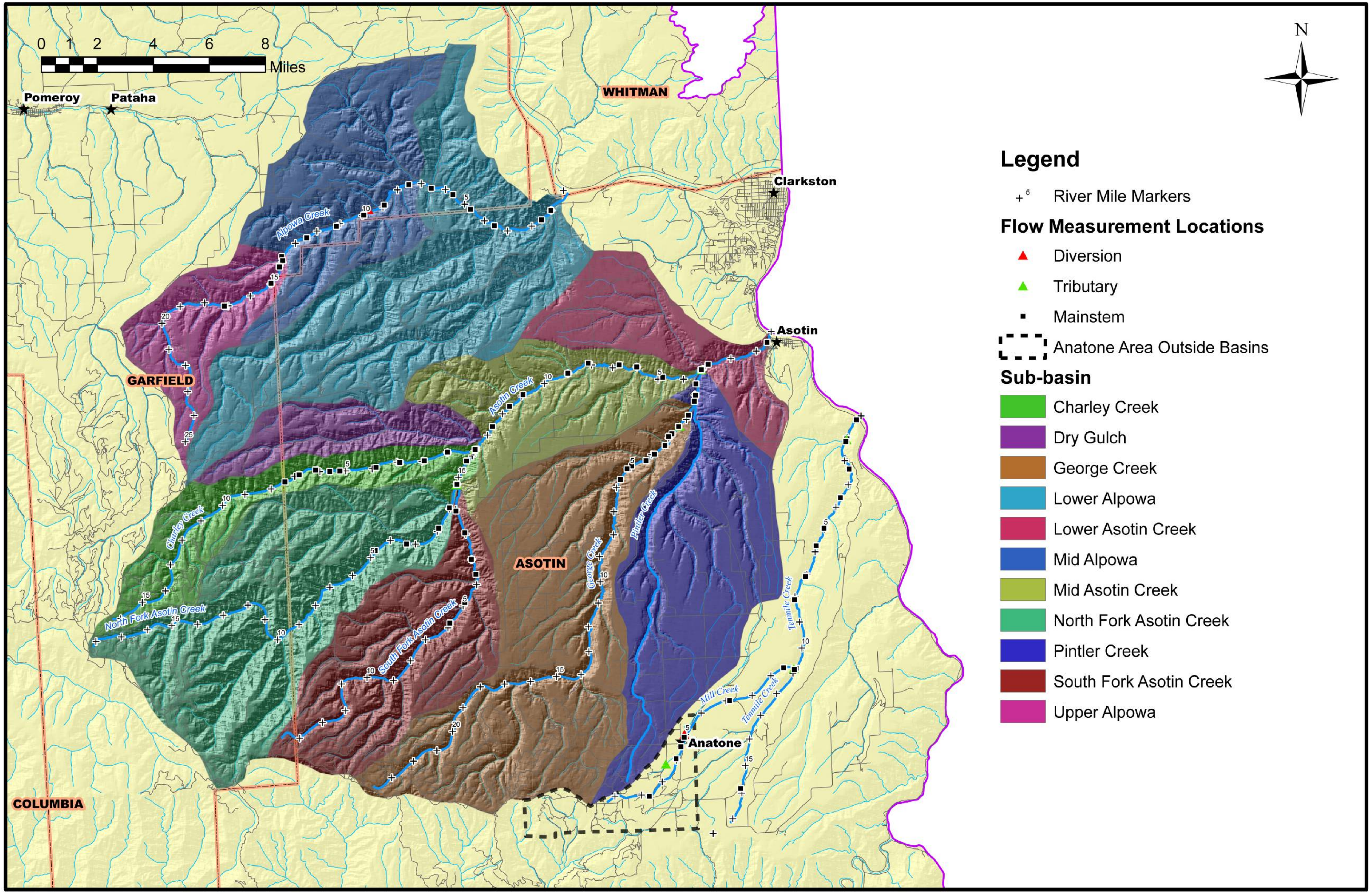


Figure 2-10 **Location of field measurements during seepage run**

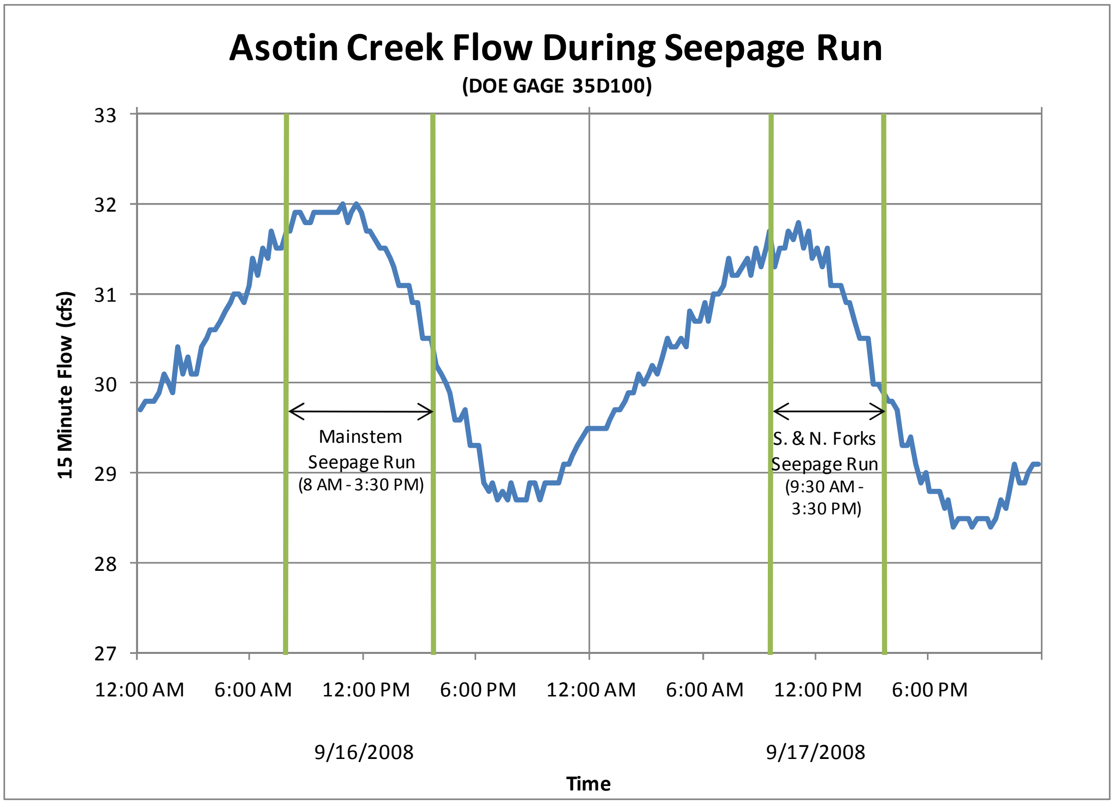


Figure 2-11 Flow on Asotin Creek during seepage run.

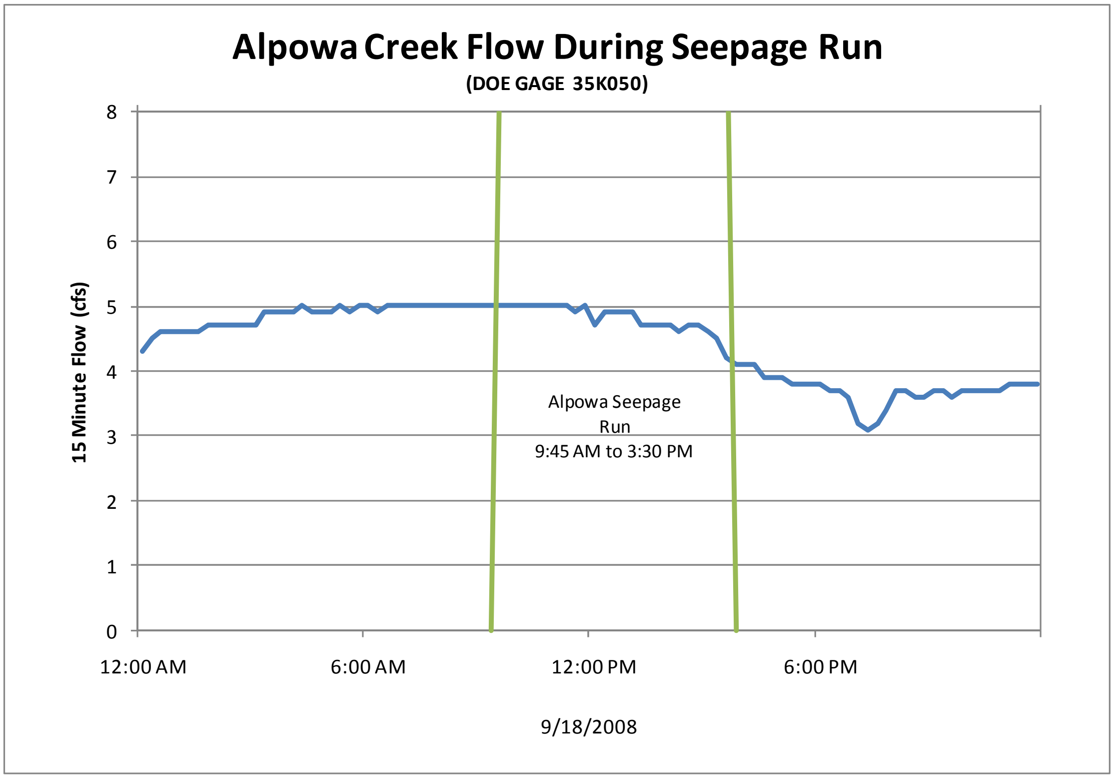


Figure 2-12 Flow on Alpowa Creek during seepage run.

Figure 2-13 Velocity measurement stations along Asotin Creek mainstem at RM 3.17 (left) and RM 13.76 (right).

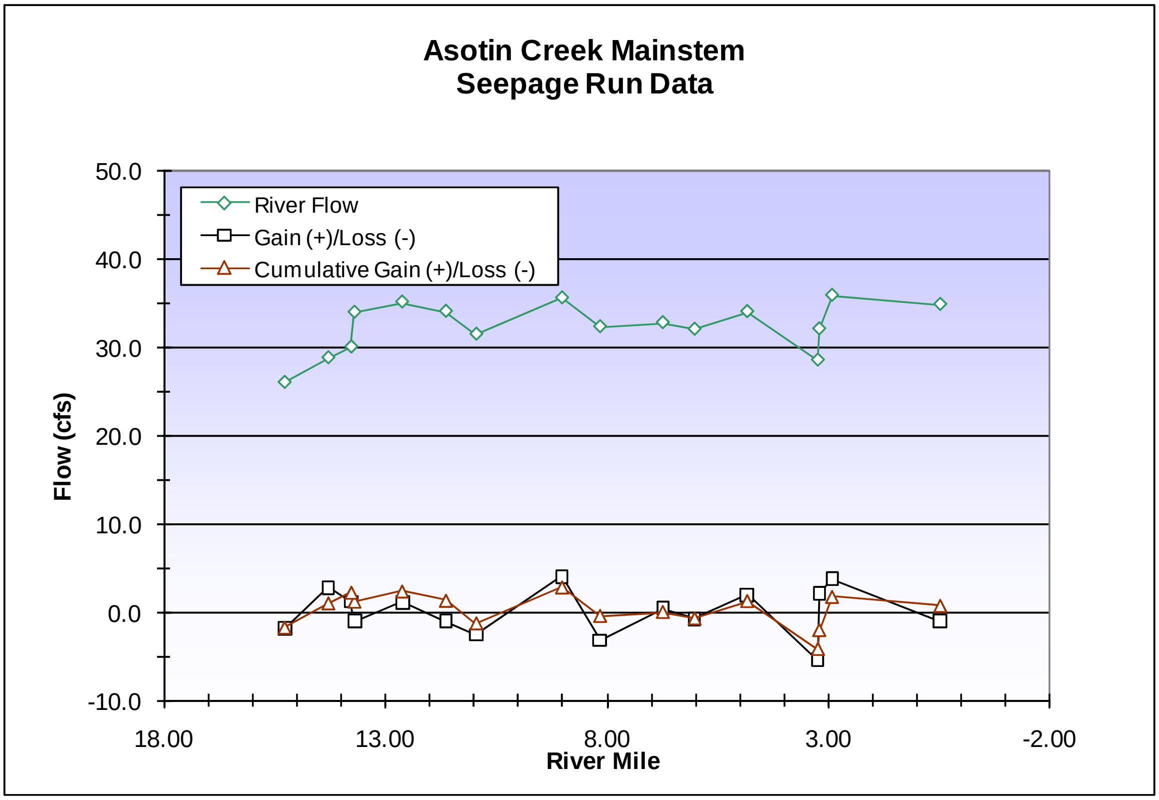


Figure 2-14 Seepage run results for mainstem of Asotin Creek conducted on September 16, 2008.

Figure 2-15 Looking US and DS from station at RM 0.96 along North Fork of Asotin Creek.

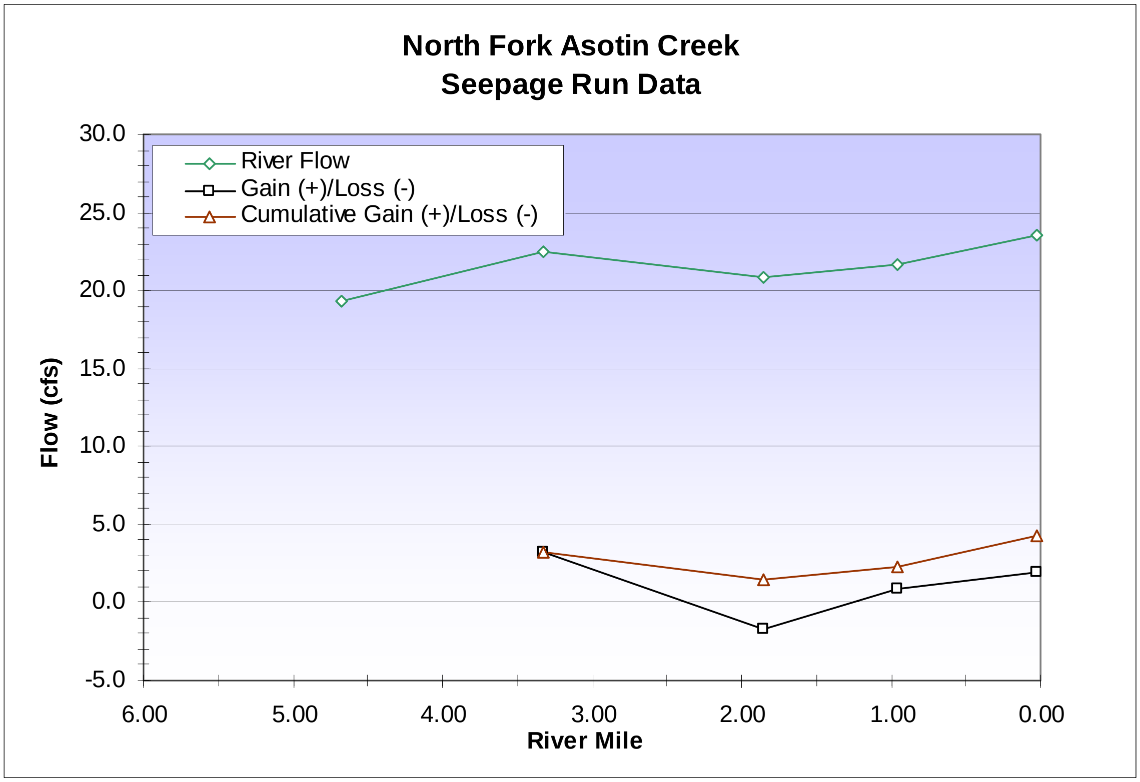


Figure 2-16 Seepage run results for the North Fork of Asotin Creek conducted on September 17, 2008.

Figure 2-17 Looking DS from RM 0.02 (left) and RM 1.95 (right) on the South Fork of Asotin Creek.

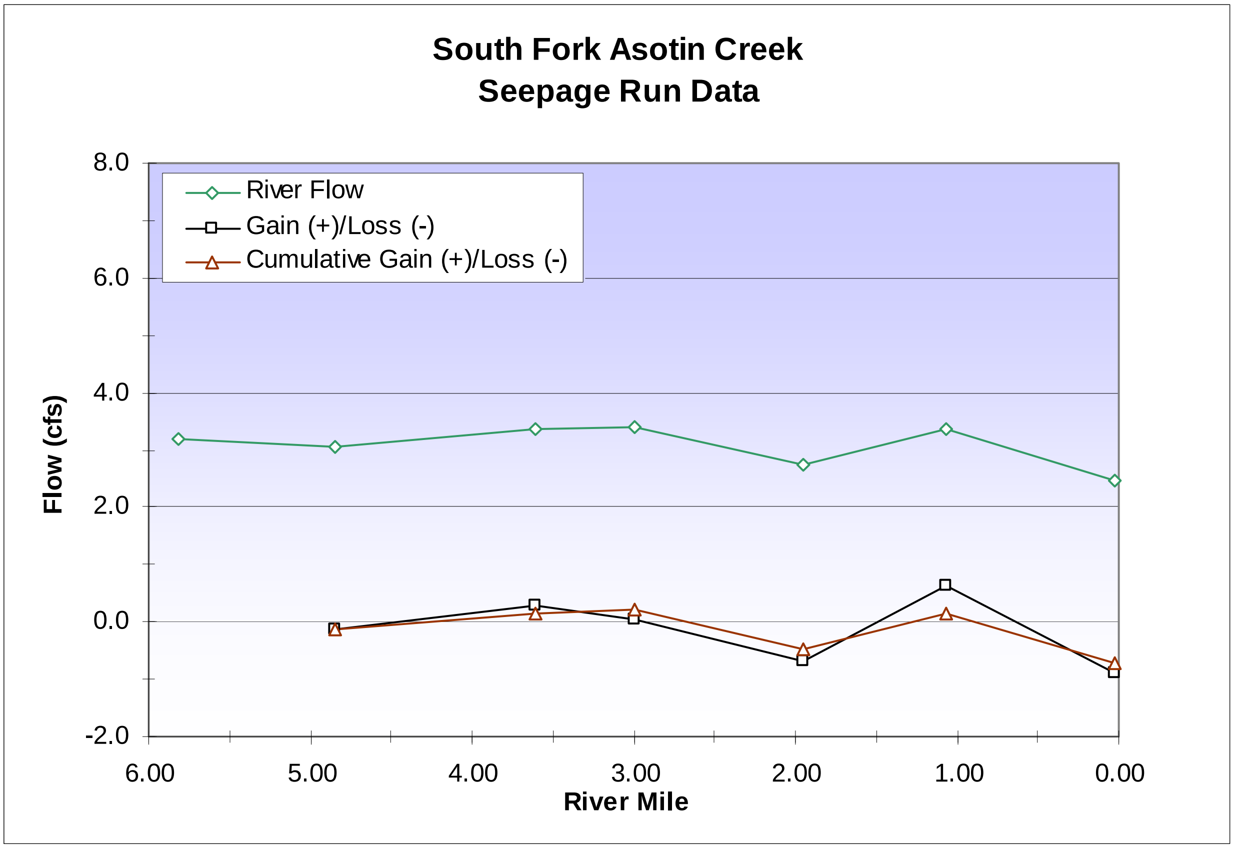


Figure 2-18 Seepage run results for the South Fork of Asotin Creek conducted on September 17, 2008.

Figure 2-19 Looking US from RM 1.90 (left) and RM 5.61 (right) along Charley Creek.

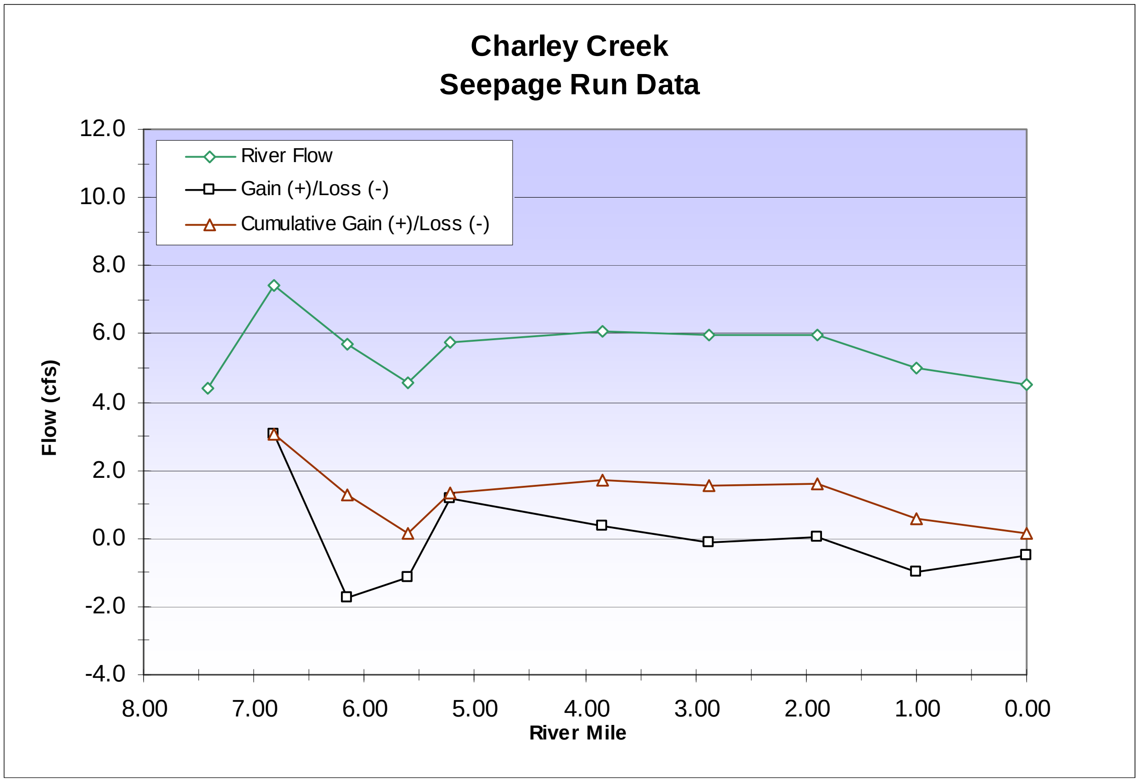


Figure 2-20 Seepage run results for Charley Creek conducted on September 19, 2008.

Figure 2-21 A comparison of stations with and with out flow on George Creek.

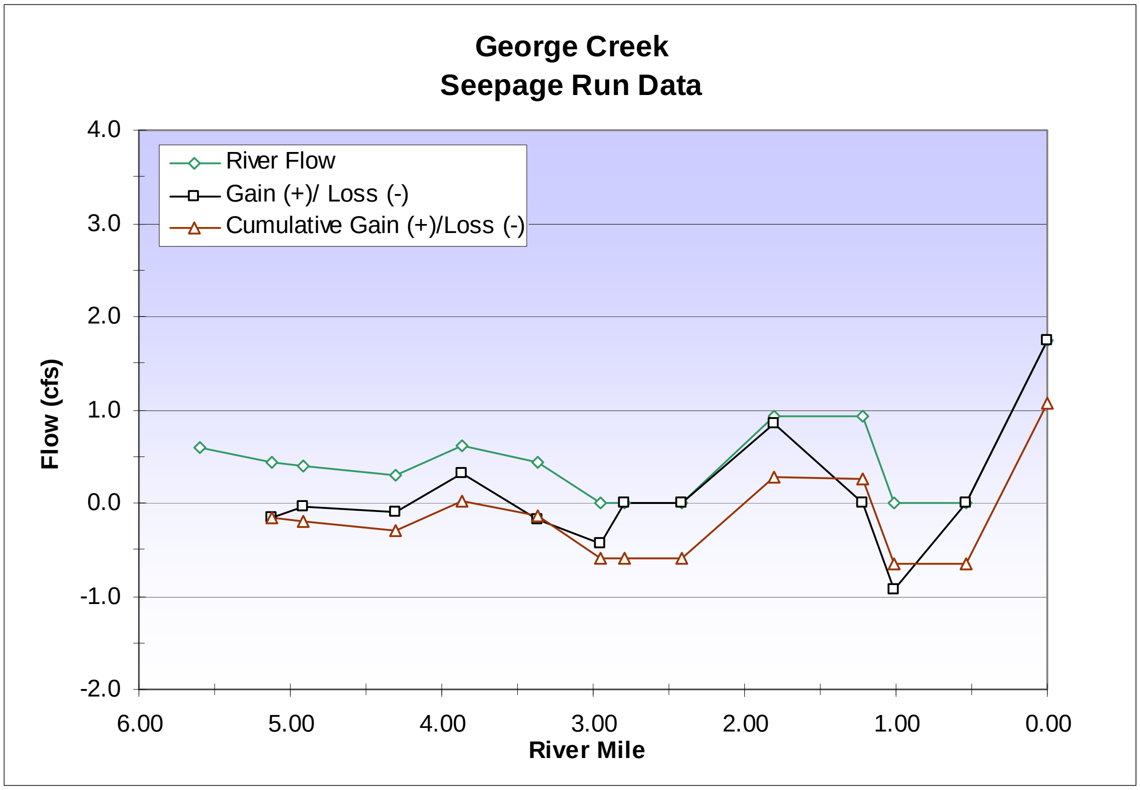


Figure 2-22 Seepage run results for George Creek conducted September 20, 2008.

Figure 2-23 Looking US at RM 7.48 (left) and RM 14.19 (right) on Alpowa Creek.

Figure 2-24 Irrigation system located along Alpowa Creek at RM 9.63.

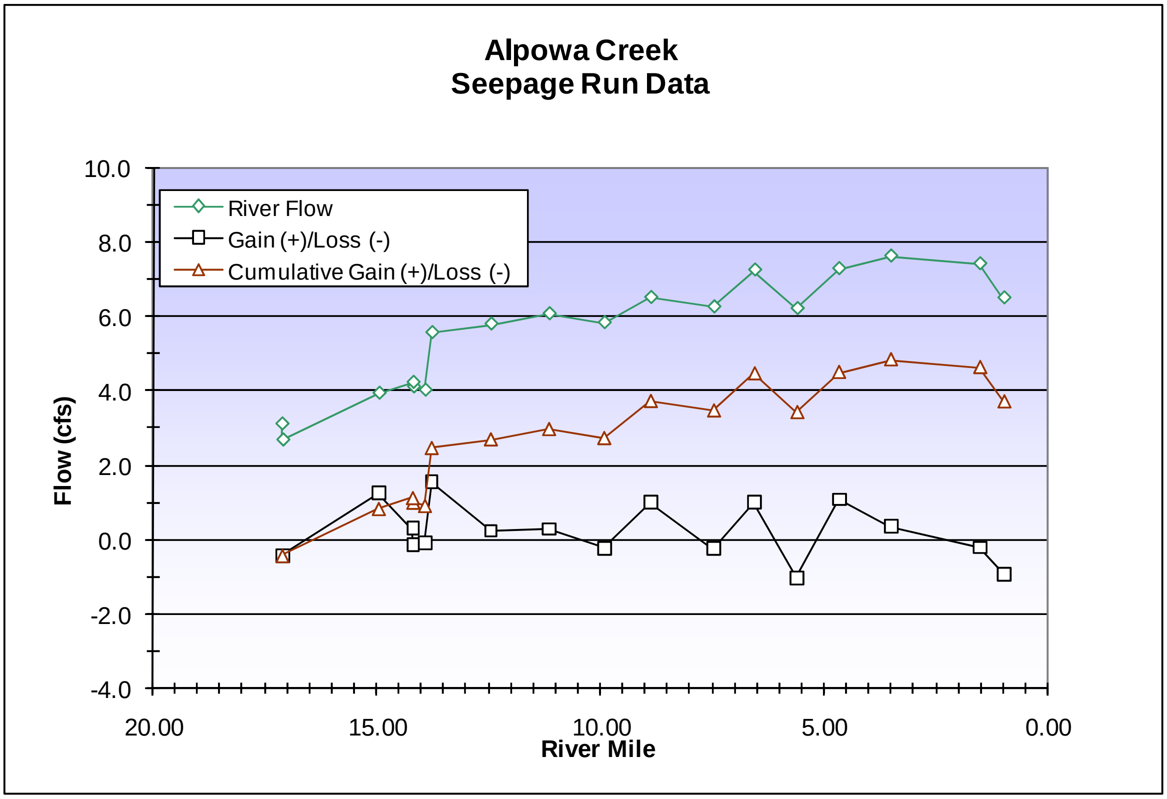


Figure 2-25 Seepage run results for Alpowa Creek conducted on September 18, 2008.

Figure 2-26 Comparison of stations with water at RM 5.73 (left) and without water at RM 8.12 (right) on Tenmile Creek.

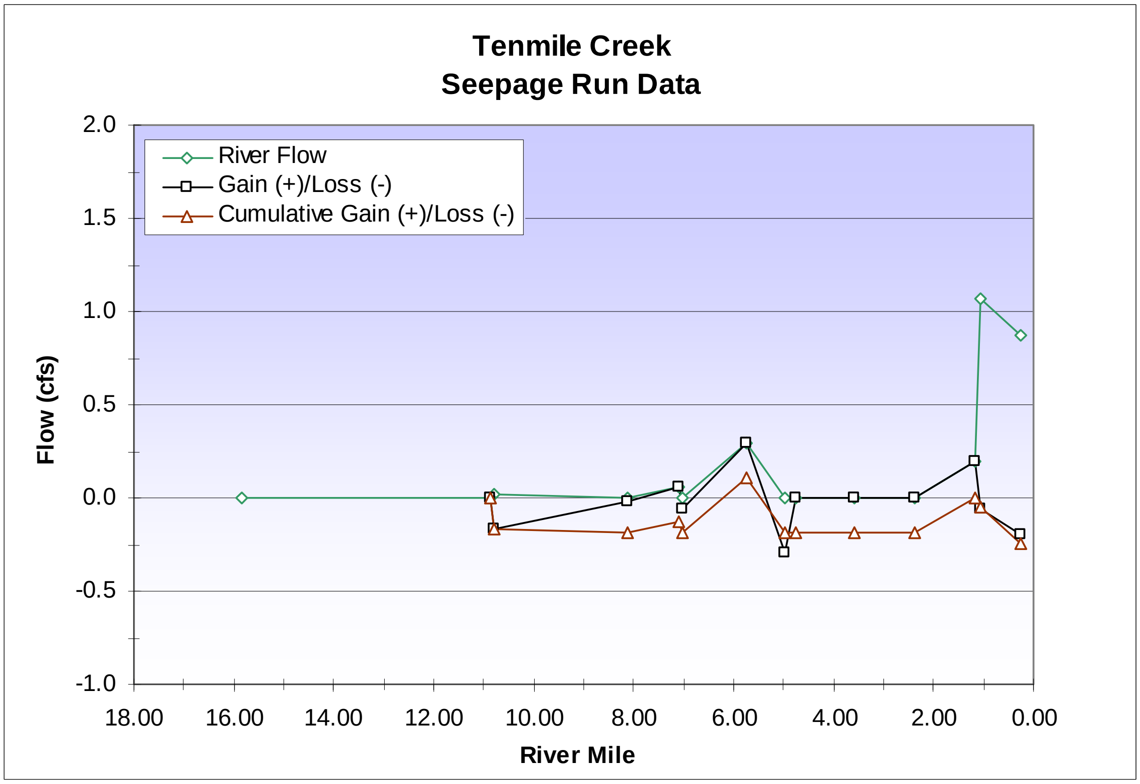


Figure 2-27 Seepage run results for Tenmile Creek conducted on September 22, 2008.

Figure 2-28 Stations along Mill Creek at RM 0.06 (left) and RM 5.95 (right).

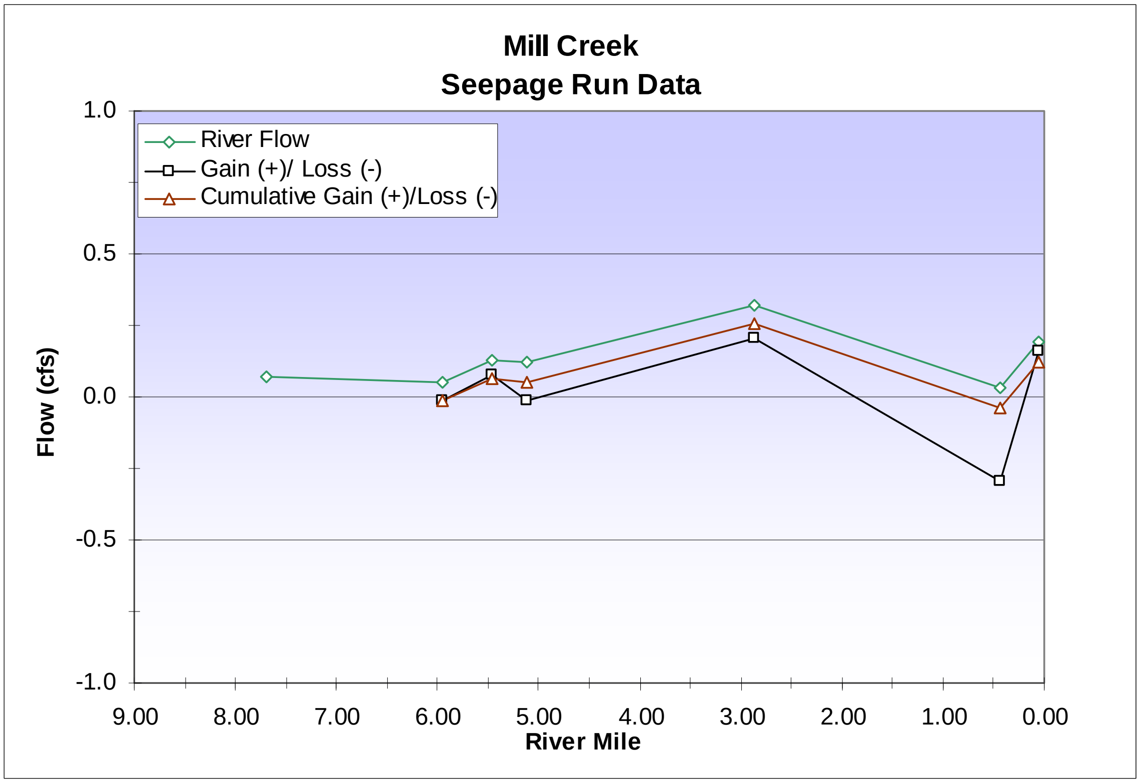


Figure 2-29 Seepage run results for Mill Creek conducted on September 21, 2008..

Chapter 3

Hydrogeologic Evaluation of the Alpowa and Asotin Creek Sub-Basins

3.1 Introduction

The chapter describes an evaluation of hydrogeologic conditions within the Alpowa Creek and Asotin Creek sub-basins of Water Resources Inventory Area (WRIA) 35 (**Figure 3-1**). This chapter identifies the main geologic units and aquifers that are interpreted to underlie the project area and describes the potential source(s), movement, occurrence, and discharge of groundwater and the hydrologic relationship between surface and groundwater.

The following sections are included:

1. Data sources and analysis methods.
2. The physical setting of the Alpowa Creek and Asotin Creek sub-basins, including a review of the basic regional geologic and hydrogeologic framework.
3. A conceptual hydrogeologic framework describing the aquifers' nature and extent, groundwater discharge and recharge, impacts of wells on surface water, and groundwater-surface water interaction.
4. Analysis of groundwater level data collected in the fall of 2008 and spring of 2009 and interpretation of available well log and geologic information associated with these wells. Evaluation of seepage run data measured in the fall of 2008. Incorporation and evaluation of these data in the context of the conceptual hydrogeologic framework developed for the project.

3.2 Data Sources

This chapter builds on an earlier geologic and hydrogeologic evaluation of WRIA 35 (Kennedy/Jenks, 2005). It also is based on a regional geologic and hydrogeologic framework evaluation of the Columbia Basin Groundwater Management Area (GWMA, 2007) and geologic studies and well evaluations in the Walla Walla Basin (GSI, 2007). This other work has utility in WRIA 35 because these areas, like WRIA 35, are underlain by similar geologic units and features, which similarly impact groundwater occurrence and movement where they exist.

The basic hydrologic, hydrogeologic, and groundwater conditions within the Alpowa Creek and Asotin Creek sub-basins (project area) of WRIA 35 (**Figure 3-1)** are based primarily on existing information, such as driller's logs and geologic maps. A limited field investigation provided additional information about potential groundwater conditions. Invasive subsurface investigations such as exploratory and/or monitoring well drilling and geologic logging or aquifer testing were not conducted.

3.2.1 Driller's Logs

Driller's logs were used to assess groundwater conditions in the project area, including:

- Identifying areas where wells are clustered and groundwater pumping is occurring.

- Interpreting potential aquifer types or units where wells might be extracting water.
- Evaluating more or less productive portions of the aquifer systems underlying the project area.
- Assessing the potential occurrence of groundwater in the project area, including source and discharge areas for that groundwater.

Driller's logs were selected for use for the project using the following criteria:

- First, if a well could be located to the nearest ¼ - ¼ section based on the location described on the driller's log, it was considered for possible use.
- If a driller's log was for a well which seemed to have a reasonable location, given the stated use of the well, then the driller's log was evaluated to determine whether or not geologic, well construction, and groundwater information recorded on the driller's log was clearly described.
- Finally, in areas where multiple wells are present, driller's logs were selected in an attempt to describe the range of potential conditions across the project area.
- Given budget and schedule constraints, well locations were only field verified as circumstances allowed.

Information compiled and interpreted from the approximately 240 driller's logs used in this chapter are tabulated in **Appendix B** and summarized below. A well location map is also presented in **Appendix B**. No well drill cuttings were found for interpretation for this project.

3.2.1.1 Alpowa Sub-Basin Wells

A total of 49 wells were evaluated within the Alpowa Creek sub-basin. General observations with respect to pumping performance for these wells include the following:

- Reported pumping rates range from 1 to 250 gpm, with the average rate being 42 gpm.
- Reported water temperatures are consistently less than 62 degrees F.
- Most of the wells evaluated are reported to be for domestic use and as a consequence well pumping data, with drawdown measurements, only were found for 3 of the 49 wells. For these three wells calculated specific capacities are 0.183, 1.632, and 18.75 gpm/ft draw down.
- Average well depth is approximately 300 ft, with deepest reported to be 700 ft.

3.2.1.2 Asotin Sub-Basin Wells

Within the Asotin Creek sub-basin, 160 driller's logs were examined to evaluate general groundwater conditions. In addition, approximately 30 driller's logs for wells located near, but outside, the sub-basin were examined to provide additional information on the Anatone area. General observations relative to these wells include the following:

- Reported pumping rates for wells within the sub-basin range from 1 to 150 gpm, with the average rate being 24 gpm.
- Reported water temperatures are consistently less than 65 degrees F.
- Most of the wells evaluated are reported to be for domestic use and as a consequence well pumping data, with drawdown measurements, only were found

for 7 of the wells. For 6 of these 7 wells, calculated specific capacities were less than 1 gpm/ft draw down. The seventh well is calculated to have a specific capacity of 250 gpm/ft draw down.

- Average well depth in the sub-basin is approximately 266 ft, with the deepest reported to be 1,155 ft.

3.2.2 Surface Geologic Maps

In conjunction with the driller's logs, surface geologic maps of the project area were also used for this evaluation. The primary geologic map used is Schuster (1993). This map was used to determine the basic physical geologic framework for the aquifers underlying the project area, including probable hydrostratigraphy, potential flow boundaries and evidence for compartmentalization, and the probable relationship of canyons to the basic aquifer architecture. This geologic map was also used to place the groundwater and well construction information from driller's logs into a basic physical geologic framework. The elements of the physical geologic framework that were identified using the geologic map and that are important in evaluating groundwater conditions within the project area include:

1. Identifying the basic geologic units which are interpreted to host groundwater.
2. Determining the distribution of these units, including dip and pinch outs.
3. Locating folds, faults, and dikes which cross-cut units, and potentially form barriers, and in some cases may be pathways, to groundwater occurrence, movement, and quantity.
4. Evaluating the depth of incision of the modern drainage system into and through geologic units and the potential impact this has on: (1) groundwater occurrence, movement, recharge, and discharge and (2) surface water and aquifer interaction.
5. Identifying basic surface units that may influence vadose zone conditions, especially soil moisture infiltration.

3.2.3 Springs

During the course of this project, one of the things noted was the presence of springs. Springs are important because they provide insight into the presence and availability of groundwater (especially shallow), discharge points from the aquifer system, and the potential for groundwater discharge to provide base flow to streams. Given these relationships a preliminary review of spring distribution was conducted in the project area primarily using published 7.5 minute topographic maps and field reconnaissance.

3.3 Physical Setting

This section briefly summarizes the physical geographic, geologic, and hydrogeologic setting of the project area.

3.3.1 Geographic Setting

The project area (**Figure 3-1**) is located in Asotin County and Garfield County in southeastern Washington. The Asotin Creek sub-basin is 322 square miles and the Alpowa Creek sub-basin is 130 square miles with a combined area for both sub-basins of 452 square miles. The project area ranges from relatively dry valleys and canyons (**Figure 3-2**) adjacent to the Snake River on the north and east, to forested highlands (**Figure 3-3**) on the edge of the Blue Mountains to the south and west. Elevations range from about 690 ft above mean sea level (msl) to over 5,000 ft. The project area is deeply incised by streams which form the main branches of Alpowa Creek and Asotin Creek, and their numerous tributaries. From the highlands of the upstream areas to the Snake River, canyon depths may exceed 1,500 ft.

In the project area the largest concentration of human population is found in the City of Asotin at the confluence of Asotin Creek with the Snake River. The largest population center in the area, the City of Clarkston and environs, generally lies outside the project area, although continued population growth west of Clarkston has resulted in rural residential home construction in the upland areas of the northeastern portion of the Asotin Creek sub-basin. The rest of the project area is characterized by a rural population with concentrations of rural homes being found in the lower portions of Asotin Creek and Alpowa Creek and in the plateau area surrounding the unincorporated town of Anatone.

Land uses across the bulk of the project area generally consist of:

1. Forest managed for recreation, rural residential, forestry, and stock grazing in the upland (western and southern) portions of the project area.
2. Dryland farming and stock grazing across many of the high, unforested plateau areas into which the many canyons in the project area are incised.
3. Small (<20 acre) irrigated farm plots, grazing, stock raising, and rural residential in canyon bottoms, especially along perennial reaches of the two streams that are the focus of this project.

3.3.2 Geologic Setting

Kennedy/Jenks (2005), completed for the WRIA 35 Phase I/II characterization effort, identifies the main geologic units underlying the project area and evaluates the relationship between these units and groundwater occurrence and movement, summarizes the possible effect of geologic structure (folds and faults) on groundwater distribution, and presents a basic conceptual model of probable groundwater occurrence and movement throughout the WRIA 35 region. The predominant geologic unit underlying the project area is the Columbia River Basalt Group (CRBG) (**Figure 3-4**). The CRBG is overlain by a series of relatively localized continental clastic deposits (clay, silt, loess, sand, and gravel) and underlain by widespread (but very deep) metamorphic rocks (**Figure 3-4**).

3.3.2.1 Sediments Overlying the CRBG

The sediments that overlie the CRBG consist of a variety of wind-deposited to water-deposited strata. These strata typically are localized in stream valleys or covering upland areas. They also occur locally where ancient streams deposited them in and around ancient river channels. Pleistocene cataclysmic flood deposits which are common in the region are not common in the project area. The following general summary is based on Hooper and others (1985), Kuhns (1980), Webster and others (1982), Schuster (1993), and our own observations.

Alluvial deposits (water-deposited): Generally coarse, well-bedded, stream-rounded, basaltic and mixed-lithology continental clastic strata (predominantly sand and gravel) are found as thin (generally less than 50 ft thick) to locally thick (>100 ft) deposits partially filling many valley and canyon bottoms and on terraces near Asotin, Washington. More angular to blocky, commonly muddy, cobble to boulder gravel also is found at the mouths of small canyons feeding into the larger valleys, and in landslide and talus deposits at the base of steep slopes and canyon walls. The coarse basaltic alluvial deposits range from Pleistocene to Holocene in age (possibly older than 700,000 years to present). Mixed lithology, partially indurated conglomerate gravel in the Clarkston area may be even older, possibly Pliocene in age and deposited by the ancestral Salmon-Clearwater River.

Loess (wind-deposited): Loess is a wind deposited silt and very fine sand. It mantles most of the upland areas within the project area lying between the edge of the Snake River canyon and the Blue Mountains. The loess, also referred to as the Palouse Formation, is deeply incised by stream erosion and rarely more than 100 ft thick. It is potentially early Pleistocene to late Pleistocene in age (>750,000 to 10,000 years).

3.3.2.2 Columbia River Basalt Group (CRBG)

Collectively the CRBG consists of a thick sequence of more than 300 continental tholeiitic flood basalt flows that cover an area of more than 164,000 km^2 in Washington, Oregon, and western Oregon (Tolan and others, 1989), and underlies the entire project area. The total estimated volume for the CRBG is greater than 174,000 km^3 (Tolan et. al, 1989) with the maximum thickness of over 3.2 km occurring in the Pasco Basin area (Reidel et al, 1982, 1989a,b). CRBG flows were erupted between approximately 17 and 6 million years ago from long (10 to >50 km), north-northwest-trending linear fissure systems located in eastern Washington, northeastern Oregon, and western Idaho, including within the project area (Schuster, 1993).

The CRBG is divided into a host of regionally mappable units (**Figure 3-5**) based on variations in physical, chemical, and paleomagnetic properties (Swanson et al, 1979a; Beeson et al, 1985; Reidel et al, 1989b; Bailey, 1989). The CRBG underlying the project area is divided into four formations. These formations are, from youngest to oldest, the Saddle Mountains Basalt, Wanapum Basalt, Grande Ronde Basalt, and Imnaha Basalt (Swanson et al, 1979a,b). These formations are further subdivided into members defined, as are the formations, on the basis of a combination of unique physical, geochemical, and paleomagnetic characteristics. These members can be, and often are, further subdivided into flow units (Beeson et al, 1985).

Most CRBG flow units, or flows, occur as sheet flows which form laterally widespread, planar-tubular sheets (or layers). Each basalt flow has a top and bottom where porous and permeable rock is found (**Figures 3-6** and **3-7**). The interiors of these flows generally consist of dense, glassy basalt. Based on available geologic studies (Lindberg, 1989) cooling joints within dense flow interiors are interpreted to have low to no effective porosity and permeability unless disturbed by deformation or erosion because they are over 99 percent filled by secondary clay, silica, and zeolite minerals. The lateral extent of individual sheet flows is controlled by erosion, faulting, and the original extent of the basalt flow. A small number of CRBG basalt flows (primarily in the Saddle Mountains Basalt) emplaced in, and filled, pre-existing canyons and valleys and form narrow, elongated, ribbons which are referred to as intra-canyon flows.

Saddle Mountain Basalt: This is the youngest (13,500,000 to 6,500,000 years ago) and aerially most limited CRBG unit in the project area. Eight Saddle Mountains units are present in the Asotin area where they occur as very small sheet flows and/or as intra-canyon flows.

Wanapum Basalt: The Wanapum Basalt consists predominantly of sheet flows subdivided into the Roza Member (1 flow), Frenchman Springs Member (3 to 6 flows) and Eckler Mountain Member (3 or more flows). Wanapum Basalt sheet flows are found predominantly in the northern portion of the project area, particularly in the Alpowa Creek sub-basin, and on the drainage divide above the Grande Ronde River. In the project area the Wanapum Basalt has limited lateral continuity because the modern drainage has cut canyons, which erode completely through it in many areas. Where it has not been removed by erosion in the project area, the Wanapum Basalt usually is less than 300 ft thick. Feeder dikes for the eruptions that feed at least the Roza Member are present in the Asotin Creek drainage.

Grande Ronde Basalt: The Grande Ronde Basalt (emplaced between approximately 15.6 and 14.5 million years ago) underlies the Wanapum Basalt and is the most widespread and voluminous CRBG unit in the project area. In the project area the Grande Ronde Basalt consists of dozens of flows subdivided into 4 magnetostratigraphic units (from top to bottom, N_2, R_2, N_1, and R_1). The depth of erosion into the Grande Ronde Basalt generally increases up gradient in the project area. The deeper Grande Ronde units (N_1 and R_1) are exposed in the deepest canyons in the upper reaches of the project area, and in the highlands bordering the southern edge of the project area. Grande Ronde Basalt sheet flows typically become more widespread and thicker away from the crest of the Blue Mountains. In the project area the Grande Ronde Basalt usually is several thousand ft thick, although immediately to the east, along the Snake River, older rocks are exposed. Feeder dikes for eruptions that feed many Grande Ronde flows are present in the Asotin Creek drainage (**Figure 3-8**).

Imnaha Basalt: The Imnaha Basalt, the oldest CRBG unit, only is exposed at the Earth's surface in the project area at the mouth of Alpowa Creek, although it underlies the entire project area. The Imnaha Basalt is exposed adjacent to the project area in the Snake River canyon. Beneath the project area it is inferred to consist of several sheet flows that buried an irregular, pre-existing land surface.

Ellensburg Formation: The Ellensburg Formation consists of claystone, mudstone, sandstone, and conglomerate interbedded between some CRBG units, especially in the Saddle Mountains Basalt. Ellensburg units are most common in the Asotin area where they crop out on canyon walls. Generally these sediments consist of coarse to fine alluvial strata deposited in fluvial systems active between CRBG eruptions.

3.3.2.3 Structural Geology (Folds and Faults)

The project area lies within the western half of the Lewiston Basin (**Figure 3-9**). The Lewiston Basin is a structural basin bounded by folded and faulted CRBG, and it has been subsiding since at least the beginning of emplacement of the Saddle Mountains Basalt approximately 13.5 million years ago. The Lewiston Basin has undergone several thousand feet of subsidence..

CRBG strata within the Alpowa Creek sub-basin and the western half of the Asotin Creek sub-basin generally dip to the east, toward the center of the Lewiston Basin. CRBG strata in the southern portion of the Asotin Creek sub-basin generally dip to the north-northeast, off the anticline which separates this drainage from the Grande Ronde River to the south. Structural dips in the CRBG across the project area commonly range from 2 to 10 degrees, and CRBG strata found exposed on the highlands surrounding the project area are found at or below the Snake River in the center of the Lewiston Basin.

Faulting accounts for much of the structural offset seen between strata surrounding and underlying the Lewiston Basin. A number of generally east-west oriented faults are mapped in association with the anticline located near the southern edge of the project area (**Figure 3-9**). Generally north-south oriented faults also occur from the mouth of

Alpowa Creek south to Charley Creek, a tributary of Asotin Creek (**Figure 3-7**). The fault movement is generally downward on the Lewiston Basin side.

3.3.2.4 Pre-CRBG Rocks

The rocks underlying the CRBG crop out in small areas in the bottoms of several canyons near the project area, especially in the Snake River canyon south of Asotin. These rocks consist of metamorphic volcanic and sedimentary rocks having liming porosity. Pre-CRBG rocks probably are not a source of significant groundwater in the project area and they essentially form the bottom of the CRBG aquifer system that is discussed in the next section.

3.3.3 Hydrogeologic Setting

The major aquifers in the project area are the alluvial aquifers in the canyon bottoms and the layered CRBG aquifers. Aquifers hosted by the CRBG range from small yielding and localized to potentially quite large and widespread. The folding, faulting, and feeder dikes cross-cutting the project area, plus the many deep canyons which are incised into the project area, probably exert some degree of influence on the lateral continuity of these CRBG aquifers. Direct evidence of aquifer conditions is generally limited for the project area due to the lack of monitoring, aquifer testing, and characterization data. Consequently, the following discussion of the hydrogeologic setting relies largely on insights inferred from driller's logs, area reconnaissance, regional knowledge of the CRBG and limited groundwater monitoring and seepage run field data collected in 2008 and 2009.

3.3.3.1 Alluvial Aquifer System

The alluvial aquifer system is found predominantly in valley fill alluvial sand and gravel. The alluvial aquifers are localized, laterally restricted, unconfined groundwater-bearing zones 50 to 150 feet thick. The water table in these situations generally is less than a few feet to 20 feet below the ground surface, although it may be deeper locally.

The alluvial valley sand and gravel aquifers have a high degree of hydrologic continuity with the valley creeks. The canyon-fill coarse alluvial sand and gravel has a high hydraulic conductivity and transmissivity.

3.3.3.2 CRBG Aquifers

The physical characteristics and properties of individual CRBG flows affect their intrinsic hydraulic properties and influence potential distribution of groundwater within the CRBG (**Figure 3-6**). Groundwater within the CRBG generally is found in flow tops and flow bottoms, with the top of one flow and the bottom of the overlying flow referred to as an interflow zone. These interflow zones are separated by dense flow interiors which are characterized by dense, glassy jointed rock. These joints typically are filled by secondary minerals and clay (Lindberg, 1989), usually resulting in little to no effective porosity. Dense flow interiors undisturbed by tensional fractures, faults, flow pinch outs, and related features act to significantly restrict, if not block, movement of groundwater between successive interflow zones. Consequently, groundwater in the CRBG generally occurs in multiple, stacked, confined, aquifers which have limited hydrologic continuity with overlying and underlying units. CRBG aquifers can be very productive (high transmissivity), but generally have very low overall storativity, which can readily result in the decline of groundwater levels where pumping exceeds recharge. This is not expected to be an issue within the project area because of the low net volume of well pumping compared to the relatively high rate of recharge. Groundwater flow direction within an individual interflow zone generally is in the down-dip direction. Given the regional dip of the CRBG in the project area, to the north and east off the Blue Mountains towards the Snake River, groundwater flow in CRBG aquifers generally will be towards the Snake River, parallel to dip direction.

The CRBG aquifers are only present where the host geologic units are present. Consequently, potential aquifers in the Saddle Mountains Basalt (dominated by intracanyon flows and very localized sheet flows) generally will be narrow and elongated, whereas those in the sheet flow dominated Wanapum and Grande Ronde Basalts are thin, but potentially laterally extensive. The lateral continuity of potential Wanapum and Grande Ronde aquifers in the project area is largely controlled by depth of erosion, flow edges, faults, and feeder dikes. The more each of these features are overprinted on the Wanapum Basalt and Grande Ronde Basalt, the more restricted or limited the lateral continuity. Groundwater movement in CRBG interflow zones generally will be down-dip in these stratified materials.

Because the dense rock flow interiors between the water bearing zones in the basalt aquifer are relatively impermeable, the majority of recharge to CRBG aquifers likely occurs where individual interflow zones crop out at, or are near, the surface. Such areas have to be where surface water and/or precipitation are present and can infiltrate into the ground. Conversely, discharge from these aquifers generally has to be where these interflow zones terminate at or near the surface (such as in canyons) or to other aquifers down dip of recharge areas.

The large number of springs shown on 1:24,000 scale maps in the headwaters of the Alpowa and Asotin Creek sub-basins suggests widespread aquifer discharge is an important source of stream flow high in the project area. Conversely, the small number of springs low in the project area suggests aquifer discharge to streams is less common down gradient of the headwaters areas. Based on the extent of interflow zone aquifers in the various CRBG units with respect to potential recharge areas, lateral continuity, and location, Saddle Mountains and Wanapum aquifers are inferred to be of limited extent and low, sustainable productivity (<100 gpm). Because these units do crop out in the canyons which cross-cut the project area, stream flows probably are in part derived from springs discharging from these units. Grande Ronde aquifers are more widespread and may be potentially more productive, but the relative lack of deep, high capacity, water production wells in the project areas makes any prediction of Grande Ronde aquifer production capacity premature.

For this project a basic three-tier subdivision of the CRBG aquifer system was adapted based on geologic unit, location, and unit distribution with respect to lateral continuity as influenced by the depth of canyon incision. Maps presented on **Figures 3-11** to **3-13** and a hydrogeologic cross-section presented in **Figures 3-14** and **3-15** assist in illustrating the geologic and hydrogeologic conditions in the study area. These subdivisions, referred to as hydrostratigraphic units, are defined as follows:

1. The Shallow Basalt Hydrostratigraphic Unit (SBHU) (consisting of the Saddle Mountains Basalt and the Wanapum Basalt) is found predominantly within the Lewiston Basin in the highlands above lower Asotin Creek. It is highly dissected by canyons which commonly cut completely through the unit. **Figure 3-11** illustrates the general extent of this unit while **Figure 3-12** shows the depth of incision typically seen where this shallow basalt hydrostratigraphic unit (SBHU) occurs.

2. The Intermediate Basalt Hydrostratigraphic Unit (IBHU) (consisting of the N2 and R2 Grande Ronde Basalt magnetostratigraphic units) is found beneath almost the entire project area (**Figure 3-13**). In the headwater areas of Alpowa Creek and Asotin Creek, it is deeply eroded by canyons, while in the lower reaches of these drainages, erosion only cuts into the top of the intermediate basalt hydrostratigraphic unit (IBHU).
3. The Deep Basalt Hydrostratigraphic Unit (DBHU) (consisting of the N1 and R1 Grande Ronde Basalt magnetostratigraphic units) is found beneath the entire project area, and is only rarely exposed in the deepest canyons (**Figure 3-13**).
4. Folds and faults cross-cut each of these hydrostratigraphic units, while dikes commonly cross-cut the deeper units in the Asotin Creek sub-basin. Based on the regional work of Newcomb (1961, 1965, 1969) these features are inferred to more likely form at least local barriers to groundwater flow, impeding groundwater movement down dip in the strataform CRBG units.

3.4 Groundwater Conditions in the Project Area

3.4.1 Basin Considerations

In the Alpowa Creek sub-basin most wells constructed in the bottoms of canyons intersect and extract water from the DBHU, while most wells in the upland areas extract water from the IBHU (**Table 3-1**). Almost all of these wells are reported to be for domestic use. Most springs seen on canyon walls are in the intermediate basalt hydrostratigraphic units, and springs are more common in upland areas and the headwaters areas of the sub-basin than they are in the lower reaches of Alpowa Creek. The small number of springs in the lower reaches of Alpowa Creek suggests the limited contribution of discharge from the deeper portions of the basalt aquifer system to base flow in this stream. The SBHU unit is essentially absent from the Alpowa Creek sub-basin.

Unlike the Alpowa Creek sub-basin, the SBHU is widespread within the Asotin Creek sub-basin. It underlies most of the upland surfaces between the deep canyons, including the Anatone area. Consequently, a large number of wells in this sub-basin, potentially as many of 75%, are open to and extracting water from the SBHU (**Table 3-1**). Of the other wells in the sub-basin, more are open to the IBHU than the DBHU.

Many springs are present in the Asotin Creek sub-basin, especially in the upper portions of the drainage and in the highland areas separating stream headwaters. These springs appear to be concentrated in the SBHU and upper part of the IBHU. Springs appear to be far less numerous in these same units, in the lower reaches of the sub-basin.

3.4.2 Conceptual Groundwater Framework

3.4.2.1 Alluvial Hydrostratigraphic Unit (AHU)

The alluvial sand and gravel localized in stream valleys and canyons is relatively thin (only a few tens of feet thick) and is in direct hydrologic continuity with nearby streams. The alluvial aquifer in these canyons likely discharges to and is recharged by the streams found in the canyons.

3.4.2.2 Shallow Basalt Hydrostratigraphic Unit (SBHU)

The SBHU is found beneath the highland plateaus separated by various deep canyons cross-cutting the project area. It is most extensive in the Asotin Creek sub-basin extending up dip from the dry canyon walls above Asotin to the Anatone area. Many of the driller's logs evaluated for wells in the upland area around Anatone appear to intersect these strata, and the low production, discontinuous aquifers within them.

Based on the distribution of the unit, recharge is probably derived predominantly from snow melt and precipitation infiltrating downwards through fractures. Data is not available to construct a reliable potentiometric map for this hydrostratigraphic unit. However, given the stratiform nature of the basalts in which the shallow basalt aquifer occurs, the depth of incision of canyons through it and dip direction, groundwater is moving to the north and northeast.

Based on this structure, most discharge from the SBHU appears to be in the upper portions of the sub-basin where springs are more abundant (such as on Pintler Creek and Huber Gulch) than in the lower portions near Asotin, where springs are rare. Given the presence of the springs near the headwaters of Pintler Creek and Huber Gulch, it seems plausible that shallow wells in that area could impact those streams. However, there are few wells in this area so the impact would be negligible. This seems to differ from other streams in the upper drainages where their headwaters generally lie in deeper hydrostratigraphic units. Wells in the shallow basalt likely will have little impact on these springs and the streams they feed. In the Anatone area, where strata dip to the northeast, a significant portion of the groundwater moving through this unit likely discharges into springs high on the walls of Tenmile Creek canyon which is outside the sub-basin. Tenmile Creek drains into the Snake River south of Asotin, and outside the project area.

Springs seen on the upper portions of canyon walls near the apparent top of basalt suggests the loess lying on the highland surfaces contains at least some groundwater. This water likely is recharged by the seepage of precipitation from the ground surface, through the loess, and to the top of basalt where it accumulates and moves down dip across the buried basalt surface. This water discharges in springs high on the canyon walls (many hundreds of feet above canyon floors) that probably have only a limited direct connection to streams in the canyon bottoms. In addition, because loess, which consist predominantly of silty fine sand to sandy fine silt, typically has very low transmissivity and conductivity, it is not to be considered a productive groundwater resource and few if any wells are completed in it.

3.4.2.3 Intermediate Basalt Hydrostratigraphic Unit (IBHU)

The IBHU is the hydrologic unit exposed in most of the canyons cross-cutting the project area. It typically is exposed at the bottom of the deepest canyons, and extends for some depth below the canyon bottoms. In the Alpowa Creek sub-basin the IBHU is deeply eroded into the main canyons, and it is completely eroded through in the lowest part of the sub-basin. Given the thinness of the SBHU in the sub-basin, the IBHU is the primary upper basalt aquifer unit in the Alpowa sub-basin and has very limited lateral continuity as a result of canyon incision. Most springs in the upper portion of the sub-basin drain this unit.

Within the Asotin Creek sub-basin the IBHU is widespread. West of Anatone, essentially in the headwaters of north and south Asotin Creek, the IBHU is deeply incised and has little lateral continuity as a result of this incision. In the lower portion of the sub-basin and in the Anatone area, structural dip places the unit deeper into the subsurface and only its uppermost parts are incised into, and potentially interrupted by canyons. Given these relationships, this unit may display some degree of lateral continuity, and is interrupted by the deepest canyons. In the deep canyons, the IBHU may discharge to streams. Based on the mapped distribution of the N2 and R2 Grande Ronde Basalt, it is inferred that this interconnection, if occurring, is more common in the upper portions of the two sub-basins, areas where few wells are drilled into these strata because of the sparse population. In the lower basin more wells intersect IBHU, but the hydrologic connection to streams in the IBHU in this area is uncertain. It appears that most wells in this area are completed several hundred ft below ground surface in interflow zones that may not be hydrologically connected with surface water because of laterally widespread dense basalt flow interiors. The absence of springs suggests these water-bearing zones may not be a major source of water for streams, but data are limited in these areas.

Many faults and feeder dikes cross-cut the basalt layers of the IBHU. While currently available data in the project area is inadequate for characterizing their actual impact on groundwater occurrence and movement, knowledge of their presence should be factored into future groundwater work in the project area. If they act as barriers to groundwater movement water levels would likely be higher on the up dip side of them. If, on the other hand, they provide pathways for groundwater movement, then springs would likely be associated with them. Based on current knowledge, including field reconnaissance, these features more likely act as barriers to groundwater movement in the project area.

3.4.2.4 Deep Basalt Hydrostratigraphic Unit (DBHU)

The DBHU consists of basalt aquifers beneath all but the deepest canyons. The only areas where this portion of the basalt aquifer system has largely unrestricted continuity with the surface is in canyons of the North Fork of Asotin Creek and the South Fork of Asotin Creek and in the lower end of the Alpowa Creek. In these canyons the recharge and discharge relationship with these streams is unknown due to the few wells completed in the unit in this area. To the east downstream, only a few wells appear to intersect and take water from this unit.

Because this hydrostratigraphic unit exists almost entirely below the depth of the deepest canyons, these canyons are expected to have little or no impact on limiting the lateral continuity of this unit. If this unit is receiving recharge, it may have the potential to support more groundwater pumping than it currently does. If this unit is compartmentalized to any extent, the most likely cause will be folds, faults, and feeder dikes such as described for IBHU.

Given the depth of the unit beneath the project area, and the dip of the unit into the Lewiston Basin, it seems likely that hydrologic continuity between this system and streams in the project area is limited to non-existent. Given the dip of Grande Ronde Basalt units into the basin, water-bearing zones in this unit will lie progressively deeper beneath canyon bottoms as one goes from the up stream to down stream portions of the sub-basin.

3.4.3 Evaluation of Hydrostratigraphy and Groundwater Levels in Project Area

In the fall of 2008 and spring of 2009 water levels were measured in a number of wells in the project area. This was done to evaluate potential groundwater flow directions and aquifer conditions at the general end of the summer and fall pumping season. This section describes and interprets the water level data collected.

3.4.3.1 Data Evaluation

Figure 3-16 shows the locations of the 46 wells evaluated for this effort and listed on **Table 3-2**. Given the wide spatial distribution of the 46 wells, including the presence of a large number of deep canyons separating many of these wells it was decided to break the project area into subdivisions that generally reflect the spatial distribution of wells. These subdivisions then provide a framework for the initial data evaluation. To that end, these subdivisions are as follow:

1. Upper Alpowa Creek (**Figure 3-17**).
2. Clarkston Heights and lower Alpowa Creek (**Figure 3-18**).
3. Upper Asotin Creek, below the forks (**Figure 3-19**).
4. Lower Asotin Creek and the northern end of Highway 129 (**Figure 3-20**).
5. Cloverland and Meyer Ridge plateaus (**Figure 3-21**).
6. The Anatone plateau (**Figure 3-22**).

Each of these maps is composed on a digital topographic base map upon which geologic information from the 1:100,000 State of Washington digital geologic maps were superimposed. This was done so that the basic geologic and hydrostratigraphic framework could be compared to the water level measurements for this evaluation.

The discussion below is based on the assumption that the geologic framework, the distribution of basalt intraflow structures and the sediment inter-bed geology exerts a fundamental control on ground recharge, movement, and discharge.

3.4.3.2 Alpowa Creek

Six wells were measured in the vicinity of Alpowa Creek from the mouth of Megginson Gulch, upstream (**Figure 3-17**). Five of the six are wells located on the canyon floor, and the sixth well (GAR0133) is located in Palmer Canyon approximately 220 ft above the canyon floor.

Of the five wells on the canyon floor, three are completed in the alluvial aquifer deposits and two are completed in basalt. The 5 wells on the canyon floor all have water levels that are relatively close to the ground surface. The seepage run data for Alpowa Creek indicate a significant cumulative increase in flow from groundwater gains (**Figure 3-17**). Almost all of the flow in the lower 18 miles of Alpowa Creek correlates strongly with the calculated groundwater inflow into the creek. The groundwater data and the seepage run data indicate hydraulic connection and gains between either the alluvial aquifer or the basalt aquifer and Alpowa Creek. The exact nature and the relative contribution between the shallow and deeper aquifers to the creek can not be determined based on the available data.

3.4.3.3 Clarkston Heights

The water levels measured in the wells in this area (**Figure 3-18**) suggest the potential presence of multiple water-bearing intervals. Focusing initially on the wells found in the Dry Creek and Maguire Gulch area along Highway 129, there is evidence for a complex, multi-unit groundwater system with multiple water levels. A three tier system, at a minimum, is suggested by this set of closely spaced wells. The data suggestive of such a potential system within the SBHU and the IBHU is as follows:

1. The westernmost 5 wells show water levels in the range of 1442 to 1476 ft above sea level. These levels are above the floor of Dry Creek, but below the depth of incision of the upper portion of Maguire Gulch, and interpreted to be reflective of conditions within at least a portion of the SBHU.

2. A second set of water levels, ranging from 1263 to 1282 ft above sea level, is seen in wells slightly to the east of the former. The close proximity of these two sets of wells, especially in wells ASO0690 (1272 ft) and ASO0824 (1459 ft), makes it difficult to equate the water levels displayed by these two sets of wells. These water levels could be from a different portion of the SBHU or the deeper IBHU.
3. The third set of wells, wells ASO0827 and ASO0670, have water levels of 931 and 919 ft above sea level, respectively. These two wells also are in close proximity to the other wells, and again the water levels measured in these two wells are not readily equated to the other nearby wells. These water levels are interpreted to most likely be from within the IBHU.

These three sets of water levels are interpreted to reflect three different water-bearing intervals, or aquifers. In addition, a single well with a water level of 1159 ft above sea level (ASO0838) suggests the possibility of a fourth aquifer. These aquifers, based on the geologic map of the area and our interpretation of well geology, are interpreted to be related to individual interflow zones in the lower portion of the Saddle Mountains Basalt and the upper Wanapum Basalt. Given the wide ranges of water levels in these closely spaced wells, the aquifers penetrated by these wells are not in equilibrium and display limited to potentially no local hydraulic connection with each other. It is likely that the aquifers in this area are truncated and the drainage patterns are very complex.

For the other three wells in this part of the project area, all three are Grande Ronde wells will water levels above the Snake River. Well ASO0673 is located in the bottom of the Alpowa Creek canyon, and given its depth, it likely in hydrogeologic connection with the creek via the boring, shallow open joints, or incision into the interflow(s) it is taking water from. Because all three of these wells have static levels above the level of the Snake River, the primary recharge areas for these well lay upslope of them, and is not the Snake River. These recharge areas likely are up dip of the wells, where erosion and structural deformation has exposed individual water bearing interflow zones to recharge sources.

3.4.3.4 Upper Asotin Creek

The seven wells measured in and around the Upper Asotin Creek area (**Figure 3-19**) display a range of water levels that we interpret to reflect several aquifer conditions. One well, ASO0302, located north of Asotin Creek is interpreted to be measuring Grande Ronde water levels within the IBHU beneath the highlands west of Asotin Creek. These water levels are high above the canyon floor. The two wells south of Asotin Creek, ASO0805 and ASO0286, are interpreted to be measuring Saddle Mountains Basalt (SBHU) water levels that also are significantly above the base of the Asotin Creek canyon. In addition, these two water levels may suggest a general groundwater flow direction to the east, away from Asotin Creek. Such a direction would be consistent with structural dip of individual interflow zones in this area.

Wells ASO0284 and ASO0285 present an interesting contrast to the highland levels discussed above, and the canyon bottom water levels seen in wells ASO0837 and ASO0836. Wells ASO0284 and ASO0285 are located on the canyon floor, yet the upstream one has a water level of 1741 ft, which is lower than the downstream one, which has a water level of 1821 ft. In addition, seepage run data in this area suggests the North Fork Asotin Creek could be gaining (**Figure 2-15**).

These two water levels suggest ASO0285, in the upper Grande Ronde, has limited connection to Asotin Creek while ASO0284, also in the upper Grande Ronde, may have a much better connection to the creek. Under these inferred conditions, it becomes likely the these two wells, both in the upper Grande Ronde, or IBHU, are in different portions of the upper Grande Ronde IBHU with limited or no hydrologic connection with each other, and only one having significant connection to the creek. This type of heterogeneity is common in basalt aquifer systems.

The final two wells on this map, those further downstream on Asotin Creek (ASO0837 and ASO0836), are interpreted to be sediment and basalt wells, and the water levels measured in them seem to be consistent with alluvial aquifer water levels (AHU). The mainstem Asotin Creek has minor gains and losses in the upper portion of the system (**Figure 2-13**) with no apparent and systematic gain that would indicate a strong contribution to flow from the deeper basalt aquifers. Based on small springs observed emanating into the creek in the upper portion of the watershed (high in the North and South Fork headwaters), we believe that the primary area of hydraulic interconnection between the basalt aquifers and Asotin Creek is upriver from the mainstem creek and there is little to no water use

3.4.3.5 Lower Asotin Creek

This area (**Figure 3-20**) contains wells interpreted to be reflective of several hydrogeologic settings. The two wells in Asotin Creek, although both basalt wells, have groundwater levels near the creek surface water level that suggest hydraulic interaction between the alluvial aquifer (AHU) and the creek. These 2 very shallow wells are in connection with the alluvial system because of canyon erosion and erosional truncation of dense flow interiors allowing connection between saturated basalt interflow zones and the alluvial system. The seepage run data for the lower portion of Asotin Creek (**Figure 2-13**) indicates minor interaction between the creek and the alluvial aquifer (a cumulative gain of less than 4 cfs out of 30 to 35 cfs total river flow). The seepage run data show regular gaining and losing reaches that are typical of water seeping into and out of the river with little overall net gain from groundwater to river flow. Therefore, it is likely that there is little interaction between the deeper basalt aquifers and the creek in this area.

South of Asotin, 4 wells generally along Highway 129 display water levels again suggestive of multiple interflow related aquifers. Water level, well construction, and location suggest well ASO0344 is open to water in the Wanapum/Grande Ronde interflow zone (e.g., at the transition between the SBHU and the IBHU). Given the location of this well, and water level elevation, the water in this well must be moving from south to north, down slope between canyons and/or below canyons that do not incise deep enough to truncate the Grande Ronde/Wanapum contact.

The three wells south of ASO02344 do not display a systematic water level variation that would be suggestive of groundwater movement in a south to north direction. Instead, these wells, if they were intercepting water in the same aquifer would suggest northwest to southeast movement. This makes little sense as that movement direction is transverse to up-dip on the geologic framework of the area, and it would suggest recharge of such a groundwater system along the arid canyon walls of lower George Creek and Pintler Creek. This seems unlikely. Instead, we interpret these three wells to reflect groundwater in at least two interflow zones. Based on the geologic framework of the area, it seems likely that ASO0299 and ASO0801 are open to one or more interflow zones in the lower Saddle Mountains and/or upper /Wanapum (the SBHU). Groundwater in this zone(s) would be moving from south to north (down-dip), beneath this plateau. Well ASO0834 likely is sampling water in a Saddle Mountains interflow zone.

The seepage run data from the lower six miles of George Creek show that the flow in the creek is almost always less than 0.5 to 1.0 cfs and there is little to no net gain in flow from groundwater (Figure 2-21). Based on the information above, and on the seepage run data, it is likely that there is full hydraulic connection between George Creek and the shallow alluvial aquifer and little hydrologic connection between George Creek and the underlying basalt aquifers.

3.4.3.6 Meyer Ridge and Cloverland Plateau

There were few wells and little information for this area. Water levels on this deeply incised highland plateau were measured in four wells scattered across this area (**Figure 3-21**). The three wells west of George Creek are suggestive of higher water levels in the south versus the north. However, the two closely spaced wells, ASO0293 andASO0294, show water levels approximately 100 ft apart. This suggests the possibility that these two wells are in different parts of the SBHU, Saddle Mountains Basalt aquifer system.

The fourth well in this area, ASO0830, is located east of the George Creek Canyon. The depth of incision in George Creek (2100 to 2200 ft above sea level – 800 to 900 ft into the plateau) suggests the water level measured in this well, 2863 ft above sea level, is independent of those measured west of George Creek. It is likely that the basalt aquifer in this area is independent of George Creek, but there is very little information to support a conclusion.

3.4.3.7 Anatone Plateau

Eight wells were evaluated in the Anatone Plateau area (**Figure 3-22**). The water levels in these 8 wells show far less variation than those in the other areas. They are interpreted to reflect a single, or possibly two or three, hydraulically connected interflow zones dipping to the northeast beneath the area within the SBHU. Based on well construction reported for these wells, recorded water levels, and local geology, the eight wells in this portion of the project area are interpreted to be open to water-bearing interflow zones within the upper 100 to 200 ft of the Saddle Mountains Basalt.

Given the shallow depth of these wells, and the location of this part of the area immediately north of the anticline crest that essentially defines the drainage divide above the Grande Ronde River (located south of the project area), it seems likely that this aquifer receives surface recharge from precipitation which percolates downwards through the uppermost basalt interflow zones. Downward movement of water would be facilitated by tensional opening of cooling joints on the anticline. If such recharge is occurring, water levels in these wells would vary in response to wet and dry seasonal and climate variations. Given the regional groundwater flow path in this shallow aquifer system it is likely that the aquifer provides base flow in the form of seeps, springs or underflow drainage to Tenmile Creek, Pintler Creek and other tributaries to George Creek. There may be some hydraulic connection between the shallow basalt aquifer and Tenmile Creek near Anatone, although total water use in this area is minor.

3.5 Summary of Hydrogeologic Investigation

Groundwater within the project area is found within both the alluvial valley and CRBG aquifers. The nature and occurrence of these aquifers varies greatly.

The alluvial aquifer is found at the bottom of the creek canyons and is composed of less than 50 to over 150 feet of coarse gravel and sand overlying bedrock. The alluvial aquifer is unconfined and the groundwater level is near the surface. The sand and gravel alluvial aquifer in canyon-fill sediments displays a high degree of hydrologic continuity with streams.

The CRBG aquifer system consists of a series of layered, stacked, confined aquifers. These aquifers generally dip down from the crest of the Blue Mountains toward the Snake River. A three-tiered subdivision of these aquifers (SBHU, IBHU, DBHU) was defined for this report. These subdivisions are based on the identity of the geologic value(s) hosting a portion of the aquifer system and lateral continuity as defined by canyon erosion. Groundwater generally follows the structural control of the basalt aquifers. In the Alpowa Creek sub-basin, groundwater flow in the basalt aquifers is inferred to generally be from the west and southwest, down structural dip towards the Snake River. In the Asotin Creek sub-basin, groundwater flow in the basalt aquifers is inferred to be to the north, east, and northeast depending on location and structural dip of the stratiform layers. In the western portion of the sub-basin this flow will generally be towards the east, while in the southern portion of the sub-basin (in the Anatone area), the structural dip suggests it will be to the northeast, with significant groundwater movement out of the sub-basin and towards Tenmile Creek and the Snake River.

The basalt aquifer water level data collected in the fall of 2008 shows a wide range of water level elevations within the same hydrostratigraphic unit. These different groundwater surface elevations are interpreted to reflect different potentiometric levels within the same hydrostratigraphic unit. The groundwater level data indicated the presence of an extremely complex, laterally and vertically spatially-discontinuous multiple basalt aquifer. For this reason, a single water table or water level map was not prepared. A few examples that support the multi basalt-aquifer system include:

1. The three or four tier system of water levels seen below Clarkson Heights (**Figure 3-18**) are highly suggestive of multiple groundwater systems (within the SBHU and possibly the IBHU) with little (if any) connection.
2. The water levels seen beneath the plateaus south of Asotin and north of Anatone (**Figures 3-19, 3-20,** and **3-21**) point to a Saddle Mountains Basalt aquifer system (SBHU) that displays several elevations and has no easily identified flow direction. The variety of water level elevations suggests several north to north-east dipping aquifers are encountered. In addition, these are dissected (truncated) by the numerous deep canyons cutting across the area.

The most laterally restricted basalt hydrostratigraphic unit is the SBHU. It consists of highly eroded Saddle Mountains Basalt and Wanapum Basalt displaying limited aerial extent, hosting low production wells and discharging to springs in the upper portions of the sub-basin. Based on the water level data collected for this effort, we generally interpreted that groundwater within the Saddle Mountains part of the aquifer system (SBHU) flows down-dip within Saddle Mountains interflow zones. Generally, this will be to the north and northeast. On the Anatone Plateau and in the Cloverland area, this is away from Asotin Creek and towards Tenmile Creek. The Saddle Mountains aquifer system generally is located much higher than the main canyon bottoms. Consequently any stream flow supported by this system will only be through springs on the canyon walls. This unit is hydrologically connected to surface water but contains only minor volumes of groundwater in the lower portions of the project area, and probably does not contribute significant discharge to streams because of the numerous deep canyons cutting into it in up-dip areas, isolating it from recharge areas at higher elevations.

The IBHU displays characteristics of both the shallow and deep units, depending on location. In the Alpowa Creek and upper Asotin Creek areas, the unit is deeply incised by canyons; aquifers likely display limited lateral continuity, water production is low, and many water-bearing zones discharge to springs in the headwaters areas of these streams. In the Lower Asotin Creek area this unit is generally at or below most canyon bottoms. Given this, the upper portions of the unit may have localized hydrologic connection to streams, while deeper portions of the unit may not be hydrologically connected to surface water.

The DBHU is present well below the creek canyon bottoms. While it may contain laterally widespread and potentially productive aquifers, few wells intersect it and the hydrogeologic properties are relatively unknown. Given the depth of the unit, its degree of hydrologic continuity with surface water is probably very limited in the project area.

There is likely to be little hydraulic connection between the deep DBHU (Grande Ronde) aquifer system and the mainstem Alpowa and Asotin Creek is uncertain. Although some wells have water levels significantly above and below stream levels, the DBHU is over several hundred feet below the canyon bottoms indicating limited hydrologic connection. If there was a large degree of hydrologic connection, wells in and near these deeply incised perennial streams should have water levels close to those seen in the stream, not several hundred ft above or below. In addition, where wells have static levels significantly above and below the creek, the creek should display corresponding gaining and loosing reaches. In the several examples cited earlier in this section, these trends do not appear to be happening. The only exception seems to be Alpowa Creek and in the North Fork Asotin Creek, where there is a consistent increase in groundwater gains into the creek (**Figure 2-24** and **Figure 2-15,** respectively). It is unlikely that the streamflow gains in these areas are from more shallow aquifers. Based on the geologic structure of the DBHU and the fact that the aquifer is located below the bottom of the mainstem creek channels, it is likely that the gains in Alpowa Creek and the upper part of the North and South Fork of Asotin Creek originate from the SHBU and IHBU. The DBHU likely is not in hydrologic connection with the mainstem creeks and discharges in the Lewiston Basin and perhaps the Snake River.

Table 3-1 **Distribution (number) of water wells evaluated for the project by geographic area and hydrostratigraphic unit.**

Sub-Bbasin	Area	Hydrostratigraphic unit						
		A	A+B	SBHU	IBHU	DBHU	SBHU+ IBHU	IBHU+ DBHU
Alpowa	Upland	0	0	0	14	2	0	1
	Valley	0	0	0	4	11	0	1
Asotin	Upland	0	0	105	12	3	0	2
	Valley	0	0	0	6	7	0	5

Table Legend:
A – alluvial hydrostratigraphic unit
B – all basalt
SBHU– shallow basalt hydrostratigraphic unit
IBHU – intermediate basalt hydrostratigraphic unit
DBHU – deep basalt hydrostratigraphic unit

Table 3-2 Wells used in the hydrogeologic evaluation

Well ID	DOE ID	T-R	SECT	Owner Last Name	Ground Elevation (NGVD 29 ft)	TOC Elevation (NGVD 29 ft)	SWL Elevation (NGVD29 ft)	Latitude	Longitude	surf elev (ft amsl)	TOB depth	TOB elev	TD (ft bgs)	TD elev (ft amsl)	surf seal depth	elev seal bottom	open int top depth	elev open int top	open int bottom depth	elev open int bottom	open int dia (in)	pump test type	rate (gpm)	DD (ft)	Temp (F)	upland	valley	QMs	Mvsu	Mvsl	Mvwu	Mvwl	N2	R2	R1	I	Aquifer
ASO0315	369497	T10R45E	21	Hendrickson	1189.5	1191.0	1182.0	46.33002808	-117.1727413	1,190	38	1,152	77	1,113	41	1,149	41	1,149	77	1,113	8	A	25			X							X	X			GRB U
ASO0686	172599	T11R45E	21	Winkler	1144.5	1146.2	811.5	46.41324581	-117.1702578	1,145	8	1,137	400	745	21	1,124	347	798	387	758	6	A	15		55	X							X				GRB U
GAR0133	354601	T11R43E	35	Ledgerwood	2161.4	2162.8	1951.8	46.39355867	-117.3968134	2,161	17	2,144	360	1,801	18	2,143	18	2,143	360	1,801	6	A	4				X							X			GRB U
GAR0419	332798	T11R44E	17	Ledgerwood	1292.9	1294.7	1267.1	46.42693678	-117.3214673	1,293	26	1,267	70	1,223	52	1,241	52	1,241	70	1,223	8	A	150		51		X							X			GRB U
ASO0610	408224	T08R46E	11	Ausman	1464.3	1465.7	1219.3	46.18341969	-117.0059058	1,464	17	1,447	325	1,139	18	1,446	285	1,179	325	1,139	8	A	22		56		X								X		GRBL
ASO0673	168925	T11R45E	30	Joe Wilson	806.8	809.6	757.1	46.40616437	-117.2199596	807	0	807	105	702	23	784	65	742	105	702	6	A	60		50		X								X		GRBL
ASO0284	316468	T09R44E	10		1827.8	1825.0	1821.6	46.27322235	-117.2924516	1,828	39	1,789	172	1,656	39	1,789	39	1,789	172	1,656	6		20	140			X						X				GRBU
ASO0285	159054	T09R44E	3	Koch	1781.0	1782.9	1751.5	46.28022487	-117.2882613	1,781	29	1,752	94	1,687	31	1,750	74	1,707	94	1,687	8	A	15				X						X				GRBU
ASO0302	352056	T10R44E	22	Lynch	2807.2	2807.4	2312.6	46.33614748	-117.2729487	2,807	12	2,795	650	2,157	18	2,789	610	2,197	650	2,157	6	A	10		55	X								X			GRBU
ASO0321	153365	T10R45E	24	Burnam	952.2	953.7	938.3	46.32641294	-117.1102216	952	19	933	76	876	18	934	36	916	76	876	6	A	40				X						X				GRBU
ASO0663	465711	T11R45E	21	Simpson	1399.5	1401.8	818.8	46.41249624	-117.1669388	1,400	26	1,374	660	740	33	1,367	620	780	660	740	8	A	30			X								X			GRBU
GAR0603	418369	T09R46E	5	Hostetler	2243.9	2246.5	1896.5	46.28707409	-117.061267	2,244	25	2,219	425	1,819	75	2,169	385	1,859	425	1,819	6	A	50		55	X								X	X		GRBU-L
GAR0604	353747	T11R43E	19	Ledgerwood	1682.2	1683.9	1648.9	46.4077505	-117.3808309	1,682	22	1,660	80	1,602	18	1,664	25	1,657	80	1,602	8	A	200				X	X									SED
ASO0836	501159	T10R45E	30	Thiessen	1426.0	1427.0	1413.3	46.32146604	-117.2290968	1,426	16	1,410	100	1,326	20	1,406	60	1,366	100	1,326	6	A	3		55		X	X					X				SED-GRBU
ASO0837	501158	T10R44E	25	Thiessen	1496.4	1498.5	1486.7	46.31586384	-117.2432115	1,496	25	1,471	88	1,408	29	1,467	48	1,448	88	1,408	6	A	50		55		X	X					X				SED-GRBU
GAR0134	353746	T11R44E	19	Ledgerwood	1474.5	1476.5	1445.4	46.41481294	-117.3482247	1,475	48	1,427	125	1,350	18	1,457	49	1,426	125	1,350	8	A	250				X	X						X			SED
GAR0420	332806	T11R44E	17	Ledgerwood	1308.5	1304.8	1265.0	46.42990819	-117.3174059	1,309	47	1,262	65	1,244	18	1,291	30	1,279	65	1,244	8	A	500		51		X	X					X				SED
ASO0263	168173	T08R45E	29	Kennedy	3672.4	3673.5	3612.5	46.13835069	-117.1880656	3,672	137	3,535	162	3,510	137	3,535	137	3,535	162	3,510	8	A	150			X				X							SMB
ASO0267	386243	T08R45E	23	Seibly	3549.4	3550.3	3532.2	46.15181495	-117.1431026	3,549	3	3,546	265	3,284	19	3,530	185	3,364	205	3,344	8	A	50		56	X			X	X							SMB
ASO0281	159637	T08R44E	1	Petty	3393.4	3395.0	3258.3	46.20401541	-117.2468484	3,393	8	3,385	192	3,201	18	3,375	152	3,241	192	3,201	6	A	12		50	X			X								SMB
ASO0286	150371	T09R44E	13	Johnson	2759.9	2761.0	2493.0	46.26450391	-117.2483433	2,760	8	2,752	328	2,432	30	2,730	288	2,472	328	2,432	8	A	20			X			X								SMB
ASO0293	160260	T09R45E	33	Hostetler	3091.2	3093.2	2906.6	46.20779756	-117.172525	3,091	6	3,085	275	2,816	19	3,072	19	3,072	275	2,816	6					X			X	X							SMB
ASO0294	160260	T09R44E	25	Parsons	3192.8	3193.8	3008.3	46.22552627	-117.2519735	3,193	3	3,190	192	3,001	19	3,174	186	3,007	196	2,997	6	A	60			X				X							SMB
ASO0299	256928	T11R43E	34	Ledgerwood	1870.7	1872.7	1834.1	46.39833835	-117.4108701	1,871	32	1,839	80	1,791	18	1,853	55	1,816	80	1,791	6	A	35				X			X							SMB
ASO0565	171985	T07R45E	5	Allen	4036.8	4038.1	3992.6	46.11259987	-117.2073862	4,037	0	4,037	116	3,921	18	4,019	96	3,941	116	3,921	6	A	30		51	X				X							SMB
ASO0571	436205	T07R45E	10	Keith	3875.9	3873.9	3832.8	46.10128827	-117.1503112	3,876	7	3,869	144	3,732	18	3,858	124	3,752	144	3,732	8	A	20			X			X								SMB
ASO0624	410867	T08R45E	26	Scheibe	3544.6	3546.9	3465.4	46.14098299	-117.1239297	3,545	1	3,544	260	3,285	20	3,525	220	3,325	260	3,285	6	A	4			X				X							SMB
ASO0649	475420	T10R45E	2	Hollenbeck	1411.6	1412.4	1263.1	46.37717212	-117.1243168	1,412	8	1,404	160	1,252	18	1,394	150	1,262	160	1,252	6	A	20		56	X				X							SMB
ASO0672	497571	T11R45E	34	Gittens	1683.9	1684.9	1442.0	46.38212928	-117.1510078	1,684	5	1,679	253	1,431	19	1,665	213	1,471	253	1,431	8	A	12		59	X				X							SMB
ASO0682	499034	T10R45E	2	Knapp	1637.1	1638.7	1442.0	46.38126259	-117.1431393	1,637	13	1,624	320	1,317	18	1,619	270	1,367	320	1,317	8	A	30		52	X				X	X						SMB
ASO0805	driller log	T09R44E	11	Greene	2751.2	2751.0	2589.0	46.27176179	-117.2619613	2,751	25	2,726	170	2,581	18	2,733	40	2,711	170	2,581	6		15			X			X								SMB
ASO0824	driller log	T10R45E	2	Wolff	1454.5	1455.8	1295.8	46.37942626	-117.1303386	1,455	13	1,442	222	1,233	19	1,436	202	1,253	222	1,233	8	A	30		52	X				X							SMB
ASO0825	491116	T08R45E	32	Andrews	3957.9	3958.4	3907.0	46.12041651	-117.1978618	3,958	7	3,951	108	3,850	18	3,940	68	3,890	108	3,850	6	A	5		51	X			X								SMB
ASO0826	422891	T07R45E	6	Ausman	4131.6	4133.8	4071.2	46.11274871	-117.2187256	4,132	2	4,130	150	3,982	19	4,113	130	4,002	150	3,982	6					X			X								SMB
ASO0830	442449	T09R44E	25	Parsons	3001.1	3003.3	2862.8	46.23039244	-117.2439308	3,001	7	2,994	157	2,844	18	2,983	142	2,859	157	2,844	6	A	60			X				X							SMB
ASO0305	254155	T10R45E	2	Wolff	1453.1	1454.8	1282.8	46.3793873	-117.1288389	1,453	6	1,447	325	1,128	40	1,413	163	1,290	325	1,128	6	A	10		54	X				X	X						SMB-W
ASO0651	497580	T10R45E	2	Lillard	1578.3	1579.1	1449.3	46.38180771	-117.1402545	1,578	3	1,575	203	1,375	18	1,560	163	1,415	203	1,375	8	A	12		60	X			X	X	X						SMB-W
ASO0670	501166	T10R45E	2	Parks	1414.4	1414.7	918.7	46.37991524	-117.1275506	1,414	7	1,407	641	773	18	1,396	611	803	641	773	8	A	10		55	X				X	X	X					SMB-W
ASO0683	446917	T11R45E	34	Zembas	1691.2	1692.1	1476.8	46.38369077	-117.1542088	1,691	2	1,689	340	1,351	38	1,653	260	1,431	340	1,351	8	A	15		52	X			X	X	X						SMB-W
ASO0838	336655	T11R45E	35	Dyer	1516.4	1517.3	1159.5	46.38992914	-117.1243747	1,516	20	1,496	375	1,141	18	1,498	350	1,166	380	1,136	6	A	20			X				X	X						SMB-W
ASO0344	381870	T10R46E	28	Bausch	1706.9	1707.9	1187.8	46.32309509	-117.0424991	1,707	8	1,699	750	957	18	1,689	700	1,007	750	957	8	A	2		56	X						X					W
ASO0563	432600	T07R45E	10	Fowler	3975.7	3977.2	3878.4	46.09550552	-117.1539615	3,976	44	3,932	225	3,751	30	3,946	131	3,845	225	3,751	6		22			X						X					W
ASO0690	408208	T10R45E	2	Parks	1383.7	1385.7	1272.5	46.3808003	-117.129702	1,384	14	1,370	175	1,209	18	1,366	175	1,209	175	1,209	6	A	15		56	X					X						W
ASO0801	driller log	T09R46E	4	Hostetler	2167.9	2169.4	1747.4	46.29377489	-117.0468503	2,168	7	2,161	520	1,648	18	2,150	420	1,748	520	1,648	8	A	4			X						X					W
ASO0827	375945	T11R45E	35	Allen	1495.1	1496.1	931.3	46.39139732	-117.1228969	1,495	6	1,489	765	730	19	1,476	765	730	765	730	8	A	25		59	X					X						W
ASO0834	442452	T09R46E	8	Hammrich	2360.9	2361.6	2009.1	46.27515176	-117.0596963	2,361	0	2,361	605	1,756	18	2,343	585	1,776	595	1,766	8	A	2			X						X					W

Open interval hydrostratigraphic unit

SEDS	suprabasalt sedimtn
SMB	Saddle Mountains Basalt
W	Wanapum Basalt
GRBU	Grande Ronde Basalt - upper
GRBL	Grande Ronde Basalt - lower

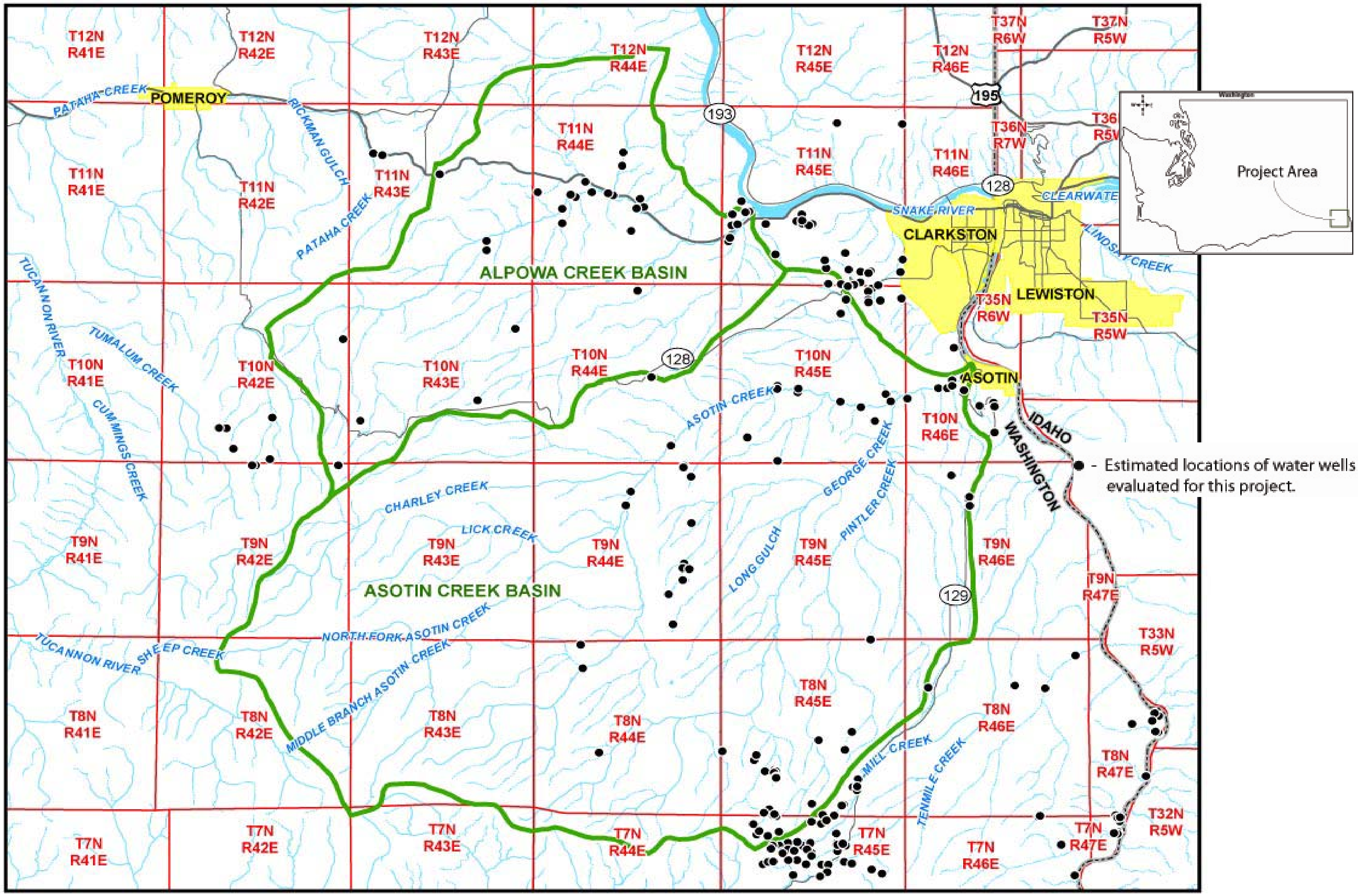


Figure 3-1 Geographic setting of the project area

Figure 3-2 Photograph of the deep, relatively dry canyons typical of the lower portions of the project area View is generally south across the lower George Creek canyon.

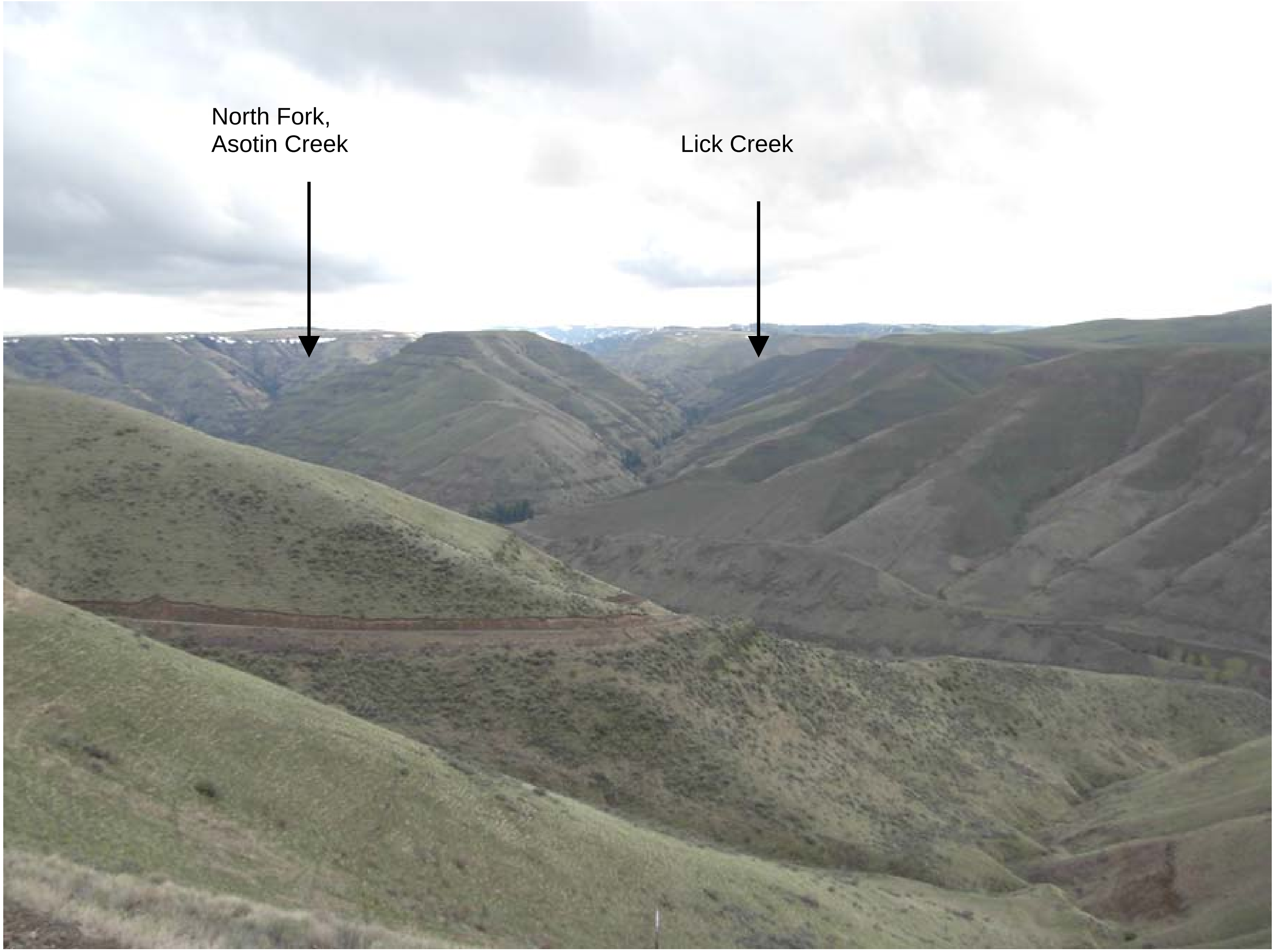


Figure 3-3 Photograph looking up the Asotin Creek drainage towards the Blue Mountain in the distance View looking west from the top of Campbell Grade.

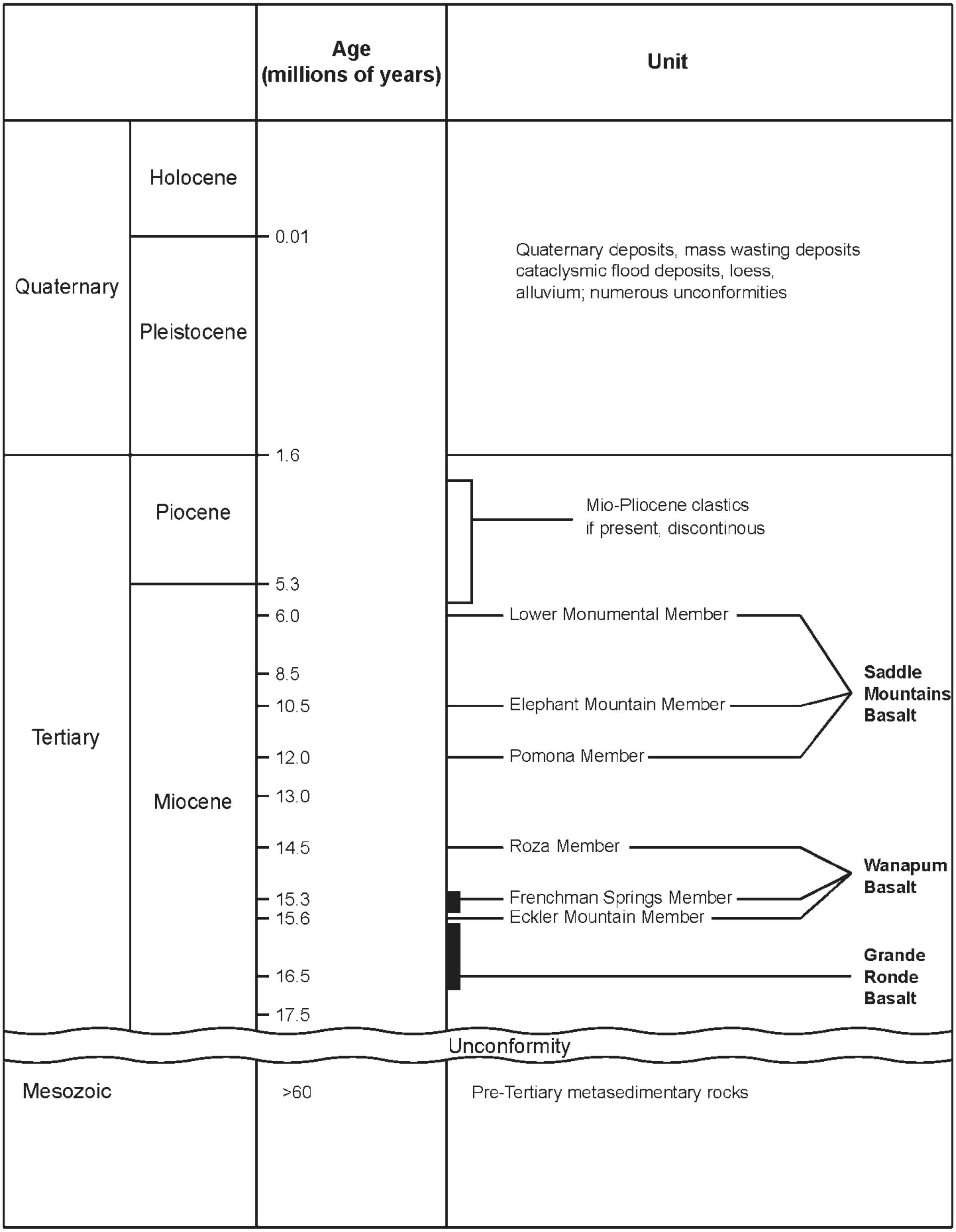
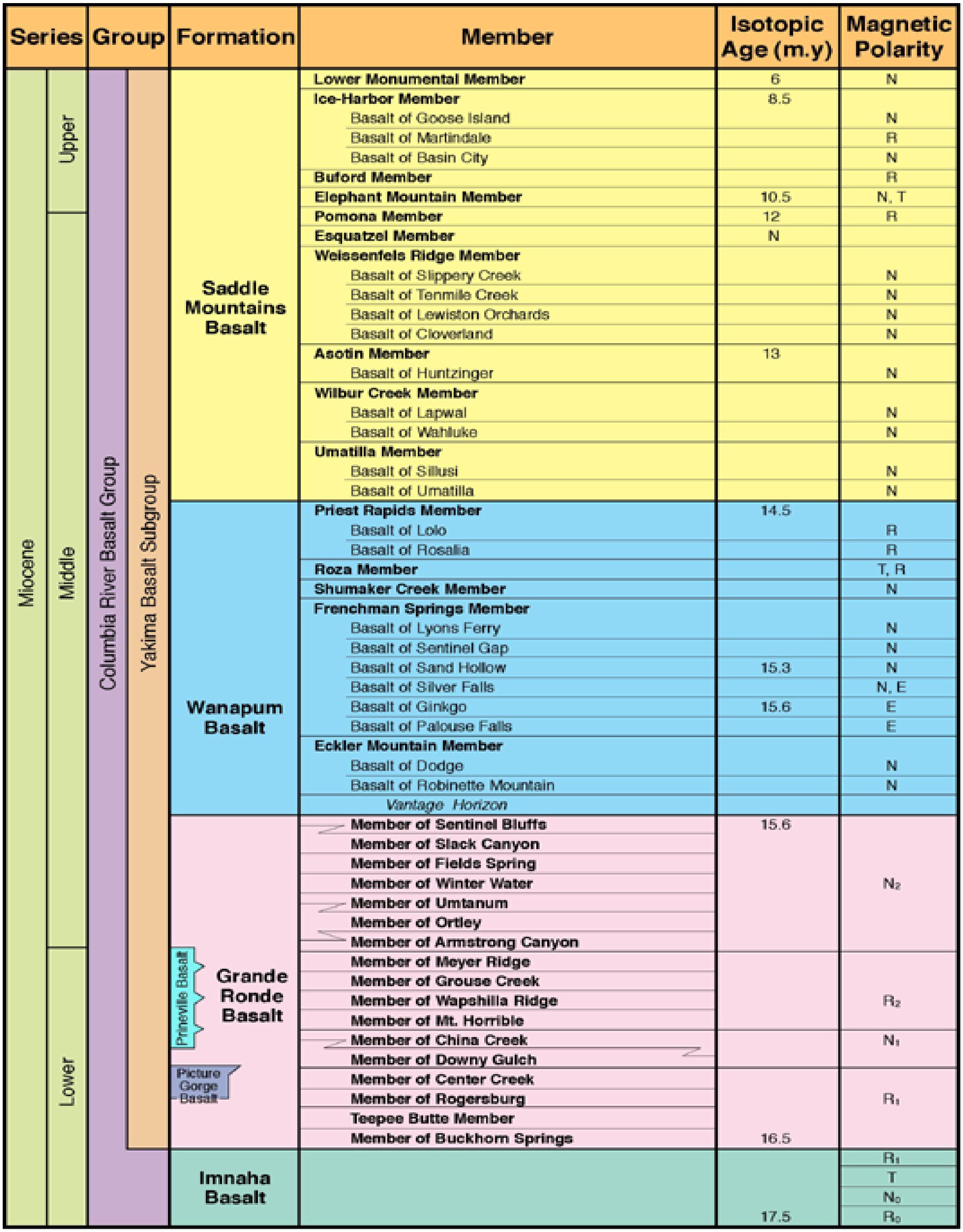


Figure 3-4 General stratigraphic chart for project area



Series		Group		Formation	Member	Isotopic Age (m.y)	Magnetic Polarity
Miocene	Upper	Columbia River Basalt Group	Yakima Basalt Subgroup	Saddle Mountains Basalt	**Lower Monumental Member**	6	N
					Ice-Harbor Member	8.5	
					Basalt of Goose Island		N
					Basalt of Martindale		R
					Basalt of Basin City		N
					Buford Member		R
					Elephant Mountain Member	10.5	N, T
	Middle				**Pomona Member**	12	R
					Esquatzel Member	N	
					Weissenfels Ridge Member		
					Basalt of Slippery Creek		N
					Basalt of Tenmile Creek		N
					Basalt of Lewiston Orchards		N
					Basalt of Cloverland		N
					Asotin Member	13	
					Basalt of Huntzinger		N
					Wilbur Creek Member		
					Basalt of Lapwai		N
					Basalt of Wahluke		N
					Umatilla Member		
					Basalt of Sillusi		N
					Basalt of Umatilla		N
				Wanapum Basalt	**Priest Rapids Member**	14.5	
					Basalt of Lolo		R
					Basalt of Rosalia		R
					Roza Member		T, R
					Shumaker Creek Member		N
					Frenchman Springs Member		
					Basalt of Lyons Ferry		N
					Basalt of Sentinel Gap		N
					Basalt of Sand Hollow	15.3	N
					Basalt of Silver Falls		N, E
					Basalt of Ginkgo	15.6	E
					Basalt of Palouse Falls		E
					Eckler Mountain Member		
					Basalt of Dodge		N
					Basalt of Robinette Mountain		N
					Vantage Horizon		
				Grande Ronde Basalt Prineville Basalt Picture Gorge Basalt	**Member of Sentinel Bluffs**	15.6	N_2
					Member of Slack Canyon		
					Member of Fields Spring		
					Member of Winter Water		
					Member of Umtanum		
					Member of Ortley		
					Member of Armstrong Canyon		
	Lower				**Member of Meyer Ridge**		R_2
					Member of Grouse Creek		
					Member of Wapshilla Ridge		
					Member of Mt. Horrible		
					Member of China Creek		N_1
					Member of Downy Gulch		
					Member of Center Creek		R_1
					Member of Rogersburg		
					Teepee Butte Member		
					Member of Buckhorn Springs	16.5	
				Imnaha Basalt			R_1
							T
							N_0
						17.5	R_0

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Figure 3-5 Detailed stratigraphic chart for the Columbia River Basalt Group

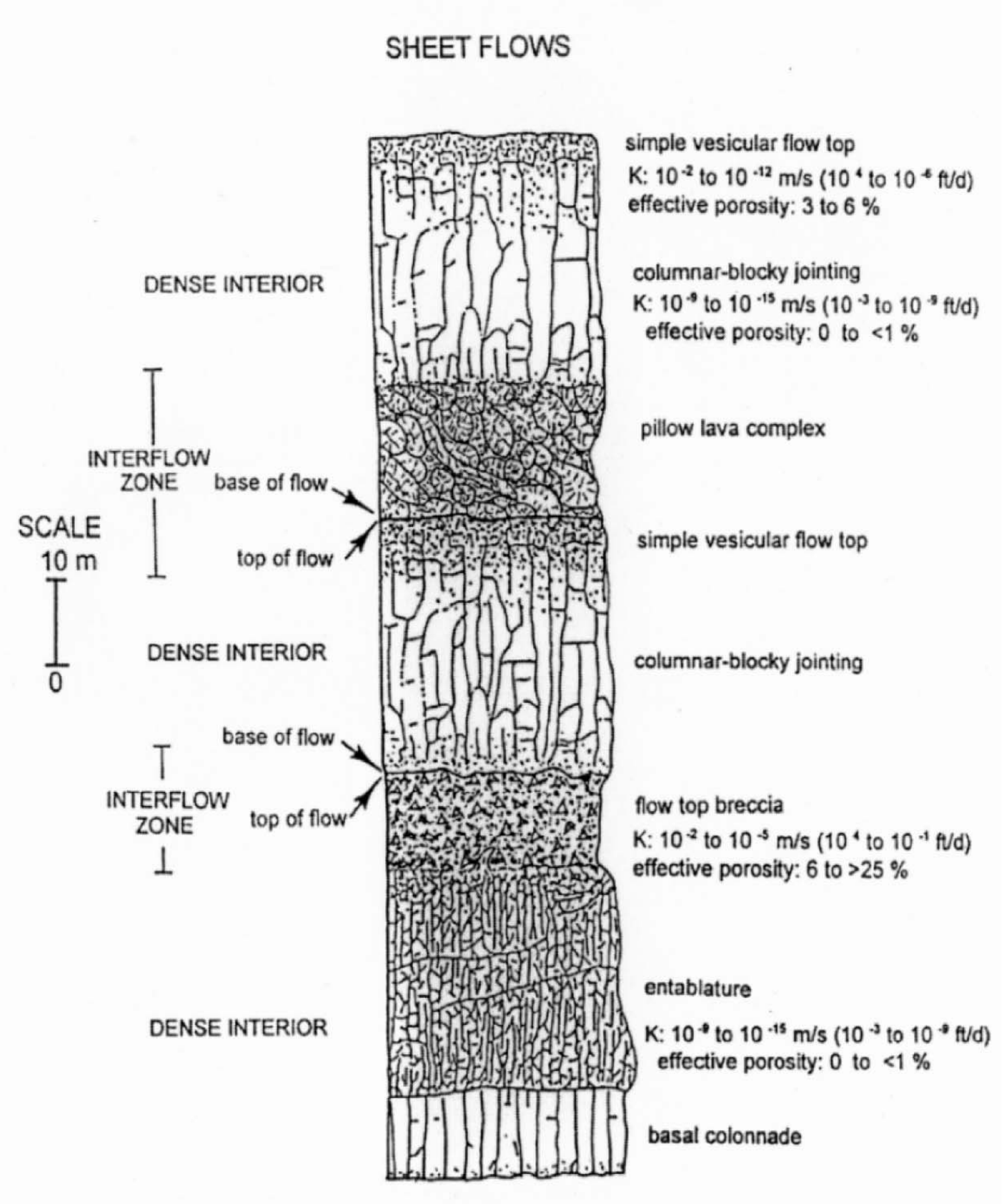


Figure 3-6 Basic interflow structure typical of CRBG sheet flows

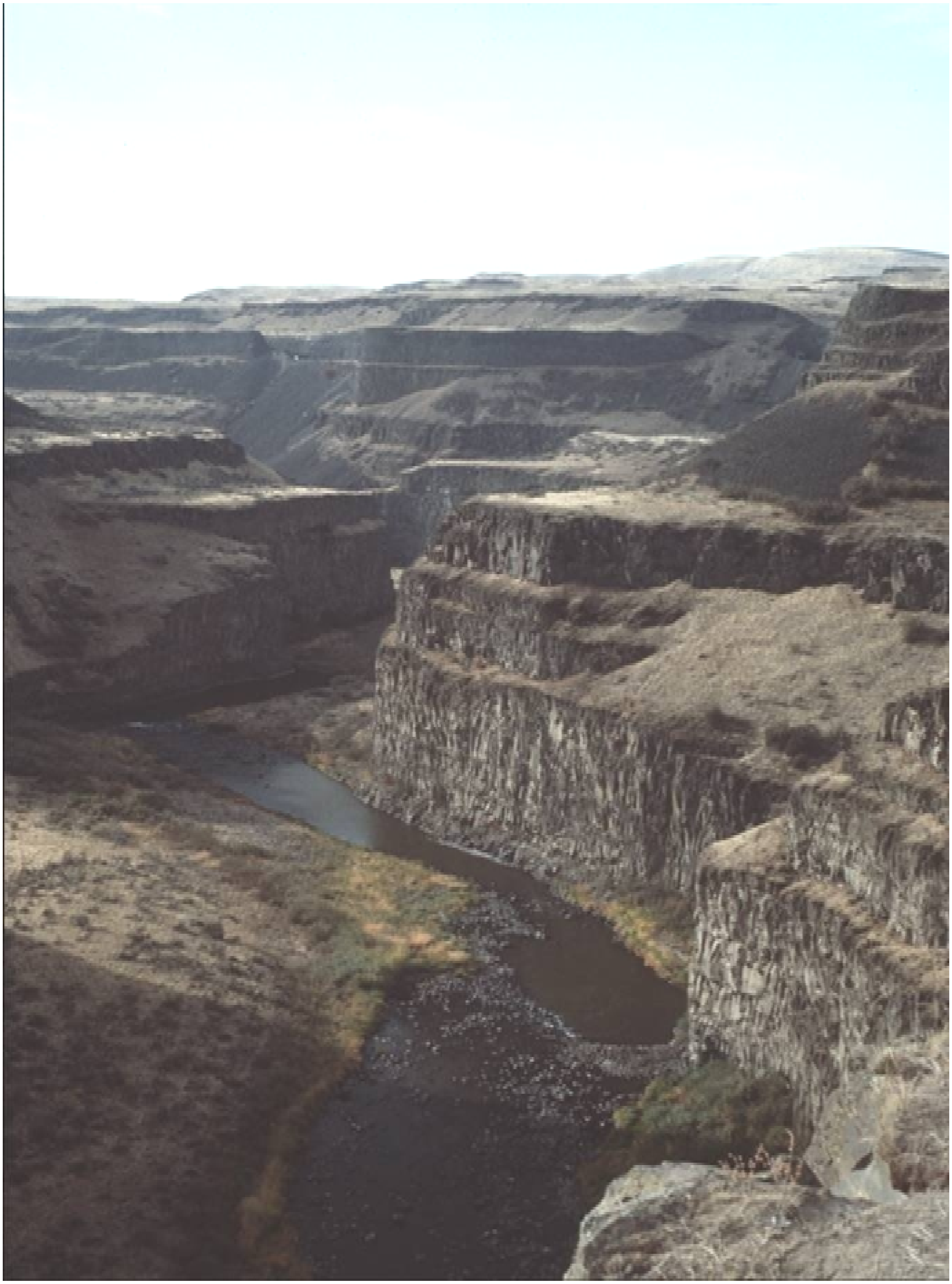


Figure 3-7 Photograph of the lower Palouse River canyon showing the layered nature of multiple, stacked CRBG flows

Most of the benches seen on the canyon walls mark interflow zones.

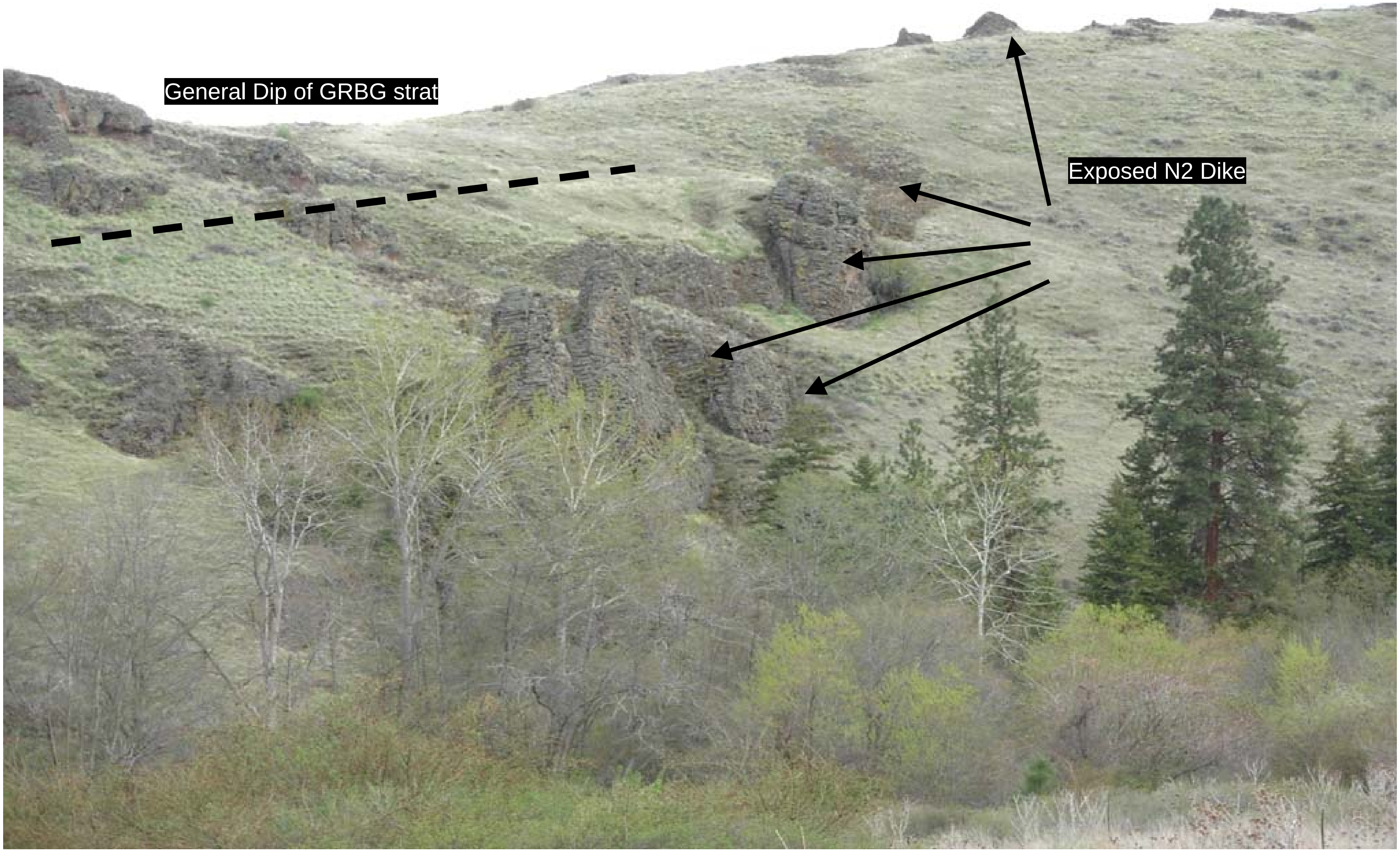


Figure 3-8 N2 Grande Ronde Basalt feeder dike cross-cutting older, sub-horizontal CRBG units. View generally is looking west across lower North Fork, Asotin Creek.

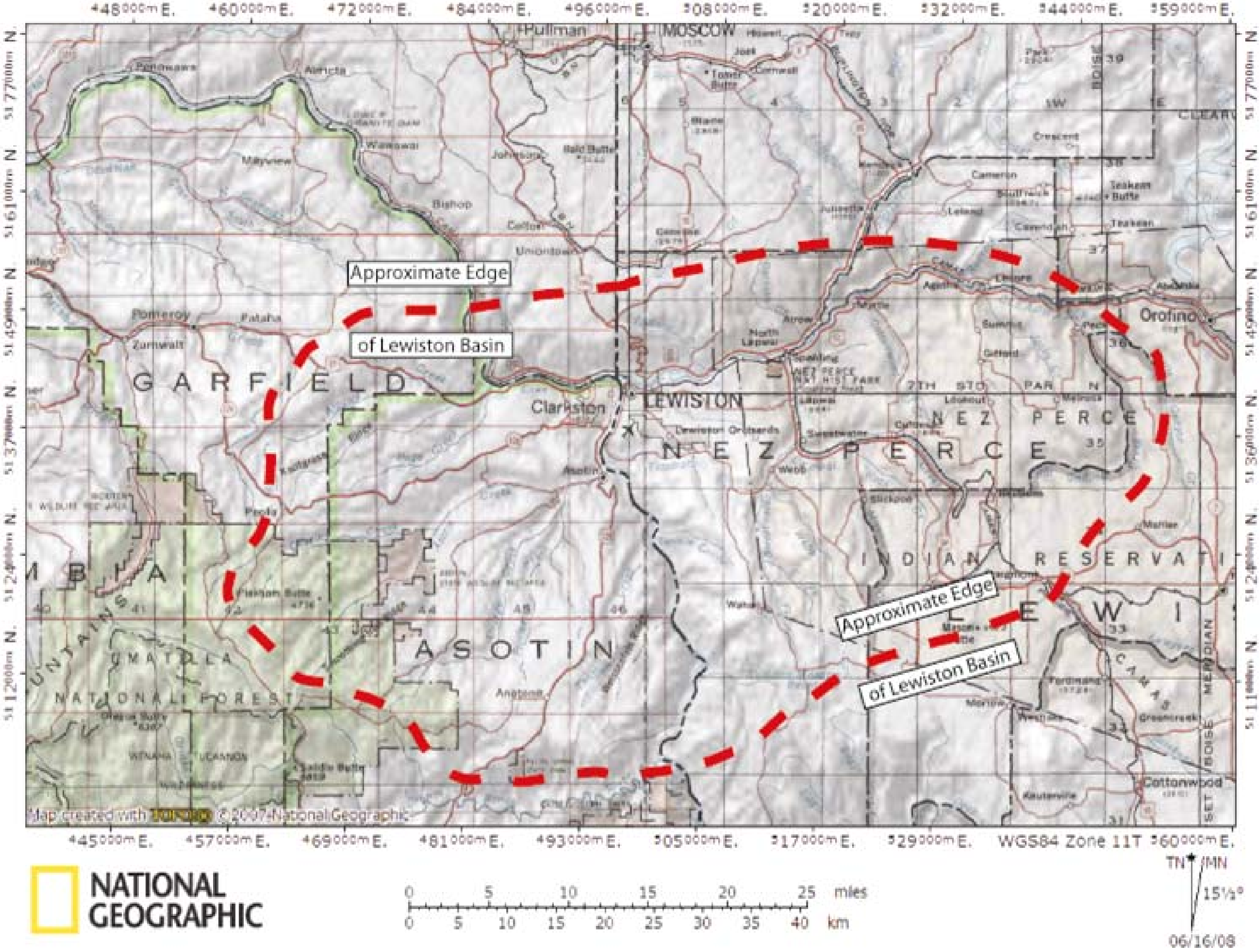


Figure 3-9 Approximate extent of the Lewiston Basin

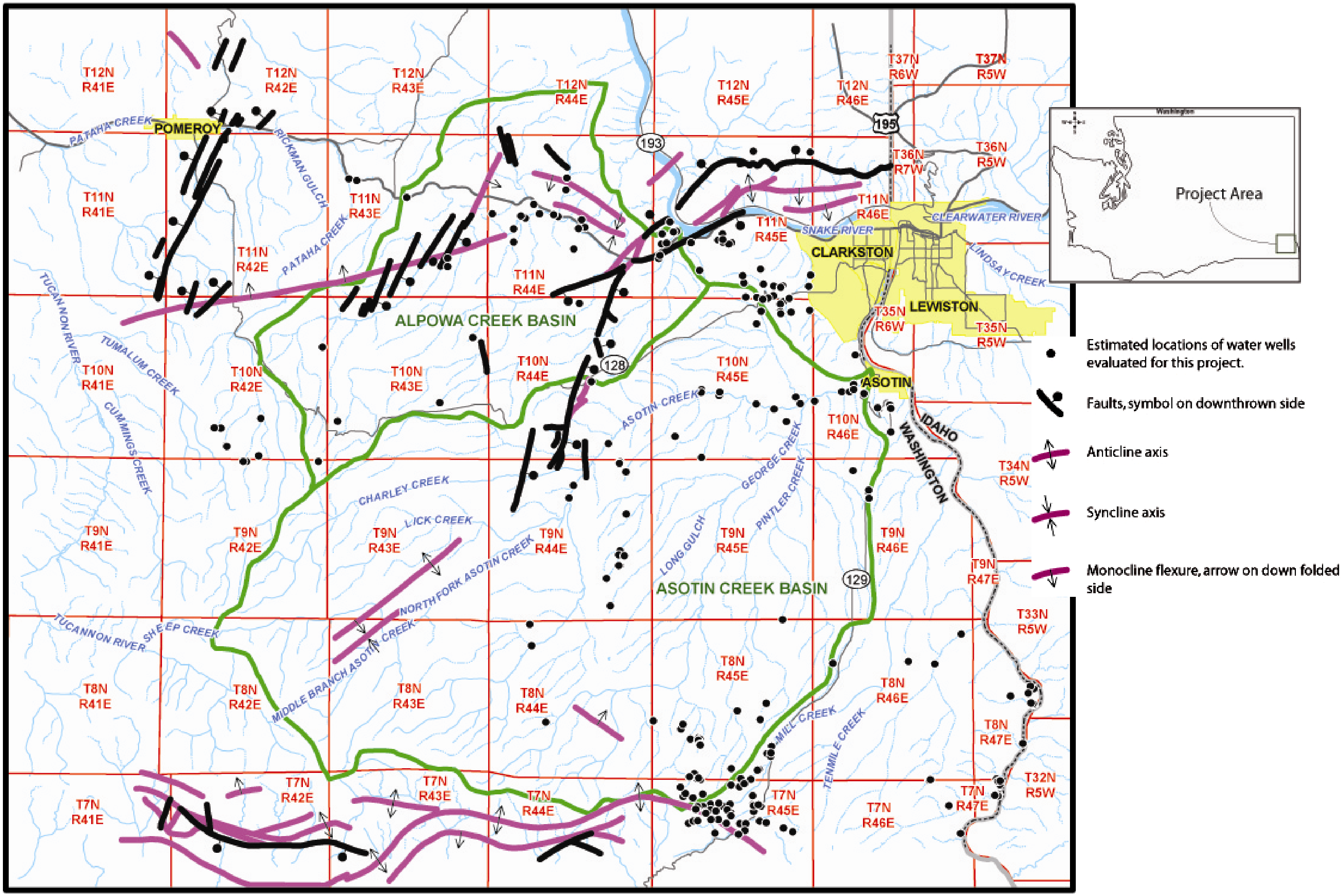


Figure 3-10 Basic Geologic Structures In The Project Area

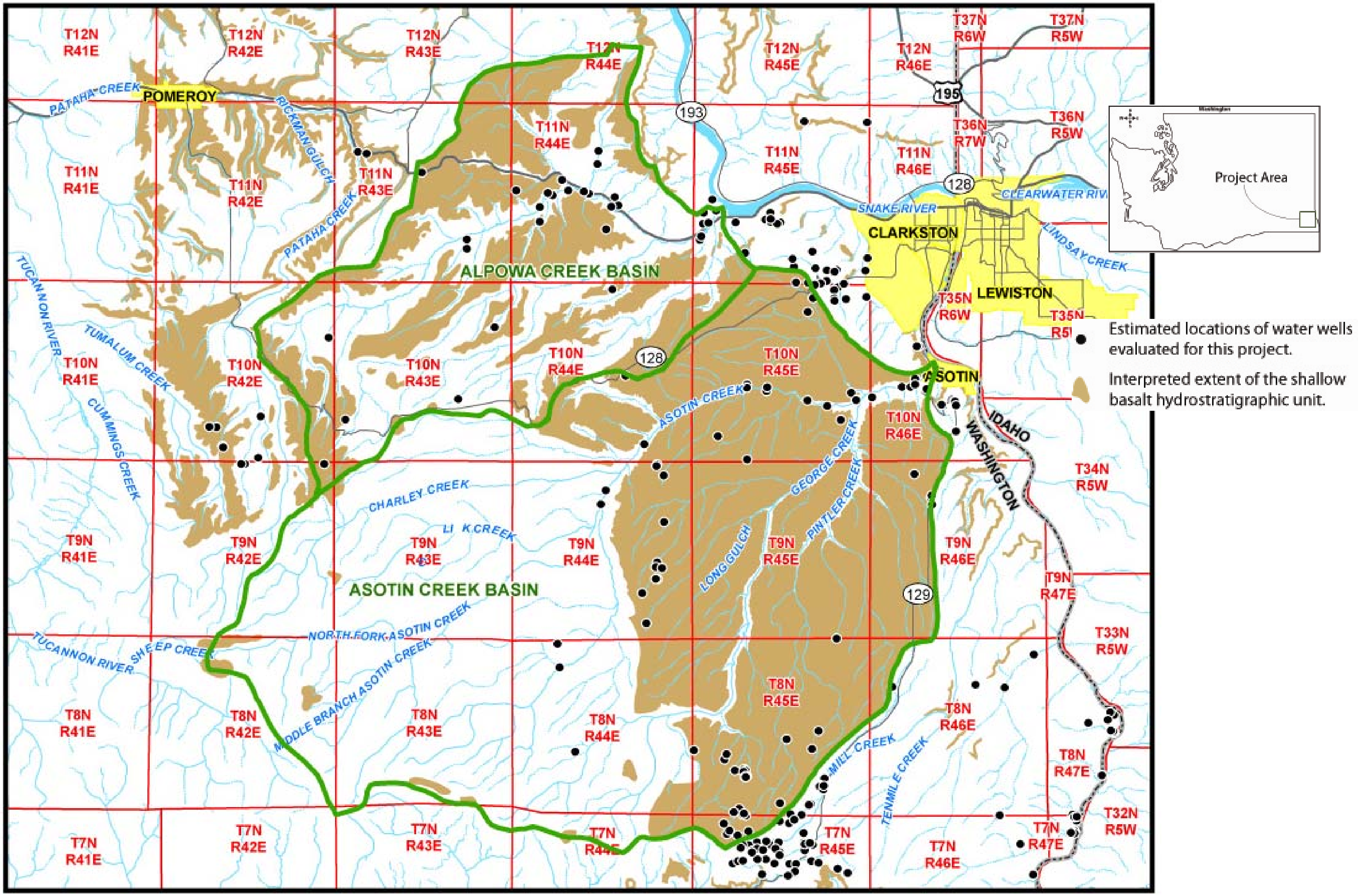


Figure 3-11 Map showing the estimated extent of the shallow basalt hydrostratigraphic unit in the Project Area Note, the unit is absent from the bottom of most canyons, being completely eroded through.

Figure 3-12 Photograph looking south, up the George Creek near its confluence with Asotin Creek
This photograph shows the highly dissected nature of the shallow basalt hydrostratigraphic unit and the limited lateral continuity of any water bearing interflow zones in it. The top of the Grande Ronde Basalt and the intermediate hydrostratigraphic unit lies near the bottom on the canyon.

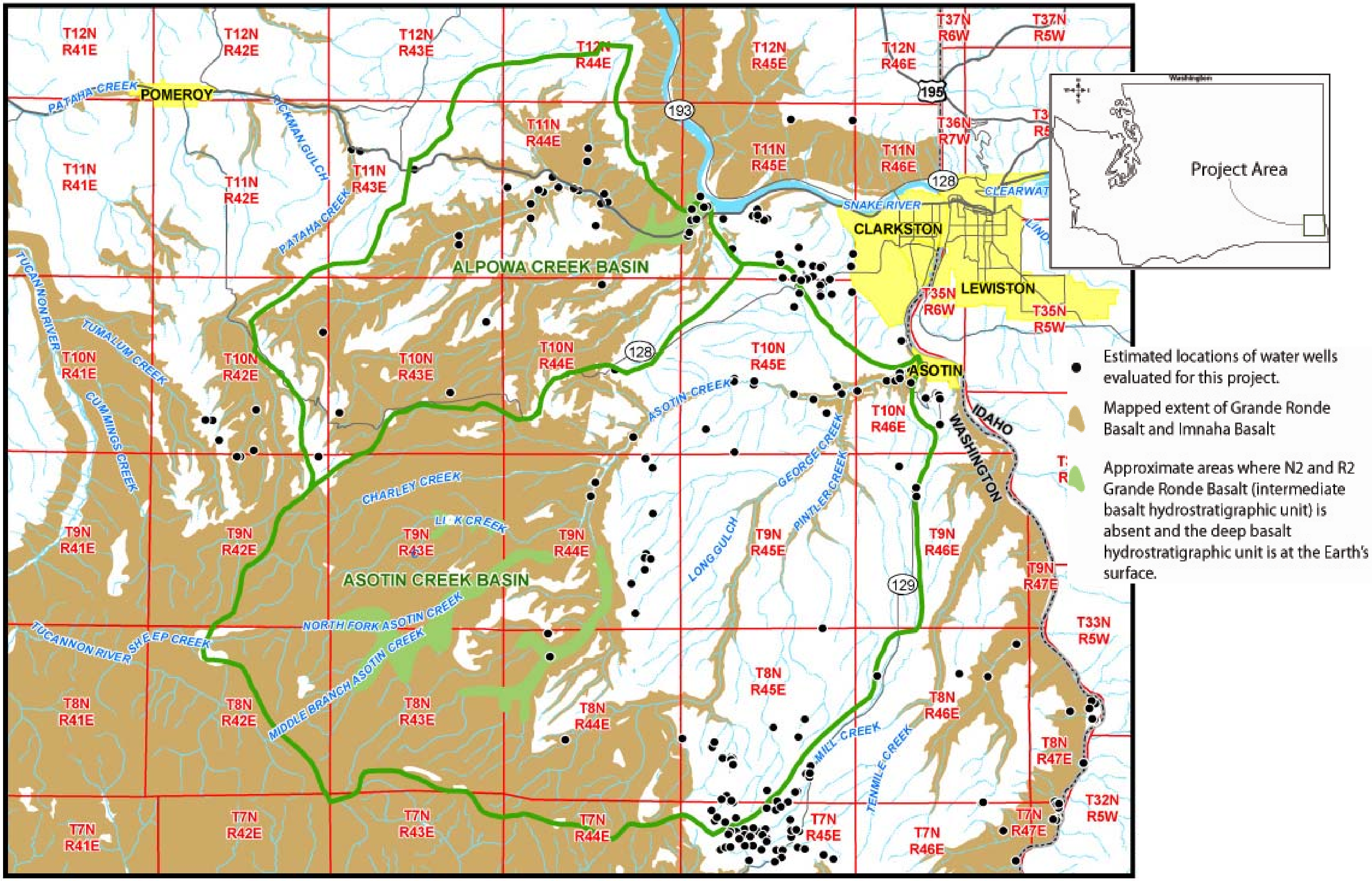


Figure 3-13 Map showing the mapped extent of the Grande Ronde Basalt and the Imanha Basalt at the Earth's surface in the project area.

These units, and the intermediate and deep basalt hydrostratigraphic units hosted by them, underlie the entire project area except as shown on the map.

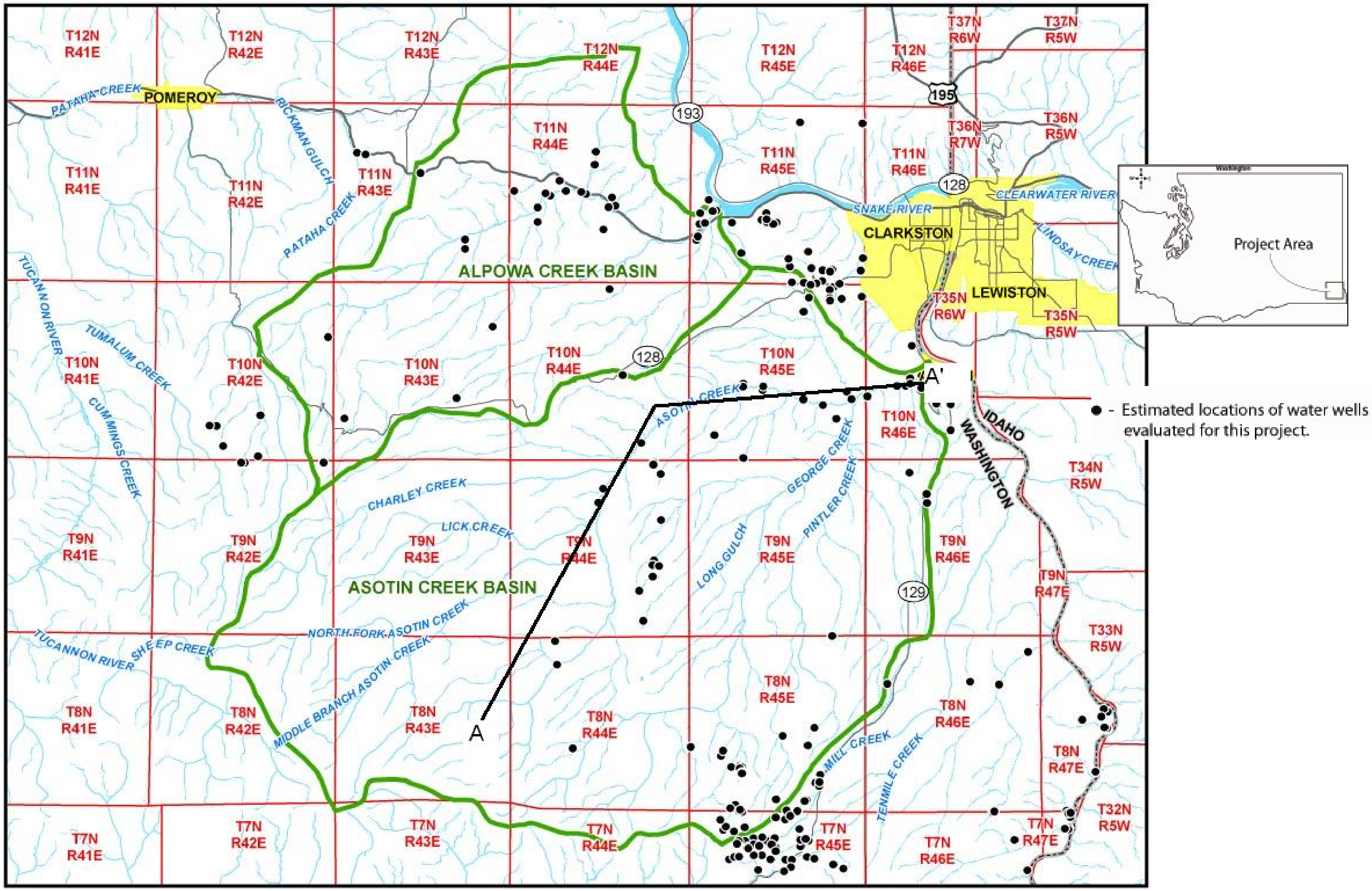


Figure 3-14 Map showing location of cross section A-A’

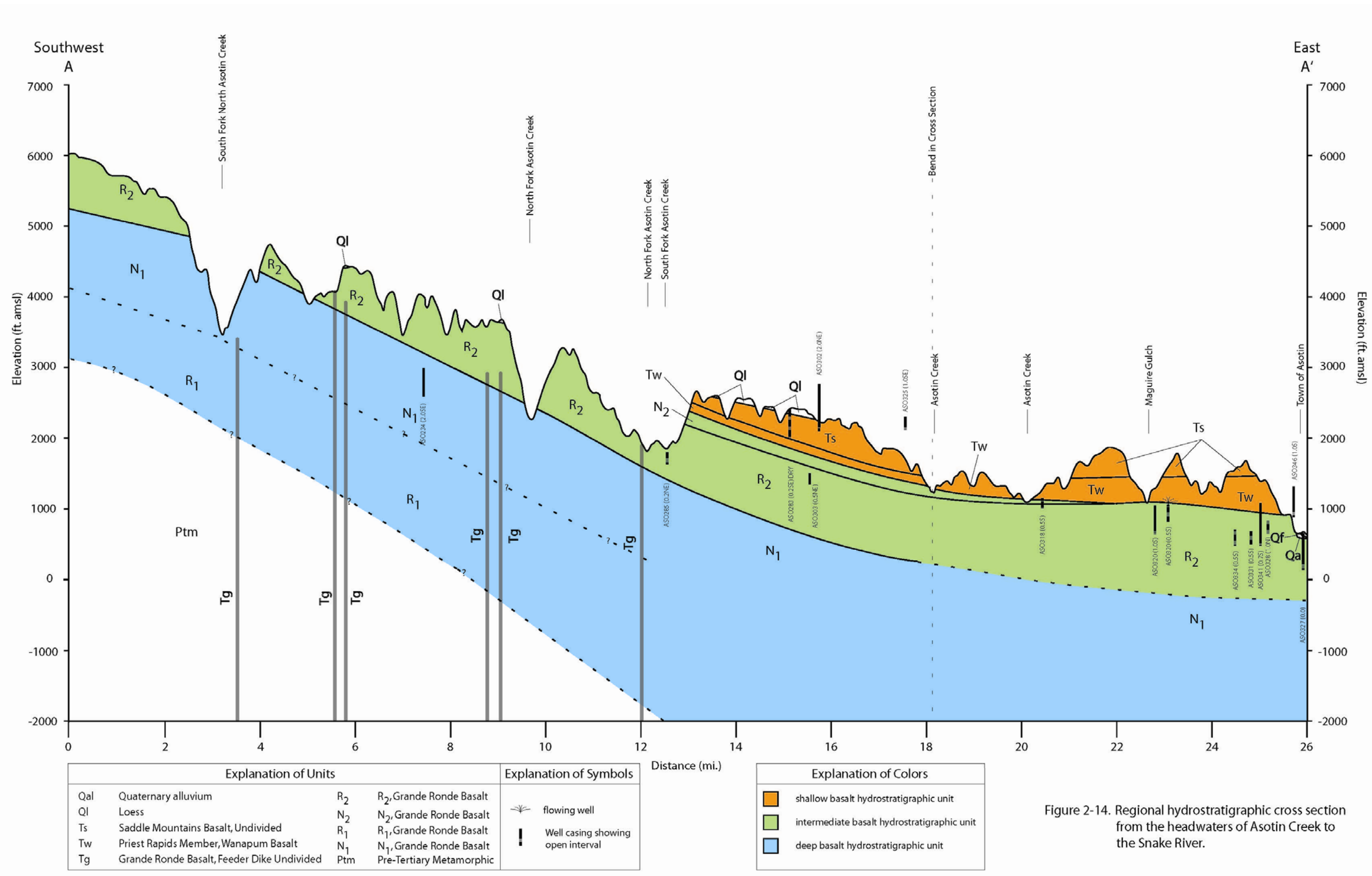


Figure 3-15 Hydrogeologic Cross-Section A-A' In The Asotin Creek Sub-Basin

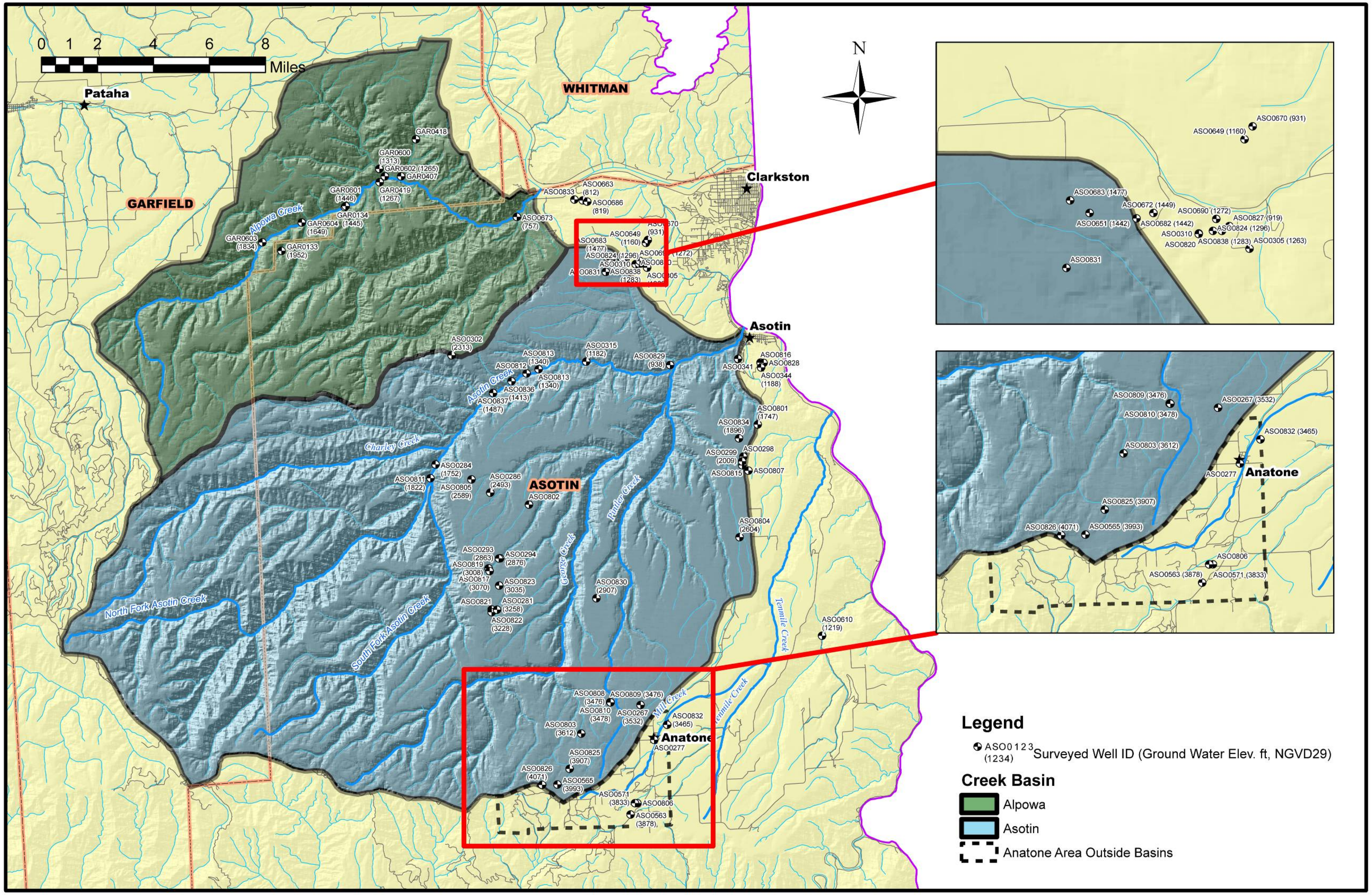


Figure 3-16 Location and ground water elevation (ft, NGVD 29) of surveyed wells

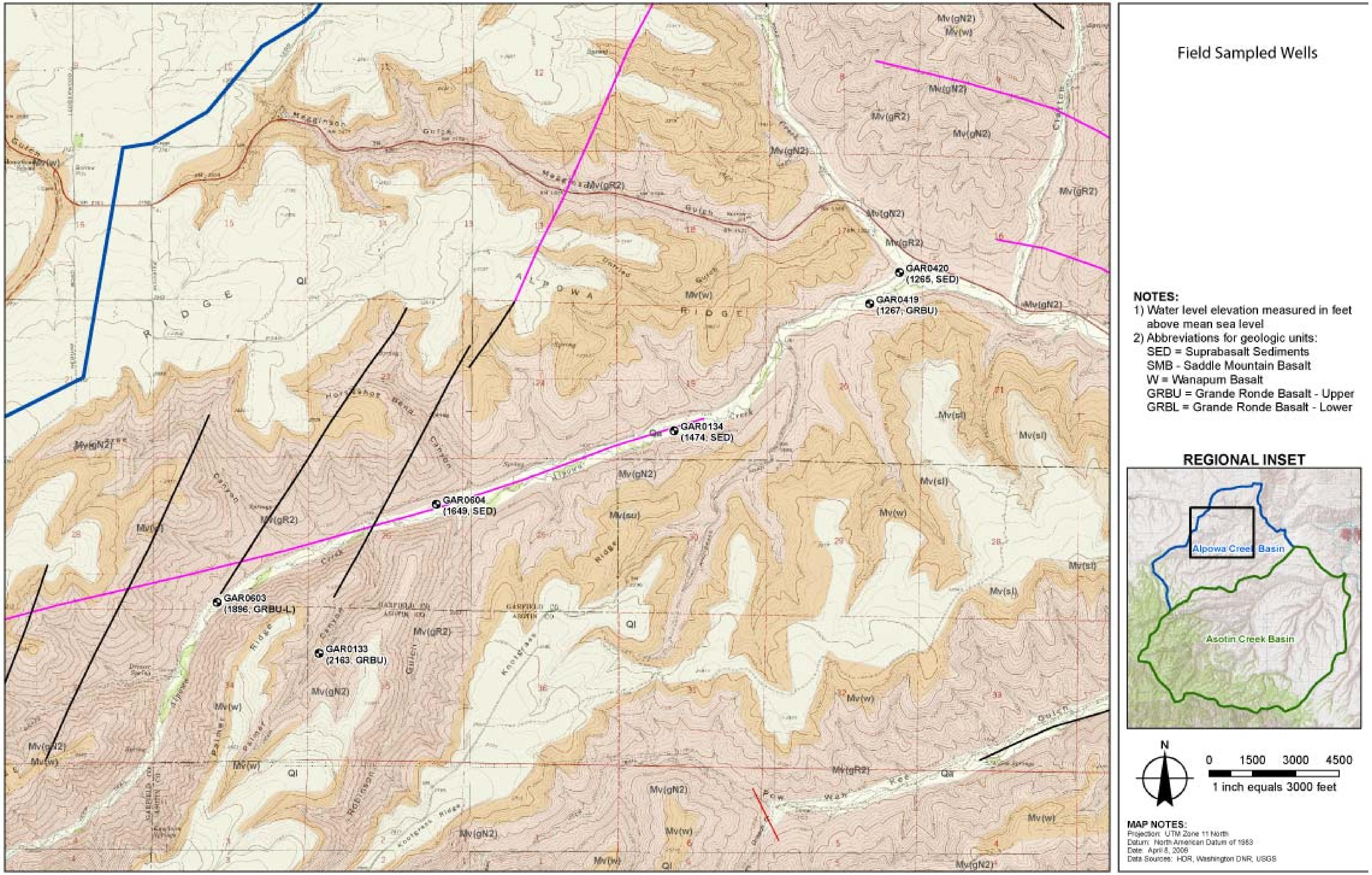
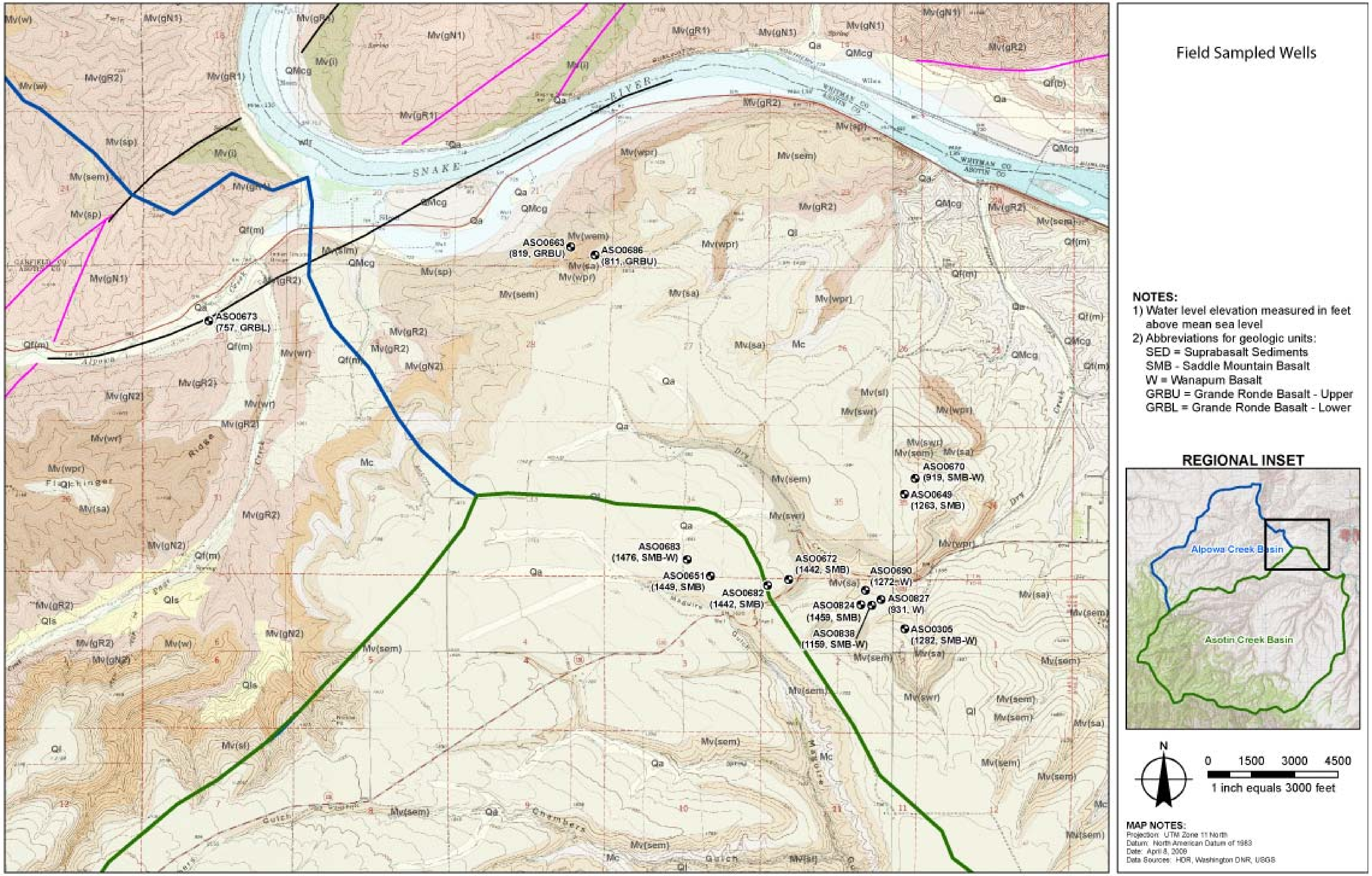


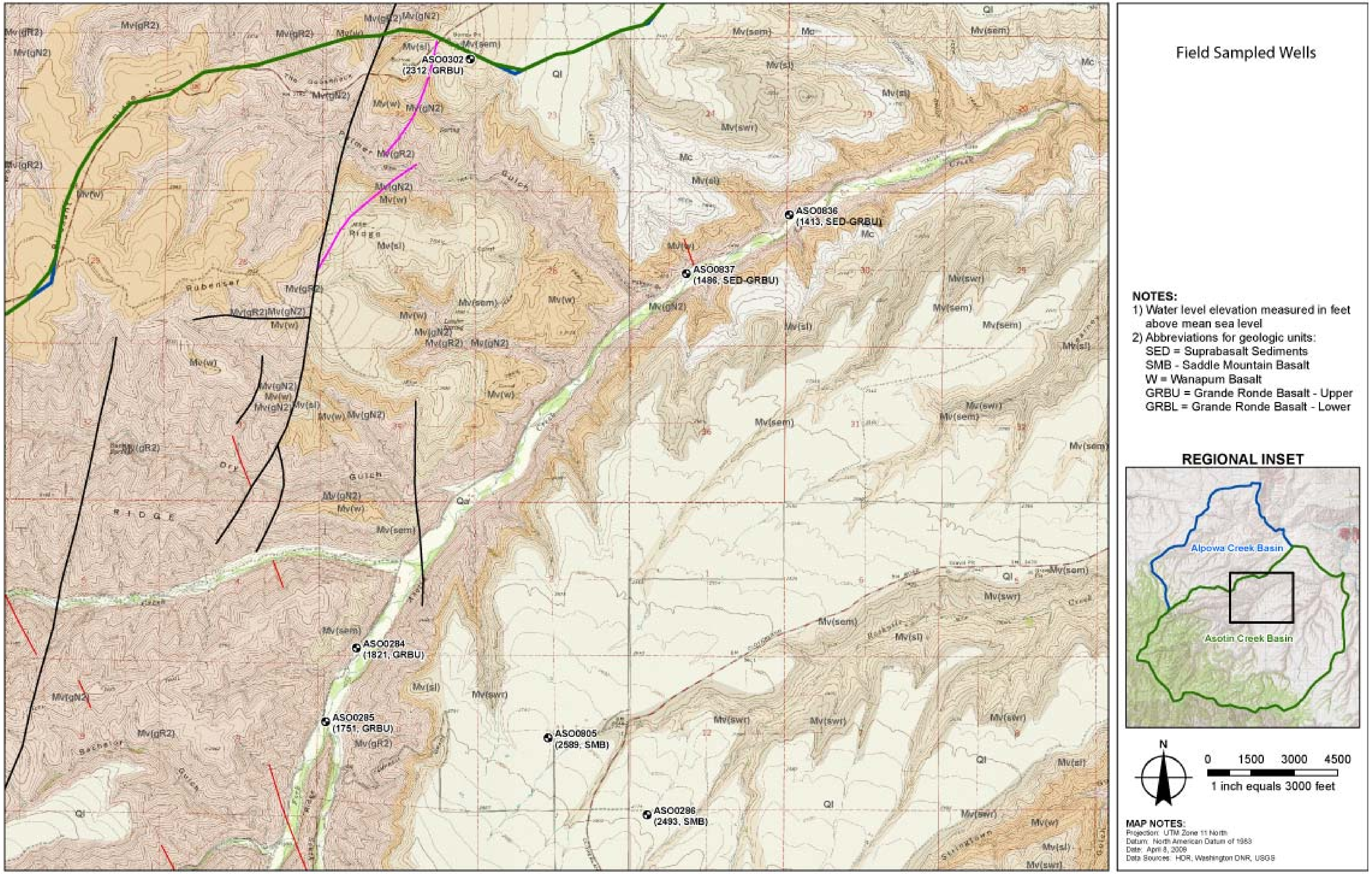
Figure 3-17 Ground water levels and hydrostratigraphy in Upper Alpowa Creek



NOTES:
1) Water level elevation measured in feet above mean sea level
2) Abbreviations for geologic units:
SED = Suprabasalt Sediments
SMB - Saddle Mountain Basalt
W = Wanapum Basalt
GRBU = Grande Ronde Basalt - Upper
GRBL = Grande Ronde Basalt - Lower

MAP NOTES:
Projection: UTM Zone 11 North
Datum: North American Datum of 1983
Date: April 8, 2009
Data Sources: HDR, Washington DNR, USGS

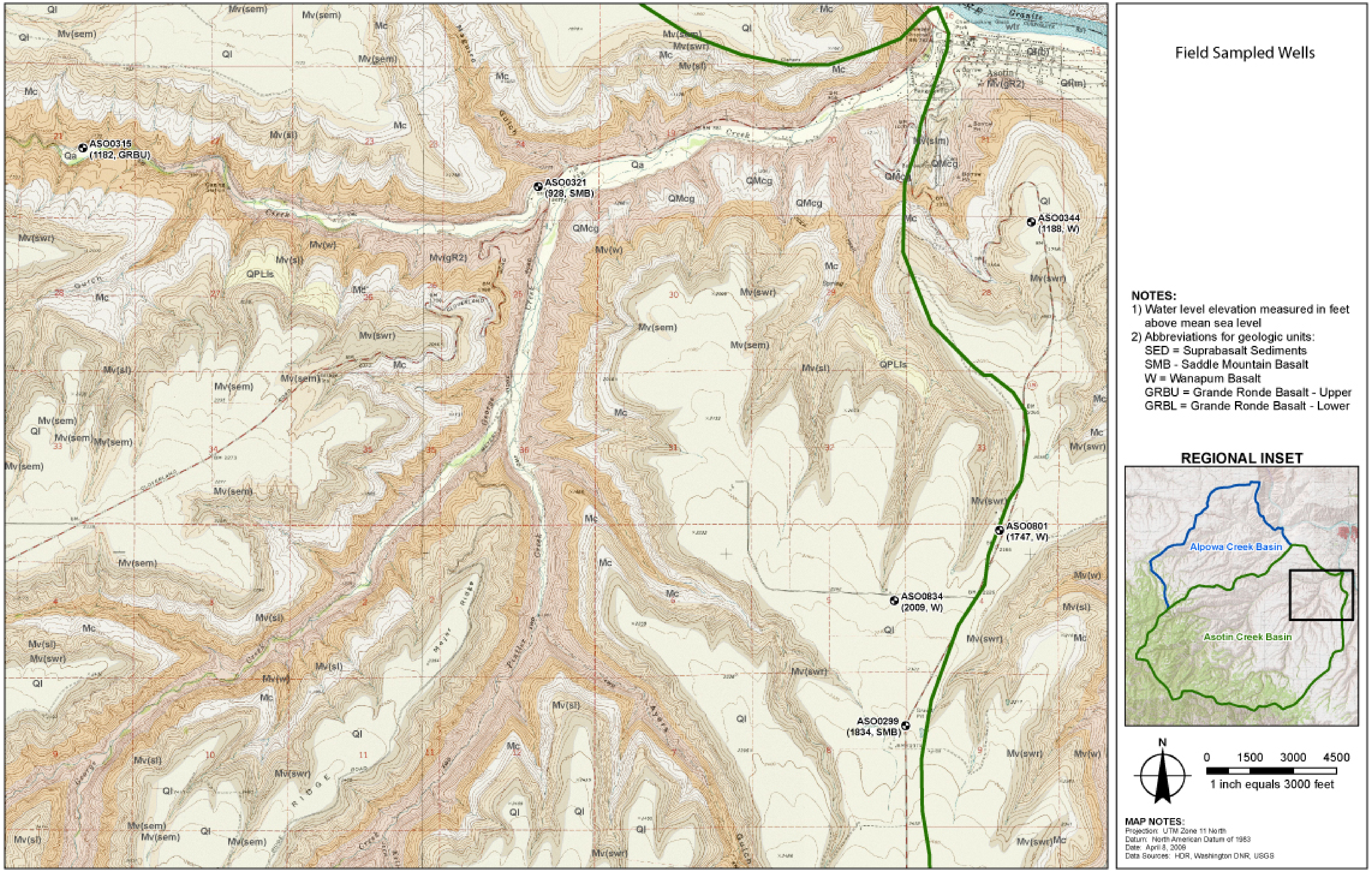
Figure 3-18 Ground water levels and hydrostratigraphy in Clarkston Heights and lower Alpowa Creek



NOTES:
1) Water level elevation measured in feet above mean sea level
2) Abbreviations for geologic units:
SED = Suprabasalt Sediments
SMB - Saddle Mountain Basalt
W = Wanapum Basalt
GRBU = Grande Ronde Basalt - Upper
GRBL = Grande Ronde Basalt - Lower

MAP NOTES:
Projection: UTM Zone 11 North
Datum: North American Datum of 1983
Date: April 8, 2009
Data Sources: HDR, Washington DNR, USGS

Figure 3-19 Ground water levels and hydrostratigraphy in upper Asotin Creek below the forks



Field Sampled Wells

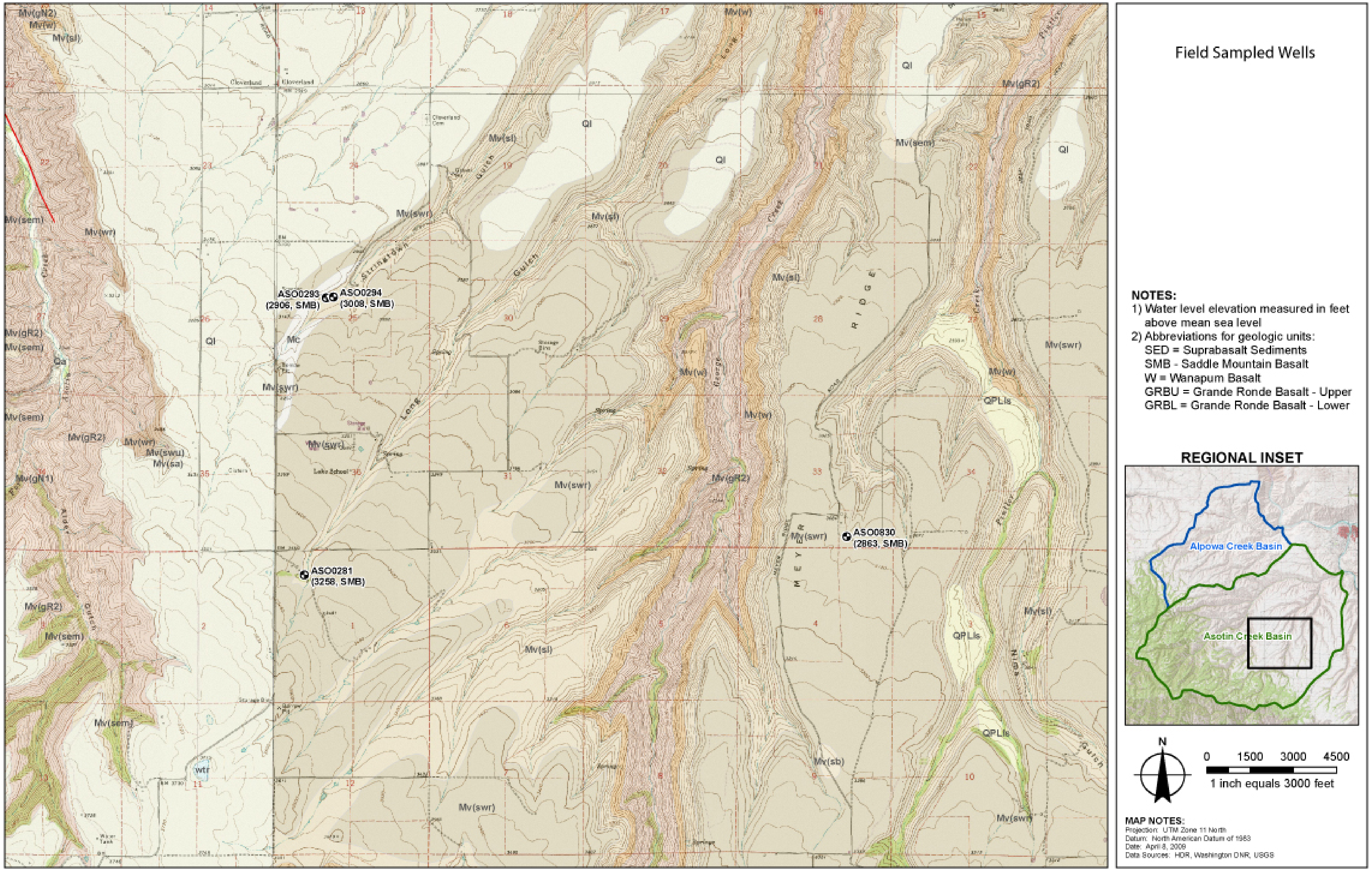
NOTES:
1) Water level elevation measured in feet above mean sea level
2) Abbreviations for geologic units:
SED = Suprabasalt Sediments
SMB - Saddle Mountain Basalt
W = Wanapum Basalt
GRBU = Grande Ronde Basalt - Upper
GRBL = Grande Ronde Basalt - Lower

REGIONAL INSET

1 inch equals 3000 feet

MAP NOTES:
Projection: UTM Zone 11 North
Datum: North American Datum of 1983
Date: April 8, 2009
Data Sources: HDR, Washington DNR, USGS

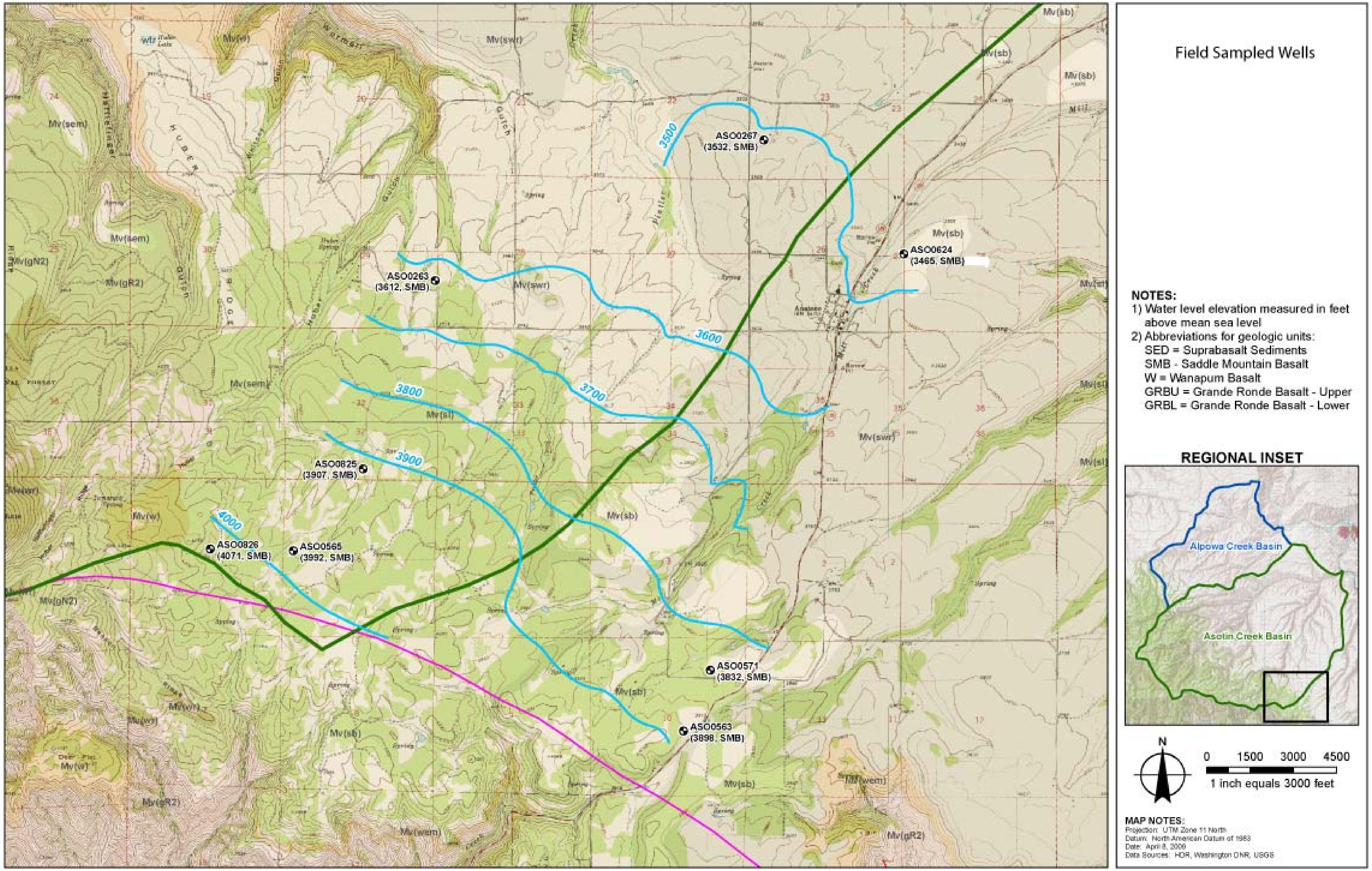
Figure 3-20 Ground water levels and hydrostratigraphy in lower Asotin Creek and the northern end of Highway 129



NOTES:
1) Water level elevation measured in feet above mean sea level
2) Abbreviations for geologic units:
SED = Suprabasalt Sediments
SMB - Saddle Mountain Basalt
W = Wanapum Basalt
GRBU = Grande Ronde Basalt - Upper
GRBL = Grande Ronde Basalt - Lower

MAP NOTES:
Projection: UTM Zone 11 North
Datum: North American Datum of 1983
Date: April 8, 2009
Data Sources: HDR, Washington DNR, USGS

Figure 3-21 Ground water levels and hydrostratigraphy in the Cloverland and Meyer Ridge plateaus



NOTES:
1) Water level elevation measured in feet above mean sea level
2) Abbreviations for geologic units:
   SED = Suprabasalt Sediments
   SMB - Saddle Mountain Basalt
   W = Wanapum Basalt
   GRBU = Grande Ronde Basalt - Upper
   GRBL = Grande Ronde Basalt - Lower

MAP NOTES:
Projection: UTM Zone 11 North
Datum: North American Datum of 1983
Date: April 8, 2009
Data Sources: HDR, Washington DNR, USGS

Figure 3-22 Ground water levels and hydrostratigraphy on the Anatone plateau.

Chapter 4
Groundwater Use

This chapter presents an estimate of the amount of groundwater used for water supply in the Alpowa and Asotin Creek sub-basins (**Figure 4-1**). Ground water use was estimated for the following three categories: domestic (permit-exempt) residential, public supply and agricultural. Ground water use was also estimated for three population scenarios: 1) current population, 2) 50-year future growth population and 3) increased population growth assuming partial build-out of current zoning.

4.1 Domestic Groundwater Use

Ground water is used in the project area by residences that are served by water right permit-exempt residential wells. A permit-exempt residential well is exempted from the requirements to obtain a water right. Ecology Publication No. F-WR-92-104 explains the limitations on the use of a permit-exempt well as:

- Providing water for livestock
- Watering a lawn or garden (up to half an acre in size)
- Providing water for a residence (5,000 gpd limit)

There may be other restrictions on the use of permit-exempt wells depending on the specific situation and the availability of water.

4.1.1 Components of Household Water Use

Total household water use for each sub-basin was calculated by estimating a per-household water use rate and multiplying by the number of residences. A water balance calculation was used to estimate typical household use for residents served by a permit-exempt well and a septic tank. The components of typical household use are summarized below and shown on **Figure 4-2**.

4.1.1.1 Lawn Watering

The amount of water used to irrigate a residential lawn was estimated based on the lawn evapotranspiration (ET) requirements and lawn size. The water applied to the lawn that is taken up for evapotranspiration is lost and the remainder returns to the shallow aquifer. The methods used to calculate the crop irrigation requirement (CIR) are summarized in Hargreaves and Merkley (1989) and Jensen et al. (1982). The flow chart in **Figure 4-3** summarizes the method, which is described below.

- Lawn size of 1/12 acre (about 3,600 sq. ft.). The results of the water use survey from Chapter 2 indicate an average irrigated lawn size of about 1/17 acre (about 2,500 sq. ft.), as shown in **Table 2-2**. The use of a larger lawn size of 1/12 acre in the water use calculation results in a larger estimate of water use as compared to the actual field conditions. Based on our field reconnaissance, lawns in these sub-basins are usually limited to a small area in the front and back of the house that can be watered with a garden hose[1]. Pictures of typical residences in the project area are shown in **Figure 4-4**. This size lawn allows for a lawn of about

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[1] Brad Johnson and Tim Simpson, Asotin PUD, April 2, 2008.

40 feet by 40 feet in the front and back of the house with some additional watering for shrubs and trees.

- Lawn watering field application efficiency of 75 percent. This is based on a periodically moved handline irrigation system as presented in the Washington State Department of Ecology guidance document GUID-1210: "Determining Irrigation Efficiency and Consumptive Use" Table 1 Page 8. For the remaining 25 percent not evaporated by the crop, 10 percent is assumed to be lost to wind evaporation and 15 percent is assumed to be return flow as per the Ecology guidance document. The return flow is assumed to enter the shallow aquifer.
- Lawn ET was calculated using the Agrimet ET data for the Lake Bryan-Rice Bar Agrimet Station located about 10 miles north of Pomeroy at an elevation of 600 ft msl. This is the closest meteorological station located at an altitude comparable to project areas (the Town of Asotin is located at elevation 800 ft msl). Agrimet ET calculations are based on meteorological records at specific stations and are computed on a monthly basis for various crop types. The period of record for ET data from the Lake Bryan-Rice Bar Agrimet station is 2003 to 2007. The daily data during this period was summed for individual months and averaged to obtain average monthly ET estimates, as shown in **Table 4-1**. Pasture grass was assumed to be the closest typical crop for a residential lawn.
- Average monthly precipitation data was obtained from the Western Regional Climate Center using the Lewiston WSO AP, Idaho weather station[2], as shown in **Table 4-2**. Monthly precipitation data from this station was used to compute effective precipitation during the irrigation season. Potential effective precipitation is the amount of precipitation during the irrigation season that potentially meets the crop ET requirement. Higher precipitation is less effective because a greater portion of the precipitation is lost to seepage or runoff. The procedure used to compute effective precipitation was based on the method in USDA Publication 1275. Potential effective precipitation is shown in **Table 4-3**.
- The residential houses that are located in the zoned area in proximity to the Town of Anatone do not have lawns. Therefore, lawn watering (irrigation) is not included in the water use calculation for this area. Pictures of typical residences in this area are shown in **Figure 4-5**. The zoned area in the vicinity of the Town of Anatone is shown on **Figure 4-6**.

4.1.1.2 Indoor Use

This is the amount of water used inside of a house for a typical residence. Water that is not consumed by the residents is returned to the subsurface via a septic tank, except for the amount evaporated by the lawn above the drainfield. The following detailed assumptions were used:

- The indoor use is assumed to be 190 gpd/residence based on the metered Asotin PUD municipal service area winter water use rate.
- Most water used indoors is assumed to drain to a septic drainfield and discharge to the shallow aquifer except the amount that is used for lawn ET above the drainfield. A septic tank drainfield with dimensions 10 ft by 20 ft was assumed.
- Lawn ET above the drainfield was assumed the same as described above.

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[2] Monthly average precipitation data was obtained from the Western Regional Climate Center for the Lewiston WSO AP, Idaho weather station for the 1948 to 2007 period www.wrcc.dri.edu/climsum.html.

4.1.1.3 Consumptive Use and Return Flow

An estimated 90 percent of water used indoors is discharged to the septic drainfield and returns to the shallow unconfined sedimentary aquifer except for lawn ET losses to the drainfield[3]. Irrigation returns of about 15 percent were assumed based on the method in Ecology Guidance Document Guid-1210. All return flows were assumed to reduce the depletive amount of pumping by wells on surface water.

The methods and assumptions for irrigation use calculations were intended to be conservative (i.e., overestimate actual use) because they assume application of water to meet the full irrigation requirement for a lawn with a well-developed soil profile for a house in the lower portion of the sub-basin. Almost all of the residences with wells and septic tanks are rural and are outside of municipal water service areas. Based on observations during field visits, interviews with residents and Brad Johnson and other members of the Planning Unit, many houses are on lots with rocky soil and do not have lawns. Houses with lawns are typically under watered and brown lawns are common during July to September. Also, many houses are located higher in the sub-basin and the ET requirements for lawns at these houses will be lower than for houses in the lower part of the watershed.

4.1.1.4 Per Household Water Use Estimate

The results of the water balance assessment for typical residences served by private wells and septic systems within the Asotin and Alpowa Creek sub-basins are presented in **Table 4-4** and the water use estimate for residences around the town of Anatone are presented in **Table 4-5**. This information shows that:

- During the summer (April to Sept) average water use is about 571 gpd/residence, with about 37 percent returning to the aquifer.
- During the winter the total use is 190 gpd/residence with 90 percent returning to the aquifer.
- On average for the year, total water use is estimated at about 381 gpd/residence with about 50 percent return flow to the aquifer.
- For residences around the Town of Anatone, the summer and annual water use is the same (because of the assumption that no lawn irrigation occurs) and is about 190 gpd/residence, with 90 percent returning to the aquifer.

4.1.1.5 Comparison to Asotin PUD Metered Water Use Data

The average annual estimated residential water use rate (381 gpd/residence) and the average summer monthly water use rate (571 gpd/residence) shown on **Table 4-4** is about 25 percent less than meter records for residences within the Asotin PUD service area. The Asotin PUD service area residential water use records for 1996-2007 report an average annual use rate of 510 gpd/residence and an average summer use rate of 759 gpd/residence. Based on interviews with persons familiar with the area, lawn sizes and lawn watering in the rural areas of these sub-basins is less as compared to residences in the Asotin PUD service area[4]. This indicates that the water use estimates discussed above compare favorably with the metered records from the Asotin PUD service areas and are reasonable.

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[3] A 90 percent in-house water use estimate was based on a recommendation from William Neve at the May 2008 WRIA 35 Planning Unit meeting.

[4] Brad Johnson and Tim Simpson, Asotin PUD, April 2, 2008.

4.1.2 Population Estimates

4.1.2.1 Current Population Scenario

The largest concentration of human population in the project area is near the City of Asotin. The City of Clarkston suburbs are generally outside the project area. Most of the project area and residences are in rural areas in the lower portions of Asotin Creek, Alpowa Creek and the highlands near the Town of Anatone.

The current residences were determined by examining aerial photos from the 2006 National Agriculture Imagery Program[5] (NAIP). All buildings were assumed to have one residential well and if a group of buildings were in close proximity to each other, such as a house and barn, they were counted as a single residence. **Figure 4-7** shows the locations of the digitized residences. Using this method, about 365 residences were identified in the project area. We assumed 2.5 residents per household based on the U.S. Census Data statistics for Asotin County. The average household population determined from the water use survey described in Chapter 2 was 2.4 residences per household, which is slightly less than the assumed 2.5 residents. Based on the results of the water use survey, 2.5 residents per household is a conservative estimate and equates to about 915 persons residing in the study area.

4.1.2.2 Projected 50-year Growth Scenario

This scenario includes the projected population and residences for the next 50 years to year 2057 for the area outside of the municipal service areas within the project area. The Washington Office of Financial Management[6] (OFM) provides projected growth scenarios at a county level and includes a medium and high projection, shown in **Table 4-6**. Currently the OFM projections extend to 2030. As a result, an average annual percentage change was calculated between the years 2010 and 2030. The high growth projection (about 1 percent annual growth) was used to project the average annual rate of growth to 2057. This level of growth would result in a 2057 population of about 1,600 persons with 640 residences. The methods and assumptions for the 50-year population growth estimates are probably conservative since population was projected using the high growth rate scenario.

4.1.2.3 Partial Build-out Population Scenario

This scenario represents a partial build-out of areas in about the lower third of each sub-basin that are zoned as rural residential or ag-transition. The partial build-out scenario assumes that areas zoned as ag-transition and rural residential will be built out according to the minimum lot sizes as stipulated in current zoning ordinance established in each county, thus representing growth well beyond the expected 50-year planning horizon. It was assumed that development of residences would only occur on lots with an average land slope of less than 20 percent (thus removing areas with steep hillsides that are less likely to experience growth). Zoning information was obtained from Asotin and Garfield Counties. The minimum lot sizes for the areas zoned as ag-transition are 1 acre per lot and rural residential is 5 acres per lot in Asotin County[7], shown on **Figure 4-6**. An ag-transition zone with 1 acre parcels exists at the bottom of the Alpowa Creek sub-basin.

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[5] The National Agricultural Imagery Program acquires aerial photos during the growing season of the continental United States. Aerial Photos were obtained from http://duff.geology.washington.edu/data/raster/doqs_naip.html

[6] The Office of Financial Management Forecasting Division develops official state and local population estimates. They also administer the U.S. Census Bureau State Data Center Program in Washington. http://www.ofm.wa.gov/pop/default.asp

[7] Asotin County 2001 Zoning Map, Asotin County Planning Dept.

Further up the lower Alpowa Creek valley, a rural residential zone with 5 acre parcels was assumed to exist because the area has potential for further growth. This assumed zoned area is not shown in the Garfield County zoning map. The Town of Anatone and the area immediately around it is zoned as ag-transition. The remainder of the Anatone area is zoned as rural residential. In both Asotin and Alpowa Creek sub-basins there is a large agricultural area used primarily for dry-land wheat farming and a 1 percent annual growth was assumed in this area. Under these assumptions the partial build-out population in the study area will be 21,000 persons with about 8,400 residences. The partial build-out scenario is an upper bound estimate of the maximum amount of groundwater use in the project areas. It is unlikely that this level of groundwater use will occur because it is unlikely that this level of growth will occur, with all buildable lots developed.

4.1.2.4 Summary of Population Estimates

Table 4-7 summarizes the estimated population for the current (2007), 50-year projection (2057), and the partial build-out scenarios. This information shows that:

<u>Current Population</u>: The population within the sub-basins in 2006 (not including of the Town of Asotin municipal service area) was 915 persons with about 365 residences.

<u>50-Year Future Population Projection</u>: By 2057 the estimated population is projected to increase to about 1,600 persons with 640 residences.

<u>Partial Build-Out Population Projection</u>: The estimated population using the partial build-out scenario will be 21,000 persons with about 8,400 residences.

4.2 Public Supply Groundwater Use

This section presents an estimate of groundwater used by the Group A and B public water systems (PWS). A GIS file showing the locations of Group A and B public water systems was obtained from the Washington Department of Health (**Figure 4-8**).

The assumptions for the water use calculation for Group A/B public groundwater systems were the same as used for residential domestic exempt wells (described above). A residential connection to a PWS was assumed to have the same water use characteristics as a single residence.

The results of the PWS water use estimate show that:

- The Town of Asotin has the highest amount of connections (544), followed by the Asotin Creek sub-basin with 30 connections, the Anatone Area with 8 connections and the Alpowa Creek Basin with 2 connections (**Table 4-8**).
- The average annual water use by Group A/B systems in the Asotin Creek sub-basin is about 7,230 gpd (0.011 cfs) with about 8,750 gpd (0.014 cfs) summer use. Approximately 73 percent (0.008 cfs) is returned on average for the year, while 63 percent (0.008 cfs) is returned during the summer (**Table 4-9**).
- The average annual water use by Group A/B systems in the Alpowa Creek sub-basin is about 760 gpd (0.001 cfs) with about 1,140 gpd (0.002 cfs) summer use. During the summer (April to Sept) in the Alpowa Creek Basin, about 37 percent (0.001 cfs) returns. On average for the year, about 50 percent (0.001 cfs) returns (**Table 4-10**).
- The water use for the Town of Asotin is about 361,000 gpd average annual use (0.56 cfs) with about 576,000 gpd summer use (0.89 cfs) (**Table 4-12)**. However,

the Town of Asotin wells are in deep basalt and are connected to the deep basalt aquifers of the Lewiston/Clarkston basin and the Snake River and are likely not in connection with Asotin Creek. Therefore, the Town of Asotin water use will not be counted in the Asotin Creek sub-basin water use.

4.3 Agricultural Groundwater Use

This section presents an estimate of groundwater used for agriculture. The predominant agricultural enterprise in the study area is dryland wheat farming in the upland plateau areas. Large irrigated farms are not present in the project area likely because of the high elevation of farmland with good soil in the plateau, the high cost of pumping groundwater up to these lands, and sufficient moisture in these areas for dryland wheat farming. There are a few small farms in the lowland valleys that irrigate using groundwater, primarily for pasture or hay and a few small orchards. Persons familiar with agricultural practices in the project area indicate that the amount of lowland valley irrigated land has decreased during the past few decades[4]. For these reasons, irrigated agriculture is relatively small in the project area.

The irrigated agricultural land was identified by first mapping land associated with agricultural water rights and then performing field surveys to determine if irrigation was occurring on land with water rights. The irrigation and stock watering groundwater rights and claims were extracted from the Ecology WRIA 35 water rights database and mapped based on geographic location data to the nearest quarter-section (**Figure 4-9**). A telephone and field survey was completed by Brad Johnson of the Asotin Public Utility District and Duane Bartels of the Pomeroy Conservation District to determine actual groundwater use (acres irrigated and stock watered) for agriculture. The details of the water rights and the results from the field survey are presented in **Appendix C**. The active water rights were then evaluated to determine how much groundwater was used for irrigation and stockwatering.

4.3.1 Irrigation Water Use

This is the amount of water used to irrigate the lowland pastures and orchards in the study area. The water applied to the land that is taken up for evapotranspiration (ET) is lost and the remainder returns to the upper shallow aquifer. The assumptions are the same as the domestic-use assumptions for the lawn irrigation.

A total of 91 acres are irrigated with groundwater irrigation water rights (**Table 4-13**). During the year, 245 AF of groundwater is needed to irrigate the crops in the project area. Approximately 32 percent (78 AF/year) of the irrigation water is used in Asotin Creek sub-basin and about 60 percent (148 AF/year) is used in the Alpowa Creek sub-basin. The remaining 8 percent (19 AF/year) is used in the Anatone area.

4.3.2 Livestock Water Use

This is the amount of water that is consumed by livestock (horses and cattle) on an annual basis. Separate water use rates were assigned for horses and cattle based on literature values. Many cattle are brought into stockyards in the winter and then transferred to pasture outside of the sub-basins in the summer. Cattle that do not reside in the sub-basins year-round were assigned appropriate seasonal use at the same rate identified below.

The literature was reviewed and a water use estimate was developed for cattle and horses. A per-stock use rate was utilized with cattle at 27 gallons of water per day (gpd) and horses at 18 gpd[8]. This water use rate is conservative because it is the high end of the range for dairy cattle and only beef cattle are present in the study area. We assumed livestock water use is 100 percent consumptive use with no return flow. The total stock estimate included about 1,000 livestock associated with specific water rights and another 900 cattle and 20 horses watered from a domestic permit-exempt well not associated with a water right.

A total of 1,900 head of stock use about 30 acre-feet (AF) of water per year assuming 27 gpd/head of cattle, 18 gpd/head of horse and 100 percent consumptive use. The breakdown of water use for livestock is 24 AF/yr in the Asotin Creek sub-basin and 6 AF/yr in the Alpowa Creek sub-basin (**Table 4-14**).

4.3.3 Total Agricultural (Irrigation and Livestock) Groundwater Use

The total agricultural (irrigation and livestock) groundwater use results are presented in **Table 4-15**, **Table 4-16** and **Table 4-17**. These tables show that during the summer (April to September) average monthly groundwater use for agriculture is 13 afm[9](Asotin Creek sub-basin), 24.6 afm (Alpowa Creek sub-basin) and 3.1 afm (Anatone Area outside of basins) with about 15 percent return flow. The peak monthly agricultural groundwater use occurs in July, reaching 22.5 afm in Asotin Creek sub-basin, 42.7 afm in Alpowa Creek sub-basin and 5.4 afm in the Anatone Area. On average for the year, monthly agricultural groundwater use is about 8.5 afm in Asotin Creek sub-basin with about 11 percent return flow. In Alpowa Creek sub-basin, the monthly average is 12.8 afm with about 14.5 percent return flow. About 37 percent of the ag water use (101.6 afm) is in the Asotin Creek sub-basin and about 56 percent (153.5 afm) of the ag water use is in the Alpowa Creek sub-basin.

4.4 Summary of Total Groundwater Use by Sub-Basin

This section summarizes total water use for each sub-basin for current, future (50-year) projected growth and partial build-out growth scenarios. The results are shown on **Figures 4-10** to **4-12** and **Tables 4-18** to **4-26**.

4.4.1 Current Population Scenario- Total Groundwater Use

In the Alpowa Creek sub-basin the current groundwater use during the summer is about 0.48 cfs (28.8 afm) with approximately 18 percent (0.09 cfs or 5.3 afm) return flow (**Table 4-18**). On average for the year, current groundwater use is about 0.26 cfs (15.6 afm) with approximately 21 percent (0.05 cfs or 3.3 afm) return flow. The majority of the groundwater use occurs in the Lower Alpowa Creek sub-basin.

Currently during the summer in the Asotin Creek sub-basin 0.38 cfs (23.1 afm) of groundwater are used with a return flow of 27 percent (0.10 cfs or 6.3 afm) (**Table 4-20**). The annual average groundwater use is about 0.26 cfs (15.6 afm) with approximately 33 percent (0.08 cfs or 5.1 afm) return flow. Lower Asotin Creek sub-basin consumes the most groundwater in the Asotin Creek sub-basin.

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[8] These estimates are based on Lardy, G. and C. Stoltenow, July 1999. Livestock and Water, NDSU Publication No. AS-954, North Dakota State University, Fargo, North Dakota. Table 5 on page 3 provides that cattle intake rate and Table 7 on page 4 provides the horse intake rate.

[9] Acre-feet per month is abbreviated as afm.

The zoned area near Anatone that lies outside of the creek basins has an annual average groundwater use of about 0.05 cfs (3.2 afm) and about 0.08 cfs (4.8 afm) during the summer (**Table 4-19**). The respective return flows are about 54 percent (0.03 cfs or 1.7 afm) for the year and approximately 41 percent (0.03 cfs or 2.0 afm) during the summer months.

4.4.2 Projected Future (50-year) Growth Scenario- Total Groundwater Use

In the Alpowa Creek sub-basin the summer groundwater use during the year 2057 will increase to about 0.53 cfs (31.8 afm) with approximately 20 percent (0.11 cfs or 6.4 afm) return flow (**Table 4-21**). On average for the year 2057, groundwater use will increase to about 0.29 cfs (17.6 afm) with approximately 24 percent (0.07 cfs or 4.3 afm) return flows. The majority of the groundwater use is estimated to occur in the Lower Alpowa Creek sub-basin.

During the summer of 2057 in the Asotin Creek sub-basin, a projected 0.50 cfs (30 afm) of groundwater will be used with a return flow of 31 percent (0.15 cfs or 9.2 afm) (**Table 4-23**). The annual average groundwater use will increase to 0.34 cfs (20.4 afm) with approximately 38 percent (0.13 cfs or 7.7 afm) return flow. Lower Asotin Creek sub-basin is estimated to consume the most groundwater in the Asotin Creek sub-basin.

In 2057 the zoned area near Anatone that lies outside of the creek basins will have an approximate annual average groundwater use of 0.07 cfs (4.4 afm) and about 0.10 cfs (5.9 afm) during the summer (**Table 4-22**). The respective return flows will be about 63 percent (0.05 cfs or 2.8 afm) for the year and approximately 50 percent (0.05 cfs or 3.0 afm) during the summer months.

4.4.3 Partial Build-out Growth Scenario- Total Groundwater Use

In the Alpowa Creek sub-basin the groundwater use during the summer will be about 0.84 cfs (50.7 afm) with approximately 27 percent (0.22 cfs or 13.5 afm) return flow (**Table 4-24**). On average for the year, groundwater use is estimated to be 0.50 cfs (30.2 afm) with approximately 35 percent (0.18 cfs or 10.7 afm) return flow. Lower Alpowa Creek sub-basin is projected to use the most groundwater.

Under the partial build out-scenario, the Asotin Creek sub-basin is estimated to use 4.06 cfs (246 afm) during the summer and return approximately 44 percent (1.8 cfs or 109 afm) (**Table 4-26**). The annual average water use will be about 2.91 cfs (176 afm) with approximately 57 percent (1.66 cfs or 101 afm) return flow. Lower Asotin Creek sub-basin is projected to use the most groundwater in the Asotin Creek sub-basin.

The zoned area near Anatone that lies outside of the creek basins has an annual average groundwater use of about 0.67 cfs (40.5 afm) and about 0.70 cfs (42.1 afm) during the summer (**Table 4-25**). The respective return flows are about 87 percent (0.58 cfs or 35.3 afm) for the year and approximately 84 percent (0.59 cfs or 35.6 afm) during the summer months.

Table 4-1 Average monthly ET estimates, 2003-2007, from the Lake Bryan-Rice Bar Agrimet station.

Month	Crop ET (in.)
January	0.00
February	0.00
March	0.72
April	2.88
May	4.32
June	5.88
July	7.56
August	5.88
September	3.48
October	0.72
November	0.00
December	0.00
Total	31.44

Table 4-2 Average monthly precipitation and potential effective precipitation, 1948 to 2007, from the Lewiston WSO AP, Idaho weather station.

Month	Crop ET (in.) [1]	Average Total Precip (in) [2]	Potential Effective Precip. (in) [3]	Actual Effective Precip Used to Meet Crop Demand (in) [4]
January	0.00	1.21	1.14	0.00
February	0.00	0.88	0.84	0.00
March	0.72	1.07	1.01	0.72
April	2.88	1.23	1.16	1.16
May	4.32	1.52	1.42	1.42
June	5.88	1.36	1.27	1.27
July	7.56	0.60	0.57	0.57
August	5.88	0.71	0.67	0.67
September	3.48	0.75	0.71	0.71
October	0.72	1.00	0.95	0.72
November	0.00	1.19	1.12	0.00
December	0.00	1.14	1.08	0.00
Total	31.44	12.66	11.94	7.25

Notes:

1. Crop ET data from Agrimet Lake Bryan - Rice Bar Station for pasture grass.
2. Precip. data from Lewistion, ID Coop Station (105241), Western Regional Climate Center.
3. Potential effective precipitation computed according to USDA Publication 1275 method.
4. Actual effective precipitation is the amount of potential effective used to meet the crop demand.

Table 4-3 Summary of effective potential precipitation method from USDA Publication 1275.

Precipitation (in/mon)	Percentage Potential Effective Precipitation
<=1	95
1-2	90
2-3	82
3-4	65
4-5	45
5-6	25
>6	5

Note: For example, consider a total rainfall of 2.5 inches for the month of March. Using the table above, it can be seen that the first inch of rain each month is 95% effective. The second inch of rain is 90% effective, and the last half inch of rain is 82% effective.. As a result, 2.5 inches of rain would be (1" x 0.95) + (1" x 0.9) + (0.5" x 0.82) = 2.26 in/mon of effective precipitation.

Table 4-4 Estimates of groundwater use, consumptive use and return flow for average residences served by private wells and septic systems in Asotin and Alpowa Creek Sub-basins.

	Water Use			Consumptive Use			Return Flow to Aquifer		
	Indoor	Irrigation	Total	Indoor	Irrigation	Total	Indoor	Irrigation	Total
January	190	0	190	19	0	19	171	0	171
February	190	0	190	19	0	19	171	0	171
March	190	0	190	19	0	19	171	0	171
April	190	166	356	25	141	167	165	25	190
May	190	271	461	29	230	260	161	41	202
June	190	445	635	36	378	414	154	67	221
July	190	653	843	43	555	599	147	98	244
August	190	486	676	37	413	451	153	73	226
September	190	267	457	29	227	256	161	40	201
October	190	0	190	19	0	19	171	0	171
November	190	0	190	19	0	19	171	0	171
December	190	0	190	19	0	19	171	0	171
Ave. Summer (April-Sept)	190	381	571	33	324	358	157	57	214
Ave. Winter (Oct.-March)	190	0	190	19	0	19	171	0	171
Annual Average	190	191	381	26	162	188	164	29	192

Note: All values are in gpd.

Table 4-5 Estimates of groundwater use, consumptive use and return flow for average residences served by private wells and septic systems in the zoned area around Anatone.

	Water Use			Consumptive Use			Return Flow to Aquifer		
	Indoor	Irrigation	Total	Indoor	Irrigation	Total	Indoor	Irrigation	Total
January	190	0	190	19	0	19	171	0	171
February	190	0	190	19	0	19	171	0	171
March	190	0	190	19	0	19	171	0	171
April	190	0	190	19	0	19	171	0	171
May	190	0	190	19	0	19	171	0	171
June	190	0	190	19	0	19	171	0	171
July	190	0	190	19	0	19	171	0	171
August	190	0	190	19	0	19	171	0	171
September	190	0	190	19	0	19	171	0	171
October	190	0	190	19	0	19	171	0	171
November	190	0	190	19	0	19	171	0	171
December	190	0	190	19	0	19	171	0	171
Ave. Summer (April-Sept)	190	0	190	19	0	19	171	0	171
Ave. Winter (Oct.-March)	190	0	190	19	0	19	171	0	171
Annual Average	190	0	190	19	0	19	171	0	171

Note: All values are in gpd.

Table 4-6 Average Annual Growth Rates 2010 to 2030.

Growth Projection	County	Average Annual Change (%)
Medium	Asotin	0.8
	Garfield	0.5
High	Asotin	1.1
	Garfield	1.1

Note: The average annual growth rate was based on the Office of Financial (OFM) Management projections for the years 2010 to 2030.

Table 4-7 Population estimates for areas outside of municipal service areas within Asotin and Alpowa Creek Sub-basins.

		Current (2007)		Projected Growth Scenario (2057)		Partial Build Out	
Creek Basin	**Sub-Basin**	**Residences**	**Population**	**Residences**	**Population**	**Residences**	**Population**
Alpowa	Lower Alpowa	41	103	71	179	424	1,061
	Mid Alpowa	29	73	51	126	51	126
	Upper Alpowa	7	18	12	30	12	30
Alpowa Total		77	193	134	335	487	1,217
Asotin	Charley Creek	1	3	2	4	2	4
	George Creek	55	138	96	240	1,321	3,302
	Lower Asotin Creek	75	188	131	327	2,912	7,281
	Mid Asotin Creek	26	65	45	113	194	485
	North Fork Asotin Creek	-	-	-	-	-	-
	Pintler Creek	42	105	73	183	1,296	3,241
	South Fork Asotin Creek	2	5	3	9	3	9
	Dry Gulch	1	3	2	4	2	4
Asotin Total		202	505	352	880	5,730	14,326
Anatone Area Outside Basins		86	215	150	375	2,184	5,460
Totals		365	913	636	1,590	8,401	21,003

Note:
1) To determine population from residences, a multiplier of 2.5 people per residence was used.
2) The current residences were digitized from 2006 National Agricultural Imagery Program (NAIP) aerial photographs, as shown in Figure 1.
3) The Projected Growth Scenario used the high projection growth scenario from the Office of Financial Management.
4) Partial Build Out was based on the ag-transition and rural residential zoned areas found in Figure 2. Land zoned as agricultural/national forest was assumed to experience minimal growth (1 percent annual growth).

Table 4-8 Public water systems in the Asotin Creek Sub-basin, the Alpowa Creek Sub-basin, the Anatone Area outside the basins and the Town of Asotin.

Public Water System	System Type	Total Connections	Creek Basin
ALPOWA SUMMIT REST AREA	A, Transient Non-Community	2	Alpowa Creek
ANATONE HIGHWAY MAINTENANCE SHOP	B	1	Anatone Area
ASOTIN COUNTY ROAD DEPT SHOP	B	2	Anatone Area
BUBBA S COUNTRY STORE & GRILL	B	1	Anatone Area
MAX MALLORY WATER SYSTEM	B	1	Anatone Area
WEB OWENS WATER SYSTEM	B	3	Anatone Area
BLUE MOUNTAIN HOMESITES	B	13	Asotin Creek
CLEARWATER GUARD STATION	B	2	Asotin Creek
CLOVERLAND FREE METHODIST CHURCH	B	2	Asotin Creek
COUNTRY LIVING COURT	B	9	Asotin Creek
HATLEY WATER SYSTEM #1	B	4	Asotin Creek
ASOTIN WATER DEPT	A, Community	544	Town of Asotin

Table 4-9 Ground water use of public water systems in Asotin Creek Sub-basin.

	Water Use			Consumptive Use			Return Flow to Aquifer		
	Indoor	Irrigation	Total	Indoor	Irrigation	Total	Indoor	Irrigation	Total
January	5,700	0	5,700	570	0	570	5,130	0	5,130
February	5,700	0	5,700	570	0	570	5,130	0	5,130
March	5,700	0	5,700	570	0	570	5,130	0	5,130
April	5,700	1,331	7,031	620	1,131	1,751	5,080	200	5,280
May	5,700	2,169	7,869	651	1,844	2,495	5,049	325	5,374
June	5,700	3,558	9,258	703	3,024	3,727	4,997	534	5,530
July	5,700	5,225	10,925	766	4,441	5,207	4,934	784	5,718
August	5,700	3,891	9,591	716	3,307	4,023	4,984	584	5,568
September	5,700	2,138	7,838	650	1,817	2,467	5,050	321	5,370
October	5,700	0	5,700	570	0	570	5,130	0	5,130
November	5,700	0	5,700	570	0	570	5,130	0	5,130
December	5,700	0	5,700	570	0	570	5,130	0	5,130
Ave. Summer (April-Sept)	5,700	3,052	8,752	684	2,594	3,278	5,016	458	5,473
Ave. Winter (Oct.-March)	5,700	0	5,700	570	0	570	5,130	0	5,130
Annual Average	5,700	1,526	7,226	627	1,297	1,924	5,073	229	5,302

Note: All values are in gallons per day.

Table 4-10 Ground water use of public water systems in Alpowa Creek Sub-basin.

	Water Use			Consumptive Use			Return Flow to Aquifer		
	Indoor	Irrigation	Total	Indoor	Irrigation	Total	Indoor	Irrigation	Total
January	380	0	380	38	0	38	342	0	342
February	380	0	380	38	0	38	342	0	342
March	380	0	380	38	0	38	342	0	342
April	380	333	713	50	283	333	330	50	379
May	380	542	922	58	461	519	322	81	403
June	380	889	1,269	71	756	827	309	133	442
July	380	1,306	1,686	87	1,110	1,197	293	196	489
August	380	973	1,353	74	827	901	306	146	451
September	380	534	914	58	454	512	322	80	402
October	380	0	380	38	0	38	342	0	342
November	380	0	380	38	0	38	342	0	342
December	380	0	380	38	0	38	342	0	342
Ave. Summer (April-Sept)	380	763	1,143	67	649	715	313	114	428
Ave. Winter (Oct.-March)	380	0	380	38	0	38	342	0	342
Annual Average	380	381	761	52	324	377	328	57	385

Note: All values are in gallons per day.

Table 4-11 Ground water use of public water systems in the Anatone Area outside the basins.

	Water Use			Consumptive Use			Return Flow to Aquifer		
	Indoor	Irrigation	Total	Indoor	Irrigation	Total	Indoor	Irrigation	Total
January	1,520	0	1,520	152	0	152	1,368	0	1,368
February	1,520	0	1,520	152	0	152	1,368	0	1,368
March	1,520	0	1,520	152	0	152	1,368	0	1,368
April	1,520	0	1,520	152	0	152	1,368	0	1,368
May	1,520	0	1,520	152	0	152	1,368	0	1,368
June	1,520	0	1,520	152	0	152	1,368	0	1,368
July	1,520	0	1,520	152	0	152	1,368	0	1,368
August	1,520	0	1,520	152	0	152	1,368	0	1,368
September	1,520	0	1,520	152	0	152	1,368	0	1,368
October	1,520	0	1,520	152	0	152	1,368	0	1,368
November	1,520	0	1,520	152	0	152	1,368	0	1,368
December	1,520	0	1,520	152	0	152	1,368	0	1,368
Ave. Summer (April-Sept)	1,520	0	1,520	152	0	152	1,368	0	1,368
Ave. Winter (Oct.-March)	1,520	0	1,520	152	0	152	1,368	0	1,368
Annual Average	1,520	0	1,520	152	0	152	1,368	0	1,368

Note: All values are in gallons per day.

Table 4-12 Ground water use of the Asotin Water Department in the Town of Asotin.

	Water Use			Consumptive Use			Return Flow to Aquifer		
	Indoor	Irrigation	Total	Indoor	Irrigation	Total	Indoor	Irrigation	Total
January	131,016	0	131,016	131,016	0	131,016	0	0	0
February	126,268	0	126,268	126,268	0	126,268	0	0	0
March	106,726	0	106,726	106,726	0	106,726	0	0	0
April	49,497	90,496	139,993	49,497	76,922	126,419	0	13,574	13,574
May	336,058	147,503	483,561	336,058	125,377	461,436	0	22,125	22,125
June	417,769	241,918	659,687	417,769	205,630	623,399	0	36,288	36,288
July	458,367	355,288	813,655	458,367	301,995	760,362	0	53,293	53,293
August	534,141	264,585	798,726	534,141	224,897	759,038	0	39,688	39,688
September	414,565	145,355	559,920	414,565	123,552	538,117	0	21,803	21,803
October	252,300	0	252,300	252,300	0	252,300	0	0	0
November	149,863	0	149,863	149,863	0	149,863	0	0	0
December	110,077	0	110,077	110,077	0	110,077	0	0	0
Ave. Summer (April-Sept)	368,399	207,524	575,924	368,399	176,396	544,795	0	31,129	31,129
Ave. Winter (Oct.-March)	146,042	0	146,042	146,042	0	146,042	0	0	0
Annual Average	257,221	103,762	360,983	257,221	88,198	345,418	0	15,564	15,564

Note:
1) All values are in gpd.
2) Water use numbers are based on meter records provided by Asotin PUD.
3) Indoor use in the Town of Asotin is assumed to be 100 percent consumptive because it is discharged to a sewer system.

Table 4-13 Estimates of irrigated acres from groundwater rights in Asotin Creek Sub-basin, Alpowa Creek Sub-basin and Anatone Area outside the basins.

Basin	Sub Basin	Number of Active Water Rights	Estimated Actual Irrigated Acres
Asotin Creek Basin	Certificates	8	8.0
	Claims	72	21.0
Alpowa Creek Basin	Certificates	5	49.5
	Claims	62	5.5
Anatone Area	Certificates	1	1.0
	Claims	11	6.0
	Totals	159	91

Table 4-14 Estimates of livestock water use from groundwater rights in Alpowa and Asotin Creek Sub-basin and the Anatone Area outside the basins.

Basin	Sub Basin	Estimated Livestock (Horses and Cattle)	Calculated Annual Livestock Use (ac-ft/year)
Asotin Creek Basin	Dry Gulch	0	0.0
	George Creek	110	1.7
	Lower Asotin Creek	450	6.8
	Mid Asotin Creek	800	12.1
	North Fork Asotin Creek	0	0.0
	Pintler Creek	170	2.6
	South Fork Asotin Creek	40	0.6
	Charley Creek	0	0.0
Alpowa Creek Basin	Lower Alpowa	123	2.1
	Mid Alpowa	109	1.7
	Upper Alpowa	120	1.9
Anatone Area	Anatone Area	0	0.0
	Totals	1,922	29.4

Note:

1) Annual livestock use assumes 27 gpd per cow and 18 gpd per horse.
2) The total water use calculation assumes most cattle are present for 6 months of the year during the winter.

Table 4-15 Estimates of total agricultural (livestock and irrigation) groundwater use, consumptive use and return flow in Asotin Creek Sub-basin.

	Irrigation and Livestock		
	Water Use (acre-feet)	Consumptive Use (acre-feet)	Return Flow to Aquifer (acre-feet)
January	4.0	4.0	0.0
February	3.6	3.6	0.0
March	4.0	4.0	0.0
April	5.6	4.7	0.8
May	9.4	7.9	1.4
June	14.8	12.6	2.2
July	22.5	19.1	3.4
August	16.8	14.3	2.5
September	8.9	7.6	1.3
October	4.0	4.0	0.0
November	3.9	3.9	0.0
December	4.0	4.0	0.0
Ave. Summer (April-Sept)	13.0	11.0	1.9
Ave. Winter (Oct.-Mar)	3.9	3.9	0.0
Annual Total	101.6	89.9	11.7

Note: All values are in acre-ft.

Table 4-16 Estimates of total agricultural (irrigation and livestock) groundwater use, consumptive use and return flow in Alpowa Creek sub-basin.

	Irrigation and Livestock		
	Water Use (acre-feet)	**Consumptive Use (acre-feet)**	**Return Flow to Aquifer (acre-feet)**
January	1.0	1.0	0.0
February	0.9	0.9	0.0
March	1.0	1.0	0.0
April	10.5	9.0	1.6
May	17.7	15.1	2.7
June	28.1	23.9	4.2
July	42.7	36.3	6.4
August	31.8	27.0	4.8
September	16.9	14.4	2.5
October	1.0	1.0	0.0
November	0.9	0.9	0.0
December	1.0	1.0	0.0
Ave. Summer (April-Sept)	24.6	20.9	3.7
Ave. Winter (Oct.-Mar)	0.9	0.9	0.0
Annual Total	153.5	131.3	22.2

Note: All values are in acre-ft.

Table 4-17 Estimates of total agricultural (irrigation and livestock) groundwater use, consumptive use and return flow in the Anatone Area.

	Irrigation		
	Water Use (acre-feet)	Consumptive Use (acre-feet)	Return Flow to Aquifer (acre-feet)
January	0.0	0.0	0.0
February	0.0	0.0	0.0
March	0.0	0.0	0.0
April	1.3	1.1	0.2
May	2.3	1.9	0.3
June	3.6	3.0	0.5
July	5.4	4.6	0.8
August	4.0	3.4	0.6
September	2.2	1.8	0.3
October	0.0	0.0	0.0
November	0.0	0.0	0.0
December	0.0	0.0	0.0
Ave. Summer (April-Sept)	3.1	2.7	0.5
Ave. Winter (Oct.-Mar)	0.0	0.0	0.0
Annual Total	18.8	16.0	2.8

Note: All values are in acre-ft.

Table 4-18 Total current groundwater use in Alpowa Creek Sub-basin.

Alpowa Creek Sub-basin									
Sub-basin	Type of Water Use	Summer Total		Summer Net (Total - Return Flow)		Annual Total		Annual Net (Total - Return Flow)	
		CFS	AFM	CFS	AFM	CFS	AFM	CFS	AFM
Lower Alpowa	Residential (Domestic Exempt)	0.04	2.19	0.02	1.37	0.02	1.46	0.01	0.72
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.35	21.20	0.30	18.02	0.18	10.78	0.15	9.19
	Sub-Basin Total	0.39	23.39	0.32	19.39	0.20	12.24	0.16	9.91
Mid Alpowa	Residential (Domestic Exempt)	0.03	1.55	0.02	0.97	0.02	1.03	0.01	0.51
	Public Water System	0.00	0.11	0.00	0.07	0.00	0.07	0.00	0.04
	Agricultural	0.06	3.35	0.05	2.85	0.03	1.81	0.03	1.56
	Sub-Basin Total	0.08	5.01	0.06	3.88	0.05	2.92	0.03	2.11
Upper Alpowa	Residential (Domestic Exempt)	0.01	0.37	0.00	0.23	0.00	0.25	0.00	0.12
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.15
	Sub-Basin Total	0.01	0.37	0.00	0.23	0.01	0.40	0.00	0.28
Total		0.48	28.77	0.39	23.51	0.26	15.56	0.20	12.30

Table 4-19 Total current groundwater use in the Anatone Area outside the basins.

Anatone Area Outside Basins									
Sub-basin	Type of Water Use	Summer Total		Summer Net (Total - Return Flow)		Annual Total		Annual Net (Total - Return Flow)	
		CFS	AFM	CFS	AFM	CFS	AFM	CFS	AFM
Anatone Area Outside Basins	Residential (Domestic Exempt)	0.03	1.53	0.00	0.15	0.03	1.53	0.00	0.15
	Public Water System	0.00	0.14	0.00	0.01	0.00	0.14	0.00	0.01
	Agricultural	0.05	3.12	0.04	2.66	0.03	1.56	0.02	1.33
Total		0.08	4.80	0.05	2.82	0.05	3.23	0.02	1.50

Table 4-20 Total current groundwater use in the Asotin Creek Sub-basin.

Asotin Creek Sub-basin									
Sub-basin	Type of Water Use	Summer Total		Summer Net (Total - Return Flow)		Annual Total		Annual Net (Total - Return Flow)	
		CFS	AFM	CFS	AFM	CFS	AFM	CFS	AFM
Charley Creek	Residential (Domestic Exempt)	0.00	0.05	0.00	0.03	0.00	0.04	0.00	0.02
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Basin Total	0.00	0.05	0.00	0.03	0.00	0.04	0.00	0.02
George Creek	Residential (Domestic Exempt)	0.03	1.94	0.02	0.95	0.02	1.46	0.01	0.53
	Public Water System	0.01	0.34	0.00	0.09	0.00	0.30	0.00	0.06
	Agricultural	0.01	0.89	0.01	0.76	0.01	0.59	0.01	0.52
	Sub-Basin Total	0.05	3.17	0.03	1.80	0.04	2.35	0.02	1.10
Lower Asotin Creek	Residential (Domestic Exempt)	0.07	4.01	0.04	2.51	0.04	2.67	0.02	1.32
	Public Water System	0.00	0.21	0.00	0.13	0.00	0.14	0.00	0.07
	Agricultural	0.15	9.37	0.13	7.97	0.09	5.26	0.08	4.55
	Sub-Basin Total	0.22	13.60	0.18	10.61	0.13	8.07	0.10	5.94
Mid Asotin Creek	Residential (Domestic Exempt)	0.02	1.39	0.01	0.87	0.02	0.93	0.01	0.46
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.02	1.12	0.02	0.95	0.03	1.57	0.02	1.49
	Sub-Basin Total	0.04	2.51	0.03	1.82	0.04	2.50	0.03	1.94
North Fork Asotin Creek	Residential (Domestic Exempt)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Public Water System	0.00	0.11	0.00	0.07	0.00	0.07	0.00	0.04
	Agricultural	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Basin Total	0.00	0.11	0.00	0.07	0.00	0.07	0.00	0.04
Pintler Creek	Residential (Domestic Exempt)	0.03	1.78	0.02	0.99	0.02	1.26	0.01	0.53
	Public Water System	0.00	0.16	0.00	0.02	0.00	0.16	0.00	0.02
	Agricultural	0.03	1.56	0.02	1.33	0.02	1.00	0.01	0.88
	Sub-Basin Total	0.06	3.50	0.04	2.34	0.04	2.42	0.02	1.43
South Fork Asotin Creek	Residential (Domestic Exempt)	0.00	0.11	0.00	0.07	0.00	0.07	0.00	0.04
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00
	Sub-Basin Total	0.00	0.11	0.00	0.07	0.00	0.12	0.00	0.04
Dry Gulch	Residential (Domestic Exempt)	0.00	0.05	0.00	0.03	0.00	0.04	0.00	0.02
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Basin Total	0.00	0.05	0.00	0.03	0.00	0.04	0.00	0.02
Total		0.38	23.10	0.28	16.77	0.26	15.60	0.17	10.52

Table 4-21 Total projected groundwater use in the year 2057 in Alpowa Creek Sub-basin.

Alpowa Creek Sub-basin									
Sub-basin	Type of Water Use	Summer Total		Summer Net (Total - Return Flow)		Annual Total		Annual Net (Total - Return Flow)	
		CFS	AFM	CFS	AFM	CFS	AFM	CFS	AFM
Lower Alpowa	Residential (Domestic Exempt)	0.06	3.82	0.04	2.39	0.04	2.55	0.02	1.26
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.35	21.20	0.30	18.02	0.18	10.78	0.15	9.19
	Sub-Basin Total	0.41	25.02	0.34	20.41	0.22	13.33	0.17	10.45
Mid Alpowa	Residential (Domestic Exempt)	0.04	2.70	0.03	1.69	0.03	1.80	0.01	0.89
	Public Water System	0.00	0.11	0.00	0.07	0.00	0.07	0.00	0.04
	Agricultural	0.06	3.35	0.05	2.85	0.03	1.81	0.03	1.56
	Sub-Basin Total	0.10	6.16	0.08	4.60	0.06	3.69	0.04	2.49
Upper Alpowa	Residential (Domestic Exempt)	0.01	0.65	0.01	0.41	0.01	0.43	0.00	0.22
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.15
	Sub-Basin Total	0.01	0.65	0.01	0.41	0.01	0.59	0.01	0.37
Total		0.53	31.83	0.42	25.42	0.29	17.60	0.22	13.31

Table 4-22 Total projected groundwater use in the year 2057 in Anatone Area outside the basins.

Anatone Area Outside Basins									
Sub-basin	Type of Water Use	Summer Total		Summer Net (Total - Return Flow)		Annual Total		Annual Net (Total - Return Flow)	
		CFS	AFM	CFS	AFM	CFS	AFM	CFS	AFM
Anatone Area Outside Basins	Residential (Domestic Exempt)	0.04	2.67	0.00	0.27	0.04	2.67	0.00	0.27
	Public Water System	0.00	0.14	0.00	0.01	0.00	0.14	0.00	0.01
	Agricultural	0.05	3.12	0.04	2.66	0.03	1.56	0.02	1.33
Total		0.10	5.93	0.05	2.94	0.07	4.37	0.03	1.61

Table 4-23 Total projected groundwater use in the year 2057 in Asotin Creek Sub-basin.

Asotin Creek Sub-basin									
Sub-basin	Type of Water Use	Summer Total		Summer Net (Total - Return Flow)		Annual Total		Annual Net (Total - Return Flow)	
		CFS	AFM	CFS	AFM	CFS	AFM	CFS	AFM
Charley Creek	Residential (Domestic Exempt)	0.00	0.09	0.00	0.06	0.00	0.06	0.00	0.03
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Basin Total	0.00	0.09	0.00	0.06	0.00	0.06	0.00	0.03
George Creek	Residential (Domestic Exempt)	0.06	3.38	0.03	1.66	0.04	2.54	0.02	0.91
	Public Water System	0.01	0.34	0.00	0.09	0.00	0.30	0.00	0.06
	Agricultural	0.01	0.89	0.01	0.76	0.01	0.59	0.01	0.52
	Sub-Basin Total	0.08	4.61	0.04	2.50	0.06	3.43	0.02	1.49
Lower Asotin Creek	Residential (Domestic Exempt)	0.12	6.99	0.07	4.37	0.08	4.66	0.04	2.30
	Public Water System	0.00	0.21	0.00	0.13	0.00	0.14	0.00	0.07
	Agricultural	0.15	9.37	0.13	7.97	0.09	5.26	0.08	4.55
	Sub-Basin Total	0.27	16.58	0.21	12.48	0.17	10.06	0.11	6.93
Mid Asotin Creek	Residential (Domestic Exempt)	0.04	2.42	0.03	1.52	0.03	1.61	0.01	0.80
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.02	1.12	0.02	0.95	0.03	1.57	0.02	1.49
	Sub-Basin Total	0.06	3.54	0.04	2.46	0.05	3.18	0.04	2.28
North Fork Asotin Creek	Residential (Domestic Exempt)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Public Water System	0.00	0.11	0.00	0.07	0.00	0.07	0.00	0.04
	Agricultural	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Basin Total	0.00	0.11	0.00	0.07	0.00	0.07	0.00	0.04
Pintler Creek	Residential (Domestic Exempt)	0.05	3.09	0.03	1.72	0.04	2.20	0.02	0.93
	Public Water System	0.00	0.16	0.00	0.02	0.00	0.16	0.00	0.02
	Agricultural	0.03	1.56	0.02	1.33	0.02	1.00	0.01	0.88
	Sub-Basin Total	0.08	4.82	0.05	3.06	0.06	3.35	0.03	1.82
South Fork Asotin Creek	Residential (Domestic Exempt)	0.00	0.19	0.00	0.12	0.00	0.12	0.00	0.06
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00
	Sub-Basin Total	0.00	0.19	0.00	0.12	0.00	0.17	0.00	0.06
Dry Gulch	Residential (Domestic Exempt)	0.00	0.09	0.00	0.06	0.00	0.06	0.00	0.03
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Basin Total	0.00	0.09	0.00	0.06	0.00	0.06	0.00	0.03
Total		0.50	30.02	0.34	20.81	0.34	20.39	0.21	12.68

Table 4-24 Total partial build-out groundwater use in Alpowa Creek Sub-basin.

Alpowa Creek Sub-basin									
Sub-basin	Type of Water Use	Summer Total		Summer Net (Total - Return Flow)		Annual Total		Annual Net (Total - Return Flow)	
		CFS	afm	CFS	afm	CFS	afm	CFS	afm
Lower Alpowa	Residential (Domestic Exempt)	0.38	22.69	0.23	14.20	0.25	15.12	0.12	7.48
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.35	21.20	0.30	18.02	0.18	10.78	0.15	9.19
	Sub-Basin Total	0.73	43.89	0.53	32.22	0.43	25.90	0.28	16.67
Mid Alpowa	Residential (Domestic Exempt)	0.04	2.70	0.03	1.69	0.03	1.80	0.01	0.89
	Public Water System	0.00	0.11	0.00	0.07	0.00	0.07	0.00	0.04
	Agricultural	0.06	3.35	0.05	2.85	0.03	1.81	0.03	1.56
	Sub-Basin Total	0.10	6.16	0.08	4.60	0.06	3.69	0.04	2.49
Upper Alpowa	Residential (Domestic Exempt)	0.01	0.65	0.01	0.41	0.01	0.43	0.00	0.22
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.15
	Sub-Basin Total	0.01	0.65	0.01	0.41	0.01	0.59	0.01	0.37
Total		0.84	50.70	0.62	37.23	0.50	30.17	0.32	19.52

Table 4-25 Total partial build-out groundwater use in the Anatone Area outside the basins.

Anatone Area Outside Basins									
Sub-basin	Type of Water Use	Summer Total		Summer Net (Total - Return Flow)		Annual Total		Annual Net (Total - Return Flow)	
		CFS	afm	CFS	afm	CFS	afm	CFS	afm
Anatone Area Outside Basins	Residential (Domestic Exempt)	0.64	38.84	0.06	3.88	0.64	38.84	0.06	3.88
	Public Water System	0.00	0.14	0.00	0.01	0.00	0.14	0.00	0.01
	Agricultural	0.05	3.12	0.04	2.66	0.03	1.56	0.02	1.33
Total		0.70	42.11	0.11	6.55	0.67	40.54	0.09	5.23

Table 4-26 Total partial build-out groundwater use in the Asotin Creek Sub-basin.

Asotin Creek Sub-basin									
Sub-basin	Type of Water Use	Summer Total		Summer Net (Total - Return Flow)		Annual Total		Annual Net (Total - Return Flow)	
		CFS	AFM	CFS	AFM	CFS	AFM	CFS	AFM
Charley Creek	Residential (Domestic Exempt)	0.00	0.09	0.00	0.06	0.00	0.06	0.00	0.03
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Basin Total	0.00	0.09	0.00	0.06	0.00	0.06	0.00	0.03
George Creek	Residential (Domestic Exempt)	0.41	24.85	0.06	3.55	0.40	24.17	0.05	2.95
	Public Water System	0.01	0.34	0.00	0.09	0.00	0.30	0.00	0.06
	Agricultural	0.01	0.89	0.01	0.76	0.01	0.59	0.01	0.52
	Sub-Basin Total	0.43	26.08	0.07	4.40	0.41	25.06	0.06	3.53
Lower Asotin Creek	Residential (Domestic Exempt)	2.58	155.78	1.61	97.47	1.72	103.79	0.85	51.32
	Public Water System	0.00	0.21	0.00	0.13	0.00	0.14	0.00	0.07
	Agricultural	0.15	9.37	0.13	7.97	0.09	5.26	0.08	4.55
	Sub-Basin Total	2.73	165.37	1.75	105.57	1.80	109.18	0.92	55.95
Mid Asotin Creek	Residential (Domestic Exempt)	0.17	10.37	0.11	6.49	0.11	6.91	0.06	3.42
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.02	1.12	0.02	0.95	0.03	1.57	0.02	1.49
	Sub-Basin Total	0.19	11.49	0.12	7.44	0.14	8.48	0.08	4.90
North Fork Asotin Creek	Residential (Domestic Exempt)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Public Water System	0.00	0.11	0.00	0.07	0.00	0.07	0.00	0.04
	Agricultural	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Basin Total	0.00	0.11	0.00	0.07	0.00	0.07	0.00	0.04
Pintler Creek	Residential (Domestic Exempt)	0.67	40.60	0.30	17.87	0.53	31.82	0.17	10.09
	Public Water System	0.00	0.16	0.00	0.02	0.00	0.16	0.00	0.02
	Agricultural	0.03	1.56	0.02	1.33	0.02	1.00	0.01	0.88
	Sub-Basin Total	0.70	42.32	0.32	19.22	0.55	32.98	0.18	10.98
South Fork Asotin Creek	Residential (Domestic Exempt)	0.00	0.19	0.00	0.12	0.00	0.12	0.00	0.06
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00
	Sub-Basin Total	0.00	0.19	0.00	0.12	0.00	0.17	0.00	0.06
Dry Gulch	Residential (Domestic Exempt)	0.00	0.09	0.00	0.06	0.00	0.06	0.00	0.03
	Public Water System	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Agricultural	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Sub-Basin Total	0.00	0.09	0.00	0.06	0.00	0.06	0.00	0.03
Total		4.06	245.73	2.26	136.93	2.91	176.07	1.25	75.52

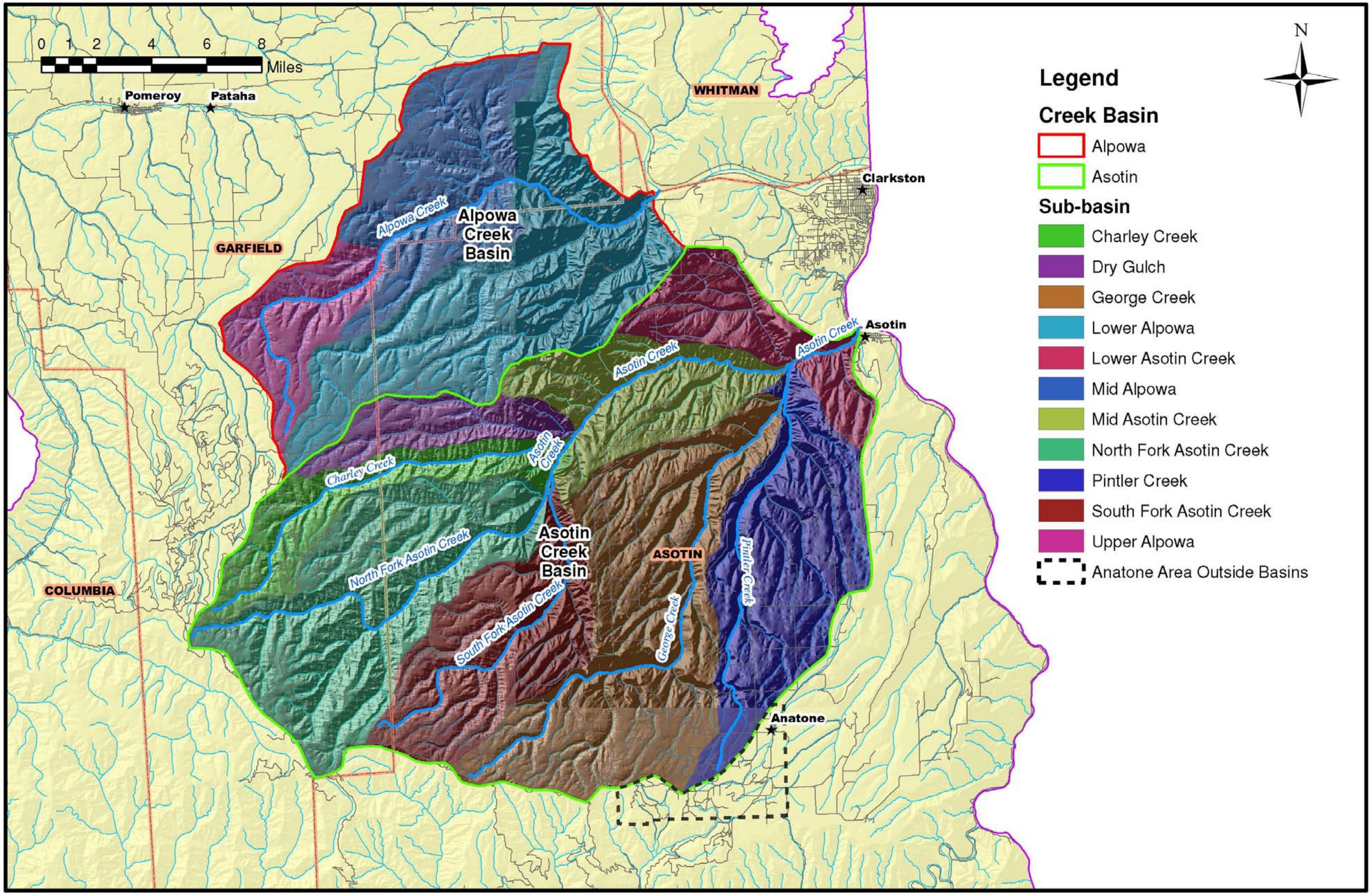


Figure 4-1 Sub-basins of Alpowa and Asotin Creek and the Anatone Area outside of the basins.

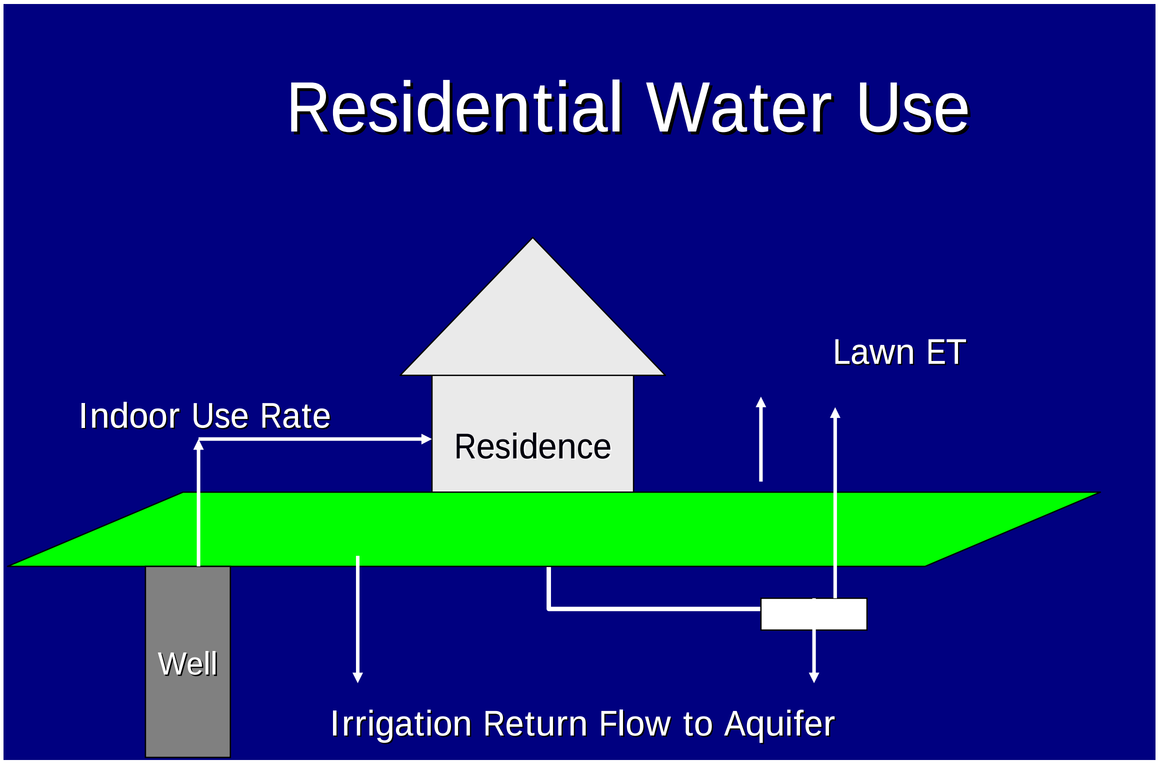


Figure 4-2 Water balance for residence served by well and septic tank.

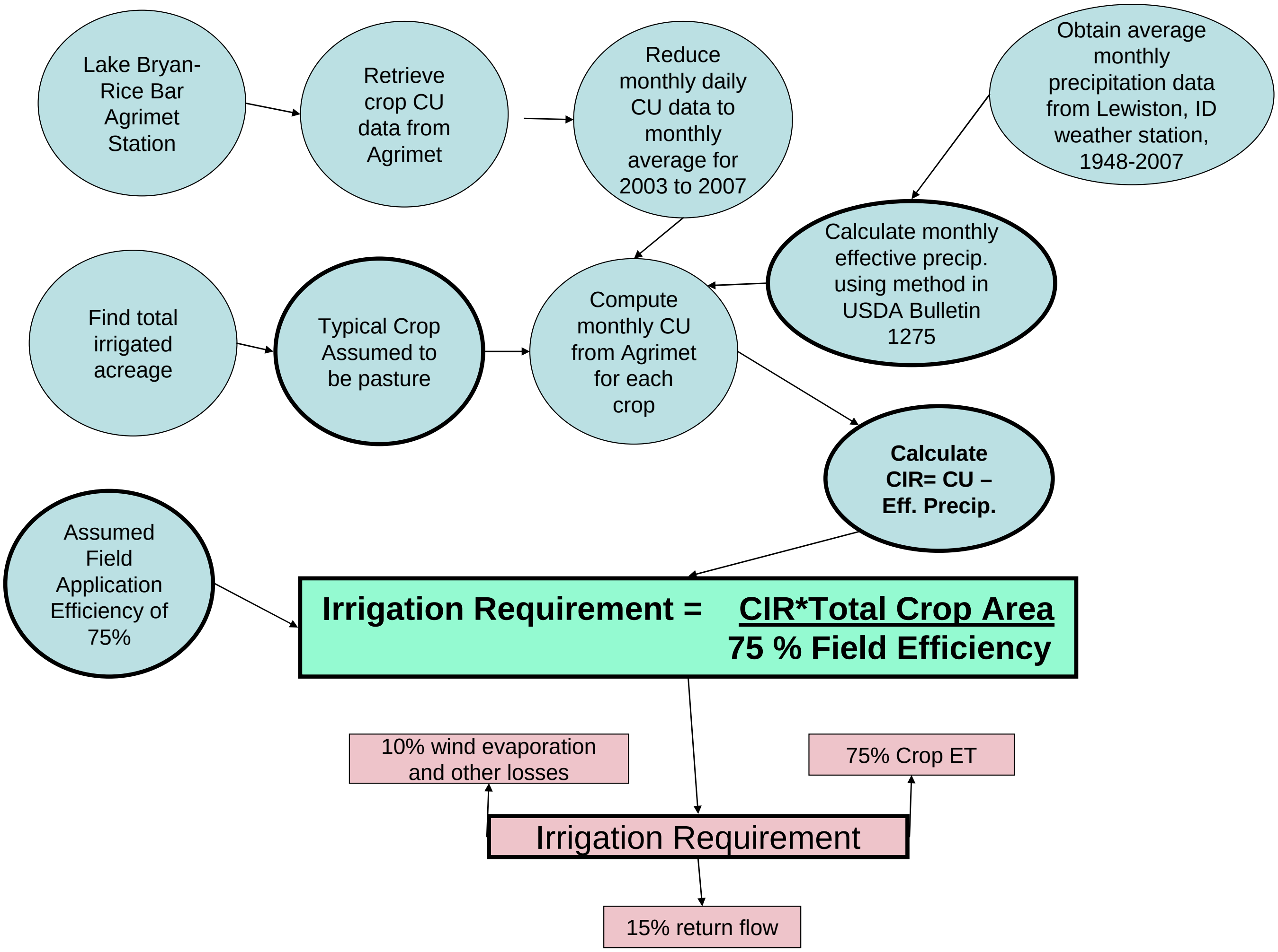


Figure 4-3 **Flowchart of the process to calculate irrigation requirements, consumptive use and return flow.**

Figure 4-4 **Photographs of typical residences in Alpowa and Asotin Creek Sub-basins.**

Figure 4-4 continued.

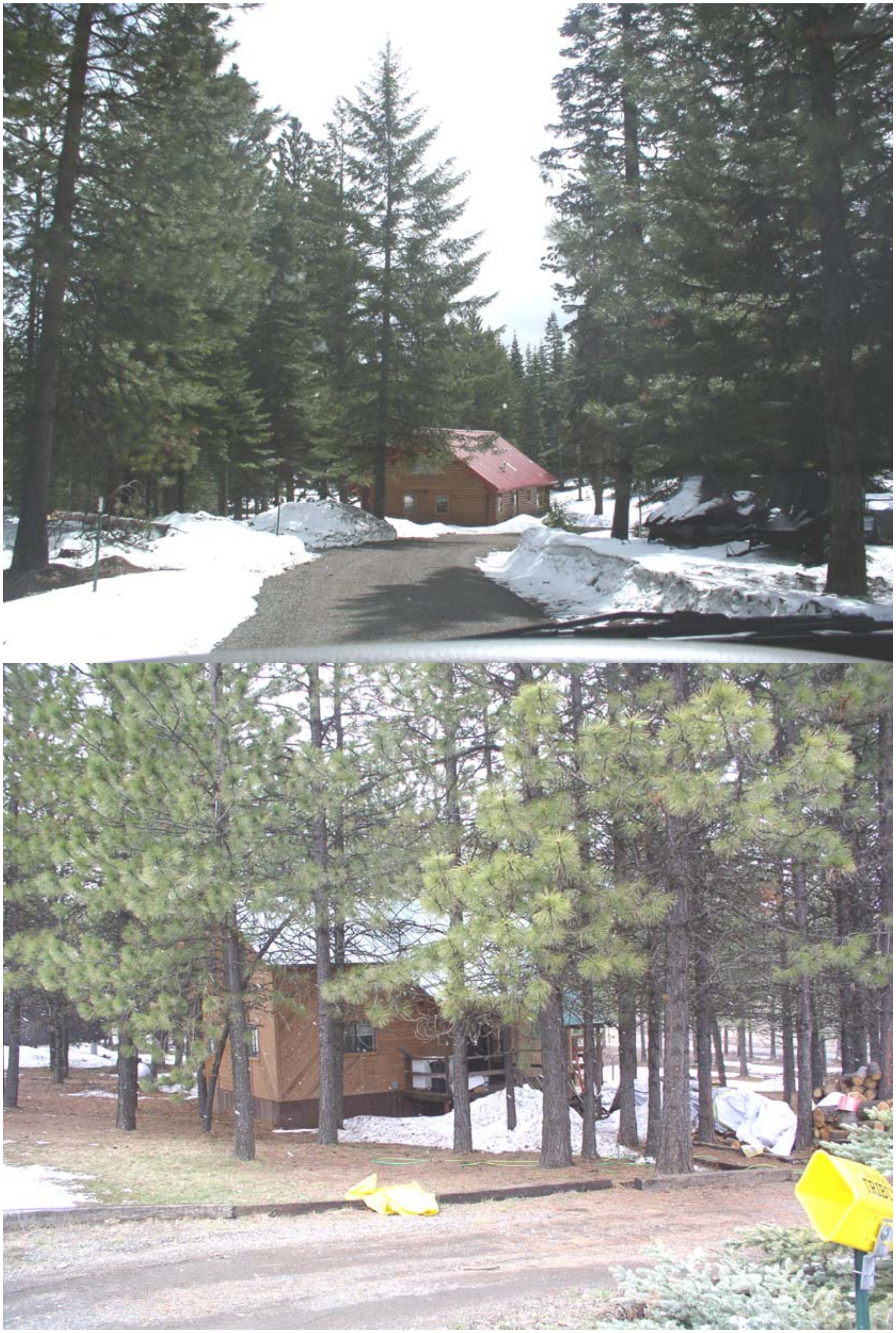
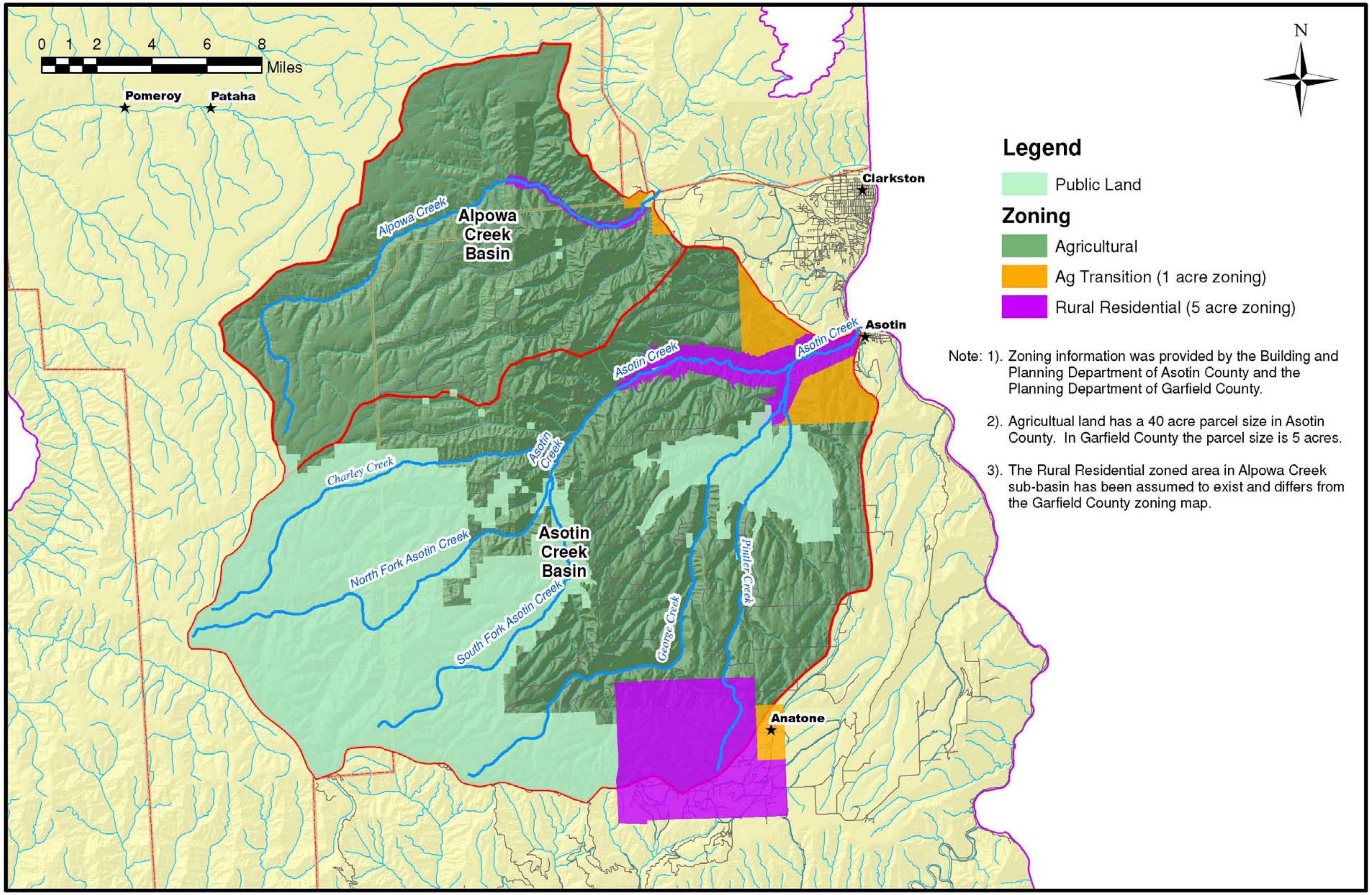


Figure 4-5 Photograph of typical residences in the Town of Anatone area.

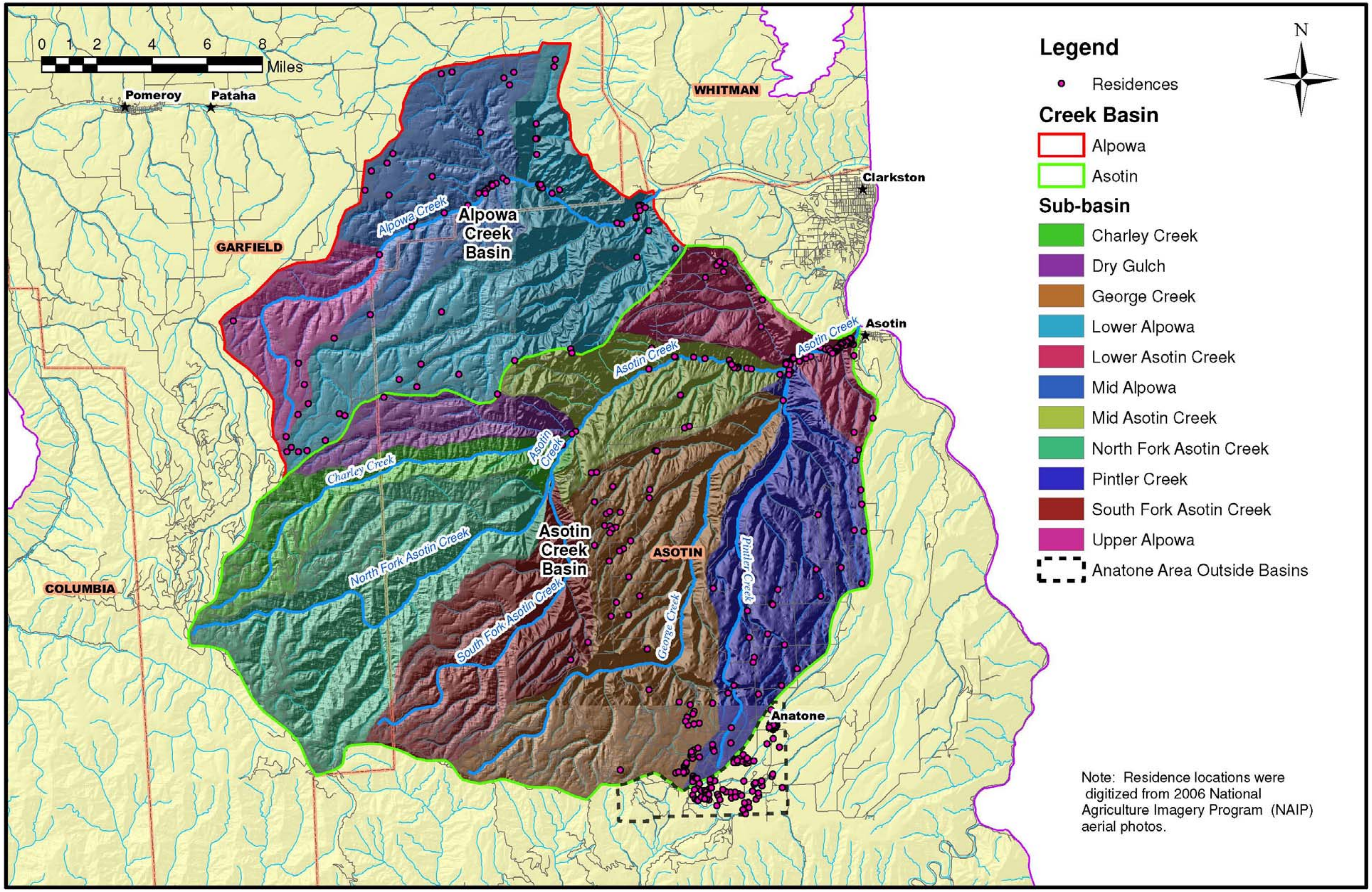


Note: 1). Zoning information was provided by the Building and Planning Department of Asotin County and the Planning Department of Garfield County.

2). Agricultual land has a 40 acre parcel size in Asotin County. In Garfield County the parcel size is 5 acres.

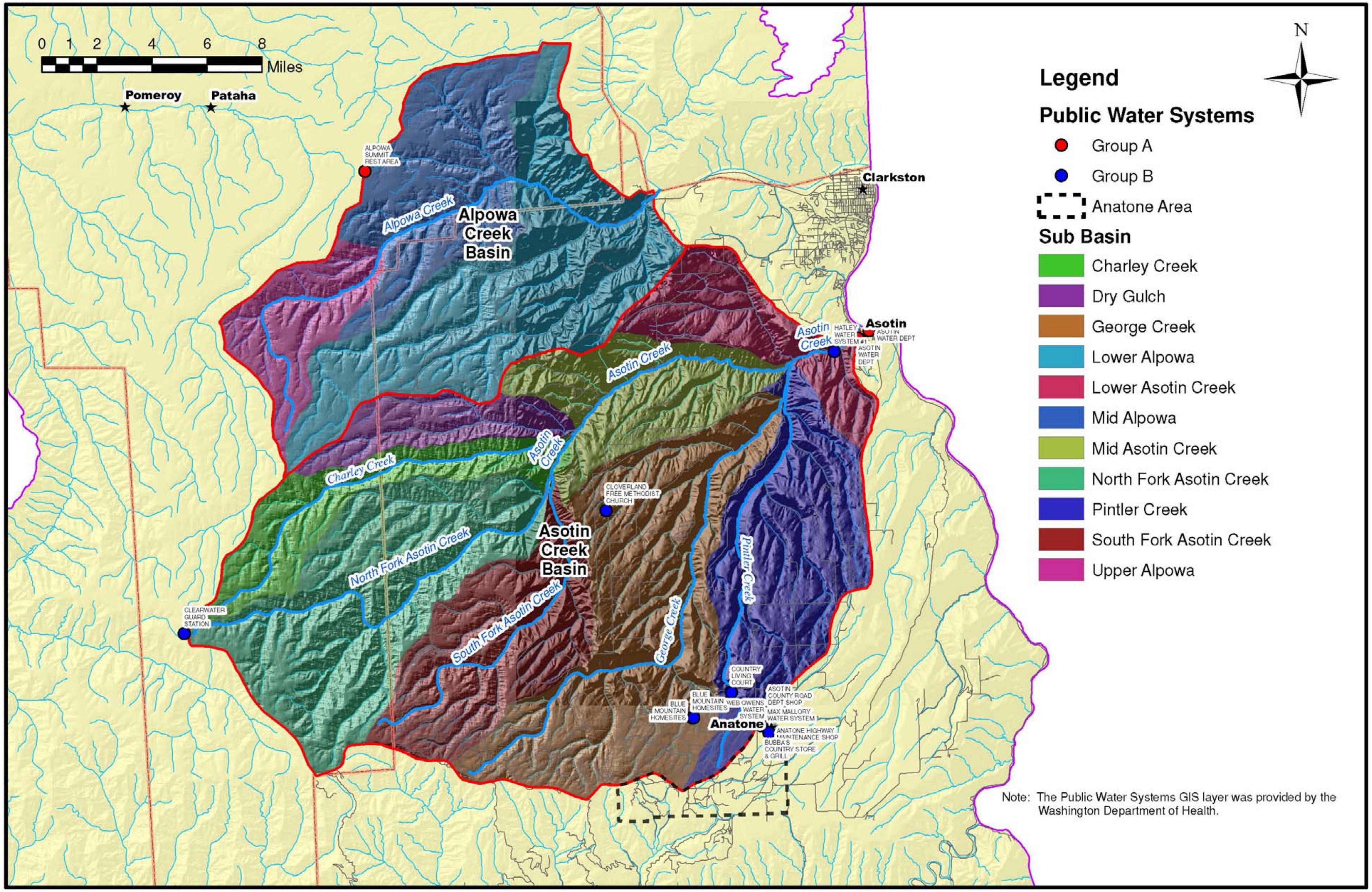
3). The Rural Residential zoned area in Alpowa Creek sub-basin has been assumed to exist and differs from the Garfield County zoning map.

Figure 4-6 Zoning and land use in the Alpowa and Asotin Creek sub-basins



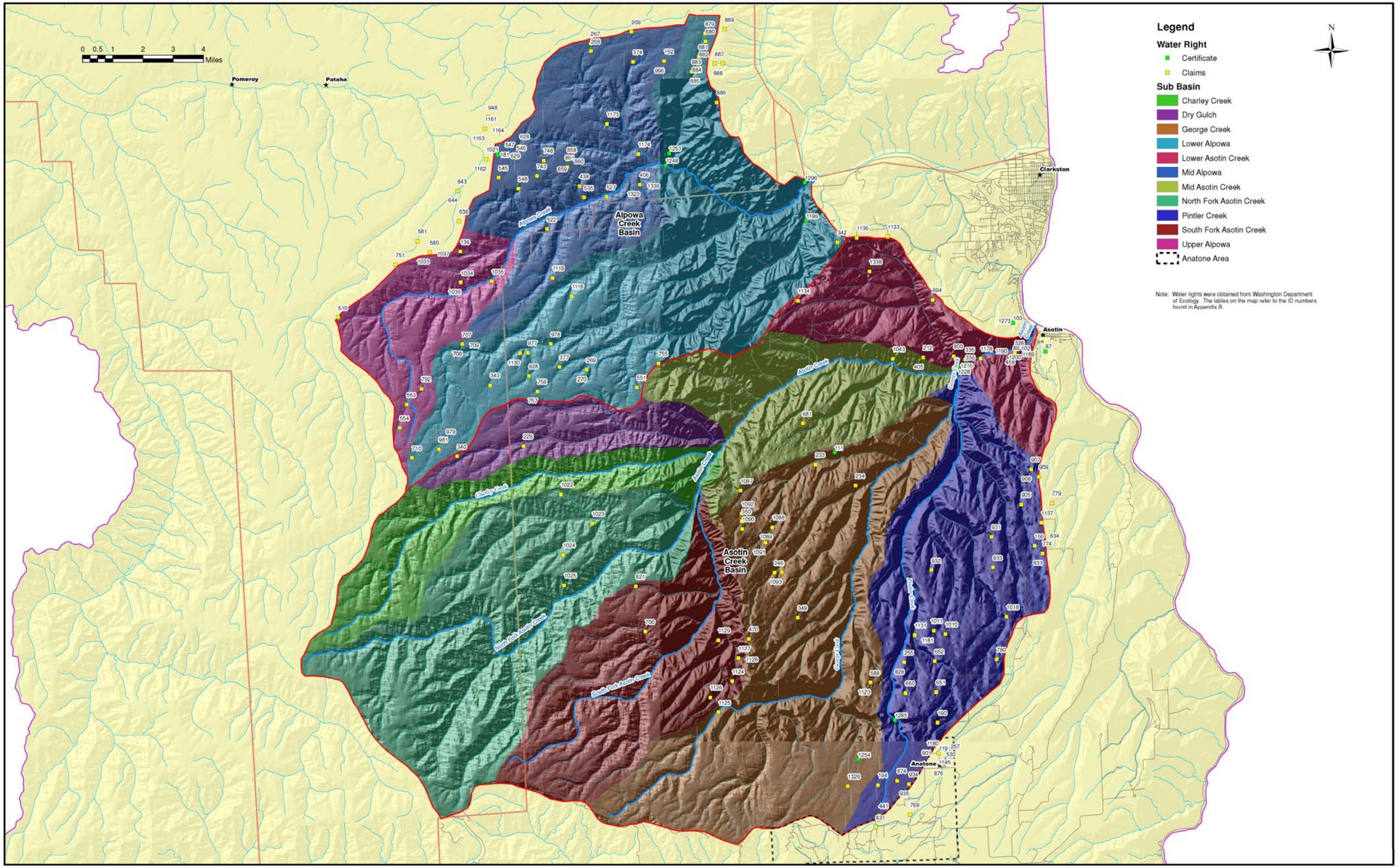
Note: Residence locations were digitized from 2006 National Agriculture Imagery Program (NAIP) aerial photos.

Figure 4-7 Locations of residences digitized from aerial photographs



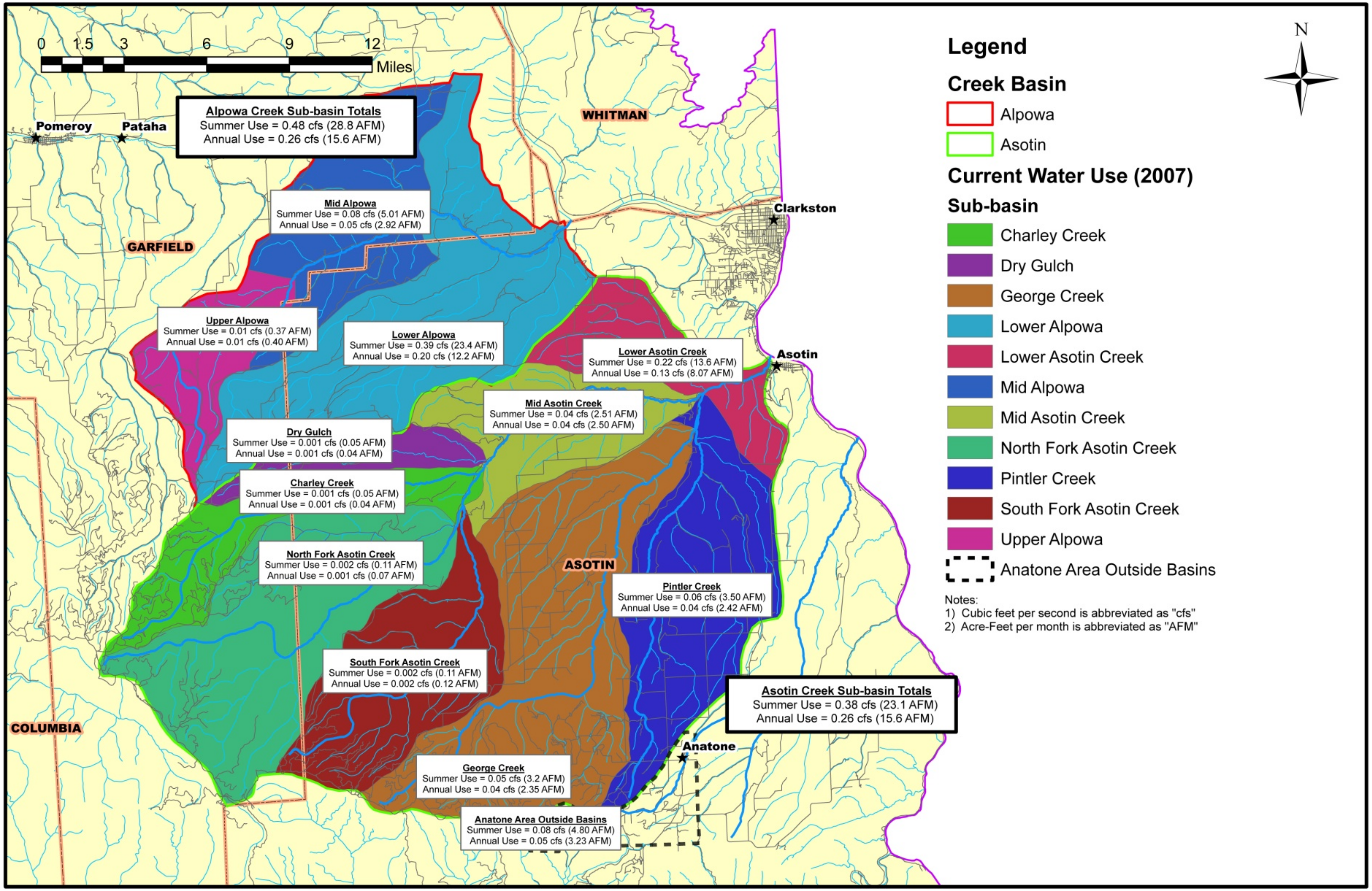
Note: The Public Water Systems GIS layer was provided by the Washington Department of Health.

Figure 4-8 Group A and B public water supply systems in the project area



Note: Water rights were obtained from Washington Department of Ecology. The lables on the map refer to the ID numbers found in Appendix B.

Figure 4-9 Water right certificates and claims in the project area



Alpowa Creek Sub-basin Totals
Summer Use = 0.48 cfs (28.8 AFM)
Annual Use = 0.26 cfs (15.6 AFM)

Mid Alpowa
Summer Use = 0.08 cfs (5.01 AFM)
Annual Use = 0.05 cfs (2.92 AFM)

Upper Alpowa
Summer Use = 0.01 cfs (0.37 AFM)
Annual Use = 0.01 cfs (0.40 AFM)

Lower Alpowa
Summer Use = 0.39 cfs (23.4 AFM)
Annual Use = 0.20 cfs (12.2 AFM)

Lower Asotin Creek
Summer Use = 0.22 cfs (13.6 AFM)
Annual Use = 0.13 cfs (8.07 AFM)

Mid Asotin Creek
Summer Use = 0.04 cfs (2.51 AFM)
Annual Use = 0.04 cfs (2.50 AFM)

Dry Gulch
Summer Use = 0.001 cfs (0.05 AFM)
Annual Use = 0.001 cfs (0.04 AFM)

Charley Creek
Summer Use = 0.001 cfs (0.05 AFM)
Annual Use = 0.001 cfs (0.04 AFM)

North Fork Asotin Creek
Summer Use = 0.002 cfs (0.11 AFM)
Annual Use = 0.001 cfs (0.07 AFM)

Pintler Creek
Summer Use = 0.06 cfs (3.50 AFM)
Annual Use = 0.04 cfs (2.42 AFM)

South Fork Asotin Creek
Summer Use = 0.002 cfs (0.11 AFM)
Annual Use = 0.002 cfs (0.12 AFM)

Asotin Creek Sub-basin Totals
Summer Use = 0.38 cfs (23.1 AFM)
Annual Use = 0.26 cfs (15.6 AFM)

George Creek
Summer Use = 0.05 cfs (3.2 AFM)
Annual Use = 0.04 cfs (2.35 AFM)

Anatone Area Outside Basins
Summer Use = 0.08 cfs (4.80 AFM)
Annual Use = 0.05 cfs (3.23 AFM)

Notes:
1) Cubic feet per second is abbreviated as "cfs"
2) Acre-Feet per month is abbreviated as "AFM"

Figure 4-10 Current groundwater use by sub-basin

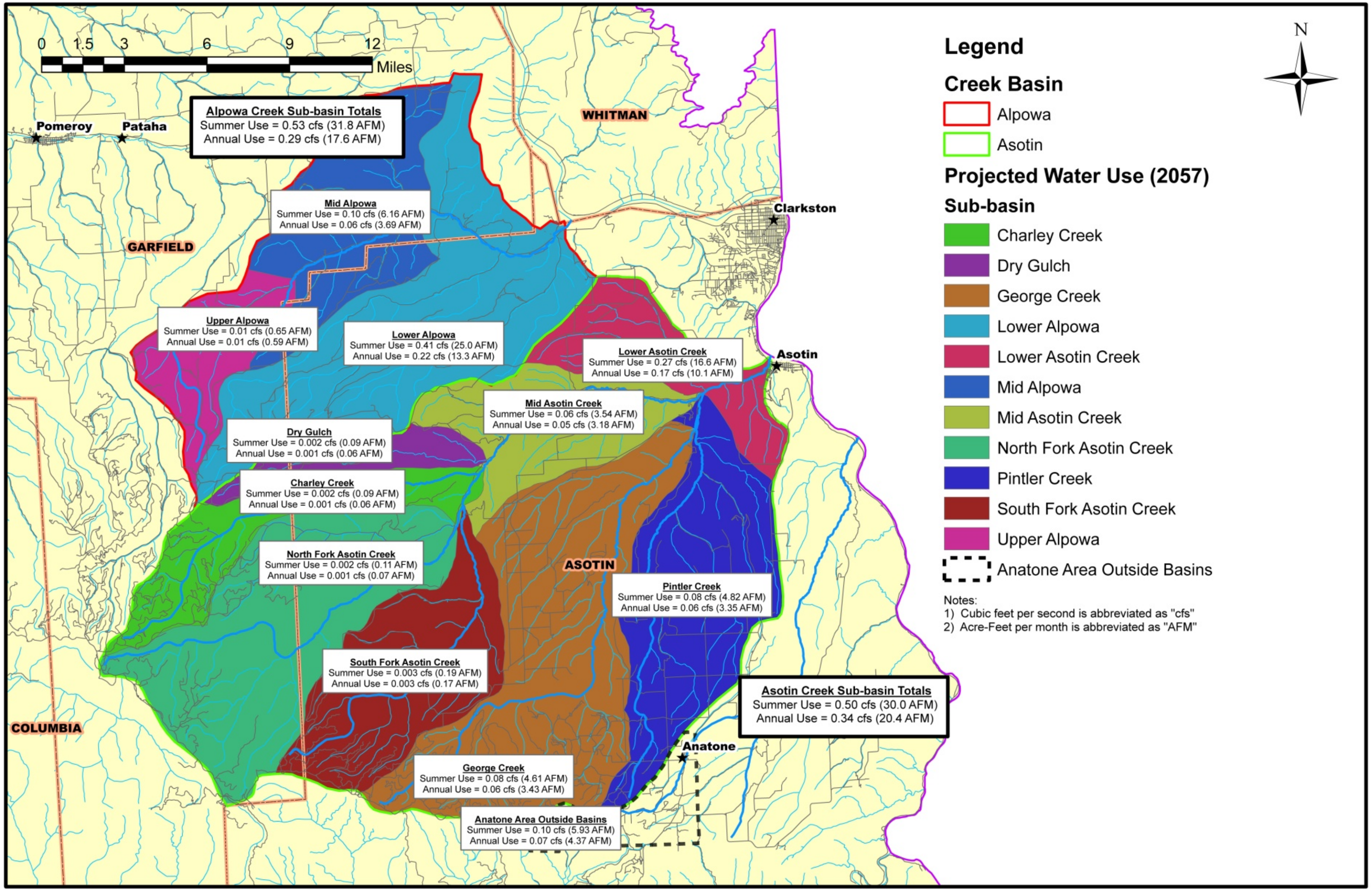


Figure 4-11 **Ground water use by sub-basin for 50-year Future-Growth Scenario**

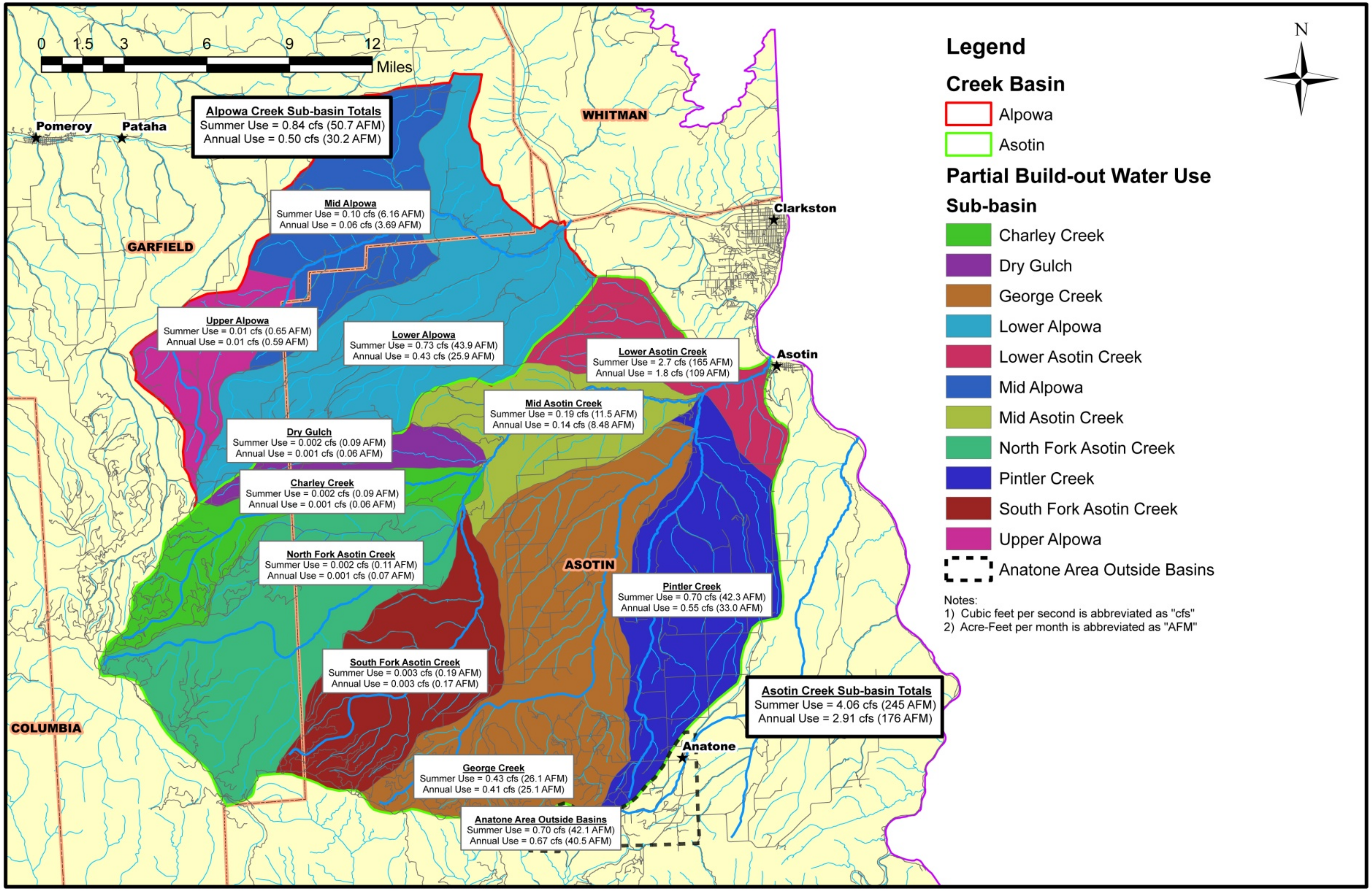


Figure 4-12 Ground water use by sub-basin for Partial Build-Out Scenario

Chapter 5
Summary and Conclusions

A field investigation, hydrogeologic evaluation and water use analysis was conducted for the Alpowa Creek and Asotin Creek sub-basins. The study area included the Alpowa and Asotin Creek sub-basins as well as the Town of Anatone and Tenmile and Mill Creek sub-basins. This chapter presents a summary of the field investigations and analysis and major conclusions.

5.1 Field Investigation

The field investigation included a physical reconnaissance of the study area, interviews with persons living at 52 households to determine water use characteristics (lawn size, number of persons per household and irrigation practices), interviews with other landowners and with persons familiar with the project area to determine the location and irrigated acreage of small valley (lowland) farms and the number and location of stock in the project area. An average of 2.4 persons per household and an average lawn size of 2,500 square feet were identified during the survey. The field investigation also included identifying, visiting and measurement of groundwater levels at about 58 wells in the fall of 2008 and 26 wells in the spring of 2009 and creek flow measurements to determine groundwater gains and losses (seepage run) for Asotin Creek (North Fork, South Fork and Mainstem), George Creek, Charley Creek, Alpowa Creek, Mill Creek and Tenmile Creek.

5.2 Hydrogeologic Evaluation

5.2.1 Geology

The project area is located in Asotin and Garfield County. The predominant geologic formation is the CRBG, which is a thick sequence of flood basalt prevalent throughout the region. The project area is within the western half of the Lewiston Basin, which is a structural basin bounded by folded and faulted CRBG. The CRBG formations on the western edge of the basin down-dip to the east to the center of the basin. The western edge of the basin and the formation anticline runs through the Town of Anatone and the northern portion of the town is on the northeastern limb of the anticline and the area south of the town is on the southwestern limb of the anticline. The structural dip (to the east) ranges from 2 to 10 degrees and the CRBG formations found exposed in the project area highlands are well below the Snake River in the center of the basin. The strong down-dip in the CRBG formations cause over one mile of structural relief in the project area. There is significant faulting on the western portion of the Lewiston basin in the project area. A number of generally east-west oriented faults are mapped in associated with the anticline on the southern edge of the project area and generally north-south faults occur from the mouth of Alpowa Creek south to the lower portion of Asotin Creek. Faulting is also evidenced in many areas throughout the upper portions of the basins. The Asotin and Alpowa Creek and their tributaries have eroded steep canyons which have truncated and divided the CRBG formations. Canyon depths are in excess of 1,500 feet.

The oldest geologic formation evaluated for this project in the study area is the CRBG. The CRBG is classified by a vertical sequence of mappable formations including (from youngest to oldest), the Saddle Mountains Basalt, Wanapum Basalt, Grande Ronde

Basalt and Imnaha Basalt. The Saddle Mountain and Wanapum basalt units are the upper units and are present in eastern portion of the Asotin Creek sub-basin (they are eroded from the western portion of the basin). The creek valleys completely truncate and erode these units in most areas. The Grande Ronde Basalt forms the deeper basalt unit in the study area. This unit is exposed in the deeper canyons in the upper portion of the sub-basins and because of down-dip and structural relief they are buried below the bottom of the canyons in the middle and lower portions of the basin.

The CRBG is overlain by younger Pleistocene deposits in the valley bottoms mostly composed of alluvial sand, gravel and cobbles ranging from less than 20 feet deep in the upper basin to 50 to 100 feet deep in the middle areas of the valleys and from 50 to over 150 feet deep in the lower valley. Asotin Creek and Alpowa Creek flow directly on these alluvial deposits. More recent silt overbank deposits are located atop the alluvial sand and gravel deposits in the middle and lower portions of the valleys.

5.2.2 Hydrogeology

The sand and gravel alluvial deposits present in most of the valleys form a shallow unconfined aquifer ranging from less than 50 to over 150 feet in thickness that is in direct hydraulic-continuity with the creeks flowing in the valley bottoms. Few wells are completed in this aquifer.

The principal groundwater supply aquifers in the study area are the confined, shallow and intermediate basalt hydrostratigraphic unit (SBHU and IBHU) aquifers. The SBHU is intersected and eroded by the tributary and mainstem creek canyons and the aquifer discharges to springs in the upper portion of the Alpowa and Asotin Creek sub-basins. The IBHU displays characteristics of both the shallow and deep units, depending on location. In the Alpowa Creek and upper Asotin Creek areas, the unit is deeply incised by canyons; aquifers likely display limited lateral continuity, water production is low, and many water-bearing zones discharge to springs in the headwaters areas of these streams. In the Lower Asotin Creek area this unit is generally at or below most canyon bottoms.

The lateral continuity of the SBHU and IBHU units is controlled by faults, feeder dikes and other geologic features in the formation and the deeper canyons which partially to completely truncate these units. Most faults are expected to form flow barriers in basalt aquifers. Most of the groundwater flow from these aquifers to surface water appears to be within the upper portions of the basin and small springs are observed emanating from the basalt in the headwaters. There is little hydrologic evidence that the basalt aquifers are in continuity with surface water in the middle and lower portions of the sub-basins. An exception is Alpowa Creek, where seepage run data indicate a cumulative gain in flow from groundwater of about 5 to 6 cfs, which is the vast majority of flow in the creek.

Most of the basalt wells are located in the middle and lower areas of the sub-basins and are completed in the SBHU or IBHU aquifers. In the mainstem Asotin Creek basin and in George and Charley Creek to the seepage run data suggests that basalt aquifers are not discharging to or providing flow to the creeks. Ground water levels measured in wells vary significantly for wells completed within the same geologic unit indicating a high degree of discontinuity within a single formation. The available geologic information also indicates that the structure of the basalt (faulting, erosion, truncation, pinch outs) causes the aquifers to be hydraulically discontinuous between wells and surface water drainages.[1] Pumping by individual wells at low rates needed for household or small agricultural use at relatively few households spread over a large area is unlikely to impact surface water flow. This is especially the case since the basalt aquifers that supply the water are not expected to be hydraulically-connected to stream flow in the middle and lower portion of the Asotin Creek sub-basin where most groundwater usage currently occurs and where most future growth is likely to occur.

There is little evidence to suggest that the deep basalt hydrostratigraphic unit (DBHU) is in hydrologic connection with streams in the mainstem Asotin and Alpowa sub-basin. Very few wells (less than 15 percent) are exclusively completed in the deep basalt hydrostratigraphic unit (DBHU). This is probably due to the high cost of drilling into deep basalt and the availability of water from the more-shallow basalt aquifers. The available data shows that the DBHU is present several hundred feet below the bottom of the canyon bottoms and is not in hydrologic connection to mainstem and tributary creeks. Most of these wells are located in the lower portion of the basin and probably use water that would eventually flow into the Snake River and are not hydraulically-connected to the Asotin or Alpowa Creeks or their tributaries. Therefore, we can conclude that the few wells that are pumping from the deep aquifer are not affecting creek flow in the project area.

5.3 Water Use Estimate

A water use estimate was conducted for the project area. The water use estimate included residential use, public supply use and agricultural use components.

Residential use was based on population estimates and household use rates. The current-day population was estimated from a count of households (365 residences) and assuming 2.5 persons per household (which is consistent with the 2.4 person per household estimate from the field survey) indicating a total current population of about 900 persons. The 50-year future population was estimated at 640 residences and 1,600 persons using a conservative estimate of 1 percent growth. An estimate of the development of the lots in the lower portion of the basins where residential growth is most likely to occur yielded an estimate of 8,400 residences with 21,000 persons. This is very conservative because it assumes that all lots in these areas will be developed with individual wells, whereas in reality, development at this level would likely involve connection to a public water supply system supplied from deep wells that would likely not be hydraulically-connected to the creeks in the sub-basin. We estimated an annual residential use rate of 381 gpd/household and a summer use rate of 571 gpd/household. This estimate is higher than national and regional averages, but is lower than the household meter record use within the Asotin PUD water service area. This is reasonable considering the arid climate and the fact that most of the lawns in the project area are much smaller than residences in the Asotin PUD service area and are irrigated at less than the irrigation demand.

Public water supply use is a minor component of total water use. There are only 38 households or businesses served by public water supply systems not counting the Town of Asotin. The Town of Asotin is served by a deep basalt well near the Snake River and the source of the water is not within the project area so it was not included in the water use estimate.

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[1] The shallow basalt aquifer near the Town of Anatone is an exception and groundwater levels in wells show a continuous groundwater flow gradient that suggests a hydraulic connection within the aquifer.

Agricultural groundwater use was estimated based on water rights, a field survey, interviews with persons knowledgeable about the irrigation practices in the area and a count of irrigated lands and stock in the sub-basins. A total of about 91 acres are irrigated for agriculture with an estimated annual water use of about 245 AF/yr. Stock watering was estimated based on a count of stock and assuming 27 gpd for cattle and 18 gpd for horses. The estimated 1,900 stock in the basin are estimated to use about 29 AF/yr assuming full consumptive use.

The Alpowa Creek sub-basin water use for current-day population in the summer is about 0.48 cfs (28.8 acre-feet/month) with 0.09 cfs (5.3 afm) return flow and the annual water use is about 0.26 cfs (15.6 afm) with about 0.05 cfs (3.3 afm) return flow. The Asotin Creek sub-basin water use for current-day population in the summer is about 0.38 cfs (23.1 afm)with 0.10 cfs (6.3 afm) return flow and the annual water use is about 0.26 cfs (15.6 afm) with about 0.08 cfs (5.1 afm) return flow. This information shows that current-day water use is not a significant factor with regards to the potential for stream flow depletion from water use.

The 50-year projected future growth scenario shows that in the Alpowa Creek sub-basin the annual and summer groundwater use rate increases to about 0.29 cfs or 17.6 afm (0.07 cfs or 4.3 afm return flow) and 0.53 cfs or 31.8 afm (0.11 cfs or 6.4 afm return flow), respectively. For the Asotin Creek sub-basin the 50-year projected future growth scenario shows that the annual and summer groundwater use rate increases to about 0.34 cfs or 20.4 afm (0.13 cfs or 7.7 afm return flow) and 0.50 cfs or 30 afm (0.15 cfs or 9.2 afm return flow), respectively. This information shows that water use is not a significant factor with regards to the potential for stream flow depletion from water use for the projected 50-year growth scenario.

The partial build-out growth scenario shows that in the Alpowa Creek sub-basin the annual and summer groundwater use rate increases to about 0.5 cfs or 30.2 afm (0.18 cfs or 10.7 afm return flow) and 0.84 cfs or 50.7 afm (0.22 cfs or 13.5 afm return flow), respectively. For Asotin Creek sub-basin the 50-year projected future growth scenario shows that the annual and summer groundwater use rate increases to about 2.9 cfs or 176 afm (1.7 cfs or 101 afm return flow) and 4.0 cfs or 246 afm (1.8 cfs or 109 afm return flow), respectively. This is a very conservative future growth scenario because it assumes that all lots in these areas will be developed with individual wells proving a water supply. In reality, if development at this scale occurred in the middle and lower Asotin Creek sub-basin the residences would be served by a public water supply system supplied from deep basalt aquifer wells that are not hydraulically-connected to Asotin Creek.

Chapter 6
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Appendix A
Water Use Survey Form

Middle Snake (WRIA 35) Watershed Planning Water Use Survey

Owner Information

Name: ______________________________

Address: ______________________________

City: ______________ State: ____________ Zip: ______________

Well Information

Township: __________ Range: __________ Section: __________ Qtr/qq: ______/__________

Well Elevation (top of casing): ______________________________

Ground Surface Elevation: ______________________________

Ground Water Level: ______________________________

Well Depth: ______________________________

Well Log ID: ______________________________

Water Use

How many people live in your house? ______________________________

Do you water your lawn and/or garden in the summer? ______________________________

How often do you water your lawn or garden? ______________________________

How do you water your lawn or garden? ______________________________

Do you water stock (horses or cattle) from your well? ______________________________

Estimate number of stock watered in the winter or summer? ______________________________

Has your well ever gone dry? ______________________________

Any other water use? ______________________________

Comments: ______________________________

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Appendix B
Well Log Information

Well Specifications

Explanation of Column Headings Abbreviations

Well ID – Project identification number

Ecology Well ID # - Department of Ecology well identification number

T-N – Township, North

R-E – Range, East

Sec. – section number

Q-Q – quarter/quarter section

Surf elev (ft amsl) – surface elevation at well estimated from digital elevation model

TOB depth – depth to top of basalt report on dirller's log in feet

TOB elev – calculate elevation of top of basalt

Use: D – domestic well; M – public supply well; S – stock well; S – stock well

Surf seal depth – depth below ground surface surface seal reported to extend, in feet

Elev seal bottom – elevation of bottom of surface seal, in feet

Prod casing depth – depth below ground surface production casing extends, in feet

Elev casing bottom – elevation of bottom of production casing, in feet

Open int top depth – depth below ground surface of top of open/screened interval, in feet

Elev open int top – elevation of top of open/screened interval, in feet

Open int bottom depth – depth below ground surface of bottom of open/screened interval, in feet

Elev open int bottom – elevation of bottom of open/screened interval, in feet

Open in dia (in) – reported diameter of open/screened interval, in inches

DTW (ft) – reported depth to water, in feet

WT elev (ft amsl) – calculated elevation of water in well, in feet above mean sea level

Pump test type: A – airlift; B – bailer; P – pump

Rate (gpm) – reported rate for well pump test, gallons per minute

DD (ft) – reported draw down during well test, in feet

SC – calculated specific capacity for pumping test, gallons per minute, per foot fo draw down

Temp – water temperature in degrees Fahrenheit

Upland – well placed in upland area above canyon bottoms

Valley – well placed at or near canyon bottoms, typical near streams

QMs – well interpreted to be open to Quaternary to Miocene sediments

Mvsu – well interpreted to be open to upper portion of Saddle Mountains Basalt
Mvsl – well interpreted to be open to lower portion of Saddle Mountains Basalt
Mvwu – well interpreted to be open to upper portion of Wanapum Basalt
Mvwl – well interpreted to be open to lower portion of Wanapum Basalt
N2 – well interpreted to be open to N2 Grande Ronde Basalt
R2 – well interpreted to be open to R2 Grande Ronde Basalt
N1 – well interpreted to be open to N1 Grande Ronde Basalt
R1 – well interpreted to be open to R1 Grande Ronde Basalt
I – well interpreted to be open to Imnaha Basalt

Well Specification Table

Well ID	DOE Well Log ID #	Latitude	Longitude	T - N	R - E	Sec.	Q-Q	Owner	year drilled	month drilled	surf elev (ft amsl)	TOB depth	TOB elev	TD (ft bgs)	TD elev (ft amsl)	Use	surf seal depth	elev seal bottom	prod casing depth	elev casing bottom	open int top depth	elev open int top	open int bottom depth	elev open int bottom
ASO0069	332825	46.360320	-117.368800	10	43	12	NE/NE	Fitzgerald Farms	2001	10	2897	17	2880	710	2187	D	18	2879	610	2287	570	2327	610	2287
ASO0071	159378	46.324730	-117.394380	10	43	23	SW/SW	Roosevelt	1986	10	3457	7	3450	61	3396	D	19	3438	19	3438	19	3438	61	3396
ASO0234	166720	46.192530	-117.321380	8	44	5	SW/SE	Schibbe	1995	7	3235	1	3234	405	2830	D	18	3217	405	2830	380	2855	405	2830
ASO0235	166721	46.204200	-117.323000	8	44	8	NW/NE	Schibbe	1995	7	3919	1	3918	445	3474	D		3919	18	3901	18	3901	445	3474
ASO0236	173571	46.150930	-117.310050	8	44	21	SE/SW	Sangster	1979	12	4128	12	4116	165	3963	D	35	4093	35	4093	35	4093	165	3963
ASO0239		46.142530	-117.190070	8	45	29	SE/NE	Blue Mtn Water Users	1986	12	3557	3	3554	377	3180	D	18	3539	323	3234	120	3437	377	3180
ASO0241		46.141800	-117.196620	8	45	29	SW/NE	Blue Mtn Water Users	1986	11	3524	60	3464	430	3094	D	70	3454	70	3454	70	3454	430	3094
ASO0242	423422	46.147320	-117.204070	8	45	29	NW/NW	Blue Mtn Water Users	1992	4	3644	0	3644	840	2804	M	18	3626	19	3625	19	3625	840	2804
ASO0243	423421	46.141930	-117.189220	8	45	29	SE/NE	Blue Mtn Water Users	1992	4	3602	15	3587	1155	2447	M	19	3583	19	3583	19	3583	1155	2447
ASO0244	163699	46.141250	-117.190280	8	45	29	SW/NE	Blue Mtn Water Users	1976	11	3588	2	3586	575	3013	M	20	3568	220	3368	25	3563	575	3013
ASO0245	343667	46.122980	-117.193450	8	45	32	N1/2 SE	VanTrease	2002	10	3884	30	3854	126	3758	D	45	3839	45	3839	45	3839	126	3758
ASO0247	353534	46.119650	-117.188870	8	45	32	SE/SE	Pabst	2002	10	3968	16	3952	157	3811	D	57	3911	157	3811	137	3831	157	3811
ASO0248	165764	46.157330	-117.159900	8	45	22	SW/NW	Poe	1987	4	3496	3	3493	213	3283	D	37	3459	37	3459	37	3459	213	3283
ASO0250	353533	46.120050	-117.191120	8	45	32	SE/SE	Mathews	2002	10	3968	3	3965	160	3808	D	62	3906	160	3808	140	3828	160	3808
ASO0252	166516	46.149850	-117.202520	8	45	20	SE/SW	Everette & Ramsden	1971	7	3576	0	3576	153	3423	D	18	3558	18	3558	18	3558	153	3423
ASO0255	353535	46.120580	-117.190130	8	45	32	SE/SE	Newbry	2002	10	3973	3	3970	160	3813	D	56	3917	56	3917	56	3917	160	3813
ASO0256	167085	46.138080	-117.132820	8	45	26	NW/SE	Reed	1979	11	3563	6	3557	95	3468	D		3563	18	3545	18	3545	95	3468
ASO0257	167128	46.161480	-117.137180	8	45	23	NE/NW	Dennier	1986	6	3477	3	3474	99	3378	D	36	3441	36	3441	36	3441	99	3378
ASO0258	167227	46.134700	-117.136200	8	45	26	SE/SW	Holzmiller	1956	3	3592	5	3587	100	3492	D	80	3512	97	3495	97	3495	100	3492
ASO0259	167518	46.120280	-117.157020	8	45	34	SE/SW	Covey	1990	7	3795	20	3775	94	3701	D	38	3757	38	3757	38	3757	94	3701
ASO0260	168170	46.138770	-117.189500	8	45	29	NE/SW	Barkly	1979	6	3648	3	3645	27	3621	D	18	3630	18	3630	18	3630	27	3621
ASO0261	168171	46.139100	-117.189020	8	45	29	NE/SE	Barkly	1979	6	3647	0	3647	176	3471	D	18	3629	160	3487	110	3537	176	3471
ASO0262	168172	46.138920	-117.188230	8	45	29	NE/SE	Barkly	1979	6	3644	5	3639	50	3594	D	18	3626	18	3626	18	3626	50	3594
ASO0263	168173	46.138620	-117.188800	8	45	29	NE/SE	Barkly	1979	6	3647	8	3639	162	3485	D	137	3510	137	3510	137	3510	162	3485
ASO0264	169083	46.125770	-117.164470	8	45	34	NW/SW	Keller	1986	6	3737	4	3733	78	3659	D	27	3710	27	3710	27	3710	78	3659
ASO0265	169733	46.125270	-117.142380	8	45	35	NW/SW	Hamilton	1995	8	3698	2	3696	485	3213	D	19	3679	265	3433	265	3433	485	3213
ASO0266	169734	46.125030	-117.143930	8	45	35	NW/SW	Hamilton	1995	8	3702	25	3677	203	3499	D	32	3670	203	3499	163	3539	203	3499
ASO0267	386243	46.152650	-117.141880	8	45	23	NW/SW	Seibly	2004	8	3540	3	3537	265	3275	D	19	3521	265	3275	185	3355	265	3275
ASO0268	294025	46.134270	-117.137030	8	45	26	SE/SW	Mallory	1969	6	3602	8	3594	200	3402	D	91	3511	91	3511	91	3511	200	3402
ASO0271	171119	46.151770	-117.225800	8	45	19	SW/SW	Ramsden	1997	5	3727	2	3725	270	3457	D	18	3709	84	3643	24	3703	27	3700
ASO0272	172216	46.134070	-117.136330	8	45	26	SW/SE	VanTrease	1979	12	3599	2	3597	110	3489	D		3599	18	3581	18	3581	110	3489
ASO0275	347009	46.121270	-117.197320	8	45	32	SW/SE	Lane	2002	9	3905	3	3902	138	3767	D		3905	47	3858	47	3858	138	3767
ASO0276	173580	46.120000	-117.149130	8	45	34	SE/SE	Trutter	1984	8	3794	2	3792	129	3665	D	31	3763	31	3763	31	3763	129	3665
ASO0277	294354	46.132600	-117.133580	8	45	35	NW/NE	WA Dept of Highways	1968	8	3597	4	3593	164	3433	D		3597	70	3527	70	3527	164	3433
ASO0278	174320	46.134420	-117.133450	8	45	26	SW/SE	Hasoenrahl	1992	5	3576	5	3571	132	3444	D	19	3557	19	3557	19	3557	132	3444
ASO0281	159637	46.287500	-117.247780	9	44	1	SW/NW	Petti	1979	7	2556	8	2548	192	2364	D	18	2538	192	2364	152	2404	192	2364
ASO0282		46.293020	-117.252430	9	44	9	NE/NE	Reeves	1979	12	2451	3	2448	250	2201	D	18	2433	18	2433	18	2433	250	2201
ASO0283	157902	46.292080	-117.253070	9	44	2	NE/NE	Reeves	1979	12	2469	30	2439	460	2009	D		2469	36	2433	36	2433	460	2009
ASO0284	316468	46.280070	-117.288930	9	44	3	SW/SW	Cook	2001	12	2195	29	2166	94	2101	D	31	2164	94	2101	74	2121	94	2101
ASO0285		46.273120	-117.292530	9	44	10	SW/NW	WA State Game Dept.	1964	1	1962	39	1923	172	1790	D		1962	39	1923	39	1923	172	1790
ASO0286	150371	46.264470	-117.247370	9	44	13	NW/NW	Johnson	1995	3	2765	8	2757	328	2437	D	30	2735	328	2437	288	2477	328	2437
ASO0287	151959	46.244530	-117.252230	9	44	23	SE/NE	McMillen	1995	7	2992	8	2984	129	2863	D	22	2970	22	2970	22	2970	129	2863
ASO0288	159613	46.242280	-117.253280	9	44	23	NE/SE	Kurdy	1995	12	3003	6	2997	120	2883	D		3003	120	2883	60	2943	120	2883
ASO0289	154559	46.236420	-117.251950	9	44	23	SE/SE	Cooper	1995	12	3080	5	3075	129	2951	D	22	3058	129	2951	69	3011	129	2951
ASO0290		46.241800	-117.248920	9	44	24	NW/SW	Strike	1997	6	3003	3	3000	475	2528	D	18	2985	263	2740	263	2740	475	2528
ASO0291	158383	46.236420	-117.253280	9	44	24	NW/SW	Strike	1995	7	3075	6	3069	304	2771	D	19	3056	19	3056	19	3056	304	2771
ASO0293	160260	46.229430	-117.262730	9	44	26	SE/NW	Parson	1993	10	3246	7	3239	157	3089	D	18	3228	157	3089	142	3104	157	3089
ASO0294	442446	46.214520	-117.259830	9	45	35	SW/NE	Parsons	1992	5	3409	3	3406	192	3217	D	19	3390	19	3390	19	3390	192	3217
ASO0295	151979	46.207050	-117.124430	9	45	35	SE/SE	Browne	1997	1	2932	1	2931	165	2767	D	18	2914	150	2782	110	2822	150	2782
ASO0296		46.288370	-117.069200	9	46	5	SW/NE	Hostetter	1992	10	2243	3	2240	500	1743	D	25	2218	446	1797	446	1797	500	1743
ASO0298	152289	46.276830	-117.057220	9	46	9	NW/NW	Ausman	1996	9	2340	2	2338	530	1810	D	38	2302	530	1810	490	1850	530	1810
ASO0299	256928	46.277770	-117.056720	9	46	9	NW/NW	Ausman	2000	7	2331	0	2331	605	1726	D	18	2313	605	1726	585	1746	595	1736
ASO0300	156184	46.273420	-117.056650	9	46	32	SW/NW	Ausman	1995	4	2345	44	2301	303	2042	D	79	2266	79	2266	79	2266	303	2042
ASO0301	149961	46.379280	-117.284750	10	44	3	NE/NW	Pernsteiner	1995	8	1848	23	1825	186	1662	D	18	1830	184	1664	184	1664	186	1662
ASO0302	352056	46.336720	-117.275200	10	44	22	NE/NE	Lunch	2002	5	2859	12	2847	650	2209	D	18	2841	650	2209	610	2249	650	2209
ASO0303	155700	46.302980	-117.261630	10	44	35	SE/NE	Hood	1997	6	1924	33	1891	175	1749	D	33	1891	175	1749	145	1779	175	1749
ASO0304	154204	46.374780	-117.118130	10	45	1	NW/SW	Pope	1997	12	1448	9	1439	489	959	D	18	1430	489	959	355	1093	489	959

Well in Alpowa Creek sub-basin
Well in Asotin Creek sub-basin

Well Specification Table

Well ID	open int dia (in)	DTW (ft bgs)	WT elev (ft amsl)	pump test type	rate (gpm)	DD (ft)	SC (gpm/ft-DD)	Temp (F)	upland	valley	QMs	Mvsu	Mvsl	Mvwu	Mvwl	N2	R2	N1	R1	I	Comments
ASO0069	8	200	2697	A	1			51	X							X	X				0069 is well deepening of 0070
ASO0071	6	25	3432	A	10				X							X					
ASO0234	12	340	2895	A	40			52	X								X				
ASO0235	12	395	3524	A	1			51	X							X					
ASO0236	8	25	4103	A	10			57	X												
ASO0239	8	120	3437	A	10																
ASO0241	8								X				X								Dry Hole
ASO0242	8								X						X						Dry Hole
ASO0243	8			B					X						X						Dry Hole
ASO0244	8	82	3506		27	30	0.900		X				X								
ASO0245	8	92	3792	A	12				X				X								
ASO0247	8	24	3944	A	6				X				X								
ASO0248	8	33	3463	A	30				X			X	X								
ASO0250	8	60	3908	A	4				X				X								
ASO0252	6	80	3496	A	5			51	X				X								
ASO0255	8	58	3915	A	6				X				X								
ASO0256	8	25	3538	A	20				X				X								
ASO0257	8	15	3462	A	2				X			X									
ASO0258	8	2	3590	B	10	70	0.143	42													
ASO0259	8	50	3745	A	42				X				X								
ASO0260	6	16	3632	A	1				X				X								
ASO0261	6	16	3631	A	2				X				X								
ASO0262	6	15	3629	A	1				X				X								
ASO0263	8	35	3612	A	150				X				X								
ASO0264	8	53	3684	A	100				X				X								
ASO0265	8	100	3598	A	1			54	X				X								
ASO0266	8	110	3592	A	50			54	X				X								
ASO0267	8	27	3513	A	50			56	X			X	X								
ASO0268	6	38	3564	A	75				X				X								
ASO0271	8	22	3705	A	3				X				X								
ASO0272	8	19	3580	A	30			54	X				X								
ASO0275	8	97	3808	A	30				X				X								
ASO0276	8	15	3779	A	3				X				X								
ASO0277	6	20	3577		25	63	0.397	60	X				X								
ASO0278	8	8	3568	A	6				X				X								
ASO0281	6	135	2421	A	12			50	X			X									
ASO0282	6								X			X									Dry hole
ASO0283	8	360	2109						X			X									water info not legible
ASO0284	8	28	2167	A	15					X						X					
ASO0285	6	18	1944		20	140	0.143			X							X	X			
ASO0286	8	225	2540	A	20				X			X									
ASO0287	8	75	2917	A	10				X				X								
ASO0288	8	60	2943	A	12				X				X								
ASO0289	8	40	3040	A	12				X				X								
ASO0290	6	240	2763	A	3				X				X								
ASO0291	8	265	2810	A	20				X				X								
ASO0293	6	96	3150	A	60				X				X								
ASO0294	6	182	3227		6				X				X								
ASO0295	8	60	2872	A	5			52	X			X									
ASO0296	6	325	1918		4				X			X									
ASO0298	8	180	2160	A	10			51	X			X									
ASO0299	8	380	1951	A	2				X			X									
ASO0300	8	80	2265	A	2				X			X									
ASO0301	6	145	1703	A	10				X								X				
ASO0302	6	490	2369	A	10			55	X								X	X			
ASO0303	6	120	1804	A	35					X							X	X			
ASO0304	6	305	1143	A	70				X					X							

Well in Alpowa Creek sub-basin
Well in Asotin Creek sub-basin

Well Specification Table

Well ID	DOE Well Log ID #	Latitude	Longitude	T - N	R - E	Sec.	Q-Q	Owner	year drilled	month drilled	surf elev (ft amsl)	TOB depth	TOB elev	TD (ft bgs)	TD elev (ft amsl)	Use	surf seal depth	elev seal bottom	prod casing depth	elev casing bottom	open int top depth	elev open int top	open int bottom depth	elev open int bottom
ASO0305	254155	46.375870	-117.103630	10	45	1	SE/NE	Sanford	2000	2	1439	8	1431	160	1279	D	18	1421	6	1433	150	1289	160	1279
ASO0306	150026	46.380650	-117.124070	10	45	2	NE/NE	Langager	1996	6	1380	7	1373	250	1130	D	143	1237	143	1237	143	1237	250	1130
ASO0307	150027	46.379280	-117.126550	10	45	2	NE/NE	Langlager	1997	11	1329	3	1326	175	1154	D		1329	172	1157	172	1157	175	1154
ASO0310	358822	46.375270	-117.141730	10	45	2	SW/NW	Cunningham	2003	4	1685	15	1670	125	1560	D		1685	125	1560	85	1600	125	1560
ASO0311	151136	46.375080	-117.126470	10	45	2	SE/NE	Pitron	1997	7	1472	33	1439	175	1297	D	38	1434	175	1297	155	1317	175	1297
ASO0312	153317	46.373950	-117.126330	10	45	2	NE/SE	Witter	1997	11	1542	12	1530	260	1282	D	23	1519	260	1282	240	1302	260	1282
ASO0313	156706	46.332450	-117.188530	10	45	20	NE/NE	Gehrke	1993	10	1515	17	1498	98	1417	D	18	1497	98	1417	78	1437	98	1417
ASO0314	149848	46.331030	-117.188900	10	45	20	SE/NE	Weatherly	1990	9	1388	0	1388	90	1298	D	18	1370		1388	18	1370	90	1298
ASO0315	369497	46.329330	-117.174750	10	45	21	NW/SE	Hendrickson	2003	7	1335	38	1297	77	1258	D	41	1294	41	1294	41	1294	77	1258
ASO0316	151201	46.331180	-117.174180	10	45	21	SW/NE	Simpson	1987	7	1479	31	1448	160	1319	D	34	1445	34	1445	34	1445	160	1319
ASO0318	153171	46.324730	-117.145570	10	45	22	SE/SE	Porter	1974	11	1240	5	1235	150	1090	D	20	1220	36	1204	36	1204	150	1090
ASO0319	156306	46.328500	-117.114380	10	45	24	NE/SW	Burnam	1972	11	1089	8	1081	97	992	D,I	37	1052	97	992	87	1002	97	992
ASO0322	426686	46.324880	-117.110920	10	45	24	SW/SE	Leavitt	1989	4	1072	16	1056	60	1012	D	18	1054	18	1054	18	1054	60	1012
ASO0323	308255	46.315200	-117.121730	10	45	25	NW/NE	McHarque	2000	11	1457	5	1452	405	1052	D,S	19	1438	401	1056	360	1097	400	1057
ASO0324	318099	46.322050	-117.131350	10	45	26	NW/NE	Hendrickson	2001	10	1080	42	1038	90	990	D	46	1034	46	1034	46	1034	90	990
ASO0325	347006	46.307000	-117.209320	10	45	31	NE/NE	Adcock	2002	4	2294	90	2204	190	2104	D	88	2206	190	2104	140	2154	180	2114
ASO0326	368583	46.295470	-117.188470	10	45	32	SE/SE	Tietz	2003	7	2329	7	2322	175	2154	D	18	2311	175	2154	135	2194	175	2154
ASO0328	159039	46.351570	-117.066030	10	46	17	NE/NE	Carl	1966	3	872	6	866	181	691	D	6	866	6	866	6	866	181	691
ASO0329	149765	46.351570	-117.067650	10	46	17	NW/NE	Marvel	1985	9	981	9	972	285	696	D		981	44	937	44	937	285	696
ASO0330	426693	46.326250	-117.099470	10	46	14	SW/SW	Dimke	1999	9	905	12	893	150	755	D	18	887	150	755	110	795	150	755
ASO0332	159564	46.331530	-117.078180	10	46	20	SW/NW	Balone	1995	3	1052	7	1045	177	875	D	18	1034	175	877	15	1037	175	877
ASO0333	155838	46.336620	-117.060450	10	46	20	NE/NE	Shuss	1969	7	923	10	913	100	823	D		923		923	0	923	100	823
ASO0336	154251	46.335380	-117.068720	10	46	20	NW/NE	Tilton	1998	8	1245	23	1222	175	1070	D	18	1227	175	1070	155	1090	175	1070
ASO0338	152372	46.331530	-117.071970	10	46	20	SE/NW	Rasmussen	1993	11	980	28	952	115	865	D	20	960	115	865	95	885	115	865
ASO0341	426677	46.330400	-117.060580	10	46	20	NE/SE	Hostetler	2002	2	1009	19	990	610	399	D	56	953	610	399	570	439	610	399
ASO0342	149688	46.332750	-117.068870	10	46	20	SW/NE	Schrader	1989	9	836	25	811	100	736	D	20	816	27	809	27	809	100	736
ASO0343	349408	46.324300	-117.040370	10	46	21	SE/SE	Thornton	2002	10	1685	6	1679	650	1035	D	18	1667	650	1035	610	1075	650	1035
ASO0344	381870	46.322430	-117.039600	10	46	28	NE/NE	Bausch	2004	5	1707	8	1699	750	957	D	18	1689	740	967	700	1007	740	967
ASO0345		46.309480	-117.039520	10	46	28	SE/SE	Donaldson	1991	3	1919	76	1843	242	1677	D	22	1897	78	1841	78	1841	242	1677
ASO0346		46.322680	-117.049920	10	46	28	NE/NW	Fohd	2001	5	1374	77	1297	435	939	D	23	1351	417	957	357	1017	417	957
ASO0505	256919	46.104980	-117.170450	7	45	4	SE/SE	Grinder	2000	8	3893		3893	110	3783	D	18	3875	110	3783	60	3833	110	3783
ASO0506	163073	46.093450	-117.123470	7	45	12	SW/SW	Lansing	1987	12	3798		3798	174	3624	D	20	3778	174	3624	144	3654	174	3624
ASO0507	432454	46.115800	-117.158070	7	45	3	NE/NW	Jeffreys	1989	7	3871		3871	166	3705	D	24	3847	24	3847	24	3847	166	3705
ASO0508	455595	46.106320	-117.180650	7	45	4	SE/SW	Lane	2006	9	3952		3952	160	3792	D	22	3930	160	3792	120	3832	160	3792
ASO0509	253939	46.095900	-117.168330	7	45	9	NE/SE	Scheurman	1999	8	3961		3961	210	3751	D	18	3943	210	3751	170	3791	210	3751
ASO0511	432456	46.107000	-117.174320	7	45	4	SW/SE	Tomlinson	1991	6	3921		3921	104	3817	D	19	3902	94	3827	24	3897	104	3817
ASO0512	163725	46.105030	-117.186480	7	45	4	SW/SW	Coleman	1995	7	3992		3992	205	3787	D	38	3954	38	3954	180	3812	205	3787
ASO0513	163833	46.098200	-117.176220	7	45	9	SW/NW	Wright	1996	7	3979		3979	120	3859	D	18	3961	120	3859	18	3961	120	3859
ASO0514	163855	46.064030	-117.006920	7	45	23	SE/SW	Bond Farms	1990	6	861		861	280	581	D		861	280	581	240	621	280	581
ASO0515	163908	46.110420	-117.202230	7	45	5	NE/SW	Palmer	1994	10	4020		4020	246	3774	D		4020	240	3780	206	3814	246	3774
ASO0516	347010	46.102350	-117.184230	7	45	9	NW/NW	Nuxoll	2002	10	4000		4000	175	3825	D	20	3980	21	3979	21	3979	175	3825
ASO0517	432453	46.111050	-117.147730	7	45	3	NE/SE	McKee	1990	9	3852		3852	118	3734	D	39	3813	39	3813	39	3813	118	3734
ASO0518	165077	46.101670	-117.164680	7	45	10	NW/NW	Norman	1995	8	3923		3923	140	3783	D	18	3905	18	3905	18	3905	140	3783
ASO0522		46.103330	-117.180570	7	45	9	NE/NW	Durham	1993	10	3960		3960	102	3858	D	18	3942	82	3878	62	3898	102	3858
ASO0523	165716	46.097170	-117.142100	7	45	11	SW/NW	Hearne	1995	7	3855		3855	205	3650	D	18	3837	205	3650	155	3700	185	3670
ASO0524	451195	46.102600	-117.176350	7	45	9	NW/NE	Nuxoll	2006	7	3957		3957	175	3782	D	21	3936	175	3782	135	3822	175	3782
ASO0526	451194	46.095850	-117.197800	7	45	8	NW/SE	Olsen	2005	7	4034		4034	205	3829	D	38	3996	205	3829	5	4029	205	3829
ASO0527	455116	46.098000	-117.174380	7	45	9	SW/NE	Genfje	2002	10	3954		3954	225	3729	D	18	3936	225	3729	205	3749	225	3729
ASO0529	432452	46.106370	-117.165450	7	45	3	SW/SW	Tenny	1990	11	3860		3860	143	3717	D	18	3842	143	3717	103	3757	143	3717
ASO0531	432599	46.095850	-117.157650	7	45	10	NE/SW	VanScotter	1995	7	3945		3945	235	3710	D	18	3927	235	3710	215	3730	235	3710
ASO0533	167147	46.103280	-117.167700	7	45	9	NE/NE	Jones	1978	7	3900		3900	155	3745	D	57	3843	155	3745	95	3805	155	3745
ASO0540	168524	46.090620	-117.177130	7	45	9	SE/SW	Geist	1998	5	3795		3795	110	3685	D	28	3767	110	3685	70	3725	110	3685
ASO0541		46.098050	-117.180280	7	45	9	SE/NW	Serades	1999	10	3891		3891	190	3701	D	18	3873	190	3701	150	3741	190	3701
ASO0543	168859	46.116920	-117.164750	7	45	3	NW/NW	Guien	1995	7	3907		3907	125	3782	D	28	3879	120	3787	100	3807	120	3787
ASO0544		46.097120	-117.194280	7	45	8	SW/NE	Patters	2001	12	4001		4001	203	3798	D	18	3983	203	3798	120	3881	203	3798
ASO0546	432455	46.111830	-117.186900	7	45	4	SW/NW	Remacle	1993	10	4035		4035	100	3935	D		4035	90	3945	70	3965	90	3945
ASO0547	372998	46.068480	-117.112980	7	45	24	SW/NE	Rickett	2003	10	2251		2251	375	1876	D	33	2218	375	1876	335	1916	375	1876

Well in Alpowa Creek sub-basin
Well in Asotin Creek sub-basin

Well Specification Table

Well ID	open int dia (in)	DTW (ft bgs)	WT elev (ft amsl)	pump test type	rate (gpm)	DD (ft)	SC (gpm/ft-DD)	Temp (F)	upland	valley	QMs	Mvsu	Mvsl	Mvwu	Mvwl	N2	R2	N1	R1	I	Comments
ASO0305	6	90	1349	A	20			56	X				X								
ASO0306	8	60	1320	A	5				X					X							
ASO0307	6	116	1213	A	9				X					X							
ASO0310	6	85	1600	A	30			55	X				X								
ASO0311	6	41	1431	A	70				X				X								
ASO0312	6	200	1342	A	100				X				X								
ASO0313	6	56	1459	A	40				X							X					
ASO0314	6	10	1378						X							X	X				
ASO0315	8	8	1327	A	25				X							X	X				
ASO0316	8	51	1428	A	128			63	X							X					
ASO0318	6	70	1170	A	40					X							X	X			
ASO0319	6	35	1054	A	30					X								X			
ASO0322	6	16	1056	A	30					X								X			
ASO0323	8	330	1127	A	30			54	X								X				
ASO0324	8	20	1060	A	35					X							X				
ASO0325	8	120	2174	A	50			50	X			X									
ASO0326	6	115	2214	A	2			55	X			X									
ASO0328	8	131	741	B	25	0	250.000			X							X	X			
ASO0329	6	261	720		40					X							X	X			
ASO0330	6	8	897	A	40					X							X	X			
ASO0332	6	83	969	A	40					X							X				
ASO0333	8	48	875		50			59		X							X				
ASO0336	6	95	1150	A	50			57	X							X					
ASO0338	6	64	916	A	30			47		X							X				
ASO0341	8	540	469	A	30			57	X								X	X			
ASO0342	6	48	788		40					X							X				
ASO0343	8	520	1165	A	20			56	X						X						
ASO0344	8	520	1187	A	2			56	X						X						
ASO0345	6	160	1759						X			X									
ASO0346	8	156	1218	A	30			56	X						X						
ASO0505	8	15	3878	A	100																
ASO0506	8	42	3756	A	30				X						X						
ASO0507	6	120	3751		12				X				X								
ASO0508	6	90	3862	A	15			55													
ASO0509	8	140	3821	A	20			51	X			X									
ASO0511	8	33	3888	A	14				X				X								
ASO0512	8	28	3964	A	10			51	X				X								
ASO0513	6	30	3949	A	10																
ASO0514	6	18	843							X										X	
ASO0515	6	62	3958	A	48				X				X								
ASO0516	6	52	3948	A	12																
ASO0517	8	90	3762	A	20				X			X									
ASO0518	8	55	3868	A	30			51													
ASO0522	6	34	3926	A	7			47													
ASO0523	12,8	90	3765	A	12			51	X			X									
ASO0524	6	100	3857	A	30			56	X			X									
ASO0526	6	150	3884	A	18			56	X			X									
ASO0527	6	104	3850	A	11			56	X			X									
ASO0529	6	10	3850	B	8	25	0.320		X			X	X								
ASO0531	6	90	3855	A	10				X			X	X								
ASO0533	8	38	3862	A	12				X			X									
ASO0540	8	50	3745	A	15			52	X						X						
ASO0541	8	90	3801	A	15			51	X				X								
ASO0543	6	30	3877	A	10				X			X									
ASO0544	8	85	3916	A	40			56	X			X									
ASO0546	6	16	4019	A	2			48	X				X								
ASO0547	6	98	2153		4			56	X										X		Artesian flow

Well in Alpowa Creek sub-basin
Well in Asotin Creek sub-basin

Well Specification Table

Well ID	DOE Well Log ID #	Latitude	Longitude	T - N	R - E	Sec.	Q-Q	Owner	year drilled	month drilled	surf elev (ft amsl)	TOB depth	TOB elev	TD (ft bgs)	TD elev (ft amsl)	Use	surf seal depth	elev seal bottom	prod casing depth	elev casing bottom	open int top depth	elev open int top	open int bottom depth	elev open int bottom
ASO0549	343663	46.112270	-117.200330	7	45	5	SE/NW	Schnider	2002	8	3997		3997	202	3795	D	37	3960	138	3859	138	3859	202	3795
ASO0551	170072	46.104980	-117.190980	7	45	7	SE/SE	Guise	1996	8	4037		4037	250	3787	D	38	3999	250	3787	210	3827	250	3787
ASO0553		46.101370	-117.184300	7	45	9	NW/NW	Mathot	1993	9	4004		4004	146	3858	D	18	3986	18	3986	18	3986	146	3858
ASO0557	170720	46.103570	-117.192250	7	45	8	NE/NE	Rooney	1994	11	4040		4040	263	3777	D	19	4021	260	3780	260	3780	263	3777
ASO0558	340816	46.105280	-117.141330	7	45	2	SW/SW	Hampton	2002	8	3867		3867	171	3696	D	20	3847	171	3696	151	3716	171	3696
ASO0560	408234	46.037930	-117.140900	7	45	35	NW/NW	Falconer	2002	2	1455		1455	160	1295	D	38	1417	160	1295	120	1335	160	1295
ASO0562	171425	46.100000	-117.164600	7	45	10	SW/NW	Crozier	1997	7	3924		3924	190	3734	D	18	3906	190	3734	150	3774	190	3734
ASO0563	432600	46.095850	-117.152930	7	45	10	NW/SE	Fauber	1992	9	3939		3939	225	3714	D	30	3909	131	3808	131	3808	225	3714
ASO0564	174991	46.117650	-117.154270	7	45	3	NW/NE	Swearingen	1996	8	3817		3817	203	3614	D	22	3795	203	3614	183	3634	203	3614
ASO0565	171985	46.115700	-117.204280	7	45	5	NW/NW	Allen	1993	10	4003		4003	116	3887	D		4003	116	3887	96	3907	116	3887
ASO0568	172158	46.109730	-117.194430	7	45	5	NW/SE	Prigo	1998	5	4042		4042	210	3832	D	36	4006	210	3832	170	3872	210	3832
ASO0570	175867	46.106320	-117.147520	7	45	3	SE/SE	Cawthon	1996	6	3910		3910	195	3715	D	18	3892	195	3715	175	3735	195	3715
ASO0571	436205	46.102450	-117.146820	7	45	10	NE/NE	Keith	2005	8	3863		3863	144	3719	D	18	3845	144	3719	124	3739	144	3719
ASO0573	173356	46.092080	-117.153780	7	45	10	SW/SE	Nash	1995	11	3942		3942	170	3772	D	97	3845	170	3772	170	3772	170	3772
ASO0575	406980	46.096330	-117.137100	7	45	11	NE/SW	Mortimer	2004	9	3844		3844	190	3654	D	44	3800	44	3800	44	3800	190	3654
ASO0576	432460	46.097220	-117.190630	7	45	8	SE/NE	Mullins	1995	7	4004		4004	275	3729	D	18	3986	275	3729	115	3889	275	3729
ASO0578	174169	46.075270	-117.168680	7	45	16	SE/SE	WA State Park & Rec	1978	4	4118		4118	185	3933	D,I	26	4092	180	3938	140	3978	180	3938
ASO0579	174045	46.091450	-117.116280	7	45	12	SE/SW	Beamer	1981	3	3807		3807	91	3716	D	19	3788	19	3788	19	3788	91	3716
ASO0580	432449	46.105630	-117.146880	7	45	3	SE/SE	Elder	1992	9	3910		3910	278	3632	D	25	3885	52	3858	52	3858	278	3632
ASO0581	174213	46.106170	-117.143150	7	45	2	SW/SW	Hayden	1989	9	3874		3874	245	3629	D	40	3834	220	3654	220	3654	275	3599
ASO0582	369498	46.090030	-117.158570	7	45	10	SE/SW	Byrne	2003	6	3998		3998	165	3833	D	64	3934	165	3833	125	3873	165	3833
ASO0583	432604	46.090520	-116.984620	7	46	12	SE/SW	Beamer	1981	3	1223	5	1218	91	1132	D	19	1204	19	1204	19	1204	91	1132
ASO0584	371128	46.072330	-116.987230	7	46	24	NE/NW	Green	2003	10	829	8	821	425	404	D	29	800	425	404	400	429	425	404
ASO0585	309657	46.073570	-116.990950	7	46	24	NW/NW	Kelly	2001	8	1033	21	1012	125	908	D	25	1008	125	908	105	928	125	908
ASO0586	309654	46.074350	-116.991020	7	46	24	NW/NW	Kondo	2001	7	1143	19	1124	275	868	D	20	1123	275	868	255	888	275	868
ASO0587	309655	46.074000	-116.991020	7	46	24	NW/NW	Kondo	2001	8	1012	27	985	275	737	D	40	972	275	737	255	757	275	737
ASO0588	432618	46.063300	-116.993070	7	46	24	SW/SW	Falkins	1990	6	1011	40	971	275	736	D	18	993	39	972	255	756	275	736
ASO0589	432616	46.063730	-116.995600	7	46	24	SW/SW	Felkins	1994	1	1006	3	1003	410	596	D		1006	400	606	370	636	410	596
ASO0590	309656	46.072930	-116.991100	7	46	24	NW/NW	Benson	2001	8	1103	16	1087	225	878	D	18	1085	225	878	190	913	225	878
ASO0591	432614	46.072530	-116.991100	7	46	24	NW/NW	Ingraham	1995	7	1096	21	1075	103	993	D	26	1070	26	1070	26	1070	103	993
ASO0592	432611	46.051230	-117.030830	7	46	27	NE/SW	Jo2 Cattle Co	1998	4	968	17	951	96	872	D	20	948	96	872	59	909	96	872
ASO0593	432620	46.048200	-117.015780	7	46	26	SW/SW	Haberm & Son	1988	1	990	34	956	180	810	D	33	957	33	957	33	957	180	810
ASO0594	353517	46.105670	-116.993700	7	46	1	SW/SW	Blessed Hope	2002	9	2661	18	2643	527	2134	D	34	2627	168	2493	168	2493	527	2134
ASO0595	455120	46.063630	-116.994050	7	46	24	SW/SW	Sulkasky	2001	9	1017	25	992	200	817	D	27	990	200	817	180	837	200	817
ASO0596	432621	46.052750	-117.009520	7	46	26	NW/SW	Haberman	1988	1	892	10	882	180	712	D	18	874	18	874	18	874	180	712
ASO0597	432619	46.068080	-116.983080	7	46	24	SW/SW	Grande Ronde Ranches	1975	6	845	15	830	173	672	M	22	823	27	818	27	818	173	672
ASO0598	173340	46.117220	-116.953870	7	47	5	NE/NE	Buell	1998	3	1018	18	1000	125	893	D	19	999	98	920	88	930	125	893
ASO0599	371127	46.111980	-116.955130	7	47	6	NE/SE	Packer	2003	10	1037	5	1032	100	937	D	18	1019	97	940	57	980	100	937
ASO0600	432624	46.076400	-116.973300	7	47	7	NW/NE	Nowoj	1999	10	818	0	818	475	343	D	18	800	18	800	18	800	475	343
ASO0601	322750	46.111400	-116.956330	7	47	6	SE/NE	Crider	2002	2	1184	0	1184	100	1084	D	18	1166	94	1090	74	1110	100	1084
ASO0602	163947	46.111000	-116.955270	7	47	6	SE/NE	Oakes	1994	1	1049	5	1044	77	972	D		1049	76	973	66	983	77	972
ASO0603	322751	46.111350	-116.957730	7	47	6	SE/NE	Gipple	2002	2	1292	0	1292	225	1067	D	18	1274	275	1017	275	1017	275	1017
ASO0606	372319	46.184420	-117.025700	8	46	10	SW/NE	Swank	2003	10	3032	2	3030	700	2332	D	18	3014	364	2668	364	2668	700	2332
ASO0607	166688	46.183330	-117.085000	8	46	7	NW/SE	Johnson	1977	11	3130	9	3121	200	2930	D	34	3096	34	3096	34	3096	200	2930
ASO0608	166718	46.119420	-117.009380	8	46	35	SE/SW	Scheibe	1995	8	3286	5	3281	503	2783	D	19	3267	320	2966	280	3006	503	2783
ASO0609	423426	46.119900	-117.008470	8	46	35	SE/SW	Scheibe	1995	7	3275	2	3273	242	3033	D	19	3256	242	3033	202	3073	242	3033
ASO0610	408224	46.183100	-117.004820	8	46	11	NW/SE	Ausman	2005	4	1487	17	1470	325	1162	D	18	1469	320	1167	285	1202	325	1162
ASO0611	318095	46.199220	-116.984270	8	46	1	SE/SE	Scheibe	2001	11	1253	12	1241	200	1053	D	24	1229	200	1053	160	1093	200	1053
ASO0613	423428	46.120280	-116.956570	8	47	31	SE/SE	Vanosdale	1993	3	1256	68	1188	204	1052	D	69	1187	69	1187	69	1187	204	1052
ASO0614	423427	46.139600	-116.935750	8	47	29	NE/SE	Army COE	1997	10	848	50	798	50	798	D	26	822	53	795	50	798	50	798
ASO0615	191605	46.119070	-116.955430	8	47	31	SE/SE	Leighton	1999	10	1394	40	1354	200	1194	D	63	1331	200	1194	160	1234	200	1194
ASO0616	316465	46.160670	-116.927170	8	47	21	NW/NW	Landrum	2001	11	884	46	838	278	606	D	48	836	268	616	268	616	278	606
ASO0617	168221	46.119170	-116.953600	8	47	32	SE/SE	Staats	1994	1	1149			69	1080			1149	66	1083	66	1083	69	1080
ASO0618	431362	46.169370	-116.927080	8	47	16	NW/SW	Flerchinger	2006	2	812			275	537	D	18	794	275	537	235	577	275	537
ASO0619	169155	46.170870	-116.929770	8	47	16	NW/SW	Myrick	1979	8	782	39	743	163	619	D		782	40	742	40	742	163	619
ASO0620	170695	46.161350	-116.927650	8	47	21	NW/NW	Gladson	1998	8	929	50	879	202	727	D	50	879	202	727	162	767	202	727
ASO0621	170696	46.161730	-116.929480	8	47	21	NW/NW	Gladson	1992	8	1031	0	1031	440	591	D		1031	110	921	110	921	440	591

🟩 Well in Alpowa Creek sub-basin
🟦 Well in Asotin Creek sub-basin

Well Specification Table

Well ID	open int dia (in)	DTW (ft bgs)	WT elev (ft amsl)	pump test type	rate (gpm)	DD (ft)	SC (gpm/ft-DD)	Temp (F)	upland	valley	QMs	Mvsu	Mvsl	Mvwu	Mvwl	N2	R2	N1	R1	I	Comments
ASO0549	8	60	3937	A	1				X				X								
ASO0551	8	60	3977	A	10			50													
ASO0553	6	50	3954	A	4				X				X								
ASO0557	8	170	3870	A	10			55	X				X								
ASO0558	6	64	3803	A	40																
ASO0560	6	40	1415	A	30			56	X										X		
ASO0562	8			A	6			50	X			X									
ASO0563	6	74	3865		22				X						X						
ASO0564	8	28	3789	A	30				X			X									
ASO0565	6	51	3952	A	30			51	X				X								
ASO0568	8	150	3892	A	35			48	X				X								
ASO0570	6	118	3792	A	20				X			X									
ASO0571	8	32	3831	A	20				X			X									
ASO0573	8	90	3852	A					X			X									
ASO0575	8	42	3802	A	15				X						X						
ASO0576	6	50	3954	A	6				X			X									
ASO0578	8	56	4062		30	87	0.345	58	X				X								Well 2, Field Springs Park
ASO0579	8	10	3797	A	52				X			X									
ASO0580	6	88	3822		30				X			X									
ASO0581	6	90	3784		30				X				X								
ASO0582	8	53	3945	A	9				X				X								
ASO0583	8	10	1213	A	52				X										X		Same well as ASO0579?
ASO0584	6	101	728	A	12			56		X										X	
ASO0585	6	18	1015	A	30			56		X									X		
ASO0586	6	17	1126	A	12			56		X									X		
ASO0587	6	75	937	A	15			55		X									X		
ASO0588	6	34	977	A	30					X									X		
ASO0589	6	160	846	A	60			45		X									X		ASO0589 & ASO0555 same well
ASO0590	6	16	1087	A	12			56		X									X		
ASO0591	6	18	1078	A	12					X									X		
ASO0592	6	25	943	A	30					X								X	X		Same as ASO0542
ASO0593	6	10	980	A	9			60		X									X		
ASO0594	6			A					X										X	X	Dry well
ASO0595	6	12	1005	A	10					X									X		
ASO0596	6	20	872	A	40			60		X										X	
ASO0597	10	16	829	A	50					X										X	
ASO0598	6	82	936	A	20					X									X		
ASO0599	6	76	961	A	30			56		X									X		
ASO0600	6	200	618	A	1			55		X										X	
ASO0601	6	50	1134	A	13			52	X										X		
ASO0602	6	63	986	A	25			44		X									X		
ASO0603	6	80	1212	A	7				X										X		
ASO0606	6	666	2366	A	1			56	X					X							
ASO0607	8	148	2982	A	37			55	X			X									
ASO0608	8	180	3106	A	6			54	X			X									
ASO0609	8	60	3215	A	9			54	X			X									
ASO0610	8	240	1247	A	22			56		X									X		
ASO0611	6	54	1199	A	10			54		X									X		
ASO0613	8	50	1206	A	15				X										X		
ASO0614	6	24	824	A	100					X	X										
ASO0615	6	119	1275	A	10			68	X										X		
ASO0616	8	36	848	A	8					X										X	
ASO0617	6	56	1093	A	10			55	X										X		
ASO0618	6	186	626	A	22			56		X											
ASO0619	8	120	662	A	10			50		X											
ASO0620	8	80	849	A	10			51		X											
ASO0621	8	90	941	A	1			50		X											

🟩 Well in Alpowa Creek sub-basin
🟦 Well in Asotin Creek sub-basin

Well Specification Table

Well ID	DOE Well Log ID #	Latitude	Longitude	T - N	R - E	Sec.	Q-Q	Owner	year drilled	month drilled	surf elev (ft amsl)	TOB depth	TOB elev	TD (ft bgs)	TD elev (ft amsl)	Use	surf seal depth	elev seal bottom	prod casing depth	elev casing bottom	open int top depth	elev open int top	open int bottom depth	elev open int bottom
ASO0622	423596	46.166970	-116.931600	8	47	16	SW/NW	Rudd	2005	11	1168			225	943	D	75	1093	225	943	125	1043	225	943
ASO0623	410865	46.165450	-116.945520	8	47	17	SE/SW	Scheibe	2005	3	2416			360	2056	D	18	2398	18	2398	18	2398	360	2056
ASO0639	173723	46.412670	-117.196950	11	45	20	SW/SE	US COE	1976	8	738	96	642	113	625	T	35	703	112	626	102	636	112	626
ASO0640	497577	46.382900	-117.145070	11	45	34	SE/SE	Ashcraft	2007	9	1628	3	1625	380	1248	D	18	1610	380	1248	340	1288	380	1248
ASO0641	163025	46.418720	-117.208550	11	45	19	NE/SE	Monte	1988	7	739	0	739	530	209	D		739	19	720	19	720	530	209
ASO0642	163535	46.397950	-117.141470	11	45	26	SW/SW	Ingram	1993	7	1567	15	1552	255	1312	D	30	1537	250	1317	210	1357	250	1317
ASO0643	163684	46.413150	-117.172630	11	45	21	SW/SE	Duckworth	1979	5	994	30	964	283	711	O	35	959	230	764	230	764	280	714
ASO0644	491120	46.388920	-117.104200	11	45	36	SE/NE	Kennedy	2007	7	1078	7	1071	900	178	D		1078	900	178	860	218	900	178
ASO0646	164317	46.417400	-117.172350	11	45	21	NW/SE	Hayden	1999	4	770	6	764	265	505	D	19	751	265	505	225	545	265	505
ASO0647	164371	46.417400	-117.219780	11	45	19	NE/SW	Kurth	1997	6	1698	1	1697	192	1506	D	18	1680	18	1680	18	1680	192	1506
ASO0648	164372	46.397520	-117.190380	11	45	29	SE/SE	Cumming	1998	2	1365	94	1271	200	1165	D	67	1298	185	1180	185	1180	200	1165
ASO0649	475420	46.390770	-117.155320	11	45	35	SE/NW	Dyer	2007	3	1619	20	1599	375	1244	D	18	1601	375	1244	350	1269	375	1244
ASO0651	497580	46.383050	-117.153830	11	45	34	SW/SE	Gittins	2007	9	1681	5	1676	253	1428	D	19	1662	253	1428	213	1468	253	1428
ASO0653	165765	46.411880	-117.220350	11	45	19	SW/SW	Potson	1993	9	1473	30	1443	204	1269	D	18	1455	37	1436	37	1436	204	1269
ASO0655	458189	46.383680	-117.132050	11	45	35	SW/SE	Ernster	2006	10	1535	9	1526	950	585	D	25	1510	25	1510	25	1510	950	585
ASO0657	165977	46.395120	-117.102870	11	45	36	NE/NE	Radke	1992	9	988	230	758	430	558	D	18	970	430	558	330	658	430	558
ASO0659	358824	46.413450	-117.173900	11	45	21	SW/SE	Czyson	2003	4	890	0	890	279	611	D	19	871	279	611	239	651	279	611
ASO0661	167007	46.418330	-117.210950	11	45	19	SE/NE	Smith	1994	10	919	19	900	300	619	D	22	897	22	897	22	897	300	619
ASO0663	465711	46.412720	-117.165130	11	45	21	SE/SE	Winkler	2006	11	1255	8	1247	400	855	D	21	1234	387	868	347	908	400	855
ASO0664	408206	46.382500	-117.136300	11	45	35	SE/SW	Chase	2005	3	1378	15	1363	960	418	D	60	1318	960	418	920	458	960	418
ASO0665		46.413500	-117.172630	11	45	21	SW/SE	Hawkins	2006	9	1007	7	1000	265	742	D	30	977	260	747	220	787	265	742
ASO0666	167730	46.412320	-117.216470	11	45	19	SW/SE	Carn	1994	1	1152	36	1116	282	870	D	22	1130	282	870	262	890	282	870
ASO0667	293798	46.398250	-117.142300	11	45	27	SW/SW	Houser	1968	1	1550	7	1543	883	667	I		1550	280	1270	280	1270	883	667
ASO0670	501166	46.389200	-117.124780	11	45	35	SE/NE	Allen	2007	10	1531	6	1525	765	766	D	19	1512	765	766	725	806	765	766
ASO0671	168822	46.403970	-117.222620	11	45	30	NE/SW	Johnson	1997	6	836	16	820	400	436	D	23	813	400	436	380	456	400	436
ASO0672	497571	46.381730	-117.140420	10	45	2	SW/SW	Lillard	2007	9	1560	3	1557	203	1357	D	18	1542	203	1357	163	1397	203	1357
ASO0673	168925	46.405630	-117.221420	11	45	30	SE/NW	Wilson	1997	10	884	0	884	105	779	D	23	861	105	779	65	819	105	779
ASO0674	468101	46.413980	-117.175670	11	45	21	SE/SW	Mayberry	2007	1	807	0	807	700	107	D	18	789	700	107	660	147	700	107
ASO0676		46.394680	-117.156300	11	45	34	NE/NW	Whittaker	2004	8	1652	6	1646	505	1147	D	19	1633	130	1522	130	1522	505	1147
ASO0677	439824	46.368430	-117.145420	10	45	3	SE/SE	Davidson	2006	4	1691	9	1682	316	1375	D	18	1673	316	1375	271	1420	316	1375
ASO0679	170252	46.423950	-117.213630	11	45	19	NE/NE	West	1988	11	738	0	738	340	398	D	40	698	36	702	36	702	340	398
ASO0682	499034	46.389100	-117.131700	11	45	35	SW/NE	Knapp	2007	10	1609	13	1596	320	1289	D	18	1591	320	1289	270	1339	320	1289
ASO0683	446917	46.390030	-117.140050	11	45	35	NW/SW	Zembas	2006	7	1553	2	1551	340	1213	D	38	1515	305	1248	260	1293	340	1213
ASO0684	254228	46.412770	-117.171650	11	45	21	SW/NE	Rainville	1997	4	1019	0	1019	305	714	D	30	989	305	714	265	754	305	714
ASO0686	172599	46.412030	-117.167330	11	45	21	SE/SE	Simpson	1994	6	1204	26	1178	660	544	D	33	1171	660	544	620	584	660	544
ASO0687.	501164	46.388270	-117.126400	11	45	35	NE/SE	Ellis	2007	10	1558	4	1554	955	603	D	18	1540	955	603	915	643	955	603
ASO0688	254530	46.414420	-117.172000	11	45	21	SW/SE	Dewitt	1999	12	966	49	917	275	691	D		966	275	691	255	711	275	691
ASO0690	408208	46.382320	-117.119680	11	45	36	SW/SW	Parks	2005	3	1326	14	1312	175	1151	D	18	1308	175	1151	175	1151	175	1151
GAR0061	397355	46.354850	-117.487070	10	42	12	SE/SE	Kimble	2004	10	3391	1	3390	700	2691	D	18	3373	19	3372	19	3372	700	2691
GAR0062	252846	46.315650	-117.535280	10	42	27	NW/SE	Schnell	1998	5	3680	12	3668	370	3310	D	18	3662	370	3310	330	3350	370	3310
GAR0063	153179	46.310120	-117.566450	10	42	28	SW/SW	Scoggin	1981	10	4200	7	4193	300	3900	D	18	4182	18	4182	18	4182	300	3900
GAR0064	152358	46.310420	-117.571680	10	42	29	SE/SE	Prescott/Ogden	1979	7	4202	2	4200	214	3988	D	16	4186	25	4177	25	4177	214	3988
GAR0065	161429	46.300930	-117.562350	10	42	33	NE/SW	Scoggin	1995	7	4334	15	4319	539	3795	D	18	4316	20	4314	20	4314	539	3795
GAR0066	161430	46.300350	-117.561650	10	42	33	NE/SW	Scoggin	1995	7	4413	8	4405	200	4213	D	18	4395	18	4395	18	4395	200	4213
GAR0067	157119	46.295270	-117.536770	10	42	34	SW/SE	Skiles	1984	7	4225	5	4220	460	3765	D	39	4186	39	4186	39	4186	460	3765
GAR0072	154937	46.314370	-117.474830	10	43	30	NE/SW	Flerchinger	1977	8	4009	2	4007	161	3848	O	18	3991	23	3986	23	3986	161	3848
GAR0127	166512	46.446630	-117.466920	11	43	7	NE/SE	Lohman	1978	11	2395	12	2383	138	2257	D	18	2377	24	2371	24	2371	138	2257
GAR0129	175305	46.445750	-117.460700	11	43	8	SW/SW	Morgan	1994	12	2600	2	2598	660	1940	D	19	2581	19	2581	19	2581	660	1940
GAR0131	294353	46.436670	-117.421180	11	43	16	SE/NE	WA Dept of Highways	1968	11	2764	22	2742	575	2189	D,I		2764	298	2466	298	2466	575	2189
GAR0133	354601	46.398980	-117.388670	11	43	26	SW/SE	Ledgerwood	2003	2	1978	17	1961	360	1618	O	18	1960	18	1960	18	1960	360	1618
GAR0134	353746	46.403670	-117.388880	11	43	26	NW/SE	Ledgerwood	2003	2	1730	48	1682	125	1605	O	18	1712	49	1681	49	1681	125	1605
GAR0400	460220	46.291450	-117.546930	9	42	4	NE/NE	Wilson	2006	8	4085	2	4083	280	3805	D	18	4067	280	3805	260	3825	280	3805
GAR0401	152250	46.292080	-117.546370	9	42	4	NE/NE	Baker	1977	5	4021	10	4011	78	3943	M	24	3997	24	3997	24	3997	78	3943
GAR0402	375031	46.292180	-117.548700	9	42	4	NE/NE	Ledgerwood	2003	10	4250	1	4249	350	3900	D	18	4232	18	4232	18	4232	350	3900
GAR0403	160288	46.292330	-117.489580	9	42	1	NW/NE	Flerchinger	1977	7	4487	1	4486	125	4362	D	19	4468	23	4464	23	4464	125	4362
GAR0404	163546	46.420780	-117.280780	11	44	22	SW/NE	Brankhorst	1995	6	1322	0	1322	363	959	D	18	1304	363	959	333	989	363	959
GAR0405	165604	46.433150	-117.321080	11	44	17	NW/SE	Ledgerwood	1980	4	1337	17	1320	139	1198	D	20	1317	29	1308	29	1308	139	1198

Well in Alpowa Creek sub-basin
Well in Asotin Creek sub-basin

Well Specification Table

Well ID	open int dia (in)	DTW (ft bgs)	WT elev (ft amsl)	pump test type	rate (gpm)	DD (ft)	SC (gpm/ft-DD)	Temp (F)	upland	valley	QMs	Mvsu	Mvsl	Mvwu	Mvwl	N2	R2	N1	R1	I	Comments
ASO0622	6	101	1067	A	17			56		X											
ASO0623	6	180	2236	A	8				X									X			
ASO0639	10	30	708							X								X	X		
ASO0640	8	250	1378		20			59													
ASO0641	6	210	529	A	3					X										X	
ASO0642	8	200	1367																		
ASO0643	8	186	808	A	100																
ASO0644	8	602	476	A	15			56													
ASO0646	8	151	619	A	12			54		X								X	X		
ASO0647	6	112	1586	A	20				X										X		
ASO0648	8	150	1215	A	50				X							X	X				
ASO0649	6	304	1315	A	20																
ASO0651	8	180	1501	A	12			59													
ASO0653	8	140	1333	A	30			51	X										X		
ASO0655	8			B																	Dry hole - decommissioned
ASO0657	8	258	730	A	60			53													
ASO0659	6	150	740	A	20			59													
ASO0661	6	160	759	A	30					X								X	X		
ASO0663	6	340	915	A	15			55	X												
ASO0664	8	720	658	A	72			56													
ASO0665	6	125	882	A	40			56													
ASO0666	6	96	1056	A	30					X									X	X	
ASO0667	8	835	715					65													
ASO0670	8	600	931	A	25			59													
ASO0671	6	340	496	A	10					X										X	
ASO0672	8	150	1410	A	12			60	X			X									
ASO0673	6	93	791	A	60			50		X										X	
ASO0674	6	488	319	A	20			56		X										X	
ASO0676	8			A					X				X								No water
ASO0677	6	196	1495	A	20			56	X			X									
ASO0679	6	57	681	A	25					X										X	
ASO0682	8	130	1479	A	30			52	X						X						
ASO0683	8	205	1348	A	15			52	X						X						
ASO0684	8	220	799	A	15			54	X								X				
ASO0686	8	570	634	A	30				X								X				
ASO0687.	8	850	708	A	10			60	X								X				
ASO0688	6	220	746	A	16			56	X								X				
ASO0690	6	60	1266	A	15			56	X					X							
GAR0061	6	510	2881	A	2				X								X				
GAR0062	8	150	3530	A	1			46	X								X	X			
GAR0063	8								X							X					DRY HOLE
GAR0064	8	178	4024	B	1				X							X					
GAR0065	6			A					X								X				DRY HOLE
GAR0066	6			A					X							X					DRY HOLE
GAR0067	6								X								X				DRY HOLE
GAR0072	8								X							X					No H2O information
GAR0127	8	70	2325	P	11	60	0.183			X						X					
GAR0129	6									X							X	X			DRY HOLE
GAR0131	8	474	2290	P	62	38	1.632	60		X						X	X				
GAR0133	6	180	1798	A	4					X							X				
GAR0134	8	33	1697	A	250					X							X				
GAR0400	6	200	3885	A	10				X									X			
GAR0401	8	46	3975		7				X								X				
GAR0402	6	250	4000	A	6				X								X				
GAR0403	8	20	4467						X								X				
GAR0404	6	323	999	A	20					X								X			
GAR0405	8	110	1227							X								X			

🟩 Well in Alpowa Creek sub-basin
🟦 Well in Asotin Creek sub-basin

Well Specification Table

Well ID	DOE Well Log ID #	Latitude	Longitude	T - N	R - E	Sec.	Q-Q	Owner	year drilled	month drilled	surf elev (ft amsl)	TOB depth	TOB elev	TD (ft bgs)	TD elev (ft amsl)	Use	surf seal depth	elev seal bottom	prod casing depth	elev casing bottom	open int top depth	elev open int top	open int bottom depth	elev open int bottom
GAR0406	165605	46.426600	-117.302000	11	44	16	SW/SE	Ledgerwood	1979	5	1257	3	1254	295	962		22	1235	51	1206	51	1206	295	962
GAR0407	165606	46.427670	-117.305470	11	44	16	SE/SW	Ledgerwood	1978	6	1285	35	1250	159	1126	I		1285	37	1248	37	1248	159	1126
GAR0408	427264	46.427920	-117.353820	11	44	18	SW/SW	Scharmon	1992	5	2115	0	2115	405	1710	D	18	2097	405	1710	365	1750	405	1710
GAR0409	166289	46.412620	-117.336780	11	44	19	SE/NE	Vornholt	1995	6	1718	2	1716	137	1581	D	18	1700	137	1581	117	1601	137	1581
GAR0410	167597	46.441250	-117.295920	11	44	9	SE/SE	Heistman	1995	5	1623	25	1598	325	1298	D	40	1583	325	1298	285	1338	325	1298
GAR0411	427262	46.408950	-117.289550	11	44	27	NW/NW	Duthie	1995	1	2255	53	2202	175	2080	D	18	2237	54	2201	54	2201	175	2080
GAR0412	309662	46.420180	-117.285820	11	44	22	SW/NW	Dimpke	2001	7	1123	7	1116	175	948	D	18	1105	161	962	141	982	175	948
GAR0413	308812	46.419750	-117.336920	11	44	19	SE/NE	Lansdowne	2000	8	1648	16	1632	110	1538	D	18	1630	110	1538	90	1558	110	1538
GAR0414	253579	46.425670	-117.327730	11	44	20	NE/NW	Lansdowne	1999	3	1491	26	1465	125	1366	D	23	1468	120	1371	85	1406	125	1366
GAR0415	427263	46.428020	-117.316700	11	44	17	SE/SW	Brooks	1994	1	1324	0	1324	125	1199	D	20	1304	20	1305	20	1304	125	1199
GAR0416	427265	46.424880	-117.283400	11	44	22	NW/NW	Estlund	1988	8	1429	29	1400	180	1249	D	20	1409	36	1393	36	1393	180	1249
GAR0418	460234	46.447700	-117.295130	11	44	9	NE/SE	Heitstuman	2006	5	1747	17	1730	380	1367	D	24	1723	24	1723	24	1723	380	1367
GAR0419	332798	46.426930	-117.331270	11	44	17	SW/SW	Ledgerwood	2007	12	1608	26	1582	70	1538	S	52	1556	57	1551	52	1556	70	1538

Well in Alpowa Creek sub-basin
Well in Asotin Creek sub-basin

Well Specification Table

Well ID	open int dia (in)	DTW (ft bgs)	WT elev (ft amsl)	pump test type	rate (gpm)	DD (ft)	SC (gpm/ft-DD)	Temp (F)	upland	valley	QMs	Mvsu	Mvsl	Mvwu	Mvwl	N2	R2	N1	R1	I	Comments
GAR0406	8	230	1027	B	15					X								X			
GAR0407	8	80	1205	P	150	8	18.750			X								X			
GAR0408	6	280	1835					51	X								X				
GAR0409	6	69	1649	A	15					X							X				
GAR0410	6	185	1438	A	40			48		X								X			
GAR0411	8	45	2210	A	42					X					X	X					
GAR0412	6	42	1081	A	42			57		X								X			
GAR0413	8	70	1578	A	200					X							X	X			
GAR0414	8	65	1426	A	60			51		X							X	X			
GAR0415	6	68	1256	A	40					X							X	X			
GAR0416	6	36	1393	A	30					X							X	X			
GAR0418	6	240	1507	A	25					X								X			
GAR0419	8	20	1588	A	150			51		X							X				

🟩 Well in Alpowa Creek sub-basin
🟦 Well in Asotin Creek sub-basin

Summary of Well Completion Depth and Geologic Unit

Well ID	surf elev (ft amsl)	open int top depth	elev open int top	open int bottom depth	elev open int bottom	upland	valley	QMs	Mvsu	Mvsl	Mvwu	Mvwl	N2	R2	N1	R1	I	COMMENTS
ASO0069	2897	570	2327	610	2287	X							X	X				
ASO0071	3457	19	3438	61	3396	X							X					
ASO0234	3235	380	2855	405	2830	X								X				
ASO0235	3919	18	3901	445	3474	X							X					
ASO0236	4128	35	4093	165	3963	X												
ASO0239	3557	120	3437	377	3180													
ASO0241	3524	70	3454	430	3094	X				X								
ASO0242	3644	19	3625	840	2804	X						X						INTO WANAPUM?
ASO0243	3602	19	3583	1155	2447	X						X						
ASO0244	3588	25	3563	575	3013	X				X								
ASO0245	3884	45	3839	126	3758	X				X								
ASO0247	3968	137	3831	157	3811	X				X								
ASO0248	3496	37	3459	213	3283	X			X	X								
ASO0250	3968	140	3828	160	3808	X				X								
ASO0252	3576	18	3558	153	3423	X				X								
ASO0255	3973	56	3917	160	3813	X				X								
ASO0256	3563	18	3545	95	3468	X				X								
ASO0257	3477	36	3441	99	3378	X			X									
ASO0258	3592	97	3495	100	3492													
ASO0259	3795	38	3757	94	3701	X				X								
ASO0260	3648	18	3630	27	3621	X				X								
ASO0261	3647	110	3537	176	3471	X				X								
ASO0262	3644	18	3626	50	3594	X				X								
ASO0263	3647	137	3510	162	3485	X				X								
ASO0264	3737	27	3710	78	3659	X				X								
ASO0265	3698	265	3433	485	3213	X				X								
ASO0266	3702	163	3539	203	3499	X				X								
ASO0267	3540	185	3355	265	3275	X			X	X								
ASO0268	3602	91	3511	200	3402	X				X								
ASO0271	3727	24	3703	27	3700	X				X								
ASO0272	3599	18	3581	110	3489	X				X								
ASO0275	3905	47	3858	138	3767	X				X								
ASO0276	3794	31	3763	129	3665	X				X								
ASO0277	3597	70	3527	164	3433	X				X								
ASO0278	3576	19	3557	132	3444	X				X								
ASO0281	2556	152	2404	192	2364	X			X									
ASO0282	2451	18	2433	250	2201	X			X									
ASO0283	2469	36	2433	460	2009	X			X									
ASO0284	2195	74	2121	94	2101		X						X					
ASO0285	1962	39	1923	172	1790		X							X	X			
ASO0286	2765	288	2477	328	2437	X			X									
ASO0287	2992	22	2970	129	2863	X				X								
ASO0288	3003	60	2943	120	2883	X				X								
ASO0289	3080	69	3011	129	2951	X				X								
ASO0290	3003	263	2740	475	2528	X				X								
ASO0291	3075	19	3056	304	2771	X				X								
ASO0293	3246	142	3104	157	3089	X				X								
ASO0294	3409	19	3390	192	3217	X				X								
ASO0295	2932	110	2822	150	2782	X			X									
ASO0296	2243	446	1797	500	1743	X			X									
ASO0298	2340	490	1850	530	1810	X			X									
ASO0299	2331	585	1746	595	1736	X			X									
ASO0300	2345	79	2266	303	2042	X			X									
ASO0301	1848	184	1664	186	1662	X								X				
ASO0302	2859	610	2249	650	2209	X								X	X			

Summary of Well Completion Depth and Geologic Unit

Well ID	surf elev (ft amsl)	open int top depth	elev open int top	open int bottom depth	elev open int bottom	upland	valley	QMs	Mvsu	Mvsl	Mvwu	Mvwl	N2	R2	N1	R1	I	COMMENTS
ASO0303	1924	145	1779	175	1749		X							X	X			
ASO0304	1448	355	1093	489	959	X					X							
ASO0305	1439	150	1289	160	1279	X				X								
ASO0306	1380	143	1237	250	1130	X					X							
ASO0307	1329	172	1157	175	1154	X					X							
ASO0310	1685	85	1600	125	1560	X				X								
ASO0311	1472	155	1317	175	1297	X				X								
ASO0312	1542	240	1302	260	1282	X				X								
ASO0313	1515	78	1437	98	1417	X							X					
ASO0314	1388	18	1370	90	1298	X							X	X				
ASO0315	1335	41	1294	77	1258	X							X	X				
ASO0316	1479	34	1445	160	1319	X							X					
ASO0318	1240	36	1204	150	1090		X							X	X			
ASO0319	1089	87	1002	97	992		X								X			
ASO0322	1072	18	1054	60	1012		X								X			
ASO0323	1457	360	1097	400	1057	X								X				
ASO0324	1080	46	1034	90	990		X							X				
ASO0325	2294	140	2154	180	2114	X			X									
ASO0326	2329	135	2194	175	2154	X			X									
ASO0328	872	6	866	181	691		X							X	X			
ASO0329	981	44	937	285	696		X							X	X			
ASO0330	905	110	795	150	755		X							X	X			
ASO0332	1052	15	1037	175	877		X							X				
ASO0333	923	0	923	100	823		X							X				
ASO0336	1245	155	1090	175	1070	X							X					
ASO0338	980	95	885	115	865		X							X				
ASO0341	1009	570	439	610	399	X								X	X			
ASO0342	836	27	809	100	736		X							X				
ASO0343	1685	610	1075	650	1035	X						X						
ASO0344	1707	700	1007	740	967	X						X						
ASO0345	1919	78	1841	242	1677	X			X									
ASO0346	1374	357	1017	417	957	X						X						
ASO0500	3961	60	3901	100	3861	X		X	X									
ASO0501	1561	80	1481	80	1481		X		X									
ASO0502	1303	110	1193	150	1153		X		X									
ASO0503	1413	18	1395	125	1288		X		X									
ASO0504	1495	85	1410	125	1370		X		X									
ASO0505	3893	60	3833	110	3783													
ASO0506	3798	144	3654	174	3624	X						X						
ASO0507	3871	24	3847	166	3705	X				X								
ASO0508	3952	120	3832	160	3792													
ASO0509	3961	170	3791	210	3751	X			X									
ASO0511	3921	24	3897	104	3817	X				X								
ASO0512	3992	180	3812	205	3787	X				X								
ASO0513	3979	18	3961	120	3859													
ASO0514	861	240	621	280	581		X										X	
ASO0515	4020	206	3814	246	3774	X				X								
ASO0516	4000	21	3979	175	3825													
ASO0517	3852	39	3813	118	3734	X			X									
ASO0518	3923	18	3905	140	3783													
ASO0522	3960	62	3898	102	3858													
ASO0523	3855	155	3700	185	3670	X			X									
ASO0524	3957	135	3822	175	3782	X			X									
ASO0526	4034	5	4029	205	3829	X			X									
ASO0527	3954	205	3749	225	3729	X			X									

Summary of Well Completion Depth and Geologic Unit

Well ID	surf elev (ft amsl)	open int top depth	elev open int top	open int bottom depth	elev open int bottom	upland	valley	QMs	Mvsu	Mvsl	Mvwu	Mvwl	N2	R2	N1	R1	I	COMMENTS
ASO0529	3860	103	3757	143	3717	X			X	X								
ASO0531	3945	215	3730	235	3710	X			X	X								
ASO0533	3900	95	3805	155	3745	X			X									
ASO0540	3795	70	3725	110	3685	X						X						
ASO0541	3891	150	3741	190	3701	X				X								
ASO0543	3907	100	3807	120	3787	X			X									
ASO0544	4001	120	3881	203	3798	X			X									
ASO0546	4035	70	3965	90	3945	X				X								
ASO0547	2251	335	1916	375	1876	X										X		
ASO0549	3997	138	3859	202	3795	X				X								
ASO0551	4037	210	3827	250	3787													
ASO0553	4004	18	3986	146	3858	X				X								
ASO0557	4040	260	3780	263	3777	X				X								
ASO0558	3867	151	3716	171	3696													
ASO0560	1455	120	1335	160	1295	X										X		
ASO0562	3924	150	3774	190	3734	X			X									
ASO0563	3939	131	3808	225	3714	X						X						
ASO0564	3817	183	3634	203	3614	X			X									
ASO0565	4003	96	3907	116	3887	X				X								
ASO0568	4042	170	3872	210	3832	X				X								
ASO0570	3910	175	3735	195	3715	X			X									
ASO0571	3863	124	3739	144	3719	X			X									
ASO0573	3942	170	3772	170	3772	X			X									
ASO0575	3844	44	3800	190	3654	X						X						
ASO0576	4004	115	3889	275	3729	X			X									
ASO0578	4118	140	3978	180	3938	X				X								
ASO0579	3807	19	3788	91	3716	X			X									
ASO0580	3910	52	3858	278	3632	X			X									
ASO0581	3874	220	3654	275	3599	X				X								
ASO0582	3998	125	3873	165	3833	X				X								
ASO0583	1223	19	1204	91	1132	X										X		
ASO0584	829	400	429	425	404		X										X	
ASO0585	1033	105	928	125	908		X									X		
ASO0586	1143	255	888	275	868		X									X		
ASO0587	1012	255	757	275	737		X									X		
ASO0588	1011	255	756	275	736		X									X		
ASO0589	1006	370	636	410	596		X									X		
ASO0590	1103	190	913	225	878		X									X		
ASO0591	1096	26	1070	103	993		X									X		
ASO0592	968	59	909	96	872		X								X	X		
ASO0593	990	33	957	180	810		X									X		
ASO0594	2661	168	2493	527	2134	X										X	X	
ASO0595	1017	180	837	200	817		X									X		
ASO0596	892	18	874	180	712		X										X	
ASO0597	845	27	818	173	672		X										X	
ASO0598	1018	88	930	125	893		X									X		
ASO0599	1037	57	980	100	937		X									X		
ASO0600	818	18	800	475	343		X										X	
ASO0601	1184	74	1110	100	1084	X										X		
ASO0602	1049	66	983	77	972		X									X		
ASO0603	1292	275	1017	275	1017	X										X		
ASO0606	3032	364	2668	700	2332	X					X							
ASO0607	3130	34	3096	200	2930	X			X									
ASO0608	3286	280	3006	503	2783	X			X									
ASO0609	3275	202	3073	242	3033	X			X									

Summary of Well Completion Depth and Geologic Unit

Well ID	surf elev (ft amsl)	open int top depth	elev open int top	open int bottom depth	elev open int bottom	upland	valley	QMs	Mvsu	Mvsl	Mvwu	Mvwl	N2	R2	N1	R1	I	COMMENTS
ASO0610	1487	285	1202	325	1162		X									X		
ASO0611	1253	160	1093	200	1053		X									X		
ASO0613	1256	69	1187	204	1052	X										X		
ASO0614	848	50	798	50	798		X	X										
ASO0615	1394	160	1234	200	1194	X										X		
ASO0616	884	268	616	278	606		X										X	ALSO INTO OLDER RXS
ASO0617	1149	66	1083	69	1080	X										X		
ASO0618	812	235	577	275	537		X											INTO OLDER RXS
ASO0619	782	40	742	163	619		X											INTO OLDER RXS
ASO0620	929	162	767	202	727		X											INTO OLDER RXS
ASO0621	1031	110	921	440	591		X											INTO OLDER RXS
ASO0622	1168	125	1043	225	943		X											INTO OLDER RXS
ASO0623	2416	18	2398	360	2056	X									X			
ASO0639	738	102	636	112	626		X								X	X		
ASO0640	1628	340	1288	380	1248													
ASO0641	739	19	720	530	209		X										X	
ASO0642	1567	210	1357	250	1317													
ASO0643	994	230	764	280	714													
ASO0644	1078	860	218	900	178													
ASO0646	770	225	545	265	505		X								X	X		
ASO0647	1698	18	1680	192	1506	X										X		
ASO0648	1365	185	1180	200	1165	X							X	X				
ASO0649	1619	350	1269	375	1244													
ASO0650	2921	191	2730	211	2710	X					X							
ASO0651	1681	213	1468	253	1428													
ASO0653	1473	37	1436	204	1269	X										X		
ASO0655	1535	25	1510	950	585													
ASO0657	988	330	658	430	558													
ASO0659	890	239	651	279	611													
ASO0661	919	22	897	300	619		X								X	X		
ASO0663	1255	347	908	400	855	X												
ASO0664	1378	920	458	960	418													
ASO0665	1007	220	787	265	742													
ASO0666	1152	262	890	282	870		X									X	X	
ASO0667	1550	280	1270	883	667													
ASO0670	1531	725	806	765	766													
ASO0671	836	380	456	400	436		X										X	
ASO0672	1560	163	1397	203	1357	X			X									
ASO0673	884	65	819	105	779		X										X	
ASO0674	807	660	147	700	107		X										X	
ASO0676	1652	130	1522	505	1147	X				X								
ASO0677	1691	271	1420	316	1375	X			X									
ASO0678	2901	270	2631	330	2571	X								X				
ASO0679	738	36	702	340	398		X										X	
ASO0682	1609	270	1339	320	1289	X						X						
ASO0683	1553	260	1293	340	1213	X						X						
ASO0684	1019	265	754	305	714	X								X				
ASO0686	1204	620	584	660	544	X								X				
ASO0687.	1558	915	643	955	603	X								X				
ASO0688	966	255	711	275	691	X								X				
ASO0690	1326	175	1151	175	1151	X					X							
GAR0061	3391	19	3372	700	2691	X								X				
GAR0062	3680	330	3350	370	3310	X								X	X			
GAR0063	4200	18	4182	300	3900	X							X					
GAR0064	4202	25	4177	214	3988	X							X					

Summary of Well Completion Depth and Geologic Unit

Well ID	surf elev (ft amsl)	open int top depth	elev open int top	open int bottom depth	elev open int bottom	upland	valley	QMs	Mvsu	Mvsl	Mvwu	Mvwl	N2	R2	N1	R1	I	COMMENTS
GAR0065	4334	20	4314	539	3795	X								X				
GAR0066	4413	18	4395	200	4213	X							X					
GAR0067	4225	39	4186	460	3765	X								X				
GAR0072	4009	23	3986	161	3848	X							X					
GAR0127	2395	24	2371	138	2257		X						X					
GAR0129	2600	19	2581	660	1940		X							X	X			
GAR0131	2764	298	2466	575	2189		X						X	X				
GAR0133	1978	18	1960	360	1618		X							X				
GAR0134	1730	49	1681	125	1605		X							X				
GAR0400	4085	260	3825	280	3805	X									X			
GAR0401	4021	24	3997	78	3943	X								X				
GAR0402	4250	18	4232	350	3900	X								X				
GAR0403	4487	23	4464	125	4362	X								X				
GAR0404	1322	333	989	363	959		X								X			
GAR0405	1337	29	1308	139	1198		X								X			
GAR0406	1257	51	1206	295	962		X								X			
GAR0407	1285	37	1248	159	1126		X								X			
GAR0408	2115	365	1750	405	1710	X								X				
GAR0409	1718	117	1601	137	1581		X							X				
GAR0410	1623	285	1338	325	1298		X								X			
GAR0411	2255	54	2201	175	2080		X					X	X					
GAR0412	1123	141	982	175	948		X								X			
GAR0413	1648	90	1558	110	1538		X							X	X			
GAR0414	1491	85	1406	125	1366		X							X	X			
GAR0415	1324	20	1304	125	1199		X							X	X			
GAR0416	1429	36	1393	180	1249		X							X	X			
GAR0418	1747	24	1723	380	1367		X								X			
GAR0419	1608	52	1556	70	1538		X							X				

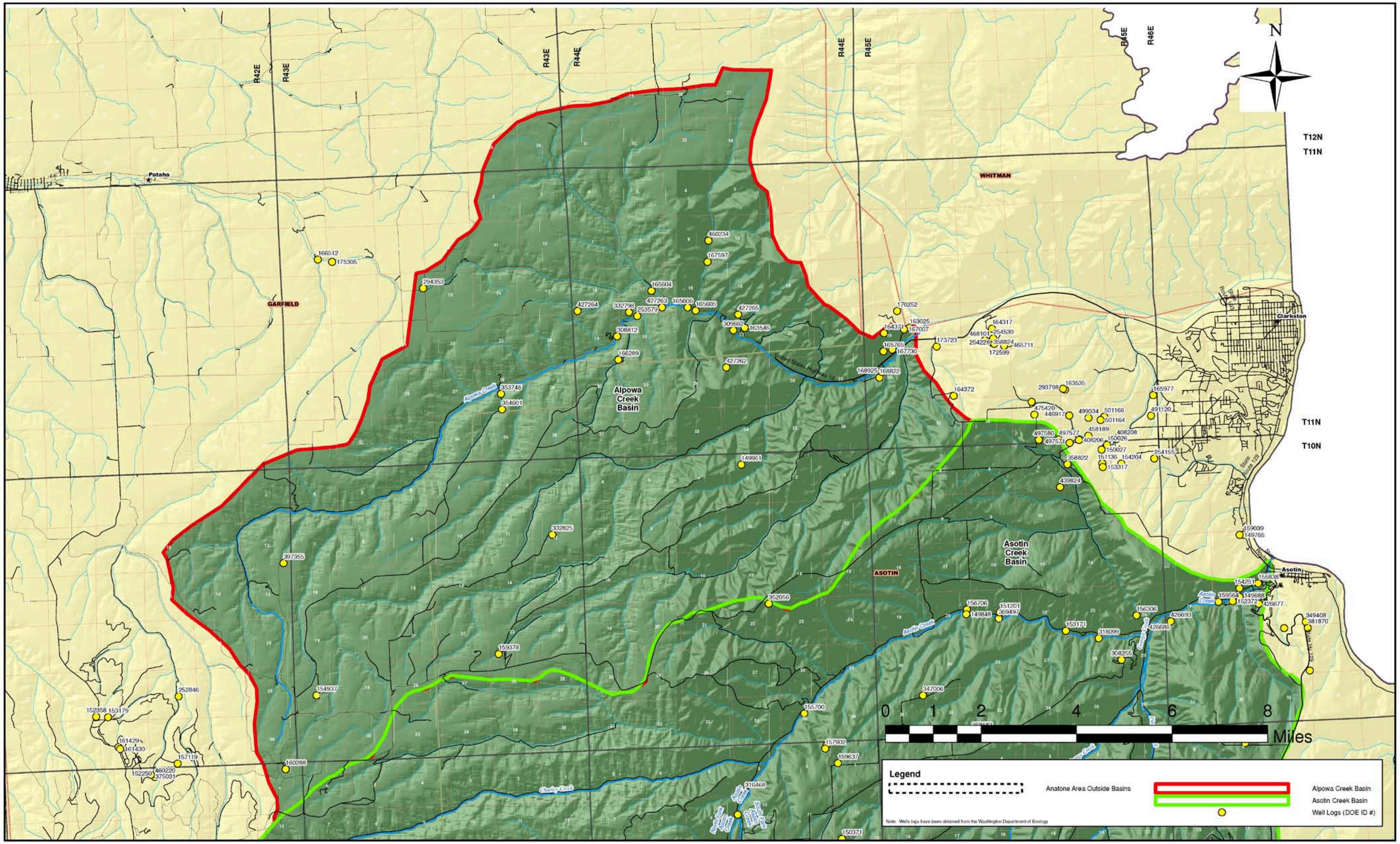


Figure B-1 Well locations in Alpowa Creek sub-basin.

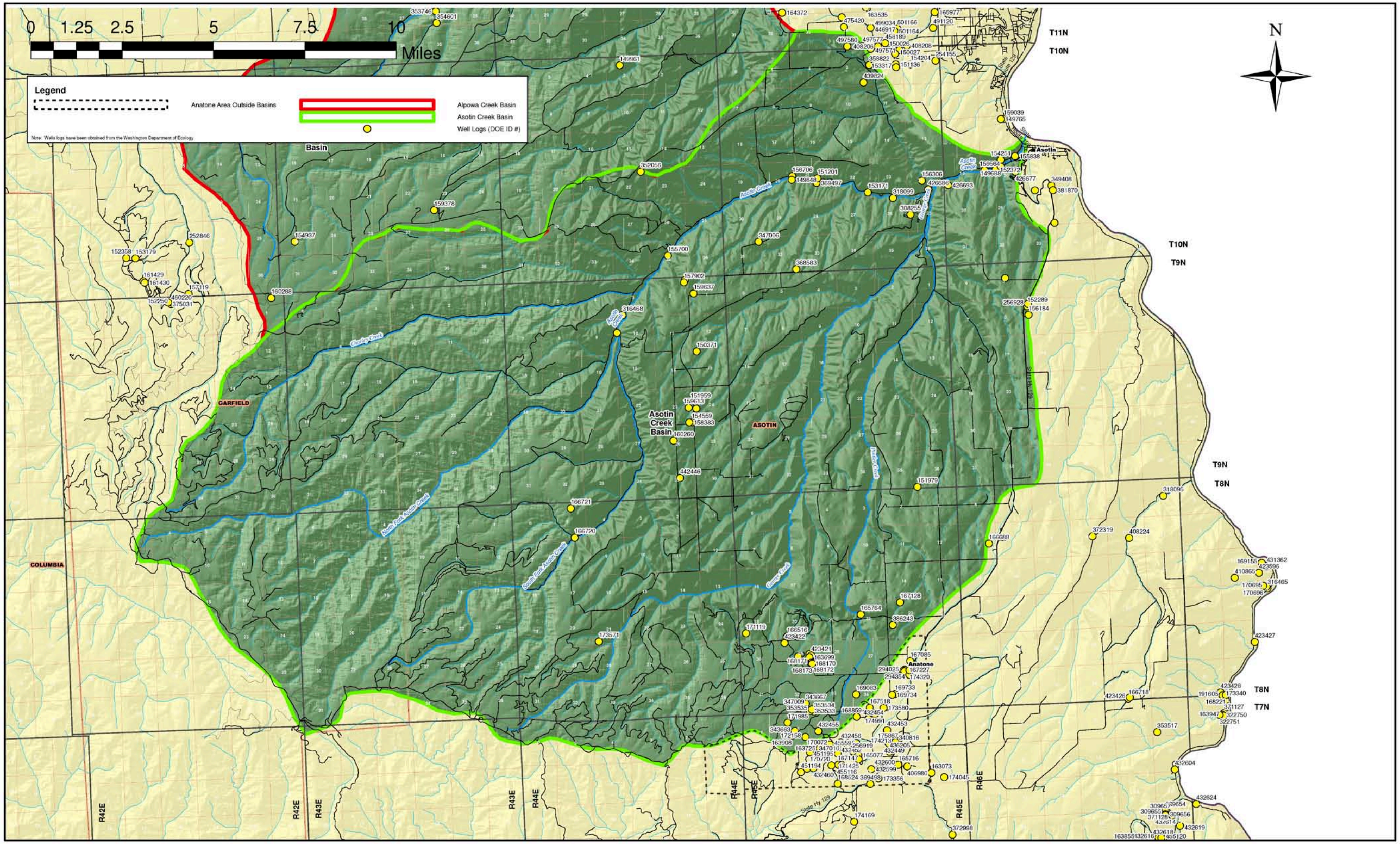


Figure B-2 Well locations in Asotin Creek sub-basin.

Appendix C
Water Rights Field Survey

Certificates

Alpowa Creek Sub-basin Ground Water Certificates

	Department of Ecology Information														Field Survey Results				
HDR ID	File #	Certificate #	Person	Document Type	Priority Date	Purpose	WRIA	County	TRS	QQ/Q	Src	1stSrc	Qi (gpm)	Qa (ac-ft)	Irrigated Acres	Actual Irrigated Acres*	Head of Cattle*	Head of Horse*	Livestock Months*	Creek Basin
181	G3-00375CWRIS		WA Health Department	Cert	8/11/1967	IR,DM	35	GARFIELD	11.0N 43.0E 16	SE/NE	1	WELL	20.0	34.0	9.0	3	0	0	0.00	Alpowa Creek Basin
1199	G3-20293CWRIS		BLANKINSHIP RAYMOND	Cert	6/2/1972	ST,IR	35	ASOTIN	11.0N 45.0E 30	SE/SE	1	WELL	20.0	27.0	5.0	5	0	0	0.00	Alpowa Creek Basin
1248	G3-26001GWRIS		DICK LEDGERWOOD&SONS	Cert	7/3/1978	IR	35	GARFIELD	11.0N 44.0E 16	SE/SW	1	WELL	150.0	162.8	25.0	25	0	0	0.00	Alpowa Creek Basin
1253	G3-26438GWRIS		DICK LEDGERWOOD/SONS	Cert	1/17/1980	IR	35	GARFIELD	11.0N 44.0E 16	S2/SE	1	WELL	100.0	64.5	15.0	15	0	0	0.00	Alpowa Creek Basin
1296	G3-28504GWRIS		WEST LYLE&MARIE	Cert	7/25/1988	IR,DS	35	ASOTIN	11.0N 45.0E 19	NE/SE	1	WELL	20.0	8.0	1.5	1.5	0	0	0.00	Alpowa Creek Basin

Anatone Area Ground Water Certificates

	Department of Ecology Information														Field Survey Results				
HDR ID	File #	Certificate #	Person	Document Type	Priority Date	Purpose	WRIA	County	TRS	QQ/Q	Src	1stSrc	Qi (gpm)	Qa (ac-ft)	Irrigated Acres	Actual Irrigated Acres*	Head of Cattle*	Head of Horse*	Livestock Months*	Creek Basin
119	G3-*09487CWRIS	06614	MALLORY M O	Cert	5/29/1968	IR,DS	35	ASOTIN	08.0N 45.0E 26		1	WELL	50.0	14.5	5.0	1	0	0	0.00	Anatone Area

Asotin Creek Sub-basin Ground Water Certificates

	Department of Ecology Information														Field Survey Results				
HDR ID	File #	Certificate #	Person	Document Type	Priority Date	Purpose	WRIA	County	TRS	QQ/Q	Src	1stSrc	Qi (gpm)	Qa (ac-ft)	Irrigated Acres	Actual Irrigated Acres*	Head of Cattle*	Head of Horse*	Livestock Months*	Creek Basin
86	G3-*05530CWRIS	04960	SHUSS L H / V	Cert	3/21/1960	IR,DS	35	ASOTIN	10.0N 46.0E 20		1	WELL	50.0	25.6		1	0	0	0.00	Asotin Creek Basin
102	G3-*07585CWRIS	05239	PALMER C W	Cert	4/26/1965	IR,DS	35	ASOTIN	10.0N 46.0E 20	SW/NE	1	WELL	10.0	4.0		1	0	0	0.00	Asotin Creek Basin
111	G3-*09084CWRIS	06599	PARSONS J M	Cert	12/6/1967	ST,IR	35	ASOTIN	09.0N 45.0E 05		1	WELL	10.0	5.0	1.0	1	0	0	0.00	Asotin Creek Basin
1200	G3-20525CWRIS		BERRY JAMES WILLIAM	Cert	9/18/1972	IR,DM	35	ASOTIN	10.0N 46.0E 20	W2/NE	1	WELL	70.0	16.4	3.0	2	0	0	0.00	Asotin Creek Basin
1216	G3-23230CWRIS		BURNOM MARK W	Cert	5/31/1974	IR,DS	35	ASOTIN	10.0N 45.0E 24	SW/SE	1	WELL	40.0	38.2	8.0	1	0	0	0.00	Asotin Creek Basin
1228	G3-24201CWRIS		ROOT CLARENCE D	Cert	1/4/1975	IR,DS	35	ASOTIN	10.0N 45.0E 24	SW/SE	1	WELL	10.0	5.7	1.0	1	0	0	0.00	Asotin Creek Basin
1254	G3-26443GWRIS		BARKLEY JACK D	Cert	2/1/1980	IR	35	ASOTIN	08.0N 45.0E 29	NE/SE	1	WELL	200.0	222.0	60.0	0	0	0	0.00	Asotin Creek Basin
1285	G3-28272C		Powe Donald	Cert	10/22/1986	IR,DS	35	ADAMS	08.0N 45.0E 22	SW/NW	2	Well 2	30.0	57.3	16.0	1	0	0	0.00	Asotin Creek Basin

Claims

Alpowa Creek Sub-basin Ground Water Claims

	Department of Ecology Information															Field Survey Results				
HDR ID	File #	Certificate #	Person	Document Type	Priority Date	Purpose	WRIA	County	TRS	QQ/Q	Src	1stSrc	Qi (gpm)	Qa (ac-ft)	Irrigated Acres	Actual Irrigated Acres*	Head of Cattle*	Head of Horse*	Livestock Months*	Creek Basin
136	G3-000238CL		FLERCHINGER ORVILLE E.	Claim L	1/1/1900	ST,DG	35	GARFIELD	11.0N 43.0E 32		1		15.0	4.0		0	65	0	6.00	Alpowa Creek Basin
152	G3-001370CL		FEIDER FRANCIS A.	Claim L	1/1/1912	ST,DG	35	GARFIELD	12.0N 44.0E 33	N2/N2	1		2.0	411.0		0	0	0	0.00	Alpowa Creek Basin
209	G3-006315CL		TAYLOR JAMES O.	Claim L	1/1/1947	ST,IR	35	GARFIELD	12.0N 44.0E 29		1		25.0	39.5	0.5	0.5	0	0	0.00	Alpowa Creek Basin
267	G3-010050CL		WASSARD JANE B.	Claim L	1/1/1955	ST,DG	35	GARFIELD	12.0N 44.0E 30	SW/SW	1		6.0	9.7		0	0	0	0.00	Alpowa Creek Basin
268	G3-010051CL		WASSARD JANE B.	Claim L	1/1/1917	ST,DG	35	GARFIELD	12.0N 44.0E 31	NW/NW	1		10.0	16.1		0	0	0	0.00	Alpowa Creek Basin
269	G3-010153CL		GALE WEATHERLY & SONS INC	Claim L		ST,DG	35	ASOTIN	10.0N 43.0E 24		1		2.0	1.0		0	0	0	0.00	Alpowa Creek Basin
270	G3-010155CL		GALE WEATHERLY & SONS INC	Claim L		ST	35	ASOTIN	10.0N 43.0E 24		1		800.0	1.0		0	0	0	0.00	Alpowa Creek Basin
342	G3-023910CL		YOCHUM HAROLD	Claim L	11/1/1908	ST,DG	35	ASOTIN	11.0N 45.0E 32	NE/SE	1		11.0	2.5		0	0	0	0.00	Alpowa Creek Basin
343	G3-023911CL		YOCHUM HAROLD	Claim L		ST	35	GARFIELD	10.0N 43.0E 21	SE/SW	1		1.0	0.5		0	0	0	0.00	Alpowa Creek Basin
374	G3-027628CL		DAVIS RACHEL J.	Claim L		ST	35	GARFIELD	12.0N 44.0E 32		1		10.0	2.0		0	0	0	0.00	Alpowa Creek Basin
377	G3-027928CL		MULLARKY LILY	Claim L		ST,IR	35	ASOTIN	10.0N 43.0E 23	SW/NE	1		10.0	5.0	1.0	1	0	0	0.00	Alpowa Creek Basin
510	G3-054949CL		DUCKWORTH GARY L.	Claim L		ST	35	GARFIELD	10.0N 42.0E 10		1	WELL	5.0	0.4		0	25	0	3.00	Alpowa Creek Basin
522	G3-055430CL		LANDKARNMA LYLE E.	Claim L	11/1/1972	ST,DG	35	GARFIELD	11.0N 43.0E 26	SE/SW	1	WELL	25.0	25.0		0	0	0	0.00	Alpowa Creek Basin
527	G3-055568CL		MAGALLON ESTHER	Claim L	2/1/1943	ST,IR	35	GARFIELD	11.0N 44.0E 19	SE/SW	1	WELL	14.0	3.0	1.5	1.5	0	0	0.00	Alpowa Creek Basin
535	G3-056587CL		PARIS GERALD L.	Claim L	6/1/1969	ST,IR	35	GARFIELD	11.0N 43.0E 24	SW/SE	1	WELL	10.0	6.0	1.5	1.5	0	0	0.00	Alpowa Creek Basin
545	G3-057908CL		FITZSIMMONS C. W.	Claim L	1/1/1948	ST,DG	35	GARFIELD	11.0N 43.0E 21	NE/NE	1	DRILLED WELL	5.0	80.0		0	No Cows	0	0.00	Alpowa Creek Basin
546	G3-057909CL		FITZSIMMONS C. W.	Claim L	4/1/1968	ST,DG	35	GARFIELD	11.0N 43.0E 15		1	DRILLED WELL	15.0	240.0		0	No Cows	0	0.00	Alpowa Creek Basin
547	G3-057910CL		FITZSIMMONS C. W.	Claim L		ST,DG	35	GARFIELD	11.0N 43.0E 15	SW/NW	1	DRILLED WELL	10.0	160.0		0	No Cows	0	0.00	Alpowa Creek Basin
548	G3-057911CL		FITZSIMMONS C. W.	Claim L		ST	35	GARFIELD	11.0N 43.0E 22		1		5.0	240.0		0	No Cows	0	0.00	Alpowa Creek Basin
551	G3-058254CL		WOLF JOE	Claim L		ST,DG	35	ASOTIN	10.0N 44.0E 29	NW/NW	1	WELL	10.0	16.1		0	No Cows	0	0.00	Alpowa Creek Basin
553	G3-058268CL		WOLF JOE	Claim L		ST	35	GARFIELD	10.0N 42.0E 25	SW/NE	1	WELL	1.0	1.6		0	No Cows	0	0.00	Alpowa Creek Basin
554	G3-058272CL		WOLF JOE	Claim L		ST	35	GARFIELD	10.0N 42.0E 36	NE/NW	1	WELL	5.0	8.1		0	No Cows	0	0.00	Alpowa Creek Basin
628	G3-070761CL		AMANDA FITZSIMMONS EST.	Claim L	1/1/1900	ST,DG	35	GARFIELD	11.0N 43.0E 15	NW/NE	1	WELL	0.5	0.8		0	0	0	0.00	Alpowa Creek Basin
629	G3-070762CL		AMANDA FITZSIMMONS EST.	Claim L	1/1/1900	ST,DG	35	GARFIELD	11.0N 43.0E 15	NW/NE	1	WELL	1.0	1.6		0	0	0	0.00	Alpowa Creek Basin
707	G3-093546CL		FLERCHINGER JOHN W	Claim L		ST,DG	35	GARFIELD	10.0N 43.0E 17		1	WELL	6.0	1.0		0	0	4	12.00	Alpowa Creek Basin
708	G3-093547CL		FLERCHINGER JOHN W	Claim L		ST,DG	35	GARFIELD	10.0N 43.0E 17		1	WELL	6.0	1.0		0	0	see id 707	0.00	Alpowa Creek Basin
709	G3-093548CL		FLERCHINGER JOHN W	Claim L		IR,DG	35	GARFIELD	10.0N 43.0E 17		1	WELL	8.0	1.5		0	0	see id 707	0.00	Alpowa Creek Basin
710	G3-093549CL		FLERCHINGER STEVE	Claim L	7/1/1925	ST,DG	35	GARFIELD	09.0N 42.0E 01	NW/NE	1	WELL	10.0	1.0		0	15	0	9.00	Alpowa Creek Basin
743	G3-096673CL		BEALE DUANE	Claim L		ST	35	GARFIELD	11.0N 43.0E 23	NW/NW	1	WELL	7.0	0.6		0	40	0	6.00	Alpowa Creek Basin
748	G3-097651CL		GILBERT JOHN V	Claim L	11/1/1935	ST	35	GARFIELD	11.0N 43.0E 14	NE/SW	1	WELL	4.0	0.5		0	No Cows	0	0.00	Alpowa Creek Basin
755	G3-098371CL		YOCHUM ROGER W	Claim L		ST,DG	35	ASOTIN	10.0N 44.0E 20	SE/NE	1	WELL	2.0	1.0		0	0	0	0.00	Alpowa Creek Basin
756	G3-098372CL		YOCHUM ROGER W	Claim L		ST	35	ASOTIN	10.0N 43.0E 27	NE/NE	1	WELL	1.0	1.0		0	No Cows	0	0.00	Alpowa Creek Basin
757	G3-098373CL		YOCHUM ROGER W	Claim L		ST	35	ASOTIN	10.0N 43.0E 27	NE/NE	1	WELL	1.0	1.0		0	No Cows	0	0.00	Alpowa Creek Basin
792	G3-103497CL		WOLF JOE	Claim L		ST	35	GARFIELD	10.0N 43.0E 19	SW/SW	1		0.5	0.8		0	No Cows	0	0.00	Alpowa Creek Basin
858	G3-116405CL		KILLINGSWOTH GORDON W	Claim L	9/1/1943	ST,DG	35	GARFIELD	11.0N 43.0E 13	NW/SW	1	WELL	5.0	2.0		0	25	0	6.00	Alpowa Creek Basin
859	G3-116406CL		KILLINGSWOTH GORDON W	Claim L	10/1/1910	ST,DG	35	GARFIELD	11.0N 43.0E 13	NW/SW	1	WELL	5.0	2.0		0	see id 858	0	0.00	Alpowa Creek Basin
860	G3-116407CL		KILLINGSWOTH GORDON W	Claim L	10/1/1942	ST,DG	35	GARFIELD	11.0N 43.0E 13	NW/SW	1	WELL	2.0	1.0		0	see id 858	0	0.00	Alpowa Creek Basin
861	G3-116408CL		KILLINGSWOTH GORDON W	Claim L	7/1/1941	ST,DG	35	GARFIELD	11.0N 43.0E 13	SW/SW	1	WELL	2.0	1.0		0	0	0	0.00	Alpowa Creek Basin
879	G3-118519CL		FEIDER THEODORE A	Claim L	1/1/1906	ST,DG	35	GARFIELD	12.0N 44.0E 27	NE/SE	1	WELL	10.0	16.1		0	50	0	6.00	Alpowa Creek Basin
880	G3-118520CL		FEIDER THEODORE A	Claim L	1/1/1906	ST	35	GARFIELD	12.0N 44.0E 27	SE/SE	1		3.0	4.8		0	see id 879	0	0.00	Alpowa Creek Basin
881	G3-118521CL		FEIDER THEODORE A	Claim L	1/1/1906	ST	35	GARFIELD	12.0N 44.0E 34	SW/NE	1		3.0	4.8		0	see id 879	0	0.00	Alpowa Creek Basin
882	G3-118522CL		FEIDER THEODORE A	Claim L	1/1/1906	ST	35	GARFIELD	12.0N 44.0E 34	NW/SE	1		3.0	4.8		0	see id 879	0	0.00	Alpowa Creek Basin
883	G3-118523CL		FEIDER THEODORE A	Claim L	1/1/1906	ST	35	GARFIELD	12.0N 44.0E 34	SE/SW	1		3.0	4.8		0	see id 879	0	0.00	Alpowa Creek Basin
884	G3-118524CL		FEIDER THEODORE A	Claim L	1/1/1906	ST	35	GARFIELD	11.0N 44.0E 03	NE/NW	1		3.0	4.8		0	see id 879	0	0.00	Alpowa Creek Basin
885	G3-118525CL		FEIDER THEODORE A	Claim L	1/1/1906	ST	35	GARFIELD	12.0N 44.0E 34	SW/SE	1		2.0	3.2		0	see id 879	0	0.00	Alpowa Creek Basin
886	G3-118526CL		FEIDER THEODORE A	Claim L	1/1/1906	ST	35	GARFIELD	11.0N 44.0E 02	SW/SW	1		2.0	3.2		0	see id 879	0	0.00	Alpowa Creek Basin
928	G3-121887CL		TRAUTMAN EMMA F	Claim L		ST	35	ASOTIN	10.0N 43.0E 22	NW/SE	1	WELL	2.0	1.0		0	0	0	0.00	Alpowa Creek Basin
977	G3-129949CL		FITZGERALD FRANCIS	Claim L		ST	35	ASOTIN	10.0N 43.0E 15	SW/SE	1		15.0	1.0		0	40	0	6.00	Alpowa Creek Basin
978	G3-129950CL		FITZGERALD FRANCIS	Claim L		ST	35	ASOTIN	10.0N 43.0E 14	NE/SW	1		10.0	1.0		0	see id 978	0	0.00	Alpowa Creek Basin
979	G3-129951CL		FITZGERALD FRANCIS	Claim L		ST,DG	35	GARFIELD	10.0N 43.0E 31	NE/SE	1	WELL	10.0	1.0		0	see id 977	0	0.00	Alpowa Creek Basin
981	G3-129954CL		FITZGERALD FRANCIS	Claim L		ST,DG	35	GARFIELD	10.0N 43.0E 31	SW/SE	1		3.0	0.3		0	see id 977	0	0.00	Alpowa Creek Basin
996	G3-133366CL		FEIDER FRANCIS A	Claim L	6/10/1974	ST,IR	35	GARFIELD	12.0N 44.0E 33		1	SPRING	6.0	9.7	1.0	1	0	0	0.00	Alpowa Creek Basin
1034	G3-140184CL		DIXON FRANK R	Claim L		ST	35	GARFIELD	10.0N 43.0E 05		1		2.0	0.5		0	30	0	9.00	Alpowa Creek Basin
1035	G3-140185CL		DIXON FRANK R	Claim L		ST	35	GARFIELD	10.0N 43.0E 04		1		5.0	1.6		0	see id 1034	0	0.00	Alpowa Creek Basin
1036	G3-140186CL		DIXON FRANK R	Claim L		ST	35	GARFIELD	10.0N 43.0E 05		1	SPRING	4.0	1.0		0	see id 1034	0	0.00	Alpowa Creek Basin
1118	G3-151018CL		ROBINSON K W	Claim L		ST,DG	35	ASOTIN	10.0N 43.0E 12	NW/NW	1		13.0	1.0		0	0	0	0.00	Alpowa Creek Basin
1119	G3-151064CL		ROBINSON K W	Claim L		ST	35	ASOTIN	10.0N 43.0E 02		1		12.0	1.0		0	20	0	6.00	Alpowa Creek Basin
1130	G3-152195CL		ROBINSON MAY	Claim L		ST	35	ASOTIN	10.0N 43.0E 15	SE/SW	1		15.0	1.0		0	see id 1119	0	0.00	Alpowa Creek Basin
1173	G3-158565CL		LEDGERWOOD RICHARD	Claim S		ST,IR	35	GARFIELD	11.0N 44.0E 07		1	WELL	unknown	unknown		0	0	0	0.00	Alpowa Creek Basin
1174	G3-158570CL		LEDGERWOOD RICHARD	Claim S		ST,IR	35	GARFIELD	11.0N 44.0E 17		1	WELL	unknown	unknown		0	0	0	0.00	Alpowa Creek Basin
406	G3-036128CL		WEISSENFELS ROLAND W.	Claim S		DG, IR	35	GARFIELD	11.0N 44.0E 20		1		unknown	unknown		0	0	4	12.00	Alpowa Creek Basin
438	G3-043431CL		PARIS GERALD L.	Claim S		ST,DG	35	GARFIELD	11.0N 43.0E 24		1		unknown	unknown		0	20	0	6.00	Alpowa Creek Basin

Anatone Area Ground Water Claims

	Department of Ecology Information															Field Survey Results				
HDR ID	File #	Certificate #	Person	Document Type	Priority Date	Purpose	WRIA	County	TRS	QQ/Q	Src	1stSrc	Qi (gpm)	Qa (ac-ft)	Irrigated Acres	Actual Irrigated Acres*	Head of Cattle*	Head of Horse*	Livestock Months*	Creek Basin
183	G3-003821CL		ROSTAIN DAWN	Claim L	8/15/1968	IR,DG	35	ASOTIN	08.0N 45.0E 26		1		35.0	2.0	1.0	1	0	0	0.00	Anatone Area
257	G3-009384CL		COOPER MRS. EARL	Claim L	1/1/1907	ST,DG	35	ASOTIN	08.0N 45.0E 26	NE/SE	1		10.0	2.0		0	0	0	0.00	Anatone Area
433	G3-043134CL		SARGEANT ROBERT J.	Claim L		IR,DG	35	ASOTIN	08.0N 45.0E 26		1	WELL	15.0	0.8	1.0	1	0	0	0.00	Anatone Area
530	G3-055858CL		BLAIR ROBERT D.	Claim L	7/22/1969	DG,IR	35	ASOTIN	08.0N 45.0E 26		1	WELL	20.0	16.0	0.5	0.5	0	0	0.00	Anatone Area
769	G3-099055CL		JENSEN ROBERT J	Claim L		IR,DG	35	ASOTIN	07.0N 45.0E 03		1	WELL	40.0	64.0	10.0	0.5	0	0	0.00	Anatone Area
831	G3-113374CL		BARKLEY JACK D	Claim L	11/1/1952	ST,DG	35	ASOTIN	07.0N 45.0E 04	SE/SW	1	WELL	5.0	1.0		0	0	0	0.00	Anatone Area
875	G3-118137CL		SANGSTER ROBERT C	Claim L	3/1/1920	ST	35	ASOTIN	08.0N 45.0E 26	SW/NE	1	WELL	2.0	1.0		0	0	0	0.00	Anatone Area
876	G3-118138CL		SANGSTER ROBERT C	Claim L	12/1/1954	ST,DG	35	ASOTIN	08.0N 45.0E 26	SW/SE	1	WELL	15.0	1.0		0	0	0	0.00	Anatone Area
901	G3-119443CL		HOUGH ROBERT G	Claim L	4/1/1959	IR,DG	35	ASOTIN	08.0N 45.0E 26		1	WELL	17.5	4.5	3.0	0.5	0	0	0.00	Anatone Area
1145	G3-152674CL		NELSON WILLIAM H	Claim L		IR	35	ASOTIN	08.0N 45.0E 26		1	WELL	25.0	40.4	1.5	1.5	0	0	0.00	Anatone Area
1180	G3-159993CL		HOUGH GARALD L	Claim L	5/10/1972	IR,DG	35	ASOTIN	08.0N 45.0E 26		1	WELL	15.0	4.0	1.0	1	0	0	0.00	Anatone Area

Asotin Creek Sub-basin Ground Water Claims

	Department of Ecology Information															Field Survey Results				
HDR ID	File #	Certificate #	Person	Document Type	Priority Date	Purpose	WRIA	County	TRS	QQ/Q	Src	1stSrc	Qi (gpm)	Qa (ac-ft)	Irrigated Acres	Actual Irrigated Acres*	Head of Cattle*	Head of Horse*	Livestock Months*	Creek Basin
166	G3-003240CL		BOLICK E. D.	Claim L	8/1/1905	ST,IR	35	ASOTIN	09.0N 46.0E 20	SE/SE	1		3.5	5.7	1.0	1	0	0	0.00	Asotin Creek Basin
190	G3-004347CL		SANGSTER JAMES J.	Claim L	8/1/1935	ST,DG	35	ASOTIN	08.0N 45.0E 23		1		5.0	4.5		0	40	0	6.00	Asotin Creek Basin
194	G3-004555CL		OSBORN CLAUD C.	Claim L	8/1/1967	ST,DG	35	ASOTIN	08.0N 45.0E 33		1		20.0	5.5		0	0	0	0.00	Asotin Creek Basin
212	G3-006525CL		MULLINS TED	Claim L		ST	35	ASOTIN	10.0N 45.0E 23		1		5.0	1.0		0	350	0	6.00	Asotin Creek Basin
226	G3-006940CL		STOLL WAYNE F.	Claim L		ST	35	ASOTIN	10.0N 43.0E 34	SE/SW	1		5.0	3.0		0	0	0	0.00	Asotin Creek Basin
233	G3-007961CL		VOGAN HARRY	Claim L	1/1/1934	IR	35	ASOTIN	09.0N 45.0E 06	SE/SE	1		10.0	12.0	3.0	0.5	0	0	0.00	Asotin Creek Basin
234	G3-008048CL		LONG LESTER R.	Claim L	7/1/1946	ST,DG	35	ASOTIN	09.0N 45.0E 09	NW/SW	1		11.0	3.0		0	0	0	0.00	Asotin Creek Basin
246	G3-008761CL		PARSONS WAYNE	Claim L	1/1/1900	ST,DG	35	ASOTIN	09.0N 44.0E 25	SE/NW	1		11.0	3.0		0	0	0	0.00	Asotin Creek Basin
255	G3-009268CL		WATKINS GEORGE E.	Claim L		IR,DG	35	ASOTIN	08.0N 45.0E 10		1		30.0	48.0	1.0	1	0	0	0.00	Asotin Creek Basin
326	G3-017779CL		BERRY JAMES W.	Claim L		ST,DG	35	ASOTIN	10.0N 46.0E 20		1		35.0	3.0		0	0	0	0.00	Asotin Creek Basin
335	G3-021101CL		BEARD LEO R.	Claim L		IR,DG	35	ASOTIN	10.0N 45.0E 24	NE/SE	1		5.0	8.0	1.0	1	0	0	0.00	Asotin Creek Basin
336	G3-021102CL		BEARD LEO R.	Claim L		ST,IR	35	ASOTIN	10.0N 45.0E 24	SE/SE	1		500.0	800.0	40.0	4	0	0	0.00	Asotin Creek Basin
340	G3-022985CL		POLUMSKY LAWRENCE	Claim L	1/1/1912	ST	35	GARFIELD	09.0N 43.0E 05	NW/NW	1		1.0	1.0		0	0	0	0.00	Asotin Creek Basin
349	G3-024433CL		HODGES JOHN	Claim L	8/1/1920	ST,DG	35	ASOTIN	09.0N 45.0E 31	SW/SW	1		11.5	3.0		0	0	0	0.00	Asotin Creek Basin
350	G3-024443CL		"PARSONS CLAUD, EST OF"	Claim L	1/1/1921	ST,DG	35	ASOTIN	09.0N 44.0E 14	NE/SW	1		21.0	5.0		0	0	0	0.00	Asotin Creek Basin
405	G3-036088CL		PARKER THOMAS F.	Claim S		DG, IR	35	ASOTIN	10.0N 45.0E 23		1		unknown	unknown		0	0	0	0.00	Asotin Creek Basin
441	G3-044722CL		COLEMAN ROBERT S.	Claim S		ST,DG	35	ASOTIN	07.0N 45.0E 04		1		unknown	unknown		0	0	0	0.00	Asotin Creek Basin
458	G3-046336CL		HOUGH HAROLD	Claim S		ST,DG	35	ASOTIN	10.0N 46.0E 20		1		unknown	unknown		0	0	0	0.00	Asotin Creek Basin
470	G3-048936CL		REEVES DUANE	Claim S		ST,DG	35	ASOTIN	08.0N 44.0E 02		1		unknown	unknown		0	0	0	0.00	Asotin Creek Basin
588	G3-063651CL		WN. ST. DEPT. NAT. RSO.	Claim L	7/1/1949	ST,DG	35	ASOTIN	08.0N 45.0E 16	NE/NW	1	WELL	50.0	1.0		0	0	0	0.00	Asotin Creek Basin
650	G3-077044CL		BAKER ERNEST E.	Claim S		ST,DG	35	ASOTIN	08.0N 45.0E 15		1		unknown	unknown		0	0	0	0.00	Asotin Creek Basin
651	G3-077046CL		BAKER ERNEST E.	Claim S		ST,DG	35	ASOTIN	08.0N 45.0E 14		1		unknown	unknown		0	0	0	0.00	Asotin Creek Basin
652	G3-077047CL		GUSTASON HAROLD	Claim S		ST,DG	35	ASOTIN	08.0N 45.0E 11		1		unknown	unknown		0	0	0	0.00	Asotin Creek Basin
681	G3-087096CL		STOREY GERALD G.	Claim S		ST,DG	35	ASOTIN	10.0N 45.0E 31		1		unknown	unknown		0	0	0	0.00	Asotin Creek Basin
694	G3-089501CL		HANSEN FLORENCE	Claim L		ST,DG	35	ASOTIN	10.0N 45.0E 11	NE/SE	1	WELL	20.0	40.0		0	0	0	0.00	Asotin Creek Basin
706	G3-093216CL		SCHLEE FARMS INC	Claim L		ST,DG	35	ASOTIN	08.0N 44.0E 05	NW/NW	1	WELL	10.0	12.0		0	0	0	0.00	Asotin Creek Basin
774	G3-100364CL		BARKLEY JACK D	Claim L	3/1/1930	ST,DG	35	ASOTIN	09.0N 46.0E 28	NW/NW	1	WELL	5.0	1.0		0	0	0	0.00	Asotin Creek Basin
780	G3-100825CL		APPLEFORD TRACY	Claim L	8/1/1900	ST,DG	35	ASOTIN	08.0N 46.0E 07		1	WELL	10.0	2.0		0	0	0	0.00	Asotin Creek Basin
800	G3-106519CL		MULLINS TED	Claim S		ST,IR	35	ASOTIN	10.0N 45.0E 24		1		unknown	unknown		0	0	0	0.00	Asotin Creek Basin
821	G3-111459CL		SCHLEE FARMS INC	Claim L	10/1/1906	ST,DG	35	ASOTIN	09.0N 44.0E 30	NE/SE	1	WELL	10.0	4.0		0	0	0	0.00	Asotin Creek Basin
828	G3-112165CL		REEVES STANLEY	Claim L		ST,DG	35	ASOTIN	08.0N 45.0E 10	N2/SE	1	WELL	5.0	1.0		0	0	0	0.00	Asotin Creek Basin
833	G3-113388CL		BARKLEY JACK D	Claim L	3/1/1971	ST,DG	35	ASOTIN	09.0N 46.0E 28	NW/NW	1	WELL	5.0	1.0		0	0	0	0.00	Asotin Creek Basin
874	G3-118136CL		SANGSTER ROBERT C	Claim L	7/1/1935	ST,DG	35	ASOTIN	08.0N 45.0E 34	SW/NW	1	WELL	13.0	1.0		0	0	0	0.00	Asotin Creek Basin
905	G3-120109CL		WATSON FARMS INC	Claim L	1/1/1971	ST,DG	35	ASOTIN	09.0N 46.0E 17		1	WELL	1.5	2.4		0	0	0	0.00	Asotin Creek Basin
907	G3-120112CL		WATSON FARMS INC	Claim L	1/1/1917	ST	35	ASOTIN	09.0N 46.0E 08	SE/NE	1	WELL	7.0	11.0		0	0	0	0.00	Asotin Creek Basin
908	G3-120113CL		WATSON FARMS INC	Claim L	1/1/1971	ST,DG	35	ASOTIN	09.0N 46.0E 08	SE/NE	1	WELL	1.5	2.4		0	0	0	0.00	Asotin Creek Basin
931	G3-122137CL		HALSEY DWIGHT W	Claim L	1/1/1925	ST,DG	35	ASOTIN	09.0N 46.0E 19		1	WELL	2.5	4.0		0	0	0	0.00	Asotin Creek Basin
932	G3-122138CL		HALSEY DWIGHT W	Claim L	1/1/1925	ST,DG	35	ASOTIN	09.0N 45.0E 26		1	WELL	2.0	3.2		0	0	0	0.00	Asotin Creek Basin
933	G3-122139CL		HALSEY DWIGHT W	Claim L	1/1/1925	ST	35	ASOTIN	09.0N 46.0E 30		1	WELL	1.0	1.6		0	0	0	0.00	Asotin Creek Basin
934	G3-122406CL		REYNOLDS DON L	Claim L	5/1/1939	IR,DG	35	ASOTIN	08.0N 45.0E 34		1	WELL	20.0	32.0	10.0	0	0	0	0.00	Asotin Creek Basin
935	G3-122407CL		REYNOLDS DON L	Claim L	4/1/1939	IR,DG	35	ASOTIN	08.0N 45.0E 34		1	WELL	20.0	32.0	10.0	0	0	0	0.00	Asotin Creek Basin
1010	G3-135049CL		PETTY WILBUR	Claim L		ST,DG	35	ASOTIN	08.0N 45.0E 02	NE/SE	1	WELL	12.0	3.0		0	0	0	0.00	Asotin Creek Basin
1011	G3-135098CL		BROWNE DOUGLAS W	Claim L		ST,DG	35	ASOTIN	08.0N 45.0E 02		1	WELL	10.0	3.0		0	0	0	0.00	Asotin Creek Basin
1018	G3-137158CL		BROWNE DOUGLAS W	Claim L	8/1/1938	ST,DG	35	ASOTIN	08.0N 46.0E 06	NE/NE	1	WELL	5.0	1.0		0	0	0	0.00	Asotin Creek Basin
1022	G3-138775CL		HEDT IRVIN W	Claim L	1/1/1904	ST	35	ASOTIN	09.0N 43.0E 11		1		7.0	0.5		0	0	0	0.00	Asotin Creek Basin
1023	G3-138777CL		HEDT IRVIN W	Claim L	9/1/1906	ST,DG	35	ASOTIN	09.0N 43.0E 13		1	WELL	10.0	1.0		0	0	0	0.00	Asotin Creek Basin
1024	G3-138778CL		HEDT IRVIN W	Claim L	7/1/1904	ST	35	ASOTIN	09.0N 43.0E 23		1		9.0	0.8		0	0	0	0.00	Asotin Creek Basin
1025	G3-138779CL		HEDT IRVIN W	Claim L	6/1/1904	ST	35	ASOTIN	09.0N 43.0E 26		1		7.0	0.5		0	0	0	0.00	Asotin Creek Basin
1043	G3-140643CL		CONWAY MARY E	Claim L		IR,DG	35	ASOTIN	10.0N 45.0E 22		1	WELL	50.0	30.0	7.5	0.5	0	0	0.00	Asotin Creek Basin
1087	G3-148964CL		PARSONS LESTER	Claim L	5/1/1974	ST,IR	35	ASOTIN	09.0N 44.0E 11	NE/SW	1	WELL	20.0	32.0	20.0	0	0	0	0.00	Asotin Creek Basin
1088	G3-148965CL		PARSONS LESTER	Claim L	5/1/1974	ST,IR	35	ASOTIN	09.0N 44.0E 13	SE/SW	1	WELL	20.0	32.0	20.0	0	0	0	0.00	Asotin Creek Basin
1089	G3-148966CL		PARSONS LESTER	Claim L	10/1/1959	ST	35	ASOTIN	09.0N 44.0E 13	SE/SW	1	WELL	2.0	3.0		0	0	0	0.00	Asotin Creek Basin
1090	G3-148967CL		PARSONS LESTER	Claim L		ST,DG	35	ASOTIN	09.0N 44.0E 14	SE/SW	1	WELL	12.0	4.0		0	0	0	0.00	Asotin Creek Basin
1091	G3-148968CL		PARSONS LESTER	Claim L	4/1/1910	ST,DG	35	ASOTIN	09.0N 44.0E 24	SW/NW	1	WELL	35.0	14.0		0	0	0	0.00	Asotin Creek Basin
1092	G3-148969CL		PARSONS LESTER	Claim L	9/1/1943	ST,DG	35	ASOTIN	09.0N 44.0E 14	SE/NW	1	WELL	11.0	2.5		0	0	0	0.00	Asotin Creek Basin
1093	G3-148974CL		WALTER FRED	Claim L	9/1/1942	ST,DG	35	ASOTIN	09.0N 44.0E 25	SW/NE	1	WELL	11.0	3.0		0	0	0	0.00	Asotin Creek Basin
1123	G3-152187CL		HOSTETLER BYRON	Claim L	1/1/1915	ST,DG	35	ASOTIN	08.0N 45.0E 16	NE/NW	1	WELL	20.0	1.0		0	110	0	6.00	Asotin Creek Basin
1124	G3-152189CL		WEISS FRENCH	Claim L		ST,DG	35	ASOTIN	08.0N 44.0E 10	SE/SE	1	WELL	5.0	2.0		0	20	0	6.00	Asotin Creek Basin
1125	G3-152190CL		WEISS FRENCH	Claim L		ST	35	ASOTIN	08.0N 44.0E 15	SE/SW	1		4.0	3.0		0	0	0	0.00	Asotin Creek Basin
1126	G3-152191CL		WEISS FRENCH	Claim L		ST	35	ASOTIN	08.0N 44.0E 15	SW/NW	1		4.0	1.0		0	0	0	0.00	Asotin Creek Basin
1127	G3-152192CL		WEISS FRENCH	Claim L		ST,DG	35	ASOTIN	08.0N 44.0E 11	NW/NW	1	WELL	50.0	2.0		0	20	0	6.00	Asotin Creek Basin
1128	G3-152193CL		WEISS FRENCH	Claim L		ST	35	ASOTIN	08.0N 44.0E 11	NW/NW	1	WELL	5.0	2.0		0	0	0	0.00	Asotin Creek Basin
1129	G3-152194CL		WEISS FRENCH	Claim L	5/1/1900	ST	35	ASOTIN	08.0N 44.0E 03		1	UNNAMED SPRING	3.0	2.0		0	0	0	0.00	Asotin Creek Basin
1131	G3-152196CL		PETTY WILBUR	Claim L		ST	35	ASOTIN	08.0N 45.0E 03	NE/SE	1	WELL	2.0	1.0		0.5	30	0	6.00	Asotin Creek Basin
1134	G3-152200CL		HOUSER & SON INC	Claim L		ST	35	ASOTIN	10.0N 45.0E 07		1	WELL	6.0	0.5		0	0	0	0.00	Asotin Creek Basin
1136	G3-152202CL		HOUSER & SON INC	Claim L	1/1/1901	ST	35	ASOTIN	11.0N 45.0E 33		1		5.0	0.5		0	0	0	0.00	Asotin Creek Basin
1137	G3-152203CL		HOLLENBECK NORMA J	Claim L	1/1/1900	ST,DG	35	ASOTIN	09.0N 46.0E 21	NW/NW	1	WELL	4.0	2.0		0	0	0	0.00	Asotin Creek Basin
1178	G3-159191CL		JENKINS DAVID G	Claim L		IR,DG	35	ASOTIN	10.0N 46.0E 19	NE/SW	1		77.0	63.2	11.0	5	0	0	0.00	Asotin Creek Basin
1181	G3-159997CL		EHNDERICKSON CARL	Claim L		ST,DG	35	ASOTIN	08.0N 45.0E 02		1	WELL	6.0	2.0		0	100	0	6.00	Asotin Creek Basin
1189	G3-161234CL		GOLD ROBIN L	Claim L		IR,DG	35	ASOTIN	10.0N 46.0E 20		1	WELL	10.0	4.0	4.0	2	0	0	0.00	Asotin Creek Basin
1190	G3-161235CL		GOLD ROBIN	Claim L		IR,DG	35	ASOTIN	10.0N 46.0E 20		1	WELLS	3.0	3.0	7.0	5	0	0	0.00	Asotin Creek Basin
1326	G3-300699CL		ROGERS RALPH	Claim		ST,IR	35	ASOTIN	08.0N 45.0E 32		1	WELL	6.0	11.0	5.0	0.5	0	0	0.00	Asotin Creek Basin

Appendix D

Gaged Hydrology Evaluation

Introduction

Gaged flow data were evaluated to determine the frequency of flow in Asotin Creek and Alpowa Creek. Exceedance flow values were calculated on a monthly basis using mean daily flow data from two flow gaging stations currently operated by Department of Ecology (Ecology) and a formerly operated USGS gage. Ecology's gages are located on Asotin Creek above George Creek (Ecology Gage ID 35D100) and at the mouth of Alpowa Creek (DOE ID 35K050). The USGS Gage No. 13334700 was located on Asotin Creek upstream of Kearney Gulch and is no longer active. **Figure 1** displays the locations of the flow monitoring gages used in this analysis. **Table 1** shows the period of record for each gage.

Results

Asotin Creek

The Ecology gage on Asotin Creek, 35D100, has been active since February 2005.. The mean daily flow is shown in **Figure 2** and monthly exceedance flow is shown **Figure 3** and **Table 2**. In July and September the 50 percent exceedance flow ranges from 30 to 38 cfs and the 80 percent exceedance flow ranges from 27 to 30 cfs.

The USGS gage on Asotin Creek, 13334700, recorded daily flow measurements from October of 1959 to November 1982 and from October 1989 to June 1996. The gage is located about one mile upstream of the Ecology gage on Asotin Creek. The mean daily flow is plotted in **Figure 4**. Monthly exceedance flow values are shown on **Figure 5** and **Table 3**. In July to September the 50 percent exceedance flow ranges from 36 to 45 cfs and the 80 percent exceedance flow ranges from 31 to 36 cfs.

Alpowa Creek

The Ecology gage on Alpowa Creek, 35K050, has been operating since June of 2003 and is currently recording flow every 15 minutes. The mean daily flow data verified by Ecology is shown in **Figure 6**. Monthly exceedance flow values are shown on **Figure 7** and **Table 4**. In July to September the 50 percent exceedance flow ranges from 5 to 7 cfs and the 80 percent exceedance flow ranges from 4 to 6 cfs.

Table 1. Gage information and period of record.

Gage Description	Gage Number	Period of Record
Asotin Creek Above George Creek[1]	Ecology# 35D100	February 2005 to September 2008
Asotin Creek below Kearney Gulch	USGS# 13334700	October 1959 to November 1982
		October 1989 to June 1996
Mouth of Alpowa Creek[1]	Ecolgoy# 35K050	June 2003 to September 2008

Table 2. Asotin Creek above George Creek flow frequency statistics (Ecology No. 35D100).

Percent Exceedance	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
20	68.26	74.56	91.78	126.20	176.80	119.60	49.42	34.84	32.70	35.10	46.08	66.96
50	49.40	57.90	73.75	86.00	115.00	59.90	38.20	31.25	30.60	34.00	37.90	54.25
70	44.61	44.24	62.14	72.17	97.00	50.45	32.07	28.59	29.00	33.02	36.17	48.86
80	43.88	41.74	37.00	65.66	82.52	46.10	30.40	27.06	28.76	32.50	35.70	44.94

Notes: All flow values are in CFS.

Table 3. Asotin Creek below Kearney Gulch flow frequency statistics (USGS Station No. 13334700).

Percent Exceedance	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
20	86	107.6	112.2	150	194	138	58	42	40	41	47	71
50	50	67	76	99	137	86	45	37	36	37	41	47
70	42	50	61.7	77.7	104	64.7	39	32	32	34	38	40
80	38	43	56	68	87	55.8	36	31	31	32	36	38

Notes: All flow values are in CFS.

Table 4. Mouth of Alpowa Creek flow frequency statistics(Ecology No. 35K050).

Percent Exceedance	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
20	10.90	12.30	13.00	12.00	9.70	8.50	6.10	6.30	8.20	9.70	10.20	10.06
50	10.00	11.10	11.90	10.70	8.90	7.10	5.30	5.70	7.20	8.90	9.00	8.70
70	8.80	10.90	11.20	10.10	7.90	6.50	4.80	5.20	6.50	8.40	8.80	8.40
80	8.52	10.80	11.00	9.88	7.50	6.30	4.30	4.60	6.10	8.20	8.40	7.84

Notes: All flow values are in CFS.

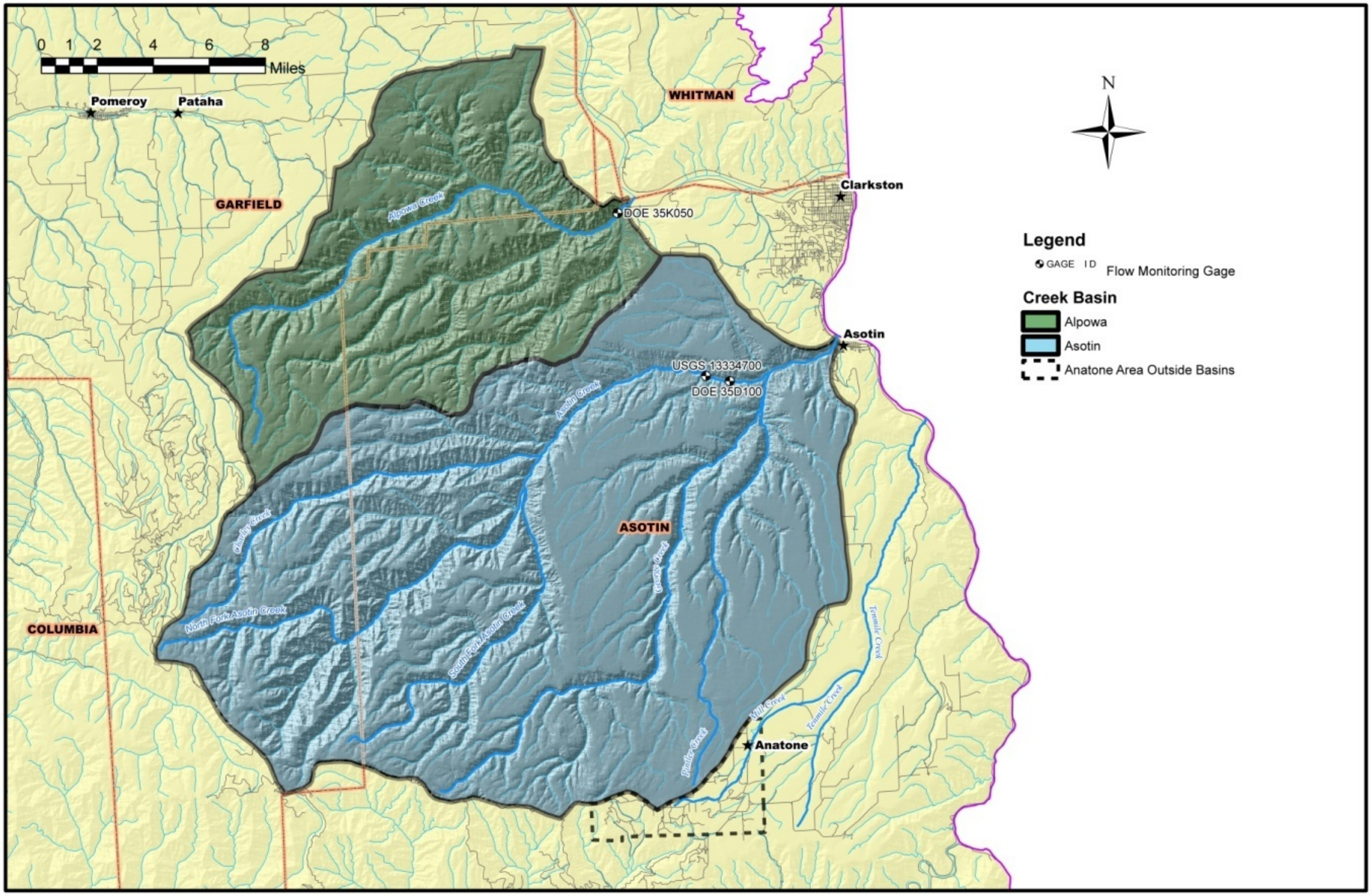


Figure 1. Map of stream flow monitoring stations in project area.

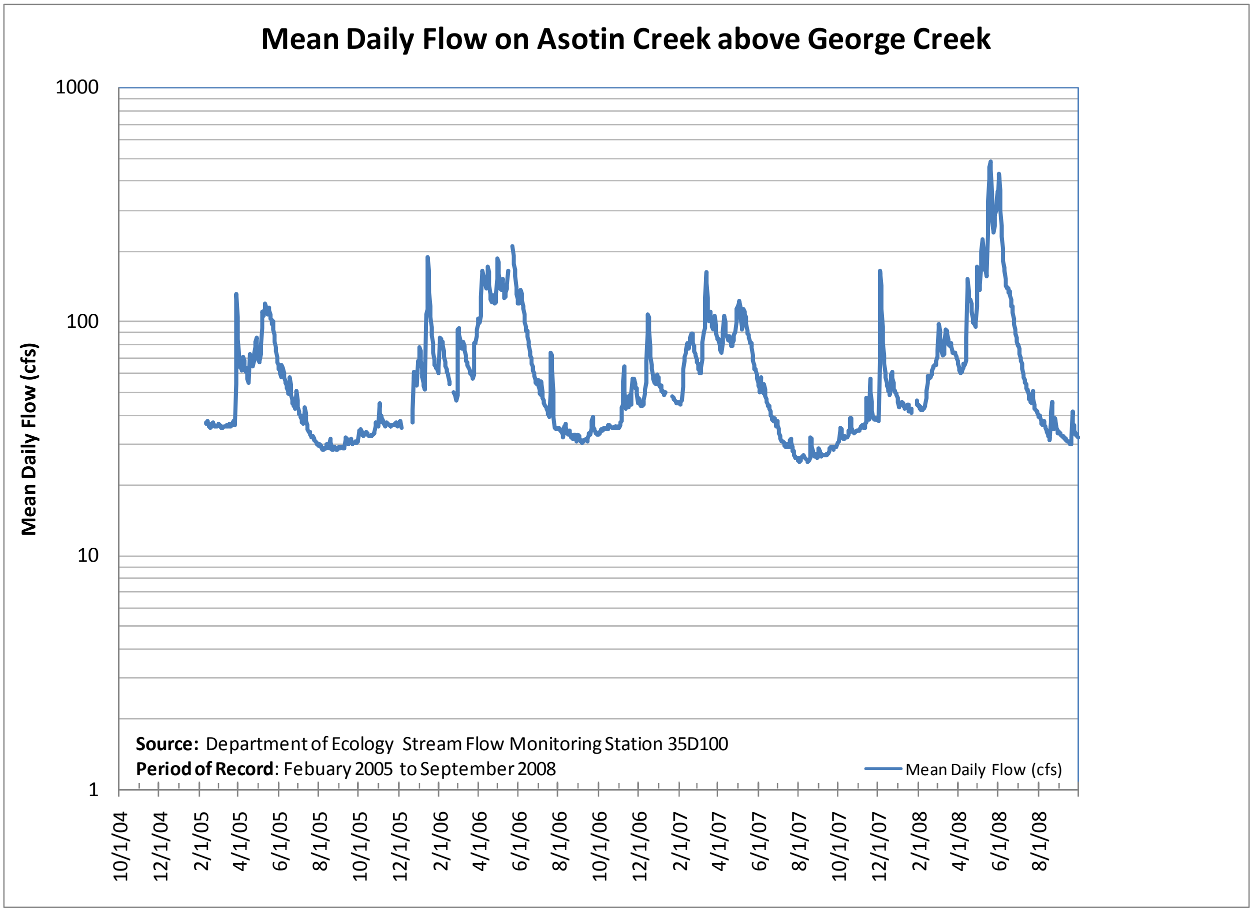
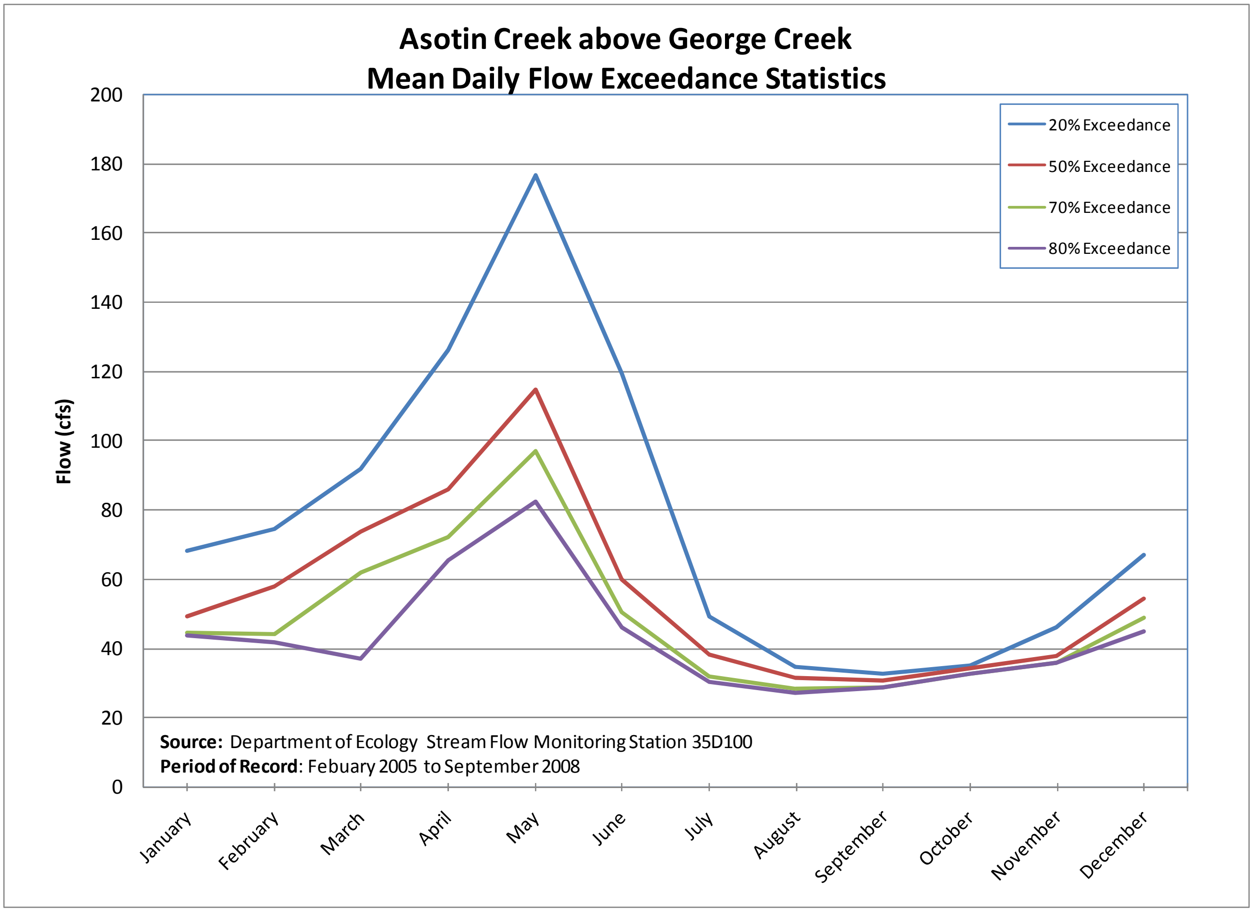


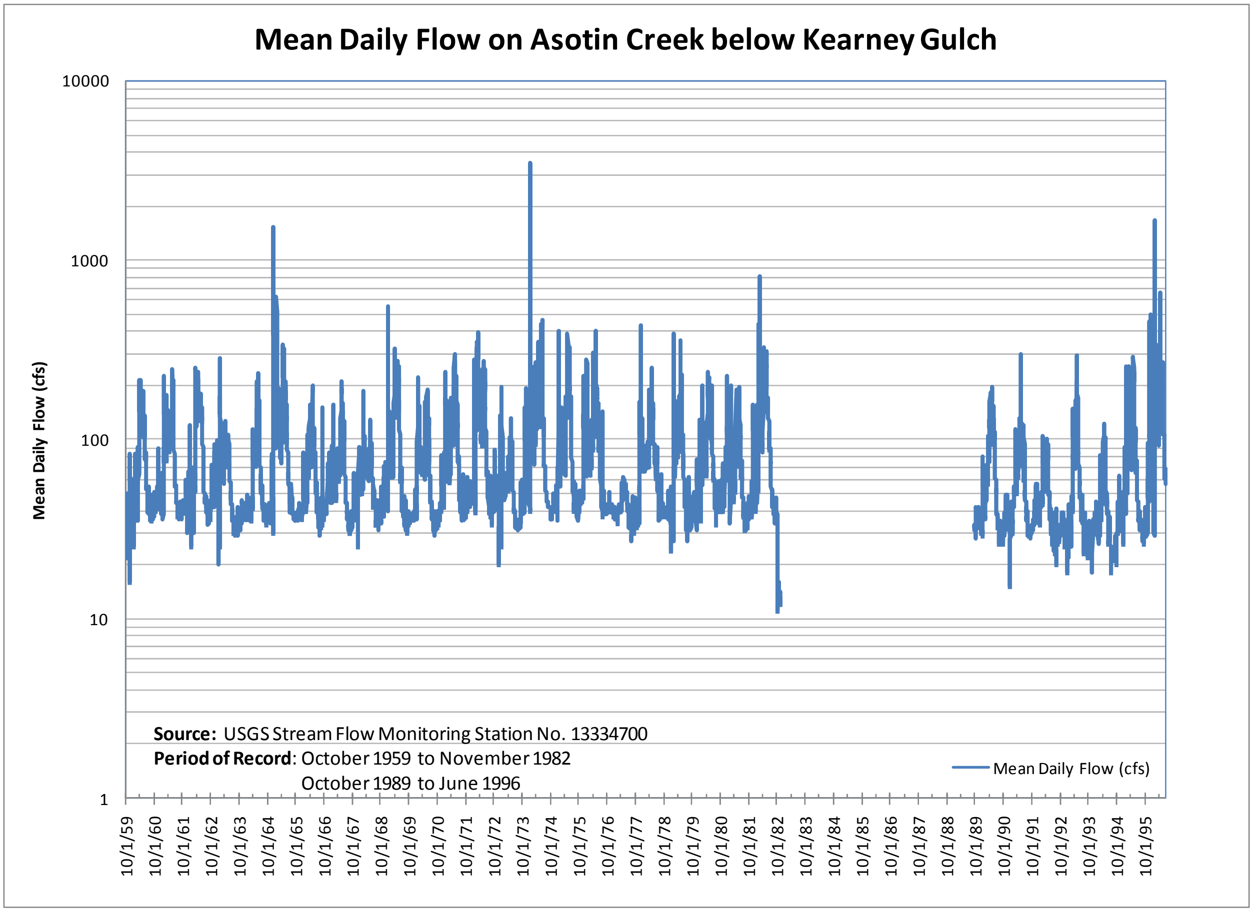
Figure 2. Mean daily flow on Asotin Creek above George Creek (Ecology No. 35D100).



Source: Department of Ecology Stream Flow Monitoring Station 35D100

Period of Record: Febuary 2005 to September 2008

Figure 3. Exceedance statistics on Asotin Creek above George Creek (Ecology No. 35D100).



Mean Daily Flow on Asotin Creek below Kearney Gulch

Source: USGS Stream Flow Monitoring Station No. 13334700
Period of Record: October 1959 to November 1982
October 1989 to June 1996

Figure 4. Historical mean daily flow on Asotin Creek below Kearney Gulch (USGS Gage No. 1334700).

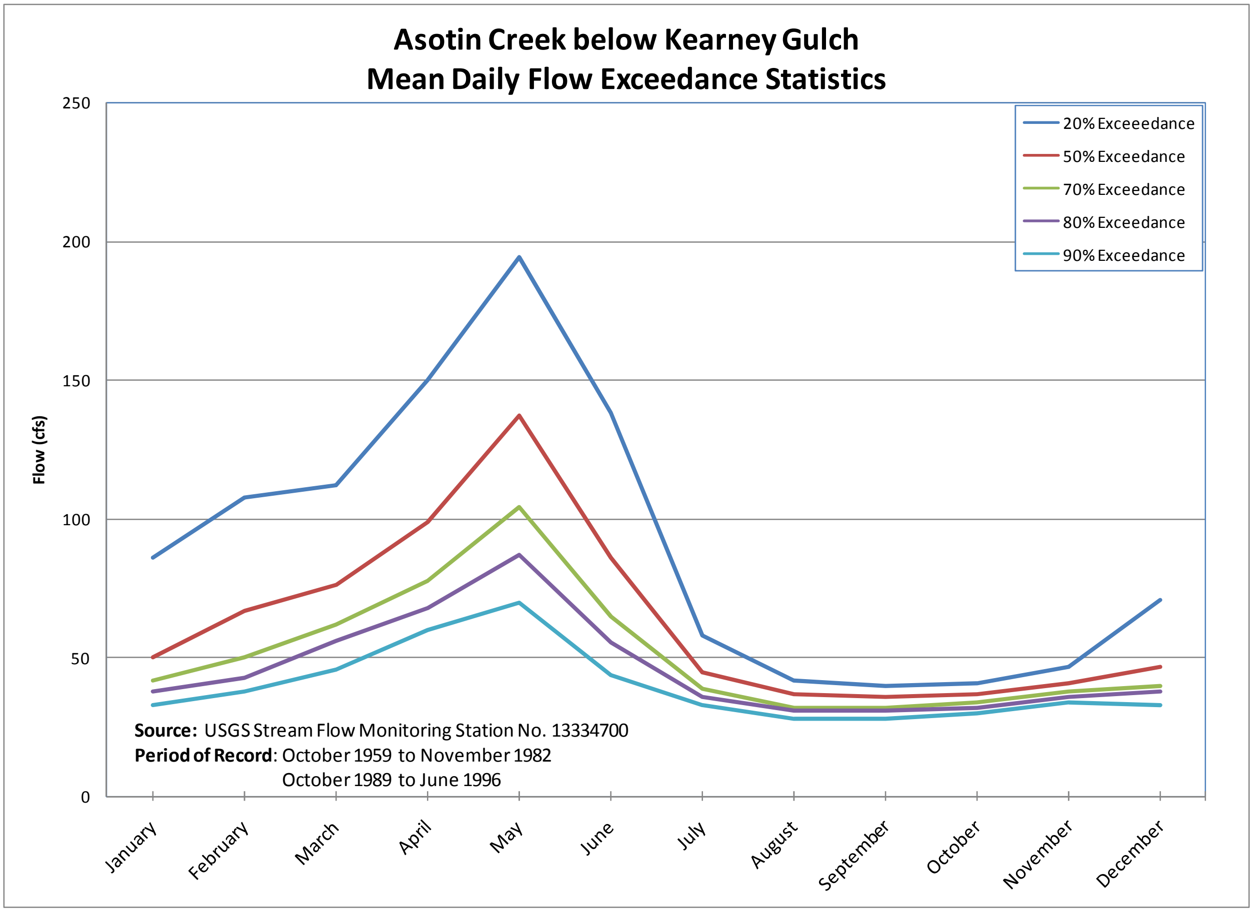
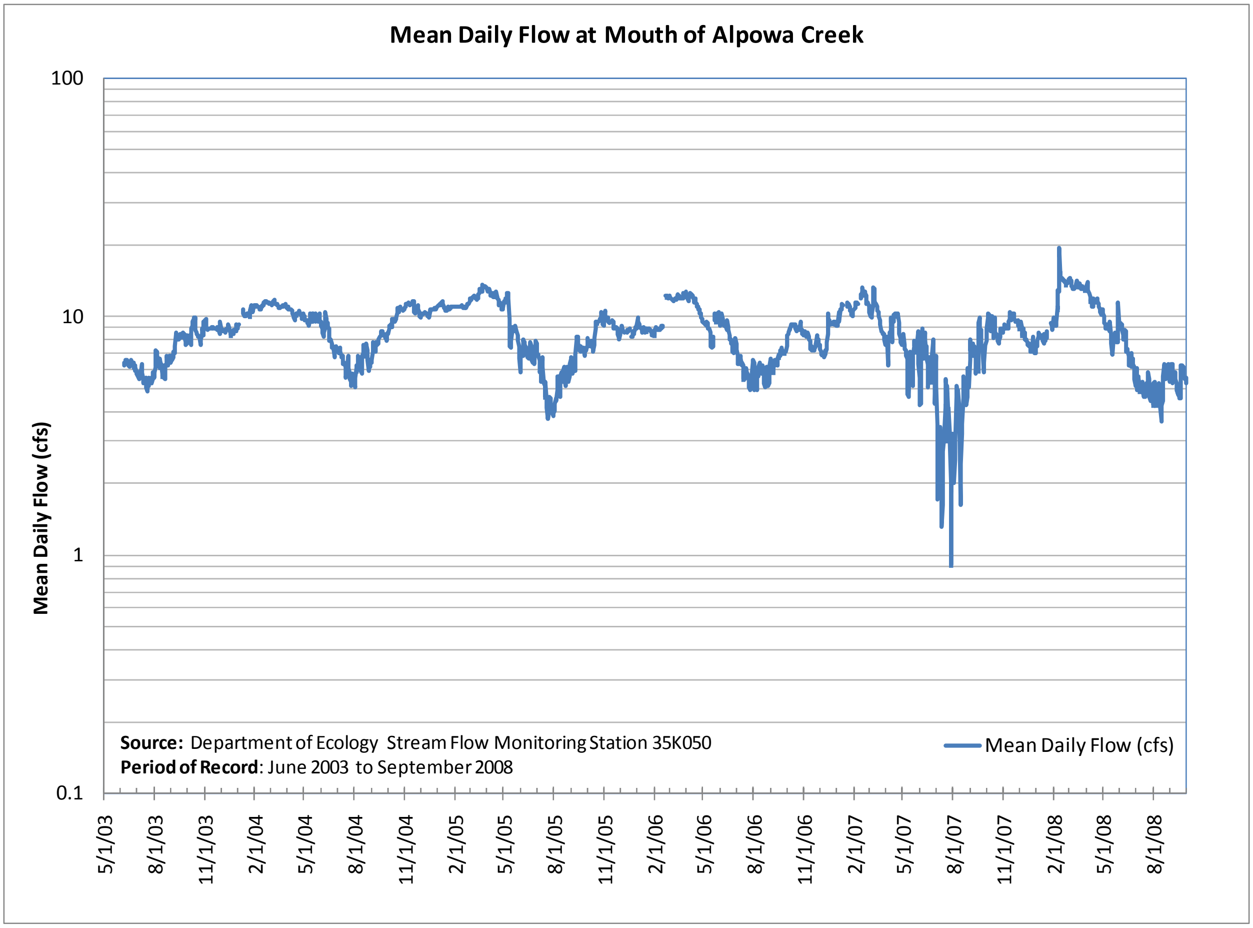
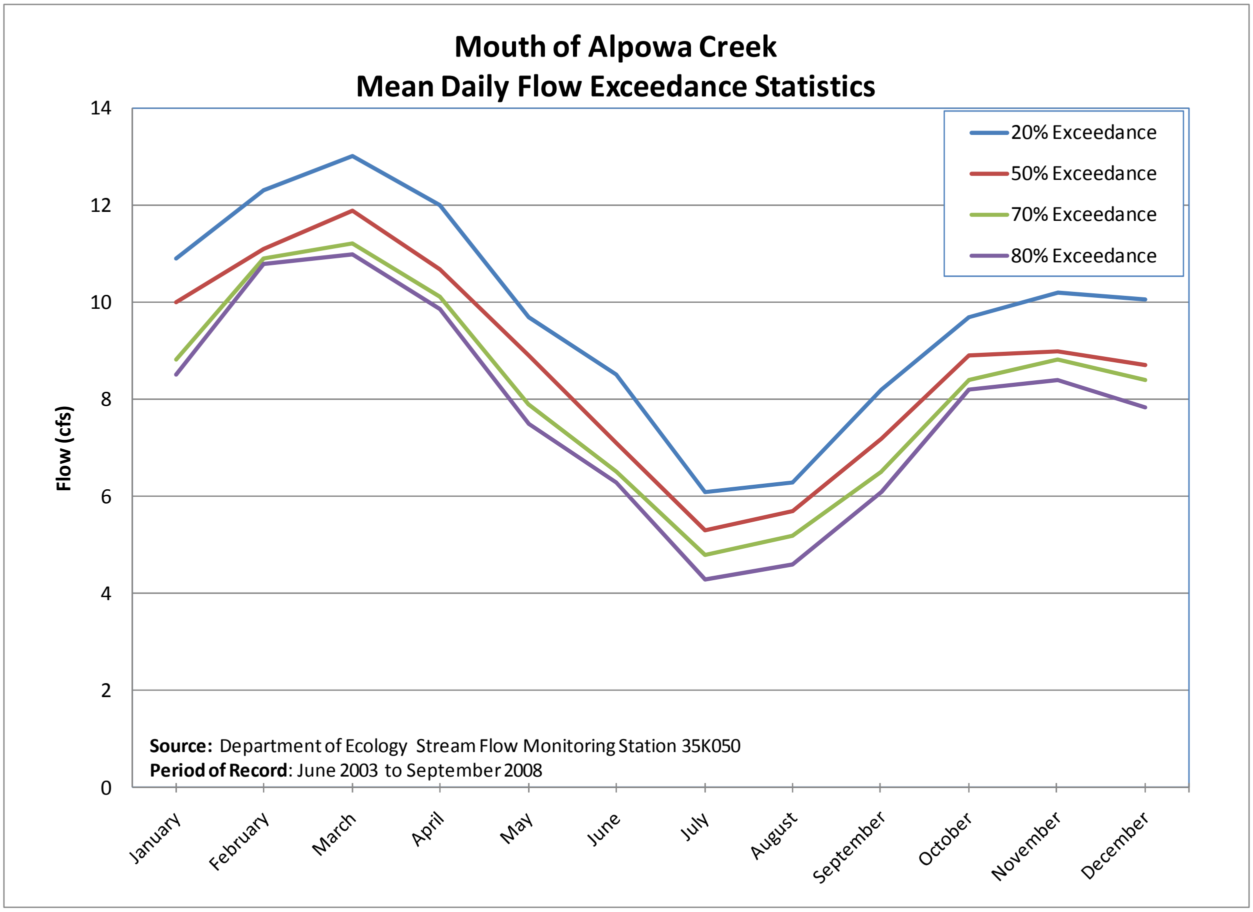


Figure 5. Historical exceedance statistics on Asotin Creek below Kearney Gulch (USGS Gage No. 1334700).



Source: Department of Ecology Stream Flow Monitoring Station 35K050
Period of Record: June 2003 to September 2008

Figure 6. Mean daily flow at the mouth of Alpowa Creek (Ecology No. 35D100).



Source: Department of Ecology Stream Flow Monitoring Station 35K050
Period of Record: June 2003 to September 2008

Figure 7. Exceedance statistics at mouth of Alpowa Creek (Ecology No. 35K050).

Appendix E
QAPP

Ground Water Monitoring Field Protocol
Phase II Hydrogeological Study
Asotin and Alpowa Creek Sub-basins

October 21, 2008

Introduction

This document summarizes the field methods that will be used for ground water monitoring of wells in the shallow basalt hydrostratigraphic unit (SBHU) and deep basalt hydrostratigraphic unit (DBHU) in the Asotin and Alpowa Creek basins for Phase II of the Hydrogeologic Study for WRIA 35.

Ground Water Monitoring

Purpose

Ground water level monitoring will be conducted to determine the elevation and flow direction of ground water levels in a subset of monitoring wells on the project that are completed in the SBHU and DBHU.

Time Period

The ground water monitoring will be take place from October 27 to November 7th, 2008.

Methods

Ground water level data will be measured in existing wells to the extent possible based on the availability of access granted by private land owners. Area of interest within the study area for the collection of shallow and intermediate basalt aquifer water level data will be identified. Well logs from the Department of Ecology well database (http://apps.ecy.wa.gov/welllog/) will be obtained for the area of interest.

The field crew will visit candidate water level sampling well owners to get permission to access wells. A letter describing the project and requesting well access has been provided by Brad Johnson (WRIA 35 Watershed Planning Director) and will be distributed to the candidate well owners (Appendix A). If verbal permission to access well is granted, the following procedures will be taken with the well owner present:

1. Verify with the well owner that the provided well log is correct. If not, obtain new log/well information.
2. Determine if the well is accessible. A well will not have the ground water elevation measured if:
    - The well owner is not present
    - The well does not have a well cap or a means of easy access
    - The well appears to be unsafe or in poor physical condition
    - The well is under pressure (artesian flow)

    - The well is located in a confined space

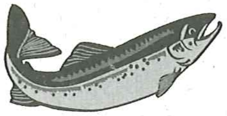
3. Take a picture of the well.
4. Remove well cap.
5. Take a picture of the well with the cap off.
6. Decontaminate the water level indicator probe and line in a chlorine bleach solution.
7. Lower the ground water indicator probe into the well. Once the ground water surface level is reached, record the distance from the top of the well to ground water. Remove the probe and repeat the decontamination process.
8. Replace well cap. Take a picture of the well with the cap replaced.
9. Place the GPS unit on the ground next to the well. The GPS unit will be a Trimble GeoXT. Record the position (x, y coordinates and elevation) for 10 minutes or until a precise measurement has been recorded. Record the distance from the ground surface to the top of the well at the ground water level measuring point.
10. While the GPS unit is recording, interview the well owner using the water use survey located in Appendix B. Record approximate size in square feet of irrigated lawn and garden.

As mentioned above, if the well owner is not present, the ground water level will not be measured. However, if verbal consent is given, a GPS reading and picture will be taken at the well.

Appendix A

Well Access Letter

MIDDLE SNAKE
WRIA 35 WATERSHED PLANNING



October 14, 2008

The WRIA 35 Planning Unit is measuring water levels in ground water wells in the Asotin Creek and Alpowa Creek area from October 27th to November 7th, 2008. The purpose of the volunteer data collection is to better understand ground water resources in Asotin and Alpowa watersheds. Trained professional will contact you to request permission to measure ground water levels in your well. If you are willing to allow access to your property and well, the measurement will involve taking the well cap off and lowering an electronic meter into your well. The meter will be decontaminated before and after each measurement. This should take about 10 minutes.

The Planning Unit would appreciate your assistance in providing access to your well. If you have any questions, please contact Brad Johnson at the phone number below.

Brad Johnson
Watershed Planning Director
(509) 758-1010
bjohnson@asotinpud.org

HDR Engineering has been retained to conduct this work and individuals working on this project include Dave Minner and Molly Reid. If you wish to contact them in the field to arrange a time to schedule visiting your residence, please call Dave's cell phone number at (515) 708-3477 or Molly's at (541) 310-8800.

Thank you for your assistance,

Bradley J Johnson

Brad Johnson

PO Box 605 • Clarkston, WA 99403-0605 • (509) 758-1010 • www.asotinpud.org/msww/

Appendix B

Water Use Survey

Middle Snake (WRIA 35) Watershed Planning Water Use Survey

Owner Information

Name: ______________________________

Address: ______________________________

City: ______________ State: ______________ Zip: ______________

Well Information

Township: __________ Range: __________ Section: __________ Qtr/qq: ______/______

Well Elevation (top of casing): ______________________________

Ground Surface Elevation: ______________________________

Ground Water Level: ______________________________

Well Depth: ______________________________

Well Log ID: ______________________________

Water Use

How many people live in your house? ______________________________

Do you water your lawn and/or garden in the summer? ______________________________

How often do you water your lawn or garden? ______________________________

How do you water your lawn or garden? ______________________________

Do you water stock (horses or cattle) from your well? ______________________________

Estimate number of stock watered in the winter or summer? ______________________________

Has your well ever gone dry? ______________________________

Any other water use? ______________________________

Comments: ______________________________

____

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