Assessment of Groundwater Storage in the Kennewick Irrigation District

A Report for Washington State Department of Ecology Project # NTA C210007 and the Groundwater Subcommittee of the Yakima Basin Integrated Plan

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By Carey A. Gazis
Central Washington University

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Abstract

The Kennewick Irrigation District (KID) is an irrigation district within the U.S. Bureau of Reclamations Yakima Project, which serves 20,200 acres within a 55,000-acre boundary. KID and several smaller irrigation districts in the lowermost Yakima basin are different than most other irrigation districts in that they depend on agricultural return flow rather than releases from reservoirs for their water supply. As climate changes and upstream users increase conservation measures, they are at risk of losing this supply, especially during the driest, hottest times. Groundwater storage is likely the most promising solution to meet KID's late summer needs. Storage plans require a full understanding of the fate of artificially recharged water. A previous study conducted for KID (RH2, 2015) quantified the amount of water that has been artificially recharged in the Badger Coulee sedimentary overburden aquifers and identified several target areas where this water might be retrieved. The current study uses geochemistry to further understand the Badger Coulee aquifer and to characterize groundwater in the larger KID region.

Statistical analysis of geochemical data reveal five hydrochemical groups that are defined by three general controls: 1) the two main lithologies with which they interact, basalt and gravel; 2) the proportion of surface water that has mixed with the groundwater; and 3) the nature of that surface water. Two hydrochemical groups have high nitrate values indicating high inputs from irrigation water containing fertilizer; another group has isotopic signatures that indicate a large surface water contribution but has low nitrate, suggesting that those waters have high proportions of canal leakage. Simple mixing models using stable isotopes suggest that much of the Badger Coulee gravel aquifer contains 50-90% Yakima River-derived water, likely a combination of canal seepage and irrigation water from the KID system. Based on these estimated mixing ratios and the saturated thickness of the gravel aquifer, an estimate of ≈40,000 acre-feet of artificially recharged water is present in the aquifer on the eastern side of the groundwater drainage divide in Badger Coulee. This is similar to a previous estimate of 47,000 acre-feet by RH2 (2015). An additional 15,000 acre-feet of storage is possible in the currently unsaturated sedimentary sequence on this side of Badger Coulee. The estimate of overall artificially recharged water for all of Badger Coulee ranges from 74,000 acre-feet to 132,000 acre-feet.

Basalt groundwaters in the study region fall into two hydrochemical groups. One group is isotopically light, has little or no nitrate, and is likely pristine basalt water that is older and receives little modern recharge. Another group of basalt groundwaters is higher in nitrate and isotopically similar to Yakima River water (and KID water). A cluster of these basalt groundwaters were found on the western side of the study area along the Yakima River. The presence of surface water in the basalt aquifers suggests that it is possible to design a managed aquifer recharge system that uses surface water infiltration.

KID has installed two wells in one of the target areas identified by RH2 (2015). Water levels in one of these wells fluctuates annually by 2.5 meters, probably in response to pumping from some nearby pivot systems. Further monitoring of water levels in this well and collection of pumping data from the nearby wells can serve both to monitor and manage this aquifer and to further assess aquifer properties and boundary conditions.

Study Objectives and Report Description

This project was funded by the Groundwater Subcommittee for the Yakima Basin Integrated Plan. The major objectives of the project were:

- Use well log data and geochemical signatures to define distinct hydrochemical groups and to characterize aquifer geometries, barriers to flow, and preferential flow paths in the KID region.
- Determine the spatial extent and depths of surface water infiltration, including regions that contain artificial recharge from past irrigation practices.
- Estimate volumes of existing artificially recharged water and volumes of potential additional storage.

This report provides a brief background of the study area and relevant previous studies. It then describes field and laboratory methodology. These methods are described in more depth in the Quality Assurance Project Plan for the project (KID QAPP, 2020). The resulting data are then discussed in the context of the project objectives. Graduate student Teo Fisher collected samples and data for this project. This report was prepared by Dr. Carey Gazis, the Principal Investigator for the project.

Study Area

The study area consists of the area served by the Kennewick Irrigation District (KID), located on the south side of the Yakima River near the confluence with the Columbia River (Figure 1). It includes the cities of Kennewick and South Richland as well as the smaller towns of Kiona and Badger. The KID uses Yakima River water that is diverted at the Prosser Dam and run through canals, pipes, and laterals to deliver water to approximately 20,000 acres between a point near the town of Chandler on the west side of the district and the Columbia River on the east (Figure 2). Geographically, the study area is bounded on the north by the Yakima River and on the south by the Horse Heaven Hills. A prominent valley, Badger Coulee, lies within the KID, defined by the Horse Heaven Hills on the south and Badger Mountain on the north.

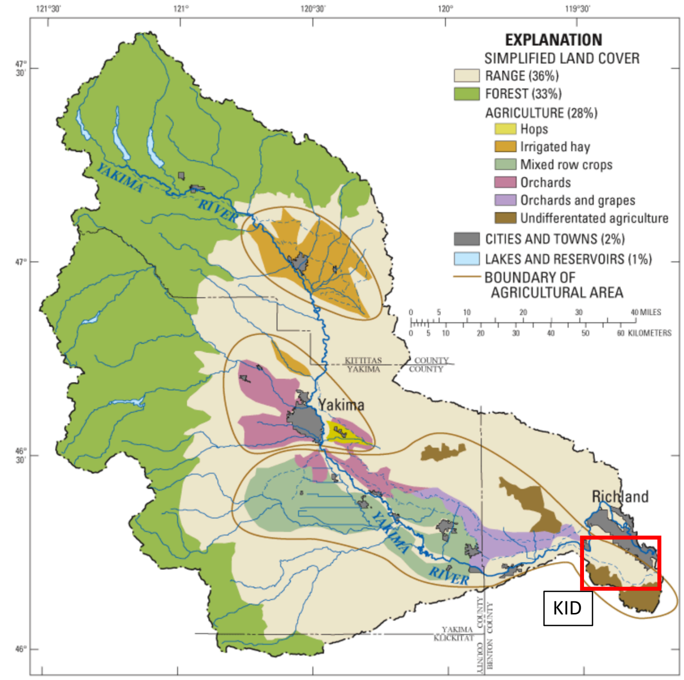


Figure 1. Map showing location of Kittitas Irrigation District (KID, Figure 2) within Yakima River basin. Modified from Vaccaro et al. (2009).

The Kennewick Irrigation District is part of the U.S. Bureau of Reclamation's Yakima Project and diverts water from the Yakima River at Prosser. The irrigation district originally served farms in the region, but now the majority of their ratepayers live in the residential developments around Kennewick. The conversion of farmland to urban development is expected to continue. KID and several smaller irrigation districts in the lowermost Yakima basin are different from irrigation districts higher in the watershed in that they depend on this agricultural return flow from upstream irrigators rather than releases from reservoirs for their water supply. This presents a future challenge as upstream irrigation districts strive to put new conservation measures in place that will reduce their return flow.

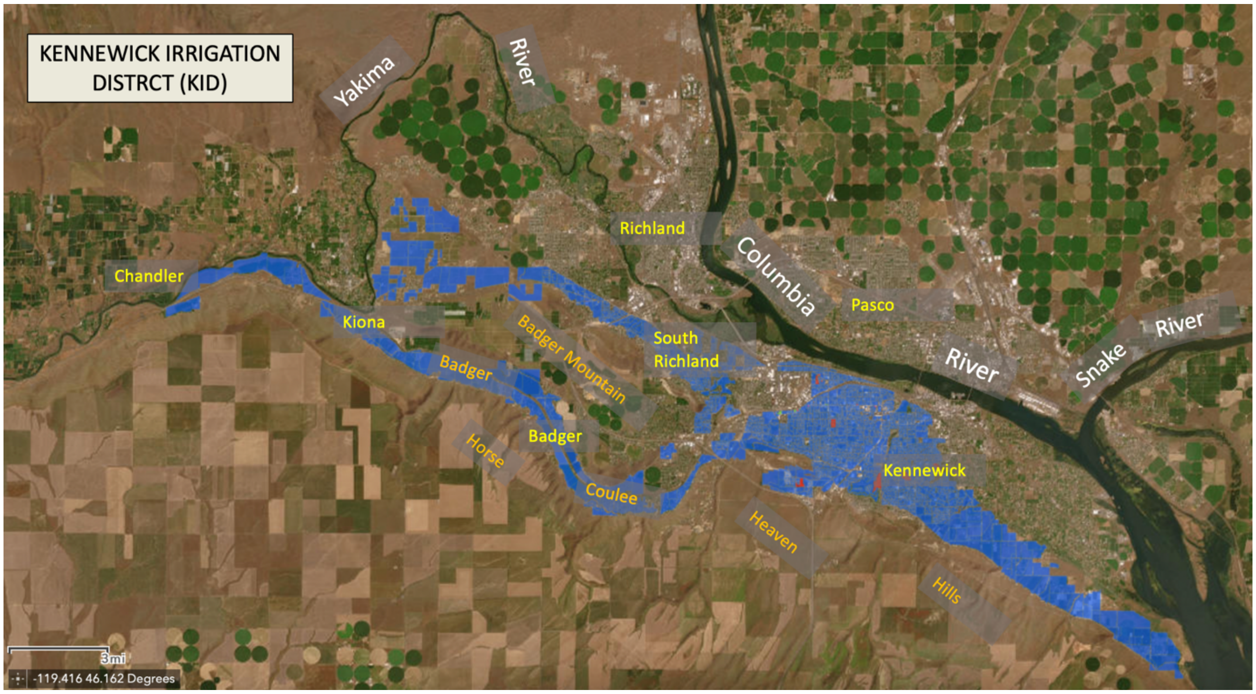


Figure 2. Kennewick Irrigation District. Blue and red shaded regions are service areas for KID. Modified from operational map from KID (2023).

Climate and Hydrology

The KID study area lies within the rainshadow of the Cascade Mountains. It is arid with 8-10 inches of precipitation per year, falling mostly in the winter months as rain with occasional snow. Mean monthly temperatures range between 34ºF in January and 75ºF in July (WRCC, 2023). In this dry region, the Yakima River has no major perennial tributaries. The Yakima River serves as the major water source for irrigation, spread seasonally across the irrigation district, providing recharge waters to shallow aquifers. There is some irrigation using groundwater, mostly outside of the KID boundaries. There are several small streams flow in the summer months serving as drains for the irrigation water and a number of small ponds that have been artificially created.

Climate change is expected to further compound the summer water deficits in the region. In the basin as a whole, a shift from rain to snow in the winter months will shift the hydrograph so that the peak flows are closer to the winter months and snow will not be stored as long into the summer. For irrigators, this will present a greater need to conserve water and there will be less return flow coming into the Yakima River. Summers will also be warmer causing higher water temperatures and greater risks to fish and other aquatic organisms.

Geology

The general stratigraphy of the study area is shown in Figure 3 and a geologic map is given in Figure 4. The study area lies entirely within the Columbia River Basalt Group (CRBG) province. In the KID area, the uppermost basalt unit is the Saddle Mountain member of the CRBG. The Saddle Mountain member is in turn underlain by the Wanapum member and then the Grande Ronde member. Sedimentary interbeds of variable thickness and continuity, known collectively as the lower Ellensburg Formation, are present throughout the CRBG sequence. Two major continuous interbeds, the Mabton member and the Vantage member, lie at the Saddle Mountain-Wanapum and the Wanapum-Grande Ronde interface, respectively. The study area lies within the Yakima Fold belt, a zone of regional compression that has resulted in E-W folds and associated faults. Horse Heaven Hills, on the south side of the study area, is one of the major anticlinal folds in the Yakima Fold belt and several large faults, predominantly thrust faults trending NE-SW, run through the area (Figure 4). Glacial outburst floods have also shaped the landscape, including the formation of Badger Coulee.

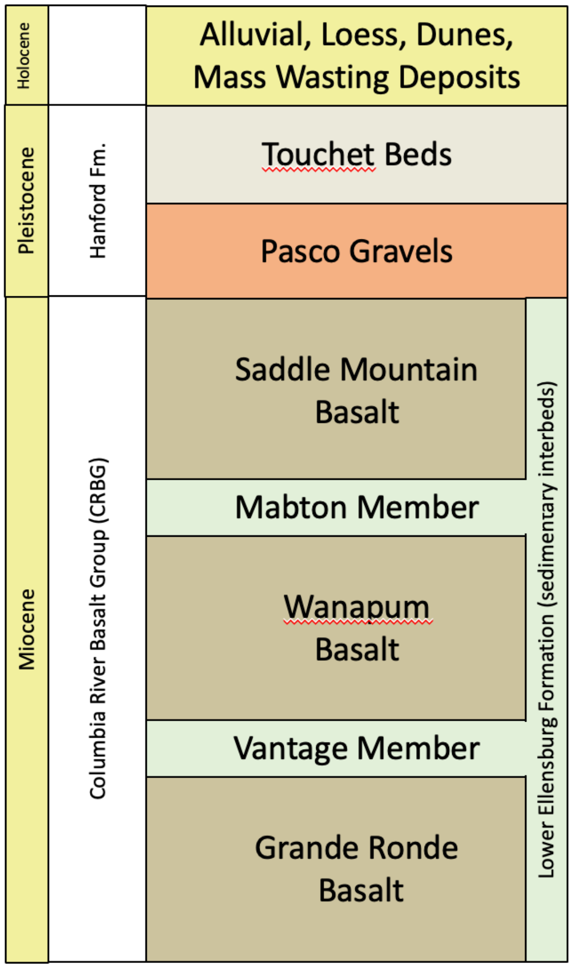
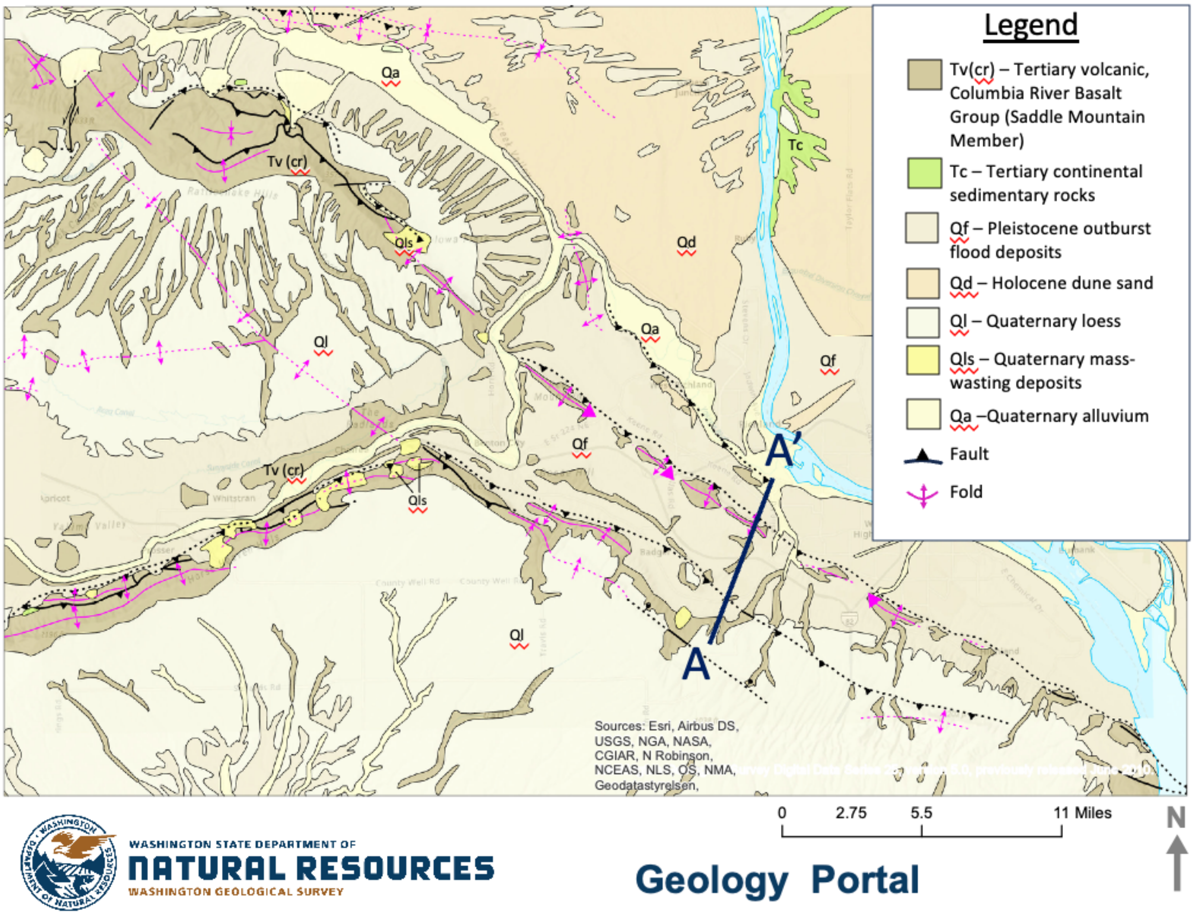


Figure 3. Generalized stratigraphy of KID area. Modified from Drost (1997).



Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen,

Figure 4. Geologic map of area around Kennewick Irrigation District. Modified from 1:100,000 geologic map from Washington Division of Geology and Earth Resources (2016). Cross section for line A-A' is shown in Figure 3.

In the KID region, the sedimentary overburden to the basalts consists of Pleistocene glacial deposits of the Hanford Formation and Holocene sediments deposited by a variety of processes. The main units in the Hanford formation are a cobble-rich unit known as the Pasco gravels and a sequence of laminated silts and fine sands known as the Touchet Beds (Reidel, 2004). The thickest deposits of Pasco gravels overlain by Touchet Beds are found within Badger Coulee. This relationship can be seen in cross-sectional view in Figure 5.

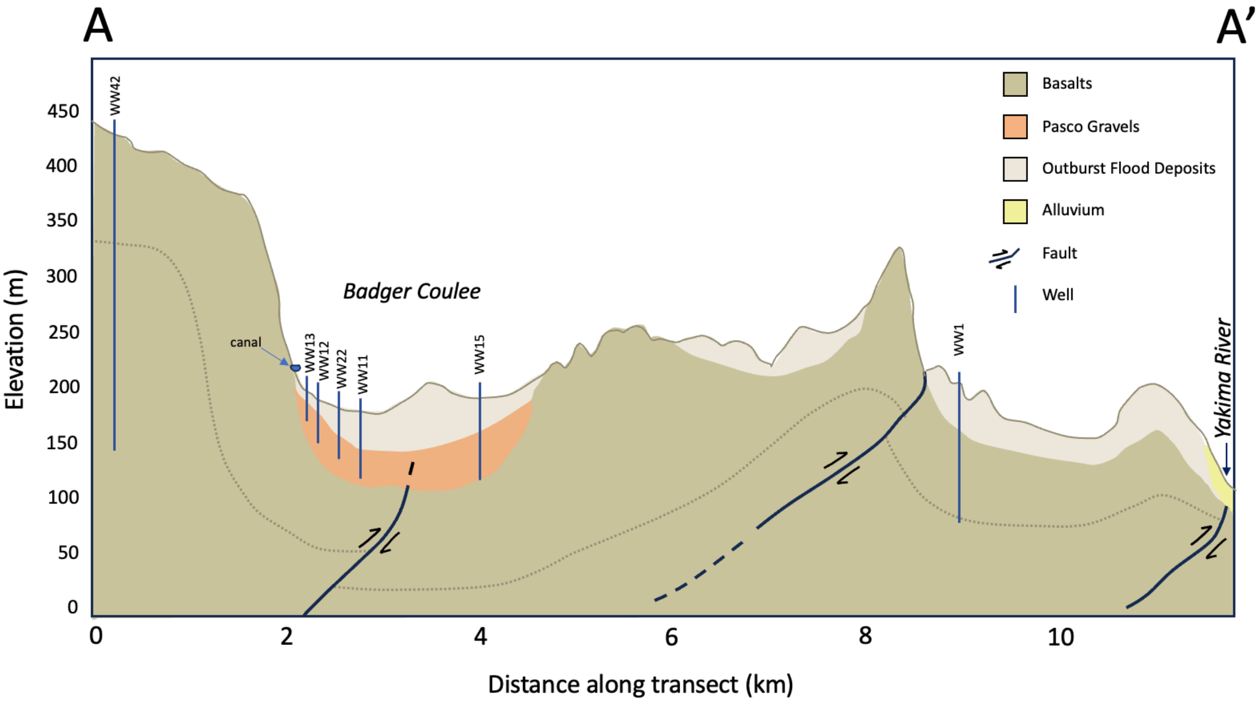


Figure 5. Cross section line A-A’ across eastern part of Badger Coulee. Figure 4 gives cross section line. Six nearby wells are projected onto the cross section. Geologic units and structures are based on well logs and geologic map. Curved lines in basalt schematically show senses of faulting and folding in area.

Hydrogeologic Framework

Among the geologic units described above, the major aquifers in the study area the Pasco gravels and the three CRBG units (Saddle Mountain, Wanapum, and Grande Ronde). The fine-grained Touchet beds are generally not permeable and act as a leaky confining layer. The Lower Ellensburg Formation sedimentary interbeds can either act as aquifers or confining layers depending on the grain size of the sediment. In general, the Mabton and Vantage interbeds serve as confining layers between the major CRBG units acting as regional barriers to flow that give rise to different heads within the major CRBG units. The major basalt units are also variable in their permeability. Within each basalt flow, the dense interior tends to restrict flow while the vesicular and brecciated inflow zones tend to store and transmit water.

Faults and folds of the Yakima Fold belt can either act as conduits to flow by creating fractures and preferential flow paths or act as barriers to flow when they juxtapose an impermeable zone with a permeable zone or when they themselves are impermeable because of fine grained material, cementing and compression. For the purpose of aquifer storage, faults can compartmentalize groundwater and create “storage cells” that are more likely to retain water. The Wanapum basalt unit on the south side of Kennewick city is a target for an ASR project aimed at securing municipal supplies.

In general recharge of basalt aquifers is slow, occurring in regions where the permeable units within the basalt are exposed at the surface or through preferential flow paths such as fractures. Flow of water through the basalt aquifers is also slow, and groundwater within the Grande Ronde unit are often older than ≈10,000 years (Vlassopoulos et al., 2009). Discharge from basalt aquifers occurs from seeps and springs on the hillside and directly into the Yakima and Columbia Rivers. Regionally, water levels within the basalt aquifer have declined because of agricultural pumpage, particularly in the lower Yakima Valley around the town of Sunnyside, northwest of the study area.

Artificial recharge from both irrigation and canal leakage can also reach the basalt aquifers but generally enters the overburden sedimentary aquifers. As described below, there is evidence that the Pasco gravels within Badger Coulee have been recharged significantly by KID operations. Basalts surround the coulee and have compartmentalized the gravel aquifer there. As a result, it is a target for groundwater recovery and storage.

Previous Work

A number of previous studies on hydrogeology are relevant to this project. The hydrogeologic framework of the entire Yakima River basin was well characterized through a decade-long study by the U.S. Geological Survey which resulted in numerous comprehensive reports (Vaccaro et al., 2009 and references therein). One aspect of the study was to characterize the hydrogeology of six major sedimentary subbasins within the Yakima basin (Jones et al, 2006), including the thicknesses and spatial extent of each sedimentary unit. In the Jones et al. (2006) study, lithologic information from >6500 well logs from within the basin were used to examine subsurface stratigraphy and hydrogeologic relationships. Within this subbasin hydrogeology report, KID falls within the eastern portion of the Benton subbasin. The USGS study represents a broad view of the hydrogeology of the area and includes a basin-wide MODFLOW model (Ely et al., 2011) that can be used to examine overall water budgets and large-scale groundwater flow trends.

Several studies have been conducted specific to the KID and Kennewick Area. In 1983, CH2M Hill examined groundwater in the Badger Coulee area in order to assess wetlands that had been increasing in recent years (CH2M Hill, 1983). They concluded, based partly on well data, that the increasing wetlands were the result of a rising water table. For fifteen wells, they calculated an average water level increase of 4.3 feet per year, which they attributed to contributions from canal losses (60-70%) and excess irrigation (30-40%). They also identified a fault across Badger Coulee (Figure 6, Badger Coulee fault). Based on water level measurements, they concluded that this fault is a barrier to flow.

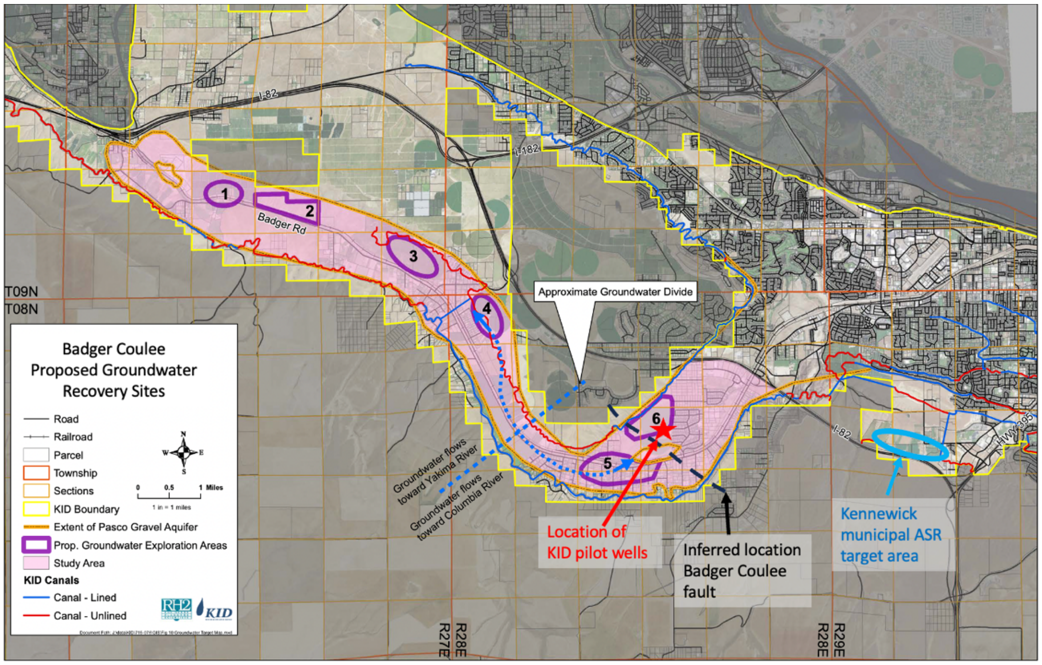


Figure 6. Badger Coulee area with proposed groundwater storage sites, modified from RH2 (2015). Base figure shows drainage divide, and boundaries to six exploration areas (purple outline) where artificially recharged groundwater might be recovered. The red star marks the location where three pilot wells were placed. Dashed black line is Badger Coulee fault, which was identified in CH2M Hill (1983) as a barrier to flow. Blue outline shows target area for Kennewick City aquifer storage and recovery project (Aspect, 2005).

In 2005, Aspect Consulting conducted a study for the City of Kennewick to assess the potential for aquifer storage and recovery (ASR) in the area around the city (Aspect, 2005). This study focused on the basalt aquifers and developed a conceptual hydrogeologic model and cross sections that were used to identify a target area and preliminary plan for ASR (Figures 6 and 7).

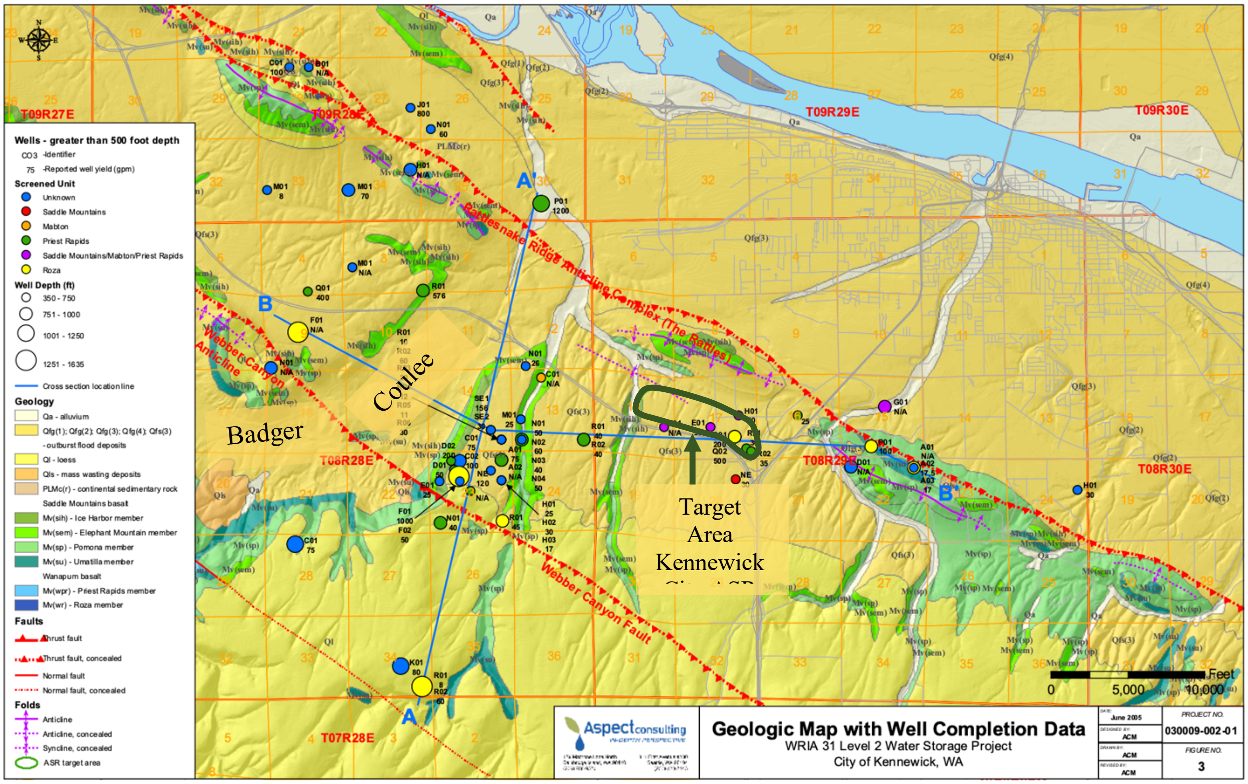


Figure 7. Geologic Map of near City of Kennewick. Modified from Aspect (2005). Target area chosen for Kennewick City Aquifer Storage and Recovery (ASR) is shown in center. Cross section for line A-A' is shown in Figure 6.

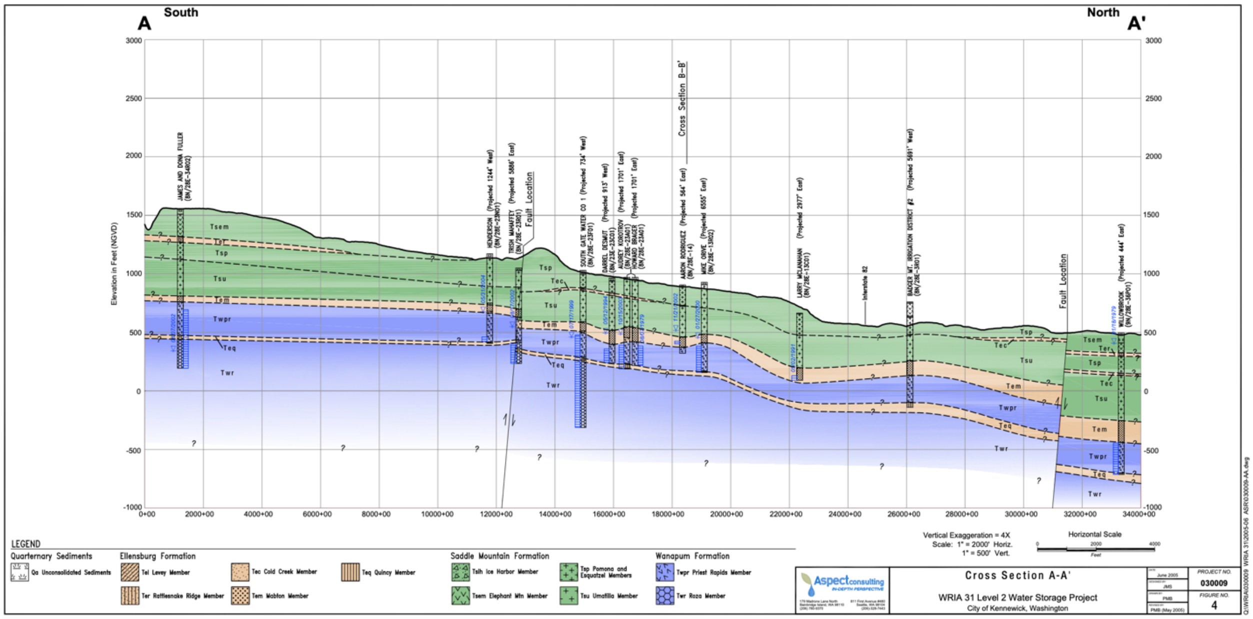


Figure 8. Cross section A-A' near City of Kennewick (see Figure 5). From Aspect (2005).

Because of the challenges to their future water supply, KID has begun exploring options for groundwater storage. Recently, RH2 Engineering, Inc, (RH2) performed an investigation to identify target aquifers and well locations with a goal of retrieving artificially stored water (RH2, 2015). They focused on Badger Coulee (Figure 6), a major feature on the southern side of the irrigation district. In this region, a 45-m thick sequence of coarse and permeable gravels, the Pasco gravels, lies below the finer grained, less permeable Touchet Beds that top the sedimentary sequence. The 2015 study asserts, based on past measurements of water levels for wells in the region (documented in Drost, 1997) that the groundwater currently in the Pasco gravels has been recharged through seepage from the KID canal network in the region. They calculate ≈132,000 acre-feet of storage within this unit, which is bounded laterally by basalts. This amount could supply the projected increased water needs during dry years well into the future. KID has begun a pilot project by drilling three large-diameter wells into the Pasco gravels in one of the locations recommended by RH2 (red star on Figure 6).

A number of previous studies have collected and presented geochemical data on groundwater within the Yakima Basin. Taylor and Gazis (2014) conducted a geochemical study of groundwater along a transect across the Yakima River in the Kittitas basin to elucidate subsurface groundwater relationships. Their study revealed seven distinct groundwater chemistries that reflected interactions with different rock/sediment types and/or mixing with surface water. These include distinct chemistries for groundwaters in the basalt aquifer versus the deep Ellensburg Formation and other groundwater chemistries show varying degrees of surface water influence.

A similar geochemical study was performed by Rene Holt in the upper Kittitas County for her M.S. thesis (Holt, 2012). In that study, groundwater samples were analyzed, mainly within South Cle Elum, North Cle Elum, and the Teanaway River valley. The geochemistry of those samples, in comparison with surface water chemistry indicates three flow systems, a shallow alluvial system in which water exchanges frequently with surface water, an intermediate system at the top of the bedrock that has influence both from surface waters and from deeper groundwater, and a deeper groundwater flow in the sedimentary rocks north of the Yakima River.

The U.S. Geological Survey has also conducted geochemical studies of groundwater as part of a larger study of the hydrogeology of the upper Yakima River basin around the towns of Cle Elum and Roslyn. The USGS study was undertaken to inform groundwater management decisions in a region where a moratorium on exempt wells had been put in place. Their findings are presented in Gendaszak et al. (2014) and Hinkle and Ely (2013). They interpret their data to reflect the complex fracture-flow system of the older bedrock in this region where remnants of isotopically lighter Pleistocene water are present at depth but have been flushed out by younger waters at shallower levels. They also note that stable isotope signatures of groundwaters suggest that subbasins are hydrologically separated.

In another basin-wide study, CWU graduate student Silas Sleeper used geochemical analyses to examine three potential groundwater storage locations in the Yakima River basin: Roslyn mines, Kittitas Valley and Moxee Valley. His M.S. thesis (Sleeper, 2020) presents the results of this research; depths of surface water interactions are identified in both Kittitas Valley and Moxee Valley based on stable isotope evidence. This information is used to estimate volumes of groundwater that are artificially recharged through irrigation. Sleeper also identified several locations that may be promising for future groundwater storage projects based on depth to groundwater and surface area and estimated potential storage volumes (minimum and maximum) for those locations. The minimum estimates range from 1,200 to 13,000 acre-ft, while the maximum estimates range from 14,000 to 88,000 acre-ft.

Methods

Sample Collection

Water samples were collected from 45 groundwater wells and 11 surface water locations (Table 1, Figure 9) between March and August, 2021. Well selection was based primarily on location and well geology with an emphasis on the Badger Coulee region. Google Earth images showing more detailed well locations and well logs for 32 of the sampled wells are provided in Appendix A. Surface water sampling sites were chosen to represent a variety of water bodies that might potentially recharge the aquifers in the study area. Groundwater samples were collected from a tap as close as possible to the well. The well was purged for several minutes until stable reading of pH, conductivity, temperature, and dissolved oxygen were achieved. Surface water samples were collected from the side of the water body in a region where the water appeared to be well mixed with the main body.

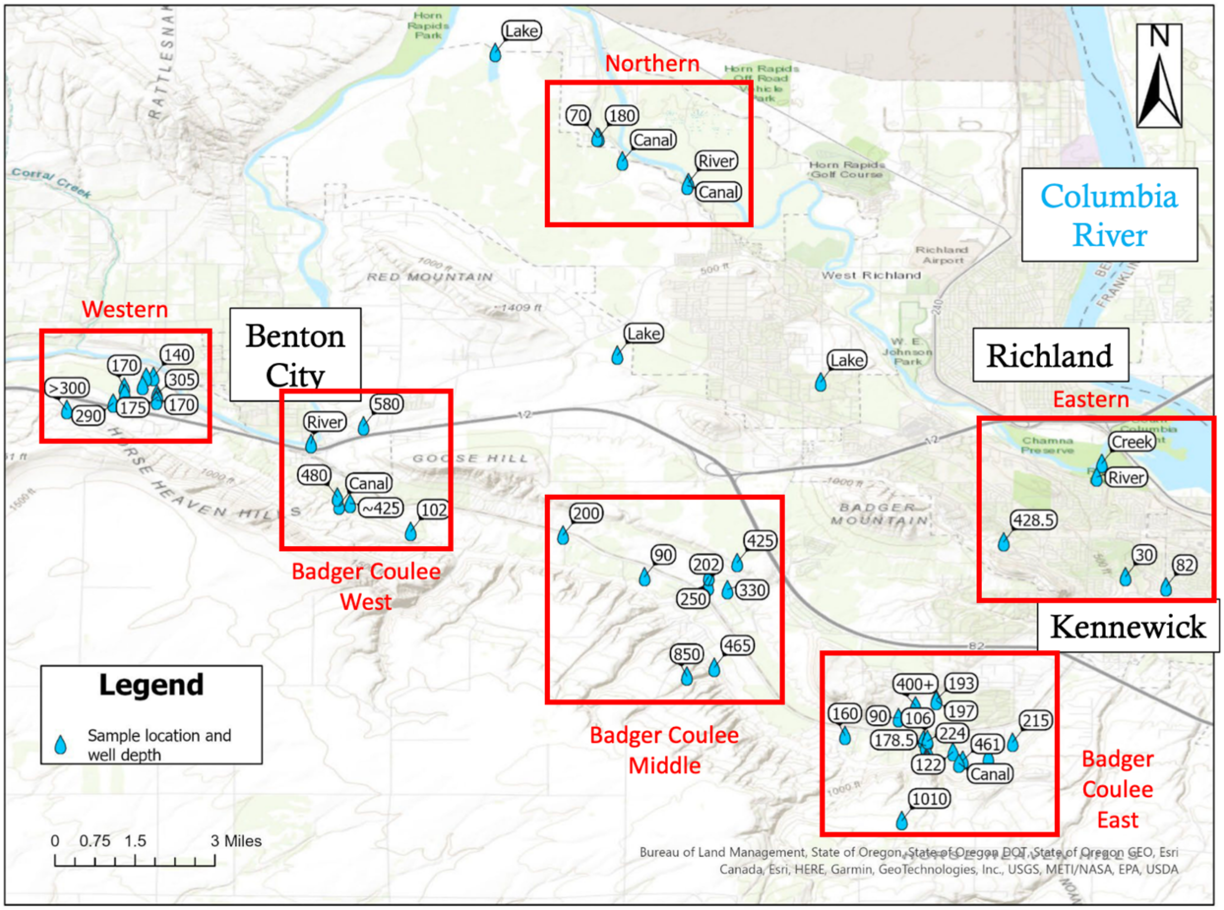
Table 1. Sample list

Sample ID	Date Sampled	Latitude*	Longitude*	Well Depth (m)	Water Body/Well Geologic Unit
Surface Water Samples					
Rivers					
SW1	3/6/21	46.25261	-119.47548		Yakima River at Kiona Bridge
SW3	3/6/21	46.32341	-119.37329		Yakima River at Twin Bridges
SW7	3/7/21	46.24658	-119.26271		Yakima River near Yakima Delta
SW6	3/7/21	46.24726	-119.26132		Amon Creek near Yakima River
Lakes					
SW5	3/7/21	46.26936	-119.33749		Lake, Park at the Lakes
SW4	3/6/21	46.27659	-119.39255		Lost Lake
SW2	3/6/21	46.35865	-119.42561		McWhorter Canal Reservoir
Irrigation Water					
SW8	4/8/21	46.23600	-119.46787		KID Main Canal 1
SW9	4/8/21	46.16604	-119.30001		KID Main Canal 2
SW10	4/8/21	46.32264	-119.37363		North Canal at Twin Bridges
SW11	4/8/21	46.32922	-119.39118		Horn Rapids Canal
Groundwater Samples					
Western Group					
WW43	8/29/21	46.26184	-119.54163	122**	Basalt
WW37	8/22/21	46.26360	-119.52908	88.4	Basalt
WW30	8/21/21	46.26793	-119.52608	51.8	Basalt
WW31	8/21/21	46.26619	-119.52593	51.8**	Basalt
WW44	8/29/21	46.26506	-119.52563	62.5	Basalt
WW45	8/29/21	46.26834	-119.52114	61.0	Basalt
WW32	8/21/21	46.27066	-119.52016	51.8**	Basalt
WW33	8/21/21	46.27078	-119.51813	42.7	Basalt
WW36	8/21/21	46.26434	-119.51734	51.8	Basalt
WW34	8/21/21	46.26614	-119.51723	93.0	Basalt
WW35	8/21/21	46.26524	-119.51706	53.3	Basalt
Badger Coulee West					
WW20	6/14/21	46.23816	-119.46832	146	Unidentified
WW16	6/14/21	46.23642	-119.46489	130**	Unidentified
WW27	7/16/21	46.25742	-119.46127	177	Basalt
WW4	3/20/21	46.22883	-119.44850	31.1	Gravel
Northern Group					

Sample ID	Date Sampled	Latitude*	Longitude*	Well Depth (m)	Water Body/Well Geologic Unit
WW29	7/21/21	46.33569	-119.39803	21.3	Basalt
WW28	7/21/21	46.33562	-119.39757	54.9	Basalt
Badger Coulee Middle					
WW5	3/20/21	46.22784	-119.40726	61.0	Unidentified
WW38	8/22/21	46.21658	-119.38516	27.4	Unidentified
WW6	3/20/21	46.18968	-119.37372	259	Basalt
WW39	8/22/21	46.21400	-119.36794	61.6	Gravel
WW8	3/27/21	46.21666	-119.36778	76.2	Unidentified
WW2	3/13/21	46.19201	-119.36628	142	Basalt
WW40	8/22/21	46.21306	-119.36273	101	Unidentified
WW7	3/27/21	46.22040	-119.36009	130	Unidentified
Badger Coulee East					
WW42	8/24/21	46.15052	-119.31547	308	Basalt
WW18	6/1/21	46.18161	-119.31177	137**	Basalt
WW21	6/14/21	46.16912	-119.30162	37.2	Basalt
WW19	6/1/21	46.16685	-119.29898	141	Basalt
WW23	6/16/21	46.16761	-119.29205	37.3	Basalt
WW26	7/16/21	46.17358	-119.33090	48.8	Gravel
WW41	8/22/21	46.17838	-119.31636	27.4	Gravel
WW10	4/21/21	46.17234	-119.30959	32.3	Gravel
WW11	4/21/21	46.17075	-119.30904	54.4	Gravel
WW9	4/21/21	46.17202	-119.30852	68.3	Gravel
WW22	6/16/21	46.16845	-119.30832	45.1	Gravel
WW17	6/1/21	46.18300	-119.30617	60.0	Gravel
WW15	5/27/21	46.18338	-119.30613	58.8	Gravel
WW24	6/16/21	46.17172	-119.28547	65.5	Gravel
WW12	4/30/21	46.16743	-119.30861	32.9	Unidentified
WW13	4/30/21	46.16678	-119.30857	33.5**	Unidentified
WW14	4/30/21	46.17244	-119.30855	30.5**	Unidentified
Eastern Group					
WW1	3/13/21	46.22603	-119.28791	131	Basalt
WW3	3/13/21	46.21659	-119.25494	9.1	Gravel
WW25	7/16/21	46.21382	-119.24396	25.0	Gravel

*WGS-84 geodetic coordinates

** estimated based on nearby wells or owner statement



Bureau of Land Management, State of Oregon, State of Oregon DOT, State of Oregon GEO, Esri Canada, Esri, HERE, Garmin, GeoTechnologies, Inc., USGS, METI/NASA, EPA, USDA

Figure 9.Sample location map. Well depths, if known are attached to groundwater sample location. For descriptive purposes, groundwater samples have been placed in six groups according to location. More detailed maps of these sampling areas are given in Appendix A.

Field measurements of pH, conductivity, temperature, and dissolved oxygen were collected at each sampling site and three separate filtered samples (0.45 micron) were collected in HDPE bottles: 60 ml acid-washed bottle for trace element analysis; 30 ml non-acid-washed bottle for major ion analysis; 30 ml non-acid-washed bottle for stable isotope analysis. An additional unfiltered 500-ml sample was collected for alkalinity analysis.

Laboratory Methods

In the laboratory, an alkalinity titration was performed on each sample within 48 hours of sample collection. A standard Gram titration was performed using 100 ml of sample titrated with 0.05 N HCl (Drever, 1997). The alkalinity and pH were used to determine concentrations of HCO_3^- and CO_3^{2-} using tabulated thermodynamic data and assuming that these two ions dominate the alkalinity and that the solution is in equilibrium. Determination of inorganic cations (Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}) was accomplished by using a Metrohm Ion Chromatography (IC), with EPA Method 300.7. Inorganic anions (F^-, Cl^-, NO_3^-, SO_4^{2-}) were quantified using the same IC in anion mode (EPA Method 300.0). The CWU Chemical Analysis Laboratory has maintained EPA accreditation for analysis of these additional nine major ions since Spring 2006. The QA/QC protocol includes regular measurement of QC standards to ensure accuracy within 10%. Detection limits were determined based on student t significance limits for 41 replicates of the QC standards (2.42*σ).

For trace element analysis, samples were acidified using trace-clean acids to 1% HCl and 0.5% HNO_3. Concentration measurements for Al, As, Ba, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Se, U, V, and Zn were obtained using an Agilent 8900 inductively-coupled plasma mass spectrometer (ICP-MS) with a triple quadripole (QQQ). The instrument was calibrated with seven standards with trace element concentrations ranging from 0.1 ppb to 50 ppb. An internal standard was used to correct for slight drifts in plasma flow. Quality control (QC) standards and replicates were run periodically. Based on these QC standards, the measurement uncertainty is less than 10%. Detection limits were determined based on the standard deviation of the QC standard.

Isotopic ratio determinations for O and H in water was performed with a Picarro L2130-i isotope analyzer. Isotope ratios are reported in the standard δ-notation as $\delta^{18}O$ for $^{18}O/^{16}O$ and δD for D/H.[1] For each sample, analyses were made on ten consecutive injections into the instrument. The first 3 values were discarded due to memory effects and the remaining 7 values were averaged. Isotope calibration curves were made using five internal laboratory standards. Repeat analyses of these standards and a replicate analysis of an unknown sample were performed every 5-6 samples. Based on these replicates, the uncertainty of the isotope analyses is 0.1 and 1.0 per mil for $\delta^{18}O$ and δD, respectively.

Data Analysis

A variety of data visualization methods were used to examine trends in the data and characterize the groundwater chemistry including x-y plots, Piper plots, and map and cross-sectional views of data. Principal component analysis (PCA) and agglomerative hierarchical cluster (AHC) were used to determine groupings of elements that can produce the observed chemical variations among the sample set. For the PCA, a Varimax rotation was applied and eigenvalues were restricted to 1.0 or greater.

Results and Discussion

Hydrogeochemical Groups

All geochemical data are tabulated in Appendix B. In the following discussion, the groundwater samples are identified as from either basalt or gravel wells based on the well log and will be called basalt waters or gravel waters. In several cases, lithology has been inferred based on the well depth. In cases, where a well log was not available and the screened unit was not clear from the well depth, the well is designated as unidentified.

The overall major ion composition of surface waters and groundwaters is most commonly Ca-Mg-HCO_3^- (Figure 10). However, some basalt waters are much more Na-rich and also have elevated SO_4. These high Na concentrations are the result of groundwater chemical evolution through time and likely represent a high proportion of ancient water. Gravel waters have the highest measured Cl concentrations and appear to be higher on average.

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[1] $\delta = \left(\frac{R_{smp}-R_{std}}{R_{std}}\right) * 1000$, where R is $^{18}O/^{16}O$ for $\delta^{18}O$ and D/H for δD, smp = sample and std = standard. Standard used here is Vienna Standard Mean Ocean Water (V-SMOW). Units are per mil (‰).

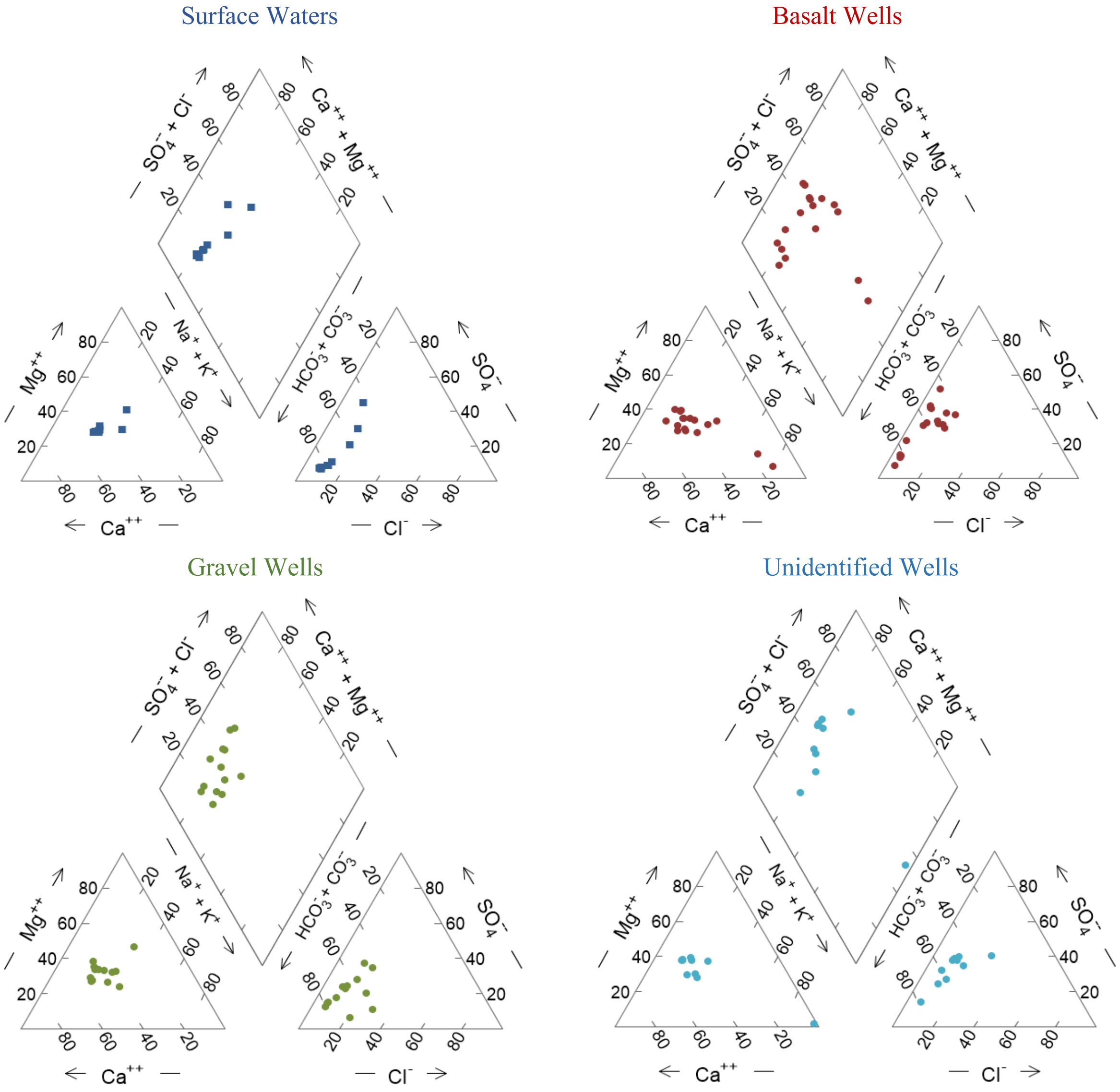

Figure 10. Piper diagrams showing major ion chemistry (in % eq/L) for all samples divided into four groups: Surface water samples – blue squares; basalt well samples – maroon circles; gravel well samples – green circles; undetermined well (aquifer unknown) samples – light blue circles.

A color-scaled table of trace element data for all samples (Table 2) reveals that concentrations are below detection limits (green) for most samples for many elements. There are some consistent differences between surface waters (higher Fe, lower V), but there are not strong patterns within groundwater, either when grouped by region or by lithology. Anomalously high trace element concentrations (dark red) tend to be localized to a single well and at times may be related to material in pipes, wells, or other infrastructure.

Table 2. Trace element data. Shaded by relative concentration: red = high; blue = low; light green = below detection limit.

ID	V (ppb)	Fe (ppb)	Cu (ppb)	As (ppb)	Mo (ppb)	Ba (ppb)	U (ppb)	Mn (ppb)	Al (ppb)	Zn (ppb)	Cr (ppb)	Se (ppb)	Ni (ppb)	Pb (ppb)
Surface Water														
Rivers														
SW1	3.18	4.23	0.39	0.65	0.60	10.4	bdl	bdl	bdl	bdl	bdl	bdl	0.49	bdl
SW3	3.36	19.3	0.50	0.80	0.87	10.2	bdl	1.54	9.60	bdl	bdl	bdl	bdl	bdl
SW7	4.01	12.0	0.45	0.76	0.67	11.2	0.8	134	4.89	bdl	bdl	bdl	0.62	bdl
SW6	17.5	1.83	0.67	4.95	5.17	50.2	14.1	3.20	bdl	bdl	0.54	1.41	bdl	bdl
Lakes														
SW5	0.45	19.61	2.96	1.01	1.19	57.3	2.3	4.86	bdl	bdl	bdl	bdl	bdl	bdl
SW4	2.38	25.84	0.67	1.48	11.34	58.0	25.2	bdl	bdl	bdl	bdl	0.83	0.63	bdl
SW2	4.89	8.00	1.43	1.77	2.82	20.3	7.1	2.32	3.36	bdl	bdl	bdl	0.59	bdl
Irrigation Water														
SW8	2.87	12.53	0.67	0.58	bdl	8.20	bdl	0.94	2.25	bdl	bdl	bdl	bdl	bdl
SW9	2.90	10.20	0.89	0.62	bdl	9.33	bdl	bdl	2.12	bdl	bdl	bdl	bdl	bdl
SW10	2.97	12.99	0.95	0.63	bdl	8.25	bdl	2.70	2.57	bdl	bdl	bdl	bdl	bdl
SW11	3.08	20.71	0.57	0.63	bdl	8.44	0.4	6.56	8.01	bdl	bdl	bdl	bdl	bdl
Groundwater														
Western Group														
WW43	7.8	bdl	6.9	0.6	4.1	33	bdl	bdl	bdl	14.7	bdl	0.72	bdl	0.91
WW37	31.7	0.42	0.81	1.81	3.86	9.32	1.3	bdl	bdl	1.40	bdl	bdl	bdl	bdl
WW30	10.7	bdl	6.58	1.35	5.42	29.6	31.9	bdl	bdl	72.3	1.19	2.05	bdl	bdl
WW31	11.9	0.99	1.31	2.29	7.41	0.58	6.8	bdl	bdl	bdl	bdl	0.78	bdl	bdl
WW44	21.7	0.4	1.6	3.5	5.2	21.3	2.5	bdl	bdl	49.5	bdl	bdl	bdl	bdl
WW45	7.27	4.53	21.12	2.56	4.66	49.9	7.4	1.06	3.45	51.4	bdl	0.79	1.85	bdl
WW32	8.93	1.57	0.43	1.70	6.92	49.2	21.0	bdl	bdl	24.1	0.53	2.05	bdl	bdl
WW33	18.7	0.54	9.08	2.53	7.60	29.8	24.4	bdl	bdl	64.5	bdl	bdl	bdl	bdl
WW36	15.1	bdl	bdl	3.46	9.56	26.2	5.6	bdl	bdl	bdl	0.56	1.72	bdl	bdl
WW34	22.3	1.0	4.0	4.5	7.7	bdl	20.4	bdl	bdl	3.8	1.9	3.69	bdl	bdl
WW35	15.9	bdl	bdl	3.39	10.76	29.8	6.5	bdl	bdl	103	0.85	1.93	bdl	bdl
Badger Coulee West														
WW20	12.8	bdl	1.10	1.64	4.53	3.52	12.1	bdl	bdl	bdl	3.64	3.32	bdl	bdl
WW16	10.6	bdl	bdl	1.33	2.62	10.1	10.4	bdl	bdl	bdl	1.10	1.64	bdl	bdl
WW27	bdl	2.59	bdl	bdl	2.83	47.3	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
WW4	29.7	bdl	0.82	4.67	2.40	2.05	4.3	bdl	bdl	10.9	bdl	bdl	bdl	bdl
Northern Group														
WW29	7.88	bdl	1.75	2.00	27.61	42.3	25.9	16.6	bdl	10.1	bdl	0.72	0.85	bdl
WW28	0.33	15.7	bdl	1.72	18.49	82.8	4.0	71.3	bdl	1.97	bdl	bdl	bdl	bdl
Badger Coulee Middle														
WW5	18.2	0.72	0.45	2.28	5.93	22.0	6.4	bdl	bdl	bdl	2.76	14.51	bdl	bdl
WW38	29.8	0.92	0.42	4.30	2.61	11.4	4.3	bdl	4.97	3.71	bdl	1.51	bdl	bdl
WW6	1.69	105	bdl	bdl	3.30	58.6	bdl	4.09	bdl	140	bdl	bdl	bdl	bdl
WW39	18.9	1.48	bdl	2.95	4.05	21.9	5.3	bdl	bdl	4.77	1.76	12.5	bdl	bdl
WW8	26.1	1.11	1.59	4.20	21.6	0.79	3.9	bdl	bdl	6.19	4.15	21.6	bdl	bdl
WW2	15.7	0.92	bdl	3.75	3.96	57.6	1.8	bdl	bdl	70.6	bdl	1.70	bdl	bdl
WW40	25.2	0.50	bdl	4.32	11.5	13.4	2.6	bdl	bdl	bdl	1.81	18.3	bdl	bdl
WW7	15.8	0.63	1.32	2.22	3.17	70.5	2.8	bdl	bdl	194	bdl	7.47	bdl	bdl
Badger Coulee East														
WW42	bdl	2.2	106.2	bdl	6.4	bdl	bdl	bdl	bdl	218	bdl	bdl	bdl	bdl
WW18	31.2	7.55	0.67	2.49	1.81	26.8	1.5	0.86	bdl	56.2	bdl	1.05	bdl	bdl
WW21	13.7	0.74	1.41	2.97	1.70	80.9	8.9	bdl	bdl	bdl	0.72	3.25	0.52	bdl
WW19	0.79	14.8	bdl	bdl	42.0	54.8	bdl	50.2	bdl	bdl	bdl	bdl	bdl	bdl
WW23	13.9	0.41	1.14	1.80	1.42	23.7	16.6	bdl	bdl	1.62	0.57	3.64	bdl	bdl
WW26	13.8	3.83	1.87	2.34	3.63	22.6	1.6	1.05	bdl	bdl	0.80	0.45	bdl	bdl
WW41	33.4	0.70	1.64	6.56	7.28	15.6	6.8	bdl	bdl	4.25	0.99	[illegible]	bdl	bdl
WW10	13.8	0.96	0.51	2.81	9.01	87.4	8.6	bdl	bdl	7.96	1.08	2.49	bdl	bdl
WW11	12.5	0.65	bdl	1.58	3.30	52.3	5.5	bdl	bdl	2.36	1.14	1.22	bdl	bdl
WW9	13.3	0.68	1.51	1.89	5.61	51.0	5.6	bdl	bdl	84.6	0.83	0.67	bdl	bdl
WW22	15.3	1.53	bdl	[illegible]	2.02	20.4	1.7	bdl	bdl	bdl	bdl	bdl	bdl	bdl
WW17	bdl	1.4	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl
WW15	bdl	0.8	bdl	bdl	bdl	bdl	bdl	3.0	bdl	bdl	bdl	bdl	bdl	bdl
WW24	21.4	13.34	0.39	3.58	6.72	18.7	1.7	bdl	bdl	3.00	bdl	bdl	bdl	bdl
WW12	16.4	bdl	6.71	2.45	2.02	47.1	4.3	0.90	bdl	1029	0.76	0.97	0.57	1.12
WW13	22.6	1.62	0.65	3.39	1.87	18.2	1.9	bdl	bdl	6.15	0.27	0.71	bdl	bdl
WW14	11.4	1.25	bdl	1.71	4.12	50.9	4.5	bdl	bdl	9.44	0.7	0.78	bdl	bdl
Eastern Group														
WW1	51.4	1.12	0.94	2.20	3.22	31.9	2.4	bdl	bdl	6.32	2.39	4.95	bdl	bdl
WW3	17.4	0.53	bdl	4.23	2.73	36.6	10.9	bdl	bdl	0.99	bdl	1.40	bdl	bdl
WW25	22.9	0.70	0.62	4.15	6.09	14.4	13.2	bdl	bdl	1.37	2.32	1.51	bdl	bdl

Principal component analysis (PCA) was performed with two data sets, using all geochemical data and using major ion and isotope data (excluding trace element data). Results were similar, but anomalously high trace element concentrations in single samples influenced the results of the PCA using all data making those results less useful for understanding large scale hydrochemistry. Therefore, the PCA which used the major ions and stable isotopes is presented here as the best chemical groupings for describing large-scale variations in water chemistry.

PCA performed on all wells with a complete data set of major ion and stable isotope data yielded five principal components, or factors, with eigenvalues greater than one (Table 3). These factors are combinations of chemical constituents that describe the observed variation in water chemistry. Table 3 gives the factor loadings for those factors. When a factor loading is high (red), there is a positive correlation between that constituent and the factor; when it is low and negative (blue), there is a negative correlation.

Table 3. PCA factor loadings, correlations between variables and factors. Conditional shading with red for high values (positive correlation) and blue for low values (negative correlation).

Variable*	F1	F2	F3	F4	F5
% variance	36.4	23.9	12.2	10.3	7.9
H	0.582	0.190	-0.586	-0.353	0.041
Na	0.194	0.446	0.529	-0.387	0.551
K	-0.218	0.887	-0.071	0.221	-0.035
Mg	0.857	0.230	-0.068	0.300	-0.258
Ca	0.917	0.078	-0.145	0.228	-0.203
F	-0.224	0.713	-0.249	0.158	0.479
Cl	0.764	0.135	0.502	-0.079	-0.151
NO_3-N	0.685	-0.017	0.332	-0.551	-0.065
SO_4	0.603	0.618	0.272	0.199	-0.105
HCO_3	0.759	0.230	-0.273	0.261	0.351
CO_3	-0.219	-0.227	0.589	0.623	0.123
$\delta^{18}O$	0.618	-0.677	-0.031	0.127	0.310
δD	0.512	-0.747	-0.119	0.147	0.331

*Units: H+ - µmol/L; major ions – ppm; stable isotopes – δ (per mil)

Figure 11 is a PCA biplot showing the scores for Factor 1 (F1) and Factor 2 (F2) for all samples. The score represents the extent to which that sample is linked to that factor. Based on these factor scores, five hydrochemical groups are identified (A, B, C, D, and E in Figure 11). Details of the samples in those five groups are given in Table 4. This tabulation reveals that the lithology in the well is a first order determinant of overall geochemistry with groups A, B, and E being predominantly basalt waters, and groups C, and D being predominantly gravel waters. Nitrate, likely from fertilizer, is linked to high scores for F1 (Groups D and E). Lower scores for F2 are associated with heavier stable isotope signatures, which indicate a high proportion of surface water (explained below in discussion of isotope data). In general, these hydrochemical groups are present across the study area indicating that these are regional geochemical signatures.

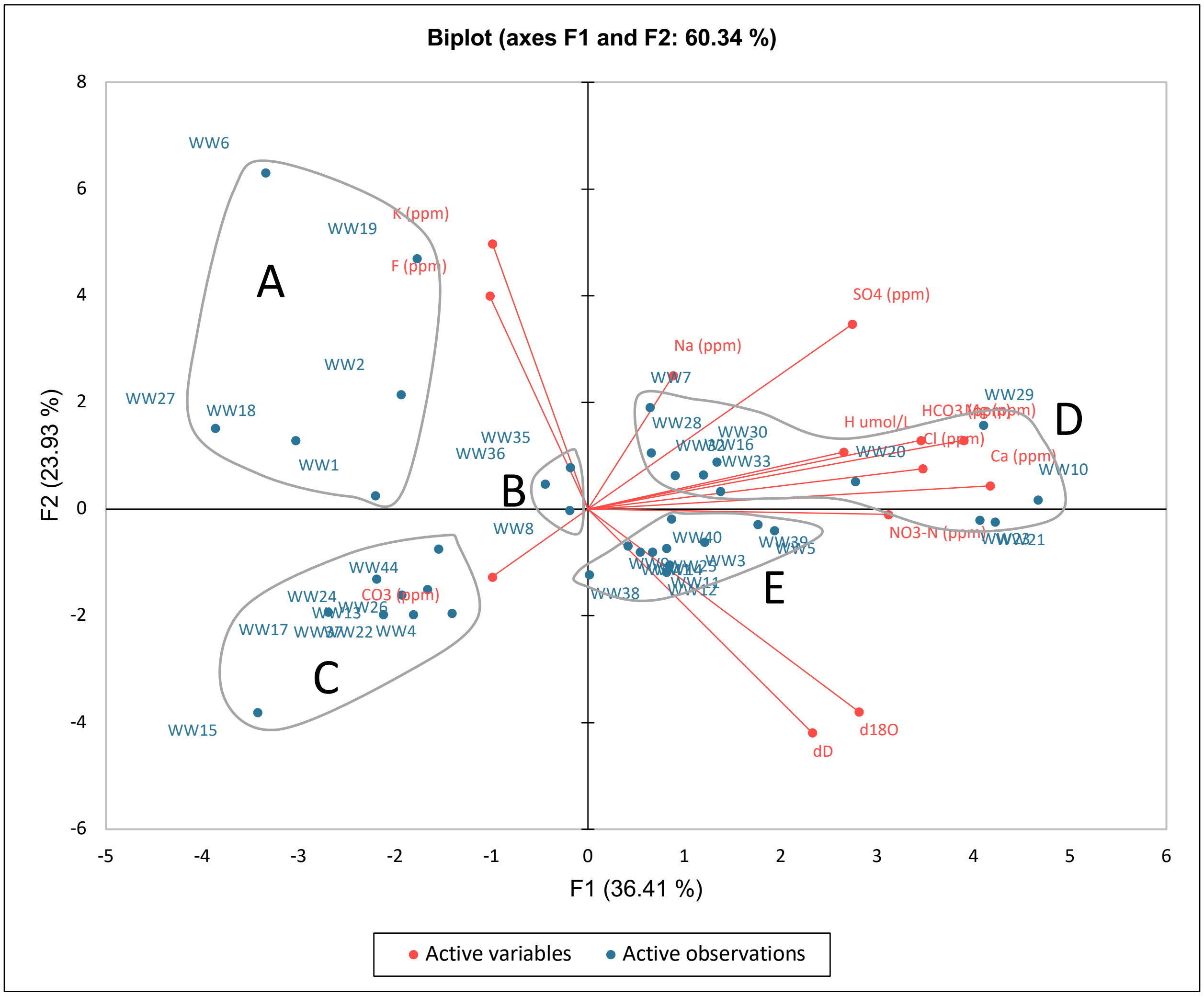

Figure 11. Biplot for principal component analysis. Axes are factor scores for each groundwater sample and red lines show correlation between chemical variables and factors. Groundwater samples have been divided into five hydrochemical groups (A, B, C, D, and E) based on factor score groupings.

Table 4. Hydrochemical groups based on PCA scores. Notes on column criteria at bottom of table.

PCA group	Sample ID	Well Depth (m)	Well Geologic Unit	Geographic Location	Trace Element Notes	Nitrate	Other Ions Notes	Calculated % Yakima River	δD
A	WW19	141	Basalt	BC East	high Mo	low	high SO_4	0	low
A*	WW42	308	Basalt	BC East	high Cu			0	low
A	WW18	137**	Basalt	BC East			high SO_4	0	low
A	WW6	259	Basalt	BC Middle	high Fe	bdl	high Cl, SO_4	0	low
A	WW2	142	Basalt	BC Middle		med	high Cl, SO_4	0	low
A	WW27	177	Basalt	BC West		bdl	high SO_4	0	low
A	WW1	131	Basalt	Eastern	high V			0	
A*	WW43	122**	Basalt	Western				0	low
B	WW8	76.2		BC Middle	high Cr, Se	high		47	
B	WW36	51.8	Basalt	Western				72	
B	WW35	53.3	Basalt	Western			high SO_4	72	
C	WW26	48.8	Gravel	BC East			high Na, SO_4	66	
C	WW22	45.1	Gravel	BC East				**77**	
C	WW17	60	Gravel	BC East		bdl	high SO_4	70	
C	WW15	58.8	Gravel	BC East		bdl	high SO_4	65	
C	WW24	65.5	Gravel	BC East				**75**	
C	WW13	33.5**		BC East				44	
C	WW4	31.1	Gravel	BC West			high SO_4	**89**	high
C	WW37	88.4	Basalt	Western			high SO_4	**95**	
C	WW44	62.5	Basalt	Western		low		**61**	
D	WW41	27.4	Gravel	BC East	high As	med		**88**	
D	WW11	54.4	Gravel	BC East		med		67	
D	WW9	68.3	Gravel	BC East		med		72	
D	WW12	32.9		BC East	high Zn, Pb	med		**79**	
D	WW14	30.5**		BC East		med	high Cl	71	
D	WW5	61		BC Middle		high	high Na, SO_4	69	
D	WW38	27.4		BC Middle		med		**83**	
D	WW39	61.6	Gravel	BC Middle		high		61	
D	WW40	101		BC Middle		high		70	
D	WW3	9.1	Gravel	Eastern		med		64	
D	WW25	25	Gravel	Eastern		med		67	

PCA group	Sample ID	Well Depth (m)	Well Geologic Unit	Geographic Location	Trace Element Notes	Nitrate	Other Ions Notes	Calculated % Yakima River	δD
E	WW21	37.2	Basalt	BC East	high Ba	high		**81**	high
E	WW23	37.3	Basalt	BC East		high		**83**	high
E	WW10	32.3	Gravel	BC East	high Ba	high		62	
E	WW7	130	Basalt	BC Middle		high	high Na		low
E	WW20	146		BC West		med	high Cl	71	
E	WW16	130**		BC West			high Cl	57	
E	WW29	21.3	Basalt	Northern		high		52	
E	WW28	54.9	Basalt	Northern		bdl	high Cl, SO_4	31	
E	WW30	51.8	Basalt	Western	high U			**85**	high
E	WW32	51.8**	Basalt	Western		med		63	
E	WW33	42.7	Basalt	Western			high SO_4	**92**	high
-	WW31	51.8**	Basalt	Western				**77**	
-	WW45	61	Basalt	Western	high Ni			**91**	
-	WW34	93	Basalt	Western				62	

*placed in group based on chemical characteristics, not PCA analysis (sample had missing data)
**estimated well depth based on nearby wells
PCA group: designated based on scores for first two PCA factors (Figure 11)
Geographic Location: BC=Badger Coulee
Trace element: high – anomalously high concentration
Nitrate-N: high > 10 ppm; 10 ppm > med > 5 ppm; low < 1 ppm; bdl = below detection limit
Other ions: high – based on percentage of ions (Piper plot, Figure 10)
Calculated % Yakima River: based on mass balance calculation described in discussion below
δD: low < –120‰; high > –100‰

Isotopic Evidence for Artificial Recharge

In the Yakima basin, stable isotopes are useful for identifying regions of surface water infiltration, particularly Yakima River derived irrigation water because the isotopic composition of the surface water is distinctly heavier than that of the resident groundwater. The Yakima River and associated irrigation water tends to have $\delta^{18}O$ and δD values around –13.5 and –99, respectively while the most evolved basalt waters are much lighter isotopically, with $\delta^{18}O$ around –16 and δD around –140 (e.g., Taylor and Gazis, 2014; Sleeper, 2020). There are also groundwaters with intermediate compositions, particularly in the basin-filling Ellensburg Formation aquifers (e.g. Taylor and Gazis, 2014; Sleeper, 2020).

General Isotopic Trends

Figure 12 is a δD- $\delta^{18}O$ plot with all of the stable isotope data for this study. The same general trends are seen in this data set: Yakima River and canal δD values around –99 and end-member basalt waters with δD around –140. Lake isotopic composition can be explained by evaporation of Yakima River derived water (grey arrow, Figure 12). Two meteoric water lines are shown on Figure 12 for reference, the Global Meteoric Water Line (GWML) and a Local Meteoric Water Line (LMWL) for Hanford, WA, approximately 40 km north of the study area. The Hanford LMWL is based on measurement of precipitation collected from multiple locations around the Hanford nuclear site (Early et al., 1986). The fact that most groundwaters lie above the Hanford LMWL suggests that these waters are not derived from modern precipitation because there is not a simple mechanism that will move the isotopic composition above a source water on a δD-δ^{18}O plot.

To the first order, all of the gravel waters and many of the basalt waters are similar isotopically to Yakima River and canal waters. However, a closer inspection of that region of the δD-δ^{18}O plot (Figure 13) reveals a spread of groundwater isotopic compositions, mostly lying below and to the right of a mixing line between the Yakima River water and the end member ancient basalts. Black arrows indicate possible mixing lines. It is difficult to explain the variations in isotopic composition by mixing alone, even between three components. But these compositions can be explained by a combination of mixing between Yakima River water and an isotopically lighter groundwater plus evaporation. This idea will be discussed further below and modeled mathematically.

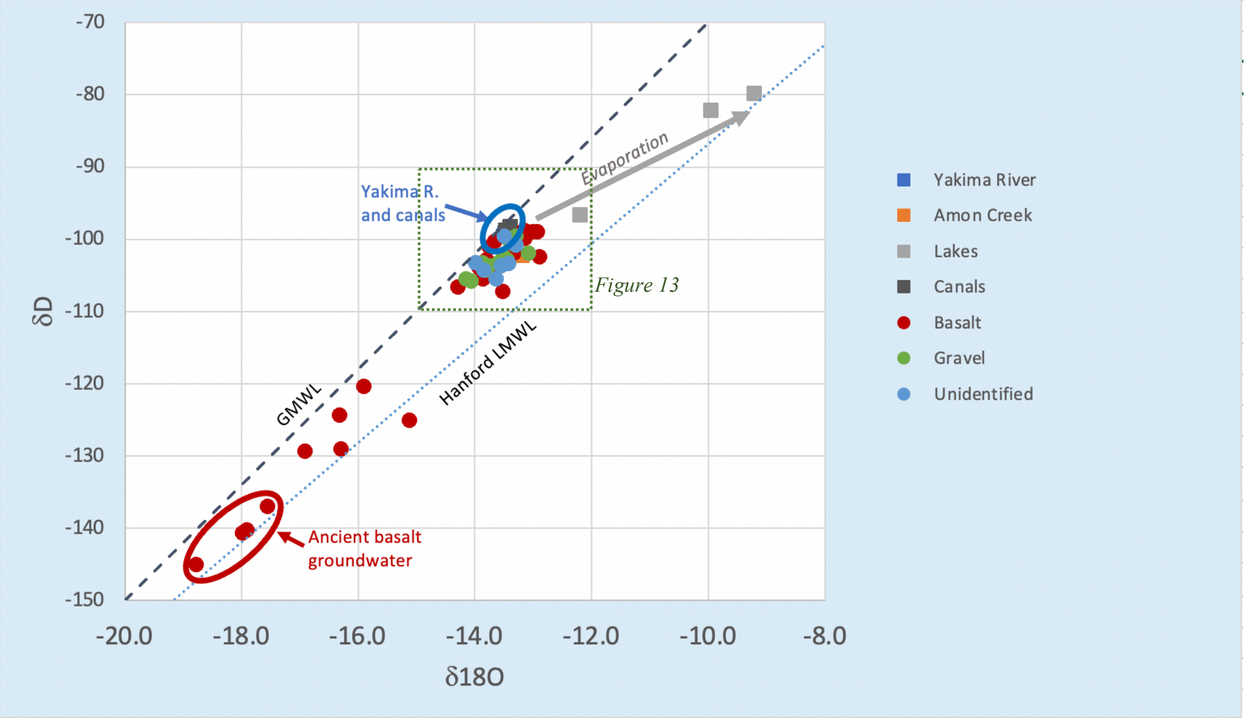

Figure 12. δD-δ^{18}O plot of all waters. Circles are groundwater samples, colored according to lithology of screened zone in wells. Squares are surface water samples. Lines are Global Meteoric Water Line (GWML) and Local Meteoric Water Line (LMWL) for Hanford, WA. Data for Hanford LMWL from Early et al. (1986). Grey arrow shows general evaporation trend for surface water. Dashed rectangle is area of Figure 13.

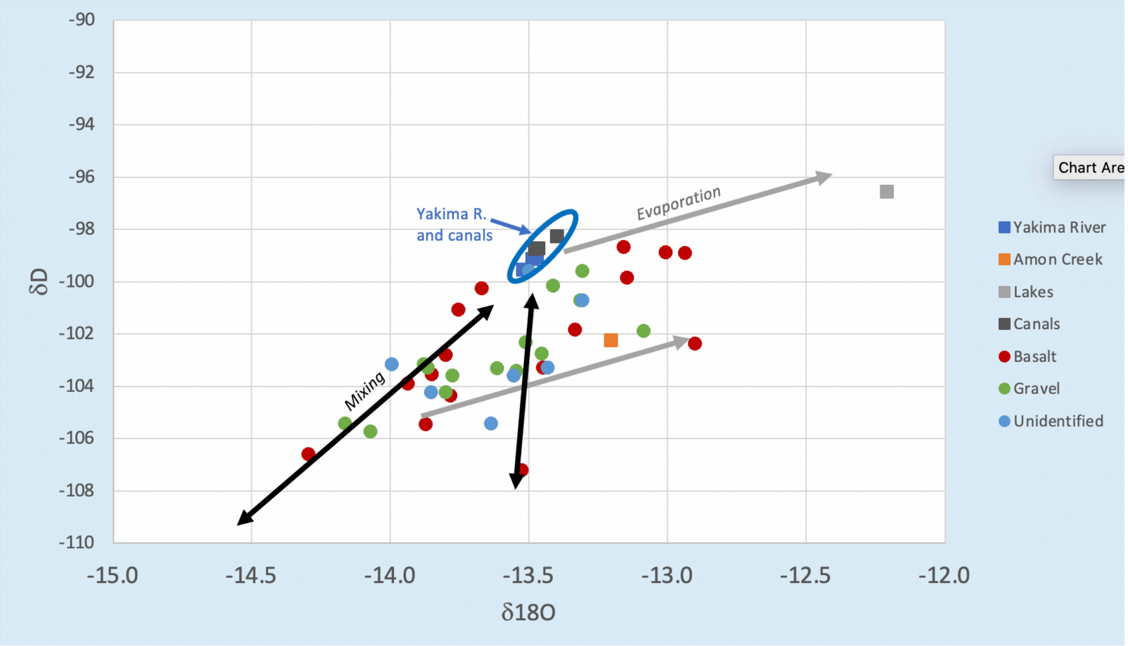

Figure 13. Detail of δD-δ^{18}O plot. Area of plot shown as dashed rectangle on Figure 12.

Nitrate as Evidence of Agricultural Influence

Comparison of stable isotope data with nitrate concentrations provides further evidence of a strong surface water influence in many groundwater samples (Figure 14). All samples with high nitrate concentrations are isotopically similar to Yakima River and canal waters indicating that these groundwater samples are dominated by this surface water, likely fertilizer-rich irrigation water. Notably, three of the samples with the highest nitrate concentration are basalt waters. As expected, ancient basalt groundwaters have very low nitrate concentrations. All other samples can be explained by mixing between the basalt waters. Some might be explained by mixing between surface water and an intermediate composition water (Figure 14).

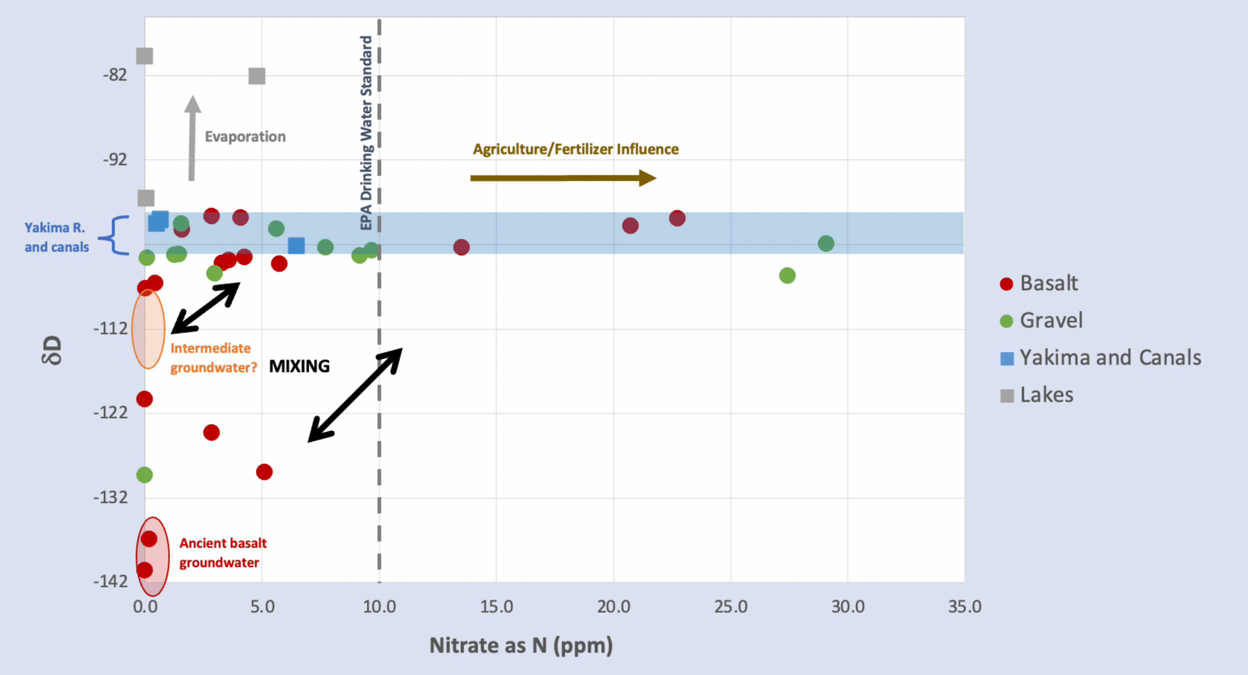

Figure 14. δD versus Nitrate-N plot. Blue shaded area shows range of δD for Yakima River and KID canals. EPA drinking water standard of 10 ppm is shown with dashed line. Possible groundwater endmembers are shown with shaded ovals. Arrows show effects of mixing, evaporation, and agriculture/fertilizer influence.

Mass Balance Calculation of Surface Water Contribution

A mass balance calculation can be used to quantify the percentage of surface water in each groundwater sample. In this calculation, a number of assumptions are made:

1. This is a simple two-component mixture between an end member groundwater and surface water with a Yakima River isotopic signature.
2. Any deviation from the mixing line is due to evaporation. That evaporation has occurred along a line with slope 3.5 on a δD-δ^{18}O plot. This is the slope that is observed for lake waters in the region.
3. No process other than mixing or evaporation has altered the isotopic composition of the groundwater.

Calculations were made for three separate groundwater endmembers (Table 5), an isotopically light basalt, a heavier basalt, and an intermediate groundwater. Figure 15 illustrates the mixing model in δD-δ^{18}O space. The first step in this calculation is to remove the effect of evaporation by projecting onto the mixing line between the two end members using the following equations:

Equation 1: $$\delta^{18}O_{mix} = \frac{(\delta D_{measure} + \delta D_{gw} + m_{evap} * \delta^{18}O_{measure} - m_{mix} * \delta^{18}O_{gw})}{(m_{evap} - m_{mix})}$$

Equation 2: $$\delta D_{mix} = m_{mix} * \left(\delta^{18}O_{mix} - \delta^{18}O_{gw}\right) + \delta D_{gw}$$

where mix represents the point where the evaporation line intersects the mixing line (the δ values when evaporation is removed) and gw is the groundwater end member. m_{evap} and m_{mix} are the slopes of the evaporation line (3.5) and the mixing line, respectively.

Once the mixing line point is determined, the percent of Yakima River (YR) water in the mixture can be determined with the mass balance equation:

Equation 3: $$\%YR = \frac{(\delta^{18}O_{mix} - \delta^{18}O_{gw})}{(\delta^{18}O_{YR} - \delta^{18}O_{gw})} * 100$$

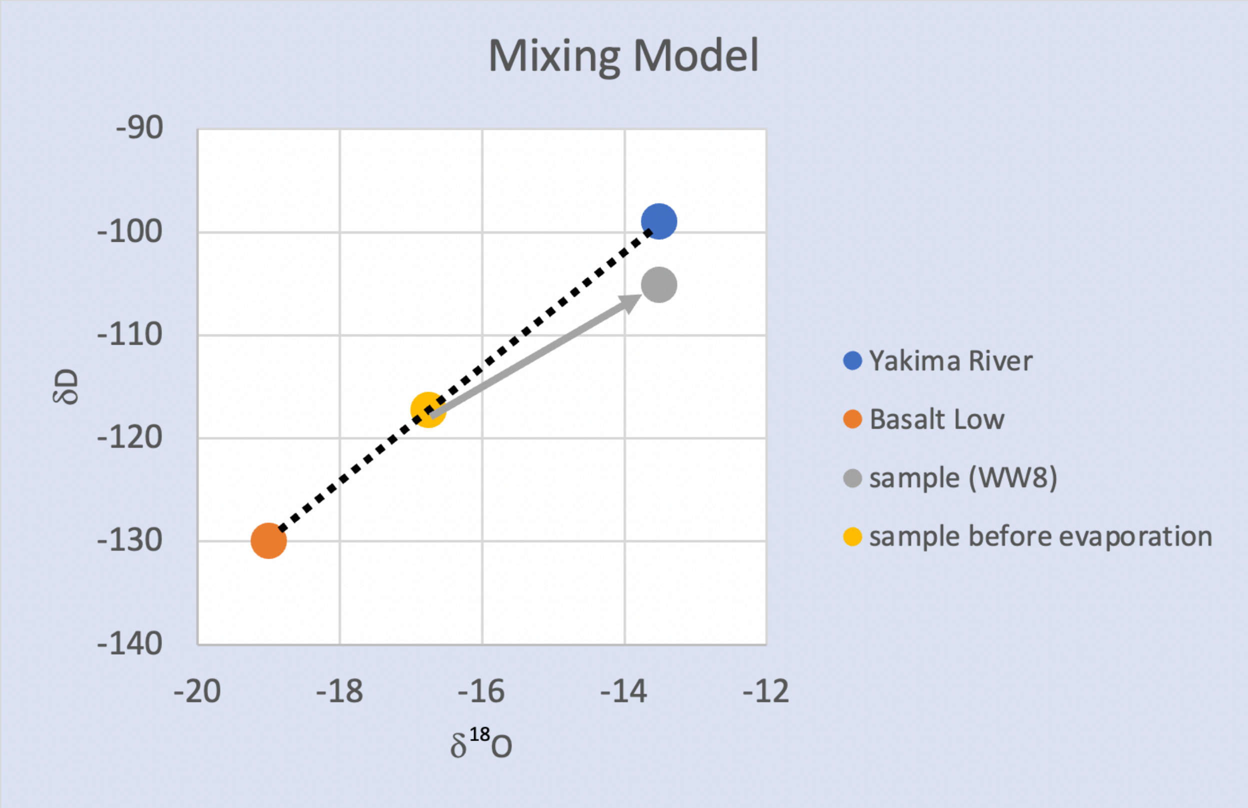

Figure 15. Isotope evaporation-mixing model. In this example, Basalt Low and Yakima River are two mixing end members. Measured sample is not on the mixing line so is projected backwards towards mixing line along an evaporation line slope to find the isotopic composition of the sample before evaporation (yellow circle). The mixing percentages are determined from this isotopic composition.

The mass balance calculation was performed for three two-component mixing scenarios (Table 5). All three have Yakima River water (equivalent isotopically to KID canal water) as one end member. Three different isotopic compositions were used for the groundwater end member: 1) a lighter basalt water with δD = –140; 2) a heavier basalt water with δD = –125; and a possible intermediate water with δD = –110. Results of the calculation are shown in Figure 16. Samples are arranged from west to east and show no obvious spatial trend. There is not a large difference between the results for the two basalt end-members. In both cases, most samples are made up of between 50% and 90% Yakima River-derived water. The calculation using an intermediate groundwater isotopic composition, which was not actually observed in our samples, provides a conservative estimate of the minimum amount of Yakima River water contribution. Even with this conservative assumption, most samples contain more than 30% Yakima River-derived water.

Table 5. End members for mixing model. Isotopic composition of end members and summary of results of calculation: maximum, minimum and median % contribution of Yakima River derived water.

Mixing End Member	δ^{18}**O**	**δD**	**Max % Yakima R.**	**Median % Yakima R.**	**Min % Yakima R.**
Yakima River/canals	–13.5	–99			
Lighter basalt groundwater	–19.0	–130	94	67	22
Heavier basalt groundwater	–16.0	–120	95	70	31
Possible intermediate	–14.0	–110	91	44	0

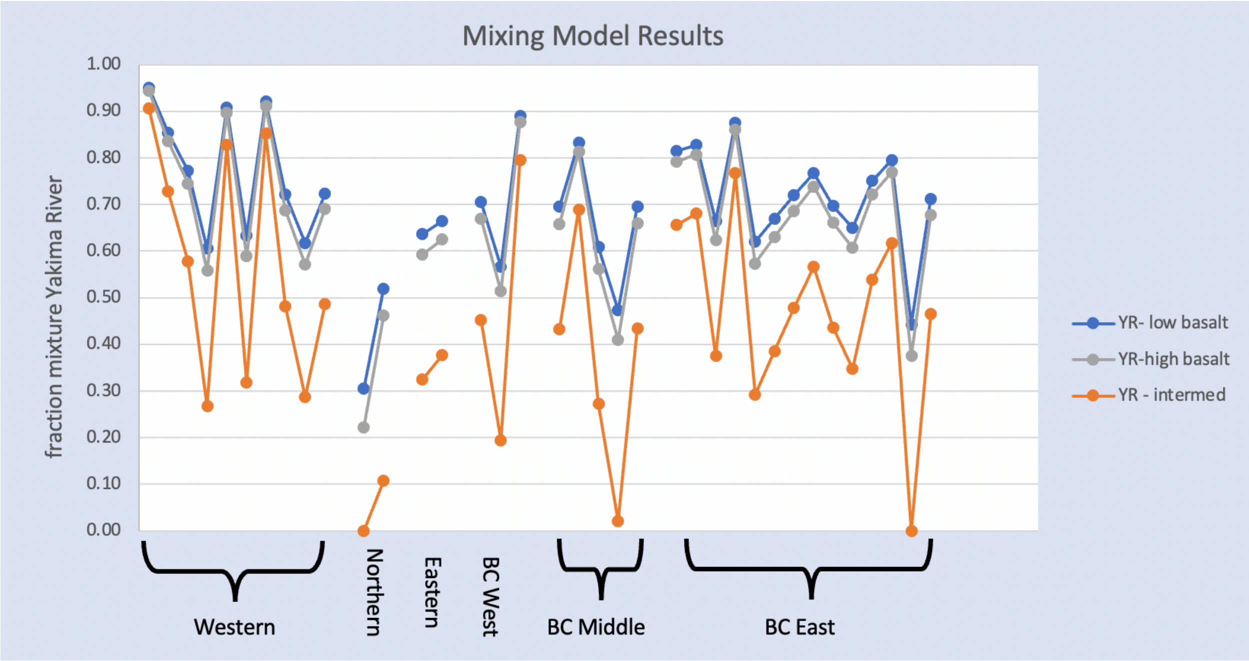

Figure 16. Results of evaporation-mixing model calculation. Results for three groundwater end members are shown (Table 5) as fraction of the mixture that is from the Yakima River end member. Horizontal axis is samples arranged from west to east. The mixture is the calculated value for the sample before evaporation. The basalt end-member samples (Group A) are excluded from the plot.

Groundwater Levels in Badger Coulee

The pressure transducer in the KID North well has obtained over a year of groundwater level data (Figure 17). There is a clear seasonal fluctuation in water level. As this well is not pumped, the water level fluctuation is likely due to seasonal pumping from nearby wells. There are two large pivot irrigation systems to the east of the KID North well (Figure 18). The drawdown, which begins in mid-May, is likely the result of pumping from one or both of these wells. The greatest drawdown occurs in September. The overall trend in water level in this well is unclear. The water level measured in September, 2018 when the well was drilled is several feet higher than it has been in September the past two years. On the other hand, the annual maximum and minimum water levels increased slightly between water years 2021 and 2022.

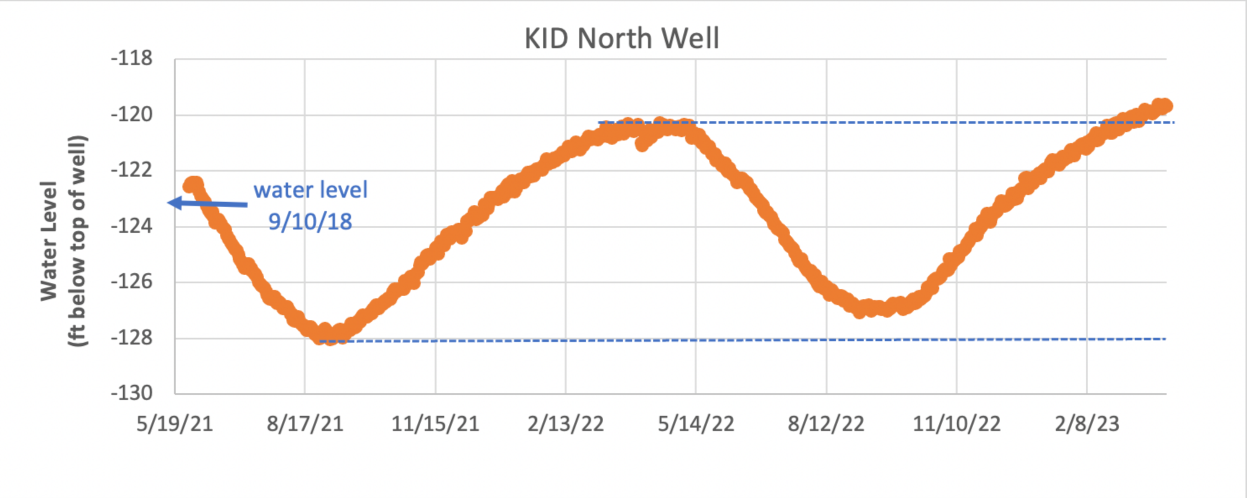

Figure 17. Water level in KID North Well from May 2021 to March 2023. The water level from the well log, recorded on 9/10/18 is shown by the blue arrow. Dashed lines are minimum and maximum water levels in first year of measurement.

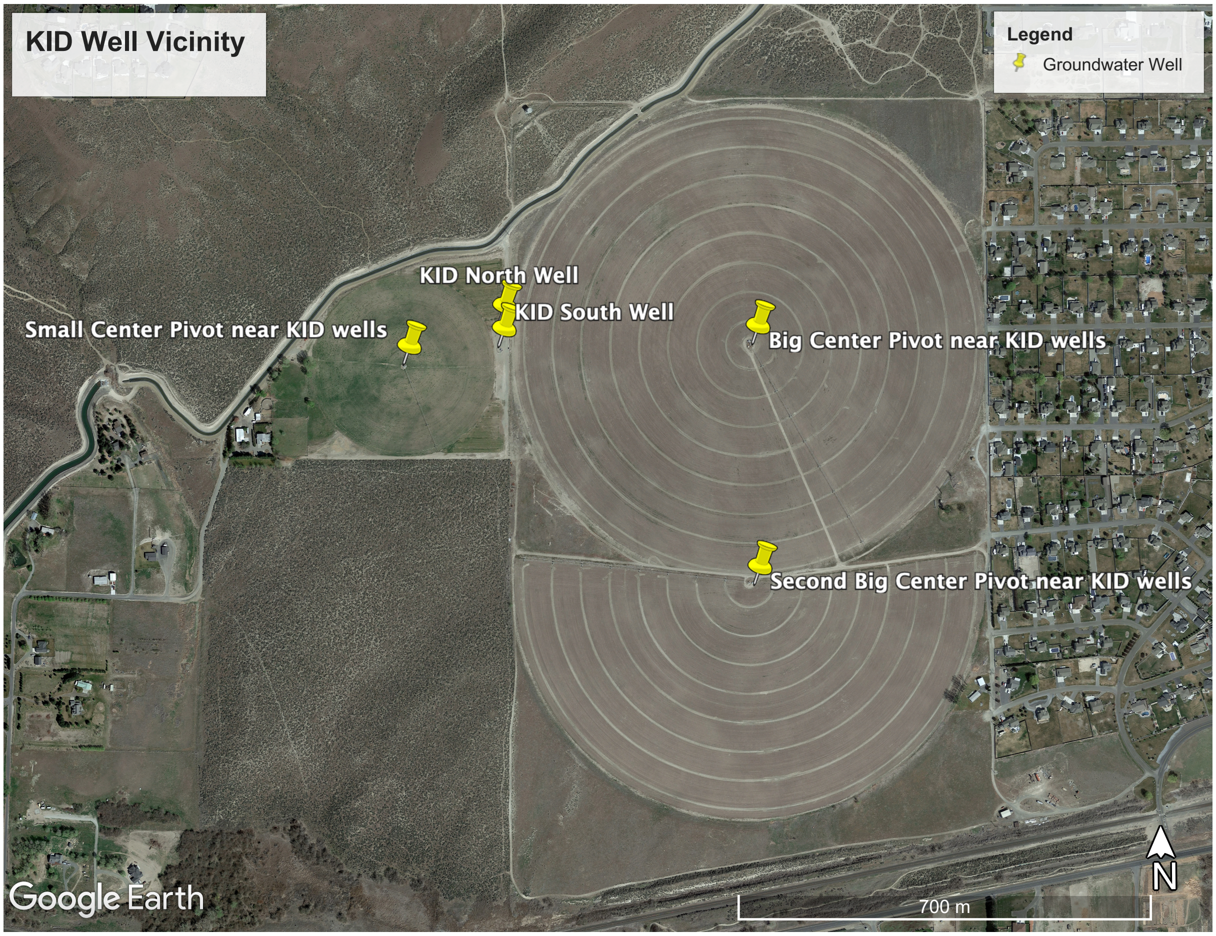

Figure 18. KID well vicinity. KID North Well is monitoring well. Two large pivot irrigation systems are located ≈600 m west of the monitoring well.

KID will continue to monitor water levels in this well to assess long-term trends in water level. This monitoring will be particularly important for documenting any changes that occur after conservation measures such as canal lining are put in place. In addition, as stated below in our recommendations, this well can be used as an observation well for a more controlled pump test from one of the nearby pivot wells.

Volume of Artificially Recharged Water and Available Additional Storage

For the Badger Coulee sedimentary aquifer (Pasco gravel plus Touchet bed silts), a simple calculation can be made to estimate both the amount of artificially recharged water that exists within the aquifer and the amount of additional storage that might be available. In this calculation, the following assumptions are made:

1. The gravel well logs that were used are representative of the Badger Coulee as a whole.
2. The gravel wells are completed at the bottom of the sedimentary aquifer and their water levels represent the saturated thickness of the aquifer.
3. The depth to groundwater recorded in the well log at the time of drilling is approximately the same as the depth to groundwater today.
4. Storage coefficients are assumed for the current saturated thickness (0.12) and for the thickness of sediment above the current groundwater level (0.08). These represent the fraction of the total volume that is/can be filled with water. The lower value was chosen for the upper part of the aquifer because it is more silt-rich.
5. Between 50% and 90% of the water in the sedimentary aquifer has been artificially recharged through canal leakage or irrigation. These percentages are based on the mass balance calculations above.

Table 6 shows the results of this calculation. Badger Coulee East represents the Columbia River discharging side of Badger Coulee while Badger Coulee West plus Badger Coulee Middle represent the Yakima River discharging side. Estimates of artificially recharged water on the Columbia River side are between 25,000 and 45,000 acre-feet. This is comparable to the estimate of 47,000 acre-feet by RH2 (2015), which was based on the assumption that artificial recharge had raised water levels by 100 feet on average and used storage coefficients of 0.15 for the gravel and 0.08 for the silt. Our calculation suggests that an additional 15,000 acre-ft of water could be stored in the current unsaturated zone. The Yakima River side of Badger Coulee has just under twice the current storage and additional storage capacity of the Columbia River side due to its larger area. The estimate by RH2 (2015) for amount of artificial recharge in the entire Badger Coulee was 132,000 acre-feet, identical to our higher estimate (90% surface water). Our value of 74,000 for 50% surface water serves as a more conservative estimate of total amount of artificially recharged water.

Table 6. Estimation of artificially recharged water and additional storage. Assumptions of calculation described in text.

Average well depth *m*	Average depth to water *m*	Saturated thickness in well *m*	Area *acre*	Total stored in gravel/silt* *acre-ft*	Total artificially added		Additional storage available* *acre-ft*
					50% surface water *acre-ft*	90% surface water *acre-ft*	
Badger Coulee West and Badger Coulee Middle							
80	24	56	4,500	97,000	49,000	87,000	28,000
Badger Coulee East							
66	20	46	2,700	50,000	25,000	45,000	15,000
Weighted average			**Total**				
74	23	52	7200	147,000	74,000	132,000	43,000

Storage coefficients used:

saturated thickness	*above top of groundwater*
0.12	0.08

Conceptual Model and Recommendations

This study has identified five hydrochemical groups based on principal component analysis (PCA) using major ion and stable isotope data (Table 6). The groups were defined based on clustering of factor scores for the first two PCA factors. Three of the groups consist mostly of basalt groundwaters and the other two are mostly gravel groundwaters, suggesting that the first two PCA factors identify the fundamental chemical signatures that are derived from water-rock interactions. One of the basalt groups, Group A, is characterized by low δD and δ^{18}O values and very little or no nitrate. This hydrochemical group is believed to be old, evolved basalt groundwater, a geochemical end-member. Wells associated with this group tend to be deeper and are present throughout the study area, often on the slope of Horse Heaven Hills or in areas where basalt is exposed on the surface. Group E is also a basalt water group, but these waters are generally higher in nitrate and have isotopic signatures that indicate a significant surface water contribution. A cluster of these surface-water influenced basalt wells are located in the Western Group, on the west side of the study area near the Yakima River (Figure 19). These wells are typically 40 to 60 m deep but appear to contain a water mixture that is 60-95% surface water. Water in the gravel aquifer in Badger Coulee is mostly in Group C and D. These two gravel groups both have high surface water contribution, but most groundwater samples in Group D have NO_3-N concentration of 5 ppm or higher, while Group C wells have lower NO_3-N concentrations, sometimes undetectable. The difference in these two groups can be interpreted as Group C being influenced by water canal leakage whereas Group D contains water that has been used for irrigation on a fertilized lawn or farm.

Table 7. Summary of hydrochemical groups and interpretation

Group	# SAMPLES	LITHOLOGY	GROUP CHARACTERISTICS	LOCATION	INTERPRETATION
A	8	basalt	deepest wells, low NO_3, low δD and $\delta^{18}O$	throughout	pristine basalt water, end-member, probably old
B	3	basalt	intermediate chemistry (factor scores)	Western and Badger Coulee Middle	probably mixture of different waters
C	9	gravel, 2 basalt	lower NO_3, high SO_4	mostly Badger Coulee East, basalts are Western	high surface water comtribution, probably canal water, has chemical signature from gravels
D	11	gravel	mostly shallower wells, med to high NO_3	Badger Coulee East, Badger Coulee Middle and Western	high surface water contribution, probably irrigation water, has chemical signature from gravels
E	11	basalt, 1 gravel	med to high NO_3, med to high δD and $\delta^{18}O$	throughout	high surface water contribution, probably irrigation water, has chemical signature from basalts

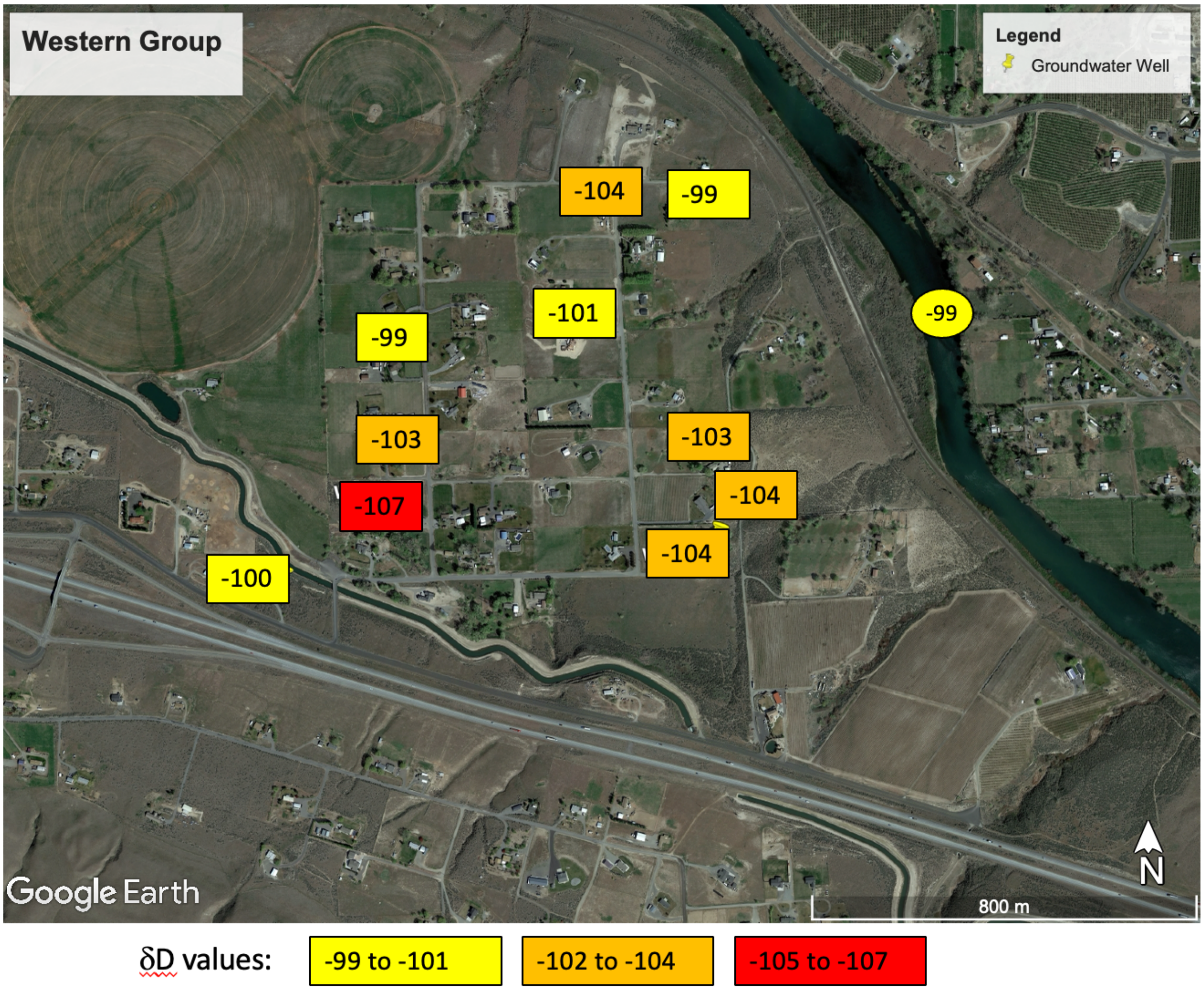

Figure 19. Hydrogen isotopic composition (δD) of groundwater from wells in Western Group and Yakima River.

Figure 20 and 21 show the distribution of the hydrochemical groups in the Badger Coulee East area, in map view and in cross section. The Group C and D wells are intermixed on the south side of Badger Coulee suggesting that application of fertilizers can have a very local influence of groundwater while all wells likely have significant contribution from canal leakage.

The KID has emplaced two wells on the west side of Badger Coulee (northernmost wells in Figure 20), both of which are chemically similar to hydrochemical Group C, gravel water with high canal-water influence. Water levels measured in the KID north well show seasonal fluctuations of 2.5 meters (8 feet) due to pumping from nearby wells. It is not clear whether there is any long-term trend in these water levels although this might be expected to change as canals are lined to conserve water and artificial recharge rates are reduced.

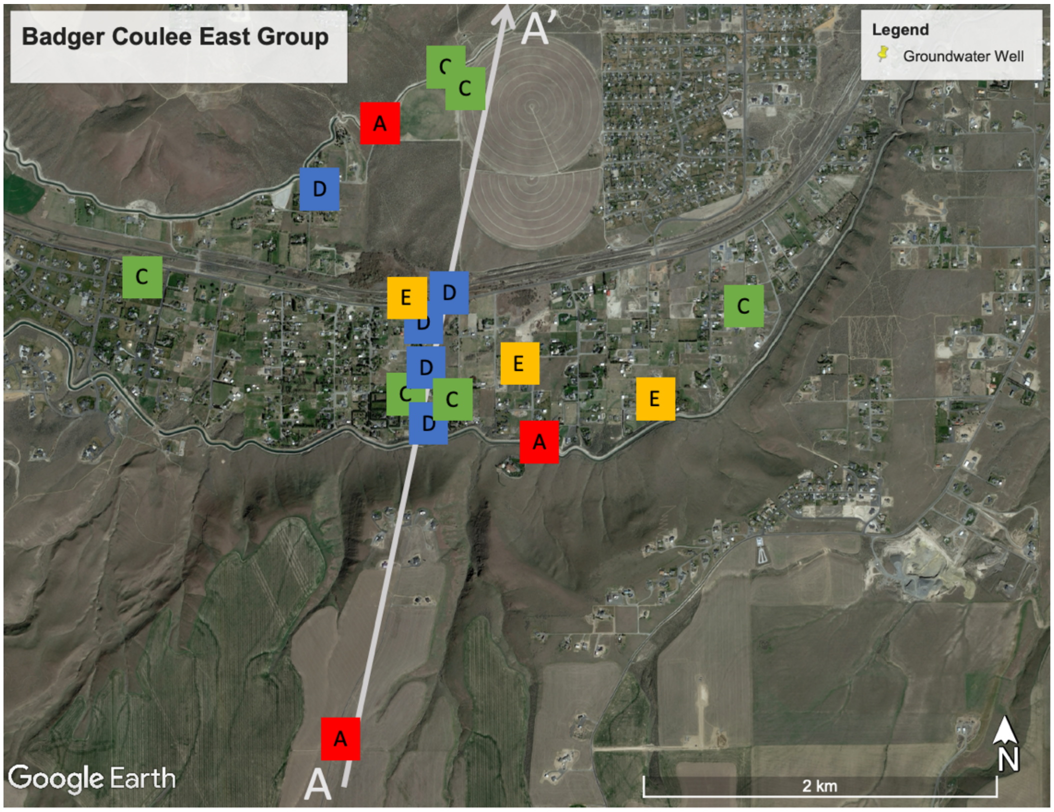

Figure 20. Badger Coulee East groundwater colored by hydrochemical group. Groups A, C, D, and E are described in the text.

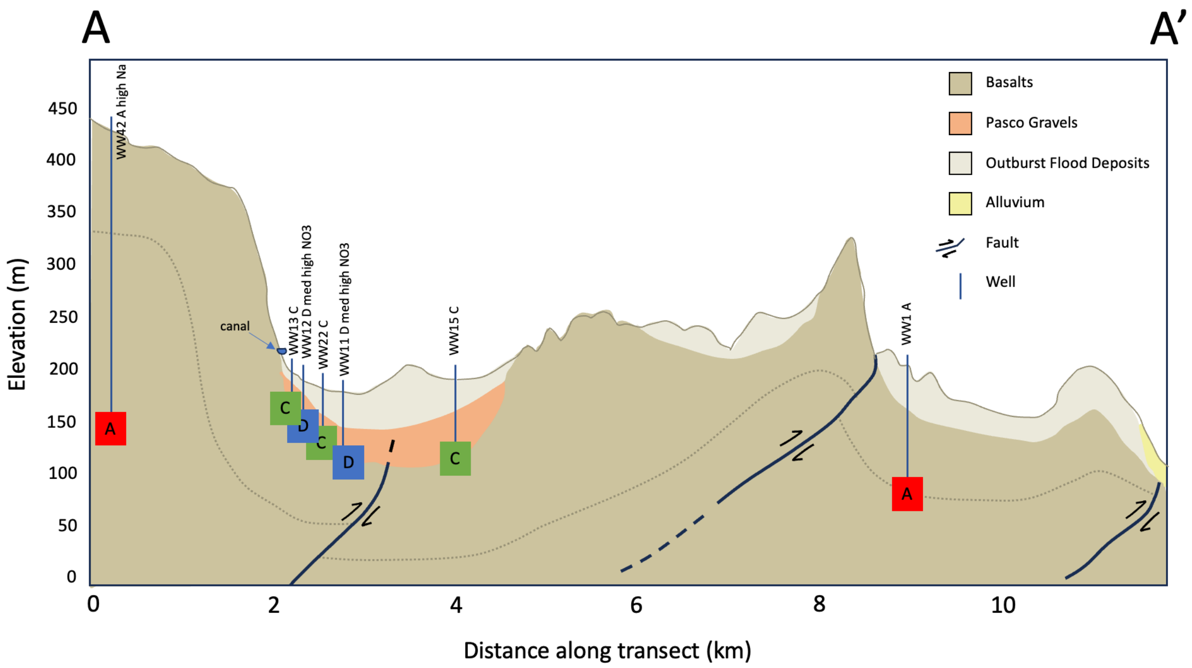

Figure 21.Cross section through Badger Coulee East with hydrochemical groups shown at bottom of well. A-A' cross section line location shown on Figure 20, in which A' is out of the figure area.

Recommendations

Based on the geochemical data and the resultant conceptual model, we submit the following recommendations:

1. The geochemical data supports the conclusion that the majority of the water in the Badger Coulee gravel aquifer was introduced either through irrigation or through leakage from the canals. If this aquifer is to be used in a managed way for storage, it is important to track any changes in water volume in this aquifer, particularly as conservation measures increase and artificial recharge decreases. Ultimately, it will probably be necessary to design a recharge system for this aquifer, ideally using surface infiltration. The transducer in KID North well should be maintained to obtain water level measurements for the next five to ten years at least.
2. The water level fluctuation in KID North well shows a clear response to pumping from nearby wells, If the pumping can be initiated in a more planned and regular way and flow rates can be monitored and recorded, then the transducer data from KID North can be treated as observation well data in a pumping test and used to determine aquifer properties and assess boundary conditions.
3. The flow of water from the north side of Badger Coulee to the Yakima River may present a unique opportunity to enhance the flow of cool groundwater into the Yakima River during the summer months, when the Yakima River water in this lower reach becomes dangerously warm for fish and other aquatic organisms. This enhanced groundwater seepage might be accomplished through artificial recharge, which would increase the head gradient and thus the discharge. This concept could be explored by examining and quantifying groundwater flow into the Yakima from northern Badger Coulee through analysis of well logs, water levels in wells, isotopic composition of groundwater, and detailed Yakima River temperatures around potential discharge areas.
4. The basalt aquifers should be considered as a potential for future water storage projects. Because of their extensive thickness, basalt aquifers have capacity to storage large volumes of water. The surface water signature in many basalts in this region suggest that there is potential for aquifer recharge through surface infiltration in some areas. In addition, faults in the region provide the potential for segmentation of the basalt aquifers.

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Appendix A
Well Information

Table A1. Groundwater Sampling Well Information

Sample ID	Date Sampled	Latitude*	Longitude*	Surface Elev (m)	Well Depth (m)	Depth to GW (m)***	Year ***	Well Geologic Unit	Well Tag	Address
Western Group										
WW43	8/29/21	46.26184	-119.54163		122**			Basalt		17504 W Yakitat Pl, South Benton
WW37	8/22/21	46.26360	-119.52908		88.4	54.6	2014	Basalt	BIF-446	15804 W Chandler Rd, South Benton
WW30	8/21/21	46.26793	-119.52608		51.8	23.8	1999	Basalt	AEL-002	37602 N 140 Pr NW, South Benton
WW31	8/21/21	46.26619	-119.52593		51.8**			Basalt		35208 N 140 Pr NW, South Benton
WW44	8/29/21	46.26506	-119.52563		62.5	29.0	1990	Basalt	AEM-768	35402 N 140 Pr NW, South Benton
WW45	8/29/21	46.26834	-119.52114		61.0	21.0	2002	Basalt	AGH-881	37002 N 114 Pr NW, South Benton
WW32	8/21/21	46.27066	-119.52016		51.8**			Basalt	AAZ-011	39304 N 114 Pr NW, South Benton
WW33	8/21/21	46.27078	-119.51813		42.7	10.7	2000	Basalt	AEM-800	39813/4 N 114 Pr NW, South Benton
WW36	8/21/21	46.26434	-119.51734		51.8	35.1	2004	Basalt	AHP-400	10506 344 Pr NW, South Benton
WW34	8/21/21	46.26614	-119.51723		93.0	32.6	2004	Basalt	AKH-796	35419 N 114 Pr NW, South Benton
WW35	8/21/21	46.26524	-119.51706		53.3	30.5	2004	Basalt	AKH-755	34821 N 114 Pr NW, South Benton
Badger Coulee West Group										
WW20	6/14/21	46.23816	-119.46832		146			Unidentified		16005 Webber Canyon West Well, West Kennewick
WW16	6/14/21	46.23642	-119.46489		130**			Unidentified		16005 Webber Canyon East Well, West Kennewick
WW27	7/16/21	46.25742	-119.46127		177	6.1	2007	Basalt	BAL-475	32901 Vineyard View Pr NE, West Kennewick
WW4	3/20/21	46.22883	-119.44850		31.1	12.2	2018	Gravel	BKG-091	10605 N Webber Canyon Rd, West Kennewick
Northern Group										
WW29	7/21/21	46.33569	-119.39803		21.3			Basalt		46304 E Drinkard Pr NE, West Richland
WW28	7/21/21	46.33562	-119.39757		54.9	4.3	2013	Basalt	BCE-912	46304 E Drinkard Pr NE, West Richland
Badger Coulee Middle Group										
WW5	3/20/21	46.22784	-119.40726		61.0			Unidentified		10204 Canyon View Pr NE, South Richland

Table A1. Groundwater Sampling Well Information
(continued)

Sample ID	Date Sampled	Latitude*	Longitude*	Surface Elev (m)	Well Depth (m)	Depth to GW (m)***	Year ***	Well Geologic Unit	Well Tag	Address
WW38	8/22/21	46.21658	-119.38516		27.4					2004 N 543 Pr NE, South Richland
WW6	3/20/21	46.18968	-119.37372		259	226	2017	Basalt	BIW-804	16275 S. Badger Canyon Rd, South Richland
WW39	8/22/21	46.21400	-119.36794		61.6	36.3	2017	Gravel	BJB-505	61310 E 7 Pr NE, South Richland
WW8	3/27/21	46.21666	-119.36778		76.2			Unidentified		1522 N Dallas Rd, South Richland
WW2	3/13/21	46.19201	-119.36628		142	43.3	2009	Basalt	APT-478	63417 E 99 Pr SE, South Richland
WW40	8/22/21	46.21306	-119.36273		101			Unidentified		11 Goose Gap Rd, South Richland
WW7	3/27/21	46.22040	-119.36009		130	102	1998	Unidentified	AEA-586	65114 E Solar Pr NE, South Richland
Badger Coulee East Group										
WW42	8/24/21	46.15052	-119.31547		308	250	2008	Basalt	BAR-764	34106 S Glenn Miller Prairie SE, Kennewick
WW18	6/1/21	46.18161	-119.31177		137**			Basalt		22410 S 823 Pr SE, Kennewick
WW21	6/14/21	46.16912	-119.30162		37.2	13.7	2014	Basalt	BHW-647	29404 S 944 Pr SE, Kennewick
WW19	6/1/21	46.16685	-119.29898		141	76.5	2018	Basalt	BCA-493	30810 S. 959 Pr SE, Kennewick
WW23	6/16/21	46.16761	-119.29205		37.3	25.6	2016	Basalt	BIF-938	30003 Pr SE, Kennewick
WW26	7/16/21	46.17358	-119.33090		48.8	16.8	2011	Gravel	BBJ-619	26405 Country Meadows Lane, Kennewick
WW41	8/22/21	46.17838	-119.31636		27.4	14.3	2005	Gravel	ALC-909	22811 S 823 Pr SE, Kennewick
WW10	4/21/21	46.17234	-119.30959		32.3			Gravel	BCS-105	27404 S. 903 Pr SE, Kennewick
WW11	4/21/21	46.17075	-119.30904		54.4	7.6	2007	Gravel	VAC-751	27902 S. 903 Pr SE, Kennewick
WW9	4/21/21	46.17202	-119.30852		68.3			Gravel		27405 S. 903 Pr SE, Kennewick
WW22	6/16/21	46.16845	-119.30832		45.1	8.2	2007	Gravel	APK-199	29603 S. 903 Pr SE, Kennewick
WW17	6/1/21	46.18300	-119.30617		60.0	36.1	2018	Gravel	BKG-085	KID South Well, Kennewick
WW15	5/27/21	46.18338	-119.30613		58.8	37.5	2018	Gravel	BLD-001	KID North Well, Kennewick
WW24	6/16/21	46.17172	-119.28547		65.5	26.5	2017	Gravel	BJG-524	27611 S. 1005 Pr SE, Kennewick
WW12	4/30/21	46.16743	-119.30861		32.9			Unidentified	BLD-720	30405 S. 903 Pr SE, Kennewick
WW13	4/30/21	46.16678	-119.30857		33.5**			Unidentified		31005 S. 903 Pr SE, Kennewick
WW14	4/30/21	46.17244	-119.30855		30.5**			Unidentified		26905 S. 903 Pr SE, Kennewick

Table A1. Groundwater Sampling Well Information (continued)

Sample ID	Date Sampled	Latitude*	Longitude*	Surface Elev (m)	Well Depth (m)	Depth to GW (m)***	Year ***	Well Geologic Unit	Well Tag	Address
Eastern Group										
WW1	3/13/21	46.22603	-119.28791		131	37.8	2001	Basalt	AGM-118	2001 Brantingham Rd, South Richland
WW3	3/13/21	46.21659	-119.25494		9.1	4.6	2014	Gravel	BIF-407	415 Larkhaven Ct, South Richland
WW25	7/16/21	46.21382	-119.24396		25.0	15.8	1999	Gravel	AEL-445	9049 W Deschutes Dr, South Richland

*WGS-84 geodetic coordinates

** estimated based on nearby wells or owner statement

***depth from top of well to groundwater, from well log

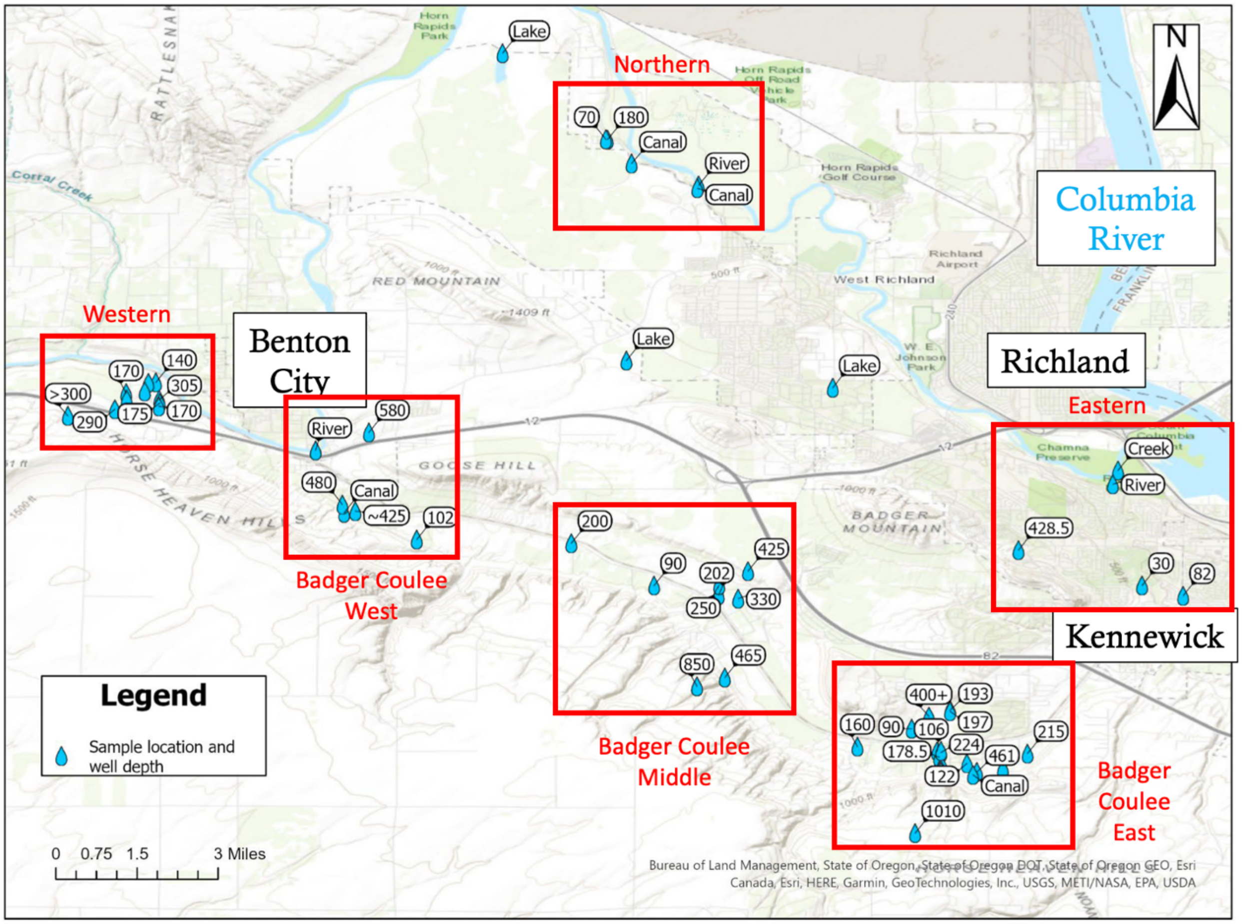

Figure A1. Sample location map. Well depths, if known are attached to groundwater samples. Groundwater samples have been placed in six groups. Detailed maps of these areas are given in Figures A2-A7.

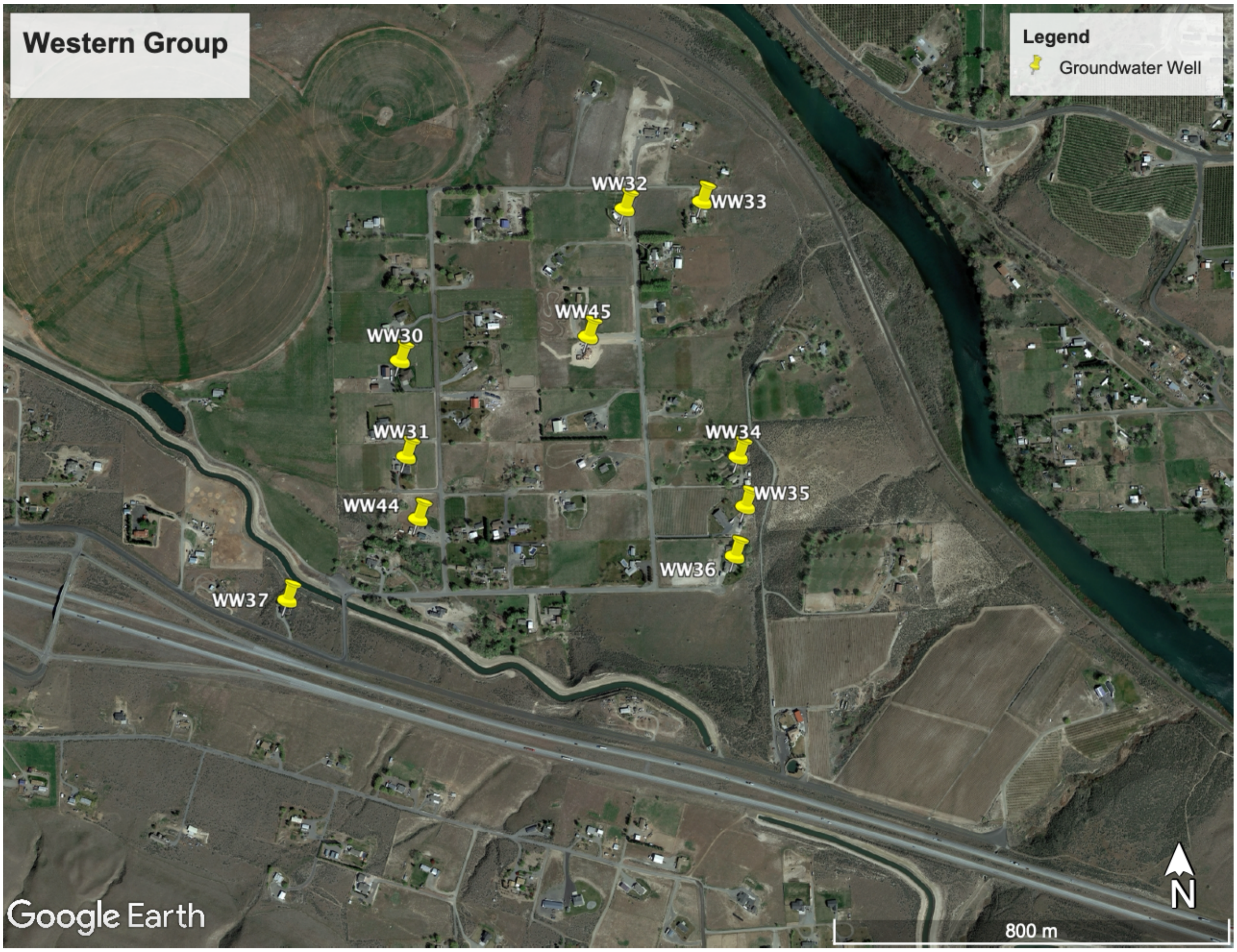

Figure A2. Map of locations for Western Group wells. Western Group location shown on Figure A1.

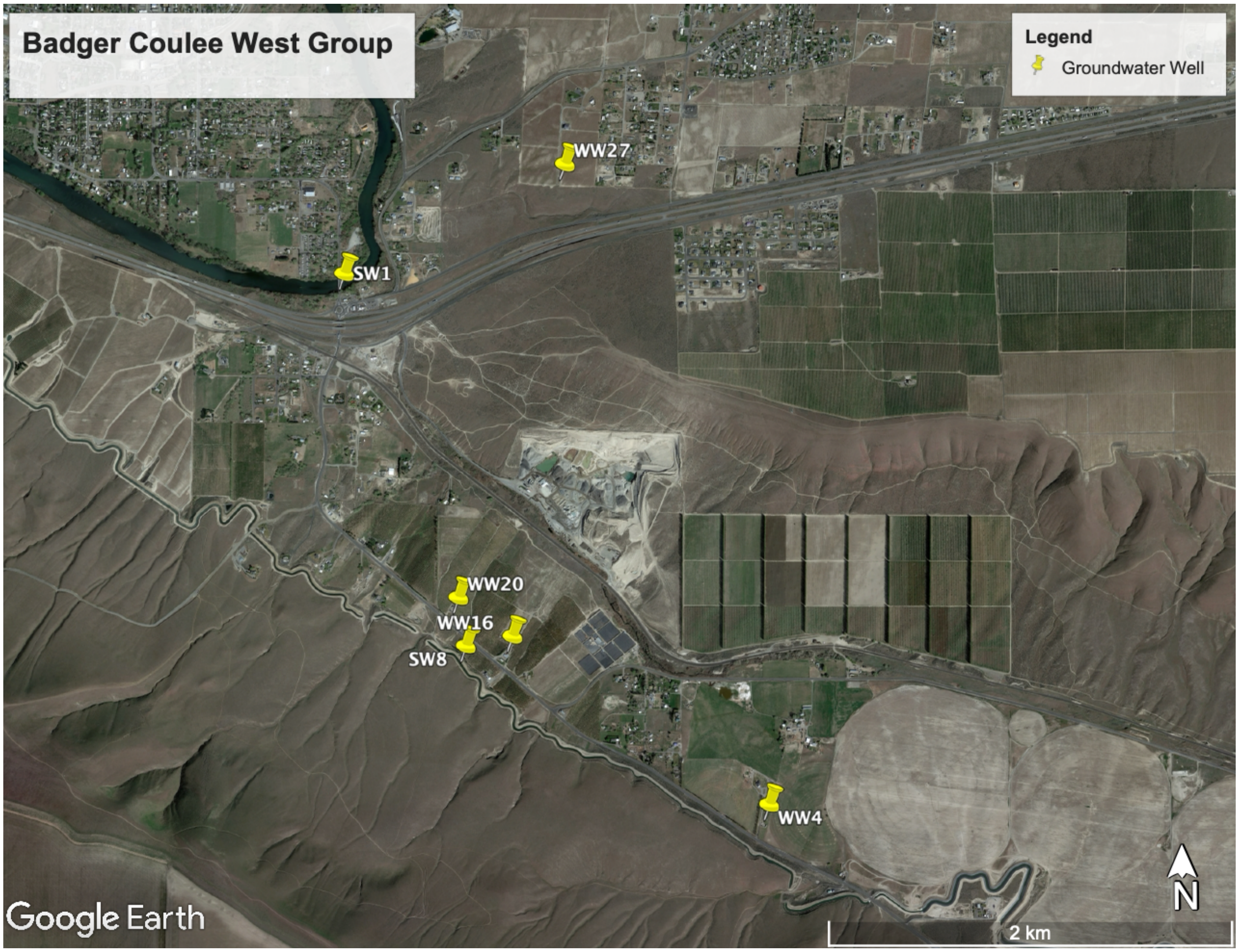

Figure A3. Map of locations for Badger Coulee West wells and two surface water samples. Badger Coulee West location shown on Figure A1.

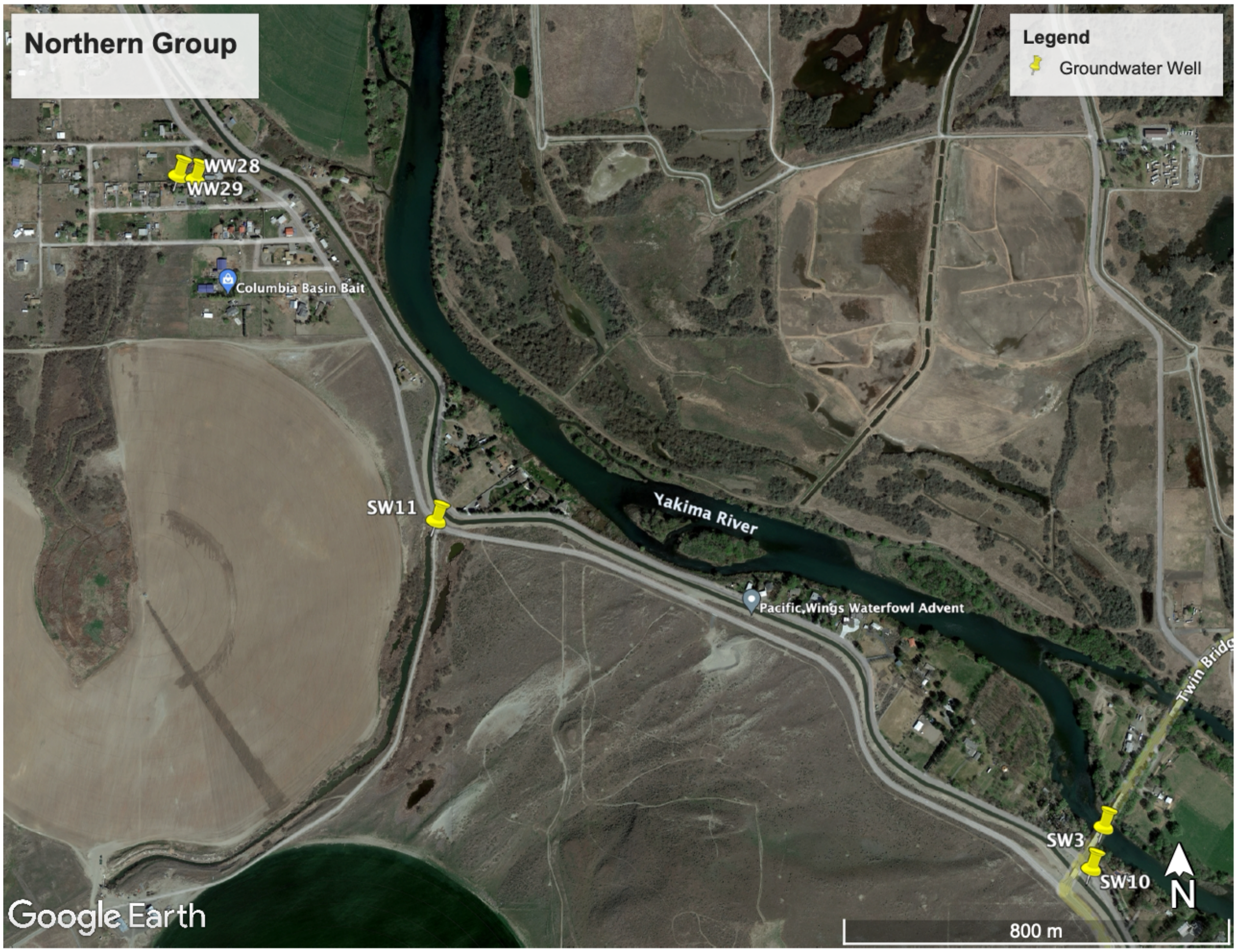

Figure A4. Map of locations for Northern Group wells and three surface water samples. Northern Group location shown on Figure A1.

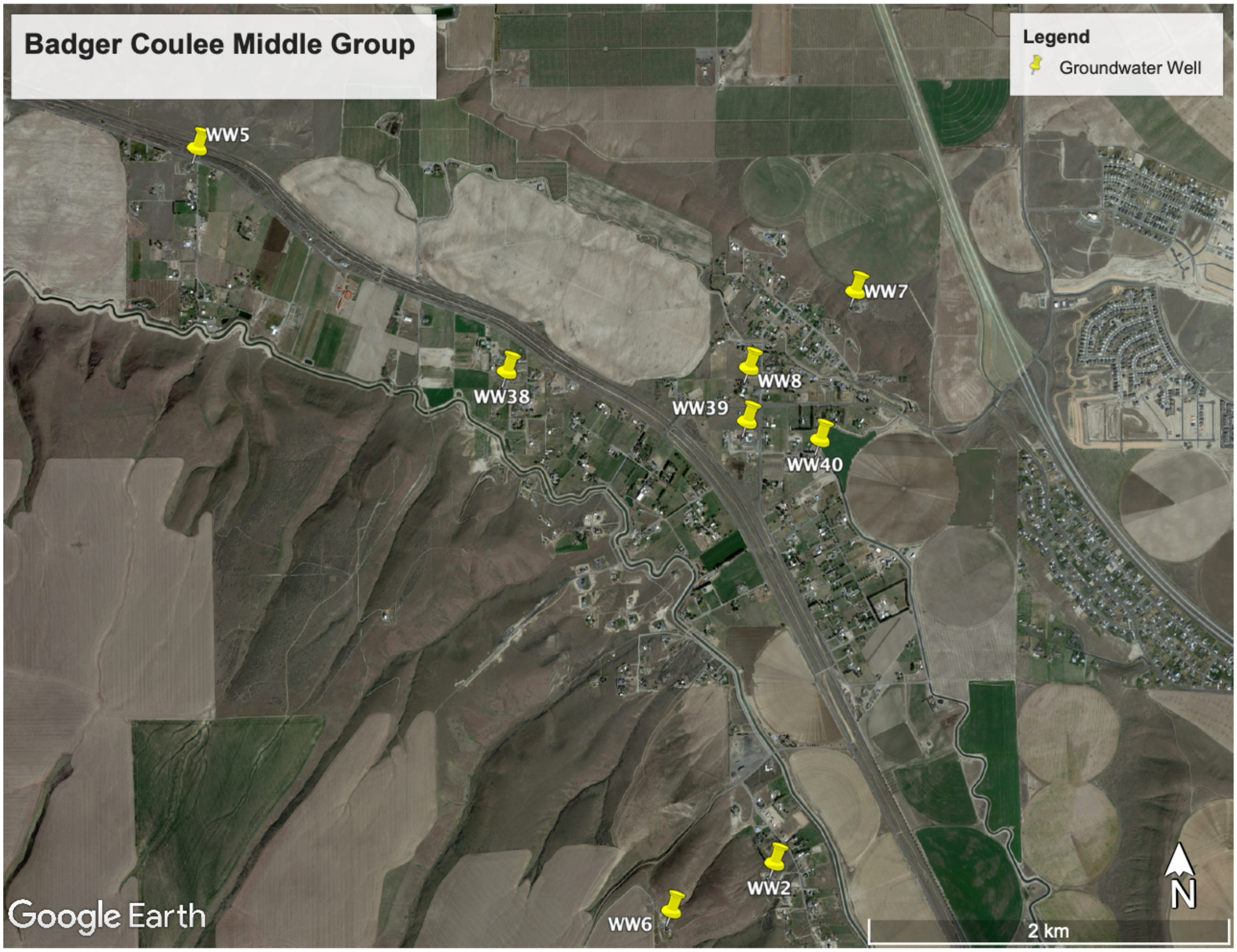

Figure A5. Map of locations for Badger Coulee Middle wells. Badger Coulee Middle location shown on Figure A1.

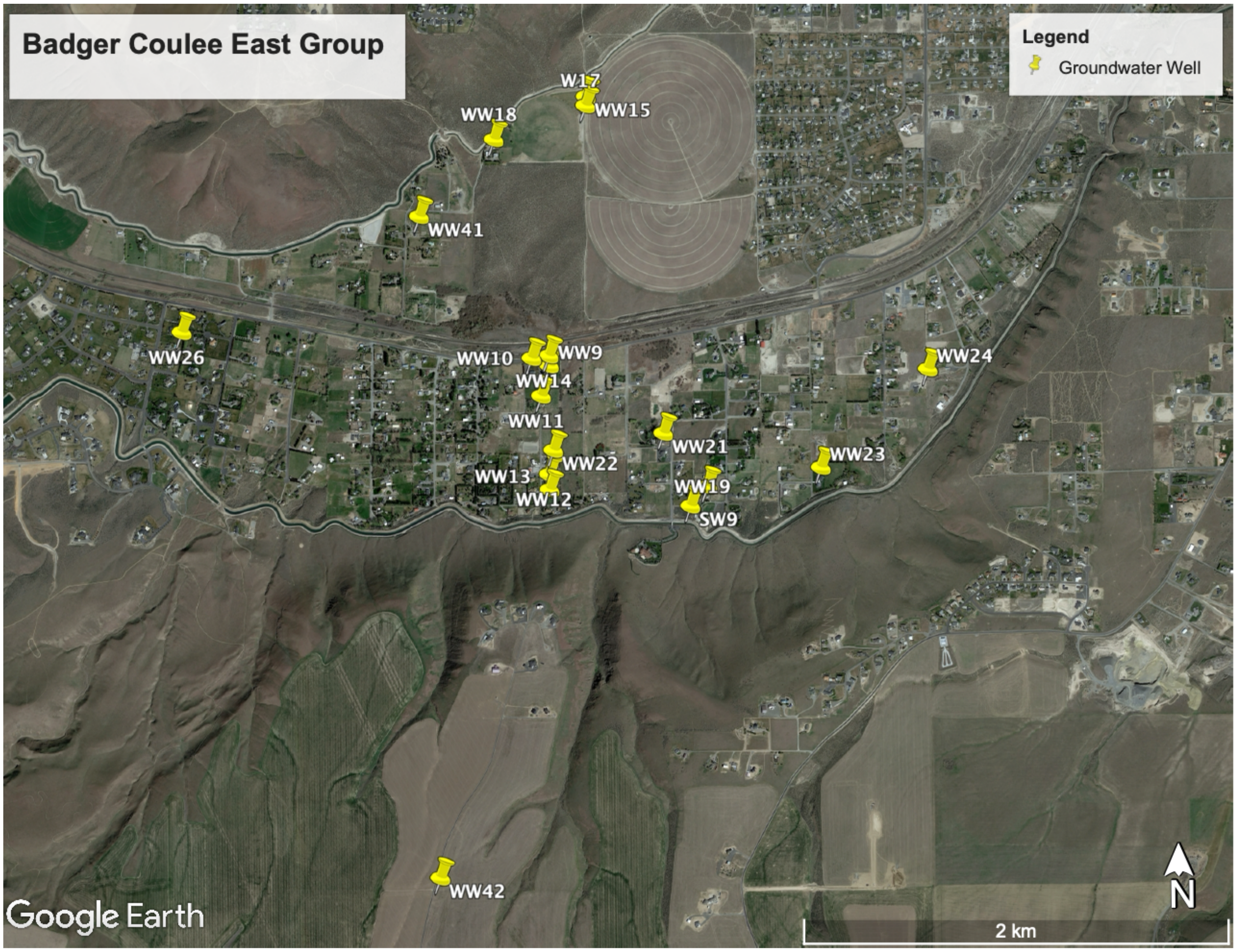

Figure A6. Map of locations for Badger Coulee East wells. Badger Coulee East location shown on Figure A1.

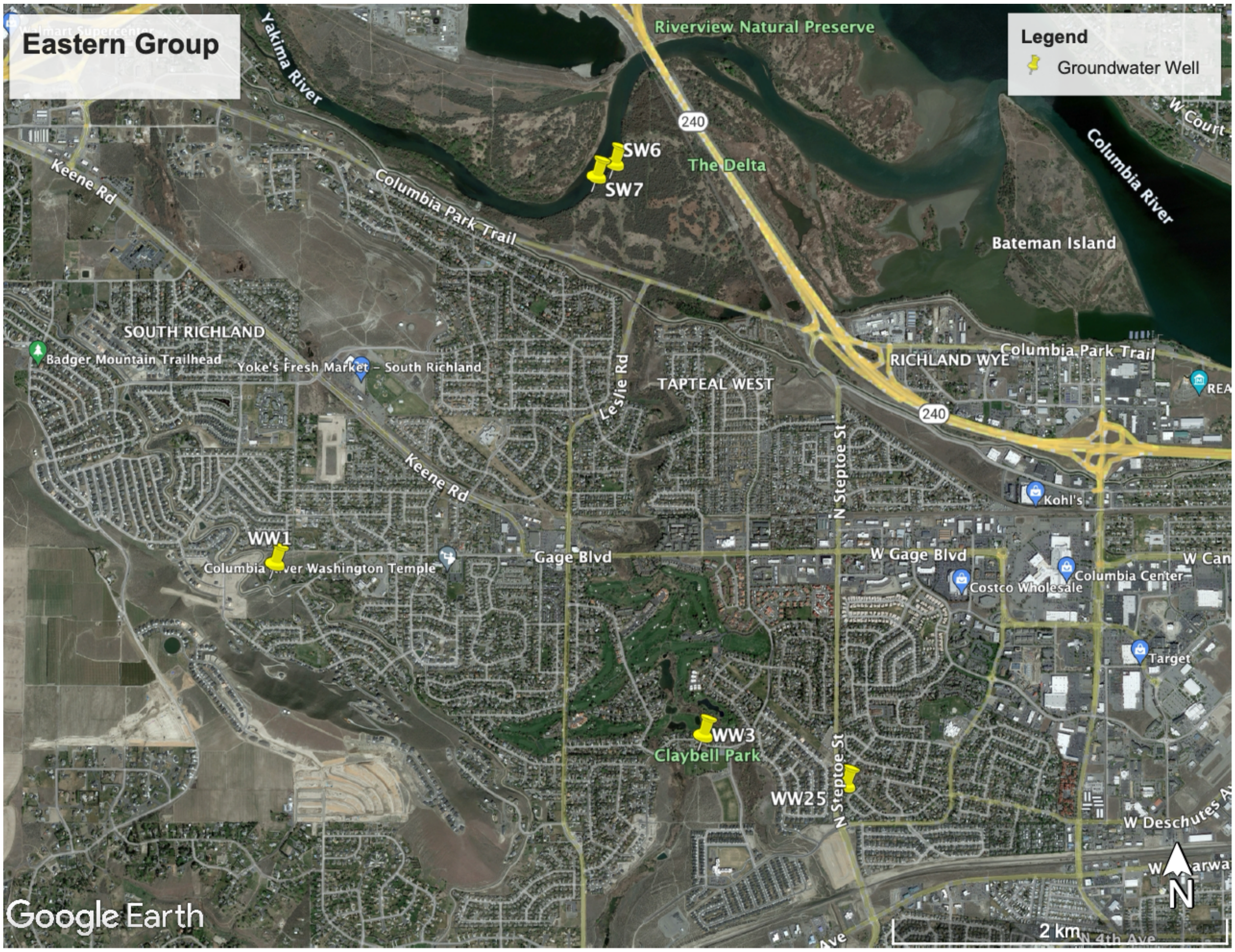

Figure A76. Map of locations for Eastern Group wells and two surface water samples. Eastern Group location shown on Figure A1.

WELL LOGS

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original with Department of Ecology
Second Copy - Owner's Copy
Third Copy - Driller's Copy
106859

WATER WELL REPORT

STATE OF WASHINGTON

Notice of Intent W148967
UNIQUE WELL I D # AGM 118
Water Right Permit No ____

(1) **OWNER:** Name John Cadwell Address 2001 BrantinghamRd Richland

(2) **LOCATION OF WELL:** County Benton NE 1/4 NE 1/4 Sec 34 T 9 N R 28E WM

(2a) **STREET ADDRESS OF WELL:** (or nearest address) 2001 Brantingham Rd Richland WA 99353

A

TAX PARCEL NO. ____

(3) **PROPOSED USE:** ☒ Domestic ☐ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐ DeWater

(4) **TYPE OF WORK:** Owner's number of well (if more than one) ____
☒ New Well ☐ Deepened ☐ Reconditioned ☐ Decommission
Method ☐ Dug ☐ Cable ☒ Rotary ☐ Bored ☐ Driven ☐ Jetted

(5) **DIMENSIONS:** Diameter of well 6 inches
Drilled 428'6" feet Depth of completed well 428'6" ft

(6) **CONSTRUCTION DETAILS**
Casing Installed:
☒ Welded 6 " Diam from +1 ft to 150'6" ft
☒ Liner installed ____ " Diam from ____ ft to ____ ft
☐ Threaded 4½ " Diam from -128' ft to 428'6" ft

Perforations: ☒ Yes ☐ No
Type of perforator used SAW
SIZE of perforations 1/8 in by 6 in
240 perforations from 300 ft to 425 ft

Screens: ☐ Yes ☒ No ☐ K-Pac Location ____
Manufacturer's Name ____
Type ____ Model No ____
Diam ____ Slot Size ____ from ____ ft to ____ ft
Diam ____ Slot Size ____ from ____ ft to ____ ft

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand ____
Material placed from ____ ft to ____ ft

Surface seal: ☒ Yes ☐ No To what depth? 25 ft
Material used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☐ No
Type of water? ____ Depth of strata ____
Method of sealing strata off ____

(7) **PUMP:** Manufacturer's Name ____
Type ____ H P ____

(8) **WATER LEVELS:** Land-surface elevation above mean sea level ____ ft
Static level 124 ft below top of well Date 12-21-01
Artesian pressure ____ lbs per square inch Date ____
Artesian water is controlled by ____ (Cap, valve, etc)

(9) **WELL TESTS:** Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☐ No If yes, by whom? ____
Yield ____ gal /min with ____ ft drawdown after ____ hrs
Yield ____ gal /min with ____ ft drawdown after ____ hrs
Yield ____ gal /min with ____ ft drawdown after ____ hrs
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ____
Bailer test ____ gal /min with ____ ft drawdown after ____ hrs
Airtest 50 gal /min with 80 ft drawdown after 2 hrs
Artesian flow ____ g p m Date ____
Temperature of water ____ Was a chemical analysis made? ☐ Yes ☐ No

(10) **WELL LOG or DECOMMISSIONING PROCEDURE DESCRIPTION**
Formation Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information Indicate all water encountered

MATERIAL	FROM	TO
Sand Tan	0	5
Sand Tan Wet	5	11
Gravel, Sand Tan	11	12
Silt Tan	12	21
Basalt Gravel, Silt Tan	21	43
Clay Tan	43	145
Basalt Black	145	179
Basalt Brechia	179	192
Basalt Black	192	264
Basalt Black Visicular	264	220
Clay Blue	220	298
Basalt Black Visicular	298	
Water Bearing		312
Basalt Black Jointed	312	411
Basalt Black Visicular	411	
Water Bearing		419
Basalt Black	419	428'6"

DEPT OF ECOLOGY
Received
DEC 24 2001
CENTRAL REGION OFFICE

Work Started 12-18-01 Completed 12-21-01

WELL CONSTRUCTION CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards Materials used and the information reported above are true to my best knowledge and belief

Type or Print Name Jim Nelson License No 361
(Licensed Driller/Engineer)

Trainee Name ____ License No ____
Drilling Company Nelson Well Drilling
(Signed) Jim Nelson License No 361
(Licensed Driller/Engineer)
Address 3200 W Argent Pasco
Contractor's Registration No. NELSOWD198CQ Date 12-21-01

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer For special accommodation needs, contact the Water Resources Program at (360) 407-

ECY 050-1-20 (11/98)

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

Construction/Decommission *("x" in circle)* 383956

○ Construction

○ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* ________

CURRENT

Notice of Intent No. W164019

Unique Ecology Well ID Tag No. APT 478

Water Right Permit No. ________

Property Owner Name Martin Moore

Well Street Address 63417 E. 99 PR SE

City Benton County Benton

Location SW 1/4-1/4 NW 1/4 Sec 7 Twn 8N R 28 [✓ EWM] or WWM circle one

Lat/Long (s, t, r Still **REQUIRED**) Lat Deg ____ Lat Min/Sec ____ Long Deg ____ Long Min/Sec ____

Tax Parcel No. 107883010893004

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ____

TYPE OF WORK: Owner's number of well (if more than one) ____

☒ New well ☐ Reconditioned *Method* : ☐ Dug ☐ Bored ☐ Driven

☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 8 inches, drilled 475 ft.

Depth of completed well 465 ft.

CONSTRUCTION DETAILS

Casing Installed: ☒ Welded 8" Diam. from +2 ft. to 40 ft.

☒ Liner installed 4" Diam. from -5 ft. to 465 ft.

☐ Threaded ____" Diam. from ____ ft. to ____ ft.

Perforations: ☒ Yes ☐ No

Type of perforator used ________

SIZE of perfs 1/8 in. by 6 in. and no. of perfs 40 from 425 ft. to 465 ft.

Screens: ☐ Yes ☐ No ☐ K-Pac Location ________

Manufacturer's Name ________

Type ________ Model No. ________

Diam. ____ Slot size ____ from ____ ft. to ____ ft.

Diam. ____ Slot size ____ from ____ ft. to ____ ft.

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand ________

Materials placed from ____ ft. to ____ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 20 ft.

Material used in seal Bentonite

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? ________ Depth of strata ________

Method of sealing strata off ________

PUMP: Manufacturer's Name ________

Type: ________ H.P. ____

WATER LEVELS: Land-surface elevation above mean sea level ____ ft.

Static level 142 ft. below top of well Date 6-20-07

Artesian pressure ____ lbs. per square inch Date ____

Artesian water is controlled by ________ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☐ No If yes, by whom? ________

Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.

Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.

Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ________

Bailer test ____ gal./min. with ____ ft. drawdown after ____ hrs.

Airtest 15 gal./min. with stem set at 455 ft. for 1 hrs.

Artesian flow ____ g.p.m. Date ____

Temperature of water 58 Was a chemical analysis made? ☐ Yes ☒ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Clay Brown	0	15
Basalt Broken	15	40
Basalt Hard	40	190
Sandstone water	190	255
Basalt Hard	255	475

RECEIVED
JUL 02 2009

RECEIVED DEPARTMENT OF ECOLOGY - CENTRAL REGIONAL OFFICE
AUG 23 2010

DEPARTMENT OF ECOLOGY - CENTRAL REGIONAL OFFICE

Start Date 6-3-07 Completed Date 6-20-07

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name (Print) ________

Driller/Engineer/Trainee Signature ________

Driller or trainee License No. 1224

If TRAINEE,
Driller's Licensed No. ________
Driller's Signature ________

Drilling Company Triple A Drilling Inc

Address 785 Tumbleweed Lane

City, State, Zip Burbank, WA 99323

Contractor's Registration No. TRIPLAD937BB Date 6-20-07

Ecology is an Equal Opportunity Employer

WASHINGTON STATE DEPARTMENT OF ECOLOGY

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

Construction/Decommission *("x" in circle)*
☒ Construction
○ Decommission *ORIGINAL INSTALLATION* Notice *of Intent Number* ________

CURRENT
Notice of Intent No. WE 18201
Unique Ecology Well ID Tag No. BIF 407
Water Right Permit No. ________
Property Owner Name David Bowers
Well Street Address 415 Larkhaven
City Richland County Benton
Location SW 1/4-1/4 SW 1/4 Sec 36 Twn 9N R 28 [✓ EWM] or WWM circle one
Lat/Long (s, t, r Still **REQUIRED**) Lat Deg ______ Lat Min/Sec ______ Long Deg ______ Long Min/Sec ______
Tax Parcel No. 136983020002002

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) ______
☒ New well ☐ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven
☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 6 inches, drilled 30 ft.
Depth of completed well 30 ft.

CONSTRUCTION DETAILS
Casing Installed: ☒ Welded 6 " Diam. from +2 ft. to 28 ft.
☐ Liner installed ______ " Diam. from ______ ft. to ______ ft.
☐ Threaded ______ " Diam. from ______ ft. to ______ ft.

Perforations: ☐ Yes ☒ No
Type of perforator used ______
SIZE of perfs ______ in. by ______ in. and no. of perfs ______ from ______ ft. to ______ ft.

Screens: ☒ Yes ☐ No ☒ K-Pac Location 23
Manufacturer's Name Johnson
Type Wire wrap Model No. ______
Diam. 5" Slot size 10 from 24 ft. to 29 ft.
Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand ______
Materials placed from ______ ft. to ______ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 20 ft.
Material used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☐ No
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

PUMP: Manufacturer's Name ______
Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ______ ft.
Static level 15 ft. below top of well Date ______
Artesian pressure ______ lbs. per square inch Date ______
Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom? ______
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______
Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.
Airtest 20+ gal./min. with stem set at 28 ft. for 2 hrs.
Artesian flow ______ g.p.m. Date ______
Temperature of water 57° Was a chemical analysis made? ☐ Yes ☒ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Topsoil	0	3
Silty Sand	3	20
gravel + Sand	20	30

DEPT OF ECOLOGY
Received
SEP 1 7 2014
CENTRAL REGION OFFICE

Start Date 5-19-2014 Completed Date 5-21-2014

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name (Print) ______
Driller/Engineer/Trainee Signature ______
Driller or trainee License No. 1224

If TRAINEE,
Driller's Licensed No. 1224
Driller's Signature

Drilling Company Triple A Drilling Inc
Address P.O. Box 278
City, State, Zip Burbank WA
Contractor's Registration No. TRIPldi093BB Date 5-21-2014

Ecology is an Equal Opportunity Employer.

WASHINGTON STATE DEPARTMENT OF ECOLOGY

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

RECEIVED
JUN 25 2018
Dept of Ecology
Central Regional Office

Construction/Decommission *("x" in circle)*
○ Construction
○ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* ____________

CURRENT Notice of Intent No. WE 31588.
Unique Ecology Well ID Tag No. BKG091.
Water Right Permit No. ____________
Property Owner Name MARTIN Haard.
Well Street Address 10605 N. Weber Canyon Rd
City Benton City County Benton.
Location SE 1/4-1/4 SW 1/4 Sec 28 Twn 9N R 27E. EWM or WWM circle one
Lat/Long (s, t, r Still **REQUIRED**) Lat Deg ______ Lat Min/Sec ______ Long Deg ______ Long Min/Sec ______
Tax Parcel No. 128973013543003

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) ______
☒ New well ☐ Reconditioned ☐ Deepened
Method: ☐ Dug ☐ Bored ☐ Driven ☐ Cable ☐ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 8 inches, drilled 106. ft.
Depth of completed well 102 ft.

CONSTRUCTION DETAILS
Casing Installed:
☒ Welded 8 " Diam. from +1.5 ft. to 101 ft.
☐ Liner installed ______ " Diam. from ______ ft. to ______ ft.
☐ Threaded ______ " Diam. from ______ ft. to ______ ft.

Perforations: ☐ Yes ☒ No
Type of perforator used ______
SIZE of perfs ______ in. by ______ in. and no. of perfs ______ from ______ ft. to ______ ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ______
Manufacturer's Name ______
Type ______ Model No. ______
Diam. ______ Slot size ______ from ______ ft. to ______ ft.
Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand ______
Materials placed from ______ ft. to ______ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 20 ft.
Material used in seal Bentonite.
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

PUMP: Manufacturer's Name ______
Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ______ ft.
Static level 40' ft. below top of well Date ______
Artesian pressure ______ lbs. per square inch Date ______
Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom? ______
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______
Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.
Airtest 70 gal./min. with stem set at 90 ft. for 1 hrs.
Artesian flow ______ g.p.m. Date ______
Temperature of water 62 Was a chemical analysis made? ☐ Yes ☒ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Brown Sand	0	38.
Brown Silty Clay	38	65.
Brown Silty Gravel	65	69.
Coarse Gravel. H2O	69	103.
Sandy Gravel	103	106.

Start Date June 12/18 Completed Date June 13/18

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name (Print) Rob Dobush.
Driller/Engineer/Trainee Signature Robert Dob
Driller or trainee License No. 2820

Drilling Company Blue Star Ent.-NW
Address 2019 Butler Loop.
City, State, Zip Richland WA. 99354.
Contractor's Registration No. BlueStar942R7 Date June 11/18.

If TRAINEE,
Driller's Licensed No. ______
Driller's Signature ______

Ecology is an Equal Opportunity Employer.

ECY 050-1-20 (Rev 3/05)

The Department of Ecology does NOT warranty the Data and/or Information on this Well Report.

DEPARTMENT OF ECOLOGY State of Washington

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

Construction/Decommission *("x" in circle)*

☒ Construction
☐ Decommission *ORIGINAL INSTALLATION*
Notice of Intent Number ______

CURRENT
Notice of Intent No. W309924
Unique Ecology Well ID Tag No. BIW 804
Water Right Permit No. JA
Property Owner Name JACob JUSSilA
Well Street Address OFF BAdger CAnyon Rd
City Kennewick County Benton -03-
Location SW-1/4 SE 1/4 Sec 12 Twn 8 R 27 EWM ☒ Or WWM ☐
(s, t, r Still REQUIRED)

Lat/Long
Lat Deg ____ Lat Min/Sec ____
Long Deg ____ Long Min/Sec ____
Tax parcel No. (Required) 1-1287-100-0002-000

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) ____
☒ New well ☐ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven
☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 8 inches, drilled 850 ft.
Depth of completed well 850 ft.

CONSTRUCTION DETAILS
Casing ☒ Welded 8" Diam. from +2 ft. to 520 ft.
Installed: ☒ Liner installed 6" Diam. from ____ ft. to ____ ft.
☐ Threaded 6" Diam. From +2 ft. to 850 ft.

Perforations: ☒ Yes ☐ No
Type of perforator used SAW Cut
SIZE of perfs 1/8 in. by 8 in. and no. of perfs 90 from 790 ft. to 850 ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ______
Manufacturer's Name ______
Type ______ Model No. ______
Diam. ____ Slot size ____ from ____ ft. to ____ ft.
Diam. ____ Slot size ____ from ____ ft. to ____ ft.

Gravel/Filter packed: ☐ Yes ☒ No Size of gravel/sand ____
Materials placed from ____ ft. to ____ ft.

Surface Seal: ☒ Yes ☒ No To what depth? 30 ft.
Material used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

PUMP: Manufacturer's Name ______
Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ____ ft.
Static level 740 ft. below top of well Date 7-7-2017
Artesian pressure ____ lbs. per square inch Date ______
Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☐ No If yes, by whom? ______
Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.
Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.
Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______
Bailer test ____ gal./min. with ____ ft. drawdown after ____ hrs.
Airtest 30 gal./min. with stem set at 840 ft. for 1 hrs.
Artesian flow ____ g.p.m. Date ______
Temperature of water ____ Was a chemical analysis made? ☐ Yes ☐ No

CONSTRUCTION OR DECOMMISSION PROCEDURE
Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

	MATERIAL	FROM	TO
	Soil	0	11
	BlAck BASAlt	11	260
	Red BASAlt	260	310
	BlAck BASAlt	310	380
	BRoken BASAlt	380	390
	BlACK BASAlt	390	430
	TAN ClAy	430	480
	Blue ClAy	480	510
	BlAck BASAlt	510	620
	Broken BASAlt	620	623
	BlAck BASAlt	623	686
	VOID	686	690
	BlAck BASAlt	690	740
WAter	BlAck BlueSeAms	740	775
	BlAck BASAlt	775	830
X—	Vescular BASAlt	830	840
	BlAck BASAlt	840	850

Start Date 6 7 17 Completed Date 7-7-17

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name ROD COX
Driller/Engineer/Trainee Signature
Driller or trainee License No. 2302
IF TRAINEE: Driller's License No:
Driller's Signature:

Drilling Company **R.W. COX DRILLING LLC.**
Address **P.O. BOX 5324**
City, State, Zip **BENTON CITY, WA 99320**
Contractor's Registration No. **RWCOXWC840DU** Date **/2016**

ECY 050-1-20 (Rev 02-2010) To request ADA accommodation including materials in a format for the visually impaired, call Ecology Water Resources Program at 360-407-6872. Persons with impaired hearing may call Washington Relay Service at 711. Persons with speech disability may call TTY at 877-833-6341.

RECEIVED
JUL 13 2017
Dept of Ecology
Central Regional Office

File Original and First Copy with
Department of Ecology
Second Copy - Owner's Copy
Third Copy - Driller's Copy

65273

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. W100334

UNIQUE WELL I.D. # AEA586

Water Right Permit No.

(1) **OWNER:** Name Gerald Hagen Address 65114 E. Solar Rd PRNE Benton City, WA

(2) **LOCATION OF WELL:** County Benton NE 1/4 SW 1/4 Sec 31 T 9 [✓ N] R 28e WM

(2a) **STREET ADDRESS OF WELL:** (or nearest address) Lot1 Shortplot 1201 L

(3) **PROPOSED USE:**
☒ Domestic ☐ Industrial ☐ Municipal
☐ Irrigation ☐ Test Well ☐ Other
☐ DeWater

(4) **TYPE OF WORK:** Owner's number of well (if more than one)
☒ New well
☐ Deepened
☐ Reconditioned
Method:
☐ Dug ☐ Bored
☐ Cable ☐ Driven
☐ Rotary ☐ Jetted

(5) **DIMENSIONS:** Diameter of well 6 inches
Drilled 425 feet. Depth of completed well 425 ft.

(6) **CONSTRUCTION DETAILS**
Casing Installed:
☒ Welded 6" Diam. from 0 ft. to 160 ft.
☐ Liner installed " Diam. from ft. to ft.
☐ Threaded " Diam. from ft. to ft.

Perforations: ☒ Yes ☐ No
Type of perforator used Skill Saw
SIZE of perforations 1/4 in. by 3 in.
40 perforations from 385 ft. to 425 ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: ☐ Yes ☒ No
Manufacturer's Name
Type Model No.
Diam. Slot size from ft. to ft.
Diam. Slot size from ft. to ft.

Gravel packed: ☐ Yes ☒ No Size of gravel
Gravel placed from ft. to ft.

Surface seal: ☒ Yes ☐ No To what depth? 20
Material used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☐ No
Type of water? Depth of strata
Method of sealing strata off

(7) **PUMP:** Manufacturer's Name
Type: H.P.

(8) **WATER LEVELS:** Land-surface elevation above mean sea level ft.
Static level 335 ft. below top of well Date 8-29-98
Artesian pressure lbs. per square inch Date
Artesian water is controlled by
(Cap, valve, etc.)

(9) **WELL TESTS:** Drawdown is amount water level is lowered below static level
Was a pump test made? ☒ Yes ☐ No If yes, by whom? US
Yield: 20+ gal./min. with — ft. drawdown after 1 hrs.
Yield: gal./min. with ft. drawdown after hrs.
Yield: gal./min. with ft. drawdown after hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
Blown		By Air	Rotary		

Date of test
Bailer test gal./min. with ft. drawdown after hrs.
Airtest gal./min. with stem set at ft. for hrs.
Atesian flow g.p.m. Date
Temperature of water 57° Was a chemical analysis made? ☐ Yes ☒ No

ECY 050-1-20 (7/97)

(10) **WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION**
Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
~~0-6'~~ Top SoiL	0"	6"
Broken & Decomposed BasalT	6"	160'
Hard Black BasalT	160'	322'
Med Hard Gray Basalt	322	401
Broken BasalT (water)	402	425

RECEIVED
FEB 23 1999
DEPARTMENT OF ECOLOGY
WELL DRILLING UNIT

Received
MAR 3 1999
DEPT OF ECOLOGY
CENTRAL REGION OFFICE

Work Started 8-24, 1998. Completed 8-29, 1998.

WELL CONSTRUCTION CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Triple A Drilling Inc.
(Person, Firm, or Corporation) (Type of Print)
Address 2202 W. Windy lane Benton City, WA
(Signed) License No. 1224
Contractor's Registration No. TRIPLDI012B9 Date , 19

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at (360) 407-6600. The TDD number is (360) 407-6006.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. W091285
UNIQUE WELL I.D. # ______
Water Right Permit No. ______

(1) **OWNER:** Name Duane Garner Address I2503 S. 903 PRSE Kenn 993

(2) **LOCATION OF WELL:** County Benton

(2a) **STREET ADDRESS OF WELL** (or nearest address) ______ ¼ NE ¼ Sec 21 T. 8 N., R 28E

A.B,G,

(3) **PROPOSED USE:** ☒ Domestic ☐ Irrigation ☐ DeWater Industrial ☐ Test Well ☐ Municipal ☐ Other ☐

(4) **TYPE OF WORK:** Owner's number of well (If more than one) ______
Abandoned ☐ New well ☒ Deepened ☐ Reconditioned ☐
Method: Dug ☐ Cable ☐ Rotary ☒ Bored ☐ Driven ☐ Jetted ☐

(5) **DIMENSIONS:** Diameter of well 6 inches.
Drilled 224 feet. Depth of completed well 224 ft.

(6) **CONSTRUCTION DETAILS:**
Casing installed: 6 " Diam. from +1½ ft. to 218 ft.
Welded ☒ ______ " Diam. from ______ ft. to ______ ft.
Liner installed ☐ ______ " Diam. from ______ ft. to ______ ft.
Threaded ☐

Perforations: Yes ☐ No ☒
Type of perforator used ______
SIZE of perforations ______ in. by ______ in.
______ perforations from ______ ft. to ______ ft.
______ perforations from ______ ft. to ______ ft.
______ perforations from ______ ft. to ______ ft.

Screens: Yes ☐ No ☒
Manufacturer's Name ______
Type ______ Model No. ______
Diam. ______ Slot size ______ from ______ ft. to ______ ft.
Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel packed: Yes ☐ No ☒ Size of gravel ______
Gravel placed from ______ ft. to ______ ft.

Surface seal: Yes ☒ No ☐ To what depth? 25 ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☐
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

(7) **PUMP:** Manufacturer's Name ______
Type: ______ H.P. ______

(8) **WATER LEVELS:** Land-surface elevation above mean sea level ______ ft.
Static level 26 ft. below top of well Date 7-27-98
Artesian pressure ______ lbs. per square inch Date ______
Artesian water is controlled by ______ (Cap, valve, etc.)

(9) **WELL TESTS:** Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☐ If yes, by whom? ______
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______
Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.
Airtest 100 gal./min. with stem set at 120 ft. for 4 hrs.
Artesian flow ______ g.p.m. Date ______
Temperature of water ______ Was a chemical analysis made? Yes ☐ No ☐

(10) **WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION**

Formation: Describe by color, character, size of material and structure, and show thickness of aquit and the kind and nature of the material in each stratum penetrated, with at least one entry for e: change of information.

MATERIAL	FROM	TO
Silt Tan Sandy	0	6
Gravel, sand Tan	65	81
Gravel, Sand Tan silt	81	83
Silt Tan	83	94
Gravel, sand Tan	94	213
Basalt Black Jointed	213	218
Basalt Black	218	220
Basalt Black Jointed Water Bearing	220	224

RECEIVED
JUL 98
DEPARTMENT OF ECOLOGY
CENTRAL REGION OFFICE

Work Started 7-24, 19 Completed 7-29, 1998

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Nelson Well Drilling Inc (PERSON, FIRM OR CORPORATION) (TYPE OR PRINT)
Address 8200 W August Pasco
(Signed) ______ (WELL DRILLER) License No. 361
Contractor's Registration No. NELSOWD198KQ Date 7-29, 1998

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at (206) 407-6600. The TDD number is (206) 407-6006.

ECY 050-1-20 (9/93)

File Original and First Copy with
Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

WATER WELL REPORT
STATE OF WASHINGTON

Application No

Permit No.

(1) OWNER: Name Duane Garner Address P. O. Box 6538 - Kennewick, Wn., 99336

(2) LOCATION OF WELL: County Benton [illegible] ¼ N [illegible] ¼ Sec 16 T 8 N., R 28 W.M.

ring and distance from section or subdivision corner Short Plat 650 Lot 1

(3) PROPOSED USE: Domestic ☒ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one)

New well ☒ Method: Dug ☐ Bored ☐
Deepened ☐ Cable ☒ Driven ☐
Reconditioned ☐ Rotary ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 120 ft. Depth of completed well 120 ft.

(6) CONSTRUCTION DETAILS:

Casing installed: 6 " Diam. from +1 ft. to 104 ft.
Threaded ☐ " Diam. from ft. to ft.
Welded ☒ " Diam. from ft. to ft.

Perforations: Yes ☐ No ☒
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

Screens: Yes ☒ No ☐
Manufacturer's Name Hydrophilic
Type Plastic Model No.
Diam. Slot size from ft. to ft.
Diam. 5 Slot size .0013 from 104 ft. to 114 ft.

Gravel packed: Yes ☐ No ☒ Size of gravel:
Gravel placed from ft. to ft.

Surface seal: Yes ☒ No ☐ To what depth? 18 ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? Depth of strata
Method of sealing strata off

(7) PUMP: Manufacturer's Name
Type: H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ft.
Static level 55 ft. below top of well Date 3/12/79
Artesian pressure lbs. per square inch Date
Artesian water is controlled by (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? Thompson
Yield: 20 gal./min. with 1 ft. drawdown after 4 hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
4 pm	55'				

Date of test 3 - 12 - 79
Bailer test gal./min. with ft. drawdown after hrs.
Artesian flow g.p.m. Date
Temperature of water Was a chemical analysis made? Yes ☐ No ☒

(10) WELL LOG:

Formation: *Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of formation.*

MATERIAL	FROM	TO
Sand	0	5
Small gravel	5	8
Hardpan and gravel	8	22
Clay and sand	22	40
Silt	40	60
Silt some gravel	60	75
Silt	75	81
Cobbles and boulders	81	86
Silt	86	100
Gravel 1" plus	100	120

Work started 3 - 5, 1979 Completed 3 - 12, 1979

WELL DRILLER'S STATEMENT:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

NAME B & H Drillig (Person, firm, or corporation) (Type or print)

Address Rt. 3 Box 3365A - Kennewick, Wn., 99336

[Signed] H. A. Bultena (Well Driller)

License No. 0046 Date 3 - 12, 1979

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

WASHINGTON STATE DEPARTMENT OF ECOLOGY

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

Construction/Decommission *("x" in circle)*
☒ Construction 276488
○ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* ____

CURRENT Notice of Intent No. W256 459
Unique Ecology Well ID Tag No. VAC 757
Water Right Permit No. ABGH
Property Owner Name Dennis Kellogg
Well Street Address 22902 So 903 PRSE
City Kennewick County Benton
Location __ 1/4-1/4 NE 1/4 Sec 21 Twn 8N R 28 [✓ EWM] or WWM circle one
Lat/Long (s, t, r Still **REQUIRED**) Lat Deg ____ Lat Min/Sec ____ Long Deg ____ Long Min/Sec ____
Tax Parcel No. 1 2188-101-660 002

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ____

TYPE OF WORK: Owner's number of well (if more than one) ____
☒ New well ☐ Reconditioned ☐ Deepened
Method: ☐ Dug ☐ Bored ☐ Driven ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 6 inches, drilled 178½ ft.
Depth of completed well 178½ ft.

CONSTRUCTION DETAILS
Casing Installed: ☒ Welded 6" Diam. from +1 ft. to 177½ ft.
☐ Liner installed ____" Diam. from ____ ft. to ____ ft.
☐ Threaded ____" Diam. from ____ ft. to ____ ft.

Perforations: ☐ Yes ☒ No
Type of perforator used ____
SIZE of perfs ____ in. by ____ in. and no. of perfs ____ from ____ ft. to ____ ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ____
Manufacturer's Name ____
Type ____ Model No. ____
Diam. ____ Slot size ____ from ____ ft. to ____ ft.
Diam. ____ Slot size ____ from ____ ft. to ____ ft.

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand ____
Materials placed from ____ ft. to ____ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 35 ~~177½~~ ft.
Material used in seal BENTONITE & CASING
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? ____ Depth of strata ____
Method of sealing strata off ____

PUMP: Manufacturer's Name ____
Type: ____ H.P. ____

WATER LEVELS: Land-surface elevation above mean sea level ____ ft.
Static level 25 ft. below top of well Date 8/24/07
Artesian pressure ____ lbs. per square inch Date ____
Artesian water is controlled by ____ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom? ____
Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.
Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.
Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ____
Bailer test ____ gal./min. with ____ ft. drawdown after ____ hrs.
Airtest 150 gal./min. with stem set at 160 ft. for 2 hrs.
Artesian flow ____ g.p.m. Date ____
Temperature of water ____ Was a chemical analysis made? ☐ Yes ☒ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
TAN SILT & SAND	0	14
TAN CLAY	14	23
TAN SILT	23	32
TAN SILT & SAND	32	47
TAN SILT	47	71
TAN SILT & BASALT GRAVELS	71	78
TAN SILT.	78	96
TAN SILT, SAND & GRAVEL H₂O	96	122
GREY SAND H₂O	122	125
TAN SAND & GRAVEL H₂O	125	177½
75 GPM @ 120		
100 GPM @ 140		
150 GPM @ 160		

Start Date 8/22/07 Completed Date 8/24/07

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name (Print) JEREMY RUDE
Driller/Engineer/Trainee Signature ____
Driller or trainee License No. 2691

If TRAINEE,
Driller's Licensed No. ____
Driller's Signature ____

Drilling Company NELSON WELL DRILLING
Address 7505 W. COURT ST.
City, State, Zip PASCO WA 99301
Contractor's Registration No. NELSOWD198 CQ Date 8/27/07

Ecology is an Equal Opportunity Employer.

ECY 050-1-20 (Rev 3/05)

The Department of Ecology does NOT warranty the Data and/or Information on this Well Report.

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

DEPARTMENT OF ECOLOGY State of Washington

Construction/Decommission *("x" in circle)*

☒ Construction

☐ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* ____

PROPOSED USE: ☐ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☒ Irrigation ☐ Test Well ☐ Other ____

TYPE OF WORK: Owner's number of well (if more than one) 3

☒ New well ☐ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven

☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 16 inches, drilled 193 ft.

Depth of completed well 192 ft.

CONSTRUCTION DETAILS

Casing Installed: ☒ Welded 16 " Diam. from +5 ft. to 193 ft.

☐ Liner installed ____ " Diam. from ____ ft. to ____ ft.

☐ Threaded ____ " Diam. From ____ ft. to ____ ft.

Perforations: ☐ Yes ☒ No

Type of perforator used ____

SIZE of perfs ____ in. by ____ in. and no. of perfs ____ from ____ ft. to ____ ft.

Screens: ☒ Yes ☐ No ☒ K-Pac Location 176

Manufacturer's Name Alloy screens

Type Stainless steel Model No. ____

Diam. 14 Slot size 80 from 189 ft. to 174 ft.

Diam. ____ Slot size ____ from ____ ft. to ____ ft.

Gravel/Filter packed: ☐ Yes ☒ No Size of gravel/sand ____

Materials placed from ____ ft. to ____ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 18 ft.

Material used in seal neat Cement

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? ____ Depth of strata ____

Method of sealing strata off ____

PUMP: Manufacturer's Name ____

Type: ____ H.P. ____

WATER LEVELS: Land-surface elevation above mean sea level ____ ft.

Static level 123 ft. below top of well Date 9/10/18

Artesian pressure ____ lbs. per square inch Date ____

Artesian water is controlled by ____ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? ☒ Yes ☐ No If yes, by whom? BSE

Yield: 150 gal./min. with 25 ft. drawdown after 1 hrs.

Yield: 250 gal./min. with 30 ft. drawdown after 1 hrs.

Yield: 330 gal./min. with 40 ft. drawdown after 9 hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
1	124				
2	123				
3	123				

Date of test 9/25/18

Bailer test ____ gal./min. with ____ ft. drawdown after ____ hrs.

Airtest 200 gal./min. with stem set at 190 ft. for 2 hrs.

Artesian flow ____ g.p.m. Date ____

Temperature of water 64 Was a chemical analysis made? ☐ Yes ☒ No

CURRENT

Notice of Intent No. WE31418

Unique Ecology Well ID Tag No. BLD001

Water Right Permit No. [redacted]

Property Owner Name Kennewick Irrigation District

Well Street Address ____

City Kennewick County Benton

Location SE 1/4-1/4 NE 1/4 Sec 16 Twn 8N R 28E **EWM** ☒ **Or WWM** ☐

(s, t, r Still REQUIRED)

Lat/Long

Lat Deg ____ Lat Min/Sec ____

Long Deg ____ Long Min/Sec ____

Tax parcel No. (Required) 116881020001001

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
silt, sand, small gravel	0	29
cemented gravel	29	68
small / medium gravel	68	168
medium gravel (water)	168	189
(trace sand 168- 169)		
Black basalt	189	193

RECEIVED

DEC 07 2018

Dept of Ecology Central Regional Office

Start Date 8/28/18 Completed Date 9/7/18

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name (Print) Derek Vahanian

Driller/Engineer/Trainee Signature

Driller or trainee License No. 3189

IF TRAINEE: Driller's License No:

Driller's Signature:

Drilling Company Blue Star Enterprises NW

Address 2019 Butler loop

City, State, Zip Richland, WA, 99354

Contractor's Registration No. BLUESEN942RM Date 12/4/18

ECY 050-1-20 (Rev 02-2010) To request ADA accommodation including materials in a format for the visually impaired, call Ecology Water Resources Program at 360-407-6872. Persons with impaired hearing may call Washington Relay Service at 711. Persons with speech disability may call TTY at 877-833-6341.

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

Construction/Decommission *("x" in circle)*
☒ Construction
○ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* ______

CURRENT
Notice of Intent No. [redacted] WE31071
Unique Ecology Well ID Tag No. BKG085
Water Right Permit No. ______
Property Owner Name Kennewick Irrigation District
Well Street Address ______
City Kennewick County Benton
Location SE 1/4-1/4 NE 1/4 Sec 16 Twn 8N R 28E [✓ EWM] or WWM circle one
Lat/Long (s, t, r Still **REQUIRED**) Lat Deg ______ Lat Min/Sec ______ Long Deg ______ Long Min/Sec ______
Tax Parcel No. 116881020001001

PROPOSED USE: ☐ Domestic ☒ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) ______
☒ New well ☐ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven
☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 16 inches, drilled 200 ft.
Depth of completed well 197 ft.

CONSTRUCTION DETAILS
Casing Installed: ☒ Welded 16 " Diam. from +2 ft. to [illegible] 179 ft.
☐ Liner installed ______ " Diam. from ______ ft. to ______ ft.
☐ Threaded ______ " Diam. from ______ ft. to ______ ft.

Perforations: ☐ Yes ☒ No
Type of perforator used ______
SIZE of perfs ______ in. by ______ in. and no. of perfs ______ from ______ ft. to ______ ft.

Screens: ☒ Yes ☐ No ☒ K-Pac Location 178 – 193
Manufacturer's Name ______
Type Stainless steel Model No. ______
Diam. 14" Slot size 100 from 178 ft. to 193 ft.
Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand ______
Materials placed from ______ ft. to ______ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 20 ft.
Material used in seal portland cement
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

PUMP: Manufacturer's Name ______
Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level [illegible] ft.
Static level 178.5 ft. below top of well Date 5/25/18
Artesian pressure ______ lbs. per square inch Date ______
Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☒ Yes ☐ No If yes, by whom? ______
Yield: 200 gal./min. with 12 ft. drawdown after 1 hrs.
Yield: 400 gal./min. with 40 ft. drawdown after 24 hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
1	119				
2	118				
3	118				

Date of test 6/6/18
Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.
Airtest ______ gal./min. with stem set at ______ ft. for ______ hrs.
Artesian flow ______ g.p.m. Date ______
Temperature of water 63° Was a chemical analysis made? ☐ Yes ☒ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
silt/sand	0	13
sandy brown clay	13	18
sand	18	29
sandy tan clay	29	39
sandy tan clay/small gravel	39	49
caliche w/ small gravel	49	59
pea gravel	59	95
small gravel/coarse sand	95	120
pea gravel w/ brown silty clay	120	148
	[illegible]	[illegible]
pea gravel/medium gravel	148	158
small gravel	158	171
medium gravel/sand (water)	171	195
black/brown weathered basalt	195	197
black basalt some tan clay	197	200

RECEIVED
AUG 02 2018
Dept of Ecology
Central Regional Office

Start Date 4/19/18 Completed Date 6/14/18

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name (Print) Derek Vahanian
Driller/Engineer/Trainee Signature
Driller or trainee License No. 3189

If TRAINEE,
Driller's Licensed No. ______
Driller's Signature ______

Drilling Company Blue Star Enterprises NorthWest
Address 2019 Butler Loop
City, State, Zip Richland WA 99358
Contractor's Registration No. BLUESEN942RM Date 7/30/18

Ecology is an Equal Opportunity Employer.

ECY 050-1-20 (Rev 3/05) **The Department of Ecology does NOT warranty the Data and/or Information on this Well Report.**

DEPARTMENT OF ECOLOGY
State of Washington

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

Construction/Decommission *("x" in circle)*

☒ Construction

☐ Decommission *ORIGINAL INSTALLATION*

Notice of Intent Number ____________

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ____________

TYPE OF WORK: Owner's number of well (if more than one) ______

☒ New well ☐ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven

☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well **8** inches, drilled **461** ft.

Depth of completed well **461** ft.

CONSTRUCTION DETAILS

Casing Installed: ☒ Welded **8**" Diam. from **+2** ft. to **100** ft.

☒ Liner installed **pvc4.5**" Diam. from **5** ft. to **456** ft.

☐ Threaded ______" Diam. From ______ ft. to ______ ft.

Perforations: ☒ Yes ☐ No

Type of perforator used **saw cut**

SIZE of perfs **1/8**in. by **6** in. and no. of perfs **40**from **436**ft. to **456**ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ____________

Manufacturer's Name ____________

Type ____________ Model No. ____________

Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☒ No Size of gravel/sand ______

Materials placed from ______ ft. to ______ ft.

Surface Seal: ☒ Yes ☐ No To what depth? **20**ft.

Material used in seal **bentonite**

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? ____________ Depth of strata ____________

Method of sealing strata off ____________

PUMP: Manufacturer's Name ____________

Type: ____________ H.P. ____________

WATER LEVELS: Land-surface elevation above mean sea level ______ ft.

Static level **251** ft. below top of well Date **6/11/18**

Artesian pressure ______ lbs. per square inch Date ____________

Artesian water is controlled by ____________ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☐ No If yes, by whom? ____________

Yield: ______gal./min. with ______ft. drawdown after ______hrs.

Yield: ______gal./min. with ______ft. drawdown after ______hrs.

Yield: ______gal./min. with ______ft. drawdown after ______hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ____________

Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.

Airtest **50** gal./min. with stem set at **455** ft. for **2** hrs.

Artesian flow ______ g.p.m. Date ____________

Temperature of water **61** Was a chemical analysis made? ☐ Yes ☒ No

CURRENT

Notice of Intent No. **WE31672**

Unique Ecology Well ID Tag No. **BCA 493**

Water Right Permit No. ____________

Property Owner Name **Dave and Kate Mills**

Well Street Address **30810 959 PRSE**

City Kennewick County Benton

Location **SE**1/4-1/4 **NW**1/4 Sec **22** Twn **8N** R **28** **EWM** ☒ **Or WWM** ☐

(s, t, r Still REQUIRED)

Lat/Long

Lat Deg ______ Lat Min/Sec ______

Long Deg ______ Long Min/Sec ______

Tax parcel No. (Required) **122882012514001**

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
brown silty sand	0	36
brown silty sand w/gravels	36	41
brown clay w/ gravels	41	72
sandy basalt gravels	72	97
black basalt	97	132
brown black fractured basalt	132	147
hard black basalt	147	258
fractured basalt	258	310
hard black basalt little water	310	395
basalt w/blue shale	395	412
black basalt	412	449
black visicular basalt water	449	461

RECEIVED
JUN 22 2018
Dept of Ecology
Central Regional Office

Start Date **6/5/18** Completed Date **6/11/18**

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name (Print) **Thomas Giles**

Driller/Engineer/Trainee Signature

Driller or trainee License No. **3109**

IF TRAINEE: Driller's License No:

Driller's Signature:

Drilling Company **StillWater LLC**

Address **1118 N. Oregon Ave**

City, State, Zip **Pasco** , **Wa, 99301**

Contractor's Registration No. **STILL**916KO** Date **6/13/18**

ECY 050-1-20 (Rev 02-2010) To request ADA accommodation including materials in a format for the visually impaired, call Ecology Water Resources Program at 360-407-6872. Persons with impaired hearing may call Washington Relay Service at 711. Persons with speech disability may call TTY at 877-833-6341.

DEPARTMENT OF ECOLOGY State of Washington

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

Construction/Decommission *("x" in circle)*

☒ Construction CRO

☐ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* ______

CURRENT

Notice of Intent No. WE19035

Unique Ecology Well ID Tag No. BHW 647

Water Right Permit No. ______

Property Owner Name GREG TRIPP

Well Street Address [redacted] 93155 944PR SE

City KENNEWICK County BENTON

Location NE 1/4-1/4 NW 1/4 Sec 22 Twn 8N R 28 EWM ☒ Or WWM ☐

(s, t, r Still REQUIRED)

Lat/Long Lat Deg ____ Lat Min/Sec ____

Long Deg ____ Long Min/Sec ____

Tax Parcel No. (Required) 122882013181012

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) ______

☒ New well ☐ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven

☐ Deepened ☐ Cable ☐ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 6 inches, drilled 122 ft.

Depth of completed well 122 ft.

CONSTRUCTION DETAILS

Casing Installed: ☒ Welded 6 " Diam. from +2 ft. to 118 ft.

☐ Liner installed ______ " Diam. from ______ ft. to ______ ft.

☐ Threaded ______ " Diam. From ______ ft. to ______ ft.

Perforations: ☐ Yes ☒ No

Type of perforator used ______

SIZE of perfs ______ in. by ______ in. and no. of perfs ______ from ______ ft. to ______ ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ______

Manufacturer's Name ______

Type ______ Model No. ______

Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☒ No Size of gravel/sand ______

Materials placed from ______ ft. to ______ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 18 ft.

Material used in seal BENTONITE

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? ______ Depth of strata ______

Method of sealing strata off ______

PUMP: Manufacturer's Name ______

Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ______ ft.

Static level 45 ft. below top of well Date 9/25/14

Artesian pressure ______ lbs. per square inch Date ______

Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☒ No If yes, by whom? ______

Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.

Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.

Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______

Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.

Airtest 60 gal./min. with stem set at 120 ft. for 1 hrs.

Artesian flow ______ g.p.m. Date ______

Temperature of water ______ Was a chemical analysis made? ☐ Yes ☒ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
LOESS	0	37
BROKEN BASALT	37	116
TAN CLAY STONE	116	122

Start Date 9/23/14 Completed Date 9/25/14

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name (Print) B MVOTH

Driller/Engineer/Trainee Signature

Driller or trainee License No. 2094

IF TRAINEE: Driller's License No: ______

Driller's Signature: ______

Drilling Company FIVE STAR DRILLING

Address 36301 HIGHWAY 12

City, State, Zip DAYTON WA 99328

Contractor's Registration No. FIVESSD*077MB Date 9/25/14

ECY 050-1-20 (Rev 02/10) *If you need this document in an alternate format, please call the Water Resources Program at 360-407-6872. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.*

WASHINGTON STATE DEPARTMENT OF ECOLOGY

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

Construction/Decommission *("x" in circle)*
☒ Construction 292165
○ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* ______

CURRENT
Notice of Intent No. W244167
Unique Ecology Well ID Tag No. APK 199
Water Right Permit No. ______
Property Owner Name Ken Howard A
Well Street Address OFF S. 903PRSE
City Kennewick County Benton -03
Location NE 1/4-1/4 NE 1/4 Sec 21 Twn 8 R 28E [✓ EWM] or WWM circle one
Lat/Long (s, t, r Still **REQUIRED**) Lat Deg ______ Lat Min/Sec ______ Long Deg ______ Long Min/Sec ______
Tax Parcel No. 1-2188-101-1700-001

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) ______
☒ New well ☐ Reconditioned *Method*: ☐ Dug ☐ Bored ☐ Driven
☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 6 inches, drilled 148 ft.
Depth of completed well 138 ft.

CONSTRUCTION DETAILS
Casing Installed: ☒ Welded 6" Diam. from +2 ft. to 138 ft.
☐ Liner installed ______" Diam. from ______ ft. to ______ ft.
☐ Threaded ______" Diam. from ______ ft. to ______ ft.

Perforations: ☐ Yes ☒ No
Type of perforator used ______
SIZE of perfs ______ in. by ______ in. and no. of perfs ______ from ______ ft. to ______ ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ______
Manufacturer's Name ______
Type ______ Model No. ______
Diam. ______ Slot size ______ from ______ ft. to ______ ft.
Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand ______
Materials placed from ______ ft. to ______ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 20 ft.
Material used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

PUMP: Manufacturer's Name ______
Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ______ ft.
Static level 27 ft. below top of well Date 12-28-07
Artesian pressure ______ lbs. per square inch Date ______
Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom? ______
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______
Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.
Airtest 40+ gal./min. with stem set at 130 ft. for 1 hrs.
Artesian flow ______ g.p.m. Date ______
Temperature of water ______ Was a chemical analysis made? ☐ Yes ☒ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Soil	0	28
Basalt Gravel	28	52
Brown clay Gravel	52	105
hard white clay	105	134
Gravels water	134	148

DEPT OF ECOLOGY
Received
FEB 07 2008
CENTRAL REGION OFFICE

Start Date 12-26-07 Completed Date 12-28-07

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ *Driller* ☐ *Engineer* ☐ *Trainee* Name (Print) David Cox
Driller/Engineer/Trainee Signature Dai
Driller or trainee License No. 2551

If TRAINEE,
Driller's Licensed No. ______
Driller's Signature ______

Drilling Company RWCox Drilling
Address P.O. Box 5324
City, State, Zip Benton City WAsh 99320
Contractor's Registration No. RWCOXMD22JC Date 12-28-07

Ecology is an Equal Opportunity Employer.

ECY 050-1-20 (Rev 3/05)

WASHINGTON STATE DEPARTMENT OF ECOLOGY

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

Construction/Decommission *("x" in circle)*
☒ Construction 292165
○ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* ______

CURRENT
Notice of Intent No. W244167
Unique Ecology Well ID Tag No. APK 199
Water Right Permit No. ______
Property Owner Name Ken Howard A
Well Street Address OFF S. 903PRSE
City Kennewick County Benton -03
Location NE 1/4-1/4 NE 1/4 Sec 21 Twn 8 R 28E [✓ EWM] or WWM (circle one)
Lat/Long (s, t, r Still **REQUIRED**) Lat Deg ______ Lat Min/Sec ______ Long Deg ______ Long Min/Sec ______
Tax Parcel No. 1-2188-101-1700-001

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) ______
☒ New well ☐ Reconditioned *Method*: ☐ Dug ☐ Bored ☐ Driven
☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 6 inches, drilled 148 ft.
Depth of completed well 138 ft.

CONSTRUCTION DETAILS
Casing Installed: ☒ Welded 6" Diam. from +2 ft. to 138 ft.
☐ Liner installed ______" Diam. from ______ ft. to ______ ft.
☐ Threaded ______" Diam. from ______ ft. to ______ ft.

Perforations: ☐ Yes ☒ No
Type of perforator used ______
SIZE of perfs ______ in. by ______ in. and no. of perfs ______ from ______ ft. to ______ ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ______
Manufacturer's Name ______
Type ______ Model No. ______
Diam. ______ Slot size ______ from ______ ft. to ______ ft.
Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand ______
Materials placed from ______ ft. to ______ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 20 ft.
Material used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

PUMP: Manufacturer's Name ______
Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ______ ft.
Static level 27 ft. below top of well Date 12-28-07
Artesian pressure ______ lbs. per square inch Date ______
Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom? ______
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______
Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.
Airtest 40+ gal./min. with stem set at 130 ft. for 1 hrs.
Artesian flow ______ g.p.m. Date ______
Temperature of water ______ Was a chemical analysis made? ☐ Yes ☒ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Soil	0	28
Basalt Gravel	28	52
Brown clay Gravel	52	105
hard white Clay	105	134
Gravels water	134	148

DEPT OF ECOLOGY Received
FEB 07 2008
CENTRAL REGION OFFICE

Start Date 12-26-07 Completed Date 12-28-07

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ *Driller* ☐ *Engineer* ☐ *Trainee* Name (Print) David Cox
Driller/Engineer/Trainee Signature David Cox
Driller or trainee License No. 2551

If TRAINEE,
Driller's Licensed No. ______
Driller's Signature ______

Drilling Company RWCox Drilling
Address P.O. Box 5324
City, State, Zip Benton City WASh 99320
Contractor's Registration No. RWCOXDM22JC Date 12-28-07

Ecology is an Equal Opportunity Employer.

ECY 050-1-20 (Rev 3/05)

DEPARTMENT OF ECOLOGY State of Washington

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

Construction/Decommission *("x" in circle)*

☒ Construction

☐ Decommission *ORIGINAL INSTALLATION*

Notice of Intent Number ______

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) ______

☒ New well ☐ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven

☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 6 inches, drilled 122 ½

Depth of completed well 122 ft. ½

CONSTRUCTION DETAILS

Casing Installed: ☒ Welded 6 " Diam. from +2 ft. to 122 ft.

☐ Liner installed ______ " Diam. from ______ ft. to ______ ft.

☐ Threaded. ______ " Diam. From ______ ft. to ______ ft.

Perforations: ☐ Yes ☒ No

Type of perforator used ______

SIZE of perfs ____ in. by ____ in. and no. of perfs ____ from ____ ft. to ____ ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ______

Manufacturer's Name ______

Type ______ Model No. ______

Diam. ____ Slot size ____ from ____ ft. to ____ ft.

Diam. ____ Slot size ____ from ____ ft. to ____ ft.

Gravel/Filter packed: ☐ Yes ☒ No Size of gravel/sand ______

Materials placed from ______ ft. to ______ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 25 ft.

Material used in seal Bentonite

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? ______ Depth of strata ______

Method of sealing strata off ______

PUMP: Manufacturer's Name ______

Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ______ ft.

Static level 84 ft. below top of well Date 7-23-16

Artesian pressure ______ lbs. per square inch Date ______

Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☐ No✓ If yes, by whom? ______

Yield: ______ gal./min. with ____ ft. drawdown after ____ hrs.

Yield: ______ gal./min. with ____ ft. drawdown after ____ hrs.

Yield: ______ gal./min. with ____ ft. drawdown after ____ hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______

Bailer test ______ gal./min. with ____ ft. drawdown after ____ hrs.

Airtest 35 gal./min. with stem set at 110 ft. for 2 hrs.

Artesian flow ______ g.p.m. Date ______

Temperature of water ______ Was a chemical analysis made? ☐ Yes ☒ No

CURRENT

Notice of Intent No. WE-24823

Unique Ecology Well ID Tag No. BIF-938

Water Right Permit No. –

Property Owner Name Sean Carr

Well Street Address 30003 S. 984 PRSE

City Kennewick County Benton

Location SW1/4-1/4 NE1/4 Sec 22 Twn 8 R 28 EWM ☒ Or WWM ☐

(s, t, r Still REQUIRED)

Lat/Long Lat Deg ____ Lat Min/Sec ____

Long Deg ____ Long Min/Sec ____

Tax Parcel No. (Required) 122881013166001

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Brown Silt + Sand	0	21
Brown Sand Some Gravel	21	50
Black Gravel + Sand	50	86
Broken Basalt + Gravel	86	105
Fractured Basalt	105	122 -

DEPT OF ECOLOGY
Received
JUL 28 2016
CENTRAL REGION OFFICE

Start Date 7-23-16 Completed Date 7-23-16

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name (Print) Josh Burns

Driller/Engineer/Trainee Signature

Driller or trainee License No. 2866

IF TRAINEE: Driller's License No:

Driller's Signature:

Drilling Company Nelson Drilling LLC

Address 600 W. Vineyard Dr.

City, State, Zip Pasco, Wa. 99301

Contractor's Registration No. NELSODL895WM Date 7-23-16

ECY 050-1-20 (Rev 02/10) *If you need this document in an alternate format, please call the Water Resources Program at 360-407-6872. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.*

DEPARTMENT OF ECOLOGY State of Washington

WATER WELL REPORT

Original & 1st copy - Ecology, 2nd copy - owner, 3rd **copy - driller**

CURRENT

Construction/Decommission *("x" in circle)*
☒ Construction
☐ Decommission *ORIGINAL INSTALLATION*
Notice of Intent Number ____

Notice of Intent No. WE28475
Unique Ecology Well ID Tag No. BJG-524
Water Right Permit No. ____
Property Owner Name Chris Bohlke
Well Street Address 1005 Prse
City kennewick County benton
Location NW 1/4-1/4 NE 1/4 Sec 22 Twn 8n R 28e EWM ☒ or WWM ☐ Check One
(s, t, r Still REQUIRED)

Lat/Long Lat Deg ____ Lat Min/Sec ____
Long Deg ____ Long Min/Sec ____
Tax Parcel No. (Required) 122881013149002

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ____

TYPE OF WORK: Owner's number of well (if more than one) ____
☒ New well ☐ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven
☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 6 inches, drilled 215 ft.
Depth of completed well 215 ft.

CONSTRUCTION DETAILS
Casing Installed: ☒ Welded 6 " Diam. from 0 ft. to 215 ft.
☐ Liner installed ____ " Diam. from ____ ft. to ____ ft.
☐ Threaded ____ " Diam. From ____ ft. to ____ ft.

Perforations: ☐ Yes ☒ No
Type of perforator used ____
SIZE of perfs ____ in. by ____ in. and no. of perfs ____ from ____ ft. to ____ ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ____
Manufacturer's Name ____
Type ____ Model No. ____
Diam. ____ Slot size ____ from ____ ft. to ____ ft.
Diam. ____ Slot size ____ from ____ ft. to ____ ft.

Gravel/Filter packed: ☐ Yes ☒ No Size of gravel/sand ____
Materials placed from ____ ft. to ____ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 20+ ft.
Material used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? ____ Depth of strata ____
Method of sealing strata off ____

PUMP: Manufacturer's Name ____
Type: ____ H.P. ____

WATER LEVELS: Land-surface elevation above mean sea level ____ ft.
Static level 87 ft. below top of well Date 08/02/2017
Artesian pressure ____ lbs. per square inch Date ____
Artesian water is controlled by ____ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom? ____
Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.
Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.
Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ____
Bailer Test ____ gal./min. with ____ ft. drawdown after ____ hrs.
Airtest 60 gal./min. with stem set at ____ ft. for 4 hrs.
Artesian flow ____ g.p.m. Date ____
Temperature of water ____ Was a chemical analysis made? ☐ Yes ☒ No

CONSTRUCTION OR DECOMMISSION PROCEDURE
Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Topsoil	0	6
Silt & Sand	6	62
Clay	62	105
Sand	105	116
Fractured Basalt & Silty Clay	116	156
Frac Basalt Fine Sand	156	200
Porous Basalt, Red & Black	200	215

RECEIVED
SEP 25 2017
Dept of Ecology
Central Regional Office

Start Date 07/28/2017 Completed Date 08/02/2017

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name (Print) Todd Haney
Driller/Engineer/Trainee Signature
Driller or trainee License No. 2343

IF TRAINEE: Driller's License No: ____
Driller's Signature: Todd Haney
Digitally signed by Todd Haney
DN: cn=Todd Haney, o=Statewide Well Drilling, Inc., ou=Manager,
email=statewide_drilling@[illegible].com, c=US
Date: 2009.06.18 09:57:14 -07'00'

Drilling Company Statewide Well Drilling Inc.
Address 6816 Road. 76 North
City, State, Zip Pasco, Wa, 99301
Contractor's Registration No. STATEWDO15LZ Date 5-21-2017

ECY 050-1-20 (Rev 06/08) If you need this document in an altenate format, please call the Water Resources Program at 360-407-6600. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

File Original and First Copy with Department of Ecology
Second Copy — Owner's Copy
Third Copy — Driller's Copy

71141

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. W 111257
UNIQUE WELL I.D. # AEL 445
Water Right Permit No. L, M, N, P

(1) OWNER: Name Steve + Carol Ghan Address 9049 W Deschutes DR Kenn

(2) LOCATION OF WELL: County Benton ___ 1/4 SW 1/4 Sec 31 T. 9 N., R. 29E W.M.

(2a) STREET ADDRESS OF WELL (or nearest address) 9049 W Deschutes Dr Kenn WA 99336

(3) PROPOSED USE: ☒ Domestic ☒ Irrigation ☐ DeWater Industrial ☐ Test Well ☐ Municipal ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (If more than one) ___
Abandoned ☐ New well ☒ Deepened ☐ Reconditioned ☐
Method: Dug ☐ Cable ☐ Rotary ☒ Bored ☐ Driven ☐ Jetted ☐

(5) DIMENSIONS: Diameter of well 6 inches.
Drilled 82 feet. Depth of completed well 82 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6" Diam. from +1 ft. to 82 ft.
Welded ☒ ___" Diam. from ___ ft. to ___ ft.
Liner installed ☐
Threaded ☐ ___" Diam. from ___ ft. to ___ ft.

Perforations: Yes ☐ No ☒
Type of perforator used ___
SIZE of perforations ___ in. by ___ in.
___ perforations from ___ ft. to ___ ft.
___ perforations from ___ ft. to ___ ft.
___ perforations from ___ ft. to ___ ft.

Screens: Yes ☐ No ☒
Manufacturer's Name ___
Type ___ Model No. ___
Diam. ___ Slot size ___ from ___ ft. to ___ ft.
Diam. ___ Slot size ___ from ___ ft. to ___ ft.

Gravel packed: Yes ☐ No ☒ Size of gravel ___
Gravel placed from ___ ft. to ___ ft.

Surface seal: Yes ☒ No ☐ To what depth? 18+ ft.
Material used in seal Bentonite
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? ___ Depth of strata ___
Method of sealing strata off ___

(7) PUMP: Manufacturer's Name ___
Type: ___ H.P. ___

(8) WATER LEVELS: Land-surface elevation above mean sea level ___ ft.
Static level 52 ft. below top of well Date 1-27-99
Artesian pressure ___ lbs. per square inch Date ___
Artesian water is controlled by ___ (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☐ No ☐ If yes, by whom? ___
Yield: ___ gal./min. with ___ ft. drawdown after ___ hrs.
" " " "
" " " "

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ___
Bailer test ___ gal./min. with ___ ft. drawdown after ___ hrs.
Airtest 35 gal./min. with stem set at 75 ft. for 2 hrs.
Artesian flow ___ g.p.m. Date ___
Temperature of water ___ Was a chemical analysis made? Yes ☐ No ☐

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
SAND	0	11
SAND Tan Silty	11	44
Gravel Sand Tan silt	44	55
Boulders, Gravel sand	55	
TAN silt water@52		69
Gravel, Sand Tan	69	
Water Bearing		82

DEPT. OF ECOLOGY
Received
FEB 16 1999
CENTRAL REGION OFFICE

Work Started 1-27, 19__ Completed 1-27, 1999

WELL CONSTRUCTOR CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Nelson Well Drilling Inc (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address 8200 W Argent Pasco
(Signed) Jim Nelson (WELL DRILLER) License No. 361
Contractor's Registration No. NELSOWD196K3 Date 1-27, 1999

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at (206) 407-6600. The TDD number is (206) 407-6006.

ECY 050-1-20 (9/93)

DEPARTMENT OF ECOLOGY State of Washington

WATER WELL REPORT

Original & 1st copy - Ecology, 2nd copy - owner, 3rd **copy - driller**

CURRENT

Notice of Intent No. WE12628

Unique Ecology Well ID Tag No. BBJ-619

Water Right Permit No. ______

Property Owner Name Jason Madison

Well Street Address 226405 Country Meadows Dr.

City Kenn. County Benton

Location sw 1/4-1/4 ne 1/4 Sec 17 Twn 8 R 28 **EWM** ☒ **Or WWM** ☐ Check One

(s, t, r Still REQUIRED)

Lat/Long Lat Deg ______ Lat Min/Sec ______

Long Deg ______ Long Min/Sec ______

Tax Parcel No. (Required) 117883020003003

Construction/Decommission *("x" in circle)*

☒ Construction 413653

☐ Decommission *ORIGINAL INSTALLATION*

Notice of Intent Number ______

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) ______

☒ New well ☐ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven

☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 6 inches, drilled 160 ft.

Depth of completed well 160 ft.

CONSTRUCTION DETAILS

Casing Installed: ☒ Welded 6 " Diam. from 0 ft. to 160 ft.

☐ Liner installed ______ " Diam. from ______ ft. to ______ ft.

☐ Threaded ______ " Diam. From ______ ft. to ______ ft.

Perforations: ☐ Yes ☒ No

Type of perforator used ______

SIZE of perfs ______ in. by ______ in. and no. of perfs ______ from ______ ft. to ______ ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ______

Manufacturer's Name ______

Type ______ Model No. ______

Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☒ No Size of gravel/sand ______

Materials placed from ______ ft. to ______ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 20 ft.

Material used in seal Bentonite

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? ______ Depth of strata ______

Method of sealing strata off ______

PUMP: Manufacturer's Name ______

Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ______ ft.

Static level 55 ft. below top of well Date 2-23-2011

Artesian pressure ______ lbs. per square inch Date ______

Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☒ No If yes, by whom? ______

Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.

Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.

Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______

Bailer Test ______ gal./min. with ______ ft. drawdown after ______ hrs.

Airtest 40+ gal./min. with stem set at 145 ft. for ______ hrs.

Artesian flow ______ g.p.m. Date ______

Temperature of water ______ Was a chemical analysis made? ☐ Yes ☒ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Brown Topsoil	0	34
Black Basalt Broken	34	76
Clay,Brown	76	144
Fractured Basalt & Gravel	144	160

RECEIVED
MAY 06 2011
DEPARTMENT OF ECOLOGY - CENTRAL REGIONAL OFFICE

Start Date 2-22-11 Completed Date 2-23-11

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name (Print) Todd Haney

Driller/Engineer/Trainee Signature

Driller or trainee License No. 2343

IF TRAINEE: Driller's License No: ______

Driller's Signature: Todd Haney

Digitally signed by Todd Haney
DN: cn=Todd Haney, o=Statewide Well Drilling Inc., ou=Manager,
email=statewide_drilling@msn.com, c=US
Date: 2009.06.15 09:57:14 -07'00'

Drilling Company Statewide Well Drilling Inc.

Address 6816 rd. 76n

City, State, Zip Pasco, Wa, 99301

Contractor's Registration No. STATEWDO15LZ Date 2-24-2011

ECY 050-1-20 (Rev 06/08) If you need this document in an altenate format, please call the Water Resources Program at 360-407-6600. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

295068

WATER WELL REPORT

Original & 1st copy - Ecology, 2nd copy - owner, 3rd copy - driller

Construction/Decommission *("x" in circle)*
☒ Construction
☐ Decommission *ORIGINAL INSTALLATION*
Notice of Intent Number ______

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) ______
☒ New well ☐ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven
☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 6 inches, drilled 100 ft.
Depth of completed well 100 ft.

CONSTRUCTION DETAILS
Casing Installed: ☒ Welded 6 " Diam. from +2 ft. to 98 ft.
☐ Liner installed ______ " Diam. from ______ ft. to ______ ft.
☐ Threaded ______ " Diam. From ______ ft. to ______ ft.

Perforations: ☒ Yes ☒ No
Type of perforator used ______
SIZE of perfs ______ in. by ______ in. and no. of perfs ______ from ______ ft. to ______ ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ______
Manufacturer's Name ______
Type ______ Model No. ______
Diam. ______ Slot size ______ from ______ ft. to ______ ft.
Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☒ No Size of gravel/sand ______
Materials placed from ______ ft. to ______ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 98 ft.
Material used in seal BENTONITE
Did any strata contain unusable water? ☐ Yes ☐ No
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

PUMP: Manufacturer's Name ______
Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ______ ft.
Static level 20 ft. below top of well Date ______
Artesian pressure ______ lbs. per square inch Date ______
Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☐ No If yes, by whom? ______
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______
Bailer Test ______ gal./min. with ______ ft. drawdown after ______ hrs.
Airtest 35 gal./min. with stem set at 95 ft. for 1 hrs.
Artesian flow ______ g.p.m. Date ______
Temperature of water ______ Was a chemical analysis made? ☐ Yes ☐ No

CURRENT
Notice of Intent No. WE07852
Unique Ecology Well ID Tag No. BAL465
Water Right Permit No. ______
Property Owner Name ROCKING MC RANCH
Well Street Address 11845 \E HIGHWAY 124
City WALLA WALLA County WALLA WALLA
Location NE 1/4-1/4 SE 1/4 Sec 1 Twn 9 R 38 EWM ☒ Or WWM ☐ Check One
(s, t, r Still REQUIRED)
Lat/Long Lat Deg ______ Lat Min/Sec ______
Long Deg ______ Long Min/Sec ______
Tax Parcel No. (Required) 360901110003

CONSTRUCTION OR DECOMMISSION PROCEDURE
Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
TOP SOIL SANDY	0	20
BROWN CLAY	20	40
GREY CLAY	40	95
GRAVEL W.B. 35 G.P.M.	95	100

RECEIVED
APR 22 2008
DEPARTMENT OF ECOLOGY
EASTERN REGIONAL OFFICE

Start Date 12/19/2007 Completed Date 12/19/2007

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name (Print) Brandon Mchaffie
Driller/Engineer/Trainee Signature ______
Driller or trainee License No. ______
IF TRAINEE: Driller's License No: 885
Driller's Signature: Jim Hickam

Drilling Company HICKAM WELL DRILLING INC.
Address 103 HUNTSVILLE ROAD
City, State, Zip DAYTON, WA, 99328
Contractor's Registration No. HICKAWD939L1 Date ______

ECY 050-1-20 (Rev 4/07)

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

DEPARTMENT OF ECOLOGY
State of Washington

WATER WELL REPORT

Original & 1st copy - Ecology, 2nd copy - owner, 3rd copy - driller

Construction/Decommission *("x" in circle)*
☒ Construction 486121
☐ Decommission *ORIGINAL INSTALLATION*
Notice of Intent Number ______

CURRENT
Notice of Intent No. W364722
Unique Ecology Well ID Tag No. BCe 912
Water Right Permit No. ______
Property Owner Name Tom Ruand
Well Street Address 46304 Dankard PRNE
City West Richand County Benton-03
Location SW 1/4-1/4 NW 1/4 Sec 23 Twn 10 R 27 ~~EWM~~ ☑ Check One Or WWM ☐
(s, t, r Still REQUIRED)

Lat/Long Lat Deg ______ Lat Min/Sec ______
Long Deg ______ Long Min/Sec ______
Tax Parcel No. (Required) 123073 000007000

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ *DeWater* ☐ *Irrigation* ☐ *Test Well* ☐ *Other* ______

TYPE OF WORK: Owner's number of well (if more than one) ______
☒ New well ☐ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven
☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 8X6 inches, drilled 180 ft.
Depth of completed well 180 ft.

CONSTRUCTION DETAILS
Casing Installed:
☒ Welded 8 " Diam. from +2 ft. to 20' ft.
☒ Liner installed 6 " Diam. from 3 ft. to 163 ft.
☐ Threaded ______ " Diam. From ______ ft. to ______ ft.

Perforations: ☐ Yes ☒ No
Type of perforator used ______
SIZE of perfs ______ in. by ______ in. and no. of perfs ______ from ______ ft. to ______ ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ______
Manufacturer's Name ______
Type ______ Model No. ______
Diam. ______ Slot size ______ from ______ ft. to ______ ft.
Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☒ No Size of gravel/sand ______
Materials placed from ______ ft. to ______ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 20' ft.
Material used in seal Bentonite
Did any strata contain unusable water? ☒ Yes ☒ No
Type of water? SANDY Depth of strata 92
Method of sealing strata off OverBore Casing

PUMP: Manufacturer's Name ______
Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ______ ft.
Static level 14' ft. below top of well Date 5 16 13
Artesian pressure ______ lbs per square inch Date ______
Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom? ______
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______
Bailer Test ______ gal./min. with ______ ft. drawdown after ______ hrs.
Airtest 20 gal./min. with stem set at 175 ft. for 1 hrs.
Artesian flow ______ g.p.m. Date ______
Temperature of water ______ Was a chemical analysis made? ☐ Yes ☐ No

CONSTRUCTION OR DECOMMISSION PROCEDURE
Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Soil gravel	0	8
Black Basalt	8	74
Sand	74	92
Grey Basalt	92	151
Red Basalt - water	151	170
Black Basalt	170	180

DEPT OF ECOLOGY
Received
MAY 2 3 2013
CENTRAL REGION OFFICE

Start Date 5 15 13 Completed Date 5 16 13

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name (Print) Rod Cox
Driller/Engineer/Trainee Signature
Driller or trainee License No. 2302
IF TRAINEE: Driller's License No: ______
Driller's Signature: ______

Drilling Company RW Cox Drilling LLC
Address P.O. Box 5324
City, State, Zip Benton City . WA . 99320
Contractor's Registration No. RWCOXWC905DU Date 5/16/13

ECY 050-1-20 (Rev 06/08) If you need this document in an altenate format, please call the Water Resources Program at 360-407-6600. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original and First Copy with
Department of Ecology
Second Copy - Owner's Copy
Third Copy - Driller's Copy 65278

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. W100343
UNIQUE WELL I.D. # AEL 002
Water Right Permit No. ______

(1) OWNER: Name Ross + Pam Dunfee Address 3960 W. VanGiesen #22 West Richland WA

(2) LOCATION OF WELL: County Benton NW 1/4 NE 1/4 Sec 14 T 9 N R 26 E WM

(2a) STREET ADDRESS OF WELL: (or nearest address) 37602 N 140 PR NW Benton City WA B

(3) PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐ DeWater

DEPT OF ECOLOGY CASHIERING SECTION

FEB 23 ...

(4) TYPE OF WORK: Owner's number of well (if more than one) ______
☒ New well
☐ Deepened
☐ Reconditioned
Method: ☐ Dug ☐ Bored ☐ Cable ☐ Driven ☒ Rotary ☐ Jetted

(5) DIMENSIONS: Diameter of well 6 inches
Drilled 175 feet. Depth of completed well 170 ft.

(6) CONSTRUCTION DETAILS
Casing Installed:
☒ Welded 6" Diam. from 0 ft. to 90 ft.
☒ Liner installed 4½" Diam. from 70 ft. to 170 ft.
☐ Threaded ___" Diam. from ___ ft. to ___ ft.

Perforations: ☒ Yes ☐ No
Type of perforator used Skill Saw
SIZE of perforations 1/4 in. by 3 in.
40 perforations from 110 ft. to 150 ft.
___ perforations from ___ ft. to ___ ft.
___ perforations from ___ ft. to ___ ft.

Screens: ☐ Yes ☒ No
Manufacturer's Name ______
Type ______ Model No. ______
Diam. ___ Slot size ___ from ___ ft. to ___ ft.
Diam. ___ Slot size ___ from ___ ft. to ___ ft.

Gravel packed: ☐ Yes ☒ No Size of gravel ______
Gravel placed from ___ ft. to ___ ft.

Surface seal: ☒ Yes ☐ No To what depth? 50'
Material used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

(7) PUMP: Manufacturer's Name ______
Type: ______ H.P. ______

(8) WATER LEVELS: Land-surface elevation above mean sea level ______ ft.
Static level 78 ft. below top of well Date 2-6-99
Artesian pressure ______ lbs. per square inch Date ______
Artesian water is controlled by ______
(Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☒ Yes ☐ No If yes, by whom? us
Yield: 25 gal./min. with — ft. drawdown after 1 hrs.
Yield: ___ gal./min. with ___ ft. drawdown after ___ hrs.
Yield: ___ gal./min. with ___ ft. drawdown after ___ hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
Blown		By	Air	Rotary	

Date of test 2-6-99
Bailer test ___ gal./min. with ___ ft. drawdown after ___ hrs.
Airtest ___ gal./min. with stem set at ___ ft. for ___ hrs.
Atesian flow ___ g.p.m. Date ___
Temperature of water ___ Was a chemical analysis made? ☐ Yes ☐ No

ECY 050-1-20 (7/97)

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information.

MATERIAL	FROM	TO
Top soil	0	3
Silty Sand	3	29
Med. Size Sand + Gravel	29	34
Med. Size Sand	34	39
Broken Basalt	39	50
(with clay)		
Hard Basalt	50	53
Broken Basalt	53	94
(with clay, Brown)		
Hard Black Basalt	94	144
Med Hard Black Basalt	144	151
Broken Basalt	151	175
Yellow + Brown		
Rock (water Bearing)		

RECEIVED
FEB 23 1999
DEPARTMENT OF ECOLOGY
WELL DRILLING UNIT

DEPT. OF ECOLOGY CENTRAL REGION OFFICE
Received
MAR 3 1999

Work Started 2-5, 1999. Completed 2-6, 1999.

WELL CONSTRUCTION CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME Triple A. Drilling, Inc.
(Person, Firm, or Corporation) (Type of Print)
Address 2202 W. Windy; Benton City
(Signed) Lyle A. Amos License No. 1224
Contractor's Registration No. TRIPLDI025B9 Date 2-7, 1999

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at (360) 407-6600. The TDD number is (360) 407-6006.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

File Original with Department of Ecology
Second Copy - Owner's Copy
Third Copy - Driller's Copy

82465

WATER WELL REPORT

STATE OF WASHINGTON

Notice of Intent W117933
UNIQUE WELL I D # AEM 800
Water Right Permit No ______

(1) **OWNER** Name John Recker Address 481 Tanglewood Richland, WA

(2) **LOCATION OF WELL** County Benton ____ 1/4 NE 1/4 Sec 14 T 9 N R 26 WM

(2a) **STREET ADDRESS OF WELL** (or nearest address) Yakitat

'00 NOV -1 P1:20

TAX PARCEL NO 1-1496-101-0930-001

abgh

(3) **PROPOSED USE** ☒ Domestic ☐ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐ DeWater

DEPT OF ECOLOGY FISCAL BUDGET

(4) **TYPE OF WORK** Owner's number of well (if more than one) ______
☒ New Well ☐ Deepened ☐ Reconditioned ☐ Decommission
Method ☐ Dug ☐ Cable ☐ Rotary ☐ Bored ☐ Driven ☐ Jetted

(5) **DIMENSIONS** Diameter of well 6 inches
Drilled 140 feet Depth of completed well 140 ft

(6) **CONSTRUCTION DETAILS**
Casing Installed
☒ Welded 6" Diam from 0 ft to 20 ft
☒ Liner installed 4" Diam from 0 ft to 140 ft
☐ Threaded ____" Diam from ____ ft to ____ ft

Perforations ☒ Yes ☐ No
Type of perforator used Skilsaw
SIZE of perforations 1/4 in by 12 in
10 perforations from 100 ft to 140 ft

Screens ☐ Yes ☒ No ☐ K-Pac Location ______
Manufacturer's Name ______
Type ______ Model No ______
Diam ______ Slot Size ______ from ______ ft to ______ ft
Diam ______ Slot Size ______ from ______ ft to ______ ft

Gravel/Filter packed ☐ Yes ☒ No ☐ Size of gravel/sand ______
Material placed from ______ ft to ______ ft

Surface seal ☒ Yes ☐ No To what depth? 20 ft
Material used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☐ No
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

(7) **PUMP** Manufacturer's Name ______
Type ______ H P ______

(8) **WATER LEVELS** Land-surface elevation above mean sea level ______ ft
Static level 35 ft below top of well Date 8-16-00
Artesian pressure ______ lbs per square inch Date ______
Artesian water is controlled by ______
(Cap, valve, etc)

(9) **WELL TESTS** Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom? ______
est Yield 12-15 gal /min with Blown Air bit bottom ft drawdown after ______ hrs
Yield ______ gal./min with ______ ft drawdown after ______ hrs
Yield ______ gal /min with ______ ft drawdown after ______ hrs
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

est

Date of test ______
Bailer test ______ gal /min with ______ ft drawdown after ______ hrs
Airtest ______ gal./min with ______ ft drawdown after ______ hrs
Artesian flow ______ g p m Date ______
Temperature of water 58° Was a chemical analysis made? ☐ Yes ☐ No

(10) **WELL LOG or DECOMMISSIONING PROCEDURE DESCRIPTION**
Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information Indicate all water encountered

MATERIAL	FROM	TO
Topsoil	0	6
decomposed basalt	6	12
hard bl. basalt	12	42
Porous basalt w/yellow hard pan	42	89
hard black basalt	89	110
Brown Sandstone	110	135
Gray Clay	135	140

RECEIVED
NOV 03 2000
DEPARTMENT OF ECOLOGY
WELL DRILLING UNIT

DEPT OF ECOLOGY
Received
NOV 09 2000
CENTRAL REGION OFFICE

Work Started 8-15 2000 Completed 8-16 2000

WELL CONSTRUCTION CERTIFICATION

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards Materials used and the information reported above are true to my best knowledge and belief

Type or Print Name Lyle O. Amos License No 1224
(Licensed Driller/Engineer)

Trainee Name ______ License No ______

Drilling Company ______

(Signed) Lyle O Amos License No 1224
(Licensed Driller/Engineer)

Address 2202 W. Windy lane Benton City, WA

Contractor's Registration No TRIPLDI025B9 Date 8-16 00

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer For special accommodation needs contact the Water Resources Program at (360) 407-6600 The TDD number is (360) 407-6006

ECY 050-1-20 (11/98) 82465

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

Please print, sign and return to the Department of Ecology

Water Well Report

Original – Ecology, 1st copy – owner, 2nd copy – driller

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Construction/Decommission
☐ Constsuction 162599
☐ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* ______

Current Notice of Intent No. 170089
Unique Ecology Well ID Tag No. AKH 796
Water Right Permit No. ______
Property Owner Name John Clark
Well Street Address Yakitat Rd
City Benton City County Benton
Location SE 1/4-1/4 NE 1/4 Sec 14 Twn 9N R 26E EWM ☐ or WWM ☐ circle one
Lat/Long (s, t, r still REQUIRED) Lat Deg ______ Lat Min/Sec ______ Long Deg ______ Long Min/Sec ______
Tax Parcel No. 1-1496-101-0932-002

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) ______
☒ New well ☐ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven
☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 6 inches, drilled 305 ft.
Depth of completed well 305 ft.

CONSTRUCTION DETAILS
Casing Installed:
☒ Welded 6" Diam. from +2 ft. to 58 ft.
☒ Liner installed 4" Diam. from -5 ft. to 306 ft.
☐ Threaded ______" Diam. from ______ ft. to ______ ft.

Perforations: ☒ Yes ☐ No
Type of perforator used Skilsaw
SIZE of perfs 1/4 in. by 6 in. and no. of perfs 40 from 280 ft. to 300 ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ______
Manufacturer's Name ______
Type ______ Model No. ______
Diam. ______ Slot size ______ from ______ ft. to ______ ft.
Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand ______
Materials placed from ______ ft. to ______ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 18 ft.
Material used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

PUMP: Manufacturer's Name ______
Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ______ ft.
Static level 167 ft. below top of well Date ______
Artesian pressure ______ lbs. per square inch Date ______
Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom? ______
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______
Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.
Airtest 30 gal./min. with stem set at 285 ft. for 1 hrs.
Artesian flow ______ g.p.m. Date ______
Temperature of water ______ Was a chemical analysis made? ☐ Yes ☒ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information indicate all water encountered. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Top Soil	0	3
Clay Brown	3	41
gravel	41	53
Basalt	53	181
Clay Green	181	221
Basalt Broken	221	232
Basalt Hard	232	281
Basalt Broken water	281	305

DEPT. OF ECOLOGY
Received
DEC 2 0 2004
CENTRAL REGION OFFICE

Start Date 12-13 Completed Date 12-15

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

Driller/Engineer/Trainee Name (Print) Lyle A. Amos
Driller/Engineer/Trainee Signature Lyle A. Amos
Driller or trainee License No. 1224

If TRAINEE,
Driller's Licensed No. ______
Driller's Signature ______

Drilling Company Triple A Drilling
Address ______
City, State, Zip ______
Contractor's Registration No. TRIPLAD825B9 Date ______

Ecology is an Equal Opportunity Employer. ECY 050-1-20 (Rev 2/03)

Please print, sign and return to the Department of Ecology

Water Well Report

Original – Ecology, 1st copy – owner, 2nd copy – driller

Construction/Decommission

☐ Construction

☐ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* 162599

Current Notice of Intent No. 170089

Unique Ecology Well ID Tag No. AKH 796

Water Right Permit No.

Property Owner Name John Clark

Well Street Address Yakitat Rd

City Benton City County Benton

Location SE 1/4-1/4 NE 1/4 Sec 14 Twn 9N R 26E EWM or WWM ☐ ☐ circle one

Lat/Long (s, t, r still REQUIRED) Lat Deg ______ Lat Min/Sec ______ Long Deg ______ Long Min/Sec ______

Tax Parcel No. 1-1496-101-0932-002

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other

TYPE OF WORK: Owner's number of well (if more than one)

☒ New well ☐ Reconditioned ☐ Deepened *Method:* ☐ Dug ☐ Bored ☐ Driven ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 6 inches, drilled 305 ft.

Depth of completed well 305 ft.

CONSTRUCTION DETAILS

Casing Installed:
- ☒ Welded 6" Diam. from +2 ft. to 258 ft.
- ☒ Liner installed 4" Diam. from -5 ft. to 300 ft.
- ☐ Threaded " Diam. from ft. to ft.

Perforations: ☒ Yes ☐ No

Type of perforator used Skilsaw

SIZE of perfs 1/4 in. by 6 in. and no. of perfs 40 from 280 ft. to 300 ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location

Manufacturer's Name

Type Model No.

Diam. Slot size from ft. to ft.

Diam. Slot size from ft. to ft.

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand

Materials placed from ft. to ft.

Surface Seal: ☒ Yes ☐ No To what depth? 18 ft.

Material used in seal Bentonite

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? Depth of strata

Method of sealing strata off

PUMP: Manufacturer's Name

Type: H.P.

WATER LEVELS: Land-surface elevation above mean sea level ft.

Static level 167 ft. below top of well Date

Artesian pressure lbs. per square inch Date

Artesian water is controlled by (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☒ No If yes, by whom?

Yield: gal./min. with ft. drawdown after hrs.

Yield: gal./min. with ft. drawdown after hrs.

Yield: gal./min. with ft. drawdown after hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test

Bailer test gal./min. with ft. drawdown after hrs.

Airtest 30 gal./min. with stem set at 285 ft. for 1 hrs.

Artesian flow g.p.m. Date

Temperature of water Was a chemical analysis made? ☐ Yes ☒ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information indicate all water encountered. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Top Soil	0	3
Clay Brown	3	41
Gravel	41	53
Basalt	53	181
Clay Green	181	221
Basalt Broken	221	232
Basalt Hard	232	281
Basalt Broken water	281	305

DEPT OF ECOLOGY Received APR 22 2005 CENTRAL REGION OFFICE

Start Date 12-13-04 Completed Date 12-15-04

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

Driller/Engineer/Trainee Name (Print) Lyle A. Amos

Driller/Engineer/Trainee Signature Lyle A. Amos

Driller or trainee License No. 1224

If TRAINEE, Driller's Licensed No.

Driller's Signature

Drilling Company Triple A Drilling

Address 785 Tumbleweed Lane

City, State, Zip Burbank. Wa.

Contractor's Registration No. TRIPLAD825B9 Date 12-15-04

Ecology is an Equal Opportunity Employer. ECY 050-1-20 (Rev 2/03)

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

WELL LOG CHANGE FORM

Instructions: Record any change made to the well log record on this form. Append this form to the well log image. File with the original.

WCL Log ID (Required) ______________ Well Log ID __________

Regional Office: ☑ CRO ☐ ERO ☐ NWRO ☐ SWRO

Type of Well: ☐ Water ☐ Resource

Notice of Intent: ____________ Ecology Well ID Tag No. __________

Property (Well) Owner's Name ____________________________________
Well Street Address ____________________________________
City ______________________ County ____________ Zip Code ____________

Location: ____1/4-1/4 ____1/4 Sec ____ Twn ____ R ____ E or W (Circle One)

Lat./Long: (Required) Lat. Deg. ______ Lat. Min/Sec ________
Long. Deg. ______ Long. Min/Sec ______
Horizontal Collection Method Code ______

Tax Parcel No ____________________________

Type of Work: ☐ New Well ☐ Reconditioned ☐ Deepened
Well Log Received Date __/__/__
Well Diameter ___ (in inches) Well Depth _____ (in feet) Well Completed Date __/__/__

Driller's Ecology License No. ________________
Trainee's Ecology License No. ________________

Reason/Source of Change (Required)
INTERNAL CORRECTION - IMAGE UNCHANGED

Signature of Well Log Tracker (Required) EG Date 1-12-04

Imaging Well Log Phase 11 – Change Form
ECY-WR-WLCF Rev. 10/02/02

File Original with Department of Ecology
Second Copy Owner's Copy
Third Copy Driller's Copy
146085

WATER WELL REPORT

STATE OF WASHINGTON

Notice of Intent W164048
UNIQUE WELL I D # ~~AKH-755~~
Water Right Permit No AKH-755

(1) **OWNER** Name Ron & Felicia Vitek Address 8801 St Thomas Rd. Pasco

(2) **LOCATION OF WELL** County Benton SE 1/4 NE 1/4 Sec 14 T 9 N R 26 [✓ WM]
(2a) **STREET ADDRESS OF WELL** (or nearest address) N. 114 PRNW Benton City, Wa. 99320
TAX PARCEL NO 1-1496-101-0932-003 H

(3) **PROPOSED USE** ☒ Domestic ☐ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐ DeWater

(4) **TYPE OF WORK** Owner's number of well (if more than one) ______
☒ New Well Method
☐ Deepened ☐ Dug ☐ Bored
☐ Reconditioned ☐ Cable ☐ Driven
☐ Decommission ☒ Rotary ☐ Jetted

(5) **DIMENSIONS** Diameter of well 6 inches
Drilled 175 feet Depth of completed well 175 ft

(6) **CONSTRUCTION DETAILS**
Casing Installed
☒ Welded 6 Diam from +2 ft to 67 ft
☒ Liner installed 4 Diam from -5 ft to 175 ft
☐ Threaded ______ Diam from ______ ft to ______ ft

Perforations ☒ Yes ☐ No
Type of perforator used Skill Saw
SIZE of perforations 1/8 in by 6 in
40 perforations from 135 ft to 175 ft

Screens ☐ Yes ☒ No ☐ K Pac Location ______
Manufacturer's Name ______
Type ______ Model No ______
Diam ______ Slot Size ______ from ______ ft to ______ ft
Diam ______ Slot Size ______ from ______ ft to ______ ft

Gravel/Filter packed ☐ Yes ☒ No ☐ Size of gravel/sand ______
Material placed from ______ ft to ______ ft

Surface seal ☒ Yes ☐ No To what depth? 20 ft
Material used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☐ No
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

(7) **PUMP** Manufacturer's Name ______
Type ______ H P ______

(8) **WATER LEVELS** Land surface elevation above mean sea level ______ ft
Static level 100 ft below top of well Date 2-11-04
Artesian pressure ______ lbs per square inch Date ______
Artesian water is controlled by ______
(Cap valve etc)

(9) **WELL TESTS** Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes by whom? ______
Yield ______ gal /min with ______ ft drawdown after ______ hrs
Yield ______ gal /min with ______ ft drawdown after ______ hrs
Yield ______ gal /min with ______ ft drawdown after ______ hrs
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______
Bailer test ______ gal /min with ______ ft drawdown after ______ hrs
Airtest 30 gal /min with — ft drawdown after 1 hrs
Artesian flow ______ g p m Date ______
Temperature of water 57° Was a chemical analysis made? ☐ Yes ☒ No

(10) **WELL LOG or DECOMMISSIONING PROCEDURE DESCRIPTION**
Formation Describe by color character size of material and structure and the kind and nature of the material in each stratum penetrated with at least one entry for each change of information Indicate all water encountered

MATERIAL	FROM	TO
Top Soil	0	4
Brown Clay	4	52
Cemented Gravel	52	61
Brown Basalt	61	130
Broken Basalt &	130	165
water		
Black Basalt	165	175

DEPT OF ECOLOGY
Received
FEB 1 8 2004
CENTRAL REGION OFFICE

Work Started 2-10 04 Completed 2-11-04

WELL CONSTRUCTION CERTIFICATION

I constructed and/or accept responsibility for construction of this well and its compliance with all Washington well construction standards Materials used and the information reported above are true to my best knowledge and belief

Type or Print Name ______ License No ______
(Licensed Driller/Engineer)

Trainee Name ______ License No ______
Drilling Company Triple A Drilling
(Signed) ______ License No 1224
(Licensed Driller/Engineer)
Address 785 Tumbleweed Lane Burbank Wa
Contractor s Registration No TRIPLAD025B9 Date 2-11 04

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer For special accommodation needs contact the Water Resources Program at (360) 407 6600 The TDD number is (360) 407 6006

ECY 050 1 20 (11/98)

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

Please print, sign and return to the Department of Ecology

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Water Well Report

Original – Ecology, 1st copy – owner, 2nd copy – driller

Construction/Decommission
☒ Construction
☐ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* ______

165236

Current Notice of Intent No. W 178479
Unique Ecology Well ID Tag No. AHP400
Water Right Permit No. ______
Property Owner Name LArry & Caroline Benson
Well Street Address GrahamBenson H
City BentonCity County Benton -03-
Location SE 1/4-1/4 NE 1/4 Sec 14 Twn 9 R 26 EWM or WWM circle one
Lat/Long (s, t, r still REQUIRED) Lat Deg ______ Lat Min/Sec ______ Long Deg ______ Long Min/Sec ______
Tax Parcel No. 1-1496-161-0932-004

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) ______
☒ New well ☐ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven
☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 6 inches, drilled ______ ft.
Depth of completed well 170 ft.

CONSTRUCTION DETAILS
Casing Installed: ☒ Welded 6" Diam. from +2 ft. to 78 ft.
☐ Liner installed ______" Diam. from ______ ft. to ______ ft.
☐ Threaded ______" Diam. from ______ ft. to ______ ft.

Perforations: ☐ Yes ☒ No
Type of perforator used ______
SIZE of perfs ______ in. by ______ in. and no. of perfs ______ from ______ ft. to ______ ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ______
Manufacturer's Name ______
Type ______ Model No. ______
Diam. ______ Slot size ______ from ______ ft. to ______ ft.
Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand ______
Materials placed from ______ ft. to ______ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 20 ft.
Material used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

PUMP: Manufacturer's Name ______
Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ______ ft.
Static level 115 ft. below top of well Date 11 30 04
Artesian pressure ______ lbs. per square inch Date ______
Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☐ No If yes, by whom? ______
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______
Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.
Airtest 20 gal./min. with stem set at 150 ft. for 3 hrs.
Artesian flow ______ g.p.m. Date ______
Temperature of water ______ Was a chemical analysis made? ☐ Yes ☐ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information indicate all water encountered. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Soil	0	15
BASAlt gravel	15	21
Silt & SAND	21	43
SAND gravel	43	68
BROWN BASAlt	68	74
BlackBASAlt	74	140
FRActure BASAlt	140	148
FRActured BASAlt	148	170
with ClAySeams		
WAter		

DEPT OF ECOLOGY
Received
FEB 01 2005
CENTRAL REGION OFFICE

Start Date 11-29-04 Completed Date 11-30-04

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

Driller/Engineer/Trainee Name (Print) Rod Cox
Driller/Engineer/Trainee Signature
Driller or trainee License No. 2302

If TRAINEE,
Driller's Licensed No. ______
Driller's Signature ______

Drilling Company RW COX Drilling
Address P.O. BOX 5324
City, State, Zip Benton City WASH 99320
Contractor's Registration No. RWCOYD022JC Date 11 2004

Ecology is an Equal Opportunity Employer. ECY 050-1-20 (Rev 2/03)

WASHINGTON STATE DEPARTMENT OF ECOLOGY

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

Construction/Decommission *("x" in circle)*
☑ Construction
○ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* _____

CURRENT
Notice of Intent No. WE 18969
Unique Ecology Well ID Tag No. BJF - 446
Water Right Permit No. _____
Property Owner Name Travis Matson
Well Street Address W. Chandler Rd
City Benton County Benton
Location SW 1/4-1/4 NE 1/4 Sec 14 Twn 9N R 26 [✓ EWM] or WWM circle one
Lat/Long (s, t, r Still **REQUIRED**) Lat Deg _____ Lat Min/Sec _____ Long Deg _____ Long Min/Sec _____
Tax Parcel No. 114963000001000

PROPOSED USE: ☑ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other _____

TYPE OF WORK: Owner's number of well (if more than one) _____
☑ New well ☐ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven
☐ Deepened ☐ Cable ☑ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 6 inches, drilled 290 ft.
Depth of completed well 290 ft.

CONSTRUCTION DETAILS
Casing Installed: ☑ Welded 6" Diam. from +2 ft. to 135 ft.
☑ Liner installed 4" Diam. from -15 ft. to 190 ft.
☐ Threaded _____" Diam. from _____ ft. to _____ ft.

Perforations: ☑ Yes ☐ No
Type of perforator used Skill Saw
SIZE of perfs 1/8 in. by 6 in. and no. of perfs 60 from 140 ft. to 180 ft.

Screens: ☐ Yes ☑ No ☐ K-Pac Location _____
Manufacturer's Name _____
Type _____ Model No. _____
Diam. _____ Slot size _____ from _____ ft. to _____ ft.
Diam. _____ Slot size _____ from _____ ft. to _____ ft.

Gravel/Filter packed: ☐ Yes ☑ No ☐ Size of gravel/sand _____
Materials placed from _____ ft. to _____ ft.

Surface Seal: ☑ Yes ☐ No To what depth? 20 ft.
Material used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☑ No
Type of water? _____ Depth of strata _____
Method of sealing strata off _____

PUMP: Manufacturer's Name _____
Type: _____ H.P. _____

WATER LEVELS: Land-surface elevation above mean sea level _____ ft.
Static level 179 ft. below top of well Date _____
Artesian pressure _____ lbs. per square inch Date _____
Artesian water is controlled by _____ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☑ No If yes, by whom? _____
Yield: _____ gal./min. with _____ ft. drawdown after _____ hrs.
Yield: _____ gal./min. with _____ ft. drawdown after _____ hrs.
Yield: _____ gal./min. with _____ ft. drawdown after _____ hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test _____
Bailer test _____ gal./min. with _____ ft. drawdown after _____ hrs.
Airtest 50+ gal./min. with stem set at 288 ft. for 2 hrs.
Artesian flow _____ g.p.m. Date _____
Temperature of water 57° Was a chemical analysis made? ☐ Yes ☑ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Top Soil	0	3
Silty Sand	3	21
Broken Basalt	21	160
Hard Brown clay	160	181
Gravel	181	190
Black Basalt	190	268
Soft Basalt (Brown)	268	279
Hard Basalt	279	290

DEPT OF ECOLOGY
Received
SEP 17 2014
CENTRAL REGION OFFICE

Start Date 9-2-2014 Completed Date 9-6-2014

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☑ Driller ☐ Engineer ☑ Trainee Name (Print) James Robling
Driller/Engineer/Trainee Signature James Robling
Driller or trainee License No. 31564

If TRAINEE, Driller's Licensed No. 1224
Driller's Signature _____

Drilling Company Triple A Drilling
Address P.O. Box 278
City, State, Zip Burbank WA
Contractor's Registration No. TRIPLDI0937BB Date 9-6-2014

Ecology is an Equal Opportunity Employer.

ECY 050-1-20 (Rev 3/05)

RECEIVED
JUL 19 2017
Dept of Ecology
Central Regional Office

DEPARTMENT OF ECOLOGY State of Washington

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

Construction/Decommission *("x" in circle)*

☒ Construction

☐ Decommission *ORIGINAL INSTALLATION*

Notice of Intent Number WE27600

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) ______

☒ New well ☐ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven

☐ Deepened ☒ Cable ☐ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 8 inches, drilled 202 ft.

Depth of completed well 202 ft.

CONSTRUCTION DETAILS

Casing Installed: ☒ Welded 8" Diam. from +1.5 ft. to 202 ft.

☐ Liner installed ____" Diam. from ____ ft. to ____ ft.

☐ Threaded ____" Diam. From ____ ft. to ____ ft.

Perforations: ☐ Yes ☒ No

Type of perforator used ______

SIZE of perfs ____ in. by ____ in. and no. of perfs ____ from ____ ft. to ____ ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ______

Manufacturer's Name ______

Type ______ Model No. ______

Diam. ____ Slot size ____ from ____ ft. to ____ ft.

Diam. ____ Slot size ____ from ____ ft. to ____ ft.

Gravel/Filter packed: ☐ Yes ☒ No Size of gravel/sand ______

Materials placed from ____ ft. to ____ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 20 ft.

Material used in seal Bentonite

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? ______ Depth of strata ______

Method of sealing strata off ______

PUMP: Manufacturer's Name ______

Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ____ ft.

Static level 119 ft. below top of well Date 7-7-2017

Artesian pressure ____ lbs. per square inch Date ______

Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☒ No If yes, by whom? ______

Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.

Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.

Yield: ____ gal./min. with ____ ft. drawdown after ____ hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______

Bailer test 10 gal./min. with 2 ft. drawdown after 1 hrs.

Airtest ____ gal./min. with stem set at ____ ft. for ____ hrs.

Artesian flow ____ g.p.m. Date ______

Temperature of water ____ Was a chemical analysis made? ☐ Yes ☐ No

CURRENT

Notice of Intent No. WE27600

Unique Ecology Well ID Tag No. BJB-505

Water Right Permit No. ______

Property Owner Name Richard Rogers

Well Street Address ______

City Benton County Benton

Location sw 1/4-1/4 sw 1/4 Sec 31 Twn 9 R 28 EWM ☒ Or WWM ☐

(s, t, r Still REQUIRED)

Lat/Long

Lat Deg ____ Lat Min/Sec ____

Long Deg ____ Long Min/Sec ____

Tax parcel No. (Required) 131983012387002

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Brown silt /Sand	0	131
Brown sand /Caliche	131	168
3/4" Gravel/sand	168	200
Black Basalt	200	202

Start Date 5-25-2017 Completed Date 7-7-2017

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name Justin Egeland

Driller/Engineer/Trainee Signature

Driller or trainee License No. 2843

IF TRAINEE: Driller's License No:

Driller's Signature:

Drilling Company

Address

City, State, Zip

Contractor's Registration No. ______ Date 7-7-2017

ECY 050-1-20 (Rev 02-2010) To request ADA accommodation including materials in a format for the visually impaired, call Ecology Water Resources Program at 360-407-6872. Persons with impaired hearing may call Washington Relay Service at 711. Persons with speech disability may call TTY at 877-833-6341.

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

Please print, sign and return to the Department of Ecology

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Water Well Report

Original – Ecology, 1st copy – owner, 2nd copy – driller

Construction/Decommission

☒ Construction

☐ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* ________

180910

Current Notice of Intent No. W- 242955

Unique Ecology Well ID Tag No. ALL- 909

Water Right Permit No. K

Property Owner Name Larry Lockard

Well Street Address Badger Canyon

City Kenn County Benton

Location NW 1/4-1/4 SE 1/4 Sec 16 Twn 8 R 28 EWM ☒ or WWM ☐ circle one

Lat/Long (s, t, r still REQUIRED) Lat Deg ______ Lat Min/Sec ______ Long Deg ______ Long Min/Sec ______

Tax Parcel No. 1-1688-302-003-018

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) ______

☒ New well ☐ Reconditioned *Method :* ☐ Dug ☐ Bored ☐ Driven

☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 6 inches, drilled 90 ft.

Depth of completed well 90 ft.

CONSTRUCTION DETAILS

Casing Installed: ☒ Welded 6" Diam. from 0 ft. to 90 ft.

☐ Liner installed ______" Diam. from ______ ft. to ______ ft.

☐ Threaded ______" Diam. from ______ ft. to ______ ft.

Perforations: ☐ Yes ☒ No

Type of perforator used ______

SIZE of perfs ____ in. by ____ in. and no. of perfs ____ from ____ ft. to ____ ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location ______

Manufacturer's Name ______

Type ______ Model No. ______

Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Diam. ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand ______

Materials placed from ______ ft. to ______ ft.

Surface Seal: : ☒ Yes ☐ No To what depth? 20 ft ft.

Material used in seal Bentonite

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? ______ Depth of strata ______

Method of sealing strata off ______

PUMP: Manufacturer's Name ______

Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level 47 ft.

Static level 47 ft. below top of well Date 8-29-05

Artesian pressure ______ lbs. per square inch Date ______

Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? ☐ Yes ☐ No If yes, by whom? ______

Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.

Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.

Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______

Bailer test ______ gal./min. with ______ ft. drawdown after ______ hrs.

Airtest 55 gal./min. with stem set at 80 ft. for 2 hrs.

Artesian flow ______ g.p.m. Date ______

Temperature of water ______ Was a chemical analysis made? ☐ Yes ☒ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information indicate all water encountered. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Tan Silty Soil	0	36
Sand & Gravel	36	90
Water Bering Zone	70	90

DEPT OF ECOLOGY
Received
SEP 28 2005
CENTRAL REGION OFFICE

Start Date 8-29-05 Completed Date 8-29-05

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

Driller/Engineer/Trainee Name (Print) Todd Haney

Driller/Engineer/Trainee Signature

Driller or trainee License No. 2343

If TRAINEE,
Driller's Licensed No. ______
Driller's Signature ______

Drilling Company Statewide Well Drilling

Address 101 KAU Trail rd.

City, State, Zip Pasco WA 99301

Contractor's Registration No. STATEWOOSLZ Date 4/06

Ecology is an Equal Opportunity Employer. ECY 050-1-20 (Rev 2/03)

WASHINGTON STATE DEPARTMENT OF ECOLOGY

WATER WELL REPORT

Original & 1st copy – Ecology, 2nd copy – owner, 3rd copy – driller

Construction/Decommission *("x" in circle)*
☒ Construction 306578
○ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* ______

CURRENT Notice of Intent No. W192557
Unique Ecology Well ID Tag No. BAR764
Water Right Permit No. ______
Property Owner Name HORSE HEAVEN HILLS PROP.
Well Street Address 47209 ColdFelter RD
City Kenn County Benton
Location SE 1/4-1/4 SE 1/4 Sec 21 Twn 8 R28 [✓ EWM] or WWM circle one
Lat/Long (s, t, r Still **REQUIRED**) Lat Deg ______ Lat Min/Sec ______ Long Deg ______ Long Min/Sec ______
Tax Parcel No. 121883000005002

PROPOSED USE: ☒ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other ______

TYPE OF WORK: Owner's number of well (if more than one) ______
☒ New well ☐ Reconditioned *Method:* ☐ Dug ☐ Bored ☐ Driven
☐ Deepened ☐ Cable ☒ Rotary ☐ Jetted

DIMENSIONS: Diameter of well 8 inches, drilled 1010 ft.
Depth of completed well 1010 ft.

CONSTRUCTION DETAILS
Casing Installed: ☒ Welded 10" " Diam. from +1 ft. to 32' ft.
☒ Liner installed ______ " Diam. from ______ ft. to ______ ft.
☐ Threaded 6 " Diam. from +1 ft. to 1010 ft.

Perforations: ☒ Yes ☐ No
Type of perforator used HoleCut
SIZE of perfs 1" in. by ______ in. and no. of perfs 100 from 920 ft. to 1010

Screens: ☐ Yes ☒ No ☐ K-Pac Location ______
Manufacturer's Name ______
Type ______ Model No. ______
Diam. ______ Slot size ______ from ______ ft. to ______ ft.
Diam ______ Slot size ______ from ______ ft. to ______ ft.

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand ______
Materials placed from ______ ft. to ______ ft.

Surface Seal: ☒ Yes ☐ No To what depth? 32' ft.
Material used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☒ No
Type of water? ______ Depth of strata ______
Method of sealing strata off ______

PUMP: Manufacturer's Name ______
Type: ______ H.P. ______

WATER LEVELS: Land-surface elevation above mean sea level ______ ft.
Static level 820' ft. below top of well Date 6-23-08
Artesian pressure ______ lbs. per square inch Date ______
Artesian water is controlled by ______ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☐ No If yes, by whom? ______
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min. with ______ ft. drawdown after ______ hrs.
Yield: ______ gal./min with ______ ft. drawdown after ______ hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ______
Bailer test + gal./min. with ______ ft. drawdown after ______ hrs.
Airtest 100 gal./min. with stem set at 1000 ft. for 2 hrs.
Artesian flow ______ g.p.m. Date ______
Temperature of water ______ Was a chemical analysis made? ☐ Yes ☐ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Soil	0	16
GREY BASALT	16	232
RED BASALT	232	250
BLACK BASALT	250	392
FRACTURED BASALT	392	410
SAND	410	434
GREY BASALT	434	532
BLACK BASALT	532	602
BROWN BASALT	602	680
BLACK BASALT	680	694
VOID	694	698
RED BASALT	698	705
GREY BASALT	705	785
RED BASALT	785	805
GREY BASALT	805	924
FRAC BASALT WATER	924	930
GREY BASALT	930	998
VESCULAR BASALT WATER	998	1005
GREY BASALT	1005	1010

RECEIVED
JUN 30 2008
DEPARTMENT OF ECOLOGY - CENTRAL REGIONAL OFFICE

Start Date 5/28/08 Completed Date 6/23/08

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☒ Driller ☐ Engineer ☐ Trainee Name (Print) ROD COX
Driller/Engineer/Trainee Signature ______
Driller or trainee License No. 2302

If TRAINEE,
Driller's Licensed No. ______
Driller's Signature ______

Drilling Company RW COX Drilling
Address P.O. BOX 5324
City, State, Zip Benton City WASH 99320
Contractor's Registration No. RWCOXD945RH Date 6/23/08

Ecology is an Equal Opportunity Employer.

File Original with
Department of Ecology
Second Copy - Owner's Copy
Third Copy - Driller's Copy 13701

WATER WELL REPORT

STATE OF WASHINGTON

Notice of Intent W117916
UNIQUE WELL I.D. # AEM 768
Water Right Permit No.

(1) **OWNER:** Name Virgilio Manzha Address —

(2) **LOCATION OF WELL:** County Benton SW 1/4 NE 1/4 Sec 14 T 9 N.R. 26E WM

(2a) **STREET ADDRESS OF WELL:** (or nearest address) Yakitat Rd. Benton City

TAX PARCEL NO.: 1-1496-101-1219-003

Cs

(3) **PROPOSED USE:** ☒ Domestic ☐ Industrial ☐ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐ DeWater

(4) **TYPE OF WORK:** Owner's number of well (if more than one)
☒ New Well ☐ Deepened ☐ Reconditioned ☐ Decommission
Method: ☐ Dug ☐ Bored ☐ Cable ☐ Driven ☒ Rotary ☐ Jetted

(5) **DIMENSIONS:** Diameter of well 6 inches
Drilled 205 feet. Depth of completed well 205 ft.

(6) **CONSTRUCTION DETAILS**
Casing Installed:
☒ Welded 6" Diam. from +2 ft. to 110 ft.
☐ Liner installed " Diam. from ft. to ft.
☐ Threaded " Diam. from ft. to ft.

Perforations: ☐ Yes ☒ No
Type of perforator used
SIZE of perforations in. by in.
perforations from ft. to ft.

Screens: ☐ Yes ☒ No ☐ K-Pac Location
Manufacturer's Name
Type Model No.
Diam. Slot Size from ft. to ft.
Diam. Slot Size from ft. to ft.

Gravel/Filter packed: ☐ Yes ☒ No ☐ Size of gravel/sand
Material placed from ft. to ft.

Surface seal: ☒ Yes ☐ No To what depth? 20 ft.
Material used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☐ No
Type of water? Depth of strata
Method of sealing strata off

(7) **PUMP:** Manufacturer's Name
Type: H.P.

(8) **WATER LEVELS:** Land-surface elevation above mean sea level ft.
Static level 95' ft. below top of well Date 2-29-00
Artesian pressure lbs. per square inch Date
Artesian water is controlled by
(Cap, valve, etc.)

(9) **WELL TESTS:** Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☒ No If yes, by whom?
Yield: gal./min. with ft. drawdown after hrs.
Yield: gal./min. with ft. drawdown after hrs.
Yield: gal./min. with ft. drawdown after hrs.
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test
Bailer test gal./min. with ft. drawdown after hrs.
Airtest Est 25 gal./min. with — ft. drawdown after 1 hrs.
Artesian flow g.p.m. Date
Temperature of water 57° Was a chemical analysis made? ☐ Yes ☒ No

(10) **WELL LOG or DECOMMISSIONING PROCEDURE DESCRIPTION**
Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. Indicate all water encountered.

MATERIAL	FROM	TO
Top Soil	0	1
Brown silty clay	2	16
Brown sand	16	24
Broken Basalt	24	95
Cemented Gravel	95	105
Med Hard Black Basalt	105	190
Broken Porous Rock	190	205
Yellow & Red		
water		

RECEIVED
APR 13 2000
DEPARTMENT OF ECOLOGY

Work Started 2-29-00 Completed 2-29-00

WELL CONSTRUCTION CERTIFICATION:

I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

Type or Print Name Lyle Amos License No. 1224
(Licensed Driller/Engineer)
Trainee Name — License No. —
Drilling Company Triple A Drilling Inc.
(Signed) Lyle O. Amos License No. 1224
(Licensed Driller/Engineer)
Address Benton City WA.
Contractor's Registration No. TRIPLEIO82S Date 3-31-90

(USE ADDITIONAL SHEETS IF NECESSARY)

Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation needs, contact the Water Resources Program at (360) 407-6600. The TDD number is (360) 407-6006.

ECY 050-1-20 (11/98)

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.

WATER WELL REPORT

ECOLOGY Original & 1st copy Ecology 2nd copy owner 3rd copy driller

Construction/Decommission (x in circle) 122208
● Construction
○ Decommission *ORIGINAL CONSTRUCTION Notice of Intent Number*________

CURRENT Notice of Intent No W164413

Unique Ecology Well ID Tag No AGH 881

Water Right Permit No ________

Property Owner Name Allan Hamilton A

Well Street Address Yakitat Rd

City Benton City County Benton 03

Location NE 1/4 1/4 NE 1/4 Sec 14 Twn 9 R 26E [✓ EWM] or WWM circle one

Lat/Long (s,t,r still REQUIRED) Lat Deg ____ Lat Min/Sec ____ Long Deg ____ Long Min/Sec ____

Tax Parcel No 114961010931004

PROPOSED USE ☑ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other____

TYPE OF WORK Owner's number of well (if more than one)____
☑ New Well ☐ Reconditioned *Method* ☐ Dug ☐ Bored ☐ Driven
☐ Deepened ☐ Cable ☑ Rotary ☐ Jetted

DIMENSIONS Diameter of well 6 inches drilled 225 ft
Depth of completed well 200 ft

CONSTRUCTION DETAILS
Casing Installed ☑ Welded 6 Diam from +18" ft to 40 ft
☑ Liner installed 5 Diam from +2 ft to 145 ft
☐ Threaded ____ Diam from ____ ft to ____ ft

Perforations ☑ Yes ☐ No
Type of perforator used____
SIZE of perfs____in by____in and no of perfs____ from____ft to____ft

Screens ☐ Yes ☑ No ☐ K Pac Location____
Manufacturer's Name____
Type____ Model No____
Diam____ Slot Size____ from____ft to____ft
Diam____ Slot Size____ from____ft to____ft

Gravel/Filter packed ☐ Yes ☑ No ☐ Size of gravel/sand____
Materials placed from____ft to____ft

Surface Seal ☑ Yes ☐ No To what depth? 25 ft
Materials used in seal Bentonite
Did any strata contain unusable water? ☐ Yes ☑ No
Type of water?____ Depth of strata____
Method of sealing strata off____

PUMP Manufacturer's Name____
Type____ H P____

WATER LEVELS Land surface elevation above mean sea level____ft
Static level 69 ft below top of well Date 10-18-02
Artesian pressure____lbs per square inch Date____
Artesian water is controlled by____ (cap valve etc)

WELL TESTS Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☑ No If yes by whom?____
Yield____gal./min with____ft drawdown after____hrs
Yield____gal./min with____ft drawdown after____hrs
Yield____gal./min with____ft drawdown after____hrs
Recovery data (time taken as zero when pump turned off)(water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test____
Bailer test____gal /min with____ft drawdown after____hrs
Airtest 10-12 gal./min with stem set at 195 ft for 2 hrs
Artesian flow____g p m Date____
Temperature of water____ Was a chemical analysis made? ☐ Yes ☑ No

CONSTRUCTION OR DECOMMISSION PROCEDURE
Formation Describe by color character size of material and structure and the kind and nature of the material in each stratum penetrated with at least one entry for each change of information Indicate all water encountered (USE ADDITIONAL SHEETS IF NECESSARY)

MATERIAL	FROM	TO
Soil	0	13
Basalt Gravel	13	38
Fractured Brown Basalt	38	73
hard Black Basalt	73	98
Soft Basalt mix Clay	98	120
Brown Basalt	120	152
Black Basalt	152	173
Soft Basalt mix Clay	173	198
Grey Clay	198	207
Green Sandy Clay	207	225

DEPT. OF ECOLOGY Received OCT 24 2002 CENTRAL REGION OFFICE

Start Date 10-16-02 Completed Date 10-18-02

WELL CONSTRUCTION CERTIFICATION I constructed and/or accept responsibility for construction of this well and its compliance with all Washington well construction standards Materials used and the information reported above are true to my best knowledge and belief

☑ Driller ☐ Engineer ☐ Trainee Name (Print) David Cox
Driller/Engineer/Trainee Signature David Cox
Driller or Trainee License No 2351

If trainee, licensed driller's Signature and License no____

Drilling Company RW Cox Drilling
Address P.O. Box 5324
City State Zip Benton City, Wash 99320
Contractor's Registration No RWCOXDO22JC Date 10-18-02

Ecology is an Equal Opportunity Employer ECY 050 1 20 (Rev 4/01)

Appendix B
Geochemical Data

Table B1. Field measurements: pH, temperature, dissolved oxygen, conductivity, alkalinity

Sample ID	Description	pH	Temp (°C)	DO** (mg/L)	Conductivity (µS/cm)	Alkalinity (meq/L)
Surface Water						
Rivers						
SW1	Yakima River at Kiona Bridge	9.9	8.7	10.4	117	1.61
SW3	Yakima River at Twin Bridges	8.0	9.3	10.0	126	1.69
SW7	Yakima River at Yakima Delta	7.6	8.8	10.3	128	1.66
SW6	Amon Creek	8.4	12.1	9.3	614	5.05
Lakes						
SW5	Park at the Lakes	7.7	11.8	9.4	288	4.51
SW4	Lost Lake, Richland	7.7	8	10.1	648	5.40
SW2	McWhorter Canal Reservoir	9.4	15.4	8.8	280	2.87
Irrigation Water						
SW8	KID Main Canal 1	8.4	12.8	11.2	--	1.27
SW9	KID Main Canal 2	7.8	12.2	11.2	131	1.24
SW10	North Canal at Twin Bridges	8.0	12.5	11.2	291	1.27
SW11	Horn Rapids Canal	7.8	12	11.3	253	1.25
Groundwater						
Western Group						
WW43	Basalt 122 m*	--	--	--	--	--
WW37	Basalt 88.4 m	8.0	19.5	8.9	165	3.22
WW30	Basalt 51.8 m	7.8	16.2	10.0	474	7.62
WW31	Basalt 51.8 m*	--	22.9	9.0	383	--
WW44	Basalt 62.5 m	7.8	18.5	8.1	226	4.01
WW45	Basalt 61 m	--	--	--	--	--
WW32	Basalt 51.8 m*	7.7	16.8	9.9	420	5.75
WW33	Basalt 42.7 m	7.5	16.2	10.0	413	7.41
WW36	Basalt 51.8 m	7.8	17.6	9.7	334	3.76
WW34	Basalt 93.0 m	--	--	--	--	--
WW35	Basalt 53.3 m	7.8	17.4	9.7	355	4.21
Badger Coulee West						
WW20	Basalt 146 m	7.9	18.5	9.1	704	5.73
WW16	Basalt 130 m*	7.8	19.2	9.0	589	6.07
WW27	Basalt 177 m	8.4	23.7	8.7	250	2.64
WW4	Gravel 31.1 m	7.8	17.8	9.3	226	3.11
Northern Group						
WW29	Basalt 21.3 m	7.8	17.4	7.7	752	6.47
WW28	Basalt 54.9 m	7.9	19.4	7.9	442	4.71

*estimated depth based on nearby wells; ** DO – dissolved oxygen

Table B1. Field measurements (continued)

Sample ID	Description	pH	Temp. (°C)	DO (mg/L)	Conductivity (µS/cm)	Alkalinity (meq/L)
Badger Coulee Middle						
WW5	Unknown 61.0 m	7.7	16.7	9.9	506	4.31
WW38	Unknown 27.4 m	7.9	18.6	9.0	335	3.26
WW6	Basalt 259 m	7.9	23.3	8.7	446	4.45
WW39	Gravel 61.6 m	7.8	18.3	9.0	478	3.96
WW8	Unknown 76.2 m	7.9	18.4	9.5	--	3.42
WW2	Basalt 142 m	7.6	18.2	8.5	--	2.55
WW40	Unknown 101 m	7.7	19.3	8.9	369	3.15
WW7	Basalt 132 m	7.9	18.4	9.5	--	2.57
Badger Coulee East						
WW42	Basalt 308 m	--	--	8.1	2913	--
WW18	Basalt 137 m*	8.0	19.4	9.1	311	2.90
WW21	Basalt 37.2 m	7.6	18.3	9.2	766	6.26
WW19	Basalt 141 m	7.9	25.2	8.2	556	4.07
WW23	Basalt 37.3 m	7.7	19.2	9.1	656	6.28
WW26	Gravel 48.8 m	8.0	19.9	9.2	207	2.79
WW41	Gravel 27.4 m	7.6	20.1	8.7	369	5.35
WW10	Gravel 32.3 m	7.5	17.4	10.2	1229	6.54
WW11	Gravel 54.4 m	7.8	16.9	10.2	666	4.37
WW9	Gravel 68.3 m	7.9	16.4	10.4	692	5.36
WW22	Gravel 45.1 m	7.9	20.3	9.0	190	3.13
WW17	Gravel 60.0 m	8.3	--	--	--	2.15
WW15	Gravel 58.8 m	9.0	--	--	--	1.36
WW24	Gravel 65.5 m	8.0	20.4	9.0	183	3.07
WW12	Unknown 32.9 m	7.9	19.7	9.2	698	4.85
WW13	Unknown 33.5 m*	7.9	19.9	9.2	330	3.03
WW14	Unknown 30.5 m*	7.8	16	9.9	660	5.08
Eastern Group						
WW1	Basalt 131 m	7.8	18	8.5	--	4.82
WW3	Gravel 9.1 m	7.9	17.8	8.6	--	3.78
WW25	Gravel 25.0 m	7.8	20.1	9.4	363	5.28

Table B2. Major ion and stable isotope data

Sample ID	Na^+ (ppm)	K^+ (ppm)	Mg^{2+} (ppm)	Ca^{2+} (ppm)	F^- (ppm)	Cl^- (ppm)	NO_3^--N (ppm)	SO_4^{2-} (ppm)	HCO_3^- (ppm)	CO_3^{2-} (ppm)	$\delta^{18}O$ (‰)	δD (‰)
Surface Water												
Rivers												
SW1	10.1	1.5	6.6	17.9	**bdl***	8.8	0.49	8.5	77	10.6	-13.52	-99.5
SW3	10.2	1.5	6.7	18.3	**bdl**	8.8	0.65	8.5	103	0.2	-13.49	-99.1
SW7	10.8	1.8	7.2	19.0	**bdl**	10.1	0.65	10.9	101	0.1	-13.47	-99.0
SW6	45.2	5.1	33.1	79.5	0.36	53.2	6.47		305	1.5	-13.21	-102.2
Lakes												
SW5	22.3	10.0	16.1	46.4	0.24	18.7	**bdl**	16.6	275	0.3	-9.23	-79.7
SW4	85.6	14.2	39.8	79.0	0.49	50.8	**bdl**	262	329	0.3	-12.21	-96.5
SW2	32.3	3.7	22.4	24.8	0.25	27.3	4.78	44.3	160	7.5	-9.97	-82.1
Irrigation Water												
SW8	6.8	1.1	4.8	13.8	**bdl**	4.6	0.33	5.0	77	0.4	-13.48	-98.7
SW9	6.6	1.2	4.7	14.0	**bdl**	4.5	0.31	5.0	75	0.1	-13.40	-98.2
SW10	7.0	1.2	4.8	14.1	**bdl**	4.8	0.31	5.5	77	0.2	-13.47	-98.7
SW11	6.9	1.2	4.8	14.1	**bdl**	4.8	0.36	5.5	76	0.1	-13.48	-98.7
Groundwater												
Western Group												
WW43	--	--	--	--	--	--	--	--	--	--	-17.92	-140.2
WW37	17.8	3.7	11.4	31.1	0.46	6.2	1.59	12.6	196	0.4	-13.67	-100.2
WW30	33.8	10.9	44.6	80.4	0.90	12.4	4.09	106	464	0.5	-13.01	-98.9
WW31	133.6	0.7	0.7	1.8	--	--	--	--	--	--	-13.80	-102.8
WW44	20.1	3.5	14.2	43.5	0.67	9.1	0.42	29.2	244	0.3	-14.30	-106.6
WW45	21.6	10.1	22.1	53.6	--	--	--	--	--	--	-13.76	-101.0
WW32	33.6	11.0	30.5	81.5	0.48	24.0	5.73	133	350	0.3	-13.78	-104.3
WW33	44.7	7.8	26.4	74.6	0.77	16.8	2.85	50.3	452	0.3	-13.16	-98.6
WW36	27.1	9.2	26.4	55.8	0.68	16.4	3.58	134	229	0.3	-13.94	-103.9
WW34	289.3	2.6	0.2	0.5	--	--	--	--	--	--	-13.45	-103.3

Table B3. Trace element data (continued)

Sample ID	**Na$^+$ (ppm)**	**K$^+$ (ppm)**	**Mg^{2+} (ppm)**	**Ca^{2+} (ppm)**	**F$^-$ (ppm)**	**Cl$^-$ (ppm)**	**NO$_3^-$-N (ppm)**	**SO$_4^{2-}$ (ppm)**	**HCO$_3^-$ (ppm)**	**CO$_3^{2-}$ (ppm)**	**δ^{18}O (‰)**	**δD (‰)**
WW35	29.0	9.3	28.9	61.6	0.79	16.6	4.24	154	256	0.3	-13.85	-103.5
Badger Coulee West												
WW20	34.6	6.8	50.5	106.7	0.44	55.7	7.29	229	349	0.5	-13.34	-101.8
WW16	34.5	10.7	41.5	80.0	0.39	30.2	4.80	154	369	0.5	-13.87	-105.4
WW27	76.7	14.8	3.7	12.2	0.64	23.3	**bdl**	77.1	160	0.7	-15.91	-120.3
WW4	16.5	4.8	15.6	35.2	0.31	10.6	1.54	28.1	189	0.2	-13.31	-99.6
Northern Group												
WW29	110.6	7.3	52.4	93.5	0.58	109.6	13.5	259	394	0.5	-12.90	-102.3
WW28	52.6	9.4	36.5	70.6	0.69	54.5	**bdl**	177	286	0.5	-13.53	-107.2
Badger Coulee Middle												
WW5	26.4	4.7	39.3	84.8	0.35	33.9	17.3	159	262	0.3	-13.43	-102.3
WW38	18.6	2.9	28.1	58.6	0.39	24.8	9.9	114	198	0.3	-13.64	-101.5
WW6	117.3	21.1	13.5	27.6	1.32	15.7	**bdl**	168	271	0.4	-17.99	-140.6
WW39	34.5	4.0	36.4	80.0	0.36	40.5	27.4	143	241	0.3	-14.07	-105.7
WW8	213.5	2.0	1.7	2.6	0.50	45.6	29.6	118	208	0.3	-13.50	-105.1
WW2	18.8	14.5	19.7	38.2	0.46	24.4	5.12	71.0	139	0.1	-16.30	-129.0
WW40	26.4	4.2	32.7	60.1	0.59	30.6	22.7	114	192	0.2	-14.00	-104.4
WW7	46.3	11.7	38.0	60.4	0.37	83.9	19.5	159	156	0.2	-15.13	-125.0
Badger Coulee East												
WW42	232.5	7.1	0.4	0.3	--	--	--	--	--	--	-18.79	-145.0
WW18	29.4	9.6	14.3	37.6	0.41	15.2	3.30	73.7	176	0.4	-16.93	-129.3
WW21	34.8	4.4	45.7	122.0	0.26	80.1	20.7	165	381	0.3	-13.15	-99.8
WW19	70.6	14.9	34.7	48.7	0.85	18.0	0.19	230	248	0.4	-17.57	-136.9
WW23	37.1	5.6	54.5	104.7	0.26	71.7	22.7	178	382	0.4	-12.94	-98.9
WW26	14.1	3.4	18.9	37.5	0.37	14.6	2.99	46.9	170	0.3	-14.16	-105.4
WW41	44.1	3.6	26.3	53.5	0.51	25.8	5.61	60.1	326	0.3	-13.41	-100.1
WW10	115.4	5.2	39.2	110.4	0.20	95.6	29.1	111	399	0.3	-13.09	-101.9
WW11	35.1	3.8	24.3	77.6	0.24	40.2	9.18	101	266	0.3	-13.62	-103.3

Table B3. Trace element data (continued)

Sample ID	**Na$^+$ (ppm)**	**K$^+$ (ppm)**	**Mg^{2+} (ppm)**	**Ca^{2+} (ppm)**	**F$^-$ (ppm)**	**Cl$^-$ (ppm)**	**NO$_3^-$-N (ppm)**	**SO$_4^{2-}$ (ppm)**	**HCO$_3^-$ (ppm)**	**CO$_3^{2-}$ (ppm)**	**δ^{18}O (‰)**	**δD (‰)**
WW9	50.1	8.0	25.5	70.2	0.28	33.9	7.71	86.9	326	0.5	-13.51	-102.3
WW22	15.9	3.1	11.7	36.2	0.31	10.1	1.46	22.6	190	0.3	-13.88	-103.1
WW17	18.0	4.4	15.4	11.7	0.44	24.0	**bdl**	8.7	130	0.5	-13.78	-103.6
WW15	8.9	1.6	7.4	21.7	**bdl**	25.8	**bdl**	11.9	80	1.5	-13.80	-104.2
WW24	22.4	5.6	14.1	26.9	0.52	10.0	1.25	26.6	187	0.4	-13.87	-103.3
WW12	35.5	4.6	27.2	76.9	0.28	38.4	9.27	102	295	0.4	-13.32	-100.7
WW13	18.5	3.6	12.8	32.9	0.40	9.6	3.45	25.7	184	0.3	-13.86	-106.8
WW14	43.9	5.5	25.7	70.3	0.30	29.9	8.61	89.1	309	0.3	-13.56	-102.6
Eastern Group												
WW1	15.5	6.5	21.1	39.6	0.27	9.2	2.85	37.0	210	0.2	-16.32	-124.3
WW3	37.9	4.8	35.3	82.3	0.29	55.0	7.75	135	230	0.3	-13.55	-103.4
WW25	42.2	4.3	31.7	68.1	0.43	35.2	9.69	94.9	321	0.4	-13.46	-102.7
Det. Limit	**0.05**	**0.05**	**0.05**	**0.05**	**0.1**	**0.1**	**0.1**	**0.5**				

*bdl = below detection limit

Table B3. Trace element data

ID	Al (ppb)	V (ppb)	Cr (ppb)	Mn (ppb)	Fe (ppb)	Ni (ppb)	Cu (ppb)	Zn (ppb)	As (ppb)	Se (ppb)	Mo (ppb)	Ba (ppb)	Pb (ppb)	U (ppb)
Surface Water														
Rivers														
SW1	**bdl***	3.18	**bdl**	**bdl**	4.23	0.49	0.39	**bdl**	0.65	**bdl**	0.60	10.4	**bdl**	**bdl**
SW3	9.60	3.36	**bdl**	1.54	19.3	**bdl**	0.50	**bdl**	0.80	**bdl**	0.87	10.2	**bdl**	**bdl**
SW7	4.69	4.01	**bdl**	134	12.0	0.62	0.45	**bdl**	0.76	**bdl**	0.67	11.2	**bdl**	0.8
SW6	**bdl**	17.5	0.54	3.20	1.83	**bdl**	0.67	**bdl**	4.95	1.41	5.17	50.2	**bdl**	14.1
Lakes														
SW5	**bdl**	0.45	**bdl**	4.86	19.61	**bdl**	2.96	**bdl**	1.01	**bdl**	1.19	57.3	**bdl**	2.3
SW4	**bdl**	2.38	**bdl**	**bdl**	25.84	0.63	0.67	**bdl**	1.48	0.83	11.34	58.0	**bdl**	25.2
SW2	3.36	4.89	**bdl**	2.32	8.00	0.59	1.43	**bdl**	1.77	**bdl**	2.82	20.8	**bdl**	7.1
Irrigation Water														
SW8	2.25	2.87	**bdl**	0.94	12.53	**bdl**	0.67	**bdl**	0.58	**bdl**	**bdl**	8.20	**bdl**	**bdl**
SW9	2.12	2.90	**bdl**	bdl	10.20	**bdl**	0.89	**bdl**	0.62	**bdl**	**bdl**	9.33	**bdl**	**bdl**
SW10	2.57	2.97	**bdl**	2.70	12.99	**bdl**	0.95	**bdl**	0.63	**bdl**	**bdl**	8.25	**bdl**	**bdl**
SW11	8.01	3.08	**bdl**	6.56	20.71	**bdl**	0.57	**bdl**	0.63	**bdl**	**bdl**	8.44	**bdl**	0.4
Groundwater														
Western Group														
WW43	**bdl**	7.8	**bdl**	**bdl**	**bdl**	**bdl**	6.9	14.7	0.6	0.72	4.1	33	0.91	**bdl**
WW37	**bdl**	31.7	**bdl**	**bdl**	0.42	**bdl**	0.81	1.40	1.81	**bdl**	3.86	9.32	**bdl**	1.3
WW30	**bdl**	10.7	1.19	**bdl**	**bdl**	**bdl**	6.58	72.3	1.35	2.05	5.42	29.6	**bdl**	31.9
WW31	**bdl**	11.9	**bdl**	**bdl**	0.99	**bdl**	1.31	**bdl**	2.29	0.78	7.41	0.58	**bdl**	6.8
WW44	**bdl**	21.7	**bdl**	**bdl**	0.4	**bdl**	1.6	49.5	3.5	**bdl**	5.2	21.3	**bdl**	2.5
WW45	3.45	7.27	**bdl**	1.06	4.53	1.85	21.12	51.4	2.56	0.79	4.66	49.9	**bdl**	7.4
WW32	**bdl**	8.93	0.53	**bdl**	1.57	**bdl**	0.43	24.1	1.70	2.05	6.92	49.2	**bdl**	21.0
WW33	**bdl**	18.7	**bdl**	**bdl**	0.54	**bdl**	9.08	64.5	2.53	**bdl**	7.60	29.8	**bdl**	24.4
WW36	**bdl**	15.1	0.56	**bdl**	**bdl**	**bdl**	**bdl**	**bdl**	3.46	1.72	9.56	26.2	**bdl**	5.6
WW34	**bdl**	22.3	1.9	**bdl**	1.0	**bdl**	4.0	3.8	4.5	3.69	7.7	**bdl**	**bdl**	20.4

Table B3. Trace element data (continued)

ID	Al (ppb)	V (ppb)	Cr (ppb)	Mn (ppb)	Fe (ppb)	Ni (ppb)	Cu (ppb)	Zn (ppb)	As (ppb)	Se (ppb)	Mo (ppb)	Ba (ppb)	Pb (ppb)	U (ppb)
WW35	0.79	15.9	0.85	**bdl**	**bdl**	**bdl**	**bdl**	103	3.39	1.93	10.76	29.8	**bdl**	6.5
Badger Coulee West														
WW20	**bdl**	12.8	3.64	**bdl**	**bdl**	**bdl**	1.10	**bdl**	1.64	3.32	4.53	3.52	**bdl**	12.1
WW16	**bdl**	10.6	1.10	**bdl**	**bdl**	**bdl**	**bdl**	**bdl**	1.33	1.64	2.62	10.1	**bdl**	10.4
WW27	**bdl**	**bdl**	**bdl**	**bdl**	2.59	**bdl**	**bdl**	**bdl**	**bdl**	**bdl**	2.83	47.3	**bdl**	**bdl**
WW4	**bdl**	29.7	**bdl**	**bdl**	**bdl**	**bdl**	0.82	10.9	4.67	**bdl**	2.40	2.05	**bdl**	4.3
Northern Group														
WW29	**bdl**	7.88	**bdl**	16.6	**bdl**	0.85	1.75	10.1	2.00	0.72	27.61	42.3	**bdl**	25.9
WW28	**bdl**	0.33	**bdl**	71.3	15.7	**bdl**	**bdl**	1.97	1.72	**bdl**	18.49	82.8	**bdl**	4.0
Badger Coulee Middle														
WW5	**bdl**	18.2	2.76	**bdl**	0.72	**bdl**	0.45	**bdl**	2.28	14.51	5.93	22.0	**bdl**	6.4
WW38	4.97	29.8	**bdl**	**bdl**	0.92	**bdl**	0.42	3.71	4.30	1.51	2.61	11.4	**bdl**	4.3
WW6	**bdl**	1.69	**bdl**	4.09	105	**bdl**	**bdl**	140	**bdl**	**bdl**	3.30	58.6	**bdl**	bdl
WW39	**bdl**	18.9	1.76	**bdl**	1.48	**bdl**	**bdl**	4.77	2.95	12.5	4.05	21.9	**bdl**	5.3
WW8	**bdl**	26.1	4.15	**bdl**	1.11	**bdl**	1.59	6.19	4.20	21.6	21.6	0.79	**bdl**	3.9
WW2	**bdl**	15.7	**bdl**	**bdl**	0.92	**bdl**	**bdl**	70.6	3.75	1.70	3.96	57.6	**bdl**	1.8
WW40	**bdl**	25.2	1.81	**bdl**	0.50	**bdl**	**bdl**	**bdl**	4.32	18.3	11.5	13.4	**bdl**	2.6
WW7	**bdl**	15.8	**bdl**	**bdl**	0.63	**bdl**	1.32	194	2.22	7.47	3.17	70.5	**bdl**	2.8
Badger Coulee East														
WW42	**bdl**	**bdl**	**bdl**	**bdl**	2.2	**bdl**	106.2	218.4	**bdl**	**bdl**	6.4	**bdl**	**bdl**	**bdl**
WW18	**bdl**	31.2	**bdl**	0.86	7.55	**bdl**	0.67	56.19	2.49	1.05	1.81	26.8	**bdl**	1.5
WW21	**bdl**	13.7	0.72	**bdl**	0.74	0.52	1.41	**bdl**	2.97	3.25	1.70	80.9	**bdl**	8.9
WW19	**bdl**	0.79	**bdl**	50.2	14.8	**bdl**	**bdl**	**bdl**	**bdl**	**bdl**	42.0	54.8	**bdl**	**bdl**
WW23	**bdl**	13.9	0.57	**bdl**	0.41	**bdl**	1.14	1.62	1.80	3.64	1.42	23.7	**bdl**	16.6
WW26	**bdl**	13.8	0.80	1.05	3.83	**bdl**	1.87	**bdl**	2.34	0.45	3.63	22.6	**bdl**	1.6
WW41	**bdl**	33.4	0.99	**bdl**	0.70	**bdl**	1.64	4.25	6.56	1.41	7.28	15.6	**bdl**	6.8

Table B3. Trace element data (continued)

ID	**Al (ppb)**	**V (ppb)**	**Cr (ppb)**	**Mn (ppb)**	**Fe (ppb)**	**Ni (ppb)**	**Cu (ppb)**	**Zn (ppb)**	**As (ppb)**	**Se (ppb)**	**Mo (ppb)**	**Ba (ppb)**	**Pb (ppb)**	**U (ppb)**
WW10	**bdl**	13.8	1.08	**bdl**	0.96	**bdl**	0.51	7.96	2.81	2.49	9.01	87.4	**bdl**	8.6
WW11	**bdl**	12.5	1.14	**bdl**	0.65	**bdl**	**bdl**	2.36	1.58	1.22	3.30	52.3	**bdl**	5.5
WW9	**bdl**	13.3	0.83	**bdl**	0.68	**bdl**	1.51	84.6	1.99	0.67	5.61	51.0	**bdl**	5.6
WW22	**bdl**	15.3	**bdl**	**bdl**	1.53	**bdl**	**bdl**	**bdl**	1.98	**bdl**	2.02	20.4	**bdl**	1.7
WW17	**bdl**	**bdl**	**bdl**	**bdl**	1.4	**bdl**	**bdl**	**bdl**	**bdl**	**bdl**	**bdl**	**bdl**	**bdl**	**bdl**
WW15	0.5	**bdl**	**bdl**	3.0	0.8	**bdl**	**bdl**	**bdl**	**bdl**	**bdl**	**bdl**	**bdl**	**bdl**	**bdl**
WW24	**bdl**	21.4	**bdl**	**bdl**	13.34	**bdl**	0.39	3.00	3.58	**bdl**	6.72	18.7	**bdl**	1.7
WW12	**bdl**	16.4	0.76	0.90	**bdl**	0.57	6.71	1029	2.45	0.97	2.02	47.1	1.12	4.3
WW13	1.08	22.6	0.27	0.31	1.62	**bdl**	0.65	6.15	3.39	0.71	1.87	18.2	**bdl**	1.9
WW14	**bdl**	11.4	0.7	**bdl**	1.25	**bdl**	**bdl**	9.44	1.71	0.78	4.12	50.9	**bdl**	4.5
Eastern Group														
WW1	0.58	51.4	2.39	0.01	1.12	**bdl**	0.94	6.32	2.20	4.95	3.22	31.9	**bdl**	2.4
WW3	0.64	17.4	0.31	0.33	0.53	**bdl**	0.31	0.99	4.23	1.41	2.73	36.6	**bdl**	10.9
WW25	0.66	22.9	2.32	0.00	0.70	**bdl**	0.62	1.37	4.15	1.51	6.09	14.4	**bdl**	13.2
Det. Lim.	**1.98**	**0.22**	**0.52**	**0.83**	**0.37**	**0.48**	**0.35**	**0.74**	**0.54**	**0.44**	**0.54**	**0.39**	**0.29**	**0.80**

*bdl = below detection limit