# 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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# 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 Riverderived 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  $\approx$ 40,000 acrefeet 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 acrefeet by RH2 (2015). An additional 15,000 acrefeet 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 acrefeet to 132,000 acrefeet.

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 34°F in January and 75°F 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).



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  $\approx 10,000$  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  $\approx$ 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 Wa	ter 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 W	/ater				
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
<u>Groundwate</u>	er Samples				
Western Gro	oup				
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 Cou	lee 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 Gr	roup				

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 Cou	lee 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 Cou	lee 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 Gro	up				
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



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<sup>+</sup>, NH<sub>4</sub><sup>+</sup>, K<sup>+</sup>, Mg<sup>2+</sup>, Ca<sup>2+</sup>) was accomplished by using a Metrohm Ion Chromatography (IC), with EPA Method 300.7. Inorganic anions (F<sup>-</sup>, Cl<sup>-</sup>, NO<sub>3</sub><sup>-</sup>, SO<sub>4</sub><sup>2-</sup>) 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\* $\sigma$ ).

For trace element analysis, samples were acidified using trace-clean acids to 1% HCl and 0.5% HNO<sub>3</sub>. 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  $\delta$ -notation as  $\delta^{18}$ O for  $^{18}$ O/ $^{16}$ O and  $\delta$ D for D/H.<sup>1</sup> 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  $\delta$ D, 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<sub>4</sub>. 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.

 $<sup>^{1}\</sup>delta = \left(\frac{R_{smp}-R_{std}}{R_{std}}\right) * 1000$ , where R is  $^{18}O/^{16}O$  for  $\delta^{18}O$  and D/H for  $\delta$ D, 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)
Junate 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	DOI	1.54	9.60	DOI	DOI	bdi	Dal	DOI
SW7	4.01	1.02	0.45	0.76	0.67	11.2	0.8	134	4.69	DOI		DOI	0.62	DOI
SWO	17.5	1.05	0.67	4.95	5.17	50.2	14.1	5.20	Dui	Dui	0.54		Dai	Dui
Lakes	0.45	10.61	2.06	1 01	1 10	57.2	2.2	1.96	hdl	bdl	bdl	bdl	bdl	bdl
5005	0.45	25.04	2.90	1.01	1.19	57.5	2.5	4.00	bul	bdl	bdl	0.92	0.62	bul
5004	2.50	2.3.64	1.42	1.40	11.34	58.0	25.2	2 2 2 2	2.26	bal	bal	0.65	0.05	bul
Jurigation	4.05	0.00	1.45	1.11	2.02		7.1	2.32	3.30	Dui	Dui	Dui		bui
SW/8	2.87	12.52	0.67	0.58	bdl	8 20	bdl	0.94	2.25	bdl	bdl	bdl	bdl	hdl
511/9	2.07	10.20	0.07	0.58	bdl	9.20	bdl	bdl	2.23	bdl	bdl	bdl	bdl	bdl
SW10	2.50	12.99	0.95	0.62	bdl	8.25	bdl	2.70	2.12	bdl	bdl	bdl	bdl	bdl
SW10	3.08	20.71	0.57	0.63	bdl	8 44	0.4	6.56	8.01	bdl	bdl	bdl	bdl	bdl
Groundw	vater	Lastri I de	0.57	0.05	bui	0.44	0.4	0.50	0.01		bui	bui	bui	Dai
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	0.9 <u>9</u>	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 C	Coulee Wes	t												
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	n Group	-	r					r						
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 C	Coulee Mid	dle	0.45	0.00	5.00		<b>C</b> 4				0.76			
WW5	18.2	0.72	0.45	2.28	5.93	11.4	6.4	bdl	DOI	D0I	2.76	14.51	DOI	100
WW38	29.8	1.92	0.42	4.30	2.01	11.4 E9.6	4.3	4.00	4.97	3.71	bdl	1.51 bdl	bal	bdl
WW0	10.0	1.49	bdl	2.05	4.05	38.0	5.2	4.05	bdl	1 77	1.76	12.5	bdl	bdl
14/14/9	26.1	1.40	1.50	4.20	21.6	0.70	2.0	bdl	bdl	6.10	1.15	21.5	bdl	bdl
WW0	15.7	0.92	bdl	3.75	3.96	57.6	1.8	bdl	bdl	70.6	4.13 hdl	1 70	bdl	bdl
WW40	25.2	0.52	bdl	4 32	11.5	13.4	2.6	bdl	bdl	bdl	1.81	183	bdl	bdl
WW7	15.8	0.50	1.32	2.22	3 17	70.5	2.8	bdl	bdl	194	bdl	7 47	bdl	bdl
Badger C	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. <u>52</u>	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	1.41	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	1.99	5.61	51.0	5.6	bdl	bdl	84.6	0.83	0.67	bdl	bdl
WW22	15.3	1.53	bdl		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	111.4	1.25	bdl	1.71	4.12	50.9	4.5	bdl	bdl	9.44	0.7	0.78	bdl	bdl
Eastern C	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	1.41	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.

Variable*	F1	F2	F3	F4	F5
% variance	36.4	23.9	12.2	10.3	7.9
Н	0.582	0.190	-0.586	-0.353	0.041
Na	0.194	0.446	0.529	-0.387	0.551
К	-0.218	0.887	-0.071	0.221	-0.035
Mg	0.857	0.230	-0.068	0.300	-0.258
Са	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 <sub>3</sub> -N	0.685	-0.017	0.332	-0.551	-0.065
SO <sub>4</sub>	0.603	0.618	0.272	0.199	-0.105
HCO₃	0.759	0.230	-0.273	0.261	0.351
CO <sub>3</sub>	-0.219	-0.227	0.589	0.623	0.123
δ <sup>18</sup> Ο	0.618	-0.677	-0.031	0.127	0.310
δD	0.512	-0.747	-0.119	0.147	0.331

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).

\*Units: H+ -  $\mu$ mol/L; major ions – ppm; stable isotopes –  $\delta$  (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.

PCA group	Sample ID	Well Depth (m)	Well Geologic Unit	Geographic Location	Trace Element Notes	Nitrate	Other Ions Notes	Calculated % Yakima River	δD
А	WW19	141	Basalt	BC East	high Mo	low	high SO <sub>4</sub>	0	low
A*	WW42	308	Basalt	BC East	high Cu			0	low
А	WW18	137**	Basalt	BC East			high SO₄	0	low
А	WW6	259	Basalt	BC Middle	high Fe	bdl	high Cl, SO <sub>4</sub>	0	low
А	WW2	142	Basalt	BC Middle		med	high Cl, SO <sub>4</sub>	0	low
А	WW27	177	Basalt	BC West		bdl	high SO <sub>4</sub>	0	low
А	WW1	131	Basalt	Eastern	high V			0	
A*	WW43	122**	Basalt	Western				0	low
В	WW8	76.2		BC Middle	high Cr, Se	high		47	
В	WW36	51.8	Basalt	Western				72	
В	WW35	53.3	Basalt	Western			high SO₄	72	
С	WW26	48.8	Gravel	BC East			high Na, SO₄	66	
С	WW22	45.1	Gravel	BC East				77	
С	WW17	60	Gravel	BC East		bdl	high SO₄	70	
С	WW15	58.8	Gravel	BC East		bdl	high SO₄	65	
С	WW24	65.5	Gravel	BC East				75	
С	WW13	33.5**		BC East				44	
С	WW4	31.1	Gravel	BC West			high SO₄	89	high
С	WW37	88.4	Basalt	Western			high SO₄	95	
С	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, SO4	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	

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
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 <sub>4</sub>	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 SO₄	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  $SD_1 \log_2 < 120\%$ ; high > 100%.

 $\delta D: low < -120\%; high > -100\%$ 

# 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  $\delta$ D values around -13.5 and -99, respectively while the most evolved basalt waters are much lighter isotopically, with  $\delta^{18}$ O around -16 and  $\delta$ D 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  $\delta D$ -  $\delta^{18}O$  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  $\delta D$  values around –99 and end-member basalt waters with  $\delta D$  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  $\delta D$ - $\delta^{18}O$  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  $\delta D$ - $\delta^{18}O$  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.  $\delta D - \delta^{18}O$  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  $\delta D$ - $\delta^{18}O$  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 concentrations 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.  $\delta D$  versus Nitrate-N plot. Blue shaded area shows range of  $\delta D$  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  $\delta D$ - $\delta^{18}O$  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  $\delta D$ - $\delta^{18}O$  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:  $\delta D_{mix} = m_{mix} * (\delta^{18}O_{mix} - \delta^{18}O_{gw}) + \delta D_{gw}$ 

where mix represents the point where the evaporation line intersects the mixing line (the  $\delta$  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  $\delta D = -140$ ; 2) a heavier basalt water with  $\delta D = -125$ ; and a possible intermediate water with  $\delta D = -110$ . 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 <sup>18</sup> Ο	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.

					Total artific	cially added			
Average well depth	Average depth to water	Saturated thickness in well	Area	Total stored in gravel/silt*	50% surface water	90% surface water	Additional storage available*		
			ucre	ucre-ji	ucre-ji	ucre-ji	ucre-jt		
Badger Co Middle	ulee West a	nd Badger Cou	ilee						
80	24	56	4,500	97,000	49,000	87,000	28,000		
Badger Co	ulee 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 c	*Storage coefficients used:								
saturated t	thickness	above top	o of groundw	vater					
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  $\delta D$  and  $\delta^{18}O$  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<sub>3</sub>-N concentration of 5 ppm or higher, while Group C wells have lower NO<sub>3</sub>-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.

Group	# SAMPLES	LITHOLOGY	GROUP CHARACTERISTICS	LOCATION	INTERPRETATION
A	8	basalt	deepest wells, low NO <sub>3</sub> , low $\delta D$ and $\delta^{18}O$	throughout	pristine basalt water, end-member, probably old
В	3	basalt	intermediate chemistry (factor scores)	Western and Badger Coulee Middle	probably mixture of different waters
С	9	gravel, 2 basalt	lower NO₃, high SO₄	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 NO₃	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 <sub>3</sub> , med to high $\delta D$ and $\delta^{18}O$	throughout	high surface water contribution, probably irrigation water, has chemical signature from basalts

Table 7. Summary of hydrochemical groups and interpretation



# Figure 19. Hydrogen isotopic composition ( $\delta D$ ) 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.

#### References

- Aspect Consulting, 2005. Aquifer storage and recovery assessment, City of Kennewick. WRIA 31 Supplemental Water Storage Project, report prepared for WRI 31 Planning Unit.
- CH2M Hill, 1983. Badger Canyon groundwater investigation for the Kennewick Irrigation District, Kennewick, Washington. CH2M Hill, Northwest Inc. March 1983.
- CH2M Hill, December 2008, revised April 7, 2009, Kennewick Irrigation District Water Conservation Plan.
- Drever, J.I., 1997. The Geochemistry of Natural Waters: Surface and Groundwater Environments. Upper Saddle River, NJ: Prentice Hall.
- Drost, B.W., Cox, S.E., and Schurr, K.M., 1997. Changes in groundwater levels and groundwater budgets, from predevelopment to 1986, in parts of the Pasco Basin, Washington: United States Geological Survey Water-Resources Investigations Report 96-4086.
- Early, T.O., Mitchell, and Spice, G.D., 1986. A hydrochemical data base for the Hanford Site, Washington.
- Ebbert, J.C., Cox, S.E., Drost, B.W., and Schurr, K.M., 1995. Distribution and sources of nitrate, and presence of fluoride and pesticides, in parts of the Pasco Basin, Washington, 1986-1988. United States Geological Survey Water-Resources Investigations Report 93-4197.
- Ely, D. M.; Bachmann, M. P.; Vaccaro, J. J., 2011. Numerical simulation of groundwater flow for the Yakima River basin aquifer system, Washington; U.S. Geological Survey Scientific Investigations Report 2011-5155;
- Gendaszak A.S., Ely D.M., Hinkle S.R., Kahle S.C. and Welch W.B., 2014. Hydrogeologic framework and groundwater/surface-water interactions of the upper Yakima River Basin, Kittitas County, central Washington. U.S. Geological Survey Scientific Investigations Report 2014-5119, https://pubs.usgs.gov/sir/2014/5119/
- Hinkle S.R. and Ely D.M., 2013. Chemical and isotopic data collected from groundwater, surface-water, and atmospheric precipitation sites in upper Kittitas County, Washington, 2010-2012. U.S. Geological Survey Data Series 752, <u>http://dx.doi.org/10.3133/ds751</u>.
- Holt R.S., 2012. Geochemical analysis of surface water and groundwater in upper Kittitas County, WA: Implications for recharge and flow. Central Washington University M.S. Thesis.
- Jones, M.A., Vaccaro, J.J., and Watkins, A.M., 2006. Hydrogeologic Framework of Sedimentary Deposits in Six Structural Basins, Yakima River Basin, Washington. USGS Scientific Investigation Report 2006-5116.
- KID Water Delivery Map, Kennewick Irrigation District Water Delivery Status, <u>https://kid.maps.arcgis.com/apps/webappviewer/index.html?id=127f86005e7b4dd4ad1293c8a0550f</u> <u>41</u>, accessed August, 2020.
- Mantua, N.J., Tohver, I. and Hamlet, A. . 2010. Climate change impacts on stream flow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State. *Climate Change* . doi:10.1007/s10584-010-9845-2.
- Packard, F., 1981. Reconnaissance of water availability and quality in abandoned coal mines near Roslyn, Kittitas County, Washington: USGS Water-Resources Investigations Open-File Report 80-955
- QAPP KID, 2020. Quality Assurance Project Plan: Assessment of Groundwater Storage in the Kennewick Irrigation District. Washington Department of Ecology Agreement #C2100007
- RH2 Engineering, Inc., 2015. Badger Coulee recapture of artificially-stored project water report. Prepared for Kennewick Irrigation District.
- Reidel, Stephen P., and Fecht, Karl R. compilers, 1994. Geologic map of the Richland 1:100,000 Quadrangle, Washington, Open File Report 94-8.
- Reidel, Stephen P., 2004. The geologic development of the Pasco Basin, South-Central Washington, Northwest Geological Society.
- Schuster, J. Eric, Gulick, Charles W., Reidel, Stephen P., Fecht, Karl R., Zurenko, Stephanie, 1997. Geologic Map of Washington – Southeast Quadrant. Washington Division of Geology and Earth Resources, Geologic Map GM-45.
- Sleeper S., 2020. A geochemical assessment of potential groundwater storage locations within the Yakima River Basin. Central Washington University M.S. Thesis.
- Taylor S.A. and Gazis C.A., 2014. A geochemical study of the impact of irrigation and aquifer lithology on groundwater in the Upper Yakima River Basin, Washington, USA. Environmental Earth Sciences 72: 1569-1587.
- United States Department of Interior, March 22, 2004, amended August 20, 2004, Kennewick Irrigation District and Columbia Irrigation District Pump Exchange Feasibility Study, Amon Wasteway Operational Spill, Kennewick Irrigation District Concept Design Report.
- Vaccaro, J. J.; Jones, M. A.; Ely, D. M.; Keys, M. E.; Olsen, T. D.; Welch, W. B.; Cox, S. E. (2009) Hydrogeologic Framework of the Yakima River Basin Aquifer System, Washington. USGS Scientific Investigation Report 2009-5152.
- Vaccaro J.J. and Sumiako S.S., 2006. Estimates of groundwater pumpage from the Yakima Basin Aquifer System, Washington, 1996–2000. US Geological Survey Scientific Investigations Report 2006–5205.
- Vlassopoulos, D., Karanovic, M., Porcello, J., Tolan, T., and Lindsey, K., 2009. Multiple tracer study of recharge mechanisms and the age of groundwater in the Columbia River Basalt Group aquifer system: Columbia Ground Water Management Area of Adams, Franklin, Grant, and Lincoln Counties.
- Washington Division of Geology and Earth Resources, 2016, Surface geology, 1:100,000--GIS data, November 2016: Washington Division of Geology and Earth Resources Digital Data Series DS-18, version 3.1, previously released June 2010.
- WRCC, 2023. Washington Climate Summaries. Western Regional Climate Center. http://www.wrcc.dri.edu/summary/Climsmwa.html. Accessed 29 April 2023.
- YRBIWRP, 2012. Yakima River Basin Integrated Water Resource Management Plan Final Programmatic Environmental Impact Statement. Washington State Department of Ecology Pub. No 12-12-002. <u>https://fortress.wa.gov/ecy/publications/SummaryPages/1212002.html</u>

## Appendix A 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 C	oulee 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 C	oulee Middl	e 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

## Table A1. Groundwater Sampling Well Information

(continued)

Sample	Date			Surface Elev	Well Depth	Depth to GW	Year	Well Geologic		
ID	Sampled	Latitude*	Longitude*	(m)	(m)	(m)***	***	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 Co	oulee East G	roup								
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 G	iroup									
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

File Depa	Driginal with WATER WELL REPOR	Notice of Intent U148967
Seco Third	I Copy - Driller's Copy	Water Right Permit No
(1)	OWNER: Name JOAN Cullell Add	tress 2001 Brantingham Rd Richland
(2) (2a)	LOCATION OF WELL: County <u>Benton</u> STREET ADDRESS OF WELL: (or nearest address) 2001 Brantiv TAX PARCEL NO.	UE 1/4 DE 1/4 Sec 34 J 9. NR 285 WM 4 hours Rd Dichland We 99353
(3)	PROPOSED USE: Domestic Industrial Municipal Irrigation Test Well Other	(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 mach stratum penetrated with at least
(4)	TYPE OF WORK:       Owner's number of well (if more than one)         Y       New Well         Method       Dug         Deepened       Dug         Reconditioned       Cable         Decommission       X Rotary         Jetted	one entry for each change of information Indicate all water encountered       MATERIAL     FROM       TAU     O       SANG     TAU       SANG     TAU       SANG     TAU
(5)	DIMENSIONS; Diameter of well 6 inches Drilled 66 feet Depth of completed well 628 15 ft	Stand I and Ital 12 21
(6)	CONSTRUCTION DETAILS Casing Installed: Melded Diam from <u>+L</u> ft to <u>HDD</u> ft Liner installed Diam from <u>-128</u> ft to <u>4286</u> ft Diam from <u>-128</u> ft to <u>4286</u> ft	Busalt Gravel, sitt Tim 21 43 Clay tim 43 145 Busalt Black 145 179 Busalt Black 129 192 Busalt Black 197 269
	Perforations:       Yes       No         Type of perforator used       SAW         SIZE of perforations       1/6 in byin         2440 perforations from       300 ft to 425 ft	Baselt Black Usicular 293 Weter Bearing. 312 Baselt Black Jointal 312 411
	Screens:         □ Yes Y No         □ K-Pac Location           Manufacturer's Name	Water Bearine 419 Basselt 13lacle 419 426
	Gravel/Filter packed:          Tes          Yes          No         Size of gravel/sandft         toft         toft         toft	CE FFOUL
	Surface seal: To what depth?	Received
(7)	PUMP: Manufacturer's Name TypeH P	Region Of
(8)	WATER LEVELS: Land surface elevation above mean sea levelft below top of wellft below top of well Date	Work Started 12-18-01 Completed 12-21, 0(
(0)	(Cap, valve, etc )	WELL CONSTRUCTION CERTIFICATION:
(a)	WELL FESTS: 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      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       Time         Date of test	Contractor's Cont
	Airtest       SO       gal /min with       SO       ft drawdown after       2       hrs         Artesian flow       g p m       Date         Temperature of water        Was a chemical analysis made?        Yes        No	(USE ADDITIONAL SHEETS IF NECESSARY)
FCY	750-1-20 (11/98)	accommodation needs, contact the Water Resources Program at (360) 407-

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Original & 1 <sup>st</sup> copy - Ecology, 2 <sup>st</sup> copy - owner, 3 <sup>st</sup> copy - driller		<u></u>	<u>na se </u>
Construction/Decommission ("x" in circle) 383956	Watar Picht Parmit No	<u>24 175</u>	<u>an an a</u>
O Decommission ORIGINAL INSTALLATION Notice	Property Owner Name AA A-A i A AA	CY P	<u>م کنو کود دار.</u> سرور کرد مرکز در معرو میتوند
of Intent Number	Well Street Address ( 2 4) 7 7.99	1312 · E	
PROPOSED USE: 6 Domestic	City Pentern County Ben	tow	
TYPE OF WORK: Owner's number of well (if more than one)	Location $\leq 1/4 = 1/4$ $\leq 1/4$ Sec 7. Twn $\leq 1/4$ R	JE EWM	circle one
New well         Reconditioned         Method         Dig         Bored         Diven           D Despend         Cable         A Rotary         Isticed	Lat/Long (s, t, r Lat Deg/Lat M	lin/Sec	۲۵، ۲۵، ۲۵، ۲۵، ۲۵ ۲۵۰ - ۲۵ ۲۰۰۰ - ۲۵۰ - ۲۵۰ - ۲۰۰۰
DIMENSIONS: Diameter of well 8 inches, drilled 975 ft.	Still REQUIRED) Long Deg Long	Min/Sec	
	Tax Parcel No. 101 883 010 797	<u>.004</u>	
Casing B. Welded S. Diam from $1$ ft to $40$ ft. Installed B. Liner installed $4$ Diam from $-5$ ft to $465$ ft.	CONSTRUCTION OR DECOMMISSION P	ROCEDUR	E
Perforations: A Yes I No.	Formation: Describe by color, character, size of material and stri nature of the material in each stratum penetrated, with at least one	icture, and the e entry for each	kind and i change of :
Type of perforator used	information (USE ADDITIONAL SHEETS IF NECESS)	ARY.)	<u></u>
Screens: Q Yes O No Q K Pac Location	Clay Brain	0	15
Type Model No	Breat Broken	15	<u>40</u>
Diam Siol size from ft. to ft. Diam Siol size from ft. to ft.	sand stone water	190	255
Gravel/Filter packed: U_Yes: 29_No// U_Size of gravel/sand Materials placed fromft. toft.	RG2014 HOX9	255	<u> NIN</u>
Surface Seal: 12 Yes			1823)22 1967-199-19
Did any strata contain unusable water?			
Type of water? Depth of strata Method of sealing strata off		<u> Seconda</u> Torrada	
PUMP: Manufacture: s Name			مر میں
WATER LEVELS: Land-surface elevation above mean sea level		<u>1992</u> 221 2009.000	ار استار زر میکرد. بر در میکرد زر میکرد بر در میکرد میکرد
Static level			میرم بیرم میرد ۱۹ مر میرون میرون مربع
Artesian pressure tos. per square inch "Date	<u>, an an</u>	<u>1997 - 1995 - 1</u> 1992 - 1965 - 1	وزیدهٔ با با این سند از ا منابع از به منابع است از ا
(cap, vaive, etc.) WELL TESTS: Drawdown is amount,water level is lowered below static level		م م ما معلم م مر مر و و مراجع م مر مر و مراجع م م مواد مر مر موجع مراجع	ار و بالمع مراجع می از می می می از این می می می می می می می می از این می می می می می می می می
Was a pump test made? Ves V No If yes, by whom?		<u>ander daarde b</u> Staarde be	iner Hei Vice Hein
Yield gal/min with ft drawdown after hrs. Yield gal/min with ft drawdown after hrs.		<u>1837, 1887</u> , 2	
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)	RECE	VED	
Time Water Level Time Water Level Time Water Level			<u>de de la com</u> Constanció
en e	JUL U 2	2009	ala a san ann an ann ann an ann an ann an ann a Tha ann ann ann ann ann ann ann ann ann a
Date of test	RECEIVED DEPARTMENT OF ECONOMY OF	TRAL REGIONAL UNI	Œ
Airtest 1 gal/min. with stem set at 4/56 ft. for hrs.	AUG 23 2010		in an an an an ann an
Artesian flow g.p.m. Date	ALL FOR ANY CLUTTAN REGIONAL OFFICE	ala ang tang tang tang tang tang tang tang	<u>en de la composition de la composition</u> Esta de la composition
n emperance o protector <u>al a comp</u> etense aparatementaria para materia de la competense de la competense de la comp A secondada de la competense de la competens	HEPAKIMENT UT LUULUUT OLITITUL TLUU	Seel 1	m

Driller/Engineer/Trainee Signature Driller or trainee License No 

Driller's Signature

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

City, State, Zip - CA-1 - 2 ج: Contractor's 20-07

Contractor's Registration No TEAPENTER Contractor's Date Co Ecology is an Equal Opportunity Employer

If TRAINEE, Driller's Licensed No. : : : : d,

WALER WEEPORT         WALER WEEPORT         WALER WEEPORT         With Comparison of the construction         Originate " "or include)         © Construction       Decommission ("x" in circle)         © Construction       Decommission (NGINAL INSTALLATION Notice () fatent Number       Decommission ("x" in circle)         © Decommission (RGINAL INSTALLATION Notice () fatent Number       Decommission ("x" in circle)       Decommission ("x" in circle)         © More will Deposed       The originate ("and the impact of the impact		CUDDENT	
PROPERTY Construction Decommission (*** in circle)         Sconstruction         O Decommission (*** in circle)         Sconstruction         O Decommission (*** in circle)         Sconstruction         PROPERTY Construction         Property Construction     <	WATER WELL REPORT Original & 1 <sup>st</sup> copy – Ecology, 2 <sup>nd</sup> copy – owner, 3 <sup>rd</sup> copy – driller	Notice of Intent No. WE 18201	
B Construction       O Decommission ORIGINAL INSTALLATION Notice of Intern Number       Property Owner Name Day 1 d. Boucer 5         PROPOSED USE:       Downer Lance Day 1 d. Boucer 5       Property Owner Name Day 1 d. Boucer 5         PROPOSED USE:       Downer Lance Day 1 d. Boucer 5       Well Street Address 415 Lar Kheven         PROPOSED USE:       Downer Lance Day 1 d. Boucer 5       Well Street Address 415 Lar Kheven         PROPOSED USE:       Downer Lance Day 1 d. Boucer 5       Well Street Address 415 Lar Kheven         PROPOSED USE:       Downer Ame Day 1 d. Boucer 5       Well Street Address 416 faure 1         Difference 1       Downer Ame Day 1 d. Boucer 5       Well Street Address 416 faure 1         Difference 1       Down from the Day 1 d. Boucer 5       Well Street Address 416 faure 1         Difference 1       Down from the Day 1 d. Boucer 5       Well Street Address 416 faure 1         Difference 1       Down from the Day 1 d. Boucer 5       Well Street Address 416 faure 1         Difference 1       Down from the Day 1 d. Boucer 5       Well Street Address 416 faure 1         Difference 1       Down from the Day 1 d. Boucer 5       Well Street Address 416 faure 1         Difference 2       Down from the Day 1 d. Boucer 5       Well Street Address 416 faure 1         Difference 2       From the Day 1 d. Boucer 5       Method 1       Method 1         <	E C 0 L 0 G Y Construction/Decommission ("x" in circle)	Unique Ecology Well ID Tag No. <u>BIF 4</u>	07
O DECOMMINISSION DATACHARDAN HOLE of Inter Number       Projectly Owner Name DAO 16 Disc.       DOI: 10.00000000000000000000000000000000000	S Construction	Water Right Permit No.	
PROPOSED USE:       Domestic       Induitivial       Manifold         PROPOSED USE:       Domestic       Induitivial       Manifold         PYEO FORMER. Cover's number of eld (from et man eng)       Event eld (Sociality Link)       Localids [Link-114_SUL4]       Social's [Link-114_SUL4]       Socia's [Link-114_SUL4]       Socia's [Link-114_SU	of Intent Number	Property Owner Name DAVIG DOW	285
City       Interview       Other       City       Interview       Control       City       Interview       City       City       Interview       City       Interview       City       Interview       City       City       Interview       City       City </td <td>PROPOSED LISE: Somestic Industrial Municipal</td> <td>Well Street Address <u>415 Lar Khave</u></td> <td><u>n</u></td>	PROPOSED LISE: Somestic Industrial Municipal	Well Street Address <u>415 Lar Khave</u>	<u>n</u>
Image: Second	DeWater	City <u>hichland</u> County <u>Bent</u>	2h
Didewide       Didewide <td< td=""><td>TYPE OF WORK:       Owner's number of well (if more than one)         Xew well       Reconditioned         Method :       Dug         Bored       Driven         Decomposition       Coble         Reconditioned       Decomposition</td><td>Location <math>\mathcal{L}_{\mathcal{L}}</math> Location <math>\mathcal{L}_{\mathcal{L}}</math> Lat/Long (s, t, r Lat Deg Lat Min/</td><td>or circle www one Sec</td></td<>	TYPE OF WORK:       Owner's number of well (if more than one)         Xew well       Reconditioned         Method :       Dug         Bored       Driven         Decomposition       Coble         Reconditioned       Decomposition	Location $\mathcal{L}_{\mathcal{L}}$ Location $\mathcal{L}_{\mathcal{L}}$ Lat/Long (s, t, r Lat Deg Lat Min/	or circle www one Sec
Depth of completed well       SD       n         Construction DETAILS       Duan from       ft       Duan from       ft       Duan from       ft       ft         Construction DETAILS       Duan from       ft       Duan from       ft       ft       ft         Installed:       Duan from       ft       ft <t< td=""><td>DIMENSIONS: Diameter of well inches, drilled _3.0ft.</td><td>Still REQUIRED) Long Deg Long Mi</td><td>n/Sec</td></t<>	DIMENSIONS: Diameter of well inches, drilled _3.0ft.	Still REQUIRED) Long Deg Long Mi	n/Sec
create       6       Diam from       10       10       10         institlet:       Under installed       Diam from       10       10       10         restrict:       Under installed       Diam from       10       10       10       10         restrict:       Under installed       Diam from       10	CONSTRUCTION DETAILS	Tax Parcel No. 136983020002	002
Ferforsition:       Tys       With         Type of perforior used       in hyin and no of perfs_fromin	Casing Welded <u>6</u> "Diam. from <u>72</u> ft. to <u>28</u> ft. Installed: Liner installed <u>"Diam. from ft. to ft</u>	CONSTRUCTION OR DECOMMISSION PRO	CEDURE
SiZE of perfs	Perforations:  Ves Perforator used	Formation: Describe by color, character, size of material and structure nature of the material in each stratum penetrated, with at least one entu- information. (USE ADDITIONAL SHEETS IF NECESSARY	e, and the kind and ry for each change of
seven:       W to get Pice Location _23         Munificative Name Codensitient       Model No.         Diam Cit and Cit	SIZE of perfsin. byin. and no. of perfsfromft. toft.	MATERIAL FR	OM TO
Maintauture is name       Jointy       Soi itse       Model No         Type       Jointy       Soi itse       for       A         Dame       Soi itse       for       A       A       A         Dame       Soi itse       for       A       A       A       A         Dame       Soi itse       for       A	Screens: BY Yes D No DrK-Pac Location 23	Topsoil	0 3
pinn       The Site size form       The Dam       The Dam       Site size form       The Dam       T	Type Arcting Large A Model No	Silty Sand	3 20
Gravel/Filter packet:       □ Yes       □ Size of gravel/sand         Material placed from       ∩ to       ∩ to         Surface Sait:       Type of water?       □ Ves       □ No         Did any strata contain musable water?       □ Ves       □ No       □ No         Type of water?       □ Depth of strata       □       □       □         Method of seating strata off       □       □       □       □         PUMPY: Manufacturer's Name       □       □       □       □       □         WATER LEVELS: Land-surface elevation above mean sca level       ft.       □       □       □       □         Static level	Diam. Slot size $10$ from $24$ ft to $29$ ft. Diam. Slot size from ft. to ft.	gravel + Sand 21	2 30
Surface Seal:       P Yes       No       To what depth?       2.0       ft.         Material used in seal       Great fee n if C       No         Type of water?       Depth of strata	Gravel/Filter packed: 🗆 Yes 😰 No 🗆 Size of gravel/sand Materials placed fromft. toft.		
Material used in seal D3240 / Pe A / I   Did any strata contain nunsable water? Depth of strata   Type of water? Depth of strata   Method of sealing strata off   PUMP: Manufacturer's Name   HP.   WATER LEVELS: Land-surface elevation above mean sea level ft. blow top of well Date Artesian pressure lbs. pr square inch Date Artesian pressure well TSTS: Drawdown is amount water level is lowered below static level Well TSTS: Drawdown is amount water level is lowered below static level Well TSTS: Drawdown is amount water level is lowered below static level Well TSTS: Drawdown is amount water level is lowered below static level Well TSTS: Drawdown is amount water level is lowered below static level Well TSTS: Drawdown is amount water level is lowered below static level Water Level Time Water Level Time Water Level Time Water Level Time Water Level Stef 1 T 2014 Date of test Bailer test gal/min. with ft. drawdown after hrs. Artesian flow gg pm. Date Temperature of water <u>ST</u> <sup>2</sup> Was a chemical analysis made? Yes <u>B</u> Vest <u>D</u> Start Date <u>ST</u> -17-QOJY Completed Date <u>S-21-R</u> Well CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with Waters <u>P</u> Driller Dengineer [Trainee Name (Print) Driller Genger [Trainee Name (Print)] Driller Construction standards. Materials used and the information reported above are true to my best knowledge and belief. Driller Construction standards. Materials used and the information reported above are true to my best knowledge and belief. Driller or trainee Name (Print) Driller Construction standards. Materials used and the information reported above are true to	Surface Seal: Yes INO To what depth? 20 ft.		
Type of wate?       Depth of strita         PUMP: Manufacturer's Name       PUMP: Manufacturer's Name         Type:       H.P.         WATER LEVELS: Land-surface elevation above mean sea level       ft.         Static level       1.5       ft. below top of well Date         Artesian pressure       lbs.per square inch Date       Artesian water is controlled by         (cap, value, etc.)       (cap, value, etc.)         WELL TESTS: Drawdown is amount water level is lowered below static level       was a pump test made?         Yield       gal/min. with       ft drawdown after         Yield       gal/min. with       ft drawdown after         Yield       gal/min. with       ft drawdown after         Into water level       Time       Water Level         Time       Water Level       Time         Bailer test       gal/min. with       ft drawdown after         Into water level       meanued for well       Stat Date         Date of test       gpm. Date       gpm. Date         Temperature of water ST2       Was a chemical analysis made?       Yes 14.760         Stant Date       ST12       Orsenstudies or norstruction standards. Materials used and the information reported above are true to my best knowledge and belief.         Driller Gengineer/Trainee Signatue	Did any strata contain unusable water? Ves No		
Method of sealing strata off	Type of water? Depth of strata		
PUMP: Manufacturer's Name       H.P.         Type:       H.P.         WATER LEVELS: Land-surface elevation above mean sea level       ft.         Static level       1.5         Artesian pressure       lbs. per square inch: Date         Artesian vater is controlled by       (cap, valve, etc.)         WELL TESTS: Drawdown is amount water level is lowered below static level       (cap, valve, etc.)         Well, dg./min. with       ft. drawdown after       hrs.         yield:       gal/min. with       ft. drawdown after       hrs.         Yield:       gal/min. with       ft. drawdown after       hrs.         Recovery duta (time taken as zero when pump turned off) (water level measured from well top to water level)       Recovery duta (time taken as zero when pump turned off) (water level measured from well top to water level)       Recovery duta (time taken as zero when pump turned off) (water level       SEE 1 1 2014         Date of test	Method of sealing strata off		
WATER LEVELS: Land-surface elevation above mean sea levelf.         Static level	PUMP: Manufacturer's Name		
Static level       IS       ft below top of well       Date         Artesian pressure       lbs. per square inch       Date	WATER LEVELS: Land-surface elevation above mean sea level ft.		
Artesian pressure	Static level 15 ft. below top of well Date		
Artesian water is controlled by	Artesian pressure lbs. per square inchr Date		
WELL TESTS: Drawdown is amount water level is lowered below static level         Was a pump test made?       Yes         Yield:       gal/min. with         ft. drawdown after       hrs.         main       Water Level         Time       Water Level         main       Water Level         main       ft. drawdown after         hrs.       Airtest         Airtest       gal/min. with stem set at       2.9 ft. ft. ft. ft. ft.         Temperature of water STO       Was a chemical analysis made?       Yes       ft. ft.         Start Date	Artesian water is controlled by (cap, valve, etc.)		
Was a pump test made?       Yes       Woo       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)       Personned         Time       Water Level       Time       Water Level	WELL TESTS: Drawdown is amount water level is lowered below static level		
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)       Image: Second condition of the second condition condition of the second condition of the second condition con	Was a pump test made? Ves Ver 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 nop to water level)       FECOLOGY         Time       Water Level       Time       Water Level	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)       Image: Sero 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	Yield:gal./min. withft. drawdown afterhrs.	E ECO	TA .
Time       Water Level       Time       Water Level       Step 1 / 2014         Date of test	Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)		dep
Date of test	Time Water Level Time Water Level Time Water Level	S' Reci-	1000
Date of test		SER 1	2014
Date of test			- te
Date test       gat/min. with stem set at       29       ft. for       2       hrs.         Artesian flow       g.p.m. Date       g.p.m. Date       g.p.m. Date       g.p.m. Date         Temperature of water 57°       Was a chemical analysis made?       Yes       Yes       Yes         WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance wi         Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.         Briller □ Engineer □ Trainee Name (Print)       Driller/Engineer/Trainee Signature         Driller or trainee License No.       1224         Contractorie       Contractorie	Daile tast and /min with A desurtain after ter	Co.	- mile
Artesian flow       g.p.m. Date         Temperature of water 57° Was a chemical analysis made?       Yes @No         Start Date 5-17-2014       Completed Date 5-21-2         WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance wi         Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.         Briller I Engineer I Trainee Name (Print)         Driller/Engineer/Trainee Signature         Driller or trainee License No. 1224         Contractoric	Bailer test gai./min. with $\underline{29}$ ft. for $\underline{2}$ hrs.	MRAL R	FCH
Temperature of water 57° Was a chemical analysis made?       Yes Two         Start Date 5-17-2014       Completed Date 5-21-2         WELL CONSTRUCTION CERTIFICATION:       I constructed and/or accept responsibility for construction of this well, and its compliance wi         Washington well construction standards.       Materials used and the information reported above are true to my best knowledge and belief.         Driller Dengineer Trainee Name (Print)       Drilling Company Tr; ple A Dr: 11ing Inc.         Driller or trainee License No.       1224         City, State, Zip       City, State, Zip         Contractorie       Contractorie	Artesian flow g.p.m. Date		
WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance wi         Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.         Driller □ Engineer □ Trainee Name (Print)       Drilling Company Tr; ple A Dr: 11ing Inc.         Driller/Engineer/Trainee Signature       Address P.O * B % 278         Driller or trainee License No       City, State, Zip Bubban K WA	Temperature of water 57° Was a chemical analysis made?  Yes 70	Start Date 5-17-2014 Completed Date	5-21-2014
In the first detroit station with the first detroit station with the first detroit station of the first detroit statio station of the first detroi	WELL CONSTRUCTION CERTIFICATION: I constructed and/or ac Washington well construction standards. Materials used and the informati	cept responsibility for construction of this well, and its co	ompliance with al
Driller/Engineer/Trainee Signature       Address P.O × B ox 2.78         Driller or trainee License No. 1224       City, State, Zip Burban K WA	washington wen consuluction standards. Materials used and the informati	Drilling Company Triple A Dri Ilina I	L.
Driller or trainee License No. <u>1224</u> City, State, Zip <u>Burban K</u> WA	Driller/Engineer/Trainee Signature	Address P.O. Box 278	
Contractor's	Driller or trainee License No. 1224	City, State, Zip Burbank WA	
IFTRAINEE, 1224 Contractor's	(IF TRAINEE, 1224	Contractor's	1
Driller's Licensed No Registration No. 7 RIPIdio 93BB Date 5-21.	Driller's Licensed No.	Registration No. 7KIPIdio 93BB Date	5-21-21

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

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

ECOLOGY	Unique Foology Wall ID Too No RL	IGA	91
Construction/Decommission ("x" in circle) JUN 25 2018	Water Right Permit No		<u>lla</u>
Decommission ORIGINAL INSTALLATION Notice Ecology	Property Owner Name MAR Tin F	trapped	
of Intent Number Central Regional Office	Well Street Address 18605 N. We	zher CA	-1 Aura
PROPOSED USE: A Domestic Industrial I Municipal	Wen Sureer Address <u>rocos rece</u>	of Tax	Pron ,
DeWater Irrigation Test Well Other	City Den on City County D	D 77ZEWN	1
TYPE OF WORK: Owner's number of well (if more than one)	Location 1/4-1/4-1/4 W 1/4 Sec 20 1 Win 1/0	Karre. or WWA	circle 4 one
Image: Seconditioned Method : Image: Dug Image: December of Cable     Image: Decem	Lat/Long (s, t, r Lat Deg Lat	Min/Sec _	- <b>.</b>
DIMENSIONS: Diameter of well <u>\$</u> inches, drilled <u>106</u> . ft. Depth of completed well <u>103</u> ft.	Still REQUIRED) Long Deg Lor	ng Min/Sec	3
CONSTRUCTION DETAILS	Tax Parcel No. / 287 / 5015	5454	/
Casing A Welded Diam. from ft. to ft. to ft. to ft.	CONSTRUCTION OR DECOMMISSION	PROCEDU	RE
Threaded "Diam. from ft. to ft.  Perforations: Dives M No. (	Formation: Describe by color, character, size of material and	structure, and the	he kind and
Type of perforator used	nature of the material in each stratum penetrated, with at least information. (USE ADDITIONAL SHEETS IF NECES	one entry for ea	ach change
SIZE of perfs in. by in. and no. of perfsfromft. toft.	MATERIAL	FROM	то
Screens: Yes X No K-Pac Location	BROWN SAND	0	38
Manufacturer's Name	BROWN SILTY CLAY	38	65
DiamSlot sizefromft. toft.	BROWN SILLA GRAyer	65	69
Diam. Slot size from ft. to ft.	COARSE CERAVER. HO	67	100
Gravel/Filter-packed:Yes Z No Size of gravel/sand Materials placed from ft. to ft.	Sandy Graveh	103	100
Material used in seal Did any strata contain unusable water? □ Yes ZNo			<u> </u>
Material used in seal			
Material used in seal		N	
Material used in seal       Jentenite         Did any strata contain unusable water?       I Yes         Type of water?       Depth of strata         whod of sealing strata off			
Material used in seal       Jenterial         Did any strata contain unusable water?       D Yes         Type of water?       Depth of strata         phod of sealing strata off			· · · · · · · · · · · · · · · · · · ·
Material used in seal Performer Yes the No Depth of strata Depth of strata thod of sealing strata off Depth of strata rUMP: Manufacturer's Name H.P H.P H.P H.P H.P H.P Artesian pressure ft. below top of well ft. Static level ft. below top of well ft. Static level ft. below top of well ft. Artesian pressure Ibs. per square inchr Date Artesian water is controlled by (cap, valve, etc.)			
Material used in seal Yes			
Material used in seal       Jentember 9         Did any strata contain unusable water?       Pes         Did any strata contain unusable water?       Depth of strata         Type of water?       Depth of strata         ihod of sealing strata off			
Material used in seal       Jewlewite         Did any strata contain unusable water?       If Yes         Type of water?       Depth of strata         inhod of sealing strata off			
Material used in seal       Jewlewite         Did any strata contain unusable water?       If Yes         Did any strata contain unusable water?       Depth of strata         Type of water?       Depth of strata         ihod of sealing strata off			
Material used in seal       Jentember 9         Did any strata contain unusable water?       Pes         Did any strata contain unusable water?       Depth of strata         Type of water?       Depth of strata         ithod of sealing strata off			
Material used in seal       Device of sealing strata contain unusable water?       If Yes         Did any strata contain unusable water?       Depth of strata         Type of water?       Depth of strata         phod of sealing strata off			
Material used in seal			
Material used in seal       Device         Did any strata contain unusable water?       If Yes         Type of water?       Depth of strata         ithod of sealing strata off			
Material used in seal       Device         Did any strata contain unusable water?       If Yes         Type of water?       Depth of strata         ihod of sealing strata off			
Material used in seal       Device for the second sec			
Material used in seal			
Material used in seal		ed Date _	
Material used in seal       Image: Content in the set of th	Start Date Jone 12/18 Complete coept responsibility for construction of this well, and	ed Date	
Material used in seal   Did any strata contain unusable water?   Did any strata contain unusable water?   Pye of water?   Depth of strata   Phod of sealing strata off   PUMP: Manufacturer's Name   Type:   WATER LEVELS: Land-surface elevation above mean sea level   Artesian pressure   Ibs. 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 A No If yes, by whom? 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 Water Level Time Water Level Water Level Time </td <td>Start Date Jone 12/19 Complete cept responsibility for construction of this well, and on reported above are true to my best knowledge at</td> <td>ed Date <u>Sec</u> d its complia pd belief.</td> <td></td>	Start Date Jone 12/19 Complete cept responsibility for construction of this well, and on reported above are true to my best knowledge at	ed Date <u>Sec</u> d its complia pd belief.	
Material used in seal	Start Date <u>Jone 12/19</u> Complete cept responsibility for construction of this well, and on reported above are true to my best knowledge as Drilling Company <u>Johns Jone</u>	ed Date	nce with
Material used in seal	Start Date <u>Jone 12/19</u> Complete Complete Complete Complete Complete Address <u>2019</u> Butther K	ed Date	$\frac{1}{1}$

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

WATER WELL REPORT	CURRENT NULS A C COLL	
Original & 1 <sup>st</sup> copy - Ecology, 2 <sup>nd</sup> copy - owner, 3 <sup>rd</sup> copy - driller	Notice of Intent No. W309929	
ECOLOGY Construction/Decommission ("x" in circle)	Unique Ecology Well ID Tag No. BIW	804
Construction	Water Right Permit No	<u>.</u>
Decommission ORIGINAL INSTALLATION	Water Hight remit to Star Jacob Jus	SIA
Notice of Intent Number	Property Owner Name	
PROPOSED USE: Domestic Industrial Municipal	Well Street Address OFF 15Hager (1	myon Ka
Dewater Imgation Itest wen I Other	City Kennewick County 3ert	on-03-
TYPE OF WORK: Owner's number of well (if more than one)	Location 5114-1/4 Sec 12 Twn 8 R 2	J EWM 🕊
Deepened Cable Rotary Jetted	(s, t, r Still REQUIRED)	Or WWM
DIMENSIONS: Diameter of well inches, drilled	Lat/Long	
CONSTRUCTION DETAILS	Lat Deg Lat Min/So	
Casing Welded X " Diam from 72 ft to 520	Long Deg Long Min/	sec
Installed: Liner installed Diam. from ft. to @	Tax parcel No. (Required)	00-0001-000
Threaded Tiam. From ft. to 8.9 ft.	8 <u></u>	
Perforations: Ves No	CONSTRUCTION OR DECOMMISSION	PROCEDURE erial and structure
Type of perforator used	and the kind and nature of the material in each stratu	m penetrated, with at
SiZE of perfs Kin. by in. and no. of perfs from from from from from from from from	least one entry for each change of information. (USI	E ADDITIONAL
Manufacturer's Name	MATERIAL I	ROM TO
Type Model No	5011	0 //
DiamSlot sizefromft. toft.	Rlock Basalt	11 700
Gravel/Filter packed: Ves No Size of gravel/sand	BIACK DAST	260
Materials placed fromft. toft.	RED BASALT	260 310
Surface Seal: Yes No ToAvhardepth? Oft.	Plack Bacalt.	2/0 280
Material used in seal	BINCK DASAIT	510 300
Type of water? Depth of strata	BROKEN BASALT	380 390
Method of sealing strata off	Rich Passill	420
PUMP: Manufacturer's Name	STACK BASAIT :	570 730
WATER LEVELS: Land-surface elevation above mean sea level ft.	TAN MAY 4	730 480
Static level 140 ft, below top of well Date 7-7- 2017		
Artesian pressure lbs. per square inch Date	Blue CIRY	180 510
Artesian water is controlled by (cap, valve, etc.) WELL TESTS: Drawdown is amount water level is lowered below static level	Black Baralt &	70 120
Was a pump test made?  Yes No If yes, by whom?	DIACK OBSATT S	10 600
Yield:gal./min. withft. drawdown afterhrs.	BROKEN BASAIT	20 623
Yield:     gal/min, with     ft, drawdown after     nrs.       Vield:     gal/min, with     ft, drawdown after     hrs.	Black Block 14	53 186
Recovery data (time taken as zero when pump turned off) (water level measured from	DIACK DIPSATT 6	523 600
well top to water level)	VOID	86 690
Time water Level Time water Level Time water Level	Alect Decalt	100 7/10
	BIACK BASHIT	- 90 140
	HABARK BLUESCAMS	740 775
Date of test	Alex plackA and I	872
Bailer tesgal/min. withft_drawdown after hrs.	V BERLINDAT	15 020
Airtest gal/min, with stem set a 14. for hrs.	RIACH ANSALL	50 070 FUA 850
Artesian flow g.p.m. Date	(717 7	717
Temperature of water Was a chemical analysis made? 🗌 Yes 🗌 No	Start Date 6 Completed Date	-/-//

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 ADDCO	Drilling Company	R.W. COX DRILLIN	G LLC.	
Driller/Engineer/Trainee Signature	Address	P.O. BOX 5324		
Driller or trainee License No.	City, State, Zip	<b>BENTON CITY, WA</b>	99320	
IF TRAINEE: Driller's License No:	Contractor's			
Driller's Signature:	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 Refur Service at 714. Persons with speech disability may call TTY at 877-833-6341.

JUL 13 2017

Dept of Ecology Central Regional Office

File Original and	First Copy	with	WATER W		ORI	Start Card No. Wie	0334	
Second Copy - (	cology Dwpers Col		STATE OF	WASHINGTON		UNIQUE WELL I.D. #	EAS	86
Third Copy - Dril	ler's Copy	by 650				Water Right Permit No		
OWNER:	Name	Gerald	Hagen	A	Address	65114 E. Solar Rd PR	NE BE	enton City,
(2) LOCATIO	N OF WEL	L: County _Be	nton	· · · · · · · · · · · · · · · · · · ·	N	E 1/4 _SW 1/4 Sec 31 T 9		28 C.WM
(2a) STREET A	DDRESS	OF WELL: (or neares	t address)	otl Shor	-t	got 1201		L
(3) PROPOSE	ED USE:	BC Domestic	<ul> <li>Industrial</li> <li>Test Well</li> </ul>	□ Municipal □ Other		(10) WELL LOG or ABANDONMENT PROCE Formation: Describe by color, character, size of r and the kind and nature of the material in each st	DURE DESC material and s	CRIPTION Structure, ated, with at
4) TYPE OF	WORK:	Owner's number of	well (if more than one)	)		least one entry for each change of information.		
		Deepened Reconditioned	□ Dug □ Cable	Bored Driven	È	Ottop Soil	0''	6''
	DNS:	Diameter of well	Rótary	Jetted inc	ches	Broken + Decomposed Base IT	6''	160
Drilled 4	25	feet. Depth of com	pleted well 47	25	ft.	Hard Black Basalt	160	322'
) CONSTRU Casing In	JCTION DE stailed:	TAILS			$\neg$	Med Hard Gray Basalt	322	461
D Welded □ Liner in	i stalled	<u> </u>	Diam. from Diam. from	ft. to <u>160</u> ft. to	ft	(hater)		102
Perforatio	eo 			II. IO	"	(	<u> </u>	
Type of pe	rforator use	ed <u>5k;11</u>	San	3				
SIZE of pe	norations	<u>40</u> perfora	in. by Itions from <u>385</u>	ft. to <u>425</u>	_ in			
		perfora	itions from	_ ft. to _ ft. to	ft. ft.	<u> </u>	+	
Screens:		□ Yes Ba No			[		Eu	
Manufactu	rer's Name				H		- <u>/ ×</u>	AR CO
Type Diam		 Slot size	Model N from	0		RECEIVE	6	Bin HC
Diam		Slot size	from	_ ft. to	ft.		12	E a
Gravel pa	cked:	🗆 Yes 🕅 No	Size of gravel			FEB 2 3 1999		
Surface of			To what dopth?	<u> </u>	-""	DEPARTMENT OF ECOLOGY		
Material us	ed in seal	Gentan t	<u>د</u>		<u> </u>			<u>}</u>
Did any str Type of wa	ata contain Iter?	unusuable water?	Yes No Deoth of str	ata				
Method of	sealing stra	ita off						<u></u>
PUMP: M	anufacturer	's Name						
Type:				H.P			<u> </u>	<u> </u>
) WATER L Static level Artesian pr	EVELS: 12 	S	above mean sea level _ ft. below top of well lbs, per square inch	Date 6-29-99	<b>9</b> <sup>n.</sup>	Work Started <u>8<sup>,</sup> 24</u> , 19 <u>98</u> . Complete	d <u>8-29</u>	<b>7</b> _, 19 <b>_98</b>
Artesian w	ater is conti	rolled by	(Cap, valve, etc.)			WELL CONSTRUCTION CERTIFICATION:		
) WELL TES Was a pun	STS: Draw	down is amount water le? 🖉 Yes 🗖 No	level is lowered below If yes, by whom?	w static level		I constructed and/or accept responsibility for co compliance with all Washington well construction and the information reported above are true to	Instruction of In standards.	this well, and its Materials used
Yield: _ <b>24</b>	<i>p</i> +	_gal./min. with	ft. drawdow ft. drawdow	n afterf	hrs. hrs.	NAME Triple A Drilling.	Inc:	
Yield:	toto /time to	gal./min. with	ft. drawdow	n afterh	hrs.	(Person, Firm, or Corporation)	(Type of Pri	nt)
necovery of top to wate Time	r level) Water Le	vel Time	Water Level	Time Water Lev	vel	(Signed) And C. Clance	License No	1224
B	0 to 1	+ By	fir Ro:	tary		Contractor's Registration No. TREPLADOI 25B	PDate	, 19
Date of tes Bailer test	t	gal./min. with	ft. dra	wdown after	_hrs.	(USE ADDITIONAL SHEETS II	F NECESSAF	RY)
Attesian flo	w	yai/min. with stel	g.p.m				A ati	war Faaraati
Temperatu	re of water	<u> </u>	chemical analysis ma	de? 🗆 Yes 🏾 🎗 No	0	Ecology is an Equal Opportunity and Affirmative accommodation needs, contact the Water Reso 6600. The TDD number is (360) 407-6006.	urces Progra	oyer. Hor special m at (360) 407-

ECY 050-1-20 (7/97)

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File Original and First Copy with Department of Ecology Second Copy — Owner's Copy Third Copy — Driller's Copy	WATER WI STATE OF	ELL REPORT	Start Card No.		15
(1) OWNER: Name Dane G	amer	Water Right Pen	THE NO.	Van	077
(2) LOCATION OF WELL: COUNTY BENTO	$\sim$			_NGAU	<u></u>
(2a) STREET ADDRESS OF WELL (or nearest active	eo)			<u> </u>	<u>28</u> E
(3) PROPOSED USE: V Domestic Ind				A_,	8, 6,
Intigation "~~ DeWater Tes	t Wetl 🗌 Other 🗆	(10) WELL LOG or ABANDO	NMENT PROCEDURE	DESCRIP	TION
(4) TYPE OF WORK: Owner's number of well (If more than one)		and the kind and nature of the material i change of information.	acte of material and structure, i n each stratum penetrated, w	and show thickr ith at least one	entry for
Abandoned I New well 15. Metho Despensed I	xd: Dug 🗋 🛛 Bored 🗖	MATERIAL		FROM	T
Reconditioned  (5) DIMENSIONS: Dimensional	Rotary Jetted	SUI An C	andy	0	6
Drilled 224 test. Depth of completed well	Inches.	Gravel, Sand	AU	65	81
(6) CONSTRUCTION DETAILS:	14	GRUED, SAND TO	n sult	91	83
Welded 0 Diam. from Diam. from	<u> </u>	Sett Tim		92	ac
inneeded* Diam. from	t.uct.	Cour A-		1 3	
Perforations: Yes No 😰		Gravel Sand I	th	94	21
SIZE of performance in. b	 У In	Basalt Black JC	Dintel	2/3	219
perforations from	_ ft. toft.	Base It Dluck			
perforations from	_t.iot.	LASSIN BUILD		1218	222
Screens: Yes No	η.	Boxit Black J	autel	20	279
Manufacturer's Name		uner lixan			
Diem Slot size from	Model No			++	
Diam Slot sizefrom	t.uot. t.uo +		VE DI	┼╾──┦	
Gravel packed: Yes No 🕅 Size of gra	avel				
Gravel placed from ft. to	h.	╼──── <del>╿<u>╟</u>╢┦──╖╖╶┷╌╷</del> ╸			
Surface seel: Yes No Tayonal deprint	m? <u>25 n</u> .				
Did any strate contain unusable water? Yes A	ю []	DEPASTMENT OF	C C C C C C C C C C C C C C C C C C C		
Type of water?	Depth of strata		UTTICE	┠╼──╁	
Type:				—— <u> </u>	
WATER LEVELS: Land-surface elevation					
Static level / below top	of well Date 7-27-64	Work Started	19 Completed	19	$\mathcal{A}$
Artesian water is controlled by	einch Date	WELL CONSTRUCTOR CERTIF	ICATION:	_	
WELL TESTS: Dent	Cap, valve, etc.)	I constructed and/or accept resp compliance with all Washington w	onsibility for construction	of this well,	and its
Was a pump test made? Yes No I if yes I	wered below static level	the information reported above are	true to my bast knowledge	and belief.	ed and
Yield: gal./min. with ft. draw	volown after hra.	NAME ABOULDE	l (hille	2 Du	c
11 11	11 11	(MERSIAN, FIRM O	R CORPORATIONIT (TYPE OR P	nem //	
Recovery data (time taken as text)		AUTORS CALL	My and	Iax	<u>Ş</u>
top to water level) Time Water Level Time Mater Level	water level measured from well	(Signed)	License	No. He	<u> </u>
	Time Water Lovel	Contractoria	-	-	•
		Registration Lyce DI asur	7-10		<b>9</b> ∨
Date of test		(USE ADDITIONAL OF		19	5
Bailer testh. draw	down after hrs			TY)	
Artesian flow	D. 11. for hrs	Ecology is an Equal Opportunity an	nd Affirmative Action en	NDIOVER E	
Temperature of water Was a chemical analysis mar		407-6600 The TDD summeds, contact	the Water Resources (	Program at (	a, a- (206)
250-1-20 (9493) ** (		206 Number is (206	5) <b>4</b> 07- <b>6006</b> .		r

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

#### WATER WELL REPORT

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STATE OF WASHINGTON

Application No Permit No. ....

	(1)	OWNER: Name Duane Garner	Address P. O. Box 6538 - Kennewick	c	.,99336
ť	(2)	LOCATION OF WELL: County Benton -	- JE1 V -14 Sec 16 T 8		8 w.w.
8	1	ing and distance from section or subdivision corner Short Plat	650 Lot 1		
Å	(3)	PROPOSED USE: Domestic D Industrial [] Municipal	(10) WELL LOG:		
_	(0)	Irrigation 🗌 Test Well 🗋 Other	Formation: Describe by color, character, size of material a	ind struc	ture, and
Š			show inconess of aquifers and the kind and nature of the stratum penetrated, with at least one entry for each char	nge of f	rmation.
ر م	(4)	TIPE OF WORK: (if more than one)	MATERIAL	FROM	то
Ë		New well 🔄 Method: Dug 📋 Bored 🗋	Sand	0	
			Small gravel	5	8
Š	-		Harapan and gravel	8	22
0	(5)	DIMENSIONS: Diameter of weil6inches.	Clay and sand	22	40
		Drilled 120 ft. Depth of completed well 120 ft.	Silt	40	60
Ľ			Silt some gravel 4	50	75
a	(6)	CONSTRUCTION DETAILS:		76	<u> </u>
Ε		Casing installed: 6 " plan from +1 to to 10/4 to			01
		Threaded [] "Diam from # to	CODDIes and Doulders 2		00
Ĕ		Welded	Silt	56	100
			Gravel 1" plus	100	120_
<u>e</u>		Perforations: Yes 🗆 No 🖅		- T	_
		Type of perforator used			
<u> </u>		SIZE of perforations in. by in.			
٥		perforations from			
ס		ft. to ft.			
Ĕ		Screens: Yes A No			
ĥ		Manufacturer's Name Hydrophillc			
-		TypePlastic			
Ĕ		Diam,			
		Diam. J. Siot size . City Troin			
2		Gravel packed: yes I No K Size of gravel:		, 1	
		Gravel placed from the to the state of the s		<u>-</u>	·
no -					
		Surface seal: Yes No D To what depth? 18 ft.			
Ž		Material used in sealBentonite			
		Did any strata contain unusable water? Yes 🗌 No 🙀			
5		Type of water? Depth of strata		· · · · · · · · · · · · · · · · · · ·	
5		Method of sealing strata off			
~	77)				
Ű	(1)	I UNII : Manufacturer 5 Name			
<u>o</u>		Туре:			
	(8)	WATER LEVELS: Land-surface elevation			
N N	<u> </u>	above mean sea reven			
ŏ.	3.44	tion pressure lbs per source inch Date			
5	~	Artesian water is controlled by			
5		(Cap, valve, etc.)			
Ц	(0)	WET I TECTS. Drawdown is amount water level is	<u>  </u>		
5	(9)	WELL IESTS: lowered below static level	Work started 2 - 2	12	17.9
5	Waa	a pump test made? Yes E No I If yes, by whom? I no mpson	WELL DELLED'S STATEMENT.		
	Yiel	$\frac{d}{20}$ gal./min. with $\frac{d}{d}$ ft. drawdown after $\frac{d}{4}$ hrs.	WELL DRILLERS STATEMENT:		
Ĕ			This well was drilled under my jurisdiction an	d this 1	eport is
3		р в d	true to the best of my knowledge and belief.		
a	Reco	overy data (time taken as zero when pump turned off) (water level			
ā.	-7-4 -7-4	me Water Level   Time Water Level   Time Water Level	NAME B & H Drillig		
ĸ	1.	nm 55*	(rerson, firm, or corporation) (Ty	pe or pr	int)
	ት		Address Rt. 3 Box 3365A - Kennewic	ck. W	n. 9933
9			, 17 1	<b>.</b>	
-			20 R. VIV.		
	<b>n</b> -**	Date of test	[Signed] The of the Million	<u>.</u>	
	1381) A -4-	er test	(weit Dritter)		
	Tem	nerature of water	License No. 0046 Date 3 - 1	12	. 19.7.9.
	* c10	horizon er alemanisken som a mennen medden menner ver D. 1000	I		

WATER WELL REPORT	CURRENT Notice of Intent No. (4)256 469
Construction Mecommission ("x" in circle)	Unique Ecology Well ID Tag No. VAC 75
Construction 376488	Water Right Permit No ABCH
O Decommission ORIGINAL INSTALLATION Notice	Property Origin Volume Deville V. of Da
of Intent Number	Property Owner Name 172112 DECUTY
	Well Street Address <u>AUDL Jo TD 3 CD JE</u>
DeWater     Irrigation     Test Well     Other	City <u>Representation</u> County <u>Benton</u>
TYPE OF WORK: Owner's number of well (if more than one)	Useditori
Image: Method     Image: December of the second secon	Lat/Long (s, t, r Lat Deg Lat Min/Sec
DIMENSIONS: Diameter of well ( inches, drilled 1785 ft.	Still <b>REQUIRED</b> ) Long Deg Long Min/Sec
CONSTRUCTION DETAILS	Tax Parcel No. / 21855-101-66000
Casing $\mathbb{Z}$ Welded (6." Diam from + 1 ft to $177/2ft$	
Installed: Liner installed Diam. from ft. to ft. to ft. to ft. to ft. to ft.	CONSTRUCTION OR DECOMMISSION PROCEDURE
Perforations: I Yes Z No	and the kind and nature of the material in each stratum penetrated, with at least one entry for each change
Type of perforator used	information (USE ADDITIONAL SHEETS IF NECESSARY.)
SIZE of perfs in. by in. and no. of perfsfromft. toft.	MATERIAL FROM TO
Screens: Li Yes X No Li K-Pac Location	TOSILT \$ SAMP 0 14
Type Model No	TAN CLAY 14 23
DiamSlot sizefromft. toft.	TAN SILT 23 32
DiamSlot sizefromft. toft.	TAN SILT & SAND 32 87
Gravel/Filter packed: C Yes Zer No C Size of gravel/sand	TAN 514T 47 21
35	TAN SILT & BATALT GRAVELS 71 78
Surface Seal: X Yes I No To what depth? / / / / / / ft.	TAN 51LT. 78 96
Material used in seal <u>BENTONITE</u> E CHISTOCI	TAJ SILT, SAJ) & BRAVELAR 96 122
Did any strata contain unusable water? LI Yes & No	6REY 5A-D HO 122 125
Depin of strata	TAN SAND & GILAVEL HO 125 177
DI MD. Manufacturar's Name	
Type:H.P	
WATER LEVELS: Land-surface elevation above mean sea level ft	- <u>· · · · · · · · · · · · · · · · · · ·</u>
Static level 25 ft. below top of well Date 8/24/07	76 1000 0 120
Artesian pressure lbs. per square inchr Date	$13 \text{ GPm} \approx 140$
Artesian water is controlled by	100 6111 20 140
(cap, valve, etc.)	1 SO GMM Control All Process
WELL TESTS: Drawdown is amount water level is lowered below static level	
Was a pump test made? 🛛 Yes 🕱 No If yes, by whom?	Nov
Yield:gal./min. withft. drawdown afterhrs. Yield:gal./min. withft. drawdown afterhrs.	
Yield:gal./min. withft. drawdown afterhrs.	
Recovery data (time taken as zero when pump turned off) (water level measured from well	A Dimosi Of
iop to water level Time Water Level Time Water Level	EFECOLUCY MUNICIPALITY
	A CONTRACTOR
· · · · ·	A A A A A A A A A A A A A A A A A A A
Date of test	7 A 100 E
Bailer test gal./min. with ft. drawdown after hrs.	
Airtest 150 gal/min. with stem set at 160 ft. for 2 hrs.	a service
Artesian flow g.p.m. Date	Scar RAL M
Temperature of water Was a chemical analysis made? Ves D No	
	Start Date 8/22/07 Completed Date 8/24/0
VELL CONSTRUCTION CERTIFICATION: I constructed and/or ac Vashington well construction standards. Materials used and the informati Coriller  Engineer  Trainee Name (Print)	ccept responsibility for construction of this well, and its compliance with ion reported above are true to my best knowledge and belief. 
riller/Engineer/Trainee Signature	Address 7505 W. COURT ST.
riller or trainee License No	City, State, Zip <u>PASCO WA 9930</u>
f TRAINEE.	Contractor's
Jriller's Licensed No.	Registration No. NELSOWN 198 CQ Date 8/27 /0
Priller's Signature	Ecology is an Equal Opportunity Employ

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Driller's Signature

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

WATER WELL REPORT	CURRENT	
Original & 1st copy - Ecology, 2nd copy - owner, 3rd copy - driller	Notice of Intent No. <u>WEST918</u>	
ECOLOGY Construction/Decommission ("x" in circle)	Unique Ecology Well ID Tag No. <u>ISLIVOO 1</u>	
Construction	Water Right Permit No.	
Decommission ORIGINAL INSTALLATION Notice of Intent Number	Property Owner Name Kennewick Irrigation Dis	shict
PROPOSED USE:       Domestic       Industrial       Municipal         DeWater       Irrigation       Test Well       Other	Well Street Address	
TVPE OF WORK: Owner's number of well (if more than one) 3	City <u>retrievent</u> county <u>state</u>	
New well       Reconditioned       Method :       Dug       Bored       Driven         Deepened       Cable       Deepened       Jetted	$\begin{array}{c} \text{Location } \frac{3E}{1/4} - \frac{1}{4} \frac{NE}{NE} \frac{1}{4} & \text{Sec } \frac{1}{6}  \text{Iwn } \frac{4N}{NE}  \text{R}  \frac{1}{230}  \text{Ew} \\ \text{(s, t, r Still REQUIRED)} & Or \\ WW \end{array}$	
DIMENSIONS: Diameter of well 16 inches, drilled 193 ft.	Lat/Long	
Depth of completed well 192 ft.	Lat Deg Lat Min/Sec	
CONSTRUCTION DETAILS	Long Deg Long Min/Sec	
Casing       Welded $(b)$ " Diam. from $+$ 5 ft. to $-10.5$ ft.         Installed:       Liner installed       " Diam. fromft. toft.         Threaded       " Diam. Fromft. toft.	Tax parcel No. (Required) 1168810 20001001	
Perforations: Yes No	CONSTRUCTION OR DECOMMISSION PROCEDU	URE
Type of perforator used	Formation: Describe by color, character, size of material and str	ucture,
SIZE of perfs in, by in, and no, of perfs from ft. to ft.	and the kind and nature of the material in each stratum penetrate	a, with a
Screens: X Yes No X K-Pac Location 176	SHEETS IF NECESSARY.)	
Manufacturer's Name Alloy Screens	MATERIAL FROM	TO
Type Stainless steel Model No.	silt, sand, small grow 0	24
Diam. <u>14</u> Slot size $\frac{30}{100}$ from $\frac{139}{189}$ ft. to $\frac{119}{119}$ ft.	cemented gravel 29	68
Diam. Slot size from ft. to ft.	small / midlum graul 68	168
Gravel/Filter packed: Yes No Size of gravel/sand	medium gravel (water) 108	104
Materials placed from ft. to ft.	(trace sure 168-169)	1/12
Surface Seal: IS: Yes       No       To what depth? ft.         Material used in seal       Must Compart          Did any strata contain unusable water?       Yes       Xo         Type of water?       Depth of strata		
PUMP: Manufacturer's Name	RECEIVED	
Type: H.P	a some week loom is W form loop	
WATER LEVELS: Land-surface elevation above mean sea level ft ft static level $1/23$ ft below top of well Date $9/10/18$	DEC 07 2018	
Artesian pressure lbs. per square inch Date	Dept of Ecology	
Artesian water is controlled by (cap, valve, etc.)	Central Regional Office	
WELL TESTS: Drawdown is amount water level is lowered below static level		
Was a pump test made? If yes I No If yes, by whom? BJE		
Yield: 170 gal/min. with 20 ft. drawdown after 1 hrs.		
Yield: <b>330</b> gal/min. with <u>40</u> ft. drawdown after <u>1</u> 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		
2 160 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 Z hrs.		
Artesian flow g.p.m. Date		
Temperature of water 64 Was a chemical analysis made? 1 Yes 1 No	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 Dengineer Trainee Name (Print) Denk Vahanian	Drilling Company Blue Stor Enterprises NW
Driller/Engineer/Trainee Signature	Address Zola Bather loop
Driller or trainee License No. 3189	City, State, Zip Richland, WA, 99354
IF TRAINEE: Driller's License No:	Contractor's the contract of the contractor's
Driller's Signature:	Registration No. BLUESEN 942 KM 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	CURRENT	ETIOT	1
Original & 1st copy - Ecology, 2nd copy - owner, 3rd copy - driller	Notice of Intent No.	OPE	•
Construction/Decommission ("x" in circle)	Unique Ecology Well ID Tag No. <u>BKB</u>	005	
Seconstruction	Water Right Permit No.		
O Decommission ORIGINAL INSTALLATION Notice	Property Owner Name Kennewick Inig	ation D	istrict
oj imeni ivanoer	Well Street Address		
PROPOSED USE: Domestic , Industrial Municipal	City Kennewick County Ben	ton	
	Location SE 1/4-1/4 NE 1/4 Sec 16 Twn 8N	RZSE EN	circle
TYPE OF WORK:       Owner's number of well (if more than one)         Ps. New well       Reconditioned       Method :       Dug       Bored       Driven         Deepened       Cable       Drate       Jetted	Lat/Long (s, t, r Lat Deg Lat	Min/Sec _	1 one
DIMENSIONS: Diameter of well 16 inches, drilled 200 ft.	Still REQUIRED) Long Dog Log	a Min/Sac	
Depth of completed well <u>197</u> ft. CONSTRUCTION DETAILS <u>172</u>	Tax Parcel No. 11688102000000	ig wiin/sec	·
Casing AWelded <u>16</u> " Diam. from <u>+</u> Z ft. to <u>+</u> T, ft.			
Installed: Dharn fromft. toft.	CONSTRUCTION OR DECOMMISSION	PROCEDU	RE
Perforations: I Yes D-No	nature of the material in each stratum penetrated, with at least	structure, and the one entry for ea	he kind and ich change of
Type of perforator used	information. (USE ADDITIONAL SHEETS IF NECES	SARY.)	
Screens: $B$ -Yes $\Box$ No $B$ -K-Pac Location $i72 - 162$	MATERIAL	FROM	TO
Manufacturer's Name	sitt/ Savid	13	10
Type Stoppless steel Model No.	sand sand	14	7.9
Diam. 1411 Slot size 100 from 178 ft. to 193 ft.	Sanda Lunk clan	79	39
Gravel/Filter packed:  Yes  No Size of gravel/sand	Sandy tun club/small	39	49
Materials placed fromft. toft.	grunel ,		
Surface Seal: 🕅 Yes 🗆 No To what depth? 🔽 ft.	caliche m/ small gravel	44	59
Material used in seal portland cement	pea gravel	54	95
Did any strata contain unusable water? 🛛 Yes 🔂 No	'small gravel ( warse sand	95	120
Type of water?	pea gravel of brown silty	120	148
PIIMP. Manufacturer's Name	clay 1 1	ind	100
Type:H.P	Shand and miciam gravel	148	171
WATER LEVELS: Land-surface elevation above mean sea level ft.	medium around sand	171	195
Static level ft. below top of well Date	(water)		
Artesian pressure lbs. per square inchr Date	black/brown weathered busalt	195	197
Artesian water is controlled by (cap, valve, etc.)	bluck basalt some tan clay	197	200
WELL TESTS: Drawdown is amount water level is lowered below static level			
Was a pump test made? 🖉 Yes 🛛 No If yes, by whom?			
Yield: <u>200</u> gal./min. with <b>12</b> ft. drawdown after <b>1</b> hrs.			
Yield:gal/min. with ft. drawdown after hrs.			
Recovery data (time taken as zero when pump turned off) (water level measured from well	Pre		
Time Water Level Time Water Level Time Water Level	ECEIVE.		
	Alle	)	
	AUG 0 2 2010	*-	
Date of test6/6/18	Dept pt pt pt		
Bailer test gal./min. withft. drawdown afterhrs.	entral Regions		
Airtest gal./min. with stem set atft. forhrs.	Office		<u> </u>
Artesian flow g.p.m. Date			
Temperature of water 6 Was a chemical analysis made? Ves 2 No	Start Date 4/19/18 Complete		4/18
VELL CONSTRUCTION CERTIFICATION: I constructed and/or acc	cept responsibility for construction of this well, and	t its compliand belief	ince with all
Poiller D Engineer D Trainee Name (Print) Descal Underlais used and the information	Drilling Company Rive, Star Ester	iovises N	orthlabet
riller/Engineer/Trainee Signature Da Loch	Address 2019 Butlar LOOD	1.0000	
riller or trainee License No. 3189	City, State, Zip Richland WA 9	9358	
	Contractor's		
riller's Licensed No.	Registration No. BLUESEN942 RM	Date 7/3	30/18
Jriller's Signature	Ecology is an	Equal Opportur	nity Employer.

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

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 & 1 <sup>st</sup> copy – Ecology, 2 <sup>nd</sup> copy – owner, 3 <sup>nd</sup> copy – driller
ECOLOGY Construction/Decommission (" $x$ " in circle) State of Washington Construction
Decommission ORIGINAL INSTALLATION
PROPOSED USE:          \[             Domestic         \[             Dimestic         \[             Dimestic         \[             Dimestic         \[             Dimestic         \[             Industrial         \[             Municipal         \[             DeWater         \[             Irrigation         \[             Test Well         \[             Other         \[             Dimestic         \[             Dimestic         \[             Dimestic         \[             Dimestic         \[             Industrial         \[             Municipal         \[             Dimestic         \]         \[             Dimestic         \[             Dimestic         \[             Dimestic         \]         \[             Dimestic         \[             Dimestic         \]         \[             Dimestic         \]         \[
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 <u>8</u> inches, drilled <u>461</u> ft. Depth of completed well <u>461</u> ft.
CONSTRUCTION DETAILS Casing X Welded 8" Diam from +2 ft to 100 ft
Installed: $\square$ Liner installed <u>pvc4.5</u> " Diam. from <u>5</u> ft. to <u>456</u> ft.
Threaded Diam. From ft. to ft.
Transformations: N Yes No
SIZE of perfortation by 6 in and no of parts 40 from 4360 to 4560
Size of peris 170m, by 0 m, and no. of peris 40 mm 450m, to 450m.
Manufacturer's Name
Type Model No
DiamSlot size from ft. to ft.
Diam. Slot size from ft. to ft.
Materials placed fromf. toft.
Surface Seal: Yes INO To what depth? 20ft.
Material used in seal <b>bentonite</b>
Type of water? Depth of strata
Method of sealing strata off
PUMP: Manufacturer's Name
Туре: Н.Р
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
Yield: gal/min. with fi. drawdown after hrs.
Yield:gal./min. withft. drawdown afterhrs.
Yield:gal./min. withft. drawdown afterhrs.
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 <u>50</u> gal/min, with stem set at <u>455</u> ft. for <u>2</u> hrs.
Artesian flow g.p.m. Date
Temperature of water $\underline{61}$ Was a chemical analysis made? $\Box$ Yes $\boxtimes$ 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 Mil	ls	
Well Street Address 30810 959 PRSE		
City Kennewick County Benta	on	
Location <u>SE1/4-1/4</u> <u>NW</u> 1/4 Sec <u>22</u> Twn <u>8</u> (s, t, r Still REQUIRED)	<u>N</u> R <u>28</u> EWM [ W	⊠ Or WM □
Lat Deg	Lat Min/Sec	
Long Deg	Long Min/Sec	-
CONSTRUCTION OR DECOMP Formation: Describe by color, character, s and the kind and nature of the material in least one entry for each change of informa SHEETS IF NECESSARY.)	MISSION PROCE ize of material and s each stratum penetra ttion. (USE ADDIT	DURE structure, ated, with at IONAL
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
R	ECEN	ED
J De	UN 22 20	118
Centra	al Regional (	gy Mice
Start Date 6/5/18 Completed Dat	e <u>6/11/18</u>	

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	Drilling Company StillWater LLC	
Driller/Engineer/Trainee Signature	Address 1118 N. Oregon Ave	
Driller or trainee License No. 3109	City, State, Zip Pasco	, Wa, 99301
IF TRAINEE: Driller's License No:	Contractor's	
Driller's Signature:	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.

	WATER WELL DEPODT	CURRENT		
	Original & 1 <sup>st</sup> copy - Ecology, 2 <sup>od</sup> copy - owner, 3 <sup>rd</sup> copy - driller	Natice of Intent No. WE19	035	
	DEPARTMENT OF	Unique Ecology Well ID Tag No Bla	w 6	47
E	Super Washington Construction Cho	Unique Ecology wen in Tag No		<u>E_l</u>
ă	Decommission ORIGINAL INSTALLATION	Water Right Permit No.	-0.0	P
Å.	Notice of Intent Number	Property Owner Name QV 424	MAPI	- 00 01
E	PROPOSED USE: Domestic Industrial Municipal	Well Street Address 23155	- 94	PRSE
Ð	DeWater Irrigation Test Well Other	City KENNEWICh County BE	NTON	<u> </u>
5	TYPE OF WORK: Owner's number of well (if more than one)	Location 1974-1/41/4 Sec 22Twn 8/	R 28	EWM
ŝ	Deepened Cable Rotary Jetted	(s, t, r Still REQUIRED)	-	OT
Þ	DIMENSIONS: Diameter of well inches, drilled /2.2 ft.			wwm Li
Ę	Depth of completed well <u>/ 2-2ft</u>	Lat/Long Lat Deg Lat Min	/Sec	
õ	CONSTRUCTION DETAILS	Long Deg Long M	in/Sec	-
5	Installed: Liner installed Diam. from ft. to ft.	Tax Parcel No. (Required) /2288	32013	18/012
ē	Threaded Threaded ft. to ft.			
2	Perforations: Yes No	CONSTRUCTION OR DECOMMISSIO	N PROCEDUR	E
Ξ	Type of perforator used	Formation: Describe by color, character, size of material a nature of the material in each stratum penetrated, with at l	east one entry for	each change
2	SIZE of perism. bym. and too. of perismomnt. tom.	of information. (USE ADDITIONAL SHEETS IF NECE	SSARY.)	
<u> </u>	Manufacturer's Name	MATERIAL	FROM	10
Ð	Type Model No	BA-WEAU RASAIS	127	115
8	DiamSlot size from ft. to ft.	TAN CLASS STO MG	11.6	122
Ē	Diam. Slot size from ft. to ft.	11010-20107-24 V		
Ś	Gravel/Filter packed: [] Yes A No Size of gravel/sand			
Z	Surface Seal- X Yes I No. To what denth? / X ft	·		
σ,	Material used in seal BENTONITE			+
22	Did any strata contain unusable water?			
ō	Type of water? Depth of strata			
	Method of sealing strata off	han have been a second s		
2	PUMP: Manufacturer's Name			
P	Туре: Н.Р			
5	WATER LEVELS: Land-surface elevation above mean sea level ft.			
S	Static level $\frac{45}{15}$ ft. below top of well Date $\frac{4725}{15}$	· · · · · · · · · · · · · · · · · · ·		
Ĕ	Artesian pressure lbs. per square inch Date			+
e	Artesian water is controlled by (cap, valve, etc.)			
5	WELL TESTS: Drawdown is amount water level is lowered below static level			
~	Was a pump test made? [] Yes [2] No if yes, by whom?	55 F 60/ 00		
¥	Yield:insit. drawdown afterins.	Ch color		
5	Yield:gal/min. withft. drawdown afterhrs.	S Receive		+
ğ	Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)	OCT 012014		
8	Time Water Level Time Water Level Time Water Level			
ž		Co. all		+
ğ		ANAL AEGU		
×	Date of test			
3	Bailer test gal/min, withft. drawdown afterhrs.			اــــــلِ
<u> </u>	Airtest @ O gal/min. with stem set at 120ft. for 1 hrs.	abolut	91.	20/11/
ð	Artesian flow g.p.m. Date	Start Date 7/2719 Completed	Date 1/0	2/18
Ħ	Temperature of water Was a chemical analysis made? U Yes No	<i>L</i>		X s
Ð			a with all 11/a-1	hington well
ε	WELL CONSTRUCTION CERTIFICATION: 1 constructed and/or accept resp	ponsibility for construction of this well, and its compliant	e with all was	mgon wen
Ę	construction standards. Materials used and the information reported above are	Drilling Commany FILLS STARI	Seuce	No
g	Driller/Engineer/Traince Signature	Address 36301 Hight	NAJE	2
D.	Driller or trainee License No. 12 2094	City, State, Zip ALADA W	0.19	7525

Registration No. FIVESDX-077 MBase Driller's Signature: 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.

IF TRAINEE: Driller's License No:

Contractor's

WATER WELL REPORT	Notice of Intent No. W244167
E C D L D C Y	Unique Ecology Well ID Tag No. APK 199
$\mathcal{O}$ Construction $\mathcal{O}$ $\mathcal{O}$ $\mathcal{O}$ $\mathcal{O}$ $\mathcal{O}$ $\mathcal{O}$ $\mathcal{O}$ $\mathcal{O}$	Water Right Permit No
O Decommission ORIGINAL INSTALLATION Notice	Read Regist Comments.
of Intent Number	Property Owner Name <u>APT 17001470</u>
	Well Street Address OFF 5. 9031752
PROPOSED USE:     Image: Domestic     Industrial     Municipal       DeWater     Irrigation     Test Well     Other	City <u>Mennewick</u> County <u>Benton</u> -03
TYPE OF WORK: Owner's number of well (if more than one)	Locationy 21/4-1/4/21/4 Sec. I'wn or circle
New well     Reconditioned     Method.     Dug     Bored     Driven     Cable     Rotary     Jetted	Lat/Long (s, t, r Lat Deg Lat Min/Sec
DIMENSIONS: Diameter of well inches, drilled ft. Depth of completed well 8ft.	Still <b>REQUIRED</b> ) Long Deg Long Min/Sec
CONSTRUCTION DETAILS	Tax Parcel No. 1-2/88-10/-1700-00
Casing Welded Diam. from 7 4 ft. to 1 3 8 ft. Installed: Unrer installed Diam. from ft. to ft.	CONSTRUCTION OR DECOMMISSION PROCEDURE
Perforations: Yes PNo	Formation Describe by color, character, size of material and structure, and the kind and
Type of perforator-used	nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)
Screens: Q Yes QNo C K-Pac Location	MATERIAL FROM TO
Manufacturer's Name	SOIL 0 48
Model No.	1395917 Gravel 28 52
DiamSlot sizefromft. toft. Gravel/Filter packed:  Uses PNo Size of gravel/sand	Brown clay Gravel 52 105
Surface Seal: DYes DNo To what depth? 20 ft.	hard white Class 105 134
Material used in sealBentonite	
Did any strata contain unusable water?	Gravels Water 134 148
Type of water? Depth of strata	
Method of sealing strata off	
PUMP: Manufacturer's Name	
WATED I EVELS. Land surface elevation above mean see level 0	
Static level 37 ft below top of well Date/7~28-07	
Artesian pressure Ibs. 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 numn test made? U Ves D No. If yes hy whom?	
Yield: gal /min, with ft, drawdown after hrs.	A UI LUCLOGI
Yield:gal./min. withft drawdown afterhrs.	A Heceiven
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	
	CAL REDOV
Date of test	
Bailer test gal/min. with ft: drawdown after ins.	
Airtest $\frac{1}{10+\text{gal}/\text{min}}$ , with stem set at $130$ ft. for $1$ hrs.	
Artesian flow g.p.m. Date	
Temperature of water Was a chemical analysis made?	Start Date / 2-36-07 Completed Date / 2-38-0
VELL CONSTRUCTION CERTIFICATION: I constructed and/or ac	cept responsibility for construction of this well, and its compliance with a on reported above are true to my best knowledge and belief
Vashington wen construction, standards. Aviateriais used and the information	Drilling Company BUIR AN MARINA MULTING
riller/Engineer/Trainee Signature	Address AID BIN 5324
riller or trainee License No	City State Zip Banton FILL MASh 993
	Contractor's
Driller's Licensed No.	Registration No. KW/INMDDJJC Date 12-28-
	- Constantion 100 - INV CO APOULATION - Date

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Ecology is an Equal Opportunity Employer

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

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

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

WATER WELL REPORT	Notice of Intent No. W244167
E C D L D C Y	Unique Ecology Well ID Tag No. APK 199
$\mathcal{O}$ Construction $\mathcal{O}$ $\mathcal{O}$ $\mathcal{O}$ $\mathcal{O}$ $\mathcal{O}$ $\mathcal{O}$ $\mathcal{O}$ $\mathcal{O}$	Water Right Permit No
O Decommission ORIGINAL INSTALLATION Notice	Read Regist Comments.
of Intent Number	Property Owner Name <u>APT) 17001470</u>
	Well Street Address OFF 5. 9031752
PROPOSED USE:     Image: Domestic     Industrial     Municipal       DeWater     Irrigation     Test Well     Other	City <u>Mennewick</u> County <u>Benton</u> -03
TYPE OF WORK: Owner's number of well (if more than one)	Locationy 21/4-1/4/21/4 Sec. I'wn or circle
New well     Reconditioned     Method.     Dug     Bored     Driven     Cable     Rotary     Jetted	Lat/Long (s, t, r Lat Deg Lat Min/Sec
DIMENSIONS: Diameter of well inches, drilled ft. Depth of completed well 8ft.	Still <b>REQUIRED</b> ) Long Deg Long Min/Sec
CONSTRUCTION DETAILS	Tax Parcel No. 1-2/88-10/-1700-00
Casing Welded Diam. from 7 4 ft. to 1 3 8 ft. Installed: Unrer installed Diam. from ft. to ft.	CONSTRUCTION OR DECOMMISSION PROCEDURE
Perforations: Yes PNo	Formation Describe by color, character, size of material and structure, and the kind and
Type of perforator-used	nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)
Screens: Q Yes QNo C K-Pac Location	MATERIAL FROM TO
Manufacturer's Name	SOIL 0 48
Model No.	1395917 Gravel 28 52
DiamSlot sizefromft. toft. Gravel/Filter packed:  Uses PNo Size of gravel/sand	Brown clay Gravel 52 105
Surface Seal: DYes DNo To what depth? 20 ft.	hard white Class 105 134
Material used in sealBentonite	
Did any strata contain unusable water?	Gravels Water 134 148
Type of water? Depth of strata	
Method of sealing strata off	
PUMP: Manufacturer's Name	
WATED I EVELS. Land surface elevation above mean see level 0	
Static level 37 ft below top of well Date/7~28-07	
Artesian pressure Ibs. 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 numn test made? U Ves D No. If yes hy whom?	
Yield: gal /min, with ft, drawdown after hrs.	A UI LUCLOGI
Yield:gal./min. withft drawdown afterhrs.	A Heceiven
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	
	CAL REDOV
Date of test	
Bailer test gal/min. with ft: drawdown after ins.	
Airtest $\frac{1}{10+\text{gal}/\text{min}}$ , with stem set at $130$ ft. for $1$ hrs.	
Artesian flow g.p.m. Date	
Temperature of water Was a chemical analysis made?	Start Date / 2-36-07 Completed Date / 2-38-0
VELL CONSTRUCTION CERTIFICATION: I constructed and/or ac	cept responsibility for construction of this well, and its compliance with a on reported above are true to my best knowledge and belief
Vashington wen construction, standards. Aviateriais used and the information	Drilling Company BUIR AN MARINA MULTING
riller/Engineer/Trainee Signature	Address AID BIN 5324
riller or trainee License No	City State Zip Banton FILL MASh 993
	Contractor's
Driller's Licensed No.	Registration No. KW/INMDDJJC Date 12-28-
	- Constantion 100 - INV CO APOULATION - Date

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

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

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

WATER WELL REPORT	CURRENT	
Original & 1 <sup>st</sup> copy - Ecology, 2 <sup>nd</sup> copy - owner, 3 <sup>nd</sup> copy - driller	Notice of Intent No. WE-24823	
ECOLOGY Construction/Decommission ("x" in circle)	Unique Ecology Well ID Tag No. 37F-938	
Construction	Water Right Permit No.	a .
Decommission ORIGINAL INSTALLATION	Property Queer Name Sea Coop	
Notice of Intent Number	The second secon	DOCE
DeWater     Irrigation     Test Well     Other	City Kennewyck County Beston	INC.
TYPE OF WORK: Owner's number of well (if more than one)	Lasting fully 1/4 AMA (A Son MTun 9 B-28	
Image: A seconditioned       Method:       Dug       Bored       Driven         Image: Deepened       Image: Cable       Image: Cable       Image: Cable       Image: Cable       Image: Cable	(s, t, r Still REQUIRED)	Or Or
DIMENSIONS: Diameter of well 6 inches, drilled 122 kg		WWM LI
CONSTRUCTION DETAILS	Lat/Long Lat Deg Lat Min/Sec	
Casing Welded 6" Diam. from +2 ft. to 122ft.	Long Deg Long Min/Sec	
Installed: [] Liner installed Diam. from ft. toft.	Tax Parcel No. (Required) 1228810131660	21
Perforations: T Yes The No	¥	
Type of perforator used	CONSTRUCTION OR DECOMMISSION PROCEDU	RE ad the kind and
SIZE of perfs in. by in. and no. of perfs from fl. to fl.	nature of the material in each stratum penetrated, with at least one entry f	or each change
Screens: Yes S No K-Pac Location	of information. (USE ADDITIONAL SHEETS IF NECESSARY.)	1 000
Manufacturer's Name	Base Sill + Second D	10
Type Model No	Drown Silf F Jand	
DiamSlot sizefromfl. toff. DiamSlot sizefromfl. tofl.	Brown Sand Same Gonvel 21	50
Gravel/Filter packed: Yes S No Size of gravel/sand	Black Connel + Shad 50	96
Materials placed from ft. to ft.		00
Surface Seal: 12 Yes 1 No To what depth? 200 ft.	Broken Basalt + Gravel 86	105
Surface Seal: 12 Yes 11 No To what depth? 20 ft. Material used in seal <b>Benton: te</b>	Broken Basalt + Gravel 86	105
Surface Seal: B Yes No To what depth? OC 5 ft. Material used in seal Buston: HC // // // // // // // // // // // // //	Broken Basalt + Gravel 86 Fractural Basalt 105	105 122
Surface Seal: B Yes No To what depth? CC ft. Material used in seal Buston: HC ' Did any strata contain unusable water? Depth of strata Type of water? Depth of strata	Broken Basalt + Gravel 86 Fractural Basalt 105	105
Surface Seal: B Yes I No To what depth? OC O ft. Material used in seal Buston: HC / Did any strata contain unusable water? I Yes I No Type of water? Depth of strata Method of sealing strata off	Broken Basalt + Gravel 86 Fractural Basalt 105	105
Surface Seal: B Yes I No To what depth? CC ft. Material used in seal Busten: HC ' Did any strata contain unusable water? I Yes I No Type of water? Depth of strata Method of sealing strata off PUMP: Manufacturer's Name Type: H.P	Broken Basalt + Gravel 86 Fractural Basalt 105	105
Surface Seal: E Yes No To what depth? CLO ft. Material used in seal Busten: HC Did any strata contain unusable water? I Yes I No Type of water? Depth of strata Method of sealing strata off PUMP: Manufacturer's Name Type: HP	Broken Basalt + Gravel 86 Fractural Basalt 105	105
Surface Seal: B Yes I No To what depth? 200 ft. Material used in seal Buston: He. Did any strata contain unusable water? I Yes I No Type of water? Depth of strata Method of sealing strata off PUMP: Manufacturer's Name Type: HP. WATER LEVELS: Land-surface elevation above mean sea level ft. Static level 84 ft. below top of well Date 7-23-16	Broken Brankt + Gravel 86 Fractural Basalt 105 Received Received 62	105
Surface Seal: If Yes       No       To what depth? OC ft.         Material used in seal       Surface.ife.	Broken Brankt + Gravel 86 Fractural Basalt 105 Received UL 2 8 2015	105
Surface Seal: LY Yes I No To what depth? 200 ft. Material used in seal <b>Buston: He</b> Did any strata contain unusable water? I Yes Is 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 <b>84</b> ft. below top of well Date <b>7-23-/6</b> Artesian pressure lbs. per square inch Date (cap, valve, etc.)	Broken Basalt + Gravel 86 Fractural Basalt 105 Received 10 JUL 28 2016	105 122
Surface Seal: If Yes       No       To what depth? 200 ft.         Material used in seal       Surface: ://2	Broken Basalt + Gravel 86 Fractural Basalt 105 Received 2 UL 2 8 2016	105 122
Surface Seal: If Yes       No       To what depth? QC ft.         Material used in seal       Surfaces: He	Broken Brss/H + Gravel 86 Fracturel Bass/H 105 Repervent UUL 2 8 2016	105 122
Surface Seal: If Yes No   Material used in seal Surface: Yes   Did any strata contain unusable water? Yes   Did any strata contain unusable water? Ptes   Depth of strata	Broken Brss/H + Gravel 86 Fractural Bass/H 105 Repeived 22 JUL 28 2016	105 123
Surface Seal: If Yes       No       To what depth? QCO ft.         Material used in seal       Surface. ://       //         Did any strata contain unusable water?       Depth of strata	Broken Basalt + Gravel 86 Fractural Basalt 105 Received 32 UL 2 8 2016 33 34 AFRICAN OFFICE	105 122
Surface Seal: If Yes       No       To what depth? 200 ft.         Material used in seal       Surface.: 142	Broken Brss/H + Gravel 86 Fracturel Bass/H 105 Received 62 UL 2 8 2016	105 123
Surface Seal: If Yes       No       To what depth? QC ft.         Material used in seal       Surface. ://       //         Did any strata contain unusable water?       If Yes       No         Type of water?       Depth of strata	Broken Brss/H + Gravel 86 Fracturel Bass/H 105 Repenveri UUL 2.8 2016	105 122
Surface Seal: If Yes       No       To what depth? If No         Material used in seal       Surface. If No         Did any strata contain unusable water?       Yes         Did any strata contain unusable water?       Depth of strata         Method of sealing strata off	Broken Brss/H + Gravel 86 Fractural Bass/H 105 Repeived 2 JUL 2 8 2016	
Surface Seal: If Yes       No       To what depth? C.O. ft.         Material used in seal       Surface. ://	Broken Brankt + Gravel 86 Fractural Basalt 105 Received 2 UL 2 8 2016	
Surface Seal: If Yes       No       To what depth? 200 ft.         Material used in seal       Surface: ://2	Broken Brss/H + Gravel 86 Fractured Bass/H 105 Repenvent 62 JUL 2.8 2016	105 123
Surface Seal: If Yes       No       To what depth? 200 ft.         Material used in seal       Surface. ://2	Broken Brss/H + Gravel 86 Fracturel Bass/H 105 Received Bass/H 105 UUL 2 8 2016	
Surface Seal: If Yes       No       To what depth? @C.O.ft.         Material used in seal       Surface.ife	Broken Brss/H + Gravel 86 Fractural Bass/H 105 Repeived 2 JUL 2 8 2016	
Surface Seal: If Yes I No To what depth? 200 ft.         Material used in seal	Broken Brss/H + Gravel 86 Fractural Bass/H 105 Received 2 JUL 2 8 2015	
Surface Seal: If Yes I No To what depth? 23 ft.         Material used in seal	Broken Brss/H + Gravel 86 Fractural Bass/H 105 Received 2 UL 2 8 2016 32 AFRICAL OFFICE Start Date 7-23-16 Completed Date 7-2	105 125
Surface Seal: LS Yes I No To what depth? 200 ft.         Material used in seal	Broken Basalt + Gravel 86 Fracturel Basalt 105 Received 2 UL 2 8 2016 324 AFRIM (NEW) Start Date 7-23-16 Completed Date 7-2	105 122 122 122 122 122 122 122 122 122 12

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	Drilling Company Nelson Drillion LLC
Driller/Engineer/Trainee Signature	Address 600 W. Vinevard Dr.
Driller or trainee License No. 2866	City, State, Zip Pasco
IF TRAINEE: Driller's License No:	Contractor's
Driller's Signature:	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.

Original & ft copy - Ecology, 2 <sup>nd</sup> copy - owner, 3 <sup>rd</sup> copy - driller	CURRENT		
	Notice of Intent No. WE28475	<i>A</i>	
Construction/Decommission ('x" in circle)	Unique Ecology Well ID Tag No. BJG-524		
Decommission ORIGINAL INSTALLATION	Wotor Dight Dermit No		n na se an
Notice of Intent Number	water Kight Permit No.		<u></u>
PROPOSED USE: Domestic Industrial Municipal	Property Owner Name Chris Bonike		
DeWater Irrigation Test Well Other	Well Street Address 1005 Prse		
TYPE OF WORK: Owner's number of well (if more than one)	City kennewick County	penton	
Deepened Cable Rotary Jetted	Location NW 1/4-1/4 NE 1/4 Sec 22 Twn8n	R 28e	
DIMENSIONS: Diameter of well 6 inches, drilled 215 ft.	(s. t. r. Still REOUIRED)		Or Or
Depth of completed well 215 ft.	(,,,,,	• 10	
Construction defails $(x)$ welded $(x)$ Diam, from $(0)$ ft to $(215)$ ft	Lat/Long Lat Deg Lat M	in/Sec _	
Installed: Liner installed " Diam. from ft. to ft.	Long Deg Long	Min/Sec	
Threaded " Diam. From ft. to ft.	Tax Parcel No. (Required) <u>122881013149002</u>		<del></del>
Perforations: Yes X No	CONSTRUCTION OR DECOMMISSION PROCI	DURE	in the second second
SIZE of perfs in. by in. and no. of perfs from ft to ft	Formation: Describe by color, character, size of material and nature of the material in each stratum penetrated, with at least	structure, and at one entry for	d the kind and or each change
Screens: Ves XNo K-Pac Location	of information. (USE ADDITIONAL SHEETS IF NECESSA	RY.)	
Manufacturer's Name	MATERIAL	FROM	TO
Type Model No	Silt & Sand	10	6
Diam. Slot size from ft. to ft.	Clay	62	105
	Sand	105	116
Materials placed from ft to ft.	Fractured Basalt & Silty Clay	116	156
Surface Seal: X Yes No To what depth? 20+ ft.	Frac Basalt Fine Sand	156	200
Material used in seal Bentonite	Porous Basalt, Red & Black	200	215
Did any strata contain unusable water?		<u> </u>	
Type of water? Depth of strata		<u> </u>	a
Method of sealing strata off		-	
PUMP: Manufacturer's Name			
Туре: Н.Р			_
WATER LEVELS: Land-surface elevation above mean sea level ft.		<u> </u>	
Static level $\delta I$ tt. below top of well Date $U\delta/U2/2017$		+	
Artesian pressurelbs per square inch Date	· · · · · · · · · · · · · · · · · · ·	1	
Arresian water is controlled by (cap, valve, etc.)			
WELL IESTS: Drawdown is amount water level is lowered below static level Was a numn test made? Yes X No. If yes by whom?			
Yield: gal./min. with ft. drawdown after hrs.		ļ	
Yield: gal./min. with fl. drawdown after hrs.	hear-		
Recovery data (time taken as zero when pump turned off) (water level measured from well	KECE	VFP	
top to water level)		· Clima Baad	
Time Water Level Time Water Level Time Water Level	SEP 25	2017	
	Dont of P		
	Sentral Beaus	elegy	_
Date of test		T CINEL	
the second		<u> </u>	
Bailer Test gal./min. with ft. drawdown after hrs.	The second statements is not be because of the second of the second statement and second statements and a	4	
Bailer Test     gal./min. with     ft. drawdown after     hrs.       Airtest     60     gal./min. with stem set at     ft. for 4     hrs.		1	
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       g.p.m.       g.p.m.       hrs.		1	

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 Signature		
Driller's License No: Driller's License No: Driller's Signature: Driller	City, State, Zip Pasco , Wa , 993 Contractor's Registration No. STATEWDO15LZ Date 5-21-2	
CY 050-1-20 (Rev 06/08) If you need this document in an altenate format, please ca	Il the Water Resources Program at 360-407-6600.	/

ile Original and First Copy with		111 25 4F1 41	7
iecond Copy — Owner's Copy hind Copy — Driller's Copy STATE OF N		n N.P	I J
MANED STAILA + CAMO ( AANA	9 (XIGI ( H) Decelutor 19	2 Kou	
When Name JICUC AC OF COLOC AND	dress LCA WE XALLE M		<u> </u>
2) LOCATION OF WELL: County Berl TOM		<u>1 n. r. 29</u>	<u>G</u> w.м.
2a) STREET ADDRESS OF WELL (or nearest address) 10 47 (	Weschutes or Kenn UL	- 91331	<u> </u>
3) PROPOSED USE: 12 Domestic Industrial  Municipal  Municipal	(10) WELL LOG or ABANDONMENT PROCEDURE D	ESCRIPTION	
DeWater Test Weil D Other	Formation: Describe by color, character, size of material and structure, and and the kind and nature of the material in each stratum penetrated, with	show thickness of a at least one entry for	aquifers or each
4) TYPE OF WORK: Owner's number of well (If more than one)	change of information.	ERON	
Abandoned 🖸 New well 🕅 Method: Dug 🗅 Bored 🗆 🗌	mer Leigh	·	<u> </u>
Reconditioned  Rotary  Science Jetted	SAUD	O	
5) DIMENSIONS: Diameter of well inches.			$\overline{m}$
Drilled <u>0</u> feet. Depth of completed well <u>0</u> f.	SAND Jan Silly		4
6) CONSTRUCTION DETAILS:	Gravel Sand Total silt	44 5	5
Casing installed: " Diam. from <u></u> ft. to <u></u> ft. Welded <u></u> " Diam. from ft. to ft.			
Liner installed  Threaded Thre	TAN SIT Invitor	100	9
Perforations: Yes No 🔀	I THE SULL WULLER OF JL		<b>i</b>
Type of perforator used	Cravel, Sand Tan	69	<u> </u>
SIZE of perforations in. by in. perforations from ft. to ft.	letter Bearing	8	2
perforations from ft. toft.			
perforations fromft: toft.			
Manufacturer's Name Model No	· · · · · · · · · · · · · · · · · · ·		
Diam Slot size from ft. to ft.		- ENLING	, DES
Diam Slot size from ft. to ft.			<u>ج چ</u>
Gravel packed: Yes No LO, Size of gravel		5	
		100 3	
Material used in seal	· · · · · · · · · · · · · · · · · · ·	CE B	<u> </u>
Did any strata contain unusable water? Yes 🗌 No 😡			
lype of water? Depth of strata			
7) PUMP: Manufacturer's Name H.P H.P H.P		·	
8) WATER LEVELS: Land-surface elevation	Work Starled _ 1 - 2 . 19. Completed _ (-7	!!	ন্দ্র
Static level S fl. below top of well Date	WELL CONSTRUCTOR CERTIFICATION:	· .	,
Artesian pressure lbs. per square inch Date Artesian water is controlled by	I constructed and/or accept responsibility for construction	n of this well, an	nd its
	compliance with all Washington well construction standard the information reported above are true to my best knowled	s. Materials used ge and belief.	1 and
WELL IESIS: Drawdown is amount water level is lowered below static level     Was a pump test made? Yes No No If yes, by whom?	LANE N/plank 10 billing	Iline T	Vr.
Yield:gal./min. withft. drawdown afterhrs.	(PEASON, FIRM, OR CORPORATION) (TYPE OF	PAINT)	<u>-1.,</u>
1) I) II II	Address SLOD (A) Hyperit	<u> 1965</u>	$\overline{O}$
" " " " " " " " " " " " " " " " " " "	(Signed) Tuli Melan Licen	se No. <u>367</u>	
top to water level) Time Water Level Time Water Level Time Water Level	Contractoria (	•	
	Registration 1 N La V 100/400 1-0	\	Cpel
		,195 ADV/	÷(
Date of test		<u> </u>	
Bailer test gal./min. with ft. drawdown after hrs.	Ecology is an Equal Opportunity and Affirmative Action	employer. For	spe-
Artesian flow g.p.m. Date	cial accommodation needs, contact the Water Resource	s Program at (2	206)
. Temperature of water Was a chemical analysis made? Yes 🛄 No 🗌			

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COLOGY Original & ft copy - Ecology, 2 <sup>nd</sup> copy - owner, 3 <sup>rd</sup> copy - driller	CURRENT		
icure et Wightragion	Notice of Intent No. WE12628	_	
Construction/Decommission ("x" in circle) $[X]$ Construction $[U] \ge 1.52$	Unique Ecology Well ID Tag No. BBI	-619	
Decommission ORIGINAL INSTALLATION			
Notice of Intent Number	Water Right Permit No.		
PROPOSED USE: Domestic Industrial Municipal	Property Owner Name Jason Madison		
DeWater Irrigation Test Well Other	Well Street Address 226405 Cour	try Meadows Dr.	
TYPE OF WORK: Owner's number of well (if more than one)	City Kenn.	County Benton	······································
New well Reconditioned Method: Dug Bored Driven	Location SW 1/4 1/4 ne 1/4 Sec 17	Tum8 p 28	
DIMENSIONS: Diameter of well 6 inches, drilled 160 ft	$\frac{1}{1} = \frac{1}{1} + \frac{1}$	K <u>==</u>	Or One
Depth of completed well 160 ft.	(S, I, I SUN REQUIRED)		WWM D One
CONSTRUCTION DETAILS	Lat/Long Lat Deg	Lat Min/Sec	
Casing Welded <u>6</u> "Diam. from <u>0</u> ft. to <u>100</u> ft.	Long Deg	Long Min/Sec	;
Threaded Pian. From ft. to ft.	Tax Parcel No. (Required) 1178830	20003003	
Perforations: Yes X No		SSION PROCEDURE	
Type of perforator used	Formation: Describe by color, character, size of	of material and structure,	and the kind and
SIZE of perfs in. by in. and no. of perfs from ft. to ft.	of information. (USE ADDITIONAL SHEETS	ed, with at least one entry S IF NECESSARY.)	for each change
Screens: Yes XNo K-Pac Location	MATERIAL	FROM	ТО
Type Model No	Brown Topsoil	0	34
Diam. Slot size from ft. to ft.	Black Basalt Broken	34	76
Diam. Slot size from ft. to ft.	Clay,Brown	76	144
Gravel/Filter packed: Yes X No Size of gravel/sand	Fractured Basalt & Gravel	144	160
Materials placed from ft. toft.	4		
Surface Seal: $\mathbf{x}$ Yes $\square$ No To what depth? 20 ft.			
Material used in seal Demonite			
The adjuster?			1
Method of senting strate off			
Dilado Manufacturar's Nama			
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 pressurelbs. per square inch Date			
Artesian water is controlled by (cap, valve, etc.)			
WELL TESTS: Drawdown is amount water level is lowered below static level	1		
Was a pump test made? Yes X No If yes, by whom?	.		
Yield:gal./min. withft. drawdown afterhrs.			
Yield:     gal./min. with     ft. drawdown after     ms.			
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		RECEIVEN	
			9
		MAY DIE DOL	
		//////	
Date of test	DEPARTMENT	OF ECOLOGY - CENTRAL DEGION	MI COMPA
Bailer Test gal /min. with ft. drawdown after hrs.			HL UNIVE
Airtest $40+$ gal./min. with stem set at $145$ ft. forhrs.			
Artesian flow g.p.m. Date			

**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	Drilling Company Statewide Well Drilling Inc.		
Driller/Engineer/Trainee Signature	- Address 6816 rd. 76n		
Driller or trainee License No. 2343	City State Zin Pasco	Wa 99301	
IF TRAINEE: Driller's License No:		,,,	
Driller's Signature: Todd Haney	Registration No. STATEWDO15LZ	Date 2-24-2011	

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CURRENT

WATER	WELL	REPORT
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	** 1 1				1/1	
	Original & 1	<sup>st</sup> copy - E	cology, 2 <sup>nd</sup> c	opy - owner, 3"	copy - drille	r
<b>Construction</b>	/Decomr	nission	("x" in circ	le)		
X Construct	ion					
Decommi	ssion OR	IGINAI	INSTAL	LATION		
	osien en	Notice	of Intent	Number _		
PROPOSED USE:	× Dome	stic	Industrial	Municipa	]	
DeWater	🔲 Irriga	tion	] Test Well	Other _	· · · · · · · · · · · · · · · · · · ·	
TYPE OF WORK:	)wner's num	ber of well	(if more than	n one)		_
🗙 New well 👔	Recondit	ioned Me	thod:	ng Bored	1 🗌 Driv	ven
Deepened				able 🗷 Rotar	y 🗍 Jett	ed
DIMENSIONS: Dia	meter of we	li <u>6</u>	inches,	drilled 100	ft.	
Dep	th of comple	ted well 10	<u>)0</u> ft.			
CONSTRUCTION	N DETAILS					
Casing × Wel	ded	6 '	Diam. fron	$+2_{-}$ ft. to	<u>98</u> f	t.
Installed: 🗌 Lin	er installed	,	Diam. fron	ft. to	ft	
🛄 Thr	eaded		Diam. Fron	ft. to	f	ł.
Perforations:	× Yes	× No				
Type of perforator	used					
SIZE of perfs	in. by	in. and r	o. of perfs	from	ft. to	ft.
Screens: Yes	× No	K-Pac	Loca	tion		
Manufacturer's Nan	ne					
Туре			Model N	D.		
Diam.	Slot size	f	rom	ft. to	ft.	
Diam.	Slot size	f	rom	ft. to	ft.	

ft. to

Yes No

H.P.

Time

ft. drawdown after

Was a chemical analysis made? 🔲 Yes 🗌 No

ft. for <u>1</u> hrs.

Depth of strata

Gravel/Filter packed: Yes X No Size of gravel/sand

Surface Seal: X Yes No To what depth? 98 Material used in seal BENTONITE

WATER LEVELS: Land-surface elevation above mean sea level

Static level 20\_\_\_\_\_ft. below top of well Date Artesian pressure \_\_\_\_\_ lbs. per square inch Date

Time

gal./min. with

gal./min. with stem set at 95

g.p.m. Date

WELL TESTS: Drawdown is amount water level is lowered below static level Was a pump test made? 
Yes No If yes, by whom?

gal./min. with \_\_\_\_\_ ft. drawdown after \_\_\_\_\_ gal./min. with \_\_\_\_\_ ft. drawdown after \_\_\_\_\_

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

Water Level

\_\_\_\_

gal/min. with ft. drawdown after

Materials placed from

Type of water?

Type:

Yield: Yield:

Yield:

Time

Date of test

Bailer Test Airtest 35

Artesian flow Temperature of water

top to water level)

Method of sealing strata off PUMP: Manufacturer's Name

Artesian water is controlled by

Water Level

Did any strata contain unusable water?

Notice of Intent No. WE07852			
Unique Ecology Well ID Tag No. BA	L465		
Water Right Permit No.			
Property Owner Name ROCKING M	IC RANCH		-
Well Street Address 11845 \E HIGH	WAY 124		
City WALLA WALLA	County W	ALLA V	WALLA
Location <u>NE_1/4-1/4 SE_1/4</u> Sec_1		R <u>38</u>	EWM 🗵 Check
(s, t, r Still REQUIRED)			<sup>Or</sup> wwm □ <sup>One</sup>
Lat/Long Lat Deg	Lat Mi	n/Sec	
Long Deg	Long N	/in/Sec	
Tax Parcel No. (Required) 360901	110003		
CONSTRUCTION OR DECOMMI Formation: Describe by color, character, size nature of the material in each stratum penetra of information. (USE ADDITIONAL SHEET	SSION PROCEDU of material and ited, with at least IS IF NECESSA	RE structure, an one entry f RY.)	nd the kind and for each change
MATERIAL		FROM	TO
BROWN CLAY	·	20	40
GREY CLAY		40	95
GRAVEL W.B. 35 G.P.M.		95	100
<u></u>			
APR 2 2 21	108		
DEPARTMENT OF E	COLOGY		
EASTERN REGIONA			
Start Date <u>12/19/2007</u> Com	pleted Date	12/19/2	007

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. Brandon Mahaffi

fì.

hrs.

hrs.

hrs.

Water Level

\_\_\_\_ hrs.

(cap, valve, etc.)

ft.

ft.

Landon Mcharne
Driller/Engineer/Trainee Signature
Driller or trainee License No.
IF TRAINEE: Driller's License No: 885
Driller's Signature:

Drilling Company HICKAM WELL I	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)

Ecology is an Equal Opportunity Employer

gnstruction/Decommission ("x" in circle)			
	Notice of Intent No. $(1)399/22$		
Construction 486171	Unique Ecology Well ID Tag No. 37 (2	912	_
Decommission ORIGINAL INSTALLATION	Water Right Bermit No.		<u> </u>
Notice of Intent Number	water Right Fernin No.		
ROPOSED USE: Domestic Industrial Municipal	Property Owner Name <u>10 m huana</u>	·/	
DeWater Infigation Test Well Other	- Well Street Address 46304 Drinka	rd P	RNE
PE OF WORK: Owner's number of well (if more than one)	City West Richard County	Bont	11-13
New well Reconditioned Method: Dug Bored Driven	Leaving Statistics Nileting 23 Tam 14	D 27	
IDeependa	$= 1/4 - 1/4 \frac{1}{14} \frac{1}{14$	K <u>44</u>	or Che
Depth of completed well 180 ft.	(s, t, r Still REQUIRED)	v	<i>ж</i> мп 🗋 Оп
ONSTRUCTION DETAILS	Lat/Long Lat Deg Lat Min	1/Sec _	
asing Welded Diam, from <u><i>FL</i></u> ft. to <u><i>LO</i></u> ft.		fin/Sec	
stalled: Liner installed " Diam. from ft. to for ft.			
Threaded " Diam. From ft. to f ft.	Tax Parcel No. (Required)	000	<u>00 100</u>
voe of perforator used	CONSTRUCTION OR DECOMMISSION PROCED	JURE	
ZE of perfs in. by, in. and no. of perfs from ft. to ft.	nature of the material in each stratum penetrated, with at least	one entry fo	r each change
reens: Ver Chron Dix-Pec Constian	of information. (USE ADDITIONAL SHEETS IF NECESSAF	ŧΥ.)	
anufacturer's Name	, MATERIAL	FROM	TO
/pe Model No.	Soll gravel		_ X`
iam. Slot size from ft. to ft.	Alack Accolt	-	
iamfl. toft.	DIACK DASAT	<u> </u>	17
avel/Filter packed: Ves Ko Size of gravel/sand		727	47
aterials placed from ft. to ft.		<i>—</i> (	+16
urface Seal: Yes No To what depth? fi.	UREY BASALF	47	157
aternal used in seal		1.6-	
ia any strate contain unusable water? Yes No	RED BASAIT - WATER	151	170
ype of water? Depth of strata			
lethod of sealing strata off	BIACK BASAIT	170	180
UMP: Manufacturer's Name			<u> </u>
	-		
ATER LEVELS: Land-surface elevation above mean sea level			-}
atic level ft. below top of well Date	· · ·		
tessan pressurelos per square inch Date			
(cap, valve, etc.)			
ELL TESTS: Drawdown is amount water level is lowered below static level		•	
eld: sal/min with b ft drawdown after brs.	-		
eld: gal./min. with fl. drawdown after hrs.			
eld: gal./min. with ft, drawdown after hrs.	OF ECOLO		-↓
covery data (time taken as zero when pump turned off) (water level measured from well p to water level)	Becoived 624	<u></u>	
ne Water Level Time Water Level Time Water Level		<u> </u>	···
	MAY 2 3 2013		+
		+	+
	3.	/	+
nie of test	TAI REGION OF		
iler Test gal./min. with ft. drawdown after hrs.	· · · · · · · · · · · · · · · · · · ·		
rtest $\angle Q$ gal./min. with stem set at $\angle Z$ ft. for $\angle I$ - hrs.			<u> </u>
tesian flow g.p.n), Date		~ 11	12
mperature of water Was a chemical analysis made? T Yes No	Start Date 3 13 13 Completed Date	<u>, 16</u>	<u></u>
LL CONSTRUCTION CERTIFICATION: 1 constructed and/or accept responsibili	ty for construction of this well, and its compliance with all Wa	shington w	vell

Dimenzingineen mannee bigharate		Address $V_{1}(1,1)/N_{1} \supset \int \sqrt{2} \Psi$	4
Driller or trainee License No.	2302	City State Zin Deptan Ait	11/19 GG32K
IF TRAINEE: Driller's License No:		Controlors	
Driller's Signature:		Registration No. AUCOXUC90504	Date 5/16/13
	· · · · · · · · · · · · · · · · · · ·	· · · · · ·	

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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.

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Ile Original and First Copy with epartment of Ecology STATE OF WASHINGTON	Start Card No. <u>W100343</u>
econd Copy - Owner's Copy	
OWNER: Name ROSS & PAM DUM For Addres	ss 3960 W. VANGiesen #22 Vest Richland,
DEATION OF WELL COUNTY OF POTET Q.T	WILL NE WASER 14 T9 MER 26 WM
(a) STREET ADDRESS OF WELL (or nearest address) 37602 M 14	10 PR New Bootloss City was B
) PROPOSED USE: ☐ Domestic <sup>1</sup> C T ☐ Industrial [ () () ☐ Municipal ☐ Irrigation A SHI [☐ Test] Well: C T [ () [] ☐ Other	(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
) TYPE OF WORK: Owner's number of well (if more than one)	least one entry for each change of information.
Deepened Dug Depend	MATERIAL FROM TO
Reconditioned     Cable     Driven     Retary     Letted	City Sand 3 29
) DIMENSIONS: Diameter of well k inches	Med Size Sund & Correl 24 34
Drilled 175 feet. Depth of completed well 170 ft.	Med. 5. 28 Sand 34 39
CONSTRUCTION DETAILS Casing Installed:	Barken Basalt 39 50 (with clay)
10 Welded $10$ $10$ $10$ $10$ $10$ $10$ $10$ $10$	Hord Basalt 50 53
□ Threaded Diam. from ft. to ft.	Braken Basalt 53 84
	(with elay, brown)
Type of perforator used <u>Skill Saw</u>	Hard Black Basalt 94 144
SIZE of perforations 14 in. by 3 in.	Med Hard Plack base H 144 151
<u><math>40</math> perforations from <u>110</u> ft. to <u>150</u> ft.</u>	Broken Busalt 131 175
perforations fromft. toft.	Autor & Branch
	Nock (Walter Dearing)
Screens: 🗆 Yes 🗯 No	
Manufacturer's Name	8
Diam Slot size from ft to ft	
Diam Slot size from ft. to ft.	
Gravel narked: D. Yes 🕅 No. Size of gravel	RECEIVED A S.
Gravel placed from ft. toft.	
Surface cost # Vac El No. To what don'th? 5'A'	FEB 2 3 1955 (2 2 2 2 2 3 1955)
Material used in seal Benten i Te	-TENENT OF ECULUSI
Did any strata contain unusuable water?	DEPARTMENT UNIT
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 levelft.	Work Started 2-5 1999. Completed 2-6 1999
Artesian pressure lbs. per souare inch. Date	
Artesian water is controlled by	
(Cap, valve, etc.)	
WELL TESTS: Drawdown is amount water level is lowered below static level	compliance with all Washington well construction standards. Materials used
Yield: 25 gal/min, with ft. drawdown after / hrs.	and the information reported above are true to my best knowledge and belief.
Yield: gal./min. with ft. drawdown afterhrs.	NAME Triple A. Urilling, IN
Yield: gal./min. with ft. drawdown afterhrs.	(Person, Firm, or Corporation) (Type of Print)
Recovery data (time taken as zero when pump turned off) (water level measured from well ton to water level)	Address 2202 Un Mindy; Dimition Ci
	(Signed) Jale (P. Umer License No. 1229
Time Water Level Time Water Level Time Water Level	Contractor's
Time Water Level Time Water Level Time Water Level	=
Time Water Level Time Water Level Time Water Level	Registration No. IR IPLUIO AS 107 Date, 197_
Date of test	(USE ADDITIONAL SHEETS IF NECESSARY)
Time Water Level Time Water Level Time Water Level Ball a target of test gal/min. with ft. drawdown after hrs.	Registration No. <u>IR IPUDIC &amp; D1</u> Date <u>41</u> , 197 (USE ADDITIONAL SHEETS IF NECESSARY)
Time     Water Level     Time     Water Level     Time     Water Level       Bailer test     2 - 6 - 9 9     4	Registration No. <u>[K IPLD IC &amp;S D]</u> Date <u>4</u> , 197 (USE ADDITIONAL SHEETS IF NECESSARY)
Time       Water Level       Time       Water Level       Time       Water Level         Biler test       2-6-99       Arr       Part       Part       Part       Part         Bailer test      gal./min. withft. drawdown afterhrs.       Airtest      hrs.       Airtest      hrs.         Atesian flow      g.p.m. Date	Registration No.       IK IPUDIC CS DT Date       Mainteen Provided State         (USE ADDITIONAL SHEETS IF NECESSARY)         Ecology is an Equal Opportunity and Affirmative Action employer. For special accommodation pages contact the Water Reserves Program at (202) 107.

ECY 050-1-20 (7/97)

File Original with Department of Ecology Second Copy - Owner's Copy Third Copy - Drifler's Copy	PORT       Notice of Intent       W117933         N       UNIQUE WELL ID # AEM 80.0         Water Right Permit No
(1) OWNER Name_John Keckey	_ Address 481 Tangle wood Richland: wa
(2) LOCATION OF WELL County Denton (2a) STREET ADDRESS OF WELL (or nearest address) <u>144(i tat 0</u> TAX PARCEL NO <u>1-149(e-101-0930-001</u>	<u>р NOV -1 P1 20</u> NR <u>26</u> WM
(3) PROPOSED USE	EP1 (WELLOOG or DECOMMISSIONING PROCEDURE DESCRIPTION FISCAL the kind and nature of the material in each stratum penetrated, with at least
(4) TYPE OF WORK       Owner's number of well (if more than one)         □ □       □         □ □       □         □ □       □         □ □       □         □ □       □         □ □       □         □ □       □         □ □       □         □       □	one entry for each change of information Indicate all water encountered       MATERIAL     FROM     TO       TOP     SOIL     O     (e)       Ole Composed     Soalt     (c)     (c)
(5) DIMENSIONS Diameter of well Drilled 140 feet Depth of completed well 140	Inches hard bl. baselt 12 42 T Panaus baselt wyellow per 42 891
(6) CONSTRUCTION DETAILS Casing Installed Set Welded Diam fromft to( Diam fromft to /( □ Threaded Diam fromft to	D the charge of
Perforations       BYYes       No         Type of perforator used $SIZE$ (SAW)         SIZE of perforations $V4$ in by $/2$ $IQ$ perforations from $/0.0$ ft to $/40$	
Screens     I Yes     ONO     K-Pac Location       Manufacturer's Name	NUV 0 3 2000     DEPARTMENT OF ECOLOGY     WELL DRILLING UNIT
Diam	H C ECOLOGY
Surface seal       'Byes       No       To what depth?       20         Material used in seal       Bontonite       9         Did any strata contain unusable water?       Yes       No         Type of water?       Depth of strata	
(7) PUMP Manufacturer's Name	
(8) WATER LEVELS, Land-surface elevation above mean sea level	ht Work Started 8-15,2000 Completed 8-16,2000
Artesian water is controlled by	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 LACAINES License No 1224  hrs rom
Bailer test     Aritest	Image: Signed billing Company     License No       Image: Signed billing Company     Image: Signed billing Company       Image: Signe billing Company
Artesian flowg p m Date Temperature of water <u>\$</u> Was a chemical analysis made? ECY 050-1-20 (11/98) <b>\$ 3 4 65</b>	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

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Please print, sign and return to the Department of Ecology

	Current
Water Well Report	Notice of Intent No. $(700  9)$
Original – Ecology, 1st copy – owner, 2nd copy – driller	
E COLOGY Construction/Decommission	Unique Ecology Well ID Tag No. AKH 790
$\Box Construction 162,599$	Water Right Permit No.
Decommission ORIGINAL INSTALLATION Notice	De la companya
of Intent Number	Property Owner Name
	Well Street Address Vakitet Rd
PROPOSED USE: Domestic Industrial Municipal	City Routhow County Gentlitan
DeWater Irrigation I lest Well Other	Leaving SELVALVADE VALSE 14 Tom Olifs 76 FEWM
TYPE OF WORK: Owner's number of well (if more than one)	Location 1 - 1/4-1/4 1 - 1/4 Sec 1 I wn - 1/4 Con or circle
New well Reconditioned Method : Dug Bored Driven	Lat/Long (str Lat Deg Lat Min/Sec
Cable Rotary Jetted	
DIMENSIONS: Diameter of well <u>0</u> inches, drilled <u>265</u> ft.	still REQUIRED) Long Deg Long Min/Sec
Depth of completed wellft.	Tox Porcel No 1-1496-101-0032-112
CONSTRUCTION DETAILS	Tax Faiter No. 11. 18 101 0 112 002
<b>Installed:</b> $[M]$ we ded $[M]$ biam. from $[M]$ to $[M]$ the $[M]$ biam. from $[M]$ to $[M]$ the $[M]$ biam. from $[M]$ to $[M]$ the $[M]$ biam. from $[M]$ b	CONSTRUCTION OR DECOMMISSION PROCEDURE
Threaded Diam. from ft. to ft.	Formation: Describe by color, character, size of material and structure, and the kind and
Perforations: 🖸 Yes 🗌 No	nature of the material in each stratum penetrated, with at least one entry for each change of
Type of perforator used <u>9/11/50/0</u>	information indicate all water encountered. (USE ADDITIONAL SHEETS IF NECESSARY.)
SIZE OF perts <u>19</u> in. by <u>y</u> in. and no. of perts <u>10</u> from <u>CR</u> Ut, to <u>500</u> ft.	MATERIAL FROM TO
Screens: LIYes L29 No LIK-Pac Location	$\frac{100501}{03}$
Tyranulaciurer's Name	Clay Brown 3 4/
Type	gravel 41 53
DiamSlot sizefromft. toft.	<u>Basalt</u> <u>53 181</u>
Gravel/Filter packed: Yes X No Size of gravel/sand	Clay Green 181 del
	Basayt Broken 221 232
Surface Seal: : $\square$ Yes $\square$ No To what depth? <u>18</u> ft.	Basalt Itard 232 281
Material used in seal <u>D20100114</u>	Basalt Broking Water 281 305
Did any strata contain unusable water? Yes 🔀 No	
Type of water? Depth of strata	
Method of sealing strata off	
PUMP: Manufacturer's Name	
WATER LEVELS: Land-surface elevation above mean sea levelft.	······································
Static level ft. below top of well Date	
Artesian pressure ios. per square inch Date	
(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. withft. drawdown afterhrs.	
Yield:gal/min. withft. drawdown afterhrs.	
Recovery data (time taken as zero when pump turned off) (water level measured from well	/ Received *
Top to water level)	
Time Water Level Time Water Level Time Water Level	
Date of test	REGIDIN'
Bailer testgal./min. withft. drawdown afterhrs.	
Airtest 30 gal/min. with stem set at 20 ft. for hrs.	
Artesian flow g.p.m. Date	· · · · · · · · · · · · · · · · · · ·
Temperature of water Was a chemical analysis made? 🔲 Yes 🕱 No	
e	Start Date Completed Date
WELL CONSTRUCTION CERTIFICATION: I constructed and/or acc	cept responsibility for construction of this well, and its compliance with all
Washington well construction standards. Materials used and the information	on reported above are true to my best knowledge and belief.
Driller/Engineer/Trainee Name (Print)	Drilling Company Treple A Wrilling
Driller/Engineer/Trainee Signature	Address
Driller or trainee License No / 1214	City, State, Zip
If TRAINEE,	Contractor's
Driller's Licensed No.	Registration No. / K+ YLUA8 15 159 Date
Driller's Signature	Ecology is an Equal Opportunity Employer. ECY 050-1-20 (Rev 2/03)

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Water Well Report	Current Notice of Intent No. 17009	7
ECOLOGY	Unique Ecology Well ID Tag No. AK I+	746
	Water Right Permit No.	
Construction		and
Decommission OKIGINAL INSTALLATION Nonce	Property Owner Name	
162511 of Intern Humber	Well Street Address <u>4 a Ki 74</u> T K	d
PROPOSED USE:	City Bell Acin (14 County 1) 2 Location SE 1/4-1/41 Et/4 Sec 14 Twn 9/	R26 EWM Circle
TYPE OF WORK: Owner's number of well (if more than one)         IX New well       Reconditioned         Method :       Dug         Bored       Driven	Lat/Long (s.t.r. Lat Deg Lat	
Deepened Cable Rotary Jetted	still REOLURED )	
DIMENSIONS: Diameter of well 12 inches, drilled 305 ft.	Long Deg Lor	ng Min/Sec
CONSTRUCTION DETAILS	Tax Parcel No. 1-1496-101-	0432-002
Casing Melded 6 "Diam from 5 ft to 56 ft.	CONSTRUCTION OR DECOMMISSIO	N PROCEDURE
Threaded Diam, from ft. toA	Formation: Describe by color, character, size of material and	structure, and the kind and
Perforations: TYes No	nature of the material in each stratum penetrated, with at least	one entry for each change of
Type of perforator used <u>5 mi 156 0</u>	information indicate all water encountered. (USE ADDITION	FROM TO
Size of peris In by In and no. of peris rom		
Manufacturar's Name		3 41
Type Model No		41 53
DiamSlot sizefromft. toft.	Bacalt	53 181
DiamRot sizeromR.	Class Grand	181 221
Gravel/Filter packed: Yes LX No Size of gravel/sandft.	Baselt Broken	221 232
	Brecht Hard	132 281
Surface Seal: $\sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_{i=1}^{n} \sum_{i=1}^{n} \sum_{j=1}^{n} \sum_{i=1}^{n} \sum_$	Baselt Bracin water	281 305
Material used in sear <u>12. of territ</u> Yes X No		OT OF ECO
Did any strata contain unusable water: Denth of strata		Received
Method of sealing strata off		1100
PLIMP: Manufacturer's Name		AFR 2 2 2005
Type: H.P	· · · · · · · · · · · · · · · · · · ·	18
WATER LEVELS: Land-surface elevation above mean sea level ft.		10.
Static level 16.7 ft. below top of well Date		REGION
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? Li Yes Ka No If yes, by whom?		
Yield:     gal/min. with     ft. drawdown after     fts.       Yield:     gal/min. with     ft. drawdown after     hrs.		
Yield:gal/min. withft. drawdown afterhrs.		
top to water level Time Water Level Time Water Level		
		<u>↓</u>
		·····
Date of test		<u>↓</u>
Bailer testgal./min. withft. drawdown afterhrs.		<u> </u>
Airtest <u>3C</u> gal/min. with stem set at <u>2ES</u> ft. for <u>1</u> hrs.		
Artesian flowg.p.m. Date		<u>├</u>
Temperature of water Was a chemical analysis made? 🔲 Yes 🐹 No	Start Date 12 - 19 - 04 Complete	ed Date 12-17-04
	i ilite for an et al of this well an	d its compliance with all
WELL CONSTRUCTION CERTIFICATION: I constructed and/or ac	ccept responsibility for construction of this well, and	a us comphance with an
Washington well construction standards. Materials used and the information	ion reported above are true to my best knowledge a	10 00101.
Driller/Engineer/Trainee Name (Print)	Drilling Company Dritter Onette	

Driller/Engineer/Trainee Name (Print)		A HORN	
Driller/Engineer/Trainee Signature	full os	Hinos	
Driller or trainee License No.	1 12	14	
IF TRAINEE,		•	
Driller's Licensed No.			
Driller's Signature			

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

Address / S //mbluld	danc
City, State, Zip Burbank. We	ci.
Contractor's	
Registration No. 1R+PLUAD 15 09	Date 17-15-04
Ecology is an Equal Opportunity Employer.	ECY 050-1-20 (Rev 2/03)



## 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 Nam Well Street Address	e		· · · · · · · · · · · · · · · · · · ·	
City	County	Zip Co	de	· · · · · · · · · · · · · · · · · · ·
Location:1/4-1/4	1/4 Sec Twn	R E or	W (Circle C	ne) -
Lat./Long: (Required) Lat Lor Hor	. Deg Lat. M ng. Deg Long. izontal Collection Meth	lin/Sec Min/Sec iod Code		· .
Tax Parcel No				
Type of Work: Well Log Received Date _/_ Well Diameter (in inches)	ll  Reconditioned / Well Depth	Deepened (in feet) Well Com	oleted Date	_/_/
Driller's Ecology License No. Trainee's Ecology License No				
Reason/Source of Change (Re	quired) TXMERNAL	, (DRRE-CTION) - IDN	NARE UN	CHANGED
·				
· .	· · · ·			
Signature of Well Log Tracker	(Required) <u>EG</u>		Date	1-12-04
	• •			
Imaging Well Log Phase 11 – Change Form ECY-WR-WLCF Rev. 10/02/02				
	-	2 · ·	·	<u> </u>

	File Dep Sec	Onginal with artment of Ecology ond Copy Owner's Copy	WATER WELL REPOR STATE OF WASHINGTON	T Notice of Intent UNIQUE WELL   D #	164048 AHA 755
	Thir	d Copy Driller's Copy 146085		Water Right Permit No	AKA - 725
ť	(1)	OWNER Name Rond :	Jelicia Vitek Addr	ress 8801 Stathomas	Kd. Pasco
ll Repo	(2) (2a)	LOCATION OF WELL County Ben STREET ADDRESS OF WELL (or neares TAX PARCEL NO 1-1496-	t address) <u>N · 114 PRNW</u> 01 - 0932-003	SE 1/4_NE_1/4 Sec 14 T.9 Benten City, WG.	NR 26 WM 99320 H
s We	(3)	PROPOSED USE A Domestic	Industrial     Municipal     Test Well     Other	(10) WELL LOG or DECOMMISSIONING PRO Formation Describe by color character size of r the kind and nature of the material in each stratu	DCEDURE DESCRIPTION naterial and structure and im penetrated with at least
i on thi	(4)	TYPE OF WORK Owner's number of New Well Deepened Reconditioned Decommission	well (if more than one) Method	ne entry for each change of information Indicat MATERIAL Top Sc. 1 Brown Clay	FROM     TO       O     Y       4     5
atior	(5)	DIMENSIONS Diameter of well Drilledfeet Depth of comp	leted wellft	Generated Granal Brown Basalt	52 61
e Inform	(6)	CONSTRUCTION DETAILS Casing Installed Welded Liner installed Threaded	Diam from <u>+2</u> ft to <u>6.7</u> ft Diam from <u>-5</u> ft to <u>1.75</u> ft Diam fromft toft	Black Basalt	7 30 102 7 65 175 51 0F ECOLO Received
a and/or th		Perforations (Yes Do Type of perforator used <u>SK</u> ) SIZE of perforations <u>Ys</u>	5 a cz- in by6in ions from13 5ft to17 5ft		FB 1 8 2005
ty the Dat		Screens     Yes     No     K       Manufacturer's Name	Pac Location Model No fromft toft _fromft toft		
rrant		Gravel/Filter packed	Size of gravel/sandftft		
NOT Wa		Surface seal     Xes     No       Material used in seal     Dett       Did any strata contain unusable water?     Type of water?       Method of sealing strata off	To what depth?ft To m i T €ft I Yes □ No Depth of strata		
Sec	(7)	PUMP Manufacturer's Name			
ogy do	(8)	Type         WATER LEVELS       Land surface elevation a         Static level       iOOO         Artesian pressure       Artesian water is controlled by	h Pft bove mean sea levelft ft below top of well Date Z -11-0-1 lbs per square inch Date	Work Started 2-10 04 Completer	2-11-04
of Ecol	(9)	WELL TESTS Drawdown is amount water	(Cap valve etc) level is lowered below static level	WELL CONSTRUCTION CERTIFICATION I constructed and/or accept responsibility for c compliance with all Washington well construct	onstruction of this well and its on standards Materials used
Department (		Yieldgal /min with         Yieldgal /min with         Yieldgal /min with         Recovery data (time taken as zero when pur well top to water level)         Time Water Level Time	ft       drawdown afterhrs        ft       drawdown afterhrs        ft       drawdown afterhrs         np turned off) (water level measured from         Water Level       Time         Water Level       Time	and the information reported above are true to Type or Print Name	my best knowledge and belief License No License No Vlicing License No224 eer)
The	ECY (	Date of test	ft drawdown afterhrs ft drawdown afterhrs g p m Date nıcal analysis made? □ Yes Â <sup>t</sup> No	Address 785 746 blowled Contractors Registration No <u>TRIPLICED</u> (USE ADDITIONAL SHEETS IF N Ecology is an Equal Opportunity and Affirmative accommodation needs contact the Water Reso 6600 The TDD number is (360) 407 6006	Date <u>2 - 11 OY</u> PDate <u>2 - 11 OY</u> NECESSARY) Action employer For special urces Program at (360) 407

Please print, sign and return to the Department of Ecology

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Water Well Report Original - Ecology, 1 <sup>st</sup> copy - owner. 2 <sup>nd</sup> copy - driller	Current Notice of Intent Now 178479	7	11
	Unique Ecology Well ID Tag No	$AD^{\mu}$	101
Construction/Decommission	Water Dight Demuit No		
Decommission ORIGINAL INSTALL ATION Notice	water Right Permit No.	anli	0
) coal of Intent Number	Property Owner Name	RIOINC	pense
	Well Street Address	ison	H
ROPOSED USE:     Domestic     Industrial     Municipal       DeWater     Irrigation     Test Well     Other	City <u>Benton [1]</u> County County	sentin	-03-
YPE OF WORK: Owner's number of well (if more than one)	$-$ Location $2$ 1/4-1/4 $\overline{\mu}$ 1/4 Sec $\underline{\gamma}$ 1 wn_		M one
Mew well     Reconditioned     Method :     Dug     Bored     Driven       Deepened     Cable     Rotary     Jetted	Lat/Long (s, t, r Lat Deg I	.at Min/Sec	
IMENSIONS: Diameter of well inches, drilled ft.	still REQUIRED ) Long Deg I	Long Min/Se	ec
ONSTRUCTION DETAILS	Tax Parcel No. $1 - 1496 - 161$	<u>0432 -</u>	004
asingwelded" Diam. from $f \neq f$ , toft			<u> </u>
Threaded Diam. from ft. to ft.	CONSTRUCTION OR DECOMMISS	ION PROCEI	DURE
erforations: Yes. No	Formation: Describe-by color, character, size of material a	nd structure, and	the kind and
/pe of perforator used	information indicate all water encountered. (USE ADDITI	ONAL SHEETS II	F NECESSARY.
ZE of perfsin. byin. and no. of perfsfromft. toft.	MAŢERIAL	FROM	то
reens: Yes K-Pac Location	501	0	15
anufacturer's Name			
/peModel No. iamSlot sizefromfl. toft.	BASALT GRAVEL	15	21
amStot sizefromft, toft.	- Citt + Soul)	+	117
aterials placed fromft.		-21-	73
Irface Seal: : Xes bo To what depth? ft.	SAND GRAVET	43	68
aterial used in seal	- AD Part		-
d any strata contain unusable water?	ISKOWN DASATT	68	19
pe of water? Depth of strata	Ricckempli		+1100
	D/ALT DAAT		176
/pe;H.P	ERACT. DO BOSATE	TLA	148
ATER   EVELS: Landsurface elevation above mean sea level ft	- FRACIORE DISSAIL	170	10
atic level ft. below top of well Date // SOOH	ERACTINE BASDIT	148	170
tesian pressure lbs. per square inch Date	1 the first for the first of th		110
tesian water is controlled by	WITH CAUSOR	me	
(cap, valve, etc.)		<u>~~</u> >-	
ELL TESTS: Drawdown is amount water level is lowered below static level	11) TPR		
as a pump test made? Yes No yes, by whom?		OF FCO	*
eld:ft. drawdown afterns, . eld:gal/min. withft. drawdown afterhrs.		AS OF COL	SUX -
eld:ft. drawdown afterhrs.		hecener	
covery data (time taken as zero when pump turned off) (water level measured from well > to water level)		FEB 0 1	2005
ne Water Level Time Water Level Time Water Level			5/
		¥2.	
	· · · · · · · · · · · · · · · · · · ·	AL REGI	¥Ž
ite of test		+	-
ther test gal/min. withft, drawdown afterhrs.	· · · · · · · · · · · · · · · · · · ·		1
tasian flow			1
instant nowg, m. Date			
imperature of water was a chemical analysis made? [ Yes [] No	Start Date 1-29-04 Comp	leted Date	-300
LL CONSTRUCTION CERTIFICATION: I constructed and/or a	ccept responsibility for construction of this well	and its compli	ance with all
shington well construction standards. Materials used and the informa-	tion reported above are true to my best knowledge	and belief.	
	Drilling Company RWICOX Drill	ing	
er/Engineer/Trainee Name (Print)	DU DAY 5324		
er/Engineer/Trainee Name (Print)	Address Addres	a	
er/Engineer/Trainee Name (Print)	Address Address City, State, Zip Benton City U	UASh 9	4320
er/Engineer/Trainee Name (Print)	City, State, Zip // Benton City Contractor's	UASh 9	1320

Original & 1 <sup>st</sup> copy - Ecology, 2 <sup>nd</sup> copy - owner, 3 <sup>rd</sup> copy - driller	Notice of Intent No. WE 1891	,9	and allowing a set
C 0 L 0 G Y C 0 L 0 G Y	Unique Ecology Well ID Tag No	TF - 44	6
Construction	Water Right Permit No.		
D Decommission ORIGINAL INSTALLATION Notice	Property Owner Name Trais	Notson	
of Intent Number	Well Street Address VID Chand	RA	·
POPOSED LISE, Prometic Industrial I Municipal	R I R	2.1.	
DeWater Irrigation Test Well Other	City Denton County	Denton	>
VPF OF WORK: Owner's number of well (if more than one)	Location <u>1/4-1/4 ne 1/4 Sec 14 Twn</u>	IN R 26 EW	circle
New well Cable Reconditioned Method : Dug Bored Driven Deepened Cable Rotary Detted	Lat/Long (s, t, r Lat Deg	Lat Min/Sec	M
IMENSIONS: Diameter of well 6 inches, drilled 290 ft.	Still REQUIRED) Long Deg	Long Min/Se	ж <u> </u>
ONSTRUCTION DETAILS	Tax Parcel No. 1149630000	1000	
asing welded $\underline{6}$ " Diam. from $\underline{72}$ ft. to $\underline{135}$ ft.			
istalled: $12^{-1}$ Liner installed $12^{-1}$ Diam. from $-15^{-1}$ ft. to $190^{-1}$ ft. to $190^{-1$	CONSTRUCTION OR DECOMMISS	SION PROCED	URE
erforations: Bryes D No	Formation: Describe by color, character, size of materia	and structure, and least one entry for	the kind and
ype of perforator used Skill Sam	information. (USE ADDITIONAL SHEETS IF NE	ECESSARY.)	
IZE of perfs 18 in. by 6 in. and no. of perfs 60 from 190 ft. to 80 ft.	MATERIAL	FROM	то
creens: 🖸 Yes 🗗 No 🗆 K-Pac Location	Top Soil	0	3
anuraciurer's Name	Si 1thy Sand	3	21
iam. Slot size from ft. to ft.	Broken Basalt	2/	160
iamSlot sizetromtt. tott.	HB-d Brenn Ellay	160	190
aterials placed fromft. toft.	Alast Realt	1911	768
urface Seal: Bres I No. To what denth? 20 ft	State Basalt (Besam)	268	279
laterial used in seal Benton: ta	Ita-el Basalt	279	290
id any strata contain unusable water?			
ype of water? Depth of strata			
lethod of sealing strata off	N		
UMP: Manufacturer's Name			
ATER LEVELS: Land-surface elevation above mean sea level			-
rtesian pressure lbs. per square inchr Date			-
rtesian water is controlled by			
(cap, valve, etc.)			
ELL TESTS: Drawdown is amount water level is lowered below static level			
ield: gal/min. with ft. drawdown after hrs.			
ield:gal./min. withft. drawdown afterhrs.			-
ecovery data (time taken as zero when pump turned off) (water level measured from well		OF EC	ACA
pp to water level)		A Receive	1 - 4
ime Water Level Time Water Level Time Water Level		1 000 17	2014
		1. SLA	1 7
ate of test			K
ailer test gal./min. with ft. drawdown after hrs.		CANDA -	PIMIC"
irtest JO + gal/min. with stem set at 288 ft. for 2 hrs.			
rtesian flow g.p.m. Date			
emperature of water 5 🥕 Was a chemical analysis made? 🛛 Yes 🖉 No	<u><u> </u></u>		1
	Start Date 7- 2- 2019 Cor	npleted Date 7	- 6- 2l
ELL CONSTRUCTION CERTIFICATION: I constructed and/or ad	ccept responsibility for construction of this well	, and its compl	iance with
ashington well construction standards. Materials used and the informat	ion reported above are true to my best knowled	ge and belief.	
Sriller D Engineer D Trainee Name (Print) JAmes Kobling	Drilling Company Ir ple H Unel	ing	
ller/Engineer/Trainee Signature	$- Address r \cdot 0 \cdot d 0 0 x 2.78$		
Iler or trainee License No	City, State, Zip Deubanic		
	Contractor's		
TRAINEE, 1224	Paristration No TRIDINTADODR	K Data 9-	6-201

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

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

			-		Call 1
O		- B	- 11		- 1 3
173		L		¥ 🖢	
	and the second s	_		And in case of the local division in which the local division in t	TABLE INCOME.

state of Washington Constructi	on/Decommission (" $x$ " in circle)
Construction	TOWAL INSTALLATION
_] Decommission OR	ofice of Intert Number WE27600
	tic Industrial I Municipal
DeWater I Irrigati	on Test Well Other
TVPE OF WORK Owner's n	umber of well (if more than one)
New well Recondition	oned Method: Dug Dored Driven
DIMENSIONS: Diameter of we	Il 8 inches, drilled 202 ft.
Depth of compl	leted well 202 ft.
CONSTRUCTION DETAILS	11.5
Casing 📕 Welded	8 " Diam. from +1.5 ft. to 202 ft.
Installed: Liner installed	Diam. from ft. to ft
Perforations: Yes N	0
Type of perforator used	2 3 V 201 Sectored
CITE of north in her	in and no of perfs from A to A
Screenes Ver M No T	K-Pac Location
Manufacturer's Name	
Туре	Model No
DiamSlot size f	fromft. toft.
Diam. Slot size 1	fromft. toft.
Surface Seal: Yes INC	To what depth? ft.
Did any strata contain unusable v	water? 🔲 Yes 🔳 No
I ype of water?	
PLIMP: Manufacturer's Name	
Туре:	н.р
WATER LEVELS: Land-surfa	ce elevation above mean sea level ft.
Static level 119 ft. below top	of well Date <u>7-7-2017</u>
Artesian pressure lbs. pe	er square inch Date
Artesian water is controlled by	(cap, valve, etc.)
Was a pump test made?	No If yes, by whom?
Yield:gal./min. with	ft. drawdown afterhrs.
Yield:gal./min. with	ft. drawdown afterhrs.
Yield:gal./min. with	ft. drawdown afterhrs.
Recovery data (time taken as zer	ro when pump turned off) (water level measured from
Time Water Level Tim	ne , Water Level Time Water Level
Date of test	
Date of test	hhhhrs.
Date of test	h 2 ft. drawdown after 1 hrs.
Date of test	h 2 ft. drawdown after 1 hrs. tem set at ft. for hrs.

## CURRENT

Long Deg

JUL 19 2017

Long Min/Sec

Notice of Intent No. WE27600	Dept of Ecology
Unique Ecology Well ID Tag No. BJB	-50 Central Regional Office
Water Right Permit No.	
Property Owner Name Richard Roge	rs
Well Street Address	
City Benton County	Benton
Location $\underline{sw}$ 1/4-1/4 $\underline{sw}$ 1/4 Sec <u>31</u> To (s, t, r Still REQUIRED)	wn <u>9</u> R <u>28</u> EWM II Or WWM []
Lat/Long	
Lat Deg	Lat Min/Sec

Tax parcel No. (Required) 131983012387002

CONSTRUCTION OR DECOMMI Formation: Describe by color, character, size and the kind and nature of the material in eac least one entry for each change of information SHEETS IF NECESSARY.)	SSION PROCED of material and st ch stratum penetra on. (USE ADDITI	URE ructure, ted, with at ONAL
MATERIAL	FROM	TO
Brown silt /Sand	0	131
Brown sand /Caliche	131	168
3/4" Gravel/sand	168	200
Black Basalt	200	202
		2 2. 2 2
Start Date 5-25-2017 Completed Da	ite <u>7-7-2017</u>	

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	Drilling Company						
Driller/Engineer/Trainee Signature	Address						
Driller or trainee License No. 2843	City, State, Zip						
IF TRAINEE: Driller's License No:	Contractor's						
Driller's Signature:	Registration No Date 7-7-2017						
	The second states of the second secon						

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.

Please print, sign and return to the Department of Ecology

Water Well Report Original - Ecology, 1 <sup>st</sup> copy - owner, 2 <sup>nd</sup> copy - driller	Current Notice of Intent No. <u> </u>	955	
E C 0 L 0 G Y Construction/Decommission	Unique Ecology Well ID Tag No. 🗡	- 1- 909	
Construction	Water Right Permit No.		K
Decommission ORIGINAL INSTALLATION Notice	Property Owner Name	Lackan	1
of Intent Number	Troperty Owner Name <u>Larry</u>	Cochar	<i>c</i>
<u>180 t</u>	Well Street Address Well Street Address	Canyor	1
PROPOSED USE:       Domestic       Industrial       Municipal         DeWater       Irrigation       Test Well       Other	City Kenn County	Benton	1 1
TYPE OF WORK: Owner's number of well (if more than one)	$1 \text{Location} \sqrt{\frac{1}{2}} \sqrt{\frac{1}{4}} \sqrt{\frac{1}$		onc onc
Provide     Provide	Lat/Long (s, t, r Lat Deg	Lat Min/Sec _	
DIMENSIONS: Diameter of well inches, drilled ft.	still REQUIRED ) Long Deg	Long Min/See	°
CONSTRUCTION DETAILS	Tax Parcel No. 1-1688-302-00	3-018	
Casing De Welded Diam. from ft. to ft. to ft.			
<b>Installed:</b> Liner installed Diam. from ft. to ft. $\Box$ Threaded Diam. from ft. to ft.	CONSTRUCTION OR DECOMMIS	SION PROCED	URE
Perforations: Yes 🔁 No	Formation: Describe by color, character, size of material nature of the material in each stratum penetrated with at	and structure, and t	he kind and ach change of
Type of perforator used	information indicate all water encountered. (USE ADDIT	TONAL SHEETS IF	NECESSARY.
SIZE of perfsin. by in. and no. of perfsfromft. toft.	MATERIAL	FROM	то
Screens: 🗌 Yes 🙀 No 🗋 K-Pac Location	Ton Silfy Soil	0	36
Manufacturer's Name	Sand & Gravel	ککہ	90
Type Model No	Water Bering Zonz	70	20
Diam.         Slot size         nonn.           Diam.         Slot size         fromft. to         ft.			
Gravel/Filter packed: Yes Pro Size of gravel/sand Materials placed from ft. to ft.			
Surface Seal: : 54 Yes L No To what depth? tt.			+
Did anu statu anataia unusuala watar?			-
The state contain disable water?			
Mathed of conting state off			
DUMP: Marchand Annual Marchand		<u> </u>	
Type: H.P.			+
			ļ
WATER LEVELS: Land-surface elevation above mean sea levelft.			<u> </u>
Static level ft. below top of well Date			
Artesian pressure lbs. per square inch Date	OFFICE		ļ
(cap, valve, etc.)			
WELL TESTS: Drawdown is amount water level is lowered below static level	<b>-</b>		
Was a pump test made? Yes No If yes, by whom?			
Yield:ft. drawdown after hrs.			
Yield:gal./min. withft. drawdown afterhrs.			ļ
Yield:gal./min. withft. drawdown afterhrs.			
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			L
			ļ
Date of test			I
Bailer test gal./min. withft. drawdown afterhrs.			<u> </u>
Airtest \$5 gal/min with stem set at 80 ft, for 2 hrs.			<u> </u>
Artesian flow g.p.m. Date			
Artesian flow g.p.m. Date Temperature of water Was a chemical analysis made? □ Yes 🌠 No			
Artesian flow g.p.m. Date Temperature of water Was a chemical analysis made?  Yes Pro	Start Date <b>8-29-05</b> Com	pleted Date	-29-05

Driller/Engineer/Trainee Name (Print) Todd Hanzy	Drilling Company STATEWISE Well Drilling
Driller/Engineer/Trainee Signature	Address 101 KAU Trail rd.
Driller or trainee License No. 3343	City, State, Zip Pasco Ug 99301
(If TRAINEE,	Contractor's
Driller's Licensed No.	Registration No. STATEWDOSLZ Date 4/06
Driller's Signature	Ecology is an Equal Opportunity Employer. ECY 050-1-20 (Rev 2/03)

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

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WATER WELL REPORT	CURRENT Notice of Intent No. (1)/9255	7	
Construction Decommission $("r")$ in circle	Unique Ecology Well ID Tag No. BAK	764	· · ·
Construction 306578	Water Right Permit No.		
O Decommission ORIGINAL INSTALLATION Notice of Intent Number	Property Owner Name HORGE HEA	VEN 14	115 PROF
	Well Street Address <u>47209 COIL</u>	<u>I-EITO</u>	(K)
DeWater Irrigation Test Well Other	City $\underline{\mathcal{K}e(\mathcal{J}\mathcal{K})}$ County $\underline{\mathcal{J}e}$	R28	circle
TYPE OF WORK:       Owner's number of well (if more than one)         New well       Reconditioned       Method : □       Dug       □       Driven	L'at/Long (s. t. r. Lat Deg. L'át	WWM Min/Sec	one
DIMENSIONS: Diameter of well inches, drilled / 01/0 ft.	Still <b>REQUIRED</b> ) Long Dag	Min/Sec	
Depth of completed well / 0 / 0ft.	Tax Parcel No. 121883000005	1011111 Sec	<u> </u>
Casing Welded 10 "Diam. from 1 ft. to, 32 ft. Installed: Diam. from 1 ft. to, 1 ft.		PRÓCEDU	
Perforations: Yes I No	Formation: Describe by color, character, size of material and	structure, and the	e kind and
Type of perforator, used <u>Hole CUT</u> SIZE, of perfs in. by in. and no. of perfs DO from 920 ft. to DAD	information. (USE ADDITIONAL SHEETS'IF NECES	SARY.)	
Screens: Q Yes No Q K-Pac Location	MATERIAL		76
Manufacturer's Name	GROU BASALT	76	237
Type Model No Diam. Slot size from the fit of fit.	RCA BASALT	232	250
DiamSlot sizefromft. toft.	BLACK BASAH	250	392
Gravel/Filter packed: D Yes INO D Size of gravel/sand	FRACTURE BASALT	392	410
	SAND 1	4/10	434
Surface Seal: Yes No Townat depth?	GREY BASAIT	434	532
Material used in seal	BLACK BASALT	53Z	602
Did-aný-strata contain unusable water? 🛛 Yes 🖉 No	BROWN BASA F	602	680
Type of water? Depth of strata	DIACKBASAIT	680	694
Method of searing strata off	-000	694	698
PUMP: Manufacturer's Name	RED BASALT	698	705
	GREY BASAL	205	185
WATER LEVELS: Land-partace elevation above mean sea levelft	REDBASAIT	185	805
Attailing assaults	GREY GASALT	KOS	924
Artesian piessure tos. per square incli Date	FRAC BASAIT WATER	924	430
(cap, valve, etc.)	GREYBASATT.	930	998
WELL TESTS: Drawdown is amount water level is lowered below static level	Vescular BASAlt	998	1005
Was a pump test made? Yes Vo If ves; by whom?	WATER		
Yield: gal/min. with ft:, drawdown.after hrs.			<u> </u>
Yield:     gal/min. with     ft. drawdown.after     hrs.       Yield:     gal/min. with     ft. drawdown after     hrs.	GREYBASAIF	1005-	1010
Recovery data (time taken as zero when pump turned off), (water level measured from well top to water level)	RE	CEIVED	
		30 2000	
Date of test		JU. 2000	
Bailer test gal /min. with ft. drawdown after hrs.	UEPARIMENT OF ECOL	GY - CENTRAL REGI	WAL OFFICE
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	Start Data 6128108 Complete	d Data (a)	72 1 A
WELL CONSTRUCTION CERTIFICATION: I constructed and/or acc Washington well construction standards. Materials used and the information Driller Engineer Trainee Name (Print)	ept responsibility for construction of this well, and in reported above are true to my best knowledge and Drilling Company BU COX DY/////	d its complian nd belief.	nce with all
Driller-or-trainee License No	City, State, Zip Benton CIty U	IBSh 9	1320
If TRAINEE, Driller's Licensed No	Contractor's Registration No. KWCOXN945RH	Date 6	23/08
Driller's Signature	Ecology is an	Equal Opportuni	ty Employer.
		-	•

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

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

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File Depa Seco Thiro	Original with artment of Ecology ond Copy - Owner's Copy d Copy - Driller's Copy 1310	WATER WELL REPOSITE OF WASHINGTON	Notice of Intent         N117916           UNIQUE WELL I.D. #         AEM 768           Water Right Permit No.
	OWNER: Name Virgilio	Manzha	Address
(2) (2a)	LOCATION OF WELL: County	<u>AIOM</u> estaddress) <u>Ya Ki tar</u> 96 - 101 - 1219 - 063	<u>5 W 1/4 ME 1/4 Sec 14 T N.R. 26E WM</u> Rd. Benton City No
(3)	PROPOSED USE: X Domestic	Industrial     Test Well     Other	(10) WELL-LOGIOD DECOMMISSIONING PROCEDURE DESCRIPTION
(4)	TYPE OF WORK: Owner's number N. New Well Deepened Reconditioned Decommission	of well (if more than one) Mëthod: □ Dug □ Bored I □ Cable □ Driven n	DEVIL OF each change of information. Indicate all water encountered.
(5)	DIMENSIONS:         Diameter of well_           Drilled         205         feet.         Depth of control	mpleted well 205	nches Brann garal 16 24 the Brahen Basalt 24 95
(6)	CONSTRUCTION DETAILS Casing Installed: Welded 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	Diam. from <u>+2</u> ft. to <u>}10</u> Diam. from,ft. to Diam. fromft. to	<u>Cementod</u> <u>Gracel</u> 95 105 <u>Med Hard Black Basalt</u> 105 190 <u>It. Broken Porong Rock 190 205</u> <u>It. Yellon &amp; Red</u> <u>Mater</u>
	Perforations:	in. by	in
	Screens:     Yes     X No       Manufacturer's Name	K-Pac Location Model No fromft. to	
	Gravel/Filter packed:	□ Size.of gravel/sand ft. to	APR 1 3 2000
	Surface seal:       X Yes       No         Material used in seal       Bent         Did any strata contain unusable water?         Type of water?         Method of sealing strata off	To what depth? えび ニャドデモ □ Yes □ No Depth of strata	
(7)	PUMP: Manufacturer's Name	H.P	·
(8)	WATER LEVELS: Land-surface elévatio Static level	n above mean sea levelft. below top of well Date <b>_2 - 2.7-</b> lbs. per square inch Date (Cap, valve, etc.)	Work Started 2-24-00 Completed 2-29-00 Well CONSTRUCTION CERTIFICATION:
(9)	WELL TESTS: Drawdown is amount wa         Was a pump test made?       □ Yes X No         Yield:      gal./min. with         Yield:      gal./min. with         Yield:      gal./min. with         Pried:      gal./min. with         Recovery data (time taken as zero when well top to water level)       Time         Time       Water Level       Time	ter level is lowered below static level If yes, by whom?	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.         _hrs.       _hrs.         _hrs.       Type or Print Name       _y Le         _hrs.
	Bailer test     gal./min. with       Airtest     Eat 25 gal./min. with       Artesian flow     Temperature of water 5 7 6 Was a contract of water 5 7 7 6 Was a contract of water 5 7 7 6 Was a contract of water 5 7 7 6 Was a contract of water 5 7 7 6 Was a contract of water 5 7 7 6 Was a contract of water 5 7 7 6 Was a contract of water 5 7 7 6 Was a contract of water 5 7 7 6 Was a contract of water 5 7 7 6 Was a contract of water 5 7 7 6 Was a contract of water 5 7 7 6 Was a contract of water 5 7 7 6 Was a contract of water 5 7 7 6 Was a contract of water 5 7 7 6 Was a contract of water 5 7 7 6 Water 5 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	ft. drawdown afterft. drawdown afterft. drawdown afterft. drawdown after ft. drawdown after g.p.m. Date chemical analysis made?	_hrshrshrs

ECY 050-1-20 (11/98)

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.

		<u> </u>
WATER WELL REPORT	CURRENT Notice of Intent No <u><i>W</i></u> 169413	
$t_{c_0 \downarrow_0 c_y}$ Original & isi copy Ecology 2nd copy owner 3rd copy artiler <b>Construction/Decommission</b> (x in circle) $17776$	Unique Ecology Well ID Tag No HGh 88/	
Construction	Water Right Permit No	
of Intent Number	Property Owner Name AllAN HAMiltoN	A
PROPOSED USE Domestic Industrial Municipal	Well Street Address YAKithat R.	
DeWater Irrigation Test Well Other	City Benton City County Benton 03	
TYPE OF WORK Owner's number of well (if more than one)	Location N & 1/4 1/4 NL 1/4 Sec 14 Twn 9 R265	WD circ
Deepened Cable Rotary Detted	Lat/Long Lat Day	WM
DIMENSIONS Diameter of well 6 inches drilled 225 ft	(s,t,r still Lat Min/Sec	
Depth of completed well ZOO ft	Tax Parcel No. 1/19/2/0/09 3/664	<u> </u>
CONSTRUCTION DETAILS Casing Dwelded 6 Diam from + 18" ft to 40ft	CONSTRUCTION OR DECOMMISSION PROCEDURE	
Installed $\square$ installed $\square$ Diam from $\cancel{f2}$ ft to $\cancel{f4}$ ft	Formation Describe by color character size of material and structure a	nd the
Diam fromft toft	entry for each change of information Indicate all water encountered	one
Perforations Pres No	(USE ADDITIONAL SHEETS IF NECESSARY )	
SIZE of perfsin byin and no of perfs fromft toft	MATERIAL FROM T	
Screens Yes Ko K Pac Location		5
Manufacturer's Name	Basalt Gravel 13 30	8
DiamSlot Sizefromft_toft		
DiamSlot Sizefromft_toft	Fractured Brown 38 7.	2
Gravel/Filter packed Yes Ko Size of gravel/sand	Basall And And A	0
Materials placed fromft toft	1942 13LaCK 13459/1 15 9	<u>8</u>
Materials used in sealBth tonite	Soft Basalt mix 98 12	10
Did any strata contain unusable water? Yes	GLAY	
Type of water?Depth of strata	Brown BasgIT/2015	2
PUMP Manufacturer's Name	Plack Dag 19102	7-7
Type H P	13LACK 13454/1 132 11	5
WATER LEVELS Land surface elevation above mean sea levelft	Soft Basalt mix 17319	78
Artesian pressurelbs per square inch Date	CLav	
Artesian water is controlled by	Grey CLay 198 20	27
(cap valve etc.)	CENTRY	
Was a pump test made? Yes No If yes by whom?	Green Sangy & Lay 20122	<u>(</u> 5)
Yieldgal /min withft drawdown afterhrs		
Yieldgal /min withft drawdown afterhrs		{
Recovery data (time taken as zero when pump turned off)(water level measured from well top to water level)	loe, all	
Time Water Level Time Water Level Time Water Level		
Date of test		
Bailer testgal/min_withft drawdown afterhrs Airtest /0-12 gal/min_with stem set at /9.5 ft for 2 hrs		
Artesian flowg p m Date	Start Date 10-16-02 Completed Date 10-18-0	7
WELL CONSTRUCTION CEPTIEICATION   Locostructed and/or accent	nsibility for construction of the set 1	-47
Washington well construction standards Materials used and the information re	ported above are true to my best knowledge and belief	
Driller Engineer Trainee Name (Print) David CO	Drilling Company RW LOX Drilling	
Driller/Engineer/Trainee Signature David Cir	- Address 40, Box 5324	
Driller or Trainee License No Z <u>Z Z /</u>	- City State Zip Benton City, Wash 993	<u>320</u>
If trainee, licensed driller s	- Contractor s Registration No RAI COX OD 225C Date 10-19-0	02
Signature and License no	Ecology is an Equal Opportunity Employer ECY 050 1 20 (Rev 4	4/01)

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## Appendix B Geochemical Data

Sample ID	Description	рН	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			r	1							
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					

Table B1. Field measurements: pH, temperature, dissolved oxygen, conductivity, alkalinity

\*estimated depth based on nearby wells; \*\* DO – dissolved oxygen

## Table B1. Field measurements (continued)

Sample ID	Description	рН	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		23.3	8.7	446	4.45
WW39	Gravel 61.6 m		18.3	9.0	478	3.96
WW8	Unknown 76.2 m		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		T	1	Г		
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

Sample ID	Na⁺ (ppm)	K⁺ (ppm)	Mg <sup>2+</sup> (ppm)	Ca <sup>2+</sup> (ppm)	F <sup>−</sup> (ppm)	Cl <sup>−</sup> (ppm)	NO₃ <sup>−</sup> -N (ppm)	SO <sub>4</sub> <sup>2-</sup> (ppm)	HCO₃ <sup>−</sup> (ppm)	CO <sub>3</sub> <sup>2-</sup> (ppm)	δ <sup>18</sup> Ο (‰)	δD (‰)
Surface Wa	ater											
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
Groundwat	ter											
Western G	roup	1	1	1	Г	1	1	Г	1	Г	1	<b></b>
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 B2. Major ion and stable isotope data

Sample	Na⁺	K⁺	Mg <sup>2+</sup>	Ca <sup>2+</sup>	F⁻	Cl⁻	NO₃ <sup>–</sup> -N	<b>SO</b> 4 <sup>2-</sup>	HCO₃⁻	CO <sub>3</sub> <sup>2–</sup>	δ <sup>18</sup> Ο	δD
ID	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)	(‰)	(‰)
WW35	29.0	9.3	28.9	61.6	0.79	16.6	4.24	154	256	0.3	-13.85	-103.5
Badger Cou	lee 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 Cou	lee 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

Sample ID	Na⁺ (ppm)	K⁺ (ppm)	Mg <sup>2+</sup> (ppm)	Ca <sup>2+</sup> (ppm)	F <sup>−</sup> (ppm)	Cl⁻ (ppm)	NO₃ <sup>−</sup> -N (ppm)	SO₄²− (ppm)	HCO₃ <sup>−</sup> (ppm)	CO₃²− (ppm)	δ <sup>18</sup> Ο (‰)	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 Gro	oup											
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

חו	AI	V	Cr	Mn	Fe	Ni	Cu	Zn	As	Se	Мо	Ba	Pb	U
	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)	(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
Ground	water													
Westerr	n 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

ID	Al	V	Cr	Mn	Fe	Ni	Cu	Zn	As	Se	Мо	Ва	Pb	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

ID	AI	V	Cr	Mn	Fe	Ni	Cu	Zn	As	Se	Мо	Ва	Pb	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								
WW15	0.5	bdl	bdl	3.0	0.8	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