Revised Groundwater Protectiveness Evaluation

City of Umatilla
Umatilla, Oregon

For

City of Umatilla

January 22, 2020

GeoEngineers
Earth Science + Technology

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1.0 INTRODUCTION/PROBLEM STATEMENT

Oregon Department of Environmental Quality (DEQ) defines setbacks from drinking water wells for stormwater underground injection controls (UICs) to protect drinking water supplies. The setbacks stipulated for a stormwater UIC are that it must be greater than 500 feet from a water well or outside of the calculated 2-year Time-of-Travel capture zone for a water system water supply well. If a stormwater UIC is within the setback, then the owner/operator must show that potential discharges from these UICs will not pollute groundwater and cause a violation of drinking water regulations and/or endanger a public water system well.

UIC owners must demonstrate protectiveness by showing that the vertical separation from the bottom of a UIC and the seasonal high groundwater table is large enough that pollutants in stormwater do not endanger groundwater or violate the prohibition of fluid movement standard. DEQ guidance allows UIC owners to use existing groundwater protectiveness studies to demonstrate that protectiveness if the demonstration has been done previously for the geology in the UIC owner's jurisdiction.

Twenty (20) City of Umatilla (City) stormwater UICs are identified within DEQ stipulated setbacks in the System-Wide Assessment prepared in support of Application number 965886 for Individual WPCF Permit for Class V Stormwater Underground Injection Control Systems dated January 5, 2015. Consequently, the City must demonstrate groundwater protectiveness for these identified UICs. This evaluation encompasses nineteen (19) of the 20 UICs. The UIC identified as UIC 65 is not included in this evaluation since the location and/or existence of the UIC is currently unknown. Maps of the locations of the identified UIC's are provided in Attachment A.

An evaluation of the geologic units in which the City's UICs are located, the units in which the City's water supply wells are located, and a detailed look at existing groundwater protectiveness demonstrations lead us to conclude that the demonstrations done for the City of Redmond (GSI 2011) and City of Canby (GSI 2013) are applicable to the City. Both have similar hydrogeologic systems. The Redmond study cites Columbia River Basalt group (CRBG) hydrogeologic properties and the Canby study cites Cataclysmic Flood Deposits that are directly applicable to Umatilla.

Based on discussions held between the City, GeoEngineers Inc. (GeoEngineers), and DEQ, it is understood that DEQ is open to evaluating a demonstration of protectiveness by the City using the existing demonstration of protectiveness by the City of Redmond (GSI 2011) and Canby (GSI 2013). To that end, GeoEngineers prepared this memo on behalf of the City to demonstrate that the geohydrologic parameters used by the City of Redmond and the City of Canby largely represent those of the CRBG aquifer system and Cataclysmic Flood Deposits in Umatilla, and where the parameters would vary, that the CRBG aquifer system is more protective than the hydrogeologic conditions encountered at Redmond.

This report is based on previously compiled and publicly available reports and data.

2.0 GEOLOGIC AND HYDROGEOLOGIC CONDITIONS

The area surrounding the UICs addressed herein displays the same basic geologic and hydrogeologic conditions which are summarized below by the Oregon Department of Water Resources (OWRD 1995).

2.1. Stratigraphic Units

The stratigraphic units underlying the area, from the surface downwards to a depth of approximately 700 to 900 feet include the following:

- Cataclysmic Flood Deposits (Pscf) laid down during Ice-Age floods. In the Umatilla area these strata are dominated by unconsolidated and uncemented sand and gravel, range from 0 to approximately 170 feet thick, and are absent where underlying basalt is exposed.
- Elephant Mountain Member, Saddle Mountains Basalt, commonly exceeds 100 feet in thickness and underlies the entire area except immediately adjacent to the Umatilla River where it is locally absent.
- Rattlesnake Ridge Member, Ellensburg Formation, consists of 20 to 40 feet of weakly indurated claystone and siltstone.
- Pomona Member, Saddle Mountains Basalt, commonly exceeds 100 feet in thickness and underlies the entire area.
- Selah Member, Ellensburg Formation, consists of 20 to 40 feet of weakly indurated claystone and siltstone.
- Umatilla Member, Saddle Mountains Basalt, commonly exceeds 100 feet in thickness and underlies the entire area.
- Mabton Member, Ellensburg Formation, consists of 5 to 10 feet of sandy strata.
- Upper Wanapum Basalt, multiple basalt layers extending many hundreds of feet deep.

2.2. Hydrogeology

The Pscf varies in thickness from not present up to 170 feet thick according to well logs for the area around the City. These deposits range from interbedded silt to unconsolidated pebble to boulder gravels. Groundwater, if present, in this unit is typically unconfined (Cameleo et al 2014). The Pacific Northwest Hydrolithologic Categories map developed by Comeleo for the EPA (2014) shows these deposits in the Umatilla area are primarily categorized as coarse-grained unconsolidated. Based on local shallow well logs typical hydraulic conductivity for this unit is 35.1 feet/day (Comeleo et al 2014).

Regional studies have demonstrated that the CRBG consists of layered planar-tabular basalt flows that display the same basic three-part internal arrangement of lithostratigraphic features (Makin 1961; Grollier and Bingham 1971, 1978; Myers and Price 1979; Swanson et al. 1979; USDOE 1988; Beeson et al. 1989; Reidel et al. 2013). These features, termed intraflow structures, originated during the emplacement and cooling of each lava flow and are referred to as the flow top, flow interior, and flow bottom (USDOE 1988; Lindbergh 1989).

The combination of a flow top of one flow and the flow bottom of the overlying flow, with or without an intervening sediment interbed, is referred to as the interflow zone (Figure 1). Individual interflow zones are laterally extensive, extending as far as the flows that they separate. Groundwater in the CRBG primarily occurs within the interflow zones (Newcomb 1969; Oberlander and Miller 1981; Lite and Grondin 1988; USDOE 1988; OWRD 1995). Laterally expansive flow top breccia can have a high degree of interconnected pore space resulting in formation of widespread, permeable, water-bearing aquifers at the tops of individual basalt flows (USDOE 1988). Groundwater within the basalt aquifers is stored and transmitted primarily in interflow zones, or groups of interflow zones. The physical properties of undisturbed, laterally extensive, dense interiors of CRBG flows give this portion of the flow low, to essentially no horizontal or vertical permeability (Newcomb 1969; Lite and Grondin 1988; USDOE 1988; Lindberg 1989; Wozniak 1995; Tolan et al. 2009).

3.0 CITY OF UMATILLA UICs

The Umatilla UICs addressed herein (Table 1) are identified to be within the 500-foot setback or 2-year time of travel of existing water supply wells. Based on a review of OWRD's well database we identified three clusters comprised of UICs that are in the vicinity of 4 water supply wells (Attachment A). The three clusters are referred to as the western, High School, and eastern clusters. These water supply wells include two City potable water supply wells, Wells No. 2 and No. 3, and two wells at Umatilla High School, only one of which is reported to now be used for irrigation. The western cluster is associated with City Well No. 2, the High School cluster is associated with the two wells drilled for the High School, and the eastern cluster is associated with City Well No. 3.

The physical characteristics of the four water supply wells are summarized on Table 2. Well logs for these wells are provided in Attachment B. Basic observations with respect to the UICs addressed herein and the four wells are summarized in the following sections below.

3.1. Western Cluster (City Well No. 2—UMAT 50632)

Twelve UICs comprise the western cluster (Attachment A-2) and all are reported to be constructed to 4 feet deep in Pleistocene Catastrophic Flood Deposits (Pscf). In this area the Pscf appears to be approximately 130 to 170 feet thick.

City Well No. 2 (UMAT 50632), which is associated with the western cluster, is reported to have several casing strings in it. The upper string is reported to be set to a depth of 165 or 170 feet. Based on the original well geologic log we interpret the bottom of this casing to be at top of basalt (Attachment B).

Groundwater has not been found in the Pscf in the vicinity of the western cluster. Three wells near-by wells (UMAT 3377, UMAT 50195, and UMAT 56104), outside of the 500-ft setback or two-year time of travel, all report first water only being encountered in the underlying basalt. Water levels on the logs show rebounding up the well bore from the depth where they are first encountered, which is indicative of confined conditions in the basalt (Attachment B).

3.2. High School UIC Cluster (UHS Wells—UMAT 53534 and 53535)

Three UICs comprise the High School cluster (Attachment A-3) and all are reported to be constructed 4 feet deep in the Pscf. The Pscf in the vicinity of these UICs is estimated to be 30 to 60 feet thick.

Of the two water supply wells associated with this cluster, both were originally installed for geothermal use. One well is currently being used for irrigation purposes. Neither well is assigned to a potable water system. One of these wells, UMAT 53534, is cased and sealed to a depth of 42.5 feet which is 5.5 feet into basalt. The other well, UMAT 53535, is cased and sealed to a depth of 63.5 feet which is 5.5 feet into basalt. Neither is reported to be open to the Pscf.

3.3. Eastern UIC Cluster (City Well No. 3—UMAT 3347)

Four UICs comprise the eastern cluster (Attachment A-4) and all are reported to be are constructed 4 feet deep in the Pscf. The thickness of the Pscf in this area is commonly less than 10 feet.

One water supply well (Well No. 3, UMAT 3347) is in the vicinity of the eastern cluster. The well log reports first water only being encountered in the underlying basalt. Water is also reported as rebounding up the well bore, which is indicative of confined conditions in the basalt. This well does not report groundwater in the Pscf in this area. Well No. 3 is cased and sealed 500 feet into the basalt and not open to the Pscf.

4.0 CONCEPTUAL UNDERSTANDING OF UMATILLA'S IDENTIFIED UICs

As noted above, the UICs in question are completed in, and discharge stormwater to Cataclysmic Flood Deposited sand and gravel, alluvial strata, overlying the CRBG. Conversely, the four water supply wells are all completed within the underlying CRBG aquifer system, are built using seal and casing, and as a result do not have hydraulic connection with sediments overlying the basalt. The alluvial sediment in the vicinity of the UIC clusters are not used as water supply sources because they usually do not host groundwater in the Umatilla Area.

In the Umatilla area, the degree of hydraulic connection between the alluvial sediments—within which the UICs are completed—and the upper CRBG aquifer system—in which the four water supply wells are completed—is addressed in general terms in OWRD's Lower Umatilla Basin (LUB) geologic and hydrogeologic investigation (OWRD 1995). The LUB investigation concluded that the potential for discharge from saturated alluvial sediments into shallow basalt aquifers is limited to areas where basalt flow margins are exposed beneath saturated alluvial sediments. Plate 2.2 in that report and online geologic maps from the U.S. Geological Survey (USGS) and OWRD suggest such conditions do not occur in the immediate vicinity of the UIC clusters. This basic understanding of likely hydrogeologic conditions, including recharge to shallow basalt aquifers, is illustrated in Figure 2.5 in OWRD (1995).

OWRD (1995), more recent USGS investigations (Kahle et al. 2011; Ely et al. 2015), and other studies (USDOE 1988; Lindberg 1989) provide additional information that is useful in understanding the potential for stormwater introduced into the alluvial system by the UICs to move into deeper basalt aquifers. This information includes:

- Median saturated horizontal hydraulic conductivity in water-bearing flow tops in the Saddle Mountains aquifer are reported to be on the order of approximately 0.5 to 8 feet/day.
- The reported range of saturated horizontal hydraulic conductivity varies from as little as 0.007 to over 3,000 feet/day. The Pacific Northwest Hydrolithologic Categories map categorizes the exposed basalt in the region as old basalt with a hydraulic conductivity of 69 ft/day (Comeleo et al 2014).
- Vertical hydraulic conductivity through intervening dense basalt flow interiors is not well understood, but the reports noted above indicate that the ratio of horizontal to vertical hydraulic conductivity ranges 3 to as much as 6 orders of magnitude.

Vertical joints might provide a pathway for movement of water through these dense rocks. The Redmond study cites evidence from Lindberg (1989) that shows that these joints have very little potential to transmit water. The Lindberg report supports this basic finding. It includes observations that joints are mostly filled with secondary silica, zeolites, and clay. As a result, less than 1 percent of joints have observable pore space, and that pumping test data in these types of strata show hydraulic conductivity of approximately $3x10^{-3}$ to $3x10^{-7}$ feet/day.

As shown on Table 2 the top of the open interval (potential water producing interval) in all four water wells is at or below the top of basalt. In addition, the two wells near the High School cluster and other wells in the area of the western and eastern clusters do not report water bearing strata until several tens of feet into the basalt sequence. Based on well construction reported on the well logs and summarized on Table 2 and OWRD's geologic and hydrogeologic investigation of the LUB Groundwater Management Area (OWRD 1995), water production from these four wells is interpreted to be from planar tabular basalt flow tops, bottoms, and interbedded coarse sedimentary strata in the Saddle Mountains Basalt and upper Wanapum Basalt. Conversely, the dense, planar tabular, rock separating basalt flow tops and bottoms are interpreted to have very low to essentially no permeability and do not produce groundwater.

Taken as a whole – existing well construction, OWRD's interpretation of basic area hydrogeology, and physical and hydrogeologic property data reported in local and regional studies – the alluvial UICs in the three clusters have very little potential to effect basalt aquifer system groundwater quality in nearby basalt aquifer wells that are open to the middle Saddle Mountains and deeper aquifer zones ranging from approximately 38 feet to almost 500 feet below the bottom of the UICs.

5.0 UIC GROUNDWATER PROTECTIVENESS

Since the UICs are completed in cataclysmic flood deposits and the water production wells of concern are completed in the CRBG, we examined two protectiveness demonstrations to compare the hydrolithology and governing hydrogeologic fate and transport parameters. The protectiveness demonstration for the City of Canby, Oregon (GSI 2013) was chosen for the cataclysmic flood deposits, and the City of Redmond (GSI 2011) was chosen for the underlying basalt.

5.1. Cataclysmic Flood Deposits

The Canby groundwater protectiveness demonstration (GSI 2013) was selected because the Cataclysmic Flood Deposits in both Canby and Umatilla are classified as coarse-grained unconsolidated alluvial deposits under the study done by Comeleo (2014). The deposits in Canby can be as thick as 120 ft (GSI 2013). A vertical separation distance of 2.5 ft was accepted for the flood deposits in Canby. The hydraulic K used in Canby model was 26.6 feet per day, which is only slightly lower than values published for the deposits in Comeleo of 35.1 feet per day. This vertical separation is applicable to the identified UICs in Umatilla for the following reasons:

- The flood deposits are classified as hydrolithogically similar, suggesting the properties governing fate and transport of stormwater are the same.
- The protection of drinking waters is greater in Umatilla, as groundwater does not exist in sufficient quantities in the flood deposits of the UICs to support water supply wells.
- All the wells in the identified clusters are screened in the basalt system.

5.2. Columbia River Basalt

The Redmond groundwater protectiveness demonstration (GSI 2011), models the UIC directly discharging into the basalt aquifer; although, the Umatilla UICs are completed in the alluvium, which regional studies show is in very low hydrogeologic connection with basalt aquifers. We will accept the conservative assumption made in the Redmond demonstration that infiltration from the UICs will result in the "eventual downward movement of water through basalt fractures"(GSI 2011) since the four wells of concern are completed in the basalt aquifer and the thickness of the Pscf is highly variable.

The Redmond groundwater protectiveness demonstration (GSI 2011) is based on a fate and transport model developed using the following ten chemical and physical parameters:

- Porosity
- Soil Moisture
- Soil Bulk density
- Fraction of organic carbon
- Organic carbon partitioning coefficient
- Distribution coefficient
- Bio degradation Rate
- Infiltration time
- Hydraulic Conductivity
- Pore Velocity

The source of data, and the use of each of these parameters in the Redmond model and report is summarized on Table 3. In reviewing the hydrogeologic properties used in the Redmond report and comparing them to CRBG characteristics summarized above, we found that some information sources are from CRBG publications, and, therefore, are applicable to Umatilla. In fact, the Redmond hydrologic conditions are less conservative than those we see in the CRBG. For example:

- Porosity cited from Lindberg is also directly applicable to Umatilla as Lindberg's study was for the CRBG.
- Vertical hydraulic conductivity (and pore velocity) derived from published values and on-site tests in Redmond showed values ranging from 0.002 to 6.2 feet/day.
- By way of comparison, the range of vertical hydraulic conductivities in the CRBG noted above fall between approximately 3x10-7 to 3 feet/day. These are similar to, or even less than those seen at Redmond, indicating CRBG vertical hydraulic conductivity is the same as, or less than, those seen at Redmond, an area underlain by similar volcanic rocks.
- With respect to infiltration time Umatilla is similar to and/or less than Redmond, reducing the number of days when precipitation exceeding 0.04 inches per hour will occur.

Taking the other Redmond parameters as reported and using the hydraulic properties cited in the report, indicates to us that the Redmond finding of a 5 foot of vertical separation between the bottom of the UIC and the aquifer for similar volcanic and sedimentary strata is applicable to Umatilla.

If that is accepted, with respect to the three clusters, vertical separation is seen to be as follows:

- In the western cluster the depth of casing and seal in Well No. 2 is 165 feet, which results in in a vertical separation of 161 feet below the bottom of the UICs.
- In the eastern cluster the depth of casing and seal in Well No. 3 is 500 feet, which results in a vertical separation of approximately 496 feet below the bottom of the UICs
- In the High School cluster well UMAT 53534 the depth of casing and seal is 42.5 feet, placing it 38.5 feet below the bottom of the UICs and well UMAT 53535 the depth of casing and seal is 63.5 feet, placing it 59.5 feet below the bottom of the UICs.

These separations meet or exceed those recommended at Redmond.

6.0 CONCLUSIONS

The Canby and the Redmond UIC evaluations showed that a vertical separation of 2.5 feet for coarse flood deposits and 5 feet for the CRBG between the bottom of UICs and the top of the water producing interval in nearby water supply wells is sufficient to protect those wells from contamination from the UICs.

- Canby relied on very coarse cataclysmic flood deposits with a higher infiltration capacity.
- Vertical hydraulic conductivity in the cataclysmic flood deposits in Umatilla are categorically the same as those for Canby.
- Redmond relied on CRBG porosity that indicate very low infiltration capacity.
- Vertical hydraulic conductivity in the CRBG are similar to and less than those seen in the similar volcanic rocks underlying Redmond.
- The basalt strata underlying Umatilla were shown during LUB investigations to limit vertical recharge of basalt aquifers except under conditions that do not apply to the UIC clusters. The basalts underlying these sites are not truncated by saturated alluvial sediments in direct hydraulic connection with the basalt aquifers intersected by the four water supply wells in question.

For these reasons the 5-foot vertical separation found to be protective of groundwater should be applied to Umatilla.

7.0 LIMITATIONS

We have prepared this report for the City of Umatilla for Groundwater Protectiveness Evaluation. The City of Umatilla may distribute copies of this report to the City of Umatilla's authorized agents and regulatory agencies as may be required for the project.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of hydrology and geology in this area at the time this report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment and experience. No warranty, express or implied, applies to our services or this report.

Any electronic form, facsimile or hard copy of the original document (email, text, table and/or figure), if provided, and any attachments should be considered a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

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Table 1

Identified Out-of-Compliance UICs

City of Umatilla Groundwater Protectiveness Evaluation
Umatilla, Oregon

UIC Identifiers		UIC Location				Well Setbacks				
Umatilla's UIC Number	DEQ UIC Number	Latitude	Longitude	UIC Depth (feet)	Discharges Directly to Groundwater (Field Observation)? (Yes/No)	Within 500 feet of water well? (Yes/No)	Within 2- Year Time of Travel? (Yes/No)	Well Affected by UIC	Prohibited Under OAR 340-044-0015(2)? (Yes/No)	Geologic Unit
36	12939-36	45.906928	-119.346803	4	No	No	Yes	Well 2	No	Pscf
37	12939-37	45.907322	-119.346717	4	No	No	Yes	Well 2	No	Pscf
38	12939-38	45.907828	-119.346494	4	No	No	Yes	Well 2	No	Pscf
42	12939-42	45.906922	-119.347449	4	No	No	Yes	Well 2	No	Pscf
43	12939-43	45.906797	-119.347725	4	No	No	Yes	Well 2	No	Pscf
44	12939-44	45.906894	-119.348708	4	No	No	Yes	Well 2	No	Pscf
45	12939-45	45.906151	-119.348431	4	No	No	Yes	Well 2	No	Pscf
46	12939-46	45.905847	-119.348564	4	No	No	Yes	Well 2	No	Pscf
47	12939-47	45.907497	-119.3478406	4	No	No	Yes	Well 2	No	Pscf
48	12939-48	45.907797	-119.347444	4	No	No	Yes	Well 2	No	Pscf
49	12939-49	45.908456	-119.348881	4	No	No	Yes	Well 2	No	Pscf
50	12939-50	45.909339	-119.348931	4	No	No	Yes	Well 2	No	Pscf
62	12939-62	45.917358	-119.339111	4	No	Yes	No	Both UHS Wells	No	Pscf
63	12939-63	45.917361	-119.338742	4	No	Yes	No	Both UHS Wells	No	Pscf
64	12939-64	45.917310	-119.335790	4	No	Yes	No	Both UHS Wells	No	Pscf
65	12939-65	45.917153	-119.326328	4	No	No	Yes	Both UHS Wells	No	Pscf
70	12939-70	45.917136	-119.279089	4	No	No	Yes	Well 3	No	Pscf
74	12939-74	45.917444	-119.279514	4	No	No	Yes	Well 3	No	Pscf
75	12939-75	45.917789	-119.279644	4	No	No	Yes	Well 3	No	Pscf
76	12939-76	45.917731	-119.280606	4	No	No	Yes	Well 3	No	Pscf

Notes:
DEQ = Oregon Department of Environmental Quality
UIC = underground injection control
Pscf = cataclysmic flood deposits

Table 2

Umatilla UIC-Affected Wells

City of Umatilla Groundwater Protectiveness Evaluation

Umatilla, Oregon

Well ID	Owner Well ID	Date Drilled	Latitude	Longitude	1/4 1/4	Section	Township	Range	Total Depth (ft bgs)	Diameter (in)	Open Interval top (ft bgs)	Open Interval Bottom (ft bgs)	Production Interval Unit(s)	SWL (ft bgs)	Sediment thickness / Depth to Basalt (ft bgs)
UMAT 50632	Well 2	Oct-47	45°54'28.30"N	119°21'1.97"W	NE NE	19	5	28	785	16	533	785	Elephant Mountain, Pomona, Umatilla	159	170
UMAT 3347	Well 3	Dec-78	45°55'15.46"N	119°16'35.44"W	NE NW	14	5	28	989	20	500	989	Pomona, Umatilla, Upper Wanapum	200	6
UMAT 53534	UHS injection	Aug-99	45°55'1.72"N	119°20'9.63"W	SW NE	17	5	28	300	10	42.5	300	Pomona, Umatilla	71	37
UMAT 53535	UHS industrial	Aug-99	45°55'1.72"N	119°20'9.63"W	SW NE	17	5	28	300	10	63.5	300	Pomona, Umatilla	56.5	58

Notes:

ID = identification

ft = feet

bgs = below ground surface

in = inches

Table 3

Redmond Demonstration Parameter Sources

City of Umatilla Groundwater Protectiveness Evaluation

Umatilla, Oregon

Parameter	Source (GSI 2011)	Description
Porosity[1,4] (η) [%,cm^3/cm^3]	Lindberg 1989 - basalt Fetter 1994 - fine sand	Linberg 1989 facture measurements are those of the Columbia River Basalt. Fetter 1994 is a hydrogeologic published reference book.
Soil Moisture[2] (Θ) [%]	Calculated - no reference sited	Equal to or less than porosity. Will vary with time step.
Soil Bulk Density[2] (ρ_b) [g/cm^3]	Freese Cherry 1979	Calculated using porosity using Freeze Cherry 1979 formula.
Fraction of Organic Carbon[2,4,5] (f_{oc}) [-]	Allen and Morrison 1973, Donahue 2010, and site specific storm water samples.	Based on filtering in the fracture flow with percentages determined via published literature, which were then applied to site specific stromwater concentrations.
Organic Carbon Partitioning Coefficient (K_{oc}) [3,4,5] [L/kg]	Local groundwater pH samples. Contaminant specific published literature (Table 5. pg. 21 GSI 2011)	K_{oc} is largely controled by pH. Published liturature provides look up tables for K_{oc} for a specific polutant for a range of pH values.
Distribution Coefficient (K_d)[2,4,] [L/kg]	Bricker 1998 and stormwater samples from Bend, OR, for metals, and Watts 1998 for all others.	Watts 1998 is based on f_{oc} and K_{oc}.
Degredation/Biodegredation Rate[4] (%/day)	Contaminant specific published literature (Table 11. pg. 28 GSI 2011)	Organic Contaminants only.
Infiltration Time[5] (day)	Nation Climatic Data Center for Redmond (COOP 357062).	Number of days with precipitation events exeecing 0.04 inches per hour, half the value required in the City of Portland permit fact sheet (0.08 inches/hour).
Hydraulic Conductivity (K_v)[3,4,5] [ft/day]	Site Specific Pump-in tests and USDU 1993, Anderson and Woessner 1992, Gannett and Lite 2004.	Tests measured horizontal saturated hydraulic conductivity (K_h), converted to vertical hydraulic conductivity (K_v) via K_h:K_v ratio
Pore Velocity [3,4,5] (v) [ft/day]	Estimated from K_v in pump in tests.	Although, defined as unsaturated flow used K_v for Quaternary Basalt. 2.1-3.0 ft/day.

Notes:

[1] Parameter values used are those of the Columbia River Basalt

[2] Parameters are caluclated from or based on other parameters using Columber River Basalt

[3] Parameter values are for the Deschutes formation

[4] Parameters based on general peer reviewed published literature.

[5] Site specific

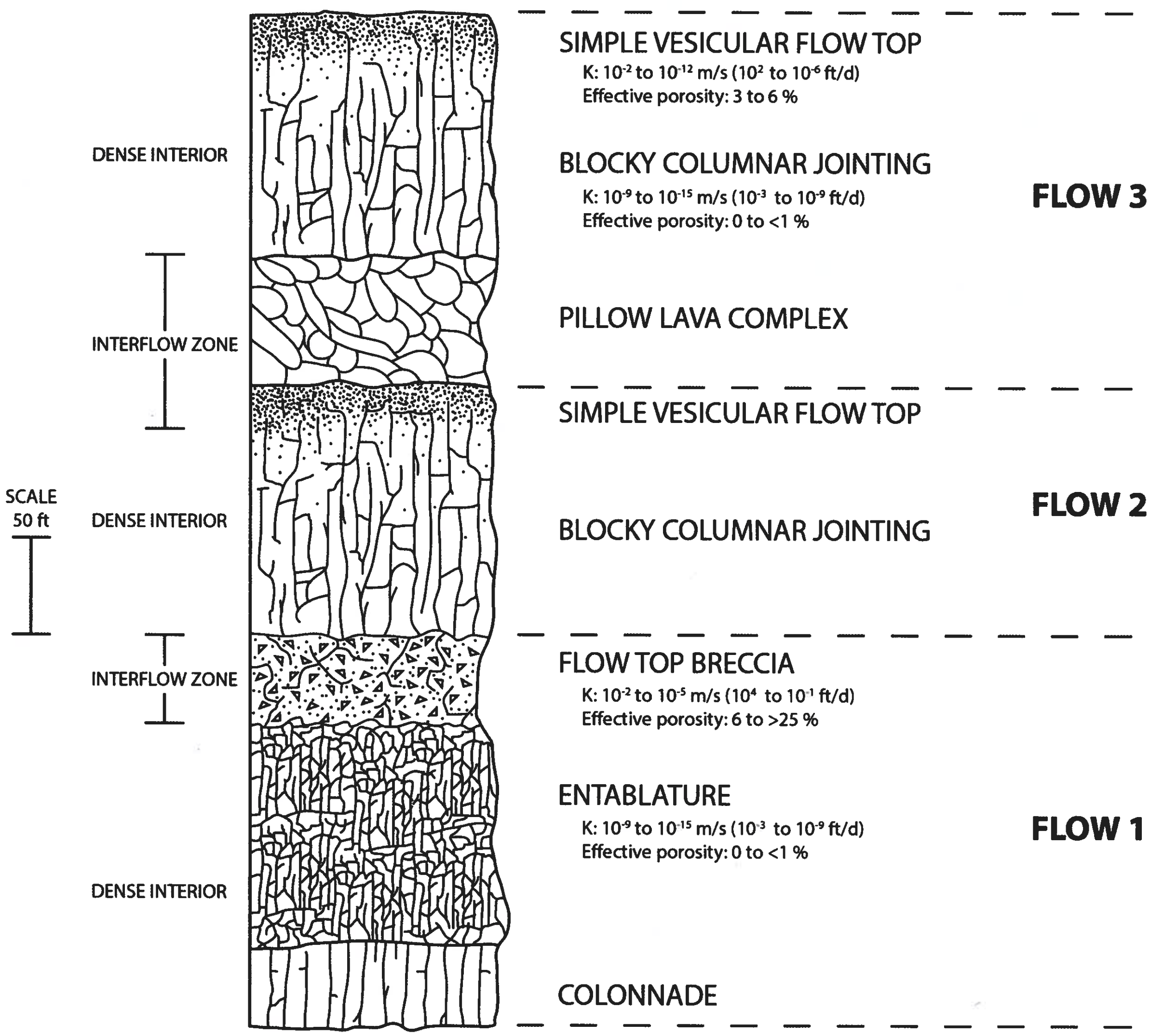
cm^3 = cubic centimeter

g = grams

L = liters

kg = kilograms

ft = feet



Notes:
1. The location of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, inc. and will serve as the official record of this communication.

Columbia River Basalt Intraflow Structures

Groundwater Protectiveness Evaluation of Selected UIC's
Umatilla, Oregon

GEOENGINEERS

Figure 1

APPENDIX A
Identified UIC Maps

Attachment A-1 CITY OF UMATILLA

Legend

UICs · Wells · City Limits · Tax Lots (5/28/19)

Feet

0 1,000 2,000 3,000 4,000

MAP DISCLAIMER: No warranty is made as to the accuracy, reliability or completeness of this data. Map should be used for reference purposes only. Not survey grade or for legal use. Created by Brandon Seitz, on 9/26/2019

Attachment A-2 CITY OF UMATILLA TAX LOT MAP

Feet
0 200 400 600 800

Legend

UICs
Wells
City Limits
Tax Lots (5/28/19)

MAP DISCLAIMER: No warranty is made as to the accuracy, reliability or completeness of this data. Map should be used for reference purposes only. Not survey grade or for legal use.
Created by Brandon Seitz, on 9/26/2019

Attachment A-3 CITY OF UMATILLA TAX LOT MAP

Legend

UICs | Wells | City Limits | Tax Lots (5/28/19)

Feet
0 100 200 300 400 500

MAP DISCLAIMER: No warranty is made as to the accuracy, reliability or completeness of this data. Map should be used for reference purposes only. Not survey grade or for legal use. Created by Brandon Seitz, on 9/26/2019

CITY OF UMATILLA TAX LOT MAP

Legend

UICs | Wells | City Limits | Tax Lots (5/28/19)

MAP DISCLAIMER: No warranty is made as to the accuracy, reliability or completeness of this data. Map should be used for reference purposes only. Not survey grade or for legal use.
Created by Brandon Seitz, on 9/26/2019

APPENDIX B
Well Driller Logs

UMAT 50632

UMAT 50632

WELL i.D.# ______

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)

Instructions for completing this report are on the last page of this form. McFarland Well

(START CARD) # ______

(1) OWNER: Well Number 2

Name City of Umatilla

Address 916 6th St

City Umatilla State OR Zip 97882

(2) TYPE OF WORK

☒ New Well ☐ Deepening ☐ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD:

☐ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger

☐ Other ______

(4) PROPOSED USE:

☐ Domestic ☒ Community ☐ Industrial ☐ Irrigation

☐ Thermal ☐ Injection ☐ Livestock ☐ Other [redacted]

(5) BORE HOLE CONSTRUCTION:

Special Construction approval ☐ Yes ☐ No Depth of Completed Well 785 ft.

Explosives used ☐ Yes ☐ No Type ______ Amount ______

HOLE			SEAL			
Diameter	From	To	Material	From	To	Sacks or pounds
15"	165	232				Unknown
12"	232	303				
8"	533	780				

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E

☐ Other ______

Backfill placed from ______ ft. to ______ ft. Material ______

Gravel placed from ______ ft. to ______ ft. Size of gravel ______

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	16"	0	165		☒	☐	☐	☐
	9.5"	303	352		☒	☐	☐	☐
	8"	352	533		☒	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) ______

(7) PERFORATIONS/SCREENS:

☐ Perforations Method ______

☐ Screens Type ______ Material ______

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour

☒ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
700	83.5		72 hr.

Temperature of water ______ Depth Artesian Flow Found ______

Was a water analysis done? ☐ Yes By whom ______

Did any strata contain water not suitable for intended use? ☐ Too little

☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other ______

Depth of strata: ______

(9) LOCATION OF WELL by legal description:

County Umatilla Latitude ______ Longitude ______

Township 5 (N) or S Range 28 (E) or W. WM.

Section 19 NE 1/4 NE 1/4

Tax Lot ______ Lot ______ Block ______ Subdivision ______

Street Address of Well (or nearest address) ______

(10) STATIC WATER LEVEL: Caliper Log

159 ft. below land surface. Date 3/20/97

Artesian pressure ______ lb. per square inch. Date ______

(11) WATER BEARING ZONES:

Depth at which water was first found ______

From	To	Estimated Flow Rate	SWL

(12) WELL LOG:

Ground Elevation ______

Material	From	To	SWL
Information on this report is from Department files and work done for the City of Umatilla.			
Marc A Norton 9/12/97			

Date started ______ Completed ______

(unbonded) Water Well Constructor Certification:

I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

WWC Number ______

Signed ______ Date ______

(bonded) Water Well Constructor Certification:

I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.

WWC Number ______

Signed ______ Date ______

ORIGINAL & FIRST COPY-WATER RESOURCES DEPARTMENT SECOND COPY-CONSTRUCTOR THIRD COPY-CUSTOMER

UMAT 50632

Umatilla City #3 - McFARLAND WELL
Well name

Index number -- 85-U
5N-28E-19-A
File number
(Code: Tp., R., Sec., ¼ Sec.)

LOCATION:

Umatilla County

Umatilla Quadrangle

5N	28E	19	NE¼ of NE¼
Tp.	Range	Section	Fractional section

D	C	B	A*
E	F	G	H
M	L	K	J
N	P	Q	R

STATISTICS:

Well type-Dug ____
Drilled x
Driven ____

Final depth 785'

Elevation (land surface) ____ ft.
above
below ____

Use status-
domestic* ____
industrial ____
irrigation ____
municipal x
*includes stock wells

Well status-
abandoned ____
dry hole ____
producer x

City of Umatilla
Owners name
Address ____

A. M. Jannsen
Original drillers name
Address 319 Pittock Block, Portland, Ore.

Date of drilling November 19, 1947

This record compiled by N.S.W. from data secured from the following sources:

Mayor J. A. Stevens, Umatilla

Deepened ____
re-cased ____
cleaned ____ by ____

Date compiled December 1947

Date ____

Material	Thickness (feet)	Depth (feet)	Remarks
Clay and top soil	17	17	Casing used:
Gravel and boulders	10	27	170' of 16"
Sand	11	38	63' of 10"
Gravel	132	170	174' of 8"
Rock	175	345	
Blue clay	28	373	
Broken rock	42	415	SWL 115'. Drawdown 90'
Rock	90	505	Yield approximately 1000
Clay	30	535	g.p.m. Temp. 71°F.
Rock	215	750	
Sandy formation	5	755	
Rock	30	785	

UMAT 50632

HOGENSON, G.M. GEOLOGY AND GROUND WATER OF THE UMATILLA RIVER BASIN OREGON GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1620, USGPO, 1964.

TABLE 2.—*Drillers' logs of representative wells*—Continued

5N/28-10R3. U.S. Army Corps of Engineers. Drilled by R. J. Strasser, 1952

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Soil and loose sand	20	20
Gravel and boulders, cemented	15	35
Gravel and boulders	5	40
Sand and gravel, cemented	11	51
Sand and gravel, loose	11	62
Gravel, some boulders and clay	10	72
Gravel, cemented, hard	14	86
Gravel	11	97
Gravel, cemented	3	100
Boulders and loose gravel	7	107
Gravel, cemented	10	117
Columbia River basalt:		
Basalt, black and red, broken	7	124
Basalt, flow breccia	9	133
Basalt, gray, hard; creviced at 182 and 194 ft	116	249
Lower part of the Ellensburg formation:		
Shale, green	24	273
Clay, gray	15	288
"Selvage"	12	300
Columbia River basalt:		
Basalt, black, porous	6	306
Basalt, gray	51	357
Basalt, black, hard and soft	48	405
Shale, green	2	407
Basalt, medium-hard	15	422
Basalt, gray and black, hard	49	471
Basalt, brown and black, creviced	5	476
Basalt, gray	20	496
Basalt, porous, caving	16	512
Basalt, gray and black, hard and broken	17	529
Basalt, broken; some clay	15	544
Basalt, gray, hard	43	587
Basalt, red, black, brown, porous	9	596
Basalt, gray	26	622
Basalt, black, porous, broken	11	633
Basalt, gray, medium-hard	17	650
Basalt, black, porous, loose	20	670
Basalt, black and gray	37	707
Basalt, broken, and blue clay	2	709
Basalt, broken, and green "slate," mineralized with iron pyrites, green coating in vesicles	4½	713½
Basalt, black, porous, and green "slate"	42½	756
Basalt, black	21	777

UMAT 50632 **5N/28-19A1. City of Umatilla (well 3). Drilled by A. M. Jannsen, 1947** McFARLAND WELL

Materials	Thickness (feet)	Depth (feet)
Glaciofluviatile deposits:		
Clay and topsoil	17	17
Gravel and boulders	10	27
Sand	11	38
Gravel	132	170
Columbia River basalt:		
Basalt	175	345
Lower part of the Ellensburg formation and interbedded basalt:		
Clay, blue	28	373
Basalt, broken	42	415
Basalt	90	505
Clay	30	535
Columbia River basalt:		
Basalt	215	750
Sandy formation (decomposed basalt?)	5	755
Basalt WATER BEARING	30	785

NOTE.—Casing, 16-inch, set to 170 feet; 10-inch set from 310 to 373 ft; 8-inch set from 361 to 535 ft. Open 8-inch hole from 535 to 785 ft. SWL 115 FT 11/13/47

RECEIVED

SEP 08 1999 umat 53534

WATER RESOURCES DEPT. SALEM, OREGON

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)

WELL ID # L 28943
START CARD # 111180

(1) OWNER:

Well Number: ______

Name: Umatilla High School
Address: 1300 7th
City: Umatilla State: OR Zip: 97212

(2) TYPE OF WORK:
☒ New Well ☐ Deepening ☐ Alteration (repair/recondition) ☐ Abandonment

(3) DRILL METHOD:
☒ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger
☐ Other:

(4) PROPOSED USE:
☐ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☒ Thermal ☒ Injection ☐ Livestock ☐ Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☐ Yes ☒ No
Depth of Completed Well 300
Explosives Used ☐ Yes ☒ No Type ____ Amount

HOLE Diameter	From	To	SEAL Material	From	To	sacks or pounds
14	0	42.5	Cement	0	42.5	24 Sacks
10	42.5	300	---------	----	----	---------

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E
☐ Other ______
Backfill placed from ____ to ____ Material ____
from ____ to ____ Material ____
Gravel placed from ____ to ____ Size of gravel

(6) CASING/LINER:

CASING:

Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
10	+2	42.5	.250	☒	☐	☒	☐
				☐	☐	☐	☐
				☐	☐	☐	☐
				☐	☐	☐	☐

LINER:

Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
8	l.s.	300	.250	☒	☐	☒	☐
				☐	☐	☐	☐

Final location of Shoe(s):

(7) PERFORATIONS/SCREENS:
☒ Perforations Method: Slotted Pipe
☐ Screen Type: Factory Material: Steel

From	To	Slot Size	No.	Diameter	Tele/pipe size	Casing	Liner
240	300	1/4x3	960	8"		☐	☒
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

Yield gpm	Drawdown	Drill Stem at	Time
300		300	1 hr.

Temperature of water 54 Depth Artesian Flow Found
Was a water analysis done? ____ By whom:
Did any strata contain water not suitable for intended use? (explain)
______
Depth of Strata: ______

(9) LOCATION OF WELL by legal description:
County: Umatilla Latitude: ____ Longitude: ____
Township: 5N Range: 28E
Section: 17 SW ¼ NE ¼
Tax Lot: N/A Lot: ____ Block: ____ Subdivision: ____
Street Address of Well (or nearest address)
1300 17th

(10) STATIC WATER LEVEL:
71 Ft. below land surface Date 8-10-99
Artesian pressure ----- lb. per sq. in. Date ____

(11) WATER BEARING ZONES:
Depth at which water was first found

From	To	Est. Flow Rate	SWL
148	156	110 GPM	71
215	235	100+	71
286	295	100+	71

(12) WELL LOG: Ground Elevation:

Material	From	To	SWL
Gravel and Sand - Red	0	19	
Silt -Tan - Red	19	28	
Gravel and Sand - Red - Loose	28	37	
Basalt - Grey - Hard	37	135	
Basalt - Light - Gray - Head	135	148	
Baslt - Fract - Gray - Hard	148	156	WB
Silt - Stone - Green - Red	156	158	
Clay - Green - Soft	158	165	
Silt - Stone - Clay - Green	165	172	
Silt - Stone - Green	172	198	
Silt - Stone - Clay - Green	198	207	
Clay - Green - Silty	207	215	
Basalt - Broken - Gray	215	235	WB
Basalt - Fract - Gray	235	237	
Clay - Stone - Free - Green	237	245	
Basalt - Fract - Gray	245	247	
Basalt - Fract - Gray	247	256	
Basalt - Hard - Gray	256	286	
Basalt - Broken - Gray	286	295	
Basalt - Hard - Gray	295	300	

Date Started: 5-25-99 Completed: 8-19-99

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration,, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

WWC Number 1620
Signed Steve Zimmerman Date ______

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.

WWC Number 723
Signed ______ Date ______

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SEP 08 1999

WATER RESOURCES
SALEM, OREGON

Umat
53535

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)

WELL ID # L 22906
START CARD # 111181

(1) OWNER:

Well Number:

Name: Umatilla High School
Address: 1300 7th
City: Umatilla State: OR Zip: 97212

(2) TYPE OF WORK:
☒New Well ☐Deepening ☐Alteration (repair/recondition) ☐Abandonment

(3) DRILL METHOD:
☒Rotary Air ☐Rotary Mud ☐Cable ☐Auger
☐Other:

(4) PROPOSED USE:
☐Domestic ☐Community ☒Industrial ☐Irrigation
☒Thermal ☐Injection ☐Livestock ☐Other

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☐Yes ☒No
Depth of Completed Well 300
Explosives Used ☐Yes ☒No Type ____ Amount

HOLE Diameter	From	To	SEAL Material	From	To	sacks or pounds
14	0	63.5	Cement	0	63.5	46 Sacks
10	63.5	300	---------	----	----	---------

How was seal placed: Method ☐A ☐B ☒C ☐D ☐E
☐ Other
Backfill placed from ____ to ____ Material ____
from ____ to ____ Material ____
Gravel placed from ____ to ____ Size of gravel

(6) CASING/LINER:

CASING:

Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
10	+1	63.5	.250	☒	☐	☒	☐
				☐	☐	☐	☐
				☐	☐	☐	☐
				☐	☐	☐	☐

LINER:

Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
8	l.s.	300	.250	☒	☐	☒	☐
				☐	☐	☐	☐

Final location of Shoe(s):

(7) PERFORATIONS/SCREENS:
☒ Perforations Method: Slotted pipe
☐ Screen Type: Factory Material: Steel

From	To	Slot Size	No.	Diameter	Tele/pipe size	Casing	Liner
240	300	1/4x3	960	8"		☐	☒
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☒ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

Yield gpm	Drawdown	Drill Stem at	Time
300		298	1 hr.
250			4 hr

Temperature of water 54 Depth Artesian Flow Found
Was a water analysis done? ____ By whom:
Did any strata contain water not suitable for intended use? (explain)

Depth of Strata:

(9) LOCATION OF WELL by legal description:
County: Umatilla Latitude: ____ Longitude: ____
Township: 5N Range: 28E
Section: 17 SW ¼ NE ¼
Tax Lot: N/A Lot: ____ Block: ____ Subdivision: ____
Street Address of Well (or nearest address)
1300 7th

(10) STATIC WATER LEVEL:
56.5 Ft. below land surface Date 8-11-99
Artesian pressure ____ lb. per sq. in. Date ____

(11) WATER BEARING ZONES:
Depth at which water was first found

From	To	Est. Flow Rate	SWL
166	173	135GPM	56.5
265	293	175	56.5

(12) WELL LOG: Ground Elevation:

Material	From	To	SWL
Gravel and Sand - Red	0	32	
Silt Tan - Soft	32	34	
Gravel and Sand - Red	34	58	
Basalt Gray - Hard	58	166	
Basalt Broken	166	173	WB
Silt Stone Green - Red	173	182	
Silt Stone and Clay - Green	182	217	
Clay Stone - Green	217	232	
Black Basalt - Med Hard	232	265	
Basalt Black & Red Fracture	265	300	WB

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OCT 2 0
WATER RES
SALEM

Date Started: 6-7-99 Completed: 8-17-99

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration,, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

WWC Number 1620
Signed Steve Zimmerman Date 8-17-99

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.

WWC Number 723
Signed ____________ Date 8-17-99

ORIGINAL & FIRST COPY - Water Resources Department SECOND COPY - Constructor THIRD COPY - Customer

NOTICE TO WATER WELL CONTRACTOR
The original and first copy of this report are to be filed with the
STATE ENGINEER, SALEM, OREGON 97310 within 30 days from the date of well completion.

WATER WELL REPORT
STATE OF OREGON
(Please type or print)
(Do not write above this line)

UMAT 3347

#3

State Well No. 5N/28E-14bq

State Permit No.

(1) OWNER:

Name: CITY OF UMATILLA

Address: P.O. BOX 130 UMATILLA ORE. 97882

(2) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:

Rotary ☒ Driven ☐
Cable ☒ Jetted ☐
Dug ☐ Bored ☐

(4) PROPOSED USE (check):

Domestic ☐ Industrial ☐ Municipal ☒
Irrigation ☐ Test Well ☐ Other ☐

CASING INSTALLED: Threaded ☐ Welded ☒

20" Diam. from +2 ft. to 500 ft. Gage .375
" Diam. from ft. to ft. Gage
" Diam. from ft. to ft. Gage

PERFORATIONS: Perforated? ☐ Yes ☒ No.

Type of perforator used

Size of perforations in. by in.

perforations from ft. to ft.
perforations from ft. to ft.
perforations from ft. to ft.

(7) SCREENS: Well screen installed? ☐ Yes ☒ No

Manufacturer's Name

Type Model No.

Diam. Slot size Set from ft. to ft.
Diam. Slot size Set from ft. to ft.

(8) WELL TESTS: Drawdown is amount water level is lowered below static level

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

Yield: 2000 gal./min. with 158 ft. drawdown after 12 hrs.
2500 " 235 " 24 "
" " " "

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

Artesian flow g.p.m.

…perature of water 68 Depth artesian flow encountered ft.

(9) CONSTRUCTION:

Well seal—Material used CEMENT GROUT

Well sealed from land surface to 60FT. AND 490 TO 500 ft.

Diameter of well bore to bottom of seal 27 in.

Diameter of well bore below seal 23 in.

Number of sacks of cement used in well seal 189 sacks

Number of sacks of bentonite used in well seal sacks

Brand name of bentonite

Number of pounds of bentonite per 100 gallons of water lbs./100 gals.

Was a drive shoe used? ☒ Yes ☐ No Plugs Size: location ft.

Did any strata contain unusable water? ☐ Yes ☒ No

Type of water? depth of strata

Method of sealing strata off

Was well gravel packed? ☐ Yes ☒ No Size of gravel:

Gravel placed from ft. to ft.

(10) LOCATION OF WELL:

County UMATILLA Driller's well number 5544

NE ¼ NW ¼ Section 14 T. 5N R. 28E W.M.

Bearing and distance from section or subdivision corner

(11) WATER LEVEL: Completed well.

Depth at which water was first found ft.

Static level 200 ft. below land surface. Date 10/11/78

Artesian pressure lbs. per square inch. Date

(12) WELL LOG: Diameter of well below casing 12

Depth drilled 989 ft. Depth of completed well 989 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. *Report each change in position of Static Water Level and indicate principal water-bearing strata.*

MATERIAL	From	To	SWL
SEE ATTACHED SHEET			

Work started MAR 30 1978 Completed DEC 8 1978

Date well drilling machine moved off of well OCT 23 1978

Drilling Machine Operator's Certification:

This well was constructed under my direct supervision. Materials used and information reported above are true to my best knowledge and belief.

[Signed] Paul O Rydman (Drilling Machine Operator) Date 1/26, 1979

Drilling Machine Operator's License No. 53

Water Well Contractor's Certification:

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

Name R.J. STRASSER DRILLING CO (Person, firm or corporation) (Type or print)

Address 8110 SE SUNSET LANE PORTLAND ORE.

[Signed] Robert L Strasser (Water Well Contractor)

Contractor's License No. 10 Date JAN 26, 1979

(USE ADDITIONAL SHEETS IF NECESSARY)

SP*45656-119

Phone: 771-2355

R. J. Strasser Drilling Co.

8110 S. E. Sunset Lane
Portland, Oregon 97206

January 28, 1979

Log of Golf Course well

brown sand	0 - 6
broken brown rock	6 - 9
med. hard grey basalt	9 - 38
broken black basalt	38 - 55
black basalt	55 - 146
broken rock and brown clay	146 - 174
broken rock and green shale	174 - 200
hard black basalt	200 - 350
broken black basalt and green shale	350 - 363
hard black basalt	363 - 418
broken black basalt and green shale	418 - 431
med. hard black basalt	431 - 541
broken and porous basalt	541 - 550
hard black basalt	550 - 561
hard grey basalt	561 - 573
porous black basalt	573 - 576
med. hard black basalt	576 - 584
broken black basalt	584 - 590
hard grey basalt	590 - 640
med. hard black basalt	640 - 653
hard grey basalt	653 - 658
porous black basalt	658 - 662
med. hard black basalt	662 - 673
hard grey basalt	673 - 685
med. hard grey basalt	685 - 700
hard grey basalt	700 - 717
porous black and blue basalt	717 - 734
hard grey basalt	734 - 758
porous black basalt	758 - 767
hard grey basalt	767 - 792
med. hard black basalt	792 - 823
hard grey basalt	823 - 859
broken black basalt	859 - 862
hard grey basalt	862 - 873
very hard grey basalt	873 - 888
med. hard black basalt	888 - 899
broken black basalt	899 - 948
med. hard black basalt	948 - 969
grey basalt	969 - 989