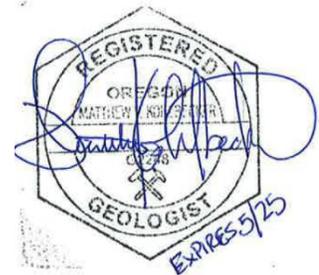




City of Hermiston

Aquifer Storage and Recovery Limited License Application and Work Plan

July 16, 2024



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- Appendix B Aquifer Testing Results
- Appendix C Well Logs for ASR Wells
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- Appendix H Land Use Information Forms
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- Appendix K Cooper-Jacob Calculations

Abbreviations and Acronyms

amsl	above mean sea level
ASR	aquifer storage and recovery
bgs	below ground surface
CaCO ₃	calcium carbonate
cfs	cubic feet per second
City	City of Hermiston
CRBG	Columbia River Basalt Group
DBP	disinfection by-product
DEQ	Oregon Department of Environmental Quality
ft	feet or foot
ft ² /day	square feet per day
ft ³ /day	cubic feet per day
gpm	gallons per minute
gpm/ft	gallons per minute per foot of drawdown
GSI	GSI Water Solutions, Inc.
MCL	maximum contaminant level
MG	million gallons
mg/L	milligrams per liter
MML	maximum measurable levels
NTU	nephelometric turbidity unit
OAR	Oregon Administrative Rules
OHA	Oregon Health Authority
OWRD	Oregon Water Resources Department
QA	quality assurance
QC	quality control
SMCL	secondary maximum contaminant level
SSPA	S.S. Papadopoulos & Associates, Inc.
TDS	total dissolved solids
UIC	Underground Injection Control
VFD	variable frequency drive

1 Introduction

The City of Hermiston (City) intends to use aquifer storage and recovery (ASR) to increase the supply and resiliency of its municipal potable water system. The City currently supplies municipal drinking water from three sources:

- Groundwater from a shallow alluvial aquifer
- Groundwater from a deep basalt aquifer
- Surface water from the Regional Water system (RWS), which supplies potable water that is sourced from the Columbia River and treated at the Regional Water Facility and Treatment Plant (RWTP).

The City’s water supply sources are summarized in Table 1 and shown in Figure 1.

Table 1. City of Hermiston Potable Water Supply.

Source Name	OWRD Well ID	Well Depth	Production Rate	Source Geology
Groundwater Sources				
Well 2	UMAT 5735	1,206 feet	1,000 gpm ^a	Columbia River Basalt Group
Well 3 (Backup)	UMAT 2075	955 feet	--	Columbia River Basalt Group
Well 4	UMAT 2061	1,041 feet	2,000 gpm ^a	Columbia River Basalt Group
Well 5	UMAT 1771	103 feet	4,000 gpm ^a	Alluvium (Catastrophic Flood Deposits)
Well 6	UMAT 5450	1,500 feet	1,781 gpm ^a	Columbia River Basalt Group
Surface Water Sources				
RWS–Potable from RWTP	NA	NA	1,527 gpm ^a	NA

Notes

^a From Table 3-1 of Anderson Perry (2019)

gpm = gallons per minute

The City intends to utilize the existing Well 6 (ASR-1) and two additional future wells (ASR-2 and ASR-3) as ASR wells. ASR wells are shown on Figure 1. Treated Columbia River water from the RWTP will be used as source water for the ASR project. The objectives of the ASR project are:

- Stabilize or reverse long-term water level declines in Well 6 due to regional overpumping.
- Increase the volume of water the City may pump from its basalt wells during the summer months by: (1) increasing groundwater levels and, therefore, available drawdown and well capacity, and (2) developing new municipal supply wells at ASR-2 and ASR-3 [the ability to develop new water supplies from native groundwater is limited due to the Sustainable Annual Yield limitations of the Columbia River Basalt Group (CRBG) aquifer].
- Increase water supply system resiliency by reducing overreliance on Well 5, the City’s current primary water source. Well 5 runs nearly continuously during the summer months and supplies 65% to 75% of the City’s water. Basalt wells are currently only used as a supplement to production from Well 5 during the summer.
- Address water quality concerns in the vicinity of Well 6 (i.e., elevated temperature) by conducting recharge with cool surface water during the winter to condition the CRBG aquifer.

This document, prepared by GSI Water Solutions, Inc. (GSI), is an ASR limited license application and includes a work plan for the City’s proposed ASR pilot testing program. The ASR limited license application and work plan are in compliance with Oregon Administrative Rules (OAR) 690-350-0020. The following index identifies where information required under OAR 690-350-0020 can be found in this document. The index was prepared to assist in reviewing the City’s ASR limited license application.

OAR	Information Location in this Document
690-350-0020 (2) Pre-Application Conference	March 14, 2024
690-350-0020 (3) (a) Applicant Information	Application Form (Appendix A)
690-350-0020 (3)(a)(B) Operations Information	Section 5 – Pilot Testing Program, ASR Limited License Application (Appendix A)
690-350-0020 (3)(a)(C) License Duration	Section 5 – Pilot Test Program
690-350-0020 (3)(a)(D) Proposed Use	Section 1 – Introduction and Section 5 – Pilot Test Program
690-350-0020 (3)(a)(E) Ultimate Project Size	ASR Limited License Application (Appendix A)
690-350-0020 (3)(a)(F) Water Right Statement	Section 3 – Permits and Approvals and Appendix F
690-350-0020 (3)(a)(G) Water Right Holder Agreement	Appendix F
690-350-0020 (3)(a)(H) Legal Land Use	Appendix H
690-350-0020 (3)(a)(I) Map	Figure 1
690-350-0020 (3)(a)(J) Oregon Health Authority (OHA) Compliance	Section 1 – Introduction
690-350-0020 (3)(a)(K) Supplemental Information	Not applicable.
690-350-0020 (3)(b)(A) Proposed ASR Test Program	Section 5 – Pilot Testing Program, Section 6 – Water Quality Monitoring Program, Section 7 – Quality Assurance and Quality Control Plan, Figure 5, Tables 8-13
690-350-0020 (3)(b)(B) Proposed System Design	Section 4 – System Operation and Wellhead Facility Design and Appendix I
690-350-0020 (3)(b)(C) Groundwater Information	Section 2 – Hydrogeologic Setting, Water Quality, and ASR Well Construction, Figures 2 through 3b, Tables 4 through 6, and Appendices B through E
690-350-0020 (3)(b)(D) Source Water Quality	Section 2 – Hydrogeologic Setting, Water Quality, and ASR Well Construction, Table 7, and Appendices D and E

OAR	Information Location in this Document
690-350-0020 (3)(b)(E) Comments on Source Water/Standards	Section 2 – Hydrogeologic Setting, Water Quality, and ASR Well Construction, Table 7, and Appendices D and E
690-350-0020 (3)(b)(F) Receiving Water Quality	Section 2 – Hydrogeologic Setting, Water Quality, and ASR Well Construction, and Appendices D and E
690-350-0020 (3)(b)(G) Comments on Compatibility	Section 2 – Hydrogeologic Setting, Water Quality, and ASR Well Construction, and Appendix E
690-350-0020 (3)(c) Other Information	UIC Registration (Appendix G)

Appendix A presents a completed Oregon Water Resources Department (OWRD) ASR limited license application for pilot testing at the City’s proposed ASR wells. The form was completed in a manner that allows operational flexibility during the testing period.

1.1 ASR Pilot Testing Objectives

ASR pilot testing will be conducted in stages and in a controlled manner designed to provide the data necessary to develop an initial ASR operational plan. The purposes of the pilot testing are to complete a testing program that can be used to apply for a permanent ASR permit and develop an operational program for ASR.

The objectives of the pilot testing are:

- Wellhead facility operation and response to ASR
- Aquifer hydraulic response to ASR
- Long-term performance of the ASR well
- Response of the CRBG aquifer to conditioning for temperature
- Optimal rate of injection and target storage volume
- Recovery rate and sustainability of pumping
- Ongoing monitoring of the chemical compatibility of the native groundwater and source water (including updating the mixing assessment, as needed)
- Quality of recovered water over time
- Frequency of redevelopment necessary to maintain an acceptable and sustainable degree of well efficiency during full-scale ASR operation
- Potential impacts of ASR including loss of stored water to springs, other aquifers, or surface water; slope instability; water quality degradation; and interference with surroundings wells as a result of recharge and recovery

1.2 Pilot Testing Study Area and Preliminary Hydrogeologic Assessment

The pilot testing study area (Figure 1) is located in the northwestern Umatilla Basin, a structural and topographic depression situated between the Blue Mountains of Oregon and the Columbia Hills of Washington. The City’s proposed ASR wells are shown in Figure 1.

The preliminary hydrogeologic assessment presented in this section is based on well testing and water quality sampling completed in January 2024, water rights, and knowledge from previous projects GSI has completed in the Umatilla Basin. The project is characterized by:

- A receiving aquifer with a transmissivity of about 4,800 square feet per day (ft²/day) based on a single-well aquifer test at Well 6 (Section 2.2.1)
- Sufficient source water availability to meet the City’s needs (up to approximately 1,050 million gallons [MG] per year). The storage capacity is based on recharging the CRBG aquifer at a rate of 2,000 gallons per minute (gpm) continuously for a year.
- Generally good groundwater and source water quality with no regulatory exceedances.

Following the issuance of an ASR limited license by OWRD, the pilot testing program will commence. Detailed geologic and hydrogeologic information for the pilot testing study area is presented in Section 2.

Key construction details of each ASR well are provided in Table 2. Because ASR-2 and ASR-3 have not yet been constructed, it is assumed that the construction of each well will be identical to Well 6.

Table 2. ASR Well Construction Details.

Well ID	Well Log	Year Completed	Static Depth to Water (1/24/2024) (feet bgs)	Total Depth (feet bgs)	Sealed/Cased Interval (feet bgs)	Production Interval (feet bgs) ^b
ASR-1 (Well 6)	UMAT 5450	1990	167.50	1,500	0 to 650	650 to 1,500
ASR-2 ^a	N/A	N/A	N/A	1,500	0 to 650	650 to 1,500
ASR-3 ^a	N/A	N/A	N/A	1,500	0 to 650	650 to 1,500

Notes

^a ASR-2 and ASR-3 do not currently exist but for planning purposes are assumed to have the same construction as Well 6.

^b Open borehole interval.

bgs = below ground surface

ASR-1 (Well 6) meets well construction requirements established by OWRD and has been approved via the Oregon Health Authority (OHA) plan review process (00372 EP-D); ASR-2 and ASR-3 will be constructed to meet current standards and be submitted for an OHA plan review as well. Data from ASR-1 (Well 6) have been incorporated into the pilot testing work plan. The goals for the City’s ASR program under this ASR limited license are: (1) to develop up to 1,050 MG of storage per year with a total recovery rate of up to 2,700 gpm per well (subject to well capacity), and (2) to improve groundwater quality by reducing groundwater temperatures in the CRBG aquifer (the groundwater temperature in Well 6 is 30.69°C).

Source water used for recharge for this ASR program will be supplied from the RWTP (certificates 96357, 9358, 96359, 96360). Details of the source water rights for the City’s ASR pilot testing program are provided in Section 3.

1.3 Pilot Testing Approach and Schedule

During pilot testing, recharge will be conducted in a controlled manner, and both the ASR well and aquifer response to ASR operations will be evaluated. Year 1 of pilot testing will consist of a shakedown test followed by a series of brief recharge-storage-recovery cycles to further evaluate system performance and develop the aquifer conditioning program. During subsequent years, water is anticipated to be recharged:

- Continuously from October 1 through March 31 of each year, and
- Intermittently from April 1 to September 30, during low demand periods when RWS water is available (e.g., overnight)¹.

The CRBG may be recharged at up to a rate of 2,000 gpm, and water may be recovered at a pumping rate up to 2,700 gpm per well (subject to well capacity). The maximum storage volume requested under this ASR limited license is 1,050 MG per year. The ASR limited license request is for 5 years (the limit established by the Oregon Administrative Rules) with the possibility of renewal if additional testing warranted before applying for an ASR operational permit.

An anticipated schedule for project development is provided in Table 3.

Table 3. Anticipated Schedule for Project Development.

Activity	Date
Pre-Application Conference	March 14, 2024
Submit Limited License Application for ASR to OWRD	July 16, 2024
ASR Limited License Issued by OWRD (assume 12-month turnaround time)	July 16, 2025
Year 1 Recharge and Monitoring	October 1, 2025 – March 31, 2026
Project Update Letter to OWRD (covers the 2025 WY, 6/14/25 to 9/30/25)	February 15, 2026
Year 1 Annual Report (covers the 2026 WY, 10/1/2025 to 9/30/2026)	February 15, 2027

Notes:

WY = water year
 ASR = Aquifer Storage and Recovery
 OWRD = Oregon Water Resources Department

¹ Sampling for disinfection by-products (DBPs) will be performed during Year 1 pilot testing to evaluate if intermittent recharge causes DBP concentrations in recovered water to exceed Environmental Protection Agency (EPA) Maximum Contaminant Levels (MCLs), which would be a fatal flaw for intermittent recharge (see Section 6.1).

2 Hydrogeologic Setting, Water Quality, and ASR Well Construction

The City is located in the Umatilla Basin, in Umatilla County, Oregon. Figure 2 shows a surficial geologic map of the City and surrounding area, and Figure 3A and Figure 3B show geologic cross sections. Geologic units beneath the City include unconsolidated alluvial deposits (consisting primarily of the Catastrophic Flood Deposits and Alkali Canyon Formation) and the Columbia River Basalt Group (CRBG). The CRBG is the target aquifer for the City's ASR program. This section presents preliminary information about the target aquifer for ASR required under OAR 690-350-020(3)(b)(C) and OAR 690-350-020(3)(b)(D).

2.1 Geology

The Umatilla Basin is a structural and topographic depression situated between the Blue Mountains of Oregon and the Columbia Hills of Washington. Basalt flows of the CRBG underlay the basin and form the basal bedrock unit. These flows are extensively exposed at the surface in the Blue Mountains but are buried beneath unconsolidated alluvial deposits underneath the City, except where locally exposed by geologic faults or folds. Unconsolidated alluvial deposits can be as thick as 250 feet near the Columbia River (Wozniak, 1995).

2.1.1 Geologic Units

The primary geologic units may be grouped as follows, organized from oldest to youngest:

- The CRBG consists of a series of continental flood basalt sheet flows that erupted between 6 and 17 million years ago from linear fissure systems located south and east of the Umatilla Basin (Tolan et al., 1989; Tolan et al., 2009). The total thickness of the CRBG in the Umatilla Basin is probably at least 5,000 feet and may exceed 10,000 feet (Davies-Smith et al., 1988). The CRBG in the Hermiston area is made up of three formations: Saddle Mountains Basalt, Wanapum Basalt, and Grande Ronde Basalt. The formations are divided into multiple members and each member consists of one or more individual lava flows. The upper 1,300 feet of the CRBG is tapped by City wells and is comprised of at least five basalt members: The Pomona Member and Umatilla Member of the Saddle Mountains Basalt, the Priest Rapids Member and Frenchman Springs Member of the Wanapum Basalt, and the Sentinel Bluffs Member of the Grande Ronde Basalt (Tolan, 1992; Wozniak et al., 1995). The basalt units are shown in the cross sections (Figure 3A and Figure 3B); the basalt members encountered by Well 6 are inferred based on well driller log interpretations and correlations with Well 2, where flows were identified by geologic logging and chemical analysis.
- The unconsolidated alluvial deposits in Hermiston are primarily composed of Catastrophic Flood Deposits and the Alkali Canyon Formation (Wozniak et al., 1995; Tolan, 1992).
 - The Alkali Canyon Formation was deposited by streams that drained the Blue Mountains to the South and is comprised of tuffaceous (ash-rich) silts and sands, as well as moderately indurated gravels. The sediments of the Alkali Canyon Formation are commonly lower permeability because much of the primary porosity of the sediments has been filled by mineral cementation.
 - The Catastrophic Flood Deposits were deposited by mega-floods caused by the episodic failure of the ice dam that impounded Glacial Lake Missoula, with the last episode occurring about 13,000 years ago (Baker, 1978). The deposits are comprised of “coarse-grained deposits” (boulders, gravels, and medium to coarse sands) and “fine-grained deposits” (silts, clays, and fine-grained sands).

2.1.2 Geologic Structure

There are two geologic structures in the vicinity of the City – the Hermiston Trough and the Service Anticline.

- The Hermiston Trough is a northeast-trending depression in the CRBG surface that was formed by structural deformation (i.e. a syncline) and erosion by the Catastrophic Floods. The trough is filled by alluvial deposits that are in hydraulic communication with shallow members of the CRBG where the water-bearing CRBG interflow zones are exposed to saturated alluvium.
- The Service Anticline is a north-south trending fold and fault complex approximately aligned with the Umatilla and Hermiston Buttes. In places, a combination of folding and erosion results in the CRBG aquifers daylighting against the saturated alluvial deposits, causing the CRBG to be in hydraulic communication with the alluvial deposits.

As shown in Figure 3A and Figure 3B, the Pomona Member appears to be in hydraulic communication with the alluvial deposits near these geologic structures and elsewhere in the Study Area.

2.2 Hydrogeology

CRBG basalt flows typically exhibit a three-part intraflow structure: flow top, flow interior, and flow bottom. The flow top and flow bottom are commonly vesicular and brecciated, and together may form relatively permeable intervals that comprise the water-bearing zones in the CRBG (interflow zones). Certain interflow zones are regionally a target storage aquifer for ASR only where they are hydraulically isolated from alluvial deposits so that recharged water cannot escape from the receiving aquifer. Based on geologic cross sections in Figure 3A and Figure 3B:

- The Pomona Member of the CRBG appears to be hydraulically connected to the alluvial deposits near structural features such as the Hermiston Trough and Service Anticline and, therefore, is not a suitable target storage aquifer for ASR.
- The Umatilla, Priest Rapids, Frenchman Springs, and Sentinel Bluffs Members of the CRBG appear to be hydraulically isolated from the alluvial deposits and, therefore, are suitable target storage aquifers for ASR.

Recharge to CRBG interflow zones in the Umatilla Basin is thought to occur at surface exposures in the Blue Mountains. Groundwater then flows downdip, flowing north towards the Umatilla Basin and the Columbia River.

2.2.1 Aquifer Properties

GSI and City staff conducted an aquifer test in January 2024 to estimate the hydraulic properties of the CRBG aquifer at ASR-1 (Well 6). A 4-hour constant rate test at a pumping rate of 1,909 gpm was conducted on January 24, 2024. The duration of the test at Well 6 was limited by water management options (i.e., the only available discharge for water was the City's reservoir, which could hold 4 hours' worth of water).

GSI was unable to collect water level data with an electronic water level meter due to a drop tube not being available. Water level data at ASR-1 (Well 6) were collected by reading off the City's SCADA system, which collected data every 5 minutes.

The specific capacity at ASR-1 (Well 6) was 8 gpm/ft (4-hour specific capacity).

All aquifer test analyses are provided in Appendix B. The results from aquifer testing are summarized in Table 4. It is important to note that the aquifer test at Well 6 is a single-well test; therefore, drawdown during the test is a function of both aquifer permeability and well inefficiency, and the transmissivity estimate is

biased low. The low transmissivity value, which is used to predict the extent of mounding and drawdown that result from ASR, is conservative because drawdown/mounding over-predicted.

Table 4. Constant Rate Aquifer Test Results.

Well ID	Pumping Rate (gpm)	Drawdown (feet)	Transmissivity, Straight Line Method (gpd/ft)	Estimated 90-day Specific Capacity (gpm/ft)
ASR-1 (Well 6)	1,909	237	36,650	7.25

2.2.2 Area Affected by ASR Operations

The area affected by the City’s ASR operations during recharge was estimated using the Cooper-Jacob approximation of the Theis solution to the groundwater flow equation to calculate the theoretical water level buildup (i.e. mounding) in the CRBG aquifer at varying distances from the ASR well:

$$\Delta s = -\frac{528Q}{T} \log(r) + \frac{1}{2} \log\left(\frac{S}{0.3Tt}\right)$$

Where:

- s = groundwater mounding (feet)
- Q = recharge rate (gallons per minute), assumed to be 75% of the recovery rate
- T = transmissivity (gallons per day per foot)
- t = time since injection started (days)
- r = radial distance from the injection well with a mounding of s (feet)
- S = storativity (dimensionless)

In addition, GSI calculated the radial extent of stored water at each ASR well:

$$R = \sqrt{\frac{V}{7.48\pi b n_e}}$$

Where:

- R = stored water radius (feet)
- V = volume of water recharged (gallons)
- b = saturated aquifer thickness (feet)
- n_e = effective porosity (dimensionless)

The potential maximum mounding during recharge was estimated for a single cycle of pilot testing at ASR-1 (Well 6) at the maximum annual recharge volume of 1,050 MG (recharge rate of 2,000 gpm for 365 days).

Table 5 shows the aquifer parameters used, and Table 6 shows radial extent of the mounding response to recharge at each ASR well after recharging for 365 days, with the radial extent defined as the location where mounding is less than twenty feet.

Table 5. Aquifer Parameters for Estimating Mounding During Recharge.

Well ID	Recharge Rate (gpm)	Transmissivity (gpd/ft)	Storativity	Volume of Water Recharged (MG)	Saturated Aquifer Thickness (feet)	Effective Porosity
ASR-1 (Well 6)	2,000	36,500	0.00005 ^a	1,050	83 ^b	0.20 ^c

Notes

^a Golder, 1996.

^b Calculated as sum of all water bearing zones noted on well log. Some are currently de-watered, but will become re-saturated as water levels rise in the well.

^c Eaton et al., 2009

gpm = gallons per minute

gpd = gallons per day

ft = foot

MG = million gallons

Table 6. Radial Extent of Mounding and Stored Water After 365 Days of Recharge.

Well ID	20-Foot Mounding Extent (miles)	Stored Water Extent (feet)	Mounding Within Stored Water Extent (feet)
ASR-1 (Well 6)	10.90	1,641	64.7 to 157.7
ASR-2	10.90	1,641	64.7 to 157.7
ASR-3	10.90	1,641	64.7 to 157.7

It is important to note that the mounding in Table 6 should be considered an approximation because, as discussed previously, the transmissivity estimated from the Well 6 aquifer test is biased low. Specifically, the mounding in Table 6 over-predicts the mounding that is anticipated to occur. As discussed in Section 2.3, up to 160 feet of mounding would not adversely affect other wells given the deep groundwater in the CRBG (Static water level of 167.5 feet bgs in Well 6 on January 24, 2024).

The estimated recharge mound in Table 6 is a pressure response within the CRBG aquifer using an equation based on several assumptions that are not met in reality (e.g., homogenous, isotropic aquifer of infinite aerial extent). While this pressure response is shown to extend over a large area (10.90 miles), the areal extent of the actual “bubble” of stored water into the aquifer will be substantially less than the recharge mound. Figure 4 shows the areal extent of stored water assuming that ASR-1 (Well 6) is exposed to 83 feet of interflows (Appendix C), the interflows are of uniform thickness and extent in the vicinity of each well, and an estimated effective porosity of 0.20 (Eaton et al., 2009). Mounding calculations are presented in Appendix K.

2.3 Anticipated Changes to Groundwater System and Loss of Stored Water

Potential impacts from ASR operations may result from: (1) pressure changes in the CRBG aquifer or (2) chemical reactions in the aquifer due to mixing between source water and native groundwater. The following paragraph discusses pressure changes in the CRBG aquifer; chemical reactions are discussed in Section 2.4.

According to an analysis of mounding using the Cooper Jacob equation, a CRBG well 2-miles away from an ASR well may experience a pressure head increase of up 41.3 feet during recharge, assuming that the CRBG well is completed in the same interflow zone(s) as the ASR well (Table 6)². This pressure head increase is not anticipated to pose an issue for other wells because the depth of groundwater in CRBG wells is over 100 feet bgs. The closest CRBG well to Well 6 is UMAT 2527, an irrigation well located 200 feet north of Well 6. UMAT 2527 is sealed from 0 to 229 feet bgs and is completed as an open borehole from 229 to 652 feet bgs; one water bearing zone is noted from 540 to 574 feet bgs. ASR-1 (Well 6) is sealed to 650 feet bgs; given that UMAT 2527 and ASR-1 (Well 6) are open to different depths, UMAT 2527 is not likely going to experience influence from ASR operations.

Available data for the Umatilla Basin indicate that the members (Frenchman Springs and Sentinel Gap) of the CRBG aquifer in which ASR-1 (Well 6) is open to (and in which ASR-2 and ASR-3 are planned to be completed) are confined and is isolated from surface streams and springs in the area. No impacts to surface water resources or users are expected.

2.4 Water Chemistry

A thorough understanding of source water quality, native groundwater quality, and the geochemical interaction between the source water and the native groundwater is necessary for an ASR project. This section discusses the water quality of the native CRBG groundwater and RWS source water, and evaluates the expected geochemical interactions between them. Results from the January 2024 sampling of ASR-1 (Well 6) and the RWS, as well as Piper and Stiff diagrams comparing water chemistry, are included in Appendix D. The water quality mixing analysis conducted by S.S. Papadopoulos & Associates (SSPA) is included in Appendix E.

2.4.1 CRBG Groundwater Quality

Groundwater sampling results from ASR-1 (Well 6) indicate that the CRBG aquifer in this area meets all regulatory standards established under the Safe Drinking Water Act and OAR 690-350-0020. Concentrations of metals, volatile organic carbons (VOCs), synthetic organic compounds (SOCs), disinfection by-products (DBPs), radionuclides, general chemistry, and aesthetic parameters were below detectable limits or relevant regulatory standards.

2.4.2 RWS Source Water Quality

Analytical results from the RWS source water quality sample are provided in Appendix D. The RWS source water quality meets the regulatory limits for ASR source water as stated in OAR 690-350-0020 of less than one-half the EPA Maximum Contaminant Level (MCL) or equal to the Secondary Maximum Contaminant Level (SMCL) for most constituents analyzed. Exceptions are haloacetic acids and total trihalomethanes detected above one half of their respective MCLs. In addition, iron was detected at 0.383 milligrams per liter

² The two-mile distance was selected based on the approximate distance between Well 6 and the closest City CRBG (Well 3)

(mg/L), slightly greater than the SMCL of 0.3 mg/L. Detections of these constituents are summarized in Table 7.

Table 7. RWS Water Quality Data.

Analyte	Criteria (mg/L)	One-Half Criteria (mg/L)	Concentration (mg/L)
Iron (total)	0.3 ^a	-	0.383
Haloacetic Acids	0.06	0.03	0.0369
Total Trihalomethanes	0.08	0.04	0.0498

Notes

^a SMCL.

mg/L = milligrams per liter

We expect that iron will be reduced to below the SMCL with increased residence time with chlorine in the City’s distribution system while source water is being conveyed to the ASR well. Disinfection by-products (DBPs) (including trihalomethane and haloacetic acids), formed during the chlorination of treated water, typically are present in drinking water and are not naturally occurring in the aquifer. Studies investigating the impact of ASR on DBPs have concluded that residual chlorine and DBPs break down rapidly in an anerobic environment and do not degrade the existing groundwater quality (Singer et al., 1993). Dissolved oxygen in ASR-1 (Well 6) was measured as 0.06 mg/L, indicating anaerobic conditions. Testing for DBPs will be conducted during the pilot testing phase to evaluate the fate of DBPs in the aquifer.

2.4.3 Groundwater Geochemical Modeling Results

The laboratory analytical results for the native groundwater (Well 6) and source water (RWS) samples collected in January 2024 were provided to S.S. Papadopoulos & Associates, Inc. (SSPA) for equilibrium geochemical modeling to evaluate compatibility between ASR source water and native CRBG groundwater. The mixing study report is provided in Appendix E.

The geochemical modeling results suggest that mixing of RWS source water with native CRBG groundwater in the project study area is not likely to result in geochemical reactions that would adversely affect the aquifer or ASR operations (Appendix E).

- **Water Quality Impacts.** Mixing of RWS and CRBG water will lower slightly elevated pH (8.52) in Well 6 groundwater but will increase total iron concentrations to levels similar to those observed in the RWS source water in a mixture that is at least 80% RWS source water. Note that the predicted increase in total iron concentrations is based on elevated iron in source water, which we expect to decline prior to recharge due to increased residence time with chlorine in City conveyance piping.
- **Potential for Mineral Precipitation.** Modeling results indicate that a mixture of RWS and CRBG groundwater will have the potential for precipitation of iron oxides, oxyhydroxides, and manganese oxides. However, low concentrations of dissolved iron and dissolved manganese in the native CRBG groundwater mean that any precipitation would likely be negligible. The potential for precipitation of other mineral groups is outlined below:
 - **Silica Minerals.** All modeled silica minerals were at or near equilibrium concentrations except for quartz. The Saturation Index (SI) for quartz was 1.0; however, the slow kinetics of quartz precipitation and low SI make precipitation unlikely.
 - **Carbonate Minerals.** Calcite and dolomite are near equilibrium in CRBG groundwater and undersaturated in RWS water. As mixing progresses, these minerals will become undersaturated.

Witherite is supersaturated in CRBG groundwater, but SI values for witherite will similarly decrease with increasing percentages of RWS water in the mixture. Witherite is also an uncommon mineral that is not expected to precipitate during ASR operations.

- **Sulfate Minerals.** Gypsum and magnesium sulfate are undersaturated in all modeled water mixtures. Barite has an SI value near equilibrium for mixtures containing more than 50% RWS water and is not expected to precipitate.
- **Temperature Sensitivity.** A sensitivity analysis conducted to assess changes in chemical composition and mineral saturation with changes in temperature found that temperature changes would not impact mineral precipitation.

Clogging caused by suspended solids is the most common issue affecting the operation and maintenance of ASR systems because of diminished ASR well performance. Suspended solids concentrations in RWS source water is less than 1 mg/L, which is the generally-accepted threshold of concern for excessive clogging (Pyne, 1995). While clogging by suspended solids is not expected to be a significant concern, solids can build up over time and eventually reduce well performance. Suspended solids that accumulate in the wellbore are anticipated to be managed by periodic backflushing during injection. The backflushing schedule will be determined during pilot testing based on changes in specific capacity.

3 Permits and Approvals

This section identifies permits and approvals necessary to conduct ASR pilot testing and provides documentation that the permits and approvals have either been obtained, requested, or will be obtained before ASR pilot testing.

3.1 Source Water Rights

The City intends to use Columbia River water from the RWS for ASR source water during late fall to early spring (October through March). This water is appropriated under water right certificates 96357, 96358, 96359, and 96360 owned by the Port of Umatilla (Port). The City has access to 1,527 gpm of treated water from the RWTP per agreement with the Port. A letter from the Port serving as the Water Right Holder Agreement verifying the availability of water and authorizing its use as source water for ASR is included in Appendix F.

3.2 Groundwater Rights

The City diverts water from the CRBG aquifer at Well 6 under Certificates 87262, 87263, and 87264. The annual volume limit under the City's CRBG water rights is limited by the Sustainable Annual Yield for the CRBG aquifer. From 2019 to 2021, allocations ranged from 644 MG to 699 MG.

3.3 Wastewater Discharge Approval

During ASR pilot testing, some well water, source water, and stored water will be pumped to waste in order to minimize and control particulates in the well or the distribution system. Discharges to waste will include backflushing episodes when injection will be stopped and the pump will be turned on for approximately 15 to 30 minutes to remove particulates that may have entered the well during recharge, and distribution system flushing conducted just before starting injection cycles to remove any particulates from the lines before injection of water into the aquifer. The discharge water will consist of mixtures of source water and native groundwater. At the ASR-1 (Well 6), ASR-2, and ASR-3 locations, the City is considering construction of infiltration basins and other alternatives (e.g., discharge to sanitary sewer or irrigation canals) to accept the pump-to-waste discharge. All proposed components of the pump-to-waste system will obtain the appropriate local and state permits before installation and operation.

3.4 Underground Injection Control Registration

All ASR operations and testing require registration and rule authorization under the Oregon Department of Environmental Quality (DEQ) Underground Injection Control (UIC) program. Appendix G contains a draft UIC registration form for each ASR well.

3.5 Land Use Approval

All ASR operations and testing require land use and development approval from the local government, or a determination from the local government that approval is not necessary. Appendix H contains a completed Land Use Information Form for the City's ASR project. The site is within City of Hermiston limits; therefore, approval was issued by the City.

4 System Operation and Wellhead Facility Design

Before pilot testing begins, each ASR well wellhead will be retrofitted for ASR operation. The wellhead design will allow the well to supply water to the distribution system during the recovery phase of pilot testing and to inject source water into the CRBG aquifer during the recharge phase. The well will be equipped with system controls that allow automatic and manual operation. A schematic diagram developed by Anderson Perry & Associates (AP) showing the proposed wellhead assembly and piping is provided in Appendix I. Each ASR wellhead will be constructed in accordance with OHA standards, and will include the following:

- Piping valves that allow for flushing distribution system water lines that provide injection source water to remove particulates before injection.
- ASR injection line valves that allow for pump-to-waste during periodic back flushing events.
- Controls to monitor turbidity and shutdown ASR injection at adjustable nephelometric turbidity unit (NTU) settings. The turbidity meter will be located far enough upstream from the wellhead to provide sufficient time for the well to be shut down if a turbidity event occurs.
- A bi-directional totalizing flow meter that can provide real-time data during recharge and recovery.
- A dedicated downhole water level transducer so that the performance of the well can be monitored.
- An access port and sounding pipe for manual water level measurements.
- Access ports for sampling during recharge, storage, and recovery.
- Real-time monitoring for temperature.
- An onsite disinfection system to maintain disinfection residual in the distribution system.

Design plans of the proposed wellhead will be submitted to OHA for plan review, and following OHA approval, the final documentation will be sent to OWRD. After the construction phase is complete, a final plan review will be submitted to OHA with the understanding that the City's ASR wells cannot be used until OHA provides final approval of the ASR facilities.

5 Pilot Testing Program

The goal for the City's ASR program under the requested limited license is to develop an ASR program that can provide storage of up to 1,050 MG of water per year. The purpose of pilot testing is to confirm ASR feasibility, and to develop design criteria for full-scale ASR operation within the aquifer. The pilot testing program described below is the framework that will be implemented initially at the City's ASR wells.

The pilot testing program under an ASR limited license consists of two components:

- **Baseline Testing and Monitoring.** Includes water level monitoring, evaluations of aquifer water quality, and well testing initiated before the start of ASR testing to document pre-ASR aquifer conditions and well performance. Baseline monitoring will begin as soon as practicable after the City receives an ASR limited license.
- **ASR Testing.** Each ASR pilot testing cycle includes an injection period, a storage period, and a recovery period.
 - **Year 1.** Includes shakedown test; four short-duration ASR cycles that will be used to develop the aquifer conditioning program; and a longer duration, operational scale pilot testing cycle. Water quality sampling will be performed throughout cycle testing to confirm compliance with ASR water quality standards, evaluate aquifer conditioning, and evaluate the response of the aquifer to ASR.
 - **Years 2 through 5.** Recharge, storage, and recovery rates and duration for subsequent pilot testing cycles will be determined based on previous years' operations. Because all stored water may not be fully recovered each year, the subsequent year's injection volume may be reduced. Water quality sampling is also included.

Each of the testing components is presented in the following subsections.

5.1 Observation Well Network

OWRD's online Well Report Query was reviewed by GSI to identify existing observation wells in the pilot test study area that could be used to evaluate background water levels and aquifer conditions in the CRBG aquifer during future ASR testing and full-scale operations. Observation wells were selected based on: (1) completion in the CRBG aquifer and (2) accessibility, based on City ownership of a well and/or recent water level measurements on OWRD's Groundwater Information System. Additional weight was given to a well if it appeared to be completed in the same deep basalt aquifers as the City's ASR wells³. The proposed observation well network is shown in Figure 5 and Table 8, and well logs are provided in Appendix J.

³ As shown in the cross section in Figure 3B, ASR-1 is inferred to be completed in the Frenchman Springs and Sentinel Bluffs Members of the CRBG, and ASR-2 is inferred to be completed in the Umatilla, Priest Rapids, and Frenchman Springs Members of the CRBG.

Table 8. Proposed Observation Well Network.

Well ID	Well Use	Latitude	Longitude	Open Interval (feet bgs)	Distance From ASR Wells (miles)	CRBG Interflow Zones Open To
UMAT 54913	Domestic	45.82411958	-119.08838498	720 to 860	9.03	Unknown
UMAT 54154	Irrigation	45.74922693	-119.19595766	319 to 1,150	5.84	Unknown
UMAT 50189	Industrial	45.76462722	-119.20517759	83 to 740	4.76	Unknown
UMAT 5736 (Well 2, #1) ^a	Monitoring	45.83884849	-119.28304249	Unknown ^b	1.81	Frenchman Springs or Sentinel Bluffs
UMAT 5736 (Well 2, #2) ^a	Monitoring	45.83884849	-119.28304249	Unknown ^b	1.81	Frenchman Springs or Sentinel Bluffs
UMAT 5736 (Well 2, #3) ^a	Monitoring	45.83884849	-119.28304249	410 to 420	1.81	Priest Rapids or Frenchman Springs
UMAT 5736 (Well 2, #4) ^a	Monitoring	45.83884849	-119.28304249	262 to 272	1.81	Priest Rapids
UMAT 2061 (Well 4)	Municipal	45.84840320	-119.28410178	310 to 1,041	2.46	Unknown

Notes

^a Collection of four nested monitoring wells within the City’s old Well 2.

^b OWRD well log showing screened depths is cutoff.

bgs = below ground surface

Note that Old Well 2 consists of four nested observation wells completed within the former City Well 2 borehole. Each observation well is open to different interflow zones in the CRBG (Appendix J), allowing for monitoring of depth-discrete impacts from ASR operations. In addition, note that inclusion of a Table 8 well in the City’s monitoring program is subject to well owner approval.

To collect observation data, the City may need OWRD’s assistance in securing access to local wells. During ASR recharge testing, water level measurements will be collected manually using an electronic water level sounder (as well access allows) bi-weekly, or less if data support less frequent measurements. During ASR storage, recovery, or idle periods, water level measurements will be collected manually once per month. In addition, water levels at City-owned wells will be monitored with existing electronic data loggers and pressure transducers. Where transducers are installed, water levels will be collected every hour.

5.2 Recovery Wells

In order to meet peaking demands, the City may construct a recovery well approximately 100 feet from each ASR well. The recovery well may be necessary if the ASR well cannot meet a peak demand requirement (for example, the current capacity of Well 6 is about 1,800 gpm, which would require a second well to reach the target recovery rate of 2,700 gpm). The recovery wells are shown as ASR-1R, ASR-2R, and ASR-3R on Figure 4. Recovery well locations were selected based on the City owning the parcel and being located within the cool water ASR bubble. Interference calculations using the Cooper Jacob equation indicate that, when an

ASR well is pumping at 1,800 gpm for 30 days⁴, about 76 feet of interference drawdown will occur in a recovery well that is located 100 feet from the ASR well. The actual interference drawdown will likely be less than 76 feet because the Cooper Jacob analysis is based on a transmissivity that is biased low, as discussed previously. Additional analysis will be conducted to confirm that this amount of interference is acceptable given the City's water demand goals, and the recovery well location will be moved with an application for a Limited License modification if needed.

5.3 Baseline Testing and Monitoring

The purpose of baseline testing and monitoring is to obtain background water level data from the CRBG aquifer and to assess pre-ASR well performance and aquifer characteristics. These data are compared to data collected during ASR testing to evaluate the effects of ASR on the aquifer and well. Baseline testing will consist of water level monitoring, water quality testing, and well performance testing. The baseline well performance and water quality testing was completed in January 2024 and is discussed elsewhere in this report (Sections 2.2 and 2.4). Similar tests will be conducted at ASR-2 and ASR-3 when they are incorporated into the ASR system.

A minimum of one month before the start of an ASR cycle, the City will begin bi-weekly monitoring of water levels in observation wells within the observation well network (Table 8).

5.4 ASR Testing: Year 1

This section describes the first year of pilot testing at the City's ASR wells. The testing will consist of an initial shake-down test; multiple short-duration ASR cycles to develop the aquifer conditioning program; and a longer duration, operational scale ASR cycle. Each of the testing cycles and the planned monitoring are described in the following sections.

During pilot testing, water levels will be measured in the same wells used for baseline groundwater monitoring. The purpose of monitoring water levels is to assess aquifer response to recharge and recovery, as well as potential impacts to other wells completed in the same aquifer. The City's ASR wells will be instrumented with pressure transducers and data loggers that will record water levels approximately every hour. Other well locations will be monitored bi-weekly during recharge using a manual water level meter unless they are instrumented with data loggers and pressure transducers. During storage, recovery, and idle periods, water levels in observation wells will be monitored monthly.

Table 9 shows the maximum recharge and recovery rates at each proposed ASR well during Year 1. The recharge and recovery rates are based on the theoretical maximum combined recharge rate of 2,000 gpm being injected through a single well. Because recharge must occur at a lower rate than recovery (typically 75% of recovery, to impart more energy on the formation during recovery), the recovery rate was calculated such that the recharge rate is 75% of the recovery rate.

⁴ Assuming that Well 6 is pumped at the current capacity of 1,800 gpm

Table 9. Maximum Recharge and Recovery Rates.

Well ID	Maximum Recharge Rate ¹ (gpm)	Maximum Recovery Rate (gpm)
ASR-1 (Well 6)	2,000	2,700
ASR-2	2,000	2,700
ASR-3	2,000	2,700

Notes

gpm = gallons per minute

(1) Recharge will occur at up to 2,000 gpm; total recharge rate among ASR-1, ASR-2, and ASR-3 will not exceed 2,000 gpm.

Water quality samples will be collected during pilot testing. The planned water quality monitoring program is presented in Sections 6 and 7.

5.4.1 Shakedown Test

Before initiating the first pilot testing cycle, a shakedown test will be performed that will consist of injecting source water into the ASR well to check the operation of the piping and valves. The function of the automatic flow control system will also be checked. Adjustments to the system will be made as necessary. After the short injection period, the well pump will be operated to recover all injected water and check well pump operation. The injection and pumping rates will be adjusted to optimize system operation for the longer cycle test. The shakedown test is anticipated to last 8 hours. Recovered water from the testing will be discharged to the City’s distribution system or a future infiltration basin.

5.4.2 Year 1 Cycle Testing

The objective of cycle testing during Year 1 is to develop the aquifer conditioning program, and to evaluate the long-term aquifer response, well performance, and water quality conditions under operational-scale ASR in the aquifer.

Year 1 will consist of five cycles of recharge, storage, and recovery. Data collected during recharge will be used to assess head buildup in the aquifer, increased production performance resulting from recharge, potential for loss of stored water, the area affected by recharge, and ASR well efficiency changes over time. Data collected during storage will be used to determine if the quality of the stored water changes substantially during storage and the degree to which the head buildup is maintained. A four-hour pumping test will be completed at the start of Cycle 5 recovery. Data collected during recovery will be used to estimate the amount of initial mixing between source water and native groundwater, and to identify changes in well performance and aquifer characteristics relative to the initial baseline pumping tests.

The Year 1 schedule will depend on construction schedules, City demands, and well performance, but is anticipated to consist of:

- **Cycle 1 to Cycle 4.** Four short-term ASR cycles of 10 to 14 days each. Data from these cycles will be used to assess storage zone development, results of aquifer conditioning for temperature, system and aquifer hydraulics, recovered water quality, aquifer response, and well performance.
- **Cycle 5.** One long-term ASR cycle of approximately 125 days. The purpose of this cycle is to approximate operational-scale ASR activities and to evaluate the feasibility of long-term ASR recharge operations.

The Year 1 schedule is provided in Table 10, assuming Well 6 is the ASR well. If a different well is used, an updated ASR testing plan for that well will be submitted to OWRD.

Table 10. Year 1 Anticipated Plan of Operations.

Cycle	Recharge			Storage		Recovery	
	Rate ^a	Duration	Volume ^a	Duration	Rate ^a	Duration	Volume ^a
	(gpm)	(days)	(MG)	(days)	(gpm)	(days)	(MG)
1	1,100	4	6.3	3	1,800	3	6.3
2	1,100	4	6.3	3	1,800	3	6.3
3	1,100	4	6.3	3	1,800	3	6.3
4 ^b	1,100	4	6.3	3	1,800	7	18.1
Evaluate test results from Cycle 1 through Cycle 4 to assess water quality and drinking water compliance of the recovered water prior to initiating Cycle 5							
5 ^c	1,100	60	95.0	30	1,800	35	90.3

Notes

^a Based on rate observed during aquifer testing in January 2024.

^b Longer recovery period to ensure all mixed source water is recovered.

^c Assumes that 95% of recharged water is recovered per the conditions of the City’s Limited License. This is presented for planning purposes only. Note that the recharge and recovery volumes will be adjusted based on the results of Cycle 1 through Cycle 4.

gpm = gallons per minute

MG = million gallons

The schedule, rates, and volumes described above are estimates only and may vary significantly. Consequently, the total amount of water stored may be variable and carryover of stored water to buffer against native groundwater, thermally condition the aquifer, and hedge against future drought periods may occur in any given year.

5.4.3 Contingency Plan

The City intends to use recovered water in its distribution system. In the unlikely event that the quality of the injected water becomes impaired or the recovered water is unacceptable, all of the water injected into the aquifer will need to be recovered and pumped to waste or managed in accordance with appropriate disposal standards. The wellhead system will be designed to allow for discharge of water to a pump-to-waste system or the storm system. However, on the basis of the water quality analysis conducted to date and GSI’s experience with ASR in CRBG aquifers, the likelihood of this situation occurring appears highly unlikely.

5.5 ASR Testing: Years 2 through 5

The results of the Year 1 pilot testing at the City’s ASR well will be evaluated and used to optimize ASR operation in future years. Target ASR volumes, rates, durations, and schedules will be developed on the basis of Year 1 results. Year 2 may consist of recharge only to condition the CRBG aquifer for temperature, to meet aquifer conditioning goals of the project. Once this goal is met, year-long cycles of recharge, storage, and recovery will begin. The ASR operations plan for the following year will be submitted with each annual report.

5.5.1 Limited License Duration

The City is seeking approval of a limited license for a 5-year period with the option to extend the limited license period for an additional length.

6 Water Quality Monitoring Program

ASR regulations require that source water and native groundwater be analyzed for OHA regulated and unregulated constituents, constituents with DEQ water quality maximum measurable levels (MML), and constituents with federal MCLs and SMCLs before pilot testing begins and periodically during the testing period. In addition to the above-mentioned constituents, the native groundwater also must be tested for selected general water quality parameters and common ions to evaluate aquifer response to recharge and recovery, and progress towards aquifer conditioning goals. Results of source water and native groundwater quality testing conducted to date are discussed in Section 2 and are provided in Appendix D.

The objectives of water quality monitoring for the ASR pilot testing program include the following:

- Confirm that the recharged and recovered water meets criteria established in OAR 690-350-0020:
 - Legally enforceable regulatory limits for drinking water constituents in the Safe Drinking Water Act and Oregon Administrative Rules
 - Aesthetics of the recovered water (taste and odor)
- Assess water quality compatibility with respect to:
 - Injection well clogging caused by particulates (turbidity), air, biological activity, and chemical reactions
 - Mineral dissolution reactions in the aquifer that could affect recovered water quality
 - ASR well redevelopment criteria
 - Recovery efficiencies

The components of water quality monitoring for the pilot testing program are described in the following subsections. A discussion of the background native groundwater quality, source water quality, and predicted geochemistry resulting from mixing is presented in Section 2.

6.1 Water Quality Monitoring: Year 1 Pilot Testing

During Year 1 of ASR, water quality samples will be collected during the injection, storage, and recovery periods of Cycle 1-5 testing as outlined in Table 11. A tentative ASR operations schedule for the first year of pilot testing at each ASR well and water quality analyses are presented in Table 10 and Table 11. The program has been designed to meet the objectives stated previously.

Table 11. Year 1 Water Quality Sampling Schedule.

Water Source		Progress Period	Analyte Groups ^{a, b, c, d}	
Native Groundwater		~30 days prior to injection	FP, GC, DBPs, Metals, Misc, Radon, Rads, SOC, VOC	
Source Water		~30 days prior to injection	FP, GC, DBPs, Metals, Misc, Rads, SOC, VOC	
		Cycles 1-4	Start of recharge	FP, WQ
			Middle of recharge	FP, WQ
			End of recharge	FP, WQ
		Cycle 5	30-50% recharge	FP, GC
70-100% recharge	FP, GC, DBPs, Radon			
Stored Water		Cycles 1-4	Prior to recovery	FP, WQ, DBPs
		Cycle 5	~30 days prior to recovery	FP, GC, DBPs, Metals, Misc, Radon, Rads, SOC, VOC
Recovered Water		Cycles 1-4	Middle of recovery	FP, WQ, DBPs
			End of recovery	FP, WQ, DBPs
		Cycle 5	30-50% of recovery	FP, GC, DBPs
			70-100% of recovery	FP, GC, DBPs

Notes

^a FP = Field Parameters; GC = General Chemistry; WQ = Water Quality Tracking; DBP = Disinfection Byproducts; Misc = Miscellaneous; Rads = Radionuclides; VOC = Volatile Organic Compounds; SOC = Synthetic Organic Compounds..

^b See Table 13 for list of analytes within each group.

^c Sampling for radon will be completed on an optional basis as radon is not currently regulated; however, the sampling frequency for will be modified to the appropriate schedule if drinking water standards are established.

^d Up to four quarters of radiological samples may be required by OHA for ASR 1 as a new source. If no radiologicals are detected in the first two consecutive quarterly samples, the remaining two consecutive quarterly samples need not be collected. If radiologicals are detected in the first two consecutive quarterly samples, two additional consecutive quarterly samples will be collected. The consecutive quarterly sampling may span more than one year if groundwater pumping or ASR recovery ends before the four consecutive quarters of samples are collected. Radiological sampling will continue at the frequency required by OHA after the initial consecutive quarterly sampling is completed, or every 3 years, whichever is more frequent.

6.2 Water Quality Monitoring: Pilot Testing, Years 2 through 5

Table 12 outlines the general sampling schedule for Years 2 through 5; Table 13 (attached) details the full analyte list. If this anticipated program changes based on Year 1 pilot testing results, an updated water quality monitoring program for future years will be developed and submitted to OWRD.

Table 12. Years 2-5 Water Quality Sampling Schedule.

Water Source	Progress Period	Analyte Groups ^{a, b, c}
Native Groundwater	~30 days prior to injection	FP, GC, Metals
Source Water	~30 days prior to injection	FP, GC, Metals, Misc, DBP, Rads ^d , VOC ^d , SOC ^d
	30-50% of injection	FP, GC
	70-100% of injection	FP, GC, DBP
Stored Water	Mid-point storage (variable)	FP, GC, DBP
Recovered Water	~30 days prior to recovery	FP, GC, Metals, Misc, DBP, Rads ^d , VOC ^d , SOC ^d
	30-50% of recovery	FP, GC
	70-100% of recovery	FP, GC, DBP

Notes

^a FP = Field Parameters; GC = General Chemistry; DBP = Disinfection Byproducts; Misc = Miscellaneous; Rads = Radionuclides; VOC = Volatile Organic Compounds; SOC = Synthetic Organic Compounds.

^b See Table 13 for list of analytes within each group.

^c Up to four quarters of radiological samples may be required by OHA for ASR 1 as a new source. If no radiologicals are detected in the first two consecutive quarterly samples, the remaining two consecutive quarterly samples need not be collected. If radiologicals are detected in the first two consecutive quarterly samples, two additional consecutive quarterly samples will be collected. The consecutive quarterly sampling may span more than one year if groundwater pumping or ASR recovery ends before the four consecutive quarters of samples are collected. Radiological sampling will continue at the frequency required by OHA after the initial consecutive quarterly sampling is completed, or every 3 years, whichever is more frequent.

^d Will be sampled every third year.

7 Quality Assurance and Quality Control Plan

This quality assurance (QA) and quality control (QC) plan describes water sampling QA/QC procedures that will be performed during the City's ASR pilot testing program at the ASR well. The purpose of the QA/QC plan is to obtain water quality data that are representative of the water quality at each sampling location. GSI and/or the City will collect the water quality samples and submit them to a laboratory for analysis. GSI or the City will review field and laboratory data for completeness and compliance with this plan.

7.1 Field QA/QC

QA/QC procedures that will be used in the field during the ASR pilot testing program include field equipment calibration, field record keeping, and chain-of custody documentation. No duplicate samples will be collected in the field. If lab testing results indicate that a parameter has an unexpectedly high concentration exceeding the MCL or MML, injection or pumping will be stopped and the location will be resampled as soon as possible. Each element of the field QA/QC is described below.

7.2 Field Equipment Calibration

Field meters require calibration to ensure accurate and precise measurement of field parameters. The field meters will be calibrated before each sampling event and subsequently operated in a manner consistent with the manufacture's recommendations.

7.3 Field Record Keeping

The sampling technician will document field observations and measurements on a water sampling field form during sampling. The following information will be recorded on the form for each sampling point:

- Time of day and date
- Name of person performing the sampling
- Location of sampling source and sampling port
- Field parameter values (pH, temperature, specific conductivity, dissolved oxygen, and oxygen reduction potential) collected during sampling
- Appearance of sample (turbid or clear)
- Thermal and chemical preservation (if any)

If groundwater samples are collected from wells, the following additional information will be recorded on the form:

- Depth to groundwater
- Field parameter values collected during purging intervals
- Purging time and volume of water purged (only if the well is sampled after startup)

7.4 Sample Labels

A sample label will be secured to each water sample container. The following information will be included on the sample labels:

- Project location and name
- Sample identification (e.g., well ID# and date)

- Date and time of sample collection
- Type of preservative (if any)
- Other pertinent information requested by the analytical laboratory that will be analyzing the water samples

7.5 Sample Names

Each sample will be named according to the following format: HER-AAAA-BB-CC-D, where:

- “HER” indicates the sample was collected from a City of Hermiston well.
- “AAAA” indicates where the sample was collected from: RWS (RW), ASR1, ASR2 or ASR3
- “BB” indicates whether the water represents native groundwater (GW), source water (SW), stored water (ST), or recovered water (RW).
- “CC” indicates the cycle (C1 for Cycle 1, C2 for Cycle 2, etc.).
- “D” indicates the sample number within a given cycle (1 indicates the first sample of “AA” collected during a cycle, and 2 indicates the second sample of “AA” collected during a cycle).

For example, HER-ASR2-RW-C1-2 would be the second recovered water sample collected during Cycle 1 at ASR-2.

7.6 Chain-of-Custody

A chain-of-custody form will be used to track possession of each sample and document the requested analyses. The following procedure will be used regarding chain-of-custody records.

1. After collecting the samples, the sampling technician will complete the chain-of-custody form.
2. The chain-of-custody record will accompany the samples from the field to the laboratory.
3. Each individual having samples in his/her custody must ensure that the samples are not tampered with and that the chain-of-custody record is completed upon sample transfer.
4. A copy of the completed forms will be retained in the project files.

7.7 Laboratory QA Program

Samples collected during the pilot testing program will be analyzed by an analytical laboratory certified by the Oregon Environmental Laboratory Accreditation Program.

The analytical laboratory will use trip blanks, method blanks, spikes, duplicates, surrogates, and control samples in each analytical batch containing the City’s samples being analyzed, or at a frequency of at least one in every 20 samples, depending on the analysis being performed. The results from these procedures will accompany the sample test results. A copy of the analytical laboratory’s QA manual is available upon request.

8 Schedule for Year 1 Pilot Testing

Table 9 presents the anticipated pilot testing schedule for the first year of the City's ASR cycle testing. Table 10 outlines the recharge, storage, recovery, and water quality sampling schedule at the City's ASR wells. The schedule may vary depending on when the ASR limited license is approved, and could change in response to construction schedules, City demands, and well performance.

9 ASR Annual Water Year Report Form

The following is an outline of the pilot test report that will be submitted at the conclusion of Year 1 pilot testing:

- Executive Summary
- Project Description
 - Introduction
 - Existing Site Conditions
- Pilot Test Results
- ASR Injection and Pumping Rates and Volumes (stored water and native groundwater)
 - Injection and Pumping Efficiency
- Water Quality Monitoring
 - Injected Water Quality
 - Recovered Water Quality
 - Chemical Reactions
- Water Level Monitoring and Aquifer Response
 - Data Collection
 - Results
- Conclusions
- Proposed ASR Operations Plan for Year 2

10 References

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APPENDIX A

ASR Limited License Application

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ASR Limited License No. _____
 (ASSIGNED AFTER FILING)



**APPLICATION FOR
 AQUIFER STORAGE AND RECOVERY (ASR) LIMITED LICENSE**

Applicant: City of Hermiston
Mailing Address: 180 NE 2nd St, Hermiston, OR 97838
Phone and Email: 541-567-5521; mmorgan@hermiston.gov

Authorized Agent: GSI Water Solutions, Inc.; Matt Thomas
Mailing Address: 650 NE Holladay St, Ste 900, Portland, OR 97232
Phone and email: 423-987-4716; mthomas@gsiws.com

1. **DATE(S) OF PRE-APPLICATION CONFERENCE(S):** March 14, 2024

INFORMATION REGARDING ASR TESTING UNDER A LIMITED LICENSE

2. **SOURCE OF INJECTION WATER for ASR:** Columbia River
 a tributary of Pacific Ocean

2.5 **WATER RIGHT AUTHORIZATIONS (Permit or Certificate numbers):** _____
 Certificates: 96357, 96358, 96359, 96360

3. **MAXIMUM DIVERSION RATE:** 2,000 gpm

4. **MAXIMUM INJECTION RATE AT EACH WELL(S):** _____

Table 1. ASR WELLS (attach additional pages as needed)

ASR Well Name	ASR Well Log ID (e.g. UMAT 12345, if not yet drilled= "proposed")	ASR Well Tag Number (e.g. L 123456)	ASR Well Location (metes and bounds from public land survey corner)
ASR-1 (Well 6)	UMAT 5450	L 246959	105 feet north and 435 feet west from C1/4 Corner, Section 24
ASR-2	Proposed	Proposed	Proposed
ASR-3	Proposed	Proposed	Proposed

5. **MAXIMUM STORAGE VOLUME:** 5,250 MG (1,050 MG/year)
6. **MAXIMUM STORAGE DURATION:** 5 years
7. **MAXIMUM WITHDRAWAL RATE AT EACH WELL(S):** 2,700 gpm

8. **LICENSE TERM OR DURATION SOUGHT (5 year maximum):** 5 years

9. **PROPOSED USE OR DISPOSAL OF RECOVERED WATER:** Municipal

10. **IF CONTINGENCIES PRECLUDE THE USE IN ITEM 9, SPECIFY AN ALTERNATE USE OR DISPOSAL OF THE RECOVERED WATER:** See text.

INFORMATION REGARDING THE ULTIMATE ASR PROJECT
AS CURRENTLY ANTICIPATED

11. **SOURCE OF INJECTION WATER for ASR:** Columbia River
a tributary of Pacific Ocean
- 11.5 **WATER RIGHT AUTHORIZATION (Application, Permit or Certificate numbers):** _____
Certificates: 96357, 96358, 96359, 96360
12. **MAXIMUM DIVERSION RATE:** 2,000 gpm
13. **MAXIMUM INJECTION RATE AT EACH WELL(S):** 2,000 gpm

14. **MAXIMUM STORAGE VOLUME:** 5,250 MG (1,050 MG/year)
15. **MAXIMUM STORAGE DURATION:** 5 years

16. MAXIMUM WITHDRAWAL RATE AT EACH WELL(S): 2,700 gpm

NOTE: The materials required by rule for an ASR limited license are extensive. The items on this sheet consist of those outlined in OAR 690-350-020(2) and (3)(a)(A-E). Please consult the rule and provide as attachments to this form the other requirements in OAR 690-350-020, including:

- ASR Test Program (3)(b)(A)
- Proposed System Design (3)(b)(B)
- Groundwater Information (3)(b)(C)
- Quality of source water, aquifer water and compatibility assessment (3)(b)(D-G)
- Water Availability Statement Water Right Holder Agreement (as necessary) (3)(a)(F-G)
- Legal Land Use Form (3)(a)(H)
- Site Map (3)(a)(I)
- OHA DWS Plan Review Acknowledgement (public supply systems only) (3)(a)(J)
- ASR LL Application Fee. Consult current fee schedule at:
<http://www.oregon.gov/owrd/pages/pubs/forms.aspx#fees>
- Submit one hard copy in person or by mail to: Oregon Water Resources Department, 725 Summer St NE, Suite A, Salem, OR 97301
- Submit a digital copy to: Jennifer.L.Woody@oregon.gov
- Questions? Contact Jen Woody, OWRD Hydrogeologist, at 503-986-0855

Signature of Applicant  Date 6/11/24

Title of Applicant Asst. City Manager

APPENDIX B

Aquifer Testing Results

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Figure B.1: Depth to Water vs. Time in Well 6

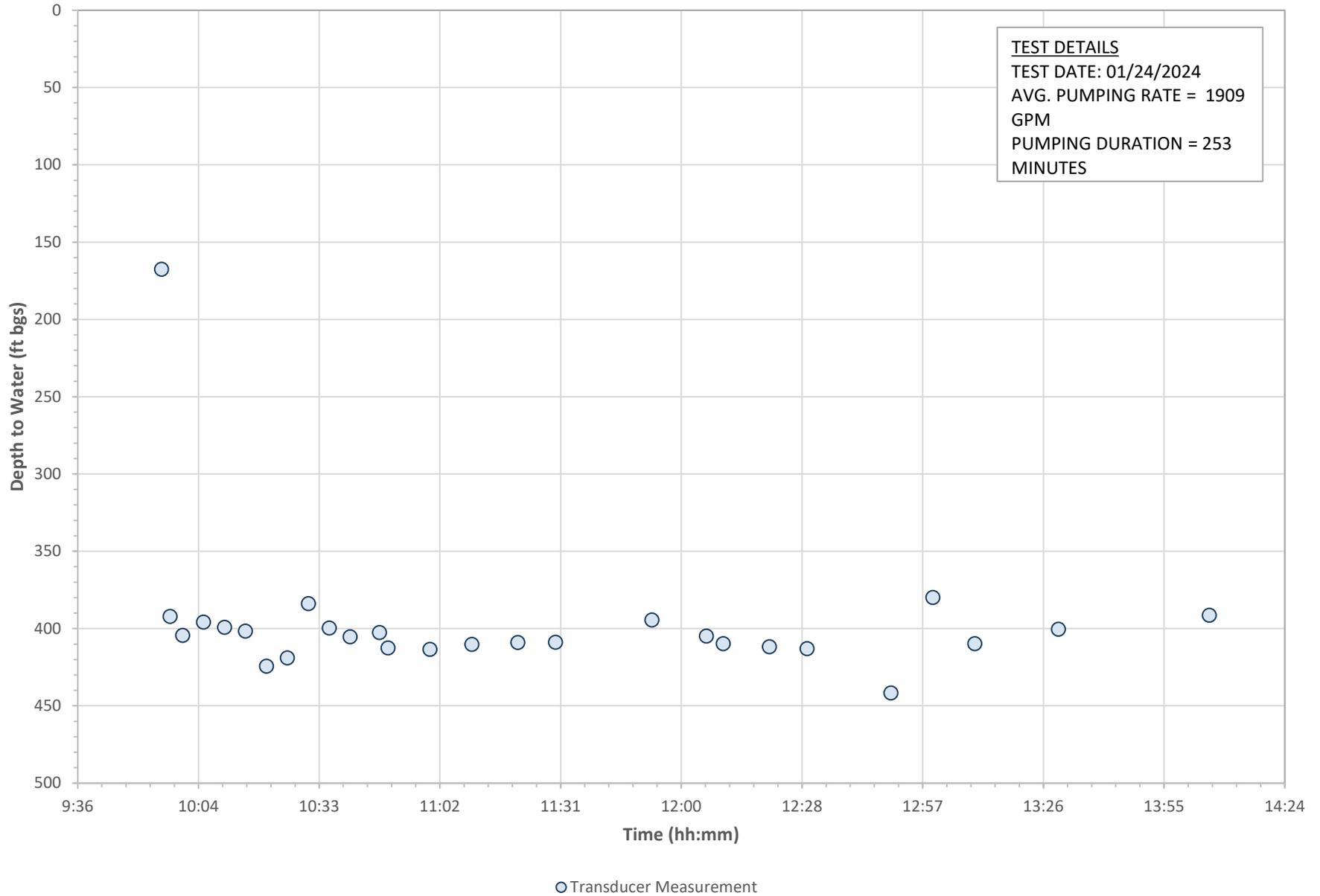


Figure B.2: Drawdown vs Time in Well 6

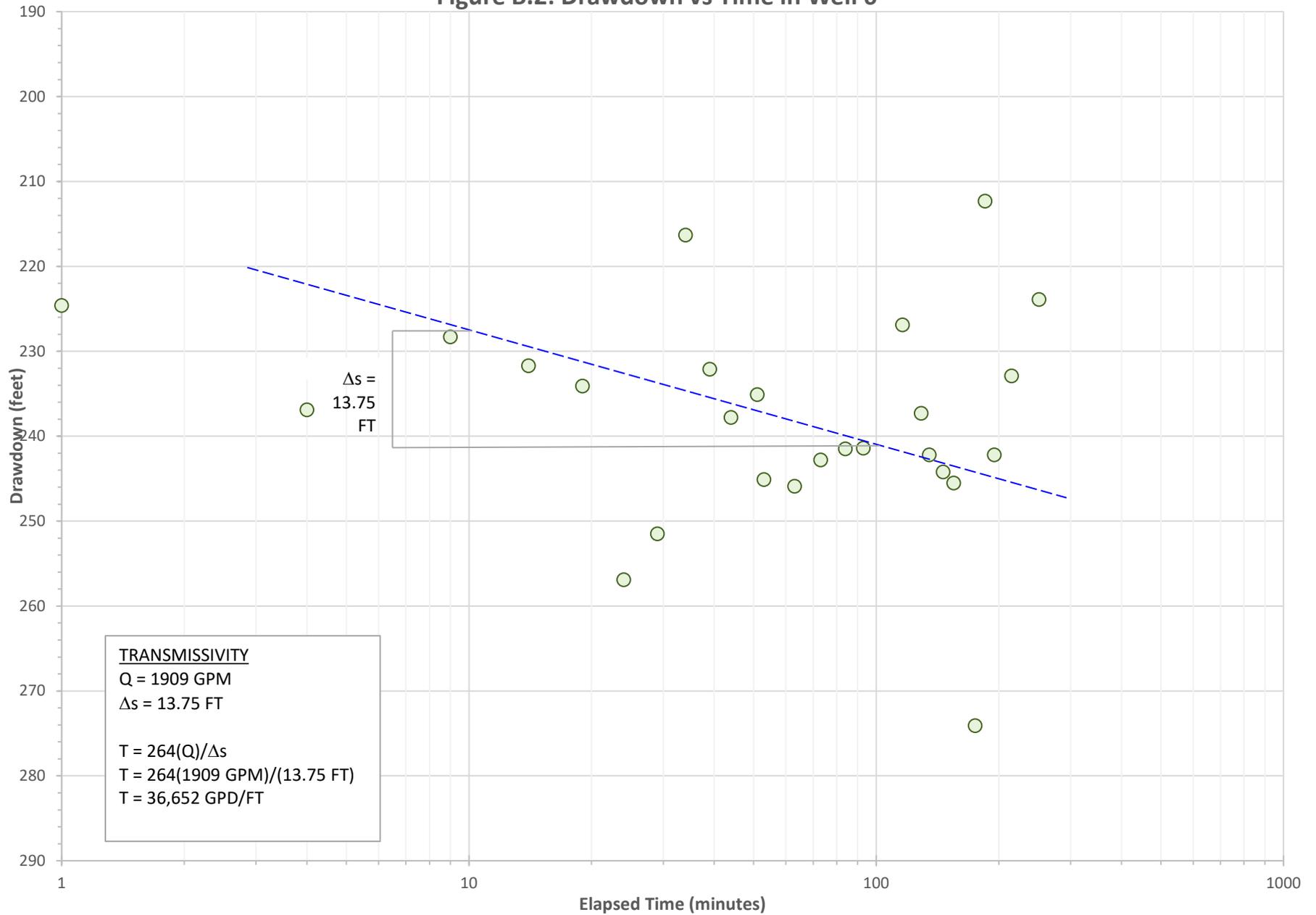
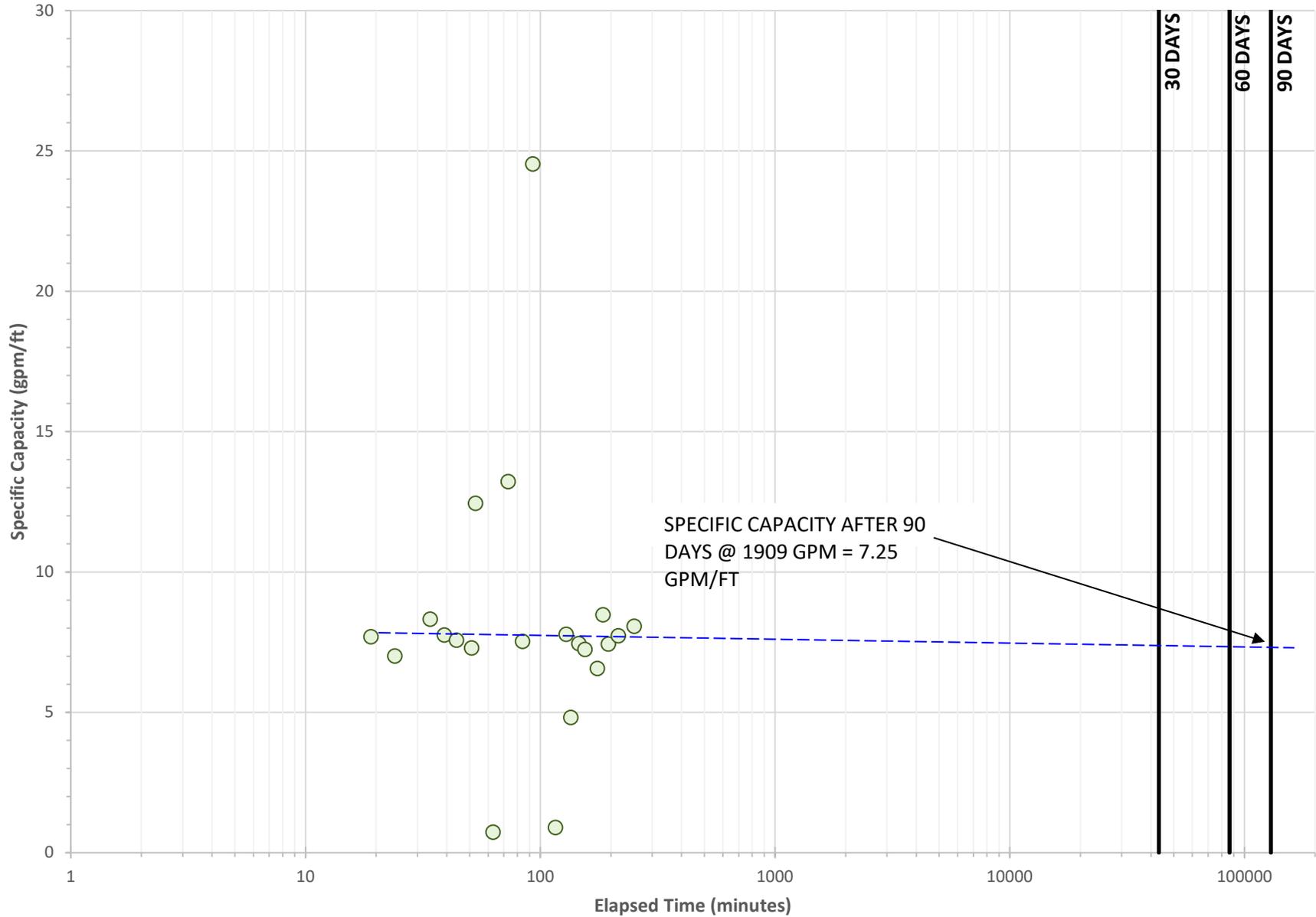


Figure B.3: Specific Capacity vs Time in Well 6



APPENDIX C

Well Logs for ASR Wells

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

RECEIVED

NOV - 2 1990

Pg. 1
 40/28E/24 bd

(START CARD) # 21804

Umat
5450

(1) OWNER:
 Name City of Hermiston
 Address 180 NE 2nd
 City Hermiston State OR Zip 97138

Well Number: LEALEM

(9) LOCATION OF WELL by legal description:
 County Umatilla Latitude _____ Longitude _____
 Township 4N N or S, Range 28E E or W, WM.
 Section 24 SE $\frac{1}{4}$ NW $\frac{1}{4}$
 Tax Lot _____ Lot 4 Block 1 Subdivision _____
 Street Address of Well (or nearest address) Hwy 395, south of Hermiston Foods

(2) TYPE OF WORK:
 New Well Deepen Recondition Abandon

(3) DRILL METHOD
 Rotary Air Rotary Mud Cable
 Other _____

(4) PROPOSED USE:
 Domestic Community Industrial Irrigation
 Thermal Injection Other _____

(5) BORE HOLE CONSTRUCTION:
 Special Construction approval Yes No Depth of Completed Well 1500 ft.
 Explosives used Yes No Type _____ Amount _____

HOLE		SEAL		Amount
Diameter	From To	Material	From To	sacks or pounds
24"	0 228	Cement	0 650	500 sacks
19"	228 650			
15"	650 1085			
10"	1085 1500			

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:

Casing/Liner	Diameter	From	To	Gauge	Steel		Plastic		Welded		Threaded	
					✓		✓		✓		✓	
Casing	16"	t2	650	.375	✓				✓			
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
						<input type="checkbox"/>	<input type="checkbox"/>
						<input type="checkbox"/>	<input type="checkbox"/>
						<input type="checkbox"/>	<input type="checkbox"/>
						<input type="checkbox"/>	<input type="checkbox"/>
						<input type="checkbox"/>	<input type="checkbox"/>
						<input type="checkbox"/>	<input type="checkbox"/>

(8) WELL TESTS: Minimum testing time is 1 hour
 Pump Bailer Air Flowing Artesian
 Yield gal/min 2500+ Drawdown 42 Drill stem at _____ Time 1 hr.
(pump test by Layne Pump, Pasco, WA)

Temperature of water 32°C Depth Artesian Flow Found _____
 Was a water analysis done? Yes By whom Cotley Lab
 Did any strata contain water not suitable for intended use? Too little
 Salty Muddy Odor Colored Other _____
 Depth of strata: _____

(10) STATIC WATER LEVEL:
380 ft. below land surface. Date 8-22-90
 Artesian pressure _____ lb. per square inch. Date _____

(11) WATER BEARING ZONES:
 Depth at which water was first found 215

From	To	Estimated Flow Rate	SWL
160	225	50	58
447	468	100+	58
(Cont.)			

(12) WELL LOG: Ground elevation _____

Material	From	To	SWL
Silty-sand	0	10	
Brown clay with found cobbles	10	13	
Brown claystone	13	68	
Silty brown clay	68	97	
Brown clay with some gravel	97	115	
Gray clay	115	142	
Brown clay	142	160	
Sandy brown clay	160	225	WB
Gray basalt, hard	225	315	
Soft brown basalt	315	322	
Gray basalt, med.	322	360	
Green clay	360	394	
Gray basalt	394	447	
Red basalt with green soapstone	447	468	WB
Gray basalt, hard	468	538	
Red basalt	538	547	
Gray basalt	547	559	
Red basalt with green soapstone	559	571	
(Cont.)			

Date started 6-28-90 Completed 9-26-90

(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 well construction standards. Materials used and information reported above are true to my best knowledge and belief.
 Signed _____ WWC Number _____
 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 well construction standards. This report is true to the best of my knowledge and belief.
 Signed Patrick Waller WWC Number 1218
 Date 10-26-90

RECEIVED

Pg. 2

NOV - 2 1990

Went 5459

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

(START CARD) # 21804

(1) OWNER:

Name City of Hermiston Well Number: 60 SALEW, OREGON

(2) TYPE OF WORK:

New Well Deepen Recondition Abandon

(3) DRILL METHOD

Rotary Air Rotary Mud Cable Other

(4) PROPOSED USE:

Domestic Community Industrial Irrigation Thermal Injection Other

(5) BORE HOLE CONSTRUCTION:

Special Construction approval Yes No Depth of Completed Well ft. Explosives used Type Amount

Table with columns: HOLE Diameter, SEAL From, To, Material, Amount sacks or pounds

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:

Table with columns: Diameter, From, To, Gauge, Steel, Plastic, Welded, Threaded

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:

Table with columns: From, To, Slot size, Number, Diameter, Tele/pipe size, Casing, Liner

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

Table with columns: Pump, Bailer, Air, Flowing Artesian, Yield gal/min, Drawdown, Drill stem at, Time

Temperature of water Depth Artesian Flow Found Was a water analysis done? Did any strata contain water not suitable for intended use?

(9) LOCATION OF WELL by legal description:

County Latitude Longitude Township N or S, Range E or W, WM. Section 1/4 1/4 Tax Lot Lot Block Subdivision Street Address of Well

(10) STATIC WATER LEVEL:

ft. below land surface. Date Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:

Table with columns: From, To, Estimated Flow Rate, SWL

(12) WELL LOG:

Table with columns: Material, From, To, SWL

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 well construction standards.

Signed Date WWC Number

(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.

Signed Patrick Wallace Date 10-26-90 WWC Number 1218

APPENDIX D

Water Quality Sampling Results

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Appendix D
 Laboratory Analytical Results
 City of Hermiston - ASR Limited License Application

Sample Location Lab	Hermiston, OR Anatek	Criteria		Sample Date	Source Water	Native Groundwater
					RWS	Well 6
					1/24/2024	1/24/2024
					6/20/2023 ^a	7/7/2020 ^{a, b}
					6/20/2023 ^a	6/20/2023 ^a
	Standard	Source Water	Native Groundwater	Unit		
Field Parameters						
Dissolved Oxygen	-	-	-	mg/L	8.17	0.06
Oxidation-Reduction Potential	-	-	-	mV	-24.8	-179.3
pH	SMCL	6.5 - 8.5	-	pH Units	6.77	8.52
Conductivity	-	-	-	us/cm ²	316	522
Temperature	-	-	-	deg C	15.38	30.69
Turbidity	-	-	-	NTU	4	1
General Chemistry						
Bicarbonate (as CaCO ₃)	-	-	-	mg/L	64.3	134
Calcium	-	-	-	mg/L	22.8	5.06
Carbonate (as CaCO ₃)	-	-	-	mg/L	< 5.00	< 5.00
Chloride	SMCL	250	-	mg/L	6.85	20.0
Hardness (as CaCO ₃)	SMCL	250	-	mg/L	80.8	14.2
Magnesium	-	-	-	mg/L	4.94	0.378
Nitrate (as N)	MCL	5	10	mg/L	0.223	< 0.1
Nitrite (as N)	MCL	0.5	1	mg/L	< 0.1	< 0.1
Total Nitrate + Nitrite	MCL	5	10	mg/L	0.223	< 0.1
Potassium	-	-	-	mg/L	2.20	10.1
Silica	-	-	-	mg/L	6.09	76.7
Sodium	-	-	-	mg/L	6.00	58.7
Sulfate	SMCL	250	-	mg/L	27.3	4.71
Alkalinity (as CaCO ₃)	-	-	-	mg/L	64.3	134
Total Dissolved Solids (TDS)	SMCL	500	-	mg/L	140	233
Total Suspended Solids (TSS)	-	-	-	mg/L	0.2	0.1
Total Organic Carbon (TOC)	-	-	-	mg/L	0.209	1.01
Metals						
Aluminum	SMCL	0.05 - 0.2	-	mg/L	0.0237	< 0.01
Antimony	MCL	0.003	0.006	mg/L	< 0.001	ND
Arsenic	MCL	0.005	0.01	mg/L	< 0.001	< 0.001
Barium	MCL	1	2	mg/L	0.0275	ND
Beryllium	MCL	0.002	0.004	mg/L	< 0.001	< 0.001
Cadmium	MCL	0.0025	0.005	mg/L	< 0.001	ND
Chromium (total)	MCL	0.05	0.1	mg/L	0.00145	0.00134
Copper	AL	0.65	1.3	mg/L	< 0.001	< 0.001
Iron (Total)	SMCL	0.3	-	mg/L	0.383	< 0.01
Iron (Dissolved)	-	-	-	mg/L	0.0494	< 0.01
Lead	AL	0.0075	0.015	mg/L	< 0.001	ND
Manganese (Total)	SMCL	0.05	-	mg/L	0.0139	0.0012
Manganese (Dissolved)	-	-	-	mg/L	0.0134	< 0.001
Mercury	MCL	0.001	0.002	mg/L	< 0.0001	< 0.0001
Nickel	MCL	0.05	0.1	mg/L	< 0.001	< 0.001
Selenium	MCL	0.025	0.05	mg/L	0.00219	0.00223
Silver	RL	0.025	0.05	mg/L	< 0.001	< 0.001
Thallium	MCL	0.001	0.002	mg/L	< 0.001	ND
Zinc	SMCL	5	-	mg/L	< 0.001	< 0.001
Disinfectants						
Chloramines	MRDL	2	4	mg/L	< 0.25 H3	-
Chlorine	MRDL	2	4	mg/L	0.03	< 0.02
Chlorine dioxide	MRDL	0.4	0.8	mg/L	< 0.25	-
Disinfection Byproducts						
Bromate	MCL	0.005	0.01	mg/L	< 0.001	-
Chlorite	MCL	0.5	1	mg/L	< 0.02	-
Haloacetic Acids (HAA5)	MCL	0.03	0.06	mg/L	0.0369	-
Total Trihalomethanes (TTHM)	MCL	0.04	0.08	mg/L	0.0498	-
Radionuclides						
Gross Alpha	MCL	7.5	15	pCi/L	< 3.00	< 3.00
Gross Beta	MML	25	50	pCi/L	< 4.00	4.64
Iodine-131	MML	1.5	3	pCi/L	< 1.02	< 0.877
Combined Radium-226 and Radium-228	MCL	2.5	5	pCi/L	< 1.00	0.578
Radon ^c	-	-	-	-	-	-
Strontium-90	MML	4	8	pCi/L	< 1.83	< 1.75
Tritium	MML	10000	20000	pCi/L	< 338	< 336
Uranium	MCL	0.015	0.03	mg/L	< 0.001	< 0.001

Volatile Organic Compounds							
Benzene	MCL	0.0025	0.005	mg/L	< 0.0005	< 0.0005	
Carbon tetrachloride	MCL	0.0025	0.005	mg/L	< 0.0005	< 0.0005	
cis-1,2-Dichloroethylene	MCL	0.035	0.07	mg/L	< 0.0005	< 0.0005	
Dichloromethane	MCL	0.0025	0.005	mg/L	< 0.0005	< 0.0005	
Ethylbenzene	MCL	0.35	0.7	mg/L	< 0.0005	< 0.0005	
Chlorobenzene (Monochlorobenzene)	MCL	0.05	0.1	mg/L	< 0.0005	< 0.0005	
1,2-Dichlorobenzene (o-Dichlorobenzene)	MCL	0.3	0.6	mg/L	< 0.0005	< 0.0005	
1,4-Dichlorobenzene (p-Dichlorobenzene)	MCL	0.0375	0.075	mg/L	< 0.0005	< 0.0005	
Styrene	MCL	0.05	0.1	mg/L	< 0.0005	< 0.0005	
Tetrachloroethylene (PCE)	MCL	0.0025	0.005	mg/L	< 0.0005	< 0.0005	
Toluene	MCL	0.5	1	mg/L	< 0.0005	< 0.0005	
trans-1,2-Dichloroethylene	MCL	0.05	0.1	mg/L	< 0.0005	< 0.0005	
Trichloroethylene (TCE)	MCL	0.0025	0.005	mg/L	< 0.0005	< 0.0005	
Vinyl chloride	MCL	0.001	0.002	mg/L	< 0.0005	< 0.0005	
Xylenes, Total	MCL	5	10	mg/L	< 0.0005	< 0.0005	
1,1-Dichloroethylene	MCL	0.0035	0.007	mg/L	< 0.0005	< 0.0005	
1,1,1-Trichloroethane	MCL	0.1	0.2	mg/L	< 0.0005	< 0.0005	
1,1,2-Trichloroethane	MCL	0.0025	0.005	mg/L	< 0.0005	< 0.0005	
1,2-Dichloroethane (EDC)	MCL	0.0025	0.005	mg/L	< 0.0005	< 0.0005	
1,2-Dichloropropane	MCL	0.0025	0.005	mg/L	< 0.0005	< 0.0005	
1,2,4-Trichlorobenzene	MCL	0.035	0.07	mg/L	< 0.0005	< 0.0005	
Synthetic Organic Compounds							
Acrylamide	TT	-	-	mg/L	< 0.0005	< 0.0005	
Alachlor (Lasso)	MCL	0.001	0.002	mg/L	< 0.0004	< 0.0004	
Atrazine	MCL	0.0015	0.003	mg/L	< 0.0002	< 0.0002	
Benzo(a)pyrene	MCL	0.0001	0.0002	mg/L	< 0.00002	< 0.00002	
Carbofuran	MCL	0.02	0.04	mg/L	< 0.001	< 0.001	
Chlordane	MCL	0.001	0.002	mg/L	< 0.0002	< 0.0002	
Chlorobenzene	MCL	0.05	0.1	mg/L	< 0.0005	< 0.0005	
Dalapon	MCL	0.1	0.2	mg/L	< 0.001	< 0.001	
1,2-Dibromo-3-chloropropane (DBCP)	MCL	0.0001	0.0002	mg/L	< 0.00002	< 0.00002	
Dinoseb	MCL	0.0035	0.007	mg/L	< 0.0002	< 0.0002	
Dioxin(2,3,7,8-TCDD)	MCL	0.000000015	0.00000003	mg/L	< 0.00000000332	< 0.00000000338	
Diquat	MCL	0.01	0.02	mg/L	< 0.0004	< 0.0004	
Di(2-ethylhexyl) adipate	MCL	0.2	0.4	mg/L	< 0.0002	< 0.0002	
Di(2-ethylhexyl) phthalate	MCL	0.003	0.006	mg/L	< 0.0006	< 0.0006	
Endothall	MCL	0.05	0.1	mg/L	< 0.009	< 0.009	
Endrin	MCL	0.001	0.002	mg/L	< 0.00001	< 0.00001	
Ethylene Dibromide (EDB)	MCL	0.000025	0.00005	mg/L	< 0.00001	< 0.00001	
Glyphosate	MCL	0.35	0.7	mg/L	< 0.005	< 0.005	
Heptachlor	MCL	0.0002	0.0004	mg/L	< 0.00004	< 0.00004	
Heptachlor epoxide	MCL	0.0001	0.0002	mg/L	< 0.00002	< 0.00002	
Hexachlorobenzene (HCB)	MCL	0.0005	0.001	mg/L	< 0.0002	< 0.0002	
Hexachlorocyclopentadiene	MCL	0.025	0.05	mg/L	< 0.0002	< 0.0002	
Lindane (BHC-gamma)	MCL	0.0001	0.0002	mg/L	< 0.00002	< 0.00002	
Methoxychlor	MCL	0.02	0.04	mg/L	< 0.0001	< 0.0001	
Oxamyl (Vydate)	MCL	0.1	0.2	mg/L	< 0.001	< 0.001	
Picloram	MCL	0.25	0.5	mg/L	< 0.0001	< 0.0001	
Polychlorinated Biphenyls (PCBs)	MCL	0.00025	0.0005	mg/L	< 0.0005	< 0.0005	
Pentachlorophenol	MCL	0.0005	0.001	mg/L	< 0.00004	< 0.00004	
Simazine	MCL	0.002	0.004	mg/L	< 0.00015	< 0.00015	
Toxaphene	MCL	0.0015	0.003	mg/L	< 0.001	< 0.001	
2,4-D	MCL	0.035	0.07	mg/L	< 0.001	< 0.001	
2,4,5-TP (Silvex)	MCL	0.025	0.05	mg/L	< 0.0002	< 0.0002	
Miscellaneous							
Color	SMCL	15		CU	10.0	5.00	
Corrosivity	SMCL	noncorrosive		-	-1.14	-0.424	
Cyanide (as free cyanide)	MCL	0.1	0.2	mg/L	< 0.003	ND	
Fluoride	MCL	2	4	mg/L	< 0.1	1.49	
Foaming Agents (MBAS)	SMCL	0.5		mg/L	< 0.05 H1	< 0.05 H1	
Odor	SMCL	3		TON	0.00	0.00	

Notes

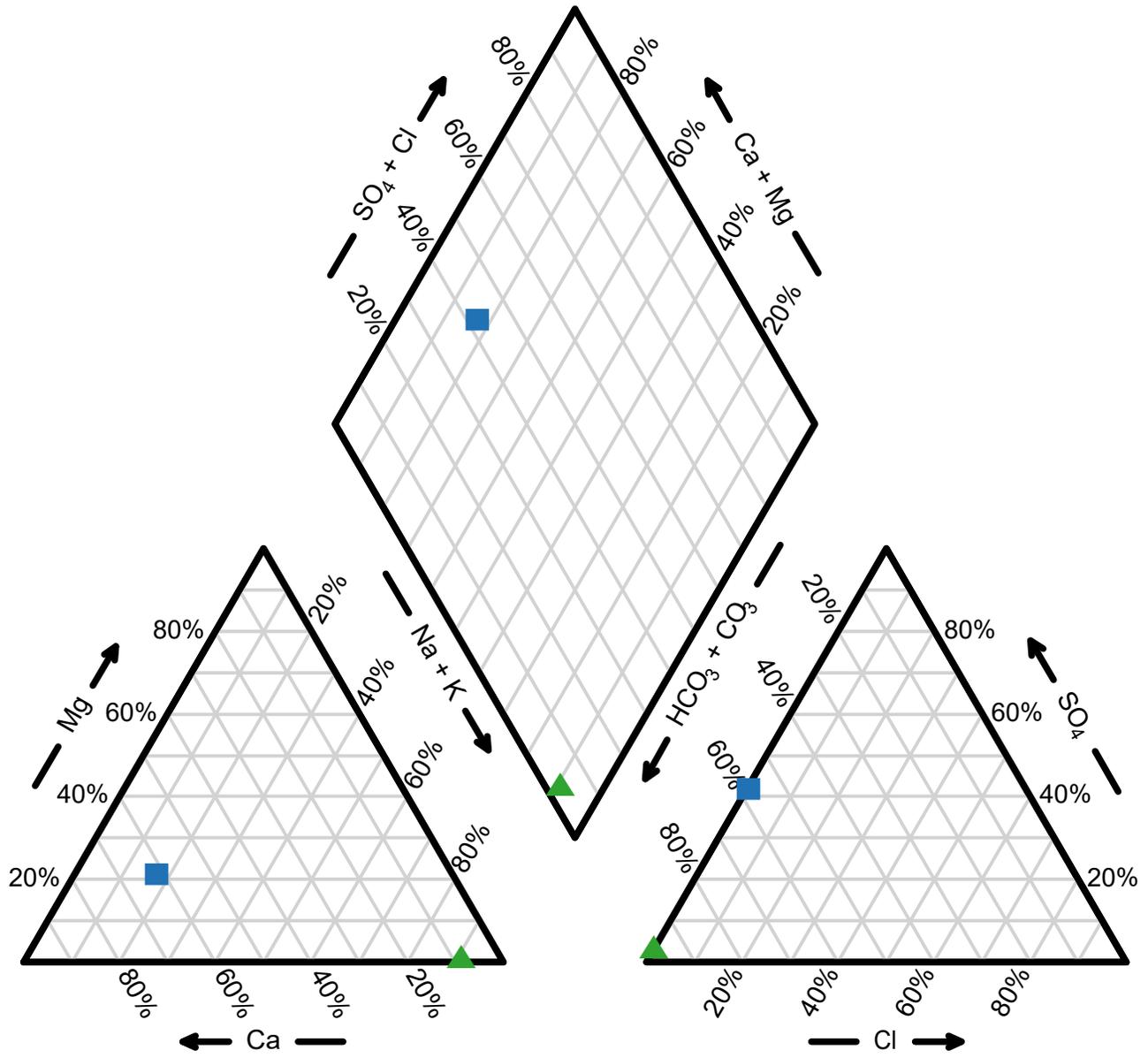
H1: Sample analysis performed past holding time

H3: Sample was received past holding time

^a City of Hermiston routine sampling

^b MRL/MDL not available

^c Radon not sampled



LEGEND

- ▲ Well 6 (Native Groundwater)
- RWS (Treated Source Water)

NOTES

For analytes reported as nondetects, a concentration of half the detection limit was used for plotting.

**FIGURE
Piper Diagram**

City of Hermiston
Aquifer Storage and Recovery Limited License Application



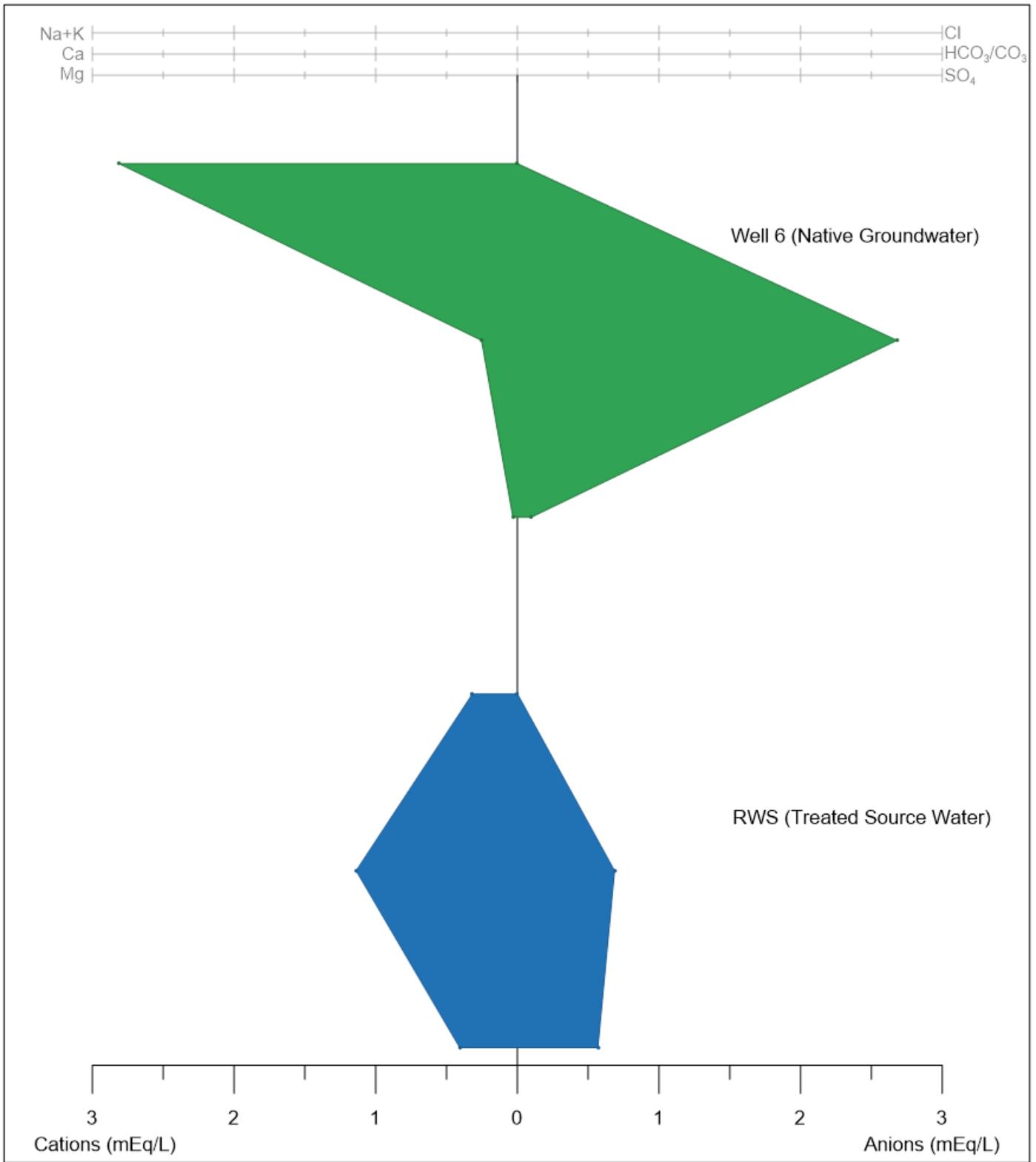


FIGURE
Stiff Diagram
 City of Hermiston
 Aquifer Storage and Recovery Limited License Application

NOTES

For analytes reported as nondetects, a concentration of half the detection limit was used for plotting.

mEq/L: milliequivalents per liter
 Ca: calcium Mg: magnesium
 Cl: chloride Na: sodium
 CO₃: carbonate SO₄: sulphate
 HCO₃: bicarbonate



APPENDIX E

Water Quality Mixing Analysis

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Memorandum

Date: May 17, 2024
Author: Kristen Slawter, Ph.D. and Erica DiFilippo, Ph.D., S.S. Papadopoulos & Associates, Inc.
To: Matt Kohlbecker, GSI Water Solutions, Inc.
Project: SSPA-1893 City of Hermiston ASR
Subject: **City of Hermiston ASR Water Quality Mixing Evaluation**

1. Introduction

The City of Hermiston, Oregon, Aquifer Storage and Recharge (ASR) project involves injecting treated surface water from the Columbia River into the regional Columbia River Basalt Group aquifer through two recharge wells (Well 6 and Stahl Well). Water from the Columbia River will be obtained from the Regional Water System (RWS) and treated with chlorination, filtration, coagulation, and flocculation prior to injection. The recharge wells are located in close proximity to one another and consist of open bore holes through the Columbia River Basalt Group at depths of 228 to 1,500 feet below ground surface (ft bgs) for Well 6 and 220 to 1,180 ft bgs for Stahl Well.

This technical memorandum (TM) presents the results of geochemical modeling performed to evaluate changes in water chemistry and potential clogging due to mixing of native groundwater and RWS water. The TM is organized into the following sections: (a) Methodology, (b) Results, (c) Discussion, (d) Conclusions, and (e) References.

2. Methodology

This section discusses the methodology used to evaluate changes in water chemistry and potential clogging due to mixing of native groundwater and RWS water for The City of Hermiston's ASR Project.

2.1. Geochemistry Dataset

A summary of water chemistry data was provided by GSI Water Solutions (GSI) for the following waters: RWS (i.e., treated recharge water), Well 6 (i.e., native groundwater), and Stahl Well (i.e., native groundwater). The RWS, Well 6, and Stahl Well water chemistry data are presented in **Table 1**. For metals, only aluminum, iron, and manganese were analyzed for both the dissolved (i.e., filtered) and total (i.e., unfiltered) content. All other metals were analyzed only for total (i.e., unfiltered) content. The temperature of the RWS water, which was sampled in January of 2024, was 15.38 degrees Celsius (°C) at the time of collection whereas the waters from Well 6 and Stahl Well were 30.69°C and 21.68°C, respectively.



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2.2. Geochemical Modeling

This section discusses the geochemical model, model inputs, modeling scenarios and assumptions used in this analysis.

2.2.1 Geochemical Model

The USGS-supported geochemical modeling program PHREEQC (version 3; Parkhurst and Appelo, 2013) was used to simulate the geochemical mixing of treated recharge water (i.e., RWS) with native groundwater (i.e., Well 6 and Stahl Well). The modeling was performed using the Lawrence Livermore National Laboratory (LLNL) thermodynamic equilibrium database (08/01/2017 version) included with the PHREEQC program package.

2.2.2 Geochemical Model Inputs

The water chemistry for each end-member water type is presented in **Table 1**. In addition to the measured results presented in **Table 1**, the following input parameters were used for the geochemical modeling:

- Oxidation-Reduction Potential (ORP) field measurements were converted to Eh, a measurement of reduction potential, by correcting for the electrode potential of the reference electrode (+200 mV). Eh was then converted to pe, the reduction potential input parameter, following the relationship described by Pankow (1991).¹
- Dissolved phase concentrations (i.e., filtered) for aluminum, iron, and manganese were used in the geochemical models.
- Total concentrations (i.e., unfiltered) were used for trace metals because the dissolved phase concentrations (i.e., filtered) were not available.

2.2.3 Geochemical Modeling Scenarios

Eleven (11) scenarios were modeled per recharge well (for a total of 22 model scenarios) representing different mixtures of native groundwater and RWS water. Modeling scenarios were classified by the percent RWS water contained in the mixture, with 0% indicating no RWS water and 100% indicating no native groundwater. Additional simulations were performed to evaluate the impact of water temperature on predicted SIs. These simulations assumed that the temperature of RWS water was the same as the native groundwater (30°C for Well 6 simulations and 21°C for Stahl Well simulations).

¹ Eh is converted to pe using the following equation: $pe = \frac{Eh(V) \times F}{(2.303 \times R \times T)}$, where Eh is in volts (V), F is the Faraday constant (96.485x10³ °C/mol), R is the gas constant (8.314 J/K mol), and T is temperature in Kelvin (K).



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2.2.4 Geochemical Modeling Assumptions

The following assumptions were made for this analysis:

- The model simulations assume equilibrium conditions. Kinetic reactions, surface complexation and transport were not accounted for in this analysis.
- Thermodynamic activities calculated for ion-exchange species are based on the assumption that thermodynamic activity is equal to the ratio of the number of moles of sites occupied by an exchange species relative to the total number of exchange sites.
- Redox reactions were equilibrated based on the dissolved oxygen (DO) content, which assumes that the field DO measurements are accurate and no oxygen was introduced during sampling. This is a reasonable assumption considering the field water quality meter (YSI 556 Handheld Multiparameter) was calibrated and field conditions (i.e., pH, temperature, conductivity, turbidity, ORP and DO) stabilized prior to sampling.²
- The reported total metal concentrations likely include some portion that is dissolved and would be available for aqueous reactions. Therefore, the total concentrations for trace metals input into the mixing models are a conservative estimate for evaluating the dissolved constituent concentrations and mineral precipitation reactions.

3. Results

This section discusses the results of the analyses described in Section 2.

3.1. Predicted Water Quality

Predicted changes to water quality resulting from mixtures of treated recharge water with native groundwater from Well 6 are presented in **Table 2** and mixtures with native groundwater from Stahl Well are presented in **Table 3**. Mixture constituent concentrations are compared to primary and secondary maximum contaminant levels (MCLs) set by the U.S. Environmental Protection Agency (USEPA) for drinking water quality standards.

3.2. Predicted Mineral Saturation Indices

The saturation index (SI) is the ratio of the chemical activity of the dissolved ions of a mineral relative to the solubility product of the mineral, expressed as a log function. When the $SI > 0$, the mineral has the potential to precipitate and when the $SI < 0$, the mineral has the potential to dissolve. When the $SI = 0$, the mineral is in equilibrium with the solution and will neither dissolve nor precipitate.

² Field sampling forms were reviewed to confirm the stabilization of field parameters prior to sampling.



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Predicted mineral SIs for mixtures of treated recharge water with native groundwater from Well 6 are presented in **Table 4** and mixtures with native groundwater from Stahl Well are presented in **Table 5**. The potential impact that increasing the temperature of RWS treated water to the same temperature of native groundwater would have on mineral precipitation are presented in **Tables 6** and **7**.

4. Discussion

This section provides discussion of the geochemical modeling results presented in Section 3 of this TM.

4.1. Predicted Water Quality

Geochemical modeling results indicate a potential for adverse impacts to groundwater quality (i.e., concentrations that exceed a primary or secondary MCL) for only two parameters: pH and total iron. For pH, the native groundwater at Well 6 exceeds the secondary MCL for pH by 0.02 standard pH units (SU) (**Table 1**). **Tables 2** and **3** indicate that mixing RWS water and native groundwater will lower pH, with a mixture of 10% RWS water predicted to lower the pH of native groundwater below the secondary MCL of 8.5 SU. Therefore, injection of RWS is predicted to have a beneficial impact on pH in the native groundwater.

Geochemical modeling predicts increasing concentrations of total iron in native groundwater, with native groundwater exceeding the secondary MCL of 0.3 milligrams per liter (mg/L) at Well 6 when greater than 80% of the mixed water is RWS water and at the Stahl Well when greater than 70% of the mixed water is RWS water. If total iron concentrations in the RWS water were lower, then no adverse impacts on total iron concentrations in native groundwater would be expected from mixing RWS water and native groundwater.

4.2. Predicted Mineral Saturation Indices

The potential for mineral precipitation and adverse impacts to the ASR aquifer (e.g., clogging) are presented in **Tables 4** and **5**. The impact of mineral precipitation on aquifer/well clogging are discussed below.

4.2.1. Silica Minerals

In the native groundwater, silica minerals (chalcedony, cristobalite-a and -b, quartz, and tridymite) are near equilibrium (i.e., SI values are within ± 1 log-unit of 0) (i.e., 0% treated recharge water in **Tables 4** and **5**). Quartz, which has the most-positive SI values, is unlikely to precipitate in native groundwater because: (1) the kinetics of quartz precipitation are extremely slow, and (2) amorphous silica (SiO₂(am)), which is the precursor to quartz precipitation, has negative SI values. Additionally, geochemical modeling of various mixtures of RWS water and native groundwater



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predicts that SI values for these silica minerals will decrease as the percentage of RWS water increases. Therefore, the injection of RWS water into the ASR aquifer decreases the likelihood that silica minerals will precipitate. In summary, precipitation of silica minerals is not expected.

4.2.2. Carbonate Minerals

Carbonate minerals (calcite and dolomite) are near equilibrium (i.e., SI values are within ± 1 log-unit of 0) in native groundwater (i.e., 0% treated recharge water in **Tables 4** and **5**). Geochemical modeling of various mixtures of RWS water and native groundwater predicts that SI values for these carbonate minerals will decrease as the percentage of RWS water increases, becoming undersaturated³ (SI < 0) in mixtures with greater than 40% RWS water. Therefore, the carbonate minerals calcite and dolomite are not expected to precipitate during ASR operations.

Witherite (a barium carbonate mineral) is supersaturated (i.e., SI values > 0) in both native groundwater and various mixtures of RWS water and native groundwater. Geochemical modeling of various mixtures of RWS water and native groundwater predicts that SI value for witherite will decrease as the percentage of RWS water increases⁴. Additionally, witherite is not a common mineral and is typically described as an alteration product of barite (Chang et al., 1996). Therefore, the carbonate mineral witherite is not expected to precipitate during ASR operations.

4.2.3. Sulfate Minerals

Gypsum and magnesium sulfate (MgSO₄) are undersaturated in all RWS water-native groundwater mixtures and, therefore, are not predicted to precipitate during ASR operations. Barite has positive SI values for mixtures greater than 50% RWS water, however, the SI values are near equilibrium (i.e., SI values are within ± 1 unit of 0). Laboratory experiments indicate that a SI value greater than 1 is needed for barite to precipitate (Canic et al., 2015). Therefore, barite precipitation is not expected in appreciable quantities.

4.2.4. Iron Minerals

The injection of RWS water with high DO (> 5 mg/L) into the suboxic⁵ native groundwater (DO < 0.3 mg/L) is predicted to oxidize the dissolved ferrous iron (Fe²⁺) in native groundwater to ferric iron (Fe³⁺) resulting in the precipitation of ferric iron oxide and oxyhydroxide minerals. Goethite

³ Minerals with negative SIs are considered undersaturated and have the potential to dissolve.

⁴ Well 6 native groundwater was not analyzed for barium so SI values could not be calculated for barium-containing minerals (e.g. witherite and barite) in this native groundwater. However, barium was detected in the Stahl well native groundwater sample and, given the close proximity of the two wells and the fact that they are drawing water from the same aquifer, it is reasonable to assume that barium is present in the Well 6 waters at a similar concentration as the Stahl well native groundwater.

⁵ Suboxic waters are defined as having DO <0.5 mg/L (McMahon and Chapelle, 2008).



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and hematite (both ferric iron minerals) have SI values greater than 1 which indicate the potential to precipitate in the ASR aquifer.

While chemical equilibrium indicates the potential for precipitation of ferric iron oxide and oxyhydroxide minerals, the likelihood of clogging is dependent on the iron concentration present in the native groundwater, RWS water and their mixtures. Dissolved phase iron and ferrous iron were not detected in the native groundwater at Well 6 and were less than 0.004 mg/L in the Stahl Well (**Table 1**). Given the low concentration of iron in the native groundwater samples, the amount of iron mineral precipitation is expected to be minimal. If we assume that the highest predicted concentration of dissolved iron (i.e., 0.049 mg/L from the 100% treated recharge water in **Tables 4 and 5**) precipitates as hematite, then the maximum volume that would precipitate from one liter of water accounts for <0.00001% of the total pore volume (**Table 8**). Therefore, while there is the potential for mineral precipitation, the amount of ferrous iron mineral precipitation is not expected to precipitate in appreciable quantities.

4.2.5. Manganese Minerals

The injection of RWS water with high DO (> 0.5 mg/L) into the suboxic⁶ native groundwater (DO < 0.3 mg/L) is predicted to oxidize the reduced manganese (Mn²⁺) in native groundwater resulting in the precipitation of manganese oxide minerals. Several manganese oxide minerals (birnessite, bixbyite, hausmannite, manganite, and pyrolusite) have SI values greater than 1 which indicate the potential to precipitate in the ASR aquifer.

While chemical equilibrium indicates the potential for precipitation of manganese oxide minerals, like iron oxide and oxyhydroxide precipitation, the amount of manganese mineral precipitation is expected to be negligible due to the low concentrations of dissolved manganese in the native groundwater samples (**Table 1**). If, as with the iron oxide/oxyhydroxide precipitation example, the highest concentration of dissolved manganese (0.013 mg/L from the 100% treated recharge water in **Tables 4 and 5**) precipitates as pyrolusite, the maximum volume that would precipitate from one liter of water occupies < 0.000001% of the total pore volume (**Table 8**).

4.2.6. Predicted Impact of Temperature on Mineral Saturation Indices

Based on the geochemical mixing models, temperature is predicted to decrease as a function of the proportion of RWS water in the mixture (**Tables 2 and 3**). The SIs for simulations where the temperature of RWS water is fixed to that of native groundwater are presented in **Tables 6 and 7**. A comparison of the SI values from the initial mixing simulations (**Tables 4 and 5**) with those of the temperature buffered simulations (**Tables 6 and 7**) shows that increased temperature would have little effect on mineral precipitation.

⁶ I.d.



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4.3. Comparison to the City of Beaverton's ASR system

Similar to the City of Hermiston, the City of Beaverton's (Oregon) Sterling Park Artificial Recharge system injects treated water⁷ into the Columbia River Basalt Group aquifer. The water chemistry of native groundwater for the City of Beaverton's system is similar to that of the City of Hermiston's proposed ASR system (**Table 9**). No mineral precipitation or clogging issues have been reported for the City of Beaverton's system (Personal Communication, GSI, 2024), consistent with the findings from pre-operation geochemical modeling (SSP&A, 2021). This supports the assessment in this analysis that mineral precipitation and clogging will be minimal for the City of Hermiston's ASR system.

5. Conclusions

Geochemical equilibrium modeling was conducted to evaluate the impact of mixing of various proportions of RWS water and native groundwater for the City of Hermiston's proposed ASR system. Modeling was performed using PHREEQC and modeling scenarios were classified by the percent RWS water contained in the mixture, with 0% indicating no RWS water and 100% indicating no native groundwater.

Adverse impacts (concentrations exceeding primary or secondary MCLs) were found for two parameters: pH and total iron. For pH, geochemical modeling predicted that injection of RWS water would have a beneficial impact on pH in the native groundwater by reducing the pH to below the secondary MCL of 8.5 SU. Geochemical modeling predicted increasing concentrations of total iron in water mixtures, with groundwater exceeding the secondary MCL of 0.3 mg/L at Well 6 when greater than 80% of the mixed water is RWS water and at the Stahl Well when greater than 70% of the mixed water is RWS water. If total iron concentrations in the RWS water were lower, then no adverse impacts on total iron concentrations in native groundwater would be expected from mixing RWS and native groundwater.

Geochemical mixing models predict the potential for precipitation of iron oxides and oxyhydroxides as well as manganese oxide minerals. Precipitation, however, is expected to be negligible due to the low concentrations of dissolved iron and dissolved manganese in the native groundwater. Finally, temperature variation is not expected to impact these findings.

⁷ The City of Beaverton injects treated stormwater in their Sterling Park Artificial Recharge system.



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TABLES

Table 1: Summary of Waters Used in Mixing Analysis

Type	Parameter	Units	RWS	Well 6	Stahl Well
General	Dissolved Oxygen	mg/L	8.17	0.06	0.28
	Electrical Conductivity	us/cm	316	522	574
	ORP	mV	-24.8	-179.3	-7.6
	pH	pH units	6.77	8.52	8.21
	Temperature	°C	15.38	30.69	21.68
	Total Dissolved Solids	mg/L	140	233	163
Major Anions	Alkalinity, Total as	mg/L	64.3	134	133
	Bicarbonate, as CaCO3	mg/L	64.3	134	133
	Carbonate	mg/L	ND	ND	ND
	Chloride	mg/L	6.85	20	14
	Sulfate	mg/L	27.3	4.71	27.8
Major Cations	Calcium	mg/L	22.8	5.06	9.03
	Magnesium	mg/L	4.94	0.378	2.97
	Potassium	mg/L	2.2	10.1	9.41
	Sodium	mg/L	6	58.7	58.8
Redox Species	Iron, Dissolved	mg/L	0.0494	ND	0.00355
	Iron, Total	mg/L	0.383	ND	0.12
	Iron (II)	mg/L	ND	ND	ND
	Manganese, Dissolved	mg/L	0.0134	ND	0.00219
	Manganese, Total	mg/L	0.0139	0.0012	0.017
	Nitrate as NO3-	mg/L	0.223	ND	ND
Trace Metals	Aluminum, Dissolved	mg/L	ND	ND	ND
	Aluminum, Total	mg/L	0.0237	ND	ND
	Antimony	mg/L	ND	NA	ND
	Arsenic	mg/L	ND	ND	ND
	Arsenic (III)	mg/L	ND	ND	NA
	Arsenic (V)	mg/L	0.00002	ND	NA
	Inorganic Arsenic	mg/L	0.00002	ND	NA
	Barium	mg/L	0.0275	NA	0.0255
	Beryllium	mg/L	ND	ND	ND
	Boron	mg/L	0.0125	0.0718	0.0447
	Cadmium	mg/L	ND	NA	ND
	Chromium, Total	mg/L	0.00145	0.00134	ND
	Copper	mg/L	ND	ND	0.00558
	Hexavalent Chromium	mg/L	ND	ND	ND
	Lead	mg/L	ND	NA	ND
	Mercury	mg/L	ND	ND	ND
	Nickel	mg/L	ND	ND	ND
	Selenium	mg/L	0.00219	0.00223	ND
	Silver	mg/L	ND	ND	ND
	Thallium	mg/L	ND	NA	ND
Uranium	mg/L	ND	ND	ND	
Vanadium	mg/L	0.00181	0.00107	0.00265	
Zinc	mg/L	ND	ND	ND	
Other	Color	Color Units	10.0 @ pH 7.19	5.00 @ pH 8.34	5.00 @ pH 7.97
	Corrosivity	-	-1.14	-0.424	-0.458
	Cyanide	mg/L	ND	ND	ND
	Flouride	mg/L	ND	1.49	1.27
	Odor	TON	0	0	0
	Silica	mg/L	6.09	76.7	66.6
	Total Organic Carbon	mg/L	0.209	1.01	0.238
	Total Suspended Solids	mg/L	0.200	0.100	2.57
Disinfection Byproducts (DBPs)	Residual Chlorine	mg/L	NA	NA	NA
	Haloacetic Acids, Total	mg/L	0.0369	NA	NA
	Trihalomethanes, Total	mg/L	0.0498	NA	NA

Notes: NA = Not Analyzed
NC = Noncorrosive
ND = Non-detect

Table 2: Predicted Composition of Well 6 Native Waters Mixed with Treated Recharge Water

Type	Parameter	Units	Primary MCL	Secondary MCL	Treated Recharge Water in Mixture										
					0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
General	Dissolved Oxygen	mg/L			0.1	0.9	1.7	2.5	3.3	4.1	4.9	5.7	6.5	7.4	8.2
	Eh	mV			673	701	721	742	761	776	789	801	812	822	832
	pH	pH units		6.5-8.5	8.52	8.38	8.17	7.90	7.66	7.46	7.30	7.16	7.03	6.90	6.77
	Temperature	°C			31	29	28	26	25	23	22	20	18	17	15
	Total Dissolved Solids	mg/L		500	342	323	305	286	267	249	230	211	193	174	156
Major Cations	Calcium	mg/L			5.1	6.8	8.6	10	12	14	16	17	19	21	23
	Magnesium	mg/L			0.4	0.8	1.3	1.7	2.2	2.7	3.1	3.6	4.0	4.5	4.9
	Potassium	mg/L			10	9.3	8.5	7.7	6.9	6.2	5.4	4.6	3.8	3.0	2.2
	Sodium	mg/L			59	53	48	43	38	32	27	22	17	11	6.0
Major Anions	Bicarbonate	mg/L			164	155	147	138	130	121	113	104	96	87	78
	Chloride	mg/L		250	20	19	17	16	15	13	12	11	9.5	8.2	6.9
	Sulfate	mg/L		250	4.7	7.0	9.2	11	14	16	18	21	23	25	27
Redox Species	Iron, Total	mg/L		0.3	ND	0.038	0.077	0.115	0.153	0.192	0.230	0.268	0.306	0.345	0.383
	Iron, Dissolved	mg/L			ND	0.005	0.010	0.015	0.020	0.025	0.030	0.035	0.040	0.044	0.049
	Manganese, Total	mg/L		0.05	0.001	0.002	0.004	0.005	0.006	0.008	0.009	0.010	0.011	0.013	0.014
	Manganese, Dissolved	mg/L			ND	0.001	0.003	0.004	0.005	0.007	0.008	0.009	0.011	0.012	0.013
	Nitrate as N	mg/L	10		ND	0.022	0.044	0.066	0.088	0.110	0.132	0.154	0.176	0.198	0.220
	Nitrite as N	mg/L	1		ND	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Trace Metals	Aluminum, Total	mg/L		0.05-0.2	ND	0.002	0.005	0.007	0.009	0.012	0.014	0.017	0.019	0.021	0.024
	Aluminum, Dissolved	mg/L			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Antimony	mg/L	0.006		NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Arsenic	mg/L	0.01		ND	0.000002	0.000004	0.000006	0.000008	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002
	Barium	mg/L	2		NA	0.028	0.055	0.083	0.110	0.138	0.165	0.193	0.220	0.248	0.275
	Beryllium	mg/L	0.004		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Cadmium	mg/L	0.005		NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Chromium, Total	mg/L	0.1		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Copper	mg/L	1.3	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Lead	mg/L	0.015		NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Mercury	mg/L	0.002		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Nickel	mg/L			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Selenium	mg/L	0.05		0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
	Silver	mg/L		0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Thallium	mg/L	0.002		NA	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	mg/L		5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Other	Flouride	mg/L	4	2	1.5	1.3	1.2	1.0	0.9	0.7	0.6	0.4	0.3	0.1	ND
	Silica	mg/L			77	70	63	56	48	41	34	27	20	13	6.1
	Total Organic Carbon	mg/L			1.0	0.9	0.9	0.8	0.7	0.6	0.5	0.5	0.4	0.3	0.2
Disinfection Byproducts (DBPs)	Residual Chlorine	mg/L			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Haloacetic Acids, Total	mg/L	0.06		NA	0.004	0.007	0.011	0.015	0.018	0.022	0.026	0.030	0.033	0.037
	Trihalomethanes, Total	mg/L	0.08		NA	0.005	0.010	0.015	0.020	0.025	0.030	0.035	0.040	0.045	0.050

Notes: NA = Not Analyzed
 ND = Non-detect
 Shaded = Value greater than MCL

Table 3: Predicted Composition of Stahl Well Native Waters Mixed with Treated Recharge Water

Type	Parameter	Units	Primary MCL	Secondary MCL	Treated Recharge Water in Mixture										
					0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
General	Dissolved Oxygen	mg/L			0.3	1.1	1.9	2.6	3.4	4.2	5.0	5.8	6.6	7.4	8.2
	Eh	mV			717	739	755	769	780	790	799	808	816	824	832
	pH	pH units		6.5-8.5	8.21	8.01	7.81	7.63	7.48	7.35	7.23	7.11	7.00	6.89	6.77
	Temperature	C			22	21	20	20	19	19	18	17	17	16	15
	Total Dissolved Solids	mg/L		500	353	333	313	293	274	254	234	215	195	175	156
Major Cations	Calcium	mg/L			9.0	10	12	13	15	16	17	19	20	21	23
	Magnesium	mg/L			3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.3	4.5	4.7	4.9
	Potassium	mg/L			9.4	8.7	8.0	7.3	6.5	5.8	5.1	4.4	3.6	2.9	2.2
	Sodium	mg/L			59	54	48	43	38	32	27	22	17	11	6.0
Major Anions	Bicarbonate	mg/L			162	154	146	137	129	120	112	104	95	87	78
	Chloride	mg/L		250	14	13	13	12	11	10	9.7	9.0	8.3	7.6	6.9
	Sulfate	mg/L		250	28	28	28	28	28	28	28	27	27	27	27
Redox Species	Iron, Total	mg/L		0.3	0.120	0.146	0.173	0.199	0.225	0.252	0.278	0.304	0.330	0.357	0.383
	Iron, Dissolved	mg/L			0.004	0.008	0.013	0.017	0.022	0.026	0.031	0.036	0.040	0.045	0.049
	Manganese, Total	mg/L		0.05	0.017	0.017	0.016	0.016	0.016	0.015	0.015	0.015	0.015	0.014	0.014
	Manganese, Dissolved	mg/L			0.002	0.003	0.004	0.006	0.007	0.008	0.009	0.010	0.011	0.012	0.013
	Nitrate as N	mg/L	10		ND	0.022	0.044	0.066	0.088	0.110	0.132	0.154	0.176	0.198	0.220
	Nitrite as N	mg/L	1		ND	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Trace Metals	Aluminum, Total	mg/L		0.05-0.2	ND	0.002	0.005	0.007	0.009	0.012	0.014	0.017	0.019	0.021	0.024
	Aluminum, Dissolved	mg/L			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Antimony	mg/L	0.006		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Arsenic	mg/L	0.01		NA	0.000002	0.000004	0.000006	0.000008	0.00001	0.00001	0.00001	0.00002	0.00002	0.00002
	Barium	mg/L	2		0.026	0.050	0.075	0.100	0.125	0.150	0.175	0.200	0.225	0.250	0.275
	Beryllium	mg/L	0.004		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Cadmium	mg/L	0.005		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Chromium, Total	mg/L	0.1		ND	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001
	Copper	mg/L	1.3	1	0.006	0.005	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	ND
	Lead	mg/L	0.015		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Mercury	mg/L	0.002		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Nickel	mg/L			ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Selenium	mg/L	0.05		ND	0.000	0.000	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002
	Silver	mg/L		0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Thallium	mg/L	0.002		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	mg/L		5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
Other	Flouride	mg/L	4	2	1.3	1.1	1.0	0.9	0.8	0.6	0.5	0.4	0.3	0.1	ND
	Silica	mg/L			67	61	55	48	42	36	30	24	18	12	6.1
	Total Organic Carbon	mg/L			0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Disinfection Byproducts (DBPs)	Residual Chlorine	mg/L			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Haloacetic Acids, Total	mg/L	0.06		NA	0.004	0.007	0.011	0.015	0.018	0.022	0.026	0.030	0.033	0.037
	Trihalomethanes, Total	mg/L	0.08		NA	0.005	0.010	0.015	0.020	0.025	0.030	0.035	0.040	0.045	0.050

Notes: NA = Not Analyzed

ND = Non-detect

Shaded = Value greater than MCL

Table 4: Predicted Mineral Saturation Indices of Well 6 Native Waters Mixed with Treated Recharge Water

Type	Mineral	SI Units	Treated Recharge Water in Mixture										
			0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Silica Minerals	Chalcedony	Unitless	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.5	0.4	0.3	-0.04
	Cristobalite-a	Unitless	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.2	0.1	-0.03	-0.3
	Cristobalite-b	Unitless	0.04	0.02	0.004	0.0	-0.1	-0.1	-0.2	-0.2	-0.3	-0.5	-0.8
	Quartz	Unitless	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.8	0.7	0.5	0.2
	SiO ₂ (am)	Unitless	-0.2	-0.3	-0.3	-0.3	-0.3	-0.4	-0.5	-0.5	-0.6	-0.8	-1.1
	Tridymite	Unitless	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.6	0.5	0.3	0.04
Carbonate Minerals	Calcite	Unitless	0.1	0.1	-0.1	-0.3	-0.5	-0.7	-0.9	-1.1	-1.3	-1.4	-1.6
	Dolomite	Unitless	0.5	0.7	0.4	0.02	-0.4	-0.8	-1.2	-1.5	-1.8	-2.2	-2.6
	Magnesite	Unitless	-1.2	-1.0	-1.1	-1.3	-1.5	-1.7	-1.9	-2.1	-2.2	-2.4	-2.6
	Witherite	Unitless	U	1.9	2.0	1.9	1.8	1.6	1.5	1.4	1.3	1.2	1.0
Sulfate Minerals	Barite	Unitless	U	-1.1	-0.7	-0.4	-0.2	0.03	0.2	0.3	0.5	0.6	0.7
	Gypsum	Unitless	-3.9	-3.6	-3.4	-3.2	-3.1	-3.0	-2.8	-2.8	-2.7	-2.6	-2.5
	MgSO ₄	Unitless	-13.9	-13.5	-13.2	-13.1	-13.0	-12.9	-12.9	-12.9	-12.8	-12.8	-12.8
Iron Minerals	Fe(OH) ₃ (am)	Unitless	U	-0.5	-0.3	-0.2	-0.1	-0.1	-0.1	-0.2	-0.2	-0.3	-0.3
	Goethite	Unitless	U	4.5	4.8	4.9	5.0	5.0	5.0	5.0	5.0	5.0	4.9
	Hematite	Unitless	U	10.1	10.6	10.8	10.9	11.0	11.0	11.0	10.9	10.9	10.8
	Magnetite	Unitless	U	-2.3	-1.7	-1.5	-1.4	-1.5	-1.6	-1.7	-1.9	-2.2	-2.4
	Siderite	Unitless	U	-12.9	-12.6	-12.3	-12.2	-12.1	-12.0	-12.0	-12.0	-12.1	-12.2
Manganese Minerals	Birnessite	Unitless	U	45.6	45.9	43.9	41.3	38.9	36.9	35.0	33.1	31.2	29.2
	Bixbyite	Unitless	U	8.2	8.2	7.7	7.1	6.5	6.0	5.6	5.2	4.7	4.3
	Hausmannite	Unitless	U	6.0	6.0	5.1	4.1	3.2	2.4	1.7	1.0	0.3	-0.5
	Manganite	Unitless	U	3.5	3.7	3.5	3.3	3.1	2.9	2.8	2.6	2.5	2.4
	Pyrolusite	Unitless	U	7.9	8.0	7.8	7.6	7.4	7.2	7.0	6.8	6.7	6.5
	Rhodochrosite	Unitless	U	-2.0	-1.8	-1.9	-2.0	-2.2	-2.3	-2.4	-2.6	-2.8	-2.9
Other	Fluorite	Unitless	-2.3	-2.2	-2.2	-2.2	-2.3	-2.4	-2.5	-2.7	-3.0	-3.5	U
	Pyrite	Unitless	U	-242.1	-243.2	-243.7	-244.3	-245.0	-245.8	-246.8	-247.7	-248.7	-249.7

Notes: Shaded = mineral saturation indices shown where supersaturation is indicated (SI > 0)

U = mineral undersaturated (SI could not be calculated due to non-detect constituent concentrations)

Table 5: Predicted Mineral Saturation Indices of Stahl Well Native Waters Mixed with Treated Recharge Water

Type	Mineral	SI Units	Treated Recharge Water in Mixture										
			0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Silica Minerals	Chalcedony	Unitless	0.9	0.8	0.8	0.8	0.7	0.7	0.6	0.5	0.4	0.2	-0.04
	Cristobalite-a	Unitless	0.6	0.5	0.5	0.5	0.4	0.4	0.3	0.2	0.1	-0.05	-0.3
	Cristobalite-b	Unitless	0.1	0.1	0.1	0.02	-0.03	-0.1	-0.2	-0.2	-0.4	-0.5	-0.8
	Quartz	Unitless	1.1	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.7	0.5	0.2
	SiO2(am)	Unitless	-0.2	-0.2	-0.2	-0.3	-0.3	-0.4	-0.5	-0.6	-0.7	-0.8	-1.1
	Tridymite	Unitless	0.9	0.9	0.9	0.8	0.8	0.8	0.7	0.6	0.5	0.3	0.04
Carbonate Minerals	Calcite	Unitless	-0.1	-0.2	-0.4	-0.6	-0.7	-0.9	-1.0	-1.2	-1.3	-1.5	-1.6
	Dolomite	Unitless	0.7	0.4	-0.03	-0.4	-0.7	-1.0	-1.3	-1.6	-1.9	-2.2	-2.6
	Magnesite	Unitless	-0.8	-1.0	-1.3	-1.5	-1.6	-1.8	-2.0	-2.1	-2.3	-2.5	-2.6
	Witherite	Unitless	1.8	1.9	1.8	1.7	1.7	1.6	1.5	1.4	1.3	1.2	1.0
Sulfate Minerals	Barite	Unitless	-0.5	-0.2	0.03	0.2	0.3	0.4	0.4	0.5	0.6	0.6	0.7
	Gypsum	Unitless	-2.9	-2.9	-2.8	-2.8	-2.7	-2.7	-2.6	-2.6	-2.6	-2.5	-2.5
	MgSO4	Unitless	-12.7	-12.7	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8	-12.8
Iron Minerals	Fe(OH)3(am)	Unitless	-1.0	-0.7	-0.5	-0.4	-0.4	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3
	Goethite	Unitless	4.1	4.5	4.6	4.7	4.8	4.9	4.9	4.9	4.9	4.9	4.9
	Hematite	Unitless	9.2	9.9	10.2	10.4	10.6	10.7	10.7	10.8	10.8	10.8	10.8
	Magnetite	Unitless	-3.9	-3.1	-2.7	-2.5	-2.3	-2.3	-2.2	-2.2	-2.3	-2.3	-2.4
	Siderite	Unitless	-13.3	-13.0	-12.7	-12.5	-12.4	-12.3	-12.2	-12.2	-12.2	-12.2	-12.2
Manganese Minerals	Birnessite	Unitless	41.9	42.1	40.8	39.3	37.8	36.4	35.1	33.7	32.3	30.8	29.2
	Bixbyite	Unitless	7.6	7.5	7.2	6.8	6.4	6.0	5.7	5.4	5.0	4.7	4.3
	Hausmannite	Unitless	5.1	4.8	4.2	3.5	2.9	2.3	1.8	1.3	0.7	0.1	-0.5
	Manganite	Unitless	3.7	3.7	3.5	3.4	3.2	3.1	2.9	2.8	2.7	2.5	2.4
	Pyrolusite	Unitless	7.6	7.8	7.7	7.5	7.4	7.2	7.1	7.0	6.8	6.7	6.5
	Rhodochrosite	Unitless	-1.9	-1.9	-2.0	-2.1	-2.2	-2.3	-2.4	-2.5	-2.6	-2.8	-2.9
Other	Fluorite	Unitless	-2.1	-2.1	-2.2	-2.2	-2.3	-2.4	-2.6	-2.8	-3.1	-3.7	U
	Pyrite	Unitless	-245.2	-246.8	-247.3	-247.6	-247.9	-248.2	-248.5	-248.8	-249.2	-249.4	-249.7

Notes: Shaded = mineral saturation indices shown where supersaturation is indicated (SI > 0)
 U = mineral undersaturated (SI could not be calculated due to non-detect constituent concentrations)

Table 6: Predicted Mineral Saturation Indices of Well 6 Native Waters Mixed with Treated Recharge Water at 30°C

Type	Mineral	SI Units	Treated Recharge Water in Mixture at 30°C										
			0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Silica Minerals	Chalcedony	Unitless	0.7	0.7	0.7	0.6	0.6	0.5	0.4	0.3	0.2	0.0	-0.3
	Cristobalite-a	Unitless	0.5	0.4	0.4	0.3	0.3	0.2	0.1	0.0	-0.1	-0.3	-0.6
	Cristobalite-b	Unitless	0.04	0.0004	-0.04	-0.1	-0.1	-0.2	-0.3	-0.4	-0.5	-0.7	-1.0
	Quartz	Unitless	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.6	0.4	0.3	-0.1
	SiO2(am)	Unitless	-0.2	-0.3	-0.3	-0.4	-0.4	-0.5	-0.6	-0.7	-0.8	-1.0	-1.3
	Tridymite	Unitless	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.4	0.3	0.1	-0.3
Carbonate Minerals	Calcite	Unitless	0.1	0.1	-0.01	-0.2	-0.4	-0.6	-0.7	-0.9	-1.0	-1.2	-1.4
	Dolomite	Unitless	0.5	0.7	0.6	0.3	-0.1	-0.4	-0.7	-1.0	-1.3	-1.7	-2.0
	Magnesite	Unitless	-1.2	-1.0	-1.0	-1.1	-1.3	-1.5	-1.6	-1.7	-1.9	-2.0	-2.2
	Witherite	Unitless	U	1.9	2.0	1.9	1.8	1.6	1.5	1.3	1.2	1.1	0.9
Sulfate Minerals	Barite	Unitless	U	-1.1	-0.7	-0.5	-0.2	-0.1	0.1	0.2	0.3	0.4	0.4
	Gypsum	Unitless	-3.9	-3.6	-3.4	-3.2	-3.1	-2.9	-2.8	-2.7	-2.7	-2.6	-2.5
	MgSO4	Unitless	-13.9	-13.4	-13.1	-12.8	-12.7	-12.5	-12.4	-12.3	-12.2	-12.1	-12.0
Iron Minerals	Fe(OH)3(am)	Unitless	U	-0.4	-0.1	0.04	0.2	0.2	0.3	0.4	0.4	0.4	0.4
	Goethite	Unitless	U	4.6	4.9	5.1	5.2	5.3	5.4	5.4	5.4	5.5	5.5
	Hematite	Unitless	U	10.2	10.8	11.2	11.4	11.6	11.7	11.8	11.9	11.9	12.0
	Magnetite	Unitless	U	-2.0	-1.1	-0.6	-0.3	-0.1	0.1	0.3	0.4	0.4	0.4
	Siderite	Unitless	U	-12.8	-12.4	-12.0	-11.7	-11.5	-11.3	-11.2	-11.1	-11.0	-10.9
Manganese Minerals	Birnessite	Unitless	U	45.9	46.9	45.7	43.7	41.6	39.8	38.1	36.6	35.0	33.3
	Bixbyite	Unitless	U	8.2	8.4	8.1	7.5	7.0	6.5	6.1	5.7	5.2	4.8
	Hausmannite	Unitless	U	6.1	6.3	5.8	4.9	4.1	3.3	2.7	2.1	1.4	0.8
	Manganite	Unitless	U	3.5	3.6	3.4	3.1	2.9	2.6	2.4	2.2	2.0	1.8
	Pyrolusite	Unitless	U	7.9	8.0	7.9	7.7	7.4	7.2	7.0	6.8	6.6	6.4
	Rhodochrosite	Unitless	U	-2.0	-1.8	-1.8	-1.9	-2.0	-2.2	-2.3	-2.4	-2.6	-2.7
Other	Fluorite	Unitless	-2.3	-2.2	-2.2	-2.3	-2.3	-2.4	-2.6	-2.8	-3.1	-3.6	U
	Pyrite	Unitless	U	-240.8	-240.6	-239.9	-239.2	-238.5	-237.9	-237.4	-236.9	-236.4	-236.0

Notes: Shaded = mineral saturation indices shown where supersaturation is indicated (SI > 0)
 U = mineral undersaturated (SI could not be calculated due to non-detect constituent concentrations)

Table 7: Predicted Mineral Saturation Indices of Stahl Well Native Waters Mixed with Treated Recharge Water at 21°C

Type	Mineral	SI Units	Treated Recharge Water in Mixture at 21°C										
			0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Silica Minerals	Chalcedony	Unitless	0.9	0.8	0.8	0.7	0.7	0.6	0.5	0.4	0.3	0.1	-0.2
	Cristobalite-a	Unitless	0.6	0.5	0.5	0.4	0.4	0.3	0.2	0.1	0.02	-0.2	-0.5
	Cristobalite-b	Unitless	0.1	0.1	0.04	-0.01	-0.1	-0.1	-0.2	-0.3	-0.4	-0.6	-0.9
	Quartz	Unitless	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.7	0.6	0.4	0.1
	SiO ₂ (am)	Unitless	-0.2	-0.2	-0.3	-0.3	-0.4	-0.4	-0.5	-0.6	-0.7	-0.9	-1.2
	Tridymite	Unitless	0.9	0.9	0.9	0.8	0.8	0.7	0.6	0.5	0.4	0.2	-0.1
Carbonate Minerals	Calcite	Unitless	-0.1	-0.2	-0.4	-0.5	-0.7	-0.8	-0.9	-1.1	-1.2	-1.4	-1.5
	Dolomite	Unitless	0.7	0.4	0.04	-0.3	-0.6	-0.9	-1.1	-1.4	-1.7	-2.0	-2.3
	Magnesite	Unitless	-0.8	-1.0	-1.2	-1.4	-1.5	-1.7	-1.8	-2.0	-2.1	-2.3	-2.5
	Witherite	Unitless	1.8	1.9	1.8	1.7	1.7	1.6	1.5	1.4	1.2	1.1	1.0
Sulfate Minerals	Barite	Unitless	-0.5	-0.2	0.01	0.1	0.2	0.3	0.4	0.4	0.5	0.5	0.6
	Gypsum	Unitless	-2.9	-2.9	-2.8	-2.8	-2.7	-2.7	-2.6	-2.6	-2.6	-2.5	-2.5
	MgSO ₄	Unitless	-12.7	-12.7	-12.7	-12.7	-12.6	-12.6	-12.6	-12.6	-12.5	-12.5	-12.5
Iron Minerals	Fe(OH) ₃ (am)	Unitless	-1.0	-0.7	-0.5	-0.3	-0.2	-0.2	-0.1	-0.1	-0.04	-0.01	-0.002
	Goethite	Unitless	4.1	4.5	4.7	4.8	4.9	5.0	5.0	5.1	5.1	5.1	5.2
	Hematite	Unitless	9.2	10.0	10.3	10.6	10.8	10.9	11.0	11.1	11.2	11.3	11.3
	Magnetite	Unitless	-3.9	-3.0	-2.5	-2.1	-1.8	-1.7	-1.5	-1.4	-1.3	-1.2	-1.2
	Siderite	Unitless	-13.3	-12.9	-12.6	-12.4	-12.2	-12.1	-11.9	-11.8	-11.8	-11.7	-11.6
Manganese Minerals	Birnessite	Unitless	41.9	42.4	41.4	40.0	38.7	37.5	36.2	35.0	33.8	32.4	31.0
	Bixbyite	Unitless	7.6	7.6	7.3	6.9	6.5	6.2	5.9	5.6	5.2	4.9	4.5
	Hausmannite	Unitless	5.1	4.9	4.4	3.8	3.2	2.7	2.2	1.7	1.2	0.6	0.05
	Manganite	Unitless	3.7	3.7	3.5	3.3	3.1	3.0	2.8	2.7	2.5	2.3	2.1
	Pyrolusite	Unitless	7.6	7.8	7.7	7.5	7.4	7.2	7.1	6.9	6.8	6.6	6.5
	Rhodochrosite	Unitless	-1.9	-1.9	-2.0	-2.1	-2.1	-2.2	-2.3	-2.4	-2.6	-2.7	-2.8
Other	Fluorite	Unitless	-2.1	-2.1	-2.2	-2.2	-2.3	-2.4	-2.6	-2.8	-3.1	-3.7	U
	Pyrite	Unitless	-245.2	-246.3	-246.2	-245.9	-245.7	-245.4	-245.1	-244.8	-244.5	-244.2	-243.9

Notes: Shaded = mineral saturation indices shown where supersaturation is indicated (SI > 0)
 U = mineral undersaturated (SI could not be calculated due to non-detect constituent concentrations)

Table 8: Maximum Estimated Pore Volume Filled by Mineral Precipitation

Parameter	Maximum Concentration (mg/L)	Mineral	Density (g/cm ³) ¹	Percent Pore Volume (%)
Dissolved Iron	0.0494	Hematite	5.255	<0.00001
		Goethite	4.18	
		Fe(OH)3(am)	3.96	
Dissolved Manganese	0.0134	Birnessite	3.4	<0.000001
		Bixbyte	5.031	
		Hausmannite	4.84	
		Manganite	4.38	
		Pyrolusite	5.189	

¹Density from mindata.org

Table 9: Comparison of Analytical Water Quality Data from Beaverton, Oregon

Type	Parameter	Units	Primary MCL	Secondary MCL	Hermiston		Beaverton ¹
					Well 6	Stahl Well	ASR 3A Groundwater
General	Dissolved Oxygen	mg/L			0.06	0.28	0.76
	Electrical Conductivity	us/cm			522	574	544.1
	ORP	mV			-179.3	-7.6	-14
	pH	pH units		6.5-8.5	8.52	8.21	7.48
	Temperature	°C			30.69	21.68	15
	Total Dissolved Solids	mg/L		500	233	163	340
Major Anions	Alkalinity, Total as CaCO ₃	mg/L			134	133	130
	Bicarbonate, as CaCO ₃	mg/L			134	133	160
	Carbonate	mg/L			ND	ND	ND
	Chloride	mg/L		250	20	14	94
	Sulfate	mg/L		250	4.71	27.8	1.6
Major Cations	Calcium	mg/L			5.06	9.03	40
	Magnesium	mg/L			0.378	2.97	19
	Potassium	mg/L			10.1	9.41	5.9
	Sodium	mg/L			58.7	58.8	41
Redox Species	Iron, Dissolved	mg/L		0.3	ND	0.00355	ND
	Manganese, Dissolved	mg/L			ND	0.00219	0.049
	Nitrate as N (or NO ₃ -)	mg/L	10 (45 as NO ₃ -)		ND	ND	ND
	Aluminum, Dissolved	mg/L			ND	ND	ND
	Antimony	mg/L	0.006		NA	ND	ND
Trace Metals	Arsenic	mg/L	0.01		ND	ND	ND
	Barium	mg/L	2		NA	0.0255	0.023
	Beryllium	mg/L	0.004		ND	ND	ND
	Cadmium	mg/L	0.005		NA	ND	ND
	Chromium, Total	mg/L	0.1		0.00134	ND	ND
	Copper	mg/L	1.3	1	ND	0.00558	0.0150
	Lead	mg/L	0.015		NA	ND	0.00065
	Mercury	mg/L	0.002		ND	ND	ND
	Nickel	mg/L			ND	ND	ND
	Selenium	mg/L	0.05		0.00223	ND	ND
	Silver	mg/L		0.1	ND	ND	ND
	Thallium	mg/L	0.002		NA	ND	ND
	Uranium	mg/L	0.03		ND	ND	ND
	Zinc	mg/L		5	ND	ND	0.022
Other	Color	Color Units		15	5.00 @ pH 8.34	5.00 @ pH 7.97	ND
	Corrosivity	-		NC	-0.424	-0.458	0.15
	Cyanide	mg/L	0.2		ND	ND	ND
	Flouride	mg/L	4	2	1.49	1.27	0.23
	Odor	TON		3	0	0	2
	Silica	mg/L			76.7	66.6	50
	Total Organic Carbon	mg/L			1.01	0.238	2.2
Total Suspended Solids	mg/L			0.100	2.57	ND	

¹From Bessinger, 2021.

Notes: NA = Not Analyzed
 NC = Noncorrosive
 ND = Non-detect
 Shaded = Value greater than MCL

APPENDIX F

Water Right Holder Agreement

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PORT OF UMATILLA

May 24, 2024

Jen Woody
Groundwater Section
Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, OR 97301

RE: City of Hermiston – Limited License Application for Aquifer Storage and Recovery Testing

Dear Ms. Woody:

The Port of Umatilla has been informed that The City of Hermiston is proposing to develop an Aquifer Storage and Recovery (ASR) project and is applying for a limited license to do ASR pilot testing. The City of Hermiston (City) intends to use treated water from the Regional Water System (RWS) as the source water to be injected into its ASR well(s). We understand that injection would occur from October 1 through March 31.

The Port of Umatilla is the holder of water right certificates 96357, 96358, 96359, and 96360 (Port Certificates). A portion of the water available under the Port Certificates are used to provide water to the RWS year-round. The Port of Umatilla and the City are parties to an agreement under which the City uses RWS water.

As the holder of the Port Certificates, the Port of Umatilla gives the City permission to use water under these water rights for ASR testing. City use of the Port Certificates is allowed while the City retains access to the RWS under its agreement with the Port of Umatilla.

Please contact me at (541) 922-3224 if you have any questions.

Sincerely,

Kim Puzey
General Manager

APPENDIX G

UIC Registration for ASR

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Submittal Receipt

Department of Environmental Quality, State of Oregon

700 NE Multnomah Street, Suite 600 Portland, OR 97232-4100

Date Created: 7/2/2024

Submittal Summary

Submittal ID: **70031**

Submittal: **UIC- Rule Authorization Application - Stormwater (all surfaces), Aquifer Storage and Recovery, Low Temperature Geothermal, Remediation, and other UICs that do not drain stormwater**

Submitted By: **Mark Morgan**

Email: mmorgan@hermiston.or.us

Submitted Date: **2024-07-02 16:57:10**

Submittal Form Info

Submittal Name: **UIC- Rule Authorization Application - Stormwater (all surfaces), Aquifer Storage and Recovery, Low Temperature Geothermal, Remediation, and other UICs that do not drain stormwater**

Submission Method: **Online**

Action Type: **New**

Payment Information (PAID IN FULL)

Processing Fee: **\$321.00**

Technology Fee: **\$12.84**

Total Amount Due: **(None)**

Payment Method: **Credit Card** Paid Amount: **\$333.84**

Date Paid: **6/28/2024**

Confirmation Number: **DEQEDM000038249**

Certification

Statement: **I certify under penalty of law that the no exposure certification completed in this application is accurate to the best of my knowledge. I certify under penalty of law that there are no discharges of stormwater contaminated by exposure to industrial activities or materials from the industrial facility or site identified in this document (except as allowed under 40 CFR 122.26(g)(2)) and/or OAR 340-044 UIC rules.**

I understand that I am obligated to submit a No Exposure Certification to DEQ once every five years. I understand that I must allow the DEQ permitting authority, where the discharge is, to perform inspections to confirm the condition of no exposure and to make such inspection reports publicly available upon request.

I hereby certify that the information contained in this registration is true and correct to the best of my knowledge and belief.

Question: **where did you first meet your spouse?**

Question's Answer: *********

PIN Number: *********

IP Address: **140.211.32.45**

Responsible Official: **Mark Morgan**



TECHNICAL MEMORANDUM

City of Hermiston ASR Injection Plan

To: Keven Weberling, Oregon Department of Environmental Quality

From: Matt Thomas, RG, GSI Water Solutions, Inc.
Matt Kohlbecker, RG, GSI Water Solutions, Inc.

Date: June 13, 2024

GSI Water Solutions, Inc. (GSI) is assisting the City of Hermiston (City) with the preparation of a Limited License application for Aquifer Storage and Recovery (ASR) testing to increase the quantity and improve the quality of the City's municipal water supply. As part of the Limited License application, GSI is submitting an application to register the existing municipal supply well (City Well 6, referred to here as ASR-1) and two future wells (ASR-2 and ASR-3) to be used as part of the ASR system as Underground Injection Controls (UICs). This Technical Memorandum (TM) is intended to serve as the ASR Injection Plan as required under OAR 340-044.

Description of Intended Injection Activities

The goal for the City's ASR program under the requested limited license is to develop an ASR program that can provide storage of up to 1,050 million gallons (MG) of water per year. The purpose of pilot testing is to confirm ASR feasibility, and to develop design criteria for full-scale ASR operation within the aquifer. The pilot testing program described below is the framework that will be implemented initially at the City's ASR wells. The maximum theoretical injection rate of the combined three well ASR system is anticipated to be no more than 2,000 gpm due to source water limitations; the actual amounts injected at each well may vary. The maximum anticipated recovery rate at each well is 2,700 gpm. The locations and construction details of each well in the proposed ASR system are provided in Table 1.

Table 1. ASR Well Locations and Construction Details.

Well ID	Well Log	Latitude	Longitude	Total Depth (feet bgs)	Sealed/Cased Interval (feet bgs)	Production Interval (feet bgs) ^b
ASR-1 (Well 6)	UMAT 5450	45.81338	-119.26078	1,500	0 to 650	650 to 1,500
ASR-2 ^a	N/A	45.81291	-119.27460	1,500	0 to 650	650 to 1,500
ASR-3 ^a	N/A	45.80679	-119.27463	1,500	0 to 650	650 to 1,500

Notes

^a ASR-2 and ASR-3 do not currently exist but for planning purposes are assumed to have the same construction as Well 6. Latitude and longitude reflect proposed (not final) locations.

^b Open borehole interval.

bgs = below ground surface

The pilot testing program under an ASR limited license consists of two components:

Baseline Testing and Monitoring. Includes water level monitoring, evaluations of aquifer water quality, and well testing initiated before the start of ASR testing to document pre-ASR aquifer conditions and well performance. Baseline monitoring will begin as soon as practicable after the City receives an ASR limited license.

ASR Testing. Each ASR pilot testing cycle includes an injection period, a storage period, and a recovery period (Table 2).

- **Year 1.** Includes shakedown test; four short-duration ASR cycles that will be used to develop the aquifer conditioning program; and a longer duration, operational scale pilot testing cycle. Water quality sampling will be performed throughout cycle testing to confirm compliance with ASR water quality standards, evaluate aquifer conditioning, and evaluate the response of the aquifer to ASR. The recharge and recovery rates are based on observed conditions during aquifer testing in January 2024.

Table 2. Year 1 Plan of Operations.

Cycle	Recharge			Storage		Recovery	
	Rate ^a (gpm)	Duration (days)	Volume ^a (MG)	Duration (days)	Rate ^a (gpm)	Duration (days)	Volume ^a (MG)
1	1,100	4	6.3	3	1,800	3	6.3
2	1,100	4	6.3	3	1,800	3	6.3
3	1,100	4	6.3	3	1,800	3	6.3
4 ^b	1,100	4	6.3	3	1,800	7	18.1
Evaluate test results from Cycle 1 through Cycle 4 to assess water quality and drinking water compliance of the recovered water prior to initiating Cycle 5							
5 ^c	1,100	60	95.0	30	1,800	35	90.3

Notes

^aBased on rate observed during aquifer testing in January 2024.

^b Longer recovery period to ensure all mixed source water is recovered.

^cAssumes that 95% of recharged water is recovered per the conditions of the City’s Limited License. This is presented for planning purposes only. Note that the recharge and recovery volumes will be adjusted based on the results of Cycle 1 through Cycle 4.

gpm = gallons per minute

MG = million gallons

Years 2 through 5. Recharge, storage, and recovery rates and duration for subsequent pilot testing cycles will be determined based on previous years’ operations. Because all stored water may not be fully recovered each year, the subsequent year’s injection volume may be reduced. Water quality sampling is also included.

Geologic Setting and Formation Description

The City is located in the Umatilla Basin, in Umatilla County, Oregon. Geologic units beneath the City include unconsolidated alluvial deposits (consisting primarily of the Catastrophic Flood Deposits and Alkali Canyon Formation) and the Columbia River Basalt Group (CRBG). The CRBG is the target aquifer for the City’s ASR program.

Geologic Units

The primary geologic units may be grouped as follows, organized from oldest to youngest:

- The CRBG consists of a series of continental flood basalt sheet flows that erupted between 6 and 17 million years ago from linear fissure systems located south and east of the Umatilla Basin (Tolan et al., 1989; Tolan et al., 2009). The total thickness of the CRBG in the Umatilla Basin is probably at least 5,000 feet and may exceed 10,000 feet (Davies-Smith et al., 1988). The CRBG in the Hermiston area is made up of three formations: Saddle Mountains Basalt, Wanapum Basalt, and Grande Ronde Basalt. The formations are divided into multiple members and each member consists of one or more individual lava flows. The upper 1,300 feet of the CRBG is tapped by City wells and is comprised of at least five basalt members: The Pomona Member and Umatilla Member of the Saddle Mountains Basalt, the Priest Rapids Member and Frenchman Springs Member of the Wanapum Basalt, and the Sentinel Bluffs Member of the Grande Ronde Basalt (Tolan, 1992; Wozniak et al., 1995). The basalt members encountered by Well 6 are inferred based on well driller log interpretations and correlations with Well 2, where flows were identified by geologic logging and chemical analysis.

- The unconsolidated alluvial deposits in Hermiston are primarily composed of Catastrophic Flood Deposits and the Alkali Canyon Formation (Wozniak et al., 1995; Tolan, 1992).
 - The Alkali Canyon Formation was deposited by streams that drained the Blue Mountains to the South and is comprised of tuffaceous (ash-rich) silts and sands, as well as moderately indurated gravels. The sediments of the Alkali Canyon Formation are commonly lower permeability because much of the primary porosity of the sediments has been filled by mineral cementation.
 - The Catastrophic Flood Deposits were deposited by mega-floods caused by the episodic failure of the ice dam that impounded Glacial Lake Missoula, with the last episode occurring about 13,000 years ago (Baker, 1978). The deposits are comprised of “coarse-grained deposits” (boulders, gravels, and medium to coarse sands) and “fine-grained deposits” (silts, clays, and fine-grained sands).

Geologic Structure

There are two geologic structures in the vicinity of the City – the Hermiston Trough and the Service Anticline.

- The Hermiston Trough is a northeast-trending depression in the CRBG surface that was formed by structural deformation (i.e. a syncline) and erosion by the Catastrophic Floods. The trough is filled by alluvial deposits that are in hydraulic communication with shallow members of the CRBG where the water-bearing CRBG interflow zones are exposed to saturated alluvium.
- The Service Anticline is a north-south trending fold and fault complex approximately aligned with the Umatilla and Hermiston Buttes. In places, a combination of folding and erosion results in the CRBG aquifers daylighting against the saturated alluvial deposits, causing the CRBG to be in hydraulic communication with the alluvial deposits.

Hydrogeology

CRBG basalt flows typically exhibit a three-part intraflow structure: flow top, flow interior, and flow bottom. The flow top and flow bottom are commonly vesicular and brecciated, and together may form relatively permeable intervals that comprise the water-bearing zones in the CRBG (interflow zones). Certain interflow zones are regionally a target storage aquifer for ASR only where they are hydraulically isolated from alluvial deposits so that recharged water cannot escape from the receiving aquifer. Based on geologic cross sections in Figure 3A and Figure 3B:

- The Pomona Member of the CRBG appears to be hydraulically connected to the alluvial deposits near structural features such as the Hermiston Trough and Service Anticline and, therefore, is not a suitable target storage aquifer for ASR.
- The Umatilla, Priest Rapids, Frenchman Springs, and Sentinel Bluffs Members of the CRBG appear to be hydraulically isolated from the alluvial deposits and, therefore, are suitable target storage aquifers for ASR.

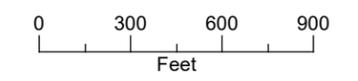
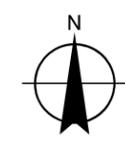
Recharge to CRBG interflow zones in the Umatilla Basin is thought to occur at surface exposures in the Blue Mountains. Groundwater then flows downdip, flowing north towards the Umatilla Basin and the Columbia River.

FIGURE 1
Site Map
 Underground Injection Control (UIC) Application



LEGEND

- Proposed ASR Well
- Tax Lot
- City Boundary (Study Area)



Date: June 10, 2024
 Data Sources: BLM, ESRI, ODOT, USGS,
 Maxar Imagery (2020)

APPENDIX H

Land Use Information Forms

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Land Use Information Form



Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301-1266
(503) 986-0900
www.oregon.gov/OWRD

NOTE TO APPLICANTS

In order for your application to be processed by the Oregon Water Resources Department (OWRD), this Land Use Information Form must be completed by a local government planning official in the jurisdiction(s) where your water right will be diverted, conveyed, used, and developed. The planning official may choose to complete the form while you wait or return the "Receipt Acknowledging Request for Land Use Information" to you. Applications received by OWRD without the Land Use Information Form, or the signed receipt, will be returned to you. **IMPORTANT:** Please note that while OWRD can accept a signed receipt as part of intake for an application for a new permit to use or store water, a completed Land Use Information Form is required for OWRD's acceptance of all other applications. Please be aware that your application cannot be approved without land use approval.

This form is **NOT** required if:

- 1) Water is to be diverted, conveyed, and used on federal lands only; **OR**
- 2) The application is for a water right transfer, allocation of conserved water, exchange, permit amendment, or ground water registration modification, and **all** of the following apply:
 - a. The existing and proposed water use is located entirely within lands zoned for exclusive farm-use or within an irrigation district;
 - b. The application involves a change in place of use only;
 - c. The change does not involve the placement or modification of structures, including but not limited to water diversion, impoundment, distribution facilities, water wells and well houses; **and**
 - d. The application involves irrigation water uses only.

NOTE TO LOCAL GOVERNMENTS

The person presenting the attached Land Use Information Form is applying for a new water right or modifying an existing water right. The Oregon Water Resources Department (OWRD) requires applicants to obtain land use information to ensure the water right does not result in land uses that are incompatible with your comprehensive plan. Please complete the form and return it to the applicant for inclusion in their application. **NOTE:** For new water right applications only, if you are unable to complete this form while the applicant waits, you may complete the "Receipt Acknowledging Request for Land Use Information" and return it to the applicant.

You will receive notice via OWRD's weekly Public Notice once the applicant formally submits their request to OWRD. The notice will give more information about OWRD's water right process and provide additional comment opportunities. If you previously only completed the receipt for an application for a new permit to use or store water, you will have 30 days from the Public Notice date to complete the Land Use Information Form and return it to OWRD. Your attention to this request for information is greatly appreciated. If you have questions concerning this form, please contact OWRD's Customer Service Group at 503-986-0900 or WRD_DL_customerservice@water.oregon.gov.

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Land Use Information Form



Oregon Water Resources Department
 725 Summer Street NE, Suite A
 Salem, Oregon 97301-1266
 (503) 986-0900
 www.oregon.gov/OWRD

NAME Mark Morgan, Assistant City Manager			PHONE 541-567-5521		
MAILING ADDRESS 180 NE 2nd St.					
CITY Hermiston		STATE OR	ZIP 97838	EMAIL mmorgan@hermiston.gov	

A. Land and Location

Please include the following information for all tax lots where water will be diverted (taken from its source), conveyed (transported), and/or used or developed. Applicants for municipal use, or irrigation uses within irrigation districts, may substitute existing and proposed service-area boundaries for the tax-lot information requested below.

Township	Range	Section	¼ ¼	Tax Lot #	Plan Designation (e.g., Rural Residential/RR-5)	Water to be:	Proposed Land Use:
						<input type="checkbox"/> Diverted <input type="checkbox"/> Conveyed <input type="checkbox"/> Used	
			See Attached			<input type="checkbox"/> Diverted <input type="checkbox"/> Conveyed <input type="checkbox"/> Used	
						<input type="checkbox"/> Diverted <input type="checkbox"/> Conveyed <input type="checkbox"/> Used	
						<input type="checkbox"/> Diverted <input type="checkbox"/> Conveyed <input type="checkbox"/> Used	

List all counties and cities where water is proposed to be diverted, conveyed, and/or used or developed:

Hermiston, Umatilla County, OR

NOTE: A separate Land Use Information Form must be completed and submitted for each county and city, as applicable.

B. Description of Proposed Use

Type of application to be filed with the Oregon Water Resources Department:

- Permit to Use or Store Water
 Water Right Transfer
 Permit Amendment or Ground Water Registration Modification
 Limited Water Use License
 Exchange of Water
 Allocation of Conserved Water

Source of water: Reservoir/Pond Ground Water Surface Water (name) Columbia River

Estimated quantity of water needed: 1500 cubic feet per second gallons per minute acre-feet

Intended use of water: Irrigation Commercial Industrial Domestic for _____ household(s)
 Municipal Quasi-Municipal Instream Other ASR

Briefly describe:

This Land Use Information Form is part of the limited license application for an Aquifer Storage and Recovery (ASR) project in Hermiston, OR. The project will involve conveying water from the Regional Water Treatment Plant at 30115 Feedville Rd to several wells between Feedville Rd and Penney Ave. Water will be stored and recovered from the underlying Columbia River Basalt Group aquifer in order to supplement the City's groundwater resource and diversify groundwater sources used by the City.
--

Note to applicant: For new water right applications only, if the Land Use Information Form cannot be completed while you wait, please have a local government representative sign the receipt on the bottom of page 4 and include it with the application filed with the Oregon Water Resources Department.

See Page 4 →

For Local Government Use Only

The following section must be completed by a planning official from each county and city listed unless the project will be located entirely within the city limits. In that case, only the city planning agency must complete this form. This deals only with the local land use plan. Do not include approval for activities such as building or grading permits.

Please check the appropriate box below and provide the requested information

- Land uses to be served by the proposed water use(s), including proposed construction, are allowed outright or are not regulated by your comprehensive plan. Cite applicable ordinance section(s): ASR NOT REGULATED BY CITY
- Land uses to be served by the proposed water use(s), including proposed construction, involve discretionary land-use approvals as listed in the table below. (Please attach documentation of applicable land-use approvals which have already been obtained. Record of Action/land-use decision and accompanying findings are sufficient.) **If approvals have been obtained but all appeal periods have not ended, check "Being Pursued."**

Type of Land-Use Approval Needed (e.g., plan amendments, rezones, conditional-use permits, etc.)	Cite Most Significant, Applicable Plan Policies & Ordinance Section References	Land-Use Approval:	
		<input type="checkbox"/> Obtained <input type="checkbox"/> Denied	<input type="checkbox"/> Being Pursued <input type="checkbox"/> Not Being Pursued
		<input type="checkbox"/> Obtained <input type="checkbox"/> Denied	<input type="checkbox"/> Being Pursued <input type="checkbox"/> Not Being Pursued
		<input type="checkbox"/> Obtained <input type="checkbox"/> Denied	<input type="checkbox"/> Being Pursued <input type="checkbox"/> Not Being Pursued
		<input type="checkbox"/> Obtained <input type="checkbox"/> Denied	<input type="checkbox"/> Being Pursued <input type="checkbox"/> Not Being Pursued

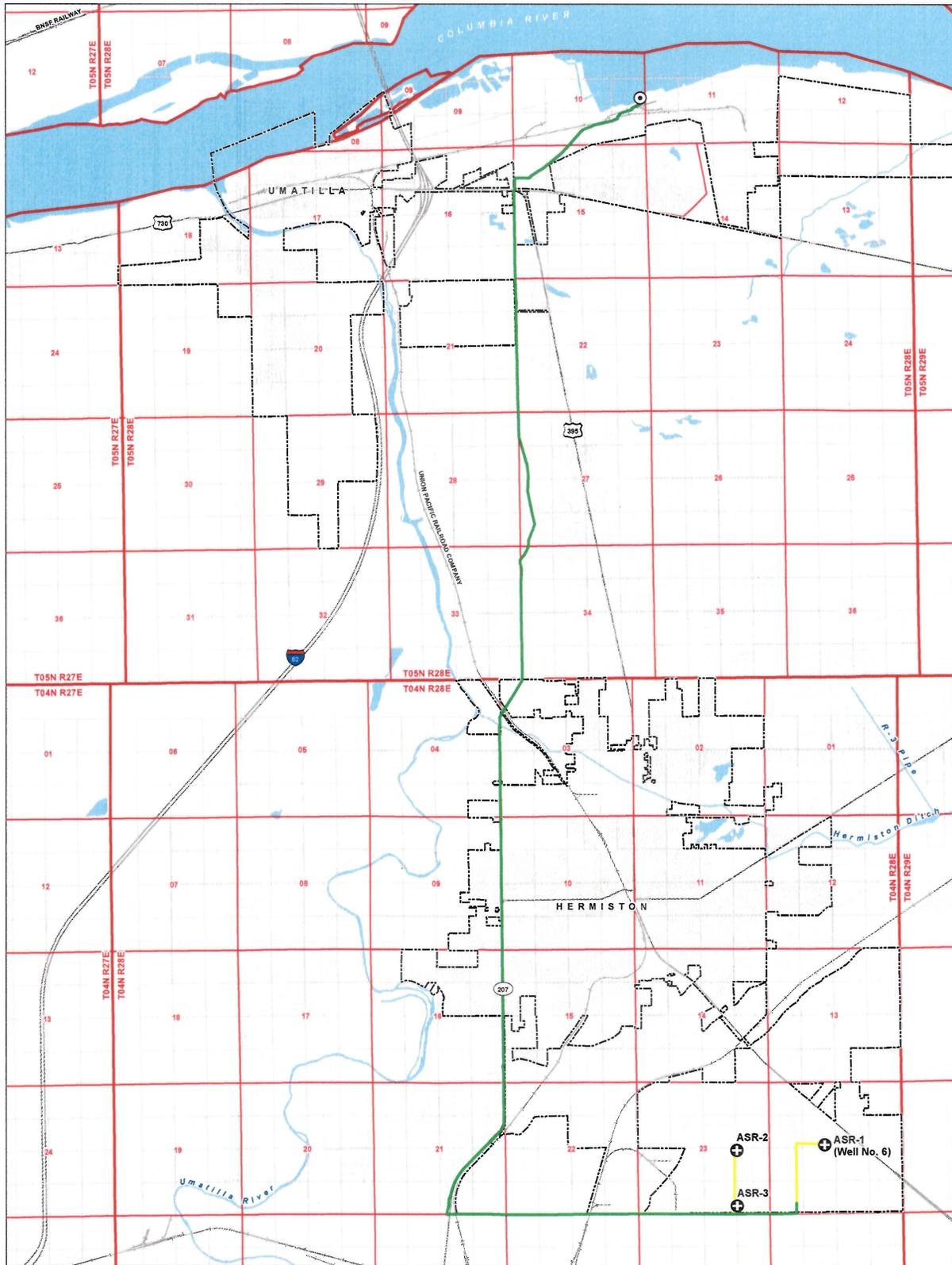
Local governments are invited to express special land use concerns or make recommendations to the Oregon Water Resources Department regarding this proposed use of water in the box below or on a separate sheet.

Name: CLINT SPENCER Title: PLANNING DIR
 Signature: *Clint Sp* Date: 5-22-24
 Governmental Entity: CITY OF HERMISTON Phone: 541 667-5025

Receipt Acknowledging Request for Land Use Information	
<p>Note to Local Government Representative: Please complete this form and return it to the applicant. For new water right applications only, if you are unable to complete this form while the applicant waits, you may complete this receipt and return it to the applicant. If you sign the receipt, you will have 30 days from the date of OWRD's Public Notice of the application to submit the completed Land Use Information Form to Oregon Water Resources Department. Please note while OWRD can accept a signed receipt as part of intake for an application for a new permit to use or store water, a completed Land Use Information Form is required for all other applications.</p>	
Applicant Name: _____	
Staff Name: _____	Title: _____
Staff Signature: _____	Date: _____
Governmental Entity: _____	Phone: _____

Table A. Land and Location

Township		Range		Section	Q	QQ	Tax Lot ID	Zone Code	Water to be:
5	N	28	E	10	NE	SE	5N28110001500	M-2	Diverted
4	N	28	E	3	NW	NW	4N2803B000200	R-1	Conveyed
4	N	28	E	3	NW	NW	4N2803B000202	R-1	Conveyed
4	N	28	E	4	NE	NE	4N2804A000300	R-1	Conveyed
4	N	28	E	21	SW	SE	4N2821D000701	F-1	Conveyed
5	N	28	E	10	NE	SE	5N28000000400	F-1	Conveyed
5	N	28	E	10	SE	SE	5N28000000400	F-1	Conveyed
5	N	28	E	10	SW	SE	5N28000000400	F-1	Conveyed
5	N	28	E	10	SE	SW	5N28000000400	F-1	Conveyed
5	N	28	E	15	NE	NW	5N28000000400	F-1	Conveyed
5	N	28	E	15	NW	NW	5N28000000400	F-1	Conveyed
5	N	28	E	15	SW	NW	5N2815BC00101	F-1	Conveyed
5	N	28	E	27	NW	NW	5N2827B001100	M-1/ Aggregate Resource	Conveyed
5	N	28	E	27	NW	NW	5N2827B001100	M-1	Conveyed
5	N	28	E	27	NW	NW	5N2827B001100	M-1	Conveyed
5	N	28	E	27	SW	SW	5N2827C000106	M-1	Conveyed
5	N	28	E	27	NW	SW	5N2827C000108	M-1	Conveyed
5	N	28	E	27	NW	SW	5N2827C000200	M-1	Conveyed
5	N	28	E	27	NW	SW	5N2827C000300	M-1	Conveyed
5	N	28	E	27	SW	SW	5N2827C000300	M-1	Conveyed
5	N	28	E	27	SW	SW	5N2827C000703	M-1	Conveyed
5	N	28	E	27	SW	SW	5N2827C000704	M-1	Conveyed
5	N	28	E	27	SW	SW	5N2827C000706	M-1	Conveyed
5	N	28	E	34	NW	NW	5N2834B000500	R-R	Conveyed
4	N	28	E	23	SW	NE	4N28230000206	M-2	Used
4	N	28	E	23	SE	SE	4N28230000210	C-2/M-2	Used
4	N	28	E	23	SE	NE	4N28230000210	C-2/M-2	Used
4	N	28	E	24	SW	NW	4N2824B000300	C-2/M-1	Used
4	N	28	E	24	SE	NW	4N2824B000300	C-2/M-1	Used
4	N	28	E	24	SE	NW	4N2824B000400	C-2/M-1	Used



LEGEND

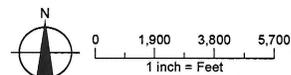
- | | | | |
|--|--------------------------|--|--------------------|
| | Proposed Recharge Area | | All Other Features |
| | Point of Diversion (POD) | | City Boundary |
| | Pipeline | | Tax Lot |
| | Proposed Pipeline | | Railroad |
| | | | Major Road |
| | | | Watercourse |
| | | | Waterbody |

DISCLAIMER

This map was prepared for the purpose of identifying the location of a water right only and it is not intended to provide legal dimensions or location of property ownership lines.
 Date: May 17, 2024
 Data Sources: BLM, ESRI, OWRD, USGS

FIGURE 1

Proposed Recharge Area
 Umatilla County
 Township 4 and 5 North, Range 28 East (W.M.)

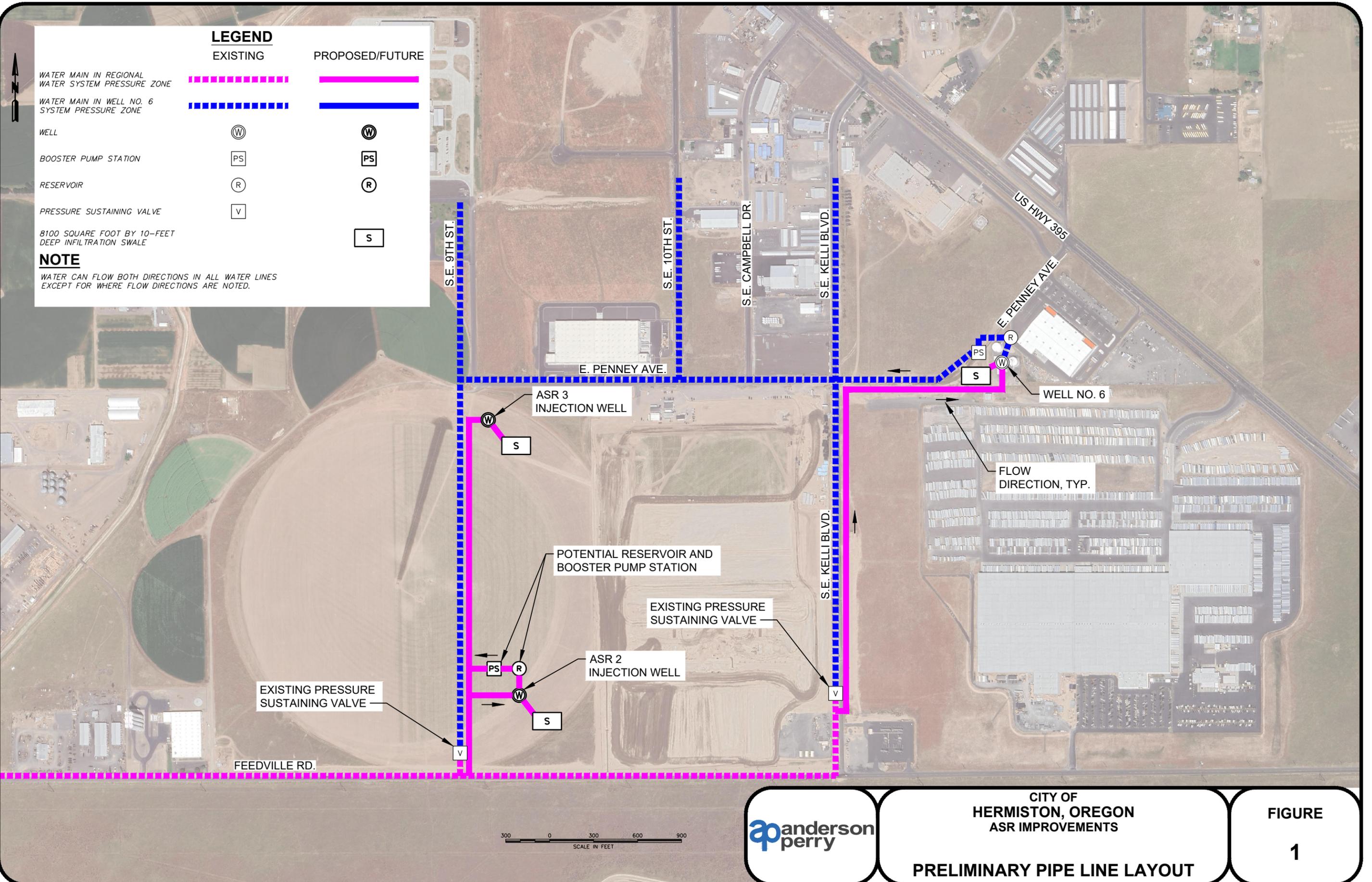


APPENDIX I

Wellhead Diagram

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X:\Clients\Hermiston OR\736-157 ASR Improvements\CAD\ASR-736-157-FIG01.dwg, Layout1, 6/11/2024 10:54 AM, prichardson

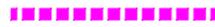


LEGEND

EXISTING

PROPOSED/FUTURE

WATER MAIN IN REGIONAL WATER SYSTEM PRESSURE ZONE



WATER MAIN IN WELL NO. 6 SYSTEM PRESSURE ZONE



WELL



BOOSTER PUMP STATION



RESERVOIR



PRESSURE SUSTAINING VALVE



8100 SQUARE FOOT BY 10- FEET DEEP INFILTRATION SWALE



NOTE

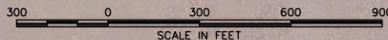
WATER CAN FLOW BOTH DIRECTIONS IN ALL WATER LINES EXCEPT FOR WHERE FLOW DIRECTIONS ARE NOTED.

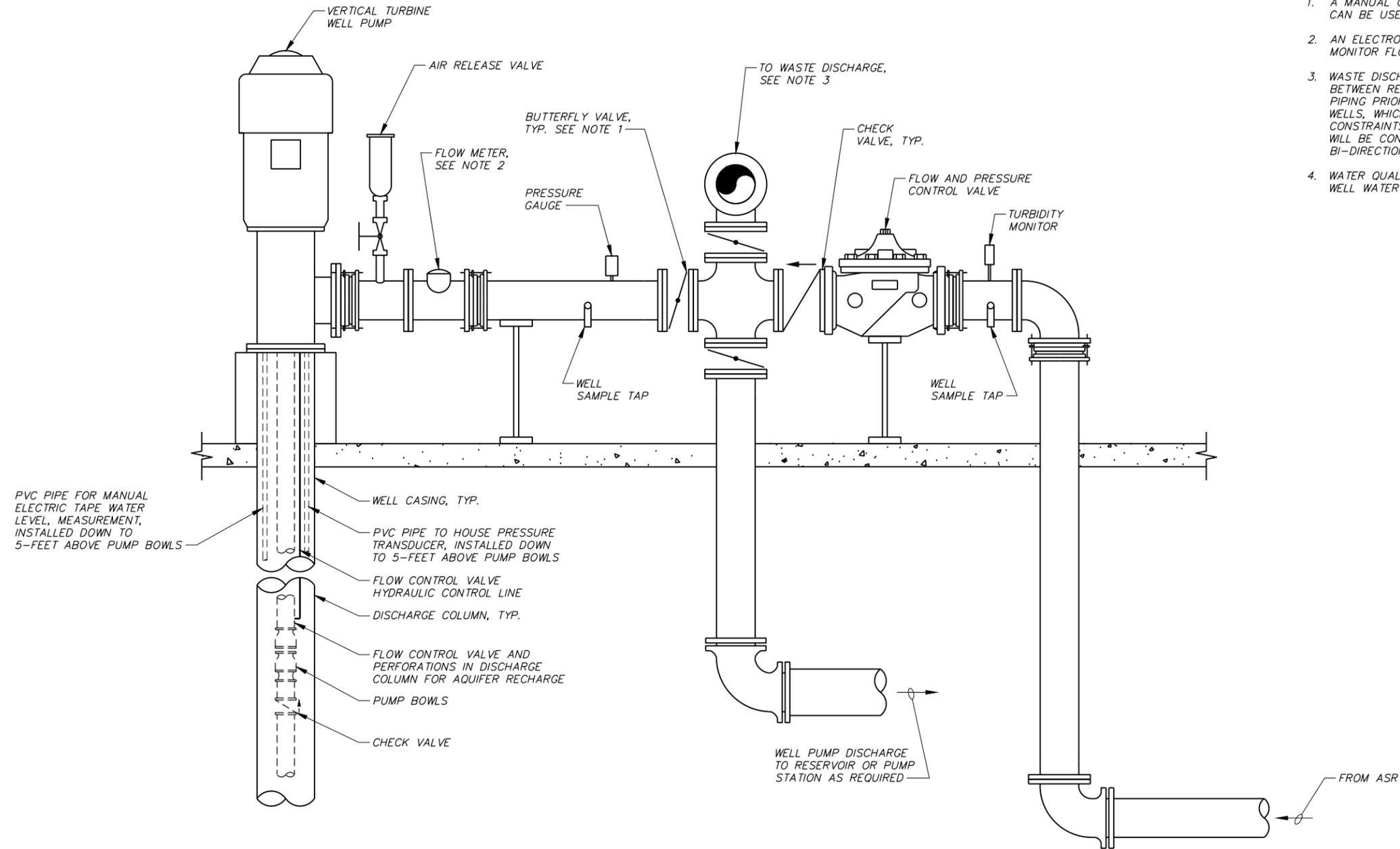
CITY OF HERMISTON, OREGON
ASR IMPROVEMENTS

PRELIMINARY PIPE LINE LAYOUT

FIGURE

1





NOTES

1. A MANUAL OR AUTOMATIC ACTUATED BUTTERFLY VALVE CAN BE USED TO ALLOW ASR FLOW INTO WELL.
2. AN ELECTROMAGNETIC FLOWMETER WILL BE NEEDED TO MONITOR FLOWS BOTH IN AND OUT OF THE WELL.
3. WASTE DISCHARGE IS NEEDED TO FLUSH BOTH THE WELL BETWEEN RECHARGE AND DISCHARGE CYCLES AND THE ASR PIPING PRIOR TO RECHARGING WELL. AT FUTURE ASR WELLS, WHICH MAY NOT BE SUBJECT TO THE SAME CONSTRAINTS AS WELL NO. 6, AN ALTERNATE PIPE DESIGN WILL BE CONSIDERED THAT ELIMINATES PIPE SECTIONS WITH BI-DIRECTIONAL FLOW THAT CANNOT BE PUMPED TO WASTE.
4. WATER QUALITY TESTING OF REGIONAL WATER SYSTEM AND WELL WATER TO OCCUR TO DETERMINE COMPATIBILITY.

X:\Clients\Hermiston OR\736-157 ASR Improvements\CAD\ASR-736-157-FIG02.dwg, Layout1, 6/11/2024 12:35 PM, prichardson

	<p>CITY OF HERMISTON, OREGON ASR IMPROVEMENTS</p>	<p>FIGURE 2</p>
<p>TYPICAL ASR WELL PIPING</p>		

APPENDIX J

Well Logs for Observation Wells

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R. J. Strasser Drilling Co.

8110 S. E. Sunset Lane
Portland, Oregon 97206

RECEIVED
JUL 31 1968
STATE ENGINEER
SALEM, OREGON

Log of well No. 4 at Hermiston, Oregon

brown sand	0 - 5	soft black basalt	952 - 972
grey sand	5 - 16	med. hard black basalt	972 - 979
sand, gravel and boulders	16 - 39	blue clay	979 - 981
gravel	39 - 46	broken black basalt	981 - 988
grey sand and clay	46 - 53	grey clay and rock	988 - 999
sand, gravel, and clay	53 - 60	broken black basalt	999 - 1018
blue clay and gravel	60 - 67	soft black basalt	1018 - 1024
hard black basalt	67 - 74	med. hard black basalt	1024 - 1026
medium hard black basalt	74 - 84	med. soft black basalt	1026 - 1041
medium hard grey basalt	84 - 95		
grey basalt	95 - 182		
broken grey basalt	182 - 187		
green lava and shale	187 - 208		
broken grey basalt	208 - 215		
brown basalt	215 - 221		
grey basalt	221 - 225		
brown basalt	225 - 229		
grey basalt	229 - 268		
broken black basalt	268 - 279		
broken brown lava	279 - 301		
medium hard grey basalt	301 - 306		
hard grey basalt	306 - 423		
broken grey basalt	423 - 449		
hard grey basalt	449 - 465		
soft black basalt	465 - 477		
grey basalt	477 - 497		
broken basalt	497 - 513		
hard grey basalt	513 - 596		
medium hard black basalt	596 - 645		
fractured black basalt	645 - 658		
medium hard black basalt	658 - 681		
hard black basalt	681 - 687		
broken porous black basalt	687 - 694		
medium soft black basalt	694 - 728		
broken brown lava	728 - 740		
medium hard black basalt	740 - 748		
hard grey basalt	748 - 754		
medium hard black basalt	754 - 831		
hard grey basalt	831 - 840		
medium hard black basalt	840 - 857		
hard black basalt	857 - 889		
medium soft black basalt	889 - 923		
hard black basalt	923 - 952		

RECEIVED

MAR 29 2001

STATE OF OREGON WATER SUPPLY WELL REPORT

(as required by ORS 537.765)

WELL ID # L 46763 START CARD # 111251

(1) OWNER:

Name: H4 Farms Address: 115 W Hermiston Ave City: Hermiston State: OR Zip: 97838

Well Number: Sieble Well LOCATION OF WELL by legal description: County: Umatilla Latitude: Longitude:

(2) TYPE OF WORK: (repair/ New Well Deepening Alteration 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 1150 Explosives Used Yes No Type Amount

Table with columns: Diameter, From, To, Material, SEAL From, To, sacks or pounds. Rows include 24" 0 20 Cement 0 20 40 Bags, 19" 200 319 Cement 200 319 200 Bags, etc.

How was seal placed: Method A B C D E Other Backfill placed from 50 to 200 Material Bent Chips Gravel placed from to Size of gravel

(6) CASING/LINER: CASING:

Table with columns: Diameter, From, To, Gauge, Steel, Plastic, Welded, Threaded. Rows include 20 0 20 .375, 16 +1 319 375, etc.

LINER: Final location of Shoe(s):

(7) PERFORATIONS/SCREENS: Perforations Method: Screen Type: Material: Slot Size: Tele/pipe size: Casing Liner

Table with columns: From, To, Size, No., Diameter, Tele/pipe size, Casing Liner. Multiple empty rows for data entry.

(8) WELL TESTS: Minimum testing time is 1 hour Pump Bailer Air Flowing Artesian Yield gpm Drawdown Drill Stem at Time

Table with columns: Yield gpm, Drawdown, Drill Stem at, Time. Row 1: 1800, 1500, 10

Temperature of water 56 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:

Township: 3N Range: 29E Section: 9 SE 1/4 SW 1/4 Tax Lot: 3200 Lot: Block: Subdivision: Street Address of Well (or nearest address) Cemetary Rd Echo, OR

(10) STATIC WATER LEVEL: 369 Ft. below land surface Date 3-22-01 Artesian pressure lb. per sq. in. Date

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

Table with columns: From, To, Est. Flow Rate, SWL. Rows include 289 302 500+ 234, 681 689 200 369, etc.

(12) WELL LOG: Ground Elevation: Material From To SWL

Large table listing well log materials and elevations. Rows include Top Soil & Sand (0-10), Basalt Broken (10-14), Basalt Brownish Black Med Soft (14-58), Basalt Gray Med Hard (58-118), Basalt Black Vic Soft (118-138), Basalt Gray Hard (138-152), Basalt Black Med to Soft (152-182), Basalt Gray Hard (182-203), Basalt Black w/Clay Blue (203-242), Basalt Gray Hard (242-289), Basalt Vic Black (289-302), Basalt Blackish Gray Med Hard (302-318), Basalt Gray Med Hard (318-340), Basalt Black Med Hard (340-380), Basalt Gray Hard (380-475), Basalt Gray Med Hard (475-570), Basalt Black Med Hard (570-605), Basalt Gray Hard (605-630), Basalt Med Soft (630-635), Basalt Hard Black (635-669), Basalt Hard Gray (669-681), Basalt Fract Gray (681-689) H2O, Basalt Hard Black (689-696), Basalt Fract Black (696-728), Basalt Med Hard Gray (728-740), Basalt Fract Black (740-766)

Date Started: 1/31/01 Completed: 3/22/01 (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.

Signed [Signature] WWC Number 806 Date 3/27/01

(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.

Signed [Signature] WWC Number 723 Date 3/27/01

Amended UMAT 54913 UMAT 54913



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

NOTE: Plugged well back to 860'

(WELL I.D.)# L 65427

(START CARD) # 152970

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

(1) OWNER: Well Number Name Stahl Hutterian #2 Address 1485 N. Hoffman Rd. City Ritzville State WA Zip 99169

(2) TYPE OF WORK: [X] New Well [] Deepening [] Alteration (repair/recondition) [] Abandonment

(3) DRILL METHOD: [X] Rotary Air [] Rotary Mud [] Cable [] Auger [] Other

(4) PROPOSED USE: [X] Domestic [] Community [] Industrial [] Irrigation [] Thermal [] Injection [] Livestock [] Other

(5) BORE HOLE CONSTRUCTION: 720' of 12" Special Construction approval [] Yes [] No Depth of Completed Well 860' ft. Explosives used [] Yes [X] No Type Amount

Table with columns: HOLE Diameter, From, To, Material, SEAL From, To, Sacks or pounds. Rows include 10", 16", and 26" diameters with cement seals.

How was seal placed: Method [] A [] B [] C [] D [] E [] Other pumped cement Backfill placed from ft. to ft. Material Gravel placed from ft. to ft. Size of gravel

(6) CASING/LINER: Table with columns: Diameter, From, To, Gauge, Steel, Plastic, Welded, Threaded. Rows for Casing (20") and Liner (12").

Final location of shoe(s)

(7) PERFORATIONS/SCREENS: Table with columns: From, To, Slot size, Number, Diameter, Material, Casing, Liner.

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

Table for well tests with columns: Pump, Bailer, Air, Flowing Artesian, Yield gal/min, Drawdown, Drill stem at, Time. Values: 1000, 75, 1150, 1 hr.

Temperature of water 75 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 [] Color [] Taste Depth of strata:

RECEIVED

(9) LOCATION OF WELL by legal description: County Umatilla Latitude Longitude Township 4 N Range 30 E WM. Section 17 SW 1/4 of SE 1/4 Tax Lot 703 Lot Block Subdivision Street Address of Well (or nearest address) 36345 Despain Gulch Rd. Stanfield, OR 97875

(10) STATIC WATER LEVEL: 419 ft. below land surface. Date 6-29-03 Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES: Depth at which water was first found 172'

Table with columns: From, To, Estimated Flow Rate, SWL

(12) WELL LOG: Ground Elevation

Table for well log with columns: Material, From, To, SWL. Lists geological layers like Brown Sandy Silt, Brown Silt, Brown Silty Clay, etc.

Date started 5-30-03 Completed 9-5-03

(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.

WVC 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.

WVC Number Signed Steve Moore Date 9-11-03

UMAT 54913

**STATE OF OREGON
WATER SUPPLY WELL REPORT**
(as required by ORS 537.763)

(WELL I.D.)# L 65427

(START CARD) # 152970

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

(1) OWNER: Stahl Hutterian #2 Well Number _____
 Name Stahl Hutterian #2
 Address 1485 N. Hoffman Rd.
 City Ritzville State WA Zip 99169

(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: 720' of 12"
 Special Construction approval Yes No Depth of Completed Well 860' ft.
 Explosives used Yes No Type _____ Amount _____

HOLE				SEAL			
Diameter	From	To	Material	From	To	Sacks or pounds	
16"	42'	846'	Cement	0	720'	845'	
26"	+1	42'	Cement	0	42'	81'	
10"	846'	1190'					

How was seal placed: Method A B C D B
 Other pumped cement
 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: 20"	+1	42'	375	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Liner: 12"	+1	720'	375	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Final location of shoe(s) _____

(7) PERFORATIONS/SCREENS:

From	To	Slot size	Number	Diameter	Material	Tele/pipe size	Casing	Liner
							<input type="checkbox"/>	<input type="checkbox"/>
							<input type="checkbox"/>	<input type="checkbox"/>
							<input type="checkbox"/>	<input type="checkbox"/>
							<input type="checkbox"/>	<input type="checkbox"/>

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

Yield gal/min	Drawdown	Drill stem at	Time
1000		1150	1 hr.

Temperature of water 75 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 4 N Range 30 E WM.
 Section 17 SW 1/4 of SE 1/4
 Tax Lot 703 Lot _____ Block _____ Subdivision _____
 Street Address of Well (or nearest address) _____
36345 Despain Guich Rd. Stanfield, OR 97875

(10) STATIC WATER LEVEL:
419 ft. below land surface. Date 6-29-03
 Artesian pressure _____ lb. per square inch. Date _____

(11) WATER BEARING ZONES:
 Depth at which water was first found 172'

From	To	Estimated Flow Rate	SWL

(12) WELL LOG:
 Ground Elevation _____

Material	From	To	SWL
Med. soft reddish brown porous basalt			
some hard green clay	213	222	
Med. hard gray basalt	222	240	
Med. soft gray porous basalt	240	281	
Med. hard gray basalt	281	292	
Soft black porous basalt Trace of hard			
green clay	292	301	
Med. hard black basalt	301	335	
Med. soft porous black basalt Trace of			
Light green claystone	335	382	
Hard dark gray basalt	382	471	
Med. soft black porous basalt	471	488	
Med. hard black porous basalt	488	494	
Soft brown & gray visicular basalt			
Little water	494	506	
Med. soft porous gray basalt	506	521	
Soft brown & black basalt	521	528	
Med. hard porous dark gray basalt	528	543	
Hard black basalt	543	649	

Date started 5-30-03 Completed 9-5-03

(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 Steve Moore Date 9-11-03

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

WATER RESOURCES DEPT
SALEM, OREGON



UMAT 54913

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

(WELL I.D.)# L 65427

(START CARD) # 152970

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

(1) OWNER: Stahl Hutterian #2 Well Number _____
 Name Stahl Hutterian #2
 Address 1485 N. Hoffman Rd.
 City Ritzville State WA Zip 99169

(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: 720' of 12"
 Special Construction approval Yes No Depth of Completed Well 860'
 Explosives used Yes No Type _____ Amount _____

HOLE			SEAL			Sacks or pounds
Diameter	From	To	Material	From	To	
10"	846'	1190'				
16"	42'	846'	Cement	0	720'	845'
26"	+1	42'	Cement	0	42'	81'

How was seal placed: Method A B C D E
 Other pumped cement
 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:	20"	+1	42	375	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Liner:	12"	+1	720	375	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Final location of shoe(s) _____

(7) PERFORATIONS/SCREENS:

From		To		Slot size	Number	Diameter	Material	Casing	Liner
								<input type="checkbox"/>	<input type="checkbox"/>
								<input type="checkbox"/>	<input type="checkbox"/>
								<input type="checkbox"/>	<input type="checkbox"/>
								<input type="checkbox"/>	<input type="checkbox"/>

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

Yield gal/min	Drawdown	Drill stem at	Time
1000		1150	1 hr.

Temperature of water 75 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: _____

RECEIVED

(9) LOCATION OF WELL by legal description:
 County Umatilla Latitude _____ Longitude _____
 Township 4 N Range 30 E WM.
 Section 17 SW 1/4 of SE 1/4
 Tax Lot 703 Lot _____ Block _____ Subdivision _____
 Street Address of Well (or nearest address) _____
36345 Despain Gulch Rd. Stanfield, OR 97875

(10) STATIC WATER LEVEL:
419 ft. below land surface. Date 6-29-03
 Artesian pressure _____ lb. per square inch. Date _____

(11) WATER BEARING ZONES:
 Depth at which water was first found 172'

From	To	Estimated Flow Rate	SWL

(12) WELL LOG:
 Ground Elevation _____

Material	From	To	SWL
Soft black visicular basalt some green clay	649	654	
Med. hard black porous basalt	654	672	
Med. hard black basalt	672	693	
Soft broken black basalt green clay-Water-	693	698	
Med. hard black basalt	698	729	
Med. soft black basalt Trace of hard green clay	729	752	
Soft Broken Brown & gray basalt Trace of green clay - Water 200gpm	752	773	
Med. hard fractured Black Basalt	773	784	
Soft Black Porus Basalt	784	792	
Med. hard dark gray basalt	792	832	
Broken brown visicular basalt some tan siltstone Water 205psi 75'	832	843	
Soft brown basalt	843	850	
Med. hard gray basalt	850	870	
Med. soft dark gray porous basalt			
Water 215 psi	870	875	
Med. hard gray basalt	875	915	

Date started 5-30-03 Completed 9-5-03

(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 Steve Moran Date 9-11-03

MAR 26 2007

UMAT 54913

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.

(WELL I.D.)# L 65427

(START CARD) # 152970

(1) OWNER: Stahl Hutterian #2 Well Number _____

Name Stahl Hutterian #2

Address 1485 N. Hoffman Rd.

City Ritzville State WA Zip 99169

(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: 720' of 12"

Special Construction approval Yes No Depth of Completed Well 860'

Explosives used Yes No Type _____ Amount _____

HOLE			SEAL				
Diameter	From	To	Material	From	To	Sacks or pounds	
16"	42'	846'	Cement	0	720'	845'	
26"	+1	42'	Cement	0	42'	81'	
10"	846'	1190'					

How was seal placed: Method A B C D B

Other Pumped cement

Backfill placed from _____ ft. to _____ ft. Material _____

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

(6) CASING/LINER:

Casing/Liner	Diameter	From	To	Gauge	Material			
					Steel	Plastic	Welded	Threaded
Casing	20"	+1	42'	37.5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Liner	12"	+1	720'	37.5	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Final location of shoe(s) _____

(7) PERFORATIONS/SCREENS:

Perforations Method _____

Screens Type _____ Material _____

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
						<input type="checkbox"/>	<input type="checkbox"/>
						<input type="checkbox"/>	<input type="checkbox"/>
						<input type="checkbox"/>	<input type="checkbox"/>
						<input type="checkbox"/>	<input type="checkbox"/>

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

Pump Bailer Air Flowing Artesian

Yield gal/min 1000 Drawdown _____ Drill stem at _____ Time 1 hr.

Temperature of water 75 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 **RECEIVED**

Depth of strata: _____

(9) LOCATION OF WELL by legal description:

County Umatilla Latitude _____ Longitude _____

Township 4 N Range 30 E WM

Section 17 SW 1/4 of SE 1/4

Tax Lot 703 Lot _____ Block _____ Subdivision _____

Street Address of Well (or nearest address) _____

36348 Despain Gulch Rd. Stanfield, OR 97875

(10) STATIC WATER LEVEL:

419 ft. below land surface. Date 6-29-03

Artesian pressure _____ lb. per square inch. Date _____

(11) WATER BEARING ZONES:

Depth at which water was first found 172'

From	To	Estimated Flow Rate	SWL

(12) WELL LOG:

Ground Elevation _____

Material	From	To	SWL
Soft porous gray basalt Water 225psi	915	926	
Hard gray basalt	926	939	
Soft porous gray basalt Trace of Green Crystals	939	945	
Med. hard porous gray basalt	945	953	
Very hard light gray basalt	953	978	
Med. hard gray porous basalt	978	1036	
Very hard light gray basalt	1036	1082	
Hard dark gray basalt - Trace of green clay	1082	1095	
Hard light gray basalt	1095	1122	
Med. soft porous basalt Trace of green clay & white crystals	1122	1127	
Med. hard gray porous basalt	1127	1145	
Med. soft Visicular gray basalt Water 260psi	1145	1152	
Med. hard gray porous basalt	1152	1190	
Plugged well back to 860' with cement.			
12" to 720'			

Date started 5-30-03 Completed 9-5-03

(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 Steve Moore Date 9-11-03

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

WATER RESOURCES DEPT
SALEM, OREGON

MAR 26 2007

Oregon

WATER
RESOURCES
DEPARTMENT

April 27, 1992

Steve Schneider
Schneider Equipment, Inc. & Drilling Co.
21881 River Road NE
St. Paul, OR 97137

RE: City of Hermiston Old Well #2

Dear Steve,

You are hereby granted a special standard to construct the referenced well as a multiple completion monitoring well. The standard is granted upon the condition that the well will be constructed as detailed in your letter and attachments of April 21, 1992, a copy of which is attached.

You must submit a start card and fee for conversion of this hole to a monitoring well.

Granting this special standard does not relieve the constructor and owner of the well from any future liability, in case the construction method provides an avenue for pollution of the groundwater body.

Sincerely,



Bud Bartels, Manager
Enforcement Section

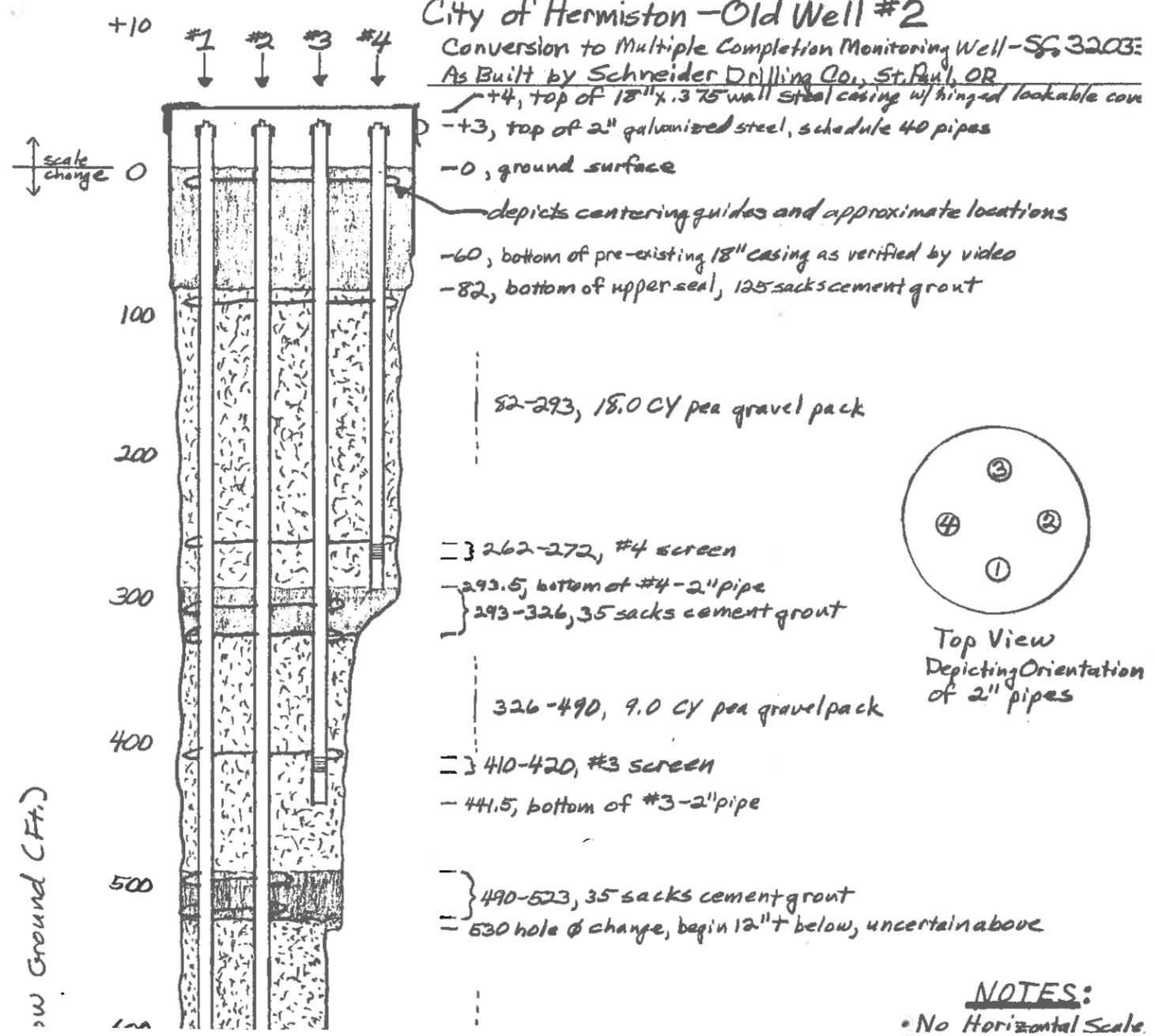
cc: Stan Wallulis
Fred Lissner
Brian Mayer



3850 Portland Rd NE
Salem, OR 97310
(503) 378-3739
FAX (503) 378-8130

City of Hermiston - Old Well #2

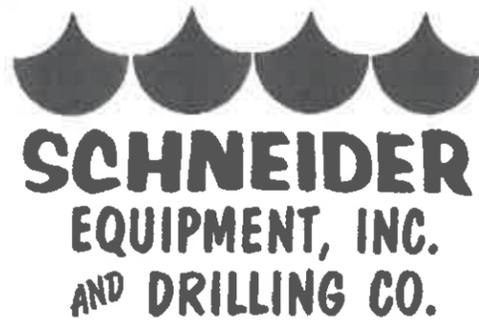
Conversion to Multiple Completion Monitoring Well - SF 3203
 As Built by Schneider Drilling Co., St. Paul, OR



scale change

w Ground (Ft.)

WELL DRILLING
IRRIGATION
CONTROL SYSTEMS



**SCHNEIDER
EQUIPMENT, INC.
AND DRILLING CO.**

PUMPS
ENGINEERED WATER SYSTEMS
SALES AND SERVICE

FAX (503) 633-2668

21881 River Road N.E. St. Paul, Oregon 97137 (503) 633-2666

April 21, 1992

Water Resources Dept.
3850 Portland Road NE
Salem Oregon 97310

Attn: Greg Beaman / Bud Bartels

Re: City of Hermiston old well #2 conversion

Dear Greg and Bud,

Pursuant to Wallulis and Associates letter to you dated March 25, 1992 and our subsequent conversations, we hereby request a special standard to construct a multi-completion monitoring well in lieu of an "other hole" as originally planned. Stan Wallulis outlined the reasoning for the sampling, the location, distances, etc. Start card No. 32008 was submitted for conversion to an "other hole" and provides the owner's name and address, etc.

Construction is currently underway deepening the hole to the targeted 1200'. We propose construction to be completed similar to the attached marked up drawing. The four screens are 10' long, 316ss, 130 slot. The four casings are 2" thread and coupled galvanized steel schedule 40 pipe. Centering guides will be fabricated steel as outlined on the attached sketch and material list. The centering guides will be located at the top of each screen and at the top and bottom of each grout interval. The guides will be supported from vertical movement along the casing(s) by the use of addition couplings in the casing string(s). Grout will be placed by pumping through a temporary 1 1/4" welded steel schedule 40 pipe run through the middle of the centering guides (where applicable) to assure proper placement. Annular space between grout intervals will be filled with 3/8" pea gravel (a small interval of finer material such as sand or crushed rock will be placed immediately below each grout interval to minimize downward grout migration).

We plan to video the well immediately following deepening to 1200' to facilitate making minor field adjustments in grout and screen locations.

Does the above approach meet with your approval? Does the Start Card need to be revised/resubmitted?

Your prompt reply will be greatly appreciated as we expect to video the well within a day or two.

Sincerely,

Stephen J. Schneider
Vice Pres.- Drilling
WWC # 649

L0999.WRD

Enc.

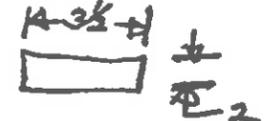
cc: Stan Wallulis
Dude Woodward
Ed Brookshier

CITY OF HERMISTON
OLD WELL NO. 2
by Schneider Drilling Co.
S.C. #32033

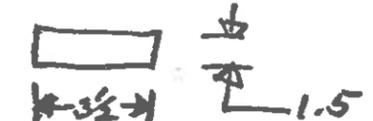
(9) Well Log

<u>From</u>	<u>To</u>	<u>Description</u>
785	802	Claystone slough, steel & brass/bronze
802	806	Steel & brass/bronze
806	807	Steel, brass/bronze & basalt, black
807	870	Open hole
870	895	Steel & some brass/bronze, (airline), etc.
895	905	Basalt, gray
905	912	Basalt, blk-gray-red, vesicular
912	944	Basalt, gray, hard
944	965	Basalt, black, medium hard
965	1055	Basalt, black & gray, medium
1055	1089	Basalt, black, medium
1089	1150	Basalt, gray, hard
1150	1165	Basalt, black & claystone, pale green, soft
1165	1176	Basalt, black, medium
1176	1196	Basalt, black & claystone, pale green
1196	1206	Basalt, black, medium

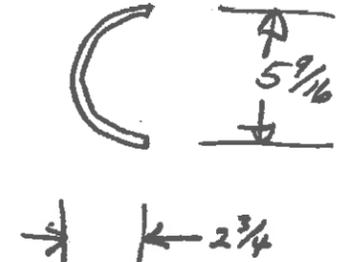
Hermiston CG, Mat'1

15 ea:  $1 @ 605$ $4 @ 260$
 $1 @ 525$ $4 @ 80$
 $1 @ 485$ $4 @ 10$

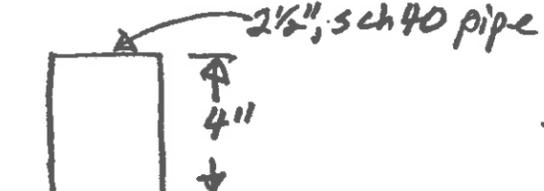
15 ea:  $4 @ 605$ $1 @ 375$
 $4 @ 525$ $1 @ 335$
 $4 @ 485$ $1 @ 315$

6 ea:  $2 @ 375$
 $2 @ 335$
 $2 @ 315$

12 ea:  $4 @ 260$
 $4 @ 80$
 $4 @ 10$

3 ea:  $1 @ 375$
 $1 @ 335$
 $1 @ 315$
 3 1/2" long
 Cut from
 Std sch 40 pipe

9 ea:  $3 @ 375$
 $3 @ 335$
 $3 @ 315$

60 27 ea:  $2 1/2$ " sch 40 pipe
 + 3 barrel stove ss.

WALLULIS & ASSOCIATES INCORPORATED
ENVIRONMENTAL - MUNICIPAL - ENGINEERING

Charbonneau District
 7725 S.W. Village Greens Circle
 Wilsonville, OR 97070
 (503) 694-1309

March 25, 1992

Mr. Bud Bartels
 Manager, Well Enforcement
 Oregon Water Resources Department
 3850 Portland Road N.E.
 Salem, Oregon 97310

Re: Request for a Special Standard as provided in Section 690-240-140 of Chapter 690, Division 240 of the Water Resources Department Administrative Rules, for the Construction and Maintenance of Monitoring Wells and Other Holes in Oregon.

Dear Bud:

The Special Standard requested is for City of Hermiston's original Deep Well No. 2, which is in the process of being constructed as an "Other Hole" (690-240-030) for an observation well. A new Well #2 has been constructed to replace the original Well #2 to function as an "ARTIFICIAL RECHARGE WELL" for injection of water from City Well No. 5, a shallow well supply, into the basalt aquifer(s) and later withdrawal to meet summer peaking demands.

The old Well #2 currently being constructed as an Other Hole will be completed as follows:

<u>BOREHOLE DEPTH BELOW SURFACE</u>	<u>BOREHOLE DIAMETER INCHES</u>	<u>FULL DIA. BOREHOLE CEMENT PLUGS</u>	<u>GRAVEL PACKING OF THE BOREHOLE</u>	<u>NUMBER OF 2" PIPES W/SCREEN*</u>
2'	24" OD	2' to		4
60'	24" OD	60' to		4
60'+	16"	60'+ to		4
80'	16"	80'		4
80'+	16"		80' to	4
270'	16"		270' to	4
270'+	16"		270'+ to	3
300'	16"		300' to	3

<u>BOREHOLE DEPTH BELOW SURFACE</u>	<u>BOREHOLE DIAMETER INCHES</u>	<u>FULL DIA. BOREHOLE CEMENT PLUGS</u>	<u>GRAVEL PACKING OF THE BOREHOLE</u>	<u>NUMBER OF 2" PIPES W/SCREEN*</u>
300'+	14"		300'+ to	3
315'	14"		315	3
315'+	14"	315' to		3
335'	14"	335'		3
335'+	14"		335' to	3
385'	14"		385' to	3
385'+	14"		385'+ to	2
485'	14"		485'	2
485'+	14"	485' to		2
505'	14"	505'		2
505'+	14"		505' to	2
535'	14"		535' to	2
535'+	12"		535+ to	2
615'	12"		615' to	2
615'+	12"		615'+ to	1
900' **	12"		900'	1
900'+	6"	900' to		1
920'	6"	920'		
920'+	6"		920' to	1
1,150'	6"		1,150' to	1
1,150'+	6"		1,150' + to	0
1,200'	6"		1,200'	0

* 10' of 2" screen with cap at the bottom of each 2" pipe.
 ** 800' TO 900' depth may be of smaller diameter (8" ?).

1. REQUESTED SPECIAL STANDARD.

The Special Standard requested is for monitoring of changes in the waters physical and chemical characteristics occurring in the different aquifers in old Well #2 after and/or during recharge (injection with shallow well water). To accomplish this background samples would be taken shortly prior to recharge. This would be accomplished by withdrawing and/or sampling of the water at the location of each of the four 2" screens as shown above.

As you are aware this is a demonstration experimental project which is 80% funded by the Federal Government. The official federal title for this project is "High Plains States Groundwater Demonstration Project" and administered through the Boise Office of the Bureau of Reclamation. The US Environmental Protection Agency and the Water Division of the USGS are active participating federal agencies that provide direction and oversight.

This project is the only one of it's kind in the State of Oregon and as far as I know the only artificial recharge project injecting water into the basalt aquifer(s) anywhere. Contrary to the focus of the rules for monitoring wells to suspected polluted groundwater, old Well #2 has no history of pollutants that would disqualify it as a potable water source. In fact prior to the construction of the proposed 20' concrete plugs in the borehole of old Well #2 this water co-mingled throughout the full depth of the borehole. The new Well #2 only 40' away will have an open borehole from its cased depth of 520' to 1,200' below the surface. Obviously the purpose and objectives sought by the requested SPECIAL STANDARD for the ARTIFICIAL RECHARGE WELL is entirely different than the captioned administrative rules.

2. LOCATION OF OLD WELL No. 2, - REQUESTED FOR SPECIAL STANDARD.

The location of old Well No. 2, as described in the Application for Permit U-282 is: 1,900' East and 1,400' North of the Southwest Corner of Section 11, Township 4 North, Range 28 East of the Willamette Meridian, County of Umatilla.

3. NAME AND ADDRESS OF THE PROJECT SITE.

a. Project Name.

High Plains States Groundwater Demonstration Project for Artificial Recharge Experiment at Hermiston, Oregon.

b. Project Address.

Situated at the Southwesterly corner of Newport Park in the vicinity of S.E. 5th Street and East Newport Avenue.

4. DISTANCE TO NEAREST WELL AND SEPTIC DRAIN FIELD.

- a. Nearest well is the new Well #2 approximately 40' away.
- b. The nearest septic drain field is over 3,400' away.

5. REASON CONFORMANCE WITH RULES FOR MONITORING WELLS CAN'T BE MET.

The primary reason for being unable to comply with the rules and regulations for monitoring wells is economic. To comply with the rules and regulations for monitoring wells and achieve the same objectives would require the construction of four (6" minimum diameter) monitoring wells with casing (pipes) of stainless steel (for the pressure and permanence) as follows:

	WELL #1	WELL #2	WELL #3	WELL #4
Total Depth	1,200'	900'	485'	315'
Bottom of Gravel Pack	1,200'	900'	485'	315'
Bottom of Screen	1,199'	899'	484'	314'
Top of Screen	923'	508'	338'	83'
Top of Gravel Pack	920'	505'	335'	80'
Cement seal from -2' to	920'	505'	335'	80'

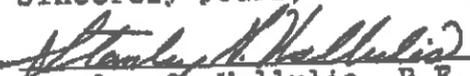
The cost of 4 individuals wells, the extensive length of screens, and the use of stainless steel in lieu of galvanized steel makes compliance with the rules and regulations for monitoring well construction prohibitively expensive.

6. DESIGN DRAWING OF THE WELL SPECIAL STANDARDS REQUESTED FOR.

The enclosed drawing is taken from the Construction Contract the City of Hermiston has with Schneider Equipment Company, Inc. This drawing shows both old Well #2 and the new Well #2.

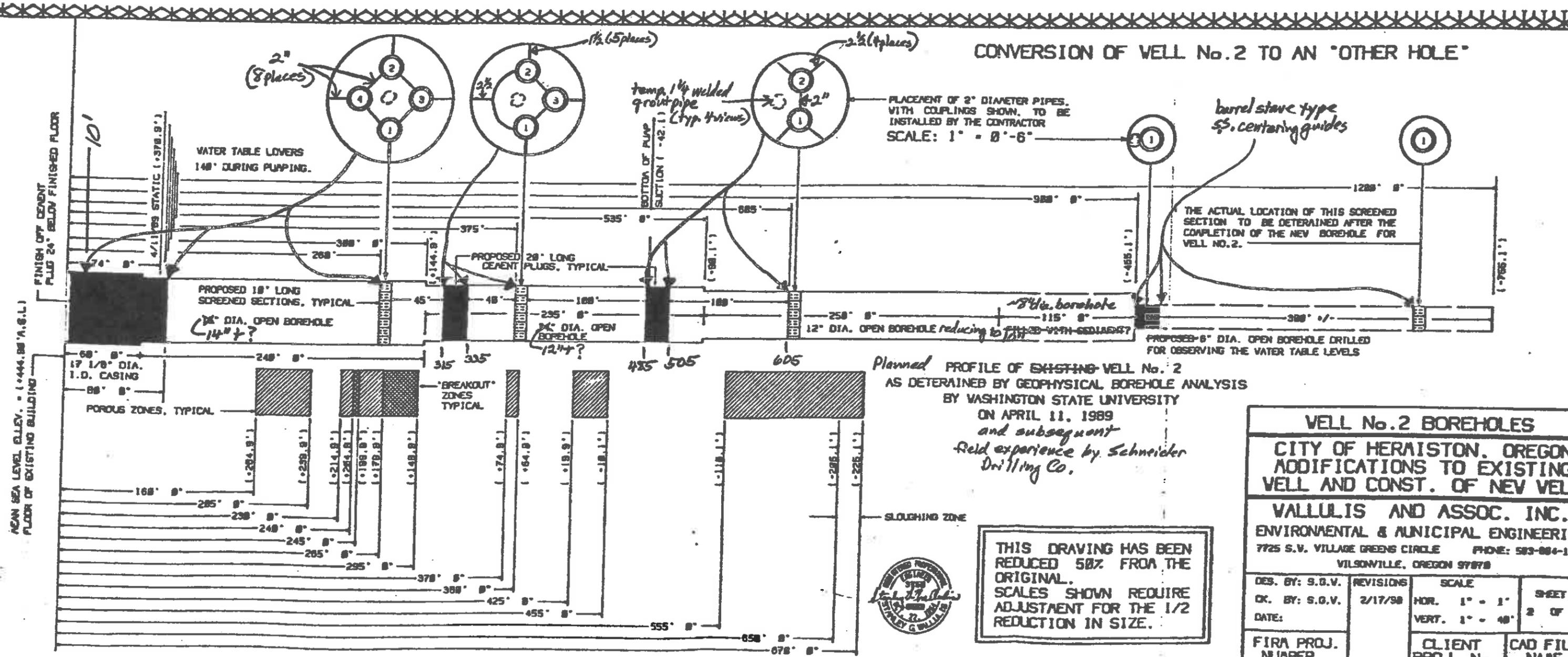
Mr. Fred Lissner of your Department advised me to direct this request to you for consideration. Please advise if any additional information is needed for your proper review of this request. This Firm would provide on-site presence during placing of piping and cement seals if required.

Sincerely yours,


Stanley G. Wallulis, P.E.
President

cc: Ed Brookshier, City Manager
Dude Woodward, City Water Superintendent

CONVERSION OF WELL No. 2 TO AN "OTHER HOLE"



Planned PROFILE OF EXISTING WELL No. 2
 AS DETERMINED BY GEOPHYSICAL BOREHOLE ANALYSIS
 BY WASHINGTON STATE UNIVERSITY
 ON APRIL 11, 1989
 and subsequent
 field experience by Schneider
 Drilling Co.

THIS DRAWING HAS BEEN
 REDUCED 50% FROM THE
 ORIGINAL.
 SCALES SHOWN REQUIRE
 ADJUSTMENT FOR THE 1/2
 REDUCTION IN SIZE.



WELL No. 2 BOREHOLES			
CITY OF HERAISTON, OREGON MODIFICATIONS TO EXISTING WELL AND CONST. OF NEW WELL			
VALLULIS AND ASSOC. INC. ENVIRONMENTAL & MUNICIPAL ENGINEERING 7725 S.V. VILLAGE GREENS CIRCLE PHONE: 503-884-13 VILSONVILLE, OREGON 97178			
DES. BY: S.G.V.	REVISIONS	SCALE	SHEET 2 OF
OK. BY: S.G.V.	2/17/98	HOR. 1" = 1' VERT. 1" = 40'	
DATE:			
FIRM PROJ. NUMBER 88-101-III	CLIENT PROJ. No.	CAD FILE NAME HVAELL	

RECEIVED

L 02 328

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

UMAT
50189

JUL 31 1996

WATER RESOURCES DEPT. (START CARD) # 76386

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

SALEM, OREGON

(1) OWNER: Well Number _____
Name Pilot Travel Center
Address 2115 Highway 395
City Stanfield State OR Zip 97

(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 740 ft.
Explosives used Yes No Type _____ Amount _____

HOLE			SEAL			
Diameter	From	To	Material	From	To	Sacks or pounds
<u>24</u>	<u>0</u>	<u>82 1/2</u>	<u>cem</u>	<u>0</u>	<u>82 1/2</u>	<u>70 SKS</u>
<u>8</u>	<u>82 1/2</u>	<u>740</u>				

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: <u>18</u>	<u>+2</u>	<u>82 1/2</u>	<u>3/8</u>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Liner: <u>6</u>	<u>+3</u>	<u>480</u>	<u>250</u>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Final location of shoe(s) 480 - 6"

(7) PERFORATIONS/SCREENS:

From	To	Slot size	Number	Diameter	Material	Tele/pipe size	Casing	Liner
							<input type="checkbox"/>	<input type="checkbox"/>

(8) WELL TESTS: Minimum testing time is 1 hour
 Pump Bailer Air Flowing Artesian
Yield gal/min 200 Drawdown _____ Drill stem at 740 Time 1 hr.

Temperature of water 56° 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 3 or S Range 29 or W. WM.
Section 5 SE 1/4 SE 1/4
Tax Lot 2902 Lot _____ Block _____ Subdivision _____
Street Address of Well (or nearest address) _____

(10) STATIC WATER LEVEL:
418 ft. below land surface. Date 7-10-96
Artesian pressure _____ lb. per square inch. Date _____

(11) WATER BEARING ZONES:
Depth at which water was first found 56

From	To	Estimated Flow Rate	SWL
<u>56</u>	<u>67</u>	<u>< 1.</u>	<u>56</u>
<u>259</u>	<u>271</u>	<u>10</u>	<u>90</u>
<u>438</u>	<u>455</u>	<u>100 +</u>	<u>150</u>
<u>718</u>	<u>740</u>	<u>200 +</u>	<u>418</u>

(12) WELL LOG:
Ground Elevation _____

Material	From	To	SWL
<u>Silt</u>	<u>0</u>	<u>45</u>	
<u>Cemented gravel</u>	<u>45</u>	<u>48</u>	
<u>Red Clay</u>	<u>48</u>	<u>56</u>	
<u>Fls Breccia</u>	<u>56</u>	<u>67</u>	
<u>Black Basalt</u>	<u>67</u>	<u>143</u>	
<u>Red Cinders</u>	<u>143</u>	<u>170</u>	
<u>Black Basalt</u>	<u>170</u>	<u>230</u>	
<u>Grey Basalt</u>	<u>230</u>	<u>259</u>	
<u>visicular Blue Clay</u>	<u>259</u>	<u>271</u>	
<u>Black Basalt</u>	<u>271</u>	<u>438</u>	
<u>visicular</u>	<u>438</u>	<u>455</u>	
<u>Black Basalt</u>	<u>455</u>	<u>472</u>	
<u>Grey Basalt</u>	<u>472</u>	<u>542</u>	
<u>Black Basalt</u>	<u>542</u>	<u>612</u>	
<u>Grey Basalt</u>	<u>612</u>	<u>718</u>	
<u>visicular Basalt</u>	<u>718</u>	<u>736</u>	
<u>Fractured Basalt</u>	<u>736</u>	<u>740</u>	
<u>Cemented water</u>	<u>off to</u>	<u>460</u>	
<u>put packer on 6" shoe</u>			

Date started 6-12-96 Completed 7-10-96

(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 759
Signed [Signature] Date 7-14-96

APPENDIX K

Cooper-Jacob Calculations

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DRAWDOWN PREDICTIONS: ASR-1 (Well 6)/ASR-2/ASR-3

GENERAL EQUATION USED

$$(-528 \cdot Q/T) \cdot (\text{LOG}(r) + (.5 \cdot (\text{LOG}(S/0.3 \cdot T^t))))$$

		Injection for one year		Recovery for 30 days	
VARIABLE	UNITS	ASR-1 (Well 6)/ASR-2/ASR-3		ASR-1 (Well 6)/ASR-2/ASR-3	
TRANSMISSIVITY	GPD/FT	36500		36500	
STORATIVITY ?	FT/FT	0.00005		0.00005	
AQUIFER THICK	FT	83		83	
Well Efficiency		50%		50%	
PUMPING RATE	GPM	2000		1800	
TIME ?	DAYS	365		30	
		SET 1		SET 2	
		DRAWDOWN		DRAWDOWN	
		(ft)	u	(ft)	u
DISTANC	FT	0.25	262.70	4.38638E-13	215.24
		0.5	249.64	1.75455E-12	203.48
		1	157.72	7.0182E-12	127.82
		2	149.01	2.80728E-11	119.98
		5	137.49	1.75455E-10	109.62
		7	133.27	3.44E-10	105.81
		10	128.78	7.0182E-10	101.78
		20	120.08	2.80728E-09	93.94
		30	114.98	6.31638E-09	89.35
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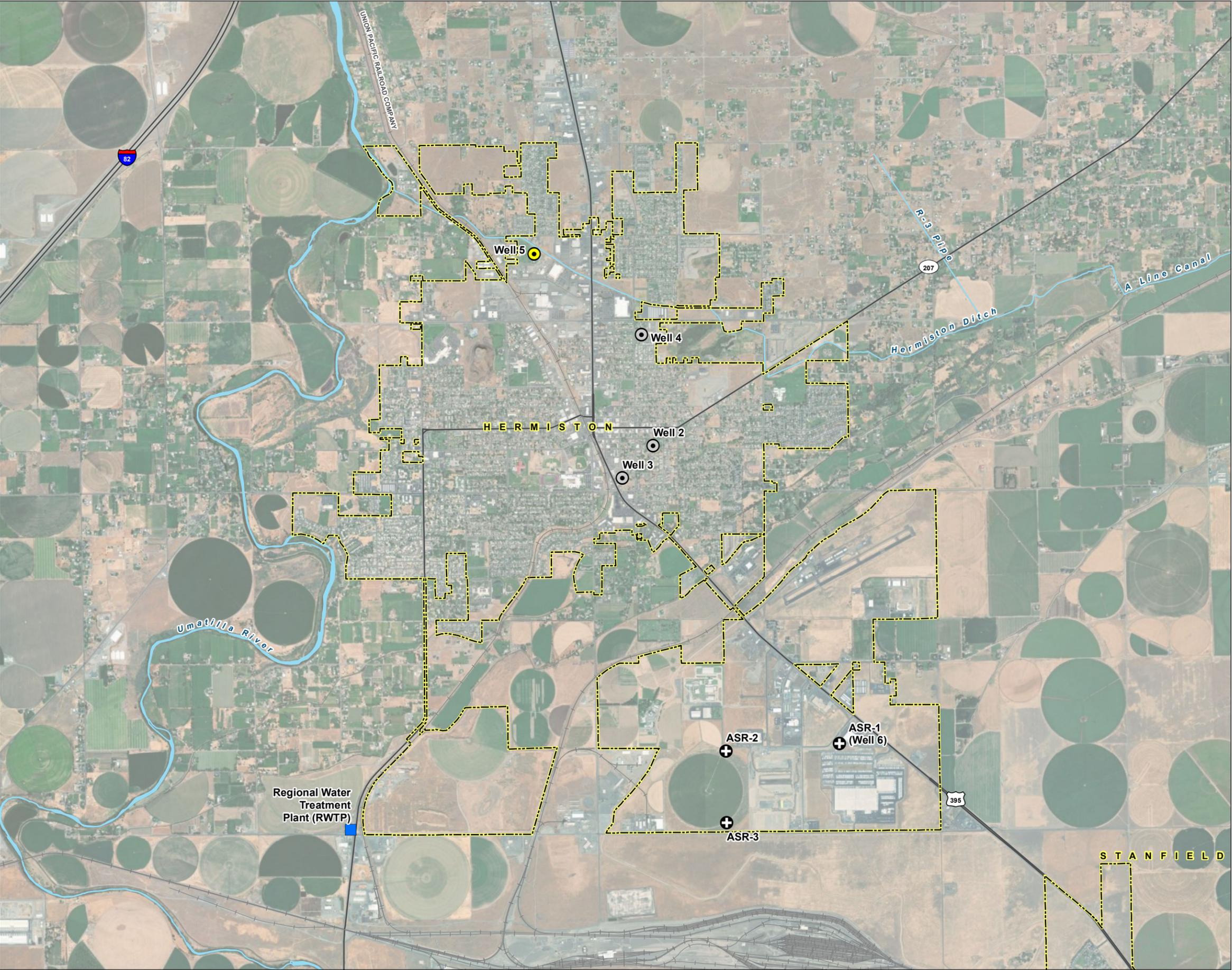
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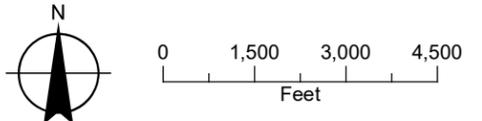
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77106	16.33	0.041725565	0.56	0.507661045
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77138	16.32	0.041760206	0.56	0.508082505
77139	16.32	0.041761289	0.56	0.508095678
77140	16.32	0.041762371	0.56	0.508108852
77141	16.32	0.041763454	0.56	0.508122025
77142	16.32	0.041764537	0.56	0.508135199
77143	16.32	0.04176562	0.56	0.508148373
77144	16.32	0.041766703	0.56	0.508161548
77145	16.32	0.041767785	0.56	0.508174722
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77147	16.32	0.041769951	0.56	0.508201072
77148	16.32	0.041771034	0.56	0.508214247
77149	16.32	0.041772117	0.56	0.508227422
77150	16.32	0.0417732	0.56	0.508240597
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77152	16.32	0.041775366	0.56	0.508266948
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77154	16.32	0.041777532	0.56	0.5082933
77155	16.32	0.041778614	0.56	0.508306476
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77160	16.32	0.04178403	0.56	0.508372359
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77163	16.32	0.041787279	0.56	0.508411892
77164	16.32	0.041788362	0.56	0.508425069
77165	16.32	0.041789445	0.56	0.508438247
77166	16.32	0.041790528	0.56	0.508451425
77167	16.32	0.041791611	0.56	0.508464603
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77170	16.32	0.041794861	0.56	0.508504139
77171	16.31	0.041795944	0.56	0.508517318
77172	16.31	0.041797027	0.56	0.508530497
77173	16.31	0.04179811	0.56	0.508543676
77174	16.31	0.041799194	0.55	0.508556856
77175	16.31	0.041800277	0.55	0.508570035
77176	16.31	0.04180136	0.55	0.508583215
77177	16.31	0.041802443	0.55	0.508596395
77178	16.31	0.041803527	0.55	0.508609575
77179	16.31	0.04180461	0.55	0.508622755
77180	16.31	0.041805693	0.55	0.508635936
77181	16.31	0.041806777	0.55	0.508649116
77182	16.31	0.04180786	0.55	0.508662297
77183	16.31	0.041808943	0.55	0.508675478
77184	16.31	0.041810027	0.55	0.508688659
77185	16.31	0.041811111	0.55	0.50870184
77186	16.31	0.041812194	0.55	0.508715022
77187	16.31	0.041813277	0.55	0.508728203
77188	16.31	0.04181436	0.55	0.508741385
77189	16.31	0.041815444	0.55	0.508754567
77190	16.31	0.041816527	0.55	0.508767749

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FIGURE 1
City of Hermiston
ASR Project Area
 City of Hermiston
 ASR Limited License Application



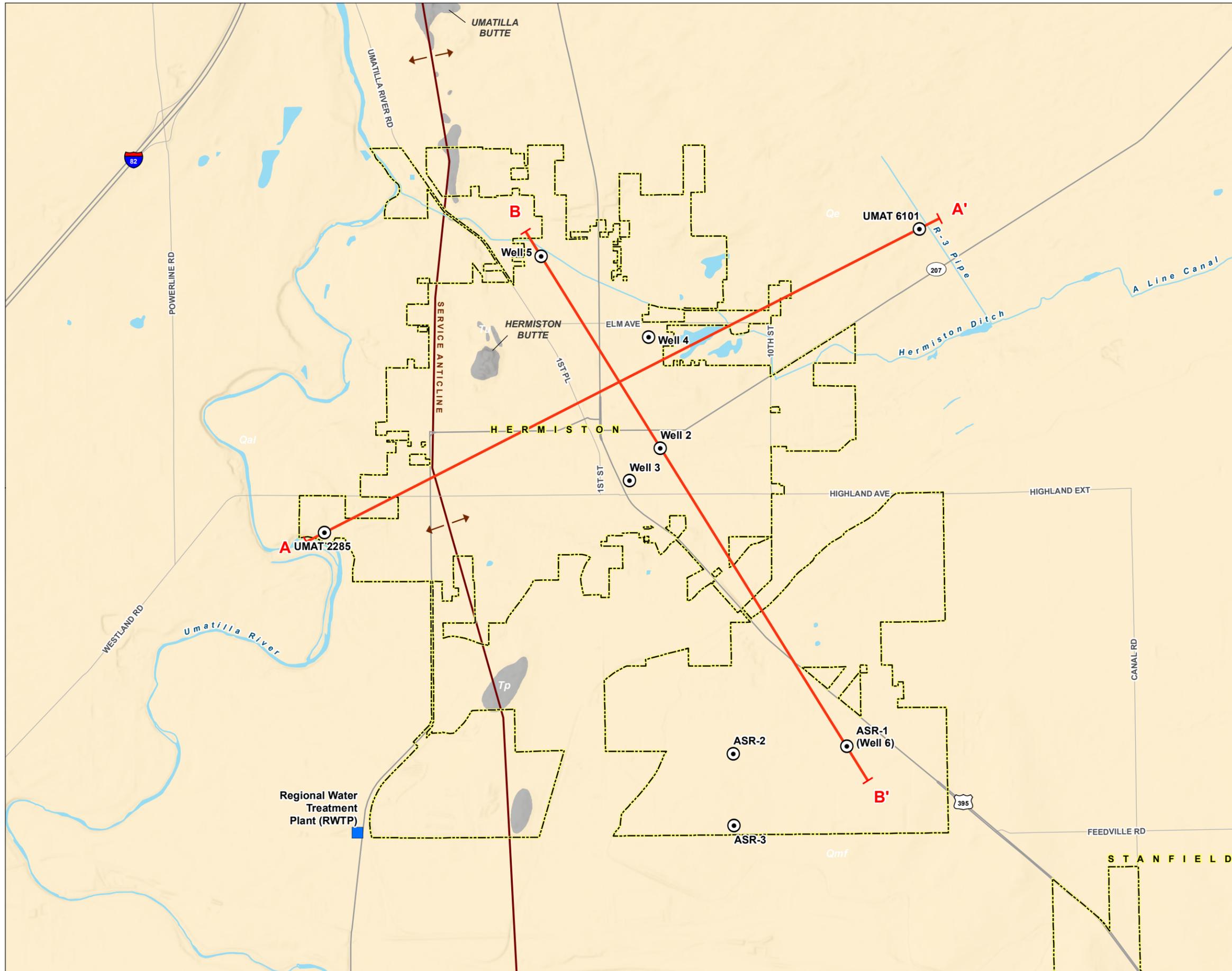
- LEGEND**
- ⊕ Proposed ASR Well
 - Alluvial Well
 - ⊙ Basalt Well
 - Regional Water Treatment Plant (RWTP)
 - ▭ City Boundary (Study Area)
 - Railroad
 - Major Road
 - ~ Watercourse
 - ~ Waterbody



Date: May 17, 2024
 Data Sources: BLM, ESRI, ODOT, USGS,
 Maxar Imagery (2020)



FIGURE 2
Geologic Map
 City of Hermiston
 ASR Limited License Application

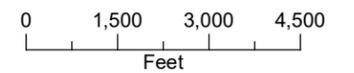


LEGEND

- ⊙ Well
- Regional Water Treatment Plant (RWTP)
- Anticline
- ⊕ Cross Section Line
- Surficial Geology**
- Alluvial Deposits*
- Unconsolidated Alluvial Deposits
- Columbia River Basalt Group*
- Saddle Mountain Basalt (Tp)
- All Other Features**
- ⬡ City Boundary
- Major Road
- ~ Watercourse
- ⊙ Waterbody

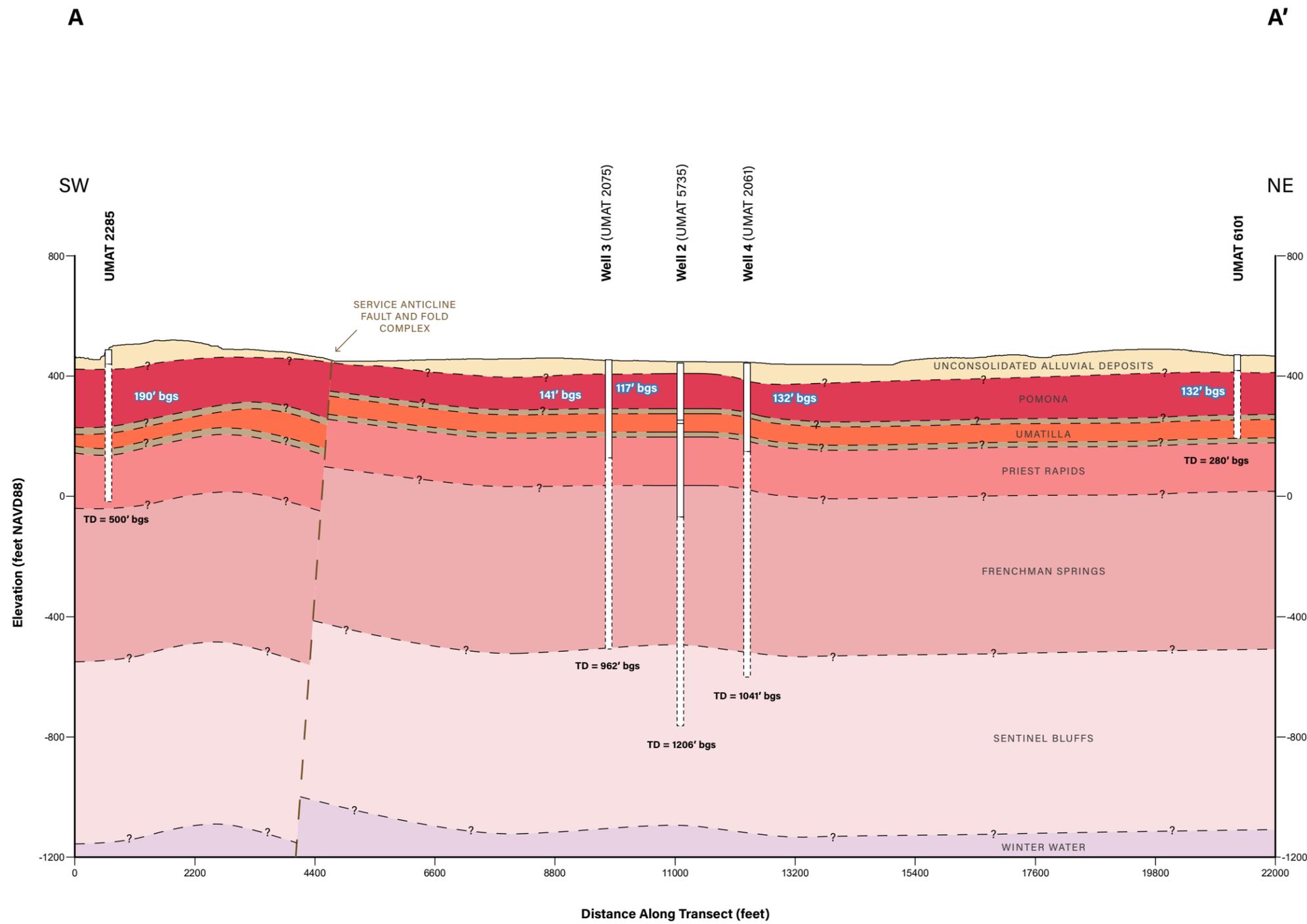
NOTE

Eolian deposits are not shown for clarity.



Date: May 17, 2024
 Data Sources: BLM, ESRI, ODOT, USGS, DOGAMI

FIGURE 3A
Cross Section A-A'
 City of Hermiston
 ASR Limited License Application



GEOLOGY LEGEND

- Fault
- Alluvial Deposits*
- Unconsolidated Alluvial Deposits
- Columbia River Basalt Group*
- Brown layers indicate interbeds
- Pomona Member
- Umatilla Member
- Priest Rapids Member
- Frenchman Springs Member
- Sentinel Bluffs Member
- Winter Water Member

WELL LEGEND

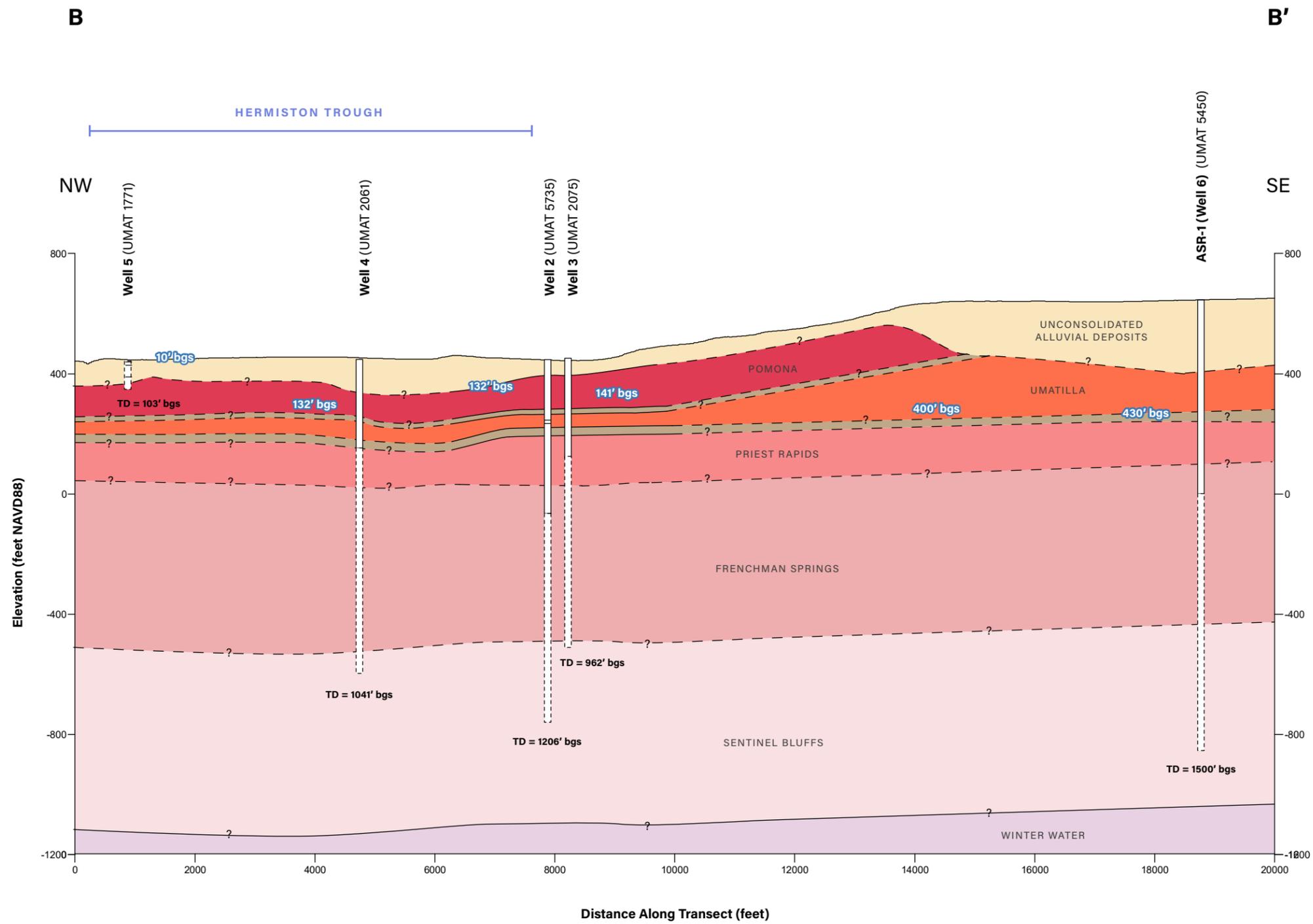
- Blank Casing
- Screen
- Open Borehole
- Static Water Level

NOTES

bgs: below ground surface
 TD: total depth
 NAVD88: North American Vertical
 Datum of 1988



FIGURE 3B
Cross Section B-B'
 City of Hermiston
 ASR Alternatives Evaluation



GEOLOGY LEGEND

- Fault
- Alluvial Deposits*
- Unconsolidated Alluvial Deposits
- Columbia River Basalt Group*
- Brown layers indicate interbeds
- Pomona Member
- Umatilla Member
- Priest Rapids Member
- Frenchman Springs Member
- Sentinel Bluffs Member
- Winter Water Member

WELL LEGEND

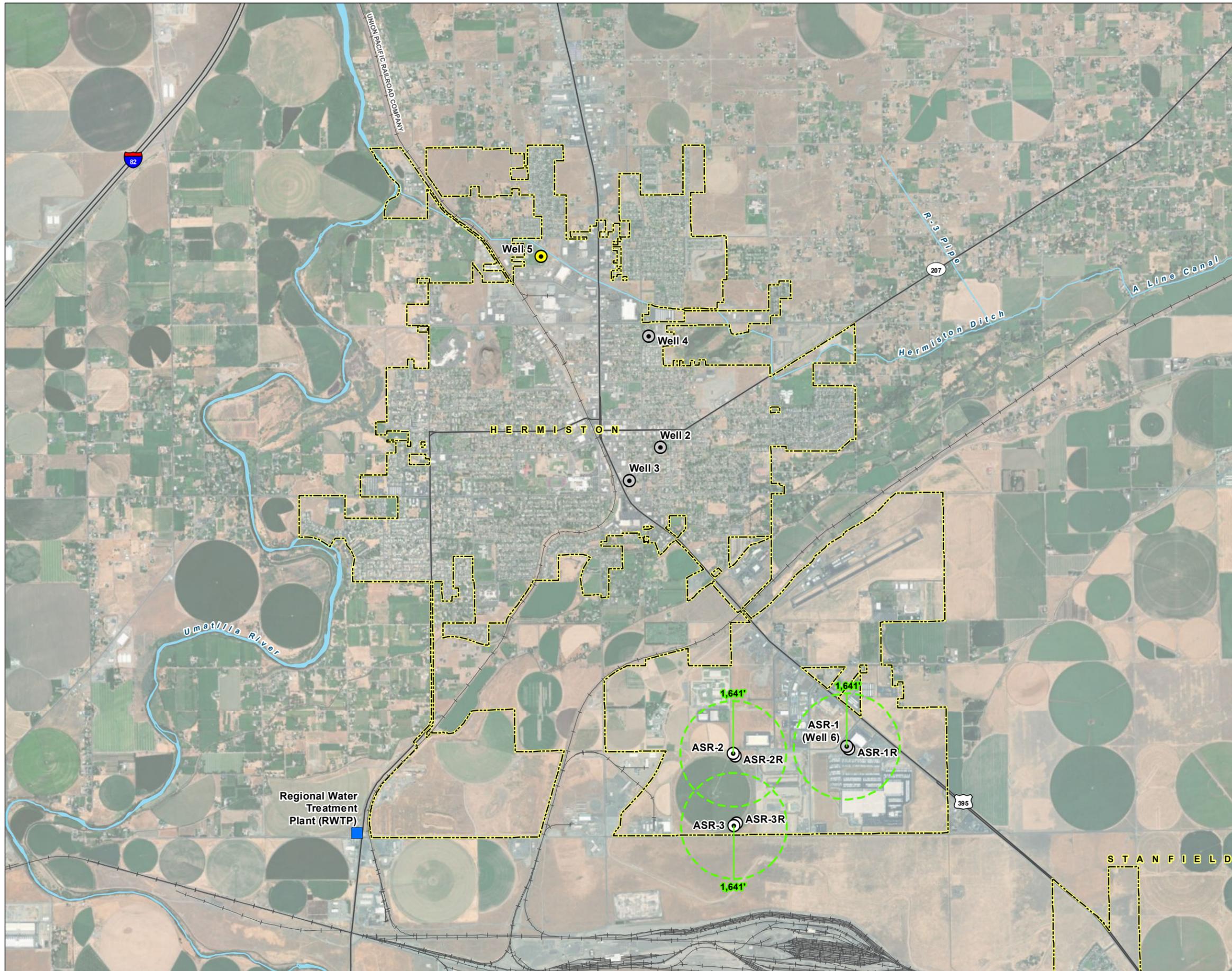
- Blank Casing
- Screen
- Open Borehole
- Static Water Level

NOTES

bgs: below ground surface
 TD: total depth
 NAVD88: North American Vertical Datum of 1988

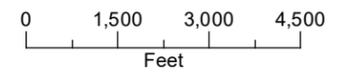


FIGURE 4
Stored Water Extent
 City of Hermiston
 ASR Limited License Application



LEGEND

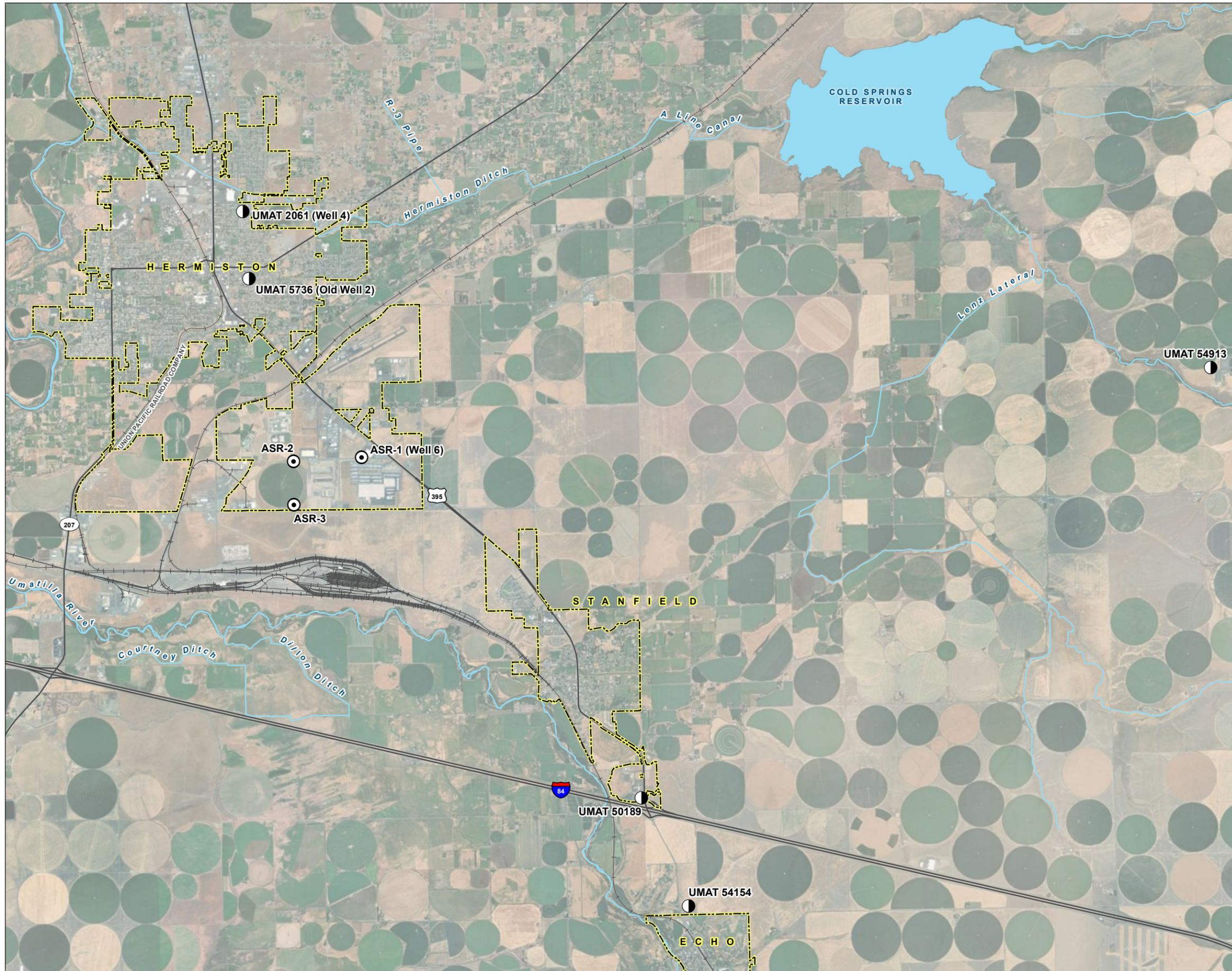
- Well
- Alluvial Well
- ⊙ Basalt Well
- Regional Water Treatment Plant (RWTP)
- Stored Water Extent
- City Boundary (Study Area)
- Railroad
- Major Road
- ~ Watercourse
- Waterbody



Date: June 11, 2024
 Data Sources: BLM, ESRI, ODOT, USGS,
 Maxar Imagery (2020)

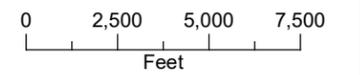


FIGURE 5
Proposed Observation
Well Network
 City of Hermiston
 ASR Limited License Application



LEGEND

- ⊙ ASR Well
- Proposed Observation Well
- ▭ City Boundary (Study Area)
- Railroad
- Major Road
- ~ Watercourse
- Waterbody



Date: May 17, 2024
 Data Sources: BLM, ESRI, ODOT, USGS,
 Maxar Imagery (2020)



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Table 13
Analyte Lists
City of Hermiston ASR Limited License Application

Field Parameters
Dissolved Oxygen
ORP
pH
Specific Conductance
Temperature
Turbidity

General Chemistry
Bicarbonate
Calcium
Carbonate
Chloride
Hardness as CaCO ₃
Magnesium
Nitrate (measured as Nitrogen)
Nitrite (measured as Nitrogen)
Total Nitrate+Nitrite
Potassium
Silica
Sodium
Sulfate
Total Alkalinity as CaCO ₃
Total Dissolved Solids
Total Suspended Solids
Total Organic Carbon

Metals
Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Chromium (total)
Copper
Iron (Total)
Iron (Dissolved)
Lead
Manganese (Total)
Manganese (Dissolved)
Mercury
Nickel
Selenium
Silver
Thallium
Zinc

Disinfectants
Chloramines
Chlorine
Chlorine Dioxide

Disinfection Byproducts
Bromate
Chlorite
Haloacetic Acids (HAA5)
Total Trihalomethanes (TTHM)

Radionuclides
Gross Alpha
Gross Beta
Iodine-131
Combined Radium 226/228
Radon
Strontium-90
Tritium
Uranium

Volatile Organic Compounds
Benzene
Carbon tetrachloride
cis-1,2-Dichloroethylene
Dichloromethane
Ethylbenzene
Chlorobenzene (Monochlorobenzene)
1,2-Dichlorobenzene (o-Dichlorobenzene)
1,4-Dichlorobenzene (p-Dichlorobenzene)
Styrene
Tetrachloroethylene (PCE)
Toluene
trans-1,2-Dichloroethylene
Trichloroethylene (TCE)
Vinyl chloride
Xylenes, Total
1,1-Dichloroethylene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,2-Dichloroethane (EDC)
1,2-Dichloropropane
1,2,4-Trichlorobenzene

Synthetic Organic Compounds
Acrylamide
Alachlor (Lasso)
Atrazine
Benzo(a)pyrene
Carbofuran
Chlordane
Chlorobenzene
Dalapon
1,2-Dibromo-3-chloropropane (DBCP)
Dinoseb
Dioxin(2,3,7,8-TCDD)
Diquat
Di(2-ethylhexyl) adipate
Di(2-ethylhexyl) phthalate
Endothall
Endrin
Ethylene Dibromide (EDB)
Glyphosate
Heptachlor
Heptachlor epoxide
Hexachlorobenzene (HCB)
Hexachlorocyclopentadiene
Lindane (BHC-gamma)
Methoxychlor
Oxamyl (Vydate)
Picloram
Polychlorinated Biphenyls (PCBs)
Pentachlorophenol
Simazine
Toxaphene
2,4-D
2,4,5-TP (Silvex)

Per- and Polyfluoroalkyl Substances
PFOA
PFOS
PFHxS
PFNA
HFPO-DA

Miscellaneous
Color
Corrosivity
Cyanide (as free cyanide)
Fluoride
Foaming Agents (Surfactants)
Odor

Notes
 Water Quality Tracking Analytes