Prineville Airport Area Aquifer
Aquifer Storage and Recovery (ASR)
Limited License Application & Pilot Testing Work Plan

Prepared For

Oregon Water Resources Department

Prepared by

GSI Water Solutions, Inc.

On Behalf of:

City of Prineville

October 2018

The City of Prineville
Prineville Airport Area Aquifer
Aquifer Storage and Recovery (ASR)

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1. Introduction

The City of Prineville (City) relies solely on groundwater for its municipal water supply. The City's current water system includes ten water supply wells. Six of the wells produce water from the confined alluvial aquifer system underlying the Prineville Valley, with the four additional wells producing water from the airport area aquifer. The airport area aquifer, located on the plateau west of the City in the vicinity of the Prineville Airport, is comprised of permeable alluvium and basalt units that were deposited within the boundaries of a narrow ancestral Crooked River canyon. The airport area aquifer is hydraulically isolated from the Prineville Valley aquifers (GSI, 2016a).

As the City explores options for developing resilient, sustainable, and cost-effective water sources to meet the growing municipal water demands of its current and future customers, the biggest challenge the City faces is meeting summertime peak day demands, which can be 3 to 4 times greater than average day demands. The airport area aquifer is a highly productive aquifer with individual wells producing up to 1,100 gallons per minute (gpm). Based on the highly productive nature of this aquifer, the City would like to take advantage of the aquifer's production capacity and isolation from the Prineville Valley aquifers as it develops new sustainable water sources.

The City's existing water sources provide the City with sufficient water to meet current demands; however, the airport area aquifer has the potential to be impacted by periods of drought, changing climate, and overuse. Water level data collected during the City's five and a half years of water level monitoring of the airport aquifer system indicates the aquifer's water levels are declining, likely related to multiple causes including long-term climate variations[1].

Aquifer Storage and Recovery (ASR) has the potential to provide the City with a water management tool for addressing both the increasing summertime peak demands while also addressing the declining water levels in the airport area aquifer.

ASR would allow the City to recharge the airport area aquifer during the non-peak season (winter) using a new City shallow alluvial well field adjacent to the Crooked River (currently under development). ASR will not only allow the City to store or "bank" water in the airport area aquifer for future use during the peak season (summer), it will also ease the stress on the native valley water sources and reduce withdrawals of native groundwater from the airport area aquifer.

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[1] GSI (2016b) summarized water level trends in the airport area aquifers for a 3-year period from 2012 to 2015, and found that water levels declined by up to 3.5 feet per year Based on water level declines in the Airport 2 Well (3.4 feet per year), which is completed in the Upper Aquifer.

1.1 Proposed ASR Project

The airport area aquifer is comprised of two distinct aquifers units: the Upper Aquifer and the Lower Aquifer[2]. This ASR Limited License Application and Pilot Testing Work Plan proposes to conduct ASR in the Upper Aquifer, which is capable of storing more water due to its higher productivity (GSI, 2018).

General observations regarding the Upper Aquifer are that it has a limited aerial extent (distinctive channel-shaped deposits), appears hydraulically isolated from the Lower Aquifer and the Prineville Valley aquifers, and from nearby water bodies such as the Crooked River. While these attributes likely contribute to the susceptibility of the Upper Aquifer to over-pumping, these attributes also make the Upper Aquifer a desirable aquifer for ASR because they indicate an ability to store large quantities of water with limited risk of loss of stored water.

In 2018, GSI Water Solutions, Inc. (GSI) performed an ASR Feasibility Study on the Airport Area's Upper Aquifer (Appendix A) (GSI, 2018). Using water quality and well performance data from the City's existing wells, the results of the feasibility study suggests that the Upper Aquifer may be capable of storing up to 870 million gallons (MG).

This document, prepared by GSI, is an ASR Limited License application and includes a work plan for pilot testing the use of the City's existing Heliport Production Well as the initial ASR well. The ASR Limited License application and pilot testing work plan are in compliance with Oregon Administrative Rules (OAR) 690-350-020. The following index identifies where information required under OAR 690-350-020 can be found in this document. The index was prepared to assist in preparing and reviewing the City's ASR Limited License application.

OAR	Information Location in this Document
690-350-020 (2) **Pre-Application Conference**	September 13, 2018
690-350-020 (3) (a) **Applicant Information**	Application Form (Appendix B)
690-350-020 (3)(a)(B) **Operations Information**	Section 5 – Pilot Testing Program ASR Limited License Application Form (Appendix B)
690-350-020 (3)(a)(C) **License Duration**	Section 5 – Pilot Testing Program ASR Limited License Application Form (Appendix B)
690-350-020 (3)(a)(D) **Proposed Use**	Section 5 – Pilot Testing Program ASR Limited License Application Form (Appendix B)
690-350-020 (3)(a)(E) **Ultimate Project Size**	Section 1.3 – Pilot Testing Scope, Schedule, and Approach Section 5 – Pilot Testing Program ASR Limited License Application (Appendix B)
690-350-020 (3)(a)(F) **Water Right Statement**	Section 3 – Permits and Approvals Appendix D

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[2] The airport area's geologic and hydrogeologic units are described in detail in both the Prineville Airport Area Aquifer, ASR Feasibility Study (GSI 2018) and the Groundwater Hydrology of the Prineville Airport Area Aquifer System—2016 Update (GSI 2016b).

OAR	Information Location in this Document
690-350-020 (3)(a)(G) **Water Right Holder Agreement**	Not applicable
690-350-020 (3)(a)(H) **Legal Land Use**	Appendix F
690-350-020 (3)(a)(I) **Map**	Appendix B
690-350-020 (3)(a)(J) **Oregon Health Authority Compliance**	Section 4 – System Operation and Wellhead Facility Design
690-350-020 (3)(a)(K) **Supplemental Information**	Not applicable
690-350-020 (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 Tables 2, 3, and 4
690-350-020 (3)(b)(B) **Proposed System Design**	Section 4 – System Operation and Wellhead Facility Design Appendix G
690-350-020 (3)(b)(C) **Groundwater Information**	Section 2 – Hydrogeologic Setting, Water Quality, and ASR Well Construction ASR Feasibility Study (Appendix A)
690-350-020 (3)(b)(D) **Source Water Quality**	Section 2.7 – Water Quality ASR Feasibility Study (Appendix A)
690-350-020 (3)(b)(E) **Comments on Source Water/Standards**	Section 2.7 – Water Quality ASR Feasibility Study (Appendix A)
690-350-020 (3)(b)(F) **Receiving Water Quality**	Section 2.7 – Water Quality ASR Feasibility Study (Appendix A)
690-350-020 (3)(b)(G) **Comments on Compatibility**	Section 2.7 – Water Quality ASR Feasibility Study (Appendix A)
690-350-020 (3)(c) **Other Information**	UIC Registration (Appendix E)

Appendix B presents a completed Oregon Water Resources Department (OWRD) ASR limited license application form and the accompanying limited license map for the proposed ASR project. The form was completed in a manner that allows operational flexibility during the pilot testing period.

1.2 ASR Pilot Testing Objectives

The purpose of ASR pilot testing is to evaluate ASR feasibility and capacity in the Upper Aquifer, and to develop design criteria for a full-scale operational ASR program. The 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 objectives of the pilot testing are to evaluate:

- Wellhead facility operation and response to ASR
- Aquifer hydraulic response to ASR
- Long-term performance of the ASR well
- Optimal rate of recharge and volume of storage

- Recovery rate and sustainability of pumping
- Chemical compatibility of native groundwater and recharge source water (including an assessment of mixing, potential clogging, and potential water quality changes)
- Quality of recovered water over time
- Frequency of redevelopment of the ASR well necessary to maintain an acceptable and sustainable degree of well efficiency during ASR operations
- Potential impacts of ASR including loss of stored water (e.g., seeps, surface streams); water quality degradation; and interference with surrounding wells as a result of recharge and recovery operations.

Pilot testing is designed to complete a testing program that will meet the objectives listed above and that can be used to apply for a permanent ASR permit.

1.3 Pilot Testing Study Area

The ASR study area is located on a plateau southwest of Prineville as shown on Figure 1. The target aquifer, the Upper Aquifer, is located within the boundaries of the ancestral Crooked River canyon and is shown in Figure 2. It is estimate the Upper Aquifer occupies approximately 5 square miles. The proposed and potential future ASR well locations and the City's source water is are shown in Figure 3.

A preliminary hydrogeologic assessment of this study area is summarized in the ASR Feasibility Study (Appendix A). Results from this preliminary assessment indicate that the target aquifer has the following characteristics:

- Highly productive (production rates at least 1,100 gpm at a single well; production rates may be higher)
- Potentially large storage capacity (at least 870 MG in a single year)

Additional geologic and hydrogeologic information is presented in Section 2 and in the ASR Feasibility Study (Appendix A).

1.4 Pilot Testing Scope, Schedule, and Approach

The City plans to initially use the existing Heliport Production Well to recharge the Upper Aquifer and the pilot testing is anticipated to begin immediately following issuance of an ASR Limited License by OWRD. Data collected during the testing of the Heliport Production Well will be used to fine-tune the pilot testing work plan included in this limited license application.

Depending on the response of the Upper Aquifer to ASR using the Heliport well, the City intends to construct an additional four (4) ASR wells in the Upper Aquifer to increase the recharge volumes and provide project flexibility. Subsequent work plans will be developed for the remaining four ASR wells as the wells are constructed and prior to the start of pilot testing at each well. A schedule will be developed for construction of additional ASR wells based on the data and observations collected during the first 5-year limited license period.

Additional 5-year extensions of the ASR limited license are anticipated to allow for full build-out of the of proposed ASR system.

The existing Heliport Production Well and preliminary locations for the additional four ASR wells are shown in Figure 3. Changes to the proposed ASR well site locations may be required as more hydrogeologic data are obtained during pilot testing. Specifically, information from each subsequent ASR well will improve the City's understanding of the storage capacity of the Upper Aquifer, the extent of the Upper Aquifer, and potential impacts of well to well interference that will help guide future ASR well siting. In the event that a proposed ASR well is relocated by a distance greater than an adjacent ¼ ¼ section, the relocation request will be accompanied by a technical memorandum justifying the movement of the well and describing any potential impacts of the move on other users. Information from pilot testing at each ASR well also will help refine further planning and economic analysis of future ASR wells and infrastructure improvements that may be needed to integrate the ASR wells into the City's existing water distribution system.

The goal for the City's ASR program in Year 1 and Year 2 of the ASR Limited License is to develop up to 179 MG of storage annually using the Heliport Production Well as the ASR well and existing wells in the Prineville Valley for source water. During the first year of ASR, source water will be provided by the City's existing well that tap the deep Prineville Valley aquifer. Using these existing wells, the City anticipates storage of up to 154 MG in Year 1[3]. The City is currently developing a new, 2.88 million gallon per day (MGD) alluvial wellfield, and plans to use the new alluvial wellfield for source water once construction is completed and the new source is operational. Therefore, during subsequent years of the ASR Limited License, the City plans to develop larger storage volumes using source water from the new alluvial wellfield (up to 179 MG) [4].

The ultimate size of the City ASR program at full build out includes plans to store up to 870 MG (inclusive of ASR account carryover)[5] in up to five (5) ASR wells. If pilot testing suggests that an increase in storage volume is appropriate, the City will seek a modification to increase in total storage volume authorized under the limited license.

At full buildout, the City is proposing recharge and recovery rates of up to 3,000 gpm and 4,000 gpm, respectively. These rates are purposely greater than what would be feasible at the City's existing Heliport Production Well (as documented in the ASR Feasibility Study) to accommodate the potential for development of greater production capacity from new

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[3] During the first year of ASR, source water will be provided by the City's existing Valley wells. We estimate that 1.02 MGD (708 gpm) from these wells is available for ASR (see page 4-2 of the ASR Feasibility Study in Appendix A). Assuming 151 days of recharge (November through March), this equates to 154 MG of storage per year.

[4] During Year 2 we expect the new City source to be available and can increase the injection to 1.2 MGD (825 gpm) for a storage volume of 179 MG

[5] We estimate the maximum storage capacity of the Upper Aquifer is 870 MG (see pages 5-4 and 5-5 of the ASR Feasibility Study in Appendix A).

wells. The maximum recharge rate (3,000 gpm) is based on the combined capacity of the City's new shallow alluvial wellfield and the City's valley floor wells in the Prineville Valley to produce source water for ASR recharge[6]. If pilot testing suggests that an increase in recharge and recovery rates is appropriate, the City will seek a modification to increase the rate(s) authorized under the limited license.

Recharge source water for this ASR program will be supplied from a combination of the City's existing and planned valley floor wells in the Prineville Valley and a new shallow alluvial wellfield currently under development at the south end of the City (see Figure 3). Details of the source water rights for the City's ASR pilot testing program are presented in Section 3. Water from the existing groundwater wells in the valley is treated at the wellhead by chlorination prior to delivery to the City's municipal water distribution system (PWS ID #00682). The City plans to construct a water treatment plant for the new alluvial wellfield to treat the water for manganese, ammonia, and odor.

The City plans to recharge water during the low-demand period of each year (approximately November through March) because the Heliport Production Well is used to supply water during the high demand period. During pilot testing, recharge and recovery will be conducted in a controlled manner and the aquifer response to ASR operations will be monitored at the ASR well(s) and a network of observation wells. The first year of the pilot testing at each ASR well will consist of a shakedown test followed by a full recharge-storage-recovery cycle. The shakedown test will assess the performance of the piping, pumps, valves, and controls, and will last about one to two days. During this test, a relatively small volume of water will be recharged and recovered to evaluate initial system operations. The full recharge-storage-recovery cycle (i.e., Cycle 1) will more closely approximate an operational-scale ASR cycle, and will be used to evaluate the aquifer response to ASR. Details regarding the anticipated rates and volumes for the City's ASR pilot testing program and the pilot testing procedures are presented in Section 5.

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[6] See Page 4-2 of the ASR Feasibility Study (source water availability from the Prineville Valley Wells) and Page 4-5 of the FS (source water availability from the new alluvial wellfield).

2. Hydrogeologic Setting, Water Quality, and ASR Well Construction

The City is located on the northeastern edge of the Deschutes Basin, in Deschutes County, Oregon. Figure 4 is a geologic map of the City and surrounding area, and Figure 5 is an accompanying geologic cross section (A-A'). The geologic units within in the ASR study area predominantly include the Deschutes Formation (interlayered sedimentary and volcanic deposits) and the Simtustus/John Day Formation (basement rock including tuffs and mudstones). As shown in Figure 5, the ancestral Crooked River flowed through the study area and appears to have eroded a deep canyon extending into the basement rock of the Simtustus and John Day Formations (called the ancestral canyon in this report). The Upper Aquifer sits within the ancestral canyon, and is the target aquifer for ASR. This section presents a summary of the hydrogeologic information about the target aquifer for ASR. A detailed review and discussion of the geology and hydrogeology of the study area, including the target aquifer, is provided in the ASR Feasibility Study (Appendix A).

2.1 Hydrogeologic Model

The hydrogeology of the airport area aquifer, including geologic units, structures, and groundwater flow was characterized for the ASR Feasibility Study, and is described in detail in Appendix A. In summary, the City's ASR project will utilize the Upper Aquifer of the Airport Area Aquifer for recharge and recovery of treated source water. The unique depositional environment and other geologic features that bound the Upper Aquifer create a hydraulically isolated aquifer that appears ideal for storing and recovering water under this proposed ASR program.

2.2 Area Affected by ASR

The area affected by the City's ASR well(s) was estimated using: (1) the Theis equation to calculate the theoretical water level buildup (i.e. mounding) in the target aquifer during recharge at varying distances from the ASR well, and (2) the known hydraulic boundaries of the target aquifer (i.e., the ancestral canyon) that will constrain the extent of mounding. The Theis equation is:

$$s = \frac{Q}{4\pi T} * W(u) \qquad u = \frac{r^2 S}{4Tt} \tag{1}$$

s = mounding (feet)
Q = injection rate (ft^3/day)
T = transmissivity (ft^2/d)
t = time (days)
r = radial distance from the well with a mounding of s (feet)
S = storativity (dimensionless)

The areal extent of mounding (i.e., area affected by the ASR well) was defined as the portion of the Upper Aquifer that experiences more than 1.0 feet of water level rise during the first year of ASR cycle testing. Assuming T = 40,000 gpd/ft (5,347 ft^2/day)[7], Q= 825 gpm (158,812 ft^3/day)[8], t= 151 days[9], s = 1.0 feet, and S= 0.23[10], the calculated areal extent of mounding (i.e., the area affected by the injection from a single ASR well) is approximately 3,000 feet radially from the well. The storativity value used in the above calculation is more typical of an unconfined aquifer; however, this value represents the data from the long term pumping test on the Heliport well where pumping lowers the local water level enough around the well to exhibit unconfined conditions. Because the Upper Aquifer is under confined/semi-confined conditions under static water levels conditions, a calculated areal extent of mounding using a storativity value that might represent the semi-confined conditions (S= 0.05) estimates the areal extent to be approximately 6,400 feet. Pilot testing work will assist in refining these estimates.

Because the Upper Aquifer is a narrow ancestral channel deposit with clear lateral boundaries, the ASR affected radius may encounter this boundary and affect the overall shape of the area of influence, but is not expected to propagate beyond that channel edge boundary. The water level data collected from the proposed network of observation wells (Table 1; refer to Section 5.0) during pilot testing will be used to confirm the magnitude of mounding that develops during ASR recharge and to estimate the mounding that may develop from larger recharge and storage volumes.

It is important to note that the recharge mound is not equivalent to the actual 'bubble' of stored water, which will be substantially smaller than the recharge mound[11]. Specifically, the areal extent of the actual 'bubble' of stored water in the aquifer will be substantially less than the recharge mound. We estimate that the bubble will extend a radial distance of approximately 513 feet from the Heliport Production Well (recharge rate of 825 gpm)[12].

2.3 Potential Loss of Storage to Surface Streams and Springs

The aquifers in the airport area are situated within an ancestral canyon that the Crooked River eroded into the Simtustus and John Day Formations (see Figure 5). Over time, the canyon has been filled, eroded, and re-filled with basalt flows and alluvium. This

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[7] Late-time transmissivity of the Upper Aquifer based on evaluation of time-drawdown and time-recovery data at Airport Well No. 2 during long-term pumping of the Heliport Production Well in 2015 (see Table 1 of the ASR FS in Appendix A).

[8] Anticipated recharge rate at the Heliport Production Well (see Page 5-4 of the ASR FS in Appendix A).

[9] Recharging from November through March.

[10] Late-time storage of the Upper Aquifer based on evaluation of time-recovery data at Airport Well No. 2 during long-term pumping of the Heliport Production Well in 2015 (see Table 1 of the ASR FS in Appendix A).

[11] See Fetter (1994). During groundwater pumping, the cone of depression does not correspond with the groundwater that is captured because water tables are sloping. Similarly, the cone of impression (i.e., mounding) does not correspond with the recharged water (i.e., bubble).

[12] See Page 5-8 of the ASR FS in Appendix A.

depositional history has created a complex sequence of basalt flows, gravel river channel deposits, and silt overbank deposits within the ancestral canyon. The Upper Aquifer (defined in the Feasibility Study) is hydraulically isolated from the Lower Aquifer, and from the deposits that comprise the walls of the ancestral canyon. Specifically:

- Groundwater elevations in the Lower Aquifer are approximately 50 feet higher than groundwater elevations in the Upper Aquifer, indicating that the Upper Aquifer and Lower Aquifer are hydraulically separate aquifers (GSI, 2018), and water levels collected during pumping in both aquifers show no changes to the water levels of the other aquifer.
- The Hollander Well[13] is a domestic water well located east of the ancestral canyon but up on the plateau area. The City equipped this well with a transducer and monitored water levels from 2013 to 2016. As shown in a hydrograph of Hollander Well water levels (see well location map and hydrograph in Appendix C), the well does not exhibit a hydraulic response to pumping of the Upper Aquifer (specifically the Heliport Production Well), indicating that the Upper Aquifer is not hydraulically connected to the native material outside of the canyon. Following failure of the transducer in this well coupled with complex access issues, the City dropped this well from the monitoring program.

Based on these data and water level observations over the past several years in the airport area observation well network, the potential loss of stored water to surface streams or springs appears unlikely. Furthermore, because recharge at the Heliport Production Well will be conducted at rates that maintain the water level in the well below ground surface, it is unlikely that recharge will create springs or seeps at ground surface.

2.4 Other Groundwater Users and Wells in the Affected Area

The City of Prineville is the only know entity (other than potentially a few exempt wells) to be producing water from the Upper Aquifer area and holding water rights in this aquifer. The other known user of the airport area aquifer channel deposits is the Facebook production wells that produce water from the Lower Aquifer unit, which is hydraulically separate from the Upper Aquifer.

In addition, any new uses (production wells) would be required to equip their systems with flow meters and to measure and report to OWRD a record of monthly groundwater withdrawals from each well. This dataset, in combination with the City's ASR recharge and recovery volumes, can be used to account for the effects of native groundwater production apart from the City's recharge and recovery of stored water on an aquifer-wide basis, as well as the total net effect of the annual aquifer additions (i.e. recharge) and withdrawals on the head regime of the aquifer.

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[13] CROO 50311

In addition to water right authorized groundwater wells, exempt wells also exist within and outside of the projected affected area. Given the limited number of potential wells completed in the target aquifer, the large distance of the exempt wells from the potential ASR wells sites (i.e., the developed storage 'bubble' of recharge water), and the limited groundwater withdrawals of an exempt well, the potential capture of stored water by exempt wells does not appear to be a concern.

2.5 Water Quality

A thorough understanding of recharge (source) water quality, native groundwater quality, and the geochemical interaction between the recharge water and the native aquifer being recharged is necessary for an ASR project. The ASR Feasibility Study (Appendix A) includes a discussion of water quality of the native groundwater and the City's source water, and presents the findings from an evaluation of the compatibility of the City's source water with the native groundwater in the Upper Aquifer. No adverse reactions or negative impacts are expected from mixing of the City's source water with native groundwater.

Native groundwater and source water analytical results are presented in Table 2 and Table 3 of the ASR Feasibility Study (Appendix A if this report) and copies of the laboratory reports are provided in Appendix B of the ASR Feasibility Study.

2.6 ASR Well Construction Details

The City plans to use the existing Heliport Production Well as the initial ASR well under the limited license. An as-built diagram for the Heliport Production Well is provided in Figure 6 and in Appendix H.

The Heliport Production Well is 607 feet deep and is completed in the Upper Aquifer, in the ancestral channel gravels deposits of the Deschutes Formation. We anticipate that future ASR wells (ASR Wells 2 through 5) will be completed in the Upper Aquifer and in the ancestral channel gravels deposits of the Deschutes Formation. In addition, we anticipate that the construction of future wells (well depth, seal depth, and well materials) will be similar to the construction of the Heliport Production Well and target the productive gravels of the Upper Aquifer unit.

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 ASR source water will be water from the City's wells in the Prineville Valley aquifers delivered through the City's distribution system up to the ASR system on the plateau west of town. Because all of the City's valley floor wells are connect to the City's distribution system, the water delivered to the ASR well(s) for recharge will be a mixture from any number of the City wells. Therefore, all of the City's wells are listed as sources of ASR recharge, including the currently planned new deep valley floor wells and the new shallow alluvial wellfield. The following summarizes the City valley floor wells and the new shallow alluvial wellfield source:

- **The City's valley floor wells.** The City owns and operates multiple water supply wells in the Prineville Valley to meet the community's water demands, shown in Table 2. There are currently six existing City wells connected to the City's distribution system that will be used to provide source water for ASR. In addition the City is currently working to install one or more new valley floor wells to increase the City's production capacity in the valley. These proposed wells locations (Figure 3) would use the existing City rights. As shown in Table 2, the City holds water rights certificates and permits for the wells in the Prineville Valley (existing and proposed) that will be used as source water. Water rights certificates and permit for the wells are provided in Appendix D.
- **A new shallow alluvial wellfield under development at the south end of the City.** The City is in the process of planning and designing a new shallow alluvial wellfield that will be a municipal water source with a production goal of 2,000 gpm (see Appendix A for additional information about development of the new wellfield). The City has submitted an application for a groundwater permit requesting the use of up to 2,000 gpm from the new wellfield for municipal use. As required by OWRD's Deschutes Basin Groundwater Mitigation Program, the City's new groundwater permit will require the submittal of groundwater mitigation credits. The City is in the process of establishing the needed mitigation credits through Permit S-55091, mitigation project 222 (the release of 5,100 acre-feet of stored water annually from Prineville Reservoir for downstream fish life and wildlife use). The City will use a portion of these new mitigation credits to secure the new groundwater permit from OWRD. Based on the current status of the application and mitigation credits in OWRD's review process it is anticipated that the permit will be issued in early 2019.

3.2 Airport Area Upper Aquifer Groundwater Rights

The City currently holds water rights (permits G-17577 and G-17236) to pump water from wells in the airport area aquifer, which includes the Heliport Production Well. Any pumping of the Heliport Production Well above the volume stored in the well under the ASR Limited License will occur under these water rights. In no case would the City pump more groundwater than is permitted under the ASR Limited License and these water rights combined. The City's water rights for the airport area aquifer are provided in Appendix D.

3.3 Wastewater Discharge Approval

During ASR pilot testing, some well water, distribution system water, and stored water will be pumped to waste in order to minimize and control particulates in the well and distribution system. Discharges to waste will include 1) backflushing episodes when recharge 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 2) distribution system flushing conducted prior to the start of recharge to remove any particulates from the distribution system lines. Depending on infrastructure and the property dimensions at each ASR well site, the pump-to-waste discharge will be conveyed to an onsite detention system adjacent to the ASR well. If needed, the pump-to-waste system will include a dechlorination system to address waste discharges associated with treated drinking water where distances to surface water discharge do not allow for natural dissipation of the residual chlorine. The discharge water will consist of ASR source water (treated drinking water), native groundwater, or a mixture of the two. 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 (UIC) Registration

ASR operation and testing requires registration under the Oregon Department of Environmental Quality (DEQ) Underground Injection Control (UIC) program. Appendix E contains a draft UIC registration form. The UIC form will be submitted to DEQ for review and approval after this ASR limited license application is assigned a number by OWRD.

3.5 Land Use Approval

ASR operation and testing requires evidence that land use and development approval from the local government is sought, obtained, or unnecessary. Appendix F contains a completed Land Use Information Form for the initial ASR well site, the Heliport well. The ASR well site and the proposed use of water will be located within the City limits and on City owned property, therefore land use approval is need only from the City. Completed Land Use Information Forms will be submitted to OWRD for all subsequent ASR well sites as the sites are confirmed for development.

3.6 Oregon Health Authority Drinking Water Program

OHA rules[14] require that community water systems (such as the City) complete a Plan Review for construction of new ASR wells and retrofit of existing wells for recharge.

- **New ASR Wells.** The Plan Review process for a new ASR well involves submitting a preliminary plan to OHA for review and approval prior to beginning construction. The submittal focuses on well siting requirements (setbacks), land use compatibility, and proposed well construction specifications. Following OHA approval of the preliminary plan, the new well is installed and water quality and production capacity are tested. A second submittal is required by OHA documenting the as-built well logs, water quality testing results, above ground wellhead design, treatment plans, and system connection details. This plan must be approved prior to beginning construction of the well to the system.
- **Existing Wellhead Retrofit.** The Heliport Production Wellhead will be retrofit for use as an ASR well. The retrofit will also require a pre-construction plan review and approval that includes appropriate setback, land use compatibility, and retrofit modifications.

The City will follow the OHA plan review process prior to constructing new ASR wells and prior to retrofitting existing wells for use as an ASR well.

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[14] Oregon Administrative Rule pertaining to the Plan Review process are OAR 333-061-0060

4. System Operation and Wellhead Facility Design

Before pilot testing, each ASR well wellhead will be designed for ASR operation. The design will allow the well to supply water to the distribution system during the peak demand season and to recharge potable water into the aquifer during the non-peak demand season. The well will be equipped with system controls that allow automatic and manual operation. The ASR wellhead will be situated within a pump house and wellhead facility. A schematic diagram showing the proposed wellhead assembly and piping for ASR 1 is provided in Appendix G. The wellhead will be constructed in accordance with the OHA standards, and will include the following:

- Piping valves that allow for flushing the distribution system water lines that provide recharge source water to remove particulates prior to the start of recharge.
- Piping valves that allow for pump-to-waste during periodic back flushing events.
- Pump-to-waste line capable of handling the discharge volumes anticipated for both well and ASR operations.
- Controls for automatic actuation of piping valves for pump-to-waste and pump-to-system.
- Controls to monitor turbidity and shutdown recharge at adjustable 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 on piping to facilitate collection of water samples during recharge, storage, and recovery.
- Recharge through the existing, vertical lineshaft pump using a non-reverse ratchet to prevent backspin. Flows will be throttled back through the pump bowls to keep the pump column full, to maintain back pressure, and to regulate the recharge rate.
- Real-time monitoring.
- An onsite disinfection system to maintain disinfection residual in the distribution system.

As discussed in Section 3.6, an OHA Plan Review will be submitted for each ASR well as the wells are designed and prior to construction, and an OHA Plan Review will be submitted for each wellhead retrofit prior to using the well for ASR.

5. ASR Pilot Testing Program

This section presents the specific details of the proposed ASR pilot testing work plan for the Heliport Production Well. The purpose of pilot testing is to confirm ASR feasibility in the target aquifer and to develop design criteria for full-scale ASR operations. Based on the current project schedule, the City plans to begin pilot testing at the Heliport Production Well immediately after OWRD issues the ASR Limited License (in 2019).

It is anticipated that the pilot testing work plan presented in this section for the Heliport Production Well will be used as a blueprint for pilot testing at the other ASR wells proposed by the limited license; however, additional pilot testing work plans for each ASR well developed will be submitted to OWRD for review and approval prior to each ASR well being brought online for operation.

The pilot testing work plan for the Heliport Production Well under the ASR limited license will consist of two components:

- **Baseline Testing and Monitoring** – Includes water level monitoring and well testing initiated before the start of ASR testing to document pre-ASR aquifer conditions and well performance.
- **ASR Pilot Testing** – ASR pilot testing is divided into yearly cycle tests for each ASR well. Each ASR pilot testing cycle includes a recharge period, a storage period, and a recovery period.
  - **Year 1** – Includes a shakedown test; a longer-duration, operational-scale pilot testing cycle; water quality sampling; and water level monitoring.
  - **Years 2 through 5** – Operational-scale pilot testing cycles, including water quality sampling and water level monitoring. The recharge and recovery rates and durations, and the storage account volume for the pilot testing cycles will be determined on the basis of previous years' operations and the water needs of the City. The ultimate objective of the ASR pilot testing is to develop a larger storage volume using the Heliport Production Well and other wells developed under the limited license to store up to 870 MG (inclusive of ASR account carryover).

A discussion of each of the testing components is presented in the following subsections.

5.1 Baseline Water Level Monitoring and Well Testing

The purpose of the baseline water level monitoring and well performance testing is to obtain background water level data in the vicinity of the Heliport Production Well, and to assess pre-ASR well performance and aquifer characteristics. These data will be compared to data collected during ASR pilot testing to evaluate the effects of ASR on the aquifer and well.

5.1.1 Water Level Monitoring

A minimum of 2 weeks before ASR pilot testing, the City will begin frequent monitoring at a network of observation well that was designed to monitor the response of all hydrogeologic units in the airport area to ASR (i.e., the Upper Aquifer, the Lower Aquifer, and the aquitard outside of the ancestral channel) and to monitor aquifer response in several directions (upgradient, downgradient, cross-gradient) and distances from the Heliport Production Well.

The proposed observation well network includes the following wells listed below. The location of the potential observation wells are shown in Figure 3, construction details are provided in Table 3, and a construction diagram for the Heliport Production well, and well logs are provided in Appendix H.

<u>ASR Program Observation Wells Owned by the City</u>

- **Heliport Observation Well (CROO 54195).** This is an observation well owned by the City and will be ASR Obs Well 1. Data will be collected using a down-hole pressure transducer with a minimum of a one hour measurement frequency.
- **Airport 2 Production Well (CROO 53453).** This is an active production well owned by the City. Because the Airport 2 Production Well is pumped during the summer and not used during the winter (except to exercise the pump every couple weeks), water levels from the well will primarily be used to evaluate aquifer response to recharge. Data will be collected using a down-hole pressure transducer with a minimum of a one hour measurement frequency.
- **New ASR Observation Well.** The City plans to construct a new Upper Aquifer observation well (ASR Obs Well 2) downgradient of the Heliport Production Well that explores the full thickness of the Upper Aquifer unit. The exact location of ASR Obs Well 2 is limited by airport restrictions. Data will be collected using a down-hole pressure transducer with a minimum of a one hour measurement frequency. The construction of ASR Obs Well 2 is anticipated to be similar to the Heliport production well and be exposed to the full thickness of the Upper Aquiver.
- **Millican Well (CROO 53956/54149).** The Millican Well is the only City-owned well completed in the Lower Aquifer. Because the Millican Well is pumped during the summer and not used during the winter (except to exercise the pump every couple weeks), water levels from the well will primarily be used to evaluate aquifer response to recharge. Data will be collected using a down-hole pressure transducer with a minimum of a one hour measurement frequency.

<u>ASR Program Observation Wells Privately Owned</u>

- **Houston Lake Road Well (CROO 53361).** This is a former test well that is currently not used and is owned by a private citizen. Data will be collected using a down-hole pressure transducer with a minimum of a one hour measurement frequency.
- **Ryan Well (CROO 532).** This a former domestic well located west of the ancestral canyon. The well is currently owned by a private citizen. Data will be collected using a water level probe (e-tape; weekly measurements).

- **Grass Butte Well (CROO 54287).** This is a former test well located west of the ancestral canyon. The well is currently owned by a private citizen. Data will be collected using a down-hole pressure transducer with a minimum of a one hour measurement frequency.
- **County Landfill Well (CROO 50990).** This is a monitoring well at the Crook County Landfill, located north of the ancestral canyon. Data will be collected using a down-hole pressure transducer with a minimum of a one hour measurement frequency.

The City currently has access to all of the wells in the monitoring well network, but, because some of the wells are privately owned, may not have access to all of the wells in the future.

The City is interested in working with OWRD to ensure that there is sufficient observation well coverage to evaluate background water levels and aquifer conditions in the target aquifer during the first years of ASR pilot testing, future years of ASR pilot testing under the ASR limited license, and full-scale ASR operations. As ASR pilot testing progresses or with future expansion of the ASR system, the City may expand and/or modify the observation well network. An addendum to the existing pilot testing work plan outlining any proposed changes to the observation well network will be submitted to OWRD.

5.1.2 Well Testing

Before pilot testing at each new ASR well, a step-rate test and a constant-rate aquifer test will be conducted after well construction. This baseline well testing will be used to assess static water level trends in the well, the specific capacity of the well, projected buildup/ drawdown during longer-term recharge and recovery, recovery rates, and local hydrogeologic boundary conditions that could affect the long-term performance of the ASR well. These baseline conditions are used to assess the performance of the well during subsequent pilot testing events.

Baseline well testing of the Heliport Production Well is documented in a 2016 Technical Memorandum to the City (GSI 2016a). Therefore during the initial ASR testing of the Heliport Production Well, only a step test will be conducted prior to pilot test start-up.

Recharge will not be conducted until the UIC permit is approved and submitted to OWRD.

5.2 ASR Pilot Testing Rates and Monitoring

ASR pilot testing at the Heliport Production Well may utilize recharge and recovery rates up to the maximum limits requested by the ASR limited license application. Monitoring during ASR pilot testing will include both water levels and water quality data. The specific details of the proposed pilot testing and monitoring are described in the following sections.

5.2.1 Pilot Testing Rates and Volumes

During the initial cycles of pilot testing at the Heliport Production Well the source water will be recharged at rates of up to 825 gpm and recovered at pumping rates of up to 1,100 gpm during pilot testing. These maximum rates requested by the limited license application are based on the findings from the ASR Feasibility Study (Appendix A). The proposed rate of recharge, however, is less than the maximum rate allowed under the City's water rights for the source water [as stipulated in OAR 690-350-0010(2) and OAR 690-350-0010(3)]. The actual recharge and recovery rates implemented during the ASR pilot testing at the Heliport Production Well will be refined based on the production capacity of the well (determined by the well pumping following recharge) and on the response of the aquifer to the initial ASR pilot testing activities.

ASR Year 1. The ASR project goal in Year 1 is to develop up to 154 MG of annual storage from the City's existing valley floor well sources and using the Heliport Production Well as the ASR Well.

ASR Year 2 -5. The ASR project goal in Year 2 is to develop up to 179 MG of annual storage that will be coming mainly from the City's new shallow alluvial wellfield (assuming that this new source has been brought online) and using the Heliport Production Well as the ASR Well. The ultimate size of the City ASR program at full build-out includes plans to store up to 870 MG (inclusive of ASR account carryover) in up to five (5) ASR wells. The drilling and construction of additional ASR wells (beyond the Heliport Production Well) will be determined based on the results of the initial years of pilot testing.

5.2.2 Water Level Monitoring

During ASR pilot testing, water levels will be measured in the same wells used for baseline groundwater monitoring. The purpose of the water level monitoring is to assess aquifer response to recharge and recovery and potential impacts to other wells completed in the same aquifer. It is important to note that the water level monitoring is designed to be proactive with regard to the water level response in the aquifer resulting from the ASR pilot testing. The observation wells chosen were selected to provide a network of observation points dispersed across the anticipated area to be affected by ASR operations in all hydrogeologic units, thereby allowing a spatial assessment of the water level changes in the target aquifer as well as potential for changes in the non-target aquifer (Figure 3). The Heliport Production Well will be instrumented with an automated data collection system (pressure transducer and data logger or telemetry system) that will record water levels on an hourly basis at a minimum. The wells within the observation well network will be instrumented and monitored as previously described in Section 5.1; however the frequency could be increased or reduced if collected data support changes.

5.2.3 Water Quality Monitoring

Water quality samples will be collected from the Heliport Production Well during ASR pilot testing. The goal of the water quality monitoring is to ensure that recharged source water and the recovered water from the ASR well meets all state and federal drinking water criteria (as defined in OAR 690-350) and is of high quality. In addition, the water quality monitoring is designed to test for potential changes in recharged, stored, and recovered water as it relates to taste, quality, and the potential for clogging the ASR well. The planned water quality monitoring program is discussed in Sections 6 and 7.

5.2.4 Contingency Plan

Unless otherwise specified in this pilot testing work plan, the City intends to deliver the recovered water to its distribution system for municipal use by the City. In the unlikely event that the quality of the recharge water becomes impaired or the recovered water is unacceptable, all of the water recharged into the aquifer will be recovered and pumped to waste. The wellhead system is designed to allow for discharge of water to an existing pump-to-waste system. However, on the basis of the water quality analysis conducted to date and GSI's experience with municipal ASR systems throughout the region, the likelihood of this situation occurring appears highly improbable.

5.2.5 Limited License Duration

The City is seeking approval of a limited license for a 5-year period with the option for additional 5-year renewals of the ASR limited license to allow for full build-out of the ASR system.

5.3 ASR Pilot Testing: Year 1

The first year of pilot testing at the Heliport Production Well will consist of an initial shake-down test followed by a longer-duration, operational-scale pilot testing cycle.

Shakedown Test

Before initiating the first pilot testing cycle, a shakedown test will be performed that will consist of the following:

- Baseline Step Test. Performing a step drawdown test to assess baseline (pre-ASR) well performance. We anticipate that the step test will consist of four, 90-minute steps of 275 gpm, 550 gpm, 825 gpm, and 1,100 gpm (25 percent increments of the maximum 1,100 gpm pumping rate of the Heliport Production Well).
- Recharge. The Heliport Production Well will be recharged with source water to test and confirm operation of the recharge system. Adjustments to the system will be made as necessary.
- Recovery. After the short recharge period, the well pump will be operated to recover the entire volume of water recharged and to test and confirm operation of the well pump system.

The initial shakedown test is anticipated to last 8 hours. A second slightly longer shakedown test may be conducted that is anticipated to last a week (injection -3 days; storage1 day; recovery 3-days) Recovered water from the shakedown test(s) will be directed into the pump-to-waste system.

Cycle 1

The objective of Cycle 1 is to evaluate the long-term aquifer response, well performance, and water quality conditions under an operational-scale pilot testing cycle. Cycle 1 of ASR pilot testing will consist of recharging, storing, and recovering source water at the Heliport Production Well. The recharge phase of Cycle 1 will be used to assess head buildup in the aquifer, increased production performance resulting from recharge, potential for loss of stored water, area affected by recharge, and well efficiency changes at the ASR well during recharge. The storage phase 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 step test will be performed at the start of the recovery phase that will be structured to match the baseline step test completed at the well during shakedown testing. Results of the step test will be compared to the baseline step- test to assess changes in well efficiency following one cycle of ASR. The recovery portion of Cycle 1 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 well testing.

The anticipated specifications for Cycle 1 at ASR 1 are outlined below. Please note that the rates and volumes described are estimates only and may vary depending on the construction schedule for ASR 1, City demands, and well performance.

- A minimum 30-day continuous recharge period during November to May, with a storage target of up to154 MG at an estimated average recharge rate of 825 gpm[15].
- A minimum 30-day storage period
- A recovery period designed to recover 100 percent of the stored volume at an estimated average recovery rate of 1,100 gpm (1.58 mgd). Note: the volume of stored water recovered will be up to the limits allowed by the ASR limited license (e.g., 95 percent) and any additional water pumped will be appropriated under the City’s native groundwater rights.

5.4 ASR Pilot Testing: Years 2 through 5

The results of the Cycle 1 pilot testing will be evaluated and used to optimize ASR operation in future years. A tentative schedule for the anticipated typical pilot testing cycle at the Heliport Production Well is provided in Table 3. The ultimate objective of ASR pilot testing is to develop a larger storage volume using the Heliport Production Well (and other wells developed under the limited license) to store up to 870 MG (inclusive of ASR account carryover). The target ASR volumes, rates, durations, and schedules for each year of pilot testing will be developed on the basis of the prior year’s pilot testing results. The anticipated ASR operations plan for a subsequent year will be included with the each ASR annual report submitted to OWRD. Any modifications to the sampling and monitoring plan for the Heliport Production Well as outlined in this work plan will be submitted to OWRD for review and approval.

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[15] Note that recharging the Heliport Production Well at a rate of 825 gpm equates to 1.18 MGD, which is slightly more water than the FS estimates is available from the Valley Wells (the FS estimates that 1.02 MGD is available, see Table 5 of the FS in Appendix A). We plan on recharging at 1.18 MGD because the estimated volume available of 1.02 MGD is only an estimate. If less than 1.18 MGD are available, then the City will adjust the recharge rate based on the available volume of water.

6. Water Quality Monitoring Program

ASR regulations require that source water used for recharge and the receiving native groundwater be analyzed for OHA regulated and unregulated constituents, DEQ water quality maximum measureable levels (MML) constituents, federal maximum contaminant levels (MCL) constituents, and federal secondary MCL (SMCL) constituents before ASR 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.

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

- Confirm that the source water used for recharge and the recovered water meets Safe Drinking Water Act (SDWA) criteria:
- Assess water quality compatibility with respect to:
    - Recharge 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 ASR pilot testing program are described in the following subsections. Laboratory analytical data, a discussion of the source water quality, native groundwater quality, and predicted geochemistry resulting from mixing is presented in the accompanying ASR Feasibility Study (Appendix A, Section 3.0 and Table 2).

6.1 Water Quality Monitoring: Year 1 Pilot Testing

Water quality samples will be collected prior to recharge and during the recovery periods of shakedown testing where the recovered water will be pumped to waste. One sample will be collected from the receiving water and source prior to the shakedown testing work, and one sample from the recovered water during the second phase of the shakedown test (at approximately 60% recovery). These three samples will be analyzed for the Limited License required constituent listed in Table 5. Field and general chemistry samples may be collected more frequently during the shakedown test.

Water quality samples will be collected during the recharge, storage, and recovery periods of Cycle 1 testing. A tentative ASR operations schedule for the first year of pilot testing and the water quality analyses to be completed are presented in Table 5 and Table 6, respectively. The water quality monitoring program has been designed to meet the objectives stated previously.

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

Table 5 also presents the anticipated water quality monitoring program for subsequent years of monitoring. This sampling schedule is based on OHA's monitoring requirements for community water systems utilizing a groundwater source. If this anticipated program needs to be changed based on Year 1 pilot testing results, an updated water quality monitoring program for future years will be developed and submitted to OWRD for review and approval.

7. Quality Assurance and Quality Control Plan

This quality assurance and quality control (QA/QC) plan describes water sampling QA/QC procedures that will be performed during the City's ASR pilot testing program at each ASR well. The purpose of the QA/QC plan is to obtain water quality data that are valid representations 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 approaching applicable regulatory standards (e.g. federal MCL, state MML, etc.), recharge or recovery 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:

- Date and time of sampling
- Name of person performing the sampling
- Location of sampling point
- Field parameter values (pH, temperature, specific conductivity, dissolved oxygen, oxygen reduction potential, and turbidity) collected during sampling
- Appearance of sample
- 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

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
- Sample name (see below)
- Name of person collecting the sample
- 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: ASR#-*AA*-*BB*-*C*, where:

- "ASR#" indicates the City ASR Well # (1, 2, etc.) from which the sample was collected (the Heliport Production Well is "ASR1").
- "*AA*" indicates the cycle (C1 for Cycle 1, C2 for Cycle 2, etc.).
- "*GW*" indicates whether the water represents groundwater , source water (SW), stored water (ST), or recovered water (RW).
- "*C*" indicates the sample number within a given cycle (1 indicates the first sample of "*BB*" collected during a cycle, and 2 indicates the second sample of "*BB*" collected during a cycle).

For example, ASR1-C1-SW-2 would be the second source water sample collected during Cycle 1 at the Heliport Production Well.

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 person collecting the sample will complete the chain-of-custody form.
2. The chain-of-custody form 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 chain-of-custody form 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 (ORELAP).

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 4 presents a tentative schedule for Cycle 1 of ASR pilot testing at the Heliport Production Well. The schedule for Year 1 of pilot testing may vary depending on when the ASR limited license is approved, and could change in response to construction schedules, City water demands, and well performance. Table 5 outlines the recharge, storage, recovery, and water quality sampling schedule at the Heliport Production Well.

As noted previously, it is anticipated that the water quality analyses and operations schedule framework summarized in Table 5 and Table 6 will be similarly implemented at each additional ASR well as the wells are constructed and brought on-line. However, if a wellfield is developed, the City may submit a request to OHA to allow water quality sampling at one ASR well within the ASR wellfield rather than each individual ASR well.

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 of ASR pilot testing:

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

Works Cited

GSI, 2016a. Water Management and Conservation Plan. Prepared for: City of Prineville. August.

GSI, 2016b. Groundwater Hydrology of the Prineville Airport Area Aquifer System—2016 Update. Prepared for: City of Prineville. October.

GSI, 2018. Prineville Airport Area Aquifer, Aquifer Storage and Recovery (ASR) Feasibility Study, Prepared for: City of Prineville. May.

Table 1. ASR Program Wells

City of Prineville ASR Limited License Application & Pilot Testing Work Plan

Well Name	OWRD Well Log ID	Hydrogeologic Unit		City Owned or Privately Owned Wells
		Prineville Valley Aquifers	Airport Area Aquifers	
ASR Source Water				
Lamonta	CROO 1540	Confined Aq	---	City owned
Yancey	CROO 50181	Confined Aq	---	City owned
Barney	CROO 3132	Confined Aq	---	City owned
Stearns #2	CROO 2083	Confined Aq	---	City owned
Stadium	CROO 184	Confined Aq	---	City owned
4th Street Deep	CROO 2121 CROO 2133	Confined Aq	---	City owned
Ochoco Heights	*to be installed*	*Confined Aq*	---	*City owned*
Industrial Park Well	*to be installed*	*Confined Aq*	---	*City owned*
Stryker Well	*to be installed*	*Confined Aq*	---	*City owned*
Juniper Well	*to be installed*	*Confined Aq*	---	*City owned*
Shallow Alluvial Wellfield	*CROO 54587* *CROO 54592* *CROO 54593* *up to 21 new wells*	*Unconfined Shallow Aq*	---	*City owned*
ASR Injection/Recovery Wells				
Heliport Prod Well	CROO 54191	---	Upper Aquifer	City owned
ASR 2 (future well)	*to be installed*	---	*Upper Aquifer*	*City owned*
ASR 3 (future well)	*to be installed*	---	*Upper Aquifer*	*City owned*
ASR 4 (future well)	*to be installed*	---	*Upper Aquifer*	*City owned*
ASR 5 (future well)	*to be installed*	---	*Upper Aquifer*	*City owned*
ASR Observation Wells				
Heliport Obs Well	CROO 53965 CROO 54195	---	Upper Aquifer	City owned
ASR Obs 2	*to be installed*	---	*Upper Aquifer*	*City owned*
Huston Lake Road	CROO 53361	---	Upper Aquifer	Privately owned
Ryan Well	CROO 532	---	Outside of Channel	Privately owned
Grass Butte Well	CROO 54287	---	Outside of Channel	Privately owned
County Landfill	CROO 50990	---	Outside of Channel	Privately owned
Airport Well 1	CROO 1894/50095 53890/54206		Upper Aquifer	City owned
Airport Well 2	CROO 53453		Upper Aquifer	City owned
Millican Well	CROO 53956/54149		Lower Aquifer	City owned

Notes:

Blue italic Texts = future wells to be installed by the City

Table 2. Summary of City of Prineville Water Rights - ASR Source Water Supply

City of Prineville ASR Limited License Application & Pilot Testing Work Plan

Well Name	OWRD Well Log ID	Use	Water Rights				Hydrogeologic Unit	Authorized Rate	
			Application	Permit	Certificate	Transfers		(gpm)	(MGD)
Municipal Water Supply System - Prineville Valley Wells									
Lamonta	CROO 1540	MU	G 605	G 506	86337		Valley Floor Confined Aq	346	0.50
Yancey	CROO 50181	MU	U 241	U 215	22839		Valley Floor Confined Aq	359	0.52
Barney	CROO 3132	MU	G 6313	G 9154	83993	~~T9762~~	Valley Floor Confined Aq	700	1.01
Stearns #2	CROO 2083	MU							
Stadium	CROO 184	MU	G 12344	G 11993	87714		Valley Floor Confined Aq	271	0.39
		MU						154	0.22
4th Street Deep	CROO 2121 CROO 2133	MU	U 402	U 372	86889		Valley Floor Confined Aq	337	0.49
Shallow Alluvial Well Field [2]	*CROO 54587* *CROO 54592* *CROO 54593* *up to 21 new wells*	*MU*	*G-18662*	*Pending* *(PFO issued)*			*Valley Floor Unconfined Aq*	*2000*	*2.88*
Ochoco Heights	*new well(s)*	*MU*	*U 147*	*U 140*	*86558*	*T-13030*	*Valley Floor Confined Aq*	*359*	*0.52*
							Total	4,526	6.52

Notes:

(1) City production capacity from valley wells excludes the 4th Street Shallow well because it is only used as an emergency source
(2) Pending water right application for new wellfield, permit expected to be issued in early 2019; total of 24 wells in wellfield
Strikethrough indicates that the transfer changed the water right, and the water right was re-certified.
MU = Municipal Use
OWRD = Oregon Water Resources Department
gpm = gallons per minute
MGD = millions of gallons per day

Table 3. Proposed Observation Well Network for ASR Pilot Testing

City of Prineville ASR Limited License Application & Pilot Testing Work Plan

OWRD Well ID	Well Name	Direction	Well Type/Use	Distance from ASR Well (feet)	Land Surface Elevation [2] (feet amsl)	Well Depth (feet bgs)	Casing Depth (feet bgs)	Depth of Seal (feet bgs)	Open/ Perforated Interval (feet bgs)
Observation Wells in the Upper Aquifer									
CROO 54195 [1]	Heliport Observation	Downgradient	Observation	32	3,268	632	462	462	472 - 632
CROO 1894/50095 53890/54206	Airport 1	Cross Gradient	Municipal Supply	430	3,253	575	25	25	open hole
CROO 53453	Airport 2	Cross Gradient	Municipal Supply	440	3,253	546	452	452	452 - 539
--	*New Upper Aquifer Well*	*Downgradient*	*Observation*	*1,200*	*--*	*~630*	*--*	*--*	*--*
CROO 53361	Houston Lake Road	Downgradient	Observation	14,000	3,163	555	18	18	375 - 535
Observation Wells in the Lower Aquifer									
CROO 53956/ 54149	Millican	Upgradient	Municipal Supply	1,550	3,255	700	20.5	20.5	20.5 - 700
Observation Wells Outside of the Ancestral Canyon									
CROO 532	Ryan	Upgradient	Observation	3,300	3,305	505	20	20	425 - 485
CROO 54287	Grass Butte	Downgradient	Observation	4,200	3,269	750	63	63	615 - 715
CROO 50990	County Landfill	Downgradient	Observation	8,850	3,223	404	368	368	391 - 401

Notes:

(1) This log corresponds to an alteration of the Heliport Observation Well seal. See also CROO 53965 (original well log) and CROO 54024 (alteration liner).

(2) From GSI (2016), except for CROO 54287, which is from Google Earth.

Blue italic Texts = future wells to be installed by the City

Table 4. Tentative Schedule for Pilot Test Cycle 1 at the Heliport Production Well

City of Prineville ASR Limited License Application & Pilot Testing Work Plan

Recharge Rate	Recharge Period[1]	Target Recharge Volume[2]
Up to 825 gpm	November to March	Up to 154 MG (Year 1) Up to 179 MG (Years 2-5)

Storage Period
April to May

Recovery Rate	Recovery Period[1]	Recovery Volume
Up to 1,100 gpm	May - October	Maximum recovery % allowed by limited license

Notes:

(1) The start, stop, and duration of the recharge and recovery periods in a given year are dependent on the water supply and demand conditions and operational restrictions experienced by the City; hence, these time estimates are an approximation.

(2) Proposed total ASR storage volume (inclusive of carryover) is 870 MG.

gpm = gallons per minute

MG = Million Gallons

Table 5. Water Quality Monitoring Schedule for ASR Pilot Testing

City of Prineville ASR Limited License Application & Pilot Testing Work Plan

Sample Type	Schedule[1]	Location	Frequency	Analyte Group[2]	Regulatory Basis
Receiving Water	1) Approximately 30 days prior to recharge[3]	Heliport Production Well	Yearly	GCs	LL requirement
				FPs	Voluntary standard
				DBPs	
				Radon	
Source Water	2) Approximately 30 days prior to recharge[3]	Heliport Production Well	Yearly	FPs	LL requirement
				GCs	
				DBPs	
				Metals	
				Misc	
			Every 3 years	Rads	
				SOCs	
				VOCs	
	3) 30-50% of recharge	Heliport Production Well	Yearly	FPs	Voluntary standard
				GCs	
	4) 70-100% of recharge	Heliport Production Well	Yearly	FPs	Voluntary standard
				GCs	
				DBPs	
				Radon[4]	
Stored Water	5) Approximately 30 days prior to recovery[3]	Heliport Production Well	Yearly	FPs	Voluntary standard
				GCs	
Recovered Water	6) 30-50% of Recovery	Heliport Production Well	Yearly	FPs	Limited License Requirement
				GCs	
				DBPs	
				Metals	
				Misc	
				Radon[4]	
			Yearly for the first 3 years, then every 3 years thereafter	Rads[5]	
				SOCs	
				VOCs	
	7) 70-100% of Recovery	Heliport Production Well	Yearly	FPs	Voluntary Standard
				GCs	
				DBPs	
				Radon[4]	

Notes:

[1] The monitoring schedule for the workplan is based on OHA's monitoring requirements for community water systems utilizing a groundwater source. Additional samples beyond those listed may be collected at the discretion of the City during recharge and recovery for testing of geochemical constituents to better understand mixing between source water and native groundwater.

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

[3] Sufficient time to obtain analytical results before initiating injection or recovery, as applicable.

[4] 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.

[5] Up to four quarters of radiological samples may be required by OHA for new ASR wells. 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.

Table 6. Analytes and Applicable Drinking Water Standards

City of Prineville ASR Limited License Application & Pilot Testing Work Plan

Analyte	Unit	Standard	Criteria
Disinfection Byproducts (DBPs)			
Bromate	mg/L	0.01	MCL
Bromodichloromethane	mg/L		
Bromoform	mg/L		
Chloramines (as Cl2)	mg/L	MRDL=4.0	MCL
Chlorine (as Cl2)	mg/L	MRDL=4.0	MCL
Chlorine dioxide (as ClO2)	mg/L	MRDL=0.8	MCL
Chlorite	mg/L	1	MCL
Chloroform (Trichloromethane)	mg/L		
Dibromoacetic Acid	mg/L		
Dichloroacetic Acid	mg/L		
Dibromochloromethane	mg/L		
Haloacetic acids (HAA5)	mg/L	0.06	MCL
Monobromoacetic Acid	mg/L		
Monochloroacetic Acid	mg/L		
Trichloroacetic Acid	mg/L		
Total Trihalomethanes (TTHMs)	mg/L	0.08	MCL, MML
Field Parameters (FP)			
Temperature	Celcius		
Conductivity	mS/cm		
Dissolved Oxygen	mg/L		
pH	Units		
Turbidity	NTU		
ORP	mV		
General Chemistry (GC)			
Bicarbonate Alkalinity	mg/L		
Calcium	mg/L		
Carbonage Alkalinity	mg/L		
Charge Balance of Major Ions			
Chloride	mg/L	250	SMCL
Fluoride	mg/L	2	MCL, MML, SMCL
Hardness (As CaCO3)			
Iron (dissolved)	mg/L		
Iron (total)	mg/L	0.3	SMCL
Lead	mg/L	TT; Action Level=0.015	MCL
Magnesium			
Manganese (total)	mg/L	0.05	SMCL
Manganese (dissolved)	mg/L		
Nitrate (measured as Nitrogen)	mg/L	10	MCL
Nitrite (measured as Nitrogen)	mg/L	1	MCL
Total Nitrate-Nitrite	mg/L		
pH	--	6.5-8.5	SMCL
Potassium	mg/L		
Silica	mg/L		
Sodium	mg/L		
Sulfate	mg/L	250	SMCL
Total Alkalinity	mg/L		
Total Dissolved Solids	mg/L	500	SMCL

Table 6. Analytes and Applicable Drinking Water Standards

City of Prineville ASR Limited License Application & Pilot Testing Work Plan

Analyte	Unit	Standard	Criteria
Total Organic Carbon	mg/L		
Total Suspended Solids	mg/L		
<u>Metals</u>			
Aluminum	mg/L	0.05 - 0.2	SMCL
Antimony	mg/L	0.006	MCL
Arsenic	mg/L	0.01	MCL
Barium	mg/L	2	MCL
Beryllium	mg/L	0.004	MCL
Cadmium	mg/L	0.005	MCL
Chromium (total)	mg/L	0.1	MCL
Copper	mg/L	1.3	MCL, SMCL
Mercury (inorganic)	mg/L	0.002	MCL
Selenium	mg/L	0.05	MCL
Silver	mg/L	0.1	SMCL
Thallium	mg/L	0.002	MCL
Zinc	mg/L	5	SMCL
<u>Miscellaneous (Misc)</u>			
Color	Color units	15	SMCL
Corrosivity	--	noncorrosive	SMCL
Cyanide (as free cyanide)	mg/L	0.2	MCL
Foaming Agents	mg/L	0.5	SMCL
Odor	Threshold odor number	3	SMCL
<u>Radionuclides (Rads)</u>			
Combined Radium 226 and 228	pCi/L	5	MML
Gross Alpha	pCi/L	15	MML
Gross Beta	pCi/L	50	MML
Radon	pCi/L		
Uranium	ug/L	30	MCL
<u>Synthetic Organic Compounds (SOCs)</u>			
2,4,5-TP (Silvex)	mg/L	0.01	MCL, MML
2,4-D	mg/L	0.07	MCL, MML
Alachlor	mg/L	0.002	MCL
Atrazine	mg/L	0.003	MCL
Benzo(a)pyrene (PAHs)	mg/L	0.0002	MCL
Carbofuran	mg/L	0.04	MCL
Chlordane	mg/L	0.002	MCL
Dalapon	mg/L	0.2	MCL
Di(2-ethylhexyl) adipate	mg/L	0.4	MCL
Di(2-ethylhexyl) phthalate	mg/L	0.006	MCL
Dibromochlorpropane (DBCP)	mg/L	0.00002	MCL
Dinoseb	mg/L	0.007	MCL
Diquat	mg/L	0.02	MCL
Endothall	mg/L	0.1	MCL
Endrin	mg/L	0.0002	MCL, MML
Ethylene dibromide (EDB)	mg/L	0.00005	MCL
Glyphosate	mg/L	0.7	MCL
Heptachlor	mg/L	0.0004	MCL

Table 6. Analytes and Applicable Drinking Water Standards

City of Prineville ASR Limited License Application & Pilot Testing Work Plan

Analyte	Unit	Standard	Criteria
Heptachlor epoxide	mg/L	0.0002	MCL
Hexachlorobenzene	mg/L	0.001	MCL
Hexachlorocyclopentadiene	mg/L	0.05	MCL
Lindane (BHC-gamma)	mg/L	0.0002	MCL, MML
Methoxychlor	mg/L	0.04	MCL, MML
Oxamyl (Vydate)	mg/L	0.2	MCL
Pentachlorophenol	mg/L	0.001	MCL
Picloram	mg/L	0.5	MCL
Polychlorinatedbiphenyls (PCBs)	mg/L	0.0005	MCL
Simazine	mg/L	0.004	MCL
Toxaphene	mg/L	0.003	MCL, MML
<u>Volatile Organic Compounds (VOCs)</u>			
1,1,1-Trichloroethane	mg/L	0.2	MCL, MML
1,1,2-Trichloroethane	mg/L	0.005	MCL
1,1-Dichloroethylene	mg/L	0.007	MCL, MML
1,2,4-Trichlorobenzene	mg/L	0.07	MCL
1,2-Dibromo-3-chloropropane (DBCP)	mg/L	0.0002	MCL
1,2-Dichlorobenzene (o)	mg/L	0.6	MCL
1,2-Dichloroethane (ethylene chloride)	mg/L	0.005	MCL, MML
1,2-Dichloropropane	mg/L	0.005	MCL
1,4-Dichlorobenzene (p)	mg/L	0.075	MCL, MML
Benzene	mg/L	0.005	MCL, MML
Carbon tetrachloride	mg/L	0.005	MCL, MML
Chlorobenzene	mg/L	0.1	MCL
cis-1,2-Dichloroethylene	mg/L	0.07	MCL
Ethylbenzene	mg/L	0.7	MCL
Methylene chloride (dichloromethane)	mg/L	0.005	MCL
Styrene	mg/L	0.1	MCL
Tetrachloroethylene (perchloroethylene)	mg/L	0.005	MCL
Toluene	mg/L	1	MCL
trans-1,2-Dichloroethylene	mg/L	0.1	MCL
Trichloroethylene	mg/L	0.005	MCL, MML
Vinyl chloride	mg/L	0.002	MCL, MML
Xylenes (total)	mg/L	10	MCL

Notes

ASR Standards = Lowest value within MCL/2, MML/2 and SMCL except Disinfection Byproducts and Radionuclides group.

ASR Standards for Disinfection Byproducts and Radionuclides = Lowest value within MCL, MML and SMCL.

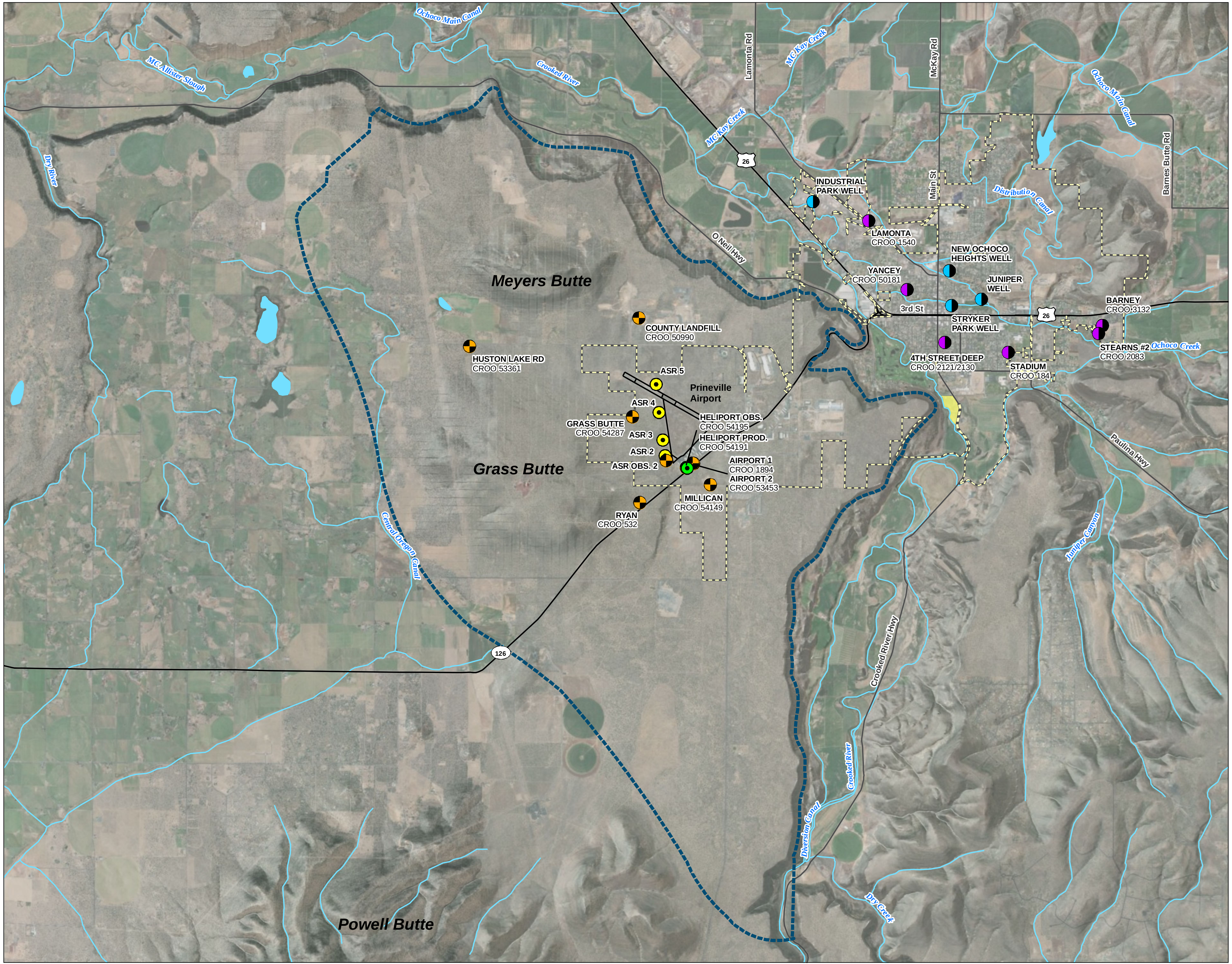

FIGURE 1

Project Study Area and Overview Map

ASR Limited License Application and Pilot Test Work Plan

LEGEND

- ● Existing ASR Well
- ● Proposed ASR Well
- ◐ Exsting Source Water Well (POD)
- ◐ Proposed Valley Well
- ◐ ASR Observation Well
- ⬚ ASR Study Area (Plateau)
- 🟨 New Alluvial Wellfield

All Other Features

- ⬚ Prineville City Limit
- ╱╲ Major Road
- 〜 Watercourse
- ▰ Waterbody

N

0 2,700 5,400 8,100

Feet

Date: August 1, 2016
Data Sources: ESRI, BLM, USGS

GSI Water Solutions, Inc.

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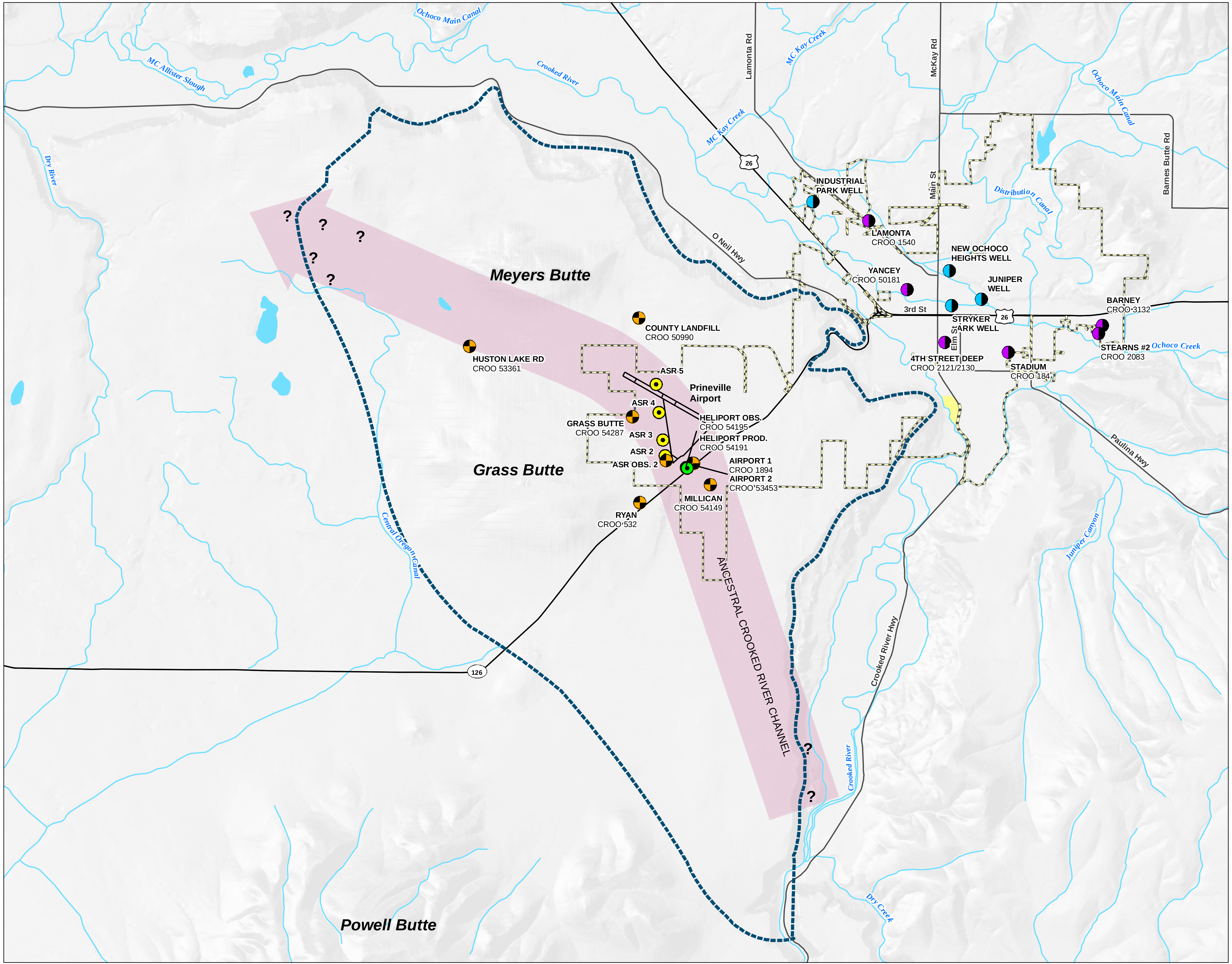

FIGURE 2

Ancestral Canyon and Target ASR Aquifer (Upper Aquifer)

ASR Limited License Application
and Pilot Test Work Plan

LEGEND

- ● Existing ASR Well
- ● Proposed ASR Well
- ◐ Exsting Source Water Well (POD)
- ◐ Proposed Valley Well
- ◐ ASR Observation Well
- ➡ Estimated Location of Ancestral Crooked River Canyon
- ▭ ASR Study Area (Plateau)
- ▨ New Alluvial Wellfield

All Other Features

- ▭ Prineville City Limit
- ╱╲ Major Road
- 〰 Watercourse
- ▨ Waterbody

N

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Feet

Date: August 1, 2016
Data Sources: ESRI, BLM, USGS

GSI Water Solutions, Inc.

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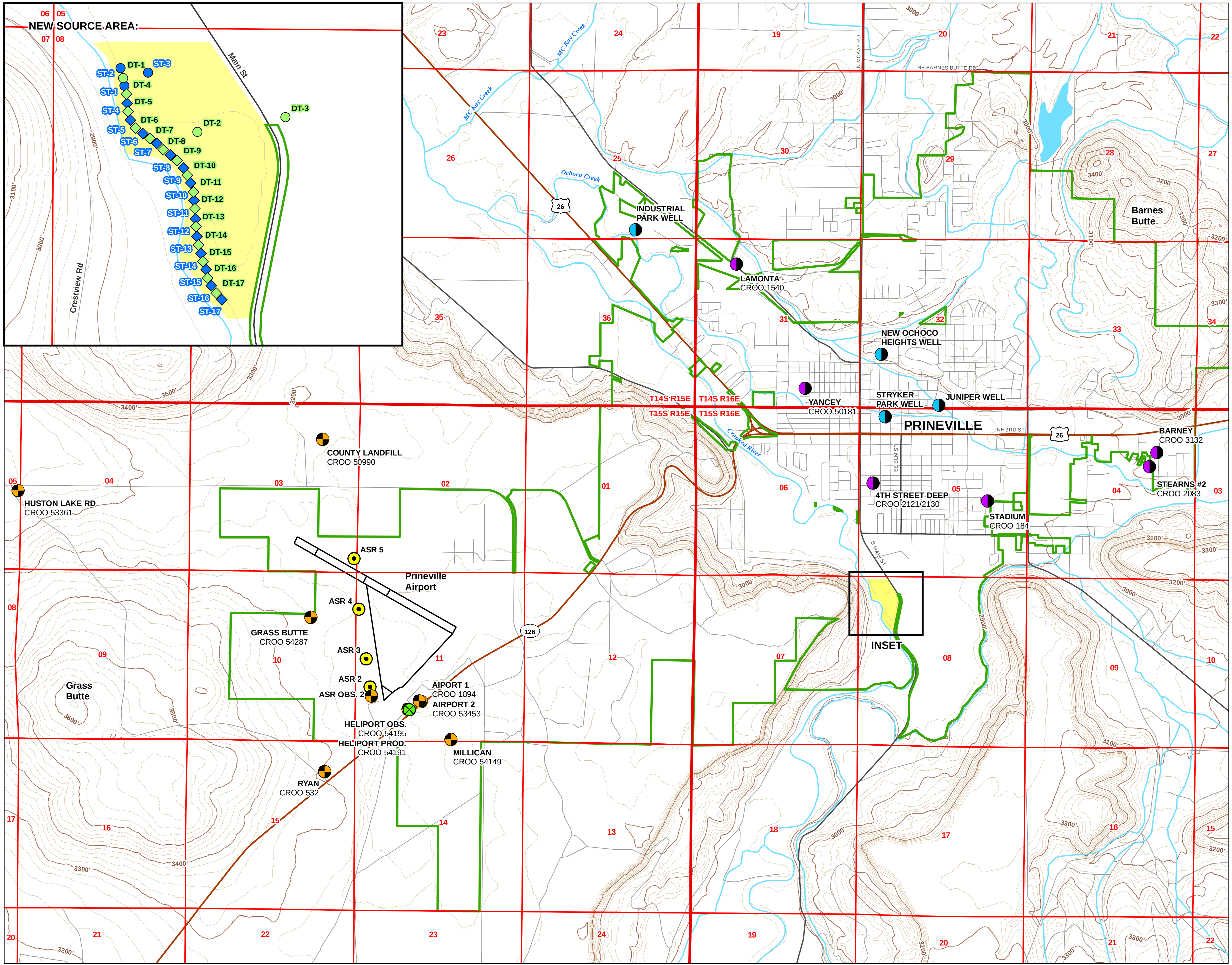

FIGURE 3

ASR Program Wells

ASR Limited License Application
and Pilot Test Work Plan

LEGEND

●	Existing ASR Well
●	Proposed ASR Well
●	Exsting Source Water Well (POD)
●	Proposed Valley Well
●	ASR Observation Well

Future New City Source Wells (PODs)

●	Existing Deep
●	Existing Shallow
◆	Future Deep
◆	Future Shallow

All Other Features

■	New Alluvial Wellfield
☐	Prineville City Limit
—	Highway
—	Major Road
~	Watercourse
■	Waterbody

NOTES:

POD = Point of Diversion

N

0 1,500 3,000 4,500
Feet

Date: September 25, 2018
Data Sources: ESRI, USGS, DigiGlobe 2016

GSI Water Solutions, Inc.

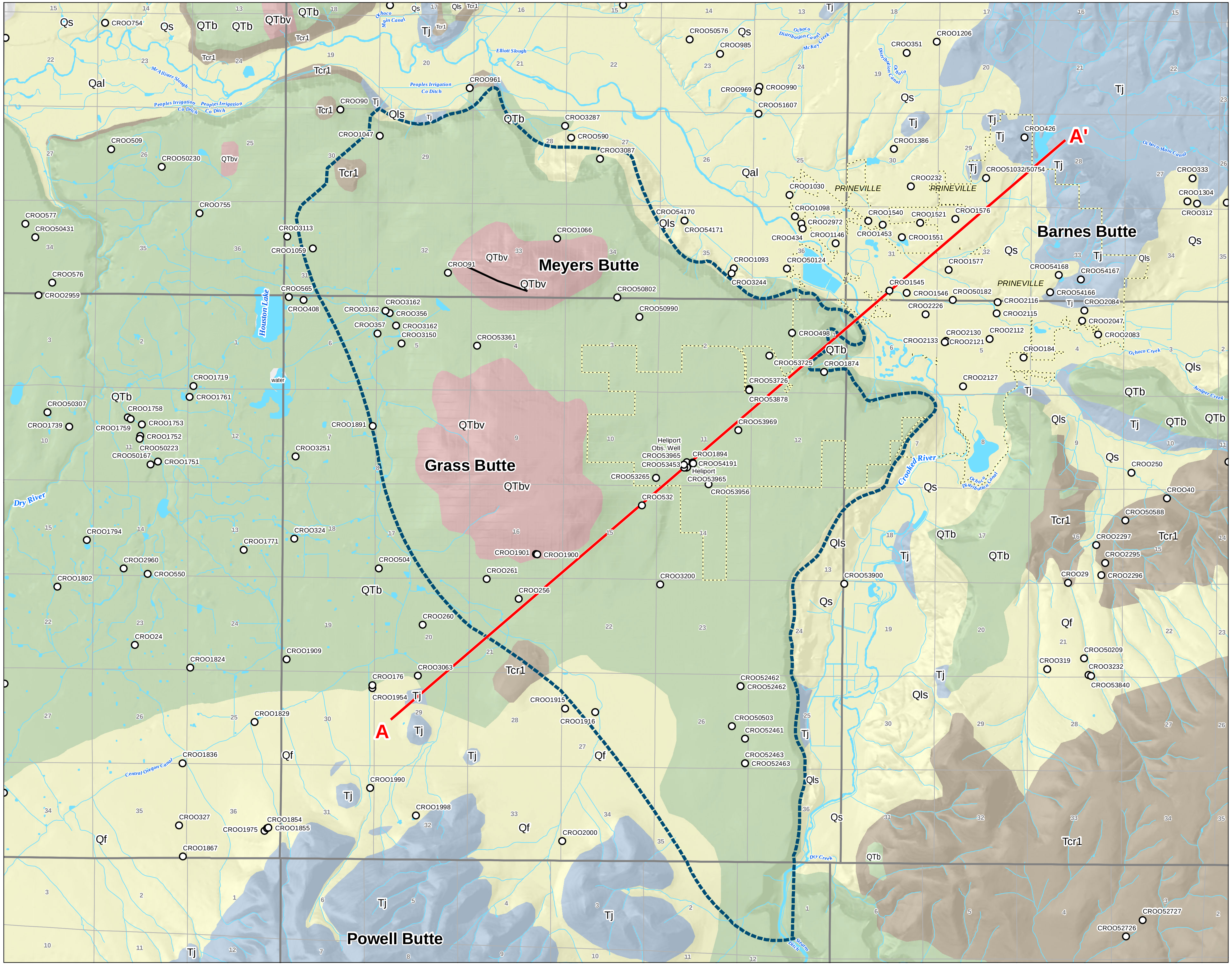

FIGURE 4

Generalized Geologic Map

ASR Limited License Application
and Pilot Test Work Plan

LEGEND

○ Well

— Cross Section Line

— Fault

⬚ ASR Study Area (Plateau)

Geology

Basin-Fill Deposits

🟨 Recent Alluvial

🟩 Deschutes Formation

Basement Rock

🟫 Prineville Basalt

🟦 John Day Formation

🟥 Vent and Pyroclastic Rocks

All Other Features

⬚ City Boundary

~ Watercourse

▨ Waterbody

N

0 2,700 5,400 8,100
Feet

Date: September 24, 2018
Data Sources: OGIC, USGS, ESRI, OWRD, DOGAMI

GSI Water Solutions, Inc.

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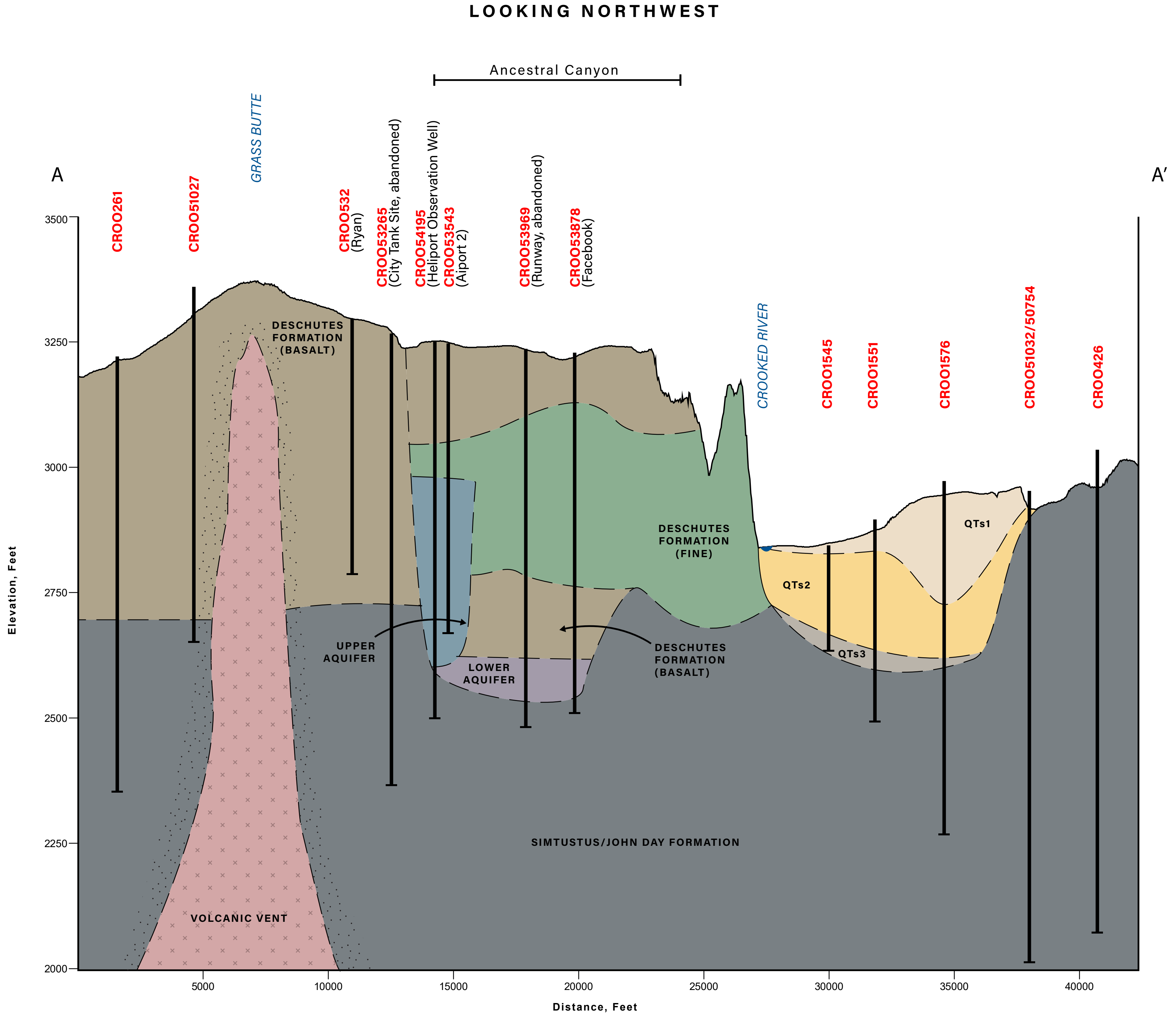


FIGURE 5

Cross Section A to A′

ASR Limited License Application
and Pilot Test Work Plan

LEGEND

Basin Fill Deposits

Recent Alluvial Deposits

- ▨ QTs1 - Upper Sand and Gravel
- ▨ QTs2 - Fine Grained Deposits (confining Unit)
- ▨ QTs3 - Lower Sand and Gravel

Deschutes Formation

- ▨ Deschutes Formation - Basalt
- ▨ Deschutes Formation - Fine Grained
- ▨ Deschutes Formation - Coarse Grained Sand and Gravel (Upper Aquifer)
- ▨ Fractured Basalt/Fine Sand and Gravel (Lower Aquifer)

Basement Rock

- ▨ Simtustus/John Day Formation
- ▨ Volcanic Vent

SCALE

250

0 5000

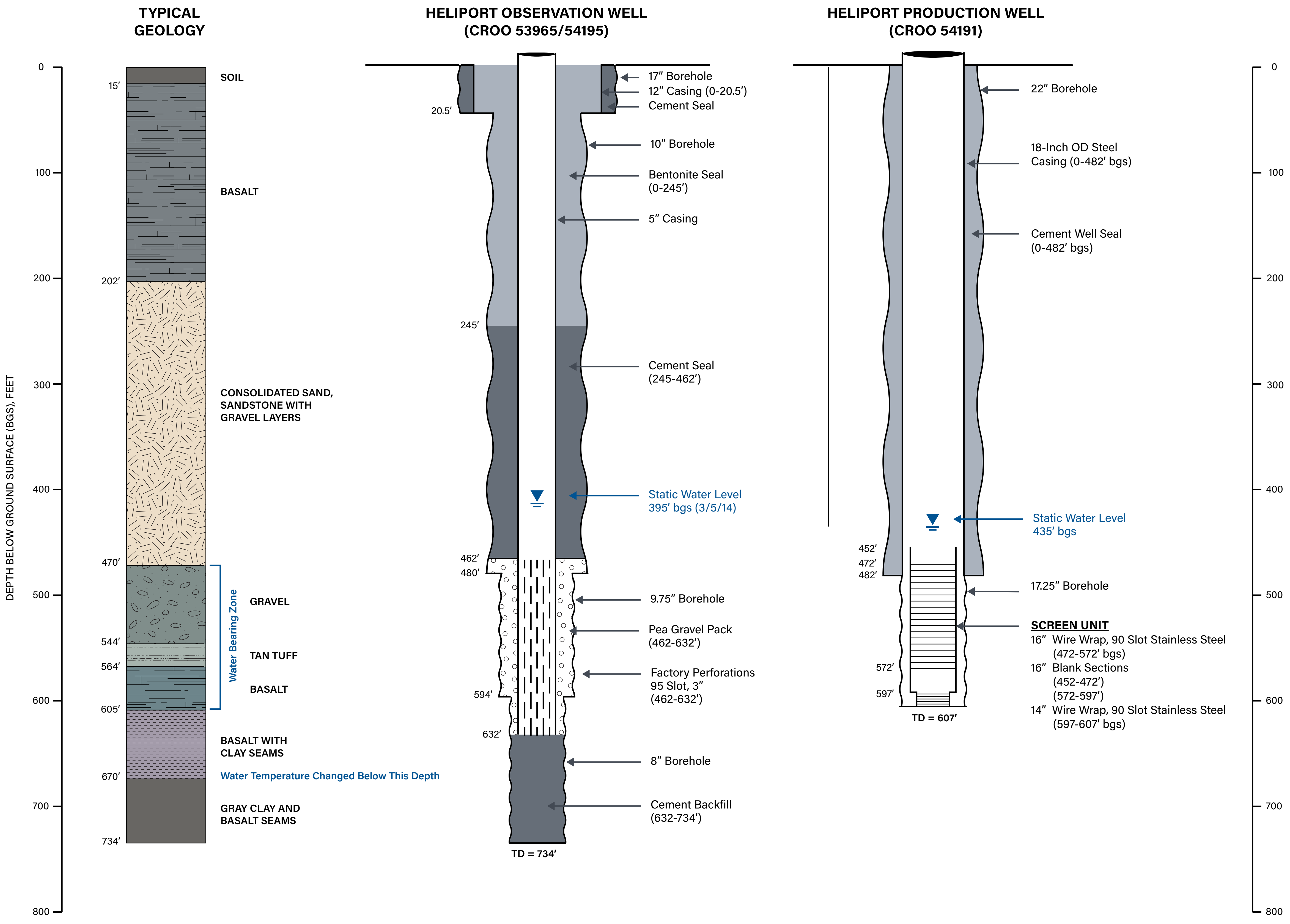
20X Vertical Exaggeration

GSI Water Solutions, Inc.

FIGURE 6

Well Construction Schematic of Heliport Production and Observation Wells and Proposed Design of Future ASR Wells

ASR Limited License Application and Pilot Test Work Plan



GSI Water Solutions, Inc.

APPENDIX A

Airport Area Aquifer ASR Feasibility Study

City of Prineville ASR Limited License Application

Prineville Airport Area Aquifer Aquifer Storage and Recovery (ASR) Feasibility Study

City of Prineville

October 2018

Prepared by

GSI Water Solutions, Inc.

CASCADE GEOENGINEERING

JACOBS

The City of Prineville
Prineville Airport Area Aquifer
Aquifer Storage and Recovery (ASR)
Feasibility Study

Prepared For
City of Prineville

REGISTERED PROFESSIONAL
OREGON
BRUCE A. BRODY-HEINE
Bruce Brody-Heine
No. G1391
GEOLOGIST

Prepared By
GSI Water Solutions, Inc.
147 SW Shevlin Hixon Drive
Bend, OR 97702

October 2018

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Executive Summary

The City of Prineville is exploring options for developing resilient, sustainable, and cost-effective water sources to meet growing demands of its customers. The biggest challenge the City faces is meeting summertime peak day demands, which can be almost 3 times greater than average day demands. Aquifer storage and recovery (ASR) is a cost-effective water management tool that would allow the City to meet its growing peak day demands by taking advantage of the natural storage space found underground in geologic formations near the City.

An ASR system uses a well to inject water into the aquifer, where it is stored and later pumped back out for use. Water is collected during periods of cooler temperatures, higher streamflow, and lower demands. The stored water can later be recovered and used during periods of hotter temperatures and higher water demands—typically during the summer months—thereby easing peak demand stress on native water sources and reducing the need to build expensive water infrastructure (e.g. above-ground storage, etc.) in order to meet these short-duration peak demands. In addition, ASR programs can be used to counteract long-term impacts from climate change (such as reduced snowpack water volumes), and provides for a readily available underground reservoir of stored water for use in the event of drought or supply interruption.

This ASR feasibility study (FS) is part of the City's ongoing ASR assessment project for the airport area aquifer (Study Area) and evaluates:

- Hydrogeologic characteristic of the recharge aquifer
- Recharge rates and potential storage volumes
- Water quality compatibility between the source water and the target aquifer
- Potential loss of stored water to surface water or seepage

The findings of this FS indicate that implementing an ASR program appears to be feasible in the airport area's Upper Aquifer.

The highly productive Upper Aquifer, with its deep water table, can take advantage of the natural storage capacity of the system resulting in the storage of millions of gallons of water that can be later recovered to meet summer peak day demands. Potential storage volume evaluation indicates that with a single well (the Heliport Production Well) volumes of up to 179 million gallons (MG) could be stored annually. If additional wells are installed, the Upper Aquifer may be capable of storing up to 870 MG annually.

The evaluation also indicates that there would be minimal potential for creating excessive groundwater level changes in nearby wells, and a large proportion of the recharged water (stored water) will remain in place and be available for recovery by the City's wells.

In summary, these geologic, hydrogeologic, and regulatory evaluations suggest favorable ASR feasibility in the Upper Aquifer. Based on the technical analysis presented in this feasibility study, GSI Water Solutions, Inc. (GSI), recommends proceeding with the next steps of the project: ASR permitting, design, and construction tasks; and ASR pilot testing.

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1 Introduction

The City of Prineville (City) has been has been proactively exploring opportunities to cost effectively meet the City's peak municipal water demand and increase the long-term resiliency of its water supply. Aquifer storage and recovery (ASR) is a water management tool that that the City can use to achieve these objectives. A City ASR system would store water in an airport area aquifer (Study Area) by artificially recharging the existing Heliport Production Well during periods of low water demand (typically winter). The stored water will be available for recovery and use during periods of high water demand (typically summer). The water sources for ASR are (1) a new shallow alluvial wellfield on the south side of Prineville that the City is evaluating, and (2) the City's existing production wells in the Prineville Valley. Locations of the new shallow alluvial wellfield, existing production wells in the Prineville Valley, the Heliport Production Well (ASR Well), and the Study Area are shown in Figure 1.

1.1 Purpose and Objectives

This ASR feasibility study (FS) is part of the City's ongoing ASR assessment project for the airport area aquifer. The purposes of this report are to (1) evaluate the feasibility of ASR in the Study Area, and (2) summarize key information required in an application for an ASR limited license from the Oregon Water Resources Department (OWRD). The report objectives include:

- Summarize the geology and hydrogeology of the Study Area, including the geologic and hydrogeologic units, aquifer properties (e.g., transmissivity), and aquifer characteristics (e.g., depth to groundwater).
- Assess the suitability of the Study Area for ASR based on performance of existing wells, aquifer properties, and aquifer characteristics.
- Estimate the volume of water that can be stored in the aquifers in the Study Area.
- Evaluate the potential for adverse impacts to other wells as a result of ASR (e.g., an unacceptable amount of water level buildup in other wells).
- Evaluate source water and native groundwater quality, including the geochemical compatibility between source water and native groundwater, and whether source water quality meets ASR standards.
- Evaluate groundwater and surface water conditions for basing recovery estimations.

1.2 ASR Feasibility Project Scope

ASR projects commonly are divided into three phases: Phase 1 - ASR Feasibility Study, Phase 2 - ASR Pilot Testing, and Phase 3 – Expansion and Full-Scale Operation. This report documents Phase 1 of ASR implementation, and is designed to provide the City with key information needed to:

- Identify potential fatal flaws to ASR development in the Study Area.

- Submit an ASR limited license application to OWRD.
- Identify factors determining the approximate water volume that the ASR system will store.
- Identify key uncertainties to address.

After receiving an ASR limited license from OWRD, the City intends to implement Phase 2 of ASR (i.e., ASR pilot testing) to test and demonstrate ASR feasibility in the Study Area.

The ASR FS for the Study Area is organized into the following sections:

Section 1 – Introduction.

Section 2 – Hydrogeologic Characterization. Review available information about the geology of the Study Area, including surficial geologic maps, geologic cross sections, publications from the U.S. Geological Survey (USGS), and reports by consultants. Based on the geologic information, characterize the hydrogeology of aquifers in the Study Area (including aquifer properties and aquifer characteristics) to provide the basis for evaluating ASR.

Section 3 – Source Water and Native Groundwater Quality and Compatibility. Evaluate source water and native groundwater quality data to understand whether the water quality meets ASR or drinking water regulatory standards, and to assess the potential for adverse chemical reactions to occur as a result of mixing source water and native groundwater in the aquifer.

Section 4 – Source Water Availability. Review the sources of water available to supply water for recharge, and assess the amount of water that may be available for recharge.

Section 5 – ASR Feasibility Evaluation. Evaluate the feasibility of ASR based on the hydraulic properties of the aquifer, performance of existing wells, depth to groundwater, likely volume of water that can be stored and recovered, potential adverse impacts to existing wells (e.g., unacceptable water level build-up), well construction issues, and compatibility between source water and native groundwater.

Section 6 – Permitting Requirements. Identify required permits for ASR, fatal flaws associated with obtaining the permits (if any), and the schedule for obtaining the permits.

Section 7 – Conclusions and Recommendations. Discuss conclusions of the ASR FS, and present recommendations for proceeding with the project.

2 Hydrogeologic Characterization

This section presents a hydrogeologic characterization of the Study Area, which is a required component and application for an ASR limited license[1]. The hydrogeologic characterization is based on previous geologic and hydrogeologic reports by GSI Water Solutions, Inc. (GSI), Newton Consultants, Inc.; Oregon Department of Geology and Mineral Industries (DOGAMI); OWRD; and USGS.

2.1 Physical Setting

The City is planning to implement ASR using an aquifer located in the Study Area, which is a plateau located southwest of Prineville as shown on Figure 1. The topographic relief in the Study Area ranges from approximately 3,260 feet above mean sea level (amsl) within the level areas surrounding the Prineville Airport to about 3,600 feet above amsl at the peak of Grass Butte and Meyers Butte, two volcanic vents at the edges of the plateau. The Crooked River Canyon, located in the valley to the east and north of the Study Area, ranges from 2,920 feet amsl upstream of the City to 2,820 feet amsl downstream of the City. The Study Area is arid, with an average annual rainfall of 9.89 inches per year based on climate data from 1897 to 2012 (WRCC, 2018).

Most of the Study Area is undeveloped, with the exception of rural homes, the Prineville Airport, Crook County Landfill, data centers, and industrial manufacturing warehouses. The risk of the aquifers in the Study Area being contaminated by surficial sources of contamination is relatively low because of the deep water table in the Study Area (more than 400 feet below ground surface [bgs]). The City can further minimize aquifer contamination risk by tracking the types of industrial activities in the Study Area and their potential for being a contaminant source to the drinking water aquifer.

2.2 Geology of the Study Area

The Study Area is located on the northeastern flank of a large topographic paleo-basin known as the Upper Deschutes Basin. Locally, the bottom and sides of the basin are composed of old, low permeability tuffs, ash deposits, and fine sedimentary rock (called basement rock in this report). The basin is filled by unconsolidated sediments and volcanic rock (called basin-fill deposits in this report).

A generalized geologic map of the Prineville area is provided in Figure 2. Cross sections showing the basement rock and basin-fill deposits are provided in Figure 3 (A to A’) and Figure 4 (B to B’). The location of the cross section lines are shown in Figure 2. The following sections describe the significant geologic units and geologic structure in the Study Area.

---

[1] See Oregon Administrative Rule (OAR) 690-350-0020(3)(b)(C)

2.2.1 Geologic Units

Geologic units are packages of rock or soil that have distinctive features. The following sections describe the geologic units in the Study Area and adjacent valley from oldest to youngest.

Basement Rock

The basement rock is the low permeability material that is located below the regional groundwater system. Unlike other portions of the Deschutes Basin, in Prineville the basement rock is found at relatively shallow depths (as part of an old caldera structure) and rises to land surface on the eastern side of the Prineville Valley (the edge of the older Ochoco Mountains). From oldest to youngest, the basement rock is composed of the John Day Formation and Simtustus Formation.

John Day Formation

The John Day Formation is composed of volcanically derived fine-grained tuff, ignimbrite, and ash deposited between 22 and 39 million years ago. Local examples of the John Day Formation include the rock formations at Smith Rock State Park, the rocks that make up Powell and Barnes Buttes, and the Ochoco Mountains northeast of the City (see Figure 2). This formation is characterized by a very low-permeability resulting from weathering and alterations of the original deposits, and does not contain significant water production zones; therefore, it forms the hydrologic basement for the regional groundwater system (Gannett et al., 2001; Gannett and Lite, 2003).

Simtustus Formation

The Simtustus Formation is a local deposit of fine-grained, water-lain tuffs, sandstones, and mudstones deposited between 12 and 15 million years ago. The fine-grained fluvial sedimentary deposits of this formation generally do not contain significant water production zones; therefore, it is considered to be part of the deposits that form the hydrologic basement of the regional groundwater flow system (Smith, 1985).

Basin-Fill Deposits

Following a period erosional activity between 15 and 9 million years ago, the Upper Deschutes Basin near Prineville was filled with sedimentary, volcanic, and alluvial deposits. From oldest to youngest, the basin fill deposits include the Deschutes Formation and recent alluvial deposits.

Prineville Basalt Formation

The Prineville Basalt Formation consists of lava flows that originated from one or more vents near Prineville between 15.6 and 15.8 million years ago (Smith, 1985). The source vents are exposed near Bowman Dam (10 miles southeast of the City) and in the Crooked River Canyon south of the City (see Figure 2). The Prineville Basalt is found beneath the western portion of the Study Area. Although the Prineville Basalt has the ability to transmit groundwater (Gannett et al., 2001), it is generally found above the local and regional water tables within them Study Area and is unsaturated.

Deschutes Formation

Volcanic activity in the Deschutes Basin surged between approximately 4 and 9 million years ago, rapidly filling the basin with interlayered sedimentary and volcanic deposits collectively known as the Deschutes Formation (Sherrod et al., 2004). As shown on the geologic map (Figure 2) and cross sections (Figure 3 and Figure 4), the Deschutes Formation is the primary geologic unit above the basement rock in the Study Area. The basalts and sediments of the Deschutes Formation exhibit a complex nature and extent caused by erosion and filling of canyons over time, and formation of volcanic vents. As shown in Figure 3, the ancestral Crooked River flowed through the Study Area and appears to have eroded a deep canyon extending into the basement rock of the Simtustus and John Day Formations (called the ancestral canyon in this report). McKay Creek, originating in the Ochoco Mountains, also incised a canyon through the basement rock to reach the ancestral Crooked River. After the erosional period ended, the canyons began filling in with Deschutes Formation age lava flows and alluvial deposits. At some point during the early portion of the Deschutes Formation depositional period, one of the many local volcanic vents (such as Meyers Butte and Round Butte [located north of the Study Area]) plugged the northern end of the ancestral canyon with basalt, forcing the ancestral Crooked River to move northeast into its current location. Following the shift, the ancestral canyon subsequently was filled with younger Deschutes Formation sediments and lava flows.

Near the Heliport Production Well, which the City plans to use as the initial ASR well, the eastern and western edges of the ancestral canyon have been reasonably well defined. The eastern edge of the ancestral canyon is located on or near the Facebook property (about 1 mile northeast of the Heliport Production Well). Facebook owns one production well that is completed within the ancestral canyon. However, several exploratory borings drilled just east of that well were either dry or produced very little water, and encountered basement rock at much higher elevations, indicating that the exploratory borings were located outside of the ancestral canyon. The western edge of the ancestral canyon is located about ¾ mile southwest of the Heliport Production Well, based on the geologic deposits that were logged in the exploratory boring at the City's water tank.

Recent Alluvial (Quaternary) Deposits

Approximately 3 million years ago, changes in the regional tectonic forces began a significant amount of regional uplift, again creating a period of erosional activity that resulted in deep channels being incised into the basement rock beneath the current Prineville Valley. Following this erosional event, sedimentary deposits began refilling the deeply eroded channels. From about 1.6 million years ago until present day, three distinctive sedimentary units were deposited in these deeply eroded channels. As shown in Figure 3, from oldest to youngest, the sedimentary units are (Robinson and Price, 1963):

- Lower Sand and Gravel (QTs3)
- Fine-Grained Deposits (QTs2)
- Upper Sand and Gravel (QTs1), which include terrace deposits, landslide deposits, and recent alluvial system deposits.

The groundwater system in the Prineville Valley is found within these recent alluvial deposits. The QTs3 is relatively permeable[2] and is typically under artesian pressure. The QTs2 has a much lower permeability relative to the other alluvial deposits and likely acts as a confining to semi-confining layer to the QTs3. GSI interpreted the Upper Sand and Gravel, terrace deposits, landslide deposits, and recent alluvium overlying QTs2 to be a single geologic unit (QTs1), which is saturated to varying degrees depending on location. The recent alluvial deposits are located in the Prineville Valley and, therefore, are separate from the Study Area. However, the wells that will provide source water for ASR will appropriate water from these deposits (i.e., within the QTs3 and QTs1).

2.2.2 Geologic Structure

Geologic structures in the Study Area include faults and volcanic vents (i.e., Grass Butte and Meyers Butte). These structures are important to evaluating fatal flaws for ASR because faults can form barriers to the lateral and vertical movement of groundwater, and volcanic vents can locally reduce aquifer permeability.

Faults

Two faults have been identified in the northern portion of the Study Area near Meyers Butte (Ferns and McClaughry, 2006). These faults are northwest and northeast trending normal faults. The faults are located outside of the ancestral canyon and, therefore, are not likely to influence groundwater movement and ASR operations in the Study Area because the aquifers in the Study Area are located within the ancestral canyon and isolated from the effects of these faults.

Volcanic Vents

Grass Butte and Meyers Butte are two prominent volcanic vents in the Study Area. Meyers Butte formed 5.42 million years ago (McClaughry et al., 2009). Molten rock pushing up through the Deschutes Formation resulted in surface lava flows extending from the vents. The high temperature of the molten rock passing through the existing rock and sediments, combined with the associated hydrothermal alterations, could create a halo of reduced permeability near the vents and their feeder dikes. The volcanic eruptive centers are not located close to the proposed ASR well (i.e., the Heliport Production Well) and, therefore, are not likely to influence groundwater movement and ASR operations.

2.3 Hydrogeology of the Study Area

The aquifers within the Study Area occur in the ancestral canyon's deeper Deschutes Formation deposits; the Deschutes Formation outside of the ancestral canyon does not transmit significant quantities of groundwater and, therefore, is not included in this evaluation of hydrogeology in the Study Area.

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[2] See Appendix A for transmissivity of the QTs3.

2.3.1 Hydrogeologic Units

A hydrogeologic unit is a package of rock or soil that, because of its porosity or permeability, has a distinct influence on the storage or movement of groundwater. Drilling data and long-term water level monitoring show that there are two hydrogeologic units in the ancestral canyon: the Lower Aquifer and the Upper Aquifer. Groundwater elevations in the Lower Aquifer are approximately 50 feet higher than groundwater elevations in the Upper Aquifer, indicating that the Upper Aquifer and Lower Aquifer are hydraulically separate aquifers. All large production wells (water production rates greater than 200 gallons per minute [gpm]) in the Study Area are located in these hydrogeologic units[3].

The Upper Aquifer and Lower Aquifer are shown in the Figure 3 and Figure 4 cross sections. The areal extents of the Lower Aquifer and Upper Aquifer are shown in Figure 5. The Lower Aquifer is stratigraphically below the Upper Aquifer.

Lower Aquifer

The Lower Aquifer is located at the base of the ancestral canyon and is composed of a silty clayey sand and gravel (composed of basalt) and possibly a fractured basalt near the Prineville Airport and a fine sand and gravel in the southern part of the Study Area (i.e., in well CROO 52461, located approximately 3 miles to the south). The lower aquifer contains moderate groundwater production capacity (existing wells yield up to 300 gpm) and is characterized by an elevated groundwater temperature (68 to 70 degrees Fahrenheit [°F])[4].

The Millican Well (CROO 53956), Runway Well (CROO 53969, now abandoned), Facebook Well (CROO 53878), and Linhares/Raasch domestic well (CROO 52461) are completed in the Lower Aquifer. The Lower Aquifer is confined, based on the low storage coefficients ($1.7x10^{-4}$ and $5.7x10^{-7}$) and static water levels above the top of the lithology that comprises the aquifer[5].

Upper Aquifer

The Upper Aquifer is a permeable coarse sand and gravel deposit that represents the ancestral Crooked River's alluvial channel deposits. The City's Airport 1 Well, Airport 2 Well, and Heliport Production Well are completed in a sequence of Upper Aquifer sand and coarse gravel deposits that is more than 100 feet thick. Two of the City's production wells in the Upper Aquifer produce up to 1,100 gpm.

The Upper Aquifer exhibits characteristics of confined and unconfined aquifers. Unconfined characteristics of the Upper Aquifer include the high storage coefficient (0.14 to 0.23). Confined characteristics of the Upper Aquifer include observations during drilling of the

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[3] Other wells drilled outside of the ancestral canyon are located in fine-grained, low-permeability alluvial or volcanic deposits. These wells either did not encounter groundwater or have minimal groundwater production capacity (generally on the order of a few to tens of gallons per minute is reported on well logs).

[4] The Heliport Production Well was drilled into the fractured basalt of the Lower Aquifer, and water levels in the borehole rose 50 feet and water temperature increased. Based on driller logs, the temperature of groundwater in the Facebook Well is 71°F, the temperature of groundwater in the Runway Well is 62°F, and the temperature of groundwater in the Millican Well is 61°F.

[5] See wells CROO 52461, CROO 53956, and CROO 53878.

Heliport Production Well (specifically, a water-bearing zone was encountered at 470 feet bgs and the static water level in the zone was 435 feet bgs, indicating that the water-bearing zone was under pressure). High-quality data collected during ASR cycle testing (e.g., high-resolution water level data from pumping and observation wells[6]) will be used to further evaluate whether the Upper Aquifer is confined or unconfined.

2.3.2 Groundwater Levels and Trends

Groundwater elevations in the Study Area range from 358 feet bgs[7] to 448 feet bgs[8]. This is an approximately 90 feet difference in elevation between the highest and lowest groundwater elevations.

Generally, groundwater levels in the Study Area have been declining over time. GSI (2016) summarized water level trends in the Lower Aquifer and Upper Aquifer for a 3-year period from 2012 to 2015, and found that water levels in the Lower Aquifer declined less than 1 foot per year[9], and water levels in the Upper Aquifer declined less than 3.5 feet per year[10]. These static water level declines can be observed in Figure 6 (Heliport Production Well, Upper Aquifer) and Figure 7 (Millican Well, Lower Aquifer). The water level declines correlate to both a decrease in precipitation in the Study Area and an increase in annual groundwater production from the Upper Aquifer and Lower Aquifer. Central Oregon has experienced a drying trend since the 1950s, and more recently a drying trend in the Prineville Valley starting in 1998 correlates closely with the declining water levels in the Upper Aquifer (GSI, 2016). It is currently unclear to what extent these identified factors are contributing to the observed water level declines.

2.3.3 Aquifer Properties (Transmissivity, Hydraulic Conductivity, Storativity)

Aquifers are characterized by hydraulic properties, including transmissivity (which is the rate at which groundwater is transmitted through a unit width of an aquifer under a unit hydraulic gradient), hydraulic conductivity (which is the transmissivity divided by the aquifer thickness), and storativity (which is the volume of water an aquifer releases from, or takes into, storage per unit surface area of the aquifer per unit change in head). Because aquifer properties are scale-dependent (Bear, 1972), aquifer properties measured at the wellfield-scale and at the regional-scale in the Study Area are presented in this section.

Wellfield-Scale Aquifer Properties

The City completed a long-term pumping test at the Millican Well (completed in the Lower Aquifer) and Heliport Production Well (completed in the Upper Aquifer) during the summer of 2015. This testing was conducted as part of the City's long-term water level monitoring

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[6] During the Heliport Production Well pumping test in 2015 (GSI, 2016), groundwater elevation in the Airport 2 Well was measured only daily. Higher-resolution measurements can be used to determine whether the Airport 2 Well exhibits a delayed response to Heliport Production Well pumping (which may be indicative of unconfined conditions) or a near-instantaneous response to Heliport Production Well pumping (which may be indicative of confined conditions).

[7] CROO 53361, the Houston Lake Road Well.

[8] CROO 532, the Ryan Well.

[9] Based on water level declines in the Runway Well (0.6 foot per year) and the Linhares-Raasch Well (0.73 foot per year).

[10] Based on water level declines in Airport 2 Well (3.4 feet per year).

program of the aquifers in the Study Area. The results of the water level study and pumping tests were used to refine the understanding of the two aquifers and develop aquifer properties for each unit. The results are summarized in the *Groundwater Hydrology of the Prineville Airport Area Aquifer System – 2016 Update Report,* (GSI, 2016)

During the summer 2015 pumping, the City monitored water levels in the each of the two pumping wells and several other nearby water wells. As the cone of depression during the pumping test extended outward from the pumping well, it encountered the edge of the ancestral canyon (negative boundary), which was observed in the water level datasets with an abrupt change in the slope. This negative boundary (i.e., increased rate of drawdown with time) was encountered during the tests, likely related to the fact that both the Lower and Upper Aquifers are situated in an ancestral canyon[11]. Wellfield-scale aquifer properties from the tests are summarized in Table 1, and all aquifer testing results are presented in Appendix A.

Regional-Scale Aquifer Properties

Regional-scale aquifer properties are from the numerical groundwater model of the Study Area. The transmissivity of the Upper Aquifer was determined by matching model-simulated conditions to observed conditions based on testing of the Heliport Production Well in 2011 (GSI, 2013). The transmissivity of the Lower Aquifer was determined by matching model-simulated drawdown and observed drawdown in the Runway Well and Linhares-Raasch Well during the 2015 Millican Well pumping test (GSI, 2016). Regional-scale aquifer properties from the tests are summarized in Table 1, and all aquifer testing results are presented in Appendix A.

2.3.4 Estimated Groundwater Flow Direction and Velocity

The groundwater flow directions in the Lower Aquifer and Upper Aquifer mimic the slope of the ancestral canyon, flowing from south to north-northwest. The average linear velocity of groundwater in the Lower Aquifer and Upper Aquifer was calculated using Darcy's Law:

$$v = \frac{K}{\eta_e} \nabla h \tag{1}$$

where:

v = average linear groundwater velocity (feet per day or ft/d),
K = hydraulic conductivity (ft/d),
η_e = effective porosity (dimensionless), and
∇h = the horizontal hydraulic gradient (feet per foot or ft/ft).

The following sections summarize the assumptions that were used to calculate the average linear groundwater velocity in the Upper Aquifer and Lower Aquifer.

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[11] See Appendix C of GSI (2016)

Lower Aquifer

The average linear groundwater velocity in the Lower Aquifer was estimated based on the following assumptions:

- Hydraulic conductivity is 570 ft/d (Table 1).
- The horizontal hydraulic gradient is 0.00136 ft/ft under ambient (non-pumping) conditions (from the numerical groundwater model of the Prineville area documented by GSI [2016]).
- The effective porosity of the basalt is 0.08 (based on the specific yield of a "young basalt" on Heath [1983, page 9]).

Using Equation (1), the average linear groundwater velocity in the Lower Aquifer under ambient (non-pumping) conditions is about 9.7 ft/d (3,537 feet per year).

Upper Aquifer

The average linear groundwater velocity in the Upper Aquifer was estimated based on the following assumptions:

- Hydraulic conductivity is 100 ft/d (Table 1).
- The horizontal hydraulic gradient is 0.00255 ft/ft under ambient (non-pumping) conditions (from the numerical groundwater model of the Prineville area documented by GSI [2016]).
- The effective porosity of the coarse sand and gravel is 0.185 (based on the specific yield measured during the Heliport Production Well aquifer test, see Table 1).

Using Equation (1), the average linear groundwater velocity in the Upper Aquifer under ambient (non-pumping) conditions is about 1.4 ft/d (about 503 feet per year).

2.3.5 Specific Capacity

Pumping rate and drawdown measurements can be used to calculate a hydraulic parameter called specific capacity, which reflects well performance and aquifer transmissivity, and is used to evaluate the ASR potential of an aquifer. Specific capacity (*SC*) is calculated by dividing the pumping rate (*Q*) by the drawdown (*s*) as follows:

$$SC = \frac{Q}{s} \tag{2}$$

where:

SC = specific capacity in gallons per minute per foot of drawdown (gpm/ft)
Q = the pumping rate in gallons per minute (gpm)
s = the drawdown in the well in feet (ft) at that pumping rate

The higher the specific capacity, the more productive the well and the higher the aquifer transmissivity. Although specific capacity varies with pumping rate, duration of pumping, and well construction, it is still a reasonable approximation of the aquifer response that is anticipated from recharge and recovery during ASR.

Specific capacities in the Study Area are shown in Figure 8. GSI included specific capacity data in Figure 8 if there was measureable drawdown during the test (i.e., several well tests in the Study Area report no drawdown during the test, but the lack of drawdown is likely caused by the pumping rate not being sufficiently high). Specific capacities at wells completed in the Upper Aquifer are 15 to 60 gpm/ft of water level change; specific capacities in the Lower Aquifer range from 1.5 to 3.0 gpm/ft of water level change. Specific capacities of sediments outside of the ancestral canyon are generally less than 1 gpm/ft of water level change.

2.4 Relative ASR Potential of the Upper Aquifer and Lower Aquifer

Based on the lower specific capacity and transmissivity of wells completed within the Lower Aquifer[12], it appears likely that the storage potential of the Upper Aquifer is substantially higher than the Lower Aquifer, and that the sediments outside of the ancestral canyon have no potential for ASR. As such, the remainder of this evaluation is focused on the water quality characteristics and storage potential of the Upper Aquifer. Additional exploration of the Lower Aquifer may be warranted as a location for supplemental groundwater storage as ASR pilot testing proceeds. Specifically, it may be possible to develop future ASR capacity within the Lower Aquifer near ASR wells targeting the Upper Aquifer to vertically "stack" groundwater storage that could leverage ASR infrastructure investments.

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[12] The specific capacity of the Millican Well (CROO 53956) is 3.1 gpm/ft (based on 110 feet of drawdown observed while pumping the well at 340 gpm for 120 hours); the specific capacity of the Facebook Well (CROO 53878) is 1.52 gpm/ft (based on 223 feet of drawdown while pumping the well at 340 gpm for 120 hours).

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3 Source Water and Native Groundwater Quality and Compatibility

This section presents an evaluation of source water and native groundwater quality and compatibility in the Upper Aquifer based on groundwater quality samples[13]. GSI evaluates groundwater quality by comparing the concentration of groundwater constituents to regulatory standards (i.e., maximum contaminant levels [MCLs] and secondary MCLs [SMCLs]), and evaluates groundwater compatibility using the geochemical speciation model PHREEQC completed by subcontractor S.S. Papadopulos & Associates Inc., (refer to summary memorandum in Appendix C).

In summary, based on the water quality data available and the geochemical mixing evaluation completed, there are no detrimental water quality changes predicted to be caused by operations of an ASR system and the planned water treatment of the new alluvial source water for manganese, iron, and ammonia will minimize any small amount of potential precipitates within the aquifer that might occur without treatment of the water.

3.1 Native Groundwater

A sample of native groundwater was collected from the Heliport Production Well on June 1, 2017, and submitted to the Neilson Research Corporation in Medford, Oregon, for analysis. The sample was analyzed for the constituents required by the ASR administrative rules under OAR 690-350-0020(3)(b)(F), for constituents required for design of a wastewater treatment plant, and for constituents required for a geochemical mixing analysis. The laboratory analytical results are presented in Table 2, and laboratory analytical reports are provided in Appendix B.

3.1.1 Water Quality

Native groundwater at the Heliport Production Well is of good quality. The concentration of total dissolved solids (TDS; 198 milligrams per liter [mg/L]), which is a measure of inorganic salt and organic matter content of the water, is sufficiently low to be considered “excellent” by the World Health Organization (WHO, 1996). The water is considered moderately hard (97.5 mg/L hardness) (WHO, 2011) and has an alkalinity of 147 mg/L. The pH is slightly basic (about 8 standard units), the water is aerobic (dissolved oxygen of 7.93 mg/L), and the temperature is relatively warm (20 degrees Celsius [°C]). The water has no color, no odor, and is non-corrosive (Langelier Index, an indicator of the degree of saturation of calcium carbonate in water, is a near neutral -0.05).

Constituent concentrations were below the applicable drinking water regulatory criteria in the native groundwater (i.e., MCLs and SMCLs). Therefore, the native groundwater at the Heliport Production Well is suitable for use as drinking water.

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[13] Required by OAR 690-350-0020(3)(b)(D), OAR 690-350-0020(3)(b)(F), and OAR 690-350-0020(3)(b)(G).

3.1.2 Mineral Stability

The geochemical speciation model PHREEQC was used to assess the equilibrium state of the native groundwater with respect to common minerals associated with basalt aquifers. The analysis is used to evaluate whether the water is undersaturated, supersaturated, or at equilibrium with respect to particular minerals. The saturation index (SI) is a measure of the chemical driving force available for mineral precipitation or dissolution reactions. Undersaturation ($SI < 0$) indicates a tendency for a mineral to dissolve into the water, if present in the subsurface. Supersaturation ($SI > 0$) indicates a tendency for a mineral to precipitate out of the water. At equilibrium, the water would not tend to either dissolve or precipitate the mineral. An understanding of the equilibrium state of a natural water provides insight on the geochemical controls on water composition and possible changes to expect when recharge water and native groundwater are mixed. The calculated SI values for common rock-forming minerals in the native groundwater samples are summarized in Appendix C.

The native groundwater is supersaturated (i.e., tendency to precipitate rather than dissolve) with respect to dolomite (SI=1.1), quartz (SI=1.3), and chalcedony (SI=1.0). Supersaturation with respect to these minerals is not uncommon and does not necessarily indicate that precipitation is occurring. Although these minerals have positive SI values, it is unlikely that quartz and chalcedony will precipitate because the precipitation kinetics are extremely slow at ambient temperatures. In addition, the precursor to quartz is amorphous silica, which has negative SI values. It is also unlikely that dolomite will precipitate because its precipitation is kinetically inhibited because of the large nucleation energy required to form new minerals. (SI values required for nucleation range from 1.3 to 2.5).

3.2 Source Water

Source water for the ASR project will be taken from the City’s municipal conveyance system on the north side of the City and will be piped to the Heliport Production Well. The water in the City’s conveyance system will be some combination of the following waters:

- **Groundwater from existing alluvial wells in the Prineville Valley.** The City holds water rights and produces groundwater from several alluvial wells in the Prineville Valley. The wells are completed in the Lower Sand and Gravel (QTs3). Because some of the alluvial wells are not connected to the City distribution system or are considered an emergency back-up well (e.g., 4th Street Shallow Well), only six of the City’s existing wells connected to the City’s conveyance system will be used to provide source water for ASR. These six wells are shown in Figure 9. The City collected a sample of groundwater from these wells on November 8, 2017 (called the “City Conveyance System” sample in Table 2 because the sample was collected from the conveyance system on the north side of the City).
- **Groundwater from a new shallow alluvial wellfield.** The City plans to install a new groundwater wellfield in alluvial sediments adjacent to the Crooked River on the south side of the City (see Figure 9). The wells will be completed in the Upper Sand

and Gravel (QTs1). The City identified a shallow water-bearing zone and a deeper water-bearing zone during the wellfield investigation. As a result, the City will install both shallow wells (total depth of up to 40 feet bgs), and deeper alluvial wells (total depths up to 80 feet bgs) as part of this new wellfield.

Shallow Aquifer Test. The City installed a shallow test well at the future wellfield site and collected samples of shallow groundwater on each day of a 5-day aquifer test (five samples total). Samples collected on the first day of the aquifer test (January 18, 2018) and the last day of the aquifer test (January 23, 2018) were analyzed for a full suite of analytes. Groundwater samples collected on Day 2, Day 3, and Day 4 of the aquifer test were analyzed for anions and cations for geochemical analysis purposes.

Deep Alluvial Aquifer Test. The City installed a well in the deeper zone and collected samples of deep groundwater on each day of a 5-day aquifer test (five samples total). Samples collected on the first day of the aquifer test (on January 24, 2018) and on the last day of the aquifer test (on January 29, 2018) were analyzed for a full suite of analytes. Groundwater samples collected on Day 2, Day 3, and Day 4 of the aquifer test were analyzed for anions and cations for geochemical analysis purposes.

All water samples were submitted to Box R Water Analysis Laboratory (Prineville, Oregon) for analysis, and were analyzed for the constituents required by the ASR administrative rules under OAR 690-350-0020(3)(b)(D), for constituents required for design of a wastewater treatment plant, and for constituents required for geochemical mixing analysis. The laboratory analytical results are presented in Table 2.

3.2.1 Water Quality

The following sections discuss the quality of groundwater from the existing alluvial wells, and shallow and deep test wells (i.e., new alluvial groundwater source). Laboratory analytical reports are provided in Appendix B.

Existing Prineville Valley Alluvial Wells

Groundwater from the City's distribution system is of good quality. The TDS concentration (237 mg/L), which is a measure of inorganic salt and organic matter content of the water, is sufficiently low to be considered "excellent" by the World Health Organization (WHO, 1996). The water is considered moderately hard (114 mg/L hardness) (WHO, 2011) and has an alkalinity of 173 mg/L. The pH is neutral (about 7.6 standard units), the water is aerobic (dissolved oxygen of 7.58 mg/L), and the temperature is relatively cool (14°C). The color of the water (10 color units [CUs]) is below the U.S. Environmental Protection Agency (EPA) SMCL of 15 CUs, and the odor (4 threshold odor numbers [TONs]) is slightly above the EPA SMCL of 3 TONs. Because the Langelier Index is positive (0.14), the water is noncorrosive.

With the exception of odor, constituent concentrations were below the applicable ASR standards for source water (i.e., the SMCL or one half of the MCL). Odor slightly exceeds the SMCL; however, the water is still suitable for ASR because slight odor exceedances are unlikely to result in odor exceedances in recovered water, and are unlikely to impair the beneficial use of native groundwater in the Heliport Production Well.

New Shallow Alluvial Wellfield Source — Shallow Zone

The water quality analysis for the new shallow alluvial groundwater zone evaluates the quality of the Day 5 sample because it is more representative of source water quality during ASR. The TDS concentration in the new shallow groundwater source (not detected) is sufficiently low to be considered "excellent" by the World Health Organization (WHO, 1996). The water is considered moderately hard (129 mg/L hardness) (WHO, 2011) and has an alkalinity of 231 mg/L. The pH is neutral (about 7.7 standard units), the water is aerobic (dissolved oxygen of 8.6 mg/L), and the temperature is relatively cool (12°C). The color of the water (14 CUs) is below the EPA SMCL of 15 CUs, and the odor (17 TONs) is above the EPA SMCL of 3 TONs. Because the Langelier Index is positive (0.40), the water is noncorrosive.

With the exception of odor, turbidity, iron (total), and manganese (total), constituent concentrations were below the applicable ASR standards for source water (i.e., the SMCL or one half of the MCL). Source water treatment will be used to reduce odor, turbidity, iron (total), and manganese (total) to below ASR standards before recharge.

Toluene was detected in the Day 1 sample at a concentration of 0.94 microgram/liter (µg/L), but was not detected in the Day 5 sample. The Day 1 toluene concentration is below the ASR standard of 500 µg/L, but any toluene in source water would not be allowed under Oregon Department of Environmental Quality's (DEQ) groundwater protection rules because toluene would impair the beneficial use of groundwater as drinking water[14]. The toluene detection in the Day 1 sample likely is related to test well drilling because toluene was not detected in the Day 5 sample. However, GSI recommends that the City collect additional groundwater quality samples during treatment system pilot testing and wellfield installation for confirmation.

New Prineville Valley Alluvial Source — Deep Zone

The water quality analysis for the new deep alluvial groundwater zone evaluates the quality of the Day 5 sample because it is more representative of source water quality during ASR. The TDS concentration in groundwater from the deep test well (238 mg/L) is sufficiently low to be considered "excellent" by the World Health Organization (WHO, 1996). The water is considered soft (51 mg/L hardness) (WHO, 2011) and has an alkalinity of 164 mg/L. The pH is slightly basic (about 8.3 standard units), the water is anaerobic (dissolved oxygen of 0.53 mg/L), and the temperature is relatively cool (13°C). The color of the water (12 CUs) was below the EPA SMCL of 15 CUs, and the odor (4 TONs) was slightly above the EPA SMCL of 3 TONs. Because the Langelier Index is positive (0.39), the water is noncorrosive.

With the exception of odor, constituent concentrations were below the applicable ASR standards for source water (i.e., the SMCL or one half of the MCL). Source water treatment will be used to reduce odor and address the elevated ammonia (which occurs at a relatively high concentration of 6.8 mg/L and could convert to nitrate).

Toluene was detected in the Day 1 sample at a concentration of 0.10 µg/L, but was not detected in the Day 5 sample. The Day 1 toluene concentration is below the ASR standard of

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[14] OAR 340-040-0020

500 µg/L, but any toluene in source water would not be allowed under DEQ's groundwater protection rules because the toluene would impair the beneficial use of groundwater as drinking water[15]. The toluene detection in the Day 1 sample likely is related to test well drilling because toluene was not detected in the Day 5 sample. However, GSI recommends that the City collect additional groundwater quality samples during wellfield installation for confirmation.

3.2.2 Mineral Stability

PHREEQC was used to assess the equilibrium state of the existing alluvial wells, new shallow alluvial source, and new deep alluvial source with respect to common minerals associated with alluvial aquifers. The analysis is used to evaluate whether the water is undersaturated, supersaturated, or at equilibrium with respect to particular minerals. The saturation index (SI) is a measure of the chemical driving force available for mineral precipitation or dissolution reactions (see Section 3.1.2).

Existing Prineville Valley Alluvial Wells

The groundwater from existing alluvial wells is supersaturated (i.e., tendency to precipitate rather than dissolve) with respect to dolomite (SI=0.5), quartz (SI=1.1), chalcedony (SI=0.8), pyrolusite (SI=8.1), bixbyite (SI=7.7), and hausmannite (SI=4.7). Supersaturation with respect to these minerals is not uncommon and does not necessarily indicate that precipitation is occurring. Although these minerals have positive SI values, it is unlikely that quartz and chalcedony will precipitate because the precipitation kinetics are extremely slow at ambient temperatures. In addition, the precursor to quartz is amorphous silica, which has negative SI values. It is also unlikely that dolomite will precipitate because its precipitation is kinetically inhibited because of the large nucleation energy required to form new minerals. (SI values required for nucleation range from 1.3 to 2.5). The high positive values of iron and manganese minerals pyrolusite, bixbyite, and hausmannite indicate a potential for mineral precipitation and/or biofouling by iron-related bacteria in the ASR well, and for manganese precipitation. However, the amount of precipitate is likely to be small, and will be unlikely to cause clogging in the ASR well.

New Shallow Alluvial Wellfield Sources – Shallow and Deep Zones

The groundwater from the deep and shallow new alluvial sources exhibit similar saturation indices. Both new alluvial sources are supersaturated (i.e., tendency to precipitate rather than dissolve) with respect to dolomite (SI=0.8 to 1.2), quartz (SI=1.1 to 1.2), chalcedony (SI=0.8 to 0.9), amorphous iron hydroxide (SI=3.2 to 4.2), goethite (SI=5.7 to 6.7), pyrolusite (SI=9.1 to 9.2), bixbyite (SI=9.6 to 10.0), and hausmannite (SI=7.4 to 8.4). Supersaturation with respect to these minerals is not uncommon and does not necessarily indicate that precipitation is occurring. Although these minerals have positive SI values, it is unlikely that quartz and chalcedony will precipitate because the precipitation kinetics are extremely slow at ambient temperatures. In addition, the precursor to quartz is amorphous silica, which has negative SI values. It is also unlikely that dolomite will precipitate because its precipitation is

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[15] OAR 340-040-0020

kinetically inhibited because of the large nucleation energy required to form new minerals (SI values required for nucleation range from 1.3 to 2.5). The high positive values of iron and manganese minerals amorphous iron hydroxide, goethite, pyrolusite, bixbyite, and hausmannite indicate a potential for mineral precipitation and/or biofouling by iron-related bacteria in the ASR well, and for manganese precipitation. However, the amount of precipitate is likely to be small, and will be unlikely to cause clogging in the ASR well. In addition, water from the new alluvial sources will be treated prior to recharge, which will reduce the concentrations of iron and manganese (see Section 4.2).

3.3 Comparison of Native Groundwater and Source Water

Stiff diagrams and Piper plots are provided in Figure 10 and Figure 11, respectively. The water quality data that were used to create these diagrams are provided in Table 2 and Table 3.

These diagrams illustrate the chemical signatures and water types in terms of dominant ions for native groundwater and the source waters, and are commonly used to graphically compare the chemistry of water samples. As can be seen from the shape and size of the polygon on the Stiff diagram (Figure 10), the new alluvial source waters (both shallow and deep) are significantly more mineralized than the native groundwater and source water from existing alluvial wells. In addition, the mineral content of the new alluvial source waters (both shallow and deep) throughout the 5-day aquifer test was relatively consistent. Based on the Piper plot (Figure 11), the native groundwater and City conveyance source water are a bicarbonate type water; the new alluvial sources are sodium-bicarbonate type waters.

3.4 Compatibility of Native Groundwater and Source Water

PHREEQC was used to assess the equilibrium state of a mixture of native groundwater and each alluvial source water with respect to common minerals associated with basalt and alluvial aquifers. The assessment considered multiple mixing ratios (e.g., 10 percent native groundwater and 90 percent alluvial source water, 20 percent native groundwater and 80 percent alluvial source water, etc.). A memorandum documenting the results is provided in Appendix C.

Most mixtures of native groundwater and source water are supersaturated with respect to quartz, chalcedony, dolomite, and iron, and manganese minerals (i.e., the SI values of the mixed water for these minerals are greater than zero). Therefore, these minerals have a tendency to precipitate (rather than dissolve) in the mixed water. Supersaturation with respect to these minerals is not uncommon and does not necessarily indicate that precipitation is occurring. It is unlikely that quartz and chalcedony will precipitate because the precipitation kinetics are extremely slow at ambient temperatures. In addition, the precursor to quartz is amorphous silica, which has negative SI values. It is also unlikely that dolomite will precipitate because its precipitation is kinetically inhibited because of the large nucleation energy required to form new minerals (SI values required for nucleation range from 1.3 to 2.5). The high positive values of iron and manganese minerals amorphous iron hydroxide, goethite, pyrolusite, bixbyite, and hausmannite indicate a potential for mineral precipitation and/or biofouling by iron-related bacteria in the ASR well, and for manganese precipitation. However, the amount of precipitate is likely to be small, and will be unlikely to cause clogging in the ASR well. In addition, water from the new alluvial sources will be treated prior to recharge, which will reduce the concentrations of these iron and manganese minerals (see Section 4.2).

3.5 Water Quality and Compatibility Summary

Based on the water quality data available and the geochemical mixing evaluation completed, there are no detrimental water quality changes predicted to be caused by operations of an ASR system. The planned water treatment of the new alluvial source water for manganese, iron, and ammonia will minimize any small amount of potential iron and manganese precipitates that might occur without treatment of the water.

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4 Source Water Availability

This section documents the availability of source water for ASR, which is a required component of an application for an ASR limited license[16]. In the context of an ASR limited license, source water availability means that the City has a water right to appropriate the source water, and that the amount of source water the City can appropriate exceeds water demand (i.e., the City has excess water that can be used for ASR). The City plans to use the following waters for ASR source water:

- Groundwater from the City's existing alluvial wells completed in the Lower Sand and Gravel (QTs3) of the Quaternary alluvial deposit in the Prineville Valley.
- Groundwater from a new shallow alluvial wellfield currently under development at the south end of the City. These wells are completed in the Upper Sand and Gravel (QTs1) deposits.

The City's existing alluvial wells may provide most if not all of the ASR source water for the initial cycles of ASR, while the new shallow alluvial wellfield is being installed and connected to the City's distribution system during the next couple years. However, after the new wellfield is completed, the existing alluvial wells are expected to comprise a relatively minor component of ASR source water.

The availability of source water from existing alluvial wells is documented by identifying the water rights for the wells, and by comparing the current average production from the wells to the maximum potential production. The availability of source water from the new shallow alluvial wellfield is based on the process to be undertaken by the City to obtain a groundwater right for the wells, and by providing an overview of the preliminary aquifer testing results from pilot wells that have been drilled to estimate the yield and water quality of the wellfield.

4.1 Existing Prineville Valley Alluvial Wells

The City owns and operates multiple water supply wells in the Prineville Valley to meet the community's water demands, shown in Table 4. Because several of the existing wells are not connected to the City distribution system or are considered an emergency back-up well (e.g., 4th Street Shallow Well), only six of the City's existing wells connected to the City's conveyance system will be used to provide source water for ASR, shown in Figure 9.

4.1.1 Water Rights

The water right certificates and permits that authorize appropriation of groundwater from the six existing alluvial wells in the Prineville Valley are summarized in Table 4. These water rights add up to 2,167 gpm (see "Authorized Rate" in Table 4). However, the amount of actual water supply produced by the wells is less due to limited well capacity at this time (about 1,350 gpm, see "Maximum Production Rate" in Table 4).

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[16] See OAR-690-350-0020(3)(a)(F)

4.1.2 Water Availability for ASR – Existing Prineville Valley Alluvial Wells

The estimated amount of source water that is available for ASR from the existing alluvial wells is shown in Table 5, and was estimated on the basis of the following assumptions:

- The maximum total production from the six alluvial wells is 1.94 million gallons per day (mgd) (see "Maximum Production Rate" in Table 5). The maximum total production is based on City-provided production rates for each well.
- A portion of the water that is produced is not available for ASR because it is needed to meet current average municipal water demand during the recharge period (estimated from November through March). The City's total production from November through March (151 days) from the wells that are connected to the municipal conveyance system in water year 2017 was 139.6 million gallons (MG), which equates to an average municipal demand during the recharge period of 0.92 mgd (Table 5).
- The water available for ASR from the City's existing municipal wells is the average municipal demand (0.92 mgd) subtracted from the maximum production rate (1.94 mgd), or 1.02 mgd.

Assuming that the City recharges water into the ASR well for 151 days, and 1.02 mgd of source water are available, the City's existing alluvial wells can supply a total of 154 MG for ASR each year. The estimate does not change significantly if production data from the 2015 or 2016 water year are used[17]. However, the City's existing alluvial water source is from a highly confined aquifer in Prineville valley that displays large seasonal water level fluctuations associated with the annual water demand cycles. During the high stress summer months, water levels in the Prineville valley aquifer drop, but during the winter months recharge to the aquifer is higher than the City's demands, allowing the water levels in the system to return to static conditions. Long-term additional pumping stress on this aquifer during the winter recharge period would likely upset this use and recharge balance. Therefore, this feasibility study also evaluated and identified a location in a different Prineville valley aquifer adjacent to the Crooked River for the ASR project source water that would be impact neutral.

4.2 New Shallow Alluvial Wellfield Source

The City is in the process of evaluating and planning a new shallow alluvial wellfield that will be a new municipal water source. The new wellfield is located adjacent to the Crooked River in the southern part of the City (Figure 9) and will connect to the existing City water conveyance system. The City's goal for this new wellfield is for production of up to 2,000 gpm.

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[17] Using production data from the 2015 water year, GSI estimated that 159 MG of source water are available for recharge. Using production data from the 2016 water year, GSI estimated that 165 MG of source water are available for recharge.

4.2.1 Shallow Alluvial Aquifer Evaluation

Site Investigation

In 2017, the City began actively researching locations for a new groundwater source to provide municipal water supply. Between October 2017 and January 2018 the City drilled exploratory borings to assess the subsurface geology at the identified site and installed wells for testing the aquifer. Test wells and observation wells were designed and installed on the basis of the following hydrogeologic units identified during drilling. This investigation and subsequent evaluation and documentation was completed by subcontractor Cascade Geoengineering LLC (CGE), and the full report summarizing this work is found in Appendix E. Below is a summary of CGE's investigation and results.

Shallow Water-Bearing Sand and Gravel Unit

The shallow water-bearing Sand and Gravel Unit extends from about 15 to 40 feet bgs; the static water level in the unit is about 5 feet bgs. The well network in the unit consists of:

- One test well
- Two observation wells (about 90 feet and 130 feet, respectively, from the pumping well)
- One existing shallow irrigation well (CROO 2218, about 310 feet from the pumping well)

Below the shallow water-bearing zone is a 5-foot-thick fine-grained silty/clayey layer separating the shallow zone from the deep sand and gravel water-bearing zone present from approximately 45 to 80 feet bgs.

Deep Water-Bearing Sand and Gravel Unit

The deep water-bearing Sand and Gravel Unit extends from 45 to 80 feet bgs; the static water level in the unit is about 2.5 feet bgs. The well network in the unit consists of:

- One test well
- Two observation well (about 430 feet and 950 feet, respectively, from the pumping well)

The static water levels in both water-bearing zones were identified during drilling as slightly higher than the top of the unit where water was first encountered and also continued to show this condition after the wells were completed. Water levels above the top of a water-bearing zone indicate confined or semi-confined conditions. The locations of the test and observation wells are shown in Figure 12, and the well logs for each of the new wells are included in Appendix D.

Aquifer Testing

A step-drawdown test and 5-day aquifer test were conducted on each water-bearing zone, with water level monitoring equipment in all of the new shallow and deeper alluvial wells, the existing irrigation well, and two of the City's production wells (4th Street Shallow and Deep Wells) located approximately 3,400 feet north of the test wells. The following are specifics about of the 5-day aquifer test developed by CGE:

Shallow Zone Aquifer Test (zero to 40 feet bgs)

Start 10:00 a.m. 1/18/2018
Stop 10:30 a.m. 1/23/2018
Pumping Rate = 87 gpm

Deeper Zone Aquifer Test (45 to 80 feet bgs)

Start 10:05 a.m. 1/24/2018
Stop 10:45 a.m. 1/29/2018
Pumping Rate = 102 gpm

Plots of water level drawdown versus time in the pumping wells and observation wells are provided in Appendix E. A positive boundary was encountered in the pumping wells during the shallow zone and deep zone aquifer tests[18], indicating that the cone of depression from the pumping encountered a recharge source. When a single boundary is encountered during an aquifer test, aquifer properties before the boundary are called "early-time," and aquifer properties after the boundary are called "late time." Cascade Geoengineering, LLC, calculated both the early-time and late-time transmissivity and a transmissivity for each water-bearing zone by averaging the early-time and late-time transmissivities at the pumping wells. The transmissivities are provided in Table 6.

New Shallow Alluvial Wellfield

Based on the 5-day aquifer tests of the shallow and deep Sand and Gravel Units, CGE estimated individual wells can produce up to 100 gpm and, if spaced properly, will have minimal interference with one another when operating. Based on the aquifer testing results, the wellfield design concept, at full build out, includes 10 shallow wells drilled to a maximum of 40 feet deep, and 10 deeper wells drilled and screened from 80 to 140 feet deep. The preliminary layout of the wells is shown in Figure 13, and consists of a well spacing of 100 feet (for wells completed in the same zone). The water from the new wellfield will be piped to a central location where it will undergo an appropriate level of treatment and disinfection before being added to the City's conveyance system. The City anticipates completing construction of the wells in the wellfield in phases to allow the flexibility of adding more capacity to meet City demands as needed.

It is recommended that during the future wellfield design stage of the project a more detailed evaluation of the existing data and interference analysis, and the any additional data and analyses are used to develop the final wellfield spacing and configuration.

Water Treatment for New Shallow Alluvial Wellfield Source

Based on the results of the 5-day pump test samples for both the shallow and deep wells, water treatment will be required for the manganese, ammonia, and odor. Treatment for manganese also will treat any elevated iron in the new source. Based on an equal number of shallow and deep wells, the blended water concentrations for manganese and ammonia are calculated in Table 7.

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[18] The boundary is not apparent at monitoring wells because drawdown at monitoring wells was plotted on arithmetic axes.

The blended manganese concentration is nearly twice the SMCL and the ammonia concentration would exert a free chlorine demand of nearly 50 mg/L if it were not removed. The processes that could be used for removing ammonia and manganese include:

- Aeration, biological filtration, chlorination, and manganese dioxide filtration
- Biological denitrification, aeration, chlorination, and manganese dioxide filtration
- Aeration, biological filtration, anion exchange, chlorination, and manganese dioxide filtration
- Clinoptilolite adsorption, chlorination, and manganese dioxide filtration
- Low pressure nanofiltration or RO membrane

An evaluation of these options will be provided in the basis of design report for the wellfield by JACOBS Consultancy. That document has been completed and supplied to the project team under a separate cover (Jacobs 2018).

In addition, it is recommended that treatment pilot testing is conducted on the new alluvial source to both confirm the high concentration of ammonia in the deep well, given that it is significantly higher than the Total Kjeldahl nitrogen level measured in the same sample, and refine the currently conservatively designed treatment system. It is anticipated that a pilot test will pump water from both wells for several weeks to better understand the aquifer water quality patterns over time and test the effectiveness of various treatment configurations.

4.2.2 Water Rights

The City is in the preliminary stages of developing an application for a groundwater permit authorizing the use of up to 2,000 gpm from the new wellfield for municipal use. As required by OWRD's Deschutes Basin Groundwater Mitigation Program, the City's new groundwater permit will require the submittal of groundwater mitigation credits prior to a permit being issued by OWRD. The City is in the process of establishing 5,100 mitigation credits from the U.S. Bureau of Reclamation's application S-55091 (the release of 5,100 acre-feet of stored water annually from Prineville Reservoir for downstream fish life and wildlife use). The City will use a portion of these new mitigation credits to secure the new groundwater permit from OWRD. Once the application is submitted, OWRD is expected to process the City's water rights application in 12 to 18 months.

4.2.3 Water Availability for ASR – New Shallow Alluvial Wellfield

Based on the drilling and testing investigations, the City's new wellfield is being designed for production of up to 2,000 gpm. The estimated amount of source water that is available for ASR recharge from the new wellfield source is estimated on the basis of following assumptions:

- The City's existing production capacity from the existing alluvial wells is capable of meeting the average municipal demand during the recharge period based on 2015 through 2017 water use data.

- The full production rate (up to 2,000 gpm) from the new wellfield during the recharge period (November 1 through March 31) is available for use as a source of water for ASR, further assuming the City obtains its 5,100 mitigation credits and OWRD approves the permit application for 2,000.

Assuming that the City recharges the ASR well for 151 days, and 2.88 mgd (2,000 gpm) of source water are available, the City's new wellfield source can supply a total of 435 MG for ASR recharge each year.

5 ASR Feasibility Evaluation

This section presents an evaluation of the feasibility of ASR in the Upper Aquifer. ASR feasibility in the Upper Aquifer is focused on using the Heliport Production Well as the ASR well, and considers the following key factors: aquifer properties, performance of existing wells, depth to groundwater, volume of water that can be stored, potential adverse impacts to nearby wells (i.e., unacceptable water level buildup), potential for movement of stored water (to streams or other wells), well construction considerations, and source and receiving water quality and compatibility. Based on those criteria, GSI determined the feasibility of ASR in the Upper Aquifer using the Heliport Production Well as the ASR well.

5.1 Transmissivity, Storage, and Boundaries

Transmissivity, storativity, and boundaries are important aquifer characteristics for assessing the feasibility of ASR at a particular location. Transmissivity indicates whether the aquifer can readily accept ASR source water. Storage and transmissivity indicate whether there will be a large increase or decrease in water levels in response to recharge or recovery. Boundary conditions may limit the volume of water than can be stored in an aquifer. Together these parameters are used to predict the effects of ASR recharge, and to predict water level buildup during recharge and subsequent drawdown during recovery of the ASR stored water. The following sections evaluate whether transmissivity, storage, and boundaries are favorable to ASR in the Upper Aquifer.

5.1.1 Transmissivity

The transmissivities in the Upper Aquifer range from 94,250 gpd/ft (regional-scale) to 40,000 gpd/ft (late-time, wellfield-scale) and are shown in Table 1. To evaluate ASR feasibility with respect to transmissivity both locally in the Heliport Production Well and regionally in the Upper Aquifer, GSI compared the transmissivity of the Upper Aquifer to the transmissivity of the only sedimentary aquifer in Oregon that hosts an ASR system (i.e., the Troutdale Sandstone Aquifer)[19]. The regional- and wellfield-scale transmissivity of the Upper Aquifer is an order of magnitude larger than the transmissivity in the Troutdale Sandstone Aquifer (GSI, 2006), which hosts wells capable of recharging at 550 gpm. Therefore, given the comparatively high transmissivity of the Upper Aquifer, it appears favorable to ASR at the Heliport Production Well (wellfield-scale) and throughout the Study Area (regional-scale).

5.1.2 Storage

Storage is the volume of water an aquifer releases from, or takes into, storage per unit surface area of the aquifer per unit change in head, and is called specific yield for unconfined aquifers and storativity for confined aquifers. The aquifer storage in the Upper Aquifer ranges from 0.02 (regional-scale) to 0.23 (late-time, wellfield-scale). The relatively high storage of the Upper Aquifer indicates that water level rise in response to recharge will be

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[19] The Sunrise Water Authority, located southeast of Portland, Oregon, stores water in the Troutdale Sandstone Aquifer, which consists of unconsolidated to consolidated sands.

small in areal extent, which is favorable to ASR both throughout the Study Area (regional-scale) and at the Heliport Production Well (wellfield-scale).

5.1.3 Boundaries

Negative boundaries may indicate compartmentalization of an aquifer, potentially limiting the volume of water that can be stored in the aquifer. Aquifer tests conducted in 2015 at the Heliport Production Well indicated that negative boundaries are present in the Upper Aquifer (see Appendix C of GSI [2016]), which indicates potential compartmentalization of the aquifer. However, two lines of evidence indicate that any compartments are very large and, therefore, capable of storing a large volume of water. First, the boundaries were observed long after pumping started (about 12 days after pumping started in the Upper Aquifer). Second, there is no geologic evidence for the Upper Aquifer being characterized by small-scale compartments. Specifically, no faults or other barriers to groundwater flow are evident in the Upper Aquifer based on existing geologic maps of the Study Area (see Figure 2 and Figure 5).

Based on the areal extent of the Upper Aquifer shown in Figure 5, GSI estimated that the saturated volume of the Upper Aquifer is 4.9 billion cubic feet (about 37 billion gallons)[20]. This is an order-of-magnitude estimate of saturated aquifer volume, but indicates that the Upper Aquifer is large and, therefore, favorable to storing a large volume of water using ASR.

5.2 Well Performance

In locations where detailed aquifer testing is not available, aquifer favorability for ASR can be approximated using specific capacity tests documented on OWRD well logs (see Section 2.3.5 for an in-depth discussion of specific capacity). The higher the specific capacity, the more water that can be recharged into the well. Specific capacities in the Upper Aquifer are shown in Figure 8. Specific capacity data were included in Figure 8 if there was measureable drawdown during the test (i.e., several well tests in the Study Area reported no drawdown during the test, but the lack of drawdown is likely due to the pumping rate not being sufficiently high). Specific capacities at wells completed in the Upper Aquifer are 15 to 60 gpm/ft, and indicate that the Upper Aquifer is favorable to ASR.

5.3 Depth to Groundwater

Another characteristic used to asses ASR feasibility is the depth to groundwater within the Upper Aquifer. The primary purpose of assessing depth to groundwater is based on a preference to conduct ASR recharge without groundwater levels in the aquifer rising above the ground surface. If groundwater levels rise above ground surface, then recharge will occur under pressure. Although maintaining groundwater levels below ground surface during ASR recharge is not a necessity (many ASR projects around the world conduct recharge under pressure), recharge under pressure requires upgrades to seal the wellhead and increases the potential for inducing flowing conditions at nearby wells, and is therefore a less preferable

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[20] Based on an aerial extent of 133,500,000 square feet, thickness of 132 feet porosity of 0.275 [midrange of a “sand and gravel, mixed” from Table 4.3 of Fetter (1994)].

option than maintaining groundwater levels below ground surface. Therefore, although not a critical feasibility element, depth to groundwater should be considered when siting ASR wells and evaluating ASR feasibility.

The deep groundwater table in the Upper Aquifer is favorable to ASR. At the Heliport Production Well, the groundwater table is at 435 feet bgs[21], and in the Upper Aquifer, the groundwater table ranges from 358 feet bgs[22] to 448 feet bgs[23]. The deep groundwater table, together with the high specific capacity of Upper Aquifer, indicates that large volumes of water could be recharged in the Study Area without raising the groundwater level at the ASR well above ground surface.

5.4 ASR Storage and Recovery Volumes

The volume of water that can be stored at an ASR well depends on several factors, including the length of time that water can be recharged into the well, the amount of source water that is available, the ASR well production rate, specific capacity, and available buildup in the aquifer. GSI's estimates of ASR annual storage and recovery volumes are based on the following assumptions:

- Recharge will be conducted with groundwater levels in the ASR well remaining below ground surface.
- Ninety-five percent of the stored water is available for recovery, which is the maximum percentage of stored water that OWRD will allow an applicant to initially recover under an ASR limited license. OWRD sets this percentage based on project specific information, so the recovery volume may be lower (or higher) than the assumed 95 percent used in this analysis.
- The City will recharge water continuously from November 1 through March 31 of each year.
- Recharge will occur at a rate that is approximately 75 percent of the maximum production rate during recovery, which is standard practice to ensure the ability to impart more energy during ASR recovery as a means to reduce the potential for long-term well clogging.

Based on the characteristics of the aquifers in the Study Area, the limiting factor for storage volume appears to be the maximum well production rate. Specifically, water could be recharged into the Upper Aquifer at several thousand gpm based only on source water availability[24] and well performance[25]. However, given that the recharge rate is recommended

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[21] See the driller log for CROO 54191. Measured on November 28, 2014.

[22] CROO 53361, the Houston Lake Road Well.

[23] CROO 532, the Ryan Well.

[24] As discussed in Section 4, the City's existing alluvial wells can provide about 154 MG of source water (708 gpm continuously for 151 days), and in addition, the City expects to develop a new groundwater right for up to 1,051 MG of source water (the City expects the new wells to produce 2,000 gpm; water produced from the new well will be used for municipal supply and ASR).

[25] Based on a 120-hour pumping test documented on the well log for the Heliport Production Well (CROO 54191), 26 feet of drawdown were observed at a pumping rate of 780 gpm, for a specific capacity of 30 gpm/ft. Assuming 415 feet of available headroom for water levels to rise in the well (a static depth to water of 435 feet and safety factor of 20 feet), water could be

to be no more than 75 percent of the maximum production rate (1,100 gpm at the Heliport Production Well), the maximum production rate becomes the limiting factor defining the maximum rate that water can be recharged into the Upper Aquifer. GSI developed planning-level estimates of the storage volume and recovery volume under a baseline condition using the existing Heliport Production Well configuration, and two additional scenarios that involved recharge at 2,000 gpm and 4,000 gpm using a series of hypothetical new wells. The following sections discuss the storage and recovery volumes in the Upper Aquifer under these three scenarios.

Baseline ASR Scenario

The baseline scenario includes implementing ASR using the Heliport Production Well's existing pumping rate. The Heliport Production Well produces 1,100 gpm under this scenario, based on the well yield during the summer of 2015 (GSI, 2016). Based on setting the maximum recharge rate to 75 percent of the Heliport Production Well's pumping rate of 1,100 gpm, the maximum recharge rate in the Heliport Production Well is 825 gpm. Assuming a recharge rate of 825 gpm and a recharge period of 151 days (November 1-March 31), **GSI estimates that 179 MG can be stored in the Upper Aquifer using the Heliport Production Well as the ASR well.** Because the City's ASR limited license potentially will authorize the City to recover up to a maximum of 95 percent of this volume, 170 MG of the water that is stored was assumed to be available for recovery. Storage and recovery volumes are summarized in Table 8.

This planning-level estimate of the storage capacity of the Heliport Production Well is based on historical operation of the well, and will need to be confirmed as a part of additional assessment work on the production well (i.e., potential down-hole video and bacteriological sampling), groundwater elevation analysis, and data obtained from the Cycle 1 pilot testing results.

Additional Upper Aquifer Storage Capacity Evaluation

Based on the results of the baseline ASR scenario, the Upper Aquifer likely has the capacity to store a significant volume of water because the depth to groundwater and specific capacity of the Upper Aquifer are high (indicating that water can be recharged at a high rate with relatively little buildup in the ASR well). Therefore, this study evaluated potential ASR programs that store water under two additional scenarios.

- **Scenario 1.** Recharge water into the Upper Aquifer at 2,000 gpm using a total of two ASR wells (i.e., the Heliport Production Well and one additional hypothetical well that is completed the same as Heliport Production Well and has the same local aquifer conditions). Each well recharges groundwater at 1,000 gpm and recovers stored water at 1,100 gpm. Although this scenario assumes recharge at a rate higher than the recommended 75 percent of recovery rate, it is conservative with regard to

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recharged into the Heliport Production Well at a rate of several thousand gallons per minute (because the recharge rate is found by multiplying 415 feet of available headroom by 30 gpm/ft).

potential response to recharge and recovery (because the water is recharged using fewer wells), and was selected to simplify the modeling process.

- **Scenario 2.** Recharge water into the Upper Aquifer at 4,000 gpm using a total of five ASR wells (i.e., the Heliport Production Well and four additional hypothetical wells that are completed the same as Heliport Production Well and have the same local aquifer conditions). Each well recharges groundwater at 800 gpm and recovers stored water at 1,100 gpm.

Results of the additional Upper Aquifer storage capacity evaluation are summarized in Table 8. Neither scenario results in groundwater levels rising above ground surface (i.e., both scenarios are feasible from the perspectives of the Upper Aquifer's ability to accept the recharge without adverse effects to other wells). **Under Scenario 1, GSI estimates that 434 MG can be stored in the Upper Aquifer (a storage volume of 217 MG per well)**; 412 MG can be recovered assuming OWRD allows the City to recover 95 percent of the storage volume. **Under Scenario 2, GSI estimates that 870 MG can be stored in the Upper Aquifer (174 MG per well)**; 827 MG can be recovered assuming OWRD allows the City to recover 95 percent of the storage volume.

The additional Upper Aquifer storage capacity evaluation is a planning-level estimate of the storage capacity of the Upper Aquifer based on historical operation of the Heliport Production Well. These storage volumes will need to be confirmed following additional assessment work and data obtained from the Cycle 1 pilot testing results. An evaluation of the water level rise and drawdown under each of these three scenarios is described in Section 5.5.

Heliport Production Well Current Operations

Since the Heliport Production Well began operating in 2015, the well has produced groundwater at a rate of approximately 1,100 gpm. As shown in Figure 6, pumping at 1,100 gpm in 2016 and 2017 caused the water level in the Heliport Production Well to be drawn down into the upper portion of the 135-foot-long well screen. Although this is a complex topic with multiple potential sources for a declining pumping water level as has been observed, lowering the water level into the screen interval could lead to the following undesirable conditions:

- Increased oxygenation in both the water column and in the aquifer near the well can enhance biological activity in well and in the vicinity of the well. This may create water quality problems, screen clogging, and an accelerated decline in well performance.
- Potential for acceleration of encrustation build up.
- Cascading water and air-entrainment can increase pump wear and limit pumping system efficiency.
- Increased flow velocity in the remaining open area of the well screen could cause increased drawdown due to turbulent well losses if entrance velocities are significantly exceeded.

Exposing the well screen in an ASR well adds a layer of additional risk due to possible bacterial growth problems that needs to be properly monitored and addressed, if necessary. Experience has shown that sometimes these risks can quickly contribute to negatively impact the ASR program (declines in well production and recharge capacity). Because bacterial testing of ASR wells is a standard procedure in all ASR systems with wellhead retrofits, GSI recommends that this testing be completed on the Heliport Production Well prior to the well's startup and regular use in the spring of 2018. Following bacterial sampling testing and evaluation of the results, the project team will re-assess the final design of the ASR system retrofit plans.

In addition, it was noticed that there is a potential decline in the Heliport Production Well performance since beginning operation in 2015 for unknown reasons. ASR systems potentially can affect well performance in both a negative or positive manner. Regular evaluations and well maintenance practices can manage any potential issues resulting from well performance declines well screen exposure or other causes.

Because projections about ASR capabilities have been made from the existing dataset, the Heliport Production Well's performance will need to be carefully monitored through the pilot testing cycles to determine if well performance issues (declines) might impact the ASR program objectives.

5.5 Potential Impacts to Nearby Wells

ASR recharge and recovery will cause groundwater elevations in the Study Area to change, which has the potential to adversely impact other wells in the Study Area. Potential impacts to wells were evaluated by predicting groundwater level changes in the Study Area caused by ASR using two different approaches:

- A numerical groundwater model that simulates groundwater flow in the Prineville area (GSI, 2011; GSI, 2016)[26]
- An analytical equation derived from Cooper and Jacob (1946) and Jacob (1944)

The approaches provide different predictions of groundwater level changes because the numerical model is based on regional-scale aquifer properties and the analytical equation is based on wellfield-scale aquifer properties. Together, the numerical model and analytical equation help to bracket the potential range of groundwater level changes in response to ASR.

The numerical model simulated 10 years of ASR operation; GSI used the maximum drawdown and buildup observed during the 10-year simulation as the predicted water level change. The analytical equation simulated a recharge period and a recovery period; GSI used the buildup at the end of the recharge period (151 days of recharge) and drawdown at the end of the recovery period *and* pumping under the City's native groundwater right

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[26] The USGS finite difference, block-centered groundwater flow code MODFLOW-2005.

through the end of October (May 1 through October 31; 184 days of pumping) for the predicted water level changes.

Water level predictions based on groundwater models and analytical equations do not account for the ASR well inefficiencies. Based on the 2015 summer pumping season aquifer evaluations, GSI estimated that the Heliport Production Well has an efficiency of 59 percent. The water level changes in the ASR well were adjusted for this well inefficiency to more accurately predict build up and drawdown in the ASR well. These calculations should be reassessed following collection and analysis of data from the Year 1 pilot testing program. The following sections present GSI's analysis of potential impacts to nearby wells under the baseline ASR scenario and the additional storage capacity evaluation scenarios.

Baseline ASR Scenario

The baseline ASR scenario is the same as described in Section 5.4 with the following additional assumptions:

- Aquifer properties in the numerical model are presented in Section 2 (see "Regional Scale" properties of the Upper and Lower Aquifer in Table 1).
- Aquifer properties in the analytical equation were determined on the basis of the late-time response of the Airport 2 Well during the Heliport Production Well pumping test (see "Wellfield Scale" properties for the Upper Aquifer in Table 1)[27]. Using late-time aquifer properties is conservative (because late-time transmissivity is lower than early-time transmissivity) and is representative of aquifer response to long-term pumping that will occur during ASR)[28].

Predicted water level changes in response to ASR in the Study Area are provided in Table 9. Wells completed in the Lower Aquifer are not shown in Table 9 because the numerical model predicted no water level change in the Lower Aquifer in response to ASR. The numerical groundwater model predicts smaller buildup and drawdown than the analytical equation, which is the result of higher transmissivities in the model. Note that the analytical equation cannot compute drawdowns of less than 9.53 feet during recharge and 12.7 feet during recovery due to assumptions that are required for use of the analytical equation[29].

The water level buildups in Table 9 do not indicate adverse impacts to nearby wells as a result of ASR recharge because the buildup does not exceed the ground surface within the Study Area (see Section 5.3). Therefore, the predicted water level buildups in the Study Area

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[27] The properties of the Upper Aquifer in the analytical model (hydraulic conductivity and specific yield) are based on early-time drawdown and late-time recovery in the Airport 2 Well during the Heliport Production Well pumping test (early-time drawdown data and late-time recovery data reflect conditions near the well).

[28] Because the analytical equation only estimates drawdown in a single aquifer, the Lower Aquifer properties are not variables in the equation.

[29] The Cooper Jacob equation requires that the ratio $\frac{r^2S}{4Tt}$ is less than 0.01 (Freeze and Cherry, 1979). When this requirement is violated, the equation cannot accurately predict drawdown. During recharge, the ratio exceeds 0.01 when build-up is less than 9.53 feet (i.e., at a radius of 375 feet from the Heliport Production Well). During recovery, the ratio exceeds 0.01 when drawdown is less than 12.7 feet (i.e., at a radius of 413 feet from the Heliport Production Well).

are favorable to ASR. With the exception of the Heliport Production Well, the water level drawdowns in Table 9 are small (i.e., drawdowns in vicinity pumping wells are less than 10 percent of the thickness of the Upper Aquifer)[30]. Therefore, the predicted water level drawdowns in the Study Area are favorable to ASR.

Additional Storage Capacity Evaluation Scenarios

The additional storage capacity evaluation using the previously described Scenarios 1 (injection of 2,000 gpm) and Scenarios 2 (injection of 4,000 gpm) were conducted using only the numerical groundwater model because application of the analytical equation becomes more complex when more than one ASR well is used.

Predicted water level changes in response to ASR at the Heliport Production Well under the two additional storage scenarios (recharge rates at 2,000 and 4,000 gpm, respectively) are shown in Table 10. The water level buildups in Table 10 do not indicate adverse impacts to nearby wells as a result of ASR recharge because the buildup does not exceed the ground surface within the Study Area (see Section 5.3). Therefore, the predicted water level buildups in the Study Area are favorable to ASR. With the exception of the Heliport Production Well, the water level drawdowns in Table 10 are small (i.e., drawdowns in vicinity pumping wells are less than 10 percent of the thickness of the Upper Aquifer)[31]. Therefore, the predicted water level drawdowns in the Study Area are favorable to ASR.

5.6 Affected Area by ASR and Potential Movement of Stored Water

This section summarizes the area affected by ASR operations at the Heliport Production Well under the baseline ASR conditions and presents an evaluation of the net movement of the stored water within the aquifer. The area affected by the City's ASR well was estimated using the Theis equation to calculate the areal extent of buildup (mounding) in the Upper Aquifer as a result of recharge:

$$s = \frac{Q}{4\pi T} * W(u) \qquad u = \frac{r^2 S}{4Tt} \tag{3}$$

s = mounding (feet)
Q = injection rate (ft3/day)
T = transmissivity (ft2/d)
t = time (days)
r = radial distance from the well with a mounding of s (feet)
S = storativity (dimensionless)

The areal extent of mounding (i.e., area affected by the ASR well) was defined as the portion of the Upper Aquifer that experiences more than 1.0 feet of water level rise during ASR cycle testing. Assuming T = 40,000 gpd/ft (5,347 ft2/day), Q= 825 gpm (158,812 ft3/day), t= 151 days, s = 1.0 feet, and S= 0.23, GSI calculated that the areal extent of mounding (i.e., the area

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[30] The thickness of the Upper Aquifer is 126 feet (see Table 1). The maximum drawdown at a pumping well is less than 11.6 feet and occurs in the Airport 1 and Airport 2 Wells.

[31] The thickness of the Upper Aquifer is 126 feet (see Table 1). The maximum drawdown at a pumping well is less than 1 foot and occurs in the Airport 1 and Airport 2 Wells.

affected by the injection from a single ASR well) is approximately 3,000 feet radially from the well. Because the Upper Aquifer is a narrow ancestral channel deposit with clear lateral boundaries, the ASR affected radius may encounter this boundary and affect the overall shape of the area of influence, but is not expected to propagate beyond that boundary.

Using the affected area distance, the net movement of the stored water during a yearly ASR cycle is presented below. Conceptually, there is a low potential for the stored water not to be recovered because the City plans to pump groundwater at a higher rate and for a longer duration (using the City's native groundwater rights) during recovery than during recharge. GSI verified this concept by estimating the distances that recharged water travels using the average linear groundwater velocity equation [Equation (1) in Section 2.3.4].

- **Recharge (825 gpm for 151 days).** During the 151-day recharge period, GSI estimated that recharged water should migrate no more than 351 feet downgradient from the ASR well[32].
- **Storage (30 days).** During the 30-day storage period, GSI estimated that stored water that is downgradient of the ASR well should migrate an additional 42 feet away from the ASR well[33].
- **Recovery (1,100 gpm for 183 days).** During the 183-day recovery period, GSI estimated that the stored water should migrate up to 525 feet back toward the ASR well[34].

The distance that water will migrate away from the ASR well during recharge and storage (351 feet during recharge plus an additional 42 feet during storage, for a total of 393 feet) is less than the distance that water will migrate back toward the ASR well during recovery (525 feet).

Based on this analysis, significant overall movement or loss of stored water is not anticipated.

5.7 Well Construction Considerations

The ASR well must meet current well construction standards in the OARs to be authorized by OWRD for ASR use, and must be able to be retrofit for ASR purposes. GSI reviewed the construction of the Heliport Production Well (as reported on well log CROO 54191) to evaluate whether well construction was favorable for use as an ASR well.

- **Well Seal.** The Heliport Production Well is sealed to a depth of 482 feet bgs with cement and bentonite, in between the 18-inch-diameter production casing and 22-inch-diameter borehole wall (i.e., 4-inch seal thickness). This meets the requirements of OAR 690-210-150.

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[32] Based on a horizontal hydraulic gradient of 0.01273 during recharge [calculated using the Cooper Jacob equation, recharging at 825 gpm after 151 days, and using late-time transmissivity and storage (see Table 1)].

[33] Based on the ambient groundwater velocity in the Upper Aquifer of 1.4 ft/day (see Section 2.3.4).

[34] Based on a horizontal hydraulic gradient of 0.01573 during recovery [calculated using the Cooper Jacob equation, recharging at 1,100 gpm after 183 days, and using late-time transmissivity and storage (see Table 1)].

- **Well Casing.** The Heliport Production Well is cased to a depth of 482 feet bgs with 18-inch-diameter, 0.375-inch gauge steel welded casing, which meets the requirements of OAR 690-210-0190(3) for well casing.
- **Well Liner.** The Heliport Production Well is lined from 422 to 452 feet bgs and from 572 to 597 feet bgs with 16-inch-diameter, 0.375-inch gauge steel welded pipe, which meets the requirements of OAR-210-0290 for liner pipe.
- **Well Diameter.** The Heliport Production Well is constructed of 18-inch-diameter production casing and a 16-inch-diameter liner. These diameters should be sufficiently large to accommodate downhole flow control valves, pump, and polyvinyl chloride (PVC) drop tubes that are required to operate a 1,100-gpm ASR well.

In summary, the Heliport Production Well has a sufficiently large diameter to be retrofit as an ASR well, and meets current OAR water well construction standards. Therefore, the Heliport Production Well is suitable for ASR purposes.

5.8 Source and Receiving Water Quality and Compatibility

Most mixtures of native groundwater and source water are supersaturated with respect to quartz, chalcedony, dolomite, iron, and manganese minerals. Therefore, these minerals have a tendency to precipitate (rather than dissolve) in the mixed water. However, supersaturation with respect to these minerals is not uncommon and does not necessarily indicate that precipitation is occurring. It is unlikely that quartz and chalcedony will precipitate because the precipitation kinetics are extremely slow at ambient temperatures. In addition, the precursor to quartz is amorphous silica, which has negative SI values. It is also unlikely that dolomite will precipitate because its precipitation is kinetically inhibited due to the large nucleation energy required to form new minerals. The high positive values of iron and manganese minerals (amorphous iron hydroxide, goethite, pyrolusite, bixbyite, and hausmannite) indicate a potential for mineral precipitation and/or biofouling by iron-related bacteria in the ASR well, and for manganese precipitation. However, the amount of precipitate is likely to be small, and will be unlikely to cause clogging in the ASR well. In addition, water from the new alluvial sources will be treated before recharge, which will reduce the concentrations of these iron and manganese minerals (see Section 4.2). Therefore, source and receiving water quality and compatibility are favorable to ASR.

6 Permitting Requirements

This section presents a summary of the permits, licenses, and certifications that are required for the ASR project as conceptualized in March 2018. The objectives of the summary are to identify the permits that the state of Oregon requires, and describe the key elements of each permit. The ASR project will require source water rights from OWRD, a design review from the Oregon Health Authority (OHA), an underground injection control (UIC) authorization from DEQ, and an ASR limited license from OWRD. The need for other permits, licenses, or certifications beyond those described in this section may become apparent as the ASR project details are finalized.

6.1 Source Water Rights

OWRD requires that the City hold a water right to appropriate the source water that will be recharged into the ASR well. The following sections describe water rights permitting for the two source waters that the City will use: (1) groundwater from existing alluvial wells in the Prineville Valley and (2) groundwater from a new shallow alluvial wellfield on the south side of the City.

6.1.1 Groundwater from Existing Prineville Valley Alluvial Wells

The existing alluvial wells that will supply source water for the ASR project are shown in Table 4 and Figure 9. The City holds one water right permit and five water right certificates to appropriate water from the wells. The City does not need to obtain any new water rights, or make any modifications to the existing water rights to use groundwater from these existing alluvial wells for ASR source water.

6.1.2 Groundwater from the City's New Shallow Alluvial Wellfield Source

The City is developing a new municipal water source located in the southern part of the City, shown in Figure 9 and Figure 13. The City plans to develop groundwater from the shallow alluvial system through a wellfield consisting of up to 20 wells, which in combination will produce up to 2,000 gpm total. Use of the new source for municipal use and as an ASR source water requires a groundwater permit from OWRD (as previously discussed) and a design review from OHA.

6.2 Native Groundwater Right for the Upper Aquifer

The City plans to continue pumping native groundwater from the Heliport Production Well and recovering the stored water volume permitted under the ASR limited license. The City currently has water rights to appropriate up to 1,770 gpm of native groundwater from the City's existing groundwater wells in the airport area aquifer under Permits G-17089 and G-17236.

6.3 OHA Design Review

OHA must review and approve wellhead modifications and any proposed new wells that will provide water for community water systems. The review process involves submittal of two plans: (1) a preliminary plan submitted to OHA prior to drilling the well, and (2) a final plan submitted to OHA after the well is drilled. Initially, the City plans to retrofit the Heliport Production Well to allow for ASR recharge. At a later date, the City may choose to install additional new ASR wells or possibly retrofit other existing wells for ASR. Design plans of the modifications to the existing Heliport Production Well will be submitted to OHA for plan review and approval prior to work on the wellhead. Construction of the new well can begin after OHA completes its preliminary review and issues an approval letter. OHA issues its final approval after well construction is complete. Future modifications or new wells also will follow OHA review requirements.

6.4 UIC Authorization

Because the Heliport Production Well will be used for the subsurface emplacement of fluids, it is classified as a UIC under the Safe Drinking Water Act (and is specifically classified as a Class V UIC). DEQ requires that UICs are authorized by rule or permit. ASR wells in Oregon are authorized by rule, and the City can meet this requirement by submitting an application for authorization by rule to DEQ.

6.5 ASR Limited License Application

To implement ASR, the City must apply for and obtain a limited license for ASR testing. The limited license authorizes the City to pilot test the ASR system, with the objectives of confirming ASR feasibility in Study Area aquifer and developing criteria for full-scale ASR operation and project size. Upon completion of pilot testing, the City can apply for an ASR permit, which contains a reduced set of testing and reporting requirements. The following bullets provide an overview of the information needed to apply for an ASR limited license:

- OWRD Limited License Application
- ASR Feasibility Study
  - Hydrogeologic characterization and impact to the proposed aquifer
  - Demonstrate access to source water
  - Analysis of water quality and compatibility (source water and native groundwater)
  - Evaluation of proposed recharge, storage, and recovery volumes
  - Evaluation of ASR feasibility

- ASR Pilot Testing Work Plan
  - Wellhead facility designs
  - Baseline and ASR monitoring plan
  - Water quality monitoring plan
  - Proposed pilot testing program
  - Pilot testing report outline

7 Conclusions and Recommendations

The findings from the hydrogeologic characterization, water quality compatibility analysis, and ASR feasibility evaluation indicate that ASR appears to be feasible in the Study Area's Upper Aquifer. The Heliport Production Well appears capable of storing up to 179 MG (95 percent of which may be available for recovery based on ASR regulatory requirements). If additional wells are installed, the Upper Aquifer may be capable of storing up to 870 MG (95 percent of which may be available for recovery). GSI's conclusions are based on a number of hydrogeologic factors including the following.

7.1 Conclusions

Aquifer Characteristics

Aquifer characteristics of Upper Aquifer are favorable for ASR. The Upper Aquifer has a transmissivity of at least 40,000 gpd/ft that supports highly productive wells with specific capacities ranging from about 16 to 60 gpm/ft. In addition, the depth to groundwater in the Upper Aquifer is more than 358 feet bgs, which can accommodate significant water level rise during recharge. This highly productive aquifer has a deep water table that allows high rates of recharge and recovery, and a large capacity for ASR storage with minimal potential for creating excessive groundwater level changes in other wells.

Recharge Rate, Pumping Rate, and Storage Volumes

Based on an initial assessment of ASR storage, a minimum of 179 MG of storage appears feasible in the Heliport Production Well and significantly more storage appears feasible with additional ASR wells. Further, the findings from the ASR recharge evaluation suggest that larger storage volumes and higher rates of recharge and recovery may be possible without negative impacts, such as groundwater levels exceeding ground surface during recharge or excessive aquifer drawdown during recovery.

Potential Loss of Stored Water

GSI's analysis indicates that recharged water is likely to be captured by the City's wells during ASR recovery. Therefore, losses of stored water to surface streams are not anticipated.

Permitting Issues

The City has evaluated the opportunity to obtain a water right for the new wellfield on the south side of the City, and has not found any fatal flaws. Preliminary development of the permit application is underway. While the new wellfield is being constructed and permitted, the City can use existing water rights for existing alluvial groundwater in the Prineville Valley to supply source water. No fatal flaws have been identified for obtaining an ASR limited license; however, the City will need to address (treat) source water quality in the new wellfield (i.e., high concentrations of manganese, iron, odor, and ammonia).

In summary, these geologic, hydrogeologic, and regulatory observations suggest favorable ASR feasibility within the Upper Aquifer.

7.2 Recommendations

Based on the technical analysis presented in the FS, GSI identified no fatal flaws for implementing ASR in the Upper Aquifer, and thus recommend proceeding forward with the next steps of the project: ASR permitting and pilot testing. The following is a summary of the tasks outlined in the ASR Implementation Plan document being prepared for the City; that summarizes the steps necessary to implement an ASR program using the Heliport Production Well.

- **Heliport Production Well Bacterial Sampling.** Bacteriological sampling is a common component of ASR well retrofits to evaluate, understand, and control bacterial populations in the well. Collect samples in the spring of 2018 prior to beginning use of the well for the season.
- **ASR Limited License Application.** As previously mentioned, the ASR pilot testing program is a required element of the ASR permitting process and it is designed to demonstrate ASR feasibility and to provide necessary pilot testing operational data. The next step of the project will be to prepare and file an ASR limited license application and ASR work plan with OWRD.
- **Groundwater Right Application.** A new groundwater permit will need to be obtained for the new shallow alluvial wellfield.
- **Engineering Preliminary and Final Design and Construction.**
  - Wellhead Retrofit
  - Treatment Stream Pilot Testing
  - New Shallow Alluvial Source (Wellfield and Treatment System)

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Tables

Table 1. Study Area Aquifer Properties.

City of Prineville ASR Feasibility Study

Hydrogeologic Unit	Scale	Transmissibility, T (gpd/ft)	Aquifer Thickness, b (feet)	Hydraulic Conductivity, K (ft/day)	Storage, S (-)
Upper Aquifer	Wellfield - Scale[1]	75,400 (early-time) 40,000 (late-time)	126[2]	80 (early-time) 42 (late-time)	0.14 (early-time) 0.23 (late-time)
	Regional - Scale[3]	94,250	126[2]	100	0.2
Lower Aquifer	Wellfield - Scale[4]	54,400 (early-time) 31,000 (late-time)	50[5]	145 (early-time) 83 (late-time)	5.7E-07 (early-time) 1.7E-04 (late-time)
	Regional - Scale[3]	85, 250	20[6]	570	5.00E-05

Notes:

(1) Based on time-drawdown and time-recovery at the Airport 2 observation during the Heliport Production Well pumping test in 2015.

(2) Aquifer thickness at the Airport 2 Well

(3) Based on a hydraulic conductivity from the numerical groundwater model of the Prineville Area (GSI, 2016)

(4) Based on time-drawdown data at the Runway observation well during the Millican Well pumping test in 2015.

(5) Aquifer thickness at the Runway Well

(6) The thickness of the Lower Aquifer in the numerical groundwater model

gpd/ft = gallons per day per foot

ft/day = feet per day

Table 2. Water Quality Sampling - Source Water and Receiving Aquifer Results

City of Prineville - ASR Feasibility Study

	ASR Source Water Options									Receiving Aquifer			
	ASR Source Water Quality Standard	Criteria	Units	Crooked River 6/1/2017	City Conveyance System.¥ 11/8/17	Shallow AQ Test Day 1 Sample 1/18/18	Shallow AQ Test Day 5 Sample 1/23/19	Deep Aq Test Day 1 Sample 1/24/19	Deep Aq Test Day 5 Sample 1/29/19	Drinking Water Quality Standard	Criteria	Units	Heliport Well 6/1/2017 ^{1}
Field Parameters													
Chlorine	2	MCL	mg/L	**0.0**	--	--	--	--	--	4	MCL	mg/L	**0.08**
Specific Conductivity	--	--	uS/cm	**200**	**1463**	**687**	**1180**	**1903**	**1033**	--	--	uS/cm	**342**
Dissolved Oxygen	--	--	mg/L	**8.53**	**3.36**	**5.01**	**8.62**	**1.28**	**0.53**	--	--	mg/L	**7.93**
ORP	--	--	mV	--	**252**	**39.1**	**34.4**	**83.1**	**208.3**	--	--	mV	**272.6**
pH	6.5 - 8.5	SMCL	su	**7.58/7.35**	**7.58**	**8.03**	**7.66**	**8.32**	**8.32**	6.5 - 8.5	SMCL	su	**7.99/8.10**
Temperature	--	--	degC	**12**	**14.36**	**12.12**	**12.13**	**12.76**	**12.75**	--	--	degC	**20.04**
General Chemistry (GC)													
Alkalinity, Total as CaCO3	--	--	mg/L	**100**	**173**	**201**	**231**	**161**	**164**	--	--	mg/L	**147**
Ammonia	--	--	mg/L	0.15 U	**0.11**	**3.1**	**3.3**	**1.26**	**6.8**	--	--	mg/L	0.15 U
Ammonium	--	--	mg/L	0.5 U	**0.14**	**4**	**4.3**	**1.62**	--	--	--	mg/L	0.05 U
Bicarbonate	--	--	mg/L	**120**	**211**	**234**	**281**	**182**	**186**	--	--	mg/L	**176**
Biological Oxygen Demand (BOD5)	--	--	mg/L	**15.43**	2 UH		2 U	1 U	2 U	--	--	mg/L	**11.71**
Bromide	--	--	mg/L	0.5 U	0.5 U	0.1 U	**0.0717**	0.1 U	0.1 U	--	--	mg/L	0.5 U
Calcium	--	--	mg/L	**20.6**	**24.6**	**22.2**	**29**	**12**	**12**	--	--	mg/L	**20.6**
Carbon Dioxide, total	--	--	mg/L	**89**	**156**	**175**	**208**	**137**	**140**	--	--	mg/L	**134**
Carbon Dioxide, free	--	--	mg/L	**3**	**4**	**2**	**5**	1 U	1 U	--	--	mg/L	**2**
Carbonate, as CaCO3	--	--	mg/L	6 U	5 U	**5**	5 U	**7**	**7**	--	--	mg/L	6 U
Chloride	250	SMCL	mg/L	**2.69**	**7**	**7**	**10**	**6**	**5**	250	SMCL	mg/L	**9.47**
Cyanide	0.1	MCL	mg/L	0.003 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.2	MCL	mg/L	0.003 U
Fluoride	1	MCL/SMCL	mg/L	**0.11**	**0.3**	**0.4**	**0.4**	**0.4**	**0.3**	2	MCL/SMCL	mg/L	**0.706**
Hardness, as CaCO3	250	SMCL	mg/L	**85.2**	**114**	**102**	**129**	**53**	**51**	250	--	mg/L	**97.5**
Magnesium	--	--	mg/L	**8.2**	**12.7**	**11.4**	**13.7**	**5.5**	**5.6**	--	--	mg/L	**11.2**
Nitrate + Nitrite	5	MCL	mg/L	**0.12**	**0.2** ER	0.01 U	0.01 U	0.01 U	**0.01**	10	MCL	mg/L	**0.841**
Nitrate as N	5	MCL	mg/L	**0.12**	**0.2** H	0.01 U	0.01 U	0.01 U	0.01 U	10	MCL	mg/L	0.05 U
Nitrite as N	0.5	MCL	mg/L	0.05 U	0.2 UER	0.01 U	0.01 U	0.01 U	0.01 U	1	MCL	mg/L	**0.841**
Ortho-phosphate	--	--	mg/L	**0.0632**	**0.11** H	**0.296**	**0.285**	**0.108**	**0.124**	--	--	mg/L	0.025 U
Potassium	--	--	mg/L	**2.41**	**3.3**	**4.6**	**4.7**	**1.9**	**2.3**	--	--	mg/L	**3.65**
Silica	--	--	mg/L	**41.5**	**45**	**49**	**51**	**37**	**35**	--	--	mg/L	**58.6**
Sodium	--	--	mg/L	**16.6**	**31.9**	**51.9**	**59.7**	**50.6**	**58**	--	--	mg/L	**38.3**
Sulfate	250	SMCL	mg/L	**4.79**	**11**	**15**	**39.4**	**7**	**7**	250	SMCL	mg/L	**10.7**
Sulfide	--	--	mg/L	0.04 U	--	0.04 U	**0.103**	0.05 U	**0.056**	--	--	mg/L	0.04 U
Sulfur	--	--	mg/L	**1.6**	**4.12**	**5.52**	**6.6**	**2.6**	**2.5**	--	--	mg/L	**3.4**
Total Dissolved Solids	500	SMCL	mg/L	**142**	**237**	**282**	7 U	**232**	**238**	500	SMCL	mg/L	**198**
Total Kjeldahl Nitrogen (TKN)	--	--	mg/L	0.625 U	**0.5**	**3.2**	**3.6**	**1.4**	**1.4**	--	--	mg/L	0.625 U
Organic Carbon (dissolved)	--	--	mg/L	**5.38**	**1.1**	**1.3**	**2.4**	**1**	**1.6**	--	--	mg/L	0.189 N
Total Organic Carbon (total)	--	--	mg/L	**5.66**	**0.9**	**1.2**	**2.1**	**0.9**	**1**	--	--	mg/L	0.163 N
Total Phosphorous	--	--	mg/L	**0.120**	**0.11**	**0.32**	**0.31**		**0.124**	--	--	mg/L	**0.0493**
Total Suspended Solids	--	--	mg/L	**7**	1 U	**4**	**8**	**9**	1 U	--	--	mg/L	0 J

Table 2. Water Quality Sampling - Source Water and Receiving Aquifer Results

City of Prineville - ASR Feasibility Study

	ASR Source Water Options									Receiving Aquifer			
	ASR Source Water Quality Standard	Criteria	Units	Crooked River 6/1/2017	City Conveyance System.[¥] 11/8/17	Shallow AQ Test Day 1 Sample 1/18/18	Shallow AQ Test Day 5 Sample 1/23/19	Deep Aq Test Day 1 Sample 1/24/19	Deep Aq Test Day 5 Sample 1/29/19	Drinking Water Quality Standard	Criteria	Units	Heliport Well 6/1/2017 [1]
Turbidity†	0.5	MCL	NTU	**6.69** *	--	**0.66**	**0.69**	**5.05**	0.36 U	1	MCL	NTU	**0.330**
Metals													
Aluminum (total)	0.05 - 0.2	SMCL	mg/L	**0.640** *	0.001 U	**0.554**	**0.03**	**0.255**	**0.009**	0.05 - 0.2	SMCL	mg/L	0.0158 U
Aluminum (dissolved)	--	--	mg/L	**0.119** *	0.03 U	0.03 U	**0.332**	**0.21**	0.03 U			mg/L	**0.0108**
Antimony (total)	0.003	MCL	mg/L	0.002 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.006	MCL	mg/L	0.002 U
Antimony (dissolved)	--	--	mg/L	0.002 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			mg/L	0.002 U
Arsenic (total)	0.005	MCL	mg/L	0.001 U	**0.003**	**0.001**	0.001 U	0.001 U	0.001 U	0.01	MCL	mg/L	**0.00219**
Arsenic (dissolved)	--	--	mg/L	0.001 U	**0.003**	**0.001**	0.001 U	0.001 U	0.001 U			mg/L	**0.00197**
Barium (total)	0.5	MML	mg/L	**0.0181**	**0.01**	**0.03**	0.035	**0.004**	**0.003**	1	MML	mg/L	**0.00563**
Barium (dissolved)	--	--	mg/L	**0.015**	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U			mg/L	**0.00519**
Beryllium (total)	0.002	MCL	mg/L	0.0002 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.004	MCL	mg/L	0.0002 U
Beryllium (dissolved)	--	--	mg/L	**0.0002**	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			mg/L	**0.000216**
Cadmium (total)	0.0025	MCL	mg/L	0.0001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.005	MCL	mg/L	0.0001 U
Cadmium (dissolved)	--	--	mg/L	0.0001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			mg/L	0.000103 U
Chromium (total)	0.025	MCL	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.05	MCL	mg/L	**0.00177**
Chromium (dissolved)	--	--	mg/L	0.001 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U			mg/L	**0.00185**
Copper (total)	1	SMCL	mg/L	0.00245 U	**0.002**	**0.001**	0.001 U	0.001 U	0.001 U	1	SMCL	mg/L	**0.000811**
Copper (dissolved)	--	--	mg/L	**0.00203**	0.005 U	**0.009**	0.005 U	0.005 U	**0.018**			mg/L	0.0005 U
Iron (total)	0.3	SMCL	mg/L	**0.637** *	0.03 U	**0.79**	**0.46**	**0.27**	0.03 U	0.3	SMCL	mg/L	**0.0863**
Iron (dissolved)	--	--	mg/L	**0.104**	0.02 U	0.06 U	**0.18**	**0.29**	**0.02**			mg/L	0.162 U
Lead (total)	0.025	MML	mg/L	0.0001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.05	MML	mg/L	0.0001 U
Lead (dissolved)	--	--	mg/L	0.0001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			mg/L	0.0001 U
Manganese (total)	0.05	SMCL	mg/L	**0.0459**	**0.025**	**0.097**	**0.161**	**0.033**	**0.030**	0.05	SMCL	mg/L	0.005 U
Manganese (dissolved)	--	--	mg/L	**0.0280**	**0.025**	**0.093**	**0.148**	**0.038**	**0.031**			mg/L	0.00515 U
Mercury (total)	0.001	MCL	mg/L	0.0002 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.002	MCL	mg/L	0.0002 U
Mercury (dissolved)	--	--	mg/L	**0.0002**	0.0001 UH	0.00001 U	0.0001 U	0.0001 U	0.0001 U			mg/L	0.0002 U
Nickel (total)††	††	††	mg/L	**0.00108**	0.01 U	0.001 U	0.001 U	0.001 U	0.001 U	--	††	mg/L	0.0005 U
Nickel (dissolved)††	--	--	mg/L	**0.00104**	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U			mg/L	0.0005 U
Selenium (total)	0.005	MML	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.01	MML	mg/L	0.001 U
Selenium (dissolved)	--	--	mg/L	0.001 U	0.001 U	0.002 U	**0.002**	0.001 U	0.001 U			mg/L	0.001 U
Silver (total)	0.025	MML	mg/L	0.0001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.05	MML	mg/L	0.0001 U
Silver (dissolved)	--	--	mg/L	0.0001 U	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0010 U			mg/L	0.0001 U
Thallium (total)	0.001	MCL	mg/L	0.0005 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.002	MCL	mg/L	0.0005 U
Thallium (dissolved)	--	--	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U			mg/L	0.0005 U
Zinc (total)	5	SMCL	mg/L	0.0050 U	**0.009**	**0.011**	**0.008**	**0.003**	**0.002**	5	SMCL	mg/L	0.005 U
Zinc (dissolved)	--	--	mg/L	0.005 U	0.01 U	**0.02**	0.01 U	**0.01**	**0.01**			mg/L	0.005 U

Table 2. Water Quality Sampling - Source Water and Receiving Aquifer Results

City of Prineville - ASR Feasibility Study

	ASR Source Water Options									Receiving Aquifer			
	ASR Source Water Quality Standard	Criteria	Units	Crooked River 6/1/2017	City Conveyance System.¥ 11/8/17	Shallow AQ Test Day 1 Sample 1/18/18	Shallow AQ Test Day 5 Sample 1/23/19	Deep Aq Test Day 1 Sample 1/24/19	Deep Aq Test Day 5 Sample 1/29/19	Drinking Water Quality Standard	Criteria	Units	Heliport Well 6/1/2017 [1]
Disinfection Byproducts (DBPs)§													
Chloroform	--	--	mg/L	0.0005 U	0.0005 U	0.5 U	0.0005 U	0.0005 U	0.0005 U	--	--	mg/L	0.0005 U
Bromoform	--	--	mg/L	0.0005 U	**0.00069**	0.0005 U	0.0005 U	0.0005 U	0.0005 U	--	--	mg/L	0.00069
Dibromochloromethane	--	--	mg/L	0.0005 U	**0.00094**	--	0.0005 U	--	0.0005 U	--	--	mg/L	0.00094
Bromodichloromethane	--	--	mg/L	0.0005 U	0.0005 U	--	0.0005 U	--	0.0005 U	--	--	mg/L	0.0005 U
Total Trihalomethanes (TTHM)	0.08	MCL	mg/L	0.0005 U	0.00163	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.08	MCL	mg/L	0.00163
Dibromoacetic Acid	--	--	mg/L	0.003 U	0.003 U	--	0.003 U	--	0.003 U	--	--	mg/L	0.003 U
Dichloroacetic Acid	--	--	mg/L	0.003 U	0.003 U	--	0.003 U	--	0.003 U	--	--	mg/L	0.003 U
Monobromoacetic Acid	--	--	mg/L	0.003 U	0.003 U	--	0.003 U	--	0.003 U	--	--	mg/L	0.003 U
Monochloroacetic Acid	--	--	mg/L	0.003 U	**0.00923** CF	--	0.003 U	--	0.003 U	--	--	mg/L	0.003 U
Trichloroacetic Acid	--	--	mg/L	0.003 U	0.003 U	--	0.003 U	--	0.003 U	--	--	mg/L	0.003 U
Total Haloacetic Acids (HAA-5)	0.06	MCL	mg/L	0.003 U	**0.00923**	--	0.003 U	--	0.003 U	0.06	MCL	mg/L	0.00923
Bromate	0.01	MCL	mg/L	0.005 U	--	*0.025* U	0.01 U	*0.025* U	0.005 U	0.01	MCL	mg/L	0.025 U,ER
Chlorite	1	MCL	mg/L	0.01 U	--	0.05 U	0.01 U	0.02 U	0.01 U	1	MCL	mg/L	0.01 U
Microbial													
Total Coliform	Absent	MCL	CFU	**> 2,419.6**	Absent	*1* U	*1* U	*1* U	*1* U	Absent	MCL	CFU	1 U
Fecal Coliform	Absent	MCL	MPN/100mL	**500** FC	NA	NA	NA	NA	NA	Absent	MCL	MPN/100mL	2 U,FC
E. Coli	Absent	MCL	CFU	**307.6**	Absent	*1* U	*1* U	*1* U	*1* U	Absent	MCL	CFU	1 U
Miscellaneous (Misc.)													
Color	15	SMCL	cu	**35** *	**10** H	**16** H	**14**	**13**	**12**	15	SMCL	cu	5 U
Corrosivity (Langelier Index)	noncorrosive	SMCL	none	**-0.59**	**0.14**	**0.59**	**0.4**	**0.37**	**0.39**	noncorrosive	SMCL	none	**-0.05**
Foaming Agents (MBAS)	0.5	SMCL	mg/L	0.04 U	*1* UH	*1* H	*1* H	*1* U	*1* UH	0.5	SMCL	mg/L	0.04 U
Odor	3	SMCL	ton	1 U	**4** H	**2**	**17** H	**12**	**4** H	3	SMCL	ton	1 U
SDWA Radionuclides (Rads)													
Gross Alpha	7.5	MML	pCi/L	0.9 U	**4.6**	**1.3** U	**2.5**	**1.3**	**0.08**	15	MML	pCi/L	0.3 U
Gross Beta ‡	25	MML	pCi/L	3.3 U	5 U	**2.6** U	**3.4**	**0.5**	**2.5**	50	MML	pCi/L	3.1 U
Radium 226	--	--	pCi/L	0.1 U	0.2 U	**0.2** U	**0.2**	**0.2**	**0.2**	--	--	pCi/L	**0.2**
Radium 228	--	--	pCi/L	**3.2**	0.6 U	**-0.2** U	**-0.3**	**0.5**	**-0.07**	--	--	pCi/L	**1.5**
Radium 226/228	2.5	MML	pCi/L	**3.3**	0.8 U	-0.09 U	**-0.1**	**0.7**	**0.09**	5	MML	pCi/L	**1.7**
Uranium	0.015	MCL	mg/L	0.0003 U	**0.0008**	0.0003	0.0003 U	0.0003 U	0.0003 U	0.03	MCL	mg/L	**0.0010**
Uranium activity	--	--	pCi/L	0.2 U	**5.4E-10**	**2.00E-10**	2.00E-10	2.00E-10 U	2.00E-10 U	--	--	pCi/L	**0.70**
Radon†††	--	--	pCi/L	-50 U	**580**	**177**	**73.8**	**618**	**377**	--	--	pCi/L	**251**
Synthetic Organic Compounds (SOCs)													
Regulated SOCs													
2,4,5-TP (Silvex)	0.005	MML	mg/L	0.005 U	0.0002 U	0.005 U	0.005 U	0.005 U	0.005 U	0.01	MML	mg/L	0.005 U
2,4-D	0.035	MCL	mg/L	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.07	MCL	mg/L	0.001 U
Alachlor (Lasso)	0.001	MCL	mg/L	0.0002 U	--	0.0004 U	0.0002 U	0.0004 U	0.0002 U	0.002	MCL	mg/L	0.0002 U
Aldicarb	--		mg/L	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U				
Aaldicarb Sulfone	--		mg/L	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U				

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	ASR Source Water Options															Receiving Aquifer				
	ASR Source Water Quality Standard	Criteria	Units	Crooked River 6/1/2017		City Conveyance System.$^{¥}$ 11/8/17		Shallow AQ Test Day 1 Sample 1/18/18		Shallow AQ Test Day 5 Sample 1/23/19		Deep Aq Test Day 1 Sample 1/24/19		Deep Aq Test Day 5 Sample 1/29/19		Drinking Water Quality Standard	Criteria	Units	Heliport Well 6/1/2017 ^{1}	
Aldicarb Sulfoxide	--		mg/L	0.004	U	0.004	U	0.004	U	0.004	U	0.004	U	0.004	U					
Aldrin	0.00001	MCL	mg/L	0.00001	U	0.00001	U	0.00001	U	0.00001	U	0.00001	U	0.00001	U					
Atrazine	0.0015	MCL	mg/L	0.0003	U	--		0.0006	U	0.0003	U	0.0006	U	0.0003	U	0.003	MCL	mg/L	0.0003	U
Baygon	--		mg/L	0.004	U	0.004	U	0.004	U	0.004	U	0.004	U	0.004	U					
Benzo(a)pyrene	0.0001	MCL	mg/L	0.00004	U	*0.01*	U	0.00006	U	0.00004	U	0.00008	U	0.00004	U	0.0002	MCL	mg/L	0.00004	U
BHC, gamma (Lindane)	0.0001	MCL	mg/L	0.00001	U	0.00005	U	0.00001	U	0.0001	U	0.00001	U	0.00001	U	0.0002	MCL	mg/L	0.00001	U
bis(2-Ethylhexl)adipate	--		mg/L	0.004	U	0.004	U	0.008	U	0.004	U	0.008	U	0.004	U					
bis(2-Ethylhexl)phthalate	--		mg/L	0.002	U	0.002	U	0.004	U	0.002	U	0.004	U	0.002	U					
Butachlor	--		mg/L	0.0003	U	0.0003	U	0.0006	U	0.0003	U	0.0006	U	0.0003	U					
Carbaryl	--		mg/L	0.004	U	--		0.004	U	0.004	U	0.004	U	0.004	U					
Carbofuran	0.02	MCL	mg/L	0.004	U	--		0.004	U	0.004	U	0.004	U	0.004	U	0.04	MCL	mg/L	0.004	U
Chlordane	0.001	MCL	mg/L	0.00025	U	0.0005	U	0.00025	U	0.00025	U	0.00025	U	0.00025	U	0.002	MCL	mg/L	0.00025	U
Dalapon	0.1	MCL	mg/L	0.005	U	0.0025	U	0.005	U	0.005	U	0.005	U	0.005	U	0.2	MCL	mg/L	0.005	U
Dieldrin	--	MCL	mg/l	0.00001	U	--		0.00001	U	0.00001	U	0.00001	U	0.00001	U					
Di(2-Ethylhexyl) Adipate	0.2	MCL	mg/L	0.004	U	--		0.008	U	0.004	U	0.008	U	0.004	U	0.4	MCL	mg/L	0.004	U
Di(2-Ethylhexyl) Phthalate	0.003	MCL	mg/L	0.002	U	*0.01*	U	*0.004*	U	*0.002*	U	*0.004*	U	*0.002*	U	0.006	MCL	mg/L	0.002	U
Dibromochloropropane (DBCP)	0.0001	MCL	mg/L	2.01E-05	U	--		0.0005	U	*0.001*	U	2.08E-05	U	2.06E-05	U	0.0002	MCL	mg/L	0.00002	U
Dicamba	--		mg/L	0.005	U	0.00025	U	0.0005	U	0.0005	U	0.005	U	0.005	U					
Dinoseb	0.0035	MCL	mg/L	0.0005	U	0.001	U	0.0005	U	0.0005	U	0.0005	U	0.005	U	0.007	MCL	mg/L	0.0005	U
Diquat	0.01	MCL	mg/L	0.002	U	0.0004	U	0.002	U	0.002	U	0.002	U	0.002	U	0.02	MCL	mg/L	0.002	U
Endothall	0.05	MCL	mg/L	0.01	U	0.008	U	0.01	U	0.01	U	0.01	U	0.01	U	0.1	MCL	mg/L	0.01	U
Endrin	0.0001	MML	mg/L	0.00001	U	0.00005	U	0.00001	U	0.00001	U	0.00001	U	0.00001	U	0.0002	MML	mg/L	0.00001	U
Ethylene Dibromide (EDB)	0.000025	MCL	mg/L	2.01E-05	U	*0.0005*	U	0.0000204	U	0.0000205	U	0.0000208	U	0.0000205	U	0.00005	MCL	mg/L	0.00002	U
Glyphosate	0.35	MCL	mg/L	0.05	U	0.005	U	0.05	U	0.05	U	0.06	U	0.05	U	0.7	MCL	mg/L	0.05	U
Heptachlor	0.0002	MCL	mg/L	0.0001	U	0.00005	U	0.00001	U	0.00001	U	0.00001	U	0.00001	U	0.0004	MCL	mg/L	0.0001	U
Heptachlor Epoxide	0.0001	MCL	mg/L	0.00001	U	0.00005	U	0.00001	U	0.00001	U	0.00001	U	0.00001	U	0.0002	MCL	mg/L	0.00001	U
Hexachlorobenzene (HCB)	0.0005	MCL	mg/L	0.0001	U	*0.01*	U	0.0002	U	0.0001	U	0.0002	U	0.0001	U	0.001	MCL	mg/L	0.0001	U
Hexachlorocyclopentadiene	0.025	MCL	mg/L	0.005	U	0.01	U	0.01	U	0.005	U	0.01	U	0.005	U	0.05	MCL	mg/L	0.005	U
Methomyl	--			0.004	U	--		0.004	U	0.004	U	0.004	U	0.004	U					
Methoxychlor	0.02	MCL, MML	mg/L	0.001	U	0.00005	U	0.0001	U	0.001	U	0.0001	U	0.0001	U	0.04	MCL, MML	mg/L	0.001	U
Metolachlor	--		mg/L	0.0004	U	--		0.0008	U	0.0004	U	0.0008	U	0.0004	U					
Metribuzin	--		mg/L	0.0004	U	--		0.0008	U	0.0004	U	0.0008	U	0.0004	U					
Oxamyl (Vydate)	0.1	MCL	mg/L	0.004	U	0.0004	U	0.004	U	0.004	U	0.004	U	0.004	U	0.2	MCL	mg/L	0.004	U
Pentachlorophenol	0.0005	MCL	mg/L	0.0001	U	*0.05*	U	0.0001	U	0.0001	U	0.0001	U	0.0001	U	0.001	MCL	mg/L	0.0001	U
Picloram	0.25	MCL	mg/L	0.006	U	0.0005	U	0.005	U	0.005	U	0.005	U	0.005	U	0.5	MCL	mg/L	0.006	U
Polychlorinated Biphenyls (PCBs)	0.00025	MCL	mg/L	0.00025	U	*0.0005*	U	0.00025	U	0.00025	U	0.00025	U	0.00025	U	0.0005	MCL	mg/L	0.00025	U
Simazine	0.002	MCL	mg/L	0.0004	U	--		0.0008	U	0.0004	U	0.0008	U	0.0004	U	0.004	MCL	mg/L	0.0004	U
Toxaphene	0.0015	MCL, MML	mg/L	0.0003	U	*0.005*	U	0.0003	U	0.0003	U	0.0003	U	0.0003	U	0.003	MCL, MML	mg/L	0.0003	U

Table 2. Water Quality Sampling - Source Water and Receiving Aquifer Results

City of Prineville - ASR Feasibility Study

	ASR Source Water Options									Receiving Aquifer			
	ASR Source Water Quality Standard	**Criteria**	**Units**	**Crooked River** 6/1/2017	**City Conveyance System.**¥ 11/8/17	**Shallow AQ Test Day 1 Sample** 1/18/18	**Shallow AQ Test Day 5 Sample** 1/23/19	**Deep Aq Test Day 1 Sample** 1/24/19	**Deep Aq Test Day 5 Sample** 1/29/19	**Drinking Water Quality Standard**	**Criteria**	**Units**	**Heliport Well** 6/1/2017 [1]
Volatile Organic Compounds (VOCs)													
Regulated VOCs													
1,1,1-Trichloroethane	0.1	MCL, MML	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.2	MCL, MML	mg/L	0.005 U
1,1,2-Trichloroethane	0.0025	MCL	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.005	MCL	mg/L	0.005 U
1,1-Dichloroethene	0.0035	MCL, MML	mg/L	0.005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.007	MCL, MML	mg/L	0.005 U
1,2,4-Trichlorobenzene	0.035	MCL	mg/L	0.005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.07	MCL	mg/L	0.005 U
1,2-Dichlorobenzene (o-dichlorobenzene)	0.3	MCL	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.6	MCL	mg/L	0.005 U
1,2-Dichloroethane (EDC)	0.0025	MCL, MML	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.005	MCL, MML	mg/L	0.005 U
1,2-Dichloropropane	0.0025	MCL	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.005	MCL	mg/L	0.005 U
1,4-Dichlorobenzene (p-dichlorobenzene)	0.0375	MCL, MML	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.075	MCL, MML	mg/L	0.005 U
Benzene	0.0025	MCL, MML	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.005	MCL, MML	mg/L	0.005 U
Carbon Tetrachloride	0.0025	MCL, MML	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.005	MCL, MML	mg/L	0.005 U
Chlorobenzene (Monochlorobenzene)	0.05	MCL	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.1	MCL	mg/L	0.005 U
cis-1,2-Dichloroethene	0.035	MCL	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.07	MCL	mg/L	0.005 U
Ethylbenzene	0.35	MCL	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.7	MCL	mg/L	0.005 U
Methylene Chloride (Dichloromethane)	0.0025	MCL	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.005	MCL	mg/L	0.005 U
Styrene	0.05	MCL	mg/L	0.0005 U	0.0005 U	0.94 U	0.0005 U	0.0005 U	0.0005 U	0.1	MCL	mg/L	0.005 U
Tetrachloroethene	0.0025	MCL, MML	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.005	MCL, MML	mg/L	0.005 U
Toluene	0.5	MCL	mg/L	0.0005 U	0.0005 U	**0.00094**	0.0005 U	**0.001**	0.0005 U	1	MCL	mg/L	0.005 U
trans-1,2-Dichloroethene	0.05	MCL	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.1	MCL	mg/L	0.005 U
Trichloroethene (TCE)	0.0025	MCL, MML	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.005	MCL, MML	mg/L	0.005 U
Vinyl Chloride	0.001	MCL, MML	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.002	MCL, MML	mg/L	*0.005* U
Xylenes, Total	5	MCL	mg/L	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	0.0005 U	10	MCL	mg/L	0.005 U

Table 2. Water Quality Sampling - Source Water and Receiving Aquifer Results

City of Prineville - ASR Feasibility Study

	ASR Source Water Options									Receiving Aquifer			
	ASR Source Water Quality Standard	Criteria	Units	Crooked River 6/1/2017	City Conveyance System.¥ 11/8/17	Shallow AQ Test Day 1 Sample 1/18/18	Shallow AQ Test Day 5 Sample 1/23/19	Deep Aq Test Day 1 Sample 1/24/19	Deep Aq Test Day 5 Sample 1/29/19	Drinking Water Quality Standard	Criteria	Units	Heliport Well 6/1/2017 [1]

Notes:

Analytes added by CH2M for Wastewater Treatment Plant Project review.

Bold = parameter detected

Red = Parameter concentration exceeds groundwater protection or drinking water quality standards, or is greater than one-half the MCL for source water anticipated for recharge

Italics = Laboratory detection level exceeded groundwater protection or drinking water quality standards

1 = ORP and Temperature readings were collected on 1/29/18

AL = Action Level

MCL = Maximum Contaminant Level

SMCL = Secondary Maximum Contaminant Level

MML = Maximum Measureable Level

† MCLs for turbidity are applicable to all public water systems using surface water sources or groundwater sources under the direct influence of surface water in whole or in part. Compliance with MCLs shall be calculated pursuant to OAR 333-061-0036(5).

†† MCL being re-evaluated by EPA.

††† USEPA proposed standard is 300 to 4,000 pCi/L, depending on State primacy.

‡ Gross beta MCL is 4 mrem/yr; however lab results presented in pCi/L so compared it to the MML standard.

¥ Additional parameters were evaluated but are not reported on this table. All parameters not reported in this table were not detected above the reporting limit established by the labaratory. For more details please refer to XXXXX.

§ DBPs results are from a sample that was collected

Units:

Units are in milligrams per liter (mg/L) unless otherwise noted. Milligrams per liter are equivalent to parts per million.

MPN = most probable number

CU = color number

TON = threshold odor number

pCi/L = picocuries per liter

su = standard units

uS/cm = micro Siemens per centimeter

mV = millivolts

degC = degrees Celsius

Data Flags:

* = Value exceeds Maximum Contaminant Level or is outside the acceptable range.

ER = Elevated reporting limit due to matrix. Report limits (MDLs, MRLs & PQLs) are adjusted based on variations in sample preparation amounts, analytical dilutions, and percent solids, where applicable.

H = analysis performed past recommended holding time

FC = Fecal Coliforms: Sample(s) received past 40 CFR Part 136 specified holding time. Results reported as estimated values.

J = detected below quantification limits

N = The Dissolved Organic Carbon (DOC) is greater than the Total Organic Carbon (TOC). The acceptable RPD between samples analyzed in duplicate is <25%. The relative percent difference (RPD) between the TOC and DOC in this sample is at 14.7%, which shows that the TOC is in the dissolved form of organic carbon.

U = Not detected at the minimum reporting limit

Table 3. Summary of Aquifer Test Common Anions and Cations Testing Results

City of Prineville ASR Feasibility Study

Day of Test		Time Since Test Started		Ca	Mg	Na	K	Cl	SO_4	CO_3		HCO_3 as CACO3	Nitrate+Nitrite as N	
		(days)	(minutes)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)		(mg/L)	(mg/L)	
Crooked River Sample *(baseline)*														
River Sample - 6/1/2017		*- NA -*	*- NA -*	20.6	8.2	16.6	2.41	2.69	4.79	6		120	0.02	U
Shallow Aquifer Test *(1/18/18 thru 1/23/18)*														
Day 1	1/19/18 12:30	1.10	1,590	32.0	16.0	65.0	5.0	11.0	18.0	5.0	U	298.0	0.01	U
Day 2	1/20/18 11:00	2.04	2,940	33.0	16.0	66.0	5.0	11.0	18.0	5.0	U	303.0	0.02	
Day 3	1/21/18 11:10	3.05	4,390	31.0	15.0	64.0	5.0	11.0	17.0	5.0	U	295.0	0.01	U
Day 4	1/22/18 11:20	4.06	5,840	30.0	15.0	64.0	5.0	10.0	16.0	5.0	U	287.0	0.01	U
Day 5	1/23/18 9:30	4.98	7,170	29.0	13.7	59.7	4.7	10.0	17.0	5.0	U	231.0	0.01	U
Deep Aquifer Test *(1/24/18 thru 1/29/18)*														
Day 1	1/25/18 12:45	1.11	1,605	13.0	6.0	54.0	2.0	6.0	6.0	6.0		203.0	0.01	U
Day 2	1/26/18 13:30	2.15	3,090	13.0	6.0	55.0	2.0	6.0	6.0	7.0		185.0	0.01	U
Day 3	1/27/18 11:00	3.04	4,380	13.0	6.0	55.0	2.0	6.0	7.0	6.0		186.0	0.01	U
Day 4	1/28/18 15:00	4.21	6,060	12.0	6.0	52.0	2.0	6.0	7.0	7.0		186.0	0.01	U
Day 5	1/29/18 7:30	4.90	7,050	12.0	5.6	58.0	2.3	5.0	7.0	7.0		186.0	0.01	

Notes

Day 1a - collected at initial test start up

Day 1b - collected at end of day 1 (i.e., 24 hours into test)

Table 4. City of Prineville Water Rights for Alluvial Wells in the Prineville Valley

City of Prineville ASR Feasibility Study

Well ID	OWRD ID [1]	Use	Water Rights [1]				Geologic Unit	Authorized Rate [1]		Maximum Production Rate [2]		Notes
			Application	Permit	Certificate	Transfers		(gpm)	(MGD)	(gpm)	(MGD)	
Water Sources Currently Connected to the Municipal Water Supply System - Valley Wells												
Lamonta	CROO 1540	MU	G 605	G 506	86337		QTs3	346	0.50	210	0.302	
Yancey	CROO 50181	MU	U 241	U 215	22839		QTs3	359	0.52	210	0.302	
Barney	CROO 3132	MU	G 6313	G 9154	83993	~~T9762~~	QTs3	700	1.01	340	0.490	
Stearns #2	CROO 2083	MU								210	0.302	
Stadium	CROO 184	MU	G 12344	G 11993	87714		QTs3	271	0.39	205	0.295	
		MU					QTs3	154	0.22			Extension application pending
4th Street Deep	CROO 2121 CROO 2133	MU	U 402	U 372	86889		QTs3	337	0.49	175	0.252	
4th Street Shallow *(Emergency Use only)*	CROO 2130	MU	U 396	U 370	88146		QTs1	135	0.19	*90*	*NA*	Currently not in use - emergency well
Total								2,167	3.12	1,350	1.94	
Water Sources NOT Connected to the Municipal Water Supply System												
Ochoco Heights	CROO 1577	MU	U 147	U 140	86558		QTs3	359	0.52			Currently not in use due to water quality and/or production issues
10th Street Well	CROO 1549	MU	U 140	U 133	15539		QTs3	45	0.06			Currently not in use due to water quality and/or production issues
Northridge A		GD	G-13280	G-13280				67	0.10			Not connected to City's Municipal Water Supply System
Clear Pine		FP, Pollution Abatement, I/M	G-13238	G-12541				1,791	2.58			Not connected to City's Municipal Water Supply System
Freight Depot		MU	G-605	G-506	89853	~~T-11026~~		148	0.21			Not connected to City's Municipal Water Supply System
Stearns #1		GD	G-3139	G-2919	57438			112	0.16			Currently not in use due to water quality and/or production issues

Notes:

(1) From Exhibit 2-18 of the City of Prineville Water Management and Conservation Plan (GSI, 2017b)

(2) City production capacity from valley wells excludes the 4th Street Shallow well because it is only used as an emergency source

Strikethrough indicates that the transfer changed the water right, and the water right was re-certified.

MU = Municipal Use

GD = Group Domestic

FP = Fire Protection

I/M = Industrial / Manufactoring

OWRD = Oregon Water Resources Department

gpm = gallons per minute

MGD = millions of gallons per day

QTs1 = Upper Sand and Gravel Geologic Unit

QTs3 = Lower Sand and Gravel Geologic Unit

Table 5. Estimated Source Water Availability from Existing Alluvial Wells in the Prineville Valley

City of Prineville ASR Feasibility Study

Well ID	OWRD ID [1]	Rate Authorized by Water Right [2] (MGD)	Maximum Production Rate [3] (MGD)	Average Municipal Demand During Recharge Period [4] (MGD)	Water Available for Recharge [5] (MGD)
Lamonta	CROO 1540	0.50	0.30	0.92	1.02
Yancey	CROO 50181	0.52	0.30		
Barney	CROO 3132	1.01	0.49		
Stearns #2	CROO 2083		0.30		
Stadium	CROO 184	0.39	0.30		
		0.22			
4th Street Deep	CROO 2121 CROO 2133	0.49	0.25		
Total		3.12	1.94	0.92	1.02

Notes:

(1) From Oregon Health Authority Drinking Water Data Online

(2) From Exhibit 2-18 of the City of Prineville Water Management and Conservation Plan (GSI, 2017b)

(3) Based on maximum well production rate, provided by the City

(4) Based on the maximum monthly production rate from November to March of the 2017 Water Year, from OWRD Water Use Reporting System (OWRD, 2018b)

(5) The water available for recharge is the average water demand during the recharge period subtracted from the maximum production rate

MGD = Million gallons per day

MG = Million gallons

Table 6. Preliminary Aquifer Properties for the New Wellfield.

City of Prineville ASR Feasibility Study

Hydrogeologic Unit	Well	Early-Time Transmissivity, T (gpd/ft)	Late-Time Transmissivity, T (gpd/ft)	Average Transmissivity, T (gpd/ft)
Shallow Zone (ST-1 Pumping Test)	ST-1 (pumping well)	8,957	12,540	10,748
Deep Zone (DT-1 Pumping Test)	DT-1 (pumping well)	4,072	9,953	7,012

Notes:

(1) Transmissivity is an average of early-time and late-time values.

gpd/ft = gallons per day per foot

Table 7. Blended Manganese and Ammonia Concentrations

City of Prineville ASR Feasibility Study

Parameter	Shallow Well Concentration (mg/L)	Deep Well Concentration (mg/L)	Blended Wells Concentration (mg/L)
Manganese, Dissolved	0.148	0.031	0.090
Ammonia as N, Dissolved	3.3	6.8	5.1

Notes:

mg/L = milligrams per liter

Table 8. Predicted ASR Storage and Recovery Volumes in the Upper Aquifer

City of Prineville ASR Feasibility Study

Scenario	Storage Volume [1] (MG)	Storage Volume Per Well [2] (MG)	Volume Available for Recovery [3] (MG)
Baseline Scenario - 825 gpm	179	179	170
Scenario 1 - 2,000 gpm	434	217	412
Scenario 2 - 4,000 gpm	870	174	827

Notes:

(1) Assumes recharge from November 1 through March 31.

(2) The baseline scenario uses one ASR well, Scenario 1 uses two ASR wells, and Scenario 2 uses five ASR wells.

(3) Assumes OWRD allows maximum recovery of 95% of stored water; it is possible that OWRD will choose a lower percentage, which will affect the availability of stored water for recovery.

gpm = gallons per minute

MG = million gallons

Table 9. Predicted Water Level Changes in Response to ASR

Upper Aquifer - Baseline Scenario Conditions

City of Prineville ASR Feasibility Study

ASR Scenario Evaluated

Recharge = 825 gpm from November through March (151 days) - 1 well (Heliport Production Well)

Storage = 30 days

Recovery = 1,100 gpm from May through October (183 days)

Numerical Model = ASR recharge/recovery program cycled for 10 years

Analytical Equation = ASR recharge/recovery program - 1 full year ASR cycle

OWRD Well Log ID	Well Name	Distance from Heliport Well (feet)	Water Level Buildup [1] (feet)		Water Level Drawdown [1] (feet)	
			Numerical Groundwater Model	Analytical Equation	Numerical Groundwater Model	Analytical Equation
Wells in the Upper Aquifer						
CROO 54191	Heliport Production Well[2]	- NA -	12.4	66.4	21.7	87.5
CROO 53965	Heliport Observation Well	35	6.9	20.0	12.8	26.0
CROO 1894	Airport 1 Well	428	5.8	<9.53	11.2	<12.7
CROO 53453	Airport 2 Well	440	5.9	<9.53	11.4	<12.7
CROO 53361	Houston Lake Road	10,775	0.0	<9.53	0.9	<12.7
Wells West of Channel						
CROO 532	Ryan Well	3,280	0.0	<9.53	1.9	<12.7
CROO 54287	Grass Butte Well	4,180	0.0	<9.53	1.9	<12.7
CROO 3200	Gravel Quarry	6,825	0.0	<9.53	0.2	<12.7
Wells East of Channel						
CROO 50311	Hollander Well	8,115	0.0	<9.53	0.0	<12.7
CROO 50990	County Landfill	8,875	0.0	<9.53	0.2	<12.7
CROO 50802	County Landfill	10,500	0.0	<9.53	0.2	<12.7

Notes

The Cooper Jacob equation requires that the ratio $\frac{r^2 S}{4Tt}$ is less than 0.01 (Freeze and Cherry, 1979). When this requirement is violated, the equation cannot accurately predict drawdown. During recharge, the ratio exceeds 0.01 when drawdown is less than 9.53 feet (i.e., at a radius of 375 feet from the Heliport Production Well). During recovery, the ratio exceeds 0.01 when drawdown is less than 12.7 feet (i.e., at a radius of 413 feet from the Heliport Production Well).

(1) "<" indicates that exact mounding or drawdown could not be calculated because *u* was greater than 0.01.

(2) Well efficiency of 59% is incorporated into the build-up and drawdown estimates for the production well to more accurately estimate responses within the well, and and provide a conservative estimate of conditions for the ASR feasibility evaluation

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Table 10. Predicted Water Level Changes in the Upper Aquifer--2,000 gpm and 4,000 gpm ASR Recharge Scenarios

City of Prineville ASR Feasibility Study

ASR Scenario 1

 # ASR Wells = 2 wells
Recharge = November through March (151 days)
Storage = 30 days
Recovery = May through October (183 days)

ASR Scenario 2

 # ASR Wells = 5 wells
Recharge = November through March (151 days)
Storage = 30 days
Recovery = May through October (183 days)

Numerical Model = ASR recharge/recovery program cycled for 10 years

OWRD Well Log ID	Well Name	Scenario 1 Inject at 2,000 GPM				Scenario 2 Inject at 4,000 GPM			
		Injection Rate (gpm)	Recovery Rate (gpm)	Max Buildup (feet)	Max Drawdown (feet)	Injection Rate (gpm)	Recovery Rate (gpm)	Max Buildup (feet)	Max Drawdown (feet)
Wells in the Upper Aquifer									
CROO 54191	Heliport Production Well[1]	1,000	1,100	17.3	19.1	800	933	13.6	17.0
- NA-	Hypothetical Heliport 2 Well	1,000	1,100	23.2	24.7	800	933	18.4	20.6
- NA-	Hypothetical Heliport 3 Well	*- NA-*	*- NA-*	*- NA-*	*- NA-*	800	933	11.7	13.9
- NA-	Hypothetical Heliport 4 Well	*- NA-*	*- NA-*	*- NA-*	*- NA-*	800	933	10.6	12.2
- NA-	Hypothetical Heliport 5 Well	*- NA-*	*- NA-*	*- NA-*	*- NA-*	800	933	15.7	16.2
CROO 53965	Heliport Observation Well	0.0	0.0	9.7	10.8	0.0	0.0	7.6	9.7
CROO 1894	Airport 1 Well	0.0	0.0	8.2	9.1	0.0	0.0	6.5	8.7
CROO 53453	Airport 2 Well	0.0	0.0	8.4	9.3	0.0	0.0	6.7	8.9
CROO 53361	Houston Lake Road	0.0	0.0	0.0	0.3	0.0	0.0	0.1	0.4
Wells West of Channel									
CROO 532	Ryan Well	0.0	0.0	0.1	0.5	0.0	0.0	0.0	0.8
CROO 54287	Grass Butte Well	0.0	0.0	0.1	0.7	0.0	0.0	0.0	1.2
CROO 3200	Gravel Quarry	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wells East of Channel									
CROO 50311	Hollander Well	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CROO 50990	County Landfill	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
CROO 50802	County Landfill	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1

Notes

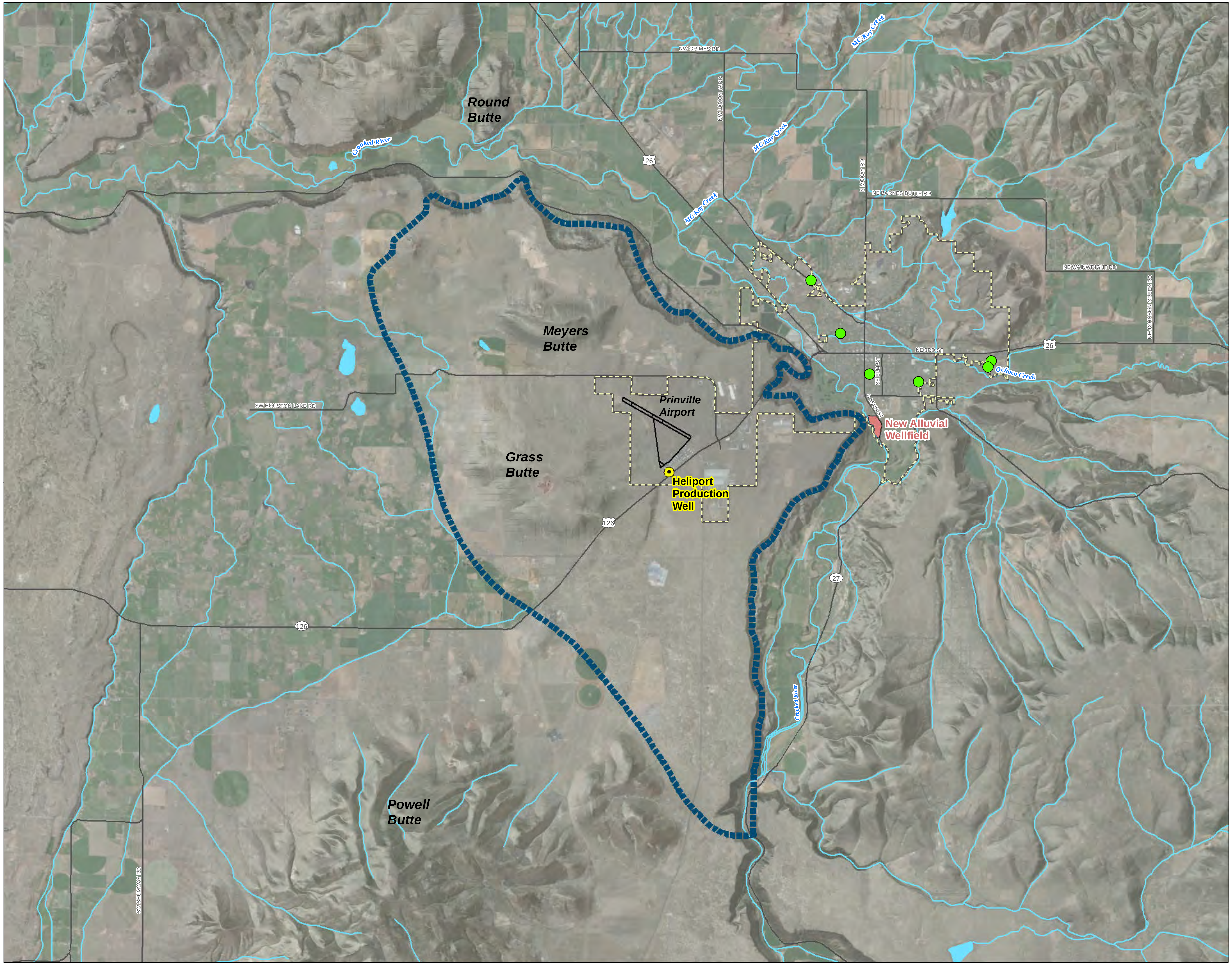
(1) Well efficiency of 59% is incorporated into the build-up and drawdown estimates for the production well to more accurately estimate responses within the well, and provide a conservative estimate of conditions for the ASR feasibility evaluation

Figures

FIGURE 1

Study Area

Prineville ASR Feasibility Study



LEGEND

- ● Exsting Source Water Well
- ⊙ ASR Well
- 🟥 New Alluvial Wellfield
- ▨ ASR Study Area (Plateau)

All Other Features

- ▢ Prineville City Limit
- Roads
- Watercourse
- Waterbody

N

0 3,500 7,000 10,500

Feet

Date: March 14, 2018
Data Sources: ESRI, USGS, DigiGlobe 2016

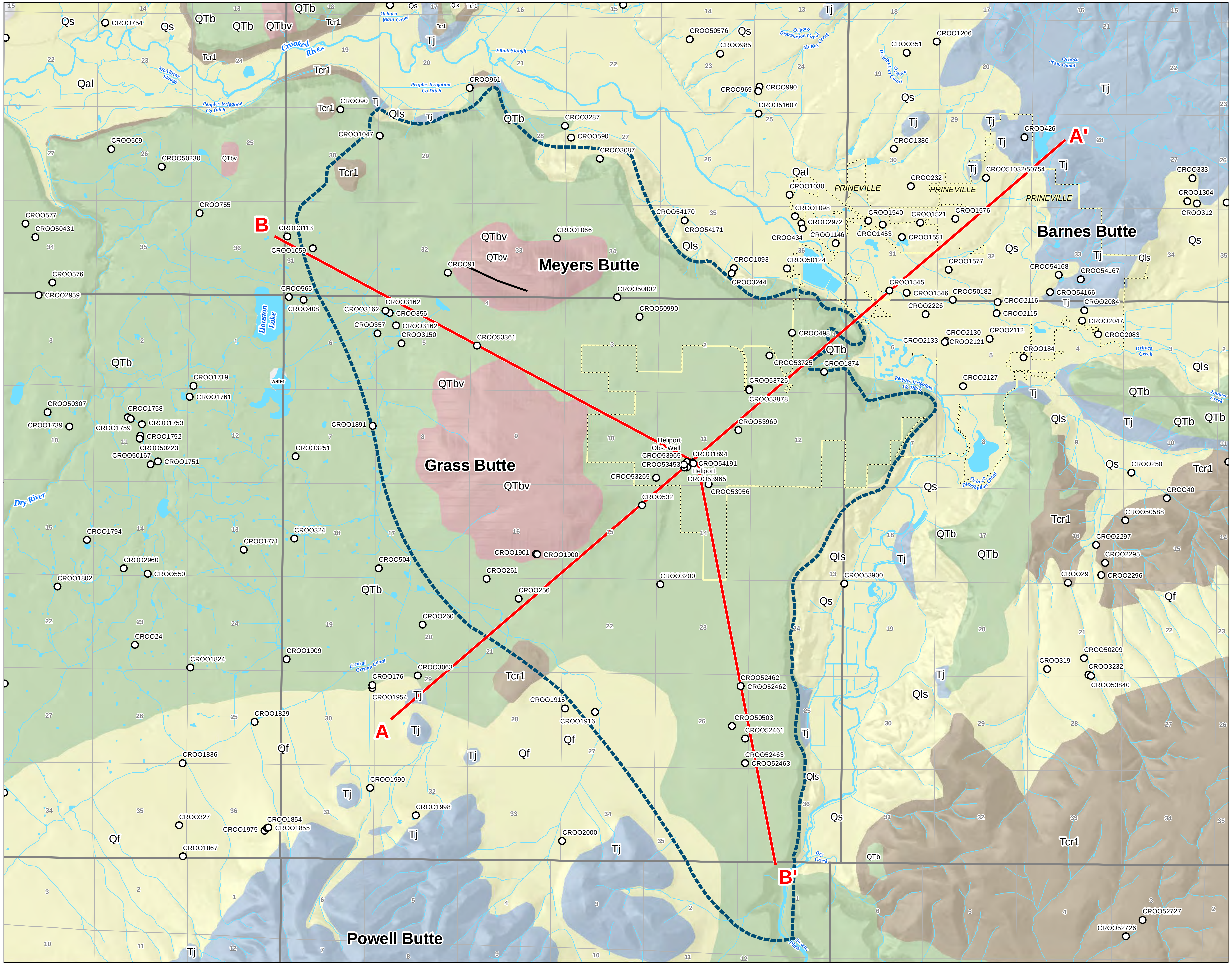
GSI Water Solutions, Inc.

Document Path: P:\Portland\224 - Prineville\025-ASR Feasibility Study\Project_GIS\Project_mxds\ASR_Feasibility_Study\Figure1_Study_Area.mxd

FIGURE 2

Generalized Geologic Map

Prineville ASR Feasibility Study



LEGEND

- ○ Well
- Cross Section Line
- Fault
- ASR Study Area (Plateau)

Geology

Basin-Fill Deposits

- Recent Alluvial Deposits
- Deschutes Formation

Basement Rock

- Prineville Basalt
- John Day Formation
- Vent and Pyroclastic Rocks

All Other Features

- City Boundary
- Watercourse
- Waterbody

Date: March 12, 2018
Data Sources: OGIC, USGS, ESRI, OWRD, DOGAMI

GSI Water Solutions, Inc.

Document Path: P:\Portland\224 - Prineville\025-ASR Feasibility Study\Project_GIS\Project_mxds\ASR_Feasibility_Study\Figure2_Cross_Section_Location_Map.mxd

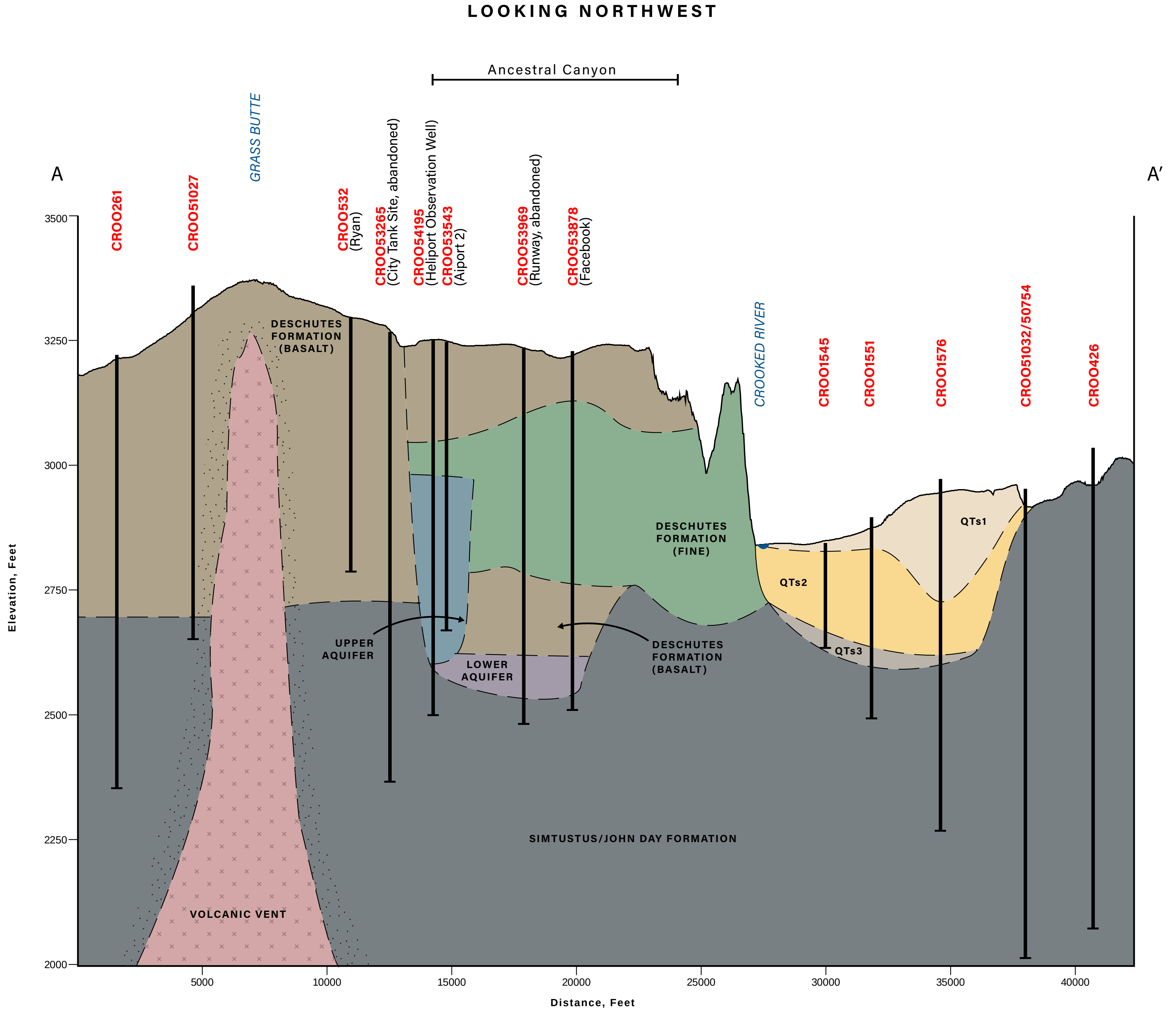


FIGURE 3

Cross Section A to A′

Prineville ASR Feasibility Study

LEGEND

Basin Fill Deposits

Recent Alluvial Deposits

- ▨ QTs1 - Upper Sand and Gravel
- ▨ QTs2 - Fine Grained Deposits (confining Unit)
- ▨ QTs3 - Lower Sand and Gravel

Deschutes Formation

- ▨ Deschutes Formation - Basalt
- ▨ Deschutes Formation - Fine Grained
- ▨ Deschutes Formation - Coarse Grained Sand and Gravel (Upper Aquifer)
- ▨ Fractured Basalt/Fine Sand and Gravel (Lower Aquifer)

Basement Rock

- ▨ Simtustus/John Day Formation
- ▨ Volcanic Vent

SCALE

250

0 5000

20X Vertical Exaggeration

GSI Water Solutions, Inc.

ALONG THE AXIS OF THE ANCESTRAL CANYON
LOOKING NORTH AND EAST

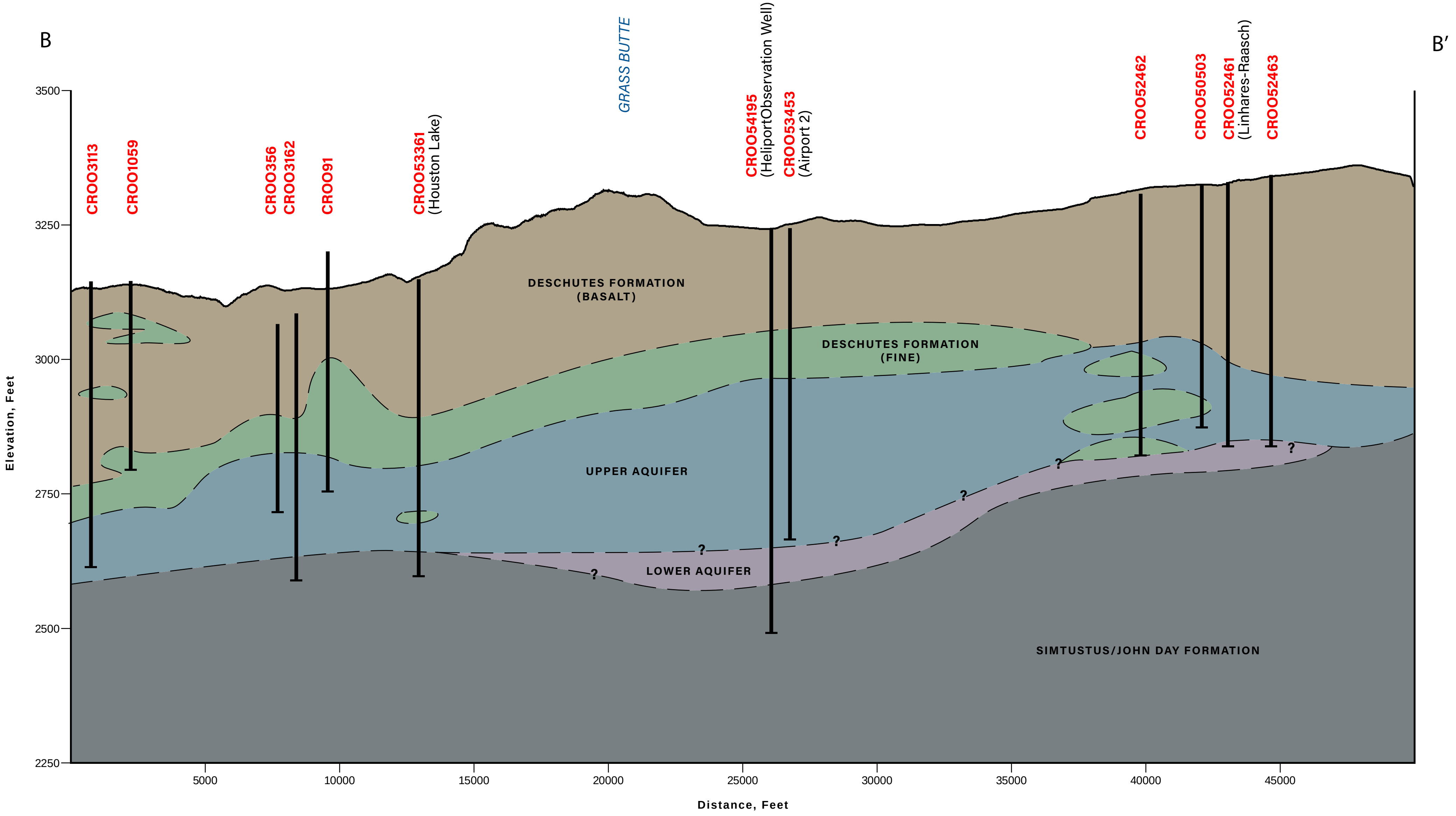


FIGURE 4

Cross Section B to B’

Prineville ASR Feasibility Study

LEGEND

Basin Fill Deposits

Deschutes Formation

🟫 Deschutes Formation - Basalt

🟩 Deschutes Formation - Fine Grained

🟦 Deschutes Formation - Coarse Grained Sand and Gravel (Upper Aquifer)

🟪 Fractured Basalt/Fine Sand and Gravel (Lower Aquifer)

Basement Rock

⬛ Simtustus/John Day Formation

SCALE

250

0 5000

20X Vertical Exaggeration

GSI Water Solutions, Inc.

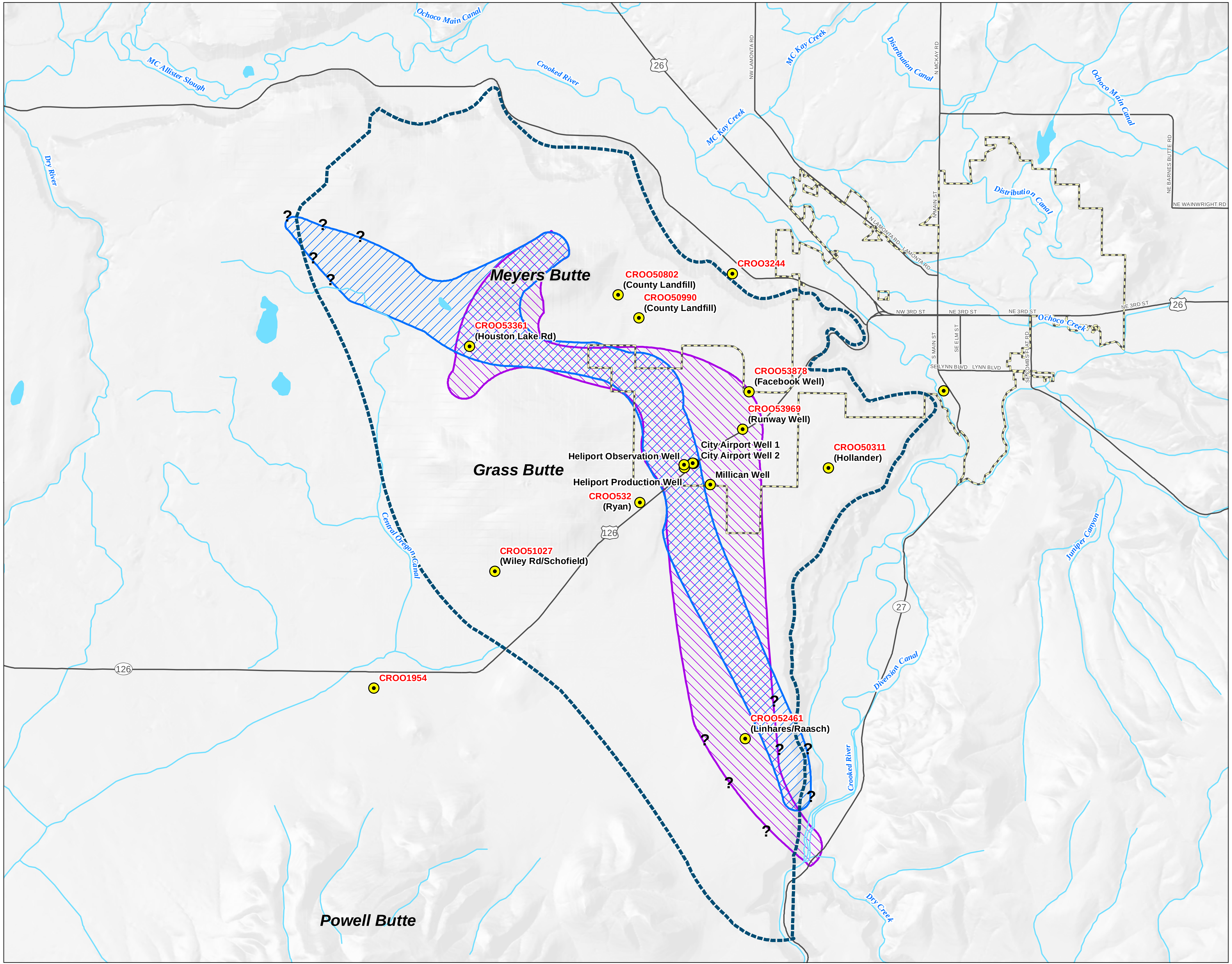


FIGURE 5

Estimated Areal Extent of the Upper Aquifer and Lower Aquifer

Prineville ASR Feasibility Study

LEGEND

- ● Well
- Upper Aquifer
- Lower Aquifer
- ASR Study Area (Plateau)

All Other Features

- Prineville City Limit
- Major Road
- Watercourse
- Waterbody

N

0 2,700 5,400 8,100

Feet

Date: August 1, 2016
Data Sources: ESRI, BLM, USGS

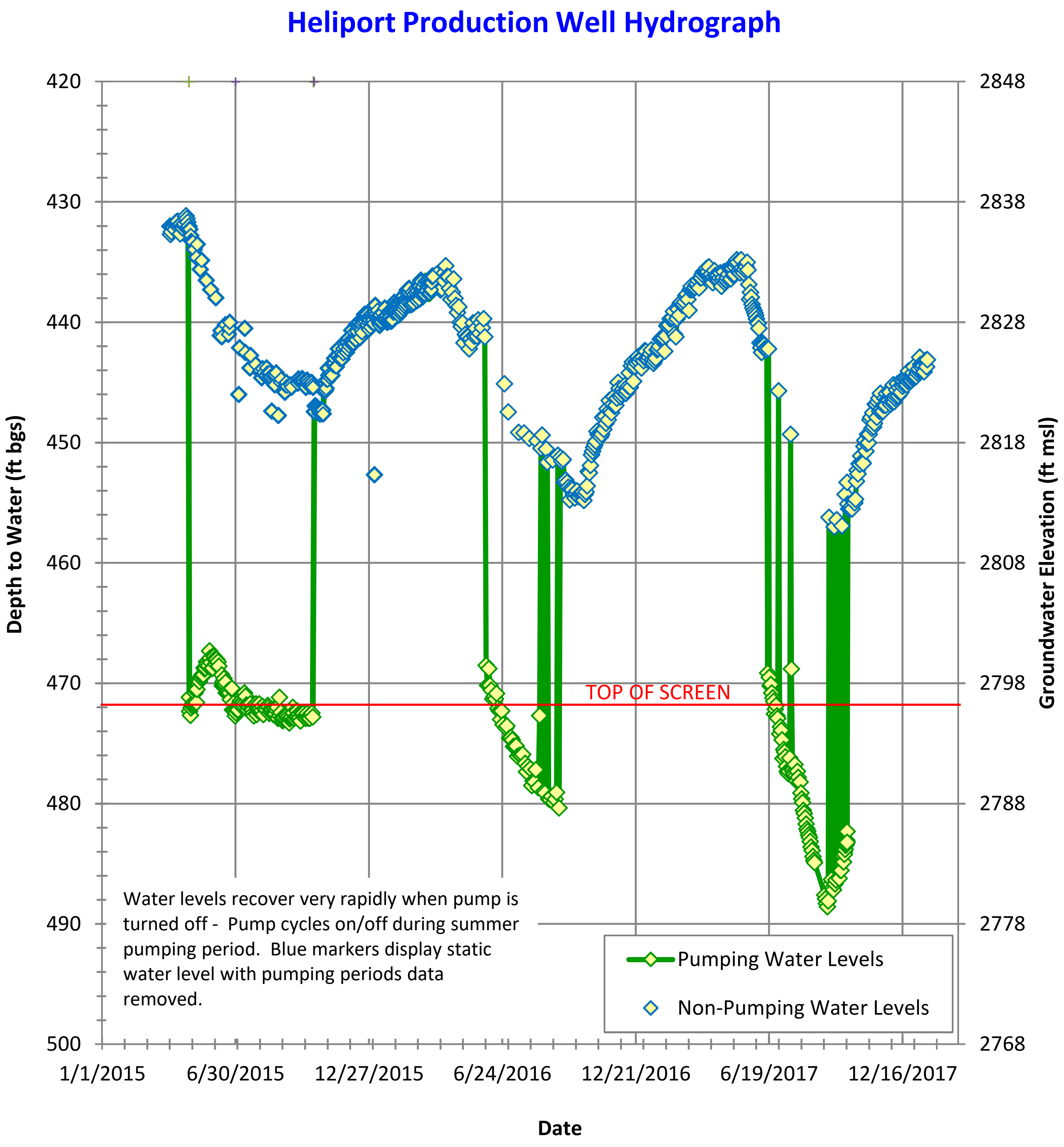
GSI Water Solutions, Inc.

Document Path: P:\Portland\224 - Prineville\025-ASR Feasibility Study\Project_GIS\Project_mxds\ASR_Feasibility_Study\Figure5_Location_Aquifers.mxd

FIGURE 6

Heliport Production Well Hydrograph

OWRD Well Log # :	**CROO 54191**
Location of well (T/R/S QQ):	**T15S/R15E/S11 SE-SW**



GSI Water Solutions, Inc.

FIGURE 7

Millican Well Hydrograph

OWRD Well Log # : **CROO 53956**
Location of well (T/R/S QQ): **T15S/R15E/S11 SW - SE**

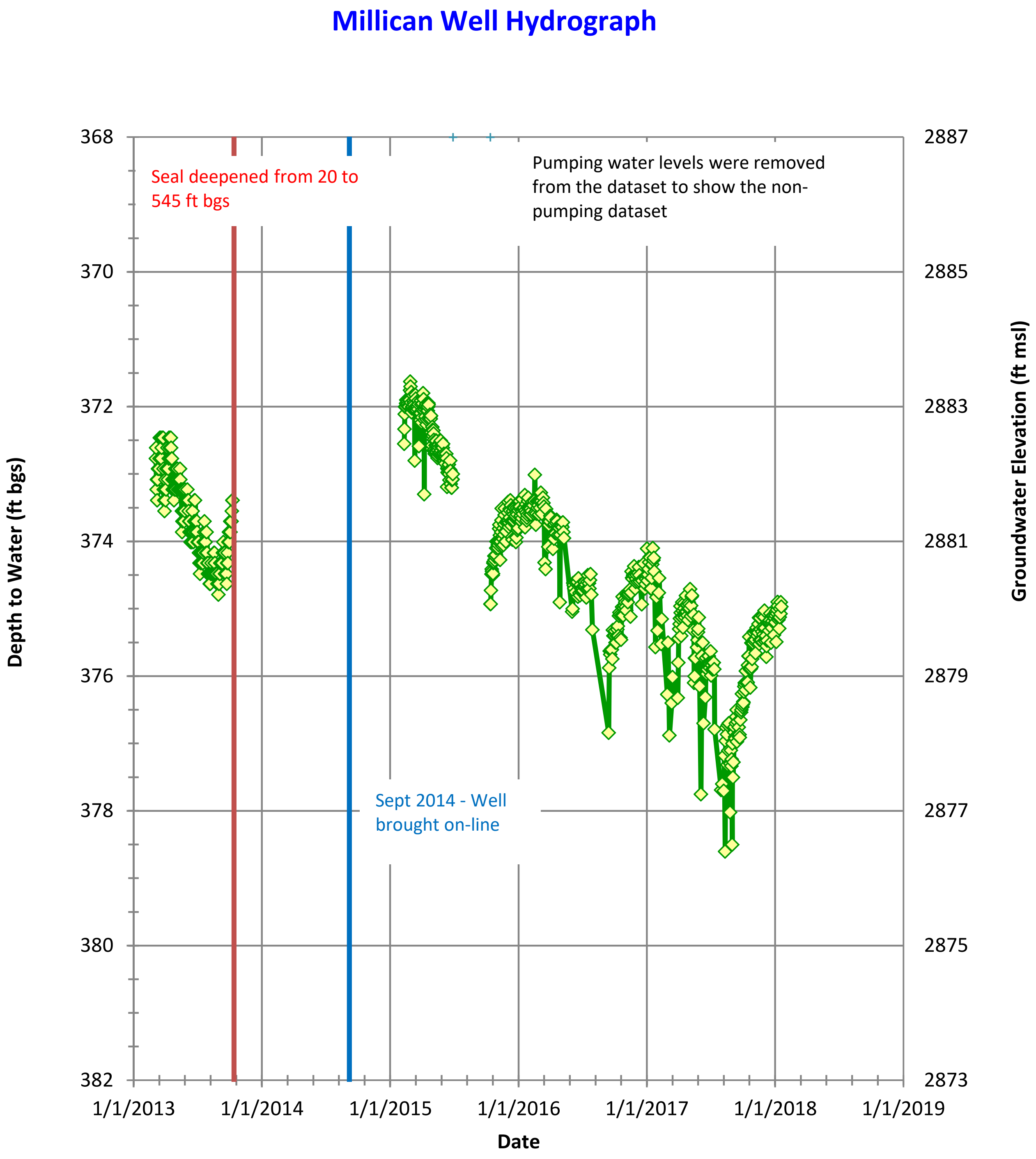
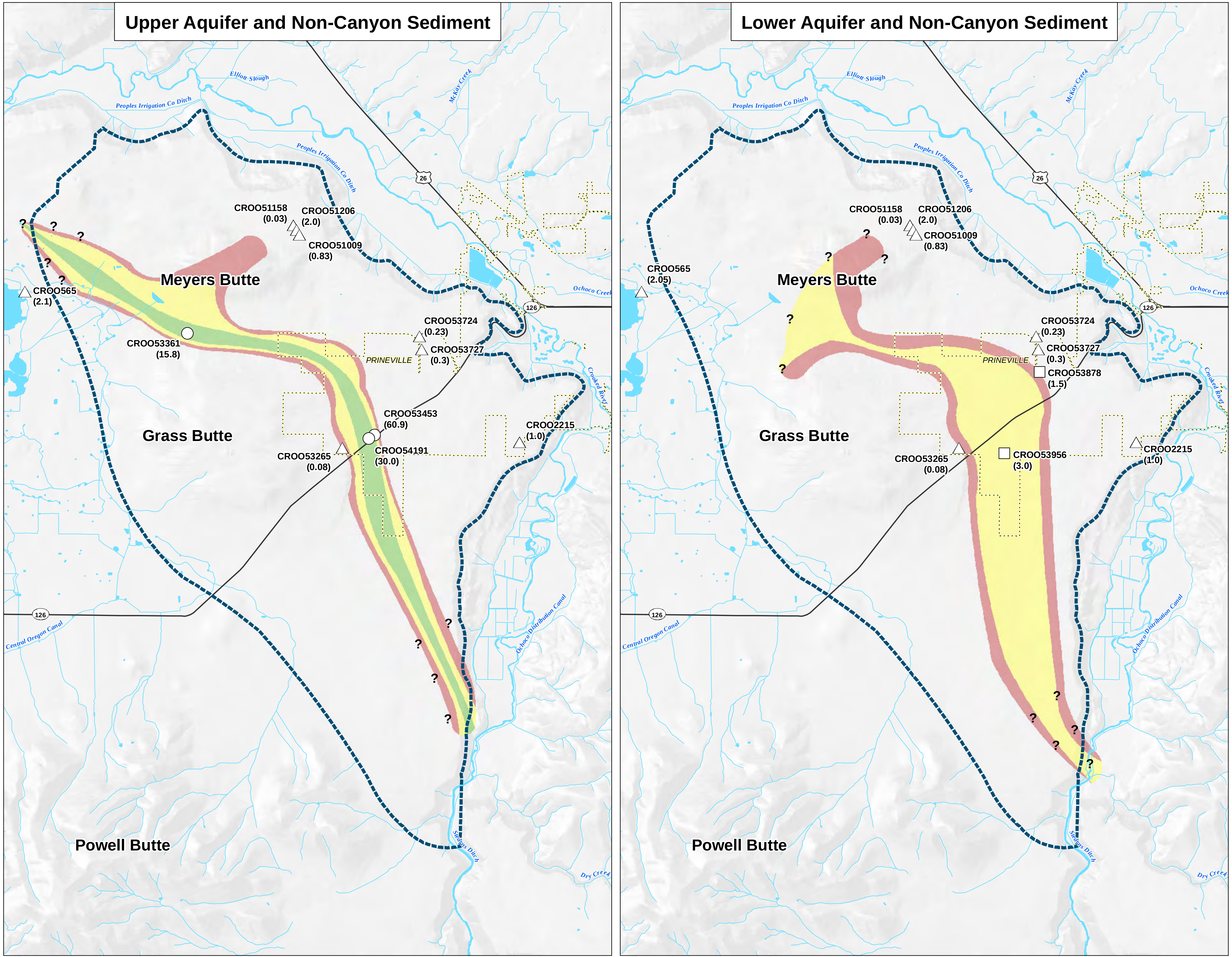


FIGURE 8

Specific Capacity in the Lower Aquifer and Upper Aquifer

Prineville ASR Feasibility Study



LEGEND

- ☐ Lower Aquifer
- ○ Upper Aquifer
- △ Out of Channel
- ASR Study Area (Plateau)

Specific Capacity (gpm/ft)

- 🟥 <1
- 🟨 1-10
- 🟩 >10

All Other Features

- City Boundary
- Major Road
- Watercourse
- Waterbody

N

0 3,100 6,200 9,300
Feet

Date: March 12, 2018
Data Sources: OGIC, USGS, ESRI, OWRD

Document Path: P:\Portland\224 - Prineville\025-ASR Feasibility Study\Project_GIS\Project_mxds\ASR_Feasibility_Study\Figure8_ASR_SC.mxd

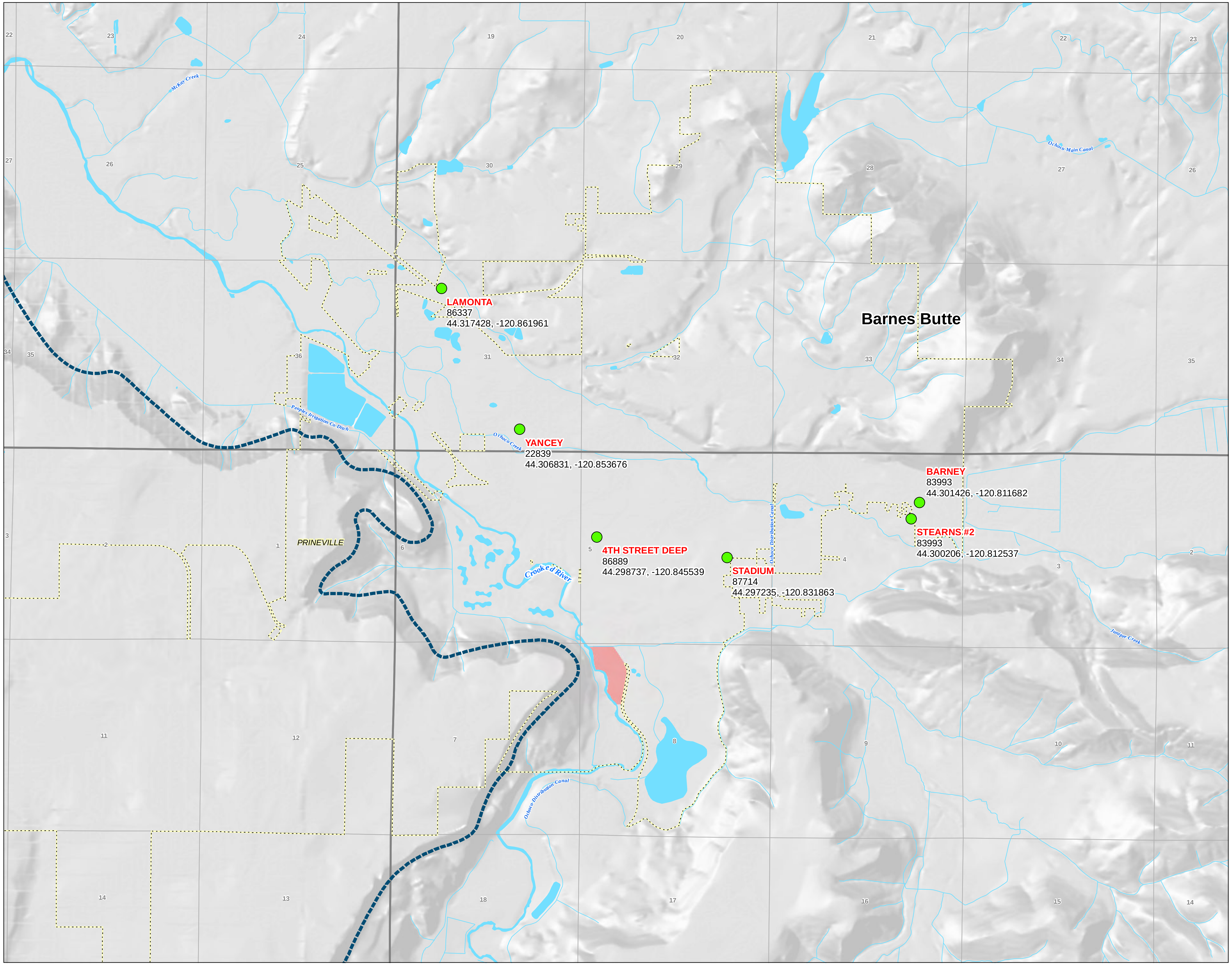


FIGURE 9

City of Prineville
Source Water Wells

Prineville ASR Feasibility Study

LEGEND

Existing Alluvial Source Water Well

● **Barney**	*Well Name*
83993	*Water Right*
44.3, -120.8	*Latitude, Longitude*

🟥 New Alluvial Wellfield

▭ ASR Study Area (Plateau)

All Other Features

▭ City Boundary

〜 Watercourse

▨ Waterbody

N

0 0.25 0.5 0.75
Miles

Date: March 12, 2018
Data Sources: OGIC, USGS, ESRI, OWRD, DOGAMI

GSI Water Solutions, Inc.

Document Path: P:\Portland\224 - Prineville\025-ASR Feasibility Study\Project_GIS\Project_mxds\ASR_Feasibility_Study\Figure9_Source_Water_Wells.mxd

Figure 10. Stiff Diagrams - Prineville ASR Feasibility Study

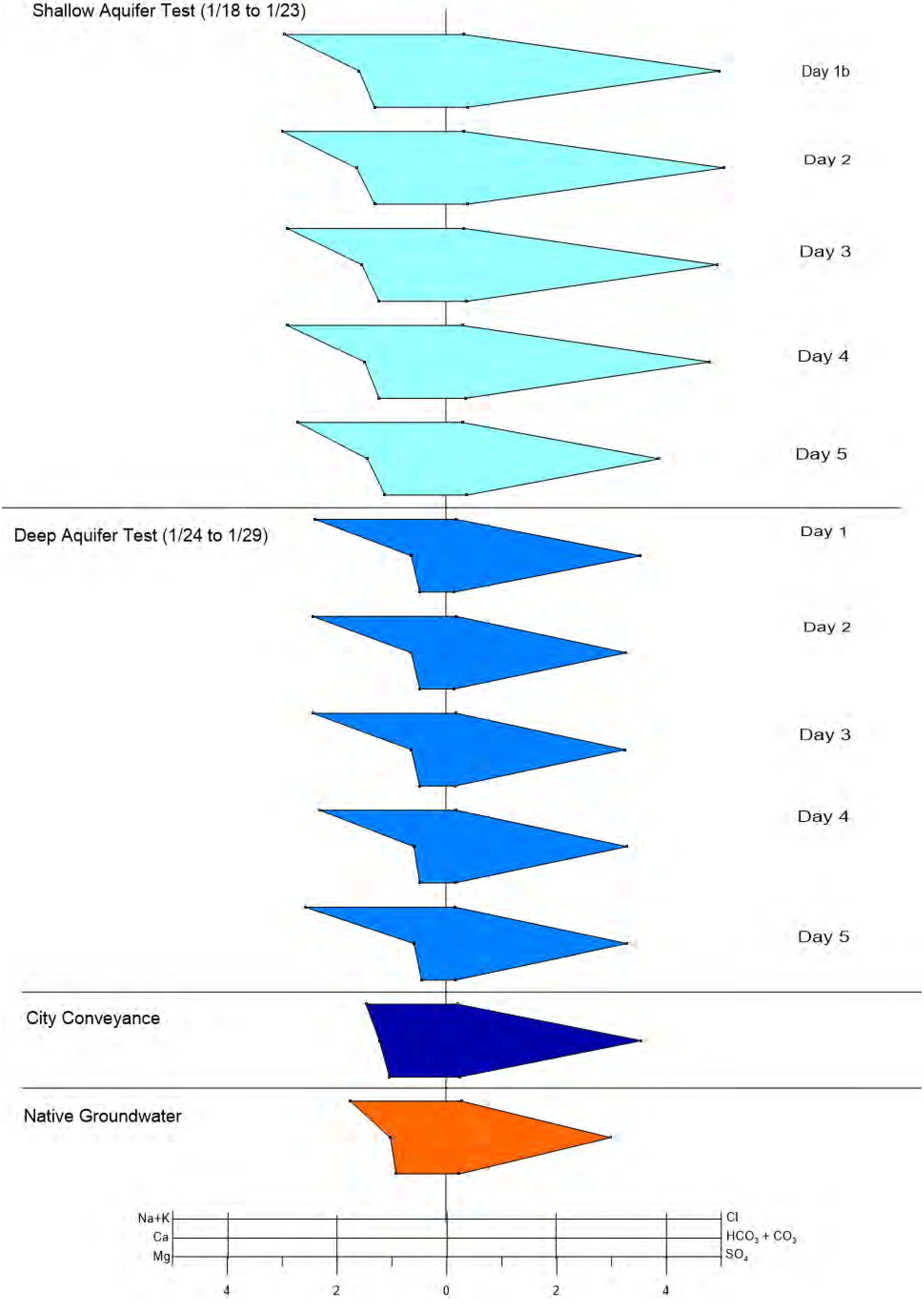


Figure 11. Piper Plots - Prineville ASR Feasibility Study

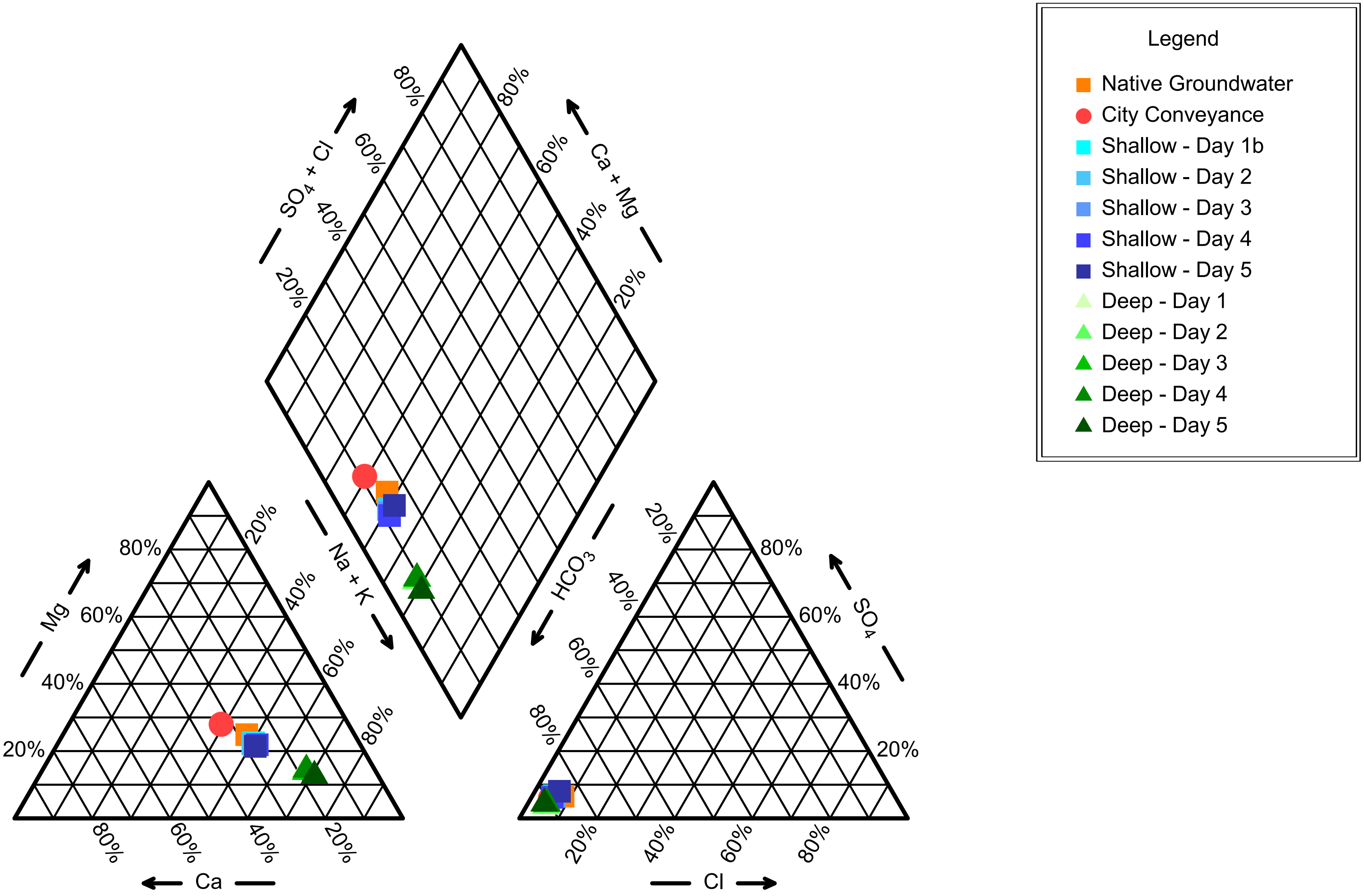


FIGURE 12

New Alluvial Source Investigation Test and Observation Well Network

Prineville ASR Feasibility Study

LEGEND

🟥 New Alluvial Wellfield

▭ ASR Study Area (Plateau)

Test Wells

● Deep Test Well

● Shallow Test Well

Observation Wells

🟩 Deep Test Observation Well

🟦 Shallow Test Observation Well

All Other Features

▭ City Boundary

〜 Watercourse

▨ Waterbody

N

0 100 200 300

Feet

Date: March 14, 2018
Data Sources: OGIC, USGS, ESRI, OWRD, DOGAMI

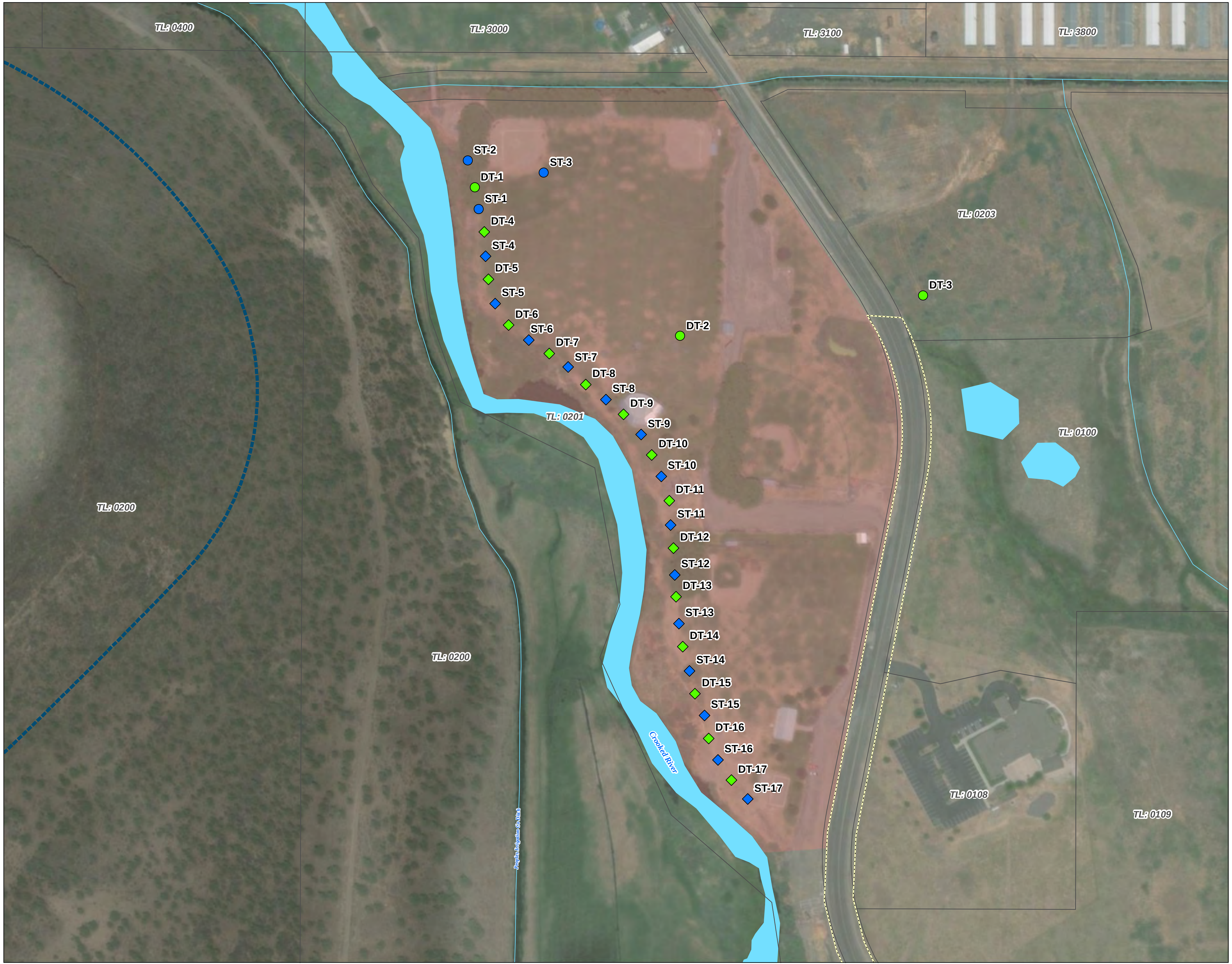


FIGURE 13

Proposed Source Water Well Locations – New Alluvial Wellfield

Prineville ASR Feasibility Study

LEGEND

● Existing Deep Test Well
● Existing Shallow Test Well
◆ Propsoed Deep Test Well
◆ Proposed Shallow Test Well
⬚ ASR Study Area (Plateau)

All Other Features

⬚ City Boundary
⬚ Tax Lot
▬ Waterbody
∼ Watercourse
▭ New Alluvial Wellfield

N

0 100 200 300
Feet

Date: March 14, 2018
Data Sources: OGIC, USGS, ESRI, OWRD, DOGAMI

GSI Water Solutions, Inc.

Document Path: P:\Portland\224 - Prineville\025-ASR Feasibility Study\Project_GIS\Project_mxds\ASR_Feasibility_Study\Figure13_Proposed_SourceWells.mxd

Appendix A

Aquifer Hydraulic Properties

Appendix A. Aquifer Test Results.

City of Prineville ASR Feasibility Study

Hydrogeologic Unit	Well	Transmissivity, T (gpd/ft)	Aquifer Thickness, b (feet)	Hydraulic Conductivity, K (ft/day)	Storage, S (-)	Reference
QTs3	14/15-15Q1	7200	--	--	--	Robinson and Price (1963), Theis nonequilibrium and recovery
	14/15-22B1	7900	--	--	--	Robinson and Price (1963), Theis nonequilibrium and recovery
	14/15-36H1	11000	--	--	--	Robinson and Price (1963), Theis nonequilibrium and recovery
	14/16-31P1	9500	--	--	--	Robinson and Price (1963), Theis nonequilibrium and recovery
	14/16-31Q1	11000	--	--	--	Robinson and Price (1963), Theis nonequilibrium and recovery
	14/16-32N1	5500	--	--	--	Robinson and Price (1963), Theis nonequilibrium and recovery
Deschutes Formation - Upper Aquifer	Airport 2 Well (CROO 53453)	76,420	126	77	1.40E-01	GSI (2016), time-drawdown (early)
		31,560	126	33	2.30E-01	GSI (2016), time-drawdown (late)
	Airport 2 Well (CROO 53453)	74,460	126	79	--	GSI (2016), time-recovery (early)
		49,220	126	52	--	GSI (2016), time-recovery (late)
	Heliport Production Well (pw) (CROO 54191)	42,090	137	41	--	GSI (2016), time-recovery
Deschutes Formation - Lower Aquifer	Runway & Linhare Wells	35,380	50	94	7.02E-04	GSI (2016), distance-drawdown[2]
	Runway Well (CROO 53969)	54,420	50	145	5.70E-07	GSI (2016), time-drawdown (early)
		31,030	50	83	1.70E-04	GSI (2016), time-drawdown (late)
	Runway Well (CROO 53969)	78,610	50	210	--	GSI (2016), time-recovery
	Linhare Well (CROO 52461)	153,800	47	437	7.30E-05	GSI (2016), time-drawdown (early)
		59,960	47	171	5.40E-04	GSI (2016), time-drawdown (late)
	Linhare Well (CROO 52461)	228,200	47	649	--	GSI (2016), time-recovery (early)
		85,240	47	242	--	GSI (2016), time-recovery (late)
	Millican Well (pw) (CROO 53956)	18,620	54	46	--	GSI (2016), time-drawdown (early)
		64,320	54	159	--	GSI (2016), time-drawdown (late)
	Millican Well (pw) (CROO 53956)	67,380	54	167	--	GSI (2016), time-recovery

Notes:

(1) Average excludes estimates based on time-drawdown analysis at the pumping well

(2) Aquifer thickness for the distance-drawdown test is the average thickness at the Millican Well, Runway Well and Linhare Well

gpd/ft = gallons per day per foot
pw = pumping well
"--" = no value
ft/day = feet per day
S = storage (specific yield or storativity)

Laboratory reports included in the electronic version of this Report - No paper copies

Appendix B

Laboratory Analytical Reports

Appendix C

Geochemical Water Quality Mixing Evaluation

S.S. PAPADOPULOS & ASSOCIATES, INC.
Environmental & Water-Resource Consultants

Memorandum

Date: March 12, 2018

From: Brad Bessinger

To: Matt Kohlbecker, GSI Water Solutions, Inc.

Project: City of Prineville ASR Feasibility Study

Subject: **Water Quality Mixing Evaluation**

This memorandum summarizes an evaluation of water chemistry data for an Aquifer Storage and Recovery (ASR) system proposed by the City of Prineville, Oregon (the City). Included is an evaluation of potential changes in water quality caused by mixing native groundwater with the following ASR water sources:

- A new shallow groundwater well located near the Crooked River;
- A new deep groundwater well located near the Crooked River; and
- The City's municipal distribution system, which is fed by several shallow alluvial wells located throughout the City.

Also included in this memorandum is an assessment of mineral precipitation reactions that could potentially occur in the ASR system.

Methodology

A summary of water chemistry data for native groundwater from the Heliport Production Well and proposed injection water was provided in spreadsheet format by GSI Water Solutions (GSI) (Table 1). As shown in the table, concentrations of total dissolved solids (TDS) in both native and proposed injection water are relatively low, with no primary maximum contaminant level (MCL) exceedances for any constituent. By comparison, total iron and both dissolved and total manganese concentrations are higher than secondary MCLs analyzed for the new shallow groundwater well located near the Crooked River. Finally, secondary drinking water criteria for odor are exceeded in all proposed injection waters.

The USGS-supported geochemical model PHREEQC (Parkhurst and Appelo 1999) was used to calculate the effect of water mixing on (1) the concentrations of dissolved constituents in groundwater-injected water mixtures, and (2) mineral saturation indices[1] (SI). Model results were

---

[1] As concentrations of dissolved aqueous species that comprise a particular mineral increase, the tendency for that mineral to precipitate out of groundwater is enhanced. This tendency is defined mathematically by a value called the saturation index (SI), which is expressed on a logarithmic scale as the ratio of the concentration of ions in solution to the concentration required for mineral precipitation to occur. SI values greater than or equal to zero represent groundwater that is saturated or supersaturated (under these conditions, there is a thermodynamic driving force for

reported as a function of the percentage of alluvial source groundwater contained in the mixture (from 0 to 100%). A separate PHREEQC model simulation was conducted to evaluate the potential for trihalomethane formation in the ASR system.

Predicted Water Quality

Tables 2a through 2c compare model-predicted constituent concentrations in mixed groundwater to primary and secondary MCLs. The mixing of native groundwater with groundwater from the new shallow alluvial aquifer results in the exceedance of the secondary MCL for manganese when the percentage of injection water comprises more than 40% of the mixture (Table 2b). This exceedance is due to the presence of dissolved manganese in the alluvial groundwater. No other exceedances are predicted for any source water or constituent.

Predicted Mineral Saturation Indices

The saturation states of water mixtures with respect to selected minerals are summarized at the bottom of Tables 2a through 2c. Results include the following:

- Silica (SiO_2) Minerals: Groundwater is close to equilibrium with several silica polymorphs, including chalcedony and SiO_2(am) (SI values ± 1.0). Although quartz has the most-positive SI value, it is unlikely to precipitate. This is because quartz precipitation kinetics are extremely slow, and its precursor is SiO_2(am), has negative SI values. In summary, silica precipitation is not predicted.
- Carbonate Minerals: Native groundwater is close to equilibrium with calcite (SI = 0.0), which is consistent with it potentially-being present as a buffering mineral within the aquifer. Although dolomite is supersaturated (SI = 1.1), its precipitation is kinetically-inhibited and unlikely to occur[2]. As shown in Tables 2a and 2b, the use of municipal water or shallow groundwater results in a decrease in the saturation index of calcite. This implies that a small fraction of the calcite potentially-present in the aquifer could dissolve into recovered water. Although calcite re-precipitation is possible if CO_2(g) exsolution occurs within the ASR system, the model predicts that carbonate scale is unlikely ($SI_{calcite} < 0.6$ following exsolution of native groundwater).

---

mineral precipitation to occur). Conversely, values less than zero imply that a mineral is unstable, and if present in aquifer soils, will dissolve into groundwater.

[2] Although carbonate scale formation is possible, precipitation is inhibited by the large nucleation energy required to form new minerals. For example, SI values required for calcite nucleation and crystal growth range from 1.3 to 2.5 (Morse et al., 2007; Lebron and Suarez, 1996), which are higher than predicted by the model.

- Iron and Manganese Minerals: Iron oxyhydroxides (such as $Fe(OH)_3(am)$ and goethite) are very insoluble ferric iron minerals that are known to precipitate in ASR and injection well systems (due to the oxidation/conversion of dissolved ferrous iron to ferric). As shown by the positive saturation indices for these minerals in Table 2, there is predicted to be a potential for mineral precipitation[3] and/or biofouling by Fe-related bacteria in the proposed ASR system when the injection water is from either the shallow or deep groundwater wells located near the Crooked River[4]. Also, there is predicted to be a potential for manganese to oxidize and precipitate (as shown in Table 2, the SI values for pyrolusite, bixbyite, and hausmannite are positive for all proposed mixing scenarios[5]).

  Although some iron and manganese oxyhydroxide precipitation is possible, the amount is likely to be small, based low concentrations of ferrous iron and manganese in the aquifer. Therefore, it is unlikely that these minerals will significantly affect injection well operations through clogging. Supporting evidence for a lack of clogging is provided in Table 3, which summarizes water quality from other regional ASR systems in basalt aquifers with similar iron and manganese concentrations, and no reported issues associated with mineral precipitation.

Total Trihalomethanes

Because residual chlorine is reported in native groundwater (0.08 mg/L; Table 1), a separate model simulation was conducted to evaluate the potential for the formation of trihalomethanes due to reactions with organic carbon. The initial concentration used in the simulations was 0.08 mg/L and additional trihalomethanes were formed via reaction between residual chlorine and the maximum-reported reactive organic carbon (2.1 mg/L). Also, the reaction rates used were those described in Clark et al. (1998a and 1998b). As shown in Figure 2, total trihalomethanes (TTHMs) are predicted

---

[3] Evidence that iron oxyhydroxide mineral precipitation is possible includes the following: 1) the occurrence of ferrous iron in groundwater (Table 1); 2) Eh-pH diagrams showing that the mineral $Fe(OH)_3(am)$ is more-stable than dissolved iron (Fe^{+2}) (Figure 1; top diagram); and 3) positive saturation indices (SI) predicted for Fe(OH)3(am) and goethite during mixing (Tables 2b and 2c).

[4] Both wells reported detectable dissolved ferrous (Fe^{+2}) iron, which can be oxidized by dissolved oxygen and/or residual chlorine reported in the system.

[5] This result is predicated on the assumption that there was no oxygen introduced during sampling, which has the effect of increasing the stability of manganese oxide minerals relative to dissolved manganese (Mn^{+2}). It is important to note in this regard that even if the oxidation state of groundwater were assumed to be better-represented by ORP (or Eh), three of the groundwaters evaluated would still be near (or within) the stability field of manganese minerals (Figure 1, bottom Eh-pH diagram). Although the other groundwater sample (from the new shallow groundwater well near the Crooked River) is predicted to be within the stability field of Mn^{+2} (based on ORP/Eh), it could still oxidize and precipitate upon mixing with native groundwater (as indicated by the arrow in the figure, which shows the change in Eh-pH expected during mixing).

to increase initially, but then decay over time. Most-importantly, concentrations of TTHMs are predicted to be significantly-less than the MCL of 0.08 mg/L.

Conclusions and Recommendations

No detrimental water quality changes are predicted to be caused by operation of the ASR system; however, there is some potential for iron or manganese mineral precipitation to occur. The amount of precipitate formed would be small and could be mitigated by blending groundwater from new shallow well near the Crooked River, which has the highest dissolved manganese concentrations, with groundwater from the deep well and the City's municipal distribution system.

References

Clark, R.M. 1998a. Chlorine demand and TTHM formation kinetics: a second-order model. *J. Env. Eng.* 124: 16–24.

Clark, R.M. and M. Sivaganesan. 1998b. Predicting chlorine residuals and formation of TTHMs in drinking water. *J. Env. Eng.* 124: 1203–1210.

Lebron, I., and D.L. Suarez. 1996. Calcite nucleation and precipitation kinetics as affected by dissolved organic carbon. G*eochim. Cosmochim. Acta* 60:2765-2776.

Morse, J.W., R.S. Arvidson, and A. Lüttge. 2007. Calcium carbonate formation and dissolution. *Chem. Rev.* 107:342-381.

Parkhurst, D.L. and C.A.J. Appelo. 1999. User's guide to PHREEQC (Version 2)—A computer program for speciation, batch-reaction, one-dimensional transport, and inverse geochemical calculations. U.S. Geological Survey Water Resources Investigations Report 99-4259.

Table 1. Summary of Water Quality of Waters Used in Mixing Analysis

Type	Parameter	Units	Primary MCL	Secondary MCL	Native Groundwater	Municipal Distribution	New Shallow GW Well	New Deep GW Well
General	Conductivity	us/cm			342	1463	1180	1033
	Dissolved Oxygen	mg/L			7.93	3.36	8.62	0.53
	ORP	mV			272.6	252	34.4	208.3
	pH	unitless		6.5-8.5	7.99/8.10	7.58	7.66	8.32
	Temperature	degC			12	14.36	12.13	12.75
	Total Dissolved Solids	mg/L		500	198	237	319	238
Cations	Calcium	mg/L			20.6	24.6	29	12
	Magnesium	mg/L			11.2	12.7	13.7	5.6
	Potassium	mg/L			3.65	3.3	4.7	2.3
	Sodium	mg/L			38.3	31.9	59.7	58
Anions	Alkalinity, Total as CaCO3	mg/L			147	173	231	164
	Bicarbonate	mg/L			176	211	281	186
	Carbonate	mg/L			< 6	< 5	< 5	7
	Chloride	mg/L		250	9.47	7	10	5
	Sulfate	mg/L		250	10.7	11	17	7
Redox Species	Iron, Dissolved	mg/L		0.3	< 0.162	< 0.02	0.18	0.02
	Iron, Total	mg/L		0.3	0.0863	< 0.03	0.46	< 0.03
	Manganese, Dissolved	mg/L		0.05	< 0.00515	0.025	0.148	0.031
	Manganese, Total	mg/L		0.05	< 0.005	0.025	0.161	0.03
	Nitrate + Nitrite	mg/L			0.841	0.2	< 0.01	0.01
	Nitrate as N	mg/L	10		< 0.05	0.2	< 0.01	< 0.01
	Nitrite as N	mg/L	1		0.841	< 0.2	< 0.01	< 0.01
Metals	Aluminum	mg/L		0.05 to 2	0.0108	< 0.03	0.03	< 0.03
	Antimony	mg/L	0.006		< 0.002	< 0.001	< 0.001	< 0.001
	Arsenic	mg/L	0.01		0.00197	0.003	< 0.001	< 0.001
	Barium	mg/L	2		0.00519	< 0.05	< 0.05	< 0.05
	Beryllium	mg/L	0.004		0.000216	< 0.001	< 0.001	< 0.001
	Cadmium	mg/L	0.005		< 0.000103	< 0.001	< 0.001	< 0.001
	Chromium	mg/L	0.1		0.00185	< 0.005	< 0.005	< 0.005
	Copper	mg/L	1.3	1	< 0.0005	< 0.005	< 0.005	0.018
	Lead	mg/L	0.015		< 0.0001	< 0.001	< 0.001	< 0.001
	Mercury	mg/L	0.002		< 0.0002	< 0.0001	< 0.0001	< 0.0001
Metals	Nickel	mg/L			< 0.0005	< 0.005	< 0.005	< 0.005

Table 1. Summary of Water Quality of Waters Used in Mixing Analysis

Type	Parameter	Units	Primary MCL	Secondary MCL	Native Groundwater	Municipal Distribution	New Shallow GW Well	New Deep GW Well
	Selenium	mg/L	0.05		< 0.001	< 0.001	0.002	< 0.001
	Silver	mg/L		0.1	< 0.0001	< 0.001	< 0.001	< 0.001
	Thallium	mg/L	0.002		< 0.0005	< 0.0005	< 0.0005	< 0.0005
	Zinc	mg/L		5	< 0.005	< 0.01	< 0.01	0.01
Other Parameters	Color	c.u.		15	< 5	10	14	12
	Corrosivity	--		NC	-0.05	0.14	0.4	0.39
	Cyanide	mg/L	0.2		< 0.003	< 0.005	< 0.005	< 0.005
	Fluoride	mg/L	4	2	0.706	0.3	0.4	0.3
	Odor	ton		3	< 1	4	17	4
	Silica	mg/L			58.6	45	51	35
	Total Organic Carbon	mg/L			0.163	0.9	2.1	1
	Total Suspended Solids	mg/L			0	< 1	8	< 1
Disinfection Byproducts (DBPs)	Bromate	mg/L	0.01		< 0.025	--	< 0.01	< 0.005
	Bromodichloromethane	mg/L			< 0.0005	< 0.0005	< 0.0005	< 0.0005
	Bromoform	mg/L			< 0.0005	0.00069	< 0.0005	< 0.0005
	Chlorine	mg/L	4		0.08	--	--	--
	Chlorite	mg/L	1		< 0.01	--	< 0.01	< 0.01
	Chloroform	mg/L			< 0.0005	< 0.0005	< 0.0005	< 0.0005
	Dibromoacetic Acid (DBAA)	mg/L			< 0.003	< 0.003	< 0.003	< 0.003
	Dibromochloromethane	mg/L			< 0.005	0.00094	< 0.0005	< 0.0005
	Dichloroacetic Acid (DCAA)	mg/L			< 0.003	< 0.003	< 0.003	< 0.003
	Monobromoacetic Acid (MBAA)	mg/L			< 0.003	< 0.003	< 0.003	< 0.003
	Monochloroacetic Acid (MCAA)	mg/L			< 0.003	0.00923	< 0.003	< 0.003
	Total Haloacetic Acids	mg/L	0.06		< 0.003	0.00923	< 0.003	< 0.003
	Total Trihalomethanes	mg/L	0.08		< 0.0005	0.00163	< 0.0005	< 0.0005
	Trichloroacetic Acid (TCAA)	mg/L			< 0.003	< 0.003	< 0.003	< 0.003

Notes

- Unless otherwise notes, all values are the dissolved portion

-- = Not Tested

NC = Noncorrosive

Shading indicates exceedance of Water Quality Criteria

Table 2a. Summary of Mixing Calculations (Native Groundwater + Municipal Distribution System)

Type	Parameter	Units	Primary MCL	Secondary MCL	Municipal Distribution System										
					0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
General	Dissolved Oxygen	mg/L			7.0	6.6	6.3	5.9	5.5	5.2	4.8	4.5	4.1	3.7	3.4
	Eh	mV			764	767	770	772	774	776	778	779	780	781	782
	pH	s.u.		6.5-8.5	8.1	8.0	7.9	7.9	7.8	7.8	7.7	7.7	7.6	7.6	7.6
	Temperature	degC			12.0	12.2	12.5	12.7	12.9	13.2	13.4	13.7	13.9	14.1	14.4
	Total Dissolved Solids	mg/L		500	198	202	206	210	214	218	221	225	229	233	237
Cations	Calcium	mg/L			20.6	21.0	21.4	21.8	22.2	22.6	23.0	23.4	23.8	24.2	24.6
	Magnesium	mg/L			11.2	11.4	11.5	11.7	11.8	12.0	12.1	12.3	12.4	12.6	12.7
	Potassium	mg/L			3.7	3.6	3.6	3.6	3.5	3.5	3.4	3.4	3.4	3.3	3.3
	Sodium	mg/L			38.3	37.7	37.0	36.4	35.8	35.1	34.5	33.8	33.2	32.6	31.9
Anions	Bicarbonate	mg/L			179.0	183.0	186.0	189.0	192.0	195.0	198.0	202.0	205.0	208.0	211.0
	Chloride	mg/L		250	9.5	9.2	9.0	8.7	8.5	8.2	8.0	7.7	7.5	7.3	7.0
	Sulfate	mg/L		250	10.7	10.7	10.8	10.8	10.8	10.9	10.9	10.9	10.9	11.0	11.0
Redox Species	Iron, Dissolved	mg/L		0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Manganese, Dissolved	mg/L		0.05	ND	0.003	0.005	0.008	0.010	0.013	0.015	0.018	0.020	0.023	0.025
	Nitrate as N	mg/L	10		0.8	0.8	0.7	0.6	0.6	0.5	0.5	0.4	0.3	0.3	0.2
	Nitrite as N	mg/L	1		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Metals	Aluminum	mg/L		0.05 to 2	0.011	0.010	0.009	0.008	0.006	0.005	0.004	0.003	0.002	0.001	ND
	Antimony	mg/L	0.006		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Arsenic	mg/L	0.01		0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.003
	Barium	mg/L	2		0.005	0.005	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	ND
	Beryllium	mg/L	0.004		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	ND
	Cadmium	mg/L	0.005		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Chromium	mg/L	0.1		0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	ND
	Copper	mg/L	1.3	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	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
	Selenium	mg/L	0.05		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	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 Parameters	Fluoride	mg/L	4	2	0.7	0.7	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.3	0.3
	Silica	mg/L			59	57	56	55	53	52	51	49	48	46	45
	Total Organic Carbon	mg/L			0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.8	0.8	0.9
Disinfection Byproducts (DBPs)	Bromate	mg/L	0.01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Chlorine	mg/L	4		0.08	0.07	0.06	0.06	0.05	0.04	0.03	0.02	0.02	0.01	ND
	Chlorite	mg/L	1		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Total Haloacetic Acids	mg/L	0.06		ND	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
	Total Trihalomethanes	mg/L	0.08		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Saturation Index	Quartz	unitless			1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.1
	Chalcedony	unitless			1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.8
	SiO2(am)	unitless			-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
	Calcite	unitless			0.0	0.0	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2	-0.3	-0.3	-0.3
	Dolomite	unitless			1.1	1.0	0.9	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.5
	Gypsum	unitless			-3.0	-3.02	-3.01	-3.00	-3.00	-2.99	-2.98	-2.97	-2.96	-2.96	-2.95
	Siderite	unitless			-100	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0
	Fe(OH)3(am)	unitless			-100	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0
	Goethite	unitless			-100	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0	-100.0
	Pyrolusite	unitless			-100	8.0	8.2	8.2	8.3	8.3	8.2	8.2	8.2	8.2	8.1
	Bixbyite	unitless			-100	7.2	7.6	7.7	7.8	7.8	7.8	7.8	7.8	7.7	7.7
	Hausmannite	unitless			-100	3.9	4.4	4.7	4.8	4.8	4.8	4.8	4.8	4.7	4.7
	Rhodochrosite	unitless			-100	-2.1	-1.9	-1.7	-1.7	-1.6	-1.5	-1.5	-1.5	-1.4	-1.4

Notes

Shading indicates either (1) exceedance of Water Quality Criteria, or (2) Saturation Index value greater than 0.0

Table 2b. Summary of Mixing Calculations (Native Groundwater + New Shallow GW Well)

Type	Parameter	Units	Primary MCL	Secondary MCL	Municipal Distribution System										
					0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
General	Dissolved Oxygen	mg/L			7.0	7.1	7.3	7.5	7.6	7.8	8.0	8.1	8.3	8.5	8.6
	Eh	mV			764	768	771	774	777	779	781	783	784	786	787
	pH	s.u.		6.5-8.5	8.1	8.0	7.9	7.9	7.8	7.8	7.8	7.7	7.7	7.7	7.7
	Temperature	degC			12.0	12.0	12.0	12.0	12.1	12.1	12.1	12.1	12.1	12.1	12.1
	Total Dissolved Solids	mg/L		500	198	210	222	234	246	259	271	283	295	307	319
Cations	Calcium	mg/L			20.6	21.0	21.3	21.6	22.0	22.3	22.7	23.0	23.3	23.7	24.0
	Magnesium	mg/L			11.2	11.5	11.7	12.0	12.2	12.5	12.7	13.0	13.2	13.5	13.7
	Potassium	mg/L			3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7
	Sodium	mg/L			38.3	40.5	42.6	44.7	46.9	49.0	51.2	53.3	55.4	57.6	59.7
Anions	Bicarbonate	mg/L			179.0	190.0	200.0	210.0	220.0	231.0	241.0	251.0	262.0	272.0	282.0
	Chloride	mg/L		250	9.5	9.5	9.6	9.6	9.7	9.7	9.8	9.9	9.9	10.0	10.0
	Sulfate	mg/L		250	10.7	11.3	12.0	12.6	13.2	13.9	14.5	15.1	15.8	16.4	17.0
Redox Species	Iron, Dissolved	mg/L		0.3	ND	0.018	0.036	0.054	0.072	0.090	0.108	0.126	0.144	0.162	0.180
	Manganese, Dissolved	mg/L		0.05	ND	0.015	0.030	0.044	0.059	0.074	0.089	0.104	0.118	0.133	0.148
	Nitrate as N	mg/L	10		0.8	0.8	0.7	0.6	0.5	0.4	0.3	0.3	0.2	0.1	ND
	Nitrite as N	mg/L	1		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	ND
Metals	Aluminum	mg/L		0.05 to 2	0.011	0.013	0.015	0.017	0.019	0.020	0.022	0.024	0.026	0.028	0.030
	Antimony	mg/L	0.006		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Arsenic	mg/L	0.01		0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.000	0.000	ND
	Barium	mg/L	2		0.005	0.005	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	ND
	Beryllium	mg/L	0.004		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	ND
	Cadmium	mg/L	0.005		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Chromium	mg/L	0.1		0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	ND
	Copper	mg/L	1.3	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	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
	Selenium	mg/L	0.05		ND	0.000	0.000	0.001	0.001	0.001	0.001	0.001	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 Parameters	Fluoride	mg/L	4	2	0.7	0.7	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.4	0.4
	Silica	mg/L			59	58	57	56	56	55	54	53	53	52	51
	Total Organic Carbon	mg/L			0.2	0.4	0.6	0.7	0.9	1.1	1.3	1.5	1.7	1.9	2.1
Disinfection Byproducts (DBPs)	Bromate	mg/L	0.01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Chlorine	mg/L	4		0.08	0.07	0.06	0.06	0.05	0.04	0.03	0.02	0.02	0.01	ND
	Chlorite	mg/L	1		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Total Haloacetic Acids	mg/L	0.06		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Total Trihalomethanes	mg/L	0.08		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Saturation Index	Quartz	unitless			1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2
	Chalcedony	unitless			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9
	SiO2(am)	unitless			-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2
	Calcite	unitless			0.0	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2
	Dolomite	unitless			1.1	1.0	0.9	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	Gypsum	unitless			-3.0	-3.00	-2.98	-2.95	-2.93	-2.91	-2.88	-2.86	-2.84	-2.82	-2.81
	Siderite	unitless			-100	-12.1	-11.8	-11.5	-11.4	-11.2	-11.1	-11.0	-10.9	-10.8	-10.8
	Fe(OH)3(am)	unitless			-100	3.3	3.6	3.7	3.9	3.9	4.0	4.1	4.1	4.1	4.2
	Goethite	unitless			-100	5.7	6.0	6.2	6.3	6.4	6.5	6.5	6.6	6.6	6.7
	Pyrolusite	unitless			-100	8.8	9.0	9.1	9.1	9.2	9.2	9.2	9.2	9.2	9.2
	Bixbyite	unitless			-100	8.8	9.1	9.3	9.4	9.5	9.5	9.5	9.5	9.6	9.6
	Hausmannite	unitless			-100	6.2	6.7	7.0	7.1	7.2	7.2	7.3	7.3	7.3	7.4
	Rhodochrosite	unitless			-100	-1.4	-1.1	-0.9	-0.8	-0.8	-0.7	-0.6	-0.6	-0.5	-0.5

Notes

Shading indicates either (1) exceedance of Water Quality Criteria, or (2) Saturation Index value greater than 0.0

Table 2c. Summary of Mixing Calculations (Native Groundwater + New Deep GW Well)

			Primary	Secondary	Municipal Distribution System										
Type	Parameter	Units	MCL	MCL	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
General	Dissolved Oxygen	mg/L			7.0	6.3	5.7	5.0	4.4	3.8	3.1	2.5	1.8	1.2	0.5
	Eh	mV			764	762	759	757	755	752	749	746	742	738	731
	pH	s.u.		6.5-8.5	8.1	8.1	8.1	8.1	8.2	8.2	8.2	8.2	8.3	8.3	8.3
	Temperature	degC			12.0	12.1	12.2	12.2	12.3	12.4	12.5	12.5	12.6	12.7	12.8
	Total Dissolved Solids	mg/L		500	198	202	206	210	214	218	222	226	230	234	238
Cations	Calcium	mg/L			20.6	19.7	18.9	18.0	17.2	16.3	15.4	14.6	13.7	12.9	12.0
	Magnesium	mg/L			11.2	10.6	10.1	9.5	9.0	8.4	7.8	7.3	6.7	6.2	5.6
	Potassium	mg/L			3.7	3.5	3.4	3.3	3.1	3.0	2.8	2.7	2.6	2.4	2.3
	Sodium	mg/L			38.3	40.3	42.3	44.2	46.2	48.2	50.1	52.1	54.1	56.0	58.0
Anions	Bicarbonate	mg/L			179.0	182.0	184.0	186.0	188.0	190.0	192.0	194.0	196.0	198.0	200.0
	Chloride	mg/L		250	9.5	9.0	8.6	8.1	7.7	7.2	6.8	6.3	5.9	5.5	5.0
	Sulfate	mg/L		250	10.7	10.3	10.0	9.6	9.2	8.9	8.5	8.1	7.7	7.4	7.0
Redox Species	Iron, Dissolved	mg/L		0.3	ND	0.002	0.004	0.006	0.008	0.010	0.012	0.014	0.016	0.018	0.020
	Manganese, Dissolved	mg/L		0.05	ND	0.003	0.006	0.009	0.012	0.016	0.019	0.022	0.025	0.028	0.031
	Nitrate as N	mg/L	10		0.8	0.8	0.7	0.6	0.5	0.4	0.3	0.3	0.2	0.1	ND
	Nitrite as N	mg/L	1		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	ND
Metals	Aluminum	mg/L		0.05 to 2	0.011	0.010	0.009	0.008	0.006	0.005	0.004	0.003	0.002	0.001	ND
	Antimony	mg/L	0.006		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Arsenic	mg/L	0.01		0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.000	0.000	ND
	Barium	mg/L	2		0.005	0.005	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	ND
	Beryllium	mg/L	0.004		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	ND
	Cadmium	mg/L	0.005		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Chromium	mg/L	0.1		0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000	ND
	Copper	mg/L	1.3	1	ND	0.002	0.004	0.005	0.007	0.009	0.011	0.013	0.014	0.016	0.018
	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
	Selenium	mg/L	0.05		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	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	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	0.010
Other Parameters	Fluoride	mg/L	4	2	0.7	0.7	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.3	0.3
	Silica	mg/L			59	56	54	52	49	47	45	42	40	37	35
	Total Organic Carbon	mg/L			0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.8	0.9	1.0
Disinfection Byproducts (DBPs)	Bromate	mg/L	0.01		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Chlorine	mg/L	4		0.08	0.07	0.06	0.06	0.05	0.04	0.03	0.02	0.02	0.01	ND
	Chlorite	mg/L	1		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Total Haloacetic Acids	mg/L	0.06		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Total Trihalomethanes	mg/L	0.08		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Saturation Index	Quartz	unitless			1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.1
	Chalcedony	unitless			1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.8
	SiO2(am)	unitless			-0.1	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2	-0.3	-0.3	-0.3	-0.3
	Calcite	unitless			0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Dolomite	unitless			1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2
	Gypsum	unitless			-3.0	-3.06	-3.09	-3.13	-3.17	-3.20	-3.24	-3.29	-3.33	-3.38	-3.43
	Siderite	unitless			-100	-13.2	-12.9	-12.7	-12.6	-12.5	-12.5	-12.4	-12.4	-12.3	-12.2
	Fe(OH)3(am)	unitless			-100	2.3	2.6	2.8	2.9	3.0	3.0	3.1	3.1	3.2	3.2
	Goethite	unitless			-100	4.8	5.1	5.3	5.4	5.5	5.5	5.6	5.6	5.7	5.7
	Pyrolusite	unitless			-100	8.3	8.6	8.8	8.9	9.0	9.1	9.2	9.2	9.2	9.1
	Bixbyite	unitless			-100	7.7	8.4	8.8	9.1	9.4	9.6	9.8	9.9	10.0	10.0
	Hausmannite	unitless			-100	4.6	5.6	6.3	6.8	7.2	7.5	7.8	8.0	8.2	8.4
	Rhodochrosite	unitless			-100	-2.0	-1.7	-1.5	-1.3	-1.2	-1.1	-1.0	-0.9	-0.8	-0.8

Notes

Shading indicates either (1) exceedance of Water Quality Criteria, or (2) Saturation Index value greater than 0.0

Table 3.Water Quality Data for Select Columbia River Basalt Wells

Analyte	Unit	Regulatory Standard	Regulatory Criteria	City of Beaverton (Hanson Well) ASR 1 (WASH 8988)	City of Beaverton ASR No. 3 Pilot Well -- Start of Pump Test Day 10	City of Tigard ASR 1	City of Tigard ASR 2	Grabhorn Well	TVWD Miller Hill Road Well	Cornelius Test Well
Date Sampled				**7/14/1994**	**3/18/2004**	**11/29/2001**	**8/4/2004**	**5/15/2003**	**10/21/2011**	**1/20/2015**
Alkalinity	mg/L	250	SMCL	110	NT	109	139	135	100	140
Calcium	mg/L	None	None	36	58	25	26.1	23.4	15	31
Chloride	mg/L	250	SMCL	47.5	210	3.7	16	3.86	3.5	380
Total Hardness, as CaCO3	mg/L	250	SMCL	140	256	108	120	107	70	120
Bicarbonate (HCO3)	mg/L	None	None	110	NT	133	139	138	120	170
Potassium	mg/L	None	None	2.6	7.9	3	5.3	2.8	2.6	30
Magnesium	mg/L	None	None	19	27	11	13.7	11.9	7.7	10
Manganese Total	mg/L	0.05	SMCL	NT	0.085	0.0024	0.14	ND	0.021	0.14
Manganese Dissolved	mg/L	None	None	NT	NT	NT	0.14	0.01	ND	0.15
Iron Total	mg/L	0.3	SMCL	ND	0.12	ND	0.13	ND	0.18	0.15
Iron Dissolved	mg/L	None	None	NT	NT	NT	ND	NT	ND	0.16
Fluoride	mg/L	2	SMCL	ND	NT	0.09	ND	0.11	0.18	1.2
Sodium	mg/L	20	URC (advisory)	12.1	73	8.2	21.3	13.3	20	220
Nitrite as N	mg/L	1	MCL	0	NT	ND	ND	ND	ND	ND
Nitrate as N	mg/L	10	MML	0.56	NT	1.7	0.9	0.09	ND	ND
Silica	mg/L	None	None	NT	NT	NT	55.1	66.5	59	66
Sulfate	mg/L	250	URC, SMCL	ND	NT	4.3	ND	2.33	2.3	ND
Total Dissolved Solids	mg/L	500	SMCL	245	530	200	220	210	150	870
Total Organic Carbon	mg/L	None	None	0.7	NT	NT	ND	ND	ND	0.54
Total Suspended Solids	mg/L	None	None	ND	NT	NT	ND	NT	ND	ND
Field pH	Units	6 - 8.5	None	6.88	6.78	6.78	7.14	7.2	7.45	7.53
Field Temperature	Celsius	None	None	NT	15.7	11.7	15.2	14.4	15.7	19.7
Field Specific Conductance	umho/cm	None	None	377	902	NT	349	252	218	957
Field Dissolved Oxygen	mg/l	None	None	4.2	6.3	6.98	1.5	NT	1.86	0.39
Odor	TON	3	SMCL	NT	NT	NT	NT	ND	1	ND
Radon 222	pCi/l	300 or 4000	Proposed MCL	NT	NT	NT	NT	NT	330	460
Field Oxidation-Reduction Potential	mV	None	None	NT	NT	NT	NT	72.9	NT	-89.8

Footnotes:

Analytical data shown in shading exceed the applicable regulatory standard

ND = not detected

NT = not tested

SMCL = Secondary Maximum Contaminant Levels -- Federal Regulations

MCL = Maximum Contaminant Levels -- Federal Regulations

MML = Maximum Measurable Level -- Oregon Department of Environmental Quality

URC = Oregon Health Authority Unregulated Contaminants

mg/l = milligrams per liter

umhos/cm = micromhos per centimeter

Celsius (C = 5/9 (F - 32))

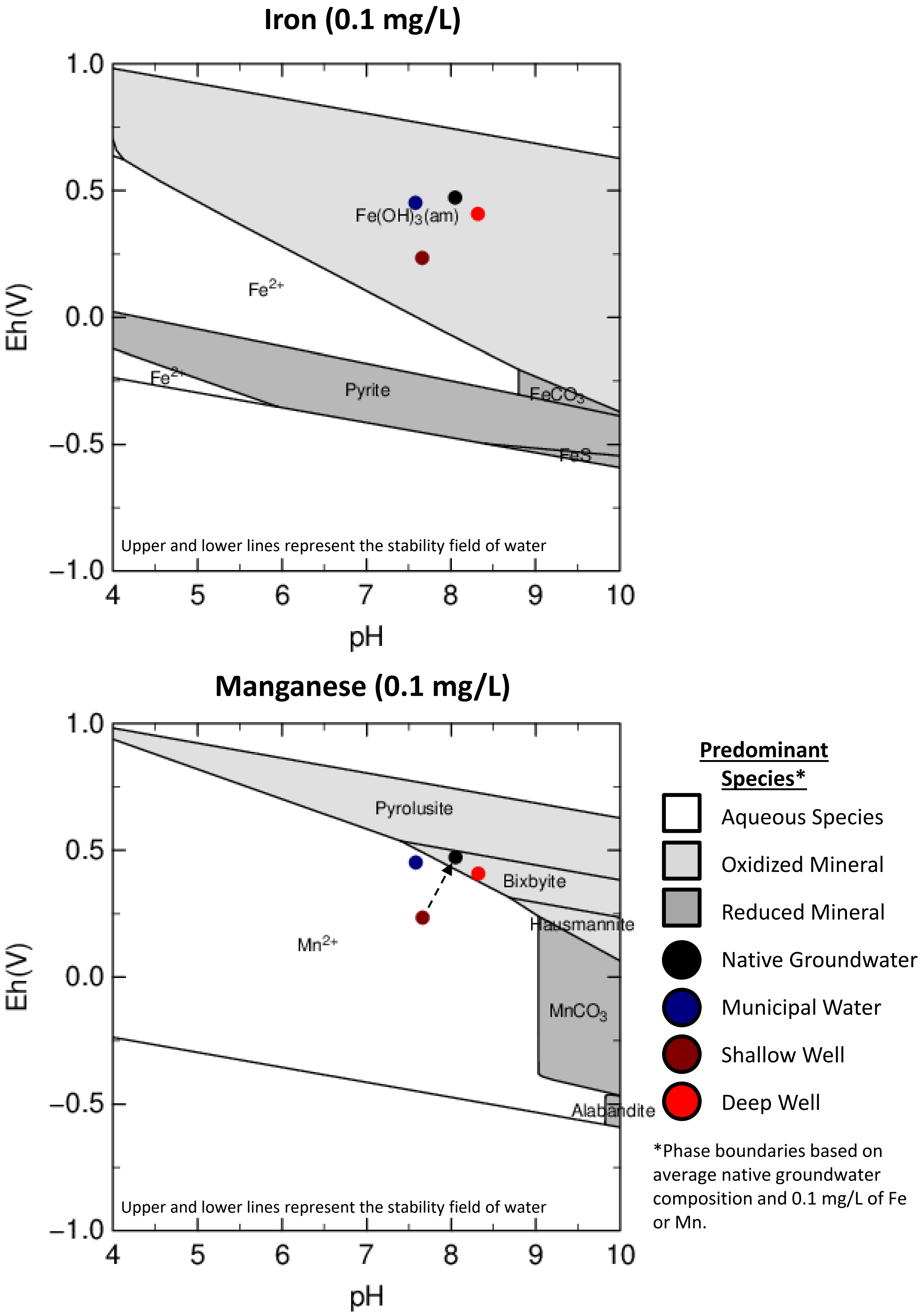
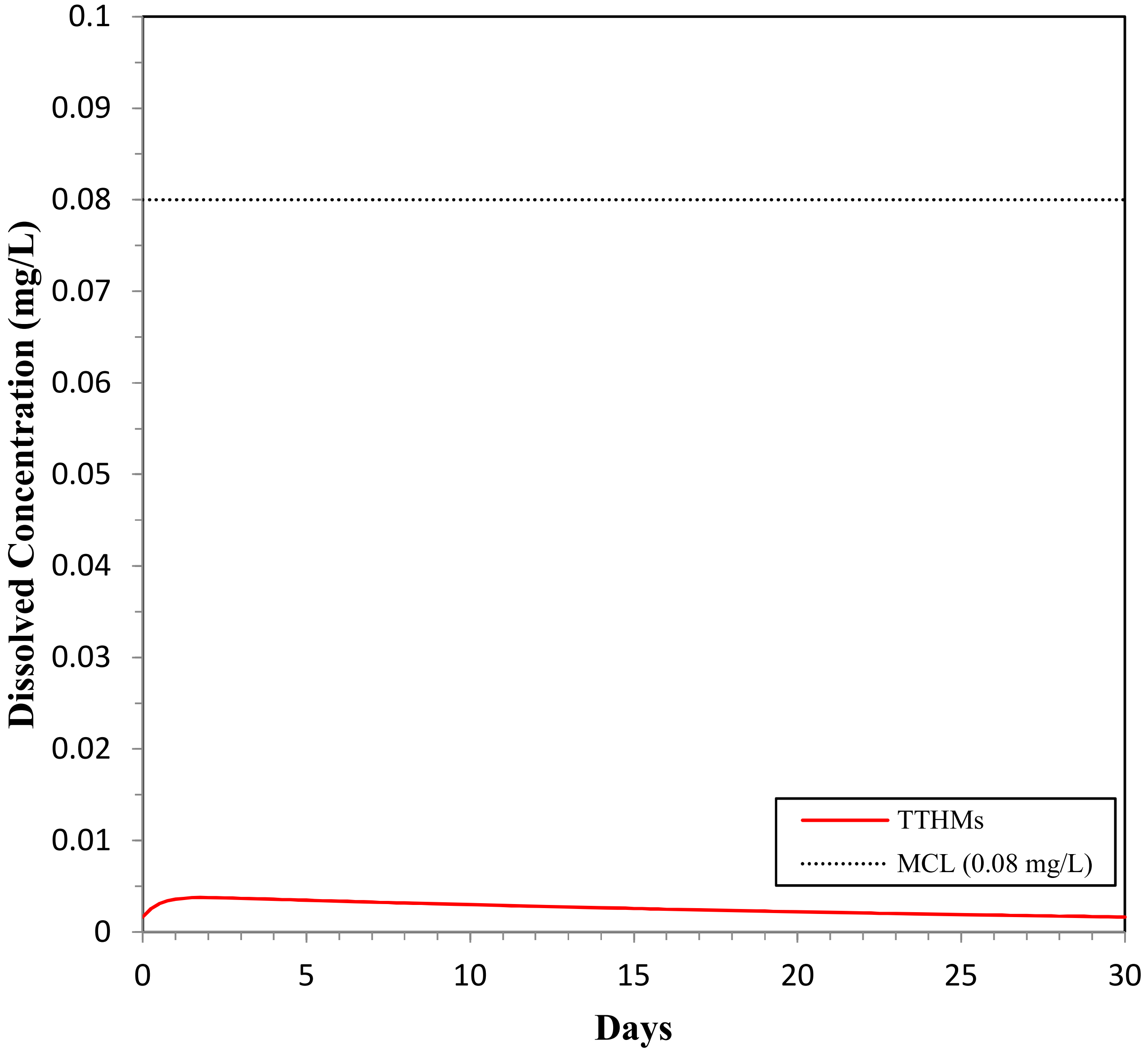


Figure 1. Eh-pH diagram for iron (*top*) and manganese (*bottom*) showing the stability fields of minerals and dissolved species.

Figure 2. Predicted Change in TTHMs Over Time



Appendix D

New Alluvial Water Source Investigation
OWRD Well Logs

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CROO 54587
2/16/2018

WELL I.D. LABEL# L 127083
START CARD # 1037842
ORIGINAL LOG #

(1) LAND OWNER

Owner Well I.D. STW-1
First Name JIM Last Name NEWTON
Company CITY OF PRINEVILLE
Address 387 NE 3RD ST
City PRINEVILLE State OR Zip 97754

(2) TYPE OF WORK

☒ New Well ☐ Deepening ☐ Conversion
☐ Alteration (complete 2a & 10) ☐ Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:		☐				○	○	☐	☐

	Material	From	To	Amt	sacks/lbs
Seal:					

(3) DRILL METHOD

☐ Rotary Air ☐ Rotary Mud ☒ Cable ☐ Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☐ Community
☐ Industrial/ Commericial ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☒ Other EXPLORITORY

(5) BORE HOLE CONSTRUCTION

Special Standard ☐ (Attach copy)
Depth of Completed Well 40.00 ft.

BORE HOLE Dia	From	To
12	0	40

SEAL Material	From	To	Amt	sacks/ lbs
Bentonite Chips	0	18	53	S
		Calculated	14	
		Calculated		

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☒ Other POURED DRY
Backfill placed from ft. to ft. Material
Filter pack from 18 ft. to 40 ft. Material SAND Size 8/12
Explosives used: ☐ Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
●	○	6	☒	2	20	.250	●	○	☒	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☒ Outside ☐ Other Location of shoe(s)
Temp casing ☒ Yes Dia 12 From + ☒ 1 To 40

(7) PERFORATIONS/SCREENS

Perforations Method
Screens Type JOHNSON Material STAINLESS

Perf/ Screen	Casing/ Screen Liner	Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Screen	Casing	6	20	40	.05			

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

○ Pump ● Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
100	26	38	120
25	5		4

Temperature 54 °F Lab analysis ☐ Yes By
Water quality concerns? ☐ Yes (describe below) TDS amount 111 ppm

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County CROOK Twp 15.00 S N/S Range 16.00 E E/W WM
Sec 8 NW 1/4 of the NW 1/4 Tax Lot 201
Tax Map Number Lot
Lat ° ' " or 44.28944444 DMS or DD
Long ° ' " or -120.84569444 DMS or DD
○ Street address of well ● Nearest address

WEST OF MAIN ST/CROOKED RIVER HWY CROOKED RIVER PARK (STW-1)

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration			☐	
Completed Well	1/9/2018		☐	11

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found 14.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
10/24/2017	24	37	20		☐	12
					☐	
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation 2886.00

Material	From	To
CLAY GRAVEL	0	9
SILT GRAY CLAY	9	12
GRAVELS SAND GRAY	12	24
SILT SAND GRAY	24	32
CLAY SAND GRAY	32	37
CLAY GRAY	37	40

Date Started 10/24/2017 Completed 1/9/2018

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number 758 Date 2/16/2018

Signed THOMAS R PECK (E-filed)

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1720 Date 2/16/2018

Signed JACK ABBAS (E-filed)

Contact Info (optional)

ORIGINAL - WATER RESOURCES DEPARTMENT

THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK Form Version:

WATER SUPPLY WELL REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

CROO 54587

2/16/2018

Map of Hole

STATE OF OREGON
WELL LOCATION MAP
This map is supplemental to the WATER SUPPLY WELL REPORT

Oregon Water Resources Department
725 Summer St NE, Salem OR 97301
(503)986-0900

LOCATION OF WELL

Latitude: 44.28944444 Datum: WGS84
Longitude: -120.84569444
Township/Range/Section/Quarter-Quarter Section:
WM 6S 2W 34 NWNW
Address of Well:
WEST OF MAIN ST/CROOKED RIVER HWY CROOKED RIVER PARK (STW-1)

Well Label: 127083

Printed: February 16, 2018

DISCLAIMER: This map is intended to represent the approximate location the well. It is not intended to be construed as survey accurate in any manner.

Provided by well constructor

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CROO 54588
2/16/2018

WELL I.D. LABEL# L 129187
START CARD # 1037839
ORIGINAL LOG #

(1) LAND OWNER

Owner Well I.D. DTW-3
First Name JIM Last Name NEWTON
Company CITY OF PRINEVILLE
Address 387 NE 3RD ST
City PRINEVILLE State OR Zip 97754

(2) TYPE OF WORK

☒ New Well ☐ Deepening ☐ Conversion
☐ Alteration (complete 2a & 10) ☐ Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:		☐				○	○	☐	☐

	Material	From	To	Amt	sacks/lbs
Seal:					

(3) DRILL METHOD

☐ Rotary Air ☐ Rotary Mud ☒ Cable ☐ Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☐ Community
☐ Industrial/ Commericial ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☒ Other EXPLORITORY

(5) BORE HOLE CONSTRUCTION

Special Standard ☐ (Attach copy)
Depth of Completed Well 140.00 ft.

BORE HOLE		
Dia	From	To
16	0	140

SEAL				sacks/
Material	From	To	Amt	lbs
Bentonite Chips	0	7	28	S
		Calculated	10	
Cement	7	70	70	S
		Calculated	39	

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E
☒ Other POURED DRY
Backfill placed from ft. to ft. Material
Filter pack from 70 ft. to 140 ft. Material PEA GRAVE Size pea gravel
Explosives used: ☐ Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
●	○	8	☒	2	140	.250	●	○	☒	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☒ Outside ☐ Other Location of shoe(s)
Temp casing ☒ Yes Dia 16 From + ☒ 1 To 140

(7) PERFORATIONS/SCREENS

Perforations Method MACHINE
Screens Type Material

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Perf	Casing	8	80	140	.125	3	1824	

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

○ Pump ● Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
30	10		2

Temperature 54 °F Lab analysis ☐ Yes By
Water quality concerns? ☐ Yes (describe below) TDS amount 120 ppm

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County CROOK Twp 15.00 S N/S Range 16.00 E E/W WM
Sec 8 NW 1/4 of the NW 1/4 Tax Lot 203
Tax Map Number Lot
Lat ° ' " or 44.28961111 DMS or DD
Long ° ' " or -120.84225000 DMS or DD
○ Street address of well ● Nearest address

EAST OF MAIN ST/CRROKED RIVER HWY \NCROOKED RIVER PARK (DTW-3)

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration			☐	
Completed Well	2/6/2018		☐	4

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found 10.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
1/19/2018	10	25	20		☐	10
1/24/2018	70	112	20		☐	4
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation 2876.00

Material	From	To
CLAY SAND SILT	0	9
GRAVELS LARGE	9	25
SILT GRAY CLAY	25	70
SAND GRAY	70	112
SILTY GRAY SAND	112	140

Date Started 1/19/2018 Completed 2/6/2018

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number Date

Signed

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1720 Date 2/16/2018

Signed JACK ABBAS (E-filed)
Contact Info (optional)

WATER SUPPLY WELL REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

CROO 54588

2/16/2018

Map of Hole

STATE OF OREGON
WELL LOCATION MAP
This map is supplemental to the WATER SUPPLY WELL REPORT

Oregon Water Resources Department
725 Summer St NE, Salem OR 97301
(503)986-0900

LOCATION OF WELL
Latitude: 44.28961111 Datum: WGS84
Longitude: -120.84225
Township/Range/Section/Quarter-Quarter Section:
WM 15S 16E 8 NWNW
Address of Well:
EAST OF MAIN ST/CRROKED RIVER HWY
CROOKED RIVER PARK (DTW-3)

Well Label: 129187

Printed: February 16, 2018

DISCLAIMER: This map is intended to represent the approximate location the well. It is not intended to be construed as survey accurate in any manner.

Provided by well constructor

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CROO 54589
2/16/2018

WELL I.D. LABEL# L 127081
START CARD # 1037841
ORIGINAL LOG #

(1) LAND OWNER

Owner Well I.D. STW-2
First Name JIM Last Name NEWTON
Company CITY OF PRINEVILLE
Address 387 NE 3RD ST
City PRINEVILLE State OR Zip 97754

(2) TYPE OF WORK

☒ New Well ☐ Deepening ☐ Conversion
☐ Alteration (complete 2a & 10) ☐ Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:		☐				○	○	☐	☐

	Material	From	To	Amt	sacks/lbs
Seal:					

(3) DRILL METHOD

☐ Rotary Air ☐ Rotary Mud ☒ Cable ☐ Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☐ Community
☐ Industrial/ Commericial ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☒ Other EXPLORITORY

(5) BORE HOLE CONSTRUCTION

Special Standard ☐ (Attach copy)
Depth of Completed Well 40.50 ft.

BORE HOLE

Dia	From	To
12	0	40.5

SEAL

Material	From	To	Amt	sacks/ lbs
Bentonite Chips	0	18	27	S
		Calculated	14	
		Calculated		

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☒ Other POURED DRY
Backfill placed from ft. to ft. Material
Filter pack from 18 ft. to 40.5 ft. Material PEA GRAVE Size 6/9
Explosives used: ☐ Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☐ Outside ☐ Other Location of shoe(s)
Temp casing ☐ Yes Dia From + ☐ To

(7) PERFORATIONS/SCREENS

Perforations Method MACHINE
Screens Type Material

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Perf	Casing	6	20.5	40.5	.125	3	456	

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

○ Pump ● Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
20	20		2

Temperature 54 °F Lab analysis ☐ Yes By
Water quality concerns? ☐ Yes (describe below) TDS amount 115 ppm

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County CROOK Twp 15.00 S N/S Range 16.00 E E/W WM
Sec 8 NW 1/4 of the NW 1/4 Tax Lot 201
Tax Map Number Lot
Lat ° ' " or 44.28969444 DMS or DD
Long ° ' " or -120.84572222 DMS or DD
○ Street address of well ● Nearest address

WEST OF MAIN ST/CROOKED RIVER HWY
CROOKED RIVER PARK (STW-2)

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration			☐	
Completed Well	12/14/2017		☐	8

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found 10.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
10/31/2017	10	37	20		☐	8
					☐	
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation 2864.00

Material	From	To
CLAY BROWN	0	10
GRAVELS SAND BROWN	10	12
GRAVELS SAND SILT GRAY	12	20
LARGE GRAVELS TIGHT	20	22
SILT GRAY SAND	22	35
SAND GRAVELS GRAY SMALL	35	37
CLAY SILT GRAY	37	40.5

Date Started 10/30/2017 Completed 12/14/2017

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number 758 Date 2/16/2018

Signed THOMAS R PECK (E-filed)

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1720 Date 2/16/2018

Signed JACK ABBAS (E-filed)
Contact Info (optional)

WATER SUPPLY WELL REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

CROO 54589

2/16/2018

Map of Hole

STATE OF OREGON
WELL LOCATION MAP

This map is supplemental to the WATER SUPPLY WELL REPORT

Oregon Water Resources Department
725 Summer St NE, Salem OR 97301
(503)986-0900

LOCATION OF WELL

Latitude: 44.28969444 Datum: WGS84

Longitude: -120.84572222

Township/Range/Section/Quarter-Quarter Section:

WM 15S 16E 8 NWNW

Address of Well:

WEST OF MAIN ST/CROOKED RIVER HWY CROOKED RIVER PARK (STW-2)

Well Label: 127081

Printed: February 16, 2018

DISCLAIMER: This map is intended to represent the approximate location the well. It is not intended to be construed as survey accurate in any manner.

Provided by well constructor

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CROO 54591
2/18/2018

WELL I.D. LABEL# L 127080
START CARD # 1037844
ORIGINAL LOG #

(1) LAND OWNER

Owner Well I.D. STW-3
First Name JIM Last Name NEWTON
Company CITY OF PRINEVILLE
Address 387 NE 3RD ST
City PRINEVILLE State OR Zip 97754

(2) TYPE OF WORK

☒ New Well ☐ Deepening ☐ Conversion
☐ Alteration (complete 2a & 10) ☐ Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:		☐				○	○	☐	☐

	Material	From	To	Amt	sacks/lbs
Seal:					

(3) DRILL METHOD

☐ Rotary Air ☐ Rotary Mud ☒ Cable ☐ Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☐ Community
☐ Industrial/ Commerical ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☒ Other EXPLORITORY

(5) BORE HOLE CONSTRUCTION

Special Standard ☐ (Attach copy)
Depth of Completed Well 40.00 ft.

BORE HOLE

Dia	From	To
12	0	40

SEAL

Material	From	To	Amt	sacks/ lbs
Bentonite Chips	0	18	47	S
		Calculated	14	
		Calculated		

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☒ Other POURED DRY
Backfill placed from ft. to ft. Material
Filter pack from 18 ft. to 40 ft. Material SAND Size 6/9
Explosives used: ☐ Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
●	○	6	☒	2	40	.250	●	○	☒	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☒ Outside ☐ Other Location of shoe(s)
Temp casing ☒ Yes Dia 12 From + ☒ 1 To 40

(7) PERFORATIONS/SCREENS

Perforations Method MACHINE
Screens Type Material

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Perf	Casing	6	20	40	.125	3	456	

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

○ Pump ● Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
20	10		2

Temperature 54 °F Lab analysis ☐ Yes By
Water quality concerns? ☐ Yes (describe below) TDS amount 111 ppm

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County CROOK Twp 15.00 S N/S Range 16.00 E E/W WM
Sec 8 NW 1/4 of the NW 1/4 Tax Lot 201
Tax Map Number Lot
Lat ° ' " or 44.28969444 DMS or DD
Long ° ' " or -120.84525000 DMS or DD
○ Street address of well ● Nearest address

WEST OF MAIN ST/CROOKED RIVER HWY \NCROOKED RIVER PARK (STW-3) S SIDE OF NW BASEBALL FIELD

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration			☐	
Completed Well	12/12/2017		☐	11

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found 18.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
11/3/2017	18	25	20		☐	11
					☐	
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation 2868.00

Material	From	To
CLAY BROWN	0	12
GRAVELS LARGE	12	17
LARGE GRAVELS TIGHT	17	18.5
SAND GRAVELS GRAY	18.5	25
SILT SAND GRAY	25	40

Date Started 11/3/2017 Completed 12/12/2017

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number 758 Date 2/16/2018

Signed THOMAS PECK (E-filed)

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1720 Date 2/18/2018

Signed JACK ABBAS (E-filed)
Contact Info (optional)

ORIGINAL - WATER RESOURCES DEPARTMENT
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK Form Version:

WATER SUPPLY WELL REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

CROO 54591

2/18/2018

Map of Hole

STATE OF OREGON
WELL LOCATION MAP

This map is supplemental to the WATER SUPPLY WELL REPORT

Oregon Water Resources Department
725 Summer St NE, Salem OR 97301
(503)986-0900

LOCATION OF WELL

Latitude: 44.28969444 Datum: WGS84

Longitude: -120.84525

Township/Range/Section/Quarter-Quarter Section:
WM 6S 2W 34 NWNW

Address of Well:
WEST OF MAIN ST/CROOKED RIVER HWY
CROOKED RIVER PARK (STW-3) S SIDE OF NW BASEBALL FIELD

Well Label: 127080

Printed: February 17, 2018

DISCLAIMER: This map is intended to represent the approximate location the well. It is not intended to be construed as survey accurate in any manner.

Provided by well constructor

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CROO 54592

2/18/2018

WELL I.D. LABEL# L 129186
START CARD # 1037840
ORIGINAL LOG #

(1) LAND OWNER
Owner Well I.D. DTW-2
First Name JIM Last Name NEWTON
Company CITY OF PRINEVILLE
Address 387 NE 3RD ST
City PRINEVILLE State OR Zip 97754

(2) TYPE OF WORK
☒ New Well ☐ Deepening ☐ Conversion
☐ Alteration (complete 2a & 10) ☐ Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:		☐				○	○	☐	☐

	Material	From	To	Amt	sacks/lbs
Seal:					

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

(4) PROPOSED USE
☐ Domestic ☐ Irrigation ☐ Community
☐ Industrial/ Commercial ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☒ Other EXPLORITORY

(5) BORE HOLE CONSTRUCTION
Special Standard ☐ (Attach copy)
Depth of Completed Well 140.00 ft.

BORE HOLE			SEAL				sacks/
Dia	From	To	Material	From	To	Amt	lbs
16	0	140	Bentonite Chips	0	7	14	S
					Calculated	10	
			Cement	7	50	70	S
					Calculated	31	

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E
☒ Other POURED DRY
Backfill placed from ft. to ft. Material
Filter pack from 50 ft. to 140 ft. Material SAND Size 50 MESH
Explosives used: ☐ Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE
Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
●	○	8	☒	2	60	.250	●	○	☒	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☒ Outside ☐ Other Location of shoe(s)
Temp casing ☒ Yes Dia 16 From + ☒ 1 To 140

(7) PERFORATIONS/SCREENS
Perforations Method
Screens Type JOHNSON Material STAINLESS

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Screen	Casing	8	60	140	.008			

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

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
20	25		2

Temperature 54 °F Lab analysis ☐ Yes By
Water quality concerns? ☐ Yes (describe below) TDS amount 118 ppm

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)
County CROOK Twp 15.00 S N/S Range 16.00 E E/W WM
Sec 8 NW 1/4 of the NW 1/4 Tax Lot 201
Tax Map Number Lot
Lat ° ' " or 44.28905556 DMS or DD
Long ° ' " or -120.84419444 DMS or DD
○ Street address of well ● Nearest address

WEST OF MAIN ST/CROOKED RIVER HWY
CROOKED RIVER PARK (DTW-2)

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration			☐	
Completed Well	1/17/2018		☐	4

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found 13.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
11/7/2017	13	22	20		☐	10
11/8/2017	32	133	20		☐	4
					☐	
					☐	
					☐	

(11) WELL LOG
Ground Elevation 2876.00

Material	From	To
FILL	0	2
CLAY SILT BROWN	2	6
CLAY SILT GRAY	6	13
GRAVELS	13	16
GRAVELS TIGHT LARGE	16	23
SILT CLAY GRAY	23	32
SAND FINE GRAY HEAVING	32	56
SAND TIGHT LOOSE LAYERS	56	133
CLAY GRAY	133	140

Date Started 11/17/2017 Completed 1/17/2018

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number 758 Date 2/18/2018

Signed THOMAS PECK (E-filed)

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1720 Date 2/18/2018

Signed JACK ABBAS (E-filed)
Contact Info (optional)

ORIGINAL - WATER RESOURCES DEPARTMENT
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK Form Version:

WATER SUPPLY WELL REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

CROO 54592

2/18/2018

Map of Hole

STATE OF OREGON
WELL LOCATION MAP

This map is supplemental to the WATER SUPPLY WELL REPORT

Oregon Water Resources Department
725 Summer St NE, Salem OR 97301
(503)986-0900

LOCATION OF WELL

Latitude: 44.28905556 Datum: WGS84

Longitude: -120.84419444

Township/Range/Section/Quarter-Quarter Section:

WM 15S 16E 8 NWNW

Address of Well:

WEST OF MAIN ST/CROOKED RIVER HWY
CROOKED RIVER PARK (DTW-2)

Well Label: 129186

Printed: February 18, 2018

DISCLAIMER: This map is intended to represent the approximate location the well. It is not intended to be construed as survey accurate in any manner.

Provided by well constructor

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CROO 54593
2/19/2018

WELL I.D. LABEL# L 127082
START CARD # 1037843
ORIGINAL LOG #

(1) LAND OWNER

Owner Well I.D. DTW-1
First Name JIM Last Name NEWTON
Company CITY OF PRINEVILLE
Address 387 NE 3RD ST
City PRINEVILLE State OR Zip 97754

(2) TYPE OF WORK

☒ New Well ☐ Deepening ☐ Conversion
☐ Alteration (complete 2a & 10) ☐ Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:		☐				○	○	☐	☐

	Material	From	To	Amt	sacks/lbs
Seal:					

(3) DRILL METHOD

☐ Rotary Air ☐ Rotary Mud ☒ Cable ☐ Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☐ Community
☐ Industrial/ Commericial ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☒ Other EXPLORITORY

(5) BORE HOLE CONSTRUCTION

Special Standard ☐ (Attach copy)
Depth of Completed Well 87.00 ft.

BORE HOLE			SEAL				sacks/
Dia	From	To	Material	From	To	Amt	lbs
16	0	140	Bentonite Chips	0	4	7	S
					Calculated	6	
			Cement	4	50	70	S
					Calculated	31	

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E
☒ Other POURED DRY
Backfill placed from 87 ft. to 140 ft. Material PEA GRAVEL
Filter pack from 50 ft. to 87 ft. Material SAND Size 6/9
Explosives used: ☐ Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
●	○	8	☒	2	52	.250	●	○	☒	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☒ Outside ☐ Other Location of shoe(s)
Temp casing ☒ Yes Dia 16 From + ☒ 1 To 73

(7) PERFORATIONS/SCREENS

Perforations Method
Screens Type JOHNSON Material STAINLESS

Perf/ Screen	Casing/ Screen Liner	Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Screen	Casing	8	52	87	.01			

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

● Pump ○ Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
20	20		2
103	54	80	120

Temperature 54 °F Lab analysis ☐ Yes By
Water quality concerns? ☐ Yes (describe below) TDS amount 572 mg/L

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County CROOK Twp 15.00 S N/S Range 16.00 E E/W WM
Sec 8 NW 1/4 of the NW 1/4 Tax Lot 201
Tax Map Number Lot
Lat ° ' " or 44.28950000 DMS or DD
Long ° ' " or -120.84572222 DMS or DD
○ Street address of well ● Nearest address

WEST OF MAIN ST/CROOKED RIVER HWY
CROOKED RIVER PARK (DTW-1)

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration			☐	
Completed Well	1/5/2018		☐	4.5

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found 14.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
10/3/2017	14	27	20		☐	10
10/6/2017	42	58	20		☐	4.5
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation 2875.00

Material	From	To
TOP SOIL	0	1
CLAY BROWN	1	9
CLAY SAND	9	14
GRAVELS GRAY SILT COARS MEDIUM	14	27
CLAY SILT GRAVELS	27	38
SILT CLAY	38	42
GRAVELS SAND SILT	42	58
CLAY GRAY	58	88
CLAY GRAY ASH MIX	88	104
CLAY HARD GRAY	104	120
CLAY SOFT STICKY BROWN	120	140

Date Started 10/2/2017 Completed 1/5/2018

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number 758 Date 2/16/2018

Signed THOMAS PECK (E-filed)

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1720 Date 2/19/2018

Signed JACK ABBAS (E-filed)
Contact Info (optional)

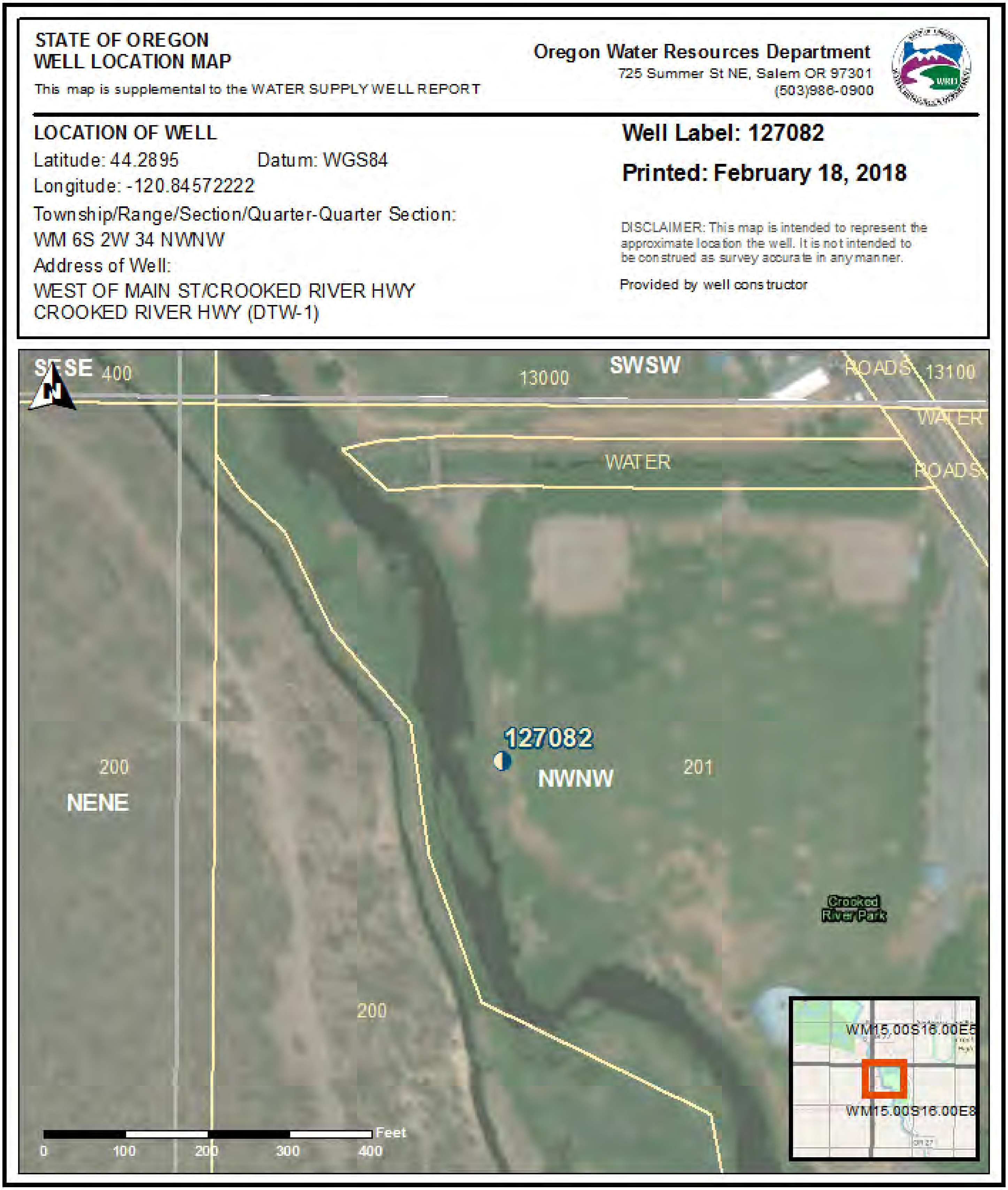
ORIGINAL - WATER RESOURCES DEPARTMENT
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK Form Version:

WATER SUPPLY WELL REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

CROO 54593

2/19/2018

Map of Hole



STATE OF OREGON
WELL LOCATION MAP

This map is supplemental to the WATER SUPPLY WELL REPORT

Oregon Water Resources Department
725 Summer St NE, Salem OR 97301
(503)986-0900

LOCATION OF WELL

Latitude: 44.2895 Datum: WGS84

Longitude: -120.84572222

Township/Range/Section/Quarter-Quarter Section:
WM 6S 2W 34 NWNW

Address of Well:
WEST OF MAIN ST/CROOKED RIVER HWY
CROOKED RIVER HWY (DTW-1)

Well Label: 127082

Printed: February 18, 2018

DISCLAIMER: This map is intended to represent the approximate location the well. It is not intended to be construed as survey accurate in any manner.

Provided by well constructor

Appendix E

Aquifer Test Summary for the New Alluvial Wellfield

Technical Memorandum

CASCADE
GEOENGINEERING

21145 Scottsdale DR, Bend, Oregon 97701
360-907-4162 newtonjim@hotmail.com

May 20, 2018

REGISTERED
OREGON
JAMES B. NEWTON
G-2122
GEOLOGIST

James B. Newton

TO:
Bruce Brody-Heine, RG, CWRE
GSI Water Solutions

FROM:
Jim Newton, P.E., R.G., C.W.R.E.
Cascade Geoengineering, LLC

RE: SUMMARY OF GROUNDWATER SOURCE INVESTIGATION – CITY OF PRINEVILLE ASR FEASIBILITY; CROOK COUNTY, OREGON

This memorandum was prepared by Cascade Geoengineering, LLC (CGE) to assess potential new municipal water source for the City of Prineville Aquifer Storage and Recovery Project (Project) located in Prineville, Oregon. CGE specializes in water supply and water resources management. Accordingly, CGE has provided hydrogeologic services related to geologic investigation and has prepared Project source water test-well designs, and recommendations for installation and testing.

The City of Prineville (City) contracted with GSI Water Solutions (GSI) for work that includes overseeing the installation of 6 test wells used to investigate groundwater capacity on the identified Crooked River Park and adjacent Crook County Fairgrounds properties (Site), and the provision of preliminary results of short-duration pump tests. The locations of the test wells, the results of the well pump tests and the Project Vicinity Map (Figure 1) are attached to this memorandum.

INTRODUCTION

The Project consists of installation and testing of groundwater source wells located within the Site. These wells will serve to investigate the potential for production of up to 2,000 gallons per minute (gpm) of flow from within the Site, to be used by the City for injection into the airport area aquifer system near the Prineville Municipal Airport. The Airport is just over 1 mile west of the City of Prineville. (See Figure 1).

The purpose of this assessment is to provide a summary of the well installations and pump testing of two of these wells on the Site and to determine a reasonable course of action that may allow the City to achieve 2,000 gpm of source water for City and ASR use. The Site is shown on the attached Figure 2. Analysis logs of wells in the Site vicinity and boring test data indicates that groundwater exists in geologic strata underlying the Site. The findings also suggest that it is feasible to obtain groundwater from geologic strata beneath the Site for needs of the objectives of the Project.

SITE LOCATION

The Project area is approximately 33.06 acres located on the south end of the City of Prineville in section 8, township 15 south, range 16 east, Willamette Meridian. The Site currently consists of Crooked County Park (Park, 26.3 acres) and Crook County Fairground property (Fairgrounds, 6.76 acres) with the two properties separated by the Crooked River Highway. Prior to the onsite test well installations which inform this investigation, two shallow wells were sited within the Park, one of which was used for Park irrigation and the other was previously used for lavatory facilities. Additionally, the Fairgrounds site has two existing wells that were installed by the City in 2006 for exploratory purposes. The western border of the Park is bound by the Crooked River and to the north by the Juniper Canal (flood control canal). The area immediately east and south of the Fairgrounds is bordered by farm or grazing lands.

REGIONAL HYDROGEOLOGY

Source of Groundwater

The upper Deschutes River Basin covers about 4,500 square miles and extends between the headwaters of the Deschutes and Little Deschutes Rivers on the south to Lake Billy Chinook on the north. The High Cascade Mountain Range bounds the southwest and west sides of the basin. The Ochoco Mountain complex bounds the easterly side of the basin. The Crooked River comprises the eastern portion of the upper Deschutes River Basin and is a major tributary to the Deschutes River downstream from Prineville near Culver, Oregon.

The source of groundwater in the upper basin is precipitation and water from melting snow which infiltrates into the ground through permeable soil and rock. Downward infiltrating water ultimately comes to rest upon subsurface formations with low permeability which prevents or impedes continued downward movement. Accumulated groundwater moves under gravitational forces through permeable flow paths from high elevation recharge areas to low elevation discharge areas. Recharge areas are where the more significant amounts of precipitation and water from melted snow enter the ground to supply the groundwater system. Discharge areas are where the groundwater escapes the subsurface aquifer system through springs or through streambeds in canyons that have been down cut across the aquifers.

Recharge Areas

The principal groundwater recharge area is located in the higher elevations of the Cascade Mountain Range along the west boundary and the relatively high-elevation areas in the south and southeast parts of the upper basin. These areas receive substantial precipitation and snow pack. Local precipitation in high elevation areas near the west boundary of the upper basin can exceed 200 inches per year, mostly as snow during the winter. Annual precipitation rates drop toward the east to less than 10 inches per year in the central part of the upper basin near the City and the Project.

Discharge Areas

Groundwater discharge from the upper Deschutes Basin occurs primarily in Davis and Cultus Creeks, the Fall and Spring Rivers south of Bend, the Deschutes and Crooked Rivers north of Lower Bridge, and in Whychus Creek and the Metolius River. The incised canyons of the Deschutes and Crooked Rivers, and Whychus Creek are down-cut across aquifer zones in the lower-elevation part of the upper basin, resulting in groundwater discharge into the streams near Lake Billy Chinook. Of the major discharge areas, those in the Deschutes and Crooked Rivers near Lake Billy Chinook are nearest the Site, at distances of approximately 15 to 20 miles to the west-northwest. The Fall, Metolius, and Spring Rivers flow from large springs located at relatively high elevations in the upper basin.

Groundwater Conditions at the Site

Information on groundwater in the area of the Site was obtained from available well logs on file at the Oregon Water Resources Department (OWRD), U.S. Geological Survey published reports, and from previous CGE experience in the area. Well logs were obtained for an area extending up to 1 mile outside the Project boundaries in order to evaluate groundwater availability, geology, and potential well yield and to also consider potential for interference between Project wells and other offsite wells and water rights.

Well logs provide information on depths at which groundwater was first reported by the driller, static water levels in the wells after they were completed, types of geologic materials penetrated by the wells as described by the drillers, pump or well test results, and other well construction information.

PROJECT SITE TEST WELLS

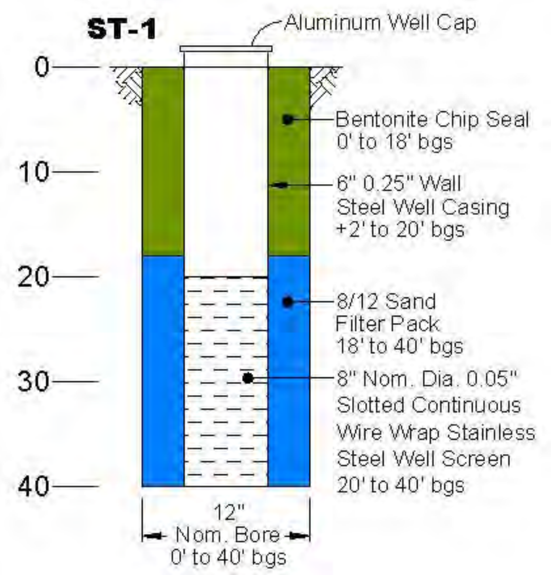
In an effort to investigate potential for groundwater development on the Site, CGE oversaw the installation of 6 test wells ranging in depth from 40 feet below ground surface (bgs) at boring location ST1, ST-2 and ST-3, and up to 140 feet bgs at borings DT-1, DT-2 and DT-3 (locations of Project test wells are shown on the attached Figure 3). Installation of these test wells provided critical Site-specific information on subsurface geologic conditions and potential for groundwater development at the Site for Project water needs. The test well DT-1 was installed first to understand the geologic deposits at the Site followed by completion of the three shallow test wells (ST-1, ST-2, ST-3) and other deep wells (DT-2, DT-2)Driller well logs for the installed test wells are included in the attached Appendix A.

Shallow Test Wells (ST-1, ST-2 and ST-3)

Test Well ST-1 is located in the northwestern corner of the Site at a surface elevation of approximately 2,869 feet MSL. ST-1 was installed to a depth of approximately 40 feet bgs, with water encountered at 14 feet bgs, as reported by the driller (driller log CROO 54587). The water-bearing zone at 14 feet bgs corresponded with an approximate transition in geology between a gray silty-clay layer and an underlying fine to coarse grained sand and gravel-cobble layer. Based on observations during drilling of the boring, water persisted to depth; however, at approximately 38.5 a significant increase in silt with trace clay was observed. The static water level recorded prior to each day of drilling by CGE was 8 feet bgs, corresponding to an approximate elevation of 2,861 feet MSL (subsequently, the driller log reflects a static water level of 11 feet bgs). The overall nominal boring diameter of ST-1 was 12 inches.

The boring was terminated when drilling encountered silt with clay, as similar material was encountered in DT-1 (Deep Test Well, as described below) and the very fine black sand with silt and clay appeared to be a confining layer, and it was not penetrated below 40 feet bgs. A detailed geologic log of ST-1 was developed from onsite geologic observations and samples collected by CGE during drilling and included in the attached Appendix B.

As ST-1 was determined to be a pumped test well, a 6 inch inside diameter stainless steel continuous wire wrap screen and sand pack was installed from a depth interval of 40 feet to 20 feet bgs, with the well seal being from 18 feet to ground surface. The screen slot size was calculated based on sieve analysis of representative fine-grained drill cutting samples and sized to 0.050-inch slot size with an 8/12 grit sand filter pack. A schematic diagram of the well completion of ST-1 is shown below:



Test Well ST-2 is located in the northwestern corner of the Site, approximately 100 feet north of ST-1, at an approximately surface elevation of 2,870 feet MSL. ST-2 was installed to a depth of approximately 40.5 feet bgs, encountering water at 10 feet bgs, with a reported static level during drilling and on the driller log of 8 ft bgs (driller log CROO-54589). The water producing zone of the aquifer was very similar to ST-1 and ST-3 (described below), being a fine to coarse grained sand and gravel-cobble layer. Based on observations during drilling, water persisted to depth; however, at depths below 37 feet bgs increases in silt and trace clays proved similar to encountered materials in ST-1 and DT-1, and drilling ceased at approximately 40 feet bgs. The overall nominal boring diameter of ST-2 was 12 inches.

As ST-2 was determined to primarily be a monitoring well for pumped test wells, ST-2 was completed with vertical machine perforated 6-inch nominal diameter steel casing (0.250-inch wall thickness). The perforations were 1/8-inch machined perforations with a 6/9 grit sand filter pack. A detailed geologic log of ST-2 was developed from onsite geologic observations and samples collected by CGE during drilling and included in the attached Appendix B.

Test Well ST-3 is located in the northwestern corner of the Site, approximately 200 feet east of ST-2 and 240 feet from ST-1, at an approximately surface elevation of 2,870 feet MSL. ST-3 was installed to a depth of approximately 40 feet bgs, encountering water at 18 feet bgs, with a reported static level during drilling and on the driller log of 11 ft bgs (driller log CROO-54591). The water producing zone of the aquifer was very similar to ST-1 and ST-2, being a fine to coarse grained sand and gravel-cobble layer. Based on observations during drilling, water persisted to depth; however, at depths nearing 40 feet bgs increases in silt and trace clays proved similar to encountered materials in ST-1 and DT-1(described below), and drilling ceased at approximately 40 feet bgs. The overall nominal boring diameter of ST-3 was 12 inches.

As ST-3 was determined to primarily be a monitoring well for pumped test wells, ST-3 was completed with vertical machine perforated 6-inch nominal diameter steel casing (0.250-inch wall thickness). The perforations were 1/8-inch machined perforations with a 6/9 grit sand filter pack. A detailed geologic log of ST-3 was developed from onsite geologic observations and samples collected by CGE during drilling and included in the attached Appendix B.

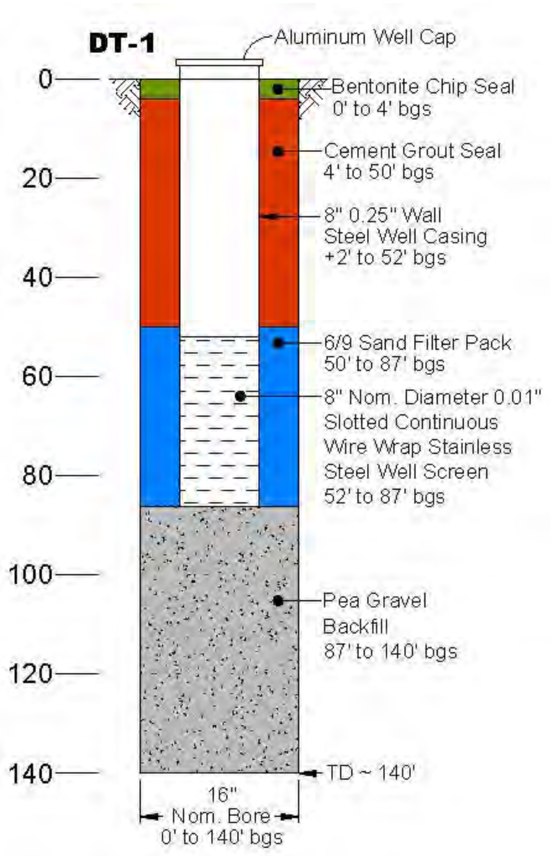
Deep Test Wells DT-1, DT-2 and DT-3

Test Well DT-1 is located in the northwestern corner of the Site at a surface elevation of approximately 2,870 feet MSL. DT-1 was drilled to a depth of approximately 140 feet bgs, however, because clay material non-water bearing water zones were encountered below 80 feet bgs, the well was backfilled from 140 feet to 80 feet bgs and completed at 80 feet bgs. DT-1 encountering first water at 14 feet bgs as reported by the driller (driller log CROO 54593), and below the silty clay a second water bearing zone was encountered at approximately 46 feet bgs. The water-bearing zone at 14 feet bgs was at an approximate transition in geology between a gray silty-clay layer and an underlying fine to coarse grained sand and gravel-cobble layer, the same water-bearing zone encountered in ST-1/2/3. The lower water-bearing zone encountered at 46 feet to 80 feet bgs was comprised of fine sands to course gravels-cobbles with silt and interbeds of clayey-silt and silty-clays with gravels to a depth of approximately 80 feet bgs; below 80 feet the boring encountered clays of light tan to bluish green clays. Based on observations during drilling of the boring, water persisted in the lower water-bearing zone from approximately 45 feet to 80 feet bgs.

The static water level recorded upon completion of the well (after sealing off the upper water-bearing zone) was approximately 4.5 feet bgs, corresponding to an approximate elevation of 2,865.5 feet MSL. The overall nominal boring diameter of DT-1 was 16 inches.

The boring was terminated when drilling reached 140 feet in depth, and because DT-1 was the first well drilled it served as the marker for encountered materials, providing relative comparison for each subsequent well installed. A detailed geologic log of DT-1 was developed from onsite geologic observations and samples collected by CGE during drilling and included in the attached Appendix B.

As DT-1 was determined to be a pumped test well, an 8-inch inside diameter stainless steel continuous wire wrap screen and sand pack was installed from a depth interval of 52 feet to 87 feet bgs, with the well seal being from 50 feet bgs to ground surface. The screen slot size was calculated based on sieve analysis of representative fine-grained drill cutting samples and sized to 0.010-inch slot size with an 6/9 grit sand filter pack. A schematic diagram of the well completion of DT-1 is shown below:

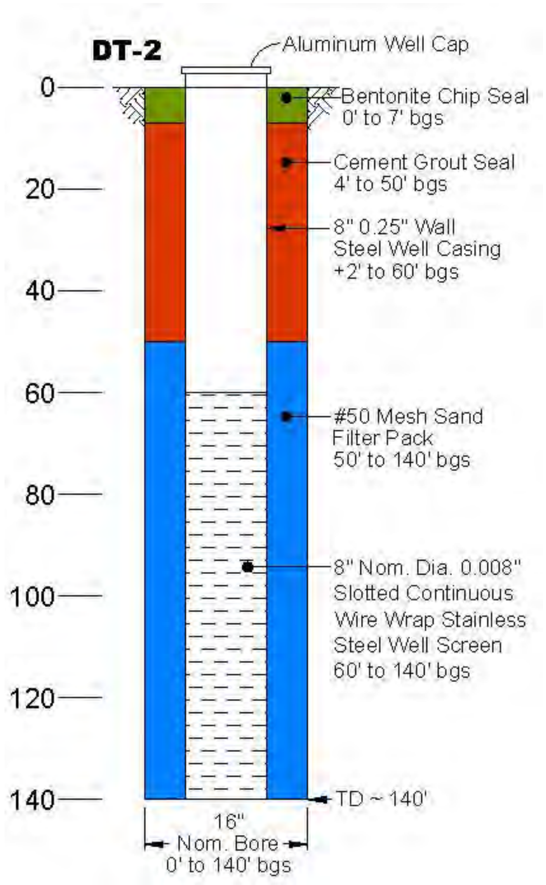


Test Well DT-2 is located in the northern center of the Site at a surface elevation of approximately 2,872 feet MSL. DT-2 was drilled to a depth of approximately 140 feet bgs, producing water continuously in the lower water-bearing zone from approximately 32 feet to 133 feet. The lower interval from 133 feet to 140 feet bgs likely produced water, however, the very fine silts with clay likely did not contribute appreciable amounts of water to the well bore. DT-2 encountered first water at 13 feet bgs as reported by the driller (driller log CROO 54592), and below the silty clay a second water bearing zone was encountered at approximately 32 feet bgs. The first water-bearing zone at 13 feet bgs was at an approximate transition in geology between a gray silty-clay layer and an underlying fine to coarse grained sand and gravel-cobble layer, likely the same water-bearing zone encountered in ST-1/2/3. The lower water-bearing zone encountered from 32 feet to 140 feet bgs was comprised of very fine black sands with silt and intervals of trace clay; below 133 feet the boring encountered a higher mix of clay with the very fine silts and sands. Based on observations during drilling of the boring, water persisted in the lower water-bearing zone from approximately 32 feet to 140 feet bgs.

The static water level recorded upon completion of the well (after sealing off the upper water-bearing zone) was approximately 4 feet bgs, corresponding to an approximate elevation of 2,868 feet MSL. The overall nominal boring diameter of DT-2 was 16 inches.

The boring was terminated when drilling reached 140 feet in depth, in anticipation that DT-2 may exhibit properties similar to the previous City exploratory wells CROO-53215/53355 that anecdotally reported a strong scent of sulfur. A detailed geologic log was developed from samples collected during drilling by CGE.

As DT-2 was determined by the City to potentially have future viability as a water source based on placement in the Site park, an 8-inch inside diameter stainless steel continuous wire wrap screen and sand pack was installed from a depth interval of 60 feet to 140 feet bgs, with the well seal being from 50 feet bgs to ground surface. The screen slot size was calculated based on sieve analysis of representative fine-grained drill cutting samples and sized to 0.008-inch slot size with a 50-grit sand filter pack. A schematic diagram of the well completion of DT-1 is shown below:



Test Well DT-3 is located on the east side of the Crooked River Highway portion of the Site at a surface elevation of approximately 2,872 feet MSL. DT-3 was drilled to a depth of approximately 140 feet bgs, producing water continuously in the lower water-bearing zone from approximately 70 feet to 112 feet. The lower interval from 112 feet to 140 feet bgs likely produced water, however, the very fine silts likely did not contribute appreciable amounts of water to the well bore. DT-3 encountered first water at 10 feet bgs as reported by the driller (driller log CROO 54588), and below the silty gray clay a second water bearing zone was encountered at approximately 70 feet bgs. The first water-bearing zone at 10 feet bgs was at an approximate transition in geology between a gray silty-sand layer and an underlying fine to coarse grained sand and gravel-cobble layer, likely the same water-bearing zone encountered in ST-1/2/3. The lower water-bearing zone encountered from 70 feet to 112 feet bgs was comprised of fine gray sands; below 112 feet the boring encountered a high mix of very fine silts and sands. Based on observations during drilling of the boring, water persisted in the lower water-bearing zone from approximately 70 feet to 140 feet bgs.

The static water level recorded upon completion of the well (after sealing off the upper water-bearing zone) was approximately 4 feet bgs, corresponding to an approximate elevation of 2,868 feet MSL. The overall nominal boring diameter of DT-3 was 16 inches.

The boring was terminated when drilling reached 140 feet in depth, in anticipation that DT-3 may exhibit properties similar to the previous City exploratory wells CROO-53215/53355 that anecdotally reported a strong scent of sulfur. The drillers well log is included in the attached Appendix A, however, based on pump testing of ST-1 and DT-2 being conducted concurrently to drilling of DT-3, a detailed well log was not prepared by CGE.

PUMP TESTING OF EXPLORATORY BORINGS

The completed test wells ST-1 and DT-1 were constructed with stainless steel wire wrap screens and sand filter packs appropriately sized to allow for test pumping of the wells while reducing the potential to develop sand or fine-grained material from entering the well bore. Each of the 5-day continuous constant rate pump tests performed on ST-1 and DT-1 were conducted using a 10-horsepower submersible well pump set near the bottom of the well screens to allow installation of a test pump which helps estimate potential water yield from each boring. Test pump water was piped through a digital totalizing flow meter and discharged to the ground approximately 500 feet south of each well respectively.

Flow rates for the 5-day pump test on each of the pump tested wells ST-1 and DT-1 were determined by conducting a step-drawdown pump test, where the flow rate began at a relatively low pumping rate of 50 gpm or less. Once water levels in the pumped well began to stabilize at each interval flow rate, the control valve was adjusted to allow for an incrementally higher flow rate. With each subsequent increase in flow rate during the step-drawdown test, the drawdown would increase; once the drawdown was not sustainable, the flow rate was adjusted to a previous lower flow rate until a relatively stable water pumping level was observed. This *stabilized pumping rate* was the target constant flow at which each respective well was operated for each 5-day pump test, respectively.

During each pump test, an automated water-level recorder, or pressure transducer, was installed in the pumped well and in nearby wells to monitor influence of the pump tested well on non-pumped wells. Pressure transducers recorded water levels before, during and after the pumping portion of the 5-day pump tests in all monitored wells. The period after pumping is described as the recovery portion of the well test.

Pump tests are described below.

ST-1 Pump Test

The pump test of test well ST-1 was conducted between January 18 and January 23 2018, using a 10-horsepower test pump set at approximately 32 feet bgs with an average pumping rate of approximately 86.8 gpm. For the duration of the 5-day pump test, the maximum observed drawdown was approximately 21.8 feet. The drawdown and recovery curves for the test are shown in Appendix C. The drawdown vs. time curve has a period around minute 150 where the water level began to sharply rise followed immediately by continuing, uninterrupted drawdown thereafter. During this short, sharp rise in drawdown, the discharge valve maintaining the flow rate was adjusted to maintain a consistent flow, causing a slight disruption in the flow rate and resulting in a temporary lower rate. As shown in the drawdown curve, once the flow rate was returned to the constant rate for the remainder of the 5 -day test, the drawdown remained relatively consistent.

Using the maximum drawdown of 21.8 feet recorded during the test of ST-1 and the average pumping rate of 86.8 gpm, an approximate specific capacity value is 3.98 gpm/ft of drawdown. Using this calculated specific capacity value, the nature of the drawdown observed in ST-1, and drawdown observed in surrounding non-pumped monitor wells during the 5-day test, the following aquifer parameters were calculated:

- T_2 = 8,957 gpd/ft or 1,197 ft^2/day
- T_3 = 12,540 gpd/ft or 1,676 ft^2/day
- An Average Transmissivity for ST-1; $T_{2\ \&\ 3}$ = 10,748 gpd/ft or 1,436 ft^2/day
- Estimated Storage Coefficient.) = 8.9×10^{-5}
- Calculated Hydraulic Coefficient (K) of $T_{2\ \&\ 3\ avg.}$ = 62.4 ft/day

The following non-pumped monitored wells were used to help calculate the above-listed aquifer parameters:

- The ST-2, ST-3, and DT-1 wells,
- The nearby existing Park Irrigation Well, and
- The City's 4th Street Shallow Well about 3200 feet to the north.

NOTE: These well yield calculations are consistent with methods described in *"Ground Water and Wells" 1975*.

DT-1 Pump Test

The pump test of test well DT-1 was conducted between January 18 and January 23 2018, using a 10-horsepower test pump set at approximately 75 feet bgs with an average pumping rate of approximately 101.8 gpm. For the duration of the 5-day pump test, the maximum observed drawdown was approximately 54.6 feet. The drawdown and recovery curves for the test are shown in Appendix C. As shown in the drawdown curve, the constant rate and the drawdown remained relatively consistent throughout the 5 -day test.

Using the maximum drawdown of 54.6 feet recorded during the test of DT-1 and the average pumping rate of 101.8 gpm, an approximate specific capacity value is 1.86 gpm/ft of drawdown. Using this calculated specific capacity value, the nature of the drawdown observed in DT-1, and drawdown observed in surrounding non-pumped monitored wells during the 5-day test, the following aquifer parameters were calculated:

- T_2 = 4,072 gpd/ft or 544 ft^2/day
- T_3 = 9,953 gpd/ft or 1,330 ft^2/day
- An Average Transmissivity for DT-1; $T_{2\ \&\ 3}$ = 7,011 gpd/ft or 937 ft^2/day
- Calculated Storage Coefficient (Avg $T_{2\ \&\ 3}$) = 3.95×10^{-4}
- Calculated Hydraulic Coefficient (K) of $T_{2\ \&\ 3\ avg.}$ = 26.7 ft/day

The following non-pumped monitored wells were also used to calculate aquifer parameters:

- The ST-2, ST-3, and DT-2 wells,
- The nearby existing Park Irrigation Well, and
- The City's 4th Street Shallow Well about 3200 feet to the north.

NOTE: These well yield calculations are consistent with methods described in *"Ground Water and Wells" 1975*.

FUTURE WELL PLACEMENT CONCEPT

Based on the testing completed on the Project test wells ST-1 and DT-1, there is capacity in the aquifer to develop multiple wells within the Park Site. Because the pumping of ST-1 and DT-1 had very limited observed drawdown in the monitored wells nearby each pumped well, there seems to be limited potential for well interference (interference being when the pumping of one well causes measurable drawdown in a nearby well in the same aquifer). Accordingly, there is the potential to install pumped wells in a series along the Crooked River. The following maximum drawdown was observed in each monitored well during pump testing of ST-1 and DT-1:

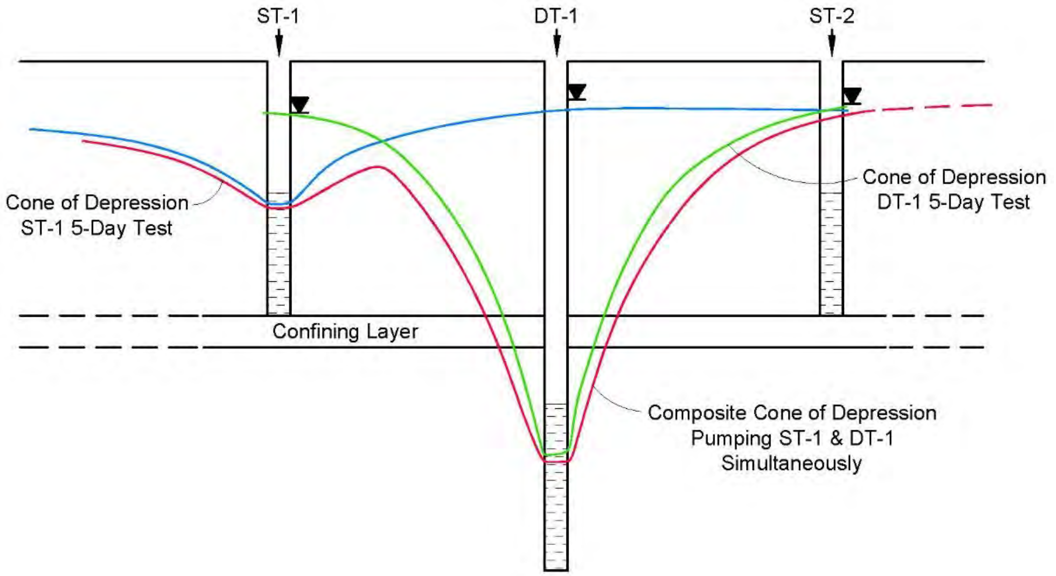
Pump Test of ST-1 – Observed Drawdown

- ST-2, located approximately 100 feet from ST-1, experienced 1.25 feet of maximum drawdown during the pump test;
- ST-3, located approximately 140 feet from ST-1, experienced 1.03 feet of maximum drawdown during the pump test;
- DT-1, located approximately 50 feet from ST-1, experienced 1.9 feet of maximum drawdown during the pump test;
- Park Irrigation Well, located approximately 320 feet from ST-1, experienced 0.37 feet of maximum drawdown during the pump test;
- City's 4th Street Shallow Well had no discernable effect, the water level in this well inclined approximately 0.18 feet during the testing of ST-1.

Pump Test of DT-1 – Observed Drawdown

- ST-2, located approximately 50 feet north of DT-1, experienced 0.69 feet of drawdown in the first 6.5 hours of testing DT-1, only to fluctuate up to only 0.27 feet of drawdown over the course of the 5-day pump test;
- ST-3, located approximately 115 feet from DT-1, experienced 0.38 feet of maximum drawdown during the pump test;
- DT-2, located approximately 430 feet from DT-1, experienced 0.47 feet of maximum drawdown during the pump test;
- Park Existing Irrigation Well, located approximately 270 feet from DT-1, experienced 1.23 feet of maximum drawdown during the pump test;
- City's 4th Street Deep Well had no discernable effect; the water level in this well inclined approximately 0.32 feet during the testing of DT-1.

Based on the minimal potential for pumping interference between properly spaced wells from others producing water from the same water-bearing zone, and the minimal communication between the shallow and deep water-bearing zones between ST-1 and DT-1 respectively, multiple wells may be installed at the Park Site. The below graphic illustrates the observed drawdown effect and potential pumping impacts from pumping ST-1 (shallow water-bearing zone) and DT-1 (deep water-bearing zone) and the cumulative effect on one another and on ST-2 (the nearby shallow water-bearing zone monitored well).



This minimal interference potential demonstrated by pumping wells in the same water-bearing zone, and the limited leakage interference of wells in the alternate water-bearing zone, (e.g. limited effect between ST-1 and DT-1 when pumped respectively) suggests that installation of new well locations at an alternating distance of 50 feet away would have little to no effect on overall well pumping capacities. The attached Figure 4 has been prepared to show the potential to install alternating shallow and deep wells along the western boundary of the Park Site along the eastern shore of the Crooked River, staying above the river bank. This figure illustrates the potential to install wells at a recurring shallow well-deep well-shallow well-deep well (and so on) fashion, with minimum separation distances of 50 feet between wells. Figure 4 further illustrates that up to 30 alternating deep-shallow well installations along the Site river bank may reasonably fit. However, based on the likely capacity of the wells during simultaneous production, a mix of only 10 shallow and 10 deep wells (20 wells total) may likely reach the Project combined production target of 2,000 gpm.

CONCLUSIONS

Groundwater is available beneath the Site and is contained in two water-bearing zones: a shallow zone with a depth range of approximately 15 feet to 40 feet, and a deep zone between approximately 45 feet and 80 feet. Initial testing and preliminary findings suggest it is possible to construct multiple production wells in the Park meet the City's production target of 2,000 gpm for the new municipal water source. However, additional considerations must be addressed to account for geologic variability in aquifer conditions, to refine estimates of water yield capacity relative to ultimate Project needs, and to plan and develop a water supply system.

The vertical geologic section revealed in the 6 well borings consists generally of interbedded sand and gravel sediments with a confining layer of silty clay (likely a leaky confining layer) overlaying a lower confining clay unit. Groundwater was encountered in the upper shallow-sediment unit which ranges in apparent thickness of around 27 to 28 feet. The lower sediment unit range in thickness of 35 feet to nearly 100 feet or more. Considering this general characteristic and discovery of groundwater in both materials beneath the Site, the potential groundwater source for the proposed Project may be developed from both the shallow and deep sand/gravel interbed units.

Findings during testing of ST-1 an DT-1 suggest that water-bearing units have a potentially leaky confined relationship. Production wells constructed to depths of approximately 40 feet bgs for the shallow water-bearing zone; and depths of between 80 and 140 feet for the deep water-bearing, indicate a groundwater source on the Site with potential to meet Project water supply objectives.

Initial pump test results suggest that it is possible for the City to develop a new municipal water source from multiple wells. Initial testing suggests that multiple wells at or near the western boundary of the Park site could produce in a range of 85 to 120 gpm per well. Pumping interference between wells is a possibility and based on the 5-day pump tests conducted on ST-1 and DT-1, placement of the alternating shallow and deep wells with minimum separation distances of 50 feet or more is recommended to reduce overall pumping interference potential.

RECOMMENDATIONS

1. Construct additional potential Project wells along the western boundary of the Park Site on the eastern bank of the Crooked River at minimum separation distance of 50 to each neighboring well, alternating between deep and shallow well installations. This would yield

a minimum separation distance of 100 feet between wells developing water from the same water-bearing zone.

2. Consider construction in 6-well increments, 3 shallow and 3 deep, and perform a monitored 5-day pump test to compare and confirm aquifer observed and calculated aquifer characteristics from testing of ST-1 and DT-1 contained herein. Analyze the well test results including specific capacity, drawdown characteristics and recovery characteristics. Analyze potential drawdown effects on the other borings on the site and evaluate the potential capacity of the new well sets.

3. During installation of new wel6-well installation increments, it is recommended that a minimum of 1 of each shallow and deep well installation be logged with detailed geologic oversight to allow for comparison to current test wells ST-1/2/3, and DT-1/2. If significant deviation of observed geologic conditions exist in comparison to anticipated geology, further analysis may be warranted prior to installation of the next 6-well installation increment.

4. Depending on results of items 1 thru 3, continue to install new Project production wells considering the comparative results of the newly installed wells with calculated aquifer characteristics from testing of ST-1 and DT-1.

CLOSURE

If you have questions regarding this memorandum, please feel free to contact me at your convenience. I can be reached by email at newtonjim@hotmail.com, or by telephone at 360-9047-4162.

Sincerely,

Jim Newton, PE, RG, CWRE
Principal – Engineer-Geologist
Cascade Geoengineering, LLC

REFERENCES

Lite Jr., Kenneth E., Gannett, Marshall W., 2000, Framework for Regional, Coordinated Monitoring in the Middle and Upper Deschutes River Basin, Oregon: U.S. Geological Survey Open File Report 00-386.

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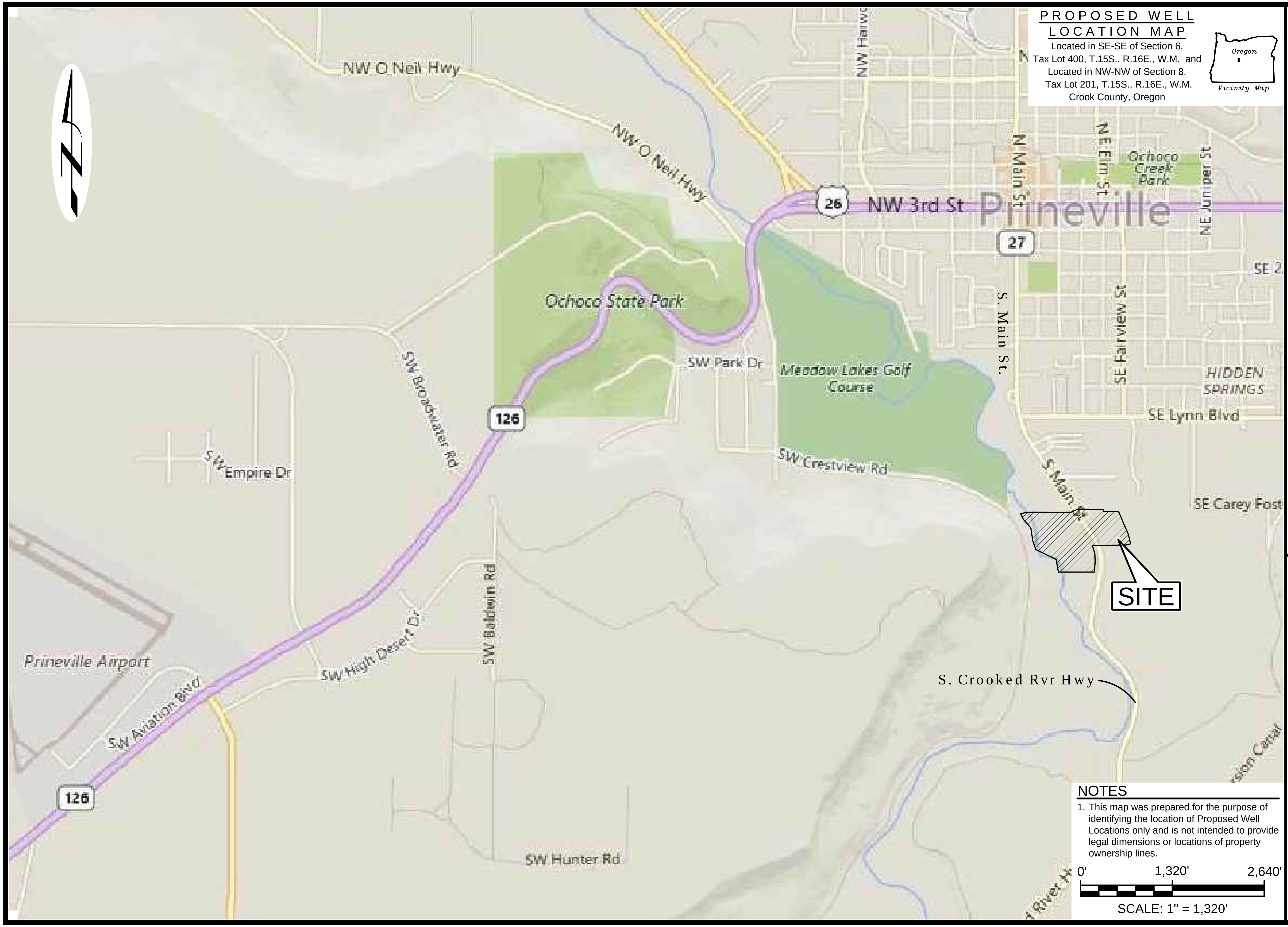
FIGURES



PROPOSED WELL LOCATION MAP

Located in SE-SE of Section 6,
Tax Lot 400, T.15S., R.16E., W.M. and
Located in NW-NW of Section 8,
Tax Lot 201, T.15S., R.16E., W.M.
Crook County, Oregon

NOTES

1. This map was prepared for the purpose of identifying the location of Proposed Well Locations only and is not intended to provide legal dimensions or locations of property ownership lines.

0' 1,320' 2,640'

SCALE: 1" = 1,320'

Vicinity Map

City of Prineville - ASR Project
Crook County, Oregon

FIGURE 1

PROJECT NO. CG-1002-104

DATE: APR 2018

DRAWN BY: R2D

DESIGNED BY: J. Newton

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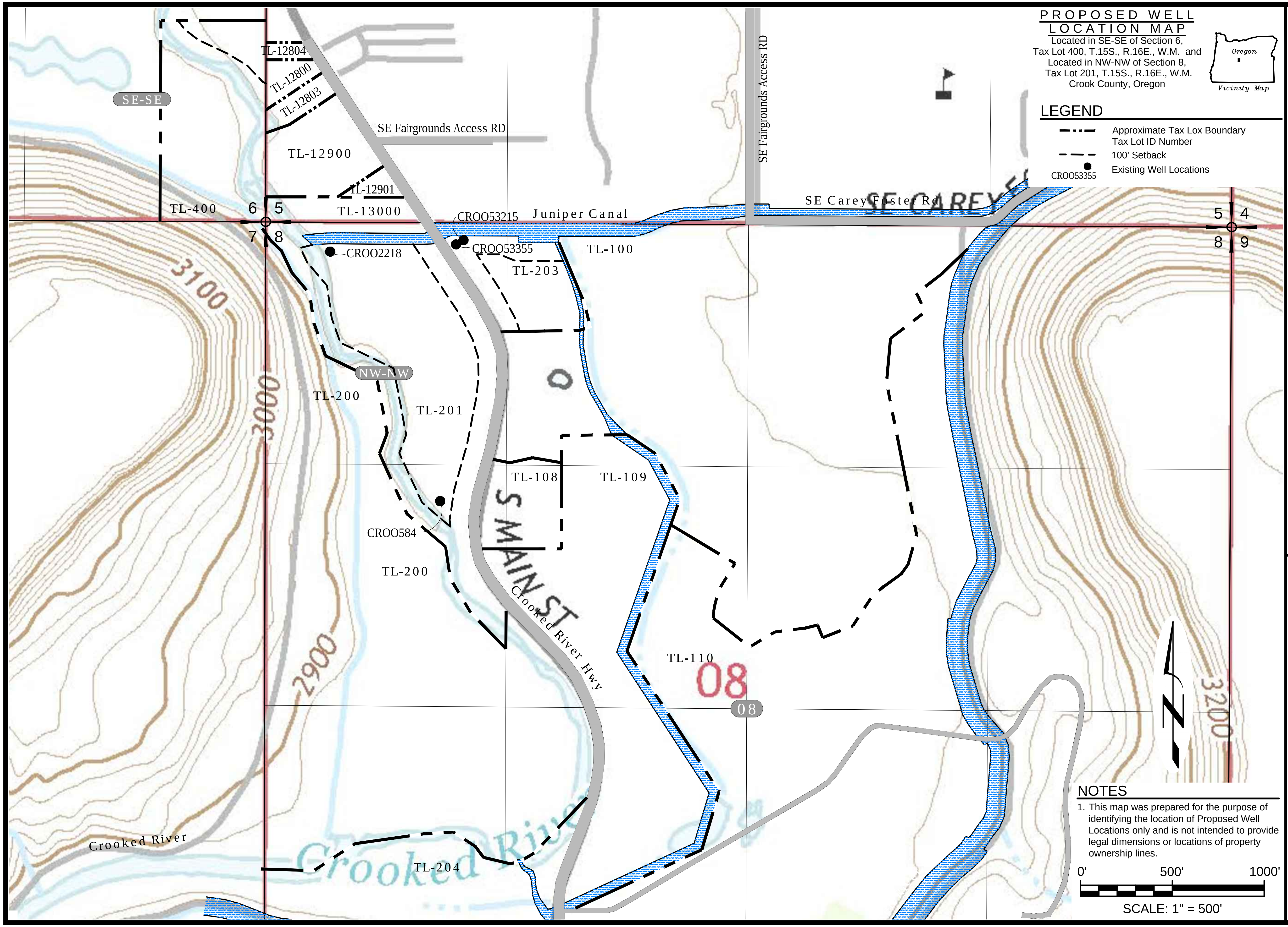
360.907.4162
cascadegeoengineering.com



PROPOSED WELL LOCATION MAP

Located in SE-SE of Section 6,
Tax Lot 400, T.15S., R.16E., W.M. and
Located in NW-NW of Section 8,
Tax Lot 201, T.15S., R.16E., W.M.
Crook County, Oregon

LEGEND

-··	Approximate Tax Lox Boundary
	Tax Lot ID Number
- -	100' Setback
● CROO53355	Existing Well Locations

NOTES

1. This map was prepared for the purpose of identifying the location of Proposed Well Locations only and is not intended to provide legal dimensions or locations of property ownership lines.

0' 500' 1000'

SCALE: 1" = 500'

Site - Existing Well Locations

City of Prineville - ASR Project
Crook County, Oregon

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cascadegeoengineering.com

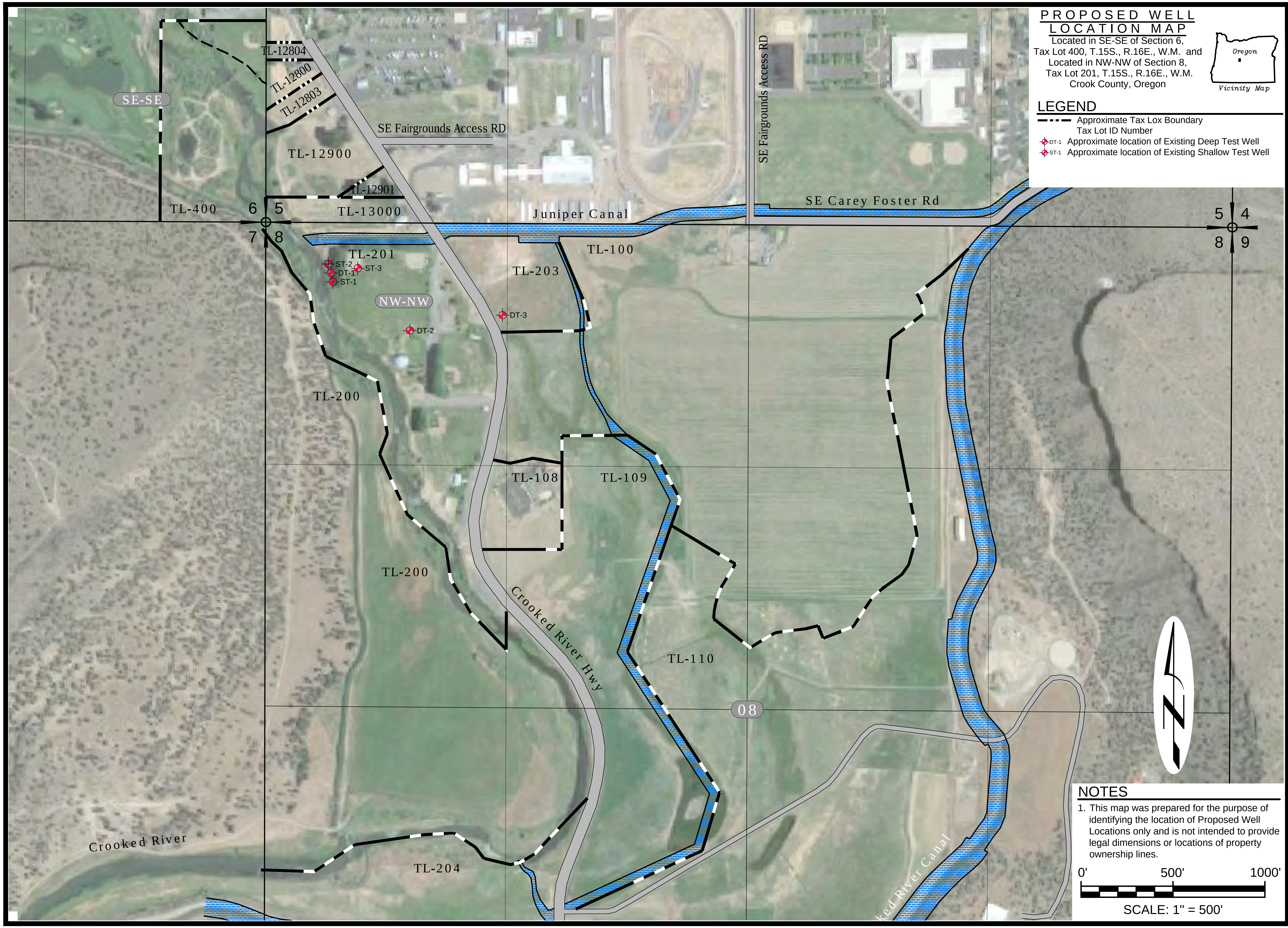
FIGURE 2

PROJECT NO. CG-1002-104

DATE: APR 2018

DRAWN BY: R2D

DESIGNED BY: J. Newton



PROPOSED WELL LOCATION MAP

Located in SE-SE of Section 6,
Tax Lot 400, T.15S., R.16E., W.M. and
Located in NW-NW of Section 8,
Tax Lot 201, T.15S., R.16E., W.M.
Crook County, Oregon

LEGEND

- — - - — Approximate Tax Lox Boundary
- Tax Lot ID Number
- ⊕DT-1 Approximate location of Existing Deep Test Well
- ⊕ST-1 Approximate location of Existing Shallow Test Well

NOTES

1. This map was prepared for the purpose of identifying the location of Proposed Well Locations only and is not intended to provide legal dimensions or locations of property ownership lines.

0' 500' 1000'

SCALE: 1" = 500'

ASR Test Well Locations

City of Prineville - ASR Project
Crook County, Oregon

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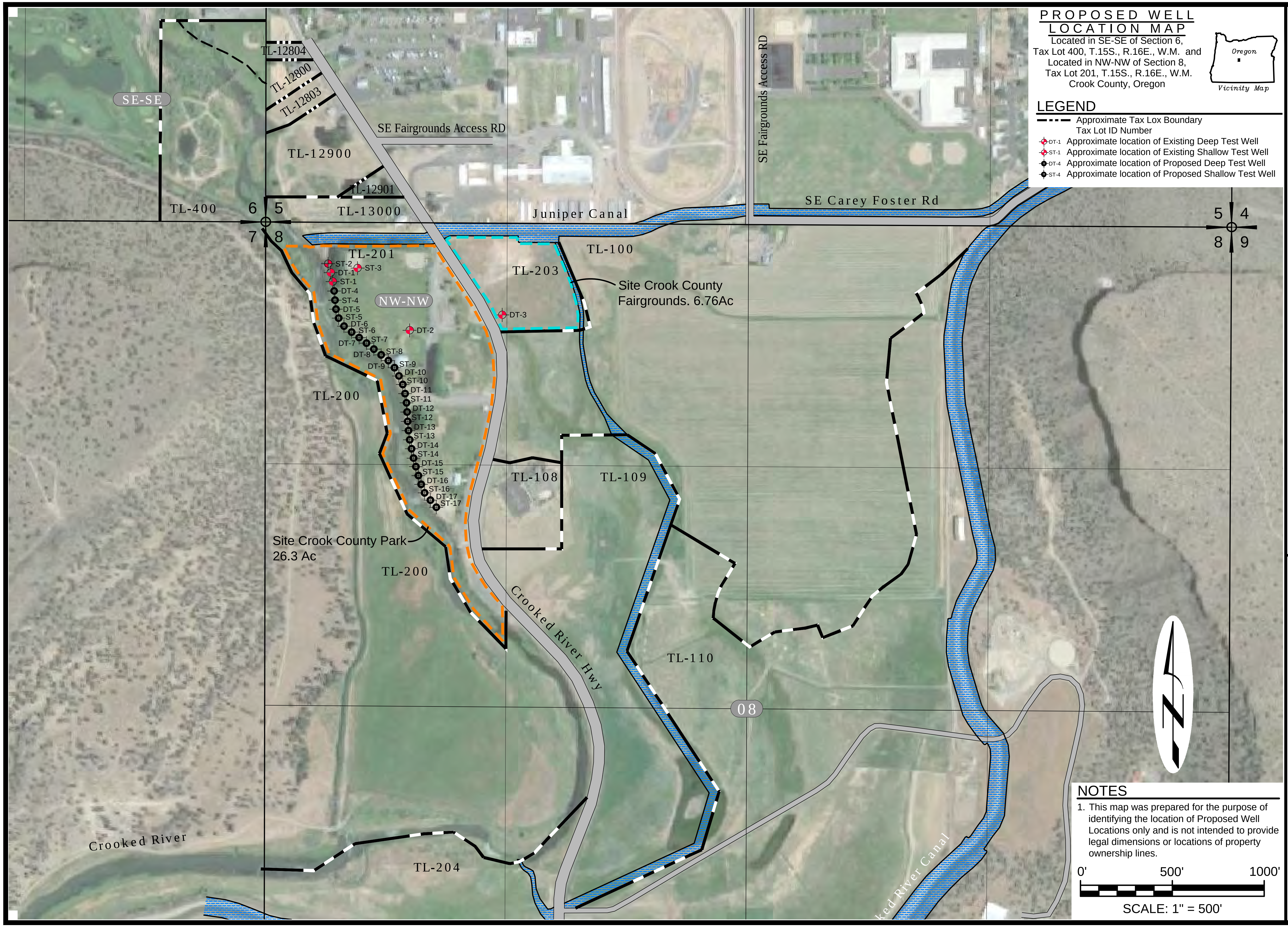
FIGURE	3
PROJECT NO.	CG-1002-104
DATE:	APR 2018
DRAWN BY:	R2D
DESIGNED BY:	J. Newton



PROPOSED WELL LOCATION MAP

Located in SE-SE of Section 6,
Tax Lot 400, T.15S., R.16E., W.M. and
Located in NW-NW of Section 8,
Tax Lot 201, T.15S., R.16E., W.M.
Crook County, Oregon

Oregon

Vicinity Map

LEGEND

- Approximate Tax Lox Boundary
- Tax Lot ID Number
- DT-1 Approximate location of Existing Deep Test Well
- ST-1 Approximate location of Existing Shallow Test Well
- DT-4 Approximate location of Proposed Deep Test Well
- ST-4 Approximate location of Proposed Shallow Test Well

NOTES

1. This map was prepared for the purpose of identifying the location of Proposed Well Locations only and is not intended to provide legal dimensions or locations of property ownership lines.

0' 500' 1000'

SCALE: 1" = 500'

Proposed ASR Well Locations

City of Prineville - ASR Project
Crook County, Oregon

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PROJECT NO. CG-1002-104

FIGURE 4

DATE: APR 2018

DRAWN BY: R2D

DESIGNED BY: J. Newton

APPENDIX A
OWRD WELL LOGS

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CROO 54587
2/16/2018

WELL I.D. LABEL# L 127083
START CARD # 1037842
ORIGINAL LOG #

(1) LAND OWNER

Owner Well I.D. STW-1
First Name JIM Last Name NEWTON
Company CITY OF PRINEVILLE
Address 387 NE 3RD ST
City PRINEVILLE State OR Zip 97754

(2) TYPE OF WORK

☒ New Well ☐ Deepening ☐ Conversion
☐ Alteration (complete 2a & 10) ☐ Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:		☐				○	○	☐	☐

	Material	From	To	Amt	sacks/lbs
Seal:					

(3) DRILL METHOD

☐ Rotary Air ☐ Rotary Mud ☒ Cable ☐ Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☐ Community
☐ Industrial/ Commericial ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☒ Other EXPLORITORY

(5) BORE HOLE CONSTRUCTION

Special Standard ☐ (Attach copy)
Depth of Completed Well 40.00 ft.

BORE HOLE

Dia	From	To
12	0	40

SEAL

Material	From	To	Amt	sacks/ lbs
Bentonite Chips	0	18	53	S
		Calculated	14	
		Calculated		

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☒ Other POURED DRY
Backfill placed from ft. to ft. Material
Filter pack from 18 ft. to 40 ft. Material SAND Size 8/12
Explosives used: ☐ Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
●	○	6	☒	2	20	.250	●	○	☒	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☒ Outside ☐ Other Location of shoe(s)
Temp casing ☒ Yes Dia 12 From + ☒ 1 To 40

(7) PERFORATIONS/SCREENS

Perforations Method
Screens Type JOHNSON Material STAINLESS

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Screen	Casing	6	20	40	.05			

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

○ Pump ● Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
100	26	38	120
25	5		4

Temperature 54 °F Lab analysis ☐ Yes By
Water quality concerns? ☐ Yes (describe below) TDS amount 111 ppm

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County CROOK Twp 15.00 S N/S Range 16.00 E E/W WM
Sec 8 NW 1/4 of the NW 1/4 Tax Lot 201
Tax Map Number Lot
Lat ° ' " or 44.28944444 DMS or DD
Long ° ' " or -120.84569444 DMS or DD
○ Street address of well ● Nearest address
WEST OF MAIN ST/CROOKED RIVER HWY CROOKED RIVER PARK (STW-1)

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration			☐	
Completed Well	1/9/2018		☐	11

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found 14.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
10/24/2017	24	37	20		☐	12
					☐	
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation 2886.00

Material	From	To
CLAY GRAVEL	0	9
SILT GRAY CLAY	9	12
GRAVELS SAND GRAY	12	24
SILT SAND GRAY	24	32
CLAY SAND GRAY	32	37
CLAY GRAY	37	40

Date Started 10/24/2017 Completed 1/9/2018

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number 758 Date 2/16/2018

Signed THOMAS R PECK (E-filed)

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1720 Date 2/16/2018

Signed JACK ABBAS (E-filed)

Contact Info (optional)

ORIGINAL - WATER RESOURCES DEPARTMENT

THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK Form Version:

WATER SUPPLY WELL REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

CROO 54587

2/16/2018

Map of Hole

STATE OF OREGON
WELL LOCATION MAP
This map is supplemental to the WATER SUPPLY WELL REPORT

Oregon Water Resources Department
725 Summer St NE, Salem OR 97301
(503)986-0900

LOCATION OF WELL

Latitude: 44.28944444 Datum: WGS84

Longitude: -120.84569444

Township/Range/Section/Quarter-Quarter Section:

WM 6S 2W 34 NWNW

Address of Well:

WEST OF MAIN ST/CROOKED RIVER HWY CROOKED RIVER PARK (STW-1)

Well Label: 127083

Printed: February 16, 2018

DISCLAIMER: This map is intended to represent the approximate location the well. It is not intended to be construed as survey accurate in any manner.

Provided by well constructor

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CROO 54589
2/16/2018

WELL I.D. LABEL# L 127081
START CARD # 1037841
ORIGINAL LOG #

(1) LAND OWNER

Owner Well I.D. STW-2
First Name JIM Last Name NEWTON
Company CITY OF PRINEVILLE
Address 387 NE 3RD ST
City PRINEVILLE State OR Zip 97754

(2) TYPE OF WORK

☒ New Well ☐ Deepening ☐ Conversion
☐ Alteration (complete 2a & 10) ☐ Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:		☐				○	○	☐	☐

	Material	From	To	Amt	sacks/lbs
Seal:					

(3) DRILL METHOD

☐ Rotary Air ☐ Rotary Mud ☒ Cable ☐ Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☐ Community
☐ Industrial/ Commericial ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☒ Other EXPLORITORY

(5) BORE HOLE CONSTRUCTION

Special Standard ☐ (Attach copy)
Depth of Completed Well 40.50 ft.

BORE HOLE

Dia	From	To
12	0	40.5

SEAL

Material	From	To	Amt	sacks/ lbs
Bentonite Chips	0	18	27	S
		Calculated	14	
		Calculated		

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☒ Other POURED DRY
Backfill placed from ft. to ft. Material
Filter pack from 18 ft. to 40.5 ft. Material PEA GRAVL Size 6/9
Explosives used: ☐ Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☐ Outside ☐ Other Location of shoe(s)
Temp casing ☐ Yes Dia From + ☐ To

(7) PERFORATIONS/SCREENS

Perforations Method MACHINE
Screens Type Material

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Perf	Casing	6	20.5	40.5	.125	3	456	

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

○ Pump ● Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
20	20		2

Temperature 54 °F Lab analysis ☐ Yes By
Water quality concerns? ☐ Yes (describe below) TDS amount 115 ppm

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County CROOK Twp 15.00 S N/S Range 16.00 E E/W WM
Sec 8 NW 1/4 of the NW 1/4 Tax Lot 201
Tax Map Number Lot
Lat ° ' " or 44.28969444 DMS or DD
Long ° ' " or -120.84572222 DMS or DD
○ Street address of well ● Nearest address

WEST OF MAIN ST/CROOKED RIVER HWY
CROOKED RIVER PARK (STW-2)

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration			☐	
Completed Well	12/14/2017		☐	8

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found 10.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
10/31/2017	10	37	20		☐	8
					☐	
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation 2864.00

Material	From	To
CLAY BROWN	0	10
GRAVELS SAND BROWN	10	12
GRAVELS SAND SILT GRAY	12	20
LARGE GRAVELS TIGHT	20	22
SILT GRAY SAND	22	35
SAND GRAVELS GRAY SMALL	35	37
CLAY SILT GRAY	37	40.5

Date Started 10/30/2017 Completed 12/14/2017

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number 758 Date 2/16/2018

Signed THOMAS R PECK (E-filed)

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1720 Date 2/16/2018

Signed JACK ABBAS (E-filed)
Contact Info (optional)

ORIGINAL - WATER RESOURCES DEPARTMENT
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK Form Version:

WATER SUPPLY WELL REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

CROO 54589

2/16/2018

Map of Hole

STATE OF OREGON
WELL LOCATION MAP
This map is supplemental to the WATER SUPPLY WELL REPORT

Oregon Water Resources Department
725 Summer St NE, Salem OR 97301
(503)986-0900

LOCATION OF WELL
Latitude: 44.28969444 Datum: WGS84
Longitude: -120.84572222
Township/Range/Section/Quarter-Quarter Section:
WM 15S 16E 8 NWNW
Address of Well:
WEST OF MAIN ST/CROOKED RIVER HWY CROOKED RIVER PARK (STW-2)

Well Label: 127081

Printed: February 16, 2018

DISCLAIMER: This map is intended to represent the approximate location the well. It is not intended to be construed as survey accurate in any manner.

Provided by well constructor

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CROO 54591
2/18/2018

WELL I.D. LABEL# L 127080
START CARD # 1037844
ORIGINAL LOG #

(1) LAND OWNER

Owner Well I.D. STW-3
First Name JIM Last Name NEWTON
Company CITY OF PRINEVILLE
Address 387 NE 3RD ST
City PRINEVILLE State OR Zip 97754

(2) TYPE OF WORK

☒ New Well ☐ Deepening ☐ Conversion
☐ Alteration (complete 2a & 10) ☐ Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:		☐				○	○	☐	☐

	Material	From	To	Amt	sacks/lbs
Seal:					

(3) DRILL METHOD

☐ Rotary Air ☐ Rotary Mud ☒ Cable ☐ Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☐ Community
☐ Industrial/ Commericial ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☒ Other EXPLORITORY

(5) BORE HOLE CONSTRUCTION

Special Standard ☐ (Attach copy)
Depth of Completed Well 40.00 ft.

BORE HOLE			SEAL				sacks/
Dia	From	To	Material	From	To	Amt	lbs
12	0	40	Bentonite Chips	0	18	47	S
					Calculated	14	
					Calculated		

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☒ Other POURED DRY
Backfill placed from ft. to ft. Material
Filter pack from 18 ft. to 40 ft. Material SAND Size 6/9
Explosives used: ☐ Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
●	○	6	☒	2	40	.250	●	○	☒	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☒ Outside ☐ Other Location of shoe(s)
Temp casing ☒ Yes Dia 12 From + ☒ 1 To 40

(7) PERFORATIONS/SCREENS

Perforations Method MACHINE
Screens Type Material

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Perf	Casing	6	20	40	.125	3	456	

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

○ Pump ● Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
20	10		2

Temperature 54 °F Lab analysis ☐ Yes By
Water quality concerns? ☐ Yes (describe below) TDS amount 111 ppm

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County CROOK Twp 15.00 S N/S Range 16.00 E E/W WM
Sec 8 NW 1/4 of the NW 1/4 Tax Lot 201
Tax Map Number Lot
Lat ° ' " or 44.28969444 DMS or DD
Long ° ' " or -120.84525000 DMS or DD
○ Street address of well ● Nearest address

WEST OF MAIN ST/CROOKED RIVER HWY \NCROOKED RIVER PARK (STW-3) S SIDE OF NW BASEBALL FIELD

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration			☐	
Completed Well	12/12/2017		☐	11

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found 18.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
11/3/2017	18	25	20		☐	11
					☐	
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation 2868.00

Material	From	To
CLAY BROWN	0	12
GRAVELS LARGE	12	17
LARGE GRAVELS TIGHT	17	18.5
SAND GRAVELS GRAY	18.5	25
SILT SAND GRAY	25	40

Date Started 11/3/2017 Completed 12/12/2017

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number 758 Date 2/16/2018

Signed THOMAS PECK (E-filed)

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1720 Date 2/18/2018

Signed JACK ABBAS (E-filed)
Contact Info (optional)

WATER SUPPLY WELL REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

CROO 54591

2/18/2018

Map of Hole

STATE OF OREGON
WELL LOCATION MAP

This map is supplemental to the WATER SUPPLY WELL REPORT

Oregon Water Resources Department
725 Summer St NE, Salem OR 97301
(503)986-0900

LOCATION OF WELL

Latitude: 44.28969444 Datum: WGS84

Longitude: -120.84525

Township/Range/Section/Quarter-Quarter Section:

WM 6S 2W 34 NWNW

Address of Well:

WEST OF MAIN ST/CROOKED RIVER HWY
CROOKED RIVER PARK (STW-3) S SIDE OF NW BASEBALL FIELD

Well Label: 127080

Printed: February 17, 2018

DISCLAIMER: This map is intended to represent the approximate location the well. It is not intended to be construed as survey accurate in any manner.

Provided by well constructor

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CROO 54593
2/19/2018

WELL I.D. LABEL# L 127082
START CARD # 1037843
ORIGINAL LOG #

(1) LAND OWNER

Owner Well I.D. DTW-1
First Name JIM Last Name NEWTON
Company CITY OF PRINEVILLE
Address 387 NE 3RD ST
City PRINEVILLE State OR Zip 97754

(2) TYPE OF WORK

☒ New Well ☐ Deepening ☐ Conversion
☐ Alteration (complete 2a & 10) ☐ Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:		☐				○	○	☐	☐

	Material	From	To	Amt	sacks/lbs
Seal:					

(3) DRILL METHOD

☐ Rotary Air ☐ Rotary Mud ☒ Cable ☐ Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☐ Community
☐ Industrial/ Commericial ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☒ Other EXPLORITORY

(5) BORE HOLE CONSTRUCTION

Special Standard ☐ (Attach copy)
Depth of Completed Well 87.00 ft.

BORE HOLE			SEAL				sacks/
Dia	From	To	Material	From	To	Amt	lbs
16	0	140	Bentonite Chips	0	4	7	S
					Calculated	6	
			Cement	4	50	70	S
					Calculated	31	

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E
☒ Other POURED DRY
Backfill placed from 87 ft. to 140 ft. Material PEA GRAVEL
Filter pack from 50 ft. to 87 ft. Material SAND Size 6/9
Explosives used: ☐ Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
●	○	8	☒	2	52	.250	●	○	☒	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☒ Outside ☐ Other Location of shoe(s)
Temp casing ☒ Yes Dia 16 From + ☒ 1 To 73

(7) PERFORATIONS/SCREENS

Perforations Method
Screens Type JOHNSON Material STAINLESS

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Screen	Casing	8	52	87	.01			

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

● Pump ○ Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
20	20		2
103	54	80	120

Temperature 54 °F Lab analysis ☐ Yes By
Water quality concerns? ☐ Yes (describe below) TDS amount 572 mg/L

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County CROOK Twp 15.00 S N/S Range 16.00 E E/W WM
Sec 8 NW 1/4 of the NW 1/4 Tax Lot 201
Tax Map Number Lot
Lat ° ' " or 44.28950000 DMS or DD
Long ° ' " or -120.84572222 DMS or DD
○ Street address of well ● Nearest address

WEST OF MAIN ST/CROOKED RIVER HWY
CROOKED RIVER PARK (DTW-1)

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration			☐	
Completed Well	1/5/2018		☐	4.5

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found 14.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
10/3/2017	14	27	20		☐	10
10/6/2017	42	58	20		☐	4.5
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation 2875.00

Material	From	To
TOP SOIL	0	1
CLAY BROWN	1	9
CLAY SAND	9	14
GRAVELS GRAY SILT COARS MEDIUM	14	27
CLAY SILT GRAVELS	27	38
SILT CLAY	38	42
GRAVELS SAND SILT	42	58
CLAY GRAY	58	88
CLAY GRAY ASH MIX	88	104
CLAY HARD GRAY	104	120
CLAY SOFT STICKY BROWN	120	140

Date Started 10/2/2017 Completed 1/5/2018

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number 758 Date 2/16/2018

Signed THOMAS PECK (E-filed)

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1720 Date 2/19/2018

Signed JACK ABBAS (E-filed)
Contact Info (optional)

ORIGINAL - WATER RESOURCES DEPARTMENT
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK Form Version:

WATER SUPPLY WELL REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

CROO 54593

2/19/2018

Map of Hole

STATE OF OREGON
WELL LOCATION MAP
This map is supplemental to the WATER SUPPLY WELL REPORT

Oregon Water Resources Department
725 Summer St NE, Salem OR 97301
(503)986-0900

LOCATION OF WELL

Latitude: 44.2895 Datum: WGS84
Longitude: -120.84572222
Township/Range/Section/Quarter-Quarter Section:
WM 6S 2W 34 NWNW
Address of Well:
WEST OF MAIN ST/CROOKED RIVER HWY
CROOKED RIVER HWY (DTW-1)

Well Label: 127082

Printed: February 18, 2018

DISCLAIMER: This map is intended to represent the approximate location the well. It is not intended to be construed as survey accurate in any manner.

Provided by well constructor

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CROO 54592
2/18/2018

WELL I.D. LABEL# L 129186
START CARD # 1037840
ORIGINAL LOG #

(1) LAND OWNER

Owner Well I.D. DTW-2
First Name JIM Last Name NEWTON
Company CITY OF PRINEVILLE
Address 387 NE 3RD ST
City PRINEVILLE State OR Zip 97754

(2) TYPE OF WORK

☒ New Well ☐ Deepening ☐ Conversion
☐ Alteration (complete 2a & 10) ☐ Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:		☐				○	○	☐	☐

	Material	From	To	Amt	sacks/lbs
Seal:					

(3) DRILL METHOD

☐ Rotary Air ☐ Rotary Mud ☒ Cable ☐ Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☐ Community
☐ Industrial/ Commericial ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☒ Other EXPLORITORY

(5) BORE HOLE CONSTRUCTION

Special Standard ☐ (Attach copy)
Depth of Completed Well 140.00 ft.

BORE HOLE		
Dia	From	To
16	0	140

SEAL				
Material	From	To	Amt	sacks/ lbs
Bentonite Chips	0	7	14	S
		Calculated	10	
Cement	7	50	70	S
		Calculated	31	

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E
☒ Other POURED DRY
Backfill placed from ft. to ft. Material
Filter pack from 50 ft. to 140 ft. Material SAND Size 50 MESH
Explosives used: ☐ Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
●	○	8	☒	2	60	.250	●	○	☒	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☒ Outside ☐ Other Location of shoe(s)
Temp casing ☒ Yes Dia 16 From + ☒ 1 To 140

(7) PERFORATIONS/SCREENS

Perforations Method
Screens Type JOHNSON Material STAINLESS

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Screen	Casing	8	60	140	.008			

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

○ Pump ● Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
20	25		2

Temperature 54 °F Lab analysis ☐ Yes By
Water quality concerns? ☐ Yes (describe below) TDS amount 118 ppm

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County CROOK Twp 15.00 S N/S Range 16.00 E E/W WM
Sec 8 NW 1/4 of the NW 1/4 Tax Lot 201
Tax Map Number Lot
Lat ° ' " or 44.28905556 DMS or DD
Long ° ' " or -120.84419444 DMS or DD
○ Street address of well ● Nearest address

WEST OF MAIN ST/CROOKED RIVER HWY
CROOKED RIVER PARK (DTW-2)

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration			☐	
Completed Well	1/17/2018		☐	4

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found 13.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
11/7/2017	13	22	20		☐	10
11/8/2017	32	133	20		☐	4
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation 2876.00

Material	From	To
FILL	0	2
CLAY SILT BROWN	2	6
CLAY SILT GRAY	6	13
GRAVELS	13	16
GRAVELS TIGHT LARGE	16	23
SILT CLAY GRAY	23	32
SAND FINE GRAY HEAVING	32	56
SAND TIGHT LOOSE LAYERS	56	133
CLAY GRAY	133	140

Date Started 11/17/2017 Completed 1/17/2018

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number 758 Date 2/18/2018

Signed THOMAS PECK (E-filed)

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1720 Date 2/18/2018

Signed JACK ABBAS (E-filed)
Contact Info (optional)

ORIGINAL - WATER RESOURCES DEPARTMENT

THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK Form Version:

WATER SUPPLY WELL REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

CROO 54592

2/18/2018

Map of Hole

STATE OF OREGON
WELL LOCATION MAP

This map is supplemental to the WATER SUPPLY WELL REPORT

Oregon Water Resources Department
725 Summer St NE, Salem OR 97301
(503)986-0900

LOCATION OF WELL

Latitude: 44.28905556 Datum: WGS84

Longitude: -120.84419444

Township/Range/Section/Quarter-Quarter Section:
WM 15S 16E 8 NWNW

Address of Well:
WEST OF MAIN ST/CROOKED RIVER HWY
CROOKED RIVER PARK (DTW-2)

Well Label: 129186

Printed: February 18, 2018

DISCLAIMER: This map is intended to represent the approximate location the well. It is not intended to be construed as survey accurate in any manner.

Provided by well constructor

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CROO 54588
2/16/2018

WELL I.D. LABEL# L 129187
START CARD # 1037839
ORIGINAL LOG #

(1) LAND OWNER

Owner Well I.D. DTW-3
First Name JIM Last Name NEWTON
Company CITY OF PRINEVILLE
Address 387 NE 3RD ST
City PRINEVILLE State OR Zip 97754

(2) TYPE OF WORK

☒ New Well ☐ Deepening ☐ Conversion
☐ Alteration (complete 2a & 10) ☐ Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:		☐				○	○	☐	☐

	Material	From	To	Amt	sacks/lbs
Seal:					

(3) DRILL METHOD

☐ Rotary Air ☐ Rotary Mud ☒ Cable ☐ Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☐ Community
☐ Industrial/ Commericial ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☒ Other EXPLORITORY

(5) BORE HOLE CONSTRUCTION

Special Standard ☐ (Attach copy)
Depth of Completed Well 140.00 ft.

BORE HOLE

Dia	From	To
16	0	140

SEAL

Material	From	To	Amt	sacks/ lbs
Bentonite Chips	0	7	28	S
		Calculated	10	
Cement	7	70	70	S
		Calculated	39	

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E
☒ Other POURED DRY
Backfill placed from ______ ft. to ______ ft. Material ______
Filter pack from 70 ft. to 140 ft. Material PEA GRAVE Size pea gravel
Explosives used: ☐ Yes Type ______ Amount ______

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
●	○	8	☒	2	140	.250	●	○	☒	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☒ Outside ☐ Other Location of shoe(s) ______
Temp casing ☒ Yes Dia 16 From + ☒ 1 To 140

(7) PERFORATIONS/SCREENS

Perforations Method MACHINE
Screens Type ______ Material ______

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Perf	Casing	8	80	140	.125	3	1824	

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

○ Pump ● Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
30	10		2

Temperature 54 °F Lab analysis ☐ Yes By ______
Water quality concerns? ☐ Yes (describe below) TDS amount 120 ppm

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County CROOK Twp 15.00 S N/S Range 16.00 E E/W WM
Sec 8 NW 1/4 of the NW 1/4 Tax Lot 203
Tax Map Number ______ Lot ______
Lat ___°___'___" or 44.28961111 DMS or DD
Long ___°___'___" or -120.84225000 DMS or DD
○ Street address of well ● Nearest address
EAST OF MAIN ST/CRROKED RIVER HWY \NCROOKED RIVER PARK (DTW-3)

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration			☐	
Completed Well	2/6/2018		☐	4

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found 10.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
1/19/2018	10	25	20		☐	10
1/24/2018	70	112	20		☐	4
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation 2876.00

Material	From	To
CLAY SAND SILT	0	9
GRAVELS LARGE	9	25
SILT GRAY CLAY	25	70
SAND GRAY	70	112
SILTY GRAY SAND	112	140

Date Started 1/19/2018 Completed 2/6/2018

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number ______ Date ______

Signed ______

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1720 Date 2/16/2018

Signed JACK ABBAS (E-filed)
Contact Info (optional) ______

ORIGINAL - WATER RESOURCES DEPARTMENT
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CROO 54588

2/16/2018

Map of Hole

STATE OF OREGON
WELL LOCATION MAP

This map is supplemental to the WATER SUPPLY WELL REPORT

Oregon Water Resources Department
725 Summer St NE, Salem OR 97301
(503)986-0900

LOCATION OF WELL

Latitude: 44.28961111 Datum: WGS84

Longitude: -120.84225

Township/Range/Section/Quarter-Quarter Section:
WM 15S 16E 8 NWNW

Address of Well:
EAST OF MAIN ST/CRROKED RIVER HWY
CROOKED RIVER PARK (DTW-3)

Well Label: 129187

Printed: February 16, 2018

DISCLAIMER: This map is intended to represent the approximate location the well. It is not intended to be construed as survey accurate in any manner.

Provided by well constructor

APPENDIX B

CGE Detailed Well Boring Logs

CASCADE
GEOENGINEERING
360.907.4162 cascadegeoengineering.com

PROJECT NUMBER: CG1002-104

EXCAVATION DATE: 11/3/2017

TRENCH No. ST-1

EXPLORATORY BORING LOG

SHEET 1 OF 1

PROJECT Prineville ASR Project
LOCATION Crooked Rvr Fork, Prineville OR
ELEVATION 2870 Ft MSL
TRENCHING CONTRACTOR Abbas Well & Drilling
TRENCHING METHOD AND EQUIPMENT Cable Tool Drilling - 12" Nominal
WATER LEVEL 4' bgs (Croo_54587)
GEOLOGIST J. Newton

SAMPLE			SOIL DESCRIPTION	COMMENTS
INTERVAL DEPTH IN FEET	NUMBER AND TYPE	USCS CLASSIFICATION SYMBOL	SOIL NAME, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	
0				
		OB		
5				
	ST1-1 (9')		Very dark brown silty-sand loam with fine gravels	First Water ~ 9' bgs
10				
	ST1-2(12')		Very dark greenish brown sand & gravel, well graded from fine sand to very coarse gravel of sub-round to smooth gravel up to ~ 80%	
15	ST1-3(15')		~70% gravels med-coarse & very coarse, ~30% med-coarse sands, gravels (30-40%) and cobbles of basalt, (~20%) with sands of basalt, hematite feldspar, quartz & misc.	
	ST1-4(16')			
	ST1-5(16'2)			
	ST1-6(17')		Increase in sand to ~50%	
20		SW-GW		SWL 10/26 8'bgs
	ST1-7(21')			
25	ST1-8 (25'-26')		Very fine to fine grained black sand with trace very coarse sands of rounded oblong basalt and silt - sand primarily block basalt (~90%)	
30	ST1-9(30')		Fine to medium gravels trace; rounded-oblong or flattened.	
	ST1-10(32')		Very fine black sand free draining and un-lithified	
	ST1-11(34')		90+% basalt with ash sands, very fine black sand with silt (~10-20% silt), rolls mildly to 1/8"; breaks and won't fold.	
35				
		SM-SW		
40	ST1-12 (38.5') TD~38.5'		Very fine black sandy silt with trace clay, bit face sample was tight, had minor cohesion and relatively dry (humid).	Boring Completed 10/26/2017
		ML-CL		
45				
50				

SAMPLE TYPES: SPT = Standard Penetrometer Test Sample ___________" Dia.
B = Bag Sample ST = Shelby tube Sample SS = Split Spoon Sample SK = Sack Sample

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

CASCADE
GEOENGINEERING
360.907.4162 cascadegeoengineering.com

PROJECT NUMBER CG1002-104

EXCAVATION DATE 11/3/2017

TRENCH No. ST-2

SHEET 1 OF 1

EXPLORATORY BORING LOG

PROJECT Prineville ASR Project

LOCATION Crooked Rvr Fork, Prineville OR

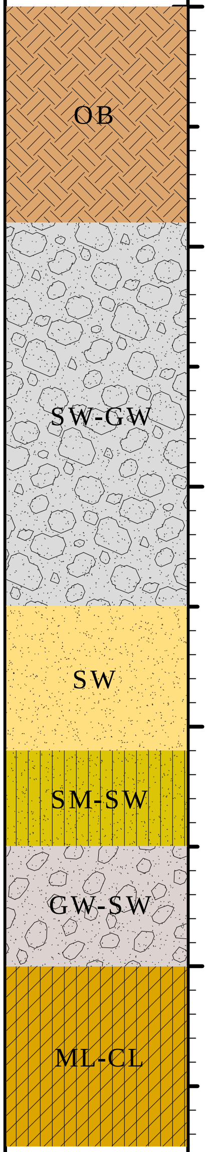
ELEVATION 2870 Ft MSL

TRENCHING CONTRACTOR Abbas Well & Drilling

TRENCHING METHOD AND EQUIPMENT Cable Tool Drilling - 12" Nominal

WATER LEVEL 8' bgs (Croo_54589)

GEOLOGIST J. Newton



SAMPLE		USCS CLASSIFICATION SYMBOL	SOIL DESCRIPTION	COMMENTS
INTERVAL DEPTH IN FEET	NUMBER AND TYPE		SOIL NAME, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	
0		OB	Medium dark brown sand loam	
5				
10	ST2-1 (9'-12')	SW-GW	Fine to medium grained medium brown in to sand and gravel, gravels are sub-round to sub-angular ~50/50, 90%) basalt and mixed mineralogy of ~10% feldspar and hematite.	15' @ 10/31 Startup SWL ~9' bgs
	ST2-2 (12'-15')		Color changes to medium gray with trace permice (?)	
15	ST2-3(16')			
	ST2-4(19')		Sands and fine gravels intervals, includes trace white series sub-rounded, cobbles to ~120mm	SWL 11/1 12'bgs
20	ST2-5(22')		Sands, fine-coarse ~8%, fine to medium gravels ~20%	
25		SW	Fine sands	
30	ST2-6(29')		Fine-coarse sands with fine-medium gravels	
	ST2-7(32')	SM-SW	Very fine black sand with silt	
35	ST2-8 (35'-36')	GW-SW	Very fine-medium sand with fine-medium sub-round oblong and flattened gravels (gravels ~40%)	
40	ST2-9 (39'-40') TD~40'	ML-CL	Very fine black silty-sand / sandy-silt with clay trace.	
45				
50				

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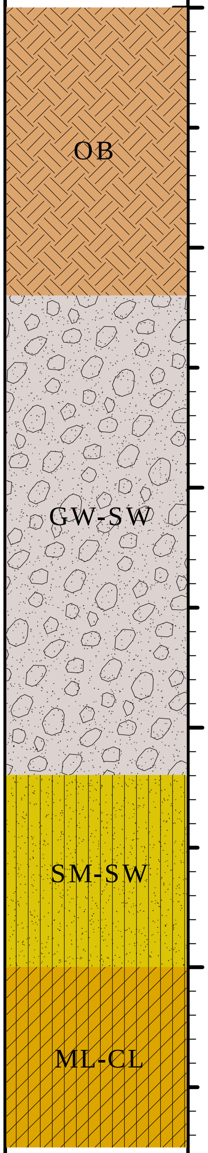
CASCADE GEOENGINEERING
360.907.4162 cascadegeoengineering.com

PROJECT NUMBER: CG1002-104
EXCAVATION DATE: 11/3/2017
TRENCH No.: ST-3

EXPLORATORY BORING LOG

SHEET 1 OF 1

PROJECT: Prineville ASR Project
LOCATION: Crooked Rvr Fork, Prineville OR
ELEVATION: 2870 Ft MSL
TRENCHING CONTRACTOR: Abbas Well & Drilling
TRENCHING METHOD AND EQUIPMENT: Cable Tool Drilling - 12" Nominal
WATER LEVEL: 11' bgs (Croo_54591)
GEOLOGIST: J. Newton



SAMPLE			SOIL DESCRIPTION	COMMENTS
INTERVAL DEPTH IN FEET	NUMBER AND TYPE	USCS CLASSIFICATION SYMBOL	SOIL NAME, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	
0				
5		OB		
	ST3-1 (8')			
10				SWL 11'bgs
	ST3-2 (12'-15')		Fine to medium coarse sand and gravel, sands are mixed mineralogy of ~40% basalt, trace hematite. gravels are ~30% basalt; sub-round to oblong and flattened and sub-angular to smooth.	
15	ST3-3(16')		Cobbles included up to ~80mm sub-round and sub-smooth, cobbles ~10%	
	ST3-4(19')			
20		GW-SW		
	ST3-5(22')		Less gravels (~10-20%)	
	ST3-6(24')		Trace silt	
25				
	ST3-7(24')		No silt	
30				
	ST3-8 (31.5')		Very fine black sand with silt	
35	ST3-9(36')	SM-SW	Very fine silty-sand (black-very dark brown)	
	ST3-10 (40') TD~40' 11/6/2017		Very fine silty black sand with trace clay (clay provides very minimal cohesion to create saturated clods/clumps of materials retrieved from bailer	
40				
		ML-CL		
45				
50				

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B = Bag Sample ST = Shelby tube Sample SS = Split Spoon Sample SK = Sack Sample

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CASCADE GEOENGINEERING
360.907.4162 cascadegeoengineering.com

PROJECT NUMBER CG1004-104

EXCAVATION DATE 10/9/2017 - 10/23/2017

TRENCH No. DT-1

EXPLORATORY BORING LOG

SHEET 1 OF 3

PROJECT Prineville ASR Project

LOCATION Crooked Rvr Fork, Prineville OR

ELEVATION 2870 Ft MSL

TRENCHING CONTRACTOR Abbas Well & Drilling

TRENCHING METHOD AND EQUIPMENT Cable Tool Drilling

WATER LEVEL First Water ~16' bgs

GEOLOGIST J. Newton

SAMPLE			SOIL DESCRIPTION	COMMENTS
INTERVAL DEPTH IN FEET	NUMBER AND TYPE	USCS CLASSIFICATION SYMBOL	SOIL NAME, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	
0	DT-1-1 0-5' Bag	OB	Grass Field Adjacent to Crooked River; Silt-Sand Loam, OMC, dk brown w/trace fine rooting below grass	
5				
10				
15	DT-1-2 14'-15' DT-1-3 16'-18'	SW-GW	Med-coarse grained gravels with silty sand of v.fine sand, basalt sub-rounded - sub-spherical gravels	1st Ground Water 16' DT-1-4 & previous samples were collected w/trip rampler; for DT-1-4 switched sand pump (plunger bailer style) & got good representative samples (with larger gravels)
			Fine-med grained gravels with fine sand	
20	DT-1-4 21' DT-1-5 22'		Increased gravels to primarily 90% graves 15mm to 30mm in size of sub-round smooth gravels	Stiffer drilling & slower penetration rate
25	DT-1-6 24' DT-1-7 25'-26' DT-1-8 27'		Large gravels with fine to medium sub-round to elongated rock up to 50mm to 300mm (large gravels up to 50%, fine-med gravels ~50%)	DT-1-6 collected at bottom of 24' hole
30	DT-1-9 30'-33'	SM-GW	Sample includes dark gray silty clay low to moderate plasticity w/v.fine to coarse gravels (gravels v.fine-med & coarse even split of ~50% of material, silty clays ~50% of materials); gravels are primarily basalt round to sub-spherical & oblong	
35	DT-1-10 34'-36'			
	DT-1-11 38'-40'	SM-SW	Silty sand w/clay, v.fine-fine black sand w/v.dk grey clay-silt ~90% sand, 5% silt, 5% clay. Sand composed of black basalt (50%), hematite trace, feldspars (5%), misc.	(sample came from directly from bit face)
40	DT-1-12 41'	ML-CL	Silty sand v.dk. Gray low plastic clay	(sample from bit face & bailer material added to bag)
	DT-1-13 43'		---samples included v.fine grained sub-angular gravels with clay	
	DT-1-14 44'	SW	Dk grey-black v.fine-fine grained sand w/trace silt	(bailer sample)
45	DT-1-15 45' DT-1-16 46' DT-1-17 47'	SW-GW	Compacted gravels w/sand	10/12 9:50 a.m. SWL prior to drilling 8'3" bgs
50	DT-1-18 49'-50'			

SAMPLE TYPES: SPT = Standard Penetrometer Test Sample ___________" Dia.
B = Bag Sample ST = Shelby tube Sample SS = Split Spoon Sample SK = Sack Sample

CASCADE GEOENGINEERING
360.907.4162 cascadegeoengineering.com

PROJECT NUMBER	EXCAVATION DATE	TRENCH No.
CG1004-104	10/9/2017 - 10/23/2017	DT-1

EXPLORATORY BORING LOG

SHEET 2 OF 3

PROJECT Prineville ASR Project LOCATION Crooked Rvr Fork, Prineville OR
ELEVATION 2870 Ft MSL TRENCHING CONTRACTOR Abbas Well & Drilling
TRENCHING METHOD AND EQUIPMENT Cable Tool Drilling
WATER LEVEL First Water ~16' bgs GEOLOGIST J. Newton

SAMPLE			SOIL DESCRIPTION	COMMENTS
INTERVAL DEPTH IN FEET	NUMBER AND TYPE	USCS CLASSIFICATION SYMBOL	SOIL NAME, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	
50 55	DT-1-19 52'-53'	SW-GW	Compacted gravels w/sand continued.	10/16 SWL 11' bgs
60 65	DT-1-20 58' DT-1-21 59'-60' DT-1-22 62'	SW-CL	Dark green silty plastic clay w/fine-med. Gravels & v. coarse sands (clays ~60%, sands & gravels ~40%; sands & gravels of angular to sub-angular)	10/17 SWL 12' bgs
70	DT-1-23 71'-74'	SW-GW	Fine sands - v. fine gravels in silty clay; med bluish green plastic clay; gravels are angular to sub-round of quartzite, basalt & mixed mineralogy	
75	DT-1-24 75'		---increase in fine gravels to ~40% sands-gravels	
	DT-1-25 77'-79'		---reduced coarse sands & fine gravels ~20%-30% sands & gravels	
80 85 90 95 100	DT-1-26 82'-85'	ML-CL	Rock found in bailer head of pastel green silty claystone with trace coarse sands	85'; 10/18 SWL 13'2" bgs 94'; 10/19 SWL 13' bgs

SAMPLE TYPES: SPT = Standard Penetrometer Test Sample ___________" Dia.
B = Bag Sample ST = Shelby tube Sample SS = Split Spoon Sample SK = Sack Sample

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

CASCADE GEOENGINEERING
360.907.4162 cascadegeoengineering.com

PROJECT NUMBER	EXCAVATION DATE	TRENCH No.
CG1004-104	10/9/2017 - 10/23/2017	DT-1

EXPLORATORY BORING LOG

SHEET 3 OF 3

PROJECT Prineville ASR Project LOCATION Crooked Rvr Fork, Prineville OR

ELEVATION 2870 Ft MSL TRENCHING CONTRACTOR Abbas Well & Drilling

TRENCHING METHOD AND EQUIPMENT Cable Tool Drilling

WATER LEVEL First Water ~16' bgs GEOLOGIST J. Newton

SAMPLE			SOIL DESCRIPTION	COMMENTS
INTERVAL DEPTH IN FEET	NUMBER AND TYPE	USCS CLASSIFICATION SYMBOL	SOIL NAME, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	
100			Rock found in bailer head of pastel green silty claystone with trace coarse sands continued.	
	DT-1-27 104'		Pastel green silty/claystone w/black ash, sticky	
105				107'; SWL 13' bgs 10/20
110	DT-1-28 110'			Sample from drill bit head
	DT-1-29 113'	ML-CL		
115			Pastel green silty clay/claystone w/lt.-yellowish brown silty clay & trace of v.fine gravels /v.couarse sands of basalt grains	
	DT-1-30 119'			
120	DT-1-31 120'		---slight increase in v.coarse sands up to ~5%-8% basalt sands; clay is lt-yellowish greenish-lt. brown	
	DT-1-32 122'		---trace of med. Gravels in silty-claystone	
	DT-1-33 124'			124'; Monday morning 10/23 SWL 8' bgs
125			Lt-yellowish brown silty clay/claystone with gravels; clay is sticky, v.coarse sands - v.fine gravels ~5%	
	DT-1-34 127' DT-1-35 128'			
130				
135				
140	DT-1-36 TD~140'			
145				
150				

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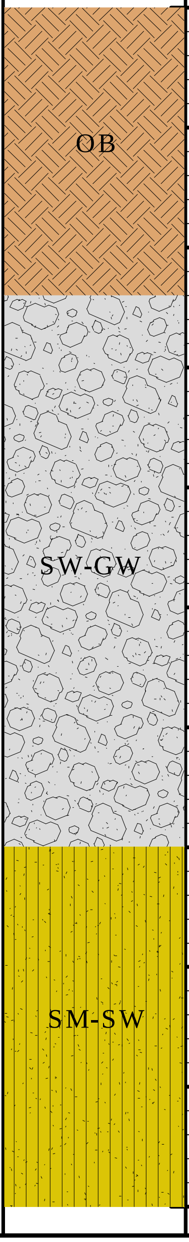
CASCADE GEOENGINEERING
360.907.4162 cascadegeoengineering.com

PROJECT NUMBER: CG1002-104
EXCAVATION DATE: 11/17/2017
TRENCH No.: DT-2

EXPLORATORY BORING LOG

SHEET 1 OF 3

PROJECT: Prineville ASR Project
LOCATION: Crooked Rvr Fork, Prineville OR
ELEVATION: 2872 Ft MSL
TRENCHING CONTRACTOR: Abbas Well & Drilling
TRENCHING METHOD AND EQUIPMENT: Cable Tool Drilling
WATER LEVEL: 4' bgs (Croo_54592)
GEOLOGIST: J. Newton



SAMPLE		USCS CLASSIFICATION SYMBOL	SOIL DESCRIPTION	COMMENTS
INTERVAL DEPTH IN FEET	NUMBER AND TYPE		SOIL NAME, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	
0				
5		OB		
10				
			Loose sand and gravels, fine ~ very coarse sands with gravels with mixed mineralogy of sub-round smooth gravels. (basalt~40%, hematite trace, feldspar, quartzite trace) Tight sands and gravels	SWL 11/13 11' bgs (Sampled with trip sampler, no coarse materials)
15				
	DT-2-2 (18')			
20				
		SW-GW		
25				
30	DT-2-3 (30')		Very fine silty - black-brown/green sand with trace of clay, sand appears to be fine dark green-black basalt grains.	
	DT-2-4 (32'-36')			
35				
40	DT-2-5 (40')		Very fine black sand; mineralogy appears ~90% basalt olivine grains with trace cinder/hermitite, feldspar, quartz/quartzite.	
		SM-SW		
45	DT-2-6 (45')			
50	DT-2-7 (49'-50')		Bailer pulled up lightly, littlefield sandstone of same makeup sand encountered.	

SAMPLE TYPES: SPT = Standard Penetrometer Test Sample ___________" Dia.
B = Bag Sample ST = Shelby tube Sample SS = Split Spoon Sample SK = Sack Sample

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

CASCADE
GEOENGINEERING
360.907.4162 cascadegeoengineering.com

PROJECT NUMBER	EXCAVATION DATE	TRENCH No.
CG1002-104	11/17/2017	DT-2

EXPLORATORY BORING LOG

SHEET 2 OF 3

PROJECT Prineville ASR Project

LOCATION Crooked Rvr Fork, Prineville OR

ELEVATION 2872 Ft MSL

TRENCHING CONTRACTOR Abbas Well & Drilling

TRENCHING METHOD AND EQUIPMENT Cable Tool Drilling

WATER LEVEL 4' bgs (Croo_54592)

GEOLOGIST J. Newton

SAMPLE			SOIL DESCRIPTION	COMMENTS
INTERVAL DEPTH IN FEET	NUMBER AND TYPE	USCS CLASSIFICATION SYMBOL	SOIL NAME, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	
50	DT-2-8 (51') 2 bgs			
55	DT-2-9 (56')		Very dark brown-black with fine silty-sand with possible trace clay and minor cohesive (clods)	
60				
65	DT-2-10 (64')			
70				
75		SM-SW		
80				
85	DT-2-11 (85')			
90				
95	DT-2-12 (95')			
100				

SAMPLE TYPES: SPT = Standard Penetrometer Test Sample ___________" Dia.
B = Bag Sample ST = Shelby tube Sample SS = Split Spoon Sample SK = Sack Sample

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

CASCADE GEOENGINEERING
360.907.4162 cascadegeoengineering.com

PROJECT NUMBER CG1002-104

EXCAVATION DATE 11/17/2017

TRENCH No. **DT-2**

SHEET 3 OF 3

EXPLORATORY BORING LOG

PROJECT Prineville ASR Project

LOCATION Crooked Rvr Fork, Prineville OR

ELEVATION 2872 Ft MSL

TRENCHING CONTRACTOR Abbas Well & Drilling

TRENCHING METHOD AND EQUIPMENT Cable Tool Drilling

WATER LEVEL 4' bgs (Croo_54592)

GEOLOGIST J. Newton

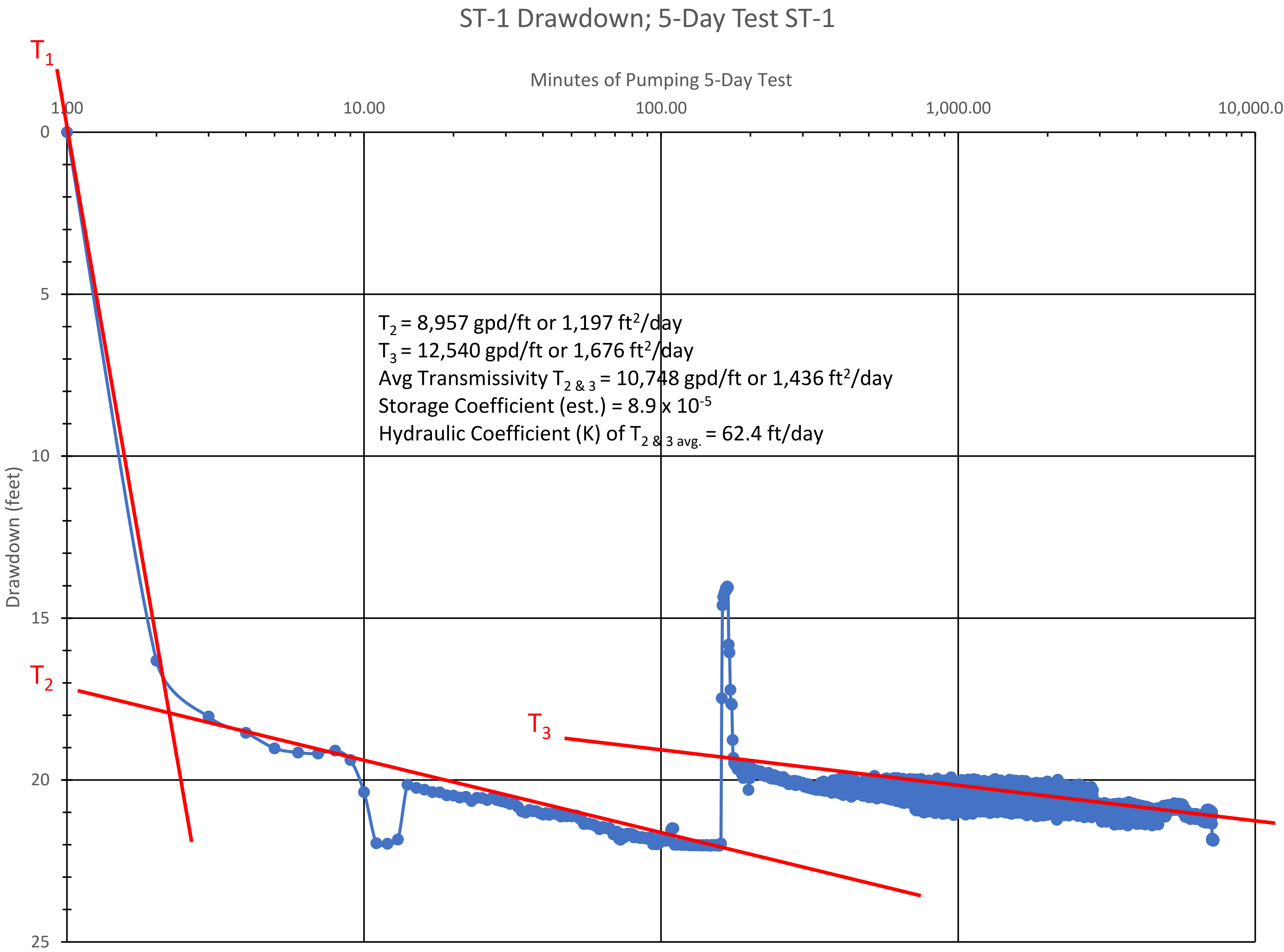
SAMPLE			SOIL DESCRIPTION	COMMENTS
INTERVAL DEPTH IN FEET	NUMBER AND TYPE	USCS CLASSIFICATION SYMBOL	SOIL NAME, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	
100	DT-2-13 (105')			
105				
110		SM-SW		
115	DT-2-14 (115')		Very fine dark with brownish (silt) black silty sand (black, very fine)	Noticeable sulfur (rotten egg) smell when sand pump discharges to catchment. Silts and sand settle quickly.
120				
125				
130				
135				
140				
145				
150				

SAMPLE TYPES: SPT = Standard Penetrometer Test Sample ___________" Dia.
B = Bag Sample ST = Shelby tube Sample SS = Split Spoon Sample SK = Sack Sample

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

APPENDIX C

WELL TEST GRAPHS



T_2 = 8,957 gpd/ft or 1,197 ft^2/day

T_3 = 12,540 gpd/ft or 1,676 ft^2/day

Avg Transmissivity $T_{2\ \&\ 3}$ = 10,748 gpd/ft or 1,436 ft^2/day

Storage Coefficient (est.) = 8.9 x 10^{-5}

Hydraulic Coefficient (K) of $T_{2\ \&\ 3\ avg.}$ = 62.4 ft/day

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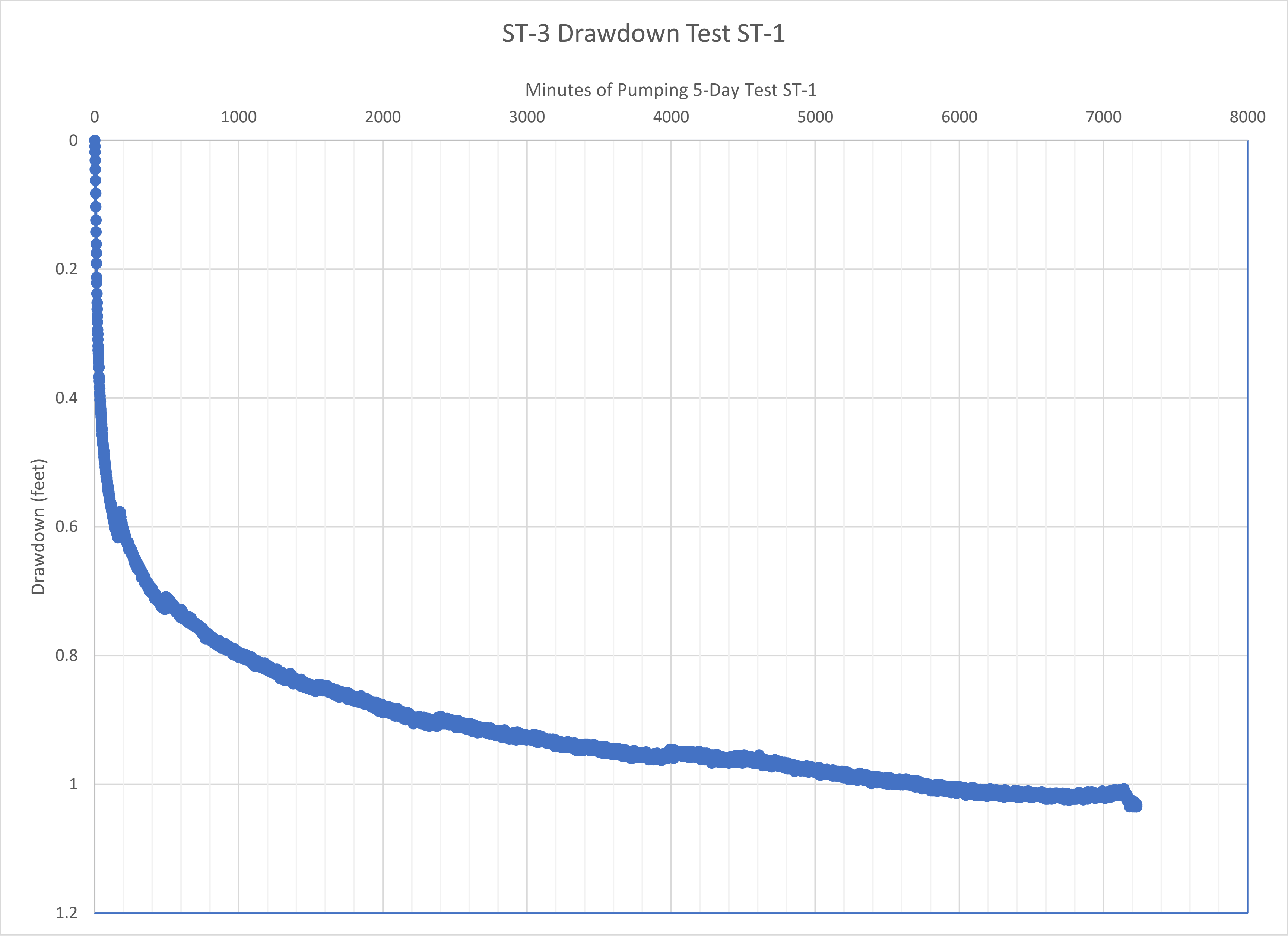

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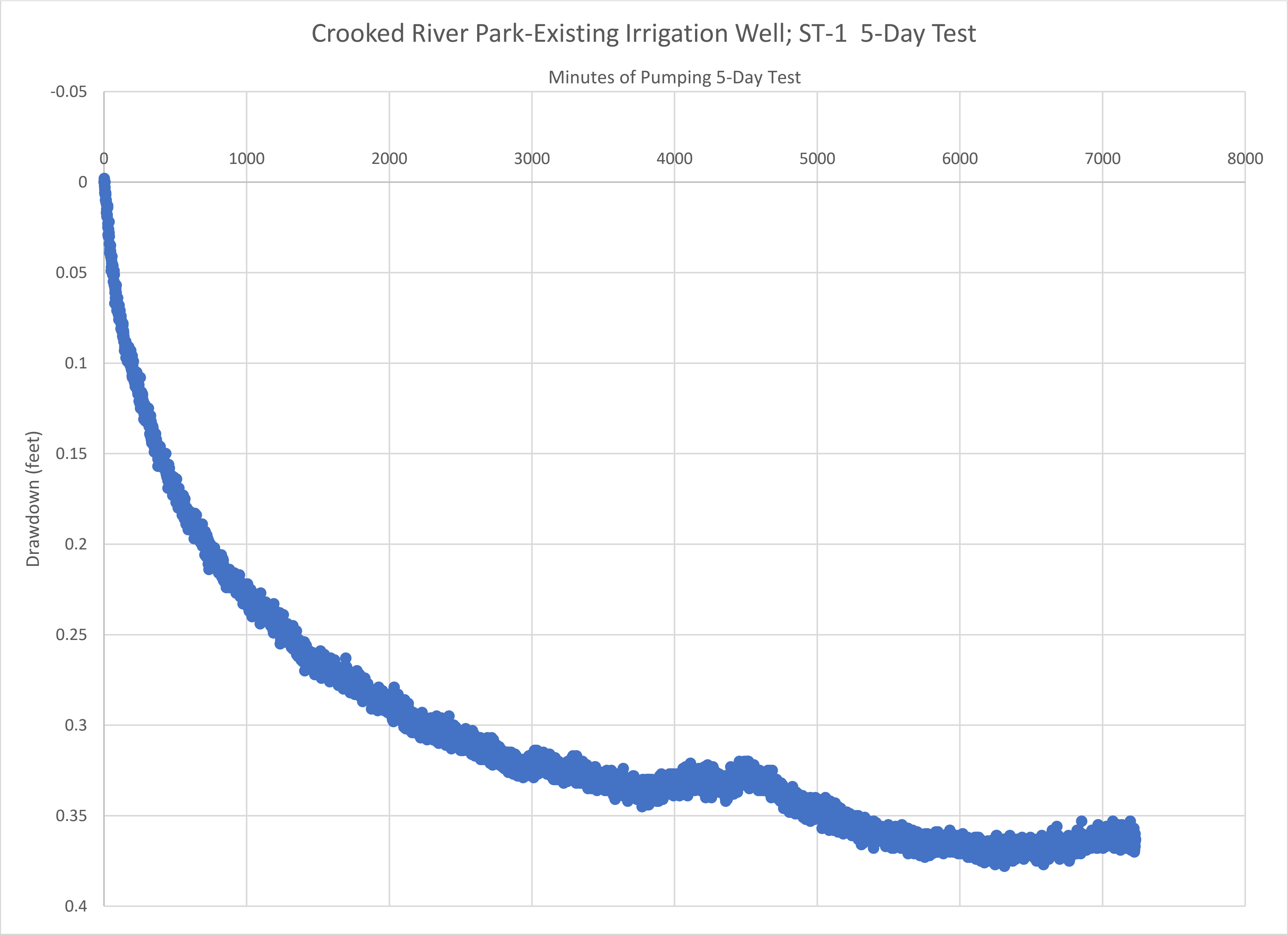

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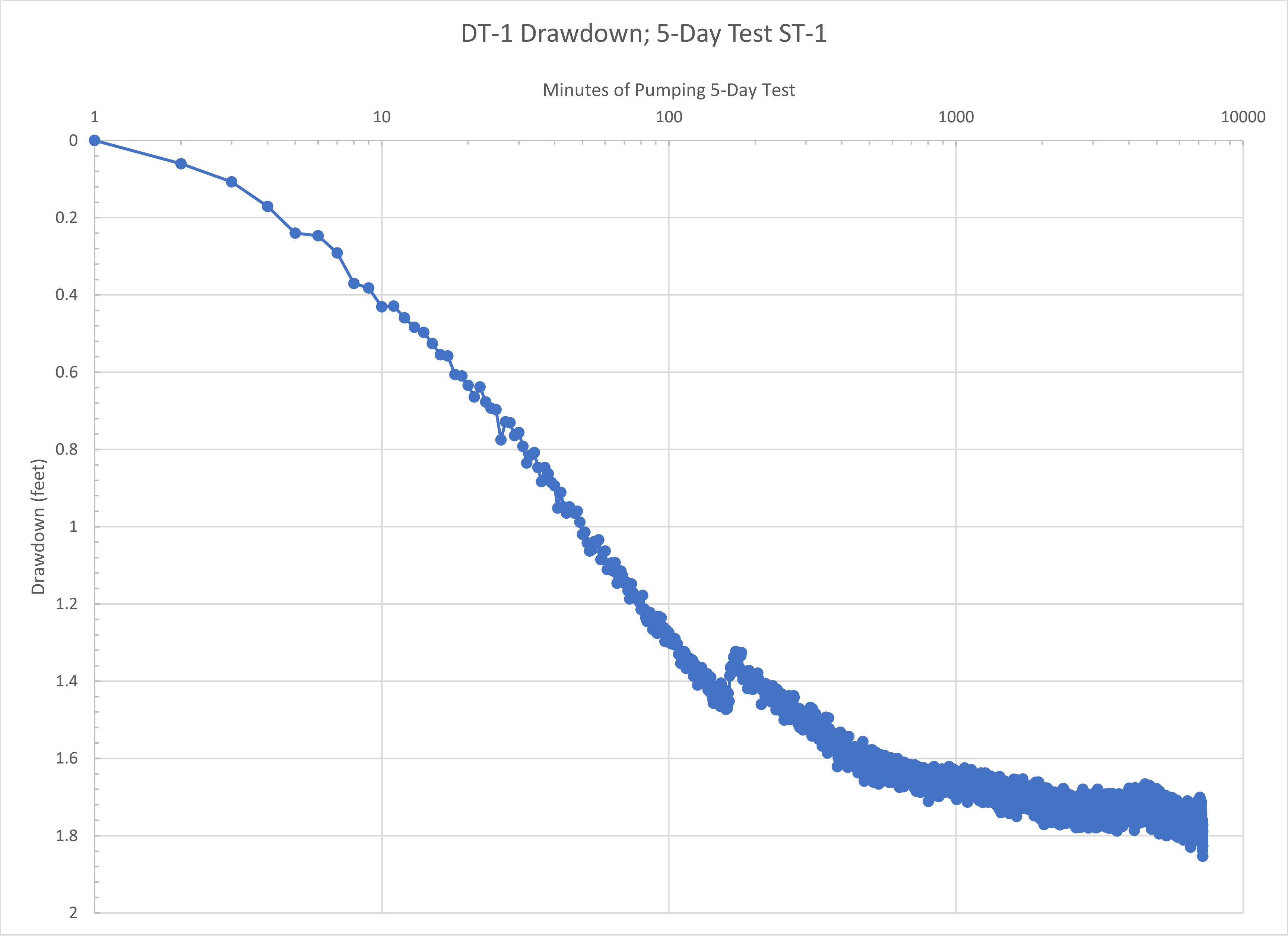

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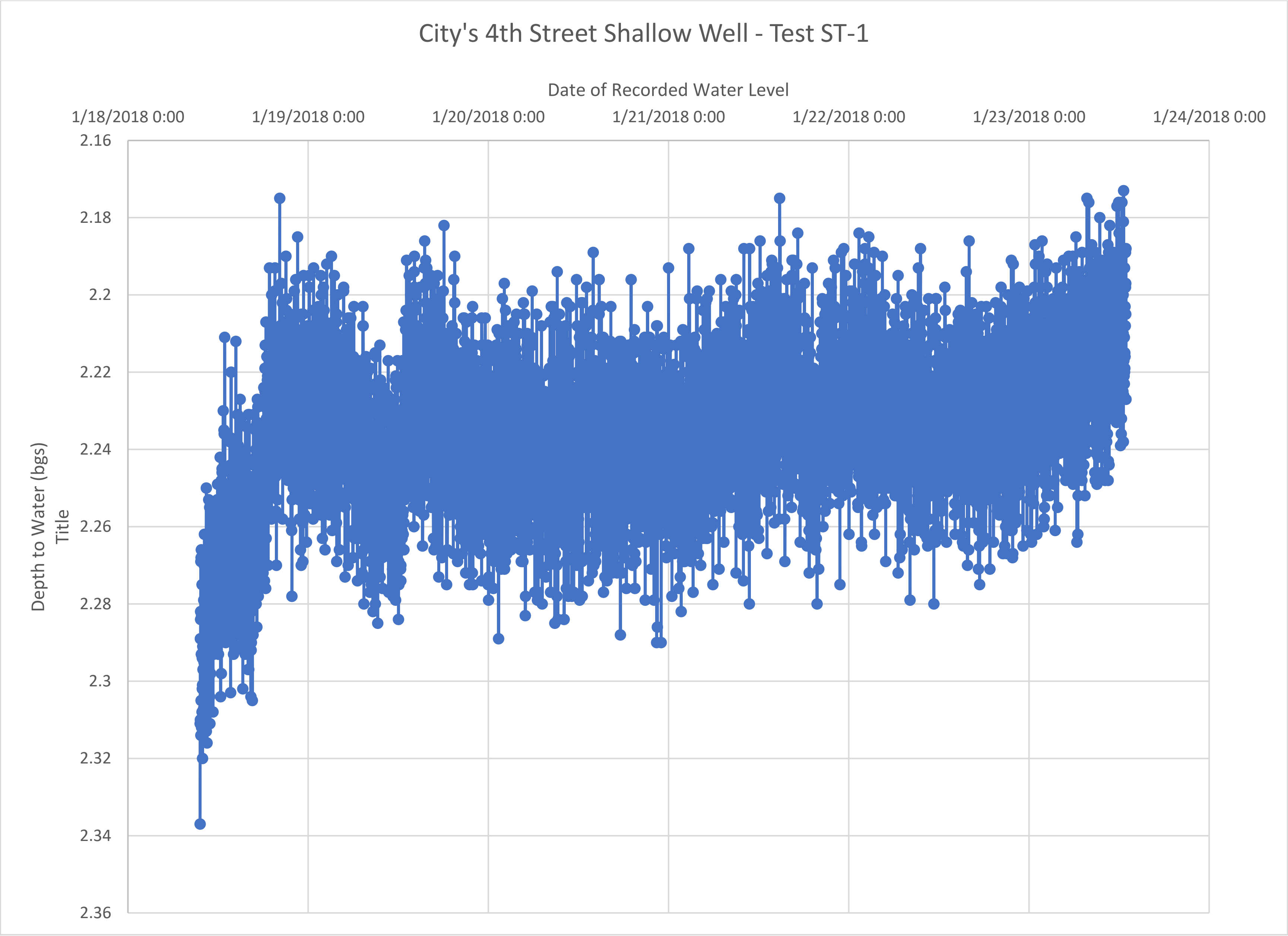

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DT-1 Drawdown; 5-Day Test DT-1

T_2 = 4,072 gpd/ft or 544 ft^2/day
T_3 = 9,953 gpd/ft or 1,330 ft^2/day
Avg Transmissivity $T_{2\ \&\ 3}$ = 7,011 gpd/ft or 937 ft^2/day
Storage Coefficient (Avg $T_{2\ \&\ 3}$) = 3.95 x 10^{-4}
Hydraulic Coefficient (K) of $T_{2\ \&\ 3\ \mathrm{avg.}}$ = 26.7 ft/day

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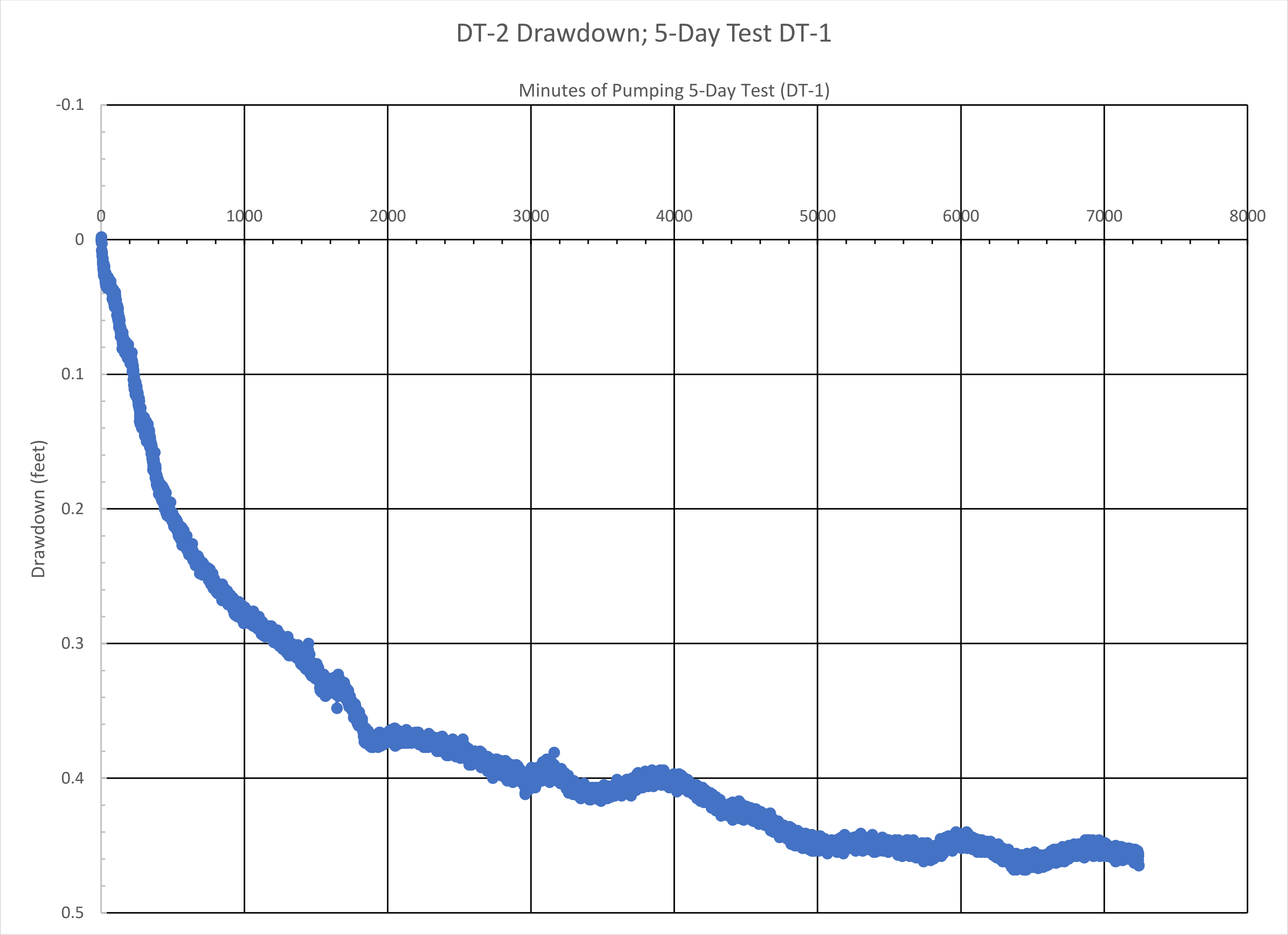
GEOENGINEERING



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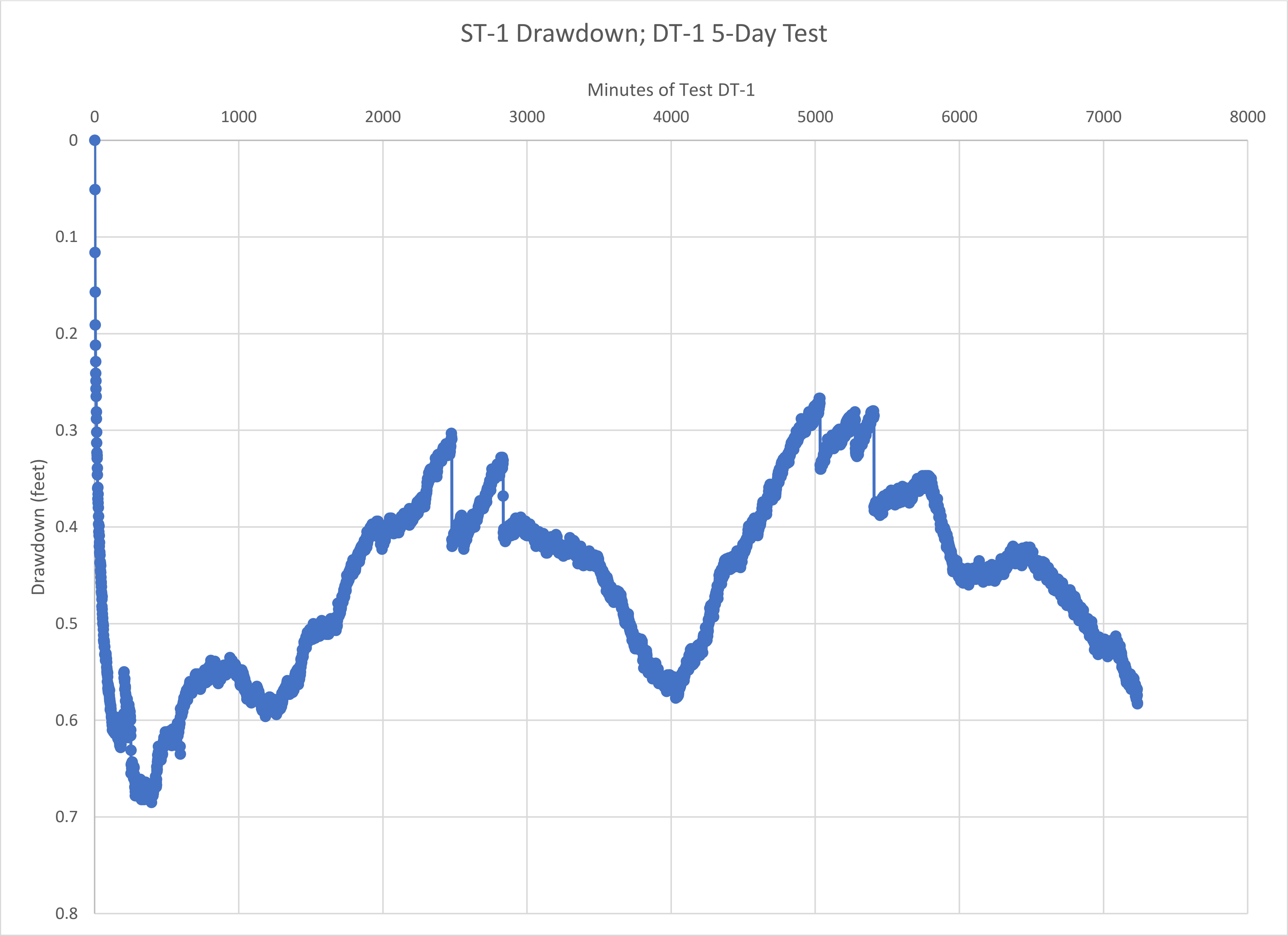

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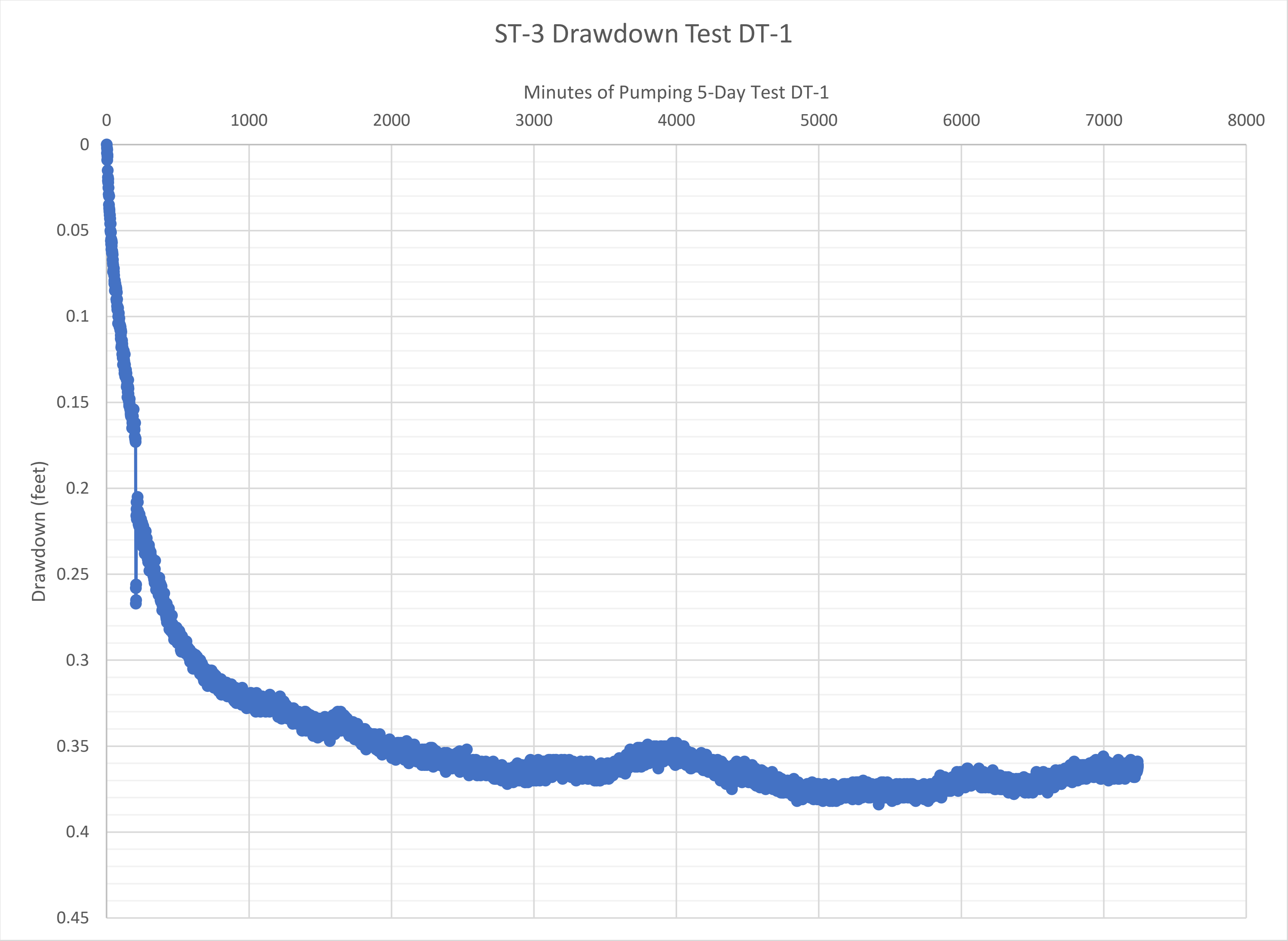

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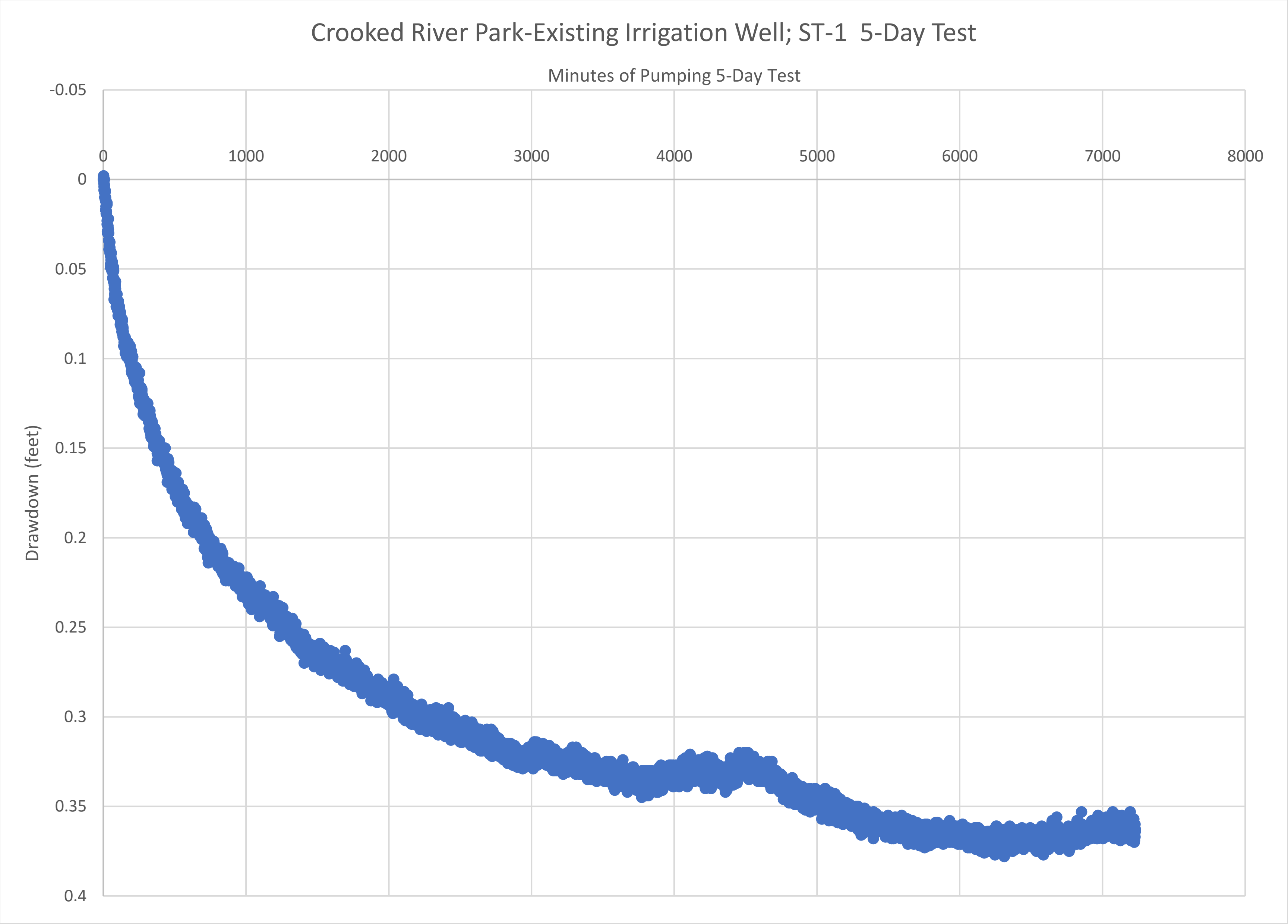

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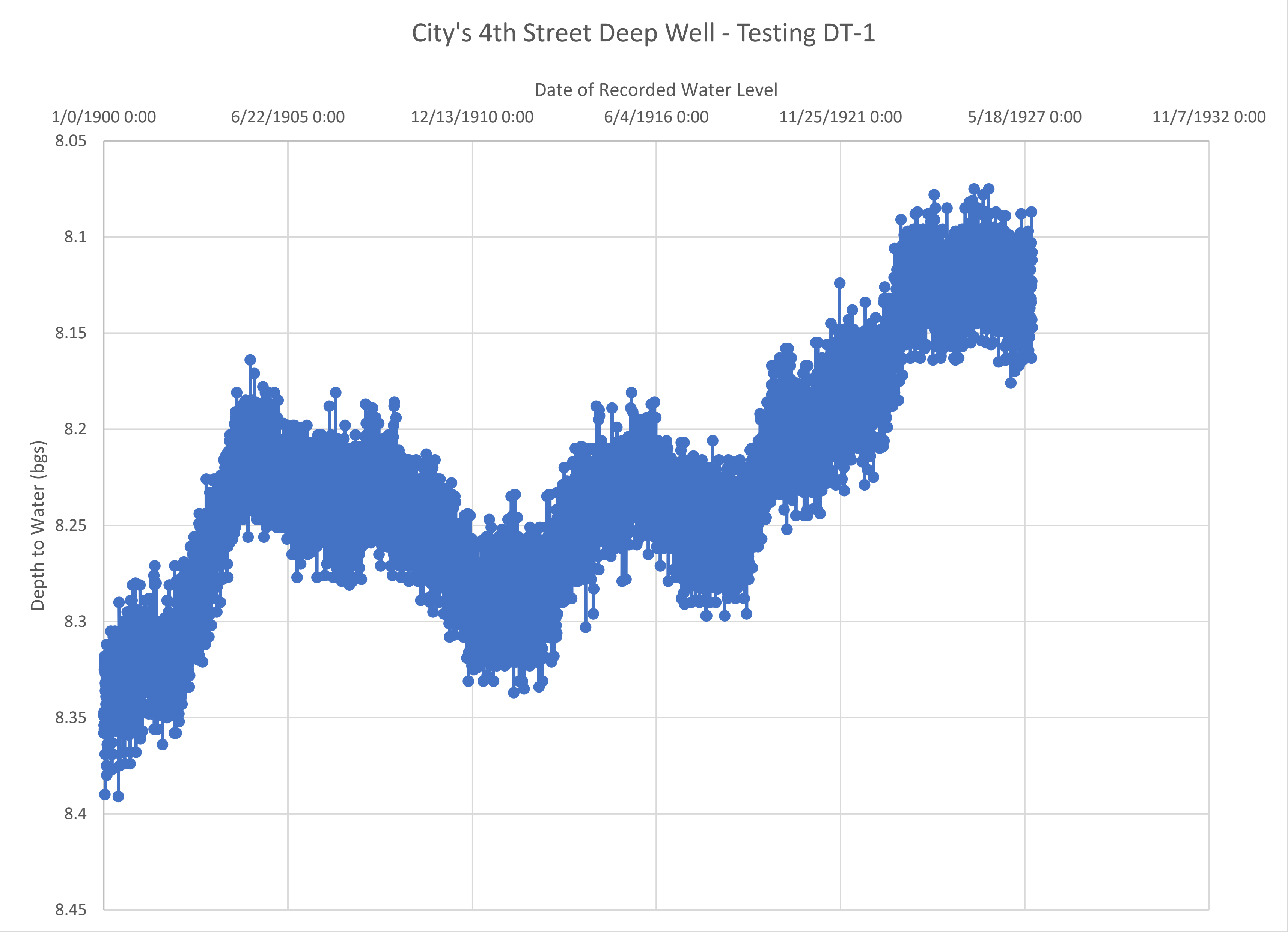
GEOENGINEERING



CASCADE GEOENGINEERING

APPENDIX B

ASR Limited License Application Form & Map

City of Prineville ASR Limited License Application

ASR Limited License No. __________
(ASSIGNED AFTER FILING)

APPLICATION FOR
AQUIFER STORAGE AND RECOVERY (ASR) LIMITED LICENSE

Applicant: __City of Prineville, Attn: Eric Klann Public Works Director____________
Mailing Address: __387 NE 3rd Street, Prineville, OR 97754 _ ____________________
Phone and Email: __(541) 447-2357 eklann@cityofprineville.com__________________

Authorized Agent:_____GSI Water Solutions, Inc. Attn: Bruce Brody-Heine________ ____
Mailing Address: ___147 SW Shevlin Hixon Dr, Suite 201, Bend OR 97702_ _____ ___
Phone and email: ___(541) 200-8519__ bbheine@gsiws.com ___ __________________

1. **DATE(S) OF PRE-APPLICATION CONFERENCE(S):**_____September 13, 2018_ _______

INFORMATION REGARDING ASR TESTING UNDER A LIMITED LICENSE

2. **SOURCE OF INJECTION WATER for ASR:** City of Prineville Valley Aquifer Wells (see ASR Limited License Application Map)________________________________

   a tributary of: NA (wells located in Prineville Valley with Crooked and Ochoco Rivers)

2.5 **WATER RIGHTAUTHORIZATIONS (Permit or Certificate numbers):** ____________________
_____See Attachment A – Existing City Water Rights________________________

3. **MAXIMUM DIVERSION RATE:**Years 1-2 up to 825 gpm; Future years up to 3,000 gpm

4. **MAXIMUM INJECTION RATE AT EACH WELL(S):**________________________________
__________Years 1-2 up to 825 gpm; Future years up to 1,100 gpm___ ___________

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 – Heliport Production Well	**CROO 54191**	**L 114180**	1070 feet North and 1710 feet East from the SW corner of Section 11, Township 15 South, Range 15 East (W.M.)
ASR 2 Future Well	**- NA -**	**- NA -**	1691 feet North and 462 feet East from the SW corner of Section 11, Township 15 South, Range 15 East (W.M.)
ASR 3 Future Well	**- NA -**	**- NA -**	2569 feet North and 327 feet East from the SW corner of Section 11, Township 15 South, Range 15 East (W.M.)
ASR 4 Future Well	**- NA -**	**- NA -**	1141 feet South and 83 feet East from the NW corner of Section 11, Township 15 South, Range 15 East (W.M.)
ASR 5 Future Well	**- NA -**	**- NA -**	442 feet North and 86 feet West from the SE corner of Section 3, Township 15 South, Range 15 East (W.M.)

5. **MAXIMUM STORAGE VOLUME:** Year 1 up to 154 MG; Year 2-3 up to 179 MG
Future years up to 870 MG (cumulative with carryover)

6. **MAXIMUM STORAGE DURATION:** Annual storage period of 2 to 4 months, with annual carryover of stored volume over multiple years

7. **MAXIMUM WITHDRAWAL RATE AT EACH WELL(S):**
Year 1-2 up to 825 gpm. Future years up to 1,400 gpm from each ASR Well

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

9. **PROPOSED USE OR DISPOSAL OF RECOVERED WATER:**
Municipal Use by the City of Prineville

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

INFORMATION REGARDING THE ULTIMATE ASR PROJECT
AS CURRENTLY ANTICIPATED

11. **SOURCE OF INJECTION WATER for ASR:** City of Prineville Valley Aquifer Wells (see ASR Limited License Application Map
a tributary of: NA (wells located in Prineville Valley with Crooked and Ochoco Rivers)

11.5 **WATER RIGHT AUTHORIZATION (Application, Permit or Certificate numbers):**
See Attachment A – City Water Rights

12. **MAXIMUM DIVERSION RATE:** up to 3,000 gpm

13. **MAXIMUM INJECTION RATE AT EACH WELL(S):** up to 1,100 gpm

14. **MAXIMUM STORAGE VOLUME:** up to 870 MG (cumulative with carryover)

15. **MAXIMUM STORAGE DURATION:** Annual storage period of 2 to 4 months, with an annual carryover of stored volume over multiple years

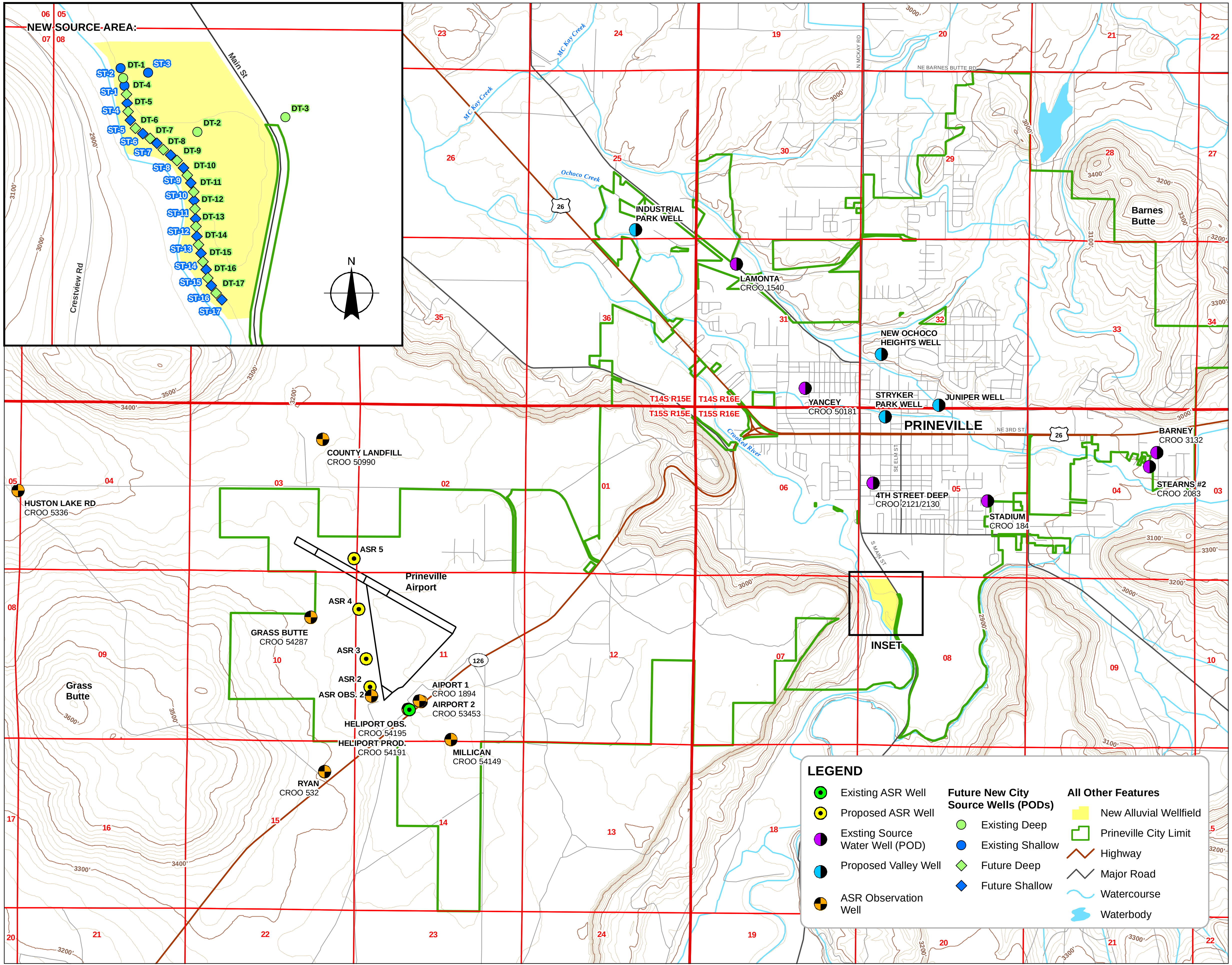
16. **MAXIMUM WITHDRAWAL RATE AT EACH WELL(S):** up to 1,400 gpm

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 10/8/2018

Title of Applicant Public Works Dir



Limited License Map

ASR Limited License Application and Work Plan

City of Prineville

POD LOCATION DESCRIPTIONS

PROPOSED ASR WELL AND FUTURE WELL SITES

Heliport Production Well: Located 1070 feet North and 1710 feet East from the SW corner of Section 11, Township 15 South, Range 15 East (W.M.)
Future ASR Well 2: Located 1691 feet North and 462 feet East from the SW corner of Section 11, Township 15 South, Range 15 East (W.M.)
Future ASR Well 3: Located 2569 feet North and 327 feet East from the SW corner of Section 11, Township 15 South, Range 15 East (W.M.)
Future ASR Well 4: Located 1141 feet South and 83 feet East from the NW corner of Section 11, Township 15 South, Range 15 East (W.M.)
Future ASR Well 5: Located 442 feet North and 86 feet West from the SE corner of Section 3, Township 15 South, Range 15 East (W.M.)

ASR SOURCE WATER POINTS OF DIVERSION

New Ochoco Heights Well: Located 1673 feet North and 677 feet East from the SE Corner of Section 32, Township 14 South, Range 16 East (W.M.)
Industrial Park Well: Located 277 feet North and 1888 feet West from the NW Corner of Section 31, Township 14 South, Range 15 East (W.M.)
Stryker Park Well: Located 277 feet South and 812 feet East from the SW Corner of Section 32, Township 15 South, Range 16 East (W.M.)
Juniper Well: Located 97 feet North and 2493 feet East from the SW Corner of Section 32, Township 15 South, Range 16 East (W.M.)
CROO 184 (Stadium Well): Located 2122 feet North and 461 feet West from the SE corner of Section 5, Township 15 South, Range 16 East (W.M.)
CROO 2083 (Stearns #2): Located 1810.2 feet South and 1151.5 feet East from the N 1/4 corner of Section 4, Township 15 South, Range 16 East (W.M.)
CROO 3132 (Barney): Located 1315 feet South and 1370 feet East from the N 1/4 corner of Section 4, Township 15 South, Range 16 East (W.M.)
CROO 50181 (Yancey): Located 1070 feet North and 1370 feet East and 55 degrees and 0 minutes East from the 1/4 section corner south line of Section 31, Township 14 South, Range 16 East (W.M.)
CROO 1540 (Lamonta): Located 58 degrees South and 13 minutes East, 1447 feet from the NW corner of Section 31, Township 14 South, Range 16 East (W.M.)
CROO 2121 (4th Street Deep): Located 375 feet North and 370 feet East from the W 1/4 corner of Section 5, Township 15 South, Range 16 East (W.M.)
D-1 (CROO 54593): Located 422 feet South and 400 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
S-1 (CROO 54587): Located 471 feet South and 406 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
D-2 (CROO 54592): Located 585 feet South and 793 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
D-3: Located 516 feet South and 438 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
S-2: Located 561 feet South and 466 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
D-4: Located 601 feet South and 509 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
S-3: Located 621 feet South and 564 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
D-5: Located 657 feet South and 611 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
S-4: Located 694 feet South and 654 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
D-6: Located 717 feet South and 700 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
S-5: Located 789 feet South and 731 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
D-7: Located 840 feet South and 759 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
S-6: Located 888 feet South and 784 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
D-8: Located 952 feet South and 799 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
S-7: Located 1004 feet South and 809 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
D-9: Located 1061 feet South and 815 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
S-8: Located 1116 feet South and 808 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
D-10: Located 1179 feet South and 796 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
S-9: Located 1232 feet South and 800 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
D-11: Located 1267 feet South and 836 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
S-10: Located 1320 feet South and 869 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
D-12: Located 1372 feet South and 879 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
S-11: Located 1420 feet South and 896 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
D-13: Located 1479 feet South and 909 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)
S-12: Located 1527 feet South and 949 feet East from the NW corner of Section 8, Township 15 South, Range 16 East (W.M.)

ASR OBSERVATION WELLS

Airport Well 1: Located 1210 feet North and 1950 feet East from the SW corner of Section 11, Township 15 South, Range 15 East (W.M.)
Airport Well 2: Located 1165 feet North and 1990 feet East from the SW corner of Section 11, Township 15 South, Range 15 East (W.M.)
Millican Well (Airport Well 3): Located 55 feet North and 3000 feet East from the SW corner of Section 11, Township 15 South, Range 15 East (W.M.)
CROO 53965 (Heliport Observation Well): Located 1238 feet North and 1506 feet East from the SW corner of Section 11, Township 15 South, Range 15 East (W.M.)
ASR Observation Well 2: Located 1404 feet North and 506 feet East from the SW corner of Section 11, Township 15 South, Range 15 East (W.M.)
CROO 532 (Ryan Well): Located 895 feet South and 952 feet West from the SW corner of Section 11, Township 15 South, Range 15 East (W.M.)
CROO 53361 (Houston Lake Rd): Located 183 feet South and 77 feet West from the W 1/4 corner of Section 4, Township 15 South, Range 15 East (W.M.)
CROO 54287 (Grass Butte Well): Located 1472 feet South and 1493.15 feet West from the NE corner of Section 10, Township 15 South, Range 15 East (W.M.)
CROO 50990 (County Landfill Well): Located 1067 feet South and 1161 feet West from the NW corner of Section 3, Township 15 South, Range 15 East (W.M.)

0 1,500 3,000 4,500
Feet

MAP NOTES:
POD = Point of Diversion
Date: October 1, 2018
Data Sources: ESRI, USGS, DigiGlobe 2016

GSI Water Solutions, Inc.

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ATTACHMENT A

Existing City Water Rights

Table 2. Summary of City of Prineville Water Rights - ASR Source Water Supply

City of Prineville ASR Limited License Application & Pilot Testing Work Plan

Well Name	OWRD Well Log ID	Use	Water Rights				Hydrogeologic Unit	Authorized Rate	
			Application	Permit	Certificate	Transfers		(gpm)	(MGD)
Municipal Water Supply System - Prineville Valley Wells									
Lamonta	CROO 1540	MU	G 605	G 506	86337		Valley Floor Confined Aq	346	0.50
Yancey	CROO 50181	MU	U 241	U 215	22839		Valley Floor Confined Aq	359	0.52
Barney	CROO 3132	MU	G 6313	G 9154	83993	~~T9762~~	Valley Floor Confined Aq	700	1.01
Stearns #2	CROO 2083	MU							
Stadium	CROO 184	MU	G 12344	G 11993	87714		Valley Floor Confined Aq	271	0.39
		MU						154	0.22
4th Street Deep	CROO 2121 CROO 2133	MU	U 402	U 372	86889		Valley Floor Confined Aq	337	0.49
Shallow Alluvial Well Field [2]	*CROO 54587* *CROO 54592* *CROO 54593* *up to 21 new wells*	*MU*	*G-18662*	*Pending* *(PFO issued)*			*Valley Floor Unconfined Aq*	*2000*	*2.88*
Ochoco Heights	*new well(s)*	*MU*	*U 147*	*U 140*	*86558*	*T-13030*	*Valley Floor Confined Aq*	*359*	*0.52*
							Total	4,526	6.52

Notes:

(1) City production capacity from valley wells excludes the 4th Street Shallow well because it is only used as an emergency source

(2) Pending water right application for new wellfield, permit expected to be issued in early 2019; total of 24 wells in wellfield

Strikethrough indicates that the transfer changed the water right, and the water right was re-certified.

MU = Municipal Use

OWRD = Oregon Water Resources Department

gpm = gallons per minute

MGD = millions of gallons per day

City Existing Valley Floor Water Rights for ASR Source Water

STATE OF OREGON

COUNTY OF CROOK

CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

CITY OF PRINEVILLE
387 NE THIRD STREET
PRINEVILLE, OR 97754

confirms the right to use the waters of LaMONTA WELL in the OCHOCO CREEK BASIN for MUNICIPAL USES.

This right was perfected under Permit G-506. The date of priority is APRIL 5, 1957. The amount of water to which this right is entitled is limited to an amount actually used beneficially, and shall not exceed 0.77 CUBIC FOOT PER SECOND or its equivalent in case of rotation, measured at the well.

The well is located as follows:

Twp	Rng	Mer	Sec	Q-Q	Measured Distances
14 S	16 E	WM	31	NW NW	SOUTH 58 DEGREES 13 MINUTES EAST, 1447 FEET FROM NW CORNER OF SECTION 31

The use shall conform to such reasonable rotation system as may be ordered by the proper state officer.

A description of the place of use to which this right is appurtenant is as follows:

MUNICIPAL USES					
Twp	Rng	Mer	Sec	Q-Q	GLot
14 S	16 E	WM	31	NE SE	
14 S	16 E	WM	31	NW SE	
14 S	16 E	WM	31	SW SE	
14 S	16 E	WM	31	SE SE	
14 S	16 E	WM	32	NE SW	
14 S	16 E	WM	32	NW SW	
14 S	16 E	WM	32	SW SW	
14 S	16 E	WM	32	SE SW	
15 S	16 E	WM	5	NW NE	2
15 S	16 E	WM	5	SW NE	
15 S	16 E	WM	5	NE NW	3
15 S	16 E	WM	5	NW NW	4
15 S	16 E	WM	6	NE NE	1
15 S	16 E	WM	6	NW NE	2
15 S	16 E	WM	6	SE NE	

This certificate describes that portion of the water right confirmed by Certificate 29097, State Record of Water Right Certificates, NOT modified by the provisions of an order of the Water Resources Director entered JUN 0 7 2010, approving Transfer Application T-11026.

The issuance of this superseding certificate does not confirm the status of the water right in regard to the provisions of ORS 540.610 pertaining to forfeiture or abandonment.

The right to the use of the water for the above purpose is restricted to beneficial use on the lands or place of use described.

WITNESS the signature of the Water Resources Director, affixed June 7, 2010.

Dwight French

Phillip C. Ward, Director

Permit A-1—1500—2-50 State Printing 90199

STATE OF OREGON

COUNTY OF CROOK

CERTIFICATE OF WATER RIGHT

This Is to Certify, *That* PACIFIC POWER & LIGHT CO.

of Public Service Bldg., Portland 4 *, State of* Oregon *, has made proof to the satisfaction of the STATE ENGINEER of Oregon, of a right to the use of the waters of* a well *a tributary of* *for the purpose of* municipal supply *under Permit No.* U-215 *of the State Engineer, and that said right to the use of said waters has been perfected in accordance with the laws of Oregon; that the priority of the right hereby confirmed dates from* June 17, 1947;

that the amount of water to which such right is entitled and hereby confirmed, for the purposes aforesaid, is limited to an amount actually beneficially used for said purposes, and shall not exceed 0.8 cubic foot per second

or its equivalent in case of rotation, measured at the point of diversion from the stream. The point of diversion is located in the SW¼SE¼, Section 31, Township 14 South, Range 16 East, W. M.

The amount of water used for irrigation, together with the amount secured under any other right existing for the same lands, shall be limited to - - - - - - - - *of one cubic foot per second per acre,*

and shall conform to such reasonable rotation system as may be ordered by the proper state officer.

A description of the place of use under the right hereby confirmed, and to which such right is appurtenant, is as follows:

SW¼SE¼
NW¼SE¼
NE¼SE¼
SE¼SE¼
Section 31
SW¼SW¼
NW¼SW¼
NE¼SW¼
SE¼SW¼
Section 32
Township 14 South, Range 16 East, W. M.

SW¼NW¼
NW¼NW¼
NE¼NW¼
SE¼NW¼
SW¼NE¼
NW¼NE¼
Section 5
NW¼NE¼
NE¼NE¼
SE¼NE¼
Section 6
Township 15 South, Range 16 East, W. M.

The right to the use of the water for the purposes aforesaid is restricted to the lands or place of use herein described.

WITNESS the signature of the State Engineer, affixed

this 12th *day of* July *,* 57 .

LEWIS A. STANLEY
State Engineer

Recorded in State Record of Water Right Certificates, Volume 16 *, page* 22839.

STATE OF OREGON

COUNTY OF CROOK

CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

CITY OF PRINEVILLE
387 NE 3RD STREET
PRINEVILLE, OREGON, 97754

confirms the right to use of the waters of STEARNS WELL #2 and BARNEY WELL in the OCHOCO CREEK BASIN for MUNICIPAL USE.

The right has been perfected under Permit G-9154. The date of priority is OCTOBER 5, 1973. The right is limited to 1.56 CUBIC FEET PER SECOND (CFS), IN ANY COMBINATION FROM THE TWO WELLS, AND IS FURTHER LIMITED TO A MAXIMUM OF 1.02 CFS FROM STEARNS WELL #2 OR 1.02 CFS FROM BARNEY WELL, or its equivalent in case of rotation, measured at the well(s).

The wells are located as follows:

ORIGINAL WELL

STEARNS WELL #2: SW ¼ NE ¼, SECTION 4, T15S, R16E, W.M.; 1810.2 FEET SOUTH & 1151.5 FEET EAST FROM N 1/4 CORNER OF SECTION 4.

ADDITIONAL WELL

BARNEY WELL: NE ¼ NE ¼, SECTION 4, T15S, R16E, W.M.; 1315 FEET SOUTH & 1370 FEET EAST FROM N 1/4 CORNER OF SECTION 4.

The right shall conform to such reasonable rotation system as may be ordered by the proper state officer.

This is a final order in other than a contested case. This order is subject to judicial review under ORS 183.484. Any petition for judicial review must be filed within the 60 day time period specified by ORS 183.484(2). Pursuant to ORS 536.075 and OAR 137-004-0080 you may either petition for judicial review or petition the Director for reconsideration of this order. A petition for reconsideration may be granted or denied by the Director, and if no action is taken within 60 days following the date the petition was filed, the petition shall be deemed denied.

T-9762.RA

Certificate Number 83993

A description of the place of use under the right, and to which such right is appurtenant, is as follows:

1/4 1/4		SECTION	TOWNSHIP	RANGE, W.M.
SW	NE	31	14 S	16 E
NE	NW	31	14 S	16 E
NW	NW	31	14 S	16 E
SE	NW	31	14 S	16 E
SE	SW	31	14 S	16 E
NE	SE	31	14 S	16 E
NW	SE	31	14 S	16 E
SW	SE	31	14 S	16 E
SE	SE	31	14 S	16 E
SW	NW	32	14 S	16 E
NE	SW	32	14 S	16 E
NW	SW	32	14 S	16 E
SW	SW	32	14 S	16 E
SE	SW	32	14 S	16 E
NW	SE	32	14 S	16 E
SW	SE	32	14 S	16 E
NW	NW	3	15 S	16 E
NW	NE	4	15 S	16 E
SW	NE	4	15 S	16 E
NE	NW	4	15 S	16 E
NW	NW	4	15 S	16 E
SW	NW	4	15 S	16 E
NE	NE	5	15 S	16 E
NW	NE	5	15 S	16 E
SW	NE	5	15 S	16 E
SE	NE	5	15 S	16 E
NE	NW	5	15 S	16 E
NW	NW	5	15 S	16 E
SW	NW	5	15 S	16 E
SE	NW	5	15 S	16 E
NE	SW	5	15 S	16 E
NW	SW	5	15 S	16 E
NW	SE	5	15 S	16 E
NE	NE	6	15 S	16 E
NW	NE	6	15 S	16 E
SE	NE	6	15 S	16 E
NE	NW	6	15 S	16 E
SE	NW	6	15 S	16 E
NE	SE	6	15 S	16 E

The water user shall maintain the meter or measuring device in good working order.

This certificate is issued to confirm an ADDITIONAL POINT OF APPROPRIATION approved by an order of the Water Resources Director entered NOVEMBER 22, 2004, and supersedes Certificate 57443, State Record of Water Right Certificates.

The quantity of water diverted at the additional point of appropriation, together with that diverted at the original point of appropriation, shall not exceed the quantity of water lawfully available at the original point of appropriation.

Water shall be acquired from the same aquifer (water source) as the original point of appropriation.

Water may be applied to lands which are not specifically described above, provided the holder of this right complies with ORS 540.510(3).

Issued MAR 21 2008

Dwight French for

Phillip C. Ward, Director
Water Resources Department

1859

Recorded in State Record of Water Right Certificates numbered 83993.

T-9762.RA

STATE OF OREGON

COUNTY OF CROOK

CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

CITY OF PRINEVILLE
387 NE THIRD ST
PRINEVILLE, OR 97754

confirms the right to use the waters of STADIUM WELL in the Ochoco Creek Basin for MUNICIPAL USE.

This right was perfected under Permit G-11993. The date of priority is DECEMBER 14, 1990. The amount of water to which this right is entitled is limited to an amount actually used beneficially, and shall not exceed 0.604 CUBIC FOOT PER SECOND or its equivalent in case of rotation, measured at the well.

The well is located as follows:

Twp	Rng	Mer	Sec	Q-Q	Measured Distances
15 S	16 E	WM	5	NE SE	2122 FEET NORTH & 461 FEET WEST FROM SE CORNER, SECTION 5

The period of allowed use is year round.

A description of the place of use is as follows:

Twp	Rng	Mer	Sec	Q-Q
14 S	16 E	WM	31	NE NE
14 S	16 E	WM	31	NW NE
14 S	16 E	WM	31	SW NE
14 S	16 E	WM	31	SE NE
14 S	16 E	WM	31	NE NW
14 S	16 E	WM	31	NW NW
14 S	16 E	WM	31	SW NW
14 S	16 E	WM	31	SE NW
14 S	16 E	WM	31	NE SW
14 S	16 E	WM	31	NW SW
14 S	16 E	WM	31	SW SW
14 S	16 E	WM	31	SE SW
14 S	16 E	WM	31	NE SE
14 S	16 E	WM	31	NW SE

NOTICE OF RIGHT TO PETITION FOR RECONSIDERATION OR JUDICIAL REVIEW

This is an order in other than a contested case. This order is subject to judicial review under ORS 183.484 and ORS 536.075. Any petition for judicial review must be filed within the 60 day time period specified by ORS 183.484(2). Pursuant to ORS 183.484, ORS 536.075 and OAR 137-004-0080, you may petition for judicial review and petition the Director for reconsideration of this order. A petition for reconsideration may be granted or denied by the Director, and if no action is taken within 60 days following the date the petition was filed, the petition shall be deemed denied. In addition, under ORS 537.260 any person with an application, permit or water right certificate subsequent in priority may jointly or severally contest the issuance of the certificate within three months after issuance of the certificate.

Twp	Rng	Mer	Sec	Q-Q
14 S	16 E	WM	31	SW SE
14 S	16 E	WM	31	SE SE
14 S	16 E	WM	32	NE NE
14 S	16 E	WM	32	NW NE
14 S	16 E	WM	32	SW NE
14 S	16 E	WM	32	SE NE
14 S	16 E	WM	32	NE NW
14 S	16 E	WM	32	NW NW
14 S	16 E	WM	32	SW NW
14 S	16 E	WM	32	SE NW
14 S	16 E	WM	32	NE SW
14 S	16 E	WM	32	NW SW
14 S	16 E	WM	32	SW SW
14 S	16 E	WM	32	SE SW
14 S	16 E	WM	32	NE SE
14 S	16 E	WM	32	NW SE
14 S	16 E	WM	32	SW SE
14 S	16 E	WM	32	SE SE
14 S	16 E	WM	33	NE NE
14 S	16 E	WM	33	NW NE
14 S	16 E	WM	33	SW NE
14 S	16 E	WM	33	SE NE
14 S	16 E	WM	33	NE NW
14 S	16 E	WM	33	NW NW
14 S	16 E	WM	33	SW NW
14 S	16 E	WM	33	SE NW
14 S	16 E	WM	33	NE SW
14 S	16 E	WM	33	NW SW
14 S	16 E	WM	33	SW SW
14 S	16 E	WM	33	SE SW
14 S	16 E	WM	33	NE SE
14 S	16 E	WM	33	NW SE
14 S	16 E	WM	33	SW SE
14 S	16 E	WM	33	SE SE
15 S	16 E	WM	4	NE NE
15 S	16 E	WM	4	NW NE
15 S	16 E	WM	4	SW NE
15 S	16 E	WM	4	SE NE
15 S	16 E	WM	4	NE NW
15 S	16 E	WM	4	NW NW
15 S	16 E	WM	4	SW NW
15 S	16 E	WM	4	SE NW
15 S	16 E	WM	4	NE SW
15 S	16 E	WM	4	NW SW
15 S	16 E	WM	4	SW SW
15 S	16 E	WM	4	SE SW
15 S	16 E	WM	4	NE SE
15 S	16 E	WM	4	NW SE
15 S	16 E	WM	4	SW SE
15 S	16 E	WM	4	SE SE
15 S	16 E	WM	5	NE NE

Twp	Rng	Mer	Sec	Q-Q
15 S	16 E	WM	5	NW NE
15 S	16 E	WM	5	SW NE
15 S	16 E	WM	5	SE NE
15 S	16 E	WM	5	NE NW
15 S	16 E	WM	5	NW NW
15 S	16 E	WM	5	SW NW
15 S	16 E	WM	5	SE NW
15 S	16 E	WM	5	NE SW
15 S	16 E	WM	5	NW SW
15 S	16 E	WM	5	SW SW
15 S	16 E	WM	5	SE SW
15 S	16 E	WM	5	NE SE
15 S	16 E	WM	5	NW SE
15 S	16 E	WM	5	SW SE
15 S	16 E	WM	5	SE SE
15 S	16 E	WM	6	NE NE
15 S	16 E	WM	6	NW NE
15 S	16 E	WM	6	SW NE
15 S	16 E	WM	6	SE NE
15 S	16 E	WM	6	NE NW
15 S	16 E	WM	6	NW NW
15 S	16 E	WM	6	SW NW
15 S	16 E	WM	6	SE NW
15 S	16 E	WM	6	NE SW
15 S	16 E	WM	6	NW SW
15 S	16 E	WM	6	SW SW
15 S	16 E	WM	6	SE SW
15 S	16 E	WM	6	NE SE
15 S	16 E	WM	6	NW SE
15 S	16 E	WM	6	SW SE
15 S	16 E	WM	6	SE SE

The well shall be maintained in accordance with the General Standards for the Construction and Maintenance of Water Wells in Oregon. The works shall be equipped with a usable access port, and may also include an air line and pressure gauge adequate to determine water level elevation at all times.

The Director may require water level or pump test results every ten years.

If substantial interference with a senior water right occurs due to withdrawal of water from any well listed on this right, then use of water from the well(s) shall be discontinued or reduced and/or the schedule of withdrawal shall be regulated until or unless the Department approves or implements an alternative administrative action to mitigate the interference. The Department encourages junior and senior appropriators to jointly develop plans to mitigate interferences.

Failure to comply with any of the provisions of this right may result in action including, but not limited to, restrictions on the use, civil penalties, or cancellation of the right.

This right is for the beneficial use of water without waste. The water user is advised that new regulations may require the use of best practical technologies or conservation practices to achieve this end.

By law, the land use associated with this water use must be in compliance with statewide land-use goals and any local acknowledged land-use plan.

The right to the use of the water for the above purpose is restricted to beneficial use on the lands or place of use described; however, water may be applied to lands which are not specifically described above, provided the holder of this right complies with ORS 540.510(3).

This certificate is issued for a partial perfection of Permit G-11993 as described in OAR 690-320-0040 and by an order of the Water Resources Director entered AUG 03 2012, at Volume 88, Page 247.

The use of water shall be limited when it interferes with any prior surface or ground water rights.

Issued AUG 03 2012.

Dwight W. French
Water Right Services Administrator, for
Phillip C. Ward, Director
Water Resources Department

BEFORE THE WATER RESOURCES DIRECTOR OF OREGON

CROOK COUNTY

IN THE MATTER OF PARTIAL PERFECTION OF)
WATER RIGHT PERMIT G-11993 IN THE NAME)
OF THE CITY OF PRINEVILLE)

ORDER

STATEMENT

On April 24, 2012, The Water Resources Department received a request from the City of Prineville to partially perfect the use of water under water right permit G-11993.

FINDINGS OF FACT

Permit G-11993 allows for the use of 0.947 cubic foot per second (CFS) from a well in the Ochoco Creek Basin for municipal use.

The City has requested partial perfection of permit G-11993 and issuance of a water right certificate. The request was accompanied by the survey required under ORS 537.230(4). The survey shows, to the satisfaction of the Director, that the appropriation has been partially perfected in accordance with the provision of the Water Rights Act.

ORS 537.260 allows, without loss of priority or cancellation to the permit, the incremental perfection of the water right permit in an amount of not less than 25 percent, pursuant to ORS 537.260 and OAR 690-320-0040.

The Department finds that the City has perfected 0.604 cfs. The quantity of water is equal or greater than the 25 percent of the original quantity of water allowed under permit G-11993.

OAR 690-320-0040(5) allows municipal suppliers that incrementally perfect less than the full quantity of water to request further extension of time to complete construction and apply water to beneficial use for the remaining, unperfected quantity of water.

NOTICE OF RIGHT TO PETITION FOR JUDICIAL REVIEW OR RECONSIDERATION

This is a final order in other than contested case. This order is subject to judicial review under ORS 183.482. Any petition for judicial review must be filed within the 60 day time period specified by ORS 183.482 and ORS 536.075. Pursuant to ORS 183.482, ORS 536.075 and OAR 137-003-0675, you may petition for judicial review and petition the Director for reconsideration of this order. A petition for reconsideration may be granted or denied by the Director, and if no action is taken within 60 days following the date the petition was filed, the petition shall be deemed denied.

As of the date of this order, the City has submitted an application for water right extension of time for quasi-municipal and municipal water use permit to completely apply water to beneficial use under Permit G-11993.

ULTIMATE FINDING OF FACT

The City is now entitled to a certificate in the amount of 0.604 cfs. The Director has determined the permittee has complied with the requirements to partially perfect permit G-11993 pursuant to ORS 537.250 and 537.260.

ORDER

The Department finds that there is 0.343 cfs remaining to be perfected and that a certificate in the amount of 0.604 cfs be issued to the City of Prineville.

Dated AUG 03 2012

Dwight French

Dwight W. French
Water Right Services Administrator, for
Phillip C. Ward, Director
Water Resources Department

STATE OF OREGON

COUNTY OF CROOK

PERMIT TO APPROPRIATE THE PUBLIC WATERS

THIS PERMIT IS HEREBY ISSUED TO

CITY OF PRINEVILLE
400 EAST THIRD ST 503-447-5627
PRINEVILLE, OREGON 97754

to use the waters of A WELL in the OCHOCO CREEK BASIN for MUNICIPAL USE.

This permit is issued approving Application G-12344. The date of priority is DECEMBER 14, 1990. The use is limited to not more than 0.947 cubic foot per second, or its equivalent in case of rotation, measured at the well.

The well is located as follows:

NE 1/4 SE 1/4 SECTION 5, T 15 S, R 16 E, W.M.; 2122 FEET NORTH AND 461 FEET WEST FROM THE SE CORNER OF SECTION 5..

The use shall conform to such reasonable rotation system as may be ordered by the proper state officer.

The period of allowed use is year round.

A description of the proposed place of use under this permit is within the service area of the City of Prineville, more explicitly described, but not limited to:

Sections 31, 32 and 33
Township 14 South, Range 16 East, WM

Sections 4, 5 and 6
Township 15 South, Range 16 East, WM

The well shall be constructed in accordance with the General Standards for the Construction and Maintenance of Water Wells in Oregon. The works shall be equipped with a usable access port, and may also include an air line and pressure gauge adequate to determine water level elevation in the well at all times.

Within one year of permit issuance, the City shall submit a conservation management plan consistent with Oregon Administrative Rule 690-86.

Prior to receiving a certificate of water right, the permit holder shall submit the results of a pump test meeting the department's standards, to the Water Resources Department. The Director may require water level or pump test results every ten years thereafter.

If substantial interference with a senior water right occurs due to withdrawal of water from any well listed on this permit, then use of water from the well(s) shall be discontinued or reduced and/or the schedule of withdrawal shall be regulated until or unless the Department approves or implements an alternative administrative action to mitigate the interference. The Department encourages junior and senior appropriators to jointly develop plans to mitigate interferences.

Actual construction work shall begin on or before April 24, 1996, and shall be completed on or before October 1, 1997. Complete application of the water shall be made on or before October 1, 1998.

Failure to comply with any of the provisions of this permit may result in action including, but not limited to, restrictions on the use, civil penalties, or cancellation of the permit.

This permit is for beneficial use of water without waste. The water user is advised that new regulations may require use of best practical technologies or conservation practices to achieve this end.

By law, the land use associated with this water use must be in compliance with statewide land-use goals and any local acknowledged land-use plan.

The use of water shall be limited when it interferes with any prior surface or ground water rights.

The Director finds that the proposed use(s) of water described by this permit, as conditioned, would not impair or be detrimental to the public interest.

Issued this date April 24, 1995.

/s/ MARTHA O. PAGEL

Water Resources Department
Martha O. Pagel
Director

STATE OF OREGON
COUNTY OF CROOK
CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

CITY OF PRINEVILLE
387 NE THIRD STREET
PRINEVILLE, OREGON 97754

confirms the right to use the waters of a WELL, for MUNICIPAL USE.

This right was perfected under Permit U-372. The date of priority is DECEMBER 8, 1950. The amount of water to which this right is entitled is limited to an amount actually used beneficially, and shall not exceed 0.75 CUBIC FOOT PER SECOND, or its equivalent in case of rotation, measured at the point of diversion.

The point of appropriation is located as follows:

TWP	RNG	MER	SEC	Q - Q	MEASURED DISTAMCES
15 S	16 E	WM	5	SW NW	375 FEET NORTH AND 370 FEET EAST FROM W ¼ CORNER OF SECTION 5

A description of the place of use to which this right is appurtenant is as follows:

TWP	RNG	MER	SEC	Q - Q
14 S	16 E	WM	31	NE SE
14 S	16 E	WM	31	NW SE
14 S	16 E	WM	31	SW SE
14 S	16 E	WM	31	SE SE
14 S	16 E	WM	32	NE SW
14 S	16 E	WM	32	NW SW
14 S	16 E	WM	32	SW SW
14 S	16 E	WM	32	SE SW
14 S	16 E	WM	32	NW SE
14 S	16 E	WM	32	SW SE
15 S	16 E	WM	5	NW NE
15 S	16 E	WM	5	SW NE
15 S	16 E	WM	5	NE NW
15 S	16 E	WM	5	NW NW
15 S	16 E	WM	5	SW NW
15 S	16 E	WM	5	SE NW
15 S	16 E	WM	6	NE NE
15 S	16 E	WM	6	NW NE
15 S	16 E	WM	6	SE NE

This certificate describes that portion of the water right confirmed by Certificate 22868, State Record of Water Right Certificates, NOT modified by the provisions of an order of the Water Resources Director entered March 11, 2011, and recorded at Special Order Volume 81, pages 757 to 759, canceling a portion of the water right. This certificate supersedes Certificate 22868.

The issuance of this superseding certificate does not confirm the status of the water right in regard to the provisions of ORS 540.610 pertaining to forfeiture or abandonment.

WITNESS the signature of the Water Resources Director, affixed **MAR 1 1 2011**.

Dwight French

Dwight French for
PHILLIP C. WARD, DIRECTOR

c22868-part cancel-rr.GLN

Recorded in State Record of Water Right Certificates numbered 86889.

STATE OF OREGON

COUNTY OF CROOK

CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

CITY OF PRINEVILLE
387 NE THIRD STREET
PRINEVILLE, OREGON 97754

confirms the right to use the waters of a WELL (OCHOCO HEIGHTS WELL NO.1), for MUNICIPAL USE.

This right was perfected under Permit U-140. The date of priority is MAY 20, 1942. The amount of water to which this right is entitled is limited to an amount actually used beneficially, and shall not exceed 0.8 CUBIC FOOT PER SECOND, or its equivalent in case of rotation, measured at the point of diversion.

The point of appropriation is located as follows:

TWP	RNG	MER	SEC	Q - Q
14 S	16 E	WM	32	NW SW

A description of the place of use to which this right is appurtenant is as follows:

TWP	RNG	MER	SEC	Q - Q
14 S	16 E	WM	31	SE
14 S	16 E	WM	32	SW
15 S	16 E	WM	5	NW
15 S	16 E	WM	5	NE SW
15 S	16 E	WM	5	NW SW
15 S	16 E	WM	6	NE NE
15 S	16 E	WM	6	NW NE
15 S	16 E	WM	6	SE NE

This certificate describes that portion of the water right confirmed by Certificate 75223, State Record of Water Right Certificates, NOT modified by the provisions of an order of the Water Resources Director entered SEP 14 2010, and recorded at Special Order Volume 81, pages 796 to 798, canceling a portion of the water right. This certificate supersedes Certificate 75223.

The issuance of this superseding certificate does not confirm the status of the water right in regard to the provisions of ORS 540.610 pertaining to forfeiture or abandonment.

WITNESS the signature of the Water Resources Director, affixed Sept. 14, 2010.

for
Phillip C. Ward, Director

Recorded in State Record of Water Right Certificates numbered 86558.

c75223-part cancel-rr.GLN

Oregon Water Resources Department

Water Right Services Division

Water Right Application G-18662 in the)
name of CITY OF PRINEVILLE)   PROPOSED FINAL ORDER
)

Summary: The Department proposes to issue an order approving Application G-18662, and a permit consistent with the attached draft permit.

Prior to the issuance of a permit, if it is issued the Department must receive the following:

- **Evidence that mitigation credits have been obtained.**

Please include the application number on any documents submitted.

Authority

The application is being processed in accordance with Oregon Revised Statute (ORS) 537.615 through 537.628, and 390.826, and Oregon Administrative Rule (OAR) Chapter 690, Divisions 5, 8, 9, 33, 300, 310, 400, 410, and Deschutes Basin Program OAR 690-505. OAR 690-505 and 521 describe the process by which groundwater in the Deschutes Basin may be appropriated by mitigating the impact of the proposed use. These statutes and rules can be viewed on the Oregon Water Resources website: http://www.oregon.gov/owrd/pages/law/index.aspx

The Department's main page is http://www.oregon.gov/OWRD/pages/index.aspx

The Department shall presume that a proposed groundwater use will ensure the preservation of the public welfare, safety and health as described in ORS 537.525 if:

a) The proposed use is allowed in the applicable basin program established pursuant to ORS 536.300 and 536.340 or given a preference under ORS 536.310(12);
b) Water is available;
c) The proposed use will not injure other water rights; and
d) The proposed use complies with the rules of the Commission. ORS 537.621(2); OAR 690-310-0150(2)(b)

All four criteria must be met for a proposed use to be presumed to ensure the preservation of the public welfare, safety and health. When the criteria are met and the presumption is established the Department must further evaluate the proposed use, any comments received information available in its files or received from other interested agencies and any other available information to determine whether the presumption is overcome. OAR 690-310-0140

If the Department determines that the presumption is established and not overcome, the Department shall issue a proposed final order recommending issuance of the permit subject to any appropriate modifications or conditions.

FINDINGS OF FACT

Application History

1. On April 25, 2018, City of Prineville filed a complete application for the following water use:
   Amount of Water: 4.46 cubic feet per second (CFS)
   Use of Water: municipal uses
   County: Crook County
   Location: City of Prineville Service Boundary
   Source of Water: Well D1 (CROO 54593), Well S1 (CROO 54587), Well D2 (CROO 4592), Well D3, Well S2, Well D4, Well S3, Well D5, Well S4, Well D6, Well S5, Well D7, Well S6, Well D8, Well S7, Well D9, Well S8, Well D10, Well S9, Well D11, Well S10, Well D12, Well S11, Well D13, and Well S12 in Crooked River Basin.

2. On June 29, 2018, the Department mailed the applicant notice of its Initial Review, determining that *"The appropriation of 4.46 CFS of water, further limited to 3230.0 AF annually, from Well D1 (CROO 54593), Well S1 (CROO 54587), Well D2 (CROO 54592), Well D3, Well S2, Well D4, Well S3, Well D5, Well S4, Well D6, Well S5, Well D7, Well S6, Well D8, Well S7, Well D9, Well S8, Well D10, Well S9, Well D11, Well S10, Well D12, Well S11, Well D13, and Well S12 in Crooked River Basin for municipal uses is not allowable."* The applicant did not notify the Department to stop processing the application within 14 days of that date. The initial Review included the Notice of Mitigation Obligation for the proposed groundwater use pursuant to the Deschutes Groundwater Mitigation Rules (OAR 690-505)

3. On July 3, 2018, the Department gave public notice of the application in its weekly notice. The public notice included a request for comments, and information for interested persons about obtaining future notices and a copy of the Proposed Final Order. No written comments were received within 30 days.

Presumption Criteria (a) - Consistency with Basin Program

4. The proposed groundwater use is located within the Deschutes Groundwater Study Area, and is subject to the Deschutes Groundwater Mitigation Rules (OAR 690-505-0600 to -0630).

5. The proposed use is allowed under the Deschutes Basin Program (OAR 690-505-0400). ORS 537.621(3)(b); OAR 690-310-0150(2)(b)

6. Pursuant to OAR 690-505-0500(1), there is a 200.00 CFS limit on the amount of new groundwater use that may be allocated within the Deschutes Groundwater Study Area. Any water allocated under this application will not exceed the limit.

7. The mitigation obligation for the proposed use is 1292.0 acre feet (AF), which represents the Department's determination of the consumptive portion of the proposed use. Each mitigation credit is equivalent to 1.0 AF of mitigation water. (OAR 690-505-0610(5)

8. Mitigation shall be provided in the Crooked River Zone of Impact (located anywhere in the Crooked River Basin above river mile 13.8).

Presumption Criteria (b) - Water Availability

9. An assessment of groundwater availability has been completed by the Groundwater/Hydrology section. A copy of this assessment is in the file. The proposed use of groundwater will, if properly conditioned, avoid injury to existing groundwater rights and the groundwater resource. ORS 537.621(3)(c); OAR 690-310-0150(2)(c)

Presumption Criteria (c) - Injury Determination

10. The proposed groundwater use is junior to existing water rights downstream in the Deschutes River Basin. Therefore, the proposed use, if authorized, will not injure other water rights. ORS 537.621(3)(d); OAR 690-310-0150(2)(e)

Presumption Criteria (d) - Whether the use complies with rules of the Commission

11. Documentation has been submitted from the relevant land-use planning jurisdiction that indicates the proposed use is allowed outright. ORS 537.621(3)(b); OAR 690-310-0150(2)(b)

12. The proposed groundwater use is not within a designated critical groundwater area. ORS 537.620(4)(a), 537.621(3)(a); OAR 690-310-0150(2)(a)

13. The proposed use will have the potential for substantial interference with the Deschutes River (OAR 690-009). The Division 9 (Ground Water Interference with Surface Water) review is in the file and can be viewed on the Department's website. ORS 537.621(3)(b); OAR 690-009-0040(4).

14. On August 2, 2018, the Department received the applicant's Response to Notice of Mitigation Obligation Credit or Project Option. The applicant has proposed to obtain 1292.0 mitigation credits within the Crooked River Zone of Impact (located anywhere in the Crooked River Basin above river mile 13.8) from mitigation project MP-222, approved under Permit S-55091.
15. The Department finds that the mitigation proposed by the applicant will satisfy the mitigation required under OAR Chapter 690, Division 505; therefore, pursuant to OAR 690-505-0630, that mitigation effectively eliminates the potential for substantial interference with surface water.

16. The proposed use complies with rules of the Water Resources Commission not otherwise described above.

Determination of Presumption that a proposed groundwater use will ensure the preservation of the public welfare, safety and health

Based on the review of the presumption criteria (a)-(d) above, the presumption has been established. ORS 537.621(2); OAR 690-310-0150(2)(g)

Further evaluation of the proposed use

17. No comments were received by the close of the comment period. OAR 690-310-0140(3)(a).

18. Information available in Department files, received from other interested agencies, and other available information does not provide a preponderance of evidence that the proposed use would not ensure the preservation of the public welfare, safety and health under ORS 537.525. OAR 690-310-0140(3)

Other Criteria and Requirements

19. Pursuant to ORS 390.835(9), the proposed use shall be denied unless mitigation is provided. Without the required mitigation, there is a preponderance of evidence that the proposed use will measurably reduce surface water flows necessary for the Deschutes River Scenic Waterway. The applicant must mitigate for the proposed use.

20. The Department requested comments on the application and proposed mitigation from the Oregon Departments of Fish and Wildlife, Environmental Quality, State Lands, Parks and Recreation, and Department of Agriculture pursuant to the Deschutes Groundwater Mitigation Rules. No issues were raised in the reviews that required further conditioning of the attached draft permit.

21. The applicant has not provided the Department with documentary evidence that the qualifying mitigation credits have been obtained.

22. In order to obtain a permit, documentary evidence of mitigation credits must be submitted to the Department within five years of the issuance of a Final Order approving the proposed groundwater use.

CONCLUSION OF LAW

1. The proposed use would ensure the preservation of the public welfare, safety and health as described in ORS 537.525.

NOTE: When issuing permits, ORS 537.628(1) authorizes the Department to include limitations and conditions which have been determined necessary to protect the public welfare, safety and health. The attached draft permit is conditioned accordingly.

PROPOSED ORDER

The Department recommends approval of Application G-18662, and issuance of a permit consistent with the attached draft permit.

DATED August 28, 2018

Dwight French

Dwight French
Water Right Services Division Administrator, for
Thomas M. Byler, Director
Oregon Water Resources Department

Protests

Under the provisions of ORS 537.153(7) (for surface water) or ORS 537.621(8) (for groundwater), you can protest this Proposed Final Order. Protests must be received in the Water Resources Department no later than **October 12, 2018**. Protests must be in writing, and must include the following:

- Your name, address, and telephone number;

- A description of your interest in the Proposed Final Order, and, if you claim to represent the public interest, a precise statement of the public interest represented;
- A detailed description of how the action proposed in the Proposed Final Order would impair or be detrimental to your interest;
- A detailed description of how the Proposed Final Order is in error or deficient, and how to correct the alleged error or deficiency;
- Any citation of legal authority to support your protest, if known;
- To affect the department's determination that the proposed use in this application will, or will not, ensure the preservation of the public welfare, safety and health as described in ORS 537.525, ORS 537.621(2)(b) requires that a protest demonstrate, by a preponderance of evidence any of the following: (a) One or more of the criteria for establishing the presumption are, or are not, satisfied; or (b) The specific aspect of the public welfare, safety and health under ORS 537.525 that would be impaired or detrimentally affected, and specifically how the identified aspect of the public welfare, safety and health under ORS 537.525 would be impaired or be adversely affected;
- If you are the applicant, the protest fee of $410 required by ORS 536.050; and
- If you are not the applicant, the protest fee of $810 required by ORS 536.050 and proof of service of the protest upon the applicant.
- If you are the applicant, a statement of whether or not you are requesting a contested case hearing.

Requests for Standing

Under the provisions of ORS 537.153(7) (for surface water) or ORS 537.621(8) (for groundwater), persons other than the applicant who support a Proposed Final Order can request standing for purposes of participating in any contested case proceeding on the Proposed Final Order or for judicial review of a Final Order.

Requests for standing must be received in the Water Resources Department no later than **October 12, 2018**. Requests for standing must be in writing, and must include the following:

- The requester's name, mailing address and telephone number;
- If the requester is representing a group, association or other organization, the name, address and telephone number of the represented group;
- A statement that the requester supports the Proposed Final Order as issued;
- A detailed statement of how the requester would be harmed if the Proposed Final Order is modified; and
- A standing fee of $230. If a hearing is scheduled, an additional fee of $580 must be submitted along with a petition for party status.

After the protest period has ended, the Director will either issue a Final Order or schedule a contested case hearing. The contested case hearing will be scheduled only if a protest has been submitted and either:

- upon review of the issues, the director finds that there are significant disputes related to the proposed use of water, or

- the applicant requests a contested case hearing within 30 days after the close of the protest period.

If you do not request a hearing within 30 days after the close of the protest period, or if you withdraw a request for a hearing, notify the Department or the administrative law judge that you will not appear or fail to appear at a scheduled hearing, the Director may issue a Final Order by default. If the Director issues a Final Order by default, the Department designates the relevant portions of its files on this matter, including all materials that you have submitted relating to this matter, as the record for purpose of proving a prima facie case upon default.

You may be represented by an attorney at the hearing. Legal aid organizations may be able to assist a party with limited financial resources. Generally, partnerships, corporations, associations, governmental subdivisions or public or private organizations are represented by an attorney. However, consistent with OAR 690-002-0020 and OAR 137-003-0555, an agency representative may represent a partnership, corporation, association, governmental subdivision or public or private organization if the Department determines that appearance of a person by an authorized representative will not hinder the orderly and timely development of the record in this case.

Notice Regarding Service Members: Active duty service members have a right to stay proceedings under the federal Service Members Civil Relief Act. 50 U.S.C. App. §§501-597b. You may contact the Oregon State Bar or the Oregon Military Department for more information. The toll-free telephone number for the Oregon State Bar is: 1 (800) 452-8260. The toll-free telephone number of the Oregon Military Department is: 1 (800) 452-7500. The Internet address for the United States Armed Forces Legal Assistance Legal Services Locator website is: http://legalassistance.law.af.mil

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- If you have any questions about statements contained in this document, please contact Scott Grew at Scott.A.Grew@oregon.gov or 503-986-0899.
- If you have questions about how to file a protest or if you have previously filed a protest and you want to know the status, please contact Patricia McCarty at 503-986-0820.
- If you have any questions about the Department or any of its programs, please contact our Water Resources Customer Service Group at 503-986-0801.
- Address any correspondence to : Water Right Services Division

725 Summer St NE, Suite A
Fax: 503-986-0901 Salem, OR 97301-1266

STATE OF OREGON

COUNTY OF CROOK

DRAFT PERMIT TO APPROPRIATE THE PUBLIC WATERS

THIS DRAFT PERMIT IS HEREBY ISSUED TO

CITY OF PRINEVILLE
387 NE 3RD ST
PRINEVILLE, OR 97754

The specific limits and conditions of the use are listed below.

APPLICATION FILE NUMBER: G-18662

SOURCE OF WATER: 25 WELLS IN CROOKED RIVER BASIN

PURPOSE OR USE: MUNICIPAL USE

MAXIMUM RATE: 4.46 CUBIC FEET PER SECOND

PERIOD OF USE: JANUARY 1 THROUGH DECEMBER 31

DATE OF PRIORITY: APRIL 25, 2018

WELL LOCATION:

POA	POA Name	Twp	Rng	Mer	Sec	Q-Q	Measured Distances
1	D1 (CROO 54593)	15 S	16 E	WM	8	NW NW	422 FEET SOUTH AND 400 FEET EAST FROM NW CORNER, SECTION 8
2	S1 (CROO 54587)	15 S	16 E	WM	8	NW NW	471 FEET SOUTH AND 406 FEET EAST FROM NW CORNER, SECTION 8
3	D2 (CROO 54592)	15 S	16 E	WM	8	NW NW	585 FEET SOUTH AND 793 FEET EAST FROM NW CORNER, SECTION 8
4	D3	15 S	16 E	WM	8	NW NW	516 FEET SOUTH AND 438 FEET EAST FROM NW CORNER, SECTION 8
5	S2	15 S	16 E	WM	8	NW NW	561 FEET SOUTH AND 466 FEET EAST FROM NW CORNER, SECTION 8
6	D4	15 S	16 E	WM	8	NW NW	601 FEET SOUTH AND 509 FEET EAST FROM NW CORNER, SECTION 8
7	S3	15 S	16 E	WM	8	NW NW	621 FEET SOUTH AND 564 FEET EAST FROM NW CORNER, SECTION 8
8	D5	15 S	16 E	WM	8	NW NW	657 FEET SOUTH AND 611 FEET EAST FROM NW CORNER, SECTION 8
9	S4	15 S	16 E	WM	8	NW NW	694 FEET SOUTH AND 654 FEET EAST FROM NW CORNER, SECTION 8
10	D6	15 S	16 E	WM	8	NW NW	717 FEET SOUTH AND 700 FEET EAST FROM NW CORNER, SECTION 8
11	S5	15 S	16 E	WM	8	NW NW	789 FEET SOUTH AND 731 FEET EAST FROM NW CORNER, SECTION 8
12	D7	15 S	16 E	WM	8	NW NW	840 FEET SOUTH AND 759 FEET EAST FROM NW CORNER, SECTION 8

POA	POA Name	Twp	Rng	Mer	Sec	Q-Q	Measured Distances
13	S6	15 S	16 E	WM	8	NW NW	888 FEET SOUTH AND 784 FEET EAST FROM NW CORNER, SECTION 8
14	D8	15 S	16 E	WM	8	NW NW	952 FEET SOUTH AND 799 FEET EAST FROM NW CORNER, SECTION 8
15	S7	15 S	16 E	WM	8	NW NW	1004 FEET SOUTH AND 809 FEET EAST FROM NW CORNER, SECTION 8
16	D9	15 S	16 E	WM	8	NW NW	1061 FEET SOUTH AND 815 FEET EAST FROM NW CORNER, SECTION 8
17	S8	15 S	16 E	WM	8	NW NW	1116 FEET SOUTH AND 808 FEET EAST FROM NW CORNER, SECTION 8
18	D10	15 S	16 E	WM	8	NW NW	1179 FEET SOUTH AND 796 FEET EAST FROM NW CORNER, SECTION 8
19	S9	15 S	16 E	WM	8	NW NW	1232 FEET SOUTH AND 800 FEET EAST FROM NW CORNER, SECTION 8
20	D11	15 S	16 E	WM	8	NW NW	1267 FEET SOUTH AND 836 FEET EAST FROM NW CORNER, SECTION 8
21	S10	15 S	16 E	WM	8	NW NW	1320 FEET SOUTH AND 869 FEET EAST FROM NW CORNER, SECTION 8
22	D12	15 S	16 E	WM	8	SW NW	1372 FEET SOUTH AND 879 FEET EAST FROM NW CORNER, SECTION 8
23	S11	15 S	16 E	WM	8	SW NW	1420 FEET SOUTH AND 896 FEET EAST FROM NW CORNER, SECTION 8
24	D13	15 S	16 E	WM	8	SW NW	1479 FEET SOUTH AND 909 FEET EAST FROM NW CORNER, SECTION 8
25	S12	15 S	16 E	WM	8	SW NW	1527 FEET SOUTH AND 949 FEET EAST FROM NW CORNER, SECTION 8

THE PLACE OF USE IS LOCATED AS FOLLOWS:
City of Prineville Service Boundary

1. **Measurement Devices, and Recording/Reporting of Annual Water Use Conditions:**

   A. Before water use may begin under this permit, the permittee shall install a totalizing flow meter at each point of appropriation. The permittee shall maintain the device in good working order.

   B. The permittee shall allow the watermaster access to the device; provided however, where any device is located within a private structure, the watermaster shall request access upon reasonable notice.

   C. The permittee shall keep a complete record of the volume of water used each month, and shall submit an annual report which includes the recorded water-use measurements to the Department annually, or more frequently as may be required by the Director. Further, the Director may require the permittee to report general water-use information, including the place and nature of use of water under the permit.

   D. The Director may provide an opportunity for the permittee to submit alternative measuring and reporting procedures for review and approval.

2. **Annual Measurement Condition:**

The Department requires the water user to obtain, from a qualified individual (see below), and report annual static water levels for each well on the permit. The static water level shall be measured in the month of March. Reports shall be submitted to the Department within 30 days of measurement.

The permittee shall report an initial March static water-level measurement once well construction is complete and annual measurements thereafter. Annual measurements are required whether or not the well is used. The first annual measurement will establish a reference level against which future measurements will be compared. However, the Director may establish the reference level based on an analysis of other water-level data. The Director may require the user to obtain and report additional water levels each year if more data are needed to evaluate the aquifer system.

All measurements shall be made by a certified water rights examiner, registered professional geologist, registered professional engineer, licensed well constructor or pump installer licensed by the Construction Contractors Board. Measurements shall be submitted on forms provided by, or specified by, the Department. Measurements shall be made with equipment that is accurate to at least the standards specified in OAR 690-217-0045. The Department requires the individual performing the measurement to:

A. Associate each measurement with an owner's well name or number and a Department well log ID; and

B. Report water levels to at least the nearest tenth of a foot as depth-to-water below ground surface; and

C. Specify the method of measurement; and

D. Certify the accuracy of all measurements and calculations reported to the Department.

The water user shall discontinue use of, or reduce the rate or volume of withdrawal from, the well(s) if any of the following events occur:

A. Annual water-level measurements reveal an average water-level decline of three or more feet per year for five consecutive years; or

B. Annual water-level measurements reveal a water-level decline of 15 or more feet in fewer than five consecutive years; or

C. Annual water-level measurements reveal a water-level decline of 25 or more feet; or

D. Hydraulic interference leads to a decline of 25 or more feet in any neighboring well with senior priority.

The period of restricted use shall continue until the water level rises above the decline level which triggered the action or the Department determines, based on the permittee's and/or the Department's data and analysis, that no action is necessary because the aquifer in question can sustain the observed declines without adversely impacting the resource or causing substantial interference with senior water rights. The water user shall not allow excessive decline, as defined in Commission rules, to occur within the aquifer as a result of use under this permit. If more than one well is involved, the water user may submit an alternative measurement and reporting plan for review and approval by the Department.

3. **Dedicated Measuring Tube Condition:**

   Wells with pumps shall be equipped with a minimum 3/4-inch diameter, unobstructed, dedicated measuring tube pursuant to figure 200-5 in OAR 690-200. If a pump has been installed prior to the issuance of this permit, and if static water levels and pumping levels can be measured using an electrical tape, then the installation of the measuring tube can be delayed until such time that water levels cannot be measured or the pump is repaired or replaced.

4. **Well Identification Tag Condition:**

   Prior to using water from any well listed on this permit, the permittee shall ensure that the well has been assigned an OWRD Well Identification Number (Well ID tag), which shall be permanently attached to the well. The Well ID shall be used as a reference in any correspondence regarding the well, including any reports of water use, water level, or pump test data.

5. **Groundwater Mitigation Conditions:**

   a. Mitigation Obligation: 1292.0 AF of mitigation water in the Crooked River Zone of Impact (located anywhere in the Crooked River Basin above river mile 13.8).

   b. Mitigation Source: Mitigation Credits or a Mitigation Project, in accordance with the incremental development plan on file with the Department, meeting the requirements of OAR Chapter 690, Division 505 (Deschutes Ground Water Mitigation Rules) and OAR Chapter 690, Division 522.

   c. The permittee shall provide mitigation during each stage of development under the permit, as described in the Incremental Development Mitigation Plan on file with the Department, and in accordance with the standards of the Deschutes Ground Water Mitigation Rules, OAR Chapter 690, Division 505 and Division 522.

   d. The permittee shall not increase the rate or amount of water diverted, as described in the incremental development mitigation plan, prior to increasing the corresponding mitigation.

   e. The permittee shall seek and receive Department approval prior to changing the Incremental Mitigation Development Plan and related mitigation obligation for each stage of permit development.

   f. The permittee shall report to the Department the progress of implementing the Incremental Mitigation Development Plan and related mitigation no later than April 1 of each year. The annual report shall include the annual volume of water used, the source and amount of mitigation, and any offset used for that period. This annual notification is not necessary if the permittee has completed development and submitted a Claim of Beneficial Use to the Department.

   g. Mitigation water must be legally protected instream in the Crooked River Zone of Impact (located anywhere in the Crooked River Basin above river mile 13.8) for the life of the permit and subsequent certificate(s). Regulation of the use and/or cancellation of the permit, or subsequent certificate(s) will occur if the required mitigation is not maintained.

   h. The permittee shall provide additional mitigation if the Department determines that average annual consumptive use of the subject appropriation has increased beyond the originally mitigated amount.

   i. If mitigation is from a secondary right for stored water from a storage project not owned or operated by the permittee, the use of water under this right is subject to the maintenance and terms and conditions of a valid contract or satisfactory replacement, with the owner/operator of the storage project, a copy of which must be on file in the records of the Water Resources Department.

j. Failure to comply with these mitigation conditions shall result in the Department regulating the groundwater permit, or subsequent certificate(s), proposing to deny any permit extension application for the groundwater permit, and proposing to cancel the groundwater permit, or subsequent certificate(s).

k. All water use and mitigation accounting, including the incremental development plan and the annual report required in paragraph f, may be reported on a water year basis.

6. **Scenic Waterway Condition:**

Use of water under authority of this permit may be regulated if analysis of data available after the permit is issued discloses that the appropriation will measurably reduce the surface-water flows necessary to maintain the free-flowing character of a scenic waterway in quantities necessary for recreation, fish and wildlife in effect as of the priority date of the right, or as those quantities may be reduced subsequently. However, the use of groundwater allowed under the terms of this permit will not be subject to regulation for Scenic Waterway flows, provided the mitigation required is maintained.

STANDARD CONDITIONS

7. Failure to comply with any of the provisions of this permit may result in action including, but not limited to, restrictions on the use, civil penalties, or cancellation of the permit.

8. If the number, location, source, or construction of any well deviates from that proposed in the permit application or required by permit conditions, this permit may be subject to cancellation, unless the Department authorizes the change in writing.

9. If substantial interference with surface water or a senior water right occurs due to withdrawal of water from any well listed on this permit, then use of water from the well(s) shall be discontinued or reduced and/or the schedule of withdrawal shall be regulated until or unless the Department approves or implements an alternative administrative action to mitigate the interference. The Department encourages junior and senior appropriators to jointly develop plans to mitigate interferences.

10. The well(s) shall be constructed and maintained in accordance with the General Standards for the Construction and Maintenance of Water Supply Wells in Oregon. The works shall be equipped with a usable access port adequate to determine water-level elevation in the well at all times.

11. If the riparian area is disturbed in the process of developing a point of appropriation, the permittee shall be responsible for restoration and enhancement of such riparian area in accordance with ODFW's Fish and Wildlife Habitat Mitigation Policy OAR 635-415. For purposes of mitigation, the ODFW Fish and Wildlife Habitat Mitigation Goals and Standards, OAR 635-415, shall be followed.

12. The use may be restricted if the quality of downstream waters decreases to the point that those waters no longer meet state or federal water quality standards due to reduced flows.

13. Where two or more water users agree among themselves as to the manner of rotation in the use of water and such agreement is placed in writing and filed by such water users with the watermaster,

and such rotation system does not infringe upon such prior rights of any water user not a party to such rotation plan, the watermaster shall distribute the water according to such agreement.

14. Prior to receiving a certificate of water right, the permit holder shall submit to the Water Resources Department the results of a pump test meeting the Department's standards for each point of appropriation (well), unless an exemption has been obtained in writing under OAR 690-217. The Director may require water-level or pump-test data every ten years thereafter.

15. This permit is for the beneficial use of water without waste. The water user is advised that new regulations may require the use of best practical technologies or conservation practices to achieve this end.

16. By law, the land use associated with this water use must be in compliance with statewide land-use goals and any local acknowledged land-use plan.

17. Construction of the wells shall begin within five years of the date of permit issuance. The deadline to begin construction may not be extended. This permit is subject to cancellation proceedings if the construction deadline to begin is missed.

18. Complete application of the water shall be made within twenty years of the date of permit issuance. If beneficial use of permitted water has not been made before this date, the permittee may submit an application for extension of time, which may be approved based upon the merit of the application.

19. Within one year after complete application of water to the proposed use, the permittee shall submit a claim of beneficial use, which includes a map and report, prepared by a Certified Water Rights Examiner.

Issued

DRAFT - THIS IS NOT A PERMIT

Dwight French
Water Right Services Division Administrator, for
Thomas M. Byler, Director
Oregon Water Resources Department

Airport Area Aquifer Water Right Permits

STATE OF OREGON

COUNTIES OF CROOK AND DESCHUTES

PERMIT TO APPROPRIATE PUBLIC WATERS

THIS PERMIT IS HEREBY ISSUED TO:

CITY OF PRINEVILLE
387 NE THIRD ST
PRINEVILLE OR 97754

This superseding permit is issued to describe an amendment for an additional point of appropriation and a change in point of appropriation proposed under Permit Amendment Application T-11685 and approved by Special Order Vol.93, Page 60, entered Aug 5 2014. This permit supersedes Permit G-16879.

The specific limits and conditions of the use are listed below.

APPLICATION FILE NUMBER: G-16900

SOURCE OF WATER: WELL 1 (CROO 1894/CROO 50095), WELL 2 (CROO 53453), WELL 3 (CROO 53956), WELL 4, WELL 5, WELL 6, WELL 7, WELL 8 AND WELL 9 IN CROOKED RIVER BASIN

RATE: 12.48 CUBIC FEET PER SECOND (CFS), FURTHER LIMITED TO 5.57 CFS FROM WELLS 1-7, BEING NO MORE THAN 2.23 CFS IN TOTAL FROM WELL 1 (CROO 1894/CROO 50095), WELL 2 (CROO 53453), WELL 3 (CROO 53956); NO MORE THAN 1.11 CFS IN TOTAL FROM WELL 5 AND WELL 6; AND NO MORE THAN 2.23 CFS FROM WELL 7

MAXIMUM ANNUAL VOLUME: 3682.7 ACRE FEET

DATE OF PRIORITY: JUNE 27, 2007

USE: MUNICIPAL

PERIOD: YEAR-ROUND

Authorized Points of Appropriation:

Well	Twp	Rng	Mer	Sec	Q-Q	Measured Distances
City Airport Well 1 (CROO 1894/CROO 50095)	15 S	15 E	WM	11	SE SW	1210 FEET NORTH AND 1950 FEET EAST FROM THE SW CORNER OF SECTION 11
City Airport Well 2 (CROO 53453)	15 S	15 E	WM	11	SE SW	1165 FEET NORTH AND 1990 FEET EAST FROM THE SW CORNER OF SECTION 11
City Airport Well 3 (CROO 53956)	15 S	15 E	WM	11	SW SE	55 FEET NORTH AND 3000 FEET EAST FROM THE SW CORNER OF SECTION 11
City Airport Well 4	15 S	15 E	WM	11	SE SW	1070 FEET NORTH AND 1710 FEET EAST FROM THE SW CORNER OF SECTION 11
Well 5	15 S	14 E	WM	26	NW NE	319 FEET SOUTH AND 2408 FEET WEST FROM THE NE CORNER OF SECTION 26

Well	Twp	Rng	Mer	Sec	Q-Q	Measured Distances
Well 6	15 S	14 E	WM	26	NW NE	835 FEET SOUTH AND 2477 FEET WEST FROM THE NE CORNER OF SECTION 26
Well 7	15 S	15 E	WM	6	NE SW	2000 FEET NORTH AND 2340 FEET EAST FROM THE SW CORNER OF SECTION 6
Well 8	15 S	13 E	WM	23	NE NW	110 FEET SOUTH AND 1870 FEET EAST FROM THE NW CORNER OF SECTION 23
Well 9	15 S	13 E	WM	23	NE NW	100 FEET SOUTH AND 2470 FEET EAST FROM THE NW CORNER OF SECTION 23

Authorized Place of Use: WITHIN CITY OF PRINEVILLE SERVICE BOUNDARY

Permit Amendment T-11685 Conditions:

The quantity of water diverted at the new point of appropriation, (Well 3), shall not exceed the quantity of water lawfully available at the original point of appropriation.

The combined quantity of water diverted at the proposed additional point of appropriation, (Well 4), together with that diverted at the old points of appropriation (Wells 1, 2, and 3), shall not exceed the quantity of water lawfully available at the original points of appropriation (2.23 cfs).

Water shall be acquired from the same aquifer as the original points of appropriation.

Measurement, Recording and Reporting Conditions:

A. Before water use may begin under this permit, the permittee shall install a totalizing flow meter at each point of appropriation. The permittee shall maintain the meter in good working order.

B. The permittee shall keep a complete record of the amount of water used each month, and shall submit a report which includes the recorded water use measurements to the Department annually or more frequently as may be required by the Director. Further, the Director may require the permittee to report general water-use information, including the place and nature of use of water under the permit.

C. The permittee shall allow the watermaster access to the meters; provided however, where any meter is located within a private structure, the watermaster shall request access upon reasonable notice.

D. The Director may provide an opportunity for the permittee to submit alternative measuring and reporting procedures for review and approval.

The Department requires the water user to obtain, from a qualified individual (see below), and report annual static water levels for each well on the permit. The static water level shall be measured in the month of March. Reports shall be submitted to the Department within 30 days of measurement.

The permittee shall report an initial March static water-level measurement once well construction is complete and annual measurements thereafter. Annual measurements are required whether or not the well is used. The first annual measurement will establish a reference level against which future measurements will be compared. However, the Director may establish the reference level based on an analysis of other water-level data. The Director may require the user to obtain and report additional water levels each year if more data are needed to evaluate the aquifer system.

All measurements shall be made by a certified water rights examiner, registered professional geologist, registered professional engineer, licensed well constructor or pump installer licensed by the Construction Contractors Board. Measurements shall be submitted on forms provided by, or specified by, the Department. Measurements shall be made with equipment that is accurate to at least the standards specified in OAR 690-217-0045. The Department requires the individual performing the measurement to:

A. Associate each measurement with an owner's well name or number and a Department well log ID; and

B. Report water levels to at least the nearest tenth of a foot as depth-to-water below ground surface; and

C. Specify the method of measurement; and

D. Certify the accuracy of all measurements and calculations reported to the Department.

The water user shall discontinue use of, or reduce the rate or volume of withdrawal from, the wells if any of the following events occur:

A. Annual water-level measurements reveal an average water-level decline of three or more feet per year for five consecutive years; or

B. Annual water-level measurements reveal a water-level decline of 15 or more feet in fewer than five consecutive years; or

C. Annual water-level measurements reveal a water-level decline of 25 or more feet; or

D. Hydraulic interference leads to a decline of 25 or more feet in any neighboring well with senior priority.

The period of restricted use shall continue until the water level rises above the decline level which triggered the action or the Department determines, based on the permittee's and/or the Department's data and analysis, that no action is necessary because the aquifer in question can sustain the observed declines without adversely impacting the resource or causing substantial interference with senior water rights. The water user shall not allow excessive decline, as defined in Commission rules, to occur within the aquifer as a result of use under this permit. If more than one well is involved, the water user may submit an alternative measurement and reporting plan for review and approval by the Department.

Ground Water Mitigation Conditions:

1. Mitigation Obligation: a total of 1473.1 acre-feet of mitigation water in the General Zone of Impact and/or the Crooked River Zone of Impact, as applicable.

Well	Zone of Impact
Well 1 (CROO 1894/CROO 50095)	Crooked River Zone of Impact
Well 2 (CROO 53453)	Crooked River Zone of Impact
Well 3 (CROO 53956)	Crooked River Zone of Impact
Well 4	Crooked River Zone of Impact
Well 5	Crooked River Zone of Impact
Well 6	Crooked River Zone of Impact
Well 7	Crooked River Zone of Impact
Well 8	General Zone of Impact
Well 9	General Zone of Impact

Mitigation must be provided in the General Zone of Impact for use of water from any well with a mitigation obligation in the General Zone of Impact. Mitigation must be provided in the Crooked River Zone of Impact for use of water from any well with a mitigation obligation in the Crooked River Zone of Impact. The amount of mitigation provided in each zone of impact shall be consistent with the incremental development plan on file with the Department, and shall be of sufficient quantity to mitigate for the annual volume of water used in each zone of impact.

Mitigation Source: mitigation projects, mitigation credits, or offsets

2. First increment of mitigation:
    a. Mitigation obligation: 91.5 acre feet of mitigation water in the either the General Zone of Impact or Crooked River Zone of Impact
    b. Mitigation source: 36.6 mitigation credits originating from Mitigation Project MP-140, established by instream water right certificates 87249 and 87250, and which may be used in either the General Zone of Impact or Crooked River Zone of Impact, in accordance with the incremental development plan on file with the Department, meeting requirements of OAR chapter 690, Division 505 (Deschutes Groundwater Mitigation Rules).
3. The permittee shall provide mitigation during each stage of development under the permit, as described in the incremental development mitigation plan on file with the Department, and in accordance with the standards of the Deschutes Ground Water Mitigation Rules, OAR Chapter 690, Division 505 and 522.
4. The permittee shall not increase the rate or amount of water diverted, as described in the incremental development mitigation plan, prior to increasing the corresponding mitigation.
5. The permittee shall seek and receive Departmental approval prior to changing the incremental mitigation development plan and related mitigation obligation for each stage of permit development.
6. The permittee shall report to the Department the progress made in implementing the incremental mitigation development plan and related mitigation no later than April 1 of each year. The annual report shall include the annual volume of water used, the source and

amount of mitigation, and any offset used for that period. This information shall be broken down by Zone of Impact, and shall include identification of the authorized wells utilized. This annual notification is not necessary if the permittee has completed development and submitted a Claim of Beneficial Use to the Department.

7. Mitigation water must be legally protected instream in the General Zone of Impact and the Crooked River Zone of Impact, as applicable, for the life of the permit and subsequent certificate(s). Regulation of the use and/or cancellation of the permit, or subsequent certificate(s) will occur if the required mitigation is not maintained.
8. The permittee shall provide additional mitigation if the Department determines that average annual consumptive use of the subject appropriation has increased beyond the originally mitigated amount.
9. If mitigation is from a secondary right for stored water from a storage project not owned or operated by the permittee, the use of water under this right is subject to the maintenance and terms and conditions of a valid contract or satisfactory replacement, with the owner/operator of the storage project, a copy of which must be on file in the records of the Water Resources Department.
10. Failure to comply with these mitigation conditions shall result in the Department regulating the ground water permit, or subsequent certificate(s), proposing to deny any permit extension application for the ground water permit, and proposing to cancel the ground water permit, or subsequent certificate(s).

Scenic Waterway Condition:

Use of water under authority of this permit may be regulated if analysis of data available after the permit is issued discloses that the appropriation will measurably reduce the surface water flows necessary to maintain the free-flowing character of a scenic waterway in quantities necessary for recreation, fish and wildlife in effect as of the priority date of the right, or as those quantities may be reduced subsequently.

However, the use of ground water allowed under the terms of this permit will not be subject to regulation for Scenic Waterway flows, provided the required mitigation is maintained.

Water Management and Conservation Plan Condition

The permittee shall submit a Water Management and Conservation Plan, addressing use under this permit, consistent with OAR 690-086 by November 30, 2016, or before use of the second increment of water development occurs, whichever is sooner. The Director may approve an extension of this time line to complete the required Water Management and Conservation Plan. No water may be diverted if a Water Management and Conservation Plan is not submitted according to the time lines described in this condition, unless such an extension has been approved. The time line for submittal of a plan under this permit does not alter the time lines for submittal of such a plan under any other order of the Department.

STANDARD CONDITIONS

1. Failure to comply with any of the provisions of this permit may result in action including, but not limited to, restrictions on the use, civil penalties, or cancellation of the permit.

2. If the number, location, source, or construction of any well deviates from that proposed in the permit application or required by permit conditions, this permit may be subject to cancellation, unless the Department authorizes the change in writing.

3. If substantial interference with a senior water right occurs due to withdrawal of water from any well listed on this permit, then use of water from the well(s) shall be discontinued or reduced and/or the schedule of withdrawal shall be regulated until or unless the Department approves or implements an alternative administrative action to mitigate the interference. The Department encourages junior and senior appropriators to jointly develop plans to mitigate interferences.

4. The wells shall be constructed in accordance with the General Standards for the Construction and Maintenance of Water Wells in Oregon. The works shall be equipped with a usable access port, and may also include an air line and pressure gauge adequate to determine water level elevation in the well at all times.

5. Where two or more water users agree among themselves as to the manner of rotation in the use of water and such agreement is placed in writing and filed by such water users with the watermaster, and such rotation system does not infringe upon such prior rights of any water user not a party to such rotation plan, the watermaster shall distribute the water according to such agreement.

6. Prior to receiving a certificate of water right, the permit holder shall submit the results of a pump test meeting the department's standards, to the Water Resources Department. The Director may require water level or pump test results every ten years thereafter.

7. This permit is for the beneficial use of water without waste. The water user is advised that new regulations may require the use of best-practice technologies or conservation practices to achieve this end.

8. By law, the land use associated with this water use must be in compliance with statewide land-use goals and any local acknowledged comprehensive land-use plan.

9. Completion of construction and complete application of the water to the use shall be made within twenty years of the date of permit G-16879 issuance, being November 30, 2031. If the water is not completely applied before this date, and the permittee wishes to continue development under the permit, the permittee must submit an application for extension of time, which may be approved based upon the merit of the application.

10. Within one year after complete application of water to the proposed use, the permittee shall submit a claim of beneficial use, which includes a map and report, prepared by a Certified Water Rights Examiner.

Issued August 5, 2014

Dwight French, Water Right Services Division Administrator, for
Director, Oregon Water Resources Department

STATE OF OREGON

COUNTY OF CROOK

PERMIT TO APPROPRIATE THE PUBLIC WATERS

THIS PERMIT IS HEREBY ISSUED TO

CITY OF PRINEVILLE
387 NE THIRD STREET
PRINEVILLE, OR 97754

This superseding permit is issued to describe an amendment for an additional point of appropriation proposed under Permit Amendment Application T-12192 and approved by Special Order Vol. 101, Page 88-90, entered June 1, 2016. This permit supersedes Permit G-17089.

The specific limits and conditions of the use are listed below.

APPLICATION FILE NUMBER: G-15974

SOURCE OF WATER: FOUR WELLS IN OCHOCO CREEK BASIN WITHIN THE DESCHUTES RIVER BASIN

PURPOSE OR USE: MUNICIPAL USE

MAXIMUM RATE/VOLUME: 1.715 CUBIC FEET PER SECOND (CFS), LIMITED TO A MAXIMUM ANNUAL VOLUME OF 1242.0 ACRE FEET (AF), FURTHER LIMITED BY THE CORRESPONDING MITIGATION PROVIDED UNDER THE INCREMENTAL MITIGATION DEVELOPMENT PLAN

PERIOD OF USE: YEAR ROUND

DATE OF PRIORITY: MARCH 31, 2003

WELL LOCATIONS:

Twp	Rng	Mer	Sec	Q-Q	Measured Distances
15 S	15 E	WM	11	SE SW	CITY AIRPORT WELL 1 (CROO 1894) - 1210 FEET NORTH AND 1950 FEET EAST FROM THE SW CORNER OF SECTION 11
15 S	15 E	WM	11	SE SW	CITY AIRPORT WELL 2 (CROO 53453) - 1165 FEET NORTH AND 1990 FEET EAST FROM THE SW CORNER OF SECTION 11
15 S	15 E	WM	11	SW SE	CITY AIRPORT WELL 3 (CROO 53956) - 55 FEET NORTH AND 3000 FEET EAST FROM THE SW CORNER OF SECTION 11.
15 S	15 E	WM	11	SE SW	CITY AIRPORT WELL 4 (CROO 54191) – 1070 FEET NORTH AND 1710 FEET EAST FROM THE SW CORNER OF SECTION 11.

THE PLACE OF USE IS LOCATED AS FOLLOWS:

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE				
Twp	Rng	Mer	Sec	Q-Q
14 S	15 E	WM	25	NE NE
14 S	15 E	WM	25	NW NE
14 S	15 E	WM	25	SW NE
14 S	15 E	WM	25	SE NE
14 S	15 E	WM	25	NE NW
14 S	15 E	WM	25	NW NW
14 S	15 E	WM	25	SW NW
14 S	15 E	WM	25	SE NW
14 S	15 E	WM	25	NE SW
14 S	15 E	WM	25	NW SW
14 S	15 E	WM	25	SW SW
14 S	15 E	WM	25	SE SW
14 S	15 E	WM	25	NE SE
14 S	15 E	WM	25	NW SE
14 S	15 E	WM	25	SW SE
14 S	15 E	WM	25	SE SE
14 S	15 E	WM	36	NE NE
14 S	15 E	WM	36	NW NE
14 S	15 E	WM	36	SW NE
14 S	15 E	WM	36	SE NE
14 S	15 E	WM	36	NE NW
14 S	15 E	WM	36	NW NW
14 S	15 E	WM	36	SW NW
14 S	15 E	WM	36	SE NW
14 S	15 E	WM	36	NE SW
14 S	15 E	WM	36	NW SW
14 S	15 E	WM	36	SW SW
14 S	15 E	WM	36	SE SW
14 S	15 E	WM	36	NE SE
14 S	15 E	WM	36	NW SE
14 S	15 E	WM	36	SW SE
14 S	15 E	WM	36	SE SE
14 S	16 E	WM	28	NE NE
14 S	16 E	WM	28	NW NE
14 S	16 E	WM	28	SW NE
14 S	16 E	WM	28	SE NE
14 S	16 E	WM	28	NE NW
14 S	16 E	WM	28	NW NW
14 S	16 E	WM	28	SW NW
14 S	16 E	WM	28	SE NW
14 S	16 E	WM	28	NE SW
14 S	16 E	WM	28	NW SW
14 S	16 E	WM	28	SW SW
14 S	16 E	WM	28	SE SW
14 S	16 E	WM	28	NE SE

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE				
Twp	Rng	Mer	Sec	Q-Q
14 S	16 E	WM	28	NW SE
14 S	16 E	WM	28	SW SE
14 S	16 E	WM	28	SE SE
14 S	16 E	WM	29	NE NE
14 S	16 E	WM	29	NW NE
14 S	16 E	WM	29	SW NE
14 S	16 E	WM	29	SE NE
14 S	16 E	WM	29	NE NW
14 S	16 E	WM	29	NW NW
14 S	16 E	WM	29	SW NW
14 S	16 E	WM	29	SE NW
14 S	16 E	WM	29	NE SW
14 S	16 E	WM	29	NW SW
14 S	16 E	WM	29	SW SW
14 S	16 E	WM	29	SE SW
14 S	16 E	WM	29	NE SE
14 S	16 E	WM	29	NW SE
14 S	16 E	WM	29	SW SE
14 S	16 E	WM	29	SE SE
14 S	16 E	WM	30	NE NE
14 S	16 E	WM	30	NW NE
14 S	16 E	WM	30	SW NE
14 S	16 E	WM	30	SE NE
14 S	16 E	WM	30	NE NW
14 S	16 E	WM	30	NW NW
14 S	16 E	WM	30	SW NW
14 S	16 E	WM	30	SE NW
14 S	16 E	WM	30	NE SW
14 S	16 E	WM	30	NW SW
14 S	16 E	WM	30	SW SW
14 S	16 E	WM	30	SE SW
14 S	16 E	WM	30	NE SE
14 S	16 E	WM	30	NW SE
14 S	16 E	WM	30	SW SE
14 S	16 E	WM	30	SE SE
14 S	16 E	WM	31	NE NE
14 S	16 E	WM	31	NW NE
14 S	16 E	WM	31	SW NE
14 S	16 E	WM	31	SE NE
14 S	16 E	WM	31	NE NW
14 S	16 E	WM	31	NW NW
14 S	16 E	WM	31	SW NW
14 S	16 E	WM	31	SE NW
14 S	16 E	WM	31	NE SW
14 S	16 E	WM	31	NW SW
14 S	16 E	WM	31	SW SW
14 S	16 E	WM	31	SE SW

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE				
Twp	Rng	Mer	Sec	Q-Q
14 S	16 E	WM	31	NE SE
14 S	16 E	WM	31	NW SE
14 S	16 E	WM	31	SW SE
14 S	16 E	WM	31	SE SE
14 S	16 E	WM	32	NE NE
14 S	16 E	WM	32	NW NE
14 S	16 E	WM	32	SW NE
14 S	16 E	WM	32	SE NE
14 S	16 E	WM	32	NE NW
14 S	16 E	WM	32	NW NW
14 S	16 E	WM	32	SW NW
14 S	16 E	WM	32	SE NW
14 S	16 E	WM	32	NE SW
14 S	16 E	WM	32	NW SW
14 S	16 E	WM	32	SW SW
14 S	16 E	WM	32	SE SW
14 S	16 E	WM	32	NE SE
14 S	16 E	WM	32	NW SE
14 S	16 E	WM	32	SW SE
14 S	16 E	WM	32	SE SE
14 S	16 E	WM	33	NE NE
14 S	16 E	WM	33	NW NE
14 S	16 E	WM	33	SW NE
14 S	16 E	WM	33	SE NE
14 S	16 E	WM	33	NE NW
14 S	16 E	WM	33	NW NW
14 S	16 E	WM	33	SW NW
14 S	16 E	WM	33	SE NW
14 S	16 E	WM	33	NE SW
14 S	16 E	WM	33	NW SW
14 S	16 E	WM	33	SW SW
14 S	16 E	WM	33	SE SW
14 S	16 E	WM	33	NE SE
14 S	16 E	WM	33	NW SE
14 S	16 E	WM	33	SW SE
14 S	16 E	WM	33	SE SE
14 S	16 E	WM	34	NE NE
14 S	16 E	WM	34	NW NE
14 S	16 E	WM	34	SW NE
14 S	16 E	WM	34	SE NE
14 S	16 E	WM	34	NE NW
14 S	16 E	WM	34	NW NW
14 S	16 E	WM	34	SW NW
14 S	16 E	WM	34	SE NW
14 S	16 E	WM	34	NE SW
14 S	16 E	WM	34	NW SW
14 S	16 E	WM	34	SW SW

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE				
Twp	Rng	Mer	Sec	Q-Q
14 S	16 E	WM	34	SE SW
14 S	16 E	WM	34	NE SE
14 S	16 E	WM	34	NW SE
14 S	16 E	WM	34	SW SE
14 S	16 E	WM	34	SE SE
15 S	15 E	WM	1	NE NE
15 S	15 E	WM	1	NW NE
15 S	15 E	WM	1	SW NE
15 S	15 E	WM	1	SE NE
15 S	15 E	WM	1	NE NW
15 S	15 E	WM	1	NW NW
15 S	15 E	WM	1	SW NW
15 S	15 E	WM	1	SE NW
15 S	15 E	WM	1	NE SW
15 S	15 E	WM	1	NW SW
15 S	15 E	WM	1	SW SW
15 S	15 E	WM	1	SE SW
15 S	15 E	WM	1	NE SE
15 S	15 E	WM	1	NW SE
15 S	15 E	WM	1	SW SE
15 S	15 E	WM	1	SE SE
15 S	15 E	WM	2	NE NE
15 S	15 E	WM	2	NW NE
15 S	15 E	WM	2	SW NE
15 S	15 E	WM	2	SE NE
15 S	15 E	WM	2	NE NW
15 S	15 E	WM	2	NW NW
15 S	15 E	WM	2	SW NW
15 S	15 E	WM	2	SE NW
15 S	15 E	WM	2	NE SW
15 S	15 E	WM	2	NW SW
15 S	15 E	WM	2	SW SW
15 S	15 E	WM	2	SE SW
15 S	15 E	WM	2	NE SE
15 S	15 E	WM	2	NW SE
15 S	15 E	WM	2	SW SE
15 S	15 E	WM	2	SE SE
15 S	15 E	WM	3	NE NE
15 S	15 E	WM	3	NW NE
15 S	15 E	WM	3	SW NE
15 S	15 E	WM	3	SE NE
15 S	15 E	WM	3	NE NW
15 S	15 E	WM	3	NW NW
15 S	15 E	WM	3	SW NW
15 S	15 E	WM	3	SE NW
15 S	15 E	WM	3	NE SW
15 S	15 E	WM	3	NW SW

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE				
Twp	Rng	Mer	Sec	Q-Q
15 S	15 E	WM	3	SW SW
15 S	15 E	WM	3	SE SW
15 S	15 E	WM	3	NE SE
15 S	15 E	WM	3	NW SE
15 S	15 E	WM	3	SW SE
15 S	15 E	WM	3	SE SE
15 S	15 E	WM	10	NE NE
15 S	15 E	WM	10	NW NE
15 S	15 E	WM	10	SW NE
15 S	15 E	WM	10	SE NE
15 S	15 E	WM	10	NE NW
15 S	15 E	WM	10	NW NW
15 S	15 E	WM	10	SW NW
15 S	15 E	WM	10	SE NW
15 S	15 E	WM	10	NE SW
15 S	15 E	WM	10	NW SW
15 S	15 E	WM	10	SW SW
15 S	15 E	WM	10	SE SW
15 S	15 E	WM	10	NE SE
15 S	15 E	WM	10	NW SE
15 S	15 E	WM	10	SW SE
15 S	15 E	WM	10	SE SE
15 S	15 E	WM	11	NE NE
15 S	15 E	WM	11	NW NE
15 S	15 E	WM	11	SW NE
15 S	15 E	WM	11	SE NE
15 S	15 E	WM	11	NE NW
15 S	15 E	WM	11	NW NW
15 S	15 E	WM	11	SW NW
15 S	15 E	WM	11	SE NW
15 S	15 E	WM	11	NE SW
15 S	15 E	WM	11	NW SW
15 S	15 E	WM	11	SW SW
15 S	15 E	WM	11	SE SW
15 S	15 E	WM	11	NE SE
15 S	15 E	WM	11	NW SE
15 S	15 E	WM	11	SW SE
15 S	15 E	WM	11	SE SE
15 S	15 E	WM	12	NE NE
15 S	15 E	WM	12	NW NE
15 S	15 E	WM	12	SW NE
15 S	15 E	WM	12	SE NE
15 S	15 E	WM	12	NE NW
15 S	15 E	WM	12	NW NW
15 S	15 E	WM	12	SW NW
15 S	15 E	WM	12	SE NW
15 S	15 E	WM	12	NE SW

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE

Twp	Rng	Mer	Sec	Q-Q
15 S	15 E	WM	12	NW SW
15 S	15 E	WM	12	SW SW
15 S	15 E	WM	12	SE SW
15 S	15 E	WM	12	NE SE
15 S	15 E	WM	12	NW SE
15 S	15 E	WM	12	SW SE
15 S	15 E	WM	12	SE SE
15 S	15 E	WM	13	NE NE
15 S	15 E	WM	13	NW NE
15 S	15 E	WM	13	SW NE
15 S	15 E	WM	13	SE NE
15 S	15 E	WM	13	NE NW
15 S	15 E	WM	13	NW NW
15 S	15 E	WM	13	SW NW
15 S	15 E	WM	13	SE NW
15 S	15 E	WM	13	NE SW
15 S	15 E	WM	13	NW SW
15 S	15 E	WM	13	SW SW
15 S	15 E	WM	13	SE SW
15 S	15 E	WM	13	NE SE
15 S	15 E	WM	13	NW SE
15 S	15 E	WM	13	SW SE
15 S	15 E	WM	13	SE SE
15 S	15 E	WM	14	NE NE
15 S	15 E	WM	14	NW NE
15 S	15 E	WM	14	SW NE
15 S	15 E	WM	14	SE NE
15 S	15 E	WM	14	NE NW
15 S	15 E	WM	14	NW NW
15 S	15 E	WM	14	SW NW
15 S	15 E	WM	14	SE NW
15 S	15 E	WM	14	NE SW
15 S	15 E	WM	14	NW SW
15 S	15 E	WM	14	SW SW
15 S	15 E	WM	14	SE SW
15 S	15 E	WM	14	NE SE
15 S	15 E	WM	14	NW SE
15 S	15 E	WM	14	SW SE
15 S	15 E	WM	14	SE SE
15 S	16 E	WM	3	NE NE
15 S	16 E	WM	3	NW NE
15 S	16 E	WM	3	SW NE
15 S	16 E	WM	3	SE NE
15 S	16 E	WM	3	NE NW
15 S	16 E	WM	3	NW NW
15 S	16 E	WM	3	SW NW

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE

Twp	Rng	Mer	Sec	Q-Q
15 S	16 E	WM	3	SE NW
15 S	16 E	WM	3	NE SW
15 S	16 E	WM	3	NW SW
15 S	16 E	WM	3	SW SW
15 S	16 E	WM	3	SE SW
15 S	16 E	WM	3	NE SE
15 S	16 E	WM	3	NW SE
15 S	16 E	WM	3	SW SE
15 S	16 E	WM	3	SE SE
15 S	16 E	WM	4	NE NE
15 S	16 E	WM	4	NW NE
15 S	16 E	WM	4	SW NE
15 S	16 E	WM	4	SE NE
15 S	16 E	WM	4	NE NW
15 S	16 E	WM	4	NW NW
15 S	16 E	WM	4	SW NW
15 S	16 E	WM	4	SE NW
15 S	16 E	WM	4	NE SW
15 S	16 E	WM	4	NW SW
15 S	16 E	WM	4	SW SW
15 S	16 E	WM	4	SE SW
15 S	16 E	WM	4	NE SE
15 S	16 E	WM	4	NW SE
15 S	16 E	WM	4	SW SE
15 S	16 E	WM	4	SE SE
15 S	16 E	WM	5	NE NE
15 S	16 E	WM	5	NW NE
15 S	16 E	WM	5	SW NE
15 S	16 E	WM	5	SE NE
15 S	16 E	WM	5	NE NW
15 S	16 E	WM	5	NW NW
15 S	16 E	WM	5	SW NW
15 S	16 E	WM	5	SE NW
15 S	16 E	WM	5	NE SW
15 S	16 E	WM	5	NW SW
15 S	16 E	WM	5	SW SW
15 S	16 E	WM	5	SE SW
15 S	16 E	WM	5	NE SE
15 S	16 E	WM	5	NW SE
15 S	16 E	WM	5	SW SE
15 S	16 E	WM	5	SE SE
15 S	16 E	WM	6	NE NE
15 S	16 E	WM	6	NW NE
15 S	16 E	WM	6	SW NE
15 S	16 E	WM	6	SE NE
15 S	16 E	WM	6	NE NW
15 S	16 E	WM	6	NW NW
15 S	16 E	WM	6	SW NW
15 S	16 E	WM	6	SE NW
15 S	16 E	WM	6	NE SW

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE				
Twp	Rng	Mer	Sec	Q-Q
15 S	16 E	WM	6	NW SW
15 S	16 E	WM	6	SW SW
15 S	16 E	WM	6	SE SW
15 S	16 E	WM	6	NE SE
15 S	16 E	WM	6	NW SE
15 S	16 E	WM	6	SW SE
15 S	16 E	WM	6	SE SE
15 S	16 E	WM	7	NE NE
15 S	16 E	WM	7	NW NE
15 S	16 E	WM	7	SW NE
15 S	16 E	WM	7	SE NE
15 S	16 E	WM	7	NE NW
15 S	16 E	WM	7	NW NW
15 S	16 E	WM	7	SW NW
15 S	16 E	WM	7	SE NW
15 S	16 E	WM	7	NE SW
15 S	16 E	WM	7	NW SW
15 S	16 E	WM	7	SW SW
15 S	16 E	WM	7	SE SW
15 S	16 E	WM	7	NE SE
15 S	16 E	WM	7	NW SE
15 S	16 E	WM	7	SW SE
15 S	16 E	WM	7	SE SE
15 S	16 E	WM	8	NE NE
15 S	16 E	WM	8	NW NE
15 S	16 E	WM	8	SW NE
15 S	16 E	WM	8	SE NE
15 S	16 E	WM	8	NE NW
15 S	16 E	WM	8	NW NW
15 S	16 E	WM	8	SW NW
15 S	16 E	WM	8	SE NW
15 S	16 E	WM	8	NE SW
15 S	16 E	WM	8	NW SW
15 S	16 E	WM	8	SW SW
15 S	16 E	WM	8	SE SW
15 S	16 E	WM	8	NE SE
15 S	16 E	WM	8	NW SE
15 S	16 E	WM	8	SW SE
15 S	16 E	WM	8	SE SE
15 S	16 E	WM	9	NE NE
15 S	16 E	WM	9	NW NE
15 S	16 E	WM	9	SW NE
15 S	16 E	WM	9	SE NE
15 S	16 E	WM	9	NE NW
15 S	16 E	WM	9	NW NW
15 S	16 E	WM	9	SW NW
15 S	16 E	WM	9	SE NW
15 S	16 E	WM	9	NE SW
15 S	16 E	WM	9	NW SW
15 S	16 E	WM	9	SW SW

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE				
Twp	Rng	Mer	Sec	Q-Q
15 S	16 E	WM	9	SE SW
15 S	16 E	WM	9	NE SE
15 S	16 E	WM	9	NW SE
15 S	16 E	WM	9	SW SE
15 S	16 E	WM	9	SE SE

Permit Amendment T-12192 Conditions

The combined quantity of water diverted at the new point of appropriation, City Airport Well 4, together with that diverted at the old points of appropriation, City Airport Wells 1, 2 and 3, shall not exceed the quantity of water lawfully available at the original points of appropriation, City Airport Wells 1 and 2.

Water shall be acquired by City Airport Well 4 from the same aquifer as the original points of appropriation, City Airport Wells 1 and 2.

Water use measurement conditions:

a. Before water use may begin under this order, the water user shall install a totalizing flow meter, or, with prior approval of the Director, another suitable measuring device at each new point of appropriation.

b. The water user shall maintain the meter or measuring device in good working order.

c. The water user shall allow the Watermaster access to the meter or measuring device; provided however, where the meter or measuring device is located within a private structure, the Watermaster shall request access upon reasonable notice.

The permittee shall an updated Water Management and Conservation Plan pursuant to OAR Chapter 690, Division 86 no later than November 19, 2019.

Permit Amendment T-11647 Conditions

The combined quantity of water diverted at the new points of appropriation, City Airport Well 3, together with that diverted at the old points of appropriation, City Airport Wells 1 and 2, shall not exceed the quantity of water lawfully available at the original points of appropriation, City Airport Wells 1 and 2.

Water shall be acquired by City Airport Well 3 from the same aquifer as the original points of appropriation, City Airport Wells 1 and 2.

Permit Amendment T-10378 Conditions

The combined quantity of water diverted at the new points of appropriation (wells), together with that diverted at the old points of appropriation, shall not exceed the maximum rate and duty allowed under Permit G-16146.

Water shall be acquired from the same aquifer as the original points of appropriation.

Measurement, recording and reporting conditions:

> A. Before water use may begin under this permit, the permittee shall install a totalizing flow meter on each well. The totalizing flow meter must be installed and maintained in good working order consistent with those standards identified in OAR 690-507-645(1) through 3. The permittee shall keep a complete record of the amount of water used each month and shall submit a report which includes the recorded water use measurements to the Department annually or more frequently as may be required by the Director. Further, the Director may require the permittee to report general water use information, including the place and nature of use of water under the permit.
>
> B. The permittee shall allow the watermaster access to the meters; provided however, where the meter is located within a private structure, the watermaster shall request access upon reasonable notice.

Use of water under authority of this permit may be regulated if analysis of data available after the permit is issued discloses that the appropriation will measurably reduce the surface water flows necessary to maintain the free-flowing character of a scenic waterway in quantities necessary for recreation, fish and wildlife in effect as of the priority date of the right or as those quantities may be subsequently reduced. However, the use of ground water allowed under the terms of this permit will not be subject to regulation for Scenic Waterway flows so long as mitigation is maintained.

To monitor the effect of water use from the well(s) authorized under this permit, the Department requires the water user to make and report annual static water level measurements. The static water level shall be measured in the month of March. Reports shall be submitted to the Department within 30 days of measurement.

Measurements must be made according to the following schedule:

Before Use of Water Takes Place
Initial and Annual Measurements
The Department requires the permittee to submit an initial water level measurement in the month specified above once well construction is complete and annually thereafter until use of water begins; and

After Use of Water has Begun
Seven Consecutive Annual Measurements
Following the first year of water use, the user shall submit seven consecutive annual reports of static water level measurements. The first of these seven annual measurements will establish the reference level against which future annual measurements will be compared. Based on an analysis of the data collected, the Director may require that the user obtain and report additional annual static water level measurements beyond the seven year minimum reporting period. The additional measurements may be required in a different month. If the measurement requirement is stopped, the Director may restart it at any time.

All measurements shall be made by a certified water rights examiner, registered professional geologist, registered professional engineer, licensed well constructor or pump installer licensed by the Construction Contractors Board and be submitted to the Department on forms provided by the Department. The Department requires the individual performing the measurement to:

A. Identify each well with its associated measurement; and
B. Measure and report water levels to the nearest tenth of a foot as depth-to-water below ground surface; and
C. Specify the method used to obtain each well measurement; and
D. Certify the accuracy of all measurements and calculations submitted to the Department.

The water user shall discontinue use of, or reduce the rate or volume of withdrawal from, the well(s) if any of the following events occur:

A. Annual water level measurements reveal an average water level decline of three or more feet per year for five consecutive years; or
B. Annual water level measurements reveal a water level decline of 15 or more feet in fewer than five consecutive years; or
C. Annual water level measurements reveal a water level decline of 25 or more feet; or
D. Hydraulic interference leads to a decline of 25 or more feet in any neighboring well with senior priority.

The period of non or restricted use shall continue until the water level rises above the decline level which triggered the action or until the Department determines, based on the permittee's and/or the Department's data and analysis, that no action is necessary because the aquifer in question can sustain the observed declines without adversely impacting the resource or senior water rights. The water user shall in no instance allow excessive decline, as defined in Commission rules, to occur within the aquifer as a result of use under this permit. If more than one well is involved, the water user may submit an alternative measurement and reporting plan for review and approval by the Department.

GROUND WATER MITIGATION CONDITIONS

Mitigation Obligation:	496.8 acre-feet of mitigation water in the Crooked River Zone of Impact (anywhere in the Crooked River Basin above River Mile 13.8)
Mitigation Source:	Mitigation Credits or a Mitigation Project, in accordance with the incremental development plan on file with the Department, meeting the requirements of OAR Chapter 690, Division 505 (Deschutes Ground Water Mitigation Rules). The first stage of incremental development was met with 104.4 AF of mitigation, being mitigation water resulting from Mitigation Project MP-25, a permanent instream transfer that meets the requirements of OAR 690-505-0610(2)-(5), within the Crooked River Zone of Impact.

Mitigation water must be legally protected instream for instream use within the Crooked River Zone of Impact and committed for life of the permit and subsequent certificate(s). Regulation of the use and/or cancellation of the permit, or subsequent certificate(s) will occur if the required mitigation is not maintained.

If mitigation is from a secondary right for stored water from a storage project not owned or operated by the permittee, the use of water under this right is subject to the terms and conditions of a valid contract, or a satisfactory replacement, with the owner/operator of the storage project, a copy of which must be on file in the records of the Water Resources Department prior to use of water.

The permittee shall provide additional mitigation if the Department determines that average annual consumptive use of the subject appropriation has increased beyond the originally mitigated amount.

The permittee shall provide mitigation prior to each stage of development under the permit, as described in the incremental development mitigation plan on file with the Department, and in accordance with the standards of the Deschutes Ground Water Mitigation Rules, OAR Chapter 690, Division 505.

The permittee shall not increase the rate or amount of water diverted, as described in the incremental development mitigation plan, prior to increasing the corresponding mitigation.

The permittee shall seek and receive Department approval prior to changing the incremental mitigation development plan and related mitigation obligation for each stage of permit development.

The permittee shall report to the Department the progress of implementing the incremental mitigation development plan and related mitigation no later than April 1 of each year. This annual notification is not necessary if the permittee has completed development and submitted a Claim of Beneficial Use to the Department.

The permittee shall submit a new or updated Water Management and Conservation Plan pursuant to OAR Chapter 690, Division 86 by December 29, 2008.

Failure to comply with these mitigation conditions shall result in the Department regulating the ground water permit, or subsequent certificate(s), proposing to deny any permit extension application for the ground water permit, and proposing to cancel the ground water permit, or subsequent certificate(s).

STANDARD CONDITIONS

If substantial interference with a senior water right occurs due to withdrawal of water from any well listed on this permit, then use of water from the well(s) shall be discontinued or reduced and/or the schedule of withdrawal shall be regulated until or unless the Department approves or implements an alternative administrative action to mitigate the interference. The Department encourages junior and senior appropriators to jointly develop plans to mitigate interferences.

The wells shall be constructed in accordance with the General Standards for the Construction and Maintenance of Water Wells in Oregon. The works shall be equipped with a usable access port, and may also include an airline and pressure gauge adequate to determine water level elevation in the well at all times.

The use shall conform to such reasonable rotation system as may be ordered by the proper state officer.

Prior to receiving a certificate of water right, the permit holder shall submit the results of a pump test meeting the department's standards, to the Water Resources Department. The Director may require water level or pump test results every ten years thereafter.

Failure to comply with any of the provisions of this permit may result in action including, but not limited to, restrictions on the use, civil penalties, or cancellation of the permit.

This permit is for the beneficial use of water without waste. The water user is advised that new regulations may require the use of best practical technologies or conservation practices to achieve this end.

By law, the land use associated with this water use must be in compliance with statewide land-use goals and any local acknowledged land-use plan.

The use of water shall be limited when it interferes with any prior surface or ground water rights.

The permit holder shall commence and complete the construction of any proposed works prior to October 29, 2026. The Department may order and allow an extension of time to complete construction or to perfect a water right beyond October 29, 2026.

Within one year after complete application of water to the proposed use, the permittee shall submit a claim of beneficial use, which includes a map and report, prepared by a Certified Water Rights Examiner (CWRE).

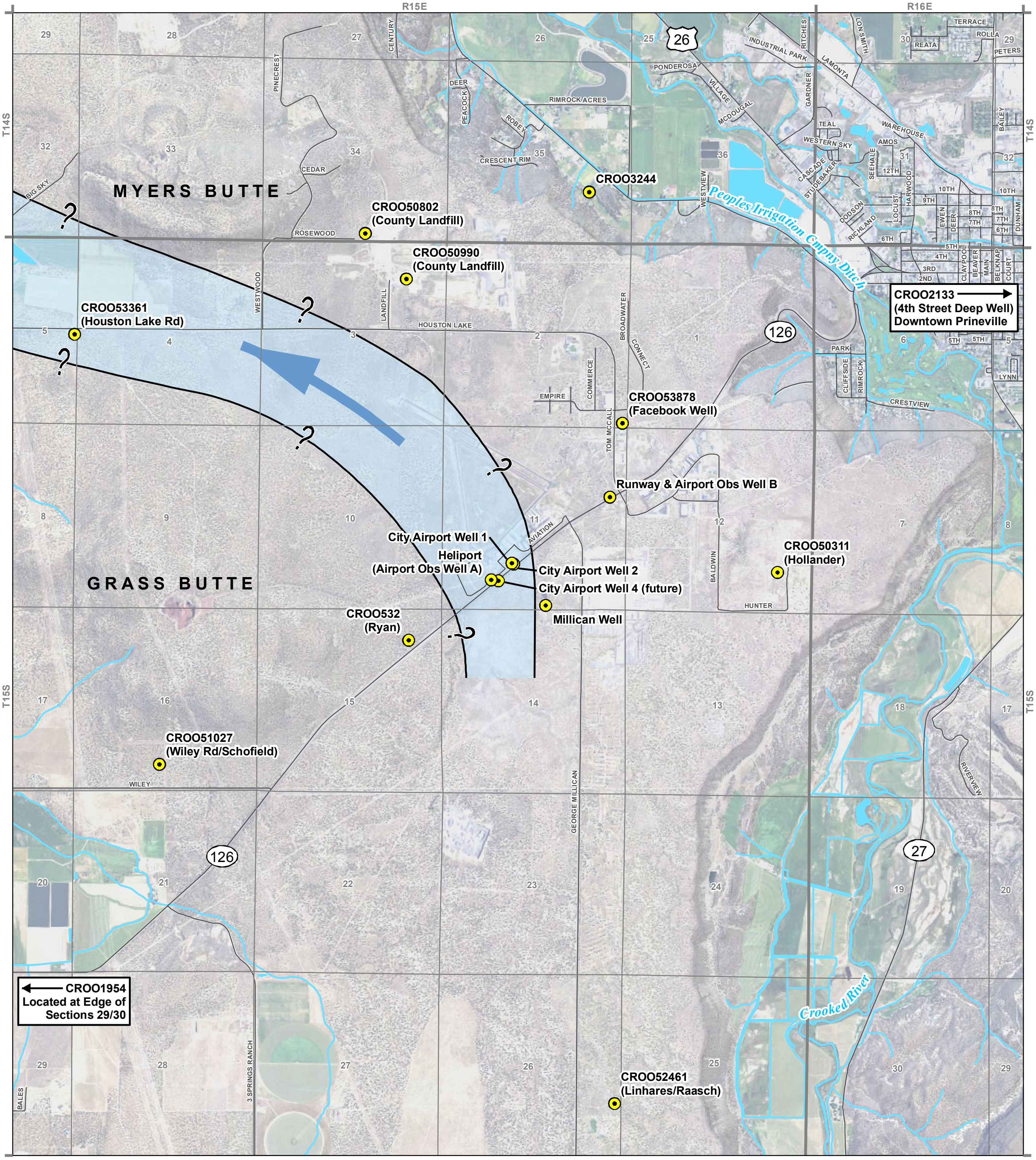
Issued June 1, 2016

Dwight French, Water Right Services Administrator, for
Thomas M. Byler, Director
Water Resources Department

APPENDIX C

Airport Area Water Level Program Hydrographs

City of Prineville ASR Limited License Application



LEGEND

● Monitoring Program Wells

Roads

Watercourses

Waterbodies

FIGURE 1

Monitoring Program Well Locations

City of Prineville

N

0 2,000 4,000

Feet

GSI Water Solutions, Inc.

MAP NOTES:

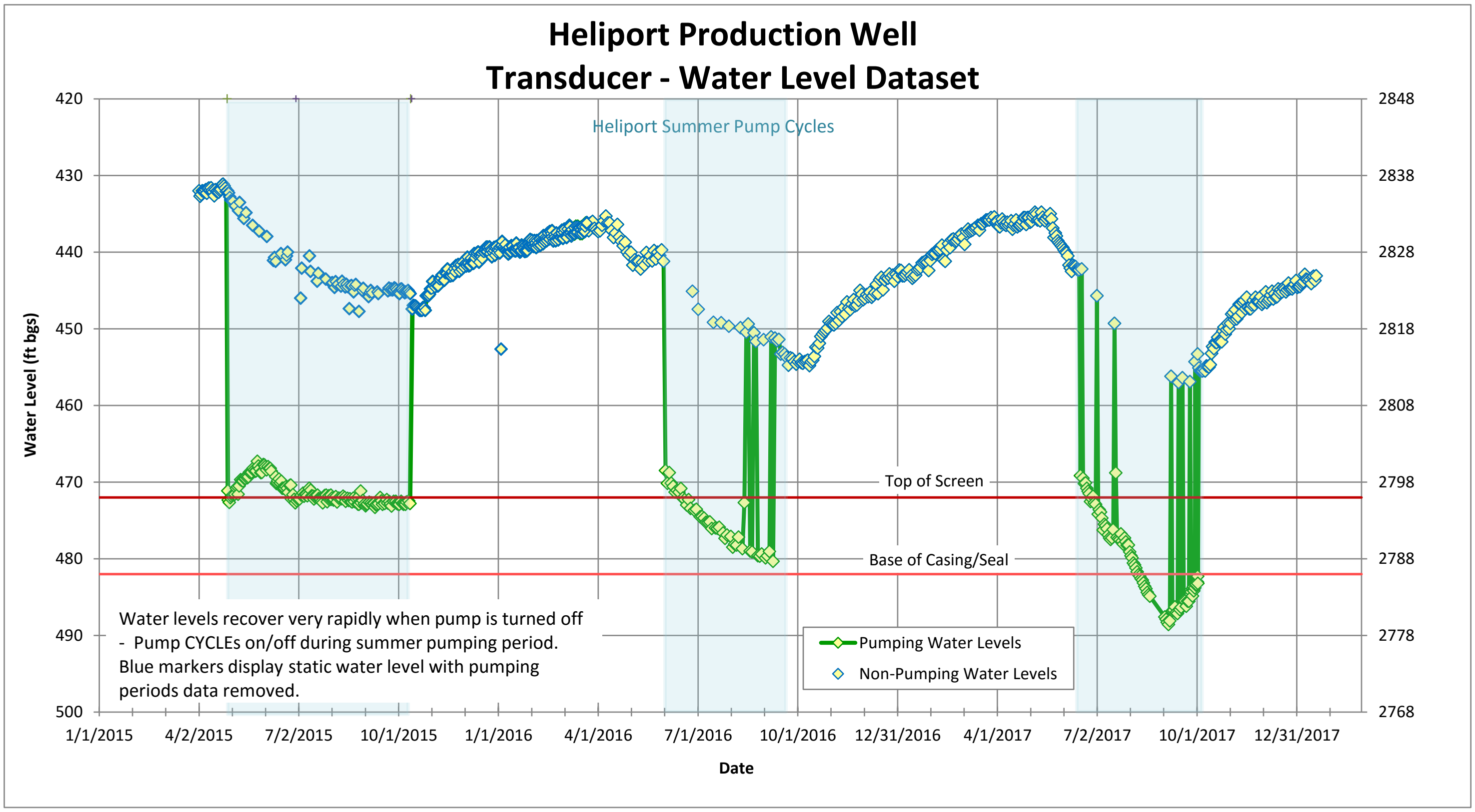
Date: January 8, 2014

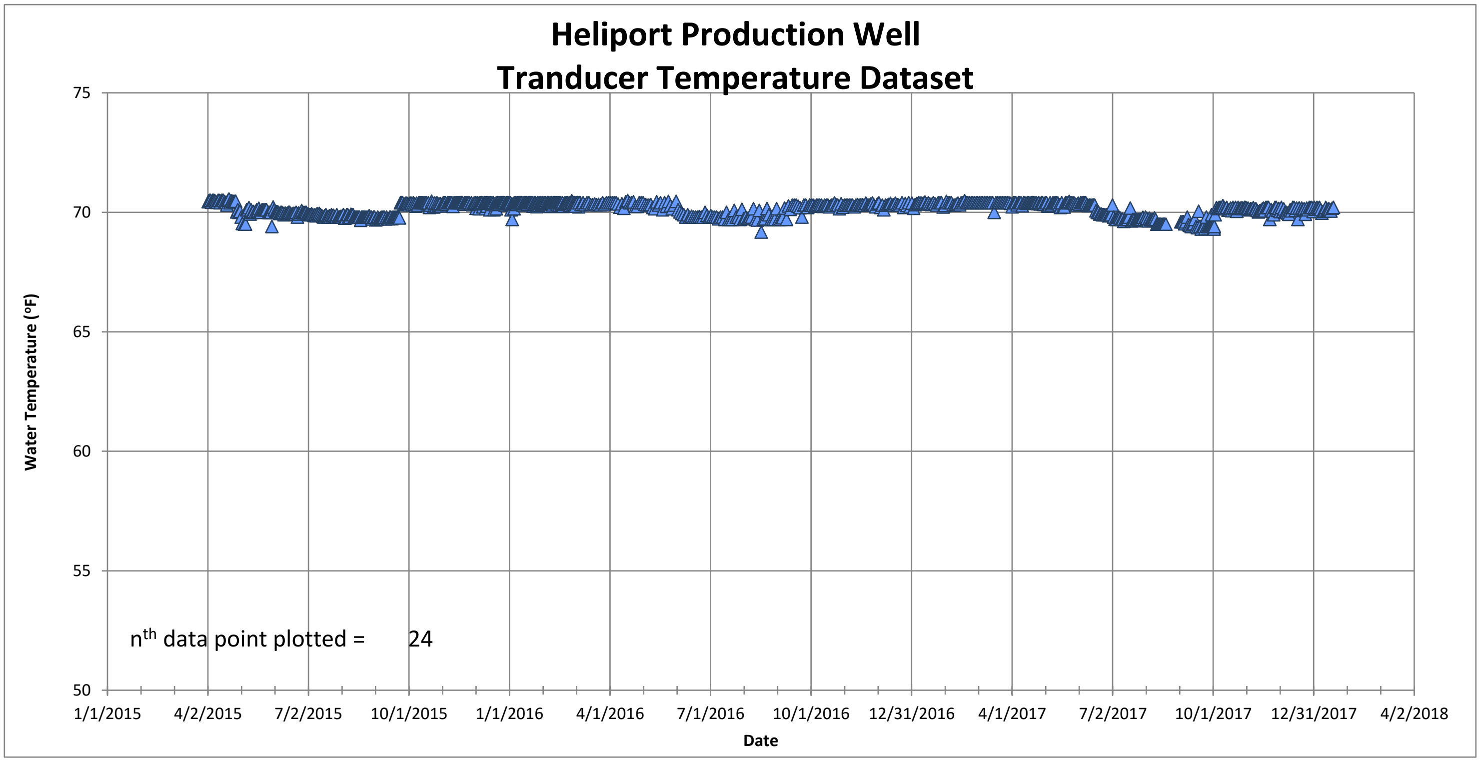
Data Sources: Crook Co. GIS, OWRD, USGS, USDA, ESRI

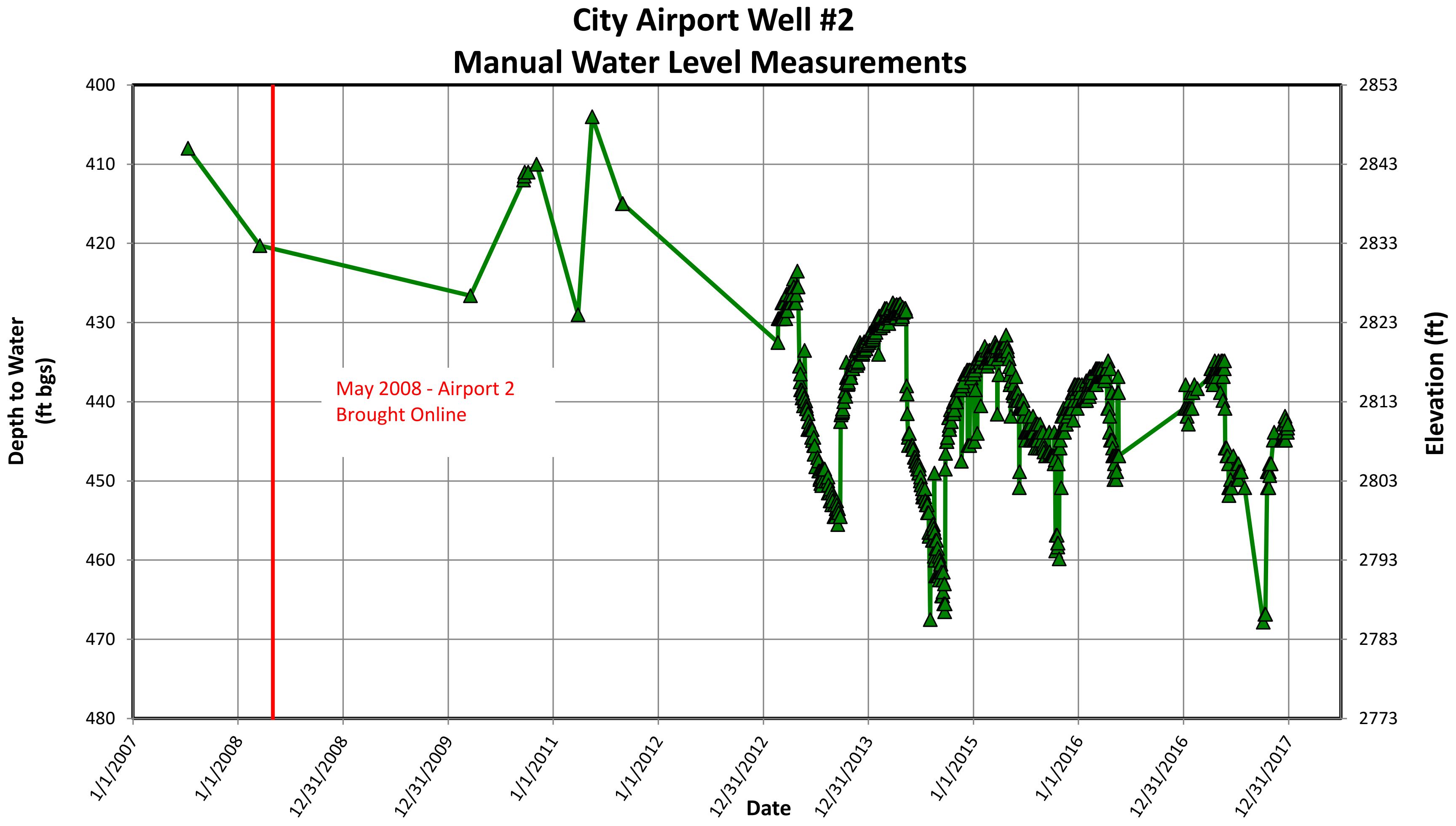
Document Path: P:\Portland\224 - Prineville\Airport GW Monitoring Program\Project_GIS\Project_mxds\Figure1_Monitoring_Program_Well_Locations.mxd

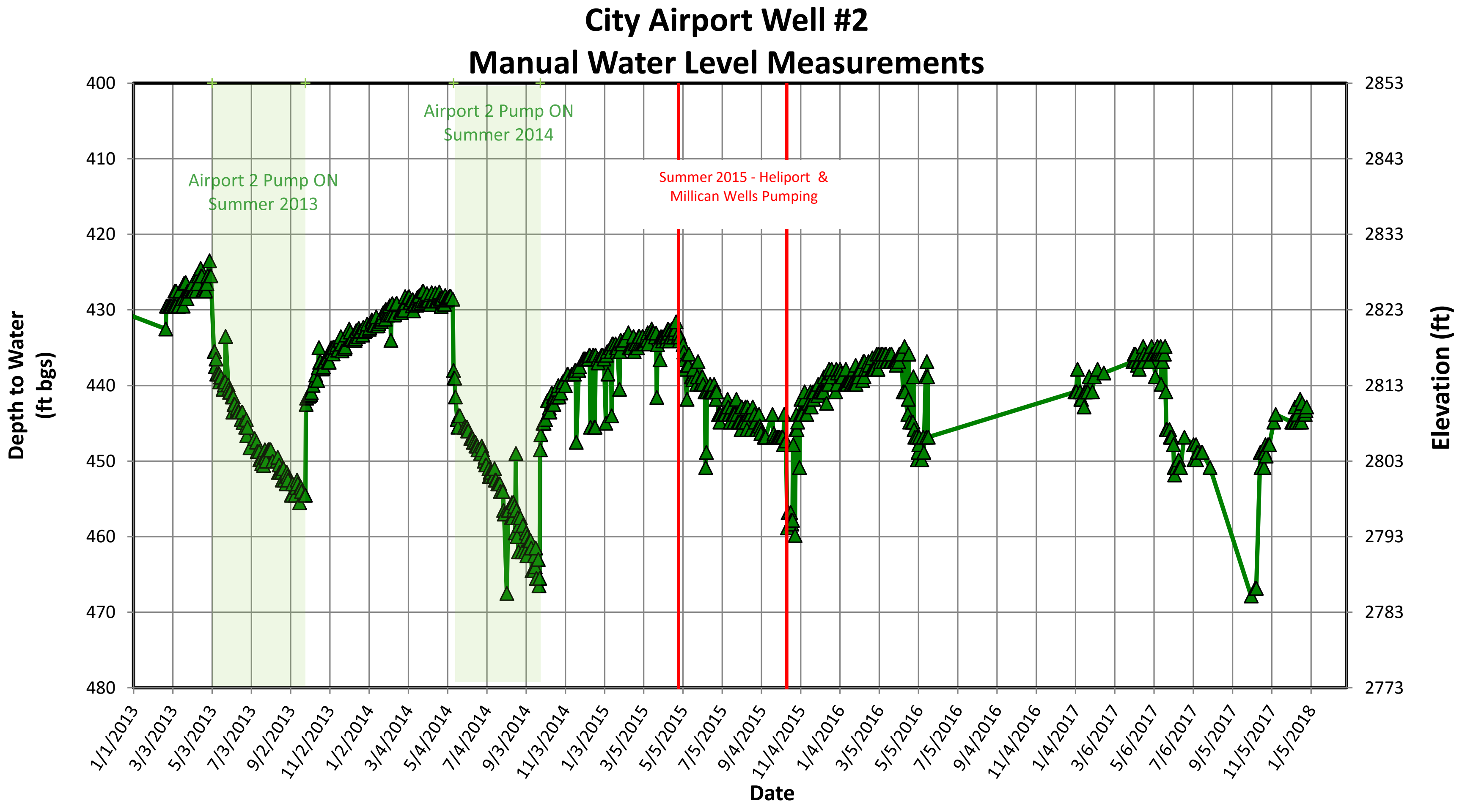
Heliport Production Well
Transducer - Water Level Dataset

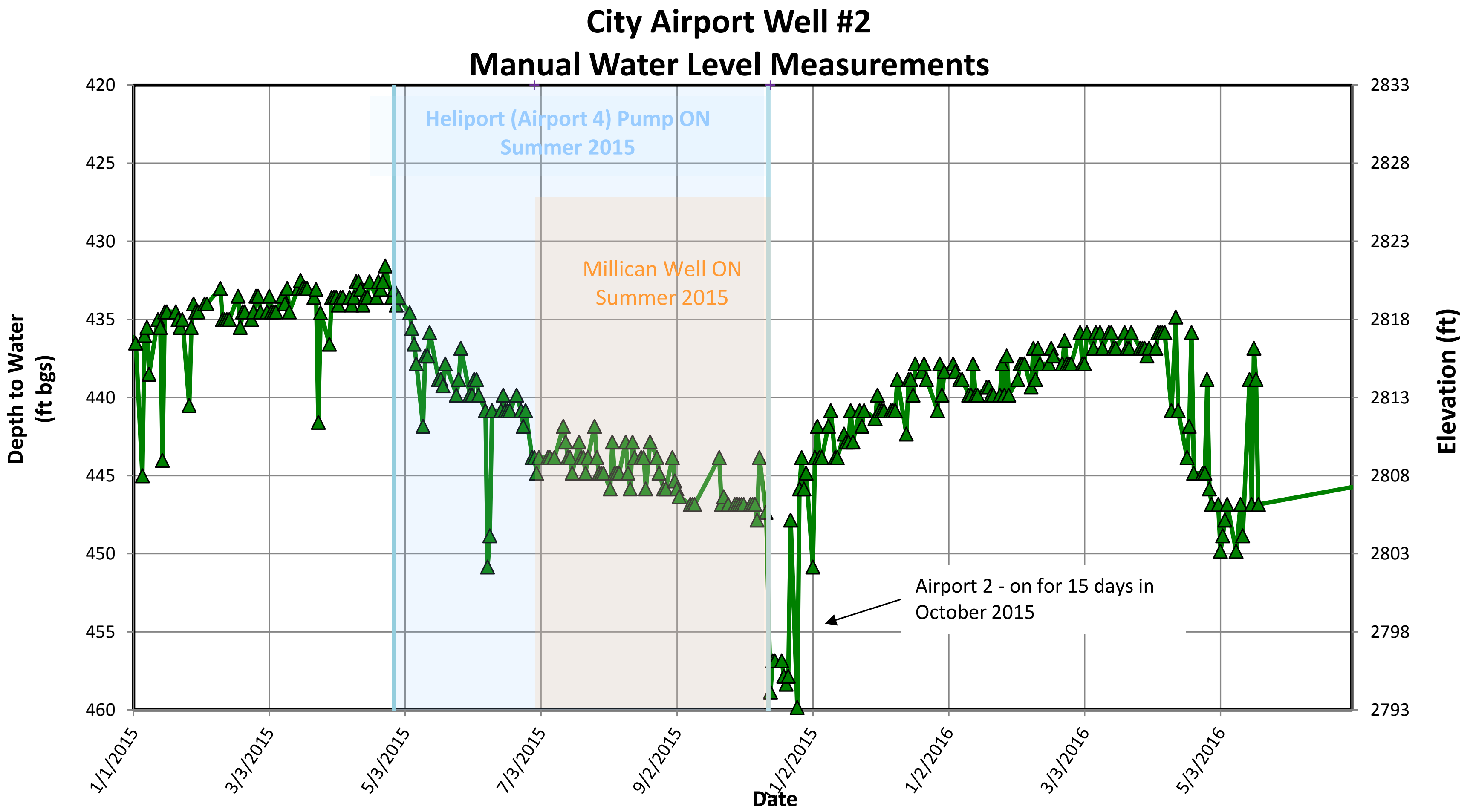
OWRD Well Log # : **CROO 54191**
Location of well (T/R/S QQ): **T15S/R15E/S11 SE-SW**



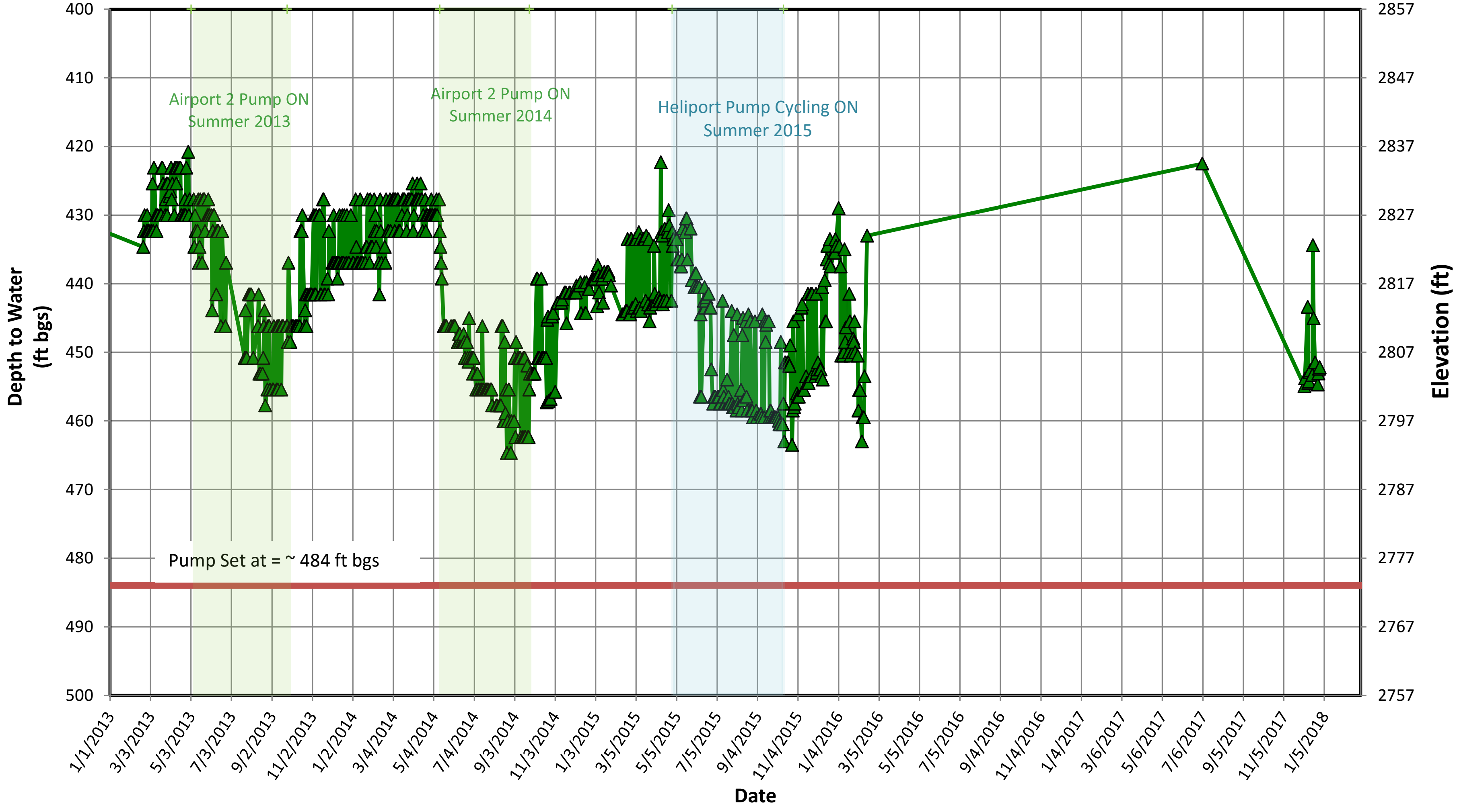



City Airport Well #2
Manual Water Level Measurements
Depth to Water (ft bgs)
Elevation (ft)
400
410
420
430
440
450
460
470
480
2853
2843
2833
2823
2813
2803
2793
2783
2773
May 2008 - Airport 2 Brought Online
1/1/2007
1/1/2008
12/31/2008
12/31/2009
1/1/2011
1/1/2012
12/31/2012
12/31/2013
1/1/2015
1/1/2016
12/31/2016
12/31/2017
Date


City Airport Well #2
Manual Water Level Measurements
Depth to Water (ft bgs)
Elevation (ft)
400
410
420
430
440
450
460
470
480
2853
2843
2833
2823
2813
2803
2793
2783
2773
Airport 2 Pump ON Summer 2013
Airport 2 Pump ON Summer 2014
Summer 2015 - Heliport & Millican Wells Pumping
1/1/2013
3/3/2013
5/3/2013
7/3/2013
9/2/2013
11/2/2013
1/2/2014
3/4/2014
5/4/2014
7/4/2014
9/3/2014
11/3/2014
1/3/2015
3/5/2015
5/5/2015
7/5/2015
9/4/2015
11/4/2015
1/4/2016
3/5/2016
5/5/2016
7/5/2016
9/4/2016
11/4/2016
1/4/2017
3/6/2017
5/6/2017
7/6/2017
9/5/2017
11/5/2017
1/5/2018
Date

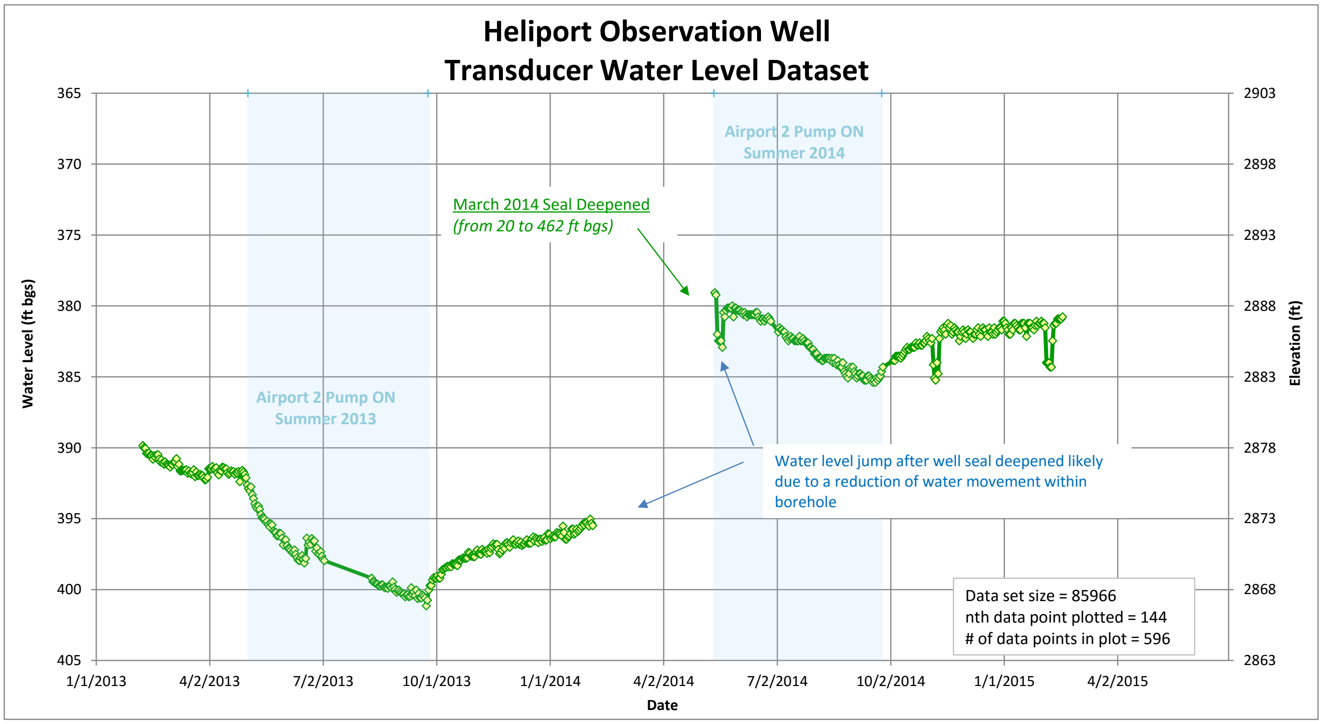

City Airport Well #2
Manual Water Level Measurements
Depth to Water (ft bgs)
Elevation (ft)
420
425
430
435
440
445
450
455
460
2833
2828
2823
2818
2813
2808
2803
2798
2793
Heliport (Airport 4) Pump ON Summer 2015
Millican Well ON Summer 2015
Airport 2 - on for 15 days in October 2015
1/1/2015
3/3/2015
5/3/2015
7/3/2015
9/2/2015
11/2/2015
1/2/2016
3/3/2016
5/3/2016
Date

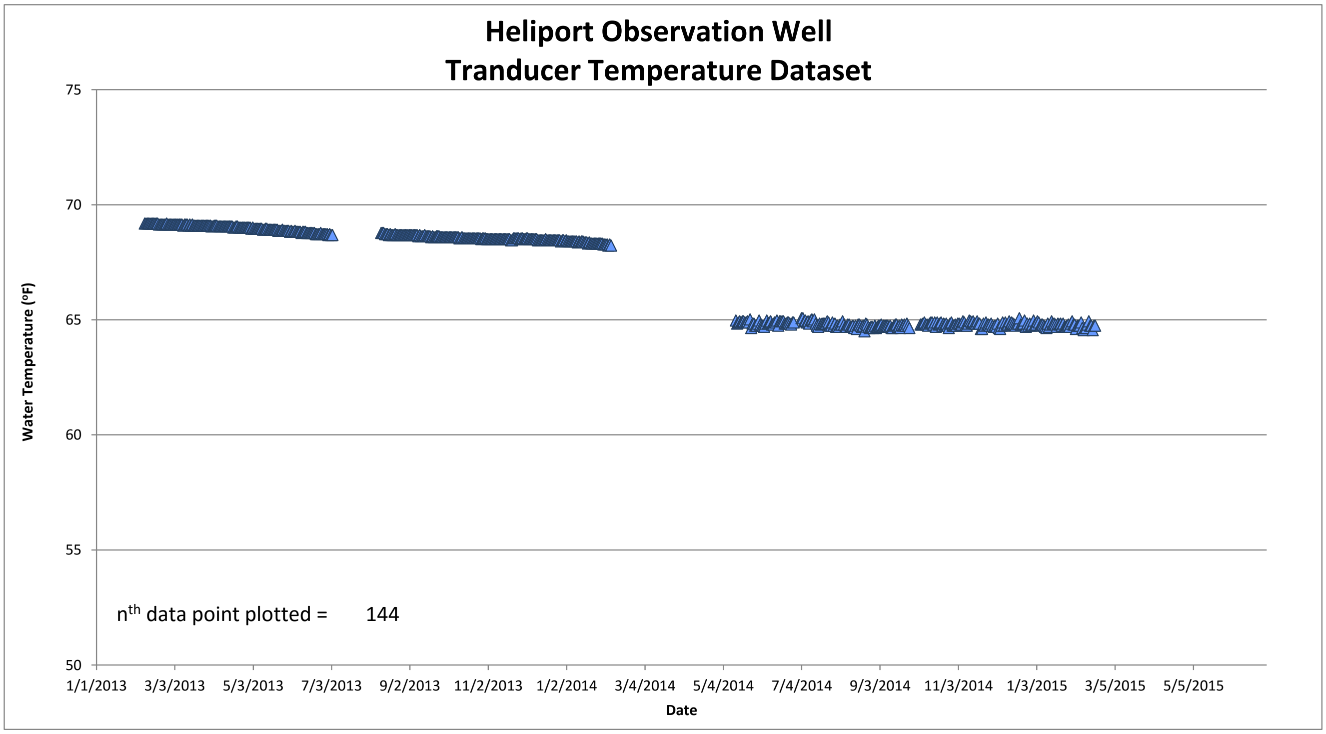
City Airport Well #1
Manual Water Level Measurements



Heliport Observation Well
Transducer Water Level Dataset

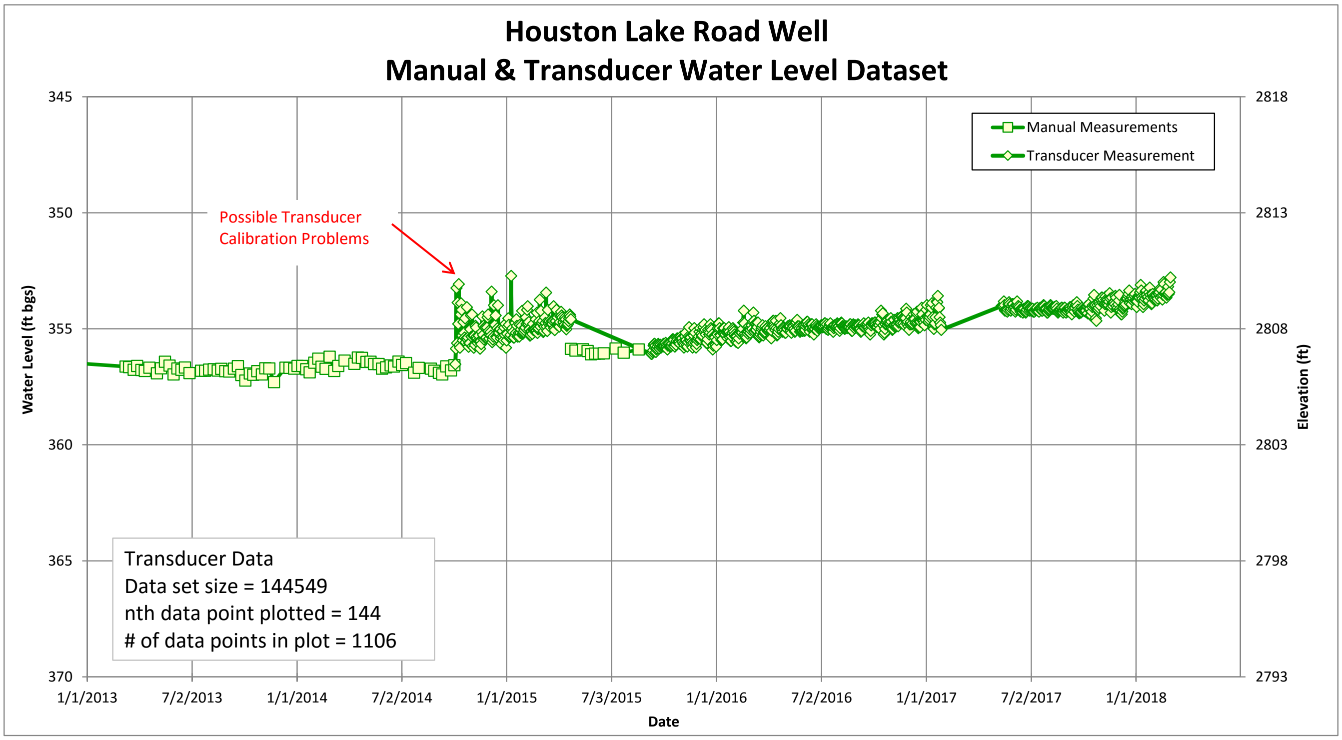
City's Monitoring Prog Well #:	**Well #8**
OWRD Well Log # :	**CROO 53965 / 54195**
Location of well (T/R/S QQ):	**T15S/R15E/S11 SE-SW**

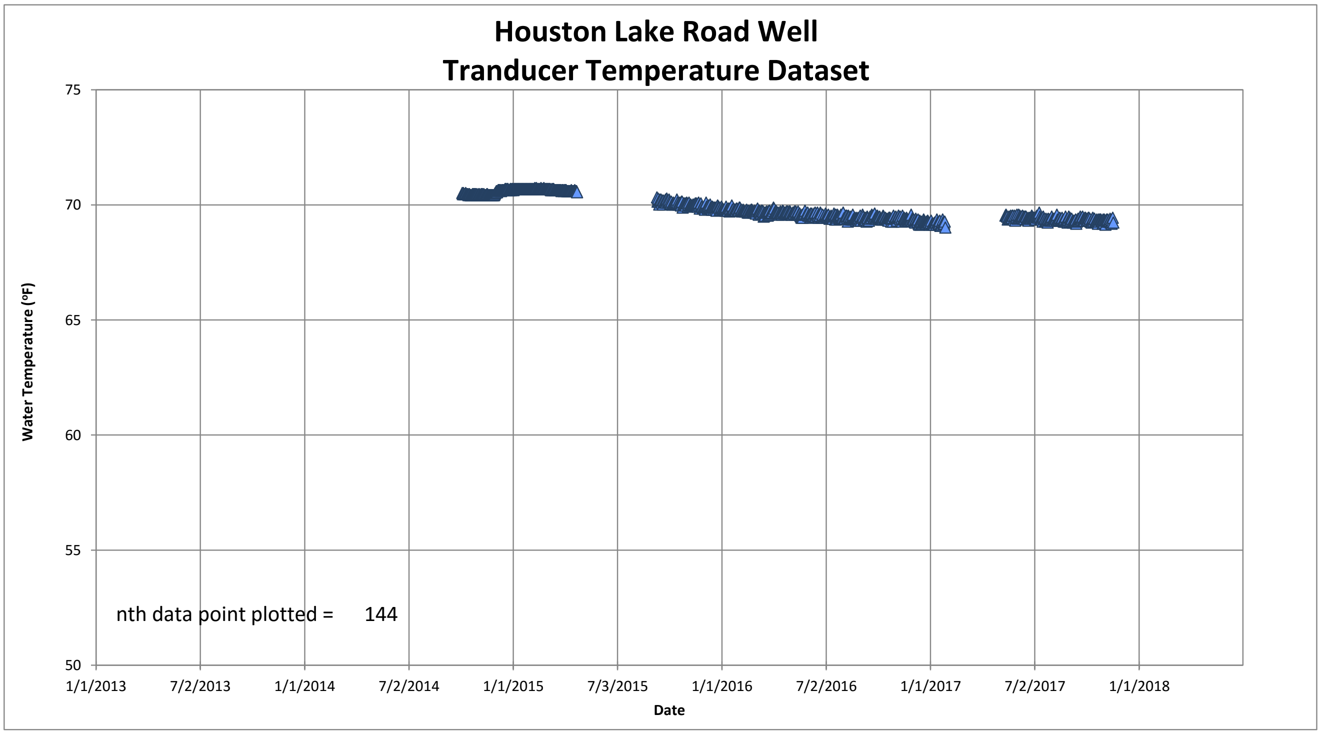




Houston Lake Road Well
Manual & Transducer Water Level Dataset

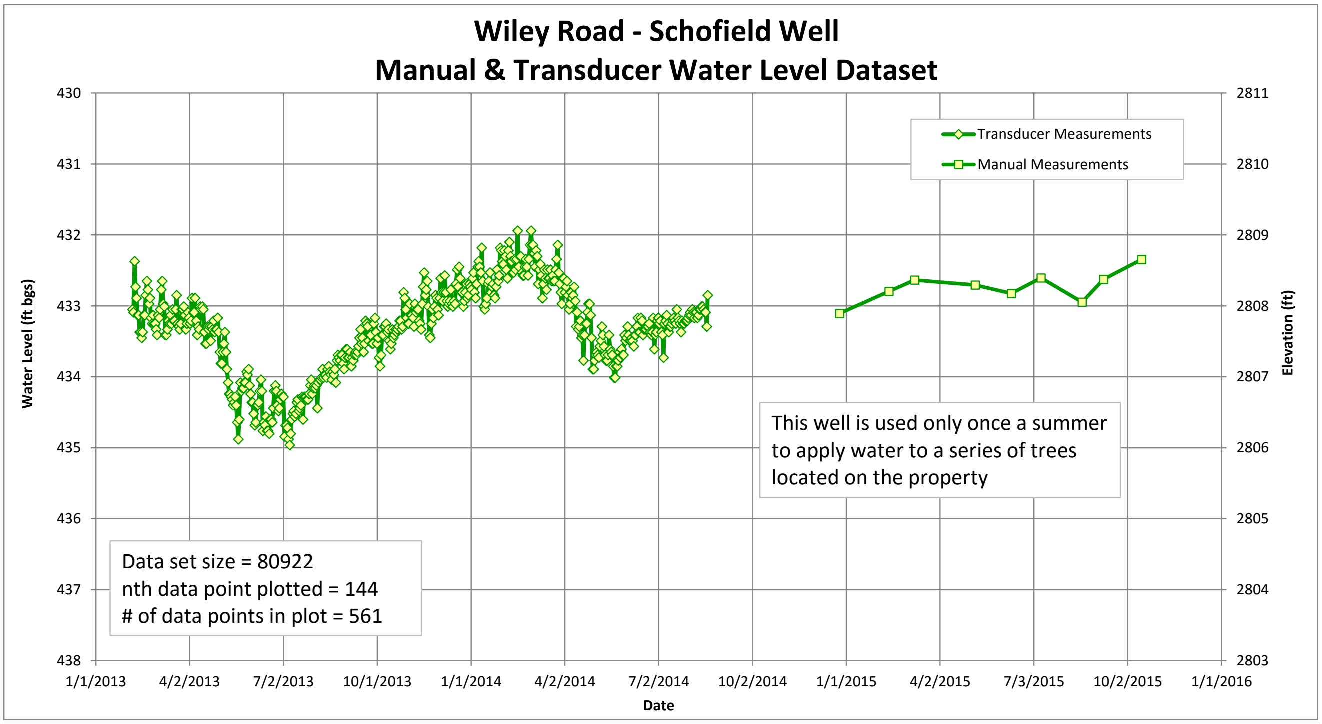
City's Monitoring Prog Well #:	**Well 5**
OWRD Well Log # :	**CROO 53361**
Location of well (T/R/S QQ):	**T15S/R15E/S4 NW-SW**

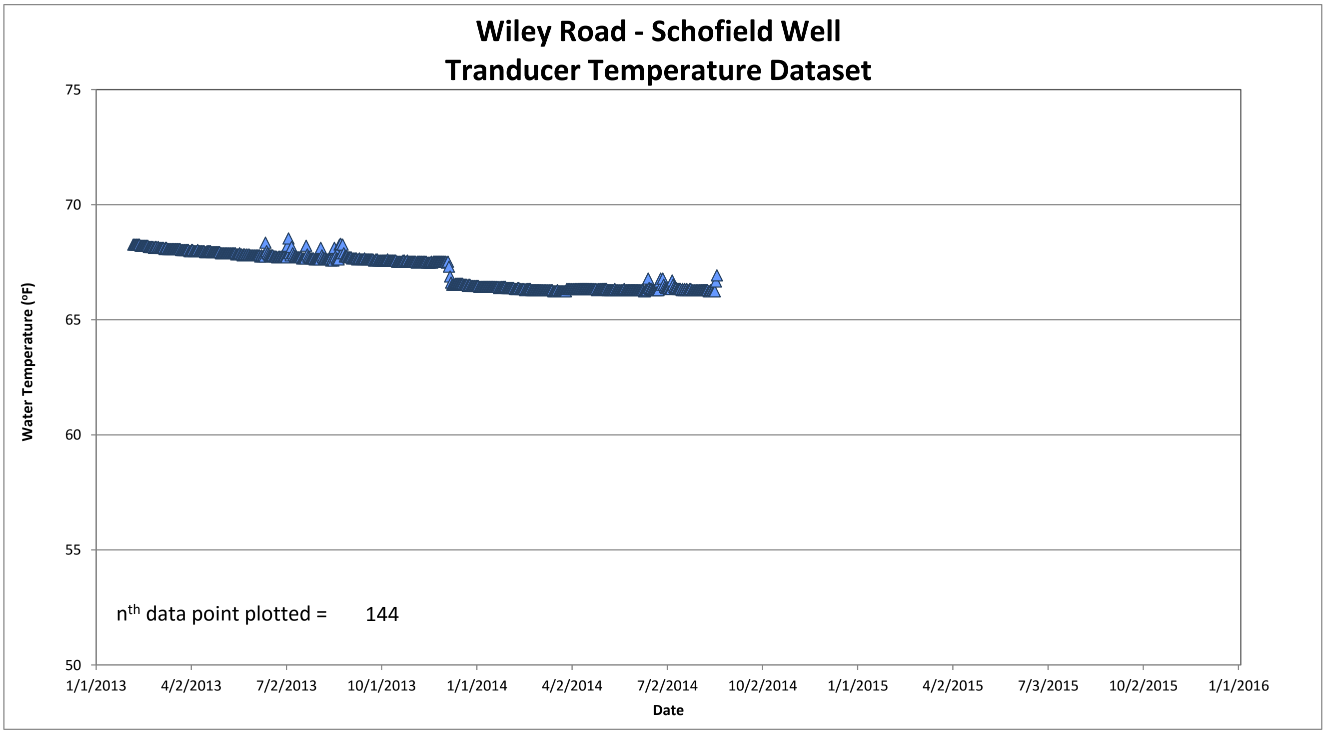




Wiley Road - Schofield Well
Manual & Transducer Water Level Dataset

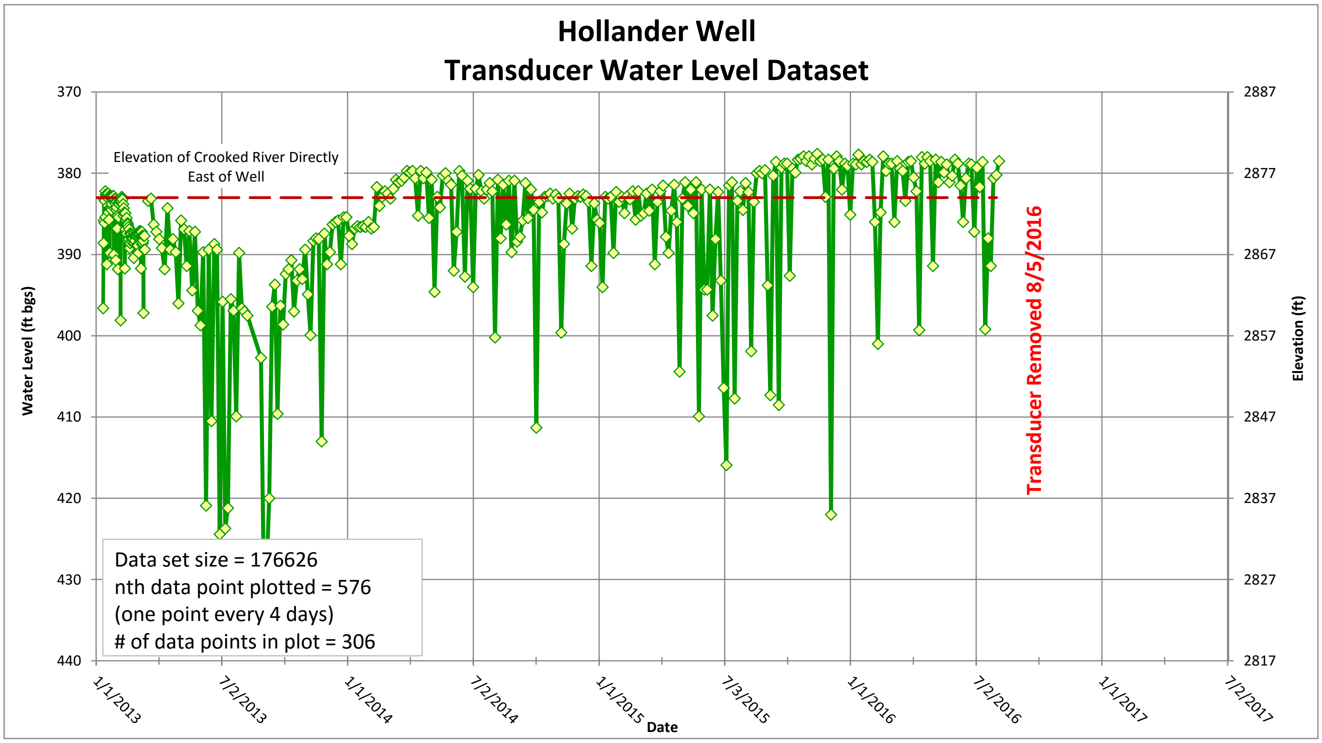
City's Monitoring Prog Well #: **Well #1**
OWRD Well Log # : **CROO 51027**
Location of well (T/R/S QQ): **T15S/R15E/S16 SE-SW**



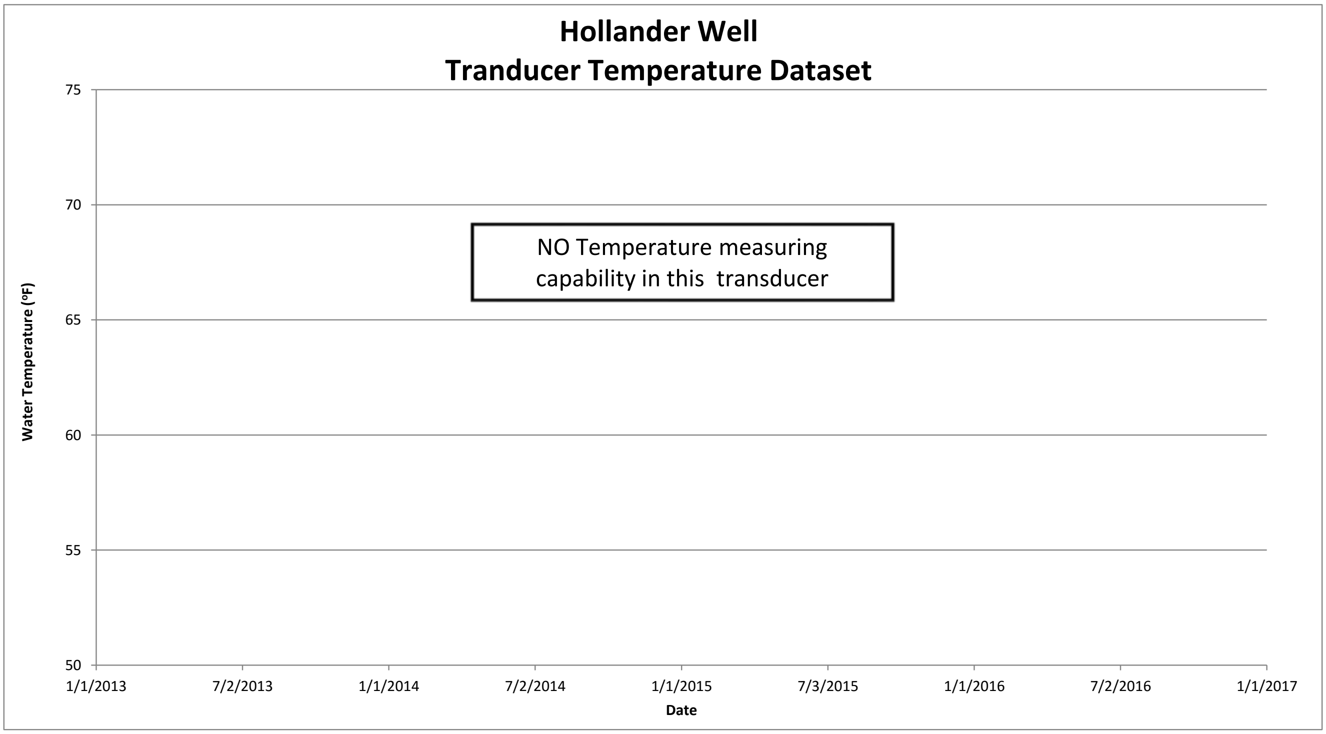


Hollander Well
Transducer Water Level Dataset

City's Monitoring Prog Well #:	**Well # 3**
OWRD Well Log # :	**CROO 50311**
Location of well (T/R/S QQ):	**T15S/R15E/S12 SE-SE**



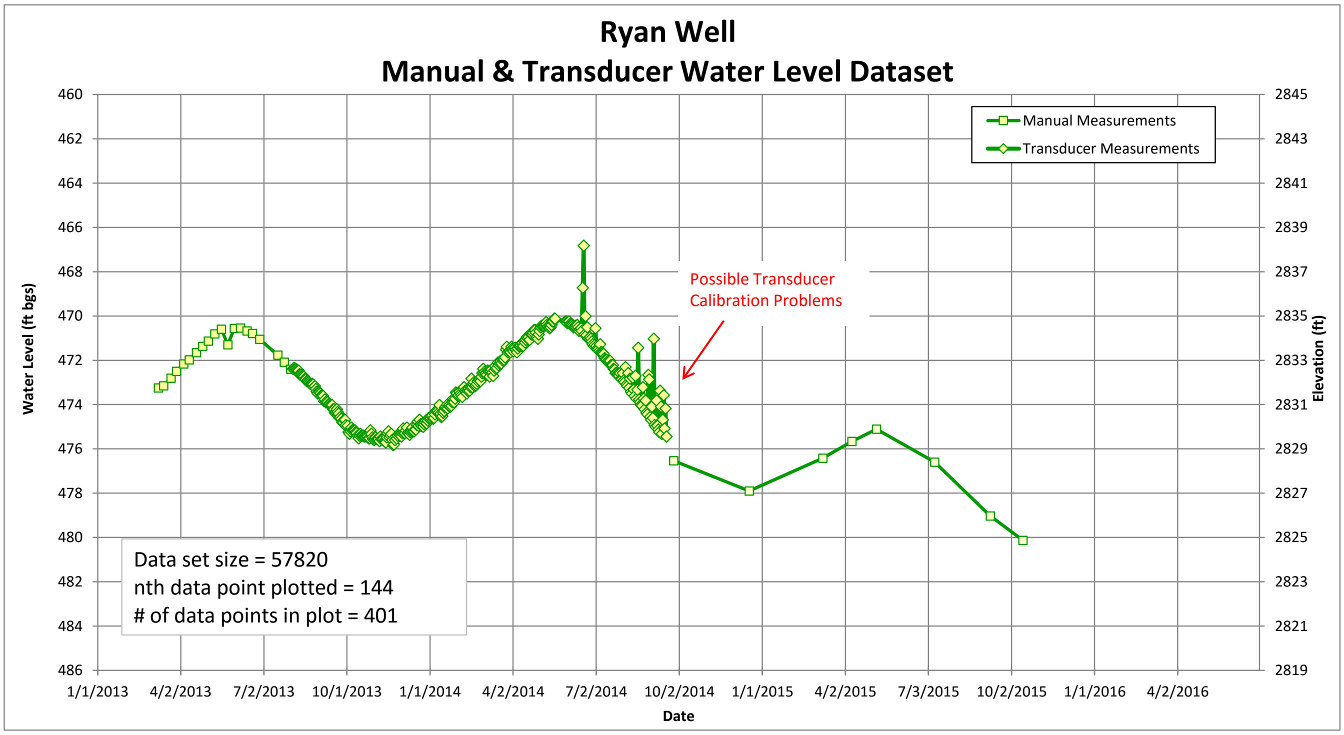
Data set size = 176626
nth data point plotted = 576
(one point every 4 days)
# of data points in plot = 306



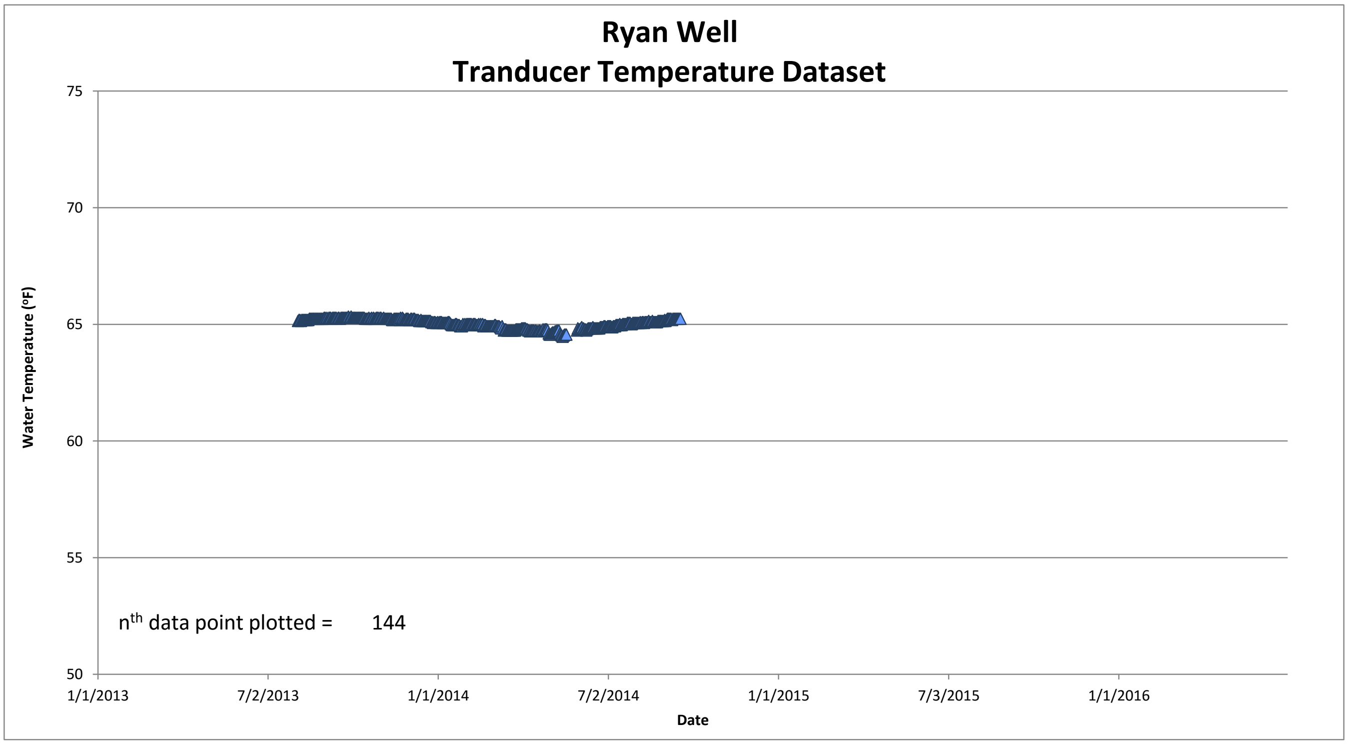
NO Temperature measuring capability in this transducer

Ryan Well
Manual & Transducer Water Level Dataset

City's Monitoring Prog Well #:	**Well #4**
OWRD Well Log # :	**CROO 532**
Location of well (T/R/S QQ):	**T15S/R15E/S15 NE-NE**



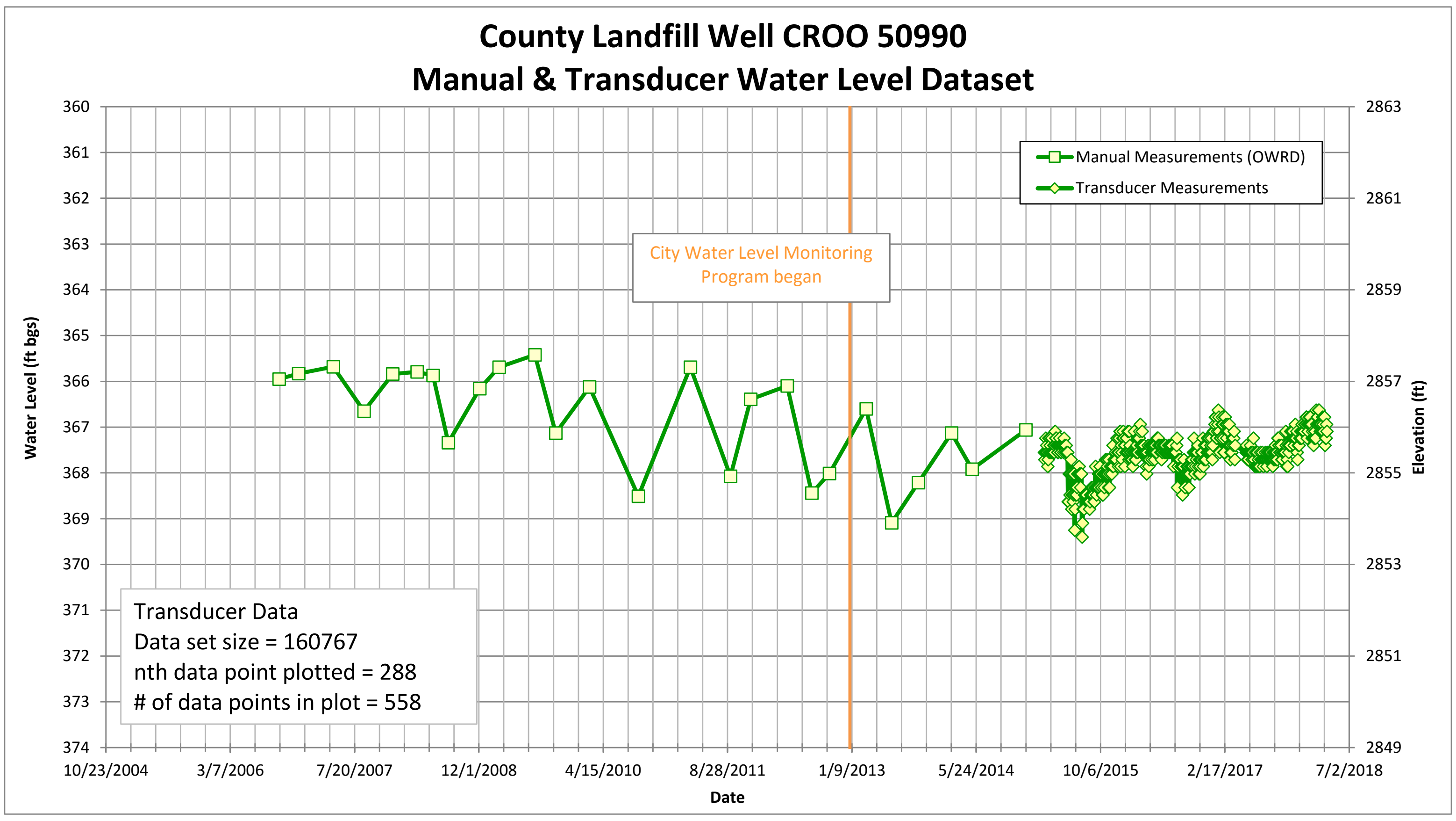
Data set size = 57820
nth data point plotted = 144
# of data points in plot = 401



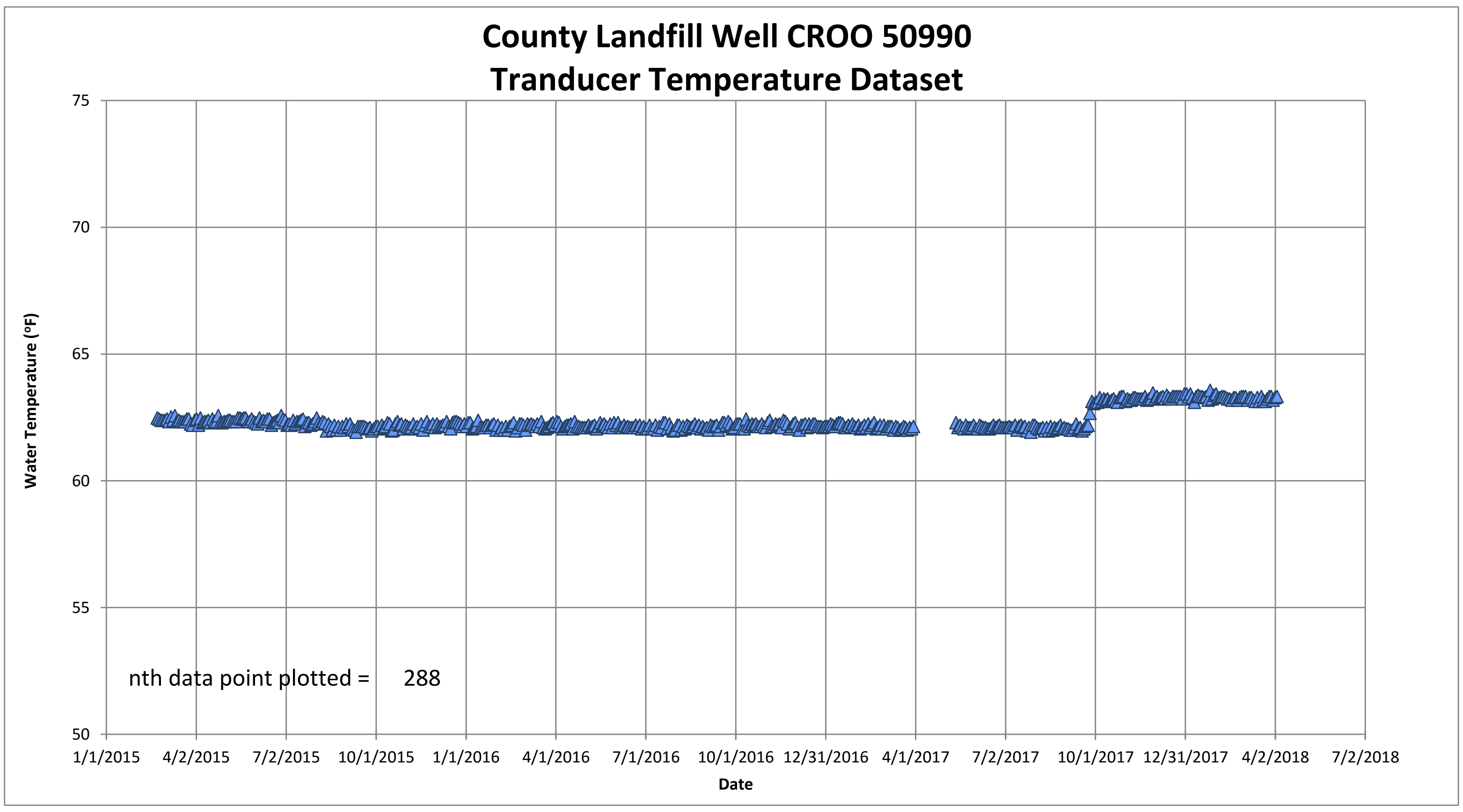
nth data point plotted = 144

County Landfill Well CROO 50990
Manual & Transducer Water Level Dataset

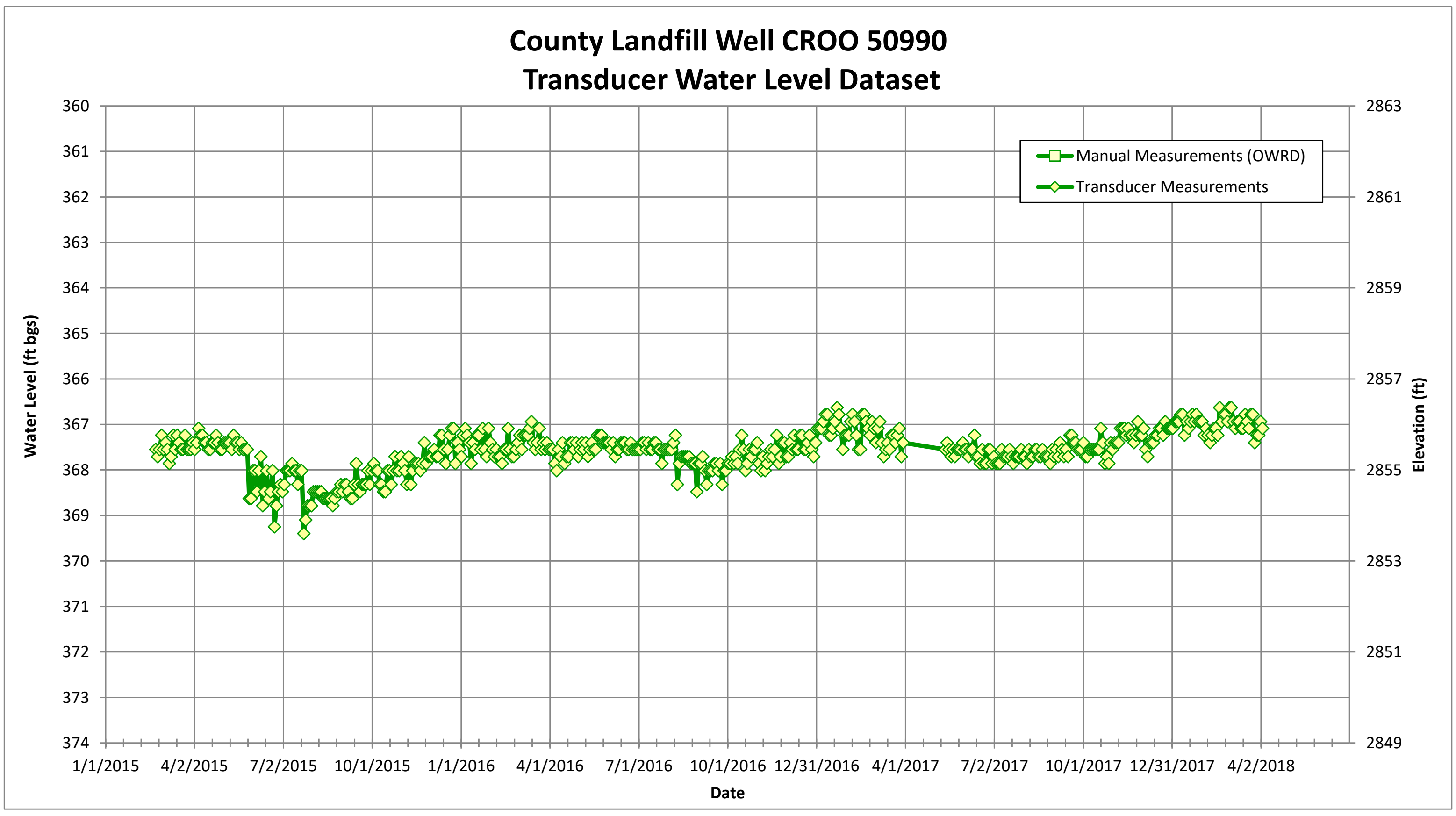
City's Monitoring Prog Well #:	**Well 12**
OWRD Well Log # :	**CROO 50990**
Location of well (T/R/S QQ):	**T15S/R15E/S3 NE-NE**



Transducer Data
Data set size = 160767
nth data point plotted = 288
# of data points in plot = 558

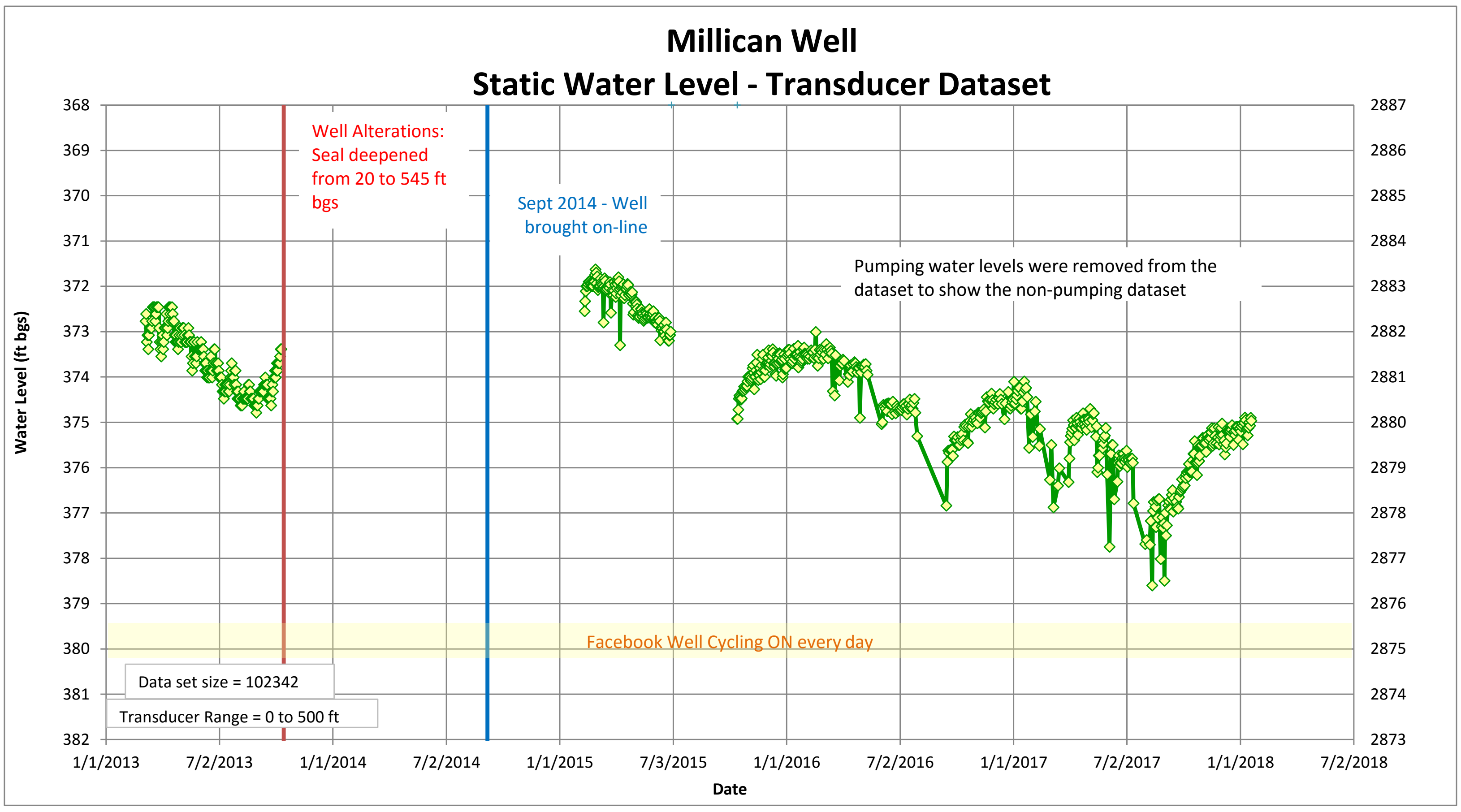


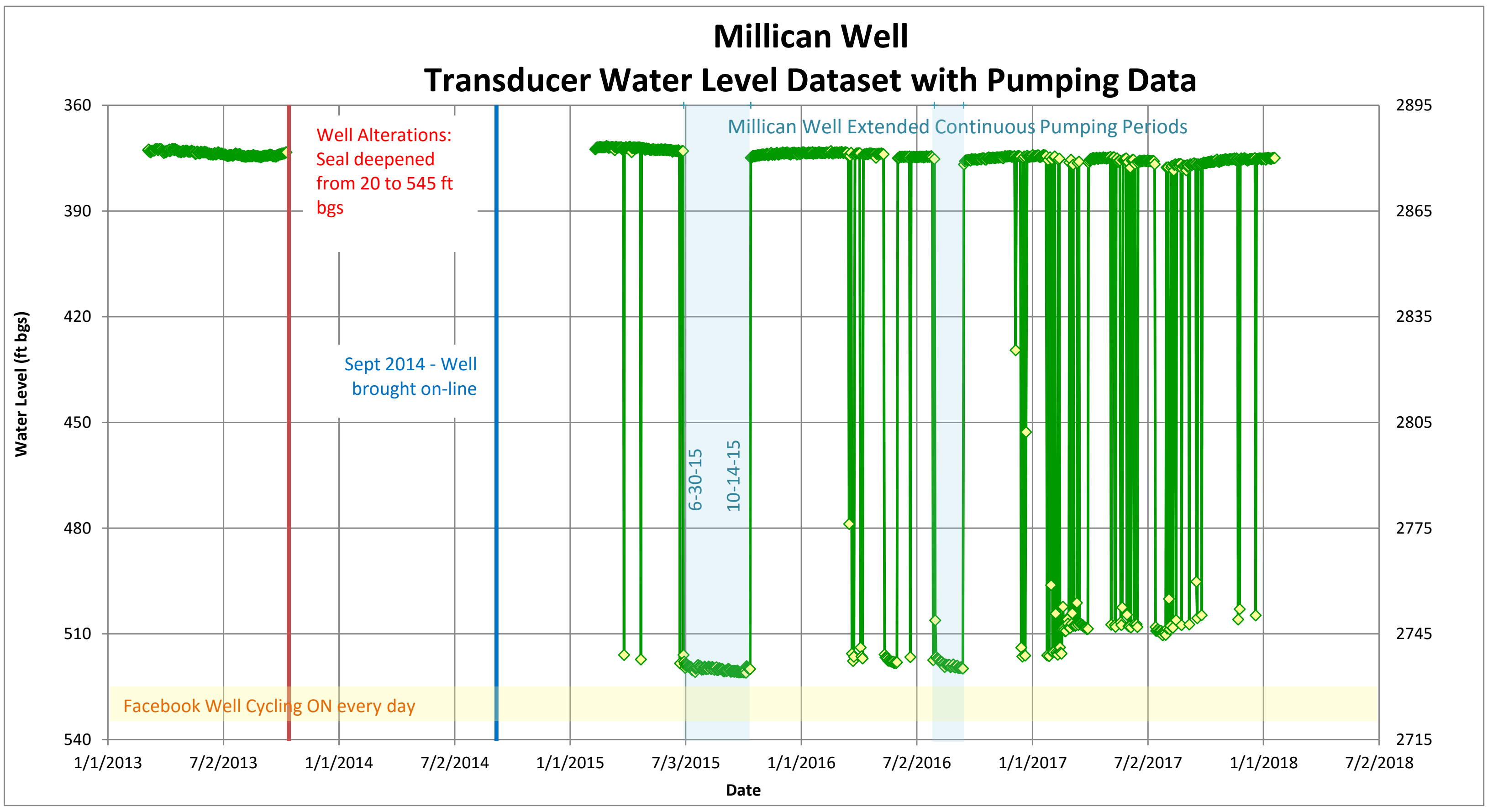
nth data point plotted = 288

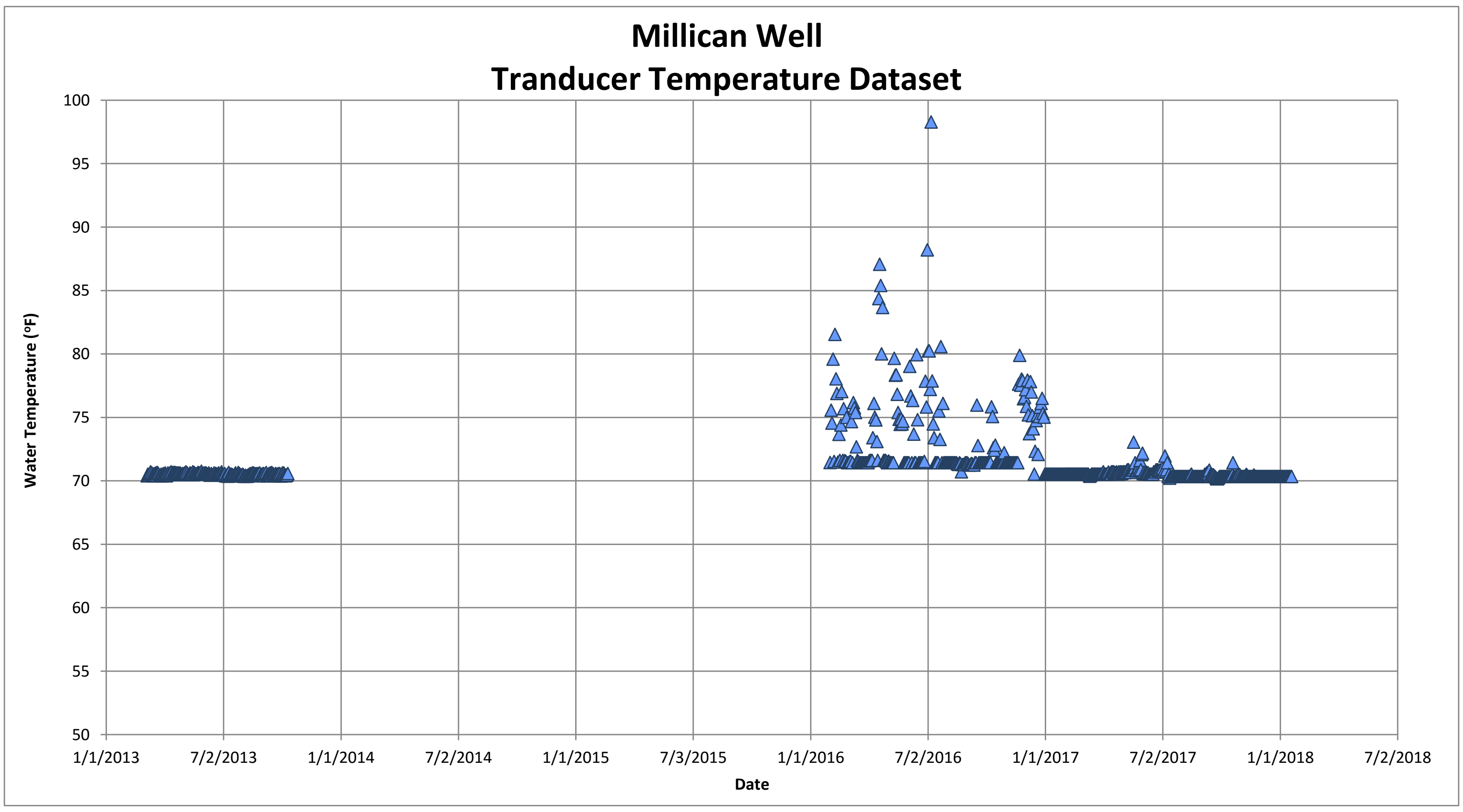


Millican Well
Transducer Water Level Dataset

City's Monitoring Prog Well #:	**Well #6**
OWRD Well Log # :	**CROO 53956**
Location of well (T/R/S QQ):	**T15S/R15E/S11 SW - SE**





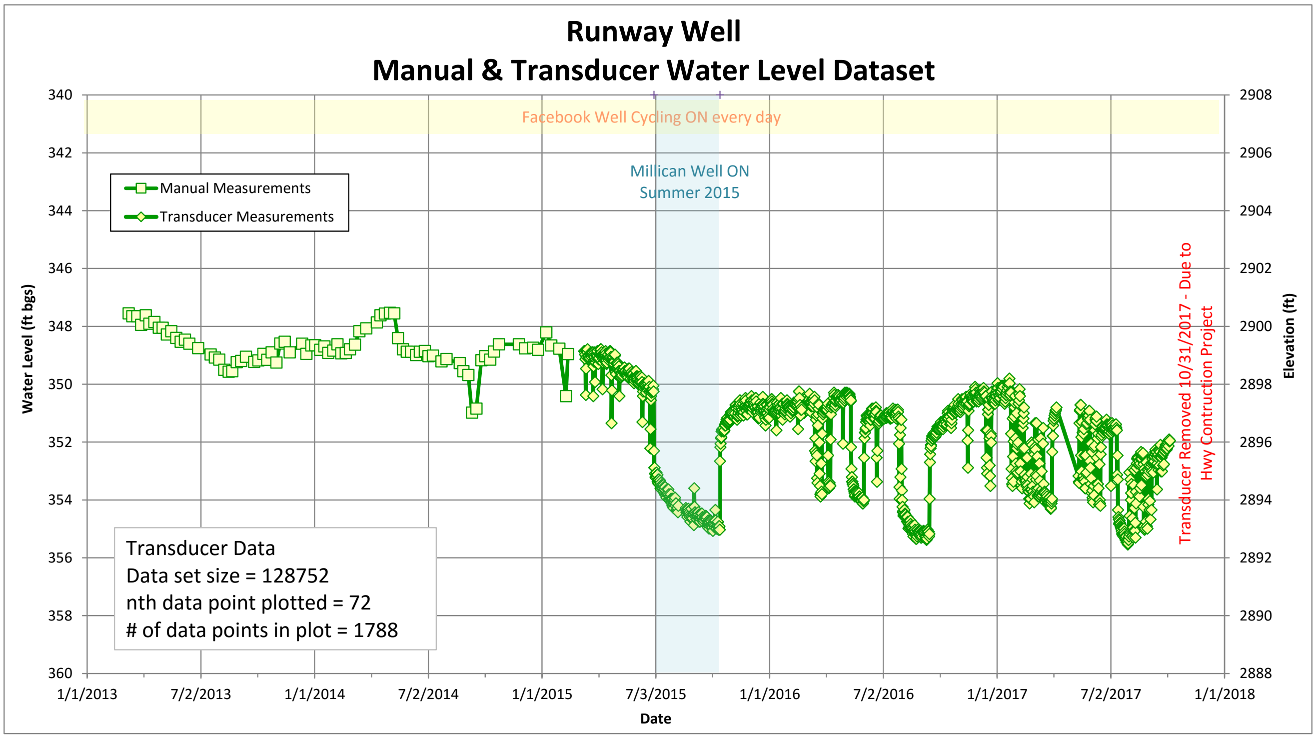


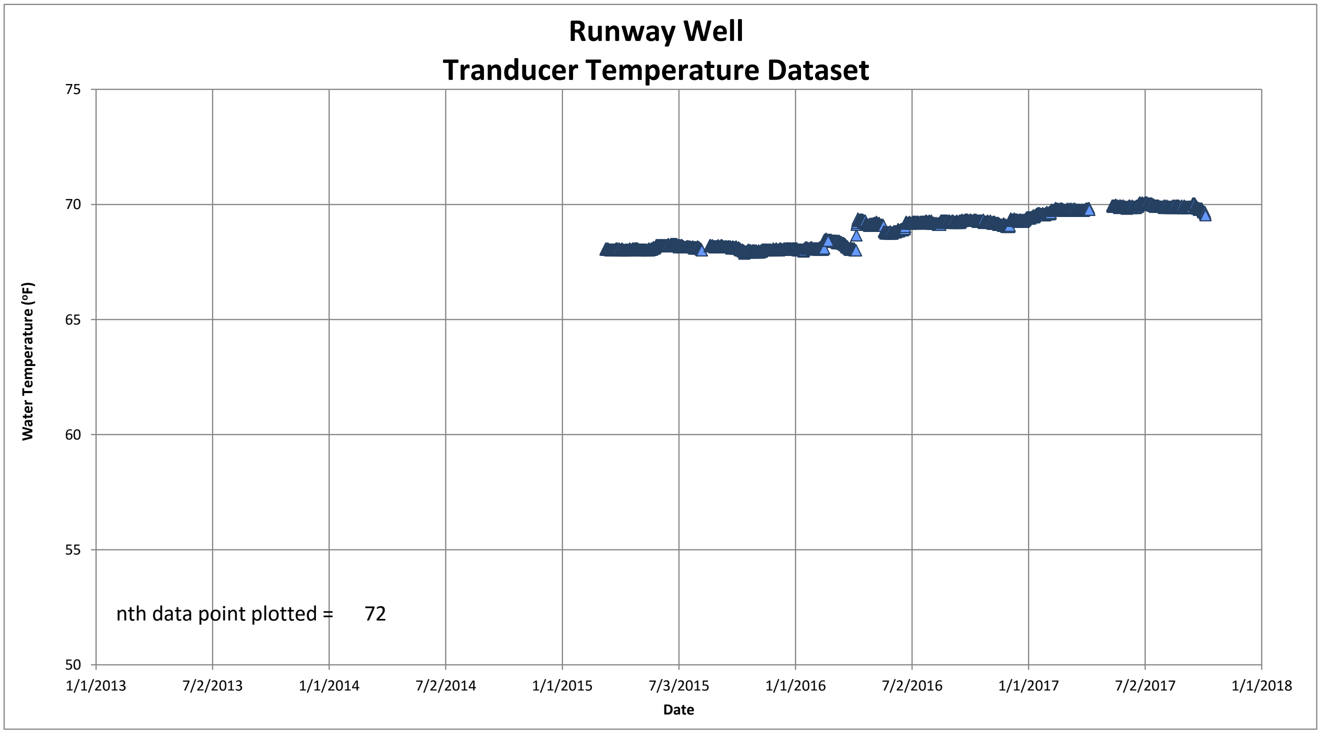
Runway Well
Manual & Transducer Water Level Dataset

City's Monitoring Prog Well #: **Well #7**

OWRD Well Log # : **CROO 53969**

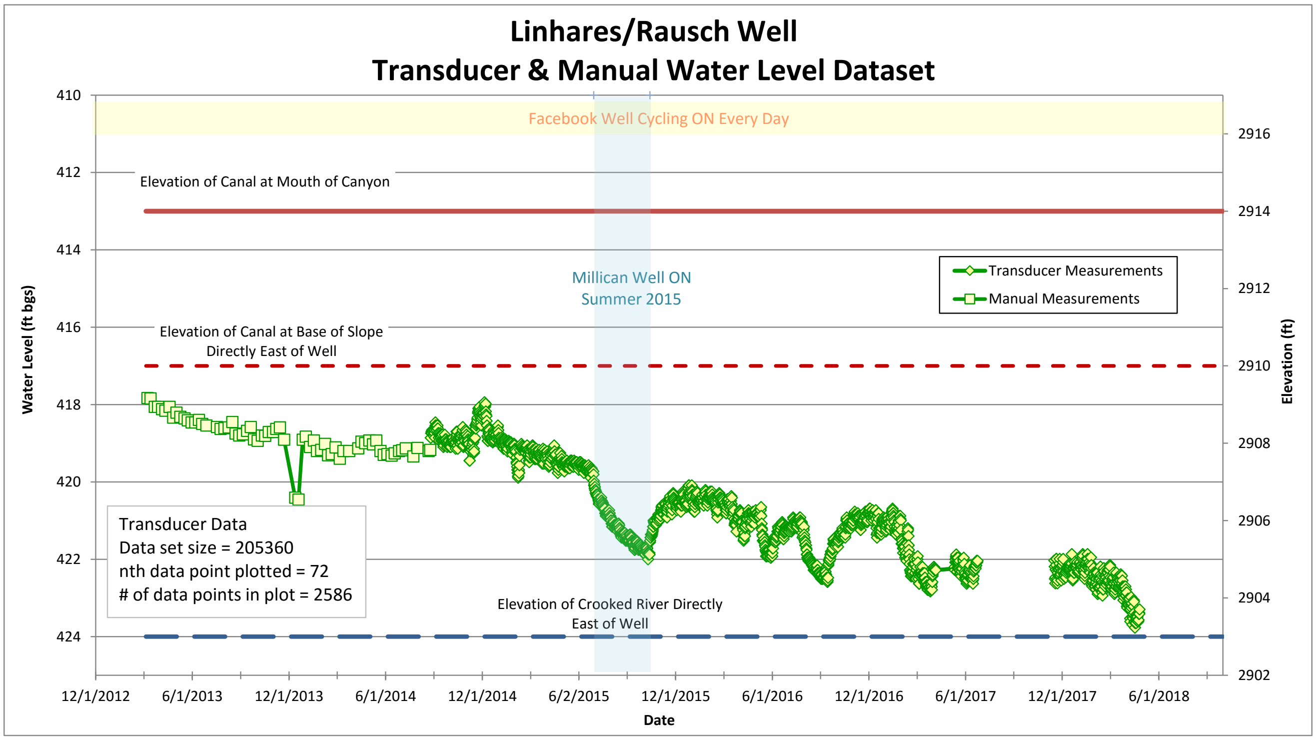
Location of well (T/R/S QQ): **T15S/R15E/S11 SE-NE**

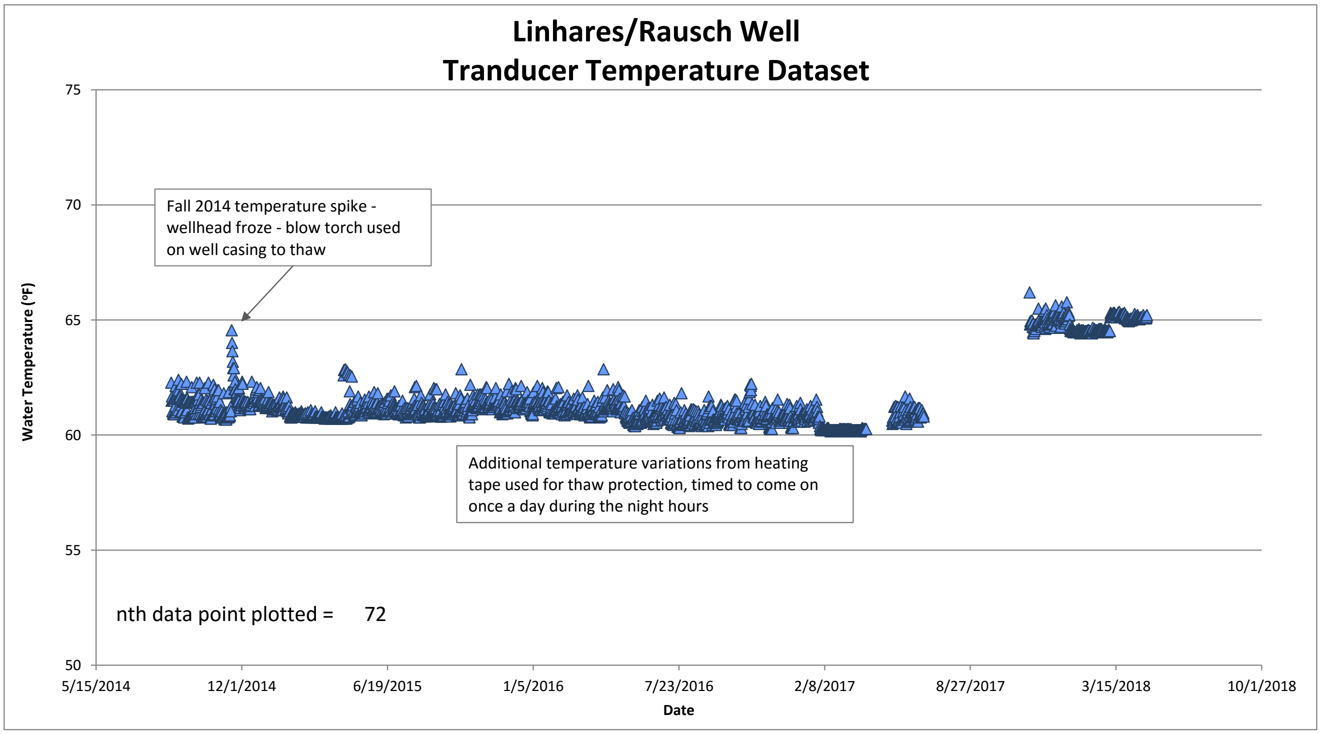




Linhares/Rausch Well
Transducer & Manual Water Level Dataset

City's Monitoring Prog Well #: **Well 2**
OWRD Well Log # : **52461**
Location of well (T/R/S QQ): **T15S/R15E/S26 NE-SE**





APPENDIX D

Existing City Water Rights

City of Prineville ASR Limited License Application

Table 2. Summary of City of Prineville Water Rights - ASR Source Water Supply

City of Prineville ASR Limited License Application & Pilot Testing Work Plan

Well Name	OWRD Well Log ID	Use	Water Rights				Hydrogeologic Unit	Authorized Rate	
			Application	Permit	Certificate	Transfers		(gpm)	(MGD)
Municipal Water Supply System - Prineville Valley Wells									
Lamonta	CROO 1540	MU	G 605	G 506	86337		Valley Floor Confined Aq	346	0.50
Yancey	CROO 50181	MU	U 241	U 215	22839		Valley Floor Confined Aq	359	0.52
Barney	CROO 3132	MU	G 6313	G 9154	83993	~~T9762~~	Valley Floor Confined Aq	700	1.01
Stearns #2	CROO 2083	MU							
Stadium	CROO 184	MU	G 12344	G 11993	87714		Valley Floor Confined Aq	271	0.39
		MU						154	0.22
4th Street Deep	CROO 2121 CROO 2133	MU	U 402	U 372	86889		Valley Floor Confined Aq	337	0.49
Shallow Alluvial Well Field [2]	*CROO 54587* *CROO 54592* *CROO 54593* *up to 21 new wells*	*MU*	*G-18662*	*Pending* *(PFO issued)*			*Valley Floor Unconfined Aq*	*2000*	*2.88*
Ochoco Heights	*new well(s)*	*MU*	*U 147*	*U 140*	*86558*	*T-13030*	*Valley Floor Confined Aq*	*359*	*0.52*
							Total	4,526	6.52

Notes:

(1) City production capacity from valley wells excludes the 4th Street Shallow well because it is only used as an emergency source

(2) Pending water right application for new wellfield, permit expected to be issued in early 2019; total of 24 wells in wellfield

Strikethrough indicates that the transfer changed the water right, and the water right was re-certified.

MU = Municipal Use

OWRD = Oregon Water Resources Department

gpm = gallons per minute

MGD = millions of gallons per day

City Existing Valley Floor Water Rights for ASR Source Water

STATE OF OREGON

COUNTY OF CROOK

CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

CITY OF PRINEVILLE
387 NE THIRD STREET
PRINEVILLE, OR 97754

confirms the right to use the waters of LaMONTA WELL in the OCHOCO CREEK BASIN for MUNICIPAL USES.

This right was perfected under Permit G-506. The date of priority is APRIL 5, 1957. The amount of water to which this right is entitled is limited to an amount actually used beneficially, and shall not exceed 0.77 CUBIC FOOT PER SECOND or its equivalent in case of rotation, measured at the well.

The well is located as follows:

Twp	Rng	Mer	Sec	Q-Q	Measured Distances
14 S	16 E	WM	31	NW NW	SOUTH 58 DEGREES 13 MINUTES EAST, 1447 FEET FROM NW CORNER OF SECTION 31

The use shall conform to such reasonable rotation system as may be ordered by the proper state officer.

A description of the place of use to which this right is appurtenant is as follows:

MUNICIPAL USES					
Twp	Rng	Mer	Sec	Q-Q	GLot
14 S	16 E	WM	31	NE SE	
14 S	16 E	WM	31	NW SE	
14 S	16 E	WM	31	SW SE	
14 S	16 E	WM	31	SE SE	
14 S	16 E	WM	32	NE SW	
14 S	16 E	WM	32	NW SW	
14 S	16 E	WM	32	SW SW	
14 S	16 E	WM	32	SE SW	
15 S	16 E	WM	5	NW NE	2
15 S	16 E	WM	5	SW NE	
15 S	16 E	WM	5	NE NW	3
15 S	16 E	WM	5	NW NW	4
15 S	16 E	WM	6	NE NE	1
15 S	16 E	WM	6	NW NE	2
15 S	16 E	WM	6	SE NE	

This certificate describes that portion of the water right confirmed by Certificate 29097, State Record of Water Right Certificates, NOT modified by the provisions of an order of the Water Resources Director entered JUN 0 7 2010, approving Transfer Application T-11026.

The issuance of this superseding certificate does not confirm the status of the water right in regard to the provisions of ORS 540.610 pertaining to forfeiture or abandonment.

The right to the use of the water for the above purpose is restricted to beneficial use on the lands or place of use described.

WITNESS the signature of the Water Resources Director, affixed June 7, 2010.

Dwight French

Phillip C. Ward, Director

STATE OF OREGON

COUNTY OF CROOK

CERTIFICATE OF WATER RIGHT

This Is to Certify, *That* PACIFIC POWER & LIGHT CO.

of Public Service Bldg., Portland 4 *, State of* Oregon *, has made proof to the satisfaction of the STATE ENGINEER of Oregon, of a right to the use of the waters of* a well *a tributary of* *for the purpose of* municipal supply *under Permit No.* U-215 *of the State Engineer, and that said right to the use of said waters has been perfected in accordance with the laws of Oregon; that the priority of the right hereby confirmed dates from* June 17, 1947 ;

that the amount of water to which such right is entitled and hereby confirmed, for the purposes aforesaid, is limited to an amount actually beneficially used for said purposes, and shall not exceed 0.8 cubic foot per second

or its equivalent in case of rotation, measured at the point of diversion from the stream. The point of diversion is located in the SW¼SE¼, Section 31, Township 14 South, Range 16 East, W. M.

The amount of water used for irrigation, together with the amount secured under any other right existing for the same lands, shall be limited to - - - - - - - - *of one cubic foot per second per acre,*

and shall conform to such reasonable rotation system as may be ordered by the proper state officer.

A description of the place of use under the right hereby confirmed, and to which such right is appurtenant, is as follows:

SW¼SE¼
NW¼SE¼
NE¼SE¼
SE¼SE¼
Section 31
SW¼SW¼
NW¼SW¼
NE¼SW¼
SE¼SW¼
Section 32
Township 14 South, Range 16 East, W. M.

SW¼NW¼
NW¼NW¼
NE¼NW¼
SE¼NW¼
SW¼NE¼
NW¼NE¼
Section 5
NW¼NE¼
NE¼NE¼
SE¼NE¼
Section 6
Township 15 South, Range 16 East, W. M.

The right to the use of the water for the purposes aforesaid is restricted to the lands or place of use herein described.

WITNESS the signature of the State Engineer, affixed

this 12th *day of* July *,* 57 .

LEWIS A. STANLEY

State Engineer

Recorded in State Record of Water Right Certificates, Volume 16 *, page* 22839.

STATE OF OREGON

COUNTY OF CROOK

CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

CITY OF PRINEVILLE
387 NE 3RD STREET
PRINEVILLE, OREGON, 97754

confirms the right to use of the waters of STEARNS WELL #2 and BARNEY WELL in the OCHOCO CREEK BASIN for MUNICIPAL USE.

The right has been perfected under Permit G-9154. The date of priority is OCTOBER 5, 1973. The right is limited to 1.56 CUBIC FEET PER SECOND (CFS), IN ANY COMBINATION FROM THE TWO WELLS, AND IS FURTHER LIMITED TO A MAXIMUM OF 1.02 CFS FROM STEARNS WELL #2 OR 1.02 CFS FROM BARNEY WELL, or its equivalent in case of rotation, measured at the well(s).

The wells are located as follows:

ORIGINAL WELL

STEARNS WELL #2: SW ¼ NE ¼, SECTION 4, T15S, R16E, W.M.; 1810.2 FEET SOUTH & 1151.5 FEET EAST FROM N 1/4 CORNER OF SECTION 4.

ADDITIONAL WELL

BARNEY WELL: NE ¼ NE ¼, SECTION 4, T15S, R16E, W.M.; 1315 FEET SOUTH & 1370 FEET EAST FROM N 1/4 CORNER OF SECTION 4.

The right shall conform to such reasonable rotation system as may be ordered by the proper state officer.

This is a final order in other than a contested case. This order is subject to judicial review under ORS 183.484. Any petition for judicial review must be filed within the 60 day time period specified by ORS 183.484(2). Pursuant to ORS 536.075 and OAR 137-004-0080 you may either petition for judicial review or petition the Director for reconsideration of this order. A petition for reconsideration may be granted or denied by the Director, and if no action is taken within 60 days following the date the petition was filed, the petition shall be deemed denied.

T-9762.RA

Certificate Number 83993

A description of the place of use under the right, and to which such right is appurtenant, is as follows:

1/4 1/4	SECTION	TOWNSHIP	RANGE, W.M.
SW NE	31	14 S	16 E
NE NW	31	14 S	16 E
NW NW	31	14 S	16 E
SE NW	31	14 S	16 E
SE SW	31	14 S	16 E
NE SE	31	14 S	16 E
NW SE	31	14 S	16 E
SW SE	31	14 S	16 E
SE SE	31	14 S	16 E
SW NW	32	14 S	16 E
NE SW	32	14 S	16 E
NW SW	32	14 S	16 E
SW SW	32	14 S	16 E
SE SW	32	14 S	16 E
NW SE	32	14 S	16 E
SW SE	32	14 S	16 E
NW NW	3	15 S	16 E
NW NE	4	15 S	16 E
SW NE	4	15 S	16 E
NE NW	4	15 S	16 E
NW NW	4	15 S	16 E
SW NW	4	15 S	16 E
NE NE	5	15 S	16 E
NW NE	5	15 S	16 E
SW NE	5	15 S	16 E
SE NE	5	15 S	16 E
NE NW	5	15 S	16 E
NW NW	5	15 S	16 E
SW NW	5	15 S	16 E
SE NW	5	15 S	16 E
NE SW	5	15 S	16 E
NW SW	5	15 S	16 E
NW SE	5	15 S	16 E
NE NE	6	15 S	16 E
NW NE	6	15 S	16 E
SE NE	6	15 S	16 E
NE NW	6	15 S	16 E
SE NW	6	15 S	16 E
NE SE	6	15 S	16 E

The water user shall maintain the meter or measuring device in good working order.

This certificate is issued to confirm an ADDITIONAL POINT OF APPROPRIATION approved by an order of the Water Resources Director entered NOVEMBER 22, 2004, and supersedes Certificate 57443, State Record of Water Right Certificates.

The quantity of water diverted at the additional point of appropriation, together with that diverted at the original point of appropriation, shall not exceed the quantity of water lawfully available at the original point of appropriation.

Water shall be acquired from the same aquifer (water source) as the original point of appropriation.

Water may be applied to lands which are not specifically described above, provided the holder of this right complies with ORS 540.510(3).

Issued MAR 21 2008

Dwight French for

Phillip C. Ward, Director
Water Resources Department

1859

Recorded in State Record of Water Right Certificates numbered 83993.

T-9762.RA

STATE OF OREGON

COUNTY OF CROOK

CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

CITY OF PRINEVILLE
387 NE THIRD ST
PRINEVILLE, OR 97754

confirms the right to use the waters of STADIUM WELL in the Ochoco Creek Basin for MUNICIPAL USE.

This right was perfected under Permit G-11993. The date of priority is DECEMBER 14, 1990. The amount of water to which this right is entitled is limited to an amount actually used beneficially, and shall not exceed 0.604 CUBIC FOOT PER SECOND or its equivalent in case of rotation, measured at the well.

The well is located as follows:

Twp	Rng	Mer	Sec	Q-Q	Measured Distances
15 S	16 E	WM	5	NE SE	2122 FEET NORTH & 461 FEET WEST FROM SE CORNER, SECTION 5

The period of allowed use is year round.

A description of the place of use is as follows:

Twp	Rng	Mer	Sec	Q-Q
14 S	16 E	WM	31	NE NE
14 S	16 E	WM	31	NW NE
14 S	16 E	WM	31	SW NE
14 S	16 E	WM	31	SE NE
14 S	16 E	WM	31	NE NW
14 S	16 E	WM	31	NW NW
14 S	16 E	WM	31	SW NW
14 S	16 E	WM	31	SE NW
14 S	16 E	WM	31	NE SW
14 S	16 E	WM	31	NW SW
14 S	16 E	WM	31	SW SW
14 S	16 E	WM	31	SE SW
14 S	16 E	WM	31	NE SE
14 S	16 E	WM	31	NW SE

NOTICE OF RIGHT TO PETITION FOR RECONSIDERATION OR JUDICIAL REVIEW

This is an order in other than a contested case. This order is subject to judicial review under ORS 183.484 and ORS 536.075. Any petition for judicial review must be filed within the 60 day time period specified by ORS 183.484(2). Pursuant to ORS 183.484, ORS 536.075 and OAR 137-004-0080, you may petition for judicial review and petition the Director for reconsideration of this order. A petition for reconsideration may be granted or denied by the Director, and if no action is taken within 60 days following the date the petition was filed, the petition shall be deemed denied. In addition, under ORS 537.260 any person with an application, permit or water right certificate subsequent in priority may jointly or severally contest the issuance of the certificate within three months after issuance of the certificate.

Twp	Rng	Mer	Sec	Q-Q
14 S	16 E	WM	31	SW SE
14 S	16 E	WM	31	SE SE
14 S	16 E	WM	32	NE NE
14 S	16 E	WM	32	NW NE
14 S	16 E	WM	32	SW NE
14 S	16 E	WM	32	SE NE
14 S	16 E	WM	32	NE NW
14 S	16 E	WM	32	NW NW
14 S	16 E	WM	32	SW NW
14 S	16 E	WM	32	SE NW
14 S	16 E	WM	32	NE SW
14 S	16 E	WM	32	NW SW
14 S	16 E	WM	32	SW SW
14 S	16 E	WM	32	SE SW
14 S	16 E	WM	32	NE SE
14 S	16 E	WM	32	NW SE
14 S	16 E	WM	32	SW SE
14 S	16 E	WM	32	SE SE
14 S	16 E	WM	33	NE NE
14 S	16 E	WM	33	NW NE
14 S	16 E	WM	33	SW NE
14 S	16 E	WM	33	SE NE
14 S	16 E	WM	33	NE NW
14 S	16 E	WM	33	NW NW
14 S	16 E	WM	33	SW NW
14 S	16 E	WM	33	SE NW
14 S	16 E	WM	33	NE SW
14 S	16 E	WM	33	NW SW
14 S	16 E	WM	33	SW SW
14 S	16 E	WM	33	SE SW
14 S	16 E	WM	33	NE SE
14 S	16 E	WM	33	NW SE
14 S	16 E	WM	33	SW SE
14 S	16 E	WM	33	SE SE
15 S	16 E	WM	4	NE NE
15 S	16 E	WM	4	NW NE
15 S	16 E	WM	4	SW NE
15 S	16 E	WM	4	SE NE
15 S	16 E	WM	4	NE NW
15 S	16 E	WM	4	NW NW
15 S	16 E	WM	4	SW NW
15 S	16 E	WM	4	SE NW
15 S	16 E	WM	4	NE SW
15 S	16 E	WM	4	NW SW
15 S	16 E	WM	4	SW SW
15 S	16 E	WM	4	SE SW
15 S	16 E	WM	4	NE SE
15 S	16 E	WM	4	NW SE
15 S	16 E	WM	4	SW SE
15 S	16 E	WM	4	SE SE
15 S	16 E	WM	5	NE NE

Twp	Rng	Mer	Sec	Q-Q
15 S	16 E	WM	5	NW NE
15 S	16 E	WM	5	SW NE
15 S	16 E	WM	5	SE NE
15 S	16 E	WM	5	NE NW
15 S	16 E	WM	5	NW NW
15 S	16 E	WM	5	SW NW
15 S	16 E	WM	5	SE NW
15 S	16 E	WM	5	NE SW
15 S	16 E	WM	5	NW SW
15 S	16 E	WM	5	SW SW
15 S	16 E	WM	5	SE SW
15 S	16 E	WM	5	NE SE
15 S	16 E	WM	5	NW SE
15 S	16 E	WM	5	SW SE
15 S	16 E	WM	5	SE SE
15 S	16 E	WM	6	NE NE
15 S	16 E	WM	6	NW NE
15 S	16 E	WM	6	SW NE
15 S	16 E	WM	6	SE NE
15 S	16 E	WM	6	NE NW
15 S	16 E	WM	6	NW NW
15 S	16 E	WM	6	SW NW
15 S	16 E	WM	6	SE NW
15 S	16 E	WM	6	NE SW
15 S	16 E	WM	6	NW SW
15 S	16 E	WM	6	SW SW
15 S	16 E	WM	6	SE SW
15 S	16 E	WM	6	NE SE
15 S	16 E	WM	6	NW SE
15 S	16 E	WM	6	SW SE
15 S	16 E	WM	6	SE SE

The well shall be maintained in accordance with the General Standards for the Construction and Maintenance of Water Wells in Oregon. The works shall be equipped with a usable access port, and may also include an air line and pressure gauge adequate to determine water level elevation at all times.

The Director may require water level or pump test results every ten years.

If substantial interference with a senior water right occurs due to withdrawal of water from any well listed on this right, then use of water from the well(s) shall be discontinued or reduced and/or the schedule of withdrawal shall be regulated until or unless the Department approves or implements an alternative administrative action to mitigate the interference. The Department encourages junior and senior appropriators to jointly develop plans to mitigate interferences.

Failure to comply with any of the provisions of this right may result in action including, but not limited to, restrictions on the use, civil penalties, or cancellation of the right.

This right is for the beneficial use of water without waste. The water user is advised that new regulations may require the use of best practical technologies or conservation practices to achieve this end.

By law, the land use associated with this water use must be in compliance with statewide land-use goals and any local acknowledged land-use plan.

The right to the use of the water for the above purpose is restricted to beneficial use on the lands or place of use described; however, water may be applied to lands which are not specifically described above, provided the holder of this right complies with ORS 540.510(3).

This certificate is issued for a partial perfection of Permit G-11993 as described in OAR 690-320-0040 and by an order of the Water Resources Director entered AUG 03 2012, at Volume 88, Page 247.

The use of water shall be limited when it interferes with any prior surface or ground water rights.

Issued AUG 03 2012.

Dwight W. French
Water Right Services Administrator, for
Phillip C. Ward, Director
Water Resources Department

BEFORE THE WATER RESOURCES DIRECTOR OF OREGON

CROOK COUNTY

IN THE MATTER OF PARTIAL PERFECTION OF)
WATER RIGHT PERMIT G-11993 IN THE NAME)
OF THE CITY OF PRINEVILLE)

ORDER

STATEMENT

On April 24, 2012, The Water Resources Department received a request from the City of Prineville to partially perfect the use of water under water right permit G-11993.

FINDINGS OF FACT

Permit G-11993 allows for the use of 0.947 cubic foot per second (CFS) from a well in the Ochoco Creek Basin for municipal use.

The City has requested partial perfection of permit G-11993 and issuance of a water right certificate. The request was accompanied by the survey required under ORS 537.230(4). The survey shows, to the satisfaction of the Director, that the appropriation has been partially perfected in accordance with the provision of the Water Rights Act.

ORS 537.260 allows, without loss of priority or cancellation to the permit, the incremental perfection of the water right permit in an amount of not less than 25 percent, pursuant to ORS 537.260 and OAR 690-320-0040.

The Department finds that the City has perfected 0.604 cfs. The quantity of water is equal or greater than the 25 percent of the original quantity of water allowed under permit G-11993.

OAR 690-320-0040(5) allows municipal suppliers that incrementally perfect less than the full quantity of water to request further extension of time to complete construction and apply water to beneficial use for the remaining, unperfected quantity of water.

NOTICE OF RIGHT TO PETITION FOR JUDICIAL REVIEW OR RECONSIDERATION

This is a final order in other than contested case. This order is subject to judicial review under ORS 183.482. Any petition for judicial review must be filed within the 60 day time period specified by ORS 183.482 and ORS 536.075. Pursuant to ORS 183.482, ORS 536.075 and OAR 137-003-0675, you may petition for judicial review and petition the Director for reconsideration of this order. A petition for reconsideration may be granted or denied by the Director, and if no action is taken within 60 days following the date the petition was filed, the petition shall be deemed denied.

As of the date of this order, the City has submitted an application for water right extension of time for quasi-municipal and municipal water use permit to completely apply water to beneficial use under Permit G-11993.

ULTIMATE FINDING OF FACT

The City is now entitled to a certificate in the amount of 0.604 cfs. The Director has determined the permittee has complied with the requirements to partially perfect permit G-11993 pursuant to ORS 537.250 and 537.260.

ORDER

The Department finds that there is 0.343 cfs remaining to be perfected and that a certificate in the amount of 0.604 cfs be issued to the City of Prineville.

Dated AUG 03 2012

Dwight W. French
Water Right Services Administrator, for
Phillip C. Ward, Director
Water Resources Department

STATE OF OREGON

COUNTY OF CROOK

PERMIT TO APPROPRIATE THE PUBLIC WATERS

THIS PERMIT IS HEREBY ISSUED TO

CITY OF PRINEVILLE
400 EAST THIRD ST 503-447-5627
PRINEVILLE, OREGON 97754

to use the waters of A WELL in the OCHOCO CREEK BASIN for MUNICIPAL USE.

This permit is issued approving Application G-12344. The date of priority is DECEMBER 14, 1990. The use is limited to not more than 0.947 cubic foot per second, or its equivalent in case of rotation, measured at the well.

The well is located as follows:

NE 1/4 SE 1/4 SECTION 5, T 15 S, R 16 E, W.M.; 2122 FEET NORTH AND 461 FEET WEST FROM THE SE CORNER OF SECTION 5..

The use shall conform to such reasonable rotation system as may be ordered by the proper state officer.

The period of allowed use is year round.

A description of the proposed place of use under this permit is within the service area of the City of Prineville, more explicitly described, but not limited to:

Sections 31, 32 and 33
Township 14 South, Range 16 East, WM

Sections 4, 5 and 6
Township 15 South, Range 16 East, WM

The well shall be constructed in accordance with the General Standards for the Construction and Maintenance of Water Wells in Oregon. The works shall be equipped with a usable access port, and may also include an air line and pressure gauge adequate to determine water level elevation in the well at all times.

Within one year of permit issuance, the City shall submit a conservation management plan consistent with Oregon Administrative Rule 690-86.

Prior to receiving a certificate of water right, the permit holder shall submit the results of a pump test meeting the department's standards, to the Water Resources Department. The Director may require water level or pump test results every ten years thereafter.

If substantial interference with a senior water right occurs due to withdrawal of water from any well listed on this permit, then use of water from the well(s) shall be discontinued or reduced and/or the schedule of withdrawal shall be regulated until or unless the Department approves or implements an alternative administrative action to mitigate the interference. The Department encourages junior and senior appropriators to jointly develop plans to mitigate interferences.

Actual construction work shall begin on or before April 24 , 1996, and shall be completed on or before October 1, 1997. Complete application of the water shall be made on or before October 1, 1998.

Failure to comply with any of the provisions of this permit may result in action including, but not limited to, restrictions on the use, civil penalties, or cancellation of the permit.

This permit is for beneficial use of water without waste. The water user is advised that new regulations may require use of best practical technologies or conservation practices to achieve this end.

By law, the land use associated with this water use must be in compliance with statewide land-use goals and any local acknowledged land-use plan.

The use of water shall be limited when it interferes with any prior surface or ground water rights.

The Director finds that the proposed use(s) of water described by this permit, as conditioned, would not impair or be detrimental to the public interest.

Issued this date April 24, 1995.

/s/ MARTHA O. PAGEL

Water Resources Department
Martha O. Pagel
Director

STATE OF OREGON
COUNTY OF CROOK
CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

CITY OF PRINEVILLE
387 NE THIRD STREET
PRINEVILLE, OREGON 97754

confirms the right to use the waters of a WELL, for MUNICIPAL USE.

This right was perfected under Permit U-372. The date of priority is DECEMBER 8, 1950. The amount of water to which this right is entitled is limited to an amount actually used beneficially, and shall not exceed 0.75 CUBIC FOOT PER SECOND, or its equivalent in case of rotation, measured at the point of diversion.

The point of appropriation is located as follows:

TWP	RNG	MER	SEC	Q - Q	MEASURED DISTAMCES
15 S	16 E	WM	5	SW NW	375 FEET NORTH AND 370 FEET EAST FROM W ¼ CORNER OF SECTION 5

A description of the place of use to which this right is appurtenant is as follows:

TWP	RNG	MER	SEC	Q - Q
14 S	16 E	WM	31	NE SE
14 S	16 E	WM	31	NW SE
14 S	16 E	WM	31	SW SE
14 S	16 E	WM	31	SE SE
14 S	16 E	WM	32	NE SW
14 S	16 E	WM	32	NW SW
14 S	16 E	WM	32	SW SW
14 S	16 E	WM	32	SE SW
14 S	16 E	WM	32	NW SE
14 S	16 E	WM	32	SW SE
15 S	16 E	WM	5	NW NE
15 S	16 E	WM	5	SW NE
15 S	16 E	WM	5	NE NW
15 S	16 E	WM	5	NW NW
15 S	16 E	WM	5	SW NW
15 S	16 E	WM	5	SE NW
15 S	16 E	WM	6	NE NE
15 S	16 E	WM	6	NW NE
15 S	16 E	WM	6	SE NE

This certificate describes that portion of the water right confirmed by Certificate 22868, State Record of Water Right Certificates, NOT modified by the provisions of an order of the Water Resources Director entered March 11, 2011, and recorded at Special Order Volume 83, pages 757 to 759, canceling a portion of the water right. This certificate supersedes Certificate 22868.

The issuance of this superseding certificate does not confirm the status of the water right in regard to the provisions of ORS 540.610 pertaining to forfeiture or abandonment.

WITNESS the signature of the Water Resources Director, affixed **MAR 1 1 2011**.

Dwight French

Dwight French for
PHILLIP C. WARD, DIRECTOR

STATE OF OREGON

COUNTY OF CROOK

CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

CITY OF PRINEVILLE
387 NE THIRD STREET
PRINEVILLE, OREGON 97754

confirms the right to use the waters of a WELL (OCHOCO HEIGHTS WELL NO.1), for MUNICIPAL USE.

This right was perfected under Permit U-140. The date of priority is MAY 20, 1942. The amount of water to which this right is entitled is limited to an amount actually used beneficially, and shall not exceed 0.8 CUBIC FOOT PER SECOND, or its equivalent in case of rotation, measured at the point of diversion.

The point of appropriation is located as follows:

TWP	RNG	MER	SEC	Q - Q
14 S	16 E	WM	32	NW SW

A description of the place of use to which this right is appurtenant is as follows:

TWP	RNG	MER	SEC	Q - Q
14 S	16 E	WM	31	SE
14 S	16 E	WM	32	SW
15 S	16 E	WM	5	NW
15 S	16 E	WM	5	NE SW
15 S	16 E	WM	5	NW SW
15 S	16 E	WM	6	NE NE
15 S	16 E	WM	6	NW NE
15 S	16 E	WM	6	SE NE

This certificate describes that portion of the water right confirmed by Certificate 75223, State Record of Water Right Certificates, NOT modified by the provisions of an order of the Water Resources Director entered SEP 14 2010, and recorded at Special Order Volume 81, pages 796 to 798, canceling a portion of the water right. This certificate supersedes Certificate 75223.

The issuance of this superseding certificate does not confirm the status of the water right in regard to the provisions of ORS 540.610 pertaining to forfeiture or abandonment.

WITNESS the signature of the Water Resources Director, affixed Sept. 14, 2010.

for

Phillip C. Ward, Director

Recorded in State Record of Water Right Certificates numbered 86558.

c75223-part cancel-rr.GLN

Oregon Water Resources Department

Water Right Services Division

Water Right Application G-18662 in the)
name of CITY OF PRINEVILLE) PROPOSED FINAL ORDER
)

Summary: The Department proposes to issue an order approving Application G-18662, and a permit consistent with the attached draft permit.

Prior to the issuance of a permit, if it is issued the Department must receive the following:

- **Evidence that mitigation credits have been obtained.**

Please include the application number on any documents submitted.

Authority

The application is being processed in accordance with Oregon Revised Statute (ORS) 537.615 through 537.628, and 390.826, and Oregon Administrative Rule (OAR) Chapter 690, Divisions 5, 8, 9, 33, 300, 310, 400, 410, and Deschutes Basin Program OAR 690-505. OAR 690-505 and 521 describe the process by which groundwater in the Deschutes Basin may be appropriated by mitigating the impact of the proposed use. These statutes and rules can be viewed on the Oregon Water Resources website: http://www.oregon.gov/owrd/pages/law/index.aspx

The Department's main page is http://www.oregon.gov/OWRD/pages/index.aspx

The Department shall presume that a proposed groundwater use will ensure the preservation of the public welfare, safety and health as described in ORS 537.525 if:

a) The proposed use is allowed in the applicable basin program established pursuant to ORS 536.300 and 536.340 or given a preference under ORS 536.310(12);
b) Water is available;
c) The proposed use will not injure other water rights; and
d) The proposed use complies with the rules of the Commission. ORS 537.621(2); OAR 690-310-0150(2)(b)

All four criteria must be met for a proposed use to be presumed to ensure the preservation of the public welfare, safety and health. When the criteria are met and the presumption is established the Department must further evaluate the proposed use, any comments received information available in its files or received from other interested agencies and any other available information to determine whether the presumption is overcome. OAR 690-310-0140

If the Department determines that the presumption is established and not overcome, the Department shall issue a proposed final order recommending issuance of the permit subject to any appropriate modifications or conditions.

FINDINGS OF FACT

Application History

1. On April 25, 2018, City of Prineville filed a complete application for the following water use:
   Amount of Water: 4.46 cubic feet per second (CFS)
   Use of Water: municipal uses
   County: Crook County
   Location: City of Prineville Service Boundary
   Source of Water: Well D1 (CROO 54593), Well S1 (CROO 54587), Well D2 (CROO 4592), Well D3, Well S2, Well D4, Well S3, Well D5, Well S4, Well D6, Well S5, Well D7, Well S6, Well D8, Well S7, Well D9, Well S8, Well D10, Well S9, Well D11, Well S10, Well D12, Well S11, Well D13, and Well S12 in Crooked River Basin.

2. On June 29, 2018, the Department mailed the applicant notice of its Initial Review, determining that "*The appropriation of 4.46 CFS of water, further limited to 3230.0 AF annually, from Well D1 (CROO 54593), Well S1 (CROO 54587), Well D2 (CROO 54592), Well D3, Well S2, Well D4, Well S3, Well D5, Well S4, Well D6, Well S5, Well D7, Well S6, Well D8, Well S7, Well D9, Well S8, Well D10, Well S9, Well D11, Well S10, Well D12, Well S11, Well D13, and Well S12 in Crooked River Basin for municipal uses is not allowable.*" The applicant did not notify the Department to stop processing the application within 14 days of that date. The initial Review included the Notice of Mitigation Obligation for the proposed groundwater use pursuant to the Deschutes Groundwater Mitigation Rules (OAR 690-505)

3. On July 3, 2018, the Department gave public notice of the application in its weekly notice. The public notice included a request for comments, and information for interested persons about obtaining future notices and a copy of the Proposed Final Order. No written comments were received within 30 days.

Presumption Criteria (a) - Consistency with Basin Program

4. The proposed groundwater use is located within the Deschutes Groundwater Study Area, and is subject to the Deschutes Groundwater Mitigation Rules (OAR 690-505-0600 to -0630).

5. The proposed use is allowed under the Deschutes Basin Program (OAR 690-505-0400). ORS 537.621(3)(b); OAR 690-310-0150(2)(b)

6. Pursuant to OAR 690-505-0500(1), there is a 200.00 CFS limit on the amount of new groundwater use that may be allocated within the Deschutes Groundwater Study Area. Any water allocated under this application will not exceed the limit.

7. The mitigation obligation for the proposed use is 1292.0 acre feet (AF), which represents the Department's determination of the consumptive portion of the proposed use. Each mitigation credit is equivalent to 1.0 AF of mitigation water. (OAR 690-505-0610(5)

8. Mitigation shall be provided in the Crooked River Zone of Impact (located anywhere in the Crooked River Basin above river mile 13.8).

Presumption Criteria (b) - Water Availability

9. An assessment of groundwater availability has been completed by the Groundwater/Hydrology section. A copy of this assessment is in the file. The proposed use of groundwater will, if properly conditioned, avoid injury to existing groundwater rights and the groundwater resource. ORS 537.621(3)(c); OAR 690-310-0150(2)(c)

Presumption Criteria (c) - Injury Determination

10. The proposed groundwater use is junior to existing water rights downstream in the Deschutes River Basin. Therefore, the proposed use, if authorized, will not injure other water rights. ORS 537.621(3)(d); OAR 690-310-0150(2)(e)

Presumption Criteria (d) - Whether the use complies with rules of the Commission

11. Documentation has been submitted from the relevant land-use planning jurisdiction that indicates the proposed use is allowed outright. ORS 537.621(3)(b); OAR 690-310-0150(2)(b)

12. The proposed groundwater use is not within a designated critical groundwater area. ORS 537.620(4)(a), 537.621(3)(a); OAR 690-310-0150(2)(a)

13. The proposed use will have the potential for substantial interference with the Deschutes River (OAR 690-009). The Division 9 (Ground Water Interference with Surface Water) review is in the file and can be viewed on the Department's website. ORS 537.621(3)(b); OAR 690-009-0040(4).

14. On August 2, 2018, the Department received the applicant's Response to Notice of Mitigation Obligation Credit or Project Option. The applicant has proposed to obtain 1292.0 mitigation credits within the Crooked River Zone of Impact (located anywhere in the Crooked River Basin above river mile 13.8) from mitigation project MP-222, approved under Permit S-55091.

15. The Department finds that the mitigation proposed by the applicant will satisfy the mitigation required under OAR Chapter 690, Division 505; therefore, pursuant to OAR 690-505-0630, that mitigation effectively eliminates the potential for substantial interference with surface water.

16. The proposed use complies with rules of the Water Resources Commission not otherwise described above.

Determination of Presumption that a proposed groundwater use will ensure the preservation of the public welfare, safety and health

Based on the review of the presumption criteria (a)-(d) above, the presumption has been established. ORS 537.621(2); OAR 690-310-0150(2)(g)

Further evaluation of the proposed use

17. No comments were received by the close of the comment period. OAR 690-310-0140(3)(a).

18. Information available in Department files, received from other interested agencies, and other available information does not provide a preponderance of evidence that the proposed use would not ensure the preservation of the public welfare, safety and health under ORS 537.525. OAR 690-310-0140(3)

Other Criteria and Requirements

19. Pursuant to ORS 390.835(9), the proposed use shall be denied unless mitigation is provided. Without the required mitigation, there is a preponderance of evidence that the proposed use will measurably reduce surface water flows necessary for the Deschutes River Scenic Waterway. The applicant must mitigate for the proposed use.

20. The Department requested comments on the application and proposed mitigation from the Oregon Departments of Fish and Wildlife, Environmental Quality, State Lands, Parks and Recreation, and Department of Agriculture pursuant to the Deschutes Groundwater Mitigation Rules. No issues were raised in the reviews that required further conditioning of the attached draft permit.

21. The applicant has not provided the Department with documentary evidence that the qualifying mitigation credits have been obtained.

22. In order to obtain a permit, documentary evidence of mitigation credits must be submitted to the Department within five years of the issuance of a Final Order approving the proposed groundwater use.

CONCLUSION OF LAW

1. The proposed use would ensure the preservation of the public welfare, safety and health as described in ORS 537.525.

NOTE: When issuing permits, ORS 537.628(1) authorizes the Department to include limitations and conditions which have been determined necessary to protect the public welfare, safety and health. The attached draft permit is conditioned accordingly.

PROPOSED ORDER

The Department recommends approval of Application G-18662, and issuance of a permit consistent with the attached draft permit.

DATED August 28, 2018

Dwight French

Dwight French
Water Right Services Division Administrator, for
Thomas M. Byler, Director
Oregon Water Resources Department

Protests

Under the provisions of ORS 537.153(7) (for surface water) or ORS 537.621(8) (for groundwater), you can protest this Proposed Final Order. Protests must be received in the Water Resources Department no later than **October 12, 2018**. Protests must be in writing, and must include the following:

- Your name, address, and telephone number;

- A description of your interest in the Proposed Final Order, and, if you claim to represent the public interest, a precise statement of the public interest represented;
- A detailed description of how the action proposed in the Proposed Final Order would impair or be detrimental to your interest;
- A detailed description of how the Proposed Final Order is in error or deficient, and how to correct the alleged error or deficiency;
- Any citation of legal authority to support your protest, if known;
- To affect the department's determination that the proposed use in this application will, or will not, ensure the preservation of the public welfare, safety and health as described in ORS 537.525, ORS 537.621(2)(b) requires that a protest demonstrate, by a preponderance of evidence any of the following: (a) One or more of the criteria for establishing the presumption are, or are not, satisfied; or (b) The specific aspect of the public welfare, safety and health under ORS 537.525 that would be impaired or detrimentally affected, and specifically how the identified aspect of the public welfare, safety and health under ORS 537.525 would be impaired or be adversely affected;
- If you are the applicant, the protest fee of $410 required by ORS 536.050; and
- If you are not the applicant, the protest fee of $810 required by ORS 536.050 and proof of service of the protest upon the applicant.
- If you are the applicant, a statement of whether or not you are requesting a contested case hearing.

Requests for Standing

Under the provisions of ORS 537.153(7) (for surface water) or ORS 537.621(8) (for groundwater), persons other than the applicant who support a Proposed Final Order can request standing for purposes of participating in any contested case proceeding on the Proposed Final Order or for judicial review of a Final Order.

Requests for standing must be received in the Water Resources Department no later than **October 12, 2018**. Requests for standing must be in writing, and must include the following:

- The requester's name, mailing address and telephone number;
- If the requester is representing a group, association or other organization, the name, address and telephone number of the represented group;
- A statement that the requester supports the Proposed Final Order as issued;
- A detailed statement of how the requester would be harmed if the Proposed Final Order is modified; and
- A standing fee of $230. If a hearing is scheduled, an additional fee of $580 must be submitted along with a petition for party status.

After the protest period has ended, the Director will either issue a Final Order or schedule a contested case hearing. The contested case hearing will be scheduled only if a protest has been submitted and either:

- upon review of the issues, the director finds that there are significant disputes related to the proposed use of water, or

- the applicant requests a contested case hearing within 30 days after the close of the protest period.

If you do not request a hearing within 30 days after the close of the protest period, or if you withdraw a request for a hearing, notify the Department or the administrative law judge that you will not appear or fail to appear at a scheduled hearing, the Director may issue a Final Order by default. If the Director issues a Final Order by default, the Department designates the relevant portions of its files on this matter, including all materials that you have submitted relating to this matter, as the record for purpose of proving a prima facie case upon default.

You may be represented by an attorney at the hearing. Legal aid organizations may be able to assist a party with limited financial resources. Generally, partnerships, corporations, associations, governmental subdivisions or public or private organizations are represented by an attorney. However, consistent with OAR 690-002-0020 and OAR 137-003-0555, an agency representative may represent a partnership, corporation, association, governmental subdivision or public or private organization if the Department determines that appearance of a person by an authorized representative will not hinder the orderly and timely development of the record in this case.

Notice Regarding Service Members: Active duty service members have a right to stay proceedings under the federal Service Members Civil Relief Act. 50 U.S.C. App. §§501-597b. You may contact the Oregon State Bar or the Oregon Military Department for more information. The toll-free telephone number for the Oregon State Bar is: 1 (800) 452-8260. The toll-free telephone number of the Oregon Military Department is: 1 (800) 452-7500. The Internet address for the United States Armed Forces Legal Assistance Legal Services Locator website is: http://legalassistance.law.af.mil

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- If you have any questions about statements contained in this document, please contact Scott Grew at Scott.A.Grew@oregon.gov or 503-986-0899.
- If you have questions about how to file a protest or if you have previously filed a protest and you want to know the status, please contact Patricia McCarty at 503-986-0820.
- If you have any questions about the Department or any of its programs, please contact our Water Resources Customer Service Group at 503-986-0801.
- Address any correspondence to : Water Right Services Division
  725 Summer St NE, Suite A
  Salem, OR 97301-1266

  Fax: 503-986-0901

STATE OF OREGON

COUNTY OF CROOK

DRAFT PERMIT TO APPROPRIATE THE PUBLIC WATERS

THIS DRAFT PERMIT IS HEREBY ISSUED TO

CITY OF PRINEVILLE
387 NE 3RD ST
PRINEVILLE, OR 97754

The specific limits and conditions of the use are listed below.

APPLICATION FILE NUMBER: G-18662

SOURCE OF WATER: 25 WELLS IN CROOKED RIVER BASIN

PURPOSE OR USE: MUNICIPAL USE

MAXIMUM RATE: 4.46 CUBIC FEET PER SECOND

PERIOD OF USE: JANUARY 1 THROUGH DECEMBER 31

DATE OF PRIORITY: APRIL 25, 2018

WELL LOCATION:

POA	POA Name	Twp	Rng	Mer	Sec	Q-Q	Measured Distances
1	D1 (CROO 54593)	15 S	16 E	WM	8	NW NW	422 FEET SOUTH AND 400 FEET EAST FROM NW CORNER, SECTION 8
2	S1 (CROO 54587)	15 S	16 E	WM	8	NW NW	471 FEET SOUTH AND 406 FEET EAST FROM NW CORNER, SECTION 8
3	D2 (CROO 54592)	15 S	16 E	WM	8	NW NW	585 FEET SOUTH AND 793 FEET EAST FROM NW CORNER, SECTION 8
4	D3	15 S	16 E	WM	8	NW NW	516 FEET SOUTH AND 438 FEET EAST FROM NW CORNER, SECTION 8
5	S2	15 S	16 E	WM	8	NW NW	561 FEET SOUTH AND 466 FEET EAST FROM NW CORNER, SECTION 8
6	D4	15 S	16 E	WM	8	NW NW	601 FEET SOUTH AND 509 FEET EAST FROM NW CORNER, SECTION 8
7	S3	15 S	16 E	WM	8	NW NW	621 FEET SOUTH AND 564 FEET EAST FROM NW CORNER, SECTION 8
8	D5	15 S	16 E	WM	8	NW NW	657 FEET SOUTH AND 611 FEET EAST FROM NW CORNER, SECTION 8
9	S4	15 S	16 E	WM	8	NW NW	694 FEET SOUTH AND 654 FEET EAST FROM NW CORNER, SECTION 8
10	D6	15 S	16 E	WM	8	NW NW	717 FEET SOUTH AND 700 FEET EAST FROM NW CORNER, SECTION 8
11	S5	15 S	16 E	WM	8	NW NW	789 FEET SOUTH AND 731 FEET EAST FROM NW CORNER, SECTION 8
12	D7	15 S	16 E	WM	8	NW NW	840 FEET SOUTH AND 759 FEET EAST FROM NW CORNER, SECTION 8

POA	POA Name	Twp	Rng	Mer	Sec	Q-Q	Measured Distances
13	S6	15 S	16 E	WM	8	NW NW	888 FEET SOUTH AND 784 FEET EAST FROM NW CORNER, SECTION 8
14	D8	15 S	16 E	WM	8	NW NW	952 FEET SOUTH AND 799 FEET EAST FROM NW CORNER, SECTION 8
15	S7	15 S	16 E	WM	8	NW NW	1004 FEET SOUTH AND 809 FEET EAST FROM NW CORNER, SECTION 8
16	D9	15 S	16 E	WM	8	NW NW	1061 FEET SOUTH AND 815 FEET EAST FROM NW CORNER, SECTION 8
17	S8	15 S	16 E	WM	8	NW NW	1116 FEET SOUTH AND 808 FEET EAST FROM NW CORNER, SECTION 8
18	D10	15 S	16 E	WM	8	NW NW	1179 FEET SOUTH AND 796 FEET EAST FROM NW CORNER, SECTION 8
19	S9	15 S	16 E	WM	8	NW NW	1232 FEET SOUTH AND 800 FEET EAST FROM NW CORNER, SECTION 8
20	D11	15 S	16 E	WM	8	NW NW	1267 FEET SOUTH AND 836 FEET EAST FROM NW CORNER, SECTION 8
21	S10	15 S	16 E	WM	8	NW NW	1320 FEET SOUTH AND 869 FEET EAST FROM NW CORNER, SECTION 8
22	D12	15 S	16 E	WM	8	SW NW	1372 FEET SOUTH AND 879 FEET EAST FROM NW CORNER, SECTION 8
23	S11	15 S	16 E	WM	8	SW NW	1420 FEET SOUTH AND 896 FEET EAST FROM NW CORNER, SECTION 8
24	D13	15 S	16 E	WM	8	SW NW	1479 FEET SOUTH AND 909 FEET EAST FROM NW CORNER, SECTION 8
25	S12	15 S	16 E	WM	8	SW NW	1527 FEET SOUTH AND 949 FEET EAST FROM NW CORNER, SECTION 8

THE PLACE OF USE IS LOCATED AS FOLLOWS:
City of Prineville Service Boundary

1. **Measurement Devices, and Recording/Reporting of Annual Water Use Conditions:**

   A. Before water use may begin under this permit, the permittee shall install a totalizing flow meter at each point of appropriation. The permittee shall maintain the device in good working order.

   B. The permittee shall allow the watermaster access to the device; provided however, where any device is located within a private structure, the watermaster shall request access upon reasonable notice.

   C. The permittee shall keep a complete record of the volume of water used each month, and shall submit an annual report which includes the recorded water-use measurements to the Department annually, or more frequently as may be required by the Director. Further, the Director may require the permittee to report general water-use information, including the place and nature of use of water under the permit.

   D. The Director may provide an opportunity for the permittee to submit alternative measuring and reporting procedures for review and approval.

2. **Annual Measurement Condition:**

The Department requires the water user to obtain, from a qualified individual (see below), and report annual static water levels for each well on the permit. The static water level shall be measured in the month of March. Reports shall be submitted to the Department within 30 days of measurement.

The permittee shall report an initial March static water-level measurement once well construction is complete and annual measurements thereafter. Annual measurements are required whether or not the well is used. The first annual measurement will establish a reference level against which future measurements will be compared. However, the Director may establish the reference level based on an analysis of other water-level data. The Director may require the user to obtain and report additional water levels each year if more data are needed to evaluate the aquifer system.

All measurements shall be made by a certified water rights examiner, registered professional geologist, registered professional engineer, licensed well constructor or pump installer licensed by the Construction Contractors Board. Measurements shall be submitted on forms provided by, or specified by, the Department. Measurements shall be made with equipment that is accurate to at least the standards specified in OAR 690-217-0045. The Department requires the individual performing the measurement to:

A. Associate each measurement with an owner's well name or number and a Department well log ID; and

B. Report water levels to at least the nearest tenth of a foot as depth-to-water below ground surface; and

C. Specify the method of measurement; and

D. Certify the accuracy of all measurements and calculations reported to the Department.

The water user shall discontinue use of, or reduce the rate or volume of withdrawal from, the well(s) if any of the following events occur:

A. Annual water-level measurements reveal an average water-level decline of three or more feet per year for five consecutive years; or

B. Annual water-level measurements reveal a water-level decline of 15 or more feet in fewer than five consecutive years; or

C. Annual water-level measurements reveal a water-level decline of 25 or more feet; or

D. Hydraulic interference leads to a decline of 25 or more feet in any neighboring well with senior priority.

The period of restricted use shall continue until the water level rises above the decline level which triggered the action or the Department determines, based on the permittee's and/or the Department's data and analysis, that no action is necessary because the aquifer in question can sustain the observed declines without adversely impacting the resource or causing substantial interference with senior water rights. The water user shall not allow excessive decline, as defined in Commission rules, to occur within the aquifer as a result of use under this permit. If more than one well is involved, the water user may submit an alternative measurement and reporting plan for review and approval by the Department.

3. **Dedicated Measuring Tube Condition:**

   Wells with pumps shall be equipped with a minimum 3/4-inch diameter, unobstructed, dedicated measuring tube pursuant to figure 200-5 in OAR 690-200. If a pump has been installed prior to the issuance of this permit, and if static water levels and pumping levels can be measured using an electrical tape, then the installation of the measuring tube can be delayed until such time that water levels cannot be measured or the pump is repaired or replaced.

4. **Well Identification Tag Condition:**

   Prior to using water from any well listed on this permit, the permittee shall ensure that the well has been assigned an OWRD Well Identification Number (Well ID tag), which shall be permanently attached to the well. The Well ID shall be used as a reference in any correspondence regarding the well, including any reports of water use, water level, or pump test data.

5. **Groundwater Mitigation Conditions:**

   a. Mitigation Obligation: 1292.0 AF of mitigation water in the Crooked River Zone of Impact (located anywhere in the Crooked River Basin above river mile 13.8).

   b. Mitigation Source: Mitigation Credits or a Mitigation Project, in accordance with the incremental development plan on file with the Department, meeting the requirements of OAR Chapter 690, Division 505 (Deschutes Ground Water Mitigation Rules) and OAR Chapter 690, Division 522.

   c. The permittee shall provide mitigation during each stage of development under the permit, as described in the Incremental Development Mitigation Plan on file with the Department, and in accordance with the standards of the Deschutes Ground Water Mitigation Rules, OAR Chapter 690, Division 505 and Division 522.

   d. The permittee shall not increase the rate or amount of water diverted, as described in the incremental development mitigation plan, prior to increasing the corresponding mitigation.

   e. The permittee shall seek and receive Department approval prior to changing the Incremental Mitigation Development Plan and related mitigation obligation for each stage of permit development.

   f. The permittee shall report to the Department the progress of implementing the Incremental Mitigation Development Plan and related mitigation no later than April 1 of each year. The annual report shall include the annual volume of water used, the source and amount of mitigation, and any offset used for that period. This annual notification is not necessary if the permittee has completed development and submitted a Claim of Beneficial Use to the Department.

   g. Mitigation water must be legally protected instream in the Crooked River Zone of Impact (located anywhere in the Crooked River Basin above river mile 13.8) for the life of the permit and subsequent certificate(s). Regulation of the use and/or cancellation of the permit, or subsequent certificate(s) will occur if the required mitigation is not maintained.

   h. The permittee shall provide additional mitigation if the Department determines that average annual consumptive use of the subject appropriation has increased beyond the originally mitigated amount.

   i. If mitigation is from a secondary right for stored water from a storage project not owned or operated by the permittee, the use of water under this right is subject to the maintenance and terms and conditions of a valid contract or satisfactory replacement, with the owner/operator of the storage project, a copy of which must be on file in the records of the Water Resources Department.

j. Failure to comply with these mitigation conditions shall result in the Department regulating the groundwater permit, or subsequent certificate(s), proposing to deny any permit extension application for the groundwater permit, and proposing to cancel the groundwater permit, or subsequent certificate(s).

k. All water use and mitigation accounting, including the incremental development plan and the annual report required in paragraph f, may be reported on a water year basis.

6. **Scenic Waterway Condition:**

Use of water under authority of this permit may be regulated if analysis of data available after the permit is issued discloses that the appropriation will measurably reduce the surface-water flows necessary to maintain the free-flowing character of a scenic waterway in quantities necessary for recreation, fish and wildlife in effect as of the priority date of the right, or as those quantities may be reduced subsequently. However, the use of groundwater allowed under the terms of this permit will not be subject to regulation for Scenic Waterway flows, provided the mitigation required is maintained.

STANDARD CONDITIONS

7. Failure to comply with any of the provisions of this permit may result in action including, but not limited to, restrictions on the use, civil penalties, or cancellation of the permit.

8. If the number, location, source, or construction of any well deviates from that proposed in the permit application or required by permit conditions, this permit may be subject to cancellation, unless the Department authorizes the change in writing.

9. If substantial interference with surface water or a senior water right occurs due to withdrawal of water from any well listed on this permit, then use of water from the well(s) shall be discontinued or reduced and/or the schedule of withdrawal shall be regulated until or unless the Department approves or implements an alternative administrative action to mitigate the interference. The Department encourages junior and senior appropriators to jointly develop plans to mitigate interferences.

10. The well(s) shall be constructed and maintained in accordance with the General Standards for the Construction and Maintenance of Water Supply Wells in Oregon. The works shall be equipped with a usable access port adequate to determine water-level elevation in the well at all times.

11. If the riparian area is disturbed in the process of developing a point of appropriation, the permittee shall be responsible for restoration and enhancement of such riparian area in accordance with ODFW's Fish and Wildlife Habitat Mitigation Policy OAR 635-415. For purposes of mitigation, the ODFW Fish and Wildlife Habitat Mitigation Goals and Standards, OAR 635-415, shall be followed.

12. The use may be restricted if the quality of downstream waters decreases to the point that those waters no longer meet state or federal water quality standards due to reduced flows.

13. Where two or more water users agree among themselves as to the manner of rotation in the use of water and such agreement is placed in writing and filed by such water users with the watermaster,

and such rotation system does not infringe upon such prior rights of any water user not a party to such rotation plan, the watermaster shall distribute the water according to such agreement.

14. Prior to receiving a certificate of water right, the permit holder shall submit to the Water Resources Department the results of a pump test meeting the Department's standards for each point of appropriation (well), unless an exemption has been obtained in writing under OAR 690-217. The Director may require water-level or pump-test data every ten years thereafter.

15. This permit is for the beneficial use of water without waste. The water user is advised that new regulations may require the use of best practical technologies or conservation practices to achieve this end.

16. By law, the land use associated with this water use must be in compliance with statewide land-use goals and any local acknowledged land-use plan.

17. Construction of the wells shall begin within five years of the date of permit issuance. The deadline to begin construction may not be extended. This permit is subject to cancellation proceedings if the construction deadline to begin is missed.

18. Complete application of the water shall be made within twenty years of the date of permit issuance. If beneficial use of permitted water has not been made before this date, the permittee may submit an application for extension of time, which may be approved based upon the merit of the application.

19. Within one year after complete application of water to the proposed use, the permittee shall submit a claim of beneficial use, which includes a map and report, prepared by a Certified Water Rights Examiner.

Issued

DRAFT - THIS IS NOT A PERMIT

____
Dwight French
Water Right Services Division Administrator, for
Thomas M. Byler, Director
Oregon Water Resources Department

Airport Area Aquifer Water Right Permits

STATE OF OREGON

COUNTIES OF CROOK AND DESCHUTES

PERMIT TO APPROPRIATE PUBLIC WATERS

THIS PERMIT IS HEREBY ISSUED TO:

CITY OF PRINEVILLE
387 NE THIRD ST
PRINEVILLE OR 97754

This superseding permit is issued to describe an amendment for an additional point of appropriation and a change in point of appropriation proposed under Permit Amendment Application T-11685 and approved by Special Order Vol.93, Page 60, entered Aug 5 2014. This permit supersedes Permit G-16879.

The specific limits and conditions of the use are listed below.

APPLICATION FILE NUMBER: G-16900

SOURCE OF WATER: WELL 1 (CROO 1894/CROO 50095), WELL 2 (CROO 53453), WELL 3 (CROO 53956), WELL 4, WELL 5, WELL 6, WELL 7, WELL 8 AND WELL 9 IN CROOKED RIVER BASIN

RATE: 12.48 CUBIC FEET PER SECOND (CFS), FURTHER LIMITED TO 5.57 CFS FROM WELLS 1-7, BEING NO MORE THAN 2.23 CFS IN TOTAL FROM WELL 1 (CROO 1894/CROO 50095), WELL 2 (CROO 53453), WELL 3 (CROO 53956); NO MORE THAN 1.11 CFS IN TOTAL FROM WELL 5 AND WELL 6; AND NO MORE THAN 2.23 CFS FROM WELL 7

MAXIMUM ANNUAL VOLUME: 3682.7 ACRE FEET

DATE OF PRIORITY: JUNE 27, 2007

USE: MUNICIPAL

PERIOD: YEAR-ROUND

Authorized Points of Appropriation:

Well	Twp	Rng	Mer	Sec	Q-Q	Measured Distances
City Airport Well 1 (CROO 1894/CROO 50095)	15 S	15 E	WM	11	SE SW	1210 FEET NORTH AND 1950 FEET EAST FROM THE SW CORNER OF SECTION 11
City Airport Well 2 (CROO 53453)	15 S	15 E	WM	11	SE SW	1165 FEET NORTH AND 1990 FEET EAST FROM THE SW CORNER OF SECTION 11
City Airport Well 3 (CROO 53956)	15 S	15 E	WM	11	SW SE	55 FEET NORTH AND 3000 FEET EAST FROM THE SW CORNER OF SECTION 11
City Airport Well 4	15 S	15 E	WM	11	SE SW	1070 FEET NORTH AND 1710 FEET EAST FROM THE SW CORNER OF SECTION 11
Well 5	15 S	14 E	WM	26	NW NE	319 FEET SOUTH AND 2408 FEET WEST FROM THE NE CORNER OF SECTION 26

Well	Twp	Rng	Mer	Sec	Q-Q	Measured Distances
Well 6	15 S	14 E	WM	26	NW NE	835 FEET SOUTH AND 2477 FEET WEST FROM THE NE CORNER OF SECTION 26
Well 7	15 S	15 E	WM	6	NE SW	2000 FEET NORTH AND 2340 FEET EAST FROM THE SW CORNER OF SECTION 6
Well 8	15 S	13 E	WM	23	NE NW	110 FEET SOUTH AND 1870 FEET EAST FROM THE NW CORNER OF SECTION 23
Well 9	15 S	13 E	WM	23	NE NW	100 FEET SOUTH AND 2470 FEET EAST FROM THE NW CORNER OF SECTION 23

Authorized Place of Use: WITHIN CITY OF PRINEVILLE SERVICE BOUNDARY

Permit Amendment T-11685 Conditions:

The quantity of water diverted at the new point of appropriation, (Well 3), shall not exceed the quantity of water lawfully available at the original point of appropriation.

The combined quantity of water diverted at the proposed additional point of appropriation, (Well 4), together with that diverted at the old points of appropriation (Wells 1, 2, and 3), shall not exceed the quantity of water lawfully available at the original points of appropriation (2.23 cfs).

Water shall be acquired from the same aquifer as the original points of appropriation.

Measurement, Recording and Reporting Conditions:

A. Before water use may begin under this permit, the permittee shall install a totalizing flow meter at each point of appropriation. The permittee shall maintain the meter in good working order.

B. The permittee shall keep a complete record of the amount of water used each month, and shall submit a report which includes the recorded water use measurements to the Department annually or more frequently as may be required by the Director. Further, the Director may require the permittee to report general water-use information, including the place and nature of use of water under the permit.

C. The permittee shall allow the watermaster access to the meters; provided however, where any meter is located within a private structure, the watermaster shall request access upon reasonable notice.

D. The Director may provide an opportunity for the permittee to submit alternative measuring and reporting procedures for review and approval.

The Department requires the water user to obtain, from a qualified individual (see below), and report annual static water levels for each well on the permit. The static water level shall be measured in the month of March. Reports shall be submitted to the Department within 30 days of measurement.

The permittee shall report an initial March static water-level measurement once well construction is complete and annual measurements thereafter. Annual measurements are required whether or not the well is used. The first annual measurement will establish a reference level against which future measurements will be compared. However, the Director may establish the reference level based on an analysis of other water-level data. The Director may require the user to obtain and report additional water levels each year if more data are needed to evaluate the aquifer system.

All measurements shall be made by a certified water rights examiner, registered professional geologist, registered professional engineer, licensed well constructor or pump installer licensed by the Construction Contractors Board. Measurements shall be submitted on forms provided by, or specified by, the Department. Measurements shall be made with equipment that is accurate to at least the standards specified in OAR 690-217-0045. The Department requires the individual performing the measurement to:

A. Associate each measurement with an owner's well name or number and a Department well log ID; and

B. Report water levels to at least the nearest tenth of a foot as depth-to-water below ground surface; and

C. Specify the method of measurement; and

D. Certify the accuracy of all measurements and calculations reported to the Department.

The water user shall discontinue use of, or reduce the rate or volume of withdrawal from, the wells if any of the following events occur:

A. Annual water-level measurements reveal an average water-level decline of three or more feet per year for five consecutive years; or

B. Annual water-level measurements reveal a water-level decline of 15 or more feet in fewer than five consecutive years; or

C. Annual water-level measurements reveal a water-level decline of 25 or more feet; or

D. Hydraulic interference leads to a decline of 25 or more feet in any neighboring well with senior priority.

The period of restricted use shall continue until the water level rises above the decline level which triggered the action or the Department determines, based on the permittee's and/or the Department's data and analysis, that no action is necessary because the aquifer in question can sustain the observed declines without adversely impacting the resource or causing substantial interference with senior water rights. The water user shall not allow excessive decline, as defined in Commission rules, to occur within the aquifer as a result of use under this permit. If more than one well is involved, the water user may submit an alternative measurement and reporting plan for review and approval by the Department.

Ground Water Mitigation Conditions:

1. Mitigation Obligation: a total of 1473.1 acre-feet of mitigation water in the General Zone of Impact and/or the Crooked River Zone of Impact, as applicable.

Well	Zone of Impact
Well 1 (CROO 1894/CROO 50095)	Crooked River Zone of Impact
Well 2 (CROO 53453)	Crooked River Zone of Impact
Well 3 (CROO 53956)	Crooked River Zone of Impact
Well 4	Crooked River Zone of Impact
Well 5	Crooked River Zone of Impact
Well 6	Crooked River Zone of Impact
Well 7	Crooked River Zone of Impact
Well 8	General Zone of Impact
Well 9	General Zone of Impact

Mitigation must be provided in the General Zone of Impact for use of water from any well with a mitigation obligation in the General Zone of Impact. Mitigation must be provided in the Crooked River Zone of Impact for use of water from any well with a mitigation obligation in the Crooked River Zone of Impact. The amount of mitigation provided in each zone of impact shall be consistent with the incremental development plan on file with the Department, and shall be of sufficient quantity to mitigate for the annual volume of water used in each zone of impact.

Mitigation Source: mitigation projects, mitigation credits, or offsets

2. First increment of mitigation:
   a. Mitigation obligation: 91.5 acre feet of mitigation water in the either the General Zone of Impact or Crooked River Zone of Impact
   b. Mitigation source: 36.6 mitigation credits originating from Mitigation Project MP-140, established by instream water right certificates 87249 and 87250, and which may be used in either the General Zone of Impact or Crooked River Zone of Impact, in accordance with the incremental development plan on file with the Department, meeting requirements of OAR chapter 690, Division 505 (Deschutes Groundwater Mitigation Rules).
3. The permittee shall provide mitigation during each stage of development under the permit, as described in the incremental development mitigation plan on file with the Department, and in accordance with the standards of the Deschutes Ground Water Mitigation Rules, OAR Chapter 690, Division 505 and 522.
4. The permittee shall not increase the rate or amount of water diverted, as described in the incremental development mitigation plan, prior to increasing the corresponding mitigation.
5. The permittee shall seek and receive Departmental approval prior to changing the incremental mitigation development plan and related mitigation obligation for each stage of permit development.
6. The permittee shall report to the Department the progress made in implementing the incremental mitigation development plan and related mitigation no later than April 1 of each year. The annual report shall include the annual volume of water used, the source and

amount of mitigation, and any offset used for that period. This information shall be broken down by Zone of Impact, and shall include identification of the authorized wells utilized. This annual notification is not necessary if the permittee has completed development and submitted a Claim of Beneficial Use to the Department.

7. Mitigation water must be legally protected instream in the General Zone of Impact and the Crooked River Zone of Impact, as applicable, for the life of the permit and subsequent certificate(s). Regulation of the use and/or cancellation of the permit, or subsequent certificate(s) will occur if the required mitigation is not maintained.
8. The permittee shall provide additional mitigation if the Department determines that average annual consumptive use of the subject appropriation has increased beyond the originally mitigated amount.
9. If mitigation is from a secondary right for stored water from a storage project not owned or operated by the permittee, the use of water under this right is subject to the maintenance and terms and conditions of a valid contract or satisfactory replacement, with the owner/operator of the storage project, a copy of which must be on file in the records of the Water Resources Department.
10. Failure to comply with these mitigation conditions shall result in the Department regulating the ground water permit, or subsequent certificate(s), proposing to deny any permit extension application for the ground water permit, and proposing to cancel the ground water permit, or subsequent certificate(s).

Scenic Waterway Condition:

Use of water under authority of this permit may be regulated if analysis of data available after the permit is issued discloses that the appropriation will measurably reduce the surface water flows necessary to maintain the free-flowing character of a scenic waterway in quantities necessary for recreation, fish and wildlife in effect as of the priority date of the right, or as those quantities may be reduced subsequently.

However, the use of ground water allowed under the terms of this permit will not be subject to regulation for Scenic Waterway flows, provided the required mitigation is maintained.

Water Management and Conservation Plan Condition

The permittee shall submit a Water Management and Conservation Plan, addressing use under this permit, consistent with OAR 690-086 by November 30, 2016, or before use of the second increment of water development occurs, whichever is sooner. The Director may approve an extension of this time line to complete the required Water Management and Conservation Plan. No water may be diverted if a Water Management and Conservation Plan is not submitted according to the time lines described in this condition, unless such an extension has been approved. The time line for submittal of a plan under this permit does not alter the time lines for submittal of such a plan under any other order of the Department.

STANDARD CONDITIONS

1. Failure to comply with any of the provisions of this permit may result in action including, but not limited to, restrictions on the use, civil penalties, or cancellation of the permit.

2. If the number, location, source, or construction of any well deviates from that proposed in the permit application or required by permit conditions, this permit may be subject to cancellation, unless the Department authorizes the change in writing.

3. If substantial interference with a senior water right occurs due to withdrawal of water from any well listed on this permit, then use of water from the well(s) shall be discontinued or reduced and/or the schedule of withdrawal shall be regulated until or unless the Department approves or implements an alternative administrative action to mitigate the interference. The Department encourages junior and senior appropriators to jointly develop plans to mitigate interferences.

4. The wells shall be constructed in accordance with the General Standards for the Construction and Maintenance of Water Wells in Oregon. The works shall be equipped with a usable access port, and may also include an air line and pressure gauge adequate to determine water level elevation in the well at all times.

5. Where two or more water users agree among themselves as to the manner of rotation in the use of water and such agreement is placed in writing and filed by such water users with the watermaster, and such rotation system does not infringe upon such prior rights of any water user not a party to such rotation plan, the watermaster shall distribute the water according to such agreement.

6. Prior to receiving a certificate of water right, the permit holder shall submit the results of a pump test meeting the department's standards, to the Water Resources Department. The Director may require water level or pump test results every ten years thereafter.

7. This permit is for the beneficial use of water without waste. The water user is advised that new regulations may require the use of best-practice technologies or conservation practices to achieve this end.

8. By law, the land use associated with this water use must be in compliance with statewide land-use goals and any local acknowledged comprehensive land-use plan.

9. Completion of construction and complete application of the water to the use shall be made within twenty years of the date of permit G-16879 issuance, being November 30, 2031. If the water is not completely applied before this date, and the permittee wishes to continue development under the permit, the permittee must submit an application for extension of time, which may be approved based upon the merit of the application.

10. Within one year after complete application of water to the proposed use, the permittee shall submit a claim of beneficial use, which includes a map and report, prepared by a Certified Water Rights Examiner.

Issued August 5, 2014

Dwight French, Water Right Services Division Administrator, for
Director, Oregon Water Resources Department

STATE OF OREGON

COUNTY OF CROOK

PERMIT TO APPROPRIATE THE PUBLIC WATERS

THIS PERMIT IS HEREBY ISSUED TO

CITY OF PRINEVILLE
387 NE THIRD STREET
PRINEVILLE, OR 97754

This superseding permit is issued to describe an amendment for an additional point of appropriation proposed under Permit Amendment Application T-12192 and approved by Special Order Vol. 101, Page 88-90, entered June 1, 2016. This permit supersedes Permit G-17089.

The specific limits and conditions of the use are listed below.

APPLICATION FILE NUMBER: G-15974

SOURCE OF WATER: FOUR WELLS IN OCHOCO CREEK BASIN WITHIN THE DESCHUTES RIVER BASIN

PURPOSE OR USE: MUNICIPAL USE

MAXIMUM RATE/VOLUME: 1.715 CUBIC FEET PER SECOND (CFS), LIMITED TO A MAXIMUM ANNUAL VOLUME OF 1242.0 ACRE FEET (AF), FURTHER LIMITED BY THE CORRESPONDING MITIGATION PROVIDED UNDER THE INCREMENTAL MITIGATION DEVELOPMENT PLAN

PERIOD OF USE: YEAR ROUND

DATE OF PRIORITY: MARCH 31, 2003

WELL LOCATIONS:

Twp	Rng	Mer	Sec	Q-Q	Measured Distances
15 S	15 E	WM	11	SE SW	CITY AIRPORT WELL 1 (CROO 1894) - 1210 FEET NORTH AND 1950 FEET EAST FROM THE SW CORNER OF SECTION 11
15 S	15 E	WM	11	SE SW	CITY AIRPORT WELL 2 (CROO 53453) - 1165 FEET NORTH AND 1990 FEET EAST FROM THE SW CORNER OF SECTION 11
15 S	15 E	WM	11	SW SE	CITY AIRPORT WELL 3 (CROO 53956) - 55 FEET NORTH AND 3000 FEET EAST FROM THE SW CORNER OF SECTION 11.
15 S	15 E	WM	11	SE SW	CITY AIRPORT WELL 4 (CROO 54191) – 1070 FEET NORTH AND 1710 FEET EAST FROM THE SW CORNER OF SECTION 11.

THE PLACE OF USE IS LOCATED AS FOLLOWS:

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE				
Twp	Rng	Mer	Sec	Q-Q
14 S	15 E	WM	25	NE NE
14 S	15 E	WM	25	NW NE
14 S	15 E	WM	25	SW NE
14 S	15 E	WM	25	SE NE
14 S	15 E	WM	25	NE NW
14 S	15 E	WM	25	NW NW
14 S	15 E	WM	25	SW NW
14 S	15 E	WM	25	SE NW
14 S	15 E	WM	25	NE SW
14 S	15 E	WM	25	NW SW
14 S	15 E	WM	25	SW SW
14 S	15 E	WM	25	SE SW
14 S	15 E	WM	25	NE SE
14 S	15 E	WM	25	NW SE
14 S	15 E	WM	25	SW SE
14 S	15 E	WM	25	SE SE
14 S	15 E	WM	36	NE NE
14 S	15 E	WM	36	NW NE
14 S	15 E	WM	36	SW NE
14 S	15 E	WM	36	SE NE
14 S	15 E	WM	36	NE NW
14 S	15 E	WM	36	NW NW
14 S	15 E	WM	36	SW NW
14 S	15 E	WM	36	SE NW
14 S	15 E	WM	36	NE SW
14 S	15 E	WM	36	NW SW
14 S	15 E	WM	36	SW SW
14 S	15 E	WM	36	SE SW
14 S	15 E	WM	36	NE SE
14 S	15 E	WM	36	NW SE
14 S	15 E	WM	36	SW SE
14 S	15 E	WM	36	SE SE
14 S	16 E	WM	28	NE NE
14 S	16 E	WM	28	NW NE
14 S	16 E	WM	28	SW NE
14 S	16 E	WM	28	SE NE
14 S	16 E	WM	28	NE NW
14 S	16 E	WM	28	NW NW
14 S	16 E	WM	28	SW NW
14 S	16 E	WM	28	SE NW
14 S	16 E	WM	28	NE SW
14 S	16 E	WM	28	NW SW
14 S	16 E	WM	28	SW SW
14 S	16 E	WM	28	SE SW
14 S	16 E	WM	28	NE SE

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE

Twp	Rng	Mer	Sec	Q-Q
14 S	16 E	WM	28	NW SE
14 S	16 E	WM	28	SW SE
14 S	16 E	WM	28	SE SE
14 S	16 E	WM	29	NE NE
14 S	16 E	WM	29	NW NE
14 S	16 E	WM	29	SW NE
14 S	16 E	WM	29	SE NE
14 S	16 E	WM	29	NE NW
14 S	16 E	WM	29	NW NW
14 S	16 E	WM	29	SW NW
14 S	16 E	WM	29	SE NW
14 S	16 E	WM	29	NE SW
14 S	16 E	WM	29	NW SW
14 S	16 E	WM	29	SW SW
14 S	16 E	WM	29	SE SW
14 S	16 E	WM	29	NE SE
14 S	16 E	WM	29	NW SE
14 S	16 E	WM	29	SW SE
14 S	16 E	WM	29	SE SE
14 S	16 E	WM	30	NE NE
14 S	16 E	WM	30	NW NE
14 S	16 E	WM	30	SW NE
14 S	16 E	WM	30	SE NE
14 S	16 E	WM	30	NE NW
14 S	16 E	WM	30	NW NW
14 S	16 E	WM	30	SW NW
14 S	16 E	WM	30	SE NW
14 S	16 E	WM	30	NE SW
14 S	16 E	WM	30	NW SW
14 S	16 E	WM	30	SW SW
14 S	16 E	WM	30	SE SW
14 S	16 E	WM	30	NE SE
14 S	16 E	WM	30	NW SE
14 S	16 E	WM	30	SW SE
14 S	16 E	WM	30	SE SE
14 S	16 E	WM	31	NE NE
14 S	16 E	WM	31	NW NE
14 S	16 E	WM	31	SW NE
14 S	16 E	WM	31	SE NE
14 S	16 E	WM	31	NE NW
14 S	16 E	WM	31	NW NW
14 S	16 E	WM	31	SW NW
14 S	16 E	WM	31	SE NW
14 S	16 E	WM	31	NE SW
14 S	16 E	WM	31	NW SW
14 S	16 E	WM	31	SW SW
14 S	16 E	WM	31	SE SW

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE				
Twp	Rng	Mer	Sec	Q-Q
14 S	16 E	WM	31	NE SE
14 S	16 E	WM	31	NW SE
14 S	16 E	WM	31	SW SE
14 S	16 E	WM	31	SE SE
14 S	16 E	WM	32	NE NE
14 S	16 E	WM	32	NW NE
14 S	16 E	WM	32	SW NE
14 S	16 E	WM	32	SE NE
14 S	16 E	WM	32	NE NW
14 S	16 E	WM	32	NW NW
14 S	16 E	WM	32	SW NW
14 S	16 E	WM	32	SE NW
14 S	16 E	WM	32	NE SW
14 S	16 E	WM	32	NW SW
14 S	16 E	WM	32	SW SW
14 S	16 E	WM	32	SE SW
14 S	16 E	WM	32	NE SE
14 S	16 E	WM	32	NW SE
14 S	16 E	WM	32	SW SE
14 S	16 E	WM	32	SE SE
14 S	16 E	WM	33	NE NE
14 S	16 E	WM	33	NW NE
14 S	16 E	WM	33	SW NE
14 S	16 E	WM	33	SE NE
14 S	16 E	WM	33	NE NW
14 S	16 E	WM	33	NW NW
14 S	16 E	WM	33	SW NW
14 S	16 E	WM	33	SE NW
14 S	16 E	WM	33	NE SW
14 S	16 E	WM	33	NW SW
14 S	16 E	WM	33	SW SW
14 S	16 E	WM	33	SE SW
14 S	16 E	WM	33	NE SE
14 S	16 E	WM	33	NW SE
14 S	16 E	WM	33	SW SE
14 S	16 E	WM	33	SE SE
14 S	16 E	WM	34	NE NE
14 S	16 E	WM	34	NW NE
14 S	16 E	WM	34	SW NE
14 S	16 E	WM	34	SE NE
14 S	16 E	WM	34	NE NW
14 S	16 E	WM	34	NW NW
14 S	16 E	WM	34	SW NW
14 S	16 E	WM	34	SE NW
14 S	16 E	WM	34	NE SW
14 S	16 E	WM	34	NW SW
14 S	16 E	WM	34	SW SW

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE				
Twp	Rng	Mer	Sec	Q-Q
14 S	16 E	WM	34	SE SW
14 S	16 E	WM	34	NE SE
14 S	16 E	WM	34	NW SE
14 S	16 E	WM	34	SW SE
14 S	16 E	WM	34	SE SE
15 S	15 E	WM	1	NE NE
15 S	15 E	WM	1	NW NE
15 S	15 E	WM	1	SW NE
15 S	15 E	WM	1	SE NE
15 S	15 E	WM	1	NE NW
15 S	15 E	WM	1	NW NW
15 S	15 E	WM	1	SW NW
15 S	15 E	WM	1	SE NW
15 S	15 E	WM	1	NE SW
15 S	15 E	WM	1	NW SW
15 S	15 E	WM	1	SW SW
15 S	15 E	WM	1	SE SW
15 S	15 E	WM	1	NE SE
15 S	15 E	WM	1	NW SE
15 S	15 E	WM	1	SW SE
15 S	15 E	WM	1	SE SE
15 S	15 E	WM	2	NE NE
15 S	15 E	WM	2	NW NE
15 S	15 E	WM	2	SW NE
15 S	15 E	WM	2	SE NE
15 S	15 E	WM	2	NE NW
15 S	15 E	WM	2	NW NW
15 S	15 E	WM	2	SW NW
15 S	15 E	WM	2	SE NW
15 S	15 E	WM	2	NE SW
15 S	15 E	WM	2	NW SW
15 S	15 E	WM	2	SW SW
15 S	15 E	WM	2	SE SW
15 S	15 E	WM	2	NE SE
15 S	15 E	WM	2	NW SE
15 S	15 E	WM	2	SW SE
15 S	15 E	WM	2	SE SE
15 S	15 E	WM	3	NE NE
15 S	15 E	WM	3	NW NE
15 S	15 E	WM	3	SW NE
15 S	15 E	WM	3	SE NE
15 S	15 E	WM	3	NE NW
15 S	15 E	WM	3	NW NW
15 S	15 E	WM	3	SW NW
15 S	15 E	WM	3	SE NW
15 S	15 E	WM	3	NE SW
15 S	15 E	WM	3	NW SW

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE				
Twp	Rng	Mer	Sec	Q-Q
15 S	15 E	WM	3	SW SW
15 S	15 E	WM	3	SE SW
15 S	15 E	WM	3	NE SE
15 S	15 E	WM	3	NW SE
15 S	15 E	WM	3	SW SE
15 S	15 E	WM	3	SE SE
15 S	15 E	WM	10	NE NE
15 S	15 E	WM	10	NW NE
15 S	15 E	WM	10	SW NE
15 S	15 E	WM	10	SE NE
15 S	15 E	WM	10	NE NW
15 S	15 E	WM	10	NW NW
15 S	15 E	WM	10	SW NW
15 S	15 E	WM	10	SE NW
15 S	15 E	WM	10	NE SW
15 S	15 E	WM	10	NW SW
15 S	15 E	WM	10	SW SW
15 S	15 E	WM	10	SE SW
15 S	15 E	WM	10	NE SE
15 S	15 E	WM	10	NW SE
15 S	15 E	WM	10	SW SE
15 S	15 E	WM	10	SE SE
15 S	15 E	WM	11	NE NE
15 S	15 E	WM	11	NW NE
15 S	15 E	WM	11	SW NE
15 S	15 E	WM	11	SE NE
15 S	15 E	WM	11	NE NW
15 S	15 E	WM	11	NW NW
15 S	15 E	WM	11	SW NW
15 S	15 E	WM	11	SE NW
15 S	15 E	WM	11	NE SW
15 S	15 E	WM	11	NW SW
15 S	15 E	WM	11	SW SW
15 S	15 E	WM	11	SE SW
15 S	15 E	WM	11	NE SE
15 S	15 E	WM	11	NW SE
15 S	15 E	WM	11	SW SE
15 S	15 E	WM	11	SE SE
15 S	15 E	WM	12	NE NE
15 S	15 E	WM	12	NW NE
15 S	15 E	WM	12	SW NE
15 S	15 E	WM	12	SE NE
15 S	15 E	WM	12	NE NW
15 S	15 E	WM	12	NW NW
15 S	15 E	WM	12	SW NW
15 S	15 E	WM	12	SE NW
15 S	15 E	WM	12	NE SW

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE				
Twp	Rng	Mer	Sec	Q-Q
15 S	15 E	WM	12	NW SW
15 S	15 E	WM	12	SW SW
15 S	15 E	WM	12	SE SW
15 S	15 E	WM	12	NE SE
15 S	15 E	WM	12	NW SE
15 S	15 E	WM	12	SW SE
15 S	15 E	WM	12	SE SE
15 S	15 E	WM	13	NE NE
15 S	15 E	WM	13	NW NE
15 S	15 E	WM	13	SW NE
15 S	15 E	WM	13	SE NE
15 S	15 E	WM	13	NE NW
15 S	15 E	WM	13	NW NW
15 S	15 E	WM	13	SW NW
15 S	15 E	WM	13	SE NW
15 S	15 E	WM	13	NE SW
15 S	15 E	WM	13	NW SW
15 S	15 E	WM	13	SW SW
15 S	15 E	WM	13	SE SW
15 S	15 E	WM	13	NE SE
15 S	15 E	WM	13	NW SE
15 S	15 E	WM	13	SW SE
15 S	15 E	WM	13	SE SE
15 S	15 E	WM	14	NE NE
15 S	15 E	WM	14	NW NE
15 S	15 E	WM	14	SW NE
15 S	15 E	WM	14	SE NE
15 S	15 E	WM	14	NE NW
15 S	15 E	WM	14	NW NW
15 S	15 E	WM	14	SW NW
15 S	15 E	WM	14	SE NW
15 S	15 E	WM	14	NE SW
15 S	15 E	WM	14	NW SW
15 S	15 E	WM	14	SW SW
15 S	15 E	WM	14	SE SW
15 S	15 E	WM	14	NE SE
15 S	15 E	WM	14	NW SE
15 S	15 E	WM	14	SW SE
15 S	15 E	WM	14	SE SE
15 S	16 E	WM	3	NE NE
15 S	16 E	WM	3	NW NE
15 S	16 E	WM	3	SW NE
15 S	16 E	WM	3	SE NE
15 S	16 E	WM	3	NE NW
15 S	16 E	WM	3	NW NW
15 S	16 E	WM	3	SW NW

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE

Twp	Rng	Mer	Sec	Q-Q
15 S	16 E	WM	3	SE NW
15 S	16 E	WM	3	NE SW
15 S	16 E	WM	3	NW SW
15 S	16 E	WM	3	SW SW
15 S	16 E	WM	3	SE SW
15 S	16 E	WM	3	NE SE
15 S	16 E	WM	3	NW SE
15 S	16 E	WM	3	SW SE
15 S	16 E	WM	3	SE SE
15 S	16 E	WM	4	NE NE
15 S	16 E	WM	4	NW NE
15 S	16 E	WM	4	SW NE
15 S	16 E	WM	4	SE NE
15 S	16 E	WM	4	NE NW
15 S	16 E	WM	4	NW NW
15 S	16 E	WM	4	SW NW
15 S	16 E	WM	4	SE NW
15 S	16 E	WM	4	NE SW
15 S	16 E	WM	4	NW SW
15 S	16 E	WM	4	SW SW
15 S	16 E	WM	4	SE SW
15 S	16 E	WM	4	NE SE
15 S	16 E	WM	4	NW SE
15 S	16 E	WM	4	SW SE
15 S	16 E	WM	4	SE SE
15 S	16 E	WM	5	NE NE
15 S	16 E	WM	5	NW NE
15 S	16 E	WM	5	SW NE
15 S	16 E	WM	5	SE NE
15 S	16 E	WM	5	NE NW
15 S	16 E	WM	5	NW NW
15 S	16 E	WM	5	SW NW
15 S	16 E	WM	5	SE NW
15 S	16 E	WM	5	NE SW
15 S	16 E	WM	5	NW SW
15 S	16 E	WM	5	SW SW
15 S	16 E	WM	5	SE SW
15 S	16 E	WM	5	NE SE
15 S	16 E	WM	5	NW SE
15 S	16 E	WM	5	SW SE
15 S	16 E	WM	5	SE SE
15 S	16 E	WM	6	NE NE
15 S	16 E	WM	6	NW NE
15 S	16 E	WM	6	SW NE
15 S	16 E	WM	6	SE NE
15 S	16 E	WM	6	NE NW
15 S	16 E	WM	6	NW NW
15 S	16 E	WM	6	SW NW
15 S	16 E	WM	6	SE NW
15 S	16 E	WM	6	NE SW

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE				
Twp	Rng	Mer	Sec	Q-Q
15 S	16 E	WM	6	NW SW
15 S	16 E	WM	6	SW SW
15 S	16 E	WM	6	SE SW
15 S	16 E	WM	6	NE SE
15 S	16 E	WM	6	NW SE
15 S	16 E	WM	6	SW SE
15 S	16 E	WM	6	SE SE
15 S	16 E	WM	7	NE NE
15 S	16 E	WM	7	NW NE
15 S	16 E	WM	7	SW NE
15 S	16 E	WM	7	SE NE
15 S	16 E	WM	7	NE NW
15 S	16 E	WM	7	NW NW
15 S	16 E	WM	7	SW NW
15 S	16 E	WM	7	SE NW
15 S	16 E	WM	7	NE SW
15 S	16 E	WM	7	NW SW
15 S	16 E	WM	7	SW SW
15 S	16 E	WM	7	SE SW
15 S	16 E	WM	7	NE SE
15 S	16 E	WM	7	NW SE
15 S	16 E	WM	7	SW SE
15 S	16 E	WM	7	SE SE
15 S	16 E	WM	8	NE NE
15 S	16 E	WM	8	NW NE
15 S	16 E	WM	8	SW NE
15 S	16 E	WM	8	SE NE
15 S	16 E	WM	8	NE NW
15 S	16 E	WM	8	NW NW
15 S	16 E	WM	8	SW NW
15 S	16 E	WM	8	SE NW
15 S	16 E	WM	8	NE SW
15 S	16 E	WM	8	NW SW
15 S	16 E	WM	8	SW SW
15 S	16 E	WM	8	SE SW
15 S	16 E	WM	8	NE SE
15 S	16 E	WM	8	NW SE
15 S	16 E	WM	8	SW SE
15 S	16 E	WM	8	SE SE
15 S	16 E	WM	9	NE NE
15 S	16 E	WM	9	NW NE
15 S	16 E	WM	9	SW NE
15 S	16 E	WM	9	SE NE
15 S	16 E	WM	9	NE NW
15 S	16 E	WM	9	NW NW
15 S	16 E	WM	9	SW NW
15 S	16 E	WM	9	SE NW
15 S	16 E	WM	9	NE SW
15 S	16 E	WM	9	NW SW
15 S	16 E	WM	9	SW SW

MUNICIPAL USES WITHIN THE MUNICIPAL SERVICE BOUNDARY OF THE CITY OF PRINEVILLE				
Twp	Rng	Mer	Sec	Q-Q
15 S	16 E	WM	9	SE SW
15 S	16 E	WM	9	NE SE
15 S	16 E	WM	9	NW SE
15 S	16 E	WM	9	SW SE
15 S	16 E	WM	9	SE SE

Permit Amendment T-12192 Conditions

The combined quantity of water diverted at the new point of appropriation, City Airport Well 4, together with that diverted at the old points of appropriation, City Airport Wells 1, 2 and 3, shall not exceed the quantity of water lawfully available at the original points of appropriation, City Airport Wells 1 and 2.

Water shall be acquired by City Airport Well 4 from the same aquifer as the original points of appropriation, City Airport Wells 1 and 2.

Water use measurement conditions:

a. Before water use may begin under this order, the water user shall install a totalizing flow meter, or, with prior approval of the Director, another suitable measuring device at each new point of appropriation.

b. The water user shall maintain the meter or measuring device in good working order.

c. The water user shall allow the Watermaster access to the meter or measuring device; provided however, where the meter or measuring device is located within a private structure, the Watermaster shall request access upon reasonable notice.

The permittee shall an updated Water Management and Conservation Plan pursuant to OAR Chapter 690, Division 86 no later than November 19, 2019.

Permit Amendment T-11647 Conditions

The combined quantity of water diverted at the new points of appropriation, City Airport Well 3, together with that diverted at the old points of appropriation, City Airport Wells 1 and 2, shall not exceed the quantity of water lawfully available at the original points of appropriation, City Airport Wells 1 and 2.

Water shall be acquired by City Airport Well 3 from the same aquifer as the original points of appropriation, City Airport Wells 1 and 2.

Permit Amendment T-10378 Conditions

The combined quantity of water diverted at the new points of appropriation (wells), together with that diverted at the old points of appropriation, shall not exceed the maximum rate and duty allowed under Permit G-16146.

Water shall be acquired from the same aquifer as the original points of appropriation.

Measurement, recording and reporting conditions:

A. Before water use may begin under this permit, the permittee shall install a totalizing flow meter on each well. The totalizing flow meter must be installed and maintained in good working order consistent with those standards identified in OAR 690-507-645(1) through 3. The permittee shall keep a complete record of the amount of water used each month and shall submit a report which includes the recorded water use measurements to the Department annually or more frequently as may be required by the Director. Further, the Director may require the permittee to report general water use information, including the place and nature of use of water under the permit.

B. The permittee shall allow the watermaster access to the meters; provided however, where the meter is located within a private structure, the watermaster shall request access upon reasonable notice.

Use of water under authority of this permit may be regulated if analysis of data available after the permit is issued discloses that the appropriation will measurably reduce the surface water flows necessary to maintain the free-flowing character of a scenic waterway in quantities necessary for recreation, fish and wildlife in effect as of the priority date of the right or as those quantities may be subsequently reduced. However, the use of ground water allowed under the terms of this permit will not be subject to regulation for Scenic Waterway flows so long as mitigation is maintained.

To monitor the effect of water use from the well(s) authorized under this permit, the Department requires the water user to make and report annual static water level measurements. The static water level shall be measured in the month of March. Reports shall be submitted to the Department within 30 days of measurement.

Measurements must be made according to the following schedule:

Before Use of Water Takes Place

Initial and Annual Measurements

The Department requires the permittee to submit an initial water level measurement in the month specified above once well construction is complete and annually thereafter until use of water begins; and

After Use of Water has Begun

Seven Consecutive Annual Measurements

Following the first year of water use, the user shall submit seven consecutive annual reports of static water level measurements. The first of these seven annual measurements will establish the reference level against which future annual measurements will be compared. Based on an analysis of the data collected, the Director may require that the user obtain and report additional annual static water level measurements beyond the seven year minimum reporting period. The additional measurements may be required in a different month. If the measurement requirement is stopped, the Director may restart it at any time.

All measurements shall be made by a certified water rights examiner, registered professional geologist, registered professional engineer, licensed well constructor or pump installer licensed by the Construction Contractors Board and be submitted to the Department on forms provided by the Department. The Department requires the individual performing the measurement to:

A. Identify each well with its associated measurement; and
B. Measure and report water levels to the nearest tenth of a foot as depth-to-water below ground surface; and
C. Specify the method used to obtain each well measurement; and
D. Certify the accuracy of all measurements and calculations submitted to the Department.

The water user shall discontinue use of, or reduce the rate or volume of withdrawal from, the well(s) if any of the following events occur:

A. Annual water level measurements reveal an average water level decline of three or more feet per year for five consecutive years; or
B. Annual water level measurements reveal a water level decline of 15 or more feet in fewer than five consecutive years; or
C. Annual water level measurements reveal a water level decline of 25 or more feet; or
D. Hydraulic interference leads to a decline of 25 or more feet in any neighboring well with senior priority.

The period of non or restricted use shall continue until the water level rises above the decline level which triggered the action or until the Department determines, based on the permittee's and/or the Department's data and analysis, that no action is necessary because the aquifer in question can sustain the observed declines without adversely impacting the resource or senior water rights. The water user shall in no instance allow excessive decline, as defined in Commission rules, to occur within the aquifer as a result of use under this permit. If more than one well is involved, the water user may submit an alternative measurement and reporting plan for review and approval by the Department.

GROUND WATER MITIGATION CONDITIONS

Mitigation Obligation:	496.8 acre-feet of mitigation water in the Crooked River Zone of Impact (anywhere in the Crooked River Basin above River Mile 13.8)
Mitigation Source:	Mitigation Credits or a Mitigation Project, in accordance with the incremental development plan on file with the Department, meeting the requirements of OAR Chapter 690, Division 505 (Deschutes Ground Water Mitigation Rules). The first stage of incremental development was met with 104.4 AF of mitigation, being mitigation water resulting from Mitigation Project MP-25, a permanent instream transfer that meets the requirements of OAR 690-505-0610(2)-(5), within the Crooked River Zone of Impact.

Mitigation water must be legally protected instream for instream use within the Crooked River Zone of Impact and committed for life of the permit and subsequent certificate(s). Regulation of the use and/or cancellation of the permit, or subsequent certificate(s) will occur if the required mitigation is not maintained.

If mitigation is from a secondary right for stored water from a storage project not owned or operated by the permittee, the use of water under this right is subject to the terms and conditions of a valid contract, or a satisfactory replacement, with the owner/operator of the storage project, a copy of which must be on file in the records of the Water Resources Department prior to use of water.

The permittee shall provide additional mitigation if the Department determines that average annual consumptive use of the subject appropriation has increased beyond the originally mitigated amount.

The permittee shall provide mitigation prior to each stage of development under the permit, as described in the incremental development mitigation plan on file with the Department, and in accordance with the standards of the Deschutes Ground Water Mitigation Rules, OAR Chapter 690, Division 505.

The permittee shall not increase the rate or amount of water diverted, as described in the incremental development mitigation plan, prior to increasing the corresponding mitigation.

The permittee shall seek and receive Department approval prior to changing the incremental mitigation development plan and related mitigation obligation for each stage of permit development.

The permittee shall report to the Department the progress of implementing the incremental mitigation development plan and related mitigation no later than April 1 of each year. This annual notification is not necessary if the permittee has completed development and submitted a Claim of Beneficial Use to the Department.

The permittee shall submit a new or updated Water Management and Conservation Plan pursuant to OAR Chapter 690, Division 86 by December 29, 2008.

Failure to comply with these mitigation conditions shall result in the Department regulating the ground water permit, or subsequent certificate(s), proposing to deny any permit extension application for the ground water permit, and proposing to cancel the ground water permit, or subsequent certificate(s).

STANDARD CONDITIONS

If substantial interference with a senior water right occurs due to withdrawal of water from any well listed on this permit, then use of water from the well(s) shall be discontinued or reduced and/or the schedule of withdrawal shall be regulated until or unless the Department approves or implements an alternative administrative action to mitigate the interference. The Department encourages junior and senior appropriators to jointly develop plans to mitigate interferences.

The wells shall be constructed in accordance with the General Standards for the Construction and Maintenance of Water Wells in Oregon. The works shall be equipped with a usable access port, and may also include an airline and pressure gauge adequate to determine water level elevation in the well at all times.

The use shall conform to such reasonable rotation system as may be ordered by the proper state officer.

Prior to receiving a certificate of water right, the permit holder shall submit the results of a pump test meeting the department's standards, to the Water Resources Department. The Director may require water level or pump test results every ten years thereafter.

Failure to comply with any of the provisions of this permit may result in action including, but not limited to, restrictions on the use, civil penalties, or cancellation of the permit.

This permit is for the beneficial use of water without waste. The water user is advised that new regulations may require the use of best practical technologies or conservation practices to achieve this end.

By law, the land use associated with this water use must be in compliance with statewide land-use goals and any local acknowledged land-use plan.

The use of water shall be limited when it interferes with any prior surface or ground water rights.

The permit holder shall commence and complete the construction of any proposed works prior to October 29, 2026. The Department may order and allow an extension of time to complete construction or to perfect a water right beyond October 29, 2026.

Within one year after complete application of water to the proposed use, the permittee shall submit a claim of beneficial use, which includes a map and report, prepared by a Certified Water Rights Examiner (CWRE).

Issued June 1, 2016

Dwight French

Dwight French, Water Right Services Administrator, for
Thomas M. Byler, Director
Water Resources Department

APPENDIX E

Underground Injection Control Application

City of Prineville ASR Limited License Application

DEQ
State of Oregon
Department of Environmental Quality

Class V Underground Injection Control Authorization by Rule

Aquifer Storage & Recovery, Low Temperature Geothermal, Remediation, and Other UICs that **do not** Drain Stormwater

DEQ Use Only
Received:__________
Amount:__________
Check #: __________
From:__________
UIC #: __________

This form will be processed within two weeks of receipt. All sections must be filled out unless the form indicates that that a section is "optional." Instructions begin on page 2.

A. Fee for authorization by rule

Number of injection systems 1 x $125 = $125 (total payment) **Note: See Instructions for fees related to remediation projects**

B. Owner information

Organization: City of Prineville	Site contact: Eric Klann		
Mailing address: 387 NE Third Street	City: Prineville	State: OR	Zip code: 97754
Phone number: 541-447-5627	E-mail address: eklann@cityofprineville.com		

C. Facility information

Facility name: Prineville ASR			
Physical address: 4735 SW Airport Road	City: Prineville	State: OR	Zip code: 97754

D. Consultant information (optional)

Consultant contact name: Matt Kohlbecker	Company: GSI Water Solutions
Phone number: 971-200-8531	E-mail address: mkohlbecker@gsiws.com

E. UIC system type

☒ Aquifer Storage and Recovery (5R21, 2-ASR)	Limited License or Permit #:	
☐ Low Temp Geothermal (5A7, 2-Geo Heat Pump)	Water Right Permit or Certificate #:	
☐ Remediation (5X26, 2-Remediation)	ECSI Site ID and/or LUST #:	☐ Voluntary Cleanup Program
☐ Other	Describe fluid:	

F. Individual UIC information

1. ID: ASR-1	Fluid type: Groundwater	Status: ☐ Under Construction ☒ Active	Depth: 607 feet
☒ Site map is attached		Latitude: 44.279128	Longitude: -120.900743
2. ID:	Fluid type:	Status: ☐ Under Construction ☐ Active	Depth:
☐ Site map is attached		Latitude:	Longitude:
3. ID:	Fluid type:	Status: ☐ Under Construction ☐ Active	Depth:
☐ Site map is attached		Latitude:	Longitude:
4. ID:	Fluid type:	Status: ☐ Under Construction ☐ Active	Depth:
☐ Site map is attached		Latitude:	Longitude:

G. Signature of legally authorized representative

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

Signature of legally authorized representative	Date 10/8/2018		
Legally authorized representative: Eric Klann	Title: Public Works Director		
Mailing address: 387 NE Third Street	City: Prineville	State: OR	Zip code: 97754
Phone number: 541-447-5627	Email address: eklann@cityofprineville.com		

Revised date: 05/01/2018

Application Instructions for Class V Underground Injection Control Authorization by Rule

Important Note: This form is regularly updated. Always download a new copy of this form from DEQ's website when applying for rule authorization.

A. Fee for authorization by rule

A fee of $125 per UIC must be submitted with the application. DEQ waives the per UIC fee when the UIC is located at a remediation site, **and** remediation is being conducted under the DEQ Voluntary Cleanup Program. Fees for a remediation project that is not part of the Voluntary Cleanup Program fees can be discussed with the permit coordinator at 503-229-5623.

B. Owner information

Organization: the person, business, or public organization that controls the facility where the UIC is located. A business or public organization must be registered with the Oregon Secretary of State's Business Registry: http://egov.sos.state.or.us/br/pkg_web_name_srch_inq.login. Business registration information is available online at: http://sos.oregon.gov/business/Pages/register.aspx . If the company operates under an assumed business name, the organization name should be listed by the name of the legal representative. The organization will receive official DEQ correspondence.

Site contact: the person DEQ will contact for questions concerning the facility's UICs.

C. Facility information

Facility name: the name of the facility or business operation where the UIC is located.

Physical address: the physical location (not the mailing address) of the facility where the UIC is located.

D. Consultant information

Consultant: the individual hired by the organization to provide the applicant technical assistance.

C. UIC system type

Select a UIC type and provide the information to the right of the system type category.

D. Individual UIC information

If you are applying for authorization of more than four UICs, please provide the individual UIC information on a separate sheet of paper and attach it to this application.

- Enter the **ID** used to identify your UIC, **fluid type**, **status**, **depth**, **latitude** and **longitude** in decimal degrees NAD 83 datum for each UIC (for example,45.407666/-122.669015).
- A site map is required. The site map must show the UIC (labeled by name), property lines, adjoining streets, buildings, and a north arrow.

E. Signature of legally authorized representative

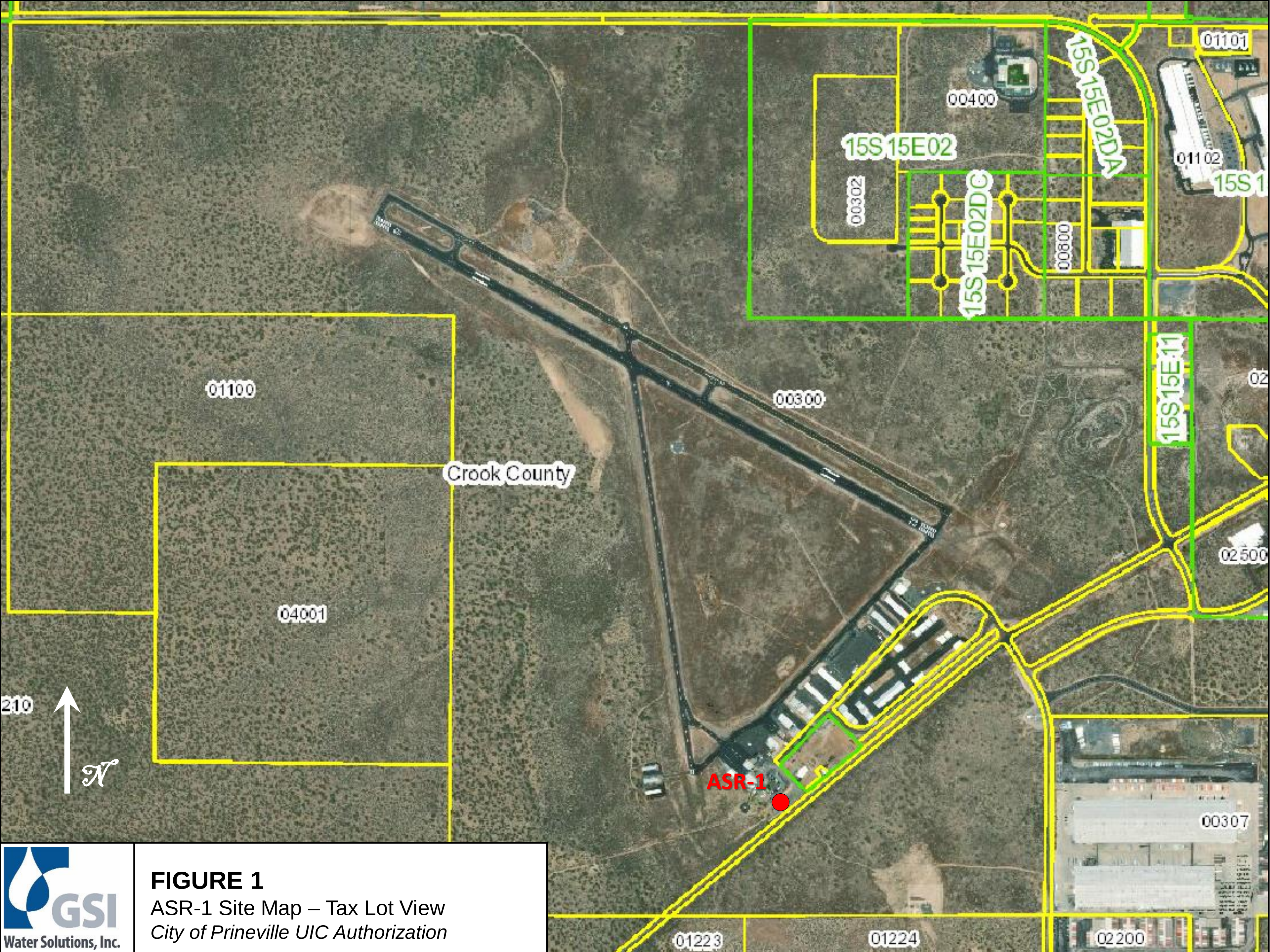
The signature and contact information of the person responsible for signing official according to the table below:

Entity	Legally Authorized Representative
Corporation	President, secretary, treasurer, vice-president, or any other person who performs principal business functions, or a manager of one or more facilities authorized in accordance to corporate procedure to sign such documents
Partnership	General partner
Sole Proprietorship	Owner(s)
City, County, State, Federal, Public Facility	Principal executive officer or ranking elected official
Limited Liability Company	Member
Trusts	Acting Trustee

Please submit a hard copy and an electronic copy of your application materials	
Submit a hard copy of your application and payment to: Oregon DEQ Attn: Business Office 700 NE Multnomah Suite 600 Portland, Oregon 97232-4100	**Submit an electronic copy of your application to:** UIC@deq.state.or.us
Call the UIC Permit Coordinator at 503-229-5623 with questions	

DEQ will discard oversize (larger than 11" by 17") application documentation, and other documentation that is not required.

Print



GSI Water Solutions, Inc.

FIGURE 1

ASR-1 Site Map – Tax Lot View

City of Prineville UIC Authorization

FIGURE 2

ASR-1 Site Map – Site View

City of Prineville UIC Authorization

APPENDIX G

Heliport Production Well Retrofit Drawings

City of Prineville ASR Limited License Application

GSI
Water Solutions, Inc.

James Nusrala
Plan Review
OHA Drinking Water Services
800 NE Oregon St, Ste 640
Portland, OR 97232-2162

October 5, 2018

RE: Documentation Supporting the Plan Review Process for the City of Prineville – Prineville Heliport Production Well Modification

Water System ID: City of Prineville OR41 00682

Dear Mr. Nusrala,

The City of Prineville (City) is in the planning process for retrofitting an existing City water supply production well that has been previously reviewed and approved by OHA. This well will be retrofitted to be used for Aquifer Storage and Recovery (ASR). The Heliport Production Well (OHA Well ID #: SRC-GC; CROO 54191; Well tag ID L-114180) is located on City property at Prineville Airport located on the Ochoco Highway southwest of Prineville. The City has explored the feasibility of an ASR program to secure adequate water resources for increasing water supply demands. The City plans to develop an ASR program targeting the Upper Aquifer in the vicinity of the airport, which is comprised of sand and gravel. No changes will be made to the seal or casing of the existing well during the retrofitting activities. Only changes to the above-ground pump and piping system will be completed during the retrofitting.

According to our conversations with the Oregon Health Authority (OHA), the modification of an existing well in the City's drinking water system requires that a variation of a New Well Plan Review, mandated by OAR 333-061-0060, be completed and submitted to OHA prior to construction. This letter and its attached supporting documents provide the information required by OHA for the City's Heliport production well modification at the Prineville Airport.

Supporting Documents

Plan Review Specific Requirements

- Site Location
- Tax Lot map with specific setback from potential contaminants
- Ownership radius of control map
- Drainage map and floodplain boundaries
- Planned above-ground pump and piping modifications

Figure 1 shows the Prineville Heliport production well site and includes a 500-foot buffer displaying there are no nearby water courses or areas within a 100-year floodplain boundary per requirements listed in OAR 333-061-0050 (2) (a) (f). The site is relatively flat with drainage as shown by arrows on Figure 1.

The City of Prineville owns the land at the Prineville Airport and the Heliport Production well is located on City property. Figure 1 also displays tax maps and a 100-foot buffer to illustrate the land area within 100-feet of the well is owned by the City or occupied by a public right-of-way (Oregon Highway 126) per requirements listed in OAR 333-061-0050 (2) (a) (B).

No known septic tanks or other potential contaminant sources are located near the well site.

The figures included in Attachment A present the proposed retrofit design.

Attachment B includes e-mail correspondence between the City's agent and OHA about Initial Plan Review requirement exemptions regarding existing well modifications. An OHA representative approved including only above-ground well monument and pump modifications to the well for the purpose of this Plan Review.

We are pleased to provide you this information to initiate the plan review process for beginning the modifications to the City of Prineville's Heliport Production well. We have enclosed the $3,300 Plan Review fee with this document.

If you require any additional information or have any questions, please do not hesitate to contact me. We look forward to your initial favorable review and continuing with the plan review process.

Respectfully submitted,

Bruce Brody-Heine

Bruce Brody-Heine, RG, CWRE
GSI Water Solutions, Inc.

Robyn Cook, RG
GSI Water Solutions, Inc.

Cc: Eric Klann, City of Prineville, City Engineer/Public Works Director

GSI File: 0224-030

Enclosed:
Figure 1
Attachment A – ASR Wellhead Modification Drawings
Attachment B – E-mail correspondence with OHA
Check in the amount of $3,300

FIGURE 1

Site Location Map

Prineville, Oregon

Township 15 S, Range 15 E,
Section 11 (W.M.)

LEGEND

- ⦿ Proposed Well
- — Sanitation Line
- ~ Elevation Contour
- ➡ Drainage Direction
- ▭ Tax Lot

N

0 60 120 180
Feet

Date: October 2, 2018
Data Sources: Crook Co. ESRI, USGS

GSI Water Solutions, Inc.

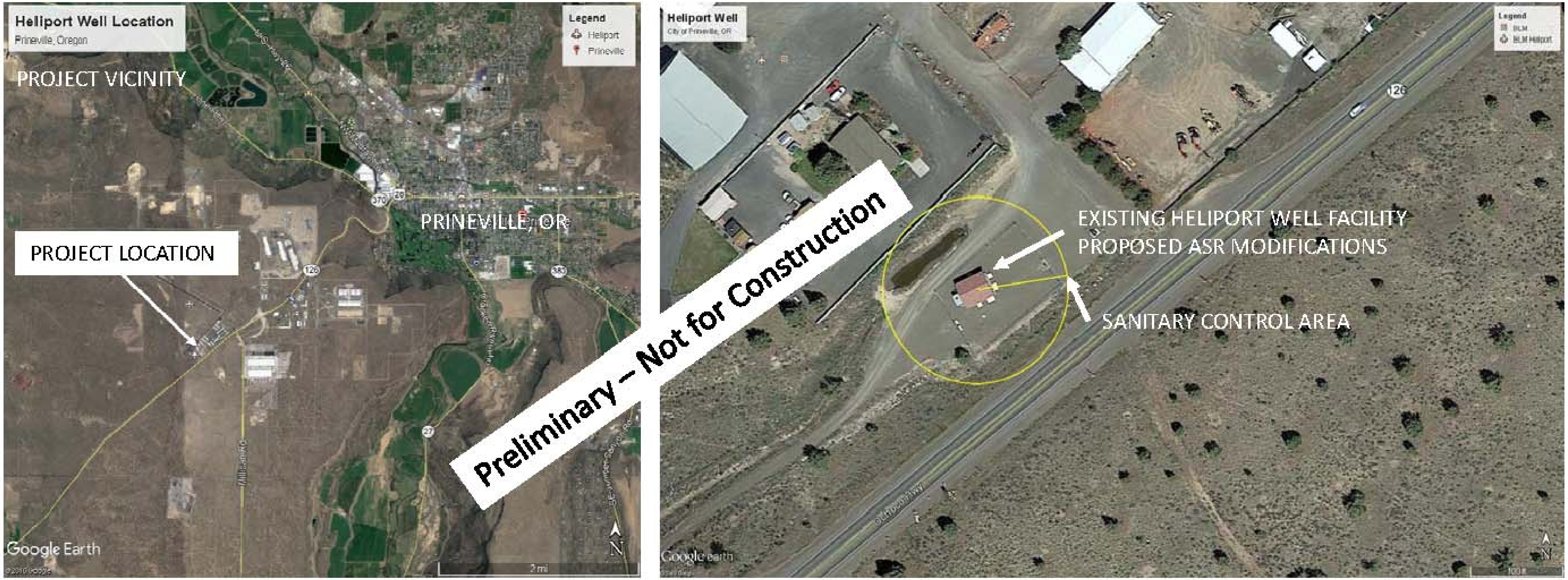
Document Path: Y:\0224_Prineville\Source_Figures\031_Ph2_ASR_LL_Application\OHA\Figure1_Site_Location.mxd

Attachment A

ASR Wellhead Modification Drawings

OHA Plan Review – Prineville Airport: Heliport ASR Well Modifications

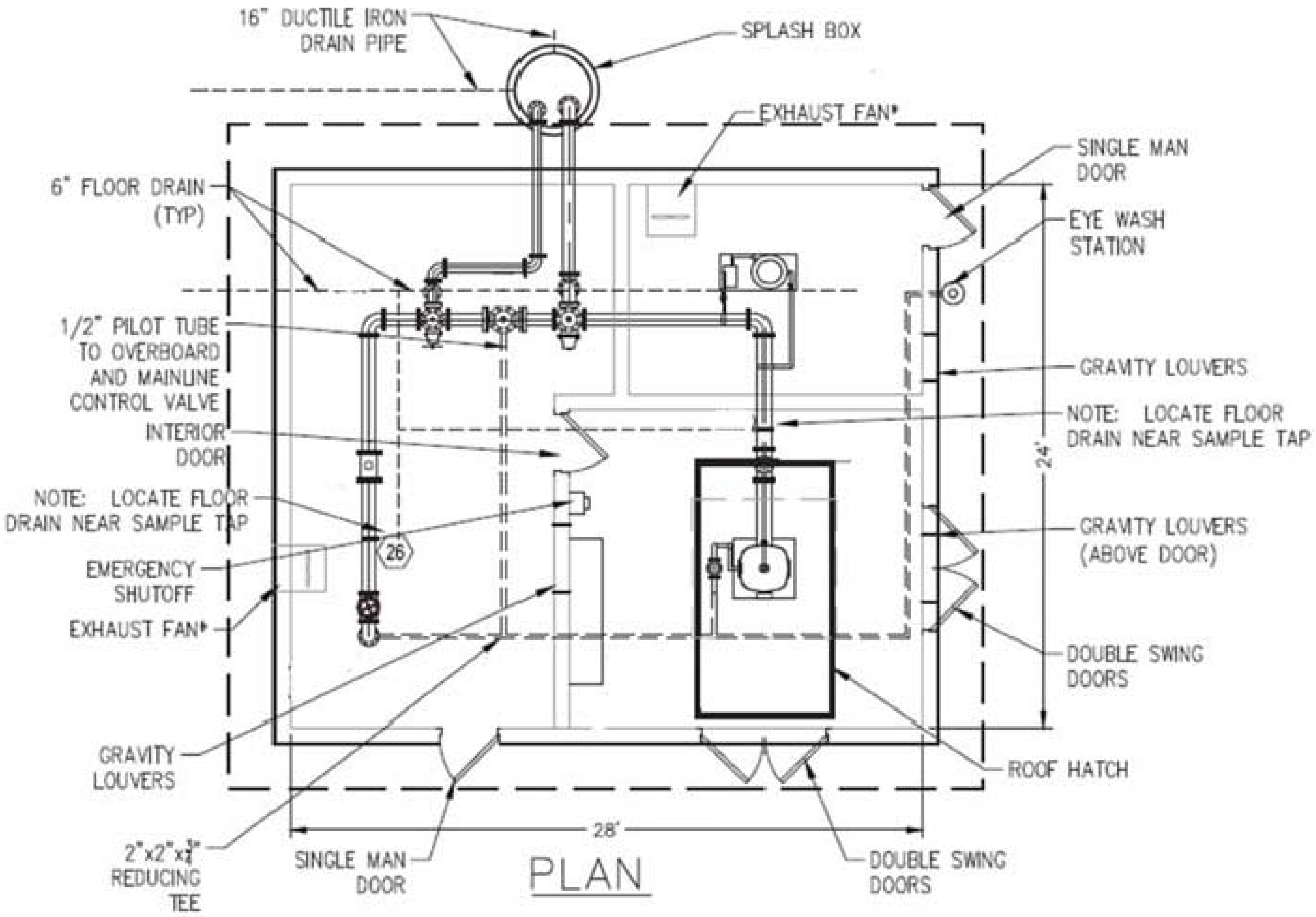
CITY OF PRINEVILLE
PROPOSED AQUIFER STORAGE AND RECOVERY MODIFICATIONS
HELIPORT WELL
LOCATED IN SE1/4 OF SW1/4, SECTION 11, T.15S, R.15E.
TAXLOT# 1515000000300



16528PE
Lee H Odell
May 18, 1993
LEE H. ODELL

FIGURE 1
EXISTING FACILITY LAYOUT
CITY OF PRINEVILLE, OR

Existing Well Piping Plan

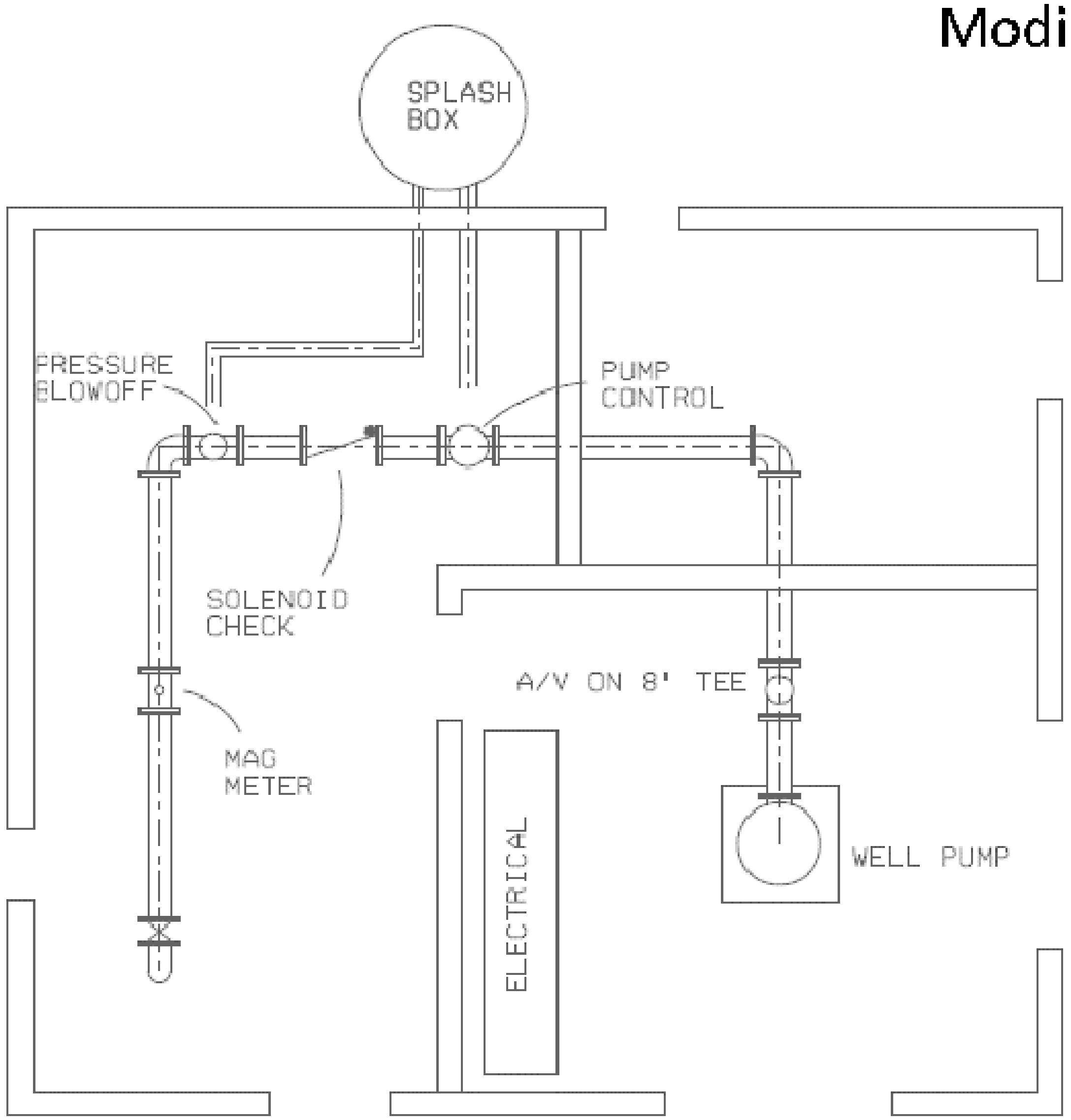


Preliminary – Not For Construction

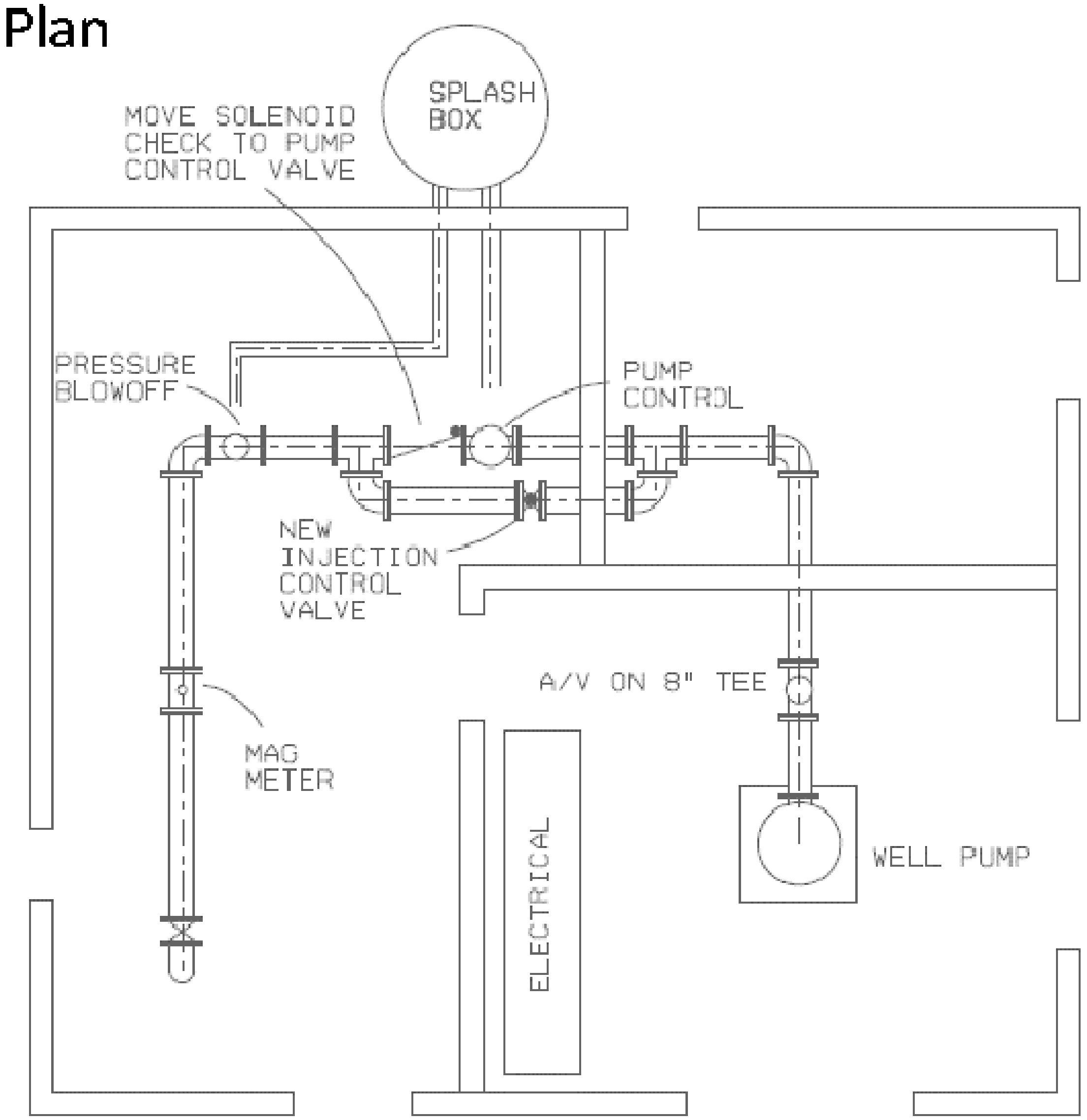
16528PE
Lee H Odell
OREGON
May 18, 1993
LEE H. ODELL

FIGURE 2
EXISTING FACILITY LAYOUT
CITY OF PRINEVILLE, OR

Proposed Well Piping Modifications Plan



EXISTING PIPING



MODIFIED PIPING

1. MOVE SOLENOID CHECK VALVE TO MOUNT ON PUMP CONTROL VALVE
2. ADD NEW 8" TEE
3. ADD ELBOW, STRAIGHT PIPE AND INJECTION CONTROL VALVE
4. BORE THRU BLOCK WALL
5. CUT IN NEW 8' TEE, ADD ELBOW, AND STRAIGHT PIPE
6. INJECTION NPIPING CAN BE 6" OR 8'
7. MAG METER MUST BE BI-DIRECTIONAL

REGISTERED PROFESSIONAL ENGINEER
16528PE
Lee H Odell
OREGON
May 18, 1993
LEE H. ODELL

Preliminary – Not For Construction

FIGURE 3
PROPOSED ASR MODIFICATIONS
CITY OF PRINEVILLE, OR

JACOBS

Attachment B

E-mail Correspondence with OHA

OHA Plan Review – Prineville Airport: Heliport ASR Well Modifications

From: GENTRY Carrie L
To: Robyn Cook
Cc: Trevor Grandy
Subject: RE: Plan review question
Date: Tuesday, September 25, 2018 11:26:26 AM

In that case, just the site map and above ground changes.

From: Robyn Cook <rcook@gsiws.com>
Sent: Tuesday, September 25, 2018 10:43 AM
To: GENTRY Carrie L <Carrie.L.GENTRY@dhsoha.state.or.us>
Cc: Trevor Grandy <tgrandy@gsiws.com>
Subject: RE: Plan review question

Hi Carrie,
Nope, only the pump system. Water will be injected through the existing pump column. They will be adding some valves to the above-ground piping.

Thanks,
Robyn

Robyn Cook, RG, PG
Hydrogeologist
direct: 971.200.8505 | mobile: 503.930.3382
55 SW Yamhill St., Suite 300, Portland, OR 97204
GSI Water Solutions, Inc. | www.gsiws.com

From: GENTRY Carrie L <Carrie.L.GENTRY@dhsoha.state.or.us>
Sent: Tuesday, September 25, 2018 10:15 AM
To: Robyn Cook <rcook@gsiws.com>
Cc: Trevor Grandy <tgrandy@gsiws.com>
Subject: RE: Plan review question

Robyn,

Can you clarify if there will be any alteration of the casing or the casing seal?

From: Robyn Cook <rcook@gsiws.com>
Sent: Monday, September 24, 2018 3:06 PM
To: GENTRY Carrie L <Carrie.L.GENTRY@dhsoha.state.or.us>
Cc: Trevor Grandy <tgrandy@gsiws.com>
Subject: Plan review question

Hello Carrie,
I have a slightly different project than our typical plan review. We have an existing production well for the City of Prineville that they want to retrofit to use for ASR. The system is OR41-00682, and the facility ID is SRC-GC. Since this is already an approved source, I wanted to see which elements of the

typical plan review you will need. Do you need to see the site map, well log, etc, or only the designs for the above-ground modifications?

Thank you,
Robyn

Robyn Cook, RG, PG
Hydrogeologist
direct: 971.200.8505 | mobile: 503.930.3382
55 SW Yamhill Street, Suite 300, Portland, OR 97204
GSI Water Solutions, Inc. | www.gsiws.com

APPENDIX H

Water Well Logs & Heliport Construction Drawing

City of Prineville ASR Limited License Application

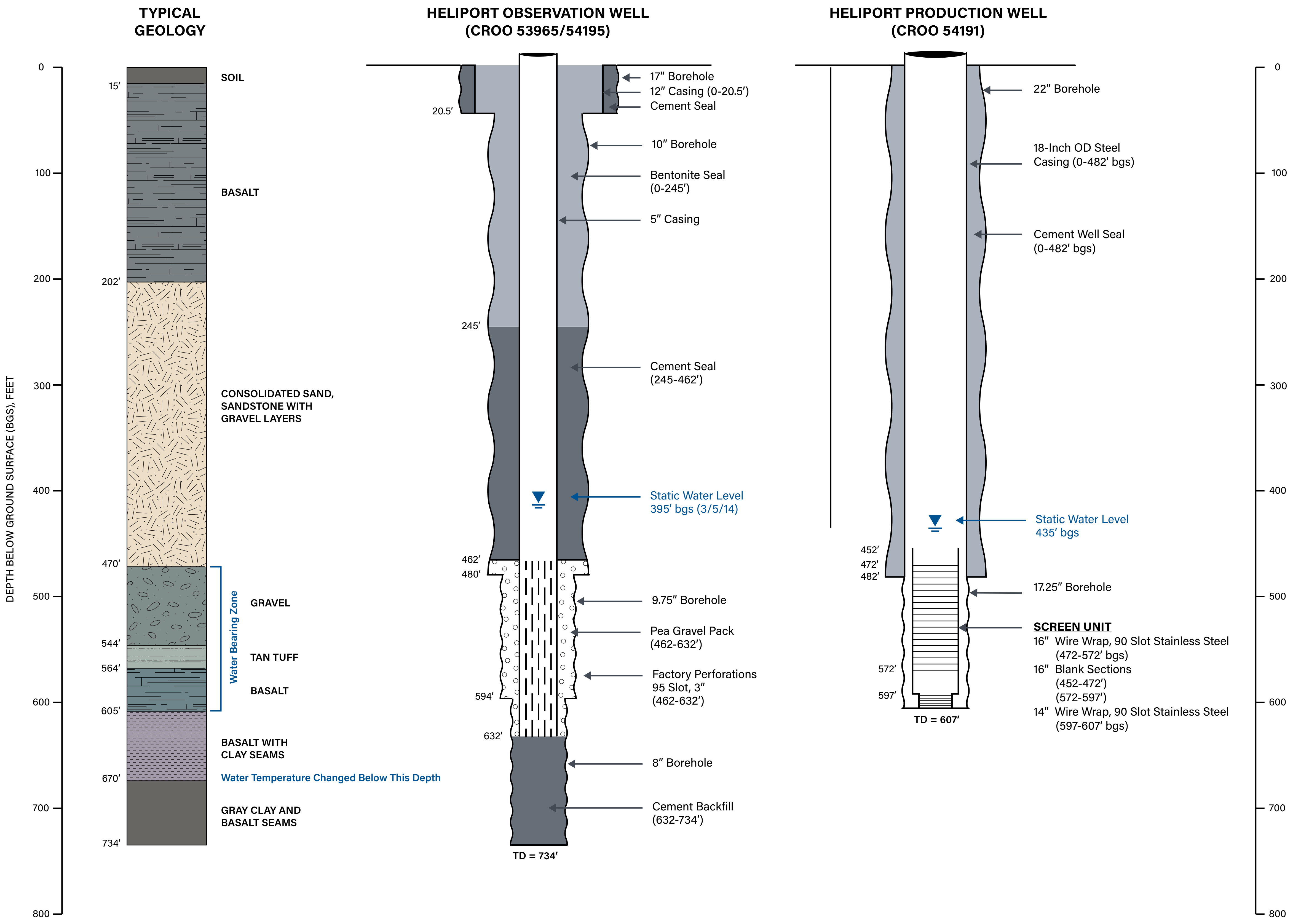


FIGURE 6

Well Construction Schematic of Heliport Production and Observation Wells and Proposed Design of Future ASR Wells

ASR Limited License Application and Pilot Test Work Plan

GSI Water Solutions, Inc.

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CROO 54191
12/29/2014

WELL I.D. LABEL# L 114180
START CARD # 1021882
ORIGINAL LOG #

(1) LAND OWNER

Owner Well I.D.
First Name Last Name
Company CITY OF PRINEVILLE
Address 387 N.E. THIRD STREET
City PRINEVILLE State OR Zip 97754

(2) TYPE OF WORK

☒ New Well ☐ Deepening ☐ Conversion
☐ Alteration (complete 2a & 10) ☐ Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:		☐				○	○	☐	☐

	Material	From	To	Amt	sacks/lbs
Seal:					

(3) DRILL METHOD

☒ Rotary Air ☒ Rotary Mud ☐ Cable ☐ Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☒ Community
☐ Industrial/ Commericial ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION

Special Standard ☐ (Attach copy)

Depth of Completed Well 607.00 ft.

BORE HOLE			SEAL				
Dia	From	To	Material	From	To	Amt	sacks/ lbs
22	0	482	Cement w/2% Bentonite	0	482	462	S
17.25	482	607					

How was seal placed: Method ☒ A ☐ B ☐ C ☐ D ☐ E
☐ Other
Backfill placed from ft. to ft. Material
Filter pack from ft. to ft. Material Size
Explosives used: ☐ Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
●	○	18	☒	2	482	.375	●	○	☒	☐
○	●	16	☐	452	472	.375	●	○	☒	☐
○	●	16	☐	572	597	.375	●	○	☒	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☐ Outside ☐ Other Location of shoe(s)
Temp casing ☐ Yes Dia From To

(7) PERFORATIONS/SCREENS

Perforations Method
Screens Type Wire wrap Material SS 304L

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Screen	Liner	16	472	572	.09			16
Screen	Liner	14	597	607	.09			14

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

● Pump ○ Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
780	26	575	120

Temperature 56 °F Lab analysis ☒ Yes By Umpqua Labs
Water quality concerns? ☐ Yes (describe below) TDS amount

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County CROOK Twp 15.00 S N/S Range 15.00 E E/W WM
Sec 11 1/4 of the 1/4 Tax Lot 300
Tax Map Number Lot
Lat ° ' " or 44.27911111 DMS or DD
Long ° ' " or -120.90075000 DMS or DD
○ Street address of well ● Nearest address
AIRPORT ROAD, PRINEVILLE, OREGON

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration			☐	
Completed Well	11/28/2014		☐	435

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found 340.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
1/20/2014	340	365	200		☐	340
3/3/2014	470	607	1200		☐	435
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation 3248.00

Material	From	To
Road Fill	0	3
Brown Caliche	3	14
Hard Gray Basalt	14	32
Broken Brown and Gray Basalt & Lost Circ	32	209
Sand & Gravels some brown clay	209	245
Brown Sandstone	245	340
Sandstone with Gravel Layer WB	340	365
Brown Sandstone	365	465
Broken Basalt, Gravel & Cinders	465	515
Gray Basalt with Gravel interbeds	515	545
Brown Sandstone Tuff	545	565
Hard Gray Basalt	565	607

Date Started 12/23/2013 Completed 5/30/2014

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number Date

Signed

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1385 Date 12/29/2014

Signed ROBERT BUCKNER (E-filed)

Contact Info (optional)

ORIGINAL - WATER RESOURCES DEPARTMENT

THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK Form Version:

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CROO 53965
4/26/2012

WELL I.D. LABEL# L 108442
START CARD # 1016032
ORIGINAL LOG #

(1) LAND OWNER

Owner Well I.D.
First Name Last Name
Company CITY OF PRINEVILLE
Address 387 NE THIRD ST
City PRINEVILLE State OR Zip 97754

(2) TYPE OF WORK

☒ New Well ☐ Deepening ☐ Conversion
☐ Alteration (complete 2a & 10) ☐ Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:		☐				○	○	☐	☐

	Material	From	To	Amt	sacks/lbs
Seal:					

(3) DRILL METHOD

☒ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☐ Community
☐ Industrial/ Commericial ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☒ Other TEST HOLE

(5) BORE HOLE CONSTRUCTION

Special Standard ☐ (Attach copy)
Depth of Completed Well 630.00 ft.

BORE HOLE			SEAL				
Dia	From	To	Material	From	To	Amt	sacks/ lbs
17	0	20.5	Bentonite Chips	0	20.5	28	S
10	20.5	480					
9.75	480	594					
8	594	734					

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☒ Other POURED DRY
Backfill placed from 630 ft. to 734 ft. Material CEMENT
Filter pack from ft. to ft. Material Size
Explosives used: ☐ Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
●	○	12	☒	2	20.5	.375	●	○	☒	☐
○	●	8	☒	1	594	.250	●	○	☒	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☐ Outside ☐ Other Location of shoe(s)
Temp casing ☐ Yes Dia From To

(7) PERFORATIONS/SCREENS

Perforations Method AIR PERFERATOR
Screens Type Material

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Perf	Liner	8	490	590	.125	2	2700	

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

○ Pump ○ Bailer ● Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
450		600	6

Temperature 61 °F Lab analysis ☐ Yes By
Water quality concerns? ☐ Yes (describe below) TDS amount

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County CROOK Twp 15.00 S N/S Range 15.00 E E/W WM
Sec 11 NE 1/4 of the SW 1/4 Tax Lot 300
Tax Map Number Lot
Lat ° ' " or DMS or DD
Long ° ' " or DMS or DD
○ Street address of well ● Nearest address

AIRPORT RD
PRINEVILLE,OR

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration			☐	
Completed Well	4/3/2012		☐	370

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found 460.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
3/19/2012	460	620	450		☐	370
					☐	
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation

Material	From	To
SAND PUMICE BROWN	0	2
CONGLOMERATE	2	15
LAVA GRAY	15	30
CREVICE	30	36
SOLID	36	44
CREVICE	44	48
SOLID	48	65
LAVA BROKEN	65	80
FRACTURED BROKEN NO RETURNS	80	98
LAVA GRAY HARD	98	196
LAVA FRACTURED	196	202
GRAVELS CONGLOMERATE LAYERS	202	445
SANDSTONE BROWN	445	470
GRAVELS CAVING	470	515
BASALT GRAVEL LENSES	515	544
TUFF TAN CLAY MIX	544	564
BASALT BROKEN	564	580
BASALT	580	605
BASALT INTERBEDDED	605	620

Date Started 3/12/2012 Complete 4/4/2012

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number 758 Date 4/17/2012

Signed THOMAS R PECK (E-filed)

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1720 Date 4/26/2012

Signed JACK ABBAS (E-filed)

Contact Info (optional) 541 548 2787

ORIGINAL - WATER RESOURCES DEPARTMENT

THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK Form Version:

WATER SUPPLY WELL REPORT - continuation page

CROO 53965

4/26/2012

WELL I.D. LABEL# L 108442

START CARD # 1016032

ORIGINAL LOG #

(2a) PRE-ALTERATION

Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
					○	○	☐	☐
					○	○	☐	☐
					○	○	☐	☐

Material	From	To	Amt	sacks/lbs

Water Quality Concerns

From	To	Description	Amount	Units

(5) BORE HOLE CONSTRUCTION

BORE HOLE			SEAL				
Dia	From	To	Material	From	To	Amt	sacks/ lbs

FILTER PACK

From	To	Material	Size

(10) STATIC WATER LEVEL

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)

(11) WELL LOG

Material	From	To
BASALT	620	640
BASALT CLAY SEAMS GRAY	640	670
CLAY GRAY SOME HARDNESS	670	708
BASALT GRAY	708	712
BASALT CLAY SEAMS BROWN	712	730
CLAY GRAY	730	734

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

(7) PERFORATIONS/SCREENS

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size

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

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Comments/Remarks

9 YARDS SAND GROUT 22 FEET - 96 FEET
3 YARDS SAND GROUT 140 FEET - 250 FEET
3 YARDS SAND GROUT 250 FEET - 340 FEET
4 YARDS SAND GROUT 320 FEET - 418 FEET
Cemented from 734-630' to reduce the potential of temperature influence on upper water producing zone

Page 1 of 1

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CROO 54024
12/21/2012

WELL I.D. LABEL# L 108442
START CARD # 1018690
ORIGINAL LOG # CROOK 53965

(1) LAND OWNER

Owner Well I.D.
First Name Last Name
Company CITY OF PRINEVILLE
Address 387 NE THIRD ST
City PRINEVILLE State OR Zip 97754

(2) TYPE OF WORK

☐ New Well ☐ Deepening ☐ Conversion
☒ Alteration (complete 2a & 10) ☐ Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:	8	☒	1	594	.250	●	○	☒	☐

	Material	From	To	Amt	sacks/lbs
Seal:					

(3) DRILL METHOD

☐ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger ☐ Cable Mud
☐ Reverse Rotary ☒ Other PUMP RIG

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☐ Community
☐ Industrial/ Commericial ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☒ Other TEST HOLE

(5) BORE HOLE CONSTRUCTION

Special Standard ☐ (Attach copy)
Depth of Completed Well 630.00 ft.

BORE HOLE			SEAL				
Dia	From	To	Material	From	To	Amt	sacks/ lbs
8	0	630					

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☒ Other DID NOT DISTURB
Backfill placed from ft. to ft. Material
Filter pack from ft. to ft. Material Size
Explosives used: ☐ Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
○	●	6	☐	570	630	.250	●	○	☒	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☐ Outside ☐ Other Location of shoe(s)
Temp casing ☐ Yes Dia From To

(7) PERFORATIONS/SCREENS

Perforations Method MACHINE
Screens Type Material

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Perf	Liner	6	577	630	.187	3	950	

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

○ Pump ○ Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Temperature °F Lab analysis ☐ Yes By
Water quality concerns? ☐ Yes (describe below) TDS amount

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County CROOK Twp 15.00 S N/S Range 15.00 E E/W WM
Sec 11 NE 1/4 of the SW 1/4 Tax Lot 300
Tax Map Number Lot
Lat ° ' " or DMS or DD
Long ° ' " or DMS or DD
○ Street address of well ● Nearest address

AIRPORT RD
PRINEVILLE,OR

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration	12/20/2012		☐	370
Completed Well	12/20/2012		☐	370

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
					☐	
					☐	
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation

Material	From	To

Date Started 12/20/2012 Complete 12/20/2012

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number 758 Date 12/21/2012

Signed THOMAS R PECK (E-filed)

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1720 Date 12/21/2012

Signed JACK ABBAS (E-filed)

Contact Info (optional)

ORIGINAL - WATER RESOURCES DEPARTMENT
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK Form Version:

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CROO 54195
12/31/2014

WELL I.D. LABEL# L 108442
START CARD # 1022370
ORIGINAL LOG # CROOK 53965

(1) LAND OWNER

Owner Well I.D.
First Name Last Name
Company CITY OF PRINEVILLE
Address 387 N.E. THIRD STREET
City PRINEVILLE State OR Zip 97754

(2) TYPE OF WORK

☐ New Well ☐ Deepening ☐ Conversion
☒ Alteration (complete 2a & 10) ☐ Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:		☐				○	○	☐	☐

	Material	From	To	Amt	sacks/lbs
Seal:					

(3) DRILL METHOD

☒ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☐ Community
☐ Industrial/ Commericial ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☒ Other WATER LEVEL MONITORING

(5) BORE HOLE CONSTRUCTION

Special Standard ☒ (Attach copy)

Depth of Completed Well 632.00 ft.

BORE HOLE

Dia	From	To
10	0	480
8	480	632

SEAL

Material	From	To	Amt	sacks/ lbs
Bentonite Chips	0	245	214	S

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E
☒ Other POURED DRY
Backfill placed from ft. to ft. Material
Filter pack from 462 ft. to 632 ft. Material GRAVEL Size pea gravel
Explosives used: ☐ Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
●	○	5	☒	1	632	.280	●	○	☒	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☐ Outside ☐ Other Location of shoe(s)
Temp casing ☐ Yes Dia From To

(7) PERFORATIONS/SCREENS

Perforations Method Factory Saw
Screens Type Material

Perf/ Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Perf	Casing	5	472	632	.095	3	1440	

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

○ Pump ○ Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Temperature 54 °F Lab analysis ☐ Yes By
Water quality concerns? ☐ Yes (describe below) TDS amount

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County CROOK Twp 15.00 S N/S Range 15.00 E E/W WM
Sec 11 1/4 of the 1/4 Tax Lot 300
Tax Map Number Lot
Lat ° ' " or 44.27911111 DMS or DD
Long ° ' " or -120.90077222 DMS or DD
○ Street address of well ● Nearest address
AIRPORT ROAD, PRINEVILLE, OREGON

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration	2/24/2014		☐	375
Completed Well	3/5/2014		☐	395

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
					☐	
					☐	
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation 3248.00

Material	From	To
Existing Well Bore	0	632

Date Started 2/24/2014 Completed 3/7/2014

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number Date
Signed

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1385 Date 12/31/2014
Signed ROBERT BUCKNER (E-filed)
Contact Info (optional)

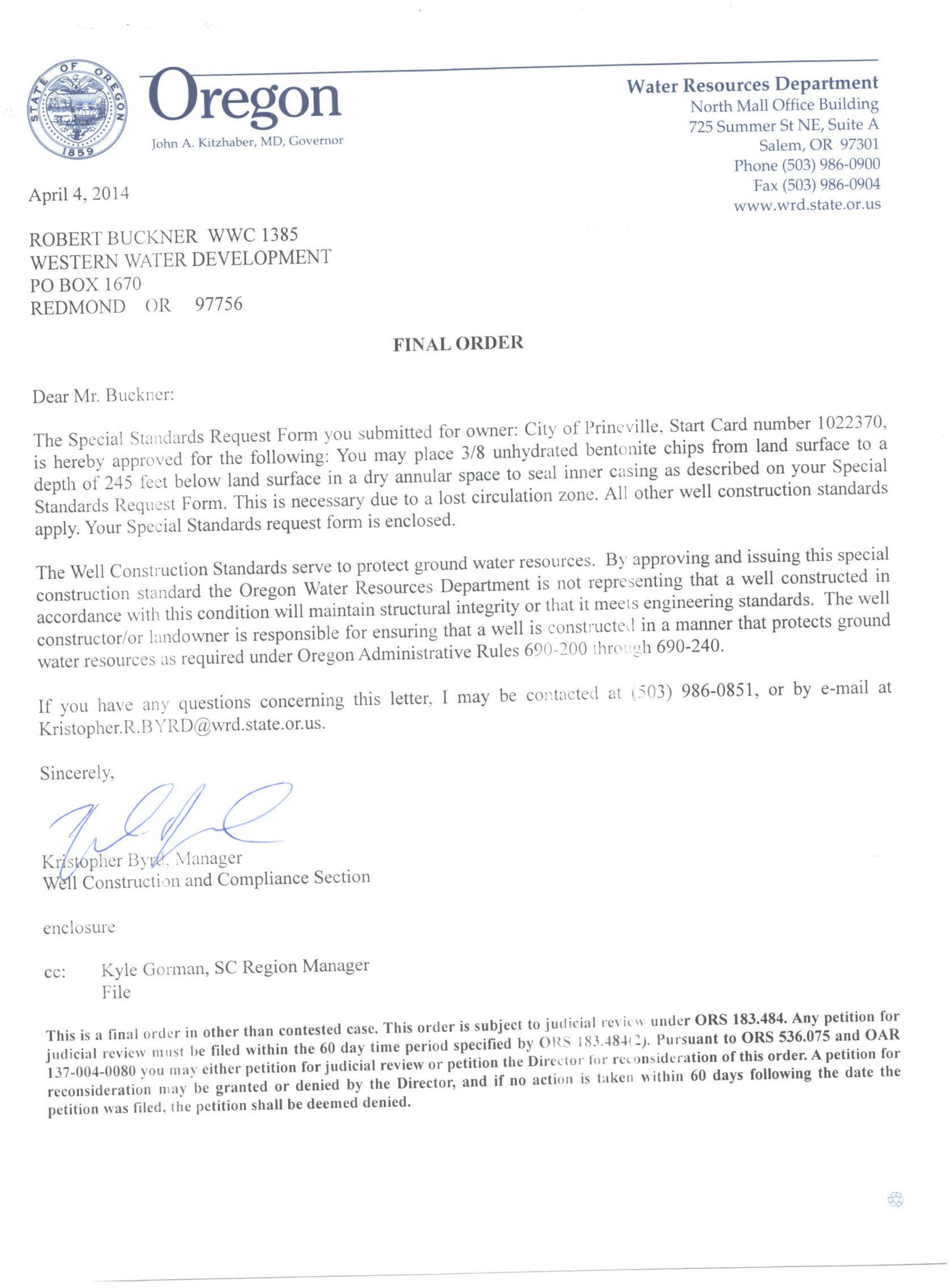
ORIGINAL - WATER RESOURCES DEPARTMENT
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK Form Version:

GEOTECHNICAL HOLE REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

CROO 54195

12/31/2014

Map of Hole



Oregon
John A. Kitzhaber, MD, Governor

Water Resources Department
North Mall Office Building
725 Summer St NE, Suite A
Salem, OR 97301
Phone (503) 986-0900
Fax (503) 986-0904
www.wrd.state.or.us

April 4, 2014

ROBERT BUCKNER WWC 1385
WESTERN WATER DEVELOPMENT
PO BOX 1670
REDMOND OR 97756

FINAL ORDER

Dear Mr. Buckner:

The Special Standards Request Form you submitted for owner: City of Prineville, Start Card number 1022370, is hereby approved for the following: You may place 3/8 unhydrated bentonite chips from land surface to a depth of 245 feet below land surface in a dry annular space to seal inner casing as described on your Special Standards Request Form. This is necessary due to a lost circulation zone. All other well construction standards apply. Your Special Standards request form is enclosed.

The Well Construction Standards serve to protect ground water resources. By approving and issuing this special construction standard the Oregon Water Resources Department is not representing that a well constructed in accordance with this condition will maintain structural integrity or that it meets engineering standards. The well constructor/or landowner is responsible for ensuring that a well is constructed in a manner that protects ground water resources as required under Oregon Administrative Rules 690-200 through 690-240.

If you have any questions concerning this letter, I may be contacted at (503) 986-0851, or by e-mail at Kristopher.R.BYRD@wrd.state.or.us.

Sincerely,

Kristopher Byrd, Manager
Well Construction and Compliance Section

enclosure

cc: Kyle Gorman, SC Region Manager
File

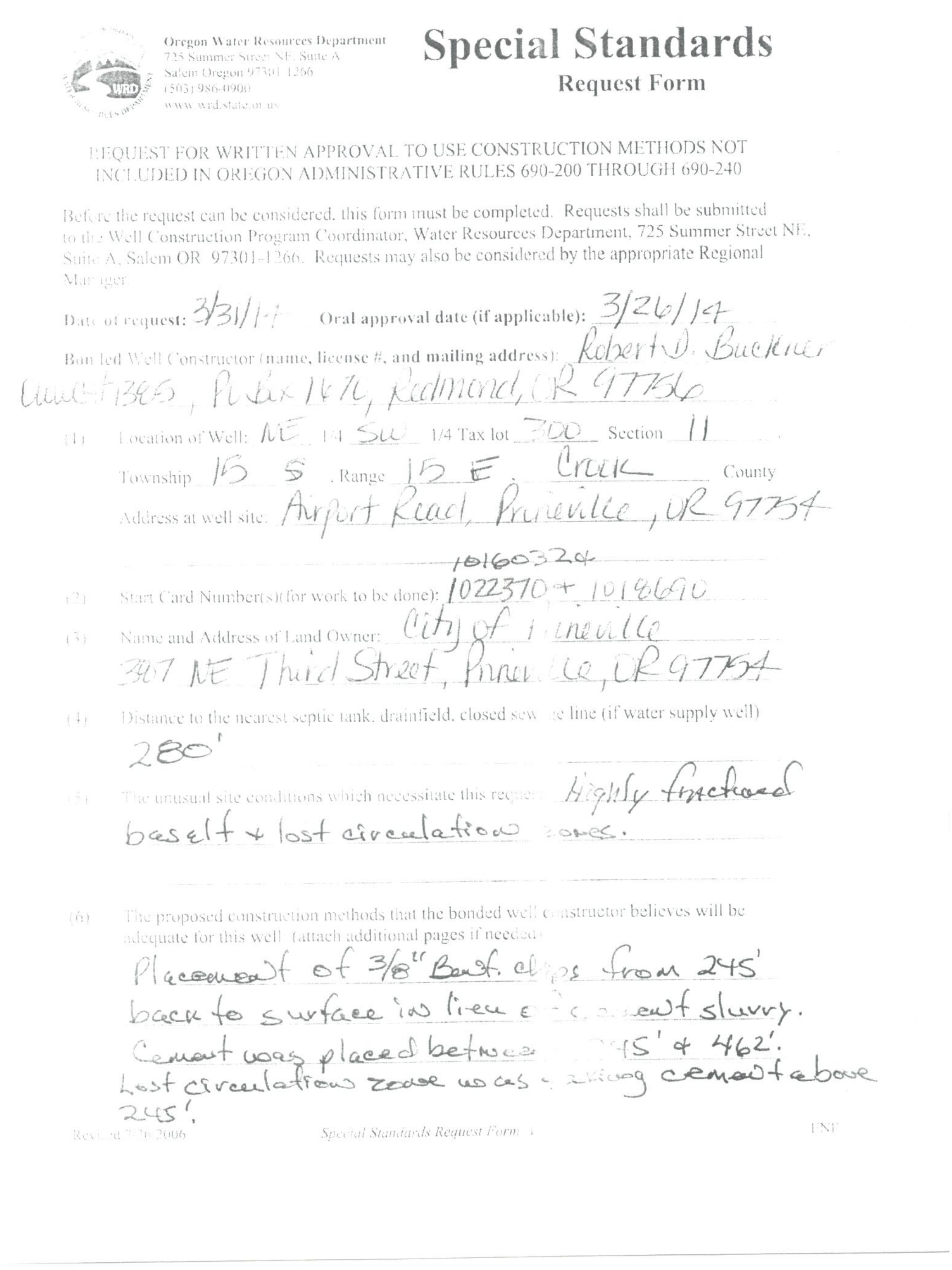
This is a final order in other than contested case. This order is subject to judicial review under ORS 183.484. Any petition for judicial review must be filed within the 60 day time period specified by ORS 183.484(2). Pursuant to ORS 536.075 and OAR 137-004-0080 you may either petition for judicial review or petition the Director for reconsideration of this order. A petition for reconsideration may be granted or denied by the Director, and if no action is taken within 60 days following the date the petition was filed, the petition shall be deemed denied.

GEOTECHNICAL HOLE REPORT - continuation page

CROO 54195

12/31/2014

Map of Hole



Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem Oregon 97301-1266
(503) 986-0900
www.wrd.state.or.us

Special Standards

Request Form

REQUEST FOR WRITTEN APPROVAL TO USE CONSTRUCTION METHODS NOT INCLUDED IN OREGON ADMINISTRATIVE RULES 690-200 THROUGH 690-240

Before the request can be considered, this form must be completed. Requests shall be submitted to the Well Construction Program Coordinator, Water Resources Department, 725 Summer Street NE, Suite A, Salem OR 97301-1266. Requests may also be considered by the appropriate Regional Manager.

Date of request: 3/31/14 **Oral approval date (if applicable):** 3/26/14

Bonded Well Constructor (name, license #, and mailing address): Robert D. Buckner CWC #1385, PO Box 1470, Redmond, OR 97756

(1) Location of Well: NE 1/4 SW 1/4 Tax lot 300 Section 11

Township 15 S, Range 15 E, Crook County

Address at well site: Airport Road, Prineville, OR 97754

10160324

(2) Start Card Number(s)(for work to be done): 1022370 + 1018690

(3) Name and Address of Land Owner: City of Prineville
307 NE Third Street, Prineville, OR 97754

(4) Distance to the nearest septic tank, drainfield, closed sewage line (if water supply well)
280'

(5) The unusual site conditions which necessitate this request: Highly fractured basalt & lost circulation zones.

(6) The proposed construction methods that the bonded well constructor believes will be adequate for this well (attach additional pages if needed):
Placement of 3/8" Bent. chips from 245' back to surface in lieu of cement slurry. Cement was placed between 245' & 462'. Lost circulation zone was taking cement above 245'.

Revised 7/26/2006 Special Standards Request Form ENF

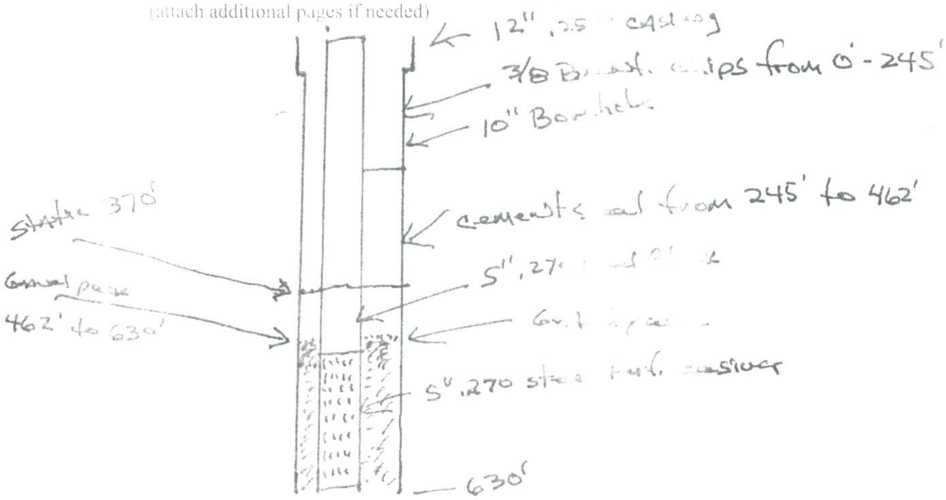
GEOTECHNICAL HOLE REPORT - continuation page

CROO 54195

12/31/2014

Map of Hole

(7) Diagram showing the pertinent features of the proposed well design and construction:
(attach additional pages if needed)



PLEASE NOTE:

(1) The Well Construction Standards serve to protect ground water resources. By approving and issuing this special construction standard the Oregon Water Resources Department is not representing that a well constructed in accordance with this condition will maintain structural integrity or that it meets engineering standards. The well constructor/or landowner is responsible for ensuring that a well is constructed in a manner that protects ground water resources as required under Oregon Administrative Rules 690-200 through 690-240.

(2) If it should be determined at some future date that the well, due to its construction, is allowing ground water contamination, waste or loss of artesian pressure, the undersigned shall return to the site and rectify the problem.

(3) If oral approval was granted, a written request must be submitted to the Department either within three (3) working days of the date of oral approval or prior to the completion of the associated well work. Failure to submit a written request as described above may void prior oral approval.

I have read and understand the above information. I further attest that the information provided is accurate to the best of my knowledge.

Bonded Constructor Signature: Robert Bu

Revised 7/28/2006 *Special Standards Request Form* ESF

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

CROO 53453

WELL ID # L 89932
(START CARD) # 190442

(1) OWNER:

Well Number: Airport#2
Name: City of Prineville
Address: 387 NE Third Street
City: Prineville State: OR Zip: 97754

(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 546 ft.
Explosives used ☐ Yes ☒ No Type Amount

HOLE			SEAL			Amount
Diameter	From	To	Material	From	To	sacks or pounds
22in	0	30	Cement Slurry	0	112	154 sacks
20in	30	335	Cement Slurry	403	452	66 sacks
18in	335	454				
15in	454	546				

How was seal placed: Method ☐ A ☐ B ☒ C ☐ D ☐ E
☐ Other
Backfill placed from 112 ft. to 403 ft. Material Bentonite Chips
Gravel placed from 442 ft. to 546 ft. Size of gravel 8x12

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	16	+2	452	.375	☒	☐	☒	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:	12in	442	447	.250	☒	☐	☒	☐
	12	452	474	.250	☒	☐	☒	☐

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:

☐ Perforations Method Factory - Roscoe Moss
☒ Screens Type Wire Wrap Material Stainless

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
447	452	.055		12	pipe	☐	☒
474	539	.055		12	pipe	☐	☒
						☐	☐
						☐	☐
						☐	☐

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

☒ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
700	11.5	475	24 hr.

Temperature of Water 54 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 Crook Latitude Longitude
Township 15S N or S. Range 15E E or W. of WM.
Section 11 NW 1/4 SE 1/4
Tax lot 303 Lot Block Subdivision
Street Address of Well (or nearest address) 4585 Airport,
Prineville, OR 97754

(10) STATIC WATER LEVEL:

408 ft. below land surface. Date 7/11/2007
Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:

Depth at which water was first found 420

From	To	Estimated Flow Rate	SWL
420	546	1000+	407

(12) WELL LOG:

Ground elevation

Material	From	To	SWL
Brown Clay & Rock	0	2	
Hard Gray Basalt	2	48	
Fractured Basalt Gray with Brown	48		
Seams		72	
Hard Gray Basalt with Green Seams	72	152	
Hard Gray with Brown Seams	152	197	
Soft Brown Sandstone Cong.	197	232	
Soft Sand Semi-Consolidated	232	270	
Loose Brown Sand	270	295	
Sand & Gravel	295	372	
Brown Conglomerate	372	420	
Brown Sandstone WB	420	442	408
Hard Gray Basalt	442	452	408
Semi Consolidated River Gravel WB	454	546	408

WESTERN WATER DEVELOPMENT
P.O. Box 1670
Redmond, OR 97756

RECEIVED
JUL 23 2007
WATER RESOURCES DEPT
SALEM, OREGO

Date started 4/13/2007 Completed 7/11/2007

(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 my best 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 1385
Signed Date 7/17/2007
Robert Buckner

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

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

CROO 53361

WELL ID # L 84248
(START CARD) # 190428

(1) OWNER:
Well Number: #2
Name CD Advisors, LLC
Address 1111 Main Street, Suite 700
City Vancouver State WA Zip 98660

(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 Test

(5) BORE HOLE CONSTRUCTION:
Special Construction approval ☐ Yes ☒ No Depth of Completed Well 555 ft.
Explosives used ☐ Yes ☒ No Type Amount

HOLE			SEAL			Amount
Diameter	From	To	Material	From	To	sacks or pounds
12	0	18	Bentonite	0	18	12 sacks
8	18	555				

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☒ Other Poured Dry
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:	8in	+2	18	.250	☒	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:	6in	-5	555	.188	☒	☐	☒	☐
					☐	☐	☐	☐

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:
☒ Perforations Method Factory Saw
☐ Screens Type Material

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
375	535	1/8	1920			☐	☒
						☐	☐
						☐	☐
						☐	☐
						☐	☐

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

Yield gal/min	Drawdown	Drill stem at	Time
190	12	425	8 hr.

Temperature of Water 67-71 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 Crook Latitude Longitude
Township 15S N or S. Range 15E E or W. of WM.
Section 4 NW 1/4 SW 1/4
Tax lot 1210 Lot Block Subdivision
Street Address of Well (or nearest address) Houston Lake Rd., Near DC Powerline, Powell Butte, OR

(10) STATIC WATER LEVEL:
358 ft. below land surface. Date 2/6/2007
Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:
Depth at which water was first found 372

From	To	Estimated Flow Rate	SWL
372	508	500-1000	358

(12) WELL LOG:
Ground elevation 3140

Material	From	To	SWL
Top Soil & Boulders	0	7	
Gray Basalt	7	28	
Broken Brown Basalt	28	43	
Broken Gray Basalt	43	84	
Lost Circulation	84	121	
Reddish Brown Broken Basalt	121	134	
Broken Gray Basalt	134	193	
Lost Circulation	193	287	
Brown Sandstone WB @ 372ft.	287	392	358
Cemented Sand & Gravels WB	392	445	358
Washed Gravel WB	445	451	358
Brown Claystone WB	451	460	385
Cemented Sands & Gravels WB	460	508	358
Brown Claystone	508	555	358

WESTERN WATER DEVELOPMENT
P.O. Box 1670
Redmond, OR 97756

Date started 2/1/2007 Completed 2/6/2007

(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 my best 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 1385
Signed Robert Buckner Date 2/27/2007
Robert Buckner

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

RECEIVED
MAR 01 2007
WATER RESOURCES DEPT
SALEM, OREGON

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

CROO 53956

02-18-2012

Page 1 of 2

WELL LABEL # L 108444

START CARD # 1015739

(1) LAND OWNER

Owner Well I.D. Milican 1
First Name ____ Last Name ____
Company CITY OF PRINEVILLE
Address 387 NE THIRD ST.
City PRINEVILLE State OR Zip 97754

(2) TYPE OF WORK

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

(3) DRILL METHOD

☒ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other ____

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☐ Community
☐ Industrial/ Commericial ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☒ Other TEST HOLE

(5) BORE HOLE CONSTRUCTION

Special Standard ☐ (Attach copy)
Depth of Completed Well 700.00 ft.

BORE HOLE			SEAL				
Dia	From	To	Material	From	To	Amt	sacks/ lbs
17.5	0	20.5	Bentonite Chips	0	20.5	23	S
10	20.5	700					

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☒ Other Poured Dry
Backfill placed from ____ ft. to ____ ft. Material ____
Filter pack from ____ ft. to ____ ft. Material ____ Size ____
Explosives used: ☐ Yes Type ____ Amount ____

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
●	○	12	☒	2	20.5	.375	●	○	☒	☐
○	●	8	☐	0	700	.250	●	○	☒	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☐ Outside ☐ Other Location of shoe(s) ____
Temp casing ☐ Yes Dia ____ From ____ To ____

(7) PERFORATIONS/SCREENS

Perforations Method Machine
Screens Type ____ Material ____

Perf/S creen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Perf	Liner	8	560	660	.125	3	1,520	

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

● Pump ○ Bailer ○ Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
340	110	550	120

Temperature 61 °F Lab analysis ☐ Yes By ____
Water quality concerns? ☐ Yes (describe below)

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County Crook Twp 15.00 S N/S Range 15.00 E E/W WM
Sec 11 NE 1/4 of the SW 1/4 Tax Lot 300
Tax Map Number ____ Lot ____
Lat ____ ° ____ ' ____ " or ____ DMS or DD
Long ____ ° ____ ' ____ " or ____ DMS or DD
○ Street address of well ● Nearest address
2900 S HWY 126 MILLICAN RD AND HWY 126

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Predeepening			☐	
Completed Well	01-27-2012		☐	368

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found 556

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
02-23-2012	556	610	300		☐	368
					☐	
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation ____

Material	From	To
Sand Pumice Brown	0	2
Lava Gray Hard	2	62
Lava Cinders	62	68
Lava Gray Hard Slight Fractures	68	90
Lava Gray Hard	90	130
Lava Hard Soft Layers	130	170
Lava Blue Gray Hard	170	212
Gravels Conglomerate	212	275
Sandstone Loose Sand Layers	275	305
Conglomerate Gravels Caving	305	340
Clay Conglomerate Layers	340	480
Sandstone Brown	480	525
Claystone Gray	525	535
Claystone Brown	535	556
Claystone Brown Broken with Pumice	556	610
Claystone Gray Brown Broken	610	650
Claystone Gray	650	700

Date Started 01-17-2012 Completed 01-27-2012

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number 758 Date 02-18-2012
Electronically Filed
Signed THOMAS R PECK (E-filed)

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1720 Date 02-18-2012
Electronically Filed
Signed JACK ABBAS (E-filed)
Contact Info (optional) ____

ORIGINAL - WATER RESOURCES DEPARTMENT
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK

Form Version: 0.95

WATER SUPPLY WELL REPORT - continuation page

CROO 53956

02-18-2012

WELL I.D. # L 108444

START CARD # 1015739

(5) BORE HOLE CONSTRUCTION

BORE HOLE

Dia	From	To

SEAL

Material	From	To	Amt	sacks/ lbs

FILTER PACK

From	To	Material	Size

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
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○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

(7) PERFORATIONS/SCREENS

Perf/Screen	Casing/ Liner	Screen Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size

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

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)

Water Quality Concerns

From	To	Description	Amount	Units

(10) STATIC WATER LEVEL

Water Bearing Zones

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
					☐	
					☐	
					☐	
					☐	
					☐	
					☐	
					☐	
					☐	
					☐	
					☐	

(11) WELL LOG

Material	From	To

Comments/Remarks

3 1/2 yards sand grout 180 feet - 280 feet
3 yards sand grout 262 feet - 380 feet

11.

CROO
532

RECEIVED
MAR 17 1993
WATER RESOURCES DEPT.
SALEM, OREGON

15S/15E/15ac

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

(START CARD) # 52642

(1) OWNER:
Well Number 01

Name John Ryan

Address 401 W.Antler Ave.

City Redmond State oregon Zip 97756

(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 495 ft.

Explosives used ☐ Yes ☒ No Type Amount

HOLE			SEAL			Amount
Diameter	From	To	Material	From	To	sacks or pounds
10"	0	20	Bentonite	0	20	12
6"	20	505				

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

☒ Other Poured Down Dry

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:	6"	+2.5	20	.250	☒	☐	☒	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:	5"	-5	485	.188	☒	☐	☒	☐
					☐	☐	☐	☐

Final location of shoe(s)

(7) PERFORATIONS/SCREENS:
☒ Perforations Method Electric Saw

☐ Screens Type Material

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
425	485	3/16	600			☐	☒
						☐	☐
						☐	☐
						☐	☐
						☐	☐

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

Yield gal/min	Drawdown	~~Drill stem at~~ Pump set at	Time
27	0	468	1 hr.

Temperature of Water 70 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 Crook Latitude Longitude

Township 15S N or S. Range 15E E or W. WM.

Section 15 SW ¼ NE ¼

Tax Lot 1210 Lot Block Subdivision

Street Address of Well (or nearest address) Hwy. 126,
Prineville, OR 97754

(10) STATIC WATER LEVEL:
448 ft. below land surface. Date 3/10/93

Artesian pressure lb. per square inch. Date

(11) WATER BEARING ZONES:
Depth at which water was first found 448 ft.

From	To	Estimated Flow Rate	SWL
462	505	45-50 gpm	448

(12) WELL LOG:
Ground elevation

Material	From	To	SWL
Top Soil & Brkn Rock	0	3	
Brown Basalt some Broken	3	14	
Black Basalt	14	36	
Brown Conglomerate	36	41	
Brown Sandstone	41	62	
Black Basalt	62	95	
Brown/Black Basalt	95	139	
Black Basalt/Green Seams	139	164	
Brown/Black Basalt	164	183	
Black Basalt/Green Seams	183	222	
Brown Sandstone	222	258	
Black Basalt	258	279	
Brown Sandstone	279	352	
Black Basalt/Green Seams	352	358	
Brown Sandstone	358	376	
Black Basalt/Green Seams	376	382	
Brown Sandstone	382	389	
Broken Black Basalt Caving	389	411	
Brown Sandstone	411	423	
Black Basalt/Green Seams	423	431	
Brown Sandstone	431	462	
Brown Sandstone Rounded WB	462	505	448

Date started 3/1/93 Completed 3/10/93

(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 Robert Buckner WWC Number 1385 Date 3/13/93

(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 Robert Buckner WWC Number 1385 Date 3/13/93

ORIGINAL & FIRST COPY - WATER RESOURCES DEPARTMENT SECOND COPY - CONSTRUCTOR THIRD COPY - CUSTOMER 9809C 10/91

STATE OF OREGON
MONITORING WELL REPORT
(as required by ORS 537.765 & OAR 690-240-095)

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

CROO
50990

WELL I.D.# L29311

Start Card # W120259

(1) OWNER/PROJECT: WELL NO. EB-3

Name Crook County Landfill
Address 300 E. 3rd Street
City Prineville State OR Zip 97754

(2) TYPE OF WORK: piezometer

☒ New construction ☐ Alteration (Repair/Recondition)
☐ Conversion ☐ Deepening ☐ Abandonment

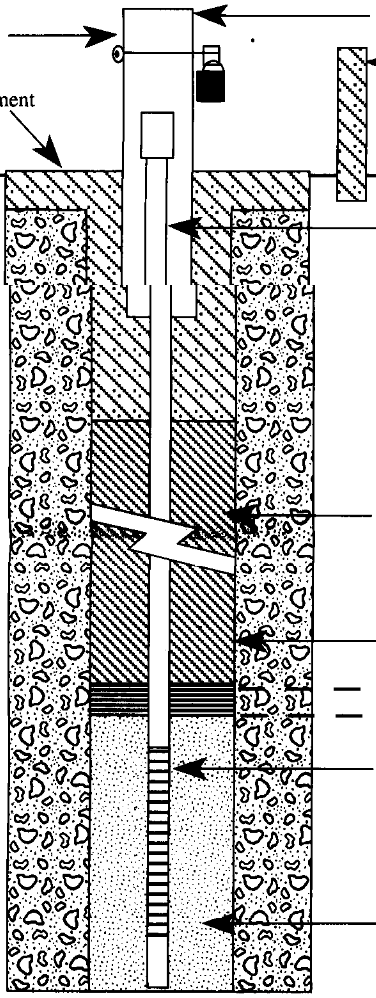
(3) DRILLING METHOD

☐ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Hollow Stem Auger ☒ Other Core NQ Wireline

BORE HOLE CONSTRUCTION

Special Standards Yes ☒ No ☐ Variance approved 4-23-99

Depth of completed well 401 ft.



Monument 0 ft. TO 2 ft.

Seal 2 ft. TO 368 ft.

Filter pack ___ ft. 368 TO 372 ft.
372 to 404.3 formation collapse

Casing diameter 1 in.
material Sch80 PVC
Welded ☐ Threaded ☒ Glued ☐

Liner diameter ___ in.
material ___
Welded ☐ Threaded ☐ Glued ☐

Well seal: 2'-32'/150#
Material bentonite
Amount chips
Grout weight 32'-368' 30% solids ben.grout/400#
Borehole diameter 3 in.

Bentonite plug at least 3 ft. thick

Screen material Sch80 PVC
interval(s):
From 391 To 401
From ___ To ___
Slot size .020 in.
Filter pack: 368'-370'
Material 30 mesh silica
Size 370-372' in. 8/12 silica

(5) WELL TEST: n/a piezometer

☐ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Permeability ___ Yield ___ GPM
Conductivity ___ PH ___
Temperature of water n/a °F/C Depth artesian flow found ___ ft.
Was water analysis done? ☐ Yes ☒ No
By whom? ___
Depth of strata to be analyzed. From ___ ft. to ___ ft.
Remarks: ___

Name of supervising Geologist/Engineer Rick Malin/Ann Ackerman

(6) LOCATION OF WELL By legal description

Well Location: County Crook
Township 15S (N or S) Range 15E (E or W) Section 3
1. NE 1/4 of NW 1/4 of above section.
2. **Either** Street address of well location 5601 SW Huston Lake Road, Prineville
or Tax lot number of well location 300
3. **ATTACH MAP WITH LOCATION IDENTIFIED. Map shall include approximate scale and north arrow.**

(7) STATIC WATER LEVEL:

362.96 Ft. below land surface. Date 6-07-99
Artesian Pressure ___ lb/sq. in. Date ___

(8) WATER BEARING ZONES:

Depth at which water was first found 390.3 (moist)

From	To	Est. Flow Rate	SWL
390.3	404.3	n/a moist	

(9) WELL LOG: Ground elevation ~~xx/xx~~ 3209.03

Material	From	To	SWL
Tuffaceous ash	0	9.2	
Basalt	9.2	79.3	
Volcaniclastic sandstone	79.3	137.2	
Sandstone	137.2	175.7	
Interbedded siltstone	175.7	214.6	
Claystone	214.6	248.0	
Vocaniclastic sandstone	248.0	361.8	
Ashy Claystone	361.8	388.2	
Silty sandstone	388.2	404.3	

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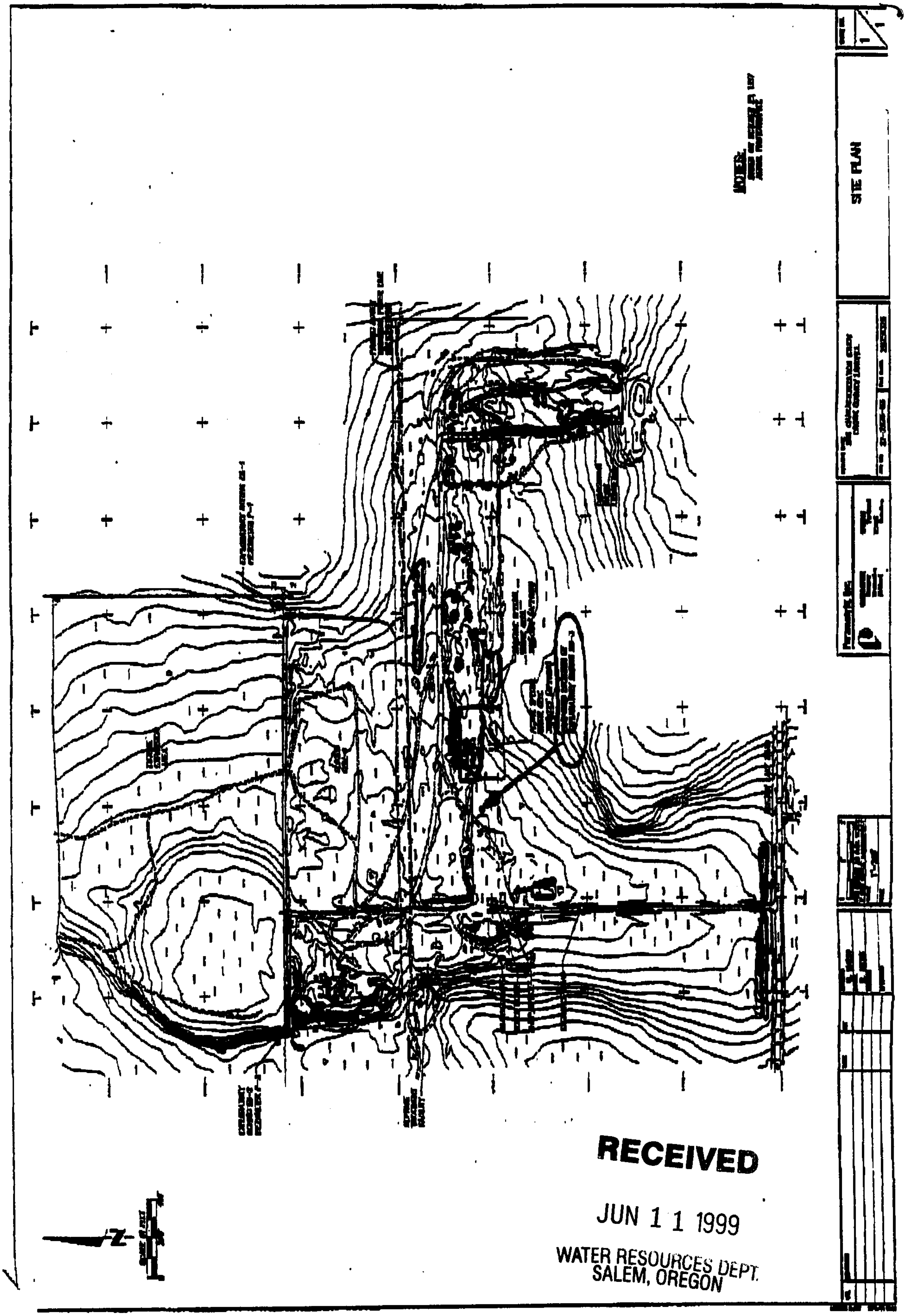
JUN 11 1999
WATER RESOURCES DEPT.
SALEM, OREGON

Date started 5-04-99 Completed 5-17-99

(unbonded) Monitor 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 the best knowledge and belief.
MWC Number ___
Signed ___ Date ___

(bonded) Monitor 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.
MWC Number 10333
Signed ___ Date 6-09-99

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


SITE PLAN
NOTES:

CROO 54287

Page 1 of 2

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765 & OAR 690-205-0210)

9/22/2015

WELL I.D. LABEL# L 118392
START CARD # 1027856
ORIGINAL LOG #

(1) LAND OWNER

Owner Well I.D.
First Name Last Name
Company LEGACY RANCHES, LLC.
Address 500 WEST MONROE STREET
City CHICAGO State IL Zip 60661

(2) TYPE OF WORK

☒ New Well ☐ Deepening ☐ Conversion
☐ Alteration (complete 2a & 10) ☐ Abandonment(complete 5a)

(2a) PRE-ALTERATION

	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
Casing:		☐				○	○	☐	☐

	Material	From	To	Amt	sacks/lbs
Seal:					

(3) DRILL METHOD

☒ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger ☐ Cable Mud
☐ Reverse Rotary ☐ Other

(4) PROPOSED USE

☐ Domestic ☐ Irrigation ☐ Community
☐ Industrial/ Commercial ☐ Livestock ☐ Dewatering
☐ Thermal ☐ Injection ☒ Other TEST HOLE - Commercial

(5) BORE HOLE CONSTRUCTION

Special Standard ☐ (Attach copy)

Depth of Completed Well 750.00 ft.

BORE HOLE

Dia	From	To
12	0	63
8	63	750

SEAL

Material	From	To	Amt	sacks/ lbs
Bentonite Chips	0	63	76	S
		Calculated	35.72	
		Calculated		

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☒ Other POURED DRY
Backfill placed from ft. to ft. Material
Filter pack from ft. to ft. Material Size
Explosives used: ☐ Yes Type Amount

(5a) ABANDONMENT USING UNHYDRATED BENTONITE

Proposed Amount Actual Amount

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd
●	○	8	☒	1	63	.250	●	○	☒	☐
○	●	6	☐	2	720	.188	○	●	☒	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐
○	○		☐				○	○	☐	☐

Shoe ☐ Inside ☐ Outside ☐ Other Location of shoe(s)
Temp casing ☐ Yes Dia From To

(7) PERFORATIONS/SCREENS

Perforations Method Holt Downhole
Screens Type Material

Perf/ Screen	Casing/ Screen Liner	Dia	From	To	Scrn/slot width	Slot length	# of slots	Tele/ pipe size
Perf	Liner	6	615	715	.25	1	2000	

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

○ Pump ○ Bailer ● Air ○ Flowing Artesian

Yield gal/min	Drawdown	Drill stem/Pump depth	Duration (hr)
350		740	1

Temperature 72 °F Lab analysis ☐ Yes By
Water quality concerns? ☐ Yes (describe below) TDS amount

From	To	Description	Amount	Units

(9) LOCATION OF WELL (legal description)

County CROOK Twp 15.00 S N/S Range 15.00 E E/W WM
Sec 10 SW 1/4 of the NE 1/4 Tax Lot 300
Tax Map Number Lot
Lat ° ' " or 44.28709000 DMS or DD
Long ° ' " or -120.91232200 DMS or DD
○ Street address of well ○ Nearest address
OFF AIRPORT WAY, PRINEVILLE, OREGON 97754

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration			☐	
Completed Well	9/4/2015		☐	381

Flowing Artesian? ☐ Dry Hole? ☐

WATER BEARING ZONES Depth water was first found 420.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
9/2/2015	381	390	25		☐	381
9/2/2015	635	750	350		☐	381
					☐	
					☐	
					☐	

(11) WELL LOG

Ground Elevation 3263.00

Material	From	To
Sandy Loam Top soil	0	3
Hard Gray Basalt	3	18
Broken Basalt & Cinders	18	56
Hard Gray Basalt	56	136
Brown Sandstone	136	147
Gray Fractured Basalt	147	163
Red Cinders	163	170
Hard Gray Fractured Basalt	170	205
Fractured Gray Basalt & Cinder Seams	205	230
Black Basalt & Brown Sandstone Seams	230	265
Brown Conglomerate	265	290
Hard Gray Basalt	290	330
Brown Sandy Conglomerate	330	350
Greenish Gray Sandy Clay	350	380
Sandstone Mostly Tan some Gray WB	380	560
Hard Claystone Tan & Some Gray	560	635
Sandstone & Busted Gray Basalt WB	635	695
Brown Sandstone, Gray Basalt some Cinder	695	750

Date Started 8/31/2015 Completed 9/4/2015

(unbonded) Water Well Constructor Certification

I certify that the work I performed on the construction, deepening, 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.

License Number Date

Signed

RECEIVED BY OWRD
OCT 15 2015
SALEM, OR

(bonded) Water Well Constructor Certification

I accept responsibility for the construction, deepening, 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.

License Number 1385 Date 9/22/2015

Signed ROBERT BUCKNER (E-filed)

Contact Info (optional)

ORIGINAL - WATER RESOURCES DEPARTMENT

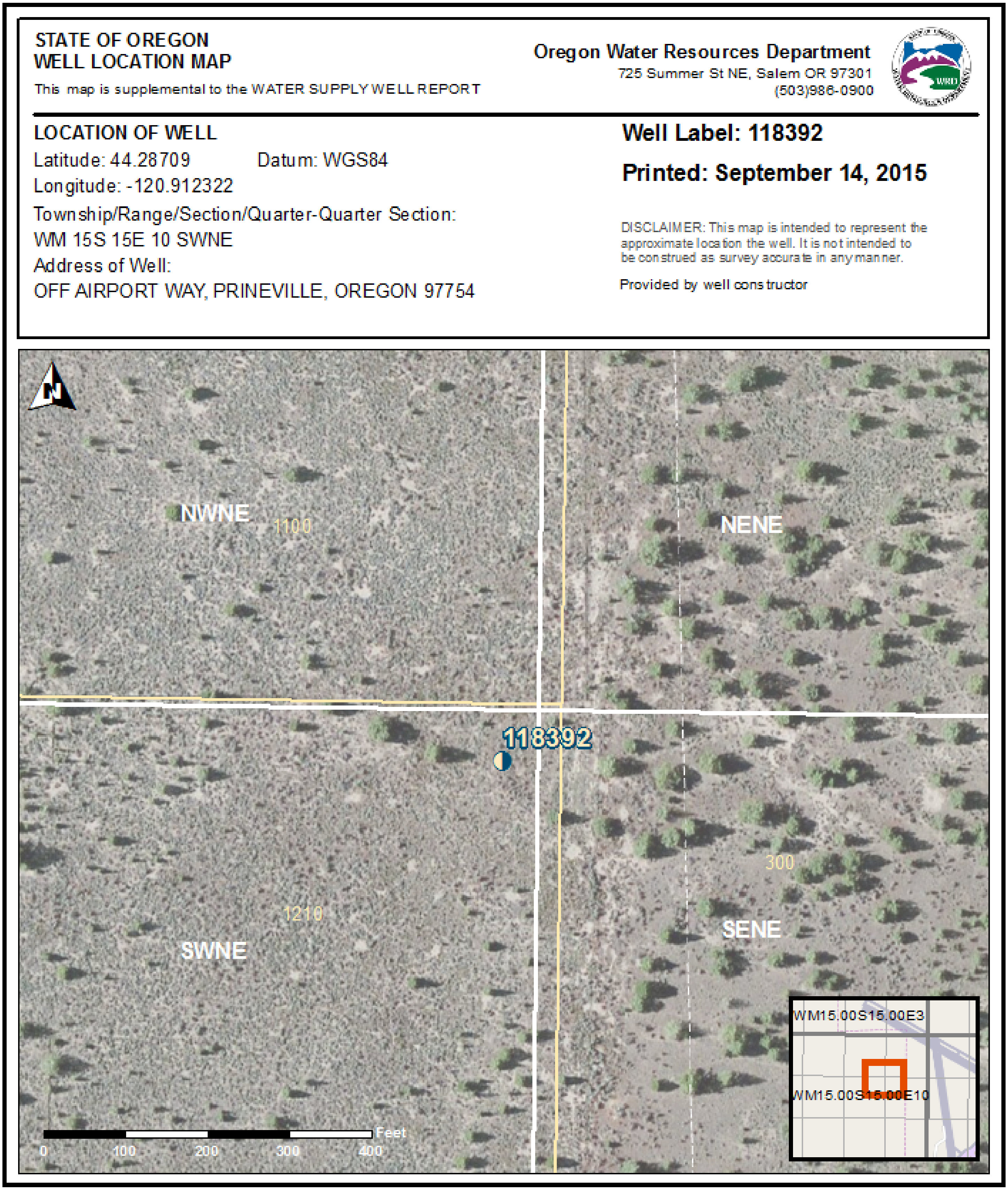
THIS REPORT MUST BE SUBMITTED TO THE WATER RESOURCES DEPARTMENT WITHIN 30 DAYS OF COMPLETION OF WORK Form Version:

WATER SUPPLY WELL REPORT - Map with location identified must be attached and shall include an approximate scale and north arrow

CROO 54287

9/22/2015

Map of Hole



STATE OF OREGON
WELL LOCATION MAP

This map is supplemental to the WATER SUPPLY WELL REPORT

Oregon Water Resources Department
725 Summer St NE, Salem OR 97301
(503)986-0900

LOCATION OF WELL

Latitude: 44.28709 Datum: WGS84

Longitude: -120.912322

Township/Range/Section/Quarter-Quarter Section:
WM 15S 15E 10 SWNE

Address of Well:
OFF AIRPORT WAY, PRINEVILLE, OREGON 97754

Well Label: 118392

Printed: September 14, 2015

DISCLAIMER: This map is intended to represent the approximate location the well. It is not intended to be construed as survey accurate in any manner.

Provided by well constructor