MEMORANDUM

DATE: May 8, 2015

TO: Jon Unger

FROM: Marci Pape (SPF Water Engineering)

CC: Cynthia Moscoso (National Park Service); David Keil, Terry Scanlan (SPF)

RE: Grant Agreement Package: Water Conservation, Reuse & Storage Grant #GB-0073-15 - Feasibility of ASR/AR for Crater Lake National Park and the Klamath Basin

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SPF Water Engineering, LLC was awarded a grant in October, 2014 through the Oregon Water Resources Department's Water Conservation, Reuse, & Storage Grant Program. Grant Agreement #GB-0073-15, entitled "*Determining the Feasibility of Aquifer Storage and Recovery (ASR) or Artificial Recharge (AR) to Enhance Water Management for Crater Lake National Park and the Klamath Basin"* includes specific tasks to be completed by SPF, as outlined in Exhibit B of the agreement. A summary of those tasks is provided below, along with the location within the package where the required information may be found.

A. Grant Agreement Tasks

Task 1) Provide Oregon Water Resources Department with site-specific characterization of the existing well

- Provide a digital copy of "*Well Construction and Testing Report"* for the Crater Lake National Park Test Well, prepared by SPF Water Engineering and dated January 22, 2014, to OWRD.

  That report is included here as Attachment A.

- Provide a brief memorandum to OWRD which describes the characteristics of the Crater Lake Test Well for application of artificial recharge(AR) or aquifer storage and recovery(ASR).

  A description of the characteristics of the well for application of AR or ASR is included in Attachment B, the report entitled "Determining the Feasibility of Aquifer Storage and Recovery (ASR) or Artificial Recharge (AR) to Enhance Water Management for Crater Lake National Park and the Klamath Basin: Summary Report".

Task 2) Characteristics of Local Hydrogeology: Prepare a qualitative description of conceptual aquifer flow paths, travel time, and confining geologic layers.

- Qualitatively analyze potential groundwater discharge areas through review of published geologic mapping, well-site specific geologic mapping, and through localized field observations.

  Described in Attachment B, specifically Section 2 of the report.

- Review water level monitoring data from the Crater Lake Test Well.

  Described in Attachment B, Section 2 of the report.

- Review aquifer hydraulic characteristics determined through the single-well pumping test conducted on the Crater Lake Test Well in 2013.

  Described in Attachment B, Section 2 of the report.

Task 3) Technical Support for Permitting and Licensing: Prepare application for water right permit or limited license for ASR diversion. SPF Water Engineering, LLC anticipates that OWRD may require construction of an additional well so that the project will have an ASR injection/production well and an observation well. Test pumping of the new well will provide additional information for aquifer characterization purposes.

- Prepare application for limited license for ASR diversion.

  Included as Attachments C through E:

  Attachment C provides a checklist of the ASR application requirements and the locations where all required information can be found, if it has been gathered and/or completed to date.

  Attachment D contains the completed ASR Limited License Application, as well as all other basic application elements that are required.

  Attachment E contains the Draft Schematic Design Plans, which describe in detail the system design changes necessary for the incorporation of ASR/AR into the existing water supply system.

  Attachment F contains a completed Application for Permit to Use Ground Water and an accompanying map. This application will be required in order to use the existing test well or a new well for production and/or ASR.

  Attachment G contains a copy of the State of Oregon Rules and Statutes Regarding ASR and AR.

- Prepare driller performance specification for drilling and testing of an additional well (should OWRD require an observation well).

  Draft included as Attachment H.

B. List of Attachments

Attachment A: Well Construction and Testing Report

Attachment B: *Determining the Feasibility of Aquifer Storage and Recovery (ASR) or Artificial Recharge (AR) to Enhance Water Management for Crater Lake National Park and the Klamath Basin: Summary Report*

Attachment C: ASR Application Checklist

Attachment D: ASR Limited License Application and other basic application elements

Attachment E: Draft Schematic Design Plans

Attachment F: Application for a Permit to Use Ground Water and accompanying map

Attachment G: State of Oregon Rules and Statutes Regarding ASR and AR

Attachment H: Draft Driller Performance Specification

C. Recommended Next Steps

1. ASR pre-application meeting with attendance by representatives of NPS, SPF, and OWRD, with possible attendance by DEQ and OHA DWP.
2. Together with NPS, assemble the remaining information required for an ASR application. Information that is not readily available may be developed or assembled outside of the scope of services for this Water Conservation, Reuse, and Storage Grant.
3. Should NPS and OWRD determine that ASR is an appropriate water management strategy, complete remaining elements of the ASR application and submit it to OWRD for approval.
4. Determine from OWRD if the existing well may be used as either a production or ASR well, and whether an additional well must be constructed.
5. Modify the draft well driller performance specification to reflect the production well or ASR well requirements from OWRD.

Attachment A

Well Construction and Testing Report

Well Construction and Testing Report

Crater Lake National Park Test Well
PMIS #203499

Prepared for

National Park Service
c/o Steven Bosiljevac, P.E.
333 Bush St., Suite 500
San Francisco, CA 94104

Prepared by

SPF Water Engineering, LLC
300 E. Mallard Dr., Suite 350
Boise, ID 83706

January 22, 2014 (Final)

SPF WATER ENGINEERING

REGISTERED
OREGON
TERRY M. SCANLAN
G1511
GEOLOGIST
expires 4/30/14

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Attachment A: As-Built Well Drawing and Well Driller's Report
Attachment B: Test Pumping Data and Graphs
Attachment C: Water Quality Results

1. INTRODUCTION

The National Park Service (NPS) is evaluating development of a new groundwater supply for potable uses at Crater Lake National Park (CRLA). NPS issued a task order under its civil/environmental engineering indefinite delivery/indefinite quantity (IDIQ) contract (P13PC00103) with SPF Water Engineering, LLC (SPF) to design and oversee construction of an exploratory well to test a potential groundwater source at CRLA (PMIS#203499). This report summarizes the construction, testing, and water quality for the CRLA test well.

The average peak water demand at CRLA is approximately 70,000 gallons per day, or about 50 gallons per minute (gpm). Peak demand occurs during the summer when the number of visitors to CRLA is greatest. Currently, CRLA facilities are supplied with potable water from Annie Spring. Diversion from Annie Spring is authorized under a water right with a 1902 priority date. Senior water-right holders can call on the CRLA water right during drought years, which could require CRLA to stop using the spring as a source of water for the park. Thus, the CRLA seeks a supplemental source of potable water in the event (or during times) that CRLA can no longer divert water from Annie Spring.

The exploratory well was constructed and tested in October and November 2013. Terry Scanlan, P.E., P.G. designed and oversaw construction of the well. On-site monitoring of drilling and testing activities was provided by Christian Petrich Ph.D., P.E., P.G., Jason Thompson, P.E., and Erik Boe, E.I.T.

2. WELL DRILLING AND CONSTRUCTION

2.1. Site Location

The CRLA test well was constructed in a Pacific Crest Trail (PCT) trailhead parking area on the south side of Oregon Highway 62 within CRLA, in Klamath County, Oregon (Figure 1 and Figure 2). The well location (42°52.25’ latitude and -122°10.802’ longitude) is approximately 0.6 miles west-northwest from the CRLA Annie Springs Entrance Station and approximately 54 miles northwest of Klamath Falls, Oregon. The well site elevation is approximately 6,180 feet.

The test well location was selected by National Park Service Water Resources Division Hydrogeologist Larry Martin, and detailed in a trip report dated July 23, 2013. The test well target depth was set at 500 feet. Site characteristics were further defined and described in a Test Well Work Plan prepared by SPF Water Engineering (SPF) dated September 27, 2013.

Figure 1. Well site location

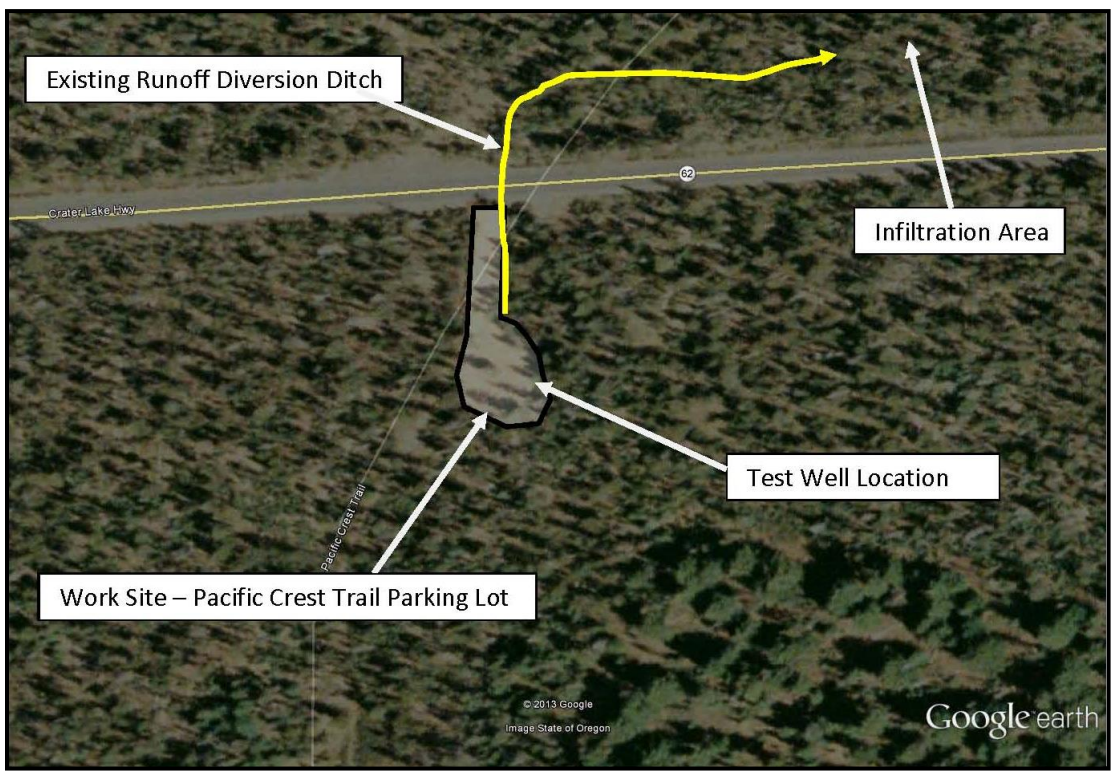


Figure 2. Well site features.

2.2. Preliminary Well Design

The conceptual well design for this exploratory well consisted of 8-inch steel well casing drilled and sealed to a depth of approximately 100 feet, with 8-inch open borehole from 100 feet to 500 feet. An optional 6-inch diameter perforated steel liner was included in the conceptual well design if needed to stabilize the borehole. Detailed well specifications were provided in the work plan.

2.3. Drilling Methods

SPF Water hired Chancellor Drilling and Pump (Chancellor) from Klamath Falls, Oregon to carry out the field activities of test well drilling and test pumping under the Title I Supplemental Services Task Order. The well was drilled using air and mud rotary drilling methods. Drilling equipment, consisting of a rotary drilling rig, support truck, and mud tank, is shown in Figure 3.

All drill cuttings and drilling fluids (drill water, foam, or mud) were collected and disposed of off-site. Cuttings and drilling fluids flowed into a sump (Figure 4) and were pumped into the mud tank (Figure 5), or were discharged directly from a well head diverter to the mud tank. Cuttings were separated upon entering the mud tank, with cuttings ported to a trailer for off-site removal (Figure 6). Cuttings remaining in the sump were periodically removed with a backhoe and placed into the cuttings trailer (Figure 6). Any seepage from the cuttings trailer was collected (Figure 7) and poured back into the mud tank. Drilling fluids were recycled as practical; spent fluids were pumped from the mud tank into the tanker truck (Figure 8) and removed from the site for proper disposal outside of the park boundary. All cuttings from the cuttings trailer were removed by front-end loader and dump truck, and transported out of the park for disposal on private property. Any incidental oil/radiator drips were collected in containers and tarps underlying drilling equipment (Figure 9).

Figure 3. Drilling rig and support equipment.

Figure 4. Cuttings sump.

Figure 5. Mud tank and cuttings disposal in cuttings trailer.

Figure 6. Cuttings trailer.

Figure 7. Seepage collection from cuttings trailer.

Figure 8. Tanker truck.

Figure 9. Tarp/containers under drilling rig.

2.4. Pilot Borehole Drilling

Chancellor mobilized to the site and began drilling on Tuesday, October 8, 2013. SPF was present to observe drilling, collect cuttings samples at 5-foot intervals, and ensure compliance with approved erosion and sediment control procedures. Two sets of cuttings were collected: one set for SPF's use in describing subsurface lithology and one set for the Oregon Department of Water Resources (OWRD), as requested by Ivan Gall, OWRD Groundwater Section Manager.

The borehole encountered topsoil to 1-foot depth, pumice to 34 feet, and hard grey basalt to 62 feet. Below 62 feet, circulation was lost until a depth of 82 feet, presumably because of fractured, broken basalt. Broken grey basalt was observed between 82 and 88 feet, with hard grey basalt noted to the bottom of the borehole at 103 feet. These observations reflect drilling through the end of the day on Thursday, October 10.

Because of loose materials encountered in the upper 50 feet of borehole, the hole was drilled using the mud-rotary method of drilling to a depth of approximately 57 feet. Drilling was slow through hard basalt between 35 and 45 feet. Below 57 feet, Chancellor returned to air-rotary drilling.

On Friday, October 11 the 8-inch pilot borehole was reamed to 12-inch diameter to a depth of 93 feet. A surface casing was installed to a depth of 44 feet through the soft pumice zone to prevent sloughing of the borehole.

2.5. Casing Installation and Surface Seal

On Monday, October 14, 8-inch steel casing (0.250-inch wall thickness) with a drive shoe was installed from 3 feet above ground surface to a depth of 93 feet within the 12-inch borehole. The annular surface seal was then installed using a three-step process:

1. On Monday, October 14, neat cement was pumped through a tremie pipe to the bottom of the 12-inch borehole to form a seal around the bottom of the casing. The lower seal was placed from a depth of 65 feet to 93 feet.
2. On Tuesday, October 15, bentonite chips were poured from the top of the lower cement seal at 65 feet to a depth of 48 feet, through the formation where circulation was lost during drilling.
3. Above the bentonite chip seal, neat cement was pumped from a depth of 48 feet to ground surface to complete the annular surface seal. The surface casing was removed as the upper seal was placed. This step also occurred on October 15.

2.6. Open Borehole Drilling

Drilling resumed on Wednesday, October 16. An 8-inch open hole was drilled using the air-rotary method of drilling from a depth of 93 feet to a depth of 420 feet on October 16 through 18. Foam was used to aid in lifting of drill cuttings.

The lithology is described as follows:

- grey, brown, and red basalt from 93 feet to 194 feet, with loose/broken zones noted between 128 and 138 feet, 158 to 173 feet, and 184 to 194 feet
- brown cinders from 194 and 222 feet
- grey basalt from 222 and 227 feet,
- grey basalt with red cinders from 227 and 235 feet
- brown and red cinders from 235 and 258 feet
- grey basalt from 258 and 274 feet,
- broken grey basalt with red cinders from 274 and 402 feet, with broken zones noted between 280 and 294 feet and between 302 and 312 feet, and
- red cinders zone from 402 feet and 420 feet.

Water was first encountered at 403 feet. The cinder zone from 403 to 420 feet produced an estimated 20 gpm by air-lift pumping. Static water level was measured at 316 feet below ground surface (bgs) on the morning of Friday, October 18.

2.7. Liner Installation in 8-inch Borehole

A 6-inch steel liner (0.188-inch wall thickness) was installed within the 8-inch borehole due to unstable conditions and borehole sloughing. Liner installation began on Friday, October 18. The liner was lowered into the borehole to a depth of 320

feet. Below 320 feet, the borehole was caving so the well driller had to redrill the 8-inch borehole using an under-reamer to place the liner to a depth of 420 feet.

2.8. Liner Installation by Under-Reaming Below 8-inch Borehole

On October 22 and 23, the borehole and liner were advanced below the original 8-inch borehole by under-reaming.

- Red cinders were noted between 420 and 423 feet. Below 423 feet, hard to medium grey basalt was encountered to a depth of 447 feet.
- Softer grey basalt with red cinders was observed between 447 and 488 feet.
- At a depth of between 488 and 490 feet, a red cinder zone was encountered, with soft gray basalt with cinders observed from 490 to 495 feet.
- At a depth of 495 feet, a red cinder zone was encountered. This cinder bed looked promising as a water-bearing zone, so under-reaming and liner placement continued through the cinder zone to a depth of 504 feet. Water produced by air-lift pumping from the well was estimated to be approximately 20 to 30 gpm at this time.
- Grey basalt was observed from 504 to 505 feet.

The 6-inch liner was placed to a depth of 505 feet into the hard grey basalt, with the top of the liner at a depth of 9 feet below ground surface.

2.9. Liner Perforation

The 6-inch liner was perforated *in situ* opposite water-bearing cinder zones and soft basalt on October 23. The liner was perforated from a depth of 400 to 420 feet and from 440 to 500 feet. Each perforation was 3/16-inch wide by 3 inches long, with 400 perforations per 20-foot stick of pipe.

2.10. Well Development

The well was developed (following perforation of the liner) by air-lift pumping on October 23. The down-hole perforator was removed from the liner and drill pipe was re-installed to a depth of 380 feet. The well produced approximately 30 gpm by air-lift pumping. The well produced approximately the same flow rate when the drill stem was lowered to 400 feet. The well was developed until the water produced was relatively clear (the water had only slight turbidity) and there was no visible cinder production.

Clean groundwater was discharged into a drainage channel located on the east side of the parking lot entrance road. This channel enters a culvert that crosses under State Highway 62. On the north side of the highway, the drainage channel turns easterly for approximately 200 feet before dispersing into a flat area.

2.11. Well Driller's Report

An as-built well construction schematic and driller's report are provided as Attachment A.

3. TEST PUMPING

3.1. Well Testing

Well test pumping consisted of a step-rate test and a constant-rate test. Water levels were measured with an electric-line well sounder. A pressure transducer (Solinst Levelogger Model 3001) was also installed in the well prior to test pumping to automatically measure water levels every 2 minutes. A barometric pressure logger (Solinst Barologger Model 3001) was installed in the well to allow total pressure measurements recorded by the pressure transducer to be compensated for barometric pressure fluctuations.

The test pump was a 15-hp submersible turbine (Grundfos 85S150-12) supplied by Chancellor. The pump was set at a depth of approximately 420 feet below ground surface on Monday, November 4. Flow rates were measured with a 5-gallon bucket and stopwatch (step-rate test) and a 2-inch McCrometer propeller flow meter (constant-rate test). Test pumping equipment is shown on Figure 4.

Figure 10. Test pump discharge piping.

During testing, clean groundwater was discharged into the drainage channel located on the east side of the parking lot entrance road, where it flowed through the culvert

under State Highway 62 to the north side of the highway and ultimately to a large flat infiltration area. Jason Thompson, P.E. (SPF) supervised testing, verified flow-rate measurements, and measured water levels with an electric-line well sounder.

3.1.1. Step-Rate Test

The step-rate pumping test was conducted on November 4, 2013 and consisted of two 30-minute steps and one 1-hour step. Flow rates were approximately 30 gpm and 50 gpm for the 30-minute steps and 100 gpm for the 1-hour step.

Static water level at the beginning of the test was measured at 325.63 feet below the measurement point (3.93 feet above ground surface) prior to installing the transducer in the sounding tube. Static water level was measured at 325.57 feet below the measurement point after installing the transducer.

The pumping water level at the end of the first 30-minute step at 30 gpm was measured at 327.12 feet below the measurement point, equal to a drawdown of 1.55 feet. The pumping water level at the end of the second 30-minute step (50 gpm) was measured at 328.53 feet below the measurement point, representing a drawdown of 2.96 feet. The pumping water level at the midpoint of the third step (after 30 minutes of pumping) at 100 gpm was 338.12 feet below the measurement point, representing a drawdown of 12.55 feet. At the end of the third step (pumping for 1 hour) at 100 gpm, the pumping water level was measured at 339.27 feet below the measurement point, representing a drawdown of 13.70 feet.

The specific capacity at each step-rate flow rate is summarized in Table 1 and shown on Figure 11. Two specific capacities are listed for the third step at 100 gpm, one after 30 minutes of pumping for direct comparison to the previous two steps and one after 60 minutes of pumping.

Flow (gpm)	Specific Capacity (gpm/ft of drawdown)
30	19.4
50	16.9
100 (30 minutes)	8.0
100 (1 hour)	7.3

Table 1. Summary of specific capacity from step-rate test.

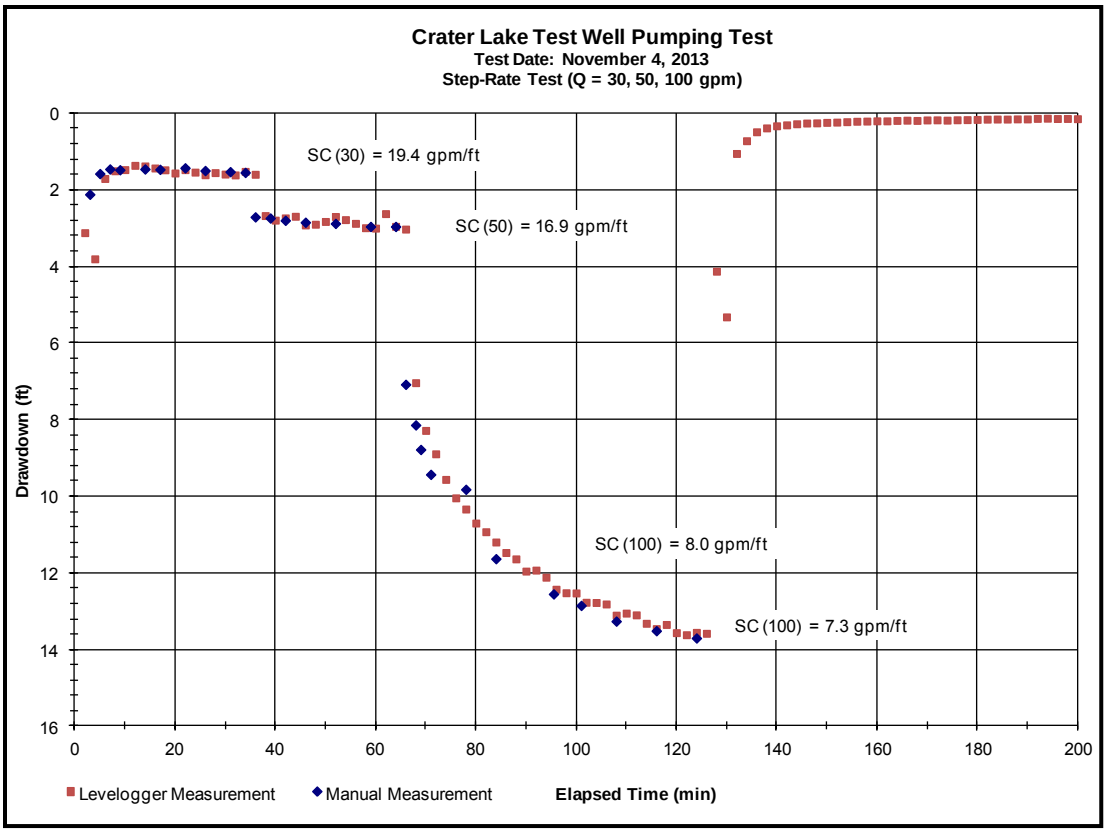


Figure 11. Step-rate test water level graph

The specific capacity at pumping rates of 30 and 50 gpm are comparable, suggesting that the well is relatively efficient over this pumping range. At the higher flow rate of 100 gpm, the specific capacity declined by approximately 50%, indicating a lower well efficiency. The specific capacity at 100 gpm did not vary significantly at 30 minutes compared to 1 hour.

Attachment B includes a summary of the step-rate test field data, including manual measurements, levelogger data, and graphs.

3.1.2. Constant-Rate Test

Based on the results of the step-rate test, a pumping rate of approximately 80 gpm was selected for the subsequent 24-hour constant-rate test. The constant-rate test began on November 5 and concluded on November 6, 2013. Attachment B includes the constant-rate test field data, including manual measurements, levelogger data, and graphs.

The static water level was measured at 325.67 feet below the measurement point (3.93 feet above ground surface) prior to beginning the constant-rate test. At the end of the constant-rate test, following 24 hours of pumping, the pumping water level was measured at 343.02 feet below the measurement point for a total drawdown of 17.35 feet. The flow meter totalizer indicated that 118,600 gallons were pumped during the constant-rate test, equal to an average of 82 gpm over the duration of the test.

Using a pumping rate of 82 gpm and a total drawdown of 17.35 feet, the well has a specific capacity of 4.7 gpm/ft over a 24-hour period.

A plot of the constant-rate test pumping data (Figure 12) shows an unexpected decline in drawdown during the constant-rate test starting at around 4 am on November 6 (1150 minutes elapsed pumping time). The pumping water level dropped approximately 1 foot over a period of about 80 minutes. This decline was not caused by increasing the pumping rate by opening the throttling valve. The water-level decline may have been caused by power fluctuations from the generator (resulting in an increase in pumping rate) or a slight loss in well capacity from plugging of perforations due to sloughing of the formation. Such a loss in well capacity is not considered significant or detrimental to the long-term function of the well. Following this water-level decline, water levels stabilized through the end of the test.

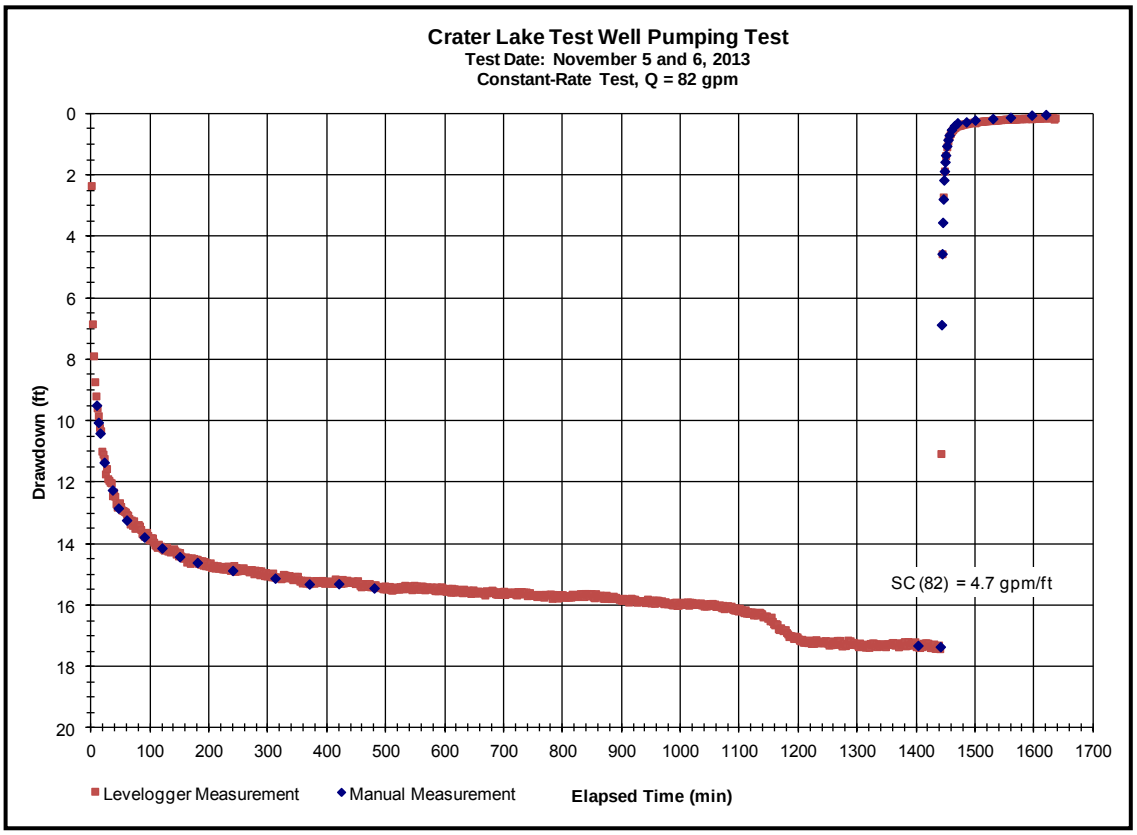


Figure 12. Constant-rate pumping test water level graph

3.1.3. Water-Level Recovery

After the constant-rate pumping test ended on November 6, water-level recovery was measured for 3 hours. Water level recovered to 325.70 feet, only 0.03 feet lower than the static water level measured before the test pumping began.

Chancellor removed the pumping equipment and demobilized from the site on Thursday, November 7. The well was fitted with a sanitary well seal after the pump was removed.

3.2. Test Pumping Discussion

Test pumping demonstrates that the test well is sufficiently productive to supply the 50 gpm CRLA water system demand. The well was test pumped at a maximum rate of 100 gpm, but higher rates are possible with a larger pump.

At the projected peak-day CRLA demand of 50 gpm, pumping water levels will likely range from 325 to 340 feet below ground surface. Pumping water levels will vary based on duration of pumping and potential seasonal trends in aquifer water levels. The magnitude of any seasonal trends cannot be ascertained without additional monitoring data.

Well productivity, as measured by specific capacity, varies significantly with pumping rate (Figure 11). During step-rate testing, the ½-hour specific capacity ranged from 19 gpm/ft at 30 gpm to 8 gpm/ft at 100 gpm. The typical cause of lower specific capacity at higher pumping rates is a decline in well efficiency.

The near well transmissivity calculated from the constant-rate drawdown response and early-time (5 to 30 minute) recovery data (Figures 13 and 14) is relatively low (approximately 5,000 gpd/ft). Note, however, that this 5,000 gpd/ft apparent transmissivity is inconsistent with (1) the high specific capacity measured during the 30 gpm step of the step-rate test and (2) high aquifer transmissivity calculated based on late-time (30 to 180 minutes) constant-rate test recovery response. The specific capacity data and late-time recovery data suggest an aquifer transmissivity in the range of 40,000 gpd/ft to 60,000 gpd/ft (Figure 15; note the different y-axis scale than in Figure 14). Based on data from this 24-hour test, a transmissivity of approximately 50,000 gpd/ft is likely most representative for the aquifer.

The inconsistent water-level responses to test pumping (e.g.., wide variations in specific capacity and apparent transmissivity) could be caused by the presence of vertical gradients. The presence of vertical gradients has not been confirmed. However, the well taps water-bearing cinder zones at approximately 400 and 500 feet depths that are separated by competent basalt. These two cinder zones could have different static water levels. For example, a water level of approximately 316 feet bgs was measured on October 18 when the borehole was at 420 feet. Due to the presence of drill foam within the borehole on October 18, it is not known whether this static water level was accurate. If the October 18 measurement is accurate, it suggests a static water level in the uppermost water-bearing zone approximately 6 feet higher than the static water level of the completed well (tapping both the 400 and 500-foot zones) measured prior to test pumping on November 4.

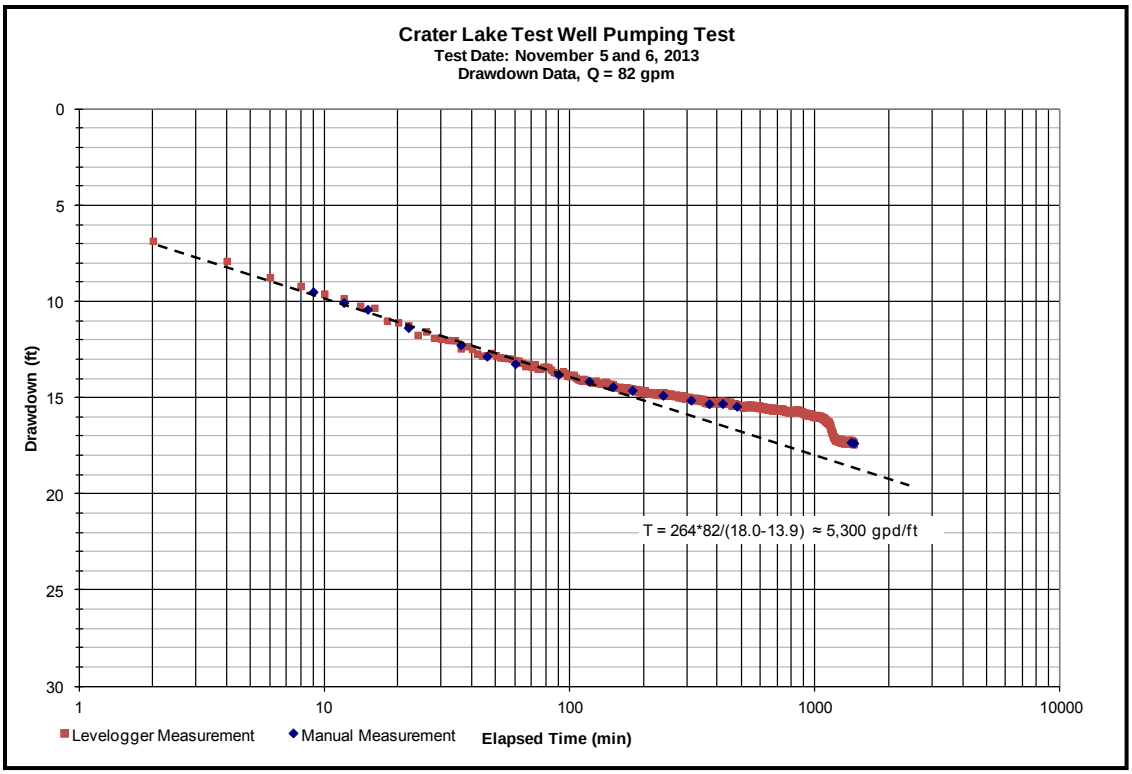


Figure 13. Constant-rate test drawdown (semi-logarithmic scale)

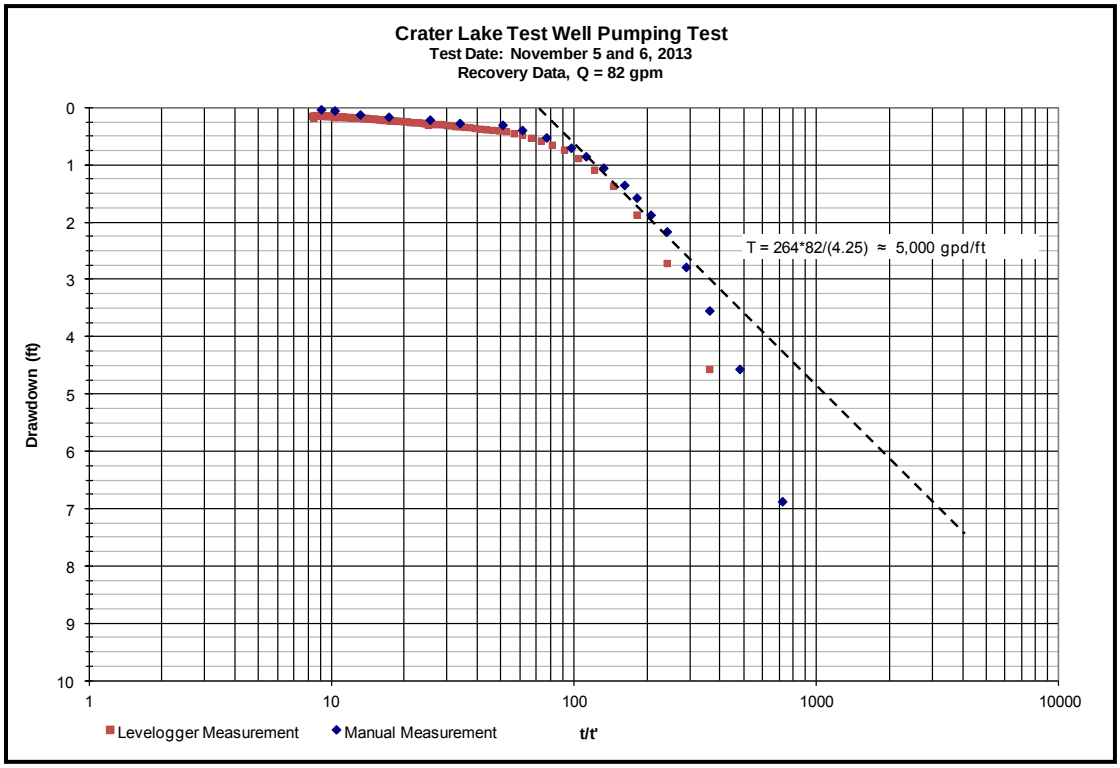


Figure 14. Constant-rate test recovery showing early time (5- to 30-minute) trend

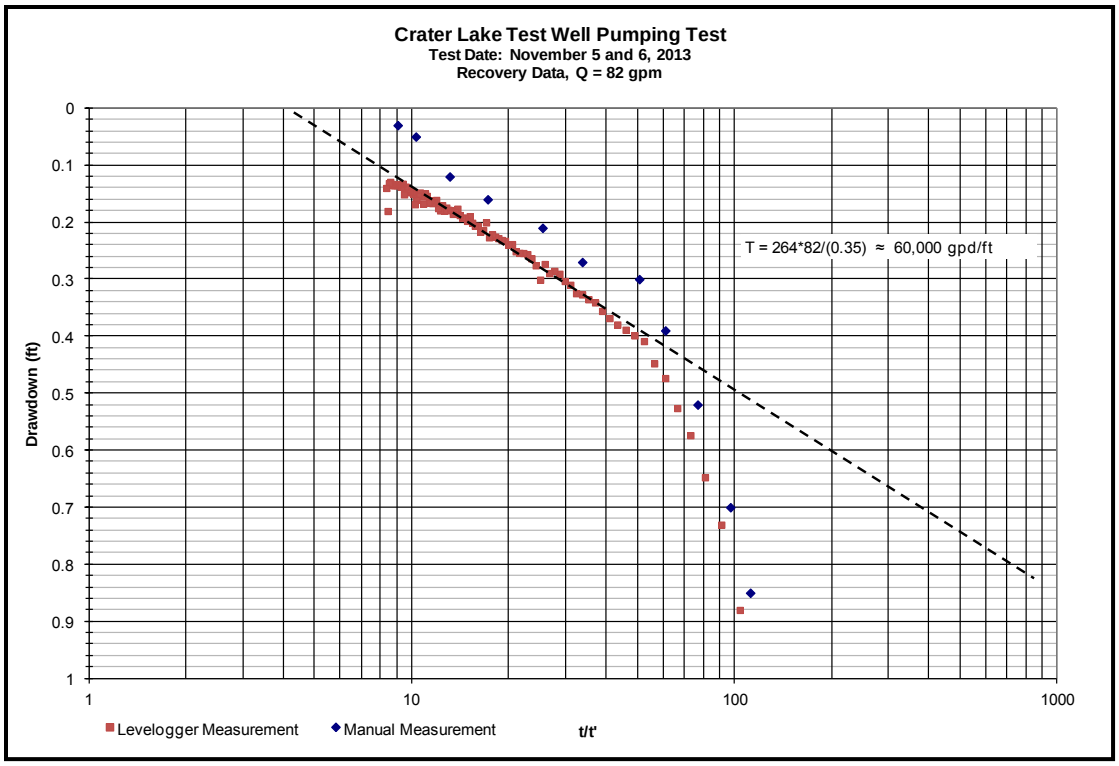


Figure 15. Late-time (30 to 180 minute) constant-rate test recovery

4. WATER QUALITY

Water quality samples were collected by Jason Thompson of SPF near the end of the constant-rate pumping test on November 6, 2013, and submitted to the Umpqua Research Company in Bend, Oregon, for analysis. Samples were taken from a sample tap in the discharge piping while pumping at 82 gpm. Both laboratory and field analyses demonstrate excellent quality water.

4.1. Field Parameters

Electrical conductivity, specific conductance, temperature, and pH were measured in the field at 29.7 µS, 51.1 µS, 3.0°C (37°F), and 6.57 S.U., respectively. The water was clear with no detectable odor.

4.2. Laboratory Analyses

Samples were collected and analyzed for primary drinking water contaminants, including volatile organic contaminants (VOCs), synthetic organic contaminants (SOCs), inorganic contaminants (IOCs), total coliform bacteria, and radiologicals. The only inorganics detected in the groundwater from the well were fluoride, at a concentration of 0.119 mg/L, and sodium at a concentration of 3.62 mg/L. The level of fluoride was well below the drinking water maximum contaminant level (MCL) of 4 mg/L. There is no MCL for sodium. There were no SOCs or VOCs detected in the groundwater. The water sample collected tested absent for *E. coli* and total coliform

bacteria. There were no radiologicals detected in the sample collected. Based on these results, the well produces water that meets EPA drinking water standards.

Laboratory reports are provided as Attachment C.

4.3. Sand Content

The quantity of sand (i.e. cinders) produced from the well during the constant-rate test at 82 gpm was measured using a Rossum centrifugal sand sampler installed on the test pump discharge line. Sand accumulation was measured for a total of 8 hours. Results are presented in Table 2, and show that after 10 minutes of pumping at 82 gpm, the concentration of cinders was slightly over 5 ppm. As pumping progressed, the concentration of cinders decreased. After approximately 8 hours of pumping, the concentration of cinders had declined to about 0.3 ppm. Additional pumping of the test well appears to have further developed the well, reducing the amount of cinders produced. Sand (i.e. cinders) concentrations of 5 ppm or less are generally considered acceptable. Therefore, cinder production should not present any future problems, particularly with lower pumping rates expected.

Duration (min)	Incremental Time (min)	Sand Accumulation (mL)	Incremental Accumulation (mL)	Sample Flow Rate (gpm)	Sand Concentration (ppm)
0		0		0	
10	10	0.06	0.06	0.3	5.3
50	40	0.10	0.04	0.3	0.9
110	60	0.20	0.1	0.3	1.5
170	60	0.22	0.02	0.3	0.3
230	60	0.28	0.06	0.3	0.9
310	80	0.32	0.04	0.3	0.4
360	50	0.35	0.03	0.3	0.5
410	50	0.38	0.03	0.3	0.5
470	60	0.40	0.02	0.3	0.3

Table 2. Results of sand testing.

5. WELL CONSTRUCTION AND TESTING SUMMARY

1. A test well was drilled to 505 feet at Crater Lake National Park in October 2013.
2. The well is constructed with 8-inch steel casing from +3 to 93 feet bgs and 6-inch steel liner from 9 to 505 feet bgs. The liner is perforated between 400 and 500 feet.

3. The well penetrated pumice to a depth of 34 feet, and basalt and cinders from 34 feet to total depth of 505 feet.
4. Primary water-bearing zones were found in cinders between 400 and 423 feet and between 495 and 504 feet.
5. Upon completion, static water level was 322 feet below ground surface.
6. The well was test pumped for 24 hours at an average rate of 82 gpm with total drawdown of 17.35 feet.
7. Analysis of pumping test data suggests an aquifer transmissivity of approximately 50,000 gpd/ft. Near-well transmissivity appears to be less, at approximately 5,000 gpd/ft. The aquifer response to test pumping may be influenced by the potential presence of vertical gradients within the aquifer and/or heterogeneous aquifer conditions.
8. Water quality from the well is excellent, with a specific conductance of 51 μS, temperature of 37°F, and pH of 6.6. The water meets EPA primary drinking water standards, and is suitable for use within a public drinking water system without further treatment.

Attachment A
As-Built Well Drawing and
Well Driller's Report

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

KLAM 58507

11/29/2013

WELL I.D. LABEL# L	110337
START CARD #	1021341
ORIGINAL LOG #	

(1) LAND OWNER

Owner Well I.D. _____

First Name _____ Last Name _____

Company SPF WATER ENGINEERING/ NATIONAL PARK SERVICE

Address 300 E. MALLARD DRIVE , SUITE 350

City BOISE State ID Zip 83706

(2) TYPE OF WORK

[X] 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

[X] Rotary Air [X] Rotary Mud [ ] Cable [ ] Auger [ ] Cable Mud
[ ] Reverse Rotary [ ] Other _____

(4) PROPOSED USE

[ ] Domestic [ ] Irrigation [ ] Community
[ ] Industrial/ Commericial [ ] Livestock [ ] Dewatering
[ ] Thermal [ ] Injection [X] Other TEST WELL

(5) BORE HOLE CONSTRUCTION

Special Standard [ ] (Attach copy)

Depth of Completed Well 505.00 ft.

BORE HOLE Dia	From	To	SEAL Material	From	To	Amt	sacks/lbs
12	0	93	Cement	0	48	45	S
8	93	505	Bentonite Chips	48	65	26	S
			Cement	65	95	10	S

How was seal placed: Method [ ] A [ ] B [X] C [ ] D [ ] E

[X] Other BENTONITE POURED D

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	[X]	3	93	.250	(•)	( )	[X]	[ ]
( )	(•)	6	[ ]	9	505	.188	(•)	( )	[X]	[ ]
( )	( )		[ ]				( )	( )	[ ]	[ ]
( )	( )		[ ]				( )	( )	[ ]	[ ]
( )	( )		[ ]				( )	( )	[ ]	[ ]

Shoe [ ] Inside [X] Outside [ ] Other Location of shoe(s) 93

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	400	420	.188	3	400	
Perf	Liner	6	440	500	.188	3	1200	

(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	12.5	422	24

Temperature 44 °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 KLAMATH Twp 31.00 S N/S Range 5.00 E E/W WM

Sec 13 NW 1/4 of the SW 1/4 Tax Lot 0000

Tax Map Number _____ Lot _____

Lat ___ ° ___ ' ___ " or 42.87097260 DMS or DD

Long ___ ° ___ ' ___ " or -122.18025600 DMS or DD

( ) Street address of well (•) Nearest address

HIGHWAY 62 & PACIFIC CREST TRAIL

(10) STATIC WATER LEVEL

	Date	SWL(psi)	+	SWL(ft)
Existing Well / Pre-Alteration			[ ]	
Completed Well	11/4/2013		[ ]	325

Flowing Artesian? [ ] Dry Hole? [ ]

WATER BEARING ZONES Depth water was first found 400.00

SWL Date	From	To	Est Flow	SWL(psi)	+	SWL(ft)
10/21/2013	400	505	100		[ ]	325
					[ ]	
					[ ]	
					[ ]	
					[ ]	

(11) WELL LOG

Ground Elevation _____

Material	From	To
SOIL	0	1
RED & BROWN PUMICE	1	12
RED PUMICE	12	20
GREY PUMICE	20	34
GREY & BROWN BASALT	34	45
HARD GREY BASALT	45	62
LOST CIRC.	62	82
BROKEN GREY BASALT	82	88
HARD GREY BASALT	88	128
GREY BASALT & RED CINDER	128	138
BROWN,GREY,RED BASALT	138	179
GREY BASALT	179	194
BROWN CINDER	194	222
GREY BASALT & RED CINDER	222	400
RED CINDER	400	423
GREY BASALT	423	495
RED CINDER	495	504
GREY BASALT	504	505

Date Started 10/9/2013 Complete 11/4/2013

(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 1844 Date 11/29/2013

Signed COLTER CHANCELLOR (E-filed)

Contact Info (optional) CHANCELLOR DRILLING & PUMP

WATER SUPPLY WELL REPORT - continuation page

KLAM 58507

11/29/2013

WELL I.D. LABEL# L 110337
START CARD # 1021341
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

Dia	From	To

SEAL

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)

(6) CASING/LINER

Casing	Liner	Dia	+	From	To	Gauge	Stl	Plstc	Wld	Thrd

(11) WELL LOG

Material	From	To

(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

6" SYMETRIX SHOE AT 505' WELDED TO 6" .188 STEEL LINER (W-140)

Attachment B

Test Pumping Data and Graphs

Crater Lake Test Well Pumping Test

Step-Rate Test: Manual Water Level Measurements

Date: November 4, 2013

Test Performed by: Jason Thompson (SPF) and Chancellor Drilling and Pump, Inc.

Pump used for test: Grundfos submersible pump 85S150-12, 15 hp, set at ~420 feet

Flow rate measured with 5 gallon bucket and stopwatch

Water-Level Measurement Point: top of sounding tube; 3.93 feet above ground surface

Date	Time	Elapsed Time (min)	t' (min)	t/t'	DTW (ft)	DD (ft)	Remarks
11/4/2013	13:23				325.63		static water level prior to transducer install
11/4/2013	13:36				325.57		static water level after transducer install
11/4/2013	13:44	0					pump on; adjusting valve, Q~100 gpm
11/4/2013	13:47	3			327.69	2.12	adjusting valve
11/4/2013	13:48	4					Q~30 gpm
11/4/2013	13:49	5			327.15	1.58	
11/4/2013	13:51	7			327.03	1.46	
11/4/2013	13:53	9			327.05	1.48	
11/4/2013	13:58	14			327.03	1.46	
11/4/2013	14:01	17			327.04	1.47	
11/4/2013	14:06	22			327.00	1.43	
11/4/2013	14:10	26			327.07	1.50	
11/4/2013	14:15	31			327.10	1.53	
11/4/2013	14:18	34			327.12	1.55	adjusting valve
11/4/2013	14:19	35					Q~50 gpm
11/4/2013	14:20	36			328.28	2.71	
11/4/2013	14:23	39			328.31	2.74	
11/4/2013	14:26	42			328.37	2.80	
11/4/2013	14:30	46			328.42	2.85	
11/4/2013	14:36	52			328.45	2.88	
11/4/2013	14:43	59			328.53	2.96	
11/4/2013	14:48	64			328.53	2.96	open valve, Q~100 gpm
11/4/2013	14:50	66			332.65	7.08	
11/4/2013	14:52	68			333.71	8.14	
11/4/2013	14:53	69			334.35	8.78	
11/4/2013	14:55	71			335.00	9.43	
11/4/2013	15:02	78			335.39	9.82	
11/4/2013	15:08	84			337.20	11.63	
11/4/2013	15:19	96			338.12	12.55	
11/4/2013	15:25	101			338.42	12.85	
11/4/2013	15:32	108			338.83	13.26	
11/4/2013	15:40	116			339.08	13.51	
11/4/2013	15:48	124			339.27	13.70	end step-rate test

Crater Lake Test Well Pumping Test

Step-Rate Test: Levelogger Measurements

Date: November 4, 2013

Test Performed by: Jason Thompson (SPF) and Chancellor Drilling and Pump, Inc.

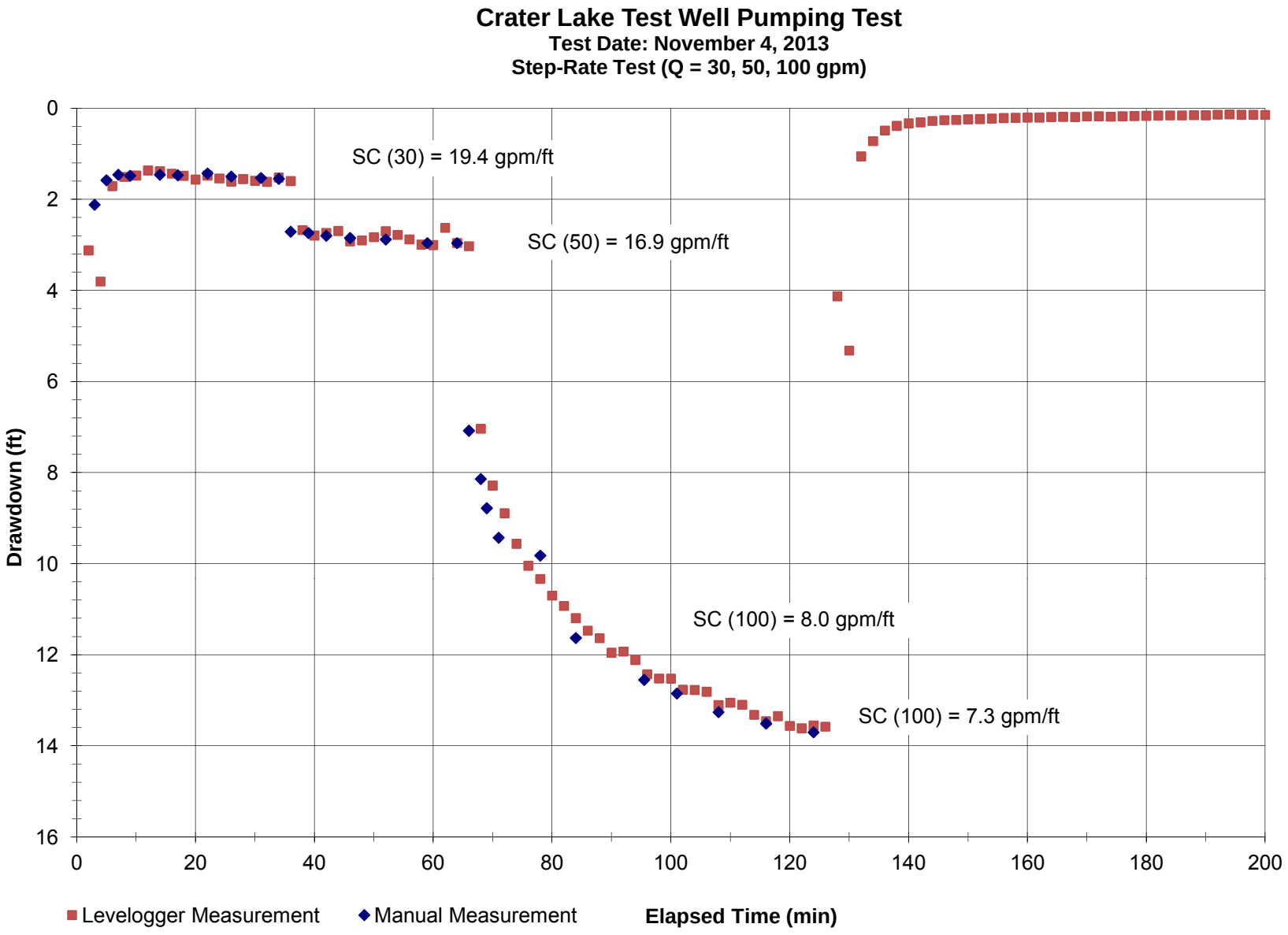
Pump used for test: Grundfos submersible pump 85S150-12, 15 hp, set at ~420 feet

Flow rate measured with 5 gallon bucket and stopwatch

Water-Level Measurement Point: top of sounding tube; 3.93 feet above ground surface

Date	Time	Elapsed Time (min)	t' (min)	t/t'	DTW (ft)	DD (ft)	Remarks
11/4/2013	13:30				325.56		static water level
11/4/2013	13:32				325.56		static water level
11/4/2013	13:34				325.57		static water level
11/4/2013	13:36				325.57		static water level
11/4/2013	13:38				325.56		static water level
11/4/2013	13:40	0			326.48		pump on; adjusting valve, Q~100 gpm
11/4/2013	13:42	2			328.68	3.12	adjusting valve
11/4/2013	13:44	4			329.36	3.80	adjusting valve
11/4/2013	13:46	6			327.27	1.71	Q~30 gpm
11/4/2013	13:48	8			327.07	1.51	
11/4/2013	13:50	10			327.04	1.48	
11/4/2013	13:52	12			326.93	1.36	
11/4/2013	13:54	14			326.94	1.38	
11/4/2013	13:56	16			326.99	1.43	
11/4/2013	13:58	18			327.04	1.48	
11/4/2013	14:00	20			327.13	1.56	
11/4/2013	14:02	22			327.04	1.48	
11/4/2013	14:04	24			327.10	1.54	
11/4/2013	14:06	26			327.17	1.61	
11/4/2013	14:08	28			327.12	1.55	
11/4/2013	14:10	30			327.15	1.59	
11/4/2013	14:12	32			327.18	1.61	
11/4/2013	14:14	34			327.08	1.52	
11/4/2013	14:16	36			327.16	1.60	
11/4/2013	14:18	38			328.24	2.68	adjusting valve
11/4/2013	14:20	40			328.35	2.79	Q~50 gpm
11/4/2013	14:22	42			328.30	2.74	
11/4/2013	14:24	44			328.25	2.69	
11/4/2013	14:26	46			328.48	2.92	
11/4/2013	14:28	48			328.46	2.90	
11/4/2013	14:30	50			328.39	2.83	
11/4/2013	14:32	52			328.26	2.70	
11/4/2013	14:34	54			328.34	2.78	
11/4/2013	14:36	56			328.44	2.88	
11/4/2013	14:38	58			328.55	2.99	
11/4/2013	14:40	60			328.56	3.00	
11/4/2013	14:42	62			328.18	2.62	
11/4/2013	14:44	64			328.52	2.96	
11/4/2013	14:46	66			328.59	3.03	
11/4/2013	14:48	68			332.60	7.04	open valve, Q~100 gpm
11/4/2013	14:50	70			333.84	8.28	
11/4/2013	14:52	72			334.45	8.89	
11/4/2013	14:54	74			335.12	9.56	
11/4/2013	14:56	76			335.60	10.04	
11/4/2013	14:58	78			335.89	10.33	
11/4/2013	15:00	80			336.26	10.70	
11/4/2013	15:02	82			336.49	10.93	
11/4/2013	15:04	84			336.76	11.20	
11/4/2013	15:06	86			337.03	11.47	
11/4/2013	15:08	88			337.20	11.64	
11/4/2013	15:10	90			337.51	11.95	
11/4/2013	15:12	92			337.49	11.93	
11/4/2013	15:14	94			337.67	12.11	
11/4/2013	15:16	96			337.99	12.43	
11/4/2013	15:18	98			338.08	12.52	
11/4/2013	15:20	100			338.08	12.52	
11/4/2013	15:22	102			338.33	12.77	
11/4/2013	15:24	104			338.33	12.77	
11/4/2013	15:26	106			338.37	12.81	
11/4/2013	15:28	108			338.66	13.10	
11/4/2013	15:30	110			338.61	13.05	
11/4/2013	15:32	112			338.66	13.10	
11/4/2013	15:34	114			338.88	13.32	
11/4/2013	15:36	116			339.02	13.46	
11/4/2013	15:38	118			338.91	13.35	
11/4/2013	15:40	120			339.12	13.56	

Date	Time	Elapsed Time (min)	t' (min)	t/t'	DTW (ft)	DD (ft)	Remarks
11/4/2013	15:42	122			339.17	13.61	
11/4/2013	15:44	124			339.11	13.55	
11/4/2013	15:46	126			339.14	13.58	end step-rate test
11/4/2013	15:48	128			329.69	4.13	recovery
11/4/2013	15:50	130			330.88	5.32	
11/4/2013	15:52	132			326.62	1.05	
11/4/2013	15:54	134			326.28	0.72	
11/4/2013	15:56	136			326.05	0.49	
11/4/2013	15:58	138			325.95	0.39	
11/4/2013	16:00	140			325.89	0.33	
11/4/2013	16:02	142			325.87	0.31	
11/4/2013	16:04	144			325.84	0.28	
11/4/2013	16:06	146			325.82	0.26	
11/4/2013	16:08	148			325.82	0.26	
11/4/2013	16:10	150			325.80	0.24	
11/4/2013	16:12	152			325.80	0.24	
11/4/2013	16:14	154			325.79	0.23	
11/4/2013	16:16	156			325.77	0.21	
11/4/2013	16:18	158			325.77	0.21	
11/4/2013	16:20	160			325.7632	0.20	
11/4/2013	16:22	162			325.7645	0.20	
11/4/2013	16:24	164			325.7529	0.19	
11/4/2013	16:26	166			325.7465	0.19	
11/4/2013	16:28	168			325.7529	0.19	
11/4/2013	16:30	170			325.7404	0.18	
11/4/2013	16:32	172			325.7379	0.18	
11/4/2013	16:34	174			325.7454	0.18	
11/4/2013	16:36	176			325.7359	0.18	
11/4/2013	16:38	178			325.7323	0.17	
11/4/2013	16:40	180			325.7269	0.17	
11/4/2013	16:42	182			325.7196	0.16	
11/4/2013	16:44	184			325.717	0.16	
11/4/2013	16:46	186			325.7179	0.16	
11/4/2013	16:48	188			325.7126	0.15	
11/4/2013	16:50	190			325.7139	0.15	
11/4/2013	16:52	192			325.7001	0.14	
11/4/2013	16:54	194			325.6946	0.13	
11/4/2013	16:56	196			325.7032	0.14	
11/4/2013	16:58	198			325.7019	0.14	
11/4/2013	17:00	200			325.7072	0.15	
11/4/2013	17:02	202			325.6966	0.14	
11/4/2013	17:04	204			325.6959	0.14	
11/4/2013	17:06	206			325.6942	0.13	
11/4/2013	17:08	208			325.6967	0.14	
11/4/2013	17:10	210			325.6929	0.13	
11/4/2013	17:12	212			325.6922	0.13	
11/4/2013	17:14	214			325.6867	0.13	
11/4/2013	17:16	216			325.6959	0.14	
11/4/2013	17:18	218			325.691	0.13	
11/4/2013	17:20	220			325.6917	0.13	
11/4/2013	17:22	222			325.6894	0.13	
11/4/2013	17:24	224			325.6903	0.13	
11/4/2013	17:26	226			325.6826	0.12	
11/4/2013	17:28	228			325.6928	0.13	
11/4/2013	17:30	230			325.6956	0.14	
11/4/2013	17:32	232			325.6946	0.13	
11/4/2013	17:34	234			325.6867	0.13	
11/4/2013	17:36	236			325.6857	0.13	
11/4/2013	17:38	238			325.6914	0.13	
11/4/2013	17:40	240			325.6841	0.12	
11/4/2013	17:42	242			325.6756	0.12	
11/4/2013	17:44	244			325.6756	0.12	
11/4/2013	17:46	246			325.6799	0.12	
11/4/2013	17:48	248			325.6782	0.12	
11/4/2013	17:50	250			325.6787	0.12	
11/4/2013	17:52	252			325.6795	0.12	
11/4/2013	17:54	254			325.6839	0.12	
11/4/2013	17:56	256			325.6769	0.12	
11/4/2013	17:58	258			325.6676	0.11	
11/4/2013	18:00	260			325.6743	0.11	


Crater Lake Test Well Pumping Test
Test Date: November 4, 2013
Step-Rate Test (Q = 30, 50, 100 gpm)
SC (30) = 19.4 gpm/ft
SC (50) = 16.9 gpm/ft
SC (100) = 8.0 gpm/ft
SC (100) = 7.3 gpm/ft
Drawdown (ft)
0
2
4
6
8
10
12
14
16
0
20
40
60
80
100
120
140
160
180
200
Levelogger Measurement
Manual Measurement
Elapsed Time (min)

Crater Lake Test Well Pumping Test

Constant-Rate Test: Manual Water Level Measurements

Date: November 5 and 6, 2013

Test Performed by: Jason Thompson (SPF) and Chancellor Drilling and Pump, Inc.

Pump used for test: Grundfos submersible pump 85S150-12, 15 hp, set at ~420 feet

Flow rate measured with McCrometer propeller meter and 5 gallon bucket and stopwatch

Water-Level Measurement Point: top of sounding tube; 3.93 feet above ground surface

Date	Time	Elapsed Time (min)	t' (min)	t/t'	DTW (ft)	DD (ft)	Remarks
11/5/2013	8:34				325.67		static water level with transducer installed
11/5/2013	9:00	0					pump on; valve open, Q~100 gpm
11/5/2013	9:05	5					adjusting valve; Q=82 gpm, discharge pressure = 10 psi
11/5/2013	9:09	9			335.16	9.49	Q=82 gpm; P=10 psi
11/5/2013	9:12	12			335.72	10.05	
11/5/2013	9:15	15			336.07	10.40	Q=82 gpm; P=10 psi
11/5/2013	9:22	22			337.02	11.35	9:10-9:20, sand accum=0.06 mL; fine red cinders
11/5/2013	9:36	36			337.92	12.25	5 gallon bucket, t = 3.5 sec (86 gpm)
11/5/2013	9:46	46			338.51	12.84	Q=82 gpm; P=10 psi
11/5/2013	10:00	60			338.90	13.23	9:10-10:00, sand accum=0.1 mL; fine red cinders
11/5/2013	10:30	90			339.45	13.78	Q=82 gpm; P=10 psi
11/5/2013	11:00	120			339.81	14.14	9:10-11:00, sand accum=0.20 mL; fine red cinders
11/5/2013	11:30	150			340.09	14.42	Q=82 gpm; P=10 psi
11/5/2013	12:00	180			340.28	14.61	9:10-12:00, sand accum=0.22 mL; fine red cinders
11/5/2013	13:00	240			340.54	14.87	9:10-13:00, sand accum=0.28 mL; fine red cinders
11/5/2013	14:12	312			340.79	15.12	9:10-14:20, sand accum=0.32 mL; fine red cinders
11/5/2013	15:10	370			340.98	15.31	9:10-15:10, sand accum=0.35 mL; fine red cinders
11/5/2013	16:00	420			340.97	15.30	9:10-16:00, sand accum=0.38 mL; fine red cinders
11/5/2013	17:00	480			341.11	15.44	9:10-17:00, sand accum=0.40 mL; fine red cinders
11/6/2013	8:23	1403			342.98	17.31	pH = 6.57, EC = 29.7, SC = 51.1, T = 3.0°C
11/6/2013	9:01	1441	0		343.02	17.35	pump off; start recovery; TOT = 118,600 gal
11/6/2013	9:03	1443	2	722	332.54	6.87	
11/6/2013	9:04	1444	3	481	330.23	4.56	
11/6/2013	9:05	1445	4	361	329.21	3.54	
11/6/2013	9:06	1446	5	289	328.45	2.78	
11/6/2013	9:07	1447	6	241	327.83	2.16	
11/6/2013	9:08	1448	7	207	327.54	1.87	
11/6/2013	9:09	1449	8	181	327.24	1.57	
11/6/2013	9:10	1450	9	161	327.02	1.35	
11/6/2013	9:12	1452	11	132	326.72	1.05	
11/6/2013	9:14	1454	13	112	326.52	0.85	
11/6/2013	9:16	1456	15	97	326.37	0.70	
11/6/2013	9:20	1460	19	77	326.19	0.52	
11/6/2013	9:25	1465	24	61	326.06	0.39	
11/6/2013	9:30	1470	29	51	325.97	0.30	
11/6/2013	9:45	1485	44	34	325.94	0.27	
11/6/2013	10:00	1500	59	25	325.88	0.21	
11/6/2013	10:30	1530	89	17	325.83	0.16	
11/6/2013	11:00	1560	119	13	325.79	0.12	
11/6/2013	11:36	1596	155	10	325.72	0.05	
11/6/2013	12:00	1620	179	9	325.7	0.03	end recovery

Crater Lake Test Well Pumping Test

Constant-Rate Test: Levelogger Measurements

Date: November 5 and 6, 2013
Test Performed by: Jason Thompson (SPF) and Chancellor Drilling and Pump, Inc.
Pump used for test: Grundfos submersible pump 85S150-12, 15 hp, set at ~420 feet
Flow rate measured with McCrometer propeller meter and 5 gallon bucket and stopwatch
Water-Level Measurement Point: top of sounding tube; 3.93 feet above ground surfac

Date	Time	Elapsed Time (min)	t' (min)	t/t'	DTW (ft)	DD (ft)	Remarks
11/5/2013	8:56				325.70		static water level with transducer installed
11/5/2013	8:58	0			328.04	2.34	pump on; valve open, Q~100 gpm
11/5/2013	9:00	2			332.54	6.84	
11/5/2013	9:02	4			333.58	7.88	adjusting valve; Q=82 gpm, discharge pressure = 10 psi
11/5/2013	9:04	6			334.42	8.73	
11/5/2013	9:06	8			334.89	9.19	
11/5/2013	9:08	10			335.28	9.58	
11/5/2013	9:10	12			335.53	9.83	
11/5/2013	9:12	14			335.91	10.21	
11/5/2013	9:14	16			336.02	10.32	
11/5/2013	9:16	18			336.68	10.99	
11/5/2013	9:18	20			336.78	11.08	
11/5/2013	9:20	22			336.92	11.23	
11/5/2013	9:22	24			337.42	11.73	
11/5/2013	9:24	26			337.25	11.55	
11/5/2013	9:26	28			337.58	11.88	
11/5/2013	9:28	30			337.63	11.94	
11/5/2013	9:30	32			337.70	12.00	
11/5/2013	9:32	34			337.72	12.02	
11/5/2013	9:34	36			338.13	12.44	
11/5/2013	9:36	38			338.02	12.32	
11/5/2013	9:38	40			338.15	12.46	
11/5/2013	9:40	42			338.40	12.70	
11/5/2013	9:42	44			338.51	12.81	
11/5/2013	9:44	46			338.48	12.79	
11/5/2013	9:46	48			338.36	12.66	
11/5/2013	9:48	50			338.48	12.79	
11/5/2013	9:50	52			338.60	12.90	
11/5/2013	9:52	54			338.62	12.92	
11/5/2013	9:54	56			338.64	12.94	
11/5/2013	9:56	58			338.67	12.97	
11/5/2013	9:58	60			338.73	13.04	
11/5/2013	10:00	62			338.77	13.07	
11/5/2013	10:02	64			338.88	13.18	
11/5/2013	10:04	66			339.06	13.36	
11/5/2013	10:06	68			338.93	13.23	
11/5/2013	10:08	70			339.10	13.40	
11/5/2013	10:10	72			338.95	13.25	
11/5/2013	10:12	74			339.1941	13.50	
11/5/2013	10:14	76			339.1857	13.49	
11/5/2013	10:16	78			339.0958	13.40	
11/5/2013	10:18	80			339.0727	13.37	
11/5/2013	10:20	82			339.1199	13.42	
11/5/2013	10:22	84			339.2335	13.54	
11/5/2013	10:24	86			339.3615	13.66	
11/5/2013	10:26	88			339.4039	13.71	
11/5/2013	10:28	90			339.4538	13.76	
11/5/2013	10:30	92			339.4088	13.71	
11/5/2013	10:32	94			339.3263	13.63	
11/5/2013	10:34	96			339.4256	13.73	
11/5/2013	10:36	98			339.5614	13.86	
11/5/2013	10:38	100			339.5781	13.88	
11/5/2013	10:40	102			339.4992	13.80	
11/5/2013	10:42	104			339.5104	13.81	
11/5/2013	10:44	106			339.6472	13.95	
11/5/2013	10:46	108			339.733	14.03	
11/5/2013	10:48	110			339.768	14.07	
11/5/2013	10:50	112			339.8164	14.12	
11/5/2013	10:52	114			339.7114	14.01	
11/5/2013	10:54	116			339.7828	14.08	
11/5/2013	10:56	118			339.7776	14.08	
11/5/2013	10:58	120			339.8437	14.15	
11/5/2013	11:00	122			339.8736	14.18	
11/5/2013	11:02	124			339.908	14.21	
11/5/2013	11:04	126			339.8212	14.12	
11/5/2013	11:06	128			339.8081	14.11	
11/5/2013	11:08	130			339.9373	14.24	
11/5/2013	11:10	132			339.9157	14.22	
11/5/2013	11:12	134			339.9656	14.27	
11/5/2013	11:14	136			339.9538	14.26	
11/5/2013	11:16	138			339.8843	14.19	
11/5/2013	11:18	140			339.8604	14.16	
11/5/2013	11:20	142			339.925	14.23	
11/5/2013	11:22	144			340.0354	14.34	
11/5/2013	11:24	146			339.9653	14.27	
11/5/2013	11:26	148			340.0947	14.40	
11/5/2013	11:28	150			339.9835	14.29	
11/5/2013	11:30	152			340.0959	14.40	
11/5/2013	11:32	154			340.1329	14.43	
11/5/2013	11:34	156			340.1632	14.46	
11/5/2013	11:36	158			340.1661	14.47	
11/5/2013	11:38	160			340.1257	14.43	
11/5/2013	11:40	162			340.2957	14.60	
11/5/2013	11:42	164			340.1556	14.46	
11/5/2013	11:44	166			340.2803	14.58	
11/5/2013	11:46	168			340.338	14.64	
11/5/2013	11:48	170			340.1534	14.46	
11/5/2013	11:50	172			340.2891	14.59	
11/5/2013	11:52	174			340.1748	14.48	
11/5/2013	11:54	176			340.2529	14.55	
11/5/2013	11:56	178			340.1992	14.50	
11/5/2013	11:58	180			340.2063	14.51	
11/5/2013	12:00	182			340.3396	14.64	
11/5/2013	12:02	184			340.2461	14.55	
11/5/2013	12:04	186			340.3672	14.67	
11/5/2013	12:06	188			340.2483	14.55	
11/5/2013	12:08	190			340.3967	14.70	

Date	Time	Elapsed Time (min)	t' (min)	t/t'	DTW (ft)	DD (ft)	Remarks
11/5/2013	12:10	192			340.275	14.58	
11/5/2013	12:12	194			340.415	14.72	
11/5/2013	12:14	196			340.3203	14.62	
11/5/2013	12:16	198			340.4152	14.72	
11/5/2013	12:18	200			340.4284	14.73	
11/5/2013	12:20	202			340.3182	14.62	
11/5/2013	12:22	204			340.4745	14.78	
11/5/2013	12:24	206			340.455	14.76	
11/5/2013	12:26	208			340.3974	14.70	
11/5/2013	12:28	210			340.4916	14.79	
11/5/2013	12:30	212			340.426	14.73	
11/5/2013	12:32	214			340.4122	14.71	
11/5/2013	12:34	216			340.4973	14.80	
11/5/2013	12:36	218			340.4527	14.75	
11/5/2013	12:38	220			340.4328	14.73	
11/5/2013	12:40	222			340.5135	14.82	
11/5/2013	12:42	224			340.5161	14.82	
11/5/2013	12:44	226			340.5124	14.81	
11/5/2013	12:46	228			340.522	14.82	
11/5/2013	12:48	230			340.4395	14.74	
11/5/2013	12:50	232			340.4226	14.72	
11/5/2013	12:52	234			340.5187	14.82	
11/5/2013	12:54	236			340.5659	14.87	
11/5/2013	12:56	238			340.5423	14.84	
11/5/2013	12:58	240			340.4746	14.78	
11/5/2013	13:00	242			340.4048	14.71	
11/5/2013	13:02	244			340.5966	14.90	
11/5/2013	13:04	246			340.4715	14.77	
11/5/2013	13:06	248			340.5822	14.88	
11/5/2013	13:08	250			340.5105	14.81	
11/5/2013	13:10	252			340.5714	14.87	
11/5/2013	13:12	254			340.5476	14.85	
11/5/2013	13:14	256			340.4935	14.80	
11/5/2013	13:16	258			340.4799	14.78	
11/5/2013	13:18	260			340.5681	14.87	
11/5/2013	13:20	262			340.5507	14.85	
11/5/2013	13:22	264			340.5712	14.87	
11/5/2013	13:24	266			340.5777	14.88	
11/5/2013	13:26	268			340.614	14.92	
11/5/2013	13:28	270			340.5413	14.84	
11/5/2013	13:30	272			340.5392	14.84	
11/5/2013	13:32	274			340.5774	14.88	
11/5/2013	13:34	276			340.6756	14.98	
11/5/2013	13:36	278			340.5553	14.86	
11/5/2013	13:38	280			340.6522	14.95	
11/5/2013	13:40	282			340.5981	14.90	
11/5/2013	13:42	284			340.5717	14.87	
11/5/2013	13:44	286			340.7085	15.01	
11/5/2013	13:46	288			340.5784	14.88	
11/5/2013	13:48	290			340.6996	15.00	
11/5/2013	13:50	292			340.659	14.96	
11/5/2013	13:52	294			340.7364	15.04	
11/5/2013	13:54	296			340.6336	14.94	
11/5/2013	13:56	298			340.7467	15.05	
11/5/2013	13:58	300			340.7069	15.01	
11/5/2013	14:00	302			340.6843	14.99	
11/5/2013	14:02	304			340.6654	14.97	
11/5/2013	14:04	306			340.7752	15.08	
11/5/2013	14:06	308			340.6502	14.95	
11/5/2013	14:08	310			340.775	15.08	
11/5/2013	14:10	312			340.7772	15.08	
11/5/2013	14:12	314			340.7898	15.09	
11/5/2013	14:14	316			340.7833	15.09	
11/5/2013	14:16	318			340.8067	15.11	
11/5/2013	14:18	320			340.7855	15.09	
11/5/2013	14:20	322			340.8374	15.14	
11/5/2013	14:22	324			340.8089	15.11	
11/5/2013	14:24	326			340.6936	15.00	
11/5/2013	14:26	328			340.7139	15.02	
11/5/2013	14:28	330			340.7217	15.02	
11/5/2013	14:30	332			340.774	15.08	
11/5/2013	14:32	334			340.8103	15.11	
11/5/2013	14:34	336			340.7324	15.03	
11/5/2013	14:36	338			340.7611	15.06	
11/5/2013	14:38	340			340.8136	15.12	
11/5/2013	14:40	342			340.8676	15.17	
11/5/2013	14:42	344			340.8277	15.13	
11/5/2013	14:44	346			340.759	15.06	
11/5/2013	14:46	348			340.8055	15.11	
11/5/2013	14:48	350			340.7553	15.06	
11/5/2013	14:50	352			340.8687	15.17	
11/5/2013	14:52	354			340.9184	15.22	
11/5/2013	14:54	356			340.8818	15.18	
11/5/2013	14:56	358			340.9755	15.28	
11/5/2013	14:58	360			340.8915	15.19	
11/5/2013	15:00	362			340.9115	15.21	
11/5/2013	15:02	364			340.9764	15.28	
11/5/2013	15:04	366			340.8866	15.19	
11/5/2013	15:06	368			340.9311	15.23	
11/5/2013	15:08	370			340.9977	15.30	
11/5/2013	15:10	372			340.9557	15.26	
11/5/2013	15:12	374			340.965	15.27	
11/5/2013	15:14	376			340.8978	15.20	
11/5/2013	15:16	378			340.9849	15.29	
11/5/2013	15:18	380			340.9162	15.22	
11/5/2013	15:20	382			340.8932	15.19	
11/5/2013	15:22	384			340.9027	15.20	
11/5/2013	15:24	386			340.9086	15.21	
11/5/2013	15:26	388			340.9606	15.26	
11/5/2013	15:28	390			340.9336	15.24	
11/5/2013	15:30	392			340.8911	15.19	
11/5/2013	15:32	394			340.9375	15.24	
11/5/2013	15:34	396			340.9876	15.29	
11/5/2013	15:36	398			340.945	15.25	
11/5/2013	15:38	400			340.9266	15.23	

Date	Time	Elapsed Time (min)	t' (min)	t/t'	DTW (ft)	DD (ft)	Remarks
11/5/2013	15:40	402			340.9096	15.21	
11/5/2013	15:42	404			340.966	15.27	
11/5/2013	15:44	406			340.9193	15.22	
11/5/2013	15:46	408			340.9898	15.29	
11/5/2013	15:48	410			340.9545	15.26	
11/5/2013	15:50	412			340.9454	15.25	
11/5/2013	15:52	414			340.8415	15.14	
11/5/2013	15:54	416			340.9833	15.29	
11/5/2013	15:56	418			340.9734	15.28	
11/5/2013	15:58	420			340.9302	15.23	
11/5/2013	16:00	422			340.9036	15.21	
11/5/2013	16:02	424			340.9888	15.29	
11/5/2013	16:04	426			340.8577	15.16	
11/5/2013	16:06	428			340.9768	15.28	
11/5/2013	16:08	430			340.9461	15.25	
11/5/2013	16:10	432			340.9404	15.24	
11/5/2013	16:12	434			340.8822	15.18	
11/5/2013	16:14	436			340.9577	15.26	
11/5/2013	16:16	438			340.9364	15.24	
11/5/2013	16:18	440			340.9308	15.23	
11/5/2013	16:20	442			340.9389	15.24	
11/5/2013	16:22	444			340.908	15.21	
11/5/2013	16:24	446			340.9218	15.22	
11/5/2013	16:26	448			340.9949	15.30	
11/5/2013	16:28	450			340.9758	15.28	
11/5/2013	16:30	452			340.899	15.20	
11/5/2013	16:32	454			340.9914	15.29	
11/5/2013	16:34	456			341.0514	15.35	
11/5/2013	16:36	458			341.1001	15.40	
11/5/2013	16:38	460			340.9918	15.29	
11/5/2013	16:40	462			341.089	15.39	
11/5/2013	16:42	464			341.0802	15.38	
11/5/2013	16:44	466			340.991	15.29	
11/5/2013	16:46	468			341.0373	15.34	
11/5/2013	16:48	470			341.0327	15.33	
11/5/2013	16:50	472			340.9906	15.29	
11/5/2013	16:52	474			341.0996	15.40	
11/5/2013	16:54	476			341.0651	15.37	
11/5/2013	16:56	478			341.1005	15.40	
11/5/2013	16:58	480			341.038	15.34	
11/5/2013	17:00	482			341.032	15.33	
11/5/2013	17:02	484			341.0793	15.38	
11/5/2013	17:04	486			341.0926	15.39	
11/5/2013	17:06	488			341.1269	15.43	
11/5/2013	17:08	490			341.1218	15.42	
11/5/2013	17:10	492			341.0965	15.40	
11/5/2013	17:12	494			341.1463	15.45	
11/5/2013	17:14	496			341.1672	15.47	
11/5/2013	17:16	498			341.0704	15.37	
11/5/2013	17:18	500			341.1707	15.47	
11/5/2013	17:20	502			341.1343	15.44	
11/5/2013	17:22	504			341.106	15.41	
11/5/2013	17:24	506			341.0859	15.39	
11/5/2013	17:26	508			341.1906	15.49	
11/5/2013	17:28	510			341.2093	15.51	
11/5/2013	17:30	512			341.193	15.49	
11/5/2013	17:32	514			341.1027	15.40	
11/5/2013	17:34	516			341.127	15.43	
11/5/2013	17:36	518			341.172	15.47	
11/5/2013	17:38	520			341.1561	15.46	
11/5/2013	17:40	522			341.1763	15.48	
11/5/2013	17:42	524			341.0916	15.39	
11/5/2013	17:44	526			341.1559	15.46	
11/5/2013	17:46	528			341.0845	15.39	
11/5/2013	17:48	530			341.1662	15.47	
11/5/2013	17:50	532			341.0487	15.35	
11/5/2013	17:52	534			341.152	15.45	
11/5/2013	17:54	536			341.061	15.36	
11/5/2013	17:56	538			341.1009	15.40	
11/5/2013	17:58	540			341.1418	15.44	
11/5/2013	18:00	542			341.1118	15.41	
11/5/2013	18:02	544			341.1946	15.50	
11/5/2013	18:04	546			341.1248	15.43	
11/5/2013	18:06	548			341.0488	15.35	
11/5/2013	18:08	550			341.1376	15.44	
11/5/2013	18:10	552			341.0707	15.37	
11/5/2013	18:12	554			341.1706	15.47	
11/5/2013	18:14	556			341.1704	15.47	
11/5/2013	18:16	558			341.179	15.48	
11/5/2013	18:18	560			341.076	15.38	
11/5/2013	18:20	562			341.0773	15.38	
11/5/2013	18:22	564			341.0998	15.40	
11/5/2013	18:24	566			341.1979	15.50	
11/5/2013	18:26	568			341.1671	15.47	
11/5/2013	18:28	570			341.099	15.40	
11/5/2013	18:30	572			341.1753	15.48	
11/5/2013	18:32	574			341.1522	15.45	
11/5/2013	18:34	576			341.1063	15.41	
11/5/2013	18:36	578			341.1099	15.41	
11/5/2013	18:38	580			341.1708	15.47	
11/5/2013	18:40	582			341.2034	15.51	
11/5/2013	18:42	584			341.2261	15.53	
11/5/2013	18:44	586			341.104	15.41	
11/5/2013	18:46	588			341.2283	15.53	
11/5/2013	18:48	590			341.2044	15.51	
11/5/2013	18:50	592			341.1852	15.49	
11/5/2013	18:52	594			341.0975	15.40	
11/5/2013	18:54	596			341.1344	15.44	
11/5/2013	18:56	598			341.2243	15.53	
11/5/2013	18:58	600			341.2269	15.53	
11/5/2013	19:00	602			341.2484	15.55	
11/5/2013	19:02	604			341.1655	15.47	
11/5/2013	19:04	606			341.1483	15.45	
11/5/2013	19:06	608			341.1791	15.48	
11/5/2013	19:08	610			341.2765	15.58	

Date	Time	Elapsed Time (min)	t' (min)	t/t'	DTW (ft)	DD (ft)	Remarks
11/5/2013	19:10	612			341.1467	15.45	
11/5/2013	19:12	614			341.2666	15.57	
11/5/2013	19:14	616			341.1631	15.46	
11/5/2013	19:16	618			341.2707	15.57	
11/5/2013	19:18	620			341.1758	15.48	
11/5/2013	19:20	622			341.2419	15.54	
11/5/2013	19:22	624			341.2235	15.53	
11/5/2013	19:24	626			341.204	15.51	
11/5/2013	19:26	628			341.2614	15.56	
11/5/2013	19:28	630			341.2932	15.59	
11/5/2013	19:30	632			341.1742	15.48	
11/5/2013	19:32	634			341.2708	15.57	
11/5/2013	19:34	636			341.2147	15.52	
11/5/2013	19:36	638			341.2826	15.58	
11/5/2013	19:38	640			341.2064	15.51	
11/5/2013	19:40	642			341.2614	15.56	
11/5/2013	19:42	644			341.3161	15.62	
11/5/2013	19:44	646			341.2966	15.60	
11/5/2013	19:46	648			341.1983	15.50	
11/5/2013	19:48	650			341.2696	15.57	
11/5/2013	19:50	652			341.2995	15.60	
11/5/2013	19:52	654			341.2881	15.59	
11/5/2013	19:54	656			341.2351	15.54	
11/5/2013	19:56	658			341.2995	15.60	
11/5/2013	19:58	660			341.2598	15.56	
11/5/2013	20:00	662			341.2839	15.59	
11/5/2013	20:02	664			341.2521	15.55	
11/5/2013	20:04	666			341.3199	15.62	
11/5/2013	20:06	668			341.367	15.67	
11/5/2013	20:08	670			341.2267	15.53	
11/5/2013	20:10	672			341.2944	15.60	
11/5/2013	20:12	674			341.2485	15.55	
11/5/2013	20:14	676			341.2867	15.59	
11/5/2013	20:16	678			341.256	15.56	
11/5/2013	20:18	680			341.206	15.51	
11/5/2013	20:20	682			341.2373	15.54	
11/5/2013	20:22	684			341.2854	15.59	
11/5/2013	20:24	686			341.3238	15.63	
11/5/2013	20:26	688			341.3369	15.64	
11/5/2013	20:28	690			341.3456	15.65	
11/5/2013	20:30	692			341.2687	15.57	
11/5/2013	20:32	694			341.2584	15.56	
11/5/2013	20:34	696			341.3459	15.65	
11/5/2013	20:36	698			341.268	15.57	
11/5/2013	20:38	700			341.2426	15.54	
11/5/2013	20:40	702			341.3521	15.65	
11/5/2013	20:42	704			341.2827	15.58	
11/5/2013	20:44	706			341.2636	15.57	
11/5/2013	20:46	708			341.3102	15.61	
11/5/2013	20:48	710			341.3031	15.60	
11/5/2013	20:50	712			341.2927	15.59	
11/5/2013	20:52	714			341.319	15.62	
11/5/2013	20:54	716			341.2862	15.59	
11/5/2013	20:56	718			341.2618	15.56	
11/5/2013	20:58	720			341.3403	15.64	
11/5/2013	21:00	722			341.3659	15.67	
11/5/2013	21:02	724			341.2538	15.56	
11/5/2013	21:04	726			341.3217	15.62	
11/5/2013	21:06	728			341.2872	15.59	
11/5/2013	21:08	730			341.252	15.55	
11/5/2013	21:10	732			341.3331	15.63	
11/5/2013	21:12	734			341.2697	15.57	
11/5/2013	21:14	736			341.2911	15.59	
11/5/2013	21:16	738			341.2665	15.57	
11/5/2013	21:18	740			341.3883	15.69	
11/5/2013	21:20	742			341.3015	15.60	
11/5/2013	21:22	744			341.2884	15.59	
11/5/2013	21:24	746			341.3791	15.68	
11/5/2013	21:26	748			341.3559	15.66	
11/5/2013	21:28	750			341.3739	15.68	
11/5/2013	21:30	752			341.3799	15.68	
11/5/2013	21:32	754			341.3689	15.67	
11/5/2013	21:34	756			341.4179	15.72	
11/5/2013	21:36	758			341.3452	15.65	
11/5/2013	21:38	760			341.3741	15.68	
11/5/2013	21:40	762			341.4107	15.71	
11/5/2013	21:42	764			341.3489	15.65	
11/5/2013	21:44	766			341.3867	15.69	
11/5/2013	21:46	768			341.4386	15.74	
11/5/2013	21:48	770			341.3424	15.64	
11/5/2013	21:50	772			341.3621	15.66	
11/5/2013	21:52	774			341.356	15.66	
11/5/2013	21:54	776			341.3639	15.67	
11/5/2013	21:56	778			341.3384	15.64	
11/5/2013	21:58	780			341.3369	15.64	
11/5/2013	22:00	782			341.4758	15.78	
11/5/2013	22:02	784			341.347	15.65	
11/5/2013	22:04	786			341.4061	15.71	
11/5/2013	22:06	788			341.4333	15.74	
11/5/2013	22:08	790			341.3801	15.68	
11/5/2013	22:10	792			341.4678	15.77	
11/5/2013	22:12	794			341.3862	15.69	
11/5/2013	22:14	796			341.3491	15.65	
11/5/2013	22:16	798			341.3512	15.65	
11/5/2013	22:18	800			341.3581	15.66	
11/5/2013	22:20	802			341.384	15.69	
11/5/2013	22:22	804			341.4423	15.74	
11/5/2013	22:24	806			341.4314	15.73	
11/5/2013	22:26	808			341.3888	15.69	
11/5/2013	22:28	810			341.4375	15.74	
11/5/2013	22:30	812			341.3827	15.68	
11/5/2013	22:32	814			341.4364	15.74	
11/5/2013	22:34	816			341.3385	15.64	
11/5/2013	22:36	818			341.3968	15.70	
11/5/2013	22:38	820			341.3979	15.70	

Date	Time	Elapsed Time (min)	t' (min)	t/t'	DTW (ft)	DD (ft)	Remarks
11/5/2013	22:40	822			341.4095	15.71	
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11/5/2013	22:44	826			341.4096	15.71	
11/5/2013	22:46	828			341.3403	15.64	
11/5/2013	22:48	830			341.3202	15.62	
11/5/2013	22:50	832			341.411	15.71	
11/5/2013	22:52	834			341.3244	15.63	
11/5/2013	22:54	836			341.4173	15.72	
11/5/2013	22:56	838			341.3152	15.62	
11/5/2013	22:58	840			341.34	15.64	
11/5/2013	23:00	842			341.3158	15.62	
11/5/2013	23:02	844			341.3409	15.64	
11/5/2013	23:04	846			341.3967	15.70	
11/5/2013	23:06	848			341.3184	15.62	
11/5/2013	23:08	850			341.3374	15.64	
11/5/2013	23:10	852			341.4317	15.73	
11/5/2013	23:12	854			341.4567	15.76	
11/5/2013	23:14	856			341.3205	15.62	
11/5/2013	23:16	858			341.3876	15.69	
11/5/2013	23:18	860			341.3852	15.69	
11/5/2013	23:20	862			341.3749	15.68	
11/5/2013	23:22	864			341.3711	15.67	
11/5/2013	23:24	866			341.4063	15.71	
11/5/2013	23:26	868			341.4622	15.76	
11/5/2013	23:28	870			341.4768	15.78	
11/5/2013	23:30	872			341.4527	15.75	
11/5/2013	23:32	874			341.3724	15.67	
11/5/2013	23:34	876			341.4717	15.77	
11/5/2013	23:36	878			341.4128	15.71	
11/5/2013	23:38	880			341.4212	15.72	
11/5/2013	23:40	882			341.482	15.78	
11/5/2013	23:42	884			341.4281	15.73	
11/5/2013	23:44	886			341.4034	15.71	
11/5/2013	23:46	888			341.4729	15.77	
11/5/2013	23:48	890			341.4394	15.74	
11/5/2013	23:50	892			341.4785	15.78	
11/5/2013	23:52	894			341.4816	15.78	
11/5/2013	23:54	896			341.5068	15.81	
11/5/2013	23:56	898			341.493	15.79	
11/5/2013	23:58	900			341.5458	15.85	
11/6/2013	0:00	902			341.4726	15.77	
11/6/2013	0:02	904			341.5212	15.82	
11/6/2013	0:04	906			341.4964	15.80	
11/6/2013	0:06	908			341.5393	15.84	
11/6/2013	0:08	910			341.4925	15.79	
11/6/2013	0:10	912			341.5968	15.90	
11/6/2013	0:12	914			341.4991	15.80	
11/6/2013	0:14	916			341.4693	15.77	
11/6/2013	0:16	918			341.4913	15.79	
11/6/2013	0:18	920			341.5324	15.83	
11/6/2013	0:20	922			341.4994	15.80	
11/6/2013	0:22	924			341.5335	15.84	
11/6/2013	0:24	926			341.6022	15.90	
11/6/2013	0:26	928			341.5647	15.87	
11/6/2013	0:28	930			341.5665	15.87	
11/6/2013	0:30	932			341.5807	15.88	
11/6/2013	0:32	934			341.5439	15.85	
11/6/2013	0:34	936			341.5602	15.86	
11/6/2013	0:36	938			341.5686	15.87	
11/6/2013	0:38	940			341.6135	15.92	
11/6/2013	0:40	942			341.542	15.84	
11/6/2013	0:42	944			341.4982	15.80	
11/6/2013	0:44	946			341.5555	15.86	
11/6/2013	0:46	948			341.5318	15.83	
11/6/2013	0:48	950			341.6282	15.93	
11/6/2013	0:50	952			341.5533	15.86	
11/6/2013	0:52	954			341.5328	15.83	
11/6/2013	0:54	956			341.6385	15.94	
11/6/2013	0:56	958			341.5373	15.84	
11/6/2013	0:58	960			341.5364	15.84	
11/6/2013	1:00	962			341.5384	15.84	
11/6/2013	1:02	964			341.5689	15.87	
11/6/2013	1:04	966			341.6066	15.91	
11/6/2013	1:06	968			341.5532	15.86	
11/6/2013	1:08	970			341.6267	15.93	
11/6/2013	1:10	972			341.6498	15.95	
11/6/2013	1:12	974			341.5826	15.88	
11/6/2013	1:14	976			341.6273	15.93	
11/6/2013	1:16	978			341.6551	15.96	
11/6/2013	1:18	980			341.6279	15.93	
11/6/2013	1:20	982			341.6268	15.93	
11/6/2013	1:22	984			341.6668	15.97	
11/6/2013	1:24	986			341.6872	15.99	
11/6/2013	1:26	988			341.6833	15.99	
11/6/2013	1:28	990			341.6047	15.91	
11/6/2013	1:30	992			341.5992	15.90	
11/6/2013	1:32	994			341.7075	16.01	
11/6/2013	1:34	996			341.6967	16.00	
11/6/2013	1:36	998			341.684	15.99	
11/6/2013	1:38	1000			341.6098	15.91	
11/6/2013	1:40	1002			341.5996	15.90	
11/6/2013	1:42	1004			341.6249	15.93	
11/6/2013	1:44	1006			341.6752	15.98	
11/6/2013	1:46	1008			341.656	15.96	
11/6/2013	1:48	1010			341.6049	15.91	
11/6/2013	1:50	1012			341.5914	15.89	
11/6/2013	1:52	1014			341.7002	16.00	
11/6/2013	1:54	1016			341.5984	15.90	
11/6/2013	1:56	1018			341.6743	15.98	
11/6/2013	1:58	1020			341.6069	15.91	
11/6/2013	2:00	1022			341.6666	15.97	
11/6/2013	2:02	1024			341.6633	15.97	
11/6/2013	2:04	1026			341.6292	15.93	
11/6/2013	2:06	1028			341.6731	15.97	
11/6/2013	2:08	1030			341.6385	15.94	

Date	Time	Elapsed Time (min)	t' (min)	t/t'	DTW (ft)	DD (ft)	Remarks
11/6/2013	2:10	1032			341.6744	15.98	
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11/6/2013	2:14	1036			341.6933	16.00	
11/6/2013	2:16	1038			341.6771	15.98	
11/6/2013	2:18	1040			341.7292	16.03	
11/6/2013	2:20	1042			341.7093	16.01	
11/6/2013	2:22	1044			341.7262	16.03	
11/6/2013	2:24	1046			341.6463	15.95	
11/6/2013	2:26	1048			341.6995	16.00	
11/6/2013	2:28	1050			341.643	15.94	
11/6/2013	2:30	1052			341.7104	16.01	
11/6/2013	2:32	1054			341.6385	15.94	
11/6/2013	2:34	1056			341.6724	15.97	
11/6/2013	2:36	1058			341.6579	15.96	
11/6/2013	2:38	1060			341.7405	16.04	
11/6/2013	2:40	1062			341.7059	16.01	
11/6/2013	2:42	1064			341.7294	16.03	
11/6/2013	2:44	1066			341.6865	15.99	
11/6/2013	2:46	1068			341.7487	16.05	
11/6/2013	2:48	1070			341.7819	16.08	
11/6/2013	2:50	1072			341.7019	16.00	
11/6/2013	2:52	1074			341.8114	16.11	
11/6/2013	2:54	1076			341.7885	16.09	
11/6/2013	2:56	1078			341.7691	16.07	
11/6/2013	2:58	1080			341.7113	16.01	
11/6/2013	3:00	1082			341.7732	16.07	
11/6/2013	3:02	1084			341.7398	16.04	
11/6/2013	3:04	1086			341.7278	16.03	
11/6/2013	3:06	1088			341.821	16.12	
11/6/2013	3:08	1090			341.8422	16.14	
11/6/2013	3:10	1092			341.8592	16.16	
11/6/2013	3:12	1094			341.7841	16.09	
11/6/2013	3:14	1096			341.8666	16.17	
11/6/2013	3:16	1098			341.8879	16.19	
11/6/2013	3:18	1100			341.7934	16.10	
11/6/2013	3:20	1102			341.8488	16.15	
11/6/2013	3:22	1104			341.8431	16.14	
11/6/2013	3:24	1106			341.9134	16.22	
11/6/2013	3:26	1108			341.9423	16.24	
11/6/2013	3:28	1110			341.8469	16.15	
11/6/2013	3:30	1112			341.9576	16.26	
11/6/2013	3:32	1114			341.9075	16.21	
11/6/2013	3:34	1116			341.9672	16.27	
11/6/2013	3:36	1118			341.9292	16.23	
11/6/2013	3:38	1120			341.9206	16.22	
11/6/2013	3:40	1122			341.9198	16.22	
11/6/2013	3:42	1124			342.0172	16.32	
11/6/2013	3:44	1126			341.9391	16.24	
11/6/2013	3:46	1128			341.9565	16.26	
11/6/2013	3:48	1130			342.0184	16.32	
11/6/2013	3:50	1132			341.9349	16.24	
11/6/2013	3:52	1134			341.9251	16.23	
11/6/2013	3:54	1136			341.9534	16.26	
11/6/2013	3:56	1138			341.9779	16.28	
11/6/2013	3:58	1140			342.0797	16.38	
11/6/2013	4:00	1142			342.0687	16.37	
11/6/2013	4:02	1144			342.0492	16.35	
11/6/2013	4:04	1146			342.0483	16.35	
11/6/2013	4:06	1148			342.1245	16.43	
11/6/2013	4:08	1150			342.1017	16.40	
11/6/2013	4:10	1152			342.2068	16.51	
11/6/2013	4:12	1154			342.0847	16.39	
11/6/2013	4:14	1156			342.2244	16.53	
11/6/2013	4:16	1158			342.3028	16.60	
11/6/2013	4:18	1160			342.3386	16.64	
11/6/2013	4:20	1162			342.2978	16.60	
11/6/2013	4:22	1164			342.3225	16.62	
11/6/2013	4:24	1166			342.4685	16.77	
11/6/2013	4:26	1168			342.4919	16.79	
11/6/2013	4:28	1170			342.4316	16.73	
11/6/2013	4:30	1172			342.4858	16.79	
11/6/2013	4:32	1174			342.5268	16.83	
11/6/2013	4:34	1176			342.5036	16.81	
11/6/2013	4:36	1178			342.4932	16.79	
11/6/2013	4:38	1180			342.5871	16.89	
11/6/2013	4:40	1182			342.6343	16.94	
11/6/2013	4:42	1184			342.7199	17.02	
11/6/2013	4:44	1186			342.6824	16.98	
11/6/2013	4:46	1188			342.694	17.00	
11/6/2013	4:48	1190			342.723	17.02	
11/6/2013	4:50	1192			342.7823	17.08	
11/6/2013	4:52	1194			342.7034	17.01	
11/6/2013	4:54	1196			342.7191	17.02	
11/6/2013	4:56	1198			342.7314	17.03	
11/6/2013	4:58	1200			342.791	17.09	
11/6/2013	5:00	1202			342.8404	17.14	
11/6/2013	5:02	1204			342.8588	17.16	
11/6/2013	5:04	1206			342.8079	17.11	
11/6/2013	5:06	1208			342.9017	17.20	
11/6/2013	5:08	1210			342.9001	17.20	
11/6/2013	5:10	1212			342.8991	17.20	
11/6/2013	5:12	1214			342.8559	17.16	
11/6/2013	5:14	1216			342.9168	17.22	
11/6/2013	5:16	1218			342.8313	17.13	
11/6/2013	5:18	1220			342.9129	17.21	
11/6/2013	5:20	1222			342.9434	17.25	
11/6/2013	5:22	1224			342.8963	17.20	
11/6/2013	5:24	1226			342.9415	17.24	
11/6/2013	5:26	1228			342.8563	17.16	
11/6/2013	5:28	1230			342.8185	17.12	
11/6/2013	5:30	1232			342.9255	17.23	
11/6/2013	5:32	1234			342.8905	17.19	
11/6/2013	5:34	1236			342.8869	17.19	
11/6/2013	5:36	1238			342.8608	17.16	
11/6/2013	5:38	1240			342.9117	17.21	

Date	Time	Elapsed Time (min)	t' (min)	t/t'	DTW (ft)	DD (ft)	Remarks
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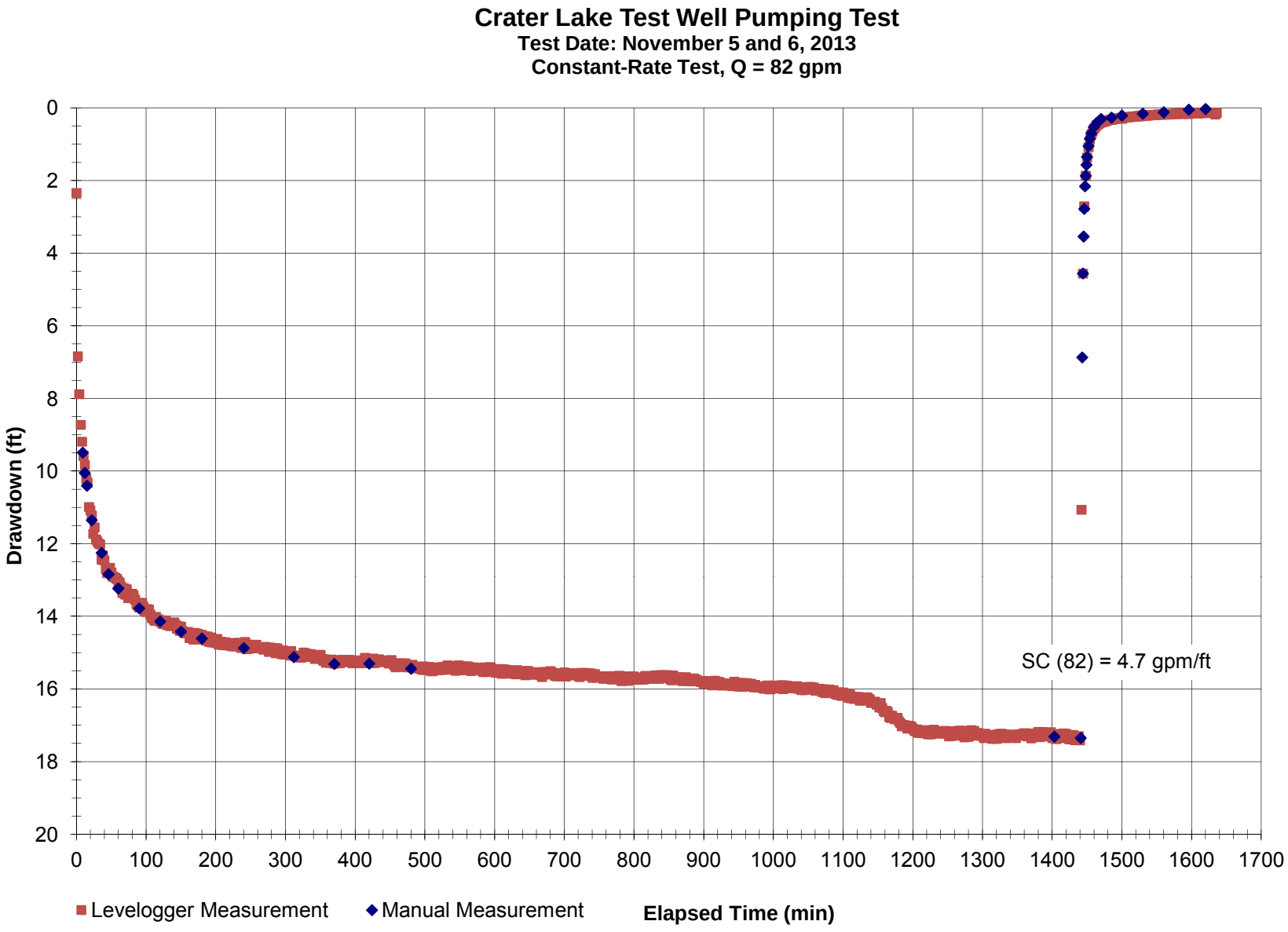
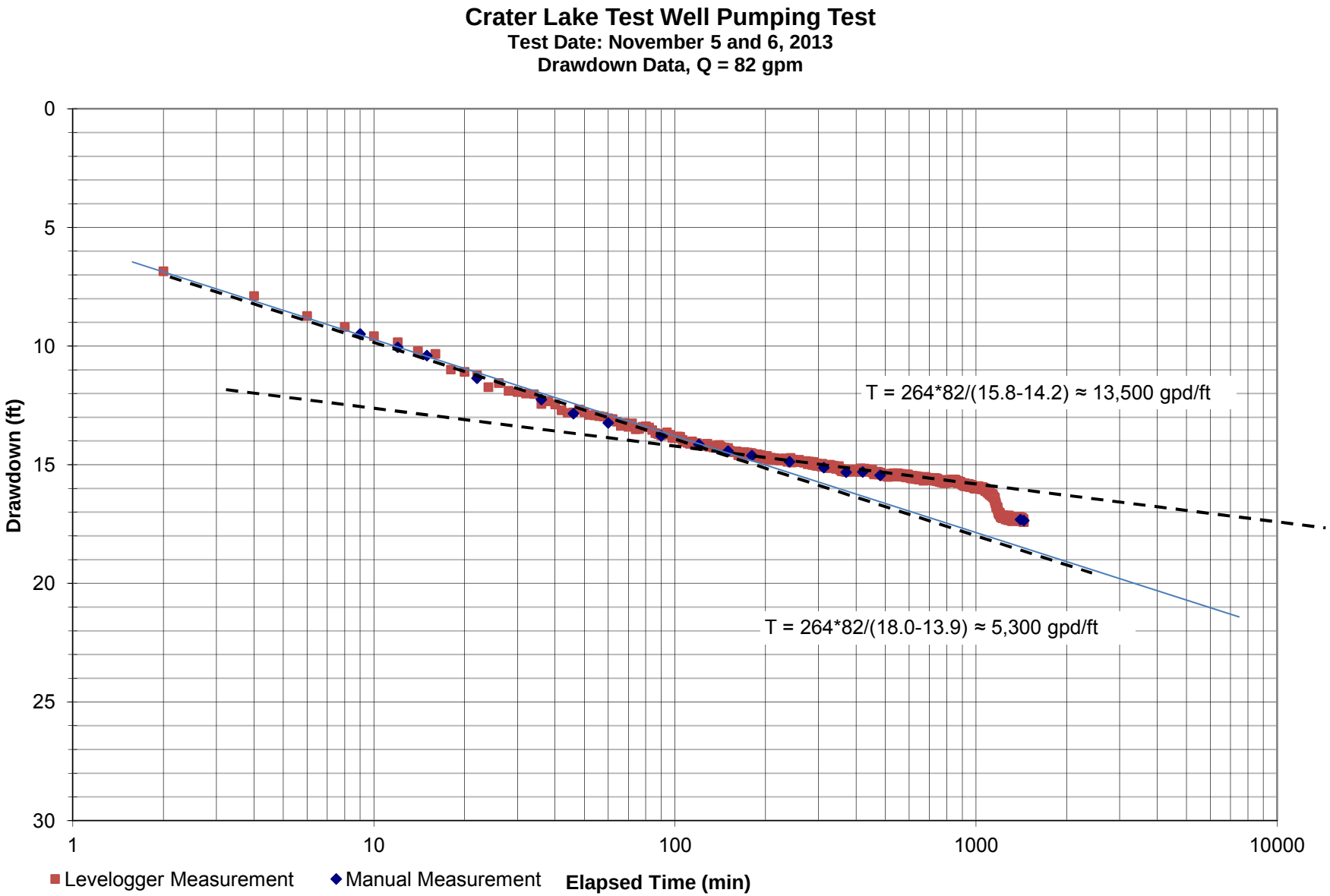
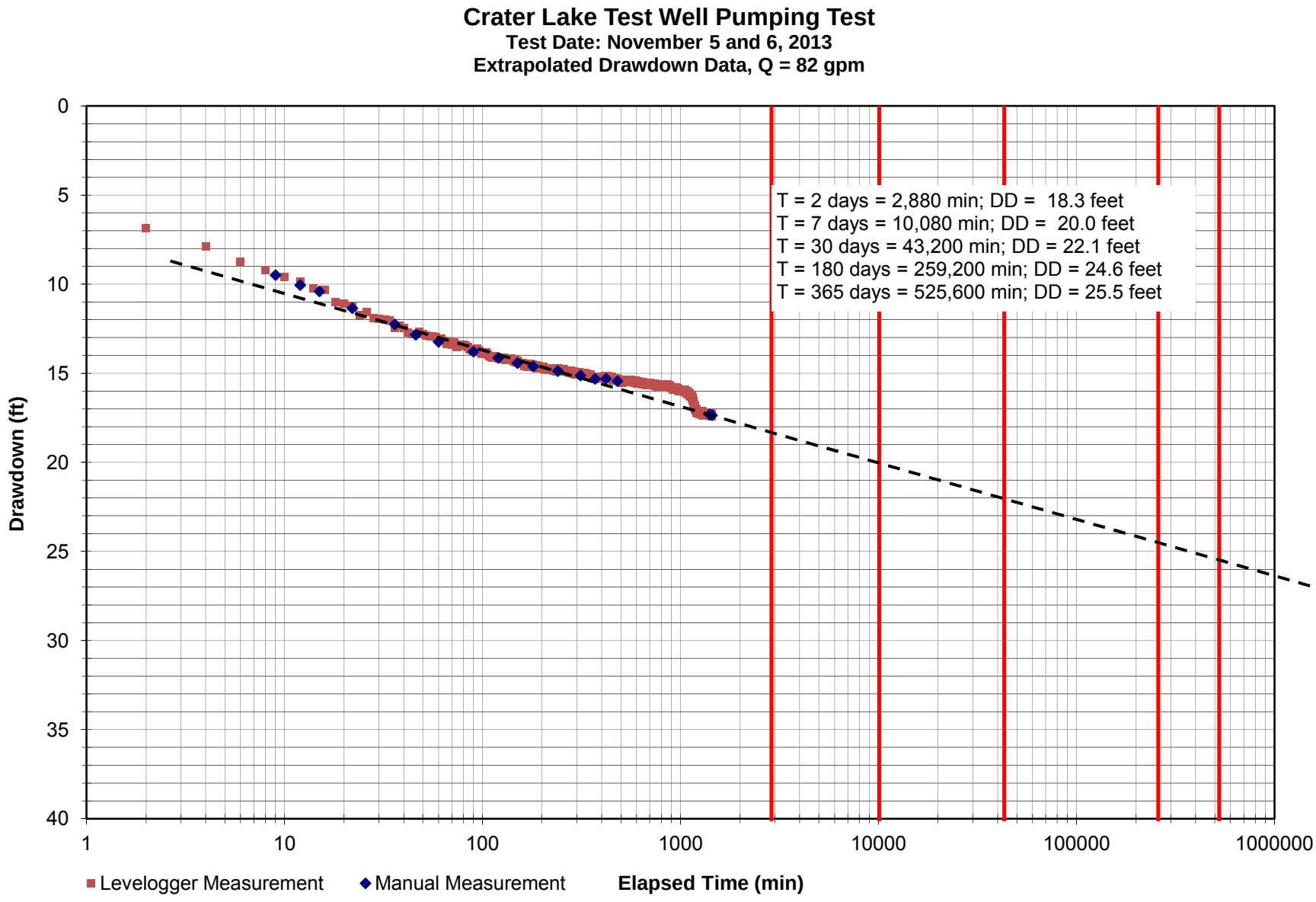
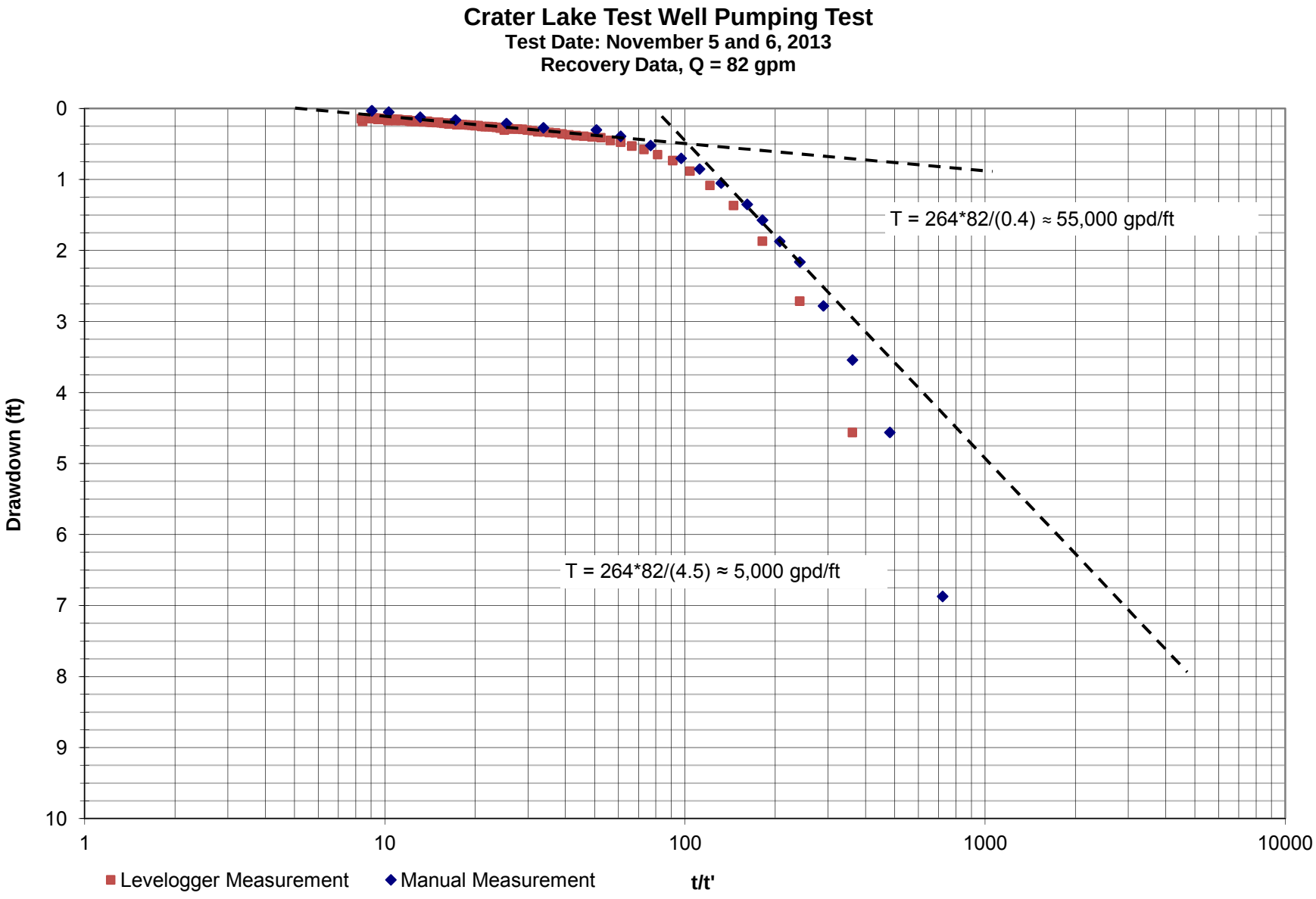
11/6/2013	5:44	1246			342.8483	17.15	
11/6/2013	5:46	1248			342.9087	17.21	
11/6/2013	5:48	1250			342.9389	17.24	
11/6/2013	5:50	1252			342.9972	17.30	
11/6/2013	5:52	1254			342.8601	17.16	
11/6/2013	5:54	1256			342.9834	17.29	
11/6/2013	5:56	1258			342.9466	17.25	
11/6/2013	5:58	1260			342.9755	17.28	
11/6/2013	6:00	1262			342.9054	17.21	
11/6/2013	6:02	1264			342.9	17.20	
11/6/2013	6:04	1266			342.843	17.14	
11/6/2013	6:06	1268			342.8816	17.18	
11/6/2013	6:08	1270			342.8426	17.14	
11/6/2013	6:10	1272			342.9765	17.28	
11/6/2013	6:12	1274			343.0257	17.33	
11/6/2013	6:14	1276			342.9372	17.24	
11/6/2013	6:16	1278			342.9425	17.24	
11/6/2013	6:18	1280			343.0136	17.32	
11/6/2013	6:20	1282			342.9688	17.27	
11/6/2013	6:22	1284			342.8331	17.13	
11/6/2013	6:24	1286			342.9456	17.25	
11/6/2013	6:26	1288			342.8544	17.16	
11/6/2013	6:28	1290			342.9775	17.28	
11/6/2013	6:30	1292			342.9708	17.27	
11/6/2013	6:32	1294			342.9068	17.21	
11/6/2013	6:34	1296			342.9789	17.28	
11/6/2013	6:36	1298			342.9697	17.27	
11/6/2013	6:38	1300			342.9951	17.30	
11/6/2013	6:40	1302			343.0492	17.35	
11/6/2013	6:42	1304			342.9275	17.23	
11/6/2013	6:44	1306			342.9983	17.30	
11/6/2013	6:46	1308			343.0241	17.33	
11/6/2013	6:48	1310			342.9637	17.27	
11/6/2013	6:50	1312			343.0259	17.33	
11/6/2013	6:52	1314			343.0666	17.37	
11/6/2013	6:54	1316			343.0461	17.35	
11/6/2013	6:56	1318			343.0206	17.32	
11/6/2013	6:58	1320			343.0719	17.37	
11/6/2013	7:00	1322			342.9417	17.24	
11/6/2013	7:02	1324			342.9736	17.28	
11/6/2013	7:04	1326			342.9242	17.23	
11/6/2013	7:06	1328			342.934	17.24	
11/6/2013	7:08	1330			343.0381	17.34	
11/6/2013	7:10	1332			342.9506	17.25	
11/6/2013	7:12	1334			343.047	17.35	
11/6/2013	7:14	1336			342.9766	17.28	
11/6/2013	7:16	1338			343.0282	17.33	
11/6/2013	7:18	1340			342.9573	17.26	
11/6/2013	7:20	1342			343.0054	17.31	
11/6/2013	7:22	1344			342.9555	17.26	
11/6/2013	7:24	1346			343.022	17.32	
11/6/2013	7:26	1348			343.05	17.35	
11/6/2013	7:28	1350			342.972	17.27	
11/6/2013	7:30	1352			342.9499	17.25	
11/6/2013	7:32	1354			342.9753	17.28	
11/6/2013	7:34	1356			342.9537	17.26	
11/6/2013	7:36	1358			342.9307	17.23	
11/6/2013	7:38	1360			342.9102	17.21	
11/6/2013	7:40	1362			342.971	17.27	
11/6/2013	7:42	1364			342.9983	17.30	
11/6/2013	7:44	1366			342.9812	17.28	
11/6/2013	7:46	1368			342.9354	17.24	
11/6/2013	7:48	1370			343.0533	17.36	
11/6/2013	7:50	1372			342.9226	17.22	
11/6/2013	7:52	1374			342.9852	17.29	
11/6/2013	7:54	1376			342.9686	17.27	
11/6/2013	7:56	1378			342.9261	17.23	
11/6/2013	7:58	1380			342.8818	17.18	
11/6/2013	8:00	1382			343.0223	17.32	
11/6/2013	8:02	1384			343.0031	17.30	
11/6/2013	8:04	1386			342.8798	17.18	
11/6/2013	8:06	1388			342.9997	17.30	
11/6/2013	8:08	1390			342.9851	17.29	
11/6/2013	8:10	1392			342.9106	17.21	
11/6/2013	8:12	1394			342.9234	17.23	
11/6/2013	8:14	1396			342.9346	17.24	
11/6/2013	8:16	1398			342.8883	17.19	
11/6/2013	8:18	1400			343.0484	17.35	
11/6/2013	8:20	1402			342.9583	17.26	
11/6/2013	8:22	1404			343.0634	17.37	
11/6/2013	8:24	1406			343.076	17.38	
11/6/2013	8:26	1408			343.0134	17.32	
11/6/2013	8:28	1410			343.0473	17.35	
11/6/2013	8:30	1412			342.934	17.24	
11/6/2013	8:32	1414			342.9641	17.27	
11/6/2013	8:34	1416			342.9202	17.22	
11/6/2013	8:36	1418			342.9363	17.24	
11/6/2013	8:38	1420			342.9333	17.24	
11/6/2013	8:40	1422			343.0258	17.33	
11/6/2013	8:42	1424			343.0755	17.38	
11/6/2013	8:44	1426			343.0798	17.38	
11/6/2013	8:46	1428			343.0308	17.33	
11/6/2013	8:48	1430			342.9596	17.26	
11/6/2013	8:50	1432			343.1033	17.41	
11/6/2013	8:52	1434			343.0998	17.40	
11/6/2013	8:54	1436			343.028	17.33	
11/6/2013	8:56	1438			342.9935	17.30	
11/6/2013	8:58	1440	0		343.1133	17.42	pump off; start recovery; TOT = 118,600 gal
11/6/2013	9:00	1442	2	721	336.7613	11.06	
11/6/2013	9:02	1444	4	361	330.2594	4.56	
11/6/2013	9:04	1446	6	241	328.4097	2.71	
11/6/2013	9:06	1448	8	181	327.5649	1.87	
11/6/2013	9:08	1450	10	145	327.0621	1.36	

Date	Time	Elapsed Time (min)	t' (min)	t/t'	DTW (ft)	DD (ft)	Remarks
11/6/2013	9:10	1452	12	121	326.7798	1.08	
11/6/2013	9:12	1454	14	104	326.5783	0.88	
11/6/2013	9:14	1456	16	91	326.4288	0.73	
11/6/2013	9:16	1458	18	81	326.3457	0.65	
11/6/2013	9:18	1460	20	73	326.2719	0.57	
11/6/2013	9:20	1462	22	66	326.2243	0.53	
11/6/2013	9:22	1464	24	61	326.1717	0.47	
11/6/2013	9:24	1466	26	56	326.1459	0.45	
11/6/2013	9:26	1468	28	52	326.1068	0.41	
11/6/2013	9:28	1470	30	49	326.0968	0.40	
11/6/2013	9:30	1472	32	46	326.0869	0.39	
11/6/2013	9:32	1474	34	43	326.0778	0.38	
11/6/2013	9:34	1476	36	41	326.0665	0.37	
11/6/2013	9:36	1478	38	39	326.054	0.36	
11/6/2013	9:38	1480	40	37	326.039	0.34	
11/6/2013	9:40	1482	42	35	326.0335	0.34	
11/6/2013	9:42	1484	44	34	326.0251	0.33	
11/6/2013	9:44	1486	46	32	326.0229	0.32	
11/6/2013	9:46	1488	48	31	326.0081	0.31	
11/6/2013	9:48	1490	50	30	326.0015	0.30	
11/6/2013	9:50	1492	52	29	325.9887	0.29	
11/6/2013	9:52	1494	54	28	325.9837	0.29	
11/6/2013	9:54	1496	56	27	325.9875	0.29	
11/6/2013	9:56	1498	58	26	325.9717	0.27	
11/6/2013	9:58	1500	60	25	325.9991	0.30	
11/6/2013	10:00	1502	62	24	325.974	0.28	
11/6/2013	10:02	1504	64	24	325.9618	0.26	
11/6/2013	10:04	1506	66	23	325.9544	0.26	
11/6/2013	10:06	1508	68	22	325.9524	0.25	
11/6/2013	10:08	1510	70	22	325.9521	0.25	
11/6/2013	10:10	1512	72	21	325.9494	0.25	
11/6/2013	10:12	1514	74	20	325.9368	0.24	
11/6/2013	10:14	1516	76	20	325.9375	0.24	
11/6/2013	10:16	1518	78	19	325.9311	0.23	
11/6/2013	10:18	1520	80	19	325.9296	0.23	
11/6/2013	10:20	1522	82	19	325.9264	0.23	
11/6/2013	10:22	1524	84	18	325.9237	0.23	
11/6/2013	10:24	1526	86	18	325.9197	0.22	
11/6/2013	10:26	1528	88	17	325.9249	0.23	
11/6/2013	10:28	1530	90	17	325.8987	0.20	
11/6/2013	10:30	1532	92	17	325.9122	0.21	
11/6/2013	10:32	1534	94	16	325.9148	0.22	
11/6/2013	10:34	1536	96	16	325.9047	0.21	
11/6/2013	10:36	1538	98	16	325.9047	0.21	
11/6/2013	10:38	1540	100	15	325.8994	0.20	
11/6/2013	10:40	1542	102	15	325.8881	0.19	
11/6/2013	10:42	1544	104	15	325.8961	0.20	
11/6/2013	10:44	1546	106	15	325.8905	0.19	
11/6/2013	10:46	1548	108	14	325.8904	0.19	
11/6/2013	10:48	1550	110	14	325.8859	0.19	
11/6/2013	10:50	1552	112	14	325.8747	0.18	
11/6/2013	10:52	1554	114	14	325.8802	0.18	
11/6/2013	10:54	1556	116	13	325.8838	0.19	
11/6/2013	10:56	1558	118	13	325.8776	0.18	
11/6/2013	10:58	1560	120	13	325.8766	0.18	
11/6/2013	11:00	1562	122	13	325.8728	0.17	
11/6/2013	11:02	1564	124	13	325.8778	0.18	
11/6/2013	11:04	1566	126	12	325.8685	0.17	
11/6/2013	11:06	1568	128	12	325.8778	0.18	
11/6/2013	11:08	1570	130	12	325.8737	0.18	
11/6/2013	11:10	1572	132	12	325.8593	0.16	
11/6/2013	11:12	1574	134	12	325.8633	0.17	
11/6/2013	11:14	1576	136	12	325.865	0.17	
11/6/2013	11:16	1578	138	11	325.8599	0.16	
11/6/2013	11:18	1580	140	11	325.8644	0.17	
11/6/2013	11:20	1582	142	11	325.8522	0.15	
11/6/2013	11:22	1584	144	11	325.848	0.15	
11/6/2013	11:24	1586	146	11	325.8657	0.17	
11/6/2013	11:26	1588	148	11	325.8532	0.16	
11/6/2013	11:28	1590	150	11	325.8463	0.15	
11/6/2013	11:30	1592	152	10	325.8517	0.15	
11/6/2013	11:32	1594	154	10	325.8591	0.16	
11/6/2013	11:34	1596	156	10	325.8669	0.17	
11/6/2013	11:36	1598	158	10	325.849	0.15	
11/6/2013	11:38	1600	160	10	325.8457	0.15	
11/6/2013	11:40	1602	162	10	325.8458	0.15	
11/6/2013	11:42	1604	164	10	325.8433	0.15	
11/6/2013	11:44	1606	166	10	325.8407	0.14	
11/6/2013	11:46	1608	168	10	325.836	0.14	
11/6/2013	11:48	1610	170	9	325.8495	0.15	
11/6/2013	11:50	1612	172	9	325.8308	0.13	
11/6/2013	11:52	1614	174	9	325.8364	0.14	
11/6/2013	11:54	1616	176	9	325.8314	0.13	
11/6/2013	11:56	1618	178	9	325.8315	0.13	
11/6/2013	11:58	1620	180	9	325.8334	0.14	
11/6/2013	12:00	1622	182	9	325.8329	0.13	
11/6/2013	12:02	1624	184	9	325.8339	0.14	
11/6/2013	12:04	1626	186	9	325.8329	0.13	
11/6/2013	12:06	1628	188	9	325.8311	0.13	
11/6/2013	12:08	1630	190	9	325.8276	0.13	
11/6/2013	12:10	1632	192	9	325.83	0.13	
11/6/2013	12:12	1634	194	8	325.8787	0.18	
11/6/2013	12:14	1636	196	8	325.8383	0.14	end recovery


Crater Lake Test Well Pumping Test
Test Date: November 5 and 6, 2013
Constant-Rate Test, Q = 82 gpm
Drawdown (ft)
0
2
4
6
8
10
12
14
16
18
20
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
SC (82) = 4.7 gpm/ft
Levelogger Measurement
Manual Measurement
Elapsed Time (min)


Crater Lake Test Well Pumping Test
Test Date: November 5 and 6, 2013
Drawdown Data, Q = 82 gpm
Drawdown (ft)
0
5
10
15
20
25
30
1
10
100
1000
10000
T = 264*82/(15.8-14.2) ≈ 13,500 gpd/ft
T = 264*82/(18.0-13.9) ≈ 5,300 gpd/ft
Levelogger Measurement
Manual Measurement
Elapsed Time (min)


Crater Lake Test Well Pumping Test
Test Date: November 5 and 6, 2013
Extrapolated Drawdown Data, Q = 82 gpm
T = 2 days = 2,880 min; DD = 18.3 feet
T = 7 days = 10,080 min; DD = 20.0 feet
T = 30 days = 43,200 min; DD = 22.1 feet
T = 180 days = 259,200 min; DD = 24.6 feet
T = 365 days = 525,600 min; DD = 25.5 feet
Drawdown (ft)
0
5
10
15
20
25
30
35
40
1
10
100
1000
10000
100000
1000000
Levelogger Measurement
Manual Measurement
Elapsed Time (min)


Crater Lake Test Well Pumping Test
Test Date: November 5 and 6, 2013
Recovery Data, Q = 82 gpm
Drawdown (ft)
0
1
2
3
4
5
6
7
8
9
10
1
10
100
1000
10000
t/t'
T = 264*82/(0.4) ≈ 55,000 gpd/ft
T = 264*82/(4.5) ≈ 5,000 gpd/ft
Levelogger Measurement
Manual Measurement

Attachment C
Water Quality Results

UMPQUA Research Company
738 SE Glenwood Drive
Bend, Oregon 97702
(541) 312-9454 Fax: (541) 312-9456
E-mail: Lab@URCmail.net
Internet: http://ChemLab.cc
ORELAP ID# OR100052

December 19, 2013

SPF Water Engineering
300 E Mallard Dr. Ste. 350
Boise, ID 83706

Attn: Jason Thompson

Re: Crater Lake Well

Enclosed are the results of analyses for samples received by UMPQUA Research Company (URC) on 11/06/13 15:10, at 4.4 °C and documented on Work Order# B3K0621.

Thank you for choosing us as your analytical laboratory. Please contact me if you have any questions regarding this report.

Sincerely,

Teresa Mireles
Client Services

UMPQUA Research Company
738 SE Glenwood Dr., Bend, Oregon 97702
(541) 312-9454 Fax: (541) 312-9456
E-mail: BendLab@URCmail.net
Internet: http://ChemLab.cc
ORELAP ID# OR100052

ANALYSIS REPORT
URC # B3K0621

Case Narrative

SPF Water Engineering	Project:	Crater Lake Well	Date Reported:	12/19/13
300 E Mallard Dr. Ste. 350			Date Sampled:	11/06/13 08:00
Boise, ID 83706	Project #: N/P		Date Received:	11/06/13 15:10
	Client Contact:	Jason Thompson	Sampled By:	Jason Thompson

Matrix: Drinking Water

URC Work Order#: B3K0621

SOC, VOC's and IOC's were subcontracted to Umpqua Research Company-Myrtle Creek, ORLAP# OR100031.
Radiologicals were subcontracted to Summit Laboratories.

UMPQUA Research Company

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Teresa Mireles, Client Services

UMPQUA Research Company
738 SE Glenwood Dr., Bend, Oregon 97702
(541) 312-9454 Fax: (541) 312-9456
E-mail: BendLab@URCmail.net
Internet: http://ChemLab.cc
ORELAP ID# OR100052

ANALYSIS REPORT
URC # B3K0621

SPF Water Engineering	Project:	Crater Lake Well	Date Reported:	12/19/2013	7:59:38A
300 E Mallard Dr. Ste. 350			Date Sampled:	11/06/13	08:00
Boise, ID 83706	Project #:	N/P	Date Received:	11/06/13	15:10
	Client Contact:	Jason Thompson	Sampled By:	Jason Thompson	

Sample Location: Crater Lake New Well

URC Sample #: B3K0621-01

Matrix: Drinking Water

Analyte	Code	Result	Units	MRL	MCL	Prepared	Analyzed	Analyst	Qualifier
Inorganics									
EPA 300.0									
Fluoride (‡)	1025	0.119	mg/L	0.100	4	11/07/13	11/7/13 17:20	TDL	
Nitrate as N (‡)	1040	ND	mg/L	0.10	10	11/07/13 15:30	11/7/13 17:20	TDL	
Nitrite as N (‡)	1041	ND	mg/L	0.01	1	11/07/13 15:30	11/7/13 17:20	TDL	
Sulfate (‡)	1055	ND	mg/L	1.00	250	11/07/13	11/7/13 17:20	TDL	
SM 4500CN-C/E									
Cyanide (‡)	1024	ND	mg/L	0.020	0.2	11/12/13	11/12/13 17:03	TDL	

UMPQUA Research Company

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Teresa Mireles

Teresa Mireles, Client Services

UMPQUA Research Company
738 SE Glenwood Dr., Bend, Oregon 97702
(541) 312-9454 Fax: (541) 312-9456
E-mail: BendLab@URCmail.net
Internet: http://ChemLab.cc
ORELAP ID# OR100052

ANALYSIS REPORT
URC # B3K0621

SPF Water Engineering	Project:	Crater Lake Well	Date Reported:	12/19/2013	7:59:38A
300 E Mallard Dr. Ste. 350			Date Sampled:	11/06/13	08:00
Boise, ID 83706	Project #:	N/P	Date Received:	11/06/13	15:10
	Client Contact:	Jason Thompson	Sampled By:	Jason Thompson	

Sample Location: Crater Lake New Well

URC Sample #: B3K0621-01

Matrix: Drinking Water

Analyte	Code	Result	Units	MRL	MCL	Prepared	Analyzed	Analyst	Qualifier
Metals									
EPA 200.8									
Antimony (‡)	1074	ND	mg/L	0.003	0.006	11/12/13	11/12/13 14:31	JMR	
Arsenic (‡)	1005	ND	mg/L	0.0030	0.01	11/12/13	11/12/13 14:31	JMR	
Barium (‡)	1010	ND	mg/L	0.030	2	11/12/13	11/12/13 14:31	JMR	
Beryllium (‡)	1075	ND	mg/L	0.0010	0.004	11/12/13	11/12/13 14:31	JMR	
Cadmium (‡)	1015	ND	mg/L	0.0010	0.005	11/12/13	11/12/13 14:31	JMR	
Chromium (‡)	1020	ND	mg/L	0.010	0.1	11/12/13	11/12/13 14:31	JMR	
Lead (‡)	1030	ND	mg/L	0.002	0.015	11/12/13	11/12/13 14:31	JMR	
Mercury (‡)	1035	ND	mg/L	0.001	0.002	11/14/13	11/14/13 10:54	JMR	
Nickel (‡)	1036	ND	mg/L	0.010	0.1	11/12/13	11/12/13 14:31	JMR	
Selenium (‡)	1045	ND	mg/L	0.005	0.05	11/12/13	11/12/13 14:31	JMR	
Thallium (‡)	1085	ND	mg/L	0.002	0.002	11/12/13	11/12/13 14:31	JMR	
SM 3111B									
Sodium (‡)	1052	**3.62**	mg/L	0.100		11/20/13	11/20/13 13:39	JMR	

UMPQUA Research Company

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Teresa Mireles, Client Services

UMPQUA Research Company
738 SE Glenwood Dr., Bend, Oregon 97702
(541) 312-9454 Fax: (541) 312-9456
E-mail: BendLab@URCmail.net
Internet: http://ChemLab.cc
ORELAP ID# OR100052

ANALYSIS REPORT
URC # B3K0621

SPF Water Engineering	Project:	Crater Lake Well	Date Reported:	12/19/2013	7:59:38A
300 E Mallard Dr. Ste. 350			Date Sampled:	11/06/13	08:00
Boise, ID 83706	Project #:	N/P	Date Received:	11/06/13	15:10
	Client Contact:	Jason Thompson	Sampled By:	Jason Thompson	

Sample Location: Crater Lake New Well

URC Sample #: B3K0621-01

Matrix: Drinking Water

Regulated Analyte	Code	Result	Units	MRL	MCL	Prepared	Analyzed	Analyst	Qualifier
Organics									
EPA 504.1									
Dibromochloropropane (‡)	2931	ND	mg/L	0.00002	0.0002	11/14/13	11/14/13 22:55	JTH	
Ethylene dibromide (‡)	2946	ND	mg/L	0.00001	0.00005	11/14/13	11/14/13 22:55	JTH	
EPA 508.1									
Chlordane (‡)	2959	ND	mg/L	0.00004	0.002	11/20/13	12/9/13 13:24	JTH	
Toxaphene (‡)	2020	ND	mg/L	0.0001	0.003	11/20/13	12/9/13 13:24	JTH	
Aroclor-1016 (‡)	2383	ND	mg/L	0.00002	0.0005	11/20/13	12/9/13 13:24	JTH	
Aroclor-1221 (‡)	2383	ND	mg/L	0.00002	0.0005	11/20/13	12/9/13 13:24	JTH	
Aroclor-1232 (‡)	2383	ND	mg/L	0.00002	0.0005	11/20/13	12/9/13 13:24	JTH	
Aroclor-1242 (‡)	2383	ND	mg/L	0.00002	0.0005	11/20/13	12/9/13 13:24	JTH	
Aroclor-1248 (‡)	2383	ND	mg/L	0.00002	0.0005	11/20/13	12/9/13 13:24	JTH	
Aroclor-1254 (‡)	2383	ND	mg/L	0.00002	0.0005	11/20/13	12/9/13 13:24	JTH	
Aroclor-1260 (‡)	2383	ND	mg/L	0.00002	0.0005	11/20/13	12/9/13 13:24	JTH	
EPA 515.2									
2,4-D (‡)	2105	ND	mg/L	0.00020	0.07	11/20/13	12/5/13 19:44	JTH	
2,4,5-TP (Silvex) (‡)	2110	ND	mg/L	0.00040	0.05	11/20/13	12/5/13 19:44	JTH	
Dinoseb (‡)	2041	ND	mg/L	0.00040	0.007	11/20/13	12/5/13 19:44	JTH	
Pentachlorophenol (‡)	2326	ND	mg/L	0.00008	0.001	11/20/13	12/5/13 19:44	JTH	
Picloram (‡)	2040	ND	mg/L	0.00020	0.5	11/20/13	12/5/13 19:44	JTH	
EPA 515.3									
Dalapon (‡)	2031	ND	mg/L	0.002	0.2	11/19/13	11/20/13 14:23	JTH	
EPA 525.2									
Alachlor (‡)	2051	ND	mg/L	0.0004	0.002	11/20/13	12/6/13 18:02	JTH	
Atrazine (‡)	2050	ND	mg/L	0.0002	0.003	11/20/13	12/6/13 18:02	JTH	
Benzo (a) pyrene (‡)	2306	ND	mg/L	0.00004	0.0002	11/20/13	12/6/13 18:02	JTH	

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E-mail: BendLab@URCmail.net
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ANALYSIS REPORT
URC # B3K0621

SPF Water Engineering	Project:	Crater Lake Well	Date Reported:	12/19/2013	7:59:38A
300 E Mallard Dr. Ste. 350			Date Sampled:	11/06/13	08:00
Boise, ID 83706	Project #:	N/P	Date Received:	11/06/13	15:10
	Client Contact:	Jason Thompson	Sampled By:	Jason Thompson	

Sample Location: Crater Lake New Well

URC Sample #: B3K0621-01

Matrix: Drinking Water

Regulated Analyte	Code	Result	Units	MRL	MCL	Prepared	Analyzed	Analyst	Qualifier
Organics									
gamma-BHC (Lindane) (‡)	2010	ND	mg/L	0.0001	0.0002	11/20/13	12/6/13 18:02	JTH	
Bis-(2-ethylhexyl) adipate (‡)	2035	ND	mg/L	0.0010	0.4	11/20/13	12/6/13 18:02	JTH	
Bis(2-ethylhexyl) phthalate (‡)	2039	ND	mg/L	0.0013	0.006	11/20/13	12/6/13 18:02	JTH	
Endrin (‡)	2005	ND	mg/L	0.0001	0.002	11/20/13	12/6/13 18:02	JTH	
Heptachlor (‡)	2065	ND	mg/L	0.0001	0.0004	11/20/13	12/6/13 18:02	JTH	
Heptachlor epoxide (‡)	2067	ND	mg/L	0.0001	0.0002	11/20/13	12/6/13 18:02	JTH	
Hexachlorobenzene (‡)	2274	ND	mg/L	0.0001	0.001	11/20/13	12/6/13 18:02	JTH	
Hexachlorocyclopentadiene (‡)	2042	ND	mg/L	0.0002	0.05	11/20/13	12/6/13 18:02	JTH	
Methoxychlor (‡)	2015	ND	mg/L	0.0005	0.04	11/20/13	12/6/13 18:02	JTH	
Simazine (‡)	2037	ND	mg/L	0.0001	0.004	11/20/13	12/6/13 18:02	JTH	
EPA 531.1									
Carbofuran (‡)	2046	ND	mg/L	0.004	0.04	12/02/13	12/2/13 20:07	BEM	
Oxamyl (Vydate) (‡)	2036	ND	mg/L	0.002	0.2	12/02/13	12/2/13 20:07	BEM	
EPA 547									
Glyphosate (‡)	2034	ND	mg/L	0.010	0.7	12/06/13	12/6/13 10:49	BEM	
EPA 548.1									
Endothall (‡)	2033	ND	mg/L	0.010	0.1	11/11/13	11/16/13 9:29	JTH	
EPA 549.2									
Diquat (‡)	2032	ND	mg/L	0.0004	0.02	11/11/13	11/19/13 15:51	BEM	

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Teresa Mireles

Teresa Mireles, Client Services

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738 SE Glenwood Dr., Bend, Oregon 97702
(541) 312-9454 Fax: (541) 312-9456
E-mail: BendLab@URCmail.net
Internet: http://ChemLab.cc
ORELAP ID# OR100052

ANALYSIS REPORT
URC # B3K0621

SPF Water Engineering	Project:	Crater Lake Well	Date Reported:	12/19/2013	7:59:38A
300 E Mallard Dr. Ste. 350			Date Sampled:	11/06/13	08:00
Boise, ID 83706	Project #:	N/P	Date Received:	11/06/13	15:10
	Client Contact:	Jason Thompson	Sampled By:	Jason Thompson	

Sample Location: Crater Lake New Well

URC Sample #: B3K0621-01

Matrix: Drinking Water

Unregulated Analyte	Code	Result	Units	MRL	MCL	Prepared	Analyzed	Analyst	Qualifier
Organics									
EPA 515.2									
Dicamba (‡)	2440	ND	mg/L	0.00050		11/20/13	12/5/13 19:44	JTH	
EPA 525.2									
Aldrin (‡)	2356	ND	mg/L	0.0001		11/20/13	12/6/13 18:02	JTH	
Butachlor (‡)	2076	ND	mg/L	0.0001		11/20/13	12/6/13 18:02	JTH	
Dieldrin (‡)	2070	ND	mg/L	0.0001		11/20/13	12/6/13 18:02	JTH	
Metolachlor (‡)	2045	ND	mg/L	0.0002		11/20/13	12/6/13 18:02	JTH	
Metribuzin (‡)	2595	ND	mg/L	0.0001		11/20/13	12/6/13 18:02	JTH	
Propachlor (‡)	2077	ND	mg/L	0.0001		11/20/13	12/6/13 18:02	JTH	
EPA 531.1									
Aldicarb (‡)	2047	ND	mg/L	0.002		12/02/13	12/2/13 20:07	BEM	
Aldicarb sulfone (‡)	2044	ND	mg/L	0.001		12/02/13	12/2/13 20:07	BEM	
Aldicarb sulfoxide (‡)	2043	ND	mg/L	0.003		12/02/13	12/2/13 20:07	BEM	
Carbaryl (‡)	2021	ND	mg/L	0.001		12/02/13	12/2/13 20:07	BEM	
3-Hydroxycarbofuran (‡)	2066	ND	mg/L	0.004		12/02/13	12/2/13 20:07	BEM	
Methomyl (‡)	2022	ND	mg/L	0.004		12/02/13	12/2/13 20:07	BEM	

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E-mail: BendLab@URCmail.net
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URC # B3K0621

SPF Water Engineering	Project:	Crater Lake Well	Date Reported:	12/19/2013	7:59:38A
300 E Mallard Dr. Ste. 350			Date Sampled:	11/06/13	08:00
Boise, ID 83706	Project #:	N/P	Date Received:	11/06/13	15:10
	Client Contact:	Jason Thompson	Sampled By:	Jason Thompson	

Sample Location: Crater Lake New Well

URC Sample #: B3K0621-01

Matrix: Drinking Water

Regulated Analyte	Code	Result	Units	MRL	MCL	Prepared	Analyzed	Analyst	Qualifier
Volatile Organics									
EPA 524.2									
1,1,1-Trichloroethane (‡)	2981	ND	mg/L	0.0005	0.2	11/20/13	11/20/13 18:56	JTH	
1,1,2-Trichloroethane (‡)	2985	ND	mg/L	0.0005	0.005	11/20/13	11/20/13 18:56	JTH	
1,1-Dichloroethylene (‡)	2977	ND	mg/L	0.0005	0.007	11/20/13	11/20/13 18:56	JTH	
1,2,4-Trichlorobenzene (‡)	2378	ND	mg/L	0.0005	0.07	11/20/13	11/20/13 18:56	JTH	
1,2-Dichlorobenzene (‡)	2968	ND	mg/L	0.0005	0.6	11/20/13	11/20/13 18:56	JTH	
1,2-Dichloroethane (‡)	2980	ND	mg/L	0.0005	0.005	11/20/13	11/20/13 18:56	JTH	
1,2-Dichloropropane (‡)	2983	ND	mg/L	0.0005	0.005	11/20/13	11/20/13 18:56	JTH	
1,4-Dichlorobenzene (‡)	2969	ND	mg/L	0.0005	0.075	11/20/13	11/20/13 18:56	JTH	
Benzene (‡)	2990	ND	mg/L	0.0005	0.005	11/20/13	11/20/13 18:56	JTH	
Carbon Tetrachloride (‡)	2982	ND	mg/L	0.0005	0.005	11/20/13	11/20/13 18:56	JTH	
Chlorobenzene (‡)	2989	ND	mg/L	0.0005	0.1	11/20/13	11/20/13 18:56	JTH	
cis-1,2-Dichloroethylene (‡)	2380	ND	mg/L	0.0005	0.07	11/20/13	11/20/13 18:56	JTH	
Ethyl Benzene (‡)	2992	ND	mg/L	0.0005	0.7	11/20/13	11/20/13 18:56	JTH	
Methylene Chloride (‡)	2964	ND	mg/L	0.0005	0.005	11/20/13	11/20/13 18:56	JTH	
Styrene (‡)	2996	ND	mg/L	0.0005	0.1	11/20/13	11/20/13 18:56	JTH	
Tetrachloroethylene (‡)	2987	ND	mg/L	0.0005	0.005	11/20/13	11/20/13 18:56	JTH	
Toluene (‡)	2991	ND	mg/L	0.0005	1	11/20/13	11/20/13 18:56	JTH	
trans-1,2-Dichloroethylene (‡)	2979	ND	mg/L	0.0005	0.1	11/20/13	11/20/13 18:56	JTH	
Trichloroethylene (‡)	2984	ND	mg/L	0.0005	0.005	11/20/13	11/20/13 18:56	JTH	
Vinyl chloride (‡)	2976	ND	mg/L	0.0005	0.002	11/20/13	11/20/13 18:56	JTH	
m-Xylene/p-Xylene (‡)		ND	mg/L	0.0005	10	11/20/13	11/20/13 18:56	JTH	
o-Xylene (‡)		ND	mg/L	0.0005	10	11/20/13	11/20/13 18:56	JTH	
Total Xylenes (‡)	2955	ND	mg/L	0.0015	10	11/20/13	11/20/13 18:56	JTH	

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(541) 312-9454 Fax: (541) 312-9456
E-mail: BendLab@URCmail.net
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ANALYSIS REPORT
URC # B3K0621

SPF Water Engineering	Project:	Crater Lake Well	Date Reported:	12/19/2013	7:59:38A
300 E Mallard Dr. Ste. 350			Date Sampled:	11/06/13	08:00
Boise, ID 83706	Project #:	N/P	Date Received:	11/06/13	15:10
	Client Contact:	Jason Thompson	Sampled By:	Jason Thompson	

Sample Location: Crater Lake New Well

URC Sample #: B3K0621-01

Matrix: Drinking Water

Unregulated Analyte	Code	Result	Units	MRL	MCL	Prepared	Analyzed	Analyst	Qualifier
Volatile Organics									
EPA 524.2									
1,1,1,2-Tetrachloroethane (‡)	2986	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
1,1,2,2-Tetrachloroethane (‡)	2988	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
Methyl-tert-butyl ether (‡)		ND	mg/L	0.0050		11/20/13	11/20/13 18:56	JTH	
1,1-Dichloroethane (‡)	2978	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
1,1-Dichloropropene (‡)	2410	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
1,2,3-Trichloropropane (‡)	2414	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
1,3-Dichlorobenzene (‡)	2967	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
1,3-Dichloropropane (‡)	2412	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
2,2-Dichloropropane (‡)	2416	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
2-Chlorotoluene (‡)	2965	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
4-Chlorotoluene (‡)	2966	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
Bromobenzene (‡)	2993	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
Bromodichloromethane (‡)	2943	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
Bromoform (‡)	2942	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
Bromomethane (‡)	2214	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
Chloroethane (‡)	2216	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
Chloroform (‡)	2941	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
Chloromethane (‡)	2210	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
Dibromochloromethane (‡)	2944	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
Dibromomethane (‡)	2408	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	
trans-1,3-Dichloropropene (‡)	2224	ND	mg/L	0.0005		11/20/13	11/20/13 18:56	JTH	

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E-mail: BendLab@URCmail.net
Internet: http://ChemLab.cc
ORELAP ID# OR100052

ANALYSIS REPORT
URC # B3K0621

Qualifiers and Definitions

A-01	Spike criteria for this analyte was not met. The total number of analyte outliers was within the acceptable range showing the analysis is in control and the data is acceptable.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the MRL (minimum reporting limit)
NA	Not Applicable
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MRL	Minimum Reporting Limit
MDL	Minimum Detection Limit
MCL	Maximum Contamination Level
(‡)	ORELAP Accredited Analyte
(~)	Due to rounding of individual analytes, the "total" may vary slightly from the sum of the individual analyte values.

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(541) 312-9454 Fax: (541) 312-9456
email: *bendlab@urcmail.net*
web: *http://chemlab.cc*
ORELAP ID# OR100052

MICROBIOLOGICAL REPORT

SPF Water Engineering

Attn:Jason Thompson

300 E Mallard Dr. Ste. 350

Boise ID, 83706

Sample Point:

Sampled By: Jason Thompson

Crater Lake New Well

URC Sample ID#: B3K0621-01 (Drinking Water)

Analyte	**Result**	Sampled	Received	Prepared	Analyzed	Analyst	Notes
Coliforms By 9223B - Colilert-18							
E. Coli (‡)	Absent	11/06/13 08:00	11/06/13 15:10	11/06/13 17:00	11/07/13 12:25	TLM	
Total Coliform (‡)	Absent	11/06/13 08:00	11/06/13 15:10	11/06/13 17:00	11/07/13 12:25	TLM	

Notes and Definitions

(‡) ORELAP Accredited Analyte

UMPQUA Research Company

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Teresa Mireles, Client Services

SUMMIT ENVIRONMENTAL TECHNOLOGIES, INC
Analytical Laboratories

Summit Environmental Technologies, Inc.
3310 Win St.
Cuyahoga Falls, Ohio 44223
TEL: (330) 253-8211 FAX: (330) 253-4489
Website: http://www.settek.com

Analytical Report

(consolidated)

WO#: **13110967**

Date Reported: **11/27/2013**

CLIENT: UMPQUA Research Company **Collection Date:** 11/6/2013 8:00:00 AM

Project: B3K0621/Crater Lake Water System/New Well

Lab ID: 13110967-001 **Matrix:** DRINKING WATER

Client Sample ID B3K0621-01

Analyses	Result	RL	Qual	Units	Uncertainty	DF	Date Analyzed
DW GROSS ALPHA/BETA ANALYSIS (900.0)					**E900.0**		Analyst: **CM**
ALPHA, Gross	ND	2.5		pCi/L	± 1.09	1	11/26/2013
DW RADIUM-226 ANALYSIS (903.0)					**E903.0**		Analyst: **CM**
Radium-226	ND	0.98		pCi/L	± 0.17	1	11/22/2013 5:11:00 PM
DW RADIUM-228 ANALYSIS (904.0)					**E904.0**		Analyst: **CM**
Radium-228	ND	0.90		pCi/L	± 0.537	1	11/20/2013 3:24:26 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	C	Value is below Minimum Compound Limit.
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
M	Manual Integration used to determine area response	N	Tentatively identified compounds
ND	Not Detected at the Reporting Limit	O	RSD is greater than RSDlimit
P	Second column confirmation exceeds	PL	Permit Limit

Attachment B

Determining the Feasibility of Aquifer Storage and Recovery (ASR) or Artificial Recharge (AR) to Enhance Water Management for Crater Lake National Park and the Klamath Basin: Summary Report

Water Conservation, Reuse & Storage Grant Program
Determining the Feasibility of Aquifer Storage and Recovery (ASR) or Artificial Recharge (AR) to Enhance Water Management for Crater Lake National Park and the Klamath Basin

Summary Report

Prepared for

Oregon Water Resources Department (Grantor)
725 Summer Street NE, Suite A
Salem, Oregon 97301-1266

and

National Park Service (Sponsor)
333 Bush Street, Suite 500
San Francisco, California 94104

Prepared by

SPF Water Engineering, LLC (Grantee)
300 East Mallard, Suite 350
Boise, Idaho 83706
(208) 383-4140

May 8, 2015

SPF WATER ENGINEERING

Executive Summary

This study's qualitative review and analysis of aquifer hydraulic and hydrogeologic characteristics provides insight into the movement of groundwater within the vicinity of the CRLA Test Well. The review and analysis indicates that the likely discharge points for the aquifer tapped by the Crater Lake National Park (CRLA) Test Well are lower Annie Creek, more than 1 mile southeast of the test well, or Castle Creek and tributaries, more than 1 mile north and west of the test well. The distance from the well to the potential discharge points is an important consideration from a water right perspective.

Alternative water supply solutions (Table ES-1) are described based upon the hydraulic and hydrogeologic characteristics and based upon the Administrative Rules regarding groundwater interference with surface water and the recent Final Upper Klamath Basin Comprehensive Agreement. Oregon Water Resources Department (OWRD) rulemaking, in general accordance with the Agreement, is now complete. The rules include provisions for administration of groundwater rights due to relative proximity of a well to surface water sources. These provisions contribute to the greater probability of success for at least two permitted well water rights strategies compared to the other alternatives, including ASR and AR. ASR and AR as mitigation of uncurtailed diversion(s) or as limited license diversions are also promising alternative water right strategies, but are subject to relatively more extensive administrative requirements for implementation.

Table ES-1. Alternative Water Supply Solutions for CRLA

Probability of Success	Water Supply Solutions	Risks
Medium-High	**Permitted Well, 500-foot Casing**	• **Risk of curtailment if another stakeholder or interested party (e.g., OWRD or downstream water right holder) demonstrates that groundwater at 500 ft depth is still tributary to Annie Creek within 1 mile of well.**
Medium-High	**Permitted Well, Proximity to Gaining/Losing Surface Water**	• **Subject to curtailment if another stakeholder or interested party demonstrates that groundwater is tributary to Annie Creek within 1 mile of well.**
Medium-High	**Aquifer Storage and Recovery (ASR)**	• **Regulatory acceptance.** • **Maximum 5-year term for limited license.**
Medium	**Artificial Recharge (AR)**	• **Regulatory acceptance.**
Medium-Low	**Account for Wastewater Infiltration/Return to Watershed**	• **Regulatory acceptance.** • **Unmitigated portion subject to curtailment.** • **Would not provide full water demand.**
Medium-Low	**Downstream Water Right Non-Use, Transfer, or Storage**	• **Third pParty nNegotiation.** • **Potentially cCost pProhibitive wWater rRight pPurchase or aAgreement.**
Low	**Permitted Well (>15,000 gpd)**	• **Subject to curtailment.**
Very Low	**Unpermitted Well (Exempt up to 15,000 gpd)**	• **Subject to curtailment.** • **Provides only a fraction of water demand.**

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1. INTRODUCTION

This report was prepared by SPF Water Engineering, LLC (SPF) using a Water Conservation, Reuse & Storage grant (Grant Agreement #GB-0073-15) from the State of Oregon, administered by the Oregon Water Resources Department (OWRD). The OWRD is the State of Oregon agency responsible for managing water resources within the state boundaries.

The sponsoring agency for the services provided under this grant is the National Park Service (NPS). The National Park Service (NPS) is a federal agency responsible for the management, maintenance, and access to the nation's National Parks, Monuments, Recreation Areas, and other historically or culturally significant areas marked for preservation and public access. The NPS has invested matching funds to support the effort to prepare this report, including services previously rendered for drilling of a test well, aquifer testing, and aquifer characterization in Crater Lake National Park (CRLA), and for preparation of a schematic design for connection of the well to the CRLA water system and pumping only to, only from, or both to and from the well.

NPS contracted with SPF to assist with water and wastewater related projects, primarily in the Pacific West Region and commonly within the NPS Repair and Rehabilitation Program. SPF assisted the NPS with drilling the test well and with preparation of the schematic design for well connection.

1.1. Location

The study area (Figure 1) is the CRLA in south central Oregon. The CRLA public water distribution system is located on the southern portion of the park and extends from the Mazama Village area to the headquarters and rim areas. The entire water distribution system is located within the Klamath River basin.

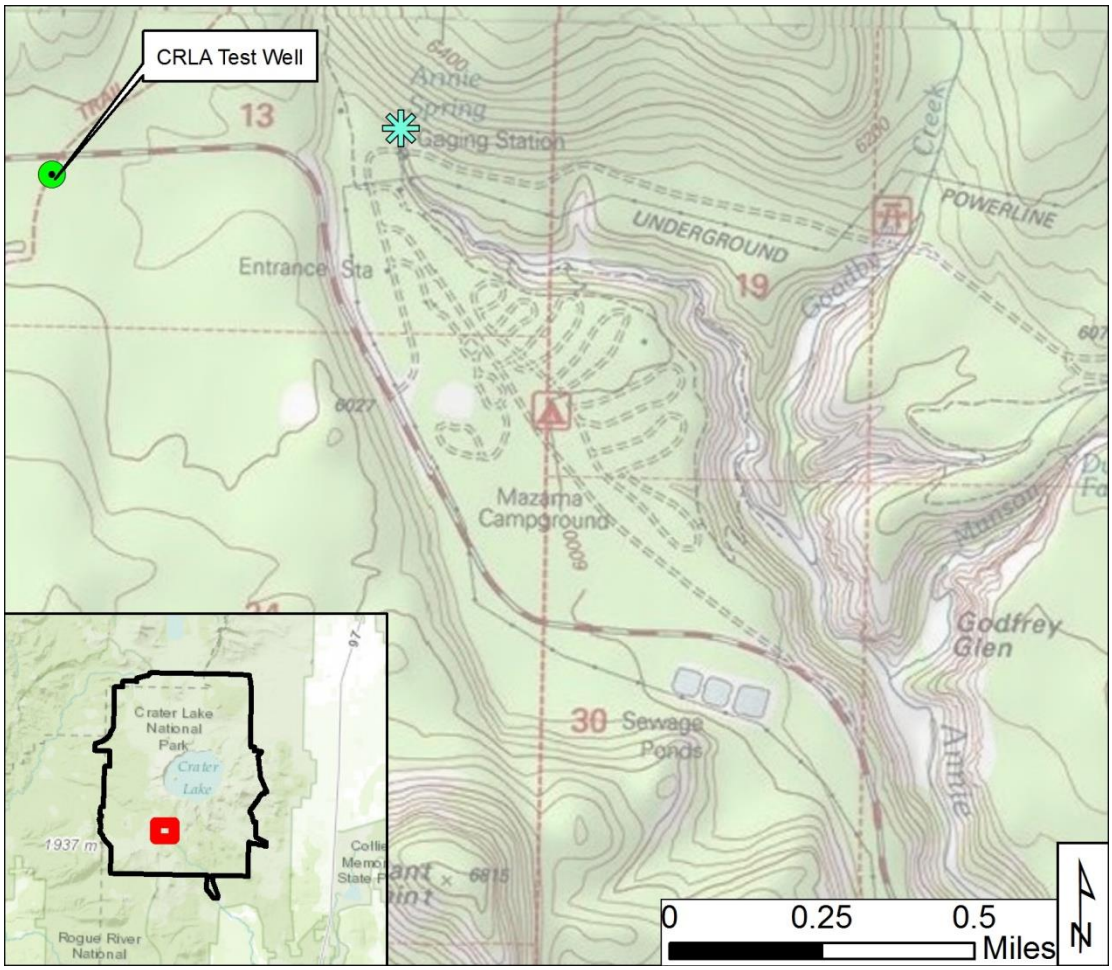


Figure 1. Study Area Location and Vicinity Map

1.2. Purpose and Need

Currently, the sole public drinking water source for CRLA is the Annie Springs source (Water Right Permit No. S15156 and Claim No. 602 in the Klamath Basin General Stream Adjudication). Without a supplemental water source, the CRLA water system risks temporary shut-downs as a result of a water call from downstream senior-priority water right holders. Temporary park closures during peak visitation periods would have significant economic and social impacts to local communities and impacts would extend throughout the State of Oregon and the region.

The NPS has already implemented water conservation measures to limit the demand on its water systems, including low-flow fixtures within each of its buildings and water meters to track and record actual water consumption at CRLA. In the fall of 2013, the

NPS drilled a test well to investigate the potential production and water quality of a new supplemental groundwater source.

To prevent a possible shut-down of the park's water system and/or park closure, the NPS is interested in converting the test well to a new potable water source which can either supplement the Annie Springs water source or provide a sole source of supply to the CRLA water system should Annie Springs not be available.

The NPS is researching ways to mitigate the impacts of water consumption in the Klamath watershed, including researching feasibility for aquifer storage and recovery (ASR) or artificial recharge (AR) implementation, and return of wastewater to the watershed as mitigation for diversions.

This study is intended to determine the feasibility of ASR or AR to enhance water management for CRLA. To assess the feasibility of ASR or AR, this study focuses on describing aquifer hydraulic and hydrogeologic characteristics near the test well. The study also explores potential alternative water right permitting strategies for a production well, water right transfer and mitigation, or limited licensing for Aquifer Storage and Recovery (ASR) to compare the relative feasibility of each water right permitting strategy to the others.

2. AQUIFER HYDRAULIC AND HYDROGEOLOGIC CHARACTERISTICS

This section provides a qualitative review and analysis of the hydraulic and hydrogeologic characteristics of the aquifer.

2.1. Characteristics of Crater Lake Test Well

The CRLA test well was constructed in a Pacific Crest Trail (PCT) trailhead parking area on the south side of Oregon Highway 62 within CRLA, in Klamath County, Oregon. The well location (42°52.25' latitude and -122°10.802' longitude) is approximately 0.6 miles west-northwest from the CRLA Annie Springs Entrance Station and approximately 54 miles northwest of Klamath Falls, Oregon. Exploratory drilling, well construction and aquifer testing occurred in October and November 2013.

The well site elevation is approximately 6,180 feet above mean sea level, with the site located on a plateau that is bounded by Annie Creek (in the Klamath River Basin) to the east, Castle Creek (in the Rogue River Basin) to the north, and Union Peak to the southwest.

The administrative basin boundary between the Rogue and the Klamath is located approximately ½ mile west of the CRLA Test Well site. The actual groundwater divide between the two basins has not been determined.

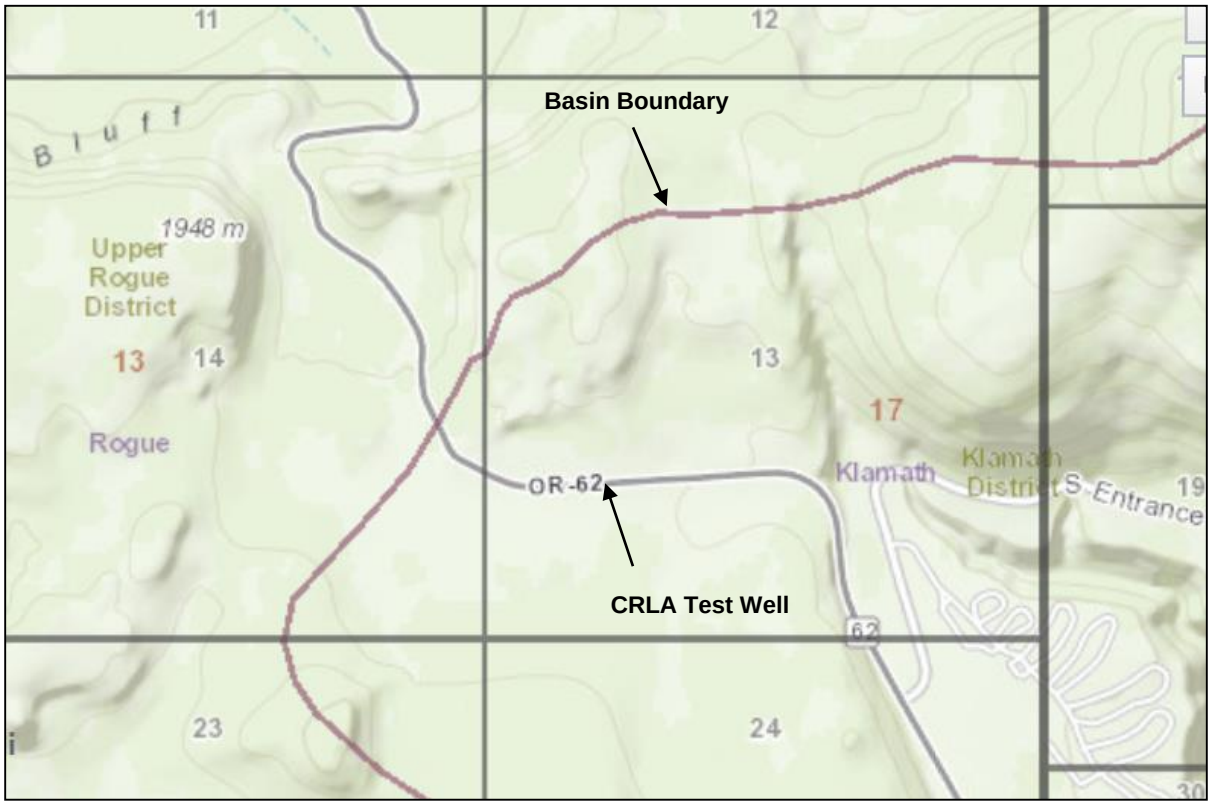


Figure 2. CRLA test well location with respect to the administrative boundary between the Klamath and Rogue Basins (Source OWRD on-line mapping tool).

The borehole was drilled to a total depth of 505 feet using the air-rotary method, and penetrated pumice to 34 feet and basalt from 34 feet to total depth. The basalt was grey in color, and generally ranged in character from unbroken to highly fractured with zones of brown to red cinders. Water was first observed at 403 feet in cinders. This layer extended from 403 to 420 feet. Additional water-bearing cinder and broken basalt zones were found between 447 to 504 feet.

The well was constructed with 8-inch casing sealed to 93 feet, and 6-inch under-reamed liner from 9 feet to 505 feet. The liner was perforated from 400 to 420 feet and 440 to 500 feet, and the well was subsequently developed by air-lift pumping. Static water level upon completion was approximately 322 feet below ground surface (approximate elevation 5,858 feet).

The well was step-rate tested using a submersible pump at rates of up to 100 gpm on November 4, 2013. A 24-hour constant-rate test was conducted on November 5 and 6, 2013. Total drawdown during the test was 17.35 feet. Analysis of test response found an aquifer transmissivity of approximately 50,000 gpd/ft. Near-well transmissivity appears to be less, at approximately 5,000 gpd/ft. The aquifer response to test pumping may be influenced by the potential presence of vertical gradients within the aquifer and/or heterogeneous aquifer conditions. The deep static water level and the high transmissivity of the aquifer indicate that the aquifer would accept moderate to high rates of recharge through an injection well.

Water quality from the well is excellent, with a specific conductance of 51 μS, temperature of 37°F, and pH of 6.6. The water meets EPA primary drinking water standards, and is suitable for use within a public drinking water system without further treatment, although the NPS has a policy to provide disinfection at all public drinking water sources.

2.2. Published Hydrology and Geologic Investigations

Water resources of CRLA are described by Frank and Harris (1969). Their report describes climate, physiography, geology, and hydrology, with emphasis on water supply for existing and future development. Their geologic description builds upon previous work by Williams (1942).

Frank and Harris described generalized hydrogeologic processes within the park, but noted that the groundwater information is lacking due to lack of groundwater development within the Park. Specifically, their report describes only two known wells drilled within the Park at that time. Those wells consisted of test wells drilled at Cleetwood Cove (429 feet depth) and the North Entrance (1,037 feet depth) in 1962. The test wells yielded little water, and demonstrated that the regional water table was below elevation 4,960 feet near the North Entrance.

In the vicinity of the South Entrance, Frank and Harris provide measurement data from Annie Springs, Annie Creek, and other springs and streams. They commented that the highly-permeable pumice that covers large portions of the park provides excellent infiltration of precipitation, providing recharge to groundwater systems anticipated to be present in permeable volcanic units.

Detailed geologic mapping is provided by Bacon (2008). Figure 3 contains digital soils data obtained from the Oregon Geologic Data Compilation (OGDC), found online in the Oregon Spatial Data Library. The OGDC makes available the best geologic mapping from state and federal agency sources. The soils layer shown here is consistent with that contained in Bacon (2008), and shows the following in the vicinity of the test well.

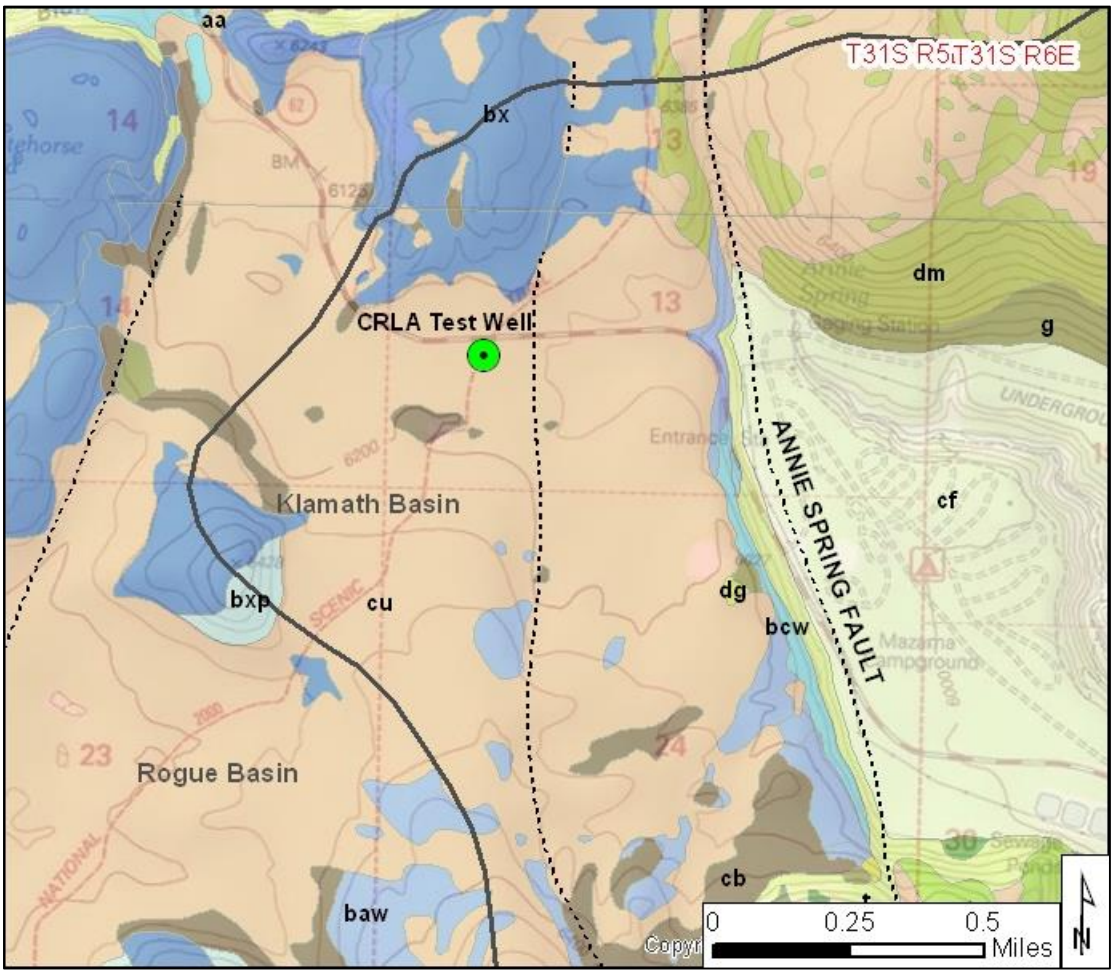


Figure 3. Detailed Geologic Mapping (OGDC)

1. Surface geology around the well site is mapped as fine-grained lithic- and crystal-rich ignimbrite (map symbol cu) deposited as a pyroclastic flow of ash and pumice from the climatic eruption of Mount Mazama approximately 7,700 years ago. In the CRLA Test Well, the ignimbrite was logged as gray pumice to a depth of 34 feet.

2. South of the well site scattered exposure of lithic breccia (map symbol cb) are exposed. Like the ignimbrite, these rocks are surface deposits from the climatic eruption of Mount Mazama and likely do not extend to significant depth.

3. Basaltic andesite is exposed north, southwest, and east of the CRLA Test Well site, and is assumed to underlay the test well site. Mapped as separate units (map symbols bx, bxp, baw, bcw) for various flows and eruption sources, these rock units all consist of middle Pleistocene-aged lava flows and cinders, erupted from vents

on the southern side of Mount Mazama approximately 200,000 years ago, prior to the climactic eruption of Mount Mazama. It is likely that the map units are present from the base of the ignimbrite to depths of several hundred feet at the CRLA Test Well site. Whether the CRLA Test Well bottomed in these units, or in older basaltic units, was not determined.

4. Northerly trending normal-faults, with downthrown blocks on the east side, trend through the Crater Lake region. Between the CRLA Test Well and Annie Creek are two mapped faults. An unnamed fault is believed to be approximately 500 feet to the east of the test well, while the Annie Spring Fault is located approximately 2500 feet to the east of the test well. The unnamed fault has no obvious surface expression where it crosses the plateau near the well site. In contrast, the Annie Spring Fault forms a distinct scarp between the plateau to the west and Annie Creek valley to the east.

With regard to groundwater, Bacon noted "Groundwater flow in Mount Mazama and in the surrounding volcanic terrain is controlled by gently inclined to horizontal, relatively permeable zones (perched aquifers) such as rubbly tops of lava flows or fragmental deposits of various kinds. Cold springs commonly occur where such permeability contrasts intersect the ground surface. Deep circulation of ground water is facilitated by the dominantly north-south normal faults that may act as conduits or may retard transverse flow because relatively impermeable gouge is present." NPS or OWRD could conduct additional subsurface exploration to evaluate the hydrogeologic significance of fault lines between the well and Annie Creek.

2.3. Water Level Monitoring Data

Soon after completion of the CRLA Test Well, OWRD installed a water-level transducer to record water levels within the well. Figure 4 shows water levels in the well (blue line) and water levels in Crater Lake (red line). Note that groundwater levels appear to respond primarily to recharge from snowmelt, with a rising trend beginning in early May extending through June, followed by decline from July through February. In contrast, Crater Lake water levels appear to respond from direct precipitation and snowmelt runoff, with 2014 Lake level rising beginning in February and peaking in May.

Seasonal groundwater-level fluctuation in 2014 was approximately 10 feet. This fluctuation is entirely due to natural recharge and discharge, as there are no pumping stresses on the aquifer within the park boundary. The relatively large seasonal groundwater-level fluctuations demonstrate that annual recharge has a significant impact on water levels; such fluctuations are not uncommon in upland areas that receive heavy seasonal precipitation. The timing of the groundwater-level trend might also suggest a lag between snowmelt and recharge, as water moves through the thick unsaturated zone to reach the aquifer.

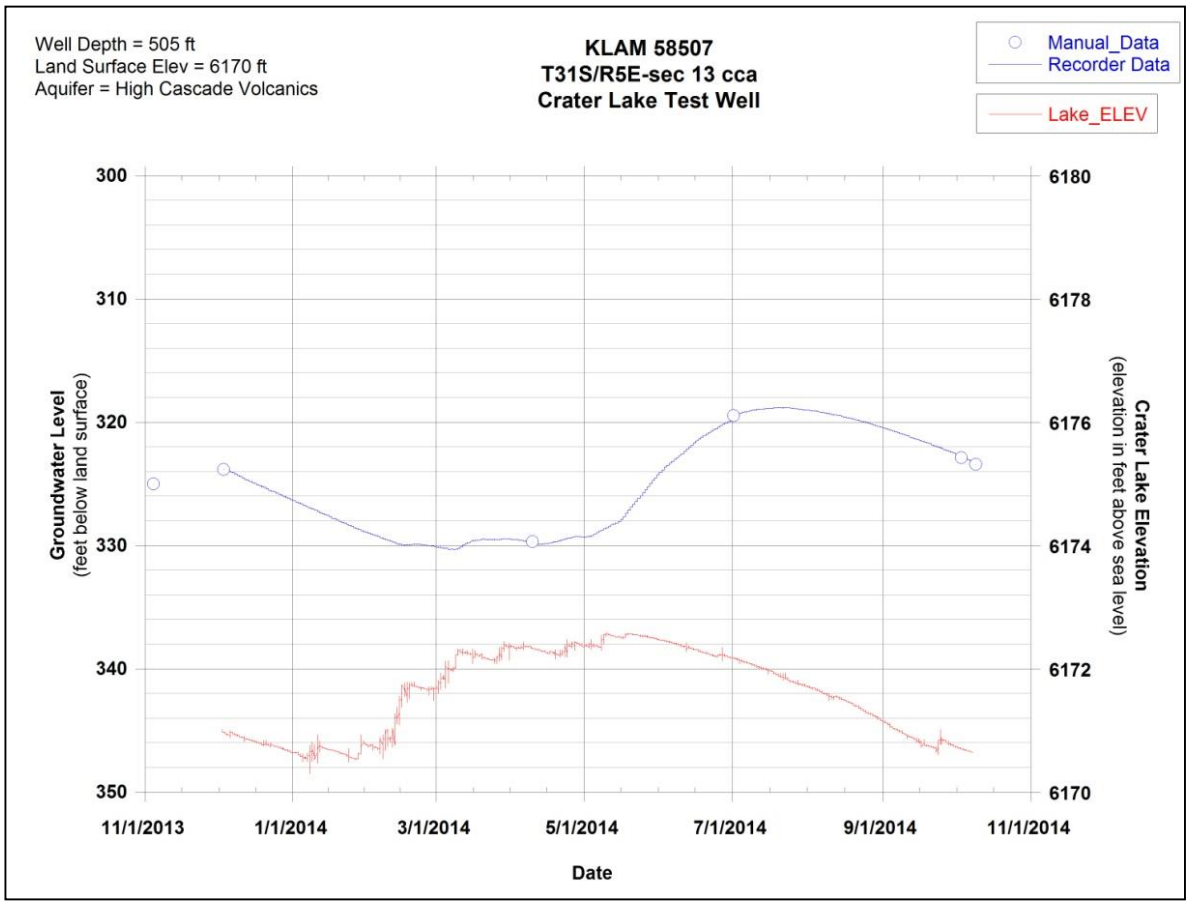


Figure 4. Water levels in the Test Well and in Crater Lake

2.4. Potential Groundwater Discharge Areas

Locations for discharge from the aquifer tapped by the CRLA Test Well have not been determined. It is reasonable to surmise the following.

1. Groundwater tapped by the CRLA test well is recharged from precipitation that occurs on the plateau and surrounding uplands between Annie Creek, Union Creek, Red Blanket Creek, and Castle Creek. Annie Creek is within the Klamath Basin and the other creeks are within the Rogue Basin.
2. Groundwater at the CRLA test well site is moving toward a discharge point at a stream or spring. The point of discharge could be either Annie Creek (> 1 mile to the east and southeast), Castle Creek (> 1 mile to the northwest), Union Creek (> 3 miles to the west), or Red Blanket Creek (> 5 miles to the south and southwest). There are no other springs or perennial streams shown on USGS topographic maps below elevation 5,858 feet within the vicinity of the CRLA Test Well Site.

3. Groundwater flows by gravity from areas of higher head (elevation or pressure) to lower head. A water surface elevation difference between the test well and the point of discharge creates a potentiometric gradient to cause groundwater to flow.
4. Flow direction is controlled both by gradient and geology. Geologic controls on flow occur when permeability is anisotropic, meaning that permeability is higher in one direction than another. In such instances, flow may occur at some angle to the gradient, but always from a higher head to a lower head.
5. Data are insufficient to characterize the magnitude or direction of the gradient or flow direction at the CRLA test well site.

Figure 5 shows the locations of the creeks where discharge from the CRLA well might occur. For reference, an approximate 5,858 foot elevation contour has been included. The contour was developed using GIS by interpolating between the 5,840 foot and 5,880 foot elevation contours provided by digital USGS topographic map data.

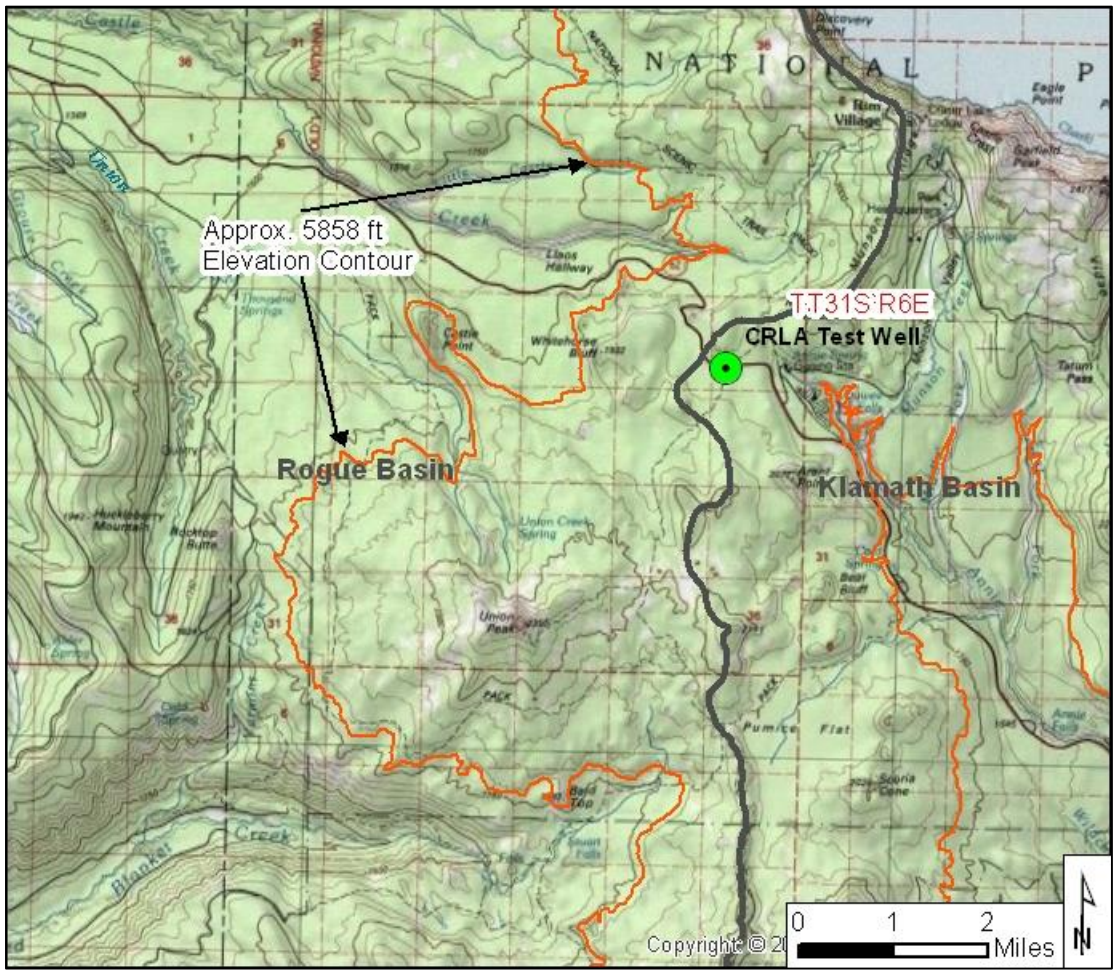


Figure 5. CRLA Test Well and Potential Discharge Creeks

It is important to note that Annie Spring is found at approximate elevation 6,050. Given that Annie Spring is nearly 200 feet higher than groundwater in the test well, it is likely that water discharging at Annie Spring is derived from an aquifer that is not in direct hydraulic communication with the aquifer tapped by the CRLA Test Well.

The two identified normal faults located between the CRLA Test Well and Annie Creek may act as either a barrier or a conduit to groundwater flow. If the faults function as a barrier, groundwater may preferentially move toward the Rogue River Basin to the west. If the faults function as a conduit, groundwater may be moving southward along the faults with eventual discharge to Annie Creek or tributaries further south.

The information listed above indicates that the likely discharge points for the aquifer tapped by the CRLA Test Well are lower Annie Creek, greater than 1 mile southeast of the test well, or Castle Creek and tributaries, more than 1 mile north and west of the test well.

3. ALTERNATIVE WATER RIGHT PERMITTING STRATEGIES

The Water Conservation, Reuse, and Storage Grant which has funded this study is intended to assess the feasibility of using ASR or AR to enhance water management at CRLA and the Klamath Basin. Enhanced water management strategies are being explored since the source of supply to the CRLA water system is exposed to potential curtailment in the event of a water call from downstream senior-priority water right holders.

Upon review of the Park's existing water rights, Oregon Rules and Statutes, and water system infrastructure, a number of possible permitting strategies have presented themselves. The different strategies are described in this report section, along with their risks and potential for long-term success. The OWRD online water rights database was searched to identify the permits and water right actions that may be necessary for each alternative. To better understand the alternatives, an understanding of the water supply and the water right administration in the Klamath Basin is necessary.

Background

Crater Lake Water Supply. An adjudication of water rights to define water rights priority within the Klamath River Basin is nearing completion. CRLA domestic water supply is provided under a federal reserved water right claim in that adjudication, Claim No. KA602. On March 7, 2013, the OWRD issued the Adjudicator's Findings of Fact and Final Order of Determination, which is the Adjudicator's determination of all claims in the Klamath River Basin Adjudication. Claimants have had the opportunity to file exceptions to this order, and following the Court's review of those exceptions, the final Klamath River Basin Decree will be issued, either affirming or modifying the Final Order of Determination. Once the final Decree has been issued, the Department will issue water right certificates in accordance with the Decree.

The Adjudicator's determination of Claim KA602 authorizes a combined diversion rate of 0.34 cfs for domestic, administrative, and wildlife watering. An additional 1.0 cfs is authorized for fire protection. The annual diversion volume is limited to 62.7 acre-feet per year for the domestic and administrative uses, and 0.1 acre-feet per year for wildlife watering. The water right source is Annie Creek and its tributaries within the boundary of the Park, and the right has a priority date of May 22, 1902.

In addition to Claim KA602, Water Right Permit S15156 authorizes the diversion of 0.16 cfs from Annie Spring for municipal use, with a priority date of November 28, 1941. The right authorizes a total of 1.26 cfs for municipal use from a number of points of diversion, each with its own diversion rate limitation.

In the Partial Order of Determination, Claim KA602 describes Annie Creek as its water source, whereas Permit S15156 describes its source as Annie Spring. The spring itself is located within the quarter-quarter described for the point of diversion in Claim KA602. Additionally, there are thirteen future points of diversion described in the partial order for the claim, one of which has its upper reach boundary described as "at Annie Springs". All these factors together would indicate that the claim's source is intended to be Annie Creek at the location of Annie Spring.

The CRLA Test Well does not have a recorded water right. Water can be diverted under the 15,000 gallon per day group domestic use exemption provided under ORS537.545.

Based on 7-day averages of 2013 daily measurements, water use at Crater Lake varies from 1,500 gallons per day during winter to a maximum flow of 71,600 gallons per day during summer. Wastewater is treated and infiltrated. A preliminary review of water use and wastewater flow suggests that, prior to the occurance of any evaporative losses from the wastewater ponds, the amount of water lost to consumption averages approximately 5,000 gallons per day in the peak summer months. One estimate suggests that consumptive losses from wastewater pond evaporation may be as much as 30,000 gallons per day during peak months.

Klamath River Basin Water Right Administration. In an effort to settle water right issues that have arisen in the Upper Klamath Basin during the adjudication process, the Final Upper Klamath Basin Comprehensive Agreement (Agreement) was signed on April 18, 2014, and awaits ratification by Congress.

The Klamath River Basin experiences extensive water shortages during drought years. The Agreement provides a framework for administration of water rights upstream of the Bureau of Reclamation Klamath Irrigation Project during shortages, and defines proposed conservation measures in the Upper Klamath Basin.

Curtailment of junior priority groundwater rights can be expected during water calls. Within the basin, nearly all water rights junior to 1905 (the priority date for the Klamath Project water rights) may be subject to water calls in normal to dry years, and earlier priority water rights will be subject to water calls by the Tribes (with priority dates of 1864 for tribal allotted rights and time immemorial for instream flow rights) during drought

years. The Klamath Basin Restoration Agreement included provisions to provide water right assurances related to water diversions for On-Project water users, but left unanswered questions regarding regulation in Off-Project areas. The Upper Klamath Basin Comprehensive Agreement contains provisions for regulation of groundwater in defined Off-Project areas. The CRLA is outside of both the On-Project and Off-Project areas, so is not bound by either set of regulations.

Rules Regarding Groundwater/Surface Water Hydraulic Connection and Interference. Any new permit application for groundwater is reviewed based on its potential for substantial interference with surface water supplies. Criteria for making that determination are detailed in OAR 690-009. The Department first determines whether the well produces water from a confined or unconfined aquifer, then whether the aquifer is hydraulically connected to the surface water source. If a well is determined to be hydraulically connected to, and has the potential to interfere with, a surface water source, use of that well would be controlled conjunctively with the surface water source, after first determining whether any control would provide effective and timely relief to the surface water source. Wells greater than one mile from a surface water source would only be controlled under this Administrative Rule through a critical ground water area determination. With regard to the CRLA Test Well, a new permit would have a late priority date and would be subject to curtailment if the well were found to be hydraulically connected to surface water.

Scenic Waterways Statutes. Annie Spring flows into Annie Creek, a tributary to the Wood River. The Wood River flows into Agency Lake within the upper Klamath River Basin. Agency Lake is the northern arm of Upper Klamath Lake, and is at least 30 miles downstream of Annie Spring. After traveling approximately 30 more miles beyond the southern outlet of the lake, through at least two other reservoirs, the Klamath River reaches John Boyle Dam. The stretch of the Klamath River from the dam to the California border has been designated as a State Scenic Waterway, with the intent of restoring streamflows for fish and wildlife, recreation, and pollution abatement. Statutes ORS 390.805 to 390.940 and Rules OAR 736-40-005 to 736-40-095 specifically relate to the Scenic Waterway designation. As explained in ORS 390.835(9), OWRD has the authority to deny or require mitigation for any new water right application for use of groundwater if, based on a preponderance of evidence, it was determined that the use would 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.

A large portion of the water used at the Park is treated and sent to unlined wastewater ponds, then either returns to the aquifer through infiltration or evaporates, hence there is little consumption. Of the 0.34 cfs authorized under claim KA602, only 0.054 cfs is consumptively used, based on a preliminary 35,000 gpd average peak summertime consumptive use estimate. Regardless of whether the Annie Creek source or a hydraulically connected groundwater source was used, any effects on streamflows more than 50 miles downstream would be insignificant. Additionally, an instantaneous diversion rate of 0.34 cfs from a well in the Park would have a negligible effect on

downstream reservoirs, and that effect could be mitigated through discharges into the system by way of injection or other recharge efforts during periods of low water demand. These factors would support the argument that diversion from a well during times of water right curtailment would have a negligible impact on the stretch of the Klamath River that has been designated a Scenic Waterway.

3.1. Production Well Water Right Alternatives

The CRLA Test Well could be developed into a production well to supply water to the Park during times when the Annie Creek source is unavailable. The well might only be used as a source of supply during periods when a water call has been made by a downstream early-priority water user.

3.1.1. Unpermitted Well (Exempt up to 15,000 gpd)

The test well could be developed as an unpermitted, supplemental source of supply for the Park. Operation of the test well under the exemption would provide a maximum of 15,000 gallons per day for domestic use. However, the domestic exemption does not provide protection from curtailment. Even if the well were not subject to curtailment, the 15,000 gpd allowance would only provide a fraction of the quantity needed during periods of peak demand, making it necessary to either severely restrict water use in the Park or find yet another source of supply, such as trucking water into the park.

Risk(s) to National Park Service Water Supply

- **Subject to curtailment.**
- **Provides only a fraction of water demand.**

Probability of Long-Term and Reliable Water Supply Success

- **Very Low.**

3.1.2. Permitted Well (>15,000 gpd)

The test well could be developed and permitted as a supplemental source of domestic water supply for the Park, with a junior priority date. Annie Creek could be the primary source of supply, but in the case of a water call, the well would supply the Park's full water demand. However, the late priority date of the new groundwater permit would not provide protection from curtailment.

Because of the well's proximity to Annie Creek, the Administrative Rules related to groundwater/surface water interference may increase the likelihood of curtailment. Given the administration of groundwater described in OAR 690-009, the well would be regulated only if it were determined that the well and Annie Creek were hydraulically connected. If so, and the well is a horizontal distance less than one mile from the Annie Creek source, then regulation would occur if either 1) depletion to Annie Creek is greater

than 25 percent of the appropriation within 30 days of start of pumping, or 2) the rate of appropriation is greater than 1 percent of an adopted minimum streamflow or instream water right or of the discharge that is equaled or exceeded 80 percent of time. A streamflow depletion analysis might be conducted to determine actual depletion. Local hydrogeologic data are limited, so whether a stream flow depletion analysis would be acceptable is unknown.

A potentially favorable aspect to be considered is that the well is on the crest between the Rogue and Klamath basins. If only 50 percent of the depletive effect is to the Klamath basin, the likelihood that depletion is greater than 25 percent of the appropriation becomes lower.

If there is convincing evidence indicating that the well and Annie Creek are not hydraulically connected, such as that gouge is discovered along the Annie Spring fault line which acts as a positive barrier from the well to Annie Creek, these regulations could be avoided.

Risk(s) to National Park Service Water Supply

- **Subject to curtailment.**

Probability of Long-Term and Reliable Water Supply Success

- **Low.**

3.1.3. Permitted Well, Proximity to Gaining/Losing Surface Water

As described in Section 3.1.2, the test well could be developed and permitted as a supplemental source of water with a junior priority date, to be used only in the case of a call on Annie Creek. However, it should be noted that the groundwater elevation in the well is approximately 5,858 feet. The point at which Annie Creek's elevation is 5,858 feet is 1 mile distance from the well. Given that there must be a significant gradient to drive groundwater flow to the stream, the point at which water from the well would be tributary to Annie Creek must be more than one mile (i.e. downstream from the 5,858 foot stream elevation) from the well, thus the right would be protected from curtailment.

Risk(s) to National Park Service Water Supply

- **Subject to curtailment if another stakeholder or interested party (e.g., OWRD or downstream water right holder) demonstrates that groundwater is tributary to Annie Creek within 1 mile of well.**

Probability of Long-Term and Reliable Water Supply Success

- **Medium-High.**

3.1.4. Permitted Well, 500-foot Casing

The well could be permitted as a supplemental source to meet the peak water demands of the park during times when a call has been made on Annie Creek. The test well could be filled with lean cement to seal off all zones above the bottom of the well at 505 feet. The cement could be drilled out to demonstrate that all aquifer zones above 500 feet are effectively sealed. An open borehole could then be advanced below 500 feet to potentially develop a well that would not be subject to regulation. Alternatively, should the drilled-out diameter not be sufficiently large to accommodate a well pump with sufficient capacity, a second well could be drilled, cased and sealed to more than 500 feet to serve as the supplemental source not subject to regulation.

According to the regulations of the Upper Klamath Basin Comprehensive Agreement, wells that are greater than one-half mile but up to and including one mile from a Gaining Reach and are continually cased and sealed to at least 500 feet will be regulated as if they are located greater than one mile from a Gaining Reach, and will not be subject to regulation in the absence of a critical groundwater determination. Recognizing that the test well is not located within the Off-project area and thus is not bound by this agreement, the existence of the regulation indicates an acknowledgement by OWRD that casing and sealing a well to 500 feet does mitigate the effects of pumping on a surface water source.

Risk(s) to National Park Service Water Supply

- **Risk of curtailment if another stakeholder or interested party demonstrates that groundwater at 500 ft depth is still tributary to Annie Creek within 1 mile of well.**

Probability of Long-Term and Reliable Water Supply Success

- **Medium-High.**

3.2. Water Right Transfer and Mitigation Alternatives

These alternatives could apply to either a new water supply well, to the existing Annie Creek diversion, or to a new water source.

3.2.1. Downstream Water Right Non-Use, Transfer, or Storage

A downstream user's water right (or a portion thereof) could be used as mitigation for continued water use within CRLA during periods when a water call has been made. This could be done either through an agreement with the water right owner or purchase of their water right.

The NPS could enter into an agreement with a senior-priority water right holder from the upper Klamath River Basin for the non-use of that user's water during curtailment periods. This non-use could provide mitigation for the continued use of Annie Creek.

The water right would remain in the name of the original water right owner, but that individual would have to suspend use of the water during calls, as well as change the water right's nature of use to protect it from forfeiture during periods of non-use. Alternatively, a senior-priority water right from the upper Klamath River Basin could be purchased and transferred to Annie Creek to mitigate for the continued use of Annie Creek during a call. Yet another approach would be for the senior-priority water right holder to store a portion of their water, and then release it to Annie Creek during a high-demand period, making it available for use by downstream users.

If the test well were developed for production as a supplemental source, the non-use, transfer, and storage alternatives could be used as mitigation for use of the well. In this case, a new water right application and mitigation plan would be necessary for diversion from the new source.

These alternatives are all reasonably attractive from a permitting and approval standpoint, but do require the cooperation of a third party. The potential obstacles range from needing to locate and build a water storage facility to unreasonably high prices for scarce water rights.

Risk(s) to National Park Service Water Supply

- **Third party negotiation.**
- **Potentially cost prohibitive water right purchase or agreement.**

Probability of Long-Term and Reliable Water Supply Success

- **Medium-Low.**

3.2.2. Account for Wastewater Infiltration/Return to Watershed

Because wastewater is treated and infiltrated within the Park, a certain amount of used water returns to the watershed. This infiltrated water could be measured and utilized as mitigation during curtailment periods.

One approach is to mitigate for the continued use of the Annie Creek diversion. During a curtailment period, diversion from Annie Creek would continue, but would be limited to a volume that is equal to or less than the annual volume of wastewater that returns to the watershed through infiltration. This would be accomplished through the use of a mitigation plan for the existing 1902 Annie Creek water right.

Another approach would involve the use of the test well. In this scenario, the consumptive portion of the total water use at the Park would be determined. One preliminary estimate of peak summertime consumption, including evaporation from waste ponds, is 35,000 gpd. During a call, Annie Creek would continue to supply some of the non-consumptive volume, not to exceed a volume equal to the infiltration

volume. The wastewater infiltration into the watershed would mitigate the continued diversion from Annie Creek. A consumptive water use of up to 15,000 gallons per day would be allowed from the well under an exempted water right, but the well diversion would continue to be subject to curtailment. An exempt water right would likely offer more protection than non-exempt rights, but curtailment would still be a threat. If the total water demand exceeds the amount allowed through the mitigated Annie Creek volume and the exempt volume from the well, which appears likely during the peak season, reductions in use within the Park would be needed. Alternatively, a new permit application could be filed for a consumptive amount exceeding 15,000 gallons per day. If approved, it would still be subject to curtailment.

Risk(s) to National Park Service Water Supply

- **Regulatory acceptance.**
- **Unmitigated portion subject to curtailment.**
- **Would not provide full water demand.**

Probability of Long-Term and Reliable Water Supply Success

- **Medium-Low.**

3.2.3. Artificial Recharge

Artificial recharge would occur through the process of pumping water into the test well during low-demand winter months to offset continued diversion of water from either Annie Creek or from the test well during high-demand periods when a water call has been made. There are two potential scenarios for artificial recharge, based on whether the test well is used as a supplemental water source for the Park or solely as an injection well. Artificial recharge projects require a new permit to divert water for the purpose of artificial recharge and a supplemental groundwater permit to extract this water.

Use artificial recharge for mitigation of groundwater pumping. In this situation, the test well would be a supplemental water source; used only during high-demand summer months when a water call has been made. Water from Annie Creek could be pumped into the test well, at a rate no greater than the permitted rate of diversion, during winter months to offset groundwater diversions during late summer months. Under this scenario, the water injected into the aquifer during winter months is assumed to build up the aquifer supply enough to offset depletions to stream flow occurring from groundwater pumping during summer months, if any. A new supplemental groundwater permit would be necessary for diversion from the well as a supplemental water source, along with a mitigation plan and a groundwater recharge permit to divert water from Annie Creek for artificial recharge.

Use artificial recharge for mitigation of continued Annie Creek use. In this scenario, the test well would only be used for injection, while Annie Creek serves as both the sole water supply for the Park, and the water source for artificial recharge. Water would continue to be diverted from Annie Creek to the CRLA water system during curtailment periods. Off-season aquifer recharge would mitigate the continued diversion from Annie Creek. Similar to using artificial recharge to mitigate for groundwater impacts, artificial recharge during winter may stimulate enough summer return flows to offset the depletive impacts of summer diversions. This recharge could potentially include a combination of recharge to the test well and recharge from wastewater infiltration. A groundwater recharge permit would be needed to divert water from Annie Creek for artificial recharge. A mitigation plan may need to be submitted to accompany the existing claim from Annie Creek, as well.

Risk(s) to National Park Service Water Supply

- **Regulatory acceptance.**

Probability of Long-Term and Reliable Water Supply Success

- **Medium.**

3.3. Limited License Water Right Alternative

3.3.1. Aquifer Storage and Recovery

Operationally, this scenario would be the same as the first scenario in Section 3.2.3, where Annie Creek is the primary water source for the Park, and the test well is both an injection well and a source of supply to the Park through stored water. Under an ASR program, it is assumed that groundwater will be stored in the aquifer for later recovery. This is similar to using aquifer recharge for mitigation of groundwater pumping, except that the focus of the mitigation in ASR is on storing water in the aquifer for later recovery, whereas aquifer recharge would provide water into the aquifer for more discharge to surface streams. ASR is allowed temporarily through the approval of an ASR limited license, and permanently through the approval of an ASR permit. The existing water right from Annie Creek would not need further action, as long as the use of the recovered water remains the same as the use authorized under the original right.

Risk(s) to National Park Service Water Supply

- **Regulatory acceptance.**
- **Maximum 5-year term for limited license.**

Probability of Long-Term and Reliable Water Supply Success

- **Medium-High.**

4. CONCLUSION AND RECOMMENDATION

While the qualitative review and analysis of aquifer hydraulic and hydrogeologic characteristics provides insight into the movement of groundwater within the vicinity of the CRLA Test Well, additional detailed investigation using data from additional subsurface investigation and quantitative, numerical modeling could provide greater definition and accuracy. Nonetheless, this review and analysis indicates that the likely discharge points for the aquifer tapped by the Crater Lake National Park (CRLA) Test Well are lower Annie Creek, more than 1 mile southeast from the test well, or Castle Creek and tributaries, more than 1 mile north and west of the test well.

Each of the alternative water supply solutions presented in this study are summarized in Table 1. Provisions in Administrative Rule OAR 690-009 for administration of groundwater rights due to relative proximity to surface water sources contributes to the greater probability of success for two permitted well water rights strategies compared to the other alternatives, including ASR and AR. ASR and AR as mitigation of uncurtailed diversion(s) or as limited license diversions are also promising alternative water right strategies, but are subject to relatively more extensive administrative requirements for implementation.

Table 1. Alternative Water Supply Solutions for CRLA

Probability of Success	Water Supply Strategy	Risks
Very Low	**Unpermitted Well (Exempt up to 15,000 gpd)**	• **Subject to curtailment.** • **Provides only a fraction of water demand.**
Low	**Permitted Well (>15,000 gpd)**	• **Subject to curtailment.**
Medium-High	**Permitted Well, Proximity to Gaining/Losing Surface Water**	• **Subject to curtailment if another stakeholder or interested party (e.g., OWRD or downstream water right holder) demonstrates that groundwater is tributary to Annie Creek within 1 mile of well.**
Medium-High	**Permitted Well, 500-foot Casing**	• **Risk of curtailment if another stakeholder or interested party demonstrates that groundwater at 500 ft depth is still tributary to Annie Creek within one mile of well.**
Medium-Low	**Downstream Water Right Non-Use, Transfer, or Storage**	• **Third party negotiation.** • **Potentially cost prohibitive water right purchase or agreement.**
Medium-Low	**Account for Wastewater Infiltration/Return to Watershed**	• **Regulatory acceptance.** • **Unmitigated portion subject to curtailment.** • **Would not provide full water demand.**
Medium	**Artificial Recharge (AR)**	• **Regulatory acceptance.**
Medium-High	**Aquifer Storage and Recovery (ASR)**	• **Regulatory acceptance.** • **Maximum 5-year term for limited license.**

Attachment C

ASR Application Checklist

ASR Application Guidelines and Checklist

Basic Application Elements			
690-350-0020(3)(a) Rule Requirements	**Suggestions**	**Complete?**	**Location**
ASR LL Application Form		Y	Attached
Pre-Application Conference	Includes WRD, DEQ, OHA DWP. Discuss proposal, feasibility, potential regulatory requirements, any uncertainties.		
Map	Reproducible quality, drawn to standard scale of no less than 2 inches =1 mile. Show PODs, all ASR wells, and Observation wells with coordinates or by bearing and distance from PLS corner. Include streams, topographic features, roads, etc.	Y	Attached
Land Use Approval	Documentation of approval from local government, use WRD Land Use form for water rights	N/A (federal land)	Form attached
Water Availability or Water Right Statement	If new appropriation, need watermaster to complete water availability statement form. If existing water rights, cite those. Place and character of use of recovered water must be the same as that allowed in the underlying source water right.	Y	KA #602, copy attached; also available - Permit #15156.
Water Right Holder Agreement	If applicant is not the holder of water right proposed for ASR source water, a statement from the holder giving permission for the use of water for ASR testing is required.	N/A	
Public Supply Systems: Plan Review	Acknowledge in ASR application that OHA Drinking Water Program plan submission and review requirements apply.	Y	Attached, with Admin. Rule 333-061-0060 for reference
ASR LL Application Fee	Currently $1000, but check current fee schedules on WRD website to confirm.		

Supplemental Reports			
690-350-0020(3)(b)(A) Rule Requirements: Test Program	**Suggestions**	**Complete?**	**Location**
Rates, schedules, volumes	Anticipated injection and recovery rates, volumes and schedules	Y	Described in application
Water quality Monitoring Plan	Analyte lists for source water, receiving aquifer water, recovered water. Sampling schedules and locations.		
Water quality QA/QC	QA/QC, Sampling and Analysis Plan		
Water Level Monitoring Plan	Table of wells with well log ID, well tag #s, project well names, locations of wells as coordinates from PLS corner. Technical explanation of how data from these wells are likely to describe the hydraulic influence of ASR in the target aquifer and impact to nearby wells and springs. Present pre-ASR water level data, or the plan to collect before project		

	begins.		
Contingency plan	If recovered water cannot be used: this contemplates a water quality problem where recovery and disposal of ASR water is necessary. Usually includes an acknowledgement of necessary DEQ permits for disposal or discharge to the surface (NPDES).		Described in application
Anticipated final scope and design of the project	Number of wells, volume expect to store, layout of final project	Y	Detailed in Draft Schematic Design Plans
Testing report outline	ASR Annual Report Outline		
Qualifying signatures	RG		

690-350-0020(3)(b)(B) Rule Requirements: Proposed System Design	**Suggestions**	**Complete?**	**Location**
Well Construction	Drillers Well Log and /or geologic log for any injection, recovery or observation well and comments	Y	Attached
Wellhead Assembly	Usually engineering drawing and explanation		To be added -Sheet C-7 Of Draft Schematic Design Plans
Piping System for injection and recovery	Usually engineering drawing and explanation of the system	Y	Sheet C-6 Of Draft Schematic Design Plans
Other Conceptual Components of the system		Y	Detailed in Draft Schematic Design Plans
Qualifying Signature	PE		

690-350-0020(3)(b)(C) Rule Requirements: Groundwater Information	**Suggestions**	**Complete?**	**Location**
Local Geology	Describe the local geologic framework	Y	Summary Rept.–Sec 2.1
Conceptual Hydrogeologic Model	Describe the local aquifer(s), previous studies, what is known and relevant to this project. Hydrographs are useful.	Y	Summary Rept.–Secs 2.1-2.2
Description of Aquifer Targeted for Storage	Hydrogeologic properties, extent, boundaries	Y	Summary Rept.–Secs 2.1-2.2
Estimated Flow Direction and Rate of Movement	By making a technical argument, this gets at the question of where will stored water go? Who might be impacted?	Y	Summary Rept.–Sec 2.3
Allocation of Surface Water, springs or wells in the area	Summarize the density of wells, surface water users, etc in the area of potential impact	Y?	Summary Rept.–Sec 2.4

affected by ASR wells			
Rationale for estimating the affected area	Hydrogeologic argument.	Y	Summary Rept.–Sec 2.4
Anticipated changes to the groundwater system from ASR testing	Water level and water quality are relevant	Y	Summary Rept.–Sec 2.4
Potential natural resource problems of testing	Varies with the project. Are there springs that could be affected? Water level changes in nearby wells? Geochemical reactions in the aquifer? Many other site-specific possibilities, of course it is not known for sure what will happen, but the most likely issues should be acknowledged and any plans available to address those issues..		
Groundwater and surface water conditions antecedent to ASR	Hydrographs of wells in the area, especially those expected to be affected by ASR, surface water hydrographs, any info related to the quality of those waters		
Qualifying Signature	RG		

690-350-0020(3)(b)(D) &(E) Rule Requirements: Source Water Quality*	**Suggestions**	**Complete?**	**Location**
Regulated constituents with MCL	Reference SDWA for analytes, per 333-061-0030. use OHA accredited lab(s).	Y	Collected through routine PWS quality testing (results available from NPS or OHA)
Unregulated constituents	Also called secondary contaminants, per 333-061-0030(6)	Y	See above (results available from NPS or OHA)
Constituents with MML	DEQ maximum measureable levels- per 340-040-0090	Y	See above (results available from NPS or OHA)
Compliance with treatment requirements for Groundwater under the Direct Influence of surface water (GWUDI)	If applicable, see OHA Drinking Water Program.	N/A	Source is surface water (Annie Ck. at Annie Spring)
Common ions and water quality parameters	Per 690-350-0020(3)(b)	Y	See above (results available from NPS or OHA)
Others constituents are required by reviewing agencies	Project-specific	N/A?	
If applicable, address constituents found that are regulated		N/A?	

If applicable, address constituents detected in source water above 50% of SDWA standards	Options: install treatment system to reduce to below 50% SDWA level, show there is no treatment method, make an economic case that treatment is not feasible, propose an alternative method to minimize constituent of concern: may include continuous monitoring and adjustment of operation according to levels in real time, for example.	N/A?	

690-350-0020(3)(b)(F) Rule Requirements: Receiving Aquifer Water Quality	**Suggestions**	**Complete?**	**Location**
Regulated constituents with MCL	Reference SDWA for analytes, per 333-061-0030. use OHA accredited lab(s).	Y	See Appendix C of Well Construction and Testing Report
Unregulated constituents	Also called secondary contaminants, per 333-061-0030(6)	Y	See Appendix C of Well Construction and Testing Report
Constituents with MML	DEQ maximum measureable levels- per 340-040-0090	Y	See Appendix C of Well Construction and Testing Report
Common ions and water quality parameters	Per 690-350-0020(3)(b)	Y	See Appendix C of Well Construction and Testing Report
Others constituents are required by reviewing agencies	Project-specific	N/A?	

690-350-0020(3)(b)(G) Rule Requirements: Comments on Compatibility	**Suggestions**	**Complete?**	**Location**
Compatibility Evaluation	Technical review of mixing injection water with native groundwater: evaluation of water quality differences and possible geochemical reactions and resulting hydrogeologic changes. Stiff or Piper Diagrams are an example of useful ways to convey this information. Many applicants employ a mixing model such as PHREEQC (USGS open-source software).		

Attachment D

ASR Limited License Application and Other Basic Application Elements

ASR License No. _____
(ASSIGNED AFTER FILING)

DRAFT

STATE OF OREGON
WATER RESOURCES DEPARTMENT
APPLICATION FOR LIMITED WATER USE LICENSE
FOR
AQUIFER STORAGE AND RECOVERY (ASR)

Applicant(s): US National Park Service
Contact Person: Ray Moore
Mailing Address: P.O. Box 7
Crater Lake OR 97604
City State Zip Phone #

1. **DATE(S) OF PRE-APPLICATION CONFERENCE(S):** _____

INFORMATION REGARDING ASR TESTING UNDER A LIMITED LICENSE

2. **SOURCE OF INJECTION WATER for ASR:** Annie Ck. and tribs. within Crater Lake Natl. Park
a tributary of Wood River

3. **MAXIMUM DIVERSION RATE:** 0.34 cfs or 153 gpm

4. **MAXIMUM INJECTION RATE AT EACH WELL(S):** 0.34 cfs or 153 gpm (Maximum diversion rate authorized under water right #KA602)

5. **MAXIMUM STORAGE VOLUME:** 62.8 ac-ft/yr (Max. annual div. vol. authorized under #KA602)

6. **MAXIMUM STORAGE DURATION:** 365 days

7. **MAXIMUM WITHDRAWAL RATE AT EACH WELL(S):** 0.34 cfs or 153 gpm

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

9. **PROPOSED USE OR DISPOSAL OF RECOVERED WATER:** Sole source of public water supply for Crater Lake National Park when Annie Creek source is unavailable.

10. **IF CONTINGENCIES PRECLUDE THE USE IN ITEM 9, SPECIFY AN ALTERNATE USE OR DISPOSAL OF THE RECOVERED WATER:** Recovered water will remain in ground-water for its attenuated return to the surface water source.

-over-

INFORMATION REGARDING THE ULTIMATE ASR PROJECT

AS CURRENTLY ANTICIPATED

11. SOURCE OF INJECTION WATER for ASR: Annie Ck. and tribs. within Crater Lake Natl. Park

a tributary of Wood River

12. MAXIMUM DIVERSION RATE: 0.34 cfs or 153 gpm

13. MAXIMUM INJECTION RATE AT EACH WELL(S): 0.34 cfs or 153 gpm

14. MAXIMUM STORAGE VOLUME: 62.8 ac-ft/yr

15. MAXIMUM STORAGE DURATION:

16. MAXIMUM WITHDRAWAL RATE AT EACH WELL(S): 0.34 cfs or 153 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(3)(a).

Signature of Applicant_____ **Date**_____

Title_____

BEFORE THE DIRECTOR
OF THE WATER RESOURCES DEPARTMENT
OF THE STATE OF OREGON

KLAMATH BASIN GENERAL STREAM ADJUDICATION

In the Matter of the Claim of UNITED STATES DEPARTMENT OF INTERIOR, U.S. NATIONAL PARK SERVICE	))))	PARTIAL ORDER OF DETERMINATION
		Water Right Claim 602

The GENERAL FINDINGS OF FACT of the FINAL ORDER OF DETERMINATION is incorporated as if set forth fully herein.

A. FINDINGS OF FACT

1. Claim 602 (Claimant: UNITED STATES DEPARTMENT OF INTERIOR, NATIONAL PARK SERVICE) and its associated contests (2729, 2734, 3115, 3698, 3946) were referred to the Office of Administrative Hearings for a contested case hearing which was designated as Case 001.

2. The Office of Administrative Hearings conducted contested case proceedings and ultimately issued an AMENDED PROPOSED ORDER for Claim 602 on March 26, 2002. A NOTICE OF *EX PARTE* CONTACT AND ORDER AMENDING PROPOSED ORDER was issued on April 17, 2002 to correct an error in Item 7, Appendix B at 8 (Claim 604). The AMENDED PROPOSED ORDER in conjunction with the NOTICE OF *EX PARTE* CONTACT AND ORDER AMENDING PROPOSED ORDER is herein referred to as the "Proposed Order."

3. No exceptions were filed to the Proposed Order within the exceptions filing deadline.

4. The Proposed Order is adopted and incorporated in its entirety as if set forth fully herein. In addition, a Water Right Claim Description in a format standardized by OWRD is set forth in Section B this Partial Order of Determination for Claim 602; the outcome of the Order is without modification.

B. DETERMINATION

1. The Proposed Order is adopted and incorporated in its entirety as if set forth fully herein.

2. The instream flows recognized pursuant to this claim are not additive to any other instream flows based on other water rights, permits or claims within the same stream reach or a portion of the same stream reach.

3. The combination of the ACT OF MAY 22, 1902, CH. 820, §1, 32 STAT. 202; the ACT OF AUG. 25, 1916, CH. 408, §2, 39 STAT. 535; the ACT OF MAY 14, 1932, CH 184, 47 STAT. 155; and PUB. L. NO. 97-250, 96 STAT. 709 (Sept. 8, 1982) are valid bases for this federal reserved water right claim, including the claimed purposes of use. The GENERAL CONCLUSIONS OF LAW CONCERNING FEDERAL RESERVED WATER RIGHTS are incorporated as if set forth fully herein.

4. The GENERAL CONCLUSIONS OF LAW CONCERNING ACQUIRED LANDS are incorporated as if set forth fully herein.

5. Claim 602 is approved for future points of diversions where the source of water is Annie Creek and its tributaries within the boundary of Crater Lake National Park; however, the overall rate of water approved in this claim may not be increased. The location of any new point of diversion must be within the reaches as described in March 26, 2002 Proposed Order, Appendix B, Section 8.2, Subsections 8.2.1 (Mainstem of Annie Creek), 8.2.2 (Unnamed Tributary "Annie-1"), 8.2.3 (East Fork of Annie Creek), 8.2.4 (Unnamed Tributary "Annie-2"), 8.2.5 (Unnamed Tributary "Annie-3"), 8.2.6 (Unnamed Tributary "Annie-4"), 8.2.7 (Middle Fork Annie Creek), 8.2.8 (Unnamed Tributary "Annie-5", 8.2.9 (Pole Bridge Creek), 8.2.10 (Munson Creek), 8.2.11 (Unnamed Tributary "Annie-6"), 8.2.12 (Goodbye Creek), and 8.2.13 (Unnamed Tributary "Annie-7").

6. Claim 602 is approved for future places of use for the purpose of domestic, administrative, wildlife watering, and/or fire protection uses within the boundaries of Crater Lake National Park as delineated in Appendix A Map (LAND RESERVATION DATES) of the March 26, 2002 Proposed Order. The priority date(s) for water use will be the priority date associated with the federal reservation of land serving as the place of use, being May 22, 1902; May 14, 1932; December 5, 1940; January 30, 1942; or December 19, 1980.

7. If new points of diversion or places of use are developed in the future, the National Park Service is required to submit a map(s) to OWRD showing the location(s) of any new point of diversion and or place of use by township, range, section and quarter-quarter. In addition, measured distances or coordinates must be provided on the map(s) for new point(s) of diversion. OWRD will record the new point(s) of diversion and/or places(s) of use and its associated priority date.

8. Based on the file and record herein, IT IS ORDERED that Claim 602 is approved as set forth in the following Water Right Claim Description.

[Beginning of Water Right Claim Description]

CLAIM NO. 602

CLAIM MAP REFERENCE:
CLAIM # 602 MYLAR MAP (Oct. 1, 1999) (EXHIBIT A, ANNIE CR WATER SUPPLY SYSTEM)

CLAIMANT: UNITED STATES DEPARTMENT OF INTERIOR
U.S. NATIONAL PARK SERVICE
1201 OAKRIDGE DR, SUITE 250
FORT COLLINS, CO 80525

SOURCE OF WATER:
ANNIE CREEK AND ITS TRIBUTARIES WITHIN THE BOUNDARY OF CRATER LAKE NATIONAL PARK, tributary to the WOOD RIVER

PURPOSE OR USE:
DOMESTIC, ADMINISTRATIVE, WILDLIFE WATERING, AND FIRE PROTECTION

RATE OF USE:
1.34 CUBIC FEET PER SECOND (CFS) AS FOLLOWS:

1.0 CFS FOR FIRE PROTECTION, AND

0.34 CFS FOR DOMESTIC, ADMINISTRATIVE AND WILDFIFE WATERING, NOT TO EXCEED 62.8 ACRE-FEET PER YEAR, BEING 62.7 ACRE-FEET FOR DOMESTIC AND ADMINISTATIVE PURPOSES; AND 0.1 ACRE-FEET FOR WILDLIFE WATERING

PERIOD OF ALLOWED USE: JANUARY 1 – DECEMBER 31

DATE OF PRIORITY: MAY 22, 1902

THE POINT OF DIVERSION IS LOCATED AS FOLLOWS:

Twp	Rng	Mer	Sec	Q-Q
31 S	5 E	WM	13	NE SE

THE PLACE OF USE IS LOCATED AS FOLLOWS:

DOMESTIC, ADMINISTRATIVE, WILDFIFE WATERING, FIRE PROTECTION			
Twp	**Rng**	**Mer**	**Sec**
31 S	5 E	WM	13
31 S	5 E	WM	24
31 S	6 E	WM	5
31 S	6 E	WM	8
31 S	6 E	WM	9
31 S	6 E	WM	17
31 S	6 E	WM	19
31 S	6 E	WM	30

FUTURE POINT(S) OF DIVERSION AND/OR FUTURE PLACE(S) OF USE:

THE SOURCE OF WATER MUST BE ANNIE CREEK AND ITS TRIBUTARIES WITHIN THE BOUNDARY OF CRATER LAKE NATIONAL PARK.

THE RATE FOR CURRENT AND FUTURE USES MAY NOT EXCEED 1.34 CUBIC FEET PER SECOND (CFS) AS FOLLOWS:

1.0 CFS FOR FIRE PROTECTION, AND

0.34 CFS FOR DOMESTIC, ADMINISTRATIVE AND WILDFIFE WATERING, NOT TO EXCEED 62.8 ACRE-FEET PER YEAR, BEING 62.7 ACRE-FEET FOR DOMESTIC AND ADMINISTATIVE PURPOSES; AND 0.1 ACRE-FEET FOR WILDLIFE WATERING.

THE LOCATION OF ANY NEW POINT OF DIVERSION MUST BE WITHIN THE REACHES AS DESCRIBED IN MARCH 26, 2002 PROPOSED ORDER, APPENDIX B, CLAIM 602, SECTION 8.2:

Subsection 8.2.1

MAIN STEM ANNIE CREEK						
	Twp	**Rng**	**Mer**	**Sec**		**Approx River Mile***
Upper Reach Boundary	31 S	5 E	WM	13	At Annie Springs	11.4
Lower Reach Boundary	32 S	6 E	WM	25	PB 58	0.0

*River miles are measured upstream from the Crater Lake National Park boundary.

Subsection 8.2.2

UNNAMED TRIBUTARY "ANNIE-1"					
	Twp	**Rng**	**Mer**	**Sec**	**Approx River Mile***
Upper Reach Boundary	32 S	6 E	WM	3	0.6
Lower Reach Boundary	32 S	6 E	WM	10	0.0

* River miles are measured upstream from the confluence of Annie-1 with Annie Creek

Subsection 8.2.3

EAST FORK OF ANNIE CREEK					
	Twp	**Rng**	**Mer**	**Sec**	**Approx River Mile***
Upper Reach Boundary	31 S	6 E	WM	15	4.9
Lower Reach Boundary	32 S	6 E	WM	4	0.0

* River miles are measured upstream from the confluence of the East Fork with Annie Creek

Subsection 8.2.4

UNNAMED TRIBUTARY "ANNIE-2," TRIBUTARY TO EAST FORK OF ANNIE CREEK					
	Twp	**Rng**	**Mer**	**Sec**	**Approx River Mile***
Upper Reach Boundary	31 S	6 E	WM	27	1
Lower Reach Boundary	31 S	6 E	WM	28	0.0

* River miles are measured upstream from the confluence with the tributary.

Subsection 8.2.5

UNNAMED TRIBUTARY "ANNIE-3," TRIBUTARY TO EAST FORK OF ANNIE CREEK					
	Twp	Rng	Mer	Sec	Approx River Mile*
Upper Reach Boundary	31 S	6 E	WM	15	1.9
Lower Reach Boundary	31 S	6 E	WM	28	0.0

* River miles are measured upstream from the confluence with the tributary.

Subsection 8.2.6

UNNAMED TRIBUTARY "ANNIE-4"					
	Twp	Rng	Mer	Sec	Approx River Mile*
Upper Reach Boundary	32 S	5 E	WM	1	3.3
Lower Reach Boundary	32 S	6 E	WM	4	0.0

* River miles are measured upstream from the confluence of Annie-4 with Annie Creek

Subsection 8.2.7

MIDDLE FORK OF ANNIE CREEK					
	Twp	Rng	Mer	Sec	Approx River Mile*
Upper Reach Boundary	31 S	6 E	WM	21	2.7
Lower Reach Boundary	31 S	6 E	WM	33	0.0

* River miles are measured upstream from the confluence of the Middle Fork with Annie Creek

Subsection 8.2.8

UNNAMED TRIBUTARY "ANNIE-5," TRIBUTARY TO MIDDLE FORK OF ANNIE CREEK					
	Twp	Rng	Mer	Sec	Approx River Mile*
Upper Reach Boundary	31 S	6 E	WM	20	0.6
Lower Reach Boundary	31 S	6 E	WM	28	0.0

* River miles are measured upstream from the confluence with the tributary.

Subsection 8.2.9

POLE BRIDGE CREEK					
	Twp	Rng	Mer	Sec	Approx River Mile*
Upper Reach Boundary	31 S	5 E	WM	36	1.9
Lower Reach Boundary	31 S	6 E	WM	32	0.0

* River miles are measured upstream from the confluence of Pole Bridge with Annie Creek

Subsection 8.2.10

MUNSON CREEK					
	Twp	Rng	Mer	Sec	Approx River Mile*
Upper Reach Boundary	31 S	6 E	WM	8	4.3
Lower Reach Boundary	31 S	6 E	WM	29	0.0

* River miles are measured upstream from the confluence Munson Creek with Annie Creek

Subsection 8.2.11

UNNAMED TRIBUTARY "ANNIE-6," TRIBUTARY TO MUNSON CREEK					
	Twp	Rng	Mer	Sec	Approx River Mile*
Upper Reach Boundary	31 S	6 E	WM	9	0.9
Lower Reach Boundary	31 S	6 E	WM	17	0.0

* River miles are measured upstream from the confluence with the tributary.

Subsection 8.2.12

GOODBYE CREEK					
	Twp	Rng	Mer	Sec	Approx River Mile*
Upper Reach Boundary	31 S	6 E	WM	17	1.4
Lower Reach Boundary	31 S	6 E	WM	30	0.0

* River miles are measured upstream from the confluence of Goodbye Creek with Annie Creek

Subsection 8.2.13

UNNAMED TRIBUTARY "ANNIE-7," TRIBUTARY TO GOODBYE CREEK					
	Twp	Rng	Mer	Sec	Approx River Mile*
Upper Reach Boundary	31 S	6 E	WM	20	1.2
Lower Reach Boundary	31 S	6 E	WM	30	0.0

* River miles are measured upstream from the confluence with the tributary.

THE PLACE(S) OF USE MUST BE WITHIN THE BOUNDARIES OF CRATER LAKE NATIONAL PARK AS DELINEATED IN APPENDIX A OF THE MARCH 26, 2002 PROPOSED ORDER.

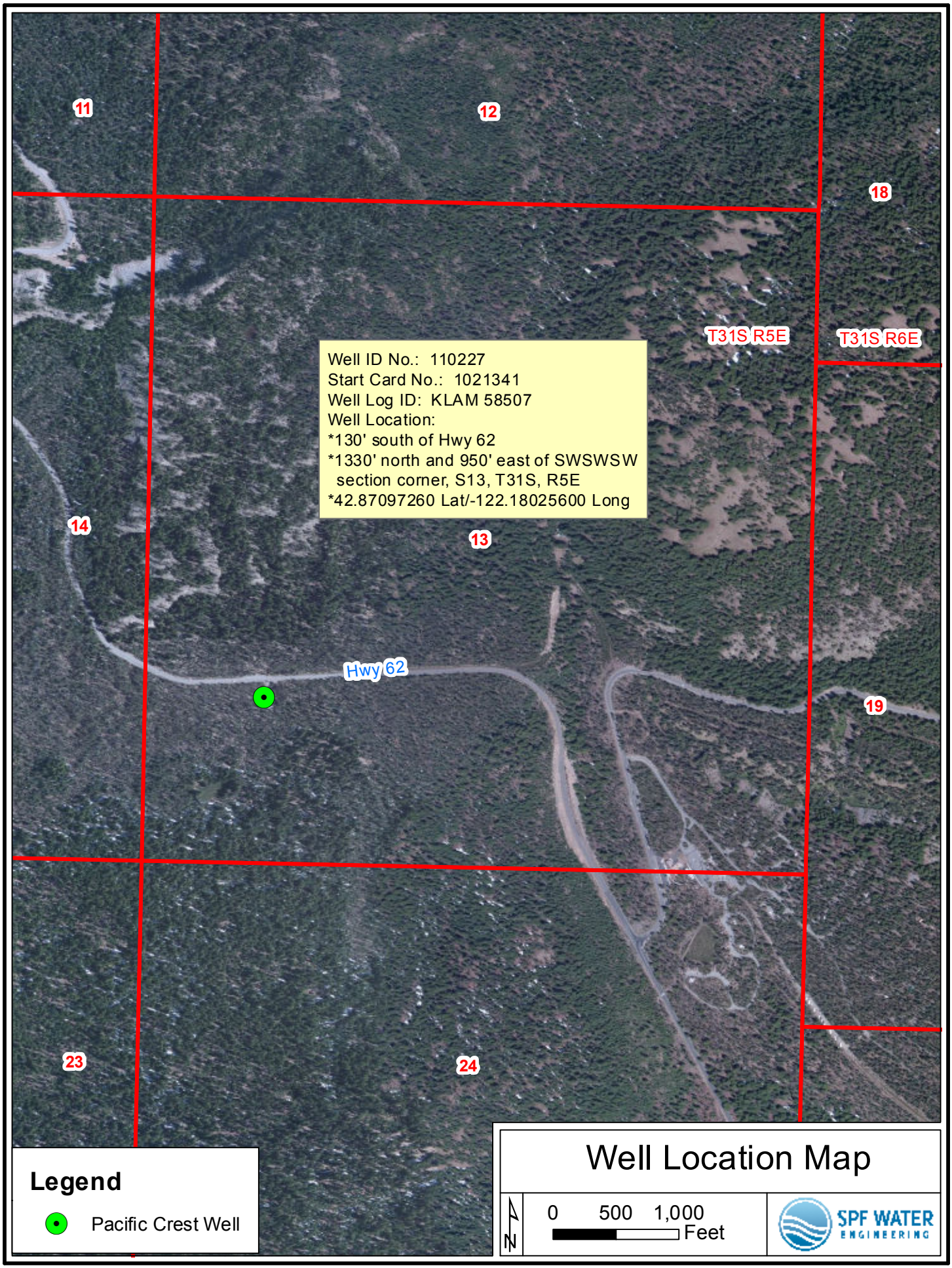
THE PRIORITY DATE(S) FOR WATER USE WILL BE THE PRIORITY DATE ASSOCIATED WITH THE FEDERAL RESERVATION OF LAND SERVING AS THE PLACE OF USE, BEING MAY 22, 1902; MAY 14, 1932; DECEMBER 5, 1940; JANUARY 30, 1942; OR DECEMBER 19, 1980.

THE NATIONAL PARK SERVICE IS REQUIRED TO SUBMIT A MAP(S) TO OWRD SHOWING THE LOCATION(S) OF ANY NEW POINT OF DIVERSION AND OR PLACE OF USE BY TOWNSHIP, RANGE, SECTION AND QUARTER-QUARTER. IN ADDITION, MEASURED DISTANCES OR COORDINATES MUST BE PROVIDED ON THE MAP(S) FOR NEW POINT(S) OF DIVERSION. OWRD WILL RECORD THE NEW POINT(S) OF DIVERSION AND/OR PLACES(S) OF USE AND ITS ASSOCIATED PRIORITY DATE.

[End of Water Right Claim Description]

Dated at Salem, Oregon on March 7, 2013

Dwight French, Adjudicator
Klamath Basin General Stream Adjudication


11
12
18
T31S R5E
T31S R6E
Well ID No.: 110227
Start Card No.: 1021341
Well Log ID: KLAM 58507
Well Location:
*130' south of Hwy 62
*1330' north and 950' east of SWSWSW
section corner, S13, T31S, R5E
*42.87097260 Lat/-122.18025600 Long
14
13
Hwy 62
19
23
24
Legend
Pacific Crest Well
Well Location Map
N
0 500 1,000
Feet
SPF WATER
ENGINEERING

This page to be completed by the local Watermaster.

WATER AVAILABILITY STATEMENT

Name of Applicant: US National Park Service _____ Limited License Number: _____

1. To your knowledge, has the stream or basin that is the source for this application ever been regulated for prior rights? ☐ Yes ☐ No

If yes, please explain:

2. Based on your observations, would be there water available in the quantity and at the times needed to supply the use proposed by this application? ☐ Yes ☐ No

3. Do you observe this stream system during regular fieldwork? ☐ Yes ☐ No

If yes, what are your observations for the stream?

4. If the source is a well and if WRD were to determine that there is the potential for substantial interference with nearby surface water sources, would there still be ground water and surface water available during the time requested and in the amount requested without injury to existing water rights? ☐ Yes ☐ No ☐ N/A

What would you recommend for conditions on a limited license that may be issued approving this application?

5. Any other recommendations you would like to make?

Signature _____ WM District #: ____ Date: _____

Land Use Information Form

Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301-1266
(503) 986-0900
www.wrd.state.or.us

NOTE TO APPLICANTS

In order for your application to be processed by the Water Resources Department (WRD), this Land Use Information Form must be completed by a local government planning official in the jurisdiction(s) where your water right will be used and developed. The planning official may choose to complete the form while you wait, or return the receipt stub to you. Applications received by WRD without the Land Use Form or the receipt stub will be returned to you. Please be aware that your application will not be approved without land use approval.

This form is NOT required if:

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

NOTE TO LOCAL GOVERNMENTS

The person presenting the attached Land Use Information Form is applying for or modifying a water right. The Water Resources Department (WRD) requires its applicants to obtain land-use information to be sure the water rights do not result in land uses that are incompatible with your comprehensive plan. Please complete the form or detach the receipt stub and return it to the applicant for inclusion in their water right application. You will receive notice once the applicant formally submits his or her request to the WRD. The notice will give more information about WRD's water rights process and provide additional comment opportunities. You will have 30 days from the date of the notice to complete the land-use form and return it to the WRD. If no land-use information is received from you within that 30-day period, the WRD may presume the land use associated with the proposed water right is compatible with your comprehensive plan. Your attention to this request for information is greatly appreciated by the Water Resources Department. If you have any questions concerning this form, please contact the WRD's Customer Service Group at 503-986-0801.

Land Use Information Form

N/A - water is to be diverted and used only on federal lands

Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301-1266
(503) 986-0900
www.wrd.state.or.us

Applicant: _____ _____
First Last

Mailing Address: _____

_____ _____ _____ Daytime Phone: _____
City State Zip

A. Land and Location

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

Township	Range	Section	¼ ¼	Tax Lot #	Plan Designation (e.g., Rural Residential/RR-5)	Water to be:	Proposed Land Use:
						☐ Diverted ☐ Conveyed ☐ Used	
						☐ Diverted ☐ Conveyed ☐ Used	
						☐ Diverted ☐ Conveyed ☐ Used	
						☐ Diverted ☐ Conveyed ☐ Used	

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

B. Description of Proposed Use

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

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

Source of water: ☐ Reservoir/Pond ☐ Ground Water ☐ Surface Water (name) _____

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

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

Briefly describe:

Note to applicant: If the Land Use Information Form cannot be completed while you wait, please have a local government representative sign the receipt at the bottom of the next page and include it with the application filed with the Water Resources Department.

See bottom of Page 3. →

For Local Government Use Only

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

Please check the appropriate box below and provide the requested information

☐ Land uses to be served by the proposed water uses (including proposed construction) are allowed outright or are not regulated by your comprehensive plan. Cite applicable ordinance section(s): _____.

☐ Land uses to be served by the proposed water uses (including proposed construction) involve discretionary land-use approvals as listed in the table below. (Please attach documentation of applicable land-use approvals which have already been obtained. Record of Action/land-use decision and accompanying findings are sufficient.) **If approvals have been obtained but all appeal periods have not ended, check "Being pursued."**

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

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

Name: _____ Title: _____

Signature: _____ Phone: _____ Date: _____

Government Entity: _____

Note to local government representative: Please complete this form or sign the receipt below and return it to the applicant. If you sign the receipt, you will have 30 days from the Water Resources Department's notice date to return the completed Land Use Information Form or WRD may presume the land use associated with the proposed use of water is compatible with local comprehensive plans.

Receipt for Request for Land Use Information

Applicant name: _____

City or County: _____ Staff contact: _____

Signature: _____ Phone: _____ Date: _____

OHA Drinking Water Program Compliance

A required element for all ASR Limited License Applications that are for public supply systems, as defined by the Health Division (OAR 333-061-0020), is compliance with the Oregon Health Authority's Drinking Water Plan submission and review requirements (OAR 333-061-0060). The US National Park Service (NPS) hereby acknowledges that, with regard to its ASR Limited License Application for Crater Lake National Park, the water system for which ASR is being proposed is a public supply system. As such, the NPS must comply with the Drinking Water Program plan submission and review requirements, attached here for reference.

333-061-0060 Plan Submission and Review Requirements

(1) Plan Submission:

(a) Construction and installation plans shall be submitted to and approved by the Authority before construction begins on new systems or major additions or modifications, as determined by the Authority, are made to existing systems. Plans shall be drawn to scale;

(b) Preliminary plans, pilot studies, master plans and construction plans shall be prepared by a Professional Engineer registered in Oregon, and submitted to the Authority unless exempted by the Authority (See OAR 333-061-0060(4));

(c) Plans shall set forth the following:

(A) Sufficient detail, including specifications, to completely and clearly illustrate what is to be constructed and how those facilities will meet the construction standards set forth in these regulations. Elevation or section views shall be provided where required for clarity;

(B) Supporting information attesting to the quality of the proposed source of water;

(C) Vicinity map of the proposed project relative to the existing system or established landmarks of the area;

(D) Name of the owner of the water system facilities during construction and the name of the owner and operator of the facilities after completion of the project;

(E) Procedures for cleaning and disinfecting those facilities which will be in contact with the potable water.

(d) Prior to drilling a well, a site plan shall be submitted which shows the site location, topography, drainage, surface water sources, specifications for well drilling, location of the well relative to sanitary hazards, dimensions of the area reserved to be kept free of potential sources of contamination, evidence of ownership or control of the reserve area and the anticipated depth of the aquifer from which the water is to be derived. The Authority will review well reports from the area and in consultation with the local watermaster and the well constructor as appropriate will recommend the depth of placement of the casing seal. After the well is drilled, the following documents shall be submitted to the Authority for review and approval: Well driller's report, report of the pump test which indicates that the well has been pumped for a sufficient length of time to establish the reliable yield of the well on a sustained basis, including data on the static water level, the pumping rate(s), the changes in drawdown over the duration of the test, the rate of recovery after the pump was turned off, reports on physical, chemical and microbiological quality of the well water, performance data on the well pump, a plan of the structure for protecting above-ground controls and

appurtenances, and a plan showing how the well will be connected to the water system. (See OAR 333-061-0050(2)).

(e) Any community, non-transient non-community, or transient non-community water system that treats surface water or groundwater under the influence of surface water and that desires to make a significant change to its disinfection treatment process as defined by paragraphs (1)(e)(A) through (1)(e)(D) of this rule, is required to develop a disinfection profile and calculate a disinfection benchmark according to OAR 333-061-0036(4)(g). The water system must consult with and provide any additional information requested by the Authority prior to making such a change. The water system must develop a disinfection profile for *Giardia lamblia* and viruses, calculate a disinfection benchmark, describe the proposed change in the disinfection process, and analyze the effect(s) of the proposed change on current levels of disinfection according to the USEPA Disinfection Profiling and Benchmarking Guidance Manual and/or the USEPA LT1-ESWTR Disinfection Profiling and Benchmarking Technical Guidance Manual and submit the information to the Authority for review and approval. Significant changes to the disinfection treatment process include:

(A) Changes to the point of application:

(B) Changes to the disinfectants used in the treatment process;

(C) Changes to the disinfection process;

(D) Any other modification identified by the Authority.

(f) A water system that uses either chloramines, chlorine dioxide, or ozone for primary disinfection, and that is required to prepare a disinfection profile for *Giardia lamblia* as prescribed by subsection (1)(e) of this rule, must also prepare a disinfection profile for viruses and calculate the logs of inactivation for viruses using the methods specified in OAR 333-061-0036(4)(g).

(2) Plan review:

(a) Upon receipt of plans, the Authority shall review the plans and either approve them or advise that correction or clarification is required. When the correction or clarification is received, and the item(s) in question are resolved, the Authority shall then approve the plans;

(b) Upon completion of a project, a professional engineer registered in Oregon shall submit to the Authority a statement certifying that the project has been constructed in compliance with the approved plans and specifications. When substantial deviations from the approved plans are made, as-built plans showing compliance with these rules shall be submitted to the Authority;

(c) Plans shall not be required for emergency repair of existing facilities. In lieu of plans, written notice shall be submitted to the Authority immediately after the emergency work is completed stating the nature of the emergency, the

extent of the work and whether or not any threats to the water quality exists or existed during the emergency.

(3) Plan review fees: Plans submitted to the Authority shall be accompanied by a fee as indicated in Table 47. Those plans not accompanied by a fee will not be reviewed.

Table 47		
Nature of Plan	Community Water System	Non-Community Water System
Water source	$600	$150
Water Treatment	$600	$150
Water Treatment (full)	$600	$150
Disinfection only	$150	$45
Corrosion Control only	$150	$45
Distribution & Storage	$600	$150
Distribution only	$600	$150
Storage only	$600	$150
Combination two or more	$750	$150
Master Plan	$750	$150
Corrosion Control study	$750	$150
As-built plans & certification statement	No fee if original plans reviewed	

(4) Plan review exemptions:

(a) Water suppliers may be exempted from submitting plans of main extensions, providing they:

(A) Have provided the Authority with a current master plan; and

(B) Certify that the work will be carried out in conformance with the construction standards of these rules; and

(C) Submit to the Authority an annual summary of the projects completed; and

(D) Certify that they have staff qualified to effectively supervise the projects.

(b) Those water suppliers certifying that they have staff qualified to effectively plan, design and supervise their projects, may request the Authority for further exemption from this rule. Such requests must be accompanied by a listing of staff proposed to accomplish the work and a current master plan. To maintain the exemption, the foregoing must be annually updated;

(c) At the discretion of the Authority, Community, Transient and Non-Transient Non-Community and State Regulated water systems may be exempted from submitting engineered plans. They shall, however, submit adequate plans

indicating that the project meets the minimum construction standards of these rules.

(5) Master plans:

(a) Community water systems with 300 or more service connections shall maintain a current master plan. Master plans shall be prepared by a professional engineer registered in Oregon and submitted to the Authority for review and approval.

(b) Each master plan shall evaluate the needs of the water system for at least a twenty year period and shall include but is not limited to the following elements:

(A) A summary of the overall plan that includes the water quality and service goals, identified present and future water system deficiencies, the engineer's recommended alternative for achieving the goals and correcting the deficiencies, and the recommended implementation schedule and financing program for constructing improvements.

(B) A description of the existing water system which includes the service area, source(s) of supply, status of water rights, current status of drinking water quality and compliance with regulatory standards, maps or schematics of the water system showing size and location of facilities, estimates of water use, and operation and maintenance requirements.

(C) A description of water quality and level of service goals for the water system, considering, as appropriate, existing and future regulatory requirements, nonregulatory water quality needs of water users, flow and pressure requirements, and capacity needs related to water use and fire flow needs.

(D) An estimate of the projected growth of the water system during the master plan period and the impacts on the service area boundaries, water supply source(s) and availability, and customer water use.

(E) An engineering evaluation of the ability of the existing water system facilities to meet the water quality and level of service goals, identification of any existing water system deficiencies, and deficiencies likely to develop within the master plan period. The evaluation shall include the water supply source, water treatment, storage, distribution facilities, and operation and maintenance requirements. The evaluation shall also include a description of the water rights with a determination of additional water availability, and the impacts of present and probable future drinking water quality regulations.

(F) Identification of alternative engineering solutions, environmental impacts, and associated capital and operation and maintenance costs, to correct water system deficiencies and achieve system expansion to

meet anticipated growth, including identification of available options for cooperative or coordinated water system improvements with other local water suppliers.

(G) A description of alternatives to finance water system improvements including local financing (such as user rates and system development charges) and financing assistance programs.

(H) A recommended water system improvement program including the recommended engineering alternative and associated costs, maps or schematics showing size and location of proposed facilities, the recommended financing alternative, and a recommended schedule for water system design and construction.

(I) If required as a condition of a water use permit issued by the Water Resources Department, the Master Plan shall address the requirements of OAR 690-086-0120 (Water Management and Conservation Plans).

(c) The implementation of any portion of a water system master plan must be consistent with OAR 333-061 (Public Drinking Water Systems, Oregon Health Authority), OAR 660-011 (Public Facilities Planning, Department of Land Conservation and Development) and OAR 690-086 (Water Management and Conservation Plans, Water Resources Department).

Stat. Auth.: ORS 448.131
Stats. Implemented: ORS 431.110, 431.150, 448.131, 448.150, 448.273 & 448.279

Document Revision Date: 12/19/2014

Oregon Health Authority, Drinking Water Services

Basic *Plan Review* Requirements

The following *plan review* requirements are basic. Specific projects likely require submission of specific information. Specifics are addressed within information packets available at:
www.healthoregon.org/pwsplanreview.
For assistance, call (971) 673-0405, fax (971) 673-0694, or call
Plan Review Coordinators
Region 1[a]: Carrie Gentry (971) 673-0191
Region 2[b]: Jay MacPherson (541) 726-2587 x57

Basic information required for all *plan reviews*:

1. Plans must be submitted to, and approved by, the Oregon Health Authority (OHA) Drinking Water Services (DWS) ***prior to construction*** of major additions or modifications to sources, treatment, disinfection, water storage, pumps, and water mains.
2. Plans prepared by an Oregon Professional Engineer.
3. A Land Use Compatibility Statement (LUCS), or equivalent documentation, approved by the local planning authority. Modifications to existing facilities with a LUCS on file may submit the original LUCS.
4. Owner's name, address, and phone number (email encouraged).
5. Vicinity map.
6. Site plan.
7. Details and specifications.
8. Description of the proposed source of water.
9. Estimates of system demand or population size and type (e.g., residents, workers, visitors)
10. The appropriate plan review fee.

The submittal materials are sent to:

ATTN: PLAN REVIEW
OHA DRINKING WATER SERVICES
800 NE OREGON ST., STE 640
PORTLAND, OR 97232-2162

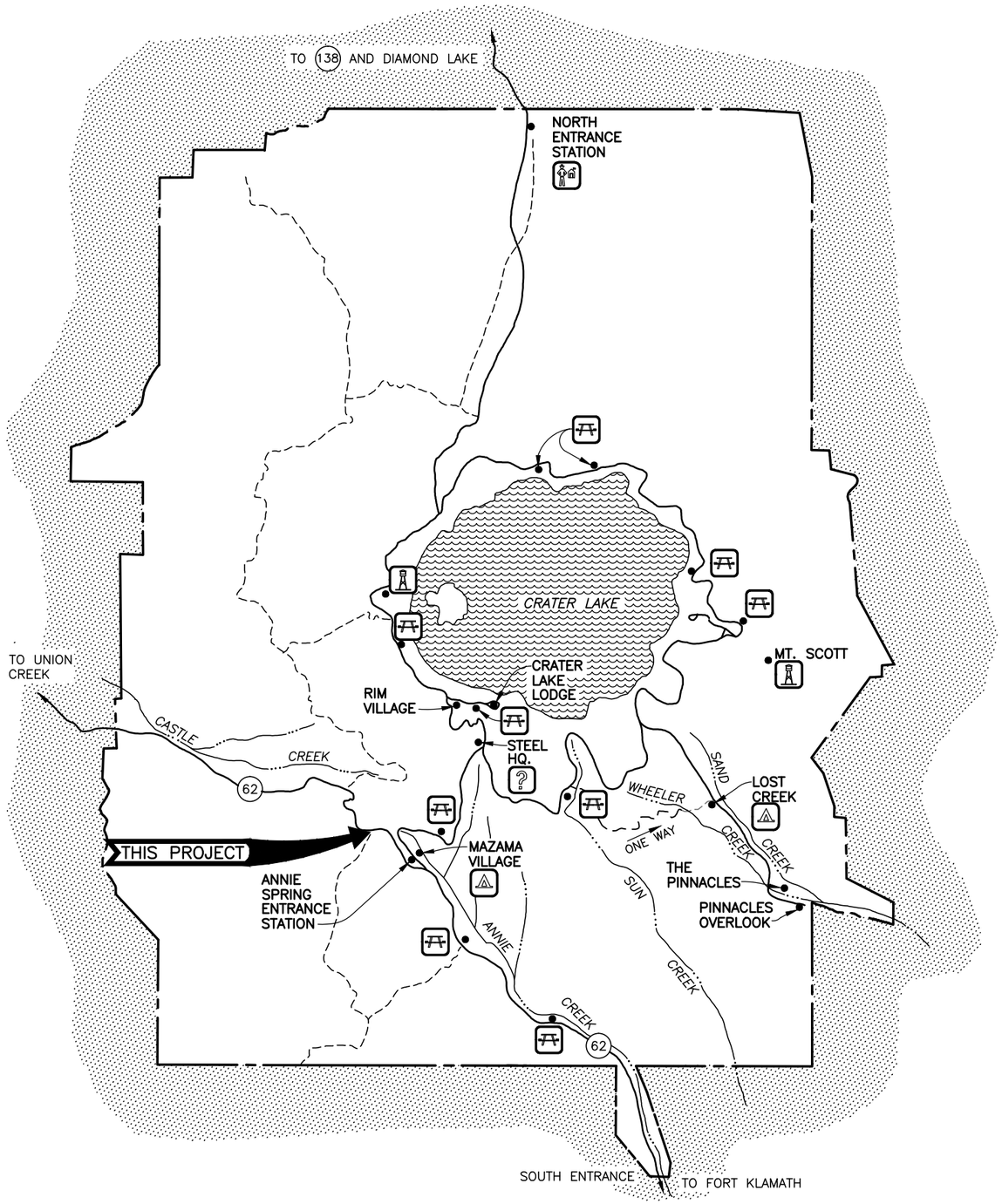
(*Materials may be sent directly to the relevant DWS regional engineer, though the fee payment [payable to "OHA Drinking Water"] should be sent to the address above. Sending the fee to a regional engineer may slow processing time*.)

[a] Region 1: Baker, Clackamas, Clatsop, Columbia, Crook, Deschutes, Gilliam, Grant, Harney, Jefferson, Malheur, Marion, Morrow, Multnomah, Polk, Sherman, Tillamook, Umatilla, Union, Wallowa, Wasco, Washington, Wheeler, and Yamhill

[b] Region 2: Benton, Coos, Curry, Douglas, Jackson, Josephine, Klamath, Lake, Lane, Lincoln, and Linn

Attachment E

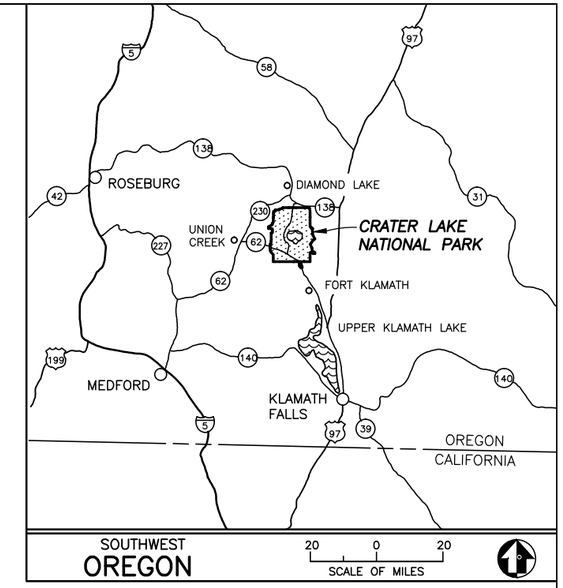
Draft Schematic Design Plans



CRATER LAKE NATIONAL PARK

LEGEND

- PARK BOUNDARY
- PAVED ROAD
- UNPAVED ROAD
- TRAIL
- CREEK
- V.C. VISITOR CENTER
- HQ. PARK HEADQUARTERS
- RANGER STATION
- PICNIC AREA
- CAMPGROUND
- FIRE LOOKOUT
- INFORMATION



INDEX

SHEET	SUB SHEET	TITLE OF SHEET
1		COVER SHEET
2	C–1	OVERALL SITE PLAN
3	C–2	WATERLINE PLAN AND PROFILE 0+00 TO 20+00
4	C–3	WATERLINE PLAN AND PROFILE 20+00 TO 36+07
5	C–4	PROCESS FLOW DIAGRAM–PUMPING FROM PACIFIC CREST WELL
6	C–5	PROCESS FLOW DIAGRAM–PUMPING TO PACIFIC CREST WELL
7	C–6	PROCESS FLOW DIAGRAM–PUMPING TO & FROM PACIFIC CREST WELL
8	C–7	WATER DETAILS
9	E–1	ELECTRICAL SITE PLAN

SCALE OF MILES
1 0 1 2
1 0 1 2 3
SCALE OF KILOMETERS

SCHEMATIC DESIGN

UNITED STATES
DEPARTMENT OF THE INTERIOR

NATIONAL PARK SERVICE
DENVER SERVICE CENTER

TITLE OF DRAWING
COVER SHEET
LOCATION WITHIN PARK
ANNIE SPRINGS
NAME OF PARK
CRATER LAKE NATIONAL PARK

REGION	COUNTY	STATE
PACIFIC WEST	KLAMATH	OREGON

DRAWING NO. 106
PKG. NO.
SHEET 1 OF

CHECK PRINT

BASIC DATA: BSE MAP 106/80,001A 3/81; COVER REVISED & REDRAWN 8/90. UPDATED 10/98. SGS.

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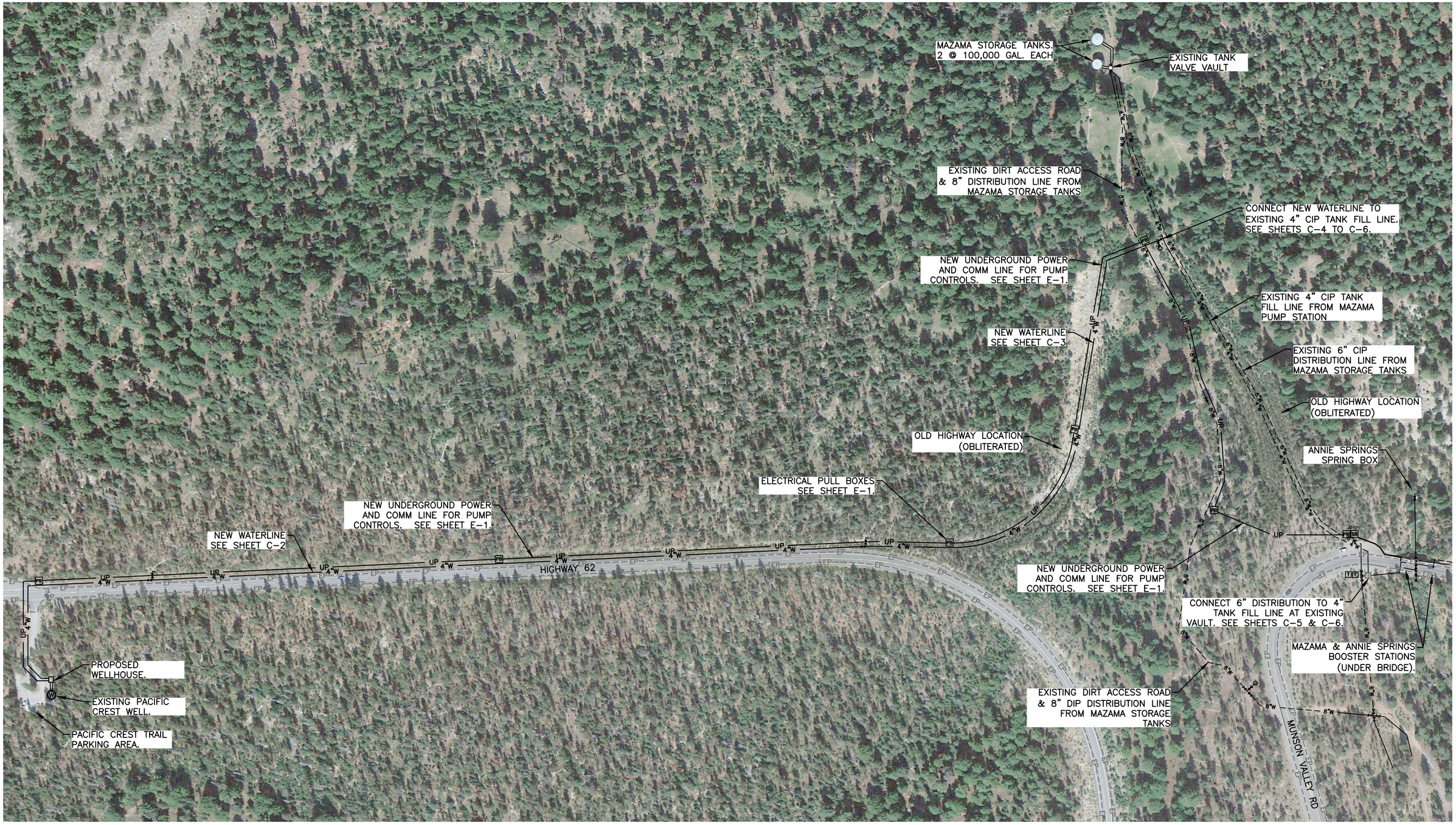

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SCALE OF FEET

DESIGNED:	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
BLW	C-1	OVERALL SITE PLAN	3
CADD: BLW			PMIS/PKG NO. 203499
TECH. REVIEW: DK		CRATER LAKE NATIONAL PARK	SHEET 2 OF 9
DATE: 7/28/2014			

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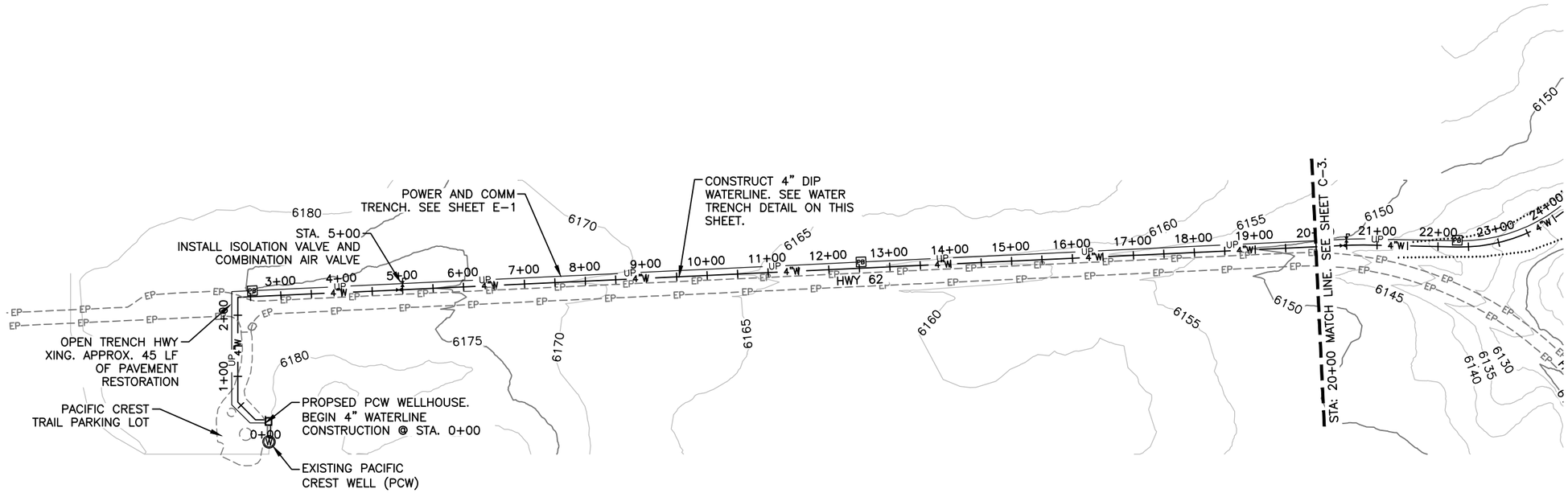

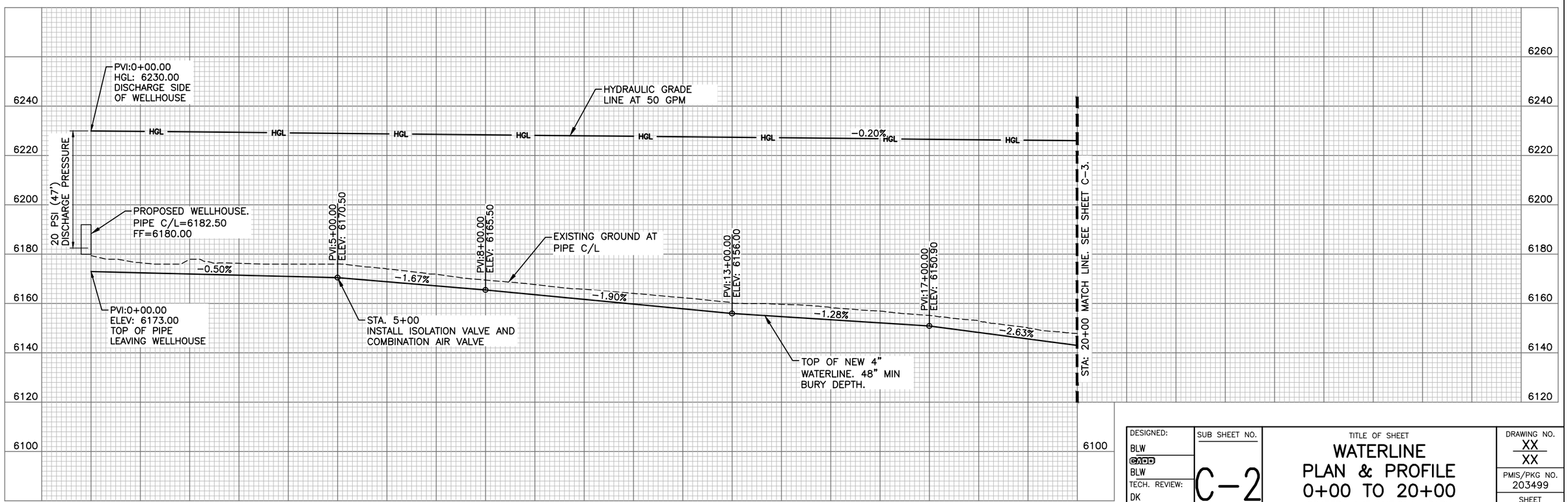

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DATE: 7/28/2014			SHEET 3 OF 9

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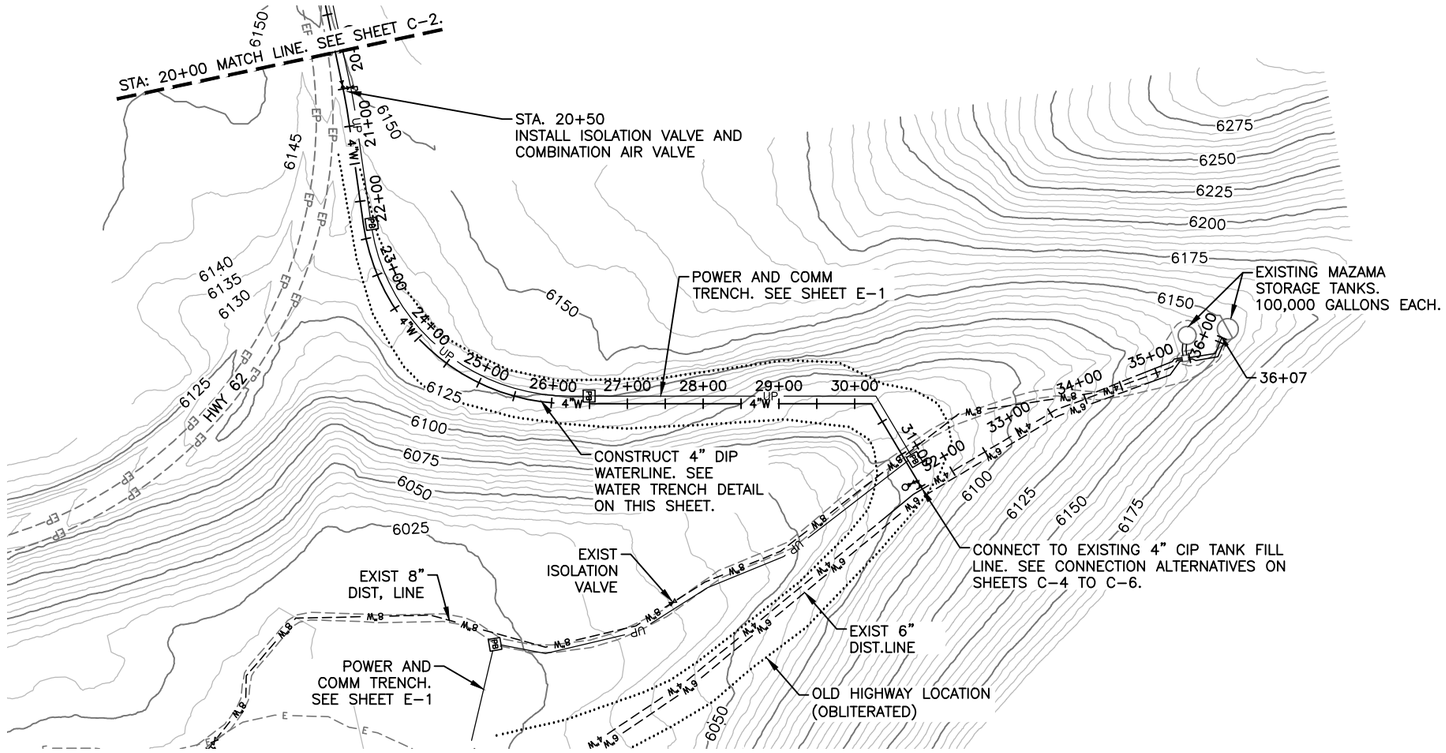

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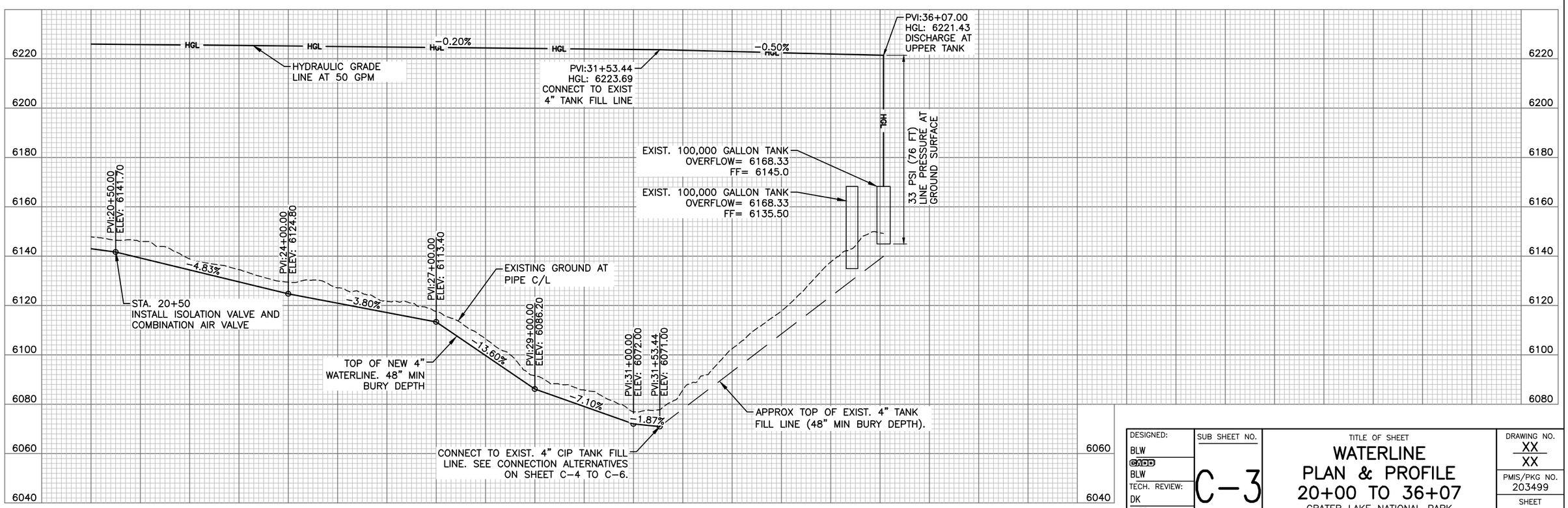
SCALE OF FEET



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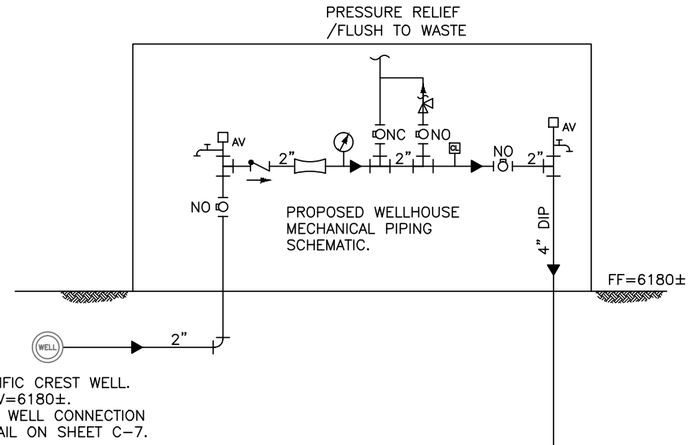
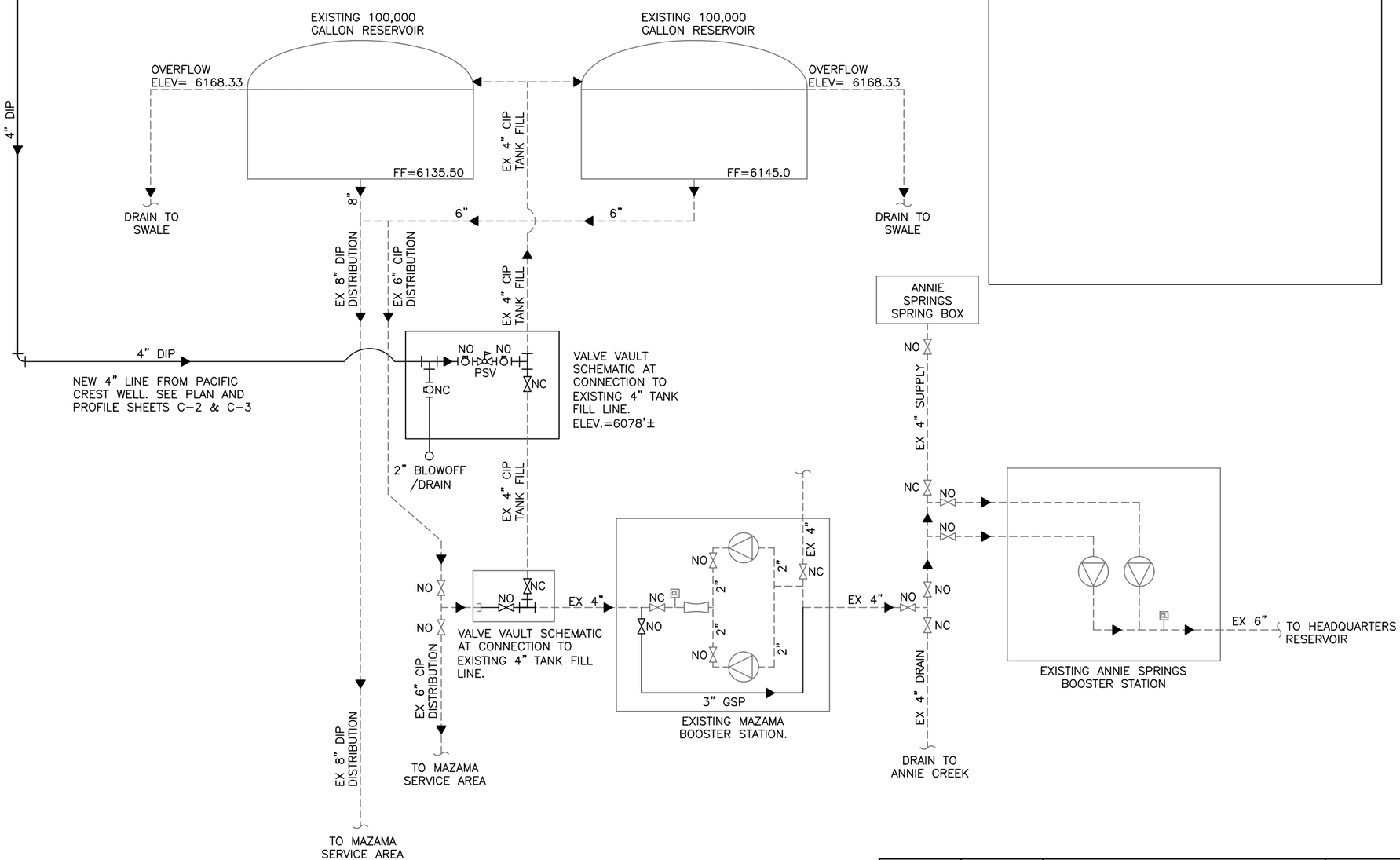


ABBREVIATIONS

CIP	CAST IRON PIPE
DIP	DUCTILE IRON PIPE
ELEV	ELEVATION
EX	EXISTING
FF	FINISH FLOOR ELEVATION
GSP	GALVANIZED STEEL PIPE
NC	VALVE NORMALLY CLOSED
NO	VALVE NORMALLY OPEN
PSV	PRESSURE SUSTAINING VALVE

LEGEND

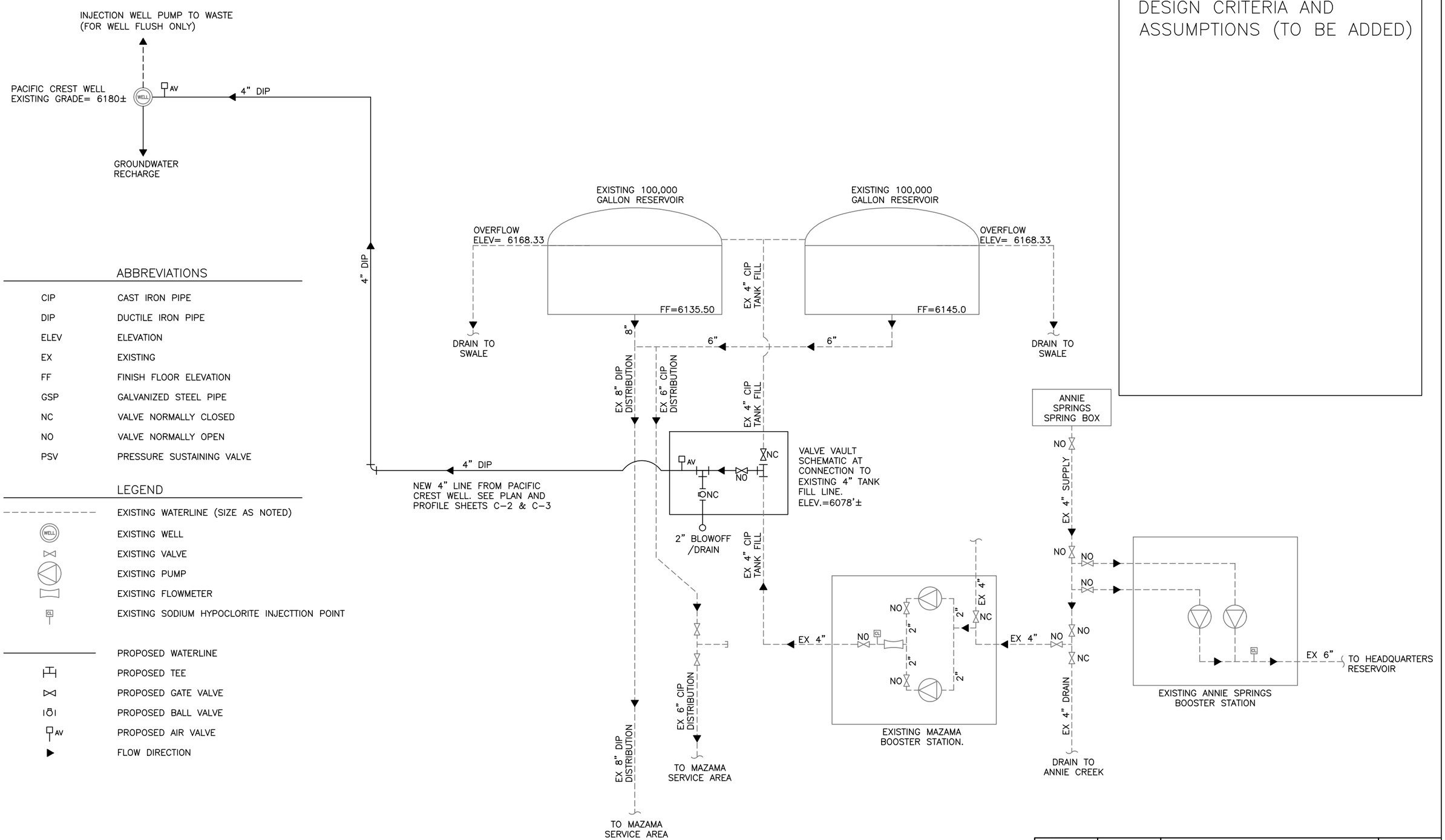
- - - - - -	EXISTING WATERLINE (SIZE AS NOTED)
WELL	EXISTING WELL
	EXISTING VALVE
	EXISTING PUMP
	EXISTING FLOWMETER
CL	EXISTING SODIUM HYPOCLORITE INJECTTION POINT
———	PROPOSED WATERLINE
	PROPOSED TEE
	PROPOSED GATE VALVE
	PROPOSED BALL VALVE
	PROPOSED CHECK VALVE
AV	PROPOSED AIR VALVE
	PRESSURE SUSTAINING VALVE
	PROPOSED PRESSURE RELIEF VALVE
	PROPOSED FLOW METER
	PROPOSED PRESSURE GAUGE
	PROPOSED SAMPLE TAP
CL	PROPOSED SODIUM HYPOCHLORITE INJECTION POINT
▶	FLOW DIRECTION



DESIGN CRITERIA AND
ASSUMPTIONS (TO BE ADDED)

DESIGNED: BLW CADD BLW TECH. REVIEW: DK DATE: 7/28/2014	SUB SHEET NO. C-4	TITLE OF SHEET PROCESS FLOW DIAGRAM PUMPING FROM PACIFIC CREST WELL CRATER LAKE NATIONAL PARK	DRAWING NO. XX/XX PMIS/PKG NO. 203499 SHEET 5 OF 9

Path: Y:\PROJECTS\958.0060\CRLA\PMIS203499\DRAWINGS\CI Filename: C-4 PROCESS FLOW SCHEMATIC FROM PCW Plot date: Jul 28, 2014-03:09:36pm CAD User: BWilkinson.
Xref Filename:



DESIGN CRITERIA AND
ASSUMPTIONS (TO BE ADDED)

ABBREVIATIONS

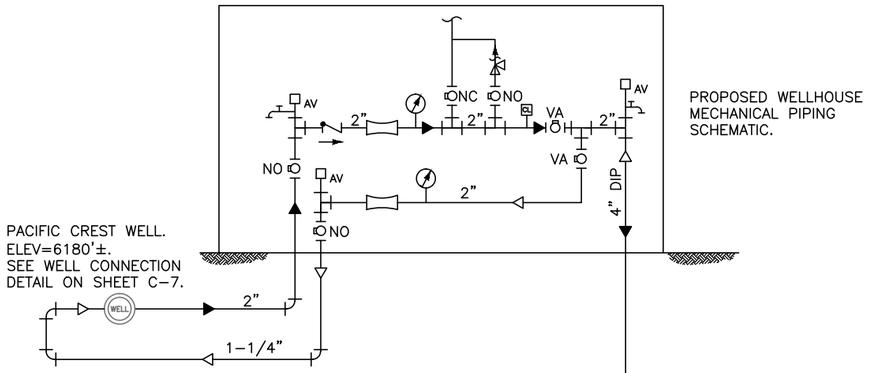
CIP	CAST IRON PIPE
DIP	DUCTILE IRON PIPE
ELEV	ELEVATION
EX	EXISTING
FF	FINISH FLOOR ELEVATION
GSP	GALVANIZED STEEL PIPE
NC	VALVE NORMALLY CLOSED
NO	VALVE NORMALLY OPEN
PSV	PRESSURE SUSTAINING VALVE

LEGEND

- - - - - -	EXISTING WATERLINE (SIZE AS NOTED)
WELL	EXISTING WELL
	EXISTING VALVE
	EXISTING PUMP
	EXISTING FLOWMETER
CL	EXISTING SODIUM HYPOCLORITE INJECTTION POINT
———	PROPOSED WATERLINE
	PROPOSED TEE
	PROPOSED GATE VALVE
	PROPOSED BALL VALVE
AV	PROPOSED AIR VALVE
▶	FLOW DIRECTION

DESIGNED: BLW CADD BLW TECH. REVIEW: DK DATE: 7/28/2014	SUB SHEET NO. C-5	TITLE OF SHEET PROCESS FLOW DIAGRAM PUMPING TO PACIFIC CREST WELL CRATER LAKE NATIONAL PARK	DRAWING NO. XX/XX PMIS/PKG NO. 203499 SHEET 6 OF 9

Path: Y:\PROJECTS\958.0060\CRLA\PMIS203499\DRAWINGS\C1 Filename: C-5 PROCESS FLOW SCHEMATIC TO PCW Plot date: Jul 28, 2014-03:11:05pm CAD User: BWilkinson.
Xref Filename: |



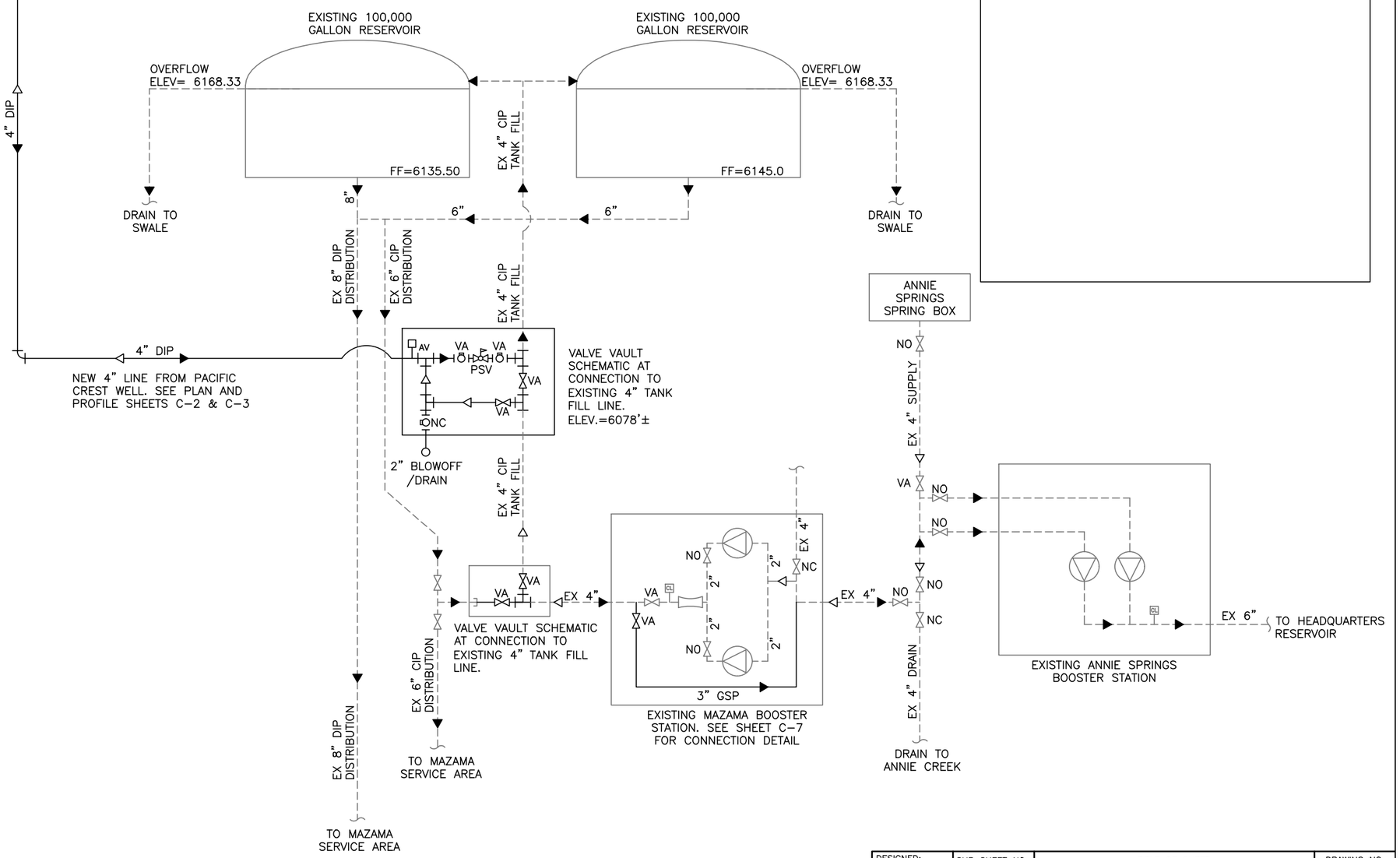
PROPOSED WELLHOUSE MECHANICAL PIPING SCHEMATIC.

ABBREVIATIONS

CIP	CAST IRON PIPE
DIP	DUCTILE IRON PIPE
ELEV	ELEVATION
EX	EXISTING
FF	FINISH FLOOR ELEVATION
GSP	GALVANIZED STEEL PIPE
NC	VALVE NORMALLY CLOSED
NO	VALVE NORMALLY OPEN
PSV	PRESSURE SUSTAINING VALVE
VA	VALVE POSITION ALTERNATES BASED ON FLOW SCENARIO.

LEGEND

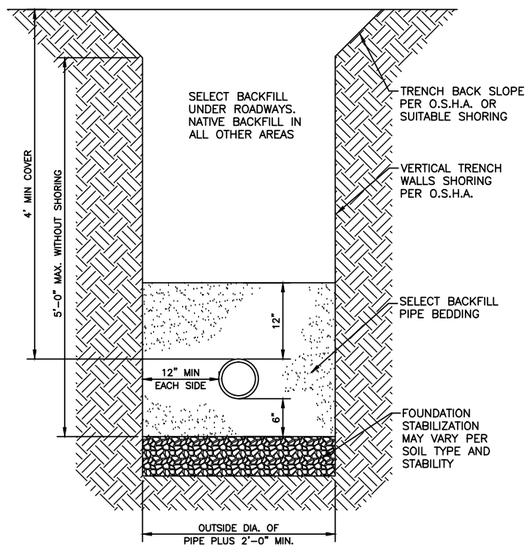
- EXISTING WATERLINE (SIZE AS NOTED)
- EXISTING WELL
- EXISTING VALVE
- EXISTING PUMP
- EXISTING FLOWMETER
- EXISTING SODIUM HYPOCLORITE INJECTTION POINT
- PROPOSED WATERLINE
- PROPOSED TEE
- PROPOSED GATE VALVE
- PROPOSED BALL VALVE
- PROPOSED CHECK VALVE
- PROPOSED AIR VALVE
- PRESSURE SUSTAINING VALVE
- PROPOSED PRESSURE RELIEF VALVE
- PROPOSED FLOW METER
- PROPOSED PRESSURE GAUGE
- PROPOSED SAMPLE TAP
- PROPOSED SODIUM HYPOCHLORITE INJECTION POINT
- FLOW DIRECTION WHEN PUMPING FROM PACIFIC CREST WELL
- FLOW DIRECTION WHEN PUMPING TO PACIFIC CREST WELL



DESIGN CRITERIA AND ASSUMPTIONS (TO BE ADDED)

DESIGNED: BLW CADD BLW TECH. REVIEW: DK DATE: 7/28/2014	SUB SHEET NO. C-6	TITLE OF SHEET PROCESS FLOW DIAGRAM PUMPING TO & FROM PACIFIC CREST WELL CRATER LAKE NATIONAL PARK	DRAWING NO. XX/XX PMIS/PKG NO. 203499 SHEET 7 OF 9

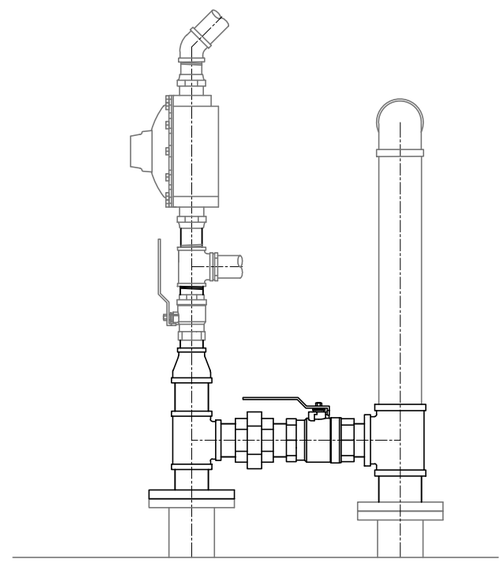
Path: Y:\PROJECTS\958.0060\CRLA\PMIS203499\DRAWINGS\CI Filename: C-6 PROCESS FLOW SCHEMATIC TO & FROM PCW Plot date: Jul 28, 2014-03:33:48pm CAD User: BWilkinson.
Xref Filename: |



NOTES:

1. TYPICAL TRENCH CONSTRUCTION AS PER TRENCH DETAIL STANDARD DRAWING OR I.S.P.W.C. STD. DWG. SD-301.

1 / – WATER TRENCH DETAIL
NTS



1 / – MAZAMA PUMP STATION PIPING
NTS

1 / – WELL CONNECTION DETAIL
NTS

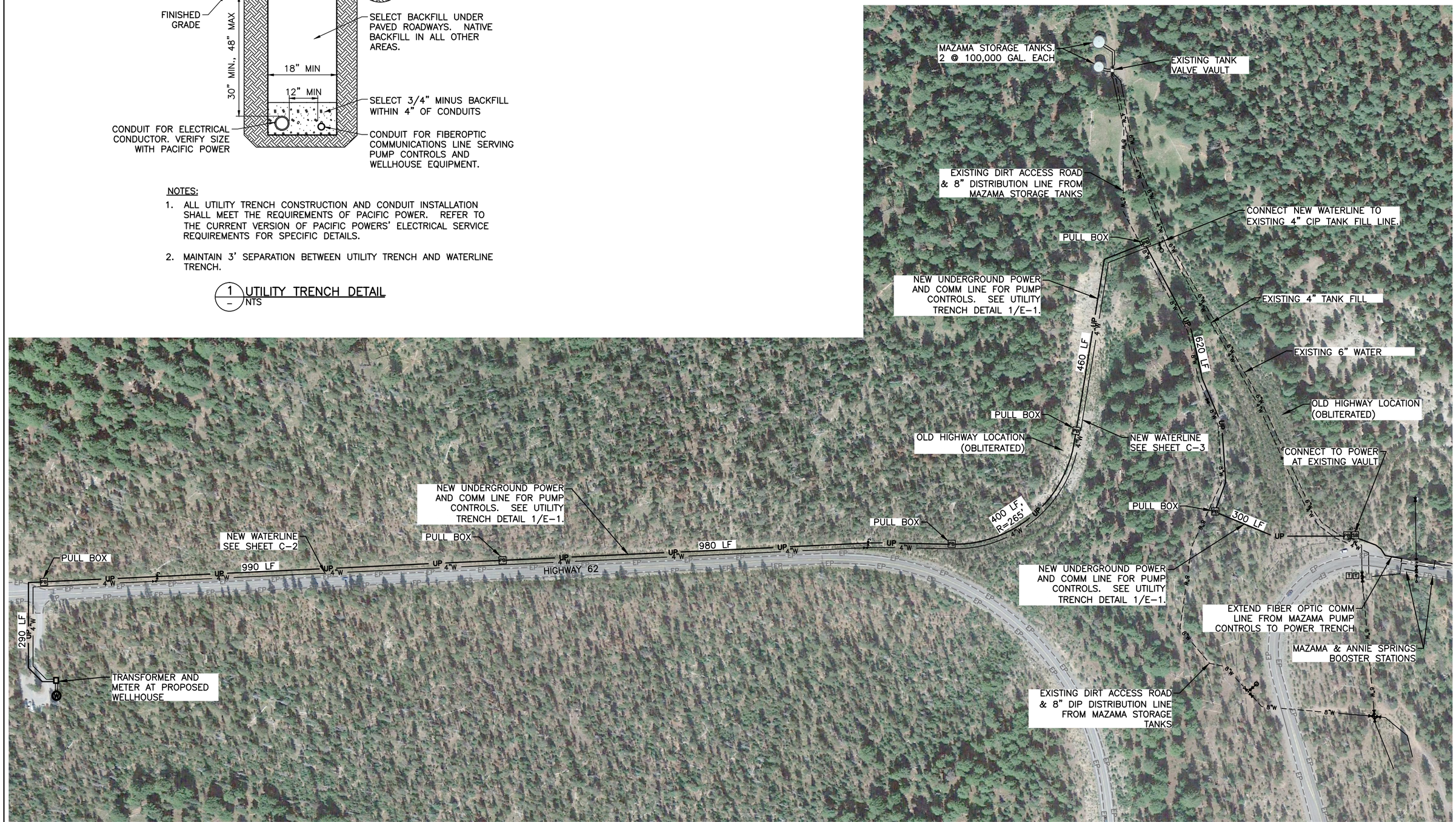
DESIGNED: BLW	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
CADD BLW	C-7	WATER DETAILS	XX / XX
TECH. REVIEW: DK			PMIS/PKG NO. 203499
DATE: 7/28/2014		CRATER LAKE NATIONAL PARK	SHEET 8 OF 9

Path: Y:\PROJECTS\958.0060\CRLA\PMIS203499\DRAWINGS\CI Filename: C-7 WATER DETAILS Plot date: Jul 28, 2014-03:50:54pm CAD User: BWilkinson.
Xref Filename: |

NOTES:

1. ALL UTILITY TRENCH CONSTRUCTION AND CONDUIT INSTALLATION SHALL MEET THE REQUIREMENTS OF PACIFIC POWER. REFER TO THE CURRENT VERSION OF PACIFIC POWERS' ELECTRICAL SERVICE REQUIREMENTS FOR SPECIFIC DETAILS.
2. MAINTAIN 3' SEPARATION BETWEEN UTILITY TRENCH AND WATERLINE TRENCH.

1 / – UTILITY TRENCH DETAIL
NTS



100 0 100 200
SCALE OF FEET

DESIGNED: BLW	SUB SHEET NO.	TITLE OF SHEET	DRAWING NO.
CADD BLW	E-1	ELECTRICAL SITE PLAN	3
TECH. REVIEW: DK			PMIS/PKG NO. 203499
DATE: 7/28/2014		CRATER LAKE NATIONAL PARK	SHEET 9 OF 9

Path: Y:\PROJECTS\958.0060\CRLA\PMIS203499\DRAWINGS\E Filename: E-1 ELECTRICAL SITE PLAN Plot date: Jul 28, 2014-04:05:02pm CAD User: BWilkinson.
Xref Filename: | XC-SITE |

Attachment F

Application for a Permit to Use Ground Water and Accompanying Map

Application for a Permit to Use

Ground Water

Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301-1266
(503) 986-0900
www.wrd.state.or.us

Water-Use Permit Application Processing

1. **Completeness Determination**

The Department evaluates whether the application and accompanying map contain all of the information required under OAR 690-310-0040 and OAR 690-310-0050 (www.oregon.gov/owrd/law). The Department also determines whether the proposed use is prohibited by statute. If the Department determines that the application is incomplete, all fees have not been paid, or the use is prohibited by statute, the application and all fees submitted are returned to the applicant.

2. Initial Review

The Department reviews the application to determine whether water is available during the period requested, whether the proposed use is restricted or limited by rule or statute, and whether other issues may preclude approval of or restrict the proposed use. An Initial Review (IR) containing preliminary determinations is mailed to the applicant. The applicant has 14 days from the mailing date to withdraw the application from further processing and receive a refund of all fees paid minus $200. The applicant may put the application on hold for up to 180 days and may request additional time if necessary.

3. Public Notice

Within 7 days of the mailing of the initial review, the Department gives public notice of the application in the weekly notice published by the Department at www.oregon.gov/owrd. The public comment period is 30 days from publication in the weekly notice.

4. Proposed Final Order Issued

The Department reviews any comments received, including comments from other state agencies related to the protection of sensitive, threatened or endangered fish species. Within 60 days of completion of the IR, the Department issues a Proposed Final Order (PFO) explaining the proposed decision to deny or approve the application. A PFO proposing approval of an application will include a draft permit, and may request additional information or outstanding fees required prior to permit issuance.

5. Public Notice

Within 7 days of issuing the PFO, the Department gives public notice in the weekly notice. Notice includes information about the application and the PFO. Protest must be received by the Department within 45 days after publication of the PFO in the weekly notice. Anyone may file a protest. The protest filing fee is $350.00 for the applicant and $700.00 for non-applicants. Protests are filed on approximately 10% of Proposed Final Orders. If a protest is filed, the Department will attempt to settle the protest but will schedule a contested case hearing if necessary.

6. Final Order Issued

If no protests are filed, the Department issues a Final Order consistent with the PFO. If the application is approved, a permit is issued that specifies the details of the authorized use and any terms, limitations or conditions that the Department deems appropriate.

Minimum Requirements Checklist

Minimum Requirements (OAR 690-310-0040, OAR 690-310-0050 & ORS 537.615)

Include this checklist with the application

Check that each of the following items is included. The application will be returned if all required items are not included. If you have questions, please call the Water Rights Customer Service Group at (503) 986-0900.

☒ SECTION 1: applicant information and signature

☒ SECTION 2: property ownership

☒ SECTION 3: well development

☒ SECTION 4: water use

☒ SECTION 5: water management

☒ SECTION 6: storage of groundwater in a reservoir

☒ SECTION 7: use of stored groundwater from the reservoir

☒ SECTION 8: project schedule

☒ SECTION 9: within a district

☒ SECTION 10: remarks

Attachments:

☒ Land Use Information Form with approval and signature (*must be an original*) or signed receipt

☒ Provide the legal description of: (1) the property from which the water is to be diverted, (2) any property crossed by the proposed ditch, canal or other work, and (3) any property on which the water is to be used as depicted on the map. Example: A copy of the deed, land sales contract or title insurance policy.

☒ Fees - Amount enclosed: $_____
See the Department's Fee Schedule at www.oregon.gov/owrd or call (503) 986-0900.

Provide a map and check that each of the following items is included:

☒ Permanent quality and drawn in ink

☒ Even map scale not less than 4" = 1 mile (example: 1" = 400 ft, 1" = 1320 ft, etc.)

☒ North Directional Symbol

☒ Township, Range, Section, Quarter/Quarter, Tax Lots

☒ Reference corner on map

☒ Location of each well, and/or dam if applicable, by reference to a recognized public land survey corner (distances north/south and east/west). Each well must be identified by a unique name and/or number.

☒ Indicate the area of use by Quarter/Quarter and tax lot clearly identified

☒ Number of acres per Quarter/Quarter and hatching to indicate area of use if for primary irrigation, supplemental irrigation, or nursery

☒ Location of main canals, ditches, pipelines or flumes (if well is outside of the area of use)

☐ Other _____

Application for a Permit to Use

Ground Water

Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301-1266
(503) 986-0900
www.wrd.state.or.us

SECTION 1: APPLICANT INFORMATION AND SIGNATURE

Applicant Information

NAME CRATER LAKE NATIONAL PARK				PHONE (HM)
PHONE (WK) (541) 594-3000	CELL			FAX
ADDRESS HIGHWAY 62				
CITY CRATER LAKE	STATE OR	ZIP 97604	E-MAIL*	

Organization Information

NAME US NATIONAL PARK SERVICE			PHONE	FAX
ADDRESS PACIFIC WEST REGIONAL OFFICE, 333 BUSH STREET, STE 500				CELL
CITY SAN FRANCISCO	STATE CA	ZIP 94104	E-MAIL*	

Agent Information – The agent is authorized to represent the applicant in all matters relating to this application.

AGENT / BUSINESS NAME			PHONE	FAX
ADDRESS				CELL
CITY	STATE	ZIP	E-MAIL*	

Note: Attach multiple copies as needed
* By providing an e-mail address, consent is given to receive all correspondence from the department electronically. (paper copies of the final order documents will also be mailed.)

By my signature below I confirm that I understand:

- I am asking to use water specifically as described in this application.
- Evaluation of this application will be based on information provided in the application.
- I cannot use water legally until the Water Resources Department issues a permit.
- Oregon law requires that a permit be issued before beginning construction of any proposed well, unless the use is exempt. Acceptance of this application does not guarantee a permit will be issued.
- If I get a permit, I must not waste water.
- If development of the water use is not according to the terms of the permit, the permit can be cancelled.
- The water use must be compatible with local comprehensive land-use plans.
- Even if the Department issues a permit, I may have to stop using water to allow senior water-right holders to get water to which they are entitled.

I (we) affirm that the information contained in this application is true and accurate.

Applicant Signature	Print Name *and title if applicable*	Date
Applicant Signature	Print Name *and title if applicable*	Date

For Department Use

App. No._____ Permit No. _____ Date_____

SECTION 2: PROPERTY OWNERSHIP

Please indicate if you own all the lands associated with the project from which the water is to be diverted, conveyed, and used.

☐ Yes
- ☐ There are no encumbrances.
- ☐ This land is encumbered by easements, rights of way, roads or other encumbrances.

☒ No
- ☐ I have a recorded easement or written authorization permitting access.
- ☐ I do not currently have written authorization or easement permitting access.
- ☐ Written authorization or an easement is not necessary, because the only affected lands I do not own are state-owned submersible lands, and this application is for irrigation and/or domestic use only (ORS 274.040).
- ☒ Water is to be diverted, conveyed, and/or used only on federal lands.

List the names and mailing addresses of all affected landowners *(attach additional sheets if necessary)*.

_____

You must provide the legal description of : 1. The property from which the water is to be diverted, 2. Any property crossed by the proposed ditch, canal or other work, and 3. Any property on which the water is to be used as depicted on the map.

SECTION 3: WELL DEVELOPMENT

		IF LESS THAN 1 MILE:	
WELL NO.	NAME OF NEAREST SURFACE WATER	DISTANCE TO NEAREST SURFACE WATER	ELEVATION CHANGE BETWEEN NEAREST SURFACE WATER AND WELL HEAD
L-110337	Annie Creek (Annie Spring)	Approx. 3,060 ft	6180' (at wellhead) - 6050' (at Annie Spring) = 130'
TBD	Annie Creek (Annie Spring)	Approx. 3,060 ft	6180' (at wellhead) - 6050' (at Annie Spring) = 130'

Please provide any information for your existing or proposed well(s) that you believe may be helpful in evaluating your application. For existing wells, describe any previous alteration(s) or repair(s) not documented in the attached well log or other materials *(attach additional sheets if necessary)*.
See Section 10.

SECTION 3: WELL DEVELOPMENT, CONTINUED

Total maximum rate requested: 0.13 cfs (each well will be evaluated at the maximum rate unless you indicate well-specific rates and annual volumes in the table below).

The table below must be completed for each source to be evaluated or the application will be returned. If this is an existing well, the information may be found on the applicable well log. *(If a well log is available, please submit it in addition to completing the table.)* If this is a proposed well, or well-modification, consider consulting with a licensed well driller, geologist, or certified water right examiner to obtain the necessary information.

										PROPOSED USE			
OWNER'S WELL NAME OR NO.	PROPOSED	EXISTING	WELL ID (WELL TAG) NO.* OR WELL LOG ID**	FLOWING ARTESIAN	CASING DIAMETER	CASING INTERVALS (IN FEET)	PERFORATED OR SCREENED INTERVALS (IN FEET)	SEAL INTERVALS (IN FEET)	MOST RECENT STATIC WATER LEVEL & DATE (IN FEET)	SOURCE AQUIFER***	TOTAL WELL DEPTH	WELL-SPECIFIC RATE (GPM)	ANNUAL VOLUME (ACRE-FEET)
	☐	☒	L-110337	☐	8 in casing 6 in liner	+3-93 ft 9-505 ft	400-420 ft, 440-500 ft (perf. liner)	0-48 ft, 48-65 ft, 65-95 ft	322 ft, 11/6/2013	Basalt, pumice, cinders	505 ft		
	☒	☐	TBD	☐	8 in casing 6 in liner	+2.5-500 ft 480-600ft	500-550 ft (perf. liner)	350-500 ft	N/A	Basalt, pumice, cinders	550 ft		
	☐	☐		☐									
	☐	☐		☐									
	☐	☐		☐									
	☐	☐		☐									
	☐	☐		☐									
	☐	☐		☐									

* Licensed drillers are required to attach a Department-supplied Well Tag, with a unique Well ID or Well Tag Number to all new or newly altered wells. Landowners can request a Well ID for existing wells that do not have one. The Well ID is intended to serve as a unique identification number for each well.

** A well log ID (e.g. MARI 1234) is assigned by the Department to each log in the agency's well log database. A separate well log is required for each subsequent alteration of the well.

*** Source aquifer examples: Troutdale Formation, gravel and sand, alluvium, basalt, bedrock, etc.

SECTION 4: WATER USE

USE	PERIOD OF USE	ANNUAL VOLUME (ACRE-FEET)
Domestic/Administrative	Year-round	50 ac-ft/yr (See Section 10)

Exempt Uses: Please note that 15,000 gallons per day for single or group **domestic** purposes and 5,000 gallons per day for a single **industrial or commercial** purpose are exempt from permitting requirements.

For irrigation use only:
Please indicate the number of primary and supplemental acres to be irrigated (*must match map*).

Primary: _____ Acres Supplemental: _____ Acres

List the Permit or Certificate number of the underlying primary water right(s): _____

Indicate the maximum total number of acre-feet you expect to use in an irrigation season: _____

- If the use is **municipal or quasi-municipal**, attach **Form M**
- If the use is **domestic**, indicate the number of households: All potable water uses within Mazama Village, Headquarters, and Rim Village areas of Crater Lake National Park

  If the use is **mining**, describe what is being mined and the method(s) of extraction: _____

SECTION 5: WATER MANAGEMENT

A. Diversion and Conveyance
What equipment will you use to pump water from your well(s)?

☒ Pump (give horsepower and type): 10 hp submersible pump

☐ Other means (describe): _____

Provide a description of the proposed means of diversion, construction, and operation of the diversion works and conveyance of water. See Section 10

B. Application Method
What equipment and method of application will be used? (e.g., drip, wheel line, high-pressure sprinkler)
N/A

C. Conservation
Please describe why the amount of water requested is needed and measures you propose to: prevent waste; measure the amount of water diverted; prevent damage to aquatic life and riparian habitat; prevent the discharge of contaminated water to a surface stream; prevent adverse impact to public uses of affected surface waters.
See Section 10

SECTION 6: STORAGE OF GROUND WATER IN A RESERVOIR

If you would like to store ground water in a reservoir, complete this section (*if more than one reservoir, reproduce this section for each reservoir).*

Reservoir name: _____ Acreage inundated by reservoir: _____

Use(s): _____

Volume of Reservoir (acre-feet): _____ Dam height (feet, if excavated, write "zero"): _____

***Note**: If the dam height is greater than or equal to 10.0' above land surface **AND** the reservoir will store 9.2 acre feet or more, engineered plans and specifications must be approved prior to storage of water.*

SECTION 7: USE OF STORED GROUND WATER FROM THE RESERVOIR

If you would like to use stored ground water from the reservoir, complete this section *(if more than one reservoir, reproduce this section for each reservoir).*

Annual volume (acre-feet): _____

USE OF STORED GROUND WATER	PERIOD OF USE

SECTION 8: PROJECT SCHEDULE

Date construction will begin: TBD

Date construction will be completed: TBD

Date beneficial water use will begin: TBD

SECTION 9: WITHIN A DISTRICT

☐ Check here if the point of diversion or place of use are located within or served by an irrigation or other water district.

Irrigation District Name	Address	
City	State	Zip

SECTION 10: REMARKS

Use this space to clarify any information you have provided in the application *(attach additional sheets if necessary).*

General Description:
The well(s) is(are) needed to provide the potable water supply for the Mazama Village, Park Service Headquarters, and Rim Village areas within Crater lake National Park in the event that diversion from the existing water source, Annie Creek, has been curtailed. The existing well was developed as a test well, but willl be further developed as a production well if OWRD approves this well as a viable water source during curtailment periods. If this well does not

provide sufficient protection from curtailment, a deeper well will be drilled at approximately the same location, in the parking area adjacent to Highway 62 near the Pacific Crest Trail. The second well will be cased to a depth of at least 500 feet to protect against interference with the surface water supply at Annie Creek. The water system has been designed such that the existing well (or the new, fully cased well) may be used in one of two ways: 1) as a production well only or 2) IN CONJUNCTION WITH THE EXISTING Annie Creek source for Aquifer Storage and Recovery (ASR).

Section 3:
The existing well, L-110337, was initially developed as a test well, but will be further developed as a production well. A deeper well at approximately the same location is contemplated to protect against future curtailment. Due to its proximity to the existing well, the characteristics of the new well are expected to be very similar to those of the existing well.
Total Maximum Rate - the total maximum rate for domestic and administrative uses, 0.13 cfs, is based on measurement data from 2013 and a peak design flow of 50 gpm, with a 20% buffer applied to account for increased visitor traffic. An additional 1.0 cfs is requested for fire protection.

Section 4:
Annual Volume - with a maximum diversion rate of 0.13 cfs, excluding the use for fire protection, the potential annual volume is 94.1 ac-ft/yr, but the NPS doesn't reasonably anticipate exceeding an annual volume of 50 ac-ft/yr.

Section 5:
A. Water will be diverted from the production well, through a system of 4 to 6 inch pipes, booster stations, and storage tanks to distribution lines. See accompanying diagram for details.
C. A flow meter will be installed at the well outlet. Diversions from the well and into the water treatment facility will be continuously measured. Conservation efforts have included installation of water-conserving plumbing fixtures and water meters, and informational signs encouraging conservation among Park guests.

Land Use Information Form

Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301-1266
(503) 986-0900
www.wrd.state.or.us

NOTE TO APPLICANTS

In order for your application to be processed by the Water Resources Department (WRD), this Land Use Information Form must be completed by a local government planning official in the jurisdiction(s) where your water right will be used and developed. The planning official may choose to complete the form while you wait, or return the receipt stub to you. Applications received by WRD without the Land Use Form or the receipt stub will be returned to you. Please be aware that your application will not be approved without land use approval.

This form is NOT required if:

1) Water is to be diverted, conveyed, and/or used only on federal lands; **OR**

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

NOTE TO LOCAL GOVERNMENTS

The person presenting the attached Land Use Information Form is applying for or modifying a water right. The Water Resources Department (WRD) requires its applicants to obtain land-use information to be sure the water rights do not result in land uses that are incompatible with your comprehensive plan. Please complete the form or detach the receipt stub and return it to the applicant for inclusion in their water right application. You will receive notice once the applicant formally submits his or her request to the WRD. The notice will give more information about WRD's water rights process and provide additional comment opportunities. You will have 30 days from the date of the notice to complete the land-use form and return it to the WRD. If no land-use information is received from you within that 30-day period, the WRD may presume the land use associated with the proposed water right is compatible with your comprehensive plan. Your attention to this request for information is greatly appreciated by the Water Resources Department. If you have any questions concerning this form, please contact the WRD's Customer Service Group at 503-986-0801.

Land Use Information Form

N/A

Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301-1266
(503) 986-0900
www.wrd.state.or.us

Applicant: _____ _____
First Last

Mailing Address: _____

_____ _____ _____ Daytime Phone: _____
City State Zip

A. Land and Location

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

Township	Range	Section	¼ ¼	Tax Lot #	Plan Designation (e.g., Rural Residential/RR-5)	Water to be:			Proposed Land Use:
						☐ Diverted	☐ Conveyed	☐ Used	
						☐ Diverted	☐ Conveyed	☐ Used	
						☐ Diverted	☐ Conveyed	☐ Used	
						☐ Diverted	☐ Conveyed	☐ Used	

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

B. Description of Proposed Use

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

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

Source of water: ☐ Reservoir/Pond ☐ Ground Water ☐ Surface Water (name) _____

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

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

Briefly describe:

Note to applicant: If the Land Use Information Form cannot be completed while you wait, please have a local government representative sign the receipt at the bottom of the next page and include it with the application filed with the Water Resources Department.

See bottom of Page 3. →

For Local Government Use Only

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

Please check the appropriate box below and provide the requested information

☐ Land uses to be served by the proposed water uses (including proposed construction) are allowed outright or are not regulated by your comprehensive plan. Cite applicable ordinance section(s): _____.

☐ Land uses to be served by the proposed water uses (including proposed construction) involve discretionary land-use approvals as listed in the table below. (Please attach documentation of applicable land-use approvals which have already been obtained. Record of Action/land-use decision and accompanying findings are sufficient.) **If approvals have been obtained but all appeal periods have not ended, check "Being pursued."**

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

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

Name: _____ Title: _____

Signature: _____ Phone: _____ Date: _____

Government Entity: _____

Note to local government representative: Please complete this form or sign the receipt below and return it to the applicant. If you sign the receipt, you will have 30 days from the Water Resources Department's notice date to return the completed Land Use Information Form or WRD may presume the land use associated with the proposed use of water is compatible with local comprehensive plans.

Receipt for Request for Land Use Information

Applicant name: _____

City or County: _____ Staff contact: _____

Signature: _____ Phone: _____ Date: _____

Date _____

(For staff use only)

Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem, Oregon 97301-1266
(503) 986-0900
www.wrd.state.or.us

WE ARE RETURNING YOUR APPLICATION FOR THE FOLLOWING REASON(S):

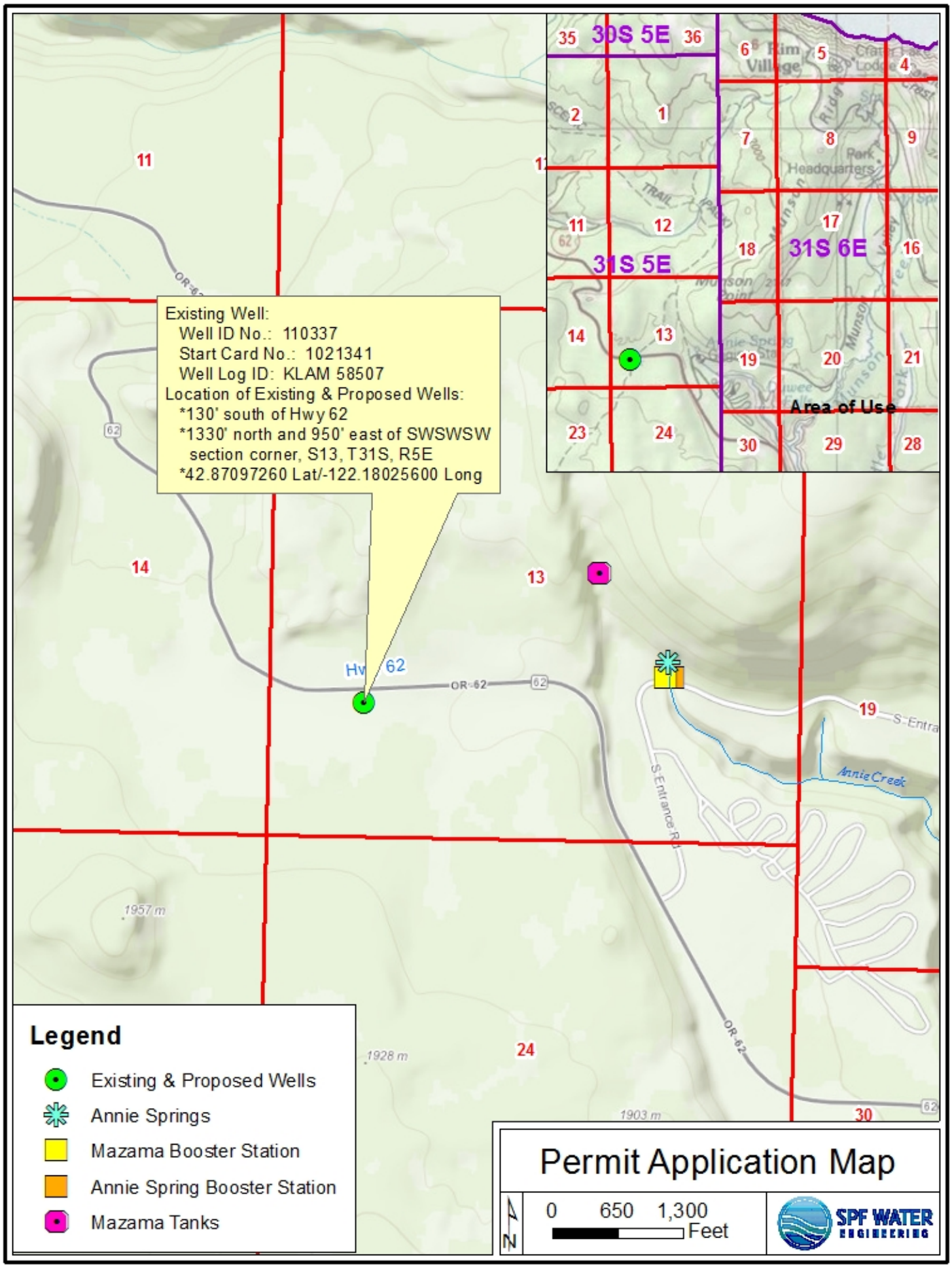
- ☐ SECTION 1: _____
- ☐ SECTION 2: _____
- ☐ SECTION 3: _____
- ☐ SECTION 4: _____
- ☐ SECTION 5: _____
- ☐ SECTION 6: _____
- ☐ SECTION 7: _____
- ☐ SECTION 8: _____
- ☐ SECTION 9: _____
- ☐ Land Use Information Form _____
- ☐ Provide the legal description of: (1) the property from which the water is to be diverted, (2) any property crossed by the proposed ditch, canal or other work, and (3) any property on which the water is to be used as depicted on the map.
- ☐ Fees _____

MAP

- ☐ Permanent quality and drawn in ink
- ☐ Even map scale not less than 4" = 1 mile (example: 1" = 400 ft, 1" = 1320 ft, etc.)
- ☐ North Directional Symbol
- ☐ Township, Range, Section, Quarter/Quarter, Tax Lots
- ☐ Reference corner on map
- ☐ Location of each well, and/or dam if applicable, by reference to a recognized public land survey corner (distances north/south and east/west). Each well must be identified by a unique name and/or number.
- ☐ Indicate the area of use by Quarter/Quarter and tax lot clearly identified
- ☐ Number of acres per Quarter/Quarter and hatching to indicate area of use if for primary irrigation, supplemental irrigation, or nursery
- ☐ Location of main canals, ditches, pipelines or flumes (if well is outside of the area of use)
- ☐ Other _____

_____

_____


Existing Well:
Well ID No.: 110337
Start Card No.: 1021341
Well Log ID: KLAM 58507
Location of Existing & Proposed Wells:
*130' south of Hwy 62
*1330' north and 950' east of SWSWSW section corner, S13, T31S, R5E
*42.87097260 Lat/-122.18025600 Long
30S 5E
31S 5E
31S 6E
Area of Use
Hwy 62
OR-62
S Entrance Rd
Annie Creek
Legend
Existing & Proposed Wells
Annie Springs
Mazama Booster Station
Annie Spring Booster Station
Mazama Tanks
Permit Application Map
0 650 1,300
Feet
N
SPF WATER ENGINEERING

Attachment G

State of Oregon Rules and Statutes Regarding ASR and AR

State of Oregon Rules & Statutes Regarding ASR and AR

Oregon Administrative Rules 690-350

AQUIFER STORAGE AND RECOVERY (ASR) AND

ARTIFICIAL GROUNDWATER RECHARGE

Aquifer Storage and Recovery (ASR)

690-350-0010

ASR General Provisions

(1) Definitions. The following definitions apply to aquifer storage and recovery in OAR Chapter 690, Division 350, Rules 0010 to 0030:

(a) "Aquifer Storage and Recovery" (ASR) means the storage of water from a separate source that meets drinking water standards in a suitable aquifer for later recovery and not having as one of its primary purposes the restoration of the aquifer (ORS 537.531). (Applications to obtain limited licenses or permits for ASR uses submitted pursuant to OAR 690-350-0010 to 690-350-0030 are not subject to provisions governing artificial groundwater recharge projects or programs pursuant to OAR 690-350-0110 to 690-350-0130.)

(b) "Commission" means the Water Resources Commission.

(c) "Department" means the Water Resources Department.

(d) "DEQ" means the Department of Environmental Quality.

(e) "Director" means the Water Resources Director.

(f) "HD" means the Oregon Health Division.

(g) "Injection Source Water" means the water which may be injected under terms of an ASR limited license or permit.

(h) "Receiving Aquifer" means the aquifer into which water may be injected under terms of an ASR limited license or permit.

(i) "Recovered Water" means water which is recovered from storage under terms of an ASR limited license or permit.

(j) "Stored Water" means water which is stored in a receiving aquifer under terms of an ASR limited license or permit.

(2) Limited License for ASR Testing. The use of water for ASR testing purposes requires a limited license pursuant to ORS 537.534. A limited license pursuant toORS 537.143 does not apply. Only after completion of an ASR testing program under a limited license may an applicant apply for a permanent ASR permit. A limited license application may propose ASR testing for a single well or same-aquifer wells in a wellfield. The limited license may allow for a beneficial use of the recovered water. If the limited license is based on a water right for injection source water, the limited license shall require the same use as the water right, but may allow a rate of injection which is no greater than that of the water right and a rate of recovery which is greater than that of the water right.

(3) Inherent to Water Rights. ASR is a beneficial use inherent in all water rights for other beneficial uses (ORS 537.531). Applicable water rights are either permits or certificates. ASR use under this inherent nature is accessed temporarily under an ASR limited license or permanently through an ASR permit. The use of water under a water right as injection source water for an ASR project up to the limits allowed in the ASR permit neither affects the priority date of the water right, nor changes the use permitted upon its recovery from the use permitted by the water right for injection source water, nor otherwise affects the water right. ASR permits may allow rates of injection which are no greater than those of the water right for injection source water and rates of recovery which are greater than those of the water right for injection source water.

(4) Separate Processes for Water Right and ASR Permit. An ASR permit does not allow an appropriation of water but does allow ASR to occur with a water right. The water right application process rules in OAR Chapter 690, Division 310 do not apply to ASR application processing. The public interest review standards for an ASR permit shall apply only to the matters raised by the ASR application, not to the water right for the injection source water. An ASR permit may allow ASR storage through a single well or same-aquifer wells in a wellfield. If a new water right is needed as part of the ASR project, the new water right application shall be subject to the same standards as any new water right application.

(5) Use Described by Water Right. The use of recovered water under an ASR permit shall be the same as the use described by the water right permit or certificate for injection source water. The holder of a permit for ASR shall apply for a transfer under procedures set out in OAR 690-015 if the use of recovered ASR water is different from that which is allowed in the water right permit or certificate for the injection source water.

(6) Water Quality. Water quality is a major consideration in ASR activities and all of the following provisions apply:

(a) Injection source water for ASR shall comply with drinking water standards, treatment requirements, and performance standards established by the HD under OAR 333-061-0030 and 0032 (ORS 448.131 and .273) or the maximum measurable levels established by the Environmental Quality Commission under OAR 340-040 (ORS 468B.165), whichever are more stringent. The injection of such water into aquifers under an ASR limited license or permit shall be exempt from the requirement to obtain a discharge permit under ORS 468B.050 or a concentration limit variance from the DEQ;

(b) Conditions shall be placed on the limited license or permit to minimize, to the extent technically feasible, practical and cost-effective, the concentration of constituents in the injection source water that are not naturally present in the aquifer;

(c) No limited license or permit may establish concentration limits for water to be injected in excess of standards established by HD or the maximum measurable levels established by the Environmental Quality Commission under OAR 340-040 (ORS 468B.165), whichever are more stringent;

(d) Except as otherwise provided in (6)(e) of this rule, if the injection source water contains constituents regulated under OAR 333-061-0030 (ORS 448.131 and .273) or OAR 340-040 (ORS 468B.165) that are detected at greater than 50 percent of the established levels, the ASR limited license or permit may require the permittee to employ technically feasible, practical and cost-effective methods to minimize concentrations of such constituents in the injection source water;

(e) Constituents that have a secondary contaminant level or costituents that are associated with disinfection of the water may be injected into the aquifer up to the standards established under OAR 333-061-0030 (ORS 448.131 and 448.273);

(f) The Department may, based upon valid scientific data, further restrict certain constituents in the injection source water if the Department finds the constituents will interfere with or pose a threat to the maintenance of the water resources of the state for present or future beneficial uses.

(7) Oversight of ASR Projects. The Department is the sole licensing and permitting agency for ASR projects. However, other state agencies and local governments have a role as follows:

(a) The Department shall seek DEQ and HD assistance in the administration of the ASR program, including recommending conditions to be included in the limited license and permit;

(b) ASR activities under a limited license or permit are subject to conformance with land use laws and may be located within or outside an urban growth boundary;

(c) The disposal of recovered ASR testing water may require discharge authorization from DEQ. All applicants should investigate this possibility;

(d) Applicants that are public water systems as defined by the HD (OAR 333-061-0020(68)) shall comply with the HD's construction standards (OAR 333-061-0050) and plan submission and review requirements (OAR 333-061-0060).

(8) Percent Recovery of Stored Water. In addition to other conditions, the limited license or permit shall specify the amount of stored water that may be recovered. The Department may allow up to 100 percent of the stored water to be recovered if data analysis demonstrates that the injected source water is not lost through migration or other means and that groundwater otherwise present in the aquifer has not been irretrievably lost as a result of ASR.

(9) Appeal of Administrative Action. Any order of the Director related to ASR limited licenses is subject to administrative reconsideration as provided in the Administrative Procedures Act (ORS Chapter 183) and judicial review as provided in ORS 536.075. Orders of the Director related to ASR permits are subject to administrative reconsideration as provided in the Administrative Procedures Act (ORS Chapter 183) and judicial review as provided in ORS 536.075.

(10) Groundwater Protection. To reduce the potential for contamination of stored water, ASR operators are encouraged to consider the protection of their groundwater supply through the development of a Wellhead Protection plan or other appropriate groundwater protection plan.

Stat. Auth.: ORS 536.027 & ORS 537.534
Stats. Implemented: ORS 537.531 - ORS 537.534
Hist.: WRD 2-1996, f. & cert. ef. 2-12-96

690-350-0020

ASR Testing Under Limited License

(1) Testing Purposes. To store and use water injected into an aquifer for aquifer storage and recovery testing purposes requires a limited license. Only after completion of an ASR testing program under a limited license may an applicant apply for a permanent ASR permit. The testing approach shall be designed

to provide information as needed to evaluate the ultimate capacity anticipated for the project. The limited license may allow for a bene-ficial use(s) of the recovered water.

(2) Pre-application Conference. The Department requires at least one pre-application conference with a prospective licensee prior to filing an application requesting the right to use water under a limited license for ASR testing. The purpose of the conference is to describe and discuss the processes and requirements which the Department associates with water storage and recovery in the ASR Program. The conference may serve as a point of review for the apparent adequacy of the applicant's hydrogeologic and other information. The Department shall invite personnel from both the DEQ and HD to the conference.

(3) Limited License Application. A request for a limited license for a period of up to five years shall be submitted on a form provided by the Department. The application shall consist of the following:

(a) Information on, and Attachments to, the Form:

(A) Name, address, and telephone number of the applicant;

(B) The proposed source for injection water, maximum diversion rate, maximum injection rate at each well(s), maximum storage volume, maximum storage duration, and maximum withdrawal rate at each well(s);

(C) License Duration. The term or duration for which the limited license is sought;

(D) Proposed Use or Disposal of Recovered Water. The proposed beneficial use or the intended disposal method for the recovered water. In the event of contingencies which preclude the beneficial use, the application should propose an alternate use or disposal. If an existing water right is cited in the application for the injection source water, the use of the recovered water shall be the same as that allowed under the existing water right;

(E) Ultimate Project Size. The ultimate capacity anticipated for the final project to be tested including the proposed source for injection water, maximum diversion rate, maximum injection rate at each well(s), maximum storage volume, maximum storage duration, and maximum withdrawal rate at each well(s);

(F) Water Availability or Water Right Statement. Access to water shall be evidenced by a completed water availability statement from the local watermaster on forms provided by the Department, results from the Department's water availability model or citation of the existing water right (permit or certificate) which is available for use in ASR testing under the limited license;

(G) Water Right Holder Agreement. If the applicant is not the holder of the water right for the proposed ASR testing as may be cited in (F) above, a statement from the water right holder shall indicate permission for use of the water for ASR testing;

(H) Legal Land Use. Evidence that land use and development approval from a local government is sought, obtained, or unnecessary;

(I) Map. A site map of reproducible quality, drawn to a standard, even scale of not less than 2 inches = 1 mile, showing:

(i) The locations of all proposed points of diversion, injection wells, recovery wells, and observation wells for the limited license and the final project referenced by coordinates or by bearing and distance to the nearest established or projected public land survey corner;

(ii) The general stream course of the source for the proposed use, if applicable;

(iii) Other topographical features such as roads, streams, railroads, etc., which may be helpful in locating the diversion points in the field.

(J) Applicants that are public supply systems as defined by the Health Division (OAR 333-061-0020(68)) shall acknowledge the need to comply with the Health Division's plan submission and review requirements (OAR 333-061-0060);

(K) Other Information. The applicant shall provide any other information the Department believes necessary to evaluate the ASR testing.

(b) Supplemental Reports:

(A) Proposed ASR Test Program. The proposed testing program shall include injection rates and schedules, water storage volumes, the injected water storage durations, recovery rates and schedule, water quality sampling including a quality assurance and quality control plan, water level monitoring including location of observation wells, contingency plan for use of recovered water if the intended use not possible, information on the anticipated final project (scope and conceptual design), and testing report outline. (A licensed professional will be required to develop this information as required by Oregon Law);

(B) Proposed System Design. The proposed system design package shall include well construction information for any injection, recovery, observation and source wells, the wellhead assembly, piping system for injection and recovery, and other conceptual design components of the system. (A licensed professional will be required to develop this information as required by Oregon Law);

(C) Groundwater Information. Preliminary hydrogeologic information shall include the local geology, a conceptual hydrogeologic model, a description of the aquifer targeted for storage, estimated flow direction and rate of movement, allocation of surface water, springs or wells within the area affected by ASR wells, rationale for estimating the affected area, anticipated changes to the groundwater system due to the proposed ASR testing, potential natural resource problems of testing, and other information on groundwater and surface water conditions antecedent to ASR for basing recovery estimations. (A licensed professional will be required to develop this information as required by Oregon law. (ORS 672.505-705));

(D) Quality of Source Water. The applicant shall provide information regarding the quality and treatment of the proposed injection source water relevant to the proposed injection time of year for:

(i) Regulated constituents with maximum contaminant levels under OAR 333-061-0030 (test results from a laboratory approved by the HD (OAR 333-061-0036));

(ii) Unregulated constituents under OAR 333-061-0036 (test results from a laboratory approved by the HD (OAR 333-061-0036));

(iii) Constituents with maximum measurable levels established under OAR 340-040 (ORS 468B.165) (test results from a laboratory approved by the HD (OAR 333-061-0036));

(iv) Compliance with treatment requirements and performance standards for source waters that fall in categories identified in OAR 333-061-0032;

(v) Common ion constituents and water quality parameters to include: alkalinity or bicarbonate, calcium, magnesium, iron, manganese, sodium, potassium, chloride, sulfate, silica, total dissolved solids, pH, redox potential and temperature;

(vi) Other constituents as required by the Department.

(E) Comments on Source Water/Standards. The applicant shall address the following situations as they apply:

(i) If a constituent that is regulated under OAR 333-061-0030 (ORS 448.131 and 448.273) or OAR 340-040 (ORS 468B.165) is detected in the source water, the applicant shall demonstrate that there are not other sources of water available to the applicant which would be satisfactory for injection and lower in the constituent of concern;

(ii) If a constituent is detected in the source water above 50% of the levels established under OAR 333-061-0030 (ORS 448.131 and 448.273) or OAR 340-040 (ORS 468B.165), the applicant shall install a treatment method, system or other alternative method to reduce the constituent to less than 50% of those levels, unless the applicant can show that there is not a treatment method, system or other alternative method that will reduce the level of a contaminant below the 50% level, or the lesser of:

(I) The applicant can show that it would be more costly to provide the treatment method, system or other alternative method necessary than to obtain the same amount of stored water from the next cheapest feasible water supply alternative; or

(II) In the case of a drinking water system the applicant can show the cost of adding the treatment method, system or other alternative method increases the cost per household of providing water (including operation, maintenance, and debt service for prior water projects) above 1.5% of the median household income of the community.

(iii) Notwithstanding paragraph (3)(b)(E)(ii) of this rule, in the event the applicant cannot reduce a constituent to less than the 50% level, the applicant shall minimize the constituent level by providing the level of treatment available or other alternative method which for the same amount of stored water is not as costly as either the next cheapest water supply alternative or an amount equal to that necessary to increase the cost per household of providing water to 1.5% of the median household income of the community, whichever is less;

(iv) Notwithstanding the provisions of paragraphs (3)(b)(E)(i), (ii) and (iii) of this rule and after consulting with the DEQ and the HD, the Department may determine that the circumstances are such that an alternative source, treatment method, system, or other alternative method is acceptable or not necessary.

(F) Quality of Receiving Aquifer Water. The applicant shall provide information regarding the quality of the receiving aquifer water for:

(i) Regulated constituents with maximum contaminant levels under OAR 333-061-0030 (test results from a laboratory approved by the HD (OAR 333-061-0036));

(ii) Unregulated constituents under OAR 333-061-0036 (test results from a laboratory approved by the HD (OAR 333-061-0036));

(iii) Constituents with maximum measurable levels established under OAR 340-040 (ORS 468B.165) (test results from a laboratory approved by the HD (OAR 333-061-0036));

(iv) Common ion constituents and water quality parameters to include: alkalinity or bicarbonate, calcium, magnesium, iron, manganese, sodium, potassium, chloride, sulfate, silica, total dissolved solids, pH, redox potential and temperature;

(v) Other constituents as required by the Department.

(G) Comments on Compatibility. The applicant shall evaluate the compatibility of the injection source water and receiving aquifer water for possible changes in aquifer characteristics due to hydrogeologic or hydrogeochemical changes.

(c) Other Information. Any other information required by the Department.

(4) Limited License Application Processing:

(a) Review of Application for Completeness. Within 45 days after an individual submits or resubmits an application, the Department shall consult with DEQ and HD about the completeness of the application, determine the completeness of the application, and either:

(A) Notify the applicant that it is complete for purposes of evaluation; or

(B) Notify the applicant of what additional information is required before the application is resubmitted.

(b) Public Notice/Comment Period. Within 7 days after determining that an application is complete, the Department shall provide public notice of the request to the public in the same manner as is used for other water use applications. The appearance in the public notice commences a 30-day public comment period for the application. The Department may require additional information from the applicant pursuant to its own concerns and those raised by the public comments;

(c) DEQ and HD Assistance. The Department shall rely on the DEQ and the HD to comment on and recommend conditions for the limited license and shall provide the public notice and a copy of the complete application to those agencies at the opening of the comment period;

(d) Director's Action on the Application. The Director shall consider comments and recommendations received during the public comment period, and shall:

(A) Issue the license with proper conditions upon finding that:

(i) The proposed ASR testing will not impair or be detrimental to the public interest;

(ii) The proposed ASR testing will produce information that will adequately describe the water quality and quantity response in the aquifer and at nearby wells and springs due to ASR activities; and

(iii) Upon written request from the applicant for minor adjustments to the authorization in the limited license.

(B) The Director may revoke or modify the ASR limited license for any of the following reasons:

(i) To prevent or mitigate injury to other water rights, minimum perennial streamflows or aquifer water quality; or

(ii) To address any other unintended, injurious effects of the ASR activity.

(C) The Department may offer an additional public comment opportunity consistent with the notice and comment provisions of this rule prior to modifying the limited license.

(g) Priority/Protection. A limited license does not receive a priority date and is not protected under ORS 540.045;

(h) Compliance with Other Laws. The injection of acceptable water into an aquifer(s) under the limited license shall comply with all applicable local, state or federal laws;

(i) Water Quality Conditions:

(A) The limited license shall include conditions to minimize, to the extent technically feasible, practical and cost-effective, the concentration of constituents in the injection source water that are not naturally present in the aquifer;

(B) Except as otherwise provided in (5)(i)(C) of this rule, if the injection source water contains constituents regulated under OAR 333-061-0030 (ORS 448.131 and 448.273) or OAR 340-040 (ORS 468B.165) that are detected at greater than 50 percent of the established levels, the aquifer storage and recovery limited license may require the licensee to employ technically feasible, practical and cost-effective methods to minimize concentrations of such

constituents in the injection source water. The Department, in consultation with DEQ and HD, may set specific limits between 50 and 100% of the established level for constituents regulated under OAR 333-061-0030 (ORS 448.131 and 448.273) or OAR 340-040 (ORS 468B.165) as provided by the standards in paragraph (3)(b)(E) of this rule;

(C) Constituents that have a secondary contaminant level or constituents that are associated with disinfection of the water may be injected into the aquifer up to the standards established under OAR 333-061-0030 (ORS 448.131 and 448.273);

(D) The Department may, based upon valid scientific data, further limit certain constituents in the injection source water if the Department finds that those constituents will interfere with or pose a threat to the maintenance of the water resources of the state for present or future beneficial uses;

(E) The licensee shall be in compliance with treatment requirements and performance standards for source waters identified in OAR 333-061-0032;

(F) If during the course of ASR testing a constituent which is regulated under OAR 333-061-0030 (ORS 448.131 and 448.273) or OAR 340-040 (ORS 468B.165) is detected above the level prescribed in the limited license, the licensee shall stop injection activities and notify the Department.

(j) Monitoring/Sampling/Recovery/Reporting. The limited license shall include conditions for reporting and monitoring the ASR project aquifer impacts and for constituents reasonably expected to be found in the injection source water. The Department may attach conditions to the limited license regarding sampling and rates of recovery up to 100 percent of the injection quantity. (Data collected under these provisions may be useful in consideration of modifications to the limited license);

(k) Protection for Existing Users. The limited license shall be conditioned to protect existing water rights and the water quality of existing users that rely upon the receiving aquifer and the injection source water;

(l) Use of Recovered Water. If the limited license proposes to recover water injected under an existing water right, the use of the recovered water shall be for the use cited in the water right. If the limited license is not predicated on an existing water right, the limited license may authorize a use(s) for the recovered water;

(m) Other Conditions. The limited license may contain any other conditions required by the Department to protect the public welfare, health, and safety.

Stat. Auth.: ORS 536.027 & ORS 537.534
Stats. Implemented: ORS 537.531 - ORS 537.534
Hist.: WRD 2-1996, f. & cert. ef. 2-12-96

690-350-0030

ASR Under ASR Permit

(1) ASR Permit Required. On-going authorization to store and recover water injected into an aquifer requires an ASR permit. Only after completion of an ASR testing program under a limited license may an applicant apply for a permanent ASR permit.

(2) Water Right before ASR Permit. A person shall possess a water right or have a water right holder agreement which allows use of a water right for the injection source water before applying for an ASR permit. This water right shall be either a permit or certificate.

(3) Pre-application Conference. The Department requires at least one pre-application conference with a prospective permittee prior to filing an ASR permit application. The purpose of the conference is to discuss the ASR testing results, information needed for the application, and possible constraints on a project. The conference may serve as a point of review for the apparent adequacy of the applicant's hydrogeologic and other information. The Department shall invite personnel from both the DEQ and HD to the conference.

(4) Permit Application. A request for an ASR permit shall be submitted on a form provided by the Department. The application shall consist of the following:

(a) Information on, and Attachments to, the Form:

(A) Name, address and telephone number of the applicant;

(B) The proposed source for injection water, maximum diversion rate, maximum injection rate at each well(s), maximum storage volume, maximum storage duration, and maximum withdrawal rate at each well(s);

(C) Identification of Water Right for Injection Source Water. The water right(s) for which the ASR permit is sought;

(D) Water Right Holder Agreement. If the applicant is not the holder of the water right for the proposed ASR project as cited in paragraph (C) of this subsection, a statement from the water right holder shall indicate permission for use of the water for ASR;

(E) Limited License(s) Used for Testing. The limited license which was issued to perform the ASR testing necessary for this application;

(F) Legal Land Use. Evidence that land use and development approval from a local government is obtained or unnecessary;

(G) Map. The map submitted with the ASR application shall be prepared by a certified water right examiner and meet the following criteria:

(i) The application map, which is made part of the record, shall be of permanent quality and drawn with sufficient clarity so as to be easily reproduced;

(ii) The map shall be drawn on vellum or mylar except that maps measuring 11" x 17" or smaller may be prepared on good-quality paper. The map shall be drawn to a standard, even scale of not less than 4 inches = 1 mile. A small area map may be more easily and clearly drawn to a larger scale, such as 1 inch = 400 feet;

(iii) The map shall show clearly the location of each injection source water diversion point, or well, by reference to a recognized public land survey corner. The locations may be shown by distance and bearing or by coordinates (distance north or south and distance east and west from the corner);

(iv) The map shall show clearly the location of main canals, ditches, pipelines, or flumes which are used to transport injection source water to the injection well(s);

(v) The map shall show clearly the location of the well(s) where water is to be injected;

(vi) The map shall show clearly the location of the well(s) where water is to be recovered;

(vii) The map shall show clearly the location of observation well(s);

(viii) The map shall show clearly other topographical features such as roads, streams, railroads, etc., which may be helpful in locating the diversion points in the field; and

(ix) The map shall show clearly the scale to which the map is drawn, the section number, township, and range, and a North directional symbol.

(H) Applicants that are public supply systems as defined by the Health Division (OAR 333-061-0020(68)) shall acknowledge the need to comply with the Health Division's plan submission and review requirements (OAR 333-061-0060);

(I) Other Information. Any other information required by the Department.

(b) Supplemental Reports:

(A) Proposed ASR Operations. A detailed description of proposed ASR operations shall include a description of the proposed manner of ASR operations including injection rates specific to each well, water storage volumes, injected water storage durations, recovery rates at each well, water level monitoring including a quality assurance and quality control plan, water quality sampling, contingency plan for use of recovered water if the intended use isn't possible and reporting. (A licensed professional will be required to develop this information as required by Oregon Law);

(B) Proposed System Design. The proposed system design package shall include well construction information for any injection, recovery, observation and source wells, the wellhead assembly, piping system for injection and recovery, and other conceptual design components of the system. (A licensed professional will be required to develop this information as required by Oregon Law;

(C) Test Report. The results of testing under the limited license, including:

(i) Quality of Injection Source Water. Test results of the quality of the injection source water as required in the test plan proposal under the limited license;

(ii) Quality of Receiving Aquifer Water. Test results of the quality of the aquifer water as required in the test plan proposal under the limited license;

(iii) Quality of Recovered Water. Test results of the quality of the recovered aquifer water as required under the limited license;

(iv) Groundwater Information. Hydrogeologic information shall include the local geology, a conceptual hydrogeologic model, a description of the aquifer targeted for storage, estimated flow direction and rate of movement, allocation of surface water, springs or wells within the area affected by ASR wells, rationale for estimating the affected area, anticipated changes to the groundwater system due to the proposed ASR project, potential natural resource problems of testing, and other information on groundwater and surface water conditions for basing recovery estimations. (A licensed professional will be required to develop this information as required by Oregon law. (ORS 672.505 - 705));

(D) Comments on Source Water/Standards. The applicant shall address the following situations as they apply:

(i) If a constituent that is regulated under OAR 333-061-0030 (ORS 448.131 and 448.273) or OAR 340-040 (ORS 468B.165) is detected in the source water, the applicant shall demonstrate that there are not other sources of water available to the applicant which would be satisfactory for injection and lower in the constituent of concern. Other sources are limited to those for which the applicant has water rights;

(ii) If a constituent is detected in the source water above 50% of the levels established under OAR 333-061-0030 (ORS 448.131 and 448.273) or OAR 340-040 (ORS 468B.165), the applicant shall install a treatment method, system or other alternative method to reduce the constituent to less than 50% of those levels, unless the applicant can show that there is not a treatment method, system or other alternative method that will reduce the level of a contaminant below the 50% level, or the lesser of:

(I) The applicant can show that it would be more costly to provide the treatment method, system or other alternative method necessary than to obtain the same amount of stored water from the next cheapest feasible water supply alternative; or

(II) In the case of a drinking water system the applicant can show the cost of adding the treatment method, system or other alternative method increases the cost per household of providing water (including operation, maintenance, and debt service for prior water projects) above 1.5% of the median household income of the community.

(iii) Notwithstanding paragraph (4)(b)(D)(ii) of this rule, in the event the applicant cannot reduce a constituent to less than the 50% level, the applicant shall minimize the constituent level by providing the level of treatment available or other alternative method which for the same amount of stored water is not as costly as either the next cheapest water supply alternative or an amount equal to that necessary to increase the cost per household of providing water to 1.5% of the median household income of the community, whichever is less;

(iv) Notwithstanding the provisions of paragraph (4)(b)(D)(i), (ii), and (iii) of this rule and after consulting with the DEQ and the HD, the Department may determine that the circumstances are such that an alternative source, treatment method, system, or other alternative method is acceptable or not necessary.

(c) Other Information. Any other information required by the Department.

(5) Permit Application Processing:

(a) Review of Application for Completeness. Within 45 days after an individual submits or resubmits an application, the Department shall consult with DEQ and HD about the completeness of the application, determine the completeness of the application, and either:

(A) Notify the applicant that it is complete for purposes of evaluation; or

(B) Notify the applicant of what additional information is required before the application is resubmitted.

(b) Public Notice/Comment Period. Within 7 days after determining that an application is complete, the Department shall provide public notice of the request to the public in the same manner as is used for water use applications. The appearance in the public notice commences a 60-day public comment period for the application. The Department may require additional information from the applicant pursuant to its own concerns and those raised by the public comments;

(c) DEQ and HD Assistance. The Department shall rely on the DEQ and the HD to comment on and recommend conditions for the permit and shall provide the public notice and a copy of the complete application to those agencies at the opening of the comment period;

(d) Scope of Public Interest Review. When making a public interest determination, the Department shall receive comments from interested parties or agencies for consideration of permit issuance, proposed conditions, and limitations. The public interest review standards shall apply only to the matters raised by the ASR permit application, not to the water right for injection source water;

(e) Referral to Commission. In the discretion of the Director, the Director may refer policy matters raised by the ASR application to the Commission for decision;

(f) Proposed Final Order. After considering comments and/or recommendations specific to the proposed ASR project during the 60-day public comment period, the Director shall issue a proposed final order on the application. The proposed final order shall be mailed to the applicant, commenting agencies, and commentors. Notice of the proposed final order shall be given in the weekly notice published by the Department;

(g) Protests:

(A) The Department shall allow a 45-day protest period, starting when the proposed final order is noticed in the public notice;

(B) Protests may be filed by any person objecting to the proposed issuance of a permit, and by any applicant objecting to proposed permit conditions;

(C) Protests shall be in the form and manner specified in OAR Chapter 690, Division 2.

(h) Director's Action on the Application. After the close of the protest period and after consideration of any protest filed, the Director may:

(A) Issue the permit with proper conditions upon finding that:

(i) The proposed ASR project will not impair or be detrimental to the public interest; and

(ii) There is a water right for injection source water.

(B) Propose to deny the application and refer to contested case hearing upon finding that the ASR project will impair or be detrimental to the public interest;

(C) Offer the applicant and protester(s) the opportunity to engage in discussions to try and resolve issues of concern;

(D) Refer to contested case hearing to consider protests against approval of the application or protests against proposed permit conditions; or

(E) Refer the application to the Commission to address policy matters raised by the application.

(i) The Department shall send a copy of the final order to commentors and protesters.

(6) Permit Conditioning. The following conditions shall be placed on the ASR permit:

(a) Injection/Storage/Recovery. The permit will specify the maximum allowable injection rate at each well, the maximum allowable storage volume, the maximum storage duration and the maximum allowable recovery rate at each well. These maximum values shall substantially reflect those amounts which were successfully demonstrated under the limited license;

(b) Record of Use. The permittee shall maintain a record of injection and recovery, including the total number of hours of injection and recovery and the total metered quantity injected and recovered. The record of use may be reviewed by Department staff upon request;

(c) Permit Modification/Revocation. The Department shall notify the permittee in writing when the Director either considers modifying or revoking the permit and allow the permittee to respond:

(A) The Director may modify the ASR permit for any of the following reasons:

(i) To reflect changes in HD and DEQ water quality or treatment standards;

(ii) To address needed technological changes as requested by DEQ or HD to minimize constituents regulated under OAR 333-061-0030 (ORS 448.131 and 448.273) or OAR 340-040 (ORS 468B.165);

(iii) Upon written request from the permittee for minor adjustments to the authorization in the permit;

(iv) Upon written request from the permittee for changes in the limits for the recovery of stored water. Any person operating an ASR project under a permit, upon approval by the Director, may recover up to 100 percent of the water stored in the aquifer storage facility if valid scientific data gathered during operations under the limited license or permit demonstrate that the injected source water is not lost through migration or other means and that groundwater otherwise present in the aquifer has not been irretrievably lost as a result of aquifer storage or recovery.

(B) The Director may revoke or modify the ASR permit for any of the following reasons:

(i) to prevent or mitigate substantial interference with other water rights, minimum perennial streamflows established prior to the granting of the ASR permit, or aquifer water quality; or

(ii) to address any other unintended, injurious effects of the ASR activity.

(C) The Department shall offer an additional public comment opportunity consistent with the notice and comment provisions of this rule prior to modifying or revoking the permit.

(d) Compliance with Other Laws. The injection of acceptable water into an aquifer(s) under an ASR permit shall comply with all applicable local, state or federal laws;

(e) Water Quality Conditions:

(A) The ASR permit shall include conditions to minimize, to the extent technically feasible, practical and cost-effective, the concentration of constituents in the injection source water that are not naturally present in the aquifer;

(B) Except as otherwise provided in paragraph (6)(e)(C) of this rule, if the injection source water contains constituents regulated under OAR 333-061-0030 (ORS 448.131 and 448.273) or OAR 340-040 (ORS 468B.165) that are detected at greater than 50 percent of the established levels, the aquifer storage and recovery permit may require the permittee to employ technically feasible, practical and cost-effective methods to minimize concentrations of such constituents in the injection source water. The Department, in consultation with DEQ and HD, may set specific limits between 50 and 100% of the established level for constituents regulated under OAR 333-061-0030 (ORS 448.131 and 448.273) or OAR 340-040 (ORS 468B.165) as provided by the standards in (4)(b)(D) of this rule;

(C) Constituents that have a secondary contaminant level or constituents that are associated with disinfection of the water may be injected into the aquifer up to the standards established under OAR 333-061-0030 (ORS 448.131 and 448.273);

(D) The Department may, based upon valid scientific data, further limit certain constituents in the injection source water if the Department finds that those constituents will interfere with or pose a threat to the maintenance of the water resources of the state for present or future beneficial uses;

(E) The permittee shall be in compliance with treatment requirements and performance standards for source waters that fall in categories identified in OAR 333-061-0032;

(F) If during the course of ASR operations a constituent which is regulated under OAR 333-061-0030 (ORS 448.131 and 448.273) or OAR 340-040 (ORS 468B.165) is detected above the level prescribed in the permit, the permittee shall stop injection activities and notify the Department.

(f) Monitoring/Sampling/Recovery/Reporting:

(A) The permit shall include requirements for reporting, sampling and monitoring the ASR project aquifer impacts and for constituents reasonably expected to be found in the injection source water;

(B) The permit shall specify limits for the recovery of stored water up to 100 percent.

(g) Protection for Existing Users. The ASR permit shall be conditioned to protect existing water rights and the water quality of existing users that rely upon the receiving aquifer and the injection source water;

(h) Other Conditions. The permit may contain any other conditions required by the Director to protect the public welfare, health, and safety.

Stat. Auth.: ORS 536.027 & ORS 537.534
Stats. Implemented: ORS 537.531 - ORS 537.534
Hist.: WRD 2-1996, f. & cert. ef. 2-12-96

Artificial Groundwater Recharge

690-350-0110

Definitions

The following definitions apply to artificial groundwater recharge in OAR Chapter 690, Division 350, Rules 0110 to 0130:

(1) "Artificial Groundwater Recharge" means the intentional addition of water diverted from another source to a groundwater reservoir. (Applications to obtain permits for artificial groundwater recharge uses submitted pursuant to OAR 690-350-0110 to 690-350-0130 are not subject to provisions governing aquifer storage and recovery projects or programs pursuant to OAR 690-350-0010 to 690-350-0030.)

(2) "Commission" means the Water Resources Commission.

(3) "Department" means the Water Resources Department.

(4) "Director" means the Director of the Department.

(5) "Groundwater Reservoir" means a designated body of standing or moving groundwater as defined in ORS 537.515(5).

(6) "Recharge Permit" means a permit for the appropriation of water for the purpose of artificial groundwater recharge.

(7) "Secondary Groundwater Permit" means a permit for the appropriation of groundwater which was stored through the exercise of a recharge permit or certificate.

(8) "Stored Recharge Water" means groundwater which results from artificial groundwater recharge.

(9) "Storage Account" means a net volume of artificially recharged groundwater which is calculated for a single recharge activity from a formula specified in a single recharge permit which records additions to a groundwater reservoir by artificial recharge and depletions from a groundwater reservoir by pumping and natural losses.

(10) "Surplus Waters" means all waters in excess of those needed to satisfy current existing rights and minimum streamflows established by the Commission.

Stat. Auth.: ORS 536.025, ORS 536.027, ORS 536.220, ORS 536.300, ORS 536.310, ORS 537.338, ORS 537.356 - ORS 537.358, ORS 540 & ORS 543
Stats. Implemented: ORS 537.135

Hist.: WRD 2-1996, f. & cert. ef. 2-12-96

690-350-0120

Groundwater Recharge Applications -- Supplemental Information Requirements; Permit Conditions

(1) Permit Required. The appropriation of water from any source for the purpose of recharging a groundwater reservoir requires a permit. Likewise, any beneficial use of artificially recharged groundwater in any such groundwater reservoir requires a secondary groundwater permit.

(2) Pre-application Conference. Due to the complexities and costs associated with recharge projects and recharge permitting, the Department requires a pre-application conference.

(3) Supplemental Information for Permit Application. In addition to data required on permit applications under OAR 690-310-0040, the applicant shall submit additional information to assist the Commission in determining the public interest on the proposed project. An application shall be accepted by the Department for filing only if it contains all required data. Upon request, the Department may assist other agencies in developing their responses to permit applications. The following attachments are necessary:

(a) Minimum Perennial Stream Flow or Instream Water Right. If a stream is the proposed recharge source, the applicant shall provide a copy of the document which establishes that the supplying steam has a minimum perennial stream flow or instream water right for the protection of aquatic and fish life. If none is established, the applicant shall attach a copy of a waiver of this prerequisite from the Oregon Department of Fish and Wildlife;

(b) Water Quality Permit. The applicant shall attach a copy of the necessary water quality permits from Oregon Department of Environmental Quality, show that the application for necessary permits has been filed, or show that permits are not necessary;

(c) Purpose of Recharge. The applicant shall describe the ultimate use or value of the groundwater recharge;

(d) Annual Storage. The applicant shall describe the volume of water, or the range of volumes, expected to be stored annually by artificial recharge. The applicant shall describe anticipated losses between the point of diversion and the place of recharge;

(e) Financial Capability. If the proposed recharge diversion is for five cfs or more, the applicant shall display proof of financial capability to construct and operate the proposed project. Unless otherwise approved by the Director, the capability shall be supported by written statements from a lending institution;

(f) Hydrogeologic Feasibility Report. The applicant shall demonstrate that the proposed recharge project is hydrologically feasible. The report should include an assessment of groundwater conditions in the reservoir and anticipated changes due to the proposed recharge project. This report shall be sealed and signed by a professional(s) registered or allowed, under Oregon law, to practice in this area of geology;

(g) Project Description Report. The applicant shall provide plans for recharge project construction, operation, and costs. The report shall outline proposed monitoring plans for flows, water levels in wells and groundwater quality. If surface water is a proposed source of recharge, the report shall indicate when surplus surface waters are generally available. The report shall be sealed and signed by a professional(s) registered or allowed, under Oregon law, to practice civil engineering and this area of geology;

(h) Additional Information. The Director may require the applicant to submit additional information to assist in making the public interest determination.

(4) Recharge Permit Processing. The Director shall work with the applicant and may work with any person or agency to prepare a draft permit. In particular, the Director shall seek assistance from the State Department of Environmental Quality to develop a water quality monitoring program and standards.

(5) Permit Conditions. Any permit shall address the following items:

(a) Maximum rate and volume. A permit shall specify a maximum diversion rate and a maximum annual diversion volume;

(b) Meters. The recharge permit shall require both the metering of recharge water from the source(s) and metering of water at the place(s) of recharge. Any subsequent secondary groundwater permit shall require metering of stored recharge water withdrawals;

(c) Records, Inspections. The permit shall require the permittee to keep accurate and current records of metered values, water levels and other pertinent information. The permit shall allow the Director to inspect records or works covered by the permit upon reasonable notice and at any reasonable time;

(d) Estimated Data. When metered or measured data are missing in whole or in part, the Director may make estimates from available data. The Director's estimates shall be reasonable and, where there is a range of uncertainty, be conservatively low on water delivered to the place of recharge and conservatively high on withdrawals of stored recharge water;

(e) Water Levels. The response of water levels in wells shall provide the principal basis on which to judge the effectiveness of recharge under the permit and the availability of stored recharge water:

(A) Monitoring Program. The permit shall specify a water level monitoring program for selected times and wells; and

(B) Key Wells, Target Levels. The permit shall designate several key wells in the monitoring program. The permit shall establish upper and lower target water levels for each well. Actual water levels on an annual assessment date shall be compared to the target levels for the purpose of prescribing allowable use of stored recharge water.

(f) Determination of Stored Recharge Water. The permit shall specify the formula to determine the availability of artificially recharged groundwater for appropriation. The formula shall result from one of the following:

(A) Negotiation. The applicant and the Department may negotiate a formula which relies principally on water levels in wells, metered quantities of recharge, secondary permit withdrawals, and hydrogeologic conditions in the area. At permit issuance, stored recharge water may be credited at up to 85 percent of water metered to the place of recharge. Withdrawals of stored recharge water shall be debited at 100 percent of metered values. Calculations of stored recharge water shall be based only on recharge over the last five years;

(B) Definitive Groundwater Investigation. The applicant may present a definitive groundwater investigation as a method to determine stored recharge water. The Director must be satisfied that use of such information accurately describes the quantity and location of water available for withdrawal as a result of the recharge. That quantity must be in excess of the groundwater which would be available if artificial recharge were not practiced. If no agreement is reached by negotiation, the applicant must determine stored recharge water by a definitive groundwater investigation.

(g) Storage Account. The Department shall record its final determinations on stored recharge water in a storage account. The permit shall specify a method by which the permittee may obtain information on that account;

(h) Annual Report. The permittee shall submit an annual report to both the Department and any secondary permittee. That report shall include the range of recharge rates and total quantities during the year at both the diversion point and the place of recharge. In addition, the report shall include a general operations review, the permittee's estimate of the storage account and the results of other water quantity and quality programs which are required in the permit;

(i) Allowable Use of Stored Recharge Water. See rules governing secondary groundwater permits in OAR 690-350-0130;

(j) Permit Assignment. A permit condition shall require a potential assignee to prove, to the Director's satisfaction, the financial capability to construct uncompleted portions of and operate the project, if such proof was required for the application;

(k) Condition Changes. If, under actual operation of the recharge project, the Director notifies the permittee that the Director has reason to believe there are adverse groundwater quantity or quality effects, the permittee shall cease recharge activities. No further diversion shall be made until measures to prevent, correct or monitor those adverse effects have been agreed to and implemented;

(l) Technical Oversight. If the recharge diversion is for five cfs or more, the permit may require the permittee to have the construction and operation of the proposed project overseen by a professional(s) registered or allowed, under Oregon law, to practice civil engineering;

(m) Other Conditions. The permit may contain other con-ditions which the Commission believes are necessary.

(6) Recharge Certificate. Annual reports as required in the permit shall be an element of proof of appropriation to the satisfaction of the Department prior to issuance of a confirming water right certificate. Operational conditions of the permit shall become conditions of the certificate.

Stat. Auth.: ORS 536.025, ORS 536.027, ORS 536.220, ORS 536.300, ORS 536.310, ORS 537.135, ORS 537.338, ORS 537.356 - ORS 537.358, ORS 540 & ORS 543
Stats. Implemented: ORS 537.135

Hist.: WRD 5-1988, f. & cert. ef. 6-28-88; WRD 16-1990, f. & cert. ef. 8-23-90; WRD 9-1992, f. & cert. ef. 7-1-92, Renumbered from 690-011-0085; WRD 5-1995(Temp), f. & cert. ef. 8-4-95; WRD 2-1996, f. & cert. ef. 2-12-96, Renumbered from 690-011-0042

690-350-0130

Secondary Groundwater Permits for Use of Artificially Recharged Waters; Supplemental Information Requirements; Limitations; Conditions

(1) Permit Required. The appropriation of artificially recharged groundwater for any beneficial use requires a secondary groundwater permit.

(2) Supplemental Information for Permit Application. In addition to data required for permit applications under OAR 690-310-0040, the applicant shall submit certain additional information. The following attachments are necessary:

(a) Identify Source. The applicant shall identify an artificially recharged groundwater reservoir as a supply of water;

(b) Written Consent. The applicant shall include the written consent of the holder of the recharge permit or certificate;

(c) Source Proof. The applicant shall submit proof that the proposed use will actually be from the recharged reservoir. Documentation may include water level similarities to the recharged reservoir, geologic and geographic similarities, hydraulic information, and other pertinent data; and

(d) Recharge Understanding. The applicant shall attach a copy of the currently valid recharge certificate or permit and a statement that the applicant understands its content and the conditions of that recharge.

(3) Limitations on Secondary Groundwater Permit Approval. During the first five years of recharge, the Department shall limit cumulative secondary permits to no more than 85 percent of the project's permitted annual recharge volume. Subsequent recharge permits may exceed 85 percent based on recharge performance as determined by the Department.

(4) Secondary Groundwater Permit Conditions. A secondary groundwater permit shall address the following items:

(a) Maximum Rate and Volume. A permit shall specify a maximum diversion rate and annual diversion volume;

(b) Meters. The permit shall require the permittee to meter all withdrawals so as to provide data as a debit against the storage account;

(c) Water Levels. The permit shall require the permittee to measure water levels on a specified basis;

(d) Estimated Data. The permit shall specify that when metered or measured data are missing in whole or in part, the Director may make estimates from available data. The Director's estimates shall be reasonable and, where a range of uncertainty exists, be conservatively high on withdrawal of stored water;

(e) Records, Inspections. The permit shall require the permittee to keep accurate and current records of withdrawals and water levels. The Director may inspect any records or works covered by the permit upon reasonable notice and at any reasonable time;

(f) Annual Report. The permittee shall be required to submit an annual report to the Director and holder of the recharge right. The report shall note withdrawals, dated water levels and other data pertinent to the storage account;

(g) Allowable Use of Stored Recharge Water. The permit shall indicate that availability shall be determined on the basis of secondary groundwater right priority and the allowable use of stored recharge water. The allowable use of stored recharge water falls into three categories. For ease of reference, these categories are named as the following color zones:

(A) Green Zone. If water levels at key wells are above the upper target level, use is allowed up to the maximum of the storage account or maximum duty, whichever is lower. These wells and targets are noted in the recharge permit;

(B) Yellow Zone. If water levels at key wells are between the upper and lower target levels, use is allowed up to 85 percent of the recharge volume for the preceding 12 months; and

(C) Red Zone. If water levels at key wells are below the lower target level, no use of stored recharge water is allowed.

(h) Condition Changes. If the Director has reason to believe that the well(s) is not with drawing artificially recharged groundwater or there are other substantial groundwater concerns, the permittee shall cease withdrawal upon notice from the Director. No further withdrawal shall be made until measures to prevent, correct or monitor the situation have been agreed to and implemented; and

(i) Other Conditions. The permit may contain other conditions which the Director specifies.

(5) Secondary Groundwater Certificate. Annual reports as required in the permit shall be an element of proof of appropriation to the satisfaction of the Department prior to issuance of a confirming water right certificate. Operational conditions of the permit shall become conditions of the certificate.

Stat. Auth.: ORS 536.025, ORS 536.027, ORS 536.220, ORS 536.300, ORS 536.310, ORS 537.135, ORS 537.338, ORS 537.356 - ORS 537.358, ORS 540 & ORS 543
Stats. Implemented: ORS 537.135
Hist.: WRD 5-1988, f. & cert. ef. 6-28-88; WRD 16-1990, f. & cert. ef. 8-23-90; WRD 9-1992, f. & cert. ef. 7-1-92, Renumbered from 690-011-0086; WRD 2-1996, f. & cert. ef. 2-12-96, Renumbered from 690-011-0044

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Oregon Revised Statutes 537.531-537.534 (Aquifer Storage and Recovery)**:**

537.531 Legislative findings. The Legislative Assembly declares that aquifer storage and recovery is a beneficial use inherent in all water rights for other beneficial uses. Aquifer storage and recovery is the storage of water from a separate source that meets drinking water standards in a suitable aquifer for later recovery and not having as one of its primary purposes the restoration of an aquifer. [1995 c.487 §2]

537.532 Injection of ground water into aquifers; standards. (1) Notwithstanding any other provision of law, the injection into aquifers of water that complies with drinking water standards established by the Oregon Health Authority under ORS 448.273 under an aquifer storage and recovery limited license or permit:

(a) Shall not be considered a waste, contaminant or pollutant;

(b) Shall be exempt from the requirement to obtain a discharge permit under ORS 468B.050 or 468B.053 or a concentration limit variance from the Department of Environmental Quality;

(c) Shall comply with all other applicable local, state or federal laws; and

(d) May be located within or outside an urban growth boundary in conformance with land use laws.

(2) In order to continue to protect the high quality of Oregon's aquifers for present and future uses, the Legislative Assembly recognizes the need to minimize concentrations of constituents in the injection source water that are not naturally present in the aquifer. Each aquifer storage and recovery limited license or permit shall include conditions to minimize, to the extent technically feasible, practical and cost-effective, the concentration of constituents in the injection source water that are not naturally present in the aquifer. In no case may an aquifer storage and recovery limited license or permit establish concentration limits for water to be injected in excess of the standards established by the authority under ORS 448.273 or the maximum measurable levels established by the Environmental Quality Commission under ORS 468B.165, whichever are more stringent.

(3) Except as otherwise provided, if the injection source water contains constituents regulated under ORS 448.273 or 468B.165 that are detected at greater than 50 percent of the established levels, the aquifer storage and recovery limited license or permit may require the permittee to employ, or continue the employment of, technically feasible, practical and cost-effective methods to minimize concentrations of such constituents in the injection source water. Constituents that have a secondary maximum contaminant level or constituents that are associated with disinfection of the water may be injected into the aquifer up to the standards established under ORS 448.273.

(4) The Water Resources Department may, based upon valid scientific data, further limit certain constituents in the injection source water if the department finds the constituents will interfere with or pose a threat to the maintenance of the water resources of the state for present or future beneficial uses. [1995 c.487 §3; 1997 c.286 §9; 2009 c.595 §984]

537.534 Rules for permitting and administering aquifer storage and recovery projects; limited license for test program; fees. (1) In accordance with this section, the Water Resources Commission shall establish rules for the permitting and administration of aquifer storage and recovery projects. The rules shall establish the Water Resources Department as the sole permitting agency for the projects, but the Department of Environmental Quality and the Oregon Health Authority may comment on permits for a project and recommend conditions to be included on the permit. When necessary, the applicant also shall obtain land use and development approval from a local government.

(2) Notwithstanding the provisions of ORS 537.130, the Water Resources Commission shall establish by rule a procedure to allow a person to obtain a limited license to store and use water injected into an underground aquifer for aquifer storage and recovery testing purposes for a short term or fixed duration after the person complies with the notice provision set forth in ORS 537.144. The rules shall provide a 30-day public comment period before issuance of a limited license. The Water Resources Department may attach conditions to the limited license regarding monitoring, sampling and rates of recovery up to 100 percent of the injection quantity. Aquifer storage and recovery under a limited license may be conditioned by the Water Resources Department to protect existing ground water rights that rely upon the receiving aquifer and the injection source water. The Water Resources Department may revoke or modify the limited license to use the stored water acquired under a limited license if that use causes injury to any other water right or to a minimum perennial streamflow. The Water Resources Director may issue a limited license for aquifer storage and recovery purposes for a term of not more than five years. The license may be renewed if the applicant demonstrates further testing is necessary.

(3) To obtain a limited license for aquifer storage and recovery, the applicant shall provide to the Water Resources Department:

(a) Well construction information;

(b) Test results of the quality of the injection source water;

(c) Test results of the quality of the receiving aquifer water;

(d) The proposed injected water storage time, recovery rates and recovery schedule;

(e) Preliminary hydrogeologic information including a description of the aquifer, estimated flow direction and rate of movement, allocation of surface water, springs or wells within the area affected by aquifer storage and recovery wells;

(f) The fee established by rule by the commission pursuant to ORS 536.050 (1)(L); and

(g) Any other information required by rule of the commission.

(4) Only after completion of a test program under a limited license issued under subsection (3) of this section may the applicant apply for a permanent aquifer storage and recovery permit. Each application for an aquifer storage and recovery permit shall be accompanied by the fee set forth in ORS 536.050 for examination of an application for a permit to store water. The Water Resources Department shall be the sole permitting agency for the project and may place conditions on the permit consistent with rules adopted by the commission, but the Department of Environmental Quality and the Oregon Health Authority may review, comment on and recommend conditions to be included on the permit. When necessary, the applicant shall obtain land use and development approval from a local government. Where existing water rights for the injection source water have been issued, the Water Resources Department shall receive comments from interested parties or agencies, but the public interest review standards shall apply only to the matters raised by the aquifer storage and recovery permit application in the same manner as any new water right application, not to the underlying water rights. If new water rights for injection source water and aquifer storage and recovery are necessary, then the public interest review standards shall apply to the new permit application in the same manner as any new water right application. The Water Resources Director may refer policy matters to the commission for decision.

(5) The commission shall adopt rules consistent with this section to implement an aquifer storage and recovery program. The rules shall include:

(a) Requirements for reporting and monitoring the aquifer storage and recovery project aquifer impacts and for constituents reasonably expected to be found in the injection source water.

(b) Provisions that allow any person operating an aquifer storage and recovery project under a permit, upon approval by the Water Resources Department, to recover up to 100 percent of the water stored in the aquifer storage facility if valid scientific data gathered during operations under the limited license or permit demonstrate that the injected source water is not lost through migration or other means and that ground water otherwise present in the aquifer has not been irretrievably lost as a result of aquifer storage or retrieval. The Water Resources Department may place such other conditions on withdrawal of stored water necessary to protect the public health and environment, including conditions allowing reconsideration of the permit to comply with ORS 537.532.

(c) The procedure for allowing the Department of Environmental Quality and the Oregon Health Authority to comment on and recommend permit conditions.

(6) The use of water under a permit as injection source water for an aquifer storage and recovery project up to the limits allowed in subsection (5)(b) of this section shall not affect the priority date of the water right permit or otherwise affect the right evidenced by the permit.

(1) The holder of a permit for aquifer storage and recovery shall apply for a transfer or change of use if the use of recovered water is different from that which is allowed in the source water permit or certificate. [1995 c.487 §4; 1997 c.587 §2; 1999 c.665 §3; 2003 c.594 §6; 2009 c.595 §985]

Oregon Revised Statutes 537.135 (Artificial Recharge)**:**

537.135 Permit required to appropriate water for recharging ground water sources; minimum perennial streamflow required for permit; exception. (1) The appropriation of water for the purpose of recharging ground water basins or reservoirs is declared to be for a beneficial purpose. Permits for such appropriation may be granted by the Water Resources Department on application made therefor. Any such application shall substantially comply with ORS 537.140 and shall be subject to the provisions of ORS 537.150 to 537.230, as are other applications and permits to appropriate water.

(2) Any person proposing to apply to a beneficial use the water stored artificially in any such ground water basin or reservoir shall file an application for permit, to be known as the secondary permit, in compliance with the provisions of ORS 537.130, 537.140, 537.142 and 537.145 to 537.230. The application shall refer to the artificially recharged ground water basin or reservoir as a supply of water and shall include the written consent of the holder of the recharge permit or certificate to appropriate the artificially recharged water.

(3) The Water Resources Commission shall develop standards that an applicant must meet before the department approves a permit to appropriate water for the purpose of recharging ground water.

(4) Before issuing a permit for the purpose of recharging ground water, the department shall determine, under ORS 537.170, whether the proposed ground water recharge project would impair or be detrimental to the public interest.

(5) The department shall not issue a ground water recharge permit unless the supplying stream has a minimum perennial streamflow established for the protection of aquatic and fish life. The State Department of Fish and Wildlife may waive this prerequisite if a minimum perennial streamflow for protection of aquatic and fish life is not required for the supplying stream. [1961 c.402 §1; 1985 c.673 §26; 1987 c.499 §1; 1995 c.416 §3

Attachment H

Driller Performance Specification

DRAFT – Not for Construction

TECHNICAL SPECIFICATIONS
CRATER LAKE ASR OR PRODUCTION WELL

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all materials, labor, plant, equipment, tools, supplies, transportation, and appurtenances for drilling, casing, developing, completing, and testing of one test well for SPF Water Engineering (the Engineer, acting as the Owner's representative) and the National Park Service (the Owner) at the Pacific Crest Trail parking area within Crater Lake National Park as specified herein and in accordance with the requirements of the Contract Documents.

B. Approximate depths of drilling and lengths of well casing/liner are to be used for the purpose of price estimation only. Exact depths and lengths may be adjusted by the Owner depending on subsurface conditions.

C. Work requirements are summarized below based on the conceptual design. Each item is discussed in subsequent sections of the Specifications.

(1) Mobilize to the work site.

(2) Drill a minimum 12-inch diameter borehole to a depth of 520 feet.

(3) Furnish and install 8-inch steel casing (minimum 0.250-inch wall thickness), placed from 2.5 feet above ground surface to a minimum depth of 500 feet.

(4) Seal annular space from bottom of casing to ground surface in accordance with Oregon Water Resources Department requirements.

(5) Drill nominal 8-inch diameter open borehole to 600 feet or to a depth determined by the Engineer.

(6) If necessary to stabilize the borehole, furnish and install 6-inch blank and slotted PVC (SDR21, 0.316-inch wall thickness) or steel liner (minimum 0.188-inch wall thickness) liner pipe. Steel liner shall be perforated across water-bearing zones as designated by the Engineer. The liner shall overlap into the 8-inch well casing by no less than 20 feet.

(7) Develop the well.

(8) Furnish, install, operate, and remove test pump.

(9) Complete site restoration and demobilize from the work site.

D. All well construction work shall conform to OAR 690-210 Well Construction Standards (Oregon Water Resources Department), and OAR 333-61 Public Water Systems (Oregon Department of Human Services). All well construction work not specifically addressed in these specifications shall conform to appropriate sections of "Recommended Standards for Water Works", and AWWA A100 – Standards for Water Wells.

E. All materials used for well construction, including drilling fluids, shall be NSF-certified to Standard 60 (Drinking Water Treatment Chemicals), Standard 61 (Drinking Water System Components), or equivalent.

1.02 BEGINNING AND COMPLETION OF WORK

A. The work shall begin within 30 calendar days of receipt of notice to proceed from the Owner. All work shall be completed within 90 calendar days of receipt of notice to proceed.

1.03 SERVICES FURNISHED BY THE OWNER

A. The Owner will provide land and rights-of-way for the Work specified in this contract. Provisions for access to the Work site will be provided by the Owner. The Contractor shall not enter on or occupy with laborers, tools, equipment, or material any ground outside the property and rights-of-way provided by the Owner unless stated otherwise by the Owner. Other contractors, employees, or agents of the Owner may enter the work site and premises used by the Contractor for business purposes.

B. The Owner (or Engineer as the Owner's Representative) will participate in well testing, evaluation of drilling characteristics, sample examination, and will advise the Contractor on the final well design. The Engineer shall be present during test pumping.

C. The Contractor will obtain the drilling permit.

1.04 WORK SITE

A. The site where the test well is proposed is on property owned by the United States of America and managed by the National park Service. The well site is located about 1/2 miles west of Mazama Village, at the parking lot for the Pacific Crest Trail, on the south side of State Highway 62.

1.05 DRILLING CONDITIONS

A. Based on an existing test well at the site, it is anticipated that drilling will be in pumice to a depth of approximately 35 feet, followed by basalt and cinders from 35 feet to more than 500 feet. Static water level is anticipated to be approximately 325 feet.

B. It is the Contractor's responsibility to make his own determination of subsurface conditions.

C. It is the Contractor's responsibility to become informed about local conditions affecting this Work. Neither the information contained in these specifications, nor gleaned from the Owner, or their agents, shall act to relieve the Contractor from any responsibility set forth in the contract.

1.06 CONTRACTOR QUALIFICATION AND EQUIPMENT

A. The Contractor shall have at least five years of well drilling experience and shall have constructed at least five wells of comparable type. The Contractor is responsible for providing equipment capable of performing the Work specified within the stipulated construction timeframe. Equipment must be inspected prior to bringing the equipment into the park and that if the equipment is not free of dirt, mud, or other material possibly carrying plant seeds the driller will not be permitted to bring the equipment into the park

B. Damages to the well or surrounding property by the Contractor's equipment, leased or otherwise, shall be repaired or replaced at the Contractor's expense.

1.07 WATER, POWER, AND SITE IMPROVEMENTS

A. Water required for drilling purposes may be obtained by the Contractor from the existing test well. Costs for water conveyance facilities to the Work site shall be borne by the Contractor including all necessary pumps, piping and components. The Contractor is responsible for preventing contamination of groundwater during drilling and testing operations.

B. The Contractor shall provide, at his own expense, all necessary piping and components to transfer the discharged well water from the drill site to a suitable disposal site. The Engineer has identified a location within approximately 100 feet of the well as an appropriate discharge site.

C. The Contractor shall implement best management practices (BMPs) to protect surface water from sediment and other pollutants during drilling and test pumping of the wells. Appropriate erosion and sediment structural controls (silt fencing, sand bags, sediment bags) must be utilized to prevent sediment from leaving the drilling area and the test pumping discharge site. Use of organic materials (straw, hay, etc.) for sediment control is prohibited. Excavation of pits or ditches is prohibited.

D. The Contractor shall provide, at his own expense, all power required for his operations under the contract.

E. Preparation and management of the drill site shall be the responsibility of the Contractor. Equipment and chemicals shall be safely stored and fenced per OSHA standards. All materials shall be stored where safe from damage or contamination.

F. The Contractor shall contain drilling fluid (i.e., water containing drilling mud or foam and other additives) and dispose of such drilling fluid outside of Crater Lake National Park. Sediment free groundwater produced from the well during drilling can be discharged to a disposal ditch identified in the project Work Plan.

1.09 WORKING HOURS

A. The Contractor shall work on this project in a steady and diligent manner. Normal working hours will be 7 am to 5 pm, Monday through Friday. The Contractor shall, during all work periods, provide an adequate crew of suitably qualified personnel to prevent unnecessary delays in project completion. The Contractor may be required to provide 24-hour per day maintenance of pumping and monitoring equipment during test pumping.

1.10 FINAL CLEANUP

A. The Contractor shall thoroughly clean the site after completion of the drilling, well construction, and test pumping operations. All well cuttings, excess drilling fluids, debris, and other materials used during these operations shall be removed and properly disposed (sanitary land fill or other approved site) of by the Contractor.

B. The Contractor shall promptly remove his equipment, temporary facilities, and materials, and leave the site in a condition acceptable to the Owner. The Contractor shall repair any damage to the property or facilities caused by his operations prior to final acceptance of the Work by the Owner. The Owner shall resurface the work area following Contractor demobilization.

PART 2 - PRODUCTS

2.01 CASING

A. **Temporary Surface Casing:** Temporary surface casing may be installed at the Contractor's option. If utilized, temporary surface casing shall be removed during installation of the surface seal.

B. **Well Casing:** The well, when completed, shall be cased with nominal 8-inch I.D. casing from 2.5 feet above natural ground surface to a depth designated by the Engineer. The casing shall be new steel ASTM A-53 or equal with a minimum wall thickness of 0.250 inches. The casing shall be equipped with centralizers at a spacing of no greater than 60 feet.

C. **Well Liner:** A liner will be installed if necessary to maintain borehole stability. The well shall be lined with nominal 6-inch I.D. liner to a depth designated by the Engineer. The liner shall

be either new PVC, conforming to ASTM F480 with a minimum wall thickness of 0.316 inches (SDR21) or new steel ASTM A-53 or equal with a minimum wall thickness of 0.188 inches. Steel liner shall be perforated at water-bearing zones as designated by the Engineer. The depth of perforations, size, and number shall be determined following completion of the borehole. PVC liner shall be slotted where installed water-bearing zones as designated by the Engineer. The liner shall be supplied with machined circumferential slots of 0.040 inch aperture. For purposes of cost estimating, the Contractor can assume a total of 120 feet of liner, and that half of the liner installed will be slotted.

2.02 WELL SEAL

A. The annulus outside the 8-inch well casing shall be sealed from the bottom of the minimum 12-inch borehole to ground surface with neat cement.

B. The Contractor shall notify the Engineer at least 24 hours prior to placement of the seal to allow for observation.

PART 3 - EXECUTION

3.01 MOBILIZATION AND DEMOBILIZATION

A. Upon receiving the Notice to Proceed, the Contractor shall move in all tools, equipment, and supplies necessary for the Work, and upon completion of the Work, shall remove all such items from the premises promptly and leave the site in a clean and orderly fashion.

3.02 CONSTRUCTION SEQUENCE

A. The sequence of construction for this project will consist of the following:

1. Mobilize to the work site.

2. Drill a minimum 12-inch diameter borehole to a depth of 520 feet.

3. Furnish and install 8-inch steel casing (minimum 0.250-inch wall thickness), placed from 2.5 feet above ground surface to a minimum depth of 500 feet.

4. Seal annular space from bottom of casing to ground surface in accordance with Oregon Water Resources Department requirements.

5. Drill nominal 8-inch diameter open borehole below the casing to 600 feet or a depth determined by Engineer.

6. Furnish and install 6-inch blank and slotted PVC (SDR21, 0.316-inch wall thickness) or steel liner (minimum 0.188-inch wall thickness) liner pipe. Steel liner shall be perforated across water-bearing zones as designated by the Engineer.

7. Develop the well.

8. Furnish, install, operate, and remove test pump.

9. Complete site restoration and demobilize from the work site.

3.03 DRILLING

A. The borehole diameters and drilling sequence will depend on the drilling technique chosen by the Contractor. The anticipated drilling method is by air-rotary. The boreholes shall be of sufficient diameter to meet OWRD standards for sealing of casing.

B. Drilling fluid properties shall be maintained in such a manner to ensure the structural integrity of the borehole and to circulate drill cuttings representative of the strata penetrated to the ground surface. The Contractor shall only use potable water and drilling fluids or drilling fluid additives manufactured for use in water wells and that are NSF, API, or ASTM/ANSI approved.

C. The Contractor shall sample the borehole drill cuttings at every formation change and at a minimum of 5-foot intervals. These samples shall be saved and maintained on the job site in a clean dry area by the Contractor. All samples are to be submitted to the Owner. The samples shall be of at least one-pint size, shall be kept in cloth sample bags or heavy-duty “zip-lock” style plastic bags to be provided by the Contractor, and shall be clearly labeled to show the depth and well from which the samples originated.

D. The Contractor shall maintain a daily drilling log of the wells. Information that shall be listed on the drilling log includes: (1) drilling fluids and additives, including quantity of materials used; (2) drilling fluid properties, including weight and viscosity; (3) type and diameter of bits used for drilling and total footage for each bit; and (4) any remarks or comments concerning the drilling characteristics of the borehole, including location and volumes of mud losses. The forms shall be kept on-site for inspection by the Owner.

E. The Contractor shall maintain an accurate record of the general character, thickness, and type of material penetrated. The location and thickness of all significant bedrock fractures shall be recorded. The Contractor shall note the depth where water is encountered, the formation producing water, and an estimate of the quantity of water produced by air-lifting. Copies of all logs shall be furnished to the Owner following completion of all operations.

F. All drilling fluids shall be disposed of in accordance with State and Federal regulations. Method and place of disposal shall be approved by the Owner. Costs incurred in connection with the disposal of drilling fluids and developed water shall be borne by the Contractor.

3.04 ALIGNMENT

A. The Contractor shall construct the well sufficiently straight and plumb to permit free installation and operation of a 5.4-inch O.D. test or production pump to a depth of 450 feet. The hole shall be drilled to the depth designated by the Engineer with a total deviation of the casing not to exceed one degree per 100 feet of the well. The alignment will be considered satisfactory if the casing will permit the free lowering and raising of a dummy between land surface and the bottom of the well. The dummy shall be constructed of a 40-foot length of standard 4-inch I.D. pipe. It shall be the responsibility of the Contractor to see that the well is being constructed straight within these limits at all times. Any indications of inadequate alignment during drilling, casing, or pump setting operation shall be cause to require measurement of alignment by a method acceptable to the Owner. No payment shall be made for tests of alignment; any such tests shall be considered subsidiary to other items in this contract.

B. If the well has unacceptable alignment, the Contractor shall undertake remedial measures. Any alignment work required by the Contractor in re-drilling or straightening the well shall be at his sole expense. If a well is deemed unacceptable following remedial measures, then as much casing as can be removed from the well shall be salvaged by the Contractor. The well

shall be abandoned in accordance with State regulations at the Contractor's expense. All payments associated with construction of the abandoned well shall be credited to construction of a replacement well.

3.05 INSTALLATION OF WELL CASING AND LINER

A. Individual lengths of steel casing shall be joined by welding performed by properly qualified operators. Welds shall penetrate the full thickness of the casing wall for both permanent and temporary casing. The casing ends to be joined by welding must be properly prepared, beveled, and gapped to allow for full penetration of the weld.

B. The completed well will have 8-inch steel casing (0.250-inch wall thickness) from +2.5 to a minimum depth of 500 feet.

C. When complete, the well casing shall extend a minimum of 30-inches above finished grade. The immediate area around the well head shall be graded to prevent surface water accumulation around the well head. The top of well casing shall be equipped with a vented, sanitary well cap.

D. The well may be completed as an open borehole below the 8-inch casing, unless a liner is needed for borehole stability. If liner pipe is necessary, it is anticipated that the pipe shall extend from approximately 480 feet to 600 feet. PVC liner must be lowered or floated into the borehole, and shall not be driven, dropped, or jacked into place. Slotted PVC liner shall be installed at water-bearing zones as designated by the Engineer following completion of the borehole. Steel liner shall be perforated at water-bearing zones as designated by the Engineer, and may be placed by lowering, under reaming, or driving. The depth of perforations, size, and number shall be determined following completion of the borehole.

3.06 WELL SEAL

A. The annular space outside the 8-inch well casing shall be sealed to ground surface with neat cement installed in a slow and continuous manner.

B. The neat cement shall be allowed to cure for 24 hours prior to resuming work on the well. The volume of neat cement required shall be recorded and compared with the calculated volume requirements.

3.07 DEVELOPMENT

A. The well shall be developed by air-lift pumping or other methods approved by the Engineer. The Contractor shall provide a well development plan for approval by the Engineer prior to the start of development activities. It shall be the Contractor's responsibility to notify the Engineer when the process of well development is to begin and to provide daily reports of progress during development.

B. If a well is developed by air-lifting, the Contractor shall have a compressor, tubing and eductor pipe capable of adequately developing the well. Sufficient tubing or drill stem shall be available to reach the total depth of the well. It is anticipated that air development will take place in a staged manner throughout the lower portion of the well, and thus may include considerable addition and subtraction of pipe. For preliminary testing purposes, the Contractor shall note approximate air-lift pumping rate during development.

C. Development shall be completed by pumping with the test pump prior to beginning the test pumping. Development shall continue until the water produced from the well is clear and sand free. Upon completion of the development, all material shall be thoroughly cleaned from the inside of the casing.

3.08 TEST PUMPING

A. Following completion of development operations, the well shall be allowed to recover for 24 hours, or less if approved by the Owner, prior to starting the test pumping. Anticipated methods of aquifer testing include: (1) a step-rate test lasting up to 2 hours, which will consist of pumping the well at various rates up to the maximum capability of the pump or well, and (2) a constant-rate pumping test at the well's sustainable yield lasting 24 hours. Standby time will not be paid at the conclusion of test pumping. The Engineer shall be present at the start of all test pumping.

B. Test pump requirements shall be determined following completion and development of the well when capacity is known. However, for preliminary planning purposes, the Contractor shall provide a pump capable of producing 100 gpm from a pumping water level of 400 feet and set at a depth of 450 feet. The Contractor shall furnish and install all necessary equipment for testing, including a discharge valve or throttle to control flow rate, orifices or flow meter for accurately measuring the discharge from the well, a pressure gage upstream from the throttling valve, a sampling tap, and a nominal 1-inch pipe to the top of the pump to facilitate the installation and removal of an electric-line well sounder or pressure transducer. The Contractor shall record flow rate, pressure, and pumping water level on a regular basis as directed by the Engineer.

C. The Engineer shall be responsible for collecting water quality samples during the pumping test.

D. The Contractor shall record flow rate, pressure, and pumping water level on a regular basis as directed by the Engineer. Typically, pumping water levels are measured on every 5-minutes during step rate testing. During constant-rate testing, water levels are measured every minute for the first 10 minutes, every 5 minutes until 1 hour, every 15 minutes until 12 hours, and every 30 minutes for the final 12 hours

E. The Contractor shall be responsible for providing power for the test pump. The Contractor shall provide a means for safe refueling during operations to prevent even brief shutdowns during the testing. Shutdowns before the end of the testing procedure in excess of ten (10) percent of the total time anticipated for this testing procedure may require the Contractor to allow the water level to recover to pre-pumping conditions and re-start the test, as determined by the Engineer.

3.09 WATER QUALITY PROTECTION

A. All water used for drilling and development operations shall be of potable quality.

B. The Contractor shall take all necessary precautions to prevent contamination of the water in the well by the introduction of any foreign substance, including contaminated water, gasoline, oil, etc., and shall conform to all laws or regulations applicable to the protection of water quality.

C. Facilities, equipment, and materials for disposing of the water produced during the development and testing of the well shall be provided by the Contractor. Water leaving the well site shall be free of chemicals and seal materials. The Contractor shall implement BMPs to prevent sediment and other pollutants from leaving the well site or water disposal area. Water shall not be discharged to streams, ponds, or lakes without proper regulatory authorization.

3.10 PLUGGING AND ABANDONMENT

A. In the event that the Contractor fails to complete the well to the designed depth, or should he abandon the well because of loss of his tools or equipment downhole, or for any other cause related to deficiencies in his equipment or performance, the Contractor shall plug and abandon the well in accordance with State regulations after removing as much casing as can be salvaged. All salvaged materials furnished by the Contractor shall remain his property.

3.11 FINAL CLEANUP

A. After completion of all Work associated with this contract, the Contractor shall clean up the Work site and any property used by his operations to the satisfaction of the Owner. The Contractor shall remove and dispose of all excess materials resulting from his work, and shall repair, replace, or restore all property of any type or nature that has been moved, damaged, or altered in any way by his operations, to the satisfaction of the Owner. The Contractor shall return all landscape, roadway, and adjoining surfaces to their original condition and appearance as soon as reasonably feasible.

PART 4 - MEASUREMENT AND PAYMENT

4.01 SCOPE

A. The quantities of work or material stated in unit price items of the Bid are supplied only to give an indication of the general scope of the Work; the Owner does not expressly or by implication agree that the actual amount of work or material will correspond therewith, and reserves the right after award to increase or decrease the quantity of any unit price item of the Work, without a change in the unit price, and shall include the right to delete any Bid item in its

entirety. Payment for materials and labor will be based on actual quantities furnished, installed, or constructed in accordance with the prices bid for unit price items.

B. The Owner may terminate Work on the project at any point if, in the Owner's judgment, the Owner's best interests are not served by continuation. Conditions which may lead to project termination include, but are not limited to, indications of low groundwater development potential as determined during drilling, , and testing. In such an event, the Contractor shall be paid for the value of Work completed at that time on the basis of the unit price and lump sum items listed on the Bid Schedule. In addition, if well construction is terminated by decision of the Owner, the Contractor may be required to properly abandon the well. Well abandonment procedures in excess of those explicitly required in these specifications must comply with current Oregon State regulations. Materials used in abandonment shall be paid at invoice cost plus 10 percent to cover handling. Payment for rig time shall be at the bid unit price.

C. No payment shall be made for tests of borehole plumbness and alignment; it shall be the responsibility of the Contractor to ensure that the hole remains within plumbness and alignment specifications.

D. No payment shall be made for drilling fluid materials used during normal drilling operations. All such costs shall be considered to be included in the unit prices listed on the Bid Schedule.

E. No payment shall be made for time or expenses incurred in the recovery or replacement of tools or equipment lost during the drilling phase or any other phase of the Work.

F. No payment shall be made for time, materials, or labor costs incurred during remedial measures or operations in the event the well is of unacceptable plumbness or alignment.

G. No payment shall be made for time, materials, or labor costs incurred in abandoning the well in the event the well is of unacceptable plumbness or alignment following remedial measures, or if lost tools or equipment cannot be recovered from the borehole. The costs incurred for construction of the abandoned well shall be applied to construction of a replacement well.

4.02 MOBILIZATION/DEMOBILIZATION (ITEM 1; LUMP SUM ITEM)

A. Measurement for payment for mobilization/demobilization to the work site will be based upon completion of the Work as a lump sum unit. The lump sum price listed on the Bid Schedule shall be full compensation for the moving in of rigs, pumps, equipment, power, labor, fuel, tools, and incidentals necessary to do the Work, and moving out of all such equipment, materials, tools, and incidentals, and well disinfection and final site cleanup upon completion of the Work. For purposes of partial payment, the mobilization portion of this bid item shall be considered as 60% of the total lump sum.

B. The lump sum price listed on the Bid Schedule shall include full compensation for obtaining a well drilling permit, and for providing erosion and sediment control during drilling and testing operations.

4.03 DRILL FOR, FURNISH, INSTALL, AND SEAL 8-INCH WELL CASING (ITEM 2; PRICES BASED ON LINEAR MEASUREMENT)

A. Measurement and payment for the drilling of the borehole, installing the well casing, and sealing the well casing will be based upon the number of feet of well casing actually installed in accordance with these Contract Documents. Payment for drilling and casing shall constitute full compensation for temporary casing, casing extraction, casing, seal materials, miscellaneous materials, transportation, labor, fuel, bits, drilling fluids, equipment, and incidentals necessary to install the well casing.

4.04 DRILL BOREHOLE BELOW THE WELL CASING (ITEM 3; PRICES BASED ON LINEAR MEASUREMENT)

A. Measurement and payment for the drilling of the nominal 8-inch borehole below the well will be based upon the number of vertical linear footage actually drilled below the bottom of the 8-inch casing in accordance with these Contract Documents. Payment for drilling the borehole shall constitute full compensation for miscellaneous materials, transportation, labor, fuel, bits, drilling fluids, equipment, and incidentals necessary to drill the borehole.

4.05 FURNISH AND INSTALL 6-INCH I.D. LINER (ITEM 4; PRICES BASED ON LINEAR MEASUREMENT)

A. Measurement for payment for the nominal 6-inch steel or PVC liner will be based upon the number of linear feet of such pipe actually installed in the borehole in accordance with these Contract Documents. Payment for the 6-inch liner shall constitute full compensation for materials, transportation, labor, fuel, equipment, perforating, centralizers, welding materials, and incidentals necessary to furnish and install the liner.

4.06 FURNISH, INSTALL, AND REMOVE TEST PUMP AND RELATED EQUIPMENT (ITEM 5; LUMP SUM ITEM)

A. Measurement and payment for furnishing, installing, and removing the test pump and related equipment will be based upon completion of the entire Work as a lump sum unit, all in accordance with the requirements of these Contract Documents. Payment for furnishing, installing, and removing will be at the price listed in the Bid Schedule, which price shall constitute full compensation for all work, including installation and removal of pump, motor, cable, controls, valves, orifices, temporary piping, and associated appurtenances.

4.07 TEST PUMPING (ITEM 6; PRICES BASED UPON TIME, HOURS)

A. Measurement and payment for test pumping will be based on the actual number of hours of pumping operations. Payment for test pumping will be made at the unit price listed in the Bid Schedule, and shall constitute full compensation for all labor, fuel, equipment, and materials associated with operating the test pumping equipment.

B. No payment shall be made for standby time during the recovery periods between tests or for time spent transporting or maintaining equipment. All such costs for time and maintenance materials shall be included in the unit price listed in the Bid Schedule.

C. No payment shall be made for time, equipment, or materials used in a test aborted due to power failure or malfunction of pumping equipment.

4.08 PLUGGING AND ABANDONMENT

A. In the event the well, successfully completed in accordance with these Contract Documents, requires plugging and abandonment, the cost for this work will either be negotiated with the Contractor or performed by others. The costs for plugging and abandonment of the well successfully completed in accordance with these Contract Documents shall not be considered as subsidiary to other bid items in the contract.

- END OF TECHNICAL SPECIFICATIONS -