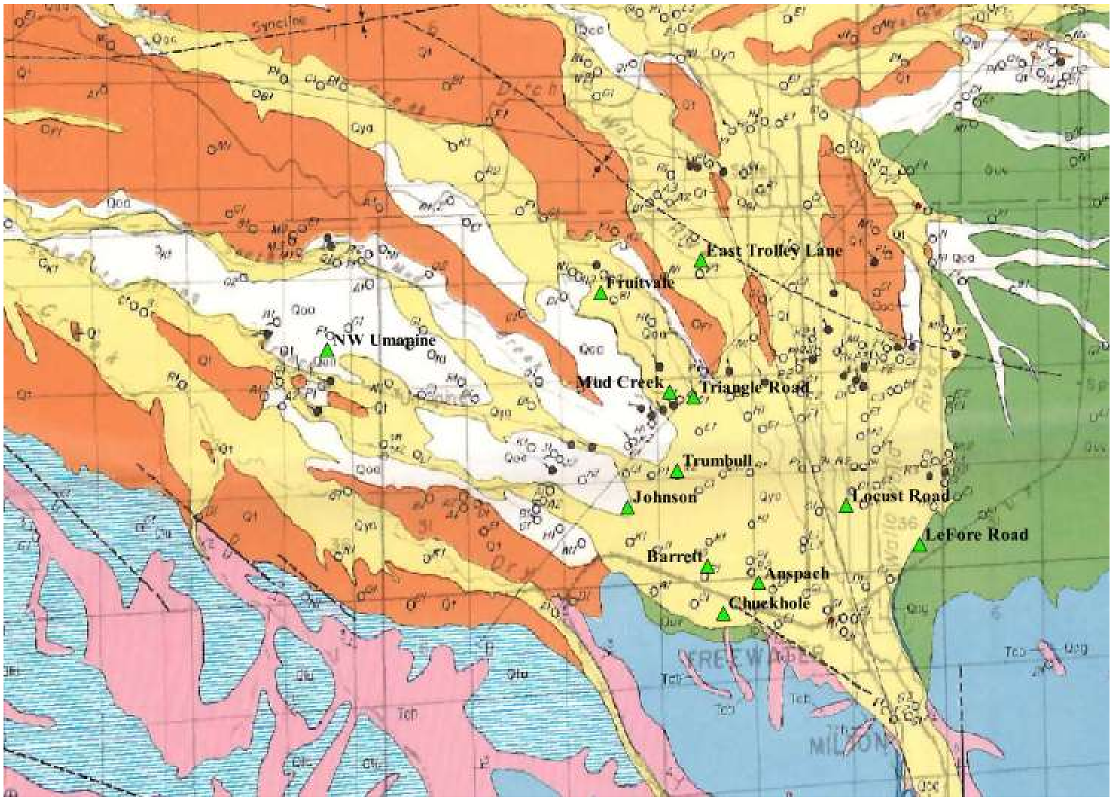
Walla Walla Basin Watershed Council

Water Year 2018

Oregon Walla Walla Basin Aquifer Recharge Report



FINAL REPORT

February 2019

Water Year 2018

Oregon Walla Walla Basin Aquifer Recharge Report

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EXECUTIVE SUMMARY

This report summarizes Water Year (WY) 2018 aquifer recharge operations at the Anspach, Barrett, Chuckhole, East Trolley Lane, Fruitvale, Johnson, LeFore, Locust Road, Mud Creek, NW Umapine, Triangle Road, and Trumbull sites and supporting groundwater level and surface water and groundwater quality monitoring data. The twelve aquifer recharge sites were operated under Limited License 1621(LL-1621) issued by the Oregon Water Resources Department. This report was prepared per Condition 11 of LL-1621 requiring annual reporting of aquifer recharge site operations and data collected in fulfillment of the water level and water quality monitoring plan.

Source water for the nine aquifer recharge sites was diverted from the Walla Walla River at the Little Walla Walla Diversion in Milton-Freewater, OR. The water was delivered through the existing irrigation system to each site's turnout. The WY 2018 recharge season started November 23, 2017 and ended May 15, 2018, with 146 days of active recharge operations at the site with the longest operation period. Annual cleaning of the fish screens at the Little Walla Walla Diversion prevented recharge operations from February 6 to March 2. The total amount of water diverted under LL-1621 for the WY 2018 recharge season, including estimated seepage losses, was 8,338 acre-feet (ac-ft). While various estimates exist of the size of the alluvial fan, using an estimate of 10 mi^2 for the central portion of the fan, if the recharge water had instead been flood waters, the volume recharged would have covered the entire alluvial fan with 1.3 feet of water if it had been released instantaneously.

Water level and water quality data were collected in accordance with the approved monitoring plan for LL-1621. Groundwater monitoring wells in the vicinity of the recharge sites responded to recharge activities, with groundwater elevations increasing and decreasing as recharge operations began and ended. After recharge operations ended on May 15, 2018, water levels at a few monitoring wells remained static or increased in response to increased seepage through the fully charged ditches/canals and percolation from irrigation.

Groundwater and surface water quality data collected during aquifer recharge activities do not indicate that aquifer recharge activities are degrading groundwater quality. Source water quality being delivered to the aquifer recharge sites was generally of good quality.

Spring performance and the potential factors influencing spring performance were evaluated. Annual yield (ac-ft of water per year) increased over time in 9 of the 12 springs evaluated. Of the factors assessed which influence spring performance, the operation of the managed aquifer recharge program was the only factor which could have reasonably resulted in the observed pattern of increased yields. Changes over time in the other factors would have resulted in decreased or variable spring performance. Because of the data gaps, qualitative nature of some of the information obtained, and limited number of monitoring sites evaluated, these results should be considered as provisional and preliminary.

Continued operation of the twelve current sites and the addition of four new aquifer recharges sites under LL-1621 is expected in WY 2019.

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LIST OF ACRONYMS

ac-ft	acre-foot
bgs	below ground (or grade) surface
°C	degrees Centigrade
cfs	cubic feet per second
gpm	gallons per minute
GW_##	Groundwater well #, e.g. GW_14, GW_171
HBDIC	Hudson Bay District Improvement Company
LL	Limited License
mg/L	milligrams per liter
ND	not detected
OWRD	Oregon Water Resources Department
µg/L	micrograms per liter
µS/cm	microsiemens per centimeter
WWBWC	Walla Walla Basin Watershed Council
WWRID	Walla Walla River Irrigation District
WY	water year

INTRODUCTION

This report describes groundwater elevation data, surface and groundwater quality data, and aquifer recharge operations during water year (WY) 2018 (October 1, 2017 – September 30, 2018) for the managed aquifer recharge program conducted by the Walla Walla Basin Watershed Council (WWBWC) in cooperation with the Hudson Bay District Improvement Company (HBDIC), Fruitvale Water Users Association, and Walla Walla River Irrigation District. The recharge program began operating in 2004 at a pilot project, the Johnson site in Oregon. The program has gradually expanded to the 12 sites operational in WY2018. For more background on the aquifer recharge program and the Walla Walla basin's hydrology and geology, please see the *Walla Walla Basin Aquifer Recharge Strategic Plan* (WWBWC, 2013, available at www.wwbwc.org/projects/recharge.html).

In the Walla Walla basin, declines in the aquifer and associated surface water performance are attributed to the change in management of the valley's distributary channels, channelization of the Walla Walla River system, lining irrigation canals, and increased use of groundwater (pumping). As described in the *Walla Walla Basin Aquifer Recharge Strategic Plan* (2013), the following benefits are expected if the annual volume recharged reaches 20,000 ac-ft:

> "Reversing the loss of storage within the alluvial aquifer will minimize seepage loss in the valley's rivers and streams, increase spring performance and related groundwater input to surface water features, and allow groundwater resources of the alluvial aquifer to continue to be used as a sustainable resource with a secondary or alternative-use benefit to surface water." (p. 79).

During WY 2018, active recharge sites were Anspach, Barrett, Chuckhole, East Trolley Lane, Fruitvale, Johnson, LeFore, Locust Road, Mud Creek, NW Umapine, Triangle Road, and Trumbull. These sites were operated under Limited License LL-1621 (Appendix A) issued by the Oregon Water Resources Department (OWRD) on October 18, 2016. Source water for aquifer recharge was diverted from the Walla Walla River near Milton-Freewater between November 23, 2017 and May 15, 2018. During WY2018, the maximum diversion rate needed to deliver the recharge water, taking into account ditch seepage losses, was 31 cubic feet per second (cfs). The sites operated from 40 to 146 days depending on water availability and ditch management. The total amount of water diverted was 8,338 acre-feet (ac-ft)[1], more volume than any previous year (Figure 1 and Table 1). This increase was primarily due to the increased ditch seepage resulting from more miles of the conveyance network being needed to deliver water to more sites at diverse locations; these seepage losses provided 45% of the water recharged to the aquifer (Figure 2). This achieved one of the design goals of the MAR program -- to place recharge sites near the ends of the conveyance systems to maximize seepage losses and increase the cost-effectiveness of each recharge site due to the added benefit of "passive" recharge from the unlined ditches and canals.

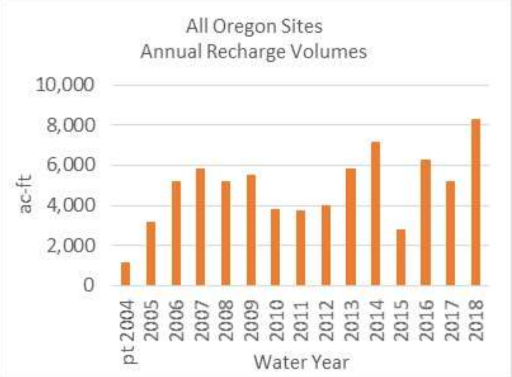

Figure 1. Annual recharge volumes by year.

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[1] One acre-foot is the amount of water needed to cover one acre (a little less than a football field) with one foot of water.

Table 1. Annual recharge volumes (ac-ft) by site, WY2004-2018.

Recharge volumes (ac-ft)														
Recharge Year	**Anspach**	**Barrett**	**Chuck-hole**	**East Trolley**	**Fruitvale**	**Johnson**	**LeFore**	**Locust**	**Mud Creek**	**NW Umapine**	**Triangle Rd**	**Trumbull**	**Conveyance Losses**	***Sum***
2004	--	--	--	--	--	409	--	--	--	--	--	--	714	***1,123***
2004-5	--	--	--	--	--	1,871	--	--	--	--	--	--	1,277	***3,148***
2005-6	--	--	--	--	--	2,813	--	--	--	--	--	--	2,342	***5,154***
2006-7	--	--	--	--	--	3,234	--	--	--	--	--	--	2,739	***5,772***
2007-8	--	--	--	--	--	2,739	--	--	--	--	--	--	2,406	***5,145***
2008-9	--	--	--	--	--	2,840	--	--	--	--	--	--	2,667	***5,507***
2009-10	--	--	--	--	--	3,734	--	--	--	--	--	--	not estimated	***3,734***
2010-11	--	--	--	--	--	3,700	--	--	--	--	--	--		***3,700***
2011-12	--	--	--	--	--	3,974	--	--	--	--	--	--		***3,974***
2012-13	12	--	--	--	--	4,556	--	--	--	--	--	84	1,175	***5,826***
2013-14	127	210	--	--	--	4,515	--	--	--	499	--	421	1,385	***7,157***
2014-15	23	200	--	--	--	1,560	--	--	--	190	--	116	696	***2,786***
2015-16	532	286	--	--	--	3,959	--	--	--	170	--	262	1,021	***6,230***
2016-17	660	383	13	--	17	2,732	--	--	8	183	13	170	968	***5,148***
2017-18	251	179	25	52	35	3,518	78	56	32	233	103	67	3710	**8,338**
Sum	1,605	1,258	38	52	52	46,154	78	56	40	1,275	116	1,120	21,100	72,742

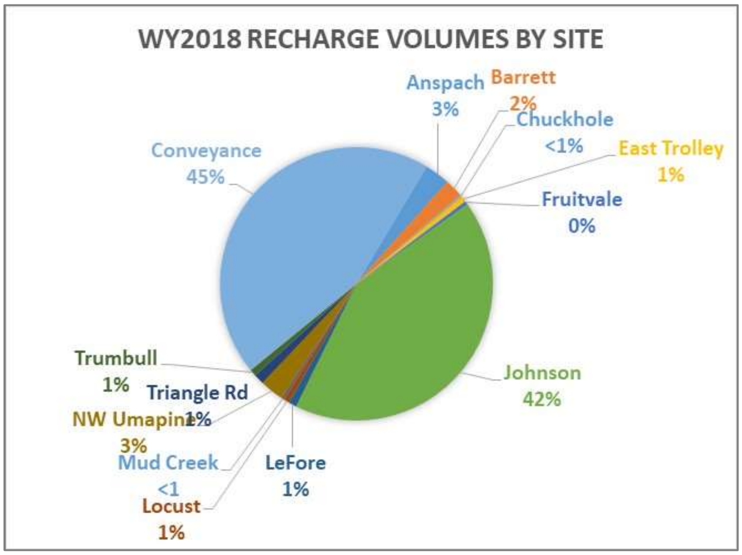


Figure 2. WY2018 recharge volumes by site.

Changes from last year include the following:

- operating three new sites for their first year (East Trolley, LeFore, and Locust),
- increased recharge volumes due to a broader distribution of sites which required using more miles of unlined ditches and canals,
- more days of operation at Chuckhole, Fruitvale, Johnson, Mud Creek, and Triangle Road, and
- decreased recharge volumes at Anspach and Barrett due to operational issues.

Per Condition 11 of LL-1621, the WWBWC is required to submit an annual report that provides a detailed description of aquifer recharge operations and source and groundwater observations during the aquifer recharge period. The annual report's main goals are to: (1) provide data to evaluate how aquifer recharge operations are influencing groundwater quality and groundwater levels; and (2) provide recommendations for modifications to the monitoring program and recharge operations based on site operations and interpretation of the data. Diverted surface water volumes, recharge volumes and rates, groundwater elevations, source water quality and ground-water quality data were collected in accordance with the approved monitoring plan for LL-1621, available at http://www.wwbwc.org/images/Projects/AR/Reports/2016_LL1621_WQPlan_FINAL_sp.pdf. In this year's report, although not required by the limited license, spring performance is also assessed.

Appendices are provided at the end of the report. Groundwater level data in the OWRD requested format were transmitted separately to the OWRD.

HYDROLOGIC SETTING

The Walla Walla River system is a bi-state watershed located in northeast Oregon and southeast Washington (Figure 3). The headwaters are located in the Blue Mountains, the crest of which defines the eastern extent of the watershed. The mainstem Walla Walla River and its primary tributaries, Mill Creek and the Touchet River, are the three primary surface water channels of the system. They coalesce within the Walla Walla Valley from which the Walla Walla River then flows to the Columbia River. This report focuses on the Oregon portion of the watershed, including the Walla Walla River mainstem and the distributary network, especially where they flow onto and across the Walla Walla Valley.

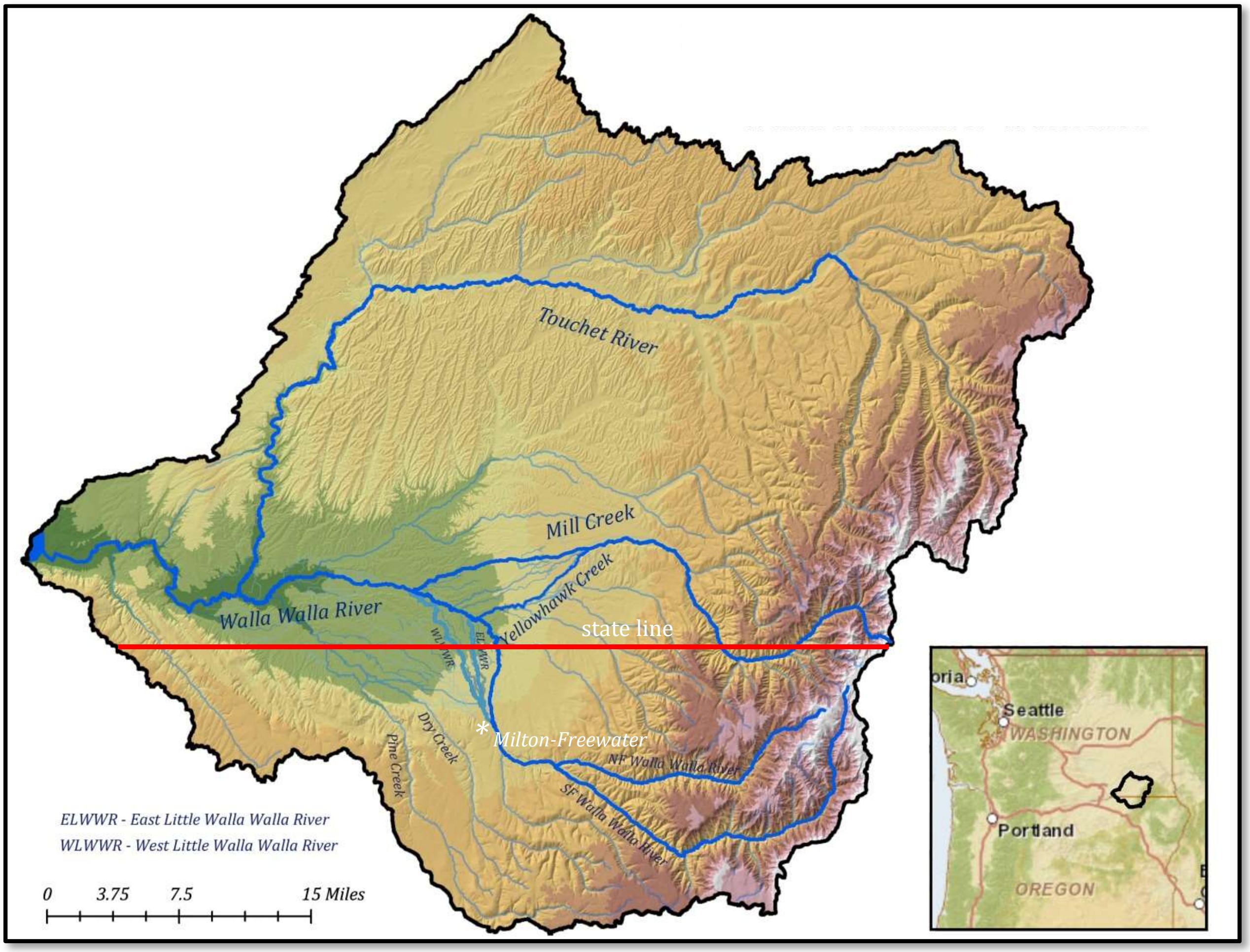


Figure 3. Walla Walla Watershed, including the Walla Walla River and its major tributaries and distributaries.

Walla Walla basin hydrology is largely defined by a distributary river system and an underlying alluvial aquifer system hosted by the sediments overlying the basalts. Surface waters entering the Walla Walla Valley changes regimes from steep sided canyons in the headwaters portion of the watershed to a system of distributary and coalescing streams on the central valley floor. With this, shallow groundwater systems see a regime change from localized, saturated valley deposits and confined basalt aquifers controlled by the geologic structure of the Columbia River basalt typical of the highland areas to the more widespread, thick alluvial aquifer system immediately underlying the valley floor. Depth to basalt beneath the base of the canyon floors in the highland areas upstream of the cities of Walla Walla and Milton-Freewater is typically less than 60 feet, with 30 feet more commonly observed. Beneath the central valley floor the top of basalt often is hundreds of feet deep below overlying alluvial sediments.

Groundwater in the Walla Walla basin occurs in two principal aquifer systems: (1) the unconfined to confined suprabasalt sediment (alluvial) aquifer system; and (2) the underlying confined basalt aquifer system (Newcomb, 1965). The basalt aquifer system is regional in character, having limited hydraulic connection to the Walla Walla River, primarily in the canyons of the Blue Mountains. The alluvial aquifer system is the focus of the aquifer recharge program because of its high degree of hydraulic connection with streams on the valley floor.

The alluvial aquifer system, or alluvial aquifer, is found within a sequence of continental clastic sediments overlying the top of basalt (the Mio-Pliocene strata [upper coarse, fine and lower coarse units] and the Quaternary coarse unit). Beneath the Walla Walla Valley floor these sediments, and the alluvial aquifer system, is up to 800 feet thick. The majority of the productive portions of the alluvial aquifer system are hosted by the Mio-Pliocene coarse unit. The alluvial aquifer is generally characterized as unconfined, but it does, at least locally, display evidence of confined conditions. Preferential groundwater flow within the alluvial aquifer is inferred to largely reflect the distribution of coarse sedimentary strata. General groundwater flow direction is from east to west based on contoured groundwater elevations in the alluvial aquifer (Figure 4).

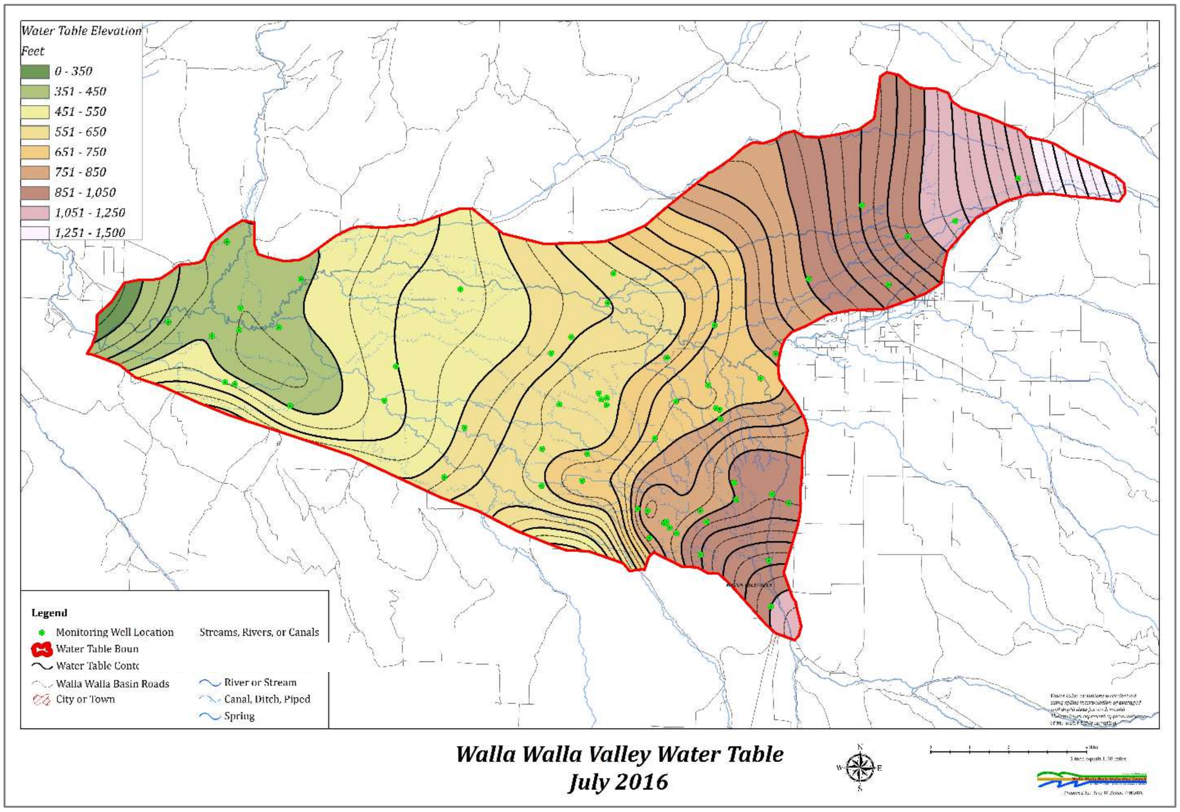


Figure 4. Water table elevation contours for the alluvial aquifer in July 2016.

The surficial hydrology of the Walla Walla basin generally is characterized by streams confined to steep-walled canyons in the foothills surrounding the valley, a distributary stream system as these streams exit the highlands and flow out onto the valley floor, and then, as the streams flow west, they coalesce into the main Walla Walla River channel. The distributary system formed as streams leaving the highlands entered the valley, went from higher to lower gradient and, as a consequence, deposited coarse sediment loads and formed a series of low angle, coalescing alluvial fans. Upon the alluvial fans in and around the cities of Walla Walla and Milton-Freewater these natural distributary channels still exist in part or in whole to this day. These channels are known today as the East Little Walla Walla River, West Little Walla Walla River, Mud Creek, Yellowhawk Creek, and Garrison Creek.

Prior to the development of water resources in the valley, these distributary channels, with other unnamed channels, conveyed large amounts of energy and water across the alluvial fan and away from the mainstem Walla Walla River and Mill Creek. These stream networks also provided off-channel habitat for aquatic species and provided recharge to the alluvial aquifer system. The distributary channels on the Milton-Freewater alluvial fan run for several miles, accumulating spring flow, before returning back to the river further down the valley (Figure 5).

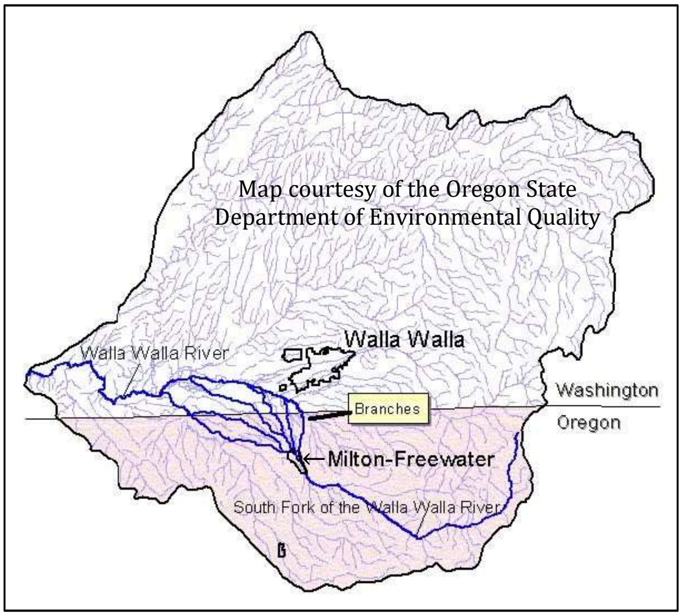
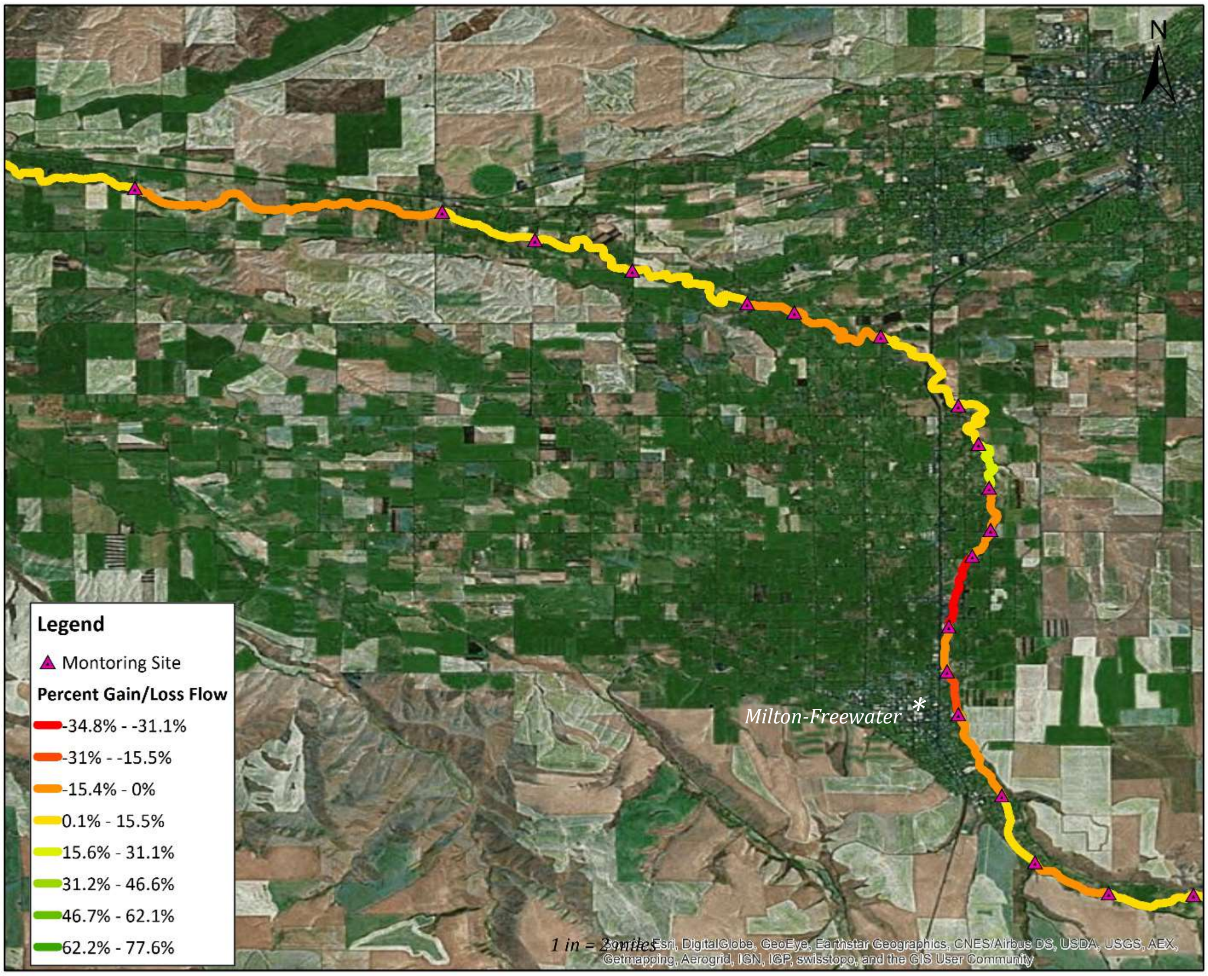


Figure 5. Distributary stream networks of the Walla Walla River originating on the Milton-Freewater alluvial fan.

Historically, the 'spreading out' of water across the alluvial fans via distributary channels and adjacent floodplains, coupled with the high hydraulic conductivity of the underlying coarse sediment, functioned as the primary groundwater recharge mechanism for the entire alluvial aquifer. Seven miles of levees were constructed along the Walla Walla River to protect the Milton-Freewater community from flooding, greatly reducing this natural floodplain connection and natural recharge of the groundwater system. Under current conditions, irrigation is also an important source of recharge from irrigation conveyance losses and on-farm irrigation practices. The seasonally recharged aquifer system feeds the valley's springs, spring creeks and larger streams. This cycling of surface water to groundwater recharge, followed by later discharge in springs and streams creates a delay in discharge of these waters from the valley. The delay can range from days to months and even years (Jiménez, 2012).

The steep gradients between alluvial aquifer water levels and water in the river, coupled with the high hydraulic connectivity between surface water and alluvial groundwater, results in losing reaches along the streams and/or rivers where high seepage loss occurs -- in some reaches greater than 30 percent (Figure 6). Instream flow is decreased as significant volumes of surface water drain to the underlying alluvial aquifer. In Figure 6, gains (positive values) indicate groundwater discharging to the river and losses (negative values) indicate surface water seeping into the ground (see WWBWC, 2017 for details).



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 6. Average percent gains or losses in flow of a segment of the Walla Walla River during seepage runs conducted 2004-2016.

In recent years, the listing of steelhead and bull trout as threatened under the Endangered Species Act and the reintroduction of spring chinook salmon within the Walla Walla basin have led to out-of-court settlement agreements between irrigators and federal fishery agencies to enhance instream flows. As a result of these agreements, local irrigators leave a portion of their legal water rights instream year-round. Since 2003, the HBDIC and Walla Walla River Irrigation District voluntarily leave 25-27 cfs of their water right in the river – roughly one-quarter of the discharge leaving the mountains during the summer. The water left in-stream is called “bypass” water. Depending on the water year, it is not unusual to have a significant portion (40-50%) of the bypass water seep into the underlying alluvial aquifer before it reaches the Washington-Oregon border (WWBWC, 2014a).

Flows in springs discharging from the alluvial aquifer and in creeks fed by the springs have decreased since the hydrogeological study conducted by Piper, Robinson and Thomas in the 1930s, (Piper *et al*., 1933); they noted spring discharge in the Big Spring area began decreasing around 1900. By 2009, McEvoy and Dugger springs were dry for portions of the year, while in the 1930's their flows during the summer were 4-6 cfs and 8-10 cfs, respectively (Figure 7) (Bower and Lindsey, 2010). Groundwater level declines in the alluvial aquifer since the 1940s (Figures 8 and 9) are consistent with the decline in discharge from springs sourced in the shallow aquifer. Out of 11 long-term state observation wells, all had downward trends and three were completely dry by 2009 (Bower and Lindsey, 2010).

As a result of these changes over the past several decades, there has been a general decrease in groundwater contributions to baseflow of the Walla Walla River and other surface water bodies during critical low-flow periods. The loss of cooler groundwater baseflow to streams affects not only the amount of flow in the river but also leads to increased surface water temperature during the low-flow periods, affecting aquatic species and the stream ecosystem. Historically, the estimated yield from 57 surveyed springs was 50,000 ac-ft (Oregon State Water Resources Board, 1963), or 69 cfs on an annual basis.

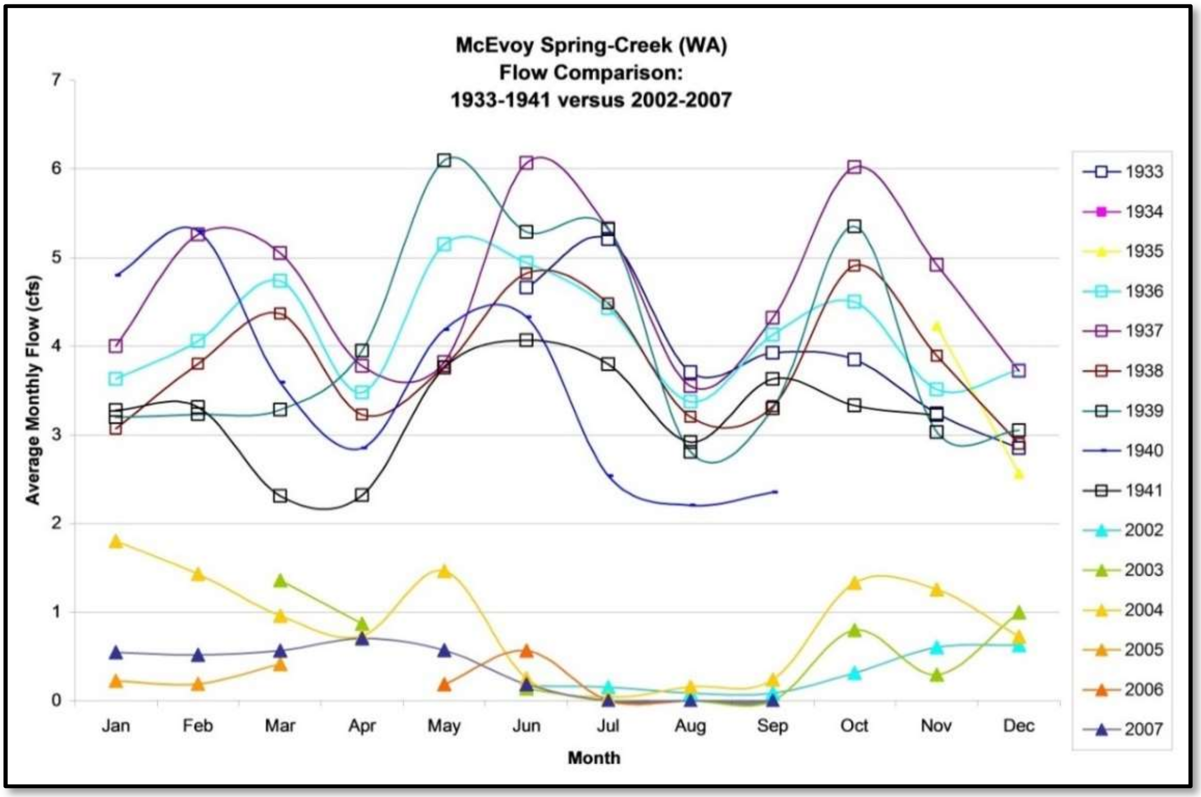


Figure 7 - Hydrograph for McEvoy Spring Creek showing the decline in flows between 1933-1941 and 2002-2007.

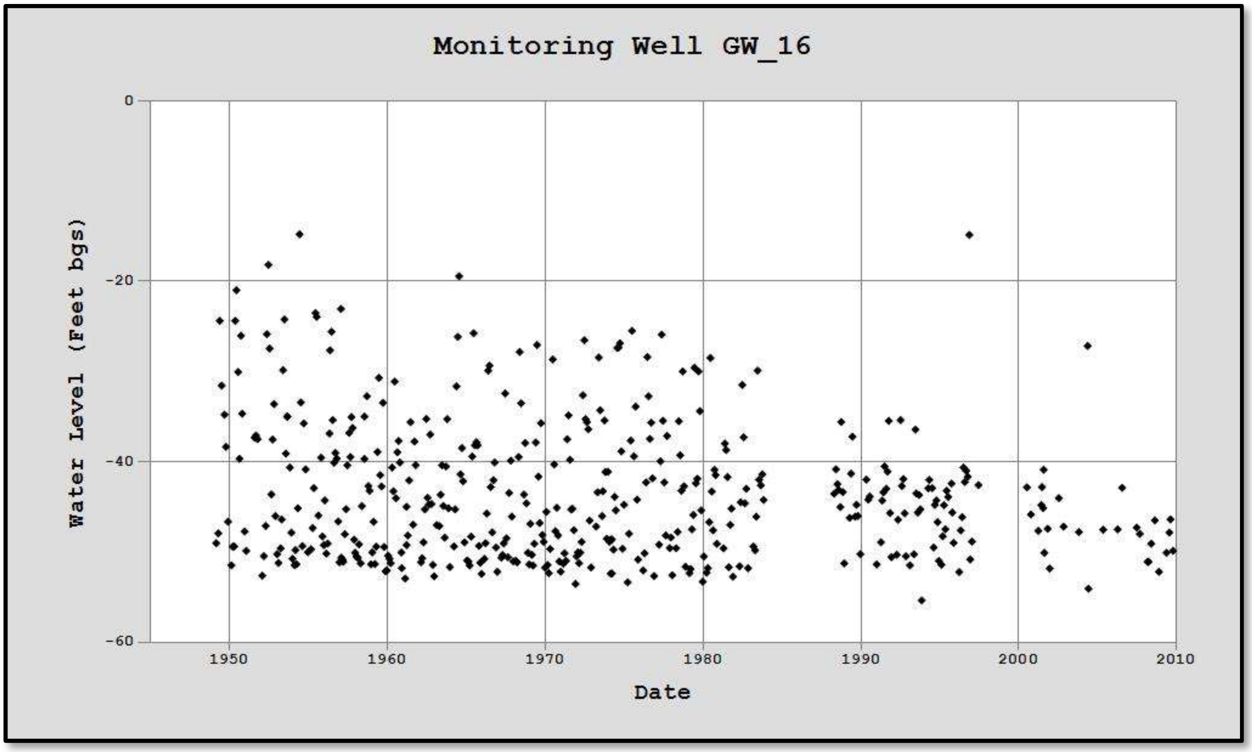


Figure 8. Long-term hydrograph for monitoring well GW_16.

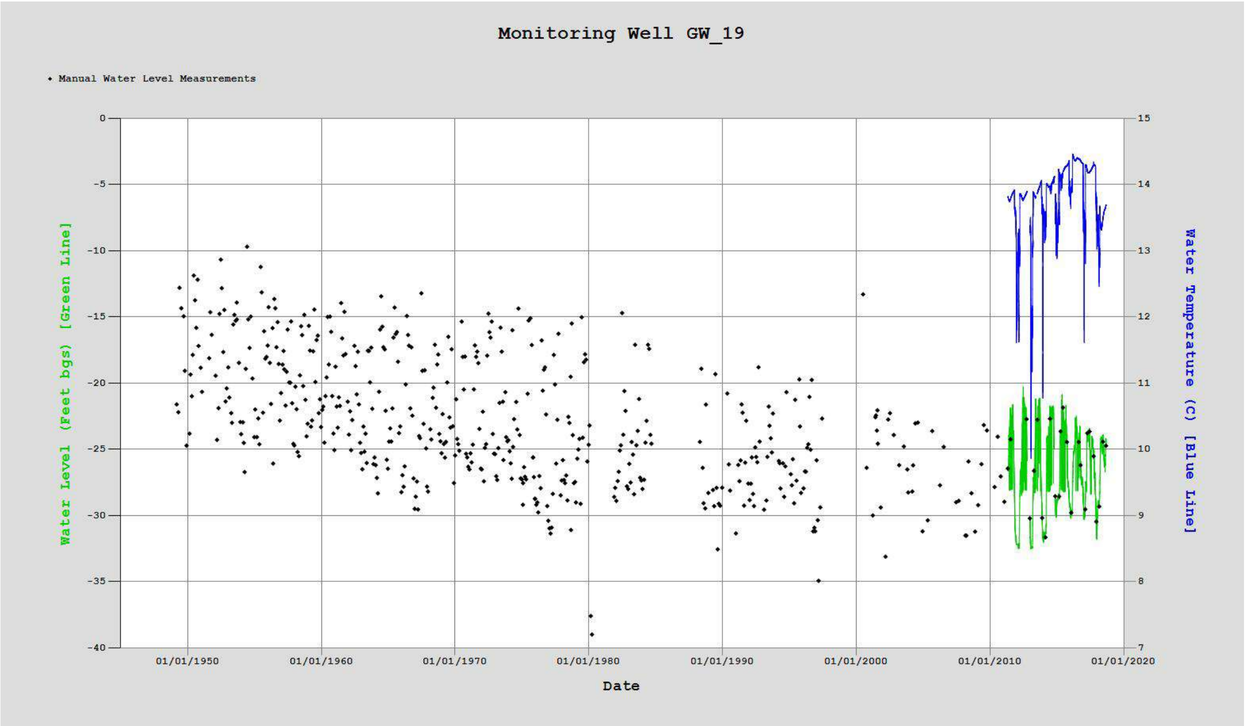


Figure 9. Long-term hydrograph for monitoring well GW_19.

DESIGN AND OPERATION OF AQUIFER RECHARGE SITES

The Anspach, Barrett, Chuckhole, East Trolley Lane, Fruitvale, Johnson, LeFore, Locust Road, Mud Creek, NW Umapine, Triangle Road, and Trumbull aquifer recharge sites were in operation during WY2018 as part of the Walla Walla basin aquifer recharge program (Figure 10). Each site's design, construction and operational capacity is provided in the following sections. Design drawings for older sites are included in past annual reports; designs for new sites reported for the first time in this annual report are included in Appendix B.

As in previous years, some sites are operating at less than the maximum design capacity. Depending on the site, this is commonly due to physical conditions which prevent attaining the maximum design capacity (such as the volume, depth or position of the source water being unable to completely fill the site's inflow pipe, biofouling of inlet screens, frozen ditches, or lower than initially estimated infiltration rates), competing demands for water (stock watering or irrigation), or operational limitations (equipment failures, groundwater mounding, clogging of coarse cobble substrate with fine sediment accumulated over years of operation, etc.)

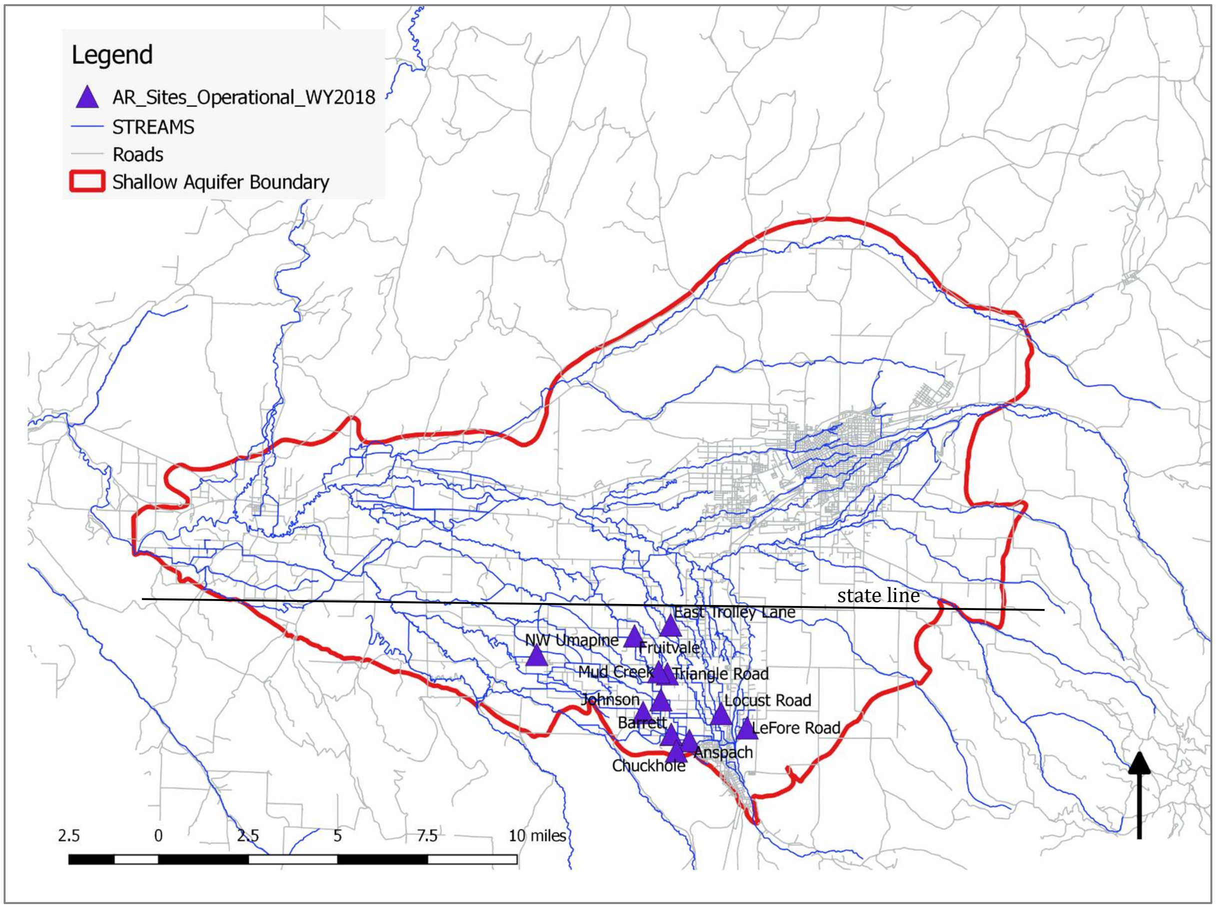


Figure 10. Recharge sites in the Oregon portion of the Walla Walla basin during WY2018 and extent of the shallow aquifer boundary.

ANSPACH SITE

The Anspach site was constructed in October 2012 then expanded in the fall/winter of 2015. The site consists of a single turnout structure installed in the HBDIC canal that delivers water to a pipeline serving two separate infiltration galleries. Each infiltration gallery is independently controlled via valves and turnout pipes. In each gallery, the pipe manifolds into ten 4-inch diameter perforated drain field pipes buried 6 to7 feet below ground surface (bgs) and extends approximately 200 feet from the source water manifold (Figure 11). The perforated pipes sit on top of approximately 1 to 2 feet of clean gravel and are overlaid with approximately 0.5 to 1 foot of clean gravel.

Water for this site is delivered down the HBDIC's White Ditch and diverted into a private pipeline/ditch. The original site was designed to operate at a recharge rate of approximately 1 cfs while the maximum design capacity of the expanded site is 3.3 cfs (1,500 gallons per minute [gpm]). During the WY2018 recharge season, the site operated at an average of 628 gpm (1.4 cfs) due to operational issues (discussed in the Monitoring section).

Figure 11. Anspach site under construction in 2012 (left) and new intake structure in 2015 (right).

BARRETT SITE

The Barrett site was constructed in the winter of 2014. The site consists of seven 4-inch diameter perforated drain field pipes buried 4 to 5 feet bgs and extending approximately 600 feet from the source water manifold (Figure 12). The perforated pipes sit on top of approximately 1 to 2 foot of clean gravel and are overlaid with approximately 0.5 to 1 foot of clean gravel. Water for this site is delivered down the HBDIC's White Ditch and diverted into the Barrett pipeline. The Barrett site's turnout and valve are situated along the pipeline. The site was designed to operate at a recharge rate of approximately 2-3 cfs (900 to 1300 gpm). During the WY2018 recharge season, based on the totalizer volume divided by the number of days of operation, the average delivery rate to the site was 0.7 cfs but the average of the instantaneous flow rates noted during field visits was 1.4 cfs; the difference was due to two periods when the meter didn't record a flow rate (discussed in the Monitoring section).

Figure 12. Barrett site under construction.

CHUCKHOLE SITE

The Chuckhole site was constructed in the fall of 2015 (Figure 13) but could not begin operating until after LL-1621 was issued on October 18, 2016. The site has an infiltration basin (roughly 0.05 acres in size) and sediment settling pond, located near the end of the Milton pipeline. The site was expected to recharge approximately 300-400 gpm or just under 1 cfs. During WY2018, its second recharge season, the site operated at an average of 0.2 cfs. The reason for the low infiltration rate is not known.

Figure 13. Chuckhole site under construction.

EAST TROLLEY LANE SITE

The East Trolley Lane Aquifer Recharge site was constructed in October 2013 (Figure 14) but did not begin operations until November 2017 due to the complexities of installing a self-cleaning fish screen. The infiltration gallery has 4 lines of 4" perforated pipes each running approximately 600 feet immediately east of Trolley Lane (see Appendix B for designs), approximately ½ mile south of the Oregon/Washington border. Water is delivered from the Walla Walla River, down the Ford Branch to the West Little Walla Walla River, then into the Trolley Lane pipeline which serves multiple users, with a separate valve specifically for the recharge site. The site was expected to recharge 1-2 cfs. During WY2018, its first year of operations, the average recharge was 215 gpm or 0.5 cfs.

Figure 14. East Trolley Lane site under construction.

FRUITVALE SITE

The Fruitvale site was constructed in the fall of 2015 (Figure 15) but could not begin operating until after LL-1621 was issued on October 18, 2016. The site is an infiltration gallery with 12 lines of 4" perforated pipes 150' in length. The Fruitvale site is located within the Fruitvale Water Users Association system. The site was expected to recharge approximately 400 gpm or just under 1 cfs. During WY2018, its second recharge season, the site operated at an average of 0.3 cfs. The lower than expected recharge rate may have been a result of the low head (pressure from the gravity-fed system).

Figure 15. Fruitvale site under construction.

JOHNSON SITE

The Johnson site, formerly known as the Hudson Bay site and/or the Hulette Johnson site, has been operating since 2004. It is the largest site in the recharge program, with 10 infiltration basins covering 3 acres and three active infiltration galleries. The site was developed in three phases (Figures 16 and 17). In Phase I, the three original basins were constructed in the winter/spring of 2004 then expanded during 2005 to almost triple their original area. In Phase II, a hydraulically upgradient basin was added in 2006 and four infiltration galleries and an associated small overflow basin were added in the winter of 2009. In Phase III, from 2010-2011, four additional basins were added on the lower end of the property.

Four different infiltration gallery designs were installed at the site to evaluate each design's performance, longevity, and cost-benefit. Infiltration Gallery #1 was constructed of four corrugated 4-inch perforated pipe, Infiltration Gallery #2 was constructed of twenty 4-inch drain field pipe, Infiltration Gallery #3 was four 4-inch drain field pipe inside Stormtech stormwater chambers, and Infiltration Gallery #4 was a single 4-inch drain field pipe inside Atlantis stormwater devices (Figure 18). During the first season of testing Infiltration Gallery #1 clogged and has not been used since. For additional details on the Johnson site please see WWBWC (2010; 2013; 2014b).

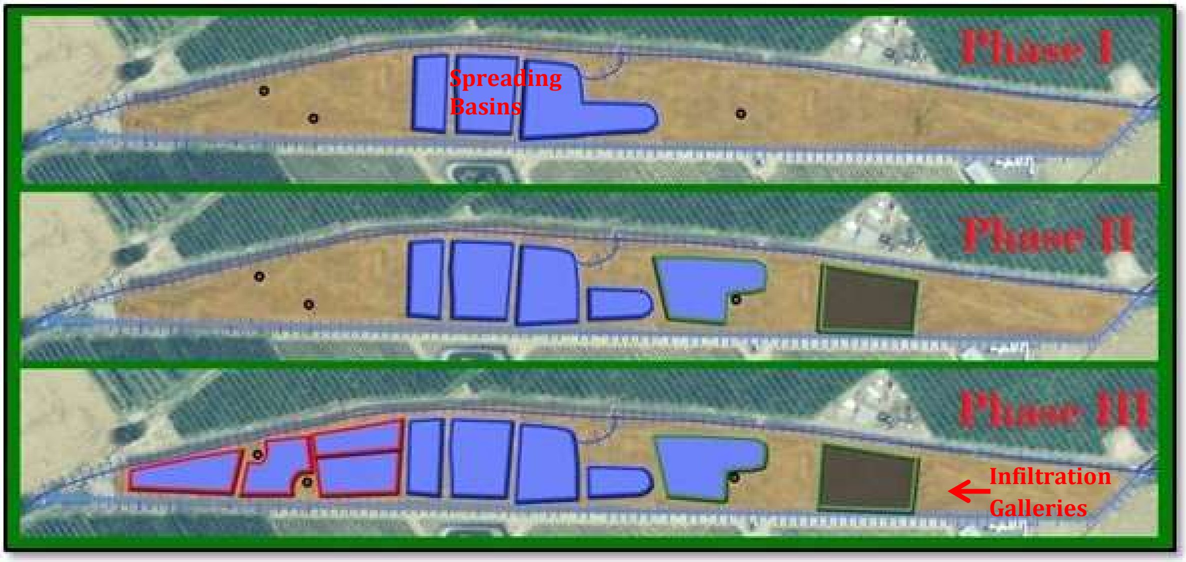


Figure 16. Three phases of constructing infiltration basins at the Johnson site: phase I in 2004-2005, phase II in 2006-2009 and phase III in 2010-2011.

Figure 17. Johnson site in 2013 showing 10 basins and location of infiltration galleries.

Figure 18. Infiltration galleries #2 (left), #3 (center), and #4 (right) being installed at the Johnson site.

The current site designed capacity is approximately 16 to 17 cfs (approximately 7,200 to 7,600 gpm) of infiltration into approximately 3 acres of infiltration basins and three infiltration galleries. During WY2018 the site operated at an average recharge rate of 12.1 cfs.

LEFORE ROAD

The LeFore Road site is located just northeast of the city of Milton-Freewater, OR. The site is an infiltration gallery basin design with three 4" perforated pipes 600' in length (see Appendix B for designs). The LeFore Road site is located in an orchard, off a private pressurized irrigation system. It is the only pressurized recharge site in the program. The site was constructed in the fall of 2014 (Figure 19). The site was expected to recharge approximately 300-400 gpm or just under 1 cfs. During WY 2018, its first year of operation, the site typically recharged 317 gpm or 0.7 cfs.

Figure 19. LeFore site under construction.

LOCUST ROAD SITE

The Locust Road site is located just north of the city of Milton-Freewater. It was constructed in the fall of 2016 (Figure 20). The site is an infiltration gallery with eight 4" perforated pipes 260' in length (see Appendix B for designs), located off of the East Branch Crockett ditch within the Walla Walla River Irrigation District. The site was expected to recharge approximately 600-800 gpm or 1-2 cfs. During WY2018, its first year of operation, typical recharge rates were 0.6 cfs or 251 gpm.

Figure 20. Locust Road site under construction.

MUD CREEK SITE

The Mud Creek site was constructed in the fall of 2015 (Figure 21) but could not begin operating until after LL-1621 was issued on October 18, 2016. The site is an infiltration basin approximately 0.6 acres in size within a grass pasture/wildlife area. Water for the project is delivered from the Fruitvale Ditch and then can overflow, if needed, back into the Fruitvale Ditch. The site is upgradient of the Mud Creek headwater springs and is expected to improve instream flows in Mud Creek and recover local groundwater levels. The site was expected to operate around 400-500 gpm or approximately 1 cfs. During WY2018, its second recharge season, the site operated at an estimated average of 0.3 cfs or 117 gpm.

Figure 21. Mud Creek site during construction.

The low recharge rate may be a function of the limitations of the method used to estimate recharge through the bottom of the basin but may also indicate a need to remove accumulated fine sediments from the bed of the basin.

NW UMAPINE SITE

The NW Umapine site was constructed in the fall of 2013. The site consists of a single infiltration basin approximately 0.46 acres in size (Figure 22). The site is supplied by an approximately 1,000-ft long lateral pipeline off of HBDIC's Richartz's pipeline. The site was designed to operate at a recharge rate of 2-3 cfs (approximately 900 to 1300 gpm). During the WY2018 recharge season the site averaged approximately 1.5 cfs or 664 gpm.

Figure 22. NW Umapine site during WY2014 recharge season.

TRIANGLE ROAD SITE

The Triangle Road site was constructed in the fall of 2016 (Figure 23). The site is an approximately 0.2-acre infiltration basin. Water is delivered from the Fruitvale Ditch and then can overflow, if needed, back into the Fruitvale Ditch. The site is upgradient of the Mud Creek headwater springs and is expected to improve instream flows in Mud Creek and recover local groundwater levels. The site was expected to operate around 400-500 gpm or approximately 1 cfs. In WY 2018, the site operated at an average of 0.9 cfs or 400 gpm.

Figure 23. Triangle Road site under construction in fall 2016.

TRUMBULL SITE

The Trumbull site was constructed in October 2012, consisting of three 8-inch perforated pipes buried 6 feet bgs and extending approximately 300 feet in length (Figure 24). The perforated pipes sit on top of 1-2 feet of clean gravel and are overlaid with 0.5-1 feet of clean gravel. The site's water source is at the structure that splits the HBDIC canal into the Hyline pipeline and the Richartz ditch. The site has its own turnout and valve so it can operate independently of the ditch or pipeline. The site was designed to operate at a recharge rate of 2-3 cfs (898 to 1347 gpm). During WY2018, the site operated at an average of 0.8 cfs or 379 gpm.

Figure 24. Trumbull site under construction in October 2012.

WY 2018 AQUIFER RECHARGE PROGRAM MONITORING

This section describes water availability, individual site operations, groundwater level monitoring, and source and groundwater quality monitoring results. Laboratory water quality testing results are provided in Appendix C.

LL-1621 allows for up to 70 cfs to be diverted from the Walla Walla River for the purpose of testing artificial recharge. Per the conditions of LL-1621, a minimum instream flow amount is required to remain in the Tum-A-Lum reach of the Walla Walla River depending on the time of year (Table 2). WWBWC coordinated with HBDIC and the OWRD District 5 Watermaster to ensure that this condition of LL-1621 was met during recharge operations in WY 2018. Managed recharge under the limited license did not begin until November 23, 2017 due to minimum flow requirements not being met prior to this date. Recharge was interrupted from February 6 to March 2 due to the annual maintenance of fish screens at the Little Walla Walla River diversion, which effectively ceases delivery of water to all canals and ditches from which the recharge sites receive their water. Diversions for aquifer recharge were terminated for the season on May 15, 2018 due to the end of the recharge season as defined in the Limited License.

Table 2. Minimum instream flows that must be met before water can be diverted for recharge under LL-1621.

Minimum Instream Flow Values for Limited License 1621		
Nov 1 thru Nov 30	***Dec 1 thru Jan 31***	***Feb 1 thru May 15***
64 cfs	***95 cfs***	***150 cfs***

Not all of the water diverted from the Walla Walla River reaches the recharge sites due to seepage through unlined portions of the canal system and/or evaporative losses. Because recharge operations occur during winter and spring months, evaporative losses are assumed to be negligible. To estimate ditch seepage losses during diversion, different seepage rates were applied to different segments of the conveyance system for the duration of recharge (Table 3). The resulting estimated cumulative seepage loss for WY2018 was 3,710 ac-ft.[2]

GROUNDWATER LEVELS

OVERVIEW

The groundwater monitoring network for the aquifer recharge program consists of 28 wells (Figure 25). For each recharge site, the following section presents the amount of water recharged during WY2018, a map of groundwater monitoring wells associated with the site, and results from monitoring groundwater levels. Of the 28 wells, 24 wells have at least three years of continuous data allowing a comparison of changes over time. Of these 24 wells, the annual shallowest or deepest groundwater levels increased between the first and most recent year of monitoring in 21 wells (Table 4).

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[2] The WY2017 annual report estimated seepage losses based on seepage rates from the WY2016 annual report, which were based on losses only from the HBDIC conveyance system. For WY2018, seepage losses are instead estimated for the unlined portions of the HBDIC, WWRID, and FWUA systems which deliver water to the recharge sites.

Table 3. Seepage loss estimates.

Segment	Segment length (miles)	Seepage loss rate (cfs or cfs/mile)	Data source	Recharge duration (days)	Convert cfs/mile to ac-ft/mile	Seepage loss (ac-ft) = ac-ft/mile x duration x miles
LWWR Diversion to Frog	1.6	0.5 total	WWBWC, average of 15 measurements from 2016-2018 was 1% loss. Assumed 50 cfs diversion, so 0.5 cfs loss.	146	1.0	227
White Ditch to Johnson	2.1	4.5 per mile	WWBWC, daily av loss 7.43 ac-ft over 1.1 miles	146		1085
Richartz to NW Umpine	3.0	3.5 per mile	HCP 2004: at 38 cfs 72% eff, so 28% loss = 10.6 cfs/3 miles = 3.5 cfs/mile	79	6.9	1632
From White Ditch to Barrett	0.1	0.3 per mile	HCP 2004: at low flow 3.8 cfs eff 87%, so 13% loss over 1.74 mi	134	0.6	8
From Frog to Crockett/Ford split	0.8	0.8 per mile	CTUIR & TFT: 0.5 cfs/km → 0.5 cfs/km x 1.6 km/mi = 0.8 cfs/mi	68	1.6	87
East Ford – LWWR West	0.8	0.8 per mile	CTUIR & TFT	68	1.6	91
Small segment West Ford	0.8	0.8 per mile	CTUIR & TFT	68	1.6	90
Small segment West Ford	0.9	0.8 per mile	CTUIR & TFT	68	1.6	92
Fruitvale Ditch + pt of Middle Mud Ck (to Fruitvale)	2.6	0.8 per mile	no data found, used LWWR average	68	1.6	275
Connector, part of Fruitvale system	0.4	0.8 per mile	no data found, used LWWR average	68	1.6	40
Part of WLWWR from FWUA split to East Trolley	1.8	gain 1.9	WWBWC March 2010, LWWR Bonnie to Residential Gravel Rd	54	--	--
Beginning of East Crocket Branch to Locust Rd	1.0	0.8 per mile	CTUIR & TFT	50	1.6	81
sum	*16.8*	--	--	--		*3710*

Acronyms not previously defined

FWUA	***Fruitvale Water Users Association***
HCP	***Habitat Conservation Planning documentation (Technical Memorandum, Walla Walla HCP – Minimization & Mitigation Plan, Hudson Bay District Improvement Company, Preliminary Draft, 2004, Prepared by Economic and Engineering Services, Inc.***
LWWR	***Little Walla Walla River***
TFT	***The Freshwater Trust***
WLWWR	***West Little Walla Walla River***

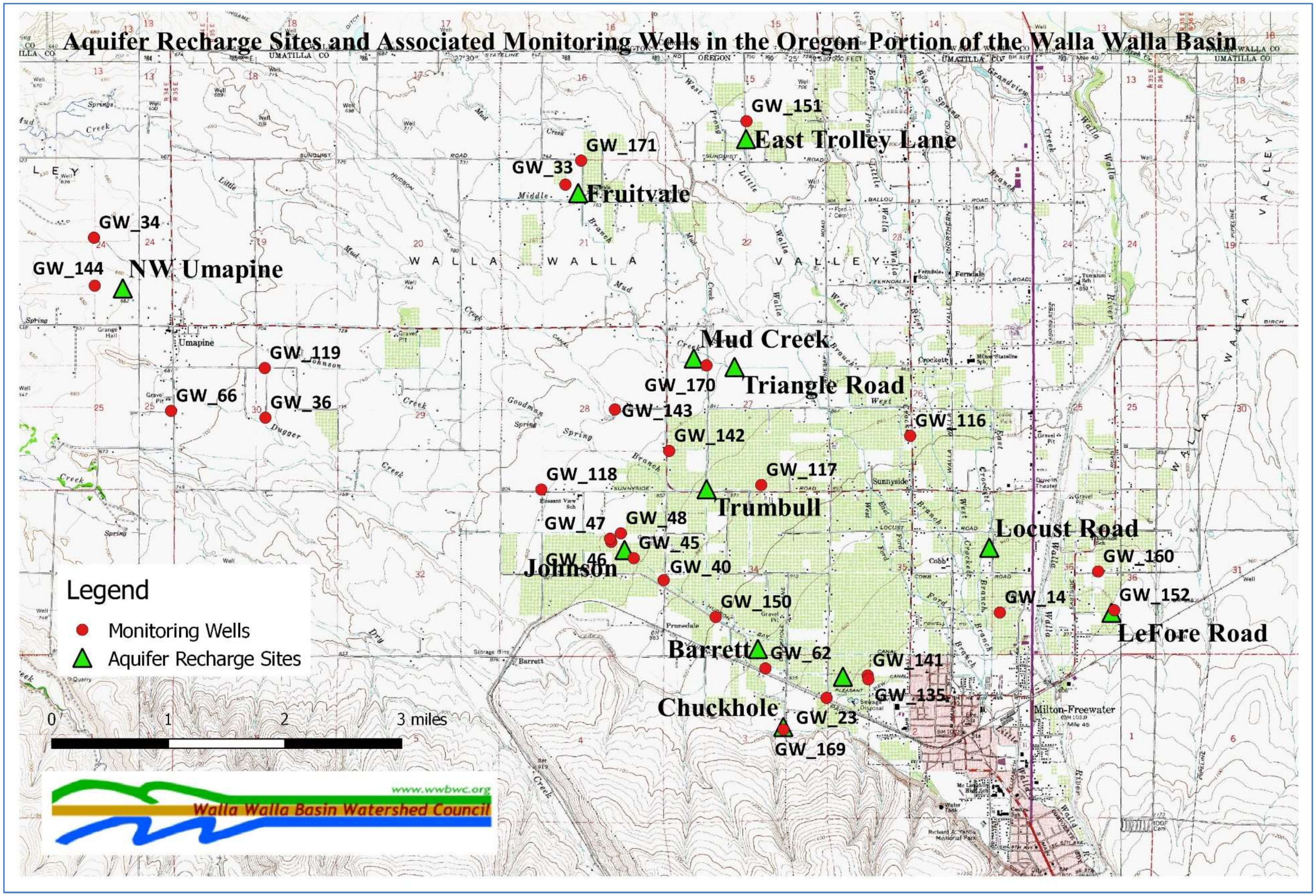


Figure 25. Groundwater monitoring wells and aquifer recharge sites.

Table 4. Differences between the first and last year of the yearly shallowest and deepest groundwater levels.

Monitoring Well	Water Years Evaluated*	Difference (ft) between first and last year of shallowest groundwater level	Difference (ft) between first and last year of deepest groundwater level	Associated Aquifer Recharge Site	Water Years Site Has Operated
GW_135	manual measurements			Anspach	part of 2013 thru 2018
GW_141	2014 to 2018	12.1	6.5	Anspach	
GW_62	2015 to 2018	incomplete data	-0.1	Barrett	part of 2014 thru 2018
GW_150	2015 to 2018	-6.0	42.7	Barrett	
GW_62	2016 to 2018	incomplete data	-0.1	Chuckhole	part of 2017 thru 2018
GW_169	only 2 years of data			Chuckhole	
GW_23	manual measurements			Chuckhole, Anspach	
GW_151	2015 to 2018	3.7	-1	East Trolley	2018
GW_171	only 2 complete years of data			Fruitvale	2017-2018
GW_33	2016 to 2018	1.0	4.8	Fruitvale	
GW_118	2010 to 2018	4.0	3.1	Johnson	part of 2004 thru 2018
GW_40	Jan. 2007 to 2018	2.7	0.0	Johnson	
GW_45	2005 to 2018	-3.3	3.0	Johnson	
GW_46	2005 to 2018	-0.3	7.7	Johnson	
GW_47	2005 to 2018	-3.3	5.3	Johnson	
GW_48	2005 to 2018	-1.0	6.7	Johnson	
GW_14	2002 to 2018	-2.7	1.1	Locust	2018
GW_116	2010 to 2018	-6.0	-2.8	Locust	2018
GW_117	2016 to 2018	-2.7	1.1	Mud Creek	part of 2017 thru 2018
GW_170	only 2 complete years of data			Mud Creek, Triangle Road	
GW_152	only 2 complete years of data			LeFore	2018
GW_160	2016 to 2018	1.9	-3.7	LeFore	
GW_119	2014 to 2018	0.8	-1.0	NW Umapine	2014 thru 2018
GW_144	2014 to 2018	0.8	8.3	NW Umapine	
GW_34	2014 to 2018	0.2	2.0	NW Umapine	
GW_36	manual measurements			NW Umapine	
GW_66	2014 to 2018	-0.6	-0.6	NW Umapine	
GW_171	only 2 complete years of data			Triangle Road	part of 2017 thru 2018
GW_143	2016 to 2018	-2	0.9	Triangle Road	
GW_117	2014 to 2018	-2.7	1.1	Trumbull	part of 2013 thru 2018
GW_142	2014 to 2018	-3.4	-0.1	Trumbull	
GW_143	2014 to 2018	-2.0	0.9	Trumbull	

*Water years with less than a year of monitoring are indicated by specifying the month in which monitoring began.

Note: Green shaded cells indicate increased water levels between years, beige shaded cells indicate decreased water levels between years.

The annual shallowest and deepest groundwater levels (the peaks and troughs in the hydrographs) were assessed because different factors influence recharge and discharge; the resulting seasonal variability is a function of the interaction between the two sets of factors. Factors influencing recharge rates include precipitation, irrigation, seepage from surface waters (e.g., rivers, streams, ponds, unlined ditches and canals), and managed aquifer recharge. Factors influencing discharge rates include pumping, spring flow rates of those springs sourced in the shallow aquifer, and groundwater returning to the surface as springs or upwelling into rivers and streams. Please note, in some of the hydrographs, the duration of the recharge season in the early years of the program is provisional because some of the on and off dates for a few of the older sites were not precise in the reports reviewed.

SPECIFIC SITES

ANSPACH SITE

The Anspach site operated for 94 days during WY2018, recharging 251 ac-ft of water for an average of 2.8 ac-ft per day. This was less than half of the previous year's volume of 659.9 ac-ft. The Anspach site has two infiltration galleries, referred to as Anspach 1 and Anspach 2. The decreased recharge at Anspach 1 was due to a flow meter battery which failed shortly after the recharge season began. The meter is located in an underground vault. The meter was submerged under water inside the vault and it took several weeks to make enough adjustments in the delivery system for the water to subside, allowing the battery to be changed. The decreased recharge values at Anspach 2 were due to intermittent readings on the flow meter; the amount recharged was likely greater than recorded.

The site has two upgradient wells, GW_135 and GW_141, and cross-gradient well GW_23 (Figure 26). At GW_141, between the first full year of operations in WY2014 and 2018, the shallowest and deepest groundwater levels became shallower by 12.1 ft and 6.5 ft, respectively (Table 4 and Figure 26). The reason for the sustained decrease in groundwater temperature beginning in mid-May 2016 at GW_141 is unknown. Because the duration of the steepest decline included the February 7 – March 3, 2017 period when all HBDIC and Walla Walla River Irrigation District (WWRID) water deliveries ceased due to the annual fish screen cleaning at the Little Walla Walla River diversion, it seems likely the cause may be a result of some change that occurred upgradient of the recharge site unrelated to irrigation water deliveries.

Although GW_141 and GW_135 are upgradient of the recharge site, the timing of the seasonal patterns (Figure 27) suggests both wells are influenced by managed recharge operations, perhaps as a result of groundwater mounding under the Anspach site. For example, at GW_141, groundwater levels began increasing in late November the day after recharge began, then decreased abruptly a few days after the site was turned off, and began increasing two days after the supply pipe for both IGs was turned on to provide water for the rest of the recharge season. At cross-gradient GW_23, quarterly readings limit preclude observing changes between each month; between years, groundwater elevations may be stabilizing after declines in the three previous decades (Figure 28).

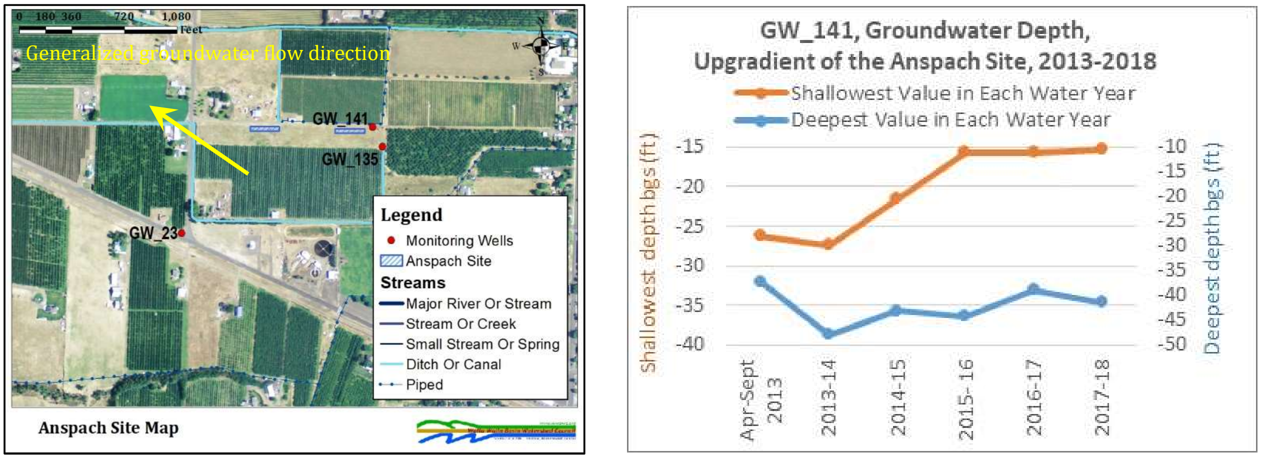
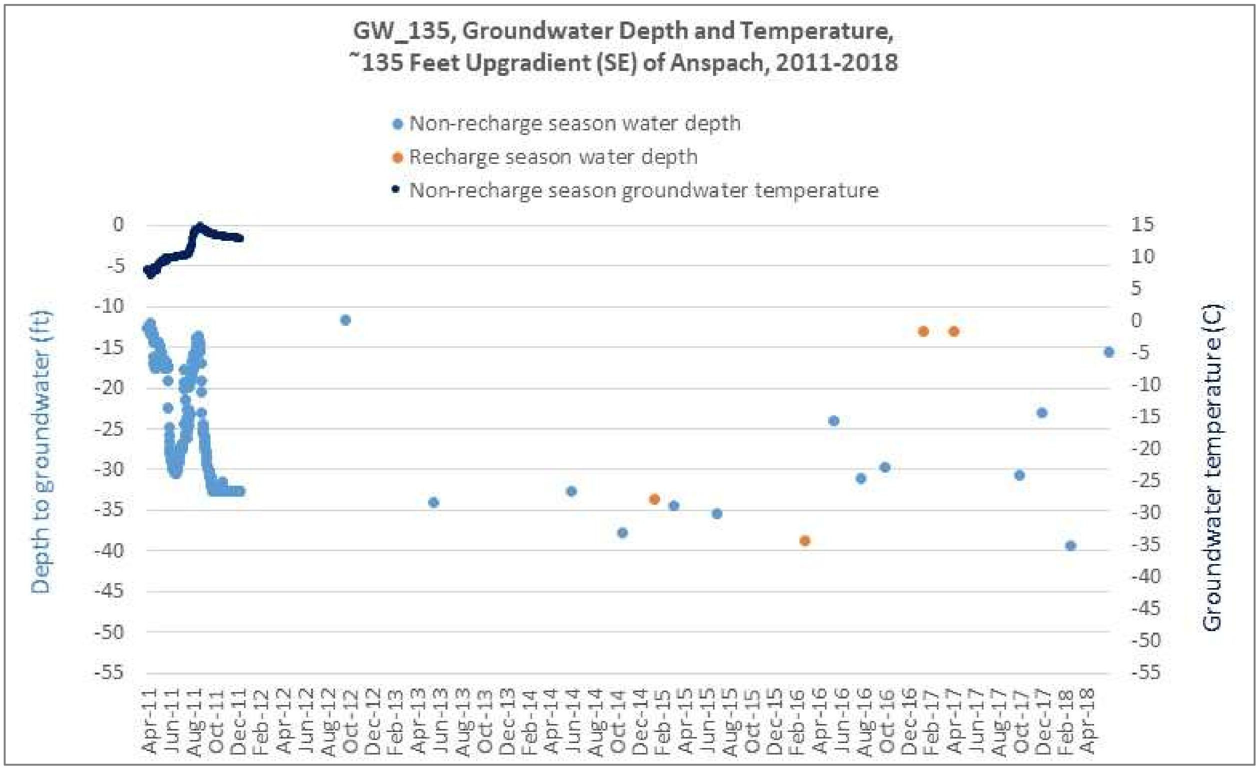


Figure26. Anspach monitoring well locations (left) and shallowest and deepest groundwater levels, by year, GW_141.



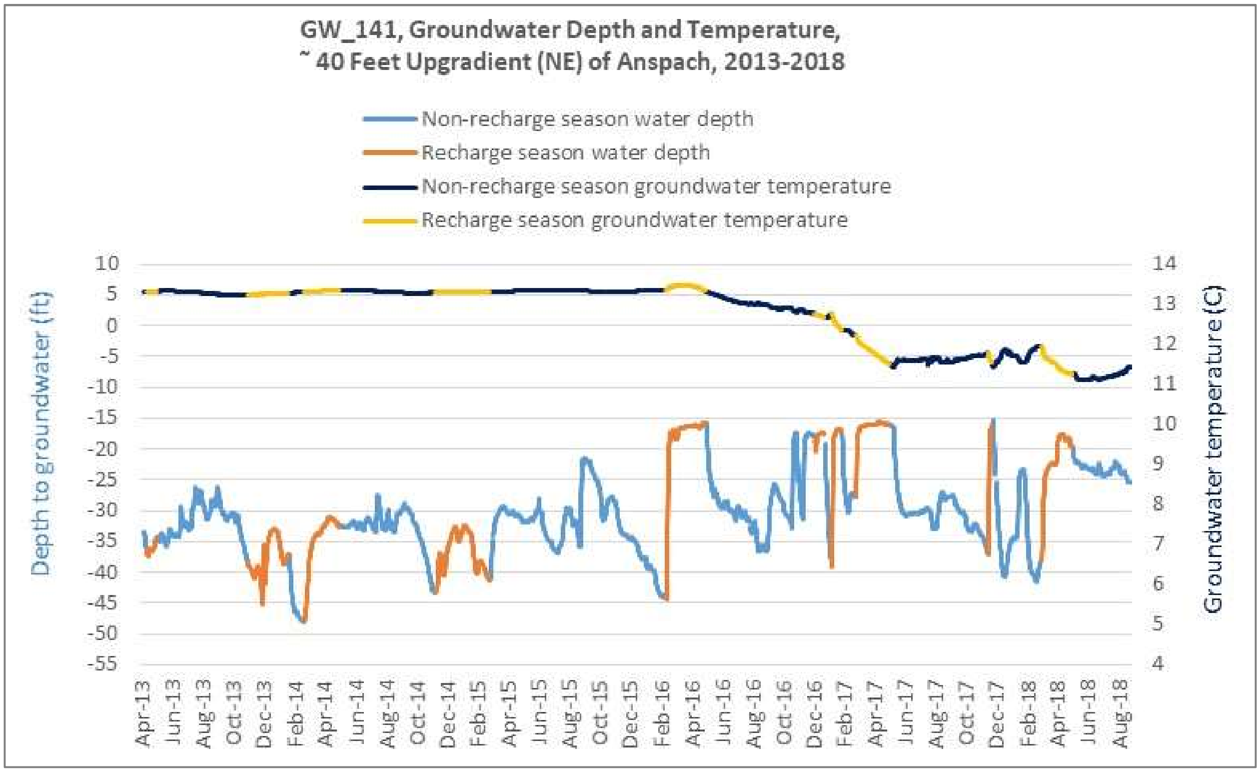


Figure 27. Hydrographs for monitoring wells GW_135 andGW_141.

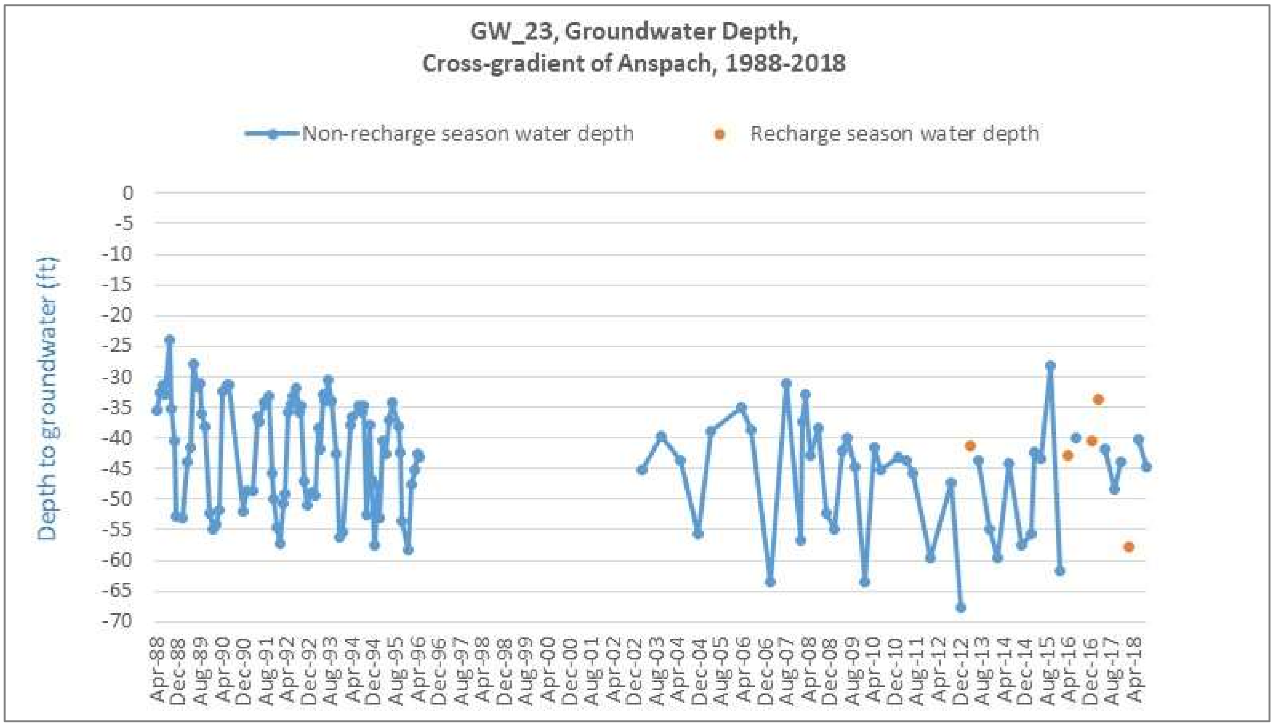


Figure 28. Hydrograph for monitoring well GW_23.

BARRETT SITE

During WY2018, the Barrett site operated for 134 days from late November 2017 until May 15, 2018, receiving an estimated total of 179 ac-ft for an average of 1.3 ac-ft/day or 0.7 cfs. This is roughly half of last year's volume of 383.5 ac-ft. The flow meter for the site frequently read "EP" indicating less than a full pipe; the meter doesn't register during those periods. Thus the reported volumes are likely less than actually recharged.

Responses to recharge operations at the Barrett site continue to be observed at the upgradient groundwater monitoring well, GW_62. Groundwater levels typically increase during recharge operations and decrease when recharge operations stop. In the years before the Barrett site began recharging, peaks in the hydrographs generally occurred in August-September, likely in response to irrigation practices. Peaks in the years after Barrett began operations in 2014 typically occur during the recharge season and are generally four feet higher than in peaks during the years prior to recharge. The battery for GW_62 died at the end of December 2017 and wasn't replaced until late June 2018, so the peak during the WY2018 recharge season was missed. Between the first year of operations in 2014 and 2018 the deepest values became lower by 0.1 ft (Table 4 and Figures 29 and 30).

At GW_150, approximately 0.3 miles downgradient of Barrett, the frequency of peaks and troughs (Figure 31) indicate influences on groundwater levels other than just the operation of the Barrett site. However, the consistent pattern of declines in groundwater temperatures during recharge operations suggest recharge operations do influence groundwater conditions.

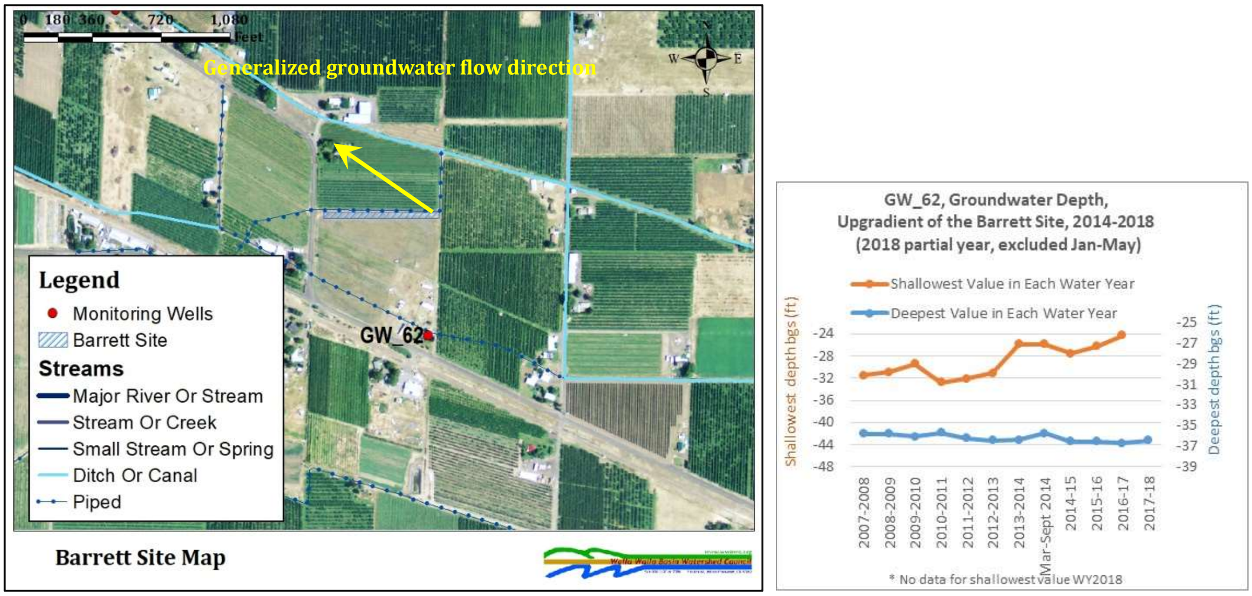


Figure 29. Barrett monitoring well location (left) and shallowest and deepest groundwater levels, by year, GW_62.

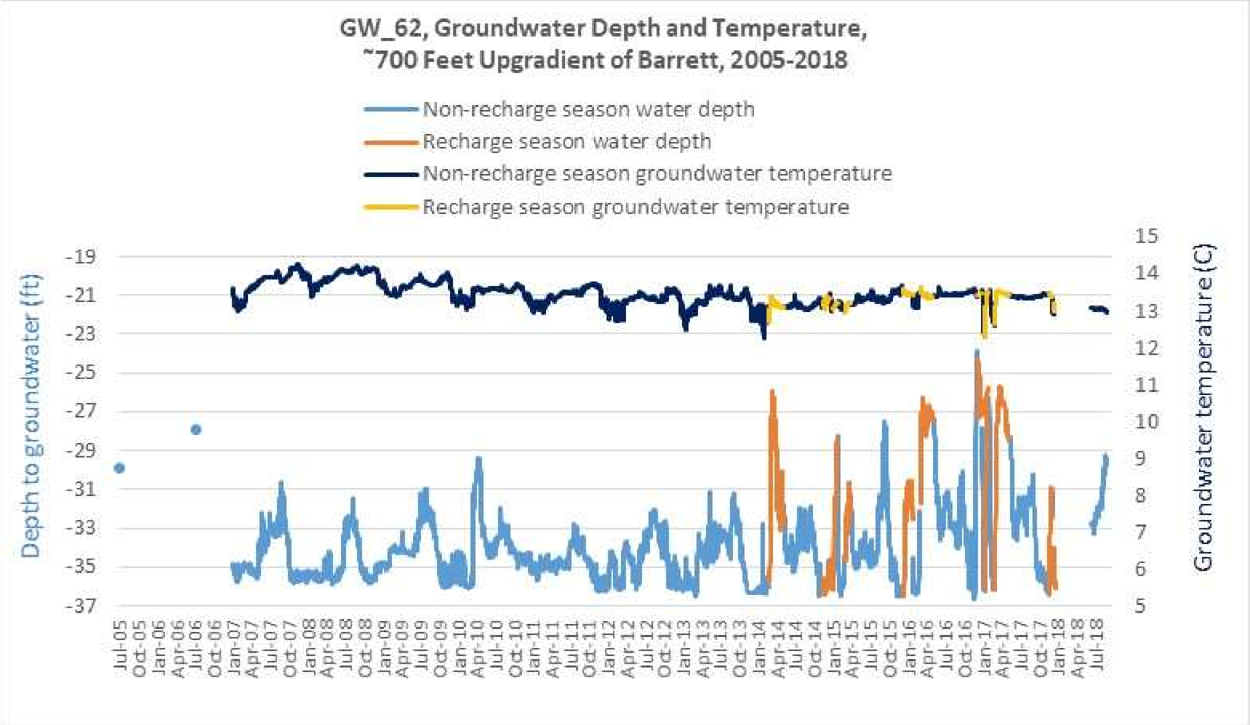


Figure 30. Hydrograph for monitoring well GW_62.

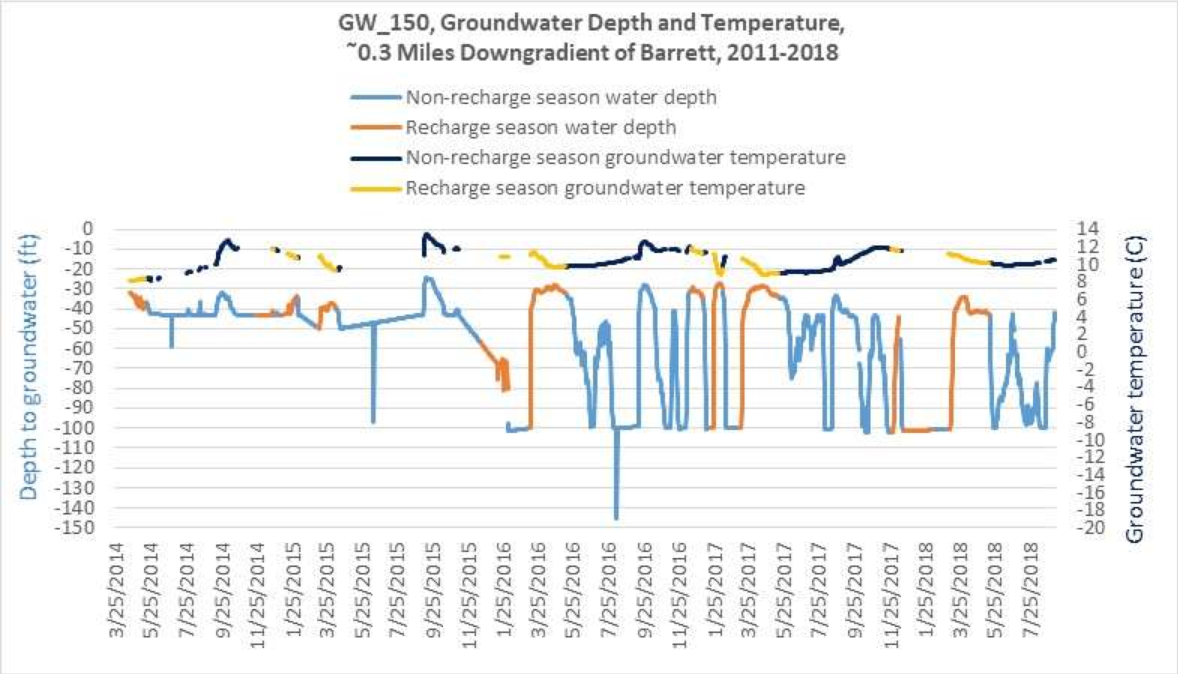


Figure 31. Hydrograph for monitoring well GW_150.

Note: It is not possible to place the transducer far enough down this well to capture the maximum depth values; the deepest value shown in August 2016 was obtained manually.

CHUCKHOLE SITE

During WY2018, the second recharge season for the Chuckhole site, the site operated for 42 days from April 3 to May 15, 2018, receiving a total of 25 ac-ft of water for an average of 0.6 ac-ft/day or 0.3 cfs. The site has three monitoring wells: GW_169 upgradient, GW_62 downgradient, and GW_23 cross-gradient (Figure 32). As discussed above, GW_62 is influenced by recharge from the Barrett site. The timing of recharge at the Chuckhole site does not correspond to an increase in groundwater levels at GW_62 (Figure 33). At GW_169, approximately 150 feet upgradient of the site, groundwater levels increased and temperature increased slightly during recharge; however, additional years of data are needed to determine if these changes recur in other years. At cross-gradient GW_23, the quarterly readings do not allow comparison of changes in water levels during the brief recharge season (Figure 34).

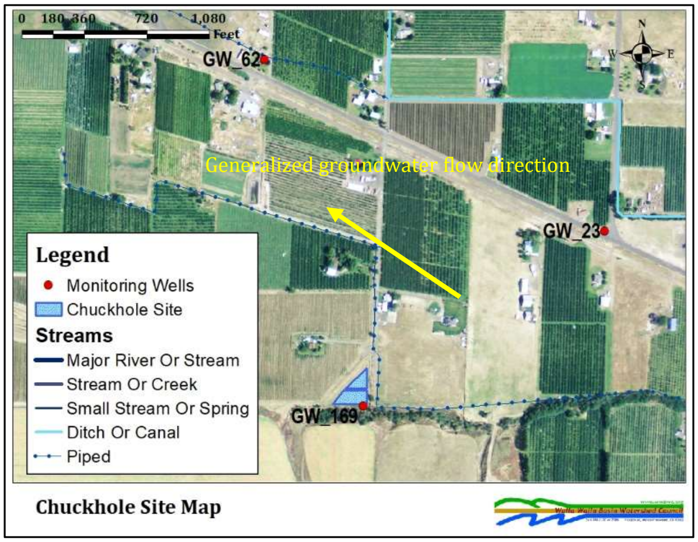
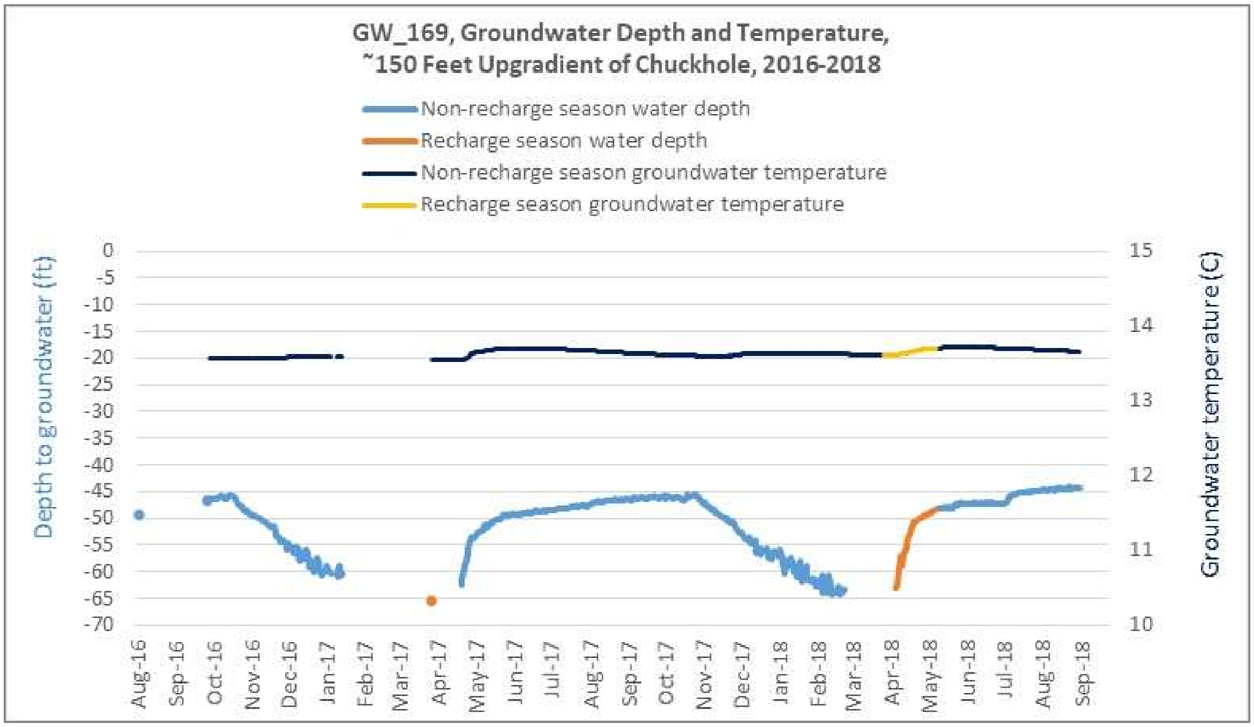


Figure 32. Chuckhole monitoring well locations.



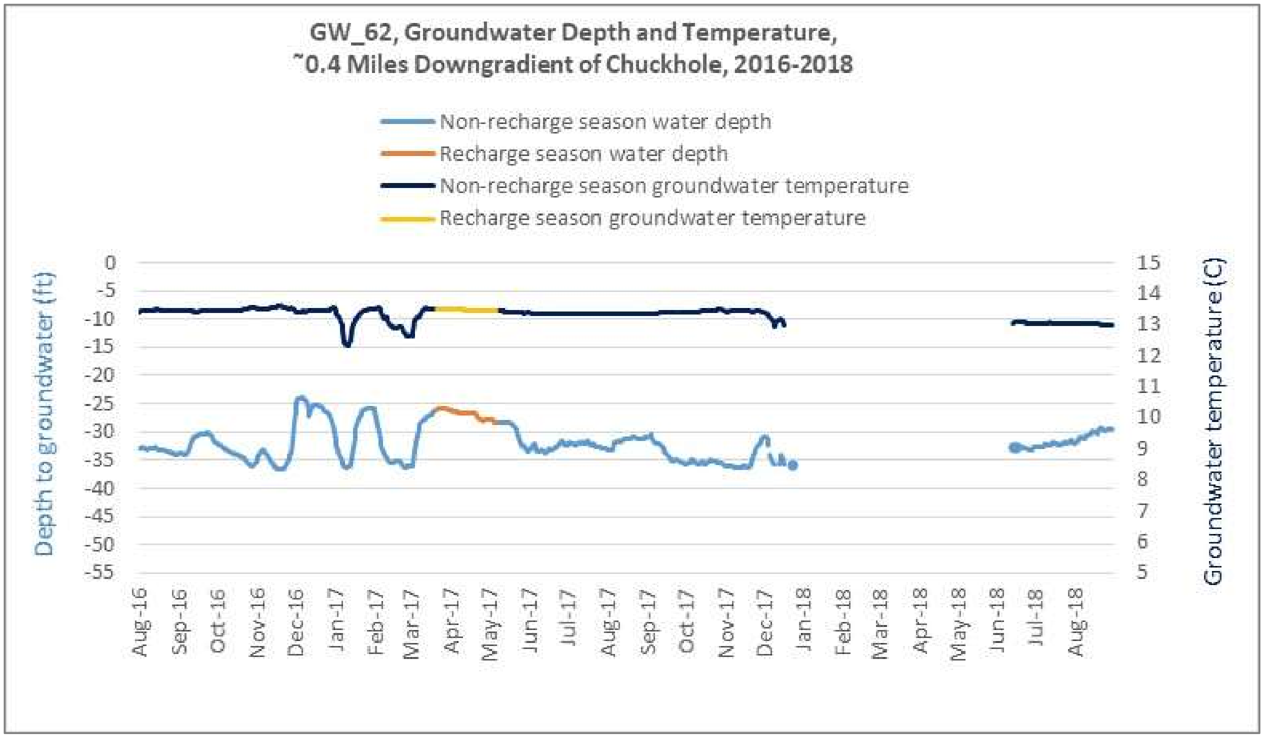


Figure 33. Hydrographs for monitoring wells GW_169 and GW_62.

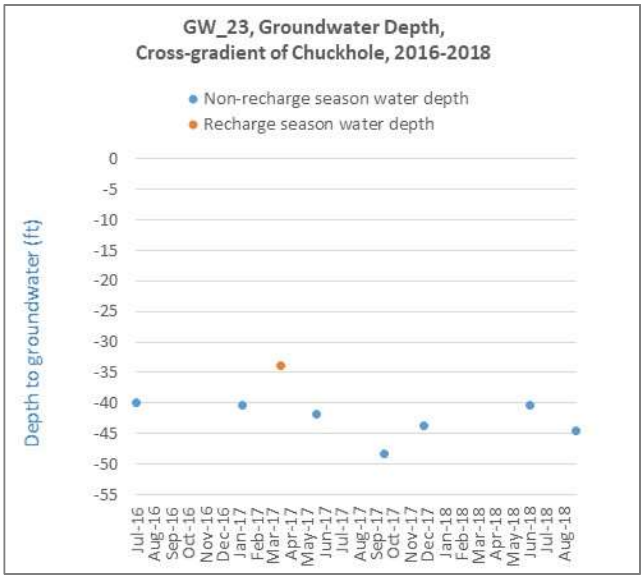


Figure 34. Hydrograph for monitoring well GW_23.

EAST TROLLEY SITE

During WY2018, the first year of the East Trolley site's operation, the site recharged for 54 days from March 22 to May 15, 2018, receiving a total of 52 ac-ft of water for an average of 1 ac-ft per day, or 0.5 cfs. Because this was its first year of operation, inflow rates were gradually increased during the first three weeks of operation. During routine site visits, the maximum flow rate observed was 310 gpm – with both the headgate and inflow pipe valve wide open.

A small but strongly characteristic response to recharge operations at the East Trolley site was observed at the immediately downgradient groundwater monitoring well, GW_151 (Figure 35). Groundwater levels increased abruptly by two feet and groundwater temperatures decreased abruptly by 0.6 degrees Centigrade (˚C) during the recharge season of mid-March to mid-May, while levels only slightly increased and temperatures remained constant during the same period in prior year (Figure 36). The decrease in groundwater temperature was due to the lower temperature of the source water, the Little Walla Walla River (roughly 6 to 11 ˚C at the state line), during the first half of this period than the groundwater, which was 13 ˚C. In the two years before recharge began, the shallowest groundwater depths in May were 34 feet in 2016 and 33 feet in 2017, while during the first recharge season the shallowest depth in May was 31 feet.

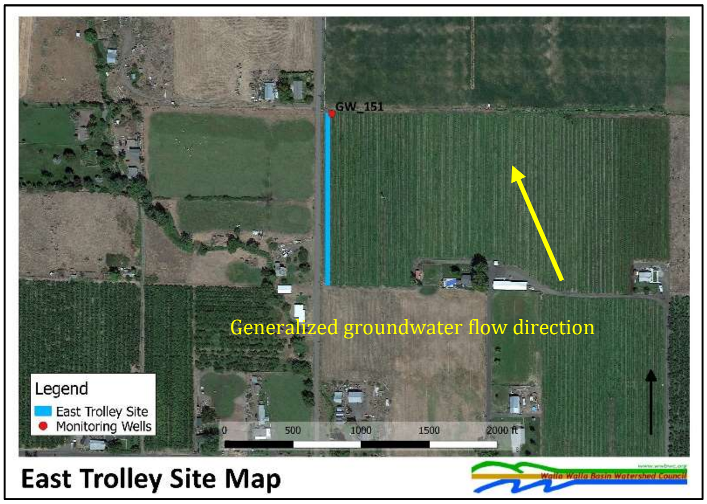


Figure 35. East Trolley monitoring well location.

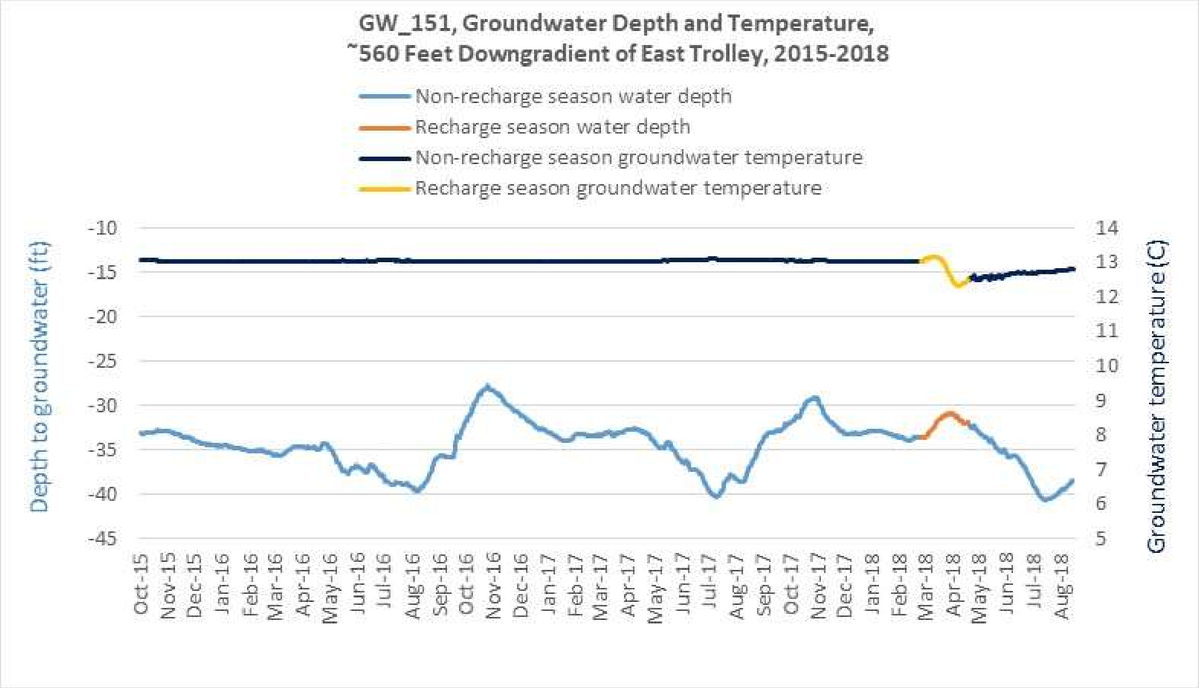


Figure 36. Hydrograph for monitoring well GW_151.

FRUITVALE SITE

During WY2018, the second recharge season for the Fruitvale site, the site operated for 68 days in from mid-March to May 15, 2018, receiving a total of 35 ac-ft of water for an average of 0.5 ac-ft/day or 0.26 cfs. The inflow rate was reduced by the landowner for a short time due to low flows in the ditch and downstream water demands.

Groundwater monitoring well GW_33 is downgradient and GW_171 is cross-gradient of the site (Figure 37). Changes in groundwater levels and temperatures at both monitoring locations do not correspond to the timing of recharge operations at this site (Figures 38 and 39). Both monitoring wells may be influenced more strongly by historical springs. The landowner has described that springs used to surface nearby. Currently no springs are visible but strong subsurface flowpaths may still be present. The cause of the abrupt, prolonged increase in temperate in GW_171 in December 2016 is unknown.

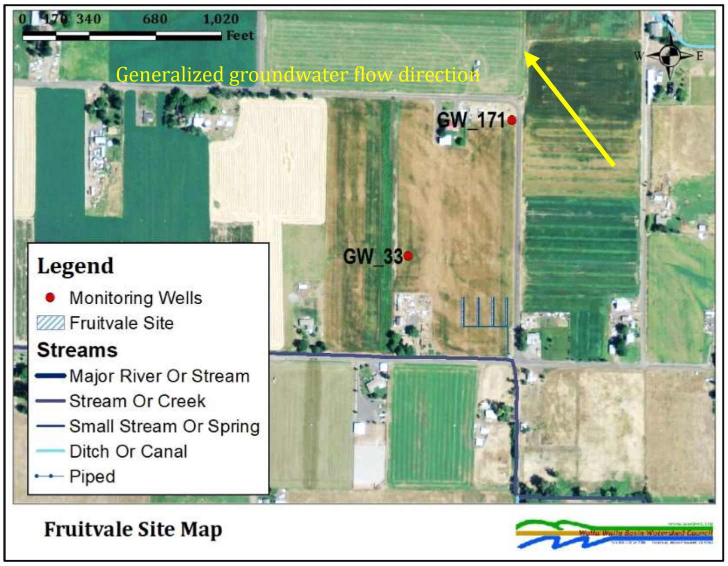


Figure 37. Fruitvale monitoring well locations.

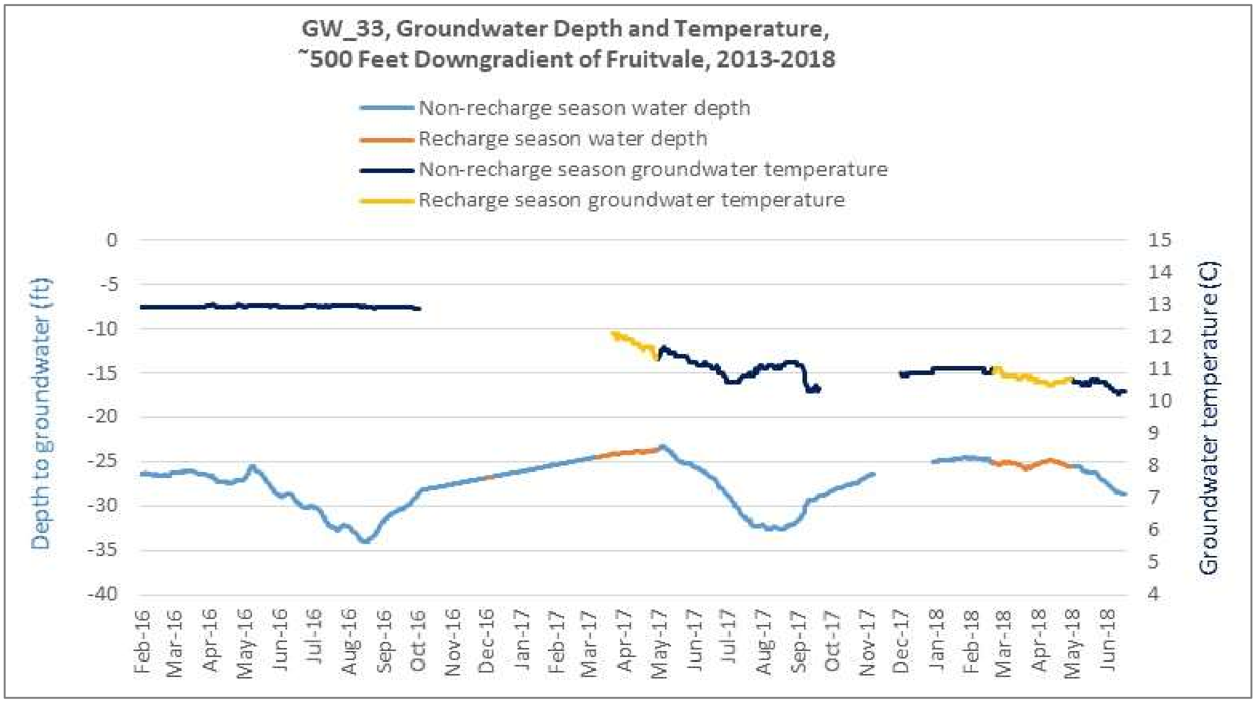


Figure 38. Hydrograph for monitoring well GW_33.

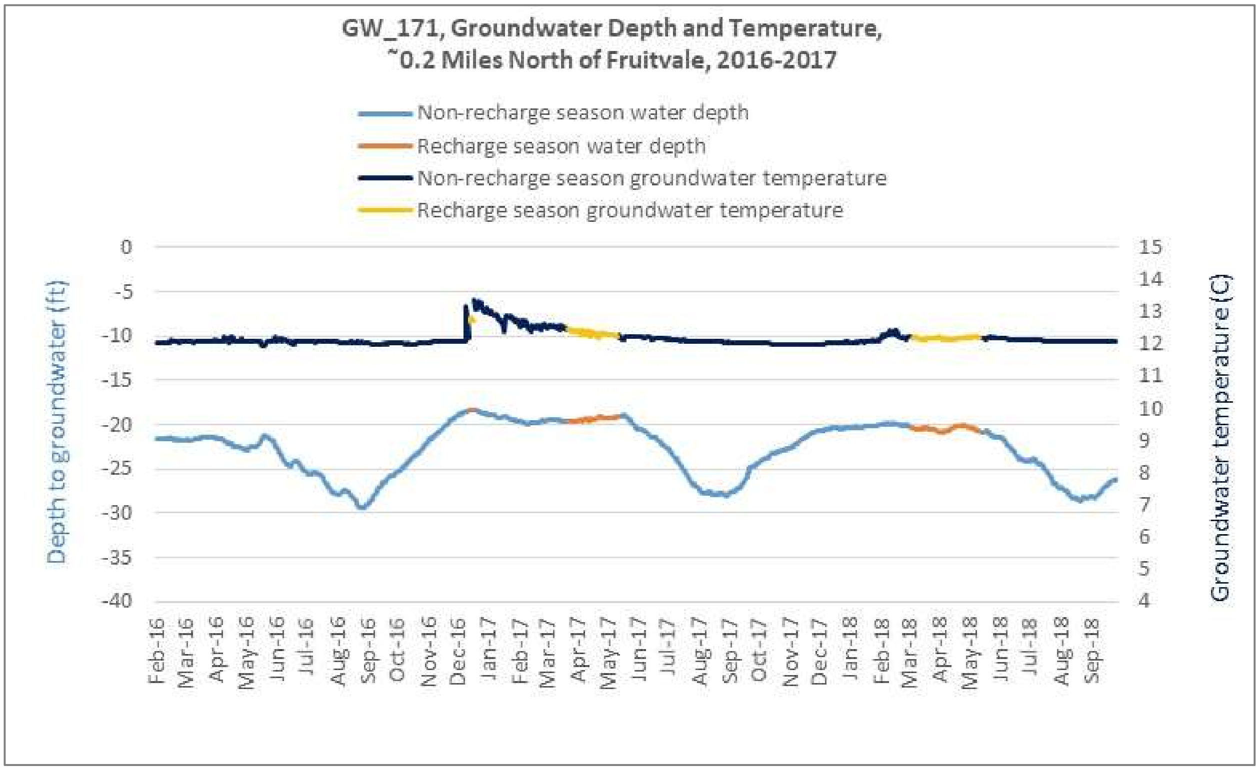


Figure 39. Hydrograph for monitoring well GW_171.

JOHNSON SITE

The Johnson site operated for 146 days during the WY 2018 recharge season. The site began recharging in late November, continued through early February, and from mid-March until May 15, 2018, receiving a total of 3,518 ac-ft of water for recharge at an average rate of 24 ac-ft per day or 12 cfs. The ten spreading basins received 2,976 ac-ft and three active infiltration galleries received 542 ac-ft.

Six monitoring wells are on or near the site (Figure 40). Groundwater levels under the Johnson site (GW_45, GW_46, and GW_47) are roughly 15-20 ft closer to the ground surface than at the upgradient well (GW_40). The shallowest groundwater levels in downgradient GW_118 are similar to levels under the Johnson site during recharge season. Groundwater levels were becoming shallower over time in all six monitoring wells to varying degrees in past years (Figures 41 – 44). However, in WY2018 the shallowest groundwater levels noticeably declined in all six wells even though the site received 786 ac-ft more water in WY2018 than in WY2017 (Figure 45). The cause of the decline is unknown at this time.

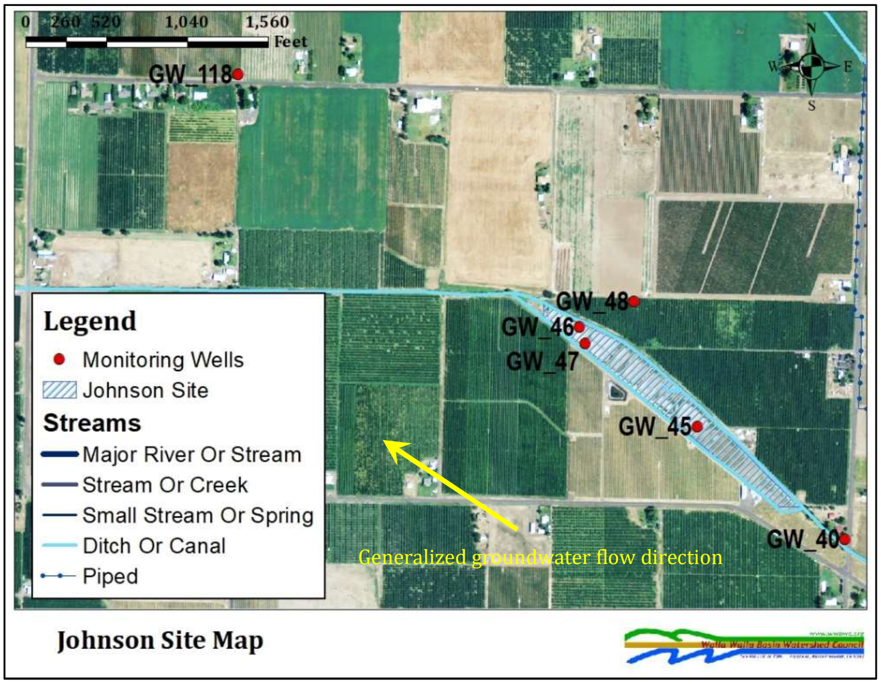


Figure 40. Johnson monitoring well locations.

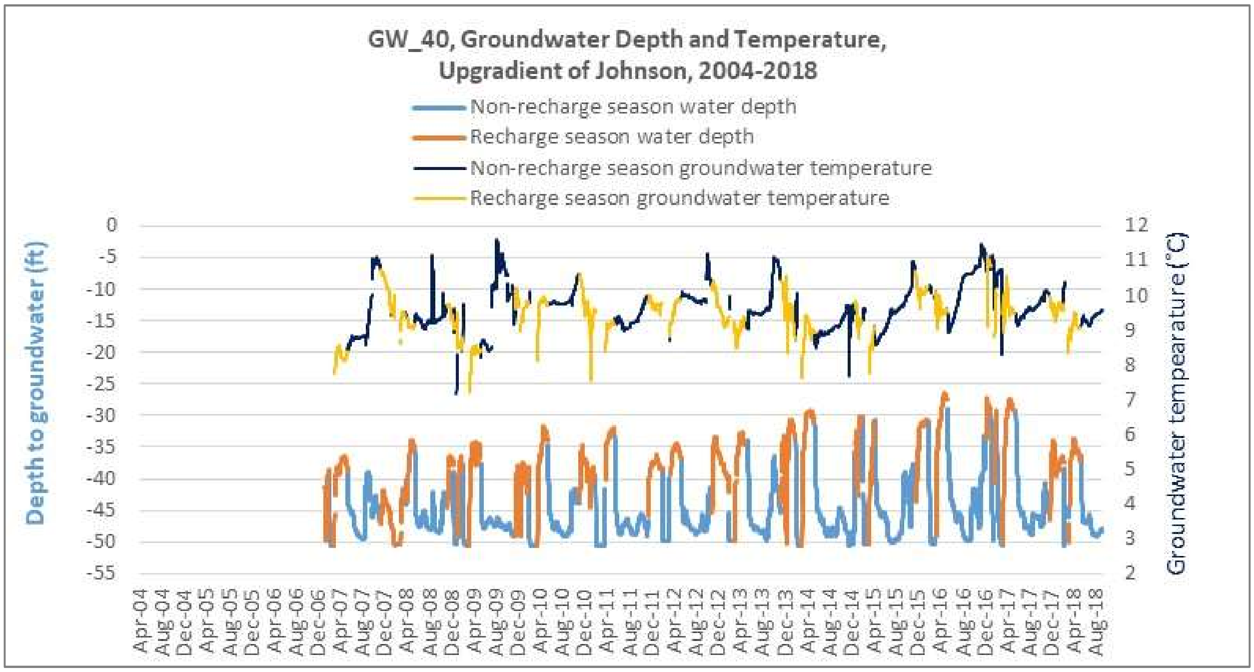
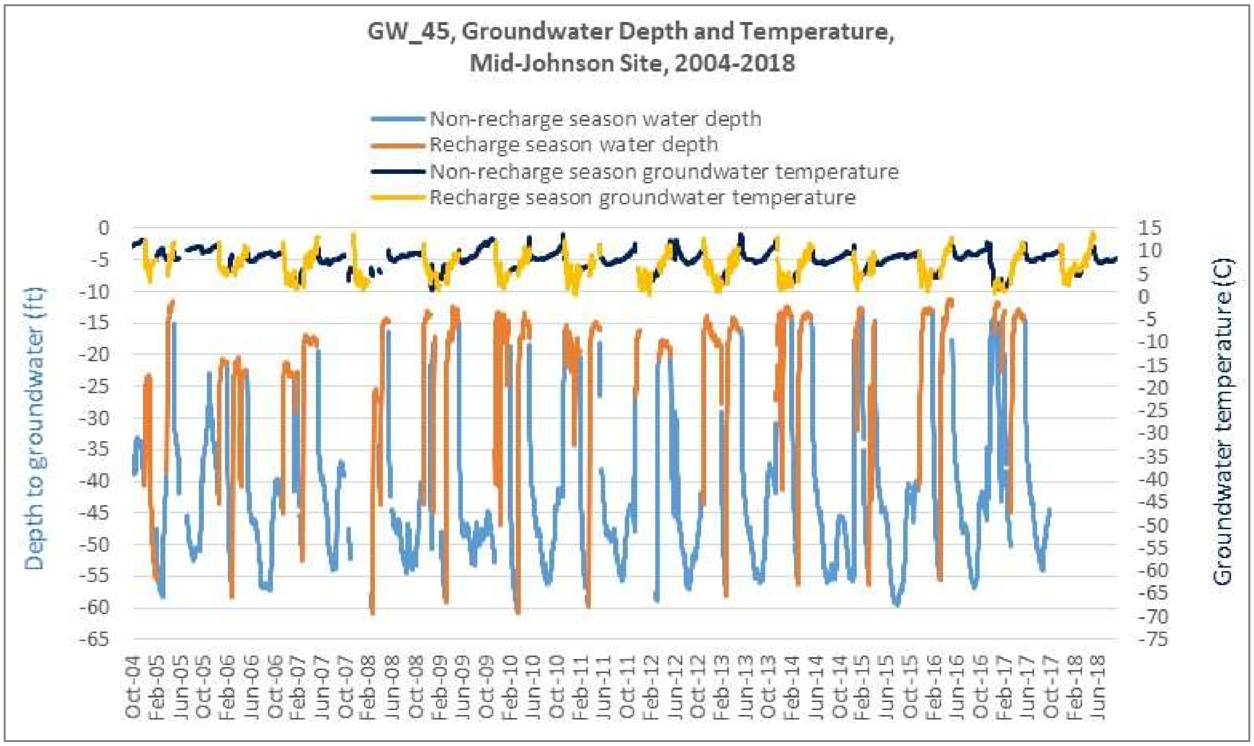


Figure 41. Hydrograph for monitoring well GW_40.



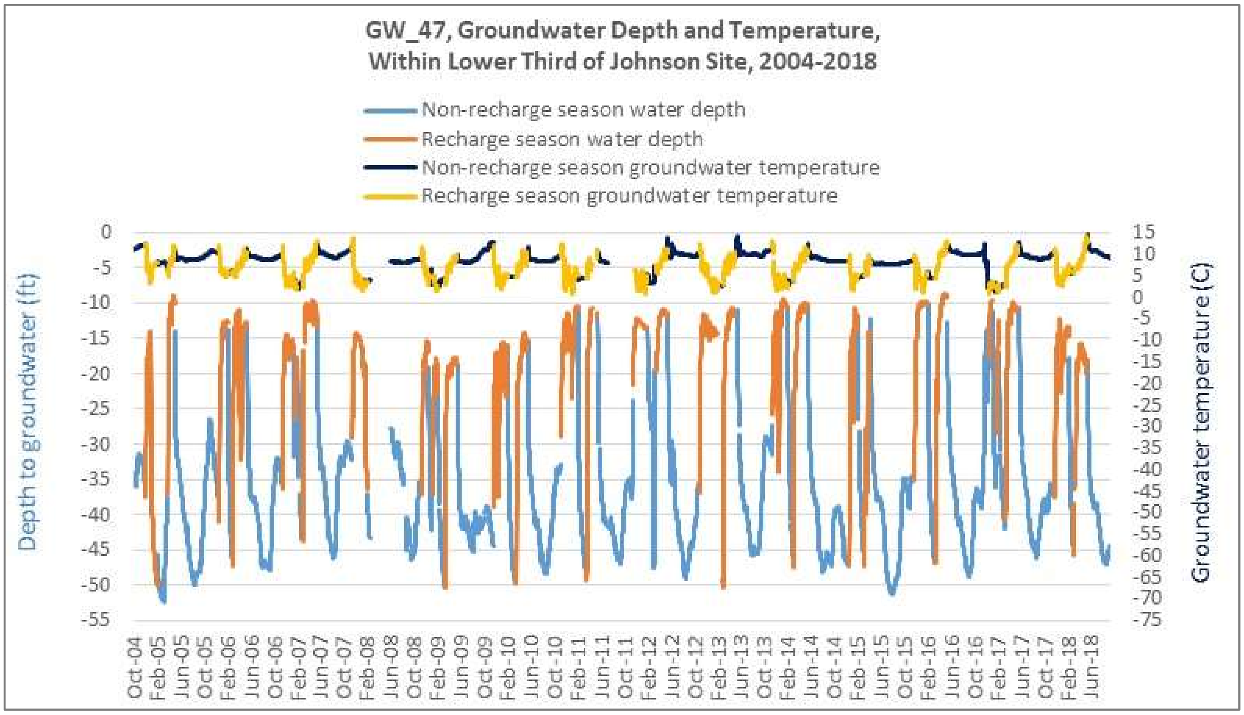


Figure 42. Hydrographs for monitoring wells GW_45 and GW_47.

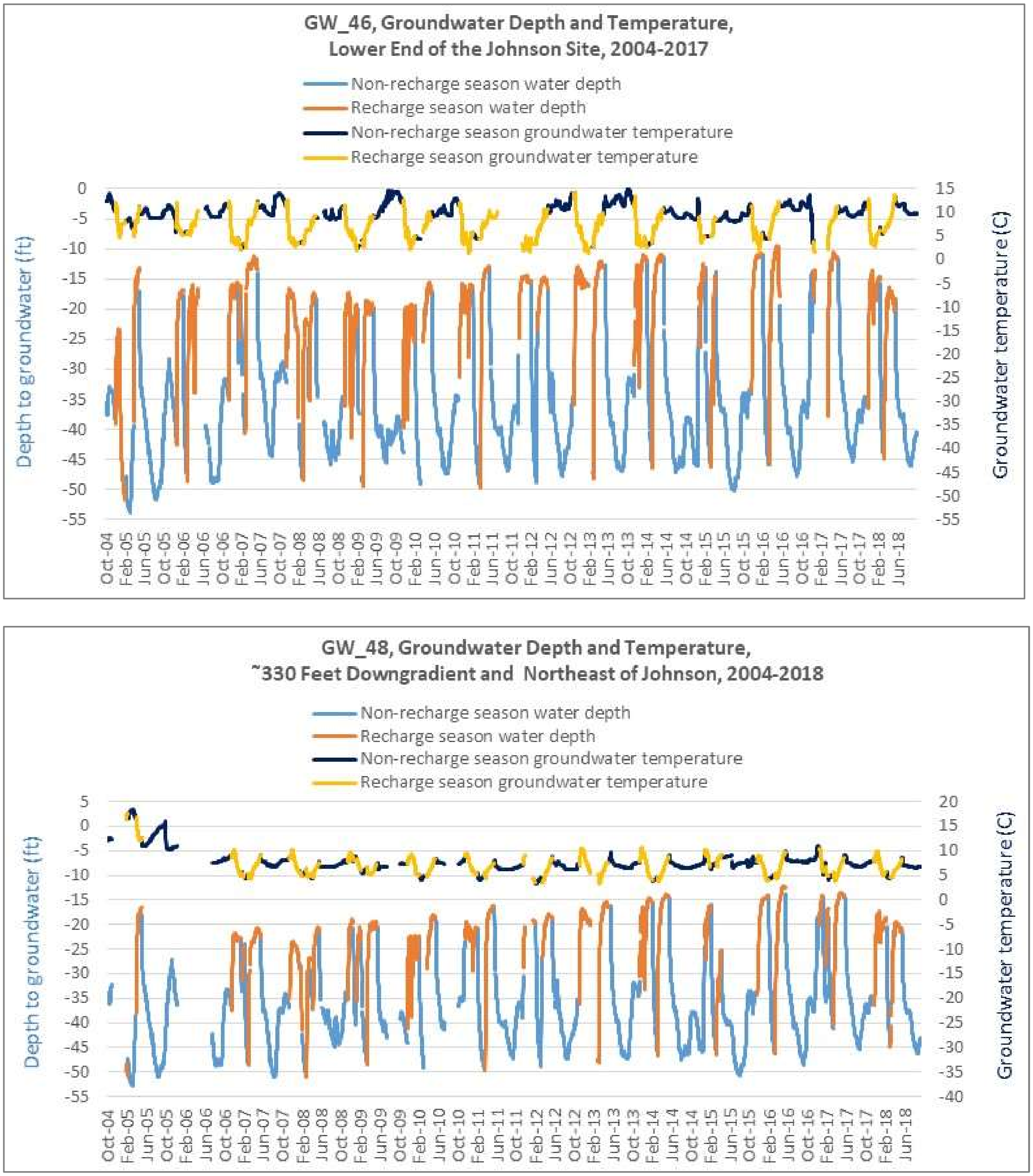


Figure 43. Hydrographs for monitoring wells GW_46 and GW_48.

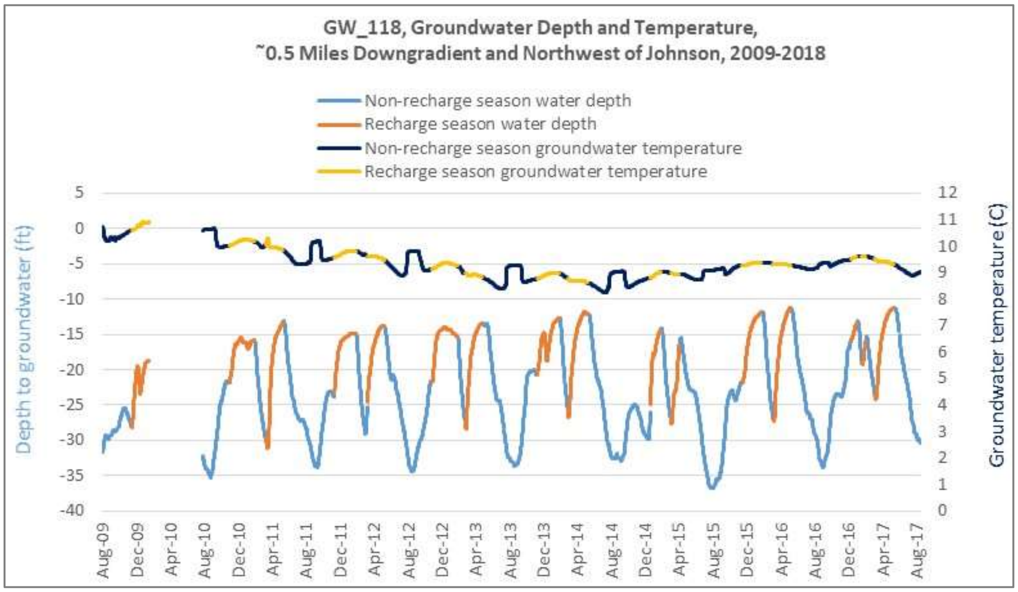


Figure 44. Hydrograph for monitoring well GW_118.

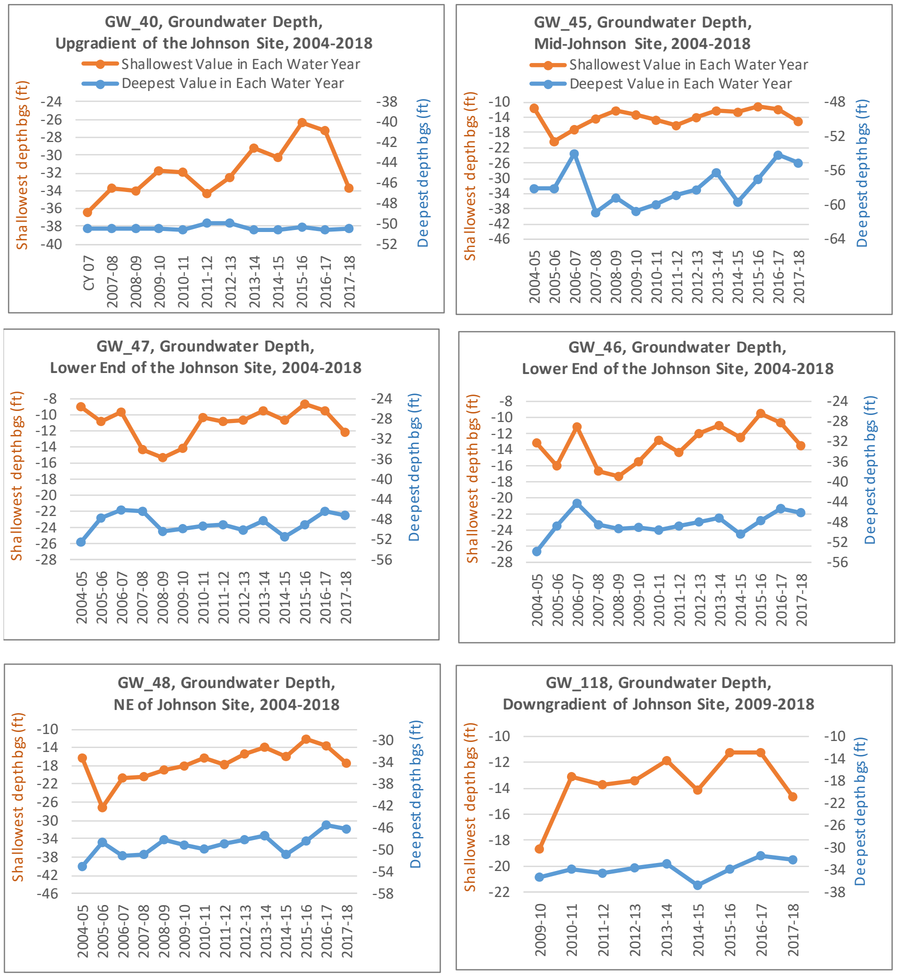


Figure 45. Shallowest and deepest groundwater levels, by year, GW_40, GW_45, GW_47, GW_46, GW_48, and GW_118

LEFORE SITE

During WY2018, the LeFore Site's first year of operation, the site recharged 78 ac-ft over 55 days (March 21 to May 15), for an average of 1.4 ac-ft per day, or 0.7 cfs. The site is approximately 0.35 miles east of the Walla Walla River, the only recharge site located east of the river. In both the downgradient and cross-gradient wells (Figure 46), changes in water elevation and temperature indicate a response from recharge operations. Groundwater levels increased by approximately 6 feet and 3 feet during the recharge season in downgradient well GW_152 and cross-gradient well GW_160 (Figures 47 and 48), respectively, with no comparable increase during the same months in the prior year. Similarly, groundwater temperatures increased at both monitoring sites during the recharge season but not during the same time period in the previous year.

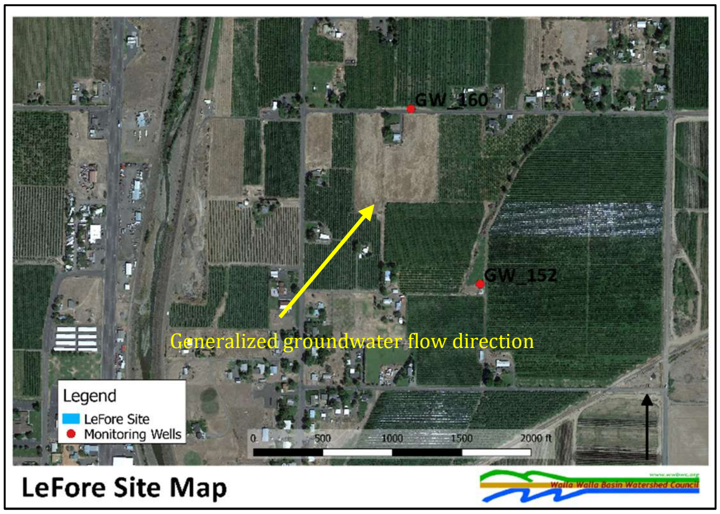


Figure 46. LeFore monitoring well locations.

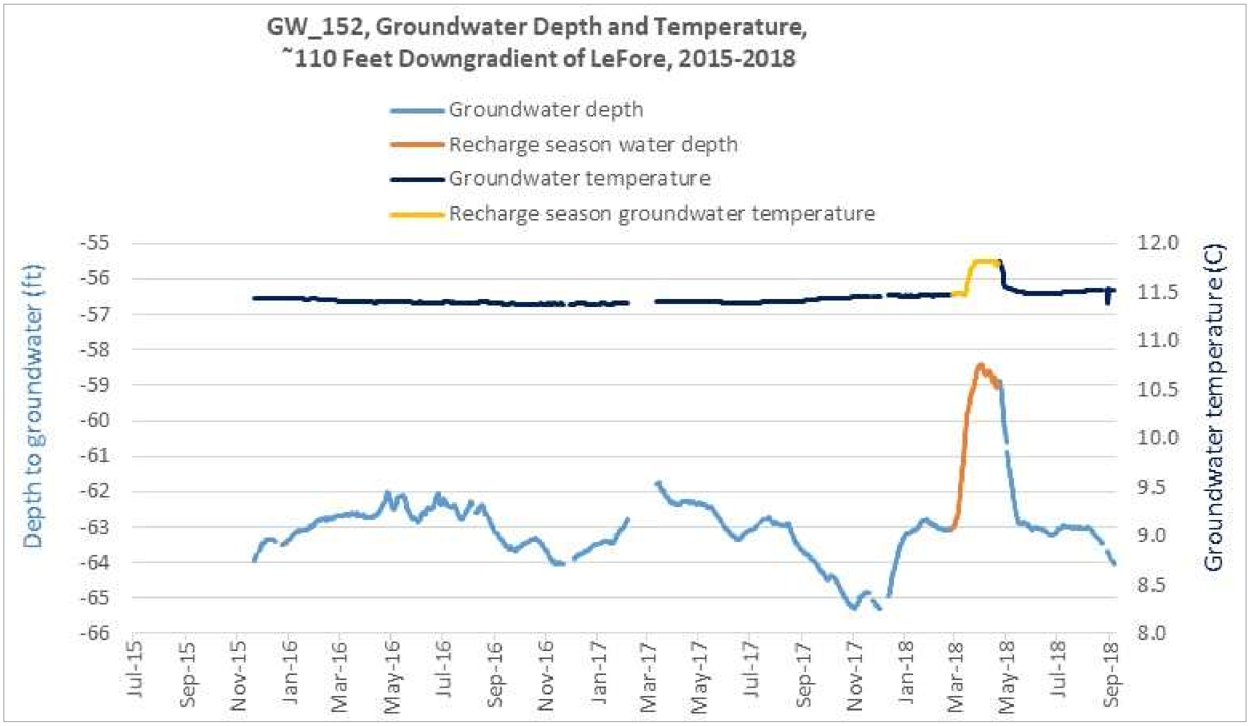


Figure 47. Hydrograph for monitoring well GW_152.

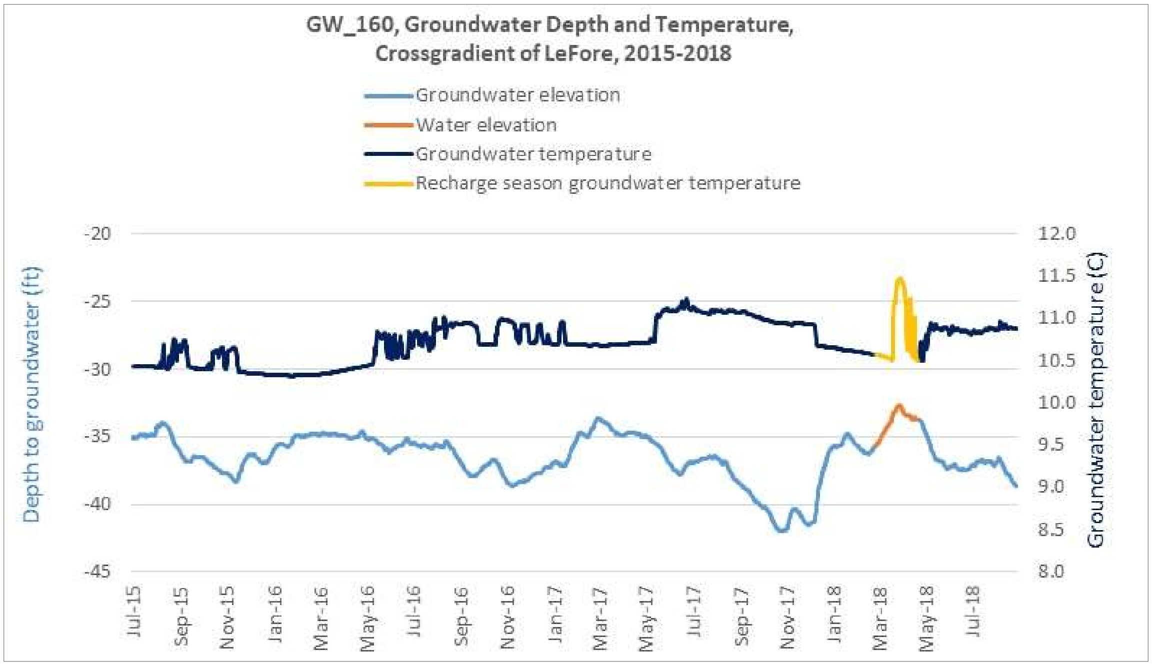


Figure 48. Hydrograph for monitoring well GW_160.

LOCUST ROAD SITE

During WY2018, the Locust Road Site's first year of operation, the site recharged 56 ac-ft over 50 days (March 28 to May 15), for an average of 1.1 ac-ft per day, or 0.6 cfs. GW_14 and GW_116 are approximately 0.4 miles upgradient and 0.8 miles downgradient of the site (Figure 49). No groundwater elevation changes solely due to recharge were apparent in either well (Figure 50) but a temperature response may have occurred in GW_116. In Figure 49, the yearly shallowest and deepest values are largely for years before recharge began; the Locust Road site did not begin recharging until the spring of 2018. The site's influence on groundwater conditions will be further assessed in future years when a greater recharge volume can be applied.

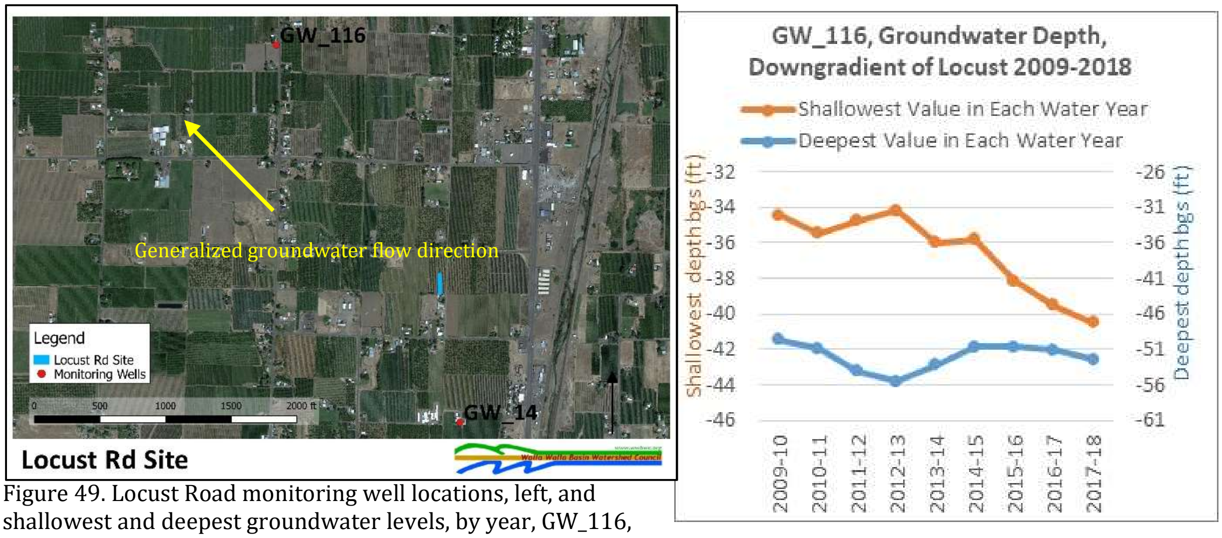
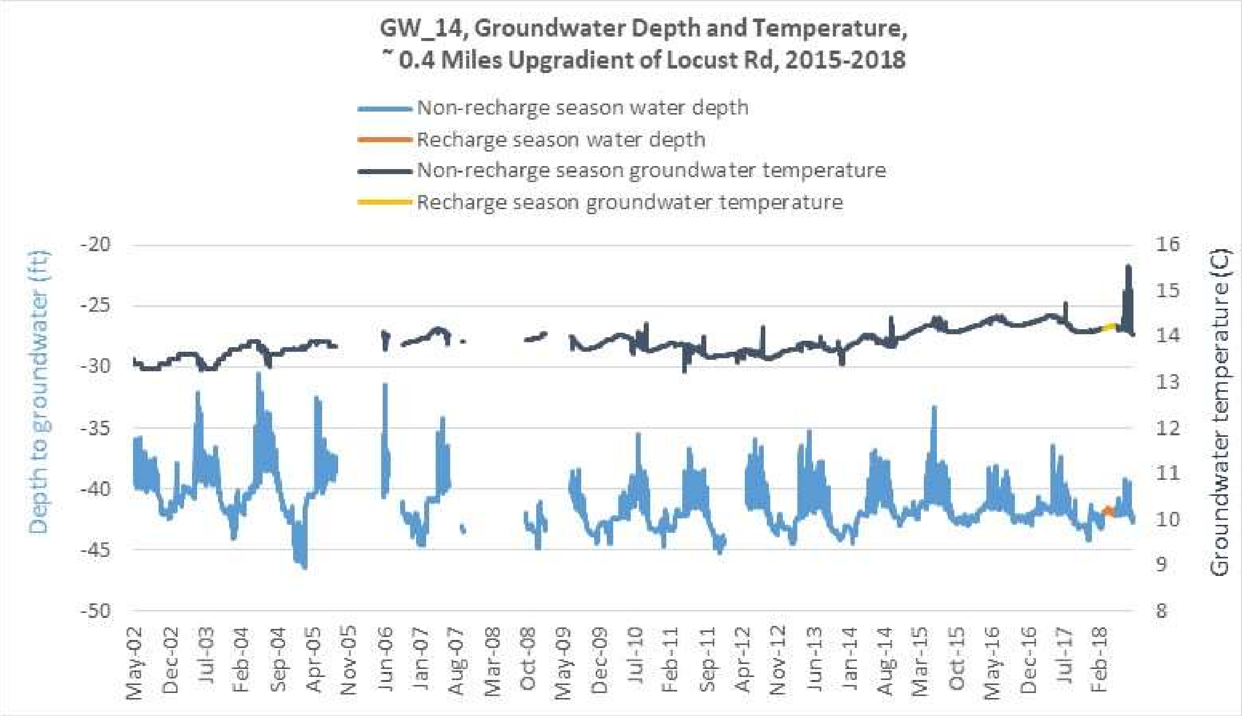


Figure 49. Locust Road monitoring well locations, left, and shallowest and deepest groundwater levels, by year, GW_116, right.



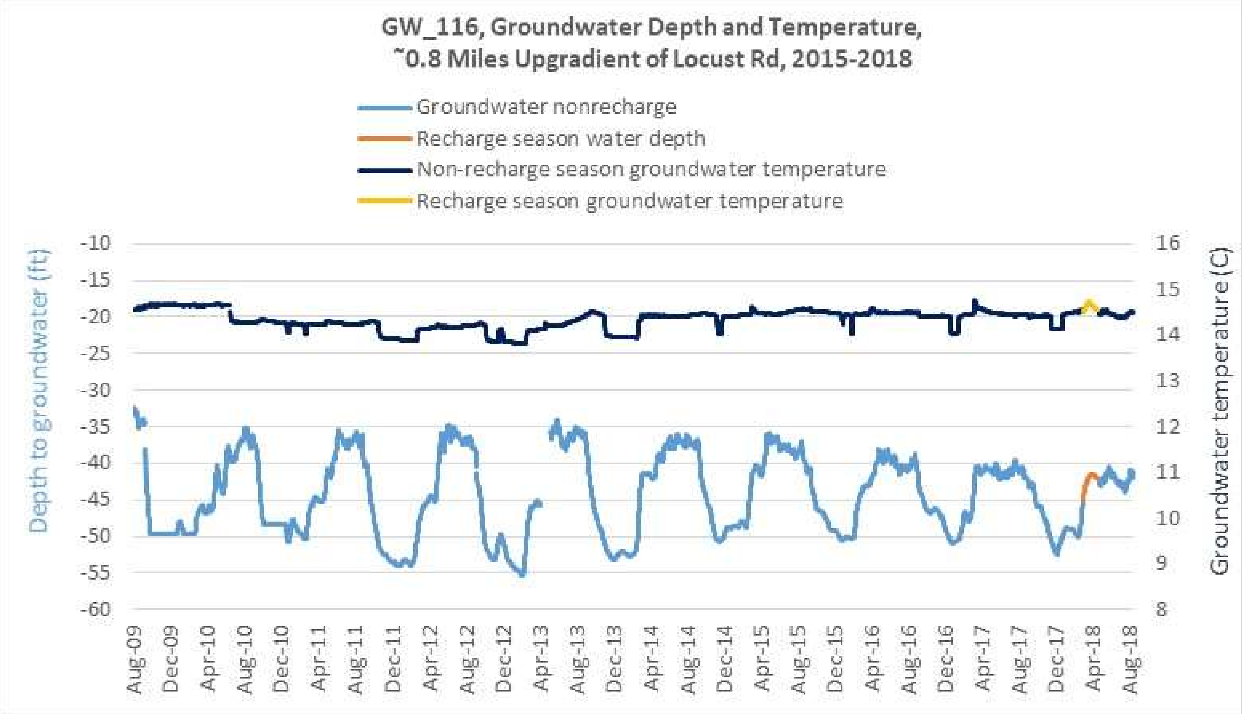


Figure 50. Hydrographs for monitoring well GW_14 and GW_116.

MUD CREEK SITE

During WY2018, the second year of the Mud Creek site's operation, the site operated for 62 days, from mid-March through mid-May, recharging a calculated total of 32 ac-ft of water. The site has two monitoring wells, GW_170[3] and GW_117, both upgradient (Figure 51). Groundwater elevations increased during the recharge season but additional years of data will be needed to discern if and how much of the increase was due to recharge operations as opposed to other factors influencing seasonal changes in groundwater elevations (Figures 52 and 53).

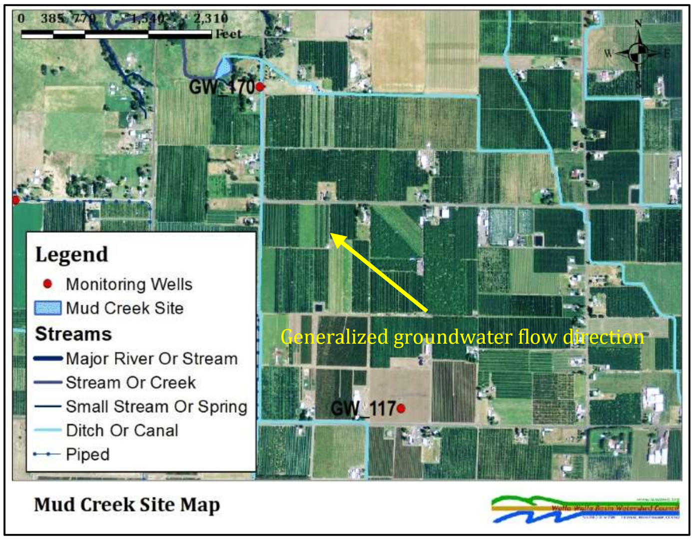


Figure 51. Mud Creek monitoring well locations.

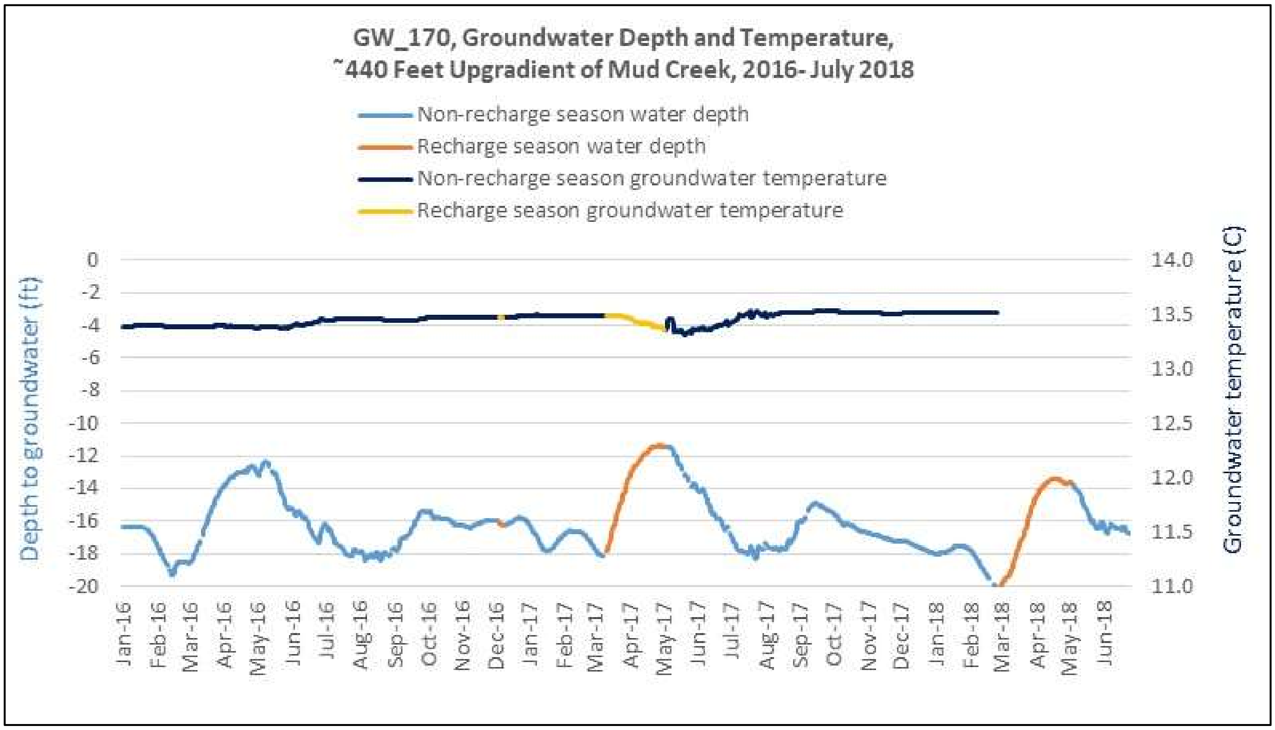


Figure 52. Hydrograph for monitoring well GW_170.

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[3] The Mud Creek Site Map shows a north-south ditch adjacent to GW_170 but it is actually a pipeline which flows into an east-west ditch located 70 feet south of GW_170.

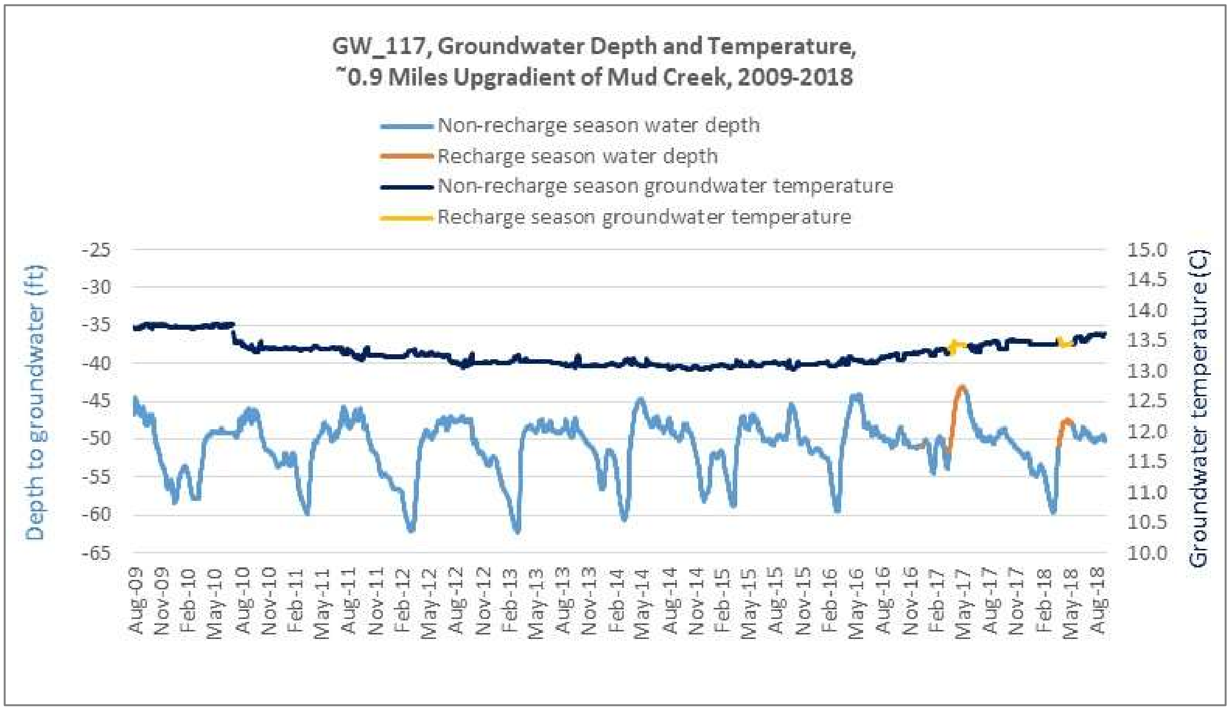


Figure 53. Hydrographs for monitoring wells GW_170 and GW_117.

NW UMAPINE SITE

The NW Umapine site operated for 79 days receiving 233 ac-ft of recharge water at an average rate of 2.9 ac-ft per day or 1.5 cfs. The site operated from late November through most of December 2017 and from April through May 15, 2018. Five monitoring wells are associated with the site (Figure 54). At upgradient wells GW_66 and GW_119, between the first year of operation in WY2014 and 2018, the deepest values became deeper by 0.6 and 1.0 ft, respectively, while the shallowest values became shallower in GW_119 by 0.8 ft and became deeper in GW_66 by 0.6 ft (Table 4 and Figure 55). Seasonal changes in depths to groundwater appear similar in the years before and after recharge began (Figures 56-58). Changes specific to the recharge season are more difficult to see in the quarterly manual measurements at GW_36 (Figure 57).

At the two downgradient wells, GW_34 and GW_144, between WY2014 and 2018, the annual shallowest water levels became shallower by 0.2 and 0.8 ft while the deepest water levels became shallower by 2.0 and 8.3 ft, respectively (Table 4 and Figure 55). Groundwater level increases observed at monitoring wells GW_34 and GW_144 in the early fall may be due to recharge from the start of fall irrigation and/or reduction of groundwater pumping in the fall. Likewise, observed groundwater level decreases during the summer are likely due to increased groundwater pumping in the area.

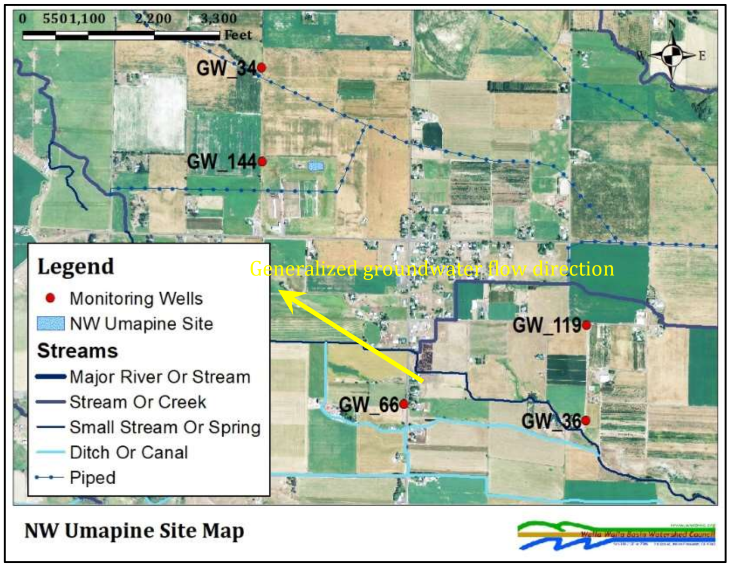


Figure 54. NW Umapine monitoring well locations.

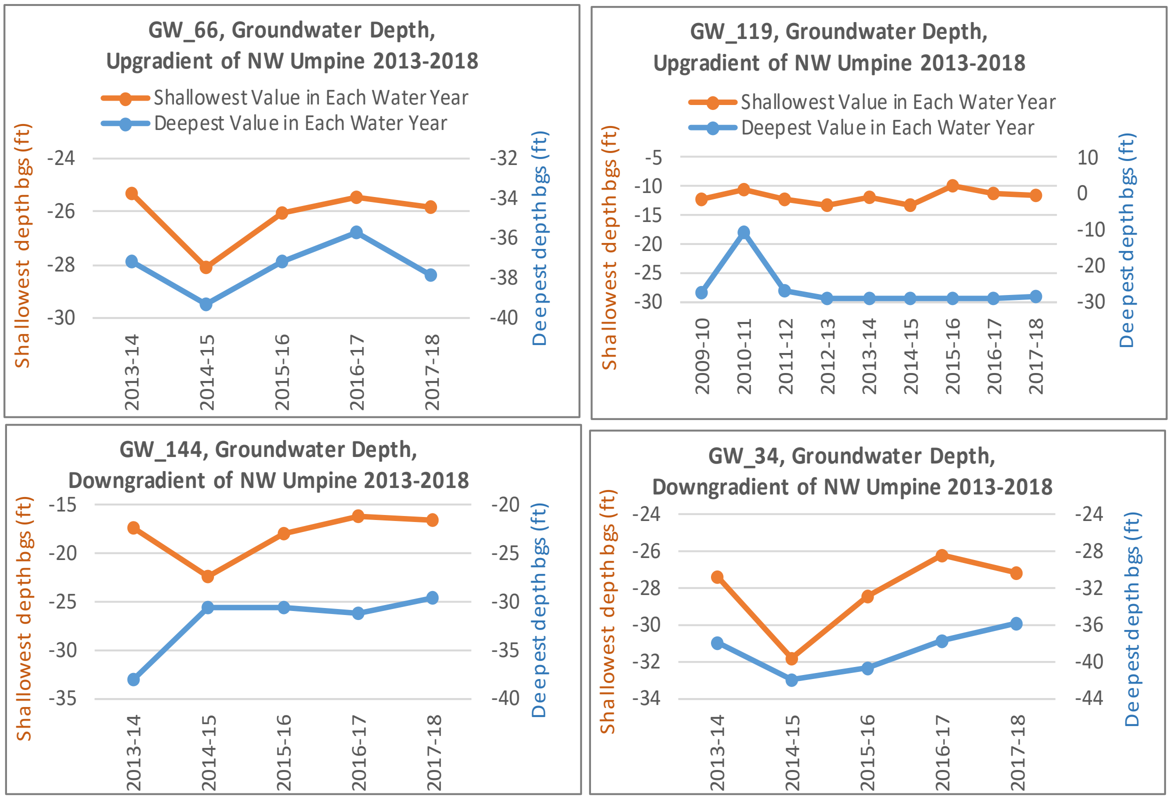


Figure 55. Shallowest and deepest groundwater levels, by year, GW_66, GW_119, GW144, and GW_34.

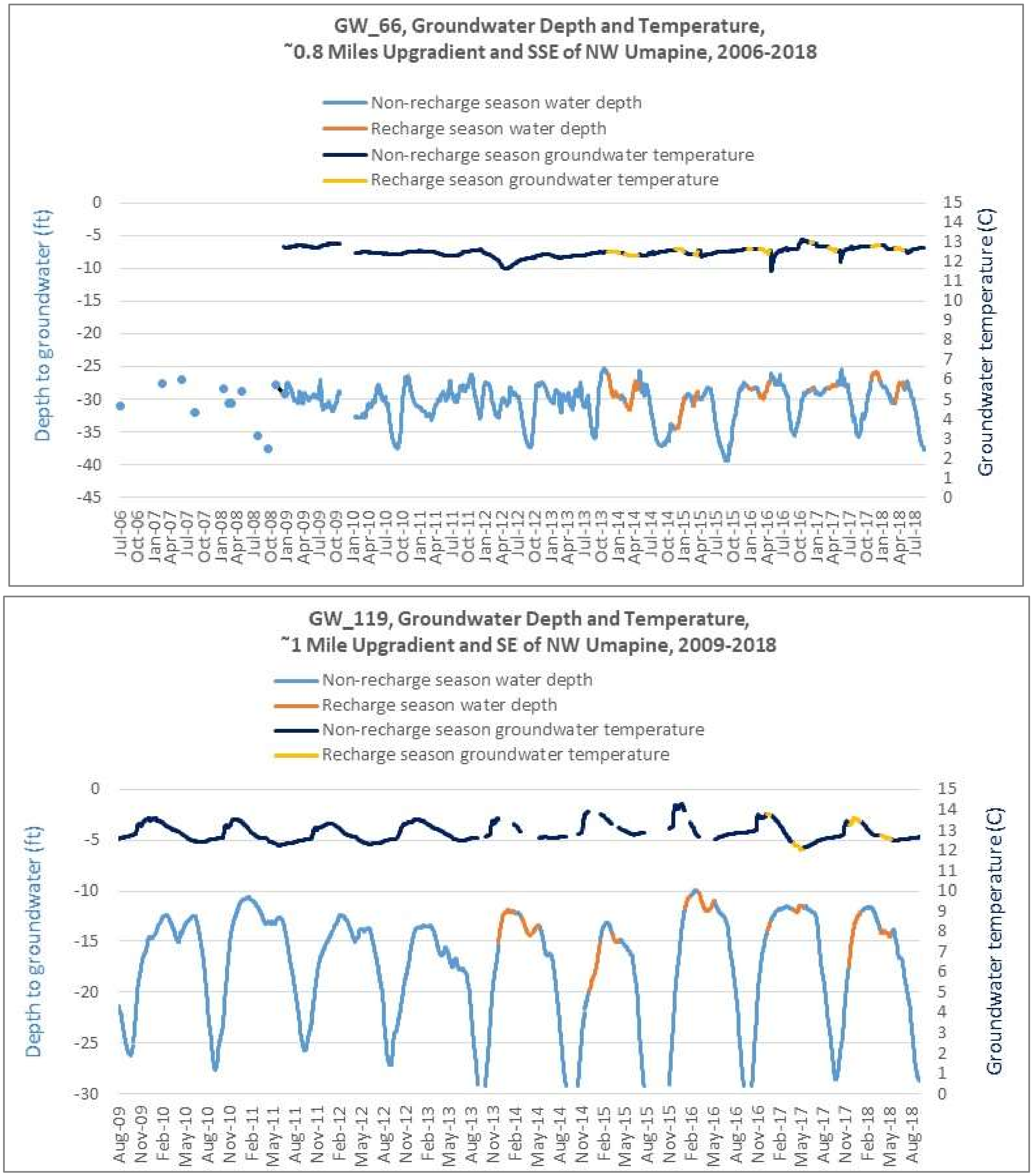
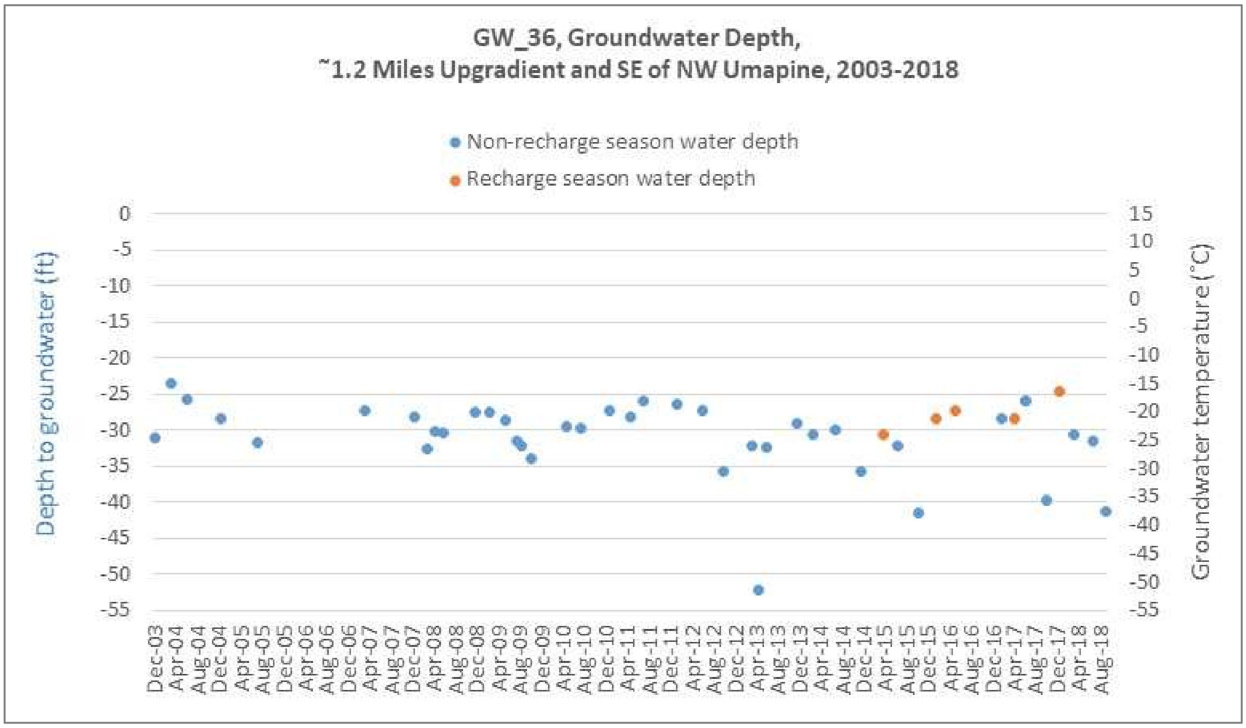


Figure 56. Hydrographs for monitoring wells GW_66 and GW_119.



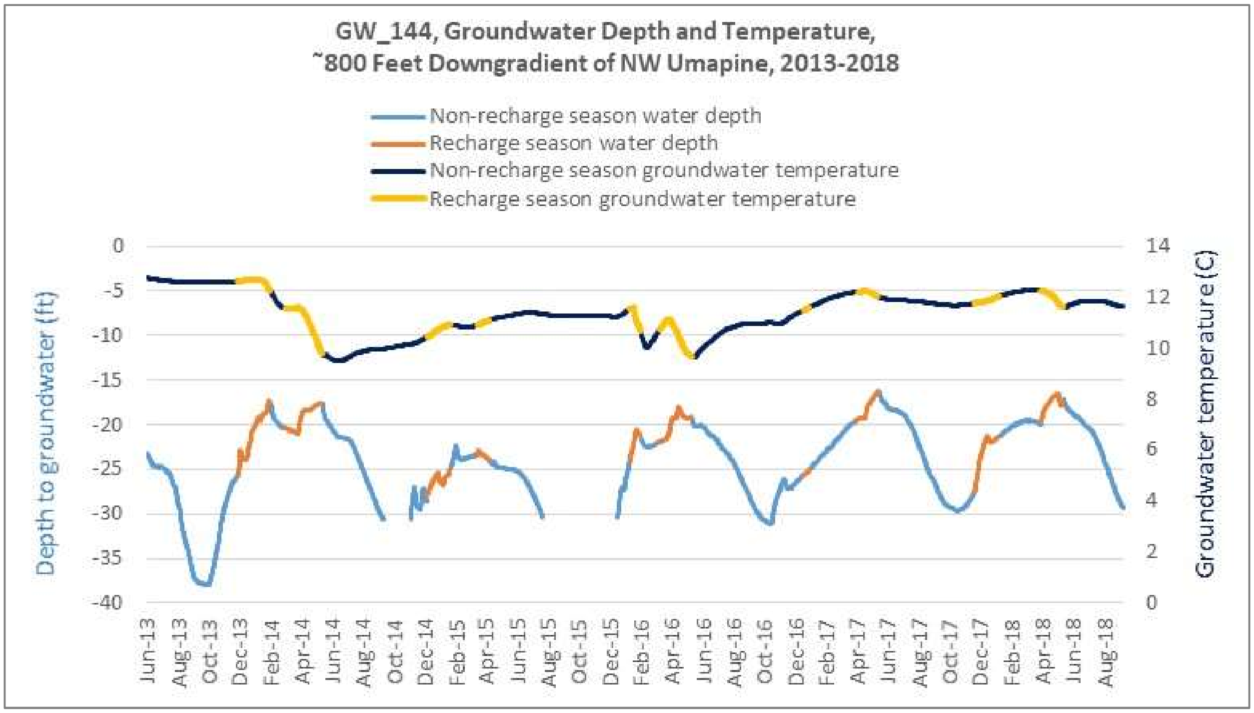


Figure 57. Hydrographs for monitoring wells GW_36 and GW_144.

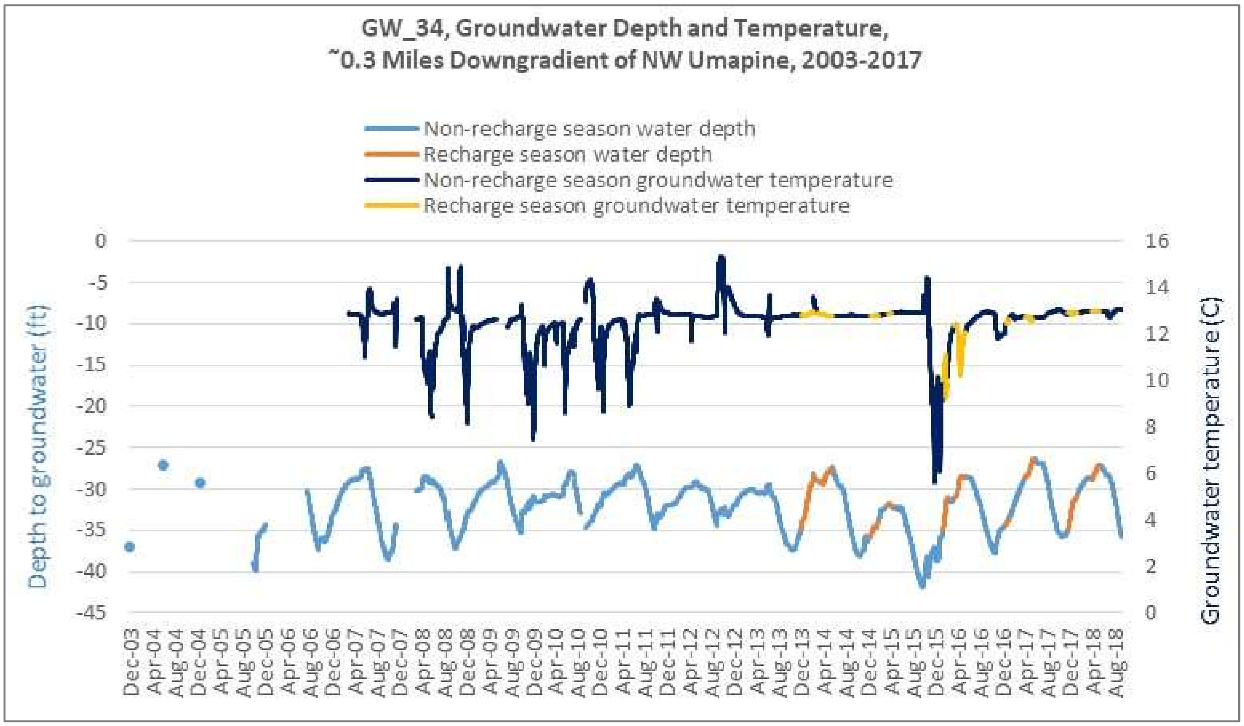


Figure 58. Hydrograph for monitoring well GW_34.

TRIANGLE ROAD SITE

During WY2018, the second year of operations for the Triangle Road site, the site operated for 58 days from March 19 to May 15, recharging 103 ac-ft of water at an average rate of 1.8 ac-ft per day or 0.9 cfs.

Four monitoring wells are associated with the site (Figure 59[4]). Seasonal changes in groundwater elevations were observed in all four wells: upgradient GW_117, cross-gradient GW_143, and downgradient GW_170 and GW_171 (Figures 60 and 61). Based on the small volume recharged so far and distance to three of the wells, the seasonal changes are unlikely in response to recharge operations. In GW_170, the closest downgradient well, existing data are insufficient to determine if a response to recharge occurred. A slight decline in groundwater temperatures occurred during last year's recharge; however, no temperature data were available in WY2018.

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[4] GW_171, one of the four monitoring wells associated with the Triangle Road site, is not shown in Figure 59 because it is 1.6 miles northwest of the site; the location of GW_171 can be seen in Figure 24.

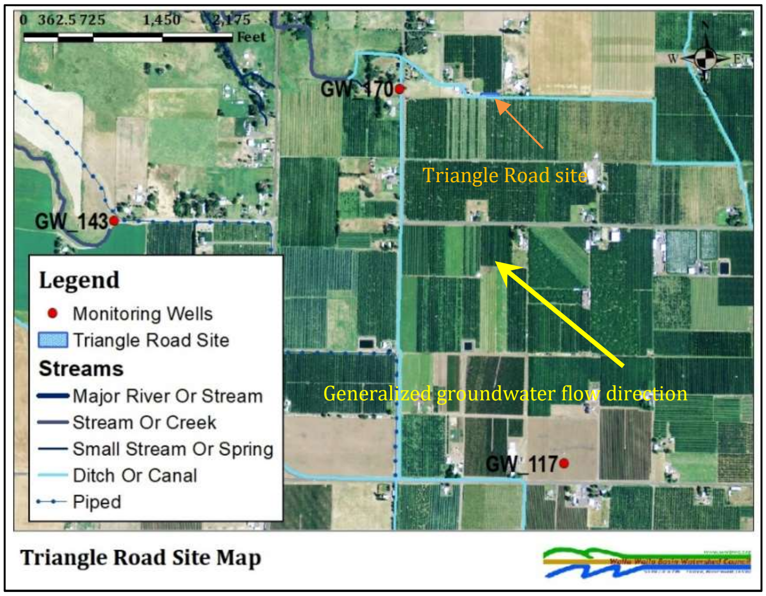


Figure 59. Triangle Road monitoring well locations (GW_171 not shown).

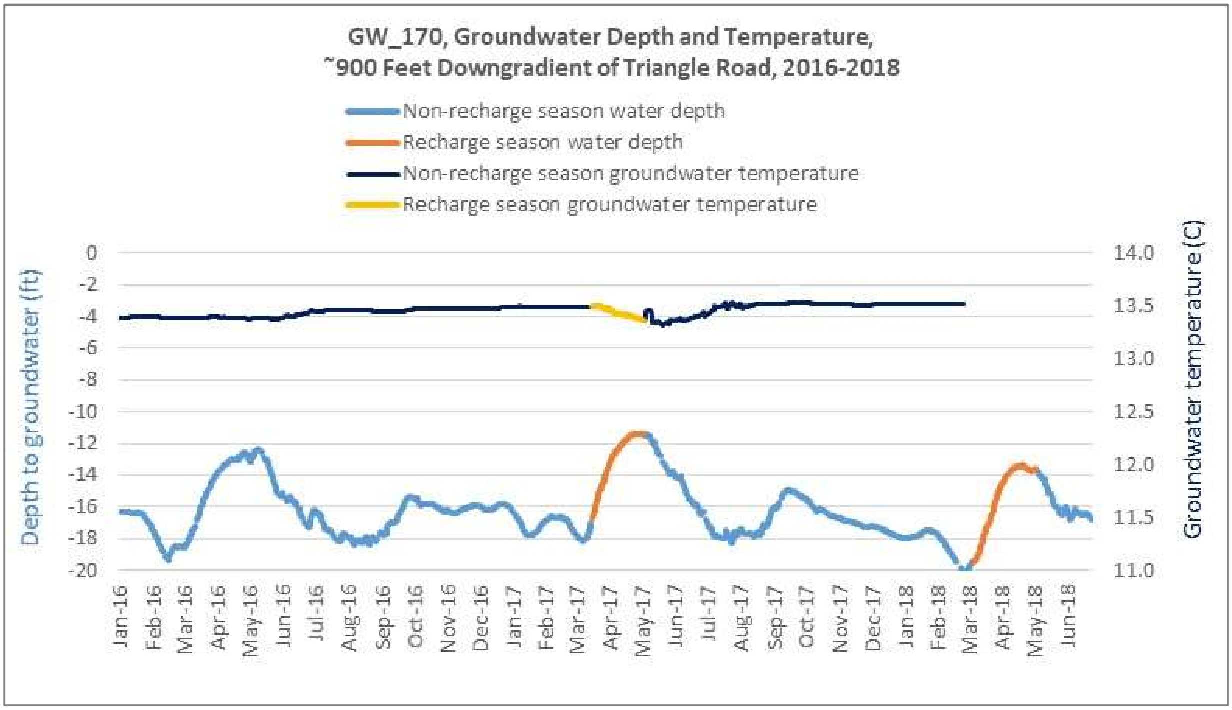
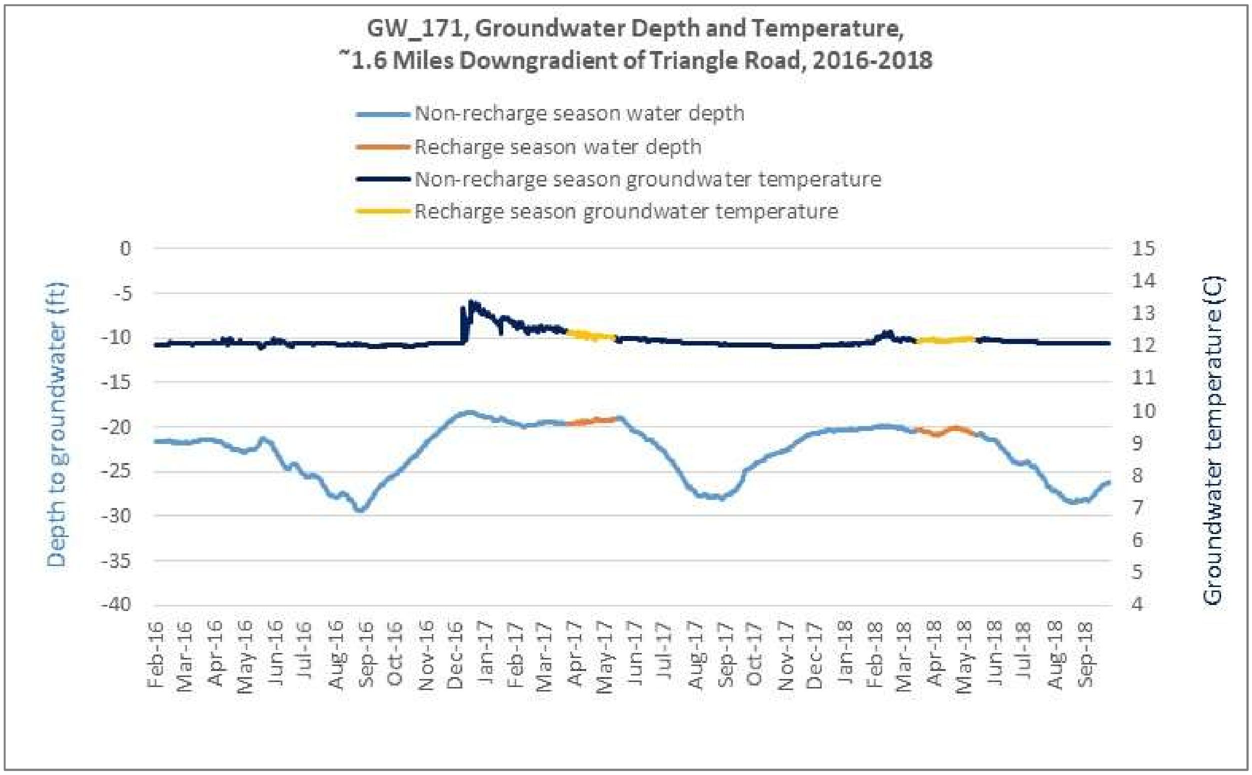


Figure 60. Hydrograph for monitoring well GW_170.



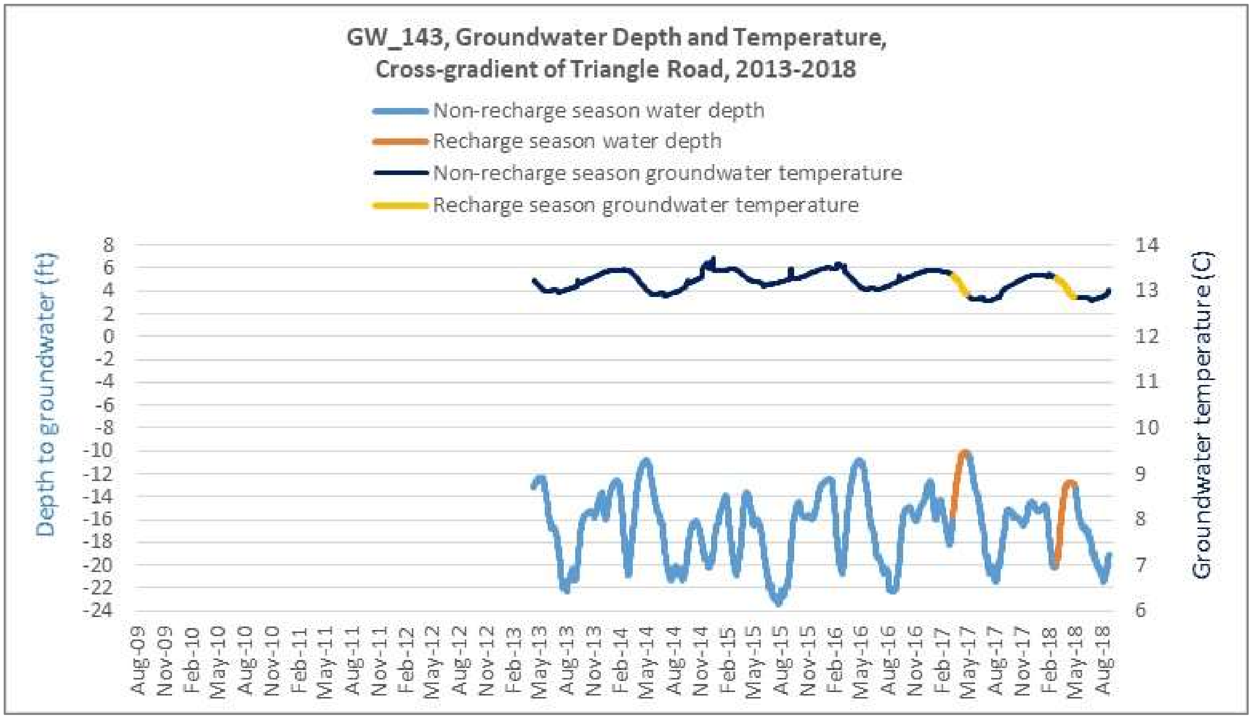


Figure 61. Hydrographs for monitoring wells GW_171 and GW_143.

TRUMBULL SITE

The Trumbull site operated for only 40 days in December and early January. The site did not operate in the spring at the request of a landowner who has experienced water logging in a field downgradient of the site during spring months. The water logging reoccurred in the spring, despite no recharge occurring from the Trumbull site in the spring. A total of 67 ac-ft of water, for an average of 1.7 ac-ft per day, was recharged at the site. At upgradient monitoring well GW_117, from the first complete year of operations in WY2014 to 2018, the annual deepest groundwater levels became deeper by 2.7 ft and the shallowest became shallower by 1.1 ft (Table 4 and Figures 62 and 63). At GW_142 during the same water years, the shallowest groundwater levels became deeper by 3.4 ft and the deepest groundwater levels became deeper by 0.1 ft.

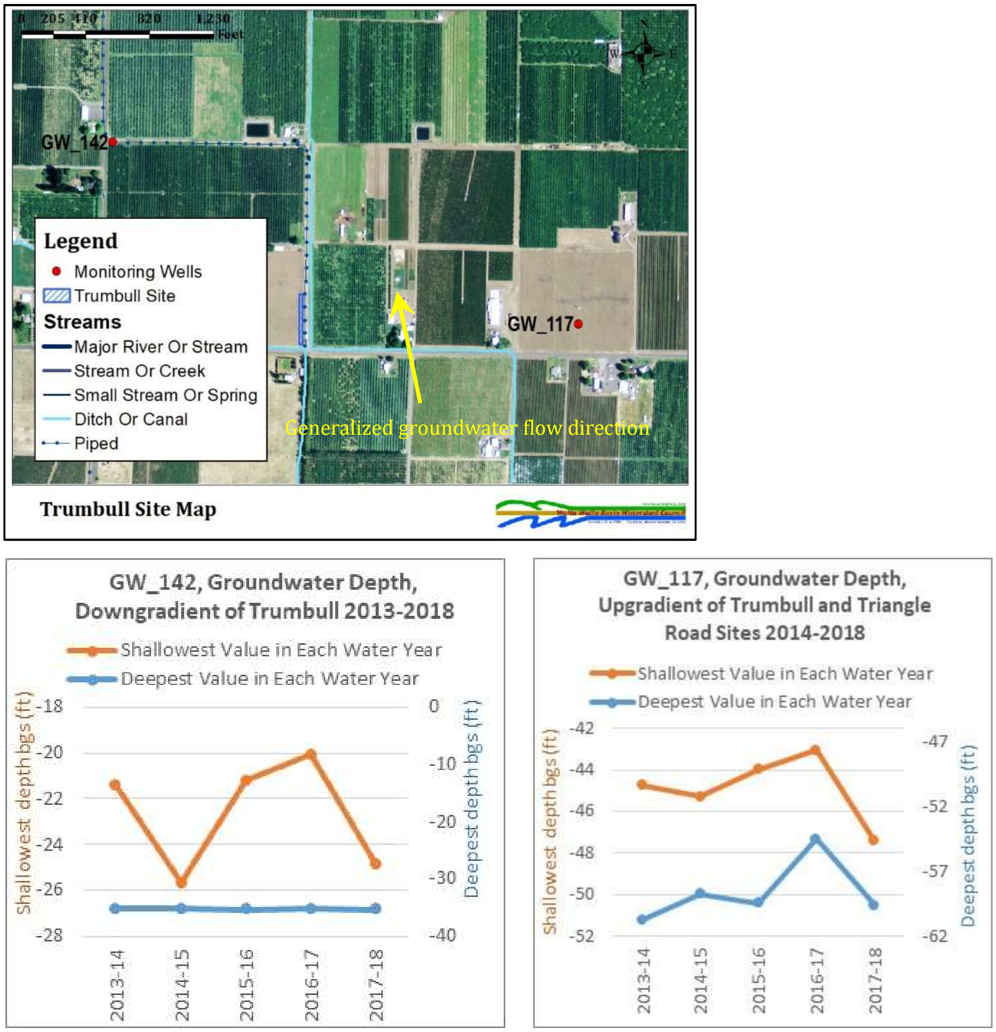
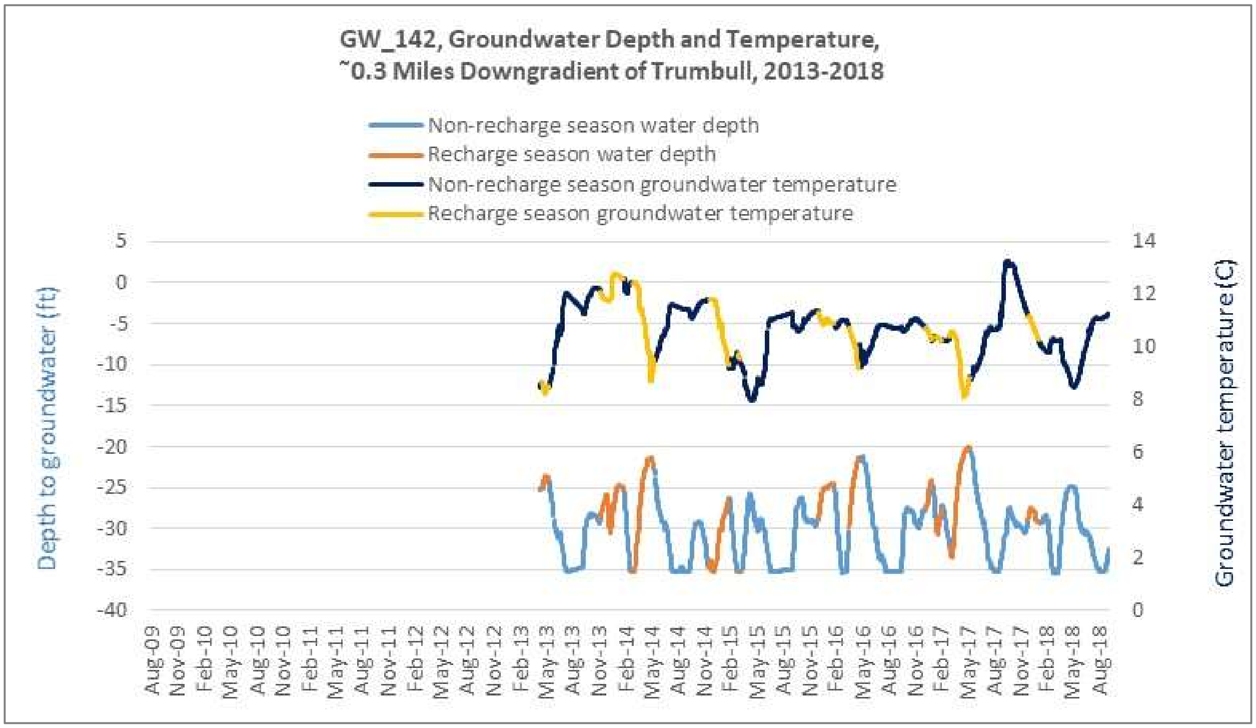


Figure 62. Trumbull monitoring well locations and shallowest and deepest groundwater levels, by year, in GW_142 and GW_117.



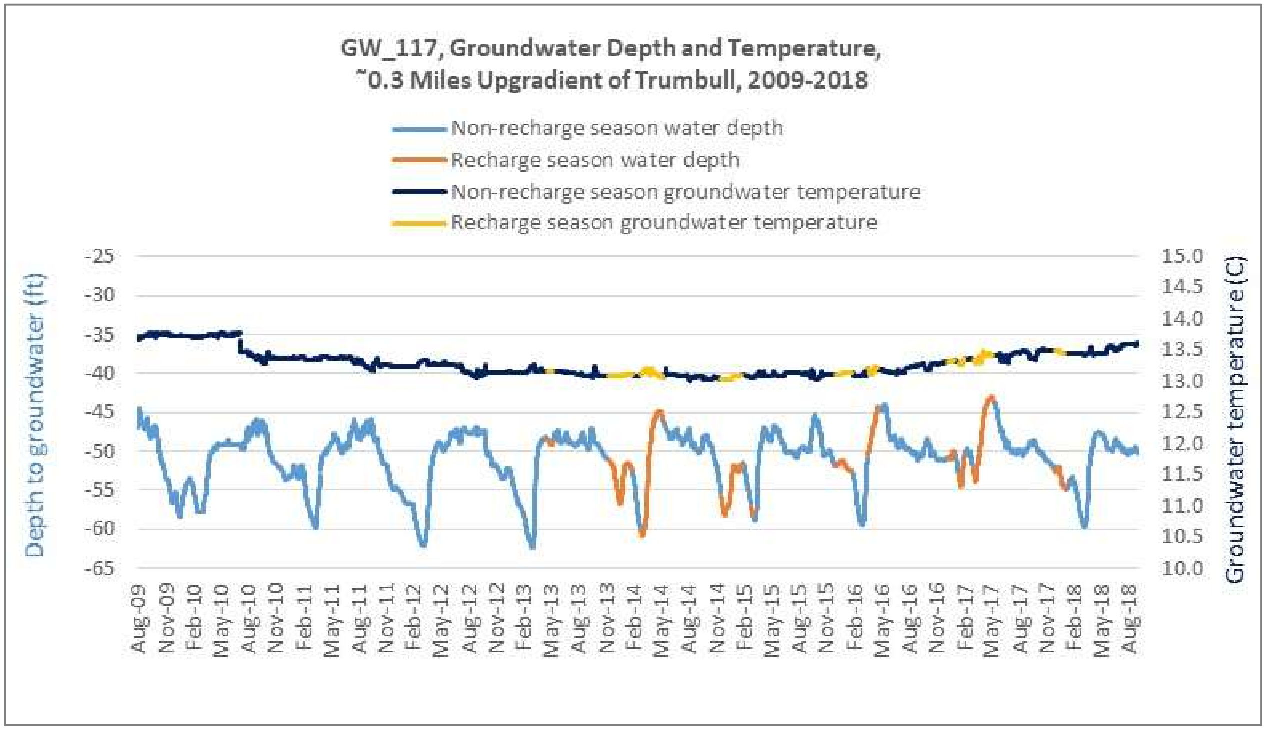


Figure 63. Hydrographs for monitoring wells GW_142 and GW_117.

WATER QUALITY

Water samples were collected under the approved monitoring plan for LL-1621[5]. The list of analytes in LL-1621 (Table 5) differed from the list in the previous limited license, LL-1433, adding zinc and copper, analyzing ammonia instead of total Kjeldahl nitrogen, sulfur instead of sulfate, and orthophosphate instead of total phosphorus, and not analyzing total organic carbon, chloride, aluminum, or alkalinity. The field parameters and nitrate, calcium, sodium, potassium, magnesium, manganese, and iron remained the same.

Water quality was sampled once before and once after the recharge season. Analytical laboratory reports are included in Appendix C. Table 5 lists detection limits for the analytical methods. Source water quality and groundwater quality at each site are discussed below.

Table 5. Analyte list, analytical methods, and method reporting limits for WY 2018.

Inorganic Analyte	**Analytical Method**	**Method Detection Limit (mg/L)**	**Analytical Method**	**Lab Reporting Limit (mg/L)**
Ammonia-N (mg/L)	Eco-Tracker (Unibest)	1.2	SM 4500	0.05
Calcium (mg/L)	Eco-Tracker (Unibest)	0.31		
Copper (mg/L)	Eco-Tracker (Unibest)	0.01	EPA 200.8	0.001
Iron (mg/L)	Eco-Tracker (Unibest)	0.05		
Magnesium (mg/L)	Eco-Tracker (Unibest)	0.27		
Manganese (mg/L)	Eco-Tracker (Unibest)	0.01		
Nitrate-N(mg/L)	Eco-Tracker (Unibest)	0.09	EPA 300.0	0.1
Phosphorus (mg/L)	Eco-Tracker (Unibest)	0.02		
Potassium (mg/L)	Eco-Tracker (Unibest)	0.18		
Sodium (mg/L)	Eco-Tracker (Unibest)	0.17		
Sulfur (mg/L)	Eco-Tracker (Unibest)	0.02		
Zinc (mg/L)	Eco-Tracker (Unibest)	0.01	EPA 200.8	0.001
Synthetic Organic Constituents	**Analytical Method**	**Quantitation Limit (µg/L)**		
Azinphos-methyl	8141B	0.3		
Chlorpyrifos	8141B	0.3		
Diuron	8321B	0.06		
Malathion	8141B	0.3		

SOURCE WATER QUALITY

Source water samples were collected at five locations on 12/12/2016 and 5/30/2018 (Figure 64:

- Source Water #1 – Zerba Weir
- Source Water #2 – Duff Weir (S-418)
- Source Water #3 -- Huffman-Richartz Split
- Source Water #4 – Fruitvale (S-318)
- Source Water #5 -- Eastside

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[5] The approved monitoring plan inadvertently lists lead and mercury as analytes. These were never intended to be part of the sampling program and a revised monitoring plan will be submitted to correct the error.

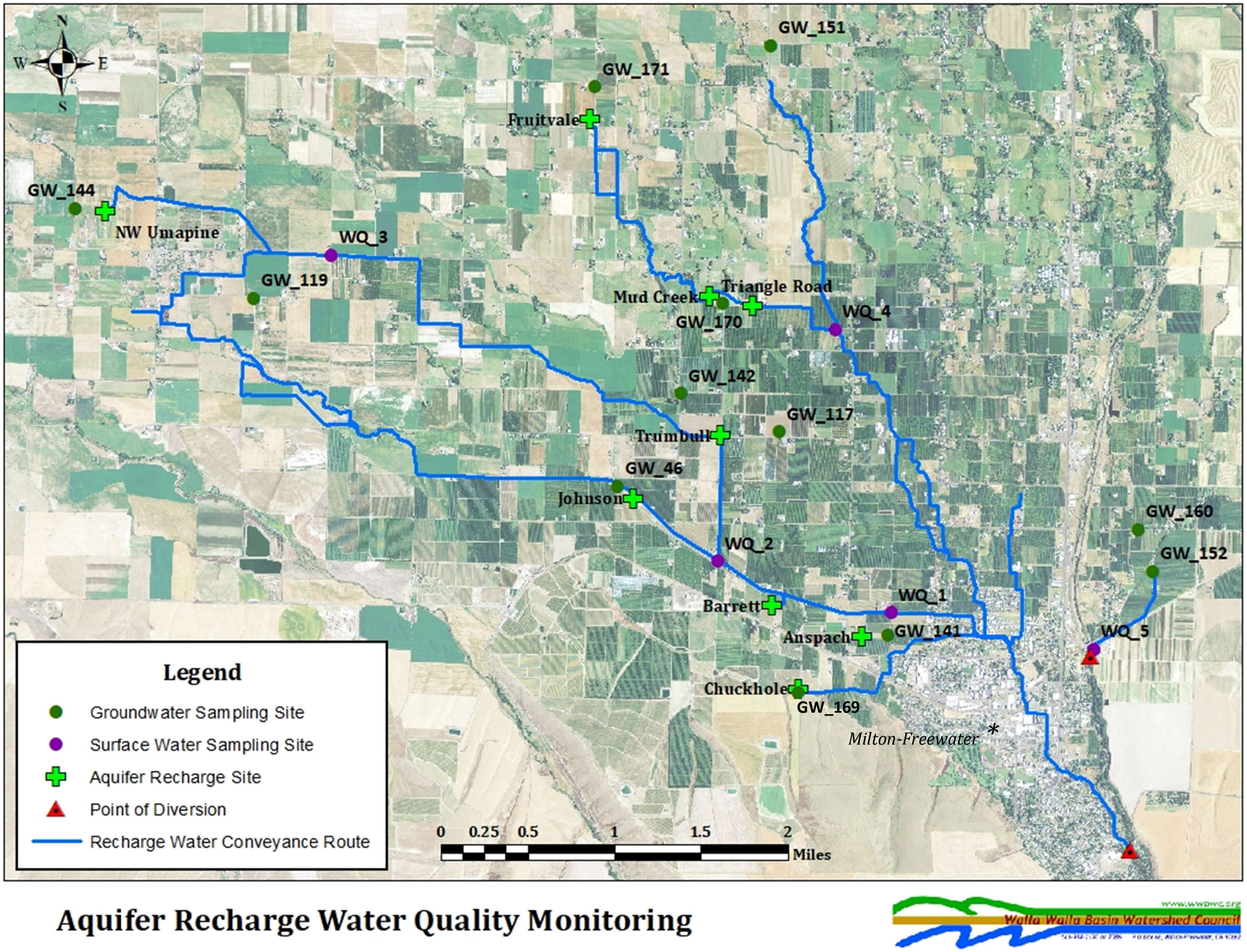

Figure 64. Water quality sampling locations for the managed aquifer recharge program in WY2018.

In general, water quality appears to be good at the sampled locations. The source water has low concentrations of major cations (sodium, potassium, calcium and magnesium), nitrate, phosphorous, iron, manganese, sulfur, and zinc (Tables 6-10).

Table 6. Source Water #1 water quality data.

Source Water #1 (Zerba Weir)	**Laboratory**		
	Unibest		**Anatek**
Analyte	**10/26/2017**	**5/21/2018**	**5/21/2018**
Ammonia-N (mg/L)	3.89	2.62	ND
Calcium (mg/L)	4.7	4.95	-
Copper (mg/L)	0	0	ND
Iron (mg/L)	0.06	0.01	-
Magnesium (mg/L)	1.79	1.83	-
Manganese (mg/L)	0	0	-
Nitrate-N(mg/L)	0.39	0	ND
Phosphorus (mg/L)	0.05	0.02	-
Potassium (mg/L)	1.84	2.21	-
Sodium (mg/L)	2.23	3.02	-
Sulfur (mg/L)	10.02	4.61	-
Zinc (mg/L)	0.04	0	0.00892

ND = not detected

Table 7. Source Water #2 water quality data.

Source Water #2 (Duff Weir)	**Laboratory**		
	Unibest		**Anatek**
Analyte	**10/26/2017**	**5/21/2018**	**5/21/2018**
Ammonia-N (mg/L)	3.85	3.52	ND
Calcium (mg/L)	5.51	4.65	-
Copper (mg/L)	0.01	0	ND
Iron (mg/L)	0.17	0.02	-
Magnesium (mg/L)	1.97	1.6	-
Manganese (mg/L)	0	0	-
Nitrate-N(mg/L)	0.03	0	ND
Phosphorus (mg/L)	0.05	0.02	-
Potassium (mg/L)	1.79	1.79	-
Sodium (mg/L)	2.36	2.54	-
Sulfur (mg/L)	10.1	6.88	-
Zinc (mg/L)	0.04	0	0.00469

ND = not detected

Table 8. Source Water #3 water quality data.

Source Water #3 – Huffman-Richartz	**Laboratory**		
	Unibest		**Anatek**
Analyte	**10/26/2017**	**5/22/2018**	**5/22/2018**
Ammonia-N (mg/L)	3.62	2.91	ND
Calcium (mg/L)	7.48	5.21	-
Copper (mg/L)	0.01	0.01	0.00288
Iron (mg/L)	0.08	0.02	-
Magnesium (mg/L)	2.31	1.93	-
Manganese (mg/L)	0.05	0	-
Nitrate-N(mg/L)	0	0	ND
Phosphorus (mg/L)	0.15	0.03	-
Potassium (mg/L)	2.3	2.64	-
Sodium (mg/L)	2.09	3.23	-
Sulfur (mg/L)	9.43	6.42	-
Zinc (mg/L)	0.03	0	0.00246

Table 9. Source Water #4 water quality data.

Source Water #4 – Fruitvale, S-318	**Laboratory**		
	Unibest		**Anatek**
Analyte	**10/26/2017**	**5/22/2018**	**5/22/2018**
Ammonia-N (mg/L)	4.27	3.15	ND
Calcium (mg/L)	4.45	4.06	-
Copper (mg/L)	0	0	ND
Iron (mg/L)	0.08	0.01	-
Magnesium (mg/L)	1.67	1.52	-
Manganese (mg/L)	0	0	-
Nitrate-N(mg/L)	0.15	0	ND
Phosphorus (mg/L)	0.09	0.01	-
Potassium (mg/L)	2.12	1.77	-
Sodium (mg/L)	2.04	2.45	-
Sulfur (mg/L)	10.1	4.11	-
Zinc (mg/L)	0.03	0	0.00162

Table 10. Source Water #5 – Eastside water quality data.

Source Water #5 - Eastside	**Laboratory**		
	Unibest		**Anatek**
Analyte	**10/26/2017**	**5/21/2018**	**5/21/2018**
Ammonia-N (mg/L)	4.01	2.92	ND
Calcium (mg/L)	5.92	5.03	-
Copper (mg/L)	0.01	0	ND
Iron (mg/L)	0.12	0.01	-
Magnesium (mg/L)	2.24	1.87	-
Manganese (mg/L)	0	0	-
Nitrate-N(mg/L)	0.66	0	ND
Phosphorus (mg/L)	0.04	0.02	-
Potassium (mg/L)	2.88	2.21	-
Sodium (mg/L)	2.6	3.03	-
Sulfur (mg/L)	9.72	4.62	-
Zinc (mg/L)	0.05	0	0.0048

ND = not detected

The two different analytical techniques performed on the spring samples for those constituents with regulatory standards yielded very different results. No regulatory standard was exceeded based on EPA and Standard Method analytical techniques, but there were exceedances using the Unibest method. The Unibest technology reflects cumulative concentrations not discrete concentrations. Zinc concentrations as measured using EPA method 200.8 were less than the state criteria of 0.043 mg/L for chronic exposure and 0.042 mg/L for acute exposure, assuming a hardness of 30 mg/L. Ammonia was not detected in any source water sampled using method SM4500. Copper was detected using method EPA 200.8 at 0.00288 mg/L in one source water sample at the Huffman-Richartz split but below state criteria. The ODEQ water quality criteria for copper are calculated on a site-specific basis using the Biotic Ligand Model. The model outputs based on WWBWC input data were 0.01221 mg/L for the acute criterion (CMC) and 0.00758 mg/L for the chronic criterion (CCC)[6].

In contrast, results from the Unibest methodology indicated exceedances of ammonia, copper, and zinc. Reported ammonia values ranged from 2.62 to 4.27 mg/L (Table 11). When the ammonia-as-nitrogen values (NH4-N) provided by the laboratory are converted to ammonium (NH4^{+}), the values range from 3.37 to 5.50 mg/L. The ODEQ water quality criterion for total ammonia nitrogen (NH4^{+}+NH3) is dependent on temperature and pH. In the October sampling, for which there were no exceedances, water temperatures were less than 14 °C and pH was between 6.85 and 7.1 (Table 12), with corresponding ammonia acute criterion values of 26 and 22 mg/L, respectively. In the May sampling, water temperature was less than 14 °C but pH was 8.67 at Source Water #4, with a corresponding criterion of 1.5 mg/L, which was exceeded by the calculated 4.06 mg/LNH4-N value based on the Unibest data.

Table 11. Ammonia water quality criterion compared to Unibest ammonia data.

Site	**Oct 2017**					**May 2018**				
	Temp (˚C)	**pH**	**NH4-N (mg/L)**	**NH4 (mg/L)**	**NH4 Criterion (mg/L)**	**Temp (˚C)**	**pH**	**NH4-N (mg/L)**	**NH4 (mg/L)**	**NH4 Criterion (mg/L)**
Source Water #1	8.10	--	3.89	5.01		11.70	7.39	2.62	3.37	15
Source Water #2	8.50	6.85	3.85	4.96	26	12.00	5.67	3.52	4.53	33
Source Water #3	9.60	--	3.62	4.66		16.60	8.10	2.91	3.75	4.1
Source Water #4	10.90	--	4.27	5.50		13.40	8.67	3.15	4.06	1.5
Source Water #5	9.80	7.1	4.01	5.16	22	10.90	7.34	2.92	3.76	18

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[6] Data for temperature and pH were from the May 2018 sampling event at the Source Water #3 location. The other model inputs were obtained from other sources. The following data were obtained from 4/23/2013 at S-417 (Zerba Weir): dissolved organic carbon 1.7 mg C/L (based on total organic carbon of 2.05 and standard conversion factor of 0.83), calcium 5.1 mg/L, magnesium 2.1 mg/L, sodium 2.9 mg/L, potassium 1.7 mg/L, sulfate 0.9 mg/L, and alkalinity 30 mg/L CaCO3. The input value of 0.82 mg/L for chloride was based on ODEQ guidance and the value of 0.001 for sulfide was based on the minimum value allowed in the model.

The copper concentrations of 0.01 and 0.02 mg/L as reported by Unibest were an order of magnitude higher than calculated toxicity values and results from split samples analyzed with EPA Method 200.8.

At Source Water #5, the reported zinc concentration of 0.05 mg/L exceeds the state chronic and acute criteria of 0.043 mg/L and 0.042 mg/L, respectively, and was an order of magnitude greater than the concentration reported by EPA Method 200.8 from a split sample.

Table 12. Field parameters for source water sampling sites.

Site	**Temperature (˚C)**		**pH**		**Dissolved oxygen (mg/L)**		**Specific conductance (µS/cm[7])**	
	Oct 2017	**May 2018**	**Oct 2017**	**May 2018**	**Oct 2017**	**May 2018**	**Oct 2017**	**May 2018**
Source Water #1	8.1	11.7	--	7.39	--	10.95	77.3	57.4
Source Water #2	8.5	12.0	6.85	5.67	11.55	11.00	73.9	57.2
Source Water #3	9.6	16.6	--	8.10	--	9.84	76.8	63.4
Source Water #4	10.9	13.4	--	8.67	--	9.67	72.8	56.3
Source Water #5	9.8	10.9	7.1	7.34	11.42	11.11	73.4	57.8

GROUNDWATER QUALITY

Groundwater samples and field parameter data were collected at 12 locations (GW_46, GW_117, GW_119, GW_141, GW_142, GW_144, GW_151, GW_152, GW_160, GW_169, GW_170, and GW_171) near the recharge sites. The general rationale for each sampling location is listed below.

- GW_152 provides upgradient monitoring of the aquifer recharge program.
- GW_160 provides downgradient monitoring of the Lefore Road site.
- GW_169 provides upgradient monitoring of the Chuckhole site.
- GW_141: provides upgradient monitoring for the entire project and specifically for the Anspach, Barrett, Chuckhole, and Johnson sites.
- GW46 provides mid-gradient monitoring for the Johnson site and central region of the aquifer recharge program and downgradient monitoring for the Barrett, Anspach, and Chuckhole sites.
- GW117 provides water quality information for the central region of the aquifer recharge program, and upgradient monitoring for the Trumbull, Mud Creek, and Triangle Road sites.
- GW_142 provides mid-gradient of the aquifer recharge program and downgradient coverage for the Trumbull site.
- GW_170 provides upgradient monitoring of the Mud Creek and Fruitvale sites, downgradient monitoring of the Triangle Road site, and mid-gradient monitoring of the aquifer recharge program.
- GW119 provides upgradient monitoring for the NW Umapine site and downgradient monitoring of the Johnson site.
- GW_144 provides downgradient monitoring for the NW Umapine site.

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[7] µS/cm is microsiemens per centimeter, a measure of conductance.

- GW_171 provides downgradient monitoring of the aquifer recharge program and specifically for the Fruitvale site.
- GW_151 provides downgradient monitoring of the aquifer recharge program.

The 12 wells were sampled on December 12, 2017 and May 30, 2018 and analyzed for the constituents listed in Table 5.

The only constituent with a regulatory reference level is nitrate, at 10 mg/L. Based on the results from EPA Method 300.0, in the May sampling event at GW_144 the concentration of 12.4 mg/L exceeded the state criterion. Results from the Unibest technology reported more frequent exceedances at GW_144 (fall and spring), GW_119 (fall), and GW_151 (fall). The source of these nitrates is unknown; however, given the low nitrate concentrations in the source water (less than the lab reporting limit of 0.09 mg/L), the source of the nitrogen is highly unlikely to be the delivery water.

ODEQ guidance levels of 0.3 mg/L iron, 0.05 mg/L manganese, and 5.0 mg/L zinc were met, except at GW_160 the pre-recharge iron concentration was 0.33 mg/L (the post-recharge concentration was 0.01 mg/L).

The groundwater samples collected at wells GW_144 and GW_171 on May 30, 2018 were also analyzed using analytical methods EPA 8141B and EPA 8321B for the approved targeted list of herbicides and pesticides: azinphos-methyl, chlorpyrifos, diuron, and malathion. There were no detections of the four targeted constituents in either sample. Analytical laboratory reports are included in Appendix C.

The primary objective of sampling source water and groundwater is to assess if adverse impacts are occurring in groundwater due to the introduced recharge water. Because of the differences between the Unibest data and data from conventional laboratory analyses, the following comparison relied on the conventional analytical data for nitrate, copper, zinc, and ammonia and on the Unibest data for the remaining constituents. When comparing source (surface) water and groundwater concentrations by constituent (Tables 13 -18 and Figures 65 - 78), the following patterns were observed:

(1) Concentrations in source water were less than in groundwater at all locations for calcium, magnesium, nitrate, phosphorus, potassium, and sodium.

(2) Concentrations in the source water were slightly greater than concentrations in groundwater at varying frequencies as follows:

   a. Copper concentration at WQ_3 (0.00288) was greater than GW_119 (0.001 mg/L) in the spring, all other copper concentrations in surface water were less than groundwater or not detected when using EPA Method 200.8.

   b. Iron concentrations in source water samples (ranging from 0.01 to 0.17 mg/L0 were greater than or equal to groundwater samples (ranging from not detected [<ND] to 0.1 mg/L] in half of the samples.

    c. Manganese concentration at WQ_3 (0.05 mg/L) was greater than GW_119 (<ND) and GW_144; manganese was not detected in any other source water sample.
    d. Phosphorus concentration at WQ_3 (0.15 mg/L) was greater than GW_119 (0.12 mg/L) and GW_144 (0.13 mg/L) in the fall, and at WQ_4 (0.09 mg/L) was greater than GW_170 (0.08) and GW_151 (0.07 mg/L) in the fall; phosphorus concentrations in all other source samples were less than or equal to groundwater samples.
    e. Potassium concentration at WQ_5 (2.88 mg/L) was greater than GW_160 (2.74 mg/L); potassium concentrations in all other source samples were less than groundwater samples.
    f. Sulfur concentration at WQ_2 (10.1 mg/L) was greater than GW_46 (9.95 mg/L) in the fall and 6.88 mg/L was greater than GW_46 (6.81 mg/L) and GW_142 (5.33 mg/L) in the spring; sulfur concentrations in all other source samples were less than groundwater samples.
    g. Zinc concentrations at WQ_1, WQ_3, WQ_4, and WQ_5 (ranging from 0.00162 to 0.00892 mg/L) were greater than the associated groundwater samples (ranging from <ND to 0.0015 mg/L) using EPA Method 200.8.
(3) No ammonia was detected using SM-4500.

When comparing groundwater conditions pre- and post-recharge (Figures 65-78), the following differences were observed:

(1) At most sites for most constituents, concentrations were greater pre-recharge than post-recharge.
(2) Constituents with the largest post-recharge increases at a few sites were calcium (GW_152, GW_160, and GW_144), magnesium (GW_152, GW_160, GW_144), nitrate (GW_160, GW_144), potassium (GW_152, GW_160, and GW_144), and sodium (GW_152, GW_144). However, concentrations of these constituents were lower in the source water than in groundwater, indicating the surface water is not the source of the constituents. It is possible the low-concentration source water is becoming enriched by constituents in the soil as the water percolates through the soil column. It is also possible the monitoring wells are detecting increased concentrations of these constituents from upgradient sources other than the recharge sites. For example, wintertime irrigation is commonly practiced near Umapine.
(3) The specific conductance of groundwater decreased by more than 10 percent between the pre- and post-recharge at GW_46, GW_141, GW_142, and GW_151 (Table 19), suggesting constituents present in the groundwater before recharge were diluted by the addition of surface water. These four wells monitor the Johnson, Anspach, Trumbull, and East Trolley sites.

When comparing upgradient and downgradient conditions, the following were observed:

(1) When considering the monitoring network as a whole, concentrations did not increase moving down the hydraulic gradient. Groundwater in this area tends to move northwest

then west (see Figure 4) but concentrations did not increase in a northwesterly to westerly direction.

(2) Comparing upgradient and downgradient monitoring locations at specific recharge sites: at the Trumbull (GW_117 and GW_142) and Johnson (GW_141 and GW_46) sites, nitrate and major anion and cation concentrations decreased at the downgradient locations relative to the upgradient locations, indicating recharge activities improved groundwater quality.

(3) Constituent concentrations in GW_46 (lower end of Johnson site and immediately adjacent to the White Ditch and GW_142 (downgradient of Trumbull and immediately adjacent to a water supply pipe) are remarkably similar to surface water concentrations, both pre- and post-recharge. Post-recharge specific conductance values of 62.5 and 70 µS/cm are closer to the range of surface water values (56.3 to 57.8 µS/cm) than other groundwater wells (124.5 to 402 µS/cm); pre-recharge specific conductance values of 93.2 and 110.1 µS/cm in GW_46 and GW_142 are higher than post-recharge values.

In summary, none of the data suggests aquifer recharge operations have added contaminants to the groundwater. While at some sites the concentrations of some constituents in surface water are slightly higher than in groundwater, the differences are generally on the order of parts-per-billion, less than the range of expected environmental variability. More commonly, constituent concentrations in surface waters are lower than in groundwater. At most sites, constituent concentrations in groundwater decrease after the recharge season; at the few sites and few constituents where they increased after recharge, concentrations in the source water were lower than in groundwater, indicating the source water was not the cause of the increase. At a few sites, groundwater conditions suggest the recharge water has improved groundwater quality.

Table 13. Ammonia and calcium concentrations.

Ammonia					
Sample Date	**Analytical Method**	**Surface Water Monitoring Sites**	**Groundwater Monitoring Sites**		
		WQ_1	GW_141	GW_169	
8/26/2017	Unibest	3.89	3.95	4.44	
5/22-22/2018	Unibest	**2.62**	2.25	3.60	
5/22-22/2018	SM-4500	ND	ND	ND	
		WQ_2	GW_46	GW_142	GW_117
8/26/2017	Unibest	**3.85**	3.95	4.02	3.74
5/22-22/2018	Unibest	**3.52**	3.21	2.79	3.21
5/22-22/2018	SM-4500	ND	ND	ND	ND
		WQ_3	GW_119	GW_144	
8/26/2017	Unibest	3.62	4.45	3.67	
5/22-22/2018	Unibest	**2.91**	3.63	2.77	
5/22-22/2018	SM-4500	ND	ND	ND	
		WQ_4	GW_170	GW_171	GW_151
8/26/2017	Unibest	**4.27**	4.00	4.20	4.33
5/22-22/2018	Unibest	**3.15**	2.66	3.12	3.39
5/22-22/2018	SM-4500	ND	ND	ND	ND
		WQ_5	GW_152	GW_160	
8/26/2017	Unibest	**4.01**	3.84	3.97	
5/22-22/2018	Unibest	**2.92**	2.70	3.11	
5/22-22/2018	SM-4500	ND	ND	ND	

Calcium					
Sample Date	**Analytical Method**	**Surface Water Monitoring Sites**	**Groundwater Monitoring Sites**		
		WQ_1	GW_141	GW_169	
8/26/2017	Unibest	4.7	23.88	15.16	
5/22-22/2018	Unibest	4.95	10.99	14.94	
		WQ_2	GW_46	GW_142	GW_117
8/26/2017	Unibest	5.51	6.43	7.19	13.51
5/22-22/2018	Unibest	4.65	4.97	5.73	15.96
		WQ_3	GW_119	GW_144	
8/26/2017	Unibest	7.48	35.21	30.66	
5/22-22/2018	Unibest	5.21	33.98	51.68	
		WQ_4	GW_170	GW_171	GW_151
8/26/2017	Unibest	4.45	13.35	22.03	27.48
5/22-22/2018	Unibest	4.06	15.79	24.48	18.65
		WQ_5	GW_152	GW_160	
8/26/2017	Unibest	5.92	24.09	7.08	
5/22-22/2018	Unibest	5.03	47.99	21.18	

ND = not detected

Bolded values indicate source water concentration greater than groundwater concentration

Table 14. Copper and iron concentrations.

Copper					
Sample Date	Analytical Method	Surface Water Monitoring Sites	Groundwater Monitoring Sites		
		WQ_1	GW_141	GW_169	
8/26/2017	Unibest	ND	0.01	0.01	
5/22-22/2018	Unibest	ND	ND	ND	
5/22-22/2018	EPA 200.8	ND	0.0014	ND	
		WQ_2	GW_46	GW_142	GW_117
1/1/1900	Unibest	0.01	0.01	0.01	ND
5/22-22/2018	Unibest	ND	0.01	ND	ND
5/22-22/2018	EPA 200.8	ND	ND	ND	ND
		WQ_3	GW_119	GW_144	
8/26/2017	Unibest	0.01	0.01	0.01	
5/22-22/2018	Unibest	0.01	ND	0.01	
5/22-22/2018	EPA 200.8	**0.00288**	0.001	0.004	
		WQ_4	GW_170	GW_171	GW_151
8/26/2017	Unibest	ND	ND	0.01	
5/22-22/2018	Unibest	ND	0.01	ND	
5/22-22/2018	EPA 200.8	ND	ND	ND	
		WQ_5	GW_152	GW_160	
8/26/2017	Unibest	0.01	0.01	0.01	
5/22-22/2018	Unibest	ND	ND	ND	
5/22-22/2018	EPA 200.8	ND	0.0012	ND	

Iron					
Sample Date	Analytical Method	Surface Water Monitoring Sites	Groundwater Monitoring Sites		
		WQ_1	GW_141	GW_169	
8/26/2017	Unibest	0.06	0.61	0.19	
5/22-22/2018	Unibest	0.01	0.01	ND	
		WQ_2	GW_46	GW_142	GW_117
8/26/2017	Unibest	**0.17**	0.1	0.05	0.18
5/22-22/2018	Unibest	0.02	0.02	0.01	ND
		WQ_3	GW_119	GW_144	
8/26/2017	Unibest	0.08	0.19	0.19	
5/22-22/2018	Unibest	0.02	ND	ND	
		WQ_4	GW_170	GW_171	GW_151
8/26/2017	Unibest	0.08	1.01	0.1	0.19
5/22-22/2018	Unibest	0.01	0.01	ND	0.01
		WQ_5	GW_152	GW_160	
8/26/2017	Unibest	**0.12**	0.08	0.33	
5/22-22/2018	Unibest	0.01	0.01	0.01	

ND = not detected

Bolded values indicate source water concentration greater than groundwater concentration

Table 15. Magnesium and manganese concentrations.

Magnesium					
Sample Date	**Analytical Method**	**Surface Water Monitoring Sites**	**Groundwater Monitoring Sites**		
		WQ_1	GW_141	GW_169	
8/26/2017	Unibest	1.79	9.26	5.81	
5/22-22/2018	Unibest	1.83	4.14	5.58	
		WQ_2	GW_46	GW_142	GW_117
8/26/2017	Unibest	1.97	2.57	2.8	5.34
5/22-22/2018	Unibest	1.6	1.84	2.14	5.99
		WQ_3	GW_119	GW_144	
8/26/2017	Unibest	2.31	14.56	12.17	
5/22-22/2018	Unibest	1.93	14.6	20.84	
		WQ_4	GW_170	GW_171	GW_151
8/26/2017	Unibest	1.67	5.19	8.86	10.68
5/22-22/2018	Unibest	1.52	6.12	9.83	7.07
		WQ_5	GW_152	GW_160	
8/26/2017	Unibest	2.24	9.25	2.77	
5/22-22/2018	Unibest	1.87	18.34	7.72	

Manganese					
Sample Date	**Analytical Method**	**Surface Water Monitoring Sites**	**Groundwater Monitoring Sites**		
		WQ_1	GW_141	GW_169	
8/26/2017	Unibest	ND	0.01	0.01	
5/22-22/2018	Unibest	ND	ND	ND	
		WQ_2	GW_46	GW_142	GW_117
8/26/2017	Unibest	ND	ND	ND	ND
5/22-22/2018	Unibest	ND	ND	ND	ND
		WQ_3	GW_119	GW_144	
8/26/2017	Unibest	**0.05**	ND	0.02	
5/22-22/2018	Unibest	ND	ND	ND	
		WQ_4	GW_170	GW_171	GW_151
8/26/2017	Unibest	ND	0.01	ND	ND
5/22-22/2018	Unibest	ND	ND	ND	ND
		WQ_5	GW_152	GW_160	
8/26/2017	Unibest	ND	ND	ND	
5/22-22/2018	Unibest	ND	ND	ND	

ND = not detected

Bolded values indicate source water concentration greater than groundwater concentration

Table 16. Nitrate and phosphorus concentrations.

Nitrate					
Sample Date	**Analytical Method**	**Surface Water Monitoring Sites**	**Groundwater Monitoring Sites**		
		WQ_1	GW_141	GW_169	
8/26/2017	Unibest	0.39	6.01	ND	
5/22-22/2018	Unibest	ND	1.25	0.83	
5/22-22/2018	EPA 300.0	ND	1.29	1.3	
		WQ_2	GW_46	GW_142	GW_117
1/1/1900	Unibest	0.03	0.64	1.75	3.58
5/22-22/2018	Unibest	ND	ND	ND	2.57
5/22-22/2018	EPA 300.0	ND	0.111	0.199	2.32
		WQ_3	GW_119	GW_144	
8/26/2017	Unibest	ND	11.17	14.38	
5/22-22/2018	Unibest	ND	9.35	18.83	
5/22-22/2018	EPA 300.0	ND	8.29	12.4	
		WQ_4	GW_170	GW_171	GW_151
8/26/2017	Unibest	0.15	1.34	4.53	13.11
5/22-22/2018	Unibest	ND	1.91	4.02	2.96
5/22-22/2018	EPA 300.0	ND	2.05	4.14	3.47
		WQ_5	GW_152	GW_160	
8/26/2017	Unibest	0.66	4.6	1.31	
5/22-22/2018	Unibest	ND	3.76	9.09	
5/22-22/2018	EPA 300.0	ND	3.28	7.47	

Phosphorus					
Sample Date	**Analytical Method**	**Surface Water Monitoring Sites**	**Groundwater Monitoring Sites**		
		WQ_1	GW_141	GW_169	
8/26/2017	Unibest	0.05	0.07	0.07	
5/22-22/2018	Unibest	0.02	0.06	0.05	
		WQ_2	GW_46	GW_142	GW_117
8/26/2017	Unibest	0.05	0.06	0.09	0.08
5/22-22/2018	Unibest	0.02	0.07	0.04	0.06
		WQ_3	GW_119	GW_144	
8/26/2017	Unibest	**0.15**	0.12	0.13	
5/22-22/2018	Unibest	0.03	0.08	0.12	
		WQ_4	GW_170	GW_171	GW_151
8/26/2017	Unibest	**0.09**	0.08	0.09	0.07
5/22-22/2018	Unibest	0.01	0.08	0.06	0.05
		WQ_5	GW_152	GW_160	
8/26/2017	Unibest	0.04	0.04	0.07	
5/22-22/2018	Unibest	0.02	0.04	0.04	

ND = not detected

Bolded values indicate source water concentration greater than groundwater concentration

Table 17. Potassium and sodium concentrations.

Potassium					
Sample Date	Analytical Method	Surface Water Monitoring Sites	Groundwater Monitoring Sites		
		WQ_1	GW_141	GW_169	
8/26/2017	Unibest	1.84	7.31	4.35	
5/22-22/2018	Unibest	2.21	4.47	3.87	
		WQ_2	GW_46	GW_142	GW_117
8/26/2017	Unibest	1.79	2.78	2.73	4.53
5/22-22/2018	Unibest	1.79	2.83	2.62	5.5
		WQ_3	GW_119	GW_144	
8/26/2017	Unibest	2.3	8.97	7.97	
5/22-22/2018	Unibest	2.64	9.41	12.86	
		WQ_4	GW_170	GW_171	GW_151
8/26/2017	Unibest	2.12	3.75	5.22	5.56
5/22-22/2018	Unibest	1.77	4.78	6.65	5.7
		WQ_5	GW_152	GW_160	
8/26/2017	Unibest	**2.88**	4.62	2.74	
5/22-22/2018	Unibest	2.21	8.15	5.8	

Sodium					
Sample Date	Analytical Method	Surface Water Monitoring Sites	Groundwater Monitoring Sites		
		WQ_1	GW_141	GW_169	
8/26/2017	Unibest	2.23	9.4	6.83	
5/22-22/2018	Unibest	3.02	6.95	8.26	
		WQ_2	GW_46	GW_142	GW_117
8/26/2017	Unibest	2.36	2.63	2.67	4.98
5/22-22/2018	Unibest	2.54	3.14	3.1	7.28
		WQ_3	GW_119	GW_144	
8/26/2017	Unibest	2.09	17.69	16.11	
5/22-22/2018	Unibest	3.23	21.68	35.72	
		WQ_4	GW_170	GW_171	GW_151
8/26/2017	Unibest	2.04	5.07	6.64	6.41
5/22-22/2018	Unibest	2.45	8.35	9.47	7.54
		WQ_5	GW_152	GW_160	
8/26/2017	Unibest	2.6	9.29	2.86	
5/22-22/2018	Unibest	3.03	29.72	6.93	

Bolded values indicate source water concentration greater than groundwater concentration

Table 18. Sulfur and zinc concentrations.

Sulfur					
Sample Date	**Analytical Method**	**Surface Water Monitoring Sites**	**Groundwater Monitoring Sites**		
		WQ_1	GW_141	GW_169	
8/26/2017	Unibest	10.02	12.63	11.59	
5/22-22/2018	Unibest	4.61	5.67	6.58	
		WQ_2	GW_46	GW_142	GW_117
8/26/2017	Unibest	**10.1**	9.95	11.65	12.7
5/22-22/2018	Unibest	**6.88**	6.81	5.33	8.11
		WQ_3	GW_119	GW_144	
8/26/2017	Unibest	9.43	17.42	16.9	
5/22-22/2018	Unibest	6.42	12.36	17.3	
		WQ_4	GW_170	GW_171	GW_151
8/26/2017	Unibest	10.1	12.85	13.26	15.62
5/22-22/2018	Unibest	4.11	8.85	7.22	9.82
		WQ_5	GW_152	GW_160	
8/26/2017	Unibest	9.72	11.94	10.63	
5/22-22/2018	Unibest	4.62	10.11	5.87	

Zinc					
Sample Date	**Analytical Method**	**Surface Water Monitoring Sites**	**Groundwater Monitoring Sites**		
		WQ_1	GW_141	GW_169	
8/26/2017	Unibest	**0.04**	0.05	0.02	
5/22-22/2018	Unibest	ND	ND	ND	
5/22-22/2018	EPA 200.8	0.00892	0.0015	ND	
		WQ_2	GW_46	GW_142	GW_117
1/1/1900	Unibest	**0.04**	0.03	0.05	0.04
5/22-22/2018	Unibest	ND	ND	0.01	ND
5/22-22/2018	EPA 200.8	0.00469	ND	ND	0.0071
		WQ_3	GW_119	GW_144	
8/26/2017	Unibest	0.03	0.09	0.04	
5/22-22/2018	Unibest	ND	0.01	ND	
5/22-22/2018	EPA 200.8	0.00246	ND	ND	
		WQ_4	GW_170	GW_171	GW_151
8/26/2017	Unibest	0.03	0.08	0.04	0.04
5/22-22/2018	Unibest	ND	0.01	0.01	ND
5/22-22/2018	EPA 200.8	0.00162	ND	ND	ND
		WQ_5	GW_152	GW_160	
8/26/2017	Unibest	0.05	0.03	0.06	
5/22-22/2018	Unibest	ND	0.01	ND	
5/22-22/2018	EPA 200.8	**0.0048**	0.0014	ND	

ND = not detected

Bolded values indicate source water concentration greater than groundwater concentration

Table 19. Field parameters for groundwater sampling sites.

Site	**Temperature (˚C)**		**pH**		**Dissolved oxygen (mg/L)**		**Specific conductance (µS/cm)**		
	Oct 2017	**May 2018**	**Oct 2017**	**May 2018**	**Oct 2017**	**May 2018**	**Oct 2017**	**May 2018**	**Percent difference Oct to May**
GW_46	12.1	13.5	6.27	6.81	8.30	8.49	93.2	62.5	-33
GW_117	14.6	14.2	5.87	5.91	6.73	7.36	177.7	166.8	-6
GW_119	13.1	13.6	--	6.50	--	8.54	389.2	392.5	1
GW_141	12.4	11.9	--	6.32	--	9.05	242.1	124.5	-49
GW_142	13.3	11.6	--	6.44	--	9.24	110.1	70.0	-36
GW_144	12.9	14.0	--	--	--	7.01	354.1	441.4	25
GW_151	14.7	13.7	5.77	6.74	6.66	8.06	301.0	177.0	-41
GW_152	12.9	12.9	6.89	6.53	7.37	8.43	268.5	402.0	50
GW_160	12.4	12.2	5.63	6.36	6.47	7.93	101.5	205.1	102
GW_169	14.2	14.7	6.61	6.85	10.04	9.55	181.4	164.3	-9
GW_170	14.4	15.1	--	6.32	--	7.42	179.8	187.7	4
GW_171	12.7	13.3	--	6.88	--	7.46	276.6	253.6	-8

-- No data

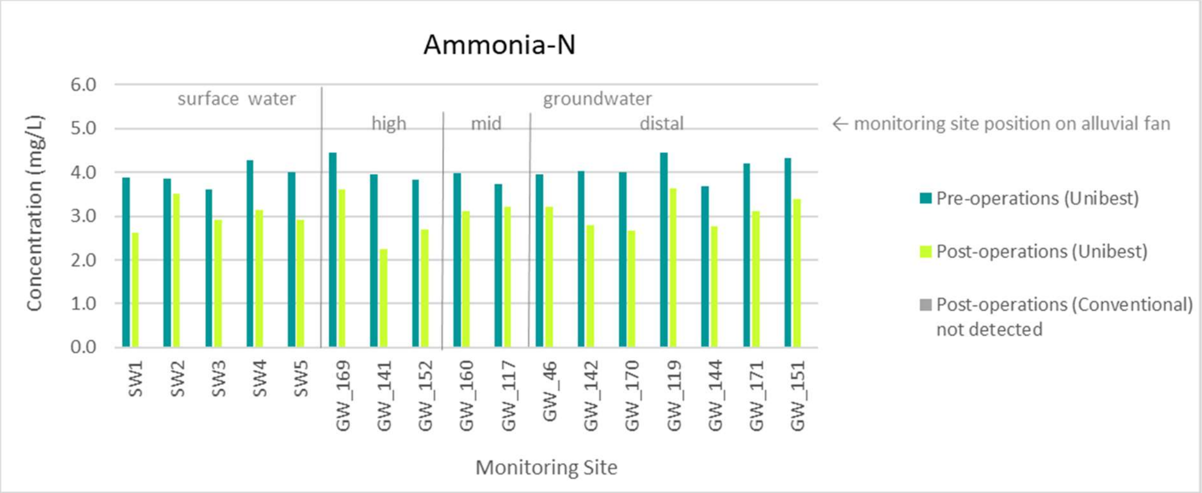


Figure 65. Ammonia concentrations in surface water and groundwater before and after managed recharge.

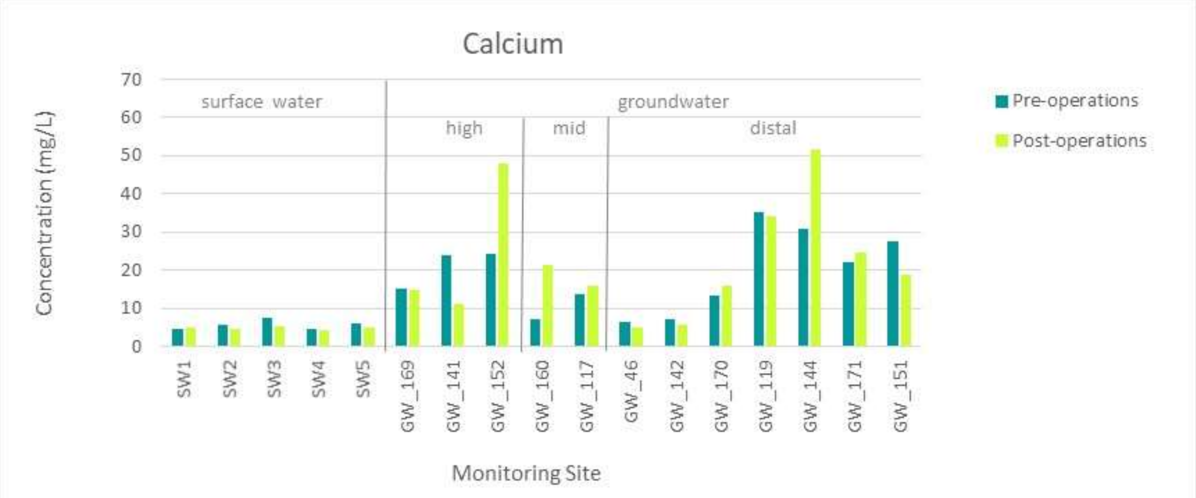


Figure 66. Calcium concentrations in surface water and groundwater before and after managed recharge.

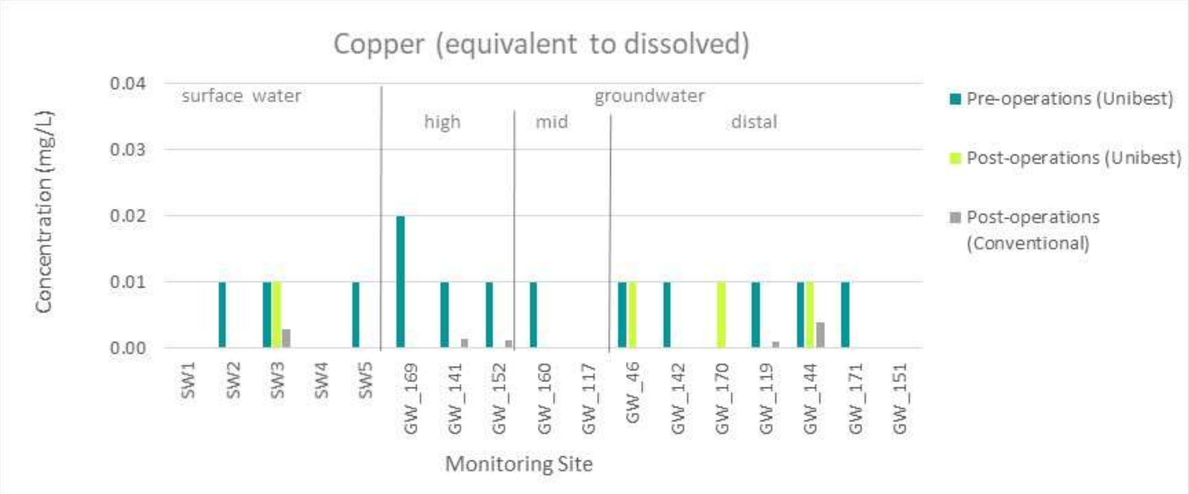


Figure 67. Copper concentrations in surface water and groundwater before and after managed recharge.

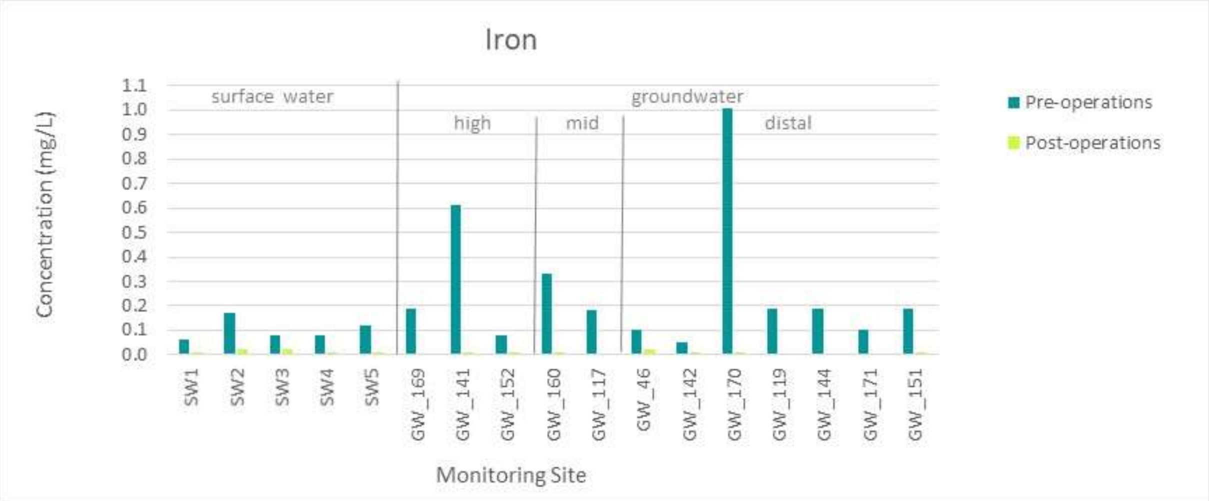


Figure 68. Iron concentrations in surface water and groundwater before and after managed recharge.

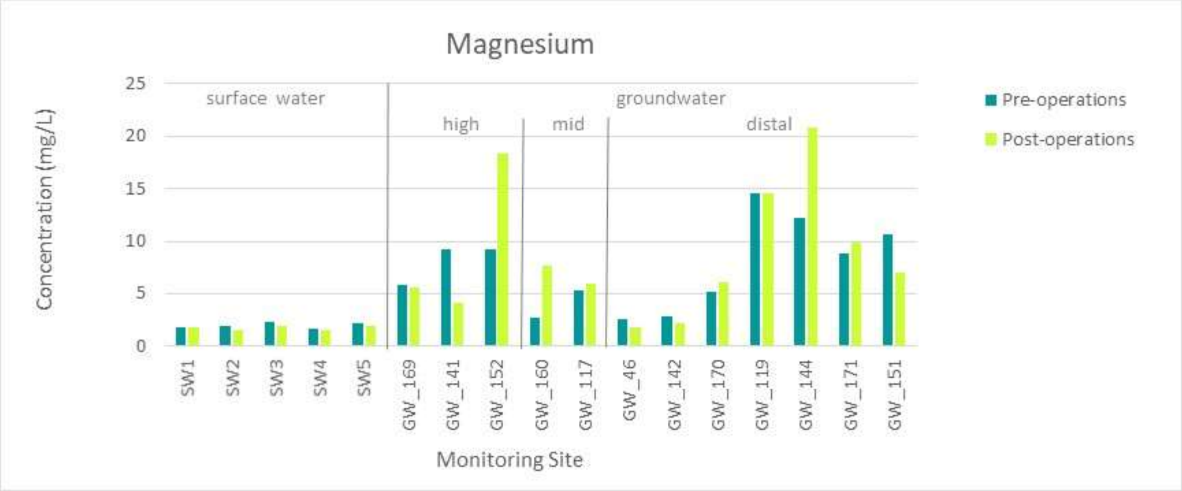


Figure 69. Magnesium concentrations in surface water and groundwater before and after managed recharge.

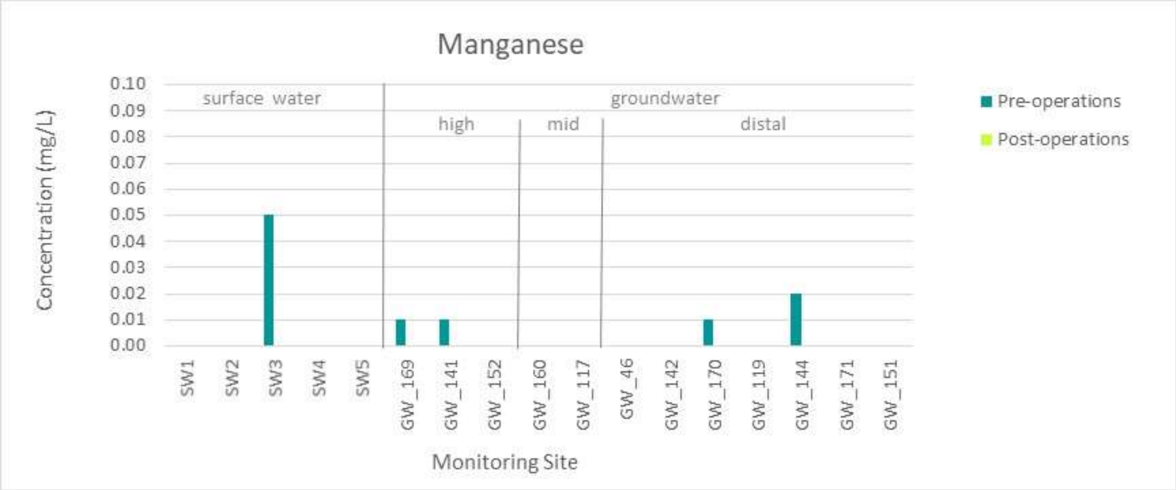


Figure 70. Manganese concentrations in surface water and groundwater before and after managed recharge.

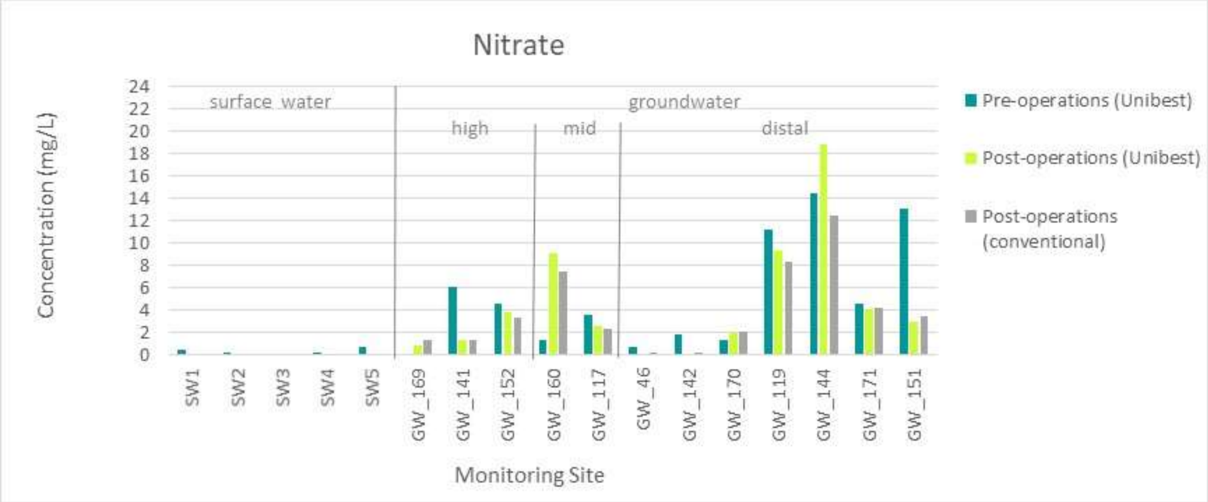


Figure 71. Nitrate concentrations in surface water and groundwater before and after managed recharge.

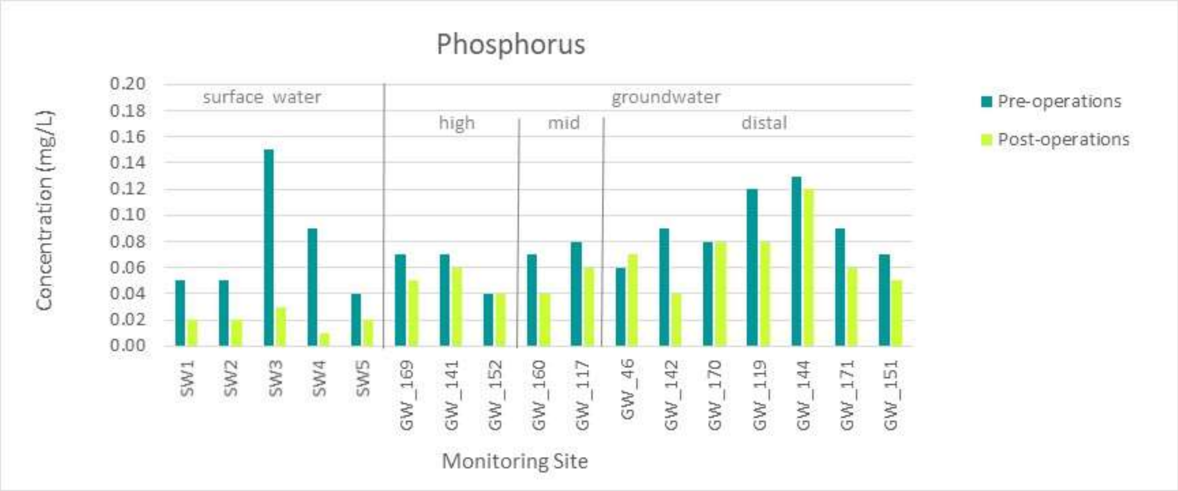


Figure 72. Phosphorus concentrations in surface water and groundwater before and after managed recharge.

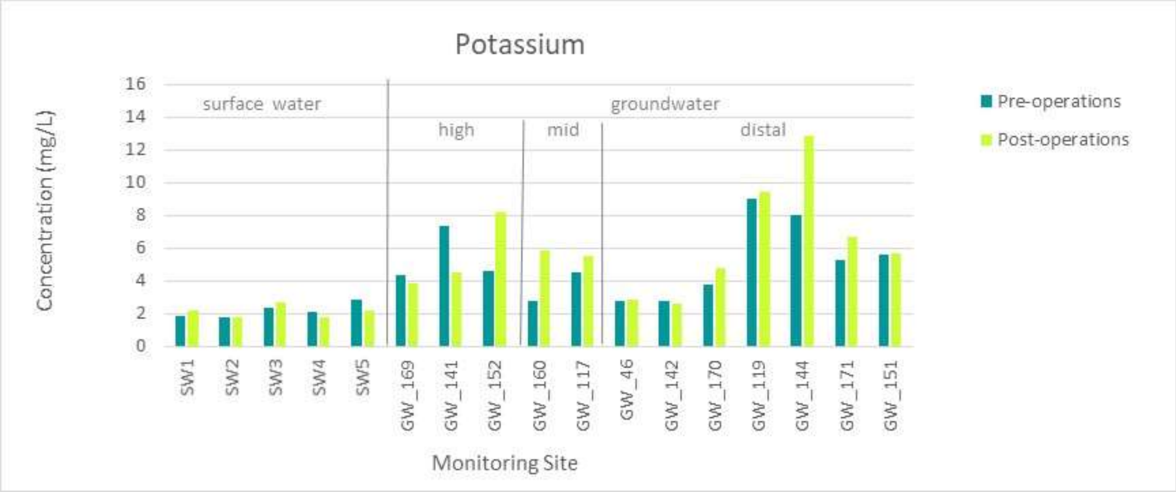


Figure 73. Potassium concentrations in surface water and groundwater before and after managed recharge.

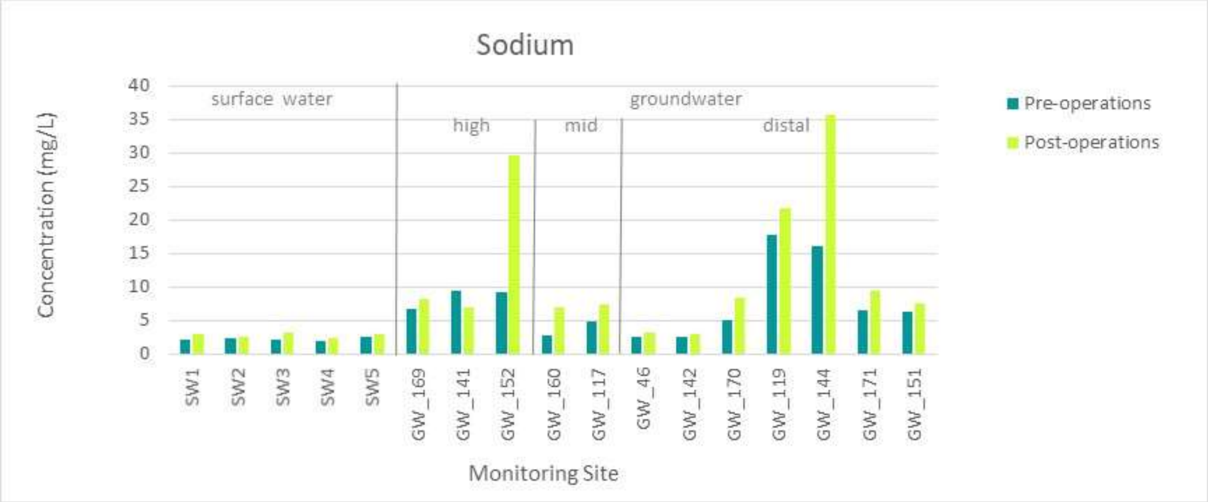


Figure 74. Sodium concentrations in surface water and groundwater before and after managed recharge.

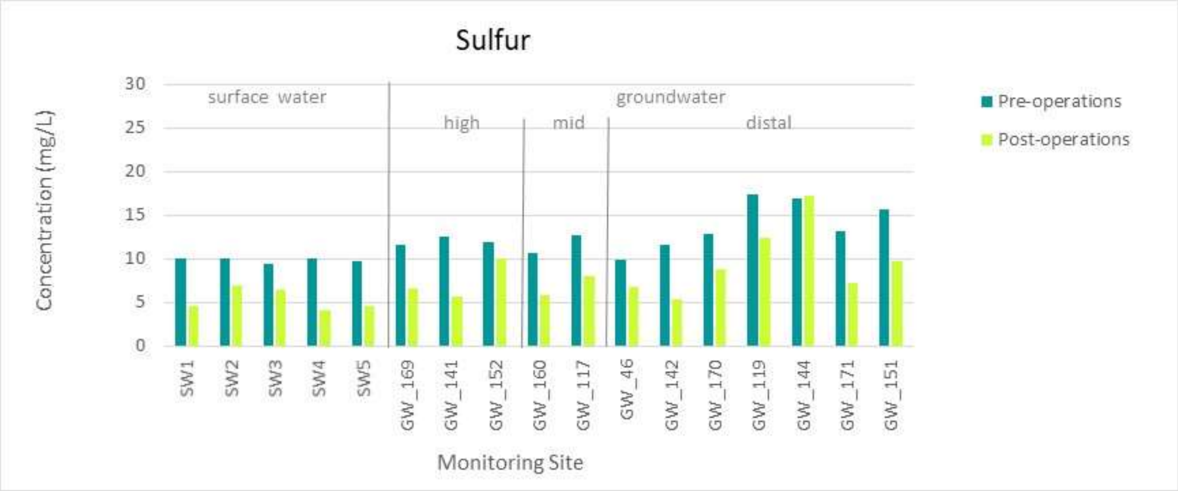


Figure 75. Sulfur concentrations in surface water and groundwater before and after managed recharge.

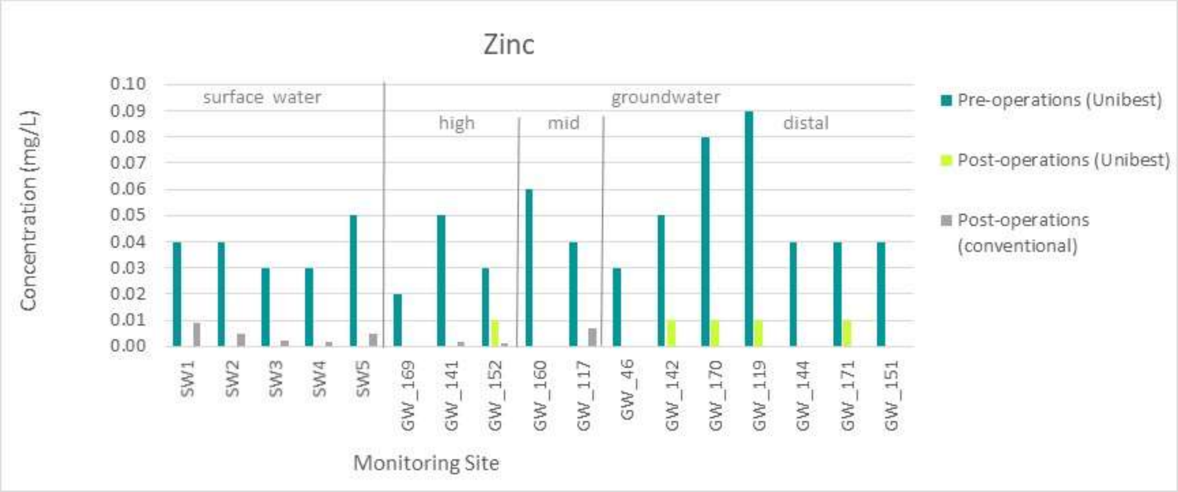


Figure 76. Zinc concentrations in surface water and groundwater before and after managed recharge.

Figure 77. Constituent concentrations pre- and post-recharge at GW_169, GW_141, GW_152, GW_160, GW_117, and GW_46 in WY2018.

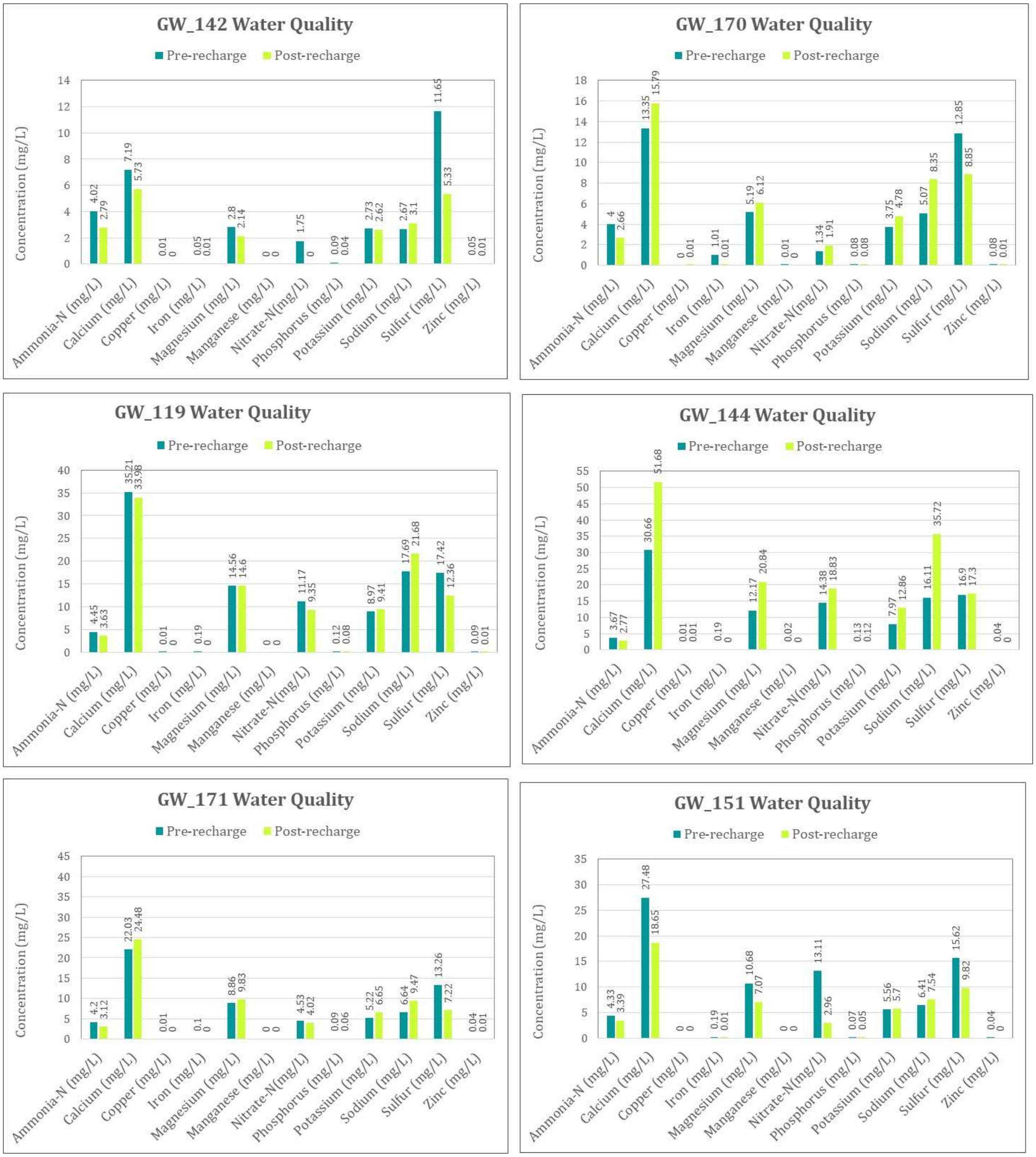


Figure 78. Constituent concentrations pre- and post-recharge at GW_142, GW_170, GW_119, GW_144, GW_171, and GW_151 in WY2018.

CONTINUOUS MONITORING

Continuous monitoring data for recharge source water were evaluated to determine their potential usefulness in operating the recharge sites. The potential value of continuous monitoring was predicated on eventual automation of the recharge sites. If the sites were fully automated, when water quality conditions worsened, the sites could be turned off remotely, preventing potential adverse impacts to the sites or the groundwater.

Continuous data were obtained for dissolved oxygen, pH, water temperature, and specific conductance at up to five surface water quality monitoring locations, four of which were also source water sampling sites for the recharge program: S-201 at the Little Walla Walla Diversion, S-318 at the Fruitvale Diversion (WQ-4), S-417 at the Zerba Weir (WQ-1), S-418 at the Duff Weir (WQ-2), and S-419 at the Huffman-Richartz Weir (WQ-3). Probes were typically deployed throughout the year but the low frequency of cleaning and calibration checks resulted in varying durations for which the data did not pass quality control checks and were therefore rejected. The finalized data, however, are sufficient to evaluate the potential usefulness of continuous data in managing the recharge sites.

Specific conductance typically had low variability with only gradual changes over time (Figure 79).

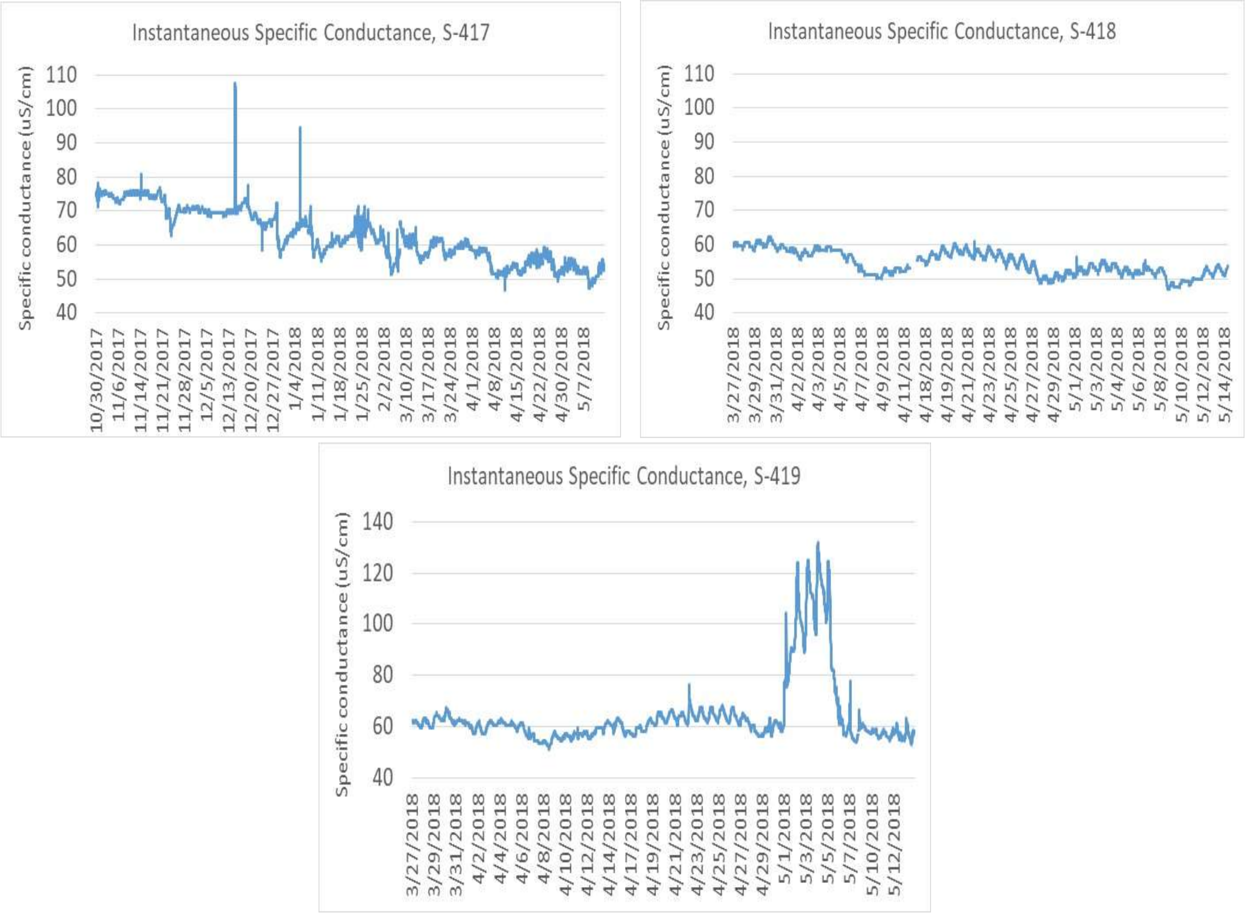


Figure 79. Specific conductance values at three surface water sites.

However, at two sites shorter-term and higher magnitude changes occurred: (1) At S-417, two very short-term spikes occurred in December 2017 and January 2018, roughly doubling specific conductance for 1½ hours. These spikes were so short in duration they may represent noise in the instrument signal rather than actual changes in water conditions. (2) At S-419 in May 2018, specific conductance gradually more than doubled then decreased to its initial value over a 7-day period. If the valve at the downstream recharge site, NW Umapine, was automated and if the specific conductance data were available real-time, it would have been possible to turn the valve off to prevent the inflow of that water. While reasons for rapid changes in specific conductance values range from innocuous to very concerning, especially since that type of change was observed only once at the five sites, it would be reasonable and prudent to prevent inflow of water of uncertain quality, if the technology allowed.

Instantaneous pH values were more variable than specific conductance values, with diel changes of up to 2 standard units although changes of roughly 1 standard unit were more common (Figure 80). The diel changes are consistent with those observed in natural waters resulting from the photosynthesis and respiration processes of plants (including algae) living in the water. Out of the four sites, three average weekly pH values were less than the state water quality criterion of 6.5 but none were less than the lowest instantaneous pH value of 5.9 observed when sampling groundwater during the two water quality sampling events before and after the recharge season. Roughly half of the average weekly pH values were greater than 7 (Table 20). The maximum average weekly pH value was 7.7.

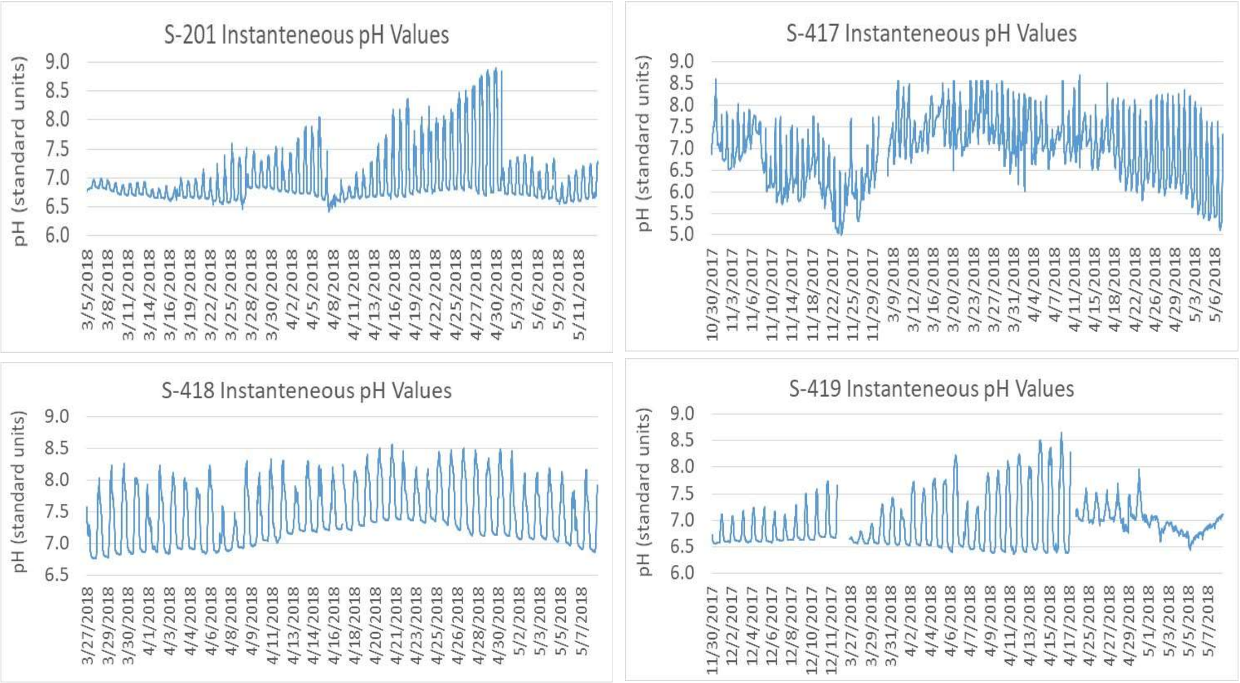


Figure 80. Instantaneous pH values at four surface water sites.

Table 20. Average weekly pH at four surface water sites.

Average Weekly pH Values							
S-201	**pH**	**S-417**	**pH**	**S-418**	**pH**	**S-419**	**pH**
3/5/2018 - 3/11/2018	6.83	10/30/2017 - 11/5/2017	7.10	3/27/2018 - 4/2/2018	7.24	11/30/2017 - 12/6/2017	6.73
3/12/2018 - 3/18/2018	6.74	11/6/2017 - 11/12/2017	6.82	4/3/2018 - 4/9/2018	7.23	12/7/2017 - 12/13/2017	6.84
3/19/2018 - 3/25/2018	6.77	11/13/2017 - 11/19/2017	6.46	4/10/2018 - 4/16/2018	7.45	3/22/2018 - 3/28/2018	6.64
3/26/2018 - 4/1/2018	6.97	11/20/2017 - 11/26/2017	5.91	4/17/2018 - 4/23/2018	7.66	3/29/2018 - 4/4/2018	6.85
4/2/2018 - 4/8/2018	6.94	11/27/2017 - 12/3/2017	6.44	4/24/2018 - 4/30/2018	7.65	4/5/2018 - 4/11/2018	6.94
4/9/2018 - 4/15/2018	6.82	3/5/2018 - 3/11/2018	7.42	5/1/2018 - 5/7/2018	7.38	4/12/2018 - 4/18/2018	7.13
4/16/2018 - 4/22/2018	7.16	3/12/2018 - 3/18/2018	7.51	5/8/2018 - 5/9/2018	7.19	4/19/2018 - 4/25/2018	7.14
4/23/2018 - 4/29/2018	7.47	3/19/2018 - 3/25/2018	7.67			4/26/2018 - 5/2/2018	7.10
4/30/2018 - 5/6/2018	7.05	3/26/2018 - 4/1/2018	7.45			5/3/2018 - 5/9/2018	6.82
5/7/2018 - 5/13/2018	6.80	4/2/2018 - 4/8/2018	7.33				
5/14/2018 - 5/15/2018	6.86	4/9/2018 - 4/15/2018	7.23				
		4/16/2018 - 4/22/2018	7.03				

All instantaneous dissolved oxygen values exceeded 8.0 mg/L at the one site with finalized data (Figure 81). As with pH, the diel variability is typical of waters containing photosynthetic plants. None of the temporal patterns indicated a contaminant had been suddenly introduced into the source water – there were no abrupt and rapid changes.

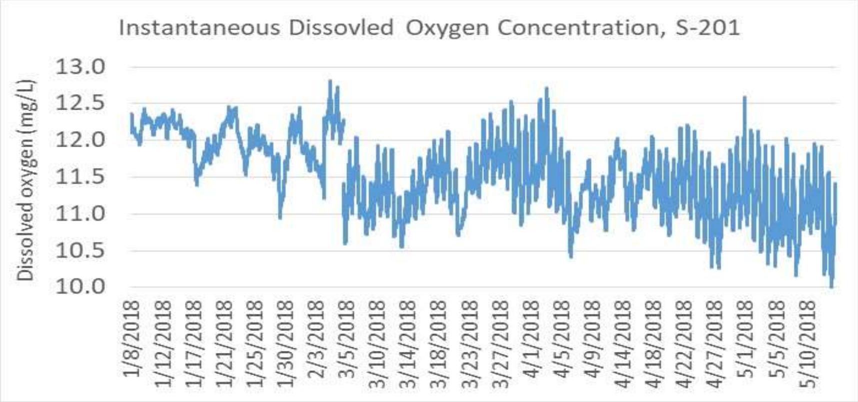


Figure 81. Dissolved oxygen concentrations at S-210.

Temperature data were not assessed in terms of potential usefulness for future operations because: (1) the tremendous heat-absorbing capacity of soil would rapidly reduce water temperature until it reached the same temperature as the soil; and (2) the temperature ranges (0-22 °C) were comparable to nearby streams and rivers.

Because obtaining continuous monitoring data is extremely expensive, primarily due to the staff time needed to frequently clean and check the calibration of the continuous monitors, the potential value of these data should be weighed against the cost. None of the data assessed indicated that the source water introduced to the recharge sites was of poorer quality than the shallow groundwater. The only parameter with any temporal change of possible concern was specific conductance, which is a poor indicator of potential contamination because it also changes in response to natural changes in surface waters. Specific conductance is also a poor indicator of one of the contaminants with the highest level of concern – pesticides. Low concentrations of pesticides would not significantly change the specific conductance values yet the low concentrations may be sufficiently high to be of ecological concern. Under the approved monitoring plan for the MAR program, surface water samples are obtained and analyzed for low-level detections of key pesticides. Therefore, while the technology exists to automate the inflow values to the recharge sites and link the valve controllers to real-time water quality data, this initial assessment suggests such a change may not substantially improve site operations.

QUALITY CONTROL

For the synthetic organic compounds, surrogate recoveries were 97-98% for azinphos-methyl, chlorpyrifos, and malathion and 108-113% for diuron, within the acceptable recovery ranges (see Appendix C for the lab report). In the lab quality control samples, none of the analytes were detected in the method blank and all percent recoveries of the blank spike were within expected ranges. The lab did not identify any quality control issues associated with analysis of these samples.

For the samples analyzed using conventional methods at Anatek: the temperature of the samples upon receipt by the lab was 3.5 °C for the first shipment and 5.1 °C for the second shipment. The second shipment exceeded the 4 °C preservation threshold for nitrate and ammonia (no temperature threshold for copper or zinc,). Samples were received within the holding time. The nitrate result for GW_144 was qualified with a “C4” code, indicating the confirmatory analysis was past the holding time. Lab control data for spikes and duplicates were within acceptable ranges, except for the NH3-N quality control analyses which were conducted three days after the WWBWC samples were analyzed and had high percent recoveries. Because ammonia was not detected in any of the field samples from WWBWC, this exceedance of the acceptable range was not considered significant by WWBWC. No detections were found in the lab blank.

One field replicate was obtained at GW_119 to quantify precision of the inorganic data (Table 21). The relative percent differences of the nitrate data were similar from both labs. All but one of the relative percent differences for Unibest were less than 20 percent. However, the differences in the ammonia, zinc, copper, and nitrate concentrations between the samples analyzed with the Unibest technology and conventional laboratory analyses are concerning. The revised monitoring plan will propose to eliminate the Unibest sampling because it is not equivalent to discrete instantaneous samples and therefore difficult to compare to regulatory thresholds and to data obtained by other organizations.

Table 21. Field duplicate results for GW_119.

Analyte	Unibest			Anatek		
	Sample	Replicate	Relative percent difference	Sample	Replicate	Relative percent difference
Ammonia	3.63	2.87	23	ND	ND	n/a
Calcium	33.98	38.55	13			
Copper	ND	ND	n/a	0.00101	0.00105	4
Iron	ND	ND	n/a			
Magnesium	14.6	16.34	11			
Manganese	0	0	0			
Nitrate-N	9.35	9.65	3	8.29	8.42	2
Phosphorus	0.08	0.09	12			
Potassium	9.41	10.09	7			
Sodium	12.36	13.43	8			
Sulfur	12.36	13.43	8			
Zinc	0.01	ND	n/a	ND	ND	n/a

SPRING PERFORMANCE

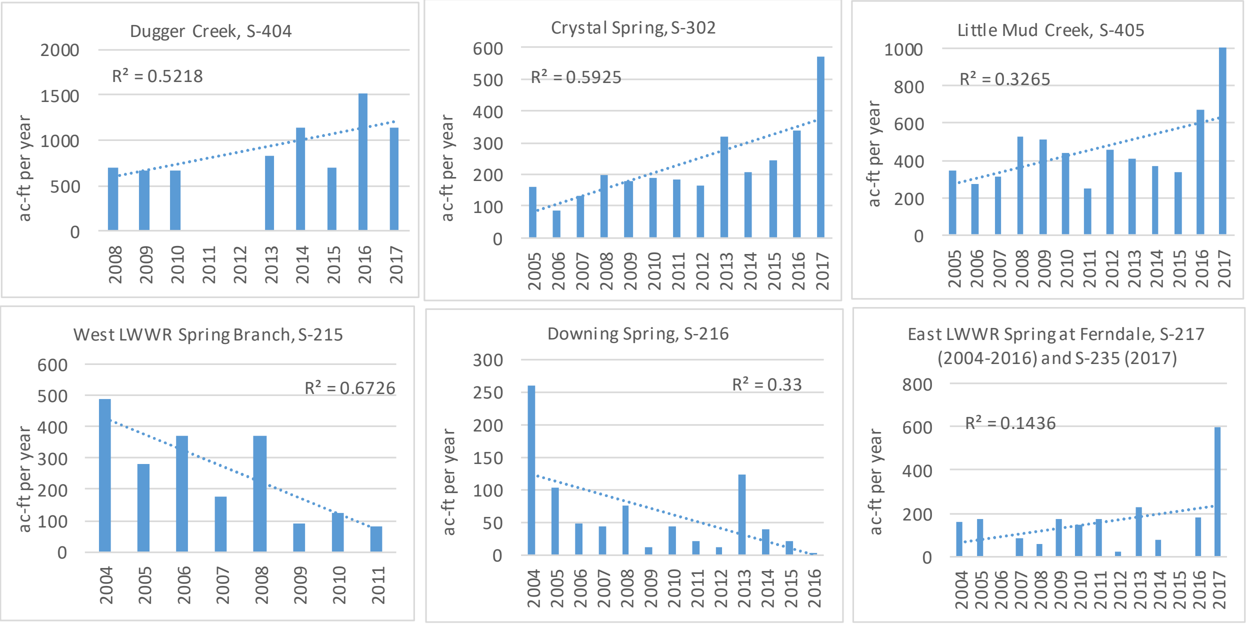
As mentioned in the introduction, one of the purposes of the recharge program is to enhance spring performance. Although only five of the twelve recharge sites have operated more than three years, four of those five sites have typically contributed a significant proportion of the total annual recharged volumes. Therefore, an initial evaluation of spring performance is warranted.

The 12 surface water monitoring sites evaluated were selected based on their period of record and their location on the alluvial fan (Figure 82). The first recharge site began operations in 2004, which is also when monitoring began at many surface water sites, so spring performance was assessed from WY 2004 to 2017, or the longest period-of-record available for a given monitoring site. Data from WY 2018 were not evaluated because the discharge data for WY2018 were still provisional when this report was written. Annual yields were calculated for each water year for each site, then linear regressions were applied using Microsoft Excel. Trend analysis was not conducted due to time limitations.

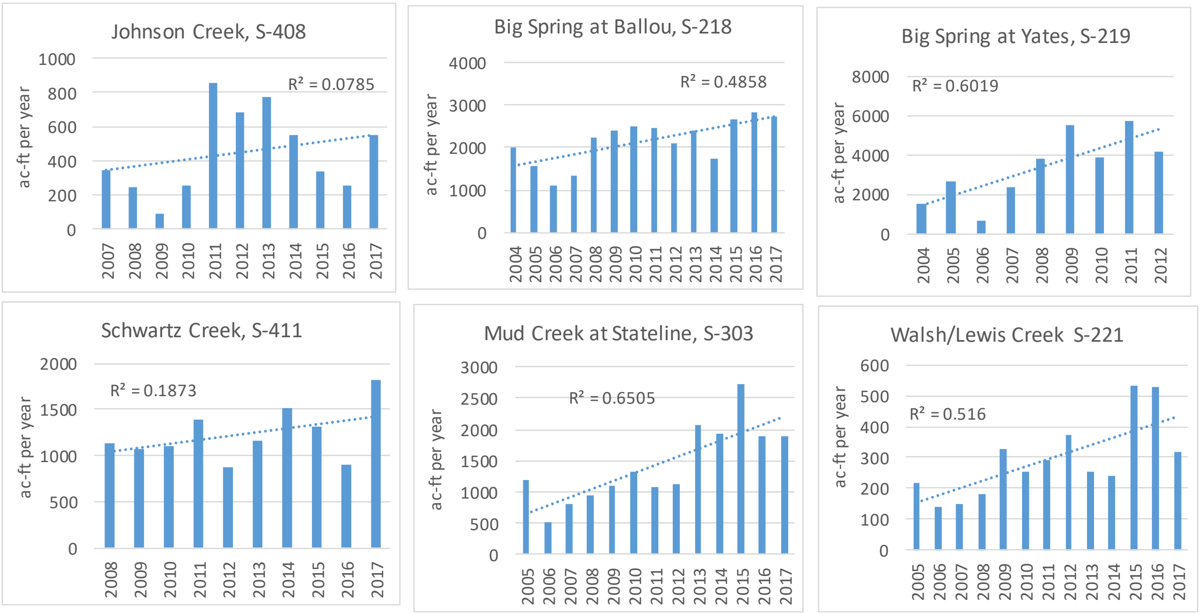
Out of 12 spring monitoring sites assessed, ten had positive linear regressions - yields increased over the years -- and two had negative regressions -- yields decreased over the years (Figure 83).

Figure 82. Approximate location of inner, intermediate and outer zones of springs on the Milton-Freewater alluvial fan based on description in text (*Piper et al.*, 1933).

Sites Near Spring Headwaters (Piper's Inner Zone of Springs)



Sites More Distal on Alluvial Fan (Past Piper's Inner Zone up to Intermediate Zone)



* S-221 missing Oct-Nov data for WY2005

Figure 83. Annual yields from 12 springs.

The two springs with decreasing yields were in the inner zone of springs and not downgradient of any active recharge site. At S-215, the West Little Walla Walla River Spring Branch, which has been dry since 2012, the decreasing yield may have been influenced by water being routed away from the West Branch of the West Crocket irrigation conveyance, which dried up a ditch connecting the West Branch of the West Crockett to the West Little Walla Walla River. The Walla Walla River Irrigation District is working with the landowner where the ditch dried up to restore the connection by removing non-native vegetation, which may increase the spring yield in future years. The cause of the declines at S-216, Downing Spring, is unknown.

In one of the ten springs with a positive regression, East Little Walla Walla Spring, monitoring site S-217 was moved slightly downstream in 2017 and re-designated S-235. Moving the site downstream allowed for more accumulation of spring flow; if the year 2017 is excluded, the regression line is nearly flat. Therefore, for purposes of this evaluation, East Little Walla Walla Spring was not considered as having increased yields. Like S-215 and S-216, S-217 is not downgradient of any recharge site (Figure 84).

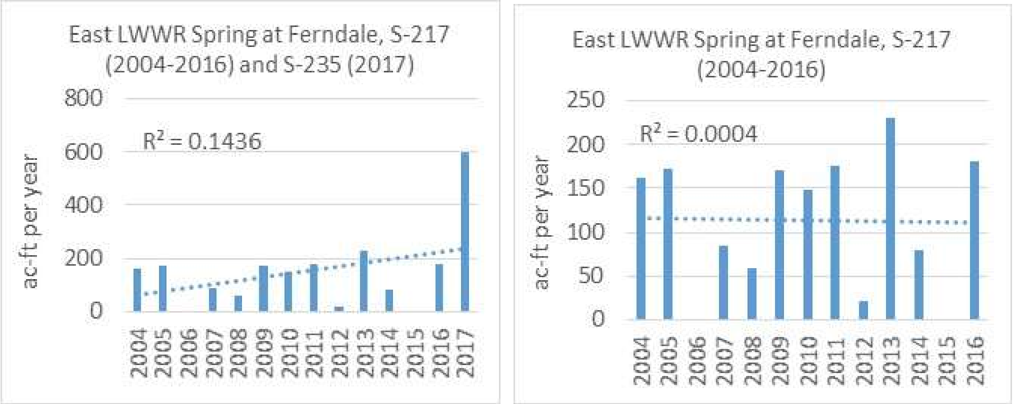


Figure 84. Annual yields, East Little Walla Walla River Spring at Ferndale, with (left) and without (right) data from S-235.

Because there is more than one monitoring site on some of the springs evaluated, to calculate the cumulative increase from the springs without double-counting, the annual yields from only the distal sites monitoring Big Spring, Walsh/Lewis, Mud Creek at Stateline, Little Mud Creek (which is not a tributary to Mud Creek), and Swartz Creek were summed. The other alternative approach, of only summing the monitoring sites nearest the location where the spring surfaces would have significantly underestimated spring yields because these springs continue to receive groundwater inputs as they traverse the alluvial fan, as illustrated by the tripling in volume at S-217 that resulted from moving the monitoring site in 2017 only approximately 650 feet downstream. The total volume of the distal spring sites (S-411, 303, 405, 221, 218/219 or 233[8], and 302) increased by more than 300%, from roughly 3,500 ac-ft in 2004 to 11,205 ac-ft in 2017 (Figure 85), for a total increase of roughly 7,700 ac-ft or 10.6 cfs or average annual increase of 549 ac-ft or 0.76 cfs.

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[8] Both branches of Big Spring were monitored, at S-218 and S-219, from 2004-2013 but in mid-2013 monitoring at S-219 was discontinued due to poor site conditions. A new site, S-333, was installed in September 2015 downstream of where the two branches meet. Thus, annual yields were the sum of S-218 and S-219 from 2004-2015 and S-233 from 2016-2017.

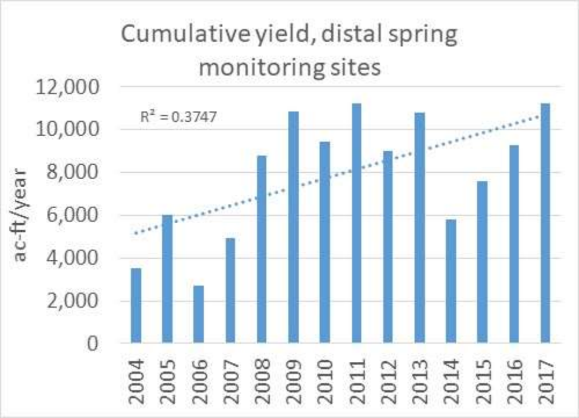

Figure 85. Cumulative yield from 5 springs

POSSIBLE REASONS FOR INCREASED SPRING YIELDS

On the edge of the alluvial fan (Figure 82), the springs act as an outlet of the alluvial aquifer. As so eloquently described by Piper, Robinson and Thomas,

> "The springs of the inner zone seem to be comparable to the spillway of a reservoir, for they are supplied by overflow from the ground-water reservoir in the permeable alluvium, which is constantly replenished from above. They are the agencies which establish and maintain equilibrium between inflow and outflow of ground water across the barrier of less permeable terrace deposits at the outer margin of the fan." (Piper *et al*., 1933)

Spring flow increases when the volume of water in the aquifer increases. To explore possible reasons for increased spring yields in 9 out of 12 springs, information was obtained on changes during the same period, 2004-2017, in various elements of the alluvial groundwater budget.

Annual variability of the volume of the alluvial aquifer is influenced by the balance between losses and gains. The major sources of recharge (gains) are seepage losses from streams and irrigation delivery systems, on-farm irrigation, precipitation, leakage from the basalt aquifer, and managed aquifer recharge. Major types of withdrawals (losses) from the shallow aquifer are subsurface inflows to streams and rivers, spring discharge, pumping, and groundwater evapotranspiration (Barker and MacNish, 1976).

Change in aquifer volume = recharge – discharge

Change in aquifer volume = (precipitation + irrigation + managed aquifer recharge + +seepage losses + leakage from basalt aquifer) – (subsurface inflows to streams and rivers + spring discharge + pumping + groundwater evapotranspiration)

Out of the above major factors which influence aquifer volumes, information was obtained on precipitation rates, potential seepage losses, factors which influence pumping rates (availability of surface water and numbers of new and abandoned wells), and factors which influence irrigation rates (evapotranspiration data and changes in crop types).

No data or even anecdotal information were available on changes over time in leakage rates from the basalt aquifer, subsurface inflows to streams and rivers, or groundwater evapotranspiration. For these factors, it was assumed they did not have an upward or downward trend over the years and thus would not be the cause of the increased spring flows. One factor influencing spring flows at some locations was not listed by Barker and MacNish -- unused irrigation water from the conveyance network. The volumes of these inflows are unknown, as is how the volumes may have varied from 2004-2017, so this is also a data gap.

SOURCES OF RECHARGE TO THE ALLUVIAL AQUIFER

Precipitation

Precipitation rates were variable with a nearly flat regression line (Figure 86). This pattern would result in variable annual spring performance, not a 300% increase from 2004 to 2017.

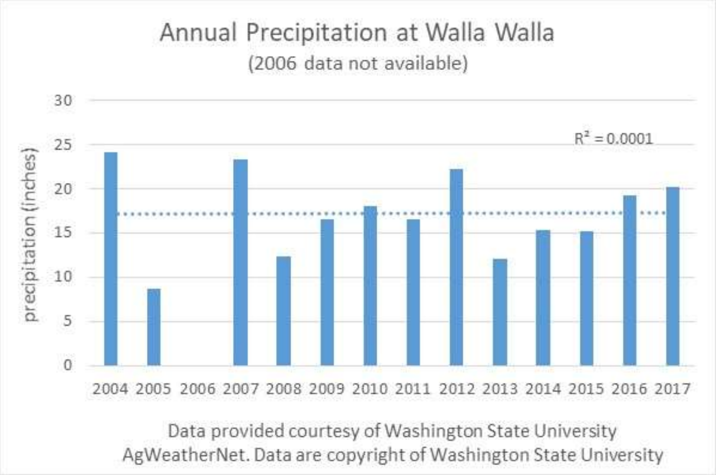

Figure 86. Annual precipitation rates at Walla Walla, WA.

Irrigation-induced recharge

Data on actual annual irrigation rates were unavailable. Three indicators of irrigation rates -- crop types, on-farm irrigation efficiencies, and evapotranspiration rates -- suggest irrigation rates did not significantly increase over the fourteen years and more likely decreased in the most recent years when the increase in spring flow was typically the greatest.

Increased irrigation rates would be expected if dominant crop types shift to crops with higher water needs. Recent data on the proportion of crops are not available. Anecdotally, it appears the number of acres of wine grapes, which have reduced water needs relative to other crops in the basin, and idle lands on the central portion of the alluvial fan have increased during these years. The Rocks District of the Walla Walla American Viticultural Area, which was designated in 2015, includes 338 acres of wine grapes, or roughly 5% of the 9.98 mi^2 central portion of the alluvial fan; another 144 acres are in development (Rocks District Winegrowers, 2018). Both of these changes in land use would decrease irrigation-induced recharge, not increase it.

On the alluvial fan during these years, some acreage was converted from flood irrigation to more efficient sprinkler or drip irrigation. This would have reduced irrigation-induced recharge, not increased it.

When evapotranspiration rates increase, crops need more water, which would indicate a possible increase in water use and thus increase in recharge resulting from irrigation. Reference evapotranspiration rates generally increased from 2004 to 2017 but have been decreasing since 2012 (Figure 87), which is inconsistent with the recent years of increased spring discharge.

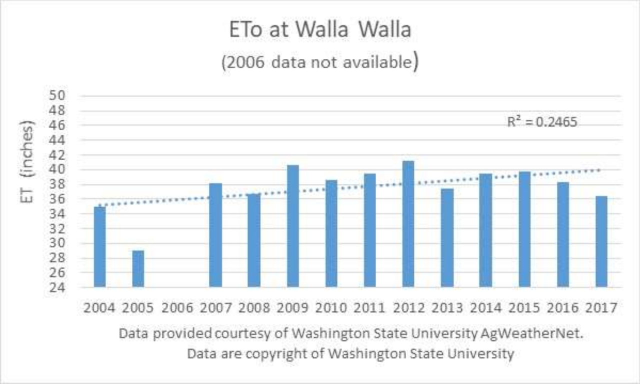

Figure 87. Reference evapotranspiration rates at Walla Walla, WA.

Managed aquifer recharge

Managed aquifer recharge rates were variable but generally increased over time (Figure 88). The increased cumulative yield of 7,700 ac-ft between 2004 and 2017 of the distal springs evaluated is similar in scale to annual managed recharge volumes added to the aquifer, which have been roughly 4,000 to 7,000 ac-ft in recent years. The total amount of water recharged from WY 2004 through 2017, including conveyance seepage losses, is 64,404 ac-ft, or an average of 4,600 ac-ft (6.3 cfs) per year.

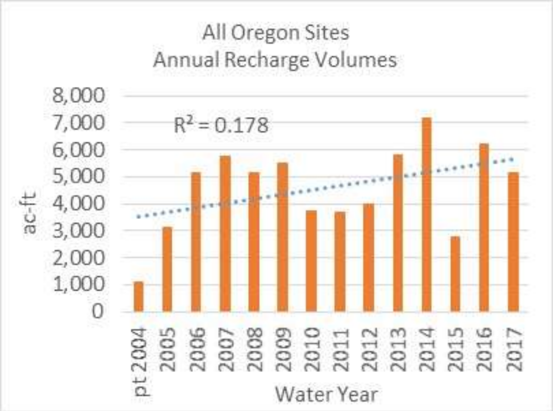

Figure 88. Cumulative annual recharge volumes by year.

<u>Seepage losses from rivers and irrigation conveyance networks</u>

Widespread seepage losses

Seepage losses from conveyance systems decreased in many locations on the alluvial fan as a result of several piping projects completed from 2004 to 2017, including the following: the Hyline (a portion), Milton, Stewart, Stillman, Trolley Lane, White (a portion), Powell Pleasantview, and Anspach Managed Aquifer Recharge Site delivery ditches. The Eastside, Huffman, and Richartz ditches piping projects were completed in 2003, just prior to the period of interest.

While data are available on seepage losses in different years at various locations in the Walla Walla River and Little Walla Walla River, data are insufficient to estimate seepage losses for entire years in the different reaches of these rivers. For the purposes of this assessment, it was assumed that the recharge rates have varied between years and locations but not in a systematic, predictable pattern.

This assumption is supported by the highly variable seepage losses and gains in the Walla Walla River near Milton-Freewater. Over the years, seepage runs have been conducted by WWBWC in different months of the summer. The month with the highest number of seepage measurements is July, where different locations were measured from 2008-2016 (Table 21). The losses and gains are highly variable, especially at M-3, upstream of Nursery Bridge, where values range from a seepage loss of 61.8% of surface flows in 2013 to a gain in the next year of 73.9% of surface flows. Other locations, such as M-4, 5B, and 7 are consistently losing, but a wide range of rates, from -2.5 to -62.6%, -1.4 to -47.3%, and -9.4 to -56.6%, respectively.

Table 22. Percent seepage losses and gains in surface flows in July, 2008-2016, Walla Walla River near Milton-Freewater

	Measurement Location					
Year	M-1A	M-3	M-4	M-5B	M-7	M-8
2008	8.6	6.3	-23.7	-23.1	-9.4	-2.2
2009	-3.7		-2.5	-4.8		-75.4
2010	-8.2		-4.1	-10.3		-42.1
2011	-2.8	3.7	-30.7	-16.7	-46.3	-18.5
2012	10.9	-1.8	-13.7	-17.1	-38.6	7.8
2013	2.3	-61.8	-10.4	-16.0	-48.2	-6.4
2014	-4.9	73.9	-62.6	-47.3	-9.4	-8.1
2015	2.1	-6.1		-1.4	-56.6	-0.9
2016	15.0	18.8	-28.6	-26.0	-42.3	6.2

Assuming seepage volumes increase with increasing flows, changes over time in the annual flows of the rivers and conveyance networks indirectly indicate possible decreased seepage volumes due to decreased inflows to the Little Walla Walla River and decreased volumes in the Walla Walla River Irrigation District conveyance network. Annual flows in the Walla Walla River were variable and in the HBDIC diversion were relatively stable, neither of which would indicate increased seepage losses (Figure 89[9]).

Figure 89. Annual volumes, Walla Walla River, Little Walla Walla River, WWRID, and HBDIC.

Localized seepage losses

Localized increases in seepage losses from conveyance systems may have occurred during these years in response to changing water management. For example, while the amount of water diverted into the Walla Walla River Irrigation District's conveyance system has decreased over these years, the amount of water reaching the end of the Ford Branch at S-214 has increased substantially, from less than 500 ac-ft per year in 2006 to 2000-2500 ac-ft per year in 2016 and 2017 (Figure 90). The increased flow likely resulted in increased seepage and could have influenced the increased yield at Crystal Spring, which is northwest of S-214; however, the groundwater gradient is more northerly in this area, in contrast with the more common northwesterly gradient so the degree of influence is unclear.

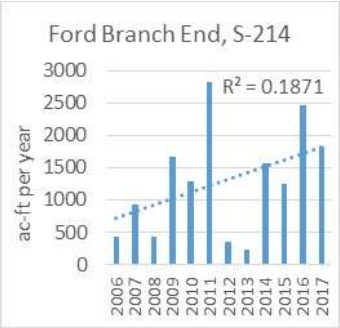

Figure 90. Annual discharge, Ford Branch End

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[9] In Figure 89, "Walla Walla River Composite" is the sum of the annual discharges of the North Fork and South Fork of the Walla Walla River and derived values for Couse Creek. It represents the discharge of the Walla Walla River as it enters the valley floor. The Walla Walla River Irrigation District diversion values are calculated by subtracting the gaged HBDIC's diversion from the gaged Little Walla Walla River where it diverges from the Walla Walla River.

In contrast, the increased yield from Big Spring at Ballou is not likely a result of increased seepage losses from the Walla Walla River at Pepper Bridge, S-108. The annual discharge of the Walla Walla River at Pepper Bridge decreased steadily from 2013 to 2016 (Figure 91), while the annual yield at Big Spring at Ballou increased over the same years, except for a decrease in 2014. Monitoring at Big Spring at Yates was discontinued after 2012 and the Pepper Bridge data begins in 2012 so no comparison is possible for that site.

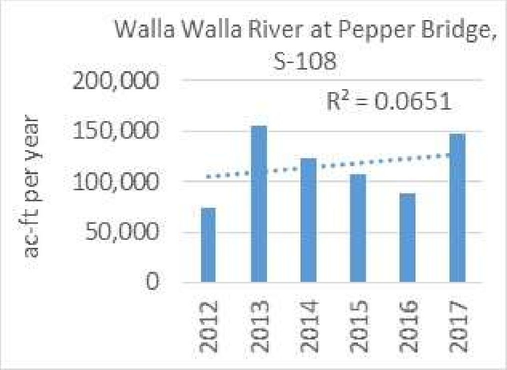

Figure 91. Annual discharge, Walla Walla River at Pepper Bridge.

TYPES OF DISCHARGE FROM THE ALLUVIAL AQUIFER

Spring flows

One type of discharge from the alluvial aquifer – spring flows – was discussed in a previous section. Spring flows increased in 9 out of 12 springs evaluated. Additionally, annual flows increased in the West Little Walla Walla River at Stateline (Figure 92), which contains a mix of water from the Walla Walla River, spring flow, and groundwater inflow. Flows increased at Stateline even though the amount contributed by the Walla Walla River declined over the same period (Figure 89, above).

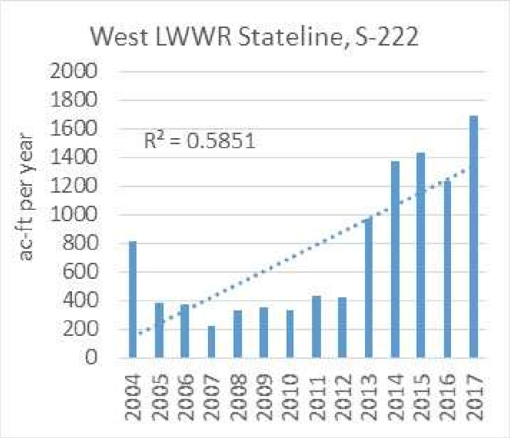

Figure 92. Annual volumes, West Little Walla Walla River at Stateline.

Pumping

In the Milton-Freewater area, it is expected that pumping rates increase when less expensive surface water supplies decrease. The availability of surface waters is indicated by the volume of water diverted into the Little Walla Walla River, which is the source of surface water for the vast majority of parcels on the alluvial fan. As described above, annual flows have slightly decreased over time in the Little Walla Walla River, which would suggest a need for additional pumping, which should result in reduced spring performance – not increased flows. A possibly stronger indicator of the availability of surface water for irrigation is the amount of water available from June through September, when the demand for irrigation water increases (Figure 93). During these months, less water was available in 2015-2017 than in the previous seven years, which would suggest the need for higher pumping rates, yet the cumulative yield of the five springs increased from 2015-2107. It may be that there is a relationship between spring yields and surface water availability that occurs over a multi-year period, rather than between single years. Additional years of monitoring may discern longer-term patterns that are not clear from the relatively short period evaluated in this report.

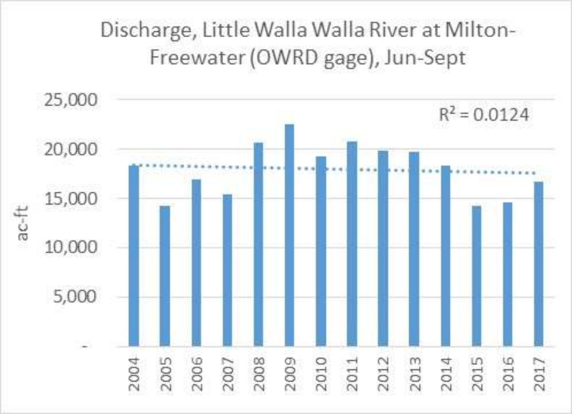

Figure 93. Discharge, Little Walla Walla River at Milton-Freewater (OWRD gage), Jun-Sept.

Pumping also increases as new wells are drilled. A search of OWRD's database for sections located on the central portion of the alluvial fan (not including the "fingers" of alluvial extending away from the fan) followed by a review of well logs identified 11 new irrigation wells completed in 2004-2017 in the alluvial aquifer. These wells represent new possible withdrawals of up to 2.2 cfs (based on the maximum well yields) from the aquifer, potentially reducing the volume of water in the aquifer. During the same years, the database listed two irrigation wells as being abandoned.

CONCLUSION

Out of the factors influencing changes in groundwater elevations for which data were available, only the increased recharge resulting from the managed aquifer recharge program would result in widespread increases in spring yield across the alluvial fan; changes over time in the other factors would result in decreased or variable spring yields. Because of the data gaps, the qualitative nature of the much of the information obtained, and the limited number of springs evaluated, these results should be considered as provisional and preliminary. A more detailed and thorough analysis will be completed if funding is obtained.

DISCUSSION OF RESULTS

During the WY 2018 recharge season, 8,338 ac-ft (2,716,978,011 gallons) of water was recharged to the alluvial aquifer near Milton-Freewater through recharge basins, infiltration galleries, and seepage from ditches delivering the water to the engineered structures. Groundwater levels in wells near three of the five sites which have operated for at least five years have generally and at some locations markedly increased, especially the annual shallowest levels. Groundwater levels and temperatures at two of the three new sites which operated for the first time in WY2018 indicated a response from recharge operations.

As in previous recharge seasons, groundwater and surface water quality data collected during aquifer recharge activities do not indicate that aquifer recharge activities are degrading groundwater quality per Condition 5 of LL-1621. Source water quality being delivered to the aquifer recharge sites continues to be of acceptable quality and would not be anticipated to degrade groundwater quality. No exceedances of surface water quality criteria were found when using conventional lab analyses.

The Walla Walla basin's aquifer recharge program continues to simulate the distributary and floodplain functions and processes that have been lost due to irrigation development and channelization of the river and stream channels for flood control and other uses. An initial evaluation of spring performance from 2004-2017 concluded the most likely cause of improved flows in the springs sourced in the alluvial fan was the increased recharge from the managed aquifer recharge program. With continued aquifer recharge activities and increases in the total annual volume of water recharged, continued increases in alluvial aquifer water levels are anticipated, which should lead to further increases in spring flow and/or base flow to the Walla Walla River system similar to those observed in previous pilot testing operations at the Johnson site (Bower and Lindsey, 2010, WWBWC, 2014b).

PROPOSED AQUIFER RECHARGE PROGRAM IN WY 2019

Continued operation of the twelve current sites under LL-1621 is expected in WY 2019. Operating existing sites which have been operated for only one or two years for longer periods will help to characterize their influence on the alluvial aquifer. An additional four sites are scheduled to be constructed by the end of WY 2019.

In WY 2019 monitoring will continue to be performed per the monitoring plan approved under LL-1621. A report summarizing groundwater level monitoring, water quality monitoring and aquifer recharge operations performed during the WY 2019 recharge season will be submitted to OWRD by February 15, 2020.

REFERENCES

Barker, R.A., and MacNish, R.D., 1976. *Digital Model of the Gravel Aquifer, Walla Walla River Basin, Washington and Oregon*. Washington Department of Ecology. Water Supply Bulletin 45, 56 p, 1 plate.

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Rocks District Winegrowers, webpage at www.rocksdistrict.com accessed 12-13-2018.

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WWBWC, 2014a. *2014 Walla Walla Basin Seasonal Seepage Assessments Report – Walla Walla River, Mill Creek and Touchet River, October 2014*.

WWBWC, 2014b. *Water Year 2013 Oregon Walla Walla Basin Aquifer Recharge Report*, February 2014.

WWBWC, 2017. *Surface Water Monitoring in the Walla Walla Basin, 2017 Water Year*, September 2017.

APPENDIX A – LIMITED LICENSE LL-1621

Oregon Water Resources Department

Final Order
Limited License Application LL-1621
Walla Walla Basin Watershed Council and
Hudson Bay District Improvement
Company

Appeal Rights

This is a final order in other than a contested case. This order is subject to judicial review under ORS 183.484. Any petition for judicial review must be filed within the 60-day time period specified by ORS 183.484(2). Pursuant to ORS 536.075 and OAR 137-004-0080 you may either petition for judicial review or petition the Director for reconsideration of this order. A petition for reconsideration may be granted or denied by the Director, and if no action is taken within 60 days following the date the petition was filed, the petition shall be deemed denied.

Requested Water Use

On June 13, 2016, the Water Resources Department received completed limited license request 1621 from Walla Walla Basin Watershed Council and Hudson Bay District Improvement Company for the use of up to 70 cubic feet per second from the Walla Walla River. The points of diversion are located in the NE ^{1}/4 NW ^{1}/4, Section l, Township 5 North, Range 35 East W.M. and in the SW ^{1}/4, NE ^{1}/4, Section 12, Township 5 North, Range 35 East, W.M., for the purpose of artificial groundwater recharge testing, for the period of March l, 2015 through December 3 1, 2020.

Authorities

The Department may approve a limited license pursuant to its authority under ORS 537.143, 537.144 and OAR 690-340-0030.

ORS 537.143(2) authorizes the Director to revoke the right to use water under a limited license if it causes injury to any other water right or a minimum perennial streamflow.

A limited license will not be issued for more than five consecutive years for the same use, as directed by ORS 537.143(8).

Findings of Fact

1. The forms, fees and map have been submitted, as required by OAR 690-340-0030(1).
2. The Department provided public notice of the application, on December 22, 2015 as required by OAR 690-340-0030(2).
3. This limited license request is limited to an area within a single drainage basin as required by OAR 690-340-0030(3).

4. The Department has determined that there is water available for the requested use.

5. The Department has determined that the proposed source has not been withdrawn from further appropriation.

6. Because this use is from surface water and has the potential to impact fish, the Department finds that fish screening is required to protect the public interest.

7. Because the use requested is longer than 120 days and because the use is in an area that has sensitive, threatened or endangered fish species, the use is subject to the Department's rules under OAR 690-33. These rules aid the Department in determining whether a proposed use will impair or be detrimental to the public interest with regard to sensitive, threatened, or endangered fish species.

8. The Department has determined that the use is not subject to its rules under OAR 690-350. However, artificial groundwater recharge testing must be done in a manner that provides a test with results and supplemental information for the user's artificial groundwater recharge permit application. Consistent with this intent, the Department has added conditions pertaining to testing, monitoring, reporting and coordination with Oregon Department of Environmental Quality (ODEQ), Oregon Department of Fish and Wildlife (ODFW) and this Department.

9. The Department has received comments related to the possible issuance of the limited license from ODEQ requesting changes to the proposed monitoring plan. The water quality monitoring plan was revised and approved by ODEQ on February 25, 2016. The Department has received comments from ODFW in support of this issuance and recommending conditions related to instream water rights and bypass flows. The Department's Groundwater Section determined the testing and water quantity monitoring plan submitted as an addendum to the application on June 13, 2016 is sufficient for artificial groundwater recharge testing. The authorization of Limited License 1621 is conditioned to satisfactorily address issues raised in those comments.

10. Pursuant to OAR 690-340-0030(4)(5), conditions have been added with regard to notice and water-use measurement.

Conclusions of Law

The proposed water use will not impair or be detrimental to the public interest pursuant to OAR 690-340-0030(2), as limited in the order below.

Order

Therefore, pursuant to ORS 537.143, ORS 537.144, and OAR 690-340-0030, application for Limited License 1621 is approved as conditioned below.

1. The period and rate of use for Limited License 1621 shall be from October 17, 2016 through December 3 1, 2020 for the use of 70 cubic feet per second from the Walla Walla River, for the purpose of artificial groundwater recharge testing. The season of use is limited to November 1 through May 15.

2. The licensee shall give notice to the Watermaster in the district where use is to occur not less than 15 days or more than 60 days in advance of using the water under this limited license. The notice shall include the location of the diversion, and the volume of water to be diverted and the intended use and place of use.

3. When water is diverted under this limited license, the use is limited to times when the following minimum streamflows are met in the Tum A Lum reach of the Walla Walla River, between the Little Walla Walla River diversion and Nursery Bridge Dam and flowing past Nursery Bridge Dam: November — 64 cfs, December and January 95 cfs, February to May 15 — 150 cfs. Nursery Bridge Dam is located just downstream of Nursery Bridge and is downstream of the Little Walla Wall diversion. The District 5 Watermaster, based on gage and/or flow measurements, shall make the determination that the above described streamflows are flowing past Nursery Bridge Dam. Diversion under this limited license shall cease when said streamflows are unmet.

4. The Licensee shall follow the operation, water quality and water level monitoring plans described in the document entitled "Surface water and Groundwater Monitoring and Reporting Plan for Limited License Application LL1621" and dated May 3 1, 2016. This plan may be modified after review and approval of changes by the Department.

5. The licensee shall comply with all ODEQ water quality requirements. If monitoring data or other information result in identification of potential water quality concerns, ODEQ may seek modifications to the monitoring and test plan and/or require a permit of its own to address the water quality concerns prior to resumption of artificial groundwater recharge testing.

6. Before water use may begin under this license, the licensee shall install a totalizing flow meter at each point of diversion and at the entry point to each recharge test site. The totalizing flow meters must be installed and maintained in good working order. In addition the licensee shall maintain a record of all water use, including the total number of hours of diversion, the total volume diverted, and the categories of beneficial use to which the water is applied. During the period of the limited license, the record of use shall be available for review by the Department upon request, and shall be submitted to the Department annually and to Watermaster upon request. This record shall include the amount of water diverted from the Walla Walla River, and the amount delivered to each recharge area.

7. The Director may revoke the right to use water for any reason described in ORS 537.143 (2), and OAR 690-340-0030(6). Such revocation may be prompted by field regulatory activities or by any other reason.

8. Use of water under a limited license shall not have priority over any water right exercised according to a permit or certificate, and shall be subordinate to all other authorized uses that rely upon the same source.

9. The licensee shall install, maintain and operate fish screening and by-pass devices as required by the Oregon Department of Fish and Wildlife to prevent fish from entering the proposed diversion. See copy of enclosed fish screening criteria for information.

10. In supporting this license, ODFW retains the prerogative to pursue a future instream water right for the Walla Walla River. A permanent water right for the requested location may fall under the requirements of Division 33 rules, which limit water usage during the period from April 15-September 30.

11. The licensee is required to provide a written annual report by February 15th of each year. This report will detail recharge testing and any subsequent recovery under a secondary limited license from the preceding water year. Reporting shall include, but is not limited to, the results of testing efforts that relate to water quality, water quantity, and operations. Water level data shall be submitted in a Department-specified digital format. The licensee shall consult with ODEQ and OWRD to identify additional specific reporting elements. The first report is due in February 2014. The annual report shall be sealed and signed by a professional(s) registered or allowed, under Oregon law, to practice geology.

12. Failure to meet the conditions of the license to the satisfaction of the Department will lead to a cancellation of the limited license, in which case it would no longer be in force.

13. The licensee shall conduct recharge testing as proposed in the application and later amended by the licensee, and as otherwise conditioned herein.

NOTE: This water-use authorization is temporary. Applicants are advised that issuance of this final order does not guarantee that any permit for the authorized use will be issued in the future; any investments should be made with that in mind.

Issued October *18*, 2016

E. Timothy Wallin

E. Timothy Wallin, Water Rights Program Manager, for
Thomas M. Byler, Director
Water Resources Department

Enclosures - limited license

cc: Greg Silbernagel, District 5 Watermaster
Bill Duke, ODFW
Phil Richerson, ODEQ
File

If you need further assistance, please contact the Water Rights Section at the address, phone number, or fax number below. When contacting the Department, be sure to reference your limited license number for better service.

Remember, the use of water under the terms of this limited license is not a secure source of water. Water use can be revoked at any time. Such revocation may be prompted by field regulatory activities or many other reasons.

Water Rights Section
Oregon Water Resources Department
725 Summer Street NE, Suite A
Salem OR 97301-1271
Phone: (503) 986-081 7 Fax: (503) 986-0901

FISH SCREENING CRITERIA FOR WATER DIVERSIONS

This summary describes ODFW fish screening criteria for all fish species.

Screen material openings for ditch (gravity) and pump screens must provide a minimum of 27% open area:

Perforated plate: Openings shall not exceed 3/32 or 0.0938 inches (2.38 mm).

Mesh/Woven wire screen: Square openings shall not exceed 3/32 or 0.0938 inches (2.38 mm) in the narrow direction, e.g., 3/32 inch x 3/32 inch open mesh.

Profile bar screen/Wedge wire: Openings shall not exceed 0.0689 inches (1.75 mm) in the narrow direction.

Screen area must be large enough to prevent fish impact. Wetted screen area depends on the water now rate and the approach velocity.

Approach velocity: The water velocity perpendicular to and approximately three inches in front of the screen face.
Sweeping velocity: The water velocity parallel to the screen face.
Bypass system: Any pipe, flume, open channel or other means of conveyance that transports fish back to the body of water from which the fish were diverted.
Active pump screen: Self cleaning screen that has a proven cleaning system.
Passive pump screen: Screen that has no cleaning system other than periodic manual cleaning.

Screen approach velocity for ditch and active pump screens shall not exceed 0.4 fps (feet per second) or 0.12 mps (meters per second). The wetted screen area in square feet is calculated by dividing the maximum water flow rate in cubic feet per second (1 cfs— 449 gpm) by 0.4 fps.

Screen sweeping velocity for ditch screens shall exceed the approach velocity. Screens greater than 4 feet in length must be angled at 45 degrees or less to flow. An adequate bypass system must be provided for ditch screens to safely and rapidly collect and transport fish back to the stream.

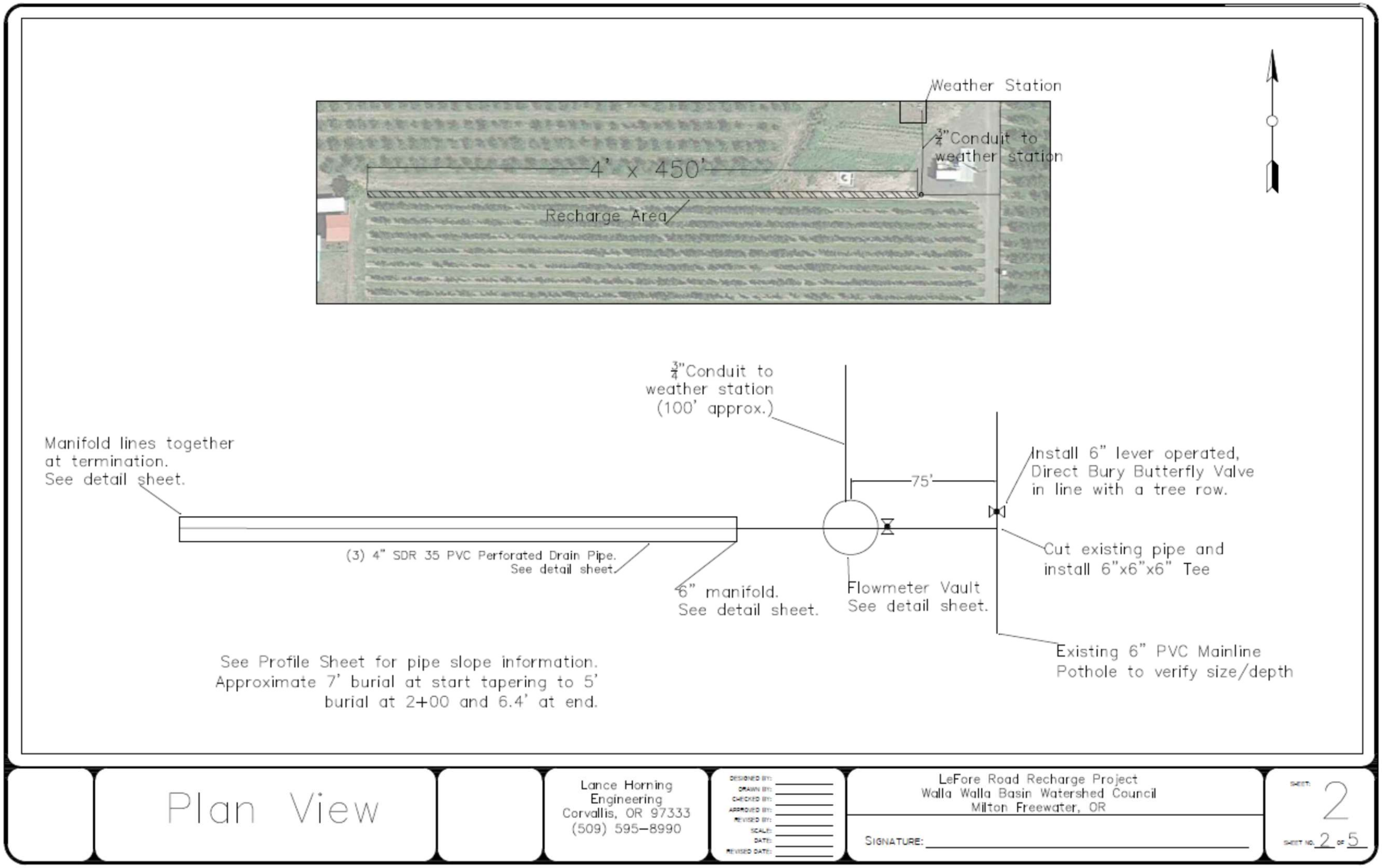
Screen approach velocity for passive pump screens shall not exceed 0.2 fps or 0.06 mps. The wetted screen area in square feet is calculated by dividing the maximum water flow rate by 0.2 fps. pump rate should be less than 1 cfs.

For further information please contact:

Bernie Kepshire
Oregon Department of Fish and Wildlife
71 1 8 NE Vandenberg Avenue
Corvallis, OR 97330-9446
(541)757-4186 055
bernard.m.kepshire@state.or.us

APPENDIX B – EXCERPTS FROM DESIGN DRAWINGS

LeFore Road Recharge Site



Profile Sheet

Lance Horning
Engineering
Corvallis, OR 97333
(509) 595-8990

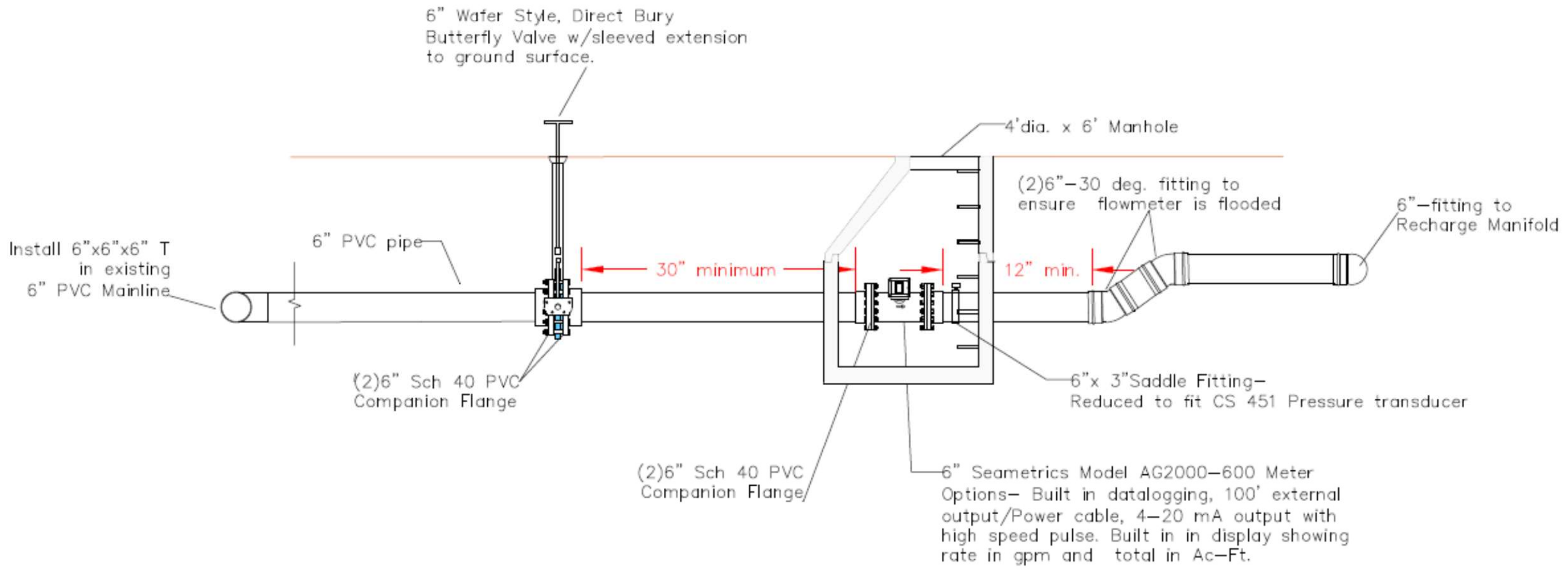
DESIGNED BY:
DRAWN BY:
CHECKED BY:
APPROVED BY:
REVISED BY:
SCALE:
DATE:
REVISED DATE:

LeFore Road Recharge Project
Walla Walla Basin Watershed Council
Milton Freewater, OR

SIGNATURE:

SHEET: 3

SHEET NO. 3 OF 5



Flowmeter Vault

Details 1

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(509) 595-8990

DESIGNED BY: ____
DRAWN BY: ____
CHECKED BY: ____
APPROVED BY: ____
REVISED BY: ____
SCALE: ____
DATE: ____
REVISED DATE: ____

LeFore Road Recharge Project
Walla Walla Basin Watershed Council
Milton Freewater, OR

SIGNATURE: ____

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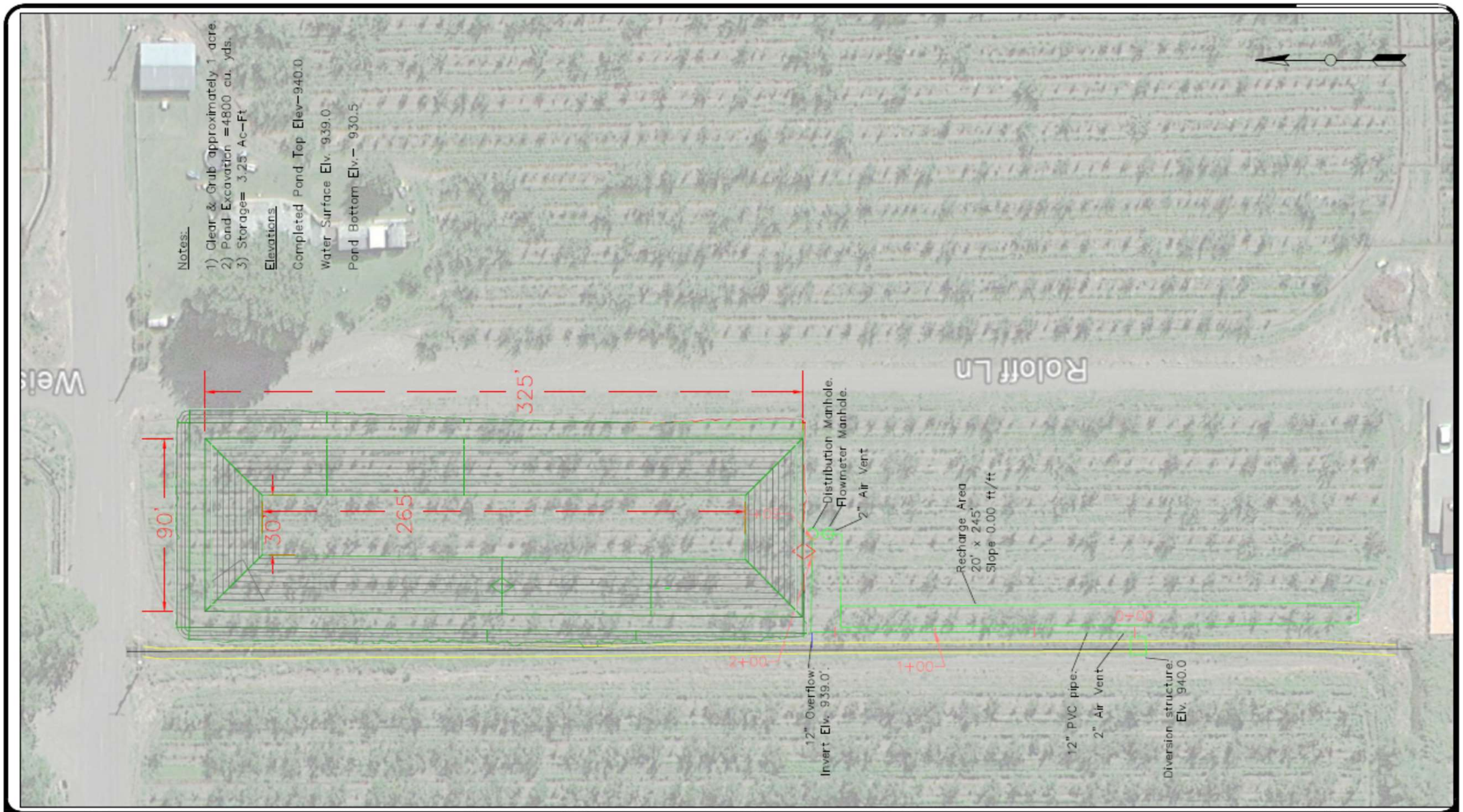
SHEET NO. 4 OF 5

Locust Road Recharge Site



Plan View

Lance Horning
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(509) 595–8990

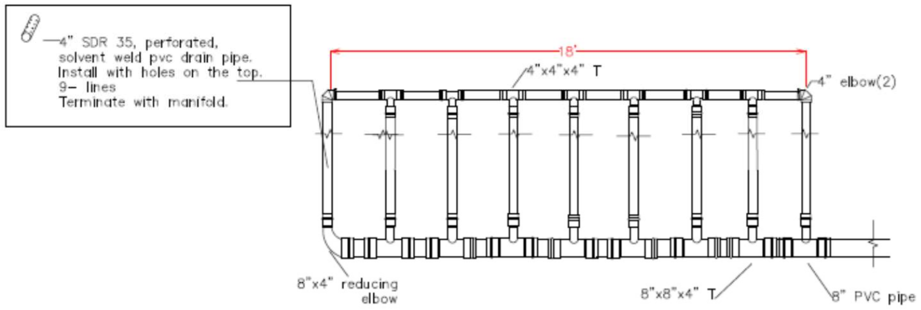
DESIGNED BY: LH
DRAWN BY:
CHECKED BY:
APPROVED BY:
REVISED BY:
SCALE:
DATE:
REVISED DATE: 9/15/16

Locust Road Shallow Aquifer Recharge Project
Walla Walla Basin Watershed Council
Milton Freewater, OR

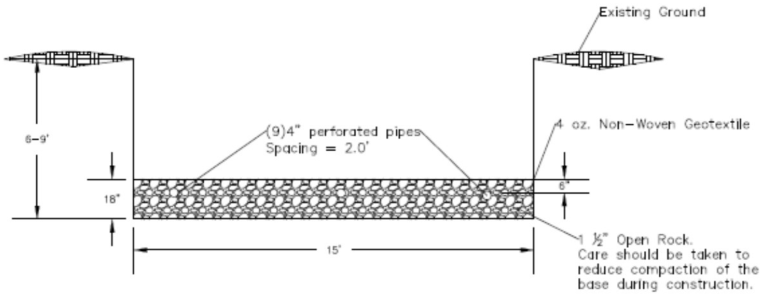
SIGNATURE:

SHEET: 2

SHEET NO. 2 OF 7



Recharge Manifold



Recharge Area– Trench

Details 3

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DESIGNED BY: LH
DRAWN BY:
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APPROVED BY:
REVISED BY:
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REVISED DATE: 9/15/16

Locust Road Shallow Aquifer Recharge Project
Walla Walla Basin Watershed Council
Milton Freewater, OR

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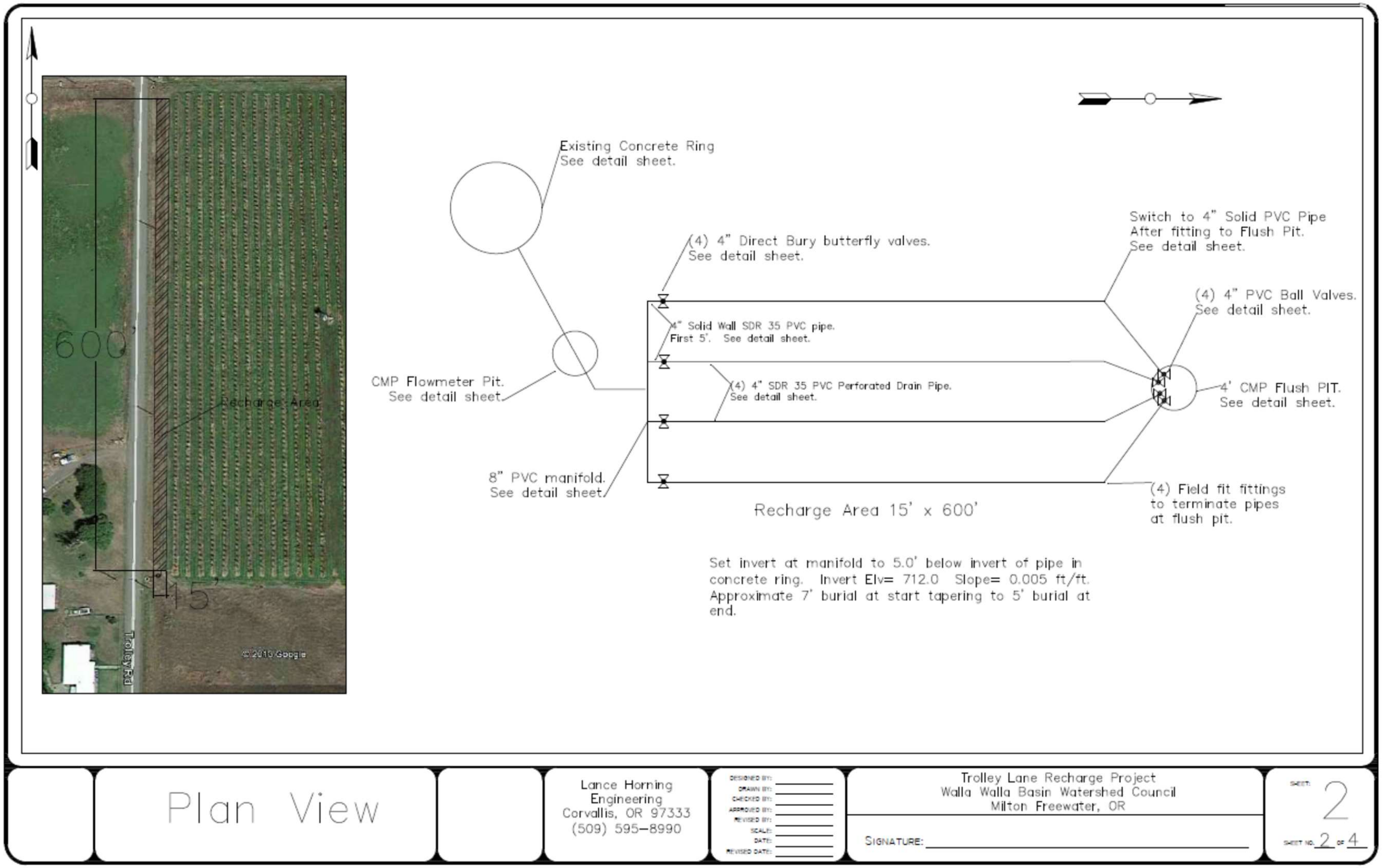
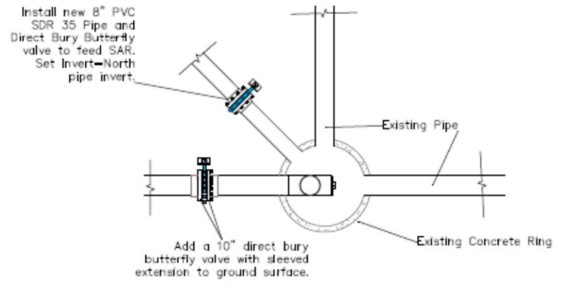
SHEET NO. 5 OF 7

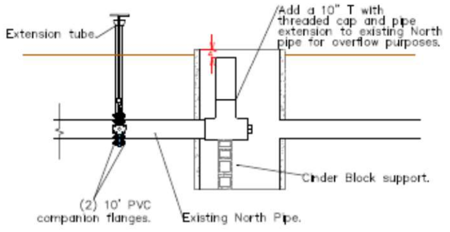
East Trolley Lane Recharge Site



Existing Concrete Ring

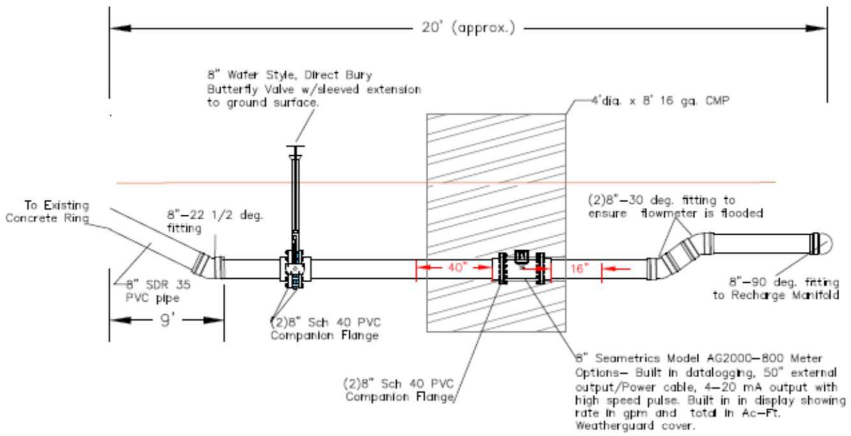


Plan View



Section View

CMP Flowmeter Pit



Details 1

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DESIGNED BY: ______
DRAWN BY: ______
CHECKED BY: ______
APPROVED BY: ______
REVISED BY: ______
SCALE: ______
DATE: ______
REVISED DATE: ______

Trolley Lane Recharge Project
Walla Walla Basin Watershed Council
Milton Freewater, OR

SIGNATURE: ______

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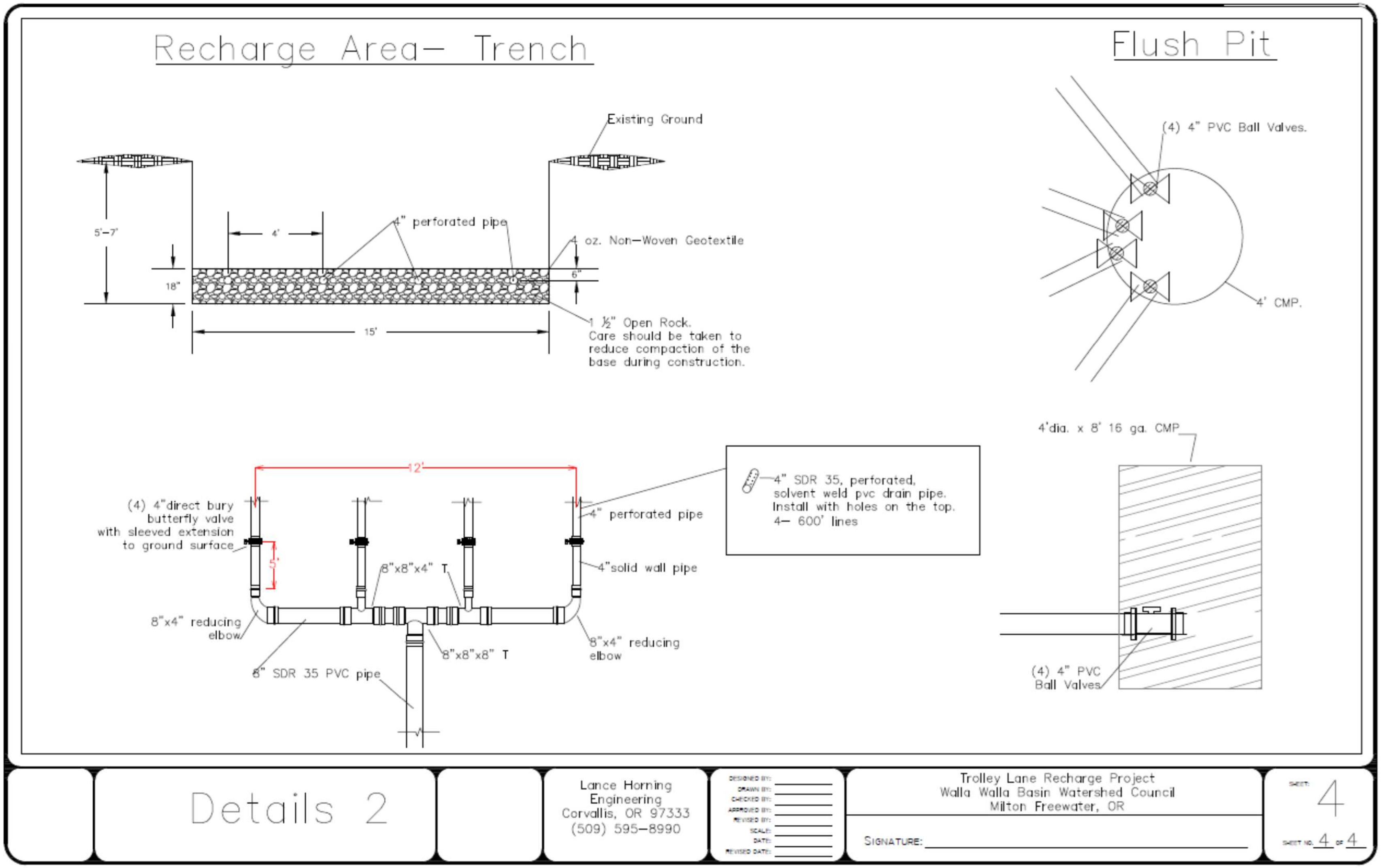
SHEET NO. 3 OF 4


Recharge Area– Trench
Existing Ground
5'–7'
4'
4" perforated pipe
4 oz. Non–Woven Geotextile
6"
18"
15'
1 ½" Open Rock.
Care should be taken to
reduce compaction of the
base during construction.
Flush Pit
(4) 4" PVC Ball Valves.
4' CMP.
4'dia. x 8' 16 ga. CMP
(4) 4" PVC
Ball Valves
12'
5'
(4) 4"direct bury
butterfly valve
with sleeved extension
to ground surface
4" perforated pipe
4" SDR 35, perforated,
solvent weld pvc drain pipe.
Install with holes on the top.
4– 600' lines
8"x8"x4" T
4"solid wall pipe
8"x4" reducing
elbow
8"x8"x8" T
8"x4" reducing
elbow
8" SDR 35 PVC pipe
Details 2
Lance Horning
Engineering
Corvallis, OR 97333
(509) 595–8990
DESIGNED BY:
DRAWN BY:
CHECKED BY:
APPROVED BY:
REVISED BY:
SCALE:
DATE:
REVISED DATE:
Trolley Lane Recharge Project
Walla Walla Basin Watershed Council
Milton Freewater, OR
SIGNATURE:
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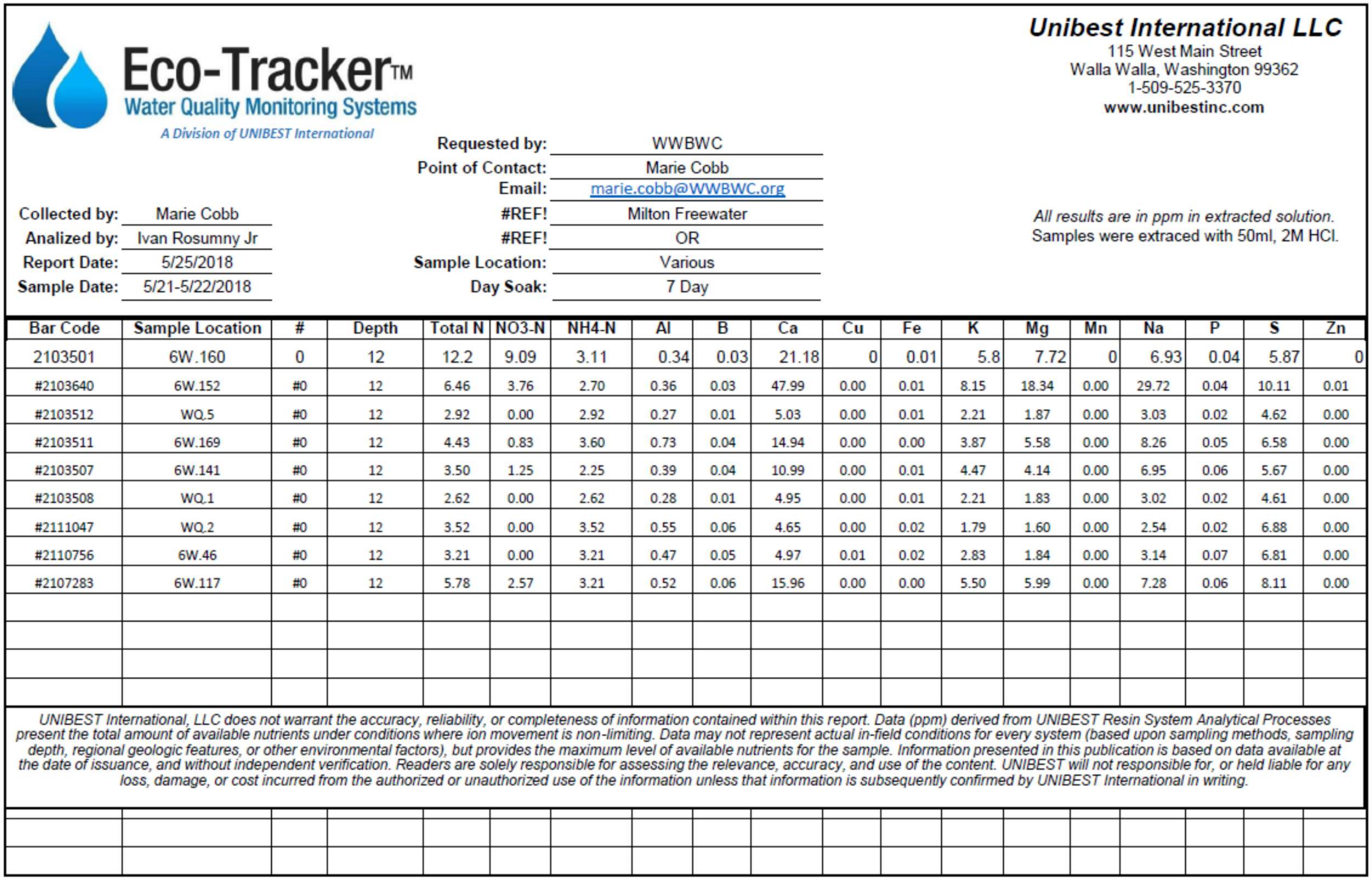
4
SHEET NO. 4 OF 4

APPENDIX C – WATER QUALITY DATA



Eco-Tracker™
Water Quality Monitoring Systems
A Division of UNIBEST International

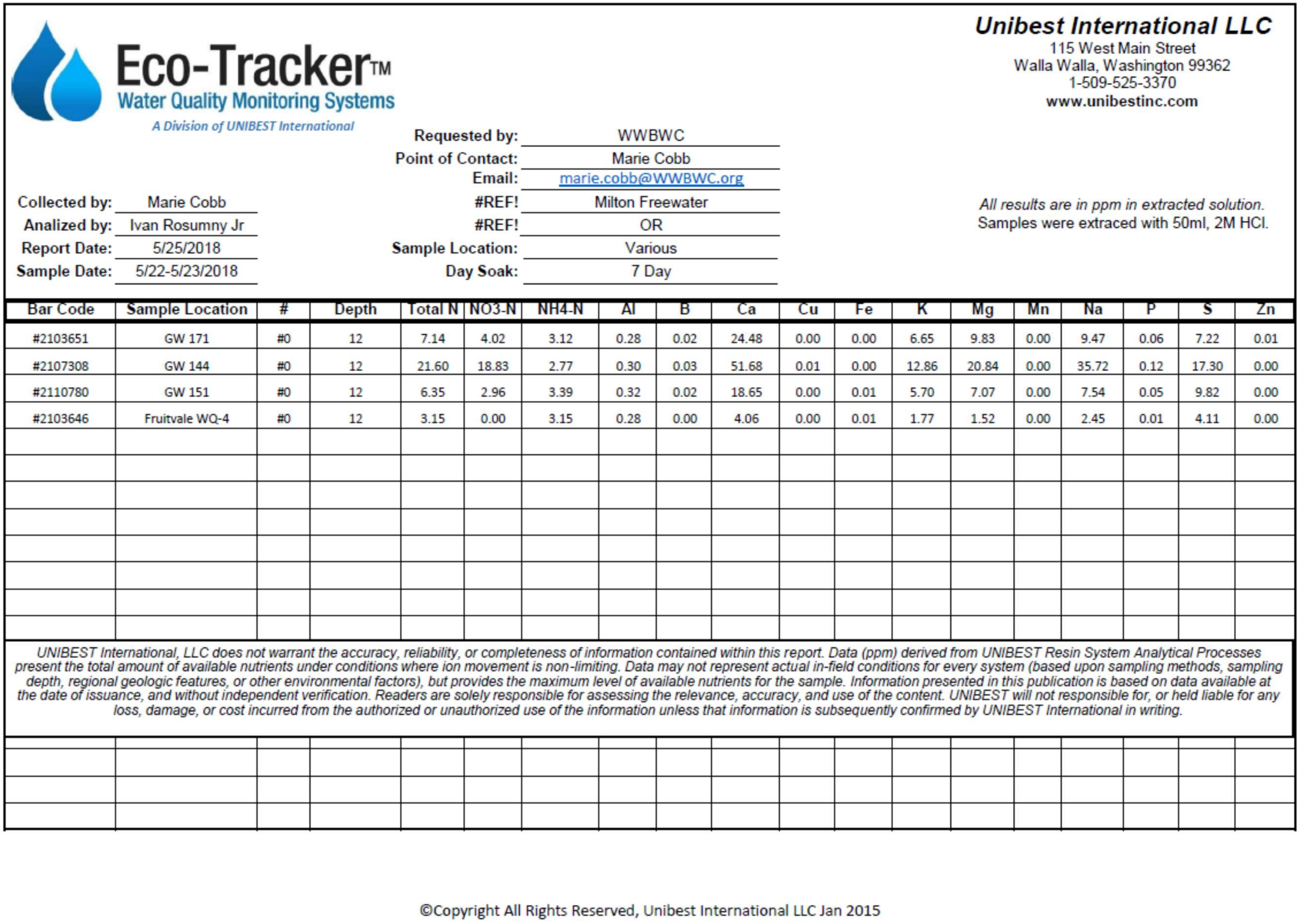
Unibest International LLC
115 West Main Street
Walla Walla, Washington 99362
1-509-525-3370
www.unibestinc.com

Requested by: WWBWC
Point of Contact: Marie Cobb
Email: marie.cobb@WWBWC.org
#REF! Milton Freewater
#REF! OR
Sample Location: Various
Day Soak: 7 Day

Collected by: Marie Cobb
Analized by: Ivan Rosumny Jr
Report Date: 5/25/2018
Sample Date: 5/21-5/22/2018

All results are in ppm in extracted solution.
Samples were extraced with 50ml, 2M HCl.

Bar Code	Sample Location	#	Depth	Total N	NO3-N	NH4-N	Al	B	Ca	Cu	Fe	K	Mg	Mn	Na	P	S	Zn
2103501	6W.160	0	12	12.2	9.09	3.11	0.34	0.03	21.18	0	0.01	5.8	7.72	0	6.93	0.04	5.87	0
#2103640	6W.152	#0	12	6.46	3.76	2.70	0.36	0.03	47.99	0.00	0.01	8.15	18.34	0.00	29.72	0.04	10.11	0.01
#2103512	WQ.5	#0	12	2.92	0.00	2.92	0.27	0.01	5.03	0.00	0.01	2.21	1.87	0.00	3.03	0.02	4.62	0.00
#2103511	6W.169	#0	12	4.43	0.83	3.60	0.73	0.04	14.94	0.00	0.00	3.87	5.58	0.00	8.26	0.05	6.58	0.00
#2103507	6W.141	#0	12	3.50	1.25	2.25	0.39	0.04	10.99	0.00	0.01	4.47	4.14	0.00	6.95	0.06	5.67	0.00
#2103508	WQ.1	#0	12	2.62	0.00	2.62	0.28	0.01	4.95	0.00	0.01	2.21	1.83	0.00	3.02	0.02	4.61	0.00
#2111047	WQ.2	#0	12	3.52	0.00	3.52	0.55	0.06	4.65	0.00	0.02	1.79	1.60	0.00	2.54	0.02	6.88	0.00
#2110756	6W.46	#0	12	3.21	0.00	3.21	0.47	0.05	4.97	0.01	0.02	2.83	1.84	0.00	3.14	0.07	6.81	0.00
#2107283	6W.117	#0	12	5.78	2.57	3.21	0.52	0.06	15.96	0.00	0.00	5.50	5.99	0.00	7.28	0.06	8.11	0.00



Eco-Tracker™
Water Quality Monitoring Systems
A Division of UNIBEST International

Unibest International LLC
115 West Main Street
Walla Walla, Washington 99362
1-509-525-3370
www.unibestinc.com

Requested by: WWBWC
Point of Contact: Marie Cobb
Email: marie.cobb@WWBWC.org
#REF! Milton Freewater
#REF! OR
Sample Location: Various
Day Soak: 7 Day

Collected by: Marie Cobb
Analized by: Ivan Rosumny Jr
Report Date: 5/25/2018
Sample Date: 5/22-5/23/2018

All results are in ppm in extracted solution.
Samples were extraced with 50ml, 2M HCl.

Bar Code	Sample Location	#	Depth	Total N	NO3-N	NH4-N	Al	B	Ca	Cu	Fe	K	Mg	Mn	Na	P	S	Zn
#2103651	GW 171	#0	12	7.14	4.02	3.12	0.28	0.02	24.48	0.00	0.00	6.65	9.83	0.00	9.47	0.06	7.22	0.01
#2107308	GW 144	#0	12	21.60	18.83	2.77	0.30	0.03	51.68	0.01	0.00	12.86	20.84	0.00	35.72	0.12	17.30	0.00
#2110780	GW 151	#0	12	6.35	2.96	3.39	0.32	0.02	18.65	0.00	0.01	5.70	7.07	0.00	7.54	0.05	9.82	0.00
#2103646	Fruitvale WQ-4	#0	12	3.15	0.00	3.15	0.28	0.00	4.06	0.00	0.01	1.77	1.52	0.00	2.45	0.01	4.11	0.00

UNIBEST International, LLC does not warrant the accuracy, reliability, or completeness of information contained within this report. Data (ppm) derived from UNIBEST Resin System Analytical Processes present the total amount of available nutrients under conditions where ion movement is non-limiting. Data may not represent actual in-field conditions for every system (based upon sampling methods, sampling depth, regional geologic features, or other environmental factors), but provides the maximum level of available nutrients for the sample. Information presented in this publication is based on data available at the date of issuance, and without independent verification. Readers are solely responsible for assessing the relevance, accuracy, and use of the content. UNIBEST will not responsible for, or held liable for any loss, damage, or cost incurred from the authorized or unauthorized use of the information unless that information is subsequently confirmed by UNIBEST International in writing.

Eco-Tracker™
Water Quality Monitoring Systems
A Division of UNIBEST International

Unibest International LLC
115 West Main Street
Walla Walla, Washington 99362
1-509-525-3370
www.unibestinc.com

Requested by: WWBWC
Point of Contact: Marie Cobb
Email: marie.cobb@WWBWC.org
#REF! Milton Freewater
#REF! OR
Sample Location: Various
Day Soak: 7 Day

Collected by: Marie Cobb
Analized by: Ivan Rosumny Jr
Report Date: 5/25/2018
Sample Date: 5/22-5/23/2018

All results are in ppm in extracted solution.
Samples were extraced with 50ml, 2M HCl.

Bar Code	Sample Location	#	Depth	Total N	NO3-N	NH4-N	Al	B	Ca	Cu	Fe	K	Mg	Mn	Na	P	S	Zn
#2110860	Huffman WQ-3	#0	12	2.91	0.00	2.91	0.32	0.02	5.21	0.01	0.02	2.64	1.93	0.00	3.23	0.03	6.42	0.00
#2023461	GW 170	#0	12	4.57	1.91	2.66	0.50	0.03	15.79	0.01	0.01	4.78	6.12	0.00	8.35	0.08	8.85	0.01
#2023517	GW 142	#0	12	2.79	0.00	2.79	0.37	0.02	5.73	0.00	0.01	2.62	2.14	0.00	3.10	0.04	5.33	0.01

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115 West Main Street
Walla Walla, Washington 99362
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www.unibestinc.com

Requested by: WWBWC
Point of Contact: Marie Cobb
Email: marie.cobb@WWBWC.org
#REF! Milton Freewater
#REF! OR
Sample Location: Various
Day Soak: 7 Day

Collected by: Marie Cobb
Analized by: Ivan Rosumny Jr
Report Date: 5/25/2018
Sample Date: 5/21-5/22/2018

All results are in ppm in extracted solution.
Samples were extraced with 50ml, 2M HCl.

Bar Code	Sample Location	#	Depth	Total N	NO3-N	NH4-N	Al	B	Ca	Cu	Fe	K	Mg	Mn	Na	P	S	Zn
2107232	GW 119	0	12	12.98	9.35	3.63	0.32	0.03	33.98	0	0	9.41	14.6	0	21.68	0.08	12.36	0.01
#2111020	GW 119 Duplicate	#0	12	12.52	9.65	2.87	0.46	0.03	38.55	0.00	0.00	10.09	16.34	0.00	23.63	0.09	13.43	0.00

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Pacific Agricultural Laboratory
21830 S.W. Alexander Ln. • Sherwood, OR 97140 • Ph 503.626.7943 • pacaglab.com

Walla Walla Basin Watershed Council
810 S. Main Street
Milton-Freewater, OR 97862

Report Number: P180783
Report Date: June 07, 2018
Client Project ID: [none]

Analytical Report

Client Sample ID: GW_144
Matrix: water

PAL Sample ID: P180783-01
Sample Date: 5/22/18

Extraction Date	Analysis Date	Analyte	Amount Detected	Limit of Quantitation	Notes
Method: Modified EPA 8141B (GC-FPD)					
5/25/18	5/29/18	Azinphos-methyl	Not Detected	0.30 ug/L	
5/25/18	5/29/18	Chlorpyrifos	Not Detected	0.30 ug/L	
5/25/18	5/29/18	Malathion	Not Detected	0.30 ug/L	

Surrogate Recovery: 98 %
Surrogate Recovery Range: 46-157
(TPP-d15 used as Surrogate)

Extraction Date	Analysis Date	Analyte	Amount Detected	Limit of Quantitation	Notes
Method: Modified EPA 8321B (LC-MS/MS)					
5/25/18	6/1/18	DCPMU	Not Detected	0.060 ug/L	
5/25/18	6/1/18	Diuron	Not Detected	0.060 ug/L	

Surrogate Recovery: 113 %
Surrogate Recovery Range: 60-140
(TPP-d15 used as Surrogate)

Client Sample ID: GW_171
Matrix: water

PAL Sample ID: P180783-02
Sample Date: 5/22/18

Extraction Date	Analysis Date	Analyte	Amount Detected	Limit of Quantitation	Notes
Method: Modified EPA 8141B (GC-FPD)					
5/25/18	5/29/18	Azinphos-methyl	Not Detected	0.30 ug/L	
5/25/18	5/29/18	Chlorpyrifos	Not Detected	0.30 ug/L	
5/25/18	5/29/18	Malathion	Not Detected	0.30 ug/L	

Surrogate Recovery: 97 %
Surrogate Recovery Range: 46-157
(TPP-d15 used as Surrogate)

Extraction Date	Analysis Date	Analyte	Amount Detected	Limit of Quantitation	Notes
Method: Modified EPA 8321B (LC-MS/MS)					
5/25/18	6/1/18	DCPMU	Not Detected	0.060 ug/L	
5/25/18	6/1/18	Diuron	Not Detected	0.060 ug/L	

Surrogate Recovery: 108 %
Surrogate Recovery Range: 60-140
(TPP-d15 used as Surrogate)

Rick Jordan, Laboratory Manager

Walla Walla Basin Watershed Council
810 S. Main Street
Milton-Freewater, OR 97862

Report Number: P180783
Report Date: June 07, 2018
Client Project ID: [none]

Quality Assurance

Method Blank Data **Matrix:** water

Extraction Date	Analysis Date	Batch QC Sample #	Analyte	% Recovery	Expected % Recovery	Notes
5/25/18	5/29/18	8052503-BLK1	Azinphos-methyl	Not Detected	< 0.30 ug/L	
5/25/18	5/29/18	8052503-BLK1	Chlorpyrifos	Not Detected	< 0.30 ug/L	
5/25/18	6/1/18	8052503-BLK1	DCPMU	Not Detected	< 0.060 ug/L	
5/25/18	6/1/18	8052503-BLK1	Diuron	Not Detected	< 0.060 ug/L	
5/25/18	5/29/18	8052503-BLK1	Malathion	Not Detected	< 0.30 ug/L	

Blank Spike Data **Matrix:** water

Extraction Date	Analysis Date	Batch QC Sample #	Analyte	% Recovery	Expected % Recovery	Notes
5/25/18	5/29/18	8052503-BS1	Azinphos-methyl	107	60-140	
5/25/18	5/29/18	8052503-BSD1	Azinphos-methyl	102	60-140	
5/25/18	5/29/18	8052503-BS1	Chlorpyrifos	86	58-119	
5/25/18	5/29/18	8052503-BSD1	Chlorpyrifos	79	58-119	
5/25/18	6/1/18	8052503-BS1	Diuron	108	60-140	
5/25/18	6/1/18	8052503-BSD1	Diuron	104	60-140	
5/25/18	5/29/18	8052503-BS1	Malathion	100	60-140	
5/25/18	5/29/18	8052503-BSD1	Malathion	98	60-140	

Rick Jordan, Laboratory Manager

Anatek Labs, Inc.

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(208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com

NELAC # E87893 ORELAP # ID200001

System ID #:

WATER SYSTEM NAME:	WALLA WALLA BASIN WATERSHED COUNCIL		
CONTACT:		Date Received:	5/22/2018
ADDRESS:	810 S. MAIN RD	Report Date:	Tuesday, June 05, 2018
CITY, STATE, ZIP:	MILTON-FREEWATER, OR 97862	Lab Batch Number:	180522012

All test results comply with and meet all requirements set forth by NELAC.

Certifying Officials:

Erin T. Linskey
Technical Director

Todd Taruscio
Laboratory Manager

For questions please contact Justin Doty at 208-883-2839

The results within this report relate only to the samples. All results are reported on a wet weight basis, and an estimation of uncertainty is available upon request.

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NELAC # E87893 ORELAP # ID200001

System ID#: Entry Point or Source ID#: Source Name(s):

Water System Name: WALLA WALLA BASIN WATERSHED COUNCIL

Contact:

Address: 810 S. MAIN RD

City, State, Zip: MILTON-FREEWATER, OR 97862

Sampled At: GW-160

Collection Date: 5/21/2018

Collection Time: 7:50:00 AM

Sampled By: LA & MC

Date Received: 5/22/2018 10:45:00 AM

Sample Composition: SOURCE

Sample Composition:

Report Date: 6/5/2018

Lab Sample Number: 180522012-001

Inorganic Compound (IOC) Report

Contaminant	Code	MCL	Analysis	LRL	Units	Method	Analyst	Analysis Date	Qualifier
Nitrate	1040	10	7.47	0.1	mg/L	EPA 300.0	RPU	5/22/2018	
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	ND	0.001	mg/L	EPA 200.8	HSW	5/29/2018	
Zinc	1095	5	ND	0.001	mg/L	EPA 200.8	HSW	5/29/2018	

LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

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NELAC # E87893 ORELAP # ID200001

System ID#: Entry Point or Source ID#: Source Name(s):

Water System Name: WALLA WALLA BASIN WATERSHED COUNCIL
Contact:
Address: 810 S. MAIN RD
City, State, Zip: MILTON-FREEWATER, OR 97862

Sampled At:	GW-152	Sample Composition:	SOURCE
Collection Date:	5/21/2018	Sample Composition:	
Collection Time:	8:24:00 AM	Report Date:	6/5/2018
Sampled By:	LA & MC	Lab Sample Number:	180522012-002
Date Received:	5/22/2018 10:45:00 AM		

Inorganic Compound (IOC) Report

Contaminant	Code	MCL	Analysis	LRL	Units	Method	Analyst	Analysis Date	Qualifier
Nitrate	1040	10	3.28	0.1	mg/L	EPA 300.0	RPU	5/22/2018	
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	0.00124	0.001	mg/L	EPA 200.8	HSW	6/1/2018	
Zinc	1095	5	0.00143	0.001	mg/L	EPA 200.8	HSW	6/1/2018	

LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

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NELAC # E87893 ORELAP # ID200001

System ID#: Entry Point or Source ID#: Source Name(s):

Water System Name: WALLA WALLA BASIN WATERSHED COUNCIL

Contact:

Address: 810 S. MAIN RD

City, State, Zip: MILTON-FREEWATER, OR 97862

Sampled At: WQ-5

Collection Date: 5/21/2018

Collection Time:

Sampled By: LA & MC

Date Received: 5/22/2018 10:45:00 AM

Sample Composition: SOURCE

Sample Composition:

Report Date: 6/5/2018

Lab Sample Number: 180522012-003

Inorganic Compound (IOC) Report

Contaminant	**Code**	**MCL**	**Analysis**	**LRL**	**Units**	**Method**	**Analyst**	**Analysis Date**	**Qualifier**
Nitrate	1040	10	ND	0.1	mg/L	EPA 300.0	RPU	5/22/2018	
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	ND	0.001	mg/L	EPA 200.8	HSW	6/1/2018	
Zinc	1095	5	0.00480	0.001	mg/L	EPA 200.8	HSW	6/1/2018	

LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

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NELAC # E87893 ORELAP # ID200001

System ID#:	Entry Point or Source ID#:	Source Name(s):	
Water System Name:	WALLA WALLA BASIN WATERSHED COUNCIL		
Contact:			
Address:	810 S. MAIN RD		
City, State, Zip:	MILTON-FREEWATER, OR 97862		
Sampled At:	GW-169	Sample Composition:	SOURCE
Collection Date:	5/21/2018	Sample Composition:	
Collection Time:		Report Date:	6/5/2018
Sampled By:	LA & MC	Lab Sample Number:	180522012-004
Date Received:	5/22/2018 10:45:00 AM		

Inorganic Compound (IOC) Report

Contaminant	Code	MCL	Analysis	LRL	Units	Method	Analyst	Analysis Date	Qualifier
Nitrate	1040	10	1.30	0.1	mg/L	EPA 300.0	RPU	5/22/2018	
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	ND	0.001	mg/L	EPA 200.8	HSW	5/29/2018	
Zinc	1095	5	ND	0.001	mg/L	EPA 200.8	HSW	5/29/2018	

LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

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NELAC # E87893 ORELAP # ID200001

System ID#: Entry Point or Source ID#: Source Name(s):

Water System Name: WALLA WALLA BASIN WATERSHED COUNCIL

Contact:

Address: 810 S. MAIN RD

City, State, Zip: MILTON-FREEWATER, OR 97862

Sampled At:	GW-141	Sample Composition:	SOURCE
Collection Date:	5/21/2018	Sample Composition:	
Collection Time:		Report Date:	6/5/2018
Sampled By:	LA & MC	Lab Sample Number:	180522012-005
Date Received:	5/22/2018 10:45:00 AM		

Inorganic Compound (IOC) Report

Contaminant	Code	MCL	Analysis	LRL	Units	Method	Analyst	Analysis Date	Qualifier
Nitrate	1040	10	1.29	0.1	mg/L	EPA 300.0	RPU	5/22/2018	
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	0.00136	0.001	mg/L	EPA 200.8	HSW	6/1/2018	
Zinc	1095	5	0.00148	0.001	mg/L	EPA 200.8	HSW	6/1/2018	

LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

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NELAC # E87893 OREL AP # ID200001

System ID#: Entry Point or Source ID#: Source Name(s):

Water System Name: WALLA WALLA BASIN WATERSHED COUNCIL

Contact:

Address: 810 S. MAIN RD

City, State, Zip: MILTON-FREEWATER, OR 97862

Sampled At:	WQ-1	Sample Composition:	SOURCE
Collection Date:	5/21/2018	Sample Composition:	
Collection Time:	10:21:00 AM	Report Date:	6/5/2018
Sampled By:	LA & MC	Lab Sample Number:	180522012-006
Date Received:	5/22/2018 10:45:00 AM		

Inorganic Compound (IOC) Report

Contaminant	Code	MCL	Analysis	LRL	Units	Method	Analyst	Analysis Date	Qualifier
Nitrate	1040	10	ND	0.1	mg/L	EPA 300.0	RPU	5/22/2018	
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	ND	0.001	mg/L	EPA 200.8	HSW	6/1/2018	
Zinc	1095	5	0.00892	0.001	mg/L	EPA 200.8	HSW	6/1/2018	

LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

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NELAC # E87893 ORELAP # ID200001

System ID#:
Entry Point or Source ID#:
Source Name(s):

Water System Name: WALLA WALLA BASIN WATERSHED COUNCIL
Contact:
Address: 810 S. MAIN RD
City, State, Zip: MILTON-FREEWATER, OR 97862

Sampled At: WQ-2
Collection Date: 5/21/2018
Collection Time: 10:36:00 AM
Sampled By: LA & MC
Date Received: 5/22/2018 10:45:00 AM

Sample Composition: SOURCE
Sample Composition:
Report Date: 6/5/2018
Lab Sample Number: 180522012-007

Inorganic Compound (IOC) Report

Contaminant	Code	MCL	Analysis	LRL	Units	Method	Analyst	Analysis Date	Qualifier
Nitrate	1040	10	ND	0.1	mg/L	EPA 300.0	RPU	5/22/2018	
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	ND	0.001	mg/L	EPA 200.8	HSW	6/1/2018	
Zinc	1095	5	0.00469	0.001	mg/L	EPA 200.8	HSW	6/1/2018	

LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

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NELAC # E87893 ORELAP # ID200001

System ID#: Entry Point or Source ID#: Source Name(s):

Water System Name:	WALLA WALLA BASIN WATERSHED COUNCIL		
Contact:			
Address:	810 S. MAIN RD		
City, State, Zip:	MILTON-FREEWATER, OR 97862		
Sampled At:	GW-46	Sample Composition:	SOURCE
Collection Date:	5/21/2018	Sample Composition:	
Collection Time:	11:13:00 AM	Report Date:	6/5/2018
Sampled By:	LA & MC	Lab Sample Number:	180522012-008
Date Received:	5/22/2018 10:45:00 AM		

Inorganic Compound (IOC) Report

Contaminant	**Code**	**MCL**	**Analysis**	**LRL**	**Units**	**Method**	**Analyst**	**Analysis Date**	**Qualifier**
Nitrate	1040	10	0.111	0.1	mg/L	EPA 300.0	RPU	5/22/2018	
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	ND	0.001	mg/L	EPA 200.8	HSW	5/29/2018	
Zinc	1095	5	ND	0.001	mg/L	EPA 200.8	HSW	5/29/2018	

LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

Anatek Labs, Inc.

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NELAC # E87893 ORELAP # ID200001

System ID#: Entry Point or Source ID#: Source Name(s):

Water System Name: WALLA WALLA BASIN WATERSHED COUNCIL

Contact:

Address: 810 S. MAIN RD

City, State, Zip: MILTON-FREEWATER, OR 97862

Sampled At:	GW-117	Sample Composition:	SOURCE
Collection Date:	5/21/2018	Sample Composition:	
Collection Time:	12:16:00 PM	Report Date:	6/5/2018
Sampled By:	LA & MC	Lab Sample Number:	180522012-009
Date Received:	5/22/2018 10:45:00 AM		

Inorganic Compound (IOC) Report

Contaminant	Code	MCL	Analysis	LRL	Units	Method	Analyst	Analysis Date	Qualifier
Nitrate	1040	10	2.32	0.1	mg/L	EPA 300.0	RPU	5/22/2018	
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	ND	0.001	mg/L	EPA 200.8	HSW	6/1/2018	
Zinc	1095	5	0.00713	0.001	mg/L	EPA 200.8	HSW	6/1/2018	

LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

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Login Report

Customer Name: WALLA WALLA BASIN WATERSHED COUNCIL
810 S. MAIN RD
MILTON-FREEWATER OR 97862

Order ID: 180522012
Order Date: 5/22/2018

Contact Name:
Project Name: METALS / NH3 / NO3
Comment:

Sample #: 180522012-001 **Customer Sample #:** GW-160

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & MC **Date Collected:** 5/21/2018
Quantity: 3 **Date Received:** 5/22/2018 10:45:00 AM **Time Collected:** 7:50 AM
Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/1/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***
NITRATE/N	M	EPA 300.0	6/1/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***

Sample #: 180522012-002 **Customer Sample #:** GW-152

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & MC **Date Collected:** 5/21/2018
Quantity: 3 **Date Received:** 5/22/2018 10:45:00 AM **Time Collected:** 8:24 AM
Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/1/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***
NITRATE/N	M	EPA 300.0	6/1/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***

Sample #: 180522012-003 **Customer Sample #:** WQ-5

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & MC **Date Collected:** 5/21/2018
Quantity: 3 **Date Received:** 5/22/2018 10:45:00 AM **Time Collected:**
Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/1/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***

Customer Name: WALLA WALLA BASIN WATERSHED COUNCIL **Order ID:** 180522012
810 S. MAIN RD **Order Date:** 5/22/2018
MILTON-FREEWATER OR 97862

Contact Name: **Project Name:** METALS / NH3 / NO3

Comment:

NITRATE/N	M	EPA 300.0	6/1/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***

Sample #: 180522012-004 **Customer Sample #:** GW-169

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & MC **Date Collected:** 5/21/2018
Quantity: 3 **Date Received:** 5/22/2018 10:45:00 AM **Time Collected:**
Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/1/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***
NITRATE/N	M	EPA 300.0	6/1/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***

Sample #: 180522012-005 **Customer Sample #:** GW-141

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & MC **Date Collected:** 5/21/2018
Quantity: 3 **Date Received:** 5/22/2018 10:45:00 AM **Time Collected:**
Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/1/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***
NITRATE/N	M	EPA 300.0	6/1/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***

Sample #: 180522012-006 **Customer Sample #:** WQ-1

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & MC **Date Collected:** 5/21/2018
Quantity: 3 **Date Received:** 5/22/2018 10:45:00 AM **Time Collected:** 10:21 AM
Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/1/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***
NITRATE/N	M	EPA 300.0	6/1/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***

Customer Name:	WALLA WALLA BASIN WATERSHED COUNCIL	**Order ID:**	180522012
	810 S. MAIN RD	**Order Date:**	5/22/2018
	MILTON-FREEWATER OR 97862		
Contact Name:		**Project Name:**	METALS / NH3 / NO3
Comment:			

Sample #: 180522012-007 **Customer Sample #:** WQ-2

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & MC **Date Collected:** 5/21/2018

Quantity: 3 **Date Received:** 5/22/2018 10:45:00 AM **Time Collected:** 10:36 AM

Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/1/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***
NITRATE/N	M	EPA 300.0	6/1/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***

Sample #: 180522012-008 **Customer Sample #:** GW-46

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & MC **Date Collected:** 5/21/2018

Quantity: 3 **Date Received:** 5/22/2018 10:45:00 AM **Time Collected:** 11:13 AM

Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/1/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***
NITRATE/N	M	EPA 300.0	6/1/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***

Sample #: 180522012-009 **Customer Sample #:** GW-117

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & MC **Date Collected:** 5/21/2018

Quantity: 3 **Date Received:** 5/22/2018 10:45:00 AM **Time Collected:** 12:16 PM

Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/1/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***
NITRATE/N	M	EPA 300.0	6/1/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/1/2018	***Normal (~10 Days)***

Customer Name: WALLA WALLA BASIN WATERSHED COUNCIL
810 S. MAIN RD
MILTON-FREEWATER OR 97862

Order ID: 180522012
Order Date: 5/22/2018

Contact Name:

Project Name: METALS / NH3 / NO3

Comment:

SAMPLE CONDITION RECORD

Samples received in a cooler?	Yes
Samples received intact?	Yes
What is the temperature of the sample(s)? (°C)	3.5
Samples received with a COC?	Yes
Samples received within holding time?	Yes
Are all sample bottles properly preserved?	Yes
Are VOC samples free of headspace?	N/A
Is there a trip blank to accompany VOC samples?	N/A
Labels and chain agree?	Yes
Total number of containers?	27

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(208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
NELAC # E87893 ORELAP # ID200001

System ID #:

WATER SYSTEM NAME:	WALLA WALLA BASIN WATERSHED COUNCIL		
CONTACT:		Date Received:	5/23/2018
ADDRESS:	810 S. MAIN RD	Report Date:	Thursday, June 07, 2018
CITY, STATE, ZIP:	MILTON-FREEWATER, OR 97862	Lab Batch Number:	180523038

All test results comply with and meet all requirements set forth by NELAC.

Certifying Officials:

Erin T. Linskey
Technical Director

Todd Taruscio
Laboratory Manager

For questions please contact Justin Doty at 208-883-2839

The results within this report relate only to the samples. All results are reported on a wet weight basis, and an estimation of uncertainty is available upon request.

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NELAC # E87893 ORELAP # ID200001

System ID#: Entry Point or Source ID#: Source Name(s):

Water System Name: WALLA WALLA BASIN WATERSHED COUNCIL
Contact:
Address: 810 S. MAIN RD
City, State, Zip: MILTON-FREEWATER, OR 97862

Sampled At:	GW-144	Sample Composition:	SOURCE
Collection Date:	5/22/2018	Sample Composition:	
Collection Time:	11:45:00 AM	Report Date:	6/7/2018
Sampled By:	LA & TP	Lab Sample Number:	180523038-001
Date Received:	5/23/2018 9:50:00 AM		

Inorganic Compound (IOC) Report

Contaminant	Code	MCL	Analysis	LRL	Units	Method	Analyst	Analysis Date	Qualifier
Nitrate	1040	10	12.4	1	mg/L	EPA 300.0	RPU	5/24/2018	C4
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	0.00395	0.001	mg/L	EPA 200.8	HSW	5/29/2018	
Zinc	1095	5	ND	0.001	mg/L	EPA 200.8	HSW	5/29/2018	

C4	Confirmatory analysis was past holding time.
LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

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NELAC # E87893 ORELAP # ID200001

System ID#: Entry Point or Source ID#: Source Name(s):

Water System Name: WALLA WALLA BASIN WATERSHED COUNCIL
Contact:
Address: 810 S. MAIN RD
City, State, Zip: MILTON-FREEWATER, OR 97862

Sampled At:	GW-144	Sample Composition:	SOURCE
Collection Date:	5/22/2018	Sample Composition:	
Collection Time:	11:45:00 AM	Report Date:	6/7/2018
Sampled By:	LA & TP	Lab Sample Number:	180523038-001
Date Received:	5/23/2018 9:50:00 AM		

Inorganic Compound (IOC) Report

Contaminant	Code	MCL	Analysis	LRL	Units	Method	Analyst	Analysis Date	Qualifier
Nitrate	1040	10	12.4	1	mg/L	EPA 300.0	RPU	5/24/2018	C4
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	0.00395	0.001	mg/L	EPA 200.8	HSW	5/29/2018	
Zinc	1095	5	ND	0.001	mg/L	EPA 200.8	HSW	5/29/2018	

C4	Confirmatory analysis was past holding time.
LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

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NELAC # E87893 ORELAP # ID200001

System ID#: Entry Point or Source ID#: Source Name(s):

Water System Name: WALLA WALLA BASIN WATERSHED COUNCIL

Contact:

Address: 810 S. MAIN RD

City, State, Zip: MILTON-FREEWATER, OR 97862

Sampled At: GW-119

Collection Date: 5/22/2018

Collection Time: 10:35:00 AM

Sampled By: LA & TP

Date Received: 5/23/2018 9:50:00 AM

Sample Composition: SOURCE

Sample Composition:

Report Date: 6/7/2018

Lab Sample Number: 180523038-003

Inorganic Compound (IOC) Report

Contaminant	**Code**	**MCL**	**Analysis**	**LRL**	**Units**	**Method**	**Analyst**	**Analysis Date**	**Qualifier**
Nitrate	1040	10	8.29	0.1	mg/L	EPA 300.0	RPU	5/24/2018	C4
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	0.00101	0.001	mg/L	EPA 200.8	HSW	5/29/2018	
Zinc	1095	5	ND	0.001	mg/L	EPA 200.8	HSW	5/29/2018	

C4	Confirmatory analysis was past holding time.
LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

System ID#:		Entry Point or Source ID#:		Source Name(s):	
Water System Name:	WALLA WALLA BASIN WATERSHED COUNCIL				
Contact:					
Address:	810 S. MAIN RD				
City, State, Zip:	MILTON-FREEWATER, OR 97862				
Sampled At:	WQ-3			Sample Composition:	SOURCE
Collection Date:	5/22/2018			Sample Composition:	
Collection Time:	9:43:00 AM			Report Date:	6/7/2018
Sampled By:	LA & TP			Lab Sample Number:	180523038-004
Date Received:	5/23/2018 9:50:00 AM				

Inorganic Compound (IOC) Report

Contaminant	Code	MCL	Analysis	LRL	Units	Method	Analyst	Analysis Date	Qualifier
Nitrate	1040	10	ND	0.1	mg/L	EPA 300.0	RPU	5/24/2018	C4
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	0.00288	0.001	mg/L	EPA 200.8	HSW	6/1/2018	
Zinc	1095	5	0.00246	0.001	mg/L	EPA 200.8	HSW	6/1/2018	

C4	Confirmatory analysis was past holding time.
LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

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NELAC # E87893 ORELAP # ID200001

System ID#: Entry Point or Source ID#: Source Name(s):

Water System Name: WALLA WALLA BASIN WATERSHED COUNCIL
Contact:
Address: 810 S. MAIN RD
City, State, Zip: MILTON-FREEWATER, OR 97862

Sampled At: WQ-4
Collection Date: 5/22/2018
Collection Time: 8:10:00 AM
Sampled By: LA & TP
Date Received: 5/23/2018 9:50:00 AM

Sample Composition: SOURCE
Sample Composition:
Report Date: 6/7/2018
Lab Sample Number: 180523038-005

Inorganic Compound (IOC) Report

Contaminant	Code	MCL	Analysis	LRL	Units	Method	Analyst	Analysis Date	Qualifier
Nitrate	1040	10	ND	0.1	mg/L	EPA 300.0	RPU	5/24/2018	C4
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	ND	0.001	mg/L	EPA 200.8	HSW	6/1/2018	
Zinc	1095	5	0.00162	0.001	mg/L	EPA 200.8	HSW	6/1/2018	

C4	Confirmatory analysis was past holding time.
LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

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NELAC # E87893 OREALAP # ID200001

System ID#: Entry Point or Source ID#: Source Name(s):

Water System Name: WALLA WALLA BASIN WATERSHED COUNCIL
Contact:
Address: 810 S. MAIN RD
City, State, Zip: MILTON-FREEWATER, OR 97862

Sampled At: GW-170
Collection Date: 5/22/2018
Collection Time: 8:43:00 AM
Sampled By: LA & TP
Date Received: 5/23/2018 9:50:00 AM

Sample Composition: SOURCE
Sample Composition:
Report Date: 6/7/2018
Lab Sample Number: 180523038-006

Inorganic Compound (IOC) Report

Contaminant	Code	MCL	Analysis	LRL	Units	Method	Analyst	Analysis Date	Qualifier
Nitrate	1040	10	2.05	0.1	mg/L	EPA 300.0	RPU	5/24/2018	C4
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	ND	0.001	mg/L	EPA 200.8	HSW	5/29/2018	
Zinc	1095	5	ND	0.001	mg/L	EPA 200.8	HSW	5/29/2018	

C4	Confirmatory analysis was past holding time.
LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

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NELAC # E87893 ORELAP # ID200001

System ID#: Entry Point or Source ID#: Source Name(s):

Water System Name: WALLA WALLA BASIN WATERSHED COUNCIL

Contact:

Address: 810 S. MAIN RD

City, State, Zip: MILTON-FREEWATER, OR 97862

Sampled At: GW-142

Collection Date: 5/22/2018

Collection Time: 9:25:00 AM

Sampled By: LA & TP

Date Received: 5/23/2018 9:50:00 AM

Sample Composition: SOURCE

Sample Composition:

Report Date: 6/7/2018

Lab Sample Number: 180523038-007

Inorganic Compound (IOC) Report

Contaminant	Code	MCL	Analysis	LRL	Units	Method	Analyst	Analysis Date	Qualifier
Nitrate	1040	10	0.199	0.1	mg/L	EPA 300.0	RPU	5/24/2018	C4
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	ND	0.001	mg/L	EPA 200.8	HSW	5/29/2018	
Zinc	1095	5	ND	0.001	mg/L	EPA 200.8	HSW	5/29/2018	

C4	Confirmatory analysis was past holding time.
LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

Anatek Labs, Inc.

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NELAC # E87893   ORELAP # ID200001

System ID#:   Entry Point or Source ID#:   Source Name(s):

Water System Name: WALLA WALLA BASIN WATERSHED COUNCIL

Contact:

Address: 810 S. MAIN RD

City, State, Zip: MILTON-FREEWATER, OR 97862

Sampled At:	GW-171	Sample Composition:	SOURCE
Collection Date:	5/22/2018	Sample Composition:	
Collection Time:	1:46:00 PM	Report Date:	6/7/2018
Sampled By:	LA & TP	Lab Sample Number:	180523038-008
Date Received:	5/23/2018 9:50:00 AM		

Inorganic Compound (IOC) Report

Contaminant	Code	MCL	Analysis	LRL	Units	Method	Analyst	Analysis Date	Qualifier
Nitrate	1040	10	4.14	0.1	mg/L	EPA 300.0	RPU	5/24/2018	C4
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	ND	0.001	mg/L	EPA 200.8	HSW	5/29/2018	
Zinc	1095	5	ND	0.001	mg/L	EPA 200.8	HSW	5/29/2018	

C4	Confirmatory analysis was past holding time.
LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

Anatek Labs, Inc.

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NELAC # E87893 ORELAP # ID200001

System ID#:	Entry Point or Source ID#:	Source Name(s):	
Water System Name:	WALLA WALLA BASIN WATERSHED COUNCIL		
Contact:			
Address:	810 S. MAIN RD		
City, State, Zip:	MILTON-FREEWATER, OR 97862		
Sampled At:	GW-151	Sample Composition:	SOURCE
Collection Date:	5/22/2018	Sample Composition:	
Collection Time:	1:05:00 PM	Report Date:	6/7/2018
Sampled By:	LA & TP	Lab Sample Number:	180523038-009
Date Received:	5/23/2018 9:50:00 AM		

Inorganic Compound (IOC) Report

Contaminant	Code	MCL	Analysis	LRL	Units	Method	Analyst	Analysis Date	Qualifier
Nitrate	1040	10	3.47	0.1	mg/L	EPA 300.0	RPU	5/24/2018	C4
Ammonia/N	1003		ND	0.05	mg/L	SM4500NH3G	RPU	5/24/2018	
Copper	1022	1.3	ND	0.001	mg/L	EPA 200.8	HSW	5/29/2018	
Zinc	1095	5	ND	0.001	mg/L	EPA 200.8	HSW	5/29/2018	

C4	Confirmatory analysis was past holding time.
LRL	Lab Reporting Limit
MCL	EPA's Maximum Contaminant Level
ND	Not Detected

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Login Report

Customer Name: WALLA WALLA BASIN WATERSHED COUNCIL
810 S. MAIN RD
MILTON-FREEWATER OR 97862

Order ID: 180523038
Order Date: 5/23/2018

Contact Name:

Project Name: METALS / NO3 / NH3

Comment:

Sample #: 180523038-001 **Customer Sample #:** GW-144

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & TP **Date Collected:** 5/22/2018
Quantity: 3 **Date Received:** 5/23/2018 9:50:00 AM **Time Collected:** 11:45 AM
Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/4/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***
NITRATE/N	M	EPA 300.0	6/4/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***

Sample #: 180523038-002 **Customer Sample #:** GW-119-DUPLICATE

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & TP **Date Collected:** 5/22/2018
Quantity: 3 **Date Received:** 5/23/2018 9:50:00 AM **Time Collected:** 10:34 AM
Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/4/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***
NITRATE/N	M	EPA 300.0	6/4/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***

Sample #: 180523038-003 **Customer Sample #:** GW-119

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & TP **Date Collected:** 5/22/2018
Quantity: 3 **Date Received:** 5/23/2018 9:50:00 AM **Time Collected:** 10:35 AM
Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/4/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***

Customer Name: WALLA WALLA BASIN WATERSHED COUNCIL **Order ID:** 180523038
810 S. MAIN RD **Order Date:** 5/23/2018
MILTON-FREEWATER OR 97862

Contact Name: **Project Name:** METALS / NO3 / NH3

Comment:

NITRATE/N	M	EPA 300.0	6/4/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***

Sample #: 180523038-004 **Customer Sample #:** WQ-3

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & TP **Date Collected:** 5/22/2018
Quantity: 3 **Date Received:** 5/23/2018 9:50:00 AM **Time Collected:** 9:43 AM
Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/4/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***
NITRATE/N	M	EPA 300.0	6/4/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***

Sample #: 180523038-005 **Customer Sample #:** WQ-4

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & TP **Date Collected:** 5/22/2018
Quantity: 3 **Date Received:** 5/23/2018 9:50:00 AM **Time Collected:** 8:10 AM
Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/4/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***
NITRATE/N	M	EPA 300.0	6/4/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***

Sample #: 180523038-006 **Customer Sample #:** GW-170

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & TP **Date Collected:** 5/22/2018
Quantity: 3 **Date Received:** 5/23/2018 9:50:00 AM **Time Collected:** 8:43 AM
Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/4/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***
NITRATE/N	M	EPA 300.0	6/4/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***

Customer Name: WALLA WALLA BASIN WATERSHED COUNCIL **Order ID:** 180523038
810 S. MAIN RD **Order Date:** 5/23/2018
MILTON-FREEWATER OR 97862

Contact Name: **Project Name:** METALS / NO3 / NH3

Comment:

Sample #: 180523038-007 **Customer Sample #:** GW-142

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & TP **Date Collected:** 5/22/2018

Quantity: 3 **Date Received:** 5/23/2018 9:50:00 AM **Time Collected:** 9:25 AM

Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/4/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***
NITRATE/N	M	EPA 300.0	6/4/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***

Sample #: 180523038-008 **Customer Sample #:** GW-171

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & TP **Date Collected:** 5/22/2018

Quantity: 3 **Date Received:** 5/23/2018 9:50:00 AM **Time Collected:** 1:46 PM

Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/4/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***
NITRATE/N	M	EPA 300.0	6/4/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***

Sample #: 180523038-009 **Customer Sample #:** GW-151

Recv'd: ☑ **Matrix:** Drinking Water **Collector:** LA & TP **Date Collected:** 5/22/2018

Quantity: 3 **Date Received:** 5/23/2018 9:50:00 AM **Time Collected:** 1:05 PM

Comment:

Test	Lab	Method	Due Date	Priority
AMMONIA-NITROGEN	M	SM4500NH3G	6/4/2018	***Normal (~10 Days)***
COPPER	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***
NITRATE/N	M	EPA 300.0	6/4/2018	***Normal (~10 Days)***
ZINC	M	EPA 200.8	6/4/2018	***Normal (~10 Days)***

Customer Name:	WALLA WALLA BASIN WATERSHED COUNCIL	**Order ID:**	180523038
	810 S. MAIN RD	**Order Date:**	5/23/2018
	MILTON-FREEWATER OR 97862		
Contact Name:		**Project Name:**	METALS / NO3 / NH3
Comment:			

SAMPLE CONDITION RECORD

Samples received in a cooler?	Yes
Samples received intact?	Yes
What is the temperature of the sample(s)? (°C)	5.1
Samples received with a COC?	Yes
Samples received within holding time?	Yes
Are all sample bottles properly preserved?	Yes
Are VOC samples free of headspace?	N/A
Is there a trip blank to accompany VOC samples?	N/A
Labels and chain agree?	Yes
Total number of containers?	9