EXHIBIT
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MEMO

CORRECTED 6/8/2021

State of Idaho
Department of Water Resources
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Date: May 17, 2021
To: Gary Spackman, P.E., Director
Cc: Sean Vincent, P.G., Hydrology Section Manager
From: Jennifer Sukow, P.E., P.G.
Subject: Predicted hydrologic response in Silver Creek and the Little Wood River to curtailment of groundwater use in 2021, Basin 37 Administrative Proceeding, AA-WRA-2021-001

On May 4, 2021, the Director of the Idaho Department of Water Resources (IDWR) initiated an administrative proceeding concerning water rights in Basin 37 (Wood River Basin).[1] Because a drought is predicted for the 2021 irrigation season and the water supply in Silver Creek and its tributaries may be inadequate to meet the needs of surface water users, the Director initiated the administrative proceeding to determine whether water is available to fill junior groundwater rights within the Wood River Valley south of Bellevue. If the Director concludes water is not available to fill groundwater rights, the Director may order the groundwater rights curtailed for the remainder of the 2021 irrigation season.

This memorandum provides technical information relevant to prediction of the hydrologic response in Silver Creek and the Little Wood River to the potential curtailment of groundwater use during the 2021 irrigation season. This memorandum addresses items 1, 4, 5, 6, and 7 from the Request for Staff Memorandum dated May 11, 2021.

[1] https://idwr.idaho.gov/legal-actions/administrative-actions/basin-37.html

Hydrology and hydrogeology

The hydrology and hydrogeology of the Big and Little Wood River basin was described in a staff memorandum for a previous proceeding (Sukow, 2015).[2] The previous memorandum (Attachment A) describes the occurrence of aquifers within Basin 37 and their interaction with surface water (Figure 1). The Wood River Valley aquifer system is hydraulically connected to Silver Creek and its tributaries above the Sportsman Access gage. Water use within the Wood River Valley aquifer system affects Silver Creek reach gain from groundwater, and thus affects streamflow in Silver Creek and in the Little Wood River downstream of Silver Creek. Other aquifers within Basin 37, including the Camas Prairie aquifer system and the Eastern Snake Plain Aquifer, do not interact with Silver Creek or the Little Wood River; therefore, water use within the other aquifers does not affect streamflow in Silver Creek or the Little Wood River below Silver Creek.

Since the 2015 memorandum was written, IDWR has continued to collect water level data in both the Wood River Valley and Camas Prairie aquifer systems. Wylie (2019a)[3] provided an update on groundwater conditions in the Big Wood River Ground Water Management Area (BWRGWMA), which encompasses these aquifer systems. Moody (2018a)[4] discussed a synoptic measurement of water levels in 103 wells during late October 2018. IDWR has also performed seepage surveys to measure aquifer discharge from the Camas Prairie aquifer system to lower Camas Creek (Moody, 2018b;[5] Moody, 2020).[6] Wylie (2019a) concluded there has been a long-term groundwater level decline in the Wood River Valley aquifer system since 1968, but that water level trends appear to have stabilized since the formation of the BWRGWMA in 1991. Seepage measurements by Moody (2018; 2020) confirmed the results of previous seepage surveys, which indicate the Camas Creek aquifer system discharges to lower Camas Creek and provides inflow to Magic Reservoir.

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[2] Sukow, J., 2015, *Hydrology, hydrogeology, and hydrologic data, Big Wood & Little Wood Water Users Association delivery calls, CM-DC-2015-001 and CM-DC-2015-002*. Idaho Department of Water Resources, August 28, 2015, 25 p., https://idwr.idaho.gov/files/legal/CM-DC-2015-001/CM-DC-2015-001-20150828-WRCall-Hydro-Memo-w-Attach.pdf.

[3] Wylie, A., 2019a, *Summary of Ground Water Conditions in the Big Wood River Ground Water Management Area, 2019 Update*. Idaho Department of Water Resources, 79 p., https://idwr.idaho.gov/files/publications/20190920-Summary-Groundwater-Conditions-Big-Wood-River-GWMA-2019-Update.pdf.

[4] Moody, A., 2018a, *Wood River Groundwater Level Synoptic, Fall 2018*. Idaho Department of Water Resources, 20 p., https://idwr.idaho.gov/files/publications/20190809-Wood-River-groundwater-level-synoptic-2018.pdf.

[5] Moody, A., 2018b, *Camas Creek Seepage Survey, Fall 2017*. Idaho Department of Water Resources, 6 p., https://idwr.idaho.gov/files/publications/20180108-OFR-Camas-Creek-Seepage-Survey.pdf.

[6] Moody, A., 2020, *Camas Creek Seepage Survey, Fall 2018*. Idaho Department of Water Resources, 5 p., https://idwr.idaho.gov/files/publications/202011-OFR-Camas-Creek-Seepage-Survey.pdf.

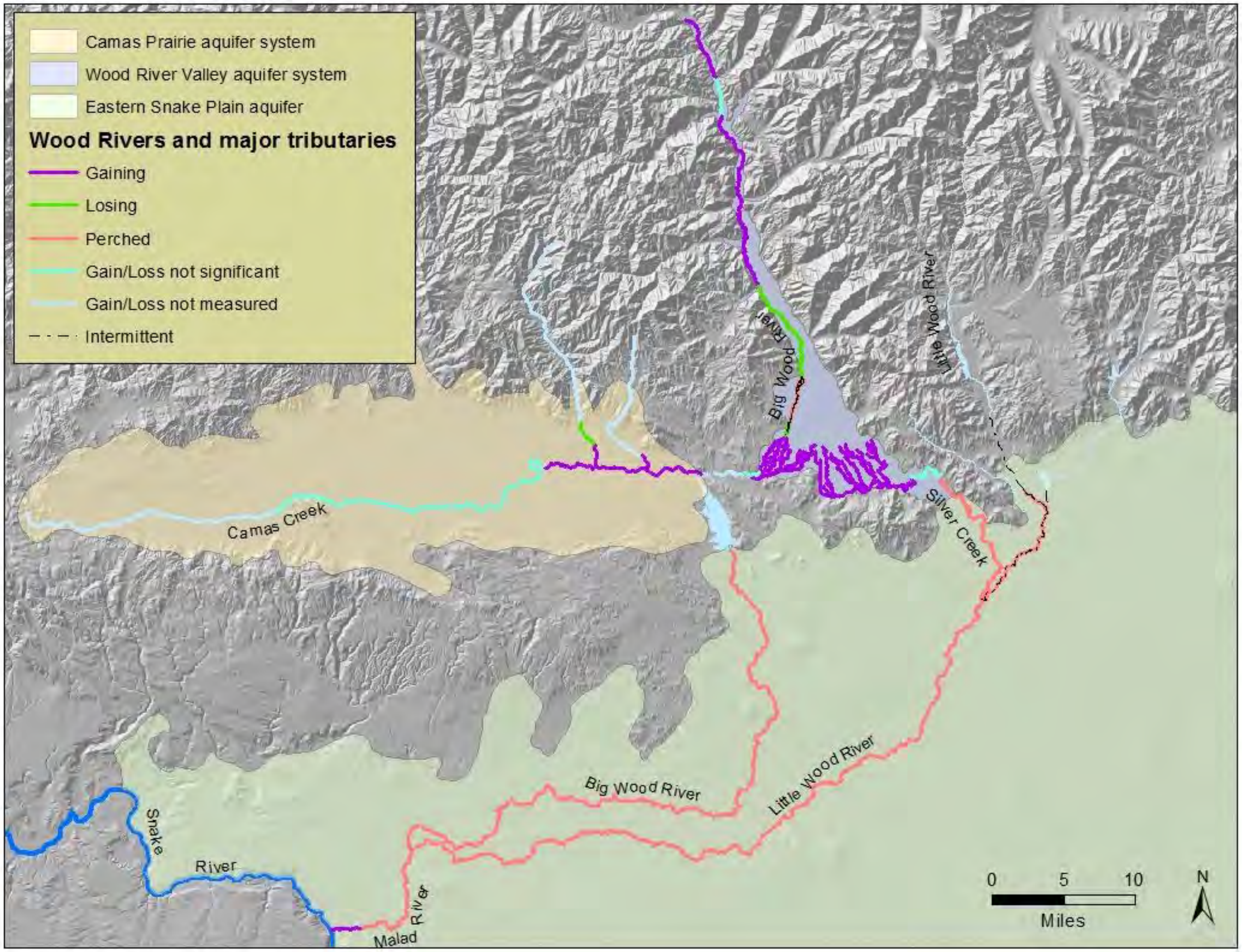

Figure 1. Generalized location of aquifers and interaction with surface water (from Sukow, 2015).

Wylie (2019a) identified four wells in the Bellevue Triangle with long water-level monitoring records beginning in the 1950s (Figure 2). Figure 3 through Figure 6 show the water level data for these four wells updated through the spring of 2021. Recent water level measurements indicate that water levels in both the unconfined and confined aquifer have declined since 2019, in response to a low water supply year in 2020. Aquifer water levels are affected by multiple sources of aquifer stress, including natural recharge from tributary underflow and infiltration of precipitation, canal seepage and incidental recharge of surface water applied in excess of crop water needs, groundwater withdrawals for irrigation, and natural discharge through evapotranspiration in wetlands and riparian areas. During years with low water supply, a combination of reduced natural recharge, reduced recharge from seepage of irrigation water, and groundwater withdrawals for irrigation all contribute to decreases in aquifer head and aquifer discharge to streams.

Discharge from the Wood River Valley aquifer system is the primary source of water for Silver Creek and Willow Creek (Sukow, 2015). Direct precipitation and snowmelt runoff provide some additional water seasonally. Well 01S 18E 14AAB1 (Figure 2, Figure 3), which is completed in the confined aquifer, and Well 01S 19E 03CCB2 (Figure 2, Figure 4), which is completed in the unconfined aquifer, have sufficient records of measurement between 1995 and 2014 to show the relationship between the aquifers and Silver Creek reach gains (Figure 7, Figure 8). Water levels at both locations correlate well with the Silver Creek reach gain from groundwater (Figure 9). Water levels at both locations have weaker correlation with the Willow Creek reach gain from groundwater (Figure 10). Water level measurements in the unconfined aquifer within the Willow Creek drainage area would be expected to correlate well with Willow Creek reach gain, but this relationship cannot be evaluated because there are not sufficient measurements of the unconfined aquifer in this area.

Streamflow measurements from October 2012 (Figure 11) and March 2013 (Figure 12) show the relative contribution of tributaries to Silver Creek streamflow at the Sportsman Access gage (Bartolino, 2014)[7]. Nearly 80% of the aquifer discharge to the Silver Creek drainage system occurred in tributaries upstream of Highway 20. Cove Creek and Loving Creek provided over half of the streamflow during these measurement events.

[7] Bartolino, J., 2014, Stream Seepage and Groundwater Levels, Wood River Valley, South-Central Idaho, 2012-2013. U.S. Geological Survey, Scientific Investigations Report 2014-5151, 34 p., https://pubs.usgs.gov/sir/2014/5151/.

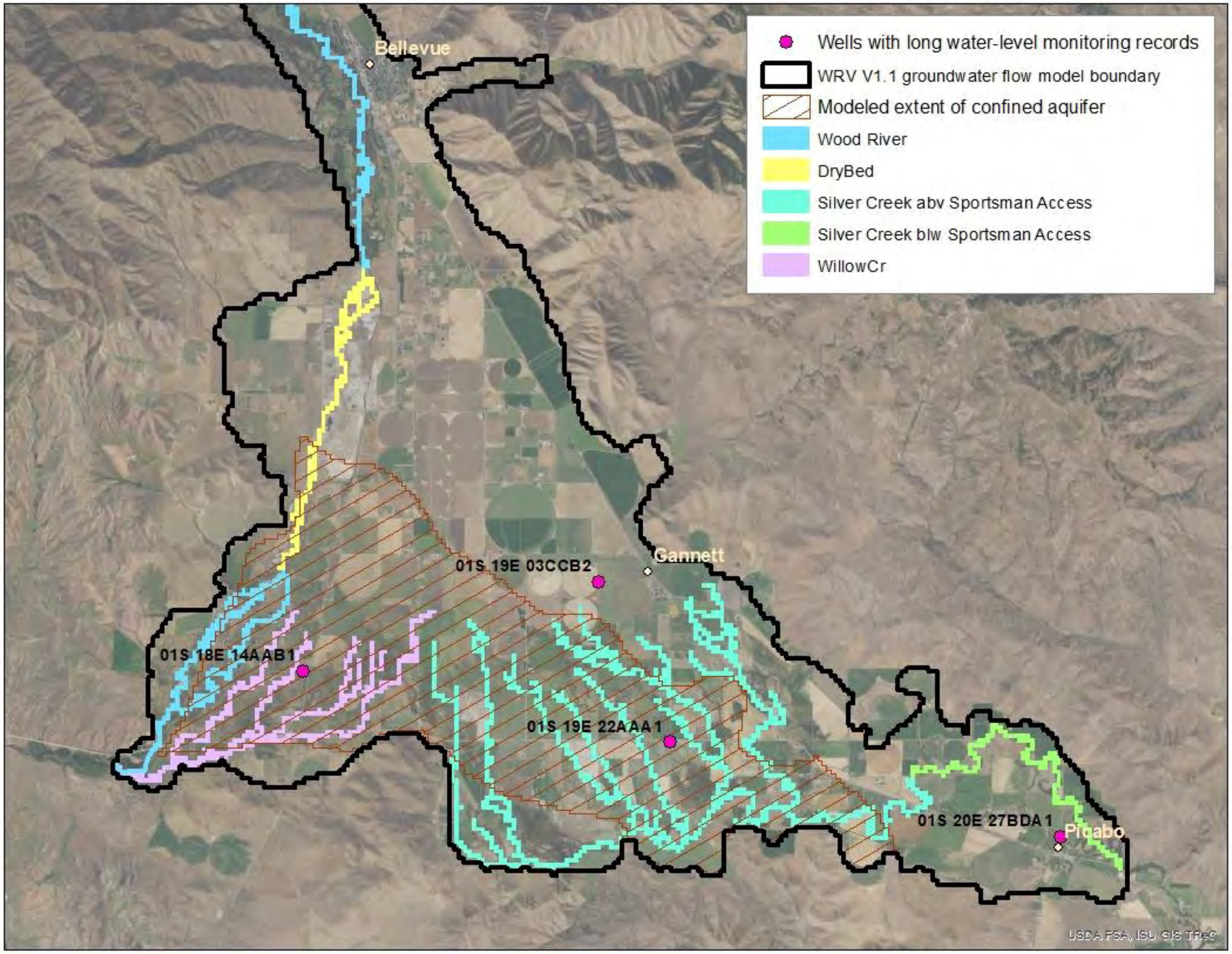

Figure 2. Wells in Bellevue Triangle with long water-level monitoring records

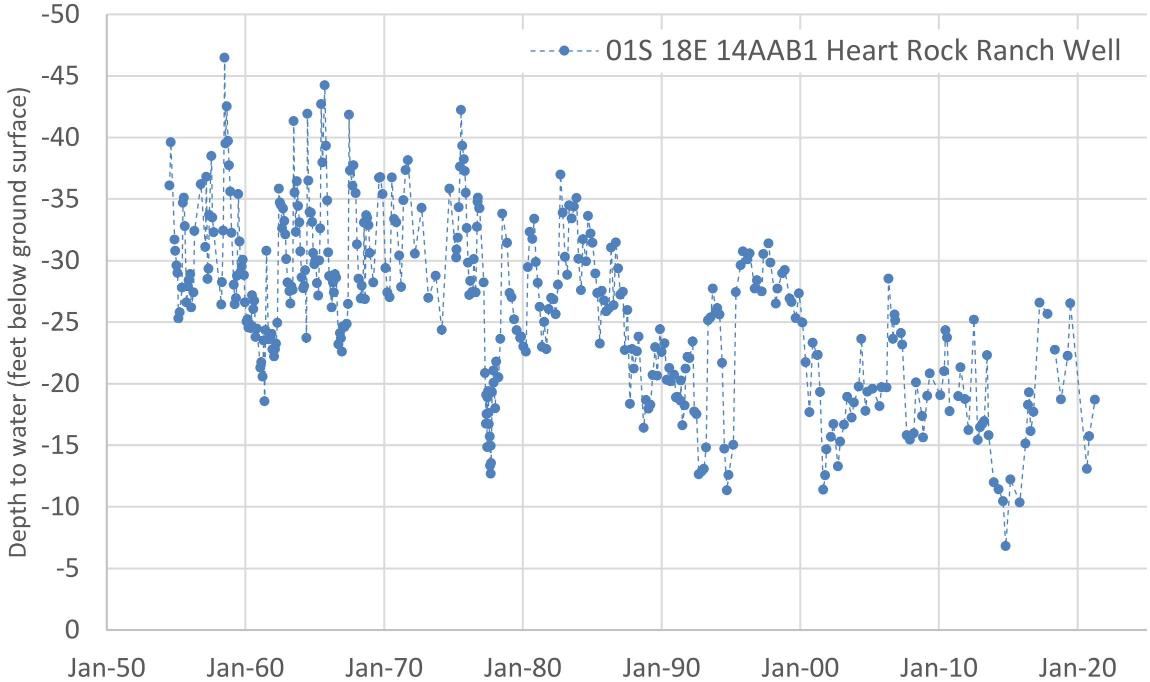

Figure 3. Updated water-level monitoring data for well 01S 18E 14AAB1 (confined aquifer)

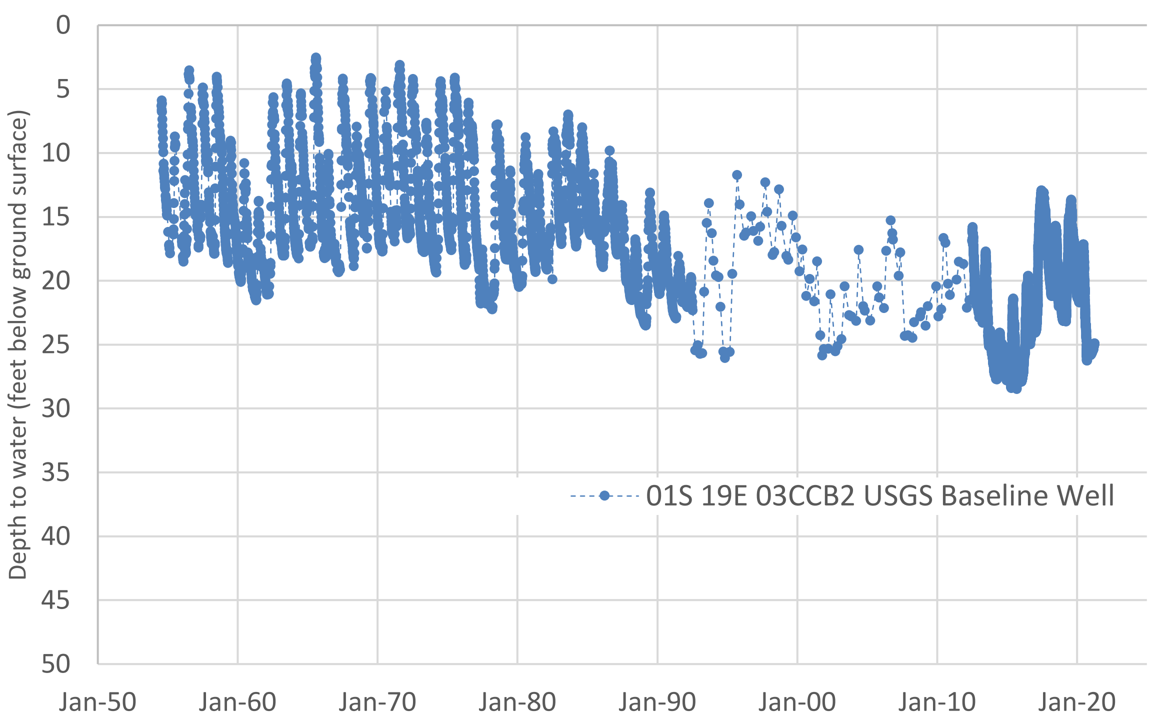

Figure 4. Updated water-level monitoring data for well 01S 19E 03CCB2 (unconfined aquifer)

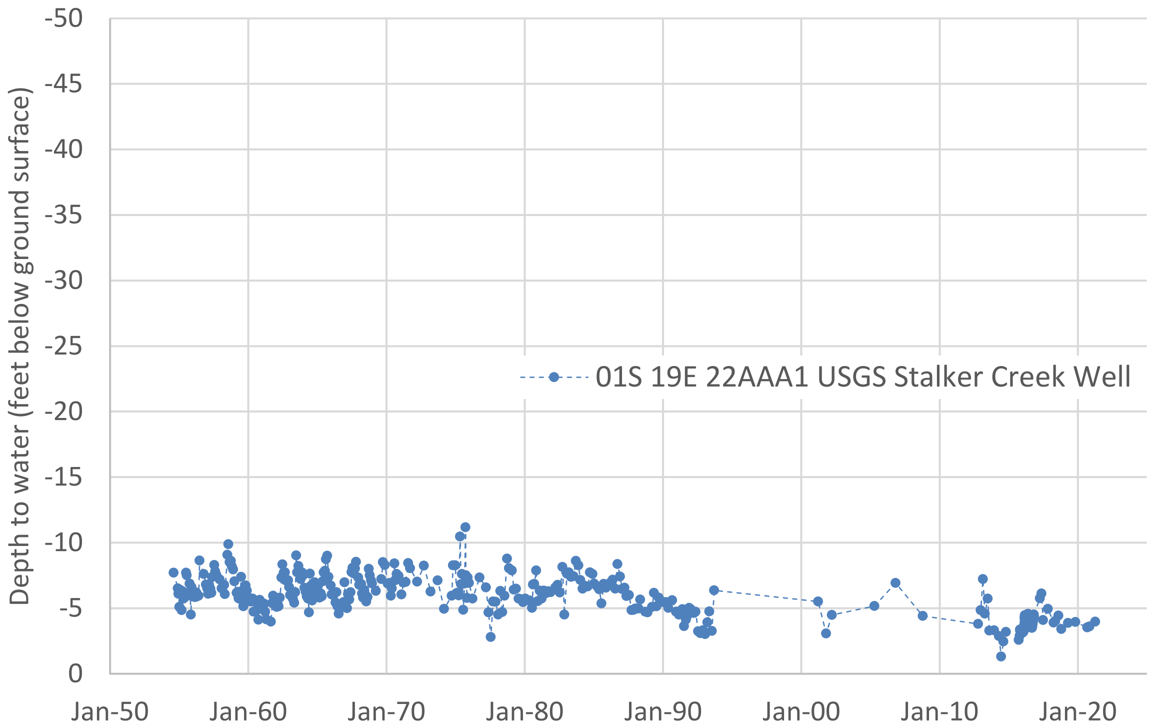

Figure 5. Updated water-level monitoring data for well 01S 19E 22AAA1 (confined aquifer)

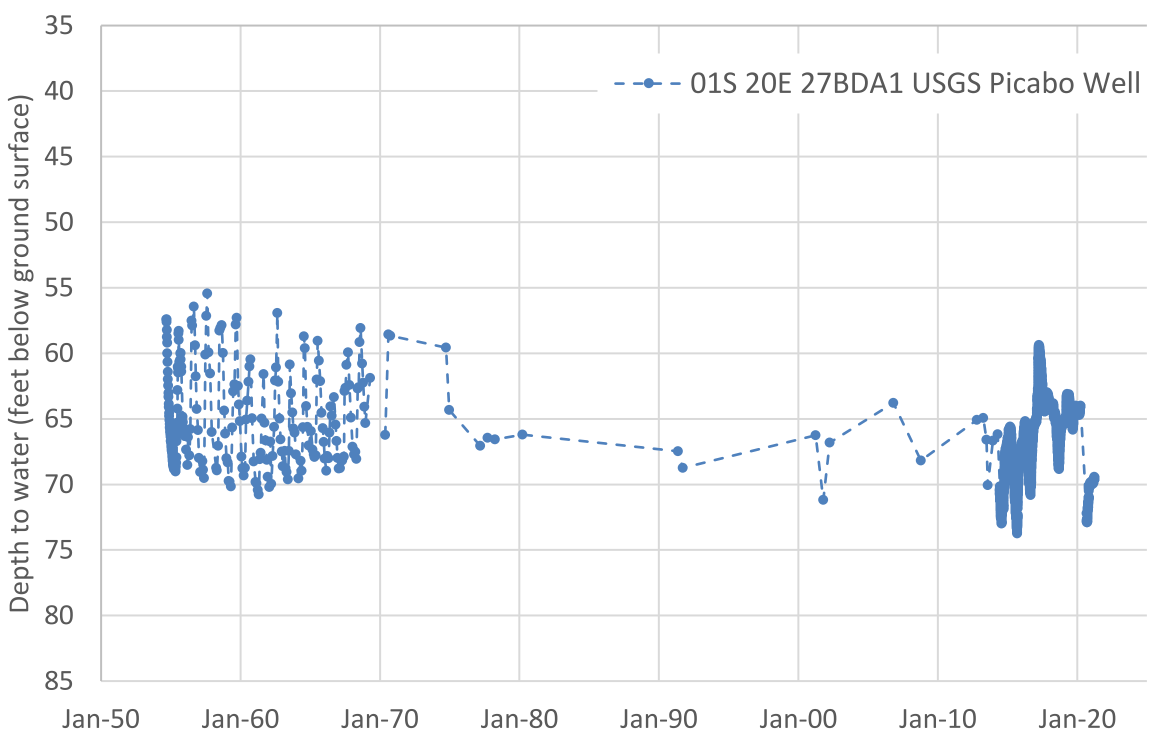

Figure 6. Updated water-level monitoring data for well 01S 20E 27BDA1 (unconfined aquifer)

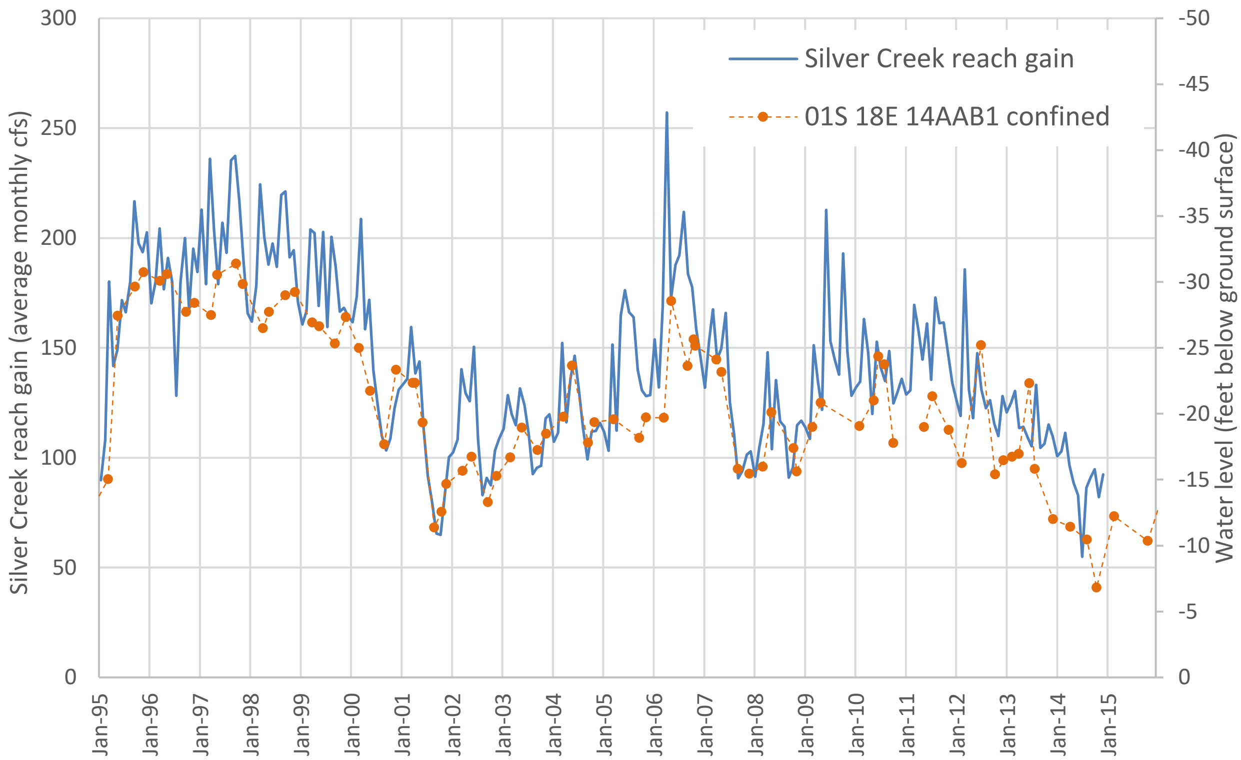

Figure 7. Silver Creek reach gain and water level in well 01S 18E 14AAB1 (confined aquifer)

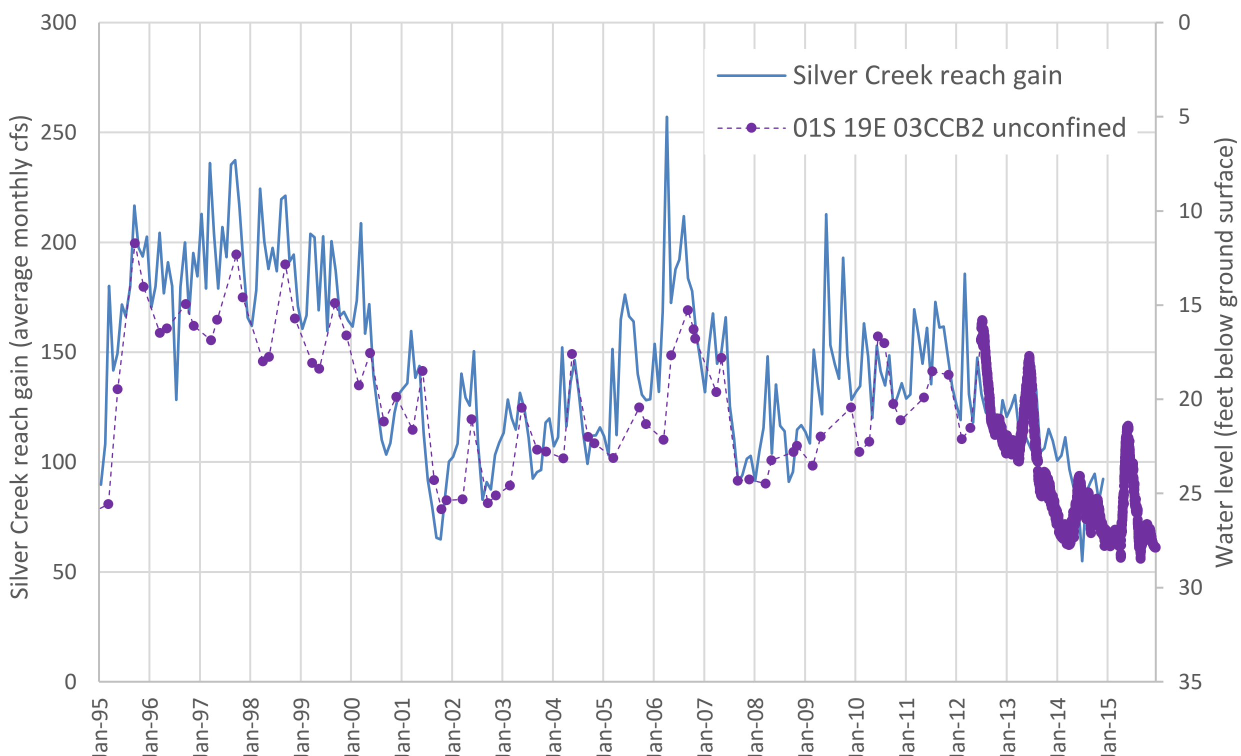

Figure 8. Silver Creek reach gain and water level in well 01S 19E 03CCB2 (unconfined aquifer)

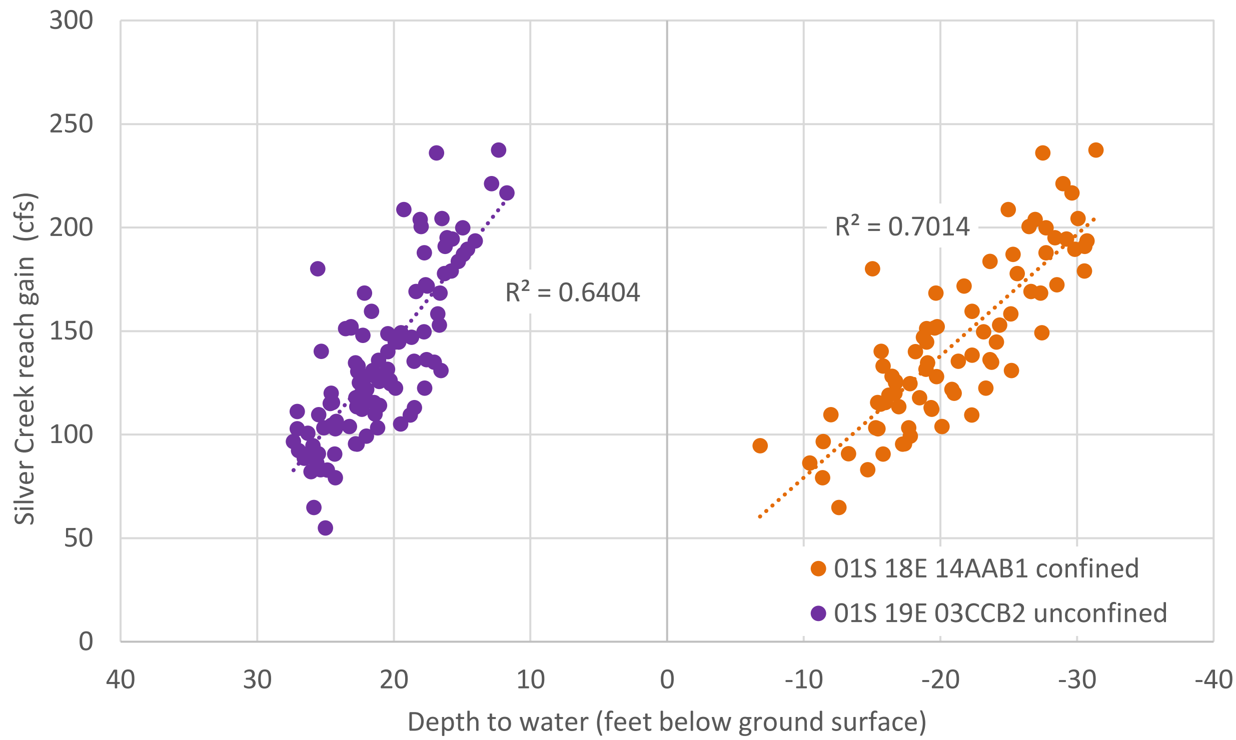

Figure 9. Correlation between Silver Creek reach gain and water levels

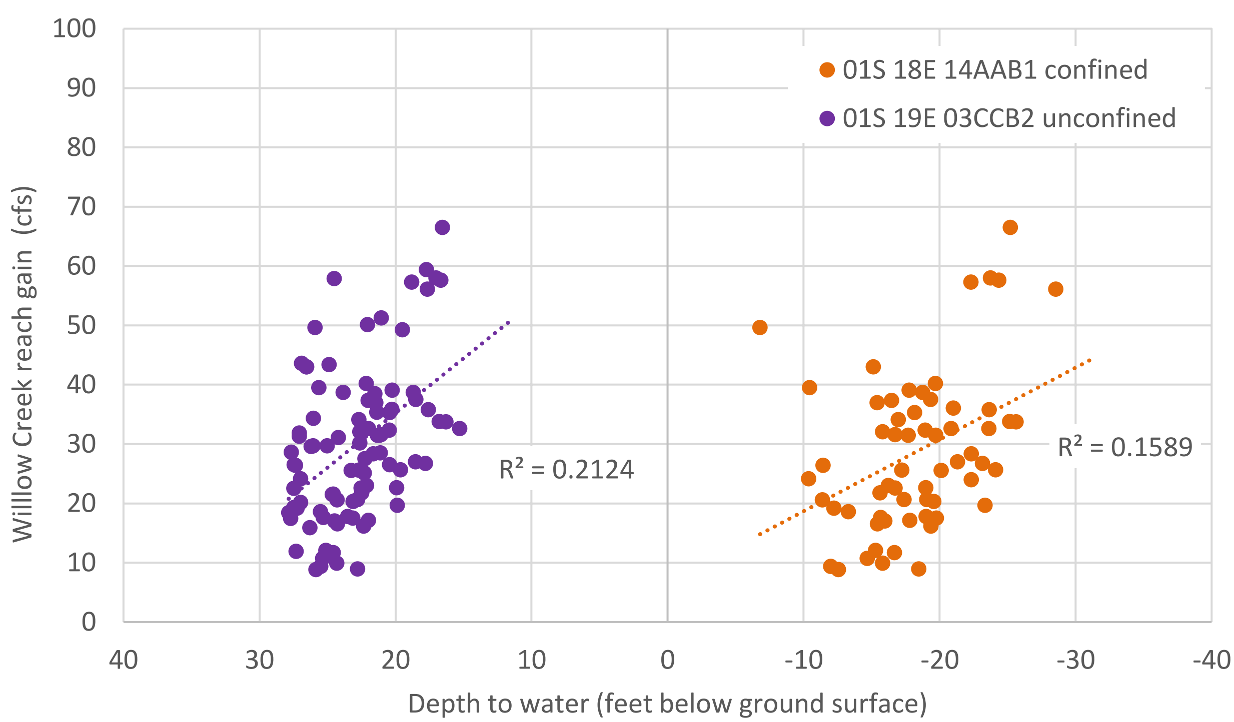

Figure 10. Correlation between Willow Creek reach gain and water levels

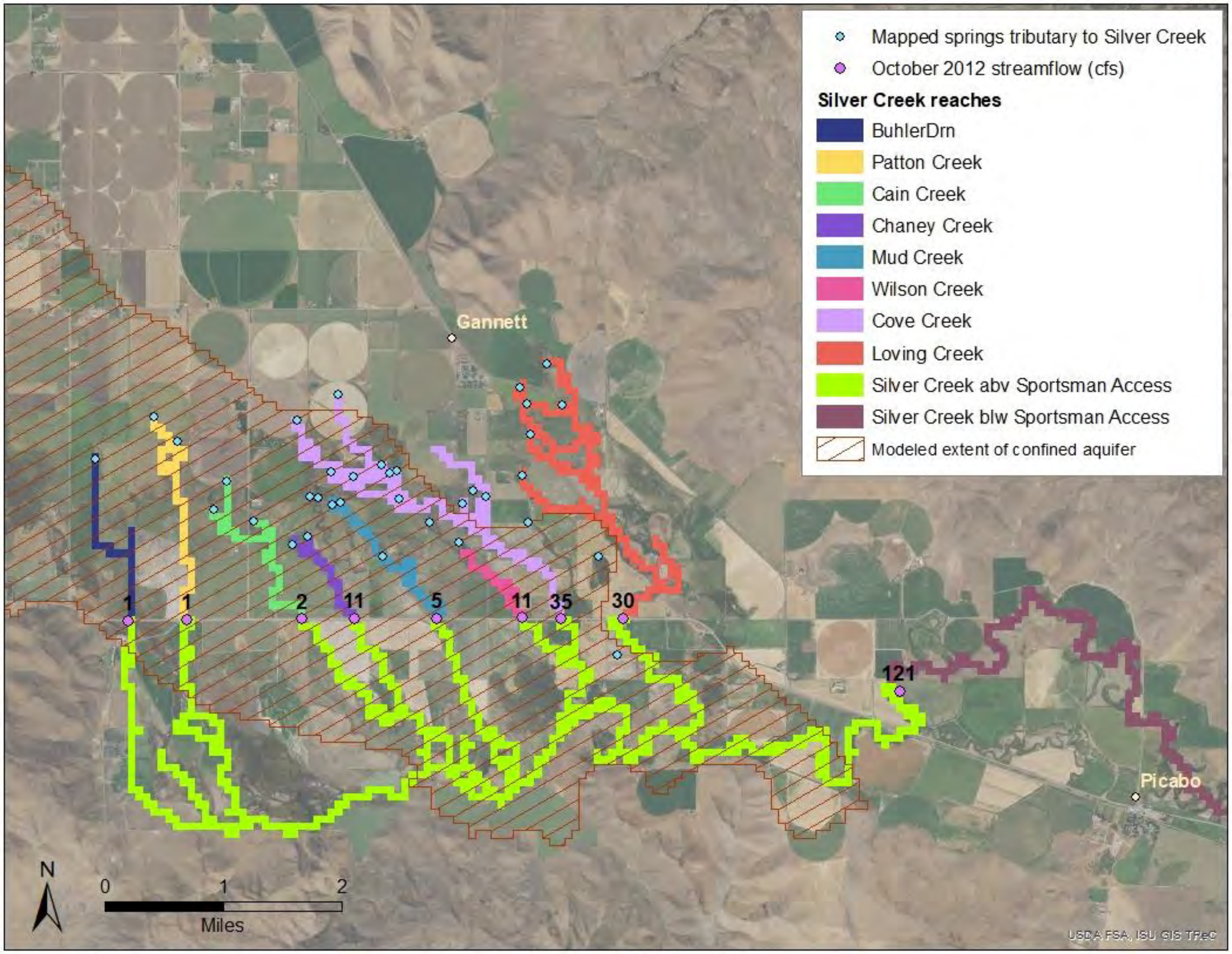

Figure 11. October 2012 streamflow measurements above Sportsman Access

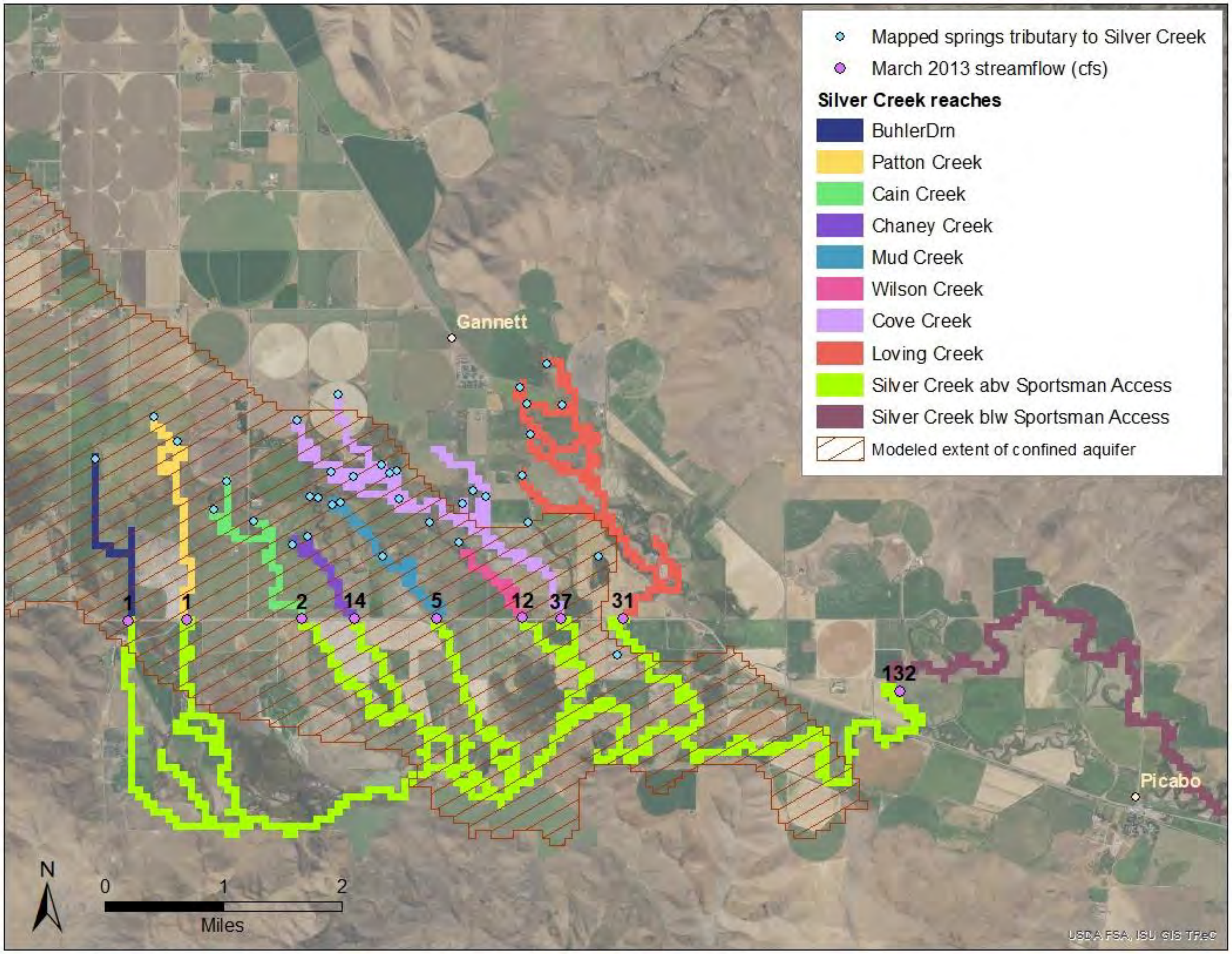

Figure 12. March 2013 streamflow measurements above Sportsman Access

Development of groundwater use

Groundwater development in the Camas Prairie aquifer system was discussed in Sukow (2015). As previously noted, the Camas Prairie aquifer system is not hydraulically connected to Silver Creek or the Little Wood River, and is not discussed further in this memorandum. Water right priority dates in the Wood River Valley aquifer system (Figure 13) provide a basis for evaluating historic groundwater development trends. Although Figure 13 shows groundwater rights for approximately 16 cfs with priority dates senior to 1900, those water rights were originally developed from a surface water source and are conditioned such that, "*Diversion of groundwater is limited to those times water is available for diversion under this right and priority from [surface water source]*." The groundwater rights with priority dates prior to 1900 are mitigated by non-use of the original surface water source, and are administered in priority with other surface water rights by Water District 37.

Based on priority dates for water rights where groundwater was the original source, groundwater development in the Wood River Valley aquifer system for municipal use began around 1907 when the Cramer Water Company in Hailey constructed a well equipped with two triplex electric pumps.[8] Groundwater development for irrigation use began around 1912 when two hand dug wells were constructed near Broadford Road and equipped with Parma Water Lifter pumps.[9] Groundwater development for irrigation in the Bellevue Triangle began around 1930. Significant development of the confined aquifer for irrigation began in the late 1940s. In 1961, the Idaho Department of Reclamation (predecessor to IDWR) designated the Silver Creek Critical Ground Water Area in the Bellevue Triangle in response to concerns about reduced pressure head in flowing artesian wells. The designation was rescinded in 1966 (IDWR, 2020).[10]

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[8] Documentation of water use and priority date for water right 37-22670, https://idwr.idaho.gov/apps/ExtSearch/DocsImages/yb5w01_.PDF.

[9] Adjudication claim file for water right 37-22243, https://idwr.idaho.gov/apps/ExtSearch/DocsImages/nt4_01_.PDF.

[10] IDWR, 2020, *Historical review of Big Wood River Ground Water Management Area*. Presentation to the BWRGWMA Advisory Committee, November 18, 2020, https://idwr.idaho.gov/files/groundwater-mgmt/big-wood-gwma-advisory-comm/20201118-Big-Wood-GWMA-Advisory-Committee-Meeting-Materials.pdf.

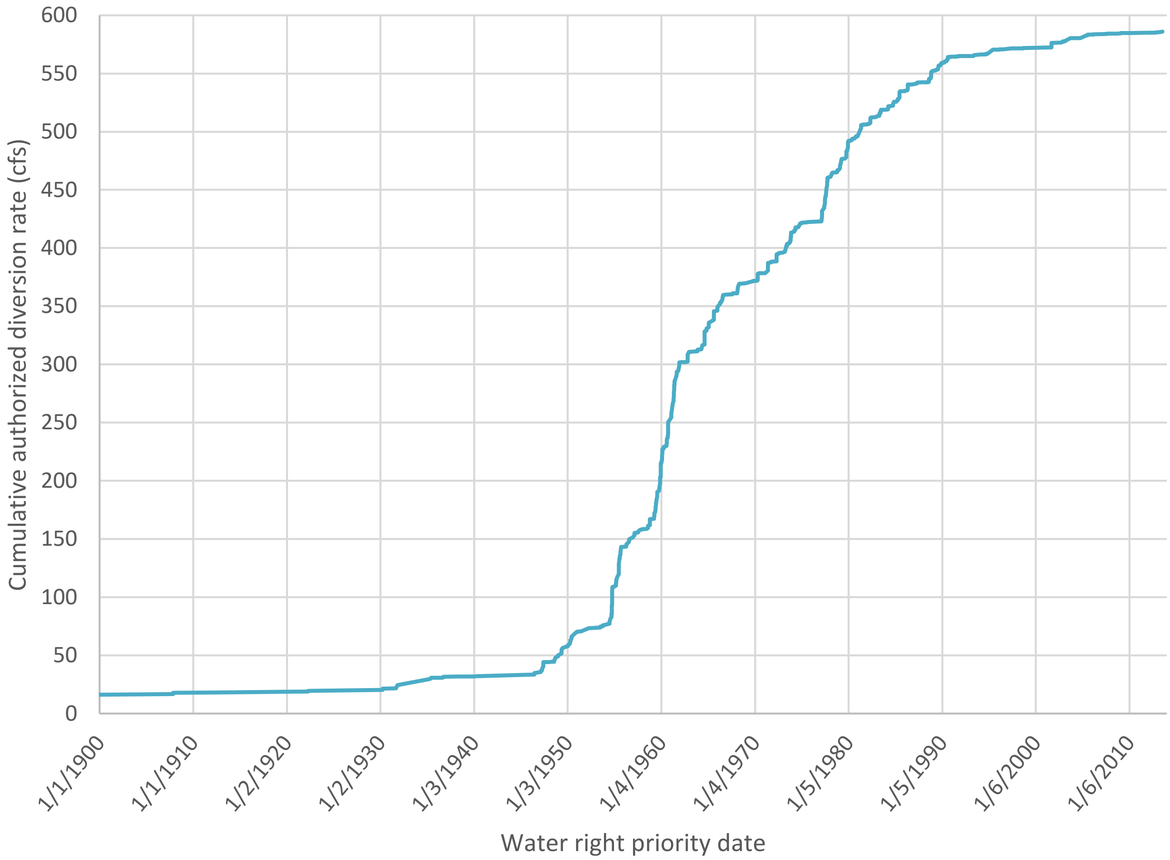

Figure 13. Cumulative authorized groundwater diversion rate for irrigation and municipal uses within the WRV1.1 model boundary

Figure 13 shows groundwater development increased steadily between the late 1940s and 1991. The BWRGWMA was designated by IDWR in 1991 because of concerns about the impacts of groundwater use on senior water users who rely on streamflow or inflow to Magic Reservoir.[11] Following the 1991 designation, the approval of new groundwater uses within the Wood River Valley aquifer system has generally been limited to non-consumptive or fully-mitigated uses. This is consistent with Wylie (2019a), who observed long-term water level trends in the Wood River Valley aquifer system declined between 1968 and 1991, while groundwater development was continuing to increase, then stabilized after 1991 when additional development was restricted.

Between 1995 and 2014, an average of approximately 42,000 acres of land in the Wood River Valley were irrigated for agriculture or partially irrigated for residential or urban uses.

[11] https://idwr.idaho.gov/files/legal/orders/1991/19910628-Big-Wood-River-GWMA-Order.pdf

Groundwater was the sole source of supply for approximately 9,000 acres and a second source of supply for approximately 27,000 acres (Sukow, 2017).[12]

Groundwater flow model development

Sukow (2015) mentioned the pending development of a groundwater-flow model of the Wood River Valley aquifer system. The U.S. Geological Survey (USGS) published the first version of the Wood River Valley groundwater flow model in 2016 (Fisher et al., 2016).[13] During development of the first version of the model, IDWR and the USGS expanded monitoring of aquifer water levels and streamflow to address data gaps. IDWR released a recalibrated version of the groundwater flow model in 2019 (Wylie et al., 2019),[14] which superseded the first version. The primary purpose of the model recalibration was to incorporate additional time-series data for aquifer head and streamflow that were measured between 2011 and 2014, with the intent of improving the model's ability to predict the timing of aquifer head and streamflow responses to aquifer stress. The model recalibration also refined the representation of the Dry Bed of the Big Wood River to facilitate prediction of streamflow responses above and below the Dry Bed. The model representation of the eastern extent of the confining layer and confined aquifer was also improved during the recalibration. The recalibrated model is referred to as Version 1.1 of the Wood River Valley groundwater flow model (WRV1.1).

Both versions of the model were constructed using MODFLOW-USG, a numerical model for simulating three-dimensional transient groundwater flow, and were calibrated using PEST, an automated parameter estimation program. Both versions of the model were developed with the input of a Modeling Technical Advisory Committee (MTAC), which was established to provide transparency in model development and to serve as a vehicle for stakeholder input (Bartolino and Vincent, 2013; Fisher et al., 2016; Wylie et al., 2019). Twenty-two MTAC meetings were convened between March 2013 and January 2019 to facilitate a transparent and open process of data collection, model construction, and model calibration.[15]

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[12] Sukow, 2017, Preliminary updated water budget for calibration of Wood River Valley groundwater model version 1.1. Presented to the Wood River Valley Modeling Technical Advisory Committee, https://idwr.idaho.gov/files/projects/wood-river-valley/20170524-WaterBudgetUpdates.pdf.

[13] Fisher, J.C., J.R. Bartolino, A.H. Wylie, J. Sukow, M. McVay, 2016, *Groundwater flow model for the Wood River Valley aquifer system, south-central Idaho*. U.S. Geological Survey Scientific Investigations Report 2016-5080, 84 p., https://pubs.er.usgs.gov/publication/sir20165080.

[14] Wylie, A., J. Sukow, M. McVay, J. Bartolino, 2019, *Groundwater flow model for the Wood River Valley aquifer system, Version 1.1*. Idaho Department of Water Resources, 39 p., https://idwr.idaho.gov/files/projects/wood-river-valley/20190627-Groundwater-Flow-Model-forthe-Wood-River-Valley-Aquifer-System.pdf.

[15] https://idwr.idaho.gov/water-data/projects/wood-river-valley/meetings.html

Both versions of the model were developed to serve as a tool for water rights administration and water resource management and planning (Bartolino and Vincent, 2013;[16] IDWR and USGS, 2014;[17]. Fisher et al., 2016). Wylie et al. (2019) provided the following statement regarding the use of WRV1.1 as a tool for evaluating groundwater and surface water interactions in the model area.

> *"Although every groundwater model is a simplification of a complex hydrologic system, WRV Aquifer Model Version 1.1 is the best available tool for evaluating the interaction between groundwater and surface water in the Wood River Valley. The science underlying the production and calibration of the WRV Aquifer Model Version 1.1 reflects the best knowledge of the aquifer system available at this time. The WRV Aquifer Model Version 1.1 was calibrated to 1,314 aquifer water-level measurements and 1,026 river gain-and loss-calculations. Calibration statistics indicate a good fit to the observed data, providing confidence that the updated model provides an acceptable representation of the hydrologic system in the Wood River Valley."*

Because every groundwater model is a simplification of complex hydrologic system, there is uncertainty in all groundwater model predictions. An evaluation of the predictive uncertainty of the WRV1.1 model was performed and documented by Wylie (2019b).[18] The evaluation included five analyses, in which the injection of water into a single model cell was simulated for a period of 10 months and the predictive uncertainty of the streamflow response at a selected river reach was evaluated. The predictive uncertainty ranged from +/- 0.54% to +/- 22% of the volume recovered in the target reach. The lowest predictive uncertainty was for an analyses where water was injected at a location north of Hailey. The highest predictive uncertainty was for three analyses where water was injected at locations south of Bellevue (+/- 15% to +/- 22% of the recovered volume).

Because the model was developed to serve as a tool to inform the conjunctive management and administration of groundwater and surface water, a curtailment scenario was performed and

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[16] Bartolino, J. and S. Vincent, 2013, *Groundwater Resources of the Wood River Valley, Idaho: A Groundwater-Flow Model for Resource Management*. U.S. Geological Survey Fact Sheet 2013-2005, 4 p., https://pubs.usgs.gov/fs/2013/3005/.

[17] IDWR and USGS, 2014, *Design Objectives, Wood River Valley Aquifer System Groundwater-Flow Model*. Draft by the USGS/IDWR Modeling Team, January 14, 2021, 3 p., https://idwr.idaho.gov/files/projects/wood-river-valley/20140131-WRV-Design-Objectives.pdf.

[18] Wylie, A., 2019b, *Wood River Valley Aquifer Model Version 1.1 Uncertainty Analysis*. Idaho Department of Water Resources, 20 p., https://idwr.idaho.gov/files/projects/wood-river-valley/20190702-WRV-Uncertainty-Analysis-v11.pdf.