documented by IDWR (Sukow, 2019).[19] The curtailment scenario simulated the cumulative impacts of the consumptive use of groundwater on streamflow from 1995 through 2014. The effects of curtailing groundwater use for a single irrigation season during the water years of 2007 and 2012 were also simulated. The curtailment simulations excluded groundwater use mitigated by non-use of surface water and exempt domestic water use with irrigation of less than ½-acre. Where groundwater diversion data were lacking, the consumptive use of groundwater was estimated by calculating the groundwater irrigation demand from land use, evapotranspiration, precipitation, and surface water diversion data as described in the model documentation (Fisher, et al., 2016; Sukow, 2019). Where measured surface and groundwater diversions to a service area exceeded the irrigation demand, groundwater consumptive use was estimated by multiplying the ratio of groundwater diversions to total diversions by the total consumptive use. Figure 14 shows the volume of curtailed consumptive use simulated in the Sukow (2019) scenario.

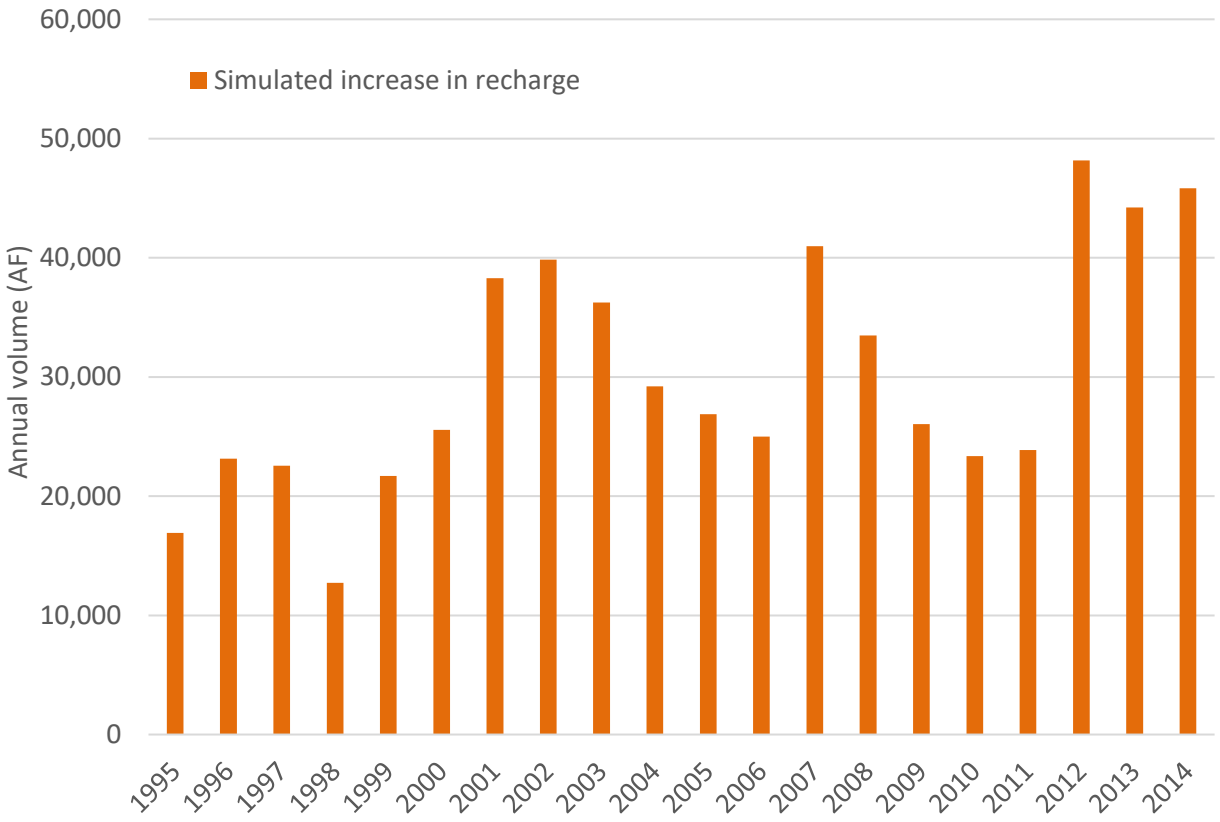

Figure 14. Volume of curtailed consumptive use simulated in Sukow (2019)

[19] Sukow, J., 2019, *Groundwater-Flow Model for the Wood River Valley Aquifer System, Version 1.1, Simulated Curtailment of Groundwater Use*. Idaho Department of Water Resources, July 31, 2019, 19 p., https://idwr.idaho.gov/files/projects/wood-river-valley/20190731-Report-WRV-V11CurtailSim.pdf.

Analyses for 2021 Basin 37 Administrative Proceeding

The WRV1.1 model was used to simulate the impact of curtailing consumptive use of groundwater for agricultural, municipal, residential, and commercial irrigation during the 2021 irrigation season. The year 2002 was used as a baseline dry year for the model simulation. Exempt self-supplied domestic water use for irrigation of less than 1/2-acre was excluded from the curtailment simulation. Groundwater use that is already mitigated by non-use of surface water or is otherwise already regulated in priority with surface water diversions by Water District 34 was also excluded from the curtailment simulation. Methods and pre-processing tools used to model the curtailment are described in detail by Sukow (2019).

Curtailment of irrigation was simulated with different starting dates of May 1, June 1, July 1, and August 1. Results for all four starting dates are provided in Attachment B and the supporting files. Because the hearing for the Basin 37 Administrative Proceeding is scheduled for June 7-11, 2021, results from the simulated curtailment starting July 1 are discussed in the text of this memorandum. Curtailment was simulated within two areas (Figure 15). The first area was the WRV1.1 model boundary. Although the effects of the curtailment were simulated with the model for a period of approximately 12 years, the WRV1.1 model predicts most of the impacts to streamflow are realized in less than 2 years (Figure 16). Because the Basin 37 Administrative Proceeding was initiated to address water delivery during the 2021 irrigation season, the results presented in the text of this memorandum focus on the hydrologic responses that are predicted to occur by the end of September.

While a significant portion (66%) of the curtailed water use remains in aquifer storage on October 1, the predicted July through September increases in streamflow are also significant (Table 1). Predicted increases to the average monthly streamflow during the 2021 irrigation season range from 23 to 28 cfs in Silver Creek, 10 to 16 cfs in the Big Wood River above the Dry Bed, and 2 to 7 cfs in the Big Wood River below the Dry Bed. Increases in streamflow in Silver Creek would be available for diversion in priority to water users on Silver Creek and the Little Wood River. Potential seepage losses within the Silver Creek and Little Wood River system are discussed later in this memorandum.

Increases in streamflow in the Big Wood River above the Dry Bed would likely be diverted in priority by water users with Big Wood River diversions above Glendale Road or off of the Bypass Canal system. If the additional predicted Big Wood River streamflow of 10 to 16 cfs (Table 1) is diverted onto the Bellevue triangle, this would likely provide some additional in-season streamflow in Silver Creek because a portion of the diversions will be lost to the aquifer via canal seepage and on-field infiltration. However, any additional benefit to streamflow in Silver Creek

would be dependent on the inefficiency of senior surface water users, who cannot be required to "waste" water to benefit other water users downstream.[20] Prediction of potential additional benefits to Silver Creek would require predicting where, when, and how efficiently the additional water would be applied, and was not attempted for this analysis.

Increases in streamflow in the Big Wood River below the Dry Bed reach, which includes Willow Creek and its tributaries, is expected to result in an increase in inflow to Magic Reservoir. Kevin Lakey, Water District 37 Watermaster, indicated during the March 24, 2021 meeting of the BWRGWMA Advisory Committee that diversion demands are generally already met in this part of the system, and that any increases in reach gains are likely to result in additional inflow to Magic Reservoir.

[20] Idaho case law has established that downstream water users cannot compel upstream users to continue wasting water. *Hidden Springs Trout Ranch v. Hagerman Water Users*, 101 Idaho 677, 680-681 (1980).

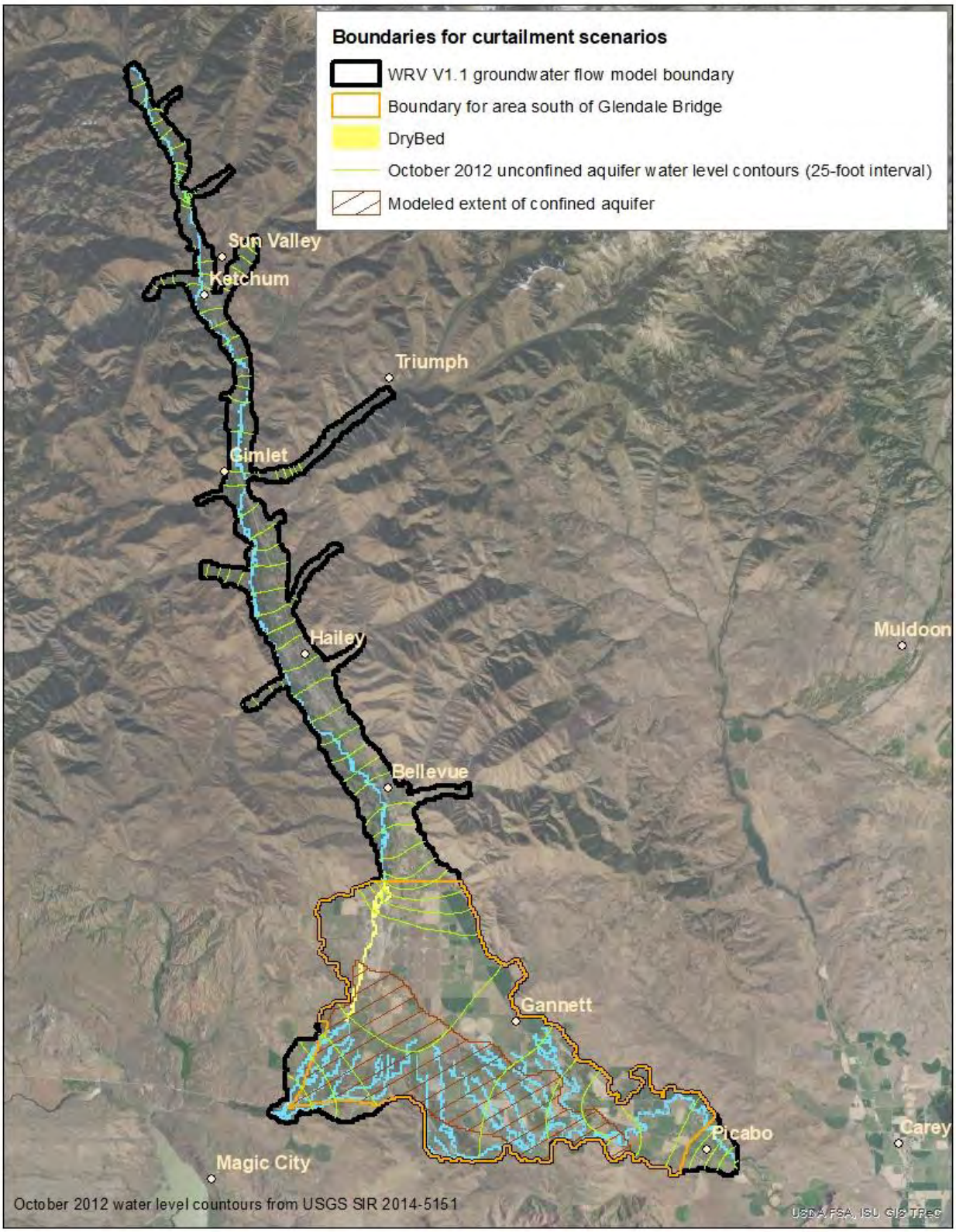

Figure 15. Areas of curtailment simulated with WRV1.1

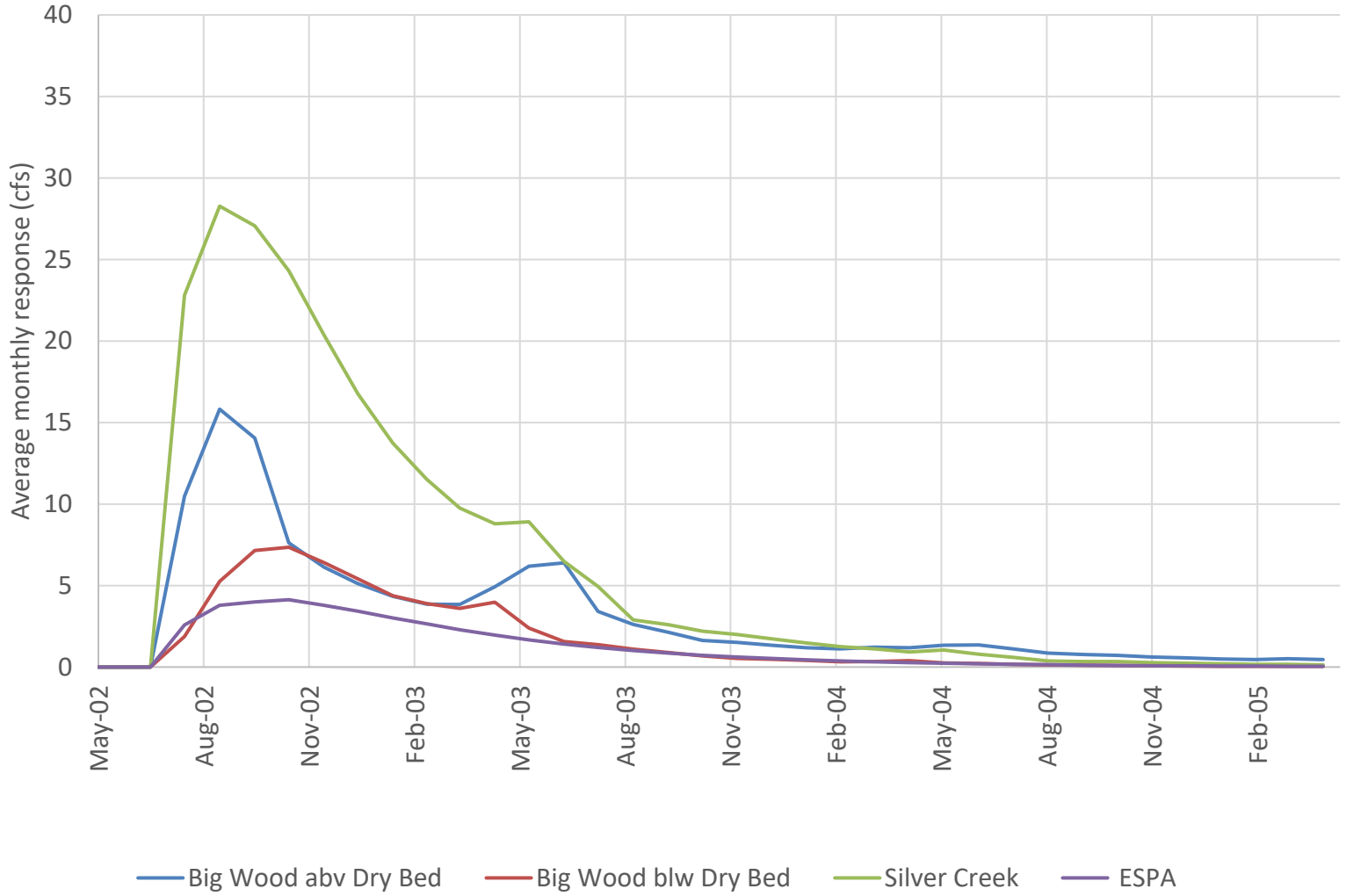

Figure 16. Predicted increase in aquifer discharge resulting from curtailment starting July 1 within the WRV1.1 model boundary

Table 1. Predicted responses to curtailment starting July 1 within the WRV1.1 model boundary

Month	Curtailed consumptive use	Silver Creek		Big Wood above Dry Bed		Big Wood below Dry Bed		Groundwater underflow to ESPA		Increase in aquifer storage	Model convergence error
	AF	cfs	AF	cfs	AF	cfs	AF	cfs	AF	AF	AF
May	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0	0	0	0
July	10,144	22.8	1,403	10.5	644	1.9	116	1.6	98	7,883	1
Aug	9,613	28.3	1,738	15.8	973	5.3	323	2.8	174	6,405	0
Sep	5,221	27.1	1,611	14.0	836	7.2	425	3.1	184	2,164	1
Sum	24,978		4,752		2,452		864		456	16,452	2
	100%		19%		10%		3%		2%	66%	0%

The second area for which curtailment was simulated comprised most of the model area south of Glendale Bridge (Figure 15, Figure 17). The second area excludes areas where groundwater pumping has minimal impact on streamflow in Silver Creek. Glendale Bridge crosses the Big Wood River at the north end of the Dry Bed. Aquifer water levels deepen at the northern margin of the triangle between Bellevue and Glendale Bridge. Between Glendale Bridge and the south end of the Dry Bed, interaction between the Big Wood River and the aquifer is generally limited to perched seepage from the Big Wood River during spring runoff, particularly during years with low water supply. North of Glendale Bridge, groundwater pumping primarily impacts streamflow in the Big Wood River above the Dry Bed. South of Glendale Bridge, groundwater pumping primarily impacts streamflow in Silver Creek, the Big Wood River below the Dry Bed, and/or underflow to the Eastern Snake Plain Aquifer (ESPA). Areas where pumping primarily impacts underflow to the ESPA or the Big Wood River below the Dry Bed where excluded from the curtailment simulation area south of Glendale Bridge.

Silver Creek and its spring-fed tributaries interact with the aquifer upstream of the Sportsman Access gage. Between the gage and the model boundary, Silver Creek is generally perched above the aquifer and streamflow measurements made by the USGS and IDWR indicate gains or losses in this reach are less than the streamflow measurement error. Aquifer water levels deepen significantly in the vicinity of Picabo (Figure 17). Groundwater pumping near the southeastern model boundary primarily impacts underflow to the Eastern Snake Plain Aquifer and has minimal effect on streamflow in Silver Creek.[21] This area was excluded from the curtailment simulation area south of Glendale Bridge.

The location of the confining unit and confined aquifer affect the distribution of the impacts of groundwater pumping. WRV1.1 model simulations[21] show groundwater withdrawals from the confined aquifer have significant in-season impacts to streamflow in Silver Creek, even in the area underlying Willow Creek. Groundwater pumping in the unconfined aquifer in this area would primarily impact streamflow in Willow Creek, but review of available well logs (Attachment C) and the early priority dates of water rights in this area both suggest that wells supplying irrigation water in this area are developed in the confined aquifer. Areas outside of the modeled extent of the confined aquifer in the vicinity of the southwestern model boundary were excluded from the curtailment simulation area south of Glendale Bridge.

The simulation of curtailment indicates that 99% of the predicted in-season benefit to Silver Creek streamflow can be achieved by curtailing 70% of the consumptive groundwater use within the

[21] In-season transient response functions were calculated for selected model cells to examine the effect of groundwater pumping in the unconfined and confined aquifers on streamflow. Model files and results are provided in the supporting files.

model domain by reducing the area of curtailment to the area south of Glendale Bridge (Figure 17). The predicted benefits to the Big Wood River and the ESPA are reduced significantly by excluding pumping in areas north of Glendale Bridge and along the southeastern and southwestern model boundaries (Figure 18). As with the full model boundary curtailment simulation, a significant portion (67%) of the curtailed water use remains in aquifer storage on October 1, but the predicted July through September increases in Silver Creek streamflow (23 to 28 cfs) are also significant (Table 2).

The simulated curtailment in the areas south of Glendale Road would affect the groundwater supply for approximately 23,000 acres of land, including approximately 4,000 acres where groundwater is the sole source of irrigation water, and approximately 19,000 acres where both groundwater and surface water are sources of irrigation water.

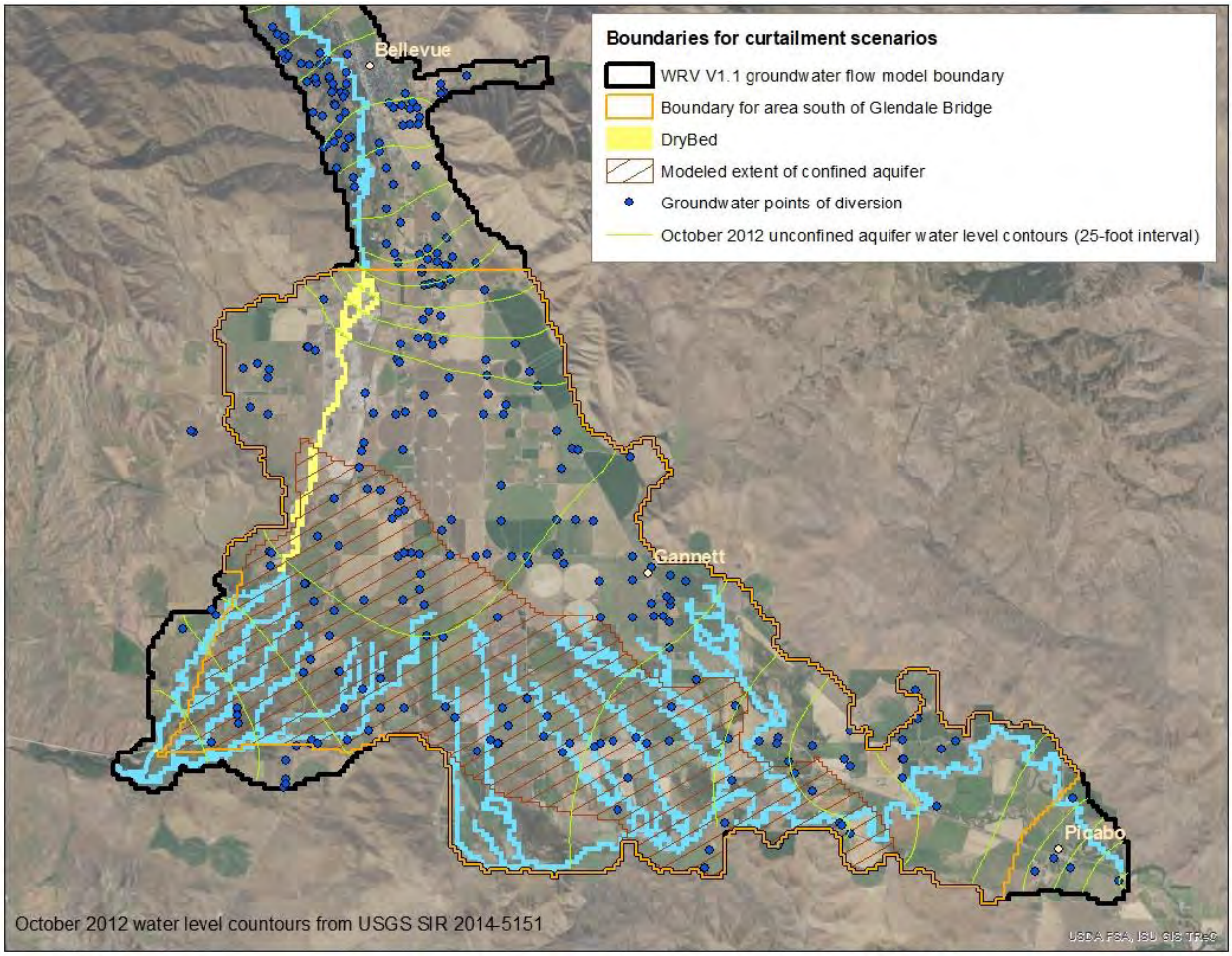

Figure 17. Simulated curtailment area south of Glendale Bridge

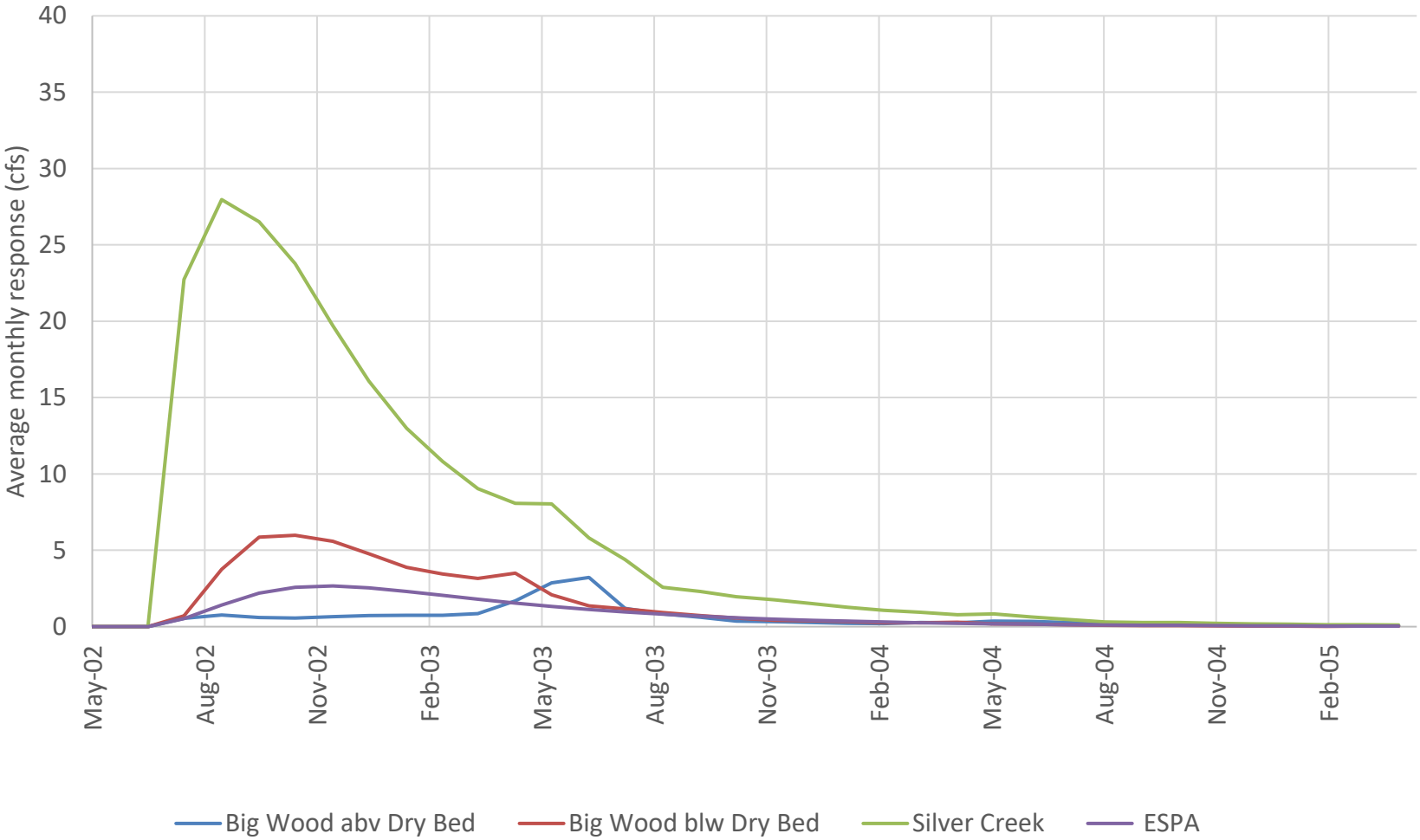

Figure 18. Predicted increase in aquifer discharge resulting from curtailment starting July 1 within the curtailment simulation area south of Glendale Bridge

Table 2. Predicted responses to curtailment starting July 1 within the area south of Glendale Bridge

Month	Curtailed consumptive use	Silver Creek		Big Wood above Dry Bed		Big Wood below Dry Bed		Groundwater underflow to ESPA		Increase in aquifer storage	Model convergence error
	AF	cfs	AF	cfs	AF	cfs	AF	cfs	AF	AF	AF
May	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	0	0	0	0	0	0
July	7,214	22.7	1,398	0.5	33	0.7	43	0.5	32	5,706	2
Aug	6,737	28.0	1,720	0.8	47	3.8	231	1.4	87	4,652	0
Sep	3,502	26.5	1,578	0.6	36	5.9	348	2.2	130	1,409	1
Sum	17,453		4,695		116		623		249	11,767	3
	100%		27%		1%		4%		1%	67%	0%

Additional streamflow in Silver Creek may benefit water users at different locations within the Silver Creek and Little Wood River system. As shown in Figure 1, Silver Creek and its tributaries gain water from the Wood River Valley aquifer system upstream of the Sportsman Access gage. Between the Sportsman Access gage and the North Picabo Road Bridge the creek becomes perched above the Wood River Valley aquifer system and periodic streamflow measurements indicate minimal interaction with the aquifer (Wylie, 2019c,[22] Fisher et al. 2016, Wylie, et al., 2019). The USGS also measured no significant seepage loss between the Sportsman Access gage and a location about 1.5 miles downstream of the Highway 20 Bridge in March 2013 (Bartolino, 2014).[23]

Between the WRV1.1 model boundary and Station 10 on the Little Wood River (Figure 19), both Silver Creek and the Little Wood River are perched above the Eastern Snake Plain aquifer system. The Little Wood River above Silver Creek flows intermittently and generally only contributes to the flow below Silver Creek during periods of high surface runoff (Sukow, 2015). During the irrigation season in relatively dry years, canals in the upper Little Wood River valley generally divert the entire flow of the upper Little Wood River. Silver Creek is expected be the only source of water for the Little Wood River at Station 10 during the 2021 irrigation season.

For the 2020 irrigation season, average monthly seepage losses between the Sportsman Access gage and Little Wood River Station 10 were calculated using the USGS recorded streamflow at the Sportsman Access gage and Water District 37 records of streamflow at Little Wood River Station 10, thirty diversions from Silver Creek, and two inflows to Silver Creek (Table 3). Estimated seepage losses range from 16 cfs to 46 cfs and from 20% to 37% of the inflow to the reach. Reliable evaluation of seepage losses is frustrated by measurement uncertainty at the gages, the large number of diversions, and lack of winter-season maintenance and calibration of the Station 10 gage. IDWR is currently working with Water District 37 to improve the future year-round operation and maintenance of the Station 10 gage.

[22] Wylie, A., 2019c, *Seven Silver Creek Flow Measurements Collected at North Picabo Bridge between October 2014 and November 2018*. Idaho Department of Water Resources, 10 p., https://idwr.idaho.gov/files/projects/wood-river-valley/20190627-SilverCreekNrModelBound0619.pdf.

[23] 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/.

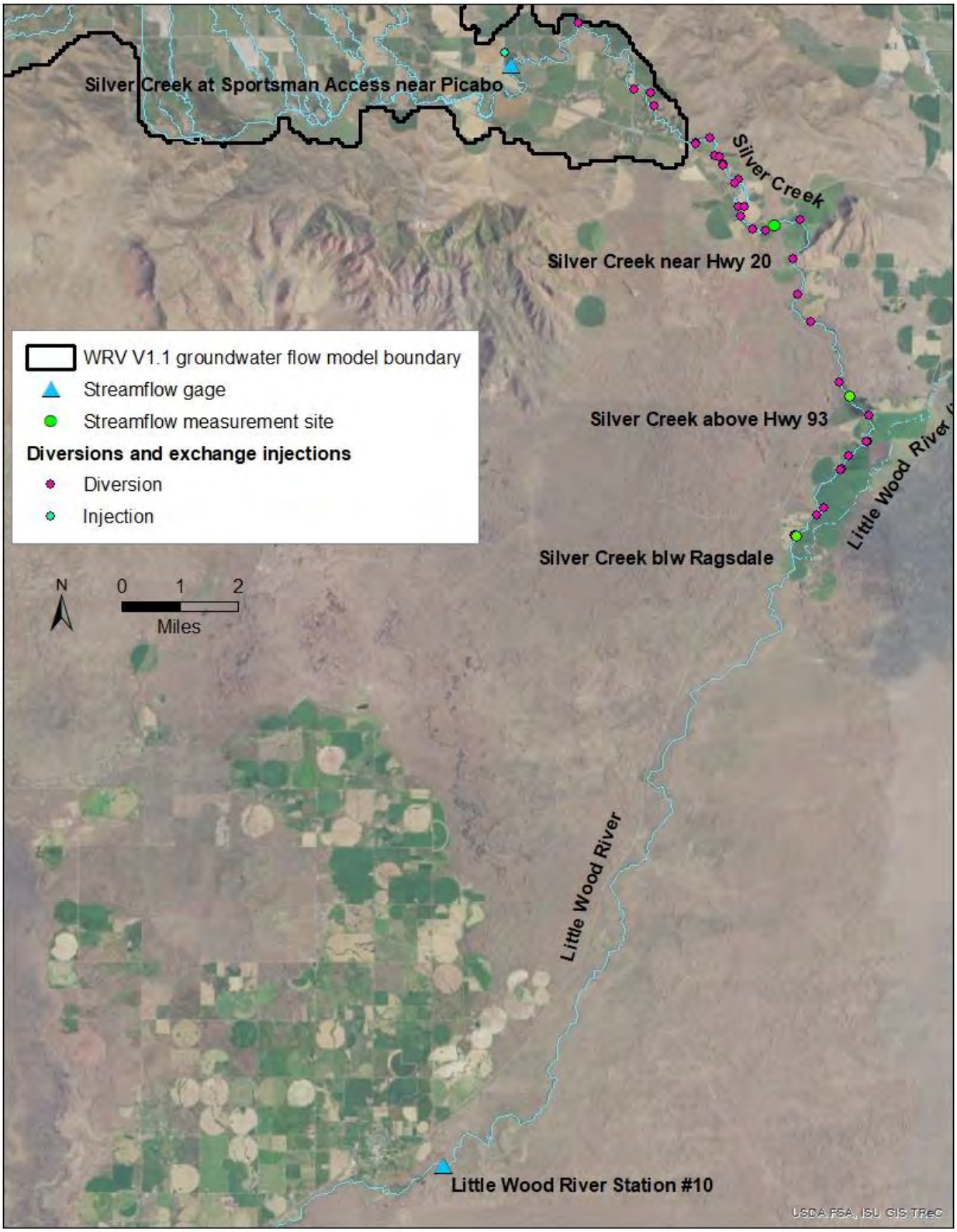

Figure 19. Silver Creek at Sportsman Access to Little Wood River Station 10

Table 3. Calculated seepage losses between Silver Creek at Sportsman Access and Little Wood River Station 10

Month	Inflows			Outflows		Calculated seepage loss (cfs)	% of inflow
	Silver Creek at Sportsman Access (cfs)	Exchange well 16P (cfs)	Little Wood River into Silver Creek 11C (cfs)	Diversions (cfs)	Little Wood River at Station 10 (cfs)		
May-20	118.3	4.9	5.3	31.5	51.2	45.8	36%
Jun-20	109.5	6.5	6.8	33.2	44.1	45.5	37%
Jul-20	83.2	6.4	6.8	35.3	29.5	31.7	33%
Aug-20	68.5	6.3	4.7	35.8	28.0	15.7	20%

As previously mentioned, seepage losses appear to be minimal between the Sportsman Access gage and where Highway 20 crosses Silver Creek. Seepage losses in the vicinity of the Highway 93 Bridge have been identified by water users as a concern, and losses in the range of 7 cfs to 15 cfs have reportedly been measured by Water District 37[24] between sites located approximately 0.5 mile upstream and 2.5 miles downstream of the bridge (Figure 19). IDWR has requested additional information regarding streamflow measurements at these sites, but has not received the data as of the date of this memorandum.

Conclusions

The Wood River Valley aquifer system is hydraulically connected to Silver Creek and its tributaries above the Sportsman Access gage, and consumptive use of groundwater within the Wood River Valley aquifer system has a significant impact on Silver Creek streamflow. Other aquifer systems in Basin 37 do not interact with Silver Creek or the Little Wood River. The WRV1.1 groundwater flow model is the best available tool for evaluating the interaction between groundwater and surface water in the Wood River Valley. The science underlying the development and calibration of WRV1.1 reflects the best knowledge of the aquifer system available at this time.

Curtailing groundwater use beginning July 1 within the WRV1.1 model boundary is predicted to result in increases in Silver Creek reach gain of approximately 23 cfs, 28 cfs, and 27 cfs during the months of July, August, and September (Table 1). Curtailing groundwater use within the reduced area south of Glendale Road delineated in Figure 15 and Figure 17 is predicted to result in similar increases, yielding approximately 99% of the benefit to Silver Creek reach gain while curtailing approximately 70% of the consumptive use within the WRV1.1 model boundary (Table 2, Attachment B).

Uncertainty is inherent in predictions made by all numerical and analytical models. Predictive uncertainty analyses of the WRV1.1 groundwater flow model performed by Wylie (2019b) found uncertainty of +/- 22% of the predicted response with a 95% confidence interval for predictions involving the impact of aquifer stress at selected locations in the Bellevue Triangle on reach gain in Silver Creek. The Wylie (2019b) predictive uncertainty analyses explored the predictive uncertainty associated with 10-month simulations. Because the simulations of curtailment beginning July 1 are shorter 3-month simulations, the predictive uncertainty associated with these predictions may be higher than +/- 22% at a 95% confidence interval.

[24] BWRGWMAAC, 2020, *Meeting minutes of the Big Wood River Groundwater Management Area Advisory Committee*, December 15, 2020, 3 p., https://idwr.idaho.gov/files/groundwater-mgmt/big-wood-gwma-advisory-comm/20201215-Big-Wood-GWMA-Advisory-Committee-Meeting-Notes.pdf.

The simulated curtailment in the area south of Glendale Road would affect the groundwater supply for approximately 23,000 acres of land, including approximately 4,000 acres where groundwater is the sole source of irrigation water, and approximately 19,000 acres where both groundwater and surface water are sources of irrigation water.

Seepage losses would not be expected to affect delivery of water to senior users upstream of the Highway 20 Bridge. The reach between the Highway 20 crossing of Silver Creek and Little Wood River Station 10 loses water via seepage to the Eastern Snake Plain Aquifer, and seepage losses would be expected to reduce the amount of water that can be delivered to senior users on lower Silver Creek and the Little Wood River to some extent. Reliable estimation of seepage losses in this reach is frustrated by measurement uncertainty associated with the gages, particularly the Station 10 gage, and the large number of diversions from Silver Creek. Gage and diversion records from the 2020 irrigation season suggest seepage losses may be between 20% and 37% of the reach inflow, but there is high uncertainty in this estimate. Streamflow gains to Silver Creek resulting from curtailment of groundwater use can be expected to incur similar rates of seepage loss if conveyed between the Highway 20 Bridge and Station 10. Additional streamflow measurement data collected by Water District 37 or their contractor may help inform the estimation of seepage rates, but was not available to IDWR as of the date of this memorandum.