GROUNDWATER RESOURCES IN MARSH VALLEY, BANNOCK COUNTY, IDAHO

IDAHO DEPARTMENT OF WATER RESOURCES

Open File Report

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INTRODUCTION

The valley of Marsh Creek, tributary to the Portneuf River and Eastern Snake Plain, has been identified by the Idaho Department of Water Resources (IDWR) as an area of potential conjunctive administration of surface and groundwater resources. This report was prepared in response to a request from the Deputy Director of IDWR for a peer reviewed technical report summarizing water level data, water level trends, and aquifer conditions in the Marsh Valley.

Marsh Creek is located in a 410 square-mile drainage area located in southeastern Idaho (Figure 1). The Marsh Creek drainage area is bounded by Red Rock Pass on the south, the Portneuf Range on the east, and the Bannock Range and Elkhorn Mountain on the west. Elevation within the drainage area ranges from approximately 4,500 to 9,300 feet above sea level. The elevation of irrigated lands ranges from approximately 4,500 feet to 5,800 feet above sea level. The towns of Downey, Virginia, Arimo, and Robin are located within Marsh Valley.

Marsh Creek initially flows in a southerly direction from the headwaters in the Portneuf Range, then abruptly turns towards the northwest at Red Rock Pass. Marsh Creek generally flows in a northerly direction from Red Rock Pass to the confluence with the Portneuf River, which is located approximately 10 miles downstream of McCammon and 12 miles upstream of Pocatello. Marsh Creek flows from an elevation of approximately 5,150 feet at its headwaters to approximately 4,780 feet at Red Rock Pass and approximately 4,520 feet at the confluence with the Portneuf River. A U.S. Geological Survey gaging station records streamflow in Marsh Creek near McCammon at an elevation of approximately 4,620 feet.

Tributaries to Marsh Creek include Birch, Hawkins, and Garden Creeks (Figure 1). Upstream of Garden Creek, Marsh Valley is approximately 5 miles wide and consists primarily of benches of loess and alluvial, fluvial, and lacustrine sediments. The benches are cut by the incised flat-bottomed meandering valley of Marsh Creek, which is generally less than a mile wide. Downstream of Garden Creek, Marsh Valley narrows to less than a mile wide, and is separated from the town of McCammon and the Portneuf River by a narrow ridge of basalt.

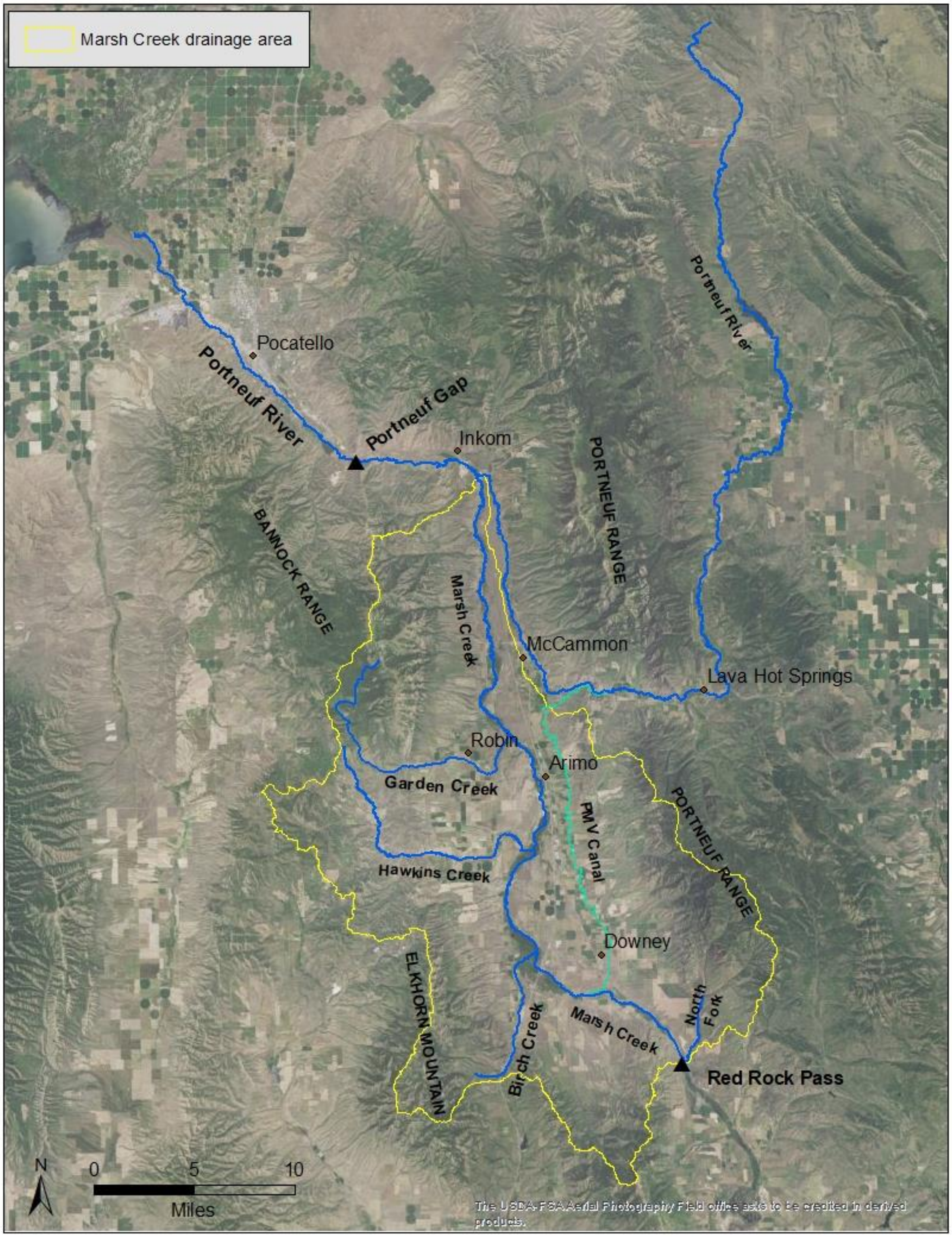

Figure 1. Marsh Creek location map

GEOLOGIC AND HYDROLOGIC SETTING

Marsh Valley is a half-graben structural basin formed by north-striking and west-dipping normal faults (Figure 2, Thackray et al., 2011). The depth of the graben estimated from gravity surveys is approximately 2.5 km in the southern valley and 1.5 km in the northern valley (Thackray et al., 2011). Basin-fill sediments of the Tertiary-age Salt Lake Formation were deposited during extensional events forming the graben (Long and Link, 2007). The Salt Lake Formation consists of a variety of consolidated sediments, including sandstone, conglomerate, diamictite, siltstone, and mudstone, along with minor amounts of dolomite, limestone and tuff. The Quaternary- and Tertiary-age Marsh Valley Formation overlies the Salt Lake Formation (Long and Link, 2007). The Marsh Valley Formation consists of alluvial and lacustrine deposits of interbedded clay, silt, and ash alternating with gravel and channel-fill deposits. The Marsh Valley Formation is overlain locally by Bonneville flood gravel deposits and Quaternary-age alluvium and alluvial fan deposits (Long and Link, 2007; Thackray et al., 2011). In northern Marsh Valley, the basalt of Portneuf Valley overlays the sedimentary deposits (Thackray et al., 2011). The basalt erupted in the Gem Valley (Figure 2) and flowed past Lava Hot Springs toward the Portneuf Gap, with a small portion of the flow ponding in the northern Marsh Valley in the vicinity of McCammon (Figure 3). Drainage from southern Marsh Valley was diverted both west and east of the basalt flow creating the inverted topographic ridge that now separates the lower reach of Marsh Creek from the Portneuf River (Thackray et al., 2011).

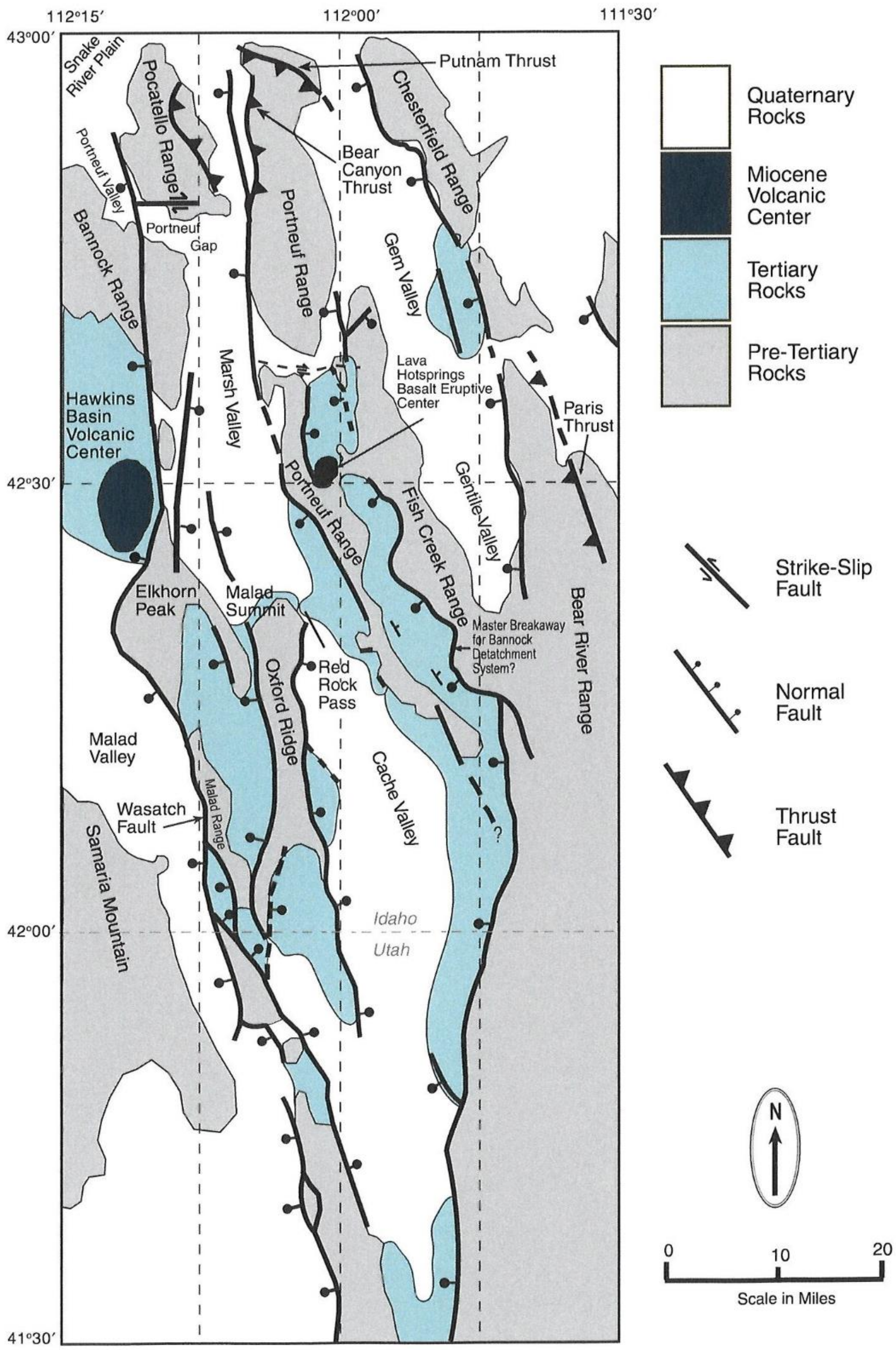

Figure 2. Generalized geologic map showing major faults (from Thackray et al., 2011)

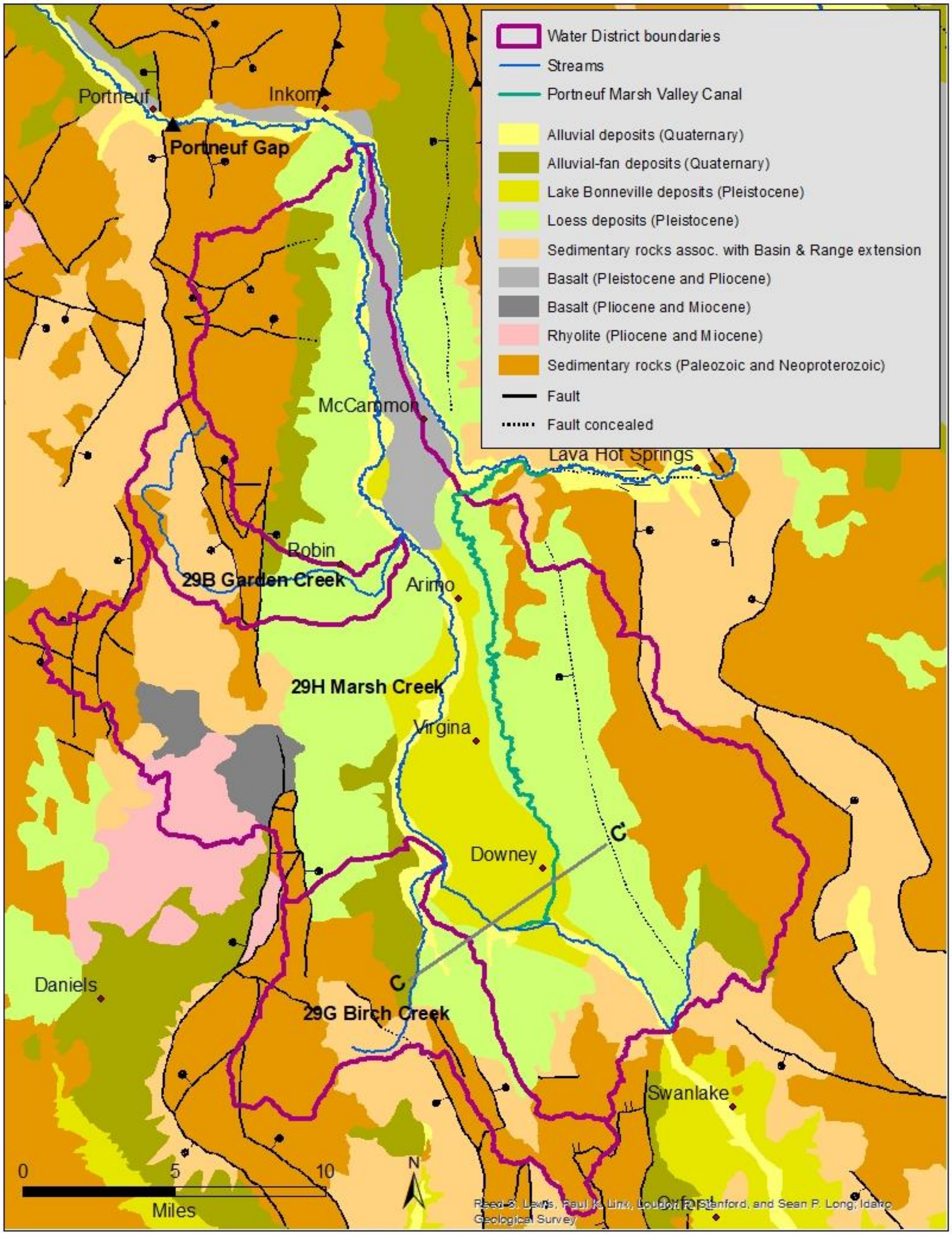

Figure 3. Surficial geology of the Marsh Creek drainage area (from Lewis, et al., 2012)

The geologic history of drainage development in Marsh Valley and the surrounding area is complex. Tectonic uplift, basin-and-range faulting, volcanism, and development of the Bonneville Basin and Snake River Plain resulted in changes in drainage areas and flow directions in this region over the past 6 million years. Figure 4 shows the history of drainage development illustrated by Link et al. (1999). Modern drainage of Marsh Valley is northward to the Portneuf River and Snake River Plain.

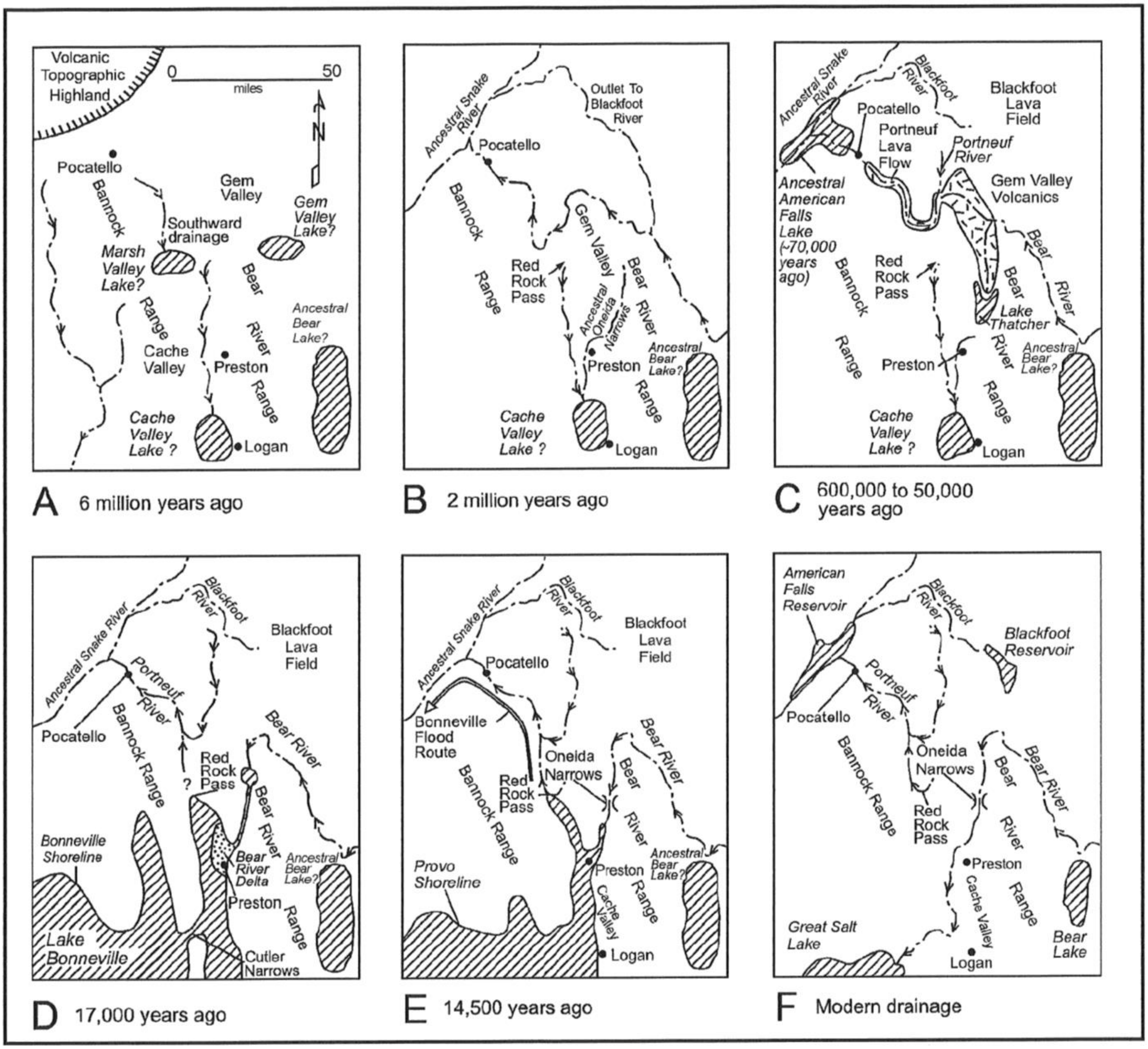

Figure 4. History of drainage development (from Link, et al., 1999)

Red Rock Pass divides Marsh Valley, which drains to the Snake River basin, from Cache Valley, which drains to the Great Salt Lake basin. During the Pleistocene, Red Rock Pass was the lowest divide for Lake Bonneville, which was a large pluvial lake covering parts of Utah, Nevada, and Idaho (Figure 5). Lake Bonneville likely spilled over Red Rock Pass during multiple time periods, including the catastrophic overflow event known as the Bonneville Flood. Periods of non-catastrophic overflow before and after the Bonneville Flood likely resulted in erosion of the incised valley of Marsh Creek, which occupies a meandering, broad valley too large to have been formed by the modern-day creek (Norvitch and Larson, 1970; Thackray et al., 2011). The catastrophic Bonneville Flood was a depositional event in Marsh Valley. Significant amounts of gravel eroded from alluvial fans that formed the threshold for Lake Bonneville at Red Rock Pass were deposited in Marsh Valley during the Bonneville Flood (Link, et al., 1999; Thackray et al., 2011).

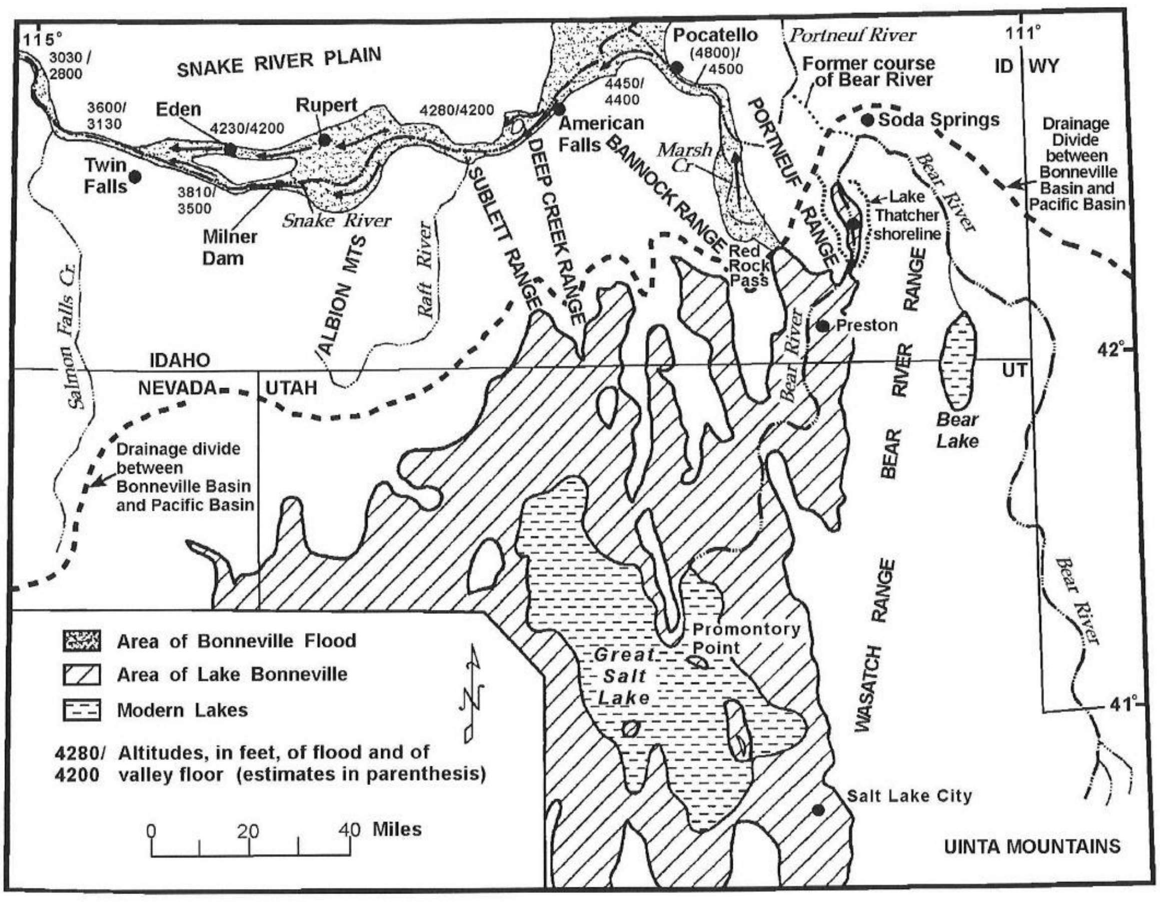

Figure 5. Lake Bonneville and the Bonneville Flood path (from Link, et al., 1999)

Present-day Marsh Creek has a low stream gradient, about 4.5 feet per mile, and the water table is at or near land surface in much of the Marsh Valley floodplain (Norvitch and Larson, 1970). A large part of the discharge to Marsh Creek is contributed by springs and seepage from groundwater. Norvitch and Larson commented that only the North Fork, Birch Creek, and Hawkins Creek tributaries likely provide perennial streamflow to Marsh Creek. Streamflow in many of the tributaries to Marsh Creek is intermittent, with much of the flow being lost to seepage into the valley-fill sediments before reaching Marsh Creek. However, much of the flow lost to groundwater reappears as springs and seeps along the Marsh Creek channel and floodplain. Figure 6 shows a hydrogeologic cross-section of the Marsh Valley aquifer near Downey depicted by Norvitch and Larson (1970).

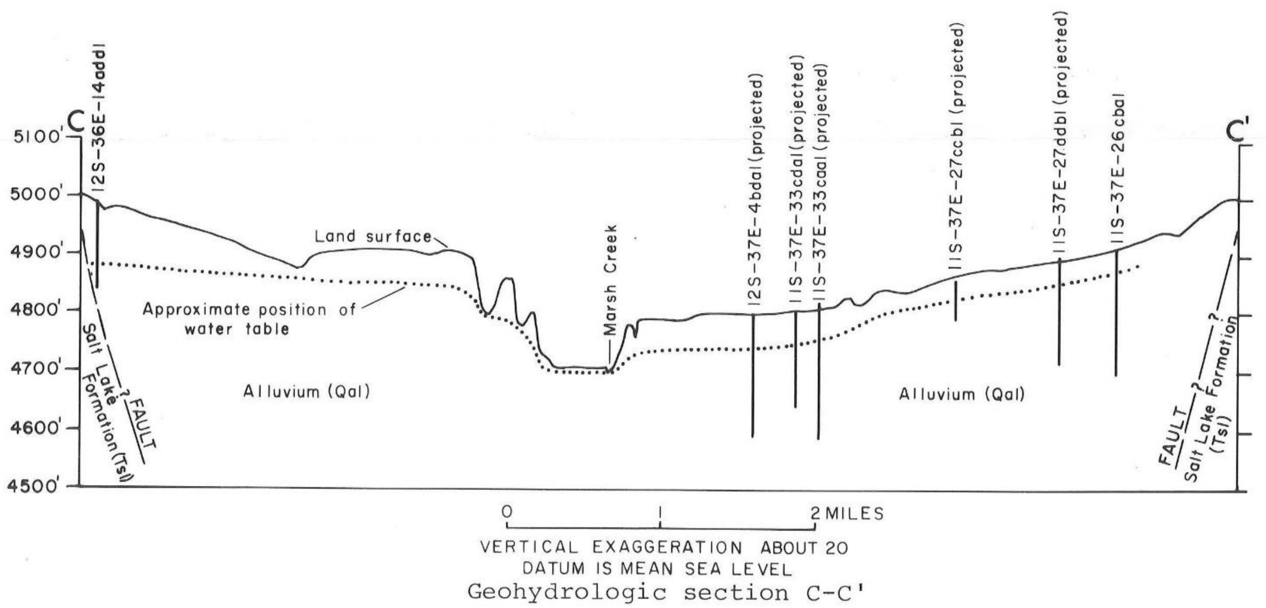

Figure 6. Hydrogeologic cross-section of Marsh Valley near Downey from Norvitch and Larson (1970)

Norvitch and Larson (1970) noted that groundwater in Marsh Valley occurs under both water table and artesian conditions. At least twelve flowing artesian wells with discharge rates of 1 to 15 gallons per minute and well depths of 300 to 570 feet were reportedly developed in the vicinity of Arimo prior to 1939. Well drillers' logs filed with IDWR also indicate flowing artesian wells have been developed in Marsh Valley. Logs indicate at least nine flowing artesian wells were developed between 1959 and 2017 for domestic and stockwater use, with discharge rates of 10 to 100 gpm and well depths of 220 to 350 feet. The flowing artesian wells identified in IDWR drillers' logs are located close to Marsh Creek, at locations extending from near the confluence with Hawkins Creek to approximately 4 miles upstream of the confluence with the Portneuf River.

Drillers' logs are available for 51 irrigation wells developed in the Marsh Creek drainage area between 1957 and 2019. Reported well yields range from 300 to 2,600 gpm and well depths range from 51 to 520 feet. Reported static water levels range from 1 to 228 feet below ground surface. Nine of the 51 drillers' logs were for deepening or replacement of an existing irrigation well.

Geologic materials described on well drillers' logs are generally consistent with the depositional history described by Link, et al. (1999), Long and Link (2007), and Thackray, et al., (2011). Water bearing units are predominantly described as gravel or sand and gravel. At some locations, the water bearing units are described as sand or sandstone. The water bearing sediments are interbedded with fine-grained sediments generally described by the drillers as clay or shale. Bonneville flood deposits described as cobbles or boulders were encountered in some wells. Basalt was encountered in some wells located between Marsh Creek and the Portneuf River on the north end of the valley. Both the Bonneville flood deposits and basalt may be water bearing, but are generally shallow and do not provide a significant portion of the valley's water supply.

In December 1968, Norvitch and Larson (1970) measured streamflow at 19 locations in the Portneuf River drainage, including 6 locations within the Marsh Creek drainage, noting that the discharges measured during that period are believed to represent base flow conditions. Locations and measured discharge rates are shown in Figure 7. The measurements indicated Marsh Creek was gaining water from groundwater throughout Marsh Valley. The measured discharge at the mouth of Marsh Creek was 90 cfs, which included a gain of 10 cfs in the lower reach of Marsh Creek downstream of the USGS gaging station near McCammon.

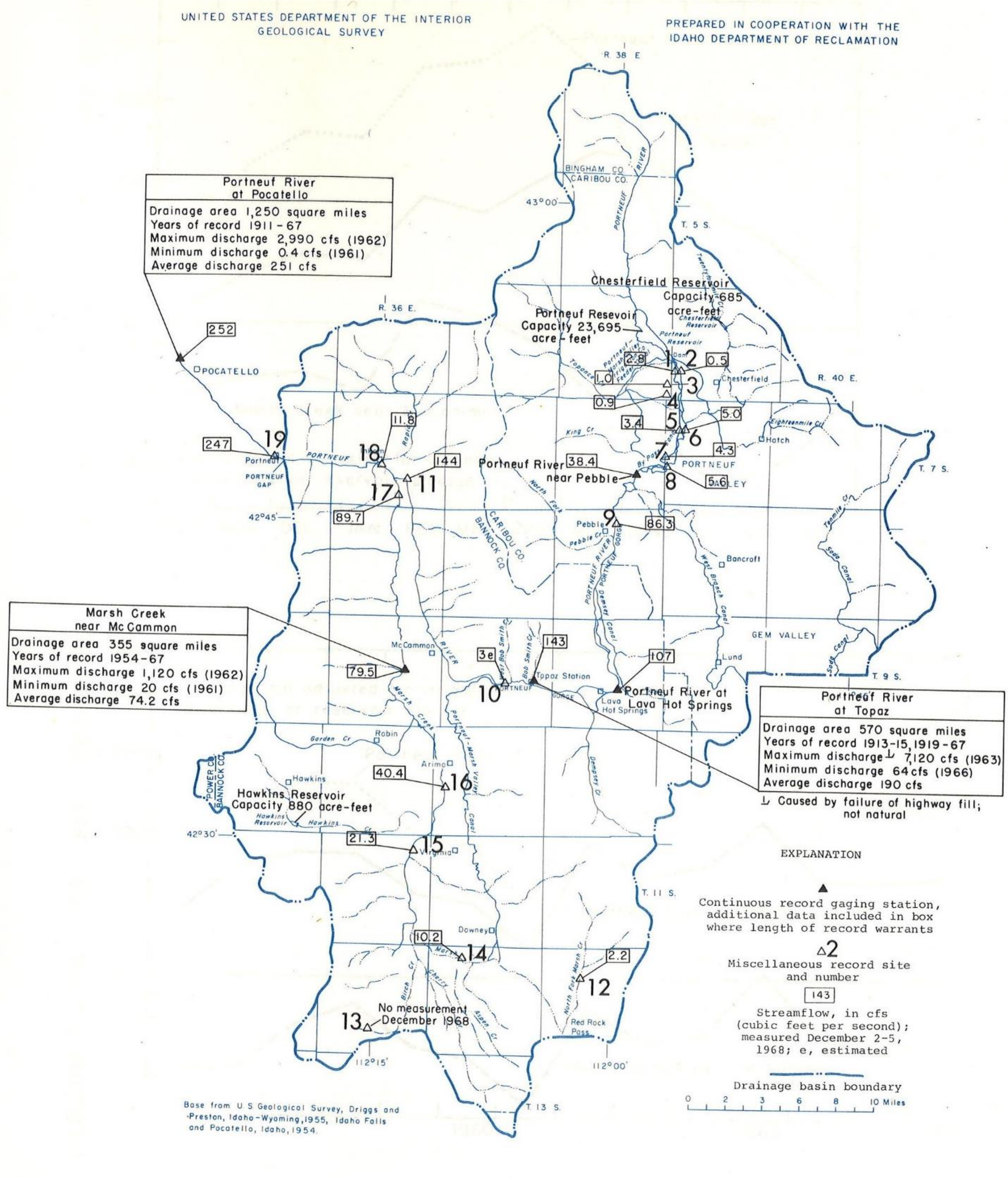

Figure 7. Streamflow observations in December 1968 from Norvitch and Larson (1970)

The USGS gaging station at Marsh Creek near McCammon has been measured continuously since October 1954 (Figure 8). The average monthly discharge peaks in March during snowmelt and is lowest in July and August when irrigation diversions reduce streamflow below base flow conditions (Figure 9). November through January discharge generally appears to represent base flow conditions, with a median discharge of approximately 68 cfs over the period of record.

The November through January discharge at the McCammon gaging station appears to be decreasing over time at a rate of approximately 0.6 cfs per year (Figure 10 through Figure 12). The median November through January discharge for 2011 through 2020 was approximately 49 cfs. Mann Kendall trend analyses of the November, December, and January discharge indicate statistically significant declining trends of 0.53 to 0.66 cfs per year over a 67 year period (Appendix A, Table 2), equivalent to a decrease of 36 to 44 cfs since the mid-1950s.

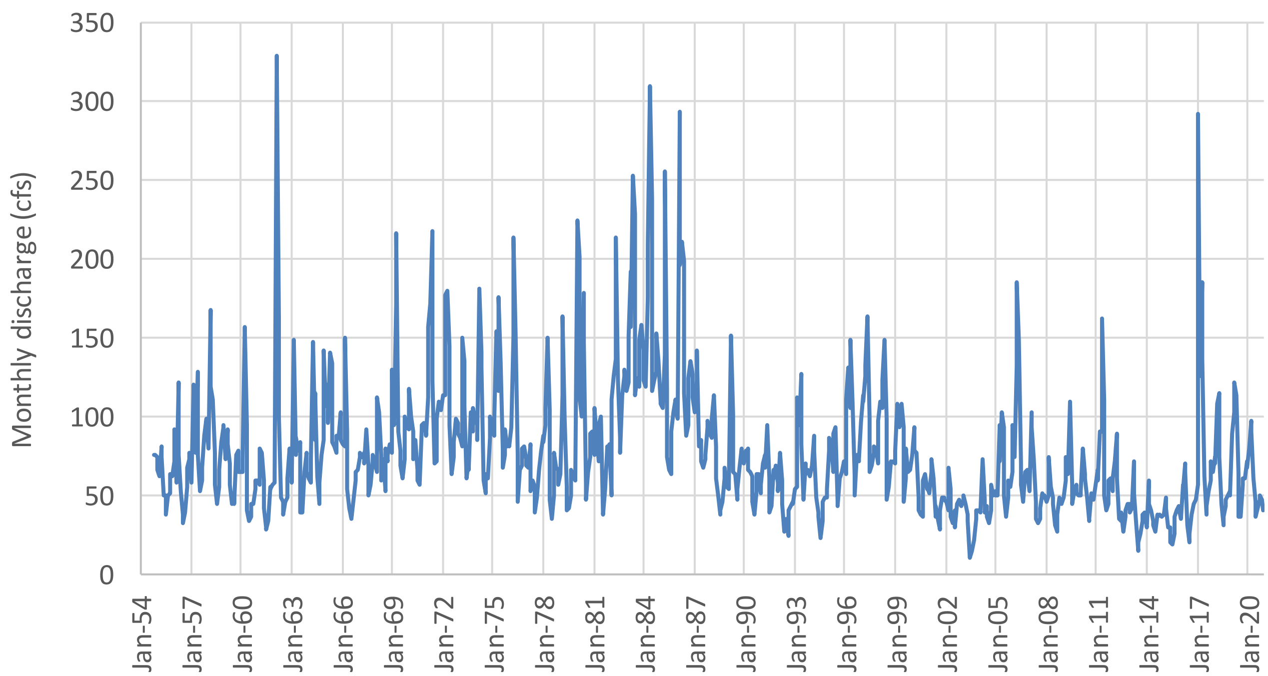

Figure 8. Monthly discharge at Marsh Creek near McCammon (USGS 13075000)

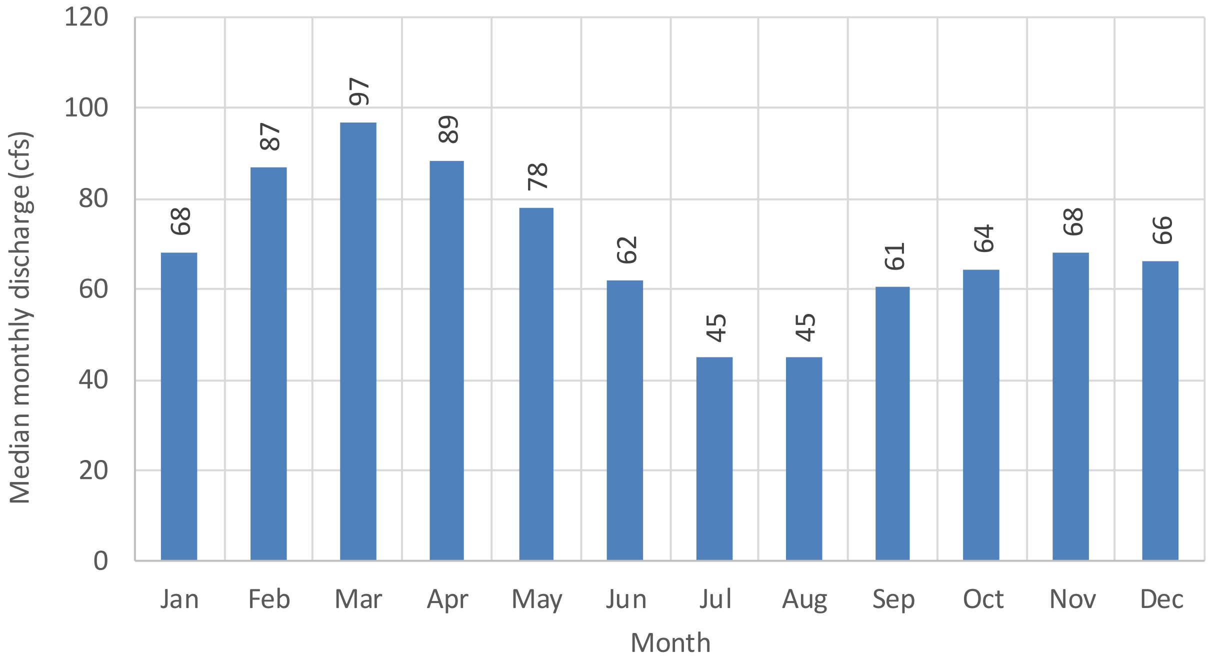

Figure 9. Median monthly discharge at Marsh Creek near McCammon (1954-2020)

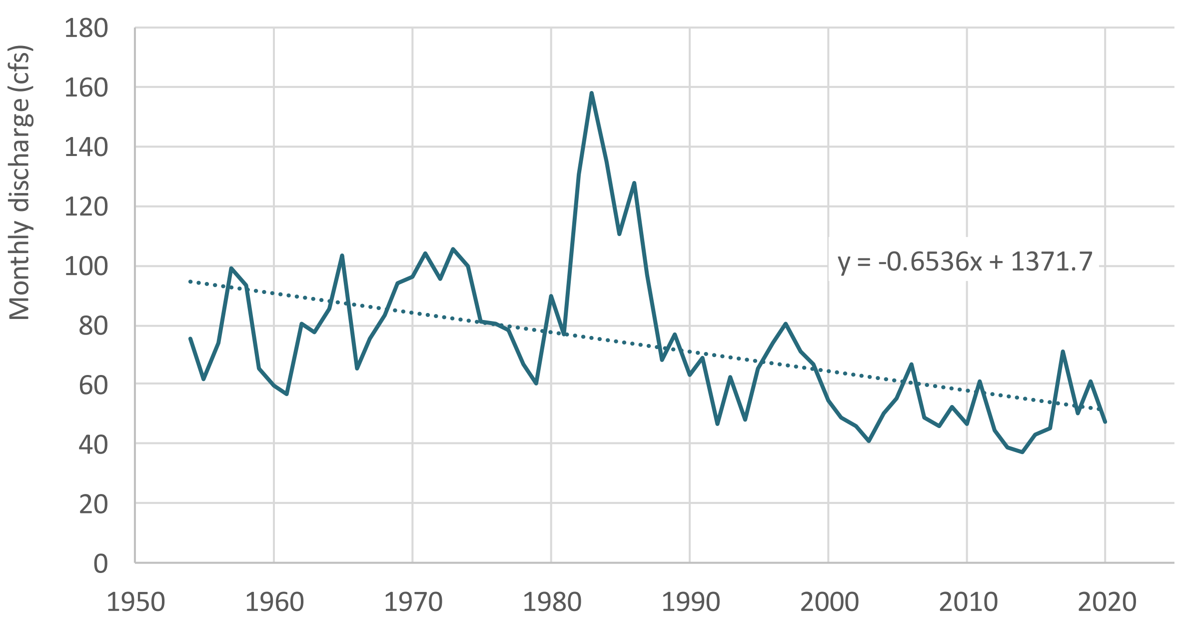

Figure 10. November discharge at Marsh Creek near McCammon

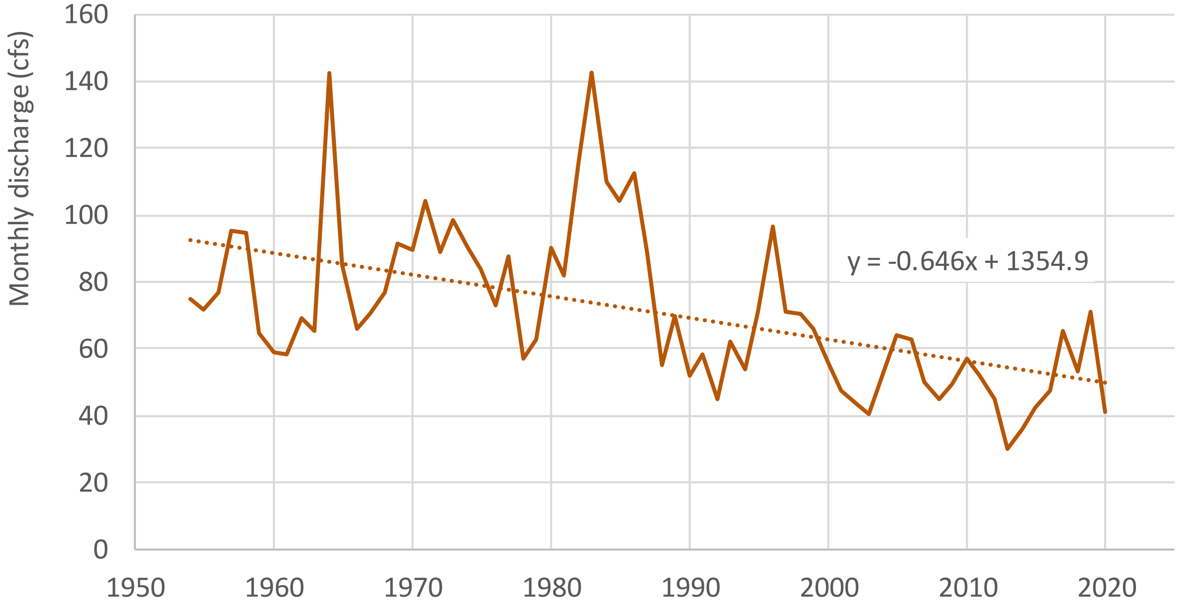

Figure 11. December discharge at Marsh Creek near McCammon

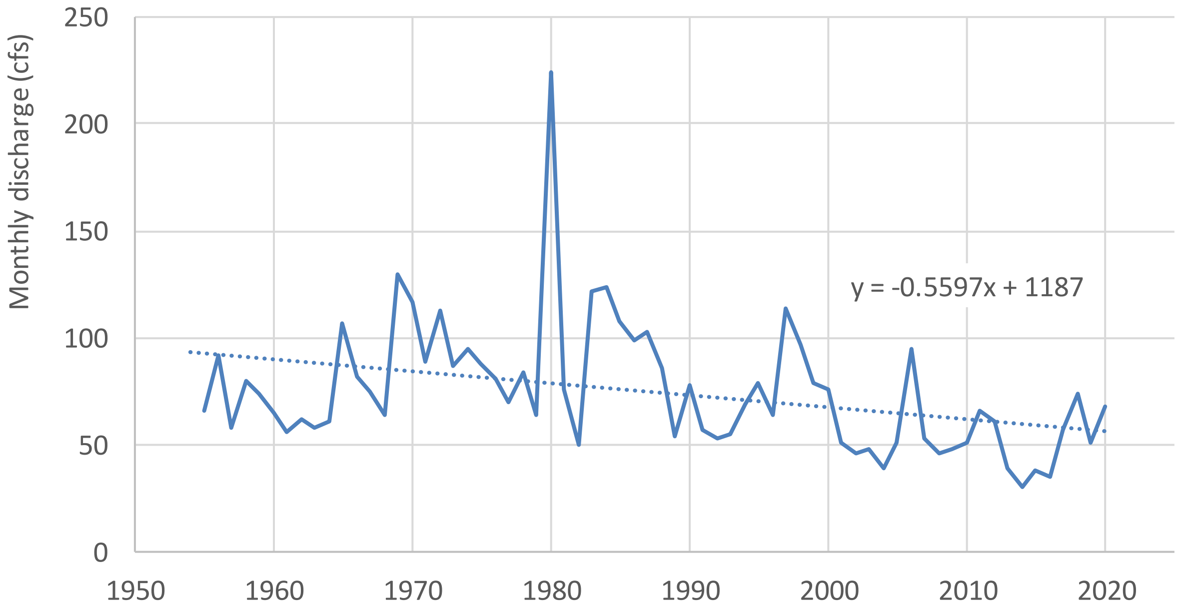

Figure 12. January discharge at Marsh Creek near McCammon

WATER USE

Surface water and groundwater provide water for irrigation, municipal, commercial, industrial, and domestic water uses in the Marsh Creek drainage area. Water supply for the Marsh Valley includes Portneuf River water delivered from outside of the drainage area. Figure 13 shows the authorized water right diversion rate developed from various water sources. Irrigation is the predominant use of water from both surface and groundwater sources (Figure 14).

Approximately 41,000 acres within the Marsh Creek drainage area are within the place of use for irrigation water rights (Figure 15), with approximately 30,000 acres having only surface water sources, approximately 6,000 acres having only groundwater sources, and about 5,000 acres having both surface and groundwater sources. Actual irrigated acreage is less than the total place of use acreage. Detailed irrigated lands delineations are not available for Marsh Valley, but review of evapotranspiration and crop irrigation requirement data sets from nine years between 2010 and 2020 suggests the actual irrigated area averaged about 30,000 acres, with about 22,000 acres served by only surface water, about 4,000 acres served by only groundwater, and about 4,000 acres served by both surface and groundwater.

The Portneuf Irrigating Company, Portneuf Marsh Valley Canal Company, and McCammon Ditch Company divert water from the Portneuf River via the Portneuf Marsh Valley Canal and the McCammon Ditch for irrigation of lands within Marsh Valley (Figure 16). These three irrigation companies provide irrigation water for approximately 11,000 acres. Water District 29 records from 1989 through 2020 indicate annual diversions of Portneuf River water by these three companies ranged from 28,000 to 52,000 acre-feet (AF), averaging approximately 43,000 AF (Figure 17). Portions of the McCammon Ditch Company and Portneuf Irrigating Company lie within the main-stem Portneuf River drainage area, but the majority of their places of use are within the Marsh Creek drainage area.

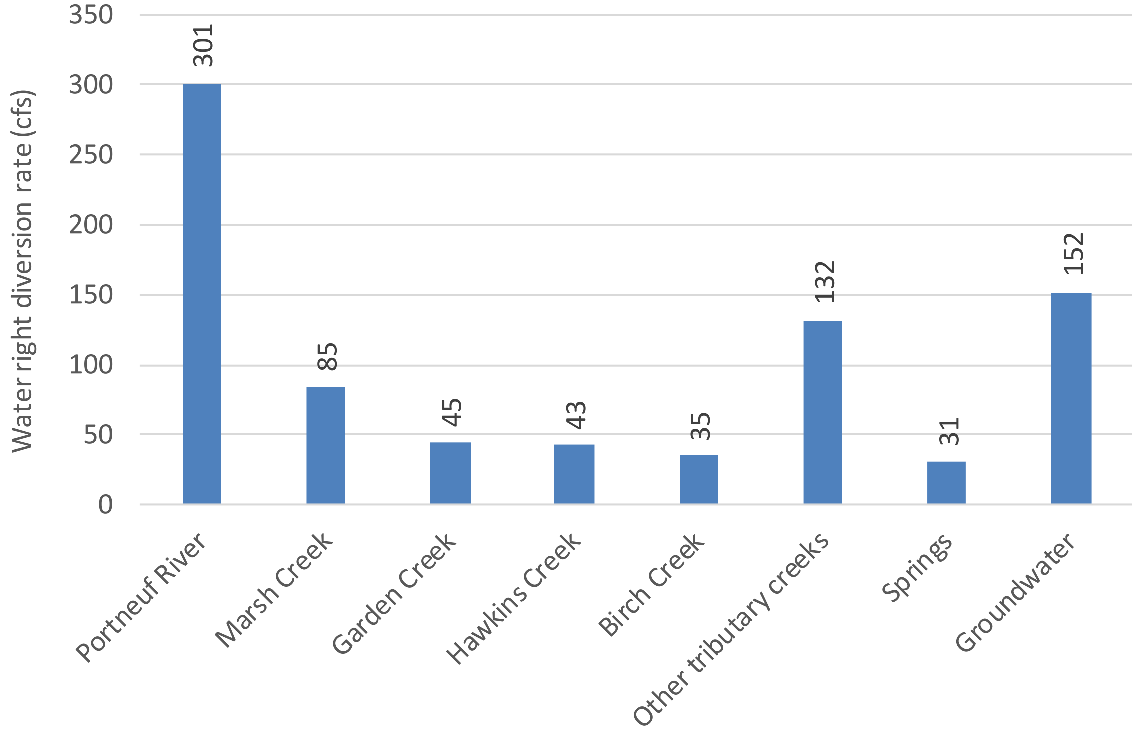

Figure 13. Water sources for irrigation, municipal, commercial, and industrial use

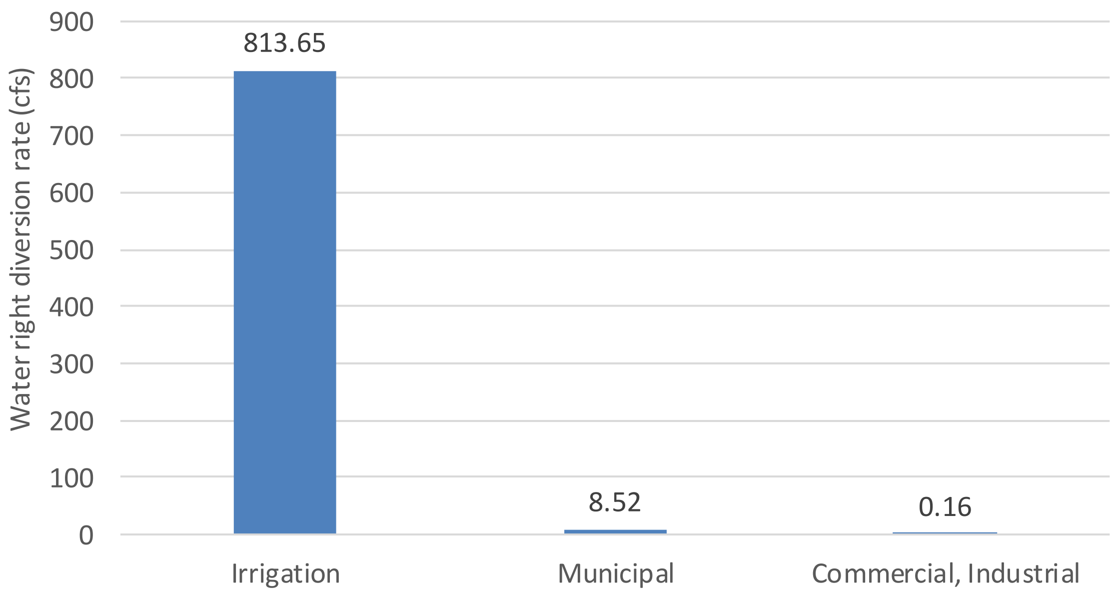

Figure 14. Water right diversion rate by nature of use

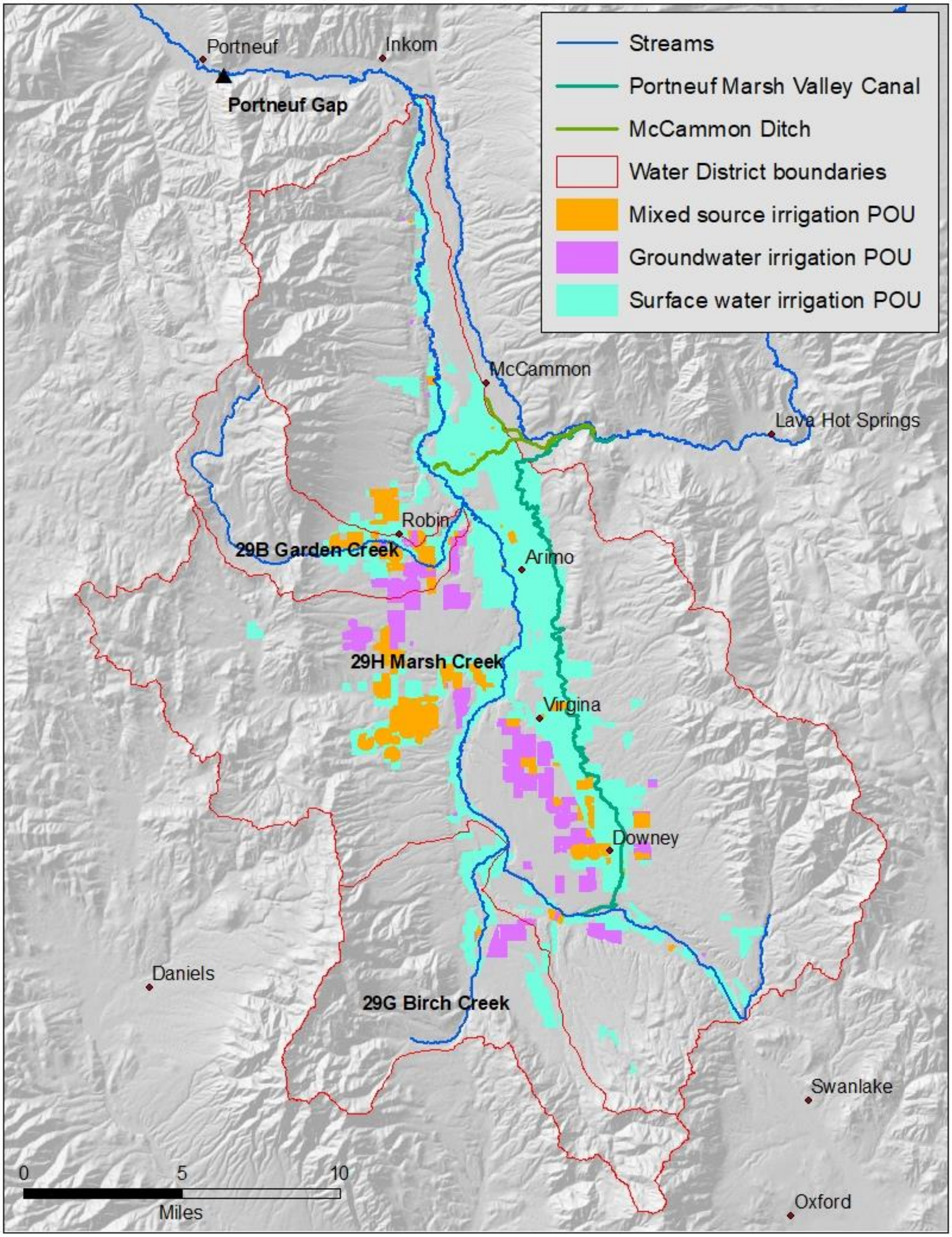

Figure 15. Irrigation water right places of use in Marsh Creek drainage area

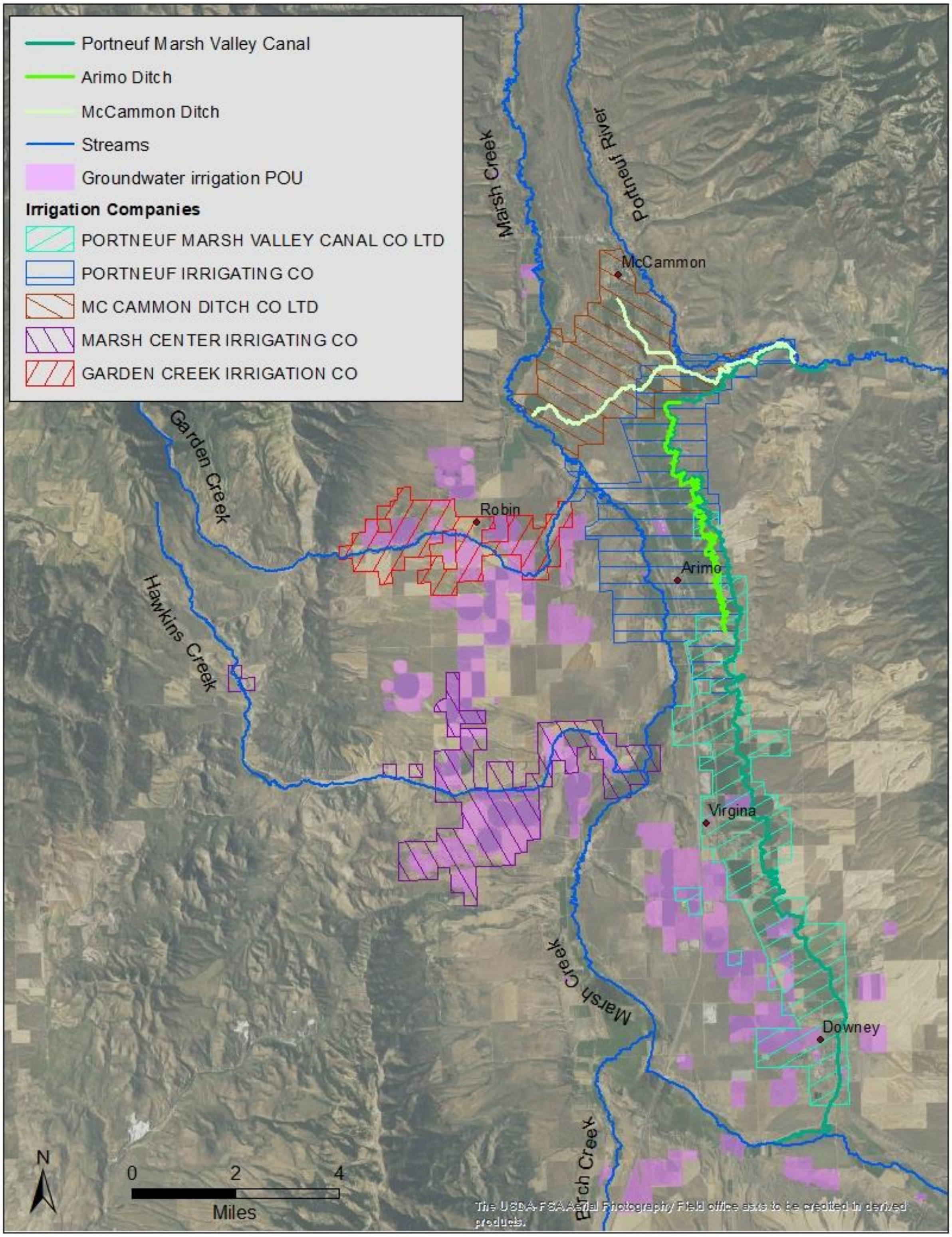

Figure 16. Irrigation companies in Marsh Creek drainage area

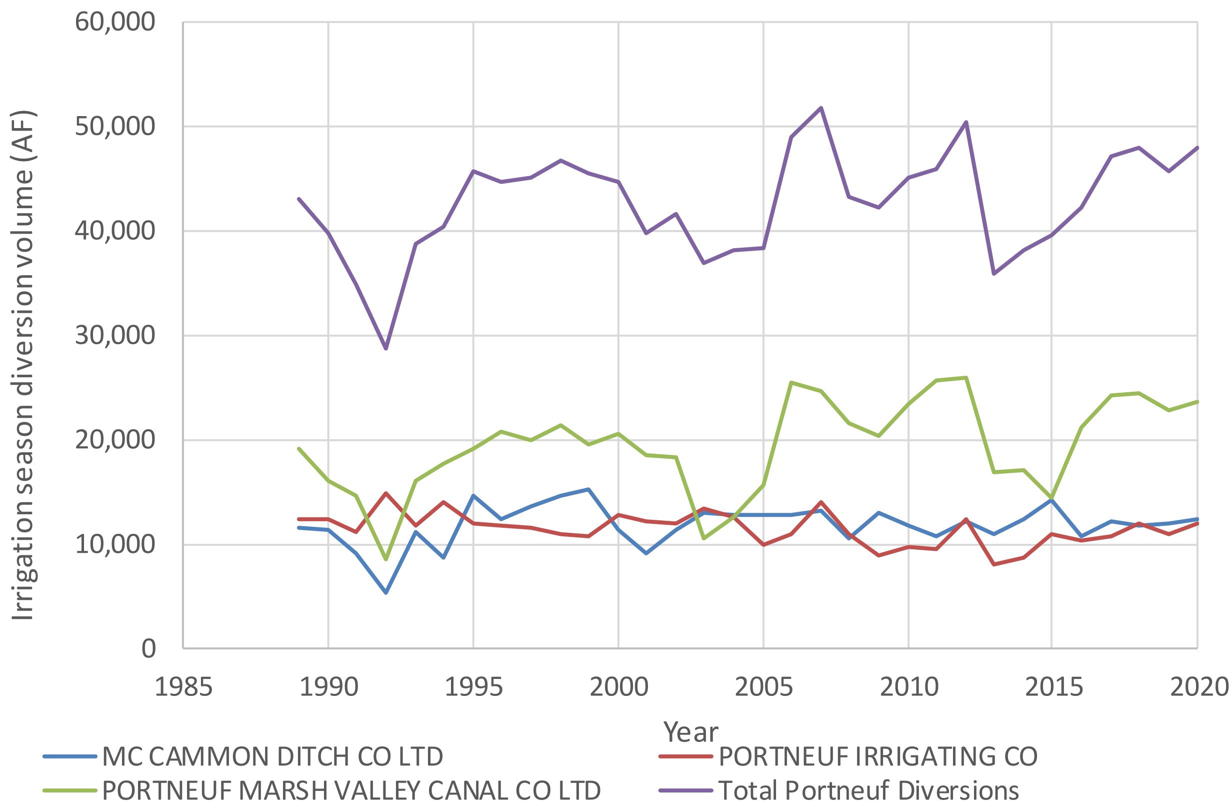

Figure 17. Diversions of Portneuf River water to Marsh Valley irrigation companies

The Marsh Center Irrigating Company (Figure 16) diverts water from Hawkins Creek (tributary to Marsh Creek) and Hawkins Reservoir for irrigation of approximately 3,200 acres. Garden Creek Irrigation Company diverts water from Garden Creek for irrigation of approximately 700 acres. Numerous other surface water right holders also divert water from Marsh Creek and its tributaries.

Water District 29H (Figure 15) was recently activated to record and administer diversions from Marsh Creek and its tributaries (except for Birch and Garden Creeks). In 2020, the Watermaster reported diversions of 530 AF by Marsh Center Irrigating Company, 401 AF by the City of Downey, and 68 AF by the City of Arimo. The City of Downey diverts water from springs, Ninemile Creek, and groundwater. The City of Arimo diverts water from Chatterton Spring and groundwater. It appears the Water District 29H records include only surface water diversions. Other water users in Water District 29H were in the process of installing measuring devices during or after the 2020 irrigation season.

Surface water deliveries from Garden Creek are administered by Water District 29B on a "pool and rotate" basis when streamflow exceeds 4 cfs.[1] The Watermaster records the number of days water is delivered to each water user, but does not record a diversion rate or volume. When streamflow drops to 4 cfs, the Garden Creek Irrigation Company delivers the remaining water to the company shareholders. Watermaster diversion records from 1994 through 2004, 2017, and 2020 indicate the "pool and rotate" deliveries typically ended between mid-May and mid-June in dry years and extended into mid-July in wet years.

Surface water deliveries from Birch Creek are administered by Water District 29G. The Watermaster reports do not include records of water delivery dates or volumes. Authorized diversions from Birch Creek include up to 6.2 cfs of out-of-basin delivery diverted by Malad Valley Irrigation Company from the head of Birch Creek into Devil Creek in Administrative Basin 15. The out-of-basin delivery also includes up to 4,464 AF per year of diversion to storage in Devil Creek Reservoir for irrigation of up to 2,232 acres in the Malad Valley.

Based on water right priority dates for irrigation, municipal, commercial, and industrial uses, it appears the majority of groundwater use was developed between 1950 and 1990 (Figure 18). Groundwater diversions in the Marsh Creek drainage area have not historically been regulated by a Water District and measured diversion records are not available. Norvitch and Larson (1970) estimated that approximately 9,200 AF per year of groundwater was pumped to irrigate approximately 4,000 acres of land in Marsh Valley in the late 1960s, with a net consumptive use of approximately 4,400 AF per year. Based on water right priority dates and diversion rates, it appears that approximately 60% of the groundwater use in Marsh Valley was developed in 1970 or later. This is consistent with the approximately 11,000 acres of land currently covered by irrigation places of use for primary or supplemental groundwater rights. Extrapolation of Norvitch and Larson's estimate suggests that current consumptive use of groundwater for irrigation in Marsh Valley may be on the order of 11,000 to 12,000 AF per year.

[1] *Garden Creek Water District 29-B Minutes of the Annual Meeting*, March 5, 2020, https://research.idwr.idaho.gov/files/relateddocs/fmny01_.PDF.

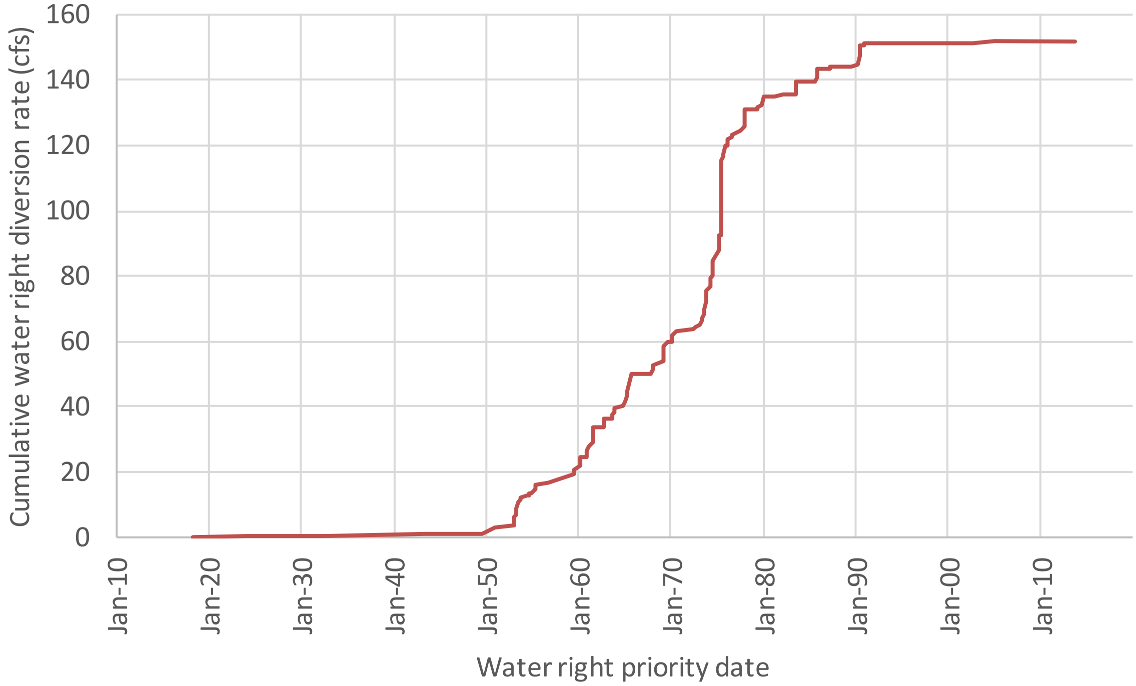

Figure 18. Historical development of groundwater rights in the Marsh Creek drainage

Consumptive use of water for irrigation was evaluated by analysis of crop irrigation requirement rasters calculated from METRIC[2] evapotranspiration and PRISM[3] precipitation data sets. Because detailed irrigated lands delineations are not available for Marsh Valley, water right places of use were used to overlay the crop irrigation requirement rasters. Areas where the crop irrigation requirement was less than 150 millimeters over the irrigation season (April through October) were assumed to be non-irrigated and were excluded from the analysis. The consumptive use calculated for nine irrigation seasons between 2010 and 2020 ranged from 31,000 to 48,000 AF per season, averaging approximately 43,000 AF per season. The mean crop irrigation requirement ranged from 1.2 to 1.7 feet per season. The consumptive use calculated for

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[2] Mapping EvapoTranspiration using high Resolution and Internalized Calibration, https://idwr.idaho.gov/GIS/mapping-evapotranspiration/

[3] Parameter-elevation Relationships on Independent Slopes Model, https://prism.oregonstate.edu/

lands irrigated wholly or partially with groundwater ranged from 8,000 to 13,000 AF per season, averaging approximately 11,000 AF.

AQUIFER CONDITIONS

Aquifer recharge and discharge

Sources of recharge to the Marsh Valley aquifer system include infiltration of precipitation and snowmelt runoff, canal seepage and infiltration of excess surface water applied to irrigated fields. Discharge from the Marsh Valley aquifer system includes groundwater withdrawals for consumptive use (primarily irrigation), aquifer discharge to Marsh Creek, and evapotranspiration from wetlands and riparian areas.

Aquifer recharge is expected to vary by year with surface water availability. Recharge from canal seepage and incidental infiltration of applied water is generally expected to be higher in years with good surface water supply and lower in years with poor surface water supply. Changes in irrigation efficiency and crop irrigation demand will also affect the quantity of aquifer recharge from canal seepage and incidental recharge. PRISM[3] precipitation data sets were analyzed to evaluate potential long-term trends in the annual precipitation within the Marsh Creek drainage area (Figure 19). A Mann Kendall trend analysis of annual precipitation indicates there is not a statistically significant trend in precipitation volume between 1954 and 2020 (Appendix A, Table 2).

Recharge associated with diversions of Portneuf River water to the Portneuf Marsh Valley Canal and McCammon Ditch appears to be a significant component of recharge to the Marsh Valley aquifer system. A Mann Kendall trend analysis of annual diversions from the Portneuf River into Marsh Valley indicates there is not a statistically significant trend in diversion volume over the 1989 through 2020 period of record (Appendix A, Table 2). Historical records of surface water diverted from sources within the Marsh Creek basin are not available.

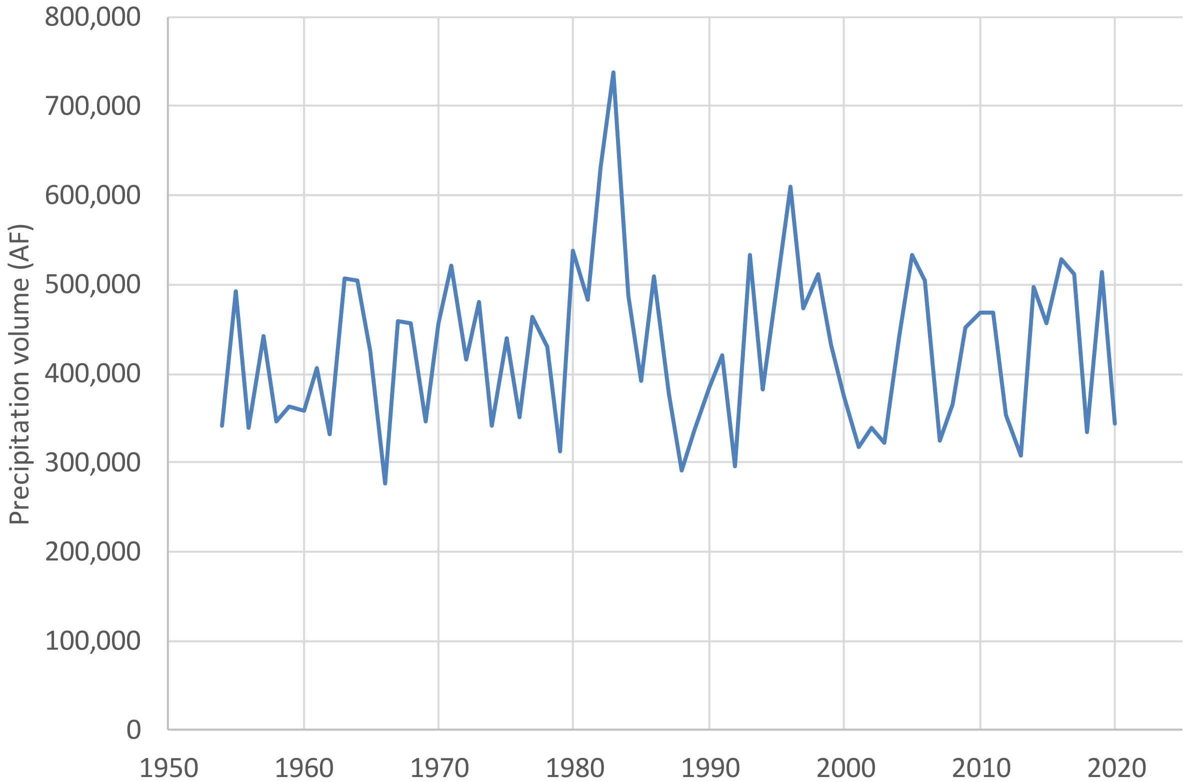

Figure 19. Annual precipitation within the Marsh Creek drainage area

The December 1968 seepage survey described by Norvitch and Larson (1970) indicates there is little or no aquifer discharge to the Portneuf River between Topaz and the confluence with Marsh Creek, and that there is not a significant gain or loss in the Portneuf River between the confluence and the Portneuf Gap (Figure 7). Welhan (2006) estimated the underflow at the Portneuf Gap to be approximately 4.5 cfs (3,300 AF per year) in a normal year and 4.3 cfs (3,100 AF per year) in a drought year. The December 1968 seepage survey (Norvitch and Larson, 1970) observed 80 cfs of aquifer discharge to Marsh Creek upstream of the McCammon gaging station and an additional 10 cfs of aquifer discharge to Marsh Creek between the gaging station and the confluence with the Portneuf River. Based on these data sources, the majority of aquifer outflow from the Marsh Valley aquifer system occurs as discharge to Marsh Creek, with groundwater outflow to the lower Portneuf Valley and Eastern Snake Plain aquifer systems comprising a relatively small portion of the aquifer discharge.

Statistical analyses of November through January streamflow records at the McCammon gaging station (Appendix A, Table 2) indicate a long-term declining trend in aquifer discharge to Marsh Creek upstream of the gaging station of approximately 0.6 cfs, equivalent to a decrease of approximately 40 cfs since the mid-1950s. The lowest monthly average base flow recorded at the McCammon gaging station was 30 cfs during December 2013 and January 2014. Most recently, the average streamflow measured at the McCammon gaging station during November 2020 through January 2021 was 44 cfs. Additional aquifer discharge to Marsh Creek is expected to occur between the gaging station and the confluence with the Portneuf River, but is likely now less than the 10 cfs observed in December 1968.

Water level monitoring

IDWR currently monitors water level in four wells located within the Marsh Creek drainage area (Figure 20). Water level trends in spring (March or April) and fall (October or November) measurements were evaluated using the regional Kendall test and Mann Kendall test as described in Helsel, et al. (2006). The regional Kendall statistical test was developed by the U.S. Geological Survey (USGS) to analyze trends where observations have been made annually at multiple locations, such as water wells, to determine whether the same trend is evident across those locations. The computer code and documentation are freely available from the USGS.

Well 09S 36E 22CCC1 is located in Lower Marsh Valley along Marsh Creek Road, approximately 900 feet west of Marsh Creek and one mile southwest of the USGS Marsh Creek near McCammon streamflow gaging station. The driller's log indicates the well obtains water from sand and gravel at a depth of 108 to 145 feet below ground surface (BGS), underlying approximately 85 feet of clay and 23 feet of boulders and topsoil. Water level in this well was measured infrequently by the USGS between 1976 and 2009 (Figure 21). IDWR began collecting spring and fall water level measurements in this well in the spring of 2016 (Figure 22). There appears to be a declining trend in groundwater level in this well, but Mann Kendall analyses of the spring and fall water levels (Appendix A, Table 1) indicate the trend is not statistically significant, likely due to the short period of record.

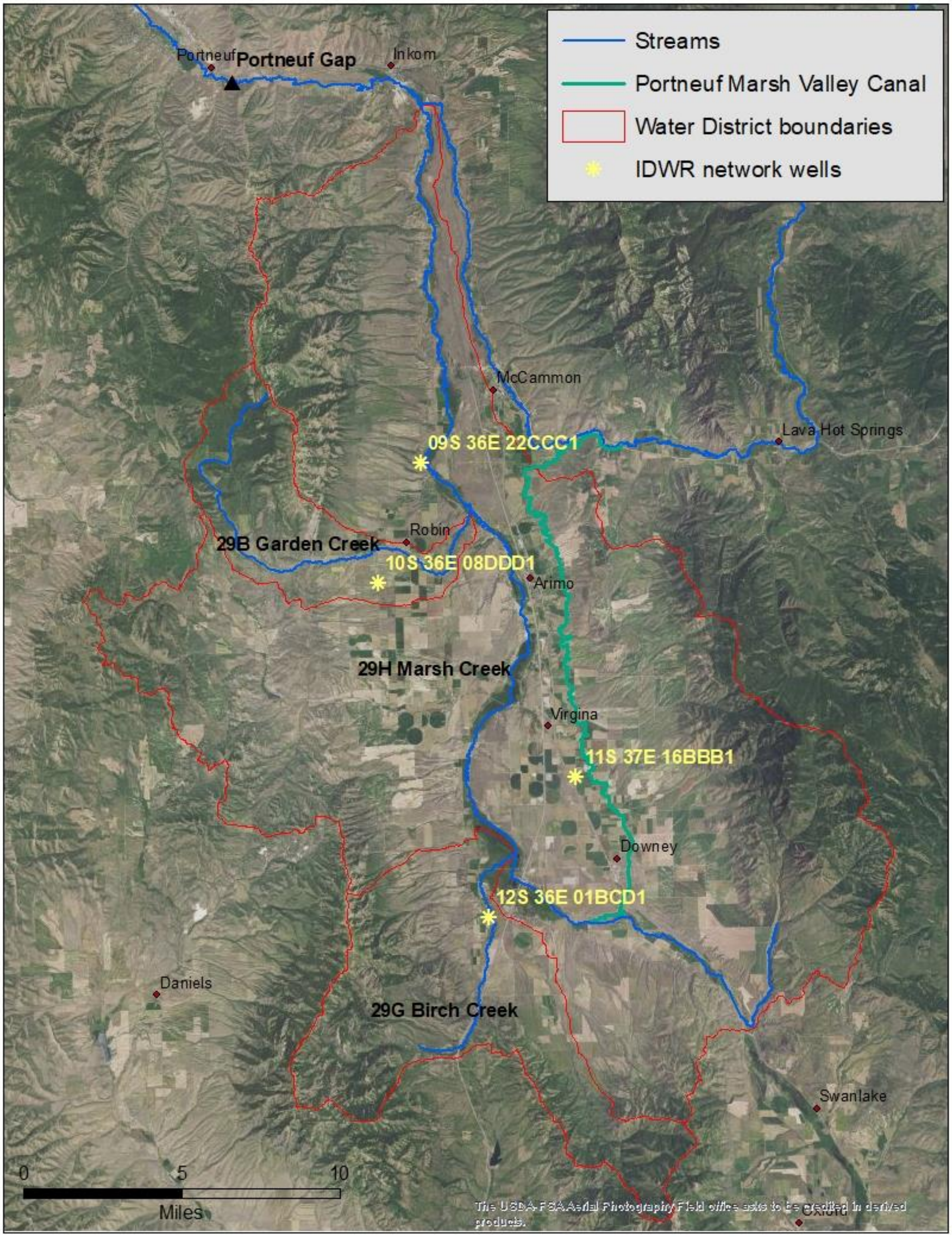

Figure 20. IDWR water level monitoring wells in the Marsh Valley aquifer system

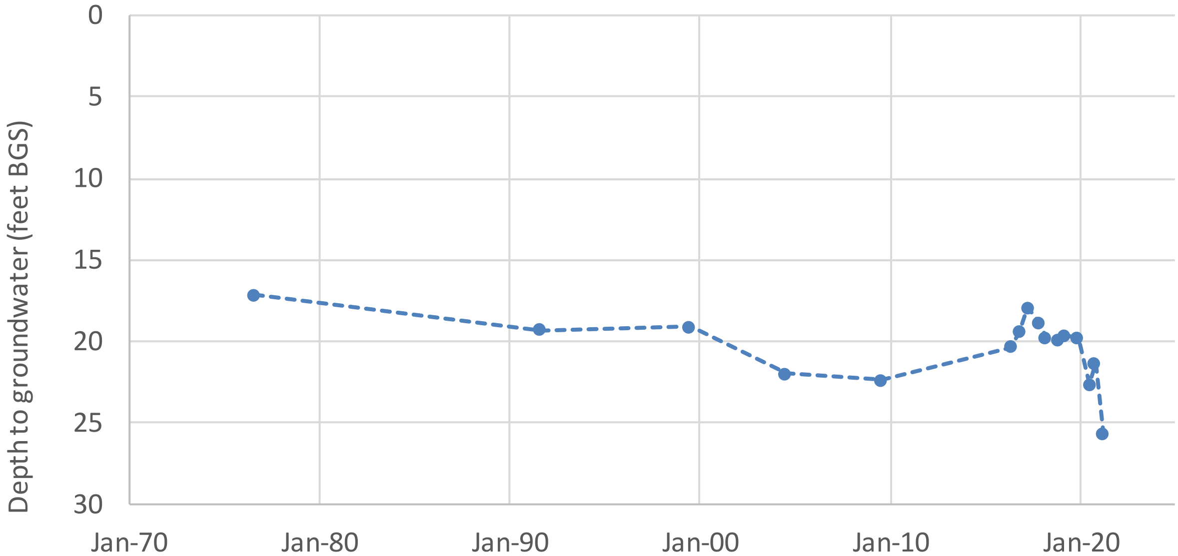

Figure 21. Water level in Well 09S 36E 22CCC1 (all measurements)

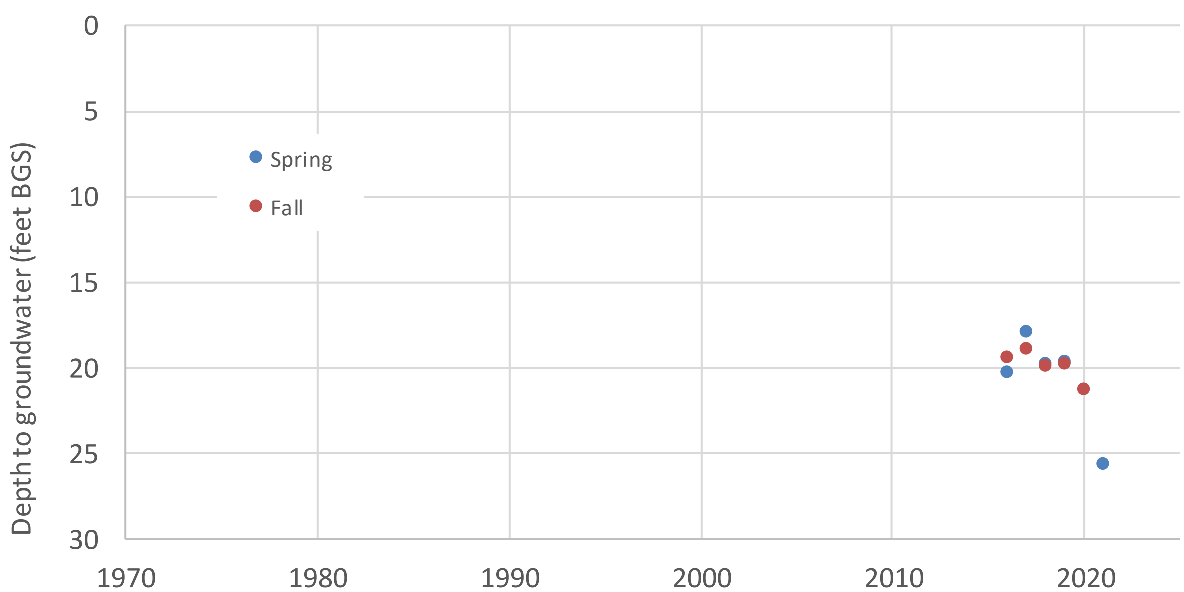

Figure 22. Water level in Well 09S 36E 22CCC1 (spring and fall measurements)

Well 10S 36E 08DDD1 is located in the Garden Creek drainage area, along Thacker Road approximately one mile south of Garden Creek and 1.5 miles southwest of the town of Robin. The driller's log indicates the well obtains water from multiple gravel layers which are interbedded with clay and sandstone. The well casing is perforated in four zones between 115 and 212 feet below ground surface. The USGS measured water levels in this well frequently between 1968 and 2009, and IDWR began monitoring water levels in 2010 (Figure 23). Spring and fall water level measurements are available for 48 and 44 years, respectively, of the 54 year period from 1968 through 2021 (Figure 24). Mann Kendall analyses indicate a statistically significant declining trend of approximately 0.4 feet per year for both spring and fall groundwater levels in this well (Appendix A, Table 1).

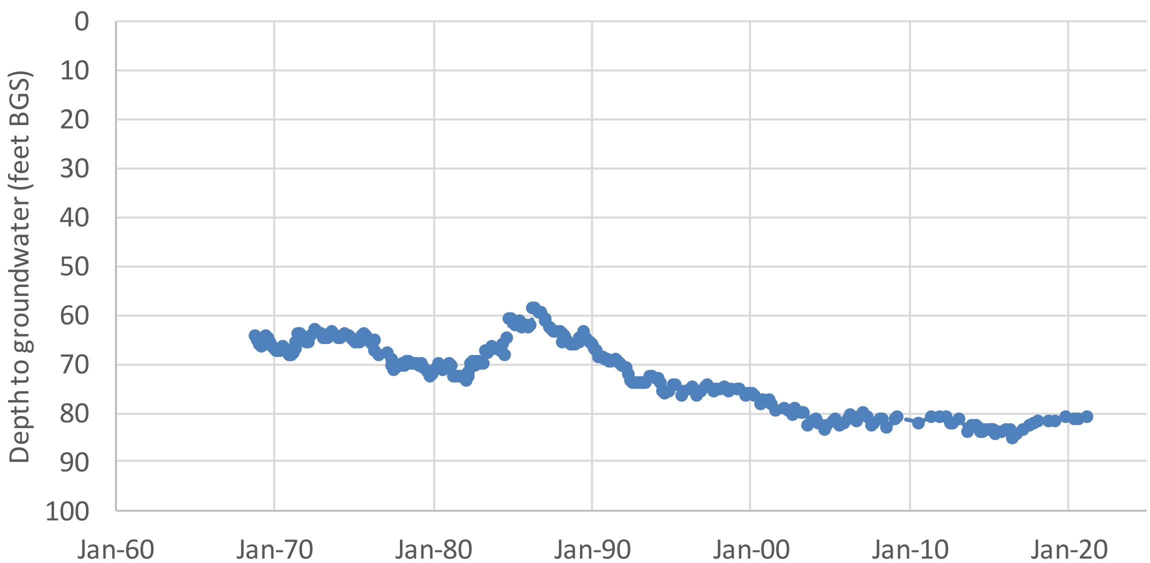

Figure 23. Water level in Well 10S 36E 08DDD1 (all measurements)

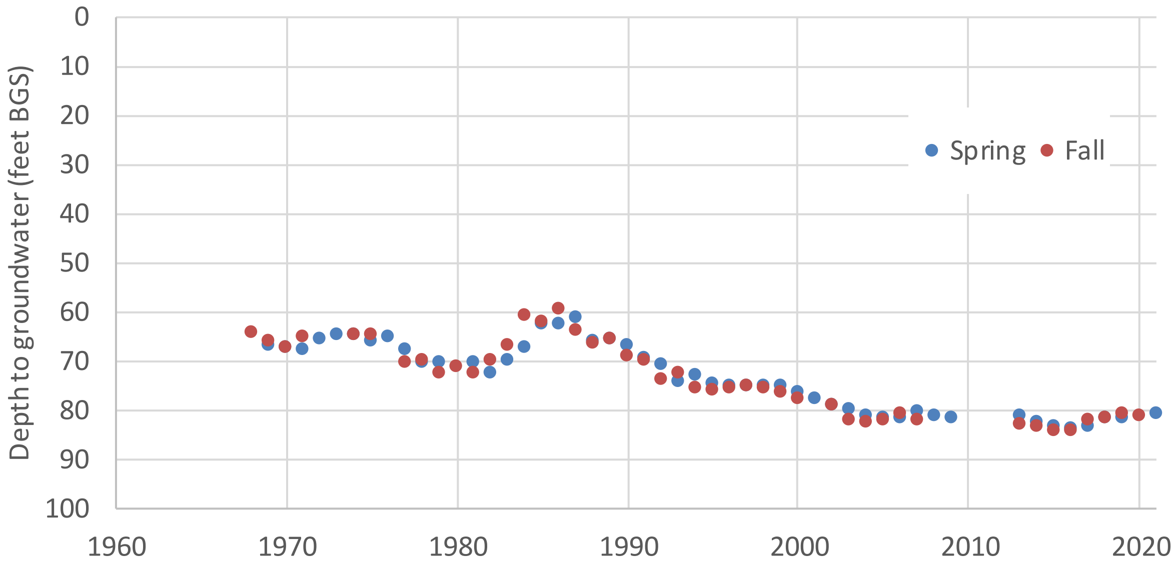

Figure 24. Water level in Well 10S 36E 08DDD1 (spring and fall measurements)

Well 11S 37E 16BBB1 is located in upper Marsh Valley, near the intersection of Highway 91 and Bowman Road, approximately 0.4 mile west of the Portneuf Marsh Valley Canal and 3 miles north-northwest of Downey. A driller's log is not available for this well. The USGS measured water levels in this well frequently between 1968 and 2009, and IDWR began monitoring water levels in 2010 (Figure 25). Spring and fall water level measurements are available for 46 and 43 years, respectively, of the 54 year period from 1968 through 2021 (Figure 26). Mann Kendall analyses indicate a statistically significant declining trend of approximately 0.07 feet per year for both spring and fall groundwater levels in this well.

In Well 11S 37E 16BBB1, the fall water level is higher than the spring water level in most years, suggesting the water level at this site is influenced by aquifer recharge from Portneuf Marsh Valley Canal seepage and other incidental recharge associated with irrigation by surface water. The fall water level was lower than the spring water level in 1992, 2003, and 2004. These three years had the lowest recorded diversions from the Portneuf River to the Portneuf Marsh Valley Canal Company (Figure 17).

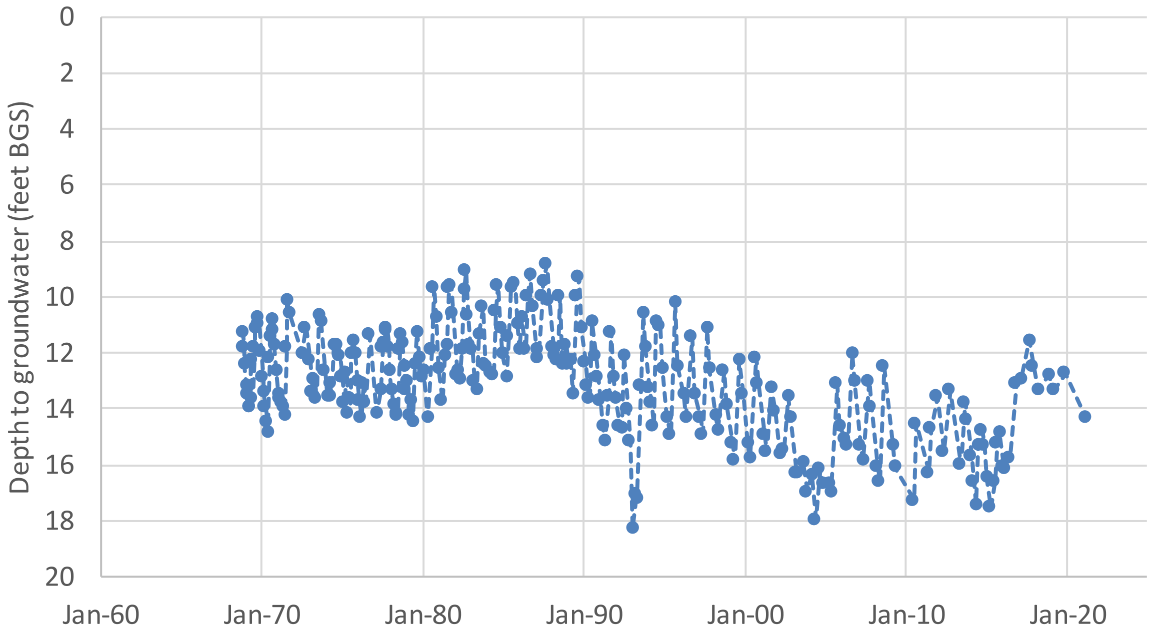

Figure 25. Water level in Well 11S 37E 16BBB1 (all measurements)

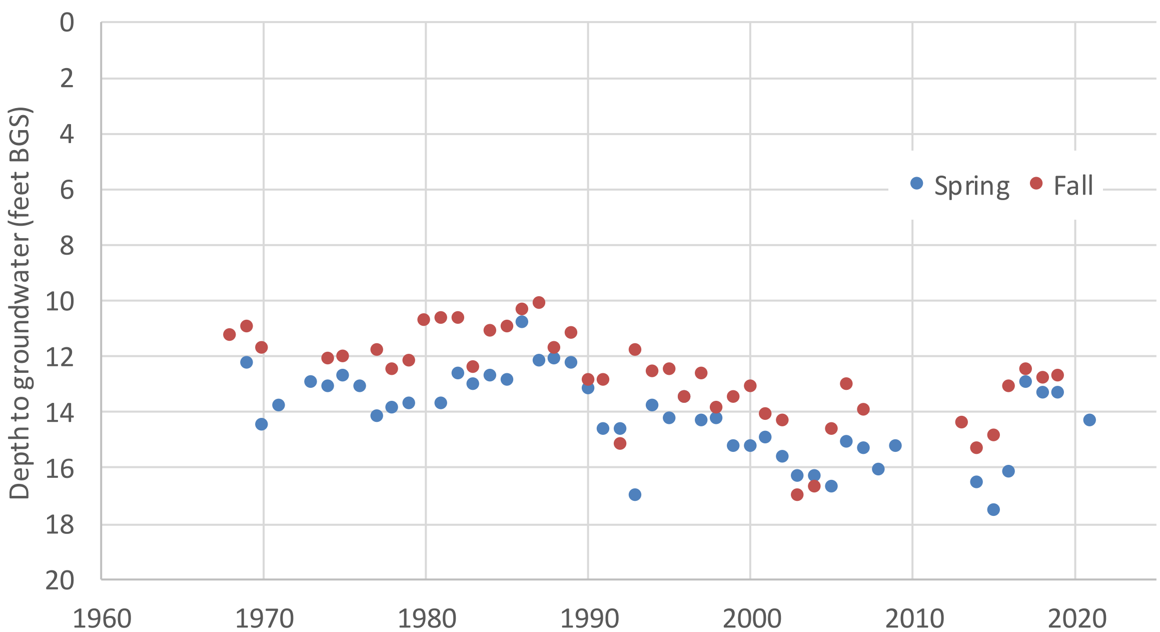

Figure 26. Water level in Well 11S 37E 16BBB1 (spring and fall measurements)

Well 12S 36E 01CD1 is located along Birch Creek Road, approximately 500 feet west of the creek. The driller's log indicates the well obtains water from gravel and sand at a depth of 140 feet below ground surface. The USGS measured water levels in this well intermittently between 1991 and 2009 (Figure 27). IDWR began monitoring spring and fall water levels in 2016 (Figure 28). Between 2016 and 2021 there appears to be an increasing trend in groundwater level in this well, but Mann Kendall analyses of the spring and fall water levels (Appendix A, Table 1) indicate the trend is not statistically significant, likely due to the short period of record.

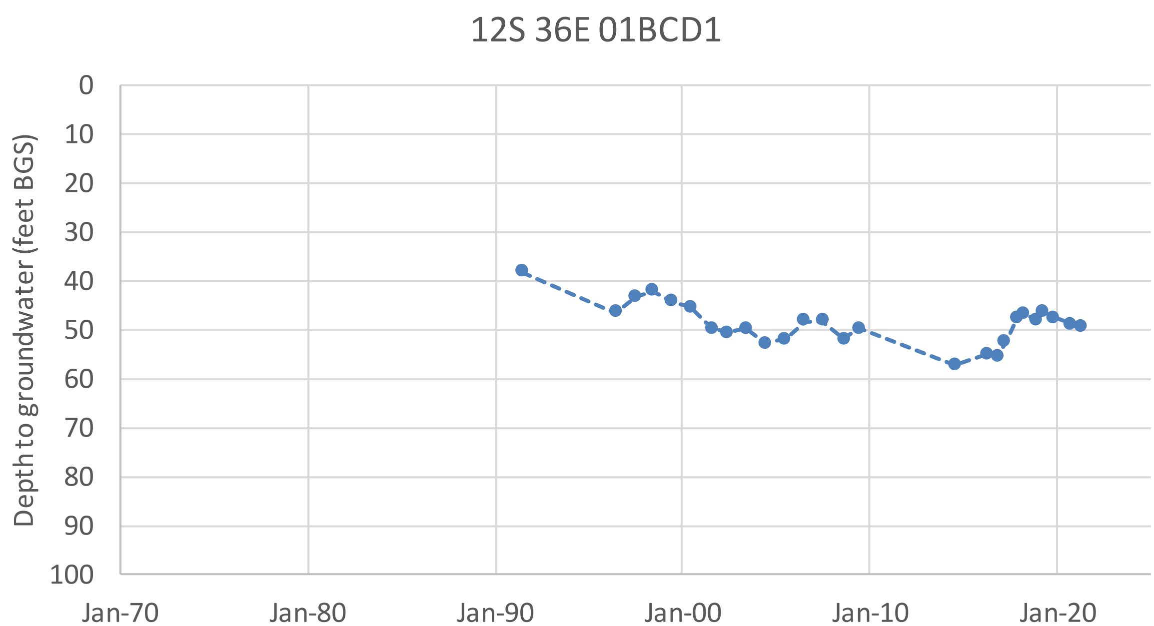

Figure 27. Water level in Well 12S 36E 01BCD1 (all measurements)

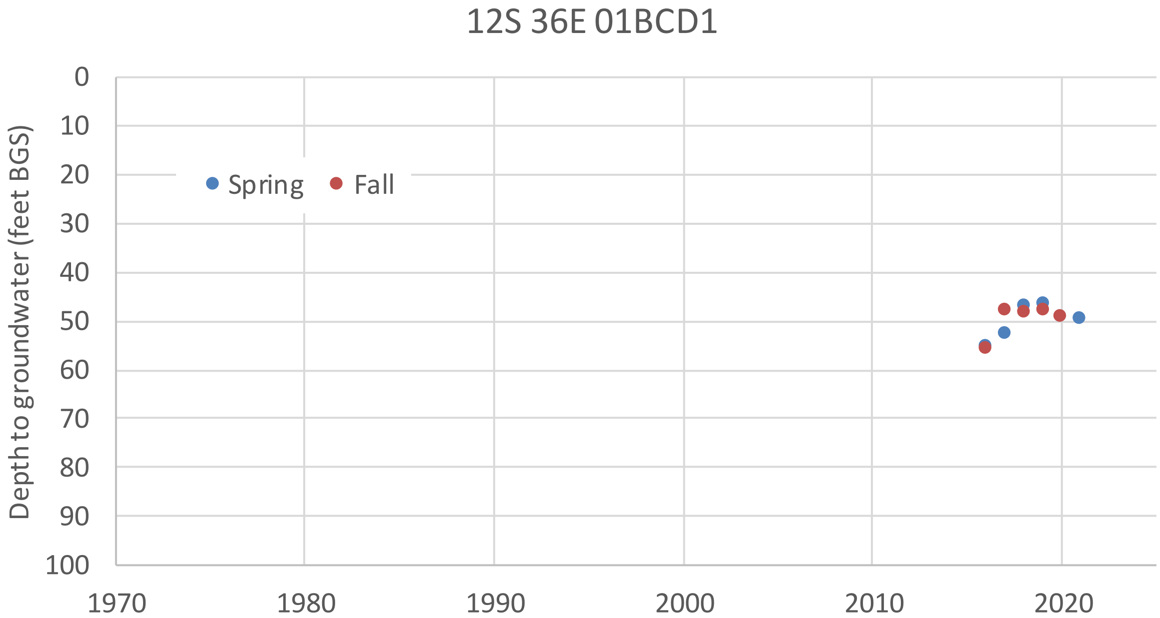

Figure 28. Water level in Well 12S 36E 01BCD1 (spring and fall measurements)

Regional Kendall trend analyses were computed for spring and fall groundwater levels from all four of the wells (Appendix A, Table 1). The analyses indicate a statistically significant declining trend of 0.2 feet per year for both spring and fall water levels over a 50-year period, which is equivalent to a long-term decline of approximately 10 feet. Because of the small number of wells in the water level monitoring network, this value may not be representative of the magnitude of the average water level decline throughout the Marsh Valley aquifer system.

CONCLUSIONS AND RECOMMENDATIONS

Sources of recharge to the Marsh Valley aquifer system include infiltration of precipitation, snowmelt runoff, canal seepage, and excess surface water applied to irrigated fields. Discharge from the Marsh Valley aquifer system includes groundwater withdrawals for consumptive use (primarily irrigation) and evapotranspiration from wetlands and riparian areas. The majority of outflow from the Marsh Valley aquifer system occurs as discharge to Marsh Creek, with groundwater outflow to the lower Portneuf Valley and Eastern Snake Plain aquifer systems comprising a relatively small portion of the aquifer discharge.

Data available regarding aquifer conditions in the Marsh Valley aquifer system are limited. IDWR currently monitors aquifer water level in four wells. Only two of these wells have sufficient records to evaluate long-term aquifer level trends. The results of one seepage survey performed in December of 1968 (Norvitch and Larson, 1970) provide some information about aquifer discharge to Marsh Creek. Streamflow records from a long-term USGS gaging station on Marsh Creek near McCammon provide information on long-term trends in aquifer discharge to Marsh Creek.

Diversion records for surface water imported from the Portneuf River into Marsh Valley are available from Water District 29. Diversion records for surface water diverted from Marsh Creek and its tributaries are currently limited. Beginning in 2021, diversion records for surface water diverted from Marsh Creek and Hawkins Creek may be available from Water District 29H. Water Districts 29B and 29G, which regulate diversions from Garden and Birch Creeks, have not historically provided records of the rate or volume of surface water diverted. Groundwater diversions are currently unregulated and unmeasured.

Consumptive use of irrigation water calculated from METRIC evapotranspiration and PRISM precipitation data averaged approximately 43,000 AF per season (1.4 AF per acre), with an average of approximately 11,000 AF per season on lands irrigated wholly or partially with groundwater.

Portneuf River water diverted by Marsh Valley irrigation companies ranges from 28,000 to 52,000 AF per year, averaging approximately 43,000 AF per year, for the irrigation of approximately 11,000 acres. Canal seepage and incidental recharge associated with these diversions are likely significant components of recharge to the Marsh Valley aquifer system.

Based on the available data, there is evidence of long-term groundwater level decline in the Marsh Valley aquifer system and long-term decline in aquifer discharge to Marsh Creek. Statistically significant declines of 0.07 and 0.4 feet per year were observed in spring and fall water levels in the two wells with long-term records, equivalent to declines of approximately 4 and 21 feet over a 52-year period or record. Evaluation of streamflow records indicates a statistically significant decline in aquifer discharge to Marsh Creek above the McCammon gaging station of 0.6 cfs per year (440 AF per year), equivalent to a decline of approximately 40 cfs (29,000 AF) over a 66-year period of record.

Precipitation within the Marsh Creek drainage area and diversions of surface water from the Portneuf River into Marsh Valley vary significantly from year to year, but there are not statistically significant long-term trends in basin precipitation or the annual volume of diversions imported from the Portneuf River.

Additional monitoring may be warranted to support conjunctive management of water resources in the Marsh Creek drainage area. Recommendations for additional data collection are provided below.

1. Continue monitoring spring and fall water levels in the four wells currently in the IDWR monitoring network. Install pressure transducers in these wells if feasible.

2. Consider adding five to eight wells to the IDWR water level monitoring network and installing pressure transducers where feasible. Manually measure water levels at least twice a year in the spring and fall. Recorded well locations from drillers' logs are shown along with the current IDWR monitoring network in Appendix B, Figure 29 for reference.

3. Consider performing a seepage survey during base flow conditions to evaluate changes in aquifer discharge to Marsh Creek since the December 1968 survey. Consider performing additional seepage surveys to evaluate seasonal changes in aquifer discharge to Marsh Creek.

4. Consider establishing additional continuous streamflow gaging stations on Marsh Creek and perennial tributaries to monitor seasonal and annual variations in reach gains to Marsh Creek.

5. Consider requiring monthly measurement and reporting of groundwater diversions and any surface water diversions not included in existing measurement orders.

6. Continue inclusion in future METRIC evapotranspiration data sets developed for the Eastern Snake Plain.

7. Consider delineating irrigated lands in Marsh Valley.

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APPENDIX A.

TREND ANALYSES

Table 1. Mann Kendall groundwater level trend analyses

Well	Period of record	Water level trend (ft/yr)	p-value	Net change (ft)	Statistical significance ($p<0.05$)
09S 36E 22CCC1	Spring 2016-2021	-0.961	0.8065	--	Not significant
09S 36E 22CCC1	Fall 2016-2020	-0.455	0.2207	--	Not significant
10S 36E 08DDD1	**Spring 1969-2021**	**-0.404**	**0.0000**	**-21.0**	**Significant**
10S 36E 08DDD1	**Fall 1968-2020**	**-0.416**	**0.0000**	**-21.6**	**Significant**
11S 37E 16BBB1	**Spring 1969-2021**	**-0.068**	**0.0001**	**-3.5**	**Significant**
11S 37E 16BBB1	**Fall 1968-2019**	**-0.073**	**0.0000**	**-3.8**	**Significant**
12S 36E 01BCD1	Spring 2016-2021	+1.825	0.2207	--	Not significant
12S 36E 01BCD1	Fall 2016-2020	+0.232	0.8065	--	Not significant
Regional (4 wells)	**Spring 1972-2021**	**-0.208**	**0.0000**	**-10.2**	**Significant**
Regional (4 wells)	**Fall 1971-2020**	**-0.191**	**0.0000**	**-9.4**	**Significant**

Table 2. Mann Kendall surface water trend analyses

Flow	Period of record	Trend	p-value	Net change	Statistical significance ($p<0.05$)
Marsh Creek nr McCammon	**November 1954-2020**	**-0.663 cfs/yr**	**0.0000**	**-44 cfs**	**Significant**
Marsh Creek nr McCammon	**December 1954-2020**	**-0.610 cfs/yr**	**0.0000**	**-40 cfs**	**Significant**
Marsh Creek nr McCammon	**January 1955-2021**	**-0.531 cfs/yr**	**0.0001**	**-35 cfs**	**Significant**
Portneuf River diversions to Marsh Valley	Annual volume 1989-2020	+183.3 AF/yr	0.0622	--	Not significant
Precipitation in Marsh Creek drainage area	Annual volume 1954-2020	+417.2 AF/yr	0.4169	--	Not significant
Crop irrigation requirement	Irrigation season volume 1986-2020	-77.39 AF/yr	0.6505	--	Not significant

APPENDIX B.

RECORDED WELL LOCATIONS

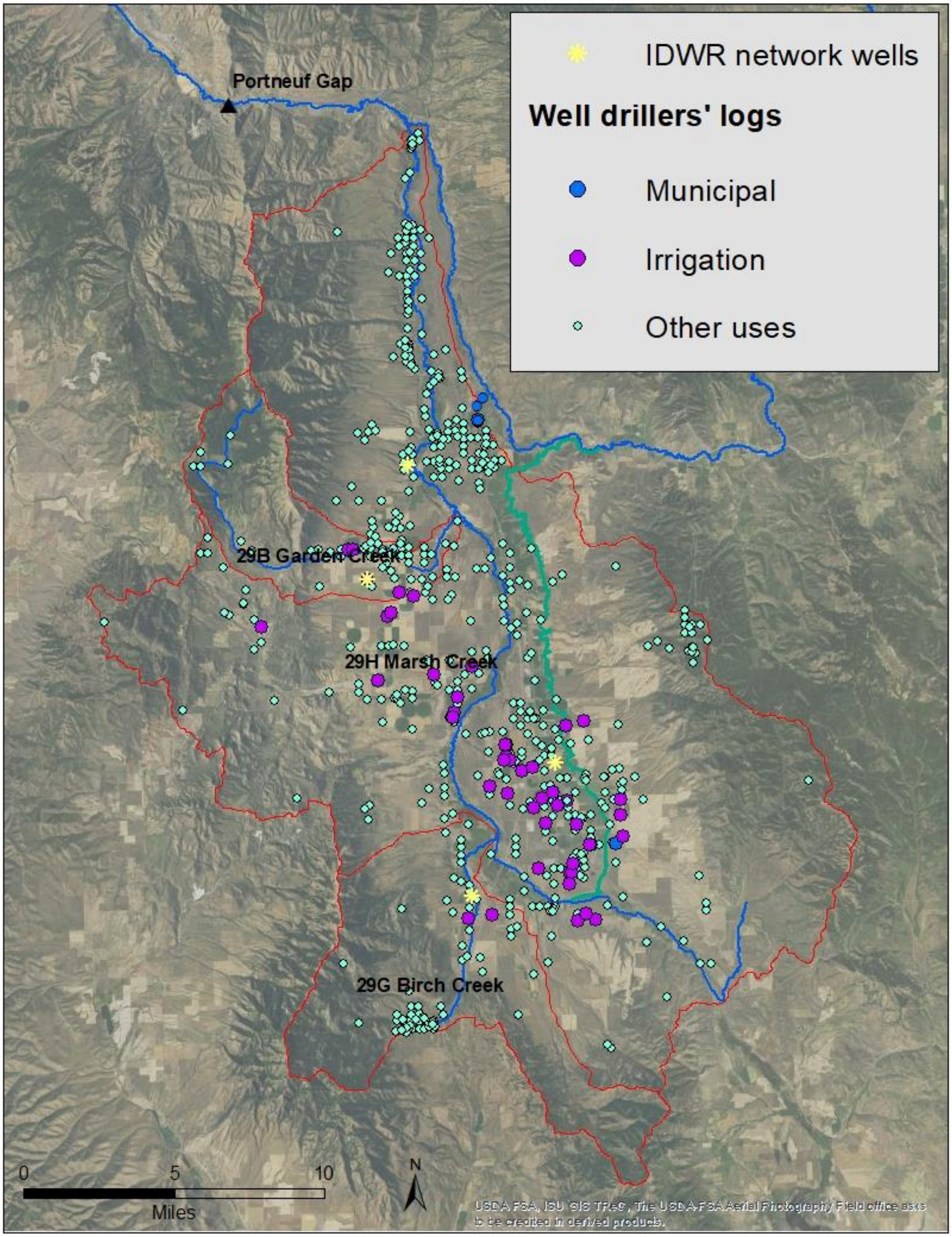

Figure 29. Recorded well locations and current IDWR monitoring network wells