

Great West Engineering, Inc.

***Judith Basin Monitoring System
Final Report***

Central Montana Regional Water Authority

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1. INTRODUCTION

This report presents water resources data and analysis completed by the Central Montana Regional Water Authority (CMRWA) in southern Judith Basin, Montana. This project was completed through a grant to CMRWA from the State of Montana in 2016. It included three years of monitoring, ending in fall 2019.

CMRWA is in the process of building the Musselshell-Judith Regional Water System (MJRWS) to supply water to public water systems from approximately Hobson to Melstone.¹ The service population is projected for 7,500 in year 2065. The source of supply for the MJRWS is groundwater obtained from the Madison aquifer 3.5-miles west of Garneill, referred to as the U Bet Wellfield due to its location along U Bet Road.

The first U Bet Wellfield well, CMRWA Well #2, was constructed in 2012 to a depth of 2,250 feet (ft) and can produce 575 gallons per minute (gpm) to the water system.² Based on hydraulic testing of the CMRWA Well #2, water rights for the MJRWS were secured. The water system is presently permitted for a maximum withdrawal rate of 2,840 gallons per minute (gpm), and annual volume of 1,310 acre-ft (af). There are presently a total of four wells planned for the U Bet Wellfield, although the final number of wells will depend on actual well capacity. The second U Bet Wellfield well, CMRWA Well #3, was constructed in 2019 and has a design capacity of 1,250 gpm (this well construction was not part of the grant project).

In 2014, CMRWA completed a Water Resources Monitoring Plan. This plan became the technical basis for the grant application to the State in 2015 to complete the Water Resources Monitoring System, the subject of this report. In preparing this plan, a meeting was conducted with local and State participants in Lewistown on April 1, 2014. Participants at the meeting included members of the Lower Missouri River Basin Advisory Council, City of Lewistown, Fergus County Conservation District, Central Montana Resource Council, Montana Fish, Wildlife and Parks (FWP), and Montana Department of Natural Resources and Conservation (DNRC). A two-hour discussion was utilized to go over the plan outline and obtain feedback from the group that was subsequently incorporated into the plan.

The grant was applied for in 2015 and authorized for funding in 2016, with the project beginning in late 2016. There were several project activities completed under the grant that focused on evaluating and documenting groundwater in the Madison and Kootenai aquifers. These activities included:

- Eighteen springs were inventoried to evaluate the source of groundwater. The main purpose of this work was to identify springs that were sourced from the Madison aquifer and could be impacted by future groundwater withdrawals. This spring inventory was required as a condition of the water rights approval. The full report is provided in **Appendix A**.
- Additional pump testing was completed in the CMRWA Well #2 located at the U Bet Wellfield to further evaluate source reliability. This work included the purchase of a permanent pump for the well. The full report is provided in **Appendix B**.
- A new monitoring well into the Kootenai aquifer was constructed at the U Bet Wellfield. This well is monitored for water level and was also sampled for water quality. The purpose of this well is to monitor for hydraulic connection between the Kootenai and Madison aquifers at the location of the wellfield. The Kootenai aquifer is used extensively in Judith Basin for domestic and agriculture. The full report is provided in **Appendix C**.

1 Participating systems presently have insufficient capacity and/or poor water quality.

2 The first well, CMRWA Well #1, was constructed to 3,700 feet at Utica and is presently not planned for use in the water system.

- Big Spring south of Lewistown was equipped with flow metering instruments and is now being monitored daily for spring discharge by FWP. The grant project included work to troubleshoot and repair the existing monitoring equipment, and to install a computerized interface for recording flow rates. FWP is maintaining the flow meter system which also requires periodic manual stream flow measurements in Big Spring Creek and data processing. Discharge data for Big Spring are presented in this report in the section on groundwater monitoring.
- A groundwater monitoring system was established including seven Madison and Kootenai wells. Each location is equipped with a water level instrument with built in computer storage. Data from these monitoring locations is presented in this report. Interim reports for 2017 and 2018 are provided in **Appendix D**.
- A rain gauge was supplied to Montana Department of Transportation for the existing Judith Gap weather station. The new gauge measures precipitation depth and includes a heater for precipitation during winter. The purpose of this gauge was to collect precipitation data at similar elevation as the Kootenai formation outcrops in Judith Basin. Data from this instrument, and temperature data from the same location, are used in recharge analyses presented in the report.
- An interim meeting was held in Lewistown on April 12, 2017 to present the results of the Spring Inventory and CMRWA #2 pumping test. A final report meeting will also be held in Lewistown during 2020. The grant project documents are publicly available through the CMRWA website (<http://www.centralmontanawater.com>) and Montana DNRC.

Grant funds for the project were administrated by Montana DNRC. Great West Engineering, Inc. is the prime consultant to CMRWA for the grant project and the MJRWS project. Great West Engineering completed work for the Big Spring flow metering system. Western Groundwater Services, LLC completed other parts of the grant project while working as a subconsultant to Great West Engineering.

2. SPRING INVENTORY SUMMARY

The spring inventory included 18 springs (**Figure 1**). Each spring was sampled for analysis of laboratory and field parameters. Lab parameters included general water chemistry, stable isotopes and tritium. The full report is provided in **Appendix A**. The conclusions from the inventory were as follows:

- Flow rate from the spring appears to be a significant indicator as to whether a spring is derived from the Madison aquifer. Springs with flow rates less than approximately 14,000 gpm (30 cfs) were identified to have non-Madison sources.
- Surface geology may be a useful determining factor as to the source of spring water. Springs located away from geological structures exhibiting significant deformation (e.g., folding, faulting, and jointing) are likely to be sourced from local near-surface formations. Where the Madison is at great depth and geological structures are absent or minimal, it is unlikely the Madison is sourcing springs in the area.
- Water chemistry analysis for selected parameters provided a clear distinction of Madison and non-Madison groundwater sources to springs. Useful separation was achieved on the Piper diagram for the springs that were sampled. Series plots for Carbon-13, Sulfur-34, and Quartz saturation index also clearly separated Madison from non-Madison groundwater.

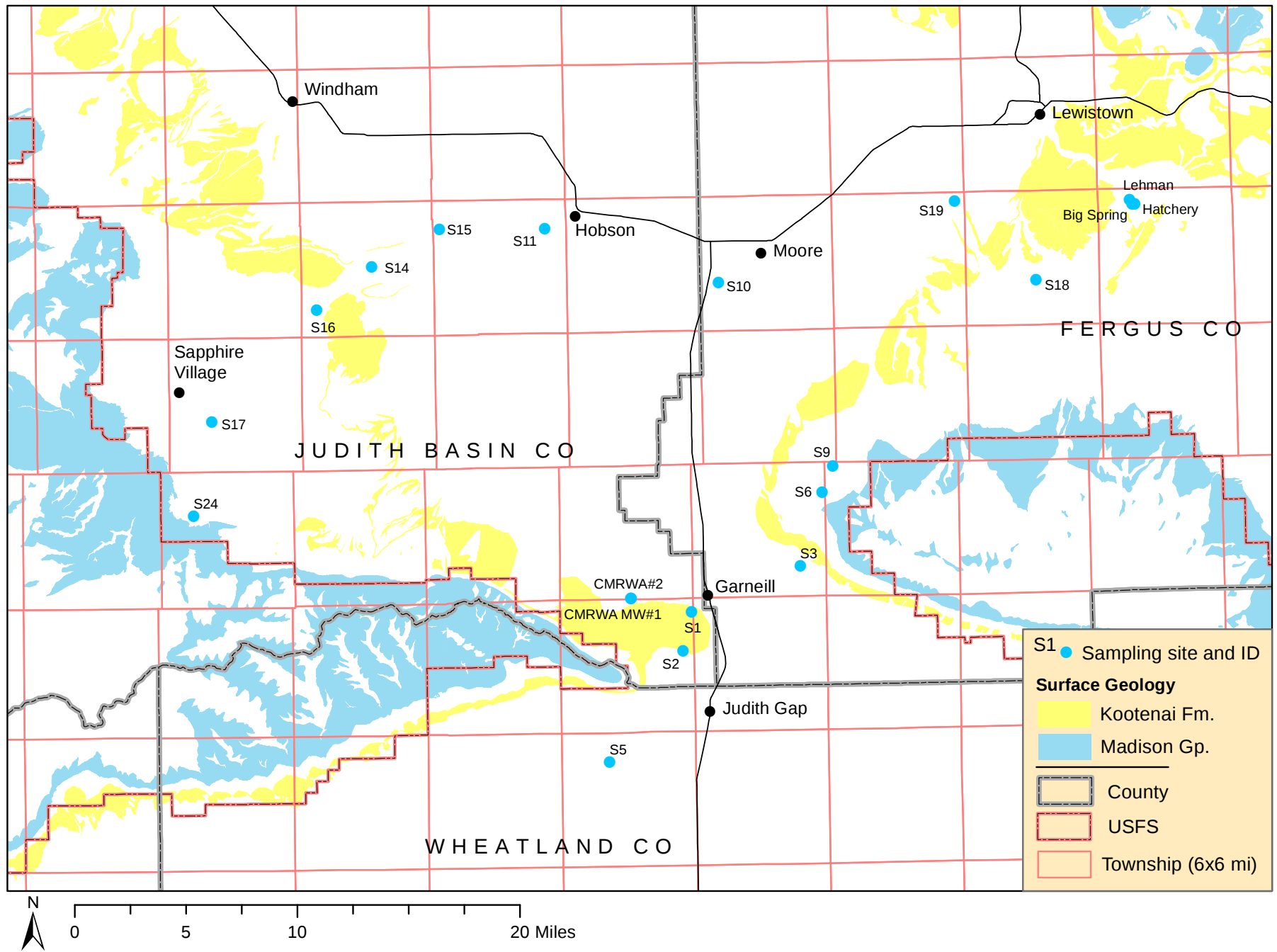


Figure 1. Spring Inventory Locations

- Tritium analysis, which provides information on groundwater age, was detected in all of the springs and the CMRWA #2 well at the U Bet Wellfield. Groundwater age at these locations is less than 70 years. Tritium was non-detectable in the Kootenai monitoring well at the U Bet Wellfield, CMRWA MW#1, indicating the groundwater sampled from this well was 70 years or older.
- The spring inventory identified three springs to be sourced from the Madison. These were Big Spring, Hatchery Spring, and Lehman Spring. The other springs included in the study, which are within about 30-miles of the U Bet Wellfield, were found to be sourced from non-Madison groundwater. Several of these springs are likely sourced directly from alluvial aquifers.

3. CMRWA #2 PUMPING TEST SUMMARY

CMRWA Well #2 produces groundwater from the Madison aquifer through a single permeable zone in the depth interval from 2,241- to 2,243-ft (**Figure 2**). Step-rate and constant-rate pumping tests were completed in the well. A four-hour step-rate test was run at rates from 381- to 631-gpm, with a maximum drawdown of 48-ft. Constant-rate tests included two phases with 9.0- and 9.8-days of continuous pumping at a rate of approximately 575 gpm with maximum drawdown of 39-ft and 42-ft, respectively. The full report is provided in **Appendix B**. The conclusions and recommendations are as follows:

- Drawdown data collected from CMRWA #2 during pumping show a trend that indicates high permeability fracture flow into the well, and enhanced drawdown caused by the occurrence of flow limiting boundaries. Two boundaries were included in the model fit to test data, one located 15,000 ft to the south, and one located 30,000 ft to the north. Other configurations could be equivalent.
- The design rate of 575 gpm for CMRWA #2 is considered an appropriate rate for operation of the well. The annual produced volume should be limited to about 480 af, although this use can be directly managed based on observed drawdown in the well. Interference drawdown in neighboring wells in the U Bet Wellfield and producing from the same zone was estimated at approximately 22 ft. Interference drawdown also would be reciprocal among multiple wells.

During pump testing of the recently constructed CMRWA Well #3, interference drawdown at CMRWA Well #2 was measured at less than 0.4 ft when pumping at 1,258 gpm. The two wells are offset 2,210 ft. CMRWA Well #3 is open to multiple fracture zones that are not intercepted by CMRWA Well #2.

- Water level data from the CMRWA #1 well located at Utica and from the CMRWA MW#1 monitoring well located at the U Bet Wellfield did not respond to pumping in CMRWA #2. The CMRWA #1 well is a Madison well. Water level in this well followed a declining trend through the test period. The CMRWA MW#1 well is completed in the Kootenai aquifer (aka 3rd Cat Creek). Water level remained essentially constant for the duration of testing.
- The occurrence of flow limiting boundary effects should be considered when planning future wells at the U Bet Wellfield. It may be advisable to build wells that allow for deeper pump settings and to locate wells to use the available offsets. Consideration should also be given to a drilling program that would construct a new well through the entire Madison formation, even in the presence of high production fractures. In order to accomplish this drilling plan, it is most likely that air-rotary drilling would need to be used once casing was set into the Madison formation.

CMRWA Well #3 was constructed to a depth of 2,850 ft using air-rotary drilling through the Madison aquifer. This drilling method enabled the borehole to be advanced through multiple fracture zones.

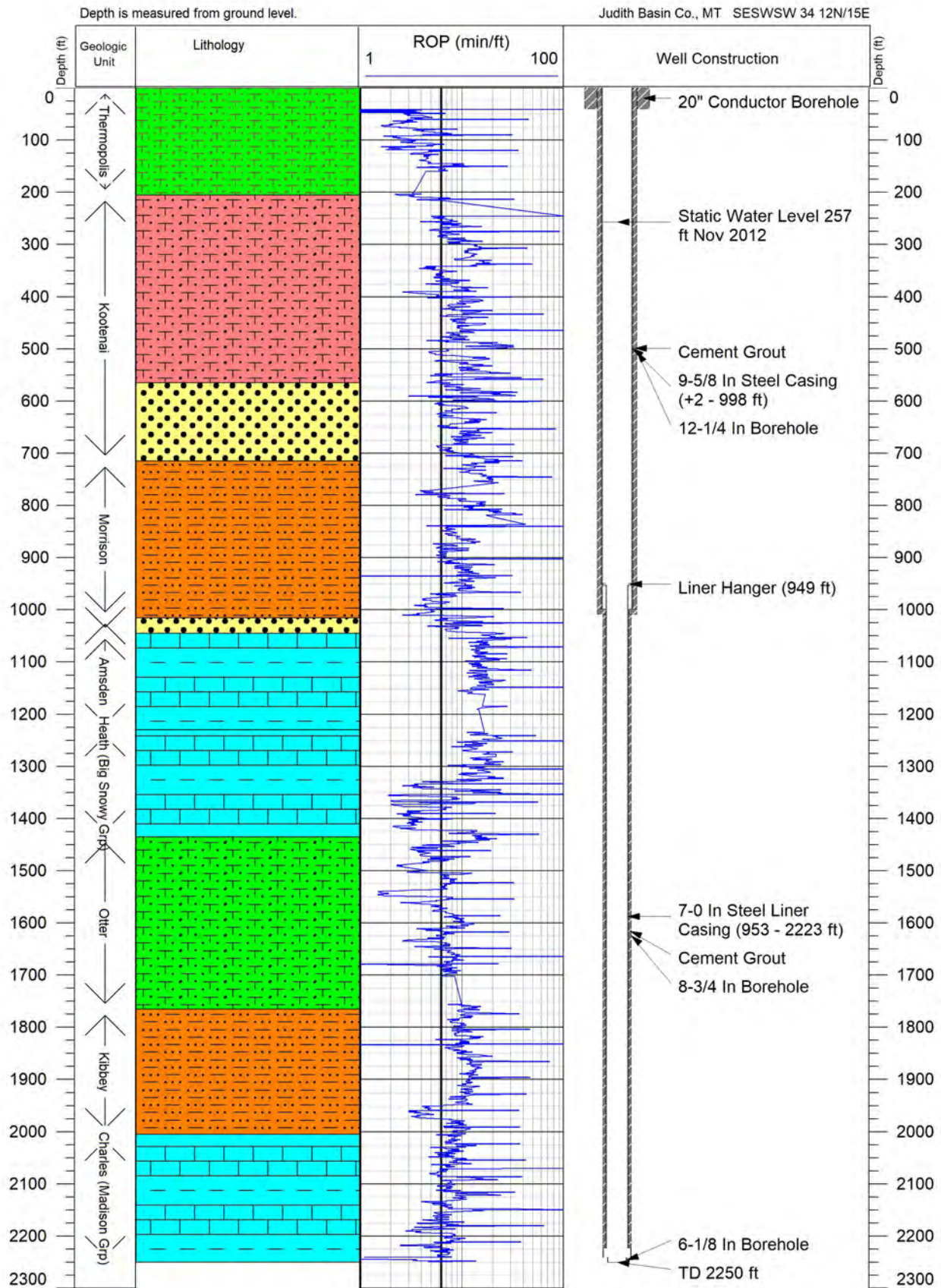


Figure 2. CMRWA #2 Well As-Built Log

4. U BET KOOTENAI MONITORING WELL SUMMARY

The Kootenai aquifer monitoring well, designated as CMRWA-MW#1, is located 100-ft east from CMRWA Well #2. The Kootenai aquifer (basal sandstone), which is also called the 3rd Cat Creek, occurs in the depth interval from 610- to 712-ft at the location of the monitoring well (**Figure 3**). This aquifer is developed extensively in Judith Basin, although some wells are probably producing from shallower sandstone beds of the Kootenai. One of the groundwater monitoring wells (Peterson Ranch) taps the same aquifer at a depth of 1,900- to 2,000-ft. The top of the Madison Group rocks, corresponding to the Charles formation, occur 1,290 ft below the Kootenai at the U Bet Wellfield. This thickness increases toward the basin interior. At Utica it is 2,800-ft from the base of the Kootenai to the top of the Charles.

Water quality data collected from CMRWA-MW#1 was found to be depleted in oxygen (0.4 mg/L) and tritium (<0.5 TU). In contrast, the Madison groundwater was measured to have 4.5 mg/L dissolved oxygen and 5.9 TU of tritium.³ These findings are indicating the Kootenai aquifer is flowing slowly through porous sandstone, whereas the Madison has more rapid flow through rock fractures. The full report on the monitoring well construction and testing is provided in **Appendix C**.

5. GROUNDWATER MONITORING SYSTEM

The monitoring system includes groundwater levels measured in wells, Big Spring discharge, precipitation at Judith Gap RWIS, and Judith River discharge near Sapphire Village (**Figure 4**). The Judith River gauging station (06110020) above Carr Creek was reinstated in 2014 based in part on discussions related to the Water Resources Monitoring Plan, however, the gauge was not funded through the grant project. It is presently funded and operated by the U.S. Geological Survey.

Interim reports for the monitoring system were prepared for 2017 and 2018, and are provided in **Appendix D**. These reports include information on the monitoring station instruments and data, and provide well logs. General information for the monitoring stations is provided in **Table 1**. Well data are accessible from the Ground Water Information Center (GWIC) at the Montana Bureau of Mines and Geology (MBMG) through the GWIC ID. Updated data plots for each monitoring station are provided in subsequent figures and briefly discussed.

3 The occurrence of detectable tritium indicates a groundwater age less than 70-years, and vice versa.

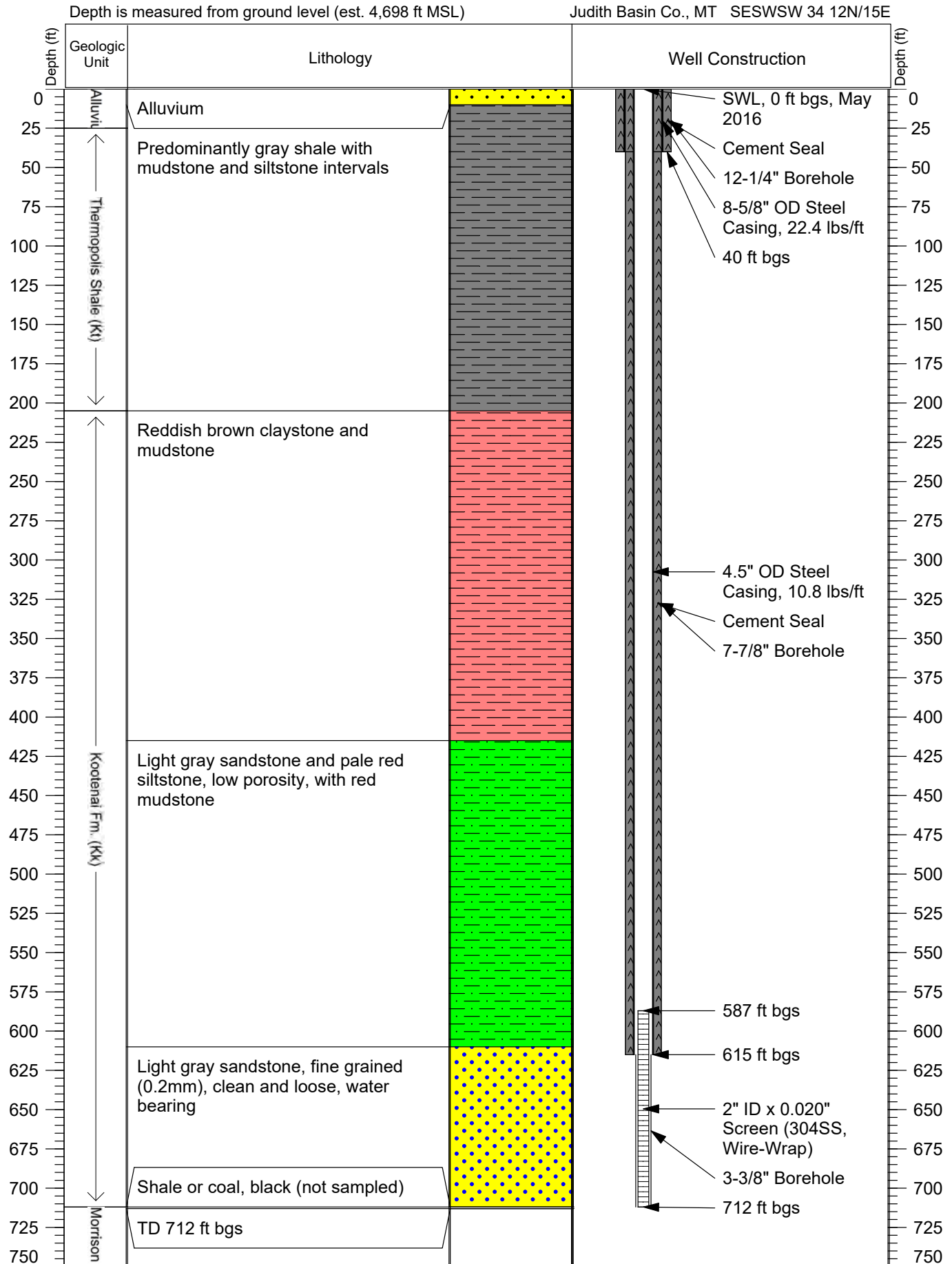


Figure 3. CMRWA MW#1 As-Built Log

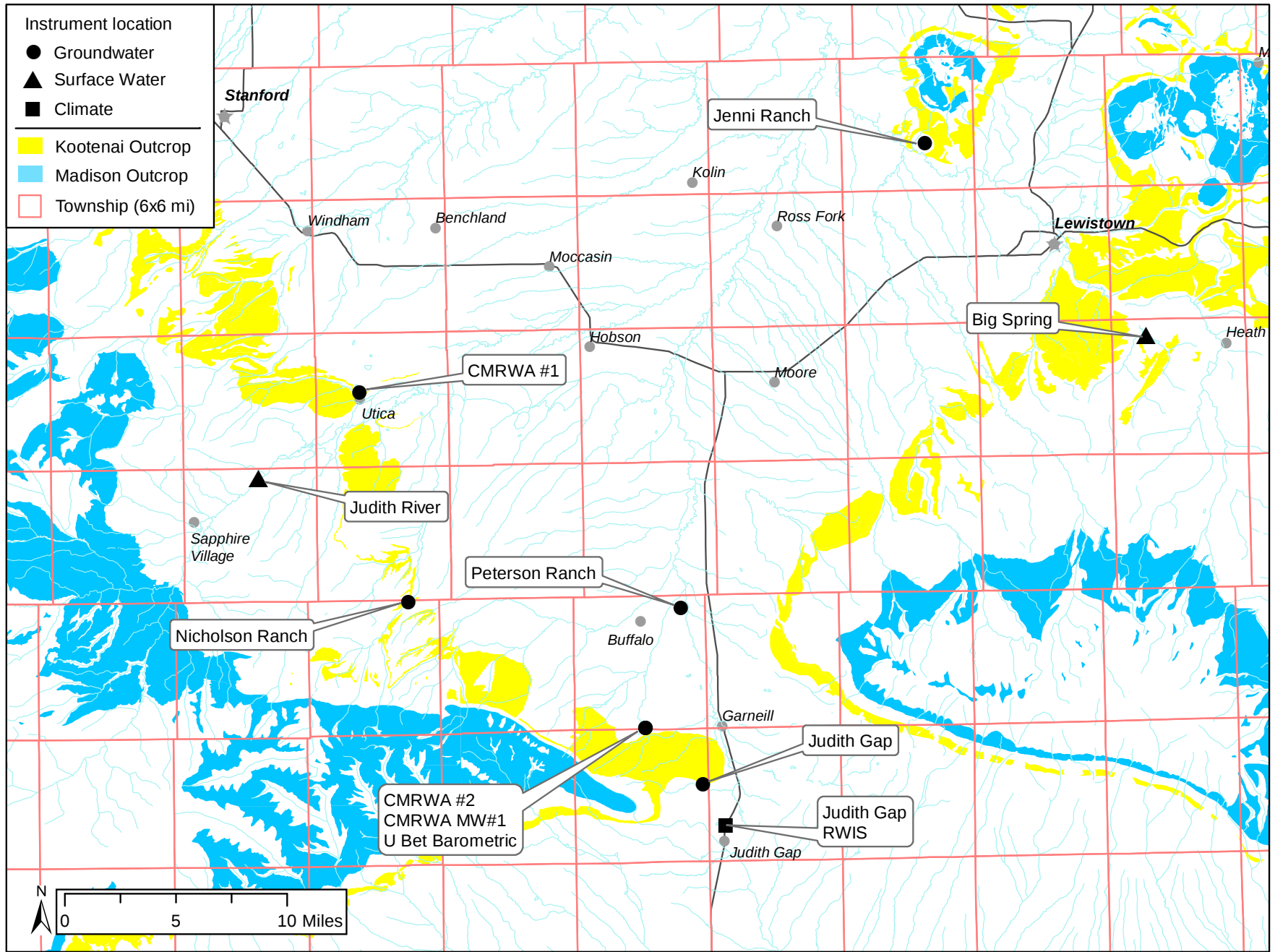


Figure 4. Monitoring Locations

Table 1. Monitoring Station Information

Location ID (GWIC ID)	Source	Latitude Longitude	Sensor Rating	Model	Mfg.
CMRWA #1 (257040)	Madison	46.973135 -110.092816	300 psig	Level Troll 500	In-Situ, Inc.
CMRWA #2 (276994)	Madison	46.751668 -109.825567	100 psig		
CMRWA Baro	Atmospheric		30 psia	Level TROLL 400	
CMRW MW #1 (289648)	Kootenai	46.751664 -109.825252	300 psig	Level TROLL 500	
Judith Gap (132756)	Kootenai	46.714447 -109.771655	100 psig		
Peterson Ranch (266587)	Kootenai	46.829638 -109.790520	300 psig		
Nicholson Ranch (204169)	Kootenai	46.836131 -110.048608	100 psig		
Jenni Ranch (174246)	Madison	47.129547 -109.550441	100 psig		
Judith River 06110020	Judith River	46.900548 -110.233129	NA	NA	USGS
Big Spring	Madison	47.001867 -109.343260	NA	NA	NA
Judith Gap RWIS	Climate	46.687538 -109.750838	NA	PWD12 (precipitation)	Vaisala

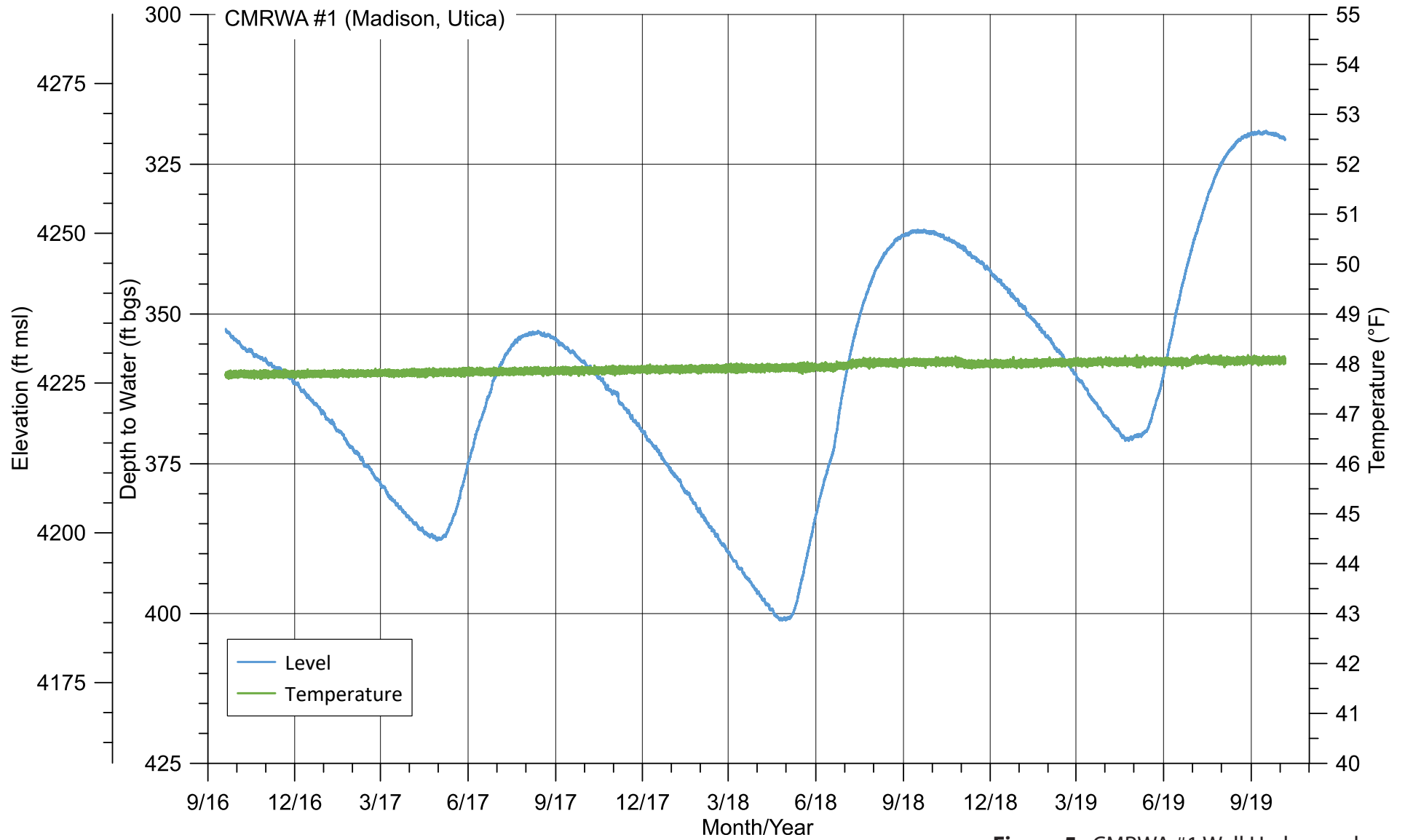
5.1 Well Monitoring Data

5.1.1 CMRWA Well #1 (Madison, 3700 ft)

The Madison aquifer water level at Utica, as measured in CMRWA Well #1, exhibits seasonal variation in water level of up to 65 ft (**Figure 5**). The maximum span for the period of the data is about 80 ft. Water level peaks occur in August to October, with the low level occurring in May. Water temperature is generally steady at 48 °F, which is unusually low for groundwater at 3,700 ft below ground surface.

5.1.2 CMRWA Well #2 (Madison, 2250 ft)

The Madison aquifer water level at the U Bet Wellfield, as measured in CMRWA Well #2, also exhibits a definitive seasonal response similar to CMRWA Well #1 (**Figure 6**). Spikes and dips occurring on this plot reflect changes when testing the well. The largest seasonal change is about 30 ft. The maximum change from low to high for the data is about 35 ft. Water temperature is about 49 °F, with spikes occurring during pump runtimes due to motor heating of the groundwater.

**Figure 5.** CMRWA #1 Well Hydrograph

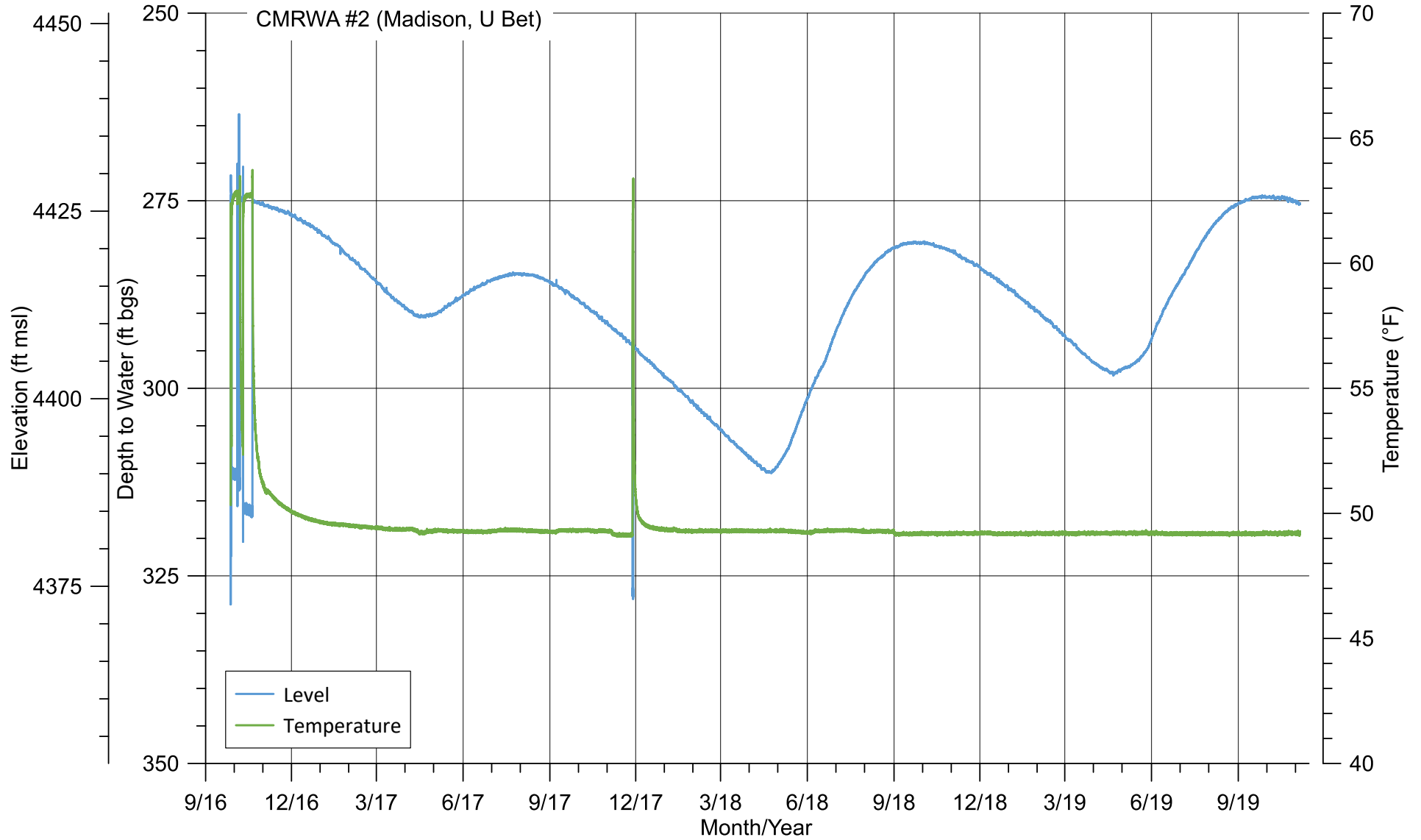


Figure 6. CMRWA #2 Well Hydrograph

5.1.3 Jenni Ranch (Madison, 750 ft)

The Jenni Ranch well, also known as the Hanover Well, was monitored for a short period in 2017 (**Figure 7**). The sensor was removed as the instrument could not be satisfactorily frost protected. This well is a flowing artesian Madison aquifer well located on a geologic structure named Hanover Dome located on the north side of South Moccasin Mountain. The Ranch is using the well for power generation with a discharge of about 1,100 gpm through a power plant and into Big Spring Creek. In the short span of data collection, it appears the water pressure may have a seasonal fluctuation of about five feet.

5.1.4 CMRWA Well MW#1 (Kootenai, 712 ft)

The Kootenai aquifer at the U Bet Wellfield has a static water level near to ground surface that at times is flowing artesian (**Figure 8**). Water level data are showing increased level due to high precipitation totals occurring in 2018 and 2019. Water level fluctuation is on the order of 10- to 15-ft and may be influenced by pumping wells. The most likely well to have influence is the Judith Gap well located 3.8 miles to the southwest. Water temperature of the Kootenai groundwater is between 48 °F to 49 °F.

5.1.5 Judith Gap Well (Kootenai, 445 ft)

Judith Gap produces groundwater from the Kootenai aquifer for the public water system. The well is flowing artesian under non-pumping conditions, but has a subsurface drawdown during pumping (**Figure 9**). The sensor is located above ground in the pump house and can only measure water level during non-pumping periods. The data exhibit a similar pattern as CMRWA Well MW#1 with about a 10-ft increase in static level over the period of the data. The lower density points above the large dark band of data reflect transient spikes that occur when pumping is stopped.

5.1.6 Nicholson Ranch (Kootenai, 120 ft)

This shallow well may produce from upper sandstones in the Kootenai formation, as the borehole sampling does not indicate penetration into the underlying Morrison formation. The well produces on the order of 10 gpm with less than 5-ft of drawdown and exhibits a definitive but small seasonality with a total fluctuation of about 7-ft (**Figure 10**). Water temperature is slightly greater than 45 °F.

5.1.7 Peterson Ranch (Kootenai, 2003 ft)

Peterson Ranch produces groundwater from the basal Kootenai sandstone (3rd Cat Creek) under artesian flow with a shut-in pressure of about 130 pounds per square inch gauge pressure (psig) (**Figure 11**). This well is in use year-round which prevents accurate static water level measurements. However, it appears the well static pressure has increased in the past couple years by about 5- to 7-psig. The sensor is located in a utility vault and does not measure water temperature at this location.

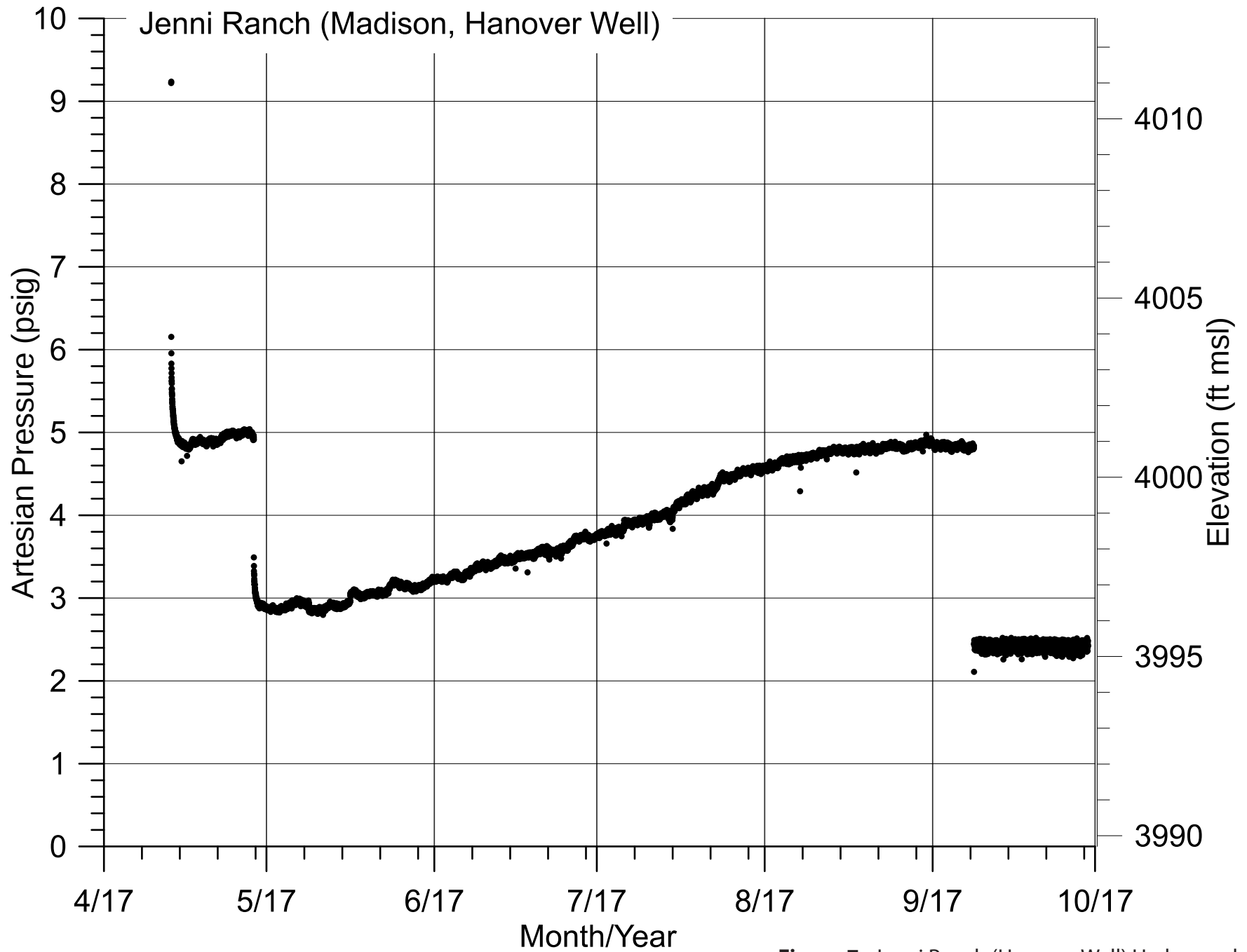


Figure 7. Jenni Ranch (Hanover Well) Hydrograph

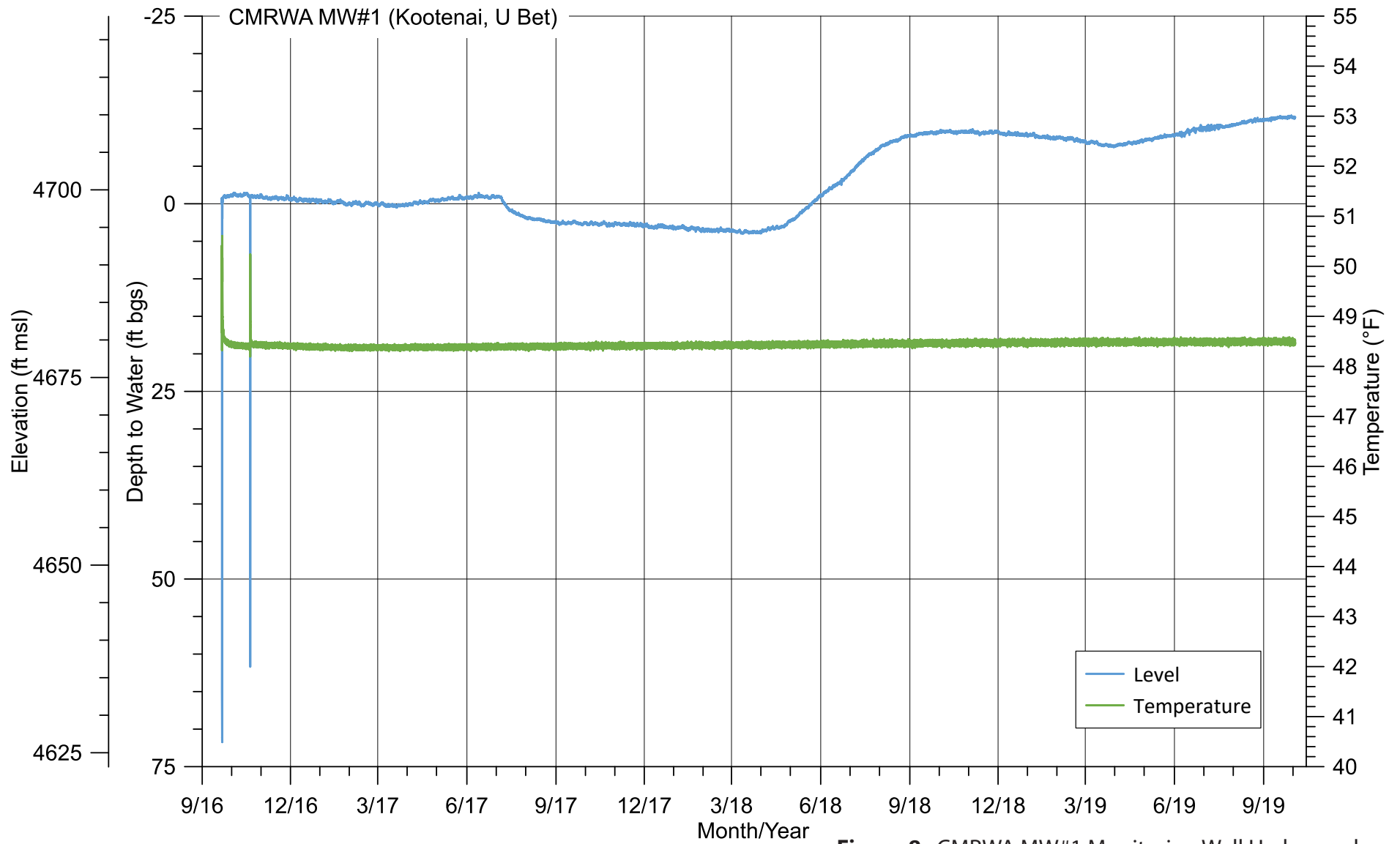


Figure 8. CMRWA MW#1 Monitoring Well Hydrograph

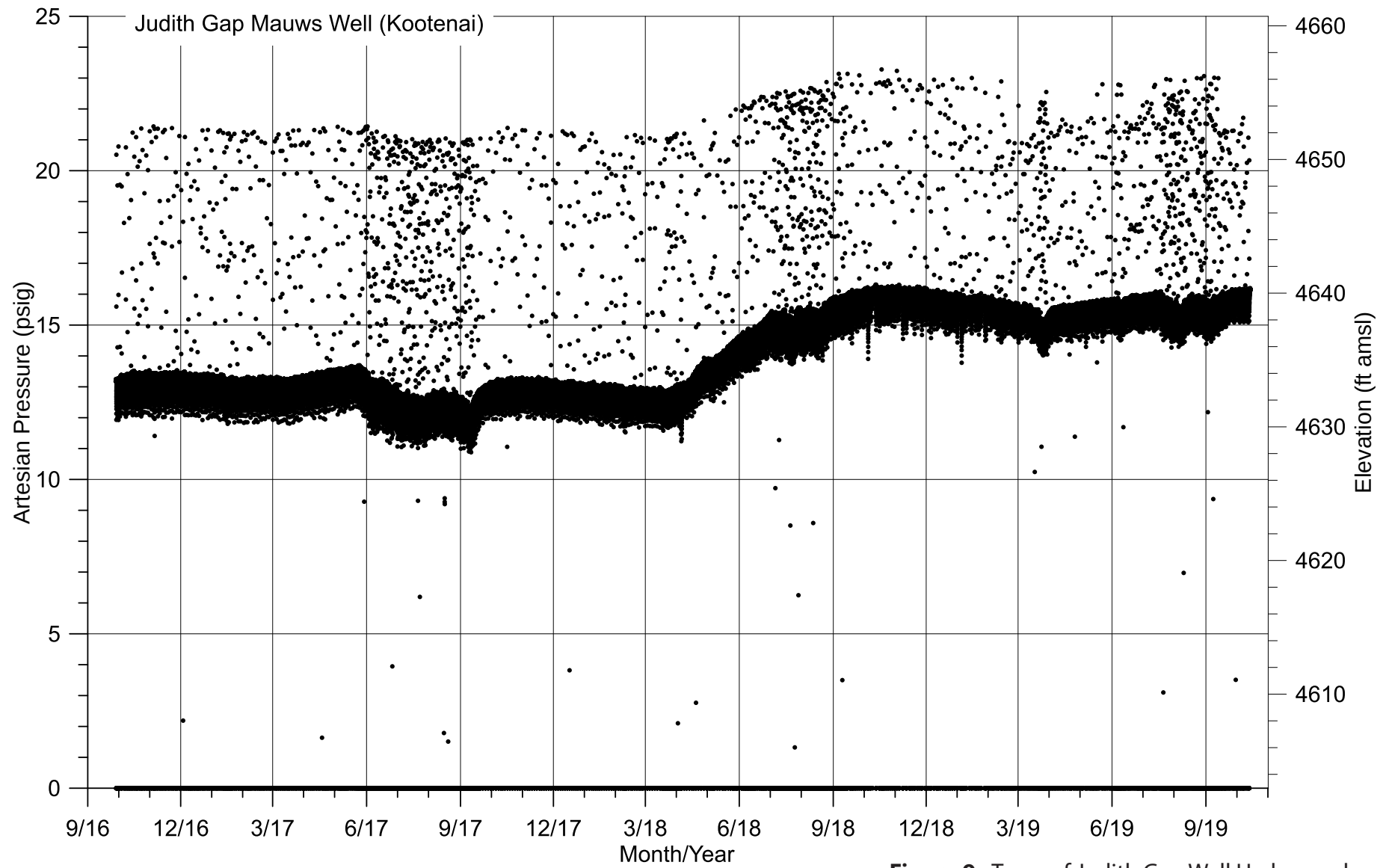


Figure 9. Town of Judith Gap Well Hydrograph

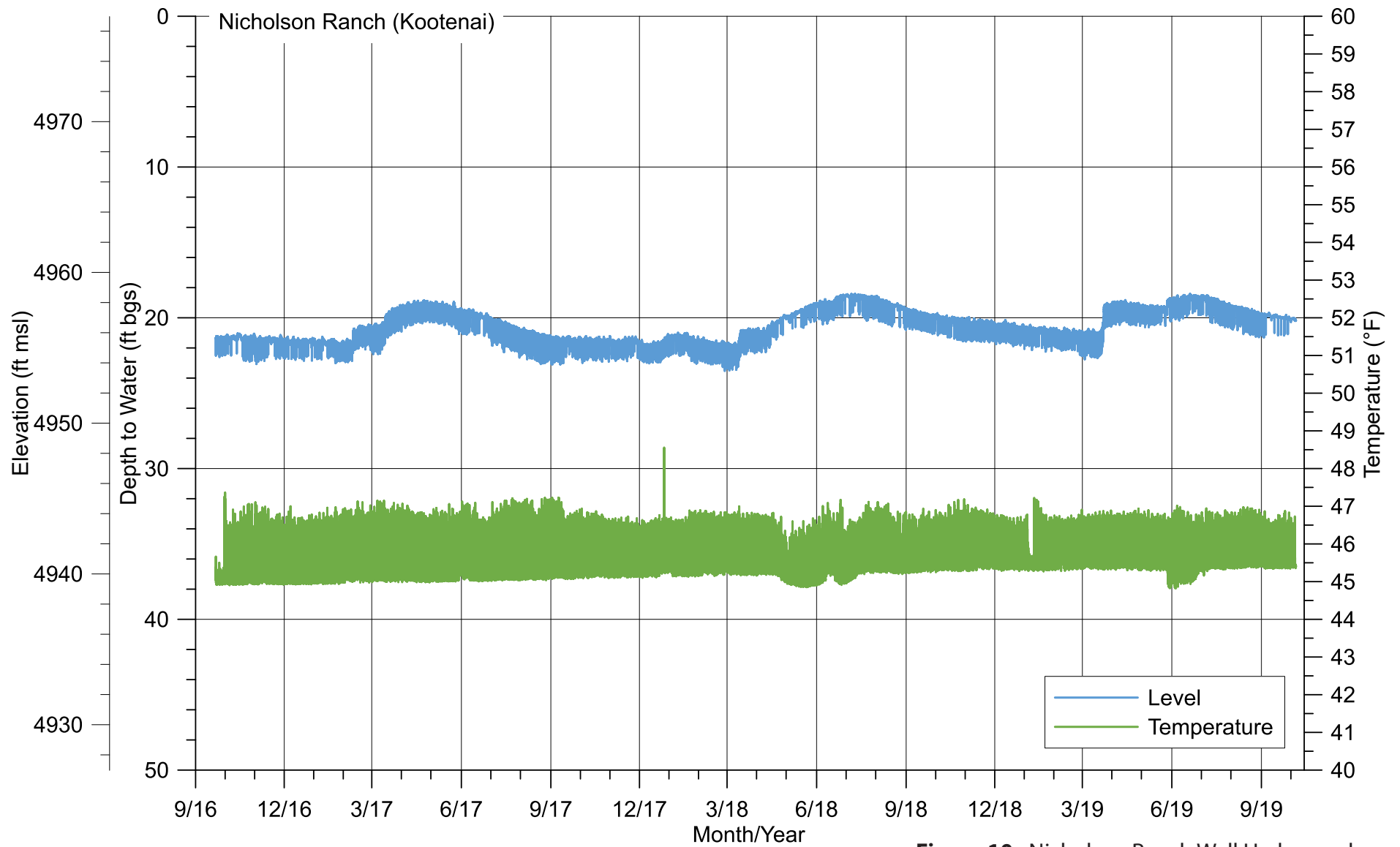
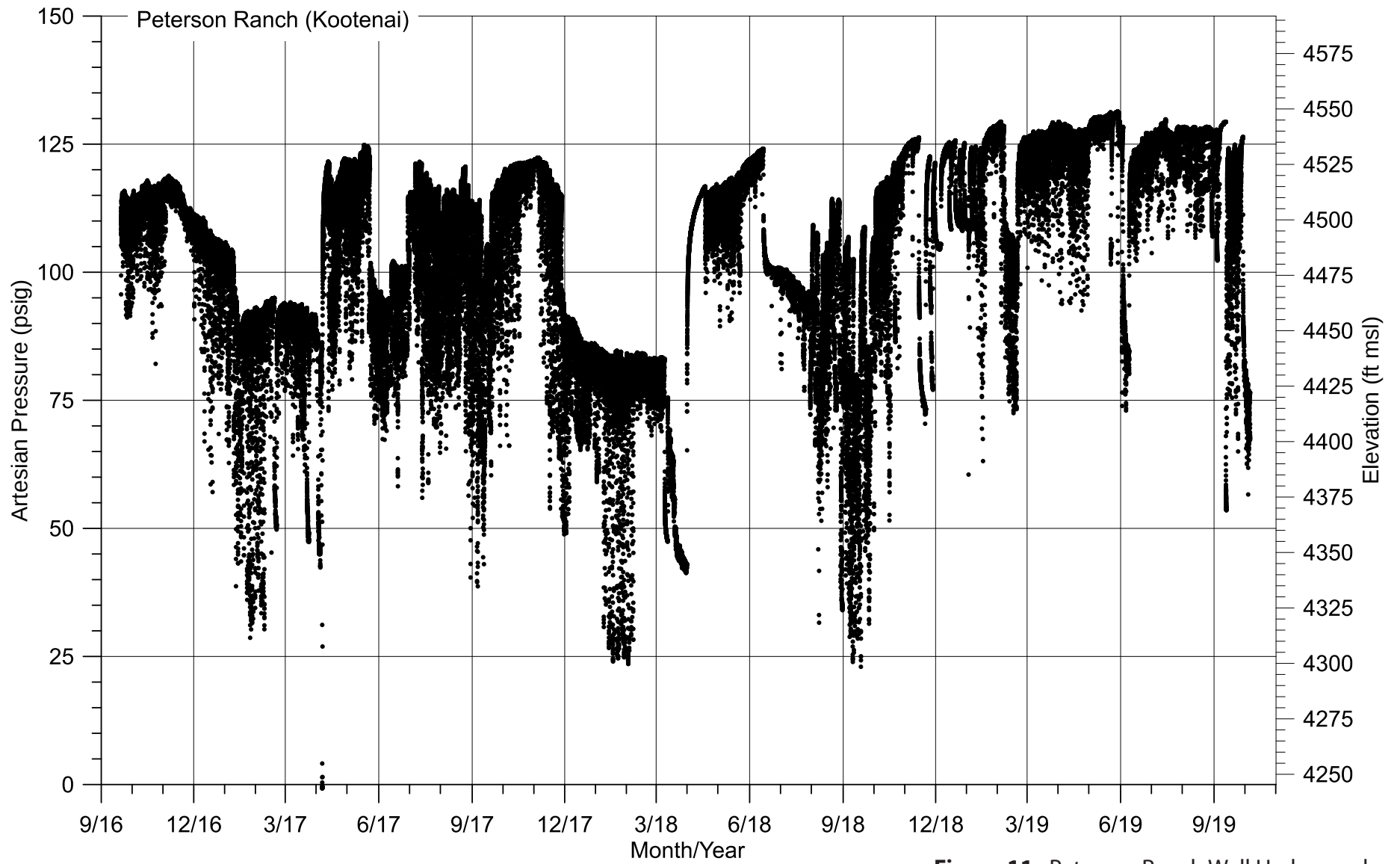


Figure 10. Nicholson Ranch Well Hydrograph

**Figure 11.** Peterson Ranch Well Hydrograph

5.1.8 Big Spring Monitoring Data

Big Spring requires several measurements to obtain a discharge estimate. A summary of the spring discharge flow metering system is provided in **Appendix D**. The spring discharges into a large vault from which the fish hatchery and the City of Lewistown directly obtain water supply. Most of the discharge leaves the vault and forms the flow of Big Spring Creek. The tributary stream, Hansen Creek, flows into Big Spring Creek upstream from the vault.

In order to obtain a flow measurement of the Big Spring discharge, the Hansen Creek flow must be subtracted while the City, Fish Hatchery and Big Spring Creek flows are added. Due to vegetation in Big Spring Creek, periodic manual measurements are required in order to calibrate the stage-discharge relationship of the creek. These manual measurements are used to process the data for a daily reading. This work to operate the flow metering system and produce flow data is completed by FWP. The need to incorporate several measurements will generally compound the amount of error present in the data. Roughly estimated, the daily discharge data may have associated error of ± 6 cubic feet per second (cfs).

Big Spring discharges through sedimentary rocks that overlie the Madison Group formations. The Madison source is determined based on magnitude of flow and water quality. It appears the spring has formed at the termination of faults and fractures that convey groundwater to the point of discharge. The source of water to the spring is the Big Snowy Mountains to the south. There are two additional Madison springs in the same location, one referred to as the Hatchery Spring and the other as Lehman Spring. All three are discharging Madison groundwater through discrete orifices in younger rocks.

Big Spring flow data exhibit variations in discharge on the order of up to 16 cfs (**Figure 12**). Average discharge for the period of the data is 93.5 cfs. Fluctuations in flow appear to reflect precipitation in the Big Snowy Mountains to the south of Big Spring. There may be about a 4- to 5-month lag between the precipitation and the discharge, as shown by data for the period from June to October 2018. Precipitation data for this plot were obtained from the Crystal Lake SNOTEL station located on the northwest side of the Big Snowy Mountains at an elevation of 6,050 ft. Big Spring discharges at an elevation of about 4,175 ft.

5.1.9 Judith River Monitoring Data

The Judith River gauge is located north of Sapphire Village 3.5 miles above the confluence with Carr Creek. There are irrigation withdrawals that occur upstream from the gauge. The range of flow measured at the gauge has a range of nearly three orders of magnitude, from near 1 cfs to 700 cfs (**Figure 13**). The large peaks in these data reflect snow melt in the Little Belt Mountains to the south, which generally occurs in April and May of each year. The falling limb of these large peaks also reflects rain events occurring from May to early July. Each year the low water discharge falls below 10 cfs. Over the past several years since 2014, discharge has a slightly increasing trend.

5.1.10 Judith Gap Road Weather Information Station (RWIS)

The Montana Department of Transportation (MDT) weather station at Judith Gap provides a location at similar elevation as the southern end of Judith Basin, which coincides with the Kootenai formation outcrop belt. Data from this station provide measurements of precipitation and temperature that can be used for recharge analysis of the Kootenai aquifer (**Figure 14**). There is a wide range in precipitation over the period of record, with annual total precipitation ranging from 13.5 inches (in) in 2017 to 27.1-in in 2019.

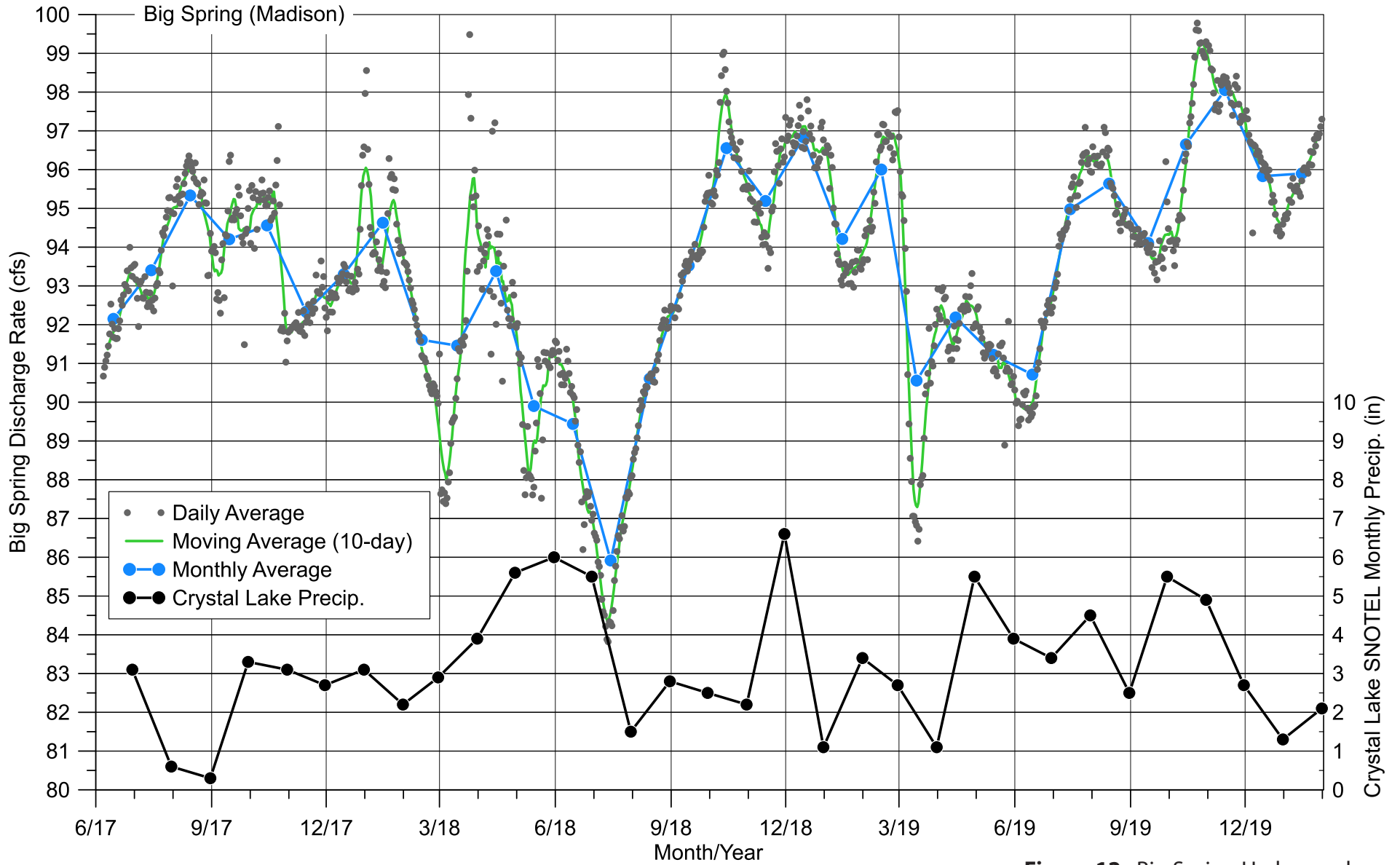
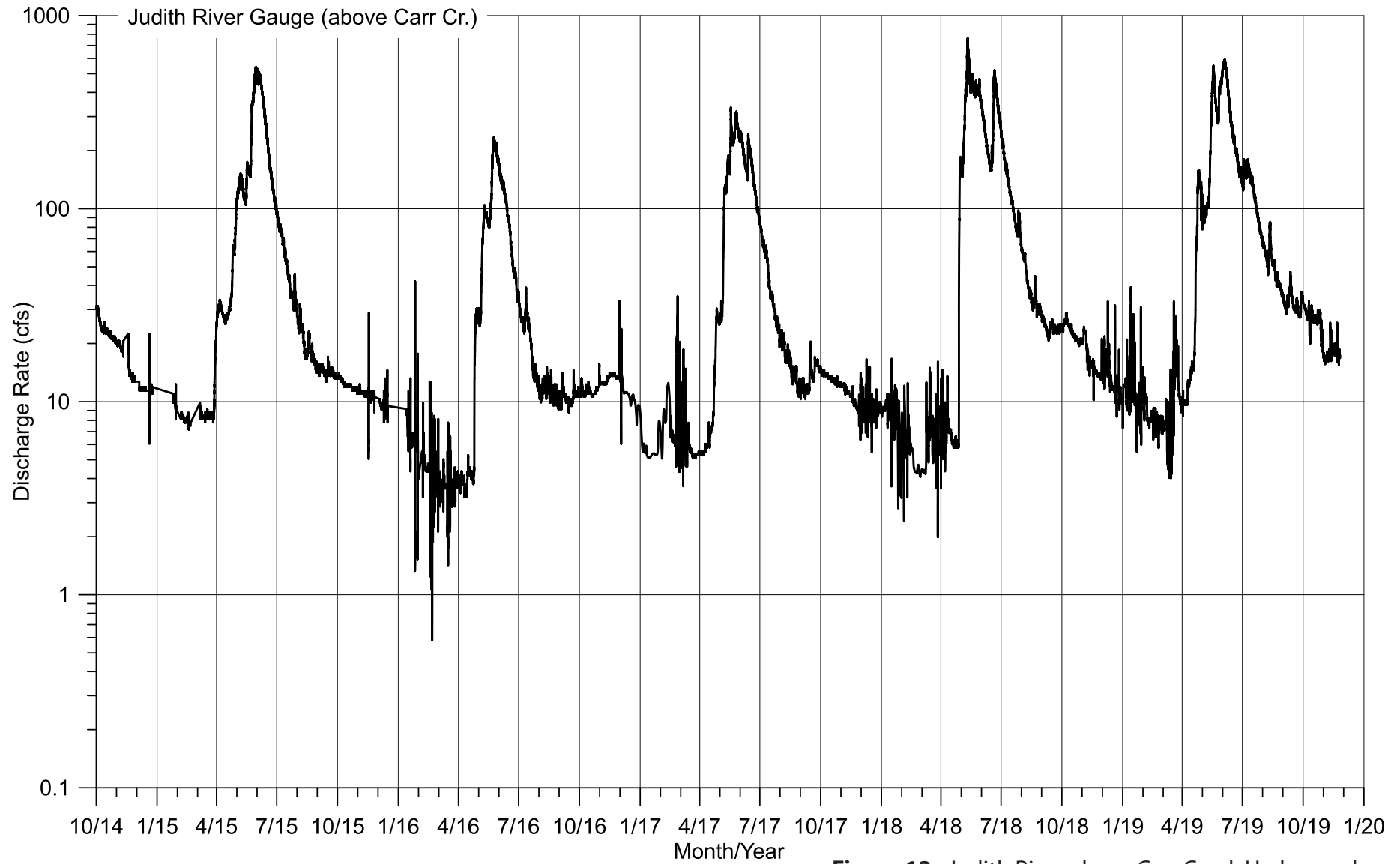


Figure 12. Big Spring Hydrograph



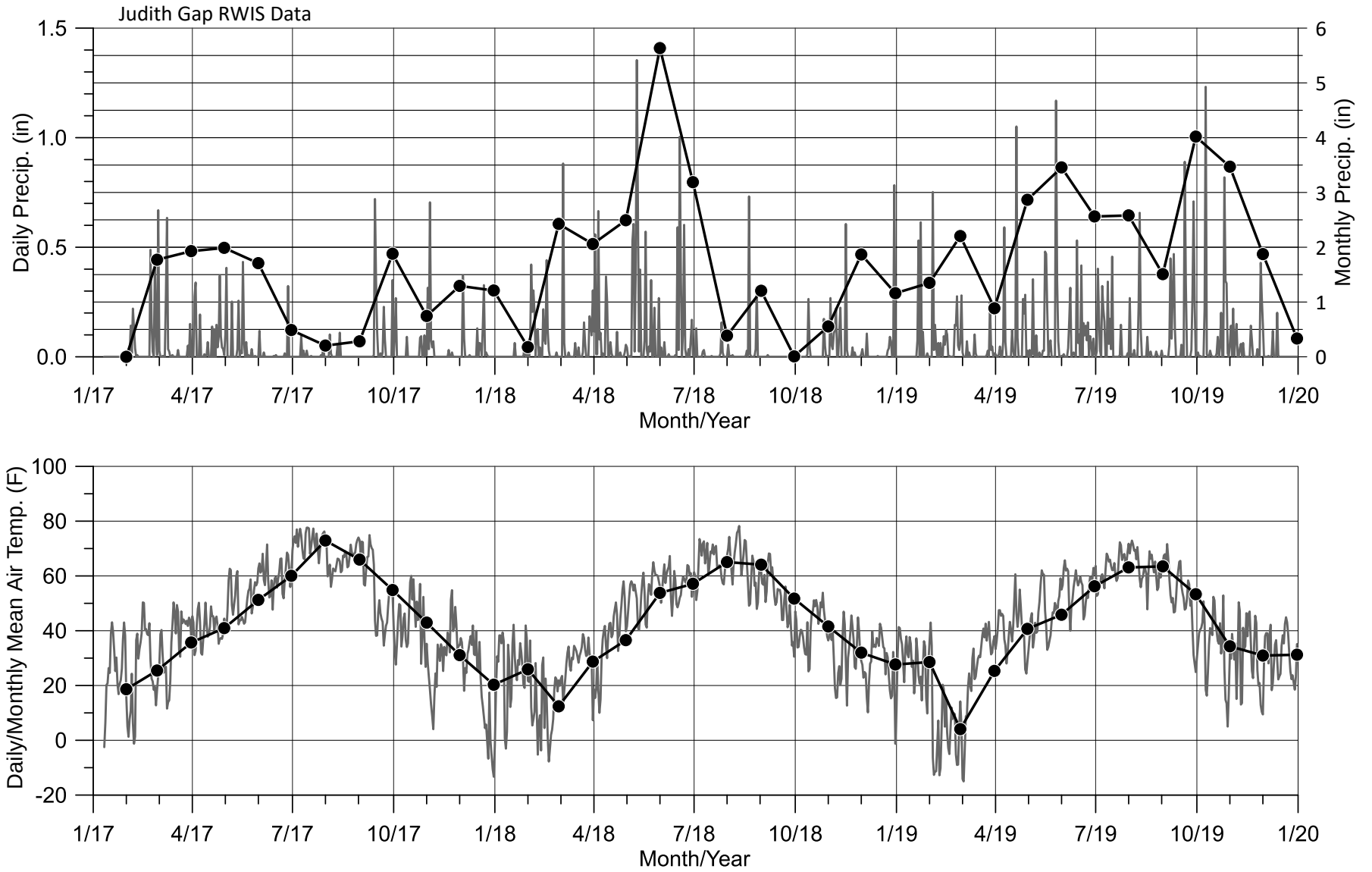


Figure 14. Judith Gap RWIS Climate Data

6. GROUNDWATER RECHARGE

This section provides estimates of groundwater recharge to the Madison and Kootenai aquifers. The analysis primarily evaluates the component of recharge occurring through the soil overlying the formations where they are mapped to occur at land surface. Recharge estimates utilize climate data in a water balance method for a soil column. The recharge to groundwater is that component of water entering the land surface that passes through the root zone, and is also referred to as deep percolation. Climate data include precipitation, temperature, and solar radiation. Soils data are also used to account for the storage of water in the soil and the ability of water to evaporate from the soil. A portion of the precipitation is also stored during winter in the snowpack. The snowpack is redistributed to the soil during the spring melt period. Estimates of recharge by the methods used generally have moderately large error bars, such as plus or minus 25% to 50% of the value.

6.1 Judith Gap RWIS

Three-years of climate data collected from the MDT Judith Gap RWIS were analyzed to estimate yearly groundwater recharge (**Figure 15**)⁴. The site of the RWIS is moderately high elevation grassland at 4,670 ft MSL and is notably a high wind location. The climate conditions at the RWIS location are generally representative of the southern Judith Basin where the Kootenai formation outcrops occur.

RWIS data for the three-year period exhibit a wide range in total precipitation and groundwater recharge (**Table 2**). Year 2017 was an extremely dry drought condition at the location of the RWIS, whereas 2018 and 2019 were slightly moist or average. Both 2018 and 2019 also had a monthly average temperature for March that was below freezing, which shifted the snow melt to April and May. Groundwater recharge as a percentage of total precipitation for the RWIS location ranged from 10% to 22%.

Table 2. Judith Gap RWIS Groundwater Recharge

Year	Pt (in)	Pn (in)	AET (in)	DP (in)	DP/Pt (%)
2017	13.51	10.01	8.70	1.30	10
2018	21.16	15.60	10.88	4.72	22
2019	27.12	20.24	14.41	5.82	21
Pt – Total precipitation; Pn – Net Precipitation; AET – Actual Evapotranspiration; DP – Deep percolation (Groundwater recharge)					

The analysis was completed according to the Thornthwaite monthly water balance model⁵ but with the Turc method⁶ for calculation of potential evapotranspiration. Input data consist of monthly values for total precipitation, mean temperature, and solar radiation. Precipitation and temperature data were obtained from the RWIS data.

Solar radiation was obtained for the location of the RWIS using the solar radiation tool in the Spatial Analyst extension of Arc GIS. Diffuse proportion (D) and transmissivity (T) values used in the solar radiation calculations were determined for each month by calibration to measured monthly solar radiation data

4 Pt – total precipitation; Pn – net precipitation (includes snow melt water); PET – potential evapotranspiration; AET – actual evapotranspiration; SM – soil moisture.

5 Thornthwaite, C.W. Mather, J.R (1955): Water balance publication in climatology. Drexel Ins. of Tech., 8(1).

6 Turc, L. (1961) Estimation of irrigation water requirements, potential evapotranspiration: a simple climatic formula evolved up to date, Annals of Agronomy 12: 13-49. Applied for RH > 50%.

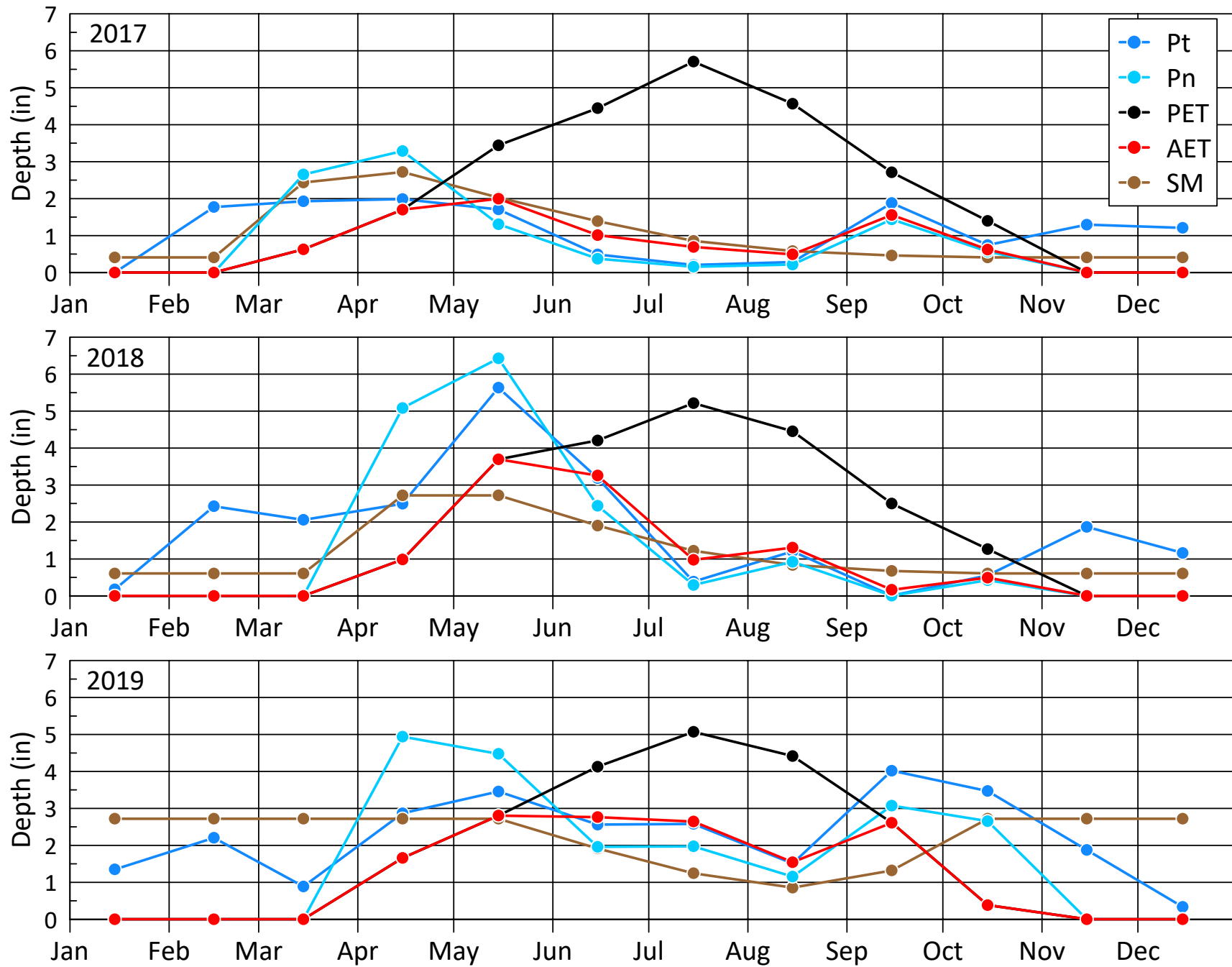


Figure 15. Judith Gap RWIS Water Balance Plots

collected at the Lewistown airport (National Solar Radiation Data Base, TMY3).⁷ Best D and T values were determined for each month and subsequently used to estimate solar radiation at the Judith Gap RWIS location.

Constant values also are input for foliage interception (C_i , 10%), surface water runoff (C_{ro} , 15%), and sublimation (C_s , 10%). The net precipitation reflects these processes plus water derived from snow melt. Snow melt is accumulated in the months with a freezing mean temperature and is subsequently added to the net precipitation during spring. The snow melt water in spring is critical for the occurrence of groundwater recharge, which can occur only under the condition that soil moisture is at the maximum depth.

The soil in the upper 1-meter acts as a storage reservoir with a maximum capacity equal to the available water content (AWC), which is 2.72 inches for the location of the RWIS. The AWC value was taken from the USDA-NRCS soil survey for Wheatland County.⁸ There is a component of the soil moisture (SM) that can contribute to actual evapotranspiration through a soil water retention function. An exponential function was fit to data in table I.3 published by Thornthwaite for this function.⁹

The water balance is computed for a 12-month period by ensuring, as an assumption, that the change in soil moisture for the period sums to zero ($\Sigma dSM=0$). The analysis was coded in visual basic in Excel©. Tabular printouts of the water balance calculations are provided in **Appendix E**.

6.2 Madison Aquifer

Recharge to the Madison aquifer was evaluated using publicly available precipitation and temperature data published by the PRISM Climate Group, Northwest Alliance for Computational Science and Engineering, based at Oregon State University, Corvallis, OR (PRISM). Monthly and annual data sets were obtained as georeferenced raster images based on data for the period 1981 to 2010, and referred to as 30-year normals. These data provide the 30-year averages for total precipitation and mean temperature by month and annually.

Annual precipitation data are used to illustrate the general pattern of precipitation depth, although recharge analyses were completed using the 30-year normal for monthly precipitation (**Figure 16**). Temperature data are showing the mean air temperature for the month of July, also over the 30-year normal period (**Figure 17**). The month of July was chosen to illustrate approximately the warmest temperatures of the year, whereas the annual averages are much lower.

Available water content (AWC) data were obtained from the same source as for the Judith Gap RWIS analysis, however, the data were processed to a raster image to facilitate the recharge analysis (**Figure 18**). These data show the AWC value when mapped to 30- by 30-meter cells for the depth interval from 0- to 100-cm.

7 Best D and T values were determined by a method developed by James Dyer, PhD, Ohio University.

8 The SSURGO database was used for the analysis and the AWC value was taken from the muagatt data table for the depth interval from 0 – 100 cm. The AWC value in the table was converted from units of cm to inches.

9 $F = \exp(-0.085 * PET)$, where F is the retained soil moisture fraction and PET is the potential evapotranspiration in units of inches.

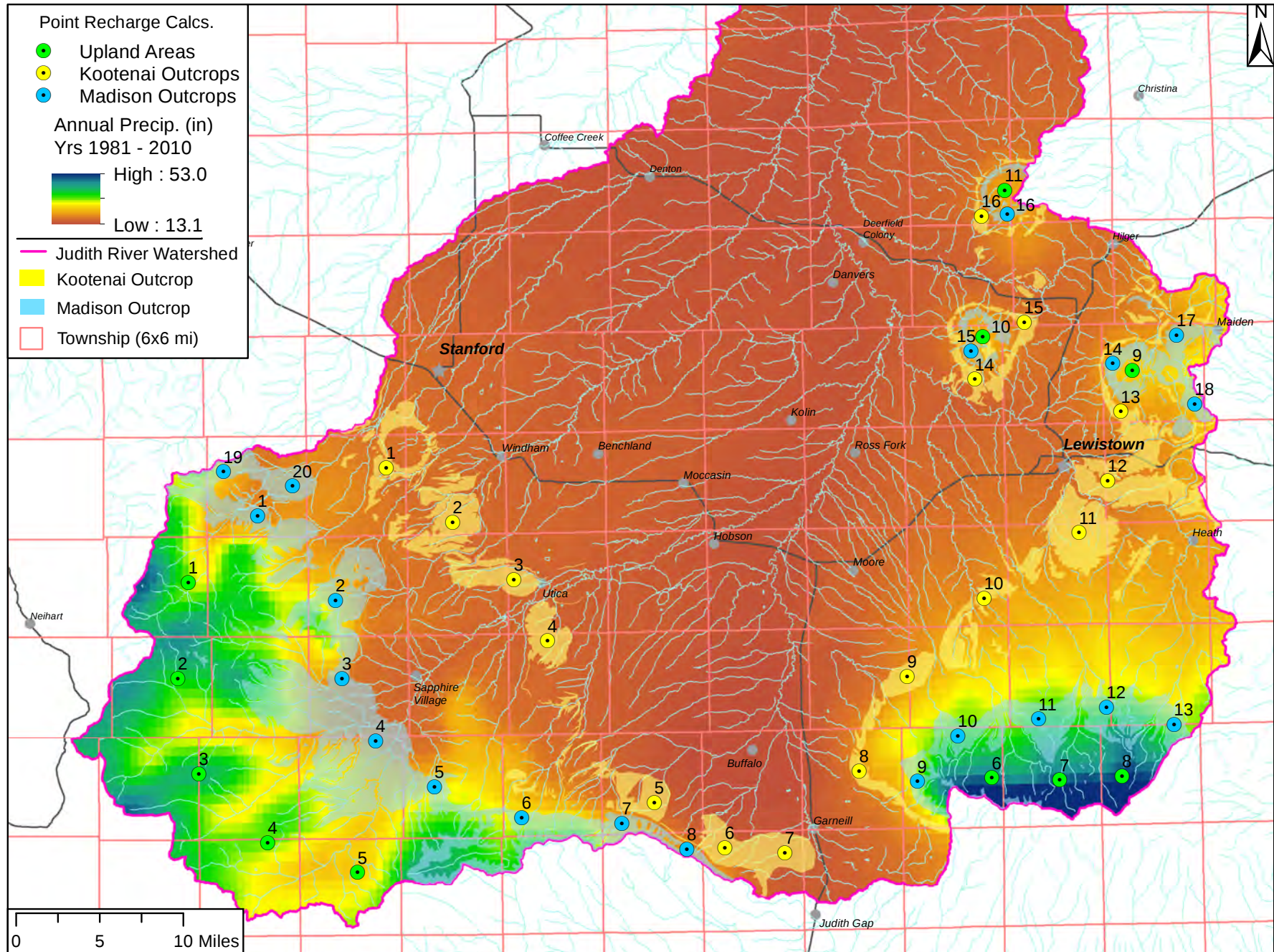


Figure 16. PRISM Annual Precipitation

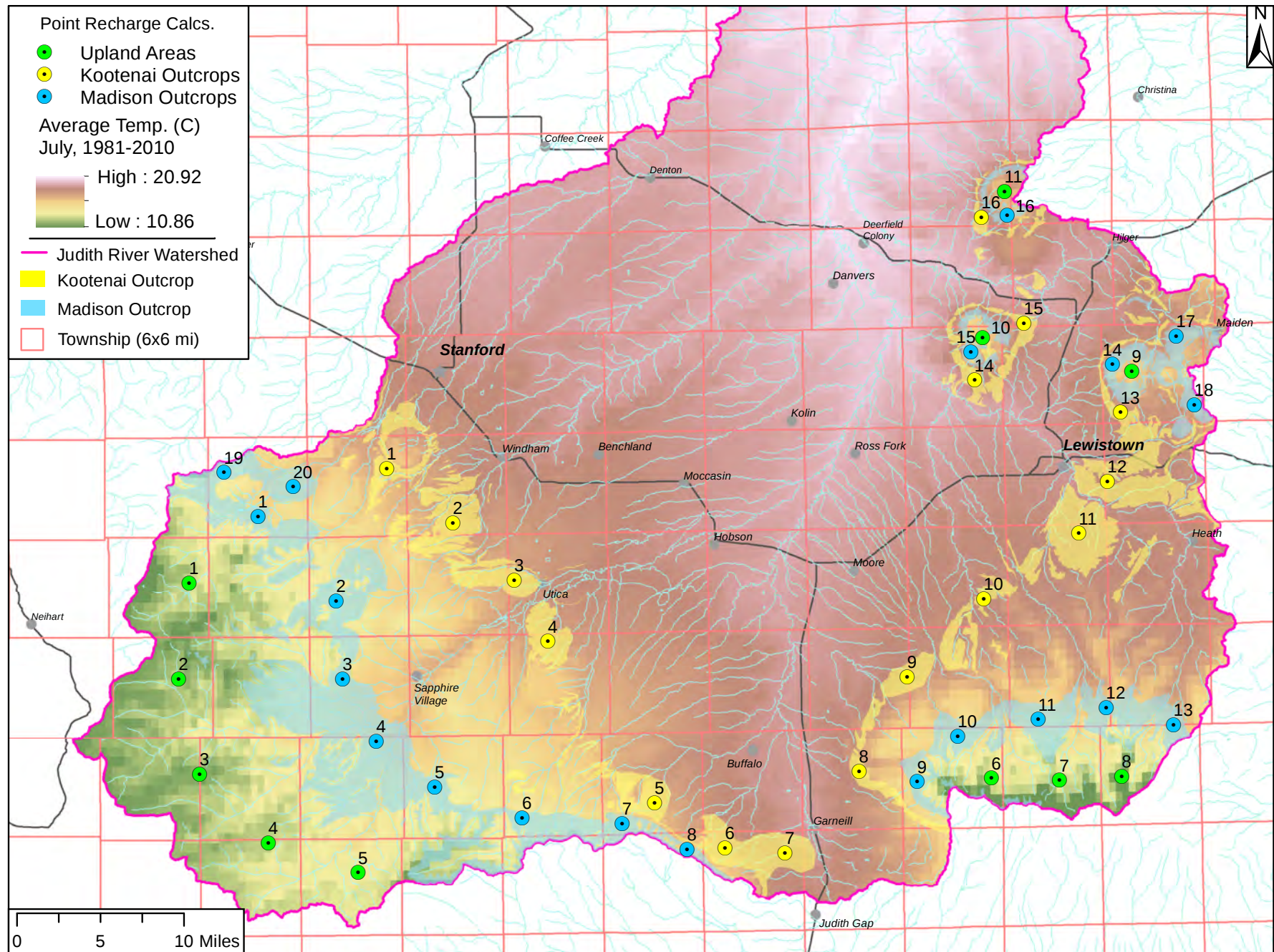


Figure 17. PRISM July Mean Temperature

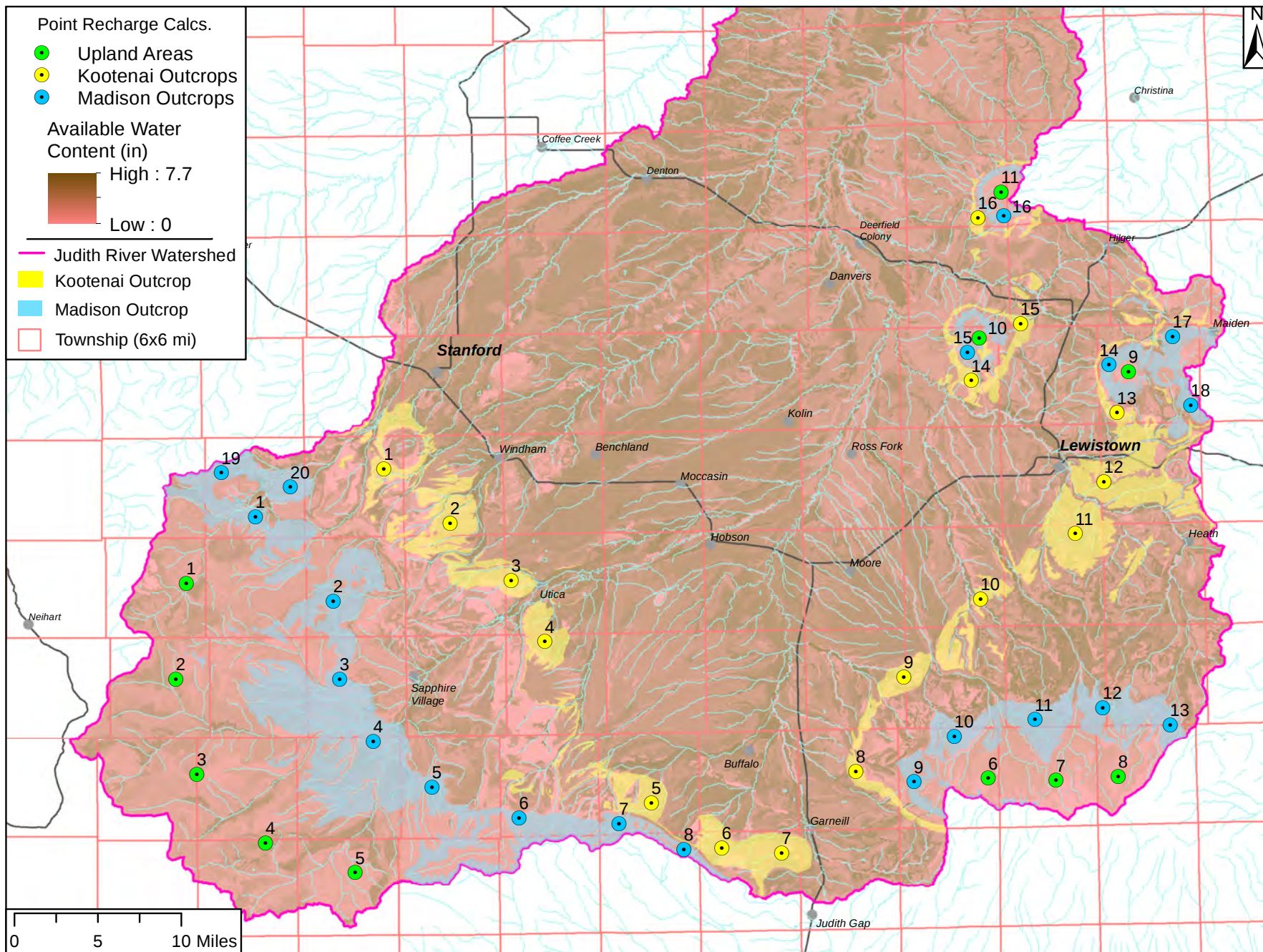


Figure 18. Available Water Content, 1-meter Depth

Table 3. Madison Recharge Through Soil

Point	Ci	Cro	Cs	AWC(in)	P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)
1	0.05	0.1	0.05	2.96	18.94	0.95	1.80	0.18	16.02	19.30	14.23	1.79	9.44
2	0.05	0.1	0.05	3.17	21.71	1.09	2.06	0.26	18.30	16.95	13.19	5.10	23.50
3	0.05	0.1	0.05	4.99	17.28	0.86	1.64	0.17	14.61	21.68	14.61	0.00	0.00
4	0.05	0.1	0.05	3.03	17.38	0.87	1.65	0.17	14.69	21.04	14.07	0.62	3.55
5	0.05	0.1	0.05	2.26	23.38	1.17	2.22	0.30	19.69	19.26	13.70	5.99	25.61
6	0.05	0.1	0.05	2.26	24.81	1.24	2.36	0.33	20.89	18.35	13.58	7.31	29.45
7	0.05	0.1	0.05	2.50	20.58	1.03	1.95	0.21	17.39	16.95	13.20	4.19	20.34
8	0.05	0.1	0.05	2.67	19.31	0.97	1.83	0.15	16.36	13.96	12.35	4.01	20.79
9	0.05	0.1	0.05	3.24	28.52	1.43	2.71	0.42	23.97	20.04	14.97	8.99	31.53
10	0.05	0.1	0.05	3.19	29.36	1.47	2.79	0.40	24.71	19.08	15.63	9.08	30.93
11	0.05	0.1	0.05	3.20	30.79	1.54	2.93	0.37	25.95	20.81	17.40	8.55	27.78
12	0.05	0.1	0.05	2.82	29.39	1.47	2.79	0.35	24.78	19.79	16.78	8.00	27.23
13	0.05	0.1	0.05	3.24	28.25	1.41	2.68	0.31	23.85	21.19	17.97	5.87	20.79
14	0.05	0.1	0.05	2.96	20.95	1.05	1.99	0.19	17.72	13.65	12.47	5.25	25.07
15	0.05	0.1	0.05	3.19	20.34	1.02	1.93	0.19	17.21	19.17	15.07	2.14	10.51
16	0.05	0.1	0.05	3.20	19.54	0.98	1.86	0.18	16.53	22.24	16.02	0.51	2.63
17	0.05	0.1	0.05	2.36	20.21	1.01	1.92	0.18	17.09	22.58	15.60	1.49	7.38
18	0.05	0.1	0.05	3.20	22.97	1.15	2.18	0.21	19.43	19.01	16.14	3.28	14.30
19	0.05	0.1	0.05	3.65	23.06	1.15	2.19	0.28	19.44	20.46	15.47	3.97	17.22
20	0.05	0.1	0.05	3.35	18.55	0.93	1.76	0.16	15.70	19.94	14.78	0.92	4.96
Ci – foliage interception coefficient; Cro – runoff coefficient; Cs – sublimation coefficient; AWC – available water content; P – total precipitation; Pi – interception depth; Pro – runoff depth; Ps – sublimation depth; Pnet – net precipitation including snow melt depth; PET – potential evapotranspiration; AET – actual evapotranspiration; DP – deep percolation (groundwater recharge); DP/P – ration of deep percolation to total precipitation.													

Recharge calculations were made using the same water balance analysis at points located systematically to span the Madison outcrop area. Data were extracted from the multiple raster images at each point. Solar radiation data were developed for each point using the Arc GIS software, as for the Judith Gap RWIS location. Recharge analyses for each of 20-points located within the Madison outcrop area are provided in **Appendix E** and summarized in **Table 3**.

As compared to the Judith Gap RWIS recharge analysis, the PRISM data were found to result in much lower groundwater recharge. Using PRISM data for the location of the Judith Gap RWIS, the groundwater recharge was estimated as 0.00 inches per year, despite running the analysis with no interception, runoff or sublimation. The same analysis using site data averaged over the 3-year monitoring period was 3.1 inches per year. These results are indicating the long-term averages do not capture the recharge that may occur during wet years, which in the case of the Judith Gap RWIS was up to 5.87 inches for 2019.

To better match the Judith Gap RWIS analysis, the interception, runoff and sublimation coefficients were reduced for the Madison analyses. These reductions provide more water for groundwater recharge. It is expected the groundwater recharge estimates are lower than would be estimated using actual data. The results indicate annual groundwater recharge for the 30-year normal period ranging from 0.00- to 9.08-inches, with an average over the 20-points of 4.1 inches per year. As a percentage of precipitation, the ratio ranges from 0% to 32%, averaging 17%.

Estimates of total recharge were made with respect to specific geographic areas in Judith Basin. These analyses assigned the average recharge of point analyses to designated areas. The point depths were multiplied by the area to obtain annual volumes (**Table 4**). In total for Judith Basin, the Madison aquifer is estimated to be receiving about 96,000 af/yr of recharge from precipitation onto the formation outcrop areas. The values shown do not include recharge to the Madison that occurs where streams cross the outcrop.

Table 4. Madison Aquifer Recharge by Area

Units	Little Belt Mtns – East	Little Belt Mtns	Big Snowy Mtns	Judith Mtns	North Moccasin Mtn	South Moccasin Mtn
af/yr	25,749	35,529	29,914	3,840	112	501
Cfs	35.6	49.1	41.3	5.3	0.2	0.7
af/yr – acre-feet per year; cfs – cubic feet per second						

Measurements of recharge directly from surface water were made by the Montana Bureau of Mines and Geology during earlier water resources studies of Judith Basin. Although these data are discrete measurements carried out one time, they show substantial instantaneous recharge from selected streams (**Table 5**).

Table 5. Madison Aquifer Recharge Occurring from Surface Water

Range	Source	Date	Rate (cfs)
Little Belt	Dry Wolf Cr.	5/28/64	164
Little Belt	Yogo Cr.	5/10/64	42
Little Belt	MF Judith R.	8/26/71	13
Little Belt	SF Judith R.	6/22/71	16
Big Snowy	Rock Cr.	6/5/68	56
Big Snowy	Cottonwood Cr.	7/16/68	32
Feltis, R. D. (1980) Water Resources of the Judith Basin, Central Montana, Hydrogeologic Map 1, Montana Bureau of Mines and Geology, Butte, MT.			

With respect to the Big Snowy Mountains, this analysis is showing 41.3 cfs of recharge by infiltration through soil within the Madison outcrop area. This rate falls substantially below the discharge from Big Spring, Lehman Spring and Hatchery spring. Some underestimation is expected by use of long-term averages in the analysis, however, this result is also indicating substantial recharge directly from surface water.

In the Little Belt Mountains, the eastern area has most relevance to the U Bet Wellfield. This area extends west from Judith Gap to Sapphire Village. The analysis is showing 35.6 cfs of recharge through soil in the Madison outcrop areas. For comparison, the Musselshell-Judith Regional Water System is projected to have maximum annual production at the U Bet Wellfield of 1.8 cfs in year 2065. The rate of 35.6 cfs also likely underestimates actual recharge and could be substantially increased by including recharge directly from surface water.

Climate change models forecast warmer atmospheric temperatures that will increase evapotranspiration and potentially reduce groundwater recharge to aquifers. The Madison aquifer, however, will see a reduction primarily in the recharge component that occurs from precipitation onto soil. The fraction of recharge originating from direct discharge of surface waters will be less impacted. In the case where precipitation remains similar to present conditions, little or no reduction in recharge from surface water may occur.

6.3 Kootenai Aquifer

Analysis of recharge into the Kootenai aquifer was completed as for the Madison aquifer. Average total precipitation and mean temperature were obtained for each month of the year for the 30-year normal period from 1981 to 2010. The Kootenai aquifer analysis was completed assuming no interception, runoff, or sublimation occurs. These assumptions were made to increase groundwater recharge, reducing the potential discrepancy between yearly data and the PRISM data, as discussed above. The point analyses are provided in **Appendix E** and summarized in **Table 6**.

Table 6. Kootenai Recharge Through Soil

Point	Ci	Cro	Cs	AWC(in)	P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)
1	0	0	0	3.55	16.39	0.00	0.00	0.00	16.39	21.63	16.05	0.34	2.08
2	0	0	0	2.28	16.13	0.00	0.00	0.00	16.13	21.63	15.11	1.03	6.35
3	0	0	0	1.56	15.74	0.00	0.00	0.00	15.74	21.79	14.45	1.29	8.22
4	0	0	0	3.60	15.59	0.00	0.00	0.00	15.59	21.73	15.59	0.00	0.00
5	0	0	0	3.60	15.79	0.00	0.00	0.00	15.79	22.01	15.79	0.00	0.00
6	0	0	0	1.56	16.24	0.00	0.00	0.00	16.24	22.09	15.27	0.97	5.96
7	0	0	0	1.56	14.64	0.00	0.00	0.00	14.64	23.04	14.26	0.38	2.60
8	0	0	0	1.72	18.52	0.00	0.00	0.00	18.52	22.40	15.80	2.72	14.67
9	0	0	0	6.33	18.76	0.00	0.00	0.00	18.76	22.06	18.76	0.00	0.00
10	0	0	0	6.48	18.66	0.00	0.00	0.00	18.66	22.87	18.66	0.00	0.00
11	0	0	0	3.72	18.96	0.00	0.00	0.00	18.96	21.35	17.44	1.52	8.03
12	0	0	0	3.29	17.16	0.00	0.00	0.00	17.16	21.82	16.63	0.53	3.08
13	0	0	0	1.56	18.76	0.00	0.00	0.00	18.76	23.39	16.27	2.49	13.29
14	0	0	0	4.59	17.41	0.00	0.00	0.00	17.41	21.88	17.41	0.00	0.00
15	0	0	0	3.74	16.79	0.00	0.00	0.00	16.79	23.27	16.79	0.00	0.00
16	0	0	0	5.78	17.66	0.00	0.00	0.00	17.66	22.12	17.66	0.00	0.00

Ci – foliage interception coefficient; Cro – runoff coefficient; Cs – sublimation coefficient; AWC – available water content; P – total precipitation; Pi – interception depth; Pro – runoff depth; Ps – sublimation depth; Pnet – net precipitation including snow melt depth; PET – potential evapotranspiration; AET – actual evapotranspiration; DP – deep percolation (groundwater recharge); DP/P – ration of deep percolation to total precipitation.

Groundwater recharge through the soil surface is expected to be the dominant recharge process to the Kootenai aquifer. It is possible that some recharge also occurs where surface water flows directly over the formation. Of the 16 locations analyzed, seven were determined to have no recharge. Recharge rate ranged from 0- to 2.72-inches per year, averaging 0.7 inches per year. Recharge as a percentage of total precipitation ranged from 0% to 15%, averaging 4%. These numbers are not unreasonable for the location of the Kootenai outcrops, which occur in the basin where precipitation is lower and air temperature is higher than in the adjacent mountain ranges.

Kootenai aquifer recharge in specific geographic areas of Judith Basin range from 0- to 5,700 af/yr (**Table 7**). In total, the Kootenai aquifer in Judith Basin is receiving average annual recharge of about 11,000 af/yr. These numbers are anticipated to be lower than actual due to some component of direct surface water recharge and due to use of the PRISM climate data, which were found to provide generally low estimates of recharge.

Kootenai aquifer recharge may undergo more substantial reductions due to climate change that increases atmospheric air temperature. Greater evapotranspiration will reduce groundwater recharge through the soil. The quantity of recharge occurring directly from surface water will be less impacted.

Table 7
Kootenai Aquifer Recharge by Area

Units	Little Belt Mtns – East	Little Belt Mtns	Big Snowy Mtns	Judith Mtns	North Moccasin Mtn	South Moccasin Mtn
af/yr	655	1,992	2,008	5,693	0	0
cfs	0.91	2.75	2.77	7.86	0.00	0.00
af/yr – acre-feet per year; cfs – cubic feet per second						

7. CONCLUSIONS

- Eighteen springs were evaluated for potential hydraulic connection to the Madison aquifer. Three springs including Big Spring, Lehman Spring and Hatchery Spring were known to be Madison aquifer discharges. There were no other springs identified with a Madison aquifer source. Other springs considered in the study appear to be discharging shallow groundwater from both alluvium and bedrock aquifers. Isotope water quality parameters were found to be the most useful data for determining if a spring discharge was being derived from the Madison aquifer. The high flow rates from Madison springs also appears to differentiate them from springs sourced from other aquifers. Madison springs also appear to discharge in areas where the bedrock geology is faulted and fractured.
- Pump testing of the CMRWA #2 well located at the U Bet Wellfield further demonstrated the Madison aquifer to be a suitable supply for the Musselshell-Judith Regional Water System. Pump testing at a rate of 575 gpm resulted in about 42-ft of drawdown after 10-days of continuous pumping. Testing identified the potential for flow-limiting boundaries in the aquifer that should be considered when planning future wells. Although the testing was of relatively short-term, there was no response to pumping in the newly installed Kootenai aquifer monitoring well located 100 ft from the pumping well. There was also no response to pumping in the CMRWA #1 well, a Madison aquifer well located at Utica, approximately 20-miles northwest from CMRWA #2.

- Groundwater monitoring for the three-year grant project period was successful at establishing baseline levels prior to the onset of pumping in the U Bet Wellfield. Water level data being collected in pumping wells is impacted by operation of the pumps, however, the data were able to show normal established pumping levels. None of the locations exhibited declining trends, as may occur when an aquifer is being over-produced. Madison aquifer locations showed the groundwater level to fluctuate 30- to 65-ft in a seasonal pattern, with the high level occurring in October, and the low water level occurring in May.
- Groundwater recharge analysis was completed using a commonly applied water balance method. The method applies to groundwater recharge occurring from precipitation onto the land and penetrating through the root zone to saturated groundwater. It does not include recharge that may occur from direct discharge of surface water. Precipitation and temperature data used in the analysis were 30-year monthly averages spanning Judith Basin obtained from the PRISM Climate Group at Oregon State University. These data were found to most likely underestimate recharge, as the long-term averages do not reflect recharge that occurs during wet years. This tendency of the data was shown by comparison to the Judith Gap weather station operated by the Montana Department of Transportation.
- Recharge of the Madison aquifer occurs in the mountain ranges that surround Judith Basin, where the formation occurs at the land surface. Near to the U Bet Wellfield, the aquifer was estimated to obtain about 26,000 af/yr of recharge from precipitation. The amount from direct surface water discharge was not quantified. The U Bet Wellfield maximum annual production estimated for year 2065 is projected at 1,310 af. Based on recharge estimates for the Big Snowy Mountains and the discharges from Big Spring, Lehman Spring, and Hatchery Spring, it is likely that 50% to 66% of total recharge occurs directly from surface waters flowing over formation outcrops. The same condition is also known to occur in the Little Belt Mountains.
- Recharge to the Kootenai aquifer is much lower than the Madison aquifer. Kootenai formation outcrops occur at lower elevation where precipitation is less and air-temperature is greater. The Kootenai aquifer also is not known to obtain large quantities of recharge by direct discharge of surface water, although this means of recharge is likely occurring to some degree. In southern Judith Basin adjacent to the Little Belt Mountains, Kootenai aquifer recharge was estimated at 2,000 af/yr. Nearly the same recharge rate was estimated on the north side of the Big Snowy Mountains. West from the Judith Mountains annual recharge was estimated at 5,700 af/yr. The Moccasin Mountains were found to have negligible recharge. In total, approximately 11,000 af/yr of recharge is estimated for the Kootenai aquifer in Judith Basin. It is likely, however, that greater recharge rates would be estimated using yearly data rather than long-term averages and with inclusion of recharge directly from surface water.
- Climate change resulting in increased air temperature is expected to decrease groundwater occurring through the soil overlying formation outcrops. Greater evapotranspiration will consume groundwater that otherwise would pass through the root zone. The Madison aquifer will likely undergo a smaller impact, as substantial recharge is occurring directly from surface water discharges. The Kootenai aquifer is expected to undergo more substantial impacts as most recharge is likely occurring through the soil profile.

APPENDIX A – SPRING INVENTORY REPORT

APPENDIX B – CMRWA #2 PUMPING TEST REPORT

APPENDIX C – U BET WELLFIELD KOOTENAI MONITORING WELL REPORT

APPENDIX D – GROUNDWATER MONITORING INTERIM REPORTS
BIG SPRING FLOW MONITORING SUMMARY

BIG SPRING FLOW MONITORING SYSTEM SUMMARY

Provided by: Andy Brummond, FWP

Hansen Creek – SonTek IQ (Tributary flow into Big Spring Creek)

This ultrasonic flow meter existed prior to the CMRWA grant project. It measures water velocity throughout the water column in addition to depth, so it is not susceptible to backwater effects that occur in the Hansen Creek channel. The communications module in the instrument failed and the grant project paid to repair the instrument. The instrument has an independent flow display in addition to the connection with the SCADA system. The SCADA system is supplied data via a 4-20 mA cable link from the display.

Fish Canal – SonTek IQ Pipe (Discharge from Big Spring Vault)

This ultrasonic flow meter is mounted in the 4-ft. diameter pipeline supplying the lower hatchery unit and was installed as part of CMRWA grant project. It is the same technology as the regular IQ instrument, but its shape is slightly different to optimize its use in pipelines. The communication cable failed in early February 2018 and was replaced in November 2018 while the Lower Hatchery was offline. The instrument has an independent flow display in addition to the connection with the SCADA system. The SCADA system is supplied data via a 4-20 mA cable link from the display.

Big Spring Creek (Discharge from Big Spring Vault)

The water level in Big Spring Creek is monitored using a pressure transducer vented to the atmosphere. (I do not have the details on the brand or model.) The pressure transducer is linked via cable to the SCADA system. The pressure transducer is mounted in a 2 ft. diameter stilling well buried in the right bank of the creek. Two $\frac{3}{4}$ in. pipes connect the stilling well to the creek, protruding into the creek about 18 in. Both pipes remain below normal water levels at all times.

Discharge in Big Spring Creek is measured normally monthly. These measurements are taken using normal USGS wading measurement protocol and are typically performed using a SonTek Flowtracker ultrasonic velocity meter but on occasion a Marsh-McBirney magnetic flow meter is used. Creek water level readings taken from the SCADA system are recorded before and after the measurement. Special attention is focused on whether the City of Lewistown is diverting water during the measurement as this reduces the flow in the creek. Preferably creek discharge measurements are taken while the City is not diverting water. The VNC remote viewing system allows the hydrographer to anticipate whether the City is likely to divert water during a planned discharge measurement.

Discharge measurements paired with corresponding water level readings are used to develop and adjust equations relating water level to discharge. These equations are then used to generate an estimated discharge in the creek for each of the water level

readings taken every 20 minutes by the pressure transducer. For Big Spring Creek at this location and for the range of flows normally observed, the rating equation is linear. The SCADA system allows for two rating endpoints to be set that define the linear equation on which it calculates the flow in Big Spring Creek based on water level data.

The channel immediately below the stilling well is stable and not subject to substantial geomorphic changes. A flood-control dam a short distance upstream on Hansen Creek attenuates extremely high flows while discharges from Big Spring and the Upper Hatchery springs remain relatively constant resulting in limited channel geometry changes due to high flow events. However, due the constant water temperature slightly above 50° F, aquatic vegetation is present in the reach of the creek immediately below the stilling well during all times of the year. This aquatic vegetation impacts the relationship between water level and flow in the creek. Photo-period seems to impact the extent of aquatic vegetation, with the vegetation peaking during the summer and receding to a minimum in the winter. This requires that shifts or offsets be made to the water level data to account for changes in aquatic vegetation.

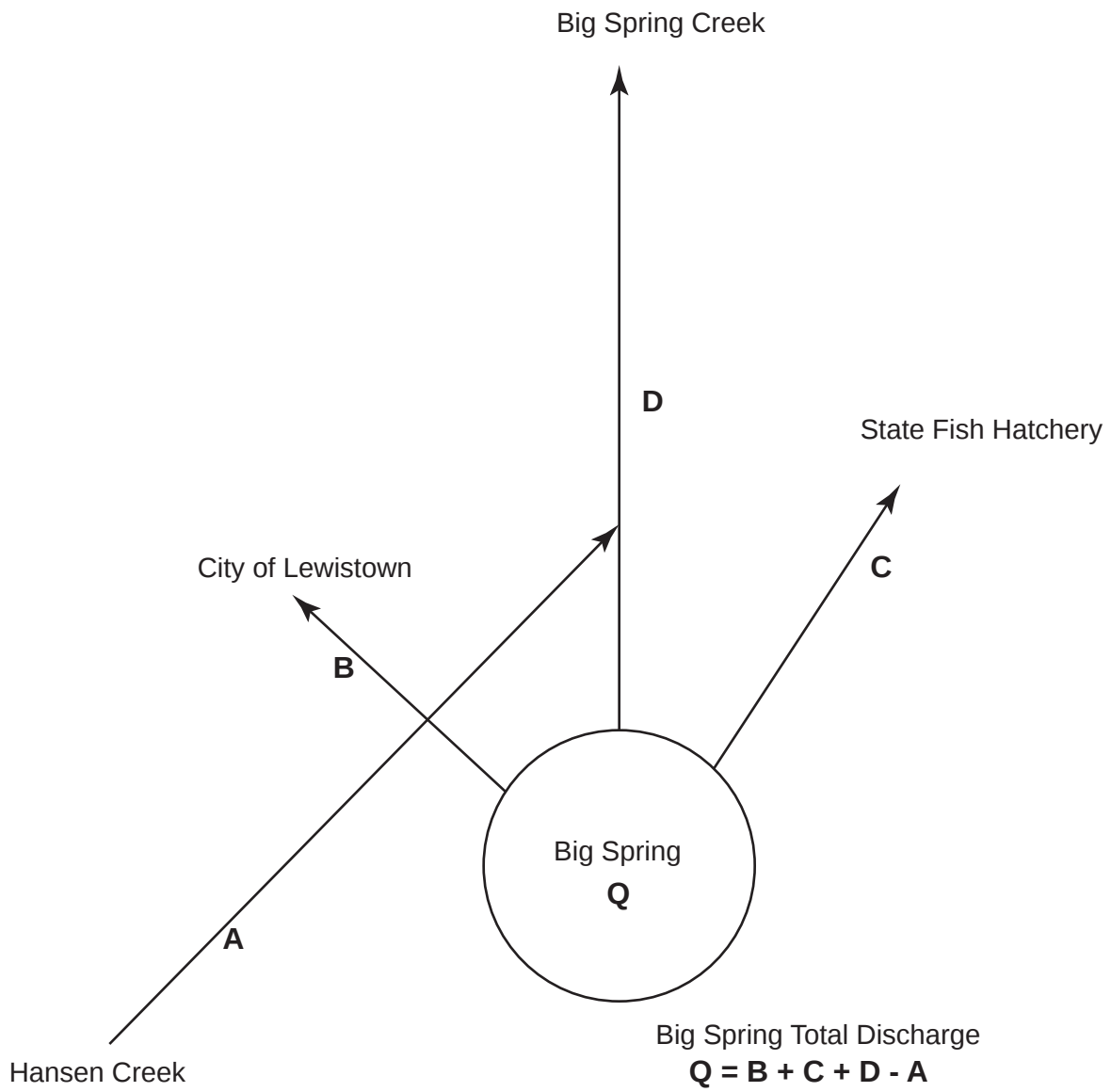
For example, the flow measure is 30,500 gpm but the rating equation yields a flow of 31,070 gpm at a water level of 11.25 in. In order to have the rating equation yield a flow of 30,500 gpm, matching the actual flow, the water level must be shifted or offset by - 0.11 in. down to 11.14 in. This value can be entered into the SCADA system to provide a correct estimated creek flow at the time of measurement. When the shift is due to changes in aquatic vegetation growth, the shift is applied incrementally to the full dataset over the period between consecutive streamflow measurements, resulting in a smooth change in shift.

Not all shifts are applied incrementally. When the flow to the lower hatchery unit is significantly changed, it seems to abruptly change the impact of aquatic vegetation on the water level. When flow to the hatchery is decreased and in turn flow increases in the creek, the increased water velocity in the creek tends to push over the aquatic vegetation causing an abrupt decrease in the water level and a corresponding increase in the shift value to correct for the impacts of the vegetation. The converse seems to be true when flow into the lower hatchery is increased, reducing flow in the creek. In these situations, the shift is not incrementally applied, but is immediately applied at the time flow conditions change abruptly.

The raw creek flow data collected by the SCADA system is provisional until it can be reviewed, and shifts corrected to account for actual streamflow measurements and for other changes such as increases or reductions in flow to the lower hatchery.

City of Lewistown Municipal Water System (Discharge from Big Spring Vault)

I believe the meters are turbine insertion type. They were replaced just prior to the CMRWA grant project and are linked via cable to the SCADA system.



(Figure from Western Groundwater Services)

Big Spring Flow Measuring System

APPENDIX E – WATER BALANCE CALCULATION TABLES

2017 WATER BALANCE
JUDITH GAP RWIS

Ci	Cro	Cs	AWC	Start Month								
--	--	--	in									
0.10	0.15	0.10	2.72	10								
Month	Pt	Tm	R	SD		SM	dSM	Pnet	PET	AET	DP	DP/P
	in	C	cal/cm2	--		in	in	in	in	in	in	%
Jan	0.00	-7.42	4373.6	0.00		0.410	0.000	0.000	0.000	0.000	0.000	
Feb	1.77	-3.63	6649.7	0.00		0.410	0.000	0.000	0.000	0.000	0.000	
Mar	1.93	2.05	10169.8	0.40		2.435	2.026	2.654	0.628	0.628	0.000	
Apr	1.99	4.99	13320.3	0.60		2.720	0.285	3.288	1.701	1.701	1.303	
May	1.71	10.69	16172.6	0.00		2.030	-0.690	1.307	3.443	1.998	0.000	
Jun	0.49	15.59	17060.7	0.00		1.391	-0.639	0.374	4.447	1.013	0.000	
Jul	0.21	22.74	18521.7	0.00		0.856	-0.535	0.157	5.707	0.691	0.000	
Aug	0.28	18.87	16029.0	0.00		0.581	-0.276	0.216	4.569	0.492	0.000	
Sep	1.88	12.70	11548.1	0.00		0.461	-0.120	1.439	2.712	1.559	0.000	
Oct	0.75	6.08	9448.8	0.00		0.410	-0.052	0.570	1.397	0.622	0.000	
Nov	1.30	-0.50	5416.4	0.00		0.410	0.000	0.000	0.000	0.000	0.000	
Dec	1.21	-6.51	4611.8	0.00		0.410	0.000	0.000	0.000	0.000	0.000	
TOTAL	13.51						0.000	10.006	24.603	8.703	1.303	10%
Ci - interception coefficient; Cro - runoff coefficient; Cs - sublimation coefficient; AWC - available water content												
Pt - total precipitation; Tm - mean temperature; R - solar radiation; SD - snow distribution												
SM - soil moisture; dSM - change in soil moisture; Pn - net precipitation; PET - potential evapotranspiration; AET - actual evapotranspiration; DP - deep percolation												
UNITS: in - inches of water; C - degrees centigrade; cal/cm2 - calories per square centimeter; -- - indicates the value is unitless												

**2018 WATER BALANCE
JUDITH GAP RWIS**

Ci	Cro	Cs	AWC	Start Month								
--	--	--	in									
0.10	0.15	0.10	2.72	10								
Month	Pt	Tm	R	SD		SM	dSM	Pnet	PET	AET	DP	DP/P
	in	C	cal/cm2	--		in	in	in	in	in	in	%
Jan	0.18	-3.38	4373.6	0.00		0.607	0.000	0.000	0.000	0.000	0.000	
Feb	2.43	-10.88	6649.7	0.00		0.607	0.000	0.000	0.000	0.000	0.000	
Mar	2.06	-1.82	10169.8	0.00		0.607	0.000	0.000	0.000	0.000	0.000	
Apr	2.49	2.53	13320.3	0.60		2.720	2.113	5.084	0.985	0.985	1.986	
May	5.63	12.11	16172.6	0.40		2.720	0.000	6.428	3.696	3.696	2.732	
Jun	3.19	13.96	17060.7	0.00		1.902	-0.818	2.439	4.207	3.257	0.000	
Jul	0.39	18.38	18521.7	0.00		1.221	-0.681	0.295	5.215	0.976	0.000	
Aug	1.21	17.84	16029.0	0.00		0.836	-0.385	0.922	4.454	1.307	0.000	
Sep	0.01	10.97	11548.1	0.00		0.676	-0.160	0.006	2.498	0.166	0.000	
Oct	0.56	5.31	9448.8	0.00		0.607	-0.069	0.425	1.267	0.494	0.000	
Nov	1.87	-0.01	5416.4	0.00		0.607	0.000	0.000	0.000	0.000	0.000	
Dec	1.16	-2.40	4611.8	0.00		0.607	0.000	0.000	0.000	0.000	0.000	
TOTAL	21.16						0.000	15.599	22.323	10.881	4.718	22%
Ci - interception coefficient; Cro - runoff coefficient; Cs - sublimation coefficient; AWC - available water content												
Pt - total precipitation; Tm - mean temperature; R - solar radiation; SD - snow distribution												
SM - soil moisture; dSM - change in soil moisture; Pn - net precipitation; PET - potential evapotranspiration; AET - actual evapotranspiration; DP - deep percolation												
UNITS: in - inches of water; C - degrees centigrade; cal/cm2 - calories per square centimeter; -- - indicates the value is unitless												

2019 WATER BALANCE
JUDITH GAP RWIS

Ci	Cro	Cs	AWC	Start Month								
--	--	--	in									
0.10	0.15	0.10	2.72	10								
Month	Pt	Tm	R	SD		SM	dSM	Pnet	PET	AET	DP	DP/P
	in	C	cal/cm2	--		in	in	in	in	in	in	%
Jan	1.35	-1.91	4373.6	0.00		2.720	0.000	0.000	0.000	0.000	0.000	
Feb	2.20	-15.51	6649.7	0.00		2.720	0.000	0.000	0.000	0.000	0.000	
Mar	0.89	-3.71	10169.8	0.00		2.720	0.000	0.000	0.000	0.000	0.000	
Apr	2.87	4.82	13320.3	0.60		2.720	0.000	4.941	1.659	1.659	3.282	
May	3.46	7.69	16172.6	0.40		2.720	0.000	4.476	2.805	2.805	1.672	
Jun	2.56	13.47	17060.7	0.00		1.915	-0.805	1.960	4.128	2.765	0.000	
Jul	2.58	17.29	18521.7	0.00		1.244	-0.671	1.974	5.071	2.645	0.000	
Aug	1.51	17.50	16029.0	0.00		0.855	-0.389	1.154	4.416	1.544	0.000	
Sep	4.02	11.85	11548.1	0.00		1.320	0.465	3.075	2.611	2.611	0.000	
Oct	3.47	1.29	9448.8	0.00		2.720	1.400	2.655	0.383	0.383	0.871	
Nov	1.88	-0.59	5416.4	0.00		2.720	0.000	0.000	0.000	0.000	0.000	
Dec	0.34	-0.42	4611.8	0.00		2.720	0.000	0.000	0.000	0.000	0.000	
TOTAL	27.12						0.000	20.236	21.072	14.411	5.825	21%
Ci - interception coefficient; Cro - runoff coefficient; Cs - sublimation coefficient; AWC - available water content												
Pt - total precipitation; Tm - mean temperature; R - solar radiation; SD - snow distribution												
SM - soil moisture; dSM - change in soil moisture; Pn - net precipitation; PET - potential evapotranspiration; AET - actual evapotranspiration; DP - deep percolation												
UNITS: in - inches of water; C - degrees centigrade; cal/cm2 - calories per square centimeter; -- - indicates the value is unitless												

JUDITH GAP RWIS RECHARGE (PRISM DATA)

3/18/2020

POINT NO.	Judith Gap RWIS										
Ci	Cro	Cs	AWC (in)								
0.00	0.00	0.00	2.72								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.39	0.00	-3.78	4373.62		0.64	0.00	0.00	0.00	0.00	0.00
2.00	0.35	0.00	-2.88	6649.65		0.64	0.00	0.00	0.00	0.00	0.00
3.00	0.68	0.40	0.46	10169.81		1.64	0.99	1.15	0.16	0.16	0.00
4.00	1.38	0.60	5.19	13320.29		1.97	0.33	2.08	1.75	1.75	0.00
5.00	2.70	0.00	9.80	16172.62		1.49	-0.48	2.70	3.27	3.18	0.00
6.00	2.94	0.00	14.19	17060.67		1.04	-0.45	2.94	4.24	3.39	0.00
7.00	1.98	0.00	18.59	18521.68		0.67	-0.37	1.98	5.24	2.36	0.00
8.00	1.48	0.00	18.45	16029.05		0.45	-0.21	1.48	4.52	1.69	0.00
9.00	1.21	0.00	12.90	11548.09		0.36	-0.09	1.21	2.73	1.30	0.00
10.00	0.78	0.00	7.11	9448.82		0.31	-0.04	0.78	1.56	0.83	0.00
11.00	0.40	0.00	0.41	5416.42		0.64	0.33	0.40	0.07	0.07	0.00
12.00	0.44	0.00	-4.27	4611.80		0.64	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
14.73	0.00	0.00	0.00	14.73	23.55	14.73	0.00	0.00			
Ci - interception coefficient; Cro - runoff coefficient; Cs - sublimation coefficient; AWC - available water content											
P - total precipitation; Tm - mean temperature; Rn - solar radiation; fSNOW - snow distribution											
SM - soil moisture; dSM - change in soil moisture; Pn - net precipitation; PET - potential evapotranspiration;											
AET - actual evapotranspiration; DP - deep percolation											
UNITS: in - inches of water; C - degrees centigrade; cal/cm2 - calories per square centimeter											

MADISON FM RECHARGE CALCULATION TABLES

3/17/2020

POINT NO.	1.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	2.96								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.69	0.00	-5.48	3564.78		0.90	0.00	0.00	0.00	0.00	0.00
2.00	0.57	0.00	-4.71	6345.49		0.90	0.00	0.00	0.00	0.00	0.00
3.00	1.30	0.00	-1.45	9622.76		0.90	0.00	0.00	0.00	0.00	0.00
4.00	1.80	0.50	2.79	13154.63		2.96	2.06	3.21	1.06	1.06	0.09
5.00	3.12	0.50	7.27	15818.14		2.96	0.00	4.34	2.64	2.64	1.69
6.00	2.96	0.00	11.44	16639.55		2.17	-0.80	2.53	3.68	3.33	0.00
7.00	2.07	0.00	15.39	18552.99		1.44	-0.73	1.77	4.80	2.49	0.00
8.00	2.02	0.00	15.19	15238.20		1.03	-0.41	1.73	3.92	2.14	0.00
9.00	1.72	0.00	10.14	11006.91		0.85	-0.18	1.47	2.27	1.65	0.00
10.00	1.13	0.00	4.59	7653.38		0.90	0.05	0.97	0.92	0.92	0.00
11.00	0.78	0.00	-1.80	3973.91		0.90	0.00	0.00	0.00	0.00	0.00
12.00	0.77	0.00	-6.07	3882.02		0.90	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
18.94	0.95	1.80	0.18	16.02	19.30	14.23	1.79	9.44			
POINT NO.	2.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	3.17								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.96	0.00	-6.17	1456.07		1.79	0.00	0.00	0.00	0.00	0.00
2.00	0.90	0.00	-5.37	5696.47		1.79	0.00	0.00	0.00	0.00	0.00
3.00	1.92	0.00	-2.02	8479.10		1.79	0.00	0.00	0.00	0.00	0.00
4.00	2.30	0.50	1.98	12558.61		3.17	1.39	4.48	0.75	0.75	2.34
5.00	3.00	0.50	6.58	14831.66		3.17	0.00	5.08	2.31	2.31	2.76
6.00	3.06	0.00	10.75	15502.04		2.48	-0.70	2.62	3.31	3.31	0.00
7.00	2.14	0.00	15.05	18170.55		1.67	-0.81	1.83	4.65	2.64	0.00
8.00	1.93	0.00	14.79	13564.81		1.24	-0.42	1.65	3.45	2.08	0.00
9.00	1.65	0.00	9.63	9845.87		1.05	-0.19	1.41	1.97	1.60	0.00
10.00	1.44	0.00	3.92	4667.25		1.79	0.73	1.23	0.50	0.50	0.00
11.00	1.23	0.00	-2.67	1745.61		1.79	0.00	0.00	0.00	0.00	0.00
12.00	1.18	0.00	-6.97	2858.23		1.79	0.00	0.00	0.00	0.00	0.00
TOTALS											

MADISON FM RECHARGE CALCULATION TABLES

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P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
21.71	1.09	2.06	0.26	18.30	16.95	13.19	5.10	23.50			
POINT NO.	3.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	4.99								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.61	0.00	-5.09	5754.35		0.80	0.00	0.00	0.00	0.00	0.00
2.00	0.55	0.00	-4.18	7210.63		0.80	0.00	0.00	0.00	0.00	0.00
3.00	1.27	0.00	-1.02	10902.46		0.80	0.00	0.00	0.00	0.00	0.00
4.00	1.71	0.50	3.21	14093.40		2.57	1.78	3.05	1.27	1.27	0.00
5.00	2.68	0.50	7.74	16864.74		3.51	0.94	3.88	2.94	2.94	0.00
6.00	2.70	0.00	12.01	17603.20		2.50	-1.01	2.31	4.00	3.33	0.00
7.00	1.96	0.00	15.98	19346.37		1.62	-0.88	1.68	5.10	2.56	0.00
8.00	1.79	0.00	15.79	16776.63		1.11	-0.51	1.53	4.40	2.03	0.00
9.00	1.46	0.00	10.63	12296.85		0.89	-0.22	1.25	2.61	1.47	0.00
10.00	1.07	0.00	5.08	10433.60		0.80	-0.10	0.92	1.35	1.01	0.00
11.00	0.76	0.00	-1.37	6214.06		0.80	0.00	0.00	0.00	0.00	0.00
12.00	0.72	0.00	-5.73	5161.43		0.80	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
17.28	0.86	1.64	0.17	14.61	21.68	14.61	0.00	0.00			
POINT NO.	4.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	3.03								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.68	0.00	-4.93	4443.76		0.72	0.00	0.00	0.00	0.00	0.00
2.00	0.60	0.00	-4.05	6733.49		0.72	0.00	0.00	0.00	0.00	0.00
3.00	1.26	0.00	-1.00	10203.69		0.72	0.00	0.00	0.00	0.00	0.00
4.00	1.70	0.50	3.35	13640.12		2.56	1.84	3.12	1.27	1.27	0.00
5.00	2.71	0.50	7.91	16392.48		3.03	0.47	3.98	2.90	2.90	0.62
6.00	2.69	0.00	12.17	17209.96		2.17	-0.86	2.30	3.94	3.16	0.00
7.00	1.93	0.00	16.14	19044.56		1.41	-0.76	1.65	5.05	2.41	0.00
8.00	1.77	0.00	15.94	15998.89		0.99	-0.42	1.51	4.22	1.94	0.00
9.00	1.43	0.00	10.83	11607.84		0.80	-0.19	1.22	2.49	1.41	0.00
10.00	1.06	0.00	5.26	8796.45		0.72	-0.08	0.91	1.17	0.98	0.00

MADISON FM RECHARGE CALCULATION TABLES

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11.00	0.79	0.00	-1.23	4877.13		0.72	0.00	0.00	0.00	0.00	0.00
12.00	0.77	0.00	-5.58	4419.22		0.72	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
17.38	0.87	1.65	0.17	14.69	21.04	14.07	0.62	3.55			
POINT NO.											
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	2.26								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	1.21	0.00	-5.93	3782.77		1.10	0.00	0.00	0.00	0.00	0.00
2.00	1.05	0.00	-5.15	6651.57		1.10	0.00	0.00	0.00	0.00	0.00
3.00	1.94	0.00	-1.83	9991.80		1.10	0.00	0.00	0.00	0.00	0.00
4.00	2.49	0.50	2.16	13659.27		2.26	1.16	4.96	0.88	0.88	2.92
5.00	3.30	0.50	6.79	16243.00		2.26	0.00	5.65	2.59	2.59	3.07
6.00	3.24	0.00	10.98	16957.74		1.65	-0.61	2.77	3.67	3.38	0.00
7.00	2.10	0.00	15.25	19171.70		1.09	-0.57	1.80	4.94	2.37	0.00
8.00	1.97	0.00	14.99	15595.46		0.77	-0.31	1.68	3.99	1.99	0.00
9.00	1.73	0.00	9.83	11396.50		0.64	-0.14	1.48	2.31	1.61	0.00
10.00	1.57	0.00	4.16	7916.24		1.10	0.46	1.34	0.88	0.88	0.00
11.00	1.41	0.00	-2.31	4193.96		1.10	0.00	0.00	0.00	0.00	0.00
12.00	1.36	0.00	-6.63	4103.54		1.10	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
23.38	1.17	2.22	0.30	19.69	19.26	13.70	5.99	25.61			
POINT NO.											
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	2.26								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	1.34	0.00	-5.94	2435.99		1.45	0.00	0.00	0.00	0.00	0.00
2.00	1.23	0.00	-5.12	6192.03		1.45	0.00	0.00	0.00	0.00	0.00
3.00	2.10	0.00	-1.81	9254.04		1.45	0.00	0.00	0.00	0.00	0.00
4.00	2.70	0.50	2.21	13217.79		2.26	0.81	5.40	0.87	0.87	3.72
5.00	3.50	0.50	6.82	15650.39		2.26	0.00	6.09	2.50	2.50	3.59
6.00	3.38	0.00	11.02	16340.94		1.67	-0.59	2.89	3.54	3.48	0.00
7.00	2.10	0.00	15.25	18873.19		1.11	-0.57	1.80	4.87	2.36	0.00

MADISON FM RECHARGE CALCULATION TABLES

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8.00	2.02	0.00	15.00	14631.58		0.80	-0.30	1.73	3.74	2.03	0.00
9.00	1.79	0.00	9.79	10658.13		0.67	-0.13	1.53	2.16	1.66	0.00
10.00	1.70	0.00	4.09	6107.79		1.45	0.78	1.45	0.67	0.67	0.00
11.00	1.54	0.00	-2.32	2794.81		1.45	0.00	0.00	0.00	0.00	0.00
12.00	1.40	0.00	-6.72	3366.86		1.45	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
24.81	1.24	2.36	0.33	20.89	18.35	13.58	7.31	29.45			
POINT NO.	7.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	2.50								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.86	0.00	-5.46	1347.19		1.45	0.00	0.00	0.00	0.00	0.00
2.00	0.78	0.00	-4.61	5222.04		1.45	0.00	0.00	0.00	0.00	0.00
3.00	1.33	0.00	-1.26	7810.68		1.45	0.00	0.00	0.00	0.00	0.00
4.00	2.18	0.50	2.89	11672.02		2.50	1.05	3.82	0.97	0.97	1.80
5.00	3.30	0.50	7.53	13937.21		2.50	0.00	4.77	2.38	2.38	2.39
6.00	3.40	0.00	11.76	14668.67		2.10	-0.40	2.90	3.30	3.30	0.00
7.00	2.22	0.00	16.02	17045.70		1.44	-0.67	1.90	4.50	2.57	0.00
8.00	1.97	0.00	15.83	12726.17		1.08	-0.36	1.69	3.35	2.04	0.00
9.00	1.47	0.00	10.54	9118.53		0.92	-0.16	1.26	1.93	1.42	0.00
10.00	1.23	0.00	4.84	4163.13		1.45	0.53	1.05	0.52	0.52	0.00
11.00	0.94	0.00	-1.69	1570.74		1.45	0.00	0.00	0.00	0.00	0.00
12.00	0.88	0.00	-6.16	2708.75		1.45	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
20.58	1.03	1.95	0.21	17.39	16.95	13.20	4.19	20.34			
POINT NO.	8.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	2.67								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.62	0.00	-5.90	1115.11		1.85	0.00	0.00	0.00	0.00	0.00
2.00	0.53	0.00	-4.78	4295.61		1.85	0.00	0.00	0.00	0.00	0.00
3.00	1.07	0.00	-1.56	6089.37		1.85	0.00	0.00	0.00	0.00	0.00
4.00	1.81	0.50	2.70	9967.10		2.67	0.82	2.96	0.78	0.78	1.36

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5.00	3.29	0.50	7.24	11839.75		2.67	0.00	4.23	1.97	1.97	2.26
6.00	3.70	0.00	11.52	12437.77		2.67	0.00	3.17	2.77	2.77	0.40
7.00	2.76	0.00	15.95	14894.02		1.91	-0.76	2.36	3.93	3.12	0.00
8.00	2.09	0.00	15.78	10395.23		1.52	-0.40	1.79	2.73	2.19	0.00
9.00	1.30	0.00	10.41	7431.11		1.33	-0.19	1.11	1.56	1.30	0.00
10.00	0.86	0.00	4.66	1768.37		1.85	0.52	0.74	0.22	0.22	0.00
11.00	0.64	0.00	-1.89	1168.69		1.85	0.00	0.00	0.00	0.00	0.00
12.00	0.62	0.00	-6.47	2451.46		1.85	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
19.31	0.97	1.83	0.15	16.36	13.96	12.35	4.01	20.79			
POINT NO. 9.00											
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	3.24								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	1.78	0.00	-6.11	4855.56		1.77	0.00	0.00	0.00	0.00	0.00
2.00	1.67	0.00	-5.23	7108.73		1.77	0.00	0.00	0.00	0.00	0.00
3.00	2.37	0.00	-1.80	10675.09		1.77	0.00	0.00	0.00	0.00	0.00
4.00	2.99	0.50	2.24	14193.55		3.24	1.48	6.53	0.94	0.94	4.11
5.00	4.14	0.50	6.58	16859.61		3.24	0.00	7.51	2.63	2.63	4.89
6.00	3.83	0.00	10.86	17551.64		2.75	-0.50	3.27	3.77	3.77	0.00
7.00	1.91	0.00	15.09	19674.79		1.79	-0.96	1.64	5.04	2.59	0.00
8.00	1.81	0.00	15.29	16455.36		1.25	-0.54	1.55	4.25	2.09	0.00
9.00	2.04	0.00	9.72	12095.84		1.01	-0.23	1.75	2.44	1.98	0.00
10.00	2.02	0.00	3.82	9304.98		1.77	0.76	1.72	0.97	0.97	0.00
11.00	1.91	0.00	-2.28	5294.47		1.77	0.00	0.00	0.00	0.00	0.00
12.00	2.05	0.00	-6.68	4744.24		1.77	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
28.52	1.43	2.71	0.42	23.97	20.04	14.97	8.99	31.53			
POINT NO. 10.00											
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	3.19								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	1.67	0.00	-5.66	2691.40		2.17	0.00	0.00	0.00	0.00	0.00

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2.00	1.54	0.00	-4.60	6178.23		2.17	0.00	0.00	0.00	0.00	0.00
3.00	2.30	0.00	-1.37	9280.30		2.17	0.00	0.00	0.00	0.00	0.00
4.00	2.97	0.50	2.81	13112.89		3.19	1.03	6.30	1.06	1.06	4.22
5.00	4.35	0.50	7.30	15615.89		3.19	0.00	7.48	2.62	2.62	4.87
6.00	4.12	0.00	11.62	16356.52		3.06	-0.13	3.52	3.65	3.65	0.00
7.00	2.37	0.00	15.82	18685.37		2.02	-1.04	2.03	4.90	3.07	0.00
8.00	2.10	0.00	15.99	14714.77		1.45	-0.57	1.80	3.89	2.36	0.00
9.00	2.18	0.00	10.18	10675.39		1.20	-0.25	1.86	2.21	2.11	0.00
10.00	2.00	0.00	4.39	6444.69		2.17	0.96	1.71	0.75	0.75	0.00
11.00	1.82	0.00	-1.75	3059.26		2.17	0.00	0.00	0.00	0.00	0.00
12.00	1.94	0.00	-6.26	3471.63		2.17	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
29.36	1.47	2.79	0.40	24.71	19.08	15.63	9.08	30.93			
POINT NO. 11.00											
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	3.20								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	1.47	0.00	-5.91	5299.17		1.84	0.00	0.00	0.00	0.00	0.00
2.00	1.25	0.00	-4.79	7206.89		1.84	0.00	0.00	0.00	0.00	0.00
3.00	2.39	0.00	-1.73	10800.82		1.84	0.00	0.00	0.00	0.00	0.00
4.00	3.07	0.50	2.64	14171.62		3.20	1.36	6.16	1.09	1.09	3.72
5.00	4.69	0.50	7.21	16782.37		3.20	0.00	7.55	2.79	2.79	4.77
6.00	4.61	0.00	11.52	17419.76		3.20	0.00	3.94	3.87	3.87	0.07
7.00	2.76	0.00	15.71	19500.76		2.07	-1.12	2.36	5.10	3.48	0.00
8.00	2.43	0.00	15.89	16501.47		1.43	-0.64	2.08	4.34	2.72	0.00
9.00	2.41	0.00	10.06	12192.78		1.16	-0.27	2.06	2.51	2.34	0.00
10.00	2.11	0.00	4.30	9814.32		1.84	0.68	1.80	1.12	1.12	0.00
11.00	1.74	0.00	-1.92	5743.43		1.84	0.00	0.00	0.00	0.00	0.00
12.00	1.87	0.00	-6.61	4972.07		1.84	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
30.79	1.54	2.93	0.37	25.95	20.81	17.40	8.55	27.78			
POINT NO. 12.00											
Ci	Cro	Cs	AWC (in)								

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0.05	0.10	0.05	2.82								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	1.39	0.00	-5.62	2897.66		1.98	0.00	0.00	0.00	0.00	0.00
2.00	1.23	0.00	-4.42	6181.09		1.98	0.00	0.00	0.00	0.00	0.00
3.00	2.18	0.00	-1.27	9331.17		1.98	0.00	0.00	0.00	0.00	0.00
4.00	2.77	0.50	3.20	13060.72		2.82	0.84	5.65	1.18	1.18	3.64
5.00	4.43	0.50	7.92	15643.92		2.82	0.00	7.07	2.77	2.77	4.30
6.00	4.50	0.00	12.28	16437.92		2.82	0.00	3.85	3.79	3.79	0.06
7.00	2.71	0.00	16.32	18582.29		1.85	-0.97	2.31	4.95	3.28	0.00
8.00	2.46	0.00	16.37	14848.20		1.32	-0.53	2.10	3.96	2.63	0.00
9.00	2.38	0.00	10.64	10724.74		1.09	-0.23	2.04	2.28	2.27	0.00
10.00	2.06	0.00	5.00	6746.21		1.98	0.89	1.76	0.87	0.87	0.00
11.00	1.54	0.00	-1.43	3278.77		1.98	0.00	0.00	0.00	0.00	0.00
12.00	1.74	0.00	-6.00	3557.92		1.98	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
29.39	1.47	2.79	0.35	24.78	19.79	16.78	8.00	27.23			
POINT NO.	13.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	3.24								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	1.19	0.00	-5.62	4535.14		1.71	0.00	0.00	0.00	0.00	0.00
2.00	1.02	0.00	-4.59	6854.67		1.71	0.00	0.00	0.00	0.00	0.00
3.00	2.00	0.00	-1.31	10326.69		1.71	0.00	0.00	0.00	0.00	0.00
4.00	2.46	0.50	3.17	13806.34		3.24	1.53	5.01	1.23	1.23	2.24
5.00	4.28	0.50	7.98	16468.06		3.24	0.00	6.56	2.93	2.93	3.63
6.00	4.53	0.00	12.38	17198.56		3.14	-0.10	3.88	3.98	3.98	0.00
7.00	2.81	0.00	16.36	19221.63		2.03	-1.11	2.40	5.13	3.51	0.00
8.00	2.58	0.00	16.40	16040.19		1.41	-0.62	2.21	4.29	2.83	0.00
9.00	2.43	0.00	10.62	11728.41		1.14	-0.27	2.08	2.49	2.35	0.00
10.00	2.01	0.00	5.06	8871.49		1.71	0.57	1.72	1.15	1.15	0.00
11.00	1.34	0.00	-1.54	4963.23		1.71	0.00	0.00	0.00	0.00	0.00
12.00	1.59	0.00	-6.08	4508.17		1.71	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
28.25	1.41	2.68	0.31	23.85	21.19	17.97	5.87	20.79			

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POINT NO.	14.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	2.96								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.71	0.00	-5.25	1008.18		2.44	0.00	0.00	0.00	0.00	0.00
2.00	0.61	0.00	-4.08	3891.44		2.44	0.00	0.00	0.00	0.00	0.00
3.00	1.27	0.00	-0.93	5569.21		2.44	0.00	0.00	0.00	0.00	0.00
4.00	1.69	0.50	3.78	8932.82		2.96	0.52	3.28	0.92	0.92	1.84
5.00	3.75	0.50	8.38	10819.59		2.96	0.00	5.04	1.99	1.99	3.05
6.00	3.59	0.00	12.87	11464.45		2.96	0.00	3.07	2.71	2.71	0.36
7.00	2.43	0.00	17.00	13494.32		2.16	-0.79	2.08	3.67	2.87	0.00
8.00	2.07	0.00	16.98	9486.43		1.74	-0.43	1.77	2.58	2.20	0.00
9.00	1.77	0.00	11.39	6657.23		1.77	0.04	1.51	1.48	1.48	0.00
10.00	1.13	0.00	5.66	2094.63		2.44	0.67	0.97	0.30	0.30	0.00
11.00	1.01	0.00	-0.83	1061.72		2.44	0.00	0.00	0.00	0.00	0.00
12.00	0.91	0.00	-5.36	2195.60		2.44	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
20.95	1.05	1.99	0.19	17.72	13.65	12.47	5.25	25.07			
POINT NO.	15.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	3.19								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.70	0.00	-5.32	2127.80		1.33	0.00	0.00	0.00	0.00	0.00
2.00	0.60	0.00	-4.25	5763.81		1.33	0.00	0.00	0.00	0.00	0.00
3.00	1.25	0.00	-1.09	8704.16		1.33	0.00	0.00	0.00	0.00	0.00
4.00	1.67	0.50	3.50	12485.86		3.19	1.87	3.19	1.21	1.21	0.12
5.00	3.45	0.50	8.14	14969.48		3.19	0.00	4.72	2.69	2.69	2.02
6.00	3.54	0.00	12.59	15760.36		2.54	-0.66	3.02	3.68	3.68	0.00
7.00	2.31	0.00	16.71	17960.99		1.68	-0.86	1.97	4.84	2.83	0.00
8.00	2.04	0.00	16.65	14013.02		1.22	-0.46	1.75	3.77	2.21	0.00
9.00	1.73	0.00	11.19	10069.08		1.01	-0.21	1.48	2.20	1.69	0.00
10.00	1.26	0.00	5.36	5639.16		1.33	0.32	1.08	0.76	0.76	0.00
11.00	0.91	0.00	-1.06	2471.33		1.33	0.00	0.00	0.00	0.00	0.00
12.00	0.89	0.00	-5.52	3088.65		1.33	0.00	0.00	0.00	0.00	0.00

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TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
20.34	1.02	1.93	0.19	17.21	19.17	15.07	2.14	10.51			
POINT NO.	16.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	3.20								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.66	0.00	-4.89	5639.35		0.71	0.00	0.00	0.00	0.00	0.00
2.00	0.58	0.00	-3.74	6812.87		0.71	0.00	0.00	0.00	0.00	0.00
3.00	1.20	0.00	-0.55	10374.32		0.71	0.00	0.00	0.00	0.00	0.00
4.00	1.61	0.50	4.20	13327.28		2.27	1.56	3.06	1.49	1.49	0.00
5.00	3.30	0.50	8.88	16083.42		3.20	0.92	4.50	3.06	3.06	0.51
6.00	3.41	0.00	13.36	16869.46		2.26	-0.93	2.92	4.06	3.85	0.00
7.00	2.20	0.00	17.48	18324.25		1.47	-0.79	1.88	5.04	2.67	0.00
8.00	1.99	0.00	17.44	16111.36		1.01	-0.46	1.71	4.43	2.17	0.00
9.00	1.64	0.00	11.84	11714.32		0.81	-0.20	1.40	2.65	1.61	0.00
10.00	1.26	0.00	6.03	10197.01		0.71	-0.10	1.08	1.50	1.17	0.00
11.00	0.86	0.00	-0.48	6088.96		0.71	0.00	0.00	0.00	0.00	0.00
12.00	0.82	0.00	-4.95	4960.43		0.71	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
19.54	0.98	1.86	0.18	16.53	22.24	16.02	0.51	2.63			
POINT NO.	17.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	2.36								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.68	0.00	-4.66	6688.97		0.51	0.00	0.00	0.00	0.00	0.00
2.00	0.58	0.00	-3.38	7062.65		0.51	0.00	0.00	0.00	0.00	0.00
3.00	1.19	0.00	-0.41	10795.19		0.51	0.00	0.00	0.00	0.00	0.00
4.00	1.65	0.50	4.19	13287.29		2.16	1.65	3.13	1.49	1.49	0.00
5.00	3.56	0.50	8.91	16093.88		2.36	0.20	4.76	3.07	3.07	1.49
6.00	3.51	0.00	13.40	16886.50		1.67	-0.69	3.00	4.08	3.70	0.00
7.00	2.35	0.00	17.55	17864.48		1.10	-0.57	2.01	4.93	2.58	0.00
8.00	2.02	0.00	17.50	16547.99		0.75	-0.35	1.73	4.56	2.08	0.00
9.00	1.73	0.00	11.87	12075.94		0.59	-0.15	1.48	2.73	1.63	0.00

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10.00	1.14	0.00	6.13	11675.71		0.51	-0.08	0.98	1.73	1.06	0.00
11.00	0.93	0.00	-0.20	7233.42		0.51	0.00	0.00	0.00	0.00	0.00
12.00	0.86	0.00	-4.86	5408.45		0.51	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
20.21	1.01	1.92	0.18	17.09	22.58	15.60	1.49	7.38			
POINT NO.	18.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	3.20								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.79	0.00	-5.29	3673.94		1.10	0.00	0.00	0.00	0.00	0.00
2.00	0.69	0.00	-4.15	5719.42		1.10	0.00	0.00	0.00	0.00	0.00
3.00	1.34	0.00	-1.18	8743.53		1.10	0.00	0.00	0.00	0.00	0.00
4.00	1.79	0.50	3.83	11792.94		3.20	2.09	3.56	1.23	1.23	0.24
5.00	4.23	0.50	8.26	14295.34		3.20	0.00	5.64	2.60	2.60	3.05
6.00	3.88	0.00	12.85	15101.90		2.95	-0.25	3.32	3.57	3.57	0.00
7.00	2.62	0.00	16.98	16593.59		2.01	-0.94	2.24	4.51	3.18	0.00
8.00	2.28	0.00	17.37	13919.18		1.45	-0.56	1.95	3.82	2.51	0.00
9.00	2.02	0.00	11.38	9991.06		1.20	-0.25	1.73	2.21	1.98	0.00
10.00	1.15	0.00	5.90	7463.27		1.10	-0.10	0.98	1.08	1.08	0.00
11.00	1.21	0.00	-0.87	4046.72		1.10	0.00	0.00	0.00	0.00	0.00
12.00	0.96	0.00	-5.33	3703.79		1.10	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
22.97	1.15	2.18	0.21	19.43	19.01	16.14	3.28	14.30			
POINT NO.	19.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	3.65								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	1.08	0.00	-5.96	5595.88		1.18	0.00	0.00	0.00	0.00	0.00
2.00	0.91	0.00	-5.14	7373.47		1.18	0.00	0.00	0.00	0.00	0.00
3.00	1.97	0.00	-1.82	11064.48		1.18	0.00	0.00	0.00	0.00	0.00
4.00	2.45	0.50	2.18	14379.92		3.65	2.48	4.72	0.93	0.93	1.31
5.00	3.18	0.50	6.66	17058.33		3.65	0.00	5.34	2.68	2.68	2.66
6.00	3.31	0.00	10.86	17725.91		2.68	-0.98	2.83	3.81	3.81	0.00

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7.00	2.28	0.00	15.26	19691.94		1.74	-0.94	1.95	5.08	2.89	0.00
8.00	2.07	0.00	15.01	16868.16		1.20	-0.53	1.77	4.32	2.30	0.00
9.00	1.76	0.00	9.83	12462.45		0.97	-0.23	1.50	2.53	1.74	0.00
10.00	1.55	0.00	4.04	10287.27		1.18	0.20	1.32	1.12	1.12	0.00
11.00	1.28	0.00	-2.39	6068.05		1.18	0.00	0.00	0.00	0.00	0.00
12.00	1.23	0.00	-6.68	5158.43		1.18	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
23.06	1.15	2.19	0.28	19.44	20.46	15.47	3.97	17.22			
POINT NO. 20.00											
Ci	Cro	Cs	AWC (in)								
0.05	0.10	0.05	3.35								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.62	0.00	-5.01	3537.27		1.07	0.00	0.00	0.00	0.00	0.00
2.00	0.55	0.00	-4.26	6371.59		1.07	0.00	0.00	0.00	0.00	0.00
3.00	1.12	0.00	-1.12	9640.43		1.07	0.00	0.00	0.00	0.00	0.00
4.00	1.80	0.50	3.17	13225.17		2.96	1.89	3.07	1.18	1.18	0.00
5.00	2.95	0.50	7.65	15877.71		3.35	0.39	4.06	2.74	2.74	0.92
6.00	2.99	0.00	11.85	16689.14		2.43	-0.92	2.56	3.77	3.48	0.00
7.00	2.10	0.00	15.99	18669.77		1.60	-0.83	1.79	4.93	2.62	0.00
8.00	1.97	0.00	15.78	15256.38		1.14	-0.46	1.68	4.00	2.14	0.00
9.00	1.68	0.00	10.63	11031.60		0.93	-0.21	1.43	2.34	1.64	0.00
10.00	1.29	0.00	4.99	7576.37		1.07	0.14	1.11	0.97	0.97	0.00
11.00	0.72	0.00	-1.41	3937.03		1.07	0.00	0.00	0.00	0.00	0.00
12.00	0.76	0.00	-5.64	3898.69		1.07	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
18.55	0.93	1.76	0.16	15.70	19.94	14.78	0.92	4.96			
Ci - interception coefficient; Cro - runoff coefficient; Cs - sublimation coefficient; AWC - available water content											
P - total precipitation; Tm - mean temperature; Rn - solar radiation; fSNOW - snow distribution											
SM - soil moisture; dSM - change in soil moisture; Pn - net precipitation; PET - potential evapotranspiration;											
AET - actual evapotranspiration; DP - deep percolation											
UNITS: in - inches of water; C - degrees centigrade; cal/cm2 - calories per square centimeter											

KOOTENAI FM RECHARGE CALCULATION TABLES

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POINT NO.	1.00										
Ci	Cro	Cs	AWC (in)								
0.00	0.00	0.00	3.55								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.48	0.00	-4.08	4048.85		0.74	0.00	0.00	0.00	0.00	0.00
2.00	0.45	0.00	-3.16	6372.19		0.74	0.00	0.00	0.00	0.00	0.00
3.00	1.00	0.50	0.05	9728.33		2.77	2.02	2.04	0.02	0.02	0.00
4.00	1.62	0.50	4.46	13085.85		3.55	0.78	2.66	1.54	1.54	0.34
5.00	2.65	0.00	8.98	15873.26		3.16	-0.39	2.65	3.04	3.04	0.00
6.00	2.78	0.00	13.26	16612.34		2.25	-0.91	2.78	3.99	3.69	0.00
7.00	1.89	0.00	17.35	18400.21		1.47	-0.78	1.89	5.05	2.67	0.00
8.00	1.78	0.00	17.24	15477.12		1.02	-0.44	1.78	4.23	2.23	0.00
9.00	1.44	0.00	11.94	11104.75		0.83	-0.20	1.44	2.52	1.64	0.00
10.00	1.15	0.00	6.26	8261.98		0.74	-0.08	1.15	1.25	1.23	0.00
11.00	0.56	0.00	-0.16	4467.68		0.74	0.00	0.00	0.00	0.00	0.00
12.00	0.59	0.00	-4.49	3962.05		0.74	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
16.39	0.00	0.00	0.00	16.39	21.63	16.05	0.34	2.08			
POINT NO.	2.00										
Ci	Cro	Cs	AWC (in)								
0.00	0.00	0.00	2.28								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.46	0.00	-3.82	3843.62		1.00	0.00	0.00	0.00	0.00	0.00
2.00	0.43	0.00	-2.93	6193.74		1.00	0.00	0.00	0.00	0.00	0.00
3.00	0.95	0.50	0.28	9492.62		2.28	1.28	1.67	0.09	0.09	0.30
4.00	1.56	0.50	4.65	12804.61		2.28	0.00	2.28	1.55	1.55	0.73
5.00	2.70	0.00	9.24	15610.43		1.93	-0.35	2.70	3.04	3.04	0.00
6.00	2.74	0.00	13.57	16398.91		1.38	-0.56	2.74	3.98	3.30	0.00
7.00	1.81	0.00	17.75	18059.48		0.90	-0.48	1.81	5.01	2.29	0.00
8.00	1.87	0.00	17.62	15213.71		0.63	-0.27	1.87	4.20	2.14	0.00
9.00	1.45	0.00	12.22	10848.56		0.51	-0.12	1.45	2.50	1.57	0.00
10.00	1.05	0.00	6.45	7987.87		0.46	-0.05	1.05	1.23	1.10	0.00
11.00	0.56	0.00	0.15	4257.18		1.00	0.54	0.56	0.02	0.02	0.00
12.00	0.55	0.00	-4.21	3816.73		1.00	0.00	0.00	0.00	0.00	0.00
TOTALS											

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P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
16.13	0.00	0.00	0.00	16.13	21.63	15.11	1.03	6.35			
POINT NO.	3.00										
Ci	Cro	Cs	AWC (in)								
0.00	0.00	0.00	1.56								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.44	0.00	-3.70	3773.86		0.79	0.00	0.00	0.00	0.00	0.00
2.00	0.41	0.00	-2.83	6196.77		0.79	0.00	0.00	0.00	0.00	0.00
3.00	0.89	0.50	0.39	9484.64		1.56	0.78	1.58	0.12	0.12	0.68
4.00	1.51	0.50	4.73	12836.78		1.56	0.00	2.19	1.58	1.58	0.62
5.00	2.64	0.00	9.36	15621.47		1.20	-0.36	2.64	3.07	3.00	0.00
6.00	2.73	0.00	13.69	16389.45		0.86	-0.35	2.73	4.00	3.07	0.00
7.00	1.79	0.00	17.87	18127.84		0.56	-0.30	1.79	5.04	2.08	0.00
8.00	1.86	0.00	17.74	15191.54		0.39	-0.17	1.86	4.21	2.03	0.00
9.00	1.41	0.00	12.28	10852.24		0.32	-0.07	1.41	2.50	1.49	0.00
10.00	1.00	0.00	6.52	7893.48		0.28	-0.03	1.00	1.23	1.03	0.00
11.00	0.54	0.00	0.27	4183.02		0.79	0.50	0.54	0.04	0.04	0.00
12.00	0.52	0.00	-4.13	3795.31		0.79	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
15.74	0.00	0.00	0.00	15.74	21.79	14.45	1.29	8.22			
POINT NO.	4.00										
Ci	Cro	Cs	AWC (in)								
0.00	0.00	0.00	3.60								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.43	0.00	-3.80	3949.27		1.18	0.00	0.00	0.00	0.00	0.00
2.00	0.41	0.00	-2.95	6262.35		1.18	0.00	0.00	0.00	0.00	0.00
3.00	0.89	0.50	0.26	9583.01		2.65	1.47	1.56	0.08	0.08	0.00
4.00	1.51	0.50	4.57	12905.41		3.29	0.63	2.18	1.54	1.54	0.00
5.00	2.61	0.00	9.27	15699.39		2.83	-0.45	2.61	3.07	3.07	0.00
6.00	2.72	0.00	13.61	16462.20		2.01	-0.82	2.72	4.01	3.54	0.00
7.00	1.77	0.00	17.75	18180.17		1.31	-0.70	1.77	5.04	2.47	0.00
8.00	1.87	0.00	17.57	15310.11		0.92	-0.40	1.87	4.23	2.26	0.00
9.00	1.38	0.00	12.13	10944.44		0.74	-0.18	1.38	2.51	1.56	0.00
10.00	0.97	0.00	6.38	8119.20		0.67	-0.07	0.97	1.24	1.04	0.00

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11.00	0.53	0.00	0.09	4363.15		1.18	0.51	0.53	0.01	0.01	0.00
12.00	0.50	0.00	-4.26	3883.25		1.18	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
15.59	0.00	0.00	0.00	15.59	21.73	15.59	0.00	0.00			
POINT NO.	5.00										
Ci	Cro	Cs	AWC (in)								
0.00	0.00	0.00	3.60								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.44	0.00	-4.34	4629.61		0.63	0.00	0.00	0.00	0.00	0.00
2.00	0.41	0.00	-3.45	6641.96		0.63	0.00	0.00	0.00	0.00	0.00
3.00	0.69	0.00	-0.24	10110.35		0.63	0.00	0.00	0.00	0.00	0.00
4.00	1.46	0.50	4.25	13402.31		1.80	1.17	2.69	1.51	1.51	0.00
5.00	2.80	0.50	8.85	16188.63		2.76	0.96	4.03	3.07	3.07	0.00
6.00	3.08	0.00	13.18	16874.52		1.96	-0.80	3.08	4.04	3.88	0.00
7.00	1.95	0.00	17.34	18689.38		1.27	-0.69	1.95	5.12	2.64	0.00
8.00	1.92	0.00	17.16	15904.33		0.88	-0.39	1.92	4.34	2.31	0.00
9.00	1.22	0.00	11.79	11489.90		0.70	-0.17	1.22	2.59	1.39	0.00
10.00	0.90	0.00	6.06	9003.49		0.63	-0.08	0.90	1.33	0.97	0.00
11.00	0.48	0.00	-0.39	5062.66		0.63	0.00	0.00	0.00	0.00	0.00
12.00	0.45	0.00	-4.88	4276.78		0.63	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
15.79	0.00	0.00	0.00	15.79	22.01	15.79	0.00	0.00			
POINT NO.	6.00										
Ci	Cro	Cs	AWC (in)								
0.00	0.00	0.00	1.56								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.42	0.00	-4.38	4458.75		0.35	0.00	0.00	0.00	0.00	0.00
2.00	0.34	0.00	-3.43	6573.13		0.35	0.00	0.00	0.00	0.00	0.00
3.00	0.80	0.00	-0.21	10020.68		0.35	0.00	0.00	0.00	0.00	0.00
4.00	1.52	0.50	4.38	13329.09		1.52	1.17	2.71	1.54	1.54	0.00
5.00	2.91	0.50	8.98	16129.87		1.56	0.04	4.10	3.09	3.09	0.97
6.00	3.22	0.00	13.32	16838.94		1.11	-0.46	3.22	4.05	3.68	0.00
7.00	2.36	0.00	17.56	18629.61		0.72	-0.39	2.36	5.14	2.75	0.00

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8.00	1.82	0.00	17.43	15822.65		0.49	-0.22	1.82	4.35	2.04	0.00
9.00	1.24	0.00	11.99	11395.92		0.40	-0.10	1.24	2.59	1.34	0.00
10.00	0.79	0.00	6.25	8812.70		0.35	-0.04	0.79	1.33	0.83	0.00
11.00	0.39	0.00	-0.34	4889.62		0.35	0.00	0.00	0.00	0.00	0.00
12.00	0.42	0.00	-4.93	4188.74		0.35	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
16.24	0.00	0.00	0.00	16.24	22.09	15.27	0.97	5.96			
POINT NO. 7.00											
Ci	Cro	Cs	AWC (in)								
0.00	0.00	0.00	1.56								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.38	0.00	-3.78	4494.10		0.60	0.00	0.00	0.00	0.00	0.00
2.00	0.36	0.00	-2.89	6490.78		0.60	0.00	0.00	0.00	0.00	0.00
3.00	0.64	0.50	0.41	9926.35		1.56	0.96	1.23	0.14	0.14	0.14
4.00	1.37	0.50	5.12	13174.46		1.56	0.00	1.96	1.72	1.72	0.24
5.00	2.69	0.00	9.71	16004.43		1.19	-0.37	2.69	3.22	3.06	0.00
6.00	2.93	0.00	14.08	16745.70		0.84	-0.35	2.93	4.15	3.29	0.00
7.00	1.83	0.00	18.52	18430.58		0.54	-0.30	1.83	5.21	2.13	0.00
8.00	1.59	0.00	18.38	15738.25		0.37	-0.17	1.59	4.43	1.76	0.00
9.00	1.23	0.00	12.83	11294.59		0.29	-0.07	1.23	2.67	1.30	0.00
10.00	0.77	0.00	7.03	8834.94		0.26	-0.03	0.77	1.45	0.81	0.00
11.00	0.41	0.00	0.39	4924.34		0.60	0.34	0.41	0.06	0.06	0.00
12.00	0.44	0.00	-4.28	4170.01		0.60	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
14.64	0.00	0.00	0.00	14.64	23.04	14.26	0.38	2.60			
POINT NO. 8.00											
Ci	Cro	Cs	AWC (in)								
0.00	0.00	0.00	1.72								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.72	0.00	-4.55	5339.12		0.38	0.00	0.00	0.00	0.00	0.00
2.00	0.68	0.00	-3.51	6768.95		0.38	0.00	0.00	0.00	0.00	0.00
3.00	1.05	0.00	-0.12	10310.30		0.38	0.00	0.00	0.00	0.00	0.00
4.00	1.58	0.50	4.43	13368.91		1.72	1.34	3.59	1.56	1.56	0.69

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5.00	3.12	0.50	9.04	16143.49		1.72	0.00	5.13	3.11	3.11	2.03
6.00	3.29	0.00	13.47	16786.29		1.22	-0.50	3.29	4.06	3.79	0.00
7.00	1.99	0.00	17.61	18463.77		0.79	-0.43	1.99	5.10	2.42	0.00
8.00	1.82	0.00	17.73	16077.92		0.54	-0.25	1.82	4.46	2.07	0.00
9.00	1.56	0.00	11.95	11654.38		0.43	-0.11	1.56	2.65	1.67	0.00
10.00	1.13	0.00	6.16	9851.12		0.38	-0.05	1.13	1.47	1.18	0.00
11.00	0.77	0.00	-0.29	5787.14		0.38	0.00	0.00	0.00	0.00	0.00
12.00	0.80	0.00	-4.99	4587.88		0.38	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
18.52	0.00	0.00	0.00	18.52	22.40	15.80	2.72	14.67			
POINT NO.	9.00										
Ci	Cro	Cs	AWC (in)								
0.00	0.00	0.00	6.33								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.67	0.00	-4.10	3657.03		2.36	0.00	0.00	0.00	0.00	0.00
2.00	0.61	0.00	-3.02	6134.03		2.36	0.00	0.00	0.00	0.00	0.00
3.00	1.07	0.50	0.43	9394.68		4.33	1.97	2.11	0.13	0.13	0.00
4.00	1.57	0.50	4.98	12751.26		5.30	0.98	2.60	1.63	1.63	0.00
5.00	3.15	0.00	9.75	15531.08		5.33	0.02	3.15	3.13	3.13	0.00
6.00	3.33	0.00	14.21	16307.56		4.59	-0.73	3.33	4.06	4.06	0.00
7.00	2.07	0.00	18.39	18036.60		2.98	-1.61	2.07	5.08	3.68	0.00
8.00	1.93	0.00	18.30	15082.17		2.08	-0.90	1.93	4.24	2.83	0.00
9.00	1.62	0.00	12.58	10753.46		1.68	-0.40	1.62	2.51	2.02	0.00
10.00	1.19	0.00	6.70	7740.90		1.64	-0.04	1.19	1.23	1.23	0.00
11.00	0.76	0.00	0.35	4063.25		2.36	0.71	0.76	0.05	0.05	0.00
12.00	0.79	0.00	-4.37	3729.63		2.36	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
18.76	0.00	0.00	0.00	18.76	22.06	18.76	0.00	0.00			
POINT NO.	10.00										
Ci	Cro	Cs	AWC (in)								
0.00	0.00	0.00	6.48								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.64	0.00	-4.19	4703.51		1.90	0.00	0.00	0.00	0.00	0.00

KOOTENAI FM RECHARGE CALCULATION TABLES

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2.00	0.53	0.00	-3.01	6358.04		1.90	0.00	0.00	0.00	0.00	0.00
3.00	1.10	0.50	0.45	9797.79		3.83	1.93	2.08	0.15	0.15	0.00
4.00	1.56	0.50	5.12	12855.79		4.68	0.86	2.53	1.67	1.67	0.00
5.00	3.15	0.00	9.95	15764.89		4.61	-0.07	3.15	3.22	3.22	0.00
6.00	3.33	0.00	14.47	16589.63		3.78	-0.83	3.33	4.17	4.17	0.00
7.00	2.11	0.00	18.61	17954.95		2.45	-1.33	2.11	5.08	3.43	0.00
8.00	1.88	0.00	18.45	15643.09		1.69	-0.77	1.88	4.41	2.65	0.00
9.00	1.59	0.00	12.78	11140.87		1.35	-0.34	1.59	2.63	1.92	0.00
10.00	1.21	0.00	6.84	9099.83		1.19	-0.16	1.21	1.46	1.37	0.00
11.00	0.78	0.00	0.44	5141.61		1.90	0.71	0.78	0.08	0.08	0.00
12.00	0.77	0.00	-4.29	4186.31		1.90	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
18.66	0.00	0.00	0.00	18.66	22.87	18.66	0.00	0.00			
POINT NO. 11.00											
Ci	Cro	Cs	AWC (in)								
0.00	0.00	0.00	3.72								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.66	0.00	-4.44	3254.17		1.98	0.00	0.00	0.00	0.00	0.00
2.00	0.54	0.00	-3.17	5850.76		1.98	0.00	0.00	0.00	0.00	0.00
3.00	1.13	0.50	0.16	8996.56		3.72	1.74	2.13	0.05	0.05	0.33
4.00	1.57	0.50	5.01	12323.15		3.72	0.00	2.57	1.58	1.58	0.99
5.00	3.26	0.00	9.85	15089.72		3.72	0.00	3.26	3.06	3.06	0.20
6.00	3.35	0.00	14.39	15913.45		3.08	-0.64	3.35	3.99	3.99	0.00
7.00	2.17	0.00	18.51	17537.26		2.02	-1.06	2.17	4.95	3.22	0.00
8.00	1.89	0.00	18.40	14594.97		1.42	-0.60	1.89	4.11	2.49	0.00
9.00	1.60	0.00	12.69	10333.20		1.16	-0.27	1.60	2.43	1.86	0.00
10.00	1.16	0.00	6.76	7179.82		1.17	0.02	1.16	1.15	1.15	0.00
11.00	0.84	0.00	0.31	3644.90		1.98	0.80	0.84	0.04	0.04	0.00
12.00	0.79	0.00	-4.47	3471.92		1.98	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
18.96	0.00	0.00	0.00	18.96	21.35	17.44	1.52	8.03			
POINT NO. 12.00											
Ci	Cro	Cs	AWC (in)								

KOOTENAI FM RECHARGE CALCULATION TABLES

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0.00	0.00	0.00	3.29								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.58	0.00	-4.31	4281.62		1.44	0.00	0.00	0.00	0.00	0.00
2.00	0.48	0.00	-3.16	6116.22		1.44	0.00	0.00	0.00	0.00	0.00
3.00	0.97	0.50	0.39	9367.88		3.15	1.70	1.83	0.12	0.12	0.00
4.00	1.43	0.50	5.09	12422.02		3.29	0.15	2.28	1.61	1.61	0.53
5.00	2.94	0.00	9.90	15105.94		3.16	-0.14	2.94	3.07	3.07	0.00
6.00	3.13	0.00	14.44	15806.40		2.32	-0.84	3.13	3.97	3.97	0.00
7.00	1.98	0.00	18.59	17400.39		1.52	-0.79	1.98	4.93	2.78	0.00
8.00	1.73	0.00	18.45	14882.19		1.07	-0.46	1.73	4.20	2.19	0.00
9.00	1.42	0.00	12.80	10669.47		0.86	-0.21	1.42	2.52	1.62	0.00
10.00	1.11	0.00	6.78	8419.54		0.77	-0.09	1.11	1.34	1.21	0.00
11.00	0.73	0.00	0.37	4692.80		1.44	0.67	0.73	0.06	0.06	0.00
12.00	0.65	0.00	-4.40	3951.08		1.44	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
17.16	0.00	0.00	0.00	17.16	21.82	16.63	0.53	3.08			
POINT NO. 13.00											
Ci	Cro	Cs	AWC (in)								
0.00	0.00	0.00	1.56								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.64	0.00	-4.44	6365.70		1.12	0.00	0.00	0.00	0.00	0.00
2.00	0.53	0.00	-3.24	6920.67		1.12	0.00	0.00	0.00	0.00	0.00
3.00	1.10	0.50	0.17	10625.16		1.56	0.44	2.07	0.06	0.06	1.57
4.00	1.54	0.50	4.79	13291.90		1.56	0.00	2.51	1.65	1.65	0.87
5.00	3.28	0.00	9.56	16183.82		1.56	0.00	3.28	3.22	3.22	0.05
6.00	3.33	0.00	14.09	16874.72		1.09	-0.47	3.33	4.18	3.79	0.00
7.00	2.18	0.00	18.23	18096.24		0.71	-0.38	2.18	5.08	2.56	0.00
8.00	1.88	0.00	18.17	16498.70		0.48	-0.23	1.88	4.62	2.11	0.00
9.00	1.56	0.00	12.48	11932.96		0.38	-0.10	1.56	2.78	1.67	0.00
10.00	1.11	0.00	6.58	11209.09		0.33	-0.05	1.11	1.75	1.17	0.00
11.00	0.85	0.00	0.21	6842.89		1.12	0.80	0.85	0.05	0.05	0.00
12.00	0.76	0.00	-4.57	4998.56		1.12	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
18.76	0.00	0.00	0.00	18.76	23.39	16.27	2.49	13.29			

KOOTENAI FM RECHARGE CALCULATION TABLES

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POINT NO.	14.00										
Ci	Cro	Cs	AWC (in)								
0.00	0.00	0.00	4.59								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.59	0.00	-4.45	3783.72		1.71	0.00	0.00	0.00	0.00	0.00
2.00	0.49	0.00	-3.19	5905.12		1.71	0.00	0.00	0.00	0.00	0.00
3.00	1.00	0.50	0.48	9139.26		3.43	1.73	1.87	0.15	0.15	0.00
4.00	1.46	0.50	5.24	12271.67		4.14	0.71	2.33	1.63	1.63	0.00
5.00	2.94	0.00	10.04	15142.14		3.97	-0.16	2.94	3.11	3.11	0.00
6.00	3.17	0.00	14.62	16029.63		3.09	-0.88	3.17	4.05	4.05	0.00
7.00	2.00	0.00	18.77	17363.90		2.03	-1.06	2.00	4.94	3.06	0.00
8.00	1.77	0.00	18.63	14848.59		1.42	-0.61	1.77	4.21	2.38	0.00
9.00	1.46	0.00	12.96	10464.50		1.15	-0.27	1.46	2.49	1.73	0.00
10.00	1.15	0.00	6.86	7888.46		1.03	-0.12	1.15	1.27	1.27	0.00
11.00	0.72	0.00	0.37	4193.52		1.71	0.67	0.72	0.05	0.05	0.00
12.00	0.67	0.00	-4.47	3679.21		1.71	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
17.41	0.00	0.00	0.00	17.41	21.88	17.41	0.00	0.00			
POINT NO.	15.00										
Ci	Cro	Cs	AWC (in)								
0.00	0.00	0.00	3.74								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.57	0.00	-4.36	4943.20		1.25	0.00	0.00	0.00	0.00	0.00
2.00	0.46	0.00	-3.14	6435.82		1.25	0.00	0.00	0.00	0.00	0.00
3.00	0.94	0.50	0.54	9915.17		2.83	1.58	1.76	0.18	0.18	0.00
4.00	1.41	0.50	5.32	12928.86		3.33	0.50	2.24	1.73	1.73	0.00
5.00	2.87	0.00	10.14	15840.93		2.93	-0.40	2.87	3.27	3.27	0.00
6.00	3.09	0.00	14.69	16644.67		2.05	-0.88	3.09	4.21	3.97	0.00
7.00	1.94	0.00	18.83	18010.08		1.32	-0.72	1.94	5.13	2.66	0.00
8.00	1.71	0.00	18.68	15782.28		0.90	-0.42	1.71	4.48	2.13	0.00
9.00	1.40	0.00	13.00	11259.65		0.72	-0.18	1.40	2.68	1.59	0.00
10.00	1.10	0.00	6.91	9390.39		0.63	-0.09	1.10	1.52	1.19	0.00
11.00	0.69	0.00	0.41	5384.79		1.25	0.61	0.69	0.07	0.07	0.00
12.00	0.62	0.00	-4.40	4308.03		1.25	0.00	0.00	0.00	0.00	0.00

KOOTENAI FM RECHARGE CALCULATION TABLES

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TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
16.79	0.00	0.00	0.00	16.79	23.27	16.79	0.00	0.00			
POINT NO.	16.00										
Ci	Cro	Cs	AWC (in)								
0.00	0.00	0.00	5.78								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.60	0.00	-4.55	3952.97		1.74	0.00	0.00	0.00	0.00	0.00
2.00	0.49	0.00	-3.20	6031.59		1.74	0.00	0.00	0.00	0.00	0.00
3.00	1.01	0.50	0.42	9317.61		3.51	1.77	1.90	0.13	0.13	0.00
4.00	1.49	0.50	5.20	12468.24		4.24	0.73	2.38	1.64	1.64	0.00
5.00	2.98	0.00	10.00	15347.24		4.08	-0.16	2.98	3.14	3.14	0.00
6.00	3.21	0.00	14.54	16215.92		3.20	-0.88	3.21	4.08	4.08	0.00
7.00	2.01	0.00	18.68	17597.79		2.09	-1.11	2.01	4.99	3.12	0.00
8.00	1.80	0.00	18.56	15070.48		1.46	-0.64	1.80	4.26	2.43	0.00
9.00	1.49	0.00	12.82	10653.91		1.18	-0.28	1.49	2.52	1.77	0.00
10.00	1.17	0.00	6.83	8131.30		1.05	-0.12	1.17	1.31	1.30	0.00
11.00	0.73	0.00	0.27	4371.76		1.74	0.69	0.73	0.04	0.04	0.00
12.00	0.68	0.00	-4.58	3786.68		1.74	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
17.66	0.00	0.00	0.00	17.66	22.12	17.66	0.00	0.00			
Ci - interception coefficient; Cro - runoff coefficient; Cs - sublimation coefficient; AWC - available water content											
P - total precipitation; Tm - mean temperature; Rn - solar radiation; fSNOW - snow distribution											
SM - soil moisture; dSM - change in soil moisture; Pn - net precipitation; PET - potential evapotranspiration;											
AET - actual evapotranspiration; DP - deep percolation											
UNITS: in - inches of water; C - degrees centigrade; cal/cm2 - calories per square centimeter											

AREAS ABOVE MADISON FM OUTCROP RECHARGE CALCULATION TABLES

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POINT NO.	1.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.15	0.05	2.62								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	1.84	0.00	-6.54	3564.78		1.83	0.00	0.00	0.00	0.00	0.00
2.00	1.56	0.00	-5.75	6345.49		1.83	0.00	0.00	0.00	0.00	0.00
3.00	2.47	0.00	-2.56	9622.76		1.83	0.00	0.00	0.00	0.00	0.00
4.00	2.93	0.50	1.22	13154.63		2.62	0.79	6.21	0.51	0.51	4.90
5.00	3.68	0.50	5.72	15818.14		2.62	0.00	6.81	2.23	2.23	4.57
6.00	3.61	0.00	9.90	16639.55		2.15	-0.47	2.91	3.38	3.38	0.00
7.00	2.32	0.00	14.32	18552.99		1.45	-0.70	1.87	4.63	2.57	0.00
8.00	2.13	0.00	14.01	15238.20		1.05	-0.40	1.72	3.77	2.12	0.00
9.00	1.99	0.00	8.82	11006.91		0.88	-0.17	1.61	2.09	1.78	0.00
10.00	2.00	0.00	3.10	7653.38		1.83	0.95	1.62	0.67	0.67	0.00
11.00	2.08	0.00	-3.21	3973.91		1.83	0.00	0.00	0.00	0.00	0.00
12.00	2.06	0.00	-7.44	3882.02		1.83	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
28.67	1.43	4.08	0.40	22.74	17.28	13.27	9.48	33.05			
POINT NO.	2.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.15	0.05	3.44								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	2.29	0.00	-7.02	1456.07		3.13	0.00	0.00	0.00	0.00	0.00
2.00	1.98	0.00	-6.23	5696.47		3.13	0.00	0.00	0.00	0.00	0.00
3.00	2.85	0.00	-3.14	8479.10		3.13	0.00	0.00	0.00	0.00	0.00
4.00	3.29	0.50	0.64	12558.61		3.44	0.31	7.31	0.26	0.26	6.74
5.00	3.87	0.50	5.16	14831.66		3.44	0.00	7.79	1.94	1.94	5.84
6.00	3.86	0.00	9.38	15502.04		3.44	0.00	3.12	3.05	3.05	0.07
7.00	2.41	0.00	13.87	18170.55		2.36	-1.09	1.95	4.46	3.04	0.00
8.00	2.27	0.00	13.52	13564.81		1.78	-0.58	1.83	3.29	2.41	0.00
9.00	2.09	0.00	8.31	9845.87		1.67	-0.11	1.69	1.80	1.80	0.00
10.00	2.25	0.00	2.57	4667.25		3.13	1.46	1.82	0.35	0.35	0.00
11.00	2.53	0.00	-3.76	1745.61		3.13	0.00	0.00	0.00	0.00	0.00
12.00	2.49	0.00	-7.94	2858.23		3.13	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			

AREAS ABOVE MADISON FM OUTCROP RECHARGE CALCULATION TABLES

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32.19	1.61	4.59	0.49	25.50	15.16	12.85	12.65	39.30			
POINT NO.	3.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.15	0.05	3.10								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	2.57	0.00	-7.42	5754.35		2.42	0.00	0.00	0.00	0.00	0.00
2.00	2.18	0.00	-6.79	7210.63		2.42	0.00	0.00	0.00	0.00	0.00
3.00	3.15	0.00	-3.55	10902.46		2.42	0.00	0.00	0.00	0.00	0.00
4.00	3.57	0.50	0.24	14093.40		3.10	0.68	8.00	0.11	0.11	7.20
5.00	4.06	0.50	4.62	16864.74		3.10	0.00	8.40	2.03	2.03	6.36
6.00	3.95	0.00	8.82	17603.20		2.96	-0.14	3.19	3.33	3.33	0.00
7.00	2.43	0.00	13.57	19346.37		1.99	-0.97	1.97	4.70	2.94	0.00
8.00	2.22	0.00	13.21	16776.63		1.41	-0.57	1.79	4.02	2.37	0.00
9.00	2.11	0.00	8.15	12296.85		1.17	-0.24	1.70	2.22	1.95	0.00
10.00	2.33	0.00	2.01	10433.60		2.42	1.25	1.88	0.63	0.63	0.00
11.00	2.73	0.00	-4.22	6214.06		2.42	0.00	0.00	0.00	0.00	0.00
12.00	2.72	0.00	-8.16	5161.43		2.42	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
34.01	1.70	4.85	0.54	26.93	17.04	13.36	13.57	39.88			
POINT NO.	4.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.15	0.05	4.28								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	1.83	0.00	-6.92	4443.76		2.24	0.00	0.00	0.00	0.00	0.00
2.00	1.49	0.00	-6.15	6733.49		2.24	0.00	0.00	0.00	0.00	0.00
3.00	2.48	0.00	-2.82	10203.69		2.24	0.00	0.00	0.00	0.00	0.00
4.00	2.91	0.50	1.00	13640.12		4.28	2.04	6.05	0.44	0.44	3.58
5.00	3.56	0.50	5.58	16392.48		4.28	0.00	6.58	2.27	2.27	4.31
6.00	3.46	0.00	9.71	17209.96		3.61	-0.67	2.79	3.46	3.46	0.00
7.00	2.16	0.00	14.10	19044.56		2.42	-1.19	1.75	4.72	2.94	0.00
8.00	1.95	0.00	13.70	15998.89		1.74	-0.68	1.58	3.91	2.26	0.00
9.00	1.89	0.00	8.61	11607.84		1.44	-0.29	1.53	2.17	1.82	0.00
10.00	1.88	0.00	2.87	8796.45		2.24	0.80	1.52	0.72	0.72	0.00
11.00	1.93	0.00	-3.50	4877.13		2.24	0.00	0.00	0.00	0.00	0.00
12.00	1.93	0.00	-7.80	4419.22		2.24	0.00	0.00	0.00	0.00	0.00

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TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
27.48	1.37	3.92	0.39	21.80	17.69	13.92	7.88	28.69			
POINT NO.	5.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.15	0.05	2.56								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	1.21	0.00	-6.23	3782.77		1.22	0.00	0.00	0.00	0.00	0.00
2.00	0.93	0.00	-5.49	6651.57		1.22	0.00	0.00	0.00	0.00	0.00
3.00	2.01	0.00	-2.18	9991.80		1.22	0.00	0.00	0.00	0.00	0.00
4.00	2.59	0.50	1.65	13659.27		2.56	1.34	4.69	0.69	0.69	2.66
5.00	3.37	0.50	6.21	16243.00		2.56	0.00	5.32	2.43	2.43	2.89
6.00	3.19	0.00	10.41	16957.74		1.89	-0.67	2.58	3.55	3.24	0.00
7.00	2.02	0.00	14.76	19171.70		1.25	-0.64	1.63	4.86	2.27	0.00
8.00	1.78	0.00	14.39	15595.46		0.90	-0.35	1.44	3.91	1.79	0.00
9.00	1.74	0.00	9.29	11396.50		0.74	-0.15	1.40	2.23	1.56	0.00
10.00	1.56	0.00	3.55	7916.24		1.22	0.48	1.26	0.78	0.78	0.00
11.00	1.34	0.00	-2.82	4193.96		1.22	0.00	0.00	0.00	0.00	0.00
12.00	1.28	0.00	-7.07	4103.54		1.22	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
23.02	1.15	3.28	0.27	18.32	18.46	12.77	5.55	24.11			
POINT NO.	6.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.15	0.05	2.82								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	2.19	0.00	-6.66	2435.99		2.82	0.00	0.00	0.00	0.00	0.00
2.00	2.02	0.00	-5.91	6192.03		2.82	0.00	0.00	0.00	0.00	0.00
3.00	3.22	0.00	-2.68	9254.04		2.82	0.00	0.00	0.00	0.00	0.00
4.00	4.21	0.50	1.11	13217.79		2.82	0.00	8.14	0.47	0.47	7.68
5.00	5.84	0.50	5.38	15650.39		2.82	0.00	9.46	2.11	2.11	7.35
6.00	5.49	0.00	9.72	16340.94		2.82	0.00	4.44	3.29	3.29	1.15
7.00	3.36	0.00	14.20	18873.19		1.89	-0.93	2.71	4.69	3.64	0.00
8.00	2.79	0.00	14.38	14631.58		1.39	-0.51	2.26	3.66	2.76	0.00
9.00	2.87	0.00	8.93	10658.13		1.67	0.28	2.32	2.04	2.04	0.00
10.00	2.56	0.00	2.80	6107.79		2.82	1.15	2.07	0.49	0.49	0.42

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11.00	2.37	0.00	-3.41	2794.81		2.82	0.00	0.00	0.00	0.00	0.00
12.00	2.57	0.00	-7.33	3366.86		2.82	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
39.49	1.97	5.63	0.50	31.39	16.76	14.80	16.59	42.02			
POINT NO.	7.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.15	0.05	2.80								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	2.32	0.00	-6.69	1347.19		2.80	0.00	0.00	0.00	0.00	0.00
2.00	2.14	0.00	-5.86	5222.04		2.80	0.00	0.00	0.00	0.00	0.00
3.00	3.34	0.00	-2.58	7810.68		2.80	0.00	0.00	0.00	0.00	0.00
4.00	4.31	0.50	1.57	11672.02		2.80	0.00	8.40	0.57	0.57	7.84
5.00	5.82	0.50	6.03	13937.21		2.80	0.00	9.62	2.05	2.05	7.58
6.00	5.36	0.00	10.33	14668.67		2.80	0.00	4.33	3.06	3.06	1.27
7.00	3.05	0.00	14.58	17045.70		1.94	-0.86	2.47	4.30	3.32	0.00
8.00	2.62	0.00	14.81	12726.17		1.48	-0.47	2.12	3.24	2.59	0.00
9.00	2.85	0.00	9.21	9118.53		2.00	0.52	2.30	1.78	1.78	0.00
10.00	2.69	0.00	3.32	4163.13		2.80	0.80	2.18	0.39	0.39	0.98
11.00	2.37	0.00	-3.03	1570.74		2.80	0.00	0.00	0.00	0.00	0.00
12.00	2.69	0.00	-7.36	2708.75		2.80	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
39.55	1.98	5.64	0.52	31.42	15.38	13.75	17.67	44.67			
POINT NO.	8.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.15	0.05	2.82								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	2.57	0.00	-8.06	1115.11		2.82	0.00	0.00	0.00	0.00	0.00
2.00	2.38	0.00	-7.45	4295.61		2.82	0.00	0.00	0.00	0.00	0.00
3.00	3.65	0.00	-4.20	6089.37		2.82	0.00	0.00	0.00	0.00	0.00
4.00	4.69	0.00	-0.93	9967.10		2.82	0.00	0.00	0.00	0.00	0.00
5.00	6.08	0.50	3.44	11839.75		2.82	0.00	12.19	1.13	1.13	11.06
6.00	5.57	0.50	7.80	12437.77		2.82	0.00	11.77	2.18	2.18	9.59
7.00	3.09	0.00	12.27	14894.02		2.11	-0.71	2.50	3.43	3.21	0.00
8.00	2.67	0.00	12.22	10395.23		1.87	-0.24	2.15	2.39	2.39	0.00

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9.00	2.97	0.00	7.07	7431.11		2.82	0.95	2.40	1.22	1.22	0.23
10.00	2.91	0.00	1.24	1768.37		2.82	0.00	2.35	0.07	0.07	2.28
11.00	2.73	0.00	-4.93	1168.69		2.82	0.00	0.00	0.00	0.00	0.00
12.00	2.95	0.00	-8.65	2451.46		2.82	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
42.26	2.11	6.02	0.77	33.36	10.42	10.20	23.16	54.79			
POINT NO.	9.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.15	0.05	2.43								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.76	0.00	-5.22	4855.56		0.53	0.00	0.00	0.00	0.00	0.00
2.00	0.66	0.00	-4.12	7108.73		0.53	0.00	0.00	0.00	0.00	0.00
3.00	1.36	0.00	-0.99	10675.09		0.53	0.00	0.00	0.00	0.00	0.00
4.00	1.80	0.50	3.79	14193.55		2.40	1.88	3.34	1.47	1.47	0.00
5.00	4.06	0.50	8.39	16859.61		2.43	0.02	5.17	3.09	3.09	2.05
6.00	3.77	0.00	12.88	17551.64		1.70	-0.72	3.05	4.15	3.77	0.00
7.00	2.64	0.00	17.02	19674.79		1.08	-0.62	2.13	5.35	2.75	0.00
8.00	2.21	0.00	17.00	16455.36		0.74	-0.34	1.79	4.47	2.13	0.00
9.00	1.94	0.00	11.40	12095.84		0.59	-0.15	1.57	2.67	1.72	0.00
10.00	1.14	0.00	5.67	9304.98		0.53	-0.06	0.92	1.31	0.98	0.00
11.00	1.13	0.00	-0.93	5294.47		0.53	0.00	0.00	0.00	0.00	0.00
12.00	1.02	0.00	-5.38	4744.24		0.53	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
22.49	1.12	3.20	0.20	17.96	22.51	15.91	2.05	9.12			
POINT NO.	10.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.15	0.05	2.43								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.72	0.00	-5.36	2691.40		0.84	0.00	0.00	0.00	0.00	0.00
2.00	0.62	0.00	-4.29	6178.23		0.84	0.00	0.00	0.00	0.00	0.00
3.00	1.29	0.00	-1.12	9280.30		0.84	0.00	0.00	0.00	0.00	0.00
4.00	1.71	0.50	3.45	13112.89		2.43	1.58	3.10	1.26	1.26	0.26
5.00	3.53	0.50	8.08	15615.89		2.43	0.00	4.58	2.80	2.80	1.78
6.00	3.59	0.00	12.54	16356.52		1.75	-0.67	2.90	3.81	3.57	0.00

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7.00	2.36	0.00	16.66	18685.37		1.14	-0.61	1.90	5.03	2.51	0.00
8.00	2.09	0.00	16.60	14714.77		0.82	-0.33	1.69	3.96	2.01	0.00
9.00	1.77	0.00	11.14	10675.39		0.67	-0.15	1.43	2.33	1.58	0.00
10.00	1.29	0.00	5.32	6444.69		0.84	0.17	1.04	0.87	0.87	0.00
11.00	0.94	0.00	-1.09	3059.26		0.84	0.00	0.00	0.00	0.00	0.00
12.00	0.93	0.00	-5.54	3471.63		0.84	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
20.83	1.04	2.97	0.18	16.64	20.04	14.60	2.04	9.81			
POINT NO.	11.00										
Ci	Cro	Cs	AWC (in)								
0.05	0.15	0.05	3.18								
MONTH	P (in)	fSnow (-)	Tm (C)	Rn (cal/cm2)		SM (in)	dSM (in)	Pnet(in)	PET (in)	AET (in)	DP (in)
1.00	0.67	0.00	-5.22	5299.17		0.69	0.00	0.00	0.00	0.00	0.00
2.00	0.60	0.00	-4.16	7206.89		0.69	0.00	0.00	0.00	0.00	0.00
3.00	1.23	0.00	-0.98	10800.82		0.69	0.00	0.00	0.00	0.00	0.00
4.00	1.64	0.50	3.79	14171.62		2.16	1.47	2.93	1.46	1.46	0.00
5.00	3.30	0.50	8.46	16782.37		3.18	1.02	4.28	3.10	3.10	0.17
6.00	3.46	0.00	12.90	17419.76		2.24	-0.94	2.80	4.12	3.73	0.00
7.00	2.22	0.00	17.01	19500.76		1.43	-0.81	1.79	5.30	2.60	0.00
8.00	2.02	0.00	16.95	16501.47		0.98	-0.45	1.63	4.48	2.08	0.00
9.00	1.65	0.00	11.41	12192.78		0.78	-0.20	1.33	2.70	1.53	0.00
10.00	1.29	0.00	5.63	9814.32		0.69	-0.09	1.04	1.37	1.12	0.00
11.00	0.87	0.00	-0.83	5743.43		0.69	0.00	0.00	0.00	0.00	0.00
12.00	0.84	0.00	-5.35	4972.07		0.69	0.00	0.00	0.00	0.00	0.00
TOTALS											
P (in)	Pi(in)	Pro(in)	Ps (in)	Pnet(in)	PET(in)	AET(in)	DP (in)	DP/P(%)			
19.77	0.99	2.82	0.17	15.80	22.53	15.63	0.17	0.85			
Ci - interception coefficient; Cro - runoff coefficient; Cs - sublimation coefficient; AWC - available water content											
P - total precipitation; Tm - mean temperature; Rn - solar radiation; fSNOW - snow distribution											
SM - soil moisture; dSM - change in soil moisture; Pn - net precipitation; PET - potential evapotranspiration;											
AET - actual evapotranspiration; DP - deep percolation											
UNITS: in - inches of water; C - degrees centigrade; cal/cm2 - calories per square centimeter											