ESTIMATE OF SEASONAL WATER RUNOFF FROM THE MOSCOW MOUNTAIN FRONT, MOSCOW IDAHO

Submitted To:

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Subject to Revision

Table of Contents

EXECUTIVE SUMMARY

The Grande Ronde aquifer supplies over 90 percent of the potable water to the residents within the Palouse region. Groundwater levels within the Grand Ronde are currently declining at a rate of 12 to 18 inches per year.

There is speculation that the sediments of Bovill, which lie along the northwestern end of the Moscow Mountain front, may provide a favorable location for artificial recharge efforts to the Grade Ronde. This study has attempted to estimate the volume of runoff coming off of the Moscow Mountain front in order to determine if enough water exists to support artificial recharge efforts in that area. The major creeks that were evaluated were Paradise Creek and its tributaries, Gnat Creek, Crumarine Creek, Randall Flat Creek, and Felton Creek. This study concludes that the estimated annual volume of water flowing off of the Moscow Mountain front is not enough to meet the current and future pumpage demands of the Palouse region. The South Fork of the Palouse River was not analyzed but this river may act as a feasible source of water to support artificial recharge efforts on the Moscow Mountain front or as a potable surface water supply to the Palouse region. More research into this area is necessary.

OBJECTIVES OF STUDY

The objectives of this study were to:

1. Estimate average monthly and annual water volumes that can be expected to run off of the Moscow Mountain front and into Paradise Creek in any given year.
2. Determine probabilities of exceedance for the total volume of water draining off the Moscow Mountain front in any given year.
3. Suggest further research.

BACKGROUND

All of the groundwater in the Palouse originates from two main aquifer systems. The lower aquifer, known as the Grande Ronde, consists of older Columbia River Basalt flows with intervening layers of sediment. The Grande Ronde is the larger of the two aquifers with individual wells capable of producing up to 2500 gallons per minute. In 1999 the Grande Ronde was the source of 90 percent of the potable water supplied to the residents of Moscow and Pullman (PBAC 1999).

The upper aquifer, known as the Wanapum, consists of younger Columbia River Basalt flows with intervening layers of sediment. The Wanapum is a relatively shallow aquifer with individual wells capable of producing up to1250 gallons per minute. Older wells in Moscow and most of the rural wells in the Palouse area pump from the Wanapum aquifer (PBAC 1999). A general stratigraphic section illustrating the geology of the region is presented in Figure 1 (Pierce 1998).

Groundwater levels in the Grande Ronde have been declining since development first began in the region in the 1890's. While water levels in the Wanapum have tended to fluctuate in recent times, water levels in the Grande Ronde have been declining steadily for many years. The current rate of groundwater level decline in the Grande Ronde is estimated at 12 to18 inches per year (PBAC 1999). This rate of groundwater decline has caused a high level of concern at the state and local levels given that groundwater is currently the only source of potable water for the municipalities within the Palouse.

While the methods and mechanics of natural recharge to the Grande Ronde remain largely unknown, it has been hypothesized that much of the recharge occurs through the sediments of Bovill which exist along the southwestern portion of the Moscow Mountain front as shown in Figure 2 (PBAC 1999). This hypothesis would indicate that the sediments of Bovill could provide a potential and feasible location for artificial recharge efforts if an adequate water supply were available. In a search for this water supply, the flow in Paradise Creek and its tributaries were evaluated.

Paradise Creek is a small fourth order stream with headwaters on the Moscow Mountain front to the northeast of Moscow, ID as shown in Figure 2. Paradise Creek drains an area of 34 square miles before draining into the Palouse River (Dixon, et al. 1993). The United States Geologic Survey (USGS) has maintained a streamgage recording 15-minute streamflow values on Paradise Creek at the University of Idaho in Moscow, Idaho since late 1978. This streamgage is identified by the USGS streamgage number 13346800 and will be hereafter referred to as "USGS gage." Paradise Creek drains 17.2 square miles before passing this USGS gage (Figure 2).

PROCEDURE

Observation Points

The Idaho Association of Soil Conservation Districts (IASCD) conducted bimonthly water quality and streamflow sampling on 14 points on Paradise Creek and its tributaries from March of 1999 to March of 2000 (IASCD 2000). The location of each of these points is shown in Figure 3. The raw streamflow data, water quality data and general notes for each of these observation points are presented in Appendix A. The observation points labeled PC-8 through PC-13 lie over the sediments of Bovill which might act as a potential area for artificial recharge efforts.

At each IASCD monitoring point, the streamflow values for that point were correlated to the respective USGS gage streamflow values of the same date and time using least-squares linear regression analysis. This technique is often used to form a prediction equation that is used to estimate missing data from streamflow data sets. In this study, the prediction equations formed were used to estimate the historical daily streamflow values from 1979 to 1999 at each IASCD monitoring point based on the USGS gage record for these years. The prediction equations for flow at each IASCD point are presented in Appendix B. Any IASCD point with a regression coefficient less than 0.6 ($R^2<0.60$) was discarded and not used in the following analysis. Based on this criterion IASCD points labeled PC-1, PC-5, PC-6, and PC-14 were discarded. Point PC-7 was also discarded from further analysis due to an uncertainty about the actual monitoring location.

Average Daily and Monthly Flows

Based on the years from 1979 to 1999, plots of the average daily flow for each month as well as the average maximum and minimum daily flow values that occurred during that month were calculated for each of the monitoring points and are shown in Appendix C. Plots comparing total monthly flow to the 5-year average monthly pumpage from the Grande Ronde (years 1994-1999) are presented in Appendix D. The plots in Appendix D also compare estimated total monthly pumpage from the Grande Ronde in the year 2019 (twenty years from 1999) to the average total monthly flows for each observation site. The pumpage values for the year 2019 were calculated by assuming a constant 1.5 percent increase per year in total pumpage from the Grande Ronde. This rate of pumpage increase is based on the assumption that the population for Moscow and Pullman will continue to increase at a rate of 1.5% per year as it did throughout the 1990s (PBAC 2000).

Average Annual Flows

Average annual flows for each observation point are presented in Table 1 on page 5. These values were estimated by using the linear regression equations presented in Appendix B and the USGS gage record from 1979 to 1999. The amount of excess water annually pumped from the Grande Ronde above the annual volume of water at each point is also listed in Table 1. Table 1 also presents the expected excess volume of water pumped in the year 2019 above the current volume of water produced at each observation point.

Exceedance Probabilities

Exceedance probabilities and return periods for the annual volume of water yielded for each IACD point and the USGS site were formed using a log-Pearson Type III statistical distribution. The prediction curves, return period tables and a brief description on their derivation are presented in Appendix E.

WATERSHED AREAS

Estimations of the volume of runoff that originated on the Moscow Mountain front but did not flow through any of the IASCD observation points were obtained by deriving an average volume of runoff per acre value expected along the Moscow Mountain front. In order to determine this value, the watershed boundaries for each gaging point were first delineated on USGS 1:24 000 topographic maps. Areas of each watershed were then determined by overlaying a grid with a density of 10 squares per inch and counting each grid square that lay within the boundaries of the watershed. The areas of partial squares were estimated. The estimated annual total flows for each observation point were then divided by that point's respective watershed area to determine an annual flow per acre expected in the watershed. These annual flows per acre were averaged in order to obtain a single value of annual flow per area of **0.1498 million gallons per acre**. This value is only a rough estimate but may be used to obtain a general idea of the annual flow expected on areas along the Moscow Mountain front which were not analyzed in this present study. The areas of and annual flow per acre for each watershed are listed in Appendix F

WATER QUALITY

An extensive set of water quality data is essential for any water source that is to be used in artificial recharge operations. The water quality sample data collected by the IASCD for each of the monitoring points is shown in Appendix A. A further analysis and interpretation of this data may be found by consulting IASCD 1999. More water quality data is needed for each of these points if they are to be used as a potable source of water for the residents of the Palouse.

RESULTS

Flow Variability

The plots of monthly variability of daily discharge in Appendix C indicate that most of the observation points have a large range of variability between high and low flows. The average flows for each site tend to be toward the low discharge portion of the chart. It should be pointed out that most of the observation points closest to the Palouse Range have negligible flows during the summer months which should be accounted for in the planning stages of artificial recharge efforts if they are to occur in the region.

Annual Flow Vs. Annual Pumpage

Average annual flows for each observation point and the current and predicted annual pumpage volumes for the Grande Ronde are presented in Table 1 below.

Table 1. Annual Flows and Total Pumpage

Observation Point	Average Annual Volume at Point (million gal/yr)	5-Year (1994-1999) Average Total Pumpage (million gal/yr)	Current Excess Volume Pumped (million gal/yr)	Predicted Pumpage in 2019 (million gal/yr)	Predicted Excess Volume Pumped in 2019 (million gal/yr)
USGS gage	1773.85	2664	890	3463	1689
PC-2	212.86	2664	2451	3463	3250
PC-3	258.49	2664	2406	3463	3205
PC-4	248.93	2664	2415	3463	3214
PC-8	902.98	2664	1761	3463	2560
PC-9	171.36	2664	2493	3463	3292
PC-10	845.31	2664	1819	3463	2618
PC-11	1008.44	2664	1656	3463	2455
PC-12	913.36	2664	1751	3463	2550
PC-13	23.53	2664	2640	3463	3440

Table 1 indicates that the annual volumes of water passing the observation points ranges from about 890 to 2600 million gallons per year short of the total volume of water pumped out of the Grande Ronde per year. The annual volumes of water passing the observation points ranges from about 1690 to 3400 million gallons short of the predicted annual pumpage in the year 2019. These data indicate that Paradise Creek and its tributaries would not be able to sustain artificial recharge efforts alone if the goal of these efforts were to stop the decrease in Grande Ronde water levels. If artificial recharge efforts were to occur, they would need to depend on sources of water other than or in addition to Paradise Creek and its tributaries.

Four major creeks that flow off the Moscow Mountain front that were not monitored in this study are Gnat Creek, Crumarine Creek, Randall Flat Creek and Felton Creek which are shown in Figure 2. While the USGS 1:24 000 topographic maps indicate that there are streamgage sites on Gnat Creek and Crumarine Creek, these data values could not be located during the course of this study. Watershed areas were delineated for all four creeks. The watersheds boundaries for Gnat Creek and Crumarine Creek were delineated by starting at the point where each of these creeks flows into the South Fork of the Palouse River. The watershed boundaries for Randall Flat Creek and Felton Creek were delineated by starting at the point where each of these creeks flows into the West Fork of Little Bear Creek. Annual flows expected for each of these creeks based on their watershed areas and the value of 0.1498 million gallons of runoff per acre expected to occur on the Moscow Mountain front are presented in Table 2 below.

Table 2. Estimated Annual Volume for Gnat, Crumarine, Randall Flat and Felton Creeks

Observation Point	Watershed Area (acres)	Annual Volume Expected (million gallons)
Gnat Creek	2973.82	445.47
Crumarine Creek	1971.98	295.40
Randall Flat Creek	2168.95	324.90
Felton Creek	4008.02	600.39

Table 2 indicates that the estimated annual flows for Gnat, Crumarine, Randall Flat and Felton Creeks combined are about 1660 million gallons. This combined flow would be enough to offset the 860 million gallons needed at the USGS gage site to meet the current 5-year average pumpage but not the 1690 million gallons needed to meet the expected pumpage in year 2019 at the same site. Furthermore, these creeks lie outside the sediments of Bovill which may hamper recharge efforts. It should also be noted that public opinion and environmental laws coordinated to support healthy riparian ecosystems will allow only a fraction of the annual flows calculated in this study to be diverted for artificial recharge efforts.

In short, the estimated annual water flowing off the Moscow Mountain front is not enough to meet the current and future pumpage demands in the Palouse region. While Big Meadow Creek and Spring Valley Creek shown in Figure 2 were not analyzed in this study, it is not expected that they will provide enough needed water to meet the expected annual pumpage in the year 2019.

South Fork of the Palouse River

While the South Fork of the Palouse River was not analyzed in this study, this river may hold the most potential to act as a viable and dependable water source for recharge efforts in the Moscow Mountain area or as a separate surface water supply for Palouse residents. A combination of the various creeks flowing off the Moscow Mountain front and the South Fork of the Palouse River may also hold as the best choice for a sustainable water supply for residents within the Palouse.

RECOMMEDATIONS FOR FURTHER STUDY

A comprehensive water balance analysis for the Palouse Basin is definitely needed to help guide the search and planning for a sustainable water supply within the Palouse. This water balance should incorporate precipitation, evapotranspiration, and runoff analysis over the entire basin. This analysis would be necessary to fully compare the feasibility of different locations for artificial recharge or potable surface water supply projects within the Palouse region. This basin wide water balance could also evaluate the potential effects of climate change within the basin.

Further streamflow and water quality data at each of the original fourteen IASCD monitoring points should continue to be collected in order to increase the accuracy of the regression equations and the historical streamflow estimations. Streamflow and water quality monitoring of Gnat, Crumarine, Randall Flat, Felton, Big Meadow and Spring Valley Creeks is encouraged as they may provide a feasible source of extra water to support recharge efforts in the Moscow Mountain front area.

No analysis was done on the gage records of the South Fork of the Palouse River. Water from this river could act as another and more dependable source of water for recharge efforts within the Moscow Mountain area. Streamgage records for the South Fork of the Palouse should be analyzed and compared to expected future pumping in the Palouse. Research into the environmental laws and local public opinion as to how much water would be acceptable to divert from any of the creeks discussed as well as the South Fork of the Palouse are essential for further action if these sources are to be used in recharge efforts.

The 1.5 percent increase per year in annual pumpage was a rough estimate that was used to obtain a general idea of the expected pumpage in the year 2019. A more rigorous analysis of future expected pumpage demands in the Palouse region should be made in the planning and design stages of any artificial recharge project.

No effort was made as to interpreting the water quality data taken by the IASCD at each of the fourteen IASCD points. The raw data is presented in Appendix A and some interpretation of the data may be found in IASCD 1999. More rigorous monitoring of the water quality in any potential source of recharge water must be made before the feasibility of using that water for recharging the aquifer system can be fully established.

Further analysis of the hydrogeological characteristics of potential recharge sites especially in the area of the sediments of Bovill along the Moscow Mountain front are needed before the area could be concluded as being feasible for artificial recharge.

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