TECHNICAL MEMORANDUM

FOR: Sumas Rural Water Association
RE: Water System Future Demand Estimates for Use in Water Sale Agreement with the City of Sumas
DATE: January 15, 2009

Purpose: The Sumas Rural Water (SRWA) Association purchases water from the City of Sumas, and is formalizing an agreement as part of its Small Water System Plan preparation. An informal agreement has existed for at least 75 years between SRWA and the City of Sumas for supplying water. As part of the formal agreement, discussions with the City of Sumas have occurred in order to determine the amount of water that the City will supply. The formalized agreement will specify a maximum total instantaneous demand (gallons per minute) and maximum total annual volume (acre-feet) that the City will supply to the SRWA. This document is to provide supporting data for the proposed maximum limits listed in the agreement. It is assumed that the limits will be in place for a twenty year period, through the year 2028. It is also assumed that fireflow will not be provided by SRWA.

Methodology: The SRWA has provided records of individual meter readings over several years, and the City of Sumas has provided several years of records for the four master meters serving SRWA. This data, in conjunction with the growth rates and flow values assumed for the SRWA hydraulic analysis, was used to estimate the potential maximum demands in the year 2028.

Annual Peak Demand Calculations:

Master meter readings were available from 2003 to 2007, with a peak annual usage of 441.82 acre-feet (2006) and a minimum annual usage of 317.72 acre-feet (2003). Variations primarily include weather (dry vs. rainy), leaks, water main flushing and meter accuracies.

Similarly, SRWA meter readings were available from 2003 to 2005, with a peak annual usage of 383.23 acre-feet (2004) and a minimum annual usage of 358.07 acre-feet (2003). Variations between years and from the master meter readings are due to similar reasons to those listed above.

Assuming the 2006 master meter data as a worst case demand, and assuming 199 services (combined 55 large and 144 residential) in the SRWA during 2006, a peak annual demand per service of 2.22 acre-feet is calculated. From the hydraulic analysis, 308 service connections (combined 55 large and 253 residential) are expected in 2028. This equates to a peak annual demand of 684 acre-feet of water.

As the water agreement value is intended to be a maximum amount, it is recommended to round the estimated value up about 10% (752 acre-feet) to the next highest 100 acre-feet, or 800 acre-feet.

Maximum Instantaneous Demand (MID)/Peak Hour Demand (PHD) Calculations:

The maximum instantaneous (peak hour) demand calculated for the hydraulic model used to evaluate estimated SRWA operation in 2028 is 979 gpm. The value of 979 gpm was calculated using the demand distribution Excel spreadsheet used for the hydraulic analysis of the system. These calculations included factoring in the effects of the residential and large user demands. For use with the water supply agreement, it is recommended to round the estimated value up about 10% (1,077 gpm) to the next highest 100 gpm, or 1,100 gpm.

Secondary MID/PHD Check. 800 acre-feet of water (assuming it is used 365 days a year, for 24 hours a day) equates to an average flowrate of 495 gpm. As the recommended instantaneous demand limit is 1,100 gpm, this implies an overall peaking factor of 2.2; appropriate for a system of this size. Thus, the peak instantaneous demand and peak annual demand values appear adequate for the water supply agreement, assuming the estimated growth rate is not exceeded.

Usage Requirements by Usage Year:
Interpolating from the above result, the water supply quantity totals listed in the table below should be requested by Sumas Rural Water Association from water purveyors. Values have been rounded for use within potential agreements.

Usage Year	Suggested Annual Supply[1] (acre-feet)	Suggested Annual Supply[2] (average gpm)	Suggested Peak Hour Demand[3] (maximum gpm)
2008	500	310	1,000
2013	575	360	1;025
2014	590	370	1,030
2018	650	410	1,050
2023	725	450	1,075
2028	800	500	1,100

Table Notes:

1. *The 2008 "Suggested Annual Supply" in acre-feet is based on the peak measured usage from previous years of 442 acre-feet, with a 10% increase, rounded up to the nearest 100 acre-feet. The 2028 value of 800 acre-feet is from the annual demand calculations on the previous page, and the values for the intermediary years are an interpolation between 2008 and 2028 rounded up to the nearest 5 acre-feet.*
2. *The "Suggested Annual Supply" in average gpm is the direct conversion of the suggested annual supply in acre-feet to gpm for each year, rounded up to the nearest 10 gpm.*
3. *The 2008 "Suggested Peak Hour Demand" is based on 2008 estimated demand for the hydraulic analysis of 880 gpm, with a 10% increase, rounded up to the nearest 100 gpm. The 2028 value of 1,100 gpm is from the PHD calculations on the previous page, and the values for the intermediary years are an interpolation between 2008 and 2028 rounded up to the nearest 5 gpm.*

SUMAS RURAL WATER ASSOCIATION
WATER SYSTEM ANALYSIS AND METHODOLOGY
TECHNICAL MEMORANDUM
JANUARY 2009

Introduction and System Background:
Sumas Rural Water Association (SRWA) is a small water system located in north-central Whatcom County, Washington. The records available show that SRWA is classified by the Washington State Department of Health (DOH) as a Group A Community Water System. Records show that in 2005, SRWA served 140 residential customers, in addition to 52 large users, the majority of which are dairy farms or other agricultural users. The service area includes approximately 6800-acres in northeast Whatcom County, located to the east and south of the City of Sumas.

In 2004, a routine sanitary survey was performed on the system by the DOH, which identified several recommendations for the water system (ID #84850 U). These recommendations are summarized below, and the letter from DOH outlining them in detail is attached in *Element 4, Preparing For Your Sanitary Survey*, as part of the Small Water System Plan (SWSMP).

<u>DOH Recommendations:</u>

1. Provide a system hydraulic analysis, showing the capacity for additional water service connections.
2. Complete a Small Water System Plan per WAC 246-390-105.
3. Update the water supply agreement with the City of Sumas.

This technical memorandum is submitted to meet the recommendations for providing a system hydraulic analysis for the additional water service connections. The results of the system analysis are summarized in this technical memorandum, and are included in *Element 13, Water Usage*, in the SWSMP. In addition, a water supply agreement, based on the system hydraulic analysis, is submitted for review with the SWSMP and included in *Element 11, Water Right Documentation*, in the SWSMP.

As summarized in the letter from DOH dated September 13, 2004 sent after the last sanitary survey for SRWA, the water system is approved to serve 135 residential connections plus 53 large users. An additional 20 interim residential services were approved with the understanding that the requirements listed above would be followed for SRWA to obtain final approval. (See letter from DOH with conditional approval for 20 interim connections, dated March 17, 2006, attached in *Element 13, Water Usage*).

Purpose:
A hydraulic analysis of the SRWA water system was performed to evaluate system performance (demands, pressures and flowrates), with results to be included within the SWSMP requested by the DOH. Analysis of current and projected future conditions was included, as well as analysis of potential improvements to increase available flows and

pressures and to accommodate future system growth. All analysis was performed for non-fire demands only, as water for fire protection is not currently provided by the SRWA, and supplying water for fire protection is not currently a long-term goal of the SRWA.

Methodology:
WaterCAD, hydraulic analysis software produced by Bentley Systems, Inc., was used to compute the flows and pressures at various system locations. The software uses a model consisting of reservoirs, junctions, pipes and pumps.

Distribution System and Source Description:
All source water for SRWA is supplied by the City of Sumas via four metered connections between the two distribution systems. The majority of both the City of Sumas' and SRWA's distribution systems act as a single pressure zone. SRWA maintains a small inline booster pumping station that maintains pressure on Minaker Road. See Figure 1, included in the SWSMP *Element 8, Service Area and Facility Map*, for the system schematic layout.

The primary source of supply for the City of Sumas and the SRWA is a well-field. Water is pumped from the well-fields to the two storage tanks located on a hill within the city limits of Sumas. One of the storage tanks belongs to the SRWA (which provided funding for its construction), but the tank is operated by Sumas and serves the needs of both water systems. These two storage tanks operate in parallel to supply a single pressure zone for both the City of Sumas and SRWA (except for small inline booster pump station described previously). Additionally, several service connections on Reese Hill Road have their own in-house booster pumps to maintain pressure at the areas where the elevations prohibit the storage tanks from providing enough pressure.

A more detailed discussion of the source and storage tanks is included in the letter referenced above from the DOH, and Figure 1 provides a system schematic.

The City of Sumas also supplies water to the Nooksack Valley Water Association, but through separate mains that are connected to the overall system and do not affect the hydraulic performance of the combined Sumas/SRWA system.

A comprehensive hydraulic model of the inter-connected Sumas/SRWA systems was created in 2005 in order to estimate the number of services available to the SRWA. The data included the full pipe network, source pumps, storage reservoirs, booster pumps, and other components that the system was comprised of at the time. The model also included estimated system demands for both Sumas and SRWA that were distributed throughout the system.

System Inventory and Layout:
The original Sumas/SRWA hydraulic model created in 1991 was used as a basis for the updated model analyzed for this SWSMP. An inventory of SRWA system components was received from the Sumas Rural Water Association, and any alterations to the system

since the earlier model was created were reflected in the new, updated model. A map of the updated model was then presented to the SRWA board, and further refinements to the updated model were made based on their comments. The changes primarily involved new waterline installation, upsizing of waterlines in a few areas, and relocation of one of the connection points with the City of Sumas. The City of Sumas system was left mostly unchanged, as a full accounting of minor improvements to the system was not available, and those changes would have a negligible effect on the SRWA.

Current System Demand Calculations:
The latest version of the hydraulic model was created in 2005 and therefore required updating to the current number of water system services. In addition, since the hydraulic model included both the City of Sumas and the SRWA water system, a method of estimating demands and distributing those demands was required. In 1999, a Microsoft Excel spreadsheet was developed by David Evans and Associates for this purpose, and this demand allocation spreadsheet was used as a basis for both the current and future demand calculations.

<u>SRWA Demand Calculations</u>
System demands were calculated for SRWA using the existing water meter readings to determine demands for the large users, and the DOH equations for determining peak hour demands (PHD) for residential services. Because much of the SRWA demand is from dairy (or other) farms, which have much higher usage than residences, two distinct user categories were assumed. Regardless of actual farm or dwelling status, those services typically using 1,000 gallons per day (gpd) or more were defined as large users, and those using under 1,000 gpd were considered as residential users. This was done for the purposes of a conservative hydraulic analysis, even though in reality some of these are residential customers with demands higher than typical residential demands. Thus, the total of large users in the model exceeds the total of 53 "actual" approved larger commercial users (such as dairy farms).

Meter readings (recorded every two months) for all services within the SRWA were reviewed for the years 2003, 2004 and 2005. These readings were used to distinguish between large and residential users, and to estimate the large user demands for use within the hydraulic model. An average of the peak two-month period for each service over the three years was computed, and then converted to an average usage per day for each service. As seen in the attached meter readings, 59 services exceeded the arbitrary average of 1,000 gpd during these peak two-month periods, and were thus deemed large users for the purposes of the hydraulic analysis. The meter readings indicated that there were 139 services below the arbitrary average of 1,000 gpd during these peak two-month periods – thus those services were deemed residential.

2005 peak hour demands (PHD) were estimated in different ways for residential and large users. Each large user PHD was calculated based on the average peak daily demands computed above. It was assumed that the PHD would roughly approximate the full daily demand compressed into an eight-hour period, so that the gpd was converted to an equivalent peak gallons per minute (gpm). This is essentially the same as the 1992 report prepared for the City of Sumas, which assumed the large user demands compressed into two four-hour time periods (morning and evening). In addition, this method of estimating demands is equivalent to the average demand over a 24-hour period with a peaking factor of three.

Residential PHD was calculated using the Department of Health's PHD formula, based on the total number of residential services. The total calculated residential PHD was then divided by the total number of services, with each service getting an equal average PHD. The spreadsheet for the above referenced calculations is included with the attached hydraulic model data.

As each large user's service location was known, the estimated demand was placed in the hydraulic model at the node nearest its location. The original base spreadsheet from 1999 had the number of services nearest each node already identified. The estimated average PHD for the residential services was incorporated into the spreadsheet at the same node locations as previously identified. This analysis assumes that there were not significant changes in residential service locations within the SRWA system.

Because water meter readings used in the demand allocation calculation were from 2005, a population growth factor increase was applied to simulate the approximate number of services in 2008. The Sumas Water Comprehensive Plan used a 2.6% annual growth rate for the SRWA, and this factor was applied in the demand allocation spreadsheet to increase the number of services (and hence the overall demand) for the year 2008. The demand allocation spreadsheet for the above referenced calculations is also attached.

City of Sumas Demand Calculations

For the City of Sumas, demands were increased starting from 1999 values to estimated 2008 values by applying an annual growth factor of 2.7 percent, identical to the rate assumed in the current Sumas Water Plan. The demand increase was distributed proportionately amongst all previous service locations, thus the ratio of each location's demand to the total demand remained the same.

Future Condition Demand Calculations:

Because this is a water system plan that is to remain in affect for many years, demands and quantities of service connections were also estimated for two future conditions in six and twenty year increments - 2014 and 2028. The same annual growth factors from above (2.6% for SRWA and 2.7% for the City of Sumas) were assumed. This result is equivalent to an average growth rate within the SRWA of approximately five new residential services per year.

Neither the number of large users nor the large user demands were increased, based on the trend of dairy farms in the region aggregating (versus expanding) and the reduction of water use by the large users (primarily through the implementation of more water conservation fixtures and practices). Thus, the number of large users and the large user demands kept constant with the 2005 estimates in the future condition models, with only the residential demands increasing.

These demand calculations assumed that no new transmission lines were added to the system. In general, the demands increased for the existing junction nodes and pipe segments, therefore assuming that the system will experience infill, not additional service area. This appears to be consistent with the discussions with the SRWA board about the future conditions for the system.

Demand Distribution in Model

Prior to running the model, additional modifications were made to the demands assigned to each node in order to increase the accuracy of the hydraulic results. Because PHD rates have a larger impact on dead-end mains, a formula in the spreadsheet is used to re-estimate PHD values for each node in the various system branches, with heavier weighting to those nodes closer to the end of a branch. The formula can result in certain nodes within looped portions of the system ending up with negative demands, but with compensatory higher demands at nodes along dead-end mains. The total overall estimated demand for the SRWA is not changed.

The modified demand values for each node from the spreadsheet were then input into the hydraulic model for the system analysis. This process was repeated for the 2014 and 2028 analyses as well.

ANALYSES AND RESULTS

Hydraulic analyses were performed for estimated system build-out in 2008, 2014 and 2028. The following two significant assumptions were made for the evaluations:

- Tank Drawdown. The analyses were performed assuming the water surface elevation in the water storage tanks was at a level corresponding to typical operating elevation near the top of the tank. The two 500,000 gallon storage tanks operate in parallel, providing ample storage for the combined Sumas and SRWA system. Each tank has a narrow actual operating range at the top, as the pumped supply of water from the well field exceeds the anticipated peak hour demand from the tank. Thus, the tanks will only fall below the top foot or two of the tank during emergency situations, when lower service pressure standards are allowed.

- PHD. The analyses were performed assuming a peak demand situation, rather than a normal operating situation with average demands. Thus, the resulting pressures would likely only occur infrequently for very short durations.

<u>Existing System Conditions – 2008</u>

Model results for the 2008 demand calculations show that for the majority of the system, pressures are above 30 pounds per square inch (psi).

There are several areas of operating pressure below 30 psi during peak hour demand operating conditions. These areas are listed below along with the approximate pressures:

- Jones Road – dead-end 3-inch line (node J-315 and J-317), pressures approximately 26 and 25 psi, respectively. Although the model shows these pressures to be low, the SRWA board members indicated that there have been no complaints of low pressures from these customers.
- Reese Hill Road – dead-end line, 4- to 3-inch lines (J-360 and J-24), with pressures of approximately 27 and 9.5 psi, respectively. There are currently small booster pumps at these service connections, owned by the water customers, which boost water to pressures acceptable to those customers. SRWA does not operate these booster pumps.
- North Pass Road (J-383) on a 4-inch line, with a pressure of approximately 28 psi. This node is located immediately before the SRWA booster pump station serving customers off of Minaker Road.
- Minaker Road – dead-end 2-inch line (J-393), with a pressure of approximately 25 psi.

The system improvements that would benefit these areas include:

- Upsize the 3-inch pipeline (P-223a) in Jones Road to 4-inch PVC. This line upsizing brings the pressures at the end of the line to 39 and 38 psi, respectively.
- Upsize the 2-inch pipeline (P-19) in Minaker Road to 4-inch PVC. This line upsizing brings the pressure at J-393 to 33.5 psi.

The service connections on the end of Reese Hill Road currently provide in-house booster pumps to raise pressures, therefore no booster pump system is currently proposed at this location. Upsizing the 3-inch pipe (P-27) to a 4-inch pipe does not appear to provide any benefit to the pressure.

No line upsizing is proposed for right before the booster pump station (PMP-7) on North Pass Road (J-383). Services downstream of the pump station are provided with boosted water through the pump station. In addition, this line serves a seasonal recreational conference and retreat center, therefore although it is considered a large user, it does not appear to be a year-round demand. Per system operators, there have been no complaints from low pressure issues here.

Future System Conditions – 2014

Model results for the 2014 demand calculations show that for the majority of the system, pressures are still above 30 psi. The areas of the water system that would have low pressures without improvements are similar to the areas with low pressures under the 2008 system conditions.

The improvements that would benefit the system in 2014 are the same as in 2008. Making these improvements would bring waterline pressures up to approximately 30.6 for junction J-393, and 41, 37 and 36 psi at junctions J-314, J-315 and J-317, respectively.

Below is a listing of affected areas with approximate pressures under current infrastructure conditions, evaluated assuming that no infrastructure improvements have been added to the system.

- Jones Road – dead-end 3-inch line (nodes J-314, J-315 and J-317), pressures approximately 27, 23 and 22 psi, respectively.
- Reese Hill Road – dead-end line, 4- to 3-inch lines (J-360 and J-24), with pressures of approximately 25, and 7 psi, respectively.
- North Pass Road (J-383) on a 4-inch line, with a pressure of approximately 23 psi. This node is located immediately before the booster pump station.
- Minaker Road – dead-end 2-inch line (J-393), with a pressure of approximately 22 psi.

Future System Conditions – 2028

Model results for the 2028 demand calculations show that for the majority of the system, pressures are above 30 psi. The areas of the water system that would have low pressures without improvements are similar to the 2014 and 2008 system conditions, but include some additional areas where pressures drop below 30 psi. These areas include services at the end of Lenhardt Road, the end of Schuett Road and the end of Telegraph Road near Deeter Road.

The improvements that would benefit the system in 2028 are similar as those for 2008 and 2014, but additional improvements are warranted to boost pressure for those areas on Schuett, Telegraph, and Deeter Roads.

The system improvements that would benefit these areas include:

- Upsize the 3-inch pipelines (P-222a and P-223a) in Jones Road to 4-inch PVC. Upsizing both of these lines is necessary to bring the pressures at junctions J-314, J-315, and J-317 at the end of the line to 34, 33 and 31 psi, respectively.
- Upsize the 3- and 2-inch pipelines (P-16, P-18 and P-19) in Minaker Road to 4-inch PVC. Upsizing all of these lines brings the pressures at J-20 and J-393 up to 40 and 36 psi.
- Upsize the 2-inch galvanized line (P-189) in Lenhardt Road to 4-inch PVC. This brings the pressure at J-332 up to approximately 44 psi.
- Provide a new 8-inch pipeline (approximately 4040-feet) from junction node J398 to J-377 (estimated route is crossing private property). In addition, upsize the existing pipes P-215, P-213, P-212, P-211, and P-208 in Bowen, Hill, and Schuett Roads. In addition, upsize pipes P-14 and P-207 to 6-inch PVC. These improvements are necessary to bring the pressures on the end of Telegraph and Deeter roads up to above 30 psi. The approximate pressures at the junctions are listed below.
  - J-378 = 37 psi
  - J-379 = 37 psi
  - J-17 = 36 psi
  - J-380 = 35 psi
  - J382 = 31 psi

The proposed improvements outlined above would also benefit Reese Hill Road dead-end lines, with resulting pressures at junctions J-359, J-360 and J-24 at approximately 32, 22, and 5 psi, respectively. Although two are still less than 30 psi, these are nodes with services using individual booster pumps, that increase the service pressure to levels adequate for the residents, as discussed previously.

These improvements would also benefit junction J-383 on North Pass Road, bringing pressures to 22 psi. As discussed earlier, this node supplies a booster pump station, which benefits the low pressures on Minaker Road. An attached model print-out shows the modified pipe locations that would benefit the areas of low pressure for the 20-year future conditions scenario.

Below is a listing of affected areas with approximate pressures under current infrastructure conditions, evaluated assuming that no infrastructure improvements have been added to the system.

- Jones Road – dead-end 3-inch line (nodes J-314, J-315 and J-317), pressures are approximately 18, 13 and 11 psi, respectively.
- Lenhardt Road – dead-end 2-inch line (node J-332), with a pressure of approximately 10 psi.
- Reese Hill Road – dead-end line, 4- to 3-inch lines (J-359, J-360 and J-24), with pressures of approximately 27, 17, and -0.5 psi, respectively.
- North Pass Road (J-383) on a 4-inch line, with a pressure of approximately 14 psi. This node is located immediately before the booster pump station.
- Minaker Road – dead-end 2-inch line (J-20 and J-393), with pressures of approximately 24 and 10 psi, respectively.
- Schuett Road – dead-end 2-inch line (J-377), with a pressure of approximately 16 psi.
- Telegraph Road – 4-inch line dead-ending at Deeter Road. The junctions and their corresponding pressures are listed below.
    - J-378 = 29 psi
    - J-379 = 29 psi
    - J-17 = 28 psi
    - J-380 = 27 psi
    - J382 = 22 psi

ATTACHMENTS

Large User Demand Calculation Excel Spreadsheet
Demand Distribution Excel Spreadsheets (2008, 2014, 2028)
WaterCAD Simulation Output Data
Water System Schematic Layout
Pump Curve Information for PMP 7

Nooksack Valley info

CASCADE ENGINEERING GROUP, P.S., INC.
119 Grand Avenue, Suite D (360) 306-8161
Bellingham, Washington 98225

Project Sumas water Plan
Date 3-10-2011 Project No. SUMS0001
By MJD Sheet 1 of

Telephone Conversation with Curt Schoenfelder @ Wilson Engineering (733-6100)

Wilson Engineering provided engineering analyses for Nooksack Valley water association (Chapter 3) of their 2009 plan update

Storage Tanks: 100,000 gallon Nooksack Valley
100,000 gallon City of Nooksack
500,000 gallon shared

Nooksack Valley 2009 info: PHD = 1,295 gpm
1,565 ERU's (1,200 larger users)

2028 : PHD = 1,295 gpm (same as 2009)
1,675 ERU's
1.6% growth rate

2005-2007 21% loss rate

Additional water to meet future demand from conservation effort

(1295-904)(t) = 95,000
t = 242 min
4 hours = 240 min

(1295-904)(150)
= 58,650 gpm

2009 Equalizing Storage = 95,000 gallons
2009 Allocation from Sumas 904.2 gpm

(1295-X)(150) = 95,000
X = 662 gpm
Supply from Sumas

Assume 60' Ø tank → 21,000 gal/ft

95,000 / 21,000 = 4.5 ft