Multi-Purpose Surface Water Storage Assessment WRIA 2

April 30, 2004

MONTGOMERY
WATER GROUP, INC.

Water Resources Engineering

April 30, 2004

Ms. Vicki Heater
San Juan County Health and Community Services
145 Rhone
Friday Harbor, WA 98250

Re: WRIA 2 – Multi-purpose Surface Water Storage Assessment

Dear Vicki,

Attached for your review is a digital copy of our draft report on water storage opportunities on Orcas Island in San Juan County. We look forward to discussing your comments at your convenience.

Thank you very much for the opportunity to provide water resources consulting services to the County and WRIA 2 Watershed Planning Unit.

Yours truly,
MONTGOMERY WATER GROUP, INC.

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1.0 INTRODUCTION

1.1 Study Goals

This study identifies and evaluates potential surface water storage sites that could be used to supplement water supplies for the Town of Eastsound on Orcas Island in San Juan County, Washington. The proposed facility would store winter streamflow for later municipal use and/or to improve instream flow during summertime. The Level 1, WRIA 2 Basin Assessment (PGG, 2001) recommends additional study of areas where seasonal diversion and shared storage can benefit designated growth areas. The Basin Assessment also identified potential limits to groundwater supplies in the county. The Eastsound area is one of the designated growth areas in San Juan County.

Streamflow estimates for three stream gauging sites on San Juan Island were also prepared as part of this study. Devine Tarbell Associates (DTA) installed stream gauges in 2003 on San Juan Island at Trout Lake, Nettle Creek and Beaverton Valley (UW Creek) for a separate study. The data has been collected; however, hydrologic analyses of that data have not been completed.

The Washington State Department of Ecology provided grant funding to San Juan County for this study through the WRIA 2 Watershed Planning process. The study was coordinated with San Juan County and representatives of the Eastsound Water Users Association.

1.2 Approach

The Montgomery Water Group (MWG) team (MWG and DTA) was tasked with identifying and evaluating a limited number of potential surface water storage sites. Other sites in the project area may also be feasible but were not identified and reviewed for this study.

We were provided a list of four potential sites by Eastsound Water Users Association (EWUA) at the outset of the project. We performed an initial reconnaissance of other potential surface water storage sites of various sizes on both private and publicly owned properties on Orcas Island. Of the sites initially reviewed, the four sites identified by EWUA were studied in more detail as other sites appear to have ownership, location, or environmental and/or property constraints that would make their use infeasible or too costly.

The four project sites selected for detailed evaluation are referred to herein as the Land Bank Parcel, the Frazier (West One Trust) Parcel, the Youngren Parcel and the Cascade Gardens Parcel. Exhibit 1 shows the site locations in relation to the project area and nearby geographic features.

The work performed for this report included the following tasks:

Task 1: Field Reconnaissance

1) Conducted two field reconnaissance trips to identify, screen and evaluate potential sites.

Task 2: Develop GIS Coverage of Stream Gauge Network

1) Prepared a GIS map depicting locations of the stream gauges installed on Orcas and San Juan Islands DTA in 2003/2004. The map was prepared using an existing GIS layer supplied by San Juan County.

Task 3: Estimate Annual volume of Surface Water Available in Priority Basins

1) Compiled surface water data for several basins identified by the County and the Lead Entity for Salmon Recovery (Dr. David Hoppes) as priorities for understanding flow for aquatic organisms (San Juan WRIA 2 Gauging and Instream Flow Study, DTA, 2003).
2) Where gauging data were available:
    a. Correlated existing gauge records to longer gauging records to estimate variability of runoff on an annual and seasonal basis.
    b. Prepared estimates of low (90% exceedance), average (50% exceedance) and high (10% exceedance) amounts of surface water runoff.
3) Compared existing facilities to current and future water needs and infrastructure needs.
4) Reviewed water use and water rights records to correct for water already allocated or used using water rights data obtained from the Department of Ecology and water use data compiled from water systems or the Department of Health.
5) Performed hydrologic analyses on three gauges located on San Juan Island (Trout Lake, Nettle Creek and UW Creek).

Task 4: Evaluate Existing Storage Capacity

1) Collected information on existing Orcas Island water storage facilities size and yield from water system operators, existing reports obtained from SJC, and other agencies.
2) Compared existing facilities to current and future water needs and infrastructure needs.

Task 5: Identify Potential Sites for Additional Storage Reservoirs

1) Collected existing data on sites including ownership, topography, geology, access, sensitive areas
2) Conducted field review of potential sites
3) Analyzed potential reservoir sites for:
    a. Size of reservoir available
    b. Potential reservoir yield
    c. Required facilities to store and transmit water including diversion structures, pumping plants and pipelines to and from reservoir
    d. Estimated costs to acquire land, construct reservoir and other features, provide engineering and construction management
    e. Environmental and permitting requirements
4) Prepared comparative analysis summary of costs and benefits for sites reviewed.
5) Prepared exhibits showing the proposed location of each site and facilities required to divert, impound and deliver water to designated water users.

2.0 HYDROLOGY

2.1 Estimate Volume of Surface Water in Priority Basins

An estimate of the volume of surface water in priority basins was made using stream gauging data compiled by DTA. The priority basins on San Juan Island are the Trout Lake tributary basin, Nettle Creek and Beaverton Valley Creek (UW Creek). On Orcas Island it is the Cascade Creek basin. The following sections describe that analysis.

San Juan Island Basins

DTA has collected almost a year of discharge data on Trout Lake inflow, Nettle Creek, and Beaverton Valley (May 2003 to April 2004). Estimated mean daily discharges were correlated with mean daily discharges from the Samish River for the same period to develop a relationship to calculate flow exceedance statistics for the San Juan Island streams. The Samish River (tributary to the Skagit River) is an active gauging site, and is a nearby low-elevation, rain-dominated system much the same as the San Juan Islands. Of all the potential stream gauges that could be used for a correlation analysis, including numerous candidates on the Olympic Peninsula within the rain-shadow of the Olympic Mountains, the Samish River had the best correlation with the San Juan data for corresponding periods of record. Flow exceedance statistics were calculated in 1% increments for the Samish River at the Samish River gauge site for another study (Water Resources Evaluation Samish River Sub-Basin, HydroLogic Services Inc., 2003). These values were used to estimate flow exceedance statistics for the San Juan Island sites. Table 2-1 shows the results of the flow exceedance calculations for the three San Juan Island streams. Graphs of the data and correlation equations are provided in Appendix A.

As a precautionary note, the period of record (May 2003 to February 2004) was unusual as monthly precipitation for most of the months were higher or lower than the mean. An illustration of that is shown in Figure 2-1. That figure compares mean monthly precipitation at the Olga station on Orcas Island for the period of record (1894-2004) to precipitation that occurred in 2003. May through September was very dry but October and November were well above the mean precipitation. December was also very dry.

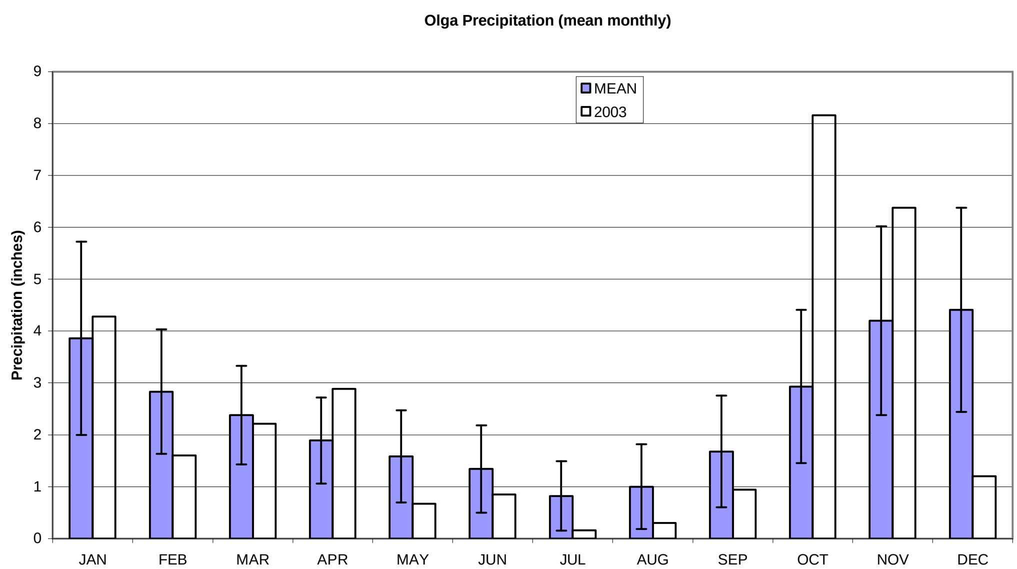


Figure 2-1. Olga 2SE Washington Monthly Precipitation for 2003 compared to mean monthly data for period of record (1892 –2004).

Table 2-1 Flow Exceedance Statistics
San Juan Island Stream Gauges
Flow in cfs

Stream	Month	% Exceedance		
		10	50	90
Trout Lake	January	1.5	0.6	0.3
	February	1.3	0.5	0.3
	March	1.0	0.5	0.3
	April	0.8	0.4	0.2
	May	0.5	0.2	0.1
	June	0.3	0.1	0.1
	July	0.2	0.1	0.0
	August	0.1	0.0	0.0
	September	0.2	0.0	0.0
	October	0.5	0.1	0.0
	November	1.1	0.4	0.1
	December	1.3	0.6	0.3
Nettle Creek	January	8.6	3.6	2.0
	February	7.8	3.5	2.1
	March	6.1	3.2	2.0
	April	5.0	2.6	1.8
	May	3.3	1.8	1.2
	June	2.2	1.2	0.9
	July	1.4	0.9	0.7
	August	0.9	0.7	0.6
	September	1.4	0.7	0.5
	October	3.0	1.1	0.6
	November	6.5	2.8	1.1
	December	7.7	3.5	1.9
Beaverton Valley (UW Creek)	January	11.8	5.3	3.3
	February	10.7	5.2	3.4
	March	8.4	4.8	3.2
	April	3.6	1.5	0.8
	May	2.1	0.8	0.3
	June	1.2	0.3	0.0
	July*	1.3	0	0
	August*	1.1	0	0
	September*	1.3	0	0
	October	1.8	0.2	0.0
	November	1.5	1.0	0.8
	December	10.7	5.2	3.1

*Used annual correlation; but 10% exceedance likely overestimated; 50 & 90% exceedance set to zero.

The correlation between the San Juan Island streams and the Samish is based on the data available, which occurred during an unusual year, and not an "average" year. However, by using the Samish data, some of the differences are smoothed. The flow exceedance estimates contained in Table 2-1 are to be used as a tool with the understanding that more data is necessary to ensure that flow exceedance statistics are not significantly over or underestimated.

The flow at the Beaverton Valley gauge is very difficult to estimate due to hysteresis in the data collected. The drainage is large and contains many storage reservoirs that likely impact the flow regime. Statistical correlations to the Samish River data improved when the data was divided into smaller time periods such as December-February, October, and April-June. It was found that November data correlated poorly to the Samish River data. In July – September, there was no flow at the Beaverton Valley gauge. Although the Samish River had flow during that time period, we assumed July-September flow for average to dry years would be zero at the Beaverton Valley gauge. We expect flow to occur in wetter than average years, so a correlation equation for 10% exceedance flows that is based upon the annual flow record was used for those months. The annual value appears to overestimate the flows so an improvement in correlations may need to wait until more data are collected.

Orcas Island Basins

The focus of the hydrologic analysis on Orcas Island is the streams that have a potential for supplying additional water to the Town of Eastsound. The two basins identified as having the potential to supply additional water are the Purdue Lake basin and the Cascade Creek basin. The Purdue Lake basin is currently used as a water source for Eastsound, and significant effort is underway by the Eastsound Water Users Association (EWUA) to assess its capability for additional storage. Cascade Creek flows from Mountain Lake in Moran State Park. The Cascade Creek system is a water supply for Rosario, Olga and Doe Bay water systems. The flow in Cascade Creek is regulated at Mountain Lake to provide water supply to those water users and to control lake levels. The regulation results in an artificial flow regime that provides more flow in the summer than an unregulated flow regime would. An analysis of hydrologic data for Cascade Creek is provided as well as an overview of the potential additional water supply in the Purdue Lake basin was made.

Cascade Creek

Cascade Creek has been gauged since May of 2003. A summary of the gauging data is provided in Table 2-2. Data for Cascade Creek as well as estimates of diversions from Cascade Creek are provided. The data is presented in both cfs and million gallons per day (mgd).

Table 2-2. Average Monthly Discharge
Cascade Creek, June 2003 through March 2004

Site/Diversion	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar*
Cascade (cfs)	1.3	1.6	1.6	1.4	8.0	12.3	9.1	9.1	14.1	3.4
Doe Bay (cfs)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Olga (cfs)	0.1	0.1	0.1	0.1	0.04	0.04	0.03			
Rosario (cfs)	1.0	0.5	0.5	1.0	2.0	3.0	3.0	3.0	2.0	2.0
Total (cfs)	**2.5**	**2.3**	**2.3**	**2.5**	**10.1**	**15.4**	**12.2**			
Total Volume, (mgd)	1.6	1.5	1.5	1.6	6.5	9.9	8.2			
Total volume after div., (mgd)	0.9	1.0	1.0	0.9	5.1	7.9	6.2	7.8	9.1	2.0

*March data only extends through the 28th day of the month.

Data were obtained from Washington Department of Health Water Treatment Plan Reports for Doe Bay and Olga Water Associations and is a record of treated water, not water allocated by water right, nor diverted water. Ten percent was added to the treated water numbers to allow for wastewater. Rosario numbers are based on rough weir openings and have not been measured.

As presented in Figure 2-1, the data was collected during an extended dry period from June through September and then a very wet period in October and November. Flow exceedance statistics could be overestimated based on this short period of data. More data would be required before a dependable analysis is completed. The data do serve to show that in a dry year, flow in Cascade Creek is at least 1 cfs even during summer. Tables 2-3 and 2-4 summarize flow exceedance estimates for Cascade Creek. The flow exceedance estimates were prepared using correlations to Samish River data. The correlation results are provided in Appendix A. Table 2-3 presents the results in cfs and Table 2-4 presents the results in million gallons per day.

Table 2-3. 10, 50 and 90% exceedance for Cascade Creek before and after diversions, based on data collected from Cascade Creek May 2003 – April 2004. Units are in cfs.

	% Exceedance before diversions			% Exceedance after diversions		
Month	**10**	**50**	**90**	**10**	**50**	**90**
January	24.7	11.2	7.0	21.8	9.1	5.2
February	22.5	10.9	7.2	19.7	8.9	5.3
March	18.0	10.3	6.9	15.4	8.2	5.1
April	15.0	8.6	6.3	12.7	6.7	4.5
May	10.5	6.2	4.8	8.4	4.5	3.1
June	7.6	4.7	3.9	5.7	3.1	2.3
July	5.2	3.9	3.4	3.5	2.2	1.8
August	4.0	3.4	3.1	2.4	1.8	1.5
September	5.3	3.4	3.0	3.5	1.8	1.4
October	9.6	4.5	3.1	7.6	2.8	1.5
November	19.2	9.1	4.5	16.6	7.2	2.8
December	22.4	11.0	6.6	19.6	8.9	4.8

Table 2-4. 10, 50 and 90% exceedance for Cascade Creek before and after diversions, based on data collected from Cascade Creek May 2003 – April 2004. Units are in million gallons per day

Month	% Exceedance before diversions			% Exceedance after diversions		
	10	50	90	10	50	90
January	16	7	5	14	6	3
February	15	7	5	13	6	3
March	12	7	4	10	5	3
April	10	6	4	8	4	3
May	7	4	3	5	3	2
June	5	3	3	4	2	1
July	3	2	2	2	1	1
August	3	2	2	2	1	1
September	3	2	2	2	1	1
October	6	3	2	5	2	1
November	12	6	3	11	5	2
December	14	7	4	13	6	3

Purdue Lake

Purdue Lake has the capacity to provide additional water to EWUA as water is currently spilled from the reservoir when it is full. As an illustration, overflow data provided by EWUA was compiled and summarized in Table 2-5. The table shows the instantaneous overflow in cfs from the period December 2001 to May 2002. This table provides an estimate of the amount of water that could potentially be available for further storage during that time period. Note that only the six months out of the year would provide additional water for further storage.

Table 2-5
Overflow Data from Purdue Lake

Month /Year	Date From:	Date To:	Calculated Monthly	
			Overflow (gallons)	Average Overflow (cfs)
Dec-01	12/17	12/31	13,214,006	1.46
Jan-02	12/31	1/31	15,563,666	0.78
Feb-02	1/31	2/28	26,172,581	1.45
Mar-02	2/28	3/31	14,824,962	0.74
Apr-02	3/31	4/30	9,207,285	0.47
May-02	4/30	5/20	2,349,831	0.18
Total			81,332,331	

The hydrology of the Purdue Lake watershed was studied by CDM (2004) as part of a feasibility study for the expansion of Purdue Lake. The average overflow reported by CDM for the 1998-2002 study period was 58.46 million gallons. The overflow in 2002-2003 was estimated by EWUA (pers. comm.. Wixom, 2004) to be about 21.4 million gallons, much less than 2001-2002 and the long-term average reported by CDM. The amount of water used by EWUA in the 1998-2002 period averaged 36.25 million gallons per year.

CDM estimated the yield of the Purdue Lake watershed to be 115 to 117 million gallons per year on an average annual basis. The yield for 1998 was the lowest during the study period and was estimated to be 72.6 million gallons.

The study period for estimating the yield of the Purdue Lake watershed was 1998-2002. The yield for 2002-2003 was low and should also be examined when estimating the long-term reliability of the Purdue Lake water supply. A quick estimate of the 2002-2003 yield was made; we estimate the yield to be about 89 million gallons. That includes about 36 million gallons water use, 21.4 million gallons overflow and an estimated 32 million gallons used to refill the reservoir.

3.0 EVALUATE EXISTING STORAGE CAPACITY AND NEEDS

3.1 Eastsound Water Users Association Water Needs

For this task, we met with EWUA and discussed their current water resources and water storage facility (Purdue Lake) and their future water needs. Documentation of the EWUA future water needs is contained in the CDM report. The EWUA currently provides 73 MG/yr to existing customers. The study used a 10-year planning horizon with intermediate planning timeframes in 2003, 2004, 2009 and 2014. The forecast water needs for 2014 are an additional 115 MG/yr. That additional water demand would be met from expansion of Purdue Lake, reduction of water system leakage and construction of an additional reservoir. The goal expressed to the MWG team was to locate and estimate the costs of constructing a reservoir with 100 MG capacity to provide sufficient capacity to meet future demands.

EWUA uses Purdue Lake and groundwater wells as its water sources. Options considered to increase their water supply included raising the dam spillways, excavating the lake, reducing unaccounted-for water, adding wells, or a combination of these options (CDM, 2004).

The CDM study determined that groundwater resources in the EWUA service area are already reaching critical thresholds for sustainability, making the use additional water wells a risky choice for long term supply. Surface water resources were also evaluated, with the Purdue Lake watershed shown to produce between 115 and 117 MG per year. Options for increasing this production through raised dam height were explored in detail. CDM conducted reservoir modeling to predict storage capacities at dam heights increased by 3, 8.5 12.5 and 23 feet. The results of this analysis were that if no other large source of supply can be implemented, medium-term goals could be met through raising the dam by at least 8.5 feet. Raising the dam by 12.5 feet is recommended if an additional large source of supply remains uncertain (CMD, 2004). Table 3-1 summarizes the results of the report for the 8.5 ft to 23 ft alternatives.

Table 3-1
Summary of Purdue Lake Alternatives

Raise Purdue Lake Spillways and Dam Height Alternatives	Storage Capacity		Additional Yield MG/yr	Initial Cost $	Cost/million gallons of Additional Storage $
	Acre-Feet	Million Gallons			
Existing	117.5	38.3	-	-	-
8.5 feet	222	72.6	25.8	1,371,245	39,600
12.5 feet	273	89	35.4	2,307,717	45,500
23 feet	426	139	69.2	6,208,680	61,700

3.2 Rosario Water Storage and Water Use

The Rosario Resort diverts flow from Cascade Creek into Cascade Lake. The Resort uses water for municipal supply, irrigation and hydropower. Cascade Lake is also actively used for recreational purposes. They divert on a schedule listed in Table 2-2, with highest diversions 3 cfs in winter and lowest 0.5 cfs in July and August. Records of water used for municipal and hydropower use were provided by the Resort and are compared to diversions on Figure 3-1. The difference between the diversions and use is presumably spilled from the impoundment into a short creek leading to saltwater. Other losses occur from evaporation and groundwater outflow. There are other small streams that also feed Cascade Lake and a hydrologic analysis (water balance) of inflows and outflow from the lake was not performed for this study. Figure 3-1 indicates that there is water spilled from the lake, which could be diverted into another impoundment and stored for later use in the summer. The amount spilled would appear to meet the water supply goals for Eastsound. That goal is 100 million gallons per year (about 1 cfs for 6 months).

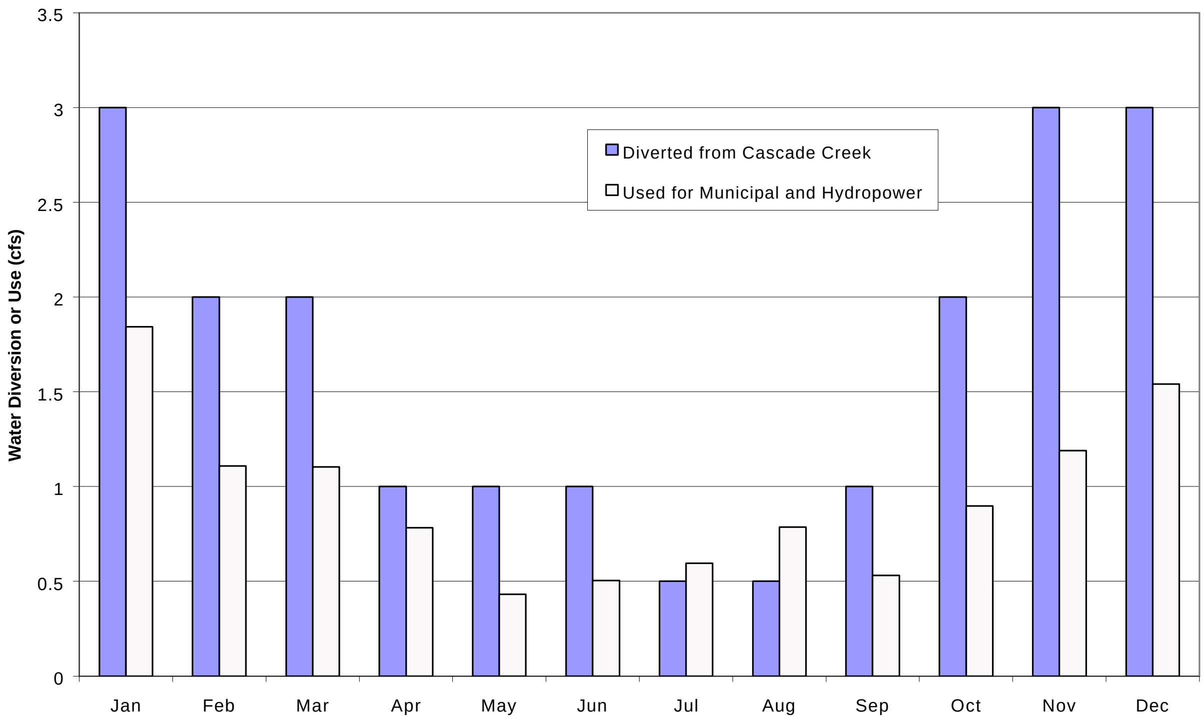


Figure 3-1. Comparison of Diversions from Cascade Creek and Water Use by Rosario Resort.

4.0 IDENTIFICATION AND SELECTION OF ALTERNATIVES

4.1 Sources of Water and Storage Sites

Four potential water storage sites were evaluated in detail for this study. Prior to selecting those four sites a number of alternative sites were quickly reviewed as well as potential sources of water for storage. A list of potential water supply sources is shown in Table 4-1.

Table 4-1
Potential Water Supply Sources

Potential Source	Description
Cascade Creek/Mountain Lake	Divert from Cascade Creek at existing Rosario Diversion and pump to new reservoir. Obtain new water rights for diversion during winter or purchase/lease water from Rosario.
Purdue Lake	Increase capacity of Purdue Lake to capture existing spill from lake. This alternative was studied by CDM (2004) and the results are summarized in this study also.
Cascade Lake	Purchase/lease water from Rosario, pump from Cascade Lake into new reservoir when lake is full and Rosario cannot use all the water diverted from Cascade Creek.
Youngren Springs	Purchase/lease water from Youngren that is either not used or is spilled from the fish hatchery into saltwater. Pump water into reservoir for later use. This potential source was identified but not studied and no information on its viability was developed.

There may be other, smaller sources of water available that were not pursued as it became apparent that the Cascade Creek system had the most available water. Table 4-2 contains a description of the potential water storage sites reviewed for this study. Exhibit 1 shows the location of the potential sites.

Table 4-2
Potential Water Storage Sites

Potential Source	Description
Land Bank Parcel	Located closest to Eastsound, a large open parcel with sufficient area to accommodate a new reservoir. Water would need to be conveyed from a diversion at Cascade Lake to this reservoir.
Frazier (West One Trust) Parcel	An available parcel that is rather steep and could not accommodate the full size of a reservoir needed for long-term EWUA water needs. Water would need to be conveyed from Cascade Lake to this reservoir.
Youngren Parcels	A reservoir would fit on the southeast part of the Youngren parcels. Water would need to be pumped from Cascade Lake into this reservoir. The storage could be coordinated with Youngren's hatchery operations to optimize their water supply also (provide flow on demand for critical periods of time)
Cascade Gardens Parcel	This parcel is located southeast of Cascade Lake. Water can be diverted into a reservoir on this site through the Rosario diversion. To transmit water to Eastsound, water can be pumped from the reservoir into the Rosario diversion and into Cascade Lake. Water would then be pumped out of Cascade Lake at the same rate input from the reservoir.

Table 4-3 lists other sites that were reviewed at the outset of the study and not further pursued because of property ownership, environmental or permitting issues.

Table 4-3
Other Potential Water Storage Sites Not Studied

Potential Source	Description
Mountain Lake	Increase storage by optimizing operation of Mountain Lake and maintaining a more full pool later in the summer. Reduce outflows from lake to minimum needed for instream resource protection. Not pursued because of potential issues with State Parks including permitting and potential impacts to parks facilities and users.
Summit Lake	Use Summit Lake to augment water supply. Although it is an artificial lake with a concrete dam, permitting and parks issues probably preclude its use as a reservoir.
Day Lake	Access to the lake would likely not be granted by owner.

4.2 Summary of Sites Considered

The following paragraphs provide a brief summary of each site reviewed. Location maps and preliminary layouts are provided in Exhibits 1-11.

Land Bank Parcel

This site is presently an undeveloped property located northwest of, and in close proximity to, the City of Eastsound. Access to this site is good. Water release from a storage facility and water treatment plant at this site could be easily directed to the existing EWUA main located under Mt. Baker Road. The potential source of water for this facility would be Cascade Lake located approximately 4 miles south of the reservoir. A pump station and force main would be required to convey non-potable water from the lake to the site. The reservoir would be filled in winter months when water is available for diversion either from Cascade Lake or Cascade Creek.

Our concept for a storage facility on this property entails balanced cuts & fills and construction of an earth embankment with the native soils to the extent they could create an impervious structure. The facility layout was constrained along its west side due existing wetlands and associated buffers. Embankment heights between 13 and 23 feet above existing grades are required to impound the target storage volume of 100 million gallons within a 28-acre footprint (embankment heights could be reduced by expanding the footprint through further property acquisition). Exhibits 2 and 7 illustrate the potential layout of a reservoir at this site. According to the NRCS Soil Survey, the site is predominately overlain with Norma loam, a slowly permeable soil. Water levels are usually high, at, or near the surface, during the winter months in areas of this soil type. This site could potentially yield 328 ac-ft. or 107 million gallons of storage capacity.

A potential issue with this site is its proximity to Eastsound and the visual impact it could have on surrounding properties. The embankment heights are high (13 to 23 ft) and may not be desirable by community members.

Frazier (West One Trust) Parcel

The Frazier property is located approximately 1½ miles southwest of Eastsound along Horseshoe Highway. It is attractive from the standpoint of close proximity to the south end of the existing water system and would be easily accessed. Source of water for this facility would come from Cascade Lake located approximately 2½ miles south. A pump station and force main would be required to convey non-potable water from the lake to the site. The reservoir would be filled in winter months when water is available for diversion either from Cascade Lake or Cascade Creek, as is the previous alternative. A pump station and water treatment plant would be required at the site as well as water main to connect to the existing EWUA system.

Since nearly the entire site has steep slopes, our concept for a reservoir on this property entailed a relatively short embankment section spanning the small natural draw. To maximize the site storage capacity, embankment heights of up to 45 feet were required and excess excavated soil was generated. Exhibits 3 and 8 illustrate this alternative. This site may also be costly to develop due to the apparent site soil. NRCS Soil Survey maps show the site overlain with Everett gravelly sandy loam, a highly permeable soil that would require the facility to be lined to reduce seepage. This site is limited in its storage potential, and our best layout resulted in only 81 ac-ft. (27 million gallons) water storage impoundment.

Youngren Parcels

The Youngren site is located about 2 miles southwest of Eastsound and abuts Horseshoe Highway. Source of water for this facility would come from Cascade Lake, located approximately 2 miles south, a pump station and force main would be required to convey non-potable water from the lake to the site. Another 1,500-foot long water main would be required to convey potable water from the site to the south end of the existing water system. Figures 4 and 9 illustrate this alternative. As with the Frazier parcel, this site features steep slopes which limits development to the northwest portion of the site. Our approach to this site was to construct a long embankment against the existing slope to maximize storage. The facility footprint appears to be overlain with the highly permeable Everett type soil that may require the installation of a liner. In our effort to maximize storage, our layout required mining of soil above the facility for embankment fill. This increased the alternative cost since the slopes above the facility are probably composed of rock. This site is also limited in its storage potential, and our best layout resulted in 114 ac-ft. (37 million gallons) of water storage.

Cascade Gardens

This site is located about 5 miles south of Eastsound. The parcel has good access since it abuts Horseshoe Highway. This site is attractive due its close proximity with the Rosario diversion system that feeds Cascade Lake with Cascade Creek flows. It appears that the water source for the facility could be taken, by gravity, from the Rosario diversion. Stored water could then be pumped back into the diversion to feed Cascade Lake. A pump station, water treatment plant and 2-mile force main would be required to convey water from the lake to the south end of the existing Eastsound water system. The site is constrained by numerous wetlands, which limits development to the northwest corner of the site. Accessing this corner of the site with a road required crossing of a wetland prompting the need to mitigate with newly created wetlands on site. Our concept for this storage facility is to balance the earthwork cuts and fills. The balance produced an embankment that nearly encircles the entire facility. Figures 5 and 10 illustrate this alternative.

The site is predominately overlain with a mix of Coveland and Everett soil, which are slow to highly permeable. The geologic unit underlying the site is glacial till. With this mix of soil types, it is likely onsite soils will be suitable as earth embankment for water impoundment. This site yields a potential storage capacity of 314 ac.-ft.(102 million gallons), which meets the water storage goal.

5.0 COST ESTIMATES

5.1 Overview

To assist in evaluating the candidate storage sites we developed preliminary layouts, cross sections and details to allow us to estimate quantities for major materials, component and other cost elements resulting in fairly detailed cost estimates for the proposed facilities.

We attempted to capture all construction and administrative cost items to the extent possible to achieve a realistic understanding of project costs for future use and planning. More detailed engineering designs would result in better precision in these cost estimates, but given the limitations of this grant budget, we included a 30% contingency amount to account for any inaccuracies in our take-offs or unit pricing, as well as unforeseen items that will likely occur during the course of construction. To the best of our knowledge, our estimates reflect current Washington State Dam Safety standards and design requirements. Items such perimeter fencing, emergency spillways and outlet works are reflected in these requirements and in our estimates.

Land area requirements for each site were determined by projecting the impoundment footprint on the property, adding any necessary temporary and permanent access roads, and adjusting the resulting facility boundary to match up with established property lines and actual parcel boundaries. We obtained land values from the San Juan County Assessors office or real estate listings if available. For the Cascade Gardens parcel, we contacted Dave Douglas, of RE/MAX Island Properties, for the current sale price. The Cascade Gardens parcel is indivisible and our estimate included the price for the entire parcel. We did not contact individual property owners to inquire what value or pricing they would want for their property to avoid unnecessary concerns and obtaining unrealistic land values. A real estate appraisal for each property would be needed to ensure an accurate value is used.

We did not include in the estimates the costs of project financing and debt repayment. We are assuming the project(s) would be completed with grant funding from agencies and no costs of financing would need to be included. If the projects are not funded by grants but are funded through bonds or loans, additional financing and debt repayment costs would need to be added.

Also excluded from the cost estimates is the water treatment plant that would be required for a new source of surface water. The cost of that plant would be common to each alternative and was not included in the estimates.

5.2 Detailed Cost Estimates

Detailed cost estimates for each alternative examined in detail are provided in Appendix B. Table 5-1 provides a summary of costs and elements of the water storage sites.

Table 5-1
Storage Alternative Summary

	Unit	Storage Alternative				Purdue Lake Alternatives	
		Land Bank Parcel	**Frazier Parcel**	**Youngren Parcel**	**Cascade Gardens Parcel**	**12.5 ft**	**23 ft**
Additional Storage volume	acre-ft.	328	81	114	314	155.6	309
Additional Storage volume	Million gallons	107	27	37	102	50.7	100.7
Water surface elev.	ft.	60	177	157	380		
Dam crest elevation	ft.	63	180	160	383		
Dam height (max)	ft.	23	44	20	23		
Land acquisition requirement	acre	34	9	15	84	0	0
Total Estimated Cost	**$Million**	**5.3**	**2.7**	**4.3**	**5.2**	**2.3**	**6.2**
Unit Cost/Storage Vol. constructed	**$/million gallons.**	**49,500**	**100,000**	**116,200**	**51,000**	**45,400**	**61,600**
Unit Cost/Annual Yield	**$/million gallons.**	**49,500**	**100,000**	**116,200**	**51,000**	**64,900**	**89,600**

The costs for the alternatives we reviewed range from 2.7 million dollars to 5.3 million dollars. The unit costs for storage for the four sites are high compared to costs we have encountered elsewhere for storage projects but the amount of earthwork required and the long pipeline to deliver water to the EWUA system increase costs substantially. It is interesting to compare the costs we developed to those listed in the CDM report. The unit costs for construction of the Cascade Gardens and Land Bank parcels fall into the range of costs developed for the 12.5 ft and 23 ft Purdue Lake alternatives. However, when the construction costs are expressed as a unit cost per annual yield the Land Bank and Cascade Gardens projects are less than the Purdue Lake alternatives. The reason for that is the reliability of water supply. It is our opinion that the Cascade Creek supply alternatives would have a greater reliability than the Purdue Lake alternatives, provided the water rights or purchase of water is secured.

More detailed cost estimates that compare the long-term O&M costs for the Cascade Creek and Purdue Lake alternatives are needed to conclude that the Cascade Creek alternatives would be less expensive per million gallons per year yield. In addition, EWUA will need both an enlarged Purdue Lake reservoir and an additional water supply and reservoir to meet long-term needs.

6.0 DISCUSSION OF ALTERNATIVES

It is our opinion that two of the site alternatives studied warrant further detailed review and consideration. These sites are the Land Bank and Cascade Gardens parcels. Estimated project costs for the alternatives developed and reviewed at these sites are high, but within costs of comparable storage projects proposed by EWUA. Neither site appears to have a fatal flaw from an environmental, permitting, design or construction standpoint. From a community perspective, we anticipate the Land Bank Parcel to be more difficult to obtain permits for because of its proximity to Eastsound and the large embankments and footprints that are necessary to obtain the desired storage volume.

Both sites rely on obtaining water either from Cascade Creek (through a new water right) or by purchasing/leasing water from the Rosario Resort.

By comparison, the other two sites result in a relatively high unit cost for water storage, and the net storage benefit from either of these sites is small when compared against the Land Bank or Cascade Gardens options. There may be an opportunity to construct a smaller, less expensive reservoir on the Youngren site that would have a large benefit to EWUA if the water supply for the hatchery could be optimized and EWUA purchase or lease water that is being spilled to saltwater. Discussions with Youngren are needed to pursue that option.

7.0 PERMITTING

7.1 Description of Permits

Table 7-1 provides a list of applicable federal, state and local permits and other regulatory approvals that may be necessary for construction of a storage reservoir.

Table 7-1
List of Likely Federal, State and Local Permits and Regulatory Approvals

Permit Type	Timeframe	When Applicable	Regulatory Agency
Federal - Corps of Engineers 404/Section 10	6 to 12 months, depending on completion of Section 7 Consultation	Locating a structure, excavating, or discharging dredged or fill material in a Water of the U.S., including wetlands. May not be applicable for these projects.	U.S. Army Corps of Engineers Seattle, WA 98124 Regulatory Branch (206) 764-3495
Federal - Section 7 Consultation (Biological Assessment)	6 to 12 months	Required for Corps 404 Permit if federally listed threatened or endangered species may be affected. May not be applicable for these projects.	U.S. Fish and Wildlife Service
State - Dam Safety Construction Permit	2 to 4 months Longer for complex projects	Constructing, modifying, or repairing any dam or controlling works for storage of 10 or more acre-feet of water.	Washington Department of Ecology Water Resources Program Dam Safety Section (360) 407-6600
State - Clean Water Act Section 401, Water Quality Certification	Concurrent with Corps 404 permit process.	Applying for a federal license or permit to conduct any activity that might result in a discharge of dredge or fill material into water or wetlands, or excavation in water or wetlands	Washington Department of Ecology Shorelands & Environmental Assistance Program (360) 407-6600
State – Water Right	1-2 years with expedited review, indefinite without expedited review	For new withdrawals from Cascade Creek and storage in a reservoir.	Washington State Department of Ecology Water Resources Program (360) 407 - 6600
State -Hydraulic Project Approval (JARPA)	2 to 3 months; concurrent with Corps 404 permit process	Work that uses, diverts, obstructs, or changes the natural flow or bed of state waters. Only required for alternatives that modify streams.	Washington State Department of Fish and Wildlife (360) 902-2534
State - Section 106 of the National Historic Preservation Act	3 to 6 months; Longer for complex projects	Needed for Federal or federally assisted projects.	Washington State Office of Archaeology and Historic Preservation w/ lead Agency (360) 586-3065
County -State Environmental Policy Act (SEPA)	EIS process with public comment is usually 12 months	Scoping of project inputs would likely determine EIS is required. In most cases a mitigated DNS would likely be issued.	San Juan County Community Development and Planning Department
County – San Juan County Environmentally Sensitive Areas	3-6 months	Work in critical areas such as wetlands, floodplains, steep slopes	San Juan County Community Development and Planning Department
County –Grading Permit, Building Permit	3-6 months	Required for grading, drainage and associated buildings and electrical services	San Juan County Community Development and Planning Department

7.2 Water Right Permitting Issues

A review of water right permitting issues was also performed for this study. Existing water rights information was extracted for San Juan County from the Department of Ecology's water rights database (DOE 2004a). The water rights were then sorted by township, range, and section. The data set was further reduced to eastern portion of Orcas Island. The table of water rights is included in Appendix C.

Pending water rights applications were downloaded from the Department of Ecology's web site and sorted by township, range and section (DOE 2004b). The data set was reduced to eastern Orcas Island (Table 7-2) to look for the potential for competing uses of water.

Many of the existing and proposed water rights only identified the maximum rate of diversion (cubic feet per second) or maximum annual diversions (acre feet). Columns were added to the tables that show the calculated annualized diversion rate or annualized diversion volume depending on which variable, volume or rate, was available in the data set. The diversion rates and volumes were summed for each section.

Of most interest is the Cascade Creek watershed. The total appropriated rights from Cascade Creek, Mountain Lake and Cascade Lake are 10.75 cfs instantaneous and 4548 acre-feet on an annual basis.

If a water right application is submitted for further withdrawals from Cascade Creek, it would compete with applications already submitted. The applications already submitted are requesting about 6 cfs additional water rights (Table 7-2). Although we did not review the applications, we understand most of the water rights applied for (5 cfs in one application) is for instream flow protection or use near the mouth of Cascade Creek.

The applications listed in Table 7-2 would be considered by the Department of Ecology prior to a new application filed for Cascade Creek by EWUA or other entity. A consideration in the review of applications for Cascade Creek will be the appropriate instream flow needed to protect instream resources. Although Cascade Creek is a regulated creek and flow in summer and fall is supplemented by storage from Mountain Lake it is likely the instream flow set would preclude additional water diversions in the summer. Therefore additional water to divert and store will likely only be available in the late fall to early spring (November – April or so).

To obtain 100 million gallons of storage in a 6-month time period, a constant diversion rate of 0.86 cfs would be required. Section 2 presented estimates of streamflow in Cascade Creek. It appears the creek has sufficient flow to allow an additional diversion of about 1 cfs during that November to April time period, even during dry years (90% exceedance). The flow remaining in the creek after an additional diversion would range from about 2 to 4.5 cfs during that time period for dry years (see Table 2-3). For average years, the flow remaining in the creek would range from about 6 to 8.8 cfs during the November to April time period. Section 3.2 presented a discussion of current Rosario Resort diversions and water use. It appears there is sufficient water available that is not currently used by Rosario that would meet the goal of about 1 cfs diversion during winter. However that water would need to be purchased or leased from Rosario Resort, provided they are willing to do so.

Table 7-2
Water Right Applications
Cascade Creek Watershed

Application Number	Priority Date	Diversion Rate (cfs)	Diversion Volume (ac-ft)	Calc. Ac-ft	Township/Range/ Section	Source
S1-23329	March 2, 1979			0.0	T36N/R01W-03	Mountain Lake
S1-28143	July 11, 2002	0.050		36.2	T36N/R01W-09	Cascade Creek
S1-28144	July 11, 2002	5.000		3619.8	T36N/R01W-16	Cascade Creek
S1-26148	April 17, 1991	0.010	0.5	7.2	T37N/R01W-17	Unnamed Spring
S1-26308	August 14, 1991	0.260		188.2	T37N/R01W-33	Cascade Creek
S1-23175	July 31, 1978	0.800		579.2	T37N/R01W-33	Cascade Creek
R1-26574	March 23, 1992			0.0	T37N/R01W-34	Mountain Lake
S1-28092	October 25, 2000	0.060		43.4	T37N/RO1W-35	Unnamed Pond
Summary		6.180	0.5	4474.1		

8.0 CONCLUSIONS

As a result of our efforts in evaluating potential water storage sites on Orcas Island in San Juan County, we offer the following conclusions:

1. A need for additional water for the Eastsound community exists. A water storage goal of 100 million gallons (308 acre-feet) was identified by EWUA.

2. Four potential water storage sites were reviewed in the project area. Two of the sites, the Land Bank Parcel and the Cascade Gardens Parcel, have room to site a reservoir large enough to meet water storage goals. The other two sites, the Frazier and Youngren parcels, are much smaller and do not meet water storage goals.

3. Projected costs for the various alternatives identified range from $2.7M to $5.3M. Unit costs for storage range from $49,500 to $116,200 per million gallons. These values are much higher than costs for other comparable water storage projects MWG has reviewed in Washington State; however the costs are high because of the large quantities of excavation and fill to create reservoirs and the costs of conveying water from Cascade Lake to the EWUA system.

4. The source of water to fill reservoirs should be Cascade Creek, either through purchase or lease of water currently diverted by Rosario Resort or by securing new water rights for diversion from Cascade Creek. Both options should be reviewed and pursued. Sufficient volume to meet water storage goals could be provided through either option.

9.0 RECOMMENDATIONS

We offer the following recommendations to San Juan County and the WRIA 2 Watershed Planning Unit:

1. Development pressures and population growth will continue to reduce the number of viable sites suitable for addressing water storage needs and goals. Therefore, additional effort should be expended to pursue acquisition of land suited for water storage in the project vicinity. The Land Bank and Cascade Gardens parcels are the best options identified at this time, although the Cascade Gardens site may be easier to permit. The later efforts in obtaining a site for water storage is started, the less chance there will be of finding a suitable site when consensus and funding are obtained.

2. As funding becomes available to pursue a water storage facility, additional site-specific data should be obtained for the preferred site. In particular, a detailed topographic survey for the preferred alternative should be completed, together with a environmental review and a geotechnical investigation program that provides a thorough understanding of subsurface soil and groundwater conditions as well as a better definition of permitting needs. This information will all be necessary to initiate preliminary and final design of a storage facility (or facilities).

3. Discussion with Rosario Resort should be initiated to determine their willingness to work with EWUA in selling or leasing water currently spilled from Cascade Lake; the feasibility of using their diversion from Cascade Creek and feasibility of locating a pump station and possible water treatment plant adjacent to Cascade Lake.

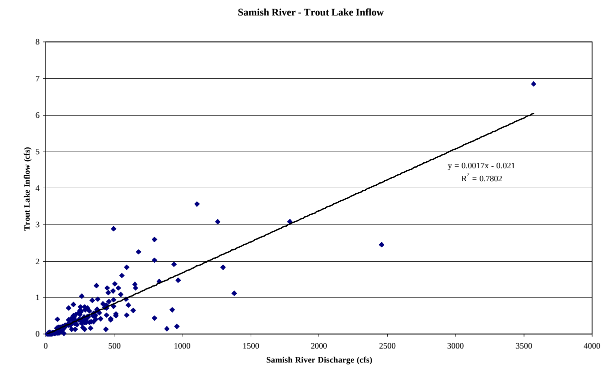
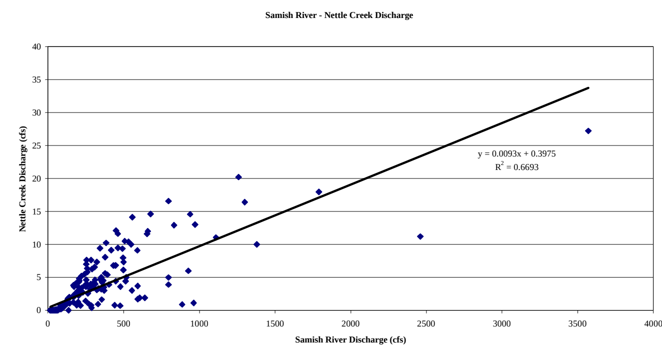
4. Water rights for Cascade Creek should be applied for, and the process of determining an instream flow for the protection of instream resources started. The Departments of Ecology and Fish and Wildlife will need to be involved in the process. With that process completed, additional water withdrawals from Cascade Creek can be evaluated. That process will take years so it should be started soon.

5. Additional hydrologic data should be collected including water levels in Cascade Lake, spills from Cascade Lake, water levels in Mountain Lake. All of that data will help in preparing a water balance necessary to determine the reliability of water supply from Cascade Lake and the long-term effects of using water from Rosario Resort/Cascade Lake.

10.0 REFERENCES

to be provided

Appendix A
Correlation Data, Equations

<table>
<tr><th>Site</th><th>Equation used for Correlation</th><th>R^2</th><th>Graph</th></tr>
<tr><td>Trout Lake</td><td>Trout Lake Q=0.0017Samish Q –0.021</td><td>0.78</td><td>
</td></tr>
<tr><td>Nettle Creek</td><td>Nettle Ck Q=0.0093Samish Q + 0.3975</td><td>.67</td><td>
</td></tr>
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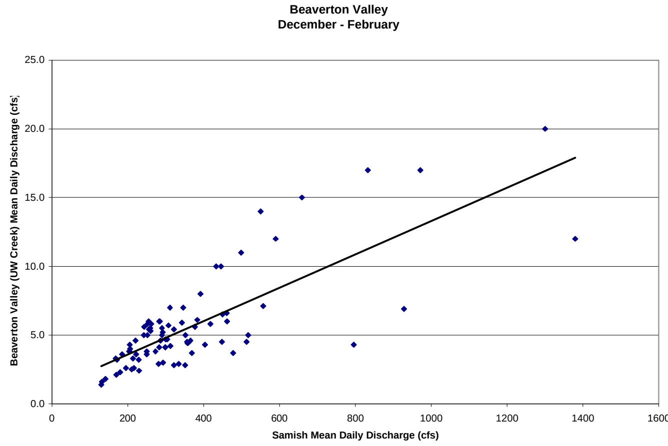
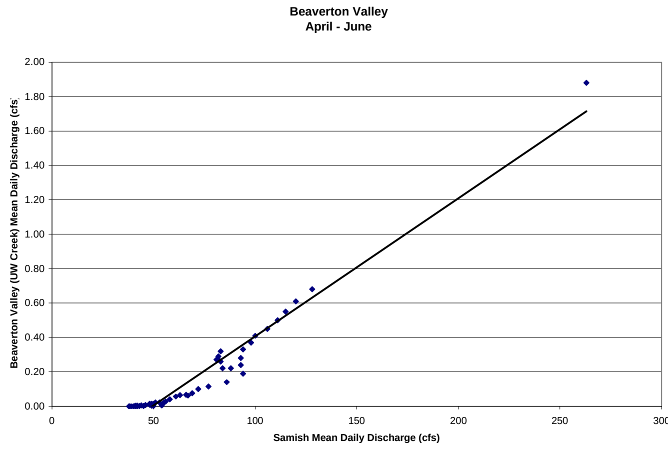
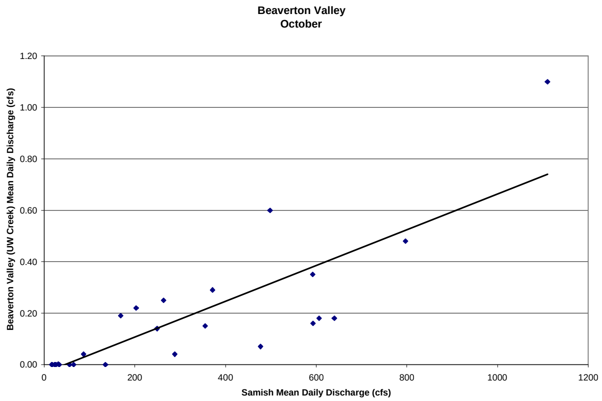
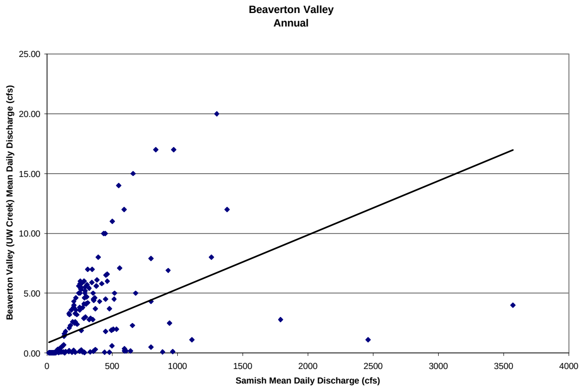
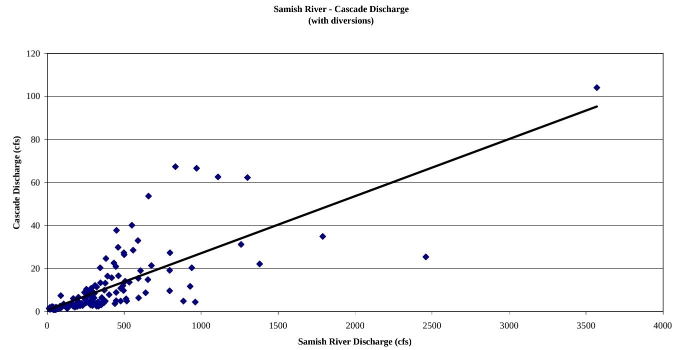
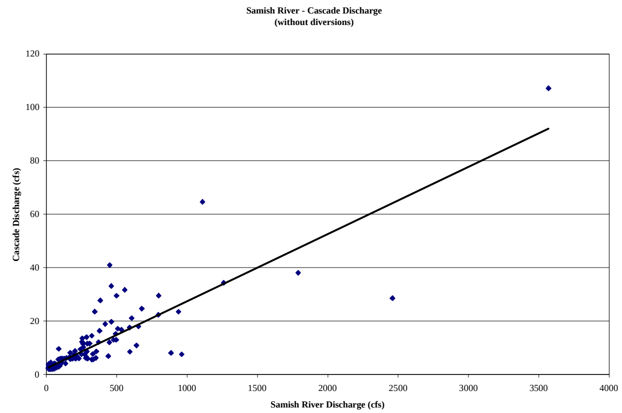
Site	Equation used for Correlation	R^2	Graph
Beaverton – Dec - Feb	Beaverton Q=0.0121Samish Q+1.1548	0.60	
Beaverton – April-June	Beaverton Q=0.008Samish Q-0.3955	0.95	

Site	Equation used for Correlation	R^2	Graph
Beaverton – October	Beaverton Q=0.0007Samish Q-0.0321	0.71	
Beaverton – Annual (March, July-September)	Beaverton Q=0.0045Samish Q+0.7972	0.25	

Site	Equation used for Correlation	R^2	Graph
Cascade Creek with diversions added in	Cascade Lake Q=0.0265Samish Q +0.7123	0.64	
Cascade Creek without water diverted	Cascade Lake Q=0.0252Samish Q +2.2392	0.76	

Appendix B
Cost Estimates

Montgomery Water Group
San Juan County WRIA 2
Surface Water Storage Evaluation 27-Apr-04

Land Bank Parcel Alternative

Item	Units	Quantity	Unit Cost	Cost
Site				
Clearing and grubbing	AC	28.0	$3,000.00	$84,000
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and wastage of duff	CY	11,300	$5.00	$56,500
Erosion and sediment control	LS	1	$30,000.00	$30,000
Revegetation outer embankment	SY	21,250	$2.00	$42,500
Fencing	LF	4,370	$10.00	$43,700
Reservoir Earthwork				
Foundation excavation and wastage	CY	18,000	$5.00	$90,000
Foundation grouting allowance	LS	1	$40,000.00	$40,000
Toe and finger drains	LS	1	$16,000.00	$16,000
Reservoir excavation (cut)	CY	150,000	$3.00	$450,000
Reservoir embankment (fill)	CY	150,000	$5.00	$750,000
Dam crest surfacing	CY	1,375	$20.00	$27,500
Cascade Lake Pump Station				
Power	LS	1	$20,000.00	$20,000
Reinforced concrete	CY	25	$150.00	$3,750
Pump equipment / control equipment	LS	1	$15,000.00	$15,000
Pump house / architectural	LS	1	$15,000.00	$15,000
Nonpotable Water Force Main				
8" DI piping	LF	21,400	$40.00	$856,000
Valves	EA	27	$500.00	$13,375
Blowoff	EA	4	$1,000.00	$4,000
Air & vacuum valve	EA	4	$1,500.00	$6,000
Land Bank Pump Station				
Power	LS	1	$20,000.00	$20,000
Pump house / architectural	CY	25	$150.00	$3,750
Pump equipment / control equipment	LS	1	$15,000.00	$15,000
Pump house / architectural	LS	1	$15,000.00	$15,000
Disharge piping (8")	LF	200	$40.00	$8,000
Connection to main	LS	1	$1,500.00	$1,500
Emergency Spillway/Drain Piping				
Maintenance drain (12")	LF	200	$30.00	$6,000
Maintenance drain valving	LS	1	$2,000.00	$2,000
Emergency spillway	LS	1	$4,000.00	$4,000
Subtotal				**$2,653,575**
Mobilization / Demobilization (10% of subtotal)				$265,358
Contingency (30%)				$875,680
Engineering, design & construction management (15%)				$529,388
Environmental review & permitting	LS	1	$50,000.00	$50,000
Tax (7.7%)				$336,798
Est. Land Acquisition Cost	AC	28	$20,000.00	$560,000
Preliminary Construction Cost Estimate				**$5,270,798**
Additional Costs (if site soils are permeable)				
HDPE Liner and subgrade prep	SY	95,000	$12.00	$1,140,000
Additional Costs (if site soils are permeable and high water table exists)				
Overex/Backfill to provide ballast for liner	CY	50,000	$8.00	$400,000

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Frazier Parcel Alternative

Item	Units	Quantity	Unit Cost	Cost
Site				
Clearing and grubbing	AC	5.2	$6,000.00	$31,200
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and wastage of duff	CY	1,600	$5.00	$8,000
Erosion and sediment control	LS	1	$10,000.00	$10,000
Revegetation outer embankment	SY	5,300	$2.00	$10,600
Fencing	LF	1,350	$10.00	$13,500
Reservoir Earthwork				
Foundation excavation and wastage	CY	3,560	$5.00	$17,800
Foundation grouting allowance	LS	1	$6,000.00	$6,000
Toe and finger drains	LS	1	$2,400.00	$2,400
Reservoir excavation (cut)	CY	80,000	$3.00	$240,000
Reservoir embankment (fill)	CY	40,000	$5.00	$200,000
Excess cut embankment (fill)	CY	40,000	$4.00	$160,000
Dam crest surfacing	CY	320	$20.00	$6,400
Cascade Lake Pump Station				
Power	LS	1	$20,000.00	$20,000
Reinforced concrete	CY	25	$150.00	$3,750
Pump equipment / control equipment	LS	1	$15,000.00	$15,000
Pump house / architectural	LS	1	$15,000.00	$15,000
Nonpotable Water Force Main				
8" DI piping	LF	13,050	$40.00	$522,000
Valves	EA	16	$500.00	$8,156
Blowoff	EA	2	$1,000.00	$2,000
Air & vacuum valve	EA	2	$1,500.00	$3,000
Frazier Pump Station				
Power	LS	1	$20,000.00	$20,000
Reinforced concrete	CY	25	$150.00	$3,750
Pump equipment / control equipment	LS	1	$15,000.00	$15,000
Pump house / architectural	LS	1	$15,000.00	$15,000
Intake piping (8")	LF	120	$40.00	$4,800
Disharge piping (8")	LF	800	$40.00	$32,000
Connection to main	LS	1	$1,500.00	$1,500
Pipingand Emergency Spillway				
Maintenance drain (12")	LF	300	$30.00	$9,000
Maintenance drain valving	LS	1	$2,000.00	$2,000
Emergency spillway	LS	1	$4,000.00	$4,000
Subtotal				**$1,416,856**
Mobilization / Demobilization (10% of subtotal)				$141,686
Contingency (30%)				$467,563
Engineering, design & construction management (15%)				$282,663
Environmental review & permitting	LS	1	$50,000.00	$50,000
Tax (7.7%)				$181,625
Est. Land Acquisition Cost	AC	9	$20,000.00	$180,000
Preliminary Construction Cost Estimate				**$2,720,392**
Additional Costs (if site soils are permeable)				
HDPE Liner and subgrade prep	SY	18,000	$12.00	$216,000

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Youngren Parcel Alternative

Item	Units	Quantity	Unit Cost	Cost
Site				
Clearing and grubbing	AC	11.6	$6,000.00	$69,600
Temporary & permanent access	LS	1	$15,000.00	$15,000
Stripping and wastage of duff	CY	4,700	$5.00	$23,500
Erosion and sediment control	LS	1	$15,000.00	$15,000
Revegetation outer embankment	SY	17,300	$2.00	$34,600
Fencing	LF	1,350	$10.00	$13,500
Reservoir Earthwork				
Foundation excavation and wastage	CY	9,471	$5.00	$47,355
Foundation grouting allowance	LS	1	$15,000.00	$15,000
Toe and finger drains	LS	1	$6,000.00	$6,000
Reservoir excavation (cut)	CY	70,000	$3.00	$210,000
Reservoir excavation (cut--rock)	CY	50,000	$12.00	$600,000
Reservoir embankment (fill)	CY	120,000	$5.00	$600,000
Dam crest surfacing	CY	780	$20.00	$15,600
Cascade Lake Pump Station				
Power	LS	1	$20,000.00	$20,000
Reinforced concrete	CY	25	$150.00	$3,750
Pump equipment / control equipment	LS	1	$15,000.00	$15,000
Pump house / architectural	LS	1	$15,000.00	$15,000
Nonpotable Water Force Main				
8" DI piping	LF	9,040	$40.00	$361,600
Valves	EA	11	$500.00	$5,650
Blowoff	EA	2	$1,000.00	$2,000
Air & vacuum valve	EA	2	$1,500.00	$3,000
Youngren Pump Station				
Power	LS	1	$20,000.00	$20,000
Reinforced concrete	CY	25	$150.00	$3,750
Pump equipment / control equipment	LS	1	$15,000.00	$15,000
Pump house / architectural	LS	1	$15,000.00	$15,000
Intake piping (8")	LF	340	$40.00	$13,600
Disharge piping (8")	LF	120	$40.00	$4,800
8" DI piping	LF	1,500	$40.00	$60,000
Connection to main	LS	1	$1,500.00	$1,500
Pipingand Emergency Spillway				
Maintenance drain (12")	LF	270	$30.00	$8,100
Maintenance drain valving	LS	1	$2,000.00	$2,000
Emergency spillway	LS	1	$4,000.00	$4,000
Subtotal				**$2,238,905**
Mobilization / Demobilization (10% of subtotal)				$223,891
Contingency (30%)				$738,839
Engineering, design & construction management (15%)				$446,662
Environmental review & permitting	LS	1	$50,000.00	$50,000
Tax (7.7%)				$284,769
Est. Land Acquisition Cost	AC	15	$20,000.00	$300,000
Preliminary Construction Cost Estimate				**$4,283,064**

Additional Costs (if site soils are permeable)				
HDPE Liner and subgrade prep	SY	28,000	$12.00	$336,000

Cascade Gardens Parcel Alternative

Item	Units	Quantity	Unit Cost	Cost
Site				
Clearing and grubbing	AC	22.0	$6,000.00	$132,000
Temporary & permanent access	LS	1	$45,000.00	$45,000
Stripping and wastage of duff	CY	8,880	$5.00	$44,400
Erosion and sediment control	LS	1	$25,000.00	$25,000
Revegetation outer embankment	SY	17,600	$2.00	$35,200
Wetland recreation	AC	0.7	$75,000.00	$52,500
Fencing	LF	3,940	$10.00	$39,400
Reservoir Earthwork				
Foundation excavation and wastage	CY	16,000	$5.00	$80,000
Foundation grouting allowance	LS	1	$35,000.00	$35,000
Toe and finger drains	LS	1	$14,000.00	$14,000
Reservoir excavation (cut)	CY	150,000	$3.00	$450,000
Reservoir embankment (fill)	CY	135,000	$5.00	$675,000
Excess cut embankment (fill)	CY	15,000	$3.00	$45,000
Dam crest surfacing	CY	1,950	$20.00	$39,000
Cascade Lake Pump Station				
Power	LS	1	$20,000.00	$20,000
Reinforced concrete	CY	25	$150.00	$3,750
Pump equipment / control equipment	LS	1	$15,000.00	$15,000
Pump house / architectural	LS	1	$15,000.00	$15,000
Potable Water Force Main				
8" DI piping	LF	10,780	$40.00	$431,200
Valves	EA	13	$500.00	$6,738
Blowoff	EA	2	$1,000.00	$2,000
Air & vacuum valve	EA	2	$1,500.00	$3,000
Connection to main	LS	1	$1,500.00	$1,500
Cascade Gardens Pump Station				
Power	LS	1	$20,000.00	$20,000
Submersible pump manhole	LS	1	$7,500.00	$7,500
Pump equipment / control equipment	LS	1	$7,500.00	$7,500
Disharge piping (8")	LF	180	$40.00	$7,200
Connection to diversion	LS	1	$1,500.00	$1,500
Pipingand Emergency Spillway				
Connection to diversion	LS	1	$2,500.00	$2,500
Intake piping	LF	190	$30.00	$5,700
Maintenance drain (12")	LF	190	$30.00	$5,700
Maintenance drain valving	LS	1	$2,000.00	$2,000
Emergengency spillway	LS	1	$4,000.00	$4,000
Subtotal				**$2,273,288**
Mobilization / Demobilization (10% of subtotal)				$227,329
Contingency (30%)				$750,185
Engineering, design & construction management (15%)				$453,521
Environmental review & permitting	LS	1	$50,000.00	$50,000
Tax (7.7%)				$289,083
Est. Land Acquisition Cost	LS	1	$1,200,000.00	$1,200,000
Preliminary Construction Cost Estimate				**$5,243,405**
Additional Costs (if site soils are permeable)				
HDPE Liner and subgrade prep	SY	78,000	$12.00	$936,000

San Juan County

Multi-Purpose Surface Water Storage Evaluation

		Storage Alternative			
	Unit	**Land Bank**	**Frazier**	**Youngren**	**Cascade Gardens**
Storage volume	acre-ft.	**328**	**81**	**114**	**314**
Water surface area	acre	18.8	3.5	5.4	15.4
Water surface elev.	ft.	60	177	157	380
Dam crest elevation	ft.	63	180	160	383
Dam height (max)	ft.	23	45	40	33
Dam crest length	ft.	3690	570	1400	3330
Land acquisition required	acre	34	9	15	84
Total Estimated Cost	**$**	**$5,270,798**	**$2,720,392**	**$4,283,064**	**$5,243,405**
Unit Cost/Storage Vol.	**$/ac-ft.**	**$16,070**	**$33,585**	**$37,571**	**$16,699**

D Cisakowski
27-Apr-04

Appendix C
Water Rights Table

Table C-1. Existing Water Rights by Section Number

Water Rights Identification Number	Priority Date	Diversion Rate (cfs)	CALC. CFS	Diversion Volume (af)	CALC. AF	Township/Range/Section	Source	Receiving Water
1960730990117248	May 2, 1974	0.050	0.001	1.0	36.2	T36N/R01W-02	Unnamed Stream	Doe Bay
Summary		**0.050**	**0.001**	**1.0**	**36.2**			
1199511321809630	March 2, 1979		0.000		0.0	T36N/R01W-03	Mountain Lake	
1960730990124829	March 16, 1981	0.010	0.001	0.5	7.2	T36N/R01W-03	Unnamed Stream	
1960730990125905	June 3, 1983	0.040	0.007	4.9	29.0	T36N/R01W-03	Unnamed Stream	
1971130990015260	June 18, 1946	0.050	0.000		36.2	T36N/R01W-03	Unnamed Stream	
Summary		**0.100**	**0.007**	**5.4**	**72.4**			
1960730990107820	March 4, 1971	0.040	0.004	3.0	29.0	T36N/R01W-04	Unnamed Swamp	
1960730990107820	March 4, 1971	0.040	0.004	3.0	29.0	T36N/R01W-04	Unnamed Stream	
Summary		**0.080**	**0.008**	**6.0**	**57.9**			
1960730990105311		3.000	0.000		2171.9	T36N/R01W-05	Cascade Creek	Buck Bay
Summary		**3.000**	**0.000**	**0.0**	**2171.9**			
1960730990126051	November 7, 1983	0.010	0.001	1.0	7.2	T36N/R01W-07	Unnamed Stream	
Summary		**0.010**	**0.001**	**1.0**	**7.2**			
1960730990053397	May 2, 1963		0.011	8.0	0.0	T36N/R01W-09	Unnamed Spring	Rosario Strait
1960730990053397	May 2, 1963		0.011	8.0	0.0	T36N/R01W-09	Unnamed Stream	Rosario Strait
1960730990071850	February 11, 1947	0.050	0.000		36.2	T36N/R01W-09	Unnamed Stream	
1960730990072506	May 3, 1947	0.050	0.000		36.2	T36N/R01W-09	Unnamed Stream	
1960730990099912	July 12, 1965	0.110	0.029	21.0	79.6	T36N/R01W-09	Unnamed Stream	Rosario Strait
1960730990099912	July 12, 1965	0.110	0.029	21.0	79.6	T36N/R01W-09	Unnamed Spring	Rosario Strait
1960730990099912	July 12, 1965	0.110	0.029	21.0	79.6	T36N/R01W-09	Unnamed Pond	Rosario Strait
1960730990105807	December 21, 1970	0.020	0.004	3.0	14.5	T36N/R01W-09	Unnamed Spring	
1960730990107820	March 4, 1971	0.040	0.004	3.0	29.0	T36N/R01W-09	Unnamed Spring	
1960730990107820	March 4, 1971	0.040	0.004	3.0	29.0	T36N/R01W-09	Unnamed Pond	
1960730990119551	July 3, 1974	0.020	0.006	4.0	14.5	T36N/R01W-09	Unnamed Spring	
1971129990012559	August 10, 1932	2.000	0.000		1447.9	T36N/R01W-09	Cascade Creek	Buck Bay
1971130990012557	August 18, 1938	0.050	0.000		36.2	T36N/R01W-09	Cascade Creek	Buck Bay
1971130990012696	March 18, 1939	0.180	0.000		130.3	T36N/R01W-09	Cascade Creek	Buck Bay
Summary		**2.780**	**0.127**	**92.0**	**2012.6**			

Water Rights Identification Number	Priority Date	Diversion Rate (cfs)	CALC. CFS	Diversion Volume (af)	CALC. AF	Township/Range/Section	Source	Receiving Water
1960730990125761	March 3, 1983	0.010	0.001	1.0	7.2	T36N/R01W-15	Unnamed Pond	
1971129990008934	April 27, 1972		0.014	10.0	0.0	T36N/R01W-15	Unnamed Tributary	
Summary		**0.010**	**0.015**	**11.0**	**7.2**			
1960730990110224	June 29, 1972	0.010	0.001	0.5	7.2	T37N/R01W-07	Unnamed Spring	
1971130990025433	September 22, 1965	0.010	0.010	7.2	7.2	T37N/R01W-07	Unnamed Spring	
1971130990025445	September 22, 1965	0.150	0.150	108.7	108.6	T37N/R01W-07	Unnamed Spring	
1971130990029672	July 21, 1980	0.140	0.018	13.0	101.4	T37N/R01W-07	Unnamed Pond	
Summary		**0.310**	**0.179**	**129.4**	**224.4**			
1960730990109107	May 20, 1971	0.120	0.033	24.0	86.9	T37N/R01W-16	Unnamed Spring	
Summary		**0.120**	**0.033**	**24.0**	**86.9**			
1199511322717411	April 17, 1991	0.010	0.001	0.5	7.2	T37N/R01W-17	Unnamed Spring	Strait of Georgia
1960730990128059	August 23, 1989	0.010	0.001	0.5	7.2	T37N/R01W-17	Unnamed Spring	Strait of Georgia
1960730990128089	August 22, 1989	0.010	0.001	0.5	7.2	T37N/R01W-17	Unnamed Stream	Strait of Georgia
1960730990128301	May 7, 1990	0.001	0.000	0.3	0.7	T37N/R01W-17	Unnamed Spring	
Summary		**0.031**	**0.003**	**1.8**	**22.4**			
1960730990054673	November 4, 1982		0.154	111.5	0.0	T37N/R01W-18	Unnamed Source	
1960730990125824	April 4, 1983	0.002	0.001	0.5	1.4	T37N/R01W-18	Unnamed Stream	
1960730990125844	April 8, 1983	0.002	0.001	0.5	1.4	T37N/R01W-18	Unnamed Spring	
1960730990128193	March 2, 1990	0.001	0.001	0.5	0.7	T37N/R01W-18	Unnamed Spring	
1971130990025445	September 22, 1965	0.150	0.150	108.7	108.6	T37N/R01W-18	Unnamed Spring	
1971130990025445	September 22, 1965	0.150	0.150	108.7	108.6	T37N/R01W-18	Unnamed Spring	
Summary		**0.305**	**0.456**	**330.3**	**220.8**			
1199511323216947	March 10, 1993	0.950	0.000		687.8	T37N/R01W-19	Unnamed Spring	Puget Sound
1960730990054673	November 4, 1982		0.154	111.5	0.0	T37N/R01W-19	Unnamed Source	
1960730990069846	April 10, 1946	0.010	0.000		7.2	T37N/R01W-19	Unnamed Stream	Puget Sound
1960730990069846	April 10, 1946	0.010	0.000		7.2	T37N/R01W-19	Unnamed Spring	Puget Sound
1971129990014871	February 18, 1946	0.010	0.000		7.2	T37N/R01W-19	Unnamed Spring	Puget Sound
1971129990018222	August 23, 1965	0.500	0.000		362.0	T37N/R01W-19	Unnamed Spring	
1971129990018222	August 23, 1965	0.500	0.000		362.0	T37N/R01W-19	Unnamed Spring	
Summary		**1.980**	**0.154**	**111.5**	**1433.5**			
1971130990013909	January 19, 1944	0.010	0.000		7.2	T37N/R01W-20	Unnamed Spring	Puget Sound
Summary		**0.010**	**0.000**	**0.0**	**7.2**			
1960730990126776	December 12, 1985	0.010	0.000	0.1	7.2	T37N/R01W-21	Twin Lake	
Summary		**0.010**	**0.000**	**0.1**	**7.2**			

Water Rights Identification Number	Priority Date	Diversion Rate (cfs)	CALC. CFS	Diversion Volume (af)	CALC. AF	Township/Range/Section	Source	Receiving Water
1971129990008239	November 4, 1946		0.442	320.0	0.0	T37N/R01W-25	Unnamed Stream	Puget Sound
1971129990015122	November 4, 1946	1.000	0.000		724.0	T37N/R01W-25	Unnamed Stream	Puget Sound
Summary		**1.000**	**0.442**	**320.0**	**724.0**			
1960730990054274	September 3, 1971		0.243	176.2	0.0	T37N/R01W-26	Unnamed Stream	Rosario Strait
1960730990109070	September 10, 1971	0.070	0.029	21.0	50.7	T37N/R01W-26	Unnamed Spring	
1971130990008768	July 7, 1967		0.097	70.0	0.0	T37N/R01W-26	Unnamed Stream	Rosario Strait
Summary		**0.070**	**0.369**	**267.2**	**50.7**			
1960730990102800	April 17, 1968	0.156	0.011	8.0	112.9	T37N/R01W-29	Moran Creek	Cascade Lake
1960730990129238	April 17, 1968	0.156	0.011	8.0	112.9	T37N/R01W-29	Unnamed Stream	Cascade Lake
Summary		**0.312**	**0.022**	**16.0**	**225.9**			
1960730990100482	February 24, 1966	0.010	0.005	3.5	7.2	T37N/R01W-30	Unnamed Spring	
1960730990116139	March 18, 1974	0.020	0.007	5.0	14.5	T37N/R01W-30	Unnamed Spring	
1971129990018222	August 23, 1965	0.500	0.000		362.0	T37N/R01W-30	Unnamed Spring	
1971129990019748	May 25, 1972	0.078	0.000		56.3	T37N/R01W-30	Unnamed Pond	
Summary		**0.608**	**0.012**	**8.5**	**440.0**			
100033011120347	December 29, 1999	0.980	0.236	171.0	709.5	T37N/R01W-31	Cascade Lake	
1960730990054841	January 1, 1910		2.595	1879.0	0.0	T37N/R01W-31	Cascade Lake	
1960730990090402	October 18, 1957	0.200	0.000		144.8	T37N/R01W-31	Unnamed Lake	
1960730990090402	October 18, 1957	0.200	0.000		144.8	T37N/R01W-31	Unnamed Stream	
1960730990129225	January 1, 1910	2.543	0.108	78.0	1841.0	T37N/R01W-31	Cascade Lake	Cascade Creek
1970722L17474991			0.000		0.0	T37N/R01W-31	Cascade Lake	
1970722L17553793			0.000		0.0	T37N/R01W-31	Cascade Creek	
197100700081934	March 22, 1995	0.980	0.236	171.0	709.5	T37N/R01W-31	Cascade Lake	
Summary		**4.903**	**3.176**	**2299.0**	**3549.6**			
1960730990102800	April 17, 1968	0.156	0.011	8.0	112.9	T37N/R01W-32	Unnamed Spring	Cascade Lake
1960730990102800	April 17, 1968	0.156	0.011	8.0	112.9	T37N/R01W-32	Coldspring Creek	Cascade Lake
1960730990129238	April 17, 1968	0.156	0.011	8.0	112.9	T37N/R01W-32	Unnamed Stream	Cascade Lake
1960730990129238	April 17, 1968	0.156	0.011	8.0	112.9	T37N/R01W-32	Unnamed Spring	Cascade Lake
Summary		**0.624**	**0.044**	**32.0**	**451.8**			
1199511321803665	July 31, 1978	0.800	0.000		579.2	T37N/R01W-33	Mountain Lake	Cascade Creek
1199511322831661	August 14, 1991	0.260	0.000		188.2	T37N/R01W-33	Cascade Creek	
1960730990105326	January 1, 1908	0.560	0.130	94.0	405.4	T37N/R01W-33	Cascade Creek	Buck Bay
1960730990105336	January 1, 1920	0.020	0.012	8.4	14.5	T37N/R01W-33	Unnamed Stream	Mountain Lake
1971129990018672	April 18, 1968	0.070	0.000		50.7	T37N/R01W-33	Unnamed Stream	Mountain Lake
1971129990018917	April 18, 1969	0.300	0.000		217.2	T37N/R01W-33	Cascade Creek	Buck Bay
Summary		**2.010**	**0.141**	**102.4**	**1455.2**			

Water Rights Identification Number	Priority Date	Diversion Rate (cfs)	CALC. CFS	Diversion Volume (af)	CALC. AF	Township/Range/Section	Source	Receiving Water
1960730990068940	November 3, 1945	0.050	0.000		36.2	T37N/R01W-34	Mountain Lake	Cascade Creek
1960730990071068	August 22, 1946	0.450	0.000		325.8	T37N/R01W-34	Mountain Lake	Cascade Creek
1960730990105346	November 3, 1945	0.050	0.017	12.0	36.2	T37N/R01W-34	Mountain Lake	Cascade Creek
1960730990105356	August 22, 1946	0.350	0.113	82.0	253.4	T37N/R01W-34	Mountain Lake	Cascade Creek
1960730990123278	November 2, 1977	0.500	0.120	87.0	362.0	T37N/R01W-34	Mountain Lake	Cascade Creek
1971129990018117	January 11, 1965	1.500	0.000		1086.0	T37N/R01W-34	Mountain Lake	Cascade Creek
Summary		**2.900**	**0.250**	**181.0**	**2099.5**			
100102600091937	October 25, 2000	0.057	0.000		41.3	T37N/R01W-35	Unnamed Pond	Rosario Strait
1960730990112127	April 30, 1973	0.030	0.007	5.0	21.7	T37N/R01W-35	Unnamed Stream	Rosario Strait
1960730990121899	August 20, 1975	0.060	0.008	6.0	43.4	T37N/R01W-35	Unnamed Pond	
1960730990127956	June 2, 1989	0.011	0.000	0.2	8.0	T37N/R01W-35	Unnamed Stream	Doe Bay
1971130990008488	December 13, 1954		0.017	12.5	0.0	T37N/R01W-35	Unnamed Stream	Puget Sound
1971130990021315	November 20, 1957	0.060	0.014	10.0	43.4	T37N/R01W-35	Unnamed Stream	Puget Sound
1971130990026828	August 20, 1969	0.010	0.000		7.2	T37N/R01W-35	Unnamed Stream	Doe Bay
Summary		**0.087**	**0.007**	**5.0**	**63.0**			
1199511321905914	July 1, 1982	0.045	0.004	3.2	32.6	T37N/R02W-12	Unnamed Pond	
Summary		**0.045**	**0.004**	**3.2**	**32.6**			
1960730990106518	February 9, 1971	0.010	0.006	4.0	7.2	T37N/R02W-13	Unnamed Spring	
Summary		**0.010**	**0.006**	**4.0**	**7.2**			
1960730990112036	April 18, 1973	0.020	0.000		14.5	T37N/R02W-14	Unnamed Stream	
1970722L16802396			0.000		0.0	T37N/R02W-14	Unnamed Spring	
Summary		**0.020**	**0.000**	**0.0**	**14.5**			
1971129990018222	August 23, 1965	0.500	0.000		362.0	T37N/R02W-24	Unnamed Spring	
Summary		**0.500**	**0.000**	**0.0**	**362.0**			
1960730990101343	November 2, 1966	0.060	0.000		43.4	T37N/R02W-25	Unnamed Spring	East Sound
Summary		**0.060**	**0.000**	**0.0**	**43.4**			
Grand Total		**22.086**	**5.498**	**3980.6**	**15989.4**			