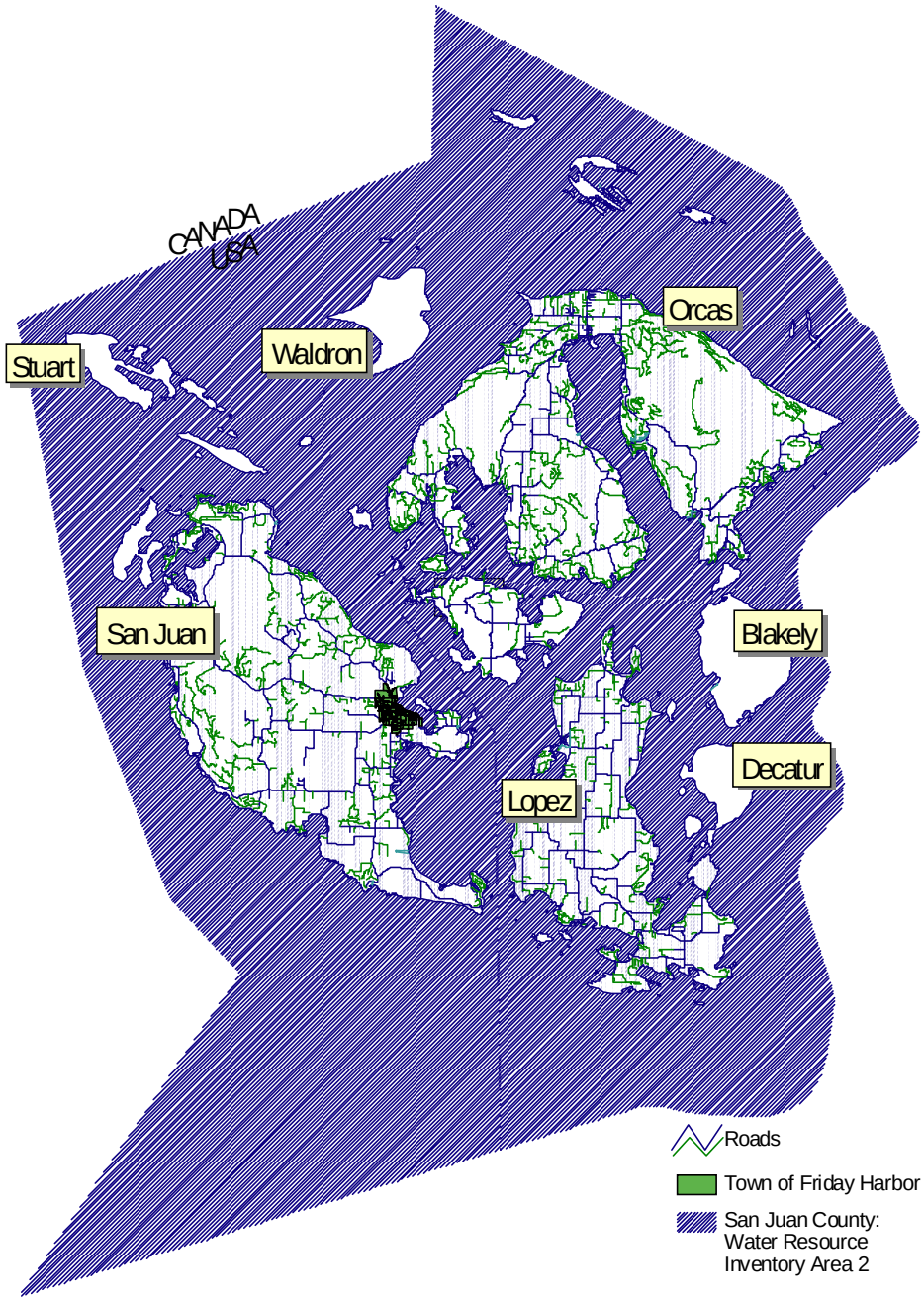
San Juan County Water Resource Management Plan

WRIA 2

The Coral Sea, state-approved water hauling vessel, delivering water from Anacortes to shoreline communities in San Juan County.

Final
as
Revised & Adopted by San Juan County
Board of County Commissioners
October, 2004


CANADA
USA
Stuart
Waldron
Orcas
San Juan
Blakely
Decatur
Lopez
Roads
Town of Friday Harbor
San Juan County:
Water Resource
Inventory Area 2

San Juan County Water Resource Management Committee, 2000 - 2004

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WRIA 2

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Reports, plans, and studies relating to water supplies in San Juan County (WRIA 2)

San Juan County Comprehensive Water and Sewer Plan, 1970. San Juan County Board of Commissioners

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Water Quality Data Compilation and TMDL Ranking for the San Juan Islands, 1999. Ecology Report #99-339.

San Juan County Watershed Action Plan and Characterization Report, 2000. San Juan County Watershed Management Committee

San Juan County Monitoring Project, Final Report, 2000. Institute for Watershed Studies, Huxley College, Western Washington University

Estimates of Ground-Water Recharge from Precipitation to Glacial-Deposit and Bedrock Aquifers on Lopez, San Juan, Orcas, and Shaw Islands, San Juan County, Washington, 2002. USGS Water Resource Investigation Report 02-4114

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Lopez Village Water Supply Report and Recommendations and Abbreviated Coordinated Water System Plan, July 2003. Lopez Village Water System Planning Committee

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San Juan County WRIA 2 Gauging and Instream Flow Study Report and Recommendations, 2003. Framatome ANP (Devine, Tarbell and Assoc.)

Handbook of Salmon Recovery in San Juan County, draft 2004. San Juan County Lead Entity

Multi-purpose Surface Water Storage Assessment, WRIA 2, April 2004. Montgomery Water Group

2003-4 Preliminary Stream Gauging Mean Daily Discharge, April 2004. Devine, Tarbell and Assoc.

San Juan County Water Resource Management Plan: Executive Summary

The San Juan County Water Resource Management Committee, the planning unit for WRIA 2, has completed four years of work to develop the San Juan County Water Resource Management Plan. This plan follows in the footsteps of the San Juan County Watershed Management Action Plan, which was developed by the committee and approved in 2000. These two plans are basically volume 1 and 2 of a management strategy for water resources in the county.

Since 2000, The Watershed Management Action Plan has been very successful in its implementation, which has involved cooperation with several organizations, including the San Juan County Lead Entity for Salmon Recovery and the county's Marine Resources Committee. These groups have initiated several programs and extensive studies of marine nearshore conditions.

San Juan County's water resources are provided by local rainfall only and are characterized by the rainshadow created by the Olympic mountains to the south and Vancouver Island to the west, by predominantly steep terrain and bedrock geology, by small watershed catchment areas, and by extensive shoreline. These conditions result in low rainfall, limited groundwater storage, and extensive runoff and discharge to the sea. With a few exceptions, streams are intermittant or ephemeral. San Juan County's freshwater habitat is generally not conducive to spawning of salmonids, but the freshwater-seawater interface supports an abundant environment for young and migrating salmon.

This plan addresses aquifer and surface water quantity, water quality, water rights, capacity to serve projected growth estimates and sets up a program for long-term resource management. The Committee established the following goals at the beginning of the planning process:

- Retain enough water in streams and wetlands to protect water quality and support diverse, healthy, and abundant plant and wildlife communities.
- Integrate water supply planning with growth management planning and determine the availability of water supplies in approved growth areas.
- Establish a county resource management program that addresses all water use, including exempt wells and alternative sources, and includes decision-making based on long-term development and analysis of resource information.

Key issues for San Juan County include:

- very low recharge to aquifers,
- seawater intrusion,
- water right allocations by the state that exceed water available,
- areas where current use of water exceeds aquifer capacity,
- all new water development is occurring with exempt wells,
- many individual and community wells fail during summer months,

- lack of capacity to serve areas designated by the county's GMA process for growth,
- a gap in responsibility and authority between state and county agencies,
- lack of comprehensive monitoring and assessment of water resource capacity, and
- lack of coordinated, cooperative resource management.

Watershed planning in San Juan County has not been comparable to other efforts in the state which focus on stream flow conditions. In order to develop an appropriate framework for the planning process, the WRMC decided to address immediate concerns about the capacity of water systems to serve the designated urban growth areas on Lopez and Orcas islands. This decision also responded to the conclusions in the Level 1 Basin Assessment for San Juan County, which indicated a need for additional assessment in several areas. The WRMC established sub-committees for Lopez Village and East Orcas and authorized additional studies; a groundwater model for Lopez Village and stream gauging and storage assessment for east Orcas. The sub-committees include water purveyors, professionals, and citizens who depend on the water in their area and meetings have been enthusiastically attended. The result is local plans for cooperative resource management that also provide the county and Ecology with guidance for decision-making. These local plans will form the basis for future water allocations and habitat protection in the county.

Recommendations in the Plan include a program to develop local management of the water resource, including:

- ongoing monitoring and assessment,
- developing a memorandum of understanding with Ecology to share in the responsibility for reviewing and approving new water supply development and changes to existing water rights,
- developing a detailed management program as part of the implementation phase,
- hiring a hydrogeologist,
- establishing a county Water Resource Review Board,
- continuing to work with local committees to develop sub-area plans for management,
- recommending the establishment of risk areas for seawater intrusion, and
- evaluating the allocation of water for exempt wells in areas with limited aquifers.

Future management of water resources in San Juan County will require careful, on-going assessment of the availability of fresh water. Stream gauging and well monitoring are essential. Working in partnership with state agencies and local water users, the county has an opportunity to effectively manage its water resources.

CHAPTER 1, BACKGROUND AND INTRODUCTION

WRIA 2 Setting

Water Resource Inventory Area 2 (WRIA 2) corresponds with the boundaries of San Juan County, which is comprised of bedrock islands in the northwest corner of Washington State. There is one incorporated town on San Juan Island -- Friday Harbor -- and many smaller villages. Two villages are designated urban growth areas under the county's comprehensive plan: Eastsound on Orcas Island and Lopez Village on Lopez. Other growth areas are designated as activity centers (Orcas Village, Doe Bay, Olga, Deer Harbor, Westsound, and North Rosario, all on Orcas) and Master Planned Resorts (Rosario on Orcas and Roche Harbor on San Juan).

San Juan County's water resources are provided by local rainfall only and are characterized by the rainshadow created by the Olympic Mountains to the south and Vancouver Island to the west, by predominantly steep terrain and bedrock geology, by small watershed catchment areas, and by extensive shoreline. These conditions result in low rainfall, limited groundwater storage, and extensive runoff and discharge to the sea. With a few exceptions, streams are intermittent or ephemeral. San Juan County's freshwater habitat is generally not conducive to spawning of salmonids, but the nearshore waters and island shorelines provide critical habitats for juvenile and adult salmon and the small forage fishes they eat.

Growth in San Juan County over the last 10 years has exceeded 3.4% per year. The county's population in 2000 was 14,077. Ferry ridership in 2000-01 averaged 1,832,500 passengers. In March of 2003, county planning staff estimated that growth will continue at an annual rate of 2.2% with most of the growth occurring as single family residences. Water resource issues have traditionally been very controversial and have been used to advocate no additional growth. Addressing the growing demand for water as the population increases while assuring existing residents safe, reliable supplies is one the greatest challenge facing water resource planners in the county. Not only are water supplies limited but costs to develop new sources must be controlled to insure affordable prices for this basic necessity.

Water resource planning

This plan is the result of four years of planning work by the San Juan County Water Resource Management Committee under a grant from the Washington State Department of Ecology through the Watershed Management Act (HB 2514, RCW 80.96). Developing the plan has involved hundreds of hours of volunteer time, including committee work, monitoring, and professional services. This planning effort was funded by the state in order to give local jurisdictions an opportunity to develop local solutions for the allocation and protection of water resources in the face of increasing legal and political restraints imposed on the Department of Ecology.

For San Juan County, this watershed plan is a continuation of efforts begun in 1997, when the Watershed Management Committee was formed to develop a water quality plan for surface water. The San Juan County Watershed Action Plan was adopted in 2000, and the Watershed Management Committee officially changed its name, changed a few members, and began full-time work on water quantity issues.

San Juan County has been involved in cycles of water resource study and planning since the early 1970s. The WRMC began the current planning process with the determination to build on past efforts and produce results. While a county-wide water resource assessment[1] and recharge analysis were being completed, the committee decided to initiate two early implementation projects in order to address known problems: legal status for the use of rainwater catchment and a more detailed assessment and coordination plan for Lopez Village. As a result, this plan is based on experience with a successful approach to local decision-making, and experience developing a working partnership with the Department of Ecology. The resulting recommendations form the foundation for a locally-driven, science-based decision-making process.

Goals of the San Juan County Water Resources Management Committee:

The goal of the San Juan County Water Resources Management Committee is to establish an effective and efficient decision-making process for sustainable water resource management based on a collaborative relationship with the Department of Ecology. To this end, the planning process has focussed on the following objectives:

[1] See page v, Reports, plans and studies

- Retain enough water in streams and wetlands to protect water quality and support diverse, healthy, and abundant plant and wildlife communities.
- Integrate water supply planning with growth management planning and determine the availability of water supplies in approved growth areas.
- Establish a county resource management program that addresses all water use, including exempt wells and alternative sources, and that includes decision-making based on long-term development and analysis of resource information.

Water resource conditions

Water resources in San Juan County vary dramatically from the high rainfall conditions of eastern Orcas (up to 45" of rainfall a year at Mt. Constitution) to the near-drought conditions of south Lopez (19" annual average).

Water resource planning in San Juan County is challenging due to geographic and geologic conditions. A county of islands, mostly bedrock, with 408 miles of shoreline, receiving fresh water from local rainfall only, creates many site-specific conditions for water supplies. Most of the concentrated population areas are served by surface water systems. The rural interior and highly desirable shoreline areas are served by a combination of private and community wells. Aquifer conditions vary from a few high-producing wells (50 gallons per minute) to wells that go dry or experience seawater intrusion during peak summer use.

An estimate of recharge was developed in 2001 by USGS as part of the assessment for this watershed planning process. Recharge estimates for San Juan, Orcas, Shaw and Lopez islands

	Recharge in inches	Percent of total rainfall
San Juan	1.99	6%
Orcas	1.46	5%
Shaw	1.44	5%
Lopez	2.49	9%
Whidbey	7.36	28%
Camano	7.24	25%
Sequim/Dungeness	8.00	28%

Table 1.1, Recharge comparison

were developed after two years of collecting rainfall and stream data. By analyzing soil conditions, vegetation cover, solar, and wind effects on a daily basis compared to rainfall and runoff patterns, USGS modeled recharge values for the four main islands. Recharge estimates in Table 1.1 include a comparison with two other areas where USGS conducted similar studies. The Dungeness/Sequim basin and Whidbey and Camano islands in Island County are also in the rainshadow of the Olympics. The Sequim basin benefits from additional recharge from the Dungeness River. See Chapter 3, Groundwater characteristics, for additional information.

The storage capacity of island aquifers is not easily quantified. A few areas have glacial deposits (Lopez, Eastsound, south San Juan) but these deposits are measured in 10s of feet, compared to hundreds of feet of glacial material found in nearby Island County. The predominant bedrock is complicated, fractured and faulted. Calculating the storage capacity of these aquifers is further complicated by the fact that groundwater is constantly flowing outward toward the shoreline in an island environment. Unlike the mainland basins that capture runoff from mountain ranges, island aquifer boundaries are sieves. It has been estimated that the aquifer supplying Lopez Village marches seaward at a rate of three feet a day[2].

Storage for the islands surface water is easier to measure and plan for, and the county's main water suppliers rely on surface water to serve areas around the Town of Friday Harbor and Roche Harbor, on San Juan Island, and Eastsound, Rosario, Olga, Doe Bay and Spring Point, on Orcas. In addition, several water systems with failed groundwater sources have resorted to treating seawater. Surface water is not always easily acquired, however. The Town of Friday Harbor has developed two pumping stations to intercept seasonal stream flows in order to augment their supply. Roche Harbor and Eastsound are in the process of increasing their storage capacity, a process that requires substantial expense for engineering and permitting as well as construction. Spring Point, like several systems in the county with low-producing wells, recently evaluated the capacity of its small lake under drought conditions and, after exploring other options, invested in a seawater treatment plant. The Cattle Point Estates, Mineral Point,

[2] Richey, 2003. Report to Lopez Village Water System Planning Committee.

and Mitchell Point water systems on San Juan Island also augment their well system with a desalinization facility.

Water quality and habitat: San Juan County Watershed Action Plan

This plan follows the San Juan County Watershed Action Plan and Characterization Report approved by Ecology in August of 2000. The Action Plan contains all the required elements for water quality and habitat under RCW 90.82 Watershed Planning. The Action Plan describes San Juan County's watersheds in detail, including history, population and growth, land cover, land use, climate, geology and hydrology, soils, wetlands, lakes and streams, terrestrial and marine habitat. It also discusses beneficial uses of water on a watershed basis. This plan included many elements to address existing and potential non-point source contamination. Most of these elements have been implemented and additional water quality monitoring and stream gauging are underway. Ongoing water quality and education programs are conducted by the San Juan County Conservation District and can be viewed at sanjuanconservation.org.

Problem statement, December 2002:

In December of 2002, the WRMC developed the following problem statement in order to identify the issues to be addressed through planning.

Current problems involving illegal use as defined by state law:

- Pond catchment use for irrigation
- Water hauling
- Irrigation from exempt wells
- Rainwater catchment use
- Overwithdrawal causing degradation

Conflict or problems with/between state and county regulations:

- Surface water (rainwater) catchment and use
- SJC liberal rules about pond construction in conflict with state law
- SJC issuance of building permits with questionable water sources
- Water reuse rules are unclear; Multiple use encouraged by not always supported
- Use of alternative wastewater systems as a source of water difficult under state and county regulations and not widely recognized and used

Exempt wells:

- Proliferation of exempt wells to avoid problems with water rights
- No knowledge of exempt well use
- Substantially, all new development based on exempt wells

Community water supplies:

- Water right regulations don't address GMA growth areas
- Municipal inchoate rights in question
- Lack of data collection about water systems (use, capacity, management)
- Lack of coordination between small water systems
- Lack of interest by water systems to expand up to their water right.

Resource management:

- Salt water intrusion is a problem in SJC
- Lack of adequate data to make decisions, esp. how senior rights and other beneficial uses are affected
- Lack of data on resource capacity, i.e., aquifers and surface water
- How much water is really there
- What is adequate data and analysis?
- Decision making in this environment will always involve uncertainty
- Distribution of water resources complex in island environment

Need for public education

Water rights should be processed and permitted at the local (county) level

Assessment conclusions:

In August, 2002, the WRIA 2, Phase 2 Basin Assessment was completed to meet the phase 2 requirements for watershed planning. This assessment had three main purposes: to characterize the water resources of San Juan County, to provide a scientific basis for developing a watershed plan, and to provide state and county agencies with the information required to effectively manage natural resources. The assessment looked at 1) rainfall and streamflow conditions, 2) compared water use to groundwater availability (a water balance or budget), and 3) compared water rights to groundwater availability. These estimates give a generalized picture of areas with adequate groundwater supplies and areas at risk of depleting available groundwater resources. *The assessment indicates that there are areas in the county where groundwater usage exceeds what is available, and, county-wide the amount of groundwater allocated by water rights exceeds what is available.*

The assessment recommendations include: data collection (streamflow, groundwater levels, and water use), conservation, establishing guidelines for groundwater development, and studies to assess long-term yield of surface water sources, further refine the water balance analysis, and assess the potential for seawater intrusion.

Outcome of early implementation and additional studies:

Rainwater harvesting

San Juan County residents have long used rainwater catchment (or harvesting) as a means of supplementing limited groundwater supplies. This practice was officially incorporated into county code in 1998. However, all waters of the state, including rainwater, require a water right in order to be put to beneficial use. This requirement puts county practice and code in conflict with state law. Efforts to resolve this issue as an early implementation project were initially frustrating, due to statewide concerns and hopes for a legislative bill to address the issue. Eventually, the WRMC and Ecology agreed to the recommendation to pursue a general permit for use of rainwater harvesting county-wide. The documentation to support this permit is contained in Appendix B, Rainwater catchment analysis.

Lopez Village

In 2000, the WRMC recognized that the county did not have adequate information about aquifer conditions or water system capacity for the Lopez Village designated urban growth area. A planning subcommittee was formed to study the resource and develop a plan for water system development to serve the area. The committee spent two years developing a plan for local management of the water supply, which included conducting a year of monitoring and analysis of aquifer conditions.

A plan for coordination of water system management by a local water users cooperative, a long-term monitoring network, and a realistic timeframe to work toward the requirements for water service in the urban growth area resulted from this two-year effort.[3]

Orcas

With the successful completion of the Lopez Village planning, the WRMC identified the area of Eastsound and adjacent Rosario as another location where current and future

[3] See Lopez Village Water Supply Report and Abbreviated Coordinated Water System Plan, Lopez Village Water Supply Planning Committee, 2003

projected growth exceeds water supply and/or service capacity. An advisory committee for water supply planning for eastern Orcas was established in the fall of 2003.

Stream gauges

Although San Juan County's streams are limited in size and few flow all year, a large part of the county's population and most of the designated growth areas are served by surface water sources. In 2003, a consulting firm was hired to install gauges in the county's main streams and report on the flow regime. At this time, a permanent network of nine gauges covers the main basins on Orcas and San Juan islands. A year of data from this network has provided an initial look at stream characteristics. This information will eventually assist the county in evaluating the capacity of surface water resources on these islands.

Storage

An assessment of potential additional storage sites for surface water was conducted in the spring of 2004, with a focus on eastern Orcas. The WRMC recognized the need for additional capacity and water rights to meet growth demands on Orcas Island. Analysis of stream gauge data and potential sites for reservoirs indicate that Cascade Creek appears to have sufficient flow to support additional diversions during the winter, while maintaining flows during the summer. See Appendices D and E, for the reports on stream flow and storage.

CHAPTER 2, SUMMARY OF ISSUES

How much water is available?

Watershed Planning mandates local involvement in defining how much water is available. In order to do this, an assessment of available water, also called a water budget, is required. San Juan County's WRIA 2 Basin Assessment, Gauging and Instream Flow Study, and Storage Assessment Report were developed to characterize the water resources of San Juan County, to provide a scientific basis for developing a watershed plan, and to provide state and county agencies with information required to effectively manage this resource. Using USGS recharge estimates, a water budget was developed to estimate water availability and provide a large-scale look at conditions county-wide. This Level 1 Assessment serves as a planning tool to identify areas with limited resources and high demand, and areas with adequate and surplus supplies. San Juan County hydrology is complex and local conditions can vary dramatically. To determine what constitutes a safe and sustainable yield, additional analysis of time-dependent and site-specific conditions is needed.

Under state law, the four standards for allocating new water rights are:

1) is the water available?
2) will it be put to beneficial use?
3) will the new right impair prior rights?
4) is the use detrimental to the public interest?

Groundwater availability:

The water budget reveals that the Department of Ecology has issued certificates and permits for groundwater that equal 57% of the amount of recharge. If you add exempt wells[4] into the picture, 174% of the amount of recharge has been allocated county-wide. These numbers represent a much more complicated reality: 1) water rights on paper

[4] RCW 90.44.050. . . . withdrawal of public ground waters for strockwatering purposes, or for the watering of a lawn or of a noncommercial garden not exceeding one-half acre in area, or for single or group domestic uses in an amount not exceeding 5000 gallons a day . . . shall be exempt . . .

must be perfected by use and it's the amount water that's actually put to beneficial use that constitutes the final water right issued by Ecology, and 2) only part of recharge is available for withdrawal. Aquifer storage capacity, the amount lost by lateral flow to the sea, the amount returned through septic systems, seasonal variations, and drought conditions all contribute to the difficulties of estimating water availability. *A general rule used for planning purposes is that 20-30% of recharge is available for withdrawal*.[5]

The assessment indicates that large portions of the county are at a point where demand for groundwater exceeds local recharge. In some of the high-demand areas, adjacent low-density rural lands help to replenish the aquifer, which is the case at Lopez Village. Most of these areas, however, have limitations due to terrain and geography, such as bedrock, narrow spits or peninsulas, and proximity to shoreline. Future development and build-out of existing parcels will only exacerbate this situation. Areas designated for high-density growth in the county's comprehensive plan that may have limited groundwater include Eastsound, Orcas Landing and Deer Harbor. See Chapter 3, Groundwater Characteristics, for more information about well capacity.

Until an adjudication or similar evaluation of the status of existing water rights is conducted, *no new permitted groundwater rights are available in San Juan County*. This leads to considerable pressure to develop exempt wells, which has been a trend in the county since the 1970s (see Figure 2.2, Water Right Allocations Over Time).

Exempt wells

Exempt wells must meet the four standards for a water right but are exempt from the requirement for a water right permit. However, exempt wells have fallen into a jurisdictional limbo throughout the state, with no regulation by Ecology (other than construction standards) and limited review by local jurisdictions during the building permit process. Exempt wells have been exploited in recent years as the only avenue to new development, since court cases and cuts to Ecology staff have stymied issuance of

[5] "The portion of groundwater withdrawn from the total natural recharge is termed the capture. No simple means exists for measuring the "available" capture and there are no adopted state-wide policies or criteria for its estimation. Normally it is no more than 50 percent of the total recharge. Carr (1983) estimates a ratio of 25 percent for Vashon Island in King County. It is possible that certain localities have little or no "available" capture. However, the probability is high that it falls between zero and 50 percent." Water Resource Assessment Technical Report, San Juan County Comprehensive Water Plan. Economic and Engineering Services, et al. 1990.

new water rights. Recent rulings by the State Supreme Court and the Western Washington Growth Management Hearings Board have addressed, in part, this gap in regulation.

In January 2002, the Western Washington Growth Management Hearings Board issued an order to Jefferson County which stated that: "The County has the overriding responsibility to protect its groundwater quality . . ."; and further, the County has authority to, "impose some form of conservation measures to reduce the withdrawal of groundwater from individual wells if that withdrawal would disrupt the seawater/freshwater balance and lead to greater seawater intrusion. The exemption of RCW 90.44.050 does not limit a local jurisdiction from complying with its mandate for protection of groundwater quality and quantity under the GMA." Jefferson County argued that exempt wells are the responsibility of Ecology and the county had no authority to regulate their development and use, other than through the building permit process. The Hearings Board found that Jefferson County failed to designate seawater intrusion areas as critical areas, failed to apply best available science, and failed to identify performance standards for protection.

In March, 2002, The State Supreme Court, in Ecology v. Campbell and Gwinn, ruled that developers could not use multiple exempt wells whose total withdrawal exceeded the 5000 gallons per day allowed under the exemption. Multiple wells for a single development were determined to be a single withdrawal, and limited to a total of 5000 gallons per day.

In 1996, San Juan County adopted stringent review standards for the use of exempt wells for new building permits and division of land. As a result, considerable progress has been made in data collection and the education of well drillers, developers, and homeowners. However, the county review process only looks at wells on a case-by-case basis, with no overview of impacts on the aquifer. Since all new groundwater development in San Juan County is occurring with exempt wells, it is essential that this Plan address future development of exempt wells in a comprehensive, scientific manner, using the four standards that apply to all water rights. In some areas of the county, groundwater development is like sand running through an hourglass. It's only a matter

of time until these aquifers are depleted or the balance is tipped to allow seawater intrusion.

Seawater intrusion

In 1982, a USGS study of San Juan County found that seawater intrusion was strongly suspected in nine percent of the wells studied (26 of 279), with most of these wells located in the southern parts of Lopez and San Juan islands. A follow-up study in 2002 by USGS on Lopez Island concluded that statistical tests of chloride concentrations indicated an increase over time.[6] High chloride concentrations and chloride concentrations increasing over time are commonly used as an indicator of seawater intrusion (see Chapter 3, page 24, for a discussion of these studies).

Seawater intrusion policies developed by the state[7] and Island, Jefferson, and Skagit counties use chloride as an indicator to establish seawater intrusion risk or protection areas. In their 2002 ruling for Jefferson County, the Hearings Board stipulated that the County "properly classify and designate vulnerable seawater intrusion areas as CARAs (critical aquifer recharge areas) using best available science, and develop and adopt protection standards to prevent further groundwater degradation from seawater intrusion". Until detailed analysis of aquifer capacity can be developed, using chloride as an indicator to define seawater intrusion risk areas is best available science.

Seawater intrusion is a condition that is not well addressed by current regulations. The maximum contaminant level for chloride as a health standard is 250 mg/L. Seawater intrusion is the replacement of fresh ground water by saline water, indicating depletion of the freshwater resource or degradation. By the time chloride levels reach 250 mg/L, a well or aquifer is already experiencing degradation. The real goal is to prevent intrusion by limiting withdrawals to sustainable rates. By starting with risk areas based on chloride levels, and requiring a combination of aquifer analysis and best management practices in order to develop new sources, a long-term management program can be established. New wells in areas at risk for seawater intrusion must be held to the

[6] Occurrence, Quantity, and Use of Ground Water in Orcas, San Juan, Lopez, and Shaw Islands, San Juan County, Washington. USGS WRIR 83-4019, and
Is Seawater Intrusion Affecting Ground Water On Lopez Island, Washington? USGS Fact Sheet 057-00.

standards for a water right, including the questions: will this new use of water impair existing rights or be detrimental to the public interest?

The WRMC adopted a recommended seawater intrusion policy in February 2004. Using chloride levels to map areas susceptible to seawater intrusion, this policy recommends a long-term evaluation of the extent and impact of seawater intrusion, and requires a greater level of analysis for approval of new water sources in designated areas. (See Appendix A, Seawater Intrusion Policy, and Figure 3.1)

Surface water availability:

Community water systems using surface water

Approximately 40% of the county's population receive their drinking water from surface water systems. On the main islands these areas include the Town of Friday Harbor, Roche Harbor, Eastsound (54% surface water), Doe Bay, Olga, Rosario Resort, Rosario Highlands, and Spring Point. These water systems serve the majority of the high-density growth areas in the county.

The Town of Friday Harbor is the only municipality in the county and has a comprehensive plan and a water system plan that match growth projections to water rights and source capacity. Roche Harbor and Rosario are privately owned systems that serve resort facilities as well as residential customers. Doe Bay, Olga, and Spring Point are private, homeowner associations. Eastsound Water Users Association (EWUA) is also a private, homeowner association but serves the urban growth area of Eastsound. The EWUA is currently struggling with growth demands that exceed its ability to provide service and is also struggling to plan for a projected build-out that exceeds both water supply and water rights. An assessment of potential storage sites was provided by consultants in the spring of 2004, with the conclusion that additional water can be provided from Cascade Creek for storage to meet Eastsound's needs[8], however, considerable time and expense will be needed to confirm and develop this potential new source.

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[7] Seawater Intrusion Control in Coastal Washington, Department of Ecology Policy and Practice. 1992 EPA 171-92-027

[8] Multi-purpose Surface Water Storage Assessment, WRIA 2. April 2004. Montgomery Water Group

The county's high-density growth areas depend on service from large surface water systems. The Town of Friday Harbor, Roche Harbor, Eastsound, and Rosario all have concerns about their ability to meet future demand. Problems for surface water systems include:

- the control of watersheds,
- capital costs,
- additional source supplies,
- adequate water rights,
- coordination of water resource management,
- increasing treatment costs, and
- matching water system capacity to the county's growth projections.

Stream, lake, wetland and nearshore freshwater needs

Conditions in San Juan County do not fit neatly into the methods used to quantify the volume of water needed to ensure the health of aquatic habitat. Lake levels are easy to observe, but the county's intermittent streams and many small wetlands dry up in the summer and fall below the threshold for regulation. Nearshore freshwater needs are even more difficult to document, since the volume of freshwater discharge (through seeps and springs, often below sea level) is not known.

Four streams in the county, all on Orcas Island, have been identified as known spawning areas for salmon. All support searun cutthroat trout, and the lower reach of Cascade Creek is also identified as supporting coho. Initially, the WRMC did not apply for funds to study stream flow conditions (instream flows), since the WRIA 2 Habitat Limiting Factors Report, 2002, prepared by the Conservation Commission as part of the planning process, stated: "There are no known naturally reproducing salmonid populations and/or stocks in the San Juan Islands. The value of the San Juan Islands is the diverse nearshore habitats that serve as nursery grounds to migrating juvenile salmonids from other watersheds and in their production of forage fish utilized by sub-adult and adult salmon on return migrations." However, several citizen groups in the county, and the Samish Nation, are working to identify and/or restore potential salmon streams. In 2003, the WRMC determined that a study of stream flow conditions was needed to help future evaluation of the amount of water available for additional appropriations while

assuring adequate stream flow to maintain aquatic habitat for fish. However, no instream flow recommendations were developed during this planning stage.

Unlike other WRIA planning efforts, where stream conditions for salmon are the main focus, in San Juan County nearshore habitat is the most important factor in the salmon life-cycle. All of the issues and recommendations from the Limiting Factors Report address the nearshore interface between marine and terrestrial habitat, or marine riparian zone. While considerable effort has gone into nearshore studies in the last two years, the island community also supports the aesthetic and cultural values linked to viable fish streams and more study is planned to identify areas for protection and restoration. The recommendations in this Plan recognize this important aspect of fresh water use and the need to provide for protection of these important habitats as they are identified. (See Appendix C, Summary of freshwater habitat issues for salmon recovery)

Rainwater use, wastewater reuse, desalinization and hauled water

Rainwater catchment

In an area with limited water resources, the capture of rainfall is a practical approach to providing water for irrigation and individual domestic use[9]. This practice has been used for decades in San Juan County, especially in the form of pond catchment on farms. It has been an official policy in San Juan County to allow rainwater systems as a source of water for individual domestic use for over a decade. This use of rainwater, however, requires a water right permit, just like any other water source.

In 1999, Ecology issued a preliminary/temporary permit authorizing the collection and use of rainwater for non-potable use to Camp Nor'wester on Johns Island, stating: "The location and geology of the San Juan Islands create an area of limited surface and ground water supply. Your proposal presents a unique opportunity to test the feasibility of rainwater collection as an alternative source of potable water supply." In May, 2001, the San Juan County Board of Commissioners adopted a resolution requesting that Ecology to set a policy that would make rainwater use exempt from the requirement for a water right permit, similar to their policy for the use of seawater. Because of state-

wide implications, Ecology is not willing to make the use of rainwater exempt from the permit process, but has proposed a general county-wide permit, with an allocation set aside for rainwater harvesting by sub-area. Currently, use of rain barrels to promote water conservation is a common practice state-wide, and several counties allow the use of rainwater for potable and/or non-potable use, including King County. Bills have been introduced in the state legislature to allow an exemption for limited rainwater harvesting, but have failed to date to generate sufficient interest to allow passage. This plan recommends following through with the general permit process in order to make rainwater use a realistic alternative in water-poor areas and continued efforts to develop legislation.

Rooftop collections systems are considered a surface water source for purposes of determining appropriate water quality treatment and monitoring requirements. For individuals using catchment systems, ongoing maintenance is essential to assure safety. Group A and B water systems with households also using catchment systems, must protect their distribution system from potential cross-connections. (See Appendix B, Rainwater catchment analysis)

Reuse of graywater and wastewater

Currently, Washington State Department of Health standards for water reuse are so stringent that reuse is cost prohibitive for the county's small community systems. Nonetheless, the main population centers in the county have seriously pursued options for wastewater reuse and continue to evaluate its potential as new projects develop. Elsewhere in the county, population density is too low for reuse to be cost effective. For individual homeowners there are options for using treated wastewater for subsurface irrigation, and county staff are working with the state to simplify requirements. The committee recommends review of reuse options for all community wastewater and water system plans and projects.

Seawater treatment

Desalinization is permitted by San Juan County for individual use or for community systems with inadequate freshwater sources. It is not allowed as a source of water for

[9] San Juan County does not allow the use of catchment systems for land division purposes. For use in a community water systems, stringent treatment requirements apply.

new land division. Seven desalinization plants have been approved by state agencies for community water systems in San Juan County and six are in operation. These systems serve a total of 360 households. A dozen individual treatment systems have been approved for building permits by the county and many more have been installed to serve existing shoreline houses. Initial costs to homeowners for installation of a desalinization system is $5,000 to $7,000 for water systems with 40 to 160 connections. Cost per gallon of water is between $0.03 and $0.04 per gallon, compared to less than one cent per gallon for customers of Eastsound or the Town of Friday Harbor. Desalinization is an effective, but expensive, alternative source of water for areas that have no other options. A study of water systems using desalinization was conducted as part of the Lopez Village Water Supply Report and is included as Appendix C, A Summary Report on Water Issues on Lopez Island.

Conservation

For many areas of San Juan County water conservation is a way of life. Documentation of water use for households using rainwater catchment, desalinization, or wells with seawater intrusion averages 80 gallons per day per household. By comparison, summer water use in July 2000 in Friday Harbor averaged 203 gallons per single family residence and in Eastsound, 249 gallons per single family residence. Water use in winter the same year was 105 gallons in Friday Harbor and 129 gallons in Eastsound (which is 52% of summer use for both systems). In 2002 the City of Seattle's annual average for residential water use was 237.5 gallons per day (95 gallons per capita)[10] with a strong conservation program.

The county's two largest water systems have incorporated conservation into their programs in order to maximize efficiency with limited resources. Water system managers in San Juan County have found that the single most effective tool for conservation in water system management is the installation and reading of meters. The initial saving is in leak detection and repairs, second is customer awareness, and finally, for the larger systems, a rate structure based on use encourages additional

[10] Saving Water Partnership 2002 Annual Report

efficiency. The county requires new community water systems to meter all connections, and, in seawater intrusion areas, restrict water use.

Historically, water resource plans in San Juan County recommended conservation in order to address unknown limitations. This Plan does not recommend specific conservation measures, but instead focuses on developing resource information and setting up a management program. When it's developed, this program will address new requirements for water use efficiency for community (municipal) water supplies, as well as measures to share limited supplies for individual well owners in high risk areas.

Hauled water

Hauled water is an alternative or back-up for many homeowners in the county who depend on it in the summer to supplement wells that go dry or rainwater catchment systems that run out of water. Water is hauled from the Town of Friday Harbor, Eastsound and Rosario as well as the mainland[11]. There are problems with hauled water however, since bulk water from island suppliers is limited during drought conditions. In addition, clarification is needed to determine if water systems must apply for a change to their water right in order to sell bulk water outside their service area. Costly and unreliable, but essential for many residents, hauled water is the choice of last resort. For more information on the extent of water hauling in the County, see Chapter 3, page 26.

Community-led, science-based decision making

In August 2002, the WRIA 2 Assessment was completed and a comparison of water availability to the county's designated growth areas indicated some potential problems. The urban growth areas of Eastsound and Lopez Village and the activity centers of Orcas Village and Deer Harbor appeared to lack adequate water supplies. While the Assessment was being developed, water supply issues were brought to a head in Lopez Village. A process of community-based resource management planning was initiated on Lopez as a pilot project: a combination of early implementation and level 2 assessment.

[11] In the spring of 2004, the County received an application to license a converted fishing vessel to haul water supplied by the City of Anacortes to shoreline communities with failed well supplies.

Lopez Village Water Supply Planning

The Lopez Village area was designated as an interim urban growth area by the Board of County Commissioners on October 3, 2000. Between 1990 and 2000, Lopez Island grew faster than any other ferry-served island in San Juan County. The population grew from 1483 in 1990 to 2176 in 2000, an increase of 47%, compared to 40% for the county as a whole.

In the spring of 2001, with the adoption of the urban growth area for Lopez Village, a moratorium on new subdivisions was lifted and several developers submitted applications to the county for their projects. Because the water purveyors in the area were not able to provide service, these subdivisions were being developed with new, small community water systems on exempt wells. With seawater intrusion documented on Lopez, and no system in place to evaluate the impact of these multiple exempt wells in a small area, the WRMC recommended action to address resource and coordination issues in the Lopez Village area, and in May, 2001, the County Commissioners passed Resolution 39-2001, declaring a Critical Water Resource Area for the Lopez Village UGA. A Lopez sub-committee was formed to address water supply issues and develop an abbreviated coordinated water system plan.

After a stormy start, with water war posters displayed across the island, the Lopez Village Water Supply Planning Committee settled into two years of planning and volunteer monitoring. After a year of monitoring and the development of a groundwater model by a consultant, the planning group learned that the aquifer was "somewhat more resilient than we initially thought", and developed a plan for conservative adaptive management with local oversight.

The Lopez Water Supply Report's recommendations include:

<u>Long-term goals</u>

- Reallocate water rights through relinquishments, transfers and changes.
- Review options for development of a water public utility district.

Interim goals

1. Implement the Abbreviated Coordinated Water System Plan design guidelines for new water system development in the Lopez Village UGA in order to assure fire flow standards are met and that future interties between systems will be efficient.
2. Establish a local Water System/Users Association to take on management and decision-making in the Lopez Village area.
3. Establish an adaptive management program for the Lopez Village area that includes ongoing monitoring and analysis of the aquifer, tracking water use, and projecting water supply capacity on a five-year cycle.
4. Develop a comprehensive water system plan that defines the needs for infrastructure and funding to meet projected growth.

East Orcas Water Supply Planning

While Lopez is solely dependent on groundwater, the eastern lobe of Orcas Island is the highest rainfall area in the county, with rainfall 1-1/2 to 2 times the amount on Lopez, the largest lakes in the County and the majority of the county's perennial streams. Where Lopez residents see themselves as sharing their resource, residents on eastern Orcas have a history of independent "ownership" of their water sources, which has been validated by an adjudication in 1970, between the Rosario, Doe Bay, and Olga water systems.

Because Eastsound Water Users Association (EWUA) and Rosario Utilities have been unable to keep up with current demand for new connections to their water systems, and because there is no coordinated resource management for eastern Orcas, a planning sub-area was formed by Resolution 106-2003 that includes the service area boundaries of EWUA and Rosario. A planning sub-committee (the East Orcas Water Supply Planning Committee) of the WRMC was appointed that includes all interested parties in the eastern Orcas area.

Cascade Lake and Mountain Lake/Cascade Creek are two major elements in the watershed that also supplies drinking water for the Rosario, Doe Bay, Olga area. This watershed has the largest storage capacity (Mountain and Cascade lakes) and greatest

volume of runoff in the county. Water rights in this area have been adjudicated and several water right applications are pending. The Cascade Lake and Mountain Lake/Cascade Creek watersheds appear to have sufficient flows during the winter months to support additional seasonal diversions to storage. A multi-purpose storage project in this area could serve many needs, including additional water supplies for EWUA, water to maintain stream flows during the summer, and management of flooding during the winter. Additional studies, as well as planning recommendations by the East Orcas Water Supply Advisory Committee will assist in making these decisions.

Outcomes of this Plan

The recommendations in this Plan include developing a *comprehensive local water resource management program* based on county policies and a memorandum of understanding (MOU) with Ecology. This program involves:

- establishing risk areas and a program of adaptive management to continually monitor and adjust requirements for these areas,
- setting up community organizations to oversee management and monitoring,
- providing public education and participation in resource management,
- establishing new standards for development and use of exempt wells,
- building a water resource management program that addresses current and future needs compared to up-to-date information on water quality and quantity conditions,
- utilizing a county hydrogeologist to review new applications and to analyze monitoring results, and
- establishing a county water resource management board to track resource changes, recommend changes to county policy, and make recommendations to Ecology for water right allocations.

CHAPTER 3, GROUNDWATER CHARACTERISTICS

Groundwater in San Juan County is solely supplied by local rainfall. There is no additional recharge from distant glacier-fed rivers. A common misconception in the county holds that island aquifers are supplied by distant Mt. Baker, or even across the Straits of Juan de Fuca by the Olympics. The physical impossibility of this geohydrologic feat is due to the major faults located between the mainland and the islands. If a conduit to deliver water did exist between the base of distant mountains and the islands, the elevation difference would create a geyser at the wellhead.

Bedrock aquifers

San Juan County's predominant geology is bedrock, characterized by its chaotic, fractured and highly deformed rock types created by thrusts and faults of ancient seabeds. Bedrock well yields tend to be moderate to poor, with water stored in a network of fractures in the rock. In some parts of the county these networks can be extensive, but in most areas they hold limited amounts of water.

Bedrock wells in the San Juans are completed "open hole" which is the practice of installing a 6-inch diameter steel casing in the first few feet of bedrock, sealing it with cement and/or bentonite clay, and then drilling the remaining bore hole without additional casing. Generally, several water-bearing fractures are encountered during drilling, making up the total yield for the well.

Bedrock wells are generally deep; 82% are drilled below sea level. Water levels in most of these wells are within zero to 50-feet of surface, indicating that the water is flowing into these wells from higher elevations. Well yields based on driller's logs indicate that these wells range from zero to 100 gallons/minute, with 51% yielding two gallons-per-minute or less[12]. This well yield information is based on a brief test at the time of drilling. Well yield information from longer duration pump tests tends to confirm the lower yield rates from driller's logs and shows that the higher rates are not sustainable.

[12] A well yield of 2 gpm or less is categorized as an alternative water supply in San Juan County code. Wells with such low flows are generally vulnerable to seasonal changes, and can run dry if overtaxed.

Recharge potential in bedrock is limited due to its impervious nature and the fact that most bedrock terrain is steep. USGS estimates for recharge in bedrock are 10- to 50-percent of that in areas with glacial deposits.

Water-bearing zones in fractured rock are susceptible to dewatering from pumping, particularly during the dry season. Fractures can be conduits to contamination from surface water and seawater intrusion. Upper fractures can fill with water during the rainy season and convey surface water directly into the well. Bacterial contamination and the presence of tannins from organic material is common in these wells in late fall and early winter (SJCHCS). These wells are also subject to natural contaminants such as barium, arsenic, fluoride, and sodium, which pose risks to human health, and to iron, manganese and hardness ($CaCO_3$) which cause cosmetic and functional problems, such as odors, staining, and mineral deposits.

Bedrock wells account for 74% of the wells documented in the county. Of these, approximately 900 residences, mostly on Orcas Island, are supplied by wells in areas with low well yields.

Glacial aquifers

Aquifers in glacial deposits in San Juan County occur in porous outwash sands and gravels and are mixed with layers of silts and clays (till) which limit water flow. On the larger islands, primary glacial aquifers are located on the south end of San Juan Island, the Eastsound area of Orcas, and large portions of Lopez. Around Lopez Village, the water table is relatively flat and within a few feet of sea level, regardless of the elevation at land surface. In addition to these main aquifers, there are shallow aquifers in glacial deposits perched on top of layers of till and bedrock. Wells in these shallow aquifers are vulnerable to surface contamination when the ground is saturated. A study of Crow Valley wells on Orcas Island indicated over 80% of the shallow wells contaminated with coliform bacteria, including *E.* coli (SJC Conservation District, 1995).

Yield from glacial wells is much higher than bedrock, although San Juan County well yield is considerably lower than mainland wells. Glacial well yield is reported on drillers' logs to range between zero gallons-per-minute and 100 gallons-per-minute (the latter number being reported for two wells). Average yield is 13 gallons-per-minute, and, as

with bedrock wells, actual sustainable yield is generally accurate at the lower rates, but not confirmed with pump tests at the higher rates. Some glacial wells have proven to be long-term high producers, used by the larger community water systems, but only one or two of these wells are pumped at a rate greater than 25 gallons-per-minute. In glacial aquifers with water tables at sea level, the edge of the aquifer is in contact with seawater at the shoreline. Where bedrock wells will dewater if overpumped, glacial wells with direct contact to seawater will become intruded.

Glacial wells account for approximately 26% of the wells developed in the county. Of these, an estimated 75% are in areas at risk for seawater intrusion.

Seawater Intrusion

Seawater intrusion is the replacement of fresh ground water with seawater. This process occurs when freshwater, which is lighter than seawater and floats as a lens on the underlying seawater, is withdrawn to the point that seawater is either drawn up toward the bottom of a pumping well (upconing) or moves laterally inland (lateral intrusion) because of depletion of the volume of the freshwater lens.

- Estimated background chloride concentrations range from 10 to 100 mg/L, whereas ground water containing more than **160 mg/L** is strongly suspected of being contaminated by seawater. Because a zone of diffusion exists where freshwater and seawater mix, the use of a single concentration value . . . albeit convenient, is not entirely realistic.
- Median change in chloride concentrations in samplings between April and September was zero for wells with less than 160 mg/L and 32 for samples with more than 160 mg/L.

— Source: USGS WRIR 83-4019, Whiteman, et al, 1983

Seawater intrusion is a dynamic process that varies with seasonal recharge, tidal changes, changes in withdrawal rates, and, to some extent, barometric pressure. Chloride is a stable ion found in seawater that is easily measured in freshwater and commonly used as an indicator of seawater intrusion. State policy uses 100 mg/L chloride concentration as a threshold for risk of seawater intrusion. Studies in San Juan County in the early 1980's found that background levels of chloride are higher than other areas studied, and that a level of 160 mg/L indicated intrusion was occurring.

Wide seasonal variation in chloride levels appears to be another indication of potential intrusion. There are many factors to take into consideration when using chloride as an indicator of sea water intrusion: 1) high readings may be caused by ancient seawater deposits, concentrated sea spray, and the use of chlorine as a disinfectant; and, 2) lateral intrusion can be occurring even though chloride levels are well below a warning level.

Wells in shoreline areas are often drilled below sea level, which increases the risk of penetrating the fresh/seawater interface. Most of the shoreline development in the county is served by individual and community wells. Near the shoreline the freshwater lens is narrowest, most vulnerable to lateral intrusion, and also to the impact of upconing in neighboring wells.

Several shoreline areas in the county are affected by seawater intrusion, however, whether this is due to local upconing or a more extensive depletion that is resulting in lateral intrusion is not known. Some parts of the county, particularly geographic landforms such as peninsulas and isthmuses with limited acreage, do not have sufficient aquifer recharge available to supply current and future users. (See Appendix A, Seawater intrusion policy)

Recharge

Recharge is freshwater that replenishes aquifers on an annual basis. In San Juan County this is solely supplied by local rainfall and varies between bedrock and glacial aquifers. USGS estimates of recharge for San Juan County are the lowest in western Washington (See table 1.1 Recharge comparison, page 3). Recharge is a useful tool for estimating the amount of groundwater available for use on an annual basis because it represents the amount that is available without depleting or mining groundwater resources. Not all recharge is available for use, however, due to limits to storage capacity and the fact that groundwater, particularly in an island environment, is dynamic, steadily flowing (discharging) seaward. For planning purposes, it is assumed that 20- to 30-percent of recharge is available for use annually.

The USGS study included two years of stream-flow and weather station data collection, including interception loss under the tree canopy. Rainfall was analyzed for chloride in

order to use the track of this stable ion to confirm the main analytical method (deep percolation model or DPM) and also to look at chloride deposition in rainfall (compared to seawater intrusion). Recharge conditions were then modeled using daily measurements for precipitation, throughfall, solar shortwave radiation, air temperature, and stream discharge data applied to soil, vegetation, and land cover conditions. (See Table 4.1, page 30)

Areas with limited well yield

Comparing recharge estimates to residential development identifies several areas of the county where demand for water exceeds available recharge. Analysis of well yield information from drilling logs tends to confirm low yields in these areas (See Figure 3.5, Average well yield). The extent of this problem in the county is probably most apparent in documentation of the amount of water hauling that occurs during the summer months when demand is highest, recharge lowest, and wells fail. In 2003 (mostly April through November), 1.1 million gallons (1%), of the water the Town of Friday Harbor produced was sold for hauled water to supplement failed wells serving individual and community systems on the island. In response to a survey by Health and Community Services, water haulers on Orcas Island reported delivering 1.3 million gallons in 2000, 1 million gallons in 2002, and 1 million gallons in 2003. These deliveries were 40% individual residences, 10% Group B community systems, and 50% Group A systems. All of this water was delivered to the western side of Orcas Island. In 2001, licensed water hauling on San Juan Island totaled 183 deliveries and a total of 441,500 gallons; and in 2002, 261 deliveries and 643,500 gallons.

Some bedrock areas of the county have very little capacity for storage or transmission of groundwater. These areas are generally located inland in rural designated areas, although some coastal areas are also affected. These areas tend to have high, steep elevations, with limited soil cover over the bedrock. They have low recharge estimates and low average well yield based on drilling log data. It is generally assumed that the fractures that supply these wells have little interconnection, and that withdrawal from one well does not affect a neighboring well.

In glacial deposits low yield wells are generally in areas that are predominately till, which is composed of a compressed mixture of materials, including fine-grained silts and clay, that act as aquitards and restrict the flow of water.

Limited aquifer capacity along shoreline areas is also subject to depletion, but rather than well failure, will draw seawater into the aquifer.

The main concern for groundwater management is in areas with low yield wells and land use designations of less than five acres, where the overall capacity for recharge may not be sufficient for the demand for water. (See Appendix A, Recommended Policies, #2)

Areas with risks of contamination

There are several naturally-occurring contaminants in San Juan County as well as geologic conditions that are vulnerable to contamination from surface sources such as septic systems.

Arsenic, barium, fluoride, and sodium are present in many areas in the county at levels that present a health risk. Exposure to arsenic over time increases the risk of cancer; barium is associated with risks of heart disease and high blood pressure; fluoride in high doses can cause brittle bones and at high levels poses a risk to children with developing teeth, particularly if combined with fluoride supplements (which in low doses helps to form strong teeth). Continued data collection, mapping, and public education are the main management recommendations for these conditions in this Plan (See Appendix A, Policy for wells with limited yield and naturally occurring contaminants).

The fractures of bedrock wells, and the porous conditions of some glacial sediments provide an avenue for surface contaminants to enter groundwater. Fractures are a particular concern, since they provide no filtration benefits. Wells in some formations are contaminated every winter by surface water that finds its way into upper fracture zones. In some cases, this surface water picks up bacteria and other pathogens that contaminate the wells. Currently, state code does not require on-site septic systems to be designed in a way that prevents downward migration of contaminants, such as nitrates.

Where wells and on-site septic systems are developed on small lots the risk of contamination is compounded. Many small lots were created in San Juan County prior to current land use regulations with the intention that community water systems would provide service, but in many cases the water systems were either never developed, are unable to keep up with the need for service, or have failed altogether. There is growing demand for development of these lots, which are generally either affordable because of their size or located in desirable shoreline and view areas.

Groundwater management issues

- The location, capacity, and quality of the county's aquifers are not known. Recharge estimates, well logs, and limited water quality data are the only sources of information available about groundwater conditions in San Juan County. Without long-term data collection and analysis, effective management of groundwater resources is not possible.
- Allocation of water rights for groundwater sources exceeds available recharge in many parts of the county. In addition, there are several areas with potential for high-density new development and infill that do not have adequate groundwater supplies.
- The risk of seawater intrusion has been documented in the county, but the extent and timing of this risk is not known. The state and county have the responsibility to manage and protect the groundwater resource, but at this time there is no working agreement or plan for management.
- In order to supply water in areas with depleted groundwater sources, coordination and cooperation with the county's community water systems is needed. At this time, these systems do not have the capacity, or desire, to serve additional customers.
    - Rural build-out in areas with low-yield wells and naturally occurring contamination will require education and on-going documentation of conditions.

CHAPTER 4, SURFACE WATER CHARACTERISTICS

Fresh surface water provides drinking water, habitat, recreation, irrigation, and power generation in San Juan County. Forty percent of the county's population depends on surface water for drinking water, most of which comes from the two largest watershed systems in the county: the False Bay watershed on San Juan Island and the Mountain Lake/Cascade Lake watersheds on Orcas. (For more information on the county's watersheds see the 2000 San Juan County Watershed Action Plan and Characterization Report.)

Several reports[13] have addressed surface water conditions in the county over the years, calculating the amount of runoff in streams and the capacity for storage in lakes and ponds. Stream gauging and hydrologic modeling are used to estimate runoff and storage potential in a watershed system by developing an equation that includes precipitation, evaporation/transpiration (loss of water through vegetation), recharge, and runoff. Stream gauging by Ecology in 1975 included 28 sites, with two read daily and 26 read monthly. USGS gauging in 1997-98 included six sites, with continuous recording by electronic recorders. (Currently, there are nine gauging sites on Orcas and San Juan islands with recorders. This network was started in November 2003, and will provide long-term, accurate data for analysis.)

These reports show that during the summer months, San Juan County is typically in a phase of water deficit. More water is lost from the soil due to evaporation and transpiration (uptake of water by plants) than is added from precipitation. The largest component of the hydrologic water budget in San Juan County is evaporation/transpiration, which uses 64-75% of rainfall annually (see Table 4.1, below). Runoff ranges from 14% of precipitation on Lopez (with low terrain and glacial deposits) to 31% on Orcas (with high elevations and bedrock conditions).

Most of San Juan County's streams are intermittent, drying up during the summer months when plants and evaporation take up all the available rainfall. The few perennial streams are maintained by groundwater discharge through seeps and springs

[13] See page v, Reports, plans and studies

and/or by diversions as part of irrigation or drinking water impoundments. Most of the county's streams, lakes, and ponds have been altered by ditching and dams for irrigation, drainage, drinking water, or hydroelectric plants.

Table 4.1

Water budget components (in inches)

Island	Water year	Precipitation	Interception loss	Simulated transpiration	Simulated direct runoff	Simulated deep percolation	Simulated change in soil moisture
Lopez	1997	30.65	6.73	14.22	5.59	3.03	0.68
	1998	21.05	5.86	12.2	2.15	1.94	-1.46
	avg	**25.85**	**6.29**	**13.21**	**3.87**	**2.49**	**-0.39**
San Juan	1997	34.99	8.24	13.4	9.77	2.24	0.48
	1998	23.59	6.73	11.65	4.1	1.75	-1.39
	avg	**29.29**	**7.49**	**12.52**	**6.93**	**1.99**	**-0.46**
Orcas	1997	40.37	9.64	13.48	14.5	1.6	0.59
	1998	25.53	7.62	11.61	6.08	1.33	-1.65
	avg	**32.95**	**8.6**	**12.54**	**10.29**	**1.46**	**-0.53**

Source: Estimates of Ground-Water Recharge, USGS WRIR 02-4114. This is a summary of annual water budget components using the deep percolation model for Lopez, San Juan, and Orcas, water years 1997-98. Components may not exactly equal precipitation because of round-off errors.

Stored surface water is an important resource in the county, capturing winter rainfall for use during dry summer months. Over the years, studies have identified potential sites for additional storage and use. As the county has grown, however, the importance of wetland and recreational areas has increased as well as impacts on water quality in the watershed and many of these locations are no longer realistic. In order to provide water to meet growth projections, the Town of Friday Harbor, Roche Harbor and Eastsound water systems are planning to increase storage by raising the height of their respective dams. There also appears to be potential for additional diversions from the Mountain Lake/Cascade Lake system without impairing existing beneficial uses of water. See Appendices D and E for reports on stream gauge results and assessment of potential storage sites.

Water quality San Juan County's streams do not have specific water quality classifications (WAC 173-201A-130). The receiving marine waters in the county are classified as AA marine waters; therefore, San Juan County streams are designated Class AA by default. The 2000 Characterization Report and follow-up San Juan County Monitoring Project identified several fresh water sites that do not meet Class AA standards, mostly during the summer and early fall. Some of these results may reflect natural conditions; others appear to indicate impact from land use activities.

In October 1999, Ecology issued a TMDL[14] ranking report for San Juan County using preliminary monitoring from the Characterization Report. This study identified five priority watersheds to consider for future TMDLs, with the recommendation that additional monitoring be conducted[15]. Ecology did not follow up on the recommendation to continue to work on the ranking, but additional monitoring has been conducted by the county. A comprehensive follow-up study was done in 1999-2000, which resulted in the Monitoring Project Report, and then, in 2002, the San Juan County Conservation District began a watershed stewards educational program that includes a volunteer/student monitoring program. This program has been very popular, resulting in active community participation in watershed protection. Results of current monitoring can be seen at the San Juan County Conservation District website, sanjuanconservation.org.

Climate trends

In order to determine a sustainable capacity for surface water diversions, the impact of climate trends must be taken into account. A sustainable yield from a surface water source must be based on drought conditions. In 1975, Deitrich commented on the pattern of dry and wet years represented in the rainfall data from Olga on Orcas Island, one of the longest recorded rainfall sites in the state. Climatologists now recognize the cool-wet and warm-dry patterns as the Pacific Decadal Oscillation (PDO) and El Nino/La Nina Southern Oscillation (ENSO), which occur on a 20-30 year cycle. A comparison of Olga rainfall patterns and the PDO is represented in Figure 4.1.

[14] total daily maximum loading of contaminants in a water body
[15] 1. East Sound, 2. Buck Bay, 3. Friday Harbor, 4. Westcott bay, 5. West Sound.

Drought conditions during 1993-4 raised concerns about the sustainable capacity of surface water sources on San Juan Island. The Town of Friday Harbor contracted a survey and analysis of the capacity of Trout Lake and found that recharge to the lake occurred only after 18.5 inches of annual rainfall, out of an average of 27.6 inches.

An estimated water balance for average conditions can be calculated with the numbers above, but the Town found that estimates can vary dramatically from actual conditions. A water balance for 1992 came up with the following results:

Table 4.2, 1992 Water Balance for the Town of Friday Harbor (in MG)	
Beginning lake storage	292.6
Inflow: Estimated runoff to Trout Lake	206.5
Aug 1 pumping	39.3
Outflow: Losses to evaporation, leakage	40.0
1992 Water Production	167.4
Calculated ending storage	331.0
Actual ending storage	219.0

Source: Town of Friday Harbor Trout Lake Capacity Analysis, 1994

The rainfall pattern in 1992 was such that there were a limited number of storm events that resulted in significant enough rainfall to saturate the soil and allow for runoff to the lake. As a result of this analysis, the Town decided to use a conservative number for sustainable yield from its watersheds, based on a 50-year drought cycle.

False Bay, Mountain Lake and Cascade Lake watersheds

Most of the surface water in the county is linked by ditches, diversions, and impoundments with a varied history of water rights and use. The False Bay watershed is the largest single watershed in the county and includes the sources of water for the Town of Friday Harbor. The Town owns 570 of the 840 acres that comprise the watershed for Trout Lake, its main source. The Town also diverts water from two locations. Augmentation 1 and 2 pump water from seasonal flows to the lake during winter months, supplementing the natural recharge to Trout Lake. The Town shares rights to these stream flows with landowners who also use the water for irrigation. The Town holds water rights for 480 MGY and estimates that the sustainable yield from its combined sources is 168 MGY.

The Mountain Lake and Cascade Lake watersheds are linked by Cascade Creek, which flows into Buck Bay. These watersheds are located on the southwest slope of Mt. Constitution, inside Moran State Park, and include the wettest area in San Juan County.

Moran State Park is a 5,252-acre pristine, forested, camping park with five freshwater lakes located on the 2,409-foot-high Mt. Constitution, the highest point on the San Juan Islands. The popular park had a total of 868,995 visitors in 2003.

At the top of the Mountain Lake watershed is Moran Creek and Summit Lake. Summit Lake is formed by a small concrete dam that releases water into Mountain Lake. Mountain Lake is impounded by a combination earthfill-concrete dam where Doe Bay Water System diverts approximately 23.6 MGY and holds water rights for a total of 59 MGY. A four-inch pipe at the base of this dam continuously discharges water into Cascade Creek independent of weather conditions, natural runoff, and lake level. Just above the bridge across Cascade Creek in Moran State Park, Olga Water System diverts water and holds a water rights for 30.6 MGY. The flow in Cascade Creek below the bridge is then diverted by a dam, pipe, and cement canal to Cascade Lake. The Cascade Lake dam was built in 1884 to generate hydroelectric power. Rosario Utilities holds rights for 92.2 MGY for domestic use and 518.3 MGY for power generation from Cascade Lake and Cascade Creek and, in 2001 produced 37.2 MG of treated water. The water rights in these lakes and creek were adjudicated in 1978.

Documentation of historic salmon spawning and rearing in San Juan County streams is not available, but numbers are likely very small compared to the salmon population passing through San Juan County as they leave and return to freshwater streams elsewhere. The current documented use of freshwater sources by spawning salmon includes only Cascade Creek on Orcas Island and San Juan Valley Creek that flows into False Bay on San Juan Island. No current natural freshwater spawning is known to exist. The Lead Entity Strategy for Salmon Recovery in WRIA 2 centers on the nearshore environment, with secondary attention to restoration of small, local runs of salmon. Further watershed analysis is needed as part of the process to determine the locations for restoration.

Surface Water Management Issues

- Surface water provides drinking water to the majority of designated growth areas in the county.
- There is a lack of coordinated, cooperative management of the county's surface water resources.
- In some areas, water rights to surface water sources exceed sustainable yield.
- Planning for additional storage is essential to addressing growth and protection of habitat.
- Long-term monitoring is needed to accurately calculate the county's surface water characteristics.

CHAPTER 5, RECOMMENDATIONS

The following recommendations were developed to address water resource issues countywide. The committee recognized that the water resource issues differ from island to island and is proposing the development of a comprehensive program for the county. The committee understands that development of such a program will be time consuming & expensive. The reader will note that under the various recommendations the words "where resources and funding are available." This will allow implementation of the various recommendations as funding and resources are identified.

In this regard, the committee recommends a phased approach, with the various recommendations being implemented as resources are obtained. The State Department of Ecology has a three-year implementation grant available that can be utilized to develop an effective implementation plan. This plan will lay the foundation and timeframe for continuation of water resource planning activities throughout the county.

Objective 1: Incentives for community water systems

Provide support and incentives to develop cooperative agreements to provide infill and serve adjacent areas in need by community water systems with adequate capacity to serve.

1.1 Strategy: Develop cooperative water system plans with local water users to identify potential for water system development, expansion, interties, and reallocation of water rights.

- 1.1.1 Identify high risk areas and areas where additional capacity is available using information from the WRIA 2 Basin Assessment and other sources,
- 1.1.2 Conduct (Level 2) assessments of water supply, water use, and water system capacity,
- 1.1.3 Establish a local water users committee to develop options for cooperative agreements,
- 1.1.4 Assist in developing water system plans or coordinated water system plans where needed,
- 1.1.5 Evaluate water right allocations and facilitate changes and reallocations to support the expansion of systems willing to serve,
- 1.1.6 Develop a source of funding through the state revolving fund, conservation easements for well sites, local taxing districts, or other sources to for grants and loans for necessary water system improvements
- 1.1.7 Provide education for purveyors and water system customers on local water resource conditions and strategies for management.

1.2 Process: Identify areas with the need to have community water service and offer assessment, planning, water right reallocation, and funds for capital expenses as incentives for expansion by existing community systems.

1.3 Implementation: This program is already underway by San Juan County Health and Community Services, as a Level 2 Assessment under Watershed Planning. Maps of the areas are part of this plan.

1.4 Effectiveness: This approach has proven very successful for the Lopez Village area and is underway on Orcas.

1.5 Feasibility: Residents in the county and property owners with limited, unreliable water sources have been forced to invest in expensive solutions, such as desalinization. Small water systems struggle with rising costs that would be more affordable with a larger rate base. A cooperative, local planning process provides an opportunity for mutual assistance.

1.6 Cost: Estimated program costs include staff at .25 FTE/year for two projects per year plus expenses.

1.7 Funding Options: Implementation grant for the first three years for assessment and planning; revolving loan funds for water system improvements; and user fees for capital projects.

1.8 Timeline: Continuation of existing work for three years utilizing implementation funds. On-going program where resources and funding are available.

Objective 2: Public education and information program

Develop a public education program that provides up-to-date information on water resource issues county-wide and in priority sub-areas.

2.1 Strategy: Provide current information on monitoring conditions, water use trends, water quality trends, county hydrology and geohydrology, policies, and best management practices.

- 2.1.1 Use internet links and community stewardship education programs distribute information.
- 2.1.2 Use existing programs, where appropriate, to increase public awareness of water resource issues, such as, EPA's Sole Source Aquifer designation.
- 2.1.3 Use skills and information offered by volunteers and local water groups to maintain a high level of public involvement.

2.2 Process: Publish maps and data at the county's web-site. Integrate water resource information and best management practices in curriculum for the Watershed Stewards program, Navigating Our Future, Master Gardeners, and other local organizations. In the Implementation Plan, address using the Sole Source Aquifer designation and some form of water master program as a potential educational tool.

2.3 Implementation: Utilize existing county web-site and existing community programs.

2.4 Feasibility: Good

2.5 Costs: Low. Some existing staff time, and possible short-term grant position.

2.6 Funding Options: Implementation grant and other agency funding sources (Conservation District, County Extension Service, etc.).

2.7 Timeline: Develop educational information utilizing implementation funds. On-going program where resources and funding are available.

Objective 3: Water resource management program

Develop a water resource management program in San Juan County as a framework for local management.

3.1 Strategy: Designate San Juan County as lead agency for development and implementation of a water resource management program through a memorandum of understanding with the Department of Ecology. This program is intended to fill in the gap between county responsibilities and authority in state law for managing ground- and surface-water resources. Criteria for identifying water resource management areas and subareas include, but are not limited to:

3.1.1 Aquifers that are declining, or being impacted by seawater intrusion, due to restricted recharge or over-utilization;

3.1.2 Aquifer and surface water systems in which over-appropriation may have occurred and adjudication or voluntary reallocation of water rights has not yet been completed;

3.1.3 Aquifer and surface water systems currently being considered for water supply reservation under Chapter 90.54 RCW for future beneficial uses;

3.1.4 Aquifers and watershed basins identified as the primary source of supply for public water supply;

3.1.5 Aquifers designated as sole source aquifers by the federal Environmental Protection Agency, and

3.1.6 Geographical areas where land use may result in contamination or degradation of ground- and surface-water quality.

3.2 Process: Designation of water resource management sub-areas will start with surface watershed control plan boundaries[16] and the risk assessment designations[17] included in this Plan. The elements of this Plan and its implementation will form the basis for the water resource management plan, which will establish a program to manage the resource to assure long-term benefits to citizens of the county. The San Juan County water resource management program shall include:

(a) A description of the specific water resource area or sub-areas and the relationship of this area to the land use management responsibilities of county government, RCW 36.70A, Critical Areas;

(b) A management program based on long-term monitoring and resource management objectives for the area or sub-area;

(c) Identification of water resources and the allocation of the resources to meet state and local needs;

[16] As designated in Department of Health approved water systems plans.

[17] See: Policy 1. Seawater intrusion, areas with low capacity wells, and areas with naturally occurring contaminants

(d) Projection of water supply needs for existing and future identified user groups and beneficial uses;

(e) Identification of water resource management policies and/or practices that may impact the recharge of the designated area or policies that may affect the safe yield and quantity of water available for future appropriation;

(f) Identification of land use and other activities that may impact the quality and efficient use of the water resource, including domestic, industrial, agricultural, waste disposal, underground storage facilities, or storm water management practices;

(g) The design of the program necessary to manage the resource to assure long-term benefits to the citizens of the state;

(h) Identification of water quality objectives for the water resource area or sub-area which recognize existing and future uses that are in accordance with Department of Ecology and Department of Health drinking and surface water quality standards;

(i) Long-term policies and construction practices necessary to protect existing water rights and subsequent facilities installed in accordance with the water resource area or sub-area management programs and/or other water right procedures;

(j) Annual withdrawal rates and safe yield guidelines, which are directed by the long-term management programs that recognize annual variations in recharge;

(k) A description of conditions and potential conflicts and identification of a program to resolve conflicts with existing water rights;

(l) Alternative management programs to meet future needs and existing conditions, including water conservation plans; and

(m) A process for the periodic review of the water resource management program and monitoring of program implementation.

3.3 Implementation: Developing this program will correspond with implementation of the elements of this Plan and be the basis of the Phase 4 Implementation Plan.

3.4 Feasibility: This program is modeled after RCW 90.44, Groundwater Management Planning, and expanded to include surface water resources. Under the provisions in 90.82, Watershed Planning, provides for ". . .specific guidance to manage the water resources of the state consistent with current law and direction provided by local entities and citizens through the process established in accordance with this chapter."

3.5 Costs: Costs for developing this program would be incurred during the first year and are incorporated in other elements in this Section.

Estimated staff time to draft documents for plan approval is less than .10 FTE.

3.6 Funding Options: Implementation grant to set up the program.

3.7 Timeline: Establish program during implementation phase. Program to continue where resources and funding are available.

Objective 4: Local water resource review board

Create a local framework for reviewing and advising Ecology on appropriating new water uses and changes in the county. Utilize locally developed policies and water resource analysis in decision-making. Develop a partnership with state agencies to delegate responsibilities pertaining to the protection and management of water resources in the county.

4.1 Strategy: Establish a county *water resource review board*, a part of county government, supported by state and county hydrogeologic, technical, and legal staff, to

- 4.1.1 review and make recommendations for new water withdrawals and changes that require approval by Ecology,
- 4.1.2 review approvals, appeals, and waivers for exempt well development and changes located in high and medium risk areas,
- 4.1.3 review reports of ongoing monitoring and data collection,
- 4.1.4 develop and revise county policies regarding water rights and water use, incorporating recommendations from established local water advisory groups,
- 4.1.5 operate under the authority of a memorandum of understanding from Ecology or county rule and provisions in San Juan County Code,

4.2 Process: Develop a program for water right review and approval of exempt wells in critical areas in conjunction with Ecology. Develop a memorandum of understanding with Ecology to designate responsibilities of county and state agencies, and delegate authority to oversee exempt well development. Adopt county code to support county authority. Establish a board with (5) members, representing the public interest of water right holders in the county. Set qualifications for members, standards for decision-making, terms of office, meeting schedule, and appointment process.

4.3 Implementation: Recommend changes to state and county rules and regulations. Develop and implement a Memorandum of Understanding between San Juan County and the departments of Ecology and Health. Hire new staff (hydrogeologist – Objective 6) and allocate existing staff time for legal, technical, and clerical support. Develop program guidelines and protocols. Set up a fee structure to pay program costs.

4.4 Effectiveness: Currently, there are two very effective state delegation programs: the Department of Health Group B water system/sanitary survey delegation and Ecology's well construction delegation. The State Legislature also created a promising delegation program for water right changes by authorizing the creation of county conservancy boards in 1997, which is a model for this proposal.

Perhaps the best examples of the effectiveness of local, science-based, resource management in San Juan County are: the San Juan County Marine Resources Committee and the Lopez Village Water System Advisory Committee.

4.5 Feasibility: This program will depend on support and implementation by the agencies involved. Operating costs can be largely incorporated into development fees, but administrative changes will take some investment of resources. Since land development and growth depend on reliable water resource management, which is lacking at this time, water purveyors and government agencies will be highly motivated to make this work.

4.6 Cost: Establishing this board is estimated to take up to one year and would begin during the second year of implementation. Technical, legal, and clerical staff time would cost roughly $10,000 - $20,000 for set up by the county, and a similar amount annually to support a board that meets two to four times a year.

4.7 Funding Options: Watershed implementation funds are available to establish this board. Ongoing costs through development fees and/or grants.

4.8 Timeline: Develop framework of board with implementation funds. Establish and convene board where resources and funding are available.

Objective 5: Exempt wells

Establish regional estimates of the amount of groundwater available for allocation to exempt wells.

5.1 Strategy: Develop regional estimates for groundwater availability using best available science[18] and allocate a daily volume to new exempt wells that will not impair senior water rights.

5.1.1 The amount of allocation for exempt wells will take into account existing users and the potential build-out of the area.

5.1.2 Estimates will be revised every five years to reflect ongoing analysis of the groundwater resource.

5.1.3 Use of new exempt wells in areas with limited amounts of groundwater will be conditionally approved.

5.1.4 In areas with limited amounts of groundwater priority will be given to protecting the resource for domestic use.

5.1.5 In some areas, alternative options will be required, such as, alternative well sites, community system development, and use of non-potable water.

5.1.6 Approval of exempt well use for new division of land will require a geohydrological report, meeting county standards, by a qualified professional.

5.1.7 In high risk areas[19], approval of exempt well use for a single family residence will require a geohydrological report, meeting county standards, by a qualified professional.

5.2 Process: Delineate groundwater management areas based on best available science, to be revised every five years. Use specific criteria to define risk categories for high, medium, and low risk areas. Conduct ongoing monitoring of water levels, water quality, and water use. Utilize local water management groups to assist with education, technical assistance, monitoring, and allocation changes. Schedule annual and five-year review by the water resource review board (Objective 4). Use existing water availability review to condition use of new wells. Develop and Memorandum of Understanding with Ecology or administrative rule to limit or condition development of wells where appropriate.

5.3 Implementation: Changes to San Juan County Code and a Memorandum of Understanding with Ecology or administrative rule to regulate exempt

[18] Starting with estimates from the WRIA 2 Basin Assessment, 2002

[19] See Policy 1, Seawater intrusion, areas with low capacity wells, and areas with naturally occurring contaminants

wells will be required. State and county staff will need to develop an annual report and recommendations based on monitoring results for the water resource review board.

5.4 Effectiveness: Current county code looks at exempt wells on a case by case basis, but does not address the resource area as a whole. By establishing regional groundwater management standards, all users will benefit.

5.5 Feasibility: This program will use an existing permit process with new criteria for approval. The Implementation Plan should provide recommendations for an administrative rule, if needed.

5.6 Cost: For the County, regulation changes and developing an agreement with Ecology will require an estimated .10 FTE during the first year; other costs are included in the sections on monitoring and establishing a water right review board. Costs for development of new exempt wells will increase for individuals in some areas, and for new subdivision county-wide.

5.7 Funding Options: Implementation funds to develop regulation changes and develop recommendations for an administrative rule. Fees for ongoing costs.

5.8 Timeline: Delineate groundwater management areas and define risk categories with implementation funds. Revise information based on monitoring data where resources and funding are available.

Objective 6: Monitoring and county hydrogeologist

Use information from on-going monitoring and analysis by qualified professional staff to support a program of adaptive management.

6.1 Strategy: Develop a county approval process for water supply development based on local policies and on-going analysis of resource capacity.

6.1.1 Establish a water resource review board (Objective 4) to review on-going analysis of resource capacity and make recommendations for policy changes,

6.1.2 Hire or contract a county hydrogeologist to analyze current conditions, review new water source development, and report every five years on resource capacity county-wide,

6.1.3 Establish resource capacity estimates by area based on best available science, starting with the data in the WRIA 2 Basin Assessment, 2002,

6.1.4 Designate risk areas[20] based on evidence of sea water intrusion risk and other indicators of depletion,

6.1.5 Conduct on-going ground and surface water monitoring to continually improve estimates of available capacity and develop a scientifically sound body of information on hydrologic characteristics in the county, and

6.1.6 Develop policies through the *water resource review board* (Objective 4) and local water users groups for resource allocation and management.

6.2 Process: Hire or contract a county hydrogeologist to

6.2.1 Evaluate on-going monitoring,

6.2.2 Review and analyze county data,

6.2.3 Provide reports every five years estimating water supply and demand, and

6.2.4 Review hydrogeologic reports submitted for new development proposals for consistency with county policies

6.2.5 Assist the water resource review board in making recommendations to Ecology for new water right applications.

6.3 Implementation: Step 1, use implementation funds during the first three years to 1) complete a groundwater monitoring network on Lopez Island; 2) set up a county data collection system for groundwater and surface water monitoring; 3) contract with a consultant hydrogeologist; and 5)

[20] See Policy 1, Seawater intrusion; and Policy 2, Areas with low capacity wells, and areas with naturally occurring contaminants

continue to work with local water users groups and the WRMC to refine county policy. Step 2, establish a long-term program if permanent funding is identified for staffing.

6.4 Feasibility: Monitoring by volunteers and county staff has provided valuable information for management decisions in the Lopez Village area. A network of stream gauges and additional monitoring wells is under development. In Island County, high quality information and professional staff provide exceptionally effective resource management.

6.5 Costs: Estimated costs include a contract with a hydrogeologist for $50,000/year; data collection and management by existing staff would involved an estimated .10 - .25 FTE; during the first year, code changes and implementation would involve less than .10 FTE.

6.6 Funding Options: First three years, implementation funds and fees; ongoing, fees, and grants.

6.7 Timeline: Utilize implementation grant to contract with hydrogeologist, complete monitoring network & conduct on-going monitoring. Continuation would be dependant on identifying additional resources or funding opportunities.

Objective 7: Continue use of rainwater catchment, and review options for wastewater reuse.

7.1 Strategy: Continue to work with the Department of Health to simplify the permit process for individual graywater reuse systems.

7.1.1 Continue county efforts to simplify use of individual graywater reuse systems;

7.1.2 Require community water and sewer systems to evaluate the use of treated wastewater.

7.2 Implementation: Continue to work with Health to simplify monitoring requirements for small-scale reuse projects.

7.3 Feasibility: Depending on approval by local and state agencies, feasibility is high if appropriate technical support is provided.

7.4 Costs: For graywater reuse, this will be a continuation of existing program for county staff, but additional planning costs will be incurred by community water and sewer systems.

Objective	Elements	Timeframe	Lead agency	Supporting agencies	Funding source
1. Incentives for community water systems	Develop cooperative water supply management plans with local sub-committees.	On-going	WRMC	SJC	Implementation funds; water system fees
2. Public education and information	Provide current information on monitoring conditions, water use trends, water quality trends, policies, and best management practices	On-going	SJC	SJCHCS, SJC Conservation District	Addition to existing grants and programs
3. Water resource management program	Develop MOU with Ecology to delineate responsibilities for water resource management in San Juan County (WRIA 2)	One year after plan adoption	SJC	Ecology	Implementation funds
	Designate water resource sub-areas and set priorities for management based on 2.2 (a) – (m)	One year after plan adoption (note: this will be the basis of the implementation plan for WRIA 2)	SJC	Ecology	Implementation funds
4. Local water resource review board	Establish county water resource review board as a part of county government.	Within 3 years of adoption of plan if resources and funding are available	SJC	Ecology	Implementation funds, development fees; water system fees
	Develop MOU with Ecology to review and make recommendations for approval of new water sources and water right changes	One year after plan adoption as part of implementation phase	SJC	Ecology	Implementation funds
	Review monitoring, hydrologic reports; develop and recommend revisions to county policy, and recommendations to Ecology for new water right applications and changes.	WRMC as implementation committee during first three years; Water Resource Review Board after three years if resources and funding are available	SJC	Ecology	Development fees; water system fees
5. Exempt well	At plan adoption, use requirements for high, medium, and low risk areas for conditions of approval of new exempt wells	Policy at plan approval; within one year adoption as county code as part of implementation phase	SJC	Ecology	Development fees
	Develop water budgets by sub-area using current monitoring, use estimates, and projected growth estimates. Update every 5 years.	Within 3-5 years, based on monitoring, analysis by hydrogeologist, review and recommendation by Water Resource Review Board if resources and funding are available	SJC	Ecology	Implementation funds, development fees, water system fees
6. Monitoring and county hydrogeologist	Hire or contract a hydrogeologist to monitor and analyze current conditions, review new water source development, and advise the Water Resource Review Board	Upon adoption, start-up phase to include 1) developing monitoring network, 2) protocol for review of hydrogeologic studies, 3) develop refined water budget analysis for sub-areas	SJC	Ecology	Implementation funds, development fees; water system fees

Objective	Elements	Timeframe	Lead agency	Supporting agencies	Funding source
	Set up a long-term surface water and groundwater monitoring network	Currently underway, finalize within 2 years of adoption of plan, continue if resources and funding are available	SJC	Ecology	Implementation funds, water system fees, aquifer protection district
7. Continue use of rainwater catchment and wastewater reuse	Evaluate reuse for the main water systems in the county. Continue to work with DOH to simplify requirements for individual wastewater reuse.	On-going	SJC	Ecology, DOH	Current program

San Juan County Water Resource Management Plan

Maps and figures

Simplified Geologic Map of San Juan County, WRIA 2

Glacial geology

- Glacial deposits including glaciomarine drift, till, stratified outwash and deltaic beds

Bedrock formations

- Constitution Formation
- Deadman Bay, volcanics of
- East Sound Group
- Fidalgo igneous complex, Fidalgo ophiolite
- Garrison Schist
- Haro Formation
- Lopez Island, basalts of Richardson
- Lopez structural complex
- Lummi Formation
- Nanaimo Group
- Orcas Chert, Deadman Bay terrane
- Padden Member, Chuckanut Formation
- Spieden Formation
- Turtleback Complex

Other features

- alluvium
- dune sand and beach deposits
- peat deposits
- tectonic zone
- lakes
- 100 foot contour lines

Source: Washington State Department of Natural Resources, Division of Geology and Earth Resources, 2002

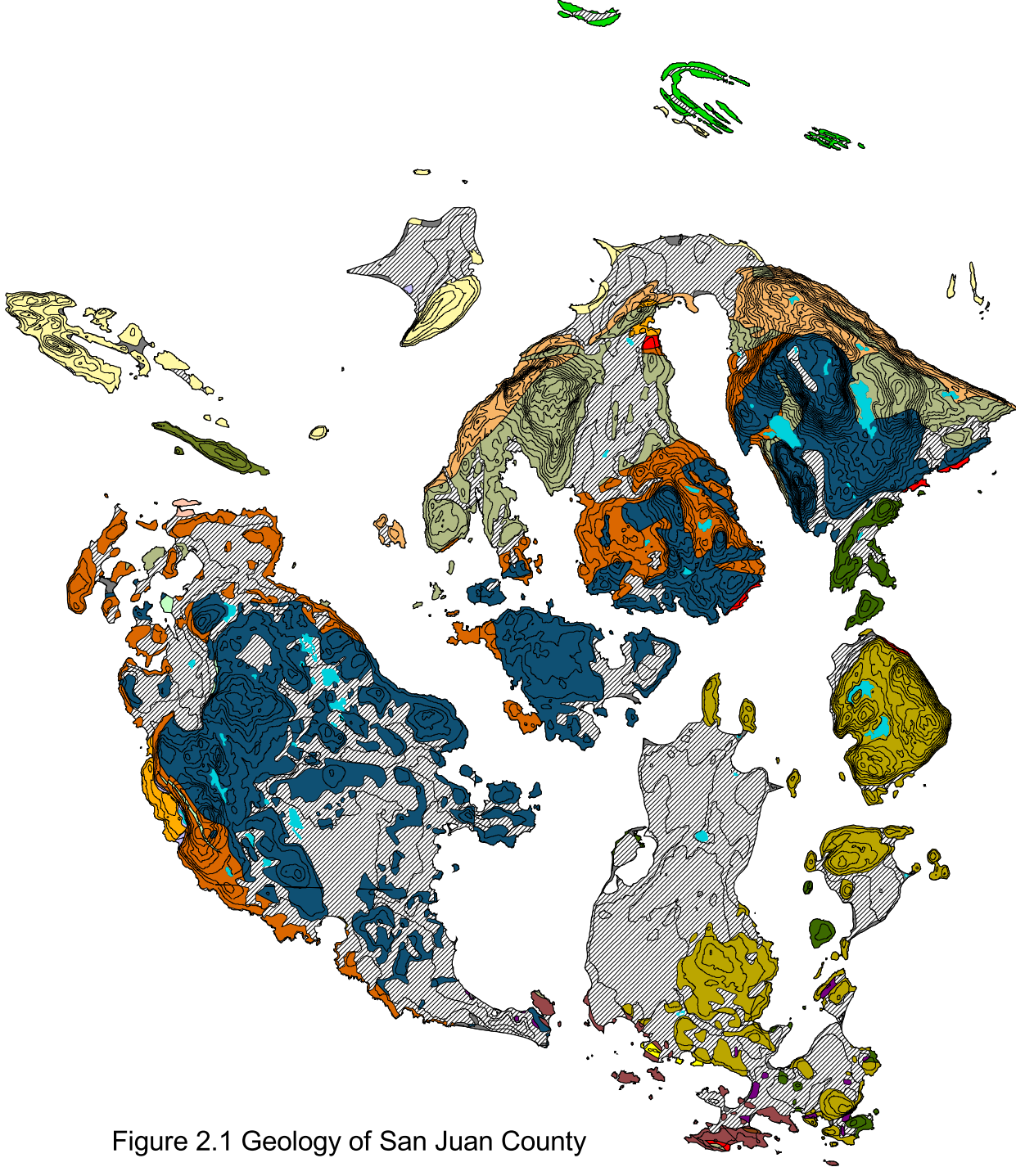
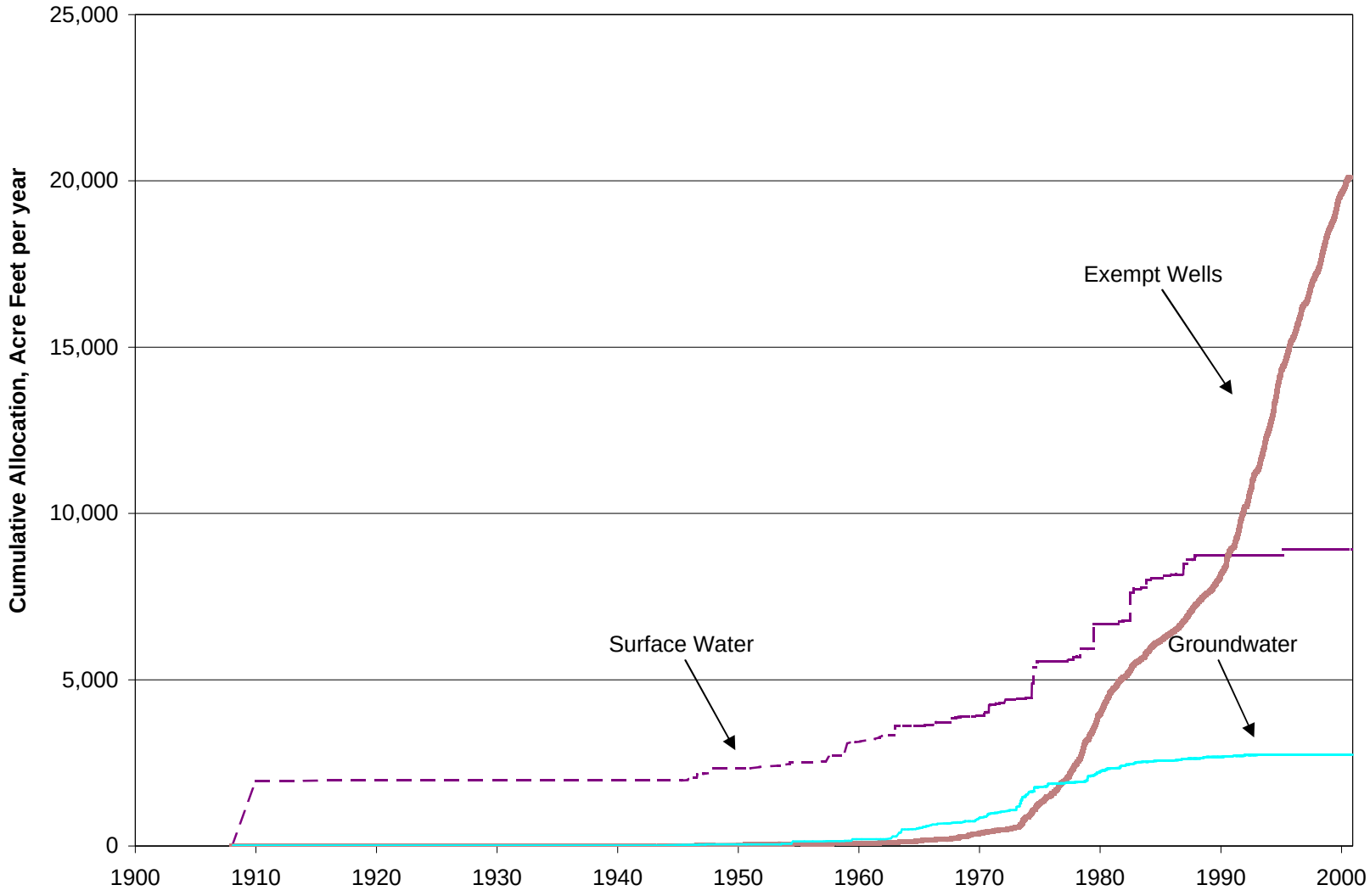


Figure 2.1 Geology of San Juan County



Legend.

- Surface Water
- Exempt
- Groundwater

Figure 2.2 Distribution of water right allocations over time

San Juan County
Phase 2 Basin Assessment

Pacific Groundwater Group

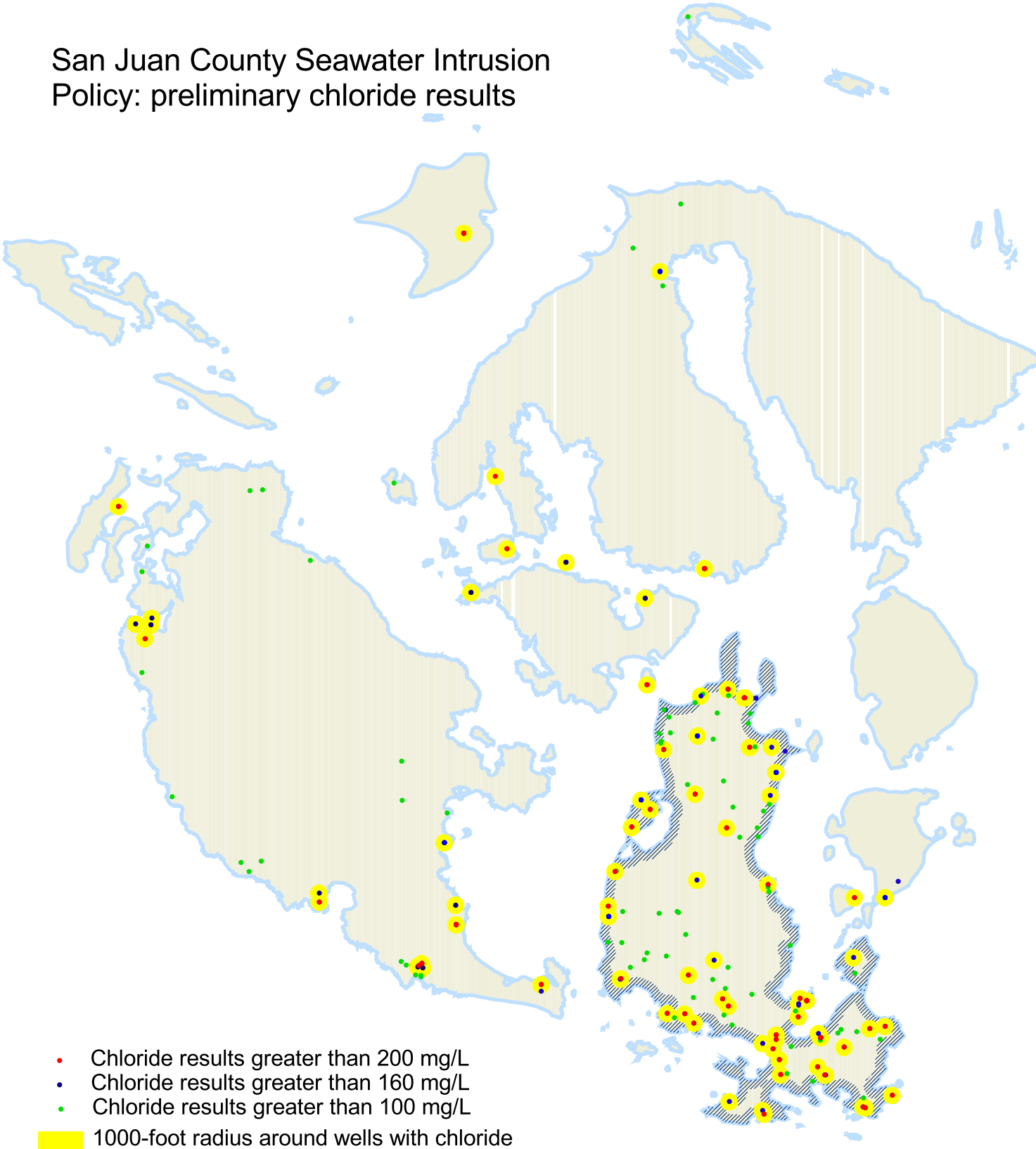


Figure 3.1. Chloride results and 1000-foot buffer
Sources: USGS, WSDOH, SJCHCS

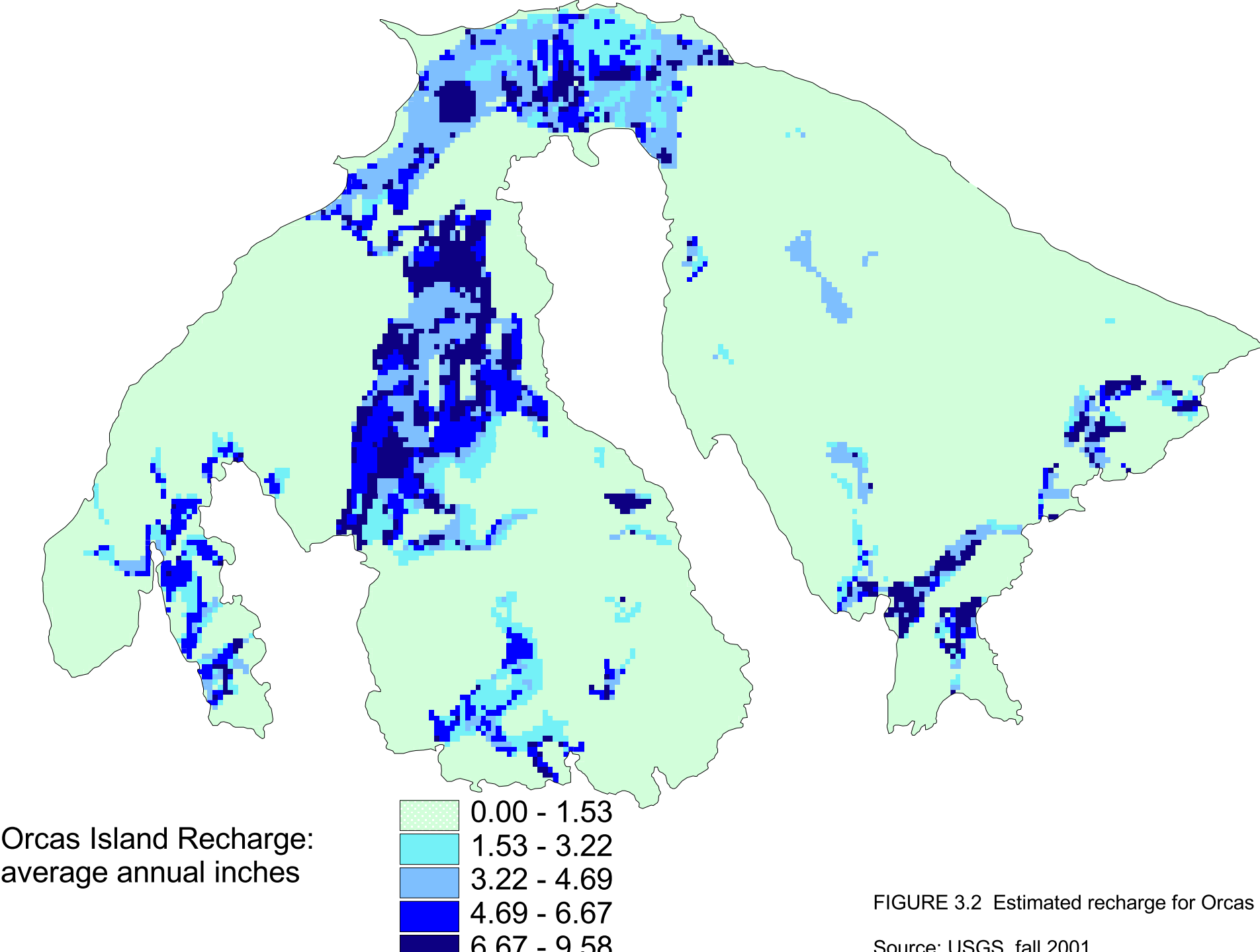


FIGURE 3.2 Estimated recharge for Orcas

Source: USGS, fall 2001

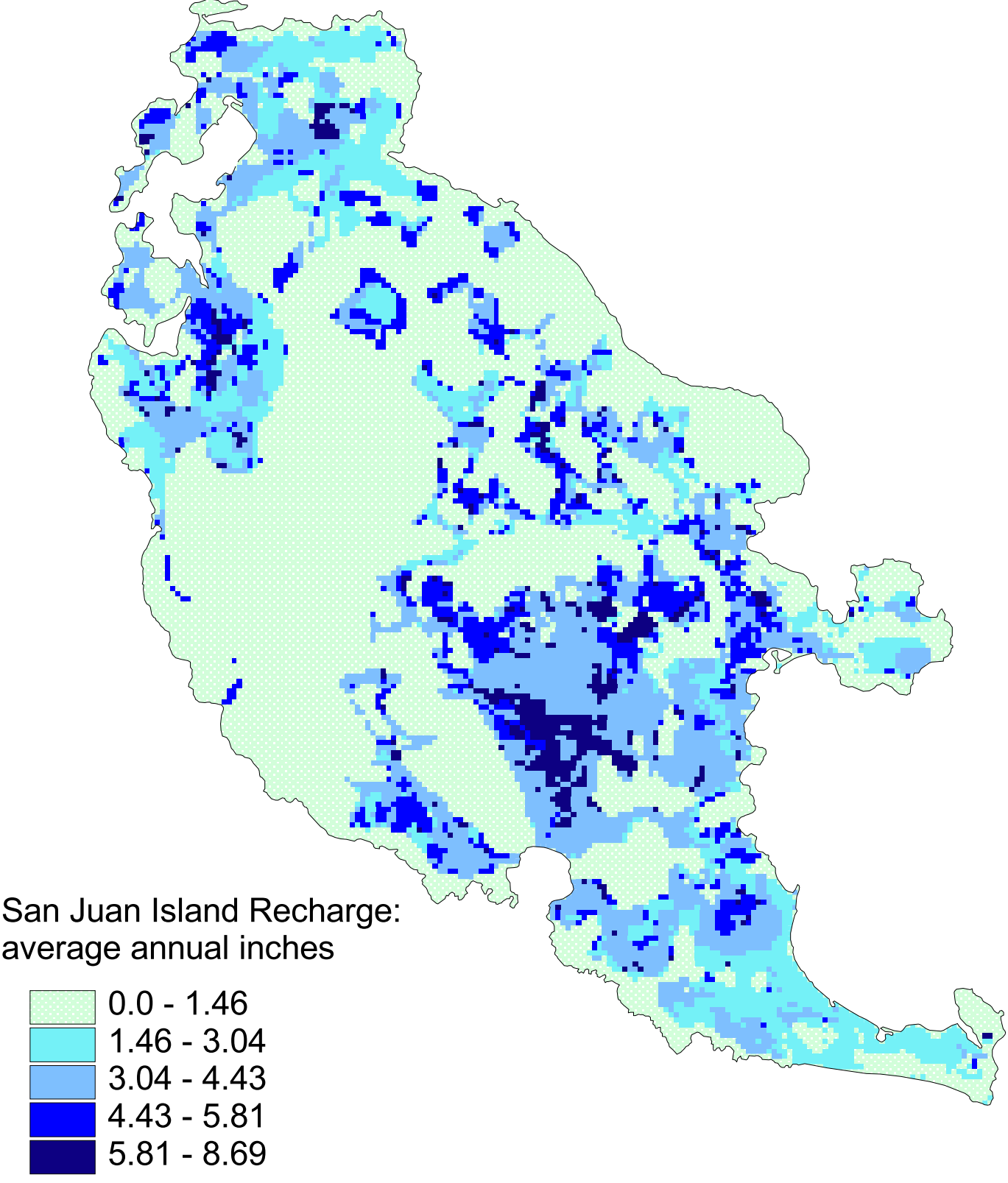


FIGURE 3.3. Estimated recharge for San Juan

Source: USGS, fall 2001

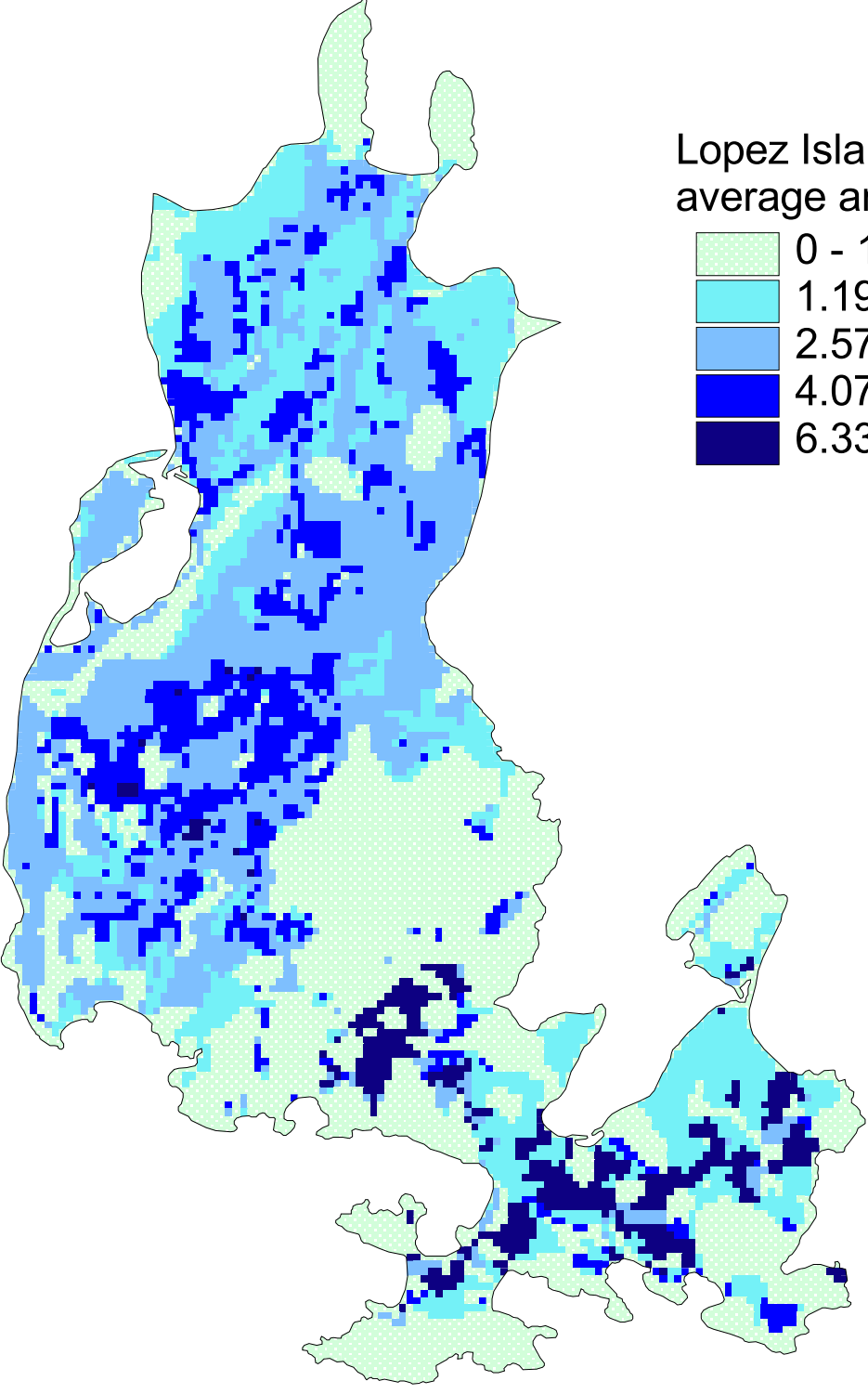
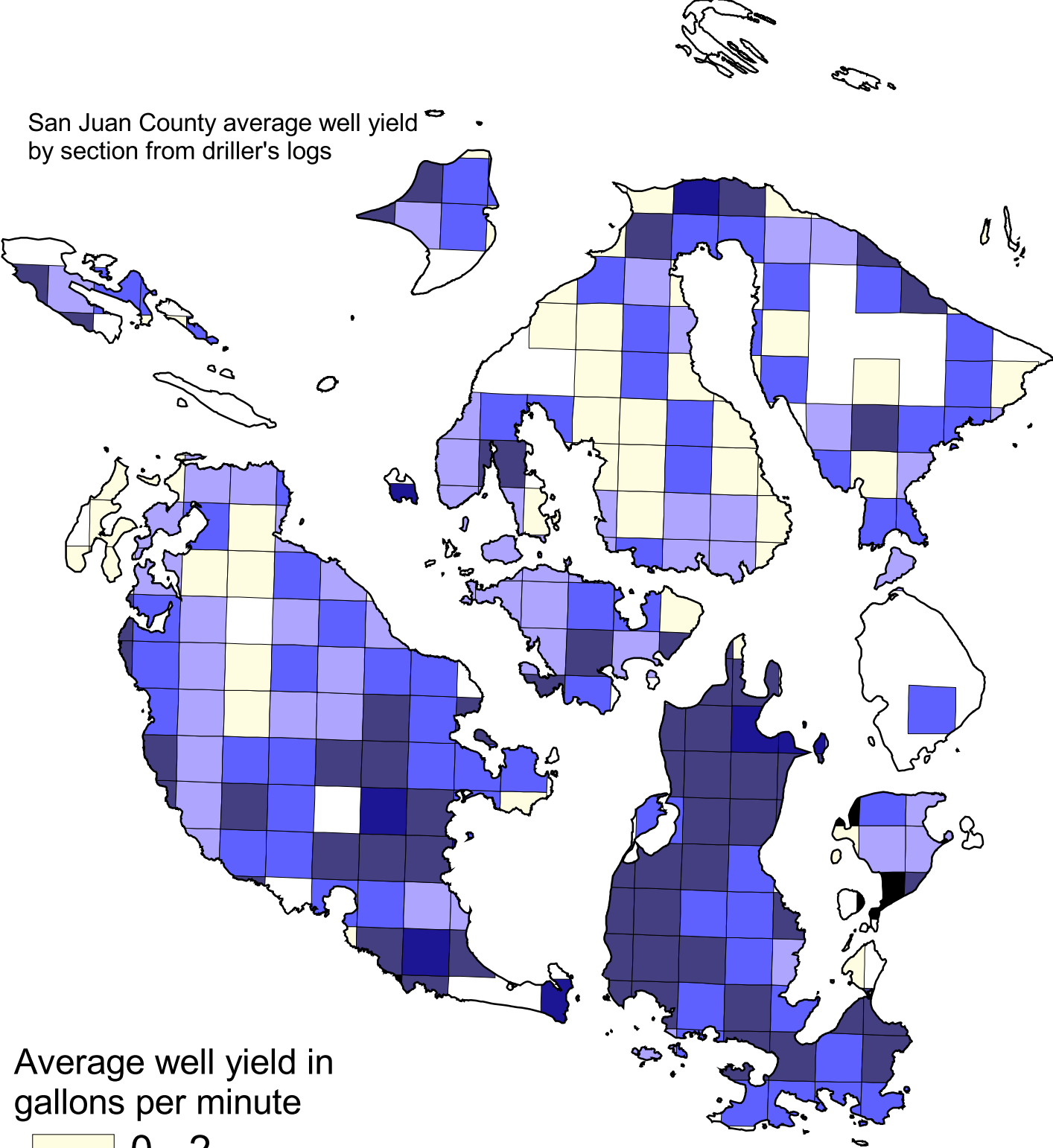


FIGURE 3.4. Estimated recharge for Lopez

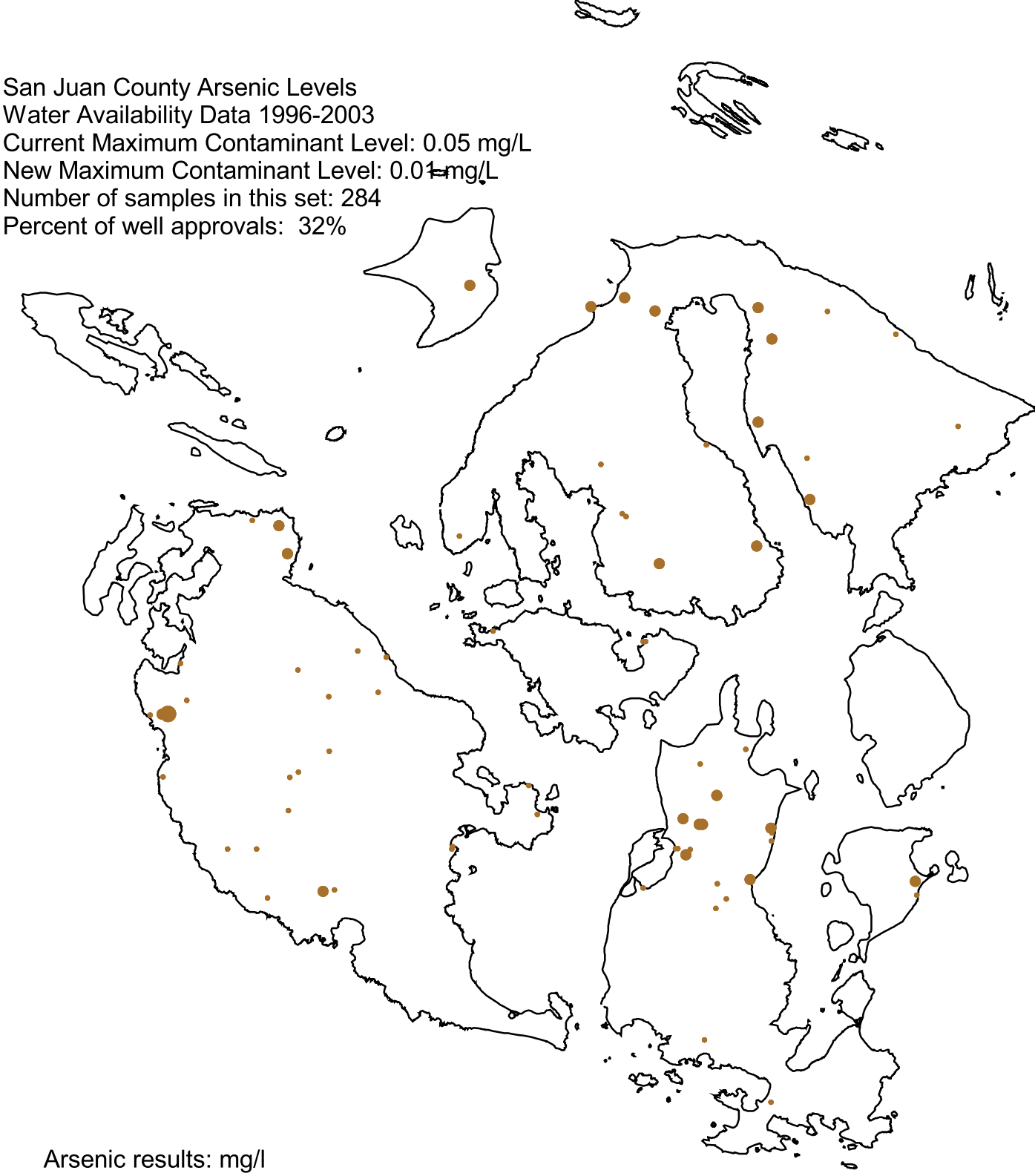
Source: USGS, fall 2001



NOTE: drilling log data is a rough estimate of yield at the time of well construction. This map is intended to give a general idea of well yield county-wide. Aquifer analysis and drawdown tests are needed to make accurate estimates of actual well capacity.

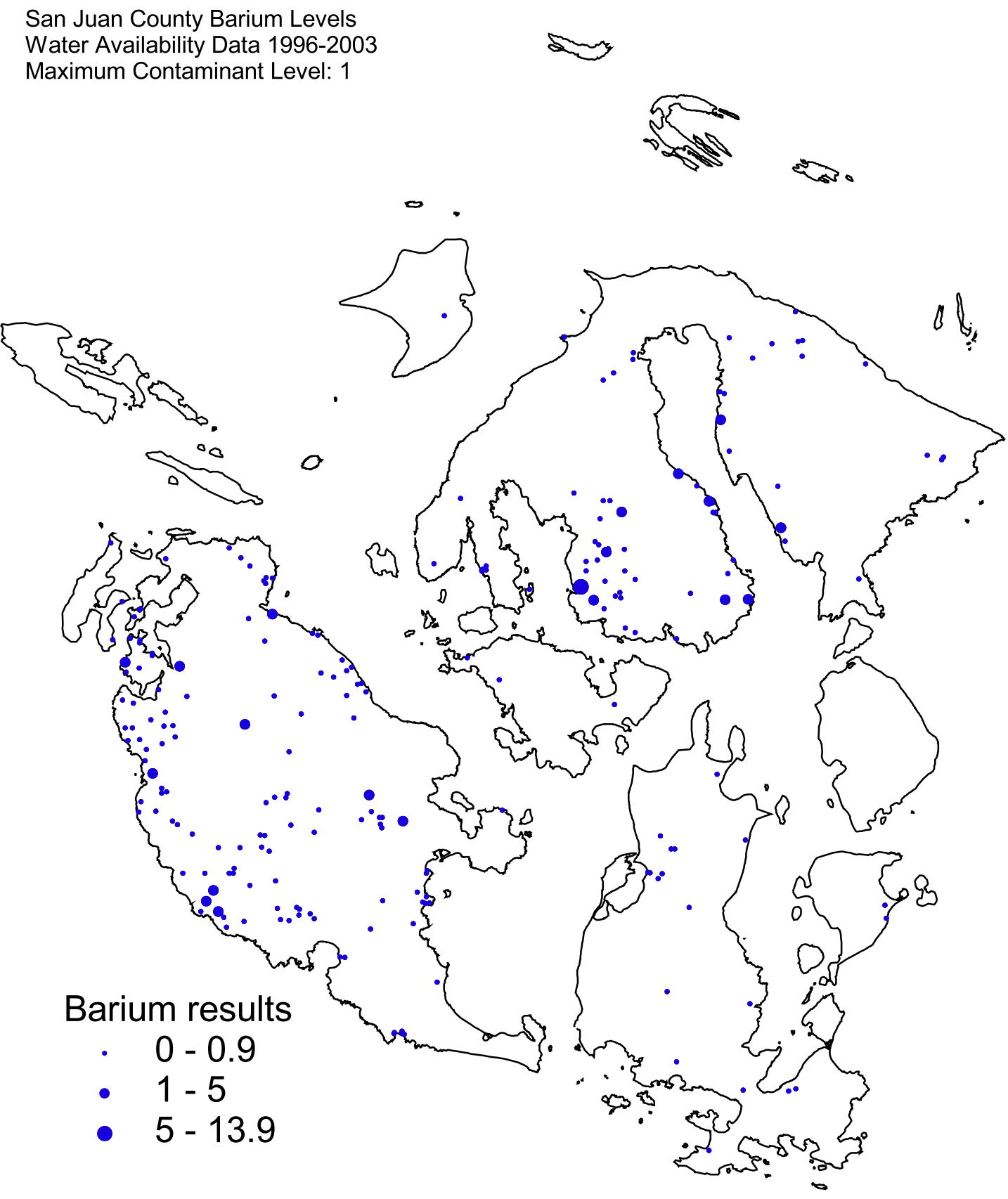
SJCHCS, 2004

FIGURE 3.5, Well yield by section



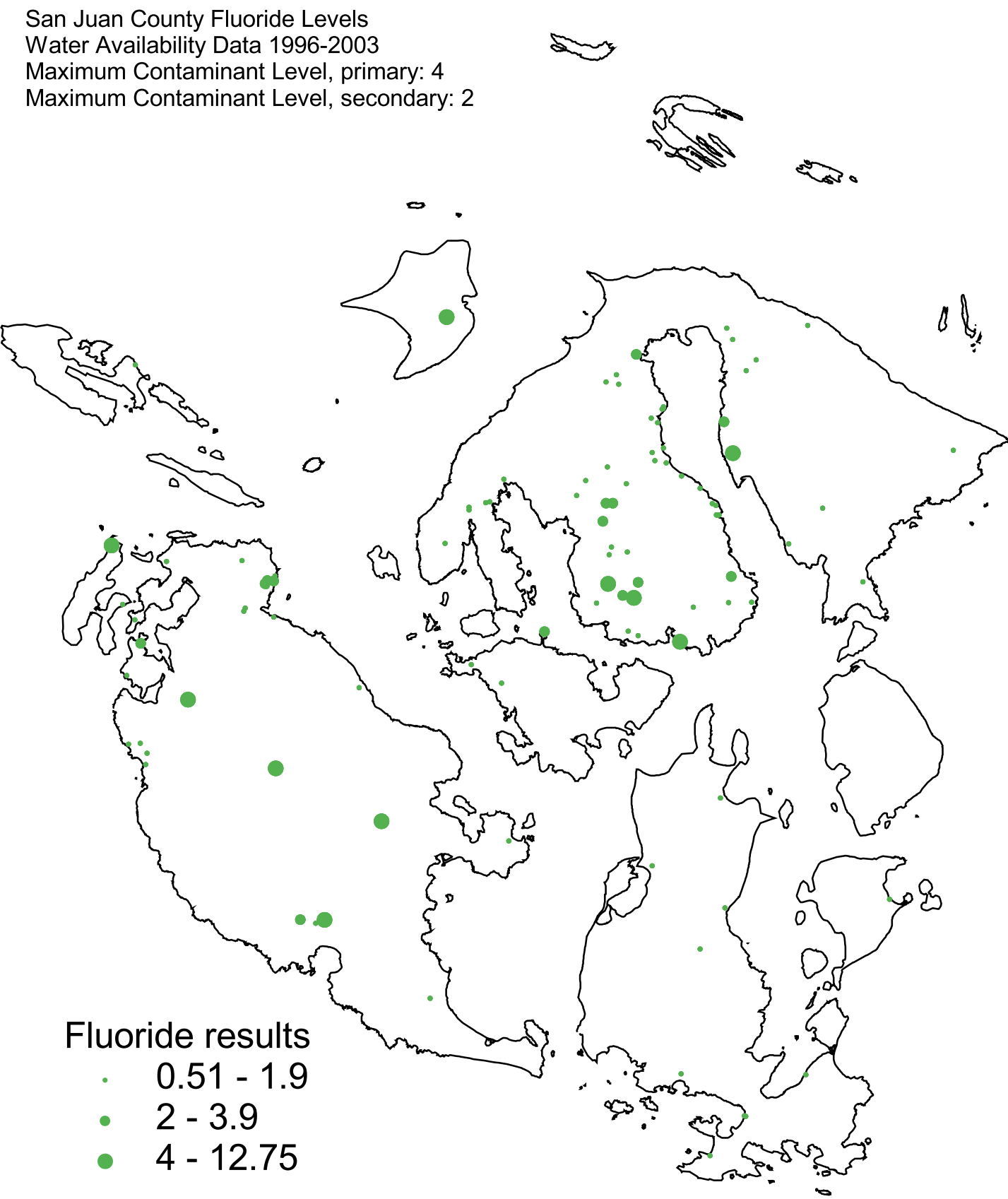
Source: SJCHCS, 2004

FIGURE 3.6, Arsenic levels in well water



Source: SJCHCS, 2004

FIGURE 3.7, Barium levels in well water



Source: SJCHCS, 2004

FIGURE 3.8, Fluoride levels in well water

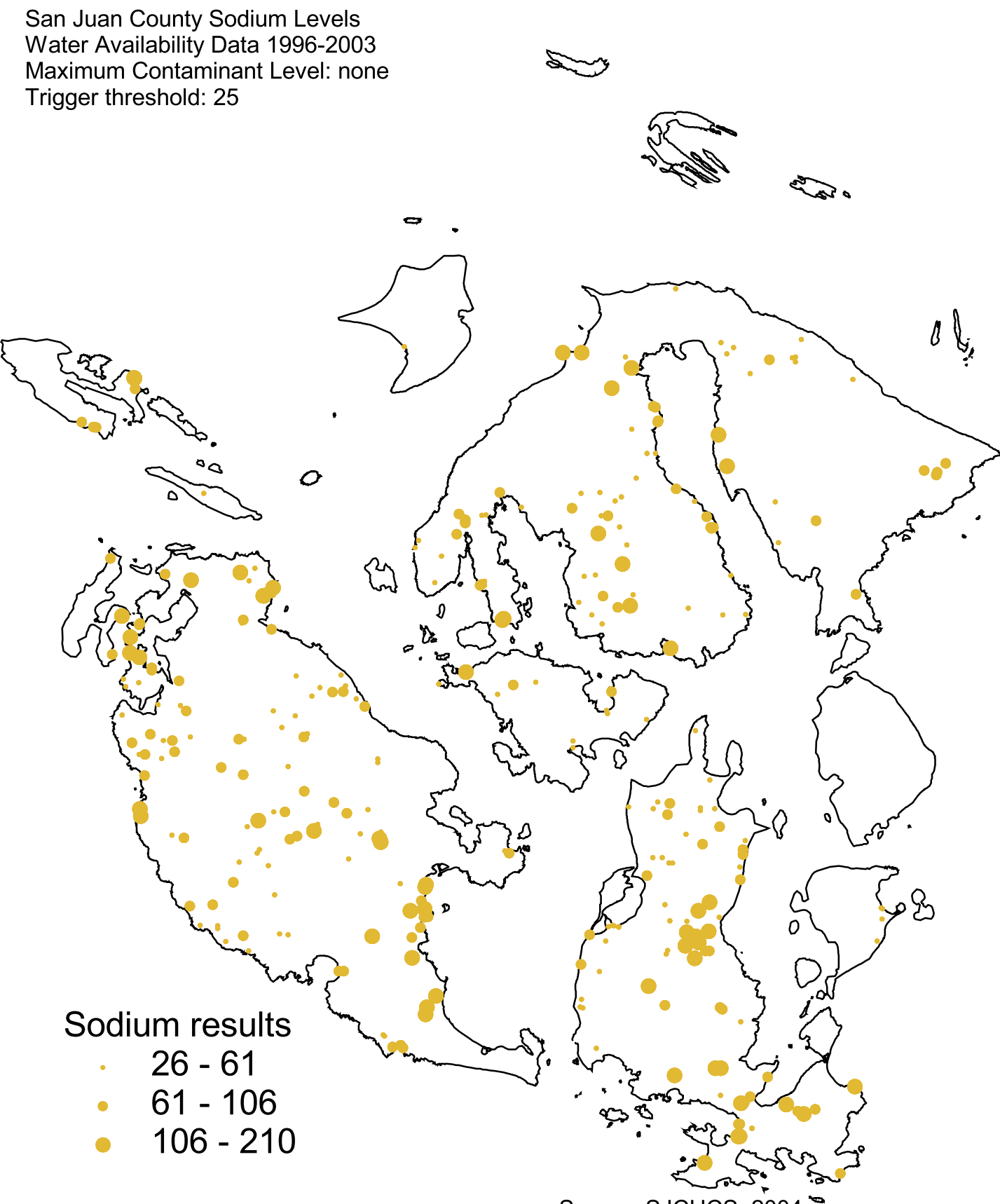
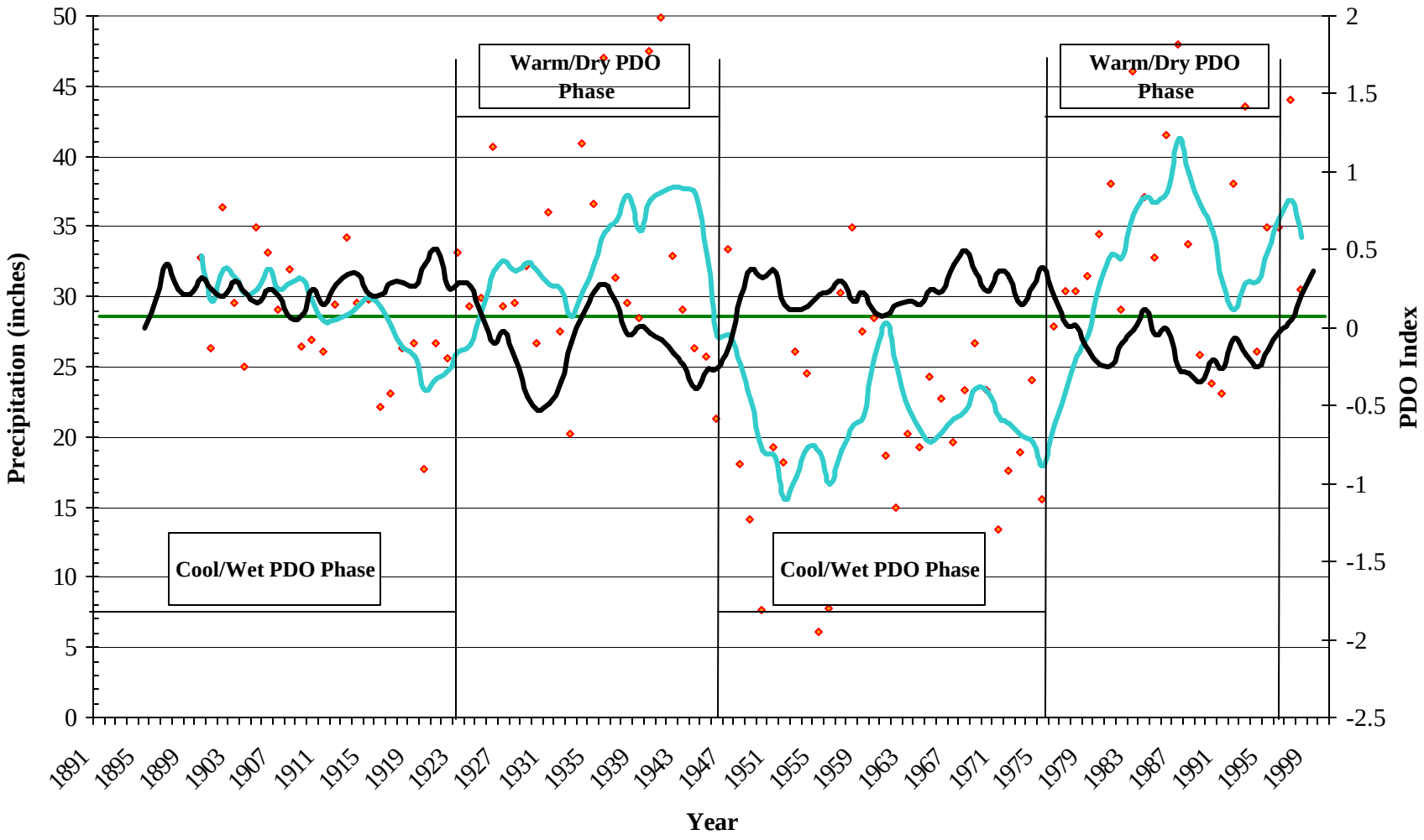


FIGURE 3.9, Sodium levels in well water



Legend

- Annual Average = 28.42 inches (1891-Present)
- PDO Index
- PDO Index: 5 Year Moving Average
- Olga Annual Precip: 5 Year Moving Average

Figure 4.1 Trend Analysis at Olga Gauge

San Juan County
Phase 2 Basin Assessment

MONTGOMERY WATER GROUP, INC.
Water Resources Engineering

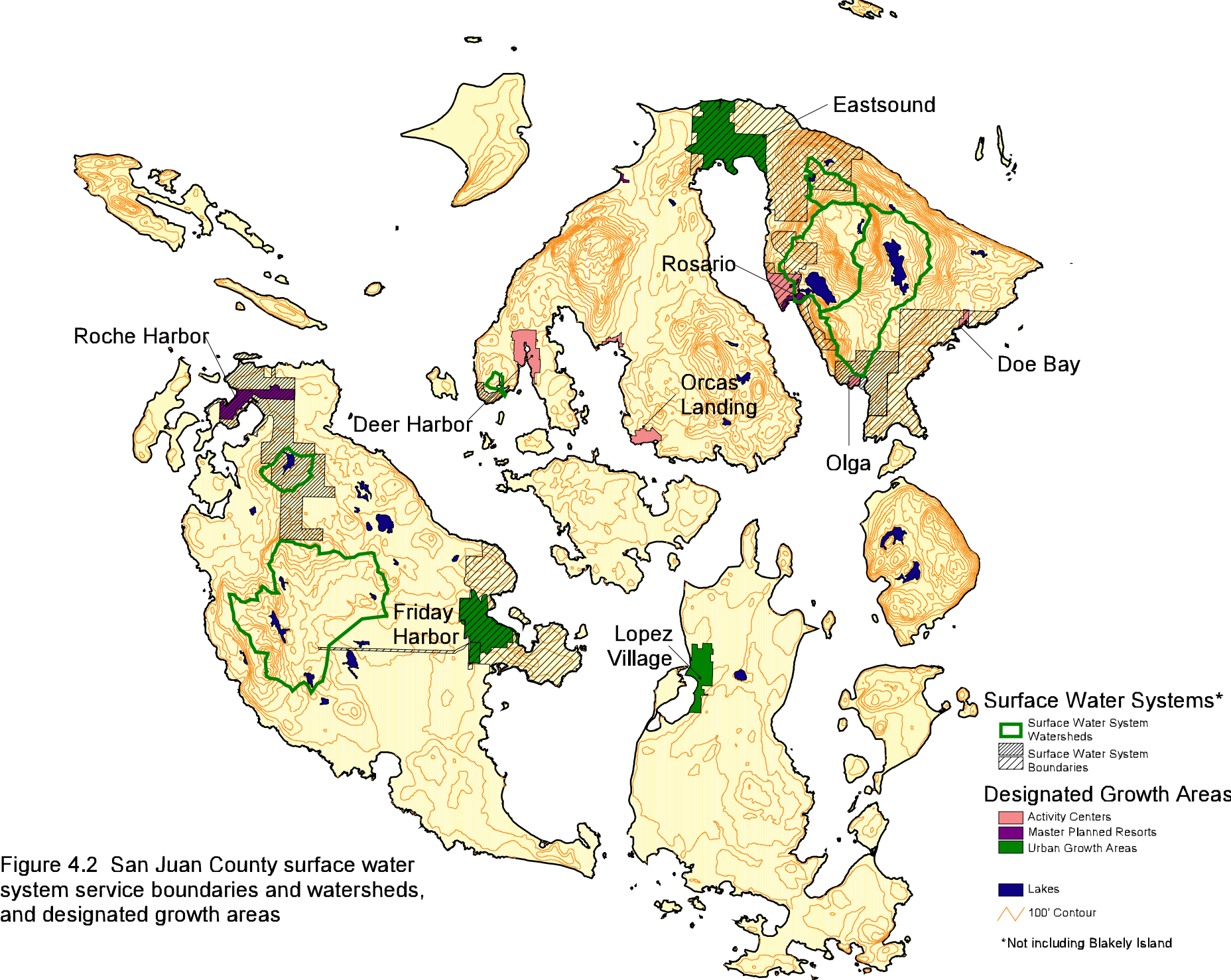


Figure 4.2 San Juan County surface water system service boundaries and watersheds, and designated growth areas

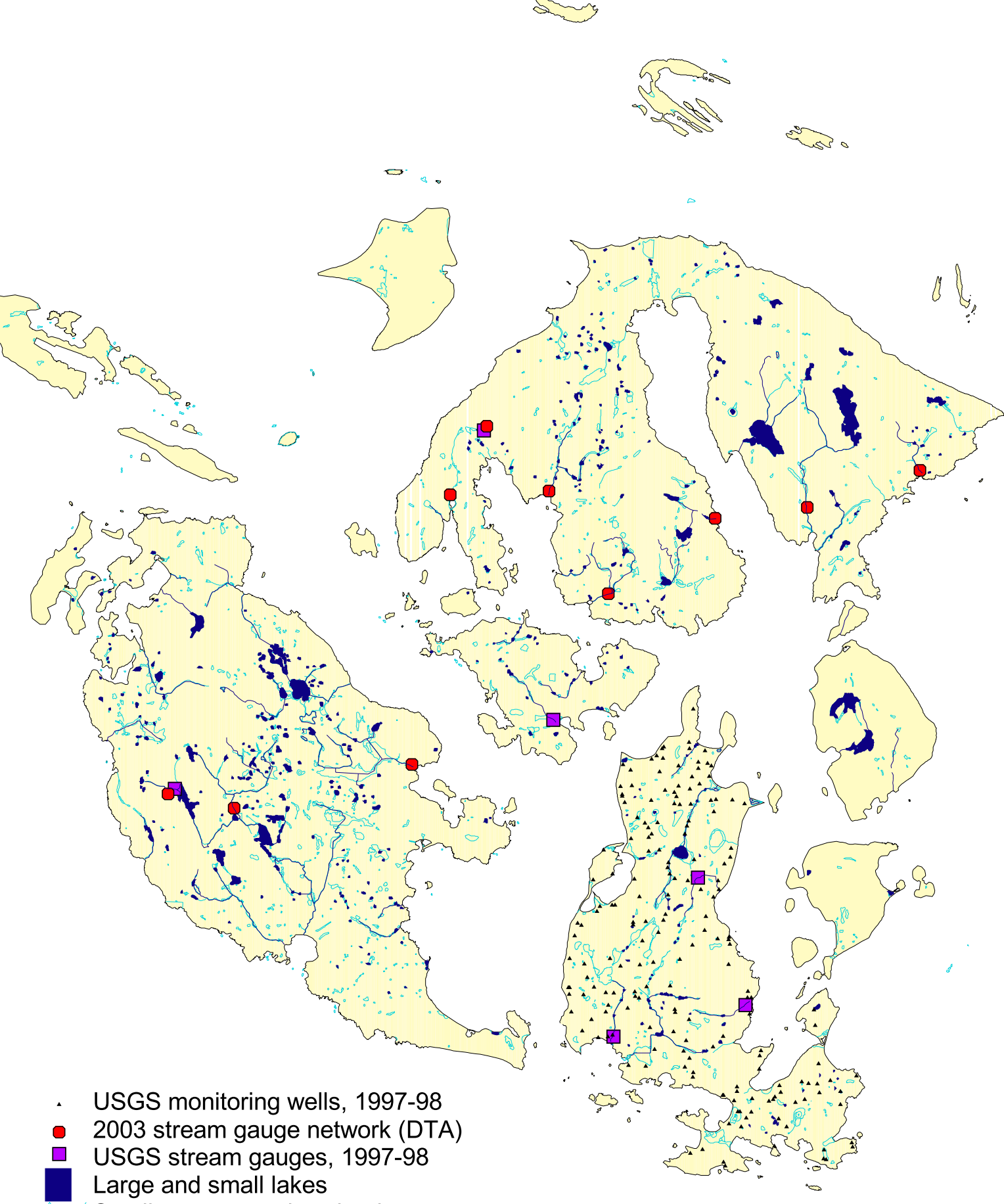


Figure 4.3. San Juan County streams and lakes. Stream gauges and monitoring wells.

San Juan County Water Resource Management Plan, Recommended Policies

1. Seawater Intrusion Policy

In 1982, a USGS study of San Juan County found that seawater intrusion was strongly suspected in 9 percent of the wells studied (26 of 279), with most of these wells located in the southern parts of Lopez and San Juan islands. A 2000 follow-up study by USGS on Lopez Island concluded that statistical tests of chloride concentrations indicated an increase over time.[1]

High chloride concentrations and chloride concentrations increasing over time are commonly used as an indicator of seawater intrusion. Chloride, a major constituent of seawater, is fairly stable chemically, and will move through a saturated zone at virtually the same rate as intruding water. One-hundred mg/L is the accepted threshold indicating seawater intrusion; however, chloride levels in this range might not be an indication of recent seawater intrusion but due to ancient seawater, artificial sources or heavy concentrations of sea-spray. In the 1982 study, Whiteman found that chloride concentrations in excess of 160 mg/L corresponded with a chemical signature similar to seawater and were statistically different from normal levels. Chloride is not a perfect indicator, but, without years of extensive study, it provides a useful framework to start making decisions.

In 1989, Island County adopted a Saltwater Intrusion Policy in conjunction with the WSDOH. The premise of this policy was later adopted by WSDOE as their Seawater Intrusion Policy, in 1992. These policies define three risk categories based on chloride levels, and maps a ½ mile radius around wells with these levels. Different conditions apply to each category, based on whether a water system is existing or applying for approval. In 2002, Jefferson County, in response to an order of compliance from the Growth Management Hearings Board, adopted a similar process for mapping risk areas, using a ¼-mile radius.[2]

At this time in San Juan County, using chloride levels to map areas susceptible to seawater intrusion is the best tool available to begin a long-term evaluation of the extent and impact of seawater intrusion. Requiring a greater level of analysis for approval of new water sources in these areas can give us a better understanding and protection of the resource -- if we take a comprehensive approach that includes long-term monitoring and research. This analysis must include cumulative impacts of all withdrawals in an aquifer.

---

[1] Occurrence, Quanity, and Use of Ground Water in Orcas, San Juan, Lopez, and Shaw Islands, San Juan County, Washington. USGS WRIR 83-4019
Is Seawater Intrusion Affecting Ground Water On Lopez Island, Washington? USGS Fact Sheet 057-00.

[2] State of Washington Department of Health/Island County Health Department Salt Water Intrusion Policy for Public Water Systems, 1989.
Seawater Intrusion Control in Coastal Washington: Department of Ecology Policy and Practice, 1992
Coastal Seawater Intrusion Policy, Jefferson County Board of Commissioners, 2002

Seawater Intrusion Risk Assessment Requirements:

	Significant impact categories:		
Susceptibility ranking:	LOW	MEDIUM	HIGH
LOW	Standard approval process	Standard approval process	Level I hydrogeologic report
MEDIUM	Standard approval process	Level I hydrogeologic report	Level II hydrogeologic report
HIGH	Level I hydrogeologic report; mitigation plan	Level I hydrogeologic report; mitigation plan	Level II hydrogeologic report

Susceptibility Ranking Categories:

High risk:
Within 1000 feet of shoreline
Within 1000 feet of wells with chloride greater than 160
Glacial geology, water table at sea level

Medium risk:
1000 feet of wells with chloride 100 – 160 mg/L
Interior of Lopez Island
Low risk:
Chlorides less than 100 mg/L and bedrock
Chlorides less than 100 mg/L and well completed above sea level

Significant Impact Categories:

High risk:
High density infill
High seasonal demand on groundwater sources
Estimates of available recharge exceeded by demand
Estimates of available recharge exceeded by water right allocations

Medium risk:
Projected demand (growth) supported by estimated recharge available

Low risk:
Projected demand (growth) less than estimated recharge available

2. Low-capacity groundwater areas and areas with natural contaminants.

San Juan County's fractured bedrock presents many difficulties for well water development. Water is contained in fracture zones that are intercepted by an uncased drilling hole. These fracture zones are highly variable, and in many areas yield limited amounts of water. The fractures can be susceptible to surface water flow, with little protection from surface contaminants, or from seawater intrusion. The fractures can also leach naturally-occurring contaminants into the well water, such as arsenic, barium, and excessive amounts of fluoride. In some areas well production will diminish or fail during the summer months when demand is high and recharge is low. Many community systems in these conditions struggle to provide adequate water to their customers, often drilling many low-yield wells. Individual well owners have fewer options, particularly in areas with small lots with limited access to additional well sites or community water supplies.

It is difficult to address bedrock well capacity on a regional basis. In most cases, bedrock fractures are discontinuous and interference between bedrock wells is probably minimal. The flow of water through bedrock fractures in the geologic jumble of the San Juans is not easily quantified. Information on bedrock well capacity and water quality is presented here as information for individuals, planners, and developers. Areas falling into the high risk category

should be scheduled for additional assessment and, where feasible, public water supply development. New subdivision in these high risk areas should be limited.

Low capacity groundwater areas and areas with naturally-occurring contaminants, risk assessment requirements

Susceptibility ranking:

High risk:
Bedrock area, average yield less than 5 gpm, or
Area known to have high incidence of barium, arsenic, fluoride

Medium risk:
Bedrock area, well production average 5 gpm or greater, low incidence of barium, arsenic, fluoride

Low Risk:
Bedrock or glacial, well production average greater than 5 gpm, low incidence of barium, arsenic, fluoride

Impact ranking:

High risk:
Five acres or less designation, no public water supply options

Medium risk:
Five acres or less designation, public water supply options available

Low risk:
Designation is 10 acres or greater

White Paper

The Hydrologic Impact of Rainwater Catchment Systems On the Groundwater of the San Juan Islands

April 21, 2004

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Purpose - The purpose of this White Paper is to (1) consider the impact of residential rainwater catchment systems (RCS) on the groundwater of San Juan County; (2) compare this impact to exempt well systems; and (3) to demonstrate a spreadsheet model for planning catchment systems. The focus of this discussion is on systems that provide potable water to individual houses. However, this information also has application to catchment systems that provide non-potable water for stock watering or gardens. As a starting point we will consider the status and design of RCS's in San Juan County.

Choosing a Residential Catchment System - Those considering the use of a RCS should bear in mind that these systems are more participatory than a community water system. In town, the resident's job is to pay the bill, turn on the water and practice a reasonable level of conservation. When one decides on a RCS, you have become the plumber, the guy that cleans gutters, the operator who monitors stuff, the sanitarian that makes sure the treatment system works, and the policeman who limits the kid's shower time; and you still pay the bills. RCS's seldom allow much outdoor watering and conservation must be considered at all times. In drought years you may need to buy water, an expensive possibility. You will have just gotten a new hobby.

Setting – San Juan County is made up of several hundred islands with the four larger being served by ferries from Anacortes, Washington. The total area of the county is 265 square miles, with the land area being 172 SM. The current permanent population is about 15,000 increasing significantly in the summer.

Domestic water is supplied primarily from wells and surface impoundments. Alternative sources include desalinization, rainwater catchments and hauling. The aquifers that supply water are typically glacial-deposit or bedrock.

Rainfall, which is the source of most domestic water, varies from about 18 inches per year in southern Lopez to 48" at the top of Mt. Constitution on Orcas.

Current Status –In the last 10 years, about 2,700 residential water supplies have been approved of which 70 (2.6%) are RCS's. Some are for summer homes but systems for

full-time residents are very common. In a few, special cases RCS's supplying more than a single residence have been approved.

To obtain approval for a RCS, the homeowner applies for a Certificate of Water Availability. We reviewed applications for 12 RCS, selected at random. We spoke to 9 of 12 owners. The responses are summarized on Table 1 and tabulated on Table 2.

Table 1 – Summary of 12 (of 70) Existing Residential Catchment Systems

	12 Approved Systems	5 Installed Systems
Average Water Budget-GPD	79	68
Average Days in Residence-Days/yr	284	263
Average design rainfall-inches per year	25	23
Required - Average Roof Area-SF	1,448	1,240
Required-Average Storage Volume-Gallons	7,294	6,543
Actual-Average Roof Area-SF	na	3,130
Actual-Average Storage Volume-Gallons	na	10,550
Owners Opinion of Catchment System	na	Good+

In all reporting cases the actual roof area and storage volumes were larger than shown on the application. About 4 of the 9 reporting cases have not actually constructed a catchment for various reasons. Two still plan to do so.

The county provides a format for planning an RCS. The permit applicant must show their basis for calculating system requirements. We compared the derived permit values (above) to values derived from a more complex model (discussed below). We conclude that the county system under projects an appropriate storage size by some amount. This isn't a major issue as most catchment owners build more than the required catchment.

Most RCS's are added to a house after the original well has failed and there is no other water source. However, in some instances approval is given before a house is built where a property owner can demonstrate that a new well is very unlikely to produce a satisfactory water supply and where no other practical sources exist.

At this time, the County is in conflict with state law by permitting RCS's without requiring that the owner obtain water rights (to the rain) from the Department of Ecology. The current expectation is that negotiations between the State and the County will find a way to resolve the "water right" issue. In any case, the County continues to issue approvals for RCS's.

Basic Components of a Residential Rainwater Catchment System - Typically a catchment system constructed to provide potable water has six basic components.

1. The Catchment Area – This is the roof where the water is collected. The favored roof material for new systems is enameled metal. The type of material used is important to how much water is collected. For example, a well constructed, clean, steep, metal roof may have a collection efficiency in the range of 98%; A concrete roof with minimal slope might have an efficiency of 85 - 90%; and a composition roof with fir needles and moss may have an efficiency as low as 75%. (The efficiency may be further reduced if there are trees "shadowing" the roof area.) We'll use the term "Rainfall Efficiency (RF)" for this measure of efficiency.

2. Gutters and Downspouts This is the elements that transport water from the catchment surface(s) to the storage tanks. The gutter area should be counted as part of the catchment area.

3. Leaf Screens and Roof-washers These are elements that remove contaminants and debris that might come from the roof. In some areas, RCS have included "Roof-washing" systems that divert the "First-flush" of water (as a rainstorm starts), away from the storage tanks. This refinement is worth considering as a water quality measure. There are some first flush systems in the county but apparently they are not generally required.

4. Storage Tanks – An RCS requires storage where the collected rainwater is stored. In the San Juans, most individual new tanks are rotomoulded polypropylene units in the 2,800-gallon size range. Typically a single-family system will have 2 to 8 of these tanks. Often these tanks also serve to settle out particles that have passed through the leaf screen. The storage tanks can serve a significant fire protection role to both owners and their neighbors. Owners should consult with Fire District personnel as how best to place fire connections and to provide adequate flows. In most cases it may be prudent to provide for a place to receive water into the system rapidly if it is necessary to buy hauled water at start-up or during droughts.

5. Water treatment – In an RCS it is necessary to treat water before it is used for domestic purposes. The treatment systems used in the county generally consist of a pump, a water meter, filters and disinfecting elements. The units are often "wall-hung" and about the size of a refrigerator in a camping trailer. The treatment system is typically placed between the storage tanks and the house. (Where the rainwater is being collected for non-potable use such as garden watering, the water treatment element is generally not included.)

6. Piping – This is the piping required to carry the stored water to the "point of use".

Where a system is to provide potable water a professional engineer or a licensed water supply designer must design it. Qualified individuals should undertake construction and assembly of system components. At least once a year a qualified installer should inspect the system, especially the treatment elements. (This is not required by the county but is strongly urged on the owner.)

Initial Costs - Each situation differs but after questioning several installers and owners we have defined a “typical basic system” for estimating. It would already have available 2,000 sf of roof area or more; it would have water tanks, with a combined effective storage volume of 8,000 gallons or more; and it would have all necessary treatment. The home would be for two people living full-time; they'd have a full compliment of "water saver" fixtures. Outside water use would be minimal in dry months and the owner would be conscious of the nature of the water supply. Most questioned said that an estimate of the initial costs in the range of $10,000 to $15,000 seems appropriate.

System Startup - An initial cost common to catchment systems is the need to buy "startup" water from suppliers. (The alternative being to wait for the rains to catch up.) Approved water haulers will supply water[1] to accessible sites in 2,000 gallon to 4,500-gallon loads for $0.04 to $0.20 per gallon.

Water Consumption – Predicting water consumption in catchment systems is difficult. There have been few direct measurements so we can only look at other systems for examples. The following table compares the single-family residential (SFR's) units of several systems in terms of size and consumption. It also illustrates the impact of water costs on consumption and the impact of meters.

Table 2 – Water System Examples

Water System	Eastsound	Frid. Har.	Harbor	Fish Bay	Cattle Pt	Potlatch
Island	Orcas	San Juan	Lopez	Lopez	San Juan	Guemes
Type of Units	SFR	SFR	SFR	SFR eq.	SFR	SFR
Source of Water	Surface	Surface	Well	Wells	RO	RO
Timeframe	Yr 2000	Yr 2000	Current	Current	Current	Current
Annual Total-MG	35.57	40.17	3.13	9.30	0.96	0.62
Peak Month-MG	4.74	5.36	0.45	1.33	0.13	0.06
Average Month-Gal/Conn	5,156	4,133	5,325	6,858	2,424	1,845
Nominal Connections	575	810	49	113	33	28
Peak Month-GPD/Conn	266	213	296	381	125	69
Ave.Month-GPD/Conn	172	136	175	225	81	62
Metered?	Yes	Yes	Yes	Yes	Yes	Yes
Charges Based on Meters?	Yes	Yes	No	No	Yes	Yes
Monthly Ch-@Ave Use	$ 31	$ 44	NA	NA	$ 81	$ 75
Monthly Ch-@4,000 GPM	$ 28	$ 37	NA	NA	$ 120	$ 130

*SFR=Single Family Res.

Drought Issues – While our planning model attempts to deal with drought issues, it is to be expected that a RCS will need water brought in from another location. Water is now

[1] From your island, other islands, or Anacortes.

hauled from class A systems in "approved" trucks to many islands on a routine basis. Presently Friday harbor sells large quantities of water to haulers, as does the city of Anacortes. The where the buyer is near the source the cost of a 3,500 gallon truckload is in the range of $0.04 to $0.06/gallon. On Lopez where there is currently no certified hauler or approved source, water from San Juan or Anacortes cost from $0.10 to $0.14/gallon in loads up to 4,500 gallons.

The larger question is will there by water for sale to catchments in an extreme drought year? Perhaps not but if we compare the plight of a catchment owner to the plight of one with an exempt well source, there may be little difference.

Distribution of Consumption – Lopez examples - We also have data available from 14 nominally full-time residential units (in two Lopez systems on community wells) over a two-year period. The meters are read monthly but charges aren't based on consumption. The meter readings are used primarily to locate leaks or unreasonable use. Both systems are well educated on the need for conservation. In general, the water isn't used for significant landscaping. The annual average consumption for these two systems is almost identical and averages 117 gallons/day. The monthly average distribution is shown on Table 3.

Table 3 – Comparison of Consumption

We can compare the "Lopez Examples" consumption to other systems in the County.

	Annual G/Day	Charge by Meters	Ch.for 4,000 g	Source
Eastsound-Orcas	172	Yes	$ 28	Surface
Friday Harbor-SJ	136	Yes	$ 37	Surface
Harbor-Lopez	175	No	LS	Wells
Fish Bay-Lopez	225	No	LS	Wells
Cattle Point-SJ	81	Yes	$ 120	Desal.
Potlatch-Guemes	62	Yes	$ 130	Desal.
Metered-Lopez-Table 2	117	No	LS	Wells

We'll compare these systems to a catchment system in these qualitative terms:

- The surface and well sources would be viewed as less limiting by homeowners than catchments.
- All sources would be viewed as more costly on a monthly basis than catchments.
- Catchment users might view desalinization users as models. If the desalinization systems get by on 60 to 90 gpd, that amount of water might be doable for a catchment user.

- Typically catchments have markers that make it very easy to see where the storage levels are. This probably has much the same impact as meters that are read each month.

- Catchment systems are very participatory for the customers and one would expect a tendency to careful water use.

Based on the above comments, we will assume that the owner of a "typical" catchment system will consider a supply pf 85 GPD to be satisfactory. This supply will be distributed through the months as shown on Table 4.

Catchment System Capacity Model – Sample computation

While the existence of operating catchment systems demonstrates their utility on Lopez Island (and the rest of the San Juans), they will not meet every need. The amount of water that can be harvested is a function of roof size and type, location, storage, assumed rainfall pattern, and pattern of use. For purposes of this White Paper we will construct a spreadsheet model and undertake a sample computation for an RCS to demonstrate how one might estimate the suitability of a particular configuration to meet a particular needs. For this sample computation, we us assume these criteria:

Pattern of Use – Even in a RCS, the consumption rates will probably vary through the year. We have proposed a pattern based on the Lopez metered systems described above. It is illustrated on Table 4.

Table 4 – Water Use Distribution

	Monthly Distribution
Jan	7.9%
Feb	8.6%
Mar	6.7%
April	8.0%
May	7.8%
June	10.9%
July	11.0%
Aug	10.0%
Sept	8.9%
Oct	7.2%
Nov	6.9%
Dec	6.1%
Average	100.0%

Water Use - As a first step in catchment analysis, we will assume an annual average water use of 85 G/Day. This is as measured by the average used over the planning period.

Assumed Rainfall Pattern – See attached Table 5. This is from the rain gage operated by Jack Giard near the center of Lopez Island over the years 1996 to 2003. This rain gage produces total rainfall readings within 2% of the sewage treatment plant rain gage in Lopez Village. We will assume that our computational models will work over a six-year rainfall period in this pattern.

Assumed Location – We'll use the center of Lopez Island, which would require no adjustment to the rainfall amounts of Table 5. (RAF=100%)

Planning Period – We will model based on the six-water year period of Table 5. This expresses the expected variations in rainfall over time (18.8" to 34.1"/year) and captures at least one dry year,

Roof Size and Type – For this computation we will assume a metal roof area of 2,100 square feet. This can include area from the house, shops and garages. (Range of 2,000 to 3,600)

Rainfall Factor (RF) - We'll assume the efficiency of rainfall collection (The rainfall factor-RF) to be 95%.

System Efficiency (SE) – Not all of the water that leaves the roof surface will be available for consumption. Leaf Screens and Roof-washers, especially during the "first flush" of a rainstorm use water will reject water from the system. There are losses that occur during system cleaning. There may be leaks. We'll assume the system efficiency (SE) to be 96%.

Storage – Storage is important in defining a systems capacity. For this modeling effort we have determined a storage volume of 14,500 gallons by "trial and error".

Storage Losses - Water is lost when tanks fill and overflow. This loss of water is derived from the model's operation. A second lost in operating the model is the water storage volume change from the start of model operation to the end.

Hauling – For this example we will assume that when the stored water gets down to 10% of the maximum storage, the owner will purchase a quantity of water equal to 3,500 gallons, a truck size typical of some local haulers. We will assume that over the 6-year period this will occur no more than twice.

Drought Consumption (DC) – For this example we will assume that when the stored water gets down to less than 40% of maximum, the consumption (DC)

will be reduced to 80% of the Basic Water Use. However, over the life of the model the total consumption will be assumed to average the 85% noted above.

Catchment Impact Model

Attached and enclosed is a series of Tables which will demonstrate this model based on the values defined above. This is a description of the individual tables:

Table 5 – Planning Basis Rainfall – This is attached and based on actual data from central Lopez. For the years 1996 to 2003.

Table 6 & 7– Catchment Model – Detail and Summary – Table 6 (attached) is a spreadsheet model using the above factors. In this model the variables of area and storage are manipulated until the system provides the basic flow desired. Table 7 summarizes the results:

Table 7 - Catchment Model Summary

Storage in Gallons	14,500	
Roof area in SF	2,100	
Rainfall onto roof in 6 years in inches	160	
Rainfall onto roof in 6 years in gals	209,100	
Rainfall into tank in gallons	190,689	
Hauled water into tank in gallons	7,000	
Total into tank in gallons	197,689	
Lost in Tank overflow in gallons	(7,506)	
Lost to Increase tank storage in gallons	(4,652)	
Water Use in Gallons	185,531	
Total Water Use in GPD/Residence	85	<<Main Criteria
Water used from Rain in gallons	178,531	
Actual Rainwater Use in GPD per residence	81	
Overall Efficiency of Rainwater use	85%	
Haul Truck Loads of Water	2	

Conclusions – If we were to construct a RCS with 14,500 gallons of storage and a 2,100 SF roof we could rely on 85 gpd. Increasing the storage by 25% would increase the available flow by no more than 6%. Whether this system would meet the needs of an individual home is a function of personal lifestyle. Clearly, when one is relying on domestic catchment systems, household conservation is important; low flush toilets, low use fixtures, and so on. Perhaps the best conservation measure can be found in the homeowner's attitude.

Water Balance – Sample Catchments

To determine the impact of this RCS, it may be helpful to derive a water balance. We have done this, starting from Table 7, on Table 8, attached. Table 8 is based on several assumptions.

- The water used through the house's plumbing, 85 GPD average, will include 5% that is used outdoors. The rest passes through the house into the septic system.

- The water that enters the septic system will include 13% that evaporates into the atmosphere. The rest passes into the aquifer as recharge water.[2]

- The water that "goes" outside (from the house, tank overflow, screening, roof spillage) will include 43% that will eventually go into the atmosphere. The rest passes into the aquifer as recharge water.

- Reviewers suggested that the values of the two proceeding paragraphs were too low. In running the model that is the base for Figure 1, I made a second run with the 13% being 25% and the 43% being 80%. The outcome will be discussed below.

- Of the rainwater that falls from the sky onto an undeveloped area, about 10% enters the aquifer and about 25% of that is available for wells.[3]

Table 8 combines the above factors with Table 7 to derive a Water Balance table for our example RCS. In summary, this single RCS reduces the water that falls on the roof (95.4 GPD) to the water that enters the aquifer (79.2 GPD) by 16.2 GPD. Table 8 is further illustrated on Figure 1.

---

[2] Figure 1 - Chehalis Watershed Plan, WRIAs 22 and 23 plan

[3] The annual average rainfall on Lopez is about 26 inches. The USGS study indicates that the island wide recharge rate for Lopez taken as a whole is 2.49 inches (10%). The remaining 90% is removed by surface runoff, evaporation, vegetation, etc.

Of the recharge amount only a fraction is actually available for use. The fraction varies with proximity to the ocean or streams, the type and location of wells, and soil types. The San Juan Water Resources Management Committee has suggested a "rule of thumb" of 20%. Carr estimated 25% for Vashon Island. Economic and Engineering Services suggested (1990) that values could range between 0% and 50%.

We asked one of the authors of the recharge study for his current opinion. He replied:

> "For Lopez Island as a whole, 20-30% of the total island recharge is probably a good conservative estimate of water availability for hundreds of wells spaced evenly over the island. I hope this helps. - Henry Bauer"

For our purposes we will assume that the available fraction is in the range of 20% to 30%. For our calculations we'll use 25%.

As noted above, in response to reviewers, we ran the model with differing values for ET discharge. In summary, this single RCS reduces the water that falls on the roof (95.4 GPD) to the water that enters the aquifer (63.7 GPD) by 31.7 GPD.

Water Balance – Exempt Wells

Figure 2 illustrates the water balance for a house using an individual well. The added element here is illustrating that this situation requires at least 1.33 acres of "natural" land to gather the water needed to feed the well (in addition to the water recycled from the house).

Residential Catchment Systems - Summary

The purpose of this White Paper is to (1) consider the impact of residential rainwater catchment systems (RCS) on the groundwater of San Juan County; (2) compare this impact to exempt well systems.

It is not especially easy to find direct and meaningful comparisons between catchments and wells but we can find some:

- In our example of Figure 1 the catchment system will supply a house with an average of 85 gpd with a 2,100 SF roof and catchment tanks holding 14,500 gallons. The gross system inflow is 95 gpd with 64 to 79 gpd returning to the groundwater.

- The house of Figure 2 (Exempt well) will receive the same supply from 1.33 acres of land with up to 73 gpd returning to the groundwater.

- Catchment systems are limited to how much they can provide by the roof and tankage sizes, and Mother Nature. A house on a well can use much more water with minimal control.

In summary, I believe individual residential catchment systems:

- Are a viable solution in many instances for San Juan County.

- Other things being equal, they will have little impact on the aquifer systems.

- Have less impact on aquifers than exempt wells providing the same supplies.

- Require that the owners/user participate in their operation more than other systems. This should be understood before choosing a catchment as a water source.

- Are well suited to management by the county under a general permit by DOE.

References

The following documents were the primary sources of information used in preparing this White Paper.

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Lopez Village Water Supply Report and Recommendations and Abbreviated Coordinated Water System Plan, Lopez Village Water System Planning Committee, July 2003

A Summary Report on Water Issues on Lopez Island, Washington by Ronald Mayo (June 30, 2003) prepared for Lopez Village Water System Planning Committee
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Chehalis Basin Watershed Plan, draft 9/03. This contains references cited there:

1 Chehalis Basin Watershed Level 1 Technical Assessment (an average of the amounts identified for WRIAs 22 and 23)

2 Nature of Residential Water Use and Effectiveness of Conservation Programs, James P. Heaney, William DeOreo, Peter Mayer, Paul Lander, Jeff Harpring, Laurel Stadjuhar, Beorn Courtney, and Lynn Buhlig (Figures for Eugene, Oregon)

3 Solly, W. B., Pierce, R.R. and Perlman, H.A. 1993. Estimated Use of Water in the United States in 1990: U.S. Geological Survey Circular 1081.

Personal Communications

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Henry H. Bauer, Retired USGS.

Attached Figures and Tables

Figure 1 – Catchment System Water Balance
Figure 2 – Exempt Well Water Balance

Tables 1, 3, 4, and 7 are in the body of the text.

Table 2 – Sample Catchment Systems
Table 5 – Planning Basin Rainfall Table (Central Lopez)
Table 6 - Catchment Model
Table 8 – Water Balance Example #1 (From Table 6)

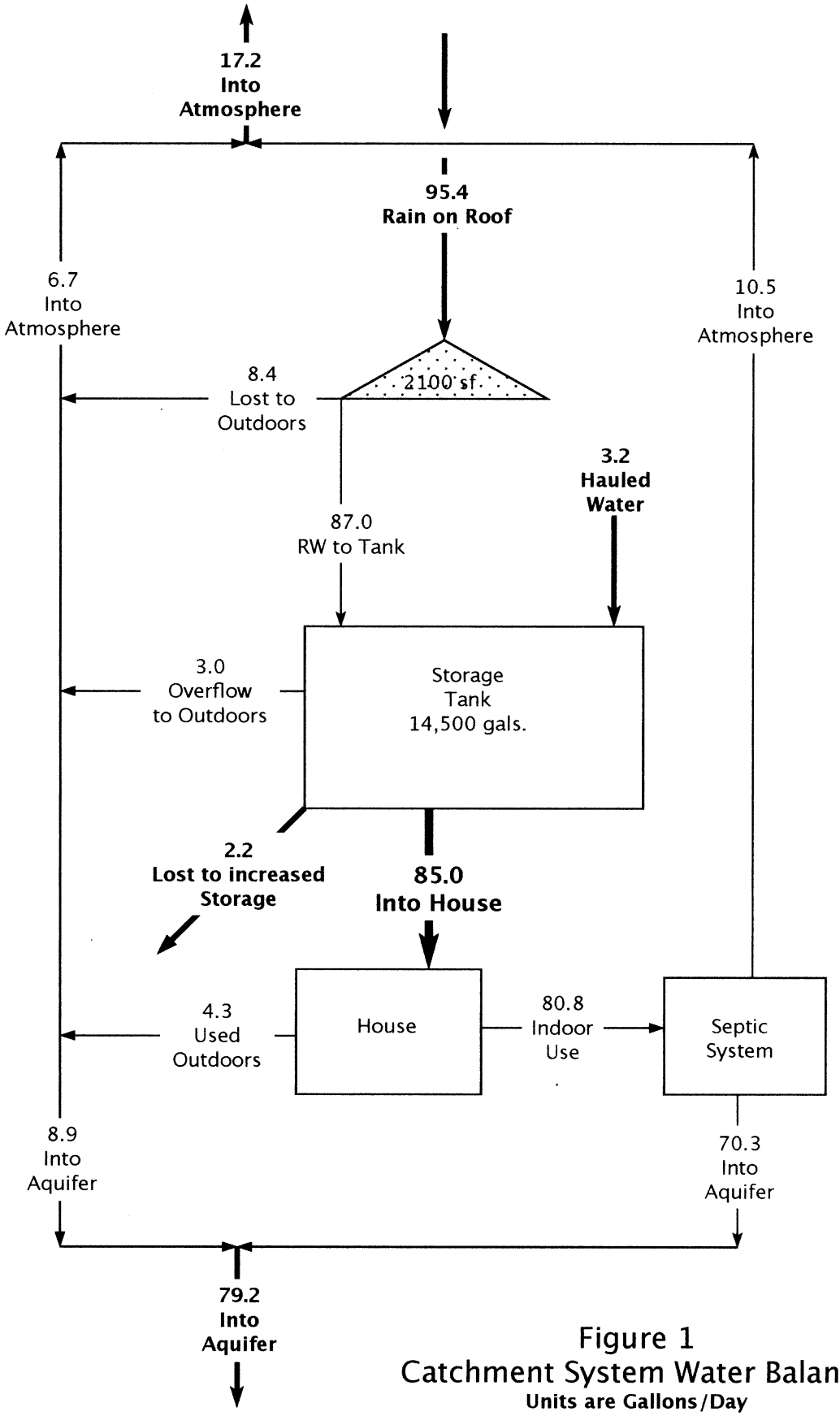

Figure 1
Catchment System Water Balance
Units are Gallons/Day

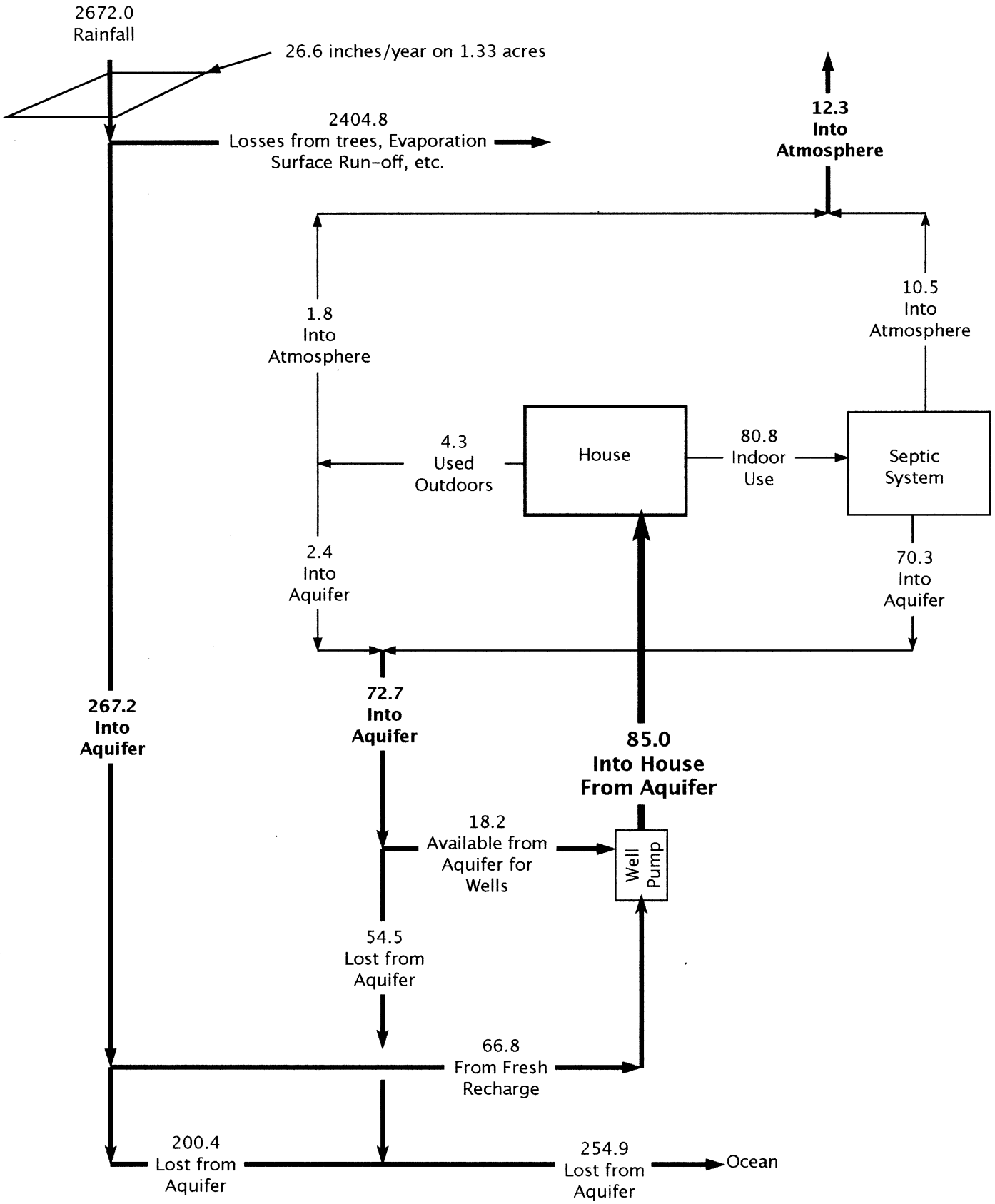

Figure 2
Exempt Well Water Balance
Units are Gallons/Day

Table 2 - Sample Catchment Systems

(Data From 12 of approximately 70 approved systems)

System # Given	Island Given	Permit Date Given	Water Budget GPD Given	Days in Resid./yr Given	Design Rain-inches Given	Days of Storage Needed Given	Water use per year gallons Calc.	Gallon per SF Year Calc.	Roof Area-SF Required Calc.	Storage in Gallons Required Calc.	Roof Area-SF Actual Calc.	Storage in Gallons Actual Calc.	Comments
Installed Systems													
1	Lopez	Sep-00	72	350	19	90	25,200	11.8	2,129	6,480	3,600	11,200	Very Satifa
4	Orcas	Aug-02	100	365	29	90	36,500	18.1	2,020	9,000	3,300	14,400	OK, Particij
6	Lopez	Jun-01	33	150	19	150	4,995	11.8	422	4,995	1,120	5,600	Happy with
7	Orcas	Jul-00	100	100	26	90	10,000	16.2	617	9,000	4,500	11,000	Love it, wo
10	Lopez	Apr-01	36	350	20	90	12,600	12.5	1,011	3,240	na	na	Very Happy
	Averages	**Apr-01**	**68**	**263**	**23**	**102**	**17,859**	**14**	**1,240**	**6,543**	**3,130**	**10,550**	
Systems Not Yet Operation													
2	Orcas	Sep-00	100	365	28	90	36,500	17.4	2,092	9,000	-	-	Did Not Bu
9	Orcas	May-01	75	365	30	90	27,375	18.7	1,465	6,750	1,920	na	Built w/con
11	Orcas	Aug-00	54	365	27	90	19,710	16.8	1,172	4,860	na	na	Not Started
12	Lopez	Feb-02	110	365	18	90	40,150	11.2	3,580	9,900	na	na	In construct
Systems Not Contacted													
3	Henry	Aug-01	100	90	26	90	9,000	16.2	556	9,000	2,800	na	3 Calls, No
5	SJ	Feb-00	50	365	30	90	18,250	18.7	976	4,500	na	na	Can't find c
8	SJ	Jul-00	120	180	26	90	21,600	16.2	1,333	10,800	2,000	na	Phone recor
AVERAGES ALL 12 SYSTEMS			**79**	**284**	**25**	**95**	**21,823**	**15**	**1,448**	**7,294**			

Table 2 - Sample Catchment Systems

(Data From 12 of approximately 70 approved systems)

System # Given	Island Given	Permit Date Given	Water Budget GPD Given	Days in Resid./yr Given	Design Rain-inches Given	Days of Storage Needed Given	Water use per year gallons Calc.	Gallon per SF Year Calc.	Roof Area-SF Required Calc.	Storage in Gallons Required Calc.	Roof Area-SF Actual Calc.	Storage in Gallons Actual Calc.	Comments
Installed Systems													
1	Lopez	Sep-00	72	350	19	90	25,200	11.8	2,129	6,480	3,600	11,200	Very Satifactory
4	Orcas	Aug-02	100	365	29	90	36,500	18.1	2,020	9,000	3,300	14,400	OK, Participatory
6	Lopez	Jun-01	33	150	19	150	4,995	11.8	422	4,995	1,120	5,600	Happy with system
7	Orcas	Jul-00	100	100	26	90	10,000	16.2	617	9,000	4,500	11,000	Love it, would add first flush
10	Lopez	Apr-01	36	350	20	90	12,600	12.5	1,011	3,240	na	na	Very Happy with system
	Averages	**Apr-01**	**68**	**263**	**23**	**102**	**17,859**	**14**	**1,240**	**6,543**	**3,130**	**10,550**	
Systems Not Yet Operation													
2	Orcas	Sep-00	100	365	28	90	36,500	17.4	2,092	9,000	-	-	Did Not Build House
9	Orcas	May-01	75	365	30	90	27,375	18.7	1,465	6,750	1,920	na	Built w/conventional source
11	Orcas	Aug-00	54	365	27	90	19,710	16.8	1,172	4,860	na	na	Not Started
12	Lopez	Feb-02	110	365	18	90	40,150	11.2	3,580	9,900	na	na	In construction-confident will be OK
Systems Not Contacted													
3	Henry	Aug-01	100	90	26	90	9,000	16.2	556	9,000	2,800	na	3 Calls, No Answer
5	SJ	Feb-00	50	365	30	90	18,250	18.7	976	4,500	na	na	Can't find contact
8	SJ	Jul-00	120	180	26	90	21,600	16.2	1,333	10,800	2,000	na	Phone recorder Twice
AVERAGES ALL 12 SYSTEMS			**79**	**284**	**25**	**95**	**21,823**	**15**	**1,448**	**7,294**			

Table 5 - Planning Basis Rainfall Table (Central Lopez)

inches per month

Design Year	1	2	3	4	5	6	Average	6 year total
Oct	3.71	4.05	1.14	2.78	1.86	4.49	3.01	18.03
Nov	4.68	2.25	7.03	3.68	2.02	3.37	3.84	23.03
Dec	5.38	2.58	6.14	4.37	2.41	4.69	4.26	25.57
Jan	4.65	3.27	4.62	2.24	2.55	4.81	3.69	22.14
Feb	3.23	0.83	3.53	1.65	1.50	2.24	2.16	12.98
Mar	2.94	2.79	1.93	1.52	2.35	2.47	2.33	14.00
April	1.89	0.36	1.09	1.61	1.43	1.72	1.35	8.10
May	2.63	2.17	2.21	2.74	0.78	1.39	1.99	11.92
June	1.63	1.27	1.80	0.97	1.75	0.83	1.38	8.25
July	0.96	1.18	0.88	0.56	0.56	0.40	0.76	4.54
Aug	0.53	0.08	1.79	0.96	0.93	0.32	0.77	4.61
Sept	1.84	0.21	0.23	1.41	0.66	2.22	1.10	6.57
Annual Rainfa	34.07	21.04	32.39	24.49	18.80	28.95	26.62	159.74

Table 6 - Catchment Model

Model Variables shown in Boxes	RAF Effective Monthly Rainfall Inches for Rainfall Adjust.Factor	Storage at Start of Month	Haul-in Water at when storage less than	Gallons of Rain Collected into Tank with RF= 95% and System Eff.=	Basic	Water Use Factor 80% When Reserv. Less than	Adjusted	Remaining Storage tank of	Overflow in
			1,480	96%		40%		14,800	
			Truck size	Roof Area SF		Otherwise			
Month	100%	Inches	3,500	2,100	Water Use	100%	Water Use	Gallons	Gallons
Oct	3.71	-	-	4,429	2,426	80%	1,941	12,312	-
Nov	4.68	2,488	-	5,587	2,255	80%	1,804	8,529	-
Dec	5.38	6,271	-	6,422	2,042	100%	2,042	4,149	-
Jan	4.65	10,651	-	5,551	2,666	100%	2,666	1,264	-
Feb	3.23	13,536	-	3,856	2,604	100%	2,604	12	-
Mar	2.94	14,788	-	3,510	2,258	100%	2,258	(1,240)	(1,240)
April	1.89	14,800	-	2,256	2,604	100%	2,604	347	-
May	2.63	14,453	-	3,140	2,618	100%	2,618	(174)	(174)
June	1.63	14,800	-	1,946	3,533	100%	3,533	1,588	-
July	0.96	13,212	-	1,146	3,699	100%	3,699	4,141	-
Aug	0.53	10,659	-	633	3,363	100%	3,363	6,871	-
Sept	1.84	7,929	-	2,196	2,906	100%	2,906	7,580	-
Oct	4.05	7,220	-	4,835	2,426	100%	2,426	5,172	-
Nov	2.25	9,628	-	2,686	2,255	100%	2,255	4,740	-
Dec	2.58	10,060	-	3,080	2,042	100%	2,042	3,702	-
Jan	3.27	11,098	-	3,904	2,666	100%	2,666	2,465	-
Feb	0.83	12,335	-	991	2,604	100%	2,604	4,078	-
Mar	2.79	10,722	-	3,331	2,258	100%	2,258	3,005	-
April	0.36	11,795	-	430	2,604	100%	2,604	5,179	-
May	2.17	9,621	-	2,590	2,618	100%	2,618	5,207	-
June	1.27	9,593	-	1,516	3,533	100%	3,533	7,224	-
July	1.18	7,576	-	1,409	3,699	100%	3,699	9,515	-
Aug	0.08	5,285	-	95	3,363	80%	2,690	12,109	-
Sept	0.21	2,691	-	251	2,906	80%	2,325	14,183	-
Oct	1.14	617	3,500	1,361	2,426	80%	1,941	11,263	-
Nov	7.03	3,537	-	8,392	2,255	80%	1,804	4,675	-
Dec	6.14	10,125	-	7,330	2,042	100%	2,042	(613)	(613)
Jan	4.62	14,800	-	5,515	2,666	100%	2,666	(2,849)	(2,849)
Feb	3.53	14,800	-	4,214	2,604	100%	2,604	(1,610)	(1,610)
Mar	1.93	14,800	-	2,304	2,258	100%	2,258	(46)	(46)
April	1.09	14,800	-	1,301	2,604	100%	2,604	1,302	-
May	2.21	13,498	-	2,638	2,618	100%	2,618	1,282	-
June	1.80	13,518	-	2,149	3,533	100%	3,533	2,667	-
July	0.88	12,133	-	1,050	3,699	100%	3,699	5,316	-
Aug	1.79	9,484	-	2,137	3,363	100%	3,363	6,542	-
Sept	0.23	8,258	-	275	2,906	100%	2,906	9,173	-
Oct	2.78	5,627	-	3,319	2,426	80%	1,941	7,795	-
Nov	3.68	7,005	-	4,393	2,255	100%	2,255	5,657	-
Dec	4.37	9,143	-	5,217	2,042	100%	2,042	2,482	-
Jan	2.24	12,318	-	2,674	2,666	100%	2,666	2,474	-
Feb	1.65	12,326	-	1,970	2,604	100%	2,604	3,108	-
Mar	1.52	11,692	-	1,814	2,258	100%	2,258	3,552	-
April	1.61	11,248	-	1,922	2,604	100%	2,604	4,233	-
May	2.74	10,567	-	3,271	2,618	100%	2,618	3,581	-
June	0.97	11,219	-	1,158	3,533	100%	3,533	5,956	-
July	0.56	8,844	-	668	3,699	100%	3,699	8,987	-
Aug	0.96	5,813	-	1,146	3,363	80%	2,690	10,531	-
Sept	1.41	4,269	-	1,683	2,906	80%	2,325	11,172	-
Oct	1.86	3,628	-	2,220	2,426	80%	1,941	10,893	-
Nov	2.02	3,907	-	2,411	2,255	80%	1,804	10,285	-
Dec	2.41	4,515	-	2,877	2,042	80%	1,633	9,042	-
Jan	2.55	5,758	-	3,044	2,666	80%	2,133	8,131	-
Feb	1.50	6,669	-	1,791	2,604	100%	2,604	8,944	-
Mar	2.35	5,856	-	2,805	2,258	80%	1,806	7,945	-
April	1.43	6,855	-	1,707	2,604	100%	2,604	8,841	-
May	0.78	5,959	-	931	2,618	100%	2,618	10,528	-
June	1.75	4,272	-	2,089	3,533	80%	2,827	11,266	-
July	0.56	3,534	-	668	3,699	80%	2,959	13,557	-
Aug	0.93	1,243	3,500	1,110	3,363	80%	2,690	11,637	-
Sept	0.66	3,163	-	788	2,906	80%	2,325	13,174	-
Oct	4.49	1,626	-	5,360	2,426	80%	1,941	9,755	-
Nov	3.37	5,045	-	4,023	2,255	80%	1,804	7,536	-
Dec	4.69	7,264	-	5,599	2,042	100%	2,042	3,979	-
Jan	4.81	10,821	-	5,742	2,666	100%	2,666	903	-
Feb	2.24	13,897	-	2,674	2,604	100%	2,604	833	-
Mar	2.47	13,967	-	2,949	2,258	100%	2,258	142	-
April	1.72	14,658	-	2,053	2,604	100%	2,604	692	-
May	1.39	14,108	-	1,659	2,618	100%	2,618	1,651	-
June	0.83	13,149	-	991	3,533	100%	3,533	4,194	-
July	0.40	10,606	-	477	3,699	100%	3,699	7,415	-
Aug	0.32	7,385	-	382	3,363	100%	3,363	10,396	-
Sept	2.22	4,404	-	2,650	2,906	80%	2,325	10,071	-
		4,729	-	-					-
	159.74								-
	Max.Storage	14,800	7,000	190,689	197,840	94%	186,428		(6,532)
	Min.Storage>	617	<<<<Balance model by keeping this more than "0".						
	Haul Truck Loads>>>>>>>		2						

Appendix C: Summary of freshwater habitat issues for salmon recovery from the Handbook for Salmon Recovery in San Juan County, April 2004 draft

II. Physical Setting

IIa. Freshwater Environment

The San Juan Islands lie in the rain shadow of the Olympic Mountains and Vancouver Island. Precipitation varies throughout the islands from an annual average of 17 to 29 inches, depending on location and topography. Groundwater recharge and surface water flow are limited by the quantity of water available. The predominantly rocky substrate provides a low storage coefficient, allowing only small amounts of water to be stored underground. Normally, evapotranspiration is highest during the summer months while surface water runoff is greatest during the winter months. In late spring and summer, prevailing westerlies and northwesterlies result in a dry season beginning in May and peaking in midsummer. In the late fall and winter prevailing westerlies and southwesterlies produce a wet season beginning in October, peaking in winter, and decreasing in the spring.

Lakes, reservoirs and ponds occur throughout the islands and are important sources of water for wildlife, domestic use, irrigation, livestock watering, fishing and other recreational activities (See Figure 1). Most of the smaller islands have little or no permanent surface water. There are 45 lakes and reservoirs totaling about 880 acres (Fig. 1). Lakes supply much of the domestic water used on San Juan and Orcas islands. Trout Lake and Briggs Pond supply domestic water for the Town of Friday Harbor and Roche Harbor, respectively. Rosario Resort draws water from Cascade Lake; the Olga and Doe Bay water systems depend on Mountain Lake; and Eastsound uses Purdue Reservoir as a backup for well water sources. Orcas Island, with its rugged, rocky terrain, has the largest lakes in the county. Lopez Island, due to its gentle topography, lack of rainfall and porous, glacial sediment overlay, has the least amount of impounded surface water. More information on the major lakes in San Juan County can be found in the San Juan County Water Management Action Plan and Characterization Report prepared by the San Juan County Health and Community Services Department and the Washington State Department of Ecology released August 24, 2000 (San Juan County Watershed Management Committee, 2000).

Island watersheds are usually less than five square miles in area, with streams that normally flow between late November-December and early May (San Juan Watershed Ranking Committee, 1988). There are four year-round streams in San Juan County. Two perennial streams of significant size are found on Orcas Island: Cold and Cascade creeks. Cold Creek is fed by a large spring and Cascade Creek has Mountain Lake as its source. Two streams also run all year on San Juan Island. These streams are San Juan Valley Creek, which begins at Trout Lake on Mt. Dallas and joins up with the drainage system for the wetlands of the False Bay watershed, Briggs pond stream that drains into the north end of Westcott Bay, and a small creek that begins at the back of Mt. Cady

and drains into Garrison Bay. Streams on the remaining islands in the archipelago have only seasonal flows.

IIb. Marine Nearshore Environment

San Juan County, the smallest in the state, with only 177 square miles of land, contains over 408 miles of marine shoreline (Nearshore Habitat Program, 2001). This represents the longest marine shoreline of any county in the United States. Length estimates vary from source to source, depending upon what the recorder considered an island and, in some instances, on the tide stage at the time of inventory but for the purpose of this document we are accepting the Washington State Shore Zone Inventory estimate of 408 miles (Washington State Shore Zone, 2001). Located at the juncture of the Strait of Juan de Fuca and the Strait of Georgia, the archipelago forms a complex tidal region having many different shore forms offering feeding, spawning, and resting areas for diverse resident and migrating marine life.

III. Biological Setting

IIIa. Freshwater Environment

San Juan, Orcas and Lopez islands contain the majority of the freshwater lakes and streams found in the county. (Include maps showing water bodies) A number of independent drainages are formed from lake outlets, springs, and natural surface and ground water run-off. Approximately 88 of these drainages provide over 100 linear miles of streams and tributaries on the three largest islands. Drainages on the remaining islands are small, intermittent in nature and have no value for salmon production.

Of the 11 streams on San Juan Island more than a mile in length, only one is known to currently support anadromous fish. San Juan Valley Creek originates in the Trout Lake-Cady Mountain watershed and enters marine waters in False Bay on the southwest coast of the island. This stream receives a small run of chum salmon, introduced in the mid-1960's by a pioneer island family whose interest in doing the planting resulted from their curiosity about the marine environment, a desire to experiment with "Mother Nature", and the wish to develop a regular return of chum salmon to the creek. Another stream draining Beaverton Valley and entering salt water on the east side of the island just north of Friday Harbor was also the site of a private chum salmon propagation program in past years. It is just over four miles long and has two moderate sized tributaries and a few small feeder drainages. The stream drains a predominantly flatland area and has been extensively channelized. Several falls just upstream from tidewater form an impassable barrier to any fish attempting to enter the stream to spawn naturally. A small stream with headwaters on Mount Cady drains into Garrison Bay along the island's northwest coast. This stream is reported to have had a population of sea-run cutthroat trout but the presence of these fish is unverified.

Thirteen streams, more than a mile in length, are located on Orcas Island of which only one currently supports anadromous fish. Cascade Creek draining from Cascade and

Mountain lakes on the south side of Mount Constitution and entering East Sound on Orcas Island presently supports an introduced run of chum salmon. A few coho salmon are also reported to spawn in the creek (pers. comm. from Sandy Taylor, August 21, 2002). The Glenwood Springs Salmon Enhancement Facility, also located on East Sound, is a private non-profit hatchery and rearing station operated by Long Live The Kings. This facility has been in operation since 1979 and currently produces 100,000 coho and 200,000 chinook smolts annually. Returns to the hatchery indicate this hatchery provides a significant contribution to several fisheries.

Two streams on Lopez Island may have a history of anadromous fish use. They are the stream that drains from Hummel Lake into Swifts Bay and a stream at the southwestern end of the island that flows into Davis Bay. Neither stream is currently known to support anadromous fish. One stream on Orcas Island, Fish Trap Creek, is reported to have been the largest stream on the island prior to settlement and early reports by members of the Northwest Boundary Commission include reference to an old weir at the mouth of the creek used by Natives to take salmon.

Because most streams in the San Juans are seasonal, they currently have limited value for salmon production. Many of the county's streams have been altered by ditching, ponding or diversion, and have been affected by the extensive logging that took place in the county at the turn of the century. Streams on the smaller islands simply do not have sufficient flow, suitable substrate, nor adequate riparian buffers to support salmonid fishes.

VII. Wild Salmon Distribution and Use

Historical salmon spawning and rearing in San Juan County streams is unknown, but is likely small in biomass when compared to the numbers of salmon that pass through San Juan County as they leave or return to freshwater. Genetically, however, past, present, and future wild runs in this region may represent an important source of genetic diversity in relationship to decreases and temporal changes in in-stream flow expected with global warming and the associated expected dramatic decrease in water availability.

Anecdotal information gathered from a variety of sources coupled with early Washington Department of Fisheries stream catalog data puts the number of streams known to be occupied by salmon at no more than three. San Juan Valley Creek, Kanaka Creek, and a stream flowing into Garrison Bay on San Juan Island also might have historically been used by salmon. In the text of this document the stream running through Beaverton Valley and emptying into Friday Harbor near the University of Washington property is also cited as supporting both coho and chum salmon. Currently, a series of falls immediately above tidewater makes this stream impassable to adult salmon. The only other stream in the county listed by the Department of Fisheries as having salmon is Cascade Creek on Orcas Island. Anecdotal information from reports contained in the U.S. Boundary Survey Commission description of the islands indicates the presence of salmon in Deer Harbor at Fish Trap Creek (Kennerly, 1857).

The current documented use of freshwater sources by spawning salmon include only Cascade Creek on Orcas Island and San Juan Valley Creek that flows into False Bay on San Juan Island. Adult chum salmon were seen entering San Juan Valley Creek on November 25, 2002 (D. Hoopes, pers. comm.) One dead male chum salmon was observed the following day just upstream from the creek mouth.

Future use of the freshwater environment by coho salmon is always limited by the fact that only a few streams contain sufficient year around flows to sustain coho rearing. Many of the streams are intermittent in nature and flow only during the winter and early spring months, making them suitable only for chum salmon which require no freshwater rearing. Currently, spawning habitat is also limited by the minimal gravel deposits in most of the island streams due to the solid rock substrate of the islands, thus providing only short patches of gravel spawning habitat even under the best of conditions. Several streams that might support salmon are currently impassable due to cascades or falls at the stream mouth (e.g. Doe Bay).

Several attempts have been made by local residents to establish native runs of both chum and coho salmon. Beginning in December 1970, some 400,000 chum eggs from Big Beef Creek were donated to the San Juan Gill Netters Association and planted in an artificial spawning section of the intermittent creek flowing through Beaverton Valley on San Juan Island and draining into marine waters near the University of Washington's Friday Harbor Labs. Adult returns never reached the numbers required to sustain a run and the project was terminated after a few years. The effort to establish a run of chum salmon in this system was revived in 1990 by the Beaverton Valley Enhancement Group with the shipment of 15,800 eggs from the Whatcom Creek Hatchery in Bellingham. Shipments of 150,000 eggs in 1991 and 37,600 in 1992 did not result in any substantial returns and efforts were shifted to the stream flowing through San Juan Valley to enter False Bay. Egg shipments ranging from 100,000 to 500,000 were provided to the Friday harbor Enhancement Association annually from the winter of 1993 to a final planting in January 1998 (Earl Steele, Whatcom Creek Hatchery, pers. comm. March 8, 2003). Returns from these plantings may be the fish observed in False Bay in November of 2002.

The private non-profit organization Long Live The Kings has operated its Glenwood Springs Salmon Enhancement Facility on Orcas Island since 1979. Releases of 0-age Chinook have averaged 277,000 in the 23-year period between 1979 and 2001. The yearling program (fish reared in ponds over winter) results in the release of 100,000 coho and 200,000 Chinook each April. Returns of Chinook adults to the hatchery have averaged about 730 fish between 1983 and 2001 for an average survival from release to return of 0.37 percent (Mike O'Connell, Facility Manager, pers. comm. February 19, 2003). In addition to releases from the Glenwood Springs facility, Long Live The Kings has provided the 4th Grade at Friday Harbor Elementary School with 250 chinook fry which the students rear over winter and release into False Bay annually. Camp Orkila on Orcas Island receives 1,500 coho eggs and 5,000 chum eggs annually which are reared to fingerlings and fry and released into the Strait of Georgia. Sandy Taylor, a resident of Orcas Island adjacent to Cascade Creek received 30,000 chum eggs in 1998 and 1999 and again in 2001 and 40,000 in 2002. Adult chum salmon have returned to

this stream for at least the past two years. In 2001 approximately 150 adults returned to Cascade Creek while in 2002 the remains of only 18 adults and two redd sites were counted. Long Live The Kings also supplied 4,000 coho eggs for two years to Victor Boede for rearing and release into West Sound Creek on Orcas Island. The lack of outmigrants in a trapping program at the mouth of the creek in 2002 may result in terminating this enhancement program.

Salmon from other natal systems in Puget Sound have been recovered in San Juan Island waters (Table 1). Recoveries of micro-tagged salmon in the San Juan Islands in 1985 include coho salmon from 16 separate mainland stocks while chinook salmon from four fall and one spring stock were also included in the San Juan tag returns (Data from other years is forthcoming from WDFW and NWIFC).

IXb. Existing Gaps in Knowledge and Implementation

The Limiting Factors Report prepared for WRIA 2 identified a number of problems that must be overcome if we are to attain our goal of salmon habitat preservation and restoration. These problems include:

1. No systematic fish habitat inventory exists for the San Juan Islands basin.
2. Habitat protection is frequently limited by gaps in interagency coordination and program integration coupled with inconsistent enforcement of existing habitat protection regulations.
3. Even when protection is provided, support for long-term monitoring to gauge its effectiveness is often lacking.
4. We lack an ecosystem approach to habitat management in the San Juan Islands.
5. The public lacks awareness, understanding, and involvement in habitat protection issues and programs. Public involvement in issues relating to the protection of fish and wildlife habitat is minimal.
6. Adequate funding is lacking for current and new programs to protect fish and wildlife habitat in the San Juan Islands, including the resources necessary for staffing habitat review, inventory, monitoring, enforcement, and education efforts.
7. Clear federal, state and local goals and policies for habitat protection are lacking.
8. Knowledge of historic fish distribution is limited to anecdotal information and no natural freshwater spawning is currently known to exist. Restoration of naturally spawning fish is highly desirable where conditions permit.

Individual salmon stocks are the combination of numerous discrete spawning populations, with each spawning population being locally adapted to those conditions (the magnitude and frequency of stream flow, substrate characteristics, the number and type of predators, channel gradient, water temperature, etc.) found in the watersheds in which they spawn and rear. The physical, chemical, and biological characteristics of individual watersheds shape the salmon that use them. Consequently, when shifts in the stock's environment occur (e.g. changes in climatic patterns), not all spawning populations of the stock respond coherently. In this manner, population-specific bio-complexity promotes the resiliency of the entire stock, buffering the stock from environmental changes.

The unique climate, topography, and geology of the San Juan Islands make them substantially different than watersheds found elsewhere in the state. For this reason, the current value of the WRIA 2 watersheds may be more associated with promoting and protecting genetic diversity of salmon populations rather than in overall production of large numbers of salmon (at least not under current environmental conditions). The uniqueness of the San Juan watersheds has influenced and will continue to drive local adaptation of the salmon that use them, no matter how few in number. Protecting these local adaptations may be critically important to the health and the long-term resiliency of Washington's salmon stocks.

At present there have been no systematic surveys of historical or current salmon use in the San Juan County watersheds. Nor have there been comprehensive fish passage barrier inventories to document anthropogenic structures that currently artificially restrict salmon distribution. It is essential that these three fundamental data gaps be addressed in the near future, so opportunities to protect and restore WRIA 2 watersheds can be identified, prioritized, and implemented.

Within the nearshore area of the county, the gap between current and desired conditions centers primarily upon the lack of comprehensive information on the present extent and status of critical habitat features. This gap in knowledge is currently being filled by a series of inventories and assessments. Once these assessments are completed, we will have a comprehensive view of current conditions.

IXc. Strategy Objectives

- Complete an inventory of critical freshwater, estuarine and nearshore habitats with initial emphasis on forage fish spawning beaches, eelgrass meadows and herring spawning sites;
- Identify and prioritize projects that support the salmon recovery strategy of WRIA 2, and encourage project sponsors to apply for SRFB and other grant funds;
- Support projects that lead to the restoration or improvement of estuarine and freshwater habitat with a record of historical or current salmon use, or that may be used in the future as salmon recovery progresses;
- Support projects that result in significant protection or improvement of habitats important to salmon, regardless of the project's primary objective;
- Build community support for protecting all key habitat areas within WRIA 2 and develop an outreach program to involve the public in salmon recovery efforts throughout the county. Encourage project sponsors to incorporate public outreach and education components within their projects.
- Seek to develop collaborative partnerships with other water resource programs in the region by establishing liaison with the San Juan county MRC, the Skagit Fisheries Enhancement Group, Tribal resource departments and local non-governmental conservation organizations.

- Review and update the WRIA 2 recovery strategy on an annual basis to identify and apply adaptive management measures.

IXd. Recovery Defined

The definition of recovery in WRIA 2 must, of necessity, be directed toward the preservation and/or restoration of those ecosystem functions vital to the nearshore life history of all salmon, regardless of ESU. Recovery in WRIA 2 centers upon retaining the maximum amount of high quality habitat possible, regardless of VSP recovery goals set for mainland river systems. In WRIA 2 we are vitally concerned with maintaining all properly functioning conditions (PFC) necessary for salmon present within the nearshore ecosystem, regardless of their origin.

IXe. Recovery Philosophy

The WRIA 2 conceptual approach to salmon recovery centers upon the maintenance of a nearshore ecosystem that can support to the maximum extent possible the outmigrants and returning adults of all VSPs moving through the San Juan Archipelago. This approach was chosen on the basis of all available knowledge which indicated that the nearshore environment of the San Juan Archipelago provided feeding grounds and shelter to a wide range of salmon stocks originating within the Puget Sound basin. While secondary attention is being directed toward the establishment or restoration of small, local runs of salmon, the major thrust of our recovery effort is the protection of nearshore habitats for the use of all stocks moving through the San Juan Islands to and from the open ocean.

Devine Tarbell & Associates, Inc.
Consulting Engineers, Scientists, & Regulatory Specialists

Principals:
John J. Devine, P.E., President
John C. Tarbell, P.E.
James M. Lynch
Edwin C. Luttrell, P.E.

April 30, 2004

Ms. Vicki Heater
145 Rhone/P. O. Box 607
Friday Harbor, WA 98250

Vicki:

It is our pleasure to submit the 2003-4 Preliminary Stream Gauging Mean Daily Discharge results for nine sites on San Juan and Orcas Island. I must again caution you that the data are preliminary and are based on incomplete rating curves. More data are needed to assure that the rating curves are correct – for many of the sites we still do not have a full year of data, and have no high-water discharge to anchor the upper limit of the curves. Following are the gauge ratings and mean daily estimates based on current (yet incomplete) rating curves. Ratings of the records are based on the in-stream controls and US Geological Survey[1] criteria of:

- Excellent - about 95% of the daily discharges are correct within 5%
- Good - about 95% of the daily discharges are correct within 10%
- Fair - about 95% of the daily discharges are correct within 15%
- Poor – daily discharges have less than fair accuracy.

<u>San Juan Island</u>

Nettle Creek: Records are good to fair in that they are now obtained by hydrographic comparison to Trout Creek, as the control at the current gauge site is constantly changing due to a low gradient channel that is partially blocked by overgrown vegetation and waterborne debris. RECOMMENDATION: Move site to location with less backwater and more stable and predictable hydraulic controls. County advised that somewhere in San Juan Valley is still preferred due to salmonid use of the mouth of San Juan Valley Creek. Site will remain where it is until further funding is available.

Trout Creek: Records are considered to be excellent quality with a stable control.

[1] Kennedy, E.J. 1983. Computation of Continuous Records of Streamflow. Techniques of Water-Resources Investigations of the USGS Chapter A13 U.S. Govt. Printing Office. 53pp.

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RECOMMENDATION: Maintain site. These records provide excellent flow data for an undiverted stream, hydraulic controls are stable, and access is controlled though the site is easily accessible.

Beaverton Valley (also known as UW Creek): Records are poor to fair in that they are obtained by hydrographic comparison to Trout Lake outflow because there is no permanent water level recorder.

RECOMMENDATION: Maintain site as non-recording. County has advised that additional use or diversion of Beaverton Valley water is not being planned. However, this basin has very high storage potential as can be seen from the large lag time between rainfall in the fall and stream response, and long, slow falling limb of the hydrograph when rainfall ceases (Figure 1). It may be that in the future, these data will be helpful in land management decisions.

Orcas Island

Crow Valley: Records are good at flows below 15 CFS but fair above this point due to the lack of a high water measurement (Figure 2).

RECOMMENDATION: Maintain site. Lead Entity for Salmon Recovery (Dr. David Hoopes) has stated that this site has salmonid use potential.

Meadowbrook Lane: Records are fair to good based on the possibility of debris buildup and removal on the control and lack of a high water measurement (Figure 2).

RECOMMENDATION: Maintain site. Lead Entity for Salmon Recovery (Dr. David Hoopes) has stated that this site has salmonid use potential.

Cascade Creek: Records are considered to be good quality below 12 CFS but fair above this point due to the lack of a high water measurement (Figure 2).

RECOMMENDATION: Maintain site. Lead Entity for Salmon Recovery (Dr. David Hoopes) has stated that this site has salmonid use potential, there is an application for an instream flow water right (Vicki Heater, San Juan County, pers.comm. 2004), and Cascade Creek is being considered in a water storage assessment for additional diversions for storage.

Doe Bay: Records are considered good at daily discharges below 7 CFS and fair above 7 CFS based on the lack of a high water measurement (Figure 2). This area has low growth potential and current and Doe Bay Water Users Association adequately provides future water needs. Waterfalls near the mouth are a barrier to fish use. This site has a low priority for further data collection.

RECOMMENDATION: Remove water level recorder and place in Mountain Lake to record water levels in a major water source for Orcas Island. Staff gauge and Solinst water level recorder were recently installed; no data for Mountain Lake levels are yet available.

Massacre Bay: Records are good quality with a stable control (Figure 3). RECOMMENDATION: Maintain site. Deer Harbor and environs is considered a growth area and these data may be helpful for land and growth management decisions.

Fishtrap Creek: Records are good quality at flows below 1.5 CFS but fair above this point due to the lack of a high water measurement (Figure 3). RECOMMENDATION: Maintain site. "Restore Estuary Ecosystem of Deer Harbor" ("REED", Ken Brown contact 360-376-2208) is working with the Salmon Recovery Board, and is very interested in the flow for salmonid and estuary recovery efforts.

Cascade Lake: The County has requested that a water-level recorder be installed. No data are yet available. Staff gauge and Solinst water level recorder were recently installed.

We enjoy doing this work. We hope that you will consider us for any additional gauging needs.

Sincerely,

Kathi Peacock
Attachments:
1. Graphs – Estimated Mean Daily Discharge
2. Tables - Estimated Mean Daily Discharge

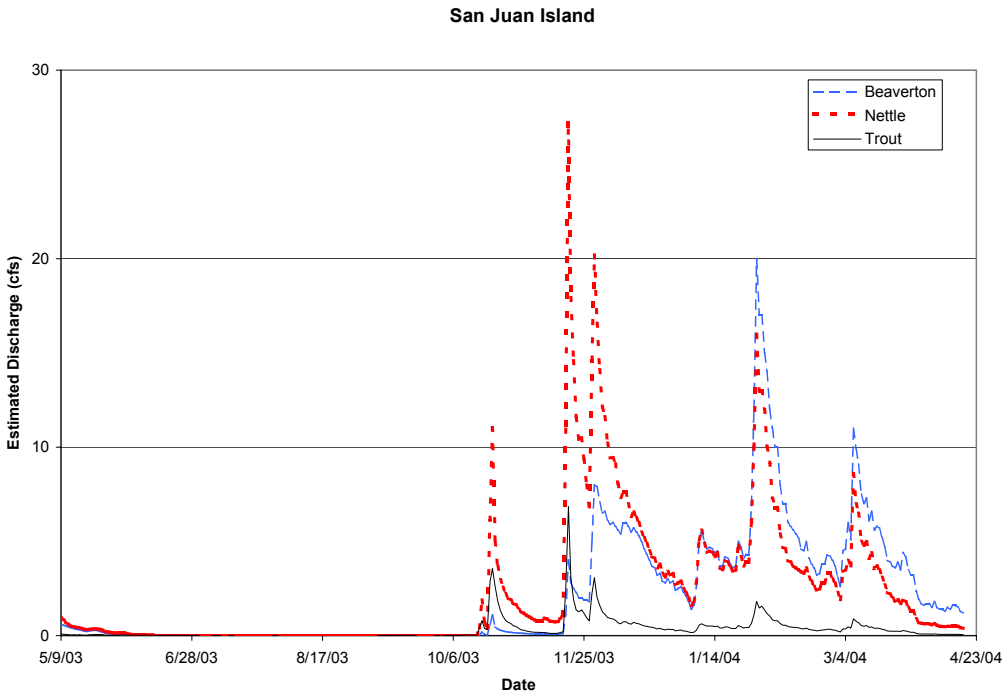

Figure 1. Estimated mean daily flows for San Juan Island gauge sites May 9, 2003, through April 19, 2004: Beaverton Valley, Nettle Creek, and Trout Creek.

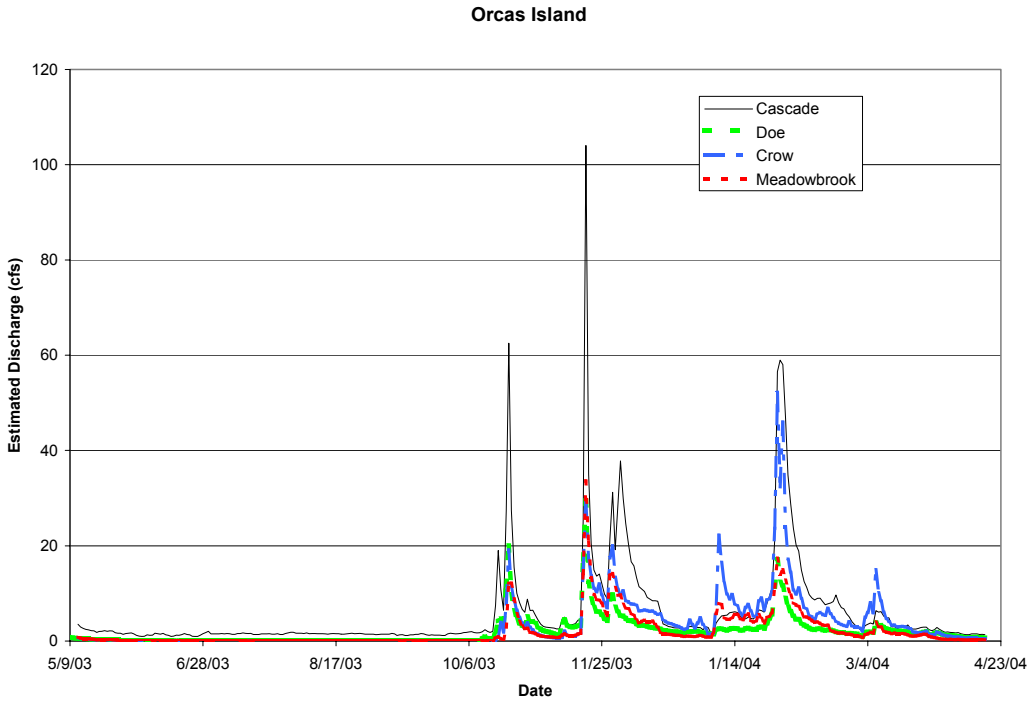

Figure 2. Estimated mean daily flows for Orcas Island gauge sites May 9, 2003, through April 18, 2004: Cascade Creek, Doe Bay, Crow Valley, and Meadowbrook Lane.

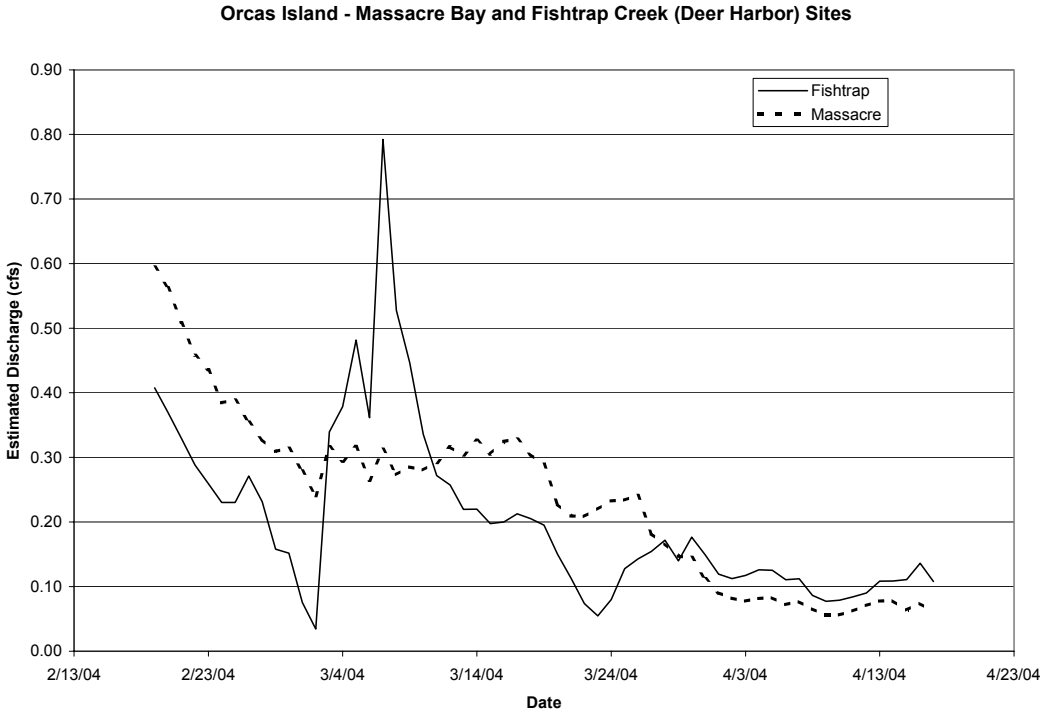

Figure 3. Estimated mean daily flows for Orcas Island gauge sites February 29, 2004, through April 17, 2004: Massacre Bay and Fishtrap Creek (Deer Harbor).

Trout Lake Tributary | **May 2003 - April 2004** | **Estimated Discharge In cfs***

*Discharges are estimated based on less than one year of records and are subject to change due to additional data and changes in rating curves.

Day

	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2003	May								0.2	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.0
	June	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	July	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	August	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	September	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	October	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
	November	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2
	December	1.6	1.3	1.1	1.0	0.9	0.9	0.8	0.7	0.6	0.7	0.7	0.6	0.6	0.7	0.7	0.6
2004	January	0.3	0.3	0.2	0.2	0.2	0.2	0.3	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.4
	February	1.6	1.4	1.2	1.1	0.9	0.8	0.8	0.6	0.6	0.6	0.5	0.5	0.4	0.4	0.4	0.4
	March	0.2	0.2	0.4	0.4	0.5	0.4	0.9	0.8	0.7	0.5	0.5	0.5	0.4	0.5	0.4	0.4
	April	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Day

	Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg. Monthly
2003	May	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	--
	June	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.0**
	July	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	August	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	September	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.0**
	October	0.8	0.4	0.3	2.9	3.6	2.6	1.8	1.3	1.0	0.8	0.7	0.6	0.5	0.5	0.4	**0.6**
	November	0.2	2.4	6.8	3.1	1.9	1.4	1.3	1.4	1.2	0.9	0.8	2.2	3.1	2.0		**1.1**
	December	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.4	0.3	0.3	0.3	0.3	**0.6**
2004	January	0.4	0.5	0.5	0.4	0.4	0.4	0.5	0.5	0.4	0.4	0.4	0.7	1.1	1.8	1.5	**0.5**
	February	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3			**0.6**
	March	0.4	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.1	**0.4**
	April	0.1	0.1														--

Nettle Creek **May 2003 - April 2004** **Estimated Discharge In cfs***

*Discharges are estimated based on less than one year of records and are subject to change due to additional data and changes in rating curves.

Day

	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2003	May								1.2	1.0	0.8	0.7	0.6	0.5	0.5	0.4	0.4
	June	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	July	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	August	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	September	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	October	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
	November	1.3	1.2	1.1	1.0	0.9	0.8	0.8	0.8	0.8	0.9	0.9	0.8	0.8	0.7	0.8	0.9
	December	14.1	12.1	11.6	10.2	9.4	9.5	9.1	8.1	7.3	7.6	7.6	7.0	6.3	6.6	6.3	6.0
2004	January	2.9	2.5	2.3	2.0	1.6	1.8	2.8	5.1	5.6	4.9	4.4	4.5	4.4	4.2	4.4	3.6
	February	13.0	12.0	10.0	9.2	7.3	6.8	6.8	5.4	4.7	4.6	4.0	3.9	3.7	3.6	3.5	3.4
	March	2.3	1.9	3.4	3.5	4.0	3.7	8.6	7.0	6.5	5.0	4.8	5.0	4.1	4.4	3.6	3.7
	April	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

Day

	Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg. Monthly
2003	May	0.4	0.3	0.3	0.3	0.3	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	--
	June	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.0**
	July	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	August	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	September	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.0**
	October	1.9	0.7	0.4	6.1	11.0	5.0	3.7	3.0	2.6	2.2	2.0	1.9	1.7	1.6	1.4	**1.5**
	November	1.1	11.2	27.2	17.9	14.6	11.6	10.4	10.5	9.3	8.0	6.8	14.6	20.2	16.6		**6.5**
	December	5.5	5.2	4.9	4.5	4.2	4.1	3.6	3.8	3.3	3.1	3.4	3.2	3.3	2.7	2.8	**6.3**
2004	January	3.5	4.0	3.9	3.6	3.4	3.5	4.8	4.2	3.7	3.9	3.9	6.0	10.0	16.0	13.0	**4.7**
	February	3.3	3.6	3.1	2.9	2.6	2.4	2.5	2.8	2.8	3.3	3.3	3.0	2.8			**4.8**
	March	3.5	3.1	2.7	2.3	2.2	2.0	1.8	1.9	1.7	1.9	1.8	1.5	1.3	1.3	0.9	**3.3**
	April	0.4	0.4														--

Beaverton Valley
(UW Creek Non-Recording Gauge)

May 2003 - April 2004

Estimated Discharge In cfs*

*Discharges are estimated based on less than one year of records and are subject to change due to additional data and changes in rating curves.

		Day															
	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2003	May								0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3
	June	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	July	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	August	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	September	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	October	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	November	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	December	7.1	6.5	6.6	6.1	5.9	6.0	5.8	5.6	5.4	6.0	6.0	5.8	5.5	5.7	5.5	5.3
2004	January	2.6	2.3	2.1	1.8	1.4	1.6	2.6	5.0	5.6	5.0	4.6	4.7	4.6	4.4	4.5	3.7
	February	17.0	15.0	14.0	12.0	11.0	10.0	10.0	8.0	7.0	7.0	6.0	5.8	5.6	5.4	5.2	4.6
	March	3.1	2.6	4.5	4.6	6.0	5.1	11.0	9.9	9.1	7.5	7.0	7.3	6.1	6.6	5.6	5.8
	April	1.9	1.7	1.6	1.7	1.7	1.5	1.8	1.5	1.4	1.4	1.3	1.5	1.4	1.6	1.6	1.5

		Day															
	Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg. Monthly
2003	May	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	--
	June	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.0**
	July	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	August	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	September	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.0**
	October	0.2	0.1	0.0	0.6	1.1	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.1	**0.1**
	November	0.1	1.1	4.0	2.8	2.5	2.3	2.0	2.0	1.9	1.9	1.8	5.0	8.0	7.9		**1.5**
	December	5.0	4.6	4.3	4.0	3.7	3.6	3.2	3.3	2.9	2.8	3.0	2.8	2.9	2.4	2.5	**4.7**
2004	January	3.7	4.2	4.1	3.8	3.6	3.7	5.0	4.7	4.1	4.3	4.3	6.9	12.0	20.0	17.0	**5.1**
	February	4.5	5.0	4.1	3.8	3.6	3.2	3.3	3.8	3.8	4.3	4.2	4.0	3.7			**6.7**
	March	5.7	5.2	4.7	4.0	3.9	3.7	3.6	3.9	3.5	4.4	4.2	3.5	3.2	3.2	2.4	**5.2**
	April	1.3	1.2														--

Crow Valley Creek | **May 2003 - April 2004** | **Estimated Discharge In cfs***

*Discharges are estimated based on less than one year of records and are subject to change due to additional data and changes in rating curves.

Day

	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2003	May												0.7	0.5	0.4	0.4	0.4
	June	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	July	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	August	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	September	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	October	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	November	1.4	1.2	1.0	0.9	0.8	0.7	0.7	0.6	0.6	0.8	2.1	1.3	1.0	1.0	1.0	1.4
	December	10.9	9.5	10.5	8.5	8.2	7.8	7.8	7.5	6.3	6.4	6.6	6.4	6.2	6.4	5.9	5.6
2004	January	4.8	3.5	2.7	1.3	1.6	1.6	7.8	22.0	17.0	12.0	9.8	8.9	9.8	7.9	7.3	5.9
	February	46.0	24.0	17.0	14.0	11.0	9.9	11.0	9.0	7.1	6.6	5.5	5.1	4.6	5.6	6.1	5.6
	March	2.6	2.1	5.0	6.0	8.0	5.9	15.0	10.0	8.4	6.1	4.7	4.1	3.3	3.4	2.9	3.0
	April	1.4	1.2	1.0	1.0	0.9	0.8	0.9	0.8	0.7	0.6	0.6	0.6	0.6	0.6	0.5	0.5

Day

	Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg. Monthly
2003	May	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.2	0.3	0.2	0.1	0.1	0.1	0.1	0.1	--
	June	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.0**
	July	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	August	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	September	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.0**
	October	0.9	3.9	1.9	7.8	19.1	11.2	8.5	6.5	5.0	3.8	2.8	3.7	2.9	2.3	1.8	**2.7**
	November	1.7	15.2	29.6	17.3	13.7	11.0	10.3	12.0	9.7	8.0	7.0	17.4	20.0	13.4		**6.8**
	December	5.7	4.5	4.1	3.8	3.7	3.4	3.2	3.1	2.7	2.4	2.8	4.4	3.5	2.8	3.7	**5.6**
2004	January	5.3	7.1	7.6	6.3	5.3	5.1	8.4	9.0	6.5	8.6	8.9	10.0	24.0	52.0	32.0	**10.3**
	February	5.4	6.9	5.7	4.9	4.2	3.8	3.5	3.3	3.1	4.0	3.2	3.0	3.0			**8.4**
	March	3.1	3.0	2.8	2.5	2.0	1.9	1.8	1.8	1.8	2.1	1.5	1.4	1.3	1.8	1.7	**3.9**
	April	0.5															--

Meadowbrook Lane Creek | **May 2003 - April 2004** | **Estimated Discharge In cfs***

*Discharges are estimated based on less than one year of records and are subject to change due to additional data and changes in rating curves.

Day

	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2003	May												0.8	0.6	0.5	0.5	0.5
	June	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
	July	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	August	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	September	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	October	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
	November	1.2	1.1	1.0	0.9	0.9	0.9	0.8	0.7	0.8	1.2	1.6	1.2	1.0	1.1	1.2	1.5
	December	9.6	9.7	7.7	7.0	6.7	5.8	5.3	4.4	3.7	4.1	4.4	3.9	3.9	4.1	3.5	2.8
2004	January	1.2	1.0	0.8	0.8	0.8	1.9	5.8	7.9	7.6	4.9	4.6	4.5	5.0	5.6	5.6	4.7
	February	15.0	13.0	11.0	9.7	8.1	7.6	7.2	5.9	5.0	5.1	4.7	4.3	3.9	4.1	3.7	3.4
	March	1.0	0.7	1.3	1.5	1.9	1.6	3.9	3.0	2.9	2.2	1.8	1.8	1.5	1.7	1.5	1.5
	April	0.4	0.4	0.3	0.4	0.3	0.3	0.4	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3

Day

	Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg. Monthly
2003	May	0.4	0.4	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.1	0.2	0.1	0.1	0.1	0.1	--
	June	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0		**0.0**
	July	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	August	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
	September	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.0**
	October	1.0	0.5	0.3	2.9	12.2	12.1	8.9	5.8	4.1	3.1	2.6	2.7	1.8	1.8	1.6	**2.0**
	November	1.6	14.2	33.6	20.7	13.3	9.8	8.7	8.5	8.0	6.2	5.3	13.8	14.2	11.2		**6.2**
	December	1.9	1.5	1.5	1.4	1.4	1.2	1.2	1.2	1.0	0.9	1.0	1.0	1.0	0.9	1.0	**3.4**
2004	January	4.5	5.3	5.7	4.4	4.0	4.3	5.5	4.7	3.7	4.9	5.3	5.9	11.0	17.0	14.0	**5.3**
	February	3.3	3.3	2.3	2.0	1.8	1.7	1.7	1.7	1.4	1.5	1.3	1.1	1.1			**4.7**
	March	1.6	1.5	1.3	1.1	1.0	1.0	1.2	1.3	1.4	1.4	1.0	0.9	0.7	0.7	0.5	**1.5**
	April	0.3															--

Cascade Creek at Olga | **May 2003 - April 2004** | **Estimated Discharge In cfs***

*Discharges are estimated based on less than one year of records and are subject to change due to additional data and changes in rating curves.

Day

	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2003	May												2.9	2.5	2.3	2.1	2.1
	June	1.6	1.4	1.2	1.1	1.1	1.1	1.3	1.2	1.3	1.6	1.5	1.4	1.5	1.3	1.2	1.1
	July	1.5	1.5	1.5	1.6	1.6	1.5	1.6	1.6	1.4	1.4	1.6	1.6	1.8	1.7	1.6	1.7
	August	2.0	1.8	1.8	1.8	1.6	1.8	1.6	1.6	1.7	1.6	1.6	1.6	1.5	1.5	1.6	1.6
	September	1.3	1.4	1.5	1.5	1.5	1.5	1.7	1.5	1.2	1.3	1.3	1.2	1.2	1.3	1.3	1.5
	October	1.6	1.6	1.7	1.9	1.9	2.1	2.2	1.9	1.8	1.9	2.1	2.8	2.3	2.0	2.3	7.4
	November	5.0	4.4	4.0	3.6	3.6	3.5	3.3	3.0	3.0	4.8	5.4	4.6	4.3	4.3	4.5	5.0
	December	25.5	33.4	26.7	22.1	18.5	15.3	14.6	12.3	10.8	10.4	9.9	8.8	8.6	8.3	8.2	8.1
2004	January	2.8	2.4	3.0	2.8	1.5	1.7	3.8	4.6	5.3	5.3	5.4	5.9	6.1	6.1	6.0	5.3
	February	58.0	46.7	34.8	28.8	23.6	20.1	18.9	14.9	12.5	11.3	9.8	9.0	8.6	8.9	9.0	8.3
	March	2.4	2.2	3.3	3.5	3.8	3.5	6.4	6.1	6.2	5.2	5.0	4.8	2.9	3.0	2.6	2.9
	April	2.1	1.8	1.9	1.8	1.8	1.7	1.8	1.5	1.4	1.3	1.3	1.5	1.5	1.5	1.4	1.4

Day

	Month	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Avg. Monthly
2003	May	1.9	1.9	1.7	1.8	1.8	1.9	1.9	1.9	1.9	1.6	1.6	1.6	1.4	1.5	1.6	--
	June	1.1	1.3	1.2	1.3	1.5	1.4	1.3	1.1	1.1	1.1	1.3	1.5	1.7	1.9		**1.3**
	July	1.4	1.4	1.4	1.5	1.5	1.6	1.6	1.5	1.5	1.6	1.4	1.4	1.6	1.8	2.0	**1.6**
	August	1.6	1.6	1.5	1.5	1.5	1.7	1.7	1.6	1.6	1.7	1.6	1.5	1.5	1.5	1.5	**1.6**
	September	1.5	1.7	1.5	1.3	1.2	1.3	1.3	1.2	1.3	1.2	1.2	1.6	1.7	1.6		**1.4**
	October	17.3	10.3	6.5	24.5	55.0	24.5	14.3	9.6	7.9	6.7	6.1	8.5	6.4	6.5	5.7	**8.0**
	November	5.1	22.9	91.9	31.0	18.5	13.8	12.7	13.1	11.4	9.5	8.6	19.4	27.8	17.5		**12.3**
	December	6.6	4.5	4.3	3.9	3.7	3.4	3.4	3.3	3.0	3.0	3.6	4.0	3.9	3.6	3.6	**9.7**
2004	January	4.8	4.7	5.0	4.8	4.6	5.3	6.5	6.4	6.1	7.8	9.4	11.2	21.1	56.5	59.0	**9.1**
	February	7.6	7.8	8.0	8.3	9.7	8.0	7.0	6.8	5.7	5.1	4.1	3.4	3.0			**14.1**
	March	2.9	3.0	3.4	2.6	2.5	2.5	2.7	2.9	2.9	2.9	2.4	2.2	2.4	2.9	2.4	**3.4**
	April	1.3															

Fishtrap Creek (Deer Harbor) **February 19 - April 17, 2004** **Estimated Discharge In cfs***

*Discharges are estimated based on less than one year of records and are subject to change due to additional data and changes in rating curves.

Day

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
February																
March	0.1	0.0	0.3	0.4	0.5	0.4	0.8	0.5	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2
April	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Day

Month	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0	31.0	Avg. Monthly
February			0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.3	0.2	0.2	0.2			--
March	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.2	0.1	**0.2**
April	0.1															--

Massacre Bay **February 19 - April 17, 2004** **Estimated Discharge In cfs***

*Discharges are estimated based on less than one year of records and are subject to change due to additional data and changes in rating curves.

Day

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
February																
March	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
April	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Day

Month	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0	31.0	Avg. Monthly
February			0.6	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.3			--
March	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	**0.3**
April	0.1															--