

# **Monitoring for Stormwater Contaminants in the Shallow Aquifer near Priest Road, Clallam County, WA**

*Prepared by:*  
**Ann Soule, L.Hg.**  
**Clallam County Environmental Health Services<sup>1</sup>**

**November 2005**

## **Summary**

In the Spring of 2005, Clallam County Environmental Health Services (EHS) prepared to monitor groundwater quality outside the western Sequim city limits. County residents in this area are served by individual or shared private wells most often tapping the shallow aquifer. A monitoring plan (Appendix A) was prepared and reviewed by hydrogeologists from external agencies and sampling was conducted accordingly in May 2005. AmTest, Inc., in Redmond, WA, analyzed samples for inorganics, semi-volatile organics, pesticides, metals, and bacteria; Clallam County Environmental Health Laboratory analyzed for bacteria and nitrates only. All analytical results are presented in Appendix C; nitrates and TDS are mapped in Figures 5 and 6.

There were no detections in any study samples of bacteria, hydrocarbons, pesticides or other organics. Trace amounts of chromium and zinc, in the range of 1-15 parts per billion, are most likely naturally occurring in local groundwater. Nitrates and TDS were detected in all study wells at levels below safe drinking water action levels; wells upgradient from Sequim city limits showed somewhat higher levels of these contaminants than did downgradient wells.

## **Background and Problem Statement**

The widespread, uppermost aquifer in eastern Clallam County is vulnerable to contamination from land activities because of shallow groundwater and the lack of a thick clay layer in many areas of the Dungeness watershed. Figure 1 shows the study area in the context of critical aquifer recharge areas in this watershed, designated by the County because of the susceptibility of the underlying aquifer to contamination (CCC 27.12.600). The regional hydrogeology of the greater Dungeness watershed includes alternating aquifers and confining layers with a northward slope. Figure 2 shows that groundwater generally flows downward in the middle watershed and upward in the lowest portion of the watershed.

---

<sup>1</sup> 223 E. 4<sup>th</sup> Street, Suite 14; Port Angeles, WA 98362; 360-417-2424; [asoule@co.clallam.wa.us](mailto:asoule@co.clallam.wa.us)

The purpose of this project was “to establish baseline groundwater quality information” for County residents with drinking water wells near recent and planned development in and around Sequim’s western city limits. (See Figures 1 and 3.) The project was conducted by EHS with a budget of \$5000 for lab analyses at the request of the County Board of Commissioners, which was petitioned by the Dungeness River Management Team in 2004.

The Sequim-Dungeness area is a rural region with a mild and relatively dry climate (often less than 20" of annual rainfall). Approximately 4,440 of Clallam County’s 65,900 residents live in the city and 17,400 live in the unincorporated area around Sequim (2003).

## Methods

The project monitoring plan (Appendix A) directed the activities of this study. First, a limited number of study wells were selected, shown on Figure 3. Selection criteria are fairly standard for this type of study and include:

- must have a well report (log),
- must tap shallowest zones of the water table aquifer,
- must be located either up- or down-gradient of the potential contamination sources of concern,
- must not be adjacent to an irrigation ditch,
- must have an accessible wellhead for water level measurement and nearby faucet for collection of raw (untreated) and fresh (not from a storage tank) samples, and
- must have a willing well owner (and tenant if applicable).

The regional groundwater flow is generally N-NE according to Thomas et. al. 1999 and Drost 1983. The Dept. of Ecology well log database and County records were both searched for wells that fit the above criteria. A summary of construction information for each well selected is found in Table 1 below; well logs may be found in Appendix B.

Table 1, Study wells

<b>Up/down gradient</b>	<b>Study ID no.</b>	<b>Well tag no.</b>	<b>Well depth</b>	<b>Screened interval</b>	<b>Date drilling completed</b>
Up	U1	None	102	97-102	10/27/1976
Up	U2	None	100	95-100	2/2/1992
Up	U3	None	120	110-120	4/4/1989
Down	D1	AKA 701	41	36-41	4/23/2004
Down	D2	None	64.5	26-37 (perforated)	3/9/1993
Down	D3	ACA 651	79	Open bottom	12/5/1975
Down	D4	None	54	Open bottom	2/28/1977

Contaminants were selected for analysis after a literature search on stormwater impacts to groundwater quality. According to Pitt (1996), potential stormwater contaminants from commercial/retail/road environments include nutrients, salts, pathogens, bromide and TOC, pesticides, other organics, and heavy metals. Which of these constituents in stormwater runoff might be contaminating groundwater in this study area depends on several factors, including whether it exists in the runoff, the treatment applied to runoff (if any), the mobility and persistence of the constituent, and the characteristics of the soils and underlying strata. Constituents for which groundwater in the study area is considered at risk of

containing are listed in Table 2. Sample containers were obtained from respective laboratories for each of these parameters according to the monitoring plan (Appendix A).

Table 2, Parameters tested

<b>Types of contaminants</b>	<b>Constituents of interest</b>
nutrients:	Nitrate as N (NO <sub>3</sub> as N) Total Kjeldahl nitrogen (TKN)
metals (total):	lead (Pb) chromium (Cr) nickel (Ni) zinc (Zn)
pesticides:	Chlorinated pesticides scan (includes chlordane)
other organics:	Semi-volatiles scan (includes pyrene, fluoranthene) Hydrocarbon identification
pathogens:	Total coliform Pseudomonas aeruginosa
solids:	Total Dissolved Solids (TDS)

During initial site visits to each of the potential study wells, EHS staff (Ann Soule) determined the accessibility of the well casing for water level measurements and availability of a sampling point for untreated, fresh groundwater. Soule also collected a sample for preliminary nitrate analysis at the CCEHS lab, to determine presence or absence of nitrates prior to full-scale sampling. An inventory form was completed and sketch map drawn showing the well location relative to buildings, roads, the septic drainfield, surface water including irrigation ditches, and the sampling spigot. A Magellan 310 Satellite navigator (GPS) was used to determine the latitude, longitude, and elevation of each well head.

Soule collected groundwater samples in May 2005. When access into the well casing was possible, a measurement of static water level was made using a Waterline Envirotech 300 electric well probe according to USGS procedures (Stallman, 1983) prior to starting the well pump. Soule then purged roughly three volumes of well water using a hose to discharge 20-30' from the wellhead, collecting 2-3 gallons in a bucket at 3-5 minute intervals. Field parameters were then measured from the bucket sample using hand-held probes until each stabilized. pH and water temperature were measured using a YSI 60. Dissolved oxygen, conductivity, and water temperature (again) were measured using a YSI 85. Soule then removed the hose and collected samples directly from the spigot according to laboratory guidelines listed in Table 3 and from AmTest, Inc. Samples were kept cooled and preserved and transported overnight to the laboratory; each cooler contained a chain-of-custody record and was sealed with tape prior to transport.

Table 3, Containers and preservation

<b>Constituent</b>	<b>Bottle description</b>
nutrients (2 analyses/bottle)	250 ml HDPE preserved with H <sub>2</sub> SO <sub>4</sub>
metals (total) (4 analyses/bottle)	500 ml HDPE rinsed with HNO <sub>3</sub>
pesticides	1L amber glass, no preservative
semi-volatiles scan	1L amber glass, no preservative
hydrocarbons	1L amber glass, no preservative
total coliform	250 ml HDPE preserved with EDTA (or similar, if from County lab)

Pseudomonas aeruginosa	250 ml HDPE preserved with EDTA
dissolved solids	250 ml HDPE, no preservative
(various, including blank water)	1L amber glass, no preservative

## Data Quality

Results of a data quality assessment indicate that measurement quality objectives were met. AmTest, Inc., provided summaries of its Quality Control analyses of blanks, duplicates, matrix spikes, and standard reference material.

Replicate samples were collected at well D3 for 11 different laboratory analyses in order to estimate field precision; the criteria for precision in this study calls for no more than a 10% difference between replicates for analyses with a detection level at or above 0.01 mg/L (nitrates, TKN, TDS, lead, and hydrocarbons), and 20% when the detection level is less than 0.01 mg/L. The results for 9 of 11 parameters were equal between the sample and the replicate sample – 3 were quantifiable and equal and 6 were not detected. In the other two cases (chromium and zinc), results were quantified in both the sample and the replicate and both were very near the detection limit. The absolute difference between each pair was quite small; however, the relative percent difference (an indicator of field precision) can't be calculated accurately because both results are close to the detection limit of 0.001 mg/L.

Analytical precision was reported in a Quality Control Summary for each shipment by AmTest, Inc., for repeated measurement of samples for TKN, nitrate + nitrite, TDS, and metals. The RPD for 15 duplicate pairs met the study criteria except for one pair each of nitrate, TKN, and TDS. The nitrate pair had concentrations of 0.28 and 0.32 mg/L with an RPD of 13%; this difference was considered unimportant because the absolute concentrations of the sample pair were low relative to the MCL of 10 mg/L. The TKN pair had concentrations of 40 and 45 mg/L (RPD = 12%), which would cause concern about TKN analyses except that there were no detections of TKN in any sample submitted for this study. Finally, the TDS pair had concentrations of 120 and 140 mg/L (RPD = 15%); not only does this difference exceed the study criteria but the concentrations are not near the detection limit (1 mg/L) nor are they particularly low (MCL = 500 mg/L). In light of this, the accuracy of laboratory TDS results should be considered less than ideal and potentially off by 10-20%. Note, however, that even after applying this factor the TDS concentrations found in this study do not indicate a health concern or evidence of contamination.

A “blank” sample was submitted with each of three shipments to the lab, to check for potential contamination resulting from sample collection and handling. Each blank was created by directly filling a nutrient sample container (HDPE preserved with H<sub>2</sub>SO<sub>4</sub>) in the field with deionized water which had been obtained in a clean glass bottle at the CCEHS lab prior to departure. Each blank was analyzed for nitrate + nitrite the same as groundwater samples were, using EPA 353.2 with a detection limit of 0.010 mg/L. Nitrates were present in 2 of 3 blanks analyzed. The concentrations were 0.030 and 0.031 mg/L. It is not known if this minor “contamination” was limited to the blanks or if it was widespread among all samples. However, because the amount of this potential contamination is very close to the detection level and is 5 times less than the lowest groundwater nitrate result, we did not adjust the reporting level for nitrates in this study.

All required holding times were met at the CCEHS lab and at AmTest, Inc.

## Results

### Groundwater Flow

Static water level data is fundamental to any investigation of groundwater hydrology. The direction of groundwater flow may be determined from the water level elevation of multiple wells tapping the same aquifer. Accurate measurements of the elevation of the ground surface at several wellheads, height of the measuring point used for each well, and depth to water when it is in equilibrium are all needed to determine flow direction accurately, in addition to details of the geologic layers each well passes through. In this study, accurate field measurements of wellhead elevation were not obtainable from the GPS equipment on hand, so they were estimated to the nearest foot from 2-ft.-contour LiDAR (Terrapoint 2001). Table 4, below, summarizes these data.

Well logs for each study well are found in Appendix B. Figure 4 shows the elevation of the static water level in study wells in May 2005 and the general direction of groundwater flow inferred from these data. The flow direction shown in this figure has a stronger eastward component (by roughly 10 degrees) compared with that described for the region in two USGS reports (Drost 1983, Thomas et. al. 1999). If this is the case for this localized area, some study wells may not capture downgradient conditions as competently as would be preferred.

Also note that, due to the absence of wells meeting selection criteria in upgradient neighborhoods, the two upgradient wells used for sampling had not had prior site visits, and neither turned out to be accessible for water level measurement. A third upgradient well, U1, was accessible and considered for use but was rejected because of its close proximity to an unlined irrigation ditch; the water level in U1 may not represent conditions for the broader area and should be confirmed by measuring additional wells if any can be found.

Table 4, Study well elevation data

Study ID no.	Well depth (ft. Below Top of Casing)	Measuring Point (MP) height (ft. Above Land Surface Datum)	Elevation at wellhead (LiDAR) (ft. ALSD)	Static water level		Water level elevation in May 2005 (ft.)	Static water level at time of drilling		Water level elevation at time of drilling (ft.)
				(ft. below MP)	Date measured		(ft. below MP)	Date measured	
<u>Up-gradient wells</u>									
U1	102	1	296	64	5/5/2005	233	47	10/27/1976	250
U2	100	1	307	na	na	na	47	2/2/1992	261
U3	120	2	304	na	na	na	35	4/4/1989	271
<u>Down-gradient wells</u>									
D1	41	1	203	19.67	5/9/2005	184	19	4/23/2004	185
D2	64.5	1.7	204	18.78	5/5/2005	187	17	3/9/1993	189
D3	79	0.8	237	67.6	5/18/2005	170	55	12/5/1975	183
D4	54	1	204	27.1	5/9/2005	178	22	2/28/1977	183

### Laboratory Analyses

Appendix C contains lab results from AmTest, Inc., for all wells and all constituents tested. The detection limit and state drinking water standard are also included for each constituent.

#### 1. Nitrate and TDS

Nitrate is a good parameter for tracking general trends in groundwater quality because, for this area, native groundwater contains little or no nitrates. Sinclair (2003) found that nitrate concentrations in

eight wells from the shallow aquifer in Agnew and Carlsborg tended to be highest in June and lowest in December. Because sample collection for this project occurred in May, nitrate concentrations are likely to be near the annual high. Figure 5 shows nitrate concentrations for the study wells.

TDS is also used to estimate groundwater quality. It represents the amount of inorganic and organic ions dissolved in a water sample, whether from natural or anthropogenic sources. Historically for the Sequim-Dungeness area, groundwater has had 100-400 ppm TDS (Drost 1986); the drinking water standard is 500 ppm. Figure 6 is a map of TDS concentrations found in this study.

A good correlation between lab-measured TDS and field-measured specific conductance is presented in Figure 7. This correlation may be useful in the future for predicting TDS from field measurements.

**2. Bacteria**

All samples tested negative for total coliform bacteria as well as *Psuedomonas aeruginosa* bacteria.

**3. Metals**

All six wells had trace detections of chromium and zinc (1-15 micrograms/Liter, or parts per billion), and one well had a trace of lead. [Note that this positive result for lead was right at the limit of quantitation (0.001 mg/L) and such results are not considered reliable until confirmed. All other lead analyses were done with a slightly higher limit of quantitation (0.01 mg/L), as originally requested, with no detections.]

Trace amounts of lead, copper, and nickel are potentially related to metals in household pipes and/or faucets. Acidic (low pH) water can be corrosive and release metals in domestic plumbing. Metals in groundwater including chromium and zinc can also come from natural erosion of geologic formations. The metal levels reported for study wells are at least one hundred times below safe drinking water standards.

**4. Hydrocarbons**

All samples had no detections of gas, diesel, or oil using the requested method for total petroleum hydrocarbons: NW-HCID (Northwest HydroCarbon Identification).

**5. Pesticides and Other Organics**

All samples had no detections of pesticides, PCBs, or semi-volatile organics.

Field parameters

Table 5, Summary of field parameters measured

<b>Parameter</b>	<b>Number of meas.</b>	<b>Min</b>	<b>Median</b>	<b>Max</b>
Temperature (°C)	6	10.0	11.2	11.3
pH (standard units)	6	6.5	7.8	8.1
Specific conductance (microsiemens/cm)	6	172	278	331
Dissolved oxygen (mg/L)	6	7.0	8.5	9.4
Purge rate (gal/min)	6	6	9	12

Other data

Within the study area, WalMart and Sequim Village Marketplace (Home Depot) are required by the City of Sequim to monitor stormwater treatment facilities. Monitoring of stormwater and/or

groundwater was to begin in both these cases in 2005 according to plans approved by the City (WalMart opened in late 2004 and Home Depot in mid-2005). However, only WalMart’s stormwater runoff has been sampled to date (once in 4<sup>th</sup> quarter 2005). The City’s Public Works Department is responsible for enforcing monitoring plans and maintaining submitted data reports.

## Conclusions

Baseline groundwater quality for study wells has been established; results of inorganic analyses (nitrates and TDS) indicate that land activities related to human/animal waste management are starting to impact groundwater quality. Results of bacteria, metals, hydrocarbon and other organic analyses were essentially negative and should serve well as baseline data with which future analyses may be compared.

Recommended follow up work includes:

- Estimate infiltration and groundwater flow rates; confirm groundwater flow direction and appropriate locations for study wells.
- Track data from stormwater monitoring activities regulated by City of Sequim, including WalMart, Home Depot, and Jennie’s Meadow, at minimum;
- Monitoring for specific parameters that may be traceable to specific sources;
- Consider adding MTBE (gasoline additive, now banned) to constituents of interest;
- Testing irrigation ditches and Dungeness River/nearby streams for same parameters as wells;
- Researching whether fish sensitivity is greater than drinking water MCLs for TDS (and others);
- Investigation of well construction and seals for wells with extreme nitrate concentrations;
- Mitigative measures such as
  - Education and encouraging repair of inadequately-constructed wells (e.g., well seal replacement);
- Tag wells with state ID tags for continuing study wells;
- Intensified research of groundwater flow patterns around the areas of highest concentration;
- Repeat sampling in study wells according to Table 6.

Table 6, Follow-up sampling schedule

<b>Timing*</b>	<b>Constituents to sample and test</b>
Spring 2005 (initial sampling)	All constituents (listed in Table 2)
Spring 2006	All constituents
Spring 2007, 2008, 2009	Nutrients and dissolved solids
Spring 2010	All constituents
Spring 2011, 2012, 2013, 2014	Nutrients and dissolved solids**
Spring 2015	All constituents
Etc.	

\* Monthly or quarterly sampling of some constituents (e.g., nitrates and/or dissolved solids) would provide information on seasonal water quality fluctuations which, in turn, may indicate the need to reconsider the timing of annual sampling. In the absence of this data, March and April are preferred months for sampling. Additionally, a sharp increase in nitrates or other parameters would warrant more frequent tests for all constituents.

\*\*Unless data indicate a statistically significant increase from 2005-06 (determining this may require up to 8 sampling events), in which case all constituents should be sampled.

## Bibliography

- Drost, B.W. 1986. Water Resources of Clallam County, WA: Phase 1 Report. USGS Water-Resources Investigations Report 83-4227. 263 pgs.
- Drost, B.W. 1983. Impact of Changes in Land Use on the Ground-Water System in the Sequim-Dungeness Peninsula, Clallam County, WA. 61 pgs.
- Johnson, Art, and Barb Carey. 2003. Screening for Pharmaceuticals in Wastewater Treatment Plant Effluents, Groundwater, and Surface Water in the Sequim-Dungeness Area: Quality Assurance Project Plan. Washington State Department of Ecology Environmental Assessment Program, Olympia, Washington.
- Kimsey, M. 2004. "Groundwater Investigation of the Nitrate and Bacterial Contamination in Agnew, WA." Washington State Dept. of Ecology Environmental Assessment Program, Olympia, Washington. 4 pgs.
- Lombard, Stuart and Cliff Kirchmer. 2001. Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies. Wash. State Department of Ecology, Olympia, Washington. 37 pgs.
- Pitt, Robert. 1996. Groundwater Contamination from Stormwater Infiltration. Ann Arbor Press, Inc., Chelsea, Michigan. 124 pgs. plus annotated bibliography on groundwater contamination.
- Simonds, F. W. and K. A. Sinclair. 2002. *Surface Water-Ground Water Interactions Along the Lower Dungeness River and Vertical Hydraulic Conductivity of Streambed Sediments, Clallam County, Washington, September 1999-July 2001*. USGS Water-Resources Investigations Report 02-4161; Washington State Department of Ecology Report 02-03-027. 62 pgs.
- Sinclair, Kirk. 2003. Groundwater Quality in the Agnew and Carlsborg Area, Clallam County, December 2000-September 2002. Washington State Department of Ecology Environmental Assessment Program, Olympia, Washington. 30 pgs.
- Soule, Ann. 2004. Groundwater Monitoring for Nitrates in the Agnew-Carlsborg Area: Quality Assurance Project Plan. Clallam County Environmental Health Services, Port Angeles, Washington. 16 pgs. plus figures and appendices.
- Soule, Ann. 2004. Groundwater Monitoring for Nitrates in the Agnew-Carlsborg Area, Clallam County, WA. 7 pgs. plus figures and appendices.
- Stallman, R.W. 1971 (reprinted in 1976 and 1983). Techniques of Water-Resources Investigations of the USGS, Chapter B1: Aquifer-Test Design, Observation and Data Analysis. 26 pgs.
- Terrapoint, Inc. 2001. Bare-earth model from LiDAR (Light Detection and Ranging) acquired in 2001 for portions of Clallam County. Prepared for Clallam County GIS program.
- Thomas, B.E., L.A. Goodman, and T.D. Olsen. 1999. Hydrogeologic assessment of the Sequim-Dungeness Area, Clallam County, Washington. U.S. Geological Survey, Water-Resources Investigations Report 99-4048, 165 p.
- Washington State Department of Ecology. 1996. Implementation Guidance for the Ground Water Quality Standards. Publication no. 96-02. 135 pgs.

# # # # #

**This report includes the following items inserted after this point:**

Figure 1. Vicinity map showing study area and Critical Aquifer Recharge Areas (CARAs) in the Dungeness watershed

Figure 2. Hydrogeologic cross section showing principal aquifers and confining units and directions of groundwater flow (from Simonds and Sinclair 2002) [separate electronic file]

Figure 3. Study well locations and surrounding land use zoning

Figure 4. Groundwater flow direction, May 2005

Figure 5. Nitrate ( $\text{NO}_3 + \text{NO}_2$  as N) concentrations, May 2005

Figure 6. TDS (Total Dissolved Solids) concentrations, May 2005

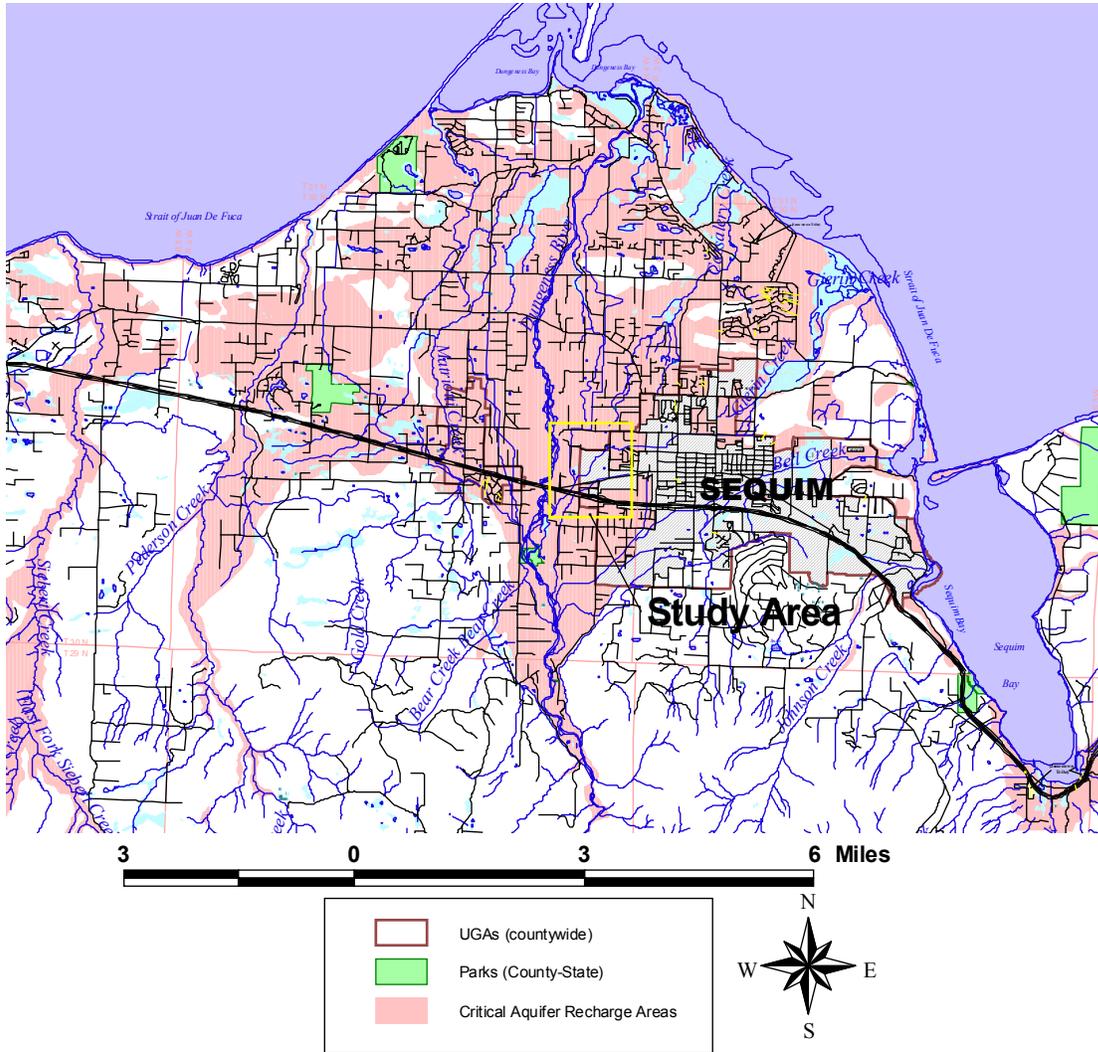
Figure 7. Correlation diagram: TDS and specific conductance

Appendix A. Monitoring Plan [separate electronic file]

Appendix B. Well Logs [well logs are separate electronic files]

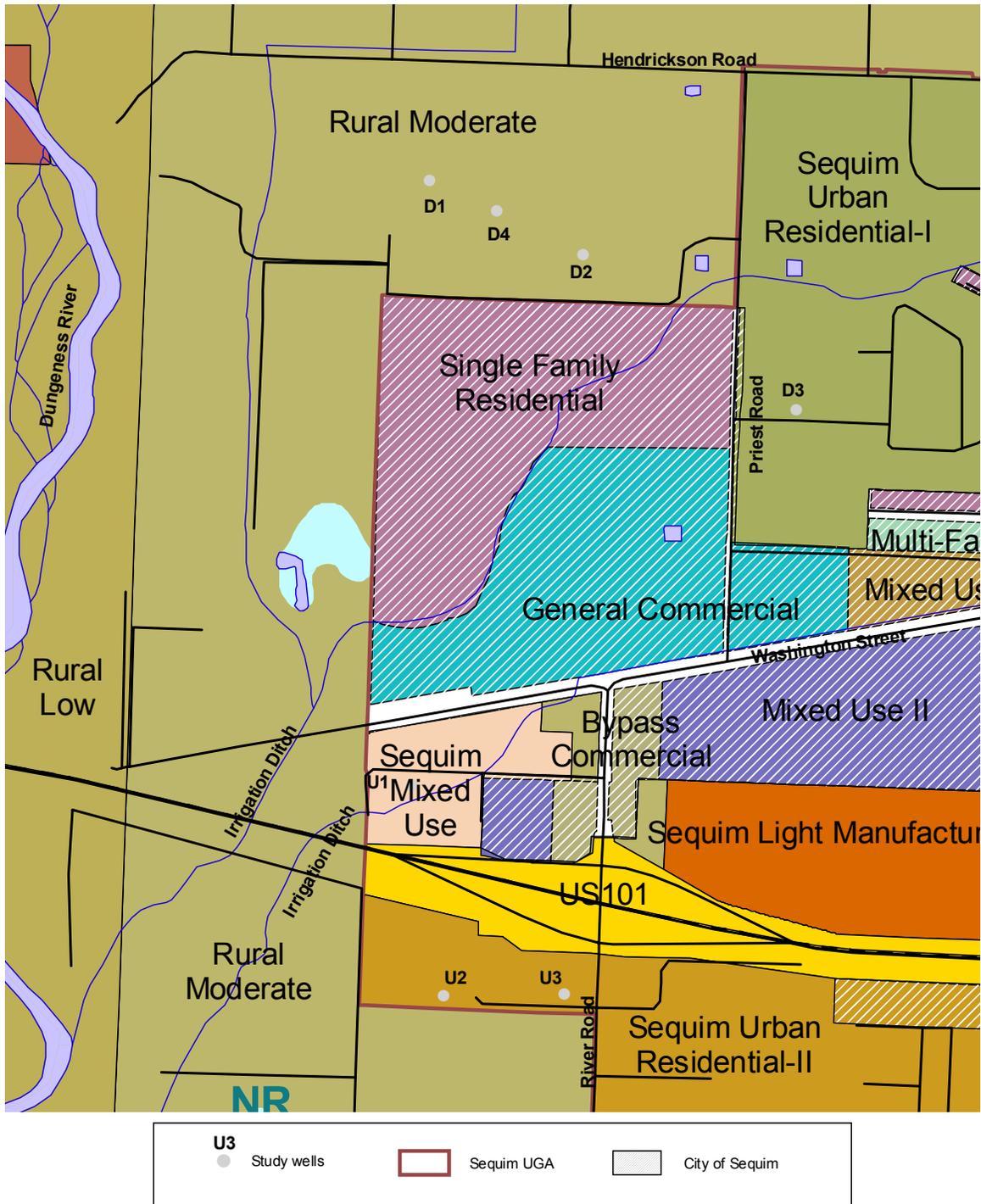
Appendix C. Summary of Laboratory Analyses

**Figure 1** Vicinity map showing study area and Critical Aquifer Recharge Areas (CARAs) in the Dungeness watershed

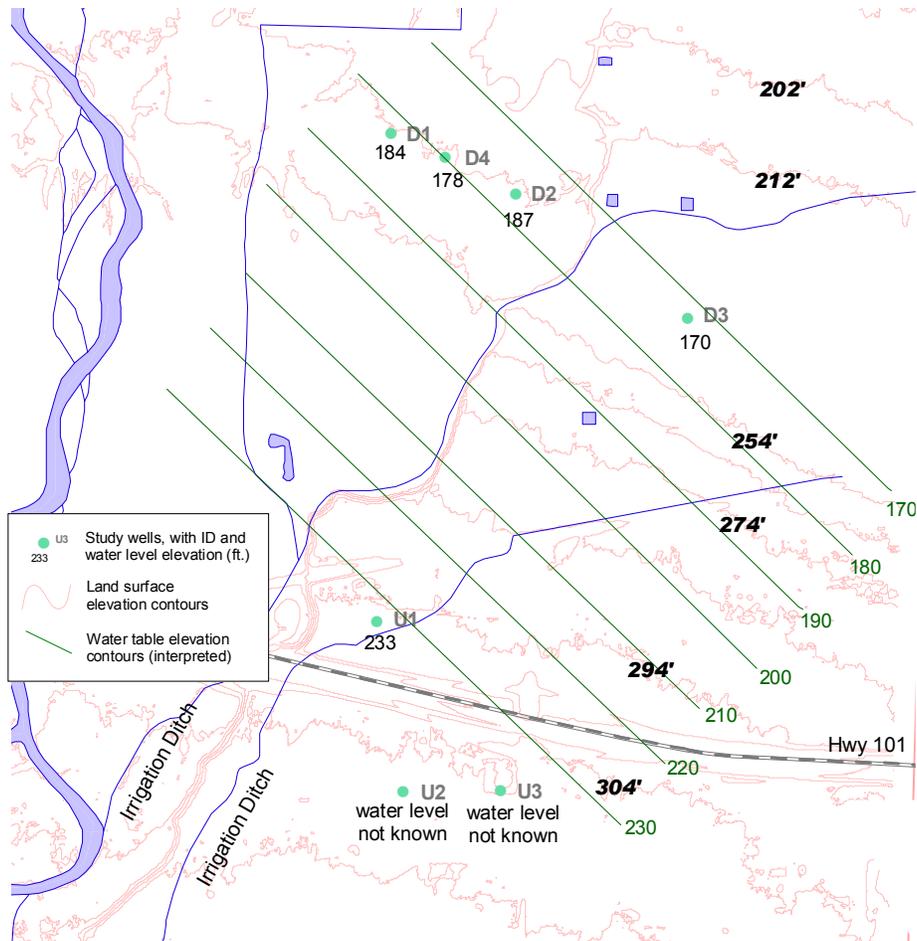


Note - Figure 2 is a separate electronic file.

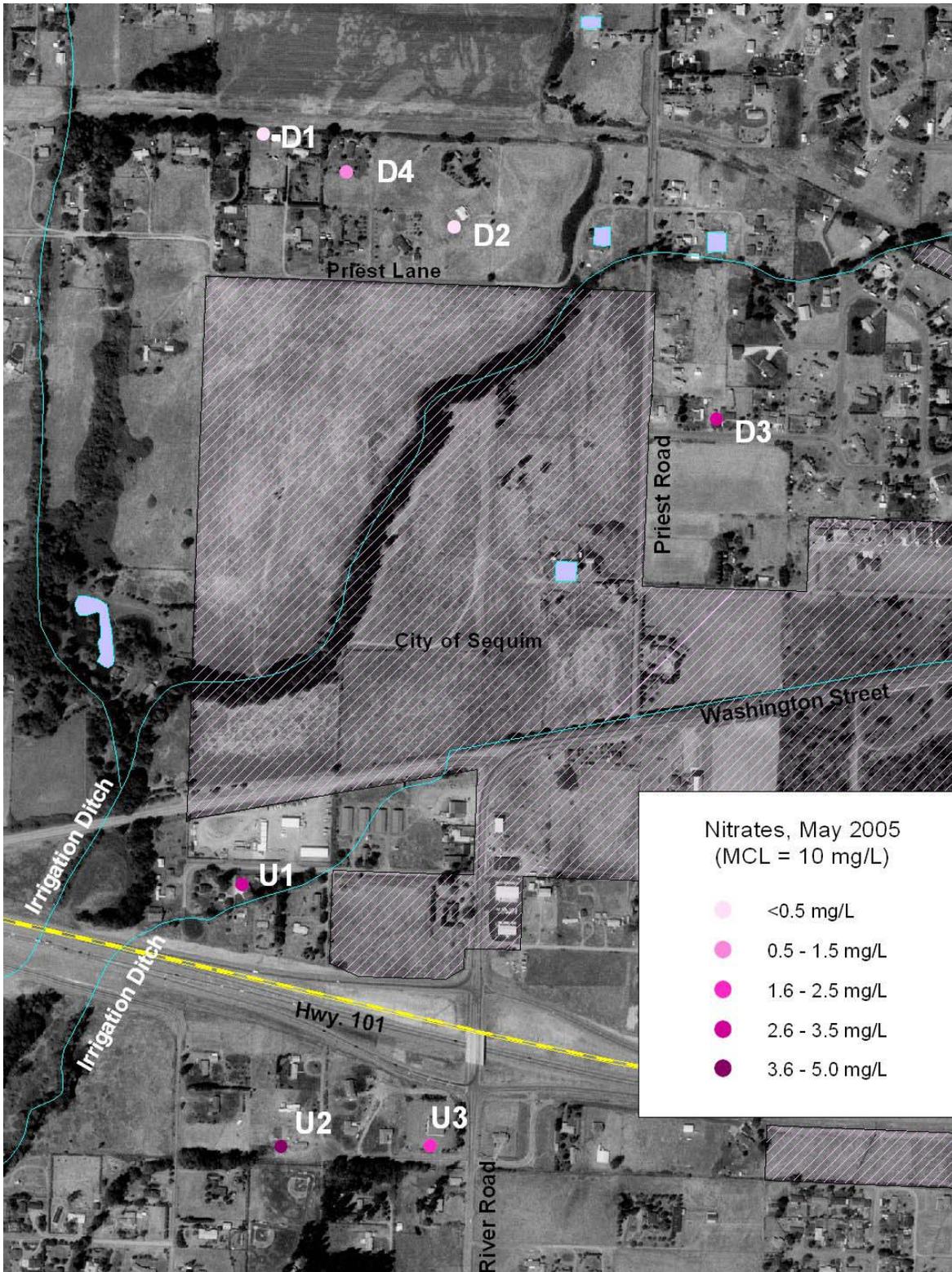
**Figure 3** Study well locations and surrounding land use zoning



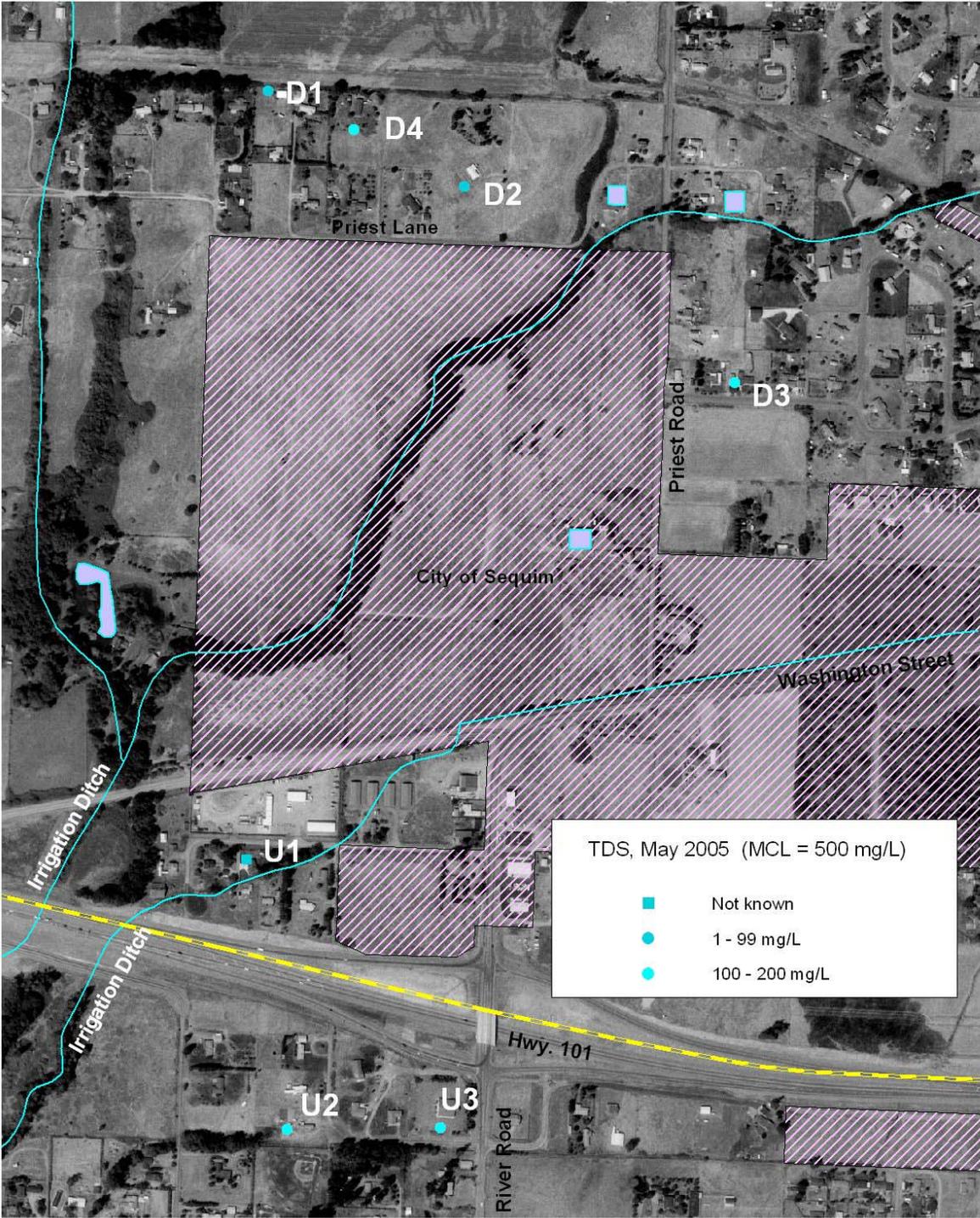
**Figure 4** Groundwater flow direction, May 2005



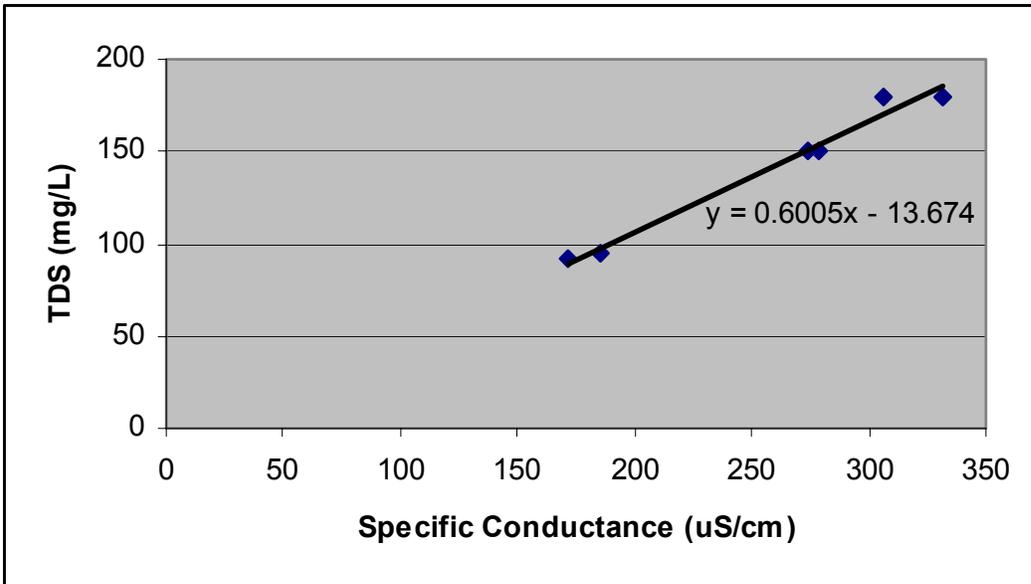
**Figure 5** Nitrate ( $\text{NO}_3 + \text{NO}_2$  as N) concentrations, May 2005 (aerial photograph taken in 2000)



**Figure 6** TDS (Total Dissolved Solids) concentrations, May 2005 (aerial photograph taken in 2000)



**Figure 7** Correlation diagram: TDS and specific conductance



## Appendix A. Monitoring Plan

### Monitoring for Stormwater Contaminants in the Shallow Aquifer Near Priest Road, Clallam County, WA

#### Monitoring Plan

Prepared by Ann Soule, LHG  
Clallam County Environmental Health Services

April 2005

#### Purpose

As described by representatives of the Board of Commissioners' office, the purpose of this project is to establish a baseline of groundwater quality information for County residents with drinking water wells downgradient of recent commercial development within City of Sequim's western city limits. We are aware that the City and project developers have (or have in progress) agreements for monitoring stormwater treatment facilities in the cases of WalMart and Sequim Village Marketplace (Home Depot), and intend to track that data as it comes in.

#### Methods

County Environmental Health (EH) staff will select wells used for domestic water supply for sampling of characteristic stormwater contaminants. This project will follow standard procedures for well and analyte selection, sampling and handling methods, laboratory analysis, and statistical analysis (when needed).

1. Write monitoring plan.

Include outside review from Ecology staff.<sup>2</sup>

2. Select study wells.

All wells 120' deep or less within a  $\frac{3}{4}$ -mile radius of the corner of Priest Rd. and West Washington St. were considered. One upgradient well and three downgradient wells (given the regional groundwater flow direction) will be selected for sampling from Table 1. Requirements for well selection include, in priority order:

- a. must have a well report (log),
- b. must tap shallowest zones of the water table aquifer,
- c. must not be located adjacent to an irrigation ditch,

---

<sup>2</sup> John Stormon and Martha Maggi both provided comments, April and May 2005

- d. must have an accessible wellhead and nearby faucet for collection of raw (untreated) and fresh (not from a storage tank) samples, and
- e. must have a willing well owner (and tenant if applicable).

**Table 1. Potential study wells**

<b>Up/down gradient</b>	<b>Well no.</b>	<b>Depth</b>	<b>Screened interval</b>	<b>Drilling company</b>	<b>Date completed</b>
Up	U1	102	97-102	Stoican	10/27/1976
Up	U2	100	95-100	Louie's	2/2/1992
Up	U3	120	110-120	Stoican	4/4/1989
Down	D1	41	36-41	Louie's	4/23/2004
Down	D2	64.5	26-37 (perf)	Stoican	3/9/1993
Down	D3	79	Open bottom	Stoican	12/5/1975
Down	D4	54	Open bottom	VanAusdle	2/28/1977

3. Select contaminants for analysis.

According to Pitt (1996), potential stormwater contaminants from commercial/retail/road environments include nutrients, salts, pathogens, bromide and TOC, pesticides, other organics, and heavy metals. Which of these stormwater runoff constituents might be contaminating groundwater in this study area depends on several factors, including whether it exists in the runoff, the treatment applied to runoff (if any), the mobility and persistence of the constituent, and the characteristics of the soils and underlying strata. Table 1 lists the stormwater constituents considered to be at risk of being present in groundwater for the study area, the analytical procedure chosen to test for each, the detection limit, and the corresponding state standard.

**Table 2. Constituents of interest**

<b>Constituents of interest</b>	<b>Analytical method</b>	<b>Detection limit</b>	<b>State standard*</b>	<b>Price per sample**</b>
<u>nutrients:</u> Nitrate as N (NO <sub>3</sub> as N) Total Kjeldahl nitrogen (TKN)	EPA 353.2 EPA 351.3	0.010 mg/L 0.25 mg/L	10 mg/L 10	\$20 \$30
<u>metals (total):</u> lead (Pb) chromium (Cr) nickel (Ni) zinc (Zn)	EPA 200.7 (ICP) EPA 200.7 (ICP) EPA 200.7 (ICP) EPA 200.7 (ICP)	0.01 mg/L 0.001 0.005 0.001	0.05 mg/L 0.1 0.1 5.0	\$10 \$10 \$10 \$10
<u>pesticides:</u> Chlorinated pesticides scan includes chlordane	EPA 608 (GC/EC)	Various (ug/L)	Various	\$75
<u>other organics:</u> Semi-volatiles scan includes pyrene, fluoranthene Hydrocarbon identification	EPA 625 (GC/MS) NW-TPH-HCID	Various (ug/L) ?? (mg/L)	Various Not defined	\$300 \$50

<u>pathogens:</u>				
Total coliform	SM 9221 B, 9222 B	MPN or MF	1	\$30***
Pseudomonas aeruginosa	SM 9213 E, F	presence	0	\$25
<u>solids:</u>				
Total Dissolved Solids (TDS)	EPA 160.1	1.0 mg/L	500 mg/L	\$15

\*Ecology, 1996, Appendix A

\*\*AmTest, Inc., 2004

\*\*\*may be tested by Clallam County Environmental Health Laboratory, 2005

#### 4. Order sample bottles as follows.

<b>Constituent</b>	<b>Bottle description</b>	<b>Quantity</b>
nutrients (2 analyses/bottle)	250 ml HDPE preserved with H <sub>2</sub> SO <sub>4</sub>	4 for groundwater samples 1 for a duplicate 2 for trip blanks
metals (total) (4 analyses/bottle)	500 ml HDPE rinsed with HNO <sub>3</sub>	4 for groundwater samples 1 for a duplicate
pesticides	1L amber glass, no pres.	4 for groundwater samples 1 for a duplicate
semi-volatiles scan	1L amber glass, no pres.	4 for groundwater samples (no lab trip blank required)
hydrocarbons	1L amber glass, no pres.	4 for groundwater samples
total coliform	250 ml HDPE preserved with EDTA (or similar, if from County lab)	4 for groundwater samples 1 for a duplicate
Pseudomonas aeruginosa	250 ml HDPE preserved with EDTA	4 for groundwater samples 1 for a duplicate
dissolved solids	250 ml HDPE, no pres.	4 for groundwater samples 1 for a duplicate
(various)	1L amber glass, no pres.	1 for a field blank (won't be used for sampling)

#### 5. Initial site visit.

Visit potential study wells to confirm that access and water level measurement is possible. Also to include well tagging, GPS location, and digital photos (if equipment is available); field notes will include a sketch map.

#### 6. Establish a database of well and sampling information.

#### 7. Field sampling.

- field notes will be taken for all steps;
- well purging, according to accepted procedures;
- measurement of field parameters (temperature, pH, conductivity, and dissolved oxygen) following equipment manuals' instructions for maintenance, calibration, and operation;
- groundwater sample collection and handling, following procedural guidance found in Koterba, 1995, and laboratory sample collection procedures (see Attachment A, AmTest Sample Collection Procedures) including requirements for containers, preservation, and

holding times (AmTest Laboratories, Inc. and Clallam County Environmental Health Lab);

- field QC sample collection, including 10% duplicates from wells expected to have positive results for various constituents (except semi-volatiles and hydrocarbons), and one transfer blank for each batch with nitrate samples sent to the lab;
- store and transport groundwater and QC samples to each laboratory for analysis according to accepted laboratory procedures.

#### 8. Interpret laboratory results and write report.

The goal for precision among repetitive measurements of the same sample will be +/- 20% for all analyses with a level of detection less than 10 ug/L, and 10% for those at or above that level of detection. Because this data will be used for baseline purposes, higher levels of precision are not required. The expected range of results for total coliform is 0 to confluent growth. The presence of any total coliform and/or E. coli will be cause for immediate corrective action, and well owners will be notified by Clallam County Environmental Health.

The report will include a summary of field methods, comparison of results to water quality standards, and time series plots for each well after the initial sampling. Any evidence that groundwater flow direction does not follow the regional pattern will be discussed. After sufficient background data have been collected (expected to be 8 sampling events), a statistical method for data evaluation will be chosen following EPA statistical guidance. Distribute report internally and to all participants (including lab results), at minimum.

#### 9. Sampling schedule.

Repeat sampling in project wells for constituents listed in Table 2 according to the following schedule. Note that monthly or quarterly sampling of some constituents (e.g., nitrates and/or dissolved solids) would provide information on seasonal water quality fluctuations which, in turn, may indicate the need to reconsider the timing of annual sampling. In the absence of this data, March and April are preferred months for sampling. Additionally, a sharp increase in nitrates or other parameters would warrant more frequent tests for all constituents.

<b>Timing</b>	<b>Constituents to sample and test</b>
Spring 2005 (initial sampling)	All constituents
Spring 2006	All constituents
Spring 2007, 2008, 2009	Nutrients and dissolved solids
Spring 2010	All constituents
Spring 2011, 2012, 2013, 2014	Nutrients and dissolved solids*
Spring 2015	All constituents
Etc.	

\*unless data indicate a statistically significant increase from 2005-06 (determining this may require up to 8 sampling events), in which case all constituents should be sampled.

## **Bibliography**

AmTest Laboratories, Inc. 2004. Capability Summary and Price Listing. 24 pgs.

Barcelona, M.J., J.P. Gibb, J.A. Helfrich, E.E. Garske. 1985. Practical Guide for Ground-Water Sampling. Illinois State Water Survey Contract Report 374, prepared in cooperation with Robert S. Kerr Environmental Research Laboratory, and the Environmental Monitoring Systems Laboratory (U.S. Environmental Protection Agency). 94 pgs.

Clallam County Environmental Health. 2005. Price list and schedule for lab procedures.

Koterba, M.T., et. al. 1995. Ground-Water Data-Collection Protocols and Procedures for the National Water-Quality Assessment Program: Collection and Documentation of Water-Quality Samples and Related Data. U.S. Geological Survey Open File Report 95-399. 87 pages plus appendix.

Pitt, Robert. 1996. Groundwater Contamination from Stormwater Infiltration. Ann Arbor Press, Inc., Chelsea, Michigan. 124 pgs. plus annotated bibliography on groundwater contamination.

U.S. EPA. 1999. Class V UIC Control Study, Appendix E, Contaminant Persistence and Mobility Factors. EPA/816-R-99-014. 19 pgs.

U.S. Geological Survey. 2004. Chapter 4 of the USGS National Field Manual.

Washington State Department of Ecology. 1996. Implementation Guidance for the Ground Water Quality Standards. Publication no. 96-02. 135 pgs.

Washington State Department of Ecology. 2003. Manchester Environmental Laboratory Lab Users Manual, 7<sup>th</sup> Edition. 178 pgs. plus appendices.

## Appendix B. Well Logs

Driller's records for the following study wells may be found after this page.

<b>Up/down gradient</b>	<b>Study ID no.</b>	<b>Elevation (LiDAR)</b>	<b>Well tag no.</b>	<b>Well depth</b>	<b>Screened interval</b>	<b>Date drilling completed</b>
Up	U1	296'	None	102	97-102	10/27/1976
Up	U2	307'	None	100	95-100	2/2/1992
Up	U3	304'	None	120	110-120	4/4/1989
Down	D1	203'	AKA 701	41	36-41	4/23/2004
Down	D2	204'	None	64.5	26-37 (perforated)	3/9/1993
Down	D3	237'	ACA 651	79	Open bottom	12/5/1975
Down	D4	204'	None	54	Open bottom	2/28/1977







WATER WELL REPORT  
STATE OF WASHINGTON

Start Card No. W 181606  
Water Right Permit No. AKA 701

151407

(1) OWNER: Name **MOORE RON** Address **358 PRIEST LANE SEQUIM, WA 98382-**

(2) LOCATION OF WELL: County **CLALLAM** - NE 1/4 NW 1/4 Sec 24 T 30 N., R 4 W WM

(2a) STREET ADDRESS OF WELL (or nearest address) **SAME**

(3) PROPOSED USE: **DOMESTIC** (10) WELL LOG

(4) TYPE OF WORK: Owner's Number of well (If more than one) **NEW WELL** Method: **ROTARY**  
Formation: Describe by color, character, size of material and structure, and show thickness of aquifers and the kind and nature of the material in each stratum penetrated, with at least one entry for each change in formation.

(5) DIMENSIONS: Diameter of well **6** inches  
Drilled **41** ft. Depth of completed well **41** ft.

(6) CONSTRUCTION DETAILS:		MATERIAL		FROM	TO
Casing installed: <b>6</b>	" Dia. from <b>01</b> ft. to <b>36</b> ft.	<b>TOPSOIL</b>	<b>0</b>	<b>2</b>	
<b>WELDED</b>	" Dia. from ft. to ft.	<b>BROWN CLAY</b>	<b>2</b>	<b>12</b>	
	" Dia. from ft. to ft.	<b>BOULDERS</b>	<b>12</b>	<b>23</b>	
	" Dia. from ft. to ft.	<b>BROWN HARDPAN</b>	<b>23</b>	<b>36</b>	
		<b>GRAVEL WATER BEARING</b>	<b>36</b>	<b>41</b>	

Perforations: **NO**  
Type of perforator used  
SIZE of perforations in. by in.  
perforations from ft. to ft.  
perforations from ft. to ft.  
perforations from ft. to ft.

Screens: **YES**  
Manufacturer's Name **COOK**  
Type **SLOTTED** Model No.  
Diam. **5** slot size **15** from **36** ft. to **41** ft.  
Diam. slot size from ft. to ft.

Gravel packed: **NO** Size of gravel  
Gravel placed from ft. to ft.

Surface seal: **YES** To what depth? **18** ft.  
Material used in seal **BENTONITE**  
Did any strata contain unusable water? **NO**  
Type of water? Depth of strata ft.  
Method of sealing strata off **NONE**

(7) PUMP: Manufacturer's Name  
Type **NONE** H.P.

(8) WATER LEVELS: Land-surface elevation above mean sea level ... ft.  
Static level **19** ft. below top of well Date **04/23/04**  
Artesian Pressure lbs. per square inch Date  
Artesian water controlled by **NOT ARTESIAN**

Work started **04/23/04** Completed **04/23/04**

(9) WELL TESTS: Drawdown is amount water level is lowered below static level.

Was a pump test made? **NO** If yes, by whom?  
Yield: gal./min with ft. drawdown after hrs.

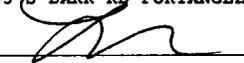
Recovery data  
Time Water Level Time Water Level Time Water Level

Date of test / /  
Bailer test gal/min. ft. drawdown after hrs.  
Air test 30+ gal/min. w/ stem set at **30** ft. for 1 hrs.  
Artesian flow g.p.m. Date  
Temperature of water Was a chemical analysis made? **NO**

WELL CONSTRUCTOR CERTIFICATION:  
I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

NAME **LOUIE'S WELL DRILLING INC**  
(Person, firm, or corporation) (Type or print)

ADDRESS **363 S BARR RD PORTANGELES**

[SIGNED]  License No. **0848**

Contractor's  
Registration No. **LOUIEWD137PW** Date **04/26/04**

RECEIVED

MAY 11 2004

The Department of Ecology does NOT Warranty the Data and/or the Information on this Well Report.









## Appendix C. Summary of Laboratory Analyses

Parameter: (analysis by AmTest, Inc., unless noted)	Total Coliform CFU/100 ml	Pseudomonas aeruginosa MPN /100 ml	TKN mg/L	Nitrate + nitrite as N mg/L	TDS mg/L	chromium mg/L	nickel mg/L	lead mg/L	zinc mg/L	gas	diesel	oil	pesticides	PCBs	semi-vol organics
Units	ml	MPN /100 ml	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	30	100	200	ug/L	ug/L	ug/L
Method reference															
Method Detection Limit															
State standard (Ecology, 1996, App. A)	1	3	0.1	0.01	1	0.001	0.005	0.01	0.001	30	100	200	various	various	various
Date sampled	1	0	10	10	500	0.1	0.1	0.05	5	not defined	not defined	not defined	various	various	various
<b>Upgradient wells:</b>															
U1															
U2	0**	nd	nd	4.9	180	0.002	nd	nd	0.008	nd	nd	nd	nd	nd	nd
U3	0**	nd	nd	1.9	150	0.004	nd	nd	0.015	nd	nd	nd	nd	nd	nd
<b>median</b>				<b>3.4</b>	<b>165</b>	<b>0.003</b>			<b>0.0115</b>						
<b>Downgradient wells:</b>															
D1*	nd	nd	nd	0.16	92	0.001	nd	0.001	0.008	nd	nd	nd	nd	nd	nd
D2*	nd	nd	nd	0.16	95	0.001	nd	nd	0.01	nd	nd	nd	nd	nd	nd
D3	0**	nd	nd	3.4	180	0.003	nd	nd	0.014	nd	nd	nd	nd	nd	nd
D4	0**	nd	nd	0.61	150	0.004	nd	nd	0.011	nd	nd	nd	nd	nd	nd
<b>median</b>				<b>0.385</b>	<b>122.5</b>	<b>0.002</b>			<b>0.0105</b>						
*for lead, EPA239.2 was used, MDL=0.001															
<b>Trip blanks:</b>															
B1				nd											
B2				0.031											
B5				0.03											
<b>Replicate:</b>															
D3B	0**	nd	nd	3.4	180	0.002	nd	nd	0.017				nd		nd

nd = not detected  
 \*\*analysis by Clallam County Environmental Health Laboratory using Colilert method 9223 for Total Coliform and E. Coli