

…the rest of the story

SEF Science Café, January 13, 2015

Ann Soule, LHg

Sequim Public Works

SEF Science Café MENU for January 2015

Starters

- Geology & hydrogeology

Salads

- Surface water—ground water interaction
- Historical water management



Pastas

- Groundwater age
- Groundwater recharge
- Water quantity / Water supply

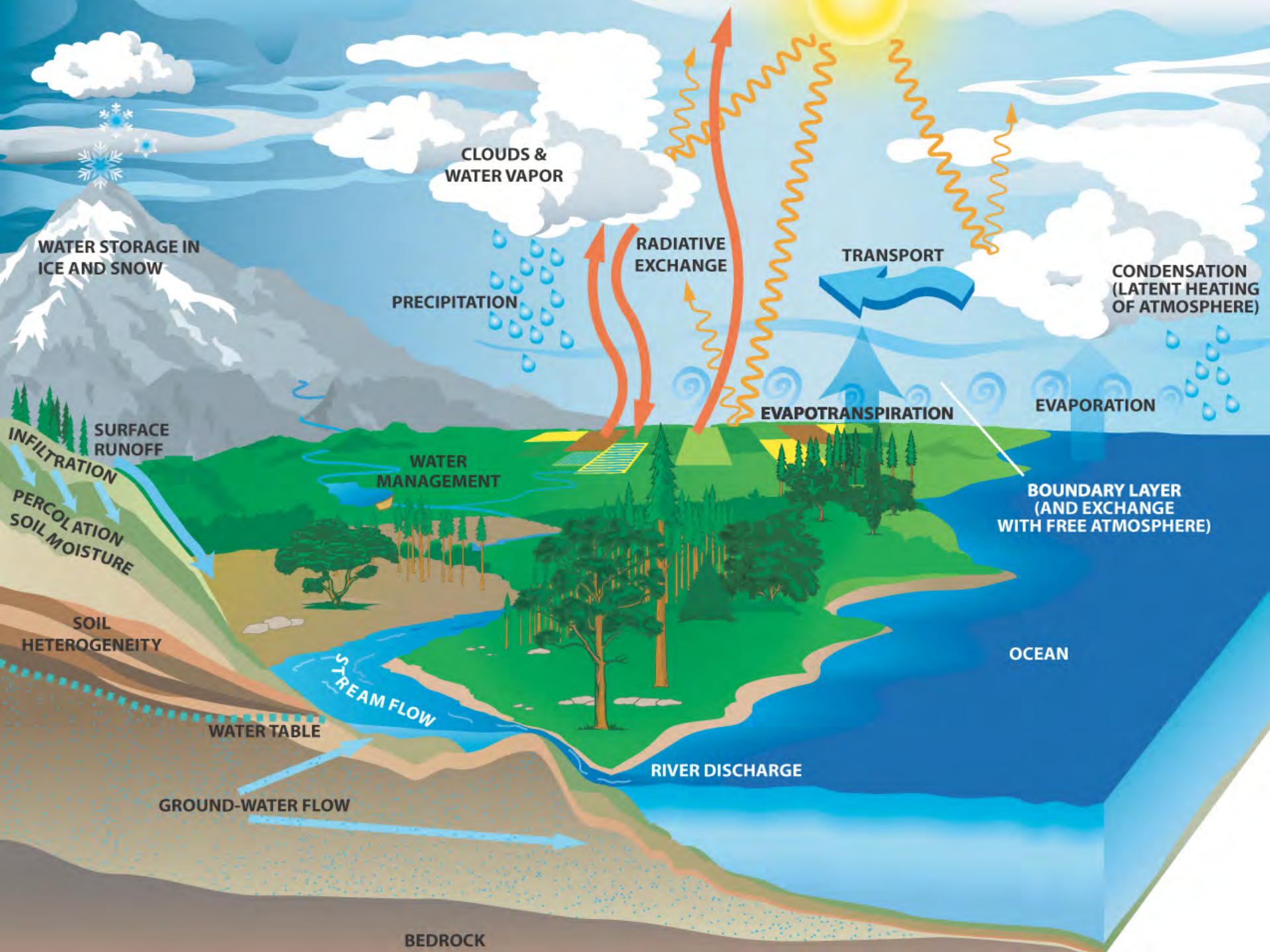
Entrees

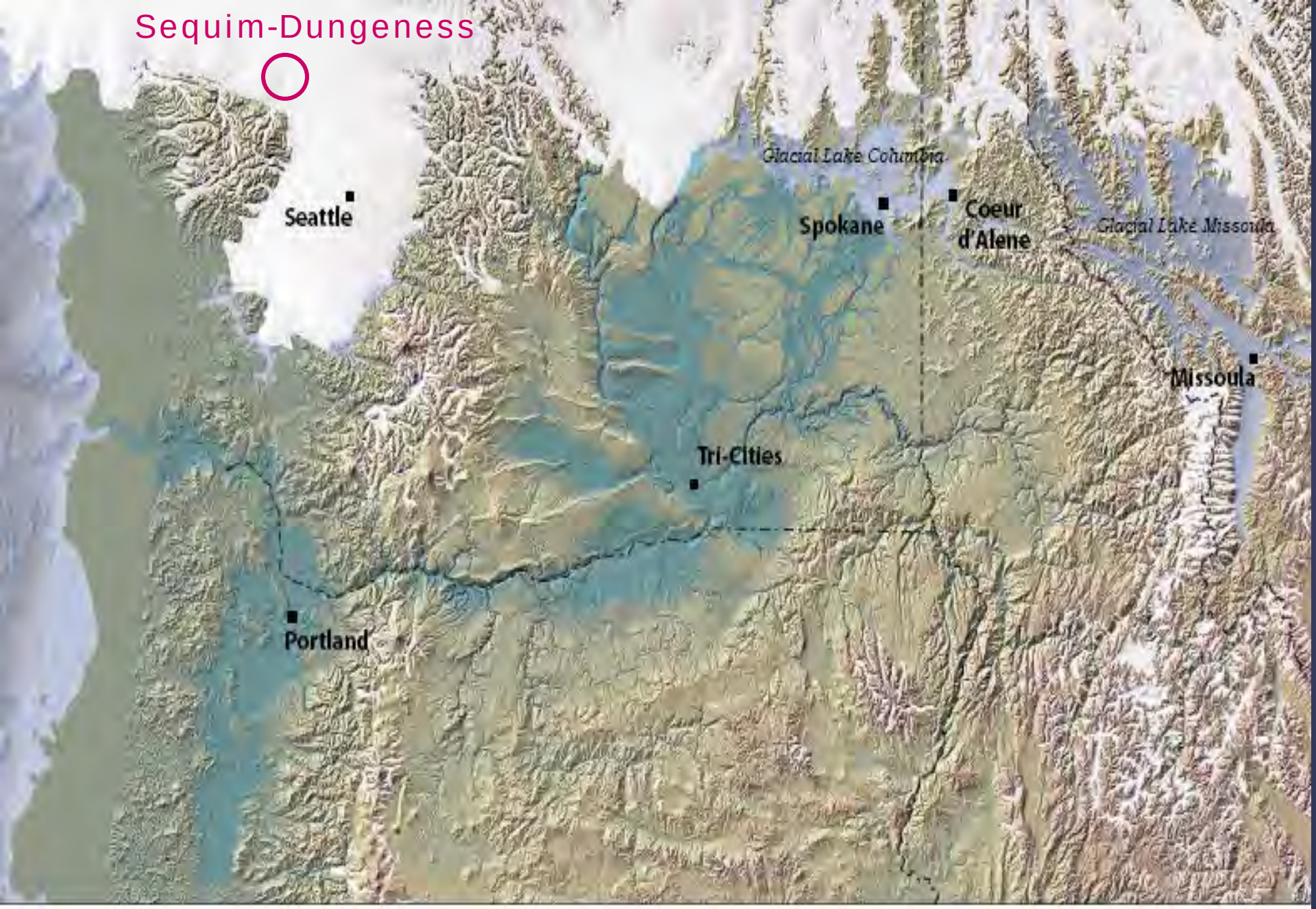
- Groundwater quality
- Contemporary water management

Dessert

- Where water is wealth… the rest of the story

Geology & hydrogeology


CLOUDS &
WATER VAPOR
WATER STORAGE IN
ICE AND SNOW
PRECIPITATION
RADIATIVE
EXCHANGE
TRANSPORT
CONDENSATION
(LATENT HEATING
OF ATMOSPHERE)
EVAPOTRANSPIRATION
EVAPORATION
SURFACE
RUNOFF
INFILTRATION
PERCOLATION
SOIL MOISTURE
WATER
MANAGEMENT
BOUNDARY LAYER
(AND EXCHANGE
WITH FREE ATMOSPHERE)
SOIL
HETEROGENEITY
STREAM FLOW
OCEAN
WATER TABLE
RIVER DISCHARGE
GROUND-WATER FLOW
BEDROCK



The Pacific Northwest During the Last Ice Age: 15,000 to 12,000 Years Ago

File Original and First Copy with Department of Ecology
Second Copy—Owner's Copy
Third Copy—Driller's Copy

WATER WELL REPORT

STATE OF WASHINGTON

Start Card No. 067885

Water Right Permit No.

(1) OWNER: Name _____ Address 187H Priest Road Sequim 98382

(2) LOCATION OF WELL: County CLALLAM SE ¼ NW¼ Sec 24 T 30 N., R 4W W.M.

(2a) STREET ADDDRESS OF WELL (or nearest address) 187-H Priest Rd

(3) PROPOSED USE: ☒ Domestic ☐ Irrigation ☐ DeWater ☐ Industrial ☐ Test Well ☐ Municipal ☐ Other ☐

(4) TYPE OF WORK: Owner's number of well (if more than one) _____
Abandoned ☐ New well ☒ Method: Dug ☐ Cable ☒ Rotary ☐ Bored ☐ Driven ☐ Jetted ☐
Deepened ☐ Reconditioned ☐

(5) DIMENSIONS: Diameter of well 6 inches. Drilled 81 feet. Depth of completed well 52 ft.

(6) CONSTRUCTION DETAILS:
Casing installed: 6 " Diam. from +1 ft. to 76.5 ft.
Welded ☒ Liner installed ☐ Threaded ☐ " Diam. from _____ ft. to _____ ft.
Perforations: Yes ☐ 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 ☒ No ☐
Manufacturer's Name COOK
Type STAINLESS STEEL Model No. 12G
Diam. 5 Slot size .012 from 77 ft. to 82 ft.
Diam. _____ Slot size _____ from _____ ft. to _____ ft.
Gravel packed: Yes ☐ No ☒ Size of gravel _____
Gravel placed from _____ ft. to _____ ft.
Surface seal: Yes ☒ No ☐ To what depth? 18 ft.
Material used in seal BENTONITE & PUDDLING CLAY
Did any strata contain unusable water? Yes ☐ No ☒
Type of water? _____ Depth of strata _____
Method of sealing strata off _____

(7) PUMP: Manufacturer's Name _____
Type: _____ H.P. _____

(8) WATER LEVELS: Land-surface elevation above mean sea level 85 ft.
Static level 19 ft. below top of well Date Jun 17 1992
Artesian pressure _____ lbs. per square inch Date _____
Artesian water is controlled by _____ (Cap, valve, etc.)

(9) WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? Yes ☒ No ☐ If yes, by whom? DRILLER
Yield: 20 gal./min. with 4 ft. drawdown after 1 hrs.
" " " " " "
" " " " " "
Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level
651	23	4:53	19		

Date of test June 16 1992
Bailer test 20 gal./min. with 4 ft. drawdown after ½ hrs.
Airtest _____ gal./min. with stem set at _____ ft. for _____ hrs.
Artesian flow _____ g.p.m. Date JUNE 16 1992
Temperature of water 51° Was a chemical analysis made? Yes ☒ No ☐

(10) WELL LOG or ABANDONMENT PROCEDURE DESCRIPTION

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 of information.

MATERIAL	FROM	TO
TOPSOIL SILT BRN	0	8"
GRAVEL PEA L SAND F TO C ROCKS STO 1" L GRAY CLAYEY BRN	8"	19'
GRAVEL PEA L SAND F TO C CLAYEY GRAY WB	19'	19'6"
SAND FROM GRAVEL PEA M GRAY CLAYEY BRN	19'6"	28
GRAVEL PEA M SAND FROM GRAY CLAYEY BRN WB	28	29
HARDPAN CLAY BRN GRAVEL PEA L SAND F TO C ROCKS STO M GRAY & BLACK	29	40
GRAVEL PEA L SAND F TO C ROCKS STO M GRAY CLAYEY BRN	40	49
HP CLAY BRN GRAVEL PEA L SAND F TO C ROCKS STO M GRAY	49	55
HP CLAY GRAY GRAVEL PEA L SAND F TO C ROCKS STO M GRAY	55	69
GRAVEL PEA M SAND F TO C GRAY & COLORS IRON WB	69	72'6"
HP CLAY BRN GRAVEL PEA L SAND F TO C GRAY	72'6"	77
SAND BLACK COARSE TO FINE GRAVEL PEA L ROCKS SMALL GRAY BLACK & COLORED WS	77	82

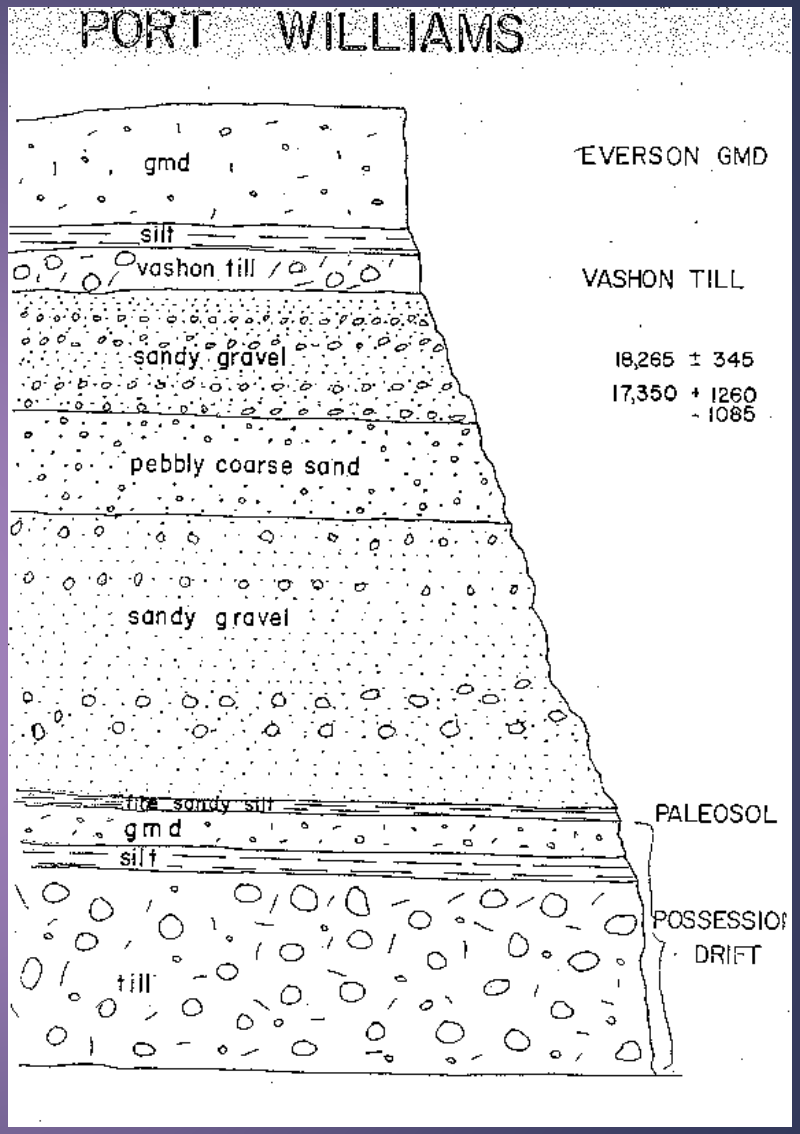
Work started JUNE 8 19 Completed JUNE 16 1992

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.

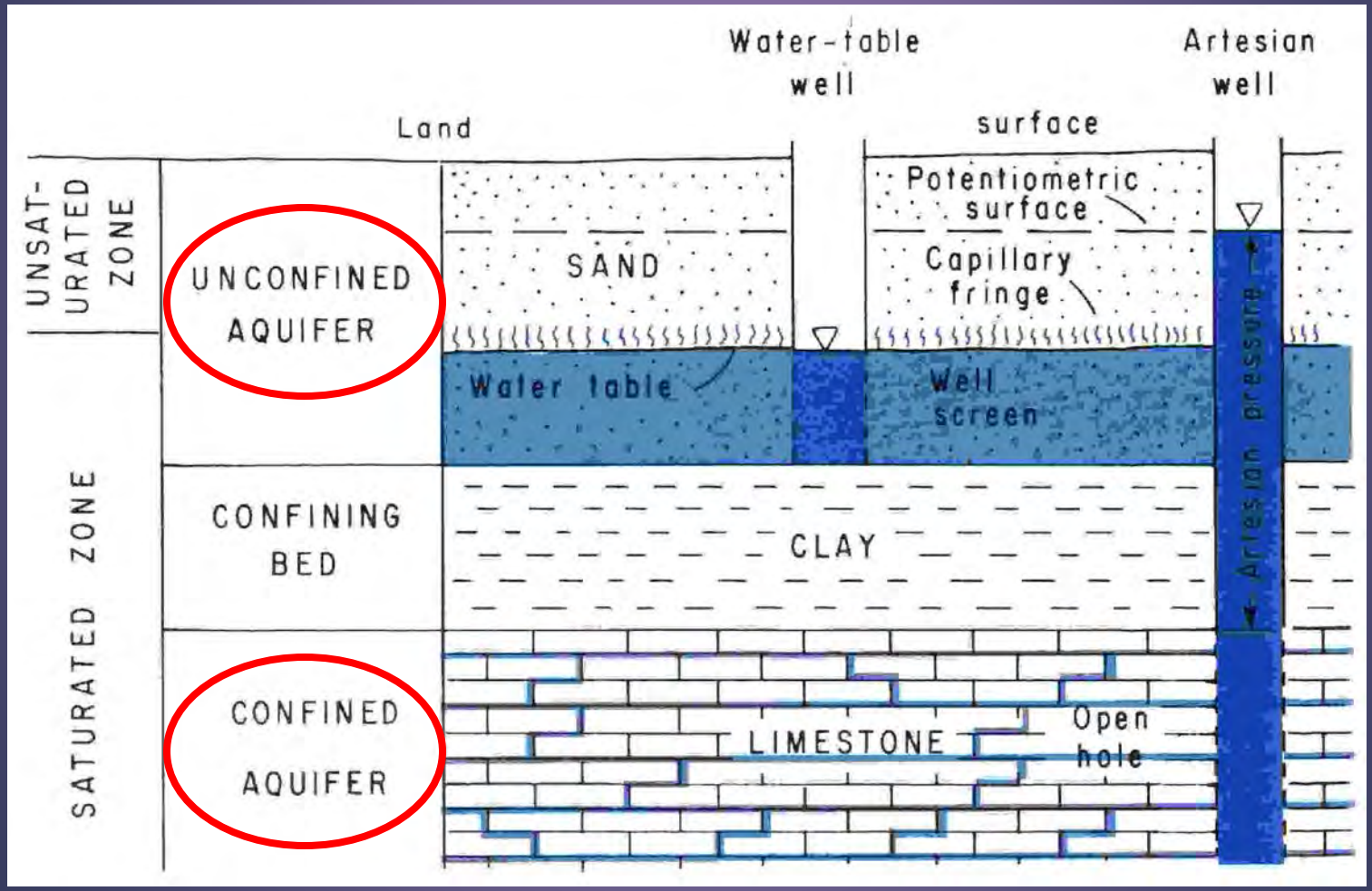
NAME PENINSULA WATER WELLS (PERSON, FIRM, OR CORPORATION) (TYPE OR PRINT)
Address 256 W Sequim Bay Rd. Sequim WA.
(Signed) Fred Grant (WELL DRILLER) License No. 1688
Contractor's Registration No. PENINWW1219NC Date June 17 1992

(USE ADDITIONAL SHEETS IF NECESSARY)

ECY 050-1-20 (10/87) -1329-

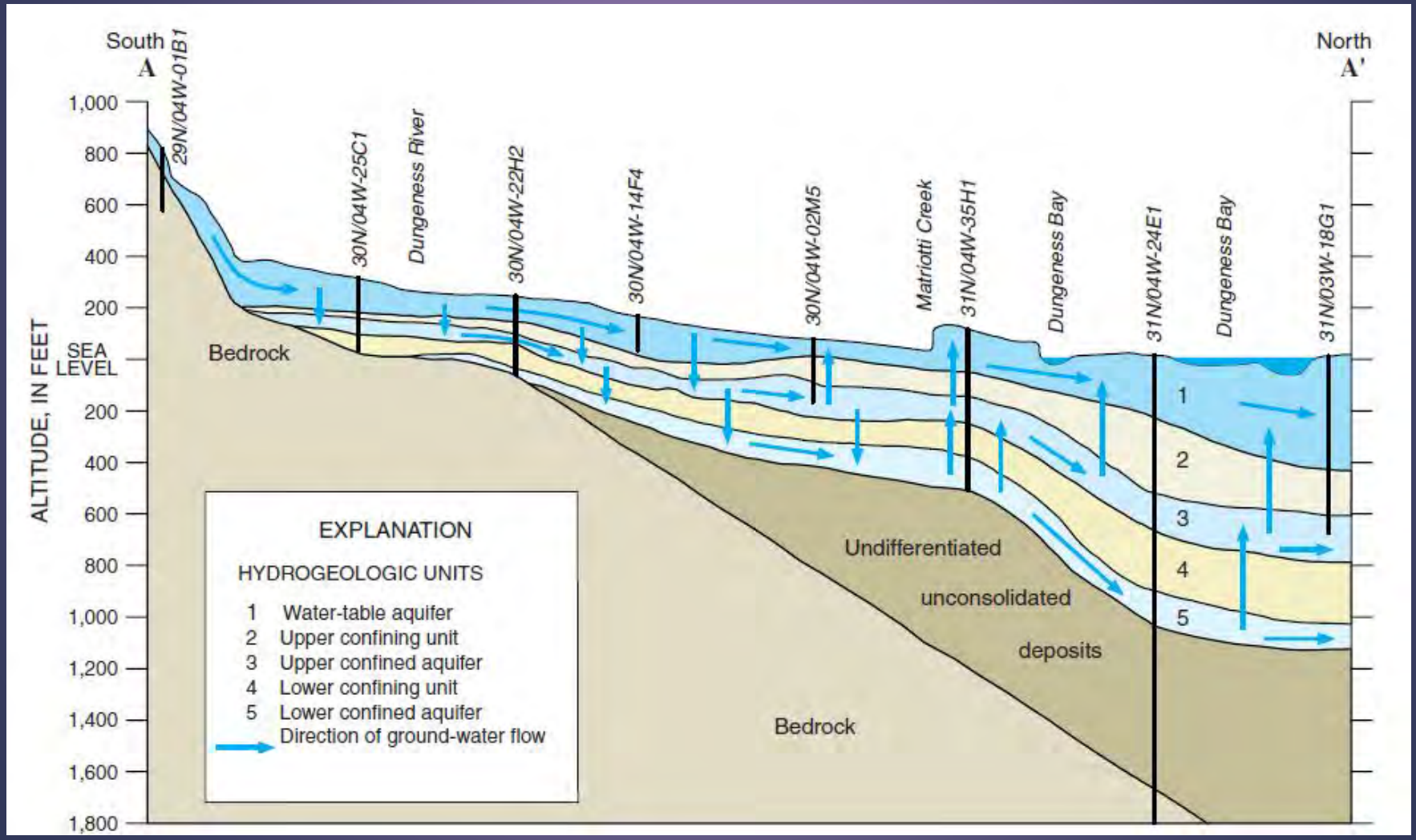


Unconfined and confined aquifers



USGS WSP 2220

Hydrogeologic x-section



Simonds and Sinclair 2002

E.g., USCG Lighthouse well



Soil groups

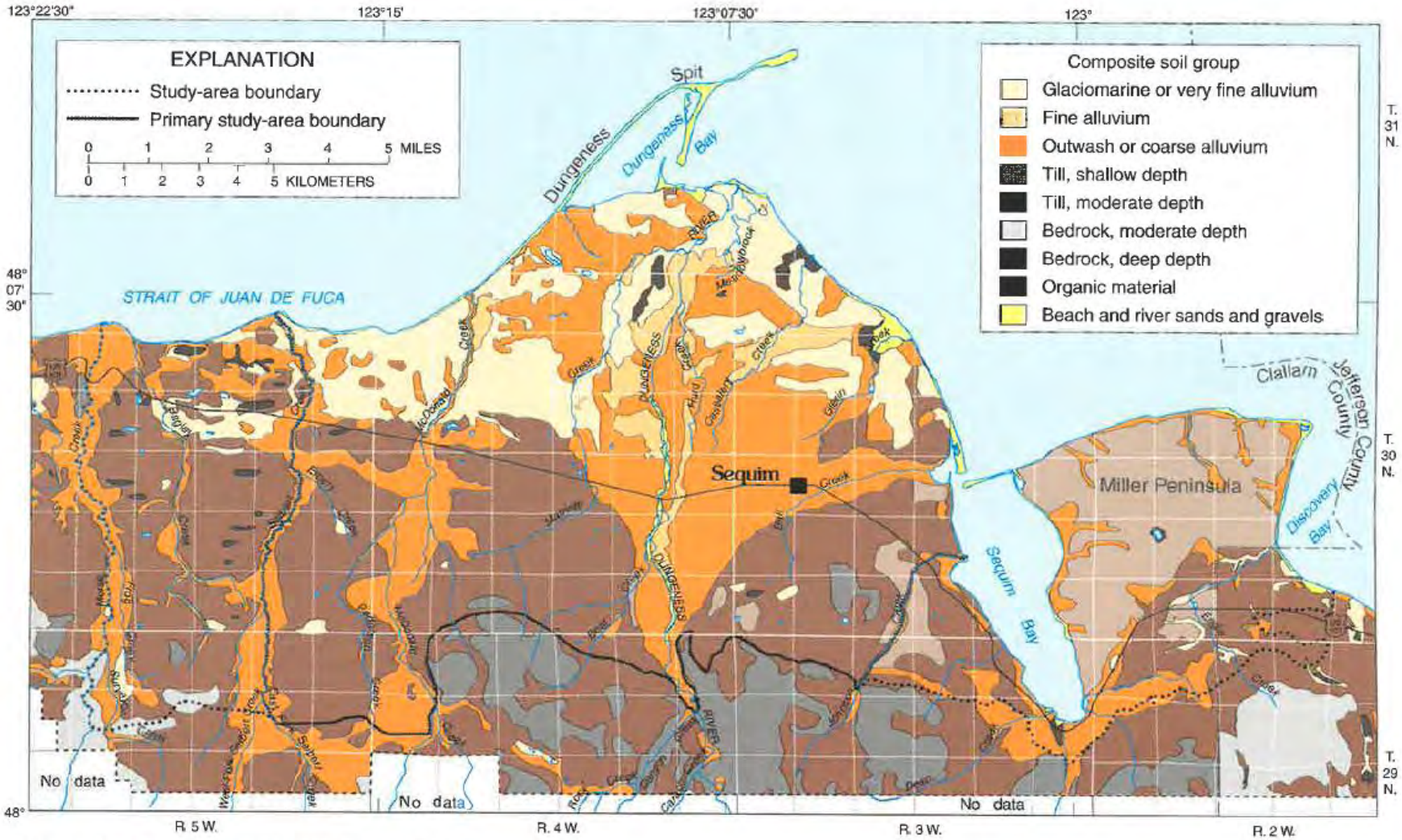


Figure 27. Composite soil groups used for recharge analysis.

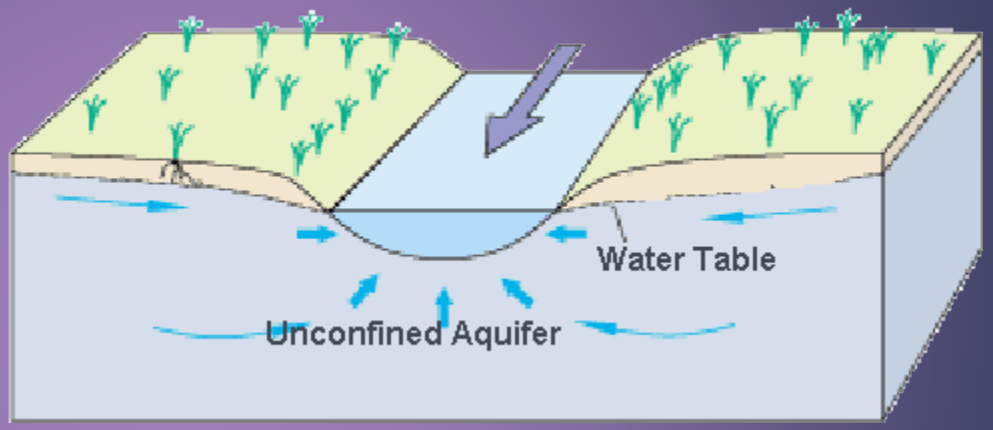
Menu

Thomas, et al 1999

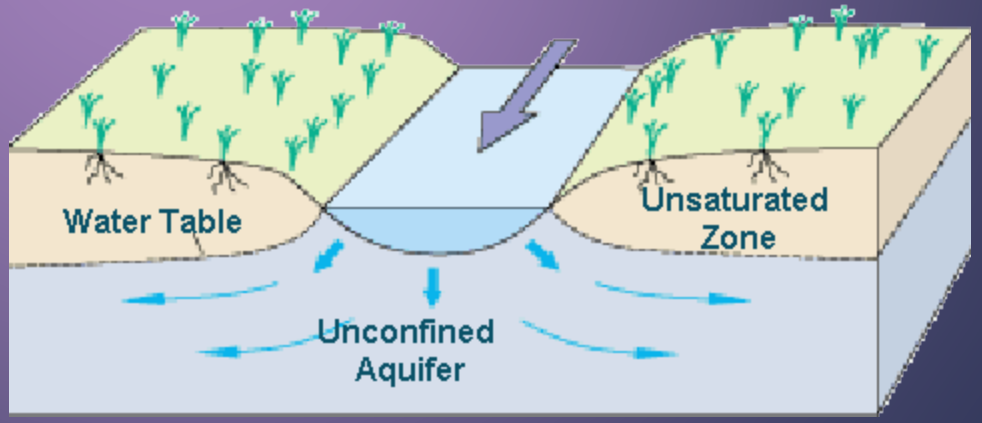
Surface water–ground water interaction

How ground and surface water interact

Gaining Stream

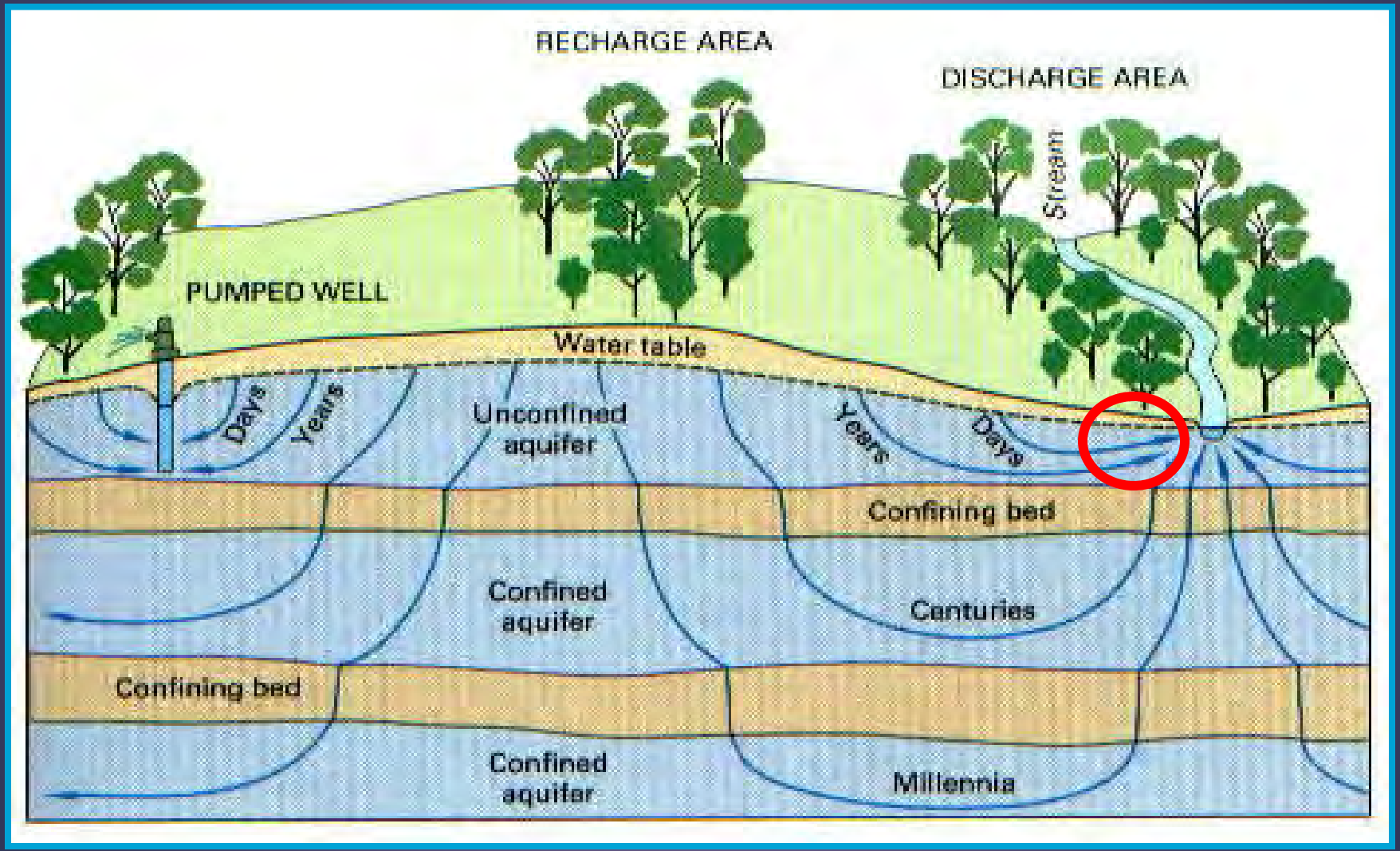


Losing Stream



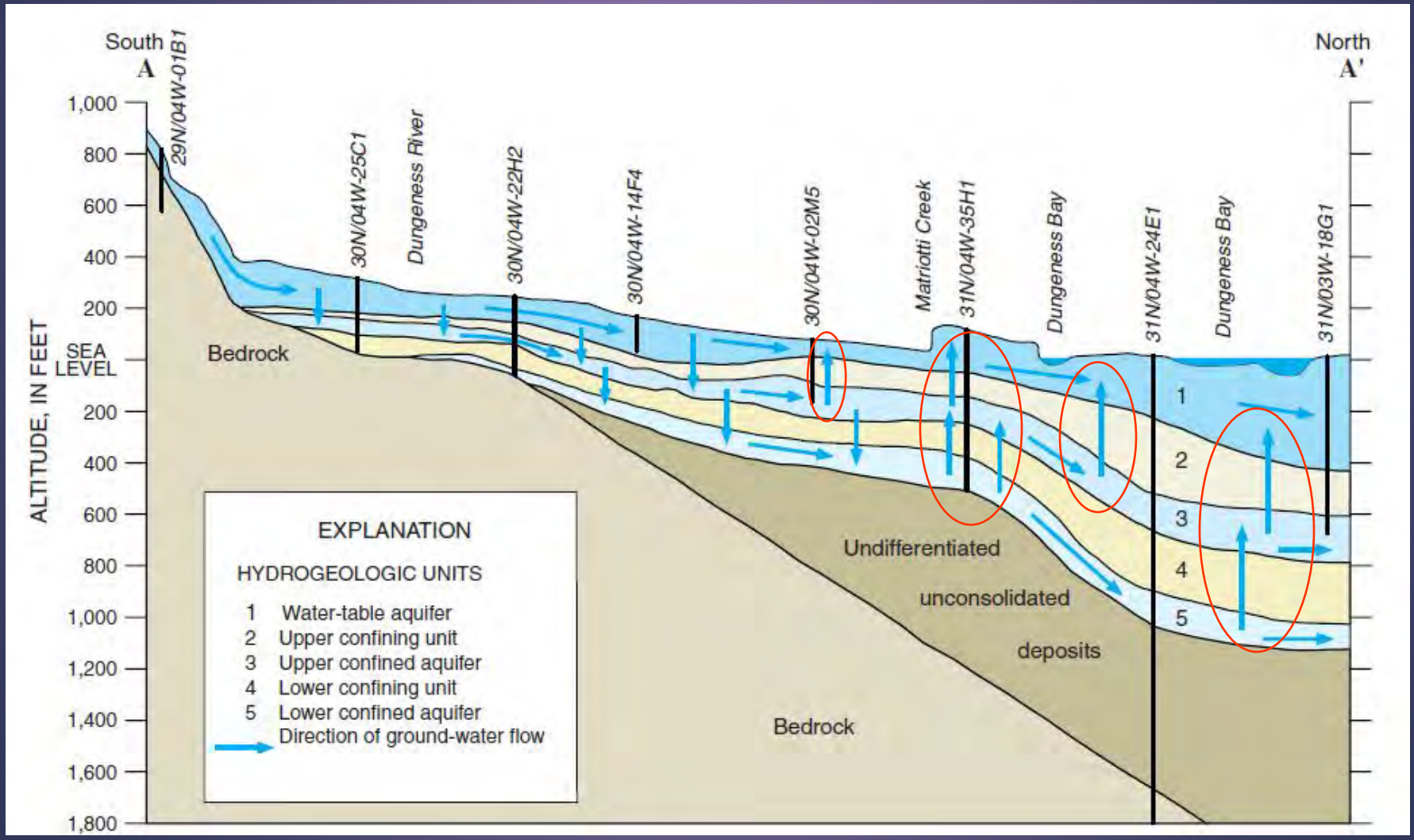
USGS C1139

How groundwater withdrawal affects the system



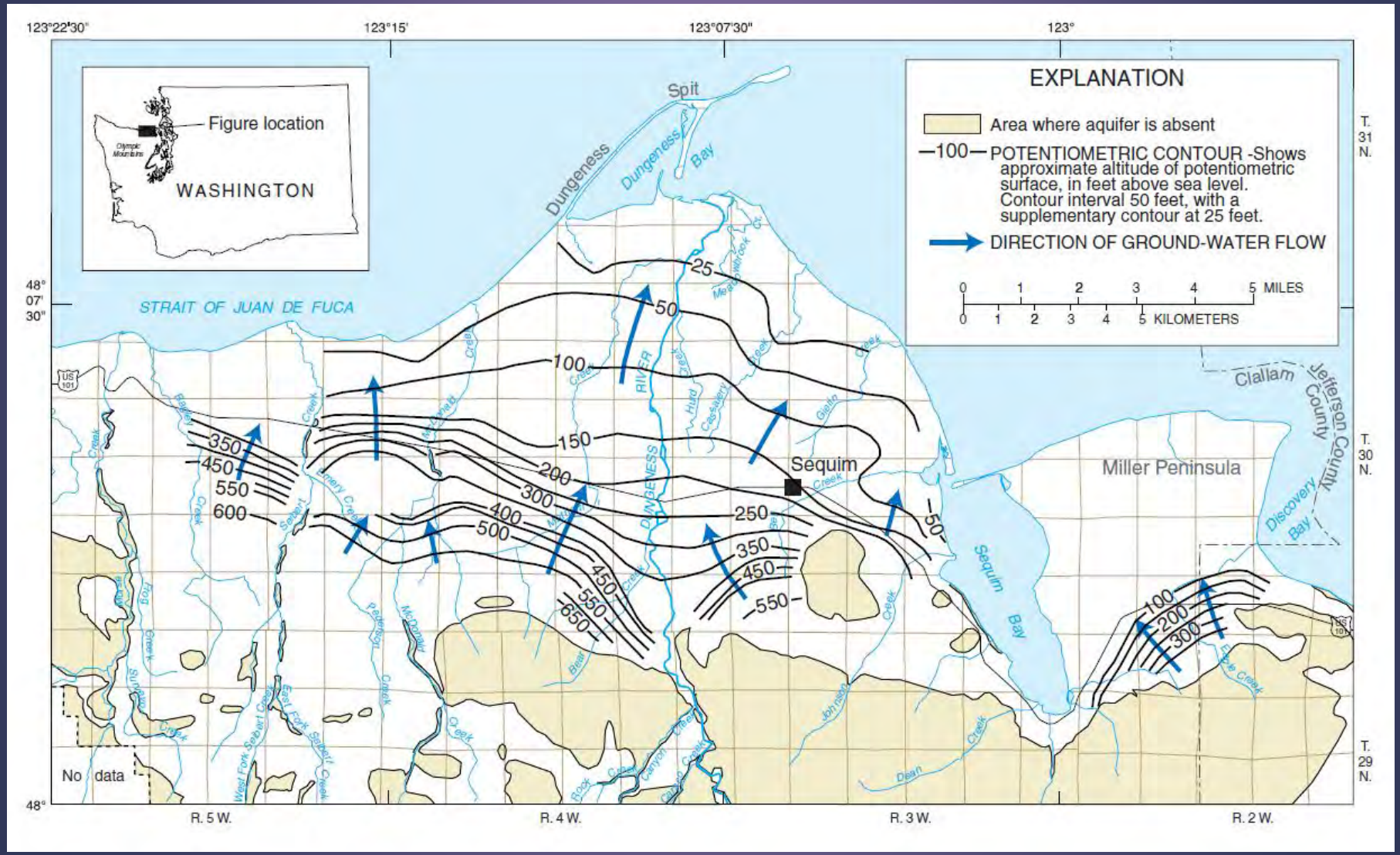
USGS C1139

3-D groundwater flow in the Dungeness Watershed



Simonds and Sinclair 2002

Groundwater flow direction



Simonds and Sinclair 2002

Connection between aquifers

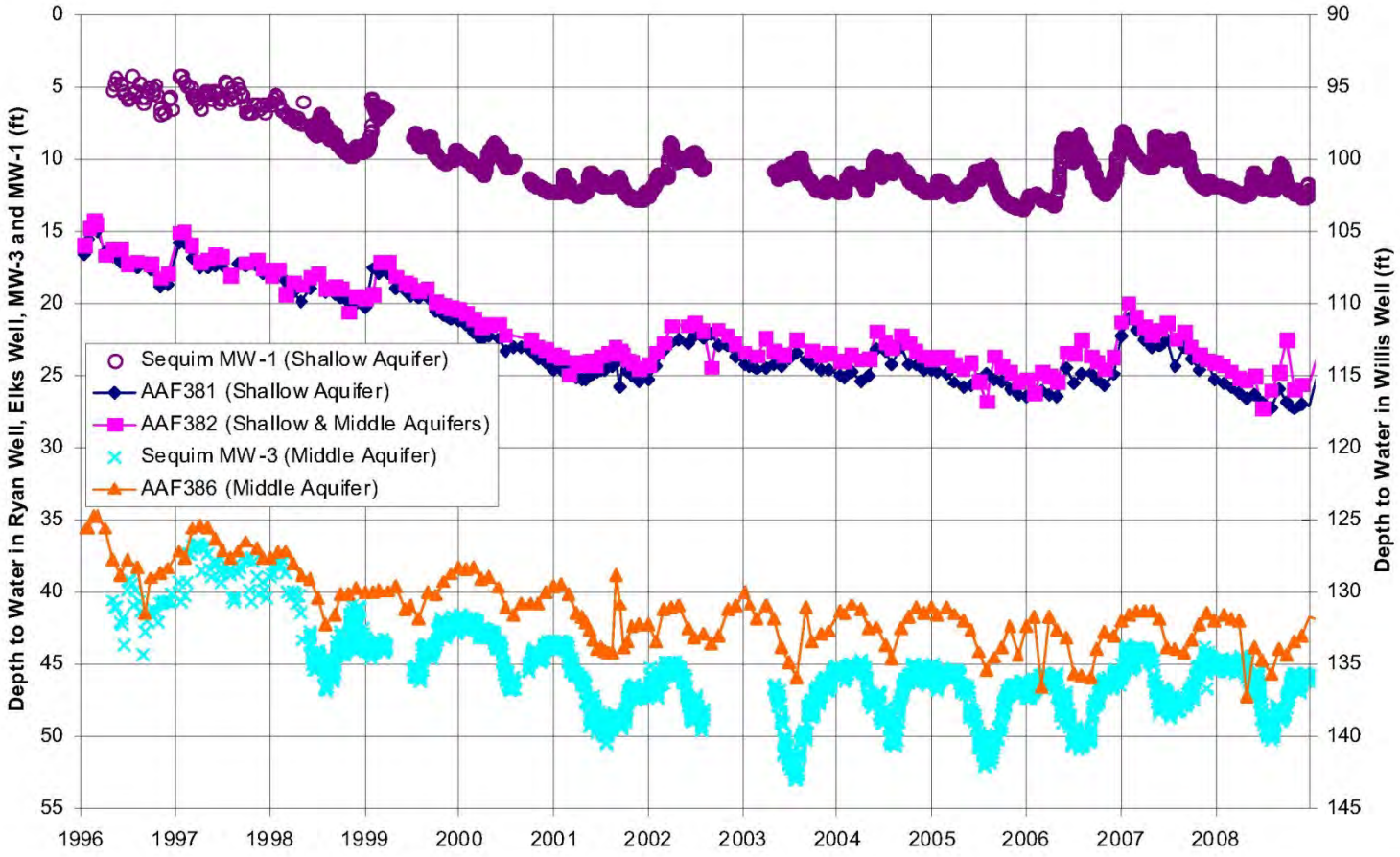
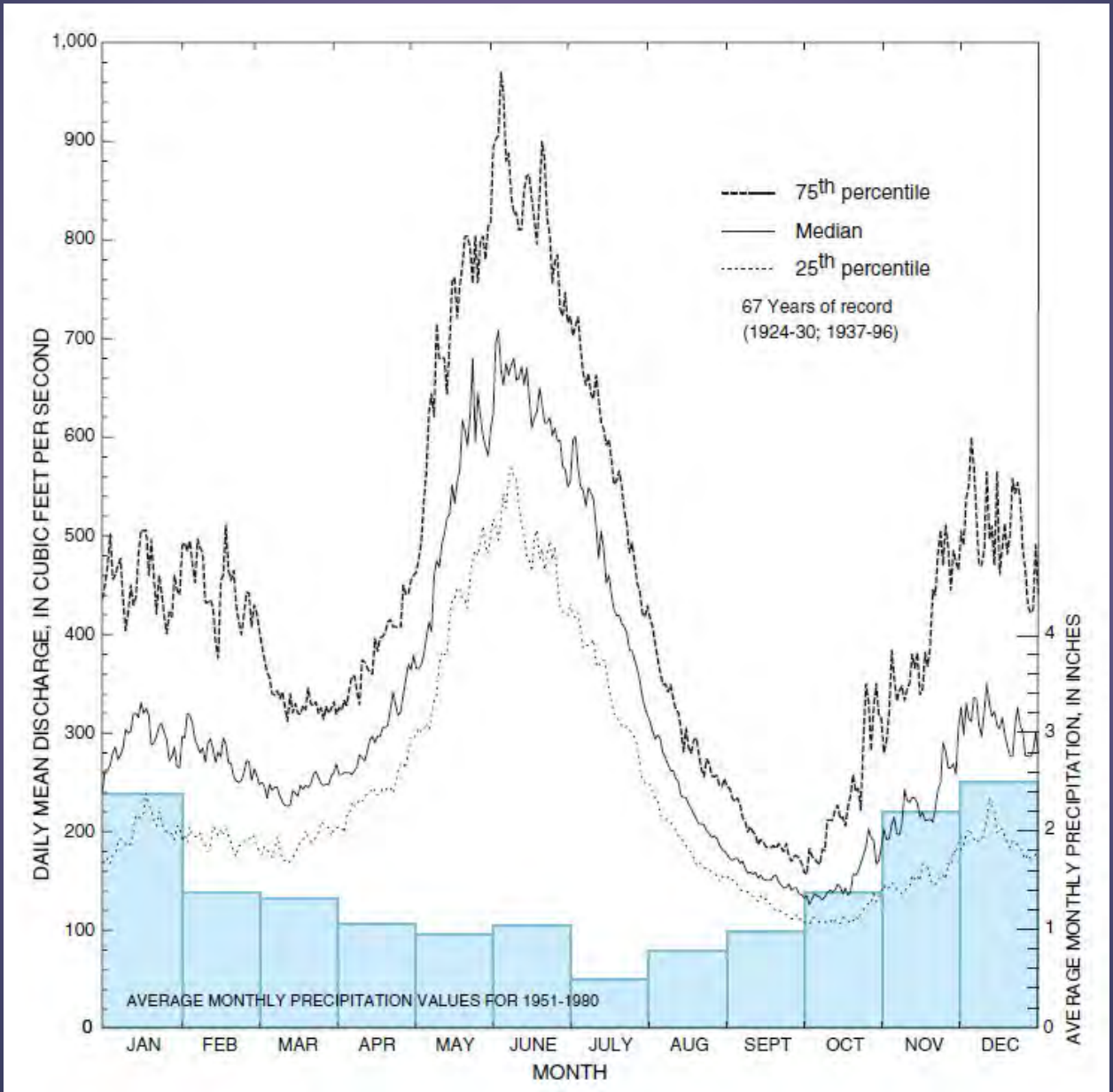


Figure 8-6
Water-Level Trends in Wells Surrounding the Port Williams Wellfield

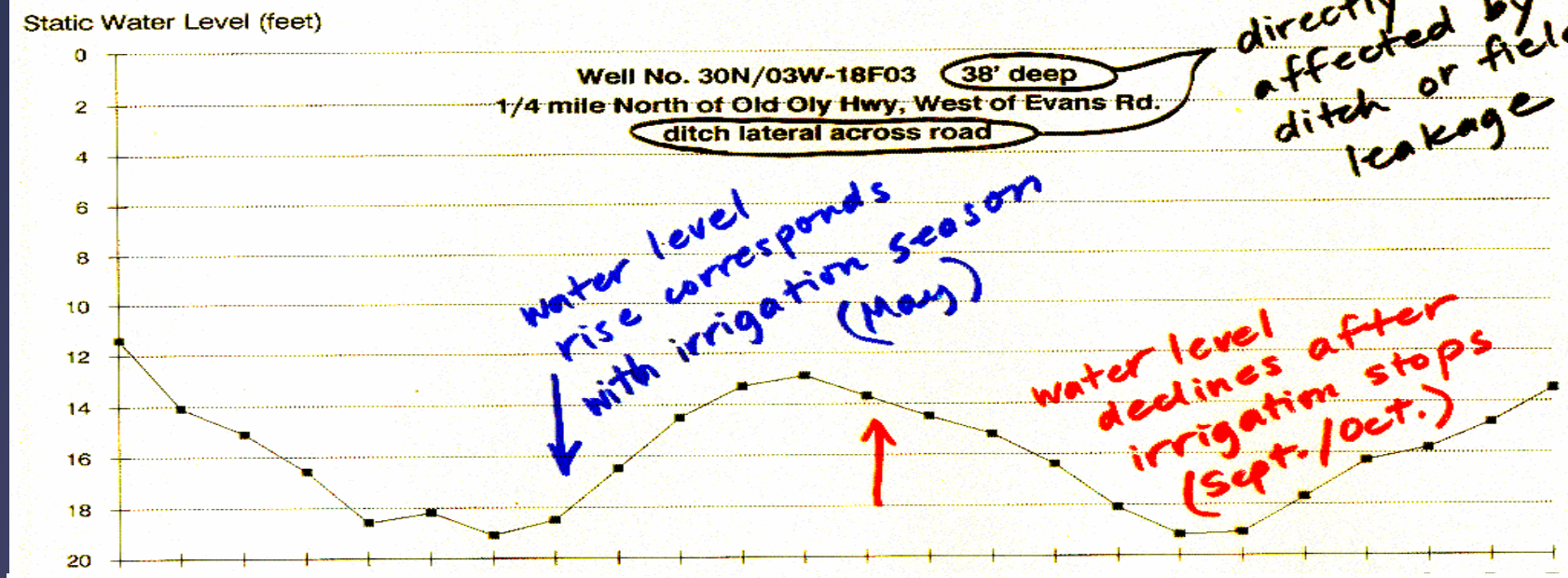
City of Sequim
2008 Monitoring Report

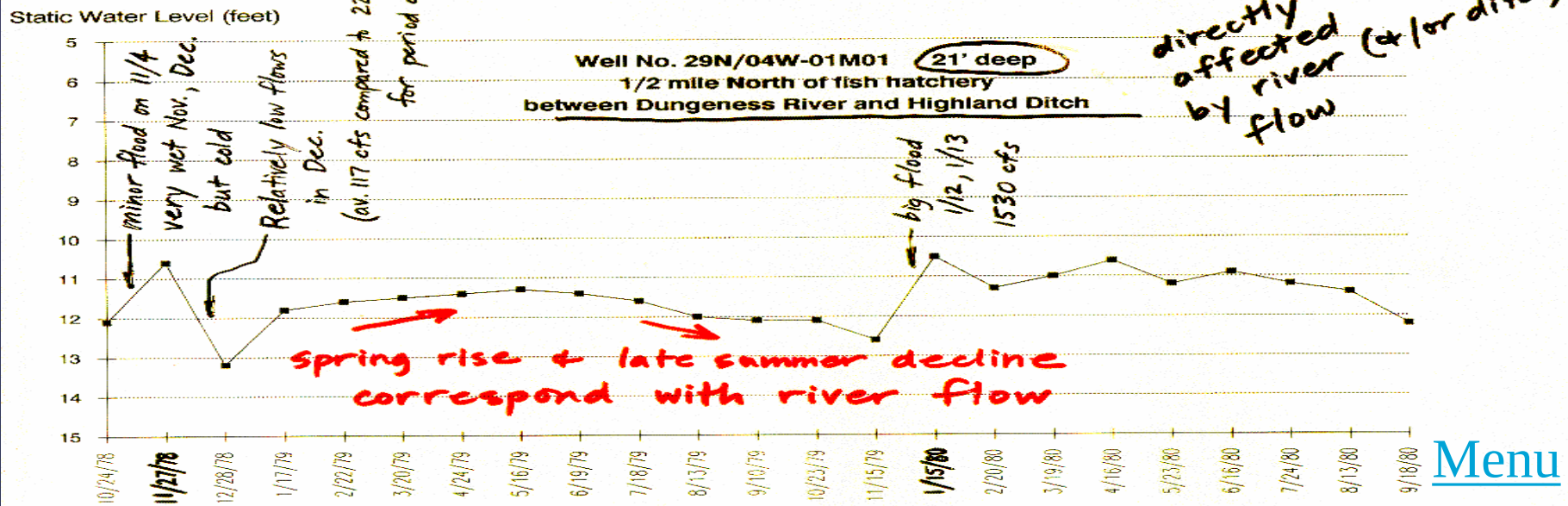
PgG

Dungeness River annual hydrograph



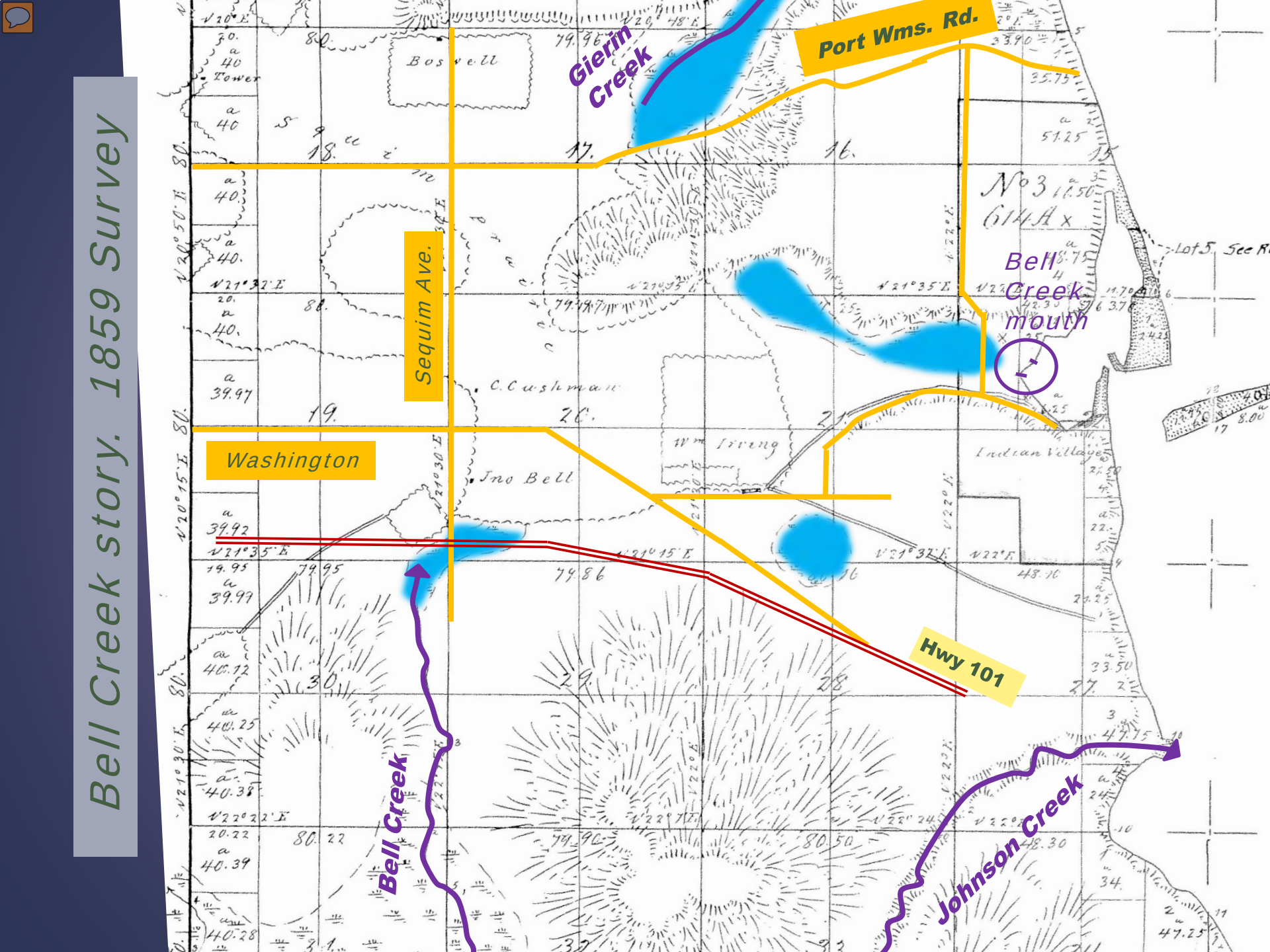
Simonds and Sinclair 2002


Static Water Level (feet)
0
2
4
6
8
10
12
14
16
18
20
Well No. 30N/03W-18F03
38' deep
1/4 mile North of Old Oly Hwy, West of Evans Rd.
ditch lateral across road
directly affected by ditch or field leakage
water level rise corresponds with irrigation season (May)
water level declines after irrigation stops (Sept./Oct.)

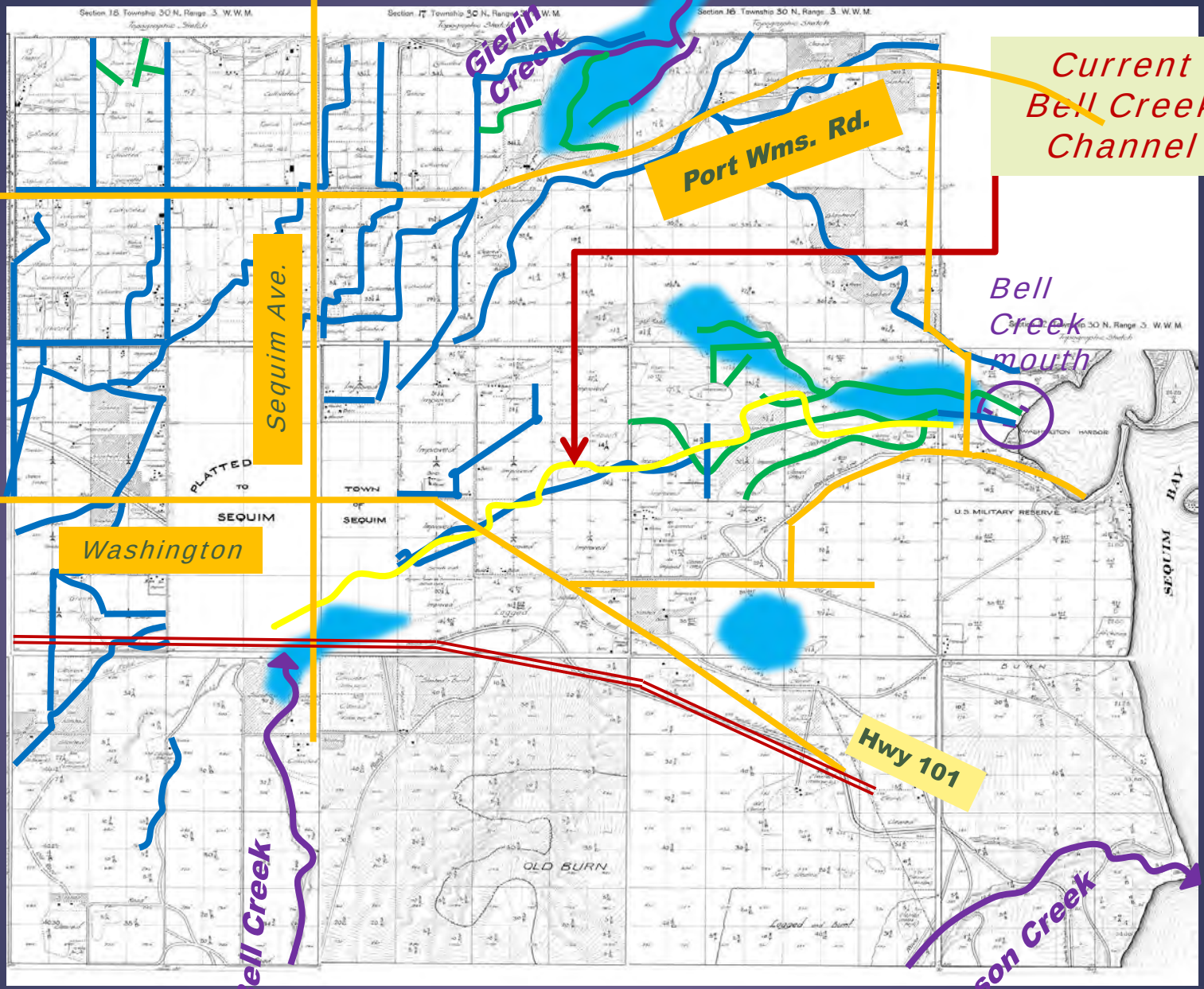

Static Water Level (feet)
5
6
7
8
9
10
11
12
13
14
15
Well No. 29N/04W-01M01
21' deep
1/2 mile North of fish hatchery
between Dungeness River and Highland Ditch
directly affected by river (& / or ditch) flow
minor flood on 11/4
very wet Nov., Dec.
but cold
Relatively low flows in Dec.
(av. 117 cfs compared to 225-250 cfs for period of record)
big flood 1/12, 1/13 1530 cfs
spring rise & late summer decline correspond with river flow
10/24/78
11/27/78
12/28/78
1/17/79
2/22/79
3/20/79
4/24/79
5/16/79
6/19/79
7/18/79
8/13/79
9/10/79
10/23/79
11/15/79
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7/24/80
8/13/80
9/18/80

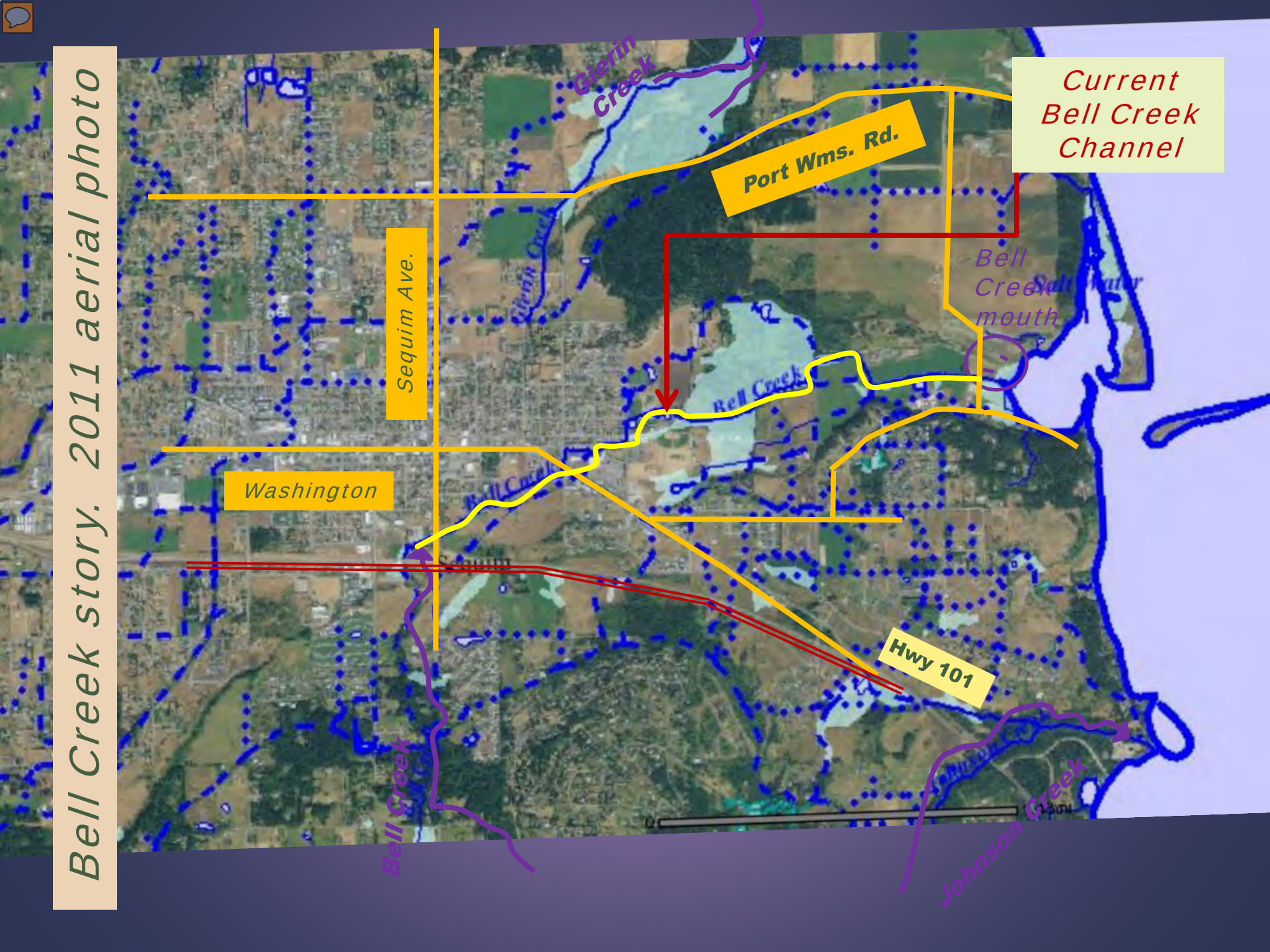
Menu

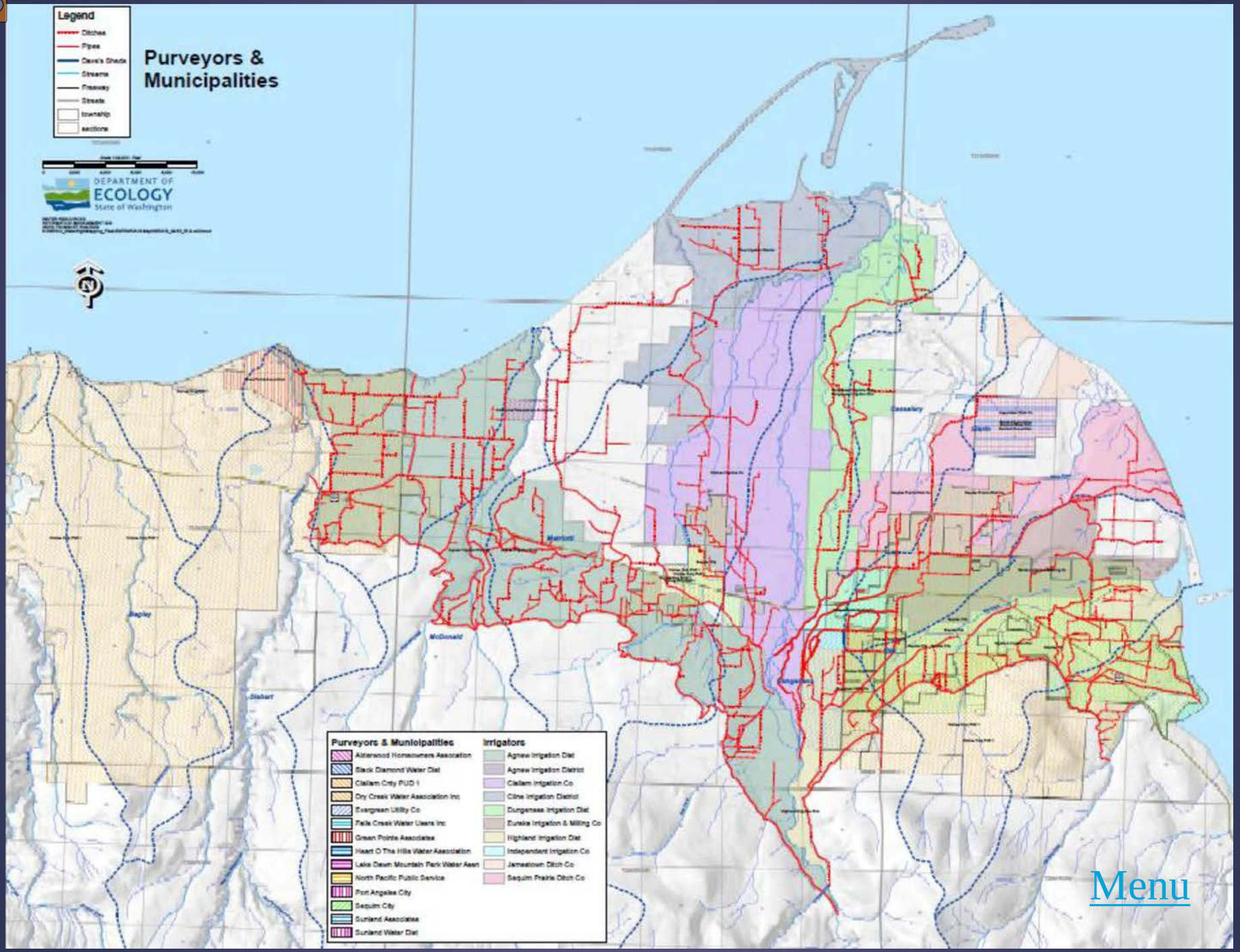
Historical water management


Bell Creek story. 1859 Survey
Gierin Creek
Port Wms. Rd.
Sequim Ave.
Washington
Bell Creek mouth
Hwy 101
Bell Creek
Johnson Creek

Bell Creek story. 1914 Survey – Highland not built yet

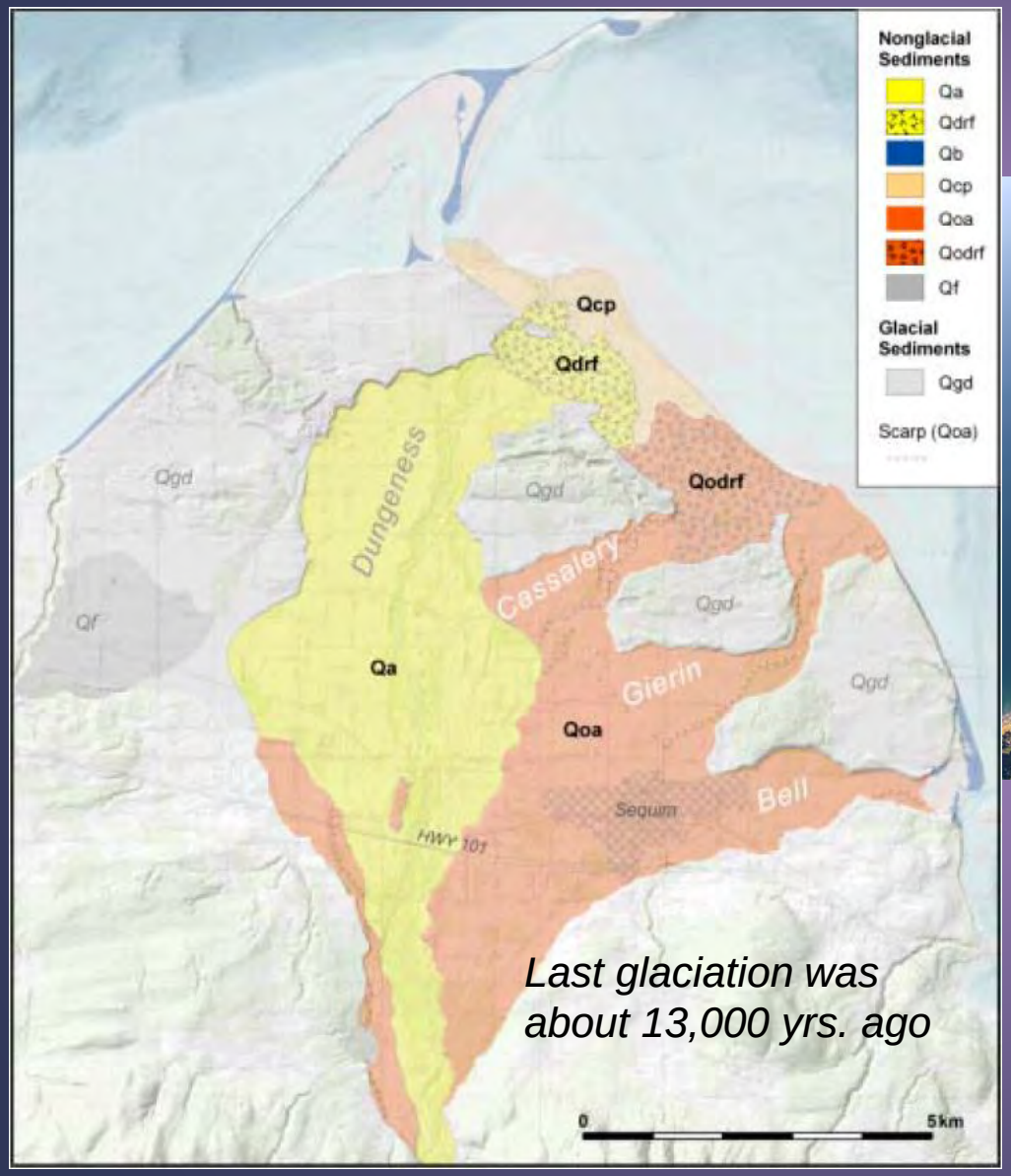



Bell Creek story. 2011 aerial photo
Current Bell Creek Channel
Port Wms. Rd.
Sequim Ave.
Washington
Hwy 101
Gierin Creek
Bell Creek
Bell Creek mouth
Johnson Creek


Legend
Ditches
Pipes
Dave's Shade
Streams
Freeway
Streets
township
sections
Purveyors & Municipalities
DEPARTMENT OF ECOLOGY
State of Washington
Purveyors & Municipalities
Alderwood Homeowners Association
Black Diamond Water Dist
Clallam Cnty PUD 1
Dry Creek Water Association Inc
Evergreen Utility Co
Falls Creek Water Users Inc
Green Pointe Associates
Heart O The Hills Water Association
Lake Dawn Mountain Park Water Assn
North Pacific Public Service
Port Angeles City
Sequim City
Sunland Associates
Sunland Water Dist
Irrigators
Agnew Irrigation Dist
Agnew Irrigation District
Clallam Irrigation Co
Cline Irrigation District
Dungeness Irrigation Dist
Eureka Irrigation & Milling Co
Highland Irrigation Dist
Independent Irrigation Co
Jamestown Ditch Co
Sequim Prairie Ditch Co
Menu

Groundwater age

Paleochannels of the Dungeness



Last glaciation was about 13,000 yrs. ago



Elwha River mouth, 2013, showing alluvial sediment transport

Collins 2005

Age-dating groundwater

Source	Apparent C14 Age (Fraction Modern)	C13/C12 Ratio	Tritium (TU)	Tritium Std. Dev. (TU)
S05-Port Williams	1840 +/- 40 BP (Fmdn 0.7949 +/- 0.0040)	-14.2 o/oo	5.21	0.31
S02-Silberhorn	1350 +/- 40 BP (Fmdn 0.8449 +/- 0.0042)	-10.6 o/oo	3.20	0.29

- Mixing is indicated, since both “new” water (post-WWII) and ancient water were identified
  - Tritium presence indicates a fraction is post-WWII
  - Carbon-14 data indicates average age could be 1500-2000 yrs. old

(Samples taken April 2008)

Menu

Groundwater recharge

Natural Recharge

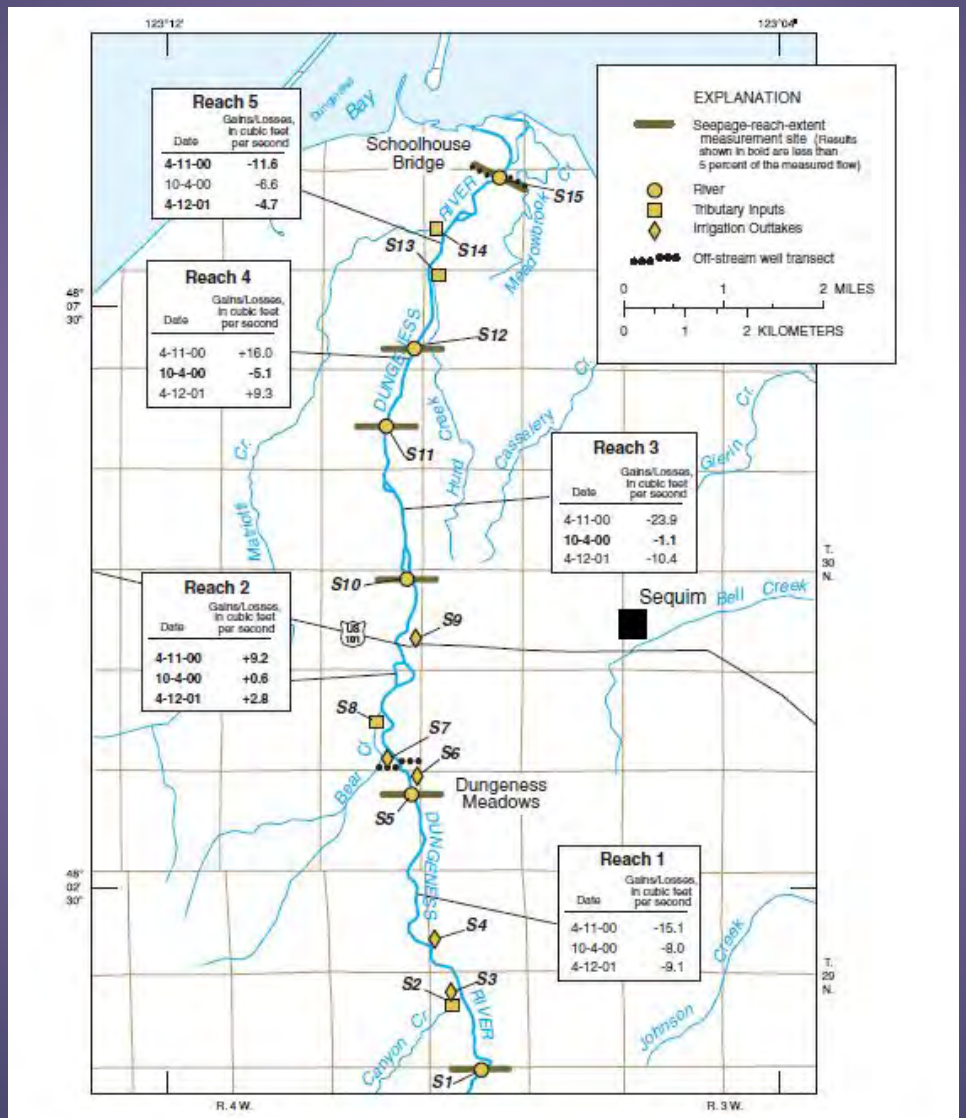


Figure 13. Results of the seepage runs on the five study reaches of the lower Dungeness River on the Sequim-Dungeness peninsula, Clallam County, Washington, April 11 and October 4, 2000, and April 12, 2001.

Artificial Recharge



Irrigation ditches (leaking intentionally or not)

Man-made ponds, used for storage of irrigation water, or stormwater runoff







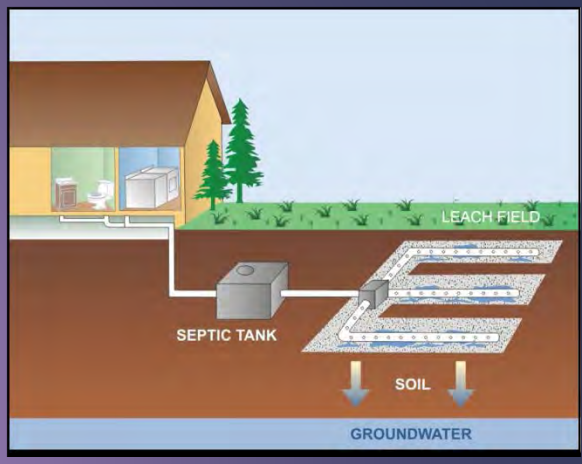
Stormwater infiltration facilities

Artificial Recharge, con't

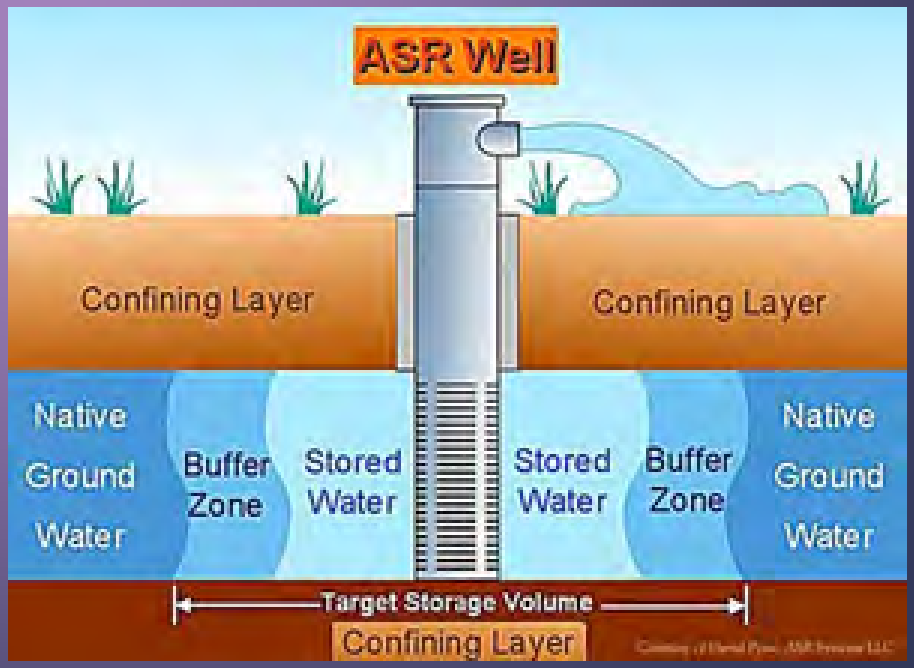


Perforated pipe gallery to test reclaimed water infiltration

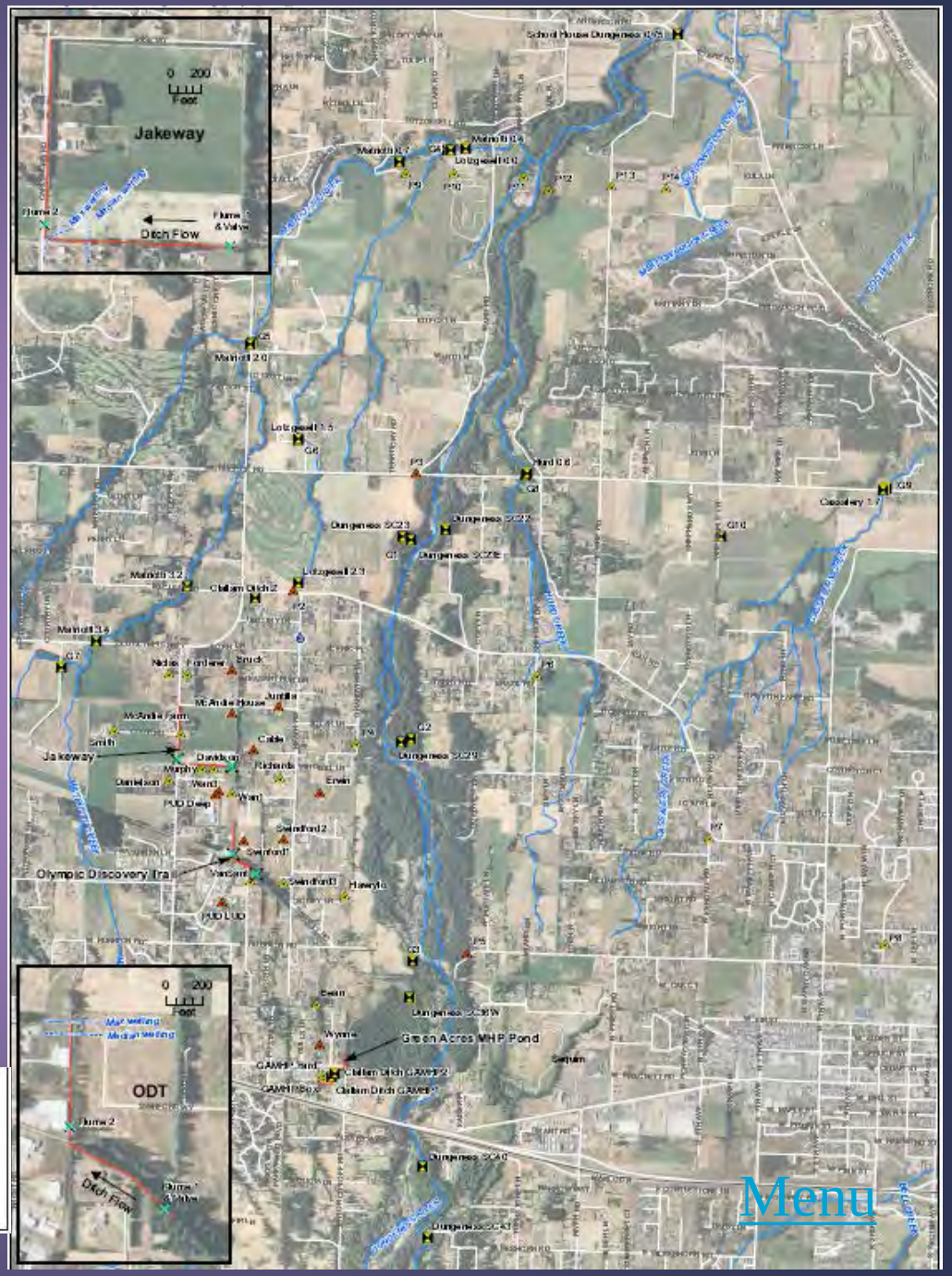
Septic systems



Aquifer Storage & Recovery (ASR)



Carlsborg Pilot Aquifer Recharge Test (2007-08)

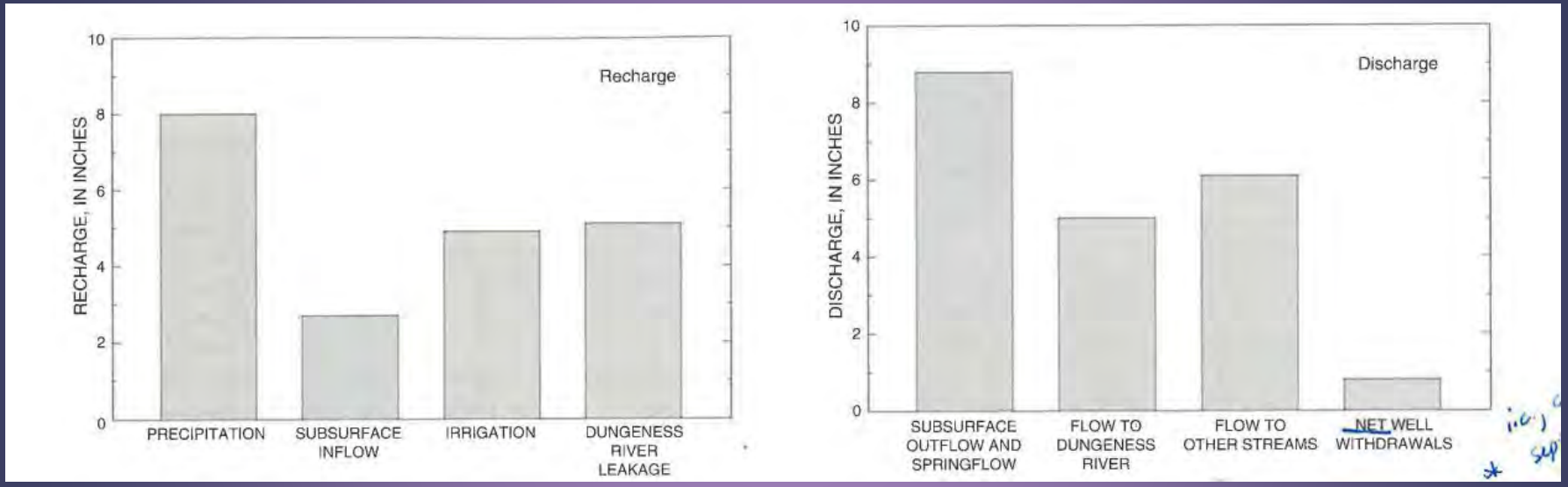


Menu

Water quantity / Water supply

Groundwater Budget

IN: OUT:



- Average annual, for the study period (Dec. 1995 through Sept. 1997), which was wetter than the long-term average
- A reduction in recharge would lead to reduced storage and natural discharge, such as to streams

Thomas et al 1999

Decreasing irrigation diversions

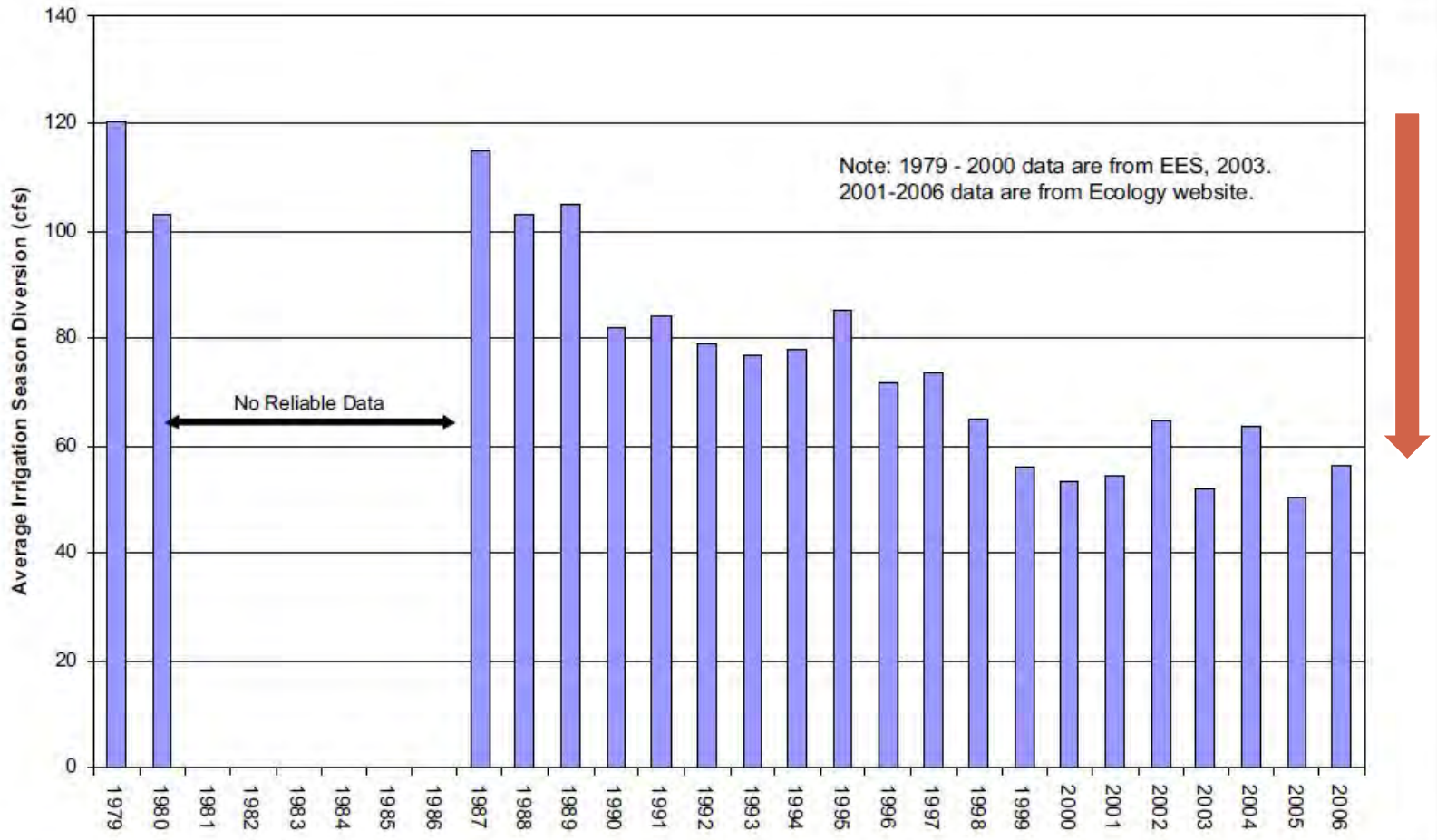
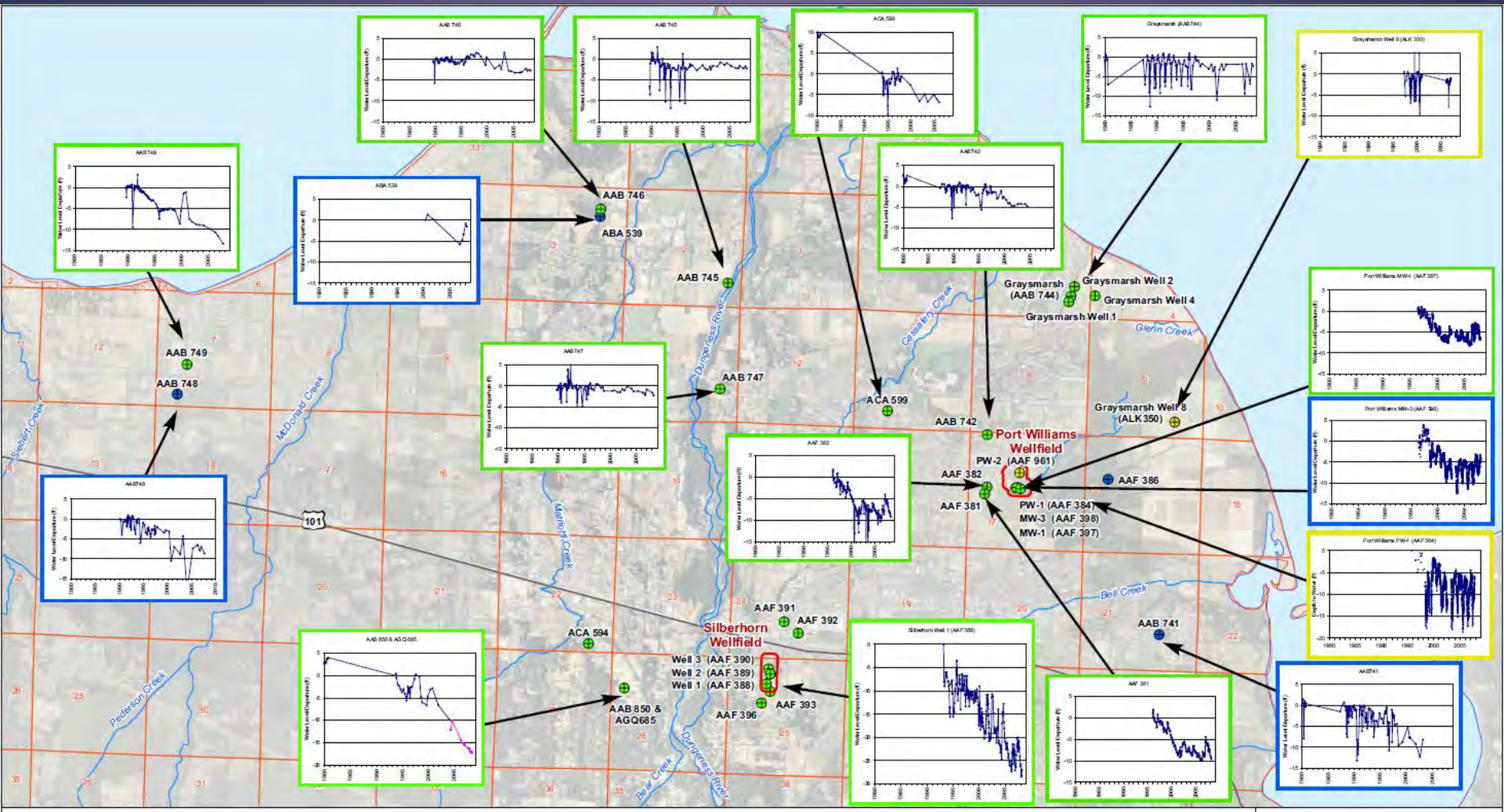


Figure 5-2
Historic Average Irrigation-Season Diversions from Dungeness River

City of Sequim
2008 Monitoring Report

PgG

Groundwater level trends



- Shallow Aquifer Well
- Middle Aquifer Well
- Lower Aquifer Well
- Sections in PGG Study Area

Please see Figure 8-2
for all Port Williams and Silberhorn Hydrographs

0 Feet 5,000 N

Figure 8-1

Representative Hydrographs

City of Sequim
2008 Monitoring Report

PgG

Precipitation / snowpack trends

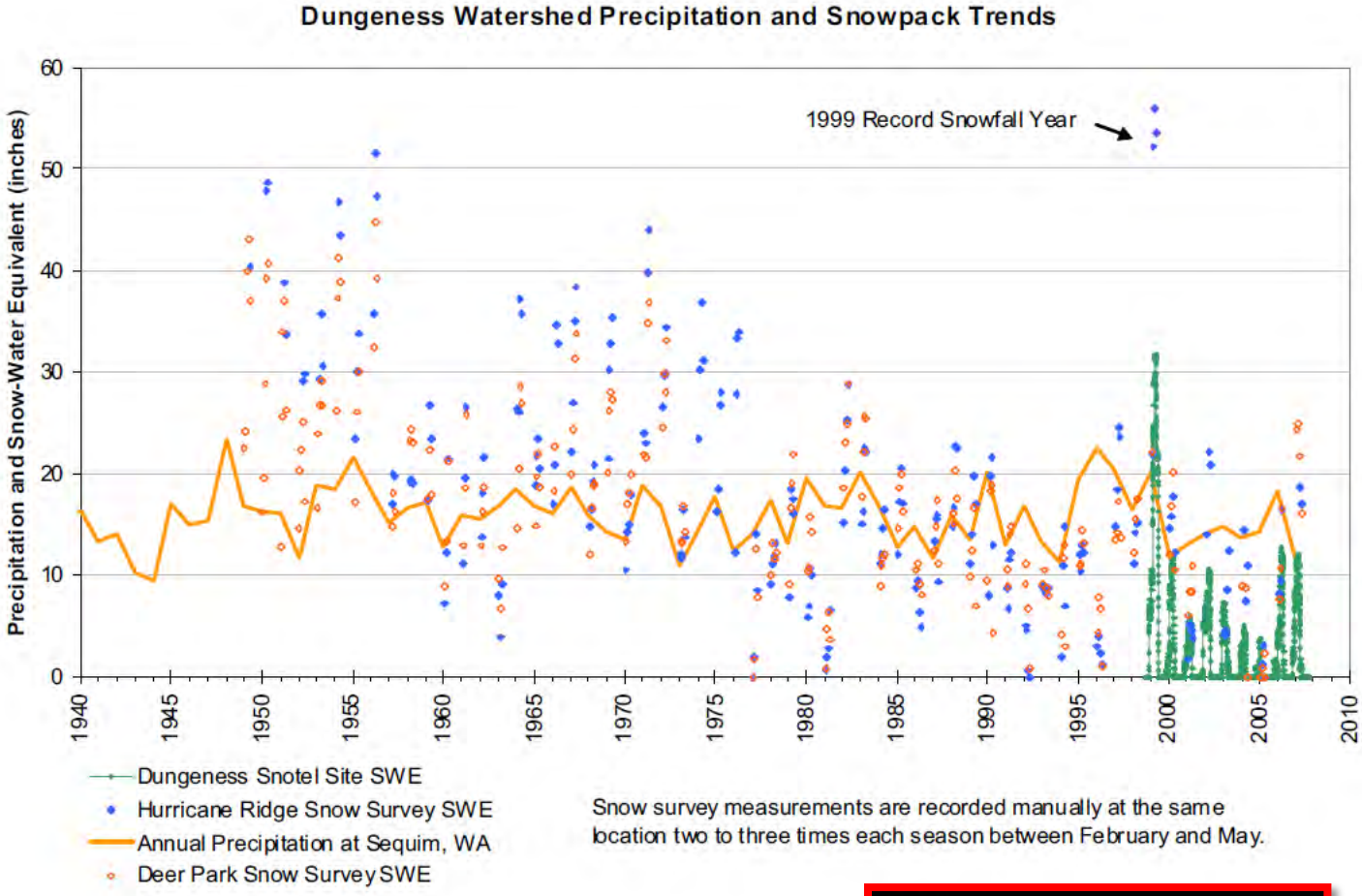


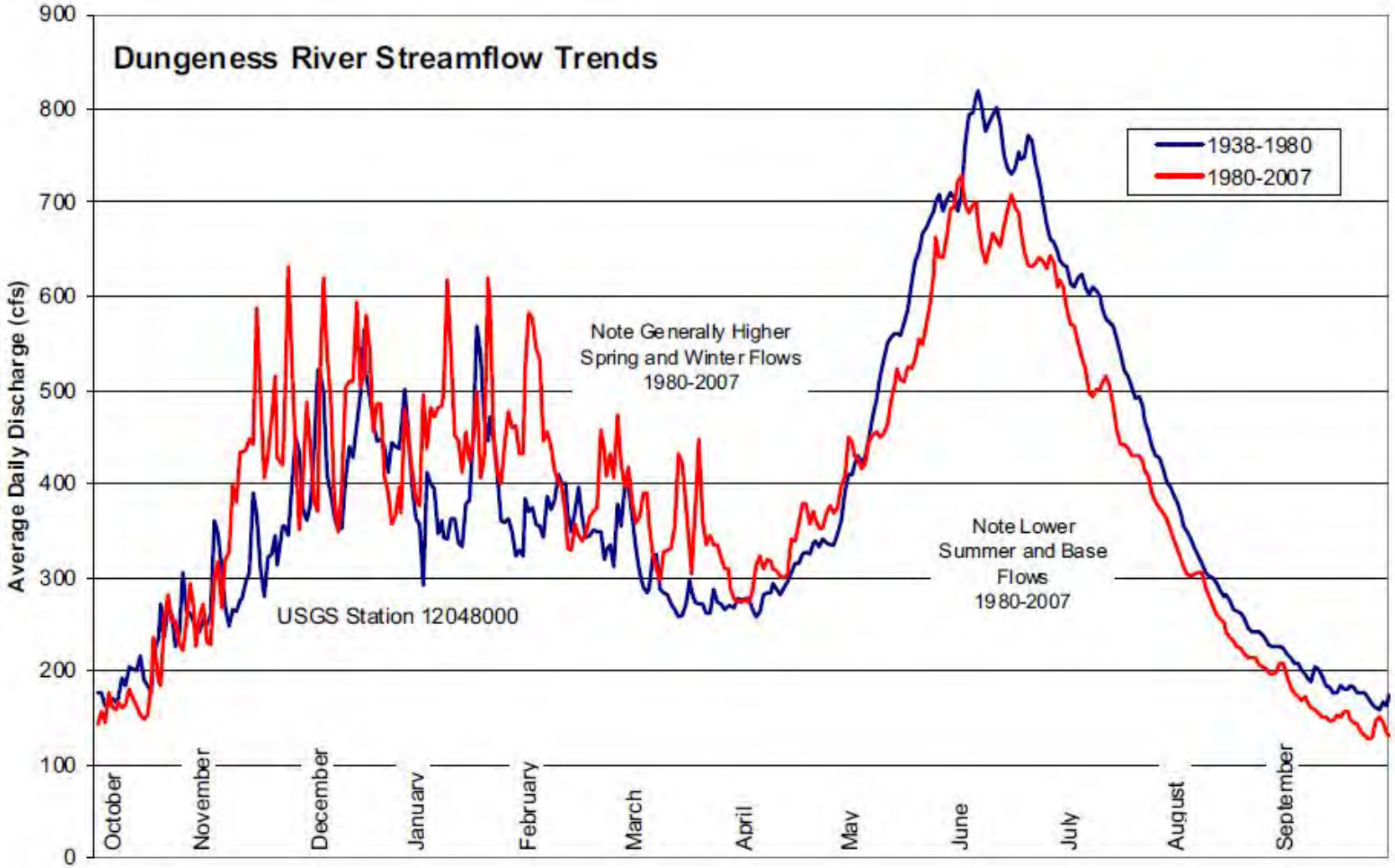


Figure 4-3
Trends in Sequim Precipitation and Dungeness Watershed Snowpack

City of Sequim
2008 Monitoring Report

PgG

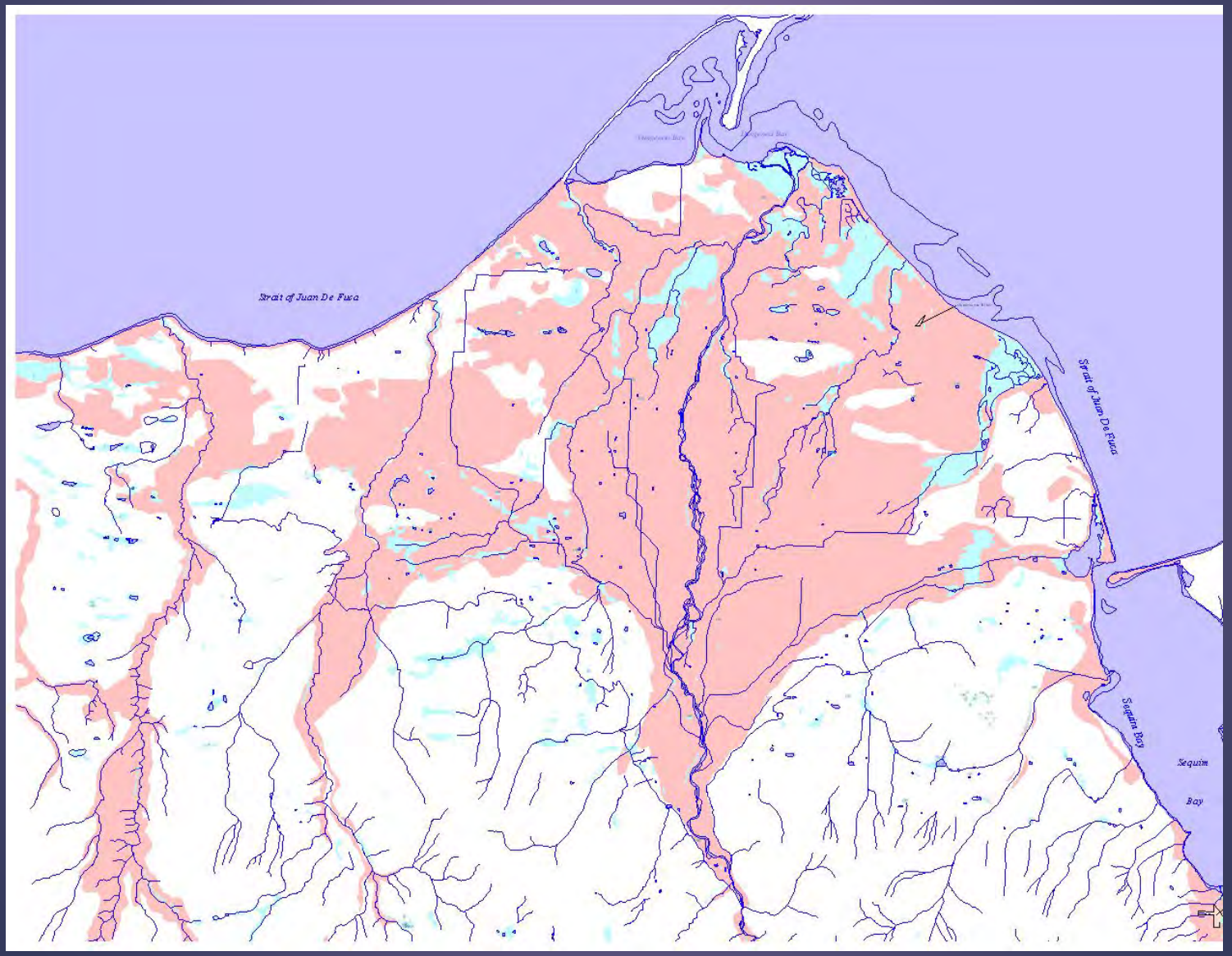
Surface water trends



Menu

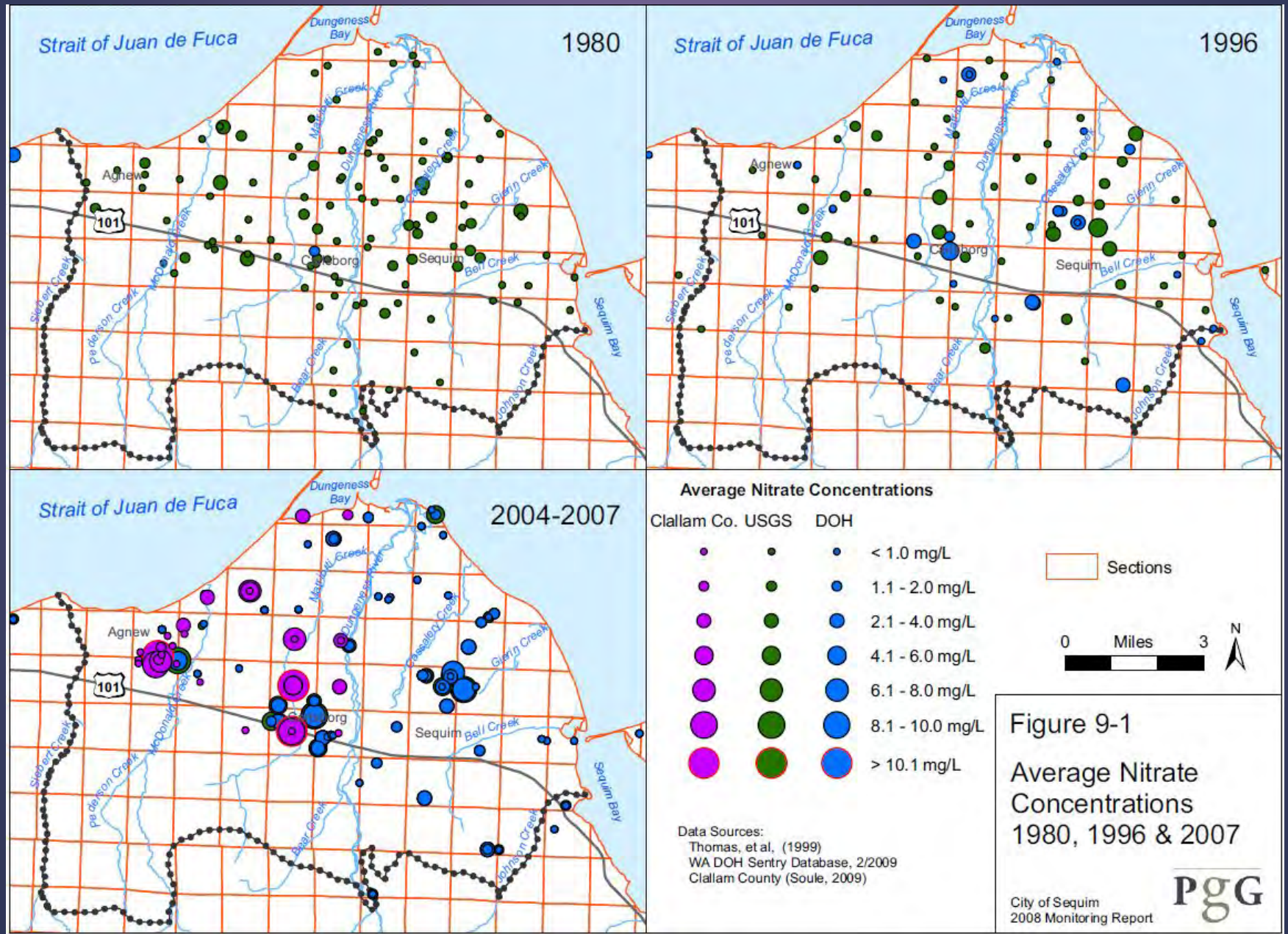
Groundwater quality

Clallam County-defined Critical Aquifer Recharge Areas (CARAs)

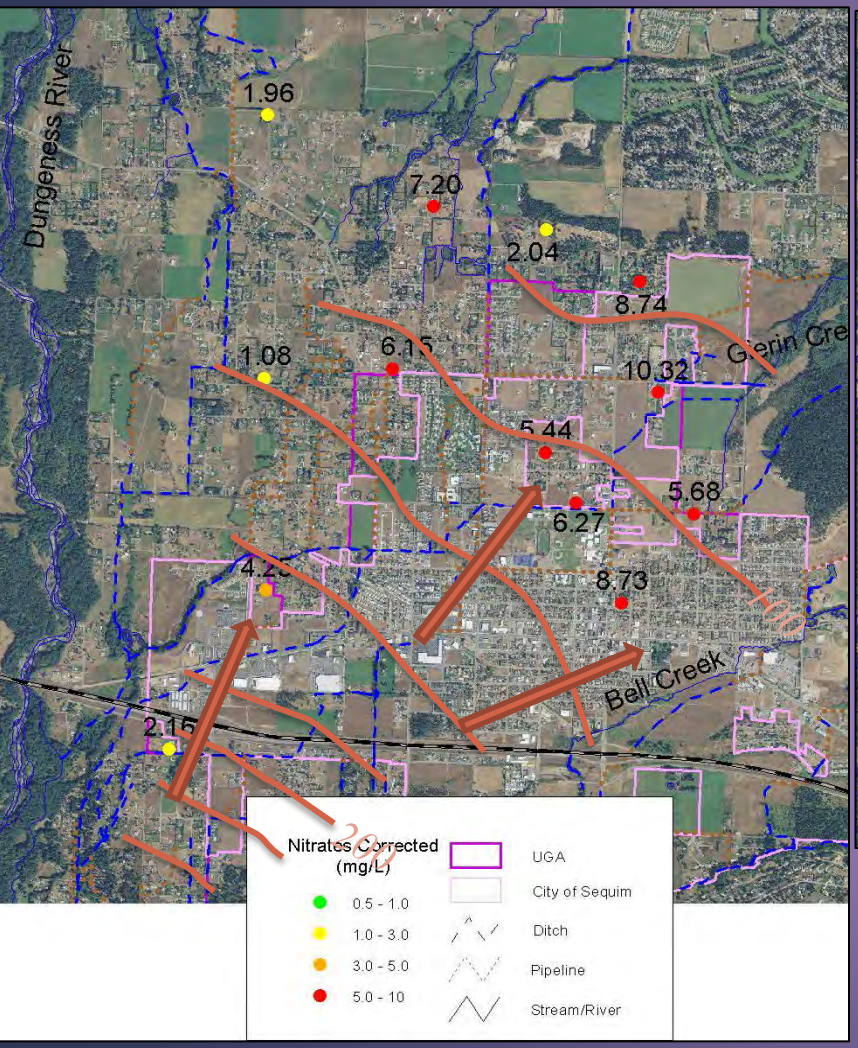


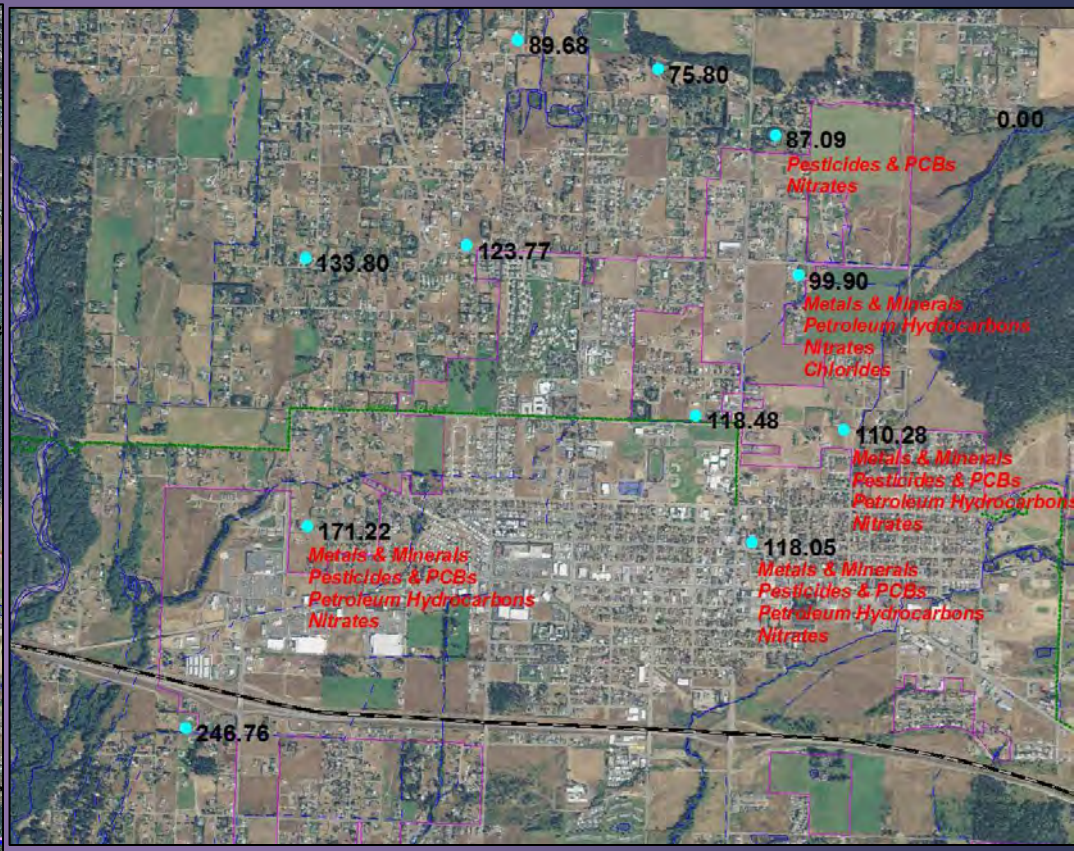
Clallam County 2009

Nitrate trends in groundwater



County nitrate and stormwater studies (2011)





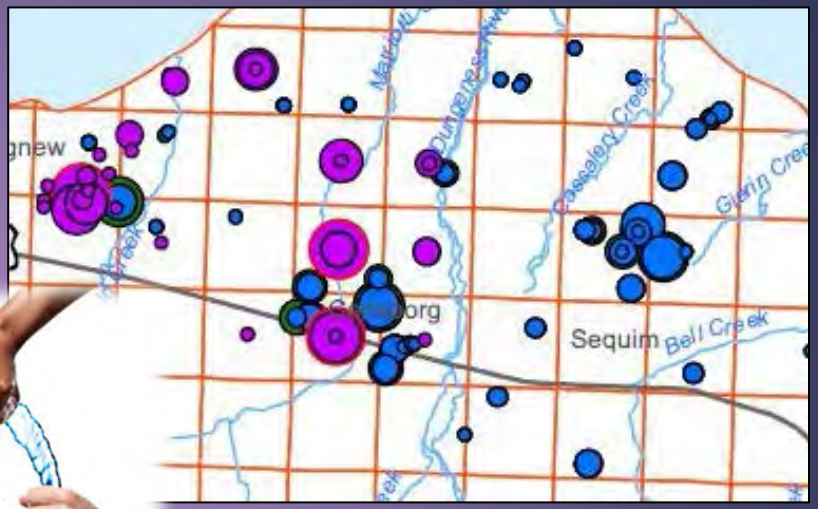
Tested for some stormwater contaminants in shallow, vulnerable wells (none found)

Menu

Contemporary water management

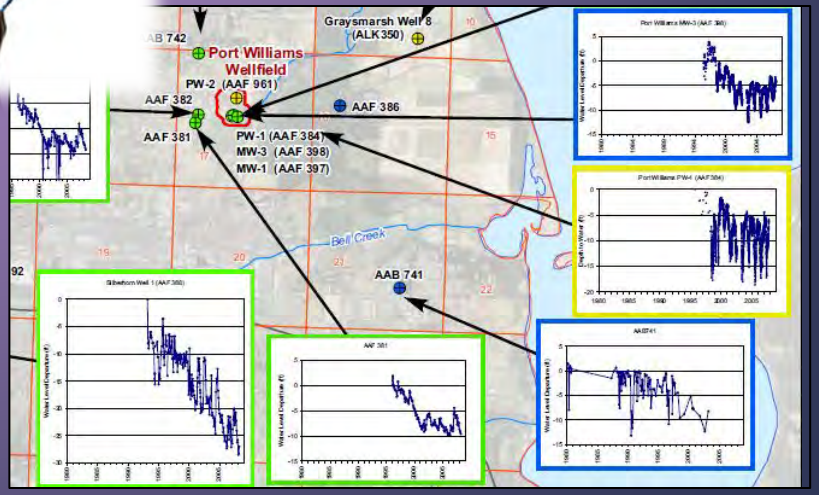
21st Century Issues







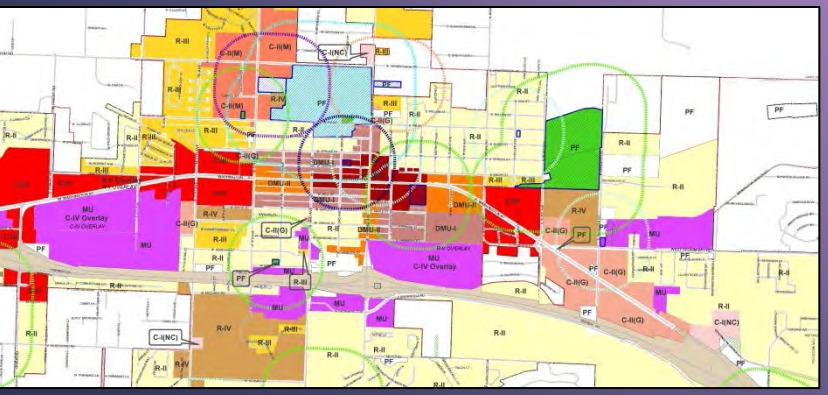


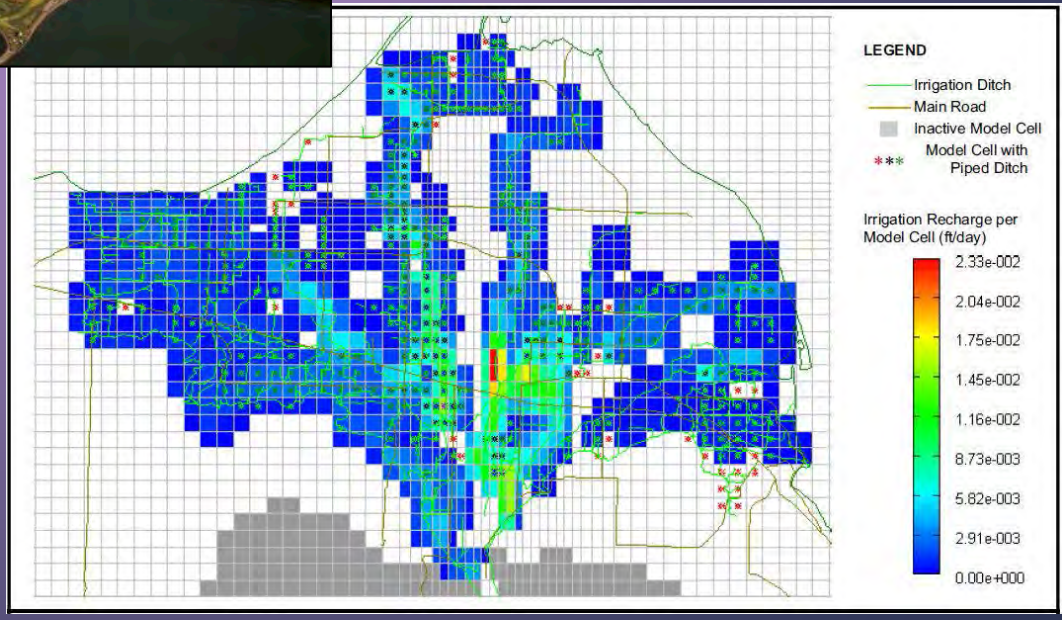


Tools, laws, cooperation

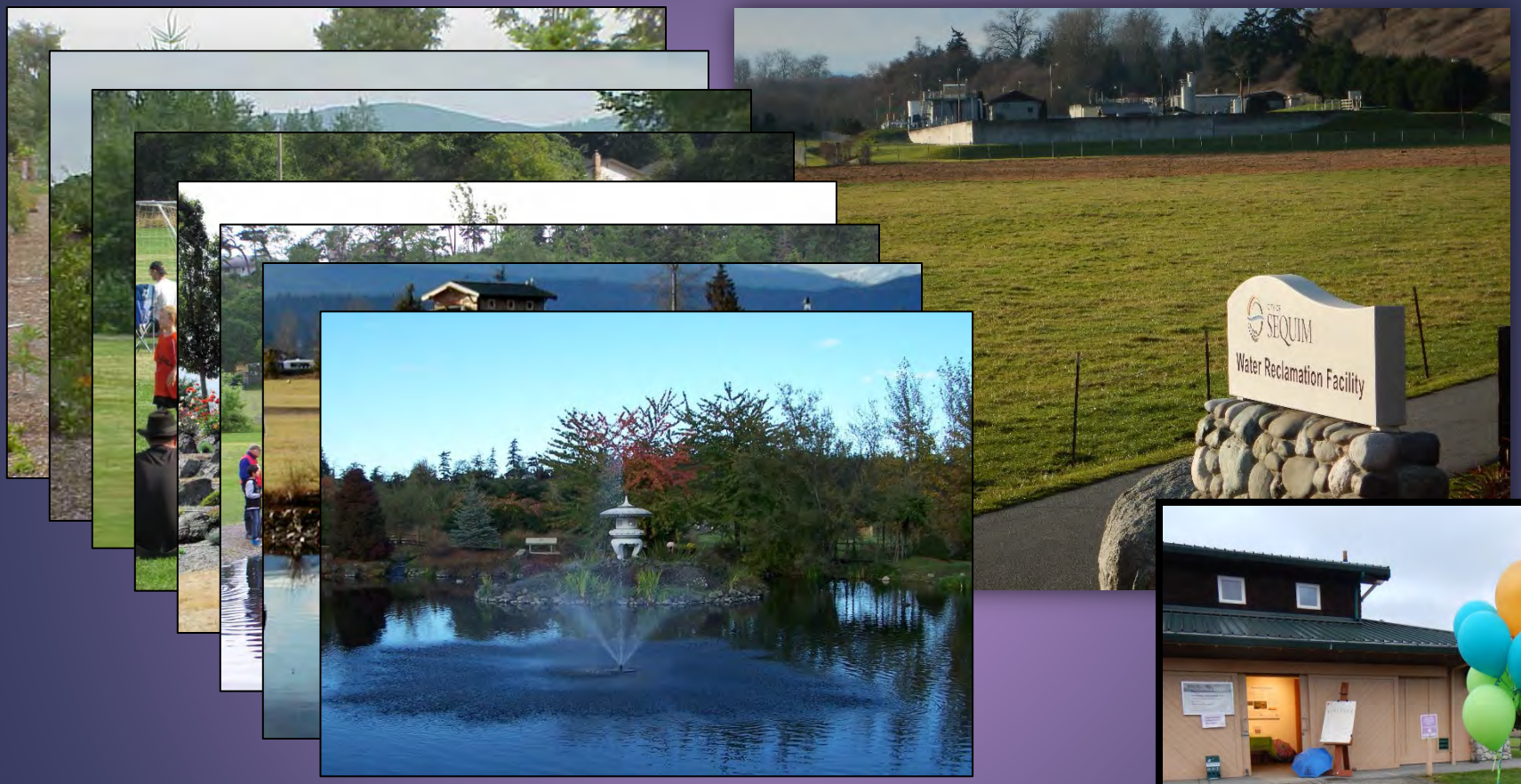








Strategy





Stormwater Stewardship

Our Water, Our Future!

Menu

Water is wealth







For more information:

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Hours: Wed. 8-10am, Thurs. 12-2pm