

**SQUAW VALLEY PUBLIC SERVICE DISTRICT  
BOARD OF DIRECTORS REGULAR MEETING MINUTES #782  
November 26, 2013**

- A. Call to Order, Roll Call and Pledge of Allegiance.** President Dale Cox called the meeting to order at 8:30 A.M.

**Directors Present:** Dale Cox, President; Eric Poulsen, Vice President; Directors: Carl Gustafson; Brian Sheehan; and John Wilcox

**Staff Present:** Mike Geary, General Manager; Kathryn Obayashi-Bartsch, Board Secretary; Aleta Drake, Controller/Network Administrator; Brandon Burks, Operations Specialist III; Peter Bansen, Fire Chief; and Thomas Archer, District Counsel

**Others Present:** Dave Brew, Ian Chan, Chuck Curtis, Lizzie & Tom Day, Alex Fisch, Emily Fralick, Margot Garcia, Stacy Wydra Gill, Patti Guilford, Ed Heneveld, Bruce Hutchinson, Chevis Hosea, Fred Ilfeld, Andrew Lange, Gary Jacobs, Steve Kastan, Jennifer Merchant, Jean Moran, Sherry McConkey, Tim Nelson, John O'Neal, Andrea Parisi, Jay Parker, Allen Riley, Russell Poulsen, Tom Rinne, Carol & Jon Shanser, Peter Schweitzer, Brent Smith, Chad Taylor, Peter VanZant, Derrik Williams, David Willoughby, Blaine Wells. Others were present that did not sign in.

President Cox asked Jay Parker to lead the Pledge of Allegiance.

**B. Community Informational Items.**

- B-1 Friends of Squaw Creek – none
- B-2 Granite Peak Management – none
- B-3 Squaw Valley Municipal Advisory Committee (SVMAC) – Brian Sheehan said the next meeting is scheduled for Thursday, January 2<sup>nd</sup>, 2014 at 6 P.M. and the December meeting is cancelled.
- B-4 Squaw Valley Mutual Water Company (SVMWC) – none
- B-5 Squaw Valley Ski Holdings – none
- B-6 Squaw Valley Property Owners Association – none
- B-7 Tahoe Truckee Sanitation Agency – Dale Cox said the November meeting was cancelled.
- B-8 Incorporate Squaw Valley – Fred Ilfeld provided an update on the group's activities including filing the incorporation application with LAFCO. He said \$43,000 has been raised for this effort. The next public meeting is Tuesday, December 3<sup>rd</sup> at 7 P.M. at the District's community room. He asked that the Board include on the December meeting agenda, the group's request for the District's General Manager to participate on the revenue neutrality negotiating team for negotiations with Placer County. The Board agreed to include this item on the December 17, 2013 meeting agenda.

**C. Public Comment/Presentation. Track 2:2:33**

Ed Heneveld said the SVMAC meeting is cancelled but the Design Review Committee meeting is scheduled for Thursday, December 5<sup>th</sup> at 4 P.M. in the District's community room.

C-1 5-Year Employment Anniversary Recognition to Jeff Geigle, Firefighter/Paramedic  
The Board presented a 5-year certificate of service to Jeff Geigle and thanked him for his excellent work. Chief Bansen accepted the certificate for Mr. Geigle.

C-2 20-Year Employment Anniversary Recognition to Pete Bansen, Fire Chief  
The Board presented a 20-year certificate of service to Pete Bansen in recognition of his outstanding service to the community and the District.

#### **D. Financial Consent Agenda Items.**

Directors Sheehan/Poulsen met with staff on Monday, November 25<sup>th</sup> from approximately 4-5 P.M. to review items D-1 through D-10 as well as other finance related items on this agenda.

Directors Poulsen said he and Director Sheehan reviewed the finance related items with staff and all items appear to be in order. Some expenses are paid early in the year, such as insurance. It was discussed how it is reflected in the financial reports. The management of the Bike Trail Snow Removal Project was discussed. Mr. Geary explained that the program's budget will dictate the scope and schedule of this year's program; the project budget will not be exceeded due to impacts on tax revenues and water and sewer rates.

Director Sheehan said the financial report tracking the expense and revenue for the bike trail project is included in the Financial Consent calendar as item D-6. Suggestions made from the Finance Committee for item D-6 include adding a revenue column and an expense to date column. These changes will be incorporated in subsequent reports.

Public Comment – none

A motion to approve the financial consent agenda was made by Directors Sheehan/Gustafson as submitted; vote was unanimous.

#### **E. Approve Minutes.**

E-1 Minutes for October 29, 2013.

A motion to approve the minutes for October 29, 2013 was made by Directors Wilcox/Sheehan: vote was unanimous.

#### **F. Old & New Business.**

##### **F-1 Village at Squaw Project Update.**

Director Poulsen left the room due to a conflict of interest.

The Board reviewed the information, discussed the project and accepted public comment.

##### Water/ Sewer/Fire/Emergency Medical Services (EMS)

Mr. Geary said because the developer postponed the project for internal review, there are few new developments with regard to Sewer and Fire/EMS. HydroMetrics continues to work with the developer's hydrogeologist on additional groundwater modeling outside the scope of the Water Supply Assessment (WSA). Mr. Geary said the WSA is specific to the project and is not a project the District would undertake independently. The WSA and EIR schedule is driven by the developer's schedule.

Public Comment – none

##### **F-2 2013 Patch Paving Project Budget Amendment.**

Director Poulsen returned to the meeting room.

The Board reviewed the item, accepted public comment, approved the budget amendment and payment of the November Patch Paving Project Progress Report.

Mr. Burks discussed the project. Staff recommends the 2013 Patch Paving Project budget be amended to include the additional work in the amount of \$4,247.10 and approve the November progress payment report.

Public Comment – none

Directors Wilcox/Sheehan made a motion to approve the budget amendment and payment of the November Patch Paving Project Progress Report.

### **F-3 North Lake Tahoe Resort Association- Funding Agreement for Trail Snow Removal Project.**

The Board reviewed the item, accepted public comment, approved the agreement and authorized staff to execute the agreement.

Mr. Geary provided a review of the item. The District will provide snow removal services on 2.3 miles of bike trail using its own staff for the 2013/14 winter with grant funds totaling \$104,700 from the following organizations in the amounts shown:

- North Lake Tahoe Resort Association (NLTRA) \$70,000
- Resort at Squaw Creek (RSC) \$18,000
- Squaw Valley Business Association (SVBA) \$10,500
- Squaw Valley Resort (SVR) \$5,000
- Squaw Valley Property Owners Association (POA) \$1,200

This is the first winter the District will provide snow removal services with its own staff but estimates the cost to be \$109,670. The actual cost will depend largely on the amount and timing of the snowfall as many expenses are not fixed costs. The NLTRA granted \$70,000 to the District for project and requires execution of the funding agreement.

Director Poulsen said the importance of not exceeding the grant funds pledged for the project was discussed at the Finance Committee meeting and staff will be monitoring costs closely. The project will be scaled back as needed to ensure expenses do not exceed grant funds.

Public Comment – none

Directors Wilcox/Sheehan made a motion to approve the NLTRA agreement for bike trail snow removal and authorized staff to execute the agreement.

### **F-4 Amendment to Operations Memorandum of Understanding (MOU). Track 8-1:08**

The Board reviewed the item, accepted public comment and approved an amendment to the MOU with International Union of Operating Engineers, Stationary Engineers Local for the Operations Department Personnel. The amendment allows staff scheduling changes to perform bike trail snow removal work on weekends.

Mr. Geary provided a review of the item. In order for the District to provide snow removal services on the bike trail for the 2013/14 winter, it is necessary for Operations Department staff to work over the weekend. An amendment to the MOU is required to modify the work week schedule.

Public Comment – none

Directors Poulsen/Gustafson made a motion to approve Resolution 2013-13 approving an amendment to the MOU with International Union of Operating Engineers, Stationary Engineers Local for the Operations Department Personnel and authorizing execution of the amendment. The motion passed unanimously.

#### **F-5 Olympic Valley Creek Aquifer Interaction Study Phase II Report.**

The Board reviewed the item and accepted public comment.

Mr. Geary said the Creek / Aquifer Interaction Study was commissioned to gain a better understanding of the impacts of domestic water well pumping on shallow groundwater adjacent to Squaw Creek so current pumping can be managed and well field improvements planned with the best available information to minimize impacts on Squaw Creek. The project's specific goals were to:

- Improve and quantify our understanding of interactions between Squaw Creek and the valley's
- aquifer;
- Diminish groundwater pumping impacts on Squaw Creek and the Truckee River; and to
- Increase groundwater storage in Olympic Valley.

The completion of the Study satisfies several of the District goals and objectives including several Basin Management Goals and Objectives (BMO's) recognized in the District's Olympic Valley Groundwater Management Plan (May, 2007) and Task 1.2.0 of the Work Plan that the Board approved to implement its Five-Year Strategic Plan in May, 2012.

The District's completion of the Study also satisfies a requirement from the California State Water Resources Control Board in its Resolution 2007-0008 to the Lahontan Regional Water Quality Control Board, which directed the Lahontan Board to support the efforts of entities pumping groundwater as well as other stakeholders in Squaw Valley to conduct a study of potential interaction between groundwater pumping and flows in Squaw Creek.

The District's work on the Interaction Study started in 2007 and was prepared in two phases by HydroMetrics Water Resources, Incorporated. Phase I was completed in March, 2011 with grant funds of approximately \$190,000 from the CA Dept. of Water Resources. Phase II of the Study was completed earlier this month with funds of approximately \$258,000 from Squaw Valley Real Estate (SVRE).

Mr. Geary said the District completed the Olympic Valley Creek / Aquifer Interaction Study and the document currently available is a draft. He said the Final version will be completed and available after the first of the year with a link from the District's website. He said public comments may be submitted until Tuesday, 12/10/13 and sent via e-mail to [info@svpsd.org](mailto:info@svpsd.org) or by hard copy to District's office. Public comment forms are available with all the submittal information. He thanked the California Department of Water Resources (DWR) and Squaw Valley Real Estate (SVRE) for their support of the study.

Mr. Geary introduced Derrik Williams, HydroMetrics Water Resources and Dr. Jean Moran, Lawrence Livermore National Laboratory and California State University, East Bay.

Mr. Williams and Dr. Moran provided a presentation of the study (see attachments A1-Williams, A2-Moran and A-3-Conclusions). Throughout the presentation, brief clarifying questions were asked and responded to.

President Cox asked the Board for comments and questions.

Director Sheehan recommended an executive summary be included and placed in the front of the report.

Director Wilcox suggested the description of the District on page 1 be modified to more accurately reflect the District's role and mission. He said the District is not the only water supplier in the valley and the phrase "environmental steward" is not specified in the District's mission statement and is a broader description than he is comfortable with. He commented on the goals listed on page 1, specifically "Diminish groundwater pumping impacts on Squaw Creek and the Truckee River...". He said the amount of water that flows out of the valley into the Truckee River is approximately 20,000-30,000 acre feet per year but pumping is approximately 700 acre feet per year or 5% of the total flow and that information should be in the report.

Director Wilcox asked if the District's pumping is responsible for "pumping the creek dry". Mr. Williams said he believes that statement is an exaggeration, however pumping has some impact on the hydrology of the area. Director Wilcox referred to another study in which Mr. Loy of West Yost stated it is typical for the creek to dry out in 70%-90% of all years regardless of pumping. Pumping will speed up the drying but the creek will still dry out. Mr. Williams agreed with the statements.

Director Wilcox asked if environmental harm is being done by pumping. Mr. Williams said defining what constitutes environmental harm is necessary to answer this.

President Cox expressed support of the suggestion to potentially modify the trapezoidal channel to reduce drainage from the shallow aquifer into the channel through water retention. He discussed the 1976-77 drought and the importance of water supply reliability. He asked Mr. Williams to comment on the potential for the aquifer to be "out of water" and compromising the aquifer. Mr. Williams said the most perilous time for provision of municipal water is when runoff ends and before winter storms. The aquifer does recover quickly and typically will recover over the winter. Dr. Moran said potential harm to the aquifer could occur due to land subsidence if water is drawn from an inelastic area with very fine grain soils but this is not likely due to the geology of the valley and current pumping operations.

Director Poulsen commented on the geology of the area which is not discussed in the report. He said the upper end of the aquifer where the well field is located is a glacial area which is why the water passes through so quickly. From the Papoose Bridge and below is a more volcanic area with different soil structure, a fault zone and confined areas with silt and clay. If water is retained, it will likely percolate through the area very quickly due to the geology of the area. Mr. William said the geology drives much of the conclusions in the study but is not detailed in the report. A lot of water is lost from the channel in this Papoose Bridge area and any retention work should be located very carefully.

Director Poulsen commented on the eastern meadow area which is a very dry area as shown in historical photos. This area is being irrigated today due to the golf course, resort and homes much more than in the past and appears lusher as a result. Mr. Williams said this may also indicate a circular cycle of pumping and irrigating.

Director Gustafson thanked SVRE and the CA DWR for funding the study. He read excerpts from August 2002 meeting and the prior General Manager's statement that any valley development should be in balance with natural resources and a letter from 2005 in which Lahontan staff state that groundwater in the valley is subject to the Truckee River Operating Agreement (TROA) and that groundwater extraction impacts creek flow. He expressed support for all efforts to maintain creek flow and asked Mr.

Williams to comment on the phrase “significant influence” on creek flow. Mr. Williams said this is a more involved discussion involving pumping scenarios and defining “significant influence” is not a purely scientific number and subject to negotiation amongst many stakeholders.

Director Gustafson said he would like more emphasis placed on the impact of the Resort at Squaw Creek’s operations on the meadow and creek.

#### Public Comment

Russell Poulsen suggested adding a fourth seasonal phase which is the end of the summer season but distinct from the fall season. Mr. Williams said three seasonal phases was used for simplicity.

Blaine Wells commented that the majority of the District’s wells #1 and #2 pump older water and are the main production wells.

Jon Shanser expressed concern about maintaining water supplies and the placement of future wells, especially in regard to SVRE’s potential development. He asked for comment on the suggestion that future wells are placed along the trapezoidal channel, upstream of Papoose Bridge. Mr. Geary said a pumping management plan was initially part of the project using current well locations. Due to the proposed SVRE development, the pumping management plan is postponed. Mr. Williams said this is a suggestion to investigate pumping toward the trapezoidal channel but may not be possible due to many other factors.

Jennifer Merchant asked how water retention will be impacted by the Truckee River Operating Agreement. Mr. Archer said the agreement reflects a very complex situation and it would be speculating to comment on this aspect at this time. Mr. Geary said diversion would not be for consumptive use, so the water would eventually recharge the Truckee River and may not impact the allocations.

Mr. Williams said water supply improvement options relevant to impacts to Squaw Creek do not provide solutions that result in a large supply of water for little cost. The current supply situation calls for managing the current amount of water for some cost.

Tom Day asked if there is any indication that pumping is drawing the aquifer down into the fine grain materials that could cause subsidence. He asked if the aquifer’s quick recharge is due to its small size. Mr. Williams and Dr. Moran said the aquifer recharge is quick due to a small aquifer, gravelly geology, and large watershed, however a single storm will not typically recharge the aquifer. Mr. Williams addressed land subsidence which occurs when water levels drop below historically low levels. An indicator would be when water levels drop below a historical low and time is also a factor. There is a greater danger if water levels drop to historic lows for a long period of time.

Dave Brew commented on the issue of land subsidence. He said there are few clay soils in the soil layers or units with high water conductivity and believes land subsidence is not likely in the valley.

Blaine Wells asked Mr. Williams to comment on the issue of land subsidence in eastern part of the valley. Mr. Williams said the potential for subsidence is not great even with more clay soil in this part of the valley, especially as the majority of pumping is not occurring in this area.

Jon Shanser asked if the aquifer is at a critical level now. Mr. Burks responded that it is not and Mr. Geary referenced the monthly maintenance report which provides this information.

Ed Heneveld thanked Mr. Hosea for funding the project. He asked if after analyzing the data from wells 5, 5s and 5d, the water is trying to flow toward the original channel. Mr. Williams said he would not say this is accurate but water has a preferred conduit and this may be what is occurring.

Mr. Heneveld commented on the disconnection between the upper mountain area with bedrock and horizontal wells and the groundwater and aquifer. Mr. Williams said this information may be helpful in determining if a horizontal or bedrock well could provide alternative water supply.

Chevis Hosea commented on the impact of snow making and providing recharge to the aquifer.

Mr. Heneveld commented on the impact of the Resort at Squaw Creek's pumping and irrigation practices. Mr. Williams said without more understanding of the Resort's practices and efficiencies, it is difficult to draw any conclusions. If the water used to irrigate is being absorbed by the grass, with little runoff, then the water in the creek is not pumped water but has remained in the aquifer. Dr. Moran said there are many factors impacting absorption such as evapotranspiration.

President Cox thanked Mr. Williams and Dr. Moran for the presentation and the public for their interest and participation. He said the presentation will be provided again for the public tonight at 6 P.M. in the District's community room.

Break 12:10-12:15

#### **F-6 Use of Community Dumpsters at 1810 Squaw Valley Road. Track 45-1:55**

The Board reviewed the item, accepted public comment and directed staff to purchase and install a rail gate prohibiting vehicular access to the dumpsters, reduce the number of dumpsters from six (6) to three (3); acquire a large dumpster for flattened cardboard, request Tahoe Truckee Sanitation District (TTSD) monitor the condition of the area and possibly increase collection frequency, replace existing dumpsters with those that have an easy opening loading chute to facilitate dumping and place signage in the area to ensure the rules are well posted.

Mr. Geary provided a review of the item and said the Ad Hoc Garbage Committee including President Cox and Director Sheehan met with staff and Patti Guilford to discuss this issue. The group also reviewed written comments from Dave Brew and Andrew Lange.

The Community Dumpsters were originally provided for disposal of household trash, instead of leaving it on the curb for the trash company to pick up. This prevented wild and domestic animals from access to household trash. Problems at the Community Dumpster Site include disposal of prohibited materials, disposal on the ground or in excess of dumpster capacity and litter in the area due to wild and domestic animal activity.

Due to continued misuse and abuse of the Community Dumpster Site, the committee recommends implementing the following changes:

- purchase and installation of a rail gate prohibiting vehicular access to the dumpsters, except for staff and TTSD personnel;
- a reduction in the number of dumpsters from six to three;
- an increase in the frequency of collection at the Community Dumpster Site by TTSD;
- replacement of the existing dumpsters with those that have an easy opening loading;
- in the future, as needed, purchase and installation of video surveillance equipment;

- in the future, as needed, passage of an Ordinance requiring all existing single family residences to purchase and install Bear Boxes and elimination of the Community Dumpster Site.

Director Wilcox supports the recommendations.

Director Poulsen suggested a bear box program could be developed to incentivize installation of these boxes.

Director Gustafson supports replacement of the dumpsters that are easier to use but has some reservations using the chute style dumpster. He supports adding more dumpsters during the holidays to accommodate the extra use but does not support a bear box ordinance.

Public Comment –

Patti Guilford commented on the condition of the site and compared it to the Alpine Meadows site. She said the Alpine site is designed very well with recycle bins. She supports replacing the existing dumpsters with those that are easier to use and are well maintained. She would like a more extensive recycle system rather than the current cardboard only bin. She also supports better signage, fewer dumpsters, and a surveillance camera. She does not support the expense of a rail gate and suggested a heavy duty chain would serve the same purpose at less cost.

Ed Heneveld said he supports Ms. Guilford's suggestion of a chain rather than a gate to minimize the expense. He supports a progressive approach that starts with a chained area, with better signage and replacement of the existing dumpsters. If these changes do not work, then additional steps may be taken.

Mr. Burks said installation of a chain creates operational issues for staff and a gate is preferred.

Mr. Archer said a bear box ordinance may fall within a land use regulation and would be Placer County's jurisdiction, not the District's.

Director Sheehan, Wilcox and Poulsen and President Cox expressed support of the Committee's recommendations with a larger dumpster for flattened cardboard.

Director Gustafson supports replacing the dumpsters with those that are easier to use.

Mr. Geary clarified that the Board's direction to staff includes:

- purchase and install a rail gate prohibiting vehicular access to the dumpsters;
- reduce the number of dumpsters from six (6) to three (3);
- acquire a large dumpster for flattened cardboard;
- request Tahoe Truckee Sanitation District (TTSD) monitor the condition of the area and possibly increasing collection frequency;
- replace existing dumpsters with those that have an easy opening loading chute to facilitate dumping;
- place signage in the area to ensure the rules are well posted.

The Board concurred that this list of items constitutes the Board's direction to staff.

## **G. Status Reports.**

### **G-1 Fire Department Operations/Capital Projects Report.**



Chief Bansen provided a review of the reports and Department activities including training, public education, fire prevention and equipment updates. He said the annual Santa Party is scheduled for Friday, December 20<sup>th</sup> and will be held in the District's community room. Fire Department staff are preparing a FEMA grant request for either regional trench rescue equipment or a thermal imaging camera.

Public Comment – none

**G-2 Water & Sewer Operations/Capital Projects Report.**

Mr. Burks provided a review of the report. He provided an update on the Granite Chief sewer line and the homeowner's meeting that Mr. McGraw, Operations Manager, attended. He also discussed the relationship of the water leak rate and water production. While the volume of water leaked has decreased since last month, the leak rate percentage is higher due to less water production. This scenario is typical for this time of year.

Public Comment –none

**G-3 Administration Report.**

Ms. Obayashi-Bartsch made no comments.

Public Comment – none

**G-4 Manager's Comments.**

Mr. Geary provided an update on Information Technology changes including the transition to a cloud based server for certain applications such as e-mail.

Public Comment – none

**G-5 Legal Report (verbal).**

Mr. Archer made no comments.

Public Comment – none

**G-6 Director's Comments.**

Director Sheehan said the Design Review Committee will meet on Thursday, December 5<sup>th</sup> at 4 P.M. in the District's community room.

**H. Adjournment.**

President Cox adjourned the meeting at 1:05 P.M.

K. Obayashi-Bartsch

Attachments A-1, A-2 and A-3- Creek Aquifer Interaction Study Presentations

November 26, 2013

## Olympic Valley Creek/Aquifer Interaction Study

### Purposes

- Establish the amount of water flowing both from the aquifer to Squaw Creek, and from Squaw Creek towards pumping wells
- Develop data that supports groundwater pumping management
- Incorporate results into the groundwater model to ensure that model accurately predicts pumping impacts on Squaw Creek



### Phase I – Data Collection

- Install new monitoring wells adjacent to Squaw Creek
- Install temperature probes and piezometers in creek
- Install data loggers along creek
- Conduct two aquifer tests

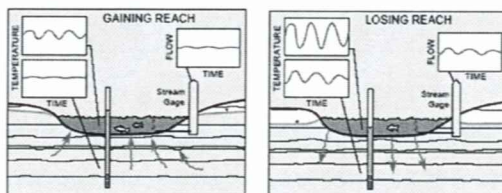


### Two Methods for Collecting Temperature Data

- Temperature Probes
- Distributed Temperature Sensing



### Temperature Probes



### Temperature Probes



## Temperature Probes

### ADVANTAGES

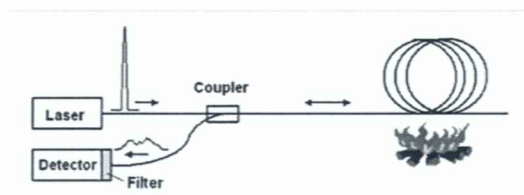
- Excellent resolution over time
- Can directly quantify groundwater inflows and outflows to the Creek

### DISADVANTAGES

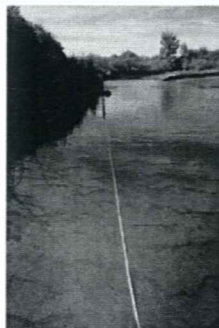
- Point measurements only
- Sensitive to localized soil conditions



## Distributed Temperature Sensor



## Distributed Temperature Sensor



## Distributed Temperature Sensor

### ADVANTAGES

- Excellent resolution over space
- Detect temperature at many locations along the creek (every meter)
- Very accurate temperature measurements

### DISADVANTAGES

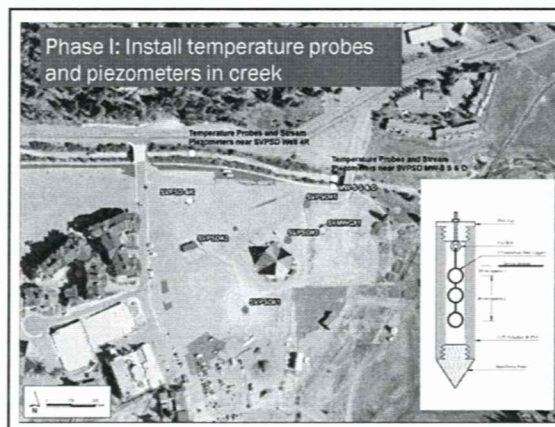
- Poorer resolution over time
- Can only detect groundwater inflow, not groundwater outflow



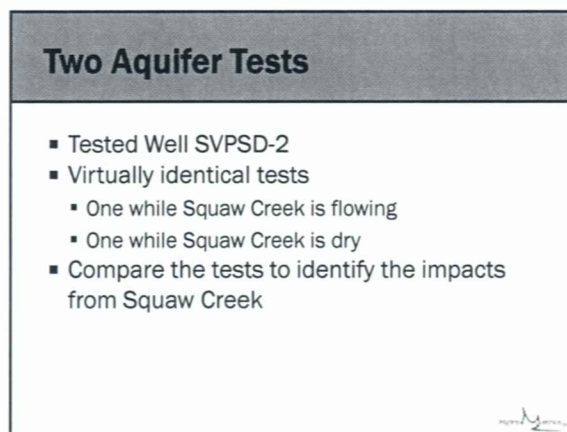
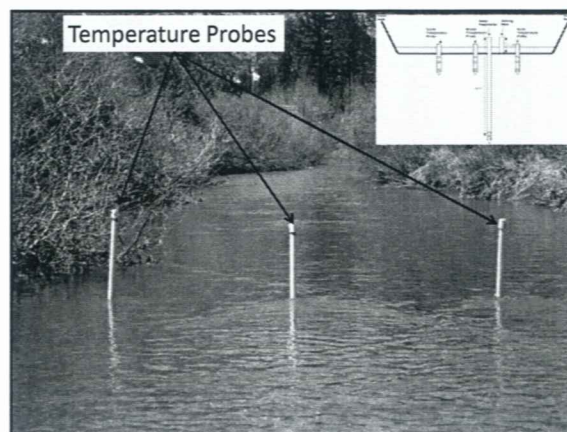
Phase I: Install new monitoring wells adjacent to Squaw Creek



Phase I: Install temperature probes and piezometers in creek



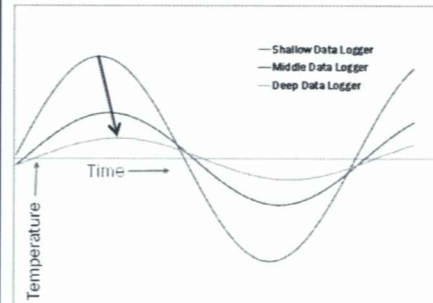




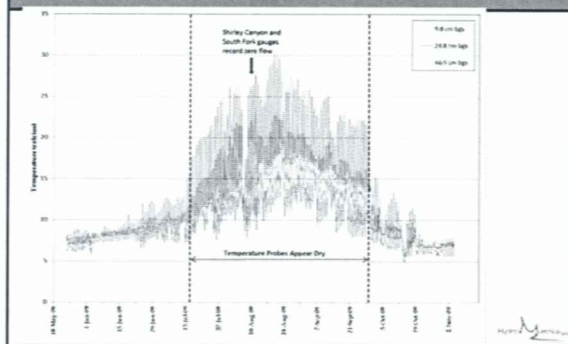
## Phase II – Analysis and Modeling

- Analyze Stream/Aquifer Interactions
- Analyze Aquifer Tests
- Update Model

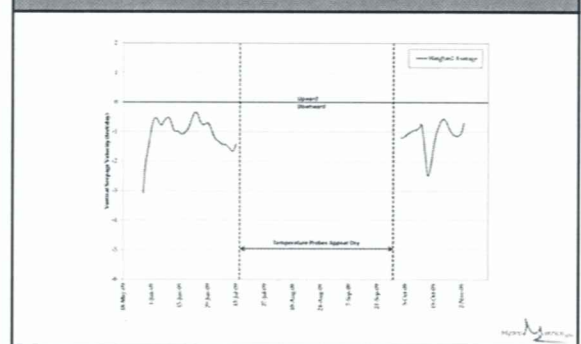
## Stream/Aquifer Interactions



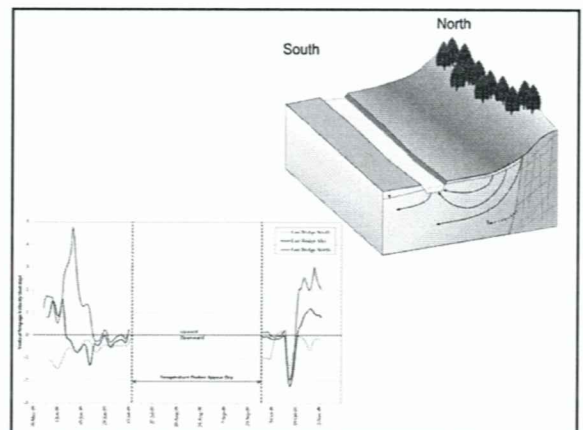
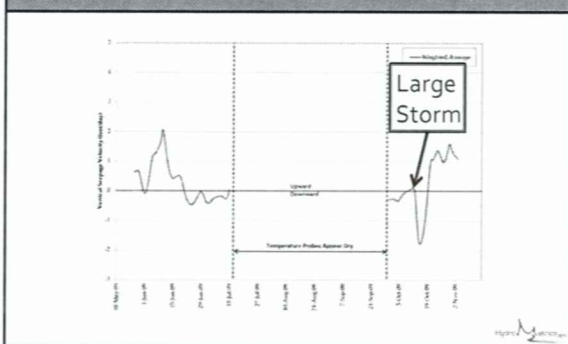
## Stream/Aquifer Interactions



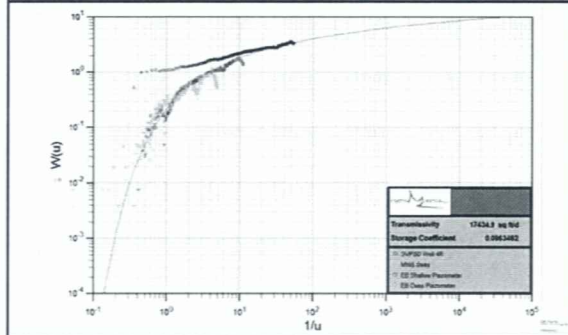
## Stream/Aquifer Interactions



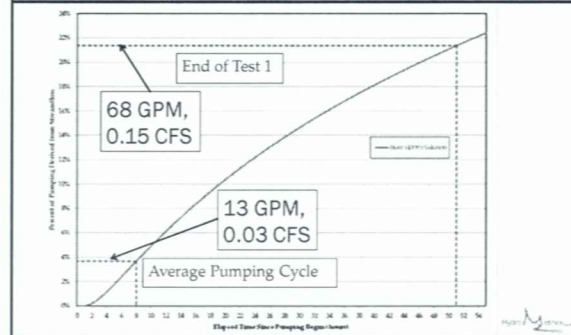
## Stream/Aquifer Interactions



### Aquifer Test Analysis



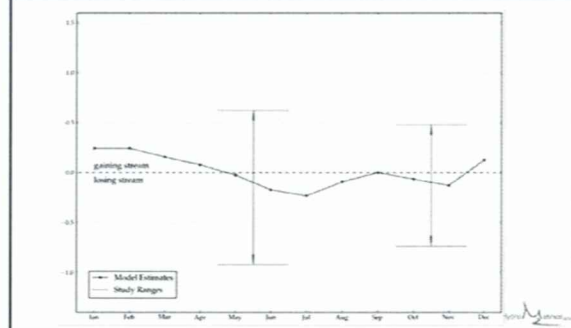
### Creek Capture from Pumping



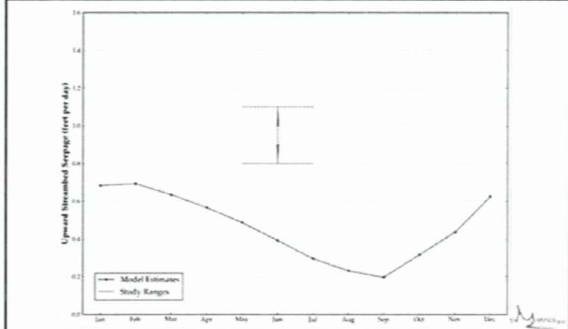
### Update Model So Predictions Reflect our Best Understanding

- Extend model through 2011
- Move to newer model code
- Incorporate aquifer test results
- Update geology
- Simulate measured stream interactions

### Model Accurately Simulates Flow in and out of Trapezoidal Channel




### Model Underestimates Flow into Creek in Meadow





## Tracing Water Sources and Flow Pathways in Olympic Valley

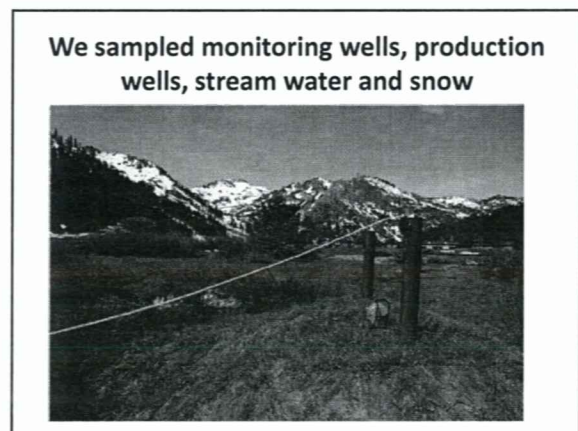
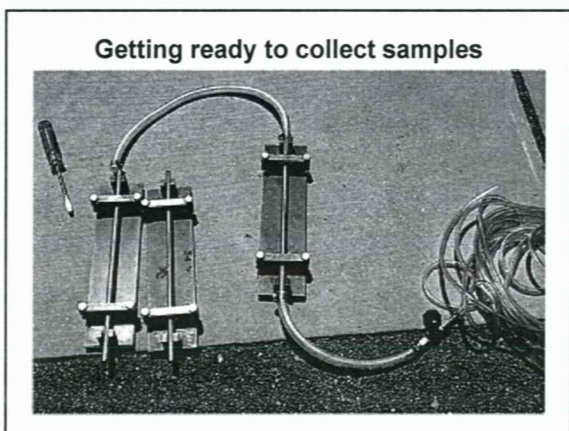
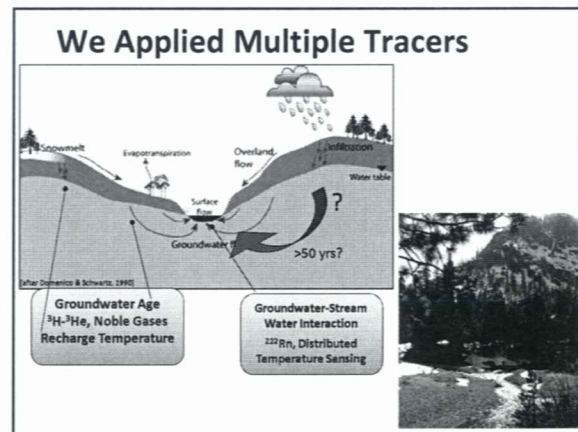
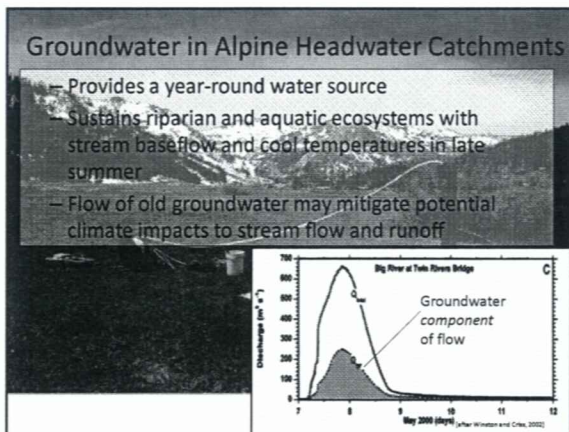


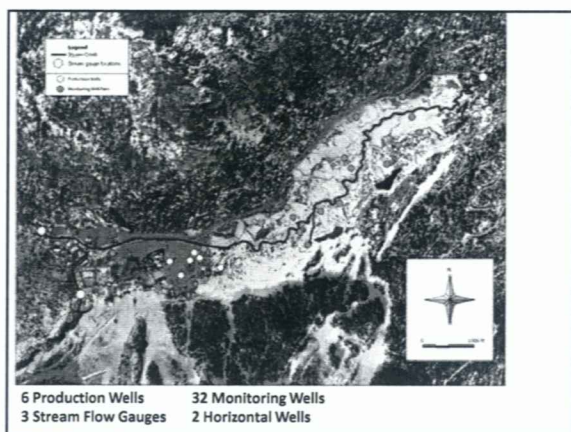
November 26, 2013

Jean Moran, PhD

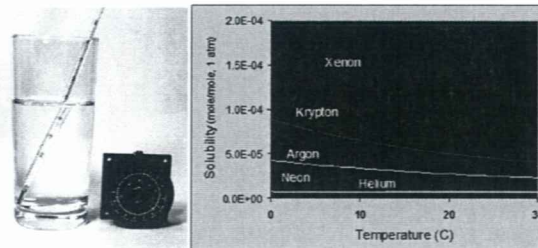
### Presentation Outline

- Motivation for study
- Water source tracers
  - Stable isotopes of the water molecule
  - Recharge temperatures from dissolved gases
- Water flow pathway tracers
  - Groundwater age
  - Dissolved radon gas
  - Heat (Temperature)
- Results for Olympic Valley
  - Recharge elevations
  - Subsurface residence time
  - Streamwater-groundwater interaction

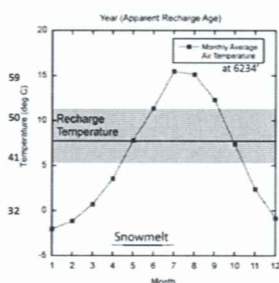




### Temperature and Pressure determine the solubility of gases in water

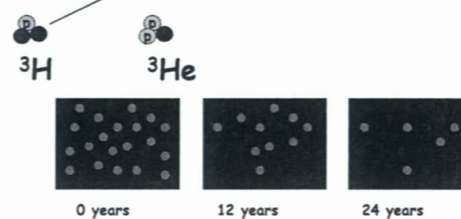


### Recharge temperatures indicate that recharge takes place just above the valley floor



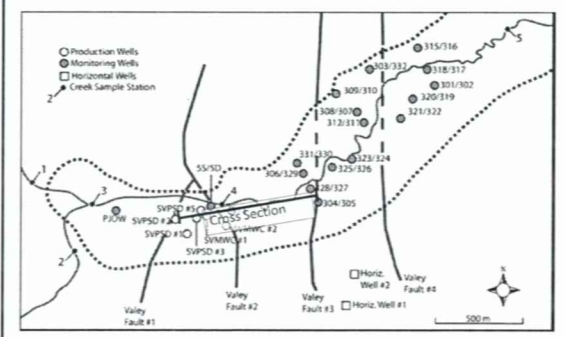
- Water equilibrates in the soil zone at the mean annual air temperature
- Recharge temperatures reflect long term average air temperatures at 6300' in May and June

### The $^3\text{He}$ from $^3\text{H}$ decay starts to accumulate once the water has become groundwater

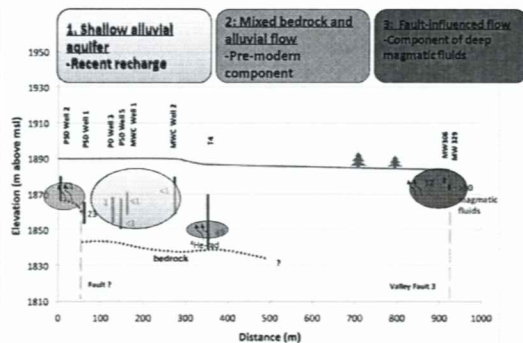


$$\text{Age (years)} = 18 \times \ln(1 + ^3\text{He} / ^3\text{H})$$

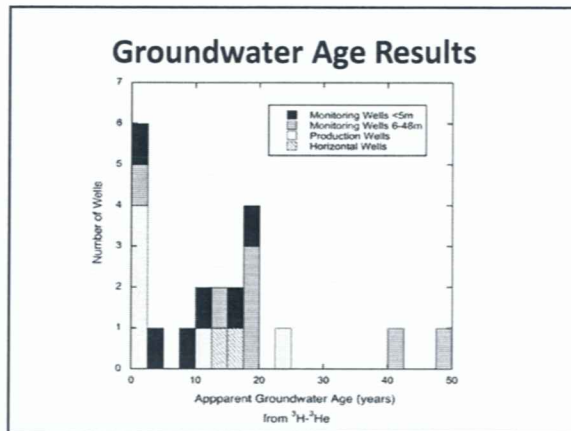
### Cross Section Location – Olympic Valley



### Groundwater Ages: Cross Section







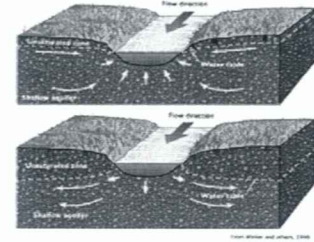
### Identification and quantification of groundwater influx to Squaw Creek

Methods:

Discharge measurements

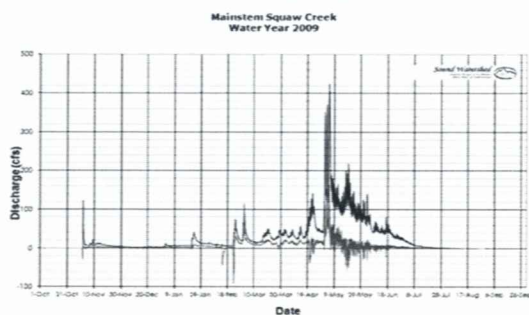
Tracers:

- heat
- geochemical tracers like radon

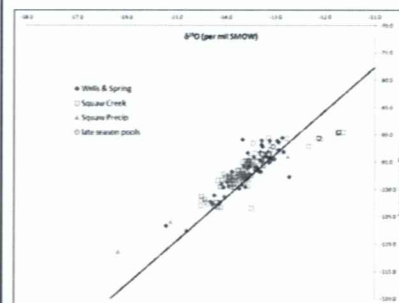


Discharge measurements:  
Typically widely spaced  
Poor precision at low flows  
May vary at high frequency  
Difficult to account for small tributaries

### Comparing upstream and downstream gauge data



### Stable isotopes reveal water sources



- Water is derived from precipitation accumulated on the lower slopes
- Some late season pools are evaporating, while others are fed by groundwater influx

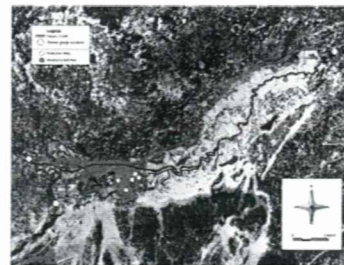
### Using temperature as a tracer of groundwater-stream interaction



#### What is Distributed Temperature Sensing (DTS)

- The measurement of temperature using only the properties of a fiber optic cable.
- The fiber optic cable serves as the thermometer, with a laser serving as the illumination source.
- Measurements of temperature every 1-2 meters for as long as 30 km can be resolved, every 1-60 minutes, with temperature resolution of 0.01-0.5°C.

### Groundwater-Stream water interaction: DTS



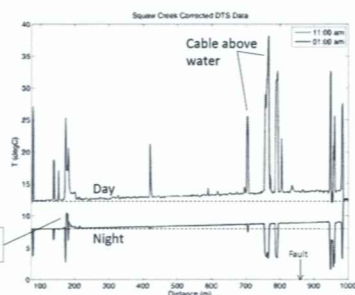
### Groundwater-Stream water interaction: DTS

-There is an increase in temperature downstream even at night

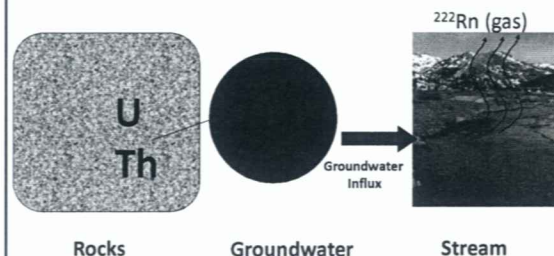
-No significant localized groundwater influx near faults that cross the stream

-Groundwater influx appears to be diffuse.

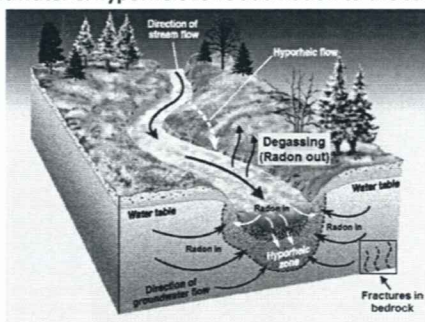
Cable placed in small tributary



Radon accumulates in groundwater, but is rapidly lost from streams

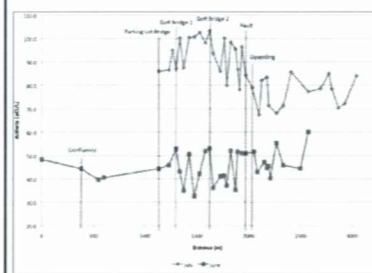


### Groundwater & hyporheic zone add Radon to the stream



Degassing takes Radon out of the stream

### Radon results from Squaw Creek



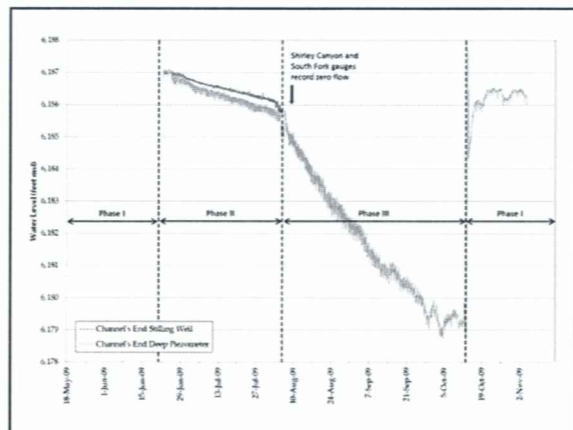
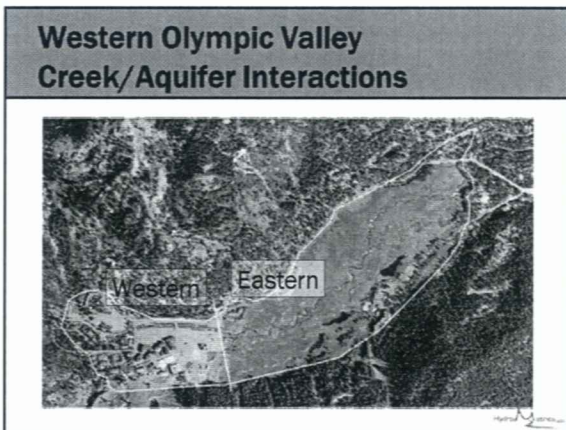
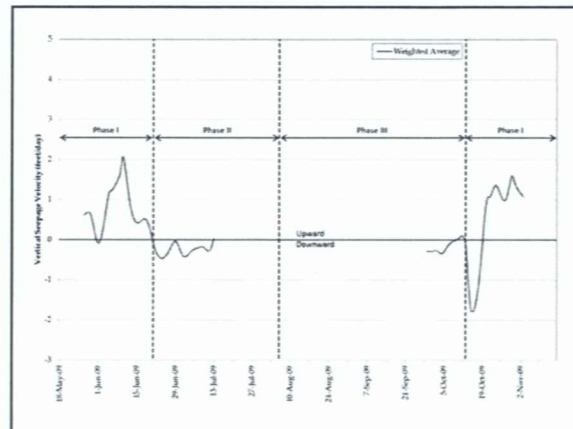
- June and July results reveal steady inflow over the study reach
- Model results indicate 5% of flow is groundwater inflow at peak flow; much higher percentages for late season flows

### Conclusions

- From recharge temperatures: elevations around the break in topographic slope, just above the valley floor are important areas for recharge to the alluvial aquifer
- From groundwater ages: alluvial aquifer allows vigorous flow that 'drains' annually (via stream and wells); distal portions of the valley and bedrock aquifer host older groundwater; during late summer and fall, high capacity wells produce somewhat older water (4-6 yrs)
- From groundwater-stream interaction tracers: groundwater inflow to Squaw Creek comprises up to 22% of annual flow, inflow is distributed over study reach; groundwater provides late season baseflow

November 26, 2013

## Olympic Valley Creek Aquifer Interaction Study Conclusions



### Western Valley Creek/Aquifer Interactions

- Three phases
  - Winter through early summer creek/aquifer interactions
  - Mid-summer Creek/Aquifer Interactions
  - Late summer through fall creek/aquifer interactions

### Winter through early Summer Creek/Aquifer Interactions

- Characteristics
  - High to medium flows in Squaw Creek (>10 to 20 cfs)
  - High groundwater levels.



### Winter through early Summer Creek/Aquifer Interactions

- Pumped water is young – often only one year old
- Pumped water comes from recharge just above the Valley floor
- Trapezoidal channel generally drains water from the shallow aquifer.



### Mid-Summer Creek/Aquifer Interactions

- Characteristics
  - Low flows in Squaw Creek (<10 to 20 cfs)
  - Groundwater levels near the base of Squaw Creek
  - End of snowmelt: period ends when snowmelt ends
  - Lasts a month or more



### Winter through early Summer Creek/Aquifer Interactions

- Municipal pumping intercepts groundwater that might otherwise flow to the trapezoidal channel
  - Trapezoidal channel is generally gaining
  - Pumped water chemistry suggests percolation through a soil zone rather than infiltration through the Creek bed
- Intercepted water is a small fraction of total Creek Flow

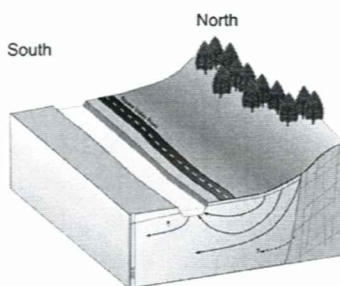


### Mid-Summer Creek/Aquifer Interactions

- Pumped water still appears to be young
- Trapezoidal channel generally loses water into the shallow aquifer.



### Winter through early Summer Creek/Aquifer Interactions

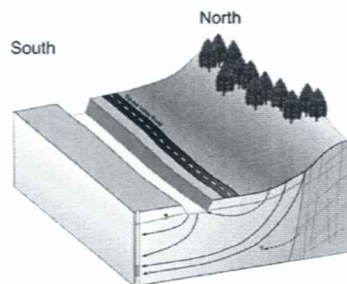


### Mid-Summer Creek/Aquifer Interactions

- Municipal pumping captures a portion of its water from Squaw Creek
- Captured creek flows represent an increasing fraction of total creek flow as creek flows decline
- Captured creek flow are on the order of 4% of pumped water for an 8-hour pumping cycle



### Mid-Summer Creek/Aquifer Interactions



### Late Summer through Fall Creek/Aquifer Interactions

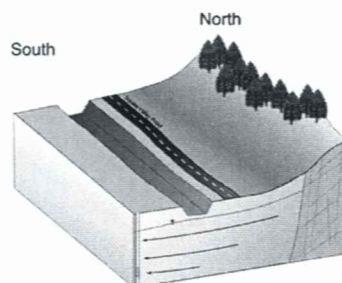
- Groundwater levels recover rapidly at the end of fall
- Rapidly revert to first phase: high groundwater levels and a gaining stream



### Late Summer through Fall Creek/Aquifer Interactions

- Characteristics
  - No runoff feeding Squaw Creek
  - Groundwater levels below the base of Squaw Creek
  - Lasts until the first significant storm of Fall

### Late Summer through Fall Creek/Aquifer Interactions



### Late Summer through Fall Creek/Aquifer Interactions

- Pumped groundwater begins to be older: up to 3 to 5 years old
- No groundwater interaction with the trapezoidal channel
- Municipal pumping derived from groundwater stored in the basin
- Groundwater levels drop more rapidly than in first two phases

### Eastern Olympic Valley Creek Aquifer Interactions



### Eastern Olympic Valley Creek Aquifer Interactions

- Three phases are not in evidence
- Squaw Creek always gains water from the shallow aquifer in at least part of the meadow
- Groundwater inflow to Squaw Creek is evenly distributed along the creek length
- Groundwater inflow constitutes 5% to 100% of creek flow



### Suggstions

- Potentially modify the trapezoidal channel to reduce drainage from the shallow aquifer into the channel in Spring and early Summer



### Eastern Olympic Valley Creek Aquifer Interactions

- Groundwater is older, likely due to clay and silt rich soils
- Groundwater recharges individual ponds even into late summer



### Suggstions

- Reduce pumping in East Olympic Valley. Move pumping as far west as possible.
- Protect recharge areas. Fast transit times imply that wells are highly vulnerable to contamination. Source water protection is important. A secondary supply will provide reliability and redundancy.



### Suggstions

- Move pumping based on flows in trapezoidal channel, following the phases of creek/aquifer interaction



### Suggstions

- Expand the wellfield with flexibility in mind.



