Water Levels 101

Joe Fenelon, U.S. Geological Survey
Nicole DeNovio, Golder Associates Inc.

Educational Session for the
Nevada Site Specific Advisory Board
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Overview

- Why do we monitor groundwater elevation?
- How does the Underground Test Area (UGTA) Activity use groundwater elevations?
- Water-level monitoring
  - What we are measuring
  - How the measurements are completed
- Public access for Nevada National Security Site (NNSS) groundwater elevation data
- Examples of the use of groundwater elevation data in the UGTA Activity

Why Do We Monitor Groundwater Elevation?

1. Identifies where water occurs in the subsurface.
2. Provides information about changes in the quantity of water in aquifers (important to sustainability of water supplies).
3. Using measurements at multiple locations, we can identify the direction of groundwater movement.
4. Combining the direction of groundwater movement with the properties of the rocks, we can understand groundwater velocity (i.e. how fast it moves).

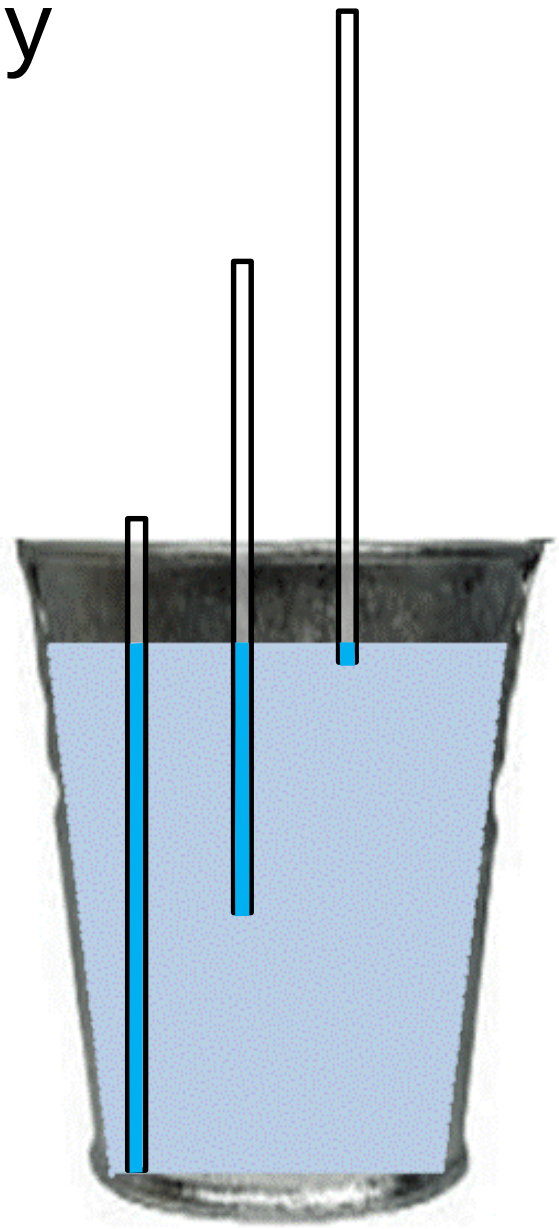
How Does the UGTA Activity Use Groundwater Elevations?

- Long-term monitoring
  - Quarterly measurements throughout the Death Valley Regional flow system (242 wells with DOE funding)
  - Used to establish groundwater flow directions
  - Provide information to establish basin boundaries which help to focus subsurface investigations
  - Used to create maps which help to communicate groundwater gradients
- Short-term monitoring
  - Completed with equipment providing continuous data (frequency of seconds to minutes)
  - Provides data used to interpret geology and rock properties

WATER-LEVEL MONITORING

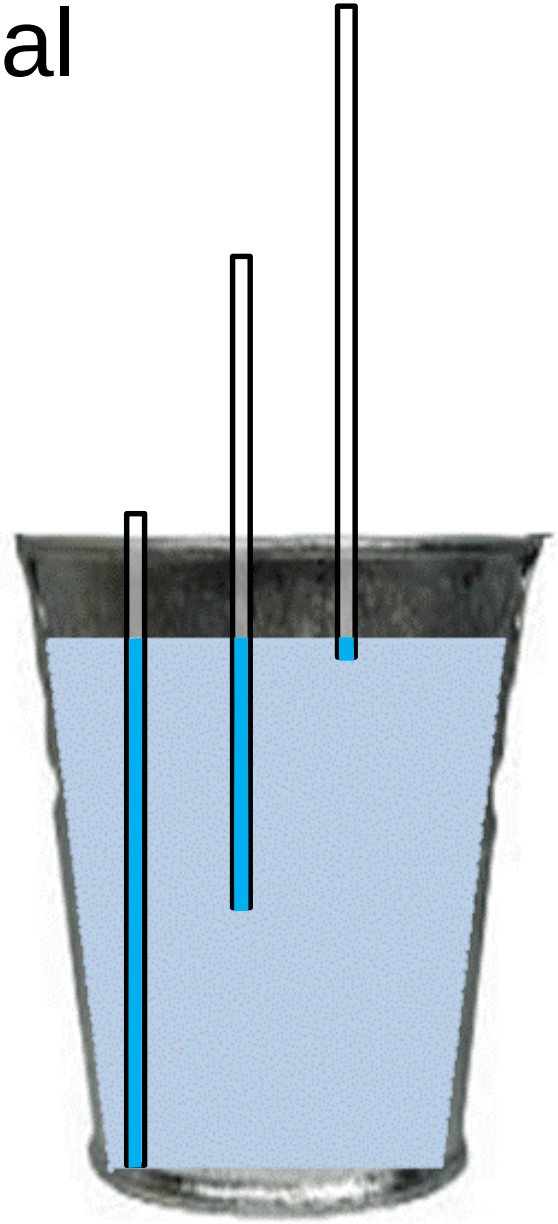
Restaurant Hydrology

- Fill a cup with water
- Insert 3 straws at different depths
- Examine water levels
- They are all the same. What does this mean?



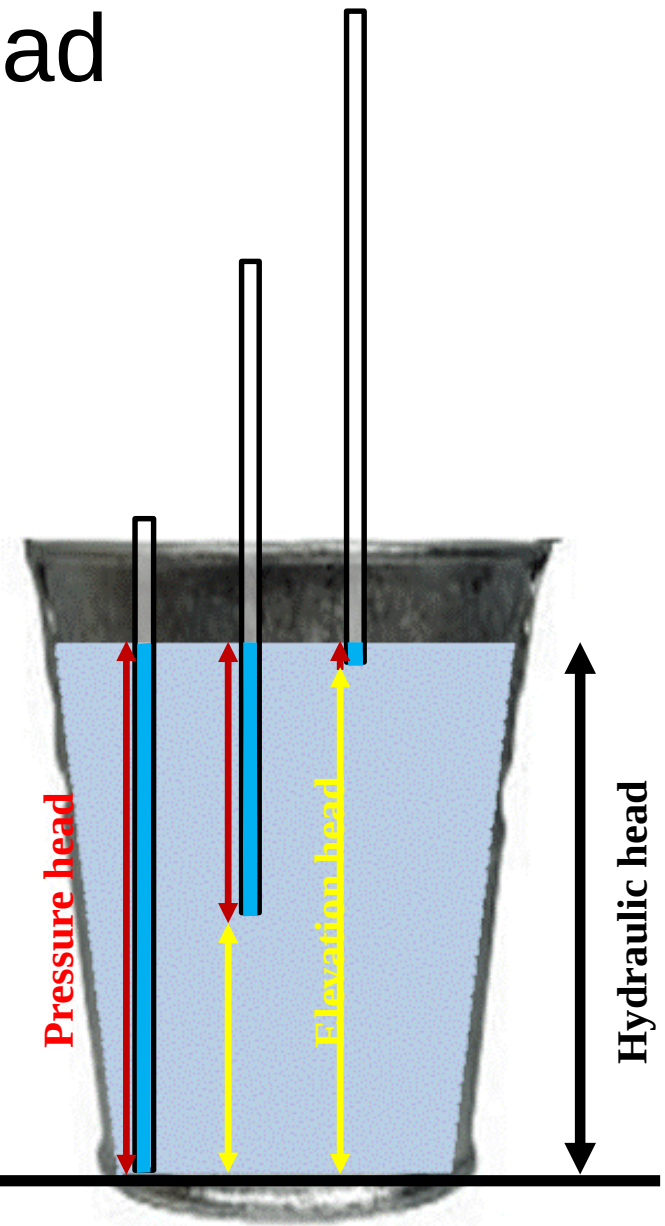
Fluid Potential

- Fluid potential = mechanical energy available at any point in cup to move the fluid
- Water always moves from high to low potential
- How do we measure the potential?



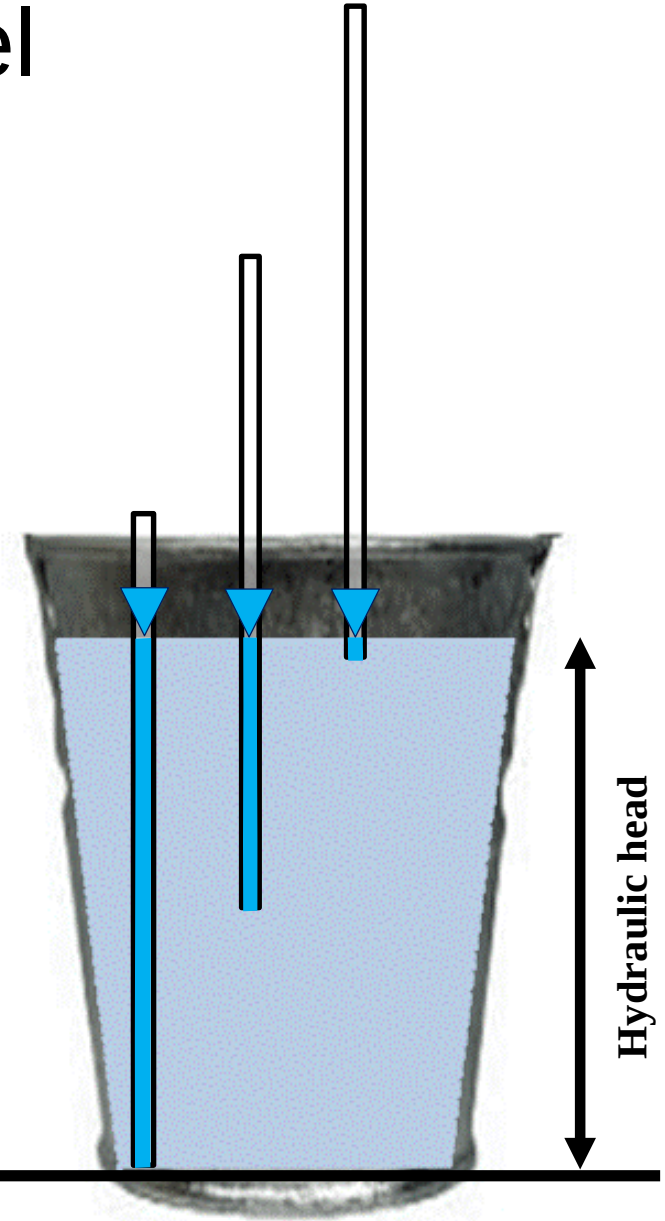
Hydraulic Head

- Hydraulic head is proportional to total energy at a point in fluid
- Three energy components:
  - Fluid movement (~0 in groundwater)
  - Fluid pressure
  - Height of fluid above arbitrary datum



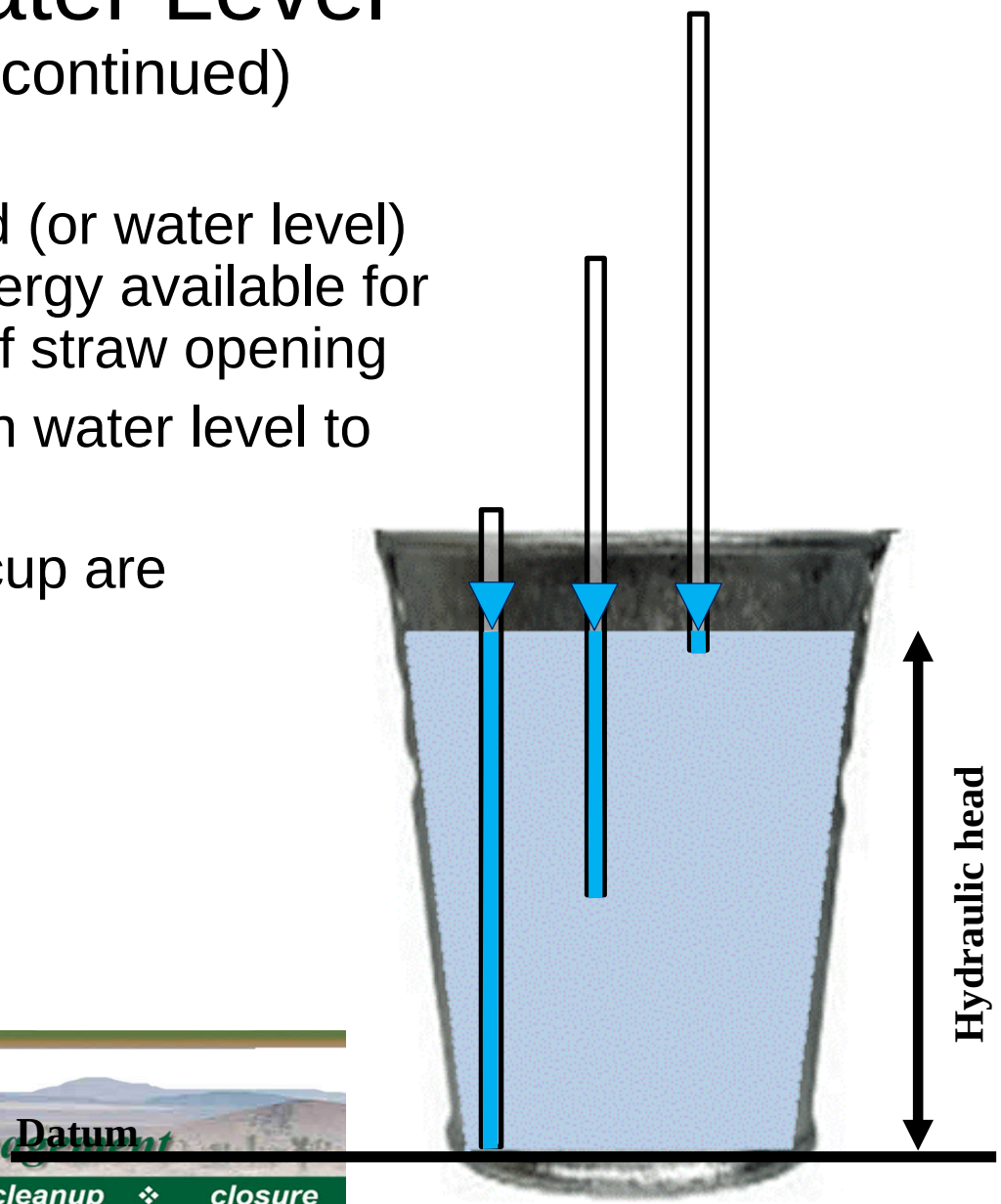
Water Level

- Hydraulic head is proportional to total energy at a point in fluid
- Three energy components:
  - Fluid movement (~0 in groundwater)
  - Fluid pressure
  - Height of fluid above arbitrary datum
- Water level = hydraulic head



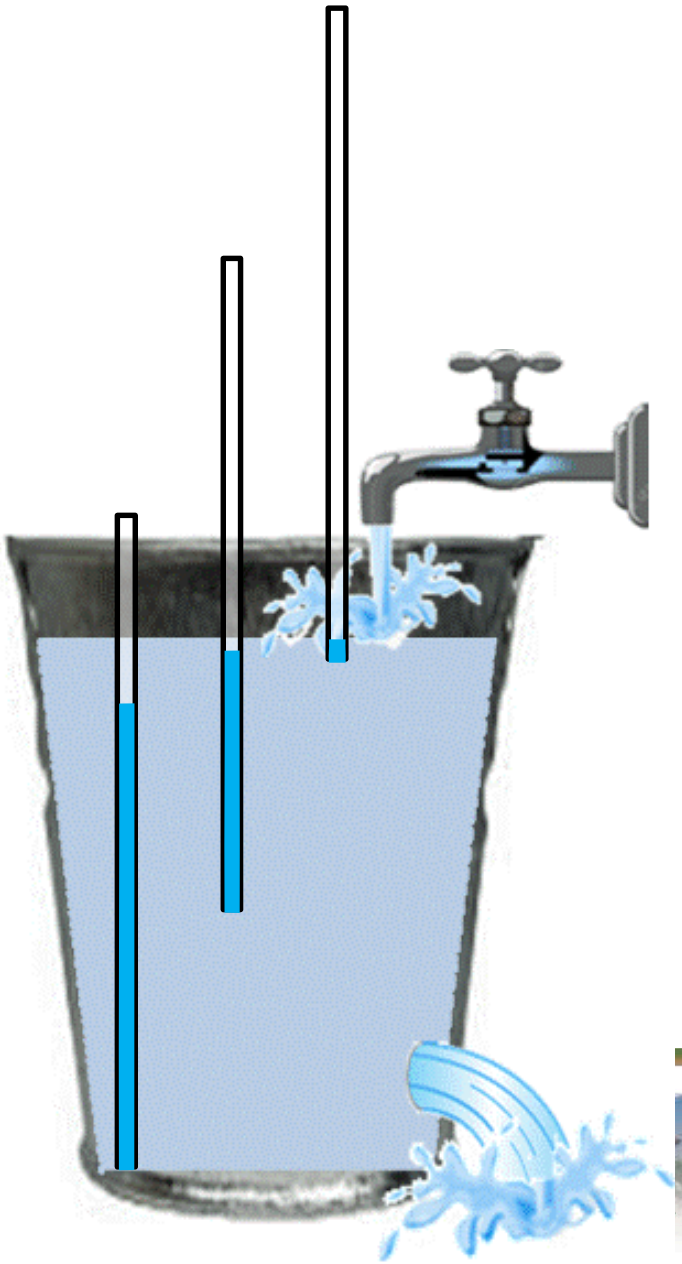
Water Level
(continued)

- Therefore, hydraulic head (or water level) indicates the potential energy available for fluid movement at point of straw opening
- Water will move from high water level to low water level
- Because water levels in cup are identical, there is no flow



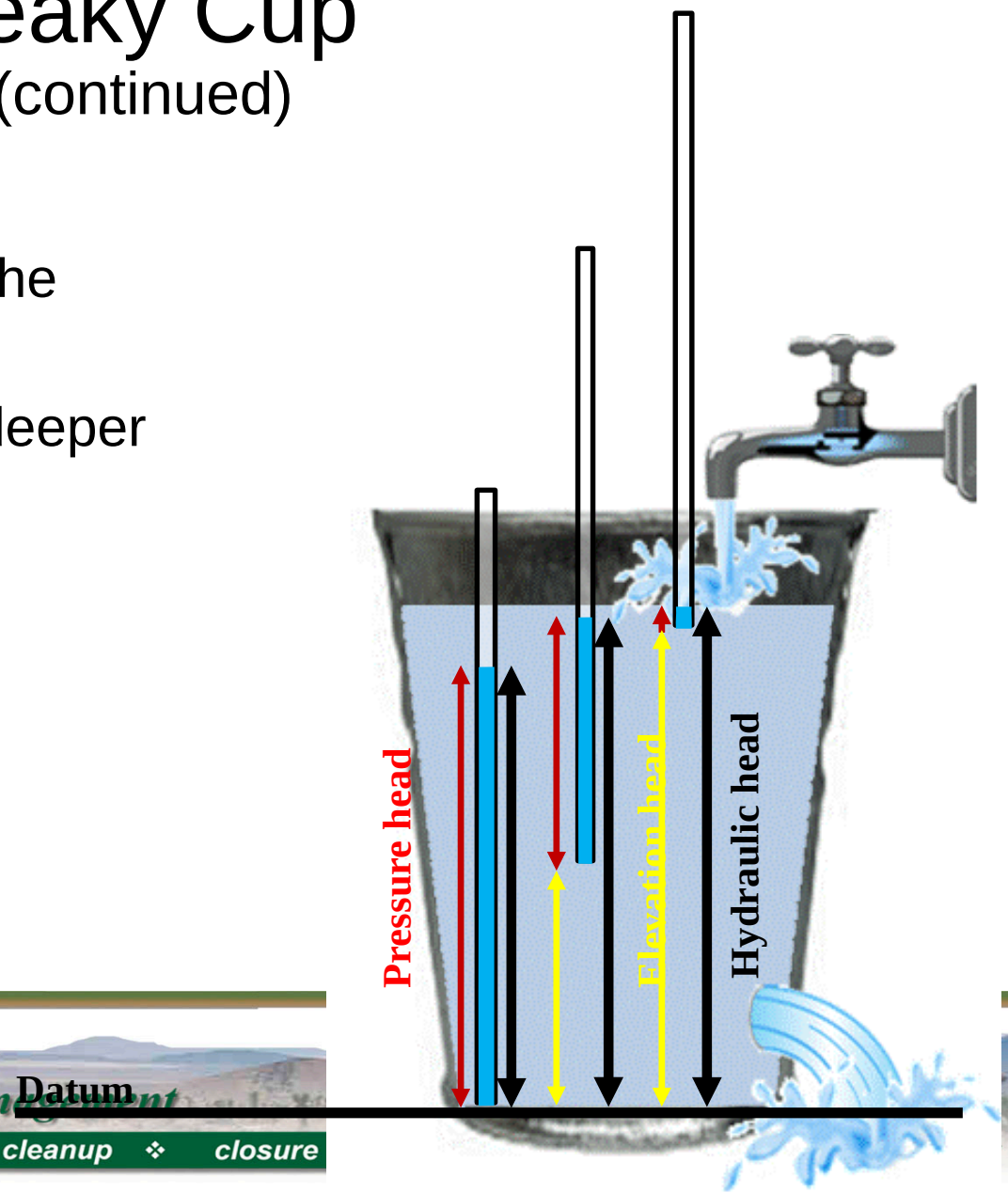
Leaky Cup

- Turn tap on and punch hole in bottom of cup
- Balance inflow and outflow so water level in cup is stable
- Examine water levels



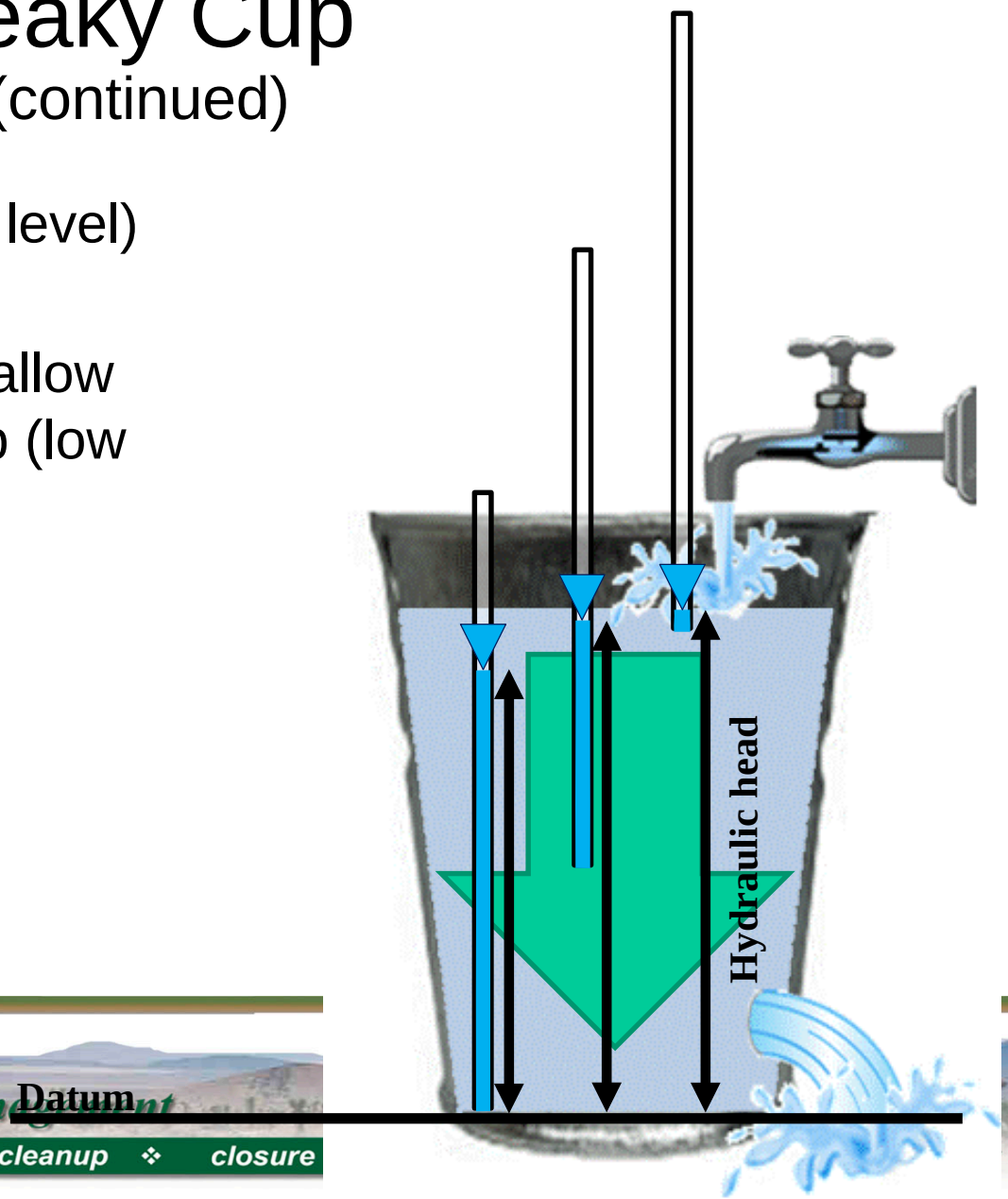
Leaky Cup
(continued)

- Elevation heads remain the same as before
- Pressure head drops in deeper straws



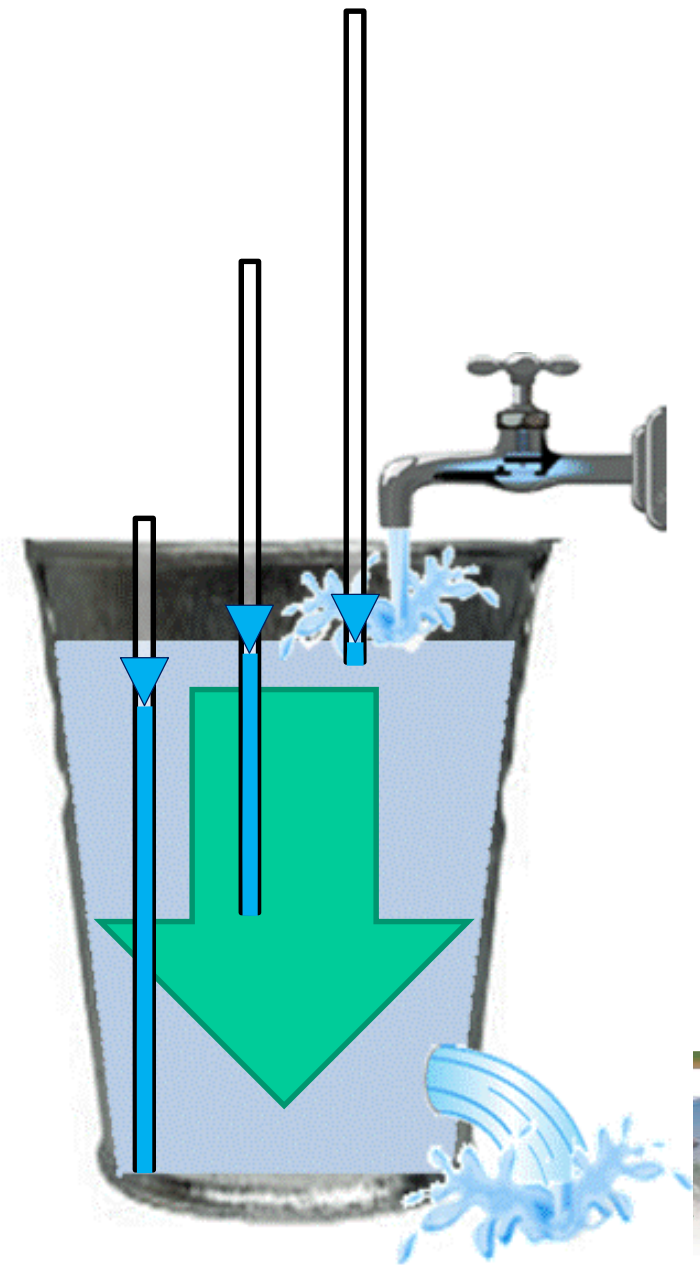
Leaky Cup
(continued)

- Hydraulic head (or water level) drops in deeper straws
- Fluid potential is from shallow (high water level) to deep (low water level)



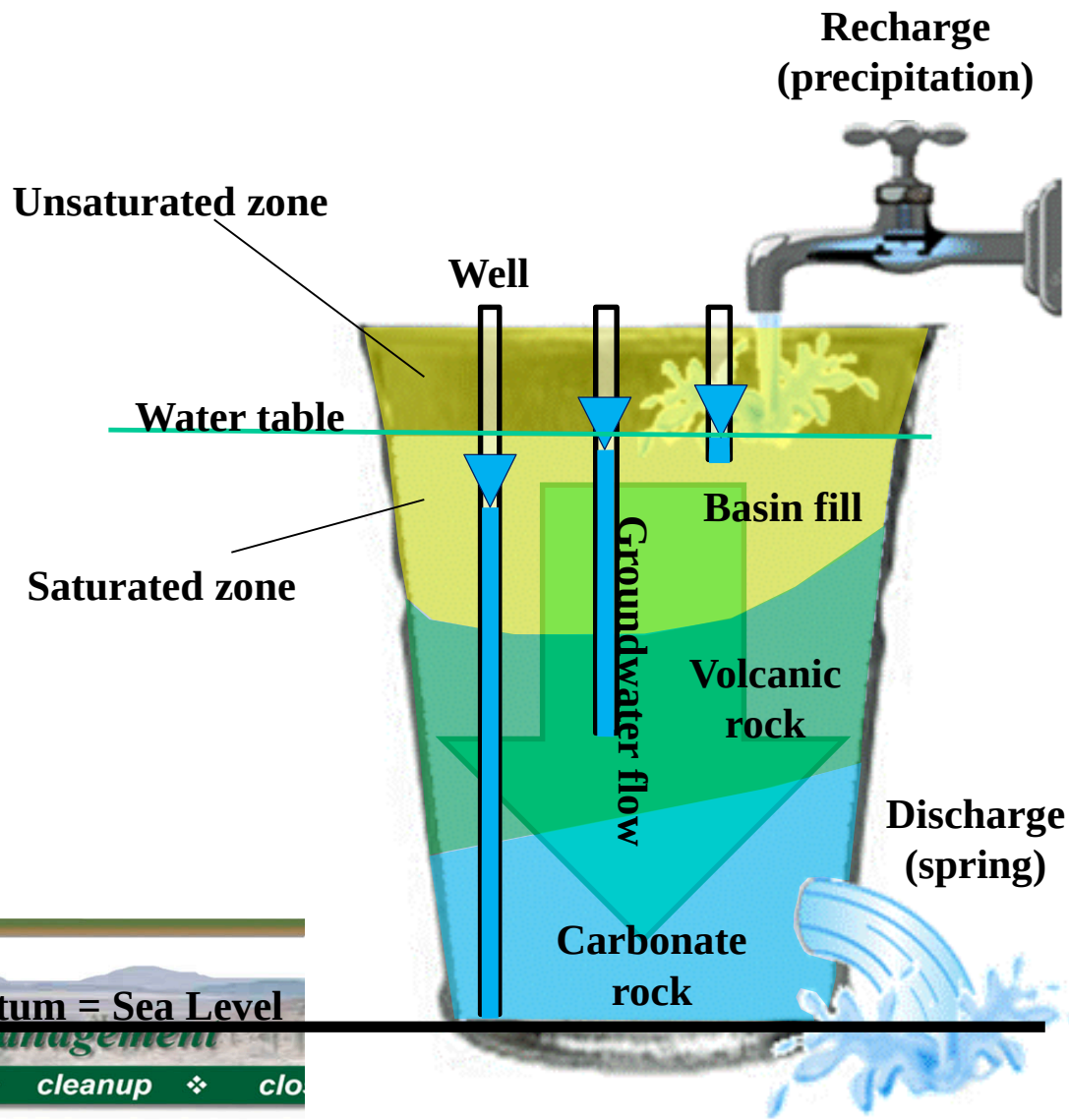
Summary

- Water level represents energy in fluid at point where water enters straw
- Water has potential to flow from high water level to low water level
- Water cannot flow from low to high



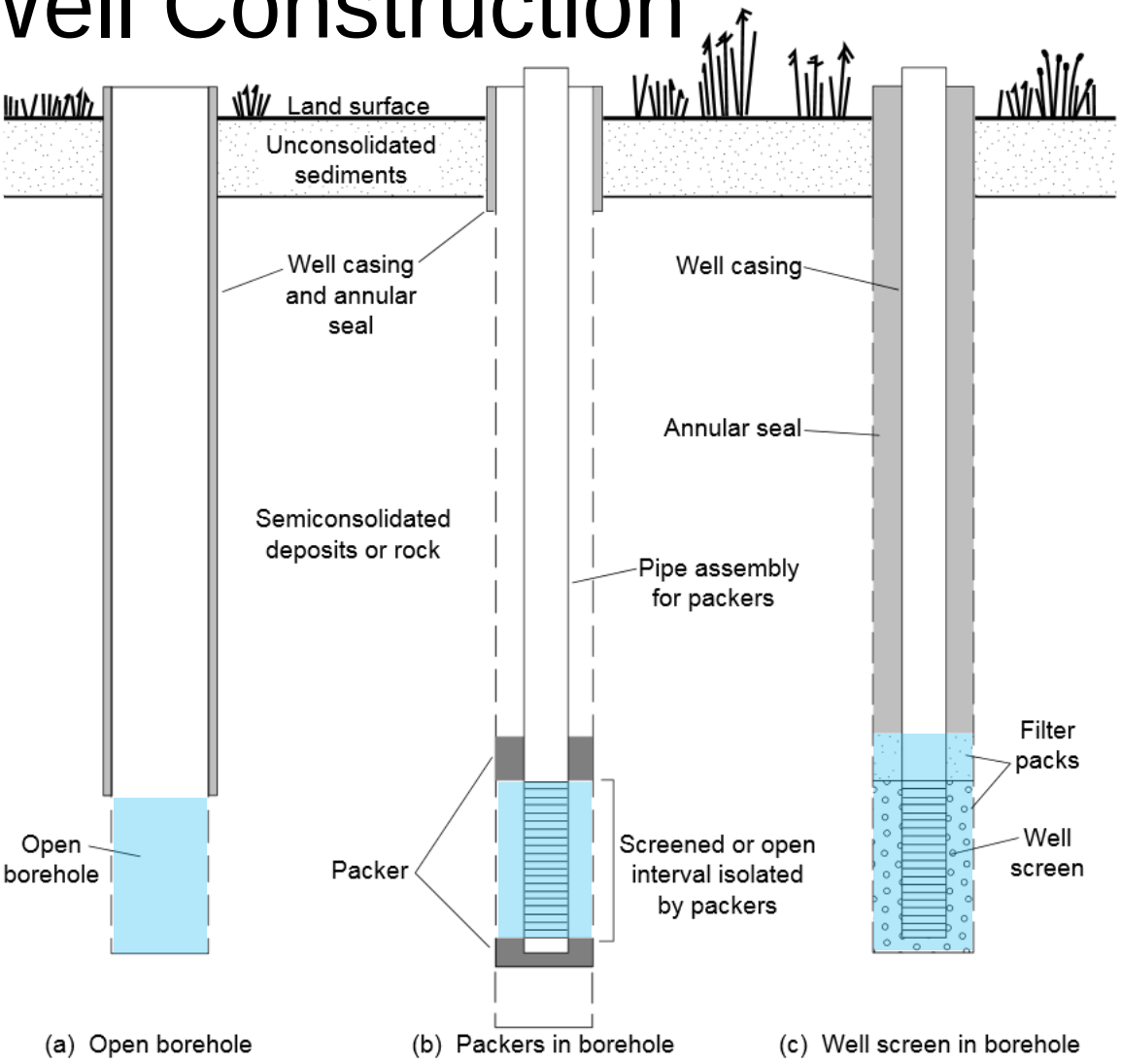
From Cup to Aquifer System

- Fill the cup with rocks and you have a hydrogeologic system



Basic Well Construction

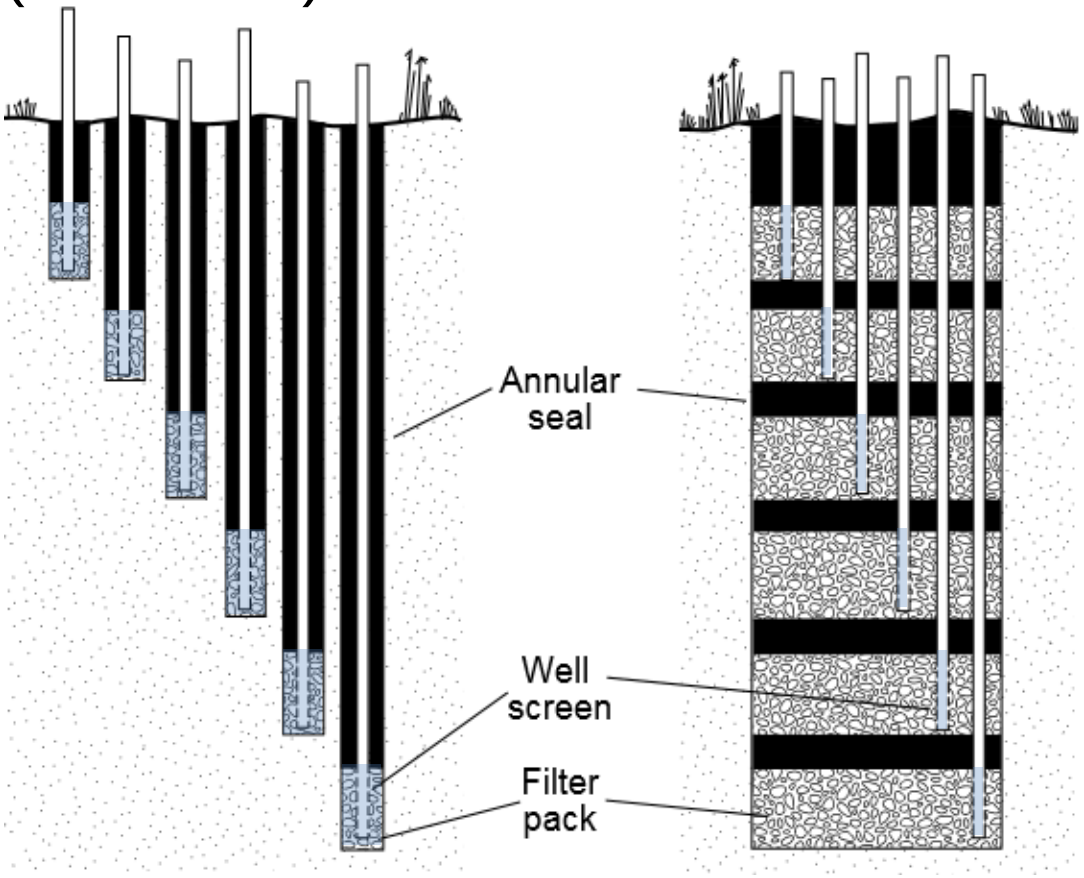
- Three common NNSS well types:
  - Open borehole
  - Packers or bridge plugs
  - Screen and filter pack



Basic Well Construction

(continued)

- Environmental restoration wells are commonly multiple well completions in single borehole



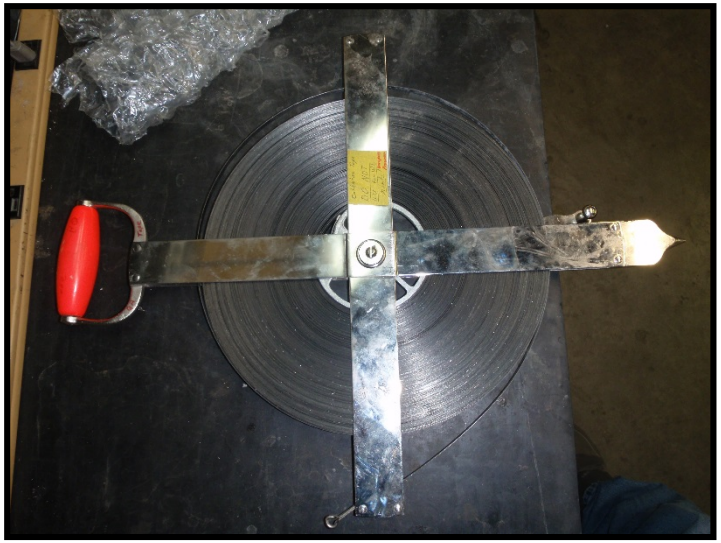
Short-screened wells in separate boreholes

Short-screened wells in single borehole

Measurement Devices

Electric Tape

Steel Tape



Pressure Transducer

Steel Tape

- Measures depth to water
- Most accurate
- Rarely used to measure water levels on NNSS – water levels too deep
- Steel reference tape used to calibrate E-Tapes

E-Tape Measurement

- USGS Video

https://www.youtube.com/watch?v=jknI9anIwF4

4 min 36 sec

E-Tape Measurement

- Measures depth to water
- Used at NNSS for quarterly measurements
- 1,000-ft, 2,700-ft, 3,700-ft, and 4,800-ft tapes

Transducer

- Measures pressure
- Converted to depth of submergence (height of water above transducer)
- Best for monitoring rapid water-level change

Transducer Installation

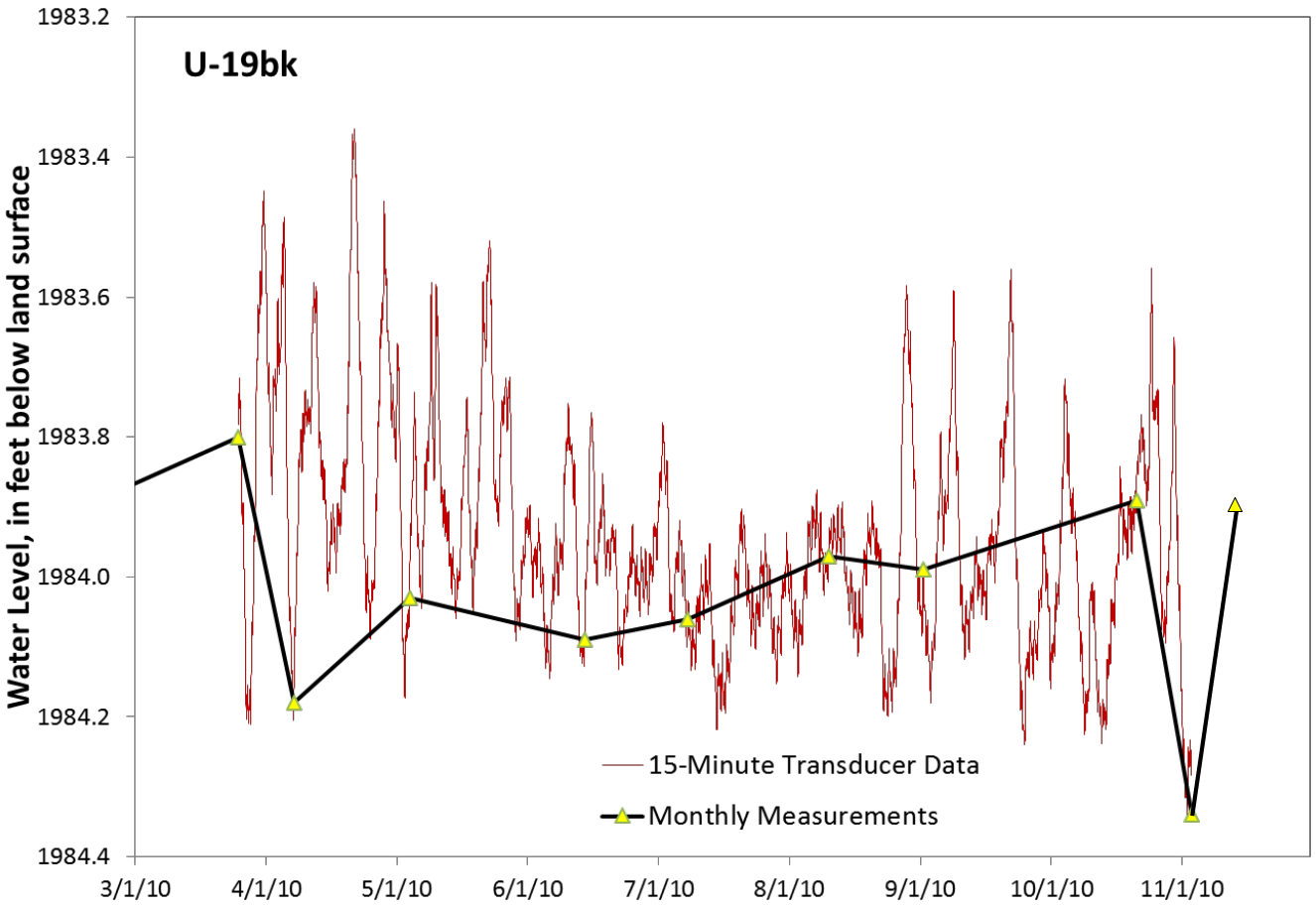
- Lowered down well with tripod and winch

Transducer Set Up

- Continuous monitoring
  - 15-minute to hourly measurements
  - Download data monthly from data logger

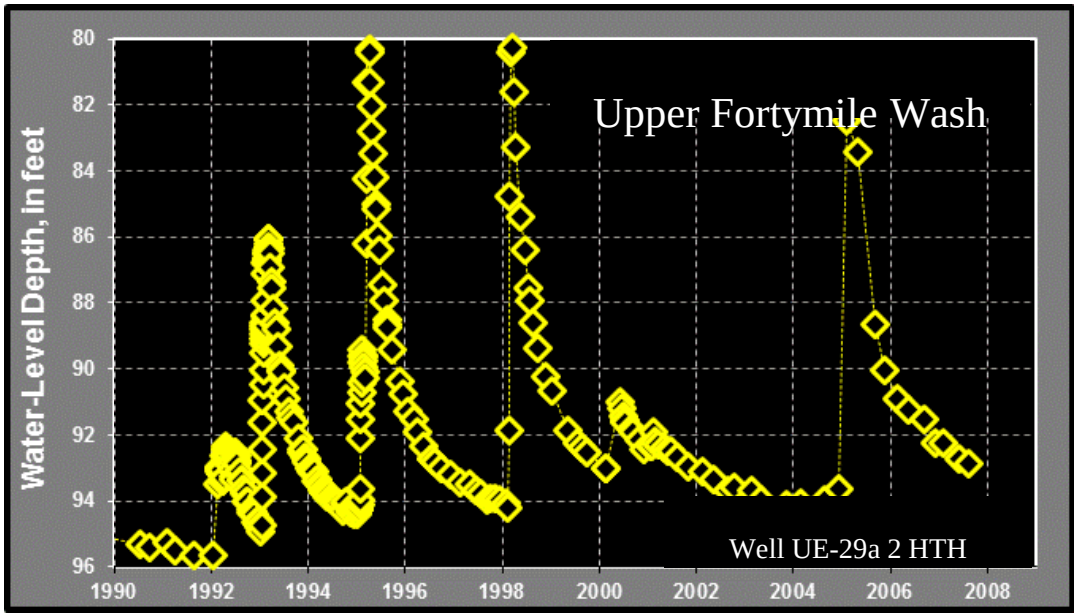
E-Tape vs. Transducer Data

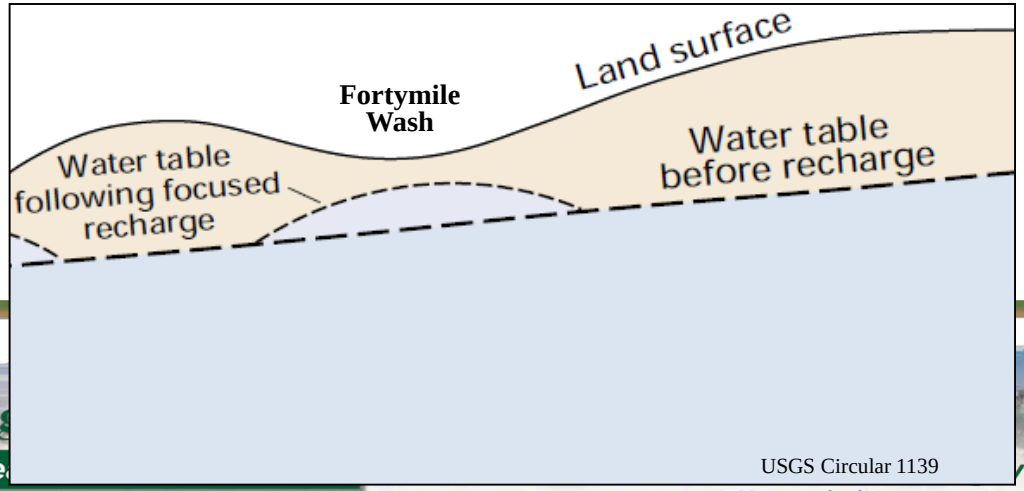
- Transducer provides high frequency data – not necessary for long-term water level records



Hydrographs – Focused Recharge

- Underlying areas where surface water concentrates
- Spikes indicate wet winters with runoff

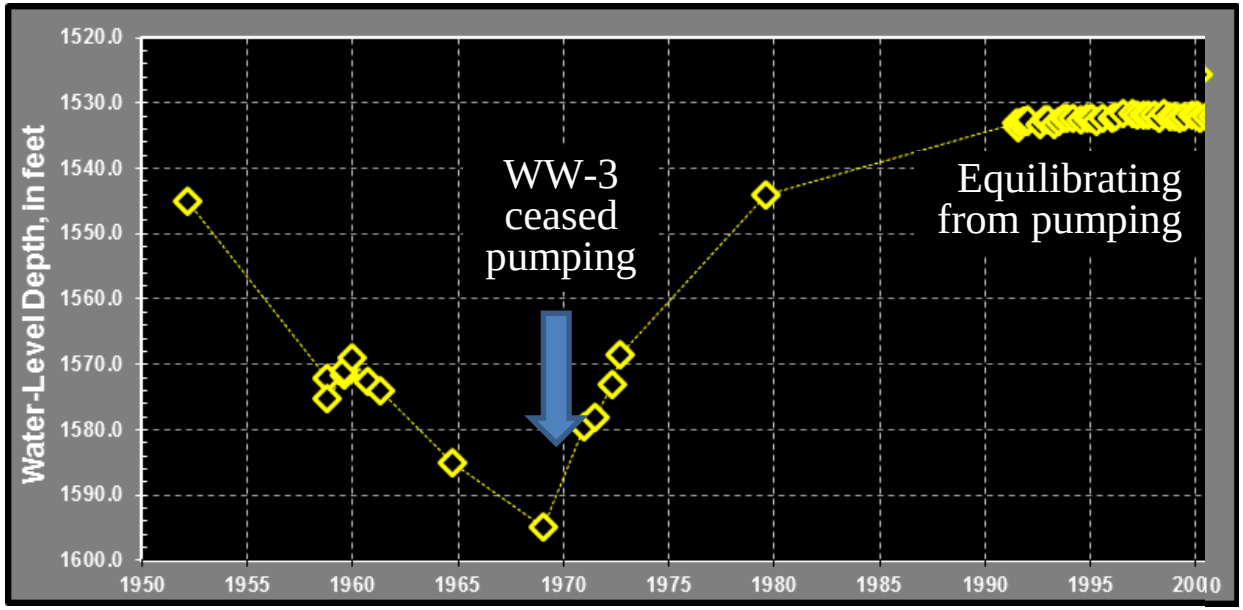


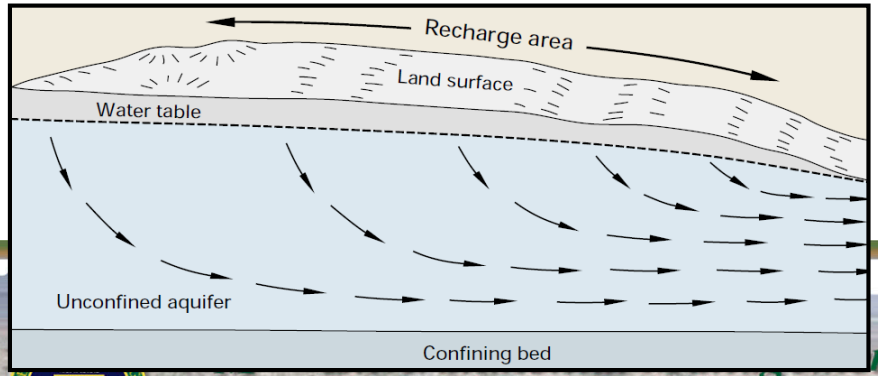


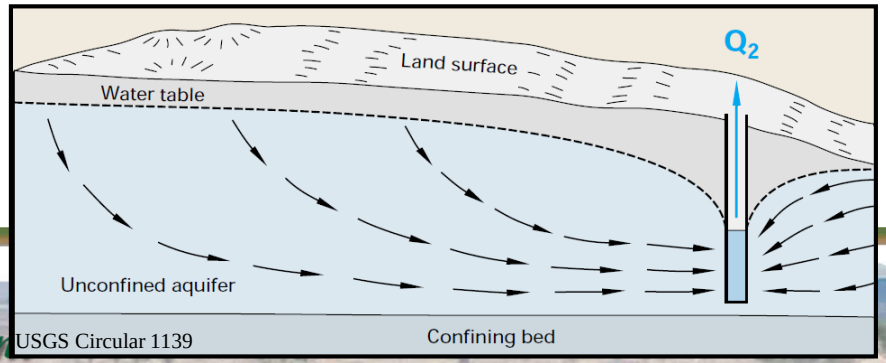
USGS Circular 1139

Hydrographs – Pumping

- Cone develops at pumping well



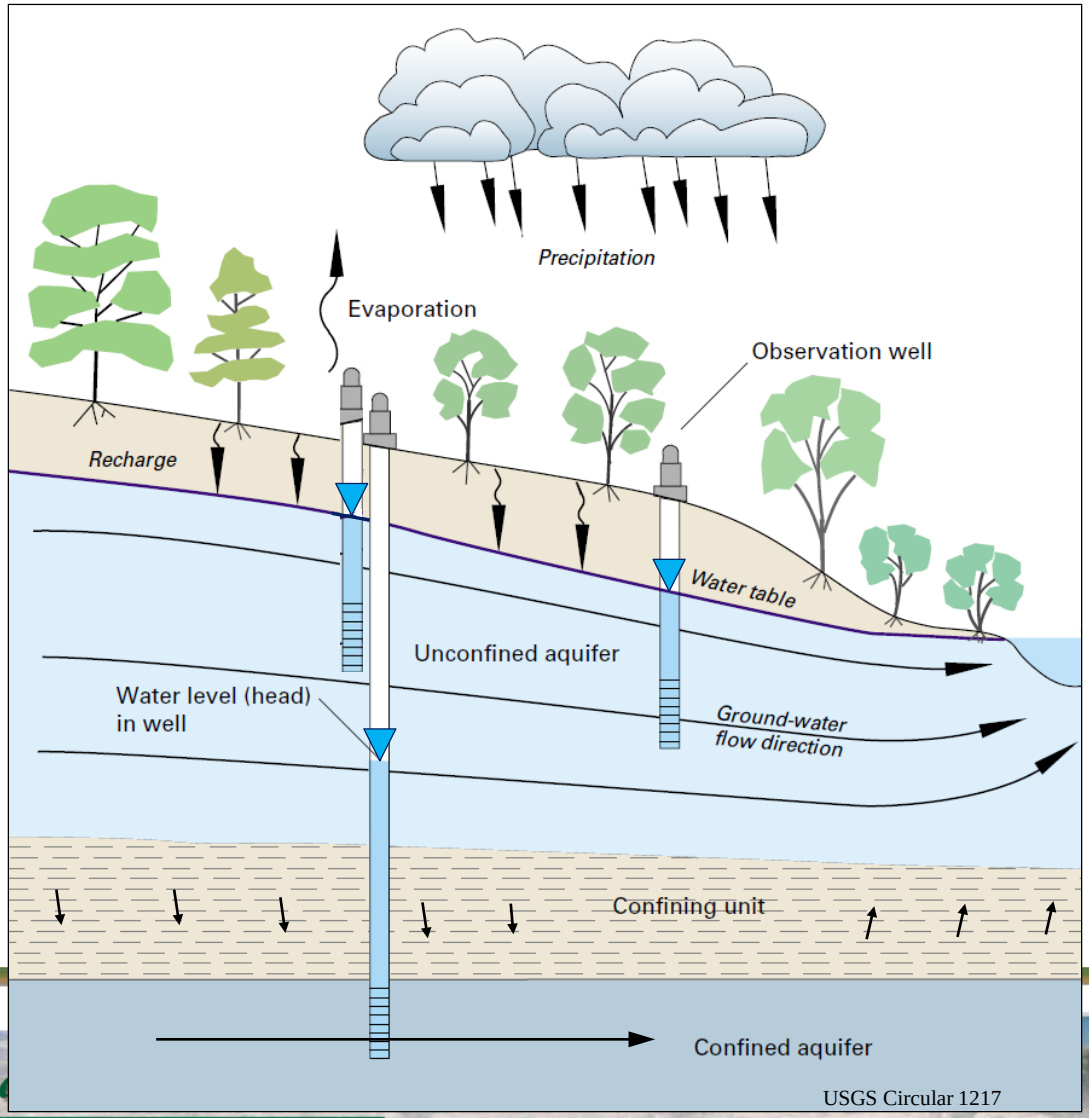




USGS Circular 1139

Horizontal and Vertical Gradients

- Gradients (and flow) primarily:
  - Horizontal in aquifers
  - Vertical in confining units



USGS Circular 1217

Public Access to Water Levels

waterdata.usgs.gov/nv/nwis

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National Water Information System: Web Interface

USGS Water Resources (District Access)

Data Category: Home | Geographic Area: Nevada | GO

Click to hide News Bulletins

- July 9, 2015 - The NWIS Mapper is back online
- Try our new Mobile-friendly water data site from your mobile device!
- Full News

USGS Water Data for Nevada

Click to hide state-specific text

Annual Water Data Reports

Search for Sites With Data

Current Conditions — Sites with real-time or recent surface-water, groundwater,or water-quality data.

Site Information — Descriptive site information for all sites with links to all available water data for individual sites.

Map of all sites with links to all available water data for individual sites.

Frequent Searches By Data Category

Surface Water — Water flow and levels in streams and lakes.

Groundwater — Water levels in wells.

Water Quality — Chemical and physical data for streams, lakes, springs, wells and other sites.

Water Use — Water use information.

Introduction

In 1889, the U.S. Geological Survey established its first gaging station in Nevada and providing to the public data about Nevada's water resources. Today, this systematic collection and dissemination of hydrologic data is made possible with the cooperation from Federal, Tribal, State, and local agencies. A list of our current cooperators is available online.

These pages provide access to water-resources data collected at approximately 20,000 sites in Nevada. Online access to this data is organized around the categories listed to the left.

The USGS investigates the occurrence, quantity, quality, distribution, and movement of surface and underground waters and disseminates the data to the public; Tribal, State and local governments; public and private utilities; and other Federal agencies involved with managing Nevada's water resources. For more information on the USGS activities in Nevada, please visit our home page.

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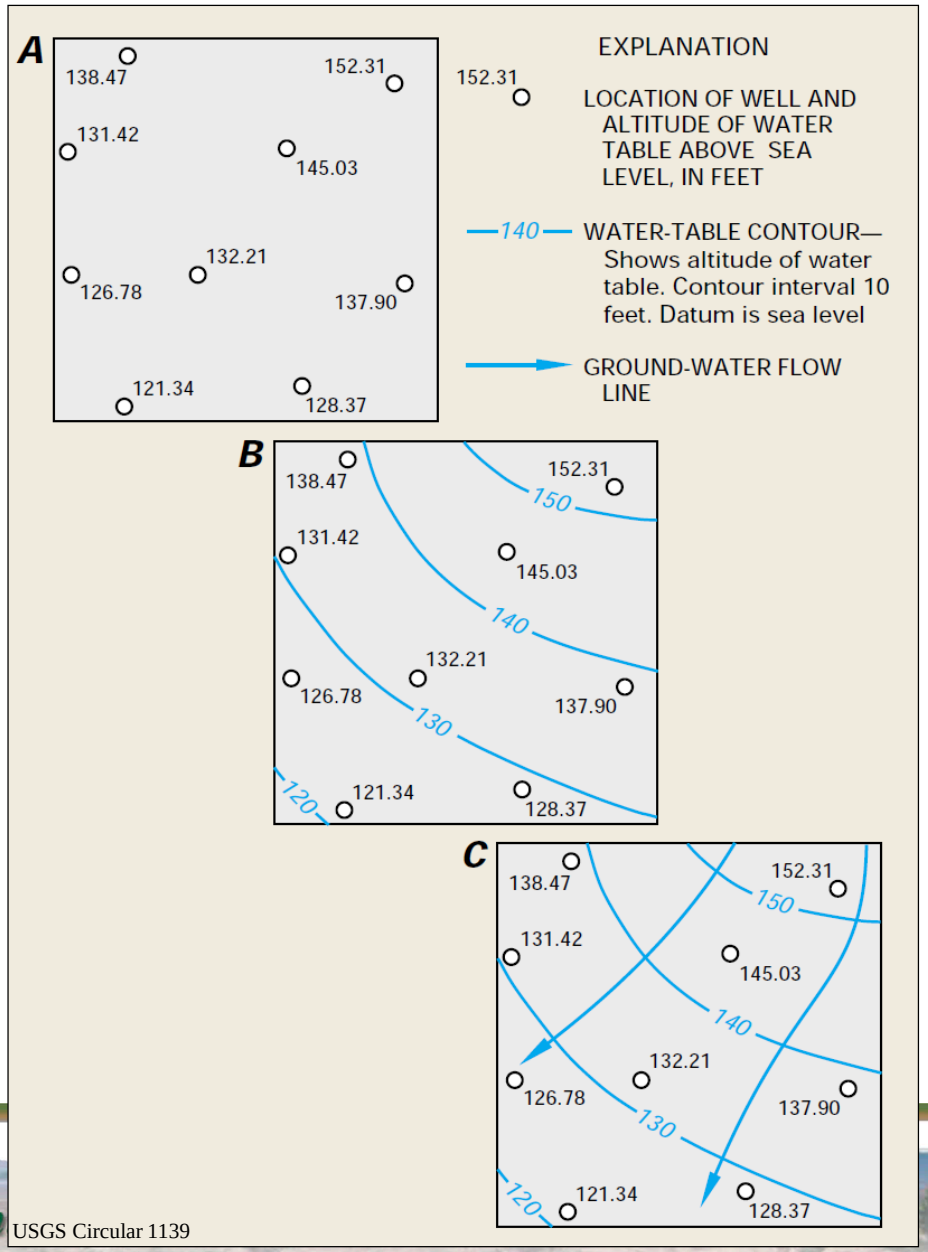
Examples of the use of groundwater elevation data in the UGTA Activity

Water-Level Contours

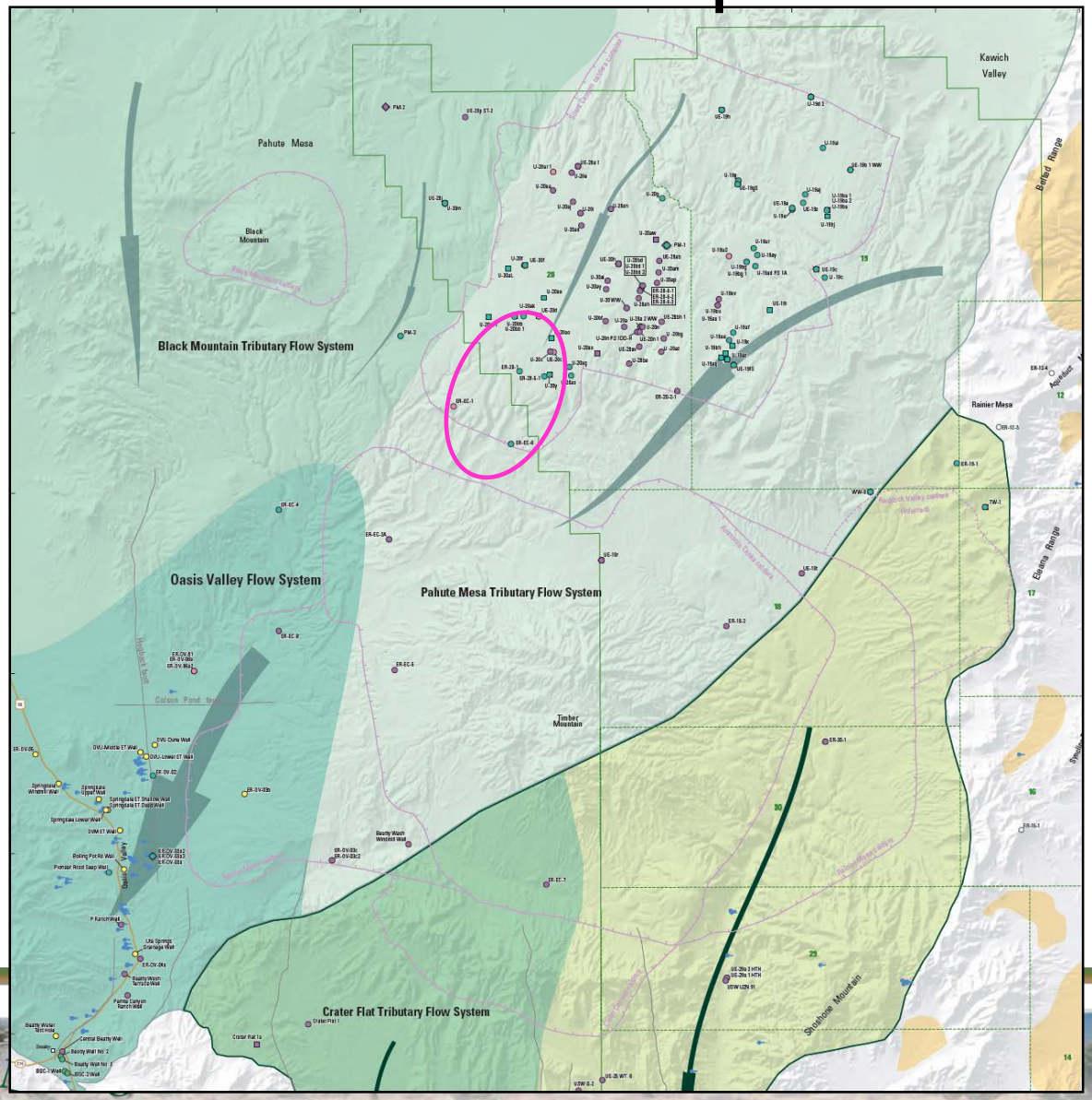
- Plot water-level altitudes (hydraulic heads) for an aquifer
- Contour water levels
- Flow paths perpendicular to contours



USGS Circular 1139

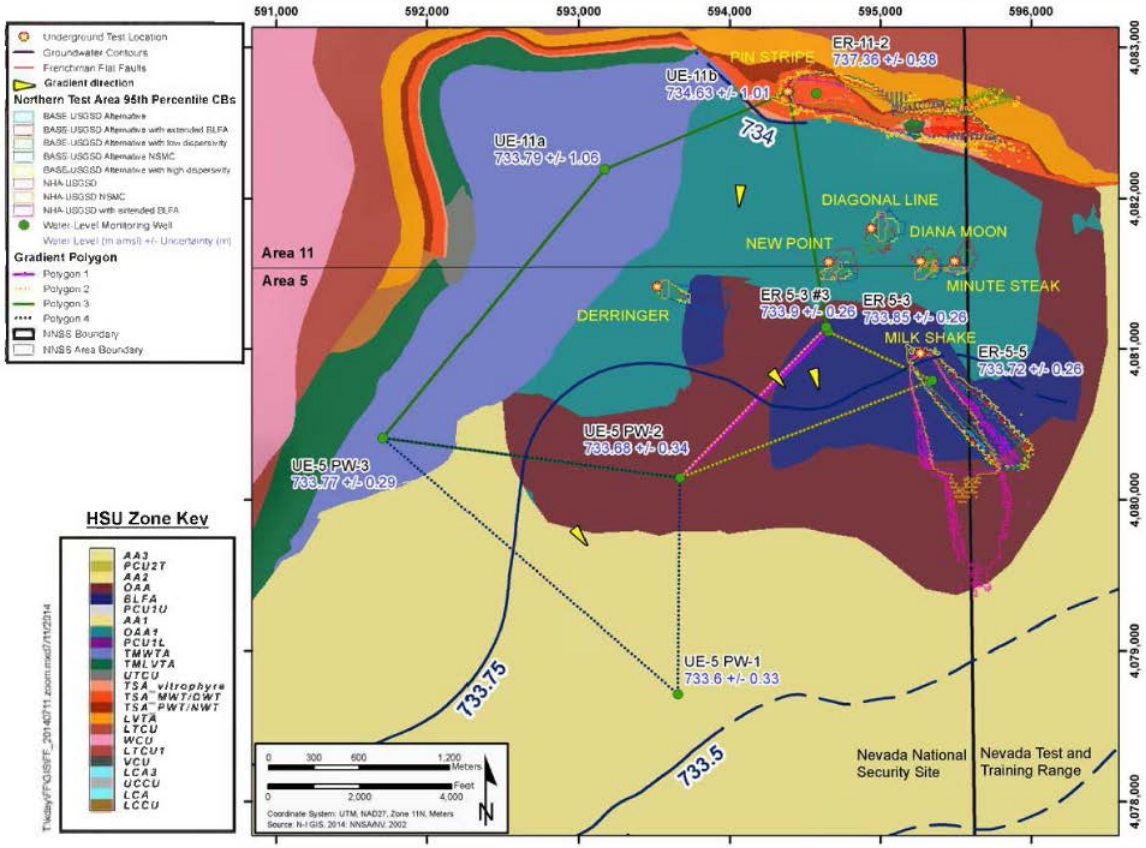
Pahute Mesa Phase II - Example

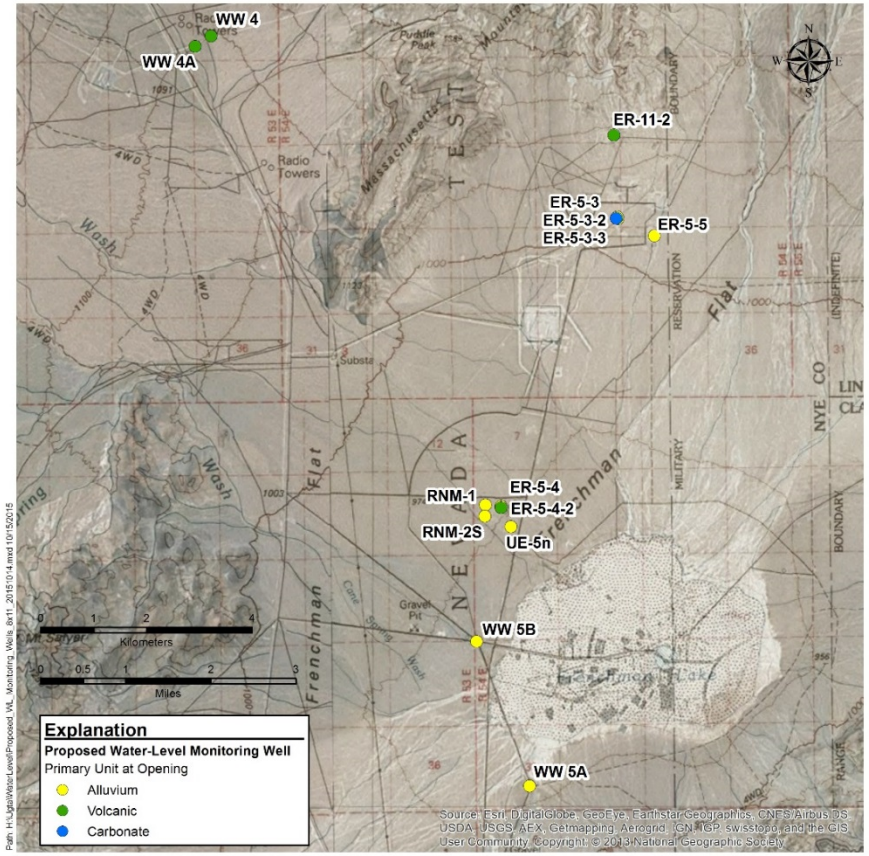
- Groundwater flows from underground tests in Areas 19 and 20 to the southwest
- Groundwater discharges at Oasis Valley near Beatty



Frenchman Flat Model Evaluation Example Analysis of Long-Term Water Level Data

- Data collection resulted in 80% increase in water level observations for Model Evaluation Stage
- Data resolution demonstrated that uncertainty was a reflection of short duration environmental variability



Frenchman Flat Long-Term Water-Level Monitoring Example

- Sixteen wells – 14 in Frenchman flat basin and two in CP Basin
  - Corrective Action Decision Document/Corrective Action Plan water-level evaluations
- Quarterly measurements for the first five years
  - Network and measurement frequency will be reevaluated after five years
- Well inspections will be concurrently performed