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- This presentation will discuss
  - Groundwater and surface water monitoring networks along with current status and trends.
  - Water planning tool models that have been developed or are currently being developed.
• Understanding and monitoring of water resources in Carson Valley would not be possible without multi-agency collaborative effort.
Streamflow gages are used to continuously monitor flows of rivers and streams.

Map shows gages - Currently operating or with historic data available.

The three key gages for the Carson Valley are the
- Carson River inflows
  - West Fork at Woodfords
  - East Fork nr Gardnerville
- Carson River outflow
  - Carson River at Carson City
Streamflows are recorded every 15 minutes, composited into average daily flows, and composited into annual flows as shown in these charts.

- All streamflow data is available online. A link to these resources is provided at the end of this presentation.
- Provisional streamflow data is available in real-time. But flow values are subject to revision as attention is given to the data.

Carson River Inflows
- East and West Forks monitored and represent inflow to Carson Valley.
- Earliest monitoring of flow in the State is at the East Fork Carson River. First measured in 1891.
- East Fork has about 3.5 times the flow of West Fork.

Carson River Outflows
- Carson at Carson gage represents outflow from Carson Valley
- Observed at inflow to Eagle Valley.

Carson River through Carson Valley
- Monitoring of inflows and outflows has been continuous since 1940.
- Approximately 60,000 AF/yr of Carson River water is 'consumed' in Carson Valley.
- 2017 was the biggest water year for the Carson River in recorded history.
• Groundwater Monitoring Network
  • Groundwater levels monitored by USGS and Nevada Division of Water Resources.
  • USGS measures a network of about 35 wells on quarterly to annual basis.
  • This provides public and water agency’s with data regarding the aquifer’s response to droughts, floods, and development.

• Nitrate network sampled once a year.
• Nitrate can be naturally occurring but higher concentrations in groundwater are often a result of septic systems, fertilizer use, and/or from applied treated wastewater effluent.

• Arsenic is only periodically monitored by USGS. Arsenic in public supply wells is routinely monitored by utilities.
• Arsenic is a naturally occurring metal in groundwater. It can be influenced by changes in aquifer conditions or pumping.
• Water levels are declining on the East side of Carson Valley.
  • At rate of approximately 1 foot per year.

• Water levels are stable within the agricultural center of the valley and along and near the Carson River.
  • Due to recharge from surface irrigation.
  • Also due to Carson River being connected with groundwater system. Water levels are supported by the river.
Most of the data shown on the map was collected during 2008-09.

Circles with dots are wells we sample once a year.

~11 wells

Nitrate concentrations are increasing in areas with high density of septic systems.

- Nitrate increases at the top of the water table first as nitrate rich water from septic systems leach through the soils and returns to the water table.
- Shallow wells are impacted greater and earlier.
- Deeper wells respond more slowly to increasing nitrates.

Two principle communities with some of the greatest nitrate contamination potential.

- Johnson Lane area.
- Ruhenstroth area.
Arsenic (As) has been measured in Carson Valley groundwater periodically over time.

- Samples are generally collected from all municipal and some domestic wells.

- Arsenic is a concern for public and domestic well supplies.
  - Treatment is very expensive.
  - Preferred approach to keep drinking water safe is to withdraw from low concentration wells.
  - Sometimes mixing of higher As concentration water with lower concentration water is done to keep As levels safe.

- EPA Maximum Contaminant Level for Arsenic is 10 ug/L.
  - Many wells in Carson Valley have concentrations at or near this level.
  - Generally greater As concentrations occur on East side of the Valley where water levels are deeper.
  - Lower concentrations generally occur along the river corridor, and near agricultural areas, and along the Sierra Front.

- Data from:
  - USGS National Water Inventory System (NWIS) Database
  - Municipalities
    - Douglas County Public Works
    - Indian Hills General Improvement District
    - South Tahoe Public Utility District
    - Town of Minden
• This chart shows the relationship of Arsenic concentrations with depth.
  • As concentration generally increases with depth.
  • Yellow symbols represent more recent observations.
  • Black symbols represent more historic observations.
Wells Deepened and Replaced in the Carson Valley

Source: Nevada State Engineers Database

[Bar chart showing the number of wells over time from 1982 to 2018, with a peak around 1993.]

[Map showing the distribution of wells in the Carson Valley with colored markers indicating deepened or replaced wells.]

[Graph showing the depth of wells versus the number of wells, with a peak at around 200.]

[Graph showing the relationship between arsenic concentration and another variable, with a trend line indicating an increase in concentration.]
Water planning tools are numerical models used to predict or forecast changes to water supply resulting from management actions or climate variability.

- Models are based on well established principles and theory.
- Properties of system are needed in the models and are estimated based on historic data and observations and are determined through a process called calibration.
- Once properties are known to satisfactory degree, model inputs are adjusted to represent proposed management actions, or range of possible future conditions. Then simulated changes to the system are evaluated.

- Three principle planning tools have been developed or are nearing completion.
  - Nitrate in groundwater from septic systems models.
  - East and West Fork Carson River flow models.
  - Carson Valley groundwater/surface water model.
Nitrate estimated from septic system model

- Nitrate models are used to estimate future nitrate concentrations in groundwater
- Nitrate from use of septic systems and captured by domestic well pumping

Nitrate from Septic Systems models have been developed for two areas.

- Johnson Lane area
  - ~2,600 wells in area
  - ~1,400 septic systems
  - 23 septic systems per mi²

- Ruhenstroth area
  - ~500 wells in area
  - ~500 septic systems
  - 36 septic systems per mi²
• The Nitrate models are used to understand how Nitrate concentrations in groundwater will respond to various management actions.
  1. Continued use of septic systems and pumping as is currently occurring.
  2. What happens if communities convert over to wastewater treatment systems and discontinue use of septic systems?
  3. How does discontinued use of domestic wells influence the nitrate trends?
• Nitrate model for the Johnson Lane area suggests that Nitrate concentrations in the area’s with highest septic density will continue to have nitrate increase.
  • In 40 years, concentrations will exceed safe drinking water levels in many locations.
  • If the community were to discontinue use of septic systems but continue to use domestic wells for water supply, conditions will not degrade as bad and more areas will still have safe drinking water supply.
  • If community were to discontinue use of septic systems and domestic wells in 2030, nitrate concentrations would have greater improvement in some areas, and worse in others.
• Results and conclusions for Ruhenstroth area are similar.
East and West Fork Carson River Flow models.

- Developed as part of Water for the Seasons project.
- Simulates snow accumulation and snowmelt processes
  - Necessary to evaluate water availability under different climate scenarios
- Two watershed models:
  - West Fork Carson River at Woodfords.
  - East Fork Carson River near Gardnerville

This figure also shows the area represented by the Carson Valley Groundwater/Surface water model discussed in a few slides.
• This slide shows the impact of warming on Carson River water supply to Carson Valley.

• The lower right figure shows runoff characteristics with increasing temperatures.
  • As temperature increases, more precipitation falls as rain, and snow melts earlier.
  • Peak runoff occurs earlier in the season. (Actually, "peak runoff" should be replaced with "½ the annual volume of water")
  • More of the seasonally available flow in the river passes by prior to start of irrigation season.
  • Lower summer flows.
• 0 degree C at the bottom left of the figure represents historical flow conditions.
  • Peak runoff occurs around mid May.
  • Last half of runoff occurs from mid May to late June.
• A 2.5 degree increase in temperature results in:
  • Peak runoff shifts earlier by approximately one month.
  • Last half of runoff occurs between mid April to late May.
  • One month less time water is available for irrigation.

• The upper left figure shows the ensemble of climate model projections used to develop this scenario.

• The lower left figure shows the relative shift in a representative hydrograph due to 2.5 degrees of warming.
This tool was developed as part of the Water for the Seasons project.

Physically-based numeric model simulates:
- Streamflow
- Groundwater system
- Groundwater/surface-water interactions
- Surface Water deliveries based on prior appropriations and the Alpine Decree
- AG pumping is dynamically triggered by surface water shortfalls, NOT specified
  - Calibrated to DWR records
  - This functionality is required to simulate impacts of climate or management on GW resources
- Municipal and other pumping based on DWR records

Tool was developed to understand how potential future changes in water supply conditions (Carson River flow) will effect:
- Irrigation deliveries in the Carson Valley.
- How Managed Aquifer Recharge strategies can be used to help buffer water supply availability.
- Changes in outflow from Carson Valley that will propagate to downstream use and effect downstream models, including Truckee Canal diversions.

Tool is currently being finalized and going to publication.

Link to additional information and resources related to this tool can be found at end of presentation.
• Flow out of the Carson Valley (Carson at Carson gage) under warming conditions.
  • Simulations account for snowmelt dynamics, ag use of SW and GW.
  • Winter flows are greater. Ag not using the water.
  • Peak flows occur earlier.
  • Late Spring and Summer flows are lower.
  • Even though the precipitation is the same, the total outflow is greater due to the lack of AG consumption.

• Downstream of Carson Valley.
  • River water supply also occurring earlier in the season.
  • Total flow downstream increases due to greater flow occurring during non-irrigation season when water is not being diverted from the river and consumed by crops.
• Supplemental pumping for ag is triggered by surface water shortfalls.
• With earlier runoff and less water available during the irrigations season, there is increase use of supplemental groundwater for irrigation resulting in additional lowering of water levels.
https://go.usa.gov/xprpT

Presentation and links to USGS resources for the Carson River Basin.

Thank You!

- Resources available from this webpage.
  - This presentation
  - Reports
  - Data
  - Water Planning Tools