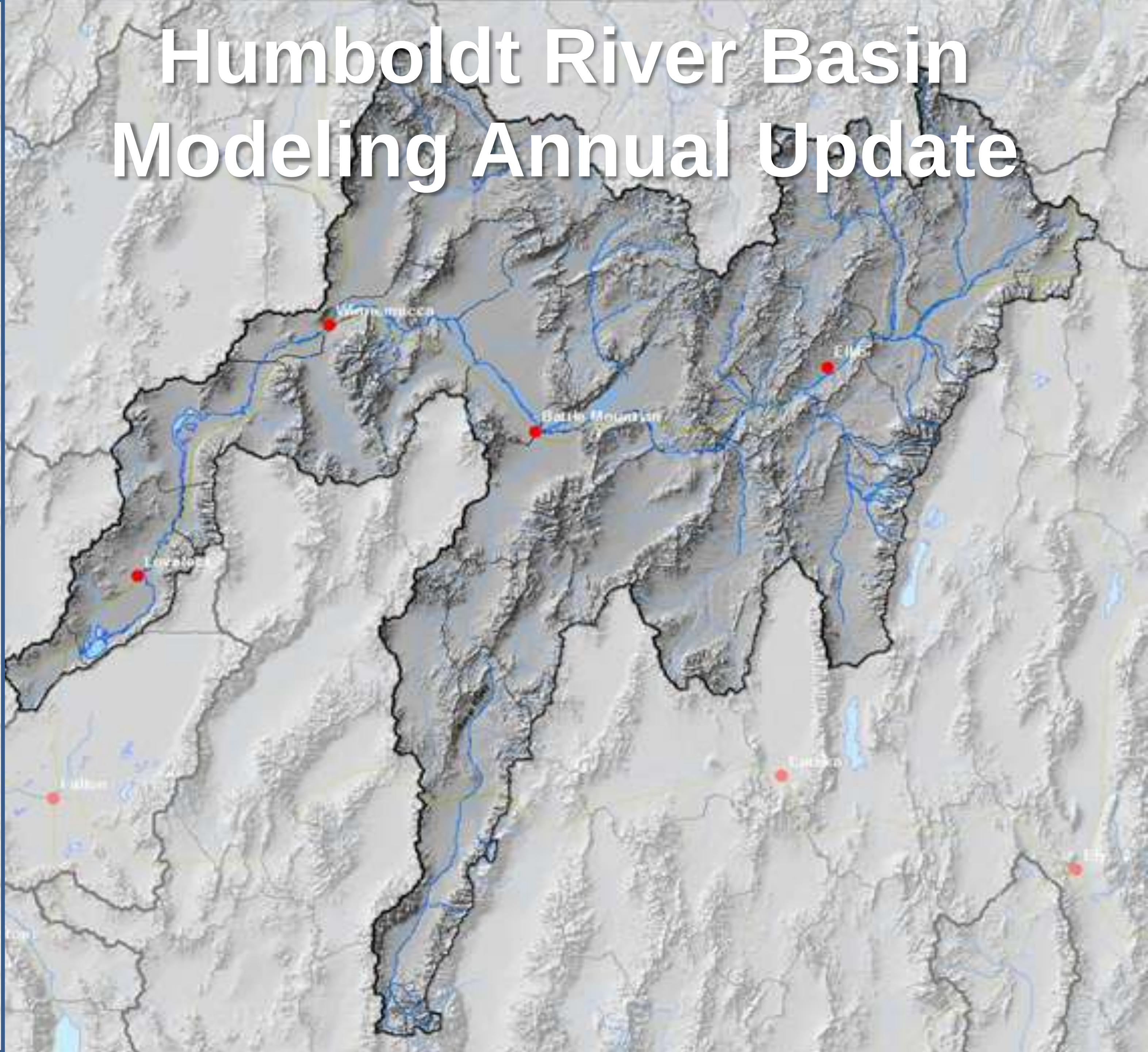
Humboldt River Basin Modeling Annual Update



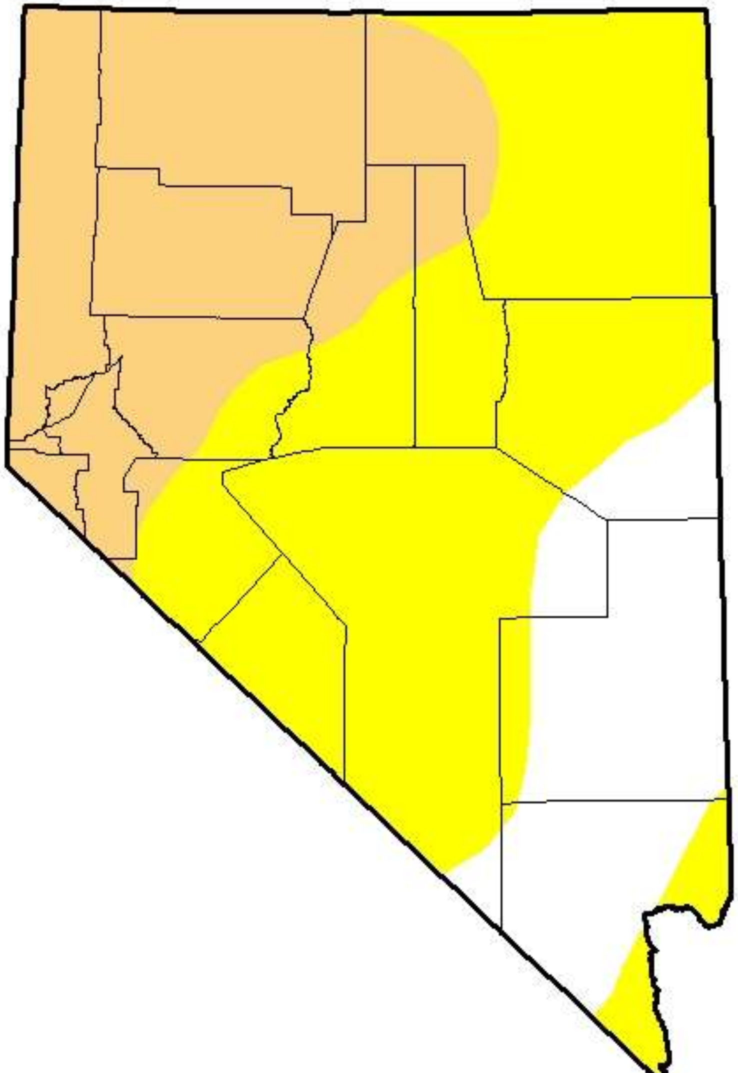
Lovelock & Winnemucca
January 17, 2017

Elko
January 18, 2017

Humboldt River Basin Modeling Update - Outline

- Humboldt Basin Water Supply Update
- Ongoing modeling and hydrologic studies
  - Hydrology General Overview
  - ET Studies
  - Upper Basin Model
  - Middle Basin Model
  - Lower Basin Model
- Plans/ideas for future conjunctive management
- Q & A

U.S. Drought Monitor
Nevada



January 3, 2012
(Released Thursday, Jan. 5, 2012)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	18.18	81.82	32.97	0.00	0.00	0.00
Last Week 12/27/2011	25.74	74.26	4.90	0.00	0.00	0.00
3 Months Ago 10/4/2011	89.99	10.01	0.00	0.00	0.00	0.00
Start of Calendar Year 1/3/2012	18.18	81.82	32.97	0.00	0.00	0.00
Start of Water Year 9/27/2011	89.92	10.08	0.00	0.00	0.00	0.00
One Year Ago 1/4/2011	86.83	13.17	0.00	0.00	0.00	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

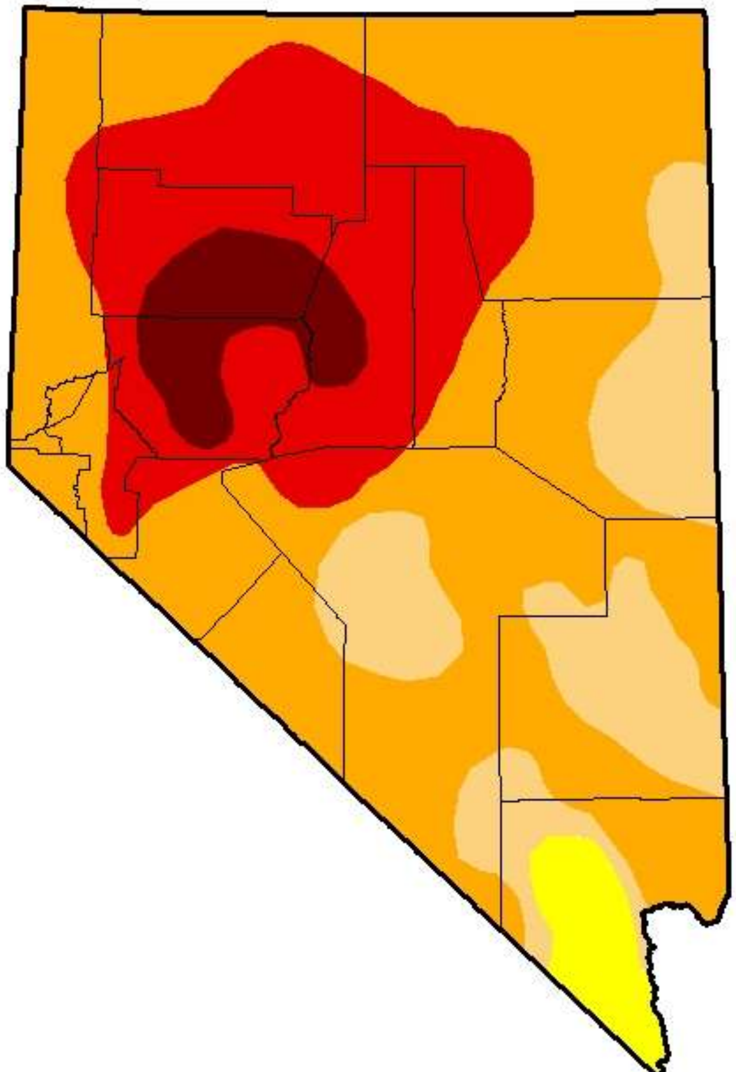
Author:
Brad Rippey
U.S. Department of Agriculture

USDA National Drought Mitigation Center

http://droughtmonitor.unl.edu/

U.S. Drought Monitor

Nevada



January 7, 2014

(Released Thursday, Jan. 9, 2014)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	96.81	80.30	28.55	5.37
Last Week *12/31/2013*	0.39	99.61	96.81	77.66	28.55	5.37
3 Months Ago *10/8/2013*	0.43	99.57	96.79	79.11	28.55	5.37
Start of Calendar Year *12/31/2013*	0.39	99.61	96.81	77.66	28.55	5.37
Start of Water Year *10/1/2013*	0.39	99.61	96.79	79.11	28.55	5.37
One Year Ago *1/8/2013*	0.10	99.90	93.71	55.93	9.23	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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Author:
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National Drought Mitigation Center

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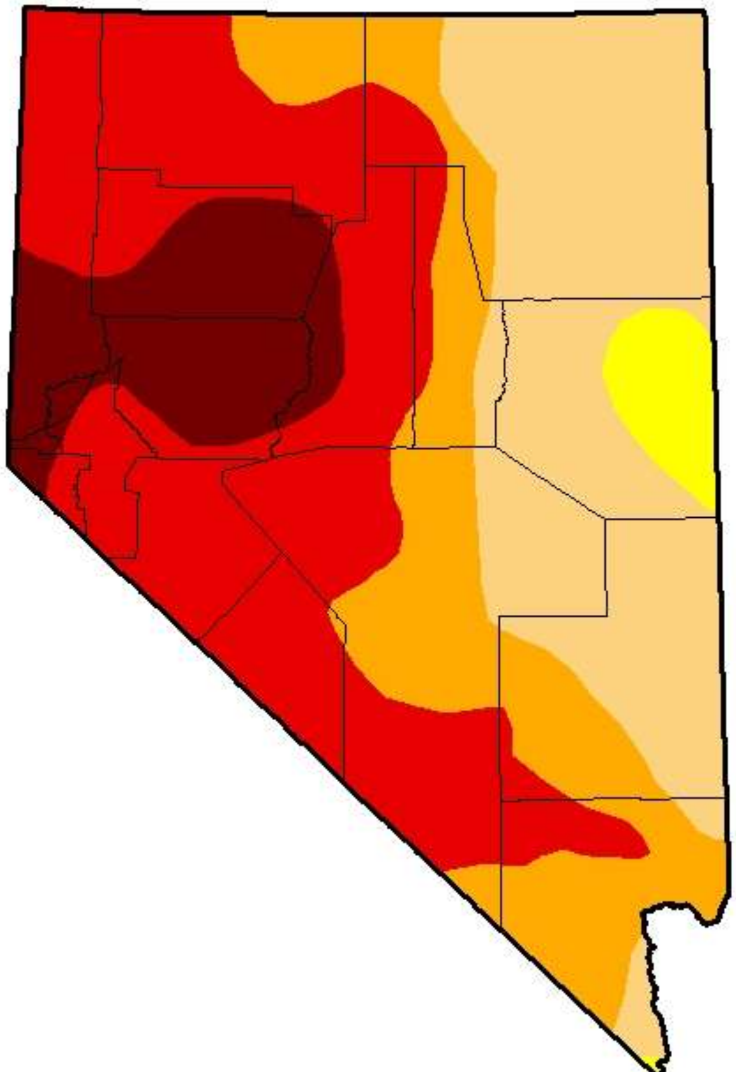
U.S. Drought Monitor
Nevada



January 6, 2015
(Released Thursday, Jan. 8, 2015)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	96.98	68.25	48.38	11.89
Last Week 12/30/2014	0.00	100.00	96.98	68.25	48.38	11.89
3 Months Ago 10/7/2014	0.00	100.00	97.07	69.89	48.38	11.89
Start of Calendar Year 12/30/2014	0.00	100.00	96.98	68.25	48.38	11.89
Start of Water Year 9/30/2014	0.00	100.00	97.04	69.89	48.38	11.89
One Year Ago 1/7/2014	0.00	100.00	96.81	80.30	28.55	5.37

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

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Author:
Brad Rippey
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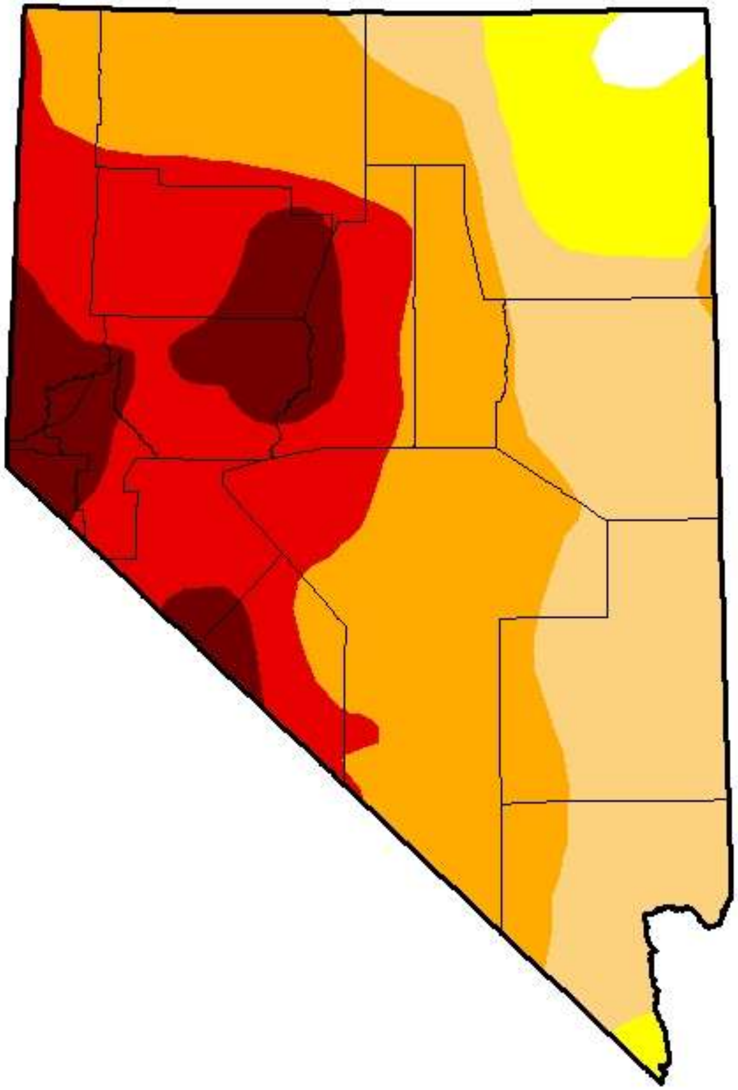
National Drought Mitigation Center

http://droughtmonitor.unl.edu/

U.S. Drought Monitor

Nevada



January 5, 2016

(Released Thursday, Jan. 7, 2016)

Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	1.34	98.66	90.76	64.40	31.40	9.35
Last Week 12/29/2015	1.34	98.66	93.08	65.49	31.74	9.35
3 Months Ago 10/6/2015	0.01	99.99	94.76	75.92	37.52	15.93
Start of Calendar Year 12/29/2015	1.34	98.66	93.08	65.49	31.74	9.35
Start of Water Year 9/29/2015	0.00	100.00	94.76	76.08	37.52	15.93
One Year Ago 1/6/2015	0.00	100.00	96.98	68.25	48.38	11.89

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
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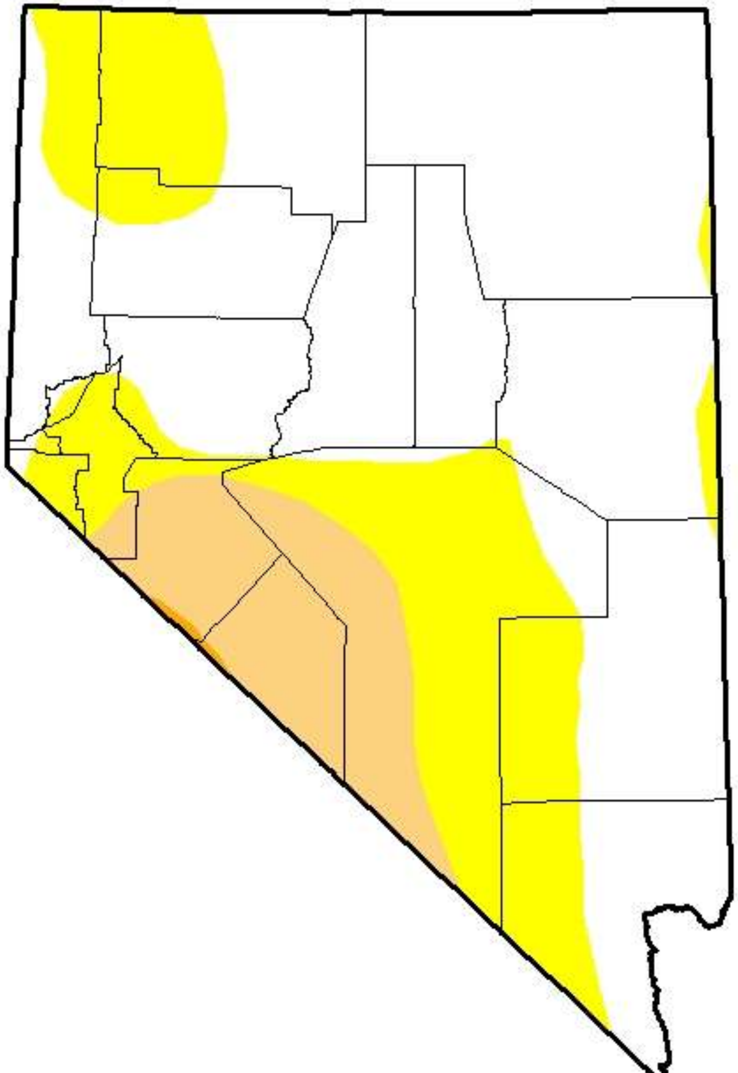
http://droughtmonitor.unl.edu/

U.S. Drought Monitor
Nevada



January 10, 2017
(Released Thursday, Jan. 12, 2017)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	62.89	37.11	11.46	0.18	0.00	0.00
Last Week *1/3/2017*	36.88	63.12	33.64	7.13	0.18	0.00
3 Months Ago *10/11/2016*	19.65	80.35	36.60	21.68	0.26	0.00
Start of Calendar Year *1/3/2017*	36.88	63.12	33.64	7.13	0.18	0.00
Start of Water Year *9/27/2016*	19.64	80.36	36.60	21.68	0.26	0.00
One Year Ago *1/12/2016*	1.35	98.65	79.90	64.40	31.40	9.35

Intensity:

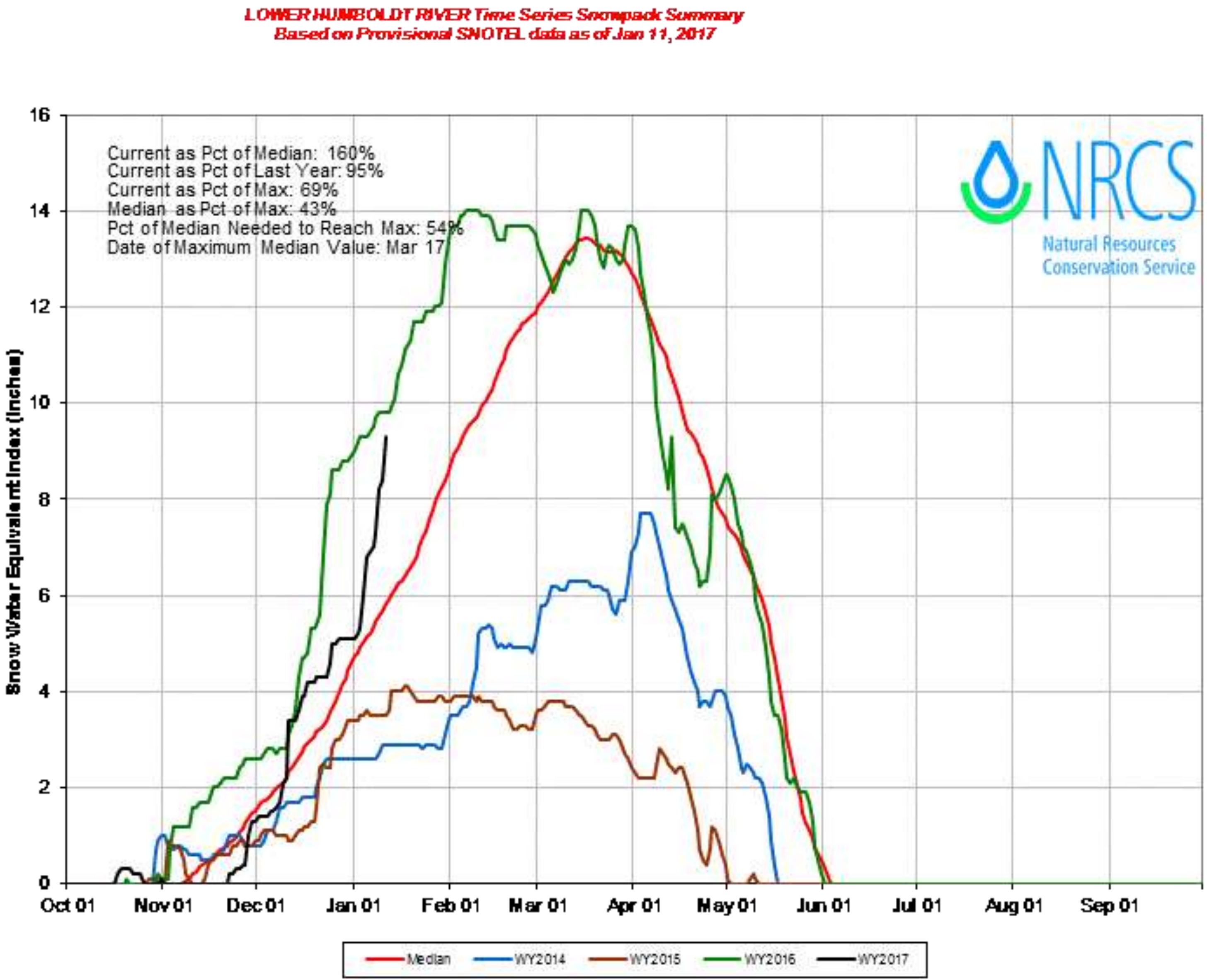
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

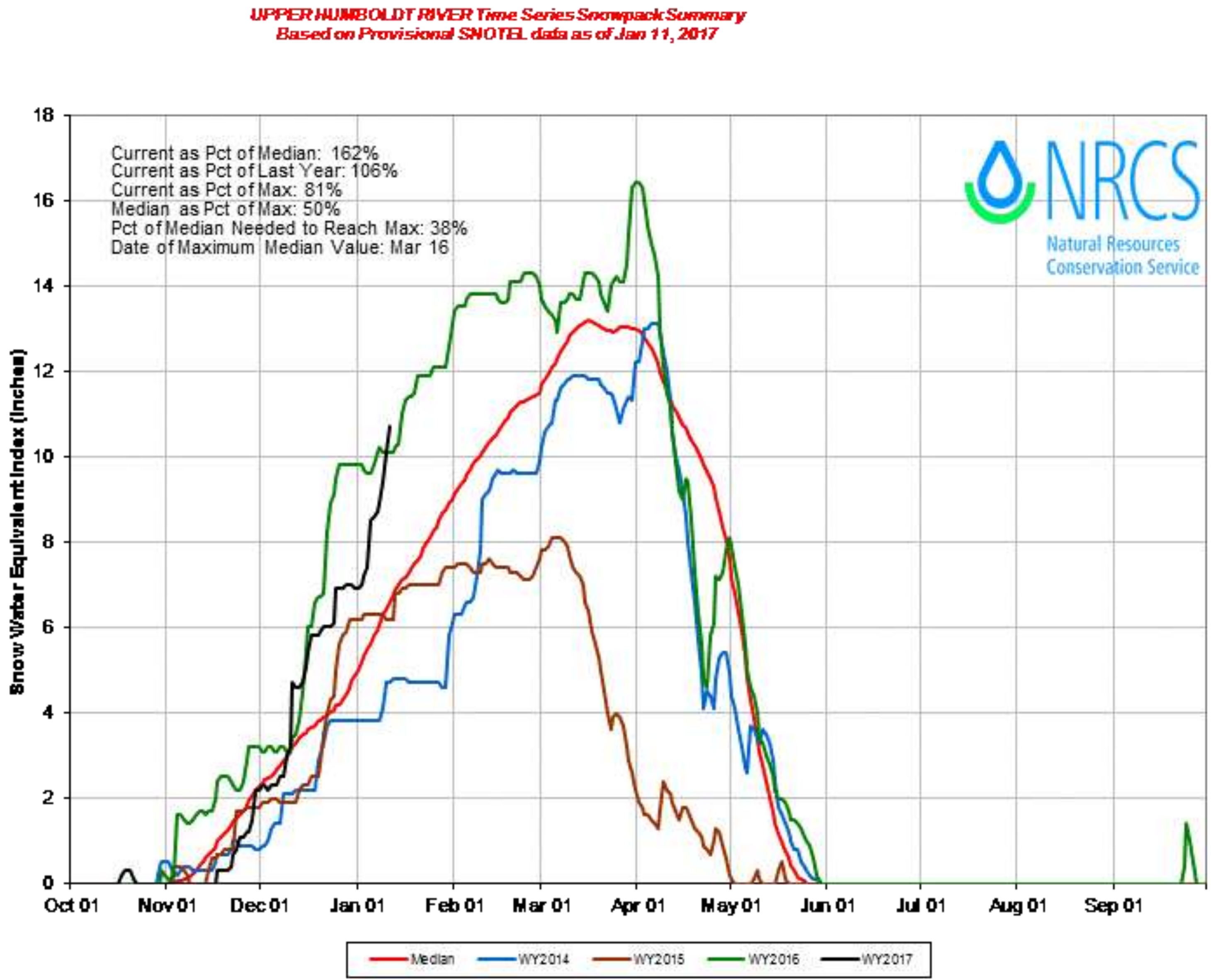
Author:
David Miskus
NOAA/NWS/NCEP/CPC

http://droughtmonitor.unl.edu/

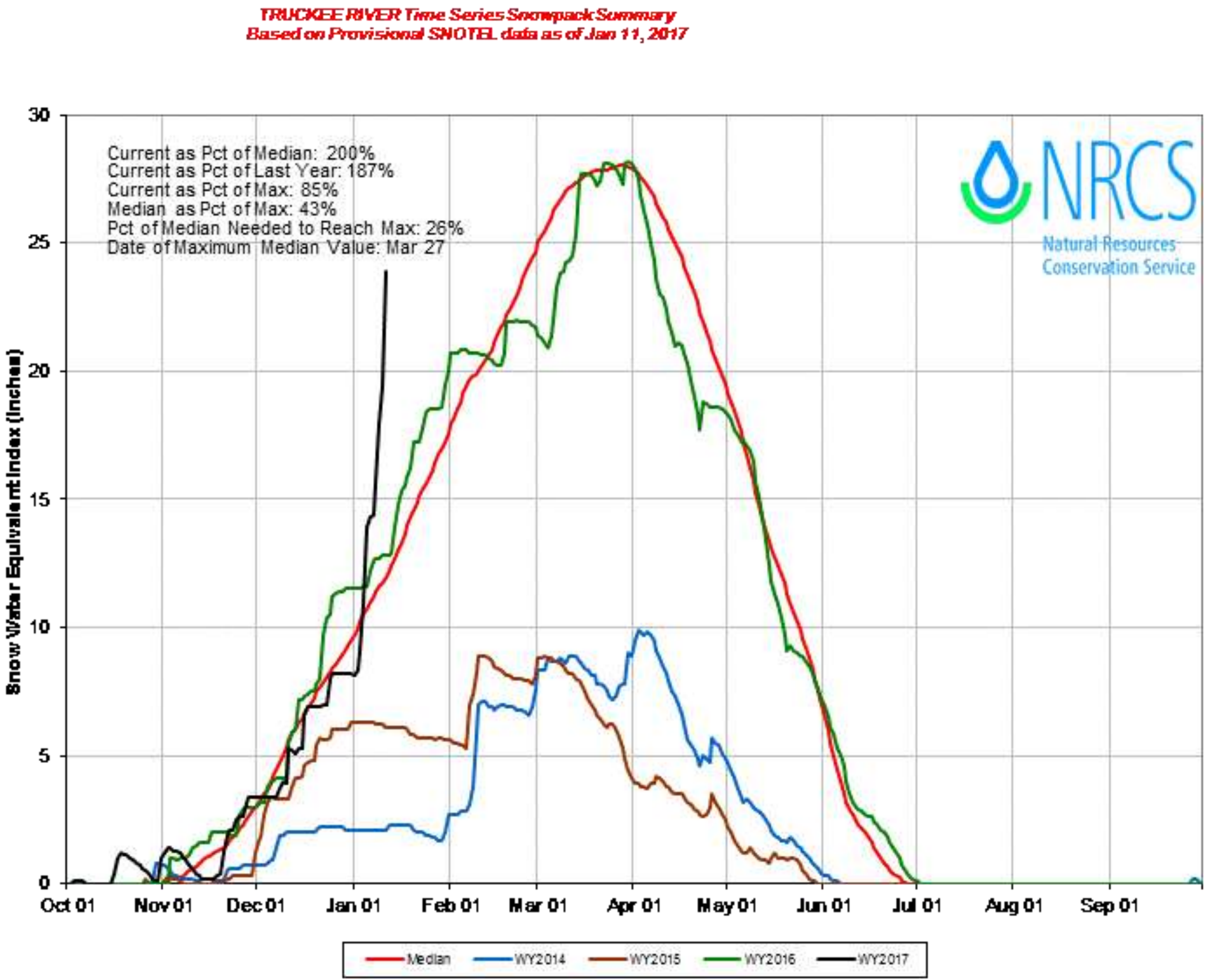
Lower Humboldt Basin Snowpack



Upper Humboldt Basin Snowpack



Truckee River Basin Snowpack



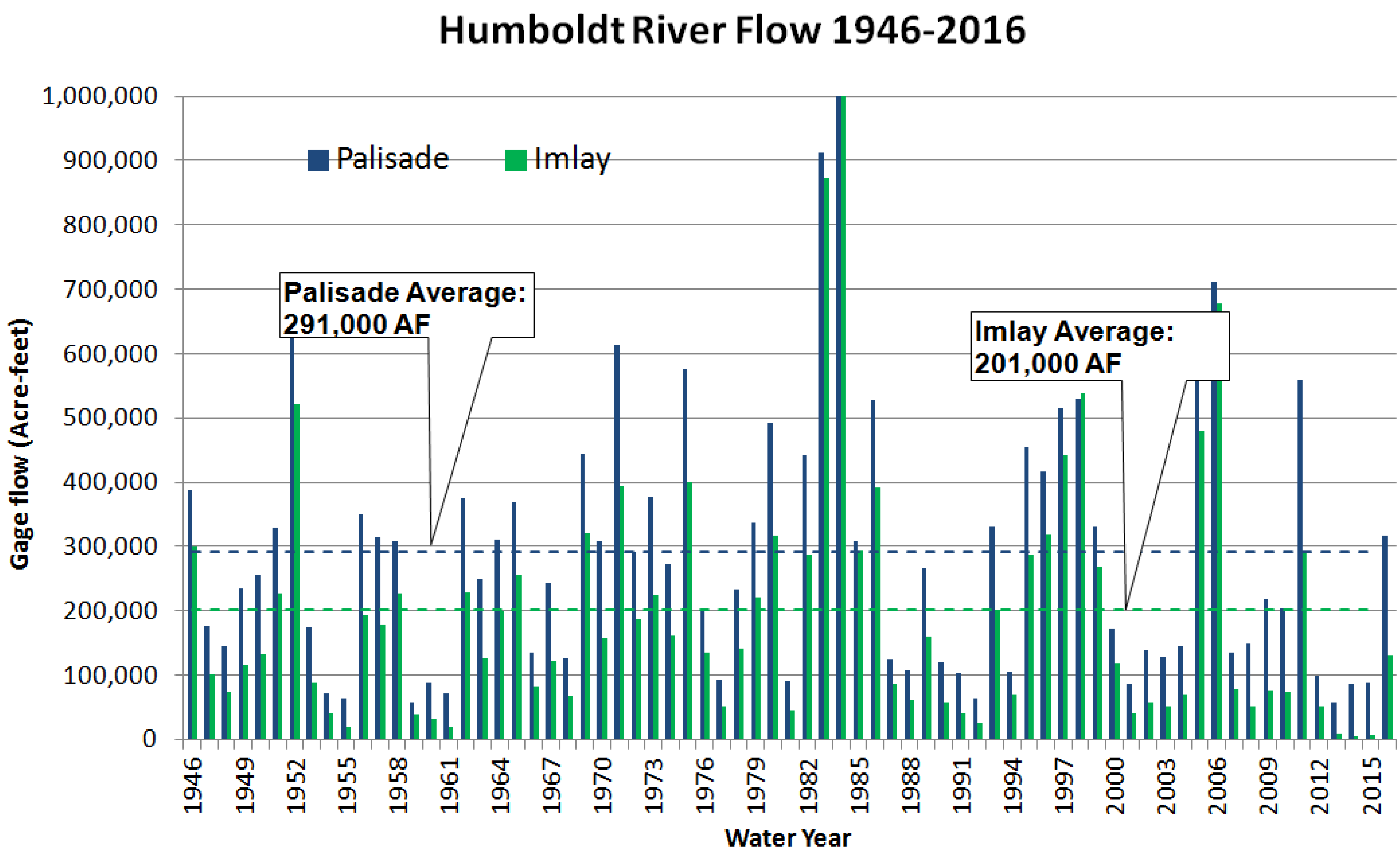
Humboldt River Forecast

Lower Humboldt River Basin	Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	30yr Avg (KAF)
Rock Ck nr Battle Mtn								
	MAR-JUL	16.2	23	26	96%	33	40	27
	APR-JUL	10.6	14.4	17	93%	19.6	23	18.2
Humboldt R at Comus								
	MAR-JUL	125	200	250	98%	300	375	255
	APR-JUL	76	150	200	94%	250	325	213
L Humboldt R nr Paradise								
	MAR-JUL	1.78	6.7	10	95%	13.3	18.2	10.5
	APR-JUL	0.95	5.7	9	93%	12.3	17.1	9.7
Martin Ck nr Paradise								
	MAR-JUL	1.76	13.2	21	95%	29	40	22
	APR-JUL	0.53	9.3	16	91%	23	33	17.5
Humboldt R nr Imlay								
	MAR-JUL	62	144	200	96%	255	340	209
	APR-JUL	14.6	101	160	90%	220	305	178

Humboldt R at Palisades								
	MAR-JUL	210	270	310	115%	350	410	270
	APR-JUL	150	215	255	113%	295	360	225

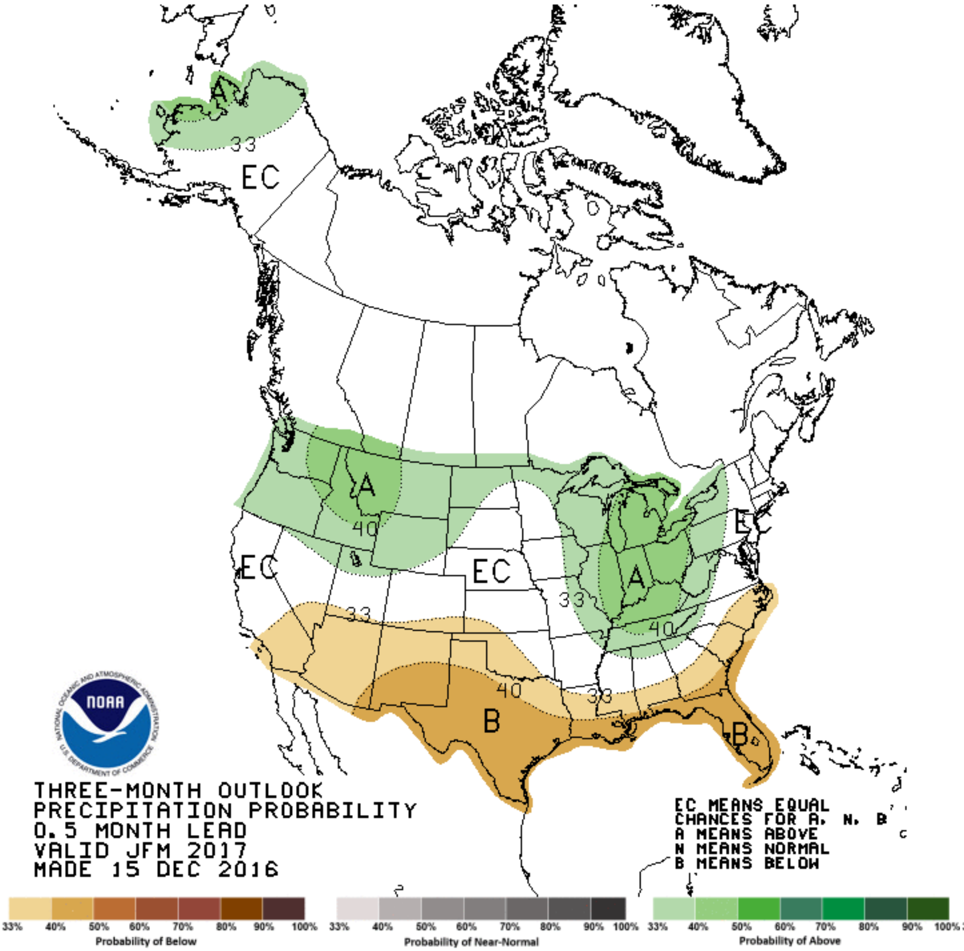
NRCS forecast made January 1, 2017

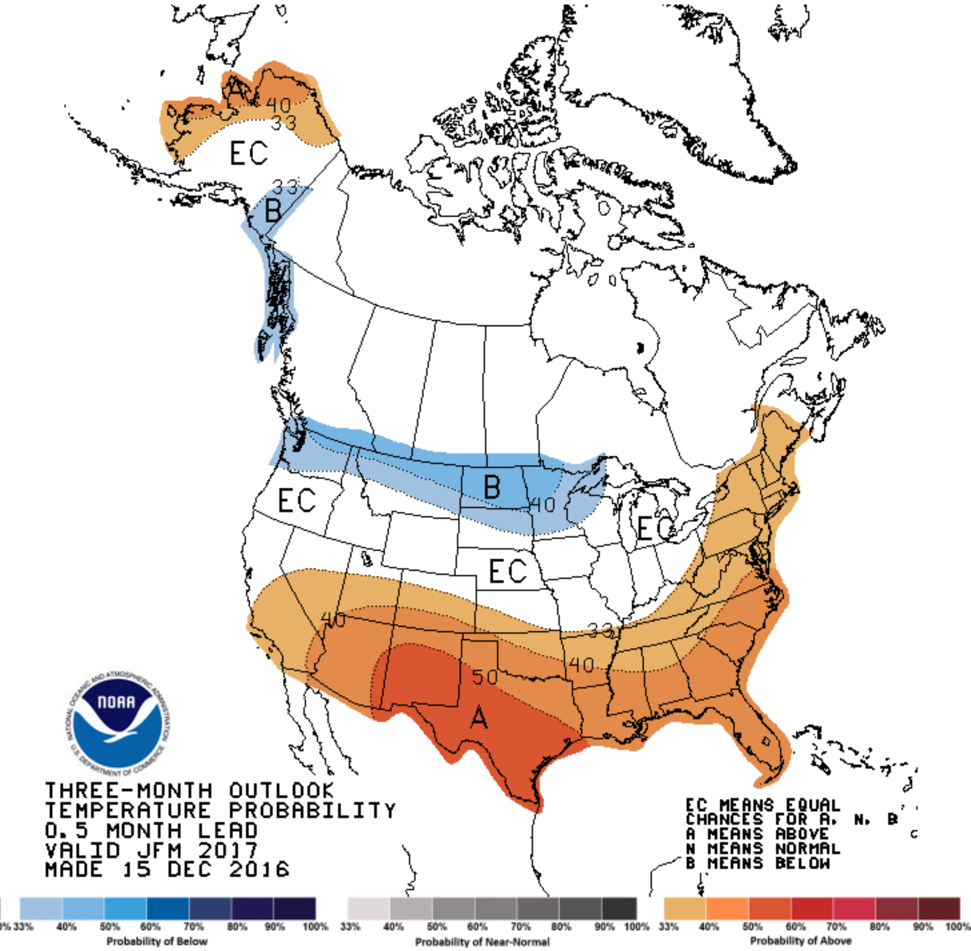
Humboldt River Flow, 1946-2015



Weather/Climate Forecast

Three-Month Outlook - Precipitation





http://www.cpc.ncep.noaa.gov/products/predictions/long_range/

Groundwater 101

Kip Allander - USGS

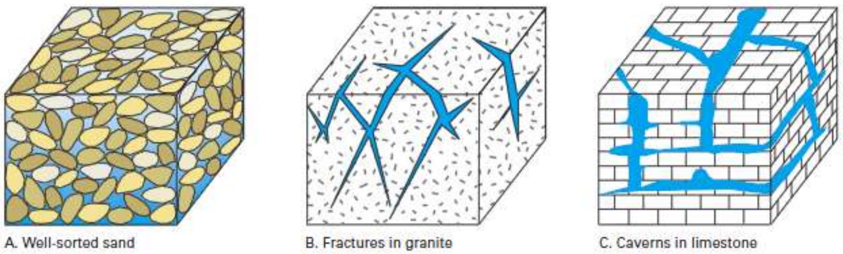
Groundwater 101 – an overview of important groundwater concepts

- What is groundwater?
- Groundwater and surface water, how are these connected or related?
- Where does water come from when pumping a well?
- What are groundwater models and why are they needed?

What is groundwater?

- Liquid water in the subsurface.
- Water occupies spaces between sand, silt, and gravel in fill; or fractures and cavities in rocks.
- Water movement through and storage within the subsurface is governed by aquifer properties.

Permeability is ability of water to move through material.

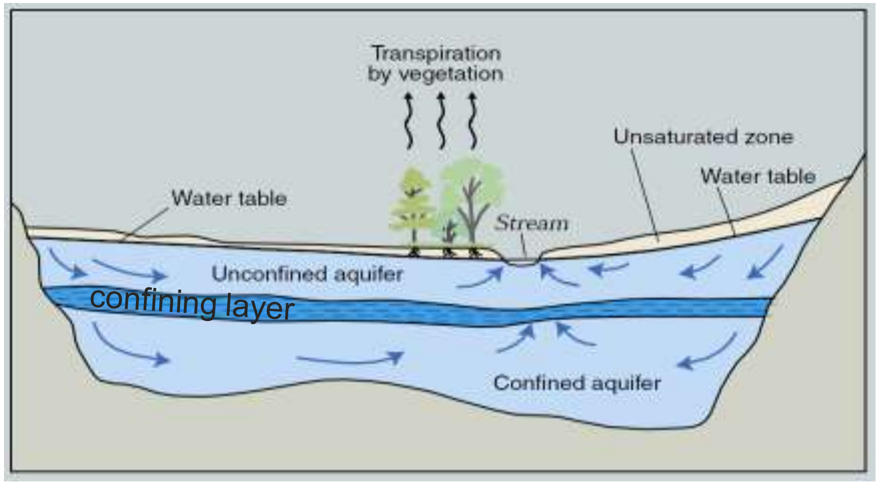


Storage is amount of water stored in a given volume of aquifer.

What is groundwater?

Aquifers exist where groundwater can be developed to provide adequate supply to wells.

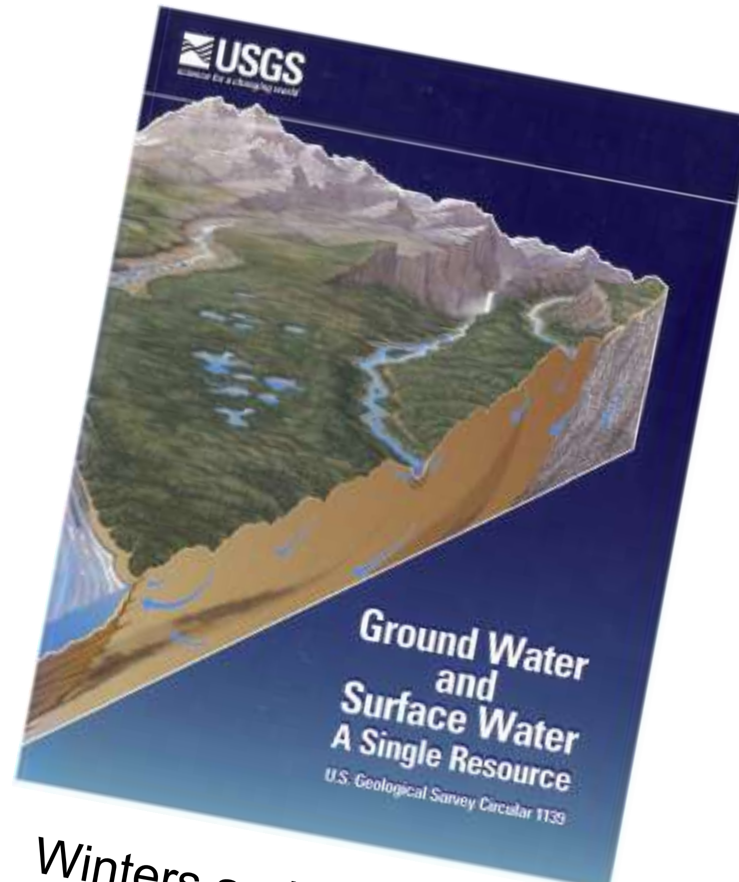
- Groundwater flows from areas of recharge to areas of discharge.



Groundwater and surface water, how are these connected or related?

Important concept for understanding how groundwater works.

Understanding is necessary for proper management of Nevada's water resources.



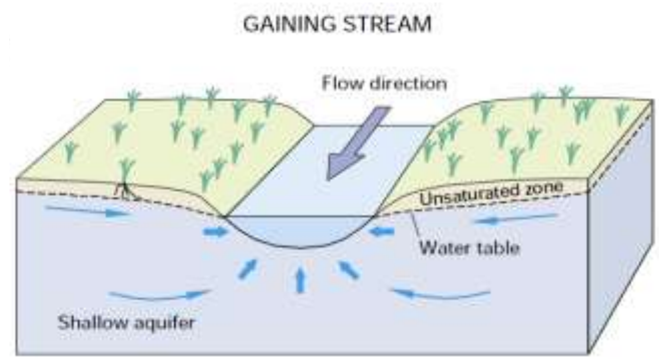
Winters and others (1998)

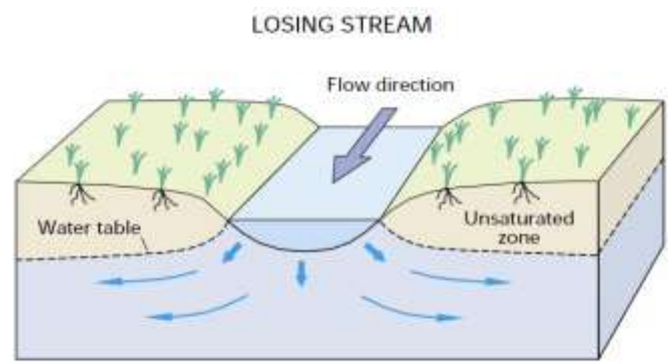
Groundwater and Surface water are a single resource

- Streams flowing year-round are connected with groundwater.

- Groundwater can:
  - Discharge to a stream (gaining stream).
  - Receive water from a stream (losing stream).

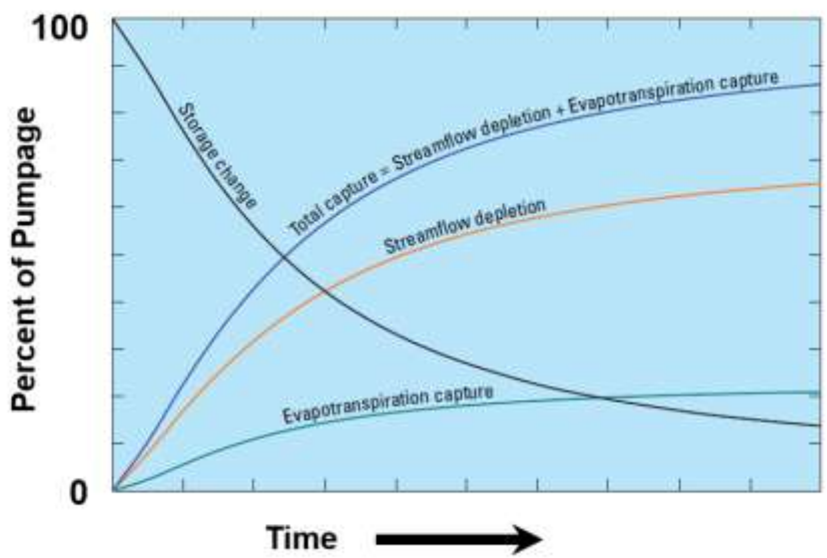
- Streams can:
  - Lose water to groundwater (losing).
  - Gain water from groundwater (gaining).

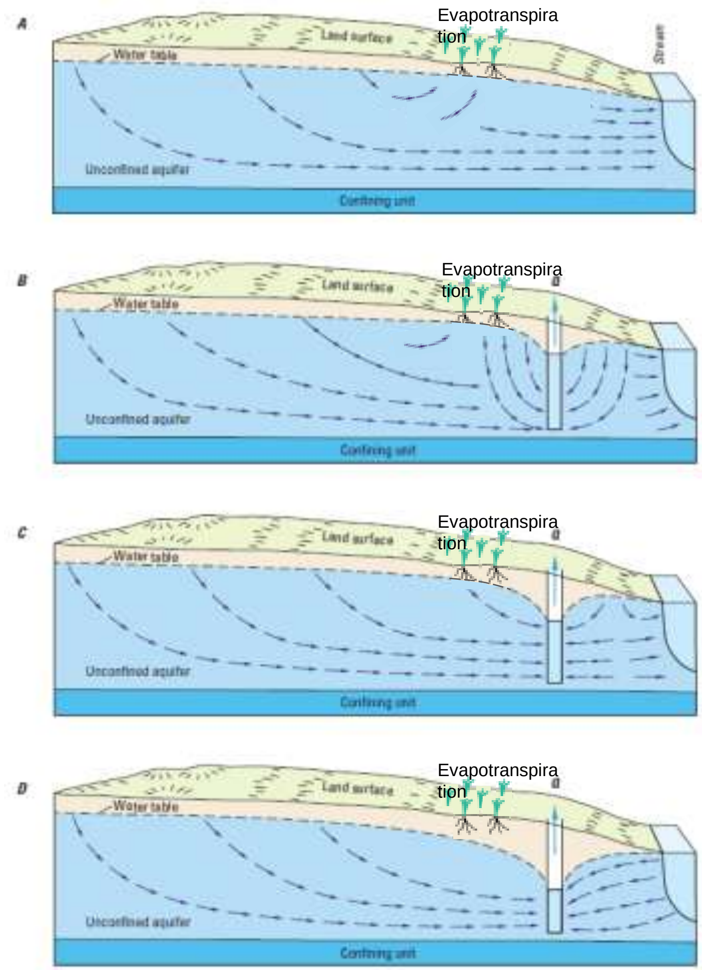




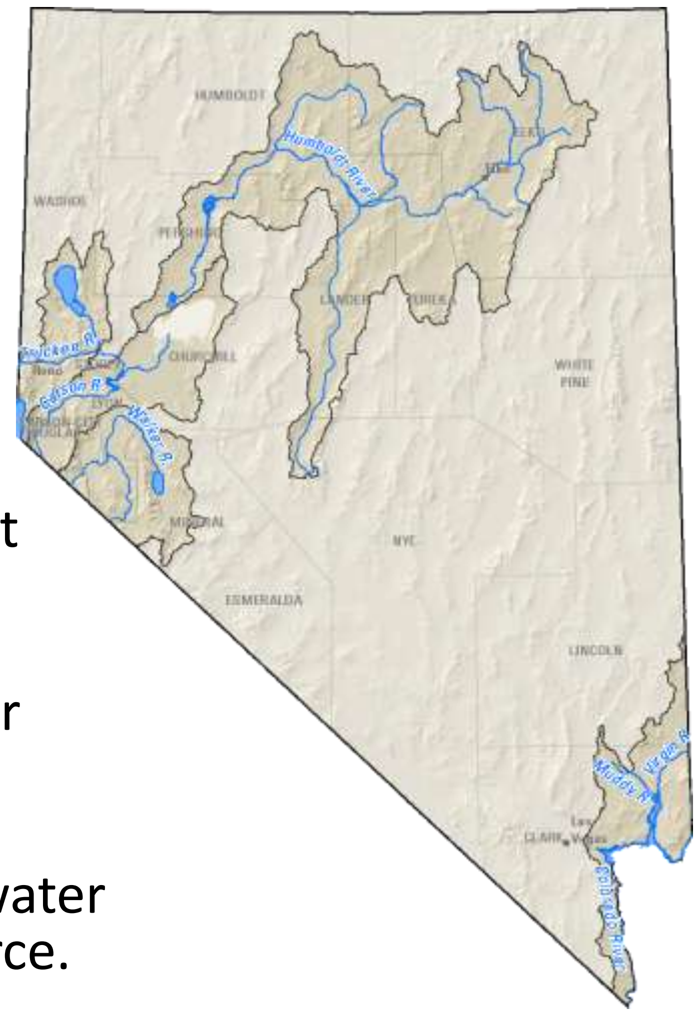
Where does water come from when pumping a well?

- Storage change – water from ground near well.
- Streamflow depletion – diversion from stream.
- Evapotranspiration capture – water intercepted from plant use and evaporation.





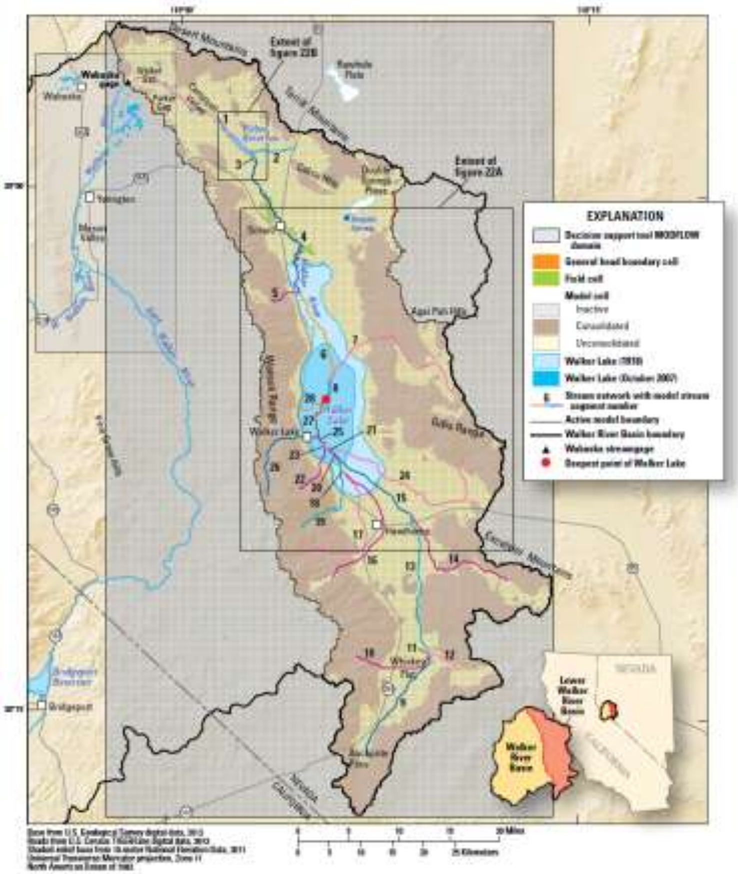
River connected Groundwater Systems in Nevada



- River connected flow systems.
  - Much of the groundwater movement through Hydrographic areas is by streamflow.
  - 25 percent of the states groundwater systems.
  - Substantial potential for conflict between groundwater and surface water users due to shared nature of resource.

What are Groundwater models?

- Mathematical representations of complex hydrologic systems.
- Simulate hydrologic systems based on principles, aquifer properties, and boundary conditions.



(Allander and others, 2014)

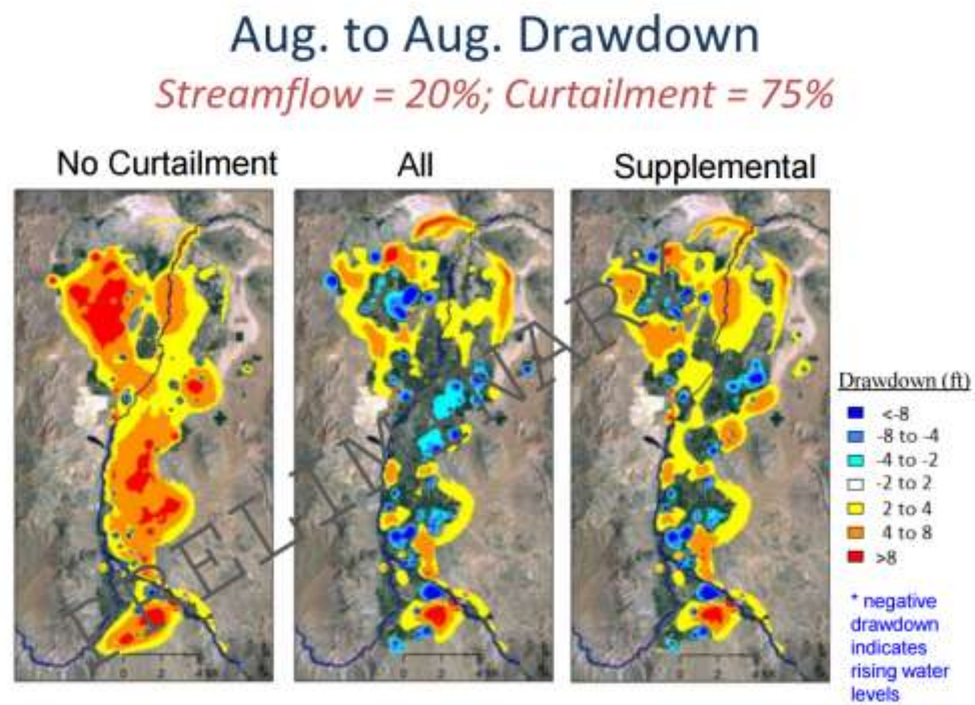
Groundwater flow equation:

$$\frac{\partial}{\partial x}\left[K_{xx}\frac{\partial h}{\partial x}\right]+\frac{\partial}{\partial y}\left[K_{yy}\frac{\partial h}{\partial y}\right]+\frac{\partial}{\partial z}\left[K_{zz}\frac{\partial h}{\partial z}\right]+W=S_S\frac{\partial h}{\partial t}$$

Why are Groundwater models needed?

- Use existing information and understanding to estimate properties that govern flow.
  - Referred to as calibration.

- Needed to understand complex system interactions and to inform results of management actions.

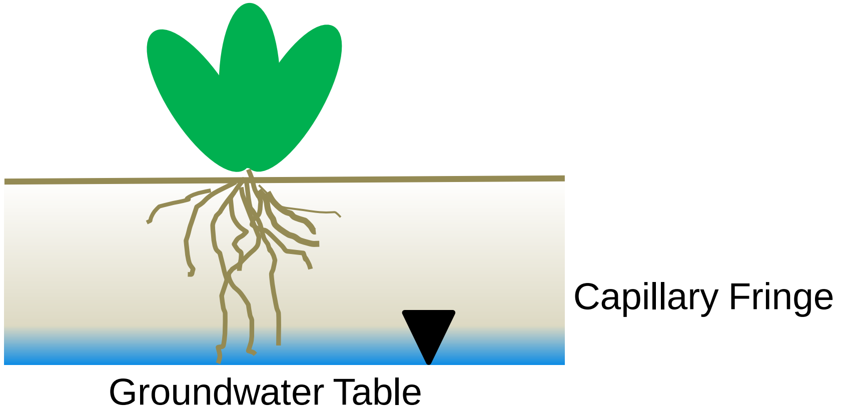


Evapotranspiration

Justin Huntington - DRI

Evapotranspiration

- Ultimately all water that is recharged in the Humboldt River Basin is discharged by Evaporation and EvapoTranspiration (ET)
  - Phreatophytes (plants that access and use groundwater)
  - Playas
  - Open Water
- ET Task: Estimate annual groundwater ET in each HA of the Humboldt River Basin

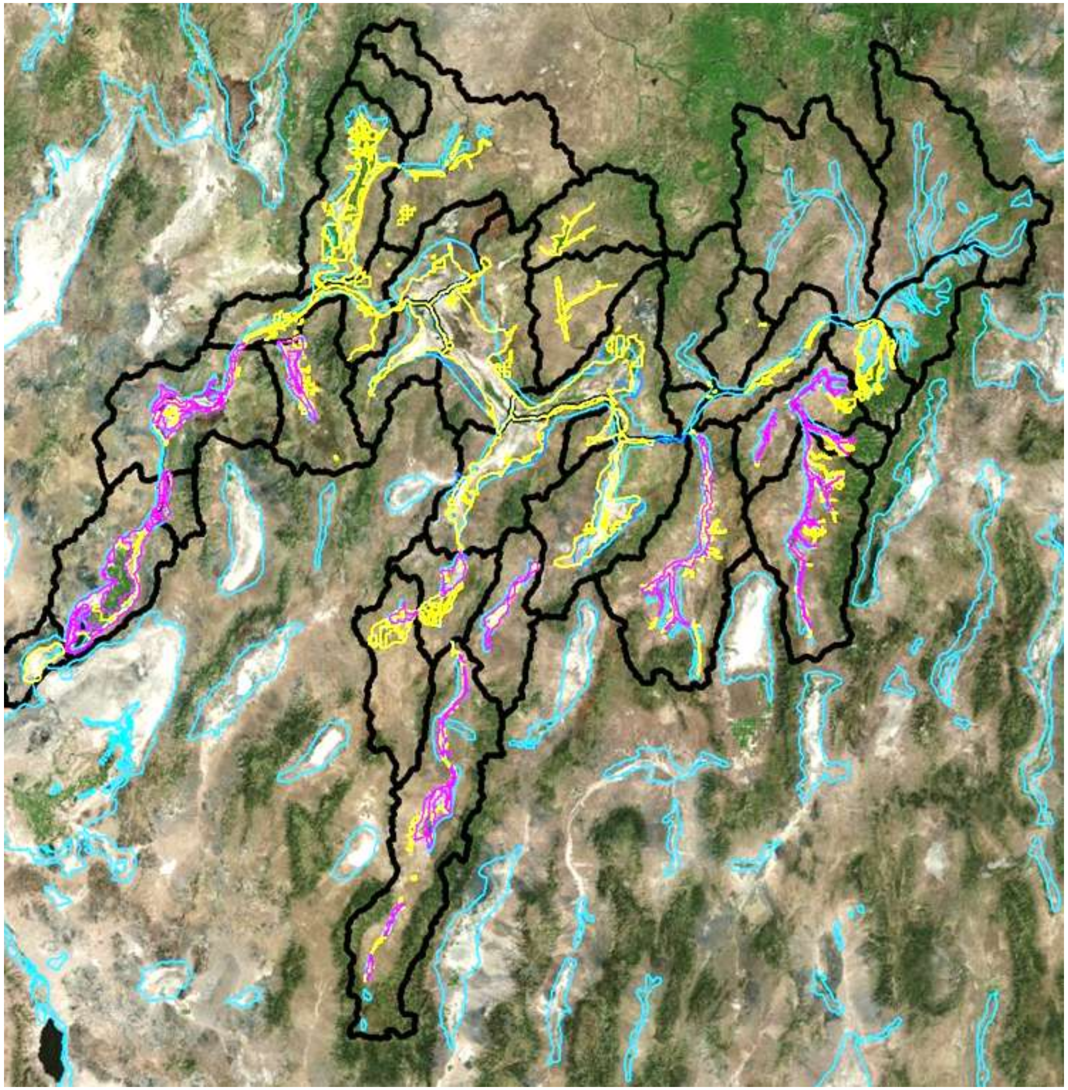


Evapotranspiration

- Project Elements
  - Review and compile previous groundwater ET estimates and develop a GIS database of
    - Phreatophyte boundaries
    - ET rates
    - ET volumes
  - Modify boundaries where needed based on satellite/aerial imagery and field investigations
  - Apply new remote sensing and gridded weather data techniques to update ET rates and volumes
  - Groundwater ET volumes will be used to support groundwater modeling efforts

Evapotranspiration

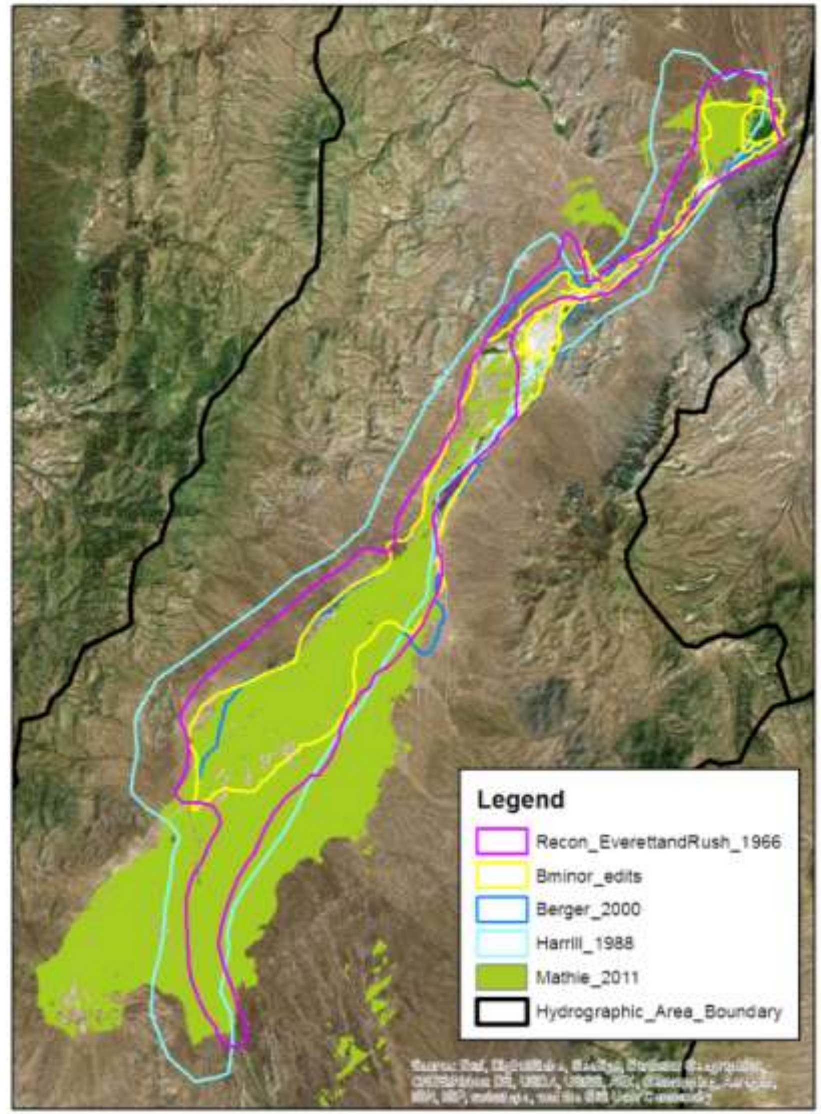
- Discharge Boundaries
  - Recon. Reports
  - Water Resource Bulletins
  - Water-Resource Investigation Reports
  - Other reports
- Assess their accuracy based on
  - Historical Landsat satellite imagery
  - High resolution aerial imagery
  - Digital elevation
  - Field investigations



Evapotranspiration

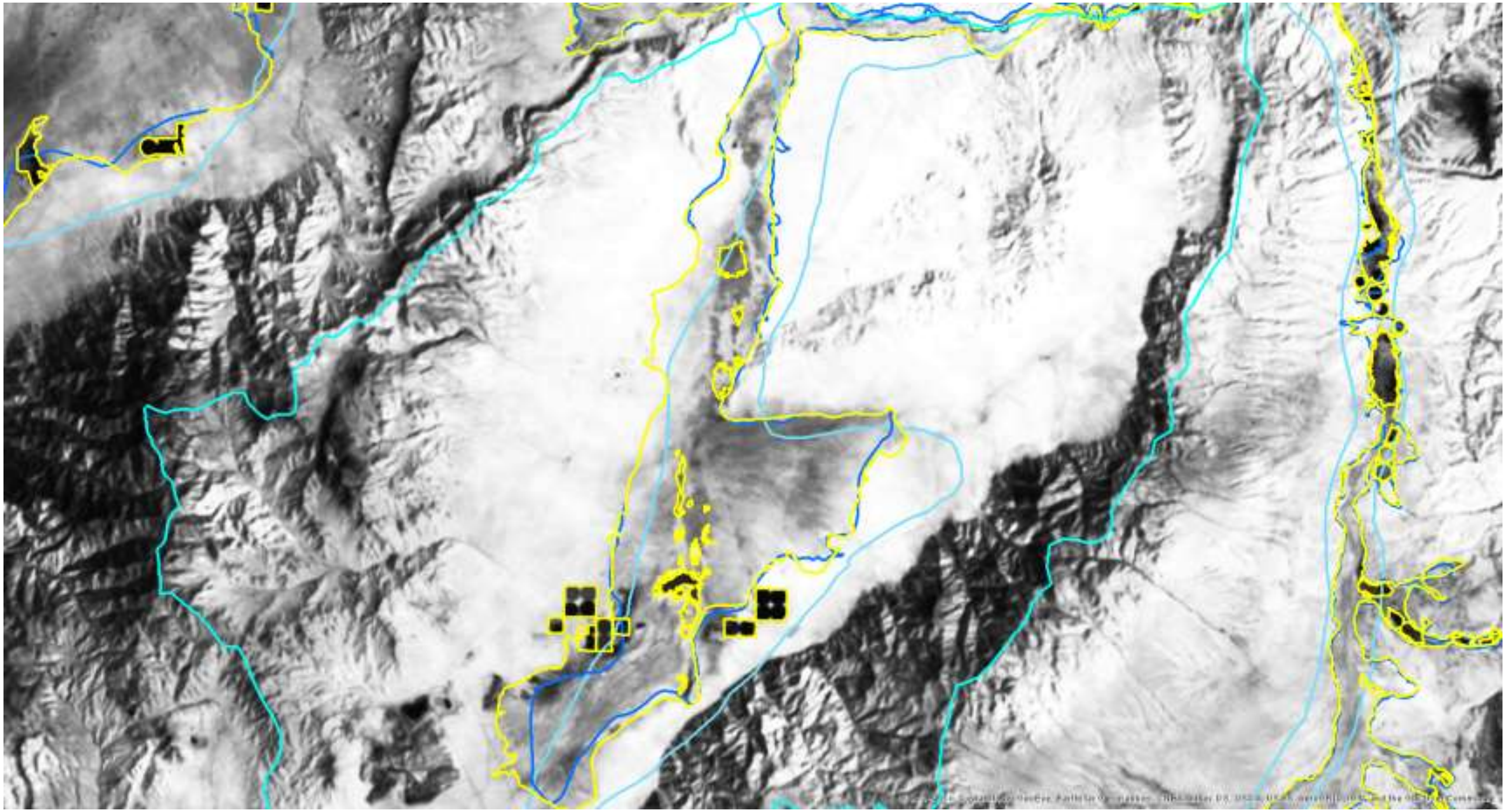
- Different boundaries can have very different areas
  - Area is the squared term in volume, so correctly defining the discharge area in each basin is important
- Modifying boundaries based on validation data
  - Satellite and areal imagery, digital elevation data, field investigations

Carico Lake Valley

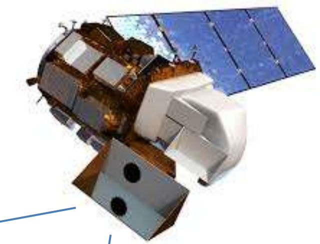


Evapotranspiration

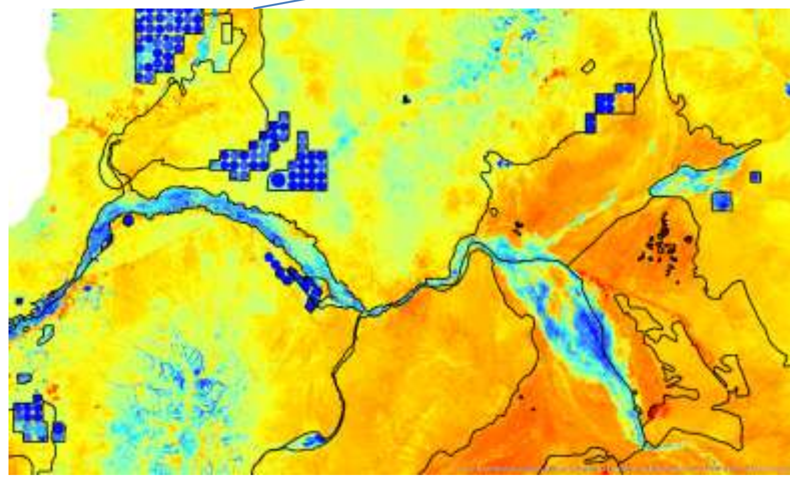
- Example: Landsat surface temperature helps to delineate groundwater discharge areas



Evapotranspiration



- Updating groundwater ET rates based on
  - Published regression model using vegetation index and climate variables
    - Based on 40 site years of measured ET from phreatophytes in NV
  - Landsat satellite images of vegetation vigor (greenness) from 1985-2016
  - Gridded weather data from 1985-2016
    - Potential ET (PET)
    - Precipitation (PPT)

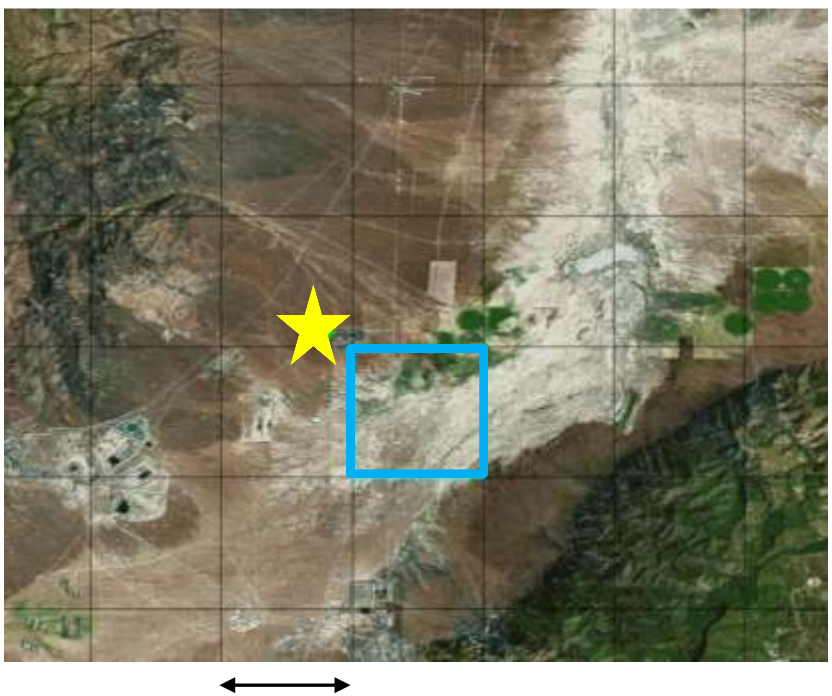


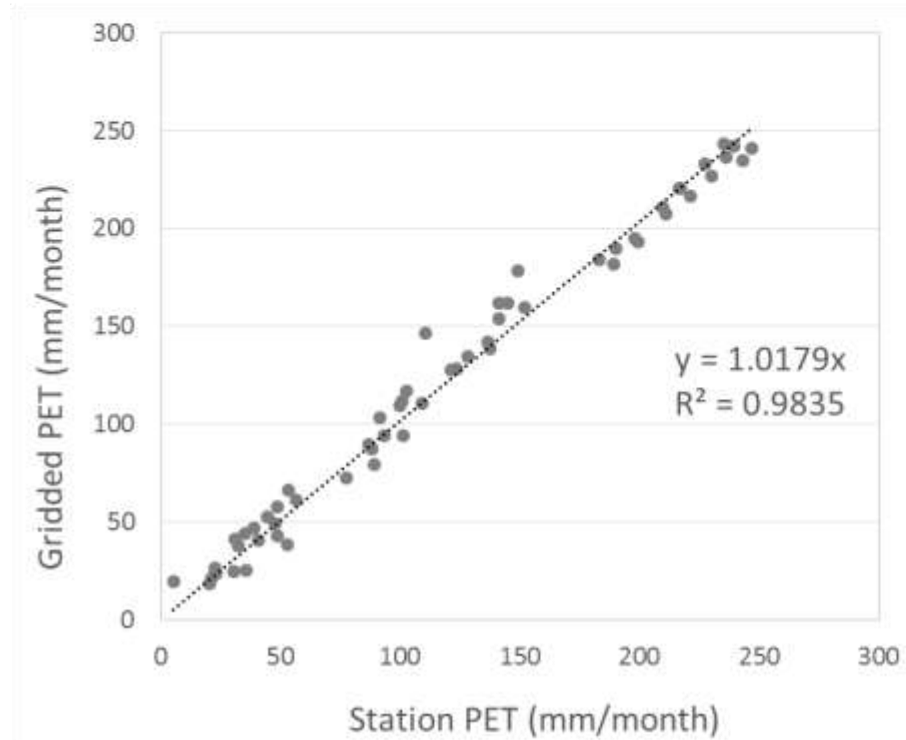
Vegetation Index (30m)

True Color

Evapotranspiration

– Validation and possible bias correction of gridded weather data and PET





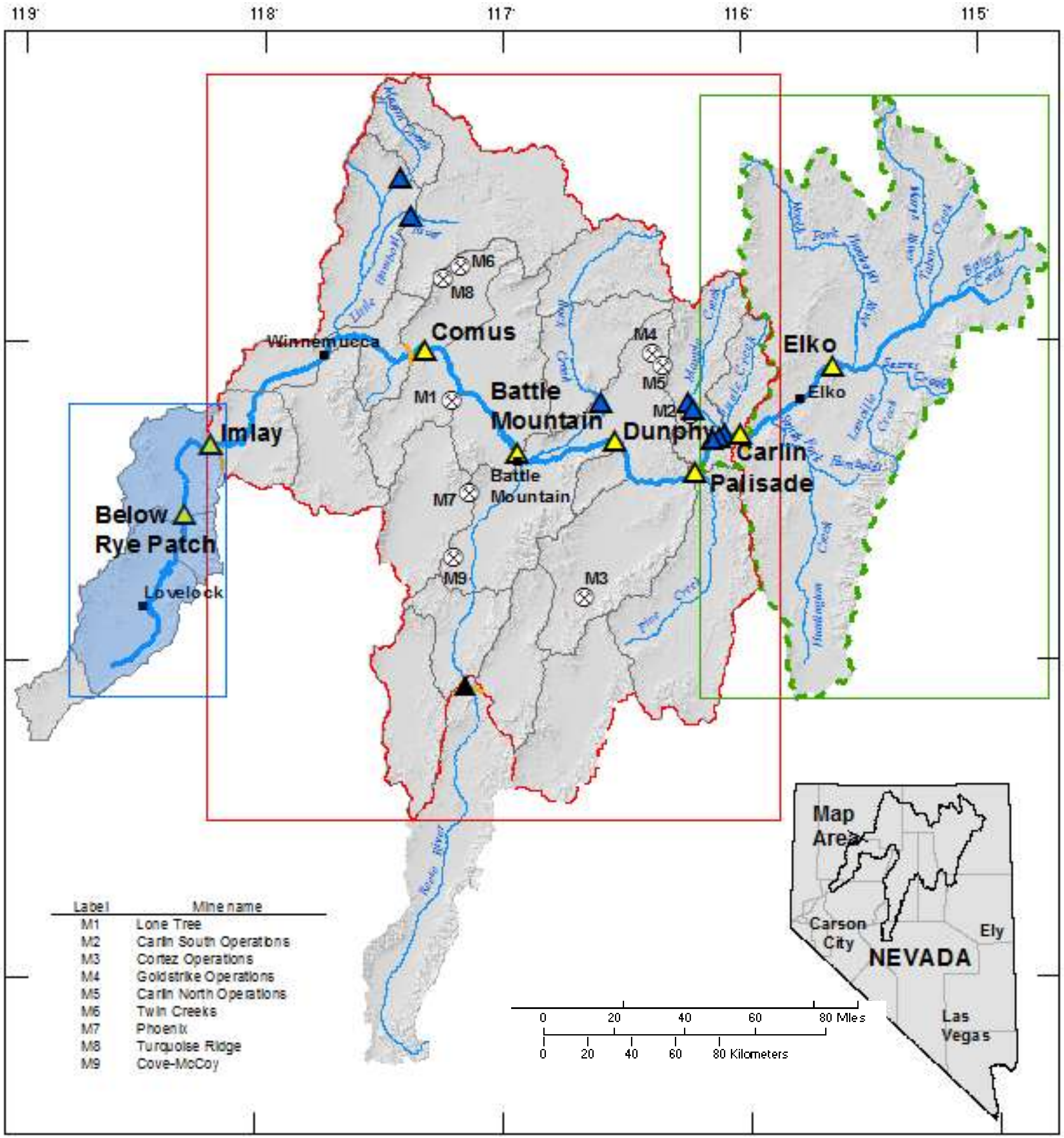
Evapotranspiration

- Next Steps
  - Integrate field investigation data and finalize recommended discharge areas per HA
  - Finalize gridded weather data comparison and bias corrections
  - Process Landsat and bias corrected climate archives per HA and compute groundwater ET
  - Compare areas, rates, and volumes to previous studies and get feedback
  - Finalize and summarize new groundwater ET estimates per HA

Groundwater Models

Upper Basin Model

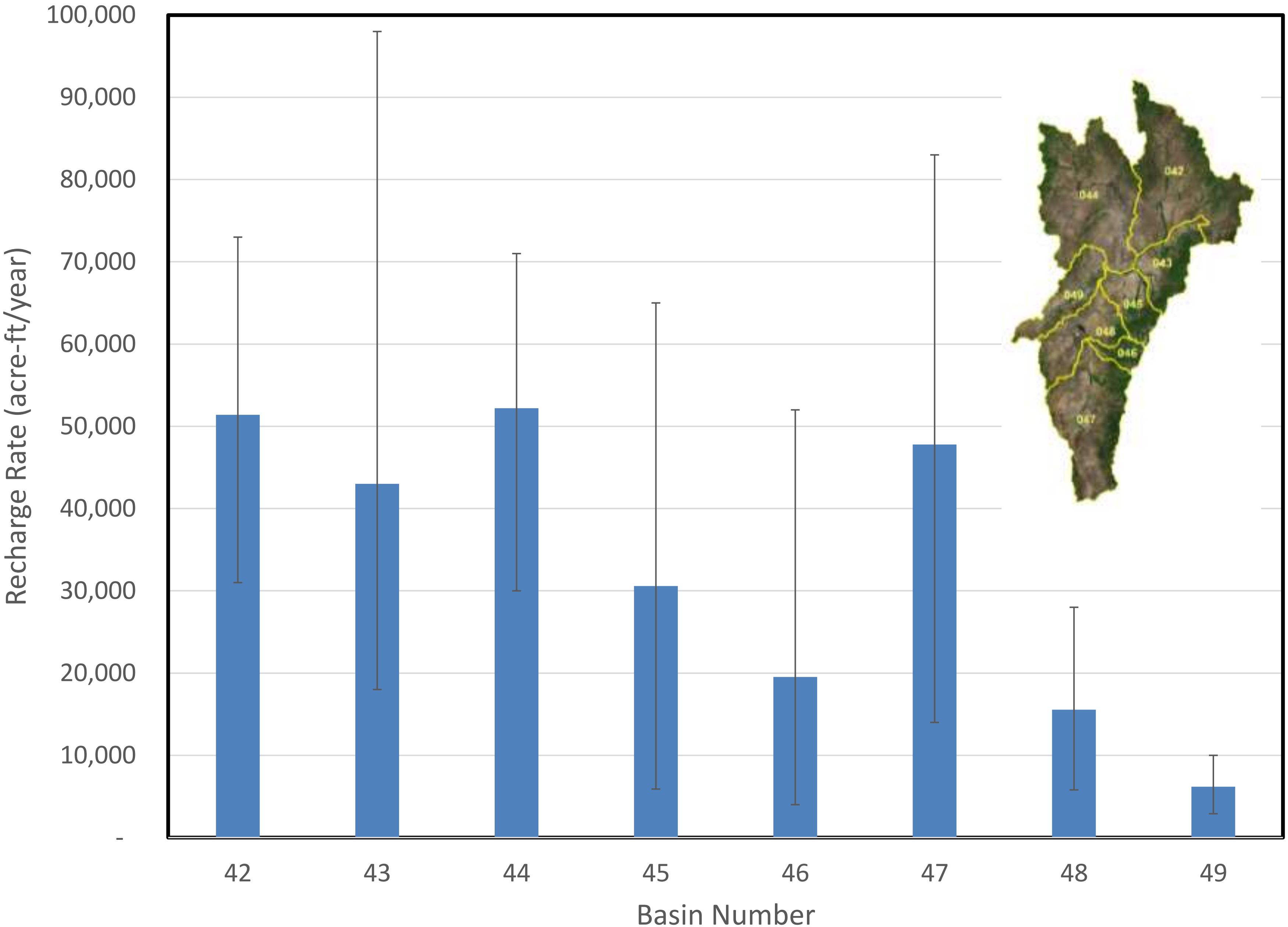
Greg Pohll - DRI



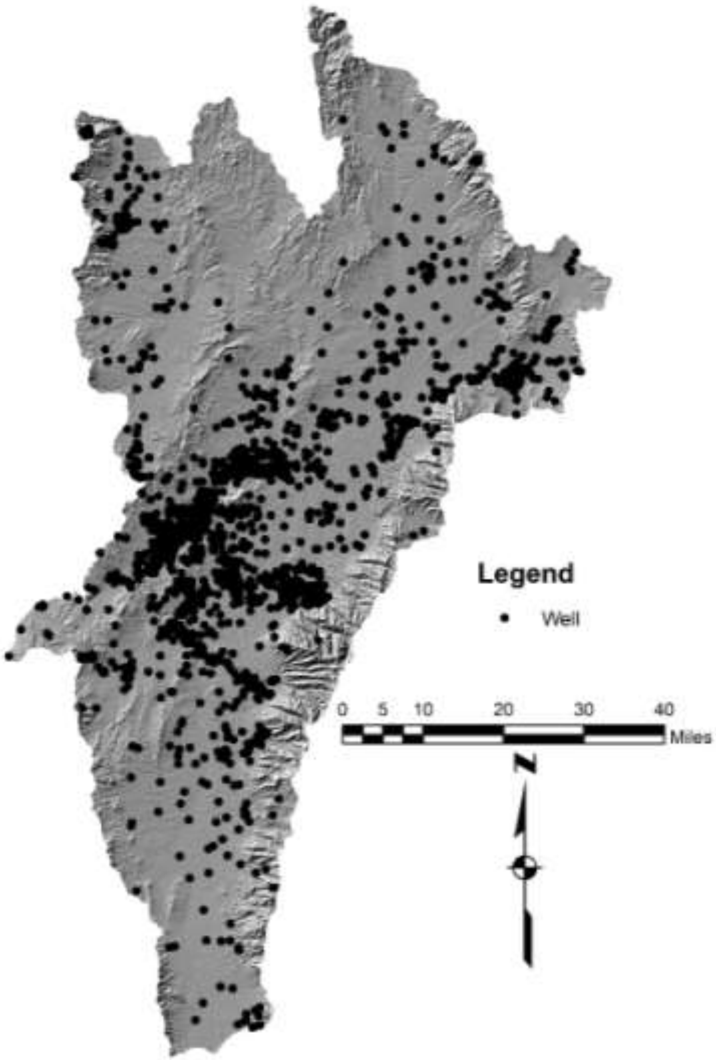
- Upper basin model - DRI
- Middle basin model - USGS
- Lower basin Model – USGS/DRI

Upper Basin Model

- Assess non-linear bias
- Update hydrogeologic database
- Reconstruct model to focus on groundwater and surface water interactions along the upper Humboldt River
- Capture analysis
- Reporting


100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
Recharge Rate (acre-ft/year)
42
43
44
45
46
47
48
49
Basin Number
044
042
043
049
045
048
046
047

Wells



- Well locations from NDWR database
- Pumping rates
  - Measured data when available
  - NDWR crop inventory
  - Ag area
  - Population estimates

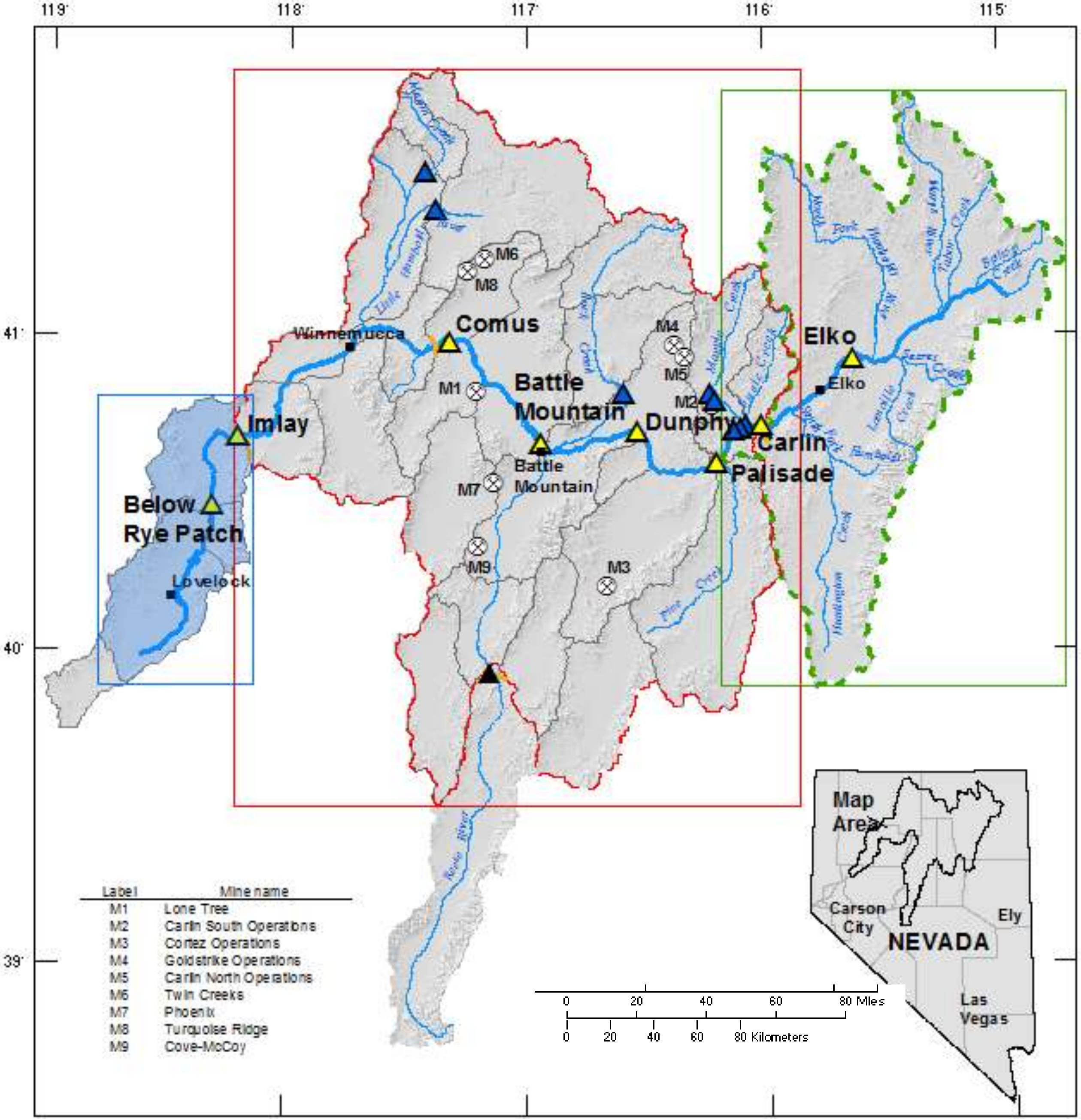
Geology

- Maurer et al., 2004
- Modeling effort will focus on basin-fill deposits
- Basin-fill deposits:
  - Alluvial slope
  - Valley floor
  - Playa
  - Fluvial deposits
  - Older alluvium

Groundwater Models

Middle Basin Model

Kip Allander - USGS



- Upper basin model - DRI
- Middle basin model - USGS
- Lower basin Model – USGS/DRI

Overview

- Progress made last year
- Changes to original model domain
- Plans for this year

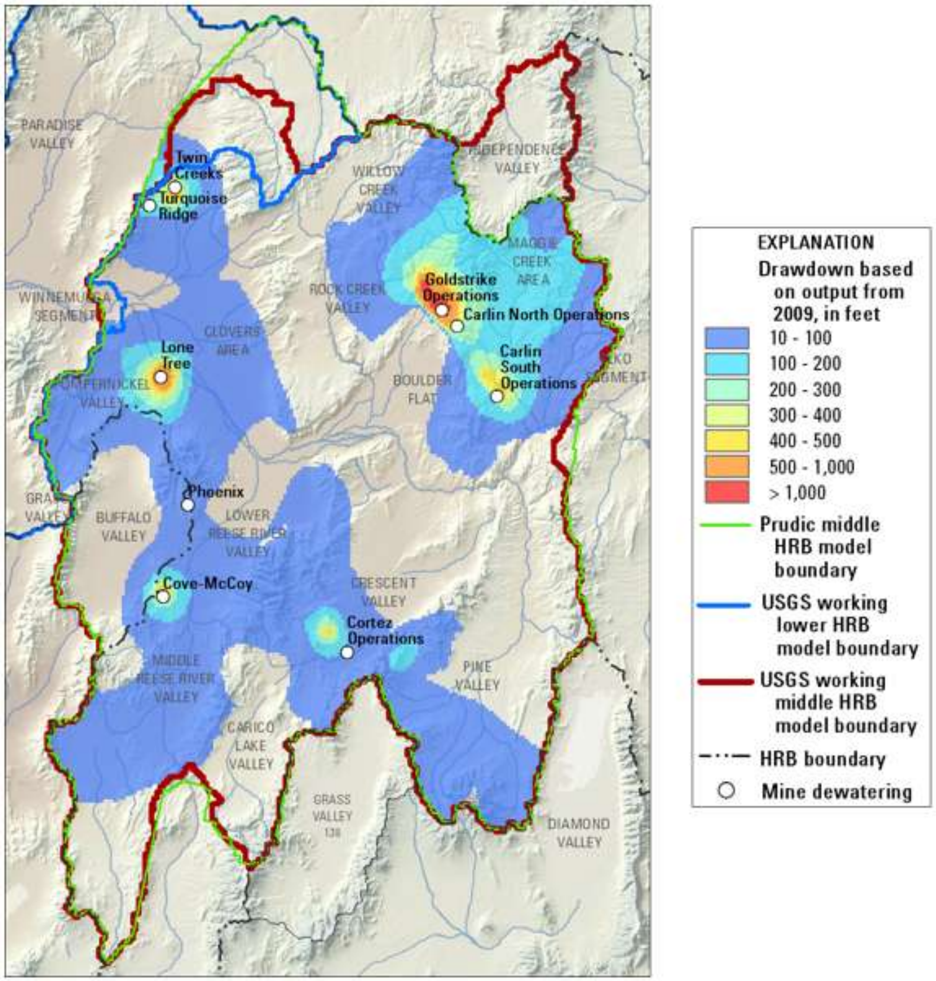
Progress

- Work officially started February 2016.
- Team assembled with major roles divided as follows:
  - GIS and Hydrologic observation datasets.
  - Recharge distribution.
  - Mine dewatering and water management.
  - Non-mine related pumping (mostly Ag).
  - Field verification/Surveying.
  - Capture bias evaluation.
  - Model development, calibration, and analysis.

Testing of original planned model boundaries

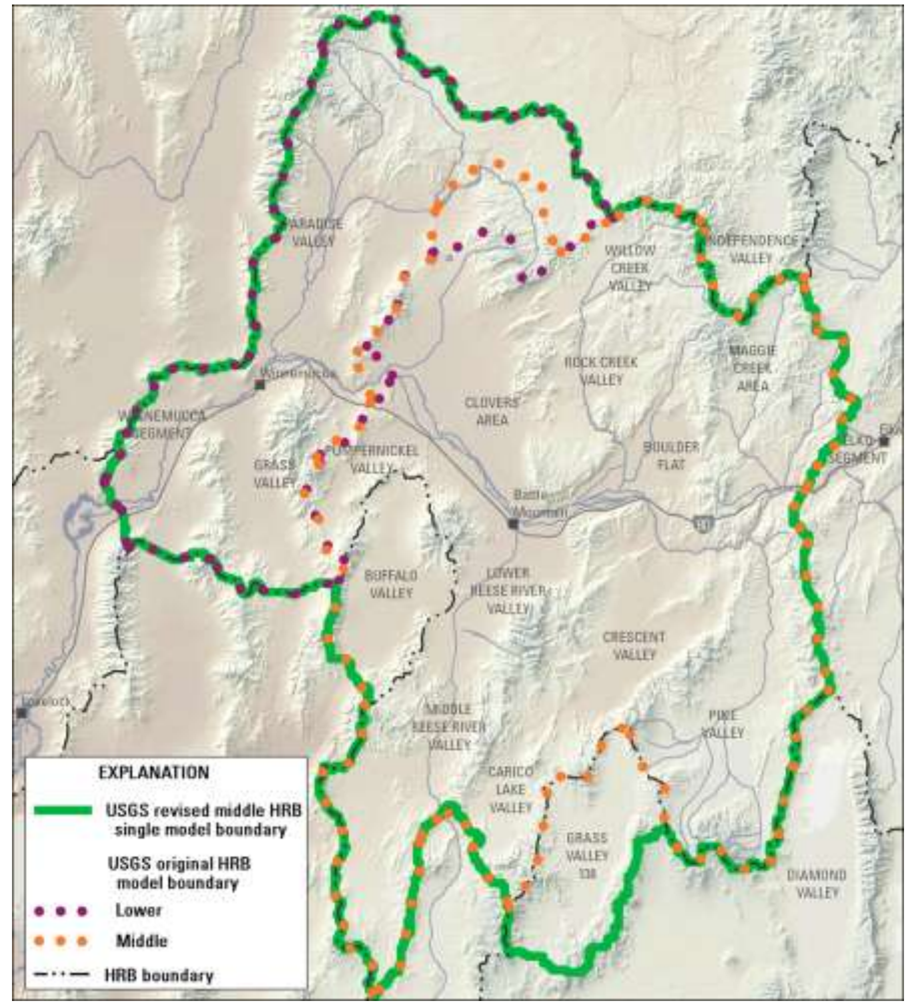
- Prudic model used to test potential boundary issues from mine dewatering.
- Plus observations of drawdown propagating beyond original planned boundaries.
- Potential boundary issues from Turquoise Ridge, Twin Cks, and Cortez mines.

Layer 3



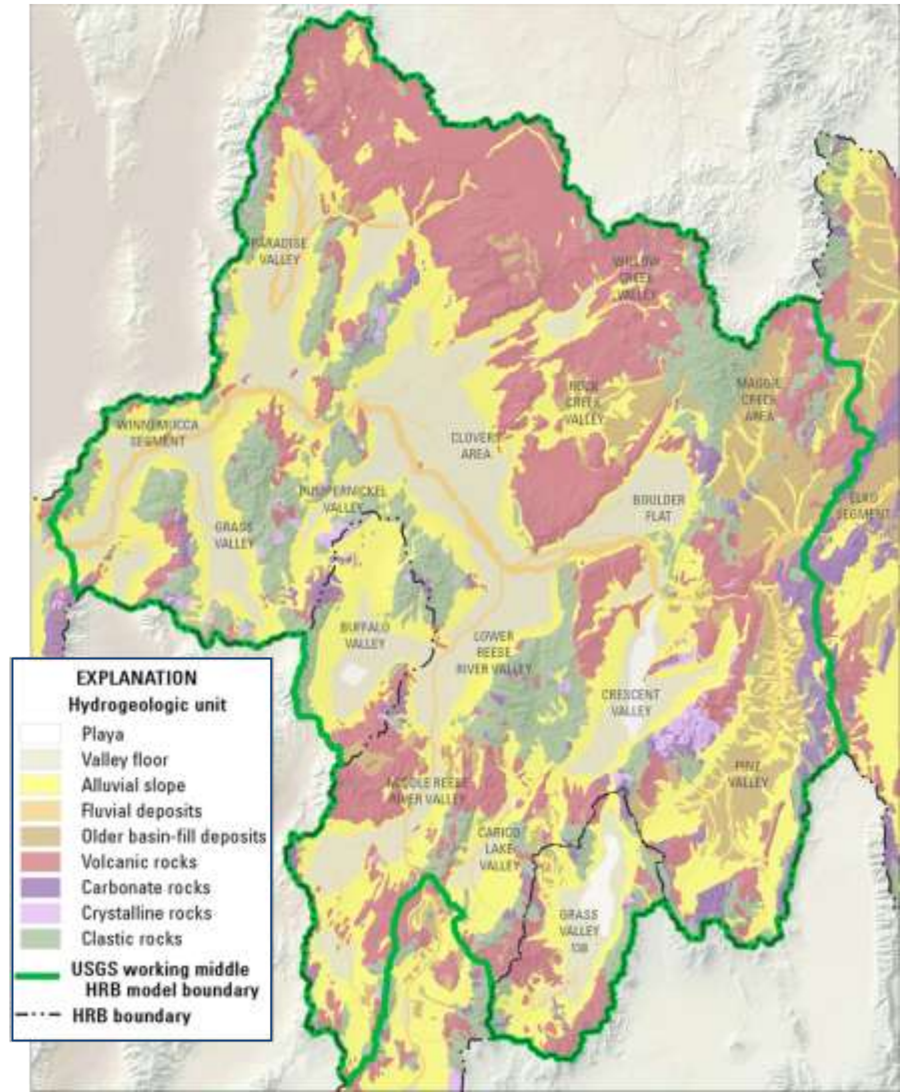
Revised model domain

- Two model concept (Middle and Lower) combined into single model.
- Model boundaries revised accordingly.
  - Model boundary expanded to include (Upper) Grass Valley (HA 138).



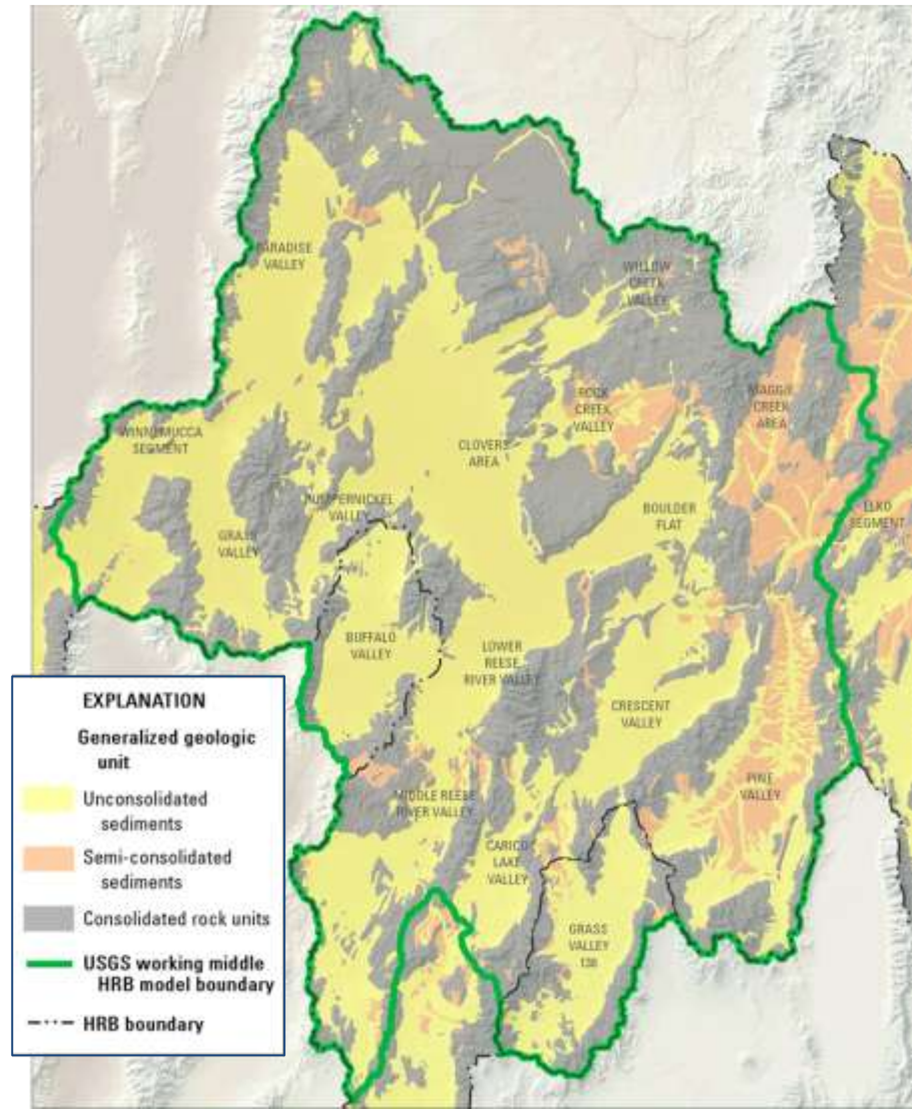
GIS and Hydrologic observation datasets - Hydrogeology

- Hydrogeology compiled from Maurer and others (2004).
  - Extends to entire Humboldt basin.
  - Consistent dataset for all Humboldt models.
  - Consists of 9 specific hydro-geo units.
- Mostly consistent with Plume and Ponce (1998) .
  - Which only covered middle Humboldt basin.



GIS and Hydrologic observation datasets – Hydrogeology (cont)

- Generalized hydrogeology.
  - 3 classes of hydro-geo units.
  - Unconsolidated sediments.
  - Semi-consolidated sediments.
  - Consolidated Rock units.



GIS and Hydrologic observation Datasets

Hydrogeology data - Based on SIR 2004-5131 (already published)

Includes generalized and hydrogeologic units

Humboldt Reconnaissance WRB 32 (digital data in press)

Includes depth-to-water contours, water-level-altitude contours, and isopleths showing mean annual runoff

Middle Humboldt Water-Budget WRIR 00-4168 (digital data in press)

Includes groundwater discharge areas

Upper Humboldt Water Budget SIR 2013-5077 (digital data in press)

Includes ET units and potential area of groundwater discharge

Middle Humboldt Mineral Assessment Bulletin 2218 (digital data in press)

Includes depth to bedrock

GIS and Hydrologic observation datasets

Hydrography data (under development)

Including waterbodies and streams

Digital elevation data (under development)

Land surface at model scale

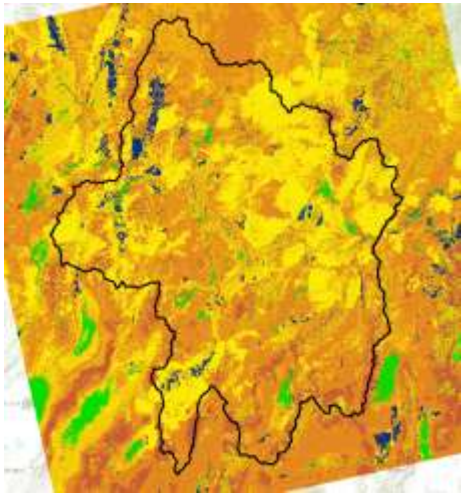
Compiled gage and well data from NWIS and NDWR (under development)

Includes location and measurements

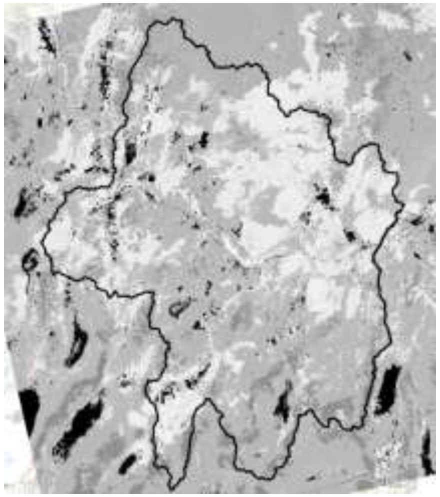
Recharge Distribution

- Using PRMS watershed model to estimate recharge distribution.
- Incorporates important data and watershed properties that affect recharge:
  - Veg type and cover.
  - Soil data and characteristics.
  - Slope, aspect, flow directions.

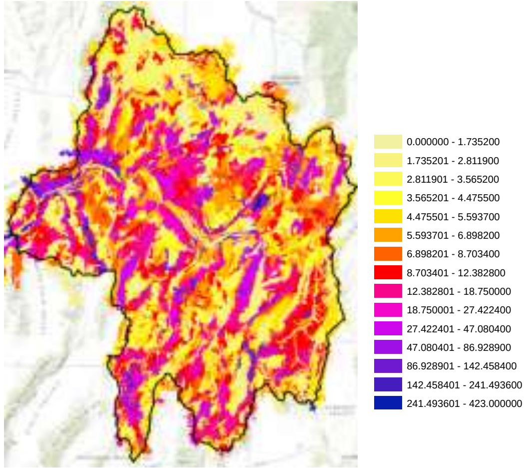
Vegetation type



Vegetation cover

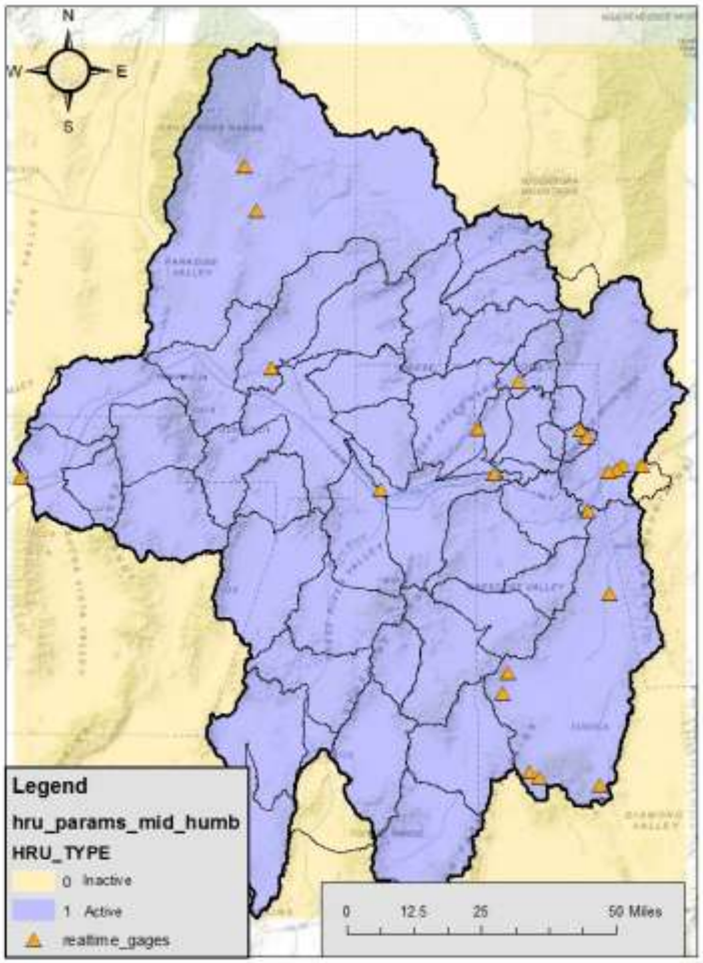


Ksat (μm/s)



Recharge Distribution (cont)

Sub-basin output

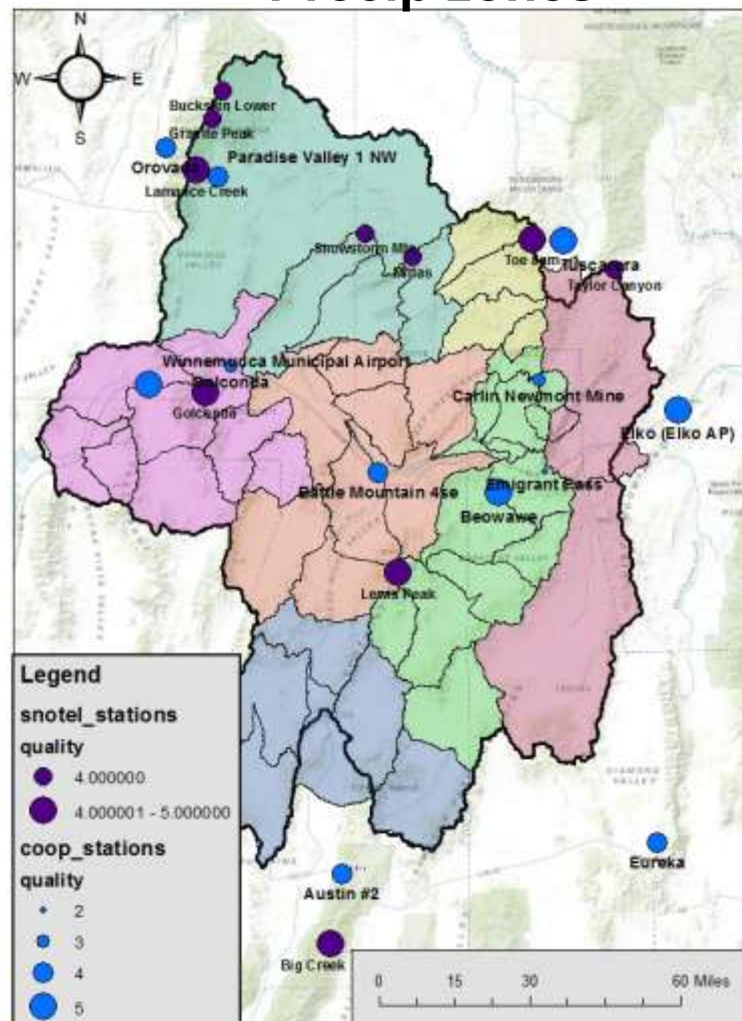


- PRMS is a type of water balance model.
  - Estimates runoff and evapotranspiration.
  - Routes flows along surface and stream network.
  - Residual water budget component is GW recharge.
  - Calibrate using known flows, ET, and existing estimates of Recharge.

Recharge Distribution (cont)

- Precipitation and temperature from local climate stations is specified
  - Applied by zones.
- PRMS calibration beginning soon.
- Estimated recharge distribution to follow.

Precip zones



Mine dewatering and water management

- Actively gathering data and information from mines.
  - Water management plans.
  - Models.
  - Hydrologic observation data.
  - Hydrogeology.
- Great participation from Mines.
  - A substantial request, most mines have provided requested information to date.
- Plans for upcoming year.
  - Assemble data, create databases, incorporate information into model files.

Fig. 1 No.	Mine Operation	Basin	2015 Mine status
M1	Lone Tree	Clovers	Inactive
M2	Carlin South Operations	Maggie Creek	Active
M3	Cortez Operations	Crescent Valley	Active
M4	Goldstrike Operations	Boulder Flat	Active
M5	Carlin North Operations	Boulder Flat	Active
M6	Twin Creeks	Kelly Creek	Active
M7	Phoenix	Buffalo Valley	Active
M8	Turquoise Ridge	Kelly Creek	Surface Inactive, Underground Active
M9	Cove-McCoy	Lower Reese River Valley	Inactive/Exploration

Non-mine related pumping

Irrigation pumping

- Entering historic Crop Inventory data into spreadsheets.
- Estimate annual pumping by well and hydrographic area.
- Compile annual data into well and pumping databases for the numerical model.
- Completed by June 2017

CROP INVENTORY - Annual NDWR report that documents irrigation pumping for each hydrographic area in Nevada

- Well permit and location
- Crop type
- Acres of crop
- Irrigation method
- Supplemental to surface water
- Net Irrigation Water Requirement
- Irrigation efficiency

Irrigation pumping – Method for estimating pumping

- Using NDWR method adopted in 2014, where

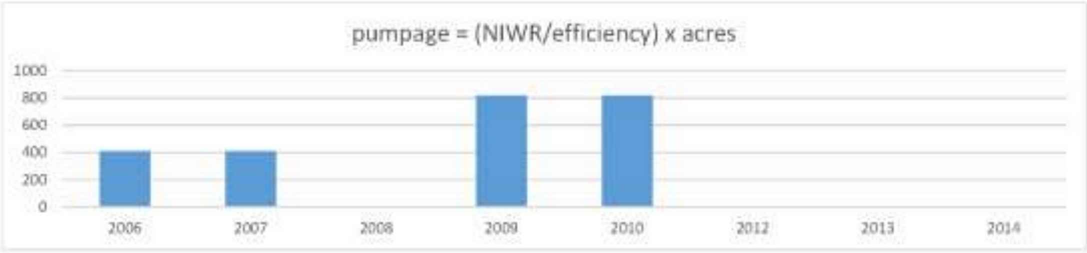
$$\text{Pumping [acre} - \text{foot]} = \frac{\text{NIWR [feet]}}{\text{irrigation efficiency [\%]}} \times \text{irrigated acres}$$

- NIWR values range from about 1.5 to 6 and depend on crop type and location.
- Irrigation efficiency: 85% for pivots, 75% for sprinklers, and 60% for flooding.
- For example: for 80 acres of alfalfa irrigated with sprinklers in Clover Valley, estimated pumping is:

$$\frac{2.5 \text{ feet}}{0.75} \times 80 \text{ acres} = 267 \text{ acre} - \text{feet}$$

Irrigation pumping - Database

- Well database to include location and permit number(s).
- Pumping database will include annual well-by-well and hydrographic-area pumping estimates.



Year	Permit	Cert	Crop Type	NIWR (ft)	Irrigation Method	Irrigation Efficiency (%)	Irr Ac	Acreage Estimation Method	Acre-Feet Pumped
2006	67616		alfalfa	2.9	PIVOT	85%	120		372
2007	67616		alfalfa	2.9	PIVOT	85%	120		372
2008	67616						120		372
2009	67616		alfalfa	2.9	PIVOT	85%	240		744
2010	67616		alfalfa	2.9	PIVOT	85%	240		744
2012	67616								
2013	67616								
2014	67616								

Municipal and domestic pumping

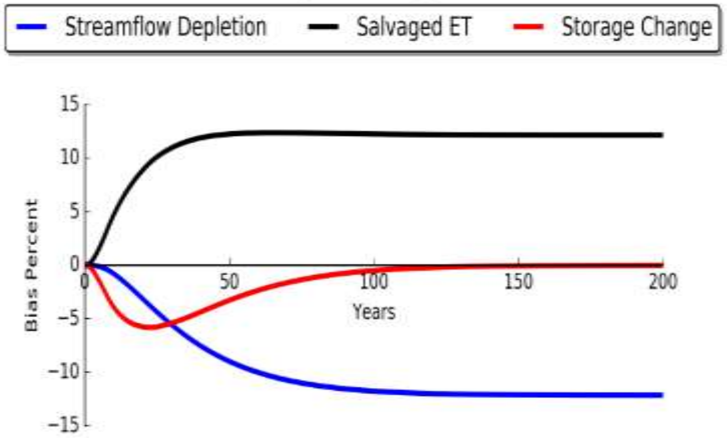
- Data sources: U.S. Bureau of the Census, NDWR Well Driller's logs, and NDWR municipal pumping data.
- Reported municipal water-use data and municipal populations suggest an approximate per capita water use of 0.4 acre-ft/yr.
- The per capita water-use value is used to estimate total municipal water use on the basis of municipal populations.
- In areas with significant Domestic water use: Domestic water use to be estimated by number of domestic wells multiplied by the average number of people per household times the per capita water use.
  - Will be applied in model as generalized pumping from Domestic use areas, not specific to any domestic wells.

Field verification and surveying

- Crews to go out this year and establish good vertical control on streamgages and key points along river.

Capture Map Bias

- M.S. thesis completed at UNR that:
  - Developed methods to evaluate capture map bias.
  - Characterized capture map bias
- Journal article summarizing findings is in review. Target publication in *Groundwater*

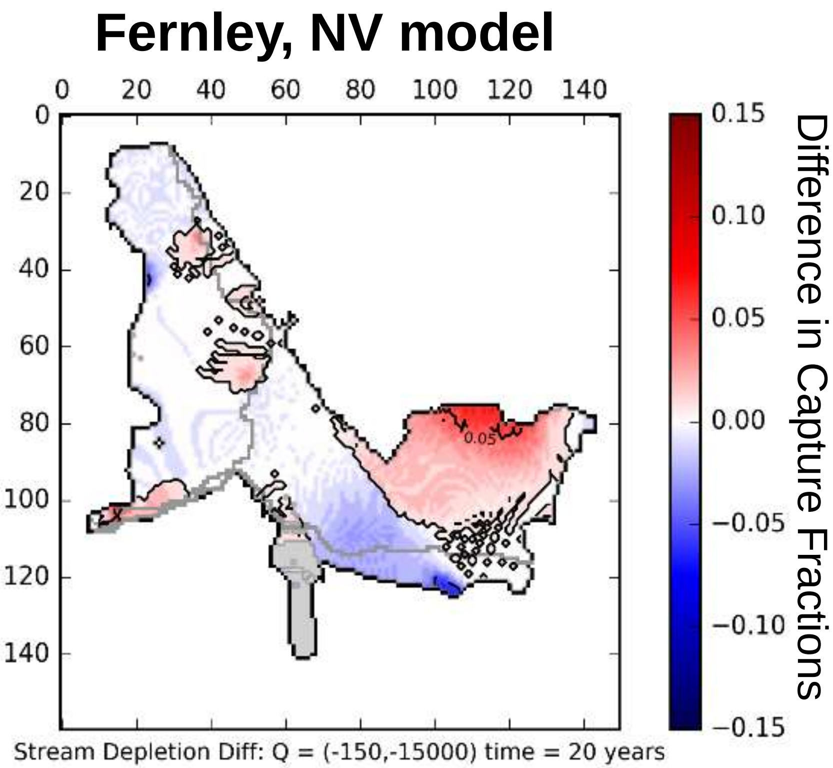


Capture Map Bias (cont)

- Capture maps may over- or underestimate capture for a group of wells.
- This over- or underestimation is Capture Map Bias
- Capture Map Bias is more present with models simulating the following conditions found in the HRB:
  - Unconfined aquifers
  - Evapotranspiration
  - Disconnecting streams

Capture Map Bias (cont)

- Capture Map Bias varies with location and time
- Capture Map Bias tends to be very low near rivers, thus capture map results are more accurate in areas of greatest concern
- Capture Map Bias often not substantial in areas of greatest concern
- Evaluation to be completed this year. Target publication is Oct 2017.



Model development, calibration, and analysis

- Data for model data files and model calibration still being assembled.
- Steady-state calibration process beginning soon.
- Will be followed by combined steady-state/transient calibration.
- Computer codes have been developed for capture map analysis.
  - Codes distribute the complex analysis to a 500 core computer cluster for more efficient evaluation.

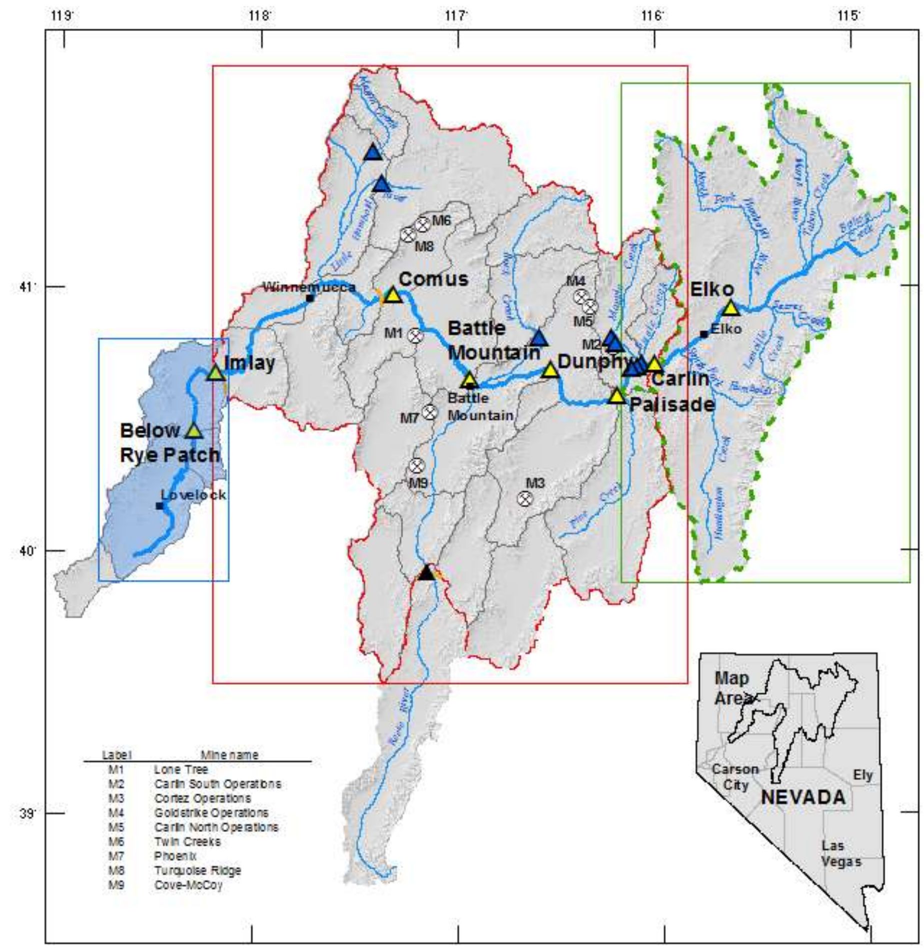
Groundwater Models

Lower Basin Model

Greg Pohll - DRI

Lower Basin Model

- A Lower Humboldt Model (Lovelock) is being developed collaboratively by the USGS and DRI
- Humboldt River streamflow depletion will be calculated after 10, 25, 50 and 100 years

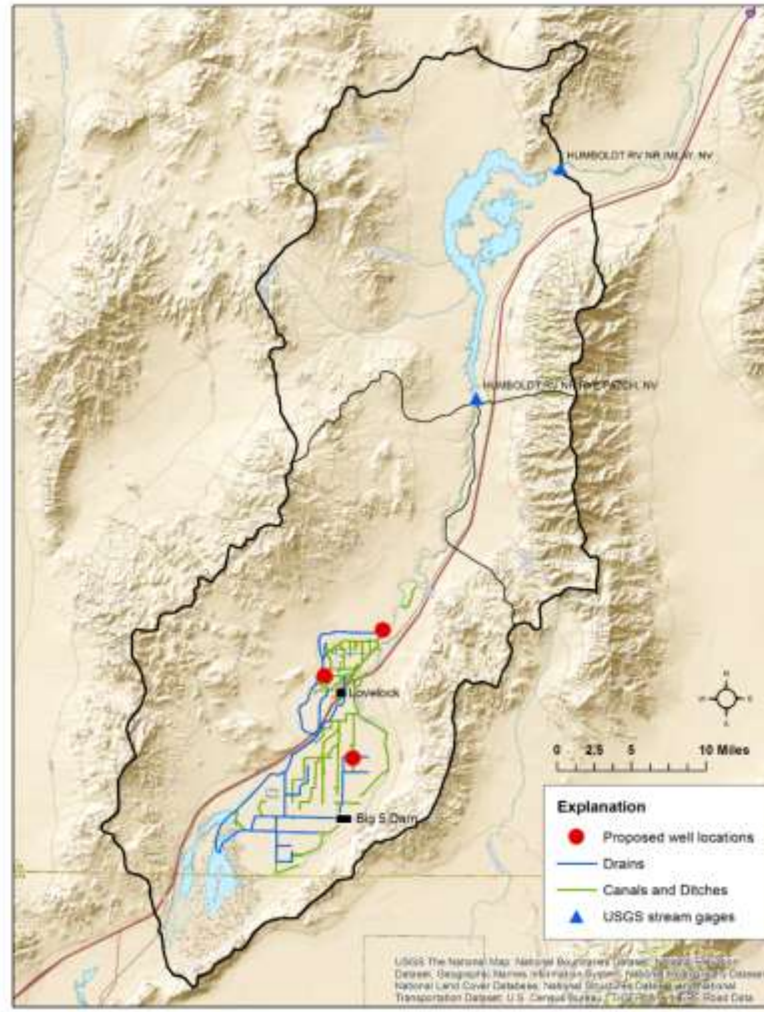


General Approach

- Build and calibrate Lower HRB MODFLOW model
- Similar construction, design, and calibration approach, but simpler
  - Steady-state model to be calibrated.
  - Does not simulate streamflow.
- Develop capture maps

Field Work

- Install six shallow observation wells
  - To help understand connection of canals and drains with GW system.
  - To evaluate storage properties from aquifer tests
- Conduct five aquifer tests



Model Design

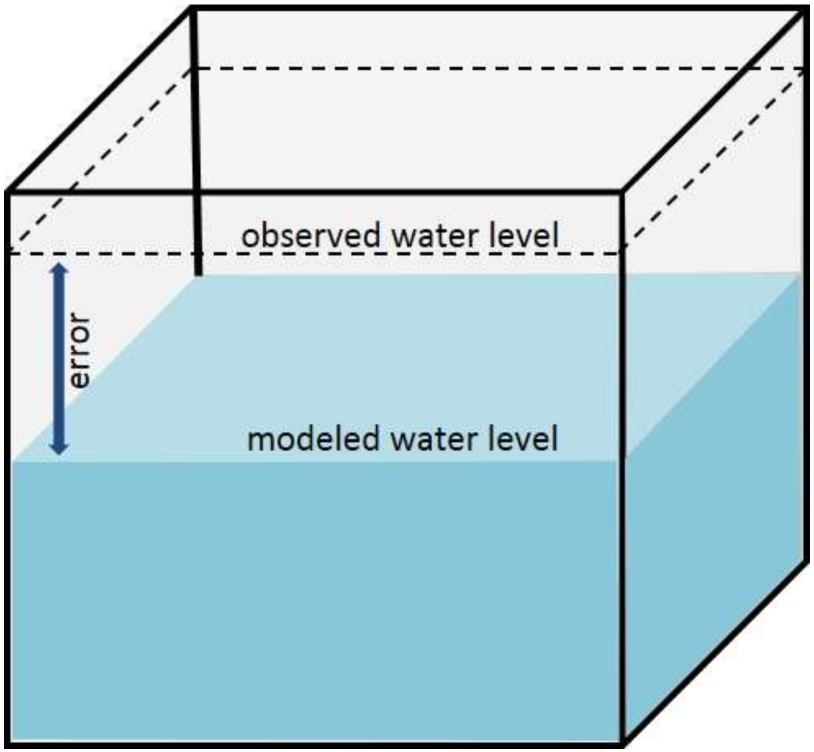
- Two to four layers including bedrock
- **Steady State model**
  - Assumes no long-term changes in groundwater storage
  - Represents the dynamic equilibrium nature of the lower system.
  - The model that will be calibrated.
- **Transient model**
  - Needed to evaluate capture over time.
  - Stresses (pumping rates) varied semi annually
  - Used to develop the capture maps.

Simulated Processes

- Recharge
- Groundwater flow and levels
- Humboldt River levels and major canal and drain levels
- Evapotranspiration of groundwater
- Groundwater pumping

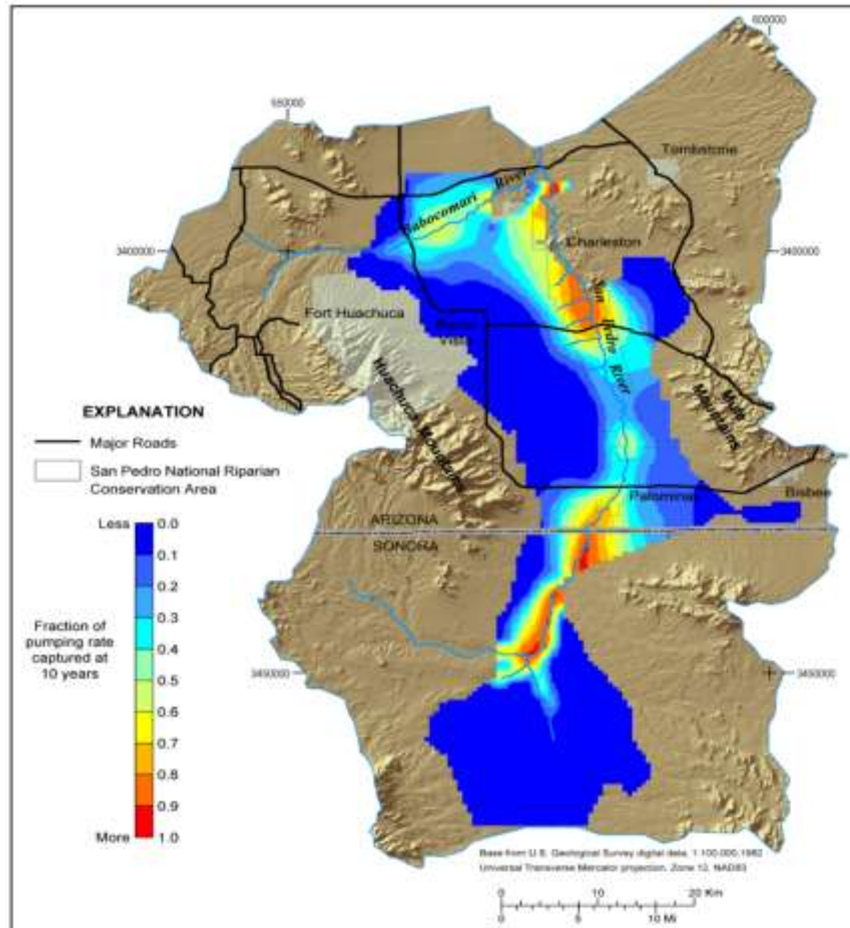
Model Calibration

- Model parameters are adjusted until a general level of agreement is met between simulated and measured:
  - Groundwater levels
  - Water budgets
  - ET rates
  - Transmissivity



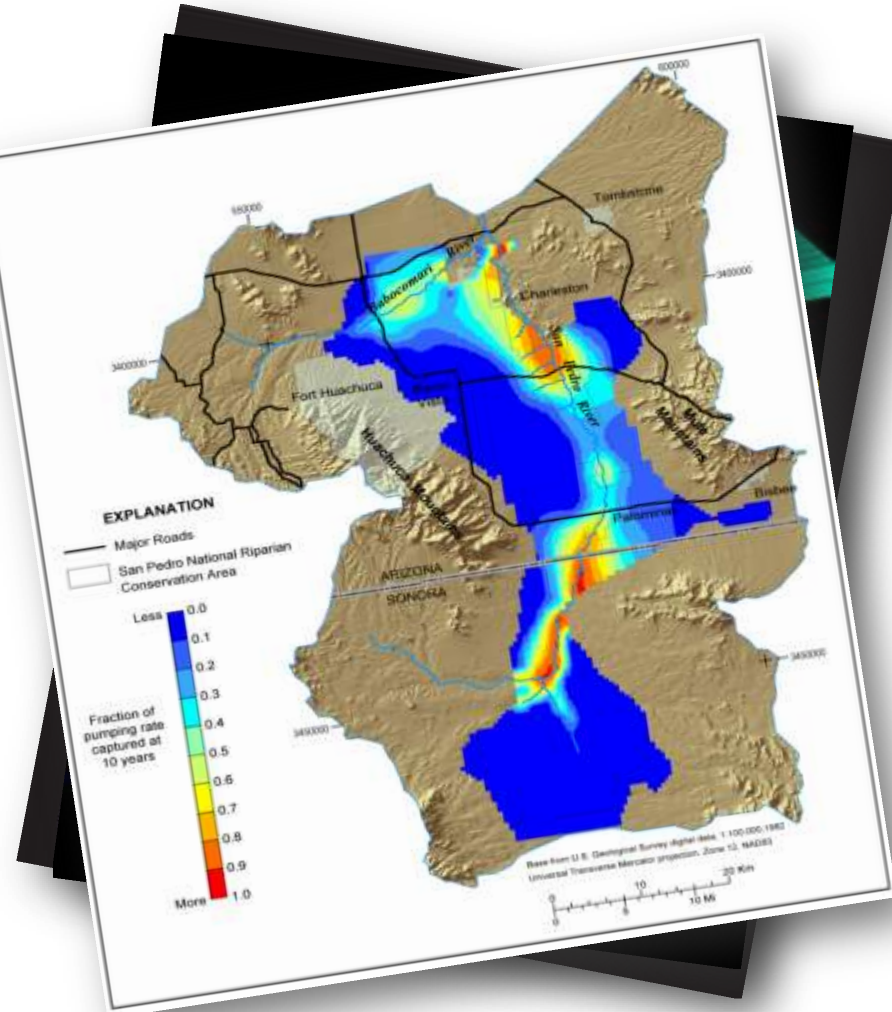
Develop capture maps

- Evaluate stream depletion as result of pumping from each cell for duration of 10, 25, 50, and 100 years

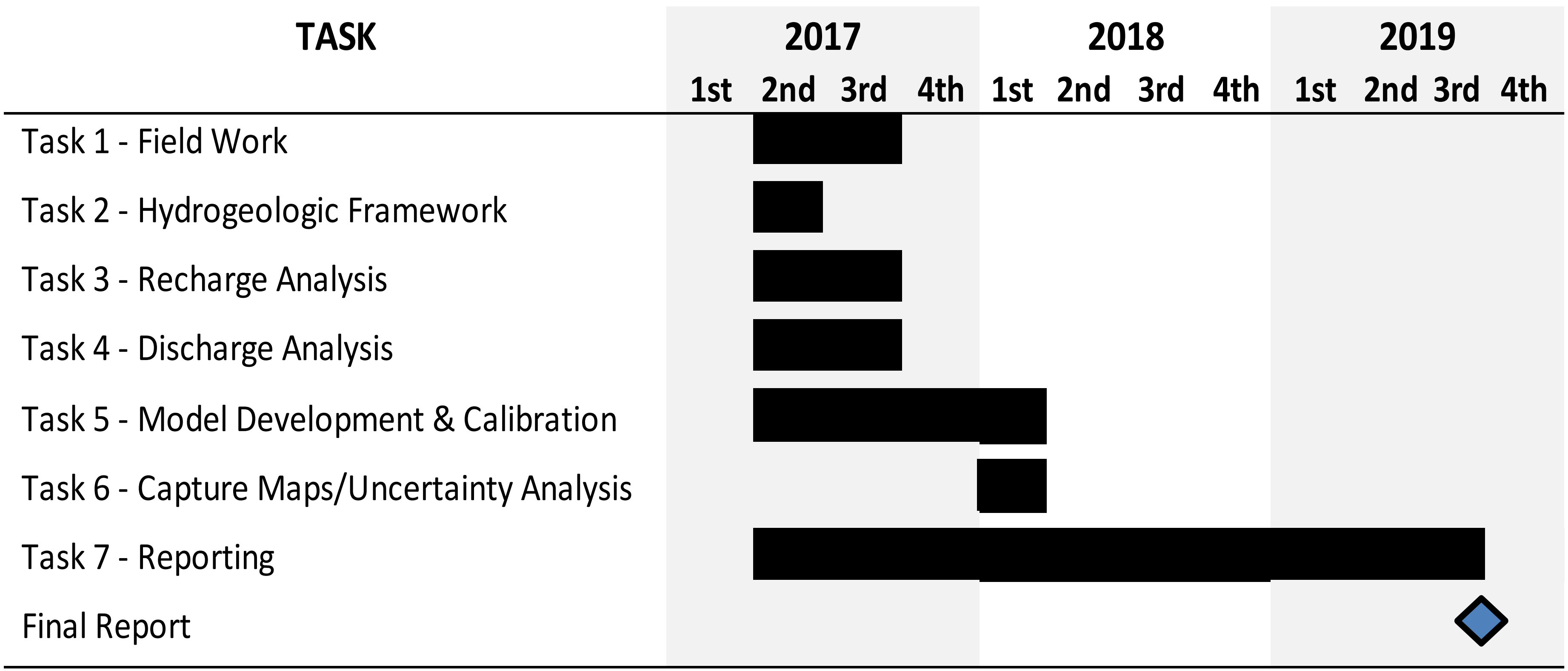


Peer-Reviewed Products

- Publically available models
- Interactive capture maps
- USGS scientific investigation report



Project Schedule



Humboldt River Basin Conjunctive Management

Humboldt River Basin Conjunctive Management

SB 73: It is the policy of this state to:

(e) To manage conjunctively the appropriation, use and administration of all waters of this State, regardless of the source of the water, and to encourage the use of augmentation plans to maximize the beneficial use of the water.

Humboldt River Basin Conjunctive Management

- Goal of establishing regulations for the conjunctive management of the waters of the Humboldt River Basin
- Maximize beneficial use
- Honor the prior appropriations doctrine
- Formed a working group of water users throughout the basin
- Regulations currently in preparation

Humboldt River Basin Conjunctive Management

Approach:

- Use models to establish percent capture
- Determine conflict – based on available supply, scheduled deliveries, actual deliveries
- Allow for multiple methods to mitigate or augment depletions
- Establish basin-wide mitigation plan with mitigation by financial compensation


Questions