

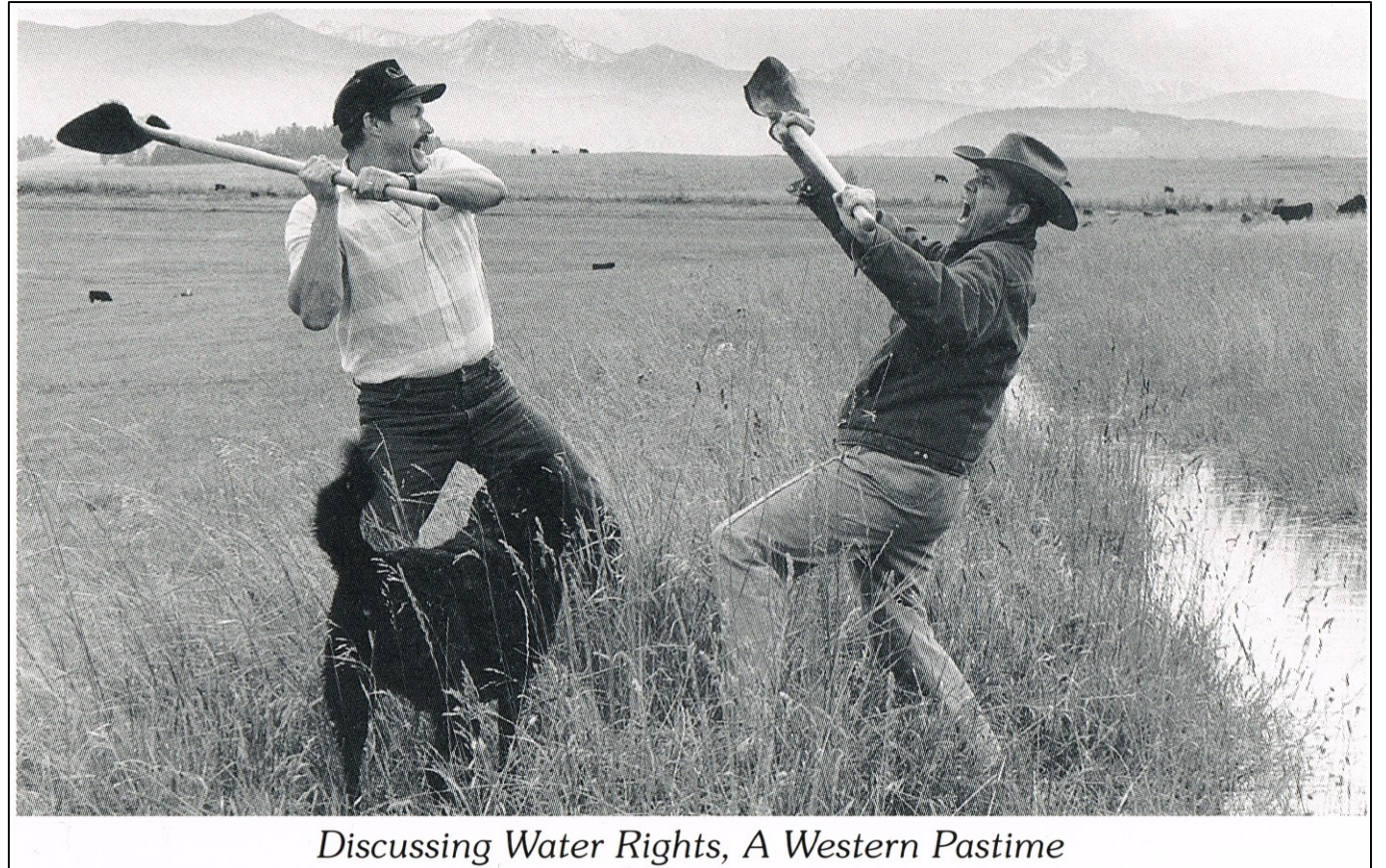
# Southern Utah

## Water Issues and Solutions

H. Roice Nelson, Jr.

Texas Professional Geoscientist #5120

04 November 2019



This presentation, with links, and a video can be downloaded from: <http://www.walden3d.com/water>



New Technologies in Exploration Geophysics

Trends and new developments in exploration methods using reflection seismology

H. Roice Nelson, Jr.

勘探地球物理新技术

石油工业出版社

04 November 2019

# Background & Ties

02 Oct 2019 Iron County Today

Howard R. Nelson, Sr.

Sara Penny

Pauline Hafen Nelson

Morris & Maxine Shirts

Russell, Randy, Andrea, Robert, & Steve

WEDNESDAY, OCTOBER 2, 2019

19

Life

COMMUNITY & PERSONAL INTEREST IN IRON COUNTY

George W. Middleton

by Jay M. JONES

FOR IRON COUNTY TODAY

One of Southern Utah's outstanding doctors was George W. Middleton, a native of Hamilton Fort, Utah. After receiving his doctorate in 1892 at Louisville, he began medical practice in Cedar City.

In addition to his medical practice, Dr. Middleton had a keen interest in civic affairs. In 1903, liquor prohibition became the major issue in Cedar City politics. As the nominee for mayor on the Citizens Prohibition Party ticket, Dr. George Middleton won 69% of the vote.

Early the next year, Cedar City prohibited the manufacture or sale of alcoholic beverages within the city limits, becoming one of the first localities in the nation to do so.

Dr. Middleton enjoyed the outdoors, and held a lifelong interest in geology. He was also a key promoter of the first culinary water system in Cedar City, which resulted in a significant reduction of local cases of typhoid fever.

In 1904, Dr. George W. Middleton's growing medical and surgical reputation

EARLY SOUTHERN UTAH DOCTOR

brought an increasing number of people to Cedar City in need of treatment. Up to that time, Dr. Middleton's out-of-town patients were quartered among the townspeople as well as could be arranged.

In order to provide more comfortable care for the patients and allow care providers better efficiencies, Dr. Middleton rented a

house on 300 West and equipped it as a hospital. Electrical power was not yet available in Cedar City, so to provide better lighting for an upstairs operating room, skylights were installed in the roof.

The first operation in the new hospital was in June of 1904 for appendicitis, and Miss Emily Banks of Minersville, UT was the patient.

Another case of appendicitis was a sad experience in the early practice of Dr. Middleton, as related by William R. Palmer in the 1942 edition of the Utah Historical

Quarterly. He had been called to the local Indian camp too see a sick boy. After diagnosing the problem, Dr. Middleton wanted to take the boy into town for an operation.

The Medicine Man resisted, so Dr. Middleton took out his prescription notepad and sketched the boy's intestines, showing the diseased point. He indicated where an incision needed to be made to remove the appendix. Still, permission was not given for Dr. Middleton to treat the boy.

A few days later, Dr. Middleton met the Medicine Man and inquired about the boy. He was horrified to learn that the Medicine Man had been impressed with the doctor's sketches, and had decided that he could perform the operation himself with a butcher knife. Tragically, the boy did not recover.

Lack of understanding of basic sanitation was widespread. Dr.

DR. MIDDLETON STANDS OUTSIDE THE HOUSE that became Cedar City's first hospital. On the porch are nurses Belle MacDonald, Belle Perry, and Kate Palmer.

MIDDLETON

\* CONTINUED FROM PAGE 19

Middleton took a local sheep rancher to court to keep sheep from grazing at the source of the city water supply. The Justice of the Peace did not see a problem. Dr. Middleton tried to explain about germs and how they carry disease. The Justice was not impressed – he reportedly said, "Show me a germ and I'll eat it. Case dismissed."

In 1906, a farewell party was held in Cedar City for Dr. Middleton, who was on his way to major medical facilities in the eastern U. S. and London for additional medical training. Following that, Dr. Middleton established practice in Salt Lake City and became one of the leading surgeons in the Intermountain West.

In addition to his medical practice, Dr. Middleton continued his interest in geology. He became friends with University of Utah geology professor Frederick J. Pack, and together they

arranged for horseback expeditions to Cedar Breaks and Zion Canyon with other leaders and residents of Salt Lake City and Cedar City.

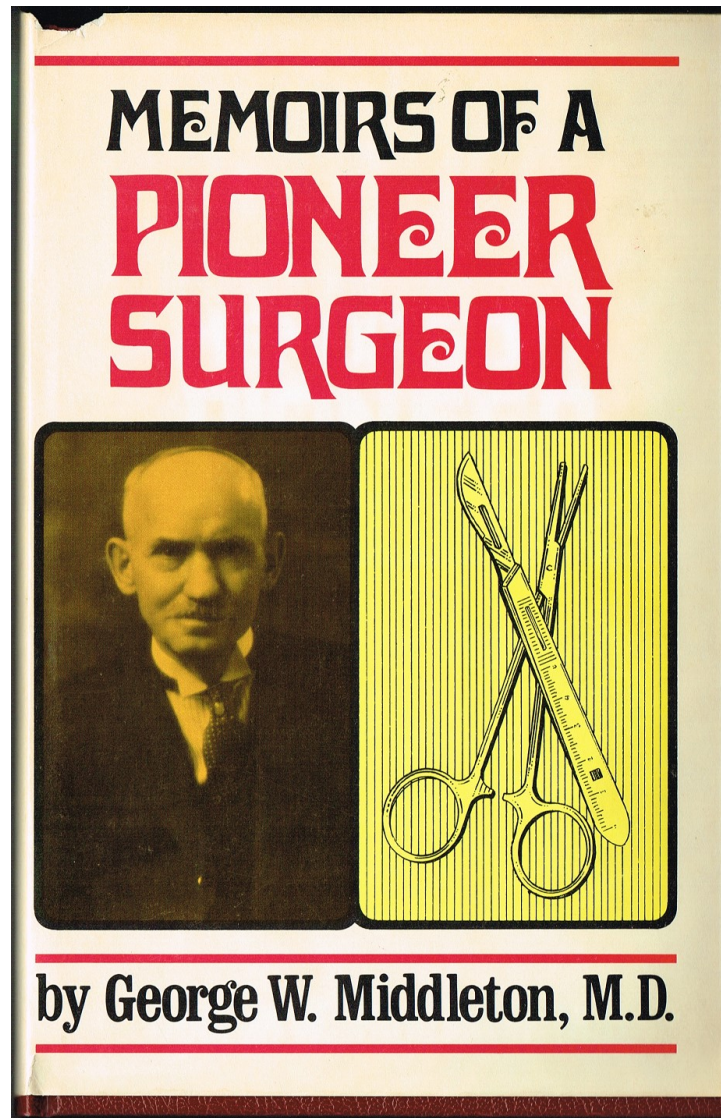
George W. Middleton died December 8, 1938 in Salt Lake City from a heart ailment. In an obituary, the Salt Lake Telegram stated, "Dr. George W. Middleton had lived an abundant and intense life. A one-line biography of this widely beloved man would possess a sense of completeness if it but said, 'He went about doing good.'"

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SUP Pot Luck Lunch Talk 2



# Pioneer Moment



and it remained for us to carry it out. Water systems outside cities of larger size were innovations in the state at that time and they met with a great deal of opposition from people who, living closely at home, could not know the advantage of such an improvement. As we proceeded with the work of having trenches dug and the pipes placed in position, the opposition grew. It tended to link itself with the opposition to prohibition, so we had a double fight.

When we were in the thick of it and feeling was running high, J. Golden Kimball, the humorous president of the Seventies (an order of the Mormon Church) came along on a preaching tour. I went to him and asked him to say something in his sermon to bolster our cause. He readily consented. When he had his audience worked up to a high pitch with his humor he said, "Just look at that filthy stuff running down the ditches in your streets. If you don't quit drinking that filthy stuff, I prophesy in the name of Israel's God it will kill three-fourths of you!"

We had levied a frontage tax on all the abutting property, allowing the owners who so wished to pay it out in labor. A big army of laborers turned out with their picks and shovels to take advantage of this opportunity. Mr. Edgar Clark, a fine gentleman from Parowan, came down one day when the trenches were under construction. When he saw this army of men at work, he said to me, "This is the finest sight I ever saw in my life. For forty years I have been coming here, and have seen these men sitting on the street-corners whittling sticks, and now to see them engaged in some useful constructive work for the benefit of their community is a sight worth coming from Parowan to see."

There were those at first who would not touch the water out of the system, although it was clear, while the water in the ditches was full of silt and organic impurities. However, one by one they gave in until the new system became very popular.

The success of this much-needed improvement seemed to initiate a spirit of progress which has continued ever since.

Piping of the water was a dramatic demonstration of the relationship of typhoid fever to an impure water supply. Every year when the floods used to begin coming down the canyon there would be an epidemic of typhoid fever, with several fatalities. As if by magic these epidemics stopped completely as soon as our new system was supplied by pure water from the mountain springs.

A few years after this, when Dr. T. B. Beatty, Secretary of the State Board of Health, was trying to induce all the larger towns to build water systems, he went to attend a mass meeting of the citizens of the village of Kamas. They had this matter under consideration. One old settler was much opposed to his town going into so unnecessary an enterprise. He said the water of Kamas tasted so good that he was always glad to get back home so he could get a drink of it.

Dr. Beatty said to the old man, "Now, while you are very definite in your opinion, there seem to be others who favor the water system. I think we can arrange it so you will all be happy. We will put in the system, and all those who are satisfied with the taste of the water can take it unmodified. You can mix enough barnyard manure with yours to give it the exact flavor you prefer. So everybody will be satisfied."

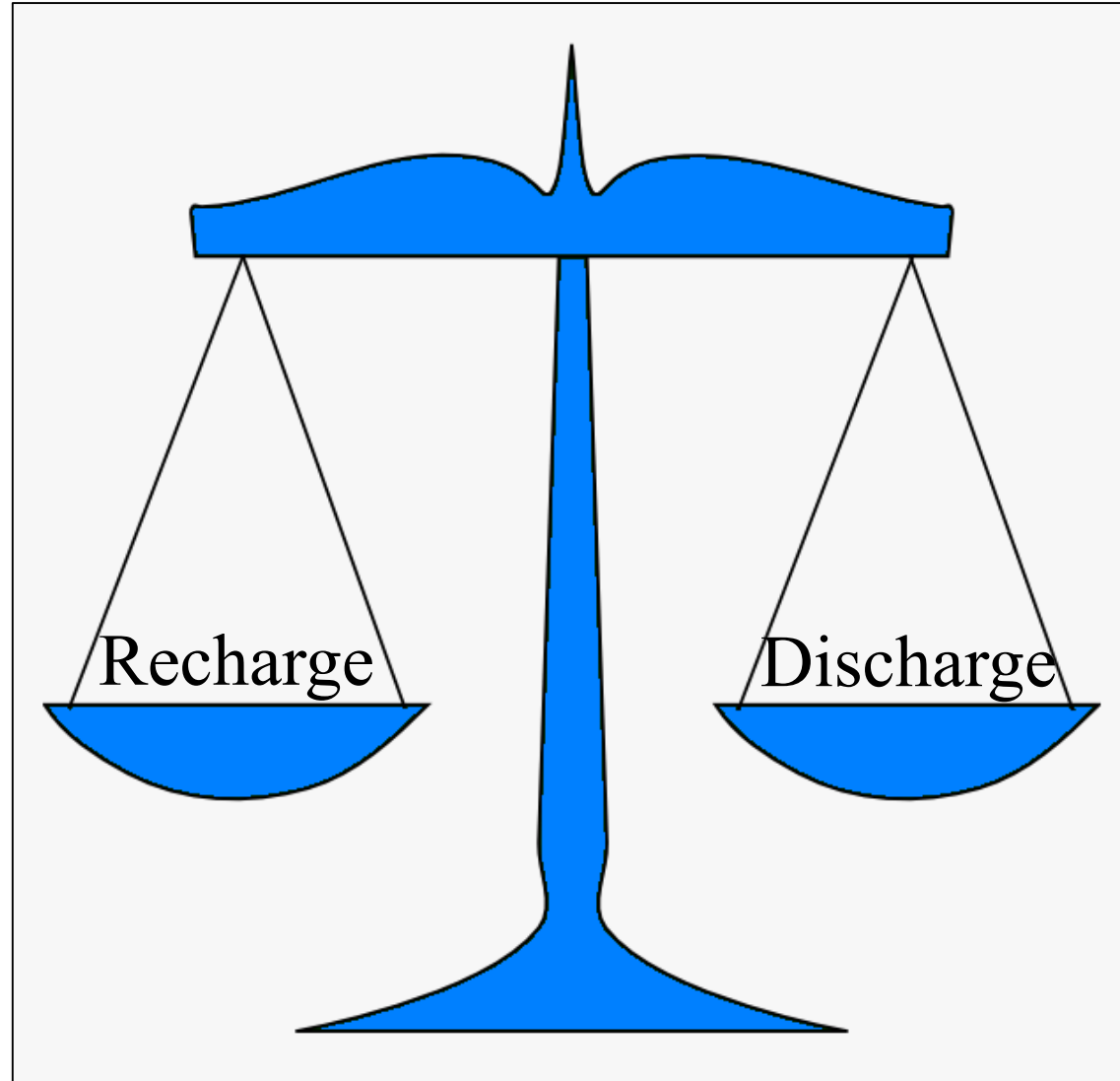
There was one great source of satisfaction to me during these years of hard medical work and political activity in that the best element of the community stood squarely behind me, and this, of course, meant the big majority of citizens. I shall never forget their loyalty and support and shall hold them in grateful remembrance as long as I live. Eventually, however, a time came when even their loyalty could not compensate for the complexities of my life.

I remember well the day this feeling crystallized in me. It

# Introduction: Water Issues are Legal not Scientific

## Law Requires:

1. Recharge must equal Discharge
2. Depth of Wells not considered
3. Age of Water not considered
4. Enforcement is model based



## Science Shows:

1. 
$$\begin{array}{r} 28,000 \text{ A.F. Out} \\ 21,000 \text{ A.F. In} \\ \hline 7,000 \text{ A.F. Over} \\ \text{in valley aquifers} \end{array}$$
2. Drainage Basins & Valley Aquifers
3. Using 5K-16K year old water
4. Models are, at best, estimates



# Two Legal Concepts used in this presentation

**Safe Yield**, the basis for State Engineering planning, which is defined as follows:

- Safe yield of a groundwater basin or aquifer system is the amount of water that can be withdrawn from it without producing an undesirable effect (Todd, 1959), including:
  - Reduced discharge of groundwater to surface water features.
  - Reduction in ecological base flows.
  - Overlapping of drawdown cones.
  - Depletion of reserves.
  - Land subsidence due to pore pressure reduction.

## **Law of Capture:**

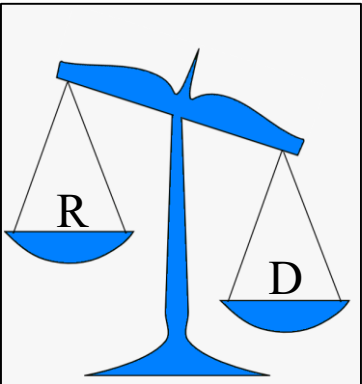
- The law of capture states that the first person to capture a natural resource owns that resource. The rule of capture helps in determining the ownership of natural resources like groundwater, oil and gas that is captured. The rule encourages an owner to drill as many wells as possible on his/her piece of land so as to extract all the groundwater, oil and gas. The rule of capture was developed by English common law. However, U.S. courts have also applied the rule of capture, and it is the basis of oil & gas law in Texas.



# Ground Water Management Plan

**Problems** (<https://www.waterrights.utah.gov/groundwater/ManagementReports/CedarValley/Recharge%20Estimate%20for%20Cedar%20City%20Valley.pdf>):

28,000 acre-feet per year depletion from groundwater pumping,  
21,000 acre-feet per year average annual recharge  
7,000 acre-feet per year over-pumping of The Aquifer +  
There is 50,878.36 acre-feet Cumulative Depletion allocated for Cedar Valley.



**Plans at Groundwater Plan Web Site for Cedar Valley** (<https://www.waterrights.utah.gov/meetinfo/m20161208/>):

- Recharge aquifers.
- Retract water rights granted after 1934:

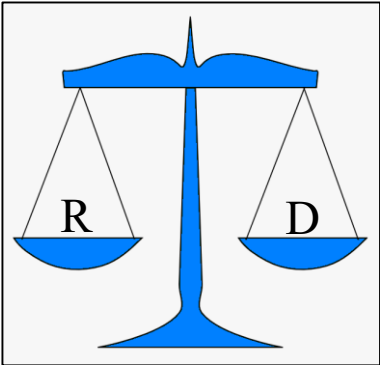


Table 1 Priority Regulation Schedule

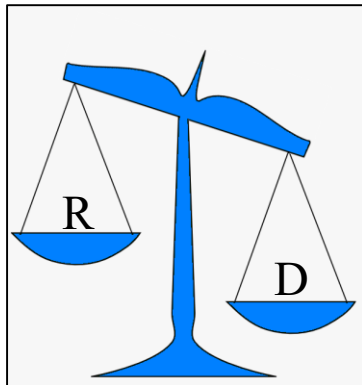
Phase	Target Date	Priority Dates Regulated Through	Acre-Feet Reduction in Estimated Depletion	Cumulative Acre-Feet Reduction in Depletion	Remaining Depletion (acre-feet)
1	January 1, 2035	December 31, 1957	5,434	5,434	45,530
2	January 1, 2050	December 31, 1954	7,330	12,764	38,200
3	January 1, 2060	December 31, 1951	8,814	21,578	29,386
4	January 1, 2070	December 31, 1935	6,761	28,339	22,625
5	January 1, 2080	July 25, 1934	1,518	29,857	21,107

- Build a \$200-\$500 million-dollar pipeline from Wah Wah & Pine Valleys in Beaver County.



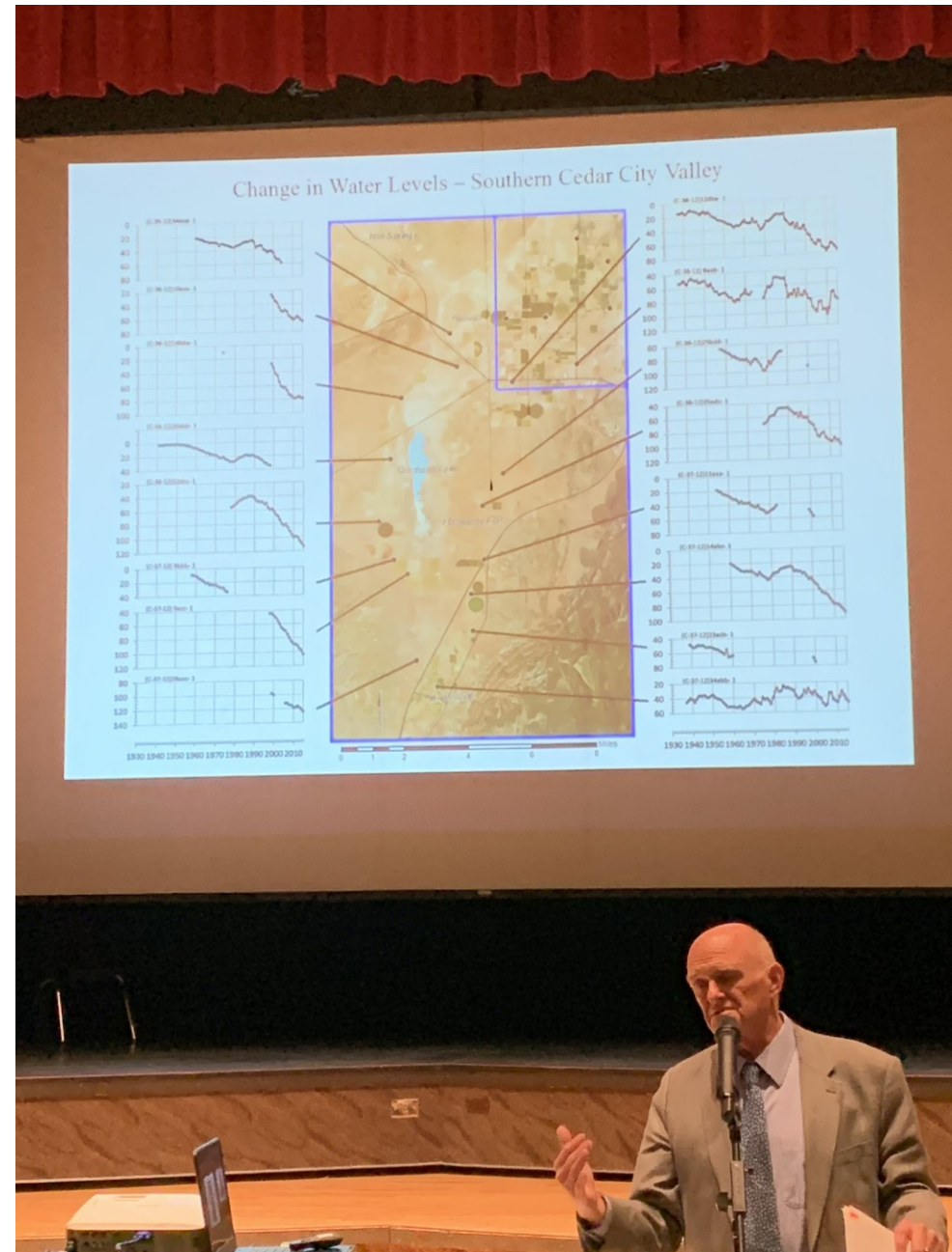
# 1. Recharge Must Equal Discharge

- The State Engineer, Kent Jones, presented a ground water management plan for Cedar Valley at Cedar High School on Wednesday, 15 Oct 2019.
- He showed the drop in water levels in wells throughout the Cedar Valley Aquifer.



04 November 2019

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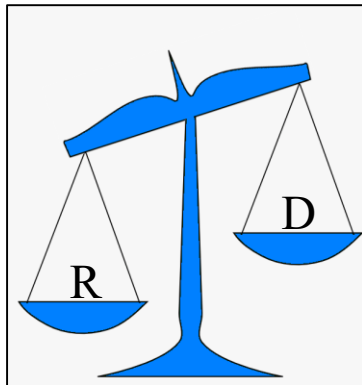
SUP Pot Luck Lunch Talk 7



# Kent Jones also talked about Recharging “the Aquifer”

<u>Storage Location</u>	<u>(Acre feet)</u>
Schmidt Pit .....	520
Airport pits .....	1,719
Horse Alley pits .....	719
*Western Rock pit .....	6,000
Enoch Graben .....	32
Quichipa .....	100
<b>Total .....</b>	<b>9,990</b>

\*Approximate number



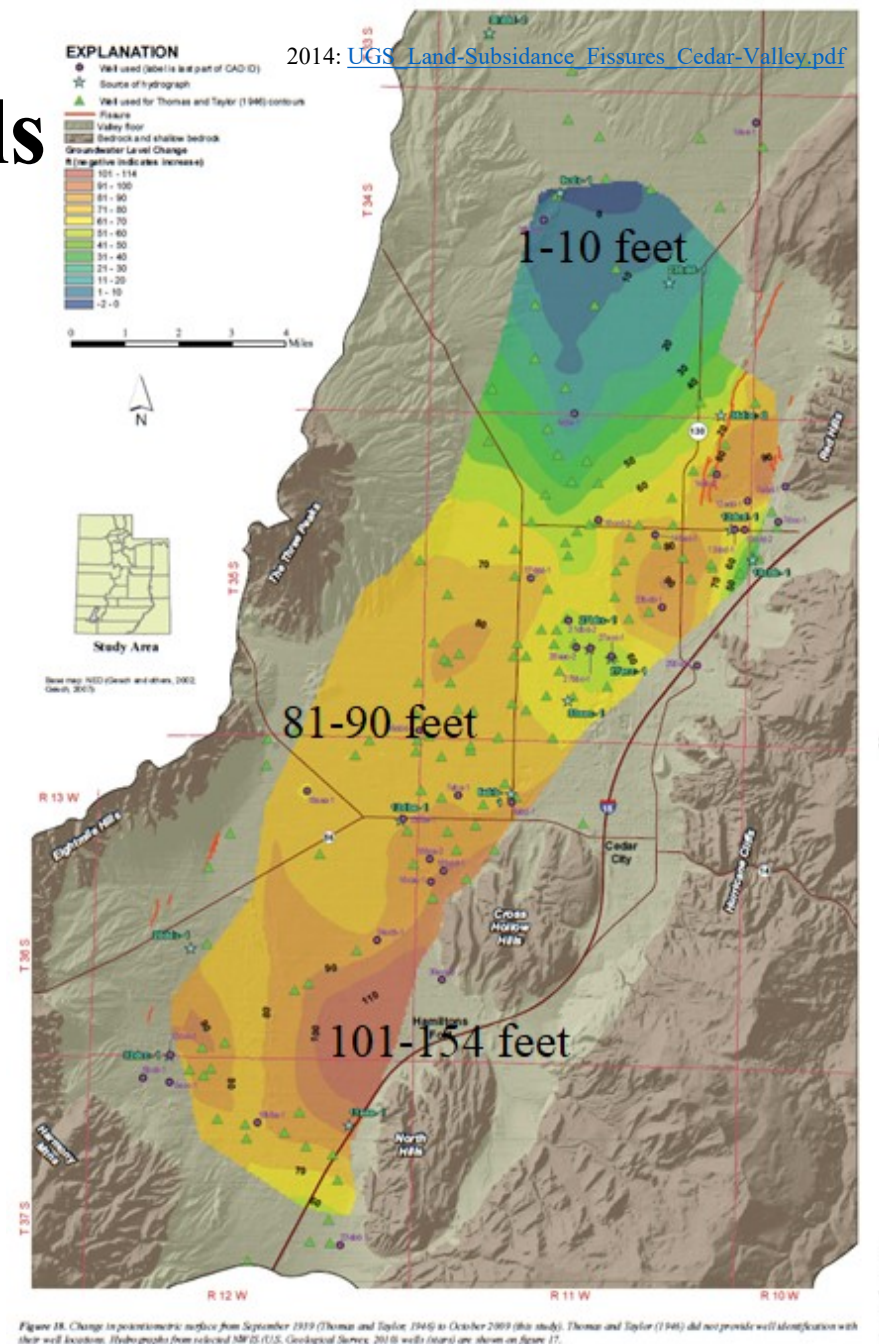
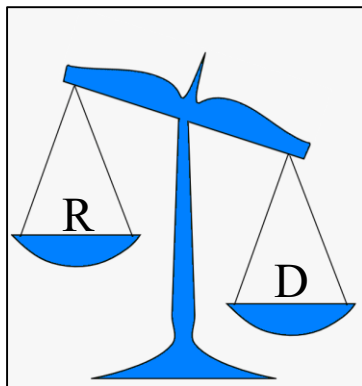
- Our deficit in the valley is 7,000 so we exceeded our deficit by nearly 3,000 acre-feet.
- Cedar City, CICWCD, Iron County and Enoch City should be very proud of the accomplishments to capture this precious resource. It was inter-local agencies and the communities working together that made this possible. We will continue to push for future projects to assist in this effort.
- The results of these efforts will protect private and governmental water rights and even though it will be needed at some point it will delay the need for a very expensive pipeline from Pine Valley. Very grateful for the moisture we have been blessed with.

Paul Cozzens  
435-590-7618



# He focused on lowering aquifer levels

- The drop in aquifer levels should be a concern for everyone in Cedar Valley:
  - Empty aquifers collapse, and will not refill.
  - This causes the fissures seen out by Enoch.
- Note the study of aquifers are only in the valley:
  - Bed Rock aquifers, outside of the valley fill, will neither drop nor collapse the same way.
- Next a brief geology lesson:



# Cedar Aquifer (white) is a subset of the Cedar Valley Drainage Basin (black)



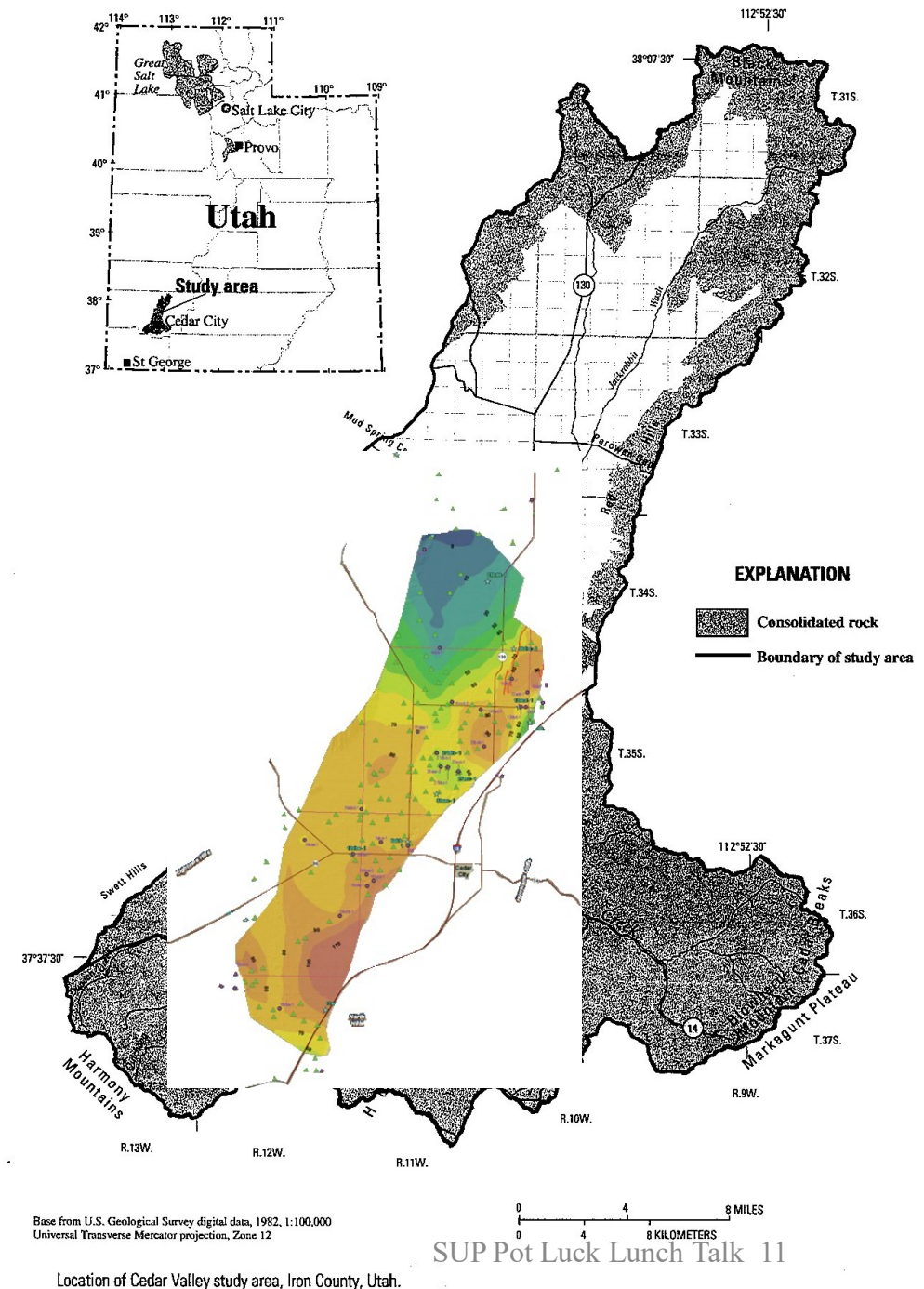
The Cedar Valley Aquifer is a subset of the Cedar Valley Drainage Basin, and is the white area on map to the left.

Black areas are referred to as “Bedrock” areas.

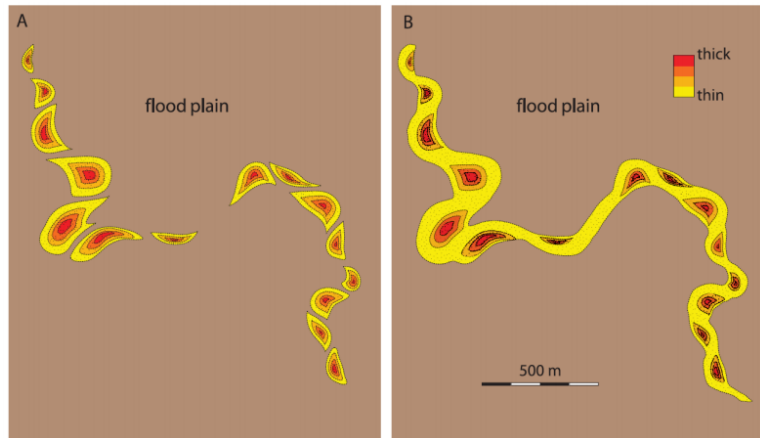


# Cedar Valley Aquifer

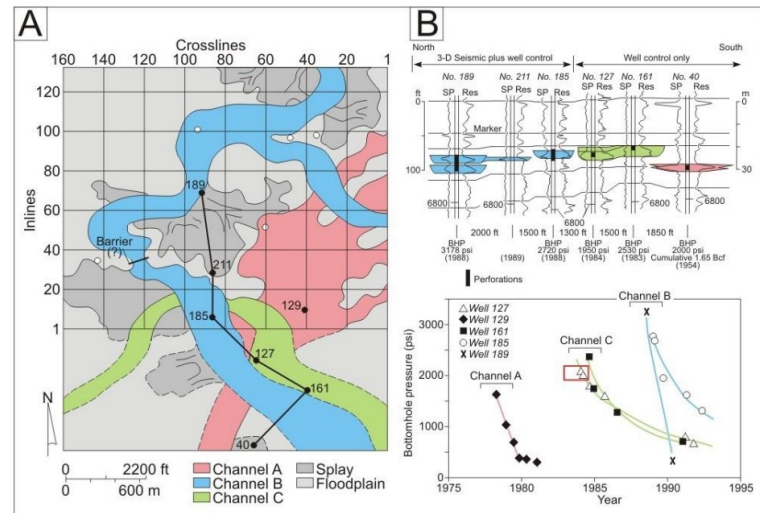
- Most of the wells, and thus the USGS & UGS model studies of aquifer level drop, and resulting problems which impact Safe Yield within the Cedar Valley Drainage Basin, are in the unconsolidated valley fill of the Cedar Valley Aquifer.
- However, the “Effective Area” defined by the State Engineer and his staff is the entire Cedar Valley Drainage Basin.



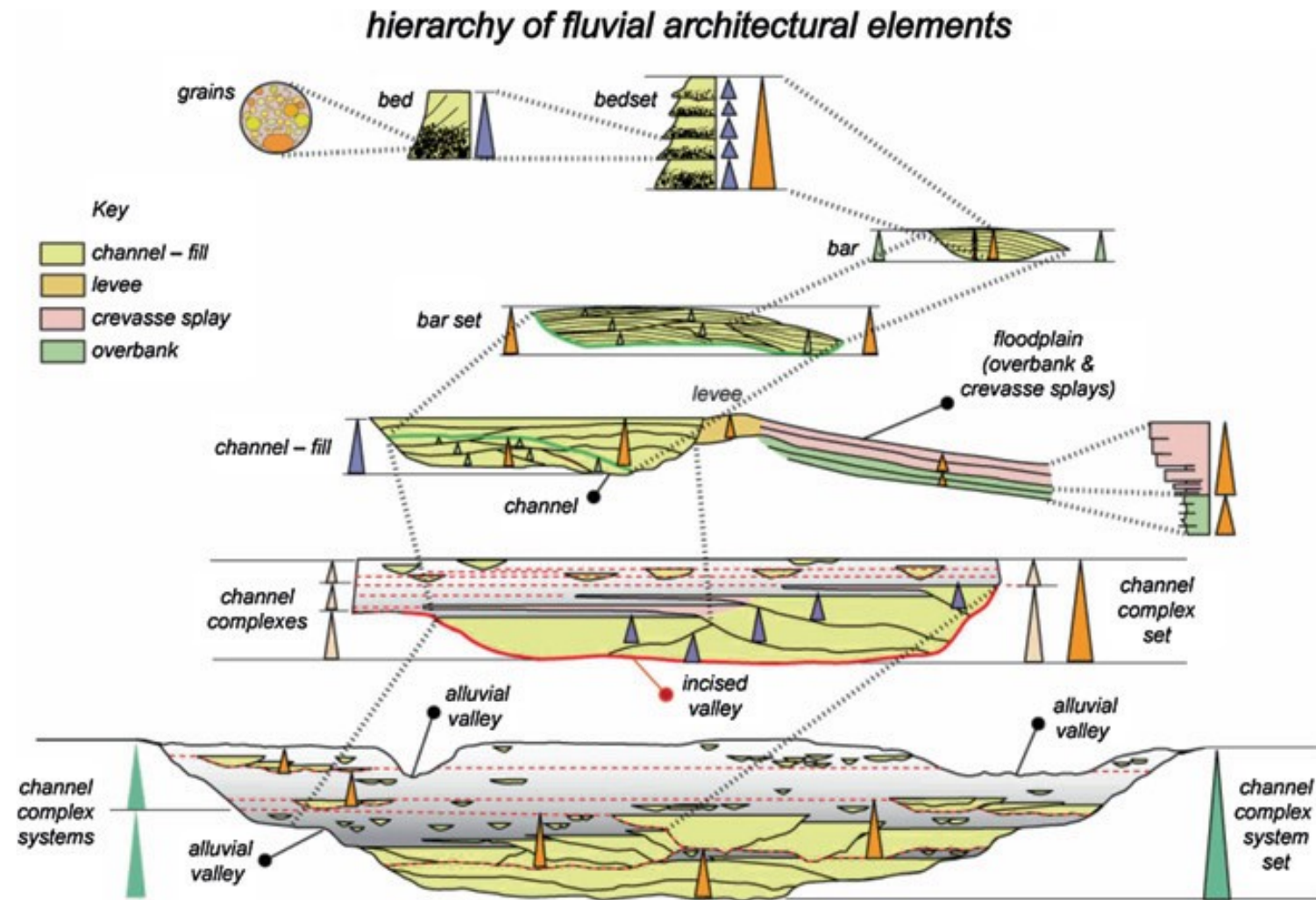
# Fluvial Systems and Aquifers, like the Cedar Valley Aquifer, have complex geometries



Flow Processes and Sedimentation in a Low-Sinuosity High Net-Sand Content Fluvial Channel Belt: 3D Outcrop Study of the Cedar Mountain Formation, Utah, Bradley Nuse, [http://inside.mines.edu/UserFiles/File/CoRE/Thesis\\_Dissertation/Nuse\\_Bradley.pdf](http://inside.mines.edu/UserFiles/File/CoRE/Thesis_Dissertation/Nuse_Bradley.pdf)



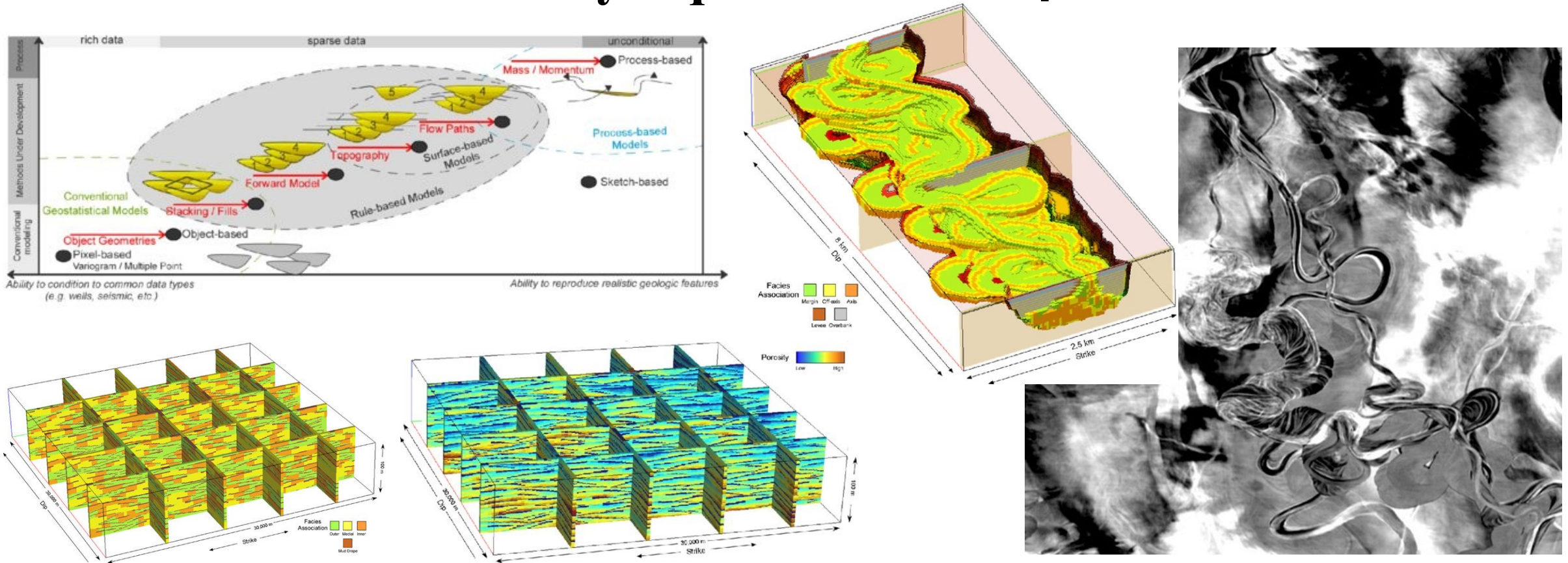
A 3-D seismic case history evaluating fluvially deposited thin-bed reservoirs in a gas-producing property, Bob A. Hardage, et. al., Geophysics, Nov. 1994.  
04 November 2019



Chapter 2, The Facies and Architecture of Fluvial Systems, Figure 2.2, page 11.



# Aquifers in the first 600-800 feet of the Cedar Valley Aquifer are Complex

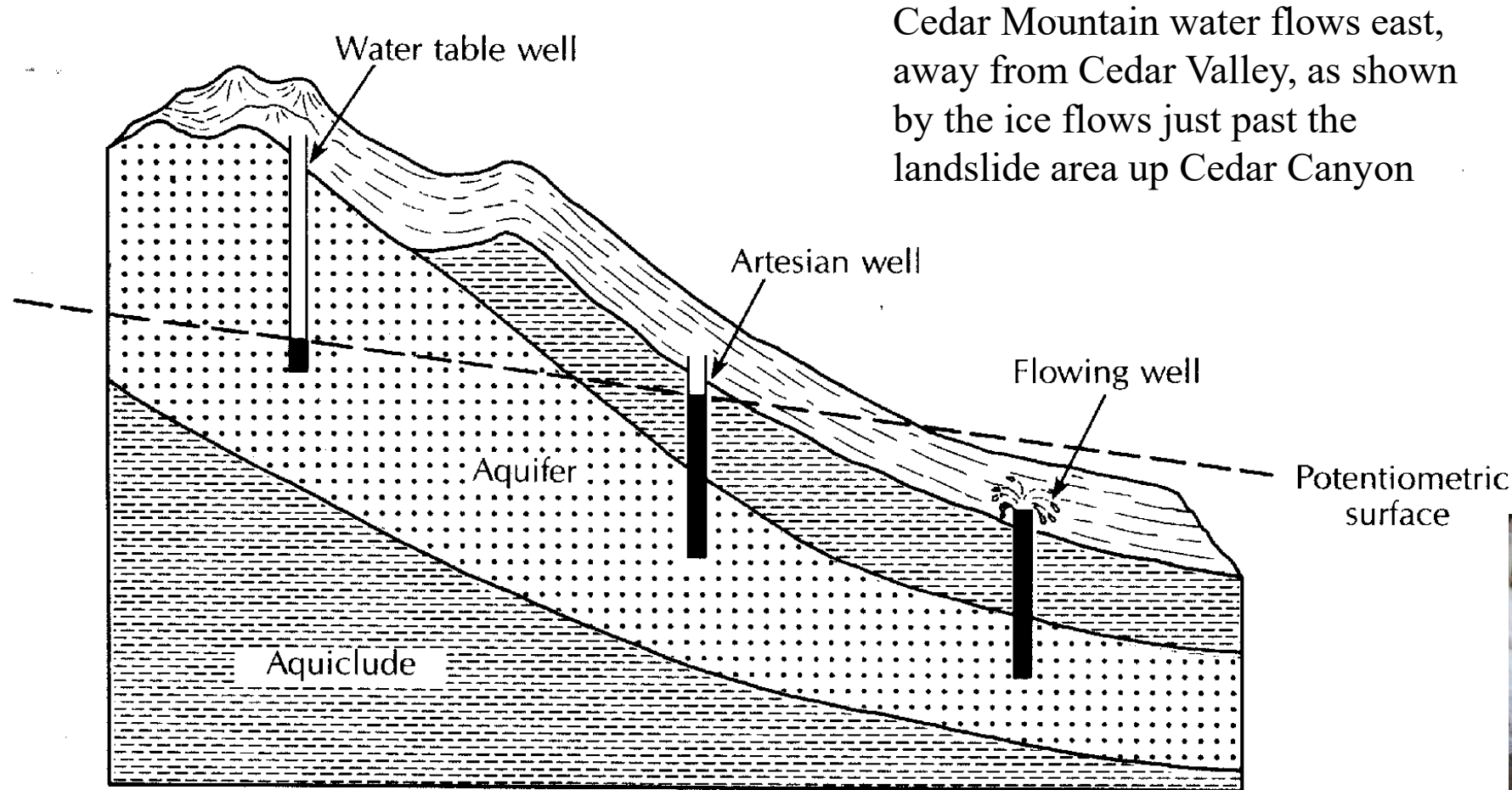


3-D seismic horizontal slice showing fluvial channels

[https://www.researchgate.net/publication/303960851\\_Stratigraphic\\_rule-based\\_reservoir\\_modeling/figures?lo=1](https://www.researchgate.net/publication/303960851_Stratigraphic_rule-based_reservoir_modeling/figures?lo=1)

<https://www.shearwatergeo.com/>

# Water & the Potentiometric Surface



Both photos west side of Highway 14  
No ice flows on east, due to east dip.



Photos by Gary F. Player

SUP Pot Luck Lunch Talk 14

**FIGURE 4.21** Artesian and flowing well in confined aquifer.

<https://www.slideshare.net/VISHNUBARUPAL/types-of-aquifer-by-bablu-bishnoi-65855846>, slide 16 of 24.



# Loss of Coal Creek Water in Jurassic Sandstone Red Rocks



Water migrates down bedding planes. Bedding planes continue underneath the valley fill soils. Joe Armstrong contends there is 50% water loss from Coal Creek as the creek passes over the high porosity Navajo Sandstone formation.

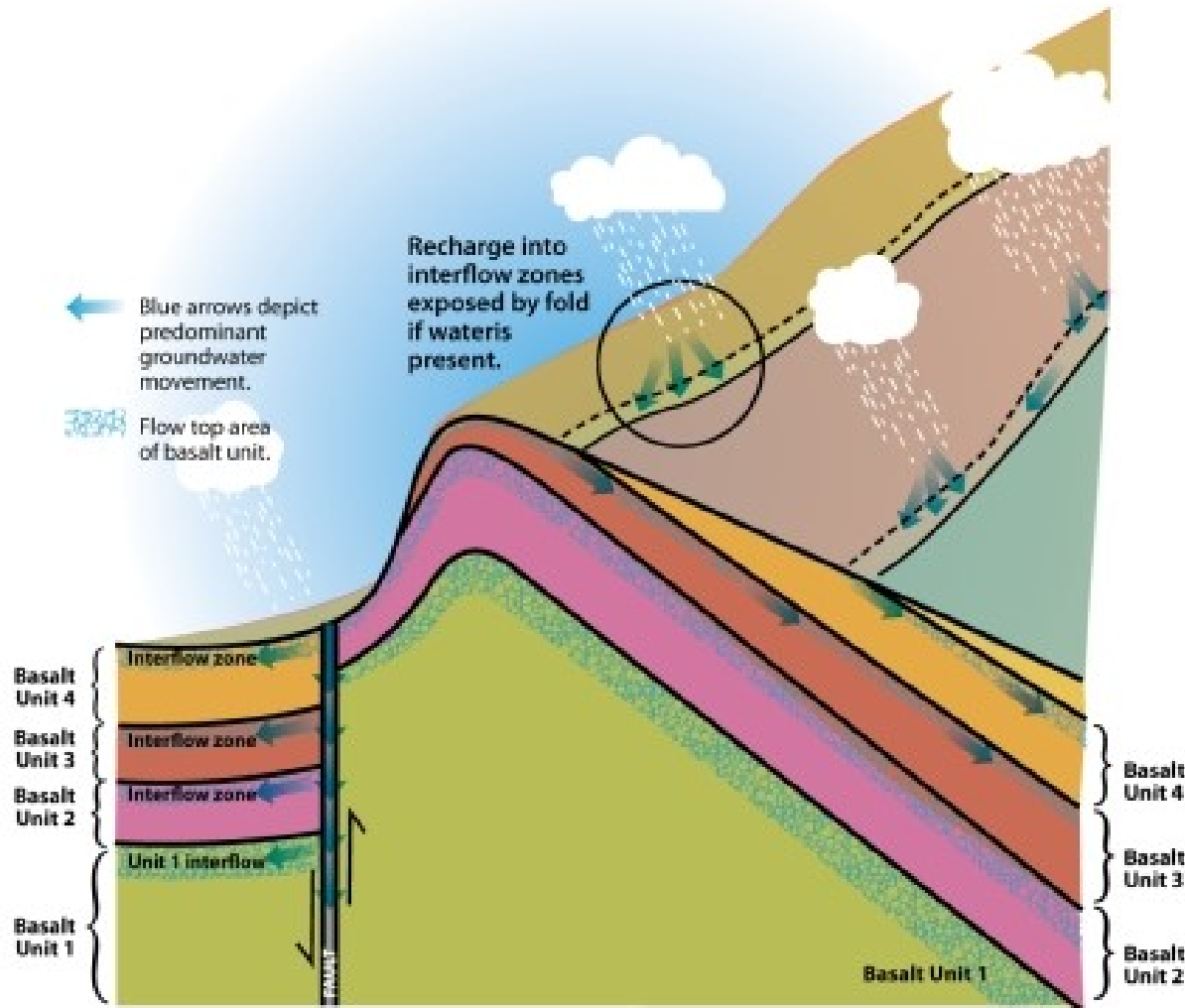


# Faults & Dip Force Water Flows from Cedar Mountain East & South

- Bedrock dips to the east about 10 degrees;



- Faults bounding the valley disrupt baseflow, especially into the Cedar Valley basin fill aquifer.
- Aquifer overproduction is very shallow (less than 800 feet depth) and except for water flowing down Coal Creek and Fiddler's Canyon these shallow layers are isolated from mountain recharge by layers of clay and the potentiometric surface dip.



[http://cbgwma.org/index.php?option=com\\_content&task=view&id=60&Itemid=115](http://cbgwma.org/index.php?option=com_content&task=view&id=60&Itemid=115)



# USGS & UGS Groundwater Budget

- Defined by Limited Area within Drainage Basin.
- Does not recognize flow along faults to south.

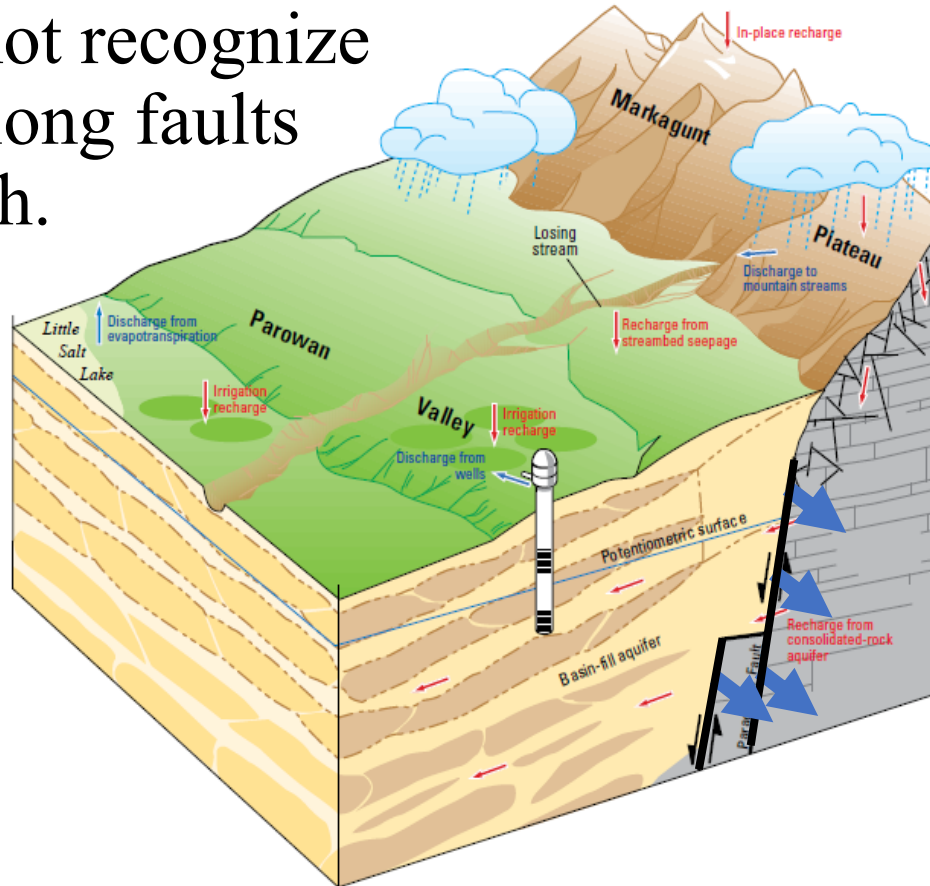
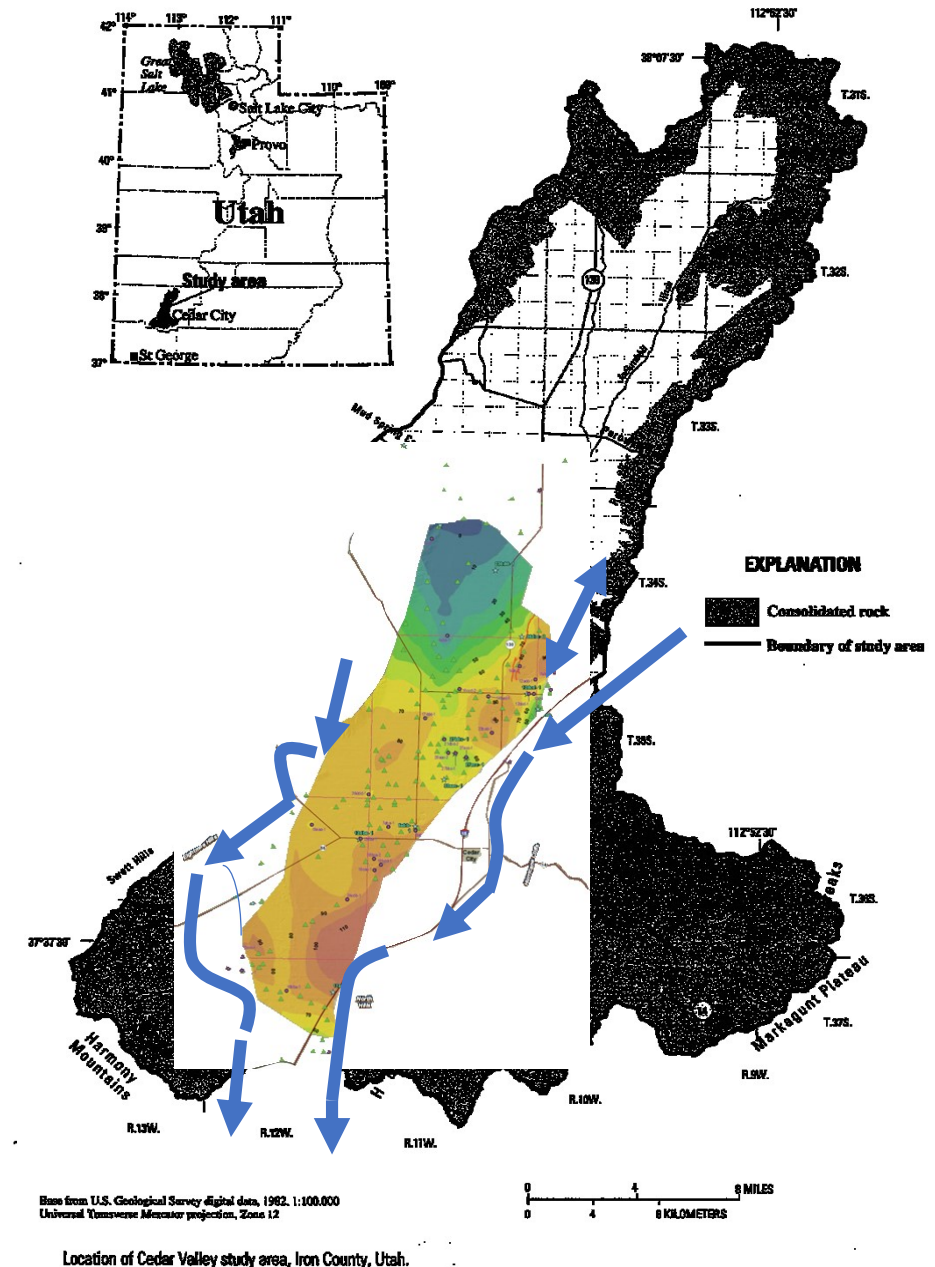


Figure 13. Conceptualized hydrologic setting and groundwater system in the Parowan Valley study area, Iron County, Utah.

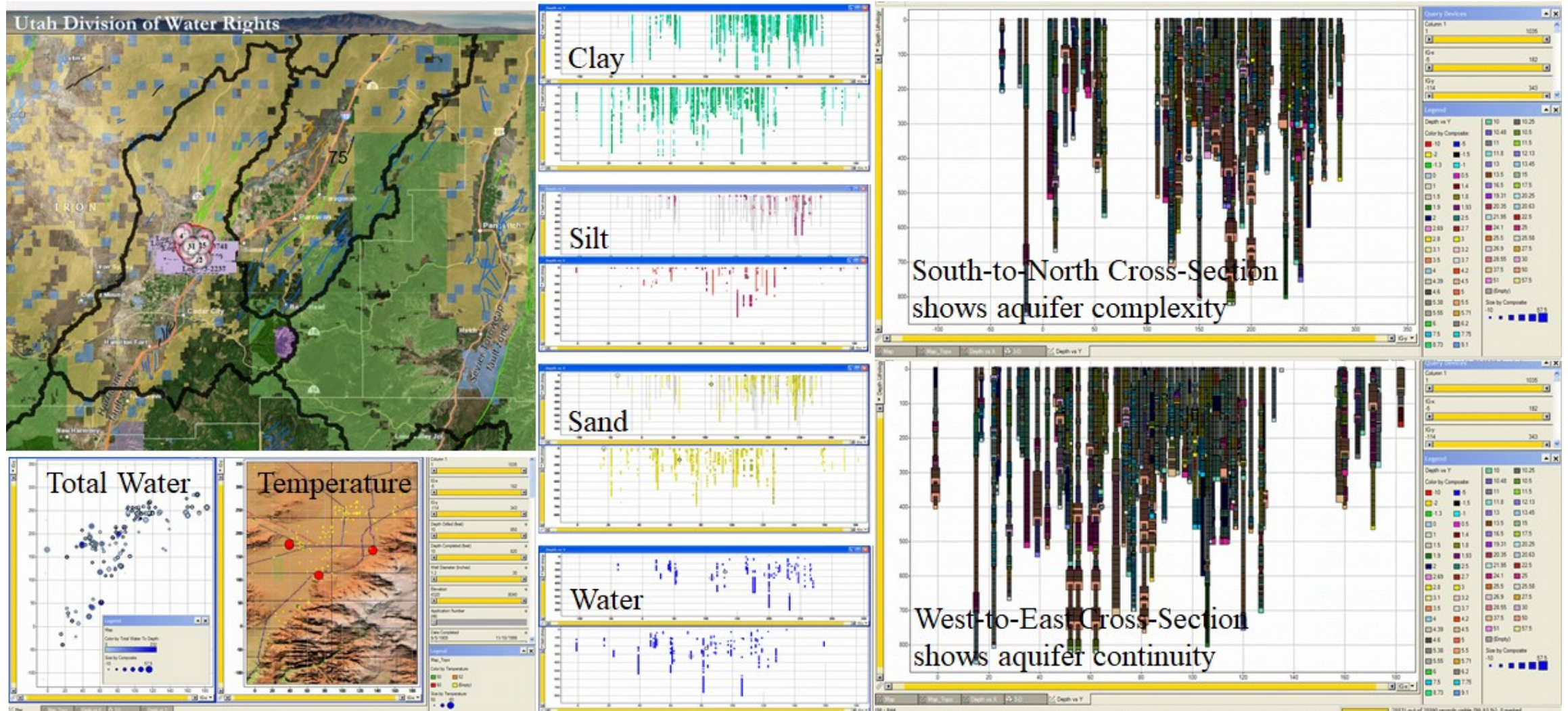
USGS Report 2017-5033, Water Resources of Parowan Valley, Iron County, Utah modified with blue south trending, along large faults transport, arrows  
<https://pubs.usgs.gov/sir/2017/5033/sir20175033.pdf>.





## 2. Depth of Wells – Drainage Basins & Valley Aquifers

In 2006, I looked at 145 well logs in Cedar Valley, the deepest well was 820 feet deep





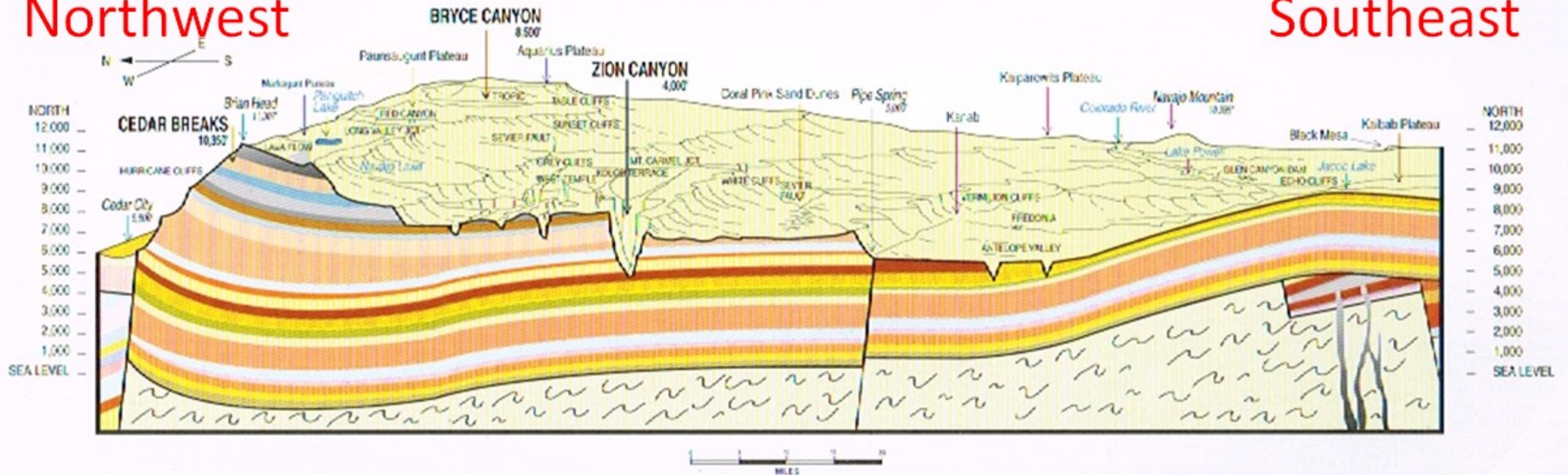
# Geologists Use Cross-Sections to Show Trends

## Geological Cross Section of the Bryce Canyon National Park area

Including Cedar Breaks National Monument and Zion National Park

Northwest

Southeast

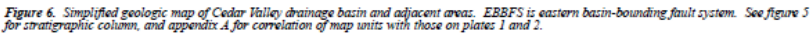


In Cedar we can drive up the Cedar Canyon to study geology faulted down underneath the valley by the Hurricane Fault.

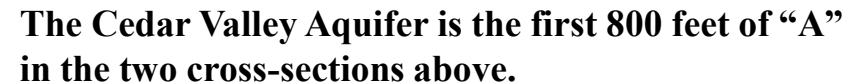
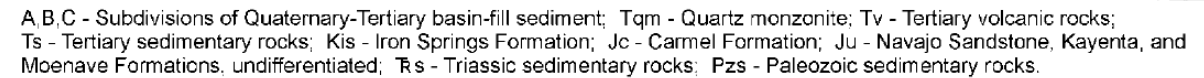
[http://www.walden3d.com/IronCounty/ig/IronCounty/IC\\_Geologic\\_Map.html](http://www.walden3d.com/IronCounty/ig/IronCounty/IC_Geologic_Map.html)



## Geology of Cedar Valley, Iron County, Utah



~7,000'



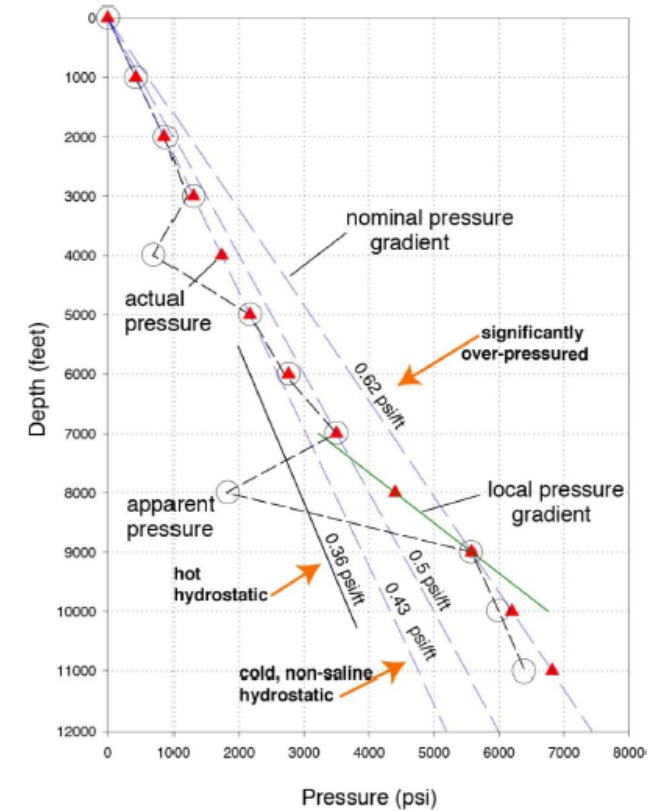
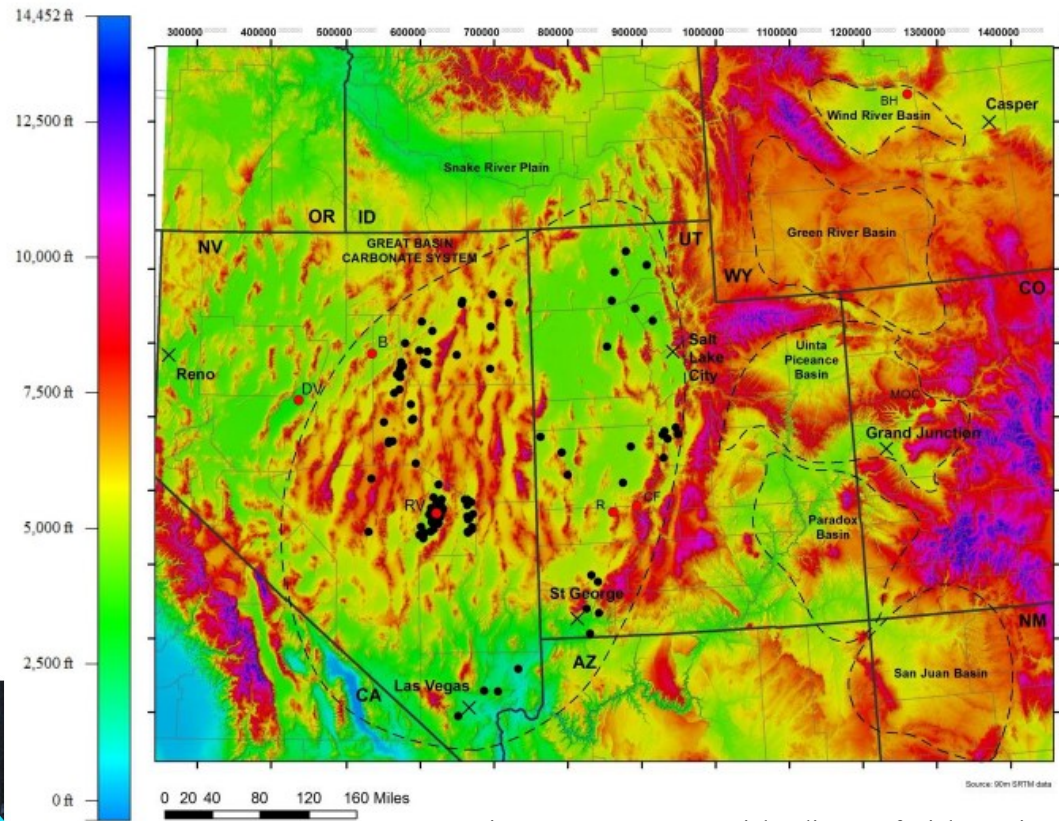
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# Lower Hydrostatic Pressure

The Southern Great Basin has lower than normal hydrostatic pressure, which the same as when there is low hydrostatic pressure in a city water system, means there is a leak in the system.

**The Great Basin leak is Grand Canyon.**



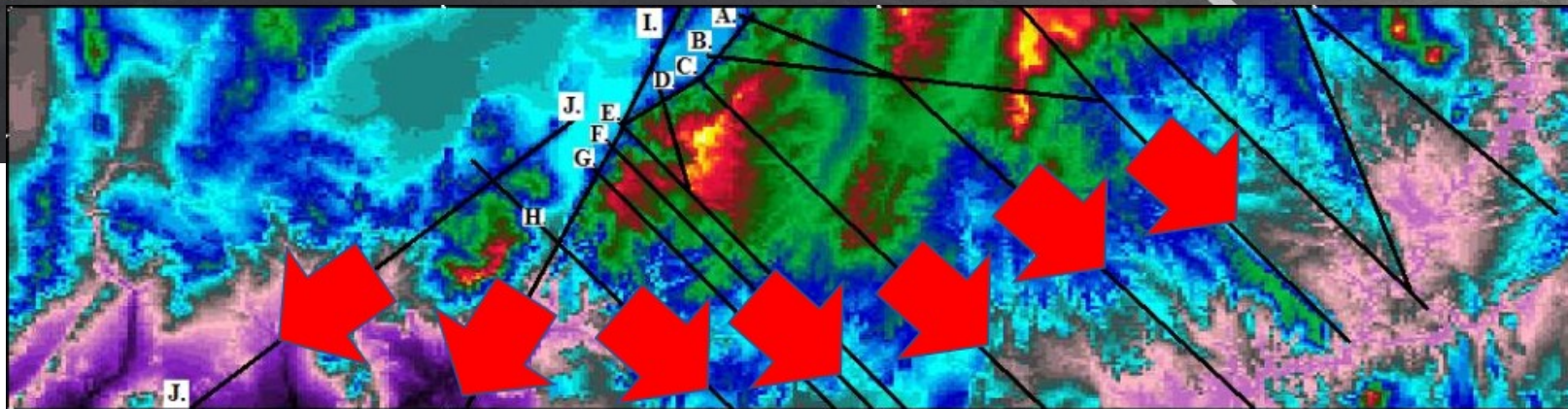
Formation Pressure as a Potential Indicator of High Stratigraphic Permeability, Rick Allis, UGS,  
[http://www.walden3d.com/IronCounty/CedarValleyWater/140224\\_Pressure\\_Permability\\_Great\\_Basin.pdf](http://www.walden3d.com/IronCounty/CedarValleyWater/140224_Pressure_Permability_Great_Basin.pdf)





# Water Flows by Gravity and along Layers and Cracks

The “leak” in the  
Southern Great Basin  
is the Grand Canyon.



A. Paragonah Canyon  
B. Parowan Canyon  
C. Summit Canyon  
D. Fiddlers Canyon  
E. Cedar Canyon  
F. Kararaville Canyon

G. Five Fingers  
H. New Harmony  
I. Hurricane Fault  
J. Pinevalley

Possible Fault Geopressure Leak Pathways  
from Cedar Valley to the Colorado River

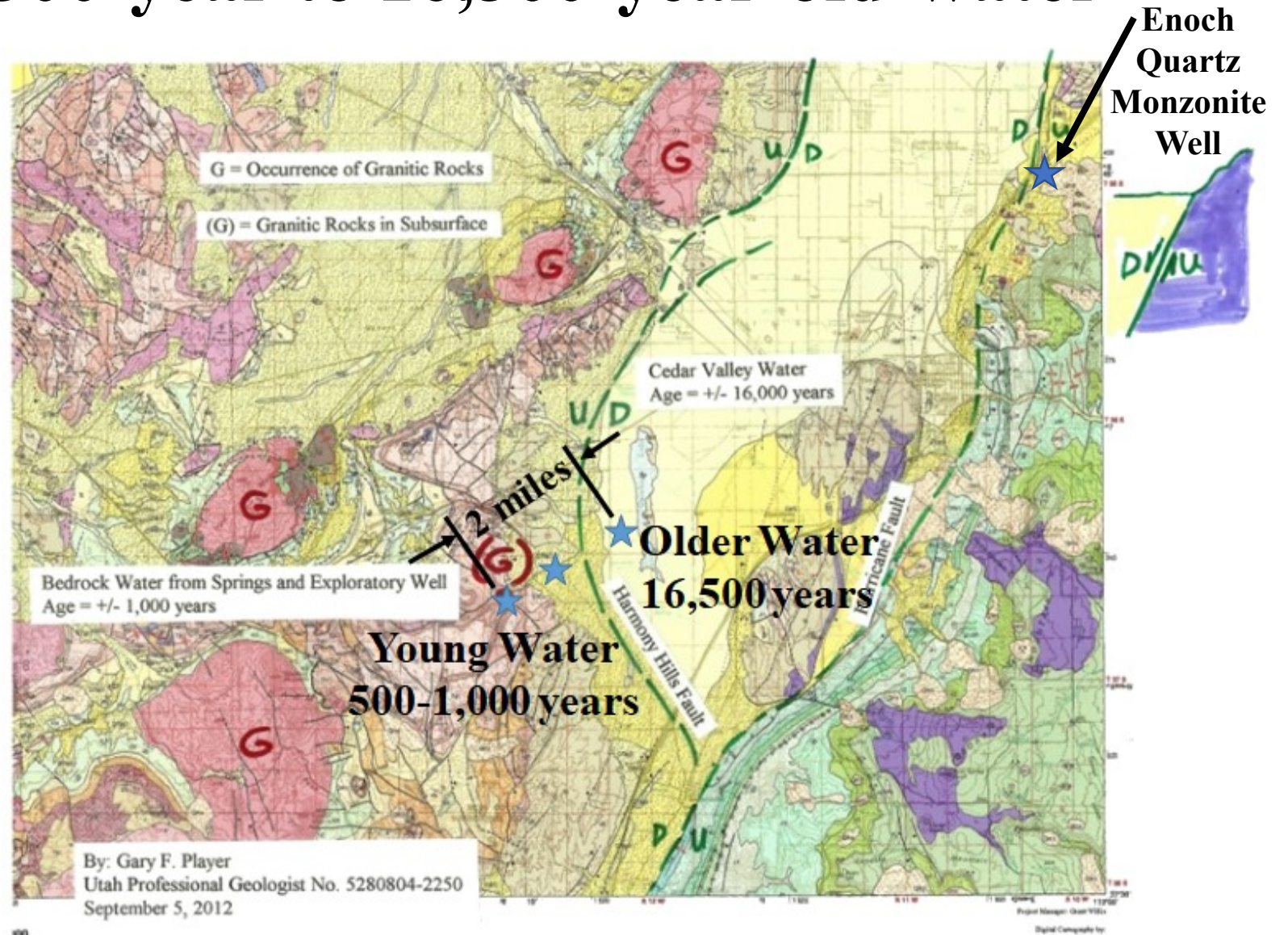
See <http://www.walden3d.com/IronCounty/CedarValleyWater/> #8. at bottom of page.



### 3. Age of Water: 500-year to 16,500-year-old-water

Understanding Water Age:

- Shows new water is leaking south along the Harmony Hills Fault.
- For \$45/sample I can get water ages for ever well in the Drainage Basin at the University of Utah.
- This data can be mapped to show relationships between different producing zones in the unconsolidated Valley Aquifer, as well as with tested bedrock aquifers.





# Ever wonder why there are so many springs at the base of volcanic flows?

- Think Condensation.
- Condensation has been used anciently.
- There are new Condensation tools.
- New Condensation materials and procedures are being worked on.





# Historical Condensation Approaches



In 1900, while he was engaged in clearing forests in Crimea (Ukraine), Russian engineer Friedrich Zibold discovered 13 large conical tumuli of stones, each about 10,000 feet square and 30-40 feet tall, on hilltops, near the site of the ancient Byzantine city of Feodosiya. Because there were numerous remains of 3-inch diameter terracotta pipes about the piles, leading to wells and fountains in the city, Zibold concluded (albeit allegedly incorrectly, according to Beysens, et al.) that the stacks of stone were condensers that supplied Feodosiya with water. Zibold calculated that each "air well" produced more than 500 gallons daily, up to 1000 gallons under optimal conditions.

Air Wells - Methods for Recovery of Atmospheric Humidity by Robert A. Nelson

- **Belgian inventor Achille Knapen built an air well on a 600-foot high hill at Trans-en-Provence in France, finished in December 1931.**
- **The tower is 45 feet tall. The walls from 8 to 10 feet thick to prevent the ground heat radiation influencing the inside temperature.**
- **Estimated the aerial well will yield 7,500 gallons of water per 900 square feet of condensation surface.**
- **With 325,851 gallons per acre-foot, this implies a 900 foot long 45 foot tall air well will generate 1 ac-ft/day.**

Air Wells: Methods for Recovery of Atmospheric Humidity by Robert A. Nelson



Figure 39 ~ Dew Pond:

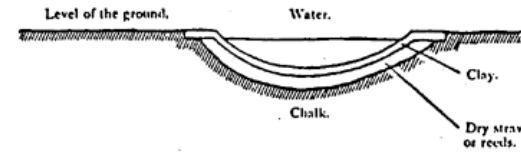


Figure 40 ~ Dew Pond (Oxtedde Bottom, Sussex):



( Photo: [Chris Drury](#) )

The water collectors known as "dew ponds" were invented in prehistoric times, but the technology is nearly forgotten today. A few functional dew ponds can still be found on the highest ridges of England's bleak Sussex Downs and on the Marlborough and Wiltshire Hills, and connected to castle walls. They always contain some water that apparently condenses from the air during the night. Gilbert White described a dew pond at Selbourne (south of London), only 3 feet deep and 30 feet in diameter, that contained some 15,000 gallons of water which supplied 300 sheep and cattle every day without fail.

Air Wells - Methods for Recovery of Atmospheric Humidity by Robert A. Nelson



( Photo source: <http://www.rexresearch.com/airwells/www.fogquest.org> )

A very successful pilot project was established at Chungungo, Chile in 1987. Over a period of 5 years, 94 fog collectors were constructed atop 2,600 ft. El Tofo Mountain, collecting up to 2,000 gallons daily (mean yield: 3 liters/m<sup>2</sup>/day). The villagers call it "harvesting the clouds". Walter Canto, regional director of Chile's National Forest Corporation, said:

"We're not only giving Chungungo all the water it needs, but we have enough water to start forests around the area that within 5 or 6 years will be totally self-sustaining."

Air Wells - Methods for Recovery of Atmospheric Humidity  
by Robert A. Nelson

SUP Pot Luck Lunch Talk 25



# Modern Condensation Approaches



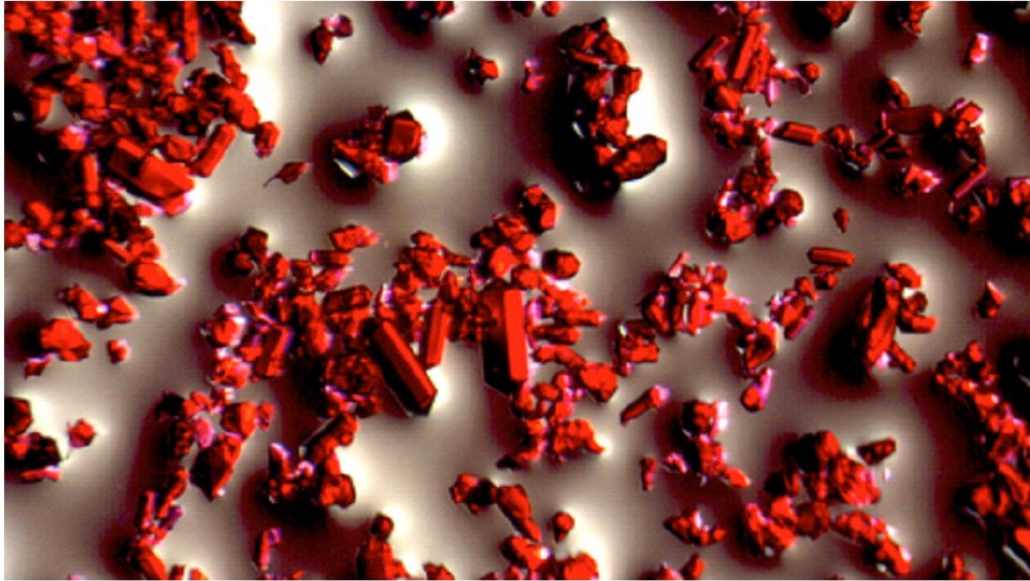
**WEDEW turns air into drinking water by creating artificial clouds in shipping container**

[https://www.dezeen.com/2018/11/05/wedew-air-drinking-water-artificial-clouds-shipping-container/?utm\\_medium=email&utm\\_campaign=Daily%20Dezeen&utm\\_content=Daily%20Dezeen+CID\\_54b9eb332f12236424294a7ff377b048&utm\\_source=Dezeen%20Mail&utm\\_term=WEDEW%20turns%20air%20into%20drinking%20water%20by%20creating%20artificial%20clouds%20in%20shipping%20container](https://www.dezeen.com/2018/11/05/wedew-air-drinking-water-artificial-clouds-shipping-container/?utm_medium=email&utm_campaign=Daily%20Dezeen&utm_content=Daily%20Dezeen+CID_54b9eb332f12236424294a7ff377b048&utm_source=Dezeen%20Mail&utm_term=WEDEW%20turns%20air%20into%20drinking%20water%20by%20creating%20artificial%20clouds%20in%20shipping%20container)

[http://technology.newscientist.com/channel/tech/dn12923-dewharvesting-web-conjures-water-out-of-thin-air.html?feedId=online-news\\_rss20](http://technology.newscientist.com/channel/tech/dn12923-dewharvesting-web-conjures-water-out-of-thin-air.html?feedId=online-news_rss20)



# Two New Condensation Tools



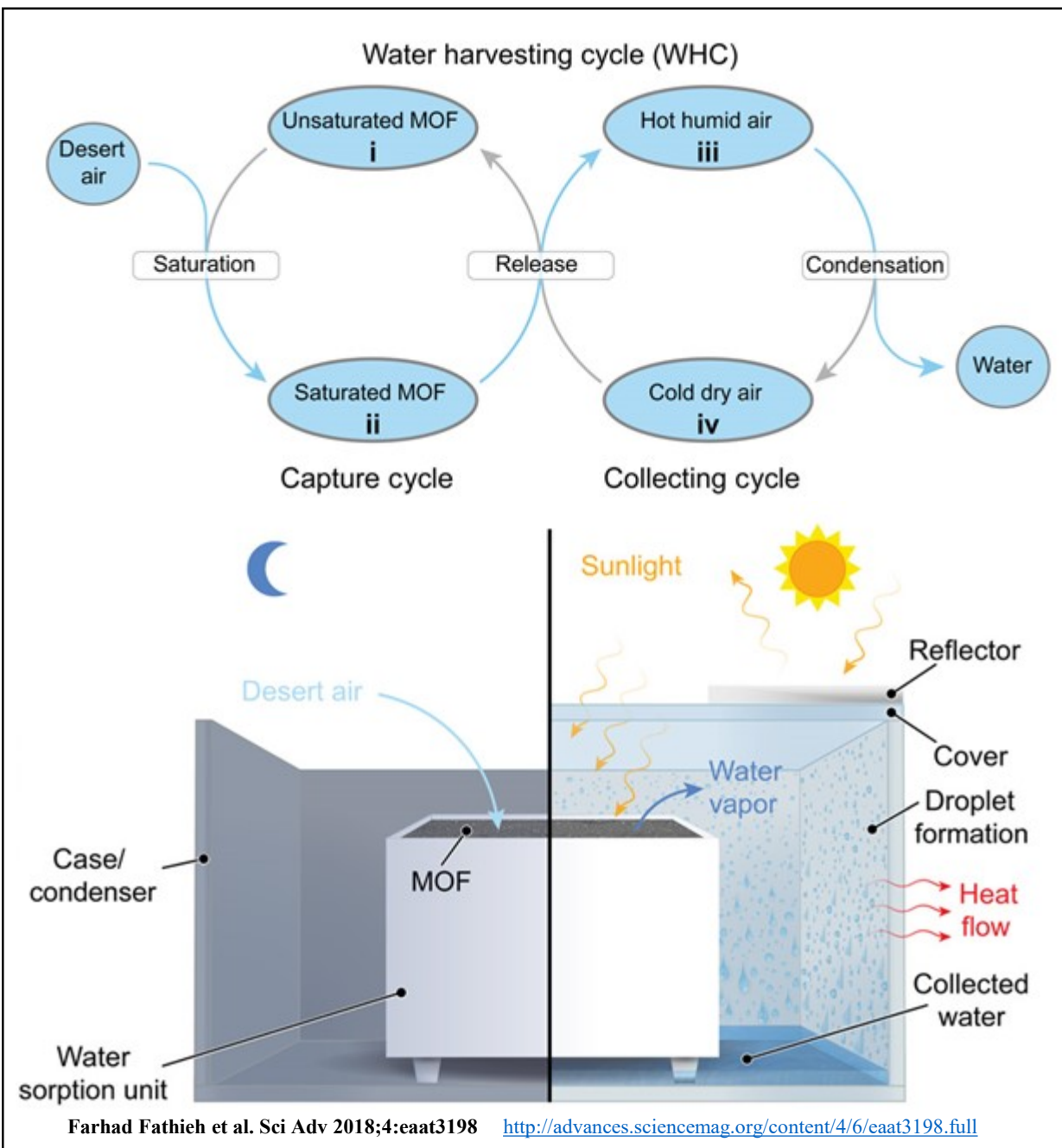
Crystalline materials similar to these can now harvest water vapor from the air.

YAGHI LABORATORY AT UC BERKELEY

This new solar-powered device can pull water straight from the desert air

By **Robert F. Service**

Apr. 13, 2017, 2:00 PM





# Deviated Wells can bring water from the Top of the Mountains to the Valley, and with turbines, will provide a new energy source.

- USGS and UGS Models do not include consolidated rock.
- There are ways other than priority allocation to solve water issues in Cedar Valley.

12 Hydrology and Simulation of Ground-Water Flow in Cedar Valley, Iron County, Utah

[http://www.walden3d.com/IronCounty/CedarValleyWater/pdf/0508Hydrogeology-Groundwater\\_Flow\\_Iron\\_County\\_Utah.pdf](http://www.walden3d.com/IronCounty/CedarValleyWater/pdf/0508Hydrogeology-Groundwater_Flow_Iron_County_Utah.pdf)

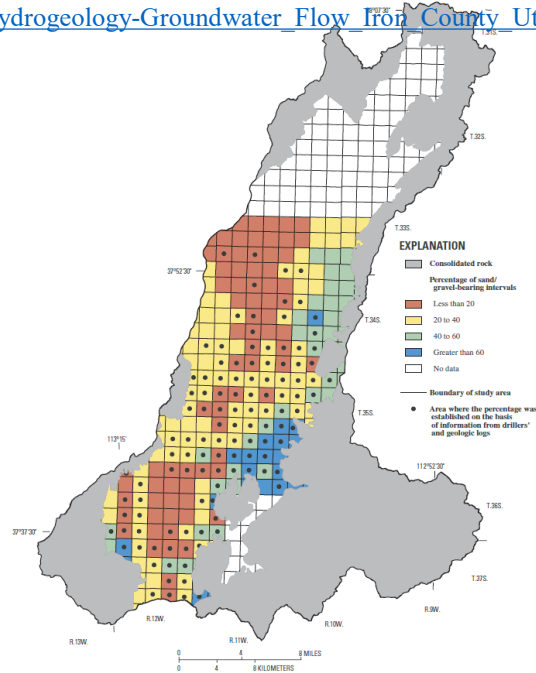
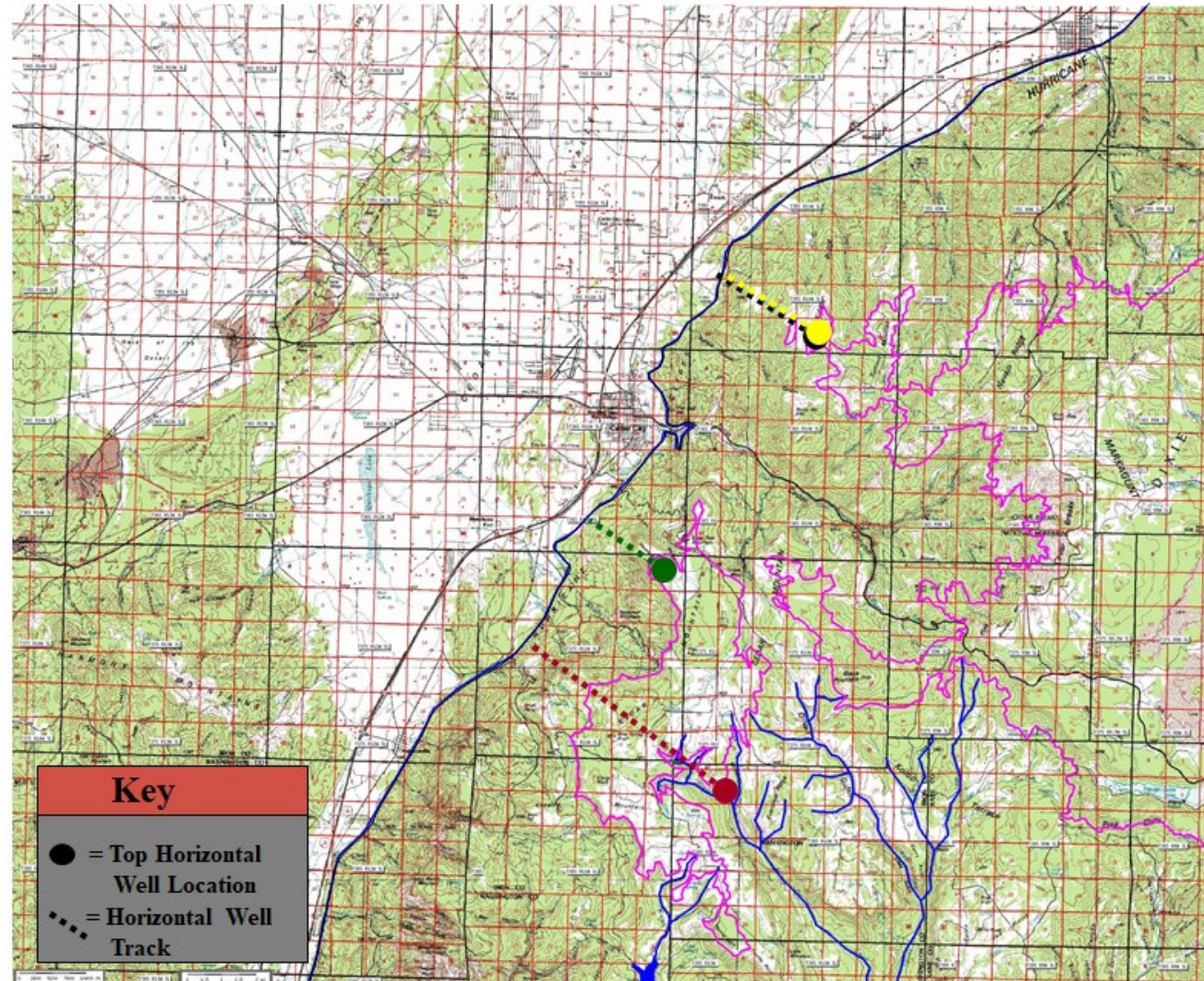


Figure 4. Estimated percentage of sand/gravel-bearing intervals in the unconsolidated basin fill, Cedar Valley, Iron County, Utah.



Source =  
Condensation  
Ponds then  
4 mile deviation  
over 3,000 foot  
drop

Source =  
Condensation  
Ponds then  
3 mile deviation  
over 3,000 foot  
drop

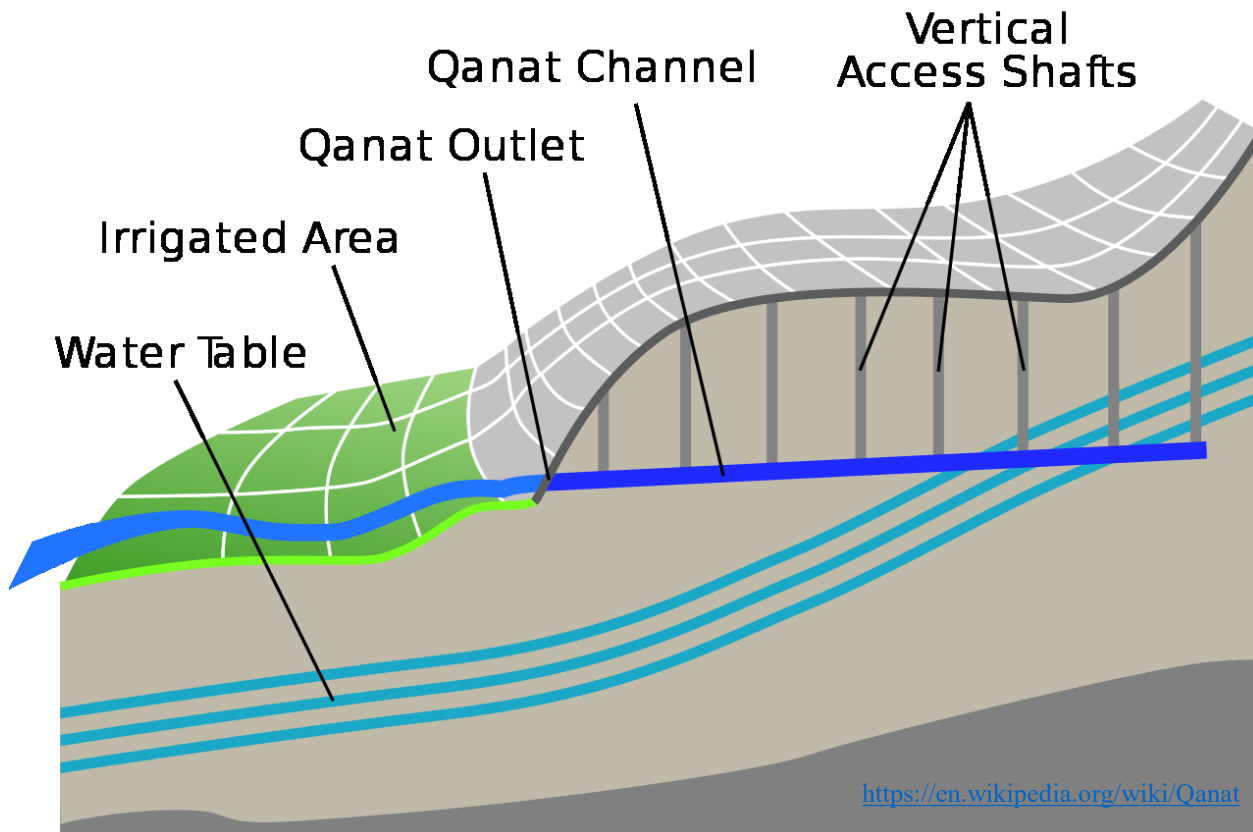
Source =  
Crystal Creek  
Confluence  
7 1/2 mile  
deviation over a  
3,000 foot drop

26 October 2019



# A Qanat or Kariz is a gently sloping underground channel to transport water from an aquifer

- Qanat technology was developed in ancient Iran about 1,000 BC.
- The water in the Granite Vault (think Quartz Monzonite) is a Qanat.

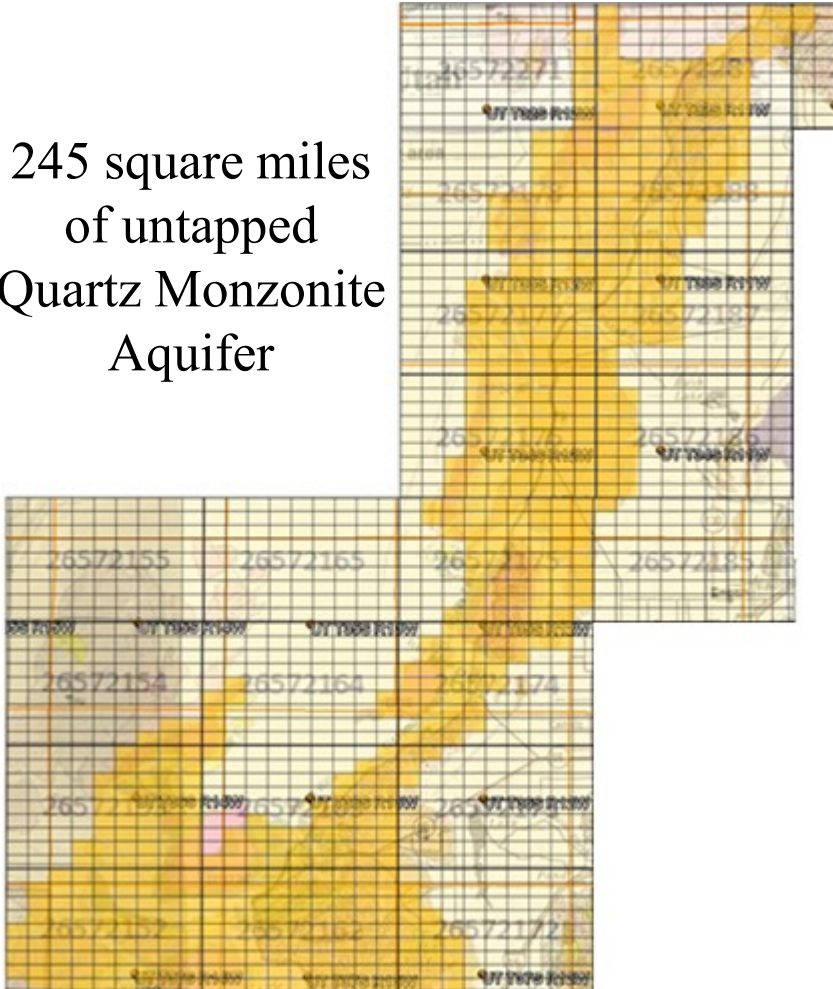




# 4. Enforcement Model are Biased Estimates

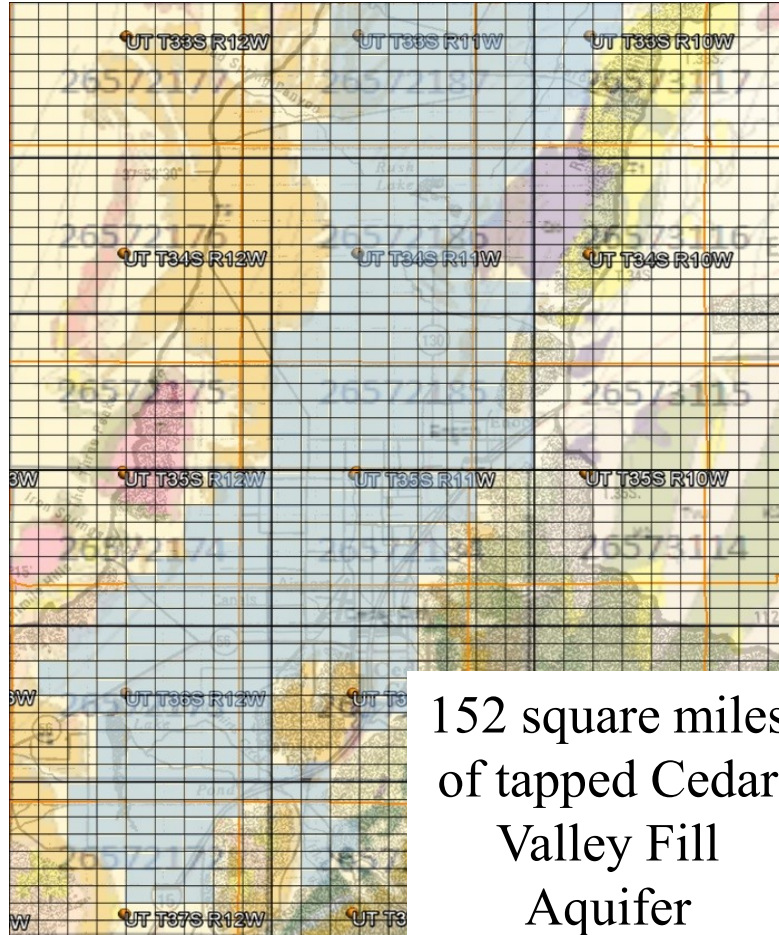
## Quartz Monzonite Aquifer

245 square miles  
of untapped  
Quartz Monzonite  
Aquifer



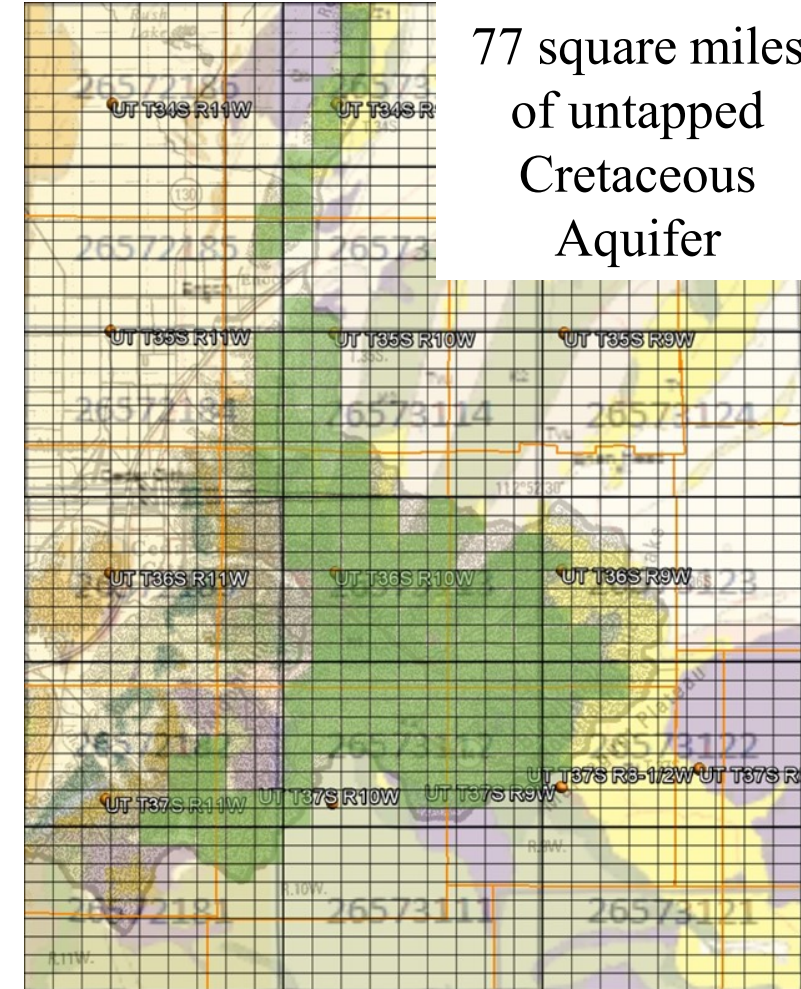
## Cedar Valley Aquifer

152 square miles  
of tapped Cedar  
Valley Fill  
Aquifer



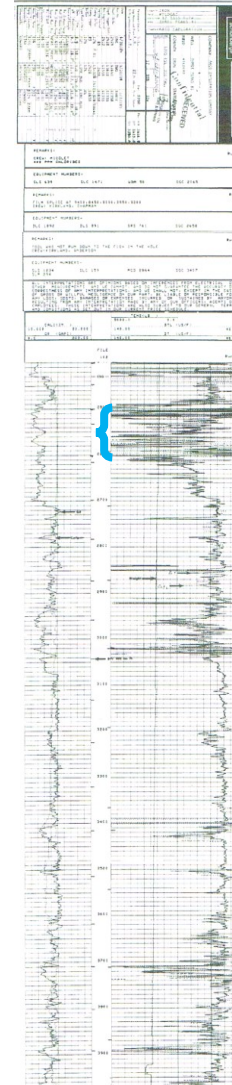
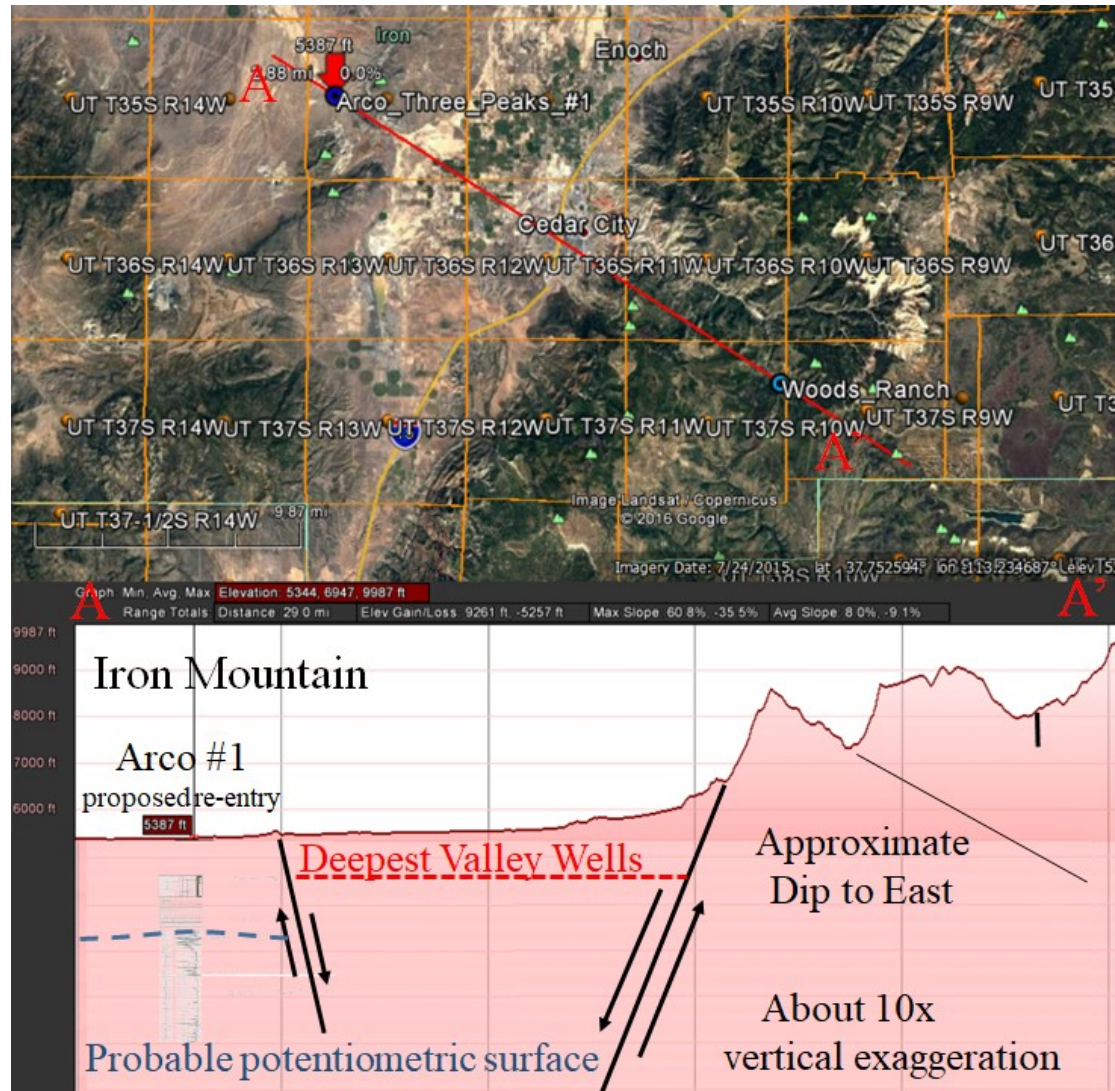
## Cretaceous Aquifer

77 square miles  
of untapped  
Cretaceous  
Aquifer





# The Quartz Monzonite Aquifer

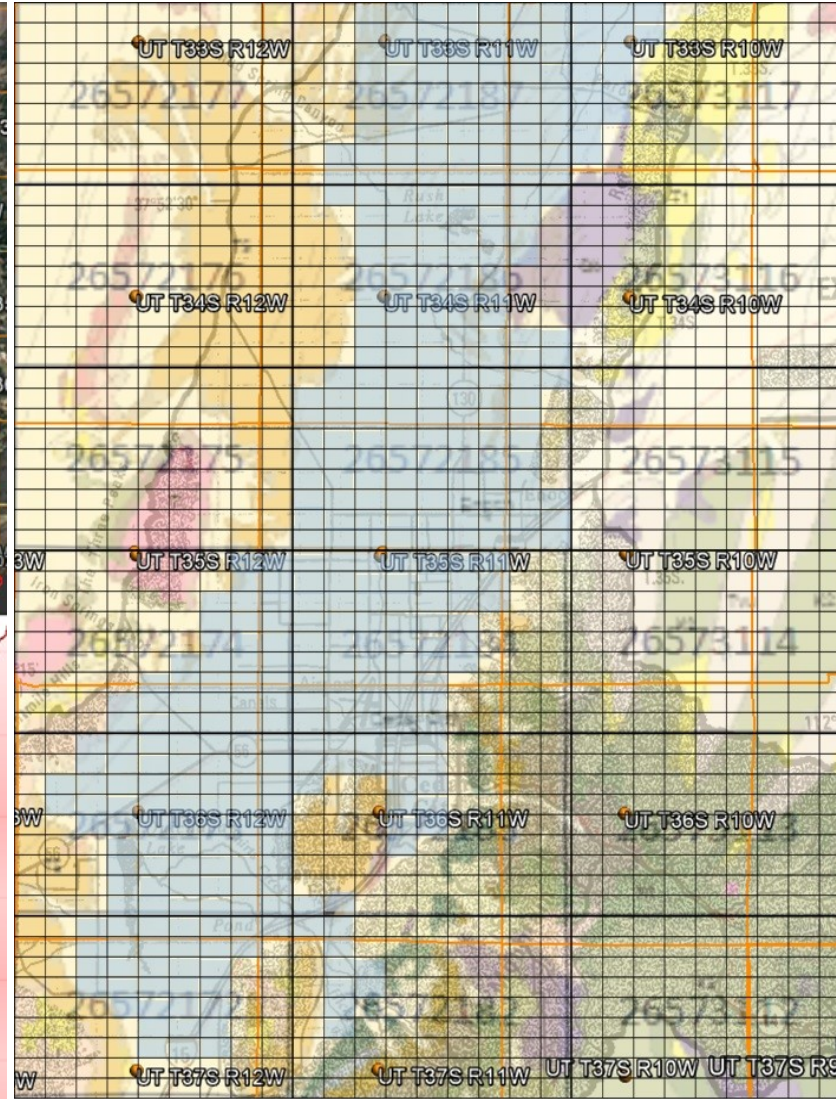
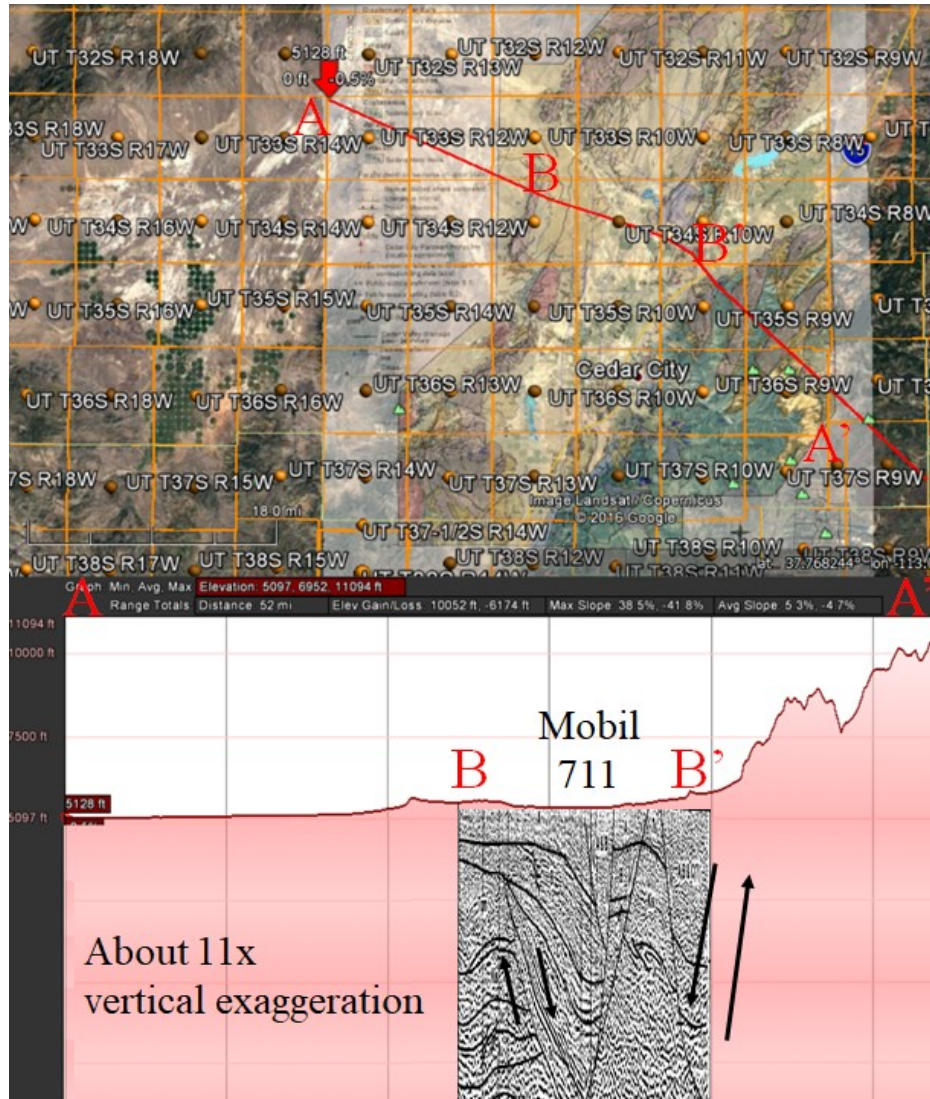


Water Table on top of untapped quartz monzonite aquifer at Blowout Pit, Iron Mountain.

To the left are Schlumberger well log results dated 30 Jun 1984, 20 Sep 1984, and 17 Jan 1985 from a well Arco drilled at Iron Springs. The high porosity, highlighted with { in blue, is from fresh water in the fractured quartz monzonite. This fractured quartz monzonite is the same geology as the successful well drilled in Enoch against the dipping Cretaceous beds.



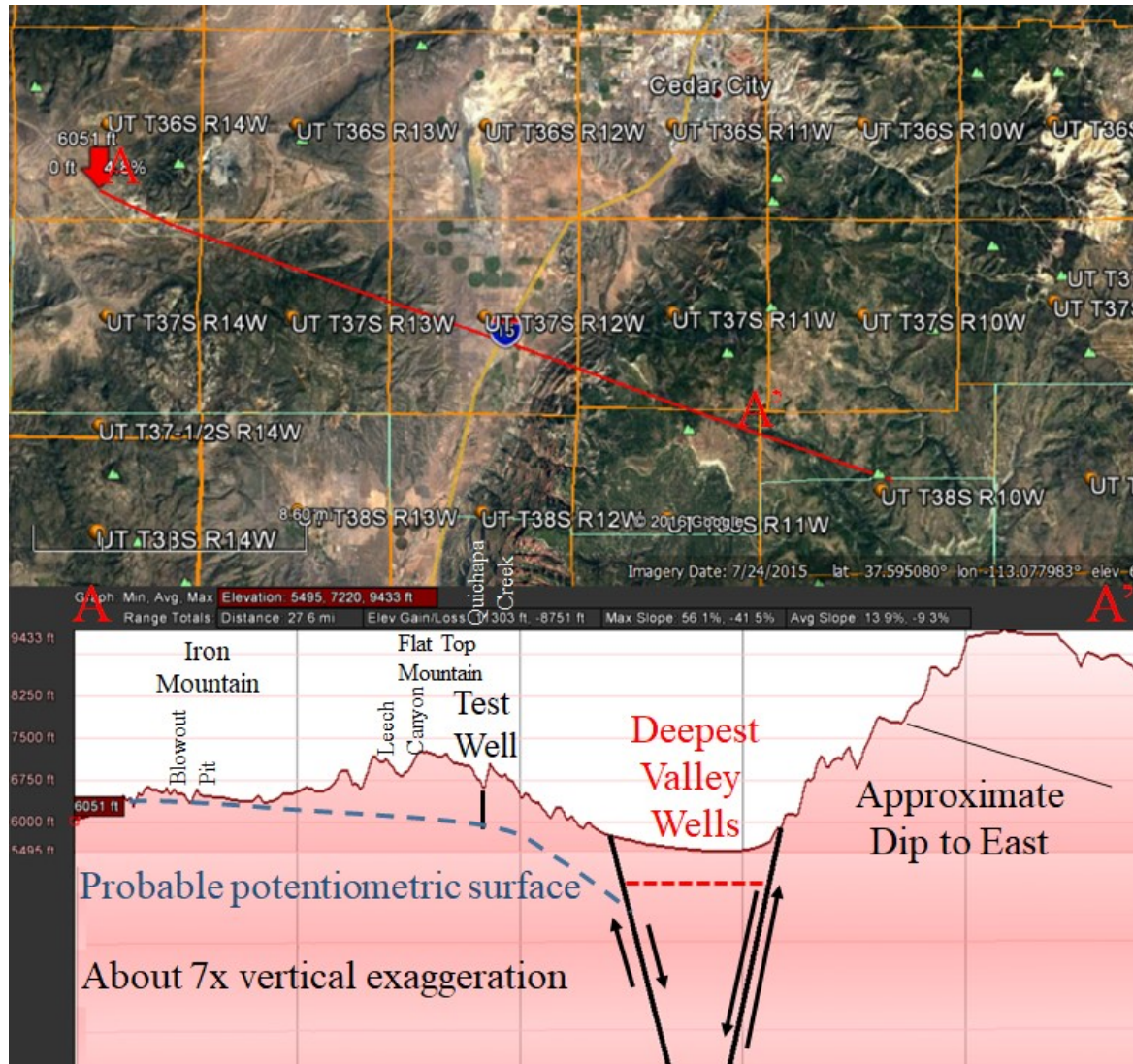
# The Overproduced Cedar Valley Aquifer



- Map and cross-section to the far left, show configuration under the Cedar Valley aquifer.
- Almost all water wells are less than 800 feet deep.
- With over a mile of sediment, only the first 800 feet have been tested with water wells and produced.
- The Cedar Valley Aquifer is shown by the blue colored squares on map just to left.
- Each colored square is about ~0.36 square miles in size. There are 421 cells covering the Cedar Valley Aquifer, or 152 sq. miles.

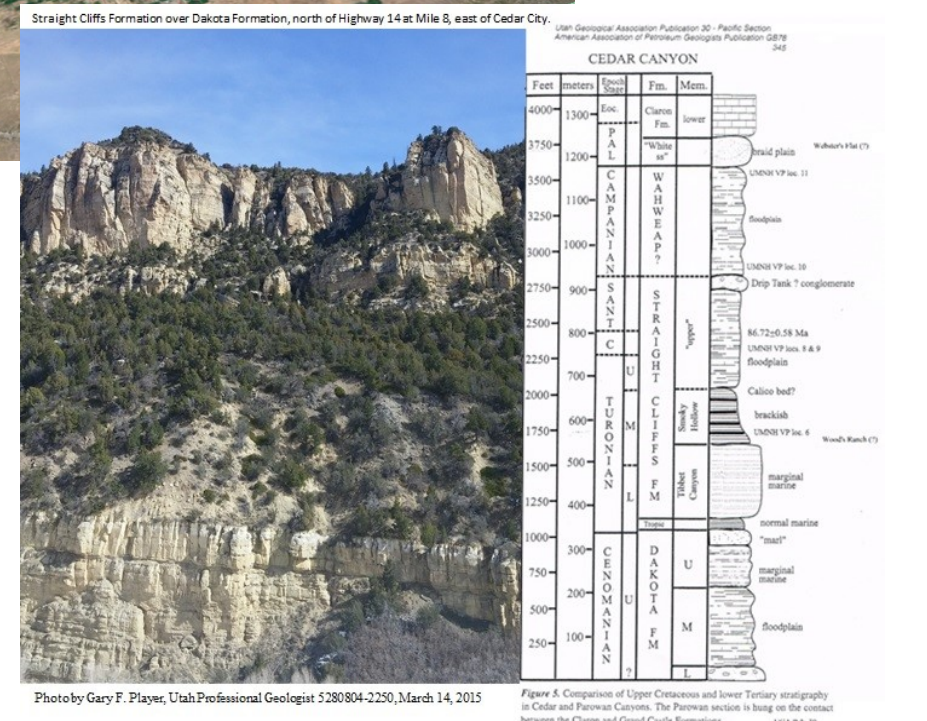


# The Cretaceous Aquifer



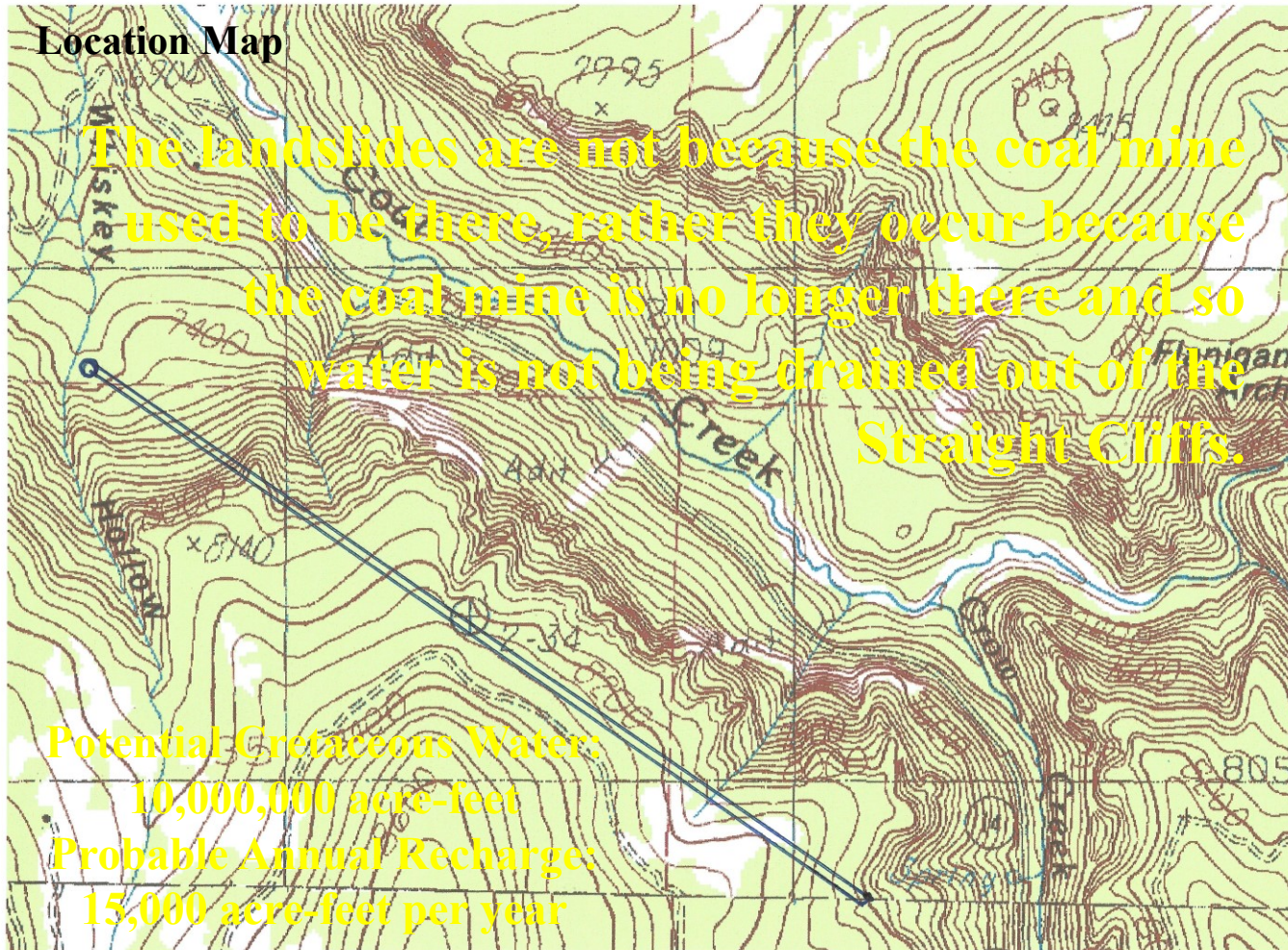
The Cretaceous Aquifer was successfully tapped at Brian Head in the city well.

The landslides are not a result of the coal mine having been here, they are a result of the coal mine not draining water off of the cliffs.





# The Landslide Area Needs to be Drained, to avoid a repeat



Well to drain Cretaceous sandstones. Surface location to right of Whiskey Hollow.  
Horizontal Well Length = 5,665'. Surface Elevation = 7,380'. Well direction = S 60° E.

Scale: 5.5" = 1 mile.  
G.F. Player 2/8/2018



The map to the left shows a horizontal well draining into Whiskey Hollow, then flowing into Coal Creek. Jay Grimshaw suggested a horizontal well from the east base of the landslide to the west to drain the rubble beds at the base of the landslide.

The plan is to eliminate future landslides caused by water buildup in the old mine adits and natural fractures southwest of and above the right of way. UDOT expressed some interest in these ideas. Additional benefits could be the addition of water to Coal Creek in the dry times of the year.

Player & Nelson took Jay Grimshaw on a field trip, where we learned Grimshaw Drilling can drill horizontally in bedrock. Jay did not like the idea of drilling from above the landslide and deviating the well underneath the highway to empty water into Coal Creek. All of the fractures in the Straight Cliff Formation create a significant risk of water escaping from of the drill hole, and coming out of the cliff above the landslide area and creating problems for the road.

[http://www.walden3d.com/IronCounty/CedarValleyWater/pdf/170817\\_How\\_to\\_Test\\_Proposed\\_New\\_Aquifers.pdf](http://www.walden3d.com/IronCounty/CedarValleyWater/pdf/170817_How_to_Test_Proposed_New_Aquifers.pdf)



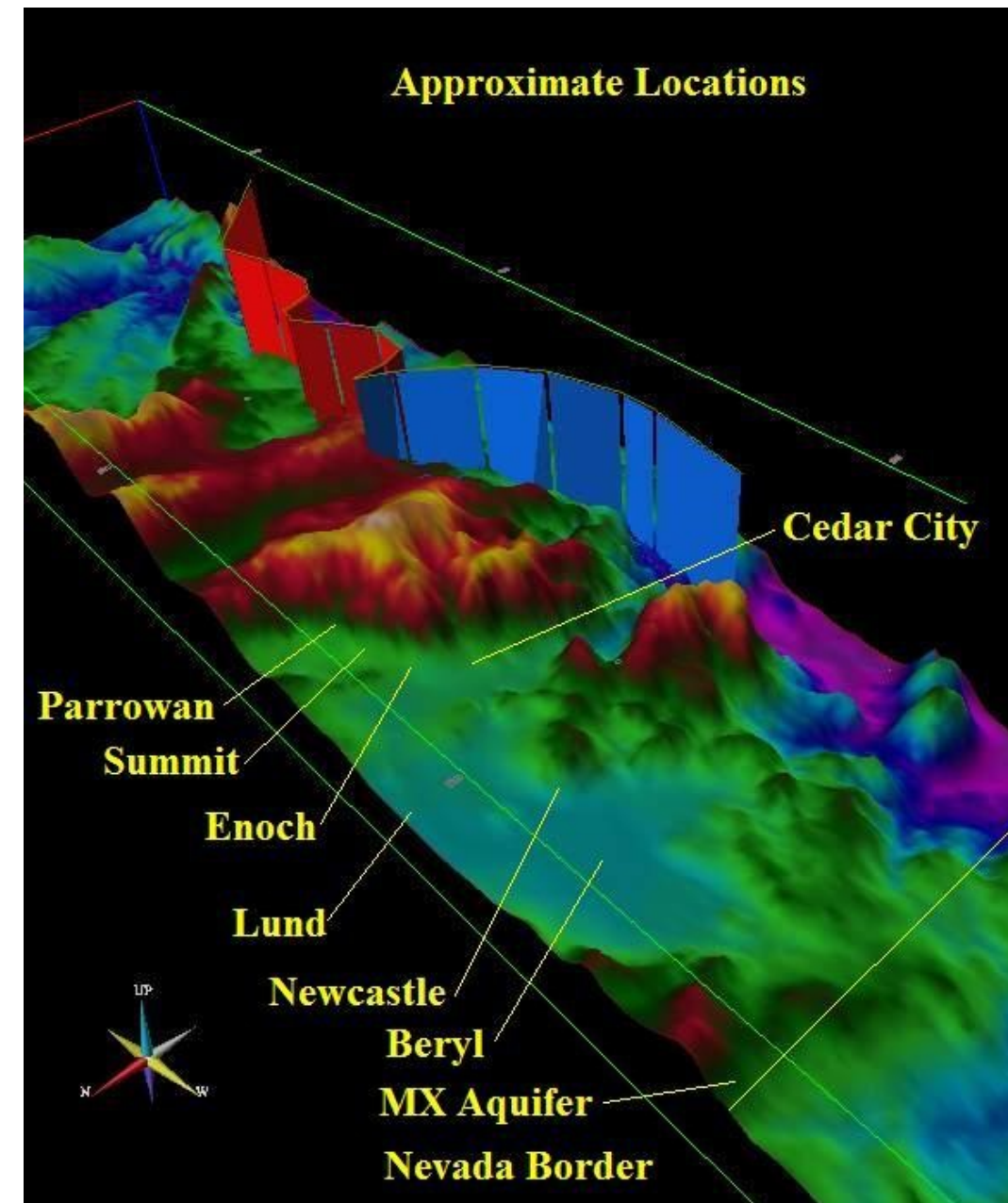
# Short Video



# 2006 Display for Eldon Smoots, President of the CICWCD

Prior to this display, CICWCD was promoting the Lake Powell Pipeline:

- In 2006 CICWCD filed on water in Wah Wah, Pine, and Hamblin Valleys, Beaver County;
- CICWCD has won lawsuits giving them the water rights being sought in Wah Wah and Pine Valleys;
- This is a forward looking, aggressive, and a worthwhile accomplishment.
- However, the current \$500 million estimate for a pipeline is unreasonable for the existing tax base.

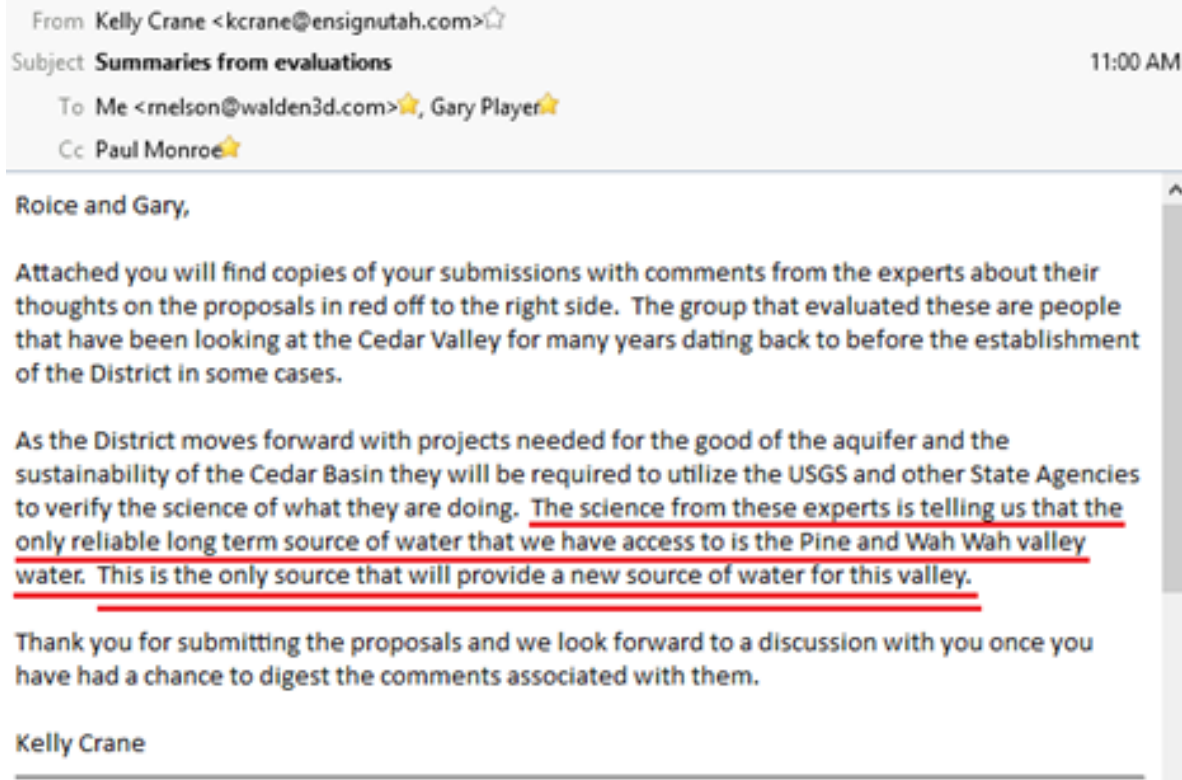




# Pine and Wah Wah Valley Water (\$500 million pipeline):

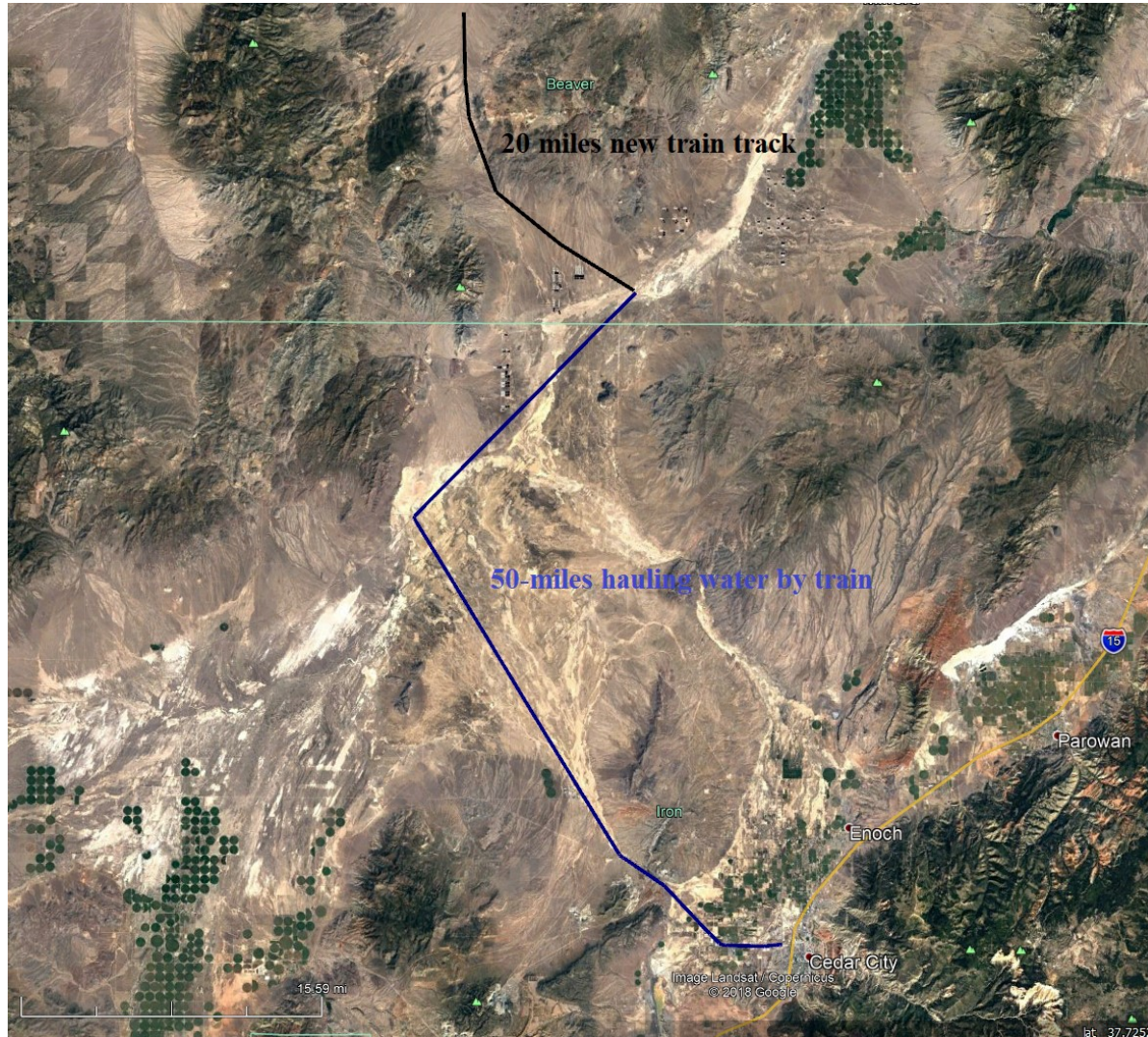
The only source that will provide new water for Cedar Valley?

- Over 12% Hay and 30% of grassy hays exported overseas (Saudi Arabia, China, etc.).
- This is exporting water from Iron County (this water exporting be taxed to pay for pipelines, etc.).
- A cheaper alternative to building a pipeline is to build a rail line into Pine Valley, and transport it by train.
- This would allow water to be sold and transported to anyplace with an emergency, for example Flint, Michigan.





# Water Train – Pipeline Alternative



## Assumptions:

- 20 or 30 miles of new track
- 1 or 2 SD70 DC or SD900MAC locomotives
- 40,500-gallon DOT 117 Tank Car
- 100 or 200 Tank Cars
- 1 trip, 300 days per year
- Transporting 2,285 acre-feet or 4,330 acre-feet water
- 5 gallons diesel per mile at \$3/gallon

## Implies:

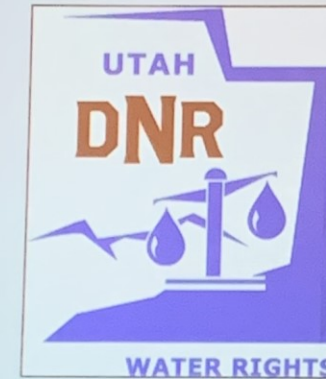
- Low Cost \$24,725,000 year 1, & \$225,000 per year 2-N
- High Cost \$77,500,000 year 1, & \$900,000 per year 2-N
- Water can be transported anywhere a train goes to for humanitarian purposes, or for profit
- This provides a train for other uses in Cedar Valley, including transporting workers to use water at origin



# Summary

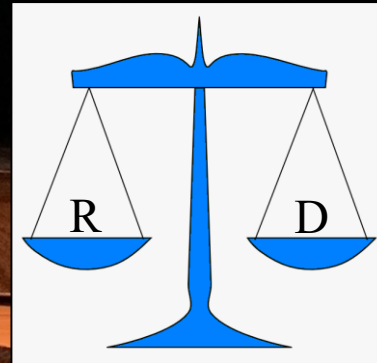
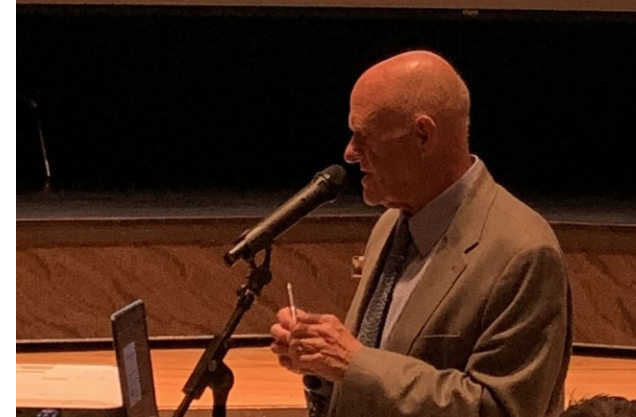
- It is logical to only apply the mandatory allocation plan to the Cedar Valley Aquifer, where all modeling was done, and not to the entire Cedar Valley Drainage Basin.
- Water rights transferred from the Cedar Valley Aquifer to bedrock aquifers in the Cedar Valley Drainage Basin will reduce the overproduction and the 50,000 acre-feet over allocation, and any wells to the east can use existing distribution systems to get water to the farms.
- Age dating needs to be done for every well in Cedar and Parowan Valleys, and ages mapped to define relationships between the different producing zones within the Valley Fill Aquifers and with any Bedrock Aquifers with well tests.
- Find funding for test wells (for example, The Department of Transportation to drain rubble beds at landslide area) to prove up the bedrock Quartz Monzonite and Cretaceous Aquifers, noting these areas can be produced under the Law of Capture without impacting Safe Yield to other basins over the next 500-1,000 years.
- Have the Water Management Committee look into new condensation, horizontal drilling, train transportation of water, and other related technologies before creating a \$500,000,000 bond.
- Note: Kent Jones, State Engineer, announced his retirement within a week of telling Iron County residents about the mandatory water allocation plan.

## Questions/Comments



Send written comments to:

Utah Division of Water Rights  
646 North Main St  
PO Box 506  
Cedar City UT 84721-0506  
[waterrights@utah.gov](mailto:waterrights@utah.gov)





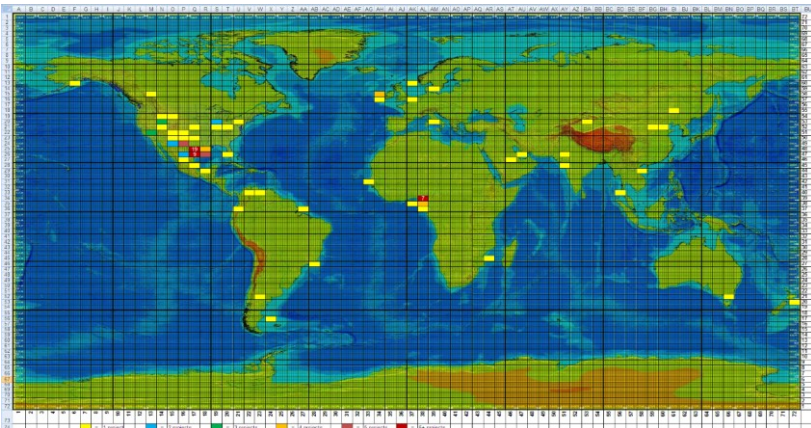
# H. Roice Nelson, Jr. Vita

## GENERAL STATEMENT

Roice is an experienced interpretation geoscientist who has spent his career working in the international petroleum industry. As a seismic interpreter he has worked over 100 interpretation projects worldwide. Roice has proven success in using, creating, and building new tools and processes for the hydrocarbon exploration industry. In 2008 Roice selected 6 professionals to join with him as co-founders of Dynamic Measurement, LLC (DML), and they have spent the last 10 years laying the groundwork for a new branch in the geophysical service industry: lightning analysis.

As the initial founder of Landmark Graphics, Roice designed the interpretation software, and created a university program which placed advanced interactive interpretation systems in many universities worldwide to support research and teaching. He taught courses on interactive interpretation and new technologies for Landmark and for IHRDC all over the world. He also has a consulting company (W3D) and an exploration company (DRC) to utilize industry and proprietary tools and processes to explore for, develop, and produce natural resources: hydrocarbons, geothermal energy, minerals, etc.

The map below shows locations of many of the exploration projects Roice has worked on since 1970.



W3D Infinite Grid<sup>SM</sup> Spatial Resume showing Roice's interpretation project locations.

## ROICE NELSON CHRONOLOGY

### **Dynamic Measurement LLC, Co-Founder / Manager, Oct 2008-Present**

DML established to exploit using lightning data as an on-shore and shelf NSEM (Natural Sourced Electromagnetic Method) exploration tool and to create a new branch in the geophysical services industry.

### **Dynamic Resources Corporation, Finder / President, Jan 2001-Present**

Generate and drill or mine prospects and commercialize new technologies.

### **Walden 3-D, Inc., Finder / President, May 1990-Present**

W3D established as a new company incubator, doing geotechnical consulting and mini-urban design. Primary companies started include DML, DRC, Walden Visualization Systems, vPatch, Advanced Structures Incorporated, HyperMedia Corporation. Completed major seismic interpretation projects on 5 continents, and developed several unique information technologies including The Infinite Grid<sup>SM</sup>, The Knowledge Backbone<sup>SM</sup>, and the Abbott Atlas.

### **Geophysical Development Corporation (GDC), Vice-President**

#### **Interpretation Business Development, April 2004- Sep 2007**

Opened GDC China market, and helped build an integrated interpretation business. Interpretation for Ji Dong (3700 B/D, largest find in China in 10 years), Tarim (130 BCM, 3<sup>rd</sup> largest gas field in Xinjiang), Da Qing, Xing Jiang, and Tuha Chinese Oilfields. Created GDC's Tiles<sup>TM</sup> Studies.

### **Continuum Resources Intern'l Corp., Co-Founder, Sep 1997-Aug 2000**

Demonstrated real-time simultaneous virtual reality collaboration with terabyte databases in London England, Perth Australia, and Houston.

### **HyperMedia Corporation, Jan 1991-2007, Co-Founder**

Designed, built, and produced a UNIX, X-Windows, Motif, Client-Server hypertext engine, sold, and installed site-license to Saudi Aramco.

### **Landmark Graphics Corporation, Nov 1982-Sep 1992, Co-Founder**

Designed user interface of first stand-alone seismic interpretation workstation software, only exploration geophysicist, worked with customers all over the world, established and ran Landmark's University Program.

### **University of Houston's Allied Geophysical Labs (AGL) & Seismic Acoustics Lab (SAL), Jan 1980-Nov 1982, Founder, General Manager**

Managed physical modeling facility at SAL, created 4 new labs.

### **Mobil Oil Corporation, Jul 1974-Jan 1980, Geophysicist**

Seismic interpretation, processing, and acquisition geophysicist.

### **Amoco Corporation/Pan American Corporation, Summers 1973 & 1970**

Summer Intern and Assistant Geophysicist in Denver

## EDUCATION

1981, MBA (Master's Business Administration) Southern Methodist Univ.

1974, B.S. Geophysics, University of Utah

## OTHER

Published 220+ technical papers since 1973, including the book New Technologies in Exploration Geophysics in English and Chinese. Details available on request, lightning papers can be reviewed at

<http://www.dynamicmeasurement.com/TAMU>.

- Co-Organized 9 SEG Research Workshops, including Remote Sensing Workshop at the Anaheim, California Convention, Friday, 19 Oct 2018.
- Honorary Membership GSH (Geophysical Society of Houston).
- Enterprise Award SEG (Society of Exploration Geophysicists).
- Key Professional Societies: AAPG, EAGE, GSH, HGS, and SEG.

## PROFESSIONAL REGISTRATIONS

American Association of Petroleum Geologists Number 476651

Texas Professional Geoscientist #5120

Louisiana Professional Geoscientist #879 (not active).

## CONTACT INFORMATION:

2155 West 700 South #31, Cedar City, UT 84720 T. (713) 5420-2207

Roice Nelson [nelson@walden3d.com](mailto:nelson@walden3d.com)

## PRESENTATION & VIDEOS Available at:

<http://www.walden3d.com/water>