

# Paradox Valley Unit



## **Colorado River Salinity Control Act**

- The Colorado River Basin Salinity Control Forum was created in 1973 by the basin states due to rapidly increasing salinity concentrations
- Public Law 93-320 enacted June 24, 1974 and authorized the construction, operation, and maintenance of certain works in the Colorado River Basin to control salinity of water delivered to users in the United States and Mexico. The provisions of the Act are found under 43 U.S.C. 1571-1599
- Amendments in 1984, 1995, 1996, 2000 & 2008
- Reduces salt load by more than 1.3 million tons/year

## Impacts of Increased Salinity

#### Economic Damages Model

- Household appliances
- Commercial sector
- Industrial sector
- Water utilities
- Agricultural crop revenues
- Additional costs of meeting state wide water quality standards
- Costs of recycled water use





# Impacts of Increased Salinity

- 2016 average salinity levels at the United States of America / Mexico border are nearly 850 mg/l
- Quantifiable damages are ~\$382 million/year to USA users

 Damages are projected to increase to \$614 million/year by 2035 if Salinity Control Program is not aggressively implemented

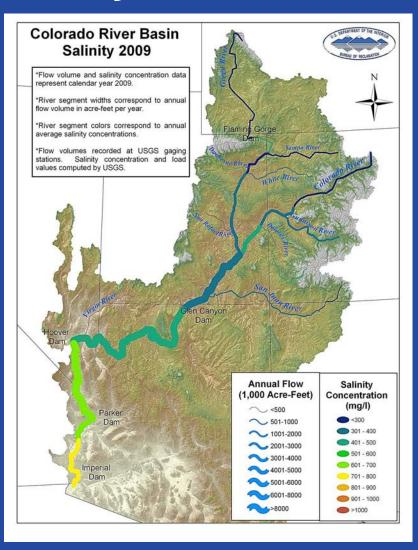
# Colorado River Basin Salinity Standards

Water Quality Station TDS limit

Below Hoover Dam 723 mg/l

Below Parker Dam 747 mg/l

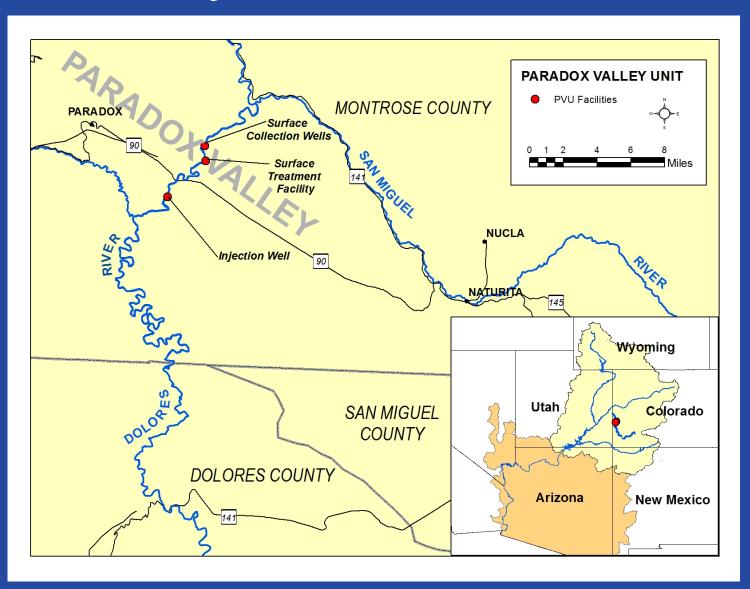
Below Imperial Dam 879 mg/l



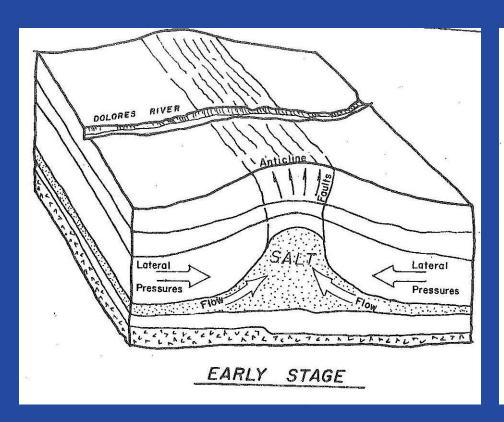
# **Paradox Valley Unit**

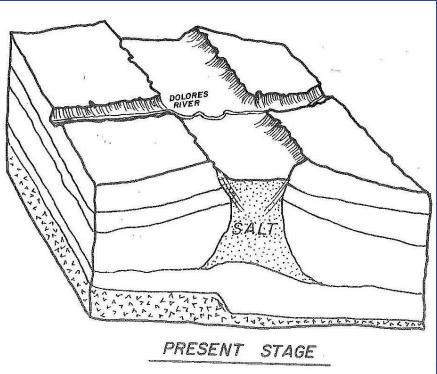


# **Paradox Valley Unit**

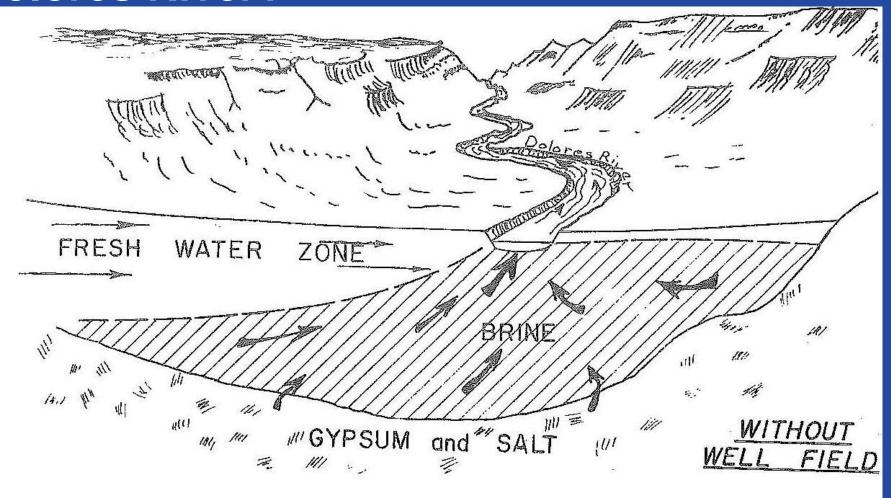


# Paradox Valley

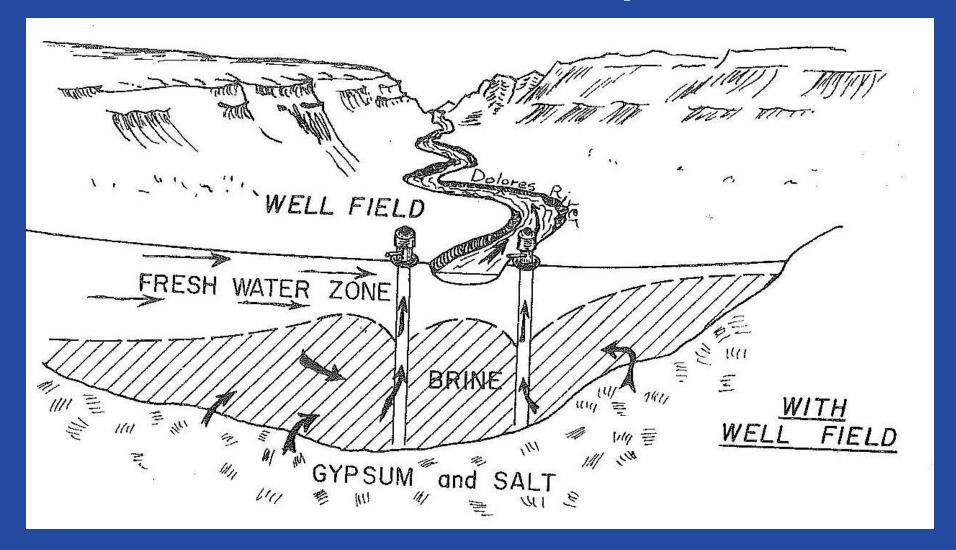




# How does the Salt Brine get into the Dolores River?



# How is the Salt Brine intercepted?





## **Salt Brine composition**

Bicarbonate	96-232 mg/l	Calcium	942-1,742 mg/l
Chloride	87,594-212,528 mg/l	Fluoride	0.1-0.2 mg/l
Magnesium	907-2,177 mg/l	Nitrite	95-108 mg/l
Potassium	1,921-4,565 mg/l	Sodium	6,177-98,991 mg/l
Sulfate	1,158-6,885 mg/l	Strontium <sup>2</sup>	2.3-27.8 mg/l
рН	6.0-7.6	Cadmium <sup>3</sup>	0.47 mg/l
Chromium <sup>3</sup>	0.26 mg/l	Copper <sup>3</sup>	0.22 mg/l
Iron <sup>3</sup>	2.4 mg/l	Lead <sup>3</sup>	2.9 mg/l
Manganese <sup>3</sup>	0.37 mg/l	Nickel <sup>3</sup>	0.23 mg/l
Lithium <sup>3</sup>	0.13 mg/l	Zinc³	0.62 mg/l
Conductivity	256,946-278,207 um/cm	Total Dissolved Solids	255,870-264,470 mg/l Seawater is usually between 30,000 & 40,000 1 Gallon of Brine contains about 2.2 lbs of Salt

Hydrogen Sulfide levels sampled at the brine wells range from 10-88 mg/l. Hydrogen sulfide is released when the brine comes in contact with the atmosphere.

<sup>1</sup>/Compiled from August 2002 sample data for wells 2E, 3E, 4E, 5E, 6E, 8E, 9E, 11E, 12E & 13E.

<sup>2</sup>/From 1978 Definite Plan Report and 2011 sample at Well 9E.

<sup>3</sup>/From 1978 Definite Plan Report.

# Salt Brine composition

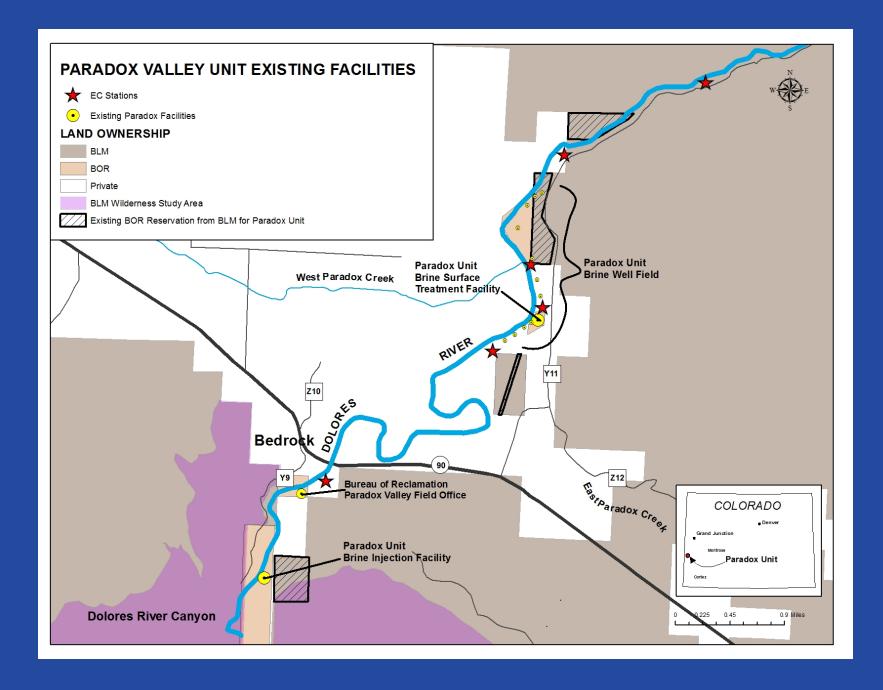
#### Phase chemistry test results

Table 1.
Salt Products Produced in Laboratory Evaporation Tests

	1st Crystals	2nd Crystals	3rd Crystals	4th Crystals
	%	%	%	%
CaSO <sub>4</sub>	2.20	0.71	0.54	0.57
MgSO <sub>4</sub>	0.07	0.00	0.13	0.37
MgCl <sub>2</sub>	0.14	0.13	0.19	0.41
NaCl (by diff)	97.59	99.16	98.94	98.61

Table 2.
Salt Type Specifications for Deicing Use

Component	Specification	Lab Results
Component	(%)	(%)
NaCldb (min)	97.9	98.6
Ca+Mg (max)	0.7	0.4
SO <sub>4</sub> (max)	0.5	0.8
Insolubles (max)	0.05	0.002
Moisture (max)	2.0	Not known



### **Collection Well**

- •9 wells
- •40 70 ft deep
- •30 120 gpm



# **Surface Treatment Facility**



# **Brine Injection Facility**



# **Injection Pumps**

- •4 pumps
- •400 hp
- •115 gpm/pump
- •5,460 psi max

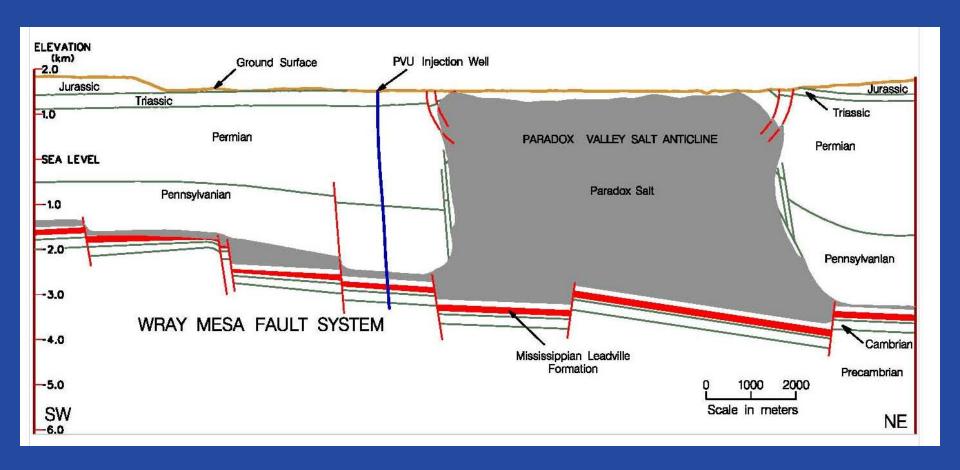


# Injection Well



•16,000 feet – deepest injection well in the world

# **Paradox Valley Geology**



# **Unit Brine Disposal**

- Currently disposing of 200 gallons per minute
- ~1 ton of salt every 4 minutes 30 seconds
- Annual disposal rate of ~110,000 tons salt (dry weight)
- EPA Maximum Allowable Surface Injection Pressure 5,350 psi at the well head
- Gradually increasing well head pressures
- Leadville geologic formation restrictions
- Paradox Valley Unit EIS initiated in 2012

# Paradox Valley Unit EIS Alternatives

- 2<sup>nd</sup> Brine Injection Well
- Evaporation Ponds
- Zero Liquid Discharge Technologies
- Be capable of disposing at least 100,000 tons of salt per year (~200 gpm)
- 50 year project life

# Volume of salt for 300 gpm system

- Volume:
  - Brine = 484 acre-feet = 157,680,000 gallons
  - Dry Salt = 87 acre-feet (compacted volume)
- The average high school football field (w/ end zones)
  - Brine = 367 feet
  - Dry Salt = 66 feet
- Transportation
  - Approximately 6,600 semi trucks/year @ 85,000 lbs

#### **Economic Calculations**

- Other types of salinity control projects
  - Competitive projects cost ~\$60/ton of salt removed
- \$/ton calculations
  - Amortize capital costs at 3.375% over 50 years

• 
$$\frac{(Annual\ Amortized\ Capital\ Costs) + (Annual\ O\&M)}{Tons\ of\ Salt\ Removed} = \$/ton$$

