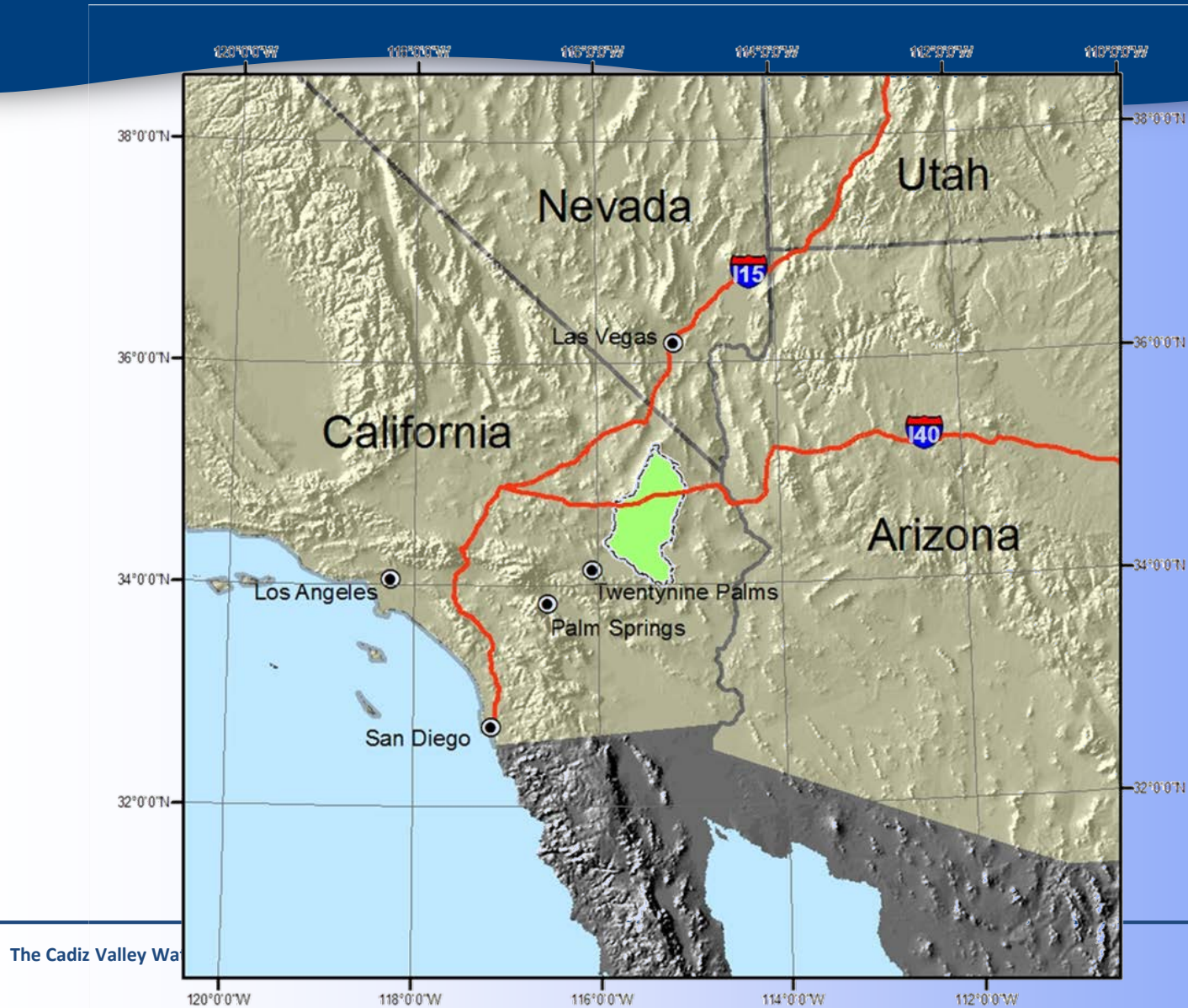


THE CADIZ VALLEY WATER CONSERVATION, RECOVERY, AND STORAGE PROJECT

Terry Foreman, PG, CHg, TLF Consulting, LLC
Dr. Dennis Williams, PHD, PG, CHg, Geoscience Support Services, Inc.
Dr. Miles Kenney, PHD, PG, Kenney Geoscience, Inc.
Scott Slater, Cadiz, Inc.

16th Biennial Symposium on Managed Aquifer Recharge
March 6-7, 2018
San Diego, California
Groundwater Resources Association of California and
Arizona Hydrological Society

Location Map



Phase 1 Pumping Plan

Objective:

To maximize conservation of groundwater that would otherwise flow to the dry lakes and evaporate – “shift the pumping from the dry lakes to the wellfield for beneficial use”



Phase 1 Pumping Plan – cont.

Two components

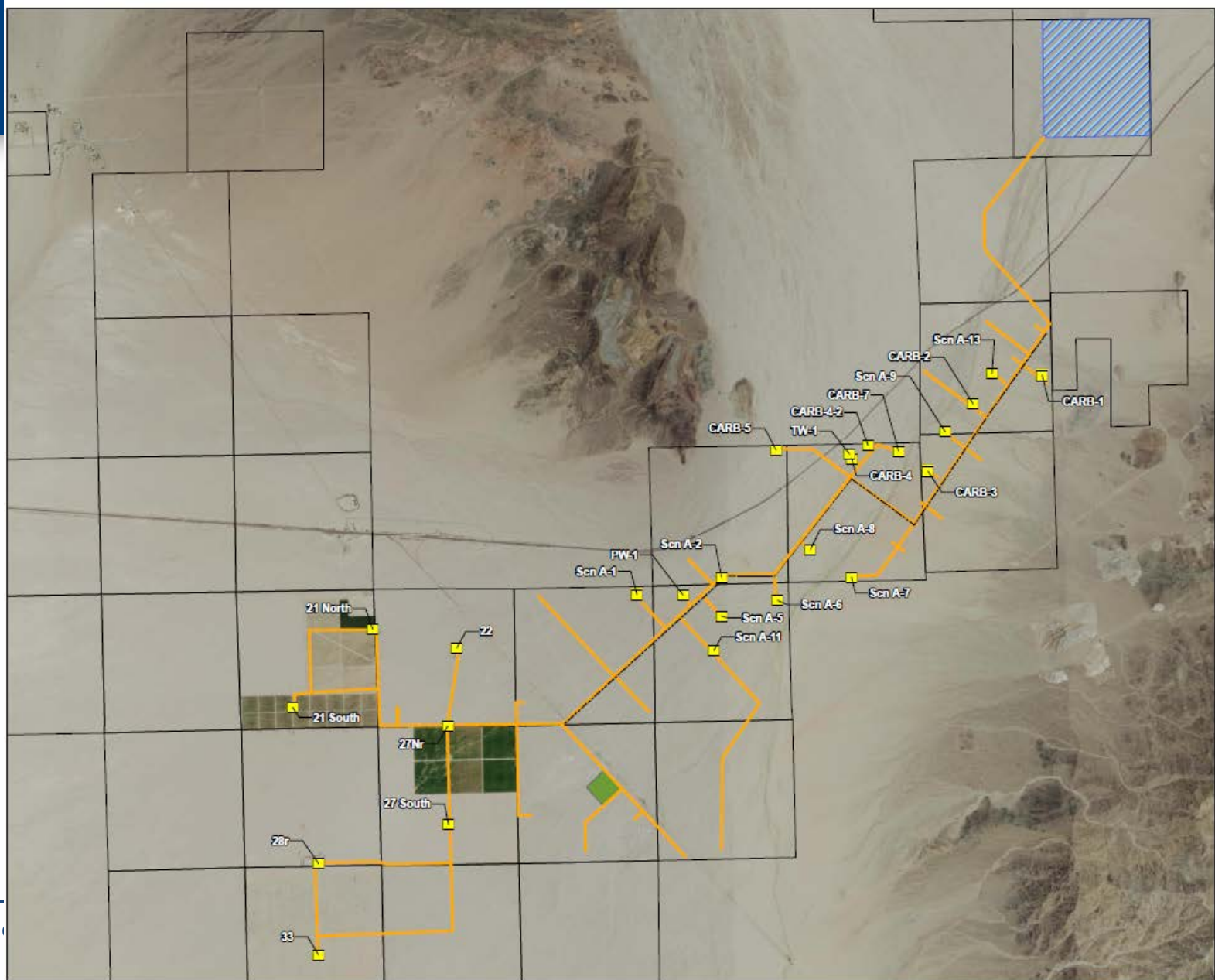
Natural recharge

**Groundwater already in transit to dry
lakes beyond wellfield**

**Pump 50,000 AFY to capture both
components**

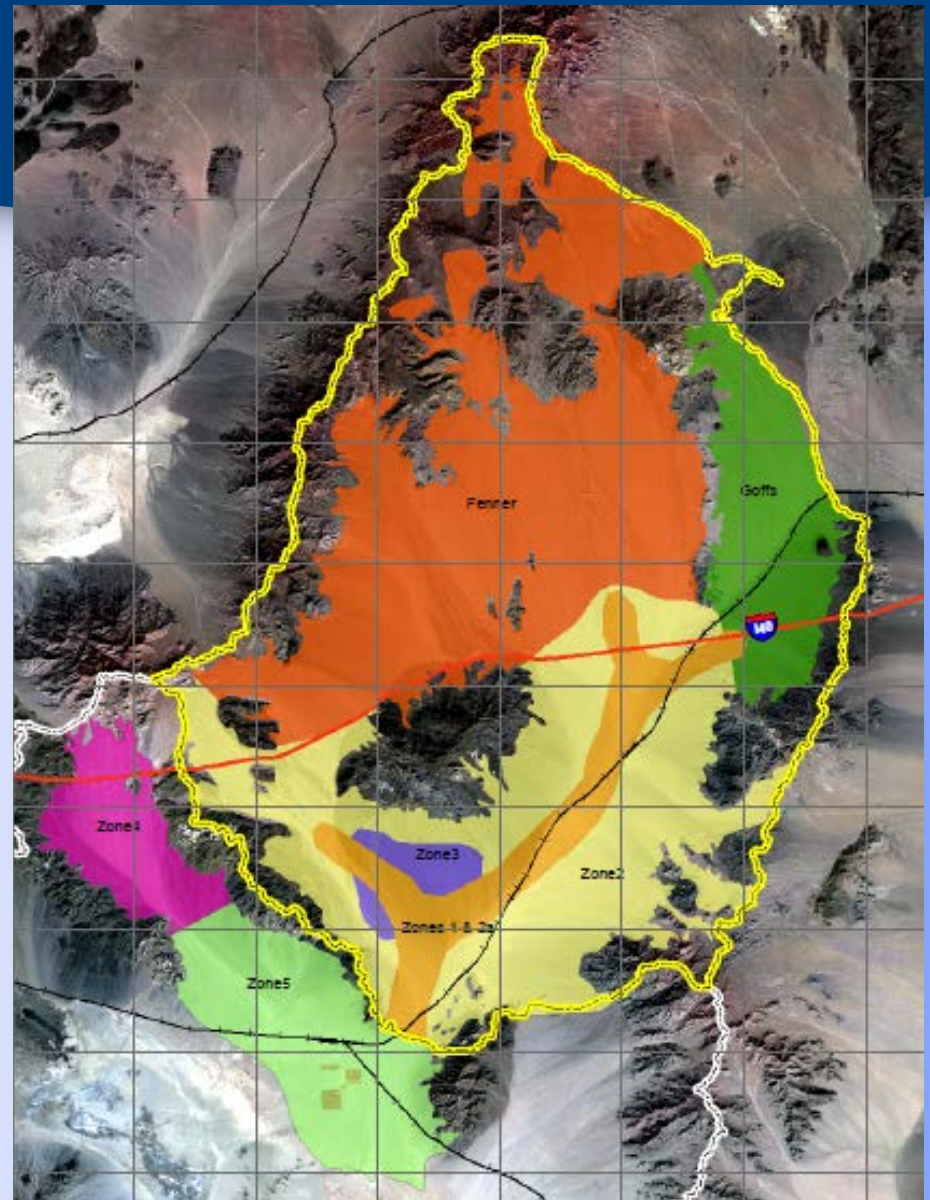
**Project to be permitted for 50 years, so
pumping levels will be revisited**

Proposed Cadiz Wellfield



Groundwater Storage

16.9 to 34.1 Million Acre-Feet of Groundwater In Storage In Alluvium

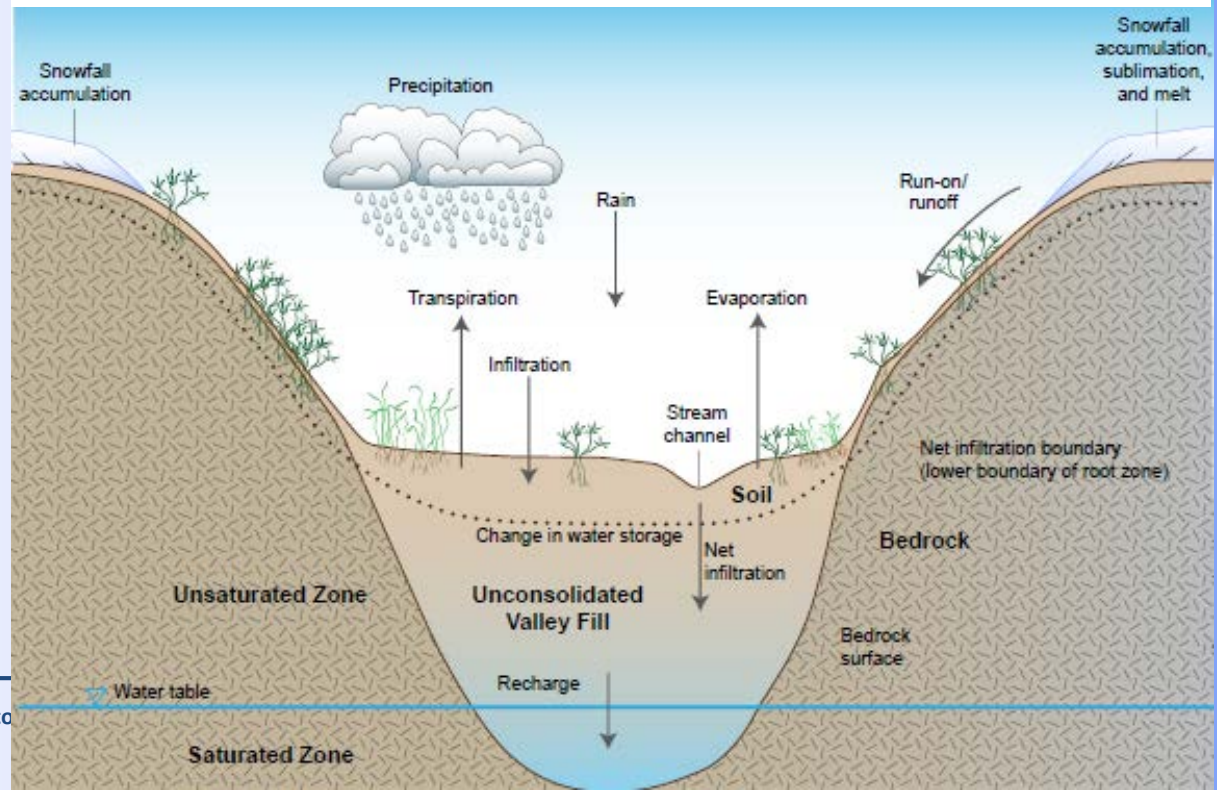


Assessment of Recoverable Water Groundwater Recharge Upgradient of Project Area

- Topography
- Precipitation/
Temperature
- Soils
- Geology
- Vegetation

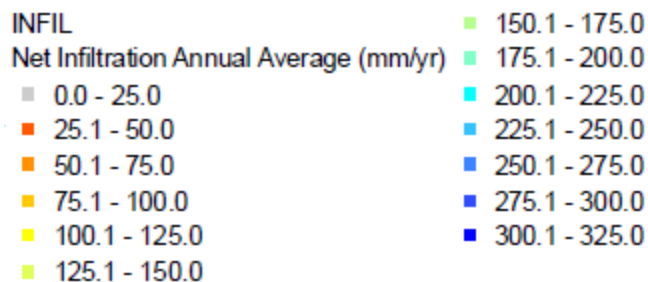


Documentation of Computer Program INFIL3.0— A Distributed-Parameter Watershed Model to Estimate Net Infiltration Below the Root Zone

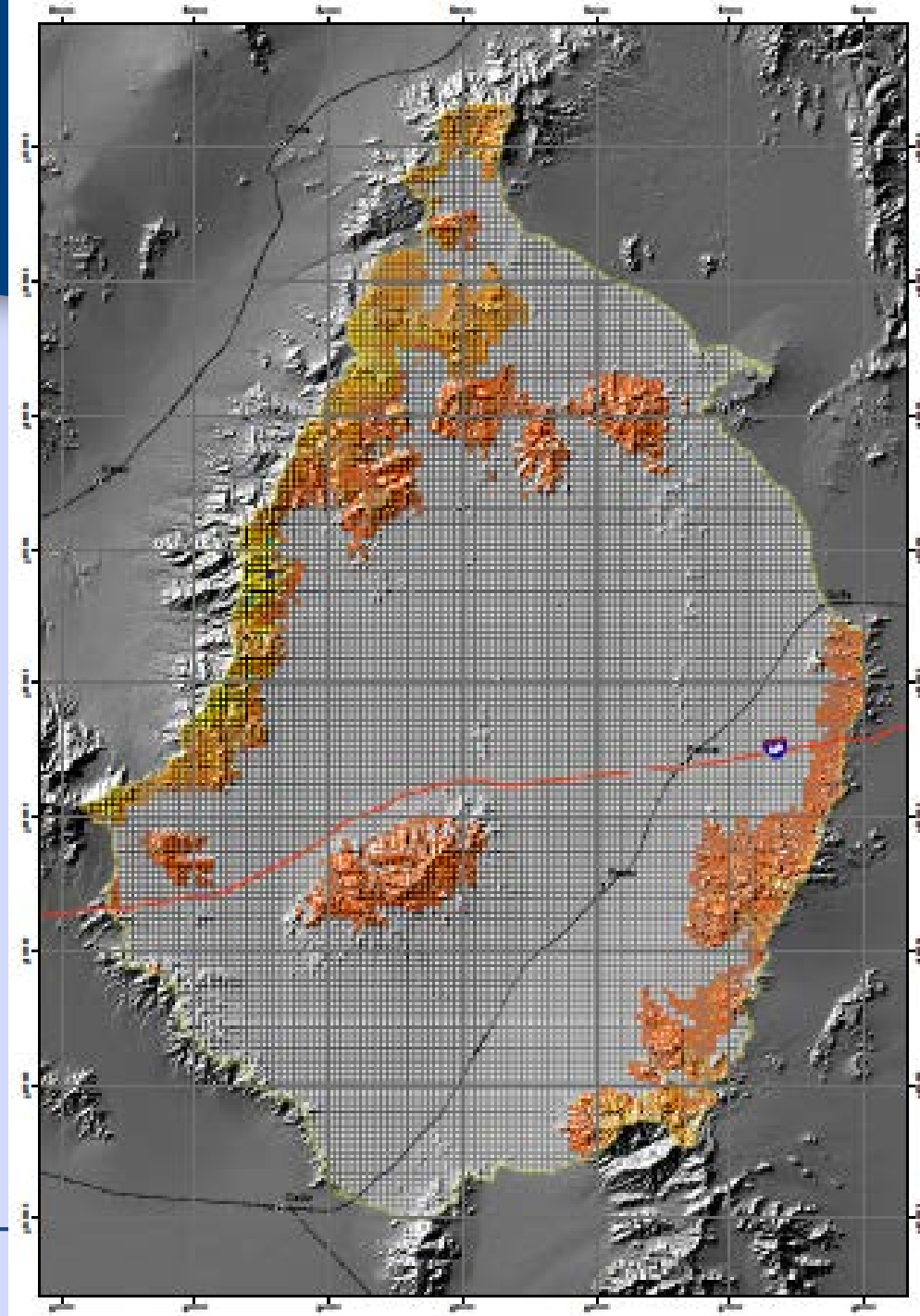


Modeled Recoverable Water

- Fenner Watershed
~30,200 AFY
1958-2007
- Orange Blossom
area ~2,200
AFY



Orange Project



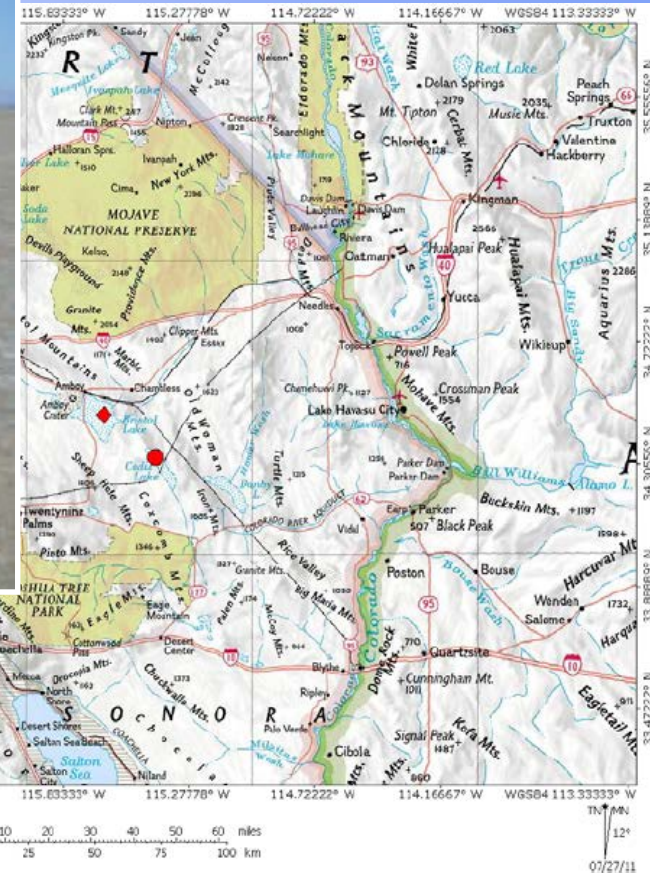
Evaporation Study of Dry Lakes

"Close the Water Budget"

EC Instrumentation



- Engaged the Desert Research Institute (DRI) to measure evaporation from dry lakes



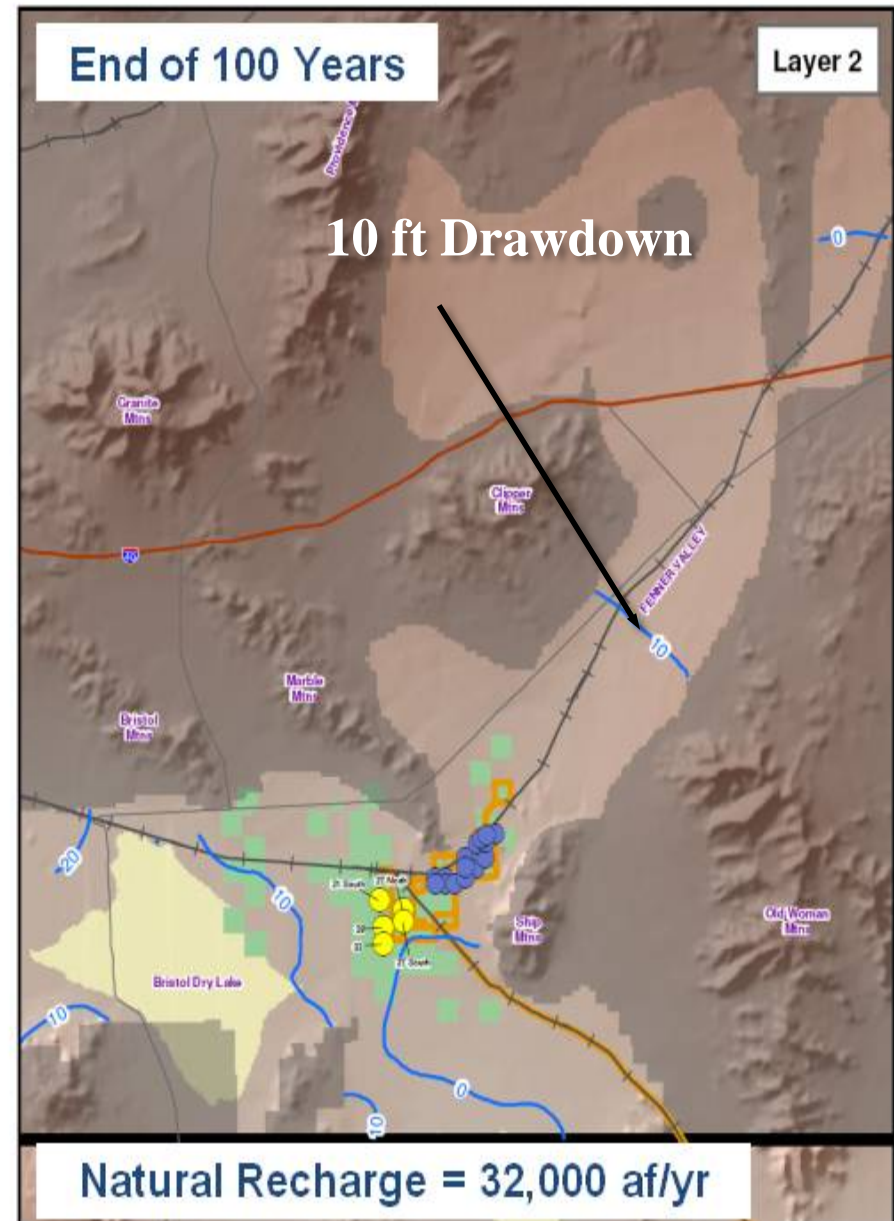
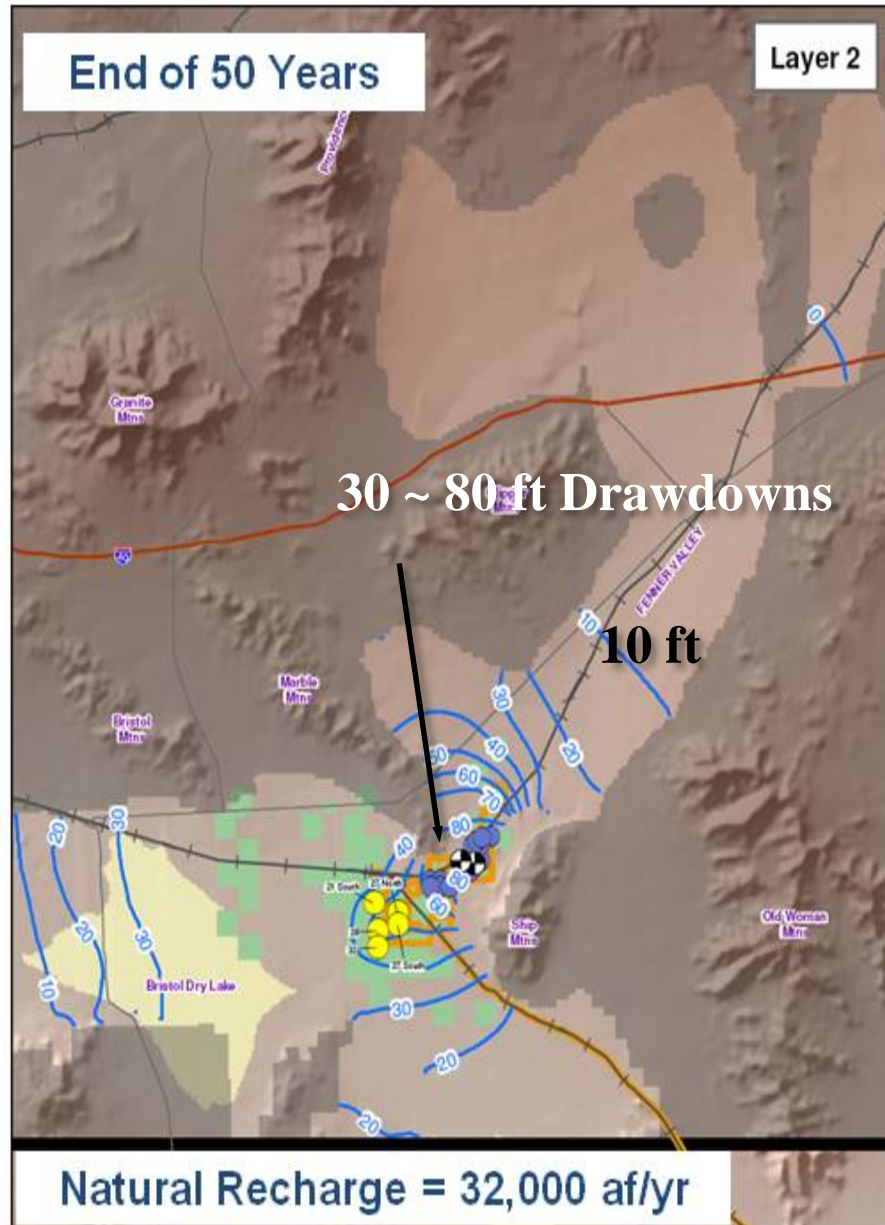
Results

- Annual Evaporation
 - Bristol – 7,860 AFY
 - Cadiz – 23,730 AFY
 - Total – 31,590 AFY
- Excludes mining operations and Cadiz agricultural operations
- Evaporative fluxes are 0.18 and 0.48 ft/yr for Bristol and Cadiz respectively, which is within range of 0.1 to 0.7 ft/yr reported by USGS for dry lakes in Death Valley flow system

Potential Project Impacts Analyzed

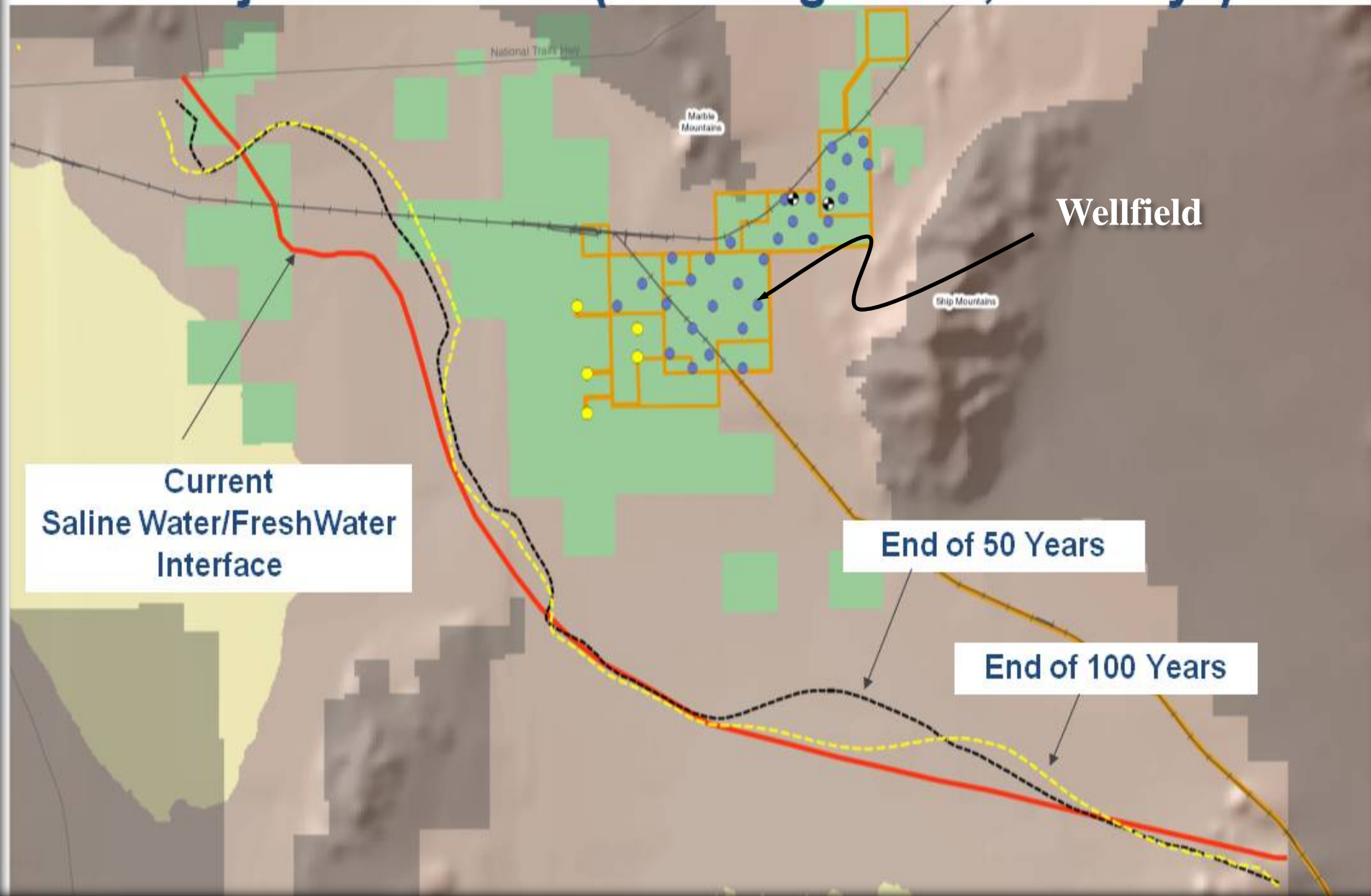
- Impacts from Regional Drawdowns
- Migration of Saline/Freshwater Interface
- Land Subsidence
- Springs

Regional Drawdown - Project Scenario



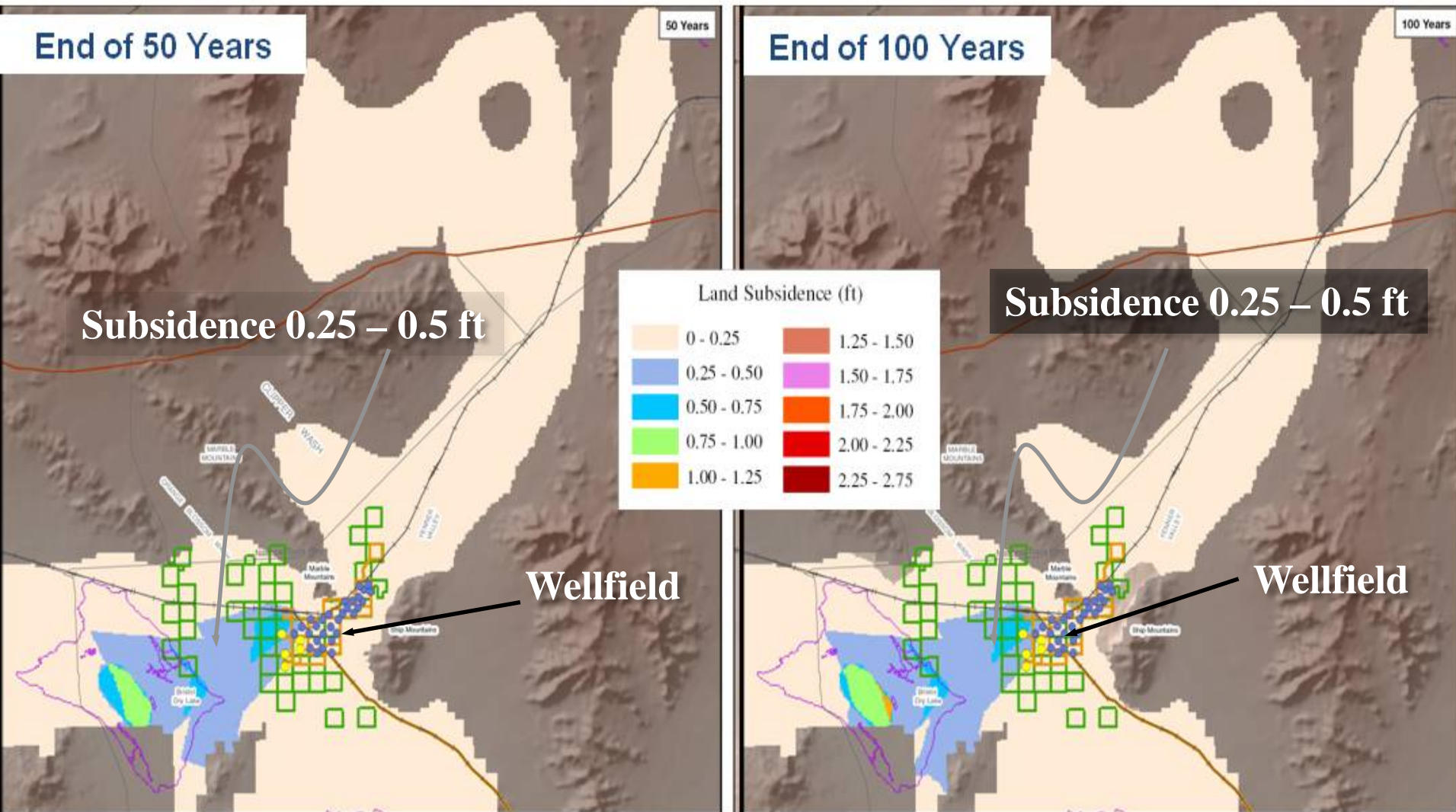
Saline Water/FreshWater Interface

Project Scenario (Recharge = 32,000 af/yr)



Potential Land Subsidence

Project Scenario (recharge = 32,000 af/yr)



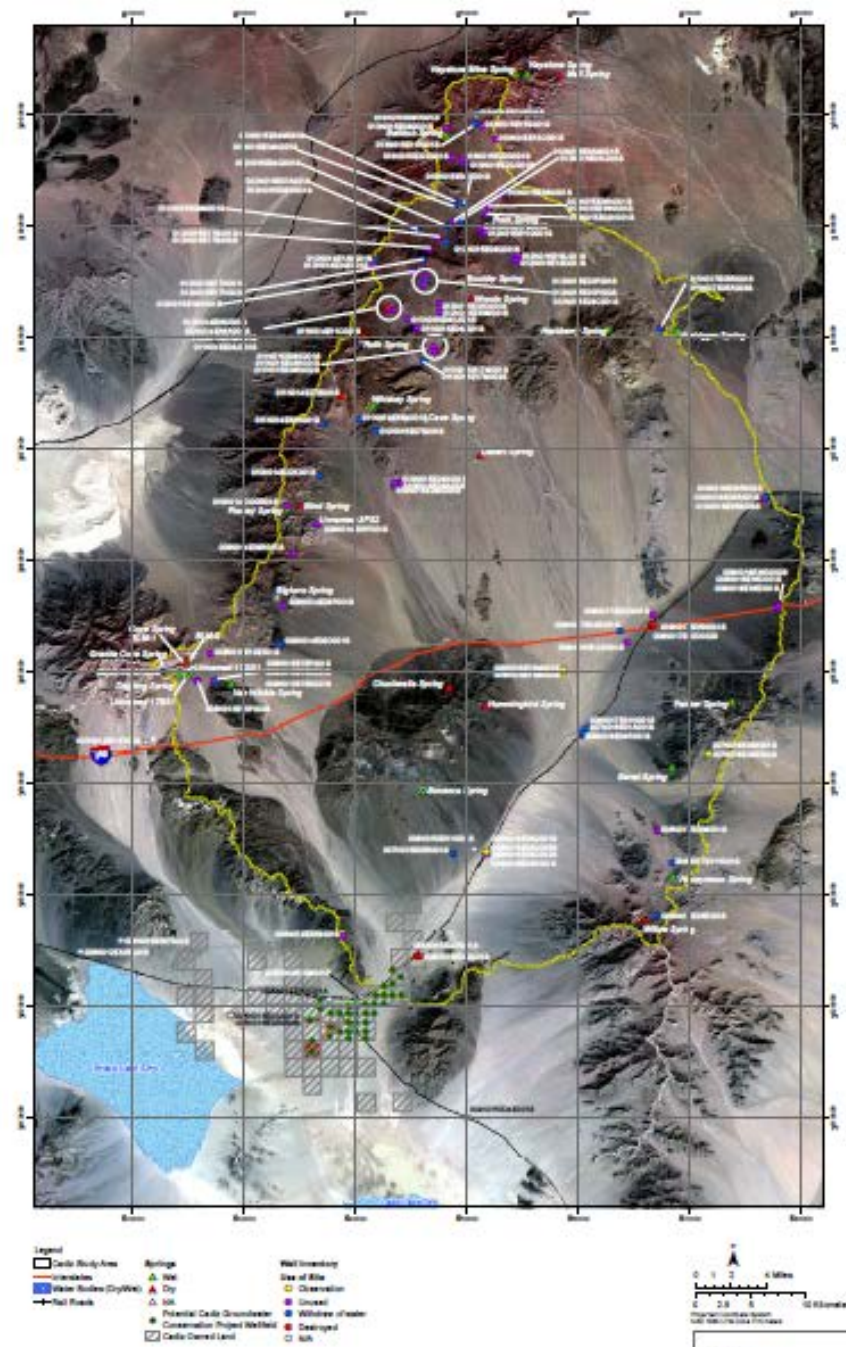
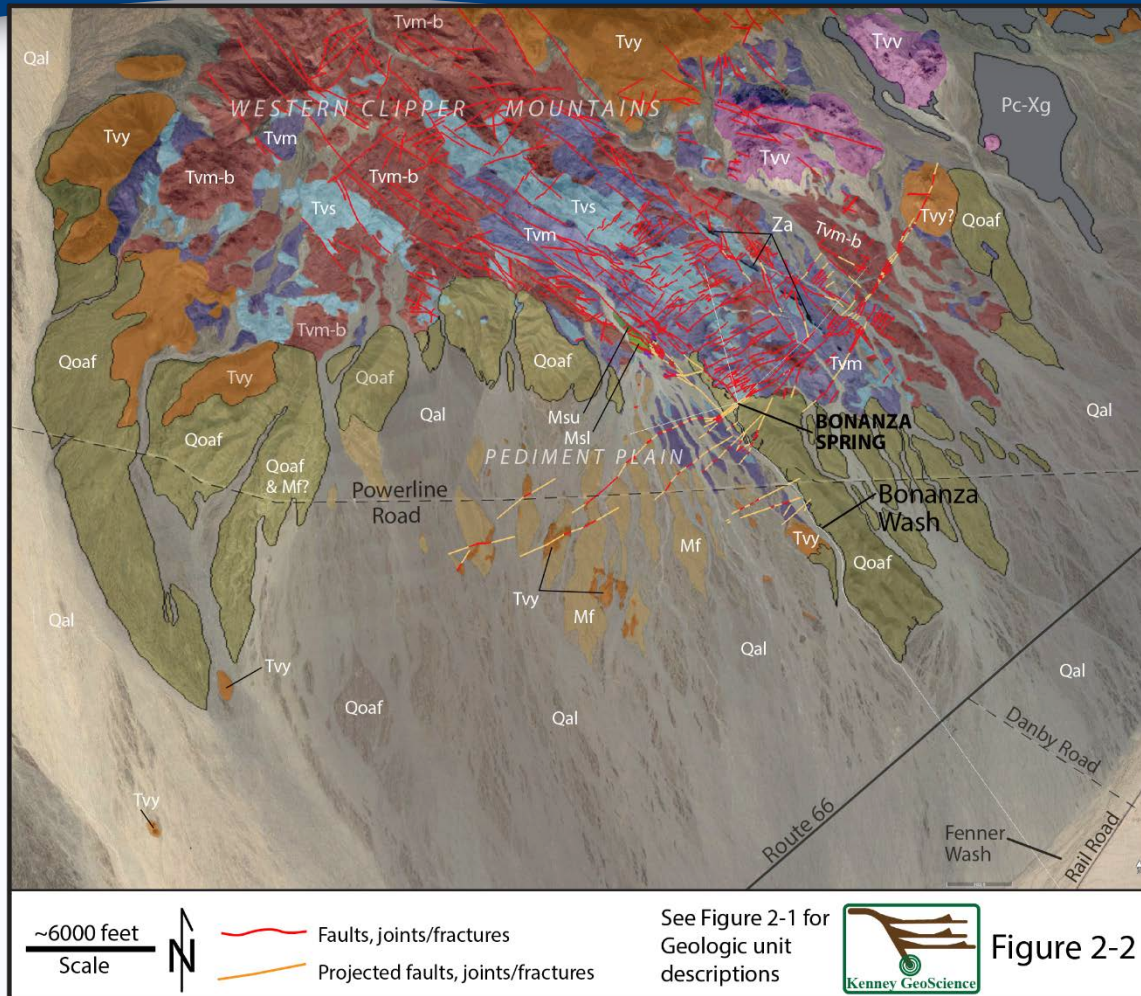


Figure 2
Location of Springs and Wells

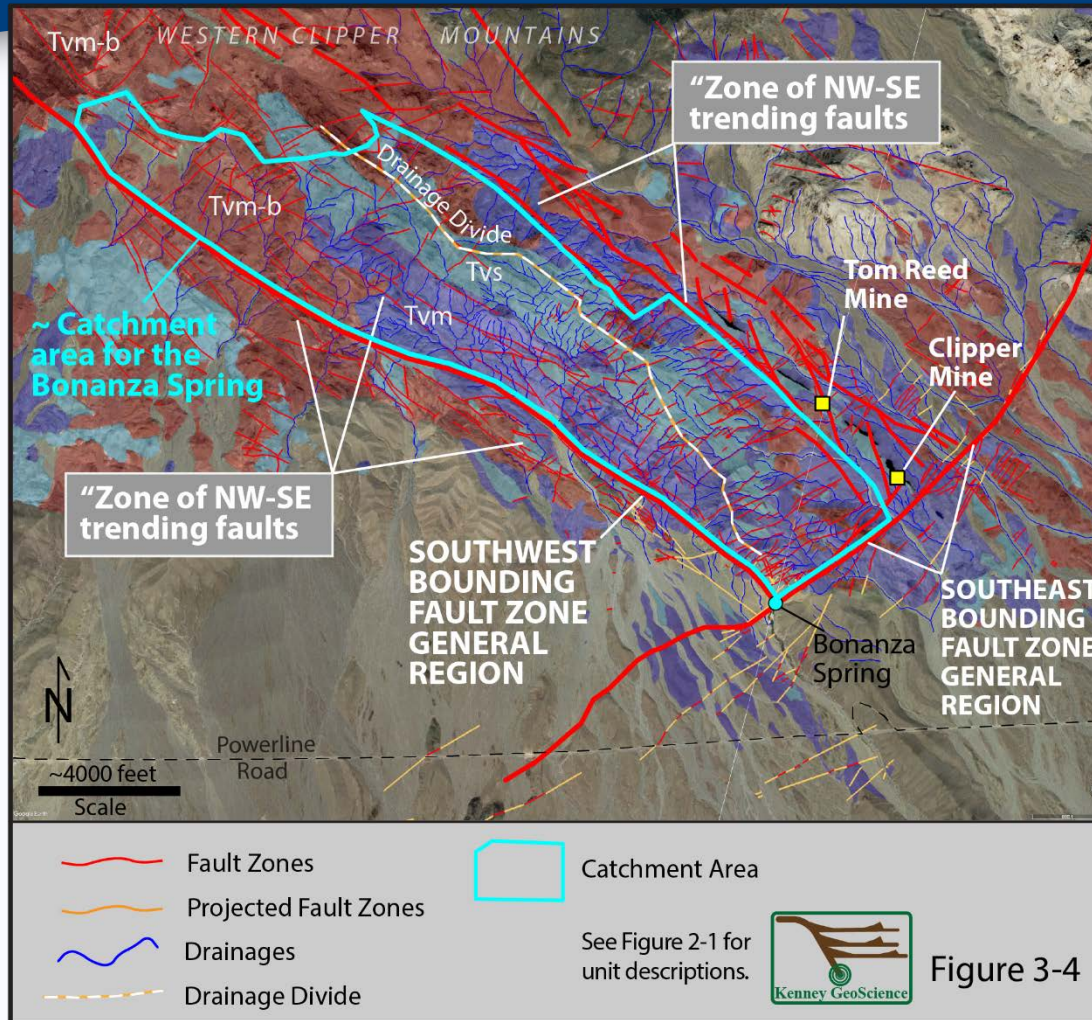
Setting



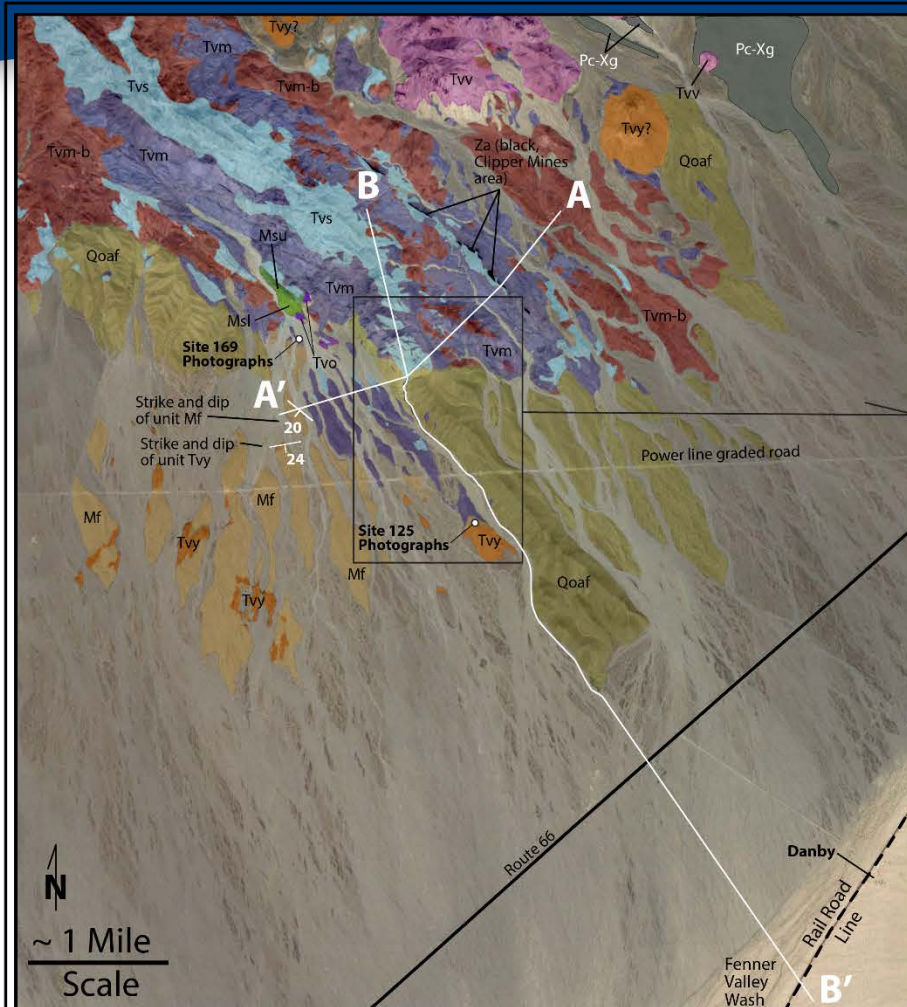
Clipper Mountains – Geology



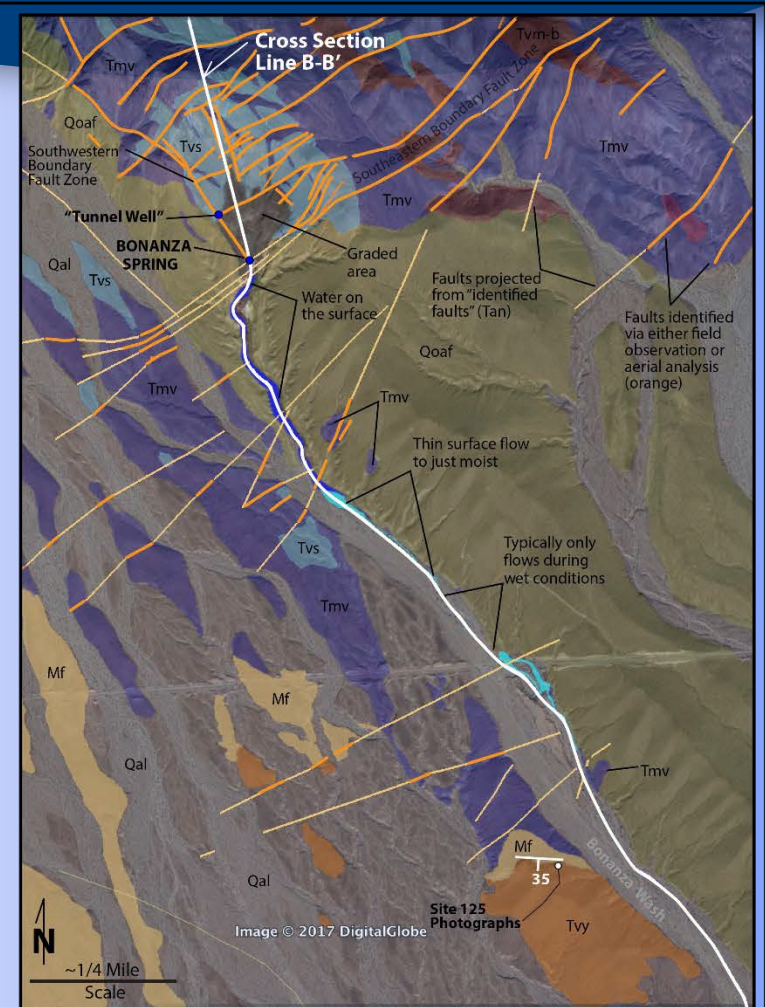
Catchment Area of Spring



Local Geology



**GEOLOGIC MAP AND CROSS SECTIONS A-A' & B-B' LOCATIONS
SOUTHWESTERN CLIPPER MOUNTAINS & FENNER VALLEY, CALIFORNIA**



NOTE: See Figure 2-1 for Geologic unit descriptions.

Figure 2-7a

Cross section B-B'

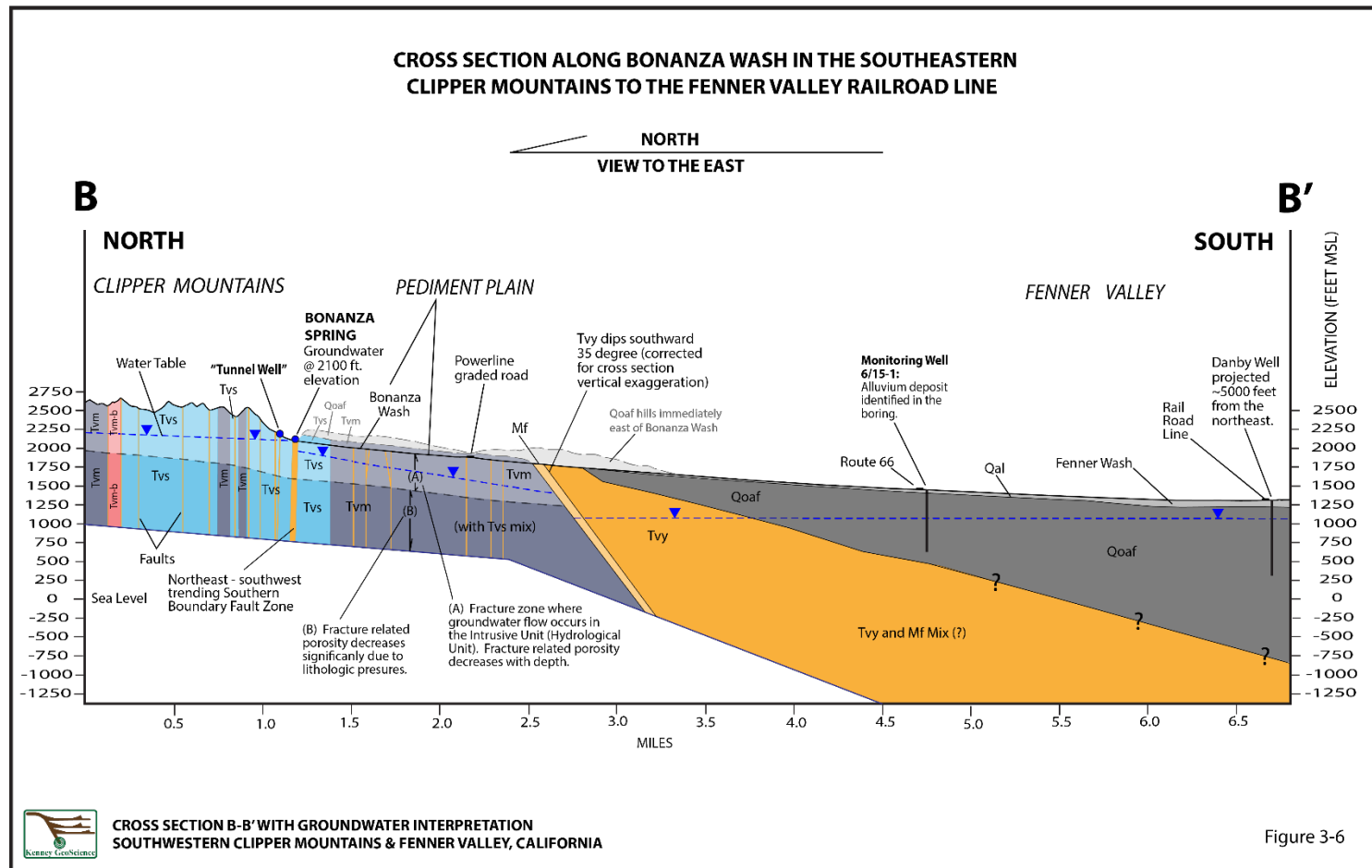


Figure 3-6

Conceptual Model of Spring

- Groundwater recharge in upper elevations is the source of groundwater
- Groundwater flow through intrusives is controlled by transmissivity of these rocks and is impeded by faulting
- Groundwater flow downgradient occurs in fractured crystalline rocks, which discharges above the groundwater level in the alluvial aquifer
- Changes in groundwater levels in the alluvium will not effect groundwater levels at the spring
- Changes in long-term recharge control groundwater levels at the spring

Summary of Impacts Assessments

- Substantial volume of high quality groundwater in storage upgradient of proposed wellfield
- Pumping above natural recharge required to capture natural recharge AND groundwater already in transit to Dry Lakes
- Pumping an average of 50,000 AFY will not have significant impacts on the environment: groundwater levels, water quality, subsidence, springs

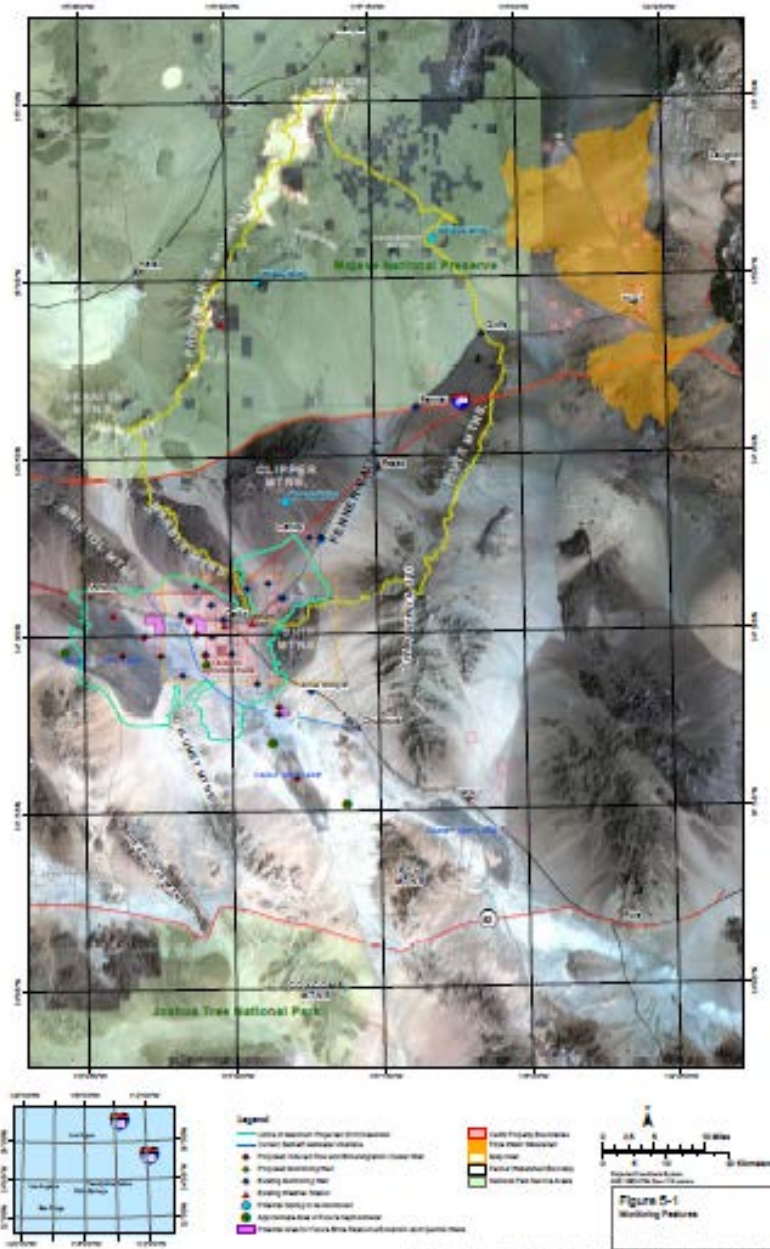
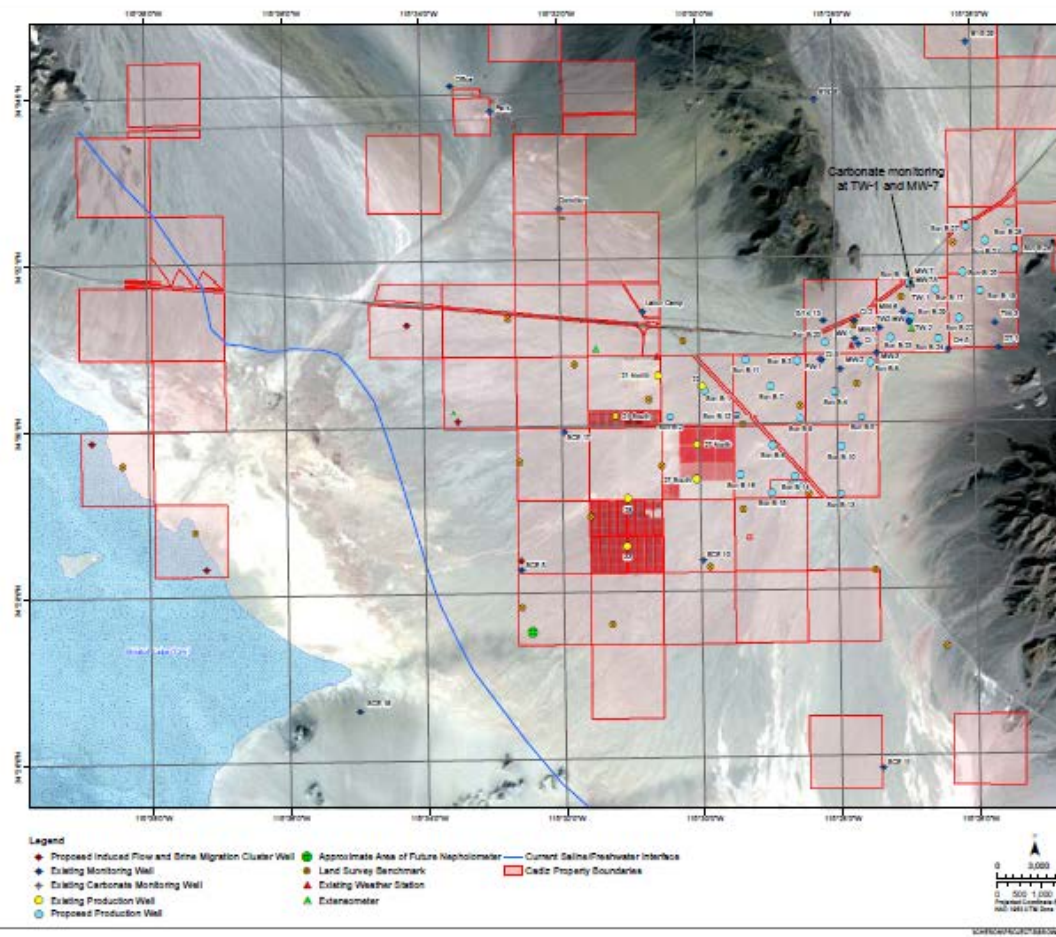
Water Quality

- Meets all Drinking Water Standards,
 - Hexavalent chromium Cr(VI) – average 14 µg/l vs.
 - Cadiz is partnering with ATEC to remove Cr(VI). Recent pilot testing on Cadiz groundwater shows it is a cost-effective RCF technology approved by State DDW.
- Total Dissolved Solids (TDS) averages around ~330 mg/l

Groundwater Management, Monitoring, and Mitigation Plan (GMMMP)

- **Avoid Undesirable Results**
- **Annual reports**
- **Five-year Groundwater Model Update and Comprehensive Re-Assessment of Groundwater Conditions**
- **Decision tree for response actions**
- **Extensive Mitigation Measures, and project design features, including potential to modify project operations**
- **Independent Technical Review Panel**

Monitoring Features



Groundwater Management, Monitoring, and Mitigation Plan

- 3 Springs
- 14 Existing Monitoring Wells
- 2 New Monitoring Wells
- 2 Existing Cluster Wells
- 9 New Cluster Wells
- 34 (5 existing and 29 New Extraction wells)
- 23 Land Survey Benchmarks
- InSAR surveys
- 3 New Extensometers
- 5 Flowmeter Surveys
- 4 Weather Stations
- 4 Nephelometers (air quality)
- Vegetation Monitoring

Phases 1 & 2 Connect SoCal's Major Water Transportation Routes



Questions?

