Land Subsidence in the San Joaquin Valley

Subsidence Monitoring and Response in Central California Irrigation District

A Local Perspective

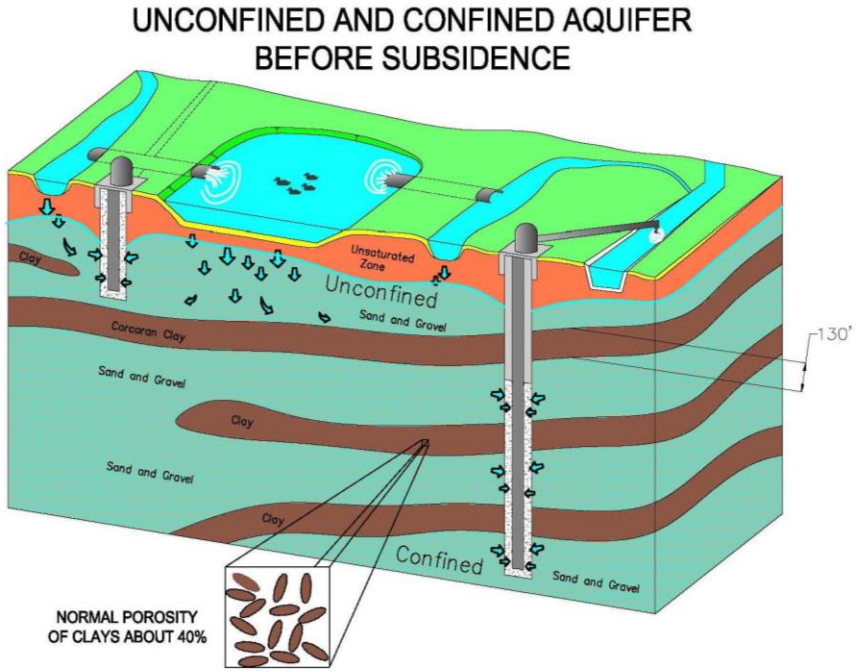
Presented by Chris White, General Manager
Central California Irrigation District

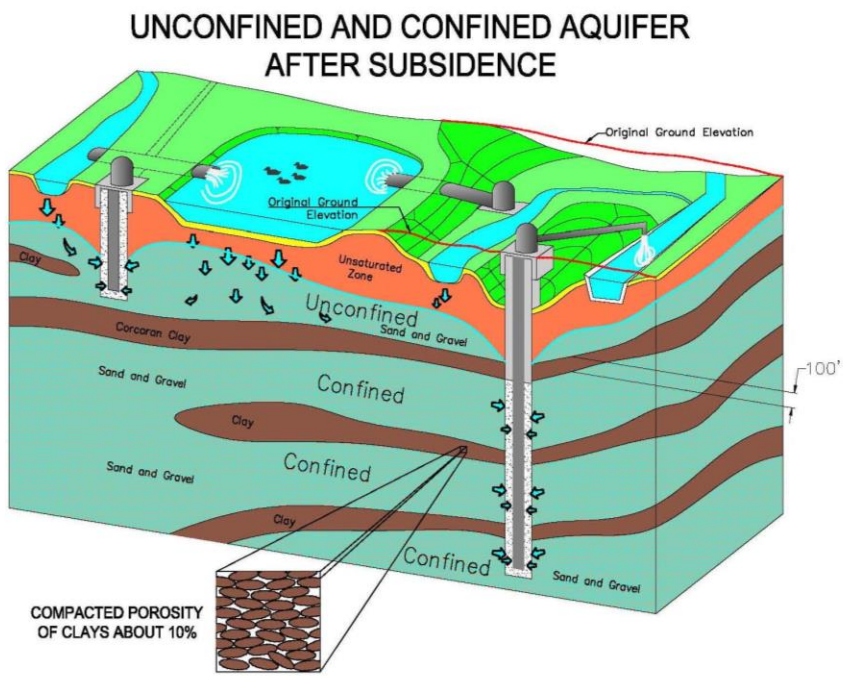
Water Education Foundation

August 16, 2017

Subsidence Monitoring

Document the Signs





Redtop Gas Well

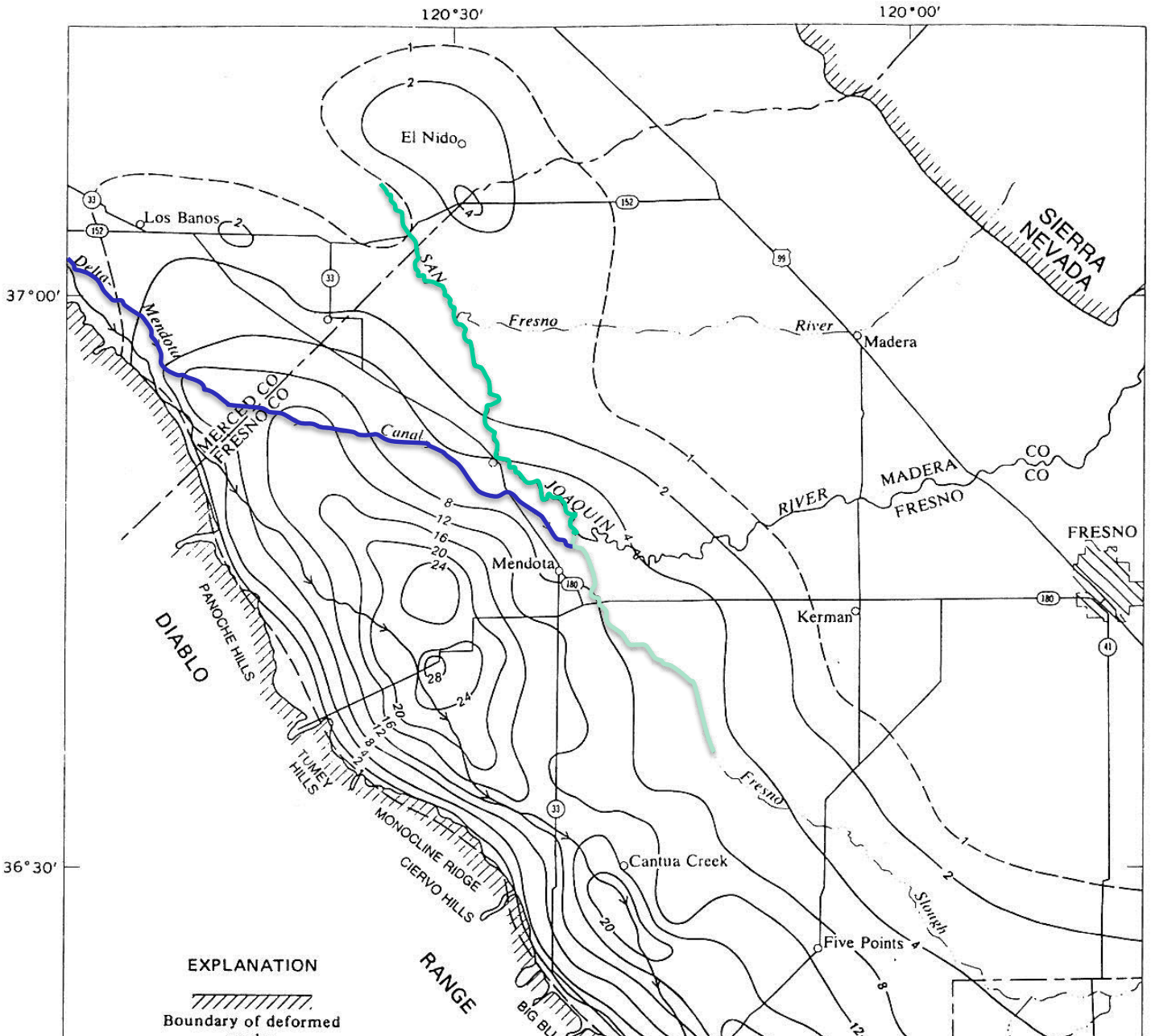
Redtop water well

EST. 1968
PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company


Federal Facilities
State Facilities
1960s
OREGON
Klamath River
Trinity Lake
2.4 MAF
Trinity River
Trinity Dam
Lewiston Dam
McCloud River
Pit River
Keswick Dam
Shasta Lake
4.5 MAF
Shasta Dam
Whiskeytown Reservoir
241,000 AF
Whiskeytown Dam
REDDING
Red Bluff Diversion Dam
Corning Canal
Tehama-Colusa Canal
Sacramento River
Lake Oroville (State)
3.5 MAF
Feather River
PACIFIC OCEAN
Lake Tahoe
732,000 AF
American River
Folsom Lake
977,000 AF
Folsom Dam
Nimbus Dam
SACRAMENTO
Folsom South Canal
Sacramento - San Joaquin Delta
New Melones Dam
New Melones Lake
2.4 MAF
Stanislaus River
Tuolumne River
SAN FRANCISCO
Contra-Costa Canal
Jones & Banks Pumping Plants
Delta - Mendota Canal
San Joaquin River
Madera Canal
Friant Dam
Millerton Lake
520,000 AF
San Luis Reservoir
966,000 AF (Federal)
1.07 MAF (State)
San Luis Dam
San Luis Canal
Coalinga Canal
FRESNO
Friant-Kern Canal
California Aqueduct
BAKERSFIELD
(State)
NEVADA
CALIFORNIA
N
0 20 40 60 80 100
SCALE OF M ILES
U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
LEGEND
RIVERS
FEDERAL CANALS
SHARED FEDERAL/STATE CANAL
STATE CANAL
MAF MILLION ACRE FEET
AF ACRE FEET

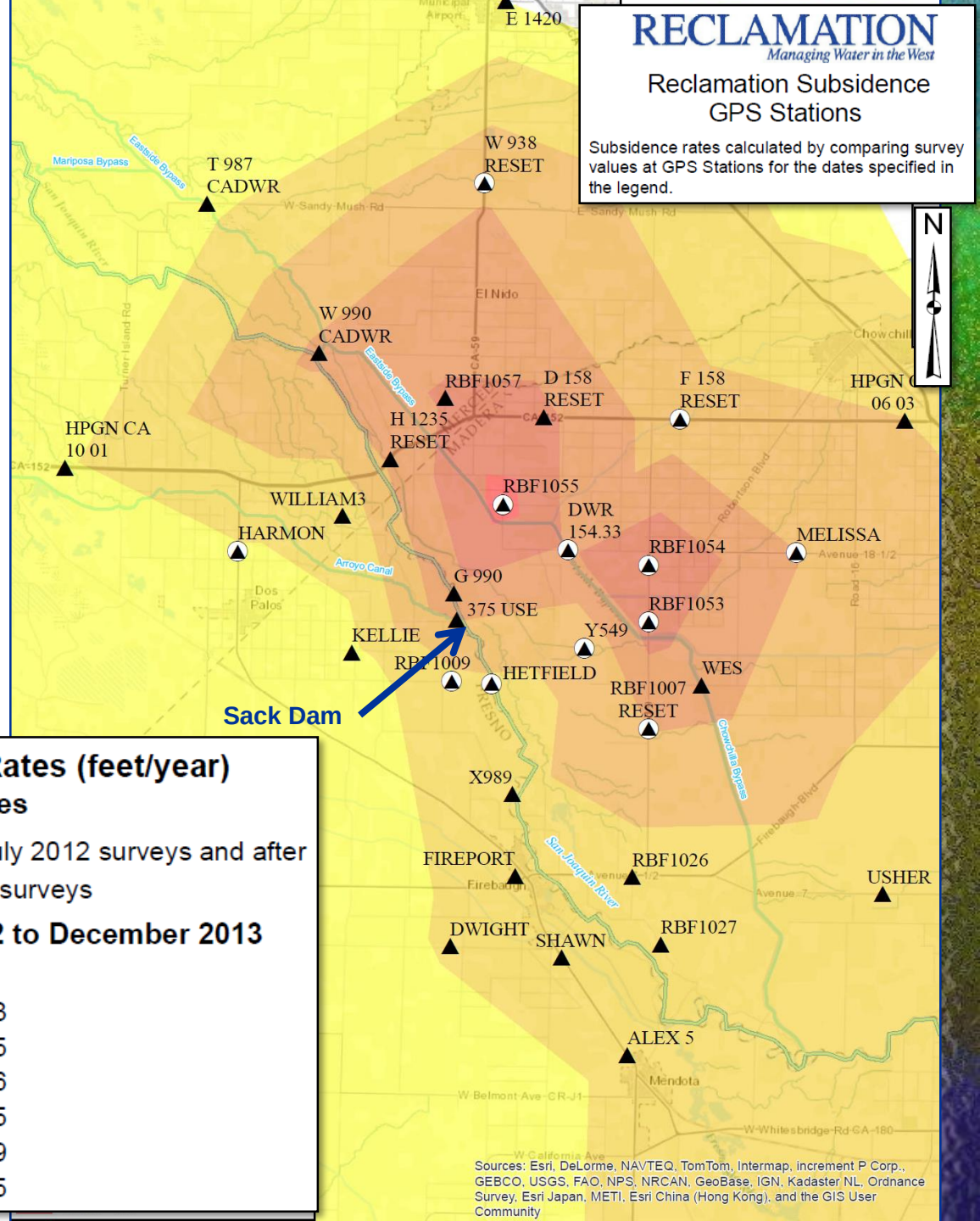
Subsidence

- New vs. Historical


120°30′
120°00′
37°00′
36°30′
El Nido
Los Banos
SAN
Fresno
River
Madera
SIERRA NEVADA
Delta-
Mendota
Canal
MERCED CO
FRESNO CO
JOAQUIN
RIVER
MADERA CO
FRESNO CO
FRESNO
Mendota
Kerman
DIABLO
PANOCHE HILLS
TUMEY HILLS
MONOCLINE RIDGE
CIERVO HILLS
RANGE
Cantua Creek
Five Points
Slough
EXPLANATION
Boundary of deformed


4
-0.45 ft
2076
-0.37 ft
26
-0.1 ft
2048
-0.08 ft
1055
-1.73 ft
2362
-0.53 ft
2077
-0.5 ft
2378
-0.25 ft
2078
-0.07 ft
2348
-0.03 ft
1054
-1.17 ft
39
-0.62 ft
1053
-1.03 ft
2383
-0.22 ft
2384
-0.56 ft
2081
-0.01 ft
1052
-0.8 ft
2050
0.03 ft
2562
-0.32 ft
1051
-0.55 ft
1007
-0.17 ft
2084
-0.13 ft
2083
-0.21 ft
1050
-0.45 ft
2054
-0.02 ft
Legend
AT Point
Primary Control Point
Secondary Control Point
Points Surveyed 06-29-2010 (Change in Elevation Since 2006 in feet)
DWR Levees
(Category 1) State-Federal Project Levee
(Category 2) Non-State-Federal Project Levee - Connected
Streams in Hydraulic Model
Limit of 2010 Subsidence Investigation
RBF Study Area
FloodSAFE
CALIFORNIA
Prepared By: JC
Figure: 1
Job No.: 60100317
Date: July 13, 2010

US Bureau of Reclamation monitoring shows that the subsidence rate in vicinity of Sack Dam from December 2012 to December 2013 was about 0.6 feet.



Process to Define Problem, Monitor, Formulate Hypothesis and Develop Solutions

- Spring 2012 – CCID contacted by U.S. Bureau of Reclamation of a “potential” subsidence issue which they initially thought was a bust in the survey.
- CCID recognized that based on historic knowledge of the area – probably subsidence
- Reclamation become concerned that San Joaquin Restoration Program capital improvements could be impacted by subsidence
- Additional Land Elevation Surveys Conducted

Process to Define Problem, Monitor, Formulate and Develop Solutions

- Met with growers in areas that seemed to be sinking to start dialogue as to what might be happening
- Growers formed committee, invited Madera County and Merced County
- Growers assess themselves to define problem and develop solutions
  - Both counties and Exchange Contractors contribute funds, monitoring and time.
- Measure ground surface changes; regionally, along canals, channels and levees

Proactive approach to avoid future cost

Land Subsidence

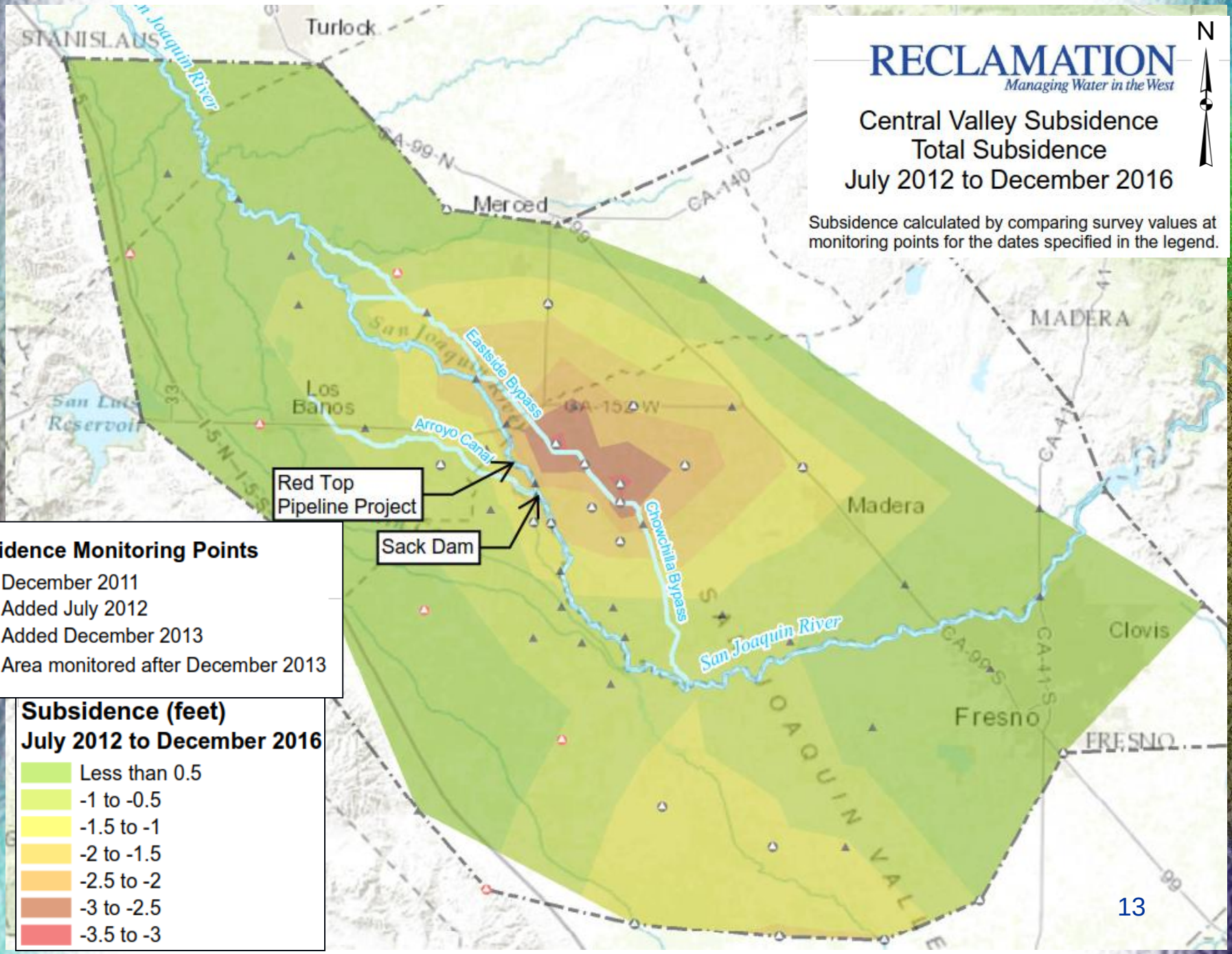
- How bad can it get?

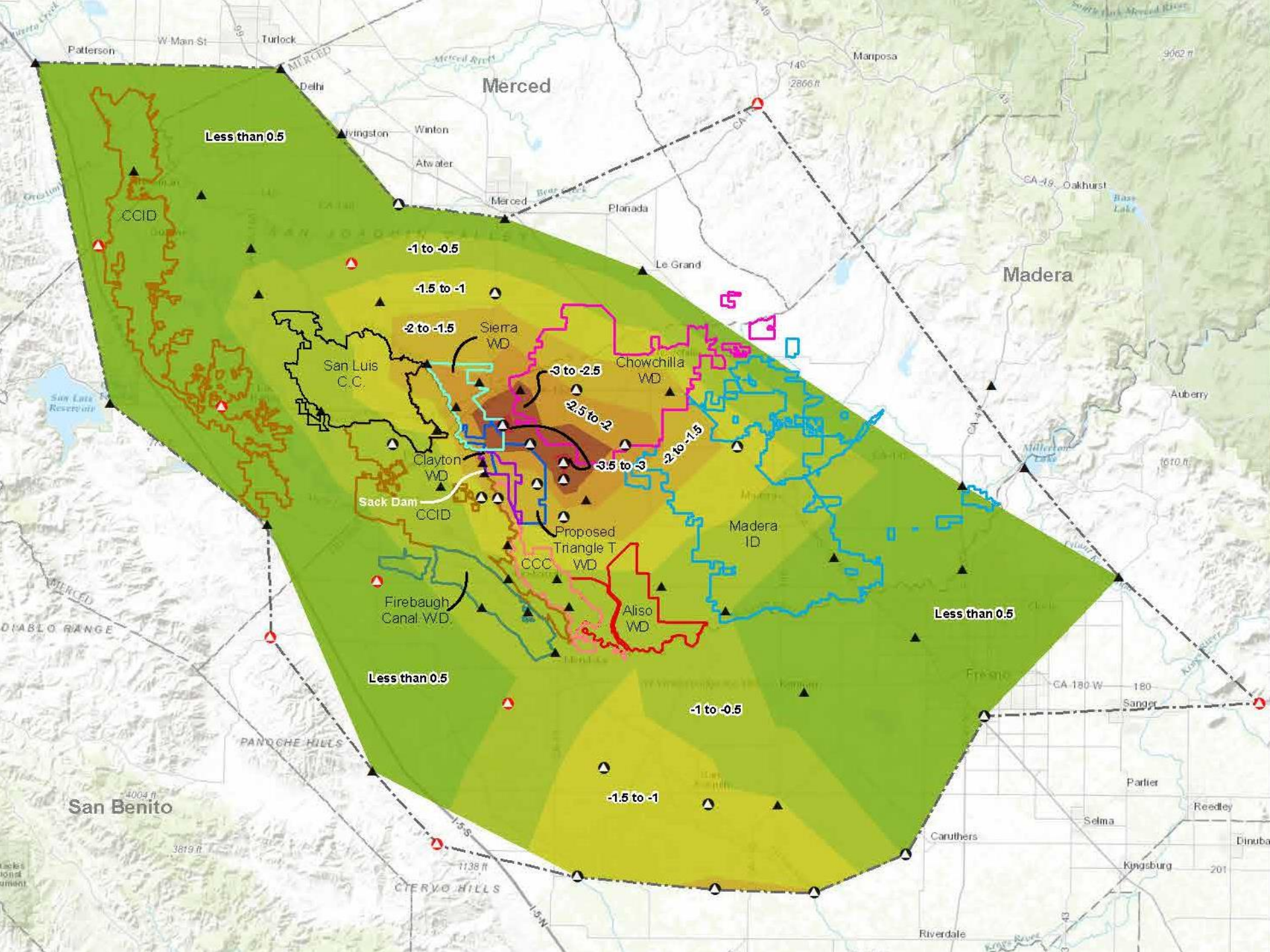
Approximate location of maximum subsidence in the United States identified by research efforts of Dr. Joseph F. Poland (pictured). Signs on pole show approximate altitude of land surface in 1925, 1955, and 1977. (28 feet in 50 years, .56 feet/year)

The site is in the San Joaquin Valley southwest of Mendota, California, 15 miles southwest of Sack Dam.

Subsidence, if not stopped, will…

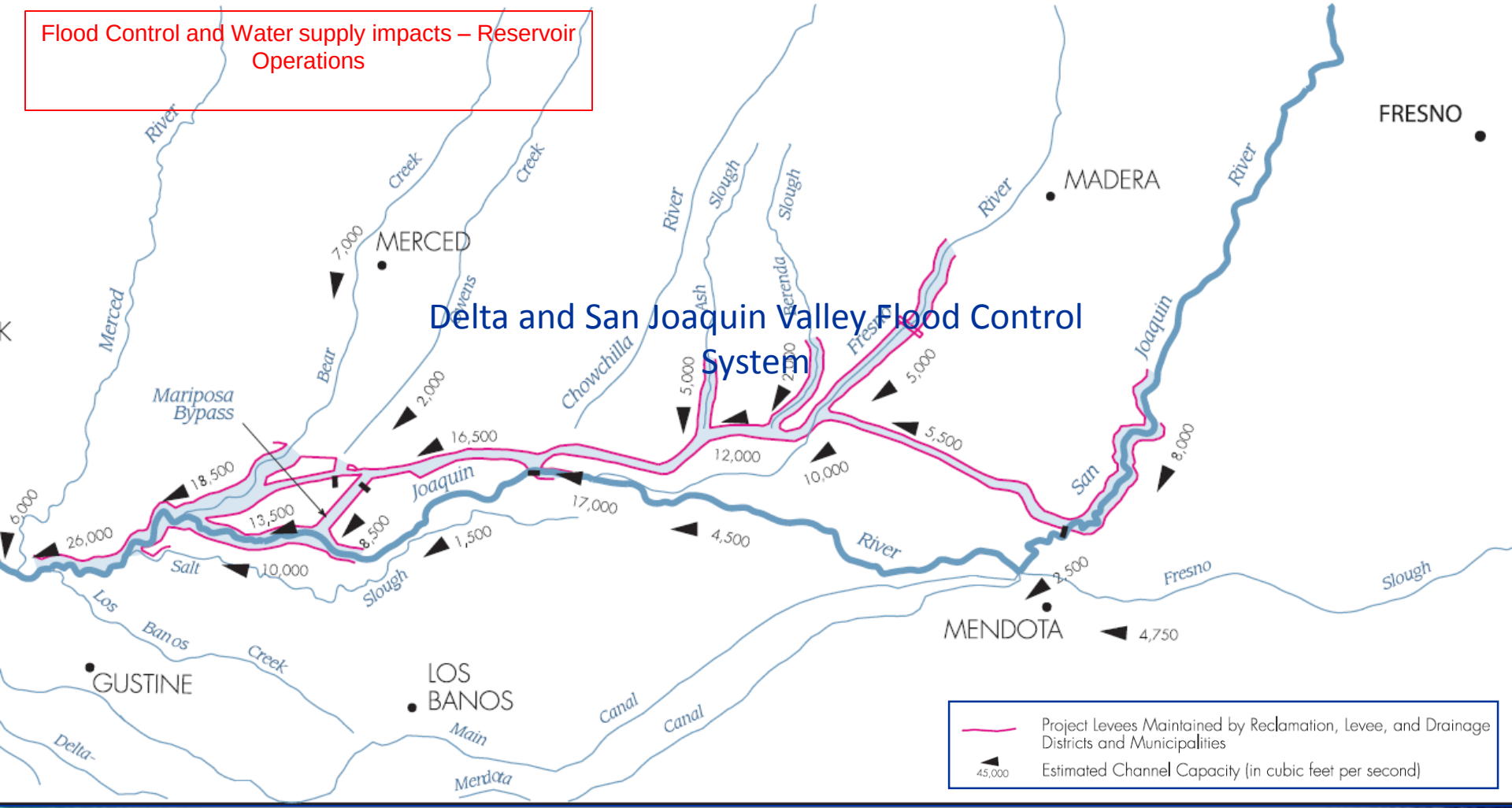
- Cause flooding in Western Madera & Merced counties
  - Highway 152
  - Elementary school
  - City of Dos Palos
  - Valuable farmland and dairies
- Jeopardize water supply of neighboring districts – up to 20% reduction in water district conveyance capacity
  - Central California Irrigation District
  - San Luis Canal Company
- Jeopardize the San Joaquin River Restoration Program


RECLAMATION
Managing Water in the West
Central Valley Subsidence
Total Subsidence
July 2012 to December 2016
Subsidence calculated by comparing survey values at monitoring points for the dates specified in the legend.
N
Subsidence Monitoring Points
December 2011
Added July 2012
Added December 2013
Area monitored after December 2013
Subsidence (feet)
July 2012 to December 2016
Less than 0.5
-1 to -0.5
-1.5 to -1
-2 to -1.5
-2.5 to -2
-3 to -2.5
-3.5 to -3
Red Top Pipeline Project
Sack Dam
Turlock
Merced
Los Banos
Madera
Clovis
Fresno
MADERA
FRESNO
STANISLAUS
San Joaquin River
Eastside Bypass
Arroyo Canal
Chowchilla Bypass
CA-99-N
CA-140
CA-152-W
CA-99-S
CA-41-S
99

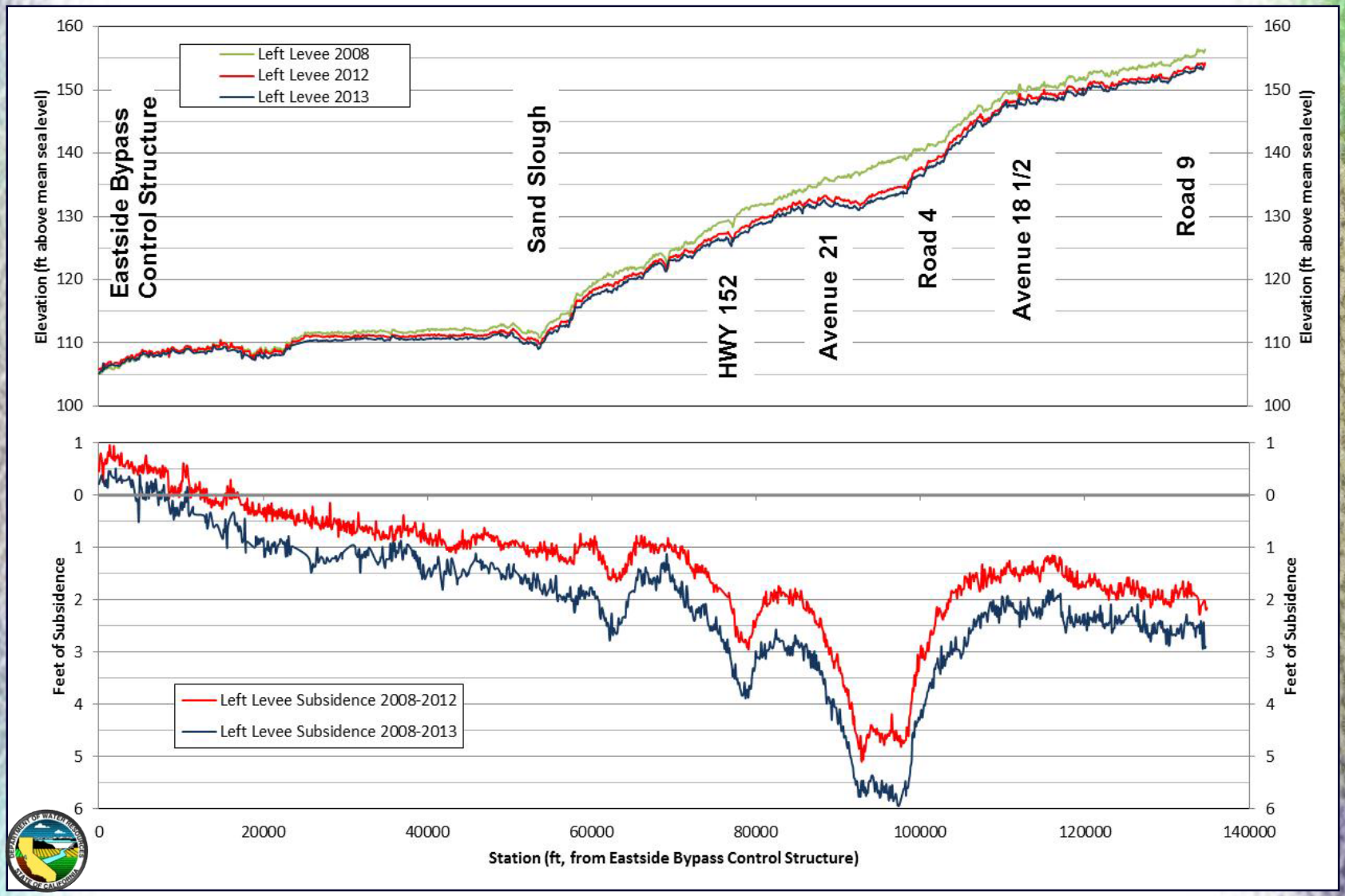

Less than 0.5
-1 to -0.5
-1.5 to -1
-2 to -1.5
-2.5 to -2
-3 to -2.5
-3.5 to -3
CCID
San Luis C.C.
Sierra WD
Chowchilla WD
Clayton WD
Sack Dam
CCID
Proposed Triangle T WD
CCC
Madera ID
Firebaugh Canal W.D.
Aliso WD
Merced
Madera
San Benito
Fresno
Patterson
Turlock
Delhi
Livingston
Winton
Atwater
Merced
Planada
Le Grand
Mariposa
Oakhurst
Auberry
Sanger
Parlier
Reedley
Selma
Caruthers
Kingsburg
Riverdale
Dinuba
DIABLO RANGE
PANOCHE HILLS
CERVO HILLS

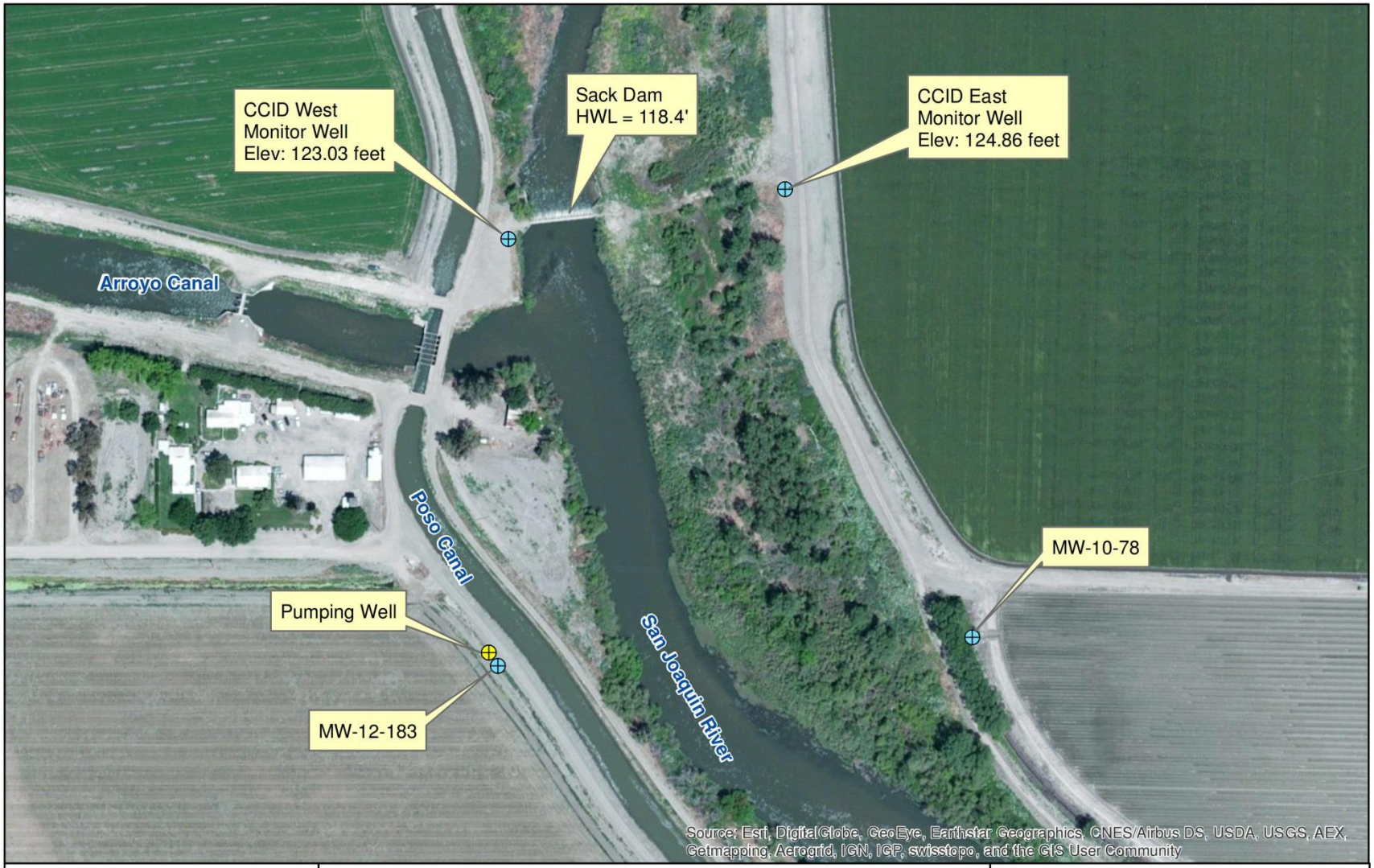
Delta and San Joaquin Valley Flood Control System

Flood Control and Water supply impacts – Reservoir Operations



Ground Subsidence along the left levee in the Upper and Middle Eastside Bypasses





0 100 200 Feet

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An Employee Owned Company

1800 30th Street, Ste. 280
Bakersfield, CA 93301
(661) 616-5900

- Monitor Well
- Pumping Well

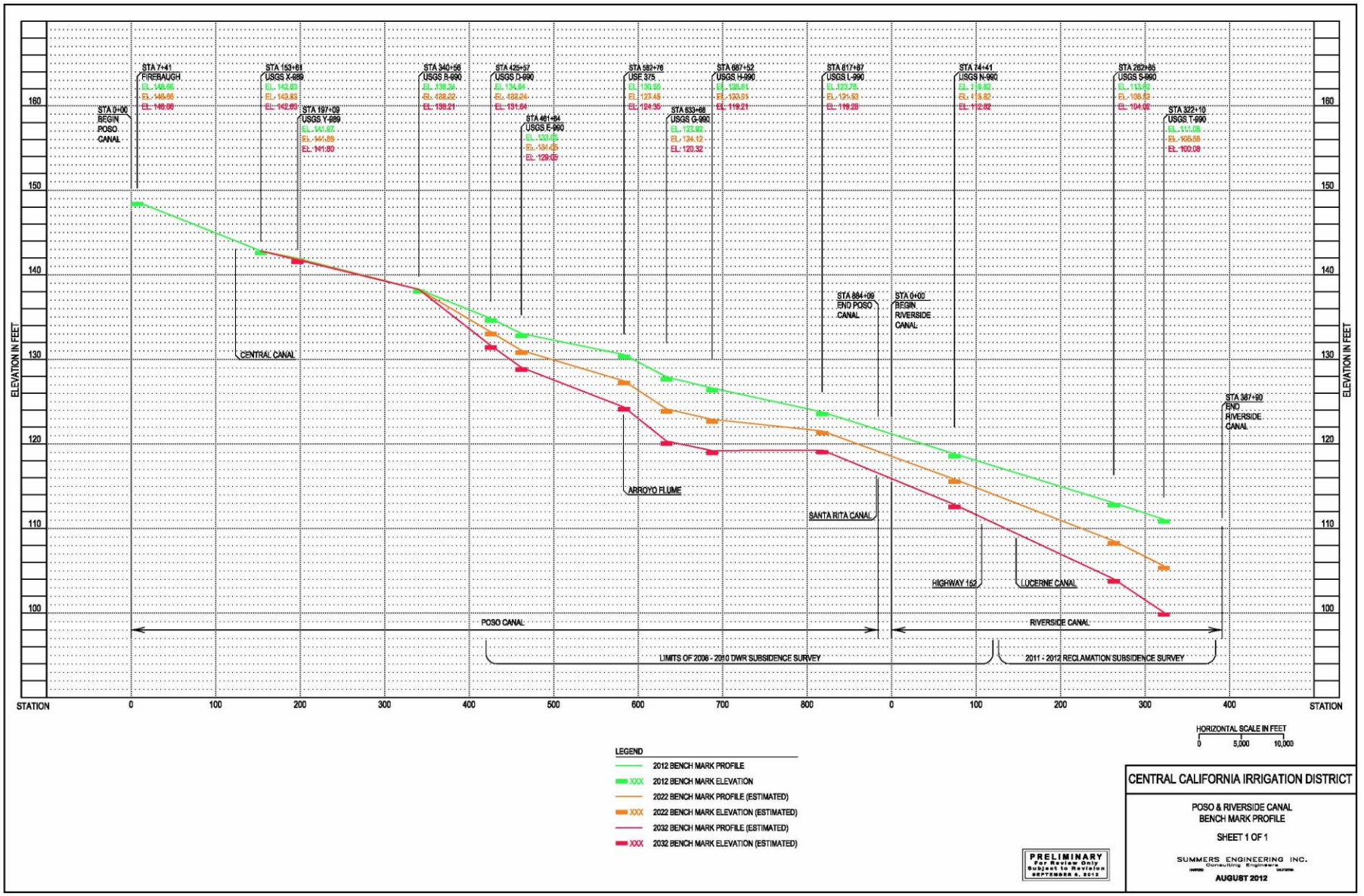
Sack Dam Subsidence

Pumping and Monitor Well Locations

5/14/2015 : G:\Central California ID-3510\351012B2-CCID Subsidence Evaluation\GIS\Map\Sack Dam MW 2015-0514.mxd

Additional Costs to Arroyo Canal Screening and Sack Dam replacement project

- Add pumping plant to deliver water to San Luis Canal Company (Currently a gravity diversion) - $30m
- Increase height of Sack Dam – Not yet designed - original costs of the project is $35m.


ELEVATION IN FEET
STATION
STA 0+00 BEGIN POSO CANAL
STA 7+41 FIREBAUGH
STA 153+89 USGS X-990
STA 197+09 USGS Y-990
STA 340+56 USGS R-990
STA 425+57 USGS D-990
STA 461+94 USGS E-990
STA 582+76 USE 375
STA 633+68 USGS G-990
STA 667+52 USGS H-990
STA 817+87 USGS L-990
STA 884+09 END POSO CANAL
STA 0+00 BEGIN RIVERSIDE CANAL
STA 74+41 USGS N-990
STA 262+85 USGS S-990
STA 322+10 USGS T-990
STA 387+90 END RIVERSIDE CANAL
CENTRAL CANAL
ARROYO FLUME
SANTA RITA CANAL
HIGHWAY 152
LUCERNE CANAL
POSO CANAL
RIVERSIDE CANAL
LIMITS OF 2008 - 2010 DWR SUBSIDENCE SURVEY
2011 - 2012 RECLAMATION SUBSIDENCE SURVEY
HORIZONTAL SCALE IN FEET
0
5,000
10,000
LEGEND
2012 BENCH MARK PROFILE
XXX 2012 BENCH MARK ELEVATION
2022 BENCH MARK PROFILE (ESTIMATED)
XXX 2022 BENCH MARK ELEVATION (ESTIMATED)
2032 BENCH MARK PROFILE (ESTIMATED)
XXX 2032 BENCH MARK ELEVATION (ESTIMATED)
PRELIMINARY
For Review Only
Subject to Revision
SEPTEMBER 6, 2012
CENTRAL CALIFORNIA IRRIGATION DISTRICT
POSO & RIVERSIDE CANAL
BENCH MARK PROFILE
SHEET 1 OF 1
SUMMERS ENGINEERING INC.
Consulting Engineers
AUGUST 2012

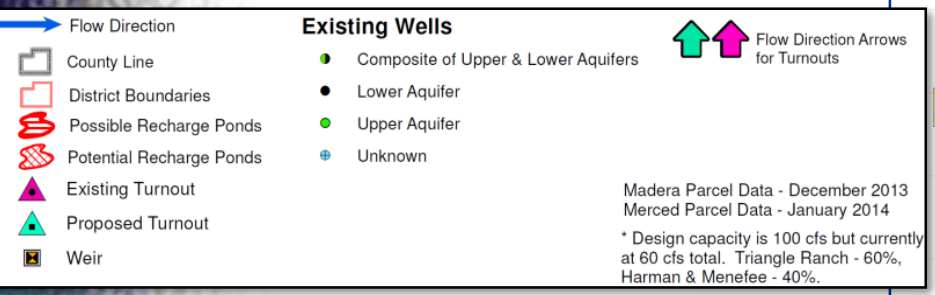
Poso Canal Subsidence Mitigation Costs

Table 4
Central California Irrigation District
Poso Canal Subsidence
Mitigation Cost Estimate for 2032 Conditions

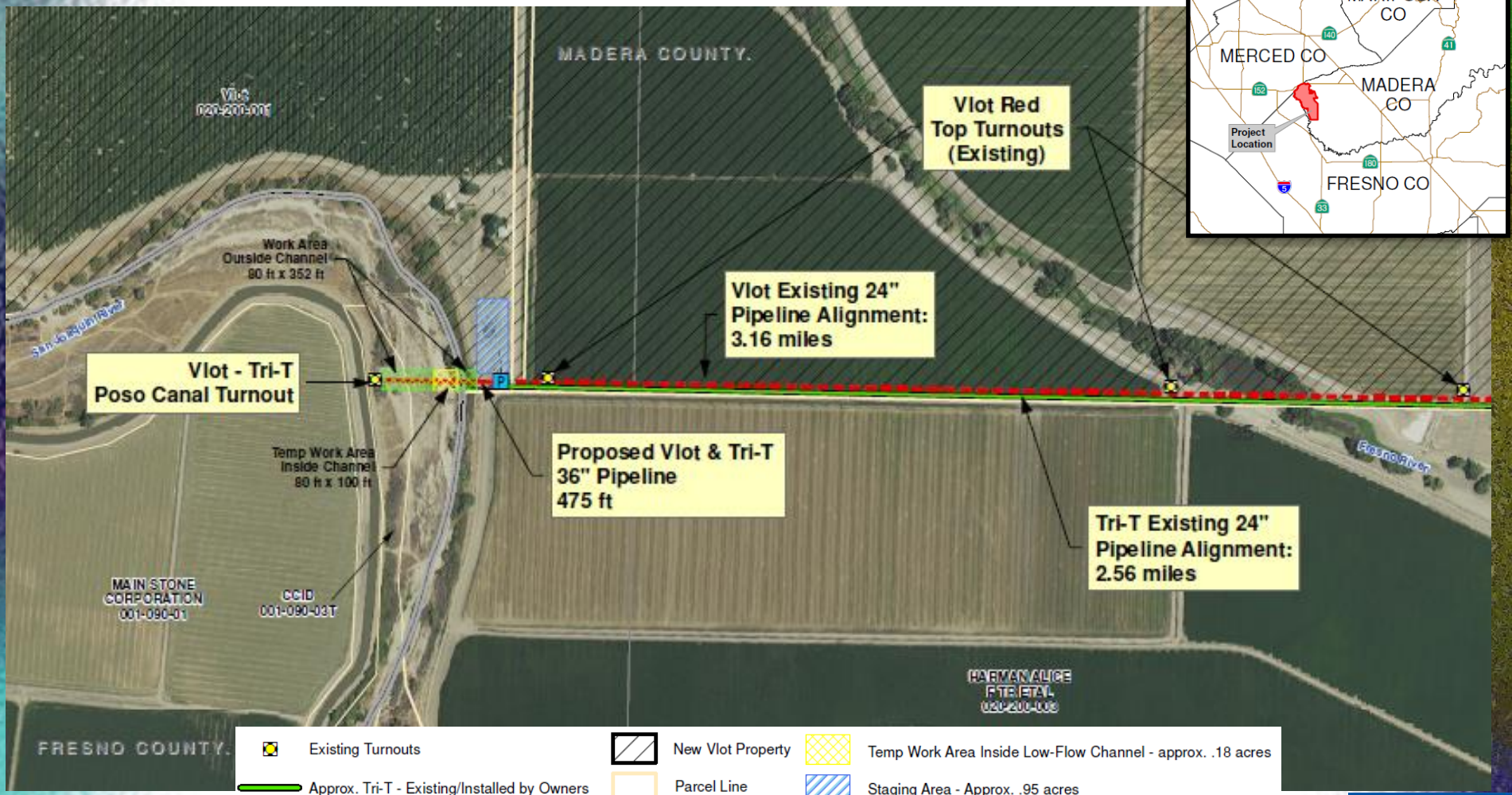
Item No.	Description	Quantity	Unit	Unit Price	Amount
1	Raise canal banks with imported material	70,000	Cubic Yards (cy)	$6.00	$420,000
2	Replace check structures	16	each	$200,000	$3,200,000
3	Raise turnout & lateral head gates		Lump sum		$50,000
4	Pump station		Lump sum		$1,000,000
5	Right-of-way acquisition	7	acres	$15,000	$105,000
				Subtotal	$4,775,000
				Contingencies & Incidentals (40%)	$1,925,000
				Total	**$6,700,000**

G:\data\NEW Wordpro\CCID\20\memos\2013\03-08-13-slj-1360-subsidence impacts.doc

Solution based on mature cropping demand, availability of flood flows, and transfers, and aquifer characteristics. (Landowner Gaming Session) $15M + Water costs.`

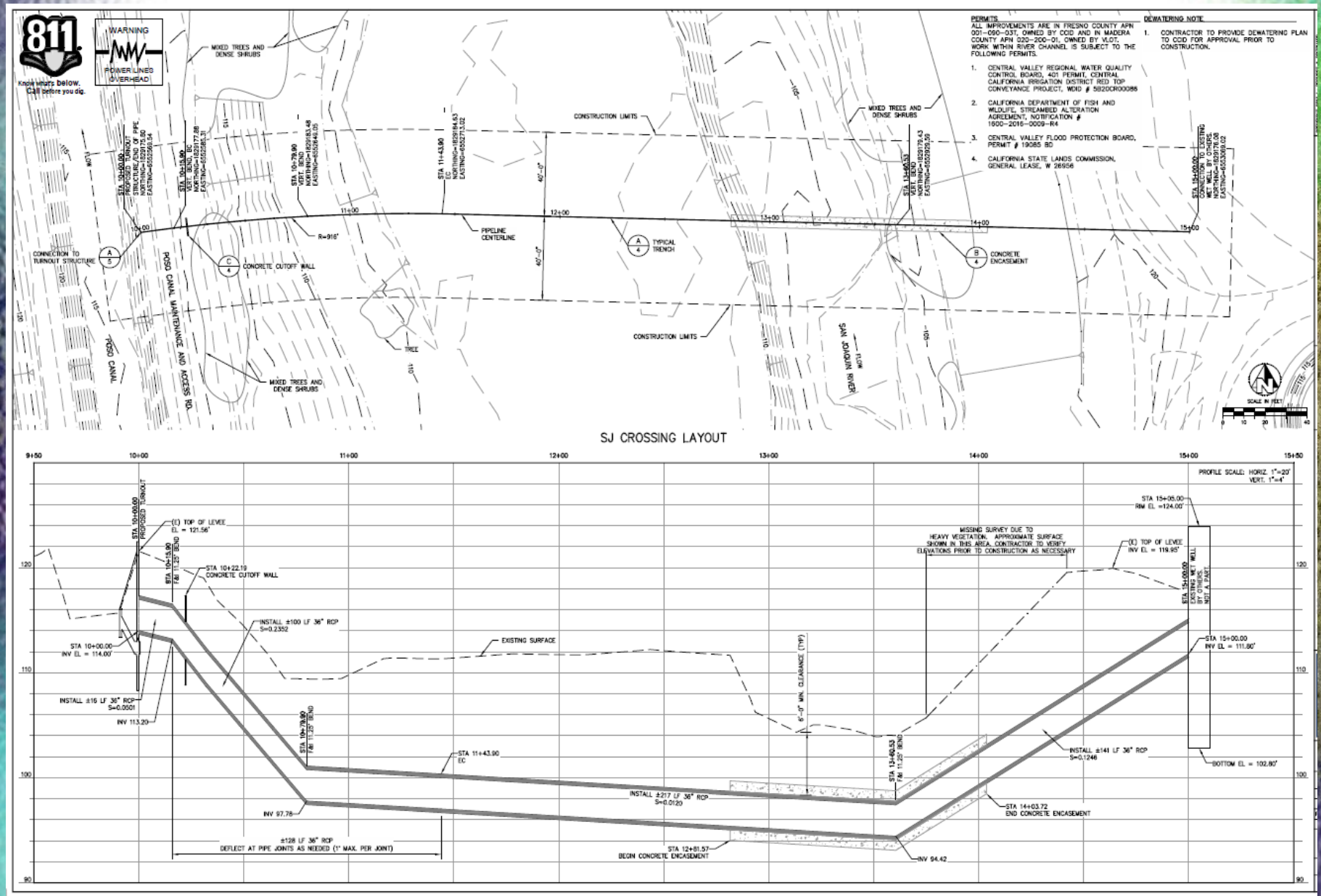


Red Top Pipeline Crossing



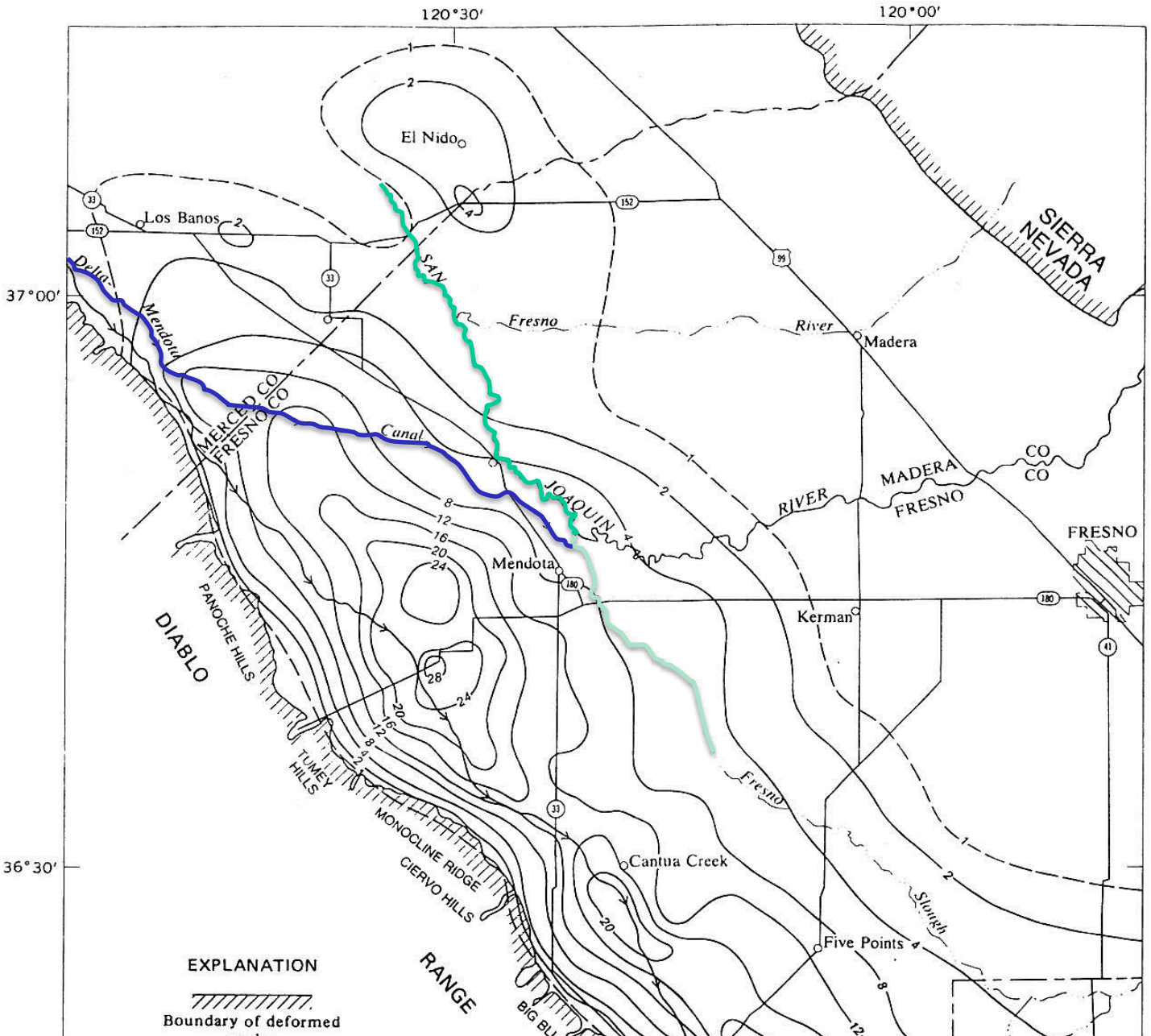
EST. 1968
PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company

Red Top Pipeline Crossing



Progress on Solutions

- Triangle T (Tri T) is a 12,000-acre property, with 530 acres are farmed to dryland crops in dry years, and groundwater recharge in wet years.
  - In 2017 they have recharged approximately 30,000 acre feet so far; groundwater level (gwl) rise of 60 feet + at ponds
  - Just as importantly, they have been able to use the Fresno River flood water to irrigate the almond and pistachio orchards as well, offsetting another 20,000 acre feet of groundwater pumping; regional gwl rise 20 feet.
- **Long term monitoring, management and Expert Panel established in agreement**; Cross River Pipeline under construction; Tri T and Vlot formed Water District; Neighbors wanting to join.


120°30′
120°00′
37°00′
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El Nido
Los Banos
SAN
Fresno
River
Madera
SIERRA NEVADA
Delta-
Mendota
Canal
MERCED CO
FRESNO CO
JOAQUIN
RIVER
MADERA CO
FRESNO CO
FRESNO
Mendota
Kerman
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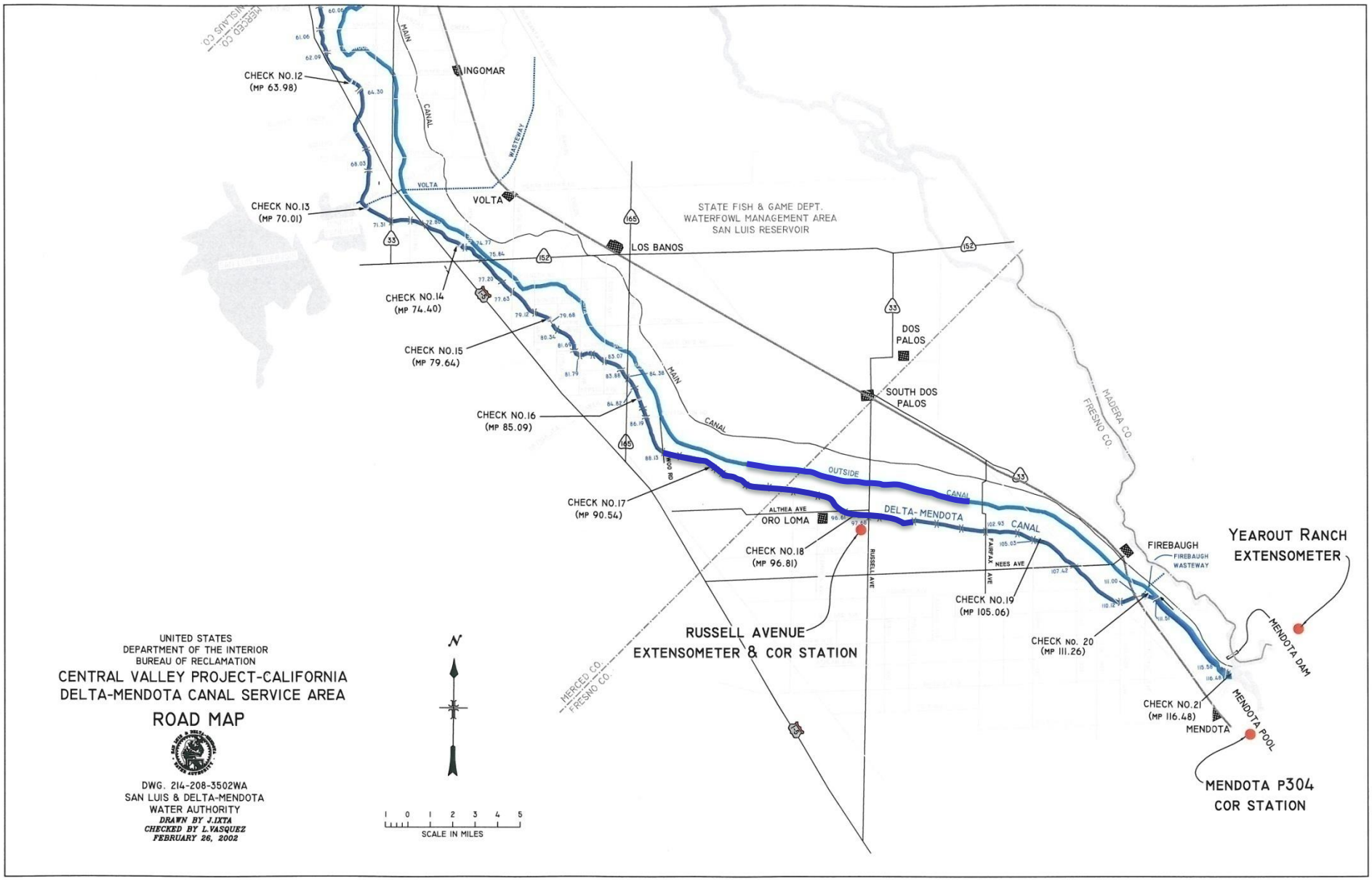
EXPLANATION
Boundary of deformed

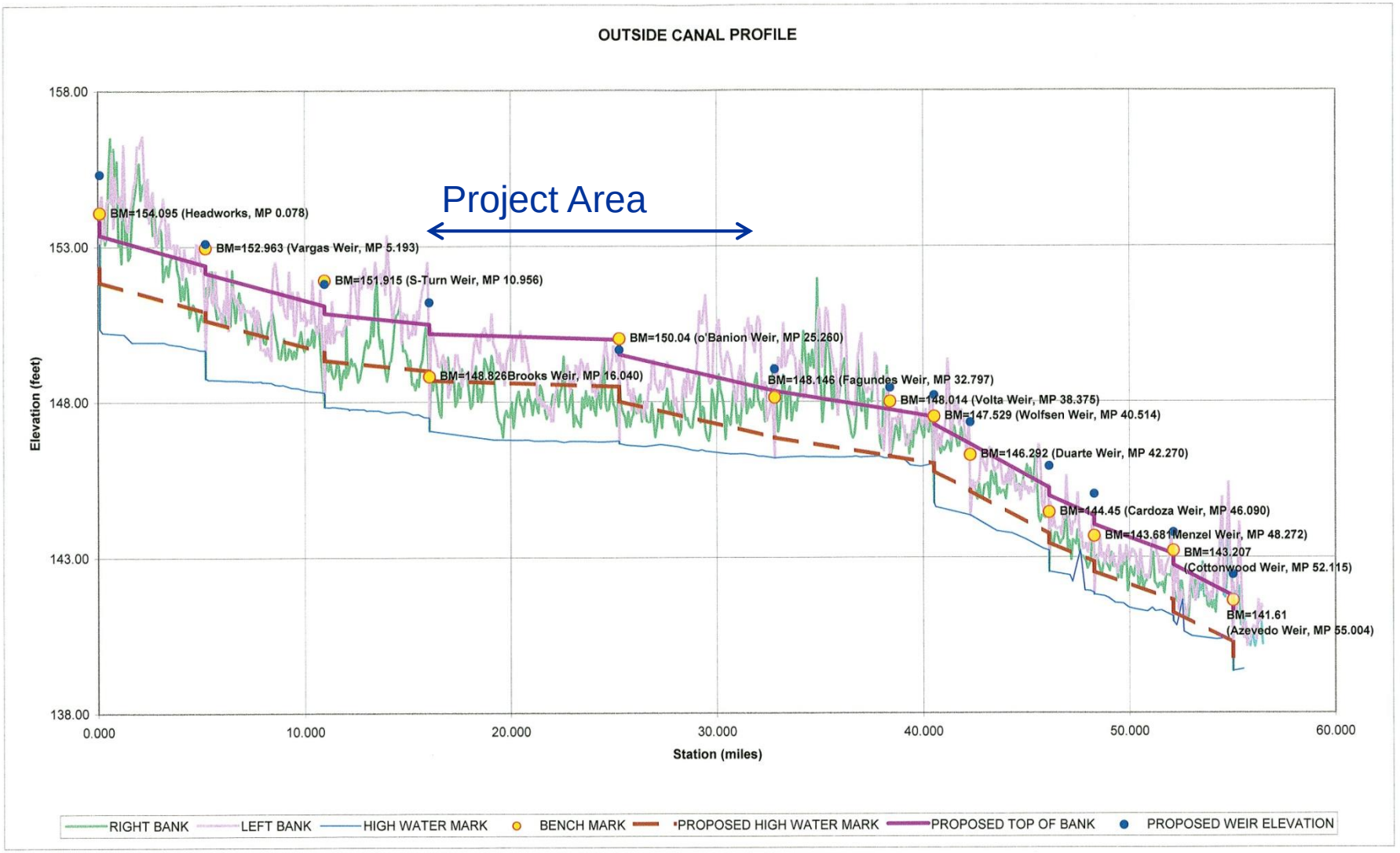


UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CENTRAL VALLEY PROJECT-CALIFORNIA
DELTA-MENDOTA CANAL SERVICE AREA
ROAD MAP

DWG. 214-208-3502WA
SAN LUIS & DELTA-MENDOTA
WATER AUTHORITY
DRAWN BY J.IXTA
CHECKED BY L.VASQUEZ
FEBRUARY 26, 2002

$4.5 Million Earthwork



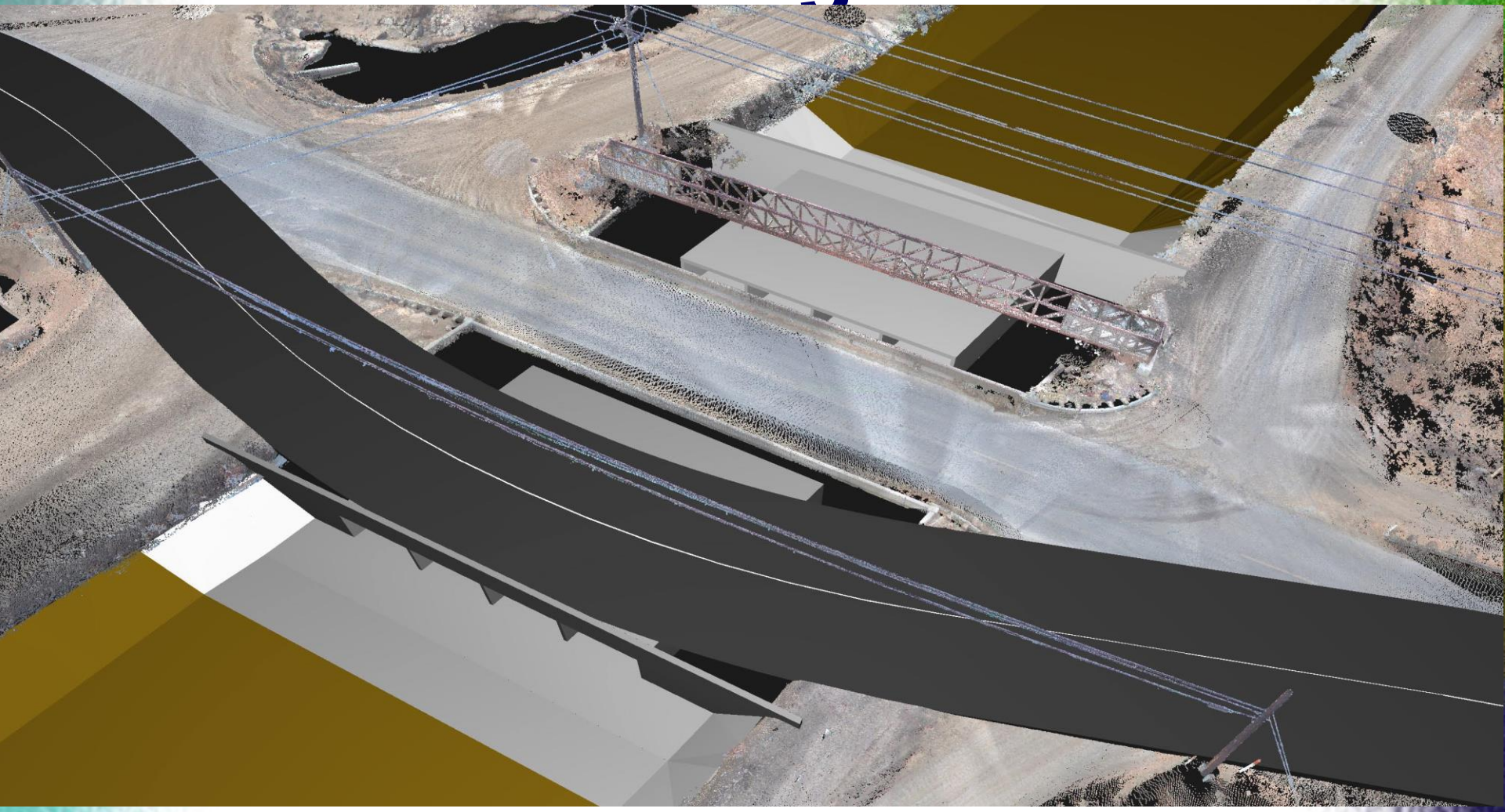
CADD2\2001\00\REVISED OUTSIDE CANAL\Outside Canal

4/5/2005, 11:54 AM


10/09/2009 15:29

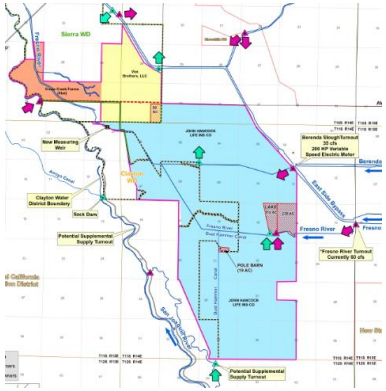

10/09/2009 15:30

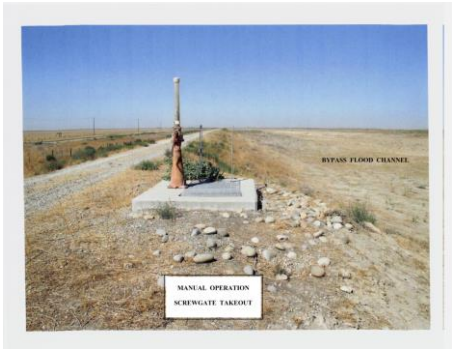
$4.1 Million Russell Ave Bridge



Subsidence Study - Long Term Solutions

- Complete subsidence and wheeling agreement and import water through Red Top Pipeline. (Avoid adjudication)
- Continue to revive existing districts, to manage water supply, subsidence and SGMA.
- Convene expert panel in the Triangle T area. (Red Top)
- Curtail Subsidence and help our neighbors comply with SGMA.
- Subsidence at Red Top has been reduced by 50% through management.





Contact Information

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