Appendix G

Summary of Hydrogeologic Conditions and Historical Mining Northwest of the Centro Subarea in the Randsburg, Red Mountain, and Atolia Area

1.1 Background

This appendix provides a summary of hydrogeologic conditions in the area northwest of the Centro Subarea within the MWA service area focusing on the Cuddeback Valley Basin. Hydrogeologic conditions in Cuddeback Valley Basin are based on information presented in DWR Bulletin Nos. 106-1 (1964b) and 118 (updated 2003) supplemented by additional water level and quality information in the MWA database. A synopsis of historical mining operations and associated water use in the Randsburg, Red Mountain, and Atolia area is also presented.

1.2 Cuddeback Valley Basin

As shown on **Figure G1**, the Cuddeback Valley Groundwater Basin (DWR Basin 6-50) is located north of the Centro Subarea and covers about 130 mi^2 of area generally east of Red Mountain and Atolia. The basin is surrounded by the Lava Mountains in the north, unnamed hills to the east, Fremont Peak and Gravel Hills to the south, and Rand Mountains to the west. Cuddeback Dry Lake, a dry playa lake, is situated in the central portion of the basin at an elevation of approximately 2,550 feet msl. Geologic faults in the area include the Cuddeback, Gravel Hills, Brown's Valley, and Blackwater faults. Potenial barrier effects of the faults are not documented. Quaternary alluvial sediments, consisting of younger alluvial deposits and underlying unconsolidated to semi-consolidated older alluvial deposits extend to a depth of about 300 feet-bgs (DWR, 2003). The basin is recharged by local mountain runoff originating in the upper watershed areas, where annual precipitation ranges from 4 to 6 inches per year. The main areas of recharge are the alluvial fans of Red Mountain and Fremont Peak.

Groundwater levels within the basin range from 2,700 feet msl in the west to about 2,500 feet msl beneath Cuddeback Dry Lake and less than 2,500 feet msl in the south. Groundwater flows from the margins of the basin towards the southern end of Cuddeback Lake and occurs under confined conditions beneath the lake. Depth to water ranges from about 40 to 50 feet-bgs near Cuddeback Dry Lake.

A small alluvial gap between Fremont Peak and the Gravel Hills has been postulated to allow some amount of groundwater flow from Cuddeback Valley to Harper Valley Basin, although no estimation has been made of the amount of subsurface flow to date. However, subsurface flow appears to be limited by the small cross-sectional area of permeable saturated alluvial sediments at this location. The deep water table recorded in the area (200 feet-bgs) suggests that the alluvial sediments are unsaturated and thereby are not expected to transmit groundwater across the gap.

Groundwater level data in the MWA water level database are available for about 40 wells with dates ranging from 1917 through 1981. Most of the water level measurements were taken between 1953 and 1970. Water level data indicate generally stable groundwater levels at least through 1981. While not well documented, water use appears to be limited to private domestic use.

Groundwater quality data are limited to a few wells in the basin. TDS concentrations along the margins of the alluvial portions of the basin are below 500 mg/L. However, in the vicinity of Cuddeback Dry Lake, TDS concentrations are greater than 2,000 mg/L.

1.3 Historical Mining in Randsburg, Red Mountain, and Atolia Area

Several mines were operated in the Randsburg, Red Mountain, and Atolia area beginning in the 1890s and early 1900s. Local mining history is captured in the publication, *Mines and Geology of the Randsburg Area: An Historical Gem of the Mojave Desert* (Trent, 2006). Additional details, including general information on water use for the mines, are contained in the publication, *Bulletin No. 95: Geologic and Ore Deposits of the Randsburg Quadrangle of California* (California State Mining Bureau, 1925).

Figure G2 shows the generalized geology and location of major mines in this area as mapped by Trent (2006). Among the mines shown on the figure are the Yellow Aster gold mine in Randsburg, California Rand (or Kelly Mine) along Highway 395 west of Red Mountain ("silver mines" on figure), and high-grade tungsten mines in Atolia.

In contrast to the single-boom-and-bust cycle experienced by many mining camps in the West, the mining in the Randsburg area experienced five different mining booms. Initially mining was focused on gold, but the escalating costs of mining during World War I (WWI) forced closure of most gold mining operation in the area. However, WWI created a demand for tungsten, which was used to harden steel. This stimulated the development and operation of several tungsten mines in the Atolia area. With the cost of gold mining still prohibitive (and tungsten demand declining after WWI), demand for silver soared with the Passage of the Pittman Act by Congress, which guaranteed the price of domestic silver at $1 per ounce. This prompted the development and operation of numerous silver mines primarily in the Red Mountain area. Silver mining declined with the expiration of the Pittman Act in 1923 (Trent, 2006).

Mining continued in the Randsburg region through the 1950s. With the rise of gold prices beginning in the 1930s, gold mining experienced a minor boom. However, gold mining was again interrupted by World War II (WWII), which shut down most mines to free miners for military service or to work in mines producing minerals needed for the war effort. Despite the expiration of the Pittman Act in 1923, silver mining continued at the Kelly Mine through the 1920s, until the mine could no longer be operated profitably. Although production dropped off by 1929, tungsten continued to be mined in Atolia through the 1950s, with increased production during WWII, making California the largest producer of tungsten in the country. In fact, Atolia is known for having the largest bodies of high-grade tungsten ore ever to have been found in the U.S. (Trent, 2006).

More recently, mining for low-grade gold ore using open-pit and and heap leach methods at the existing Yellow Aster and other nearby mines in the Randsburg area was conducted in the 1980s and 1990s. The mine was officially closed under a reclamation plan directed and approved by the RWQCB - Lahontan Region in 2005 (Trent, 2006). Exposure of soil arsenic contamination from mine tailings at the Kelly Mine has been found to be a potential health risk (BLM, 2006); however, arsenic contamination of groundwater has not been confirmed.

Notably, water use for mining and milling was generally obtained from deep wells owned by the Yellow Aster Mining and Milling Company located north/northwest of the Randsburg Mining District (along the southern base of the El Paso Mountains in the Fremont Valley Basin [Figure G1]). Water for domestic

use was obtained from deep wells north of Red Mountain (also in the Fremont Valley) (California State Mining, 1925).

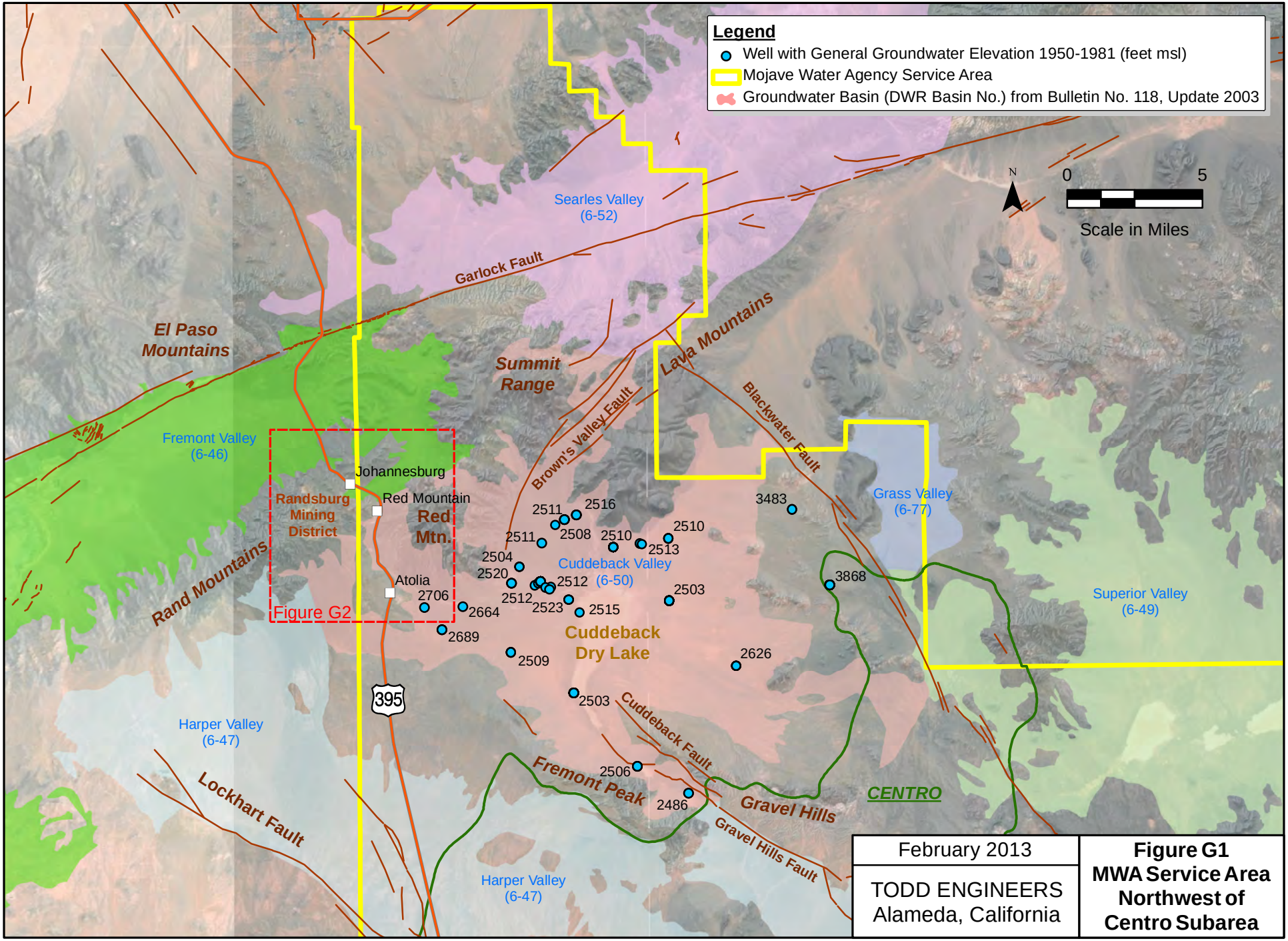
Legend
Well with General Groundwater Elevation 1950-1981 (feet msl)
Mojave Water Agency Service Area
Groundwater Basin (DWR Basin No.) from Bulletin No. 118, Update 2003
N
0
5
Scale in Miles
Searles Valley
(6-52)
Garlock Fault
El Paso
Mountains
Summit
Range
Lava Mountains
Brown's Valley Fault
Blackwater Fault
Fremont Valley
(6-46)
Johannesburg
Red Mountain
Randsburg
Mining
District
Red
Mtn.
Rand Mountains
Atolia
Figure G2
Grass Valley
(6-77)
Superior Valley
(6-49)
Cuddeback Valley
(6-50)
Cuddeback
Dry Lake
Harper Valley
(6-47)
Lockhart Fault
Fremont Peak
Cuddeback Fault
Gravel Hills
Gravel Hills Fault
CENTRO
Harper Valley
(6-47)
395
2706
2664
2689
2509
2503
2626
2506
2486
3483
3868
2504
2520
2511
2516
2508
2510
2513
2512
2523
2515
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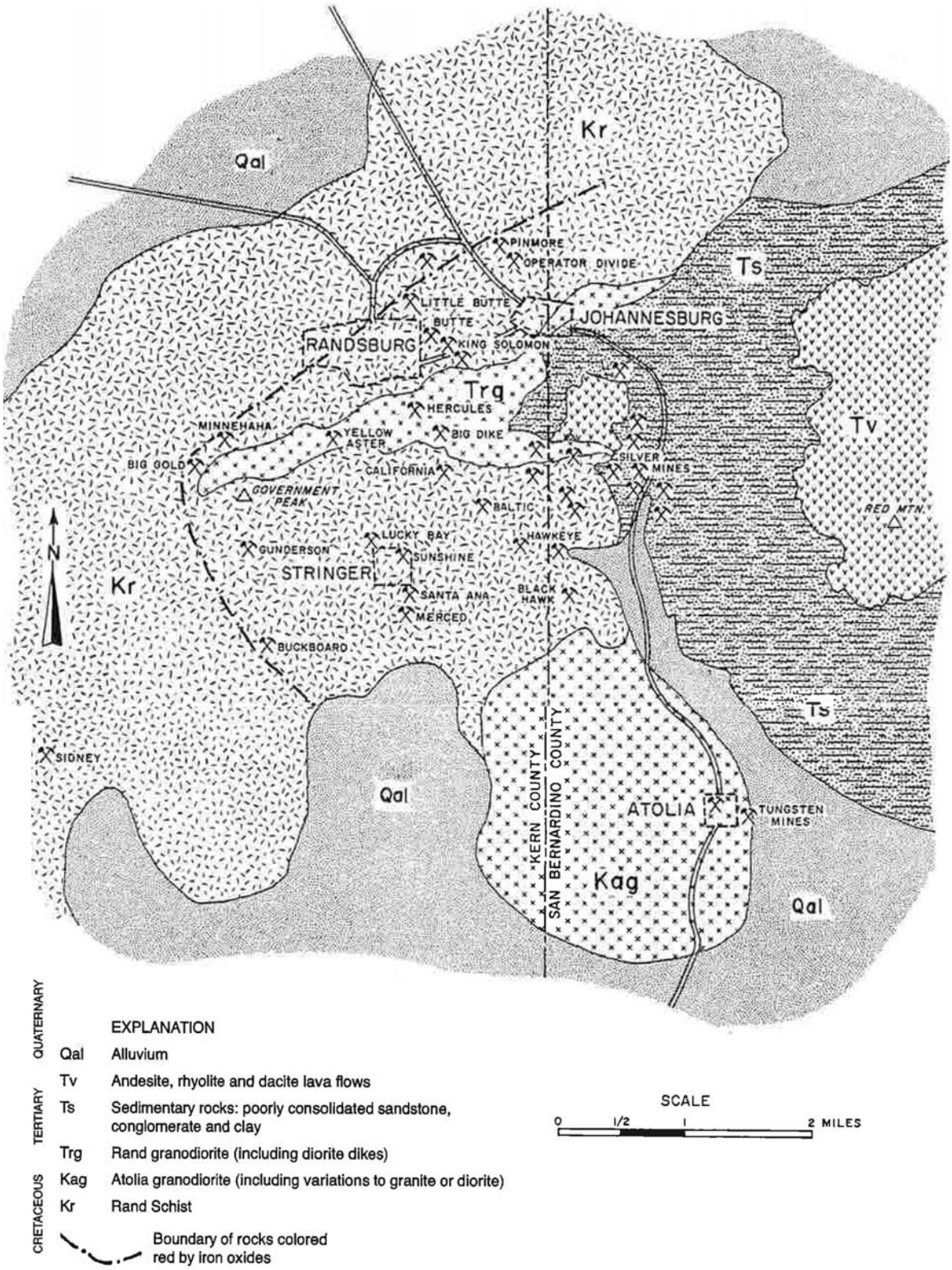
Figure G1
MWA Service Area
Northwest of
Centro Subarea



Generalized geologic map of the Rand, Red Mountain, Atolia, and Stringer Districts, showing the locations of the major mines. (Modified from Clark, 1970; Hulin, 1925, Plate 1; [Used by permission of the Department of Conservation, California Geological Survey] rock ages from Barth et al., 2003, and Jacobson, et al., in press.)

Source: Trent, 2006.

February 2013	**Figure G2 Mine Locations Randsburg, Red Mountain, and Atolia Area**
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