KERN WATER BANK

FIRST STAGE KERN FAN ELEMENT

Feasibility REPORT

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A. HYDROGEOLOGY

The material discussed in this section presents an interpretation of the data collected during DWR's exploration and monitoring programs for the KFE. The information developed provides an improved conceptual framework, as well as real data, on the ground water system underlying the KFE, and its relationship to the regional ground water flow system. This framework contributes to the level of knowledge required to effectively evaluate recharge capabilities, aquifer response to recharge and extraction, usable storage capacity, and the movement of contaminants.

Regional Geologic Setting

The KFE is located in the southern portion of the San Joaquin Valley, a large, deep asymmetric sedimentary basin. The basin consists of deep depositional centers separated by a basement high near the KFE known as the Bakersfield Arch, located generally along the Kern River. The San Joaquin basin is bordered on the south and east by the crystalline igneous and metamorphic rocks exposed in the Sierra Nevada, Tehachapi, and Sam Emigdio Mountains. These rocks also underlie the basin at depth and are considered to be nonwater-bearing. Overlying these rocks is a thick sequence of consolidated marine sedimentary rocks exposed in the Coast Range to the west and the San Emigdio Mountains to the south and extending eastward to lap onto the crystalline rocks of the Sierra Nevada. These rocks play no significant role in the developed part of the ground water basin.

Overlying the marine sedimentary rocks in the basin is a thick sequence of continental rocks and semiconsolidated to unconsolidated sediments. These continental sediments, which form the developed part of the ground water basin, are several thousand feet thick in the subsiding portions of the basin but considerably thinner where deposited on and draped over the Bakersfield Arch. On the west, the continental rocks consist of the Plio–Pleistocene Tulare Formation, a thick sequence of water-lain sands, silts, and clays exposed along the western side of the San Joaquin Valley.

The Tulare Formation dips eastward under the alluvium in the project area and interfingers with the upper portion of the Kern River Formation in the subsurface. The upper portion of these formations and the overlying alluvium constitute the developed part of the ground water basin in the KFE area. The Tulare Formation is exposed in the Elk Hills, where it consists of interbedded mudstones and pebbly sandstones, as mapped by Woodring, Roundy, and Farnsworth (1932). Woodring and others have informally divided the Tulare into a lower olive–gray mudstone unit and an upper buff-colored unit. They interpreted the sands as alluvial fan deposits derived from the Temblor Range to the west and the mudstones, in which individual beds are not laterally extensive, as mudflat or playa deposits.

Elsewhere in the San Joaquin Valley, the Tulare Formation contains a regionally extensive lacustrine or lakebed clay, generally referred to as the E–clay or Corcoran Clay, that serves as a confining layer separating the shallow semiconfined to unconfined aquifer system from a deeper confined aquifer system. Although earlier investigations have mapped the E–clay into the KFE area, based on electric log interpretations, its actual presence has been and remains problematic.

The Miocene to Pleistocene Kern River Formation, as described by Bartow and Pittman (1983), outcrops from Caliente Creek northward to the vicinity of Terra Bella on the east side of the San

Joaquin Valley. It consists of a westward dipping and thickening sequence of sandstones and conglomerates with interbedded siltstone and mudstone. The Kern River Formation is generally thought to reflect alluvial fan deposition (based on its similarity to the modern Kern River alluvial fan), although the upper portion may be predominantly of glacio–fluvial origin (Graham, Carroll, and Miller, 1988).

Kern River Fan

The developed portion of the ground water basin is within the upper portions of the continental deposits and the overlying alluvium. In the KFE area, the usable portion of the basin is considered to be above the base of fresh water. Page (1971) mapped the base of fresh water in the project area, using available electric logs, and defined fresh water as having a conductivity of less than 3,000 micromhos per centimeter. He showed that the base of fresh water varies from an elevation of about –2,800 feet (below mean sea level, MSL) near the eastern edge of the project area to about elevation –800 MSL adjacent to Elk Hills.

The hydrogeology of the KFE above the base of fresh water is dominated by the alluvial fan that has been deposited by the Kern River. The Kern River Fan is a large composite alluvial fan extending across the southern San Joaquin Valley from near Bakersfield to the Elk Hills. The alluvium of the fan has been informally divided into older and younger units. East of the project area, near Bakersfield, older alluvium containing a substantial portion of sand and gravel is exposed. The older alluvium dips westward under the younger alluvium of the present fan and probably corresponds to the "gravel lentil" identified by Dale and others (1964). Generally, because of their similar lithologic character, the younger and older alluvium cannot be differentiated in the subsurface. The western part of the project area contains material derived from western sources and probably represents alluvial fan development with materials eroded from the Elk Hills.

Dale and others (1964) studied the hydrogeology of the Kern River Fan. They identified three informal units within the alluvium:

- A gravelly clay member interpreted as representing extremely poorly sorted alluvial fan deposits of the Tulare Formation in Elk Hills. This unit may also be present in the subsurface of the western portion of the project area.
- A fine sand–clay member thought to represent overflow and lacustrine deposits of interbedded sand and silt. The E–clay was identified in this unit in the Buttonwillow Ridge anticline and Jerry Slough syncline to the north but not in the KFE area.
- A gravel–medium sand member representing recent alluvial fan deposits.

This interpretation is generally a valid description of the gross character of the alluvial deposits but masks the stratigraphic complexity of the depositional system. The alluvial fan depositional system consists of thick deposits of sand and minor gravel with extensive but discontinuous silt and clay beds.

In the western portion of the project area fan deposits of the Kern River interfinger with those of ephemeral western streams that have deposited larger material with some beds containing coarse gravel. The sand and gravel occur in sinuous and interconnected stringers and sheets that can be found throughout the fan and were deposited by active stream channels. These highly permeable deposits are interbedded with less permeable silt and clay units representing overbank, deltaic, and possibly lacustrine deposits. In a general sense, the Kern River Fan has a radial depositional system with its apex near Bakersfield, with individual units tending to be elongate parallel to radii of the fan but with restricted cross–fan extent. This radial pattern is more apparent below a depth of 200–300 feet where finer grained material is more abundant. Above this depth sand sheets are predominant in much of the project area.

Kern Fan Element Area

During investigation of the suitability of the KFE area for a ground water recharge and storage program, eighteen 700–foot deep monitoring wells were constructed. In addition, 100 shallow (50–foot) auger borings were completed, and numerous 20–foot hand auger holes were drilled at potential recharge pond sites. The logs from these holes permit a more detailed, but still sketchy, view of the project area hydrogeology. Figure 5 shows the distribution of estimated specific capacities of wells on the KFE. The distribution is generally consistent with depositional environments recognized on the electric logs.

700-Foot Logs. The location of deep (about 700 feet) monitoring wells constructed on KFE property and in the adjacent City of Bakersfield's 2,800–Acre Recharge Area is shown in Figure 6. Each well was logged by a geologist during construction, and spontaneous potential and resistivity logs were also run. In many wells, natural gamma logs were run to give an indication of the relative amount of clay present in the aquifer and to identify sand zones that may indicate source beds for the uranium commonly found in the area's ground water. These logs form the basis for a generalized interpretation of the depositional environment in the project area. The fluvial (deposits formed by rivers and streams, including alluvial fans) nature of the depositional system makes it difficult to establish reliable correlations throughout the project area. However, tentative correlations have been made in two areas. The first is a distinctive cemented zone identified in geologist's logs in the area north of the Kern River, although it lacks a distinctive electric log signature. The second is a zone of low permeability material at a depth of about 200 feet that seems to be relatively continuous beneath the western half of the City of Bakersfield's 2,800–Acre Recharge Area.

The overall depositional pattern in the study area is best illustrated by the log of the oil and gas well in T30S,R25B, Section 36, tract G. This log has two stacked, coarsening upward sequences that are typical of alluvial fan deposits. In most other logs, only the upper cycle and the top of the lower coarse-grained material are present, making the presence of the deeper cycle throughout the study area somewhat speculative. In the northern San Joaquin Valley, similar coarsening upward cycles have been attributed to episodic alluvial fan construction in response to glaciation in the Sierra Nevada. The upper Kern River drainage has undergone extensive glaciation, and such a depositional system may be tenable for this area. In this depositional model, the finer material would be deposited during interglacial periods when fans undergo erosion and basin–like deposition of the eroded material and nonglacial sediment occurs on the lower portions of the fan. Coarse material represents the deposition of material derived from erosion by glaciers and would be expected to extend across and cover the finer material. A similar depositional pattern could result from the periodic uplift of the Sierra Nevada that has occurred in Plio-Pleistocene time.

Discussion of the depositional environment in the study area is restricted in this report to the upper depositional cycle, about 700 feet, where ground water development is concentrated. In the