CARMEN A. TRUTANICH (SBN 86629)
City Attorney
EDWARD M. JORDAN (SBN 180390)
Assistant City Attorney
CITY OF LOS ANGELES
1800 City Hall, 200 N. Main Street
Los Angeles, CA 90012-4110
Telephone: (213) 978-8100
Facsimile: (213) 978-8211
Email: ted.jordan@lacity.org

GARY J. SMITH (SBN 141393)
ZACHARY M. NORRIS (SBN 268616)
BEVERIDGE & DIAMOND, P.C.
456 Montgomery Street, Suite 1800
San Francisco, CA 94104-1251
Telephone: (415) 262-4000
Facsimile: (415) 262-4040
Email: gsmith@bdlaw.com
znorris@bdlaw.com

JAMES B. SLAUGHTER (*pro hac vice pending*)
BEVERIDGE & DIAMOND, P.C.
1350 I Street, N.W., Suite 700
Washington, DC 20005-3311
Telephone: (202) 789-6000
Facsimile: (202) 789-6190
Email: jslaughter@bdlaw.com

Attorneys for Plaintiffs City of Los Angeles, Responsible Biosolids Management, Inc., R&G Fanucchi, Inc., and Sierra Transport, Inc.

SUPERIOR COURT OF THE STATE OF CALIFORNIA

FOR THE COUNTY OF TULARE

CITY OF LOS ANGELES; COUNTY SANITATION DISTRICT NO. 2 OF LOS ANGELES COUNTY; ORANGE COUNTY SANITATION DISTRICT; RESPONSIBLE BIOSOLIDS MANAGEMENT, INC.; R&G FANUCCHI, INC.; SHAEN MAGAN, BOTH INDIVIDUALLY AND D/B/A HONEY BUCKET FARMS AND TULE RANCH/MAGAN FARMS; WESTERN EXPRESS, INC.; CALIFORNIA ASSOCIATION OF SANITATION AGENCIES,

Plaintiffs,

vs.

COUNTY OF KERN; KERN COUNTY BOARD OF SUPERVISORS,

Defendants.

Case No. Civ. 242057

DECLARATION OF THOMAS M. JOHNSON, P.G., C.HG., SUPPORTING PLAINTIFFS' MOTION FOR PRELIMINARY INJUNCTION

Hearing: June 9, 2011
Dep't: 10
Hearing Judge: Hon. Lloyd L. Hicks
Action filed: January 26, 2011
Trial date: Not set

Declaration of Thomas M. Johnson, P.G., C.HG.

I, Thomas M. Johnson, declare as follows:

Summary of Conclusions

1. I am a Licensed Professional Geologist and Certified Hydrogeologist in the State of California with more than 35 years of experience. I have been retained by the City of Los Angeles to give my expert opinion on the groundwater conditions and quality of the groundwater underlying the Green Acres Farm area in Kern County, California and on whether the application of biosolids at the Farm has adversely affected this groundwater or is expected to adversely affect groundwater in the future if applications continue under current practices. As described in detail below, based on my review of comprehensive monitoring data and analyses, a site visit to Green Acres Farm and interviews with appropriate personnel, I conclude that land application of biosolids at Green Acres Farm has not affected groundwater quality in Kern County. Rather, the monitoring data demonstrate that the quality of the groundwater underlying the application site is within the general range of background conditions in the area. Therefore, continued land application of biosolids by the City of Los Angeles is not expected to adversely affect groundwater quality.

2. In the paragraphs that follow, I will describe my qualifications and detail the bases for my opinions. As will be seen, native groundwater quality in the area of Green Acres Farm is highly variable and often poor. Groundwater used for irrigation or drinking water in the area is drawn from a deep aquifer more than 300 feet below the surface and below a thick clay layer that impedes the downward migration of contaminants. This is far below the interval where any impacts of surface application of biosolids might reasonably be expected to be seen. The groundwater flow direction beneath Green Acres Farm is generally to the east and south, away from the Kern Water Bank. Numerous oil fields lie beneath Green Acres Farm and adjacent to the Site to the west and north. The production of oil and gas in the area has adversely affected groundwater quality. The impact of oil and gas production is evident in monitoring well

#4 on Green Acres Farm. All other monitoring wells on Green Acres Farm remain within the general range of background conditions in the area, and show no impact from biosolids application.

Qualifications and Involvement

3. I am currently Executive Vice President, Principal Hydrogeologist and Technical Director for ARCADIS U.S., Inc. (ARCADIS), an environmental consulting firm with offices nationwide. At ARCADIS, I direct projects involving environmental investigation and remediation, water resource assessment, and groundwater supply management. I have more than 35 years of experience as a hydrogeologist in consulting and research, and have managed or been directly involved with hundreds of projects and sites involving environmental investigation and remediation of a wide range of inorganic and organic compounds, including chloride, nitrate, and metals, such as lead, in soil and groundwater. This experience includes extensive studies of the impacts of biosolids and wastewater treatment plant sludge on soil and groundwater.

4. I have a B.A. degree in geology from Augustana College, and M.S. degrees in geology and in water resources management from the University of Wisconsin-Madison. I completed additional graduate work in geology at the University of Illinois-Urbana/Champaign. From 1986 to 2008, when my firm was acquired by ARCADIS, I was Chief Technical Officer and Principal Hydrogeologist for LFR Inc., an environmental consulting firm headquartered in Emeryville, California. From 1975 to 1986, I was a hydrogeologist with the Illinois State Geological Survey, where I was Head of the Groundwater Section and conducted research and studies of environmental contamination and groundwater resource management. I have published numerous papers on hydrogeology, waste management, and soil and groundwater contamination; and I have lectured throughout the U.S. and internationally on environmental contamination investigations remediation, groundwater resource assessment, and water supply management.

5. I am a Licensed Professional Geologist and Certified Hydrogeologist in the State of California, and a Registered or Licensed Professional Geologist in Arizona, Pennsylvania, Illinois, Indiana, and Wisconsin. I am also a registered Professional Geologist with the American Institute of Professional Geologists, and a registered Professional Hydrogeologist with the American Institute of Hydrology. I have served multiple terms on the Board of Directors and was President of the California Groundwater Resources Association (GRAC). I also was Chairman of the Board of Directors and Vice President of the National Ground Water Association-Association of Ground Water Scientists and Engineers. I have also served on two panels of the National Academy of Sciences, National Research Council, on state and local groundwater supply protection programs, and on environmental decision-making processes for the Department of Energy.

6. My education and experience is further described in my resume, which is attached to this declaration as Attachment A. My attached resume also includes a list of publications, presentations, and abstracts that I have authored or co-authored.

7. My employer, ARCADIS, U.S., Inc., is compensated $ 345 per hour for my time spent working on this matter.

8. I conducted a site visit of the Green Acres Farm on September 7, 2006. I observed the condition of the soil, the locations and condition of the groundwater wells used for groundwater monitoring, irrigation canals, oil fields, and other physical features at the Green Acres Farm and surrounding vicinity. I also observed the unloading and subsequent plowing in of two truckloads of biosolids at one of the plots on the Green Acre Farm. Additionally, I interviewed key personnel at the Green Acres Farm who are responsible for operating the Farm (i.e. irrigation scheduling, crop selection, harvesting, etc.) and for the proper application of biosolids at the Farm. I also have extensive experience evaluating hydrogeologic conditions in the Bakersfield area and the southern San Joaquin Valley. This includes a comprehensive five-year study of hydrogeologic and groundwater conditions in the vicinity of the large oil fields and irrigated farms of

western Kern County. This study included analysis of the hydrogeologic setting, groundwater depths and flow rates, groundwater quality, and impacts of surface activities related to oil fields and farming in Kern County on groundwater quality.

Site Setting and Description

9. Green Acres Farm is situated in the southern portion of the San Joaquin Valley, in the mostly arid area east of the mountains of the Temblor Range, a part of the Coast Range, and west of the Sierra Nevada range (see Attachment B, Figures 1 and 2). Green Acres Farm consists of approximately 4,708 acres located immediately west of Interstate 5 and south of Hwy 119 (the Taft Hwy; Attachment B, Figures 3 and 4). The property is currently owned by the City of Los Angeles, which purchased the property in 2000 from Valley Communities, Inc. The property was previously owned by a subsidiary of Tenneco Oil Company.

10. The area of Green Acres Farm is very flat with an elevation of approximately 300 to 310 feet above mean sea level. On the site, there is a gradual slope of the land surface toward the Kern River Flood Canal and Buena Vista Slough to the southwest. Further west and north of Green Acres Farm, the land surface rises more than 100 feet in the Elk Hills area.

11. Land use in the vicinity of Green Acres Farm is predominantly agricultural. The area west and northwest of Green Acres Farm consists of generally barren range land, while the land including Green Acres Farm and areas to the east and south include large areas of irrigated row crops and dairies. Green Acres Farm is also surrounded by oil fields that are commonly present throughout the southern San Joaquin Valley. These oil fields include the large former Elk Hills Naval Petroleum Reserve three miles west of Green Acres and numerous other oil fields that both surround and underlie the site. The South Coles Levee Oil Field includes the area west of the site, and underlies the northwest portion of the Green Acres Farm site (Attachment B, Figure 3). The North Coles Levee Oil Field is located directly northwest of Green Acres Farm, and the Ten Section Oil Field is located directly north of the site.

12. There are large numbers of active and abandoned oil and gas production wells, and saltwater injection wells used to inject wastewater from oil production (water-flood wells), as well as numerous abandoned wastewater disposal ponds and sumps, in these oil fields. A number of oil and gas production wells and saltwater injection wells associated with the South Coles Levee Oil Field are located on the Green Acres Farm property (AGT, 2004). Records from the California Department of Conservation, Division of Oil, Gas, and Geothermal Resources (DOGGR. 2011) indicate that there are 20 active or abandoned oil and gas production wells and saltwater injection wells on the Green Acres Farm property. This includes 17 oil and gas production or saltwater injection wells in section 12 (T31S/R25E), one active oil and gas well in section 1 (T31S/R25E), and two abandoned gas wells in section 6 (T31S/R26E) on Green Acres Farm. In the area immediately west of Green Acres Farm, records indicate that there are 10 oil and gas production wells or saltwater injection wells in section 2 (T31S/R25E) and 31 oil and gas production wells or saltwater injection wells in section 11 (T31S/R25E) (Attachment B, Figures 5 and 6).

13. These Kern County oil fields, which began production in the early 1900s, pump large volumes of crude oil and associated saline produced water (brine). For example, in 2010 the active oil and gas well in section 1 (T31S/R25E-1L) on Green Acres Farm produced 3,378 barrels of oil and 354 barrels (equivalent to 14,868 gallons) of saline water, as well as 2,735 million cubic feet (mcf) of natural gas. Produced water from oil and gas wells in these oil fields on and surrounding Green Acres Farm has been found to contain high concentrations of total dissolved solids (TDS), including chloride, and other constituents, such as ammonium-nitrogen and boron. In the South Coles Levee Oil Field, which underlies portions of Green Acres Farm, produced water was found to contain more than 25,500 parts per million (ppm, equivalent to milligrams per liter (mg/l)) TDS and more than 10,000 mg/l chloride (DOGGR 1998). Produced water from the North Coles Levee Oil Field, located immediately northwest of Green Acres Farm was found to contain as much as 30,191 mg/l TDS and more than 15,000 mg/l chloride.

Petroleum brines also contain ammonium-nitrogen concentrations exceeding 300 mg/l and boron at levels as high as 65 mg/l (Bean/Logan 1983). The ammonium nitrogen compound subsequently can be transformed through oxidation into ammonia, nitrite, and eventually into nitrate (Bean/Logan 1983).

14. Until recently, saline wastewater produced during oil field operations in the San Joaquin Valley was historically discharged to the land surface to surface sumps or ponds in the oil fields adjacent to the oil well, or injected into the subsurface using deep disposal wells. A study directed by the California Regional Water Quality Control Board (CRWQCB) in 1983 (Bean/Logan 1983) documented hundreds of oil sumps and wastewater ponds in the large oilfield area west of Green Acres Farm, including more than 850 sumps and ponds in 1971. These sumps and ponds, commonly placed along stream channels, were also used to recover residual amounts of petroleum by skimming oil from the sumps and ponds. Historical topographic maps of the area show the presence of oil and gas wells, wastewater sumps, ponds in the Elk Hills, South Coles Levee, and North Coles Levee oil fields immediately west and north of Green Acres Farm (Attachment B, Figure 7) (USGS 1973). While a portion of the oilfield-produced water discharged to ponds or sumps evaporated, a significant volume of this produced water percolated into the subsurface to the underlying groundwater. As a result, saline produced water has adversely impacted groundwater and water wells in the oil field areas west and north of Green Acres Farm with increasingly higher concentrations of dissolved solids (measured as electrical conductivity (EC)), including chloride, boron, and nitrogen compounds (Bean/Logan 1983). A CRWQCB study conducted in 1983 concluded that brine disposal sumps and brine injection in the Elk Hills west of Green Acres was migrating into the adjacent agricultural areas of the San Joaquin Valley, adversely impacting numerous water wells (Bean/Logan 1983). The CRWQCB study found that groundwater wells impacted by petroleum brines contained EC greater than 11,000 micromhos per centimeter (µmhos/cm), chloride over 10,000 mg/l, and nitrate levels exceeding 400 mg/l (Bean/Logan 1983). This brine-impacted groundwater has continued

to flow eastward toward and beneath Green Acres Farm from the adjacent oil fields to the west and north, and from oil field operations on Green Acres Farm, toward the east and south beneath the site.

15. The climate of Green Acres Farm is arid, with very low annual rainfall. Average annual rainfall at Green Acres Farm is less than 6 inches per year (California Department of Water Resources, Division of Flood Management (DWR CDEC)). Potential evapotranspiration (i.e. the amount of water that is evaporated from the soil and from crops) in the area is very high, averaging approximately 58 inches per year (CIMIS). As a result of the large deficit in rainfall in this area of the San Joaquin Valley, farming operations such as Green Acres Farm must rely on irrigation to supply the water needs of crops.

Hydrogeologic Conditions in the Green Acres Farm Vicinity

16. Green Acres Farm is situated in the southernmost portion of the Central Valley of California, between the Temblor Range Mountains of the Coast Range to the west and the Sierra Nevada range to the east. As a result, the sediments underlying the Green Acres Farm vicinity were derived from both mountain ranges. The rocks that comprise the Temblor Range to the west consist primarily of former marine sediments, which contain high, naturally elevated concentrations of salts (e.g., chloride, sodium, nitrate, and boron) (Dale 1966). During the past several hundred thousand years, these sediments were eroded by streams and redeposited to the east, where they underlie the western portion of the San Joaquin Valley and Green Acres Farm. Groundwater that comes in contact with these former marine sediments is generally of poor quality, with high concentrations of chloride, sodium, and other salts. In contrast, the Sierra Nevada range to the east consists primarily of granitic rock types. As a result, sediments underlying the eastern side of the San Joaquin Valley (and portions of Green Acres Farm) that were eroded from the Sierra Nevada range have a much lower natural salt content. Groundwater in the eastern portion of the San Joaquin Valley is of better quality, with lower salt content.

17. The geologic materials underlying the west-central portion of the southern San Joaquin Valley and the Green Acres Farm area consist of interbedded layers of granitic sediments from the east and former marine sediments from the west, containing high concentrations of salts. As a result, hydrogeologic conditions and groundwater quality in the area of Green Acres Farm can be highly variable, with areas of naturally poor quality groundwater commonly being interbedded with sediments containing water of better quality.

A. Surface Soils

18. Surface soils at Green Acres Farm consist primarily of loam and fine sandy loam. The primary soil series at the site are the Garces loam, formed from alluvium from mixed rock sources, and the Tennco fine sandy loam, formed from alluvium from granitic rock. Other soils include the Panoche saline-sodic loam, and the Kimberlina saline-sodic fine sandy loam. Saline soils at the Green Acres Farm site naturally contain elevated concentrations of alkali salts derived from marine sediments on the western side of the San Joaquin Valley. Salts from these sediments and soils have adversely impacted groundwater beneath the site with elevated concentrations of chloride and other inorganic contaminants. Most soils on the property exhibit a very hard, virtually impermeable hardpan horizon at a depth of approximately 2 to 4 feet beneath the surface. The permeability of soils at Green Acres Farm, indicating the ability of soils to allow water to percolate, has been classified as very slow to moderately slow (USDA).

B. Recent Alluvium

19. Beneath the surface soils, the uppermost sediments in the area consist of a complex mixture of heterogeneous, interbedded silts, sand, and clays. The thickness of alluvial sediments varies significantly as a result of depositional patterns and tectonic structural changes, ranging from less than 230 feet to over 420 feet (Dale 1966). In general, the thickness increases toward the east within the San Joaquin Valley. The thickness and extent of individual sediment layers within the alluvium varies greatly. Where present, layers of sand range from less than 5 feet thick to more than 100 feet

thick in some locations. These sand layers are interbedded with thin lenses of poorly sorted gravel and thicker layers of fine-grained silty clays, as much as 50 feet thick or more.

C. Corcoran Clay Layer

20. The Corcoran Clay is a continuous layer of very low-permeability clay (referred to as an aquitard) separating the overlying Recent Alluvium sediments from the underlying sediments throughout much of the San Joaquin Valley. The Corcoran Clay is a well-known regional aquitard, and represents organic-rich, silty clay sediments associated with the ancient Lake Tulare in the southern San Joaquin Valley, which was subsequently covered by more recent sediments (Dale 1966). The lateral extent of the Corcoran Clay layer is variable in the vicinity of Green Acres Farm. The Corcoran Clay layer has been encountered at the land surface along the western margin of the Valley, and at depths of as much as 300 to 465 feet in the area to the east. Where present, the Corcoran Clay typically ranges in thickness from 25 to 100 feet.

D. Deeper Sediments

21. Deeper sediments in the Green Acres Farm area consist of a thick sequence of interbedded clayey and silty sands, sandy clays, clayey silts, and gravelly sands referred to as the deep sediment zone. This zone, encountered at depths generally greater than 300 feet below the surface, consists of a complex mixture of heterogeneous, interbedded silts, sand, and clays derived from marine sediments, continental deposits, and igneous rocks, deposited in streams or lakes, with a thickness of approximately 400 to 800 feet. Underlying the deep sediment zone are sediments of the Lower Tulare Formation, which consists of bluish-gray sands, silts, and clays of Pliocene-Pleistocene age, ranging from 400 to over 800 feet in thickness. In the central and western San Joaquin Valley, sand layers in the Lower Tulare Formation have been found to contain oil and saline water containing high concentrations of dissolved solids. Oil was first discovered in the southern San Joaquin Valley in the early 1900s in the Lower Tulare Formation northwest of Green Acres Farm.

Groundwater Conditions in the Vicinity of the Green Acres Farm

A. Groundwater Occurrence

22. Studies conducted by the California Department of Water Resources (DWR), the Kern County Water Agency, and others have reported that groundwater in the southern portion of the San Joaquin Valley may locally occur as shallow or "perched" groundwater, unconfined or "water table" groundwater, and confined groundwater (Rector 1986).

23. The depth to the regional groundwater surface (regional water table) in the Green Acres Farm area varies from approximately 60 to 160 feet below the ground surface based on data from 2010. The interval from the land surface to the groundwater surface is called the unsaturated zone or vadose zone. However, within the vadose zone above the regional water table, are layers of low-permeability silt and clay upon which percolating water can locally collect under certain conditions. This groundwater that can locally collect above such low-permeability layers is called perched groundwater. Perched groundwater only occurs when there is sufficient water to percolate downward below the crop root zone to collect on the low-permeability silt and clay layers. Under most circumstances, perched groundwater does not accumulate in the area of Green Acres Farm due to the low rainfall and very high rates of evapotranspiration, which limit the amount of water that can percolate into the subsurface

24. Perched groundwater has not been encountered beneath Green Acres Farm. Where perched groundwater has been encountered in the southern San Joaquin Valley, it has generally been found at depths of approximately 20 to 50 feet below the ground surface, where groundwater accumulated above fine-grained soil intervals. The occurrence and depth of perched groundwater in the San Joaquin Valley is highly variable and depends on the rates of groundwater percolation and occurrence of fine-grained sediment layer intervals in the vadose zone.

25. Unconfined groundwater consists of groundwater in deeper alluvial sediments below the regional groundwater surface (water table). These alluvial

sediments, which provide regional water supplies, occur at depths below 300 feet. Groundwater levels in this deeper sediment zone vary greatly depending on seasonal conditions and groundwater irrigation pumping. During the winter rainy season, groundwater levels may be 70 to 170 feet below the ground surface. However, during the summer, when rainfall is lowest and irrigation pumping is greatest, groundwater levels generally decline to 150 to 250 feet or more below the ground surface. The direction of groundwater flow in the unconfined zone at Green Acres Farm is generally from the west, northwest, and north toward the south and east. Groundwater is flowing from areas of higher elevation in the Elk Hills west of the site toward the east and south beneath Green Acres Farm (Attachment B, Figure 8). Groundwater flow has been influenced by recharge of large volumes of water along the Kern River into the Kern Water Bank northeast of Green Acres Farm since the 1990s, and the large area of agricultural groundwater pumping south and east of Green Acres Farm (DWR 1990-1996, Attachment C). Attachment C presents DWR maps of groundwater elevations in the Kern Water Basin from 1990 to 2006. On these groundwater level maps, groundwater flow occurs at right angles to the groundwater elevation contours from areas of higher elevation to areas of lower elevation. Prior to the mid-1990s, when groundwater recharge on the Kern River increased dramatically, regional groundwater flow beneath Green Acres Farm was variable, and was generally toward the west, south, and northwest. After 1996, increased groundwater recharge along the Kern River created an area of higher groundwater elevations north and west of Green Acres Farm, which caused groundwater flow directions to change so that groundwater flow has been more toward the south and southeast beneath Green Acres Farm (DWR 1997- 2006, Attachment C). As a result, this change in groundwater flow pattern has increased the southeast migration of petroleum brine-impacted groundwater from the oil field areas to the west beneath Green Acres Farm.

26. Recent Alluvium sediments at depths of 200 feet or less do not provide adequate groundwater supplies for agricultural or irrigation use due to the limited

permeability of the sediments in this zone, the large fluctuations in groundwater levels, and water quality that may not be suitable. There are no known public water supply wells that pump groundwater solely from the uppermost unconfined groundwater zone in the immediate vicinity of Green Acres Farm.

27. Confined groundwater is groundwater that occurs beneath low permeability aquitard zones, and is encountered beneath the Corcoran Clay at depths of approximately 300 to 800 feet below the ground surface. In contrast to the limited thickness and yields of shallow groundwater, the confined groundwater zone is several hundred feet thick and widespread throughout the region. This deeper zone is able to produce relatively large volumes of water to wells. Irrigation wells in the Green Acres Farm area have been generally drilled to depths of 300 to 700 feet into the confined groundwater zone. These wells are capable of providing large quantities of water for irrigation use, although the natural quality of the water is variable and can be poor.

B. Groundwater Quality

28. Groundwater quality in western Kern County is highly variable and is locally of naturally poor quality. Additionally, there are large areas of the western San Joaquin Valley where groundwater has been impacted by saline produced water from oil field operations disposed to the land surface or placed in surface ponds or sumps. For example, a CRWQCB study conducted by Bean/Logan (1983) concluded that brine disposal sumps and brine injection in the Elk Hills west of Green Acres Farm was migrating into the adjacent agricultural areas of the San Joaquin Valley, adversely impacting numerous water wells. The CRWQCB study found that groundwater wells impacted by petroleum brines contained EC greater than 11,000 μmhos/cm, chloride over 10,000 mg/l, and nitrate levels exceeding 400 mg/l (Bean/Logan 1983). This brine-impacted groundwater has continued to flow eastward from the adjacent oil fields to the west and north beneath Green Acres Farm, and from oil field operations on Green Acres Farm, toward the east and south beneath the site.

29. Historically, groundwater in the western portions of the County has not been considered suitable for beneficial uses, such as irrigation and domestic supply. The quality of native groundwater in the Green Acres Farm area is also highly variable, and locally the groundwater contains naturally high concentrations of salts (dissolved solids) such as chloride, sulfate, nitrate, and boron. Regional maps of groundwater quality prepared by the Kern County Water Agency (1992) reflect the poor quality and naturally high concentrations of total dissolved solids (TDS) in the western portions of the San Joaquin Valley.

30. Initial studies of groundwater quality in the western portion of the County by the DWR in 1957 found that wells in the western portion of the San Joaquin Valley were "undesirable for domestic or irrigation use." Analyses of water from these wells found concentrations of TDS up to 4,991 ppm, chloride up to 940 ppm, and boron up to 7.6 ppm. Groundwater was found to be generally a sodium chloride type or sodium sulfate type. A 1957 study of groundwater conditions by the United States Geological Survey also found elevated mineral concentrations in groundwater in the southwestern portion of the San Joaquin Valley (Wood and Davis 1959).

31. The natural variability and poor quality of groundwater in the western portion of the San Joaquin Valley also results from the occurrence of alkaline soils and salts naturally leached from sediments derived from the Temblor Range, to the west. The CRWQCB Water Quality Control Plan for the Tulare Lake Basin (Second Edition – 1995) (Basin Plan) also indicates that "A few areas within the Basin have ground waters that are naturally unsuitable or of marginal quality for certain beneficial uses."

Green Acres Farm History and Operation

32. Prior to the 1960s, land use in the Green Acres Farm area was generally limited to oil production, ranching, and animal grazing, largely due to the lack of water of suitable quality to allow irrigation of crops (AGT 2004). The only source of irrigation water in the Green Acres Farm area at that time was a canal system that diverted water from the Kern River. In the late 1960s, construction of the State Water Project California

Aqueduct provided additional irrigation water to the area, allowing increased crop production. As a result, the primary crops now grown in the general area include wheat, cotton, and alfalfa. However, even today, there is limited crop production in the area immediately north and west of Green Acres Farm, which is used primarily for oil production activities. No crops are currently grown in the area directly north and west of Green Acres Farm (T31S/R25E Sections 2 and 11). Crop production in the off-site area is limited to the areas southwest and south of Green Acres Farm, where large-scale sprinkler irrigation systems are used.

33. The use of groundwater for irrigation has increased in some areas of the San Joaquin Valley, although the quality of groundwater and depths of pumping limits its use in many areas. In 1990, large areas north and east of Green Acres Farm, closer to the Kern River, were set aside for water banking purposes, where excess surface water is allowed to percolate into the subsurface during the winter, so that it can be subsequently pumped out during droughts.

34. In 1986, Tenneco West, Inc., then owner of the property now encompassed in Green Acres Farm, contracted to receive treated wastewater from the City of Bakersfield Wastewater Treatment Plant #3 (WWTP #3) for use as the Farm's primary source of water for crop irrigation. The recycling of treated wastewater effluent from the City of Bakersfield for crop irrigation at Green Acres Farm was originally permitted by CRWQCB Order No. 88-172, which was later modified by RWQCB in several subsequent Waste Discharge Requirement Orders. Currently, the use of treated effluent for irrigation at Green Acres Farm is regulated by RWQCB Order No. R-5-2009-0087. Sampling of the treated effluent from WWTP #3 from January 2007 to December 2008 indicated that the effluent contained 75 mg/l chloride, 0.46 mg/l nitrate (as nitrogen), and 798 µmhos/cm electrical conductivity (CRWQCB Order No. R-5-2009-0087).

35. Up to approximately 14 million gallons per day of treated wastewater effluent is delivered to Green Acres Farm for irrigation of forage crops and refined crops, such as wheat and corn. This treated effluent currently provides an estimated 80 percent

of irrigation water needs for farming operations at the property, and also provides nutrients to the crops. Green Acres Farm supplements this with irrigation water from the Kern Delta Water District (KDWD), consisting of water from Kern River and the California Aqueduct, and with groundwater pumped from several water supply wells on the property. Groundwater currently provides only an estimated 15 percent of irrigation water used at Green Acres Farm, and imported surface water from KDWD provides only 5 percent of the Farm's irrigation water needs.

36. In November 1994, the City of Los Angeles began delivering biosolids for recycling at Green Acres Farm under permit from the CRWQCB. These biosolids provide important fertilizer nutrients and soil amendments for growing crops at Green Acres Farm. Currently, the crops produced at Green Acres Farm include corn, wheat, alfalfa, sudan, and milo. Biosolids are applied at Green Acres Farm in accordance with a nutrient management plan that carefully plans and monitors biosolids application. The locations, timing, and rate of biosolids application are carefully calculated to match the specific demands of crops and soils in each field in order to minimize the potential for accumulation of minerals and nutrients, such as nitrate, in the soil.

Groundwater Monitoring at Green Acres Farm

37. Prior to the acceptance and use of treated wastewater effluent from the City of Bakersfield in 1986, the City conducted a comprehensive study to determine "pre-project" background groundwater conditions in the area of Green Acres Farm (Rector. 1986). That study included characterization of groundwater conditions in the Green Acres Farm area and sampling of approximately 32 groundwater wells in the area, to establish background groundwater conditions prior to the application of treated wastewater effluent.

38. Based on that study, the City of Bakersfield implemented a groundwater monitoring program to assess possible future impacts to groundwater related to use and recycling of treated effluent for crop irrigation at Green Acres Farm, which was conducted under CRWQCB Order 88-172, dated September 23, 1988. This groundwater

monitoring program has included the installation and sampling of monitoring wells to monitor potential impacts to "perched" groundwater (11 monitoring wells), unconfined groundwater (2 monitoring wells), and confined deep groundwater (19 monitoring wells). (Attachment B, Figure 9). This groundwater monitoring program has been implemented under the guidance of and in conjunction with the requirements of the RWQCB, initially under Monitoring and Reporting Program No. 88-172, September 23, 1988. Currently, monitoring activities are conducted in accordance with Monitoring and Reporting Program No. R5-2009-0087 for WWTP #3, adopted by the CRWQCB in August 2009. The groundwater monitoring program included measurement of groundwater levels and monitoring of those water quality parameters indicative of potential impacts to groundwater associated with wastewater effluent, including EC, chloride, pH, and nitrate. EC is a measure of the amount of TDS present in groundwater samples, while pH measures whether the water is acidic or alkaline.

39. Groundwater monitoring at Green Acres Farm has been conducted by the City of Bakersfield on an annual basis since approximately 1986. This monitoring program therefore provides groundwater monitoring data for a significant period of time before the 1994 onset of the City of Los Angeles biosolids recycling program at Green Acres Farm, and the monitoring program has continued to date, more than 16 years since startup of the biosolids recycling program.

40. Results of the Green Acres Farm groundwater monitoring program and groundwater sampling results from the area are available for the period since 1975. The assessment of potential impacts to groundwater caused by application of City of Bakersfield treated wastewater and City of Los Angeles biosolids recycling can be evaluated by comparing current conditions with groundwater conditions measured from 1975 to 1986, immediately prior to the first use of treated effluent from Bakersfield, and at least eight years before the use of City of Los Angeles biosolids at Green Acres Farm. Additionally, monitoring data can be evaluated for potential trends in groundwater quality over the last 30 years.

41. Results of groundwater monitoring at this site are summarized on the following chart.

Time Period and Location of Groundwater Sampling	Groundwater Quality Parameter		
	Chloride Concentration (mg/l)	Nitrate Concentration (mg/l)	Electrical Conductivity (µmhos/cm)
Groundwater Samples **Prior to Wastewater Effluent and Biosolids Use-On Site** (1975-1982)	0.9 to 96	0 to 8.7	260 to 1040
Groundwater Samples **Prior to Wastewater Effluent and Biosolids Use- Off Site** (1975-1982)	6.2 to 64	0 to 17.7	230 to 490
On Site (1990-2010)			
1990-2002	2 to 49	<0.1 to 3.6	180 to 590
2003-2010	14 to 440 14 to 99*	<0.1 to 43 <0.1 to 0.37*	312 to 5,000 312 to 860*
Off Site (1990-2010)			
1990-2002:	3 to 294	<0.1 to 3.6	190 to 1,260
2003-2010	10 to 66	<0.1 to 12	240 to 1,200

Notes:
µmhos/cm = micromhos per centimeter
mg/l = milligrams per liter
* = Not including well #4 sample from July 2010

42. As indicated on the chart above, chloride, nitrate, and TDS (as indicated by elevated EC) were encountered in groundwater at relatively elevated concentrations prior to startup of the City of Bakersfield WWTP #3 effluent recycling program and the City of Los Angeles biosolids recycling program. For example, chloride was detected at concentrations up to 96 ppm, and nitrate, and EC were detected at concentrations up to 8.7 ppm and 1,040 µmhos, respectively, prior to the application of wastewater and

biosolids at the site.

43. In the most recent sampling of groundwater at Green Acres Farm in July 2010, the concentrations of these parameters, except for monitoring well #4 (to be discussed later), were found to be generally similar to or less than the levels found prior to wastewater use and application of biosolids, and within the range of expected groundwater conditions in the area (Geocon 2010). In July 2010, groundwater from on-site agricultural well T31S/R26E-7L contained 99 ppm chloride and 860 µmhos/cm EC, while nitrate was not detected above 4.4 mg/l. The maximum concentrations in off-site groundwater in July 2010 were 65 mg/l chloride, 12 mg/l nitrate, and 1,200 µmhos/cm in well T31S/R25E-13B.

44. Changes in groundwater quality in offsite well T31S/R25E-13B and other wells in the western portion of Green Acres and the off-site area to the west appear to be caused by migration of petroleum brine-impacted groundwater from the west and northwest containing elevated concentrations of TDS, chloride, and other constituents, including nitrate. As shown in Figure 8 (Attachment B), groundwater flow is generally toward the east and southeast onto and across Green Acres Farm. Groundwater quality may also be locally influenced by irrigation return water from agricultural activities immediately south and southwest of the site, where large-scale irrigation sprinkler systems have recently been used. Water levels in off-site well T31S/R25E-13B, in the sprinkler-irrigated field immediately southeast of Green Acres Farm, increased 86 feet during the six-month period between January and July 2010, possibly the result of large-scale irrigation in this off-site area.

45. The adverse impacts of oil production on groundwater at Green Acres Farm are illustrated in City of Bakersfield monitoring well #4 (T31S/R25E-1L) in the northwest portion of Green Acres Farm. This well is located in the area of the South Coles Levee Oil Field, one mile southeast of the North Coles Levee Oil Field, and 1.25 miles south of the Ten Section Oil Field. The surface casing of this monitoring well was damaged several years ago, making it inaccessible for sampling on various occasions and

susceptible to leakage of surface contaminants into the well. Previous sampling of monitoring well #4 has indicated varying and increasing concentrations of chloride and EC, as well as sporadically high and anomalously high concentrations of nitrate. Recent sampling of monitoring well #4 indicates that groundwater at that location has been impacted by crude oil and saline produced water from oil field operations. In July 2010, groundwater from monitoring well #4 had a petroleum hydrocarbon odor and was discolored (gray-black), and contained 440 ppm chloride and 5,000 μmhos/cm EC. Previous sampling of monitoring well #4 in July 2008 indicated that the well contained 200 ppm chloride and 2,170 μmhos/cm EC (Geocon 2010). It is possible that monitoring well #4 has been impacted by downward leakage into the well as a result of the damaged surface casing. However, the increasing concentrations of dissolved solids, including chloride and the anomalously high nitrate concentrations in this well measured in recent years are also consistent with the migration of petroleum brine-impacted groundwater beneath Green Acres Farm from oil fields to the north and west.

46. Evaluation of groundwater quality data from certain groundwater wells to the west and north of Green Acres Farm indicates that there have been changes in the concentrations of certain water quality parameters over the past approximately 20 years, primarily due to migration of groundwater impacted by produced water from oilfield operations. These findings are consistent with the findings of the 1983 CRWQCB study of water quality in Kern County, which concluded that brine-impacted groundwater was migrating into the agricultural areas of San Joaquin Valley north and east of Elk Hills (Bean/Logan 1983). The migration of petroleum brine-impacted groundwater toward the south and east beneath Green Acres Farm is expected to continue in response to regional groundwater flow.

47. It is important to note that there have not been general increases in nitrate concentrations in groundwater that would indicate an adverse impact from wastewater or biosolids applications at Green Acres Farm. For example, in 1981, agricultural well 9 (T31S/R26E-7L; Attachment B, Figure 9), located in the west central portion of the site,

contained 25 mg/L chloride, 1.0 mg/L nitrate and 380 µmhos/cm EC. In the most recent July 2010 sampling, chloride and EC concentrations in this well had increased to 99 ug/l and 860 µmhos/cm EC, respectively. However, nitrate was not detected in this well in July 2010. In agricultural well 10 (T31S/R26E-8G), located in the east central and downgradient portion of the site (Attachment B, Figure 9), from 1977 to 2009 (the most recent sample), concentrations of water quality parameters either decreased, (nitrate, from 0.9 mg/l to <0.055 mg/l, and chloride, from 18.1 mg/l to 14 mg/l) or remained generally stable (EC, 290 µmhos/cm and 312 µmhos/cm). However, the presence of elevated nitrate concentrations is not necessarily related to agricultural activities or the application of wastewater or biosolids at Green Acres Farm. As shown by the 1983 CRWQCB water quality study by Bean/Logan (1983), petroleum brines can contain high concentrations of ammonium-nitrate, which can oxidize to nitrate in groundwater. Nitrate concentrations exceeding 400 mg/l have been found in brine-impacted groundwater in the area west of Green Acres Farm (Bean/Logan. 1983). Therefore, increases in nitrate concentrations in groundwater at Green Acres Farm do not necessarily indicate impacts from application of wastewater or biosolids.

48. Comparison of groundwater sampling results from groundwater monitoring and supply wells prior to 1986 with recent sampling data indicate that there have not been adverse impacts to groundwater attributable to the application of biosolids or wastewater. There is no pattern of generally increased nitrate concentrations, the best indicator of wastewater impacts, in groundwater at Green Acres Farm. Except for those wells impacted by saline produced water from oil fields in the off-site area and western portions of Green Acres Farm, analysis of trends in the concentrations of the indicator parameters used to assess possible biosolids impacts to groundwater (TDS, chloride, and nitrate) does not indicate that there have been significant consistent increases in those water quality parameters over time. Rather, groundwater monitoring data during the last 20 years from Green Acres Farm indicate that groundwater quality beneath the majority of Green Acres Farm has remained within the naturally variable background conditions

for the area. Background conditions in western Kern County include areas where groundwater naturally contains elevated concentrations of dissolved solids and salts, such as chloride, nitrate, and sulfate, derived from the surrounding marine sediments, and from oil field activities. However, the occurrence of increasing concentrations of dissolved solids, including chloride and nitrate, in wells in the northwest portion of Green Acres Farm reflects impacts of produced water from oil field operations and the eastward migration of that oilfield-impacted water beneath Green Acres Farm.

49. Groundwater data collected from off-site industrial and agricultural wells T31S/R25E-10A and -11G, and T30S/R25E-35K and -35B represent upgradient groundwater conditions and water quality. Increases is chloride and EC (TDS) observed in these wells during the past 20 years are unrelated to application of biosolids in farming operations, and reflect changes in regional groundwater quality and impacts of oil field operations. These regional changes in groundwater quality have been observed as increases in chloride and EC in some downgradient wells located on Green Acres Farm, including T31S/R26E-7L and T31S/R26E-16L. The fact that there were no general increases in nitrate concentrations in these wells and the observed increases in chloride and dissolved solids (as EC) in upgradient groundwater indicate that these changes are not related to operations of Green Acres Farm.

Impacts to Groundwater from Green Acres Farm

50. Results of groundwater monitoring and sampling data from the Green Acres Farm area since 1975 indicate that there have not been significant impacts to groundwater quality resulting from application of biosolids at Green Acres Farm. The groundwater monitoring program has not found any consistently elevated concentrations in groundwater of constituents associated with biosolids or treated wastewater effluent used for irrigation, including nitrate, chloride, and TDS at Green Acres Farm.

51. Groundwater sampling results from monitoring wells and water supply wells at Green Acres Farm are consistent with the variable groundwater conditions in the area. Native groundwater in the area commonly contains naturally high and variable

background concentrations of dissolved solids, including chloride, sulfate, nitrate and boron. For example, chloride and EC (a measurement of dissolved solids) were detected in groundwater beneath Green Acres Farm prior to the addition of effluent and biosolids at concentrations up to 96 ppm and 1,040 μmhos/cm, respectively. Additionally, groundwater in the vicinity of Green Acres Farm has been found to be impacted by petroleum and salt water from oil fields that underlie or surround the site.

52. Recent groundwater sampling results also are consistent with findings included in a pre-project groundwater conditions report prepared in 1986 (Rector. 1986). That study anticipated that movement of groundwater with elevated TDS from oil fields located north and west of the Green Acres Farm was "a definite possibility according to estimated directions of groundwater flow".

53. Information published by the Kern County Water Agency and groundwater monitoring data from the site indicate that the direction of groundwater flow beneath the majority of Green Acres Farm since at least 1997 has been consistently toward the east, south and southeast (DWR 1993 to 2006, Attachment C). This indicates that groundwater beneath Green Acres Farm is not flowing toward the Kern Water Bank area. Since 1994, when biosolids applications began, groundwater beneath Green Acres Farm has been flowing away from the Kern Water Bank area, not toward the Water Bank. Groundwater from the area of the Water Bank north and east of Green Acres Farm is flowing toward the Farm due to the large amounts of water recharged in the Kern Water Bank creating a large groundwater mound east and north of Green Acres Farm that results in groundwater flow toward the west and south and Green Acres Farm (DWR 1993-2006, Attachment C).

54. The finding that there has been no measurable impact to groundwater from the applications of biosolids at Green Acres Farm is consistent with studies conducted by the U.S. Environmental Protection Agency (U.S. EPA) and others, indicating that proper application of biosolids would not result in impacts to groundwater (U.S. EPA, Office of Wastewater Management. "A Guide to the Biosolids Risk Assessments for the EPA Part

503 Rule." EPA832-B-93-005, 1995. California State Water Resources Control Board, "Final Statewide Environmental Impact Report for Biosolids Land Application," June 30, 2004).

55. A lack of observed impact to groundwater from the applications of biosolids at Green Acres Farm is also consistent with the climate, soil type, and hydrogeology at that site. The volume of water that can percolate through the soil, beneath the crop root zone, and into groundwater beneath Green Acres Farm is limited by the very high rates of evapotranspiration in the area (approximately 58 inches per year) when compared with the low rainfall rate (approximately 6 inches per year). Also, low-permeability soils at the site tend to restrict the downward movement of water and chemical migration. A hard pan layer is present in shallow soils beneath large areas of the site, which severely restricts percolation of water from the surface. Finally, groundwater beneath the site is encountered at depths of approximately 60 to 160 feet below the ground surface. This relatively large depth to water serves to further limit potential impacts to groundwater.

Conclusions

56. Groundwater monitoring data collected from groundwater monitoring and supply wells located within and in the vicinity of the Green Acres Farm site over the past approximately 20 years indicate that the City of Los Angeles biosolids recycling program at Green Acres Farm has not resulted in impacts to groundwater quality. Comparison of groundwater quality prior to the first application of biosolids with recent groundwater quality conditions, and evaluation of trends in the concentration of the indicator parameters used to assess possible biosolids impacts to groundwater (TDS, chloride, and nitrate), indicate that startup and operation of the biosolids recycling program at Green Acres Farm has not resulted in increases in those water quality parameters. Rather, groundwater monitoring data collected at Green Acres Farm indicate that groundwater quality beneath that site has remained within the general background condition for the area.

References

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In addition to the reports that are referenced within the text of this report, documents that I have relied upon include the following:

(a) A Guide to the Biosolids Risk Assessments for the EPA Part 503 Rule. EPA/832-B-93-005. U. S. Environmental Protection Agency (September 1995).

(b) Bio-Accumulation Study. Fields: 5-1 and 16-4. Order 94-286. Valley Communities, Inc. and Responsible Biosolids Management, Inc. California Regional Water Quality Control Board, Central Valley Region (1994).

(c) California Regional Water Quality Control Board, Central Valley Region. Order Nos. 94-286. Waste Discharge Requirements for Valley

Communities, Inc. and Responsible Biosolids Management. Sludge Application to Land. Kern County (September 16, 1994).

(d) California Regional Water Quality Control Board, Central Valley Region Order No. 88-172, Wastewater Reclamation Requirements for Tenneco West, Inc., Land Application Site, Kern County (September 23, 1988).

(e) California Regional Water Quality Control Board, Central Valley Region, Order No. 94-366. Special Order for Valley Communities, Inc. Land Application Site, Kern County, Modifying Wastewater Reclamation Requirements Order No. 88-172 (December 9, 1994).

(f) California Regional Water Quality Control Board, Central Valley Region. Order No. 88-167. Waste Discharge Requirements for City of Bakersfield Wastewater Treatment Plant No. 3. Kern County (June 10, 1995).

(g) California Regional Water Quality Control Board, Central Valley Region. Monitoring and Reporting Program No. 5-01-105 for City of Bakersfield Wastewater Treatment Plant No. 3. Kern County (June 23, 1995).

(h) Groundwater Conditions in the Vicinity of Bakersfield Wastewater Treatment Plant No. 3/Tenneco West Inc. Land Application Site. Kern County, California. Michael R. Rector, Inc. Water Resources Consultant (Annual Reports 1988 through 1992).

(i) Green Acres Farm Appraisal. AGT Company (August 19, 2004).

(j) Guidelines for the Preparation of an Engineering Report for the Production, Distribution and Use of Recycled Waters. (September 1997).

(k) Kern County Water Agency. Groundwater Elevation Maps, various dates.

(l) Summary of Groundwater Conditions in the Vicinity of Bakersfield Wastewater Treatment Plant #3. Kern County, California. BSK (September 30, 1999).

(m) Summary of Groundwater Conditions in the Vicinity of the City of Bakersfield WWTF No. 3 I-5. Kenneth D. Schmidt & Associates, Annual Reports for 2004 and 2005.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on this 19th day of April, 2011, in Chicago, Illinois.

Thomas M. Johnson, P.G., CH.G.

ATTACHMENT A

ARCADIS

Thomas M. Johnson, PG, CHG

Executive Vice President / Technical Director
Principal Hydrogeologist

Education

PhD program (Non-Degree ABD), Geology University of Illinois, Champaign-Urbana, 1976-1986

MS, Geology, University of Wisconsin, Madison, 1976

MS, Water Resources Management, University of Wisconsin, Madison, 1975

BA, Geology, Augustana College, Illinois, 1972

Years of Experience

Total - 35

Professional Registrations

Professional Geologist, CA No. 4286

Certified Hydrogeologist,: CA No. 317

Professional Geologist, IL No. 196-000926

Professional Geologist, WI No. 1286-13

Registered Geologist, AZ No. 31899

Certified Geologist, IN No. 547

Professional Geologist: PA No. PG-003073-G

Professional Hydrogeologist: American Institute of Hydrology

Professional Geologist: American Institute of Professional Geologists

Professional Qualifications

National Ground Water Assoc., Assoc. of Ground Water Scientists and Engineers

California Groundwater Resources Association

American Institute of Hydrology

American Institute of Professional Geologists

Geological Society of America

Northern California Geological Society

University of Wisconsin-Madison, Department of Geoscience Advisory Board

Mr. Johnson is Executive Vice President, Technical Director and Principal Hydrogeologist for ARCADIS. He directs environmental contamination investigation and remediation projects and is Technical Director of ARCADIS' litigation consulting/expert services practice. Mr. Johnson has extensive expertise in hydrogeology and groundwater flow, contaminant fate and transport, and risk assessment. He is also an expert in modeling groundwater flow and contaminant transport and evaluating remedial technologies for soil and groundwater contamination.

Mr. Johnson has more than 35 years of consulting and research experience involving investigation and remediation of environmental contamination. He has directed and managed more than 200 projects involving environmental contamination. At the Illinois State Geological Survey, prior to joining ARCADIS, Mr. Johnson conducted research for 11 years on groundwater contamination resulting from the landfill disposal of solid wastes, hazardous chemical wastes, and low-level radioactive waste. Major areas of expertise include hydrogeology and groundwater flow-system evaluation, vadose-zone processes, environmental site investigation and remediation, computer modeling of water movement and contaminant transport, aerial photography interpretation, risk assessment, regulatory interaction, and cost allocation for environmental remediation. Mr. Johnson has published numerous papers and reports on these topics.

Mr. Johnson has provided expert testimony in both state and federal courts, and in alternative dispute resolution hearings in numerous cases involving hazardous chemical wastes and petroleum hydrocarbons. He has served multiple terms on the Board of Directors and has served as Board Chairman for the National Ground Water Association, Association of Ground Water Scientists and Engineers. Mr. Johnson serves on the Board of Directors and is past-President of the California Groundwater Resources Association. He served for ten years on the editorial review board for the journal Groundwater Monitoring and Remediation. He has been appointed to National Academy of Sciences/National Research Council Panels to evaluate state and local groundwater protection programs for the U.S. Environmental Protection Agency, and to assess innovative technology decision-making programs for the U.S. Department of Energy. He also lectures extensively throughout the U.S. and internationally on groundwater contamination and remedial actions for various universities, state and federal agencies, and organizations such as the National Ground Water Association. He has also been an invited instructor and lecturer at numerous seminars and workshops on environmental contamination.

His professional interests and areas of expertise include:

- groundwater flow system and water supply evaluation
- evaluation of contaminant migration resulting from disposal of hazardous chemical wastes, petroleum hydrocarbons, solid wastes, and low-level radioactive wastes
- environmental monitoring and sampling techniques
- unsaturated/vadose-zone water and vapor movement, and contaminant migration
- computer modeling of water flow, vapor movement, and contaminant migration
- remote sensing and aerial photograph interpretation
- environmental and human health risk assessment
- evaluation and implementation of remedial actions for soil and groundwater contamination
- cost evaluation and allocation for environmental remediation

General Experience and Qualifications

Representative Experience – Industrial Chemicals

Mr. Johnson has directed or managed more than 200 projects across the U.S. involving organic and inorganic chemicals. This includes multiple large projects involving soil and groundwater contamination by industrial solvents and associated chemical additives, such as 1,4-dioxane, as well as projects involving industrial metals, perchlorate, agricultural chemicals and petroleum hydrocarbons. This work includes environmental remediation projects to address solvent releases at large industrial client sites, and investigation and remediation of solvent contamination at dry cleaning and petroleum sites. This work has involved extensive interaction with state regulatory agencies and the U.S. Environmental Protection Agency.

Mr. Johnson has also provided litigation consulting and expert witness services since 1981 in numerous cases across the U.S. involving environmental contamination of soil and groundwater by organic, inorganic and radioactive chemicals. This includes expert witness testimony at deposition in more than 55 cases and expert trial testimony in state and federal courts in more than 20 cases. These cases have included expert testimony regarding the nature, source and timing of environmental contamination, costs and methods of environmental investigation and remediation, and impacts to water supply systems.

For more than 30 years, Mr. Johnson has lectured and published on the subject of environmental contamination investigation, monitoring and remediation. He has lectured for the

National Groundwater Association at multiple seminars for environmental professionals and regulatory agency staff in many states.

General Experience

Project director and manager for environmental assessments, investigations and remediation at sites throughout the U.S. involving soil and groundwater contamination by chlorinated organic solvents, petroleum hydrocarbons, metals, MtBE, perchlorate, radionuclides, polychlorinated biphenyls (PCBs), 1,4-dioxane, 1,2,3-trichloropropane and other contaminants. This includes numerous sites with dense nonaqueous-phase liquids (DNAPLs) and light NAPL (LNAPL).

Project management and direction of projects involving the full spectrum of state and federal environmental laws and regulations, including federal RCRA, CERCLA, NPDES, FIFRA and NRC laws and regulations. Mr. Johnson also has extensive experience with the complex network of state regulatory agencies, laws and regulations in California, Florida, Illinois, Hawaii, and numerous other states.

Directed comprehensive environmental assessments and human health and environmental risk assessments and multiple U.S. sites, including abandoned waste disposal sites, landfills, and chemical and radioactive waste disposal facilities.

Program director for one the first U.S..Studies of methyl-tert-butyl ether (MtBE) releases at operating gasoline service stations. This study, in the Santa Clara Valley of northern California, evaluated hydrogeologic conditions and the occurrence of MtBE in soil and groundwater beneath 28 operating service stations.

Directed programs to assess multiple potential sources of TCE groundwater contamination at multiple locations in the Silicon Valley area of northern California. These projects included local and regional investigations to evaluate possible sources of TCE contamination from numerous electronics manufacturing facilities at locations throughout Silicon Valley.

Performed site investigations, and developed and implemented remediation activities to address soil and groundwater contaminated by volatile organic compounds (VOCS), petroleum hydrocarbons, metals, PCBs, perchlorate, MtBE and other contaminants at sites throughout the U.S.. In addition, Mr. Johnson has served as an expert witness in many related cases, providing testimony regarding hydrogeology, groundwater conditions, the nature, source and timing of contamination, and the selection and costs of remediation.

Special advisor to the USEPA for preparation of a Technical Enforcement Guidance Document to address groundwater monitoring for RCRA facilities.

Performed groundwater resource assessments and evaluations at locations throughout the United States, including studies of conjunctive use of surface water and groundwater, groundwater recharge and groundwater well design and installation.

Program director for USEPA and USNRC studies of landfill containment systems, including comprehensive laboratory, field and computer studies of covers and liners for sanitary landfills, hazardous chemical disposal sites and radioactive waste management facilities.

Designed and implemented groundwater monitoring systems and remediation programs for sites throughout the U.S., including sites subject to federal CERCLA and RCRA regulations, and sites in multiple states with complex environmental regulations, such as California.

Conducted hydrogeologic investigations for siting of sanitary and hazardous waste landfills in Illinois, California, and Georgia.

Lectures and presentations at professional meetings and university seminars and conferences in the U.S. and internationally. Lectured at University of California-Berkeley and Davis, Purdue University, University of Wisconsin, and University of Alaska.

Co-author of the 2008 and 2009 environmental law textbook “Environmental Liability Allocation”, published by Thomson West.

Former Head of the Groundwater Section, Illinois State Geological Survey, where he directed field and laboratory research programs for USEPA, USNRC and state agencies involving evaluation of waste disposal technologies and environmental impacts from the disposal of solid and hazardous wastes, radioactive wastes, petroleum wastes and industrial wastes.

Hydrogeologist responsible for performing water resources evaluations, groundwater recharge studies, waste containment designs, monitoring leachate migration from sanitary landfills, natural resource inventories, and environmental impact studies. Duties ranged from project design and field analysis to data interpretation and report preparation.

Appointed to serve on two National Academy of Sciences/National Research Council Panels to evaluate state and local groundwater protection programs for the U.S. Environmental Protection Agency, and to assess innovative technology decision-making programs for the U.S. Department of Energy.

Representative Project Experience

Chlorinated Solvents Experience

Multiple Chlorinated Solvents Sites – U.S.

Multiple industrial sites throughout the U.S., including solvent manufacturing facilities, electronics manufacturing operations, dry cleaners, aerospace manufacturers, equipment manufacturing facilities, automobile manufacturing and repair operations, and other industrial facilities. Mr. Johnson has served as project director and manager for environmental assessments, investigations and remediation at sites throughout the U.S. These projects have involved soil and groundwater contamination by chlorinated organic solvents, including PCE, TCE, 1,1,1-TCA, and solvent additives such as 1,4-dioxane and other contaminants., and numerous sites with dense nonaqueous-phase liquid (DNAPL) and light NAPL (LNAPL).

This project experience includes evaluation, investigation and remediation of chlorinated solvent contamination at multiple industrial facilities and dry cleaner sites in Florida, California, Illinois, New Jersey, North Carolina and the northeast U.S. Mr. Johnson has directed programs to assess multiple potential sources of TCE groundwater contamination at multiple locations in the Silicon Valley area of northern California. These projects included local and regional investigations to evaluate possible sources of TCE contamination from numerous electronics manufacturing facilities at locations throughout Silicon Valley.

Project management and direction of projects involving the full spectrum of state and federal environmental laws and regulations, including federal RCRA, CERCLA, NPDES, FIFRA and NRC laws and regulations. Mr. Johnson also has extensive experience with the complex network of state regulatory agencies, laws and regulations in California, Florida, Illinois, Hawaii, and numerous other states.

Performed site investigations, and developed and implemented remediation activities to address soil and groundwater contaminated by volatile organic compounds (VOCS), petroleum hydrocarbons, metals, PCBs, perchlorate, MtBE and other contaminants at sites throughout the U.S.. In addition, Mr. Johnson has served as an expert witness in many related cases, providing testimony regarding hydrogeology, groundwater conditions, the nature, source and timing of contamination, and the selection and costs of remediation.

Lead and Metals Experience

Former Lead Battery Disposal Site, San Francisco Bay – Investigation and remediation of large lead battery disposal site adjacent to San Francisco Bay. Project included investigation of soil, sediments, groundwater and biota. The remedy included off-site disposal of battery debris, lead-contaminated sediment, and biota (clams, mussels) containing hazardous levels of lead, zinc, chromium and other metals. The final remedy consisted of dredging bay sediments and placing the sediments and lead-impacted soils into a lined and covered disposal cell along the bay shore.

Former Shooting Range, Sacramento, CA – Mr. Johnson provided expert services related to the evaluation of impacts from a former shooting range in an area of proposed residential development. The property was impacted by the widespread use of the property as a former shooting range for pistol, rifle and black-powder use. Work included review of site history, assessment of site investigation results, evaluation of alternative proposed remedial actions and costs to address lead-impacted soils, and review of regulatory requirements.

Former Battery Manufacturing Site, Los Angeles, CA – This project included expert review of site history and investigations of soil and groundwater at a former battery manufacturing site. Soil and groundwater were impacted by lead, zinc, chromium and acid.

Petroleum and MtBE Experience

Upstream Petroleum

AERA Energy LLC, South Belridge Oil Field, CA – Mr. Johnson was retained by AERA Energy LLC, a joint venture of Shell Oil Company and Exxon Mobil, to evaluate environmental impacts from upstream oil production in the 50,000-acre South Belridge oil field, western Kern County, California. This project was related to litigation over of impacts to groundwater from more than 80 years of oil production activities, and impacts from the discharge of more than 1.5 billion barrels of produced water (brine) to the environment. Work included assessment of hydrogeologic conditions, geophysical evaluation of production and disposal horizons, geochemical study of native water quality, evaluation of groundwater monitoring data from hundreds of monitoring wells, analysis of groundwater stable isotope data, evaluation of naturally-occurring radioactive materials (NORM), calculations of produced water migration, assessment of impacts from deep-well injection of produced water, evaluation of remedial methods and costs to address oil-field impacts, and evaluation of alternative methods for dealing with produced water and oil field wastes. Litigation against AERA Energy LLC by other land owners included claims for damages in amounts varying from $2 billion to $10 billion. Mr. Johnson assisted AERA and their legal counsel in two years of trial preparations and testified as an expert witness in the initial trial in California Superior Court in 2005 that resulted in a successful jury verdict to AERA. Following appeals, Mr. Johnson assisted AERA again in two years of trial preparation and testified in a second trial in 2009 that also resulted in a successful jury verdict for AERA. Key issues central to AERA's success in these trials included Mr. the work of Mr. Johnson and his staff documenting naturally poor native water quality and limited damages to the plaintiff resulting from oil field operations.

Oil Field Investigation and Remediation, Central Coast, California – ARCADIS was retained to define and remediate environmental impacts associated with oil production operations at the Guadalupe oil field, in a sensitive coastal ecosystem on the coast of California. Work conducted under the direction of the California Regional Water Quality Control Board included site investigations of hydrogeologic conditions in an ecologically sensitive coastal sand dune environment, implementation of groundwater monitoring program to assess impacts from oil field activities, including impacts from large releases of petroleum diluents used to facilitate transport of petroleum through pipelines. Other work included evaluation and implementation of alternative remedial approaches, including in situ remedial methods, phytoremediation, soil treatment, and groundwater remediation. Additional issues included evaluation of impacts to sensitive and endangered biota from oil field production and remediation activities. Finally, ARCADIS participated in a multi-agency and multi-party mediation to assess and resolve issues regarding environmental impacts at the site.

Multiple Pipeline Releases, California – ARCADIS represents Kinder Morgan Energy Partners to respond to pipeline ruptures and petroleum releases leaks at locations throughout the western U.S. Mr. Johnson has worked on pipeline release projects involving crude oil and other petroleum products at multiple sites in California,. This work has included emergency response activities, remedial investigations, ecological assessment and mitigation, and site remediation, involving multiple state and federal regulatory agencies. Mr. Johnson has also provided expert testimony regarding the timing and sources of petroleum releases from multiple pipelines.

Refinery/Terminal Experience

Petroleum Refinery, San Francisco Bay, CA – In this litigation project, Mr. Johnson and his staff evaluated releases of petroleum hydrocarbons and other chemicals since 1914 at a large refinery on San Francisco Bay. This included studies of refinery history and operations by multiple owners and operators, evaluation of multiple sources of contamination related to ship loading and unloading, handling, piping, processing and storage of crude oil and petroleum products. Mr. Johnson provided expert testimony regarding sources and timing of contamination, volumes of petroleum released to the environment, and methods for remediation.

Petroleum Refinery, Bakersfield, CA – This litigation case involved releases of petroleum products and MtBE from a refinery and associated distribution terminal adjacent to a mixed commercial, industrial and residential area. MtBE was detected in water supply wells serving the residential area. Mr. Johnson was retained by Shell Oil Company, former refinery owner, to assess environmental impacts from the refinery and the occurrence and migration of MtBE in soil and groundwater. Using historic groundwater flow data, groundwater quality data and the relative distribution of petroleum hydrocarbons and MTBE, Mr. Johnson was able to determine the sources and timing of contamination at the site and impacts to offsite wells, resulting in a favorable settlement for the client.

Service Station/MtBE Experience

Confidential Client, U.S. – Mr. Johnson has represented a confidential oil company involved with litigation over environmental impacts of MtBE releases from service stations at hundreds of locations in several states. This work has included evaluation of sources and timing of MtBE impacts to groundwater from service stations operated by a large number of parties at multiple locations, and potential impacts to public water supplies. Additional work has included evaluation of remedial technologies for MtBE contamination and assessment of natural attenuation mechanisms for MtBE.

Multiple Stations, CA, NV, OR, WA – Mr. Johnson was retained by Texaco Oil Company to represent them in a large arbitration involving environmental claims regarding the exchange of more than 250 service stations with Exxon. The arbitration was conducted by JAMS in San Francisco and involved more than 10 hearings over a two-year period before three former federal judges. Each arbitration hearing involved 4-6 sites, with issues including the timing and sources of contamination by petroleum hydrocarbons and MtBE. Mr. Johnson prepared expert reports for each site and provided expert testimony in each arbitration hearing.

Multiple Stations, Northern CA – BP Oil Company retained Mr. Johnson to represent them in an arbitration with Tosco Oil Company to evaluate relative contributions of petroleum hydrocarbons and MtBE in soil and groundwater at several service stations in the San Francisco Bay area. . Mr. Johnson assisted BP in developing a strategy to allocate responsibility for MTBE and petroleum impacts and provided expert testimony in the arbitration hearing.

Sacramento, CA – Mr. Johnson represents Shell Oil Company in a litigation involving a former service station in Sacramento, CA. The primary issues involve the sources and timing of MtBE release, the extent of MtBE migration and the appropriateness of Shell's remedial actions.

MtBE Groundwater Vulnerability Pilot Study, CA – Mr. Johnson was program manager for one the first U.S..Studies of methyl-tert-butyl ether (MtBE) releases at operating gasoline service stations. This study, funded by the Santa Clara Valley Water District, evaluated hydrogeologic conditions and the occurrence of MtBE in soil and groundwater beneath 28 operating service stations. The study provided valuable information to industry and regulatory agencies regarding the effectiveness of recently-upgraded petroleum piping and containment systems at operating service stations. MtBE was detected in groundwater at approximately half of the stations.

Superfund/CERCLA and State Superfund Experience

Multiple CERCLA Superfund Sites – CA, IL, FL

Mr. Johnson has directed and managed multiple projects at federal superfund sites in multiple states, including California, Illinois, and Florida. This includes assessment of remedial investigations (RI), risk, feasibility studies (FS) and remedial actions for chlorinated solvents in soil and groundwater, such as the Intersil-Siemens Site, the Gencorp-Aerojet Superfund Site, the San Fernando Valley Superfund site; the San Bernardino Superfund Site, and the San Gabriel Valley Superfund Site in California; and the Acme Solvents Superfund Site, in Illinois. Other projects include site investigation and remediation of metals in groundwater at the Reeves Superfund Site, in Florida.

PCB Disposal Sites, Bloomington, IN

Mr. Johnson represented USEPA and the Department of Justice in litigation involving Westinghouse Corporation and the disposal of wastes containing PCBs at multiple locations in the Bloomington, IN area. PCB-containing liquids and solid wastes were placed in landfills and other locations in an area of highly permeable and weathered karst limestone. Sampling of soil, sediment, groundwater, and surface water indicate extensive occurrence of PCBs in soils, surface water and groundwater. The primary concern was the occurrence of highly permeable karst limestone, containing large fissures, sinkholes and caves, which facilitated the movement of PCBs into groundwater and to sediments, springs and nearby surface water. Mr. Johnson provided expert testimony regarding the occurrence of PCBs in the environment and methods to contain PCB-contaminated soil and groundwater. The work includes evaluating groundwater/surface-water interaction; delineating the extent of PCB contamination of sediment; the extent of groundwater and surface-water quality impacts; and evaluation of groundwater recharge and waste isolation.

Former Radioactive Material Processing Facility – West Chicago, IL

Expert hydrogeologist for State of Illinois in assessment of hydrogeologic conditions and investigation of radioactive thorium, radium and uranium releases at a former chemical processing plant located in a residential area. The investigation focused on shallow and deep groundwater flow patterns, groundwater/surface-water interaction, and natural attenuation processes for radionuclides in soil and groundwater, and possible migration to nearby water supply wells. Additional issues included the off-site use of radioactive fill material from the plant at locations throughout the residential community. Mr. Johnson provided expert testimony in Illinois Superior Court regarding hydrogeologic conditions, the occurrence and extent of radionuclide migration in soil and groundwater, and the effectiveness of proposed remedial measures.

Hazardous Chemical and Radioactive Waste Disposal Sites - Illinois

Mr. Johnson served as expert hydrogeologist and program manager for the State of Illinois, Department of Nuclear Safety, USEPA and the Illinois Environmental Protection Agency to evaluate possible releases of hazardous chemical wastes and radioactive wastes from chemical waste landfills and low-level radioactive waste disposal sites in Illinois. This included a comprehensive study of the failure mechanisms resulting in the migration of chemical wastes from the Wilsonville, IL Hazardous Waste Disposal site. Following extensive litigation, courts ruled that the more than 86,000 containers of wastes at the state-permitted Wilsonville disposal site be excavated and removed from the site to another more secure facility. During the approximate 2-year waste excavation and removal process, Mr. Johnson directed a USEPA-funded program to investigate the nature of chemical releases from the facility and the failure mechanisms that enabled solvents and other chemicals to unexpectedly escape from the site.

Other such sites include assessment of releases of radioactive materials from the state-permitted Sheffield Low Level Radioactive Waste Disposal site, in Princeton, IL. On behalf of the Illinois Department of Nuclear Safety, Mr. Johnson evaluated hydrogeologic conditions and the migration of radioactive tritium, cesium and other chemicals in groundwater at the site. Studies showed that the emplacement of wastes in unsaturated soils was not sufficient to prevent radionuclide migration from the site. Further studies directed by Mr. Johnson and funded by the U.S. Nuclear Regulatory Commission confirmed that improvements were needed to waste containment systems, including covers and liners, to isolate radioactive wastes.

Sanitary Landfill Experience

Evaluation of Sanitary Landfills - Illinois

Mr. Johnson directed a research program at the Illinois State Geological Survey to evaluate the performance of sanitary landfills and other waste disposal sites in Illinois. This program included field studies of existing sanitary landfills in various hydrogeologic settings throughout the state to evaluate whether contaminants from the landfill was being released to the environment. This included site investigations and groundwater monitoring at multiple landfill sites to determine whether landfill leachate had impacted the underlying soil and groundwater. Mr. Johnson also was one of the first researchers in the U.S. to study the migration of landfill leachate through the unsaturated (vadose) zone beneath sanitary landfills. Mr. Johnson also was principal investigator for USEPA and USNRC research programs to assess the performance of covers and liners for landfill sites. He has published many articles regarding this research.

Perchlorate Experience

Sacramento and Los Angeles Areas - California

Mr. Johnson and ARCADIS have provided litigation consulting services to multiple clients in California since 1991 on numerous projects involving soil and groundwater contamination by perchlorate. Many of projects and sites have involved volatile organic solvents and perchlorate from former rocket testing operations and related waste disposal sites. Mr. Johnson and ARCADIS have assisted clients in evaluating contaminant source locations, plume migration and developing remedial plans to address perchlorate and VOC migration in groundwater and impacts to public water supply wells. ARCADIS conducted critical evaluations of alternative sources of perchlorate, including natural sources. This includes perchlorate formed during chlorination of public water supplies, historical sources of perchlorate from natural nitrate deposits, and natural sources of perchlorate in arid environments. ARCADIS has evaluated alternative remedial actions, and conducted computer modeling of groundwater flow and perchlorate migration to evaluate the timing and sources of contamination. These projects have included evaluation of possible sources and migration of perchlorate and VOCs at USEPA Superfund sites, and evaluation of perchlorate and VOC impacts to groundwater in multiple groundwater basins in southern California. ARCADIS has conducted extensive computer modeling to evaluate groundwater flow and possible perchlorate and VOC impacts to off-site public water supply wells. Mr. Johnson has worked as an expert on multiple large litigation cases and provided expert testimony in state court and California regulatory hearings regarding potential impacts of perchlorate on groundwater supplies.

Perchlorate Remediation

Technology Overview Document – Perchlorate: Overview of Issues, Status, and Remedial Options, prepared by the Interstate Technology & Regulatory Council, Perchlorate Team, September 2005. Team member.

National Aeronautics and Space Administration (NASA) – Cape Canaveral, FL

ARCADIS was selected by NASA in 2003 as a primary contractor at Cape Canaveral to investigate and remediate environmental impacts resulting from the U.S. space program. This work has included investigation and evaluation of possible impacts by VOCs and perchlorate on soil and groundwater. ARCADIS has assisted NASA in assessing the impacts of contamination and devising remedial action plans.

Groundwater Resource and Water Supply Experience

Water Rights Evaluation – Sacramento, CA

Evaluation of groundwater flow and surface water-groundwater interaction in the American River, Sacramento, California. Mr. Johnson provided testimony to the California State Water Resources Control Board regarding groundwater-surface water interaction at a hearing involving water rights claims and disputes between multiple parties.

Recharge and Surface Water-Groundwater Interaction – San Diego County, CA

Assessment of surface water conditions, groundwater flow, recharge and water quality impacts in large groundwater basin at U.S. Marine Corps Base – Camp Pendleton from 1940-2008. This included evaluation of historical stream flow and groundwater levels, and assessment of impacts of urbanization, agricultural land use and military site use on surface water and groundwater quality. Mr. Johnson provided expert testimony in Los Angeles federal court that assisted the client in obtaining a successful verdict for the clients, Eastern Municipal Water District and Rancho California Water District.

Groundwater Basin Assessment - Santa Clara Valley, CA

Evaluation of hydrogeology, groundwater conditions, surface water-groundwater conjunctive use, and groundwater recharge in the southern Santa Clara Valley. This included study of groundwater basin boundaries and interaction with adjacent groundwater basins for the Santa Clara Valley Water District. Mr. Johnson provided expert testimony on these subjects in state court

Litigation Support and Expert Testimony

Mr. Johnson has served as an expert witness in numerous litigation cases involving a wide range of issues. He has testified in state and federal court on multiple occasions in both bench and jury trials, and has testified in arbitration and mediation hearings, and in legislative and regulatory agency hearings. He has represented public and private sector clients and has worked with law firms throughout the U.S. Areas of expert testimony have included the nature, sources and timing of environmental impacts to soil and groundwater, hydrogeologic conditions and groundwater flow, water balance, remedial investigations, evaluation and costs of remedial actions, computer modeling of groundwater flow and contaminant migration, aerial photograph interpretation, vadose zone contaminant migration, vapor intrusion, human health and environmental risk assessment, and regulatory interaction. A list of cases in which Mr. Johnson has provided expert testimony follows, with information regarding the client, a case citation and the client law firm(s).

Selected Publications

Zuckerman, T.I., T.J. Bois and T.M. Johnson. 2010. *Environmental Liability Allocation: Law and Practice*. Thomson West Publishers, Environmental Law Series, St. Paul, MN. 1260 p.

Zuckerman, T.I., T.J. Bois and T.M. Johnson. 2009. *Environmental Liability Allocation: Law and Practice.* Thomson West Publishers, Environmental Law Series, St. Paul, MN. 1160 p.

Zuckerman, T.I., T.J. Bois and T.M. Johnson. 2008. *Environmental Liability Allocation: Law and Practice.* Thomson West Publishers, Environmental Law Series, St. Paul, MN. 1100 p.

Zuckerman, T.I., T.J. Bois and T.M. Johnson. 2007. *Environmental Liability Allocation: Law and Practice.* Thomson West Publishers, Environmental Law Series, St. Paul, MN. 1067 p.

Johnson, T.M. and J.S. Seyfried. 2006. Forensic Investigation of Sources of Perchlorate in Water-Supply Wells: A Case Study. National Groundwater Association, Western Focus Conference, San Francisco, CA. Abstracts. May 2006.

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Johnson, T.M. 2003. Forensic Evaluation of Contamination by Solvents Originating from Coatings Used in Public Water Supply Storage and Distribution Facilities: International Society of Environmental Forensics, San Diego, CA, Abstracts. November 2003.

Johnson, T.M. 2003. Forensic Evaluation of Contaminant Sources and Migration in a Regional Superfund Site: Univ. of California-Water Resources Center, California Groundwater Resources Association of California Biennial Meeting, Anaheim, CA, Abstracts. October 2003.

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Johnson, T.M., et al., 1999. Decision-Making in the U.S. Department of Energy's Environmental Management Office of Science and Technology: National Research Council, Committee on Prioritization and Decision-Making in the Department of Energy Office of Science and Technology. National Academy Press, Washington, D.C., 215 p.

Beatty, J.J., J.S. Seyfried, T.M. Johnson, and E.M. Nichols, 1999. Summary Report: Groundwater Vulnerability Pilot Study. Investigation of MtBE Occurrence Associated with Operating UST Systems: Santa Clara Valley Water District. ARCADIS Levine·Fricke, Emeryville, California. Three volumes; July 22, 1999.

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Presentations

"From ASR to CPR: California Groundwater Issues and Legislative Activities," Industrial Environmental Coalition of Orange County, Orange, California

"Litigation in Paradise: The Case of the Disconnected UST and The Role of the Hydrogeologist as an Expert Witness in Environmental Litigation" California Groundwater Resources Association, San Joaquin Valley Branch Meeting, Fresno, California

"MtBE – Impacts and Remediation" California Ground Water Association, Annual Meeting Seminar, Monterey, California.

"Environmental Sampling Techniques: Implications for Cost Allocation Litigation," Los Angeles County Bar Association, Environmental Law Section Seminar, Los Angeles, California.

"Litigation and Expert Witness Services," Groundwater Resources Association of California, Oakland, California.

"Environmental Remediation: New Technologies and Old Limitations," Purdue University School of Civil Engineering and the Environmental Science and Engineering Institute (ESEI) at Purdue, West Lafayette, Indiana.

"Innovative In Situ Environmental Remediation Technologies: Recent Developments." Keynote Address at Groundwater Studies, Tools, and Technology Symposium, Groundwater Division of The Water Management Association of Ohio, Columbus, Ohio.

"Innovative In Situ Environmental Remediation Technologies – Recent Developments," Environmental Clean Up: Litigation, Legislation and Technological Innovation Conference, sponsored by The Bar Association of San Francisco, California.

"The Role of the Expert Witness in Environmental Litigation," Florida Air and Waste Management Association Annual Meeting, Sandestin, Florida.

"Groundwater Hydrology: Theory, Monitoring and Remediation," University of California at Davis - Extension, Continuing Course Series.

"Site Assessment and Remediation," University of California at Berkeley - Extension, Continuing Course Series.

"Unsaturated Zone Monitoring and Remedial Actions," University of California at Davis - Extension, Continuing Course Series.

"Corrective Actions for Containing and Controlling Groundwater Contamination," National Ground Water Association, Continuing Course Series.

"Theory and Practice of Groundwater Monitoring and Sampling," National Groundwater Association, Continuing Short Course Series.

"Groundwater Pollution Remedial Actions," University of California at Davis Extension, Continuing Seminar Series.

"Groundwater Monitoring," U.S. EPA seminar: Transport of Viruses and Organics in the Subsurface, Ada, Oklahoma.

"Geologic Considerations in Hazardous Waste Disposal," Univ. of Wisconsin-Extension, Dept. of Engineering: Hazardous Waste Management Practices Institute, Madison, Wisconsin.

"Monitoring the Unsaturated Zone," Conference on Environmental Monitoring, sponsored by Geraghty and Miller, Inc., Arlington, Virginia.

"Groundwater Monitoring for Landfills," Univ. of Wisconsin-Extension, Dept. of Engineering: Sanitary Landfill Site Selection and Design Institute, Madison, Wisconsin.

"Interpretation of Groundwater Monitoring Data Collected in the Vicinity of Landfills" and "Monitoring in the Unsaturated Zone," National Council of the Paper Industry for Air and Stream Improvement, Technical Workshop: Groundwater Quality Monitoring at Land Disposal Sites, Chicago, Illinois.

"Groundwater Contamination -- Remedial Actions," University of Wisconsin-Extension, Dept. of Engineering: Groundwater Quality Protection Institute, Madison, Wisconsin.

"Field Investigative Procedures and Remedial Measures Related to Groundwater Contamination," Univ. of Wisconsin-Extension, Dept. of Engineering: Seminar for Wisconsin Department of Natural Resources, Madison, Wisconsin.

"Modeling of Moisture Movement Through Covers Designed to Limit Infiltration at Waste Disposal Sites," U.S. Nuclear Regulatory Commission, Symposium on Low-Level Radioactive Waste Disposal, Washington, DC.

"Waste Disposal and Groundwater Contamination," Minnesota Groundwater Association, Minneapolis, Minnesota.

"Hydrogeologic Investigations of Failure Mechanisms and Migration of Organic Chemicals at Wilsonville, Illinois," National Ground Water Association, National Symposium on Aquifer Restoration and Ground Water Monitoring, Columbus, Ohio.

"Groundwater Monitoring and Sampling Technology," American Society for Testing and Materials (ASTM) Training Course Series.

List of Expert Witness Testimony Cases Involving Deposition/Trial/Arbitration Testimony

Date	Case (Client in bold)	Client Law Firm
2010	**Port LA Distribution Center,** et al. v. United National Insurance Company, Inc.: Deposition	Jones Day, San Francisco, CA
2009-2010	Robert C. Cook, Sr. v. **Shell Oil Company**, et al.: Deposition	Munger, Tolles & Olson, San Francisco, CA
2009-2003	City of Modesto v. **The Dow Chemical Co., et al.** (**Occidental Chemical Co.**): Depositions/Trials	Barg, Coffin, Lewis & Trapp, San Francisco, CA; Filice Brown Eassa & McLeod LLP, Oakland, CA
2009-2004	Starrh and Starrh Cotton Growers v. **Aera Energy LLC**: Depositions/Trials	Munger, Tolles & Olson, Los Angeles, CA
2008	Great Oaks Water Co. v. **Santa Clara Valley Water District:** Deposition/Trial	Duane Morris, San Francisco
2008	Safety-Kleen Envirosystems Company vs. **London Market Insurers, et al.**: Deposition	Duane Morris, San Francisco/Los Angeles, CA
2008-2007	U.S., et al. vs**. Eastern Municipal Water District**, et al.: Deposition/Trial	Bingham McCutchen, Los Angeles, CA
2006	**Grove Investment** v. Collins Radio, et al.: Deposition	Bois & Macdonald, Irvine, CA
2006-2005	Daphne Adams v. **Aerojet General Corporation**, et al.: Deposition/Trial	Nossaman Guthner Knox & Elliott, San Francisco, CA
2005	Martinelli v. Shoreline Disposal et al. (**Waste Management/County of Marin**): Deposition	Reed Smith, Oakland, CA
2005-2009	Adobe Lumber, Inc. v. Taecker, et al. (**Wells Fargo Bank**): Deposition	Heller Ehrman, San Francisco, CA

Date	Case (Client in bold)	Client Law Firm
2004	**Metropolitan Life Insurance Company** v. Control Components Inc., et al.: Deposition	Sedgwick Detert Moran & Arnold, San Francisco, CA
2004	Harvey Allen v. **Equilon Enterprises LLC**, et al.: Deposition	Munger, Tolles & Olson, San Francisco /Los Angeles, CA
2003	American States Water Company v. **Aerojet General**: Deposition	Nossaman, Guthner, Knox & Elliott, San Francisco, CA
2003	Randolph & Hein, Inc. v. **Joseph Brucia, et al:** Deposition	Barg, Coffin, Lewis & Trapp, San Francisco, CA
2002	**Glovatorium, Inc**. vs. Johnson et al: Deposition	Smiland & Khachigian, Los Angeles
2002	Dow Chemical Co. vs. **Fireman's Fund, et al**: Deposition	Grippo & Elden, Chicago/Nixon Peabody, San Francisco, CA
2002	City of Martinez v. Texaco Trading/Trans, Inc. and **Equilon Pipeline Co.**: Deposition	McCutchen Doyle Brown & Enersen, San Francisco, CA
2002	United States of America v. Buena Vista Mines, Inc., et al (**San Luis Obispo County**): Deposition	Smiland & Khachigian, Los Angeles, CA
2001	**Varian Associates, Inc.** v. General Electric Co.: Deposition	Heller Ehrman White & McAuliffe, San Francisco, CA
2000	Pacific Indemnity v. County of San Diego (**ACE Insurance Co.**): Deposition	Chapin, Shea, McNitt & Carter, San Diego, CA
2000	Tosco Corporation v. Hartford Accident and Indemnity Company, et al. (**Joint Defense Group**): Deposition	Hancock, Rothert & Bunshoft et al. (**Joint Defense Group**) San Francisco, CA
1999-1997	Consolidated Electrical Distributors, Inc., v. J. Hebdon, et al. (**R. Grimsinger/Cigna Insurance Co.**): Deposition/Trial	McGahey & McGahey; Chapin, Fleming & Winet, San Diego, CA
1999	Roth, et al. v. **Texaco Refining and Marketing Inc.**, et al.: Deposition	McCutchen, Doyle, Brown & Enersen, Palo Alto, CA

Date	Case (Client in bold)	Client Law Firm
1998	Bridgestone/Firestone, Inc. v. First State Insurance Company, et al. (**International Insurance Co.**): Deposition	Thelen, Marrin, Johnson & Bridges, San Francisco, CA
1998	Roland, et al. v. Norris School District, et al. (**Occidental Chemical Corp.**): Deposition	Landels, Ripley & Diamond, San Francisco, CA
1997-1996	Pentagram Corp. v. **Property Reserve, Inc.**: Deposition/Trial	Case, Myrdahl, Bigelow & Lombardi, Honolulu, HI
1997-1995	FMC v. **Liberty Mutual**, et al.: Multiple Depositions/Trials (7)	Hancock, Rothert & Bunshoft, San Francisco, CA; Ropers, Majeski, Kohn & Bentley, CA: Nussbaum & Wald, Washington, DC
1997-1995	**Texaco Corp.** v. Exxon Corp.: Multiple Arbitrations (7)	Dewey Ballantine, Los Angeles, CA
1997	Brandeis/Bardin v. **Rockwell-Rocketdyne Corp**: Deposition	Munger, Tolles & Olson, Los Angeles, CA
1997	Cascade Corp. v. American Home Insurance et al. (**ERC/Lloyds Insurance**): Trial	Luce, Forward, Hamilton & Scripps; Hancock, Rothert & Bunshoft, San Francisco, CA
1996	**Siemens, Inc.** v. Litton Corp.: Deposition	Latham & Watkins, San Francisco, CA
1996	Lockheed Martin Corp. v. Crane Co., et al. (**PAC, Inc.**): Deposition/Trial	Allen, Matkins, Leck, Gamble & Mallory, Los Angeles CA
1994	**Los Angeles Unified School District** v. Gosman: Trial	O'Melveny/L.A. Superior Court-appointed expert, Los Angeles, CA
1994	**Spieker Partners** v. Montgomery Ward, et al.: Deposition/Arbitration	Ellman, Burke, Hoffman & Johnson, San Francisco, CA
1994	**Simi Valley Hospital** v. Safecare, Inc.: Deposition	McClintock, Weston, Benshoof, Rochefort, Rubalcava & MacCuish, Los Angeles, CA
1994	City of Concord v. **Spieker Partners:** Deposition/Arbitration	Ellman, Burke, Hoffman & Johnson, San Francisco, CA

Date	Case (Client in bold)	Client Law Firm
1993	**IMCERA** v. American Home Insurance Co., et al.: Deposition/Trial	Sidley & Austin, Los Angeles, CA
1993	Central Contra County Sanitation District v. **Woodward-Clyde Consultants**: Deposition	Confidential
1993	**Cadillac Fairview** v. Shell, Inc., Dow Chemical, United States: Deposition	Arnold & Porter, Los Angeles, CA
1992	City of Centralia, WA v. **Fireman's Fund Insurance**: Deposition	Kaufman & Logan, San Francisco, CA
1992	Pacific Asphalt v. **Chevron Pipeline**: Deposition	Crosby, Heafey, Roach & May, Oakland, CA
1991	**Prometheus Development** v. IMCERA, et al.: Deposition	Reed, Elliott, Creech & Roth, San Jose, CA
1990	**Sola Optical USA** v. Zurich Insurance: Deposition	Folger & Levin, San Francisco, CA
1989	**Confidential land owners**: Deposition	Pillsbury, Madison & Sutro, San Jose, CA
1984	**State of Illinois** v. Kerr-McGee Corp.: Deposition/Trial	State of Illinois, Attorney General
1984	**U.S.** v. Westinghouse Corp.: Deposition	U.S. Department of Justice

ATTACHMENT B

Not to Scale

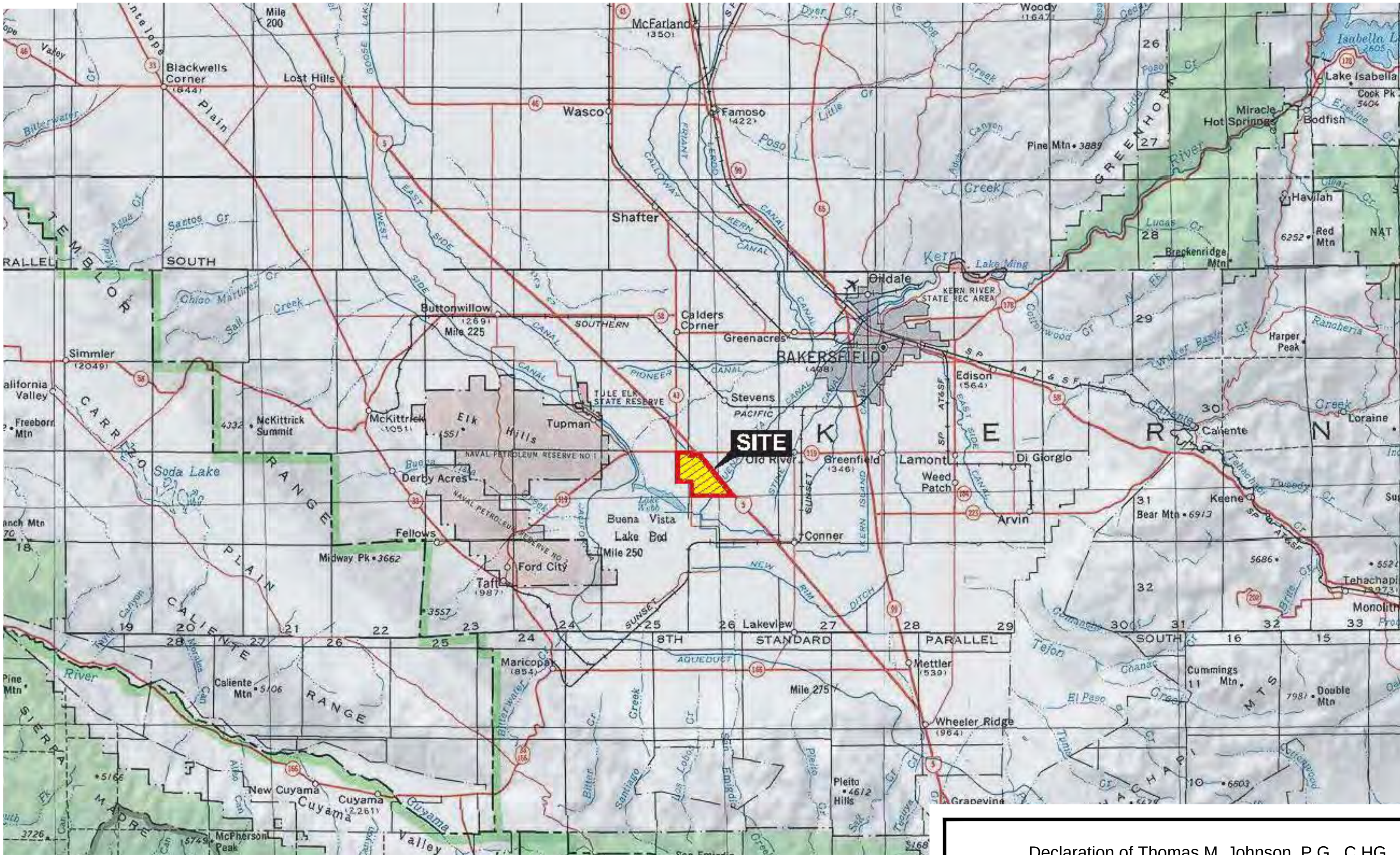
Declaration of Thomas M. Johnson, P.G., C.HG.
City of Los Angeles, et al. v. Kern County, et al.

LOCATION OF GREEN ACRES FARM

ARCADIS

FIGURE
1

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\Roseville-CA\ACT\RV009848\0000\00001\DWG\RV0098480000 B01.dwg LAYOUT: 2 SAVED: 4/19/2011 10:22 AM ACADVER: 18.0S (LMS TECH) PAGESETUP: LTR LAND PLOTSTYLETABLE: KERN.CTB PLOTTED: 4/19/2011 10:23 AM BY: ROBITAILLE, BEVERLY



0 10 Miles

SOURCE: USGS California Topo Map

Declaration of Thomas M. Johnson, P.G., C.HG.
City of Los Angeles, et al. v. Kern County, et al.

VICINITY OF GREEN ACRES FARM

ARCADIS

FIGURE
2

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
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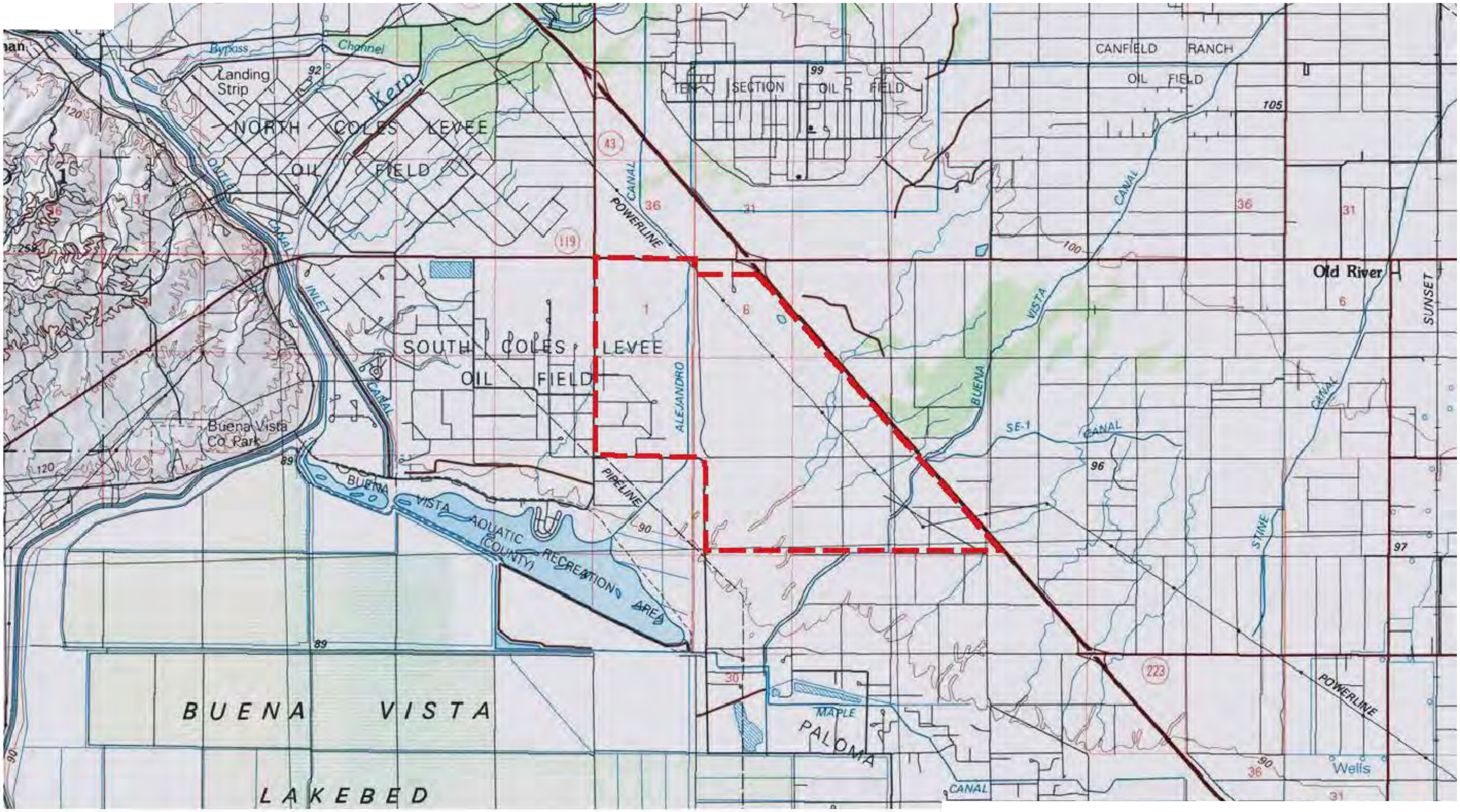


SITE BOUNDARY (APPROXIMATE)

0 1.5 Miles

SOURCE: USGS California Topo Map

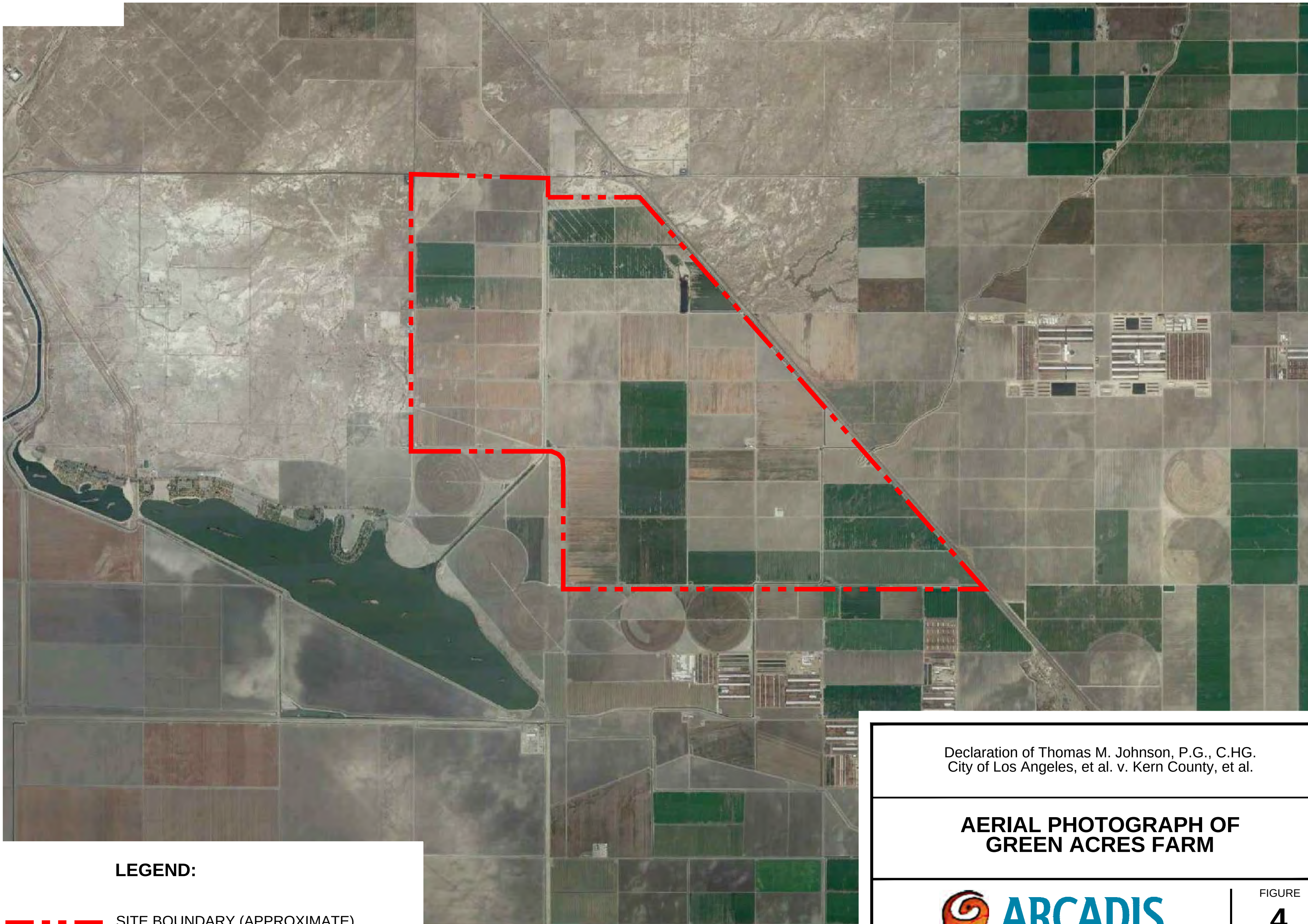
Declaration of Thomas M. Johnson, P.G., C.HG.
City of Los Angeles, et al. v. Kern County, et al.

TOPOGRAPHY SURROUNDING GREEN ACRES FARM

ARCADIS

FIGURE 3

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\Roseville-CA\ACT\RV009848\0000\00001\DWG\RV0098480000 B01.dwg LAYOUT: 4 SAVED: 4/19/2011 10:24 AM ACADVER: 18.0S (LMS TECH) PAGESETUP: LTR LAND PLOTSTYLETABLE: KERN.CTB PLOTTED: 4/19/2011 10:24 AM BY: ROBITAILLE, BEVERLY



LEGEND:

SITE BOUNDARY (APPROXIMATE)

SOURCE: GOOGLE EARTH PRO

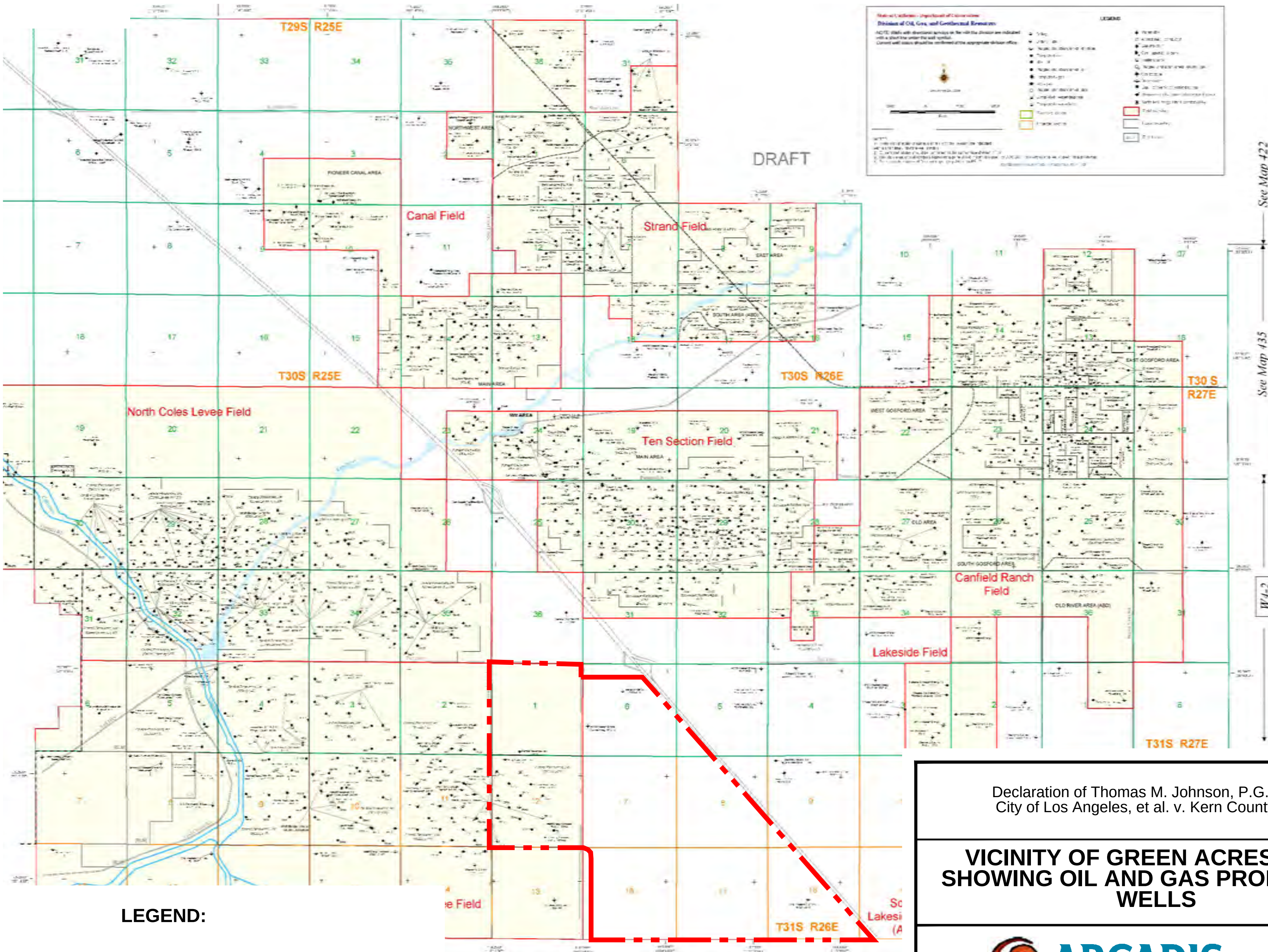
Declaration of Thomas M. Johnson, P.G., C.HG.
City of Los Angeles, et al. v. Kern County, et al.

AERIAL PHOTOGRAPH OF GREEN ACRES FARM

ARCADIS

FIGURE 4

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\Roseville-CA\ACT\RV009848\0000\00001\DWG\RV0098480000 B01.dwg LAYOUT: 5 SAVED: 4/19/2011 10:24 AM ACADVER: 18.0S (LMS TECH) PAGESETUP: LTR LAND PLOTSTYLETABLE: KERN.CTB PLOTTED: 4/19/2011 10:24 AM BY: ROBITAILLE, BEVERLY



LEGEND:

SITE BOUNDARY (APPROXIMATE)

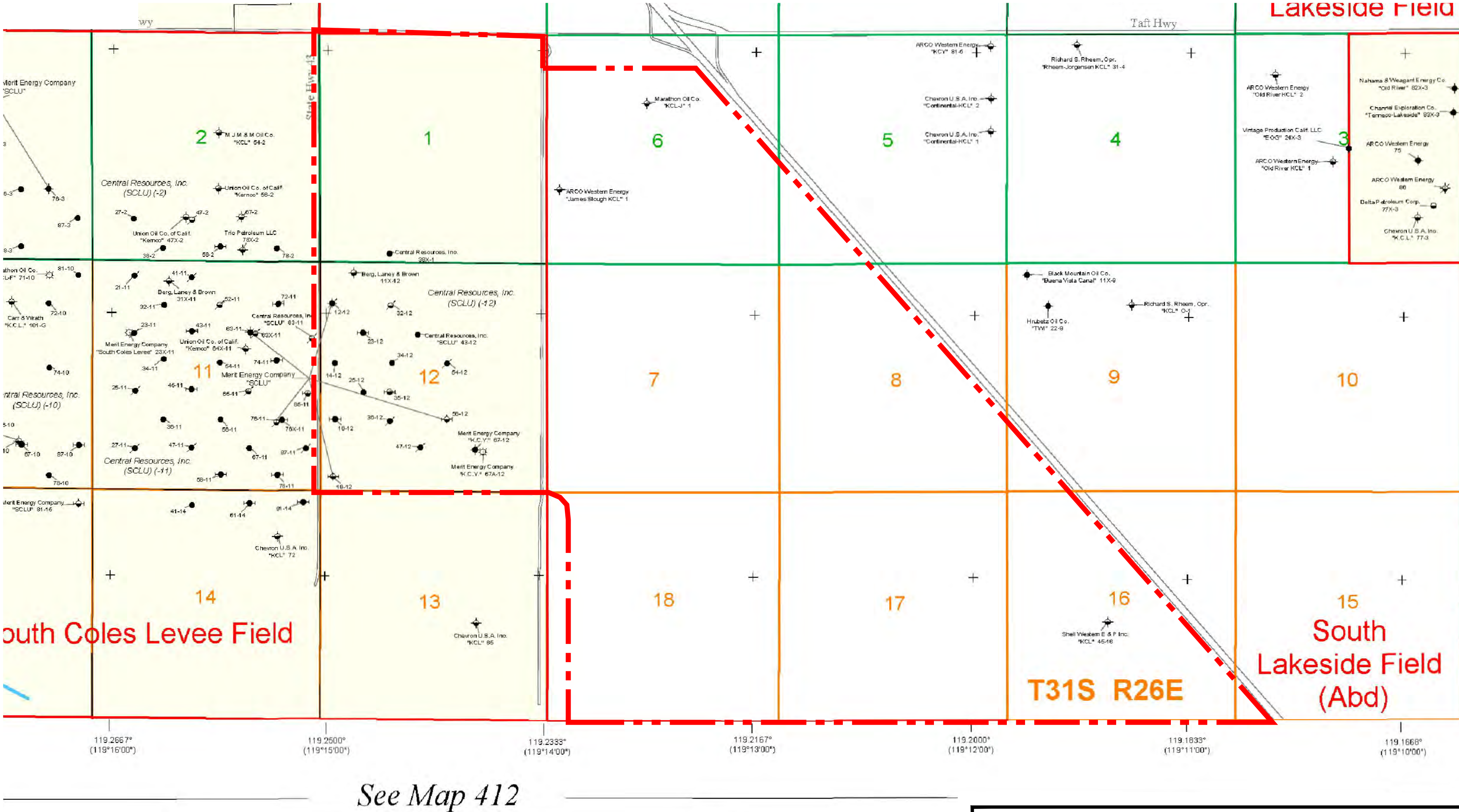
SOURCE: STATE OF CALIFORNIA, DEPT. OF CONSERVATION MAP 413

Declaration of Thomas M. Johnson, P.G., C.HG.
City of Los Angeles, et al. v. Kern County, et al.

VICINITY OF GREEN ACRES FARM SHOWING OIL AND GAS PRODUCTION WELLS

ARCADIS

FIGURE
5



LEGEND:

SITE BOUNDARY (APPROXIMATE)

SOURCE: STATE OF CALIFORNIA, DEPT. OF CONSERVATION MAP 413

Declaration of Thomas M. Johnson, P.G., C.HG.
City of Los Angeles, et al. v. Kern County, et al.

AREA SURROUNDING GREEN ACRES FARM SHOWING OIL AND GAS PRODUCTION WELLS

ARCADIS

FIGURE
6

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
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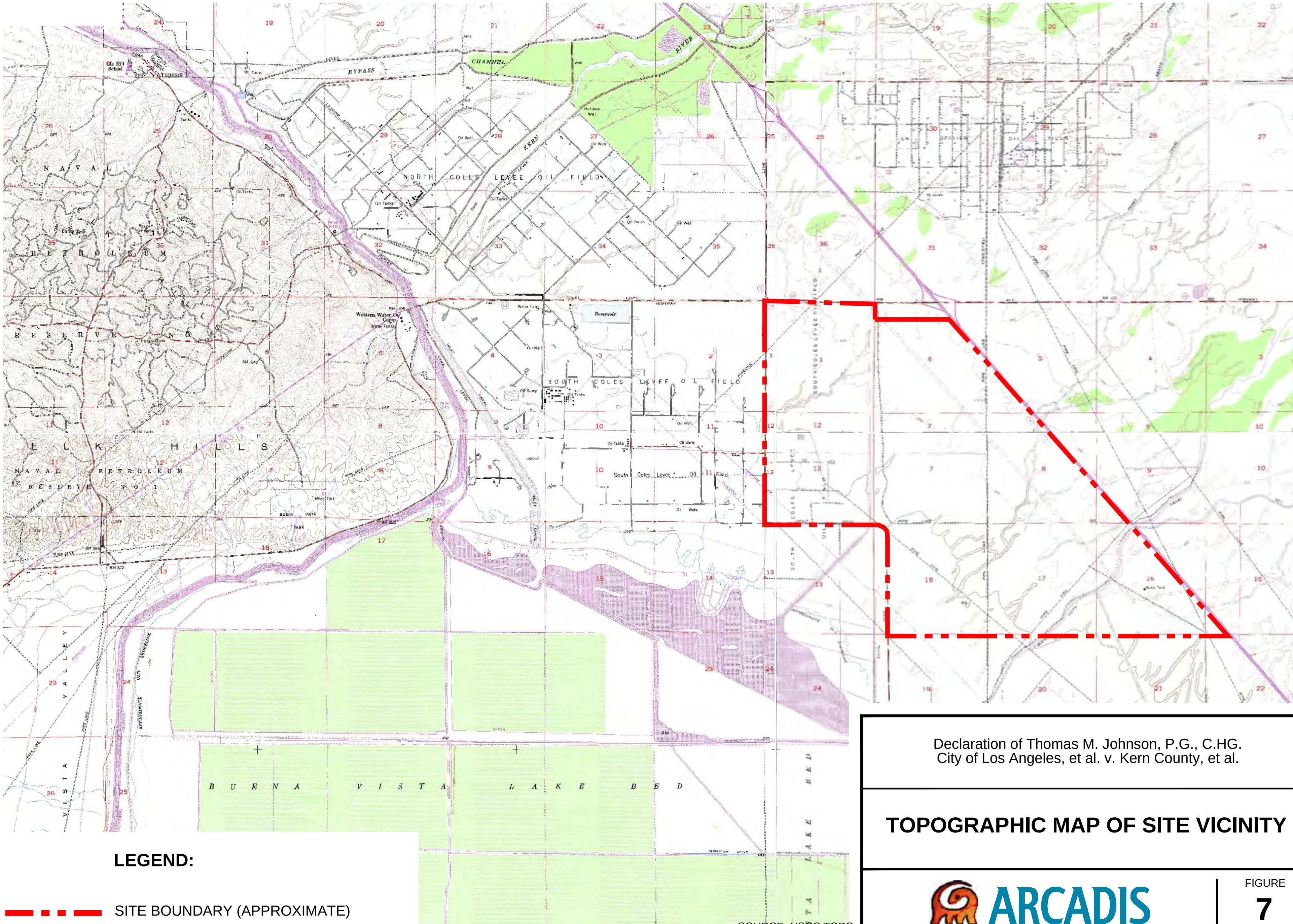


LEGEND:

SITE BOUNDARY (APPROXIMATE)

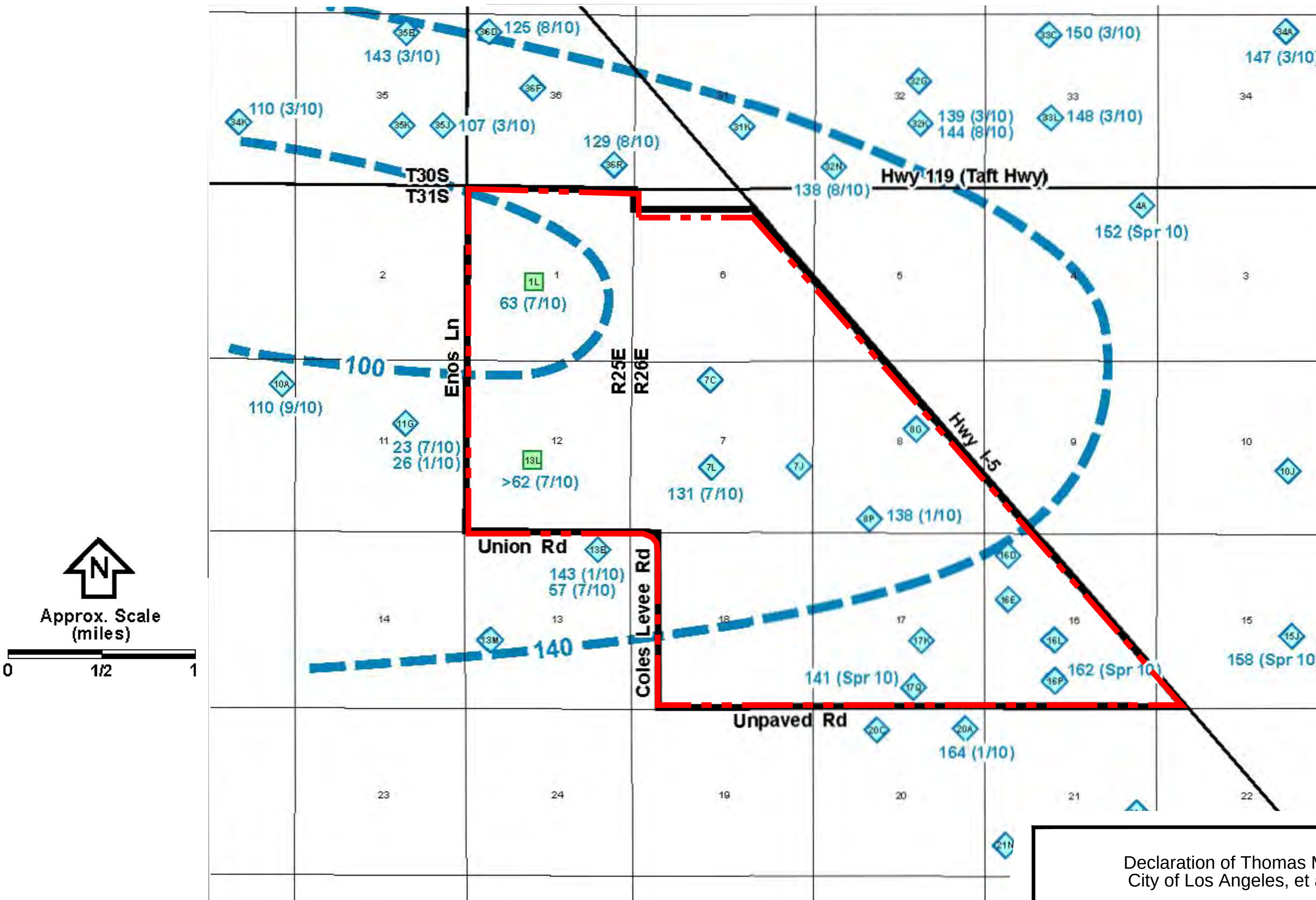
SOURCE: USGS TOPO

Declaration of Thomas M. Johnson, P.G., C.HG.
City of Los Angeles, et al. v. Kern County, et al.

TOPOGRAPHIC MAP OF SITE VICINITY

ARCADIS

FIGURE
7



Declaration of Thomas M. Johnson, P.G., C.HG.
City of Los Angeles, et al. v. Kern County, et al.

DEPTH TO GROUNDWATER AT THE GREEN ACRES FARM (OCTOBER 2010)

ARCADIS

FIGURE
8

LEGEND:

SITE BOUNDARY (APPROXIMATE)

140 DEPTH TO GROUNDWATER ISOPLETH IN FEET BELOW GROUND SURFACE, DASHED WHERE INFERRED

Note: This figure is generalized in nature and the scale, boundaries, and location are approximate. Originals of this figure are colorized.
SOURCE: GEOCON, FIGURE 5, DEPTH TO GROUNDWATER, OCTOBER 2010.

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
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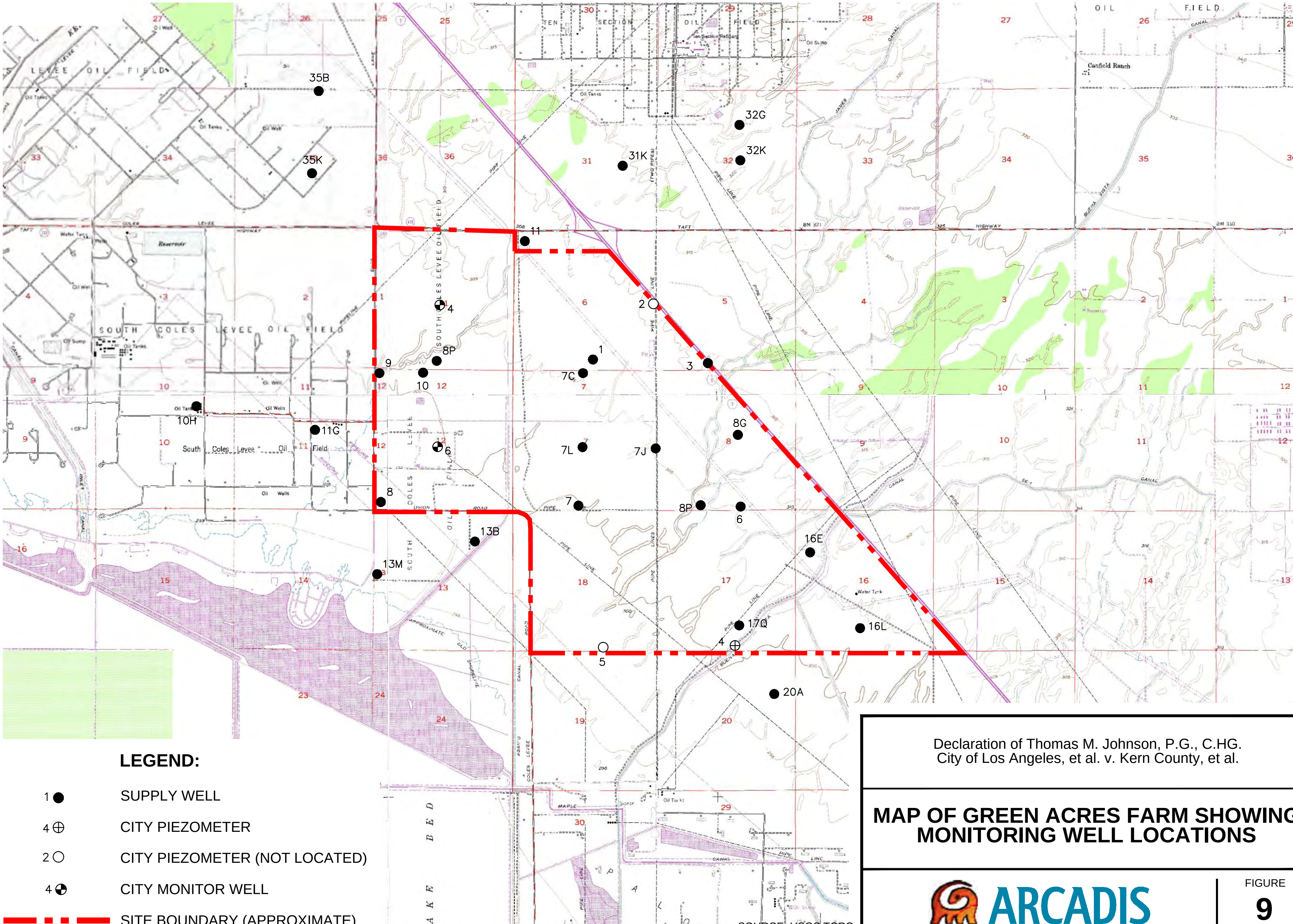


LEGEND:

1 ● SUPPLY WELL

4 ⊕ CITY PIEZOMETER

2 ○ CITY PIEZOMETER (NOT LOCATED)

4 ◕ CITY MONITOR WELL

SITE BOUNDARY (APPROXIMATE)

Declaration of Thomas M. Johnson, P.G., C.HG.
City of Los Angeles, et al. v. Kern County, et al.

MAP OF GREEN ACRES FARM SHOWING MONITORING WELL LOCATIONS

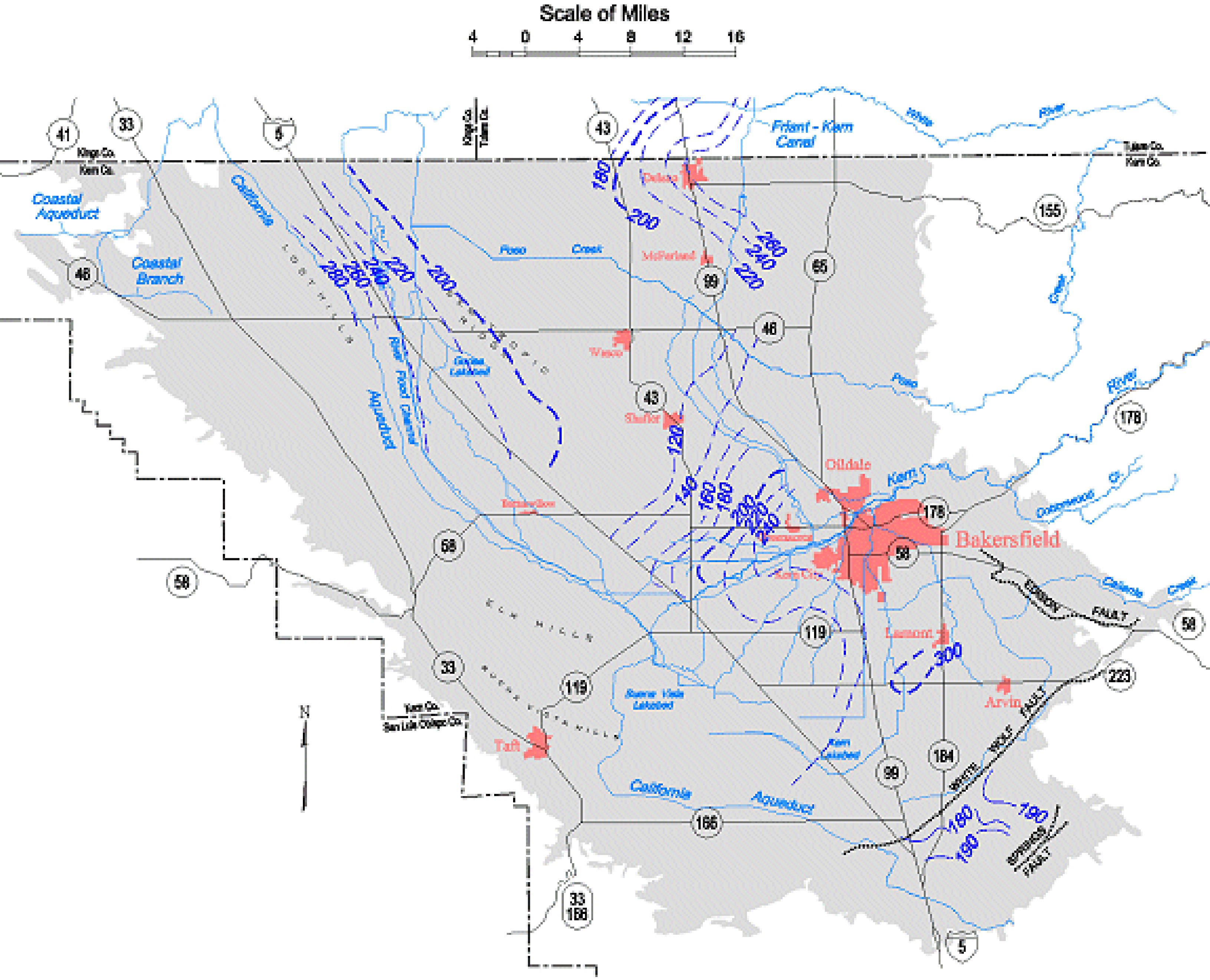
ARCADIS

FIGURE
9

ATTACHMENT C

Kern Groundwater Basin

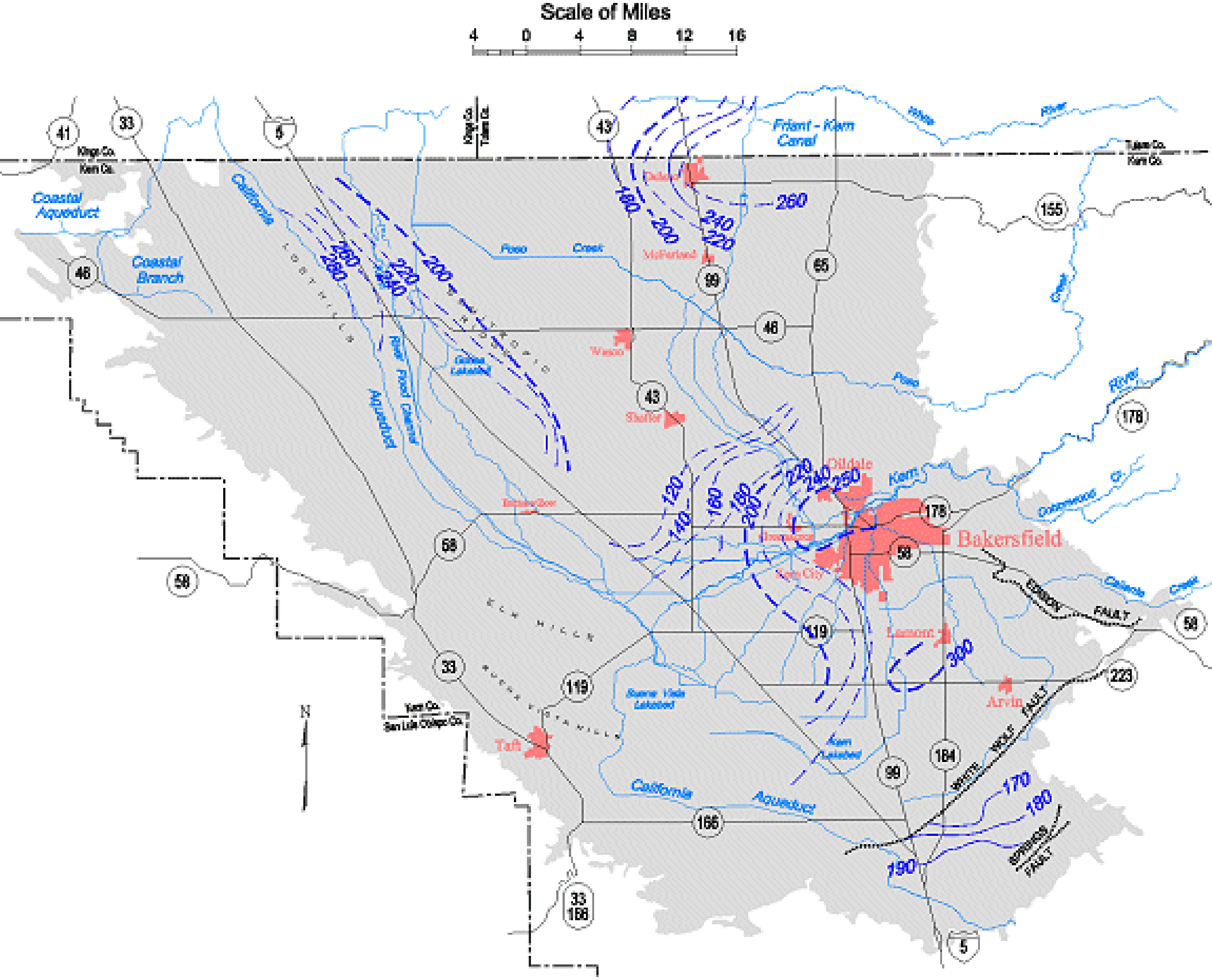
Spring 1990, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Kern Groundwater Basin

Spring 1991, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



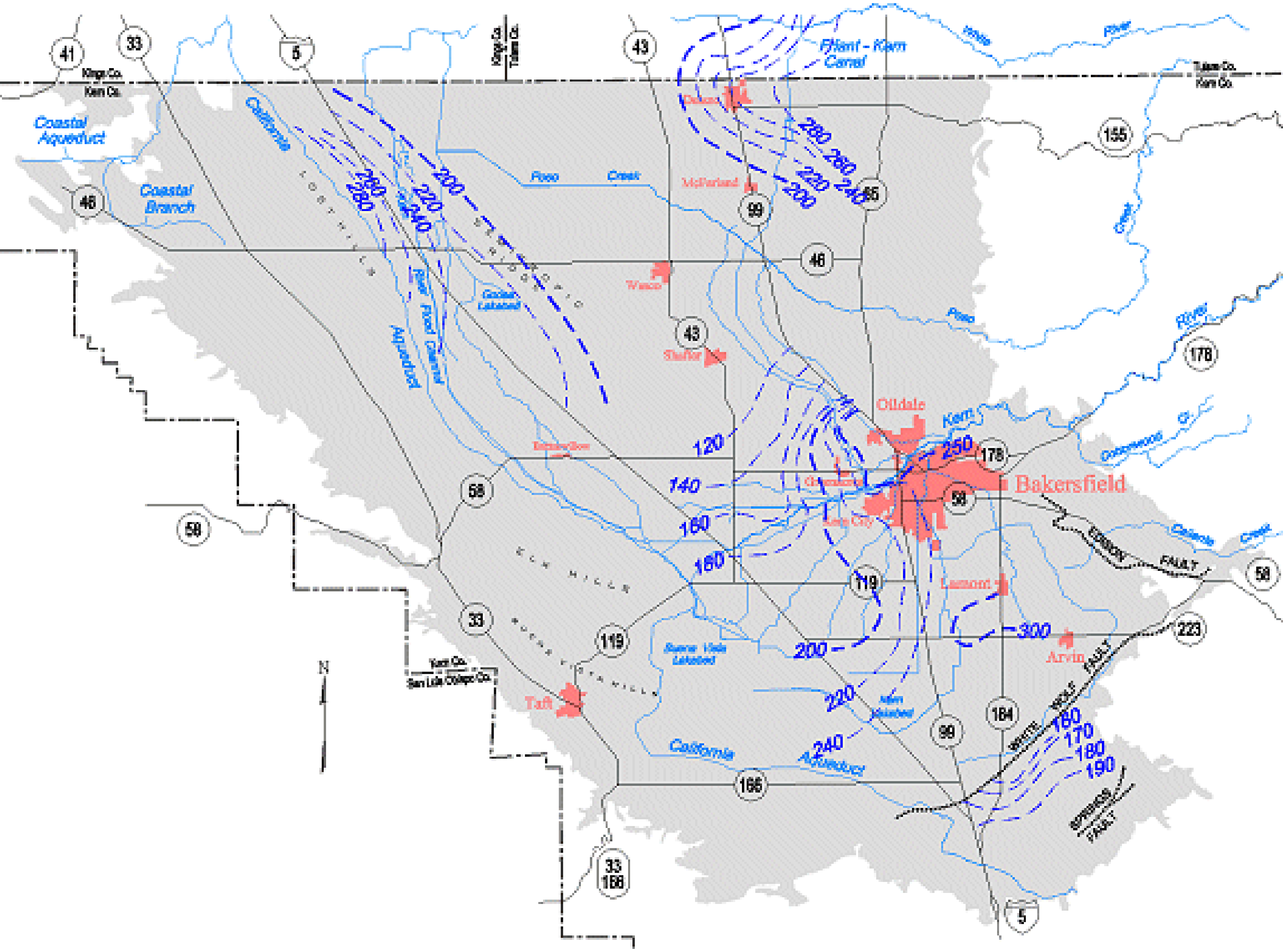
Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Kern Groundwater Basin

Spring 1992, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer

Scale of Miles

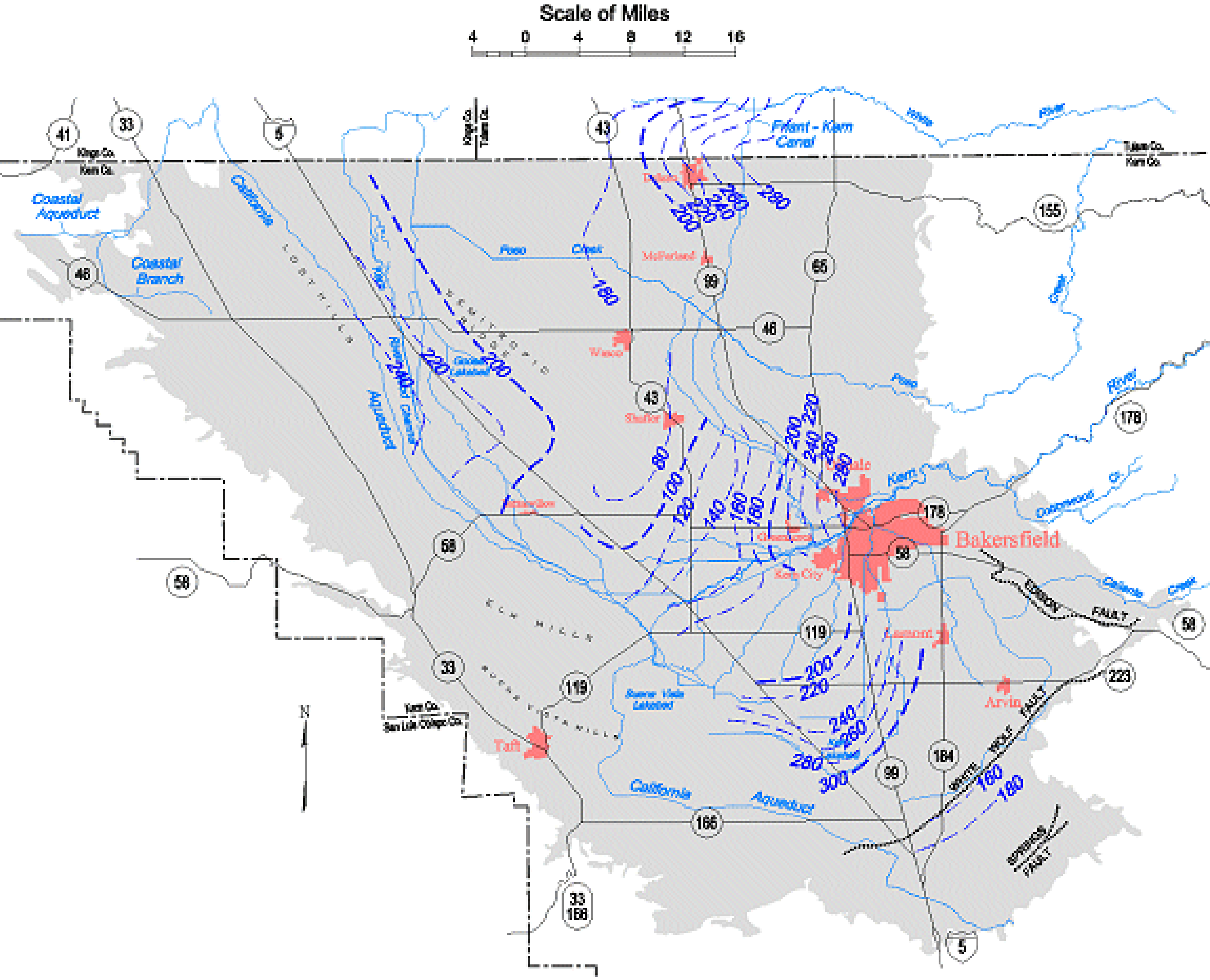
4 0 4 8 12 16



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Kern Groundwater Basin

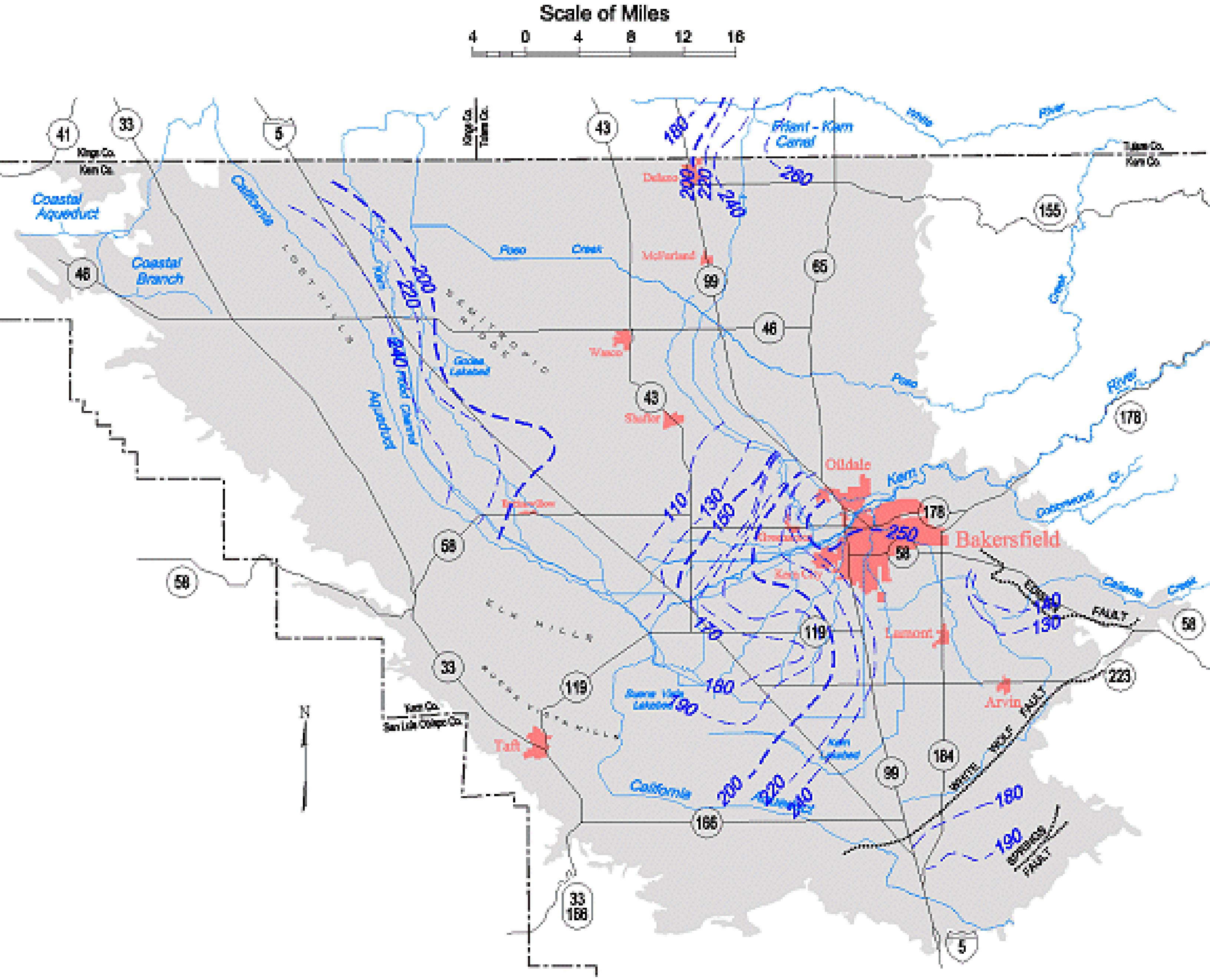
Spring 1993, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 20 feet.

Kern Groundwater Basin

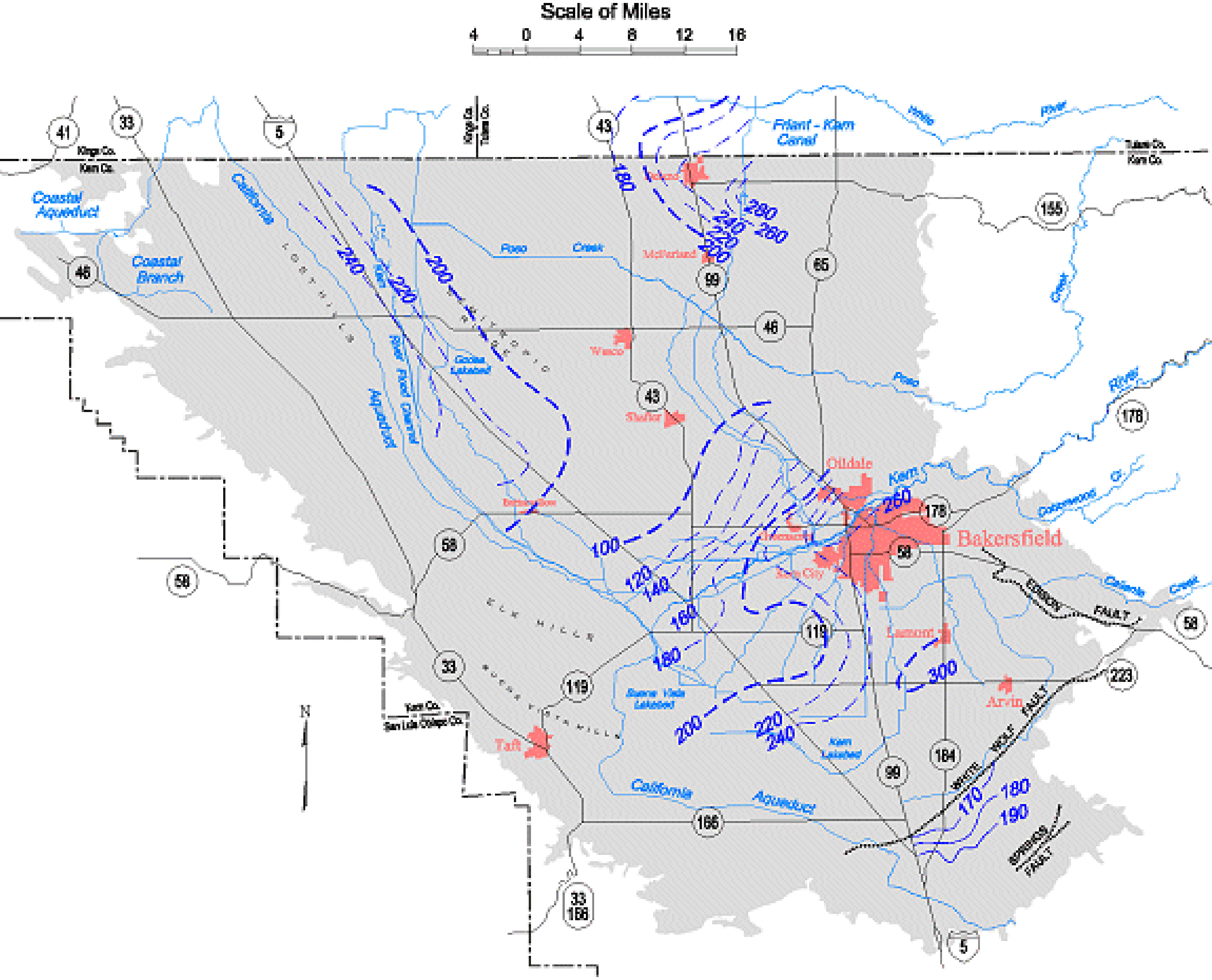
Spring 1994, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Kern Groundwater Basin

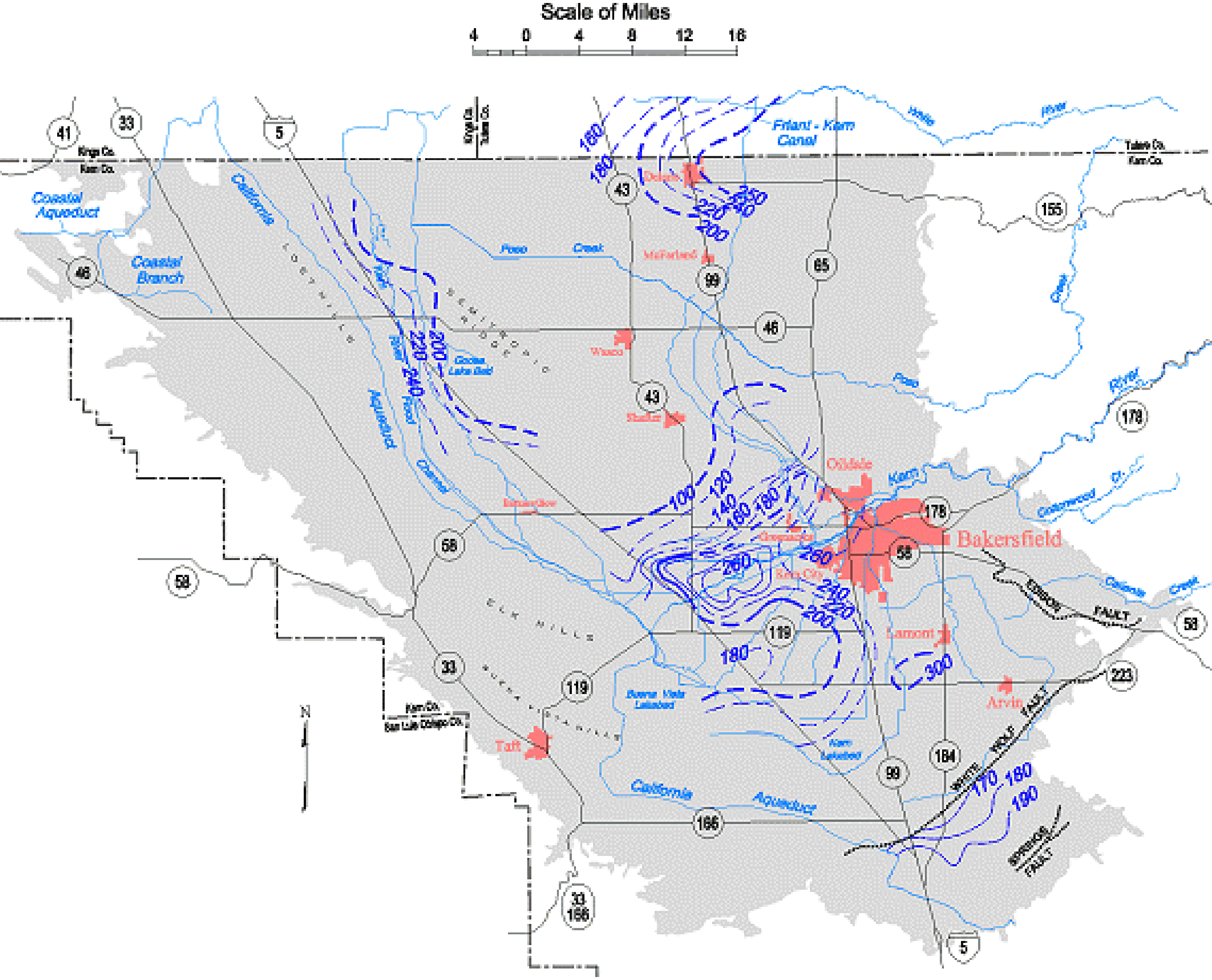
Spring 1995, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Kern Groundwater Basin

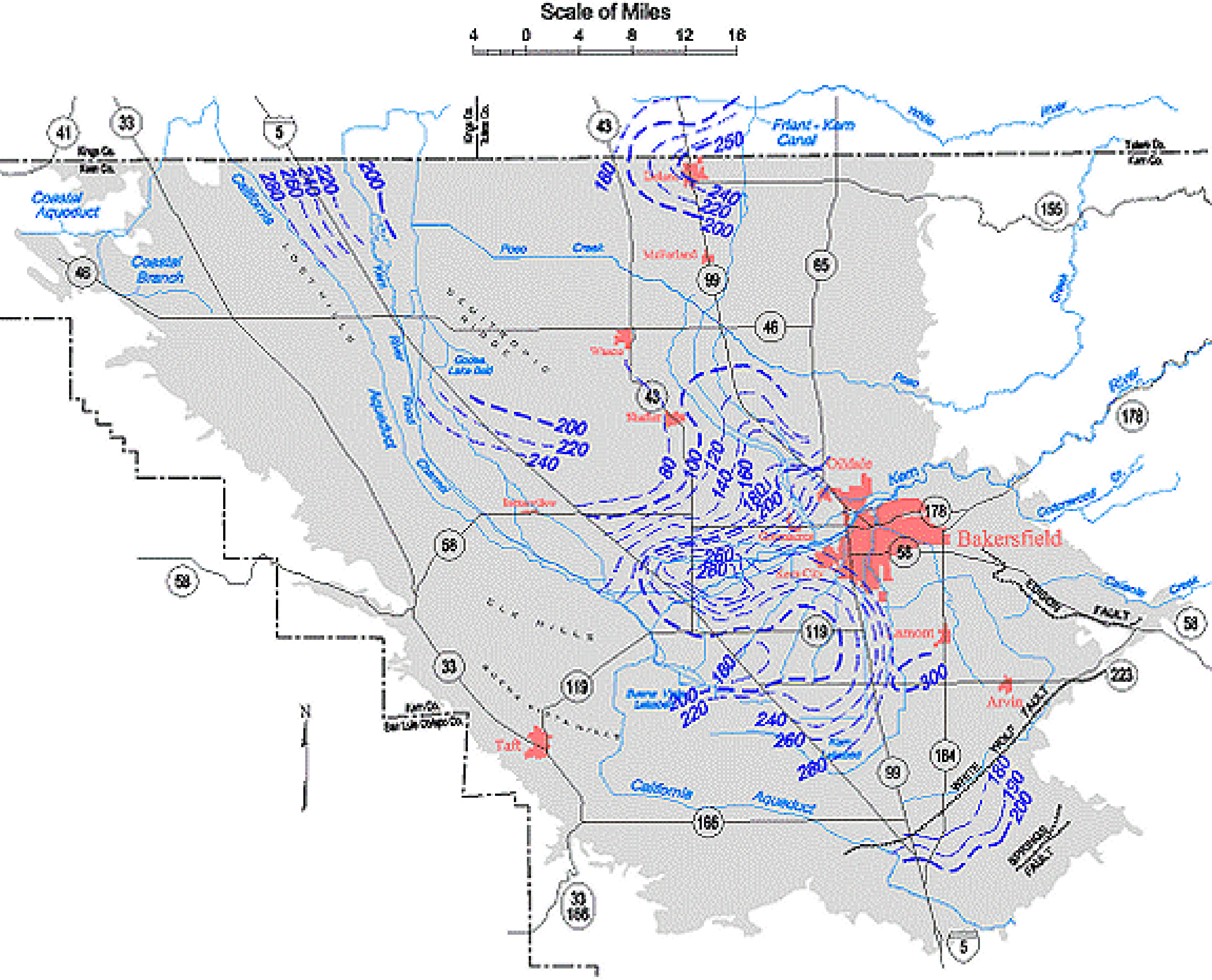
Spring 1996, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Kern Groundwater Basin

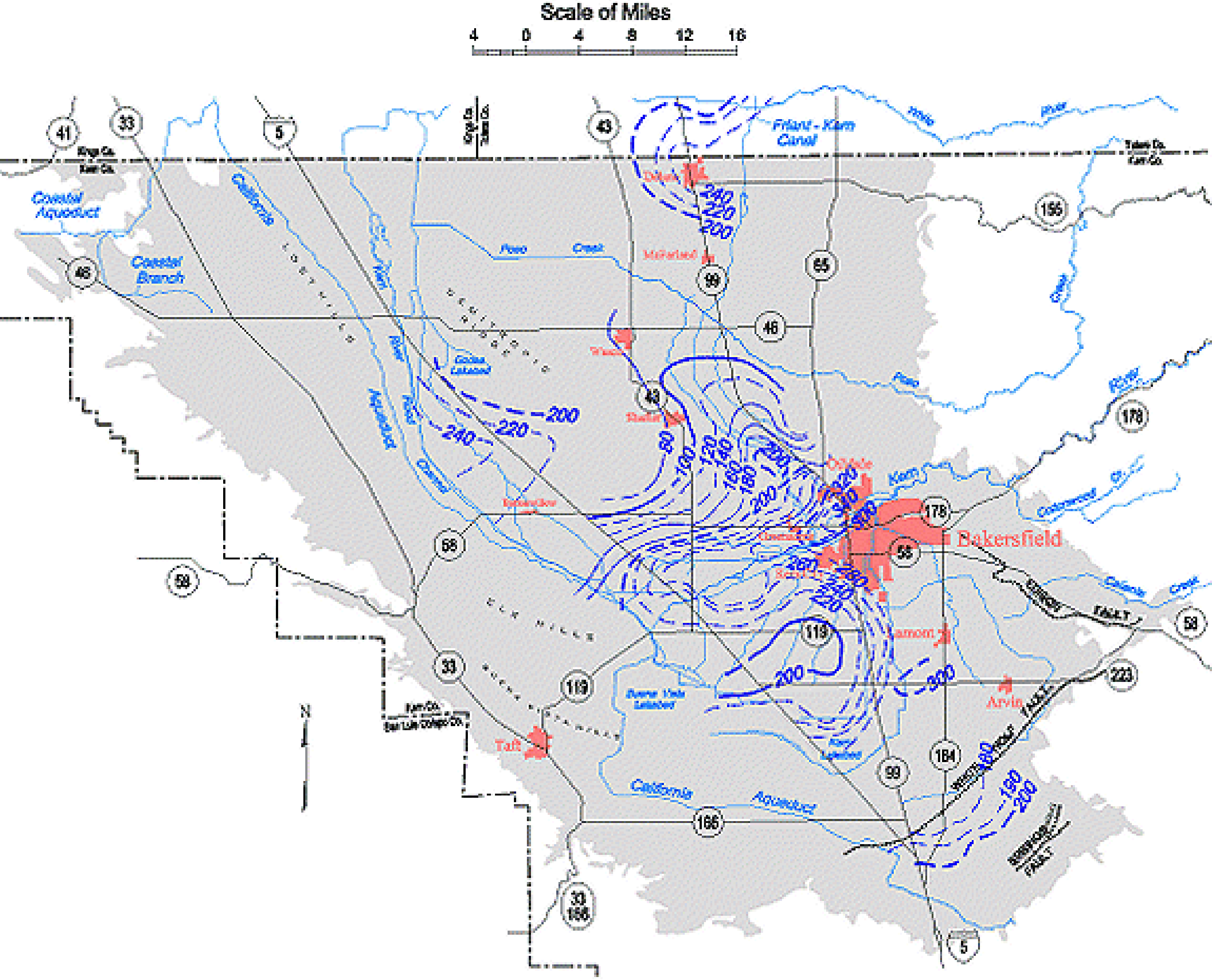
Spring 1997, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Kern Groundwater Basin

Spring 1998, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



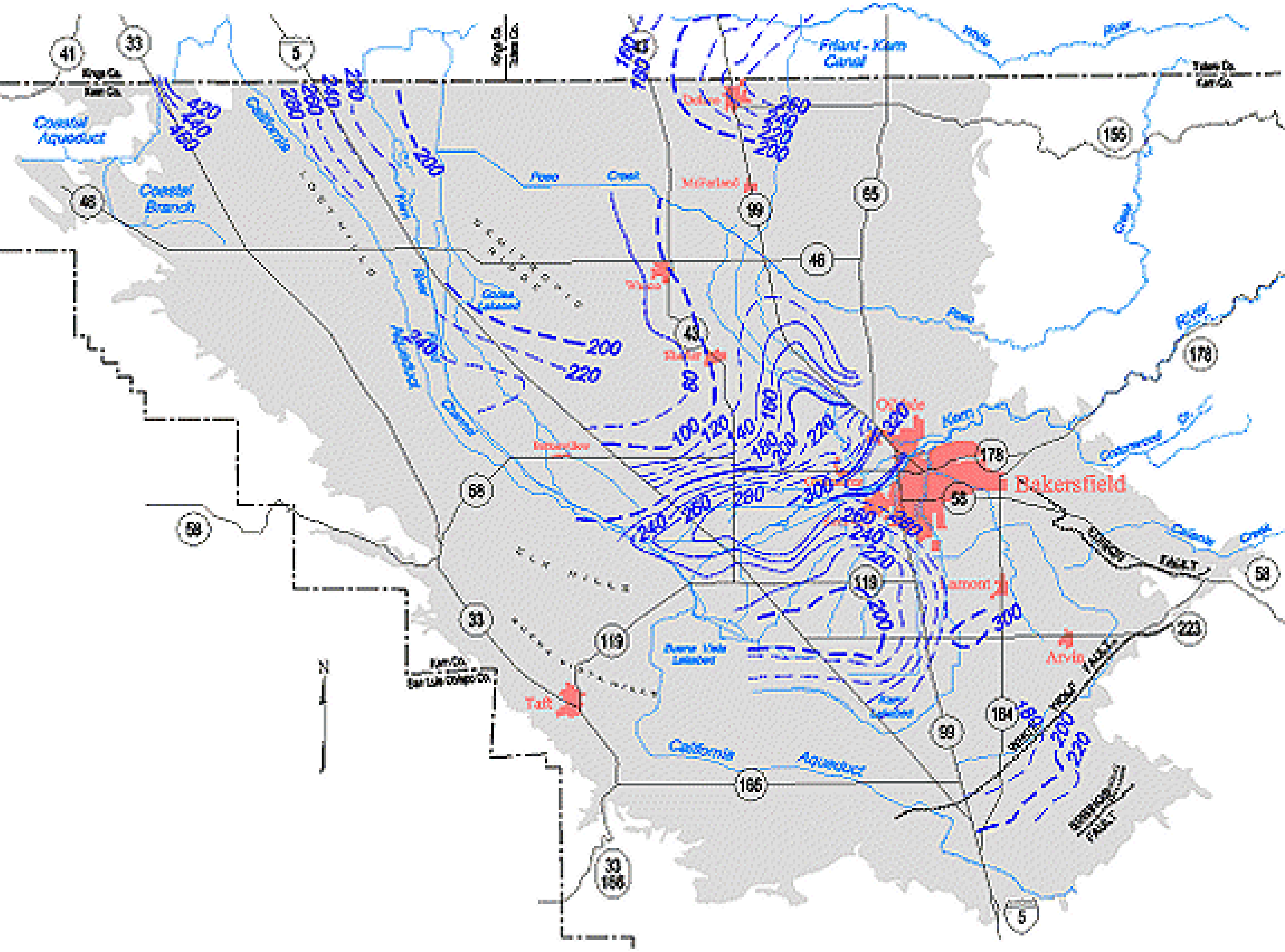
Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Kern Groundwater Basin

Spring 1999, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer

Scale of Miles

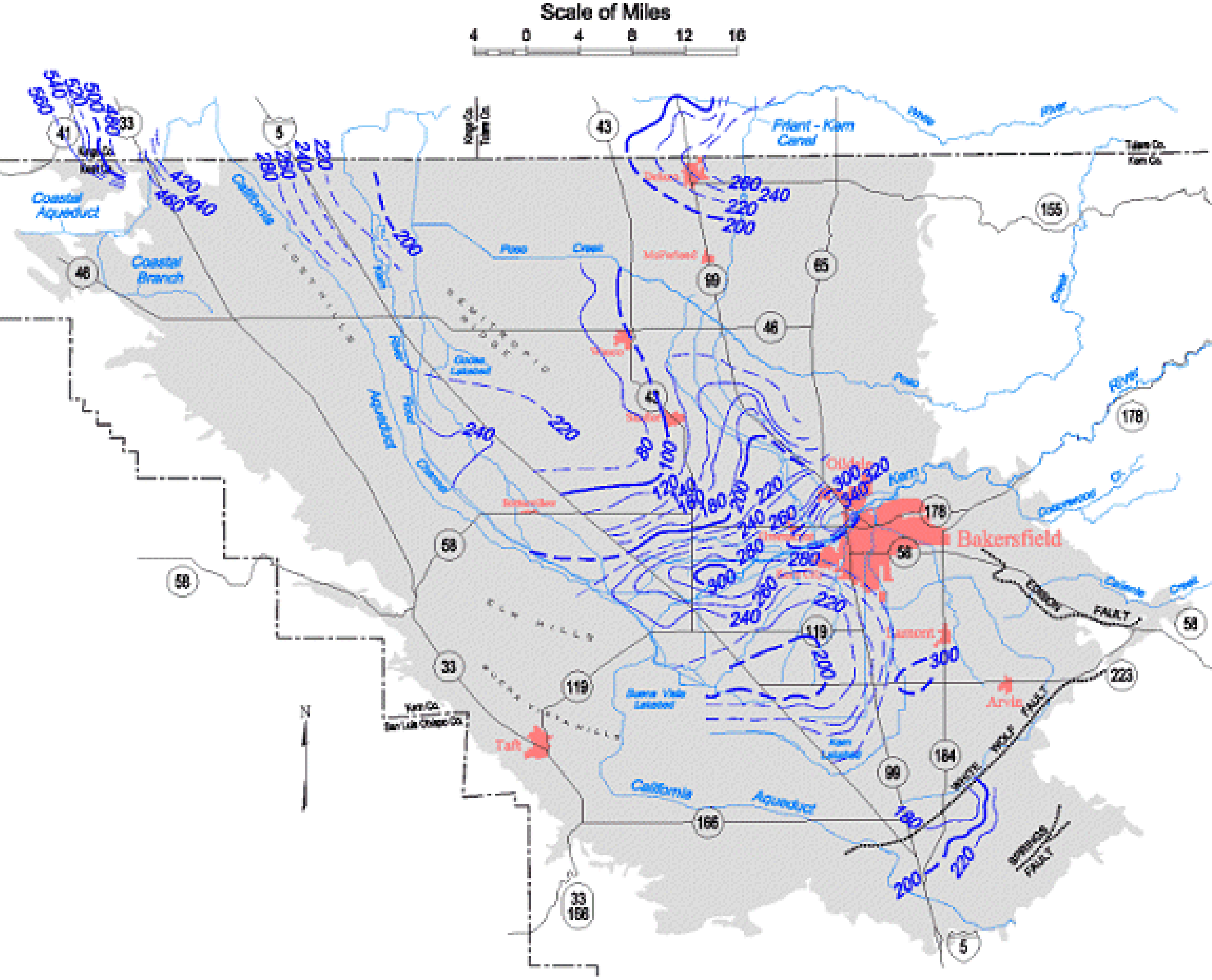
4 0 4 8 12 16



Contours are dashed where inferred. Contour interval is 20 feet.

Kern Groundwater Basin

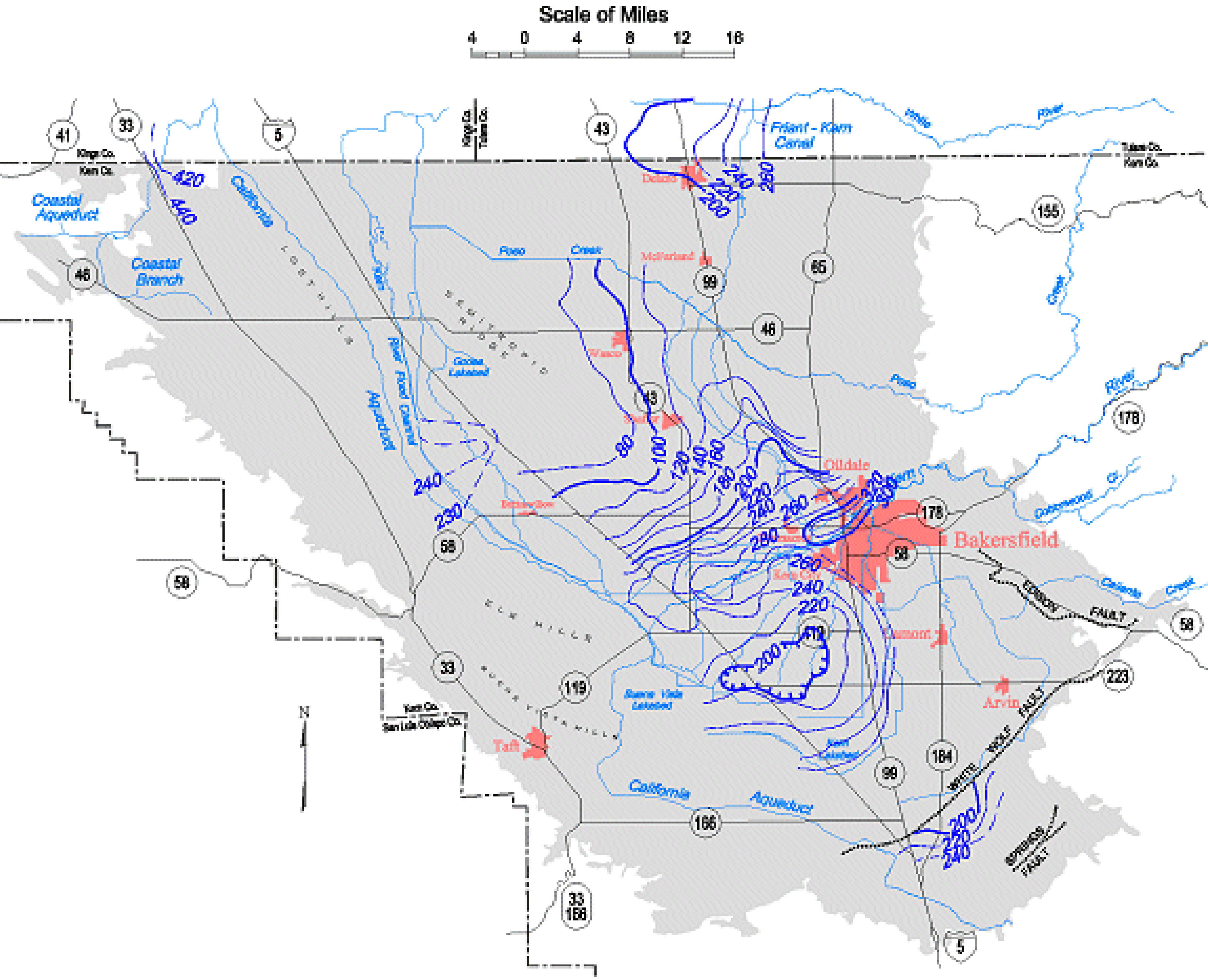
Spring 2000, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 20 feet.

Kern Groundwater Basin

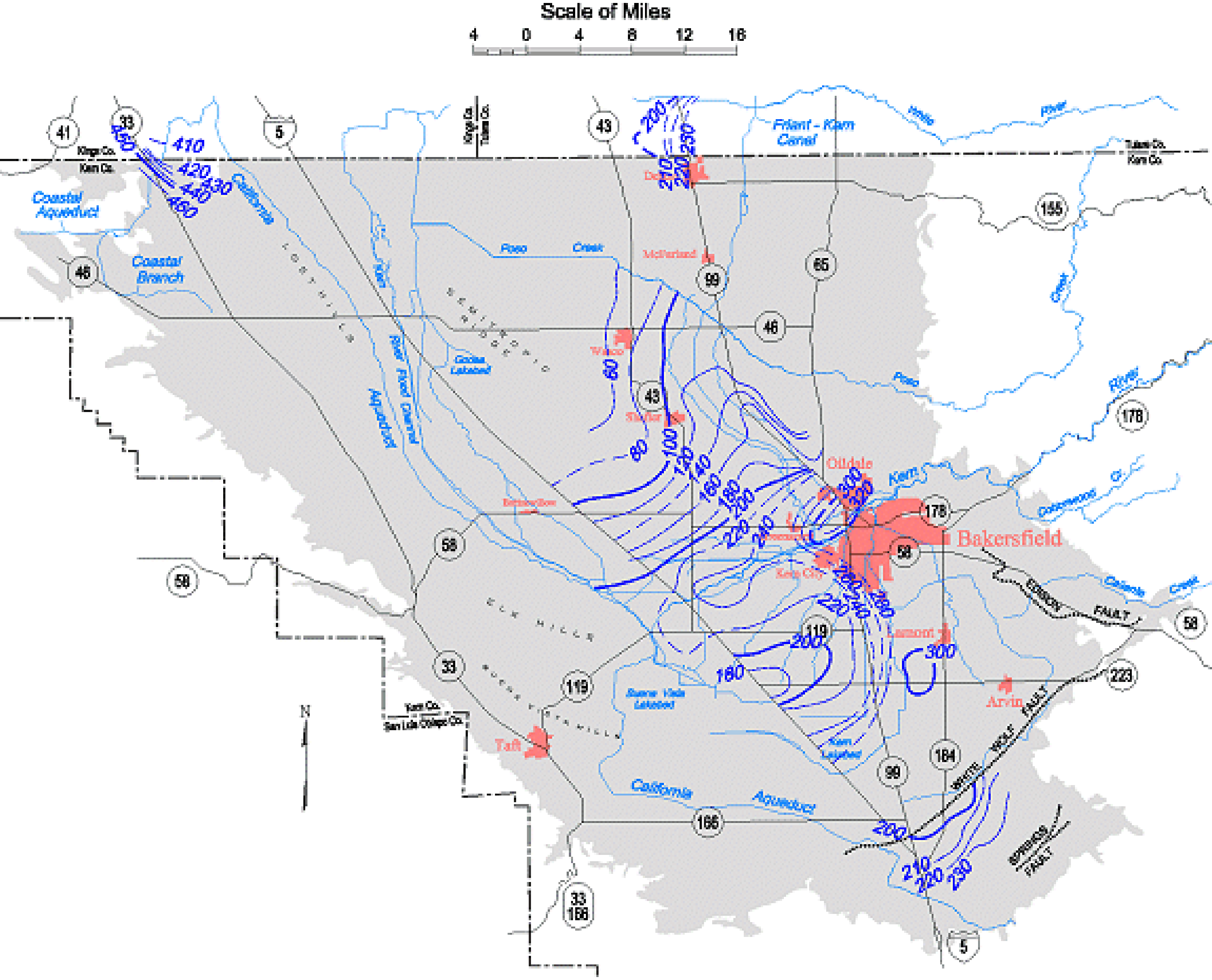
Spring 2001, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Kern Groundwater Basin

Spring 2002, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



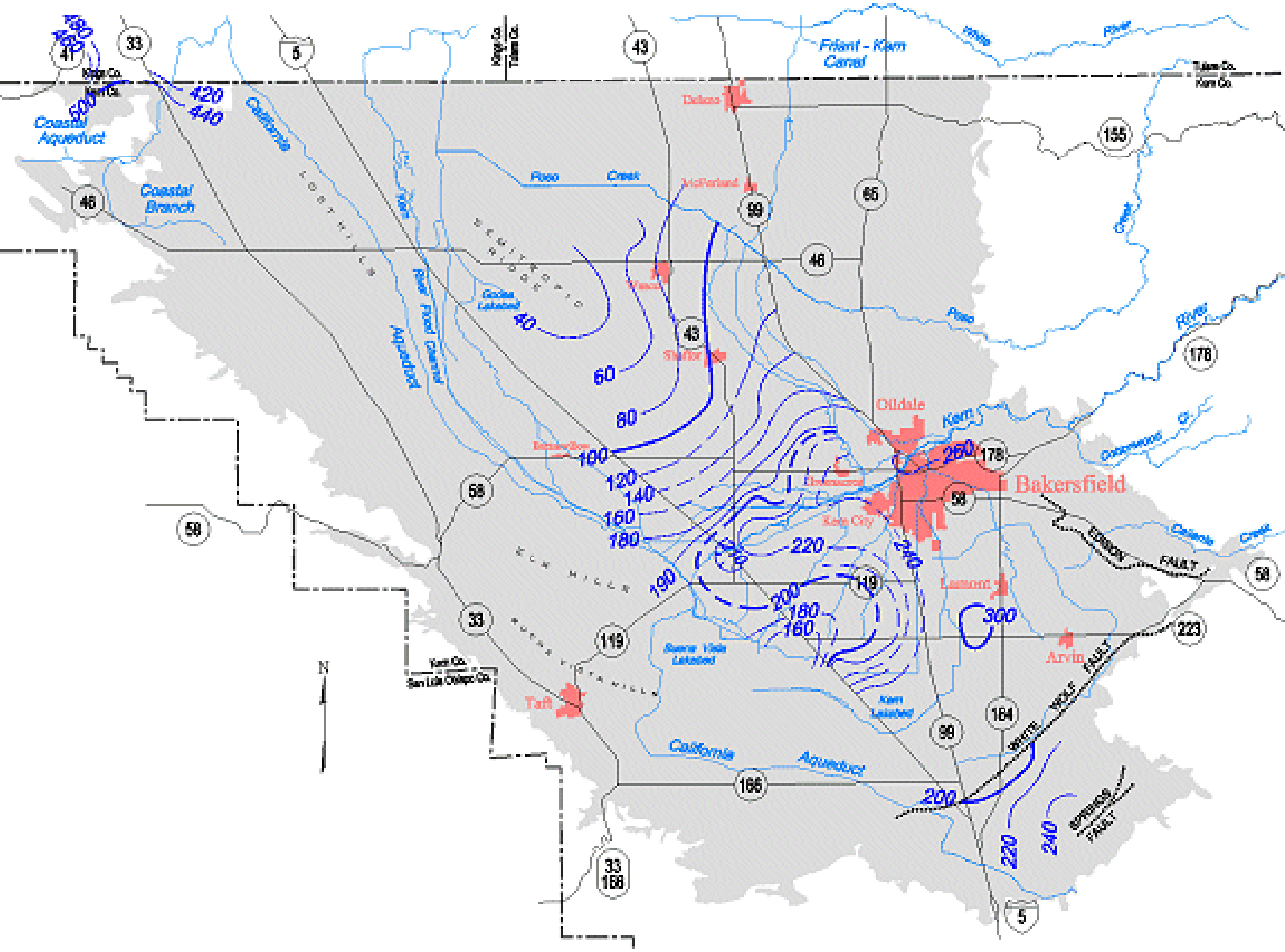
Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Kern Groundwater Basin

Spring 2003, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer

Scale of Miles

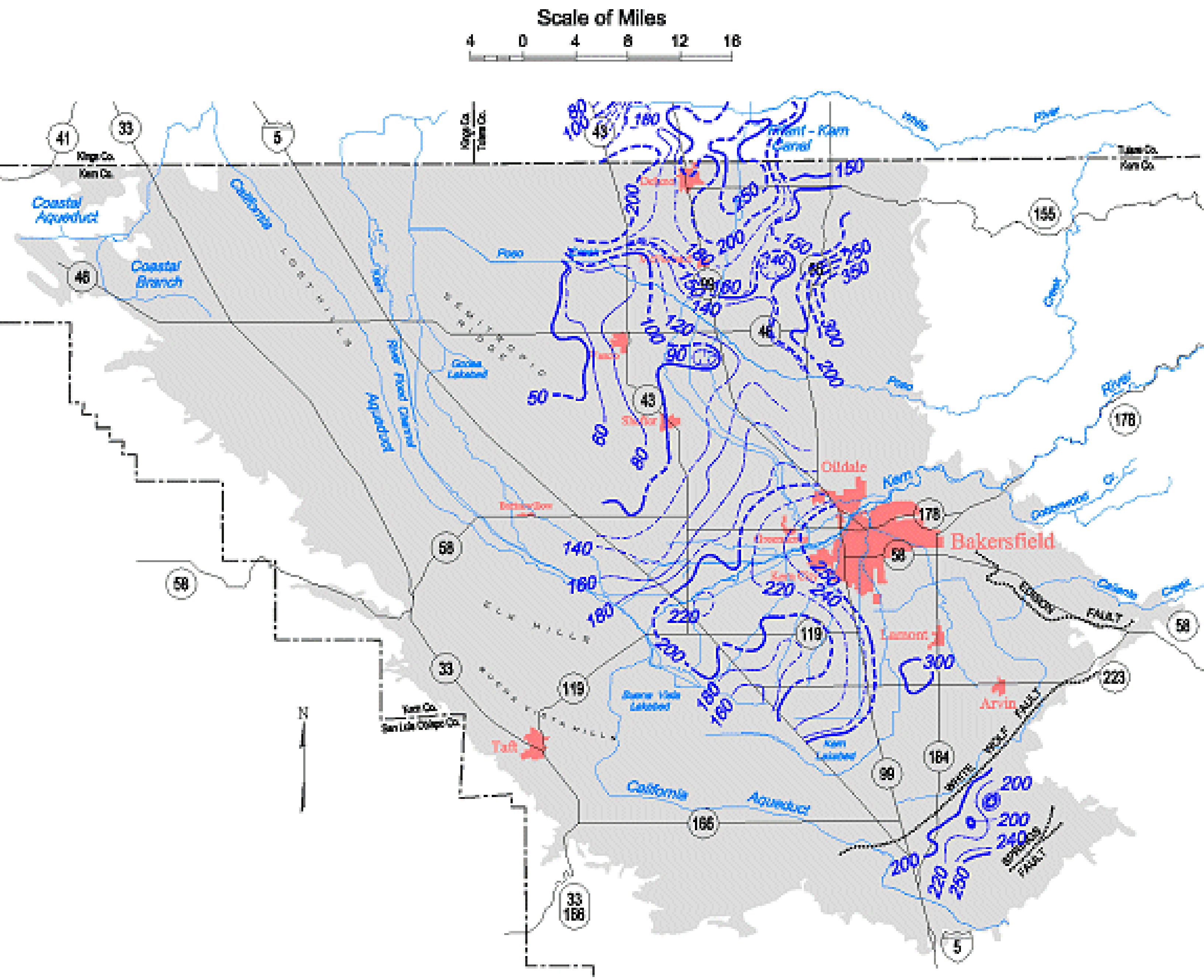
4 0 4 8 12 16



Contours are dashed where inferred. Contour interval is 10 and 20 feet.

Kern Groundwater Basin

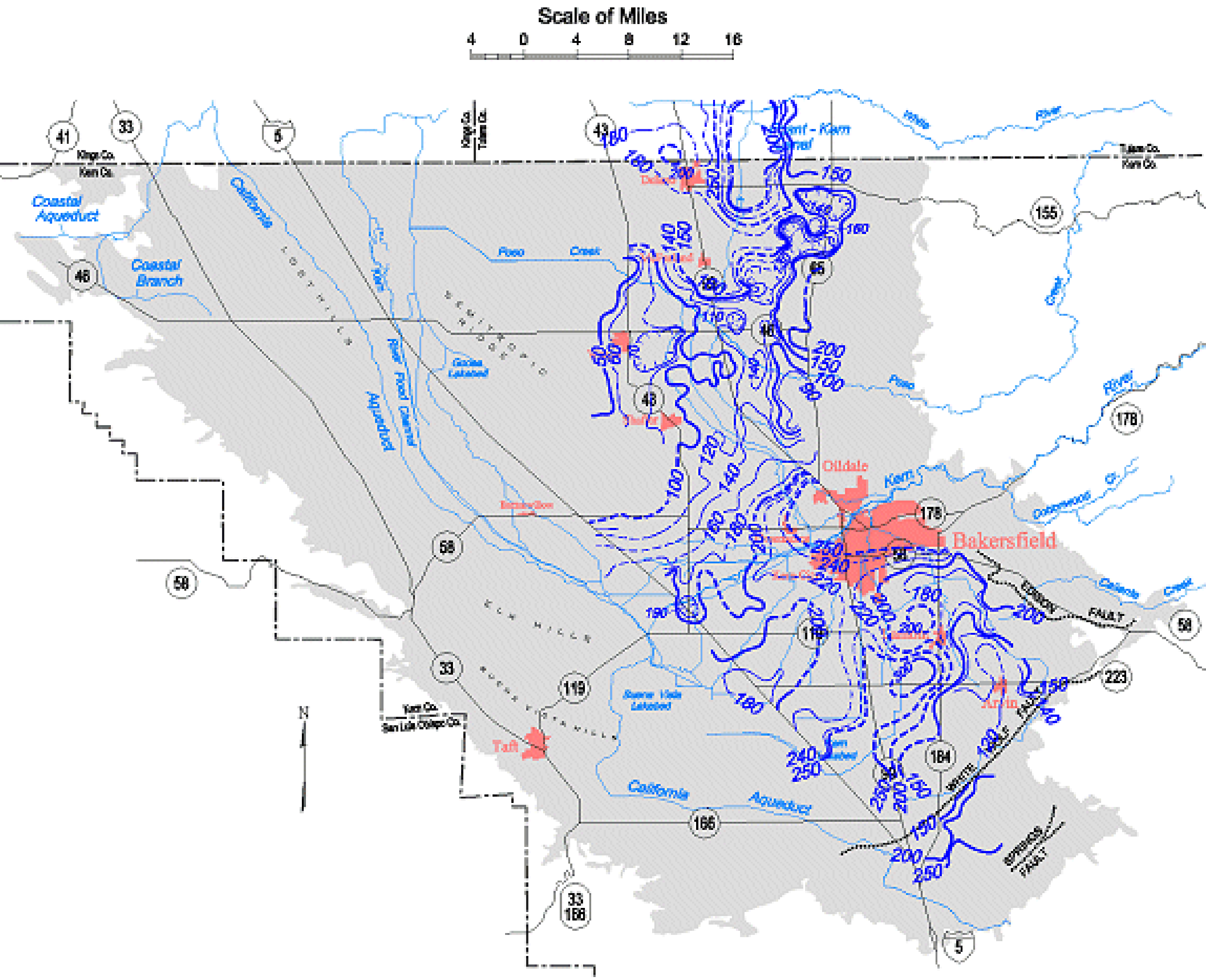
Spring 2004, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10, 20 and 50 feet.

Kern Groundwater Basin

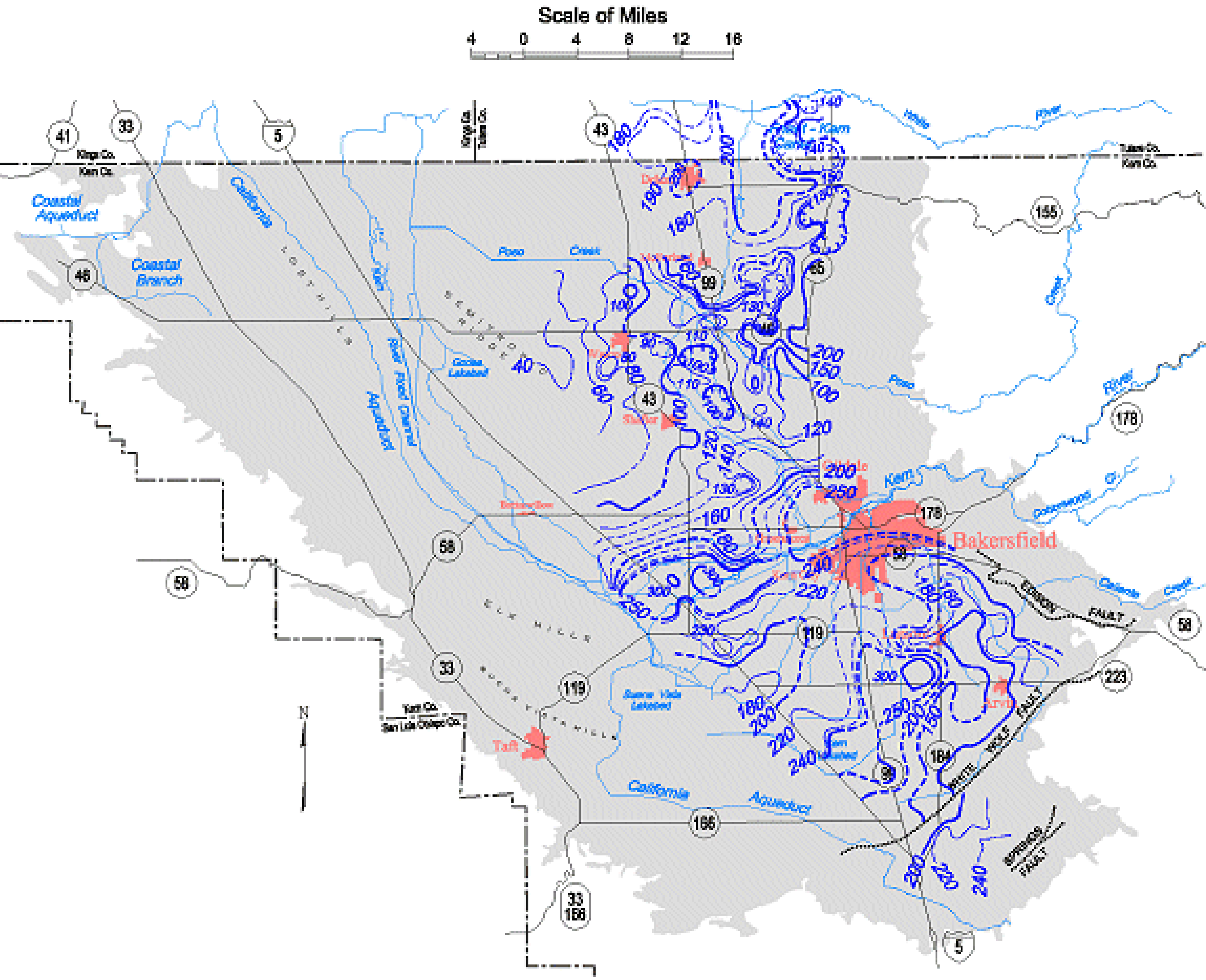
Spring 2005, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10, 20 and 50 feet.

Kern Groundwater Basin

Spring 2006, Lines of Equal Elevation of Water in Wells, Unconfined Aquifer



Contours are dashed where inferred. Contour interval is 10, 20 and 50 feet.