URS

DOCKET	
08-AFC-8	
DATE	FEB 01 2010
RECD.	FEB 02 2010

February 1, 2010

Dockets Unit
California Energy Commission
1516 Ninth Street, MS 4
Sacramento, CA 95814

RE: Hydrogen Energy California Project
Application for Certification 08-AFC-8

On behalf of Hydrogen Energy International LLC, the applicant for the above-referenced Hydrogen Energy California AFC, we are pleased to submit the enclosed document:

- One print copy of the *Responses to CEC Data Requests Set One (Nos. 17, 65, 77, and 85 through 90)*
- One DVD containing Air Quality Modeling Files for Responses to CEC Data Request Set One (Nos. 85, 86, and 89)

The enclosed document is being submitted to the CEC for docketing.

URS Corporation

Dale Shileikis
Vice President, Environmental Services

Enclosures

CC: Rod Jones (with 15 print copies and four CDs)

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Responses to CEC Data Requests Set One (Nos. 17, 65, 77, and 85 through 90)

Revised Application for Certification (08-AFC-8) for HYDROGEN ENERGY CALIFORNIA Kern County, California

Prepared for:
Hydrogen Energy International LLC

Submitted to:
California Energy Commission

January 2010

Prepared by:
URS

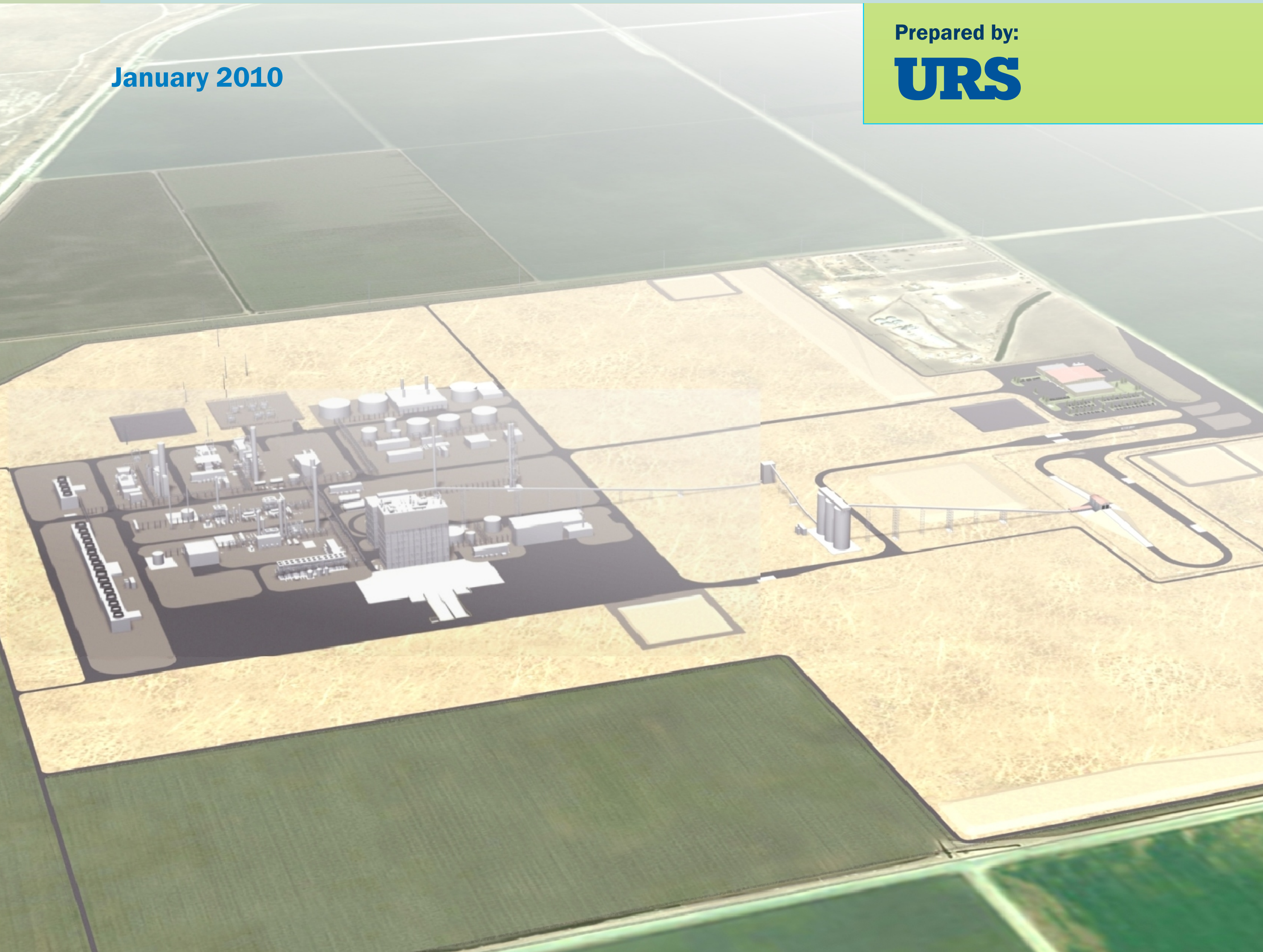


TABLE OF CONTENTS

RESPONSES TO CEC DATA REQUESTS SET ONE – NOs. 17 65, 77, ET AL.

This material is based upon work supported by the Department of Energy National Energy Technology Laboratory under Award Number DE-FE0000663.

ATTACHMENTS

TABLES

FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS USED IN RESPONSES

AFC	Application for Certification
AGR	Acid Gas Removal
AMSL	above mean sea level
APE	Area of Potential Effects
ASU	air separation unit
Bhp	Brake horsepower
B.P.	before present
Btu	British thermal units
^{14}C	radiocarbon
C_3H_6	propylene
CAPCOA	California Air Pollution Control Officers Association
CAS	Chemical Abstracts Service Registry Number
CEC	California Energy Commission
CH_3OH	methanol
CNDDB	California Natural Diversity Database
CO_2	carbon dioxide
COS	carbonyl sulfide
CTG	combustion turbine generator
DPM	diesel particulate matter
DPR	Department of Parks and Recreation
g	gram
g/hr	grams per hour
g/mi	grams per mile
H_2S	hydrogen sulfide
HARP	Hotspots Analysis and Reporting Program
HCN	hydrogen cyanide
HECA	Hydrogen Energy California
HHV	higher heating value
HRA	health risk assessment
HRSG	heat recovery steam generator
kg/hr/source	kilogram per hour per source
km	kilometers
lb/hr	pounds per hour
LDAR	leak detection and repair
L/kg-day	liters per kilogram per day
m	meters
MDEA	methyldiethanol amine
MEIR	maximally exposed individual resident
MEIW	maximally exposed individual worker
$\mu g/m^3$	micrograms per cubic meter
MYA	million years ago
NESHAP	National Emission Standard for Hazardous Air Pollutants
NH_3	ammonia
OEHHA	Office of Environmental Health Hazard Assessment
PAH	polycyclic aromatic hydrocarbons
PM_{10}	particulate matter less than 10 microns in diameter
PMI	point of maximum impact
ppm	parts per million
ppmvd	parts per million volumetric dry
scf	standard cubic feet

SJVAPCD	San Joaquin Valley Air Pollution Control District
SOCMI	Synthetic Organic Chemical Manufacturing Industry
SRU	sulfur recovery unit
SSURGO	Soil Survey Geographic
SWS	Sour Water Stripper
TAC	toxic air contaminant
TGTU	tail gas treating unit
THI	total hazard index
TOC	total organic compounds
U.S. EPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VOC	volatile organic compounds

Technical Area: Air Quality
Author: William Walters

BACKGROUND

The project description does not indicate that there is the potential for any fugitive VOC emissions. However, it is unclear if there are intermediate steps in the gasifier process that would include gaseous or liquid organic products that could result in fugitive VOC emissions.

DATA REQUEST

17. A. Please indicate if there are VOCs created as intermediate products in the gasification process and calculate the potential fugitive VOC emissions from piping components (flanges, valves, pumps, compressors, etc.).

B. Please provide an estimated count of those piping components.

RESPONSE

A. Essentially no volatile organic compounds (VOCs) are created in the gasification process; however, other parts of the facility have process areas containing VOCs. Potential fugitive VOC emissions from piping components were estimated using the U.S. Environmental Protection Agency (U.S. EPA) guidance, *Protocol for Equipment Leak Emission Estimates* (U.S. EPA, 1995). The emission factors used in the calculations are for the Synthetic Organic Chemical Manufacturing Industry (SOCMI) factors and are presented in Table 17-1. A leak detection and repair (LDAR) program will be implemented on select process areas to maximize emission reductions. Component counts for different areas at the facility along with the estimated VOC and toxic air contaminant (TAC) emission rates are addressed in Attachment 89-1 in the response to Data Request 89, later in this document. Annual facility VOC emissions from fugitive sources are estimated to be 12.45 tons per year.

B. The component count for the Hydrogen Energy California (HECA) facility, broken out by type of component, is presented in Table 17-2.

Reference

U.S. EPA (U.S. Environmental Protection Agency), 1995. *Protocol for Equipment Leak Emission Estimates*.

Table 17-1
SOCMI Average Fugitive Emission Factors

Component Type	Service Type	TOC Emission Factor (kg/hr/source)
Valves	Gas	5.97E-03
	Light Liquid	4.30E-03
	Heavy Liquid	2.30E-04
Pump Seals	Light Liquid	1.99E-02
	Heavy Liquid	8.62E-03
Compressor Seals	Gas	2.28E-01
Connectors	All	1.83E-03

Source: U.S. EPA 1995.

Note:

kg/hr/source = kilogram per hour per source
SOCMI = Synthetic Organic Chemical Manufacturing Industry
TOC = total organic compounds

Table 17-2
HECA Total Estimated Fugitive Component Counts

Components	Total Component Counts
Compressor Seals	3
Pumps – Light Liquid	17
Pump – Heavy Liquid	26
Valves – Gas	1,156
Valves – Light Liquid	1,141
Valves – Heavy Liquid	840
Connectors	9,293

Source: HECA Project.

Technical Area: Cultural Resources
Authors: Amanda Blosser, Beverly E. Bastian, and Michael McGuirt

Note: Any information that identifies the location of archaeological sites needs to be submitted under confidential cover.

BACKGROUND

Staff's review of the Cultural Resources section of the Application for Certification (AFC) and the Archaeological Resources Report indicated that some areas that the Energy Commission Regulations require to be surveyed for cultural resources were not surveyed due to access or other limitations. To complete its inventory of cultural resources that may be subject to project impacts, staff needs these areas to be surveyed and to receive a report of the survey results.

DATA REQUEST

65. Please survey for cultural resources those areas mapped under the previous Data Request, part c, as not surveyed by pedestrian archaeological survey related to this project.

RESPONSE

Additional pedestrian archaeological surveys were undertaken within areas previously unsurveyed due to lack of access, as depicted on Figure 1 of Appendix H3 of the Revised Application for Certification (AFC), as well as for modified transmission line alternative routes 1A and 1B, as depicted on Figure 64 of the Responses to Data Requests Set One (numbers 1 through 132).

The results of these efforts are presented in the Attachment 65-1 Confidential Survey Report Addendum, which is submitted under confidential cover.

It should be noted herein, that not all of the areas requiring survey as depicted on Figure 1 of Appendix H3 of the Revised AFC have been accessed. Specifically, access was denied for the parcel situated along Adohr Road (see Figure 1 [5]) and for the parcel situated along Tupman Road (see Figure 1 [7]). As the transmission routes have been modified, however, the unsurveyed portion of the parcel along Adohr Road has become irrelevant, as has the portion of the transmission line entering the Midway Sunset Substation from the north (see Figure 1[4]). Furthermore, the parcel along Tupman Road appears to present potentially hazardous conditions, as evidenced by the high cyclone fence topped with barbed wire that completely barricades the parcel.

In addition, due to the modification of transmission line alternative routes 1A and 1B, additional surveys were performed. These surveys were completed for historic architecture, biological resources, and paleontological resources, and addendum reports have been provided as Attachments 65-2, 65-3, and 65-4.

ATTACHMENT 65-1
CONFIDENTIAL SURVEY REPORT ADDENDUM

SUBMITTED UNDER CONFIDENTIAL COVER

ATTACHMENT 65-2
HISTORIC ARCHITECTURE ADDITIONAL SURVEY

California Energy Commission (CEC) Data Request 65 requested a Cultural Resources survey of the areas that were previously not surveyed due to lack of access during the preparation of the Revised AFC.

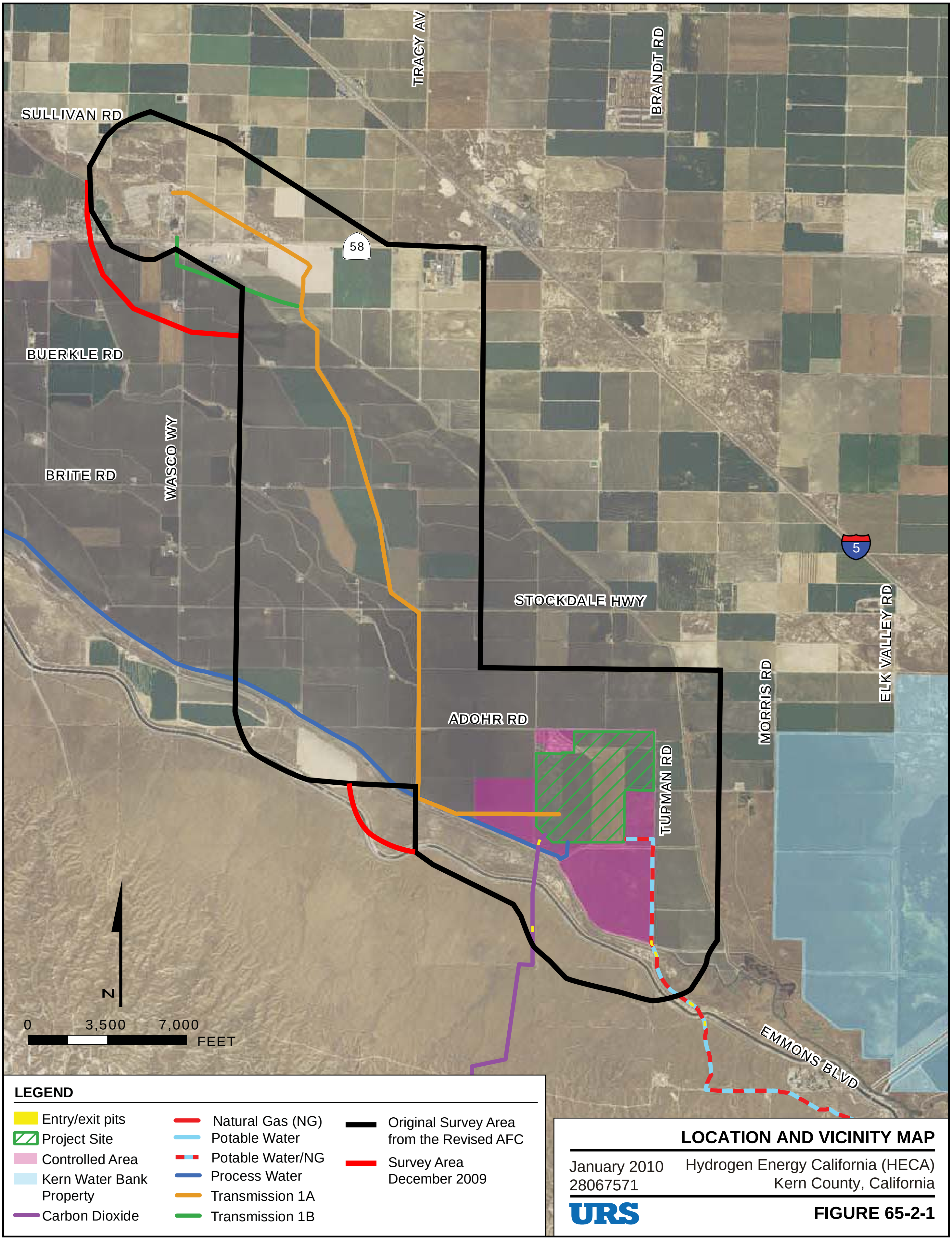
In addition to the requested Cultural Resources survey, Historic Architecture surveys were conducted of the modified transmission line alternative routes 1A and 1B, and any areas that were previously inaccessible. This attachment presents the results of the surveys.

Historic Architecture Surveys

A Historic Resources Inventory and Evaluation for historic buildings, structures, and objects located along modified transmission line alternative routes 1A and 1B. Updated study area maps are provided as Figures 65-2-1 and 65-2-2. Three additional resources were evaluated: a farmstead, a light industrial property, and a control structure on the West Side Canal (Map Reference Nos. 27, 28, and 29, respectively).[1] The respective State of California Department of Parks and Recreation (DPR) 523 forms are attached in Appendix 65-2-1. These are to be considered an addendum to the previous JRP report contained in Appendix H-4 of the Revised AFC.

It is concluded that none of these additional buildings, complexes of buildings, and/or structures are eligible for listing in the National Register of Historic Places or the California Register of Historic Resources, and thus are not historic resources for the purposes of the California Environmental Quality Act.

[1] Because JRP evaluated portions of the Buena Vista Water Storage District in the previous report, this control structure (WS-3) was recorded as an additional linear feature of this resource. The entire DPR 523 form is attached.



LOCATION AND VICINITY MAP

January 2010
28067571

Hydrogen Energy California (HECA)
Kern County, California

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FIGURE 65-2-1

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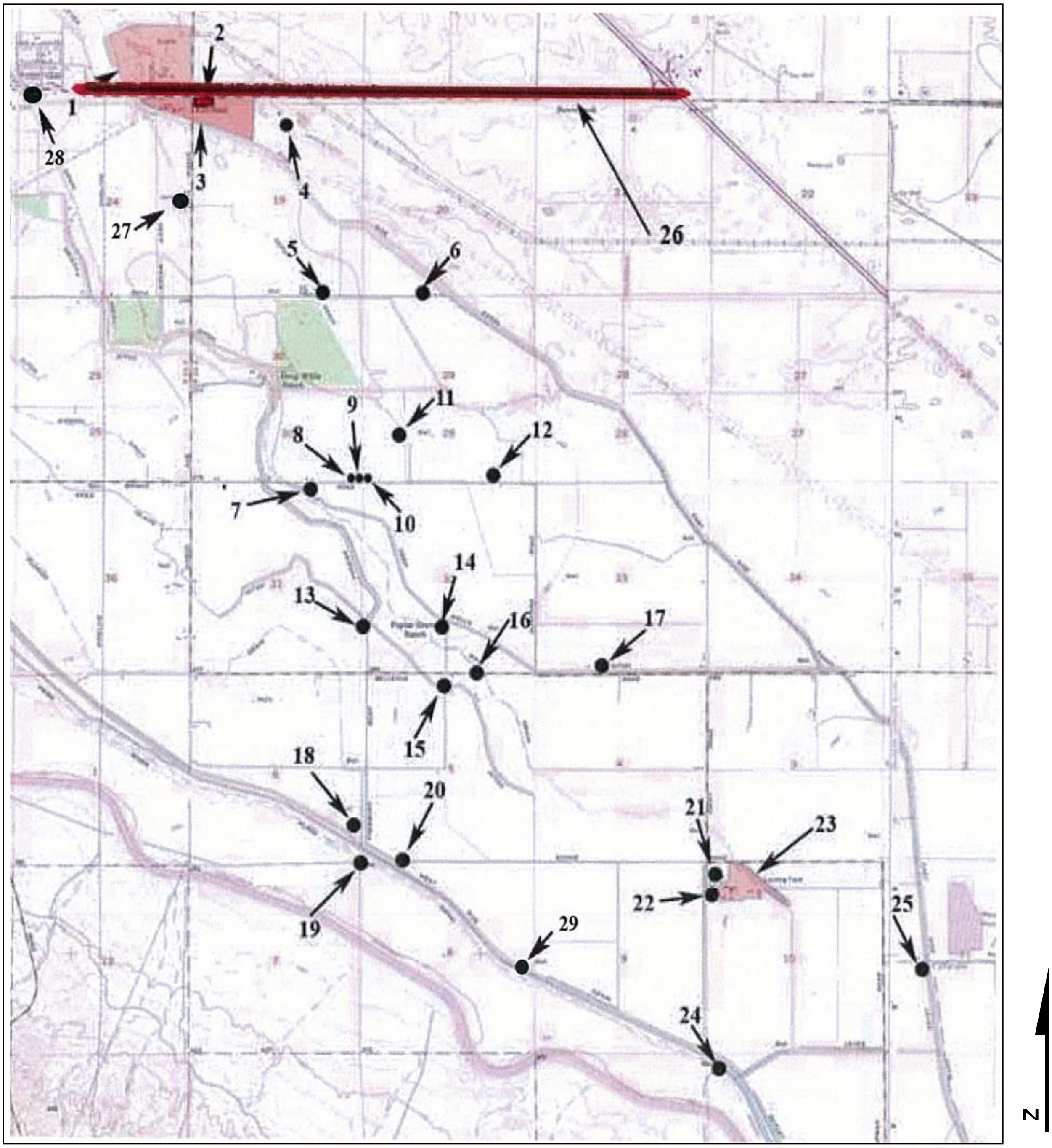

HISTORIC ARCHITECTURE RESOURCE MAP

January 2010
28067571

Hydrogen Energy California (HECA)
Kern County, California

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FIGURE 65-2-2

DPR 523 FORM

for

2901 Wasco Way

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary # ______
HRI # ______
Trinomial ______
NRHP Status Code 6Z
Other Listings ______
Review Code ______ Reviewer ______ Date ______

 ***Resource Name or #** (Assigned by recorder) Map Reference #27

P1. Other Identifier: 2901 Wasco Way

***P2. Location:** ☐ **Not for Publication** ☒ **Unrestricted** ***a. County** Kern

and (P2b and P2c or P2d. Attach a Location Map as necessary.)

***b. USGS 7.5' Quad** Buttonwillow, CA **Date** 1954 photorevised 1973 **T** 29S; **R** 23E; SE **¼ of Sec** 24; MD **B.M.**

c. Address 2901 Wasco Way City Buttonwillow Zip 93206

d. UTM: (give more than one for large and/or linear resources) Zone ______; ______mE/ ______mN

e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

Assessor Parcel Number: 102-050-02

***P3a. Description:**

The northeast corner of this 190-acre farmstead contains a collection of workers' cottages, shop buildings, silos, shelters, and pens enclosed by the parcel's boundary to the north and an irrigation ditch to the south. The cottages (Buildings 1 through 6) are arranged in a row fronting Wasco Way (**Photograph 1**), with the remaining structures located behind them to the west. The grounds and farm land are accessed by a central driveway. Buildings 1 through 4 are located south of the driveway and are similar in design. Each has an L-shaped footprint, rest on mudsills, and feature a cross-gabled composite shingle roof (with exposed rafter tails in many areas where fascia boards are missing). Buildings 1 and 4 have an off-center entry door raised atop a concrete stoop and sheltered by a braced shed extension of the roof (**Photographs 2** and **3**). A secondary entry door is located on the south side of the rear wing. Fenestration includes aluminum and vinyl replacement sliding windows throughout, apart from a pair of 1/1 wood double-hung windows on the north façade of Building 1 and a single 1/1 wood double-hung window on the front (east) façade of Building 4. They are clad in board and batten siding. (See Continuation Sheet)

***P3b. Resource Attributes:** (List attributes and codes) (HP33) Farm; (HP3) Multiple family property

***P4. Resources Present:** ☐ Structure ☒ Building ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5a. Photo of Drawing (Photo required for buildings, structures, and objects.)

P5b. Description of Photo: (View, date, accession #) **Photograph 1.** Row of cottages, facing north.

***P6. Date Constructed/Age and Sources:** ☒ Historic ☐ Prehistoric ☐ Both
1937-1973, USGS Quad Maps

***P7. Owner and Address:**
Carl and Debbie Parrish
4542 Buerkle Rd.
Buttonwillow, CA 93206

***P8. Recorded by:** (Name, affiliation, address)
Greg Rainka and Rand Herbert
JRP Historical Consulting, LLC
1490 Drew Ave, Suite 110,
Davis, CA 95618

***P9. Date Recorded:** December 2009

***P10. Survey Type:**
Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") JRP Historical Consulting LLC – "Historical Resources Inventory and Evaluation Report for the Hydrogen Energy California Project," December 2009 Addendum.

***Attachments:** ☐ None ☒ Location Map ☒ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) ______

BUILDING, STRUCTURE, AND OBJECT RECORD

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Map Reference #27

B1. Historic Name: ________________

B2. Common Name: ________________

B3. Original Use: Farm/Residential B4. Present Use: Farm/Residential

***B5. Architectural Style:** Farmhand's Cottage; Utilitarian

***B6. Construction History:** (Construction date, alteration, and date of alterations) Residences were built and/or moved to this property between 1930 and 1954; shop buildings, silos, and shelters were built between 1954 and 1973; the layout and number of residences were altered numerous times. See P3a for details on specific building alterations and/or additions.

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown Date:** ________________ **Original Location:** ________________

***B8. Related Features:** ________________

B9. Architect: Unknown b. Builder: Unknown

***B10. Significance: Theme** n/a **Area** n/a

Period of Significance n/a **Property Type** n/a **Applicable Criteria** n/a

This property does not appear to meet the criteria for listing in the National Register of Historic Places or the California Register of Historical Resources because it does not appear to have historical significance and lacks integrity. This property has also been evaluated in accordance with Section 15064.5(a)(2)-(3) of the California Environmental Quality Act (CEQA) Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to be a historical resource for the purposes of CEQA.

Like most of the agricultural land south or east of Buttonwillow, the subject property was at first under the ownership and management of Miller & Lux, Inc. Beginning in the 1920s, the company arranged to subdivide and sell their Buttonwillow land. By 1926, the transfer of their system of canals and water works to the Buena Vista Water Storage District was complete, and in 1927, under the direction of land agent C. Elmer (C.E.) Houchin, Buttonwillow was replatted. Parcels opened for sale that same year, and Houchin himself acquired the subject property from Miller & Lux in March of 1937. It has remained in the Houchin family ever since. (See Continuation Sheet)

B11. Additional Resource Attributes: ________________

***B12. References:**

John Turner, *White Gold Comes to California* (Bakersfield: California Planting Cotton Seed Distributors), 1981; Harry Barnes, *Data on Irrigation Buttonwillow Ranch and Adjacent Lands*, 1920, Manuscript, Water Resources Center Archives, Berkeley, California; Eugene Burmeister, *The Golden Empire Kern County*, California (Beverley Hills: Autograph Press), 1977; Deed of Sale, Miller & Lux to Houchin Farms, Inc., March 1937, Kern County, California, Deed Book 717, Page 389.

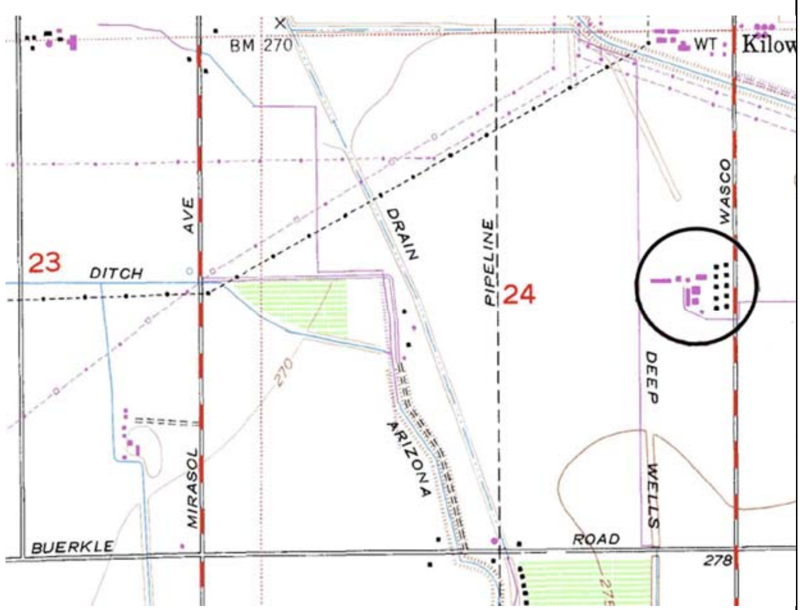
B13. Remarks:

***B14. Evaluator:** Greg Rainka

***Date of Evaluation:** December 2009

(This space reserved for official comments.)

(Sketch Map with north arrow required.)



P3a. Description (continued):

Buildings 2 and 3 have an off-center front door and two secondary entrances on their south sides, all sheltered only by the roof's overhang (**Photographs 4** and **5**). Both of these buildings are currently not in use. Building 2 is missing its windows (though the openings retain their wood surrounds), and the window openings of Building 3 are infilled with wood siding and the surrounds have been removed. The exterior walls are clad in wood drop siding.

Buildings 5 and 6 are located north of the driveway. Building 5 has a rectangular footprint, mudsills, cross-gabled composite shingle roof with exposed rafter tails, and board and batten siding (**Photograph 6**). A screened porch nearly spans the entire width of the front façade. It is enclosed by a knee wall with drop siding and is covered by a shed extension of the roof supported by braced wood posts. Fenestration includes 1/1 wood double-hung windows throughout, arranged in pairs on the front (east) and south walls. A screened back porch is recessed within the building's northwest corner. Building 6 has an L-shaped footprint, mudsills, and a cross-gabled composite shingle roof with exposed rafter tails (**Photograph 7**). The front-gabled section of the house has board and batten siding and a centered screened porch with a shed roof. The side-gabled wing appears to be an addition, as it has plywood and batten siding and a concrete foundation. Fenestration includes aluminum and vinyl replacement sliding windows throughout, apart from three 1/1 wood double-hung windows flanking the rear entry door. A modern carport with a Tudor-like arch metal roof sits directly northeast of this residence.

Three secondary buildings (Buildings 7, 8, and 9) are located behind (west of) Buildings 5 and 6. Building 7 has a rectangular footprint, mudsills, front-gabled corrugated metal roof with narrow eaves, and board and batten siding with corner boards (**Photograph 8**). A door is centered on its primary façade atop a concrete stoop. Fenestration includes 1/1 wood double-hung windows on its side and rear walls. Building 8 is identical to Building 7 apart from a shed-roofed extension on its south side and a lack of windows throughout (**Photograph 9**). Building 9 is a double garage with a metal one-piece door, front-gabled corrugated metal roof, horizontal board and batten siding, and concrete foundation (**Photograph 10**).

Building 10 is positioned northwest of Building 4, and currently functions as an office. It has a rectangular footprint, concrete foundation, wood bevel siding, and front-gabled composite shingle roof with medium-width eaves and wood fascia board (**Photograph 11**). Its primary façade is its north side, which consists of two entry doors, each flanked by a triplet of replacement single-pane fixed windows set in a wood frame. A third door is located on the opposite (south) side of the building. Fenestration also includes variably-sized vinyl replacement sliding windows with snap-in muntins on the south, east, and west façades. These alterations occurred after 2000.

A silo complex is situated south of Building 10. The gabled structure (Building 11) at its south end services a row of five cylindrical steel silos by means of an elevator and filling chain (**Photograph 12**). Building 12, the tack room, sits southeast of the silos. It has a rectangular footprint, mudsills, front-gabled corrugated metal roof with exposed rafter tails, and board and batten siding (**Photograph 13**). There are two doors on the building's north façade, each raised atop a concrete stoop. Fenestration includes 1/1 wood double-hung windows with wood surrounds throughout. A large, sheltered emu pen is located west of Building 12. Its corrugated metal roof is supported by a wood post and beam frame (**Photograph 14**). Just north of this structure and west of the silos is a metal-framed hay shelter with an octagonal corrugated metal roof (**Photograph 15**).

A gabled barn with a sliding batten door and shed extensions on both sides (Building 13) is located west of the office (**Photograph 16**). The roof is sheathed with corrugated metal panels and has wide eaves with exposed purlins. The south shed extension is an open shelter for equipment and vehicles. The roof is supported by braced wood posts. The opposite, north extension is half screened and half enclosed. The enclosed space is clad in corrugated metal panels and has paired 1/1 wood double-hung windows; the screened area is wood-framed with a full-height sliding door.

A five-bay-wide wood-framed equipment shelter with an asymmetrical gabled roof sits north of Building 13 (**Photograph 17**). The westernmost bay is screened and has a swing door. A corrugated metal Quonset hut with a board-form concrete foundation (Building 14) is attached to the west side of this structure. It has a steel door and steel four-light fixed window on its south end, a sliding door with a railroad tie sill on its west side, and a shed-roofed room extension with vertical wood board siding at its northwest corner (**Photograph 18**).

Building 15 is a gabled hay shed with extensions on both sides and is located west of the Quonset hut. The hay shed has an I-beam frame and a corrugated metal roof (**Photograph 19**). The north extension is used for storage and has a side-gabled roof, a wood stud sliding door, and 1/1 wood double-hung windows. The south extension has a shed roof, a swing door, and single aluminum sliding window. A collection of sheltered animal pens is located west of this building (**Photograph 20**), and a large corrugated metal equipment shed with full-height sliding doors is located to its south (Building 16, **Photograph 21**).

B10. Significance (continued):

After C.E.'s death in 1954, the farm was deeded to his nephews Francis, Okey, and Clarence ("Dutch"), who had started a farming company of their own (Houchin Bros. Farming), and with their respective wives. Patricia Eileen Houchin was Dutch's wife and the last surviving owner. After her death in 2000, the property was divided among her daughters Ruth, Victoria, and Debra. The entire property was deeded to the latter in 2006, and she remains the owner of record today.[1]

The subdivision of Miller & Lux holdings in the area surrounding Buttonwillow diversified cropping patterns and provided for the development of smaller farms. This farmstead has been associated with cotton production throughout its history, a crop that had been grown in Kern County since 1862. Bakersfield became a hub for processing and shipping cotton fiber and oil by the end of the nineteenth century, and the development of Acala cotton, a strong, long-fibered variety, at the Shafter Experimental Farm in 1906 further boosted the industry. In 1928, the first cotton crops were planted in the area directly south of the Buttonwillow townsite. Between 1920 and 1935, cotton production grew to 3,800 acres.[2]

California's Central Valley was a primary destination for Dust Bowl migrants during the Great Depression. Kern County, in particular, experienced a steady growth in population in response to its expanding agricultural acreage and relative labor surplus. The population influx during this time, however, resulted in a significant housing shortage. Though a single family farm would require between ten and thirty laborers during the harvest season, it could not justify the expense of housing that many farmhands year round. Conditions improved by the end of the 1930s as the economic hardships of the Great Depression passed, however. Construction of adequate housing became a priority as this new labor population settled in, and supply eventually caught up with demand.[3]

---

[1] Statement of Partnership, Houchin Bros. Farming, April 1946, Kern County, California; Deed, C.E. Houchin Estate to Francis, Dulcie, C.A., Patricia, Okey, and Bessie Mae Houchin, February 10, 1954, Kern County, California, Deed Book 2186, Page 103; Deed, C.A. and Patricia Estates to Victoria Houchin, Ruth McLoughlin, and Debra Houchin-Parrish, 2005, Kern County, California, Doc Nos. 205056768 and 205128539; Deed, Victoria Houchin, Ruth McLoughlin, and Debra Houchin-Parrish to Debra Houchin-Parrish, April 26, 2006, Kern County, California, Doc No. 206101465.

[2] Barnes, *Data on Irrigation Buttonwillow Ranch and Adjacent Lands*, 16-17; William A. Raznoff, *Drainage Investigations Buttonwillow Area of Kern County, California, (Bakersfield: USDA, Soil Conservation Service, Water Conservation District, 1945)*, 26-27; Thomas H. Means, *Report on Farming Lands Miller and Lux, Inc., Southern Division, Kern and Kings Counties California*, October 1919, Manuscript, Water Resources Center Archives, Berkeley, California, n.p.

[3] William H. Metzler, *Cotton Mechanization and Labor Stabilization*, Manuscript, Beale Memorial Library, Bakersfield, 1962; Committee to Aid Agricultural Organization, *Report of the Bakersfield Conference on Agricultural Labor-Health, Housing and Relief, Held October 29, 1938* (San Francisco: n.p., 1938) 1-4; C.F. Baughman, *Survey of Kern County Migratory Labor Problem*, Kern County Health Department, Sanitary Division, 1937, 2.

***Recorded by** G. Rainka & R. Herbert ***Date** December 2009 ☒ Continuation ☐ Update

Cotton production was a labor-intensive operation. In the years prior to extensive mechanization, rows of cotton required weeding and hoeing during the growing season, while fall months were spent hand-picking the harvest. By 1930, several labor camps were located around Buttonwillow, which later included one at this farmstead. The H.H. Curtis Ranch and the Combs Ranches (most notably Deep Wells) were the largest ranches providing both work and housing. As cotton production in Buttonwillow grew, the demand for new processing facilities also increased. By 1937, the town supported two gins, the Buttonwillow Gin and the Farmer's Cooperative Gin. A second gin was built on the latter's property in 1948. By the end of the 1940s, the three major crops of Buttonwillow were alfalfa, cereal grains, and cotton, grown on 187 farms.[4]

The reduced work force during World War II prompted a modernization of agricultural practices. New tractors, plows, cultivators, and harvesters entered the marketplace and farms were immediately able to manage their same acreage with less than one-quarter the manpower previously required. By 1960, the mechanization of farming had largely made labor camps obsolete.[5]

Development of the Subject Property

The 1932 USGS quadrangle (**Figure 1**, produced from a 1928-1929 survey) shows no buildings on the subject property. A decade later, the quad map (**Figure 2**, based on 1937 data) shows six buildings present in an L-shaped alignment. Aerial photography from 1942 (**Figure 3**) shows a much larger farmstead and labor camp that includes 28 small cottages, three larger residences, a row of six silos, and numerous shop buildings and/or shelters. By 1954, the farmstead had decreased in size, consisting of ten buildings aligned parallel to Wasco Way in two rows of five. Research did not reveal what other secondary structures existed, if any, at that time. In 1973 (**Figure 4**), those ten buildings had remained in place and all of the shop buildings and shelters described in P3a of this form had been built. A 1989 aerial photograph (**Figure 5**) shows buildings in their current configuration, with all but one of the residences fronting Wasco Way. There appears to have been no additions since then, though two cottages, a small shed, and a shelter shown in that photograph are no longer present.[6]

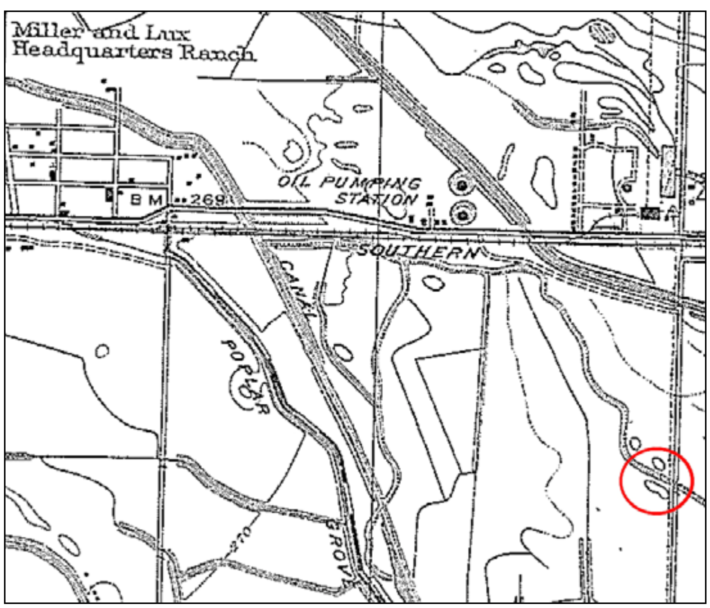


Figure 1. 1932 USGS Buttonwillow, CA Quadrangle.

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[4] Metzler, *Cotton Mechanization and Labor Stabilization*; Census Bureau, 1930 Manuscript Census, Buttonwillow precinct, Kern County, California, Enumeration District 15-55 Sheets 1A – 9A Raznoff, 81-82; Catherine Merlo, "From the Ground Up: The First Fifty Years of Farmers Cooperative Gin," (Farmers Cooperative Gin: 1987).

[5] John Turner, *White Gold Comes to California*, 56, 69-75.

[6] USGS Quadrangle, Buttonwillow, CA, 1932, 1942, 1954, and 1954 photorevised 1973; Aerial Photographs, 1942, 1989, and 2005.

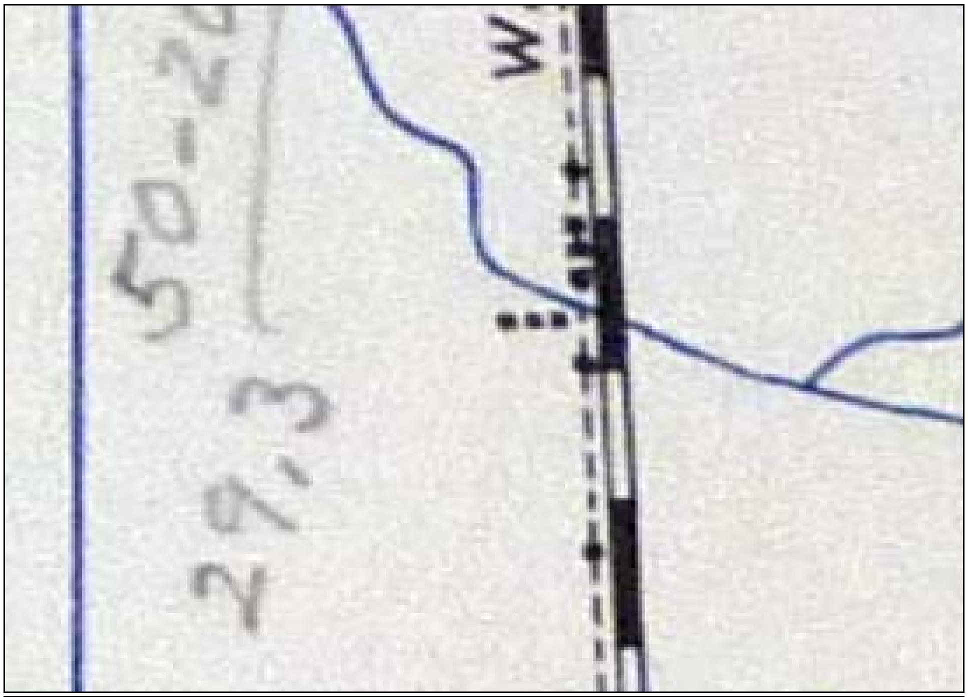


Figure 2. 1942 USGS Buttonwillow, CA Quadrangle.

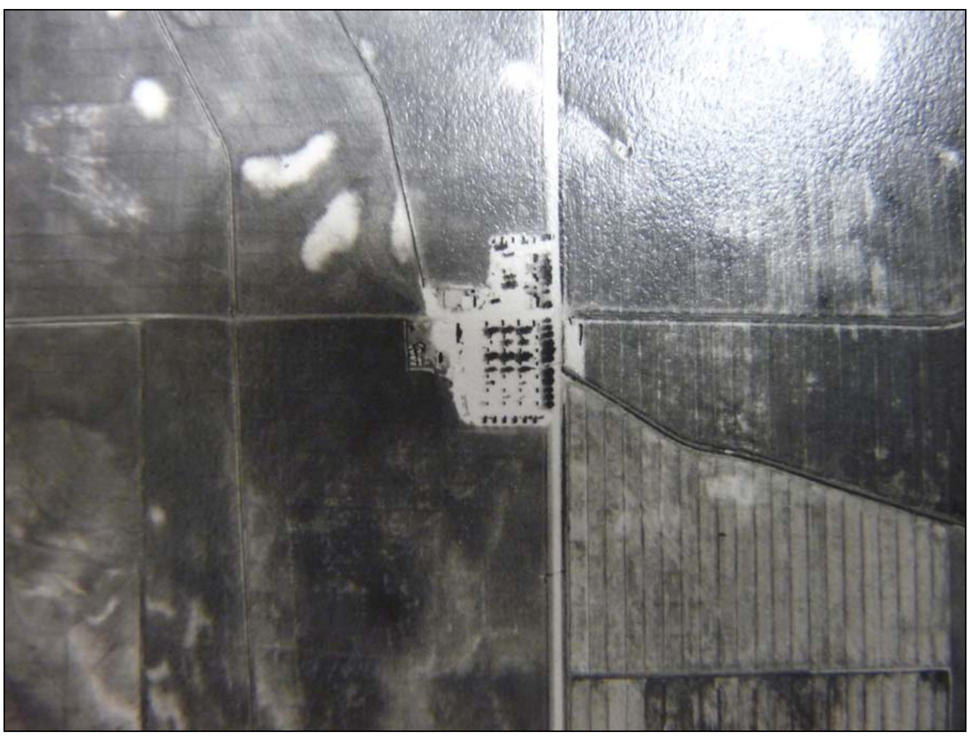


Figure 3. 1942 Aerial Photograph.

***Recorded by** G. Rainka & R. Herbert ***Date** December 2009 ☒ Continuation ☐ Update

Figure 4. 1954 USGS Buttonwillow, CA Quadrangle, photorevised 1973.

Figure 5. 1989 Aerial Photograph.

Evaluation

Under Criterion 1 or A, this property does not appear to be significant for its association with the development of Buttonwillow, specifically in relation to the area's cotton ranches and affiliated labor camps. Farm labor was central to the cotton culture of Kern County from the beginning of the crop's production in the late nineteenth century to the mechanization of farming practices by the middle of the twentieth century; however, research did not reveal a direct relationship between this farm and historically significant events.

A property is not eligible under Criterion 2 or B if its only justification for significance is that it was owned or used by a person important to history. This property does not specifically illustrate the significance of prominent land owners Henry Miller and Charles Lux or their local land agent C.E. Houchin. In addition, it does not appear that the subsequent owners of this property—ranchers Francis, Okey, and Dutch Houchin—made demonstrably important contributions to history at the local, state, or national level. The Houchin family is one of many having a long history of farming in the area, and their contribution alone is not significant.

Under Criterion 3 or C, this farmstead does not appear to embody distinctive architectural characteristics of a type, period, or method of construction, nor does it appear to be the work of a master. The residences are ordinary examples of a rural vernacular style common throughout Kern County, and all ancillary buildings and structures have standard utilitarian designs.

Lastly, this property does not appear to be a source (or likely source) of important information regarding history, and is therefore ineligible under Criterion 4 or D. It does not appear to have any likelihood of yielding important information about historic construction materials or technologies.

Overall, this property has not sufficiently retained integrity. Though the farmstead remains in its original location just west of Wasco Way, its design and configuration (in particular the number of residences) has been modified often. Many alterations appear to have occurred in the past 50 years, and therefore cannot be considered historic. Most significantly, only six cottages remain; of these, two are unoccupied and the remaining four have at least some replacement windows not in kind. In addition, Building 10 has undergone extensive exterior alterations in recent years, which have included a new roof and replacement windows throughout.

Photographs (cont):

Photograph 2. Building 1, residence, facing northwest.

Photograph 3. Building 4, residence, facing northwest.

Photograph 4. Building 2, residence, facing northwest.

Photograph 5. Building 3, residence, facing northwest.

Photograph 6. Building 5, residence, facing northwest.

Photograph 7. Building 6, residence, facing northwest.

Photograph 8. Building 7, storage shed, facing west.

Photograph 9. Building 8, storage shed, facing west.

Photograph 10. Building 9, garage, facing northwest.

Photograph 11. Building 10, office, facing southwest.

Photograph 12. Building 11 and silos, facing northwest.

Photograph 13. Building 12, tack room, facing west.

Photograph 14. Sheltered emu pen, facing southwest.

Photograph 15. Octagonal hay shelter, facing east.

Photograph 16. Gabled barn, facing southwest.

Photograph 17. Equipment shelter, facing northwest.

Photograph 18. Quonset hut, facing northeast.

Photograph 19. Hay shed, facing northwest.

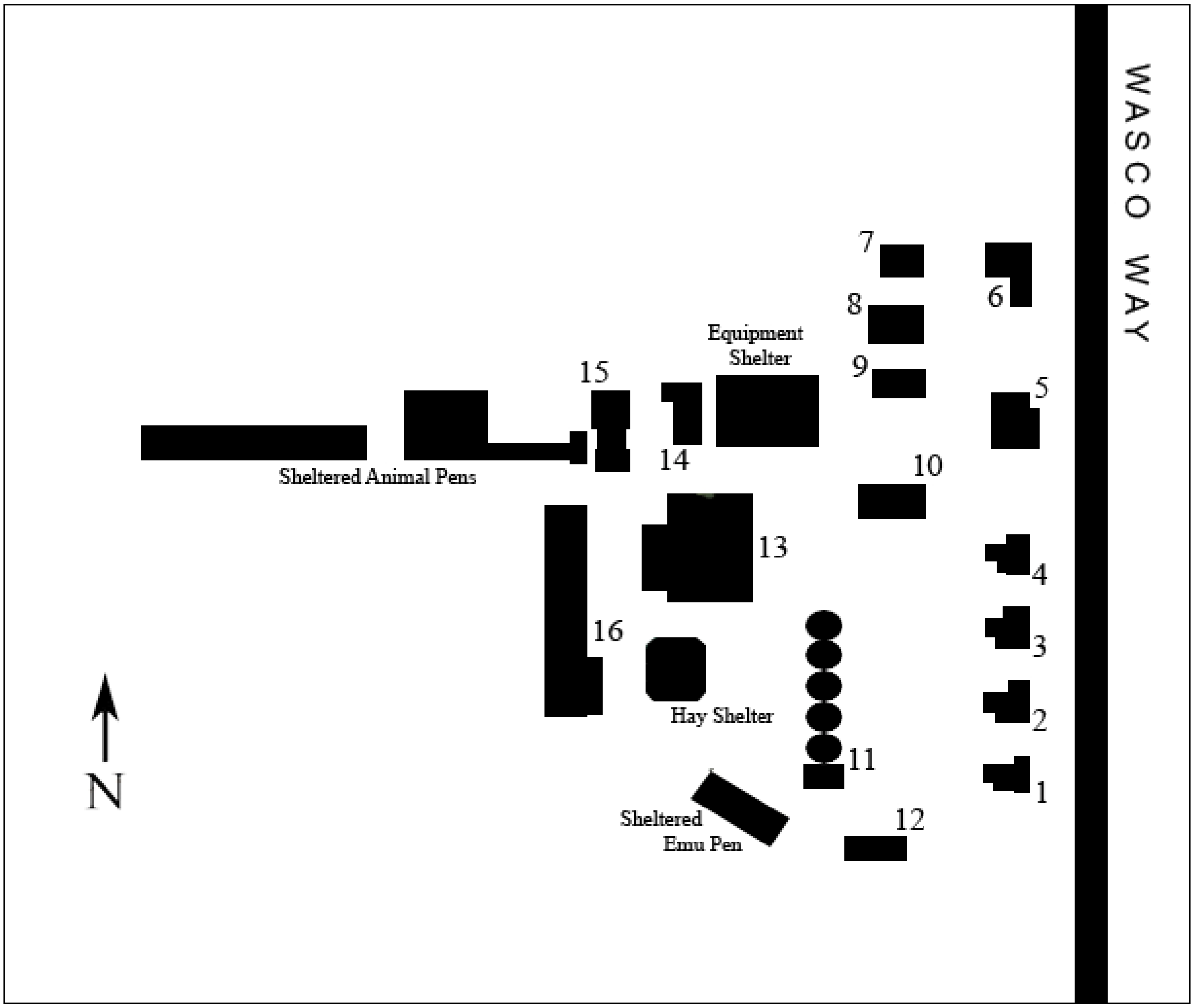
Photograph 20. Sheltered animal pens, facing northwest.

Photograph 21. Equipment shed, facing southwest.

***Resource Name or #** (Assigned by recorder) Map Reference #27

***Recorded by** G. Rainka & R. Herbert *Date December 2009 ☒ Continuation ☐ Update

Sketch Map:



DPR 523 FORM

for

401 E. Front Street

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
PRIMARY RECORD

Primary # ______
HRI # ______
Trinomial ______
NRHP Status Code 6Z

Other Listings ______
Review Code ______ Reviewer ______ Date ______

 ***Resource Name or #** (Assigned by recorder) Map Reference #28

P1. Other Identifier: 401 East Front Street

***P2. Location:** ☐ Not for Publication ☒ Unrestricted ***a. County** Kern

and (P2b and P2c or P2d. Attach a Location Map as necessary.)

***b. USGS 7.5' Quad** Buttonwillow, CA **Date** 1954 photorevised 1973 **T** 29S; **R** 23E; SW ¼ **of Sec** 13; MD **B.M.**

c. Address 401 East Front Street City Buttonwillow Zip 93206

d. UTM: (give more than one for large and/or linear resources) Zone ______; ______mE/ ______mN

e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)

Assessor Parcel Number: 101-020-12; alternate address: 41335 Highway 58

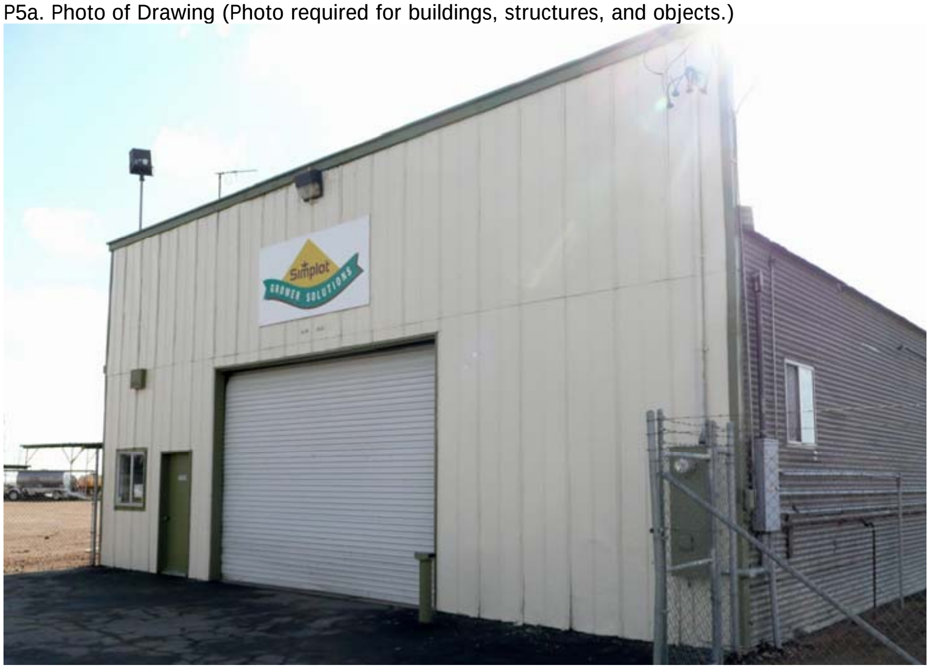
***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)

This 10.04-acre, triangular parcel is bounded by Highway 58 to the north and the McKittrick Branch of the Southern Pacific Railroad to the south, and consists of two business lots. SimPlot Grower Solutions occupies the east half of the parcel with a shop/office building, a small tank farm, and a section of railroad siding (**Photographs 1, 2,** and **3**). The remainder of the parcel is occupied by Buttonwillow Warehouse Company, and includes an office building with attached equipment shed, a small tank farm, and oil sheds (**Photographs 4**, **5,** and **6**). The only structure on this parcel requiring evaluation appears to be the SimPlot shop/office building, which was built between 1954 and 1973. This building faces Highway 58 to the north, and has a rectangular footprint, front-gabled roof, corrugated metal panel roofing and siding, and a false front with flat parapet. A large metal roll up door is centered on the primary façade, and is flanked to the east by a smaller personnel access door and aluminum sliding window. Similar sliding windows are also found on the east and west side walls. A shed-roofed equipment space is attached to the rear of the building. A large metal roll up door and personnel door face west and are sheltered by a metal-framed carport.

***P3b. Resource Attributes:** (List attributes and codes) (HP8) Industrial building

***P4. Resources Present:** ☐ Structure ☒ Building ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5a. Photo of Drawing (Photo required for buildings, structures, and objects.)



P5b. Description of Photo: (View, date, accession #) **Photograph 1.** SimPlot shop/office building, primary façade, facing southeast.

***P6. Date Constructed/Age and Sources:** ☒ Historic ☐ Prehistoric ☐ Both
Between 1954 and 1973, USGS Quad Maps.

***P7. Owner and Address:**
Union Pacific Railroad Co.
1700 Farnam St.
Omaha, NE 68102

***P8. Recorded by:** (Name, affiliation, address)
Greg Rainka and Rand Herbert
JRP Historical Consulting, LLC
1490 Drew Ave, Suite 110,
Davis, CA 95618

***P9. Date Recorded:** December 2009

***P10. Survey Type:**
Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") JRP Historical Consulting LLC – "Historical Resources Inventory and Evaluation Report for the Hydrogen Energy California Project," December 2009 Addendum.

***Attachments:** ☐ None ☒ Location Map ☒ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☐ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) ______

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Map Reference #28

B1. Historic Name: ____________
B2. Common Name: ____________
B3. Original Use: Light Industrial B4. Present Use: Light Industrial
***B5. Architectural Style:** Utilitarian
***B6. Construction History:** (Construction date, alteration, and date of alterations) SimPlot Shop/Office built between 1954 and 1973; remaining structures built after 1973.
***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown Date:** ____________ **Original Location:** ____________
***B8. Related Features:** ____________
B9. Architect: Unknown b. Builder: Unknown
***B10. Significance: Theme** n/a **Area** n/a
Period of Significance n/a **Property Type** n/a **Applicable Criteria** n/a

This property does not appear to meet the criteria for listing in the National Register of Historic Places or the California Register of Historical Resources because it does not have historical significance nor has it retained integrity. This property has also been evaluated in accordance with Section 15064.5(a)(2)-(3) of the California Environmental Quality Act (CEQA) Guidelines, using the criteria outlined in Section 5024.1 of the California Public Resources Code, and does not appear to be a historical resource for the purposes of CEQA.

In 1893, Miller & Lux, Inc., sold 71 acres to the Pacific Improvement Company to establish a townsite at Buttonwillow. The McKittrick Branch of the Southern Pacific Railroad was constructed that same year, connecting Bakersfield with Asphalto (now McKittrick), and included a depot and small rail yard in Buttonwillow. The line was shortened in the 1950s, and now ends in this town, approximately ½ mile west of the subject property. The establishment of a post office in 1895 was sign of a stable population; the majority of the townsite remained unsold, though, and reverted to Miller & Lux. In 1927, under the direction of land agent C.E. Houchin, Buttonwillow was replatted. (See Continuation Sheet)

B11. Additional Resource Attributes: (List attributes and codes) ____________

***B12. References:**

John F. Bergman, *The History of the Sunset Railway Including the McKittrick Branch of the Southern Pacific Company* (Bakersfield: Kern County Historical Society, 1994); Eugene Burmeister, *The Golden Empire Kern County*, California (Beverley Hills: Autograph Press, 1977).

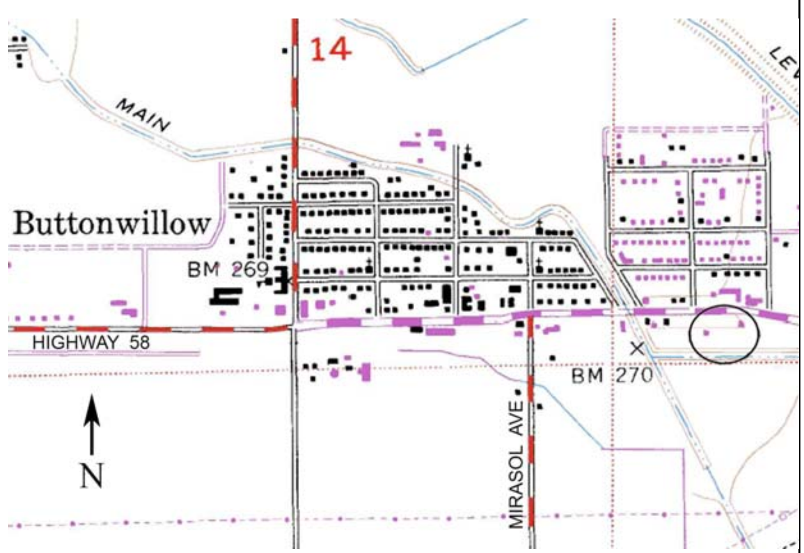
B13. Remarks:

***B14. Evaluator:** Greg Rainka

***Date of Evaluation:** December 2009

(This space reserved for official comments.)

(Sketch Map with north arrow required.)



B10. Significance (continued):

Development of the Subject Property

The 1932 USGS quadrangle (**Figure 1**, produced from a 1928-1929 survey) shows only a drainage ditch for the Main Drain Canal on the subject property. A decade later, the quad map (**Figure 2**, based on 1937 data) shows a transmission line passing through the parcel. According to aerial photography from 1942 (**Figure 3**), the south half of the property contained a side rail of the McKittrick Branch with a collection of unpaved access roads and industrial/warehouse buildings occupying the remaining area. The 1954 quad map (**Figure 4**) again shows no buildings on the subject property. Two structures are present by 1973 (**Figure 5**), with one likely being the current SimPlot shop/office building described on this form. The other building has either been demolished or exists in a modern form as a Buttonwillow Warehouse Company oil shed. Today, the property contains the facilities of two businesses (**Figure 6**). SimPlot Grower Solutions occupies the east half of the parcel with a shop/office building, a small tank farm, and a section of the aforementioned siding rail with stationary tank cars. The remainder of the parcel is occupied by Buttonwillow Warehouse Company, and includes an office building with attached equipment shed, a small tank farm, and oil sheds.[1]

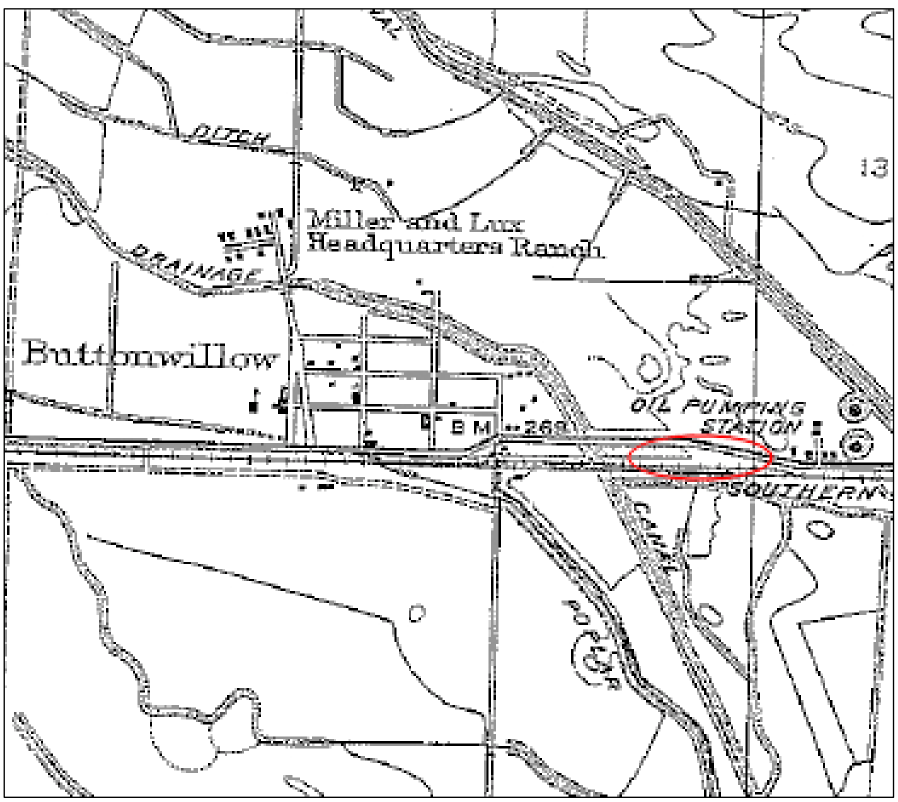


Figure 1. 1932 USGS Buttonwillow, CA Quadrangle.

[1] USGS Quadrangle, Buttonwillow, CA, 1932, 1942, 1954, and 1954 photorevised 1973; Aerial Photographs, 1942 and 2005.

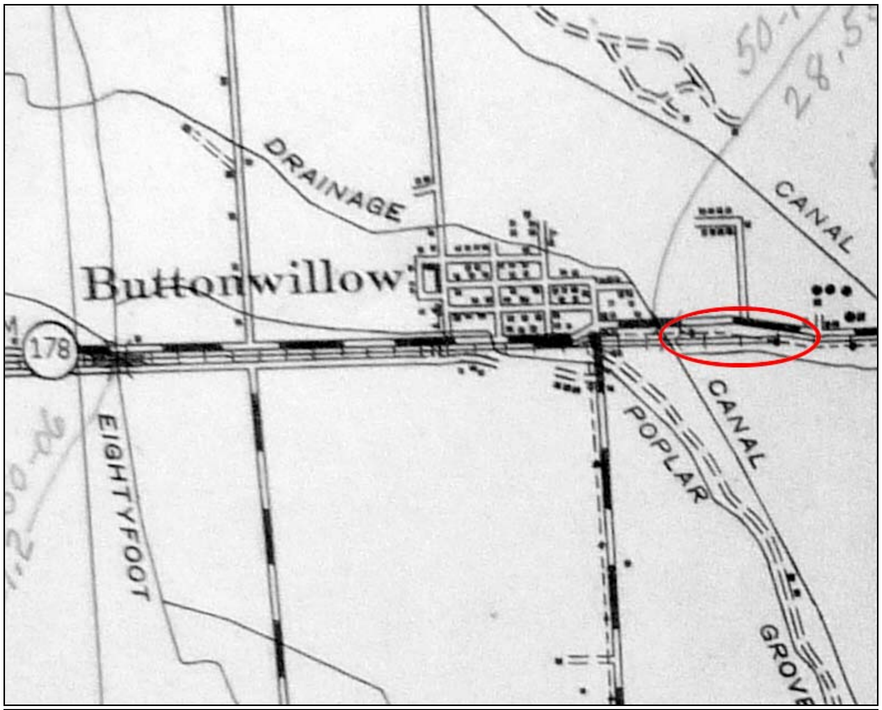


Figure 2. 1942 USGS Buttonwillow, CA Quadrangle.

Figure 3. 1942 Aerial Photograph.

***Recorded by** G. Rainka & R. Herbert *Date December 2009 ☒ Continuation ☐ Update

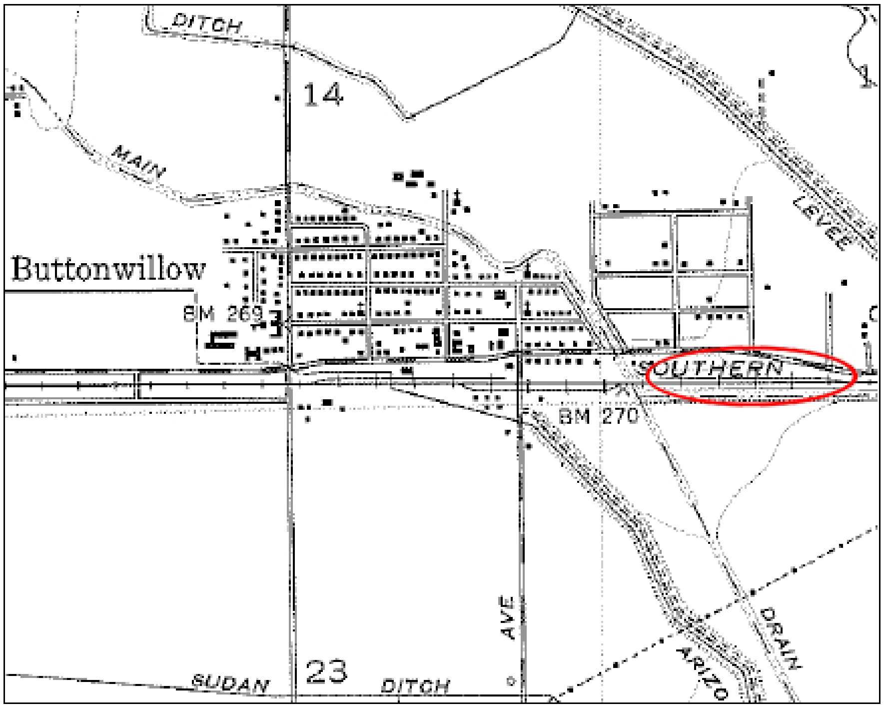


Figure 4. 1954 USGS Buttonwillow, CA Quadrangle

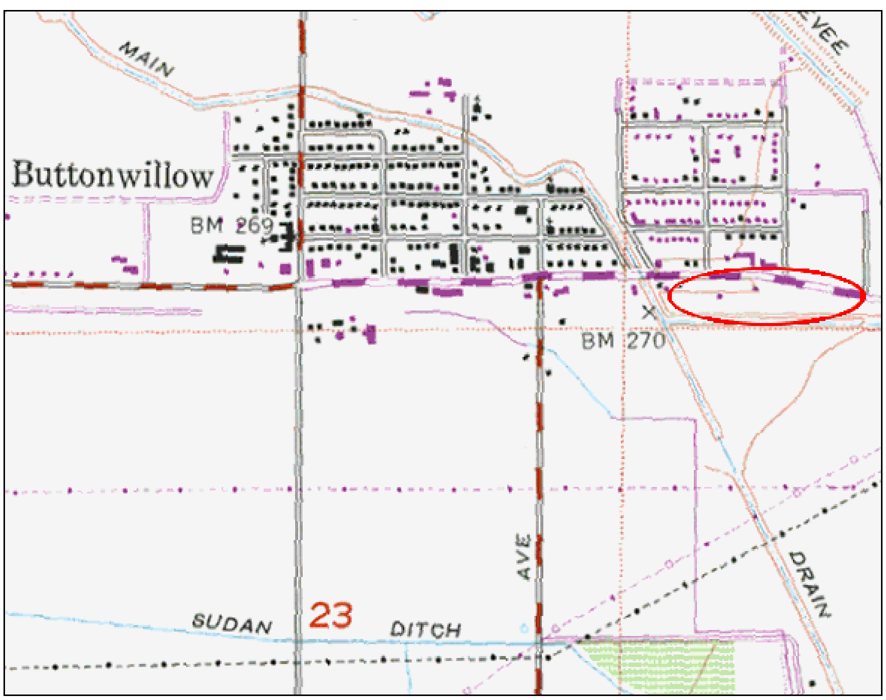


Figure 5. 1954 USGS Buttonwillow, CA Quadrangle, photorevised 1973.

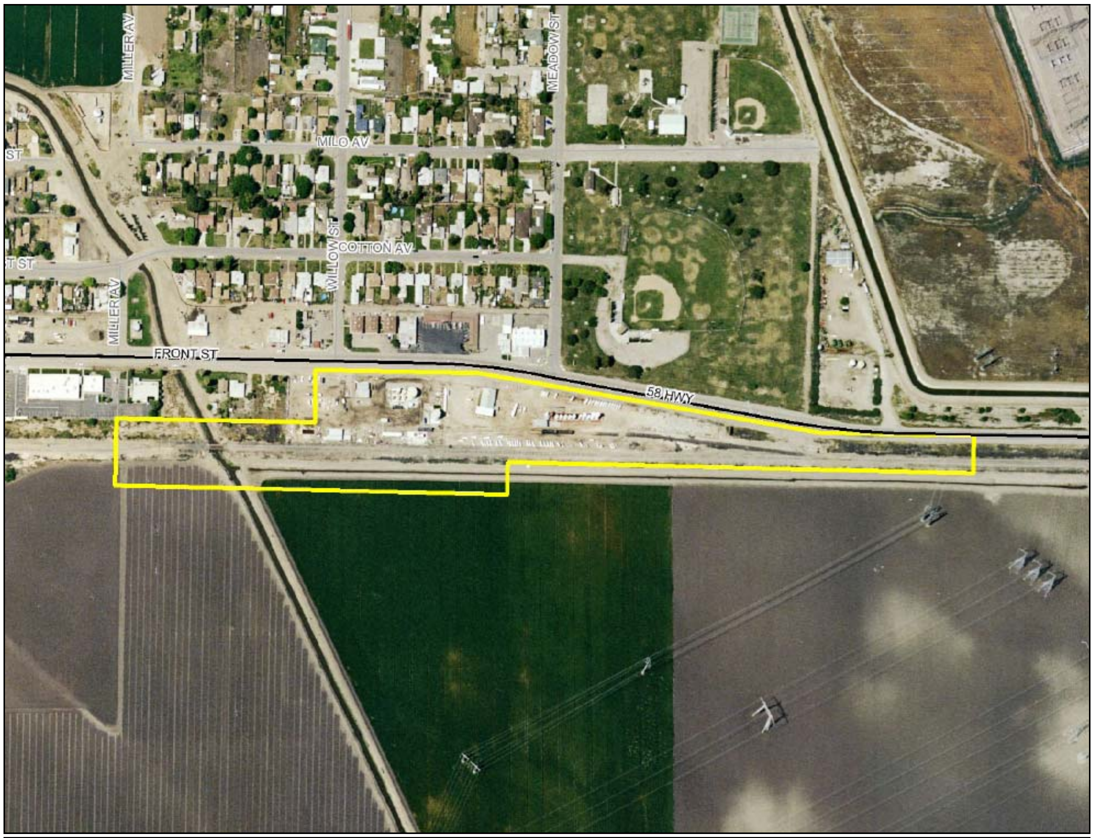


Figure 6. 2006 Aerial Photograph (with subject property outlined in yellow).

Evaluation

Under Criterion 1 or A, this property does not appear to be significant for its association with the development of Buttonwillow, specifically in relation to the McKittrick Branch of the Southern Pacific Railroad. This property appears to have been originally a portion of the town's rail yard and a drainage area for the Main Drain Canal. Under Criterion 2 or B, this property does not appear to be significant for its association with the lives of persons important to history. This property has been owned by the Southern Pacific Railroad (later Union Pacific) throughout its history and partially occupied by local businesses. Under Criterion 3 or C, the single historic building on this property (the SimPlot shop/office) does not appear to embody distinctive characteristics of a type, period, or method of construction, nor does it appear to be the work of a master. The building has a standard utilitarian design with a simple, rectangular false front. Lastly, this property does not appear to be a source (or likely source) of important information regarding history, and is therefore ineligible under Criterion 4 or D. It does not appear to have any likelihood of yielding important information about historic construction materials or technologies.

Overall, this property has not sufficiently retained integrity. Very simply, the majority of the property was developed during the past 30 years, and therefore cannot be regarded as an historic resource.

Photographs (cont):

Photograph 2. SimPlot shop/office building, west façade, facing east.

Photograph 3. SimPlot tank farm, facing east.

Photograph 4. Buttonwillow Warehouse Company office and equipment shed, facing east.

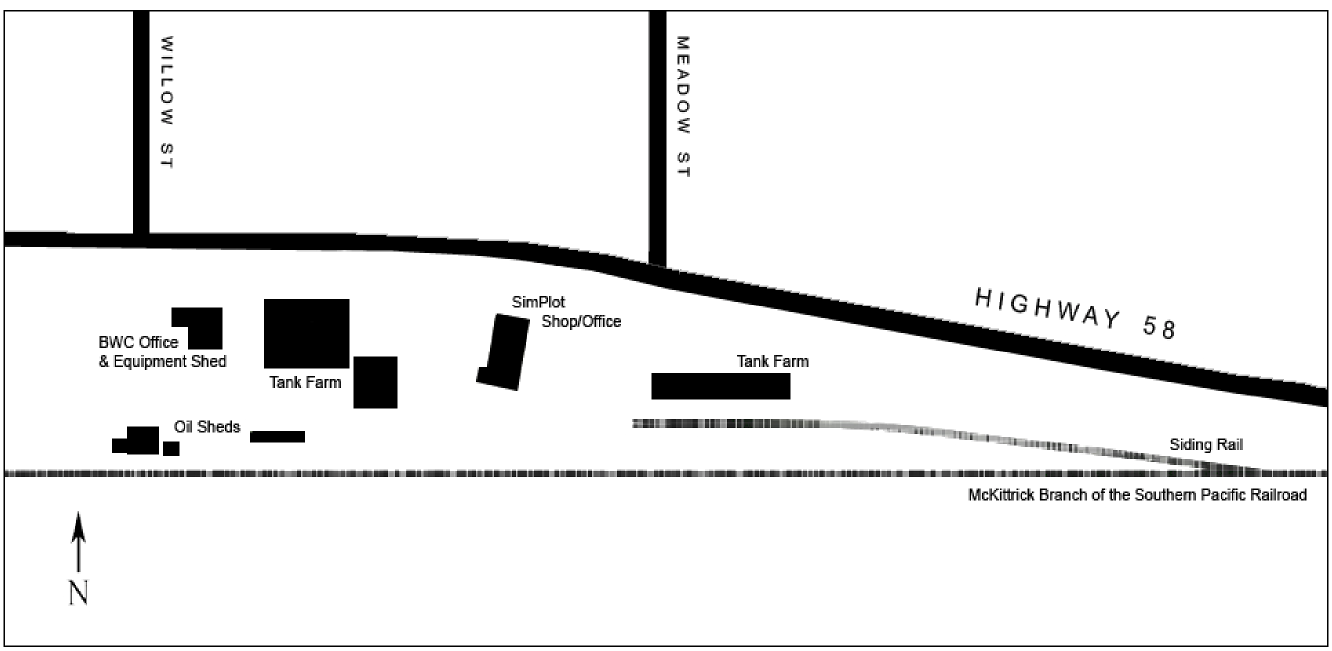
Photograph 5. Buttonwillow Warehouse Company tank farm, facing east.

***Resource Name or #** (Assigned by recorder) Map Reference #28

***Recorded by** G. Rainka & R. Herbert *Date December 2009 ☒ Continuation ☐ Update

Photograph 6. Buttonwillow Warehouse Company oil sheds, facing south.

Sketch Map:



DPR 523 FORM

for

Portions of the Buena Vista Water Storage District Updated to Include W.S. 3

State of California – The Resources Agency
DEPARTMENT OF PARKS AND RECREATION

PRIMARY RECORD

Primary # ____________
HRI # ____________
Trinomial ____________
NRHP Status Code 6Z

Other Listings ____________
Review Code ________ Reviewer ____________ Date ________

 ***Resource Name or #** (Assigned by recorder) Canals

P1. Other Identifier: Portions of the Buena Vista Water Storage District

***P2. Location:** ☐ Not for Publication ☒ Unrestricted ***a. County** Kern
and (P2b and P2c or P2d. Attach a Location Map as necessary.)

***b. USGS 7.5' Quad** East Elk Hills and Buttonwillow **Date** 1954 (revised 1973) **T**___; **R** ___; __ ¼ of Sec ___; ______ **B.M.**

c. Address ____________ City ____________ Zip ____________

d. UTM: (give more than one for large and/or linear resources) See Linear Records

e. Other Locational Data: (e.g., parcel #, directions to resource, elevation, etc., as appropriate)
Located south of Highway 58 east of Wasco Way and West of Tupman Road.

***P3a. Description:** (Describe resource and its major elements. Include design, materials, condition, alterations, size, setting, and boundaries)

The Buena Vista Water Storage District (BVWSD) formed in 1924 and assumed ownership and management of the canal system developed by Miller & Lux. The system stretches from the second point of measurement on the Kern River to Buena Vista Lake and then northwest along the former Buena Vista Slough to Tule Lake. This form evaluates a portion of the system north of the Old Headquarters Weir northwest to Highway 58 bounded by the East Side Weir on the east and Wasco Way on the west. An overall description of each canal is included in the following continuation sheets. Also included are Linear Feature Forms for each point surveyed, grouped by canal. (See Continuation Sheet)

***P3b. Resource Attributes:** (List attributes and codes) (HP20) Canal/aqueduct

***P4. Resources Present:** ☒ Structure ☐ Building ☐ Object ☐ Site ☐ District ☐ Element of District ☐ Other (Isolates, etc.)

P5a. Photo of Drawing (Photo required for buildings, structures, and objects.)

P5b. Description of Photo: (View, date, accession #) **Photograph 1:** West Side Canal south of Freeborn Road, facing southeast, March 9, 2009.

***P6. Date Constructed/Age and Sources:** ☒ Historic ☐ Prehistoric ☐ Both
1876-1918; alterations and improvements to date.

***P7. Owner and Address:**
Buena Vista Water Storage District
525 North Main
Buttonwillow, CA 93206

***P8. Recorded by:** (Name, affiliation, address)
R. Herbert, C. Brookshear, and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave, Suite 110,
Davis, CA 95618

***P9. Date Recorded:** February 2, 2009

***P10. Survey Type:** (Describe)
Intensive

***P11. Report Citation:** (Cite survey report and other sources, or enter "none.") JRP Historical Consulting, LLC. " Historical Resources Inventory and Evaluation Report for the Hydrogen Energy California Project," April 2009.

***Attachments:** ☐ None ☐ Location Map ☐ Sketch Map ☒ Continuation Sheet ☒ Building, Structure, and Object Record ☐ Archaeological Record ☐ District Record ☒ Linear Feature Record ☐ Milling Station Record ☐ Rock Art Record ☐ Artifact Record ☐ Photograph Record ☐ Other (list) ____________

***NRHP Status Code** 6Z

***Resource Name or #** (Assigned by recorder) Canals

B1. Historic Name: Kern Valley Water Company Canal, West Side Canal, East Side Canal, Main Drain, Poplar Grove Canal, Weed Island Ditch, Florida Drain, Deep Wells Ditch, Depot Drain

B2. Common Name: Flood Channel, West Side Canal, East Side Canal, Main Drain, Arizona Canal, Weed Island Ditch, Florida Drain, Deep Wells Ditch, Depot Drain

B3. Original Use: Canal B4. Present Use: Canal

***B5. Architectural Style:** Utilitarian

***B6. Construction History:** (Construction date, alteration, and date of alterations) 1876-1918; alterations and improvements up to present. See continuation sheets for individual canal histories.

***B7. Moved?** ☒ **No** ☐ **Yes** ☐ **Unknown Date:** __________ **Original Location:** __________

***B8. Related Features:** __________

B9. Architect: S.W. Wible b. Builder: Miller & Lux,; Buena Vista Water Storage District

***B10. Significance: Theme** n/a **Area** n/a

Period of Significance n/a **Property Type** n/a **Applicable Criteria** n/a

(Discuss importance in terms of historical or architectural context as defined by theme, period, and geographic scope. Also address integrity.)

This form evaluates a portion of the BVWSD system located north of the Old Headquarters Weir and south of Highway 58 bounded on the east by the East Side Canal and on the west by Wasco Way. The following section contains historic context for the development of the BVWSD, including the early Miller & Lux development. Also included are brief histories of each canal evaluated. Following the historic contexts are evaluations for the individual canals. The properties included on this form have been evaluated in accordance with Section 15064.5 (1)(2)-(3) of the California Environmental Quality Act (CEQA) Guidelines using the criteria outlined in Section 5024.1 of the California Public Resources Code. None of the canals appear to be historic resources for the purposes of the CEQA and they do not appear to meet the criteria for listing in the California Register of Historical Resources. (See Continuation Sheet)

B11. Additional Resource Attributes: (List attributes and codes) __________

***B12. References:**

USGS Quadrangles, *Buttonwillow 1932, 1942, 1954, 1954, photorevised 1973; East Elk Hills, 1933, 1954, 1954, photorevised 1973;* W. C. Hammett, *Report on Revaluation of Physical Properties to be Acquired by Buena Vista Water Storage District*, September 4, 1926 (San Francisco); Bancroft Library, Miller & Lux, CG-163, Buttonwillow Files, Carton 694 (see footnotes).

B13. Remarks:

***B14. Evaluator:** Cheryl Brookshear and Heather Norby

***Date of Evaluation:** April 2009

(This space reserved for official comments.)

(Sketch Map with north arrow required.)

See attached map on continuation sheet.

L1. Historic and/or Common Name: Kern Valley Water Company Canal

L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** KVWCC-1

b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) Less than 1/8 mile north of the corner of T30S R24 E Sections 5, 6, 7, and 8. Located at the southern end of Freeborn Road.

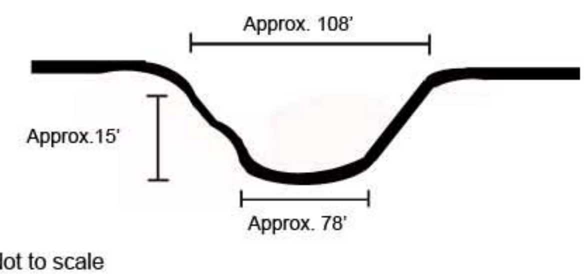
L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The Kern Valley Water Company Canal is a roughly trapezoidal earthen canal. The slopes and floor of the canal are vegetated with grasses and sagebrush. A dirt road bed has been cut in the northern side of the canal, traverses the canal, and continues up the gentler southern side. East of the end of Freeborn Road are concrete pilings embedded with metal pipes that have been cut off. A similar structure is located farther to the east. In the easternmost example, a metal pipe lies across the top of the pilings, like a pipeline. Photographs at the BVWSD indicate that wooden structures could be hung off these traversing pipelines to operate as water control features.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

a. Top Width: approximately 108 feet
b. Bottom Width: approximately 78 feet
c. Height or Depth: approximately 15 feet
d. Length of Segment: approximately 100 feet

L4e. Sketch of Cross-Section (include scale) **Facing:** West



L5. Associated Resources:
"pipeline" check structure

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)
Farmsteads, fallow fields, alfalfa.

L7. Integrity Considerations:

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing (View, scale, etc.)
KVWCC canal, "pipeline" check structure in the distance. Camera facing east, March 9, 2009

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)
C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date: March 9, 2009

L1. Historic and/or Common Name: Kern Valley Water Company Canal

L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** KVWCC-2

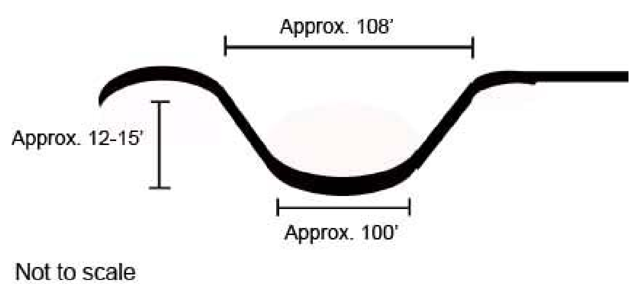
b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) At the corner of T30S R24 E Sections 9, 10, 16, and 15. At the southern end of Dairy Road.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)
The Kern Valley Water Company Canal is a roughly U-shaped canal. The path of the canal is irregular. The southern side is built up and resembles a levee or sand bar in areas. The height of this southern side is irregular and undulating, with a gentler slope into the canal. A steel reinforced concrete weir crosses the canal at this point. Northwest of the weir, the southern edge of the canal is slightly more regular. The weir has thirteen gates with metal guides for angled boards. A solid concrete railing tops the weir on the eastern side. A dirt road crosses the weir. West of the road is a replacement metal walkway above the gates with a metal railing. East of the weir is an inlet to the West Side Canal. The inlet has a concrete head wall and flanking walls. A square metal gate is raised and lowered by a screw mechanism. The gate leads to an underground culvert connecting the two canals.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

a. Top Width: approximately 180 feet
b. Bottom Width: approximately 100 feet
c. Height or Depth: varies approximately 12 to 15 feet
d. Length of Segment: approximately 100 feet.

L4e. Sketch of Cross-Section (include scale) **Facing:** West



L5. Associated Resources:
Concrete weir, west side canal inlet.

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)
Chaparral to the south, agricultural fields and the west side canal to the north.

L8a. Photograph, Map or Drawing

L7. Integrity Considerations:
The canal suffers from erosion and deposition of garbage and unwanted items.

L8b. Description of Photo, Map, or Drawing (View, scale, etc.)
Photograph: camera facing southwest, February 23, 2009

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)
C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date: February 23, 2009

L1. Historic and/or Common Name: West Side Canal

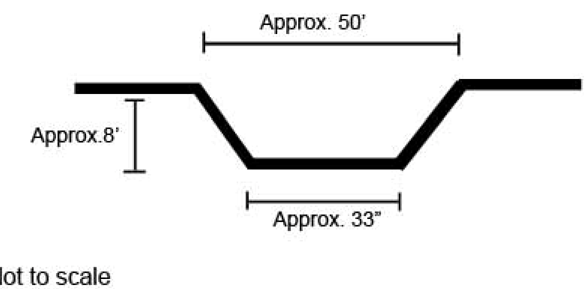
L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** WS-1

b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) Less than 1/8 mile north of the corner of T30S R24 E Sections 5, 6, 7, and 8. Located at the southern end of Freeborn Road.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)
The West Side Canal is a neatly shaped earthen ditch with a trapezoidal cross section. Two pipelines cross the canal. One is supported by two vertical pipes with a cross piece; the pipeline then lies across the crosspiece. Photographs at the BVWSD indicate that temporary check dams have been hung from these pipelines. Two gates are located along the northern side of the canal. Each gate has a concrete head wall and flanking walls. One of the two has a trash gate. Each circular metal gate is operated by a vertical screw mechanism. Northwest of Adohr Road is a concrete check dam. The dam has a concrete base and sides. Slats may be slid into six sections framed with metal guides. A metal walkway with railings is across the top of the check dam. The date 11-14-86 is incised into the concrete check dam. Concrete rubble lines the canal northwest of the check gate.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)
a. Top Width: approximately 50 feet
b. Bottom Width: approximately 33 feet
c. Height or Depth: approximately 8 feet
d. Length of Segment: approximately 100 feet.

L4e. Sketch of Cross-Section (include scale) **Facing:** Southeast



L5. Associated Resources:
Check dam, delivery gates.

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)
Alfalfa fields and two farmsteads.

L7. Integrity Considerations: Canals and ditches belonging to the BVWSD are shaped two times a year and are excavated approximately every 5 to 10 years.

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing (View, scale, etc.)
Check gate at West Side Canal, camera facing southeast, March 9, 2009

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)
C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date:

L1. Historic and/or Common Name: West Side Canal

L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** WS-2

b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) At the corner of T30S R24 E Sections 9, 10, 16, and 15. At the southern end of Dairy Road.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The West Side Canal is a well maintained, earth lined ditch with trapezoidal cross-section. This linear point is at the canal's intake where it joins Short Main Canal. From here, the canal flows in a northeasterly direction. A concrete check gate with three bays controls the flow of water into the canal and also serves as a bridge.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

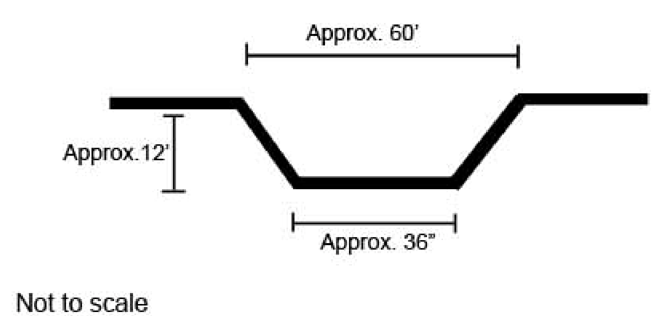
a. Top Width: Approximately 60 feet

b. Bottom Width: Approximately 36 feet

c. Height or Depth: Approximately 12 feet

d. Length of Segment:

L4e. Sketch of Cross-Section (include scale) **Facing:** Northwest



L5. Associated Resources:

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)

L7. Integrity Considerations: Canals and ditches belonging to the BVWSD are shaped two times a year and are excavated approximately every 5 to 10 years.

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing (View, scale, etc.)

Photograph 1: West Side Canal, facing northwest, February 2, 2009.

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)

C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date: February 2, 2009

L1. Historic and/or Common Name: West Side Canal

L2a. Portion Described: ☐ Entire Resource ☐ Segment ☒ Point Observation **Designation:** WS-3

b. Location of point or segment: UTM: Zone 11 / 280,698 mE / 3,912,494 mN; located approximately one-half mile south of the Adohr Road bridge over the Arizona Canal.

L3. Description:

The West Side Canal is a well-maintained, earthen-lined ditch with a trapezoidal cross-section. This linear point is at control structure W.S. 3, a concrete-framed check gate with three manual stop bays and earthen-filled buttresses. Canal water drops through this gate from east to west. A pair of slide gates is situated directly east of this structure on the canal's north bank; the larger of the two is a turnout to supply the Arizona Canal, while the other diverts water into a small lateral.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

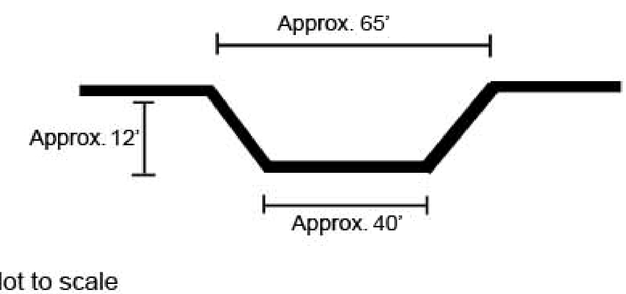
a. Top Width: Approximately 65 feet

b. Bottom Width: Approximately 40 feet

c. Height or Depth: Approximately 12 feet

d. Length of Segment:

L4e. Sketch of Cross-Section (include scale) **Facing:** Northwest



L5. Associated Resources:

L6. Setting:

This section of the West Side Canal is surrounded by agricultural land producing various row crops, namely cotton.

L7. Integrity Considerations:

Canals and ditches belonging to the BVWSD are shaped two times a year and are excavated approximately every 5 to 10 years.

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing:

W.S. 3 of the West Side Canal, facing northwest.

L9. Remarks:

L10. Form Prepared by:

Greg Rainka
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date: December 2009

L1. Historic and/or Common Name: East Side Canal

L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** ES-1

b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) T29S R24 E west line of Section 19, approximately 1/8 mile south of Highway 58 as it crosses Wasco Avenue.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

The East Side Canal is an earthen trapezoidal ditch, with few water control features. The canal crosses under Wasco Avenue via a culvert of three concrete circular pipes with concrete head walls. A three-sided concrete box leads to a pipe with pump. The pump and pipes are located to the southwest of the culvert.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

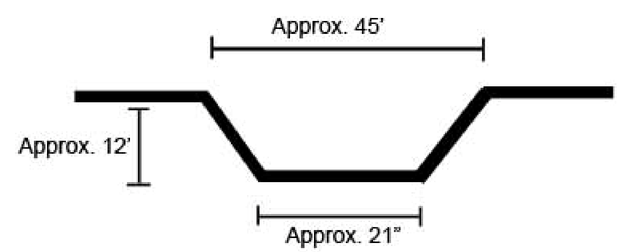
a. Top Width: approximately 45 feet

b. Bottom Width: approximately 21 feet

c. Height or Depth: approximately 12 feet

d. Length of Segment: approximately 100 feet

L4e. Sketch of Cross-Section (include scale) **Facing:** West



L5. Associated Resources:
Concrete culvert, irrigation pump

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.) The area north of the canal contains the Farmer's Cooperative Gins, and a single residence. South of the canal are fields of alfalfa.

L7. Integrity Considerations:
Canals and ditches belonging to the BVWSD are shaped two times a year and are excavated approximately every 5 to 10 years.

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing (View, scale, etc.)
East side canal, facing west from Wasco Avenue, March 9, 2009.

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)
C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date: March 9, 2009

State of California — The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
LINEAR FEATURE RECORD

Primary #
HRI #
Trinomial

Resource Name or #: (Assigned by recorder) ES

L1. Historic and/or Common Name: East Side Canal

L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** ES-2

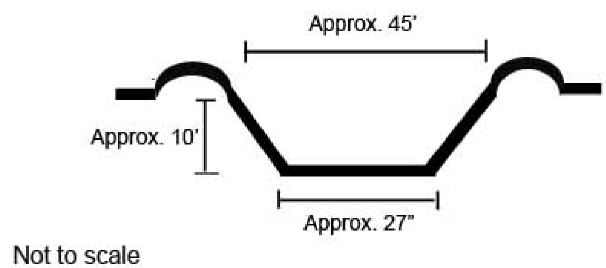
b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) T29S R24 E line between Section 20 and 29 at the end of Buerkle Road.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)
The East Side Canal is a trapezoidal earthen canal flowing northwest. A check gate is north of Buerkle Road. The gate is concrete, dated 1976, with six slots framed with metal. Drop gates consist of concrete slabs. Downstream of the check is a section of rubble lining. South of the check gate is the center pylon of a bridge. The concrete pylon is narrow and runs about 6 feet along the center of the canal.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

a. Top Width: approximately 45 feet
b. Bottom Width: approximately 27 feet
c. Height or Depth: approximately 10 feet
d. Length of Segment: approximately 100 feet

L4e. Sketch of Cross-Section (include scale) **Facing:** Northwest



L5. Associated Resources:
1976 check gate, bridge pylon

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)
The canal is surrounded by alfalfa fields, a residence, and a fallow field.

L7. Integrity Considerations:
Canals and ditches belonging to the BVWSD are shaped two times a year and are excavated approximately every 5 to 10 years.

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing (View, scale, etc.)
East side canal and check gate, camera facing northwest, March 9, 2009.

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)
C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date:

DPR 523E (1/95)

L1. Historic and/or Common Name: Main Drain

L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** MD-1

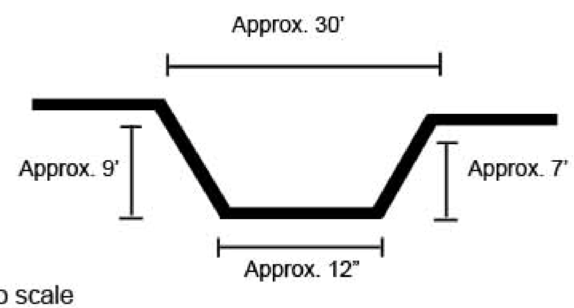
b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) T29 S R24 E south line of Section 30. Intersection of Main Drain and Brite Road, approximately ½ mile east of Wasco Avenue.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)
Main Drain is an earthen canal with a trapezoidal cross section. The drain is free of vegetation and is conveyed under Brite Road via a corrugated metal culvert. The eastern side is approximately 2 feet higher than the west.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

a. Top Width: approximately 30 feet
b. Bottom Width: approximately 12 feet
c. Height or Depth: approximately 7 to 9 feet
d. Length of Segment: approximately 100 feet.

L4e. Sketch of Cross-Section (include scale) **Facing:** South



L5. Associated Resources:

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)
Alfalfa fields.

L7. Integrity Considerations:
Canals and ditches belonging to the BVWSD are shaped two times a year and are excavated approximately every 5 to 10 years.

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing (View, scale, etc.) Main Drain camera facing south, March 9, 2009

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)
C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date: March 9, 2009

LINEAR FEATURE RECORD

Resource Name or #: (Assigned by recorder) MD

L1. Historic and/or Common Name: Main Drain

L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** MD-2

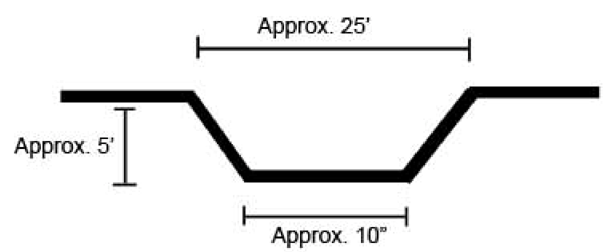
b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) T29 S R24 E South line of Section 32. Intersection of Main Drain and Stockdale Road, approximately ¾ mile east of Freeborn Road.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)
Main Drain is a narrow trapezoidal earthen ditch. The drain crosses under Stockdale Road via a round culvert with concrete head wall.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

a. Top Width: approximately 25 feet
b. Bottom Width: approximately 10 feet
c. Height or Depth: approximately 5 feet
d. Length of Segment: approximately 100 feet

L4e. Sketch of Cross-Section (include scale) **Facing:** North



L5. Associated Resources:
Culvert

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)
Farmstead, fallow field, and orchards.

L7. Integrity Considerations:
Canals and ditches belonging to the BVWSD are shaped two times a year and are excavated approximately every 5 to 10 years.

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing (View, scale, etc.)
Photograph 1: Main Drain camera facing north, March 11, 2009.

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)
C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date: March 11, 2009

L1. Historic and/or Common Name: Depot Drain

L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** DD-1

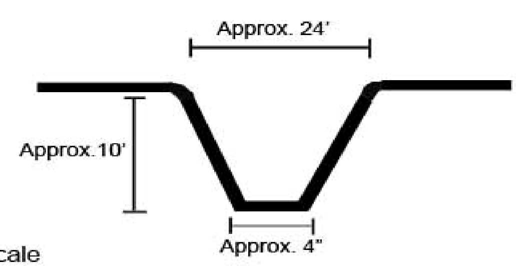
b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) South line of T29S R24 E Section 19. At intersection of Buerkle Road and Depot Drain, approximately 2/3 mile east of Wasco Avenue.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)
Depot Drain is an earthen canal with a narrow trapezoidal cross section. The ditch is conveyed under the road via a single round concrete pipe. Earth is slightly mounded on either side of the ditch. The ditch is piped for approximately 200 feet north of Burkle Road. The portion south of Burkle Road had been freshly excavated when the canal was recorded. Two pipes debouch into the canal south of Burkle Road.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

a. Top Width: approximately 24 feet
b. Bottom Width: approximately 4 feet
c. Height or Depth: approximately 10 feet
d. Length of Segment: approximately 300 feet.

L4e. Sketch of Cross-Section (include scale) **Facing:** South



L5. Associated Resources:
Culvert, pipeline

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)
Farmstead, alfalfa.

L7. Integrity Considerations:
Canals and ditches belonging to the BVWSD are shaped two times a year and are excavated approximately every 5 to 10 years.

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing (View, scale, etc.)
Camera facing south, March 9, 2009

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)
C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date: March 9, 2009

State of California — The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
LINEAR FEATURE RECORD

Primary #
HRI #
Trinomial

Resource Name or #: (Assigned by recorder) DD

L1. Historic and/or Common Name: Depot Drain

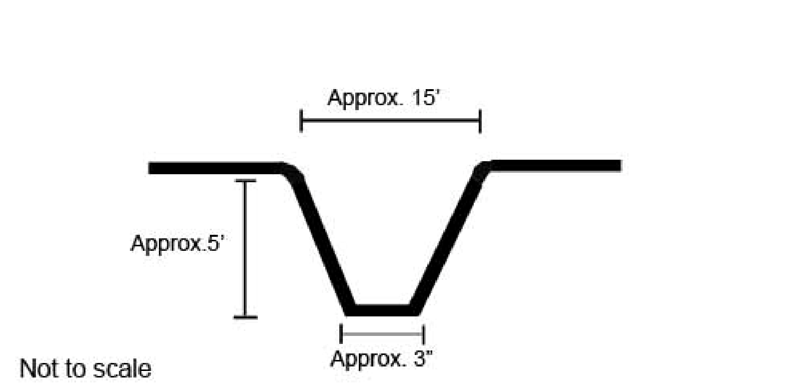
L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** DD-2

b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) East line of T29S R24 E Section 32. At intersection of Dunford Road and Depot Drain, approximately ¼ mile north of Stockdale Road.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)
Depot Drain is a narrow trapezoidal earthen canal. The north side is higher than the south. The drain is conveyed under Dunford Road via a round corrugated metal pipe. A smaller corrugated metal pipe debouches into the canal west of Dunford Road.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)
a. Top Width: approximately 15 feet
b. Bottom Width: approximately 3 feet
c. Height or Depth: approximately 5 feet
d. Length of Segment: approximately 100 feet

L4e. Sketch of Cross-Section (include scale) **Facing:** West



L5. Associated Resources:
Culvert, field drain.

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)
Alfalfa and grain fields, and a newer orchard.

L7. Integrity Considerations:
Canals and ditches belonging to the BVWSD are shaped two times a year and are excavated approximately every 5 to 10 years.

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing (View, scale, etc.)
Photograph 1: camera facing west, March 12, 2009

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)
C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date: March 12, 2009

LINEAR FEATURE RECORD

L1. Historic and/or Common Name: Deep Wells Ditch

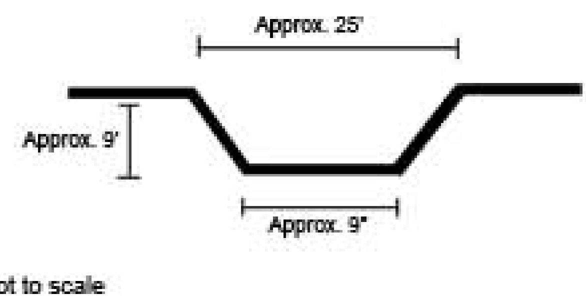
L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** DWD-1

b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) T29 S R24 E south line of Section 30. Intersection of Deep Wells Ditch and Brite Road, approximately ½ mile east of Wasco Avenue.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)
Deep Wells Ditch is a trapezoidal earthen excavation. A round metal pipe conveys the water under Brite Road. North of Brite Road is an earthen farm bridge with metal culvert. Between the road and farm bridge, the canal is lined with concrete rubble. A delivery gate with concrete headwall and flanking walls is north of the road. A circular metal gate is raised and lowered via a vertical screw mechanism. North of the road is also a second gate with concrete headwalls and a trash gate. This gate appears to be connected with a pump 10 feet away. No additional features are located south of the road.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)
a. Top Width: approximately 25 feet
b. Bottom Width: approximately 9 feet
c. Height or Depth: approximately 9 feet
d. Length of Segment: approximately 100 feet

L4e. Sketch of Cross-Section (include scale) **Facing:** East



L5. Associated Resources:
Trash grate, pump, delivery gate, farm bridge, culvert.

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)
Orchards and rye.

L7. Integrity Considerations:
Canals and ditches belonging to the BVWSD are shaped two times a year and are excavated approximately every 5 to 10 years.

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing (View, scale, etc.)
Gates north of road, camera facing east, March 9, 2009.

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)
C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date: March 9, 2009

L1. Historic and/or Common Name: Deep Wells Ditch

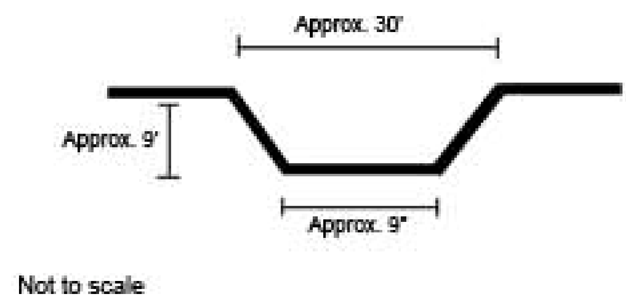
L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** DWD-2

b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) Corner of T29 S R24 E Sections 32, 33, and T30 S R 24 E Sections 4 and 5. Intersection of Deep Wells Ditch and Stockdale Road and Dunford Road.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)
Deep Wells Ditch continues as an earthen trapezoidal excavation. The ditch crosses under Dunford Road via two corrugated metal pipes. A single delivery gate is located along the north side of the road east of Dunford Road. The gate has a concrete headwall and flanking walls. The circular metal gate is operated with a vertical screw mechanism.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)
a. Top Width: approximately 30 feet
b. Bottom Width: approximately 9 feet
c. Height or Depth: approximately 9 feet
d. Length of Segment: approximately 100 feet

L4e. Sketch of Cross-Section (include scale) **Facing:** North



L5. Associated Resources:
Culvert and delivery gate.

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)
Orchards and alfalfa.

L7. Integrity Considerations:
Canals and ditches belonging to the BVWSD are shaped two times a year and are excavated approximately every 5 to 10 years.

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing (View, scale, etc.)

Photograph 1: camera facing north, March 12, 2009

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)
C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date: March 12, 2009

L1. Historic and/or Common Name: Arizona Ditch

L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** AD-1

b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) T29 S R24 E south line of Section 30. Intersection of Arizona Ditch and Brite Road, approximately 1/3 mile east of Wasco Avenue.

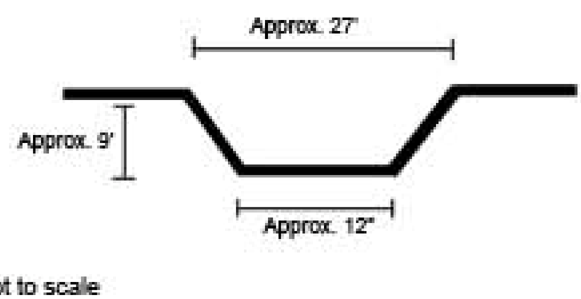
L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

Arizona Ditch is earthen with a trapezoidal cross section. A gate with a trash grate controls water entering the round culvert under Brite Road. Two distribution gates are located either side of the ditch just south of Brite Road. The distribution gates have concrete head and flanking walls. The metal circular gates are operated with vertical screws.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

a. Top Width: approximately 27 feet
b. Bottom Width: approximately 12 feet
c. Height or Depth: approximately 9 feet
d. Length of Segment: approximately 100 feet

L4e. Sketch of Cross-Section (include scale) **Facing:** North



L5. Associated Resources:
Distribution gates, culvert/check gate.

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)
Orchards and a single residence.

L7. Integrity Considerations: Canals and ditches belonging to the BVWSD are shaped two times a year and are excavated approximately every 5 to 10 years.

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing (View, scale, etc.)
Check gate culvert at Brite Road, camera facing north, March 9, 2009.

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)
C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date: March 9, 2009

State of California — The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
LINEAR FEATURE RECORD

Primary #
HRI #
Trinomial

 Resource Name or #: (Assigned by recorder) AD

L1. Historic and/or Common Name: Arizona Ditch

L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** AD-2

b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) T29 S R24 E South line of Section 32. Intersection of Arizona Ditch and Stockdale Road, approximately 1/3 mile east of Freeborn Road.

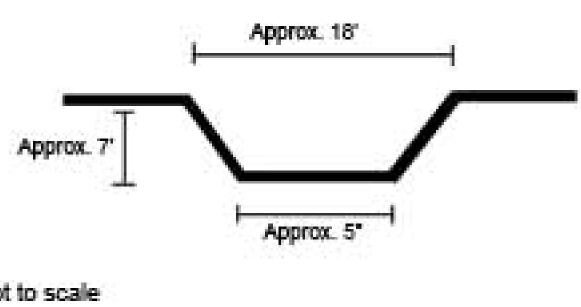
L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)

Arizona Ditch is an earthen trapezoidal canal. The canal is conveyed under the road via two round metal culverts with a concrete headwall. Along the west side of the canal to the north and to the south of the culvert are delivery gates. The gates have concrete headwalls and flanking walls. The circular metal gates are raised and lowered through a vertical screw mechanism.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

a. Top Width: Approximately 18 feet
b. Bottom Width: Approximately 5 feet
c. Height or Depth: Approximately 7 feet
d. Length of Segment: Approximately 100 feet.

L4e. Sketch of Cross-Section (include scale) **Facing:** Northwest



L5. Associated Resources:
Delivery gates and culvert.

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)
Orchards and alfalfa fields.

L7. Integrity Considerations: Canals and ditches belonging to the BVWSD are shaped two times a year and are excavated approximately every 5 to 10 years.

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing (View, scale, etc.)
Photograph: camera facing northwest, March 12, 2009.

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)
C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date: March 12, 2009

L1. Historic and/or Common Name: Weed Island Ditch

L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** WID-1

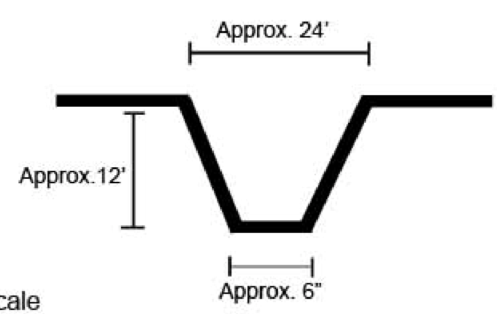
b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) Line between T29 S R24 E Section 31 and T29 S R23E Section 36. Intersection of Weed Island Ditch and Wasco Avenue, approximately ½ mile south of Brite Road.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)
Weed Island Ditch is an earthen ditch with trapezoidal cross section. The narrow base leads to a round concrete culvert that transports the water under Wasco Avenue. Southwest of Wasco Avenue is a delivery gate with concrete head wall and flanking walls. The circular metal gate is lifted and lowered by a vertical screw mechanism.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

a. Top Width: approximately 24 feet
b. Bottom Width: approximately 6 feet
c. Height or Depth: approximately 12 feet
d. Length of Segment: approximately 100 feet

L4e. Sketch of Cross-Section (include scale) **Facing:** East



L5. Associated Resources:
Culvert and delivery gate.

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)
Orchards and residence.

L7. Integrity Considerations:
Canals and ditches belonging to the BVWSD are shaped two times a year and are excavated approximately every 5 to 10 years.

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing (View, scale, etc.)
Weed Island Ditch camera facing east, March 9, 2009.

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)
C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date: March 9, 2009

LINEAR FEATURE RECORD

L1. Historic and/or Common Name: Weed Island Ditch

L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** WID-2

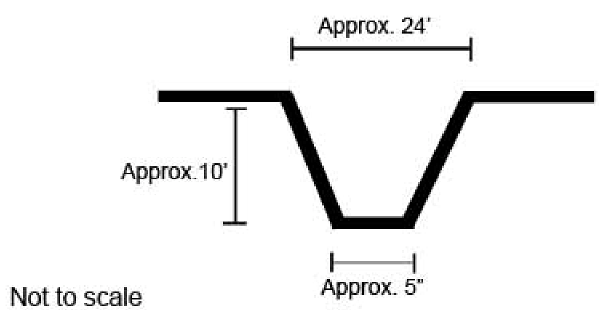
b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) T29 S R24 E SW ¼ Section 32. Approximately ¼ mile north of the intersection of Stockdale Road and Freborn Road.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)
Weed Island Ditch derives from the Arizona Ditch at this point. The earthen trapezoidal ditch has a concrete head gate that also acts as a farm bridge. The head gate has a concrete headwall and circular metal gate operated by a vertical screw mechanism. Incised in the concrete is the date 11-18-81. Northwest of the head gate, the ditch is lined with concrete rubble for several feet.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

a. Top Width: approximately 24 feet
b. Bottom Width: approximately 5 feet
c. Height or Depth: approximately 10 feet
d. Length of Segment: approximately 100 feet.

L4e. Sketch of Cross-Section (include scale) **Facing:** West



L5. Associated Resources:
Head gate.

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)
Orchards, alfalfa field, and residence.

L7. Integrity Considerations:
Canals and ditches belonging to the BVWSD are shaped two times a year and are excavated approximately every 5 to 10 years.

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing (View, scale, etc.)
Photograph 1: camera facing west, March 11, 2009

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)
C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date: March 11, 2009

Primary #
HRI #
Trinomial

 Resource Name or #: (Assigned by recorder) FD

L1. Historic and/or Common Name: Florida Drain

L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** FD-1

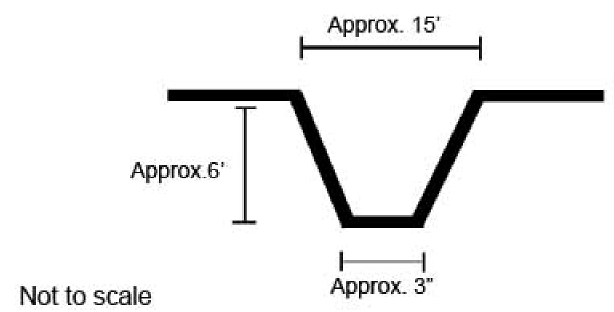
b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) Line between T29 S R24 E Section 31 and T30 S R24 E Section 6. Intersection of Florida Drain and Stockdale Road, approximately ½ mile west of Freeborn Road.

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)
The Florida Drain is an earthen canal with a trapezoidal cross section. The drain crosses under Stockdale Road via a corrugated metal pipe. Another smaller metal pipe releases water into the drain north of the road.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

a. Top Width: approximately 15 feet
b. Bottom Width: approximately 3 feet
c. Height or Depth: approximately 6 feet
d. Length of Segment: approximately 100 feet

L4e. Sketch of Cross-Section (include scale) **Facing:** North



L5. Associated Resources:
Culvert, field drain.

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)
Orchards, alfalfa, and fallow field.

L7. Integrity Considerations:
Canals and ditches belonging to the BVWSD are shaped two times a year and are excavated approximately every 5 to 10 years.

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing (View, scale, etc.)
Camera facing north, March 12, 2009

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)
C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date: March 12, 2009

State of California — The Resources Agency
DEPARTMENT OF PARKS AND RECREATION
LINEAR FEATURE RECORD

Primary #
HRI #
Trinomial

Resource Name or #: (Assigned by recorder) FD

L1. Historic and/or Common Name: Florida Drain

L2a. Portion Described: ☐ Entire Resource ☐ Segment ☐ Point Observation **Designation:** FD-2

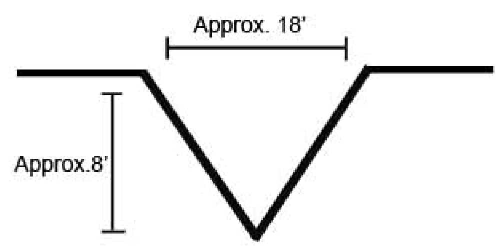
b. Location of point or segment: (Provide UTM coordinates, legal description, and any other useful locational data. Show the area that has been field inspected on a Location Map) Less than 1/8 mile north of the corner of T30S R24 E Sections 5, 6, 7, and 8. Located at the southern end of Freeborn Road

L3. Description: (Describe construction details, materials, and artifacts found at this segment/point. Provide plans/sections as appropriate.)
The Florida Ditch is a V-shaped earthen canal. The Florida Ditch joins the West Side Canal at this point. A head gate on the west side canal releases water into the Florida Drain through a round concrete culvert. The gate is operated via a manual vertical screw mechanism and has a metal round gate cover.

L4. Dimensions: (In feet for historic features and meters for prehistoric features)

a. Top Width: approximately 18 feet
b. Bottom Width: n/a
c. Height or Depth: approximately 8 feet
d. Length of Segment: approximately 100 feet

L4e. Sketch of Cross-Section (include scale) **Facing:** North



Not to scale

L5. Associated Resources:
Culvert, head gate.

L6. Setting: (Describe natural features, landscape characteristics, slope, etc., as appropriate.)
Farmstead and alfalfa fields.

L7. Integrity Considerations:
Canals and ditches belonging to the BVWSD are shaped two times a year and are excavated approximately every 5 to 10 years.

L8a. Photograph, Map or Drawing

L8b. Description of Photo, Map, or Drawing (View, scale, etc.)
Photograph 1: Florida Ditch facing north, March 9, 2009.

L9. Remarks:

L10. Form Prepared by: (Name, affiliation, and address)
C. Brookshear and H. Norby
JRP Historical Consulting, LLC
1490 Drew Ave Suite 110
Davis, CA 95618

L11. Date: March 9, 2009

DPR 523E (1/95)

P3a. Descriptions (continued):

What follows are general descriptions of the canals recorded for this survey. All of the canals in the study area follow a northwesterly route, the natural direction that water flowed when through the Buena Vista Slough. All of the following canals are currently owned and operated by the BVWSD. The district grades the canals twice per year and excavates them every 5 to 10 years. Descriptions of individual canal recordation points and comparison points appear on the Linear Forms.

Individual Canal Descriptions

Kern Valley Water Company Canal – Flood Channel
Originally constructed as a drainage canal and known as the Kern Valley Water Company Canal (KVWCC), today this waterway is simply known as the Flood Channel, which accurately describes its current use. No longer used for drainage or irrigation, the channel only receives overflow waters in years of heavy flooding. The channel begins at Old Headquarters Weir in Section 15 T30S/R24E MDBM and follows a winding path for approximately 26.8 miles in a northwesterly direction along the western boundary of the BVWSD, paralleling the West Side Canal. Entirely earth lined, the channel has a variable width due to flooding and erosion over the years. At the southern end, the top width is between 108 and 180 feet and has a variable depth of 12 to 15 feet, depending on the height of the western levy. The canal is bounded on the east by the West Side Canal. The western side is levied above the surrounding topography with soil removed from the channel. Reshaping by bulldozers traveling perpendicular to the canal has resulted in a U-shaped cross section. Flood waters have cut meandering paths in the bottom of the canal and left silt in other areas. This form addresses approximately 2 miles of the canal beginning at its southern end.
141,600 feet/26.8 miles

Miller & Lux Canals

West Side: (WS)
West Side Canal is a trapezoidal earth-lined irrigation canal that runs approximately 26.4 miles in a northwesterly direction from its origin in Section 15 T30S/R24E MDBM, where it branches off from Short Main. Water is diverted into the canal by a weir that diverts the waters of Outlet Canal into the West Side and East Side canals. It parallels the flood channel that forms the western boundary of the BVWSD. The canal acts as a main artery for the system, receiving water from drainage ditches, and supplying water to irrigation laterals. The canal slowly narrows along its path. Near its origin, it is approximately 60 feet wide and 12 feet deep. Within the study area, it supplies Arizona Canal, and receives water from Florida Drain. West Side Canal also receives water at two points from the California Aqueduct, which runs nearby to the south. With the exception of Eighty-Foot Ditch, which West Side Canal feeds directly into, the canal supplies the laterals through diversion gates. Few roads cross the canal over bridges and the canal is supplied with concrete check gates. This form addressed approximately 2 miles at the southern end of the canal. JRP recorded three points along this segment.

East Side: (ES)
East Side Canal is a wide trapezoidal earth-lined canal that forms the eastern boundary of the BVWSD. It feeds laterals and receives drainage water from the ditches on the eastern side of the

district. It runs in a northwesterly direction for approximately 24.1 miles from its origin at the diversion weir in Section 23 T30S/R24E MDBM to its terminus at Goose Lake Canal. The canal is approximately 45 feet wide at the top and has a depth between 8 to 12 feet. Concrete check gates are located along its width and culverts transport it under roads. This form address approximately 3 miles of the canal south of Highway 58.

Main Drain: (MD)
Main Drain originates on the border of Sections 4 and 5 in T30S/R24E MDBM and extends for approximately 28.2 miles along a northwesterly route through the center of the BVWSD, between the East Side and West Side canals. Main Drain is a trapezoidal earthen canal that serves as both an irrigation canal, serving numerous laterals, and as a drainage canal, collecting seepage from irrigation activities and conveying it into irrigation laterals. Through most of the study area, Main Drain functions as irrigation, but as it approaches Buttonwillow, it serves as a drain, collecting water from Depot Drain and Sudan Ditch. Main Drain widens and deepens as it travels northeast. Between Stockdale Highway and Wasco Way, it widens from 25 feet to 30 feet. This form address approximately 5 miles of the drain beginning near Adohr Road and continuing northwest to Highway 58.
148,700 feet/28.2 miles

Laterals

Depot Drain: (DD)
Depot Drain serves as a drainage ditch collecting water and conveying it into Main Drain on the eastern side of the BVWSD. The drain, a trapezoidal earth-lined ditch, originates on the border of Sections 33 and 34 in T29S/R24E MDBM and cuts a 1-mile path directly west before heading northwest for the remainder of its approximately 5.9-mile length. The path of the drain is less meandering than the other canals in the study area; its route is punctuated by 90 degree turns and straight stretches. When the drain reaches Highway 58 to the north, it heads west and feeds into Main Drain. The canal widens and deepens along its route beginning at about 15 feet wide and increasing to 24 feet near its end. The ditch is conveyed under roadways via round culverts and water is deposited into the canal by corrugated pipes that collect water in the fields. This form addresses approximately 4 miles beginning near Dunford Road and continuing to Wasco Way.
31,000 feet/5.9 miles

Deep Wells Canal: (DWD)
Deep Wells Canal originates at its junction with East Side Canal in Section 34 T29S/R24E MDBM. It extends directly west along the north side of Stockdale Highway for approximately 1.5 miles before heading northwest in a circuitous route for its remaining 3.2-mile stretch. It ends abruptly in a field at a point in Section 30 T29S/R24E MDBM. The canal is trapezoidal and earth lined, and narrows as it continues to the northeast from approximately 30 feet wide along Stockdale Highway to 25 feet at Brite Road. Two small farm bridges cross the canal along Stockdale Highway, providing access to residential homes. As the canal continues northwest of Stockdale Highway, a few farm bridges cross it, and there are a few concrete check gates along the length. This form addresses approximately 4 miles from Dairy Road and Stockdale Highway to Wasco Way.
24,800 feet/4.7 miles

Arizona Canal (formerly the Poplar Grove Canal) (AD)
Arizona Canal, a trapezoidal earth-lined irrigation canal, is fed by the West Side Canal. From its origin on West Side Canal in Section 8 T30S/R24E MDBM, it extends north in a straight line for approximately 1 mile, then turns toward the northwest for approximately 1.5 miles before joining with Weed Island Ditch and proceeding along a meandering northwesterly path for its remaining approximately 3.2 miles, ending in Section 24 T29S/R23E MDBM. The Weed Island Ditch diverts from the Arizona Canal in Section 32 T29S/R23E MDBM. The ditch widens from 18 feet to 27 feet between Stockdale Highway and Brite Road. Culverts convey the canal under roads, and a concrete check/diversion gate is located at its junction with Weed Island Ditch. This form addresses approximately 4 miles from the West Side Canal to Wasco Way.
30,300 feet/5.7 miles

Weed Island Ditch: (WID)
Weed Island Ditch, a trapezoidal earth-lined irrigation canal, originates at its junction with Arizona Canal in Section 31 T29S/R24E MDBM. Arizona Canal conveys water from West Side Canal into Weed Island Ditch. From that point, Weed Island, entirely earth lined, takes a very meandering route for approximately 3.9 miles in a generally northwesterly direction before connecting to a drainage spillway that can convey excess water into Florida Drain. The ditch is 24 feet wide and between 10 and 12 feet deep. The ditch is conveyed under roads through culverts, and a concrete check/diversion gate is located at its junction with Arizona Canal. This form addresses approximately 1 mile of the ditch from its juncture with Arizona Canal to Wasco Way.
20,800 feet/3.9 miles

Florida Drain: (FD)
Florida Drain serves as a drainage ditch along the western side of the BVWSD. It stretches northwesterly for approximately 5.6 miles along a jagged route from Freeborn Road and Adohr Road to its merge with Parallel Drain in Section 26 T29S/R23E MDBM. It collects water from Freeborn Ditch and the Weed Island Ditch spillway. The drain begins as a V-shaped ditch and widens to a trapezoidal earth-lined ditch. The canal varies from 15 to 18 feet wide. The drain crosses under roads via culverts and has a concrete delivery gate connecting it with the West Side Canal. This form addresses approximately 2 miles from the West Side Canal to Wasco Way.
29,600 feet/5.6 miles

B10. Significance (continued):

Historic Context

Canal System under Miller & Lux
In 1851, the federal government removed San Joaquin Valley tribes, opening the region to settlement under federal land law. These laws fundamentally shaped the early history of Kern County. The study area, located along the Buena Vista Slough and the marshy area connecting Buena Vista Lake and Tulare Lake, was granted to the State of California under the Arkansas Act of September 28, 1850, whereby Congress ceded to certain states the swamp and overflowed lands on the public domain within their borders. The state was to use the proceeds from the sale of such lands to reclaim them, thereby making them useful to the new landowners. The land act was subject to abuse and fraud. The seasonable nature of swamp land in California led to disagreements between state and federal surveyors regarding the boundaries of swamp land. In

some instances, parcels sold as "dry" by the federal government were also sold by the state as swamp and overflowed. In the end, the state made its own surveys in the area and on December 5, 1871, the Secretary of the Interior accepted the state's proposed boundaries.

The state also struggled to find a means of reclaiming the swamp lands. Rules on transfer of swamp and overflowed lands changed over the years, and by 1868 basically required payment of $1.00 per acre, which was refundable if the land was reclaimed.[1] Under these provisions, Henry Miller, Charles Lux, John Redington, Horatio Stebbins, F.A. Tracy, H.L. Bonestell, and Horatio Livermore amassed their acreage on the lower Kern River west of Bakersfield. They acquired swampland certificates of purchase from would-be settlers or from local agents like Julius Chester, Duncan Beaumont, Richard Stretch, and Thomas Baker, whose earliest claims in the area dated to January 28, 1870.[2] In this manner, Miller & Lux secured their "Southern Division" surrounding Buttonwillow in Kern and Kings Counties.

The partnership between Henry Miller and Charles Lux, both German immigrants, began in San Francisco where they both worked as butchers in the early 1850s. They cemented their business partnership in 1858 when they joined forces to purchase a herd of Texas cattle. From that point forward, they sought western lands to purchase for the purpose of operating ranches for their increasing herds.[3] After acquiring their Southern Division, they organized it into ranches, the largest being the Buttonwillow Ranch, which served as the headquarters ranch of that division. Originally, the headquarters complex known as "Old Headquarters" lay in the south at the base of Tupman Road before moving to Buttonwillow in 1885. The Buttonwillow Ranch consisted of 52,440 acres and the study area lies entirely within its former limits. The area operated under this single ownership from the 1870s until 1927, when Miller & Lux, Inc., started selling the land.[4]

The system of drainage, irrigation, and flood control canals built by Miller & Lux has left an enduring legacy in the area. While some of their southern lands could immediately accommodate

[1] The Arkansas Act's early history and administration in California is summarized in John Thompson, "The Settlement Geography of the Sacramento – San Joaquin Delta, California." Ph D Diss., Stanford University, 1958. Chapter 8, 185-207. The Green Act of 1855 also removed limits on acreage allowing the assembly of large tracts. After 1868, the counties boards of supervisors served as reclamation commissioners. The purchase price ($1.00 per acre) was paid into the county's swampland fund, but the county swampland commissioners could waive payment if independent commissioners attested that the land had been reclaimed and cultivated for 3 years. Upon the selection of a parcel, a settler received a certificate denoting their claim; a certificate of purchase upon partial payment; and a state patent for the lands followed upon completion of payments and reclamation.

[2] Margaret Aseman, Cooper [Zonlight], Land, Water and Settlement in Kern County, California, 1850-1890 (New York: Arno Press), 1979.

[3] Igler, 2001, Introduction.

[4] Settlers claiming tracts on dry lands nearer to Bakersfield resorted to other federal land patenting laws to obtain their lands. These included homestead entries, Desert Land Act filings, cash entries, and purchases from the Southern Pacific Railroad, which in April of 1876received patent to odd-numbered sections along its right-of-way through the San Joaquin in a strip extending 10 miles on either side of the line in Kern County. Haggin acquired substantial acreage from the railroad, and through allies amassed a large quantity of public lands through homestead, cash entry, and Desert Land Act filings; Thomas H. Means, "Report on Farming Lands Miller & Lux, Inc., Southern Division Kern and Kings Counties California, October 1919, pg. 8.

their herds of cattle, other areas required an output of time, money, and effort, primarily in the form of water control features. Construction of the drainage and irrigation canals was critical to the reclamation efforts of their newly acquired swampland along the Buena Vista Slough. If the waters of the Kern River could be diverted away from the slough, the swamp could be dried and then irrigated. Under the Arkansas Act, the Buena Vista Slough was to be reclaimed as a part of the purchase agreement. In accordance with Assembly Bill 54 of 1861, Swampland District 121 was formed in May 1871, including swamplands along Buena Vista Slough. Miller & Lux, along with a few others who had pastured their cattle in the slough, organized the Kern Valley Water Company in 1876. The Kern Valley Water Company acted as agents for the district. The principle works of the company would be canals for irrigation and for reclamation, known as the Kern Valley Water Company Canals. The largest of these, a canal that would simply be known as the Kern Valley Water Company's Canal, was a massive canal dug in 1877 to drain the slough on the west side.[5]

Miller & Lux' attempts to control the Buena Vista Slough through construction of the KVWCC played a role in the events that led to the landmark water rights case, *Lux v. Haggin*. Canal construction was completed in 1878, and Miller & Lux found themselves with a massive canal bed that had no water and 10,000 head of cattle facing starvation. Although 1876-77 had been a drought season, they quickly identified upstream diversions of water from the Kern River as the cause of their water scarcity. In the years just prior to the arrival of the railroad, irrigationists diverting water from the Kern River had a number of canals either planned or under construction to water their lands in western Kern County. Among these were the Kern Island Canal (ca. 1870), James Canal (1871), Gates Canal (1872-73), Stine Canal, Pioneer Canal, Beardsley Canal (1873), and Calloway Canal (1874-75).[6]

In particular, the Calloway Canal and the Kern Island Canal, both controlled by the end of the 1870s by their rivals in the Kern Land Company, became the focus of Miller & Lux' ire. They formed the Riparian Suits Association as their legal arm and began filing actions against Haggin, Carr, and other upstream diverters to stop their consumption of the river's flows before it reached lands Miller & Lux et al. claimed to be riparian lands.[7] The case at first was a far-reaching conflict that included, as either plaintiff or defendant, what appeared to be the bulk of the principal landowners and water users in the region. Ultimately, control of Kern River water was hammered out in an 1888 compromise that became known as the Miller-Haggin agreement. Numerous amendments have been made to the agreement over the years, but it still controls division of water in the area.[8]

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[5] Assembly Bill 54, "An Act to provide for the Reclamation and Segregation of Swamp and Overflowed, and Salt March and Tide Lands, donated to the State of California by Act of Congress" was passed on May 31, 1861, and created a Board of Swamp Land Commissioners who in turn authorized the creation of Swampland Districts. The districts, geographically similar areas, then had the ability to levy taxes and fees to fund reclamation projects. Robert Kelley, *Battling the Inland* Sea (Berkeley, California: University of California Press, 1989) 42-48; Miller, Mary Catherine, *Law and Entrepreneurship in California: Miller & Lux and California Water Law, 1879-1928, pg. 39;* United States Geological Survey, *Water Supply and Irrigation Papers, No. 17*, 1898, pp. 61-63;

[6] C.E. Grunsky, USGS, *Irrigation Near Bakersfield, California*, WSP 17, 48-58.

[7] Igler, *Industrial Cowboys*, 101.

[8] Norris Hundley, *The Great Thirst: Californians and Water, 1770s-1990s* (Berkeley: University of California Press, 1992), 94. Hundley cites two sources for his comment: Edward F. Treadwell, *The Cattle*

The system of canals created during the Miller & Lux period consisted of canals dug and maintained by Miller & Lux, and a system of laterals dug and maintained by individual tenant farmers. Sometime prior to the early 1890s, after constructing a main flood control canal along the west side of the swamp, Miller & Lux also constructed East Side and West Side canals for distribution. As their names indicate, these canals bordered the east and west sides of Buttonwillow Ranch, with West Side Canal running closely parallel to the KVWCC. Much smaller than the flood canal, the West Side Canal was only 30 feet wide and 2 feet deep, and the East Side Canal was 25 feet wide and 3 to 5 feet deep. Between 1916 and 1918, Miller & Lux also constructed a drainage canal, called Main Drain, from the southern end near the old headquarters northerly through the center of the ranch, generally along the line of the original Buena Vista Slough.[9] Farmers used the water from Main Drain, collected primarily by seepage, for irrigation. The remainder of the canals and laterals in the area, like Deep Wells Ditch, Weed Island Ditch, and Arizona Canal (formerly Poplar Grove Ditch) were primarily works of individual farmers and Miller & Lux farm divisions in the area, who connected to the main canal system for irrigation of their crops.[10]

The canal system allowed Miller & Lux to support settlement in the area. By 1919, Miller & Lux farmed the entire area south of Buttonwillow between the East Side and West Side canals south to Old Headquarters. Four ranches were established in the area adjoining major canal works.

Buena Vista Water Storage District Period

Miller & Lux, Inc., had accumulated valuable land and water rights. However, neither was profitable without the other. To sell the land, a means of attaching water rights to the land was necessary. In 1920, the California State Engineer released a report on the water resources of the Kern River and recommended that a large district, including the Haggin and Miller & Lux water rights, be formed to manage water distribution. Despite the effective implementation of the Miller-Haggin agreement, the two parties chose to protect their interests by forming separate districts.[11] Miller & Lux's holdings became the nucleus for the BVWSD. The district submitted

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King. rev. ed. (Boston: Christopher Publishing House, 1950), 362; and *Bakersfield Californian*, April 23, 1881. The Treadwell book does not mention such a proposal; its discussion of *Lux v. Haggin* can be found (in the 1931 edition) in Chapter IX, "The Swamp of the Kern," 78-94; Construction of the KVWCC played a role in the litigation that led to the seminal *Lux v. Haggin* decision. The canal represented a significant investment of capital by Miller & Lux and the Kern Valley Water Company. When it failed to save 10,000 head of cattle grazing along the slough from death by starvation, Miller & Lux began to litigate. Their capital investment in the canal, combined with a failed expectation that it would save their grazing cattle, was arguably the final straw in provoking Miller & Lux to turn litigious. While this canal may represent a "final straw" it does not, however, stand alone as the only canal significant to this case. The upstream canals diverting water before it reached Miller & Lux' property also had a crucial role in setting the scene of the conflict. One particular canal or water diversion alone could not have been entirely responsible for *Lux v. Haggin*. Numerous conditions converged in Kern County to produce this fierce litigation over water. The shifting course of the Kern River, the construction of numerous canals and ditches diverting water from the river, and the competing interests of two large-scale landholders combined produced lengthy litigation.

[9] Harry Barnes, "Data on Irrigation of Buttonwillow Ranch and adjacent lands," 1920, 9.

[10] Miller, *Law and Entrepreneurship in California*, 1982, 39; USGS, *Water Supply and Irrigation Papers, No. 17*, 1898, 61-63; *Memorial and Biographical History of the Counties of Fresno, Tulare and Kern, California* (Chicago: The Lewis Publishing Co, 1892).

[11] S.T. Harding, "Report on Bond Issue of the Buena Vista Water Storage District," April 1935, 5, 7.

a petition for formation to the State Engineer in 1922 and received approval in 1924.[12] As a part of the district formation, Miller & Lux allocated water rights to the land within the district, making future sales possible. The district exchanged bonds with Miller & Lux for the existing canals and sold additional bonds for construction of new canals. The district, however, postponed construction until 1926 to see if it could work with other Kern River users to construct a mountain storage reservoir. Without progress, the district left the location of water storage flexible and continued operations using Buena Vista Lake. The first major construction project was to lessen water loss at the end of the Kern River through construction of a direct connection to the canal system and a direct canal to Buena Vista Lake. Additional construction would focus on the northern portion of the district, as the southern end around Buttonwillow had been well developed by Miller & Lux.[13]

The district acquired all the canals in the study area, including flood water canals, irrigation canals, drainage canals, and associated water control features. The KVWCC (Miller & Lux owned 86 percent of the company) was the largest canal the district acquired in the area. It stretched northwesterly from Old Headquarters Weir in the southern part of the study area. Constructed for flood control, the canal continued to perform that occasional function. The canal was described as "expensive of maintenance" in the years when floods caused its levees to require significant repairs; it was also acknowledged that it accrued benefits to all of the lands below Wasco. The drainage system included Main Drain, bisecting the area between the East Side and West Side canals, and various shallow ditches that collected water from sloughs or other low places where water accumulated and delivered it back to Main Drain or other irrigation canals.[14]

Despite the changing crops in the study area, the extensive network of canals constructed during the Miller & Lux period remained sufficient. With the advent of groundwater pumping, farmers used the canals to move water from the wells to their fields, a practice that continues today. By 1943, several years of groundwater pumping had raised the water table to less than 6 feet for almost 95 percent of the Buttonwillow area. This rapid rise from 1935 levels called for improvements to the drainage system, including Main Drain. At that time, Main Drain was 4 to 10 feet deep and suggestions were made for deepening it. Between 1943 and 1944, 4.8 miles of new drains were constructed in the water storage district. The drains also needed improvements to remove obstacles to water flow. Culverts and bridges that were added as the road system developed were insufficient to keep the water flowing. Redwood culverts and corrugated metal pipe culverts, some installed by Miller & Lux, began to be replaced. The BVWSD also instituted a canal maintenance program in 1943 that called for regular hand maintenance and mechanized maintenance every 4 years. Today, the canals are reshaped twice a year and re-excavated

[12] Harmon S. Bonte, *Financial and General Data Pertaining to Irrigation, Reclamation and other Public Districts in California, (*Sacramento: Department of Water Resources, Bulletin No. 27, 1930), 243.

[13] Harding, "Report on Bond Issue of the Buena Vista Water Storage District," 5-8.

[14] W.C. Hammett, "Report on Revaluation of Physical Properties to be acquired by Buena Vista Water Storage District," September 4, 1926, San Francisco, 16-17.

approximately every 5 years.[15] To ease mechanized farming, ditches and drains have been rerouted around the regular fields within the district.[16]

Larger changes occurred to the water supply for the canals. The unsuitability of Buena Vista Lake for water storage had been a concern of the district from the beginning. The district had delayed construction of new canals to the lake for 2 years hoping to work with other districts to form a mountainous reservoir. The Army Corps of Engineers developed plans for Lake Isabella in the 1930s, but World War II delayed construction. The dam was finally completed in 1953. While the dam provides a reservoir for irrigation water, its main role is flood prevention.[17] The system also receives water from the California Aqueduct.

Individual Canal Histories and Evaluations

Miller & Lux Canals

Kern Valley Water Company Canal
After the Kern Valley Water Company was organized for the reclamation of the Buena Vista Slough, S.W. Wible was put in charge as engineer. Wible acquired his engineering experience in the mines of El Dorado, Amador, and Calaveras counties before going on to work for the city of San Francisco on an extensive water system. After moving to Kern County in 1874, he undertook the engineering of the Wible and Pioneer canals before going to work for the Kern Valley Water Company. The massive size of the canal he engineered for them was intended to drain the water of the Kern River from the slough and also feed irrigation laterals. When first constructed, it extended 26 miles northwesterly up the slough from Old Headquarters, had a top width of 250 feet, bottom width of 125 feet, and a depth of 7 feet. By 1893, the canal was 12 feet deep.

A series of four numbered timber weirs built on the KVWC Canal regulated the flow of water. Approximately 4 miles apart, each weir could be closed, forming a reservoir whose water could then be channeled into canals for distribution. The weirs also functioned to slow the flow of water down the canal as it proceeded northwesterly up the slough. In the early years of the canal, flood waters from the Kern River posed a constant threat to the canal's water control features. In 1878, within 3 months of the canal's completion, water split its headgates. An 1898 map indicates four weirs along the canal, but Grunsky's water supply report that year states that three of the four weirs were washed out, leaving only one remaining.[18]

Faced with constant repairs and expense, Miller & Lux made the decision to invest in only one of the weirs, the one located nearest their old headquarters, "Weir No. 1." Originally, the KVWC Canal was meant to serve as a flood canal and a distribution canal. After the West Side Canal was constructed as a distribution canal parallel to the KVWC Canal, it lost its distribution function. This meant that weirs two, three, and four were no longer needed to form reservoirs. The first weir, however, was crucial for diverting water into both the East and West Side Canals.

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[15] Raznoff, *Drainage Investigations Buttonwillow Area of Kern County, California*, 16, 18-19, Map 2.
[16] USGS, *Buttonwillow Quadrangle*, 1954 photorevised 1973; USGS, *East Elk Hills Quadrangle*, 1954 photorevised 1973.
[17] Department of Water Resources, *Bulletin No. 17 Dams Within the Jurisdiction of the State of California*, Resources Agency of California, Department of Water Resources, 1962, A-4, A-5.
[18] Kern County Map, 1898; Igler 99, 117; Grusky, WSP 17, 62.

To combat the costly and time-consuming repairs to the timber weir, Miller & Lux commissioned consulting engineers, Leonard & Day, to design a reinforced concrete structure to serve as both weir and bridge over the massive flood control canal. The resulting structure, built in 1911, was a flat span bridge and weir combination. It spanned 163 feet, was 19 feet from bottom to bridge slab, and had a 13-foot roadway across. A series of simple columns spanned each side of the roadway, serving as ornamentation and connectors for a rope guard.

In 1914, Miller & Lux and the Carmel Cattle Company collaborated to improve the irrigation system on the Buttonwillow Ranch. On August 20, 1914, Miller & Lux entered into an agreement with the Carmel Cattle Company, stipulating the lands owned by each, their water rights based on the Miller-Haggin Agreement, and plans for work on irrigation structures. Their primary concern was the northern 6-mile stretch of the KVWCC that had been deemed inadequate for proper flood control. After entering into the agreement, work began on repairing the faulty stretch and extending the canal north. The new section of canal became known as the Kern Valley Reclamation Company's Canal.[19]

When the BVWSD acquired the canal and its associated water control features, they identified the KVWCC as both asset and liability. A report on the revaluation of the physical properties they were to acquire noted that the channel performed the function of flood control and "while the floods are not of annual occurrence they occasionally come in such volume as to be disastrous in their effects. The canal is therefore expensive of maintenance, and during and after each of these floods requires the replacement of considerable levee work."[20] In calculating the value of their canal acquisitions, they used a formula that involved the quantity of excavated material for each canal. The report stated that they did not even attempt to determine excavated quantities for the KVWCC because flood waters had eroded the channel to hundreds of feet wide in places and the original channel could not be determined.[21]

Today, the KVWCC serves the same purpose it did when the BVWSD acquired it in 1926, occasional flood control. The district refers to the canal as the "flood channel" or simply, "the channel." Flooding in the 1970s and 1980s required additional maintenance of the canal to remove debris and control vegetation. BVWSD files contain photographs of maintenance efforts, including bulldozers reshaping the canal.[22]

The KVWCC, East Side Canal, and West Side Canal, constructed in 1876, along with the Kern Island Canal (ca. 1870) and Calloway Canal (1874-75), precipitated the seminal *Lux v. Haggin* litigation, which has shaped California water rights. However, on their own the KVWCC, East Side Canal, and West Side Canal are not significant for their role in the litigation. The upstream canals diverting water before it reached Miller & Lux' property also had a crucial role in setting the scene of the conflict. One particular canal or water diversion alone could not have been entirely responsible for *Lux v. Haggin*. Numerous conditions converged in Kern County to

[19] J.E. Woolley, "Review of River History and Second Point Water Rights," May 13, 1963, unpublished report, Buena Vista Water Storage District company archives, pp. 12-15; "Miller & Lux Incorporated and Carmel Cattle Company," Agreement, August 20, 914.

[20] W.C. Hammett, "Report on Revaluation of Physical Properties to be acquired by Buena Vista Water Storage District," September 4, 1926, pg. 13.

[21] Hammett, pg. 5.

[22] Telephone interview with David Hampton, February 12, 2009.

produce this fierce litigation over water. The shifting course of the Kern River, the construction of numerous canals and ditches diverting water from the river, and the competing interests of two large-scale landholders combined produced lengthy litigation. For this reason they are not eligible under Criterion 1 or A.

Under Criterion 2 or B, the canals are not associated with a significant individual. While the canals were constructed under the auspices of Miller & Lux, they are not directly associated with either of those individuals. Miller & Lux constructed numerous canals throughout their holdings to irrigate feed crops. While Henry Miller did visit most of his holdings, including Buttonwillow, most of his time was spent in San Francisco or his home ranch, which are more appropriately associated with him and the business.

Under Criterion 3 or C, the canals were designed by S.W. Wible, a civil engineer who designed mines in El Dorado, Amador, and Calaveras counties before coming to Kern County, where he designed the Pioneer and Wible canals before designing the KVWCC. Despite his engineering knowledge, the KVWCC is not an engineering success and is not significant for its design or construction.

In addition, these canals lack integrity to any historical period of significance, owing to their regular realignment, reshaping, and replacement of control structures.

West Side: (WS)
After constructing the main flood control canal along the west side of the swamp but sometime prior to the early 1890s, Miller & Lux also constructed portions of East Side and West Side canals for distribution. The intent of the West Side Canal was to collect and drain water. The canal was wide and shallow, approximately 30 feet wide and 2 feet deep. In 1912, the canal ended in Section 27 T28S/R23E MDBM. Miller & Lux records indicate problems with the planned system in 1916, "This year's experience has proved that we cannot depend on the East Side Canal and 17th canal to supply water west of the main drain, as the demands for water east of the main drain are too great."[23] A rapid program of expansion, lengthening the canal north of its former terminus and reconstructing the wooden headgates, was undertaken to provide enough water for the 1917 crops.

Additional construction and maintenance under the control of the BVWSD has replaced the weirs and headgates of the canal with modern concrete structures. The water supply for the canal has also been altered. Water entered the canal from the outlet canal to the southeast. However, after 1973, the outlet canal was removed and water now enters the canal from a short canal that connects the East Side and West Side canals.

Under Criterion 1 or A, the West Side Canal lacks historical significance for its association with the *Lux v. Haggin* litigation. Like the KVWCC, it was one of several contributing factors for the litigation. Under Criterion 2 or B, the canal is not significant for its association with the individual partners of Miller & Lux. The canals are a result of the organization, not the individuals. Under Criterion 3 or C, the canal was constructed using standard methods of the time period and is not a master work of S.W. Wible.

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[23] Miller & Lux to E.F. Ogle at Buttonwillow, April 6, 1916, Flood Canal Levees and West Side Canal 1916, Carton 694, Miller & Lux Papers, Bancroft Library, University of California, Berkeley.

In addition, this canal lacks integrity to any historical period of significance, owing to its regular realignment, reshaping, and replacement of control structures.

East Side: (ES)
The East Side Canal was also constructed by the Kern Valley Water Company under the direction of S.W. Wible in the late 1870s. Initially, the East Side Canal was to serve as the primary irrigation canal for the Buttonwillow Ranch, while the KVWCC was to drain the slough on the western side. In 1898, the canal was 25 feet wide and 3 to 5 feet deep. At its intake from the Buena Vista Slough, a regulating gate with vertical flashboards controlled water flow and also functioned as a road bridge.

As of 1920, the East Side Canal had a 25-foot-wide timber flash board headgate that served as an intake from Outlet Canal. Starting in 1918 through at least 1920, Miller & Lux had extensive work done to the canal. A levee was constructed along the East Side Canal north of the Southern Pacific Railroad tracks running through Buttonwillow. Extensive excavation was performed on the canal to increase the working capacity of the canal from 100 second feet to 300 second feet throughout.[24]

When the BVWSD acquired East Side Canal in 1926, the canal was 27 miles long and served as the main artery on the east side of the district, supplying, with few eastern exceptions, irrigation canals on its west side. The wooden control features constructed by Miller & Lux have been replaced with concrete structures.

Under Criterion 1 or A, the East Side Canal lacks historical significance for its association with the *Lux v. Haggin* litigation. Like the KVWCC, it was one of several contributing factors for the litigation. Under Criterion 2 or B, the canal is not significant for its association with the individual partners of Miller & Lux. The canals are a result of the organization, not the individuals. Under Criterion 3 or C, the canal was constructed using standard methods of the time period and is not a master work of S.W. Wible.

In addition, this canal lacks integrity to any historical period of significance, owing to its regular realignment, reshaping, and replacement of control structures.

Main Drain: (MD)
Sitting atop a former swamp, the Buttonwillow Ranch required drainage to be agriculturally productive. Although the KVWCC provided the main drainage and flood control, the trough in the middle of the ranch between East Side and West Side canals attracted excess water. The natural channel of the Buena Vista Slough had been the recipient of that water until 1916, when Miller & Lux had a drainage canal known as Main Drain constructed. It stretched from the southern end near Old Headquarters northwesterly through the center of the Buttonwillow Ranch, loosely along the extremely circuitous route of the original Buena Vista Slough.[25] Main Drain was dug with cut-offs along the natural channel, producing a somewhat straightened path through the winding natural slough. Although the drain historically functioned primarily as drainage,

[24] Harry Barnes, "Data on Irrigation of Buttonwillow Ranch and Adjacent Lands," 1920, WRCA Berkeley, 7-8; Bancroft Library, Miller & Lux, CG-163, Buttonwillow Files, Carton 694, East Side Canal, 1916-1919.
[25] Harry Barnes, "Data on Irrigation of Buttonwillow Ranch and adjacent lands, 1920, pg. 9.

water collected mainly through seepage into the drain was conveyed back into the irrigation canals serving farmers in the north. The bottom width was 8 to 10 feet at the southern end and widened to 40 feet at the northern end.

Main Drain featured bridges of redwood and Oregon pine near Old Headquarters and at Buttonwillow.[26] In 1919, Main Drain was undergoing further excavation to bring it up to "first class condition."[27] Aerial photographs taken in 1942 show the path of the natural slough in the soil weaving around the drain. The use of groundwater in the 1930s increased the water level in the Buttonwillow area. Water could be found at 3 feet in most areas. As a result, improvements for the drainage system were planned in the 1940s, including installing larger culverts to improve flow and lining the northern portion of the drain to prevent seepage. The timber bridges in the study area were replaced with culverts, but the northern end does not appear to have been lined. By 1954, the winding segments of the slough had been filled and Main Drain shortened, beginning at the southern edge of Section 10 T30S/R24E MDBM rather than its original origin further south near Old Headquarters. Maps revised in 1974 show the drain shortened even further to its current origin on the edge of Sections 4 and 5 T30S/R24E MDBM.

Under Criterion 1 or A, the Main Drain is not significant for its association with irrigated agriculture around Buttonwillow. At the time of its construction in 1916-1918, the area had been undergoing reclamation and irrigation for 40 years. The water rights for the area had also been well established with the Miller Haggin agreement following the *Lux v. Haggin* litigation, and the ditch did not play a role in that history. Under Criterion 2 or B, the drain is not significant for its association with the individual partners of Miller & Lux. The canals are a result of the organization, not the individuals. Under Criterion 3 or C, the canal was constructed using standard methods of the time period including mechanized dredgers.

In addition, this canal lacks integrity to any historical period of significance, owing to its regular realignment, reshaping, and replacement of control structures.

Farmer-Dug Canals/Laterals

The lateral canals and drains in the area were primarily the work of tenant farmers or ranch employees who sought to hook into the main canal system for irrigation of individual farms and ranches. The Miller & Lux papers at the Bancroft Library do not provide documentation on the individual laterals. While the 1912 USGS Buena Vista Quadrangle does not show the lateral canals, property ownership maps from the period do show a system of shifting lateral canals. USGS mapping from the 1930s indicates that the system of laterals was more extensive than the current system. Engineering reports indicate that all of the following canals/ditches except Depot Drain were part of the BVWSD's acquisitions in 1926.

Depot Drain: (DD)
Depot Drain was not one of the existing canals acquired by BVWSD in 1926. Rather, portions of its current route appear as two separate ditches in mapping from the early 1930s. The path of the drain meandered through the east side of the district. By 1942, the ditches were joined, the drain named, and the path of the ditch was closer to its modern route, cutting in straight diagonals

[26] Bancroft Library, Miller & Lux, CG-163, Buttonwillow Files, Carton 694, Main Drain, 1915-1920.
[27] Lippincott and Means, pg. 58.

through fields and following roads along cardinal directions. Additional straightening has occurred through the period between 1954 and 1973.[28]

Under Criterion 1 or A, the drain is not significant for its association with irrigated agriculture around Buttonwillow. The drain is one of several laterals constructed by the BVWSD following the subdivision of Miller & Lux holdings. At that time, irrigated agriculture had already been practiced in the area for more than 40 years. Under Criterion 2 or B, the drain is not significant for its association with any individual, having been constructed by the BVWSD. Under Criterion 3 or C, the canal was constructed using standard methods of the time period.

In addition, this canal lacks integrity to any historical period of significance, owing to its regular realignment, reshaping, and replacement of control structures.

Deep Wells Canal: (DWD)

Deep Wells Canal, historically also known as Deep Wells Ditch, was associated with the irrigation of Miller & Lux' Deep Wells Ranch. It originated from the East Side Canal and between Stockdale Highway and Brite Road it divided into three paths, one of which connected to Depot Ditch near Deep Wells Ranch. When the BVWSD acquired the canal in 1926, it was approximately 6 miles long. The ditch was originally consolidated along its eastern path, connecting with Depot Drain and then Main Drain. Between 1937 and 1952, it was rerouted along its western route paralleling Main Drain. Today, the canal ends closer to the point of the former Deep Wells Ranch and measures approximately 4.7 miles long.[29]

Under Criterion 1 or A, the canal is not significant for its association with irrigated agriculture around Buttonwillow. The canal is one of many farm-dug laterals constructed during the Miller & Lux era, providing needed drainage and irrigation. Deep Wells Ranch was one of several satellite ranches in the Buena Vista Slough under the management of the Buttonwillow headquarters. Under Criterion 2 or B, the drain is not significant for its association with the individual partners of Miller & Lux. The canals are a result of the organization, not the individuals. Under Criterion 3 or C, the canal was constructed using standard methods of the time period.

In addition, this canal lacks integrity to any historical period of significance, owing to its regular realignment, reshaping, and replacement of control structures.

Arizona Canal/Poplar Grove Ditch (AD)

Arizona Canal, formerly known as Poplar Grove Ditch, was associated with the irrigation of Miller & Lux' Poplar Grove Ranch. Portions of this ditch paralleling Main Drain are seen on 1912 property ownership maps. The canal traveled northeast from the West Side Canal and then turned to parallel Main Drain. In 1932, the canal returned water to the Eighty-Foot ditch at two

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[28] Hammett, *Report on Revaluation of Physical Properties*, 1926; Buena Vista Water Storage District, District Boundary Map, July 2003; USGS Quadrangles, *Buttonwillow 1932, 1942, 1954, 1954 photorevised 1973; East Elk Hills, 1933, 1954, 1954 photorevised 1973;* Aerial Photographs, Kern County, 1942.

[29] W.C. Hammett, *Report on Revaluation of Physical Properties to be Acquired by Buena Vista Water Storage District*, September 4, 1926 (San Francisco); Buena Vista Water Storage District, District Boundary Map, July 2003; USGS Quadrangles, *Buttonwillow 1932, 1942, 1954, 1954 photorevised 1973; East Elk Hills, 1933, 1954, 1954 photorevised 1973;* Aerial Photographs, Kern County, 1942.

points, one below Buttonwillow and one north of Buttonwillow, for a distance of approximately 9 miles. Sometime between 1954 and 1973, the stretch approaching Buttonwillow and paralleling Main Drain was filled and the canal hooked into Main Drain at its intersection with Buerkle Road, shortening its length to its current 5.7 miles.[30]

Under Criterion 1 or A, the drain is not significant for its association with irrigated agriculture around Buttonwillow. The drain is one of many farm-dug laterals constructed during the Miller & Lux era, providing needed drainage and irrigation. Poplar Grove was one of several satellite ranches under the management of the Buttonwillow headquarters. Under Criterion 2 or B, the drain is not significant for its association with the individual partners of Miller & Lux. The canals are a result of the organization, not the individuals. Under Criterion 3 or C, the canal was constructed using standard methods of the time period.

In addition, this canal lacks integrity to any historical period of significance, owing to its regular realignment, reshaping, and replacement of control structures.

Weed Island Ditch: (WID)
Weed Island Ditch was associated with the irrigation of Miller & Lux's Weed Island Ranch, which lies just to the west of the study area. When the BVWSD acquired the canal in 1926, it measured 3.9 miles. Its diversion from the Arizona Canal is visible on a 1912 property ownership map and was approximately 1½ miles long. The canal was lengthened by 1932, when it branched into several canals, including the northern portion of the Florida Drain. The current northern route was selected by the 1950s. Today, the canal maintains the same length of 3.9 miles.[31]

Under Criterion 1 or A, the drain is not significant for its association with irrigated agriculture around Buttonwillow. The drain is one of many farm-dug laterals constructed during the Miller & Lux era, providing needed drainage and irrigation. Weed Island Ranch was one of several satellite ranches under the management of the Buttonwillow headquarters. Under Criterion 2 or B, the drain is not significant for its association with the individual partners of Miller & Lux. The canals are a result of the organization, not the individuals. Under Criterion 3 or C, the canal was constructed using standard methods of the time period.

In addition, this canal lacks integrity to any historical period of significance, owing to its regular realignment, reshaping, and replacement of control structures.

Florida Drain: (FD)
When BVWSD acquired Florida Drain, it was 2.3 miles long, less than half its current length of 5.6 miles. Portions of its current route appear as two separate ditches in mapping from the early 1930s. By 1944, the ditches were joined and its path was much closer to its modern route. The drain has been straightened along Stockdale Highway and the path of the drain has been recently

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[30] Hammett, *Report on Revaluation of Physical Properties*, 1926; Buena Vista Water Storage District, District Boundary Map, July 2003; USGS Quadrangles, *Buttonwillow 1932, 1942, 1954, 1954, photorevised 1973; East Elk Hills, 1933, 1954, 1954, photorevised 1973;* Aerial Photographs, Kern County, 1942.

[31] Hammett, *Report on Revaluation of Physical Properties*, 1926; Buena Vista Water Storage District, District Boundary Map, July 2003; USGS Quadrangles, *Buttonwillow 1932, 1942, 1954, 1954, photorevised 1973; East Elk Hills, 1933, 1954, 1954, photorevised 1973;* Aerial Photographs, Kern County, 1942.

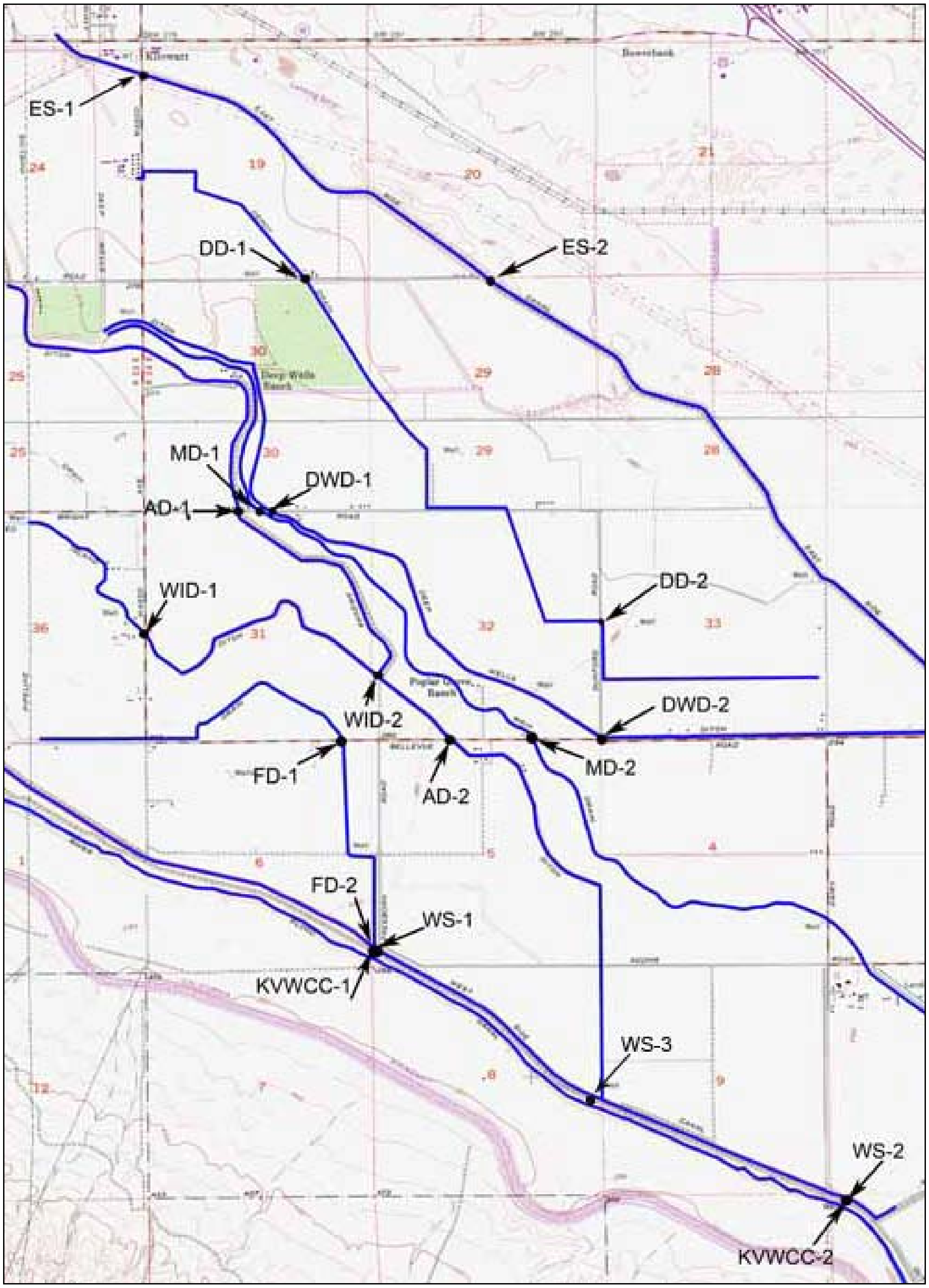
altered at its southern end. Where it used to cut a path through Section 5 to its origin at Adohr Road, it now runs straight up Freeborn from its origin at the intersection of Freeborn and Adohr, near the West Side Canal.[32]

Under Criterion 1 or A, the drain is not significant for its association with irrigated agriculture around Buttonwillow. The drain is one of many farm-dug laterals constructed during the Miller & Lux era, providing needed drainage and irrigation. In addition, the drain did not achieve its current alignment until the 1940s. Under Criterion 2 or B, the drain is not significant for its association with the individual partners of Miller & Lux. The canals are a result of the organization, not the individuals. Under Criterion 3 or C, the canal was constructed using standard methods of the time period.

In addition, this canal lacks integrity to any historical period of significance, owing to its regular realignment, reshaping, and replacement of control structures.

[32] Hammett, *Report on Revaluation of Physical Properties*, 1926; Buena Vista Water Storage District, District Boundary Map, July 2003; USGS Quadrangles, *Buttonwillow 1932, 1942, 1954, 1954 photorevised 1973; East Elk Hills, 1933, 1954, 1954 photorevised 1973;* Aerial Photographs, Kern County, 1942.

Map: *Buttonwillow Quadrangle* **Date:** 1954 photorevised 1973
Map: *East Elk Hills Quadrangle* **Date:** 1954 photorevised 1973
Map: *Tupman Quadrangle* **Date:** 1954 photorevised 1973



Please see descriptions or evaluations for key to abbreviations.

ATTACHMENT 65-3
BIOLOGICAL RESOURCES ADDITIONAL SURVEY

Modified Transmission Line Alternative Routes 1A and 1B

On December 8, 2009, URS Biologists David Kisner and Robin Murray performed a biological site reconnaissance survey along portions of modified transmission line alternative routes 1A and 1B, as shown on Figure 65-3-1. The other portions of the transmission routes were previously surveyed. The purpose of these surveys was to evaluate the modified transmission route alternatives for the potential to support rare or sensitive biological resources.

Methods

Prior to performing the survey, recent 1:1,000 aerial photos of the modified transmission alignments were reviewed to determine general habitat types and other biological features of interest in the HECA Project area. Prior to performing the surveys, a California Natural Diversity Database (CNDDB) search was performed to determine what rare and sensitive species had been documented in the area. Site reconnaissance surveys were performed by driving slowly along portions of the modified transmission routes. A 1,000-foot buffer of the modified transmission routes was also surveyed. All of the survey area was visually evaluated and scanned with binoculars, as necessary, to evaluate the habitat value for plants and wildlife, and document any potential sensitive biological resources. All habitats, dominant vegetation, and wildlife species observed during these surveys were recorded.

Results

Site reconnaissance surveys confirmed that the modified transmission line alternative routes 1A and 1B are situated within active row crop agricultural land, with the exception of the northernmost extreme of transmission line alternative routes 1A and 1B, which passes through an industrial area and then extends approximately 1,300 feet through native allscale scrub, dominated by allscale (*Atriplex polycarpa*) and a variety of ruderal herbaceous species (*Bromus* spp.). A summary of all wildlife species encountered is provided in Table 65-3-1.

Conclusion

Due to the ongoing agricultural activities along the modified transmission line alternative routes 1A and 1B, it was determined that these areas do not provide quality habitat to native plant and wildlife species. Raptor foraging was noted throughout the area, but the modified transmission line alternative routes 1A and 1B should not significantly impact raptor foraging.

Table 65-3-1
Wildlife Observations

Common Name	Scientific Name
American kestrel	*Falco sparverius*
Brewer's blackbird	*Euphagus cyanocephalus*
Killdeer	*Charadrius vociferus*
Lark sparrow	*Chondested grammacus*
Northern harrier	*Circus cyaneus*
Red-tailed hawk	*Buteo jamaicensis*
White-crowned sparrow	*Zonotrichia leucophrys*
Yellow-rumped warbler	*Dendroica coronata*

Well Field

On December 8, 2009, URS Biologists David Kisner and Robin Murray performed a biological site reconnaissance survey of the proposed Well Field northwest of Buttonwillow, California (Figure 65-3-1). The purpose of this survey was to evaluate the proposed Well Field for the potential to support rare or sensitive biological resources.

Methods

Prior to performing the survey, recent 1:1,000 aerial photos of the Well Field were reviewed to determine general habitat types and other biological features of interest in the project area. Prior to performing the survey, a CNDDB search was performed to determine what rare and sensitive species had been documented in the area. Site reconnaissance surveys were performed by driving slowly along portions of the proposed Well Field. A 1,000-foot buffer of the proposed Well Field was also surveyed. All of the survey area was visually evaluated and scanned with binoculars, if necessary, to evaluate the habitat value for plants and wildlife, and document any potentially sensitive biological resources. All habitats, dominant vegetation, and wildlife species observed during these surveys were recorded.

Results

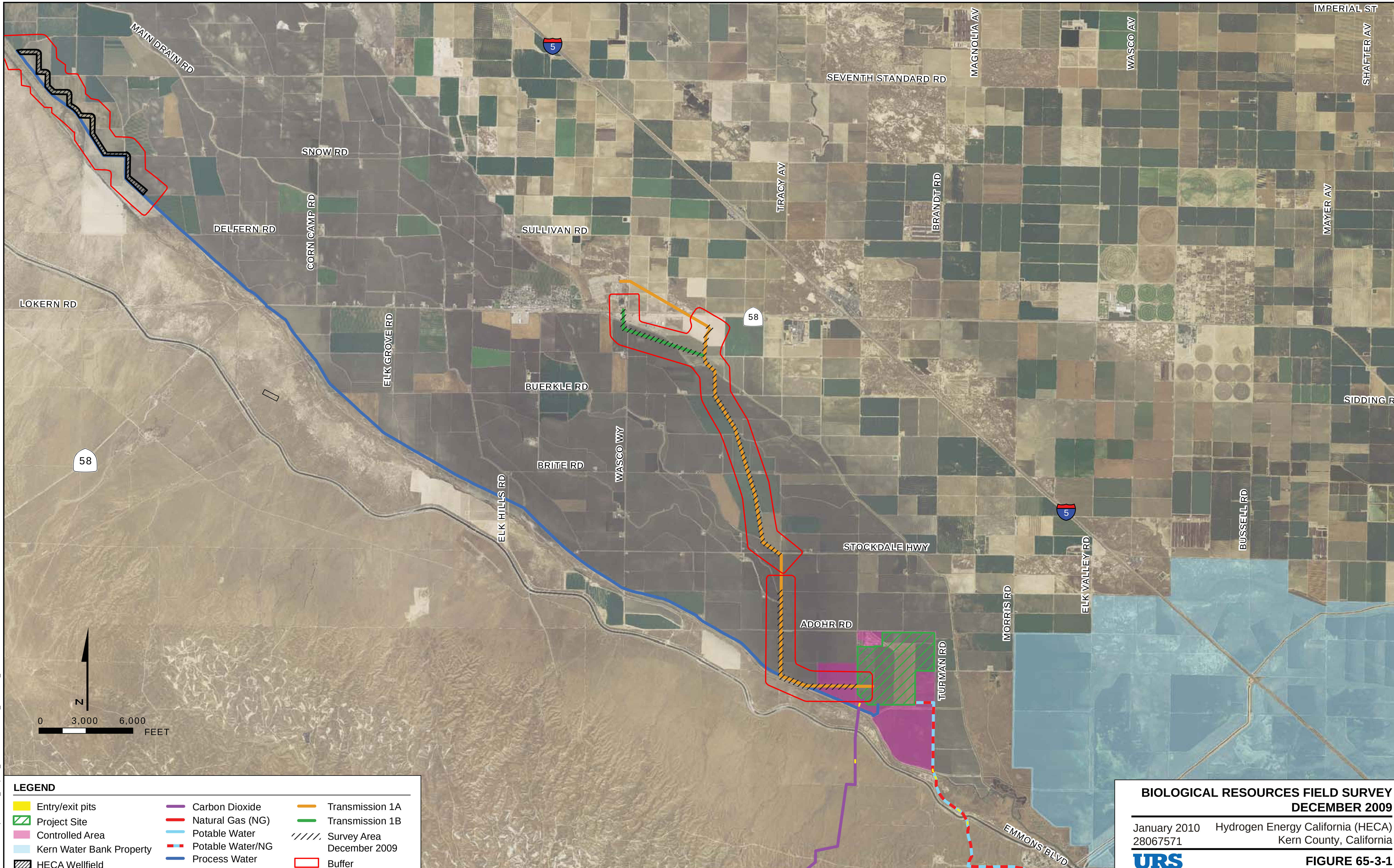
Site reconnaissance surveys confirmed that the proposed Well Field is situated in active row crop agricultural land. A summary of all wildlife species encountered is provided in Table 65-3-2.

Conclusion

Due to the ongoing agricultural activities within the proposed Well Field, it was determined that these areas do not provide quality habitat to native plant and wildlife species. Raptor foraging was noted throughout the area, but the proposed action should not significantly impact raptor foraging.

Table 65-3-2
Wildlife Observations

Common Name	Scientific Name
Black phoebe	*Sayornis nigricans*
Brewer's blackbird	*Euphagus cyanocephalus*
Brown-headed cowbird	*Molothrus ater*
European starling	*Sturnus vulgaris*
Ferruginous hawk	*Buteo regalis*
Killdeer	*Charadrius vociferus*
Northern harrier	*Circus cyaneus*
Northern mockingbird	*Mimus polyglottos*
Red tailed hawk	*Buteo jamaicensis*
Rock pigeon	*Columba livia*
Savannah sparrow	*Passerculus sandwichensis*
Western meadowlark	*Sturnella neglecta*
Yellow-rumped warbler	*Dendroica coronata*
Domestic sheep	*Ovis aries*



BIOLOGICAL RESOURCES FIELD SURVEY
DECEMBER 2009

January 2010
28067571

Hydrogen Energy California (HECA)
Kern County, California

FIGURE 65-3-1

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ATTACHMENT 65-4
PALEONTOLOGICAL ADDITIONAL SURVEY

Data Request 65 requested a Cultural Resources survey of the areas that were previously inaccessible during the preparation of the Revised AFC.

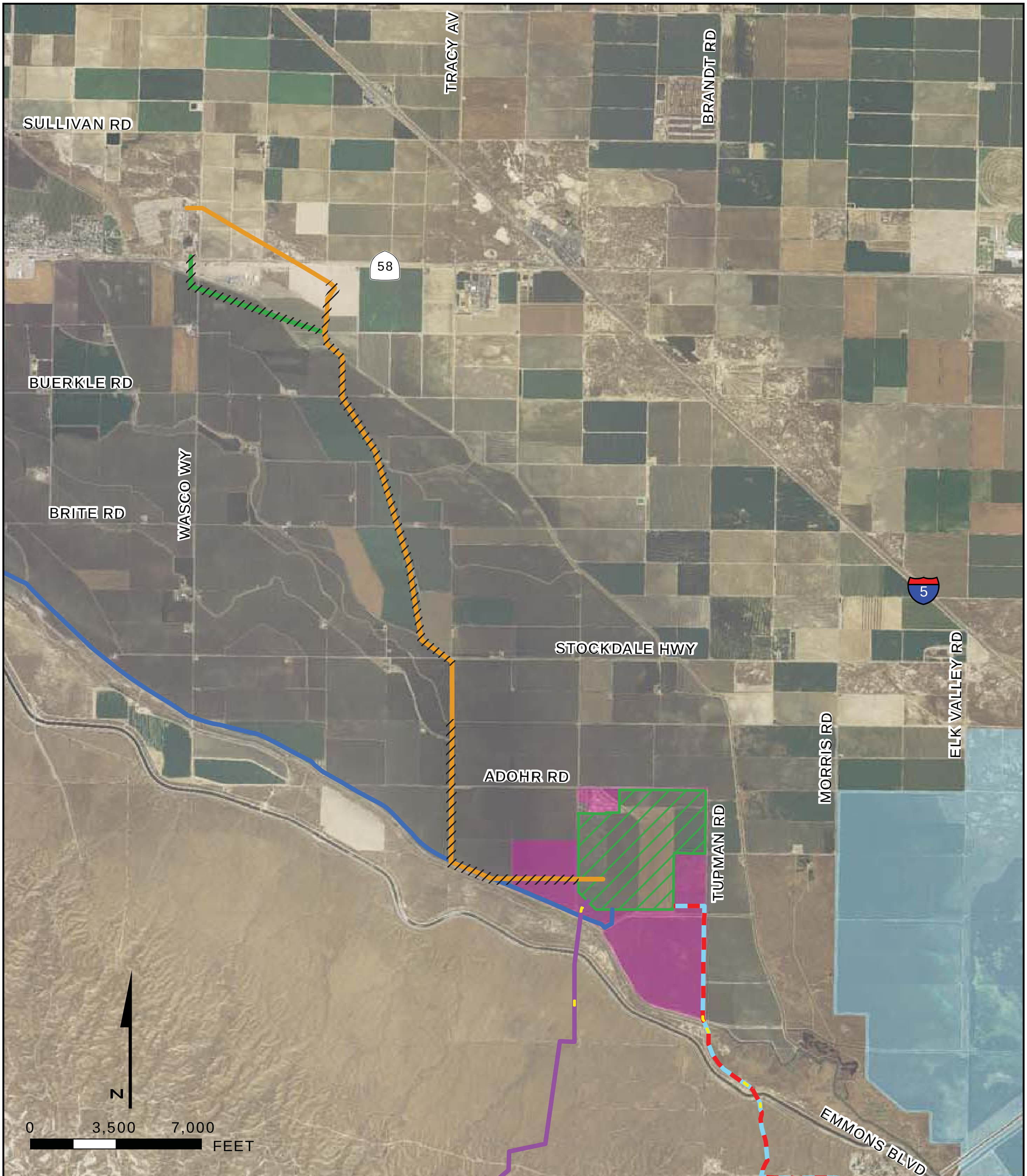
In addition to the requested survey, a paleontological survey was conducted of modified transmission line alternative routes 1A and 1B, as well as any areas that were previously inaccessible.

A field survey of the HECA modified transmission line alternative routes 1A and 1B was performed on December 8, 2009, by David F. Maloney, Field Supervisor with PaleoResource Consultants. Figure 65-4-1 identifies the areas surveyed. It should be noted that areas along routes 1A and 1B that are not identified as being surveyed were co-located with previous route alternatives and were previously surveyed in preparation of the Revised AFC. These previous survey results, and surveys for the Project Site and the other linear routes, were presented in the Revised AFC Section 5.15 and Appendix Q (the confidential Paleontological Resources Technical Report). These surveys were performed as part of an assessment of the potential adverse impacts on scientifically significant paleontological resources (fossils—the remains or traces of prehistoric plants and animals) resulting from construction of the HECA Project.

To develop a baseline paleontological resource inventory of the transmission line alternative routes 1A and 1B, and to assess the potential paleontological productivity of each stratigraphic unit present, the published as well as available unpublished geological and paleontological literature were reviewed, and stratigraphic and paleontologic inventories were compiled, synthesized, and evaluated. Museum archival records searches were also performed to document any previously recorded fossil localities in the Project vicinity. These methods are consistent with CEC (2007) and Society of Vertebrate Paleontology (1995) guidelines for assessing the importance of paleontological resources in areas of potential environmental effect.

This survey included visual inspection of exposures of potentially fossiliferous strata along the right-of-way of transmission line alternative routes 1A and 1B, and was conducted to document the presence of any previously unrecorded fossil sites or sediments suitable for containing fossil remains. During this field survey, no fossil localities and very few exposures of the subsurface stratigraphy were identified. No subsurface exploration was conducted as part of this survey, or for the associated assessment.

Because no new fossil localities were identified, it is the opinion of PaleoResource Consultants that the assessment and recommended mitigation measures presented in the Paleontological Resources Technical Report of the Revised AFC do not need modification.



LEGEND

- Entry/exit pits
- Project Site
- Controlled Area
- Kern Water Bank Property
- Carbon Dioxide
- Natural Gas (NG)
- Potable Water
- Potable Water/NG
- Process Water
- Transmission 1A
- Transmission 1B
- Survey Area December 2009

PALEONTOLOGICAL FIELD SURVEY DECEMBER 2009

January 2010
28067571

Hydrogen Energy California (HECA)
Kern County, California

URS

FIGURE 65-4-1

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BACKGROUND

A recent synthesis of archaeological and geoarchaeological information on the California Central Valley ("The Central Valley: A View from the Catbird's Seat," by Jeffrey S. Rosenthal, Gregory G. White, and Mark Q. Sutton, in *California Prehistory: Colonization, Culture, and Complexity* (Terry L. Jones and Kathryn A. Klar, eds., 2007), suggests that prehistoric deposits in the Central Valley dating before 2,500 years ago have either been obliterated by agricultural activities or buried by ongoing alluvial processes (p. 150).

The construction of the HECA Project would entail ground disturbance of the 473-acre project site and project linear facilities. The project site and much of the area traversed by the proposed liner facilities are covered by late Quaternary alluvium (AFC, pp. 5.16-5 and 5.16-11; Figure 5.15-1), potentially obscuring archaeological sites. Staff assumes parts of the project site and project linear facilities rights of way (ROWs) have been disturbed by agriculture to a depth of 3 feet, but considerable project ground disturbance would exceed that depth. The ground disturbance resulting from the construction of equipment installations at the plant site would be likely to extend as deep as 12 feet below the surface. The 8-mile-long gas and potable water pipelines would be installed together in a trench at least 5 feet below grade. The 15-mile-long process water pipeline would presumably be installed at least 5 feet below grade. The carbon dioxide pipeline would also be buried approximately 5 feet below the ground surface, and the directional drilling used to install the carbon dioxide pipeline below canals and rivers would extend to a depth of 100 feet. The amount of relatively deep ground disturbance proposed in an area sensitive for archaeological resources is considerable.

Although the Archaeological Resources Report acknowledges that archaeological deposits could be inadvertently exposed during construction activities, the Cultural Resources section of the AFC and the Archaeological Resources Report provide no information on the potential for the construction of the proposed project to truncate archaeological deposits that may lie buried beneath the surface of the project area. These deposits may be too deep to present surface manifestations, but may be within reach of construction impacts. Staff needs information of a finer resolution on the age, the structure, and the character of the geologic units beneath the surface of the project area to evaluate the project's potential to substantially and adversely change the CRHR-eligibility of archaeological deposits that may lie buried in the project ROWs.

DATA REQUEST

77. Please have the approved geoarchaeologist provide a discussion, based on the available Quaternary science and geoarchaeological literature, of the historical geomorphology of the project ROWs.

A. Describe the development of the landforms on which the ROWs are proposed, with a focus on the character of the depositional regime of each landform since the Late Pleistocene epoch.

B. Provide data on the geomorphology, sedimentology, pedology, hydrology, and stratigraphy of the ROWs, and the near vicinity. The discussion should relate landform development to the potential in the ROWs for buried archaeological deposits.

C. Provide overlaying the above data on the project ROWs.

RESPONSE

Background and Setting (in Response to Date Request 77A)

The purpose of the following discussion is to identify portions of the proposed HECA Project that have the potential for harboring buried archaeological deposits with no surface manifestation. Numerous archaeological resources were identified on the ground surface within, or directly adjacent to HECA Project facilities during the cultural resources record search and survey (URS, 2009a). However, given the potential subsurface impacts of the Project facilities (i.e., on-site foundations and utilities, off-site utilities, etc.) there is also a possibility of encountering subsurface archaeological deposits that may not be evident on the surface. The purpose of this geoarchaeological study is to assess that potential—and identify specific areas within the Area of Potential Effects (APE)[2] that have sensitivity for buried archaeological sites—based on the existing geological, geomorphological, and archaeological literature and data.

Several sources of evidence are used in this report to assess the geomorphic setting and the potential for buried archaeological sites within the proposed HECA Project area. The first of these are existing quaternary geologic and geomorphic studies, generally produced as "open-file" reports by the U.S. Geological Survey (USGS), which provide a broad context on the timing and formation of various landforms found throughout the Project area. The second are existing soils data, including a compilation of radiocarbon (^{14}C) dates and their association to specific mapped soil series within the Soil Survey Geographic (SSURGO) database, which provides a more accurate estimate of the age of a given land surface. Finally, reports from archaeological excavations and geomorphological field studies within the specific Project vicinity provide information on local depositional processes and known buried landforms. These existing data are discussed in the context of specific landforms present within the APE. This site-specific discussion and analysis is preceded by a more general discussion of the Project's physical environment and regional setting.

The challenge associated with buried archaeological sites within the San Joaquin Valley and, more generally, the Central Valley as a whole, was recently adeptly summarized:

> The Central Valley's archaeological record, as we know it today, is biased by natural processes of landscape evolution. Surface sites are embedded in young sediments set within a massive and dynamic alluvial basin, while most older archaeological deposits have been obliterated or buried by ongoing alluvial processes. Consequently archaeologists have had to struggle to identify and explain culture change in portions of the Central Valley where available evidence spans only the past 2,500 years or in rare cases 5,500 years. (Rosenthal, White, and Sutton 2007:150)

While the assumption that surface sites exist only in younger sediments is not necessarily accurate, the general problem of site visibility in a region that has been geomorphically dynamic over the past 13,500 years—roughly the period of human occupation in California—is highly relevant to the HECA Project area.

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[2] For the purposes of this geoarchaeological discussion, the APE includes all Project facilities with the potential to cause subsurface disturbance, as shown on Figures 77-4 and 77-5. The terms "Project area" and "Project vicinity" are used interchangeably to refer to the wider context within which the facilities are situated and which is considered by this study (approximated by the visible extent of Figures 77-4 and 77-5).

Geomorphic processes have played a major role in the differential preservation of archaeological sites in the San Joaquin Valley. Paleo-Indian sites (ca. 13,500 to 10,500 before present [B.P.]) and Lower Archaic sites (ca. 10,500 to 7500 B.P.) are extremely rare throughout the Central Valley (including the more northerly Sacramento Valley). These early sites are typified by sparse lithic remains, often around the edges of late Pleistocene to early Holocene lakes, including nearby Buena Vista, Goose, Kern, and Tulare lakes (Fredrickson, 1986; Porcasi, 2000; Wallace and Riddel, 1991, 1993). The end of each of these periods was marked by significant episodes of deposition—particularly at ca. 11,000 and 7500 B.P.—which buried and/or eroded away the existing landforms (Rosenthal, White, and Sutton, 2007). Studies throughout Northern California suggest that a period of relative landscape stability was followed by another episode of increased deposition ca. 2800 B.P. However, there are also indications that late Holocene landscape changes tend to be more localized, dependent upon local variability in climate and precipitation, than the more regional depositional trends documented for the earlier Holocene and Pleistocene (Meyer and Rosenthal, 2007:7-8). Geomorphic studies within the Elk Hills (Weber, 1998) and farther north in the Coalinga area (Rymer and Elsworth, 1990) have documented this more localized timing of mid- to late Holocene depositional events.

Geologic and Geomorphic Setting

The HECA Project is on the extreme southwestern edge of the San Joaquin Valley. The area is a transitional zone between the deep alluvial plain of the valley and the uplifted Coast Range. This geomorphic contact is a geologically and seismically active area, and this activity has had a direct effect on surface geomorphology, deposition, and soils.

The San Joaquin Valley is a deep structural trough that was a large marine embayment (i.e., open to the ocean) during much of its geologic history. The trough became progressively closed off during Pliocene times (ca. 5 million years ago [MYA]) due to uplift and movement along the San Andreas Fault zone, causing a transition from a marine to terrestrial depositional environment. This continued until the Pleistocene, when the valley was finally completely closed off from its outlet through Priest Valley (near Coalinga) and alluvial fan deposits like the Tulare Formation (see below) completed the infilling of the valley. Episodic alluvial sedimentation in the San Joaquin Valley throughout the Quaternary probably has been controlled more by climatic fluctuations than by tectonic activity, though both have played a role (Bartow, 1991:7-9).

Tectonic influence on the landscape is evident within the Project area. The Elk Hills, comprising the western portions of the Project area, are formed by an anticline (Figures 77-1 and 77-5)—a large structural feature associated with faulting and folding along the eastern margin of the Coast Ranges. A much smaller anticline may be represented by Buttonwillow Ridge, at the extreme northeastern boundary of the Project (Soper, 1932). As with other anticlines in the region, these are dominantly oriented northwest-southeast. The apparent bend in the trend of the Elk Hills anticline, to east-west in the southeastern part, is generated by the intersection of two distinct fault systems at the southern boundary of the San Joaquin Valley (Fiore et al., 2007). The anticlines expose older depositional units at the surface, including the Tulare Formation. This formation has been described as Pliocene to Pleistocene (2 to 0.5 MYA) primarily terrestrial deposits more than 1,000 feet thick. The two anticlines that form the northeastern and southwestern portions of the proposed Project are separated from one another by a syncline. This syncline is represented by the area historically occupied by the Buena Vista Slough, at the northern outlet of Buena Vista Lake (Figure 77-2), and has been progressively filled by sediment washed out from the lake and transported down from the surrounding hills.

The Coast Ranges flank the west side of the San Joaquin Valley. They form a natural barrier to coastal moisture and winds, creating a rain shadow on the eastern side of the range that encompasses the current Project area. Because of the arid nature of this portion of the Coast Range–Great Valley interface, the nearby slopes are drained only by intermittent creeks, including numerous unnamed gullies and drainages which cross the flank of the Elk Hills. These small intermittent drainages have apparently maintained a consistently low but fluctuating discharge for much of the Pleistocene and Holocene, building a series of small alluvial fans along the northeastern flank of the Elk Hills (the southwestern portion of the APE).

Hydrology and Paleoclimate

Despite the lack of precipitation within the study area, several large lakes occupied the southern San Joaquin Valley throughout the late Pleistocene and Holocene (Figure 77-2). The largest of these lakes was Tulare Lake, approximately 30 miles north of the Project area. The Tulare Basin is dammed by the coalescent alluvial fans of the Kings River, draining the Sierra Nevada and feeding the basin, and Los Gatos Creek, draining the Coast Ranges and feeding the San Joaquin River aquifer (draining to the north into the Delta). Tulare Lake declined rapidly after 1850, when the Kings River (and other tributary streams) began to be diverted for irrigation. At its maximum historic extent, Tulare Lake covered an area of approximately 2,000 square kilometers (km) and had a maximum depth of 10 meters (m) (Davis, 1999). In an otherwise semi-arid environment, the Holocene lakes and their shorelines would have provided a rich and diversified ecosystem for prehistoric peoples. Indeed, the attractiveness of this unique resource to people throughout prehistory is evidenced by the presence of archaeological deposits, spanning from Paleo-Indian times (ca. 13,000 B.P.) to the historic era, along the shorelines of Tulare Lake.

Much closer, and thus more relevant to this study, is Buena Vista Lake and associated wetlands. Buena Vista Lake, as well as the smaller Kern Lake, is fed by the Kern River. The Kern River drains the southern Sierra Nevada, from south of Mount Whitney to its outlet through Kern Canyon where it enters the San Joaquin Valley at Bakersfield (Figure 77-1). The large alluvial fan associated with the river extends from the foot of the Sierra Nevada mountains entirely across the valley to the Elk Hills, forming a broad natural levee across which numerous forks of the river meander, draining partly southward into Buena Vista Lake and partly northward into Goose Lake and the Tulare Basin.

Lying south of the Kern River fan (Figure 77-1) is Buena Vista Basin, measuring about 30 miles (48.3 km) from east to west by 20 miles (32.2 km). Its lowest point, which was occupied by Buena Vista Lake, is 268 feet (81.6 m) above sea level, with the north rim just under 300 feet (91.5 m). Within historic times considerable fluctuations have occurred in the height of water in the lake. In 1910 the shore line followed the 291-foot (88.7-m) contour and Buena Vista Lake was roughly 8 by 5 miles (12.8 by 8 km) with no outlet. At 295 feet (90 m) or more, Buena Vista and Kern lakes form a single broad sheet, overflowing northwestward around the Elk Hills through Buena Vista Slough into Tulare Basin (Wedel, 1941:6). Given the perennial nature of the Kern River, it is unlikely that either of the lakes ever dried up completely during the Holocene (Gifford and Schenck, 1926:15). This is confirmed by pollen core analysis conducted at Tulare Lake, which shows that lake levels fluctuated significantly throughout the latest Pleistocene and Holocene, but the lake never fully desiccated (Davis, 1999).

Following this pollen core analysis (Davis, 1999), a more recent synthesis of available pollen and pedo-stratigraphic data from Tulare Lake resulted in a relatively well-defined history of lake highstands and associated environmental perturbations (Negrini et al., 2006). Given the hydrologic connection between the Tulare Lake and Buena Vista Lake basins, a similar

Southern Sierra Nevada source for the vast majority of their hydrologic budget (i.e., the Kings, Kaweah, and Kern rivers), and the observed similarity in climate records from throughout the region (Figure 77-3), it can be assumed that Buena Vista Lake and Slough experienced perturbations in water level similar to Tulare Lake. Throughout the late Pleistocene and Holocene, water levels within these lakes and wetlands fluctuated dramatically. At least seven major fluctuations in lake levels during the past 11,500 years have been proposed (Negrini et al., 2006). Lake levels were generally higher during the early Holocene, with two highstands (ca. 220 feet above mean sea level [AMSL]) at 9500 to 8000 B.P. and 6900 to 6200 B.P. After that, it fluctuated at lower amplitude until reaching a major highstand during the most recent millennium (ca. 750 to 150 B.P.). At least three lowstands (less than 190 feet AMSL) occurred at approximately 9700, 6100, and 2750 B.P.

The timing of these lake level events is correlative with more widespread periods of landscape instability throughout the Central Valley. Several recent reviews of Central Valley geoarchaeology and geomorphology (Rosenthal and Meyer, 2004a, 2004b; Rosenthal, White, and Sutton, 2007) have identified numerous periods of local depositional events that have buried stable Holocene landforms and associated archaeological sites. While the timing of many events varies from locale to locale within the valley, several major periods of deposition seem to co-occur throughout the greater region. In order to assess the relationship between Tulare Lake Basin highstands and wider environmental processes, these major periods of alluvial deposition have been plotted against the lake level records from Tulare Lake and other well-defined lake records in the southwest (Figure 77-3).

Periods of alluvial deposition typically occur during wetter periods, when the carrying capacity and sediment load of watercourses is increased. On Figure 77-3, this process is indicated by those periods of deposition that co-occur with the onset of lake highstands (i.e., most notably at ca. 650, 4000, 7000 to 7500, and 11,000 B.P.). However, at least two periods of broadscale deposition appear to co-occur with the onset of Tulare Lake lowstands and associated environmental desertification (ca. 2800 and 1300 B.P.). These periods suggest that alluvial deposition may also be related to broader environmental perturbations, when reduced vegetation cover may lead to increased erosion of formerly stable landforms.

The timing of these major climatological events is directly relevant to the potential for buried archaeological deposits within the APE in two respects: (1) the timing of major broadscale depositional events within the San Joaquin Valley and nearby Sierra Nevada and Coast Ranges provides an indication as to the age of associated archaeological deposits that may potentially exist below successive depositional units within the Project area; and (2) local changes in lake and slough water levels would have dramatically affected the extent and productivity of those resources, and thus the spatial relationship of archaeological sites to those resources. Fluctuations in water levels would have undoubtedly resulted in changes in settlement patterns and archaeological site deposition. In conjunction with alluvial depositional and/or erosional fluctuations, these two factors can be expected to largely dictate the placement and preservation of archaeological sites on (and within) the modern landscape.

For example, Culleton stated that "widespread occupation of the Elk Hills is correlated with increasing precipitation towards the end of the Medieval Climatic Anomaly and during the Little Ice Age [ca. 650 B.P.], suggesting that slough resource exploitation may have been driven by regional population pressure rather than drought-related declines in aquatic productivity" (2006:1331). However, given the hydrology of the Buena Vista Slough area, it is more likely that increased precipitation at the outset of the Little Ice Age resulted in regular filling and overtopping of Buena Vista Lake, and thus more consistent and predictable wetlands within the slough. This would have allowed the establishment of more long-term habitation and resource exploitation sites. Therefore, larger concentrations of buried archaeological deposits within the HECA Project area can be expected to correlate with periods of greater precipitation (in the Sierra Nevada mountains, not necessarily the Southern San Joaquin Valley) when the Buena Vista Slough would have provided a unique, predictable, and productive environment. As explained below, the predominance of sites after ca. 800 B.P. in the Elk Hills and noted by Culleton (2006), may have less to do with population pressure and the hydrology of the Buena Vista basin, than geomorphic processes of erosion and deposition that have formed the area—leaving only the most recent period of occupation evident on the surface.

Project Area Soils and Geoarchaeology

A key piece of corroborative evidence used in this study to estimate the age of various landforms, is soil age assignments. Through correlation of mapped surface soil units, field observations, soil profile descriptions, and radiocarbon dates largely compiled from existing studies, Meyer, Rosenthal, and Young (2009) established a relational database of mapped soil series and landform age for the Caltrans Districts 6 and 9 (including Kern County). Their study is largely based on soils data obtained through the SSURGO database which, in the HECA Project area, is a digital duplication of the original Soil Conservation Service soil survey maps (Chang, 1988). A recreation of this landform age map is included here in Figure 77-4.

The database is predicated on the theory that specific soils types are typically associated with specific depositional environments and landforms of a particular age. The degree of soil profile development provided by official soil series descriptions was used to make initial relative age estimates. In addition to relative soil development, age estimates were also based on the geomorphic position of associated landforms, cross-cutting relationships, degree and extent of erosional dissection, radiocarbon dates, and correlation with other dated deposits (Rosenthal and Meyer, 2004a:76). In cases where there was disagreement on landform age assignments between soil surveys and/or other geomorphic studies, a combination of soil profile development, horizontal crosscutting relationships, and radiocarbon dating was used to place similar soil series and landforms into particular temporal groups. This cross-comparison effort eventually resulted in SSURGO soil-map units that were consistently associated with landforms that occupy similar geomorphic positions on the landscape. These units could then be grouped into major temporal periods that could be assigned a relative sensitivity for buried archaeological resources. In general, the older the landform, the less likely it is to harbor buried archaeological deposits.

Landform Sensitivity Assessment (in Response to Data Request 77B)

Based on an assessment of available literature and comparison with high-resolution aerial photography, five major landforms are identified within the APE of the HECA Project. These landforms are generally coincident with the Quaternary geology units mapped by Dale, French, and Gordon (1966) and shown on Figure 77-5 (in response to Data Request 77C). Each landform and its potential to harbor buried archaeological deposits is discussed individually in this section, and summarized in Table 77-1.

Elk Hills Uplands (QTt: Tulare Formation; Sensitivity: Very Low)

This unit, which is in the extreme southwestern portion of the Project area, is coincident with the higher elevations of the Elk Hills. As discussed above, the Elk Hills are formed by a structural anticline which has elevated older deposits above the surrounding valley floor and exposed them to erosion. This unit is largely composed of the Tulare Formation, which is of Plio-Pleistocene age. The Tulare Formation contains up to 2,200 feet of interbedded, oxidized to reduced sands; gypsiferous clays and gravels derived predominantly from Coast Range

Table 77-1
Summary of Geoarchaeological Sensitivity of Landforms within the HECA Project Area

Landform (map unit)	Surface Age	Depositional Regime*	Sensitivity
Elk Hills Uplands (QTt)	Pliocene to Pleistocene	Erosional	Very Low
Elk Hills Alluvial Fan Piedmont (Qa)	Late Holocene	Variable	Low to Moderate
Basin/Slough Deposits (Qb)	Late Holocene	Depositional	High
Uplifted and Preserved Older Valley Deposits (Qoa)	Pleistocene	Erosional (?)	Very Low
Kern River Alluvial Fan (Qya)	Late Holocene	Depositional	High

Note:
*Represents the dominant regime since the terminal Pleistocene

sources. The formation includes the Corcoran Clay Member, which is present in the subsurface from the Kern River Outlet Channel on the west through the central and much of the eastern Southern San Joaquin subbasin at depths of 300 to 650 feet (Croft, 1972). Within the study area, local portions of the Tulare Formation may be capped by younger Pleistocene deposits, which may or may not be directly attributable to the Formation (Lantz, 1968).

Within the APE, surface soils mapped in this unit include Elk Hills series complex and torriorthents (Chang, 1988). A review of ^{14}C dates associated with this series indicates that the landform is early to middle Pleistocene in age (Figure 77-4; Meyer, Rosenthal, and Young, 2009). This age is consistent with the surface deposits being part of the Tulare Formation, and indicates that this landform has either been stable or erosional since well before the first movement of humans into California (ca. 13,000 B.P.). However, the lack of surface archaeological sites on this upland portion of the Elk Hills predating the latest Holocene (Culleton, 2006) indicates that an erosional regime has predominated for most of the Holocene. Given the age and erosional nature of this upper portion of the Elk Hills, the potential for buried archaeological deposits in this area is considered very low.

Coalescing Alluvial Fan Piedmont (Qa: Quaternary alluvial fans; Sensitivity: Low to Moderate)

This geomorphic unit is formed by the multiple coalescing alluvial fans that form the lower elevations of the Elk Hills. Within the Project area, these coalescing fans are formed by the numerous small ephemeral streams that drain the northeastern slope of the Elk Hills. As discussed above, the Elk Hills form a remnant dissected upland, the erosional upper portions of which provide the sediment for the lower alluvial fans.

Within the APE, surface soils mapped in this unit are of the Cajon series (Chang, 1988). A review of ^{14}C dates associated with this series indicates that the surface soils are latest Holocene in age (Figure 77-4; Meyer, Rosenthal, and Young, 2009). This age is consistent with the surface deposits being part of actively (or recently) aggrading alluvial fans, with a potential for buried surfaces (paleosols) spanning most of human history in California (ca. 13,000 B.P.).

Geotechnical investigations conducted for the HECA Project on the lower portions of the Qa coalescing fans encountered sediments of the Tulare Formation at various depths, from approximately 8 to 18 feet (approximately 2.5 to 5.5 m) below ground surface (URS 2008; Figure 77-4). In general, these limited explorations (5 borings total) suggest that the Tulare Formation is generally shallower in the higher elevations of the fans, and deeper in the lower elevations (to the northeast). These findings are consistent with general observations of alluvial fans along the eastern flank of the Coast Ranges, which suggest that most fans are older in their upper portions, with progressively decreasing age towards the fan toe (e.g., Bull, 1964:105-6; Laudon and Belitz, 1991). This model suggests that the lower portions of the Qa fans are actively aggrading (or were during the late Holocene) and have a greater depth of sediment accumulation. Therefore, the lower portions of the fan piedmont are also likely more sensitive for buried archaeological resources than the upper portions. This gradational sensitivity of the Qa fans is further enhanced by the proximity of the fan toes to the wetland resources of the Buena Vista overflow basin, which is discussed further below.

A geomorphic investigation conducted in conjunction with site testing at CA-KER-3080 (Weber, 1998) is instructive in understanding the geomorphic evolution of the Elk Hills coalescing alluvial fan piedmont, and the geoarchaeological sensitivity of this landform. Gerald Weber, a highly qualified Quaternary geologist affiliated with the University of California, Santa Cruz, conducted a geomorphic reconnaissance of an incised drainage that cuts through the fan deposits adjacent to KER-3080. Mr. Weber identified three major stratigraphic units within the Qa fan. The lowest of these (Unit I) is a fluvial sand and gravel unit with a very well-developed soil profile. The profile consists of a Bt-K-Btk-Ck-K_2 (or 2Ck)-Cu sequence (see Figure 77-6). The upper horizon is a sandy clay loam with moderately developed blocky structure (Bt). This is underlain by multiple moderately developed K and Btk-horizons with Stage II to III carbonate development. The relatively unweathered parent material (Cu) is a poorly sorted fine- to coarse-grain sand with crude discontinuous bedding and some minor carbonate infiltration. Weber (1998:9) notes that the lower K_2 horizon may represent a buried surface within Unit I, but such a determination is both inconclusive and irrelevant given the presumed age of Unit I. Weber concludes that “the development of a strong textural B-horizon and the strong accumulation of calcium carbonate in the soil suggest a pre-Holocene age … and may exceed 40,000 years” (1998:1-2). This lowest observed pedogenic unit likely represents in-place weathering of the upper Pleistocene Tulare Formation, and may be equivalent to the deposits attributed to the Tulare Formation during the URS (2008) geotechnical investigations described above.

Weber’s Unit I is unconformably overlain by Unit II throughout the area investigated. Unit II variably truncates the Bt, K, and Btk horizons of Unit I, with an upper A-horizon completely absent from Unit I (Figure 77-6). This contact suggests a period of significant erosion prior to or coincident with the deposition of Unit II. Unit II itself consists of a very weakly developed, unconsolidated, poorly sorted sandy soil with a high degree of bioturbation evident. The soil has a weak A-horizon with only slight color change from the underlying parent material C-horizon (Weber, 1998:3). This very weak soil development is consistent with the official series description for the Cajon surface soils mapped in the area (Chang, 1988). Weber suggests that the fan deposits upon which these weak soils have formed were deposited less than 2,000 to 4,000 years ago (Weber, 1998:3). However, this is likely an overestimation, as

Cajon series soils have been consistently dated to the latest Holocene (ca. the last 1,000 years; Meyer, Rosenthal, and Young, 2009).

Farther downslope along the Elk Hills coalescing alluvial fan piedmont, Weber identified a third depositional unit overlying Unit II. Unit III is generally coarser than Unit II, with distinct bedding indicative of active channel and near-channel levee deposits. The contact between Units II and III also represents an erosional unconformity. The complete absence of soil development within Unit III, as well as minimal bioturbation, suggests that the unit is of recent to modern in age. Again, this age determination is consistent with some areas of Cajon series soils that date to modern times (Meyer, Rosenthal, and Young, 2009).

A general evolutionary sequence for the Elk Hills Qa fan piedmont can be extrapolated from Weber's findings: (1) deposition of alluvial sediment (Unit I) from the Elk Hills during the Pleistocene (ca. 100ka to 40ka) with a long period of stability and soil formation; (2) incision of these Pleistocene sediments by local on-fan streams, likely in response to falling base-level associated with progression to the Wisconsin glacial maxima (ca. 25ka) with additional tectonic influence on local base-level related to the continuing uplift of the Elk Hills Anticline;
(3) backfilling of incised channels along the fan piedmont begins as sea-levels (global base level) rise dramatically between 14,000 and 6000 B.P. and sediment deposited by the Kern River, within the Buena Vista Slough, raises the local base level at the base of the Elk Hills;
(4) at some point during the Holocene, the active channels backfill to the original surface elevation of Unit I and erosively strip this older surface prior to or during the deposition of Unit II;
(5) Unit II alluvial sediments are deposited by the on-fan streams during the past ca. 1,000 years, with weak soil formation and archaeological sites deposited on the surface;
(6) lateral channel migration causes local erosion of Unit II, along downstream portions of the fans, and deposition of Unit III (continued down-fan aggradation), perhaps related to greater carrying capacity during recent extreme storm events and/or the availability of greater sediment load due to historic development of the Elk Hills.

The results of Weber's study, and his assignment of a late Holocene age to Units II and III, is consistent with more recent dating of surface soil series found along the flank of the Elk Hills (Figure 77-4; Meyer, Rosenthal, and Young, 2009). These dates, a generally low-energy alluvial depositional environment, and the presence of numerous surface archaeological sites (i.e., the area was clearly attractive to prehistoric peoples) suggest that there is a high potential for buried archaeological sites within the Qa coalescing alluvial fan piedmont. However, Weber's finding of consistent and pronounced erosional contacts at the surface of paleosols on the fan piedmont indicate that there is little preservation potential. As Weber concludes, "the unconformable contact between Unit I and Unit II assures us that the A horizon of the soil formed on Unit I was erosionally stripped. Consequently, humans could have inhabited the site for 6-7 thousand years [or even upwards of 10,000 years] and deposited immense amounts of archaeological materials in the A soil horizon developed on Unit I, only to have it all erode away during the deposition of Unit II."

Although it is debatable whether Weber's findings can be applied across the Elk Hills coalescing alluvial fan piedmont, the consistency of the numerous small closely spaced seasonal watercourses that drain the hills, the similarity of parent material, and common environmental setting, all suggest that similar processes have formed the numerous small fans that make up the area. Despite the recent age of the fine-grain alluvial surface deposits, it appears that the sensitivity for buried archaeological sites is greatly reduced by the consistently observed erosional subsurface contacts. Therefore, the sensitivity for buried archaeology—with no surface manifestation—within the Elk Hills fan piedmont is considered low. Increased sensitivity can probably be anticipated for the lowest portions of the fans (within ca. 500 m from their termination at Buena Vista Slough) due to two factors: (1) proximity to the slough, its increased resource productivity, and greater likelihood of related archaeological deposits; and (2) increased sediment accretion at the fan toe, with moderate potential for site burial and preservation.

Buena Vista Slough (Qb: Basin deposits; Sensitivity: High)

Within the Project area, this Holocene-age unit is formed by progressive sedimentation of the structural syncline between the Elk Hills and Buttonwillow Ridge anticlines. Similar basin deposits are found in various places throughout the Southern San Joaquin valley and vary in both character and thickness (Department of Water Resources, 2006). In the Tulare and Buena Vista basins the unit is of silt, silty clay, sandy clay, and clay interbedded with poorly permeable sand layers. These flood basin deposits are difficult to distinguish from underlying fine-grained older alluvium and the basin deposits and alluvial fan deposits likely interfinger (Wood and Dale, 1964). However, the vast majority of sediments within this portion of the Project area are likely related to deposition associated with episodic overflow from Buena Vista Lake and filling of the Buena Vista Slough.

Within the APE, surface soils mapped in this unit are Buttonwillow and Lokern series clays (Chang, 1988). A review of ^{14}C dates associated with this series indicates that the surface soils are latest Holocene in age (Figure 77-4; Meyer, Rosenthal, and Young, 2009). This age is consistent with the surface deposits being part of historically deposited basin sediments from seasonal overflows of Buena Vista Lake and the Kern River. Given this age assignment and the low-energy depositional environment, there is a potential for paleosols spanning most of human history in California (ca. 13,000 B.P.) within this landform.

Depth of the fine-grain lacustrine and slough material is difficult to assess. The official series descriptions for both Buttonwillow and Lokern soils terminate at approximately 65 inches (165 centimeters [cm]). Geotechnical investigations within the main HECA Project Site (Figure 77-4) concluded that:

> The Project Site is immediately underlain by approximately 10 feet of fine-grained soils comprising predominantly of clays and silty clays. These upper soils are further underlain by granular soils to the maximum depth explored in the borings of 100 feet below the existing ground surface.
>
> The upper clayey soils are observed to possess a medium stiff consistency, although the top half (about 5 feet) is generally soft and wet as a result of recent agricultural use … Below 30 feet, the sandy soils become dense, grading denser to the maximum depth explored in the borings (100 feet)." (URS, 2009b, Appendix P, pp. 12-13).

Two drill sites, conducted by the USGS and located northeast of Buttonwillow along the Kern River Flood Channel (Buena Vista Slough), produced fossil wood that was radiocarbon dated. These samples, recovered at 20 and 35 feet below ground surface, both produced latest Pleistocene ages of ca. 13,500 and 14,000 ^{14}C years B.P., respectively (Manning, 1968). The samples were found in a matrix described simply as "bluish-grey sand." This color assignment is consistent with a gleyed sand deposit that formed under subaqueous lacustrine or slough conditions. These data suggest that potentially archaeologically sensitive latest-Pleistocene to Holocene age deposits can be expected within the Buena Vista Slough (Qb) sediments up to 35 feet (10.7 m) below surface.

The exact contact between the Elk Hills coalescing alluvial fans (Qa) and the Buena Vista Basin deposits (Qb) has been variously mapped by different researchers (e.g., Dale, French, and Gordon, 1966; Page, 1986; Wood and Davis, 1959) but is generally coincident with the West Side/Kern River Flood Canal (Figure 77-5). The variability of the contact, directly to the east or west of the canal, is likely related to the difficulty in differentiating the fine-grain fan-toe and basin deposits, which interfinger at their contact, as well as modern disturbance from the construction of the canal. Due to the interfingering, the fine-grain low-energy depositional environment, and the environmental setting—at the historic edge of a vast seasonal wetland—this contact is considered particularly sensitive for buried archaeological resources. While disturbance caused by the development of the West Side/Kern River Flood Control Canal has likely caused significant subsurface disturbance, and thus reduced the sensitivity of this area, the proposed Process Water line and the Potable Water/Natural Gas line project components roughly follow this geomorphic contact and, as such, are considered particularly sensitive. In the field, differentiation of the lacustrine and alluvial fan materials may be achieved through color, with lacustrine basin sediments represented by blue hue redoximorphic features, and fan sediments indicated by oxidized red and yellow hues.

Excavations conducted at the Buena Vista Lake sites, including CA-KER-116, are instructive in understanding the possible relationship between the archaeology and depositional context of the Qa/Qb interface (Fredrickson, 1986; Fredrickson and Grossman, 1977; Wedel, 1941). The Buena Vista Lake sites are approximately 8 miles south, in a very similar setting. According to Fredrickson and Grossman, the sites were part of “an extensive occupation zone situated along the southern shoreline of the now-drained Buena Vista Lake at the base of the Buena Vista Hills” (1977:174). The Buena Vista Hills are a structural anticline that is smaller than, but functionally very similar to the Elk Hills (e.g., largely composed of the Tulare Formation, etc.). The sites investigated were along the northeast-facing flank of the hills, similar to the currently proposed linear facilities along the base of the Elk Hills Qa fans. The bases of the Elk Hills fans abut the overflow basin/wetland deposits of Buena Vista Slough, whereas the investigated sites abutted the shoreline of Buena Vista Lake.

During early Smithsonian excavations (Wedel, 1941) two master profiles were created for two habitation sites investigated (“Wedel 1” and “Wedel 2”; after Fredrickson and Grossman, 1977). At the southeastern site (Wedel 2) the Tulare Formation was encountered at approximately 8 feet below surface (Wedel, 1941:79). Farther north, as the shoreline moved farther from the Buena Vista Hills, the Tulare formation was not encountered in a trench excavated to 10 feet below surface (Wedel 1). Within Wedel 2, at least three distinct cultural strata were identified. At least two of these appear to be associated with distinct (although weakly formed) paleosols. Within Wedel 1, stratification was less distinct, with the excavated profile built up of multiple interfingered lenses without lateral continuity. It is likely that this profile is the result of episodic alluvial and lacustrine/beach deposits at the interface between the Buena Vista Hills and the lake.

A third site (CA-KER-116) farther north, and thus even farther downslope from the Buena Vista Hills, was investigated in 1964 and 1965 (Fredrickson and Grossman, 1977). At least three distinct cultural components were identified at the location. This work was largely conducted in response to construction of the California Aqueduct. According to Fredrickson and Grossman (1977:178), “exploratory geological trenches excavated in connection with the aqueduct construction revealed the presence of artifacts, features, and human graves at depths of 2 m or more below ground surface. Surface appearances, however, gave no indication of either significant depth or intensive occupation.” The most deeply buried cultural component was discovered at the site at depths ranging from approximately 10 to 15 feet (3 to 4.5 m) separated from the overlying cultural deposits by several meters of sterile sediment. The buried component included diagnostic crescentic stone tools, atlatl spurs, and shell and hearth features dating to approximately 8000 B.P. The authors concluded that the observed stratigraphy "probably originated through the inter-digitation of alluvium deposited through water runoff from the hills and sediments deposited by the lake" (Fredrickson and Grossman, 1977:179). A similar depositional environment, as well as buried archaeological potential, can be expected for the western portion of the Buena Vista Slough basin deposits (Qb) which interfaces with the toe of the Elk Hills alluvial fan piedmont (Qa).

Kern River Alluvial Fan (Qya: Recent/young Quaternary alluvium; Sensitivity: High)

This unit, which is in the extreme southeastern portion of the Project area, is formed by the distal portions of the Kern River Alluvial Fan. As discussed above, the Kern River Alluvial Fan forms the north and eastern boundary of the Buena Vista Basin and is the geomorphic feature responsible for impoundment of the waters of the Kern River in Buena Vista and Kern lakes (Figure 77-1). The Kern River Alluvial Fan is the result of deposition by the Kern River as it exits the Sierra Nevada foothills, flows across the Kern River fault, and undergoes a dramatic change in slope as it spreads out from the confines of the Kern River Canyon onto the southern San Joaquin Valley. The change in slope, in conjunction with the large sediment load-carrying capacity of the river, results in a massive alluvial fan that stretches over 20 miles from the base of the Sierra foothills, across the valley, to the western terminus at the Elk Hills.

Within the APE, surface soils mapped in this unit are dominated by the Kimberlina series, with perhaps some minor components of the Westhaven series (Chang, 1988). A review of ^{14}C dates associated with these series indicates that the landform is latest Holocene in age (Figure 77-4; Meyer, Rosenthal, and Young, 2009). This age is consistent with the official soil descriptions for the Kimberlina series, which has a very weakly developed color A-horizon overlying several C-horizons, with few indications of pedogenic development (Soil Survey Staff, 2009). Westhaven soils appear more well developed and may represent older portions of the fan which have been mantled by the younger deposits upon which the Kimberlina soils are formed. Prior to the historic channelization and diversion of the Kern River for agricultural irrigation, the Kern River Alluvial Fan was an actively aggrading landform.

Although this landform is only crossed by a small section of the proposed Natural Gas Supply line, in the very southwestern extreme of the APE (Figure 77-5), it is nonetheless considered highly sensitive for buried archaeological resources. This sensitivity is a product of the young age and actively accreting nature of the Kern River Alluvial Fan, as well as the proximity to the Buena Vista Lake outlet channel and the distinct environmental resources provided by both the Buena Vista Slough and Lake.

Uplifted and Preserved Older Valley Deposits (Qoa: Older alluvium; Sensitivity: Very Low)

This unit, which is in the northeastern portion of the Project area, is coincident with Buttonwillow Ridge. As discussed above, Buttonwillow Ridge is likely formed by a deep (inactive?) structural anticline which has uplifted and preserved older valley deposits above the younger basin and fan deposits that surround the feature. This unit is largely composed of up to 250 feet of Pleistocene-age lenticular deposits of clay, silt, sand, and gravel that are loosely consolidated to cemented, and which is often indistinguishable from the Tulare Formation (Hilton et al., 1963; Wood and Dale, 1964; Wood and Davis, 1959).

Within the APE, surface soils mapped in this unit are dominated by the Garces series (Chang, 1988). A review of ^{14}C dates associated with this series indicates that the landform is latest Pleistocene to earliest Holocene in age (Figure 77-4; Meyer, Rosenthal, and Young, 2009). This age is consistent with the official soil descriptions for the Garces series, which exhibits strong pedogenic development, including a well-developed structural A-horizon overlying a distinct E-horizon (zone of elluviation) and several well-developed structural Btk-horizons (Soil Survey Staff, 2009). Given the degree of pedogenic development, it appears that this unit has been stable to slightly erosional for most of the past 13,000 years. Given the age and predominantly stable nature of these older valley deposits, the potential for buried archaeological deposits in this area is considered very low. The extreme northern portion of the modified electrical transmission line 1A is located within this unit.

Conclusions and Recommendations

Based on an analysis of existing geological, geomorphological, soils, archaeological, and geoarchaeological studies relevant to the Elk Hills/Buttonwillow region, there is a moderate to high potential for encountering buried archaeological deposits throughout the majority of the proposed HECA Project APE. Particularly relevant to this conclusion is the setting of the Project, within and directly adjacent to the Buena Vista Slough and Buena Vista Lake, which would have been highly attractive resources in an otherwise arid to semi-arid environment. The attractiveness of these resources to human populations is evidenced by the abundant archaeological sites in the area, which are known to span at least the past 8,000 years. The potential for encountering buried archaeological sites with no surface manifestation is confirmed by the young age of the vast majority of the surface deposits and associated landforms—most of which appear to date to the latest Holocene, or the past ca. 1,000 years. Furthermore, these are predominantly fine-grained alluvial depositional landforms—especially the Buena Vista Slough basin deposits and the Kern River Alluvial Fan deposits—which are likely to contain and preserve formerly stable surfaces (paleosols).

Aside from the southern portion of the carbon dioxide pipeline, which is on the Plio-Pleistocene Tulare Formation of the Elk Hills uplands (QTt), and the northern portion of the modified electrical transmission line 1A, which is on older Pleistocene alluvium (Qoa), the entire APE appears to be moderately to highly sensitive for buried archaeological deposits. The sensitivity of the carbon dioxide pipeline, which crosses the Elk Hills alluvial fan piedmont (Qa), appears to be variable with elevation. Based on a previous detailed geomorphic field investigation of the piedmont (Weber, 1998) it has been shown that significant erosion occurred prior to the most recent depositional event, and that there is little potential for archaeological preservation at the unconformable contact. The potential for burial and preservation is likely increased towards the base of the piedmont, due to increased deposition at the base of the coalescing fans and proximity to the basin deposits (Qb) that may interfinger with the fan deposits at depth. Therefore, there is a moderate potential for buried archaeological deposits for approximately the distal (lower) 500 m of the piedmont. Within this area, latest-Pleistocene and Holocene age deposits are likely limited to less than 4.5 m (15 feet) below surface. It is recommended that archaeological monitoring occur within this area and depth during ground-disturbing activities.

Portions of the APE that are located on the Buena Vista Slough (Qb) and Kern River Alluvial Fan landforms (Qya)—including the main Project Site, the process water pipeline, the natural gas/potable water pipelines, and lower-elevation portions of the carbon dioxide and modified transmission lines—have the greatest potential for buried archaeological deposits. The process water pipeline, which runs along the margin of the Buena Vista Slough, and the natural gas/ potable water pipelines, which also cross a portion of the distal Kern River Alluvial Fan, appear to be particularly sensitive. The sensitivity of the process water pipeline may be partially diminished by its proximity to the West Side Canal and the potential for significant previous ground disturbance associated with that feature. Latest Pleistocene and Holocene age deposits within the Buena Vista Slough basin landform (Qb) can be anticipated to extend up to 35 feet (10.5 m) below surface. Depth of similar age deposits within the Kern River Alluvial Fan (Qya) is unknown, but they may be similarly deep, based on the amount of deposition indicated by the massive scale of the fan. It is recommended that archaeological monitoring occur within these areas and depths during ground-disturbing activities.

References

Bartow, J. A., 1991. The Cenozoic evolution of the San Joaquin. Valley, California. U.S. Geological Survey Professional Paper 1501.

Bull, William B., 1964. Geomorphology of segmented alluvial fans in western Fresno County, California. U.S. Geological Survey Professional Paper 352-E.

Chang, Kan Kim, 1988. *Soil survey of Kern County, California, northwestern part*. U.S. Department of Agriculture, Soil Conservation Service; in cooperation with the regents of the University of California (Agricultural Experiment Station). Washington D.C.

Croft, M. G., 1972. *Subsurface Geology of the Late Tertiary and Quaternary Water-Bearing Deposits of the Southern Part of the San Joaquin Valley, California*; U.S. Geological Survey Water Supply Paper 199H.

Culleton, Brendan J., 2006. Implications of a freshwater radiocarbon reservoir correction for the timing of late Holocene settlement of the Elk Hills, Kern County, California. *Journal of Archaeological Science* 33: pp. 1331-9.

Dale, R. H., James J. French, and G. V. Gordon, 1966. *Ground-Water Geology and Hydrology of the Kern River Alluvial-Fan Area, California*. USGS Open-File Report 66-21. U.S. Department of the Interior, Geological Survey, Water Resources Division, Washington D.C.

Davis, Owen K., 1999. Pollen Analysis of Tulare Lake, California: Great Basin-like Vegetation in Central California During the Full-Glacial and Early Holocene. *Review of Palaeobotany and Palynology* 107:249-257.

Department of Water Resources, 2006. *California's Groundwater – Bulletin 118, Update 2003*. California Department of Water Resources, Sacramento. Available online at: http://www.water.ca.gov/groundwater/bulletin118/bulletin118update2003.cfm

Fiore, Patricia E., David D. Pollard, William R. Currin, and David M. Miner, 2007. Mechanical and stratigraphic constraints on the evolution of faulting at Elk Hills, California. *American Association of Petroleum Geologists Bulletin* v. 91(3), pp. 321-341.

Fredrickson, David A., 1986. Buena Vista Lake (CA-KER-116) Revisited. In Symposium: *A New Look at some Old Sites, Papers from the Symposium Organized by Francis A. Riddell, Presented at the Annual Meeting of the Society for California Archaeology, March 23-26, 1983, San Diego, California*. Coyote Press Archives of California Prehistory 6:75-81, 1986. Available online at: http://www.californiaprehistory.com/reports02/rep0029.html

Fredrickson, David A. and Joel W. Grossman, 1977. A San Dieguito Component at Buena Vista Lake, California. *Journal of California Anthropology* 4(2): pp.173-190. Malki Museum: Banning.

Gifford, E. W. and W. Egbert Schenk, 1926. Archaeology of the Southern San Joaquin Valley, California. *University of California Publications in American Archaeology and Ethnology*, v.23 (1), pp. 1-122.

Hilton, G. S., E. J. McClelland, R. L. Klausing, F. Kunkel, 1963. *Hydrology of the Terra Bella-Lost Hills area, San Joaquin Valley, California*. U.S. Geological Society Open-File Report 63-48.

Lantz, Robert J., 1968. A Review of the Elk Hills Oil Field, Kern County, California. In *1968 Guidebook, Geology and Oil Fields, West Side Southern San Joaquin Valley*. Guidebook from the 43rd annual meeting of the Pacific Section of the American Association of Petroleum Geologists, pp. 49-53.

Laudon, Julie and Kenneth Belitz, 1991. Textural and depositional history of Late Pleistocene–Holocene Alluvium in the Central Part of the Western San Joaquin Valley, California. *Bulletin of the Association of Engineering Geologists* 28(1), pp. 73-88.

Manning, John C., 1968. Two Late Pleistocene Radiocarbon Dates near Buttonwillow, California. In *Guidebook: Geology and Oil Field, West Side Southern San Joaquin Valley*, edited by Stanley E. Karp, pp. 98-99. 43rd Annual Meeting, Pacific Sections, AAPG, SEG, SEPM. Bakersfield, California.

Meyer, Jack, and Jeff Rosenthal, 2007. Geoarchaeological Overview of the Nine Bay Area Counties in Caltrans District 4. Far Western Anthropological Research Group, Davis, California. Prepared for California Department of Transportation, District 4, Oakland.

Meyer, Jack, Jeffry Rosenthal, and D. Craig Young, 2009. Appendix C [map unit soil series age associations]. From *A Geoarchaeological Study of Caltrans District 6 and 9.* [working title]. To be submitted to California Department of Transportation, District 6, Fresno, Winter 2009 (in press; obtained through personal communication with the author).

Negrini, Robert M., Peter E. Wigand, Sara Draucker, Kenneth Gobalet, Jill K. Gardener, Mark Q. Sutton, Robert M. Yohe II, 2006. The Rambla Highstand Shoreline and the Holocene Lake-Level History of Tulare Lake, California, USA. *Quaternary Science Reviews* 25:1599-1618

Page, R. W., 1986. *Geology of the Fresh Ground-Water Basin of the Central Valley, California*. U.S. Geological Survey Professional Paper 1401-C.

Porcasi, Judith F., 2000. *Contributions to Tulare Lake Archaeology III, Archaeological Investigations at CA-TUL-1613, the Creighton Ranch Site, Tulare County, California*. Tulare Lake Archaeological Research Group, Redondo Beach.

Rosenthal, Jeffry and Jack Meyer, 2004a. Volume III: Geoarchaeological Study Landscape Evolution and the Archaeological Record of Central California. In *Cultural Resources Inventory of Caltrans District 10 Rural Conventional Highways*. Prepared by Far Western Anthropological Research Group, Davis, California. Submitted to California Department of Transportation, District 10, Stockton, California.

Rosenthal, Jeffry and Jack Meyer, 2004b. *Landscape Evolution and the Archaeological Record: A Geoarchaeological Study of the Southern Santa Clara Valley and Surrounding Region*. Center for Archaeological Research at Davis Publication Number 14. University of California, Davis.

Rosenthal, Jeffrey, Gregory White, and Mark Sutton, 2007. The Central Valley: A View From the Catbird's Seat. In *California Prehistory: Colonization, Culture, and Complexity*. Edited by Terry Jones and Kathryn Klar. Alta Mira, New York.

Rymer, Michael and William Ellsworth (editors), 1990. *The Coalinga Earthquake of May 2, 1983*. U.S. Geological Survey Professional Paper 1487. U.S. Government Printing office, Washington.

Soil Survey Staff, 2009. Official Soil Series Descriptions [Online WWW]. Natural Resources Conservation Service, United States Department of Agriculture. USDA-NRCS, Lincoln, NE. Available online at: "http://soils.usda.gov/technical/classification/osd/index.html" [Accessed 18 December 2009].

Soper, Edgar K., 1932. Limitations of Ground Water as Aid in Determination of Hidden Geologic Structure. *AAPG Bulletin* v.16, pp. 335-360.

URS Corporation, 2008. Appendix P: Geotechnical Investigations. Report: Preliminary Geotechnical Investigation Proposed Hydrogen Energy California Project, Tupman, Kern County, California. In *Application for Certification Volume II, Hydrogen Energy California*. Prepared for Hydrogen Energy International, LLC, Long Beach (May 2008). Submitted to the California Energy Commission, Sacramento.

URS Corporation, 2009a. Appendix H3: Confidential Archaeological Reconnaissance, Hydrogen Energy California Study Area, Kern County, California. In *Revised Application for Certification for Hydrogen Energy California, Kern County, California*. Prepared for Hydrogen Energy International, LLC, Long Beach (May 2009). Submitted to the California Energy Commission, Sacramento.

URS Corporation, 2009b. Appendix P: Geotechnical Investigations. In *Revised Application for Certification for Hydrogen Energy California, Kern County, California*. Prepared for Hydrogen Energy International, LLC, Long Beach (May 2009). Submitted to the California Energy Commission, Sacramento.

Wallace, W. J. and F. A. Riddell (editors), 1991. *Contributions to Tulare Lake Archaeology I, Background to a Study of Tulare Lake's Archaeological Past*. Tulare Lake Archaeological Research Group, Redondo Beach.

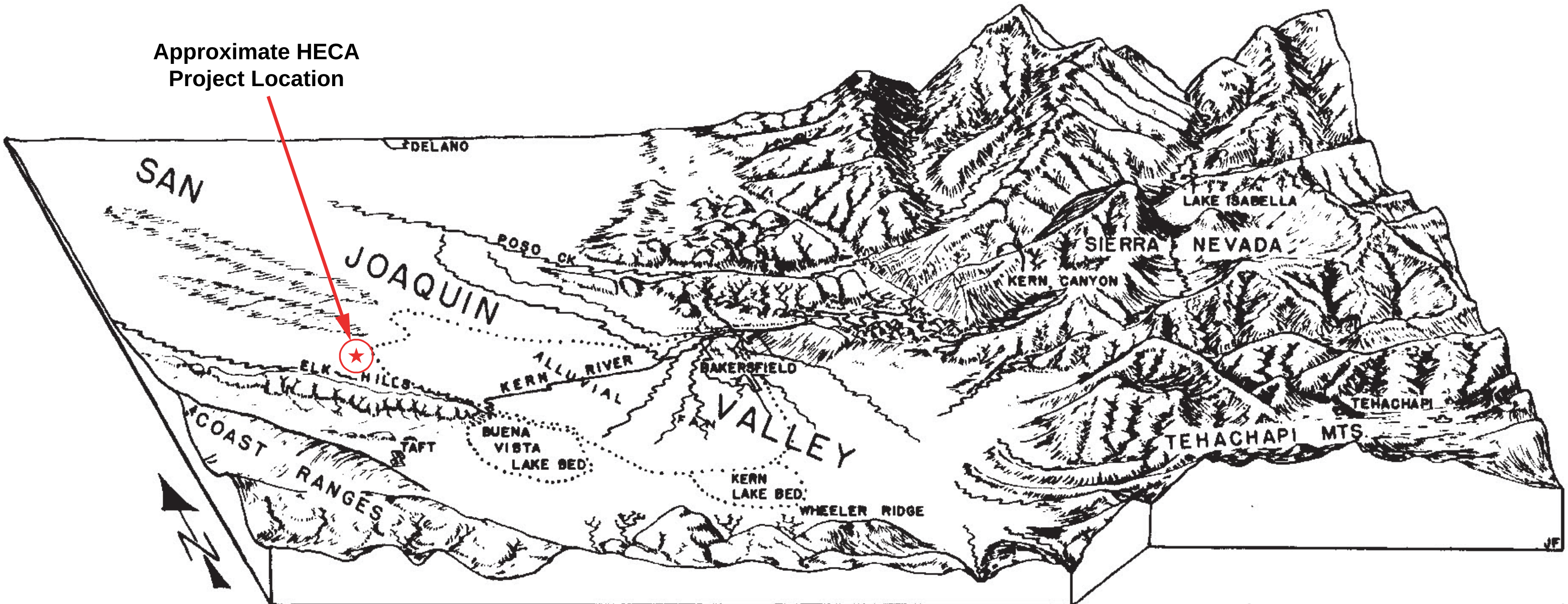
Wallace, W. J. and F. A. Riddell (editors), 1993. *Contributions to Tulare Lake Archaeology II, Finding the Evidence: The Quest for Tulare Lake's Archaeological Past*. Tulare Lake Archaeological Research Group, Redondo Beach.

Weber, Gerald E., 1998. Geologic History of Site CA-KER-3080, Interpretations and Conclusions. Letter report in *Prehistoric Archaeological Resources Inventory and Evaluation at Naval Petroleum Reserve No. 1 (Elk Hills), Kern County California*, H1 Volume 4, pp. 317-341, edited by T. L. Jackson, A. Shapiro, and J. H. King. Report on file, Southern San Joaquin Valley Information Center, California State University, Bakersfield.

Wedel, Waldo A., 1941. Archaeological Investigations at Buena Vista Lake, Kern County, California. *Smithsonian Institution, Bureau of American Ethnology Bulletin* 130, Washington, D.C.

Wood, P. R. and R. Dale, 1964. *Geology and Ground-Water Features of the Edison-Maricopa Area, Kern County, California*. U.S. Geological Survey Water Supply Paper 1656.

Wood, P. R. and G. H. Davis, 1959. *Ground-water conditions in the Avenal-McKittrick area, Kings and Kern Counties, California*: U.S. Geological Survey Water-Supply Paper 1457.



Generalized representation of
Southern San Joaquin Valley showing
the relationship between major geomorphic features, including (from east to west):
Sierra Nevada and Tehachapi mountains; Kern Canyon and Kern River; Kern River alluvial fan;
Kern and Buena Vista lakes; Elk Hills; Buttonwillow Ridge (unlabeled, north of Elk Hills); and the Coast Ranges.

Not to Scale

Sources:
Dale, French, and Gordon (1966:7), Groundwater Geology and Hydrology of the Kern River Alluvial Fan Area, California; USGS OFR 66-21.

HECA PROJECT SETTING WITH REFERENCE TO MAJOR GEOMORPHIC FEATURES

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Kern County, California

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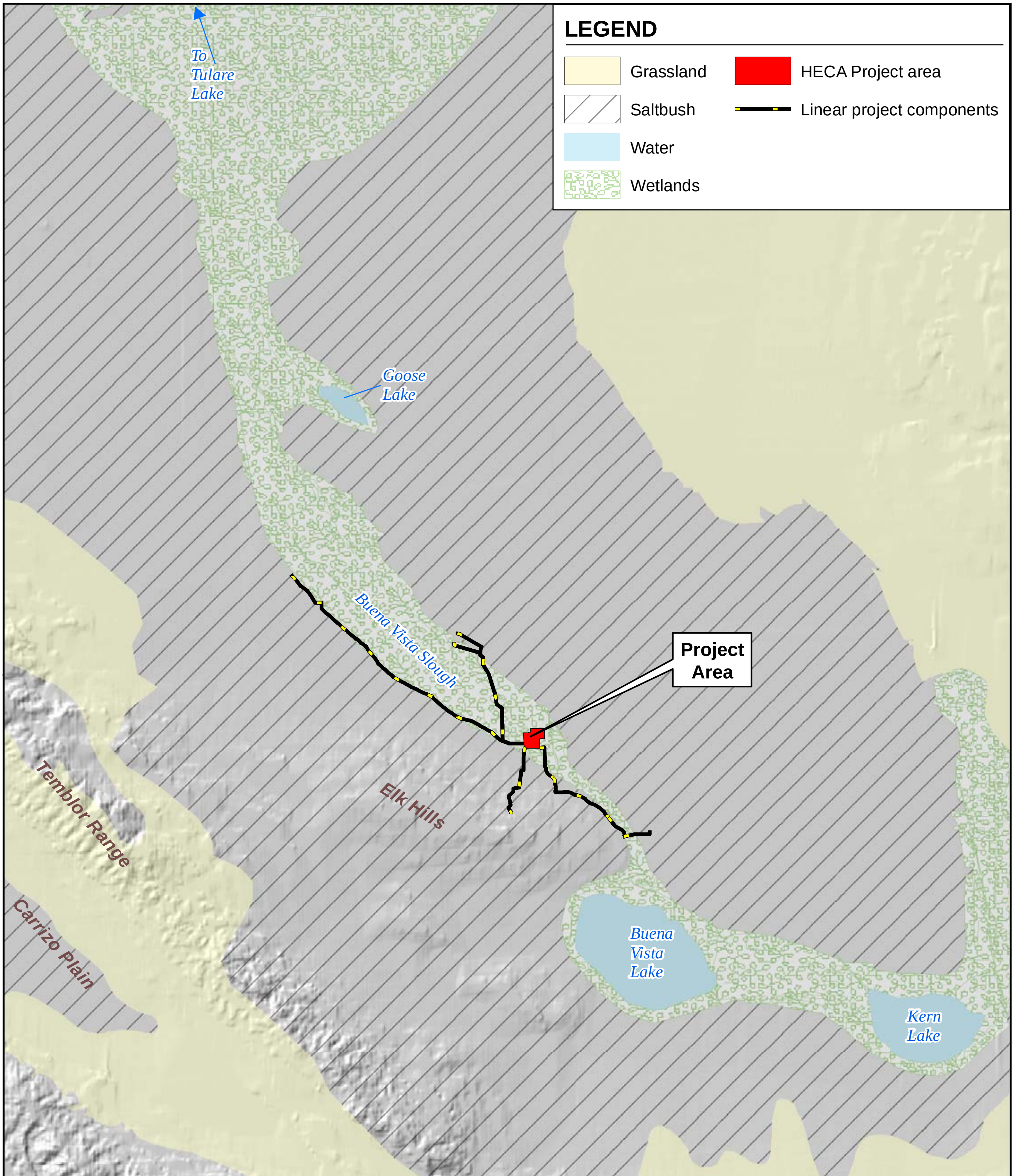
FIGURE 77-1



Sources:
Historical Lakes of the San Joaquin Valley;
Endangered Species Recovery Program;
(http://esrp.csustan.edu/gis)

N

0 5 10

Scale in Miles
(1:400,000)

PRE-CONTACT HYDROLOGY AND BIOLOGICAL COMMUNITIES OF THE SOUTHERN SAN JOAQUIN VALLEY

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Kern County, California

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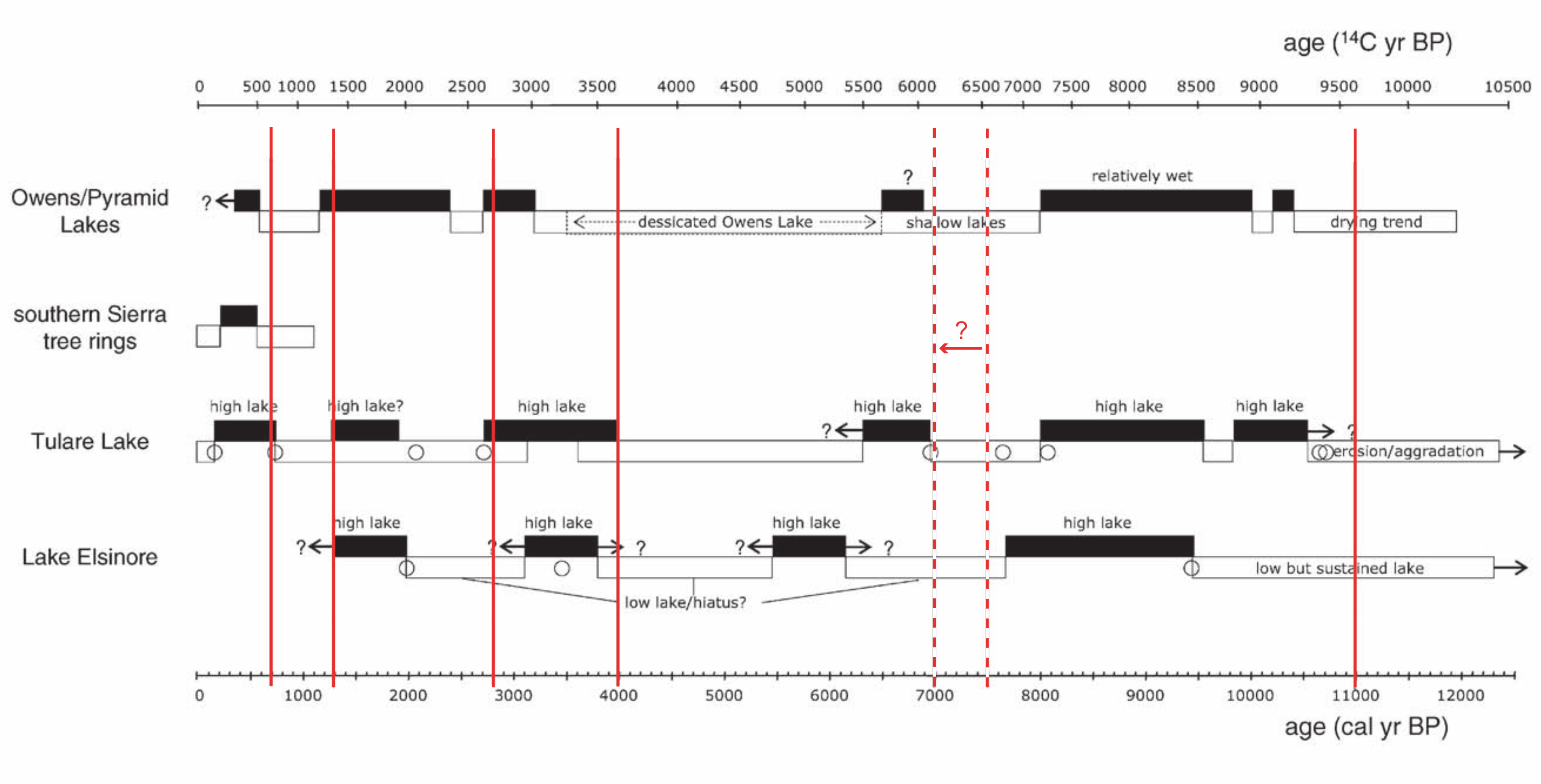
FIGURE 77-2

1/19/10 vsa..T:\HECA\GRAPHICS\Data Requests\DR 77 Geoarch\Fig 77-2_precontact hydro-bio.ai



Representative Holocene climate records for Tulare Lake and other regions of the southwestern U.S. (from Negrini et al. 2006). Red lines represent approximate periods of major widespread depositional events in central and northern California (Rosenthal and Meyer 2004; Rosenthal, White, and Sutton 2007). Note the very close relationship between the beginning and end of Tulare Lake highstands and the onset of deposition.

Sources:
Negrini, et al., (2006);
Rosenthal and Meyer (2004a);
Rosenthal, White and Sutton (2007).

REGIONAL HOLOCENE LAKE LEVEL HISTORIES AND TIMING OF MAJOR DEPOSITIONAL EPISODES

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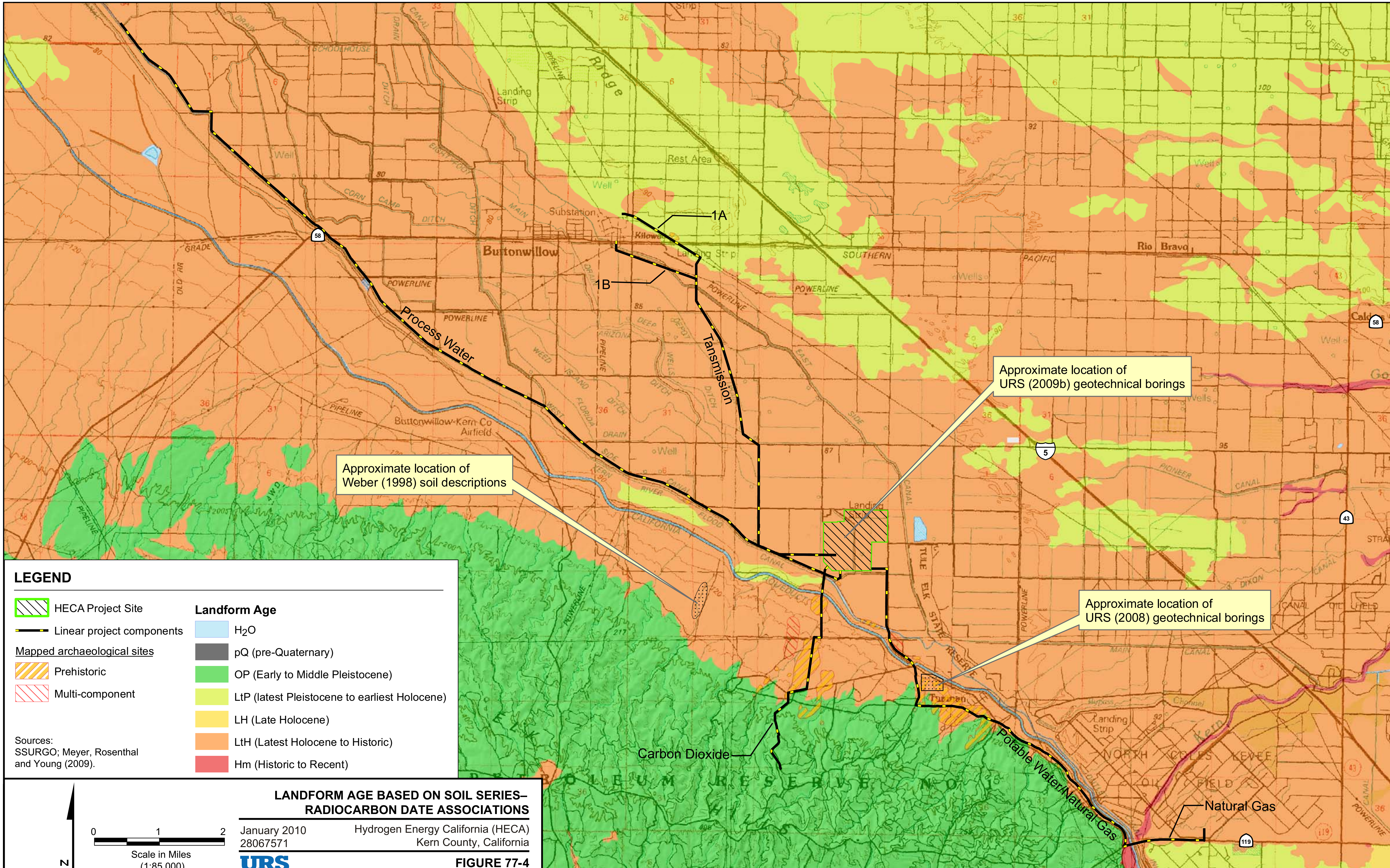
FIGURE 77-3

1/19/10 vsa..T:\HECA\GRAPHICS\Data Requests\DR 77 Geoarch\Fig 77-3_lake levels.ai



LANDFORM AGE BASED ON SOIL SERIES–RADIOCARBON DATE ASSOCIATIONS

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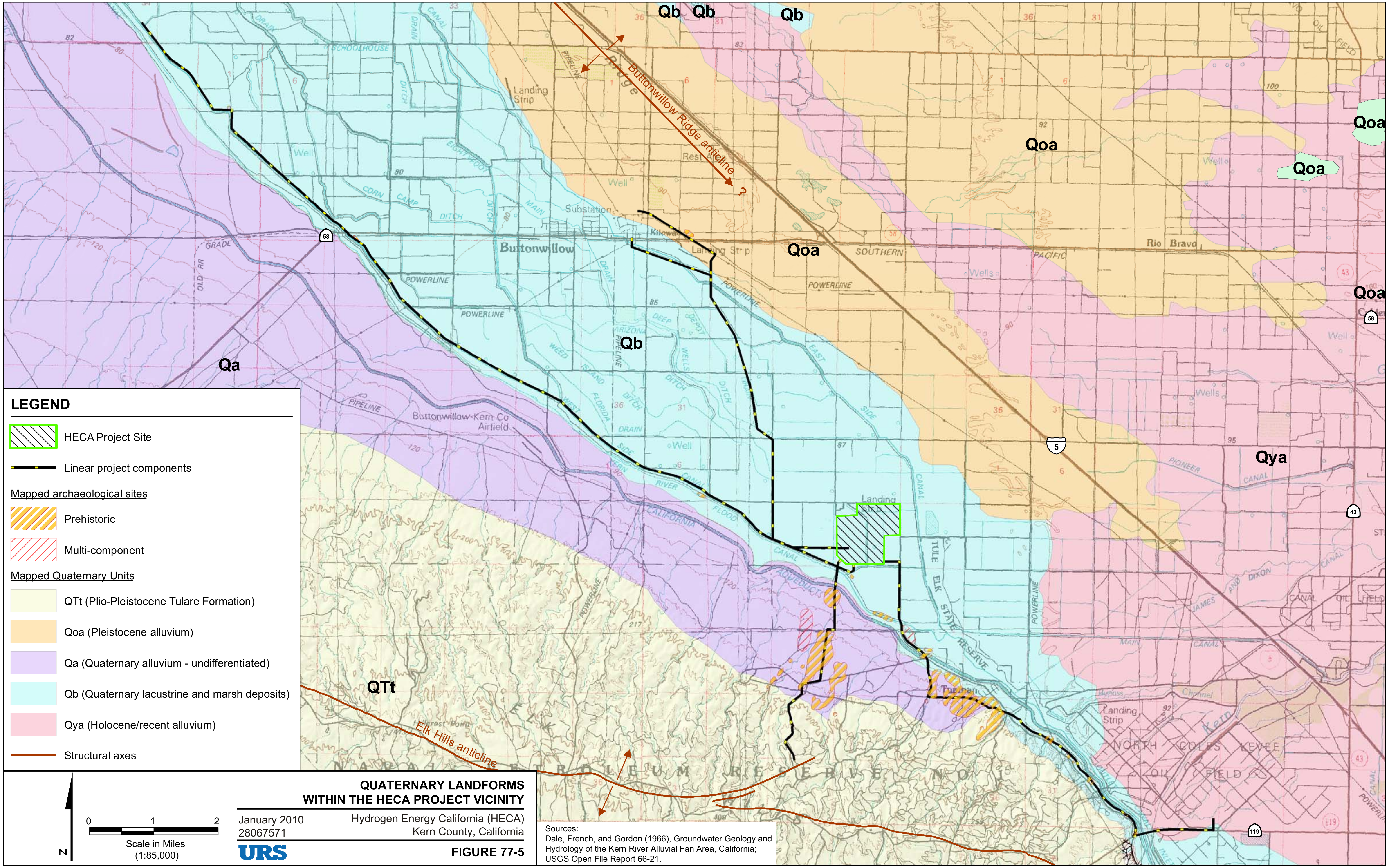
FIGURE 77-4

1/19/10 vsa..T:\HECA\GRAPHICS\Data Requests\DR 77 Geoarch\Fig 77-4_landform age.ai



LEGEND

- HECA Project Site
- Linear project components

Mapped archaeological sites

- Prehistoric
- Multi-component

Mapped Quaternary Units

- QTt (Plio-Pleistocene Tulare Formation)
- Qoa (Pleistocene alluvium)
- Qa (Quaternary alluvium - undifferentiated)
- Qb (Quaternary lacustrine and marsh deposits)
- Qya (Holocene/recent alluvium)
- Structural axes

N

0 1 2

Scale in Miles (1:85,000)

QUATERNARY LANDFORMS WITHIN THE HECA PROJECT VICINITY

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Kern County, California

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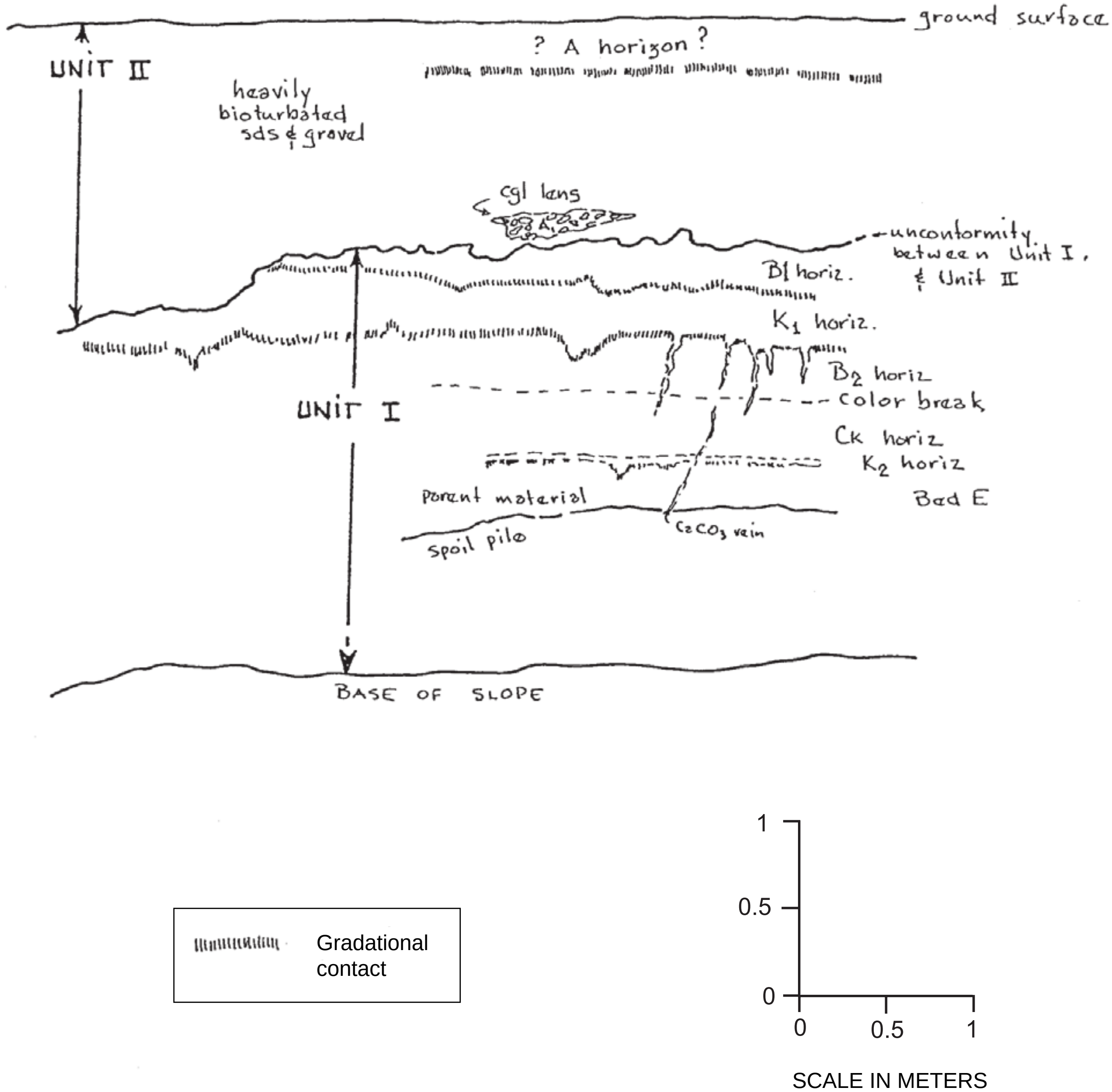
FIGURE 77-5

Sources:
Dale, French, and Gordon (1966), Groundwater Geology and Hydrology of the Kern River Alluvial Fan Area, California; USGS Open File Report 66-21.

1/19/10 vsa..T:\HECA\GRAPHICS\Data Requests\DR 77 Geoarch\Fig 77-5_quaternary geo.ai



Source:
Weber (1998:8); Geologic History of Site CA-KER-3080: Interpretations and Conclusions.

ELK HILLS ALLUVIAL FAN SOIL PROFILE

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Hydrogen Energy California (HECA)
Kern County, California

URS

FIGURE 77-6

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Technical Area: Public Health
Author: Dr. Alvin Greenberg

BACKGROUND

The AFC did not provide diesel particulate matter (DPM) emission factors for equipment and vehicles that will be used during construction activities nor was a health risk assessment prepared for diesel emissions from construction activities. Table 5.1-10 of the AFC provides modeling results for combustion sources during construction activities for criteria pollutants, including PM10 and PM2.5, but not DPM. While staff understands that project construction emissions are short-term and may indeed pose an insignificant risk to public health as the AFC states, staff needs to verify this by reviewing the DPM emission factors and health risk assessment for construction activities.

DATA REQUEST

85. Please provide DPM emission factors from construction activities, the AERMOD air dispersion results (Chi/Q in ug/m^3 per g/sec) at the PMI, MEIR and MEIW (as defined in data requests 86, 87, and 88 below), and a health risk assessment for diesel construction equipment emissions.

RESPONSE

Diesel particulate matter (DPM) emission factors and estimated emission rates from construction activities were included in Appendix D in the Revised AFC, and the monthly and annual construction DPM emissions are included for convenience as Attachment 85-1 to this data request, in the table entitled "Maximum Rolling 12-Month Onsite Construction Exhaust Emissions."

To analyze the potential cancer and chronic health impacts from DPM due to onsite DPM construction emissions, the exposure assessment was evaluated by modeling annual concentrations of particulate matter less than 10 microns in diameter (PM_{10}). As only one pollutant, DPM, was examined, AERMOD was run to estimate the ground-level PM_{10} concentration rather than Chi/Q. Emissions from the year consisting of construction months 17 through 28 were included in the health risk assessment (HRA), as this was the 1-year period with the highest DPM emissions. The cancer risk and chronic health index were estimated based on Office of Environmental Health Hazard Assessment and San Joaquin Valley Air Pollution Control District (SJVAPCD) guidance. With the exception of the offsite worker, all cancer risk was estimated based on residential cancer data assumptions. The cancer risk was estimated by determining the inhalation dose from the annual PM_{10} concentration, then multiplying that by the cancer potency factor for an exposure duration factor of 4 years as opposed to a typical lifetime exposure of 70 years, because the exposure to the DPM from construction equipment ends after 4 years. The maximally exposed individual worker (MEIW) cancer risk was analyzed in a manner similar to the residential cancer risk, with the exception that the offsite worker breathing rate of 149 liters per kilogram per day (L/kg-day) was used. The chronic hazard index was calculated by dividing the annual PM_{10} concentration by the chronic reference exposure level of 5.0 micrograms per cubic meter (µg/m^3).

Table 85-1 presents the peak PM_{10} annual concentration predicted with AERMOD, cancer risk, and chronic hazard index at the point of maximum impact (PMI), the maximally exposed individual resident (MEIR), and the MEIW. Two residences were included in the modeling: one immediately northwest of the facility, adjacent to the property boundary, and one east of the property boundary, at the corner of Station Road and Tule Park Road. The maximum modeled risk between these two residences is reported in Table 85-1 as the MEIR. As shown in this table, the cancer risk and chronic hazard index from construction-related DPM at all receptor types were predicted to be below the significance thresholds.

The modeling files from this analysis along with the spreadsheet to estimate the cancer risk and chronic hazard index are provided on the modeling DVD included with these Data Responses.

Reference

OEHHA (Office of Environmental Health Hazard Assessment), 2003. *The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*.

SJVAPCD (San Joaquin Valley Air Pollution Control District), 2006. *Guidance for Air Dispersion Modeling*.

Table 85-1
Estimated PM_{10} Concentration, Cancer Risk, and Chronic Non-Cancer THI
Due to Onsite Construction Equipment DPM Exhaust

Location	AERMOD PM10 Results (µg/m3)	DPM Cancer Risk	DPM Chronic Hazard Index
Point of maximum impact	0.29503	7.0 in 1 million	0.06 total hazard index
Peak risk at nearest offsite worker (MEIW) (Tule Elk State Reserve Ranger Station)	0.01325	0.08 in 1 million	0.003 total hazard index
Peak risk at nearest residence (MEIR) (Residence at the northwest corner of the property)	0.05441	1.29 in 1 million	0.011 total hazard index
Peak risk at nearest Sensitive Receptor (Elk Hills School, Tupman, CA)	0.00910	0.22 in 1 million	0.002 total hazard index
Significance threshold	NA	10 in 1 million	1
Below significance?	NA	Yes	Yes

Source: HECA Project

Notes:

DPM = diesel particulate matter
MEIR = maximally exposed individual resident
MEIW = maximally exposed individual worker
NA = not applicable
THI = total hazard index
$\mu g/m^3$ = micrograms per cubic meter
PM_{10} = particulate matter less than 10 microns in diameter

ATTACHMENT 85-1
MAXIMUM ROLLING 12-MONTH ONSITE CONSTRUCTION EXHAUST EMISSIONS

Hydrogen Energy, Inc
HECA Project
5/21/2009

Month	CO		CO_2		CH_4		N_2O		NO_2		PM_{10}		$PM_{2.5}$		SO_2		ROG [(1)]		CO_2e	
	Monthly Emissions (tons)	12-Month Total (tons)	Monthly Emissions (tons)	12-Month Total (tons)	Monthly Emissions (tons)	12-Month Total (tons)	Monthly Emissions (tons)	12-Month Total (tons)	Monthly Emissions (tons)	12-Month Total (tons)	Monthly Emissions (tons)	12-Month Total (tons)	Monthly Emissions (tons)	12-Month Total (tons)	Monthly Emissions (tons)	12-Month Total (tons)	Monthly Emissions (tons)	12-Month Total (tons)	Monthly Emissions (tons)	12-Month Total (tons)
1	2.01	NA	424.63	NA	0.0505	NA	0.0069	NA	5.19	NA	0.280	NA	0.257	NA	0.0047	NA	0.671	NA	427.82	NA
2	2.04	NA	432.31	NA	0.0506	NA	0.0070	NA	5.27	NA	0.284	NA	0.261	NA	0.0048	NA	0.688	NA	435.54	NA
3	1.95	NA	385.22	NA	0.0472	NA	0.0066	NA	4.68	NA	0.273	NA	0.251	NA	0.0042	NA	0.649	NA	388.24	NA
4	1.98	NA	390.40	NA	0.0474	NA	0.0067	NA	4.72	NA	0.279	NA	0.256	NA	0.0043	NA	0.666	NA	393.46	NA
5	1.46	NA	256.15	NA	0.0306	NA	0.0049	NA	2.99	NA	0.207	NA	0.189	NA	0.0028	NA	0.481	NA	258.31	NA
6	1.47	NA	257.61	NA	0.0308	NA	0.0049	NA	3.00	NA	0.207	NA	0.190	NA	0.0028	NA	0.483	NA	259.77	NA
7	1.53	NA	264.67	NA	0.0326	NA	0.0051	NA	3.09	NA	0.216	NA	0.198	NA	0.0029	NA	0.503	NA	266.94	NA
8	1.45	NA	249.92	NA	0.0320	NA	0.0050	NA	2.89	NA	0.199	NA	0.183	NA	0.0027	NA	0.482	NA	252.13	NA
9	1.40	NA	240.27	NA	0.0311	NA	0.0049	NA	2.75	NA	0.188	NA	0.172	NA	0.0026	NA	0.472	NA	242.43	NA
10	1.44	NA	236.64	NA	0.0318	NA	0.0050	NA	2.70	NA	0.197	NA	0.180	NA	0.0026	NA	0.479	NA	238.85	NA
11	1.45	NA	232.98	NA	0.0335	NA	0.0050	NA	2.62	NA	0.193	NA	0.176	NA	0.0026	NA	0.482	NA	235.22	NA
12	1.52	19.70	257.43	3,628.23	0.0355	0.454	0.0059	0.0676	2.86	42.75	0.201	2.725	0.184	2.496	0.0028	0.0399	0.505	6.562	259.99	3,658.70
13	1.50	19.19	268.88	3,472.47	0.0357	0.439	0.0063	0.0670	2.96	40.52	0.191	2.637	0.175	2.415	0.0030	0.0382	0.492	6.383	271.57	3,502.45
14	1.69	18.84	295.88	3,336.04	0.0413	0.430	0.0070	0.0670	3.31	38.56	0.220	2.573	0.202	2.356	0.0033	0.0367	0.554	6.249	298.91	3,365.82
15	1.70	18.59	302.10	3,252.92	0.0420	0.424	0.0073	0.0677	3.39	37.28	0.223	2.523	0.205	2.310	0.0034	0.0359	0.562	6.162	305.24	3,282.82
16	1.68	18.29	297.73	3,160.24	0.0419	0.419	0.0072	0.0683	3.36	35.92	0.222	2.466	0.204	2.258	0.0033	0.0349	0.546	6.041	300.85	3,190.21
17	1.84	18.67	329.22	3,233.31	0.0463	0.435	0.0081	0.0715	3.71	36.65	0.240	2.499	0.220	2.289	0.0037	0.0358	0.595	6.155	332.71	3,264.61
18	1.79	19.00	319.99	3,295.69	0.0456	0.449	0.0079	0.0746	3.62	37.27	0.233	2.525	0.214	2.314	0.0036	0.0365	0.571	6.244	323.41	3,328.25
19	1.92	19.39	348.64	3,379.65	0.0487	0.465	0.0088	0.0782	3.94	38.12	0.248	2.557	0.227	2.343	0.0039	0.0375	0.607	6.347	352.38	3,413.69
20	2.47	20.41	492.76	3,622.50	0.0623	0.496	0.0127	0.0860	5.49	40.72	0.306	2.6633	0.281	2.442	0.0053	0.0401	0.757	6.622	498.02	3,659.58
21 max short-term	2.69	21.70	547.15	3,929.38	0.0676	0.532	0.0143	0.0955	6.06	44.03	0.328	2.803	0.302	2.571	0.0059	0.0433	0.816	6.967	553.01	3,970.16
22	2.41	22.67	490.16	4,182.90	0.0609	0.561	0.0129	0.1034	5.43	46.77	0.293	2.899	0.269	2.660	0.0053	0.0460	0.727	7.214	495.43	4,226.74
23	2.45	23.67	501.39	4,451.31	0.0627	0.591	0.0132	0.1116	5.55	49.70	0.296	3.003	0.272	2.755	0.0054	0.0488	0.746	7.478	506.79	4,498.31
24	2.45	24.60	502.63	4,696.52	0.0630	0.618	0.0132	0.1189	5.57	52.40	0.297	3.099	0.273	2.844	0.0054	0.0513	0.749	7.722	508.05	4,746.37
25	2.46	25.57	503.87	4,931.51	0.0632	0.645	0.0132	0.1259	5.58	55.02	0.298	3.206	0.274	2.943	0.0054	0.0538	0.752	7.982	509.31	4,984.10
26	2.46	26.33	503.87	5,139.51	0.0632	0.667	0.0132	0.1322	5.58	57.29	0.298	3.284	0.274	3.014	0.0054	0.0559	0.752	8.181	509.31	5,194.50
27	2.25	26.87	459.51	5,296.92	0.0577	0.683	0.0120	0.1369	5.07	58.97	0.271	3.331	0.249	3.058	0.0050	0.0575	0.691	8.310	464.44	5,353.70
28 max 12 month perio	1.85	27.04	359.50	5,358.70	0.0480	0.689	0.0092	0.1389	4.00	59.61	0.230	3.339	0.211	3.065	0.0040	0.0581	0.584	8.347	363.37	5,416.22
29	1.68	26.88	323.92	5,353.40	0.0426	0.685	0.0082	0.1390	3.59	59.49	0.210	3.308	0.193	3.038	0.0036	0.0580	0.523	8.275	327.36	5,410.87
30	1.61	26.70	308.21	5,341.62	0.0401	0.680	0.0078	0.1388	3.41	59.28	0.201	3.276	0.184	3.008	0.0034	0.0578	0.496	8.200	311.48	5,398.94
31	1.61	26.38	308.21	5,301.20	0.0401	0.671	0.0078	0.1379	3.41	58.75	0.201	3.229	0.184	2.965	0.0034	0.0573	0.496	8.089	311.48	5,358.04
32	1.49	25.40	276.07	5,084.50	0.0369	0.646	0.0069	0.1320	3.06	56.33	0.188	3.111	0.172	2.857	0.0030	0.0550	0.460	7.793	278.98	5,139.00
33	1.38	24.09	259.50	4,796.85	0.0339	0.612	0.0065	0.1242	2.88	53.15	0.176	2.959	0.162	2.717	0.0028	0.0520	0.428	7.404	262.23	4,848.22
34	1.16	22.83	206.99	4,513.68	0.0274	0.579	0.0050	0.1164	2.29	50.01	0.148	2.814	0.136	2.583	0.0023	0.0490	0.355	7.032	209.13	4,561.92
35	0.89	21.27	168.63	4,180.92	0.020	0.536	0.0041	0.1073	1.78	46.24	0.106	2.624	0.097	2.408	0.0018	0.0454	0.273	6.559	170.31	4,225.45
36	0.76	19.59	148.74	3,827.03	0.017	0.491	0.0037	0.0978	1.56	42.23	0.092	2.418	0.084	2.220	0.0016	0.0416	0.230	6.040	150.25	3,867.65
37	0.56	17.68	97.71	3,420.87	0.013	0.440	0.0024	0.0869	1.04	37.70	0.068	2.188	0.062	2.008	0.0011	0.0373	0.161	5.449	98.72	3,457.06
38	0.30	15.52	51.34	2,968.34	0.006	0.382	0.0011	0.0748	0.51	32.63	0.037	1.927	0.034	1.768	0.0006	0.0324	0.086	4.782	51.81	2,999.57
39	0.29	13.56	50.10	2,558.93	0.006	0.330	0.0011	0.0639	0.50	28.06	0.037	1.693	0.033	1.553	0.0005	0.0280	0.083	4.174	50.55	2,585.68
40	0.28	12.00	48.65	2,248.07	0.005	0.288	0.0011	0.0558	0.49	24.54	0.036	1.499	0.033	1.375	0.0005	0.0245	0.081	3.671	49.09	2,271.40
41	0.25	10.57	40.97	1,965.12	0.005	0.250	0.0009	0.0485	0.41	21.36	0.031	1.321	0.028	1.211	0.0004	0.0214	0.064	3.212	41.37	1,985.41
42	0.25	9.21	40.97	1,697.88	0.005	0.215	0.0009	0.0416	0.41	18.35	0.031	1.151	0.028	1.055	0.0004	0.0185	0.064	2.781	41.37	1,715.30
43	0.24	7.85	39.52	1,429.18	0.005	0.180	0.0009	0.0347	0.40	15.34	0.030	0.980	0.028	0.898	0.0004	0.0156	0.062	2.347	39.90	1,443.72
44	0.21	6.57	36.15	1,189.26	0.004	0.147	0.0008	0.0286	0.36	12.64	0.027	0.820	0.025	0.751	0.0004	0.0129	0.049	1.936	36.49	1,201.23
Maximum (100 % load)	**2.69**	**27.04**	**547.15**	**5,358.70**	**0.0676**	**0.689**	**0.0143**	**0.1390**	**6.06**	**59.61**	**0.328**	**3.339**	**0.302**	**3.065**	**0.0059**	**0.0581**	**0.816**	**8.347**	**553.01**	**5,416.22**
Average (66 % load)	**1.78**	**17.85**	**361.12**	**3,536.74**	**0.04**	**0.455**	**0.0095**	**0.0917**	**4.00**	**39.34**	**0.217**	**2.203**	**0.199**	**2.023**	**0.0039**	**0.04**	**0.539**	**5.509**	**364.99**	**3,574.71**
	66.27		**12,557.18**		**1.61**		**0.29**		**141.50**		**8.54**		**7.83**		**0.14**		**20.98**		**12,682.02**	

Note:
(1) Assuming ROGs are equivalent to VOCs
(2) Assuming 66% operational average load

MODEL INPUTS	NO2	PM10	PM2.5	SO2	
Max annual value (tons)	39.34	2.203	2.023	0.04	hours per year 8760
Max annual value (pounds)	78686.6	4406.9	4046.4	76.7	
Max annual emission rate (lb/hr)	8.98	0.50	0.46	0.0088	

BACKGROUND

Public health impacts are modeled in the Health Risk Assessment at grid receptors located outside of both the Project Site and the Controlled Area. Impacts should also be determined for the Point of Maximum Impact (PMI) regardless of whether it occurs inside or outside of the Project Site and Controlled Area. Impacts at the location of the Maximally Exposed Individual Worker (MEIW) should likewise be determined.

DATA REQUEST

86. Please provide the location (in UTM coordinates), the AERMOD air dispersion results (Chi/Q in ug/m^3 per g/sec) at that location, and the estimated cancer risk, chronic hazard index and acute hazard index at the Point of Maximum Impact within the Project Site area, within the Controlled Area, and outside of both areas.

RESPONSE

The HRA to analyze potential health impacts from the operational TAC emissions was updated to include the fugitive emissions from various process areas. A discussion of these emissions is included in the response to Data Request 89, along with all onsite TAC emissions included in the HRA. This HRA also incorporated the revised emergency generator DPM emissions and the removal of the auxiliary combustion turbine generator (CTG). The HRA was conducted in the same three steps that were conducted for the Revised AFC. First, the dispersion model AERMOD was run to estimate the Chi/Q values from each source at each receptor for 1-hour and annual averaging times. Second, the AERMOD Chi/Q values were passed through the Hotspots Analysis and Reporting Program (HARP) On-Ramp model in preparation for input into HARP. The third step involves running the HARP model to estimate the potential health risks.

The HRA considered annual emissions from 504 hours of venting as a worst-case scenario, as previously described in the response to Data Request 45. The only TAC emitted from the carbon dioxide (CO_2) vent is hydrogen sulfide (H_2S); therefore, to ensure that all potential sources of TACs were modeled, the CO_2 vent was included in the AERMOD/HARP modeling.

The AERMOD/HARP modeling included all grid receptors used in the modeling presented in the Revised AFC, the sensitive receptor located at the Elk Hills School in Tupman, the residence along the northwest property boundary, and two additional residences at the intersection of Station Road and Tule Park Road. In addition, one offsite worker at the Tule Elk State Reserve ranger station, approximately 1 km east of the property boundary, was included in the modeling.

The risk calculation for the MEIW assumed that the worker would be present at that location for 8 hours per day, 5 days per week, 49 weeks per year, for 40 years (default HARP worker adjustment).

The public would only have access to the area outside the property boundary. Health risks were not calculated for the areas (Project Site and Controlled Area) inside the property boundary because the public would not have access to these areas and worker health is protected by Occupational Safety and Health Administration regulations.

The results of the HRA for project operations are presented below in Table 86-1 for the PMI and at the MEIW outside the property boundary, which includes the Project Site, the Controlled Area, and the MEIR. The MEIR for all health risks occurs at the residence along the northwest property boundary. The health risks at the residence at the intersection of Station Road and

Tule Park Road are also shown for informational purposes in Table 86-1. As shown in this table, all health risks were predicted to be below the significance thresholds.

The AERMOD modeling files and risk calculation reports from HARP are included on a DVD for this data response. The files include the Chi/Q in µg/m^3 per gram per second from each source at each receptor.

Table 86-1
Estimated Cancer Risk, Acute and Chronic Non-Cancer THI
Due to Operations

Location	Cancer Risk	Chronic Hazard Index	Acute Hazard Index
Point of maximum impact	3.02 in 1 million	0.27 total hazard index	0.79 total hazard index
Coordinates of PMI in UTM NAD83 (m)	283,960E 3,911,650N	283,960E 3,911,650N	282,674E 3,911,504N
Peak risk at off-site worker MEIW	0.082 in 1 million	0.035 total hazard index	0.11 total hazard index
Coordinates of MEIW in UTM NAD83 (m) (Tule Elk State Reserve Ranger Station)	285,170E 3,912,389N	285,170E 3,912,389N	285,170E 3,912,389N
Peak risk at MEIR	0.72 in 1 million	0.060 total hazard index	0.22 total hazard index
Coordinates of MEIR in UTM NAD83 (m) (Residence at the northwest corner of the property)	282,408 E 3,913,181 N	282,408 E 3,913,181 N	282,408 E 3,913,181 N
Risk at Residence at Station Road and Tule Park Road	0.59 in 1 million	0.052 total hazard index	0.16 total hazard index
Coordinates in UTM NAD83 (m) (Residence at Station Road and Tule Park Road)	284,396 E 3,912,529 N	284,396 E 3,912,529 N	284,396 E 3,912,529 N
Peak risk at nearest Sensitive Receptor (Elk Hills School, Tupman, CA)	0.43 in 1 million	0.038 total hazard index	0.10 total hazard index
Coordinates of Sensitive Receptor NAD83 (m)	285,878E 3,908,605N	285,878E 3,908,605N	285,878E 3,908,605N
Significance threshold	10 in 1 million	1	1
Below significance?	Yes	Yes	Yes

Source: HECA Project

m = meters
MEIR = maximally exposed individual resident
MEIW = maximally exposed individual worker
PMI = point of maximum impact
THI = total hazard index
UTM = Universal Transverse Mercator

DATA REQUEST

87. Please provide the location (in UTM coordinates), the AERMOD air dispersion results (Chi/Q in ug/m3 per g/sec) at that location, and the estimated cancer risk, chronic hazard index and acute hazard index at the MEIW within the Project Site area, within the Controlled Area, and outside of both areas.

RESPONSE

Please see Response to Data Request 86.

BACKGROUND

Staff identified two potential nearest Maximally Exposed Individual Residents (MEIRs). One is located next to the facility to the northwest and is evaluated in the AFC. The applicant is attempting to purchase this property. The other nearest residence is located east of the Project Site, at the intersection of Station Road and Tupman Road. The location of this residence should also be evaluated in the HRA for public health impacts.

DATA REQUEST

88. Please provide the location (in UTM coordinates), the AERMOD air dispersion results (Chi/Q in ug/m^3 per g/sec) at that location, and the estimated cancer risk, chronic hazard index and acute hazard index at the nearest residence located at the intersection of Station Road and Tule Park Road.

RESPONSE

Please see Response to Data Request 86.

BACKGROUND

The AFC identifies all HECA Toxic Air Contaminant (TAC) emission sources on page 5.6-10 of the Revised AFC under the subheading "Stationary Sources." Staff is concerned that not all sources are contained in that list. Staff needs a list of all source, all TACs emitted from those sources, and all emissions factors in order to properly and fully asses the potential for impacts to workers and the off-site public.

Also, Tables 5.6-2 through 13 show that emissions factors of TACs emitted from the facility are derived from various sources including EPA AP-42 tables, the Ventura County APCD, CARB CATEF tables, and the project itself ("HECA Project"). Staff needs to know the basis for all decisions to use these sources of emissions factors and whether for an explanation of the project itself can serve as a source of information.

DATA REQUEST

89. Please provide an updated list of all sources of TACs in tabular format listing the source, the identify of the TAC, and the emission factor. Please include all fugitive emissions of TACs from valves and flanges (especially hydrogen sulfide) and from all mobile sources (such as DPM from the trucks that would deliver petcoke and coal feedstock to the facility). Please use the maximum number of truck deliveries expected to and from the facility. (Mobile sources can be modeled as an area source in the facility fenceline and when within 0.1 mile of the facility.)

RESPONSE

The TAC emissions from all sources at HECA were summarized in Tables 5.6-2 through 5.6-14 in the Revised AFC submitted in May 2009. These tables are included here again for convenience, with the exception of Table 5.6-3, which was removed when the Project was amended due to the deletion of the auxiliary CTG from the Project. These tables summarize the TAC emissions from all sources of TACs at the HECA Project Site, including the mobile sources that deliver the petcoke and coal feedstock and remove gasifier solids. Note that Revised Table 5.6-12 has been changed from what was submitted in May 2009 to reflect the emissions changes required due to the response to Data Request 30. Specifically, the DPM emissions from the emergency generators have increased to meet the U.S. EPA Tier 4 engine standard. Revised Tables 5.6-4 and 5.6-13 were revised to provide clarification of their respective notes.

The emission factors used to estimate the emissions for each source are identified at the bottom of each table and also in Appendix N of the Revised AFC.

Fugitive emissions of TACs from various components at the facility were estimated using the U.S. EPA guidance, *Protocol for Equipment Leak Emission Estimates* (U.S. EPA, 1995). The TOC emission factors are presented in Table 17-1 in Data Response 17. The Applicant has provided estimated fugitive components counts split by different areas at the facility (presented in Table 89-1).

To minimize the fugitive emissions, a LDAR program will be implemented, as necessary. A LDAR program is a program designed to identify pieces of equipment that are leaking and that warrant a reduction of the emission through repair.

The U.S. EPA guidance for fugitive emissions (U.S. EPA, 1995) provides control efficiencies for LDAR programs at SOCMI plants and at refineries. There are three types of LDAR programs suggested by the guidance document—a monthly monitoring program, a quarterly monitoring program, and a monitoring program based on the requirements as specified in the NESHAP regulations.

To minimize the TAC emissions from fugitive sources, the Applicant will implement a LDAR program to certain fugitive areas. These are fugitive areas with the largest TAC and VOC fugitive emissions. Because the fugitive emission factors were based on factors for SOCMI facilities, the LDAR program implemented at this facility will be the LDAR programs traditionally used at SOCMI facilities. It is currently anticipated that the Applicant will apply the LDAR program that is consistent with industry practice NESHAP, and the control efficiencies for such a program are presented in Table 89-2, and these are based on the NESHAP standards.

The Applicant proposes to apply the LDAR program to Area # 1(methanol), Area # 5 (propylene) Area # 7 (H_2S-laden methanol), Area #8 (CO_2-laden methanol), Area # 9 (acid gas) and Area # 10 (ammonia-laden gas). These areas were selected because they had the largest potential fugitive emissions for methanol, propylene, and H_2S. Table 89-3 presents the fugitive TAC emissions that were calculated as requested by this Data Request.

Table 89-4 presents a summary of the total annual TAC emissions from the onsite sources; all of these emissions were included in the updated HRA. The HRA was updated to include the removal of the auxiliary CTG, the increased DPM from the emergency generators, and the fugitive TAC emissions. The fugitive TACs were modeled as volume sources. The results from the updated HRA are summarized in the responses to Data Requests 86, 87, and 88. The HRA modeling files are included on the DVD that is included as an attachment to these responses to Data Requests.

Reference

U.S. EPA (U.S. Environmental Protection Agency), 1995. *Protocol for Equipment Leak Emission Estimates*.

Table 5.6-2
HRSG Combustion Turbine (GE 7FB) Stack TACs Emission Rates

Compound	CAS #	Emission Factor (lb/10^{12} Btu fuel)	Hourly (lb/hr)	Annual (lb/yr)
Acetaldehyde	75-07-0	1.8	4.41E-03	3.64E+01
Ammonia	7664-41-7		1.84E+01	1.53E+05
Antimony	7440-36-0	1.1	2.69E-03	2.23E+01
Arsenic	7440-38-2	2.4	5.88E-03	4.86E+01
Benz[a]anthracene	56-55-3	0.0023	5.63E-06	4.66E-02
Benzene	71-43-2	2.4	5.88E-03	4.86E+01
Beryllium	7440-41-7	0.26	6.37E-04	5.26E+00
Cadmium	7440-43-9	9.6	2.35E-02	1.94E+02
Carbon disulfide	75-15-0	46	1.13E-01	9.31E+02
Chromium (hexavalent)	18540-29-9	0.15	3.75E-04	3.10E+00
Chromium, total	0-00-5	0.51	1.25E-03	1.03E+01
Cobalt	7440-48-4	0.26	6.37E-04	5.26E+00
Cyanides	57-12-5	5.7	1.40E-02	1.15E+02
Formaldehyde	50-00-0	17	4.16E-02	3.44E+02
Hydrochloric acid	7647-01-0	13	3.18E-02	2.63E+02
Hydrogen fluoride (Hydrofluoric acid)	7664-39-3	50	1.22E-01	1.01E+03
Lead	7439-92-1	0.56	1.37E-03	1.13E+01
Manganese	7439-96-5	1.0	2.55E-03	2.11E+01
Mercury	7439-97-6	1.2	2.94E-03	2.43E+01
Methyl bromide (Bromomethane)	74-83-9	47.7	1.17E-01	9.66E+02
Methylene chloride (Dichloromethane)	75-09-2	2.2	5.39E-03	4.45E+01
Naphthalene	91-20-3	2.5	6.12E-03	5.06E+01
Nickel	7440-02-0	0.39	9.55E-04	7.90E+00
Phenol	108-95-2	36.8	9.01E-02	7.45E+02
Selenium	7782-49-2	0.56	1.37E-03	1.13E+01
Sulfuric acid and sulfates	7664-93-9	572	1.40E+00	1.16E+04
Toluene	108-88-3	0.033	8.08E-05	6.68E-01

Source: HECA Project

Notes:

1) HRSG (Firing Syngas) Operating Hours = 8,322 hr/yr
2) Hourly emissions based on 100% load at winter minimum temperature (20 °F)
3) Annual emissions based on 100% load at annual average temperature (65 °F)
4) Emission rates are taken from Wabash River test data and the National Energy Technology Laboratory, U.S. Dept of Energy, Major Environmental Aspects of Gasification-based Power Generation Technologies, Final Report, December 2002.
5) Ammonia slip from the SCR (5 parts per million volumetric dry [ppmvd] @ 15% oxygen) – provided by Fluor – see Criteria Pollutant emission spreadsheet for details

CAS # = Chemical Abstracts Service Registry Number
HRSG = heat recovery steam generator
TAC = toxic air contaminant
lb/hr = pounds per hour
lb/yr = pounds per year

Revised Table 5.6-4
Cooling Tower TACs Emission Rates

Compound	CAS #	Emission Factor (ppm)	Hourly (lb/hr)	Annual (lb/yr)
Power Block				
Arsenic	7440-38-2	0.026	1.13E-05	9.38E-02
Copper	7440-50-8	0.005	2.19E-06	1.82E-02
Fluoride		0.45	1.97E-04	1.64E+00
Manganese	7439-96-5	1.29	5.63E-04	4.68E+00
Selenium	7784-49-2	0.02	9.36E-06	7.79E-02
Process Area				
Arsenic	7440-38-2	0.026	2.72E-06	2.27E-02
Copper	7440-50-8	0.005	5.29E-07	4.40E-03
Fluoride	NA	0.45	4.76E-05	3.96E-01
Manganese	7439-96-5	1.29	1.36E-04	1.13E+00
Selenium	7784-49-2	0.02	2.26E-06	1.88E-02
ASU				
Arsenic	7440-38-2	0.026	2.59E-06	2.15E-02
Copper	7440-50-8	0.005	5.03E-07	4.18E-03
Fluoride		0.45	4.52E-05	3.76E-01
Manganese	7439-96-5	1.29	1.29E-04	1.08E+00
Selenium	7784-49-2	0.02	2.15E-06	1.79E-02

Notes:

1) Cooling Tower Operating Hours = 8,322 hr/yr
2) Arsenic ppm value shown taken as average of analytical test results (Fruit Growers Laboratory)
3) Copper ppm value shown is one-half of stated detection limit
4) Fluoride ppm value shown taken as average of analytical test results (Fruit Growers Laboratory)
5) Manganese ppm value shown taken as average of analytical test results (Fruit Growers Laboratory)
6) Selenium ppm value shown taken as average of analytical test results (California Department of Water Resources)
7) The emission factors presented are the concentrations of each constituent found in the raw cooling water analysis. Emissions are estimated based on these concentrations, cycles of concentration, and drift rate.

ASU = air separation unit
CAS = Chemical Abstracts Service Registry Number
ppm = parts per million
TAC = toxic air contaminant

Table 5.6-5
Gasifier Refractory Heater TACs Emission Rates

Compound	CAS #	Emission Factor (lb/10^6 scf)	Hourly (lb/hr)	Annual (lb/yr)
Arsenic	7440-38-2	2.00E-04	3.43E-06	6.17E-03
Benzene	71-43-2	2.10E-03	3.60E-05	6.48E-02
Beryllium	7440-41-7	1.20E-05	2.06E-07	3.70E-04
Cadmium	7440-43-9	1.10E-03	1.89E-05	3.39E-02
Chromium	7440-47-3	1.40E-03	2.40E-05	4.32E-02
Cobalt	7440-48-4	8.40E-05	1.44E-06	2.59E-03
Copper	7440-50-8	8.50E-04	1.46E-05	2.62E-02
Formaldehyde	50-00-0	7.50E-02	1.29E-03	2.31E+00
Hexane	110-54-3	1.80E+00	3.09E-02	5.55E+01
Manganese	7439-96-5	3.80E-04	6.51E-06	1.17E-02
Mercury	7439-97-6	2.60E-04	4.46E-06	8.02E-03
Naphthalene	91-20-3	6.10E-04	1.05E-05	1.88E-02
Nickel	7440-02-0	2.10E-03	3.60E-05	6.48E-02
Selenium	7782-49-2	2.40E-05	4.11E-07	7.41E-04
Toluene	108-88-3	3.40E-03	5.83E-05	1.05E-01
Vanadium	7440-62-2	2.30E-03	3.94E-05	7.10E-02
Benzo(a)pyrene	PAH	1.20E-06	2.06E-08	3.70E-05
Benz(a)anthracene	PAH	1.80E-06	3.09E-08	5.55E-05
Benzo(b)fluoranthene	PAH	1.80E-06	3.09E-08	5.55E-05
Chrysene	PAH	1.80E-06	3.09E-08	5.55E-05
Dibenzo(a,h)anthracene	PAH	1.20E-06	2.06E-08	3.70E-05
Indeno(1,2,3-cd)pyrene	PAH	1.80E-06	3.09E-08	5.55E-05
2-Methylnaphthalene	PAH	2.40E-05	4.11E-07	7.41E-04
3-Methylchloranthrene	PAH	1.80E-06	3.09E-08	5.55E-05
7,12-Dimethylbenz(a)anthracene	PAH	1.60E-05	2.74E-07	4.94E-04
Acenaphthene	PAH	1.80E-06	3.09E-08	5.55E-05
Acenaphthylene	PAH	1.80E-06	3.09E-08	5.55E-05
Anthracene	PAH	2.40E-06	4.11E-08	7.41E-05
Benzo(g,h,i)perylene	PAH	1.20E-06	2.06E-08	3.70E-05
Benzo(k)fluoranthene	PAH	1.80E-06	3.09E-08	5.55E-05
Fluoranthene	PAH	3.00E-06	5.14E-08	9.26E-05
Fluorene	PAH	2.80E-06	4.80E-08	8.64E-05
Phenanathrene	PAH	1.70E-05	2.91E-07	5.25E-04
Pyrene	PAH	5.00E-06	8.57E-08	1.54E-04

Source: HECA Project

Notes:

1) Gasifier Operating Hours = 1,800 hr/yr
2) Emission factor source U.S. EPA AP-42 Section 1.4
3) Calculation assumes a typical fuel heating value, ranging from 1,020 to 1,050 Btu/scf.
4) Please note that there are three gasifier heaters. However, the current assumption is that only one gasifier heater is expected to operate at any one time. The health risk assessment included the operation of only one gasifier heater.

Btu = British thermal units
CAS = Chemical Abstracts Service Registry Number
U.S. EPA = U.S. Environmental Protection Agency
HHV = higher heating value
scf = standard cubic feet
TAC = toxic air contaminant

Table 5.6-6
Auxiliary Boiler TACs Emission Rates

Compound	CAS #	Emission Factor (lb/10^6 scf)	Hourly (lb/hr)	Annual (lb/yr)
Arsenic	7440-38-2	2.00E-04	2.70E-05	5.92E-02
Benzene	71-43-2	2.10E-03	2.84E-04	6.22E-01
Beryllium	7440-41-7	1.20E-05	1.62E-06	3.55E-03
Cadmium	7440-43-9	1.10E-03	1.49E-04	3.26E-01
Chromium	7440-47-3	1.40E-03	1.89E-04	4.15E-01
Cobalt	7440-48-4	8.40E-05	1.14E-05	2.49E-02
Copper	7440-50-8	8.50E-04	1.15E-04	2.52E-01
Formaldehyde	50-00-0	7.50E-02	1.01E-02	2.22E+01
Hexane	110-54-3	1.80E+00	2.43E-01	5.33E+02
Manganese	7439-96-5	3.80E-04	5.14E-05	1.13E-01
Mercury	7439-97-6	2.60E-04	3.52E-05	7.70E-02
Naphthalene	91-20-3	6.10E-04	8.25E-05	1.81E-01
Nickel	7440-02-0	2.10E-03	2.84E-04	6.22E-01
Selenium	7782-49-2	2.40E-05	3.25E-06	7.11E-03
Toluene	108-88-3	3.40E-03	4.60E-04	1.01E+00
Vanadium	7440-62-2	2.30E-03	3.11E-04	6.81E-01
Benzo(a)pyrene	PAH	1.20E-06	1.62E-07	3.55E-04
Benz(a)anthracene	PAH	1.80E-06	2.43E-07	5.33E-04
Benzo(b)fluoranthene	PAH	1.80E-06	2.43E-07	5.33E-04
Chrysene	PAH	1.80E-06	2.43E-07	5.33E-04
Dibenzo(a,h)anthracene	PAH	1.20E-06	1.62E-07	3.55E-04
Indeno(1,2,3-cd)pyrene	PAH	1.80E-06	2.43E-07	5.33E-04
2-Methylnaphthalene	PAH	2.40E-05	3.25E-06	7.11E-03
3-Methylchloranthrene	PAH	1.80E-06	2.43E-07	5.33E-04
7,12-Dimethylbenz(a)anthracene	PAH	1.60E-05	2.16E-06	4.74E-03
Acenaphthene	PAH	1.80E-06	2.43E-07	5.33E-04
Acenaphthylene	PAH	1.80E-06	2.43E-07	5.33E-04
Anthracene	PAH	2.40E-06	3.25E-07	7.11E-04
Benzo(g,h,i)perylene	PAH	1.20E-06	1.62E-07	3.55E-04
Benzo(k)fluoranthene	PAH	1.80E-06	2.43E-07	5.33E-04
Fluoranthene	PAH	3.00E-06	4.06E-07	8.89E-04
Fluorene	PAH	2.80E-06	3.79E-07	8.29E-04
Phenanathrene	PAH	1.70E-05	2.30E-06	5.03E-03
Pyrene	PAH	5.00E-06	6.76E-07	1.48E-03

Source: HECA Project

Notes:

1) Aux Boiler Operating Hours = 2,190 hr/yr
2) Emission factor source U.S. EPA AP-42 Section 1.4
3) Calculation assumes a typical fuel heating value, ranging from 1,020 to 1,050 Btu/scf.

Btu = British thermal units
CAS = Chemical Abstracts Service Registry Number
U.S. EPA = U.S. Environmental Protection Agency
HHV = higher heating value
PAH = polycyclic aromatic hydrocarbons
scf = standard cubic feet
TAC = toxic air contaminant

Table 5.6-7
Gasification Flare TACs Emission Rates

Compound	CAS #	Emission Factor (lb/10^6 scf)	Hourly (lb/hr)	Annual (lb/yr)
Acetaldehyde	75-07-0	0.043	9.07E-02	4.91E+00
Acrolein	107-02-8	0.01	2.11E-02	1.14E+00
Benzene	71-43-2	0.159	3.35E-01	1.82E+01
Ethyl Benzene	100-41-4	1.444	3.05E+00	1.65E+02
Formaldehyde	50-00-0	1.169	2.47E+00	1.33E+02
Naphthalene	91-20-3	0.011	2.32E-02	1.26E+00
n-Hexane	110-54-3	0.029	6.12E-02	3.31E+00
PAH (excluding Naphthalene)	PAH	0.003	6.33E-03	3.43E-01
Propylene	115-07-1	2.44	5.15E+00	2.79E+02
Toluene	108-88-3	0.058	1.22E-01	6.62E+00
Xylene(s)	1330-20-7	0.029	6.12E-02	3.31E+00
Arsenic	7440-38-2	2.00E-04	4.22E-04	2.28E-02
Beryllium	7440-41-7	1.20E-05	2.53E-05	1.37E-03
Cadmium	7440-43-9	1.10E-03	2.32E-03	1.26E-01
Chromium	7440-47-3	1.40E-03	2.95E-03	1.60E-01
Cobalt	7440-48-4	8.40E-05	1.77E-04	9.59E-03
Copper	7440-50-8	8.50E-04	1.79E-03	9.70E-02
Lead	7439-92-1	5.00E-04	1.05E-03	5.71E-02
Manganese	7439-96-5	3.80E-04	8.02E-04	4.34E-02
Mercury	7439-97-6	2.60E-04	5.49E-04	2.97E-02
Nickel	7440-02-0	2.10E-03	4.43E-03	2.40E-01
Selenium	7782-49-2	2.40E-05	5.06E-05	2.74E-03
Vanadium	7440-62-2	2.30E-03	4.85E-03	2.63E-01

Source: HECA Project

Notes:

1) Annual operation assumes total pilot operation of 8,760 hr/yr and 115,500 10^6 Btu/yr during gasifier startup and shutdown.
2) Emission factors based on AP-42 Chapter 1.4 (for metals) and Ventura County Air Pollution Control District AB2588 (for non-metals).
3) Calculation assumes a typical fuel heating value, ranging from 1,020 to 1,050 Btu/scf.

Btu = British thermal units
CAS = Chemical Abstracts Service Registry Number
HHV = higher heating value
scf = standard cubic feet
TAC = toxic air contaminant

Table 5.6-8
SRU Flare TACs Emission Rates

Compound	CAS #	Emission Factor (lb/10^6 scf)	Hourly (lb/hr)	Annual (lb/yr)
Acetaldehyde	75-07-0	0.043	1.49E-03	1.16E-01
Acrolein	107-02-8	0.01	3.46E-04	2.71E-02
Benzene	71-43-2	0.159	5.50E-03	4.31E-01
Ethyl Benzene	100-41-4	1.444	4.99E-02	3.91E+00
Formaldehyde	50-00-0	1.169	4.04E-02	3.17E+00
Naphthalene	91-20-3	0.011	3.80E-04	2.98E-02
n-Hexane	110-54-3	0.029	1.00E-03	7.85E-02
PAH (excluding Naphthalene)	PAH	0.003	1.04E-04	8.13E-03
Propylene	115-07-1	2.44	8.44E-02	6.61E+00
Toluene	108-88-3	0.058	2.01E-03	1.57E-01
Xylene(s)	1330-20-7	0.029	1.00E-03	7.85E-02
Arsenic	7440-38-2	2.00E-04	6.91E-06	5.42E-04
Beryllium	7440-41-7	1.20E-05	4.15E-07	3.25E-05
Cadmium	7440-43-9	1.10E-03	3.80E-05	2.98E-03
Chromium	7440-47-3	1.40E-03	4.84E-05	3.79E-03
Cobalt	7440-48-4	8.40E-05	2.90E-06	2.28E-04
Copper	7440-50-8	8.50E-04	2.94E-05	2.30E-03
Lead	7439-92-1	5.00E-04	1.73E-05	1.35E-03
Manganese	7439-96-5	3.80E-04	1.31E-05	1.03E-03
Mercury	7439-97-6	2.60E-04	8.99E-06	7.04E-04
Nickel	7440-02-0	2.10E-03	7.26E-05	5.69E-03
Selenium	7782-49-2	2.40E-05	8.30E-07	6.50E-05
Vanadium	7440-62-2	2.30E-03	7.95E-05	6.23E-03

Source: HECA Project

Notes:

1) Annual operation assumes total pilot operation of 8,760 hr/yr and 6 hr/yr during SRU startup and shutdown with assist gas.
2) Emission factors based on AP-42 Chapter 1.4 (for metals) and Ventura County Air Pollution Control District AB2588 (for non-metals).
3) Calculation assumes a typical fuel heating value, ranging from 1,020 to 1,050 Btu/scf.

Btu = British thermal units
CAS = Chemical Abstracts Service Registry Number
HHV = higher heating value
scf = standard cubic feet
SRU = sulfur recover unit
TAC = toxic air contaminant

Table 5.6-9
Rectisol Flare TAC Emission Rates

Compound	CAS Number	Emission Factor (lb/10^6 scf)	Hourly (lb/hr)	Annual (lb/yr)
2-Methylnaphthalene	91576	2.40E-05	7.06E-09	6.18E-05
3-Methylchloranthrene	56495	1.80E-06	5.29E-10	4.64E-06
7,12-Dimethylbenz(a)anthracene	57976	1.60E-05	4.71E-09	4.12E-05
Acenaphthene	83329	1.80E-06	5.29E-10	4.64E-06
Acenaphthylene	208968	1.80E-06	5.29E-10	4.64E-06
Anthracene	120127	2.40E-06	7.06E-10	6.18E-06
Benz(a)anthracene	56553	1.80E-06	5.29E-10	4.64E-06
Benzene	71432	2.10E-03	6.18E-07	5.41E-03
Benzo(a)pyrene	50328	1.20E-06	3.53E-10	3.09E-06
Benzo(b)fluoranthene	205992	1.80E-06	5.29E-10	4.64E-06
Benzo(g,h,i)perylene	191242	1.20E-06	3.53E-10	3.09E-06
Benzo(k)fluoranthene	205823	1.80E-06	5.29E-10	4.64E-06
Butane	106978	2.10E+00	6.18E-04	5.41E+00
Chrysene	218019	1.80E-06	5.29E-10	4.64E-06
Dibenzo(a,h)anthracene	53703	1.20E-06	3.53E-10	3.09E-06
Dichlorobenzene	25321226	1.20E-03	3.53E-07	3.09E-03
Ethane	74840	3.10E+00	9.12E-04	7.99E+00
Fluoranthene	206440	3.00E-06	8.82E-10	7.73E-06
Fluorene	86737	2.80E-06	8.24E-10	7.21E-06
Formaldehyde	50000	7.50E-02	2.21E-05	1.93E-01
Hexane	110543	1.80E+00	5.29E-04	4.64E+00
Indeno(1,2,3-cd)pyrene	193395	1.80E-06	5.29E-10	4.64E-06
Naphthalene	91203	6.10E-04	1.79E-07	1.57E-03
Pentane	109660	2.60E+00	7.65E-04	6.70E+00
Phenanthrene	85018	1.70E-05	5.00E-09	4.38E-05
Propane	74986	1.60E+00	4.71E-04	4.12E+00
Pyrene	129000	5.00E-06	1.47E-09	1.29E-05
Toluene	108883	3.40E-03	1.00E-06	8.76E-03
Arsenic	7440382	2.00E-04	5.88E-08	5.15E-04
Barium	7440393	4.40E-03	1.29E-06	1.13E-02
Beryllium	7440417	1.20E-05	3.53E-09	3.09E-05
Cadmium	7440439	1.10E-03	3.24E-07	2.83E-03
Chromium	7440473	1.40E-03	4.12E-07	3.61E-03
Cobalt	7440484	8.40E-05	2.47E-08	2.16E-04
Copper	7440508	8.50E-04	2.50E-07	2.19E-03
Manganese	7439965	3.80E-04	1.12E-07	9.79E-04
Mercury	7439976	2.60E-04	7.65E-08	6.70E-04
Molybdenum	7439987	1.10E-03	3.24E-07	2.83E-03
Nickel	7440020	2.10E-03	6.18E-07	5.41E-03
Selenium	7782492	2.40E-05	7.06E-09	6.18E-05
Vanadium	7440622	2.30E-03	6.76E-07	5.93E-03

Notes:

1) Emission factors (lb/10^6 scf) are from AP-42, Chapter 1.4, Table 1.4-3 and 1.4-4. Factors in lb/10E6 scf were converted to factors in MMBtu/hr by dividing by the design base fuel heating value in Btu/scf.
2) Rectisol Flare Pilot Firing Rate = 0.3 MMBtu/hr
3) Annual Operating Hours = 8760 hr/yr\

Table 5.6-10
Tail Gas Thermal Oxidizer TACs Emission Rates

Compound	CAS #	Emission Factor (lb/10^6 scf)	Hourly (lb/hr)	Annual (lb/yr)
Arsenic	7440-38-2	2.00E-04	1.90E-06	1.67E-02
Benzene	71-43-2	2.10E-03	2.00E-05	1.75E-01
Beryllium	7440-41-7	1.20E-05	1.14E-07	1.00E-03
Cadmium	7440-43-9	1.10E-03	1.05E-05	9.18E-02
Chromium	7440-47-3	1.40E-03	1.33E-05	1.17E-01
Cobalt	7440-48-4	8.40E-05	8.00E-07	7.01E-03
Copper	7440-50-8	8.50E-04	8.10E-06	7.09E-02
Formaldehyde	50-00-0	7.50E-02	7.14E-04	6.26E+00
Hexane	110-54-3	1.80E+00	1.71E-02	1.50E+02
Manganese	7439-96-5	3.80E-04	3.62E-06	3.17E-02
Mercury	7439-97-6	2.60E-04	2.48E-06	2.17E-02
Naphthalene	91-20-3	6.10E-04	5.81E-06	5.09E-02
Nickel	7440-02-0	2.10E-03	2.00E-05	1.75E-01
Selenium	7782-49-2	2.40E-05	2.29E-07	2.00E-03
Toluene	108-88-3	3.40E-03	3.24E-05	2.84E-01
Vanadium	7440-62-2	2.30E-03	2.19E-05	1.92E-01
Benzo(a)pyrene	PAH	1.20E-06	1.14E-08	1.00E-04
Benz(a)anthracene	PAH	1.80E-06	1.71E-08	1.50E-04
Benzo(b)fluoranthene	PAH	1.80E-06	1.71E-08	1.50E-04
Chrysene	PAH	1.80E-06	1.71E-08	1.50E-04
Dibenzo(a,h)anthracene	PAH	1.20E-06	1.14E-08	1.00E-04
Indeno(1,2,3-cd)pyrene	PAH	1.80E-06	1.71E-08	1.50E-04
2-Methylnaphthalene	PAH	2.40E-05	2.29E-07	2.00E-03
3-Methylchloranthrene	PAH	1.80E-06	1.71E-08	1.50E-04
7,12-Dimethylbenz(a)anthracene	PAH	1.60E-05	1.52E-07	1.33E-03
Acenaphthene	PAH	1.80E-06	1.71E-08	1.50E-04
Acenaphthylene	PAH	1.80E-06	1.71E-08	1.50E-04
Anthracene	PAH	2.40E-06	2.29E-08	2.00E-04
Benzo(g,h,i)perylene	PAH	1.20E-06	1.14E-08	1.00E-04
Benzo(k)fluoranthene	PAH	1.80E-06	1.71E-08	1.50E-04
Fluoranthene	PAH	3.00E-06	2.86E-08	2.50E-04
Fluorene	PAH	2.80E-06	2.67E-08	2.34E-04
Phenanathrene	PAH	1.70E-05	1.62E-07	1.42E-03
Pyrene	PAH	5.00E-06	4.76E-08	4.17E-04

Source: HECA Project

Notes:

1) Tail Gas Thermal Oxidizer Operating Hours = 8,760 per year (accounting for both process vent and SRU startup)
2) Emission factor source U.S. EPA AP-42 Section 1.4
3) Calculation assumes a typical fuel heating value, ranging from 1,020 to 1,050 Btu/scf.

Btu = British thermal units
CAS = Chemical Abstracts Service Registry Number
U.S. EPA = U.S. Environmental Protection Agency
HHV = higher heating value
PAH = polycyclic aromatic hydrocarbons
scf = standard cubic feet
SRU = sulfur recovery unit
TAC = toxic air contaminant

Table 5.6-11
Carbon Dioxide Vent TACs Emission Rates

Compound	CAS #	Emission Factor (ppm)	Hourly (lb/hr)	Annual (lb/yr)
Carbonyl Sulfide	463-58-1	55	5.01E+01	2.52E+04
Hydrogen Sulfide	7783-06-4	10	5.15E+00	2.60E+03

Source: HECA Project

Notes:

1) Emission rates based on power plant design and 21 day/yr full venting.

CAS = Chemical Abstracts Service Registry Number
ppm = parts per million
TAC = toxic air contaminant

Revised Table 5.6-12
Emergency Generator TACs Emission Rates

Compound	CAS #	Emission Factor (g/Bhp/hr)	Hourly (lb/hr)	Annual (lb/yr)
Diesel Particulate Matter	DPM	0.07	4.60E-01	2.30E+01

Source: HECA Project

Notes:

1) Emergency Generator operating hours = 50 hr/yr per generator.
2) Emission factor shown is based on U.S. EPA Tier 4 non-road diesel engine emissions standards.
3) Emission rate shown is for individual generator. There are two generators associated with the Project.

Bhp = Brake horsepower
CAS = Chemical Abstracts Service Registry Number
DPM = diesel particulate matter
g = grams
TAC = toxic air contaminant

Revised Table 5.6-13
Fire Water Pump TACs Emission Rates

Compound	CAS #	Emission Factor (g/Bhp/hr)	Hourly (lb/hr)	Annual (lb/yr)
Diesel Particulate Matter	DPM	0.015	1.84E-02	1.84E+00

Source: HECA Project

Notes:

1) Fire Water Pump operating hours = 100 hr/yr.
2) Emission factor shown is based on U.S. EPA Tier 4 non-road diesel engine emissions standards.

Bhp = Brake horsepower
CAS = Chemical Abstracts Service Registry Number
DPM = diesel particulate matter
g = gram
TAC = toxic air contaminant

Table 5.6-14
EMFAC2007 Heavy Truck Emission Factors and AERMOD Emission Rates

Pollutant	**Emission Factors from EMFAC**			
	Onsite Petcoke and Coal Trucks		**Onsite Gasifier Solids Handling Trucks**	
	Running (g/mi)	Idling (g/hr)	Running (g/mi)	Idling (g/hr)
PM_{10}	1.09	1.12	1.47	1.12
	Emission Rates for HARP			
	Onsite Petcoke and Coal Trucks		**Onsite Gasifier Solids Handling Trucks**	
PM_{10}	Running	Idling	Running	Idling
1-hour (lb/hr)	3.1e-3	5.6e-4	2.3e-4	5.4e-5
Annual (lb/yr)	6.2	1.1	3.3e-1	6.5e-2

Source: HECA Project

Notes:

g/mi = grams per mile
g/hr = grams per hour
lb/yr = pounds per year
PM_{10} = particulate matter less than 10 microns in diameter

Table 89-1
HECA Estimated Fugitive Component Counts

	Process Area													
Components	**1: Methanol**	**2: SynGas**	**3: Flash Gas-Gasification**	**4: Shifted SynGas**	**5: Propylene**	**6: Sour Water**	**7: H_2S-Laden Methanol**	**8: CO_2-Laden Methanol**	**9: Acid Gas**	**10: Ammonia--Laden Gas**	**11: Sulfur**	**12: TGTU Process Gas**	**13: TGTU MDEA**	**Total**
Compressors	0	0	1	1	1	0	0	0	0	0	0	0	0	3
Pump – Light Liquid	7	0	0	0	3	0	7	0	0	0	0	0	0	17
Pumps – Heavy Liquid	0	0	0	0	0	17	0	0	0	0	4	0	5	26
Valves – Gas	50	108	49	198	188	0	94	79	161	157	0	72	0	1,156
Valves – Light Liquid	416	0	0	0	288	0	358	79	0	0	0	0	0	1,141
Valves – Heavy Liquid	0	0	0	0	0	508	0	0	0	0	68	0	264	840
Connectors	1,225	372	151	632	1,432	1,410	1,323	516	492	407	297	290	746	9,293

Source: HECA Project

Notes:

CO_2 = carbon dioxide
H_2S = hydrogen sulfide
MDEA = methyldiethanol amine
TGTU = tail gas treating unit

Table 89-2
Control Efficiencies for LDAR Program

Equipment Type and Service	Control Efficiency
Valves – Gas	92
Valves – Light Liquid	88
Pumps – Light Liquid	75
Connectors – All	93

Source: U.S. EPA 1995.

Note:

The control efficiency presented in this table Is based on the requirements of the hazardous organic NESHAP equipment leak negotiated regulation are estimated based on equipment specific leak definitions and performance levels

Table 89-3
TAC and VOC Fugitive Emission Rates [(1)(2)]

Process Area [(3)]	Compound	CAS#	Hourly (lb/hr)	Annual (lb/yr)
"POWER" Area	H_2S	7783-06-4	0.01	129.67
	NH_3	7664-41-7	0.02	159.52
	HCN	74-90-8	1.16E-04	1.01
	COS	463-58-1	5.35E-05	1.17E-07
"SRU" Area	H_2S	7783-06-4	0.11	922.63
	CH_3OH	67-56-1	9.10E-05	0.80
	COS	463-58-1	1.37E-03	3.00E-06
"SWS" Area	H_2S	7783-06-4	0.01	99.89
	NH_3	7664-41-7	0.02	137.12
"TGTU" Area	H_2S	7783-06-4	0.06	563.22
	CH_3OH	67-56-1	1.48	12,983.70
	COS	463-58-1	7.91E-04	1.73E-06
"AGR" Area	C_3H_6	115-07-1	1.35	11,826.00
"GASIFICATION" Area	H_2S	7783-06-4	0.22	1,953.96
	NH_3	7664-41-7	2.07E-03	18.11
	HCN	74-90-8	1.02E-03	8.97
	COS	463-58-1	8.23E-03	1.80E-05
"SHIFT" Area	H_2S	7783-06-4	0.12	1,013.71
	COS	463-58-1	3.25E-04	7.13E-07

Source: HECA Project

Note:

1 Toxic air contaminant emissions were calculated using the U.S. Environmental Protection Agency (synthetic organic chemical manufacturing industry) SOCMI emission factors.

2 Emission rates are based on the TOC leak rate using SOCMI emission factors and the composition of the gas in each process area.

3 The Process Areas were split up in the following manner to modeling purposes.

"POWER" Source includes Area # 10
"SRU" Source includes Area #9 and #11
"SWS" Source includes Area #6
"TGTU" Source includes Area #1, #7, #8, #12 and #13
"AGR" Source includes Area #5
"GASIFICATION" Source includes Area #2 and #3.
"SHIFT" Source includes Area #4

AGR = Acid Gas Removal
CAS # = Chemical Abstracts Service Registry Number
H_2S = hydrogen sulfide
NH_3 = ammonia
HCN = hydrogen cyanide
CH_3OH = methanol (VOC)
C_3H_6 = propylene (VOC)
COS = carbonyl sulfide (VOC)
SOCMI = Synthetic Organic Chemical Manufacturing Industry
SRU = sulfur recovery unit
SWS = Sour Water Stripper
TGTU = tail gas treating unit

Table 89-4
Total Annual TAC and HAP Emission from the HECA Project

Compound	CAS #	Annual Rate (tons per year)	CTG/HRSG Syngas	Cooling Tower (Power Block)	Cooling Tower (Process Area)	Cooling Tower (ASU)	Auxiliary Boiler	Emergency Generators	Fire Water Pump	Gasification Flare	SRU Flare	Rectisol Flare	Tg Thermal Oxidizer	CO_2 Vent	Gasifier Warming	Onsite Truck	Fugitive
1,3-Butadiene	106-99-0	0.00E+00															
Acetaldehyde	75-07-0	2.07E-02	1.82E-02							2.45E-03	5.82E-05						
Acrolein	107-02-8	5.84E-04								5.71E-04	1.35E-05						
Ammonia*	7664-41-7	7.67E+01	7.66E+01														1.57E-01
Antimony	7440-36-0	1.11E-02	1.11E-02														
Arsenic	7440-38-2	2.44E-02	2.43E-02	4.69E-05	1.13E-05	1.08E-05	2.96E-05			1.14E-05	2.71E-07	2.58E-07	8.34E-06		1.71E-09		
Barium	7440-39-3	5.67E-06										5.67E-06					
Benzene	71-43-2	3.40E-02	2.43E-02				3.11E-04			9.08E-03	2.15E-04	2.71E-06	8.76E-05		1.80E-08		
Beryllium	7440-41-7	2.64E-03	2.63E-03				1.78E-06			6.85E-07	1.63E-08	1.55E-08	5.01E-07		1.03E-10		
Cadmium	7440-43-9	9.75E-02	9.72E-02				1.63E-04			6.28E-05	1.49E-06	1.42E-06	4.59E-05		9.43E-09		
Carbon Disulfide	75-15-0	4.66E-01	4.66E-01														
Carbonyl Sulfide	463-58-1	1.27E+01												1.26E+01			4.72E-02
Chromium	7440-47-3	1.42E-04								7.99E-05	1.90E-06	1.80E-06	5.84E-05		1.20E-08		
Chromium, (hexavalent)	18540-29-9	1.55E-03	1.55E-03														
Chromium, Total	0-00-5	5.37E-03	5.16E-03				2.07E-04										
Cobalt	7440-48-4	2.65E-03	2.63E-03				1.24E-05			4.80E-06	1.14E-07	1.08E-07	3.50E-06		7.20E-10		
Copper*	7440-50-8	2.25E-04		9.10E-06	2.20E-06	2.09E-06	1.26E-04			4.85E-05	1.15E-06	1.10E-06	3.55E-05		7.29E-09		
Cyanides	57-12-5	5.77E-02	5.77E-02														
Ethylbenzene	100-41-4	8.44E-02								8.24E-02	1.96E-03						
Fluoride*		1.21E-03		8.19E-04	1.98E-04	1.88E-04											
Formaldehyde	50-00-0	2.55E-01	1.72E-01				1.11E-02			6.67E-02	1.58E-03	9.66E-05	3.13E-03		6.43E-07		
Hexane	110-54-3	3.44E-01					2.67E-01					2.32E-03	7.51E-02		1.54E-05		
Hydrochloric Acid	7647-01-0	1.32E-01	1.32E-01														
Hydrogen Fluoride (hydrofluoric acid)	7664-39-3	5.06E-01	5.06E-01														
Hydrogen Sulfide	7783-06-4	3.64E+00												1.30E+00			2.34E+00
Lead	7439-92-1	5.70E-03	5.67E-03							2.85E-05	6.77E-07						
Manganese	7439-96-5	1.41E-02	1.05E-02	2.34E-03	5.66E-04	5.38E-04	5.63E-05			2.17E-05	5.15E-07	4.90E-07	1.59E-05		3.26E-09		
Mercury	7439-97-6	1.22E-02	1.21E-02				3.85E-05			1.48E-05	3.52E-07	3.35E-07	1.08E-05		2.23E-09		
Molybdenum	7439-98-7	1.42E-06										1.42E-06					

Table 89-4
Total Annual TAC and HAP Emission from the HECA Project (Continued)

Compound	CAS #	Annual Rate (tons per year)	CTG/HRSG Syngas	Cooling Tower (Power Block)	Cooling Tower (Process Area)	Cooling Tower (ASU)	Auxiliary Boiler	Emergency Generators	Fire Water Pump	Gasification Flare	SRU Flare	Rectisol Flare	Tg Thermal Oxidizer	CO_2 Vent	Gasifier Warming	Onsite Truck	Fugitive
Methyl Bromide (Bromomethane)	74-83-9	4.83E-01	4.83E-01														
Methylene Chloride (Dichloromethane)	75-09-2	2.23E-02	2.23E-02														
Naphthalene	91-20-3	2.61E-02	2.53E-02				9.03E-05			6.28E-04	1.49E-05	7.86E-07	2.54E-05		5.23E-09		
n-Hexane	110-54-3	1.69E-03								1.66E-03	3.93E-05						
Nickel	7440-02-0	4.47E-03	3.95E-03				3.11E-04			1.20E-04	2.84E-06	2.71E-06	8.76E-05		1.80E-08		
Phenol	108-95-2	3.73E-01	3.73E-01														
Propylene*	115-07-1	6.06E+00								1.39E-01	3.30E-03						5.91E+00
Propylene Oxide	75-56-9	0.00E+00															
Selenium	7782-49-2	5.73E-03	5.67E-03	3.90E-05	9.42E-06	8.95E-06	3.55E-06			1.37E-06	3.25E-08	3.09E-08	1.00E-06		2.06E-10		
Sulfuric Acid and Sulfates*	7664-93-9	5.79E+00	5.79E+00														
Toluene	108-88-3	4.37E-03	3.34E-04				5.03E-04			3.31E-03	7.85E-05	4.38E-06	1.42E-04		2.91E-08		
Vanadium*	7440-62-2	5.74E-04					3.41E-04			1.31E-04	3.11E-06	2.96E-06	9.59E-05		1.97E-08		
Xylenes	1330-20-7	1.69E-03								1.66E-03	3.93E-05						
Diesel Particulate Matter*	DPM	1.63E-02						1.15E-02	9.19E-04							3.85E-03	
2-Methylnaphthalene	PAH	4.59E-06					3.55E-06					3.09E-08	1.00E-06		2.06E-10		
3-Methylchloranthrene	PAH	3.44E-07					2.67E-07					2.32E-09	7.51E-08		1.54E-11		
7,12-Dimethylbenz(a)anthracene	PAH	3.06E-06					2.37E-06					2.06E-08	6.67E-07		1.37E-10		
Acenaphthene	PAH	3.44E-07					2.67E-07					2.32E-09	7.51E-08		1.54E-11		
Acenaphthylene	PAH	3.44E-07					2.67E-07					2.32E-09	7.51E-08		1.54E-11		
Anthracene	PAH	4.59E-07					3.55E-07					3.09E-09	1.00E-07		2.06E-11		
Benz(a)anthracene	PAH	2.34E-05	2.33E-05									2.32E-09	7.51E-08		1.54E-11		
Benzo(a)anthracene	PAH	2.67E-07					2.67E-07										
Benzo(a)pyrene	PAH	2.29E-07					1.78E-07					1.55E-09	5.01E-08		1.03E-11		
Benzo(b)fluoranthene	PAH	3.44E-07					2.67E-07					2.32E-09	7.51E-08		1.54E-11		
Benzo(g,h,i)perylene	PAH	2.29E-07					1.78E-07					1.55E-09	5.01E-08		1.03E-11		
Benzo(k)fluoranthene	PAH	3.44E-07					2.67E-07					2.32E-09	7.51E-08		1.54E-11		
Butane	PAH	2.71E-03					4.44E-07					2.71E-03					
Chrysene	PAH	3.44E-07					2.67E-07					2.32E-09	7.51E-08		1.54E-11		
Dibenzo(a,h)anthracene	PAH	2.29E-07					1.78E-07					1.55E-09	5.01E-08		1.03E-11		

Table 89-4
Total Annual TAC and HAP Emission from the HECA Project (Continued)

Compound	CAS #	Annual Rate (tons per year)	CTG/HRSG Syngas	Cooling Tower (Power Block)	Cooling Tower (Process Area)	Cooling Tower (ASU)	Auxiliary Boiler	Emergency Generators	Fire Water Pump	Gasification Flare	SRU Flare	Rectisol Flare	Tg Thermal Oxidizer	CO_2 Vent	Gasifier Warming	Onsite Truck	Fugitive
Dichlorobenzene	PAH	1.55E-06										1.55E-06					
Ethane	PAH	3.99E-03										3.99E-03					
Fluoranthene	PAH	1.29E-07										3.86E-09	1.25E-07		2.57E-11		
Fluorene	PAH	5.35E-07					4.15E-07					3.61E-09	1.17E-07		2.40E-11		
Indeno(1,2,3-cd)pyrene	PAH	3.44E-07					2.67E-07					2.32E-09	7.51E-08		1.54E-11		
PAH (excluding Naphthalene)	PAH	1.75E-04								1.71E-04	4.06E-06						
Pentane	PAH	3.35E-03										3.35E-03					
Phenanathrene	PAH	3.25E-06					2.52E-06					2.19E-08	7.09E-07		1.46E-10		
Propane	PAH	2.06E-03										2.06E-03					
Pyrene	PAH	9.55E-07					7.40E-07					6.44E-09	2.09E-07		4.29E-11		
Total Combined HAPs and TACs		**107.90**	**84.82**	**3.26E-03**	**7.87E-04**	**7.48E-04**	**2.80E-01**	**1.15E-02**	**9.19E-04**	**3.09E-01**	**7.32E-03**	**1.46E-02**	**7.88E-02**	**1.39E+01**	**1.62E-05**	**3.85E-03**	**8.46E+00**
Total HAPs*		**19.31**	**2.46**	**2.43E-03**	**5.87E-04**	**5.58E-04**	**2.79E-01**	**0.00E+00**	**0.00E+00**	**1.69E-01**	**4.01E-03**	**1.45E-02**	**7.87E-02**	**1.39E+01**	**1.62E-05**	**0.00E+00**	**2.39E+00**

Source: HECA Project.

Note:

* Denotes pollutants that are not listed as Federal HAPs. These pollutants are not included in the HAP total provided. As shown, combined annual HAP emissions are less than 25 tons per year. Additionally, individual HAP emissions are below 10 tons per

SRU = sulfur recovery unit

DATA REQUEST

90. Please provide a discussion to support the choice of emission factors and explain why emission factors from a similar facility were not used.

RESPONSE

Stationary Equipment Emission Factors

Sources of emission factors for TACs from stationary sources at HECA are referenced in the notes for Tables 5.6-2 through 5.6-13 and in Appendix N of the Revised AFC.

Emission factors for the heat recovery steam generator were taken from the Wabash River Generating Station test data and the National Energy Technology Laboratory, U.S. Department of Energy, *Major Environmental Aspects of Gasification-based Power Generation Technologies, Final Report*, December 2002. These are considered the most representative because of the use of similar technology in operation.

Emission factors for TACs from the natural gas external combustion sources, the gasifier refractory heater, auxiliary boiler, and tail gas thermal oxidizer are from AP-42 Section 1.4. AP-42 Section 1.4 and Ventura County Air Pollution Control District AB2588 natural gas flare emission factors were used to estimate the TAC emissions from the gasifier and sulfur recovery unit flares. The Rectisol flare emissions were estimated with AP-42 Section 1.4. Because the pilot burns natural gas for normal operations, this flare is for emergency use only.

Cooling tower TAC emissions were based on engineering calculations using the constituent concentrations in the raw water, the number of cycles of concentration in the cooling towers, and the assumed drift rate. Arsenic, fluoride, manganese, and selenium concentrations in the raw water that will be used for the Project were based on analytical test results. Copper was not detected in the raw water; consequently, the concentration was based on one-half of the stated detection limit.

The DPM emission factor for the emergency generators and fire water pump are based on the EPA Tier 4 emission standard.

The only TAC released from the CO_2 vent is H_2S. The emission rate is based on the maximum amount of CO_2 vented and the H_2S content (10 parts per million).

The auxiliary CTG is no longer part of the Project.

Fugitive Emission Factors

The SJVAPCD released a memo "*Procedures for Quantifying Fugitive VOC Emissions at Petroleum and SOCMI Facilities*" (2005). The memo recommends using emission factors from the California Air Pollution Control Officers Association (CAPCOA) document "*California Implementation Guidelines for Estimating Mass Emissions of Fugitive Hydrocarbon Leaks at Petroleum Facilities*" (1999), or the emission factors from the U.S. EPA document "*Protocol for Equipment Leak Emission Estimates*" (1995) for new or modified emission units. In cases where the CAPCOA and U.S. EPA emission factors are different, the SJVAPCD memo says that CAPCOA emissions factors will take precedence over the U.S. EPA emission factors.

According to the U.S. EPA document (U.S. EPA, 1995), the criteria for determining the appropriateness of emission factors are based on the following: (1) process design; (2) process operation parameters; (3) types of equipment used, and (4) types of material handled. Based on these criteria, the processes at the HECA IGCC plant are most similar to a SOCMI plant. Therefore, the SOCMI fugitive emission factors from U.S. EPA are used in the fugitive emission calculations.

Although the fugitive emission factors are typically used for VOC emission, the U.S. EPA document (U.S. EPA, 1995) states that the average emission factors can be used for inorganic compounds (like H_2S and ammonia), in the event that there is no other approach available to estimate the concentration of the inorganic compounds at the equipment leak source. Because this is a new facility, it is not possible to estimate the fugitive concentrations of the inorganic compounds at the equipment leaks; therefore, the average emission factor approach will be used. The SOCMI fugitive emission factors are multiplied by the equipment component count split by service types and the weight percentage of the compounds in the stream.

There were no gasification facilities similar to the HECA Project that have prepared site-specific fugitive emissions factors. Therefore, the average emission factor approach (from U.S. EPA or CAPCOA) was used as the best estimate for fugitive emissions.

Mobile Emission Factors

As described in Section 5.6.2.3 in the Revised AFC, DPM emissions from the onsite truck trips were estimated using EMFAC2007 for heavy-heavy-duty trucks for year 2040. Because the cancer risk is based on a 70-year exposure, the median of years 2015 to 2085 is 2050, but EMFAC2007 does not estimate emissions beyond year 2040; therefore, emission factors from this year were selected.

Reference

SJVAPCD (San Joaquin Valley Air Pollution Control District), 2005. Memorandum, "*Procedures for Quantifying Fugitive VOC Emissions at Petroleum and SOCMI Facilities.*"

U.S. EPA (U.S. Environmental Protection Agency), 1995. *Protocol for Equipment Leak Emission Estimates*.

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA
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APPLICATION FOR CERTIFICATION FOR THE *HYDROGEN ENERGY CALIFORNIA PROJECT*

Docket No. 08-AFC-8

PROOF OF SERVICE LIST
(Rev. 1/27/10)

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DECLARATION OF SERVICE

I, Catherine Short, declare that on February 1, 2010, I served and filed copies of the attached *Responses to Data Requests Set One (Nos. 17, 65, 77, and 85 through 90)*, dated January, 2010. The original document, filed with the Docket Unit, is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at: **[www.energy.ca.gov/sitingcases/hydrogen_energy]**.

The documents have been sent to both the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

(Check all that Apply)

FOR SERVICE TO ALL OTHER PARTIES:

_______ sent electronically to all email addresses on the Proof of Service list

X by personal delivery or by depositing in the United States mail at San Francisco, CA with first-class postage thereon fully prepaid and addressed as provided on the Proof of Service list above to those addresses **NOT** marked "email preferred."

AND

FOR FILING WITH THE ENERGY COMMISSION:

_______ sending an original paper copy and one electronic copy, mailed and emailed respectively, to the address below (***preferred method***);

OR

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CALIFORNIA ENERGY COMMISSION
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1516 Ninth Street, MS-4
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I declare under penalty of perjury that the foregoing is true and correct.

C Short
____