Kern River Watershed Coalition Authority

Sediment Discharge and Erosion Assessment Report

Kern County, California • February 2015



Prepared for:

Kern River Watershed Coalition Authority

Prepared by:

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PROVOST & PRITCHARD CONSULTING GROUP
An Employee Owned Company

Kern River Watershed Coalition Authority

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Prepared by:
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Bakersfield, California

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Table of Contents

1 Introduction 1-1

1.1 Background 1-1

1.1.1 Kern River Watershed Coalition Authority (KRWCA) 1-1

1.1.2 Waste Discharge Requirements 1-2

1.2 Objectives of the Sediment Discharge and Erosion Assessment Report (SDEAR) 1-2

1.3 Kern River Watershed 1-3

1.3.1 Location Map 1-3

1.3.2 General Characteristics 1-3

1.3.3 Climate 1-3

1.3.4 KRWCA Soils 1-4

1.3.5 KRWCA Agriculture 1-5

1.3.6 Primary Area: Central Valley Floor (extent of DWR Bulletin 118 Groundwater Basin) 1-5

1.3.7 Reconnaissance Area: Peripheral Area to the Central Valley Floor 1-6

2 Soil Erosion Factors 2-1

2.1 Precipitation 2-1

2.2 Soil 2-2

2.3 Topography 2-2

2.4 Land Use 2-2

3 Methodology 3-1

3.1 Universal Soil Loss Equation (USLE) 3-1

3.2 Revised Universal Soil Loss Equation (RUSLE) 3-2

3.3 Proximity to Waterways 3-2

3.4 Management Factors 3-2

3.5 Data Sources 3-3

4 Results 4-1

4.1 Erosivity (R) Factor 4-1

4.2 Soil Erodibility (K) Factor 4-1

4.3 Slope Length and Steepness (LS) Factor 4-1

4.4 Combined Sediment Risk Factor (LS*R*K) 4-2

4.5 Waterways 4-2

4.6 Potential Sediment Dischargers 4-3
4.7 Potential Sediment Discharger Requirements 4-3
5 References..5-1
Appendix App-1

List of Figures

Figure 1-1. Tulare Lake Basin Area 1-7
Figure 1-2. Kern River Watershed Coalition Authority Boundary Map 1-8
Figure 1-3. Kern Sub-Basin Generalized Soil Textures 1-10
Figure 4-1. KRWCA Erosivity (R) Factor 4-5
Figure 4-2. KRWCA Soil Erodibility (K) Factor..4-7
Figure 4-3. KRWCA Slope Length and Steepness (LS) Factor 4-8
Figure 4-4. KRWCA Combined Sediment Risk Factor (LS*R*K)..4-9
Figure 4-5. KRWCA Streams and Artificial Water Ways...4-10
Figure 4-6. KRWCA Identified Potential Sediment Discharge and Erosion Parcels...............................4-11

List of Tables

Table 1-1. KRWCA Temperature and Rainfall Characteristics...1-9
Table 4-1. Typical Soil Erodibility (K) Factors for Various Soil Types...4-6
Table 4-2. KRWCA Potential Sediment Discharge and Erosion Parcel Summary..................................4-12

Abbreviations

AEWSD .... Arvin-Edison Water Storage District
Ac-ft .... Acre-foot/Acre-feet
Coalition .... Kern River Watershed Coalition Authority or Third-Party
CPSEC .... Certified Professional in Erosion and Sediment Control
CPSWQ .... Certified Professional in Storm Water Quality
CVRWQCB .... Central Valley Regional Water Quality Control Board
Dairy General Order .... General Order for Existing Milk Cow Dairies (Order R5-2013-0122)
DWR .... California Department of Water Resources
ET .... Evapotranspiration
General Order .... Tulare Lake Basin General Order
GIS .... Geographic Information System
IE .... Irrigation Efficiency
ILRP .... Irrigated Lands Regulatory Program
Individual Order .... Order R5-2013-0120
K .... Soil Erodibility
KRWCA .... Kern River Watershed Coalition Authority
LS .... Slope Length and Steepness
LS*R*K .... Combined Sediment Risk Factor
MRP .... Monitoring and Reporting Program
MSL .... Mean Sea Level
NICET .... National Institute for Certification in Engineering Technologies
NOA .... Notice of Applicability
NRCS .... Natural Resources Conservation Service
R .... Erosivity
Regional Board .... Central Valley Regional Water Quality Control Board
RUSLE .... Revised Universal Soil Loss Equation
SDEAR .... Sediment Discharge and Erosion Assessment Report
SECP(s) .... Sediment Erosion and Control Plan(s)
SWRCB .... California State Water Resources Control Board
Third-Party .... Coalition
Tons/ac-yr .... Tons per acre-year

UCCE .... University of California Cooperative Extension
USDA .... United States Department of Agriculture
USLE .... Universal Soil Loss Equation
WDR .... Waste Discharge Requirements
WRMWSD .... Wheeler Ridge-Maricopa Water Storage District

1 Introduction

This Sediment Discharge and Erosion Assessment Report (**SDEAR**) has been prepared on behalf of the Kern River Watershed Coalition Authority (**KRWCA** or **Coalition**), in response to Waste Discharge Requirements (**WDR**), General Order R5-2013-0120 adopted by the Central Valley Regional Water Quality Control Board (**CVRWQCB** or **Board**) on September 19, 2013. The WDR applies to certain growers in the Tulare Lake Basin, **Figure 1-1**. The Kern River Watershed boundary generally coincides with the KRWCA boundary (**Figure 1-2**).

1.1 Background

The Tulare Lake Basin General Order (Order R5-2013-0120) (**General Order**) requires any irrigated land having the potential to discharge to surface water or groundwater to comply with the requirements set forth by the CVRWQCB. The CVRWQCB defines irrigated land as "land irrigated to produce crops or pasture used for commercial purposes including lands that are planted to commercial crops that are not yet marketable (e.g. vineyards and tree crops). Irrigated lands also include nurseries, and privately and publicly managed wetlands". Compliance with the General Order includes either membership in a coalition (**third-party**) or by obtaining coverage through the CVRWQCB under an Individual Order (Order R5-2013-0100).

The third-party option provides the ability for growers to work together as a group and share resources to minimize redundant efforts to reduce overall costs. Some investigations and evaluations could require extensive expertise and costs that could be difficult for the average grower to complete on their own.

1.1.1 Kern River Watershed Coalition Authority (KRWCA)

The KRWCA was established to serve as the coordinator and coalition (third-party) group under the Irrigated Lands Regulatory Program (**ILRP**) in a specific subarea within the Kern River Watershed portion of Kern County. There are multiple third-party groups located within Kern County. KRWCA is a joint powers authority, formed on October 1, 2011 between the following public agencies in the region:

1. Arvin-Edison Water Storage District;
2. Henry Miller Water District;
3. Kern Delta Water District;
4. Kern-Tulare Water District;
5. North Kern Water Storage District;
6. Olcese Water District;
7. Rosedale-Rio Bravo Water Storage District;
8. Semitropic Water Storage District;
9. Shafter-Wasco Irrigation District;
10. Southern San Joaquin Municipal Utilities District ; and,

11. Wheeler Ridge-Maricopa Water Storage District.

On February 4, 2014 the CVRWQCB issued a Notice of Applicability (**NOA**) to the KRWCA, approving the KRWCA to represent member owners/growers of irrigated agricultural lands within the KRWCA boundary.

The KRWCA boundary (**Figure 1-2**) encompasses approximately 3.5 million gross acres of land, of which approximately 622,200 is irrigated. Approximately 39,200 irrigated acres of this area falls under the regulatory coverage of the CVRWQCB WDR General Order for Existing Milk Cow Dairies (Order R5-2013-0122) (**Dairy General Order**). It is unknown how many acres within the KRWCA boundary are under the regulatory jurisdiction of other WDR's or conditional waivers of WDR's (i.e. effluent wastewater, food processing, recycled water, etc). As of February 4, 2015 the KRWCA has 858 growers registered as members, covering approximately 522,833 irrigated acres.

Peripheral to the primary KRWCA boundary area, and referred to as "secondary", is the Sierra Nevada Mountain Range to the east, which contains the Upper Kern River watershed, extending approximately 60 miles north into Tulare County. The Tehachapi Mountains and Transverse Ranges, which form the southern end of the San Joaquin Valley, and the San Emigdio Range, which form the southwestern end of the San Joaquin Valley, are also included in the peripheral or secondary KRWCA boundary. There is very little irrigated acreage in the KRWCA secondary boundary areas.

1.1.2 Waste Discharge Requirements

The NOA approval date (February 4, 2014) starts the timeline for several requirements outlined in the WDR, including Section IV.A in Attachment B, Monitoring and Reporting Program (**MRP**), to the General Order. In accordance with the MRP, the due date for the complete SDEAR is one year after the issuance of the NOA to the KRWCA, February 4, 2015.

1.2 Objectives of the Sediment Discharge and Erosion Assessment Report (SDEAR)

The goal of the SDEAR is to determine which irrigated agricultural areas within the Tulare Lake Basin Area are potentially subject to erosion and may discharge sediment that may degrade surface waters. The report is to determine which member operations are within such areas, and need to develop a Sediment and Erosion Control Plan (**SECP**). The report must be developed to achieve the above goal and objective and must provide a description of the potential sediment and erosion areas as a series of ArcGIS shapefiles with a discussion of methodologies utilized to develop the report. Because this report is to identify areas that are potentially subject to erosion and sediment discharge, existing field specific management practices (i.e. tail-water return systems, field berms, silt fences, etc.) are not evaluated at this time. As part of the General Order requirements, lands identified in the SDEAR that are potentially subject to erosion and sediment discharge are to prepare a SECP that is to be kept on farm. During the development of the SECP, any existing field specific management practices will be evaluated at that time.

As detailed in this report, parcels identified having the potential to discharge sediment and/or erosion to degrade surface water exceeded a potential sediment discharge threshold of 5 tons per year (**tons/yr**) and are within 500 meters of a United States Geological Survey (**USGS**) identified waterway. Extensive land leveling associated with irrigated agricultural activities has significantly altered the land surface in many locations. The land around a portion of the historical waterways shown on USGS maps have been altered such that the drainage paths no longer exist. As detailed in Section 4, the KRWCA has addressed the altered drainage paths in a portion of the KRWCA area. The KRWCA reserves the right to update the SDEAR as more detailed information becomes available pertaining to the altering of the historical waterways as shown on the USGS maps within the entire KRWCA area.

1.3 Kern River Watershed

1.3.1 Location Map

The Upper Kern River Watershed is located in the southeastern portion of the San Joaquin Valley (**Figure 1-2**) encompassing approximately 1.5 million acres. The Upper Kern River Watershed is located almost exclusively within the KRWCA secondary boundary, with the exception of the Kern River canyon portion of the watershed. There is limited irrigated agricultural land in the Upper Kern River Watershed. The Lower Kern River Watershed is located on the San Joaquin Valley floor and contains the KRWCA primary boundary. In addition to receiving runoff from the Upper Kern River Watershed, multiple other smaller watersheds discharge to the Lower Kern River Watershed. It is important to note, that although the entire KRWCA boundary covers approximately 3.5 million gross acres, only approximately 622,200 acres within the KRWCA boundary is irrigated agricultural land (18 percent); located primarily on the valley floor. The major body of water in the region is the Kern River that is regulated by Isabella Dam and Reservoir. Minor ephemeral streams in the watershed include, but are not limited to, Poso Creek (covered by a separate third-party in Kern County), Caliente Creek, El Paso Creek, and Chanac Creek.

1.3.2 General Characteristics

This SDEAR collected information on both the primary and secondary areas. Although there is limited agriculture in the secondary area, the large number of ephemeral streams found in the area required that information on erosion potential be collected for the area. The erosion potential for member parcels within the secondary area was determined and is provided in this report.

Kern County is the second largest agricultural county in the state and nation in economic value, producing over 250 crops, including 30 types of fruit and nuts, over 40 varieties of vegetables, over 20 field crops, lumber, nursery stock, livestock, poultry and dairy products. (USDA, 2014) Mineral and petroleum resources are also fundamental parts of Kern County's economy.

1.3.3 Climate

The climate for the Coalition area varies greatly between Mediterranean for the San Joaquin Valley floor to alpine in the upper reaches of the Kern River Watershed. The valley floor and foothill areas are characterized by hot dry summers and mild (often foggy) winters with precipitation that usually falls during the winter (November through March).

The mean annual temperature for the area is 64.7 °F; the mean for July, the hottest month, is 83.9 °F; and the mean for January, the coldest month, is 46.8 °F. Summertime high temperatures can approach 120 °F and wintertime lows rarely are below 30 °F. The south end of the San Joaquin Valley lies in the rain shadow of the Coastal and San Emigdio Mountains. When air masses have passed over the western side of the valley and descend to the valley floor, they contain less moisture. Average rainfall for the valley floor and foothill areas is between 5 – 6 inches per year. Precipitation increases as storms move up the western face of the Sierra Nevada Mountains and can exceed 60 inches in snow depth at the higher elevations. Snow levels rarely extend below 4,000 feet in elevation. (Wood and Dale, 1964)

See **Table 1-1** for Kern County valley floor and foothill temperature and rainfall characteristics.

Potential evapotranspiration (**ET**), the amount of water evaporated and transpired from healthy grass in a normal year, is 57.9 inches in the southern San Joaquin Valley (Jones, 1999). Potential ET varies little (less than 5 percent) from year to year from May to August (Sanden, 2014a).

Effective precipitation is the portion that can be beneficially used by crops. This varies from 1.2 inches in a dry year to 4.9 inches in a wet year, averaging 3.4 inches in a normal year (Kern County Water Agency, 2005).

1.3.4 KRWCA Soils

Soils on the Kern County valley floor have two general origins, delineated approximately by the trough of the valley. The eastern alluvial fans were deposited mostly by alluvial deposition generated from the precipitation and runoff from the Sierra Nevada, Tehachapi, and Transverse Mountain ranges. These soils are mostly of igneous and metamorphic origin, well drained, very low in salinity, with large well developed groundwater basins, and ideal for agriculture. The western alluvial fans originated mostly from Coast Range sedimentary rock formed on the sea bottom that tend to have more areas with poorly drained soils of relatively marginal quality. Many of the soils on the west side of the valley required some reclamation before crops could be grown profitably.

For the purpose of broad characterization, the valley floor area can be divided up into five main areas relative to soil texture (**Figure 1-3**):

i. Clay Rim;

ii. Foothills;

iii. Kern Fan;

iv. Northern Areas; and,

v. Wheeler Ridge/Arvin Edison Region.

The Clay Rim region accounts for approximately 154,000 gross acres in the KRWCA primary boundary, and consists of heavy (fine-textured) soils extending from the mid-northern western boundary of the focus area southerly to the southern tip. It includes the historic Buena-Vista Lake Bed and historic Kern Lake Bed, derived from lacustrine deposits, and lands in historic swamp and overflow lands at the margins of alluvial fans and historic lake beds.

The Foothills region represents about 63,000 gross acres, and consists of medium-textured soils extending along the eastern edge of the focus area.

The Kern Fan region, representing approximately 225,000 gross acres, includes soil derived from river deposition. Because of their alluvial origins soil texture varies with the distance from the mouth of the historic drainage coming from the foothills, but can generally be characterized as coarse-textured.

The Northern Areas region, representing approximately 331,000 gross acres, consist of alluvium from Poso Creek and other sources soils that are less easily characterized and divergent in texture.

The Wheeler Ridge/Arvin-Edison region encompasses approximately 198,000 gross acres and generally has coarse-textured soils and its boundary generally follows the Arvin-Edison Water Storage District (**AEWSD**) and Wheeler Ridge-Maricopa Water Storage District (**WRMWSD**) borders, with some exceptions. A portion of northeastern AEWSD has been included in the Foothills region, as it is more consistent with that area in terms of cropping and soils. Similarly, because of differences in soil texture and crop type in the northern part of WRMWSD, the northern portion is included in the Clay Rim region.

1.3.5 KRWCA Agriculture

Agriculture has been practiced in Kern County since about 1860, when livestock was brought into the area. Irrigated agriculture began soon after that (1870s). Because the climate is arid, with an average of less than six inches of annual precipitation, almost all crops must be irrigated. Kern County has a large agricultural base; the market value of agricultural products sold is about $6 billion (USDA, 2014). Kern County agriculture is characterized by a wide variety of crops and livestock, but it is mostly known for its top crops – almonds, grapes, pistachios, carrots, potatoes, other vegetables – and cattle. Kern County ranks second in the state and the USA as a producer of fruits, tree nuts, and berries.

The year-round growing season allows for successful cultivation of numerous crops, as well as the practice of potential double and triple cropping, when two or three crops are grown within one calendar year.

Irrigation is the single most expensive component of agricultural production in Kern County. Water costs range from $40 to $190 per ac/ft depending on irrigation district and elevation (Sanden, 2014b). In addition to the per acre foot tolls, growers also pay assessment fees to most water districts on a per acres basis that pay for a portion of the cost to import surface water and for overhead, and therefore the total cost of irrigation water is much higher in the area. It is important to note, that growers pay these assessment fees to most water districts annually, whether surface water is delivered or not. For this reason, irrigation efficiencies in the Kern Subbasin are currently, overall, some of the highest in the entire Central Valley. This is partly the result of on-farm and irrigation district conservation methods and system improvements. In large part, however, the high overall irrigation efficiency currently found in the Kern Subbasin can be attributed to the conversion from gravity-based irrigation systems to pressurized drip/micro systems, which has accompanied the change in crop type distribution from annual to permanent crops. Pressurized systems, however, are also used increasingly on annual crops such as tomatoes because they can save water and increase yield (Water Association of Kern County website).

Overall, permanent crops are increasing significantly in the Subbasin and in nearly all cases are developed with highly efficient drip and/or micro spray irrigation systems. This change in crop type distribution has largely occurred during the last 20 to 25 years, and is likely to continue considering the long-term return potential of these crops in comparison to that of annual crops. In summary, permanent crops have been more lucrative in recent years and supply an increasing global market for fresh nuts and fruits (Equilibrium Capital, 2013).

1.3.6 Primary Area: Central Valley Floor (extent of DWR Bulletin 118 Groundwater Basin)

As previously mentioned, **Figure 1-2** delineates the KRWCA boundary into the primary and secondary boundary. The primary boundary includes a majority of the irrigated agriculture in the KRWCA region and includes what is hydrogeologically referred to as the Central Valley Floor. The KRWCA primary boundary includes approximately 619,200 acres of irrigated agricultural lands, or 99.5 percent of the total irrigated agricultural land within the KRWCA boundary. The primary boundary covers the Kern groundwater subbasin (DWR Bulletin 118, Subbasin 5-22.14).

1.3.7 Reconnaissance Area: Peripheral Area to the Central Valley Floor

The peripheral areas to the Central Valley Floor, or KRWCA's secondary boundary (**Figure 1-2**), contains a very small portion of the irrigated lands within the KRWCA membership. This area consists of foothill and mountainous geography with steeper terrain than the lower valley floor. Although the vast majority of this area is not farmed, it is the origin for most of the area's surface streams and rivers. This area includes the Upper Kern River Watershed, Walker Basin Watershed, Tehachapi and Caliente Creek Watersheds, Lake Paulina, the Southern Watersheds of Kern Lake Bed, Southwestern Watersheds of Buena Vista Lake Bed, and Rag Gulch Watershed. Elevations range from 14,128 feet mean sea level (**msl**) to 285 feet msl.

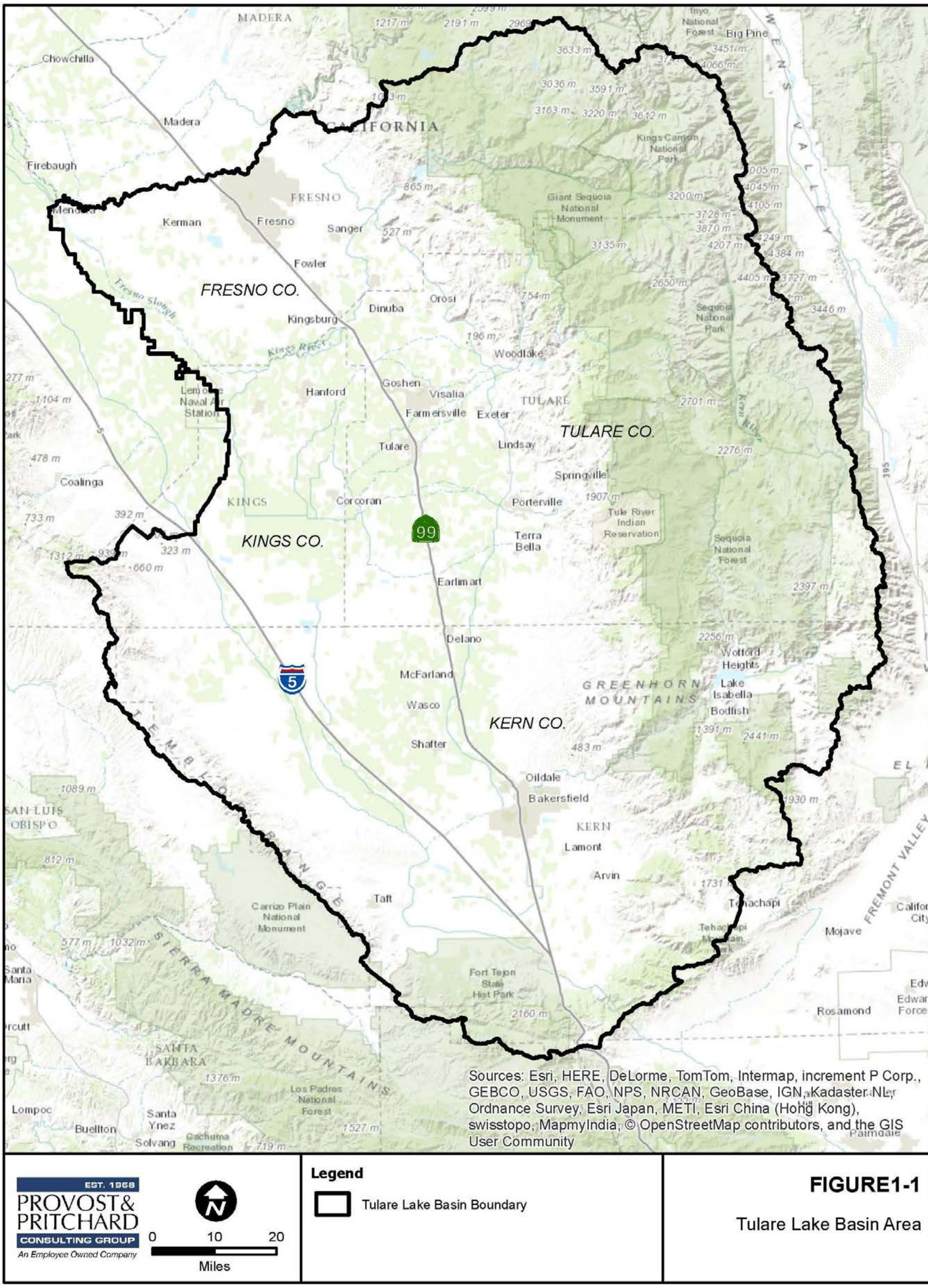


Figure 1-1. Tulare Lake Basin Area

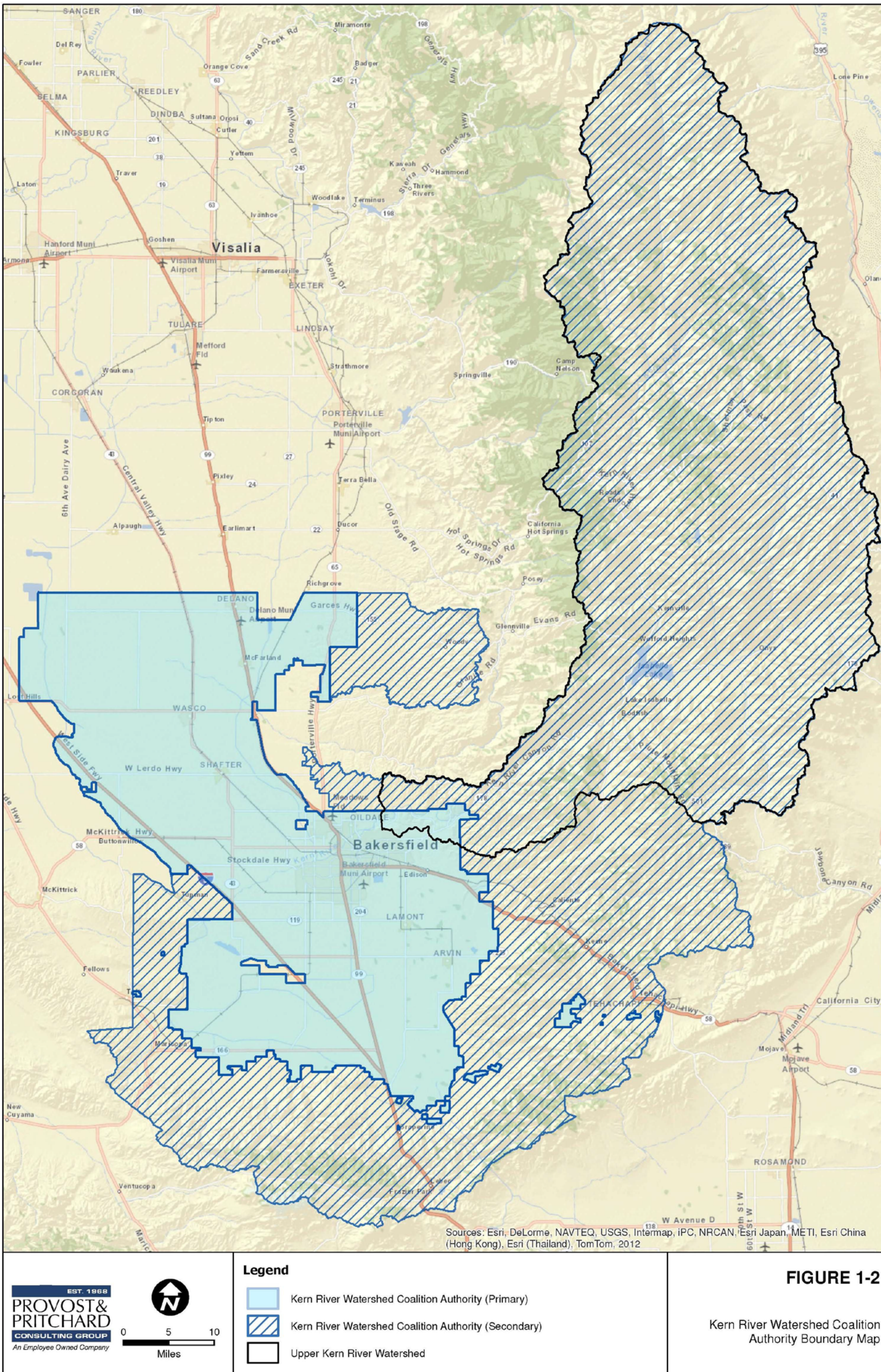


Figure 1-2. Kern River Watershed Coalition Authority Boundary Map

Table 1-1. KRWCA Temperature and Rainfall Characteristics

Temperature and Rainfall Characteristics – Kern County Valley Floor													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Ann**
Avg. Rainfall (in) /1	1.40	1.17	0.79	0.76	0.17	0.00	0.01	0.01	0.08	0.35	0.40	0.66	5.80
Avg. Max Temp (°F) /2	56.6	63.2	68.8	73.7	84.2	91.8	97.8	95.8	90.7	79.2	65.6	58.8	77.2
Avg. Min Temp (°F) /2	36.4	38.8	43.0	47.2	54.8	61.2	67.9	65.9	60.7	52.0	42.6	36.8	50.6

NOTES:
/1 - CIMIS Data for Arvin-Edison Station 125.
/2 - Western Regional Climate Center, Bakersfield 5 NW 354 Station for the Years 1999 to 2007.

Temperature and Rainfall Characteristics - Kern County Foothills													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Ann**
Avg. Rainfall (in) /1	2.79	2.39	1.93	0.87	0.28	0.10	0.12	0.18	0.29	0.38	1.35	1.84	12.52
Avg. Max Temp (°F) /1	59.1	62.7	66.4	72.8	81.0	90.3	97.6	96.7	91.1	80.1	67.3	60.0	77.1
Avg. Min Temp (°F) /1	32.2	35.0	38.0	43.1	50.5	58.0	64.3	62.7	57.3	47.4	37.5	32.3	46.5

NOTES:
/1 - National Weather Service. Average Temperature by Month 1946 to 2008, Kern River PH3 Weather Station.

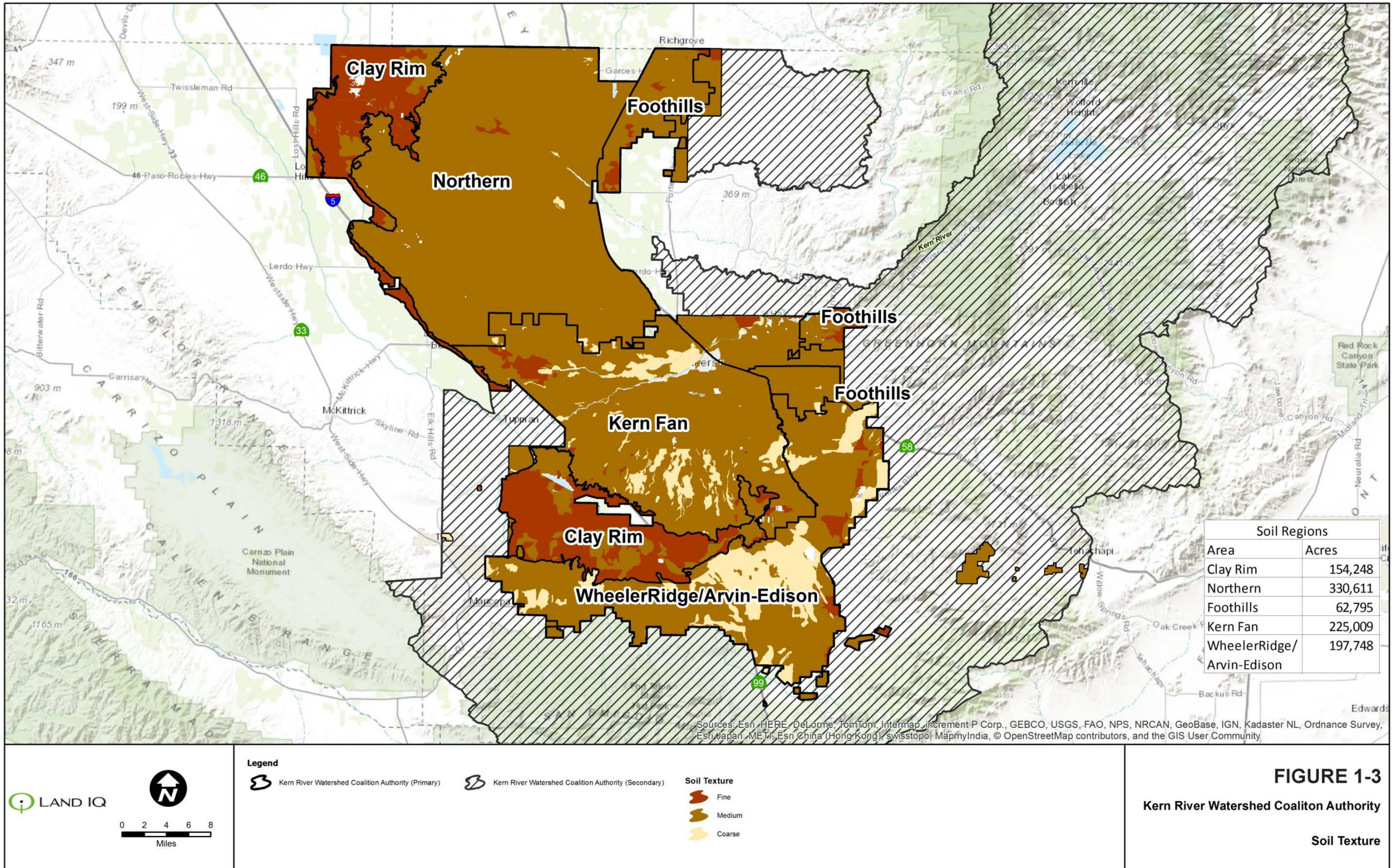


Figure 1-3. Kern Subbasin Generalized Soil Textures

2 Soil Erosion Factors

Sediment discharge from erosion on irrigated lands is caused by direct impact from raindrops and both rainfall and irrigation overland flow runoff. The rate of erosion is related to several factors. These factors include flows from off site, rainfall intensity, land surface slope grade and length, and soil properties including particle size, organic matter content, soil structure, and permeability. Additionally, agricultural management factors such as drainage infrastructure, crop cover, terraces, berms, and other methods of managing off site flows, reducing runoff and erosion affect the amount of soil erosion a property may experience.

Excessive erosion may cause problems including fouling of streams, impairment of habitat for aquatic life, production of sediment that may move pollutants, removal of topsoil, and recontouring of the land surface. Additionally on farmland, excessive erosion can cause loss in productivity, reduction in soil organic matter, and a reduction in soil nutrients. The objective of the Sediment Discharge and Erosion Assessment Report (**SDEAR**) is to develop a methodology to assess member parcels and determine which parcels are likely to experience sediment discharge.

Studies on soil erosion have found that soil erosion generally falls into two types: i) rill, and ii) inter-rill erosion. A rill is a small channel cut into the land surface by the erosive action of flowing water. Soil detachment in a rill occurs if the sediment in the flow is below the amount the load can transport and if the flow exceeds the soil's resistance to detachment. As detachment continues or flow increases, rills will become wider and deeper. Inter-rill erosion is caused by raindrops striking exposed soil that causes soil particles to detach and splashes them into the air and into shallow overland flows. Raindrops striking these shallow flows enhance the flow's turbulence and help to transport more of the detached sediment to a nearby rill or flow concentration.

Research on soil erosion by the United States Department of Agriculture (**USDA**) and Natural Resources Conservation Service (**NRCS**) have been used to develop empirical formulas that estimate the soil loss and sediment yield from land. The intrinsic properties used in the formulas have been developed for most of California and can be used to determine the relative amount of potential erosion from parcels.

2.1 Precipitation

The amount of soil lost to erosion caused by rain events is directly related to the rainfall intensity and duration. Rainfall intensity includes the amount of precipitation that occurs within a specific period of time and the size of the raindrops. As rainfall intensity increases so does the diameter of each raindrop. And, as raindrop size increases, the amount of energy transferred to the soil when it hits the soil surface also increases. The more energy a raindrop possesses, the greater its erosive potential.

The duration of rainfall also affects the amount of erosion that occurs. As the soil surface becomes saturated and runoff occurs, rill erosion begins to further erode the land surface as small channels develop. The number and size of the small channels, and the velocity of the water within the channels is partially dependant on the duration of the rainfall event and the amount of runoff that is occurring in the area.

2.2 Soil

The major soil factors affecting the erosion rate are the soil texture, organic matter content, structure, and permeability.

The soil texture is a significant contributor to the amount of erosion from the land surface. The soil texture affects the likelihood that a soil particle will detach from the soil surface and be transported some distance from its initial position. The relative rate of soil erodibility from various soil textures is provided below:

i. Clay – generally resistant to detachment except in expansive clay soils which have high runoff potential;
ii. Sand – easily detached with low runoff potential, large particles are easy to detach, but difficult to transport;
iii. Loam – moderate detachment potential, moderate transportation potential; and,
iv. Silt – high detachment potential, high transportation potential.

In addition to the soil texture, the soils with higher organic content and blocky structures tend to have lower erosion rates. These factors are combined into a soil erosivity factor developed by soil scientists and provided in the NRCS Soil Survey.

2.3 Topography

The topography of the land surface has an effect on the amount of soil erosion and deposition. The steepness, length of slope, and hill topography all influence the amount of soil erosion that occurs. In general, long, steep slopes that allow for overland flow conditions increase the potential for soil erosion. Flow from upslope areas can also increase erosion potential.

The land slope has a greater impact on rill erosion than it does on inter-rill erosion because inter-rill erosion is caused by raindrop impact. Rill erosion, however, increases as the slope increases. The overland slope length is the distance from where the origin of the overland flow begins to the concentrated flow area.

In addition to the steepness of the land surface, the slope shape or the spatial variation of steepness along the slope also affects erosion. The location of the steepness along the hillslope greatly affects erosion. Erosion is greatest for convex slopes that are steep near the end of the slope length where runoff is greatest. Erosion is least for concave slopes where the upper end of the slope is steep and runoff is least. Deposition occurs on concave slopes where transport capacity of the runoff is significantly reduced as the slope flattens. Sediment yield from these slopes is less than the amount of sediment produced by convex erosion.

2.4 Land Use

Land use in the potential erosion area has a significant impact on the amount of erosion that occurs at a site. The two factors that affect the rate of soil erosion are cover management and supporting practices. Surface drainage and erosion control infrastructure can also reduce soil erosion and sedimentation.

Cover management includes planting and cultivating vegetation. The canopy provided by the plant growth reduces the impact of raindrops on the soil surface. The canopy intercepts the rainfall and reduces the velocity before the rain hits the soil surface; thus reducing the amount of soil that is displaced by raindrop impact. The amount of reduction is tied to the percentage of ground covered by the canopy and the height of the canopy. Canopies that cover more of the ground surface, closer to the ground will achieve the greatest reduction in erositivity.

In addition to the canopy, other factors related to vegetations affect soil erosion. Below ground biomass including roots will also have an effect on soil erosion. Vegetation that has significant quantities of root mass will help hold the soil onsite and reduce erosion. These roots mechanically hold the soil in place.

In addition to vegetation, the random roughness of the soil will also affect the amount of soil erosion. Soil preparations that increase the random soil roughness will reduce the velocity of overland flow; thereby reducing the amount of soil eroded. In addition, random roughness creates depressions which increase infiltration and slow runoff velocity which reduces both soil detachment and transport capacity. Random roughness is a function of soil tillage activities, soil texture, and soil organic matter.

3 Methodology

Based on discussions between the Central Valley Regional Water Quality Control Board (**CVRWQCB** or **Board**) and coalitions within the Tulare Lake Basin, a preferred method for determining the relative potential of erosion from parcels was determined. Although determining the potential soil loss rates from irrigated lands is new to the Board's long-term Irrigated Land Regulatory Program (**ILRP**) requirements; the Board has been requiring construction sites to determine their relative threat to discharge sediment laden stormwater for a number of years. The factors the Board provides to construction stormwater applicants will be used to determine the relative threat of sediment discharge from irrigated lands within the Kern River Watershed Coalition Authority (**KRWCA**) boundary.

In addition to the potential discharge results, the proximity of the parcels to waterways was also considered. Only parcels located within a certain distance from waterways that have potential sediment discharge rates over the threshold will be required to prepare Sediment and Erosion Control Plans (**SECPs**).

3.1 Universal Soil Loss Equation (USLE)

The Universal Soil Loss Equation (**USLE**) is a mathematical formula that predicts the amount of soil erosion. The USLE was developed using soil erosion information collected by the U.S. Department of Agriculture (**USDA**) Soil Conservation Service. The agency is now referred to as the Natural Resources Conservation Service (**NRCS**). The original version of this model has been used for conservation planning both in the United States, where it originated, and around the world.

The USLE was developed from erosion plot and rainfall simulator experiments. The USLE is composed of six factors to predict the long-term average annual soil loss (**A**). The equation includes the rainfall erosivity factor (**R**), the soil erodibility factor (**K**), the topographic factors (**L** and **S**), and the cropping management factors (**C** and **P**). The USLE equation takes the simple product form:

$A = R \times K \times L \times S \times C \times P$

The USLE has developed this equation based on experiments using the unit plot concept. The unit plot is defined as the standard plot condition to determine the soil's erodibility. The unit plot is defined as a land surface with an LS factor = 1 (slope = 9% and length = 72.6 feet), where the plot is fallow, tillage is up and down slope, and no conservation practices are applied (CP=1). The USLE calculations were developed based on experiments performed on this standard. In this state:

$$K = \frac{A}{R}$$

A simpler method to predict K is available that includes the particle size of the soil, organic matter content, soil structure, and profile permeability. The soil erodibility factor (K) can be approximated from a nomograph if this information is known. The LS factors can easily be determined from a slope effect chart by knowing the length and gradient of the slope. The cropping management factor (C) and conservation practices factor (P) are more difficult to obtain and must be determined empirically from plot data.

3.2 Revised Universal Soil Loss Equation (RUSLE)

The Revised Universal Soil Loss Equation (**RUSLE**) is the most recent version of the USLE. This version incorporates quantification of soil loss from both rill and inter-rill erosion. The RUSLE can be used to approximate soil loss across larger areas by using sample points and calculating the soil loss for each sample point. The loss is then aggregated into an estimate of soil loss across the entire area. Estimates are made on a daily basis and summed to estimate the annual sediment yield.

RUSLE2 is similar to the RUSLE, but incorporates sediment detachment/deposition dynamics which includes the rate of fall of soil particles in still water, overland flow rate per unit width of flow, transport capacity, and sediment load. RUSLE2 improves the handling of several classes of soil particles and the method used to solve the equations when compared to RUSLE and USLE. These improvements increase the accuracy of the soil loss estimate.

RUSLE and RUSLE2 are used by numerous government agencies, private organizations, and individuals to assess the degree of rill and inter-rill erosion, identify situations where erosion is detrimental, and guide development of conservation plans to control erosion. RUSLE and RUSLE2 have been applied to cropland, rangeland, disturbed forest lands, landfills, construction sites, mining sites, reclaimed lands, military training lands, parks, land disposal of waste, and other land uses where soil material is exposed to the erosive forces of raindrop impact and overland flow.

3.3 Proximity to Waterways

In addition to the factors affecting the quantity of soil that is eroded from the land surface, the proximity of the site to waterways also affects the amount of soil that may be transported to waterways. Sediment laden water that flows into waterways may impact the suitability of the water for fish and other aquatic habitat, degrade spawning ground, and allow pollutant laden soil to enter waterways. Therefore, parcels that are close to the waterways and have high erosivity characteristics has been identified in this analysis.

3.4 Management Factors

As previously mentioned in **Section 2**, management factors and surface drainage characteristics can also influence the potential for sediment discharge. These factors will be addressed in the Sediment and Erosion Control Plan (**SECP**) for parcels identified as having the potential to discharge sediment to waterways.

Parcels identified as having the potential to discharge will be required to prepare the SECP. This plan will provide information and documentation of the management and surface drainage characteristics employed that will mitigate sediment discharge from the respective parcels. This SDEAR identifies the parcels that are required to prepare SECPs and implement sediment control measures to mitigate the discharge of sediment to waterways.

3.5 Data Sources

The California State Water Resources Control Board (**SWRCB**) has developed, and made available through their website, geographic information system (**GIS**) spatial datasets of the rainfall erosivity (R factor), soil erodibility based on soil properties (K factor), and the topographic effects (LS factor). These intrinsic factors were used in the equation provided in the Sediment Risk Factor Worksheet that the SWRCB has developed for the calculation of construction site sediment risk. The equation results in a potential sediment discharge in tons per year (**tons/year**). It is understood that the resulting predicted discharge is much higher than what will actually be experienced from irrigated farmland; however, the results of this equation provide a method for determining the relative risk of sediment discharge from parcels. The preliminary potential sediment discharge threshold that will be used to determine lands requiring SECPs will be 5 tons/year; the NRCS's sediment risk potential threshold.

In addition to the potential discharge results, the proximity of the parcels to waterways has also been taken into consideration. Only parcels located within 500 meters from waterways that have potential sediment discharge rates over the threshold will be required to submit SECPs.

4 Results

Using the information provided by the California State Water Resources Control Board (**SWRCB**), the intrinsic Revised Universal Soil Loss Equation (**RUSLE**) factors were mapped using geographic information system (**GIS**). The factors were then combined to calculate a combined sediment risk factor. The combined sediment risk factor map was then overlaid with the waterway buffer. Parcels identified to have the potential to degrade surface waters, a combined sediment risk factor greater than 5 tons per year (**tons/year**) and greater and at least 50 percent within the waterway buffer were identified.

4.1 Erosivity (R) Factor

The erosivity (**R**) factor for California was derived from precipitation records, placed on an isoerodent map, and published on the SWRCB website. Local R values can be taken directly from isoerodent maps or from GIS data.

Local variations in rainfall erosivity (+5 percent) are generally represented with a single R value. R values can be calculated for specific locations from rainfall intensity data. However, this is a very time and labor-intensive process requiring erodibility index (**EI**) calculations for each storm event greater than 0.5 inches for each rain gauge over a period of years. The R values given through this method provide an estimate of precipitation's affect on the erosion rate on an annual basis.

R values are directly proportional to the amount of energy and potential runoff caused by storms. The majority of the Kern River Watershed Coalition Authority (**KRWCA**) area has the minimum R factor of ≤10, with an exception in the northeastern portion of the secondary area, where the R factor increases to 40-50. A map of the R factor for the KRWCA is provided on **Figure 4-1**.

4.2 Soil Erodibility (K) Factor

The soil erodibility (**K**) factor represents the susceptibility of the soil to erosion and the amount and rate of runoff. Factors affecting the K value include soil texture, organic matter, structure, and permeability. Typical K values for various soil types are presented in **Table 4-1**. A map of the K factor for the KRWCA is provided on **Figure 4-2**.

The K factors for the study area vary depending upon location as seen on **Figure 4-2**. Soils have higher K factors in the northwestern portion of the study area and east of Bakersfield. Lower K factors are found in the southern portion of the primary study area. The secondary study area generally has soils with lower K factors, with the lowest K factors found in the eastern portion of the secondary area.

4.3 Slope Length and Steepness (LS) Factor

The Slope Length and Steepness (**LS**) factor represents erodibility due to combinations of slope length and steepness relative to a standard unit plot. L is the slope length factor, representing the effect of slope length on erosion. It is the ratio of soil loss from the field slope length to that from a 72.6-foot length on the same soil type and gradient. Slope length is the distance from the origin of overland flow along its flow path to the location of either concentrated flow or deposition.

S is the slope steepness. This represents the effect of slope steepness on the rate of erosion. Soil loss increases more rapidly with slope steepness than it does with slope length. It is the ratio of soil loss from the field gradient to that from a 9 percent slope under identical conditions. The relation of soil loss to gradient is influenced by density of vegetative cover and soil particle size.

The L factor and S factor are combined into the LS factor. The LS factor includes the slope length factor's (L) effect of slope length on erosion, and the affect of the slope steepness factor (S) has on erosion. Values of both L and S equal 1 for the unit plot conditions of 72.6 ft length and 9 percent slope steepness. Values of L and S are relative and represent how erodible the particular slope length and steepness is relative to the unit plot. Therefore, L and S values can range from less than 1 to values greater than 1.

The LS factor for the study area was mapped and is provided on **Figure 4-3**. The LS factor for the primary study area is dominated by low LS factors. As the topography changes along the boundary between the primary and secondary study areas where the valley floor transitions to the foothills, the LS factor also increases. The LS factors are highest in the secondary area in the mountainous area.

4.4 Combined Sediment Risk Factor (LS*R*K)

The LS, R and K factors were combined to determine the Combined Sediment Risk Factor (**Figure 4-4**). This factor determines the annual erosion potential in tons per acre-year (**tons/ac-yr**). This calculation assumes the maximum soil erosion potential that could potentially occur if the land was bare. The actual erosion that would occur from the farmed soils is substantially less than the calculated value. Actual soil erosion is expected to be significantly less than the values presented on **Figure 4-4**; however, these values can be used to assess the relative erosion potential across the study area.

In general, the primary study area is dominated by combined sediment risk factors that are less than 5 tons/ac-yr. These areas have a very low threat of discharging sediment to nearby waterways. Greater combined sediment risk factors are found on the boundary areas of the primary and secondary study area and in the secondary study area. These are primarily attributed to the higher LS factors found in these areas due to the transition from valley floor to foothills and mountainous regions. The highest combined sediment risk factors are found in the mountainous regions within the secondary study area.

4.5 Waterways

In addition to the combined sediment risk factor, the proximity of the member parcels to waterways also affects the potential for sediment discharge and pollution potential. The location of waterways was determined using the National Hydrography Dataset (**NHD**). All streams and artificial paths were mapped for the primary and secondary study areas (**Figure 4-5**). To determine the parcels that are located near the waterways, a 500 meter offset from centerline of these waterways was created using GIS.

The secondary area has a large number of small streams. Many of these feed into larger streams that discharge through the mountains into the valley. The large number of streams in the secondary area means that virtually the entire secondary area is within 500 meters of a waterway.

The primary area has significantly less waterways than the secondary area. Several of these waterways are small, historical ephemeral streams that are unconnected to major waterways.

Extensive land leveling associated with irrigated agricultural activities has significantly altered the land surface in many locations. The land around a portion of the historical waterways shown on United State Geologic Survey (**USGS**) maps have been altered such that the drainage paths no longer exist.

To determine which waterways are still active and which have been altered, an analysis including both a review of current aerial photographs of the area and site visits with photo documentation was conducted. Waterways were only removed from the USGS data set if the following criteria were met:

- No evidence of the waterway was found on the aerial photograph;
- No habitat was evident in the vicinity of where the waterway is located;
- No evidence of erosion was found near the location of the waterway; and,
- The waterway was not tributary to any larger, named streams.

Additionally, where short sections of stream had been altered and could no longer be identified, however, evidence of the stream was seen on either side of the section, the section was not removed from the data set. The sections removed from the analysis are shown in red on **Figure 4-5**. Documentation including aerial photos and photographs taken during the site visit are provided in the **Appendix**.

4.6 Potential Sediment Dischargers

To determine the parcels and fields that have the potential to discharge sediment that may degrade surface waters, the parcels with erosion potential factors greater than 5 tons/ac-yr and are located within 500 meters of a stream or artificial path were identified using GIS.

To further refine the GIS results, the results were overlaid with the aerial photo and topographic maps. Parcels that were not likely to discharge to the nearby waterway due to the land surface sloping away from the waterway, or that had an impediment to stormwater flow that would prevent water from entering the stream or artificial path were removed from the data set.

Additionally, parcels that had less than 50 percent of their land surface located within the 500 meter buffer area, or within the greater than 5 tons/ac-yr potential sediment discharge class were also removed from the data set. The analysis results and indentified parcels that have the potential for sediment discharge and erosion to potentially affect surface waters are presented on **Figure 4-6**. The majority of the parcels identified as having the potential to affect surface waters are located in the secondary area. Much of this land is unsuitable for irrigated agriculture and is unlikely to be converted to irrigated lands. However, the analysis includes all parcels so that it provides a comprehensive list of all potential parcels. A summary of the parcels identified in the analysis is provided in **Table 4-2**.

4.7 Potential Sediment Discharger Requirements

As mentioned above, parcels identified as having the potential to discharge sediment that may degrade surface waters will be required to develop a SECP. The respective Member(s) are required to use the SECP Template provided by the Executive Officer, or equivalent. The SECP must be prepared in one of the following ways:

- The SECP must adhere to the site-specific recommendation from the Natural Resources Conservation Service (**NRCS**), NRCS technical service provider, the University of California Cooperative Extension (**UCCE**), the local Resource Conservation District; or conform to a local county ordinance applicable to erosion and sediment control on agricultural lands. The Member must retain written documentation of the recommendation provided and certify that they are implementing the recommendation; or has completed a training program that the Executive Officer concurs provides necessary training for sediment and erosion control plan development; or,

- The SECP must be written, amended, and certified by a Qualified Sediment and Erosion Control Plan Developer possessing one of the following registrations or certifications, and appropriate experience with erosion issues on irrigated agricultural lands: California registered professional civil engineer, geologist, engineering geologist, landscape architect; professional hydrologist registered through the American Institute of Hydrology; certified soil scientist registered through the American Society of Agronomy; Certified Professional in Erosion and Sediment Control (**CPSEC**)™/Certified Professional in Storm Water Quality (**CPSWQ**)™ registered through EnviroCert International, Inc.; professional in erosion and sediment control registered through the National Institute for Certification in Engineering Technologies (**NICET**); or,

- The SECP must be prepared and certified in an alternative manner approved by the Executive Officer. Such approval will be provided based on the Executive Officer's determination that the alternative method for preparing the SECP meets the objectives and requirements of this Order.

The plan shall be maintained and updated as conditions change. A copy of the SECP shall be maintained at the farming operations headquarters or primary place of business; and must be produced by the Member, if requested, should Central Valley Regional Water Quality Control Board (**CVRWQCB** or **Board**) staff, or an authorized representative, conduct an inspection of the Member's irrigated lands operation.

For Members with small farming operations, within one year of the Executive Officer approving the third party's Sediment Discharge and Erosion Assessment Report (**SDEAR**), Members must complete and implement a SECP. For all other members, within 180 days of the Executive Officer approving the third party's SDEAR, Members must complete and implement a SECP.

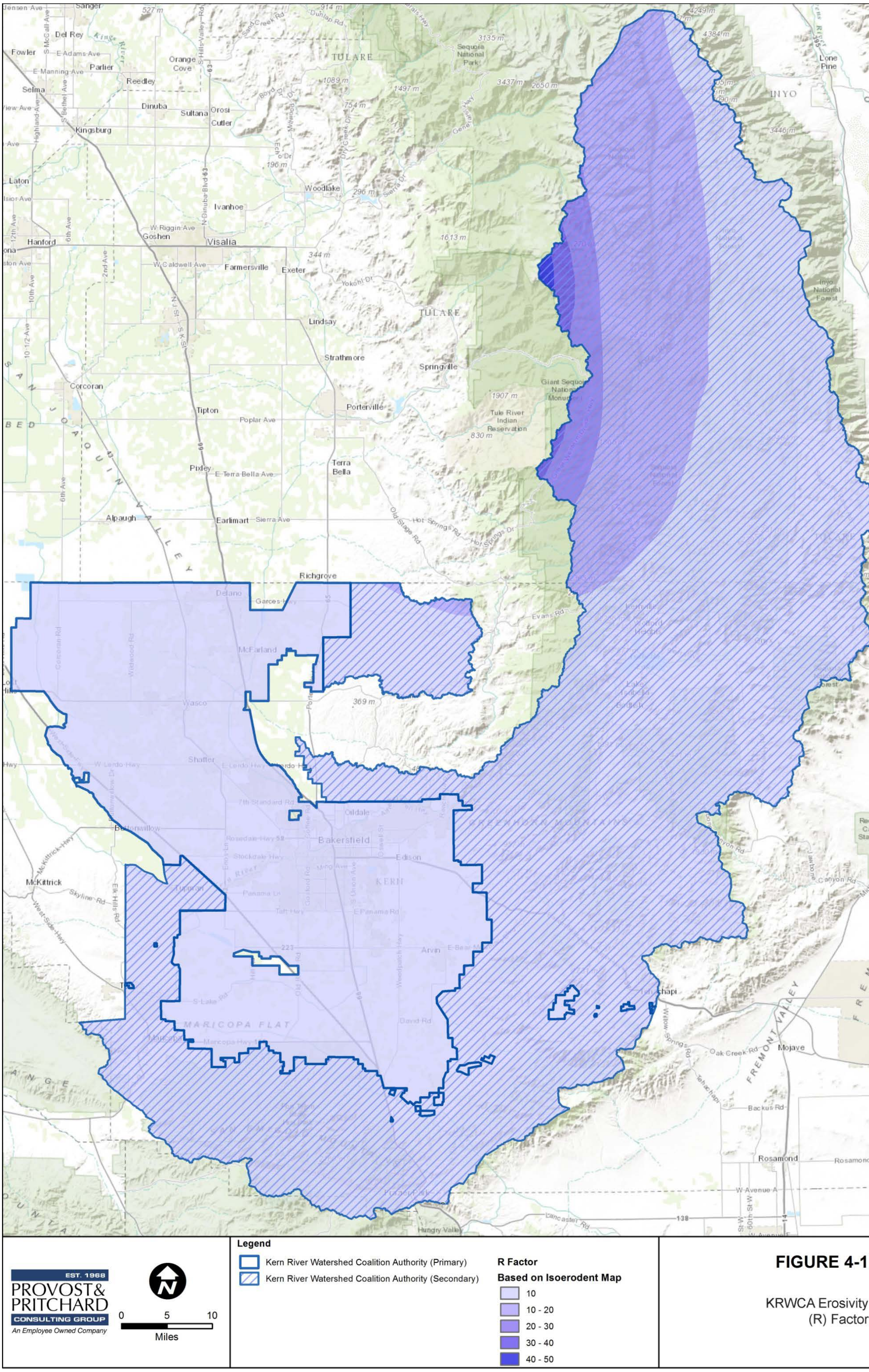


Figure 4-1. KRWCA Erosivity (R) Factor

Table 4-1. Typical Soil Erodibility (K) Factors for Various Soil Types

Typical Soil Erodibility (K) Factors for Various Soil Types		
Soil Type	**Erodibility**	**K Value Range**
Clay	High	0.05-0.15
Silt	High	0.05-0.20
Loam	Moderate	0.25-0.45
Sand	Low	0.45-0.65

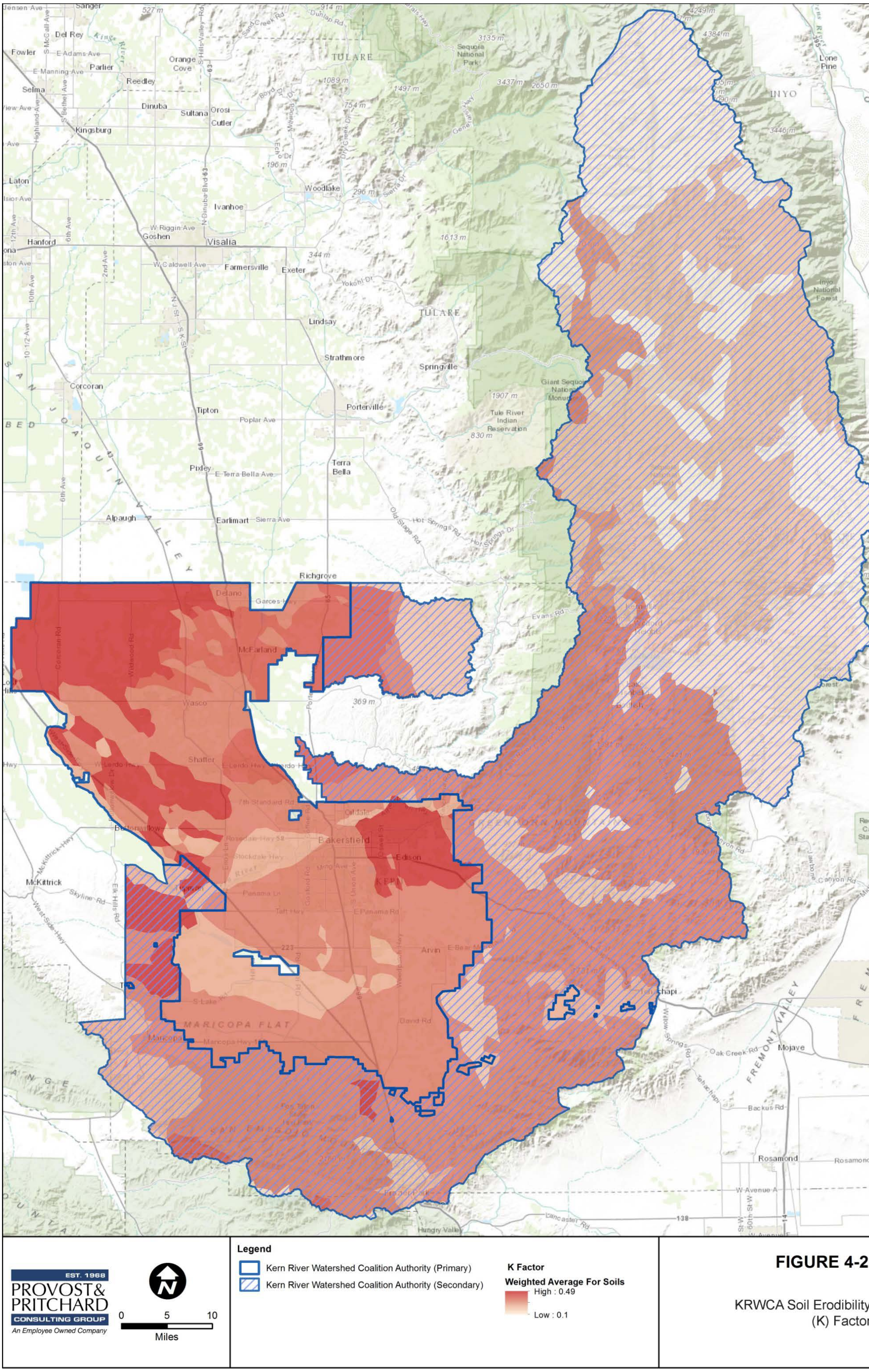


Figure 4-2. KRWCA Soil Erodibility (K) Factor

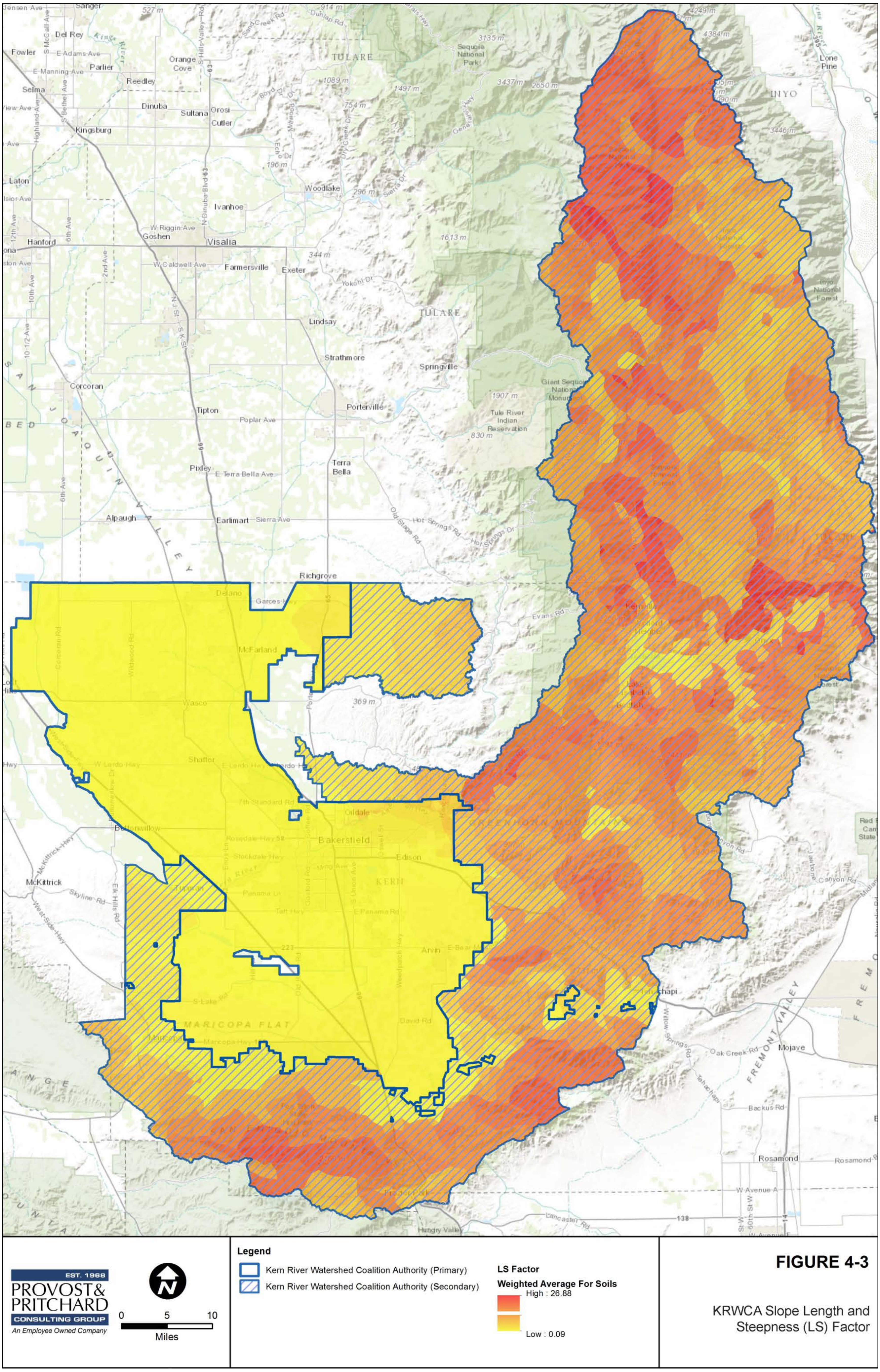


Figure 4-3. KRWCA Slope Length and Steepness (LS) Factor

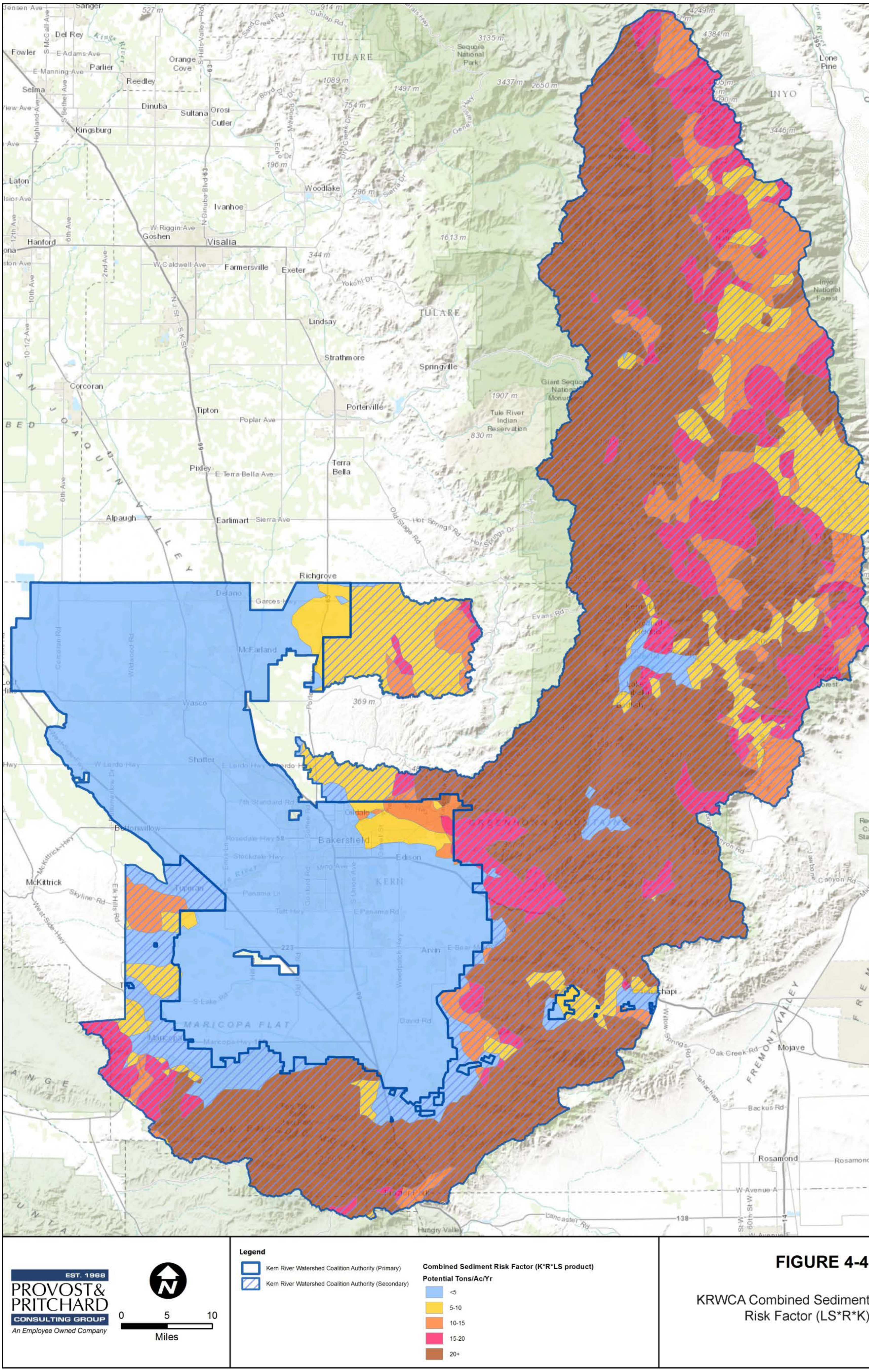


Figure 4-4. KRWCA Combined Sediment Risk Factor (LS*R*K)

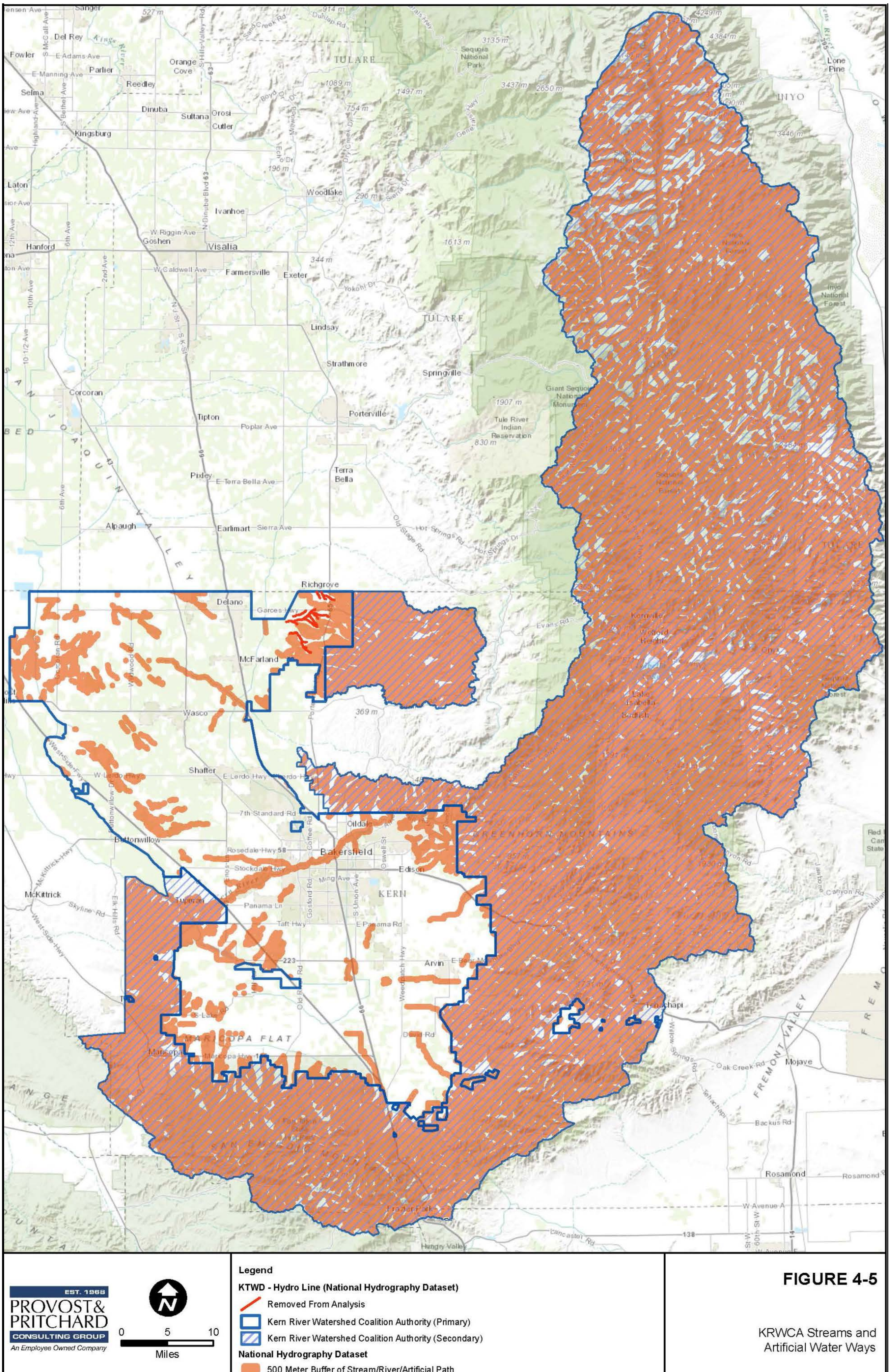


Figure 4-5. KRWCA Streams and Artificial Water Ways

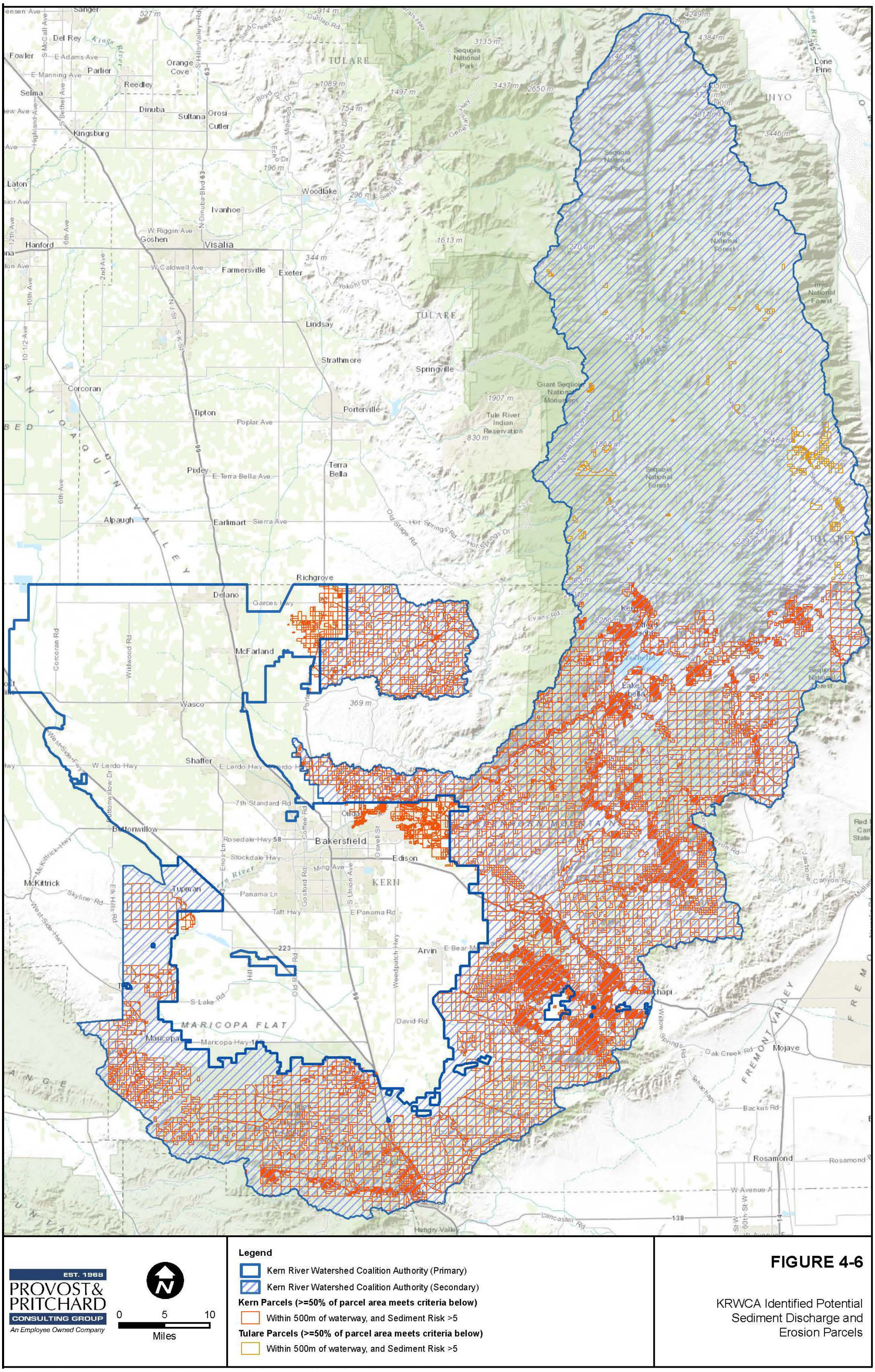


Figure 4-6. KRWCA Identified Potential Sediment Discharge and Erosion Parcels

Table 4-2. KRWCA Potential Sediment Discharge and Erosion Parcel Summary

KRWCA Potential Sediment Discharge and Erosion Parcel Summary	
Number of Parcels	42,090
Parcels Enrolled as KRWCA Members	156 parcels (13,746 gross acres)
Parcels in Primary Study Area	3,958 parcels (42,065 gross acres)
Parcels in Secondary Study Area	38,132 parcels (1,172,256 gross acres)

5 References

DWR. 2003. California's Groundwater, DWR Bulletin 118, Update 2003. Sacramento, Cal.: California Department of Water Resources.

Equilibrium Capital, 2013. The Opportunity in Permanent Crops. San Francisco, Cal.: Equilibrium Capital. Available at: http://www.eq-cap.com/wp-content/uploads/The_Opportunity_in_Perrmanent_Crops-2013_09_04.pdf. Accessed 4 September 2014.

Jones, D.W., R.L. Snyder, S. Eching and H. Gomez-McPherson. 1999. California Irrigation Management Information System (CIMIS) Reference Evapotranspiration. Climate zone map, Sacramento, Cal.: Department of Water Resources.

KCWA. 1998-2012. Water Supply Reports: 1998 through 2012. Bakersfield, Cal.: Kern County Water Agency.

Sanden, B. 2014a. UCCE Kern Soil & Water February 2014. University of California Agriculture and Natural Resources.

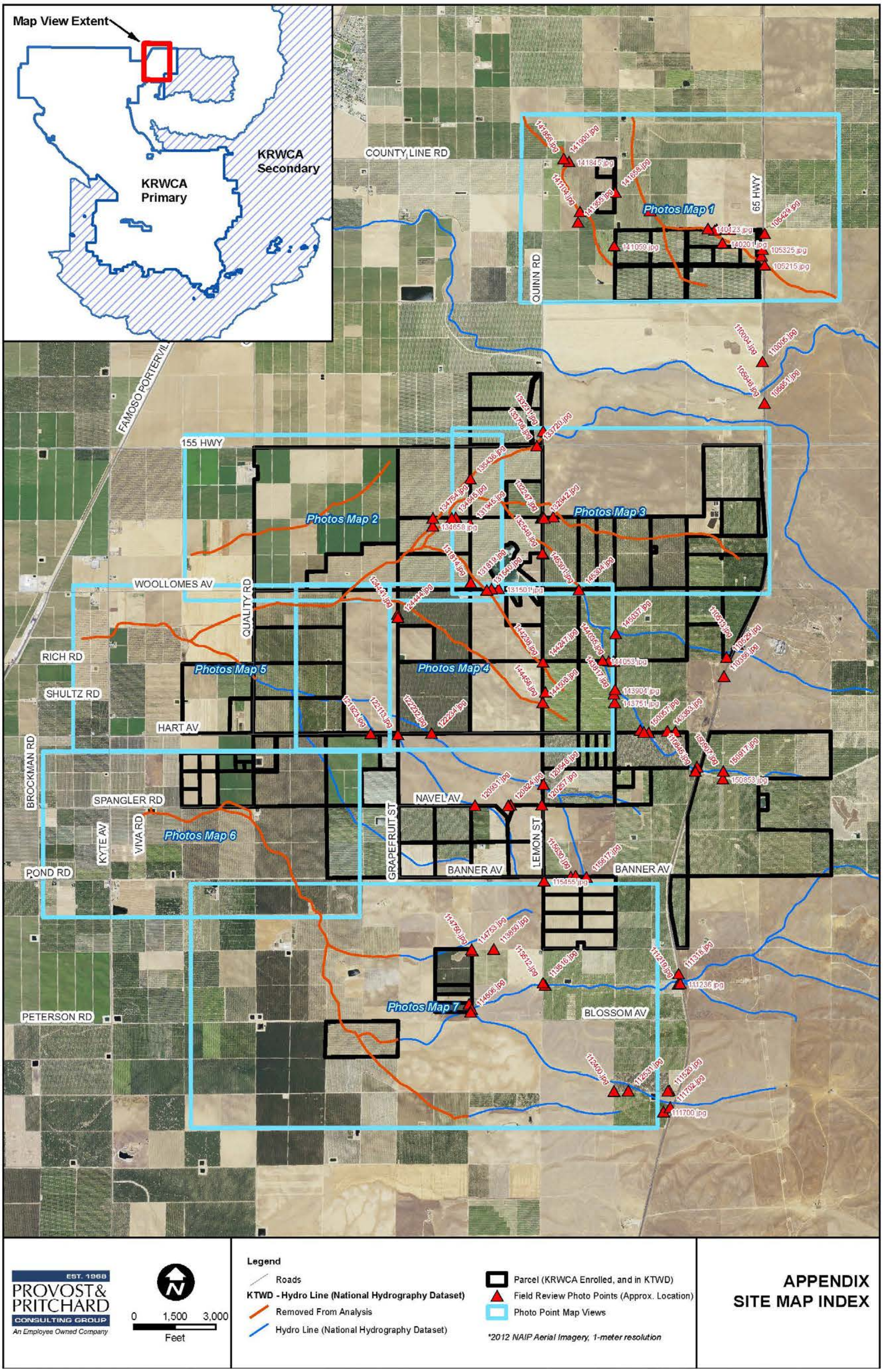
Sanden, B. 2014b. Kern County UCCE. Oakland, Cal.: Regents of the University of California. Available at: http://cekern.ucanr.edu/Irrigation_Management. Accessed 4 September 2014.

USDA. 2014. 2012 Census of Agriculture County Profile-Kern County. 29 May 2014. Washington D.C.: United States Department of Agriculture. Available at: http://www.agcensus.usda.gov/Publications/2012/Online_Resources/County_Profiles/California/cp06029.pdf. Accessed 31 December 2014.

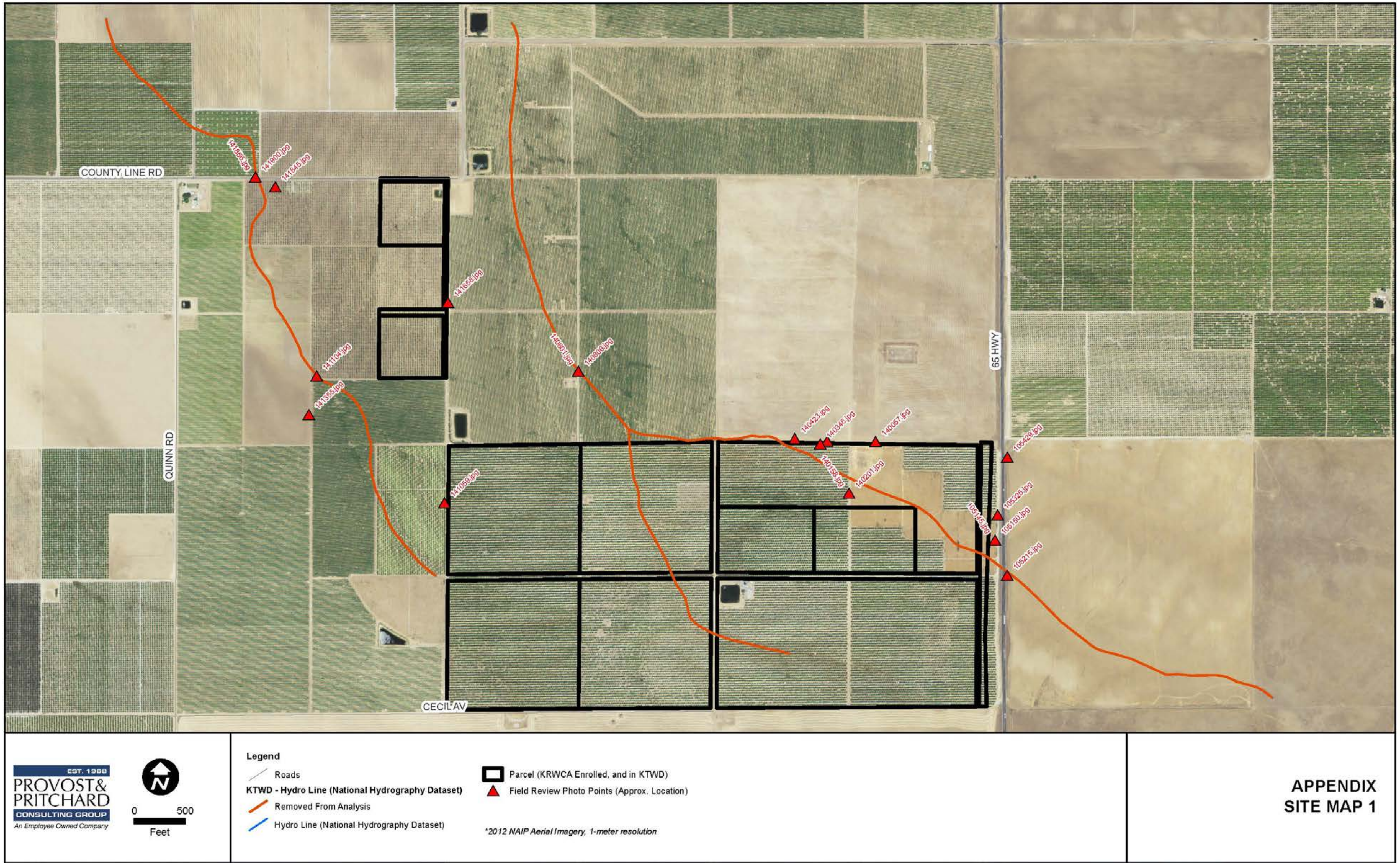
WAKC. Home Page. Bakersfield, Cal.: Water Association of Kern County. Available at: http://www.wakc.com. Accessed 4 September 2014.

Wood, P.R. and R.H. Dale, R.H. 1964. Geology and Ground-Water Features of the Edison- Maricopa Area, Kern County, California USGS Water Supply Paper 1656. Washington, D.C.: United States Department of Interior, Geological Survey.

Appendix



Site Map Index


COUNTY LINE RD
QUINN RD
65 HWY
CECIL AV
EST. 1968
PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company
0
500
Feet
Legend
Roads
KTWD - Hydro Line (National Hydrography Dataset)
Removed From Analysis
Hydro Line (National Hydrography Dataset)
Parcel (KRWCA Enrolled, and in KTWD)
Field Review Photo Points (Approx. Location)
*2012 NAIP Aerial Imagery, 1-meter resolution
APPENDIX
SITE MAP 1

Site Map – 1

QUALITY RD
155 HWY
QUALITY RD
WOOLLOMES AV
EST. 1968
PROVOST&
PRITCHARD
CONSULTING GROUP
An Employee Owned Company
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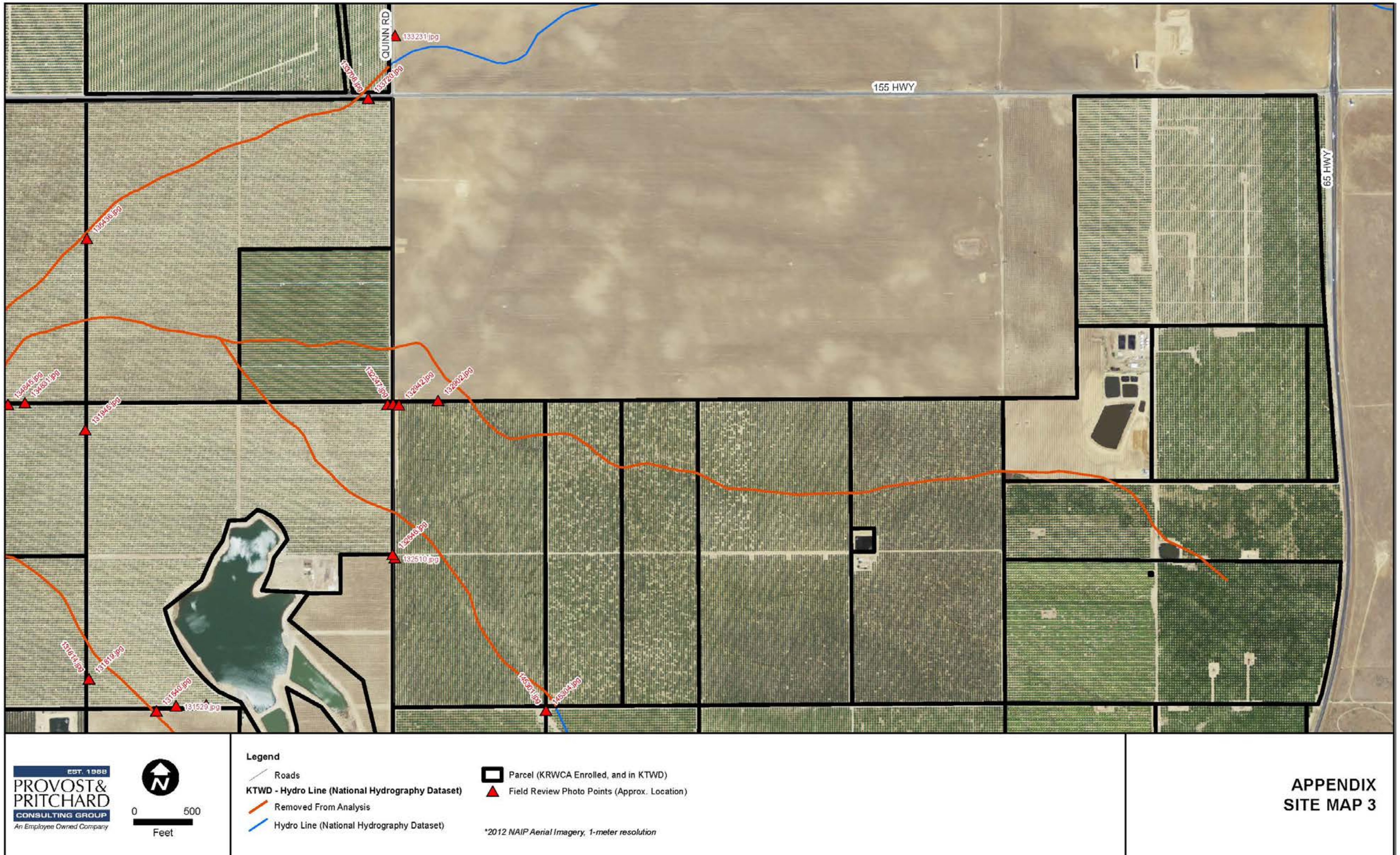
Roads
KTWD - Hydro Line (National Hydrography Dataset)
Removed From Analysis
Hydro Line (National Hydrography Dataset)
Parcel (KRWCA Enrolled, and in KTWD)
Field Review Photo Points (Approx. Location)
*2012 NAIP Aerial Imagery, 1-meter resolution
APPENDIX
SITE MAP 2

Site Map – 2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155 HWY
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KTWD - Hydro Line (National Hydrography Dataset)
Removed From Analysis
Hydro Line (National Hydrography Dataset)
Parcel (KRWCA Enrolled, and in KTWD)
Field Review Photo Points (Approx. Location)
*2012 NAIP Aerial Imagery, 1-meter resolution
EST. 1968
PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company
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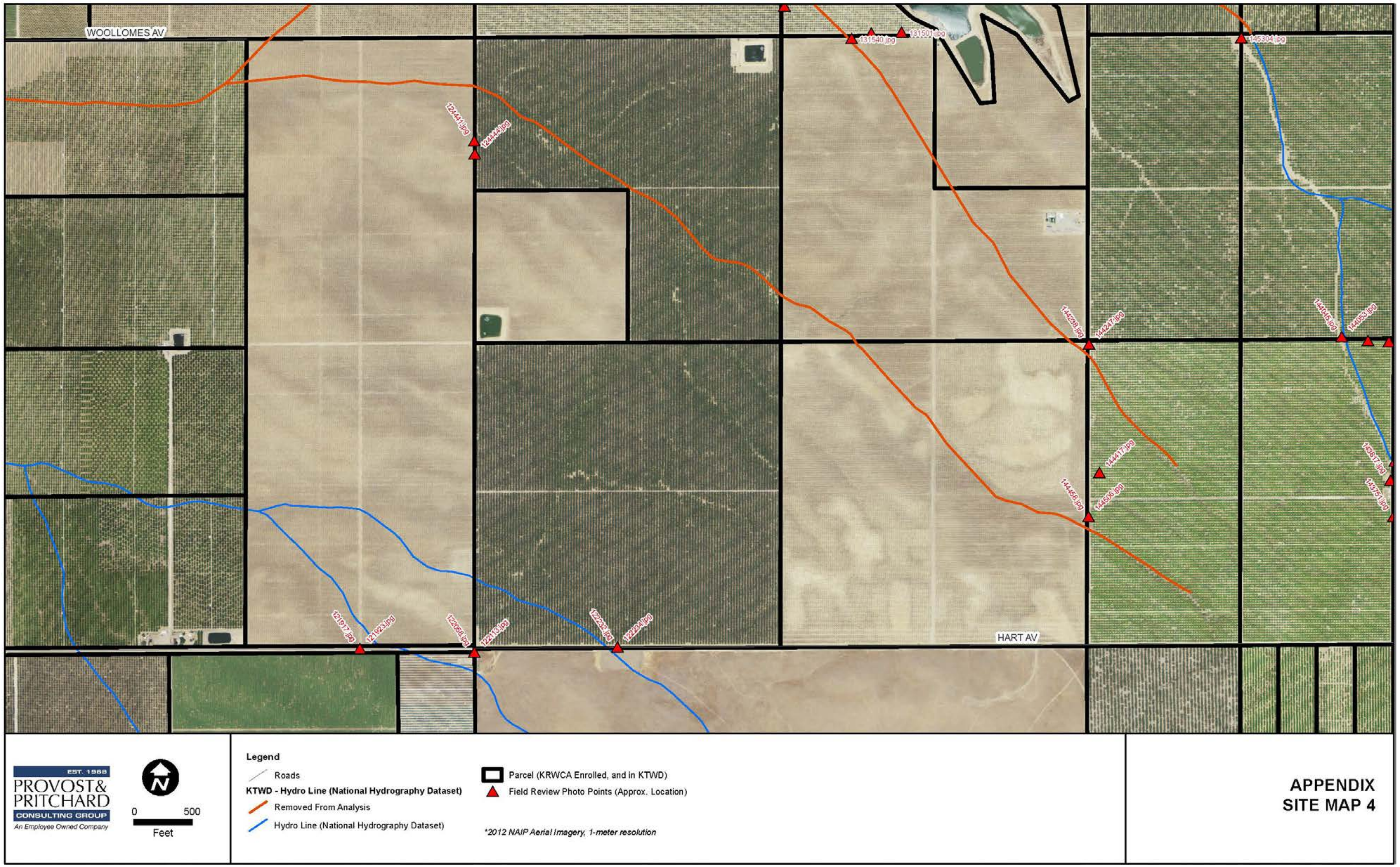
APPENDIX
SITE MAP 3

Site Map – 3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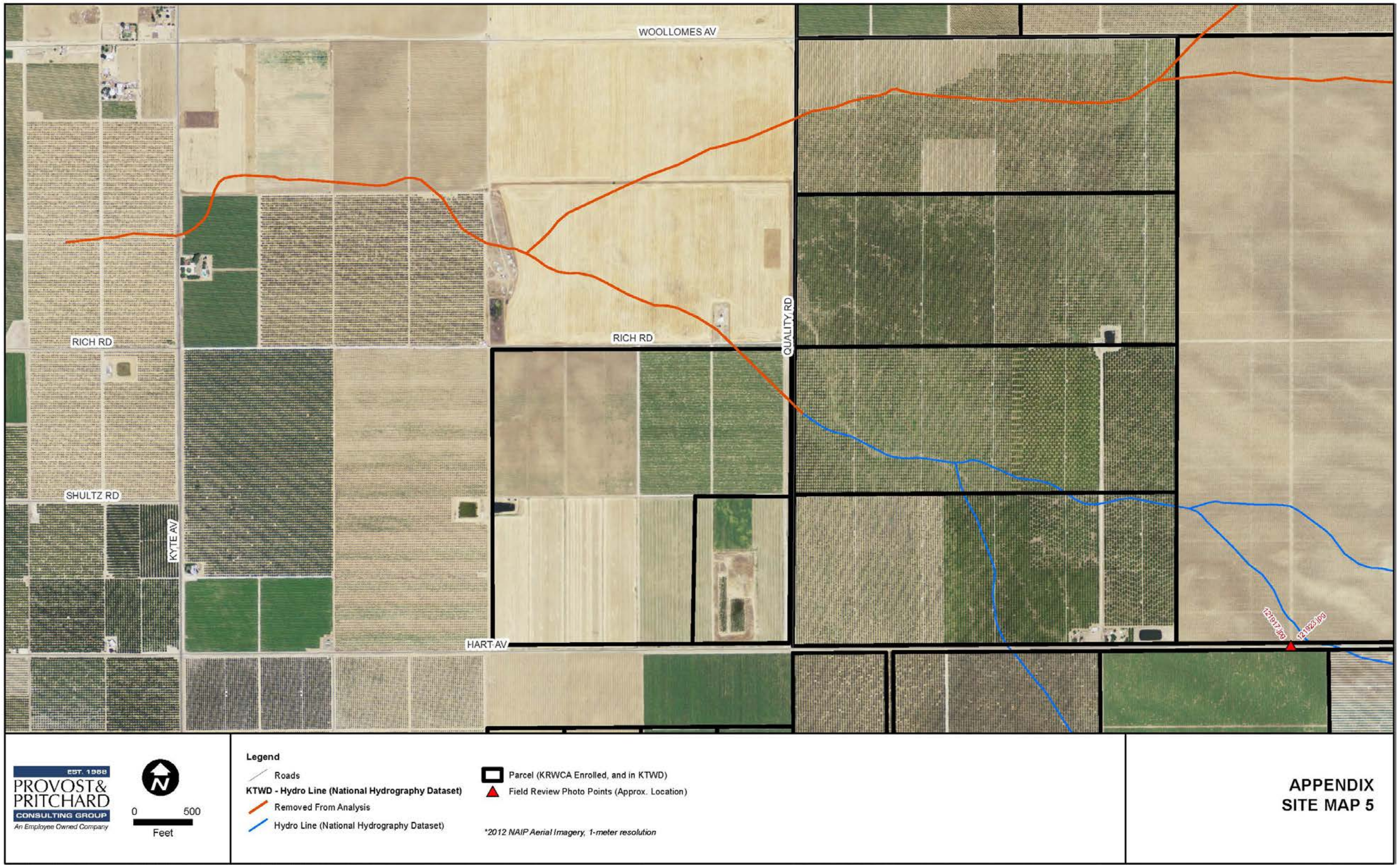
Roads
KTWD - Hydro Line (National Hydrography Dataset)
Removed From Analysis
Hydro Line (National Hydrography Dataset)
Parcel (KRWCA Enrolled, and in KTWD)
Field Review Photo Points (Approx. Location)
*2012 NAIP Aerial Imagery, 1-meter resolution
APPENDIX
SITE MAP 4

Site Map – 4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RICH RD
QUALITY RD
SHULTZ RD
KYTE AV
HART AV
121917.jpg
121923.jpg
EST. 1968
PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company
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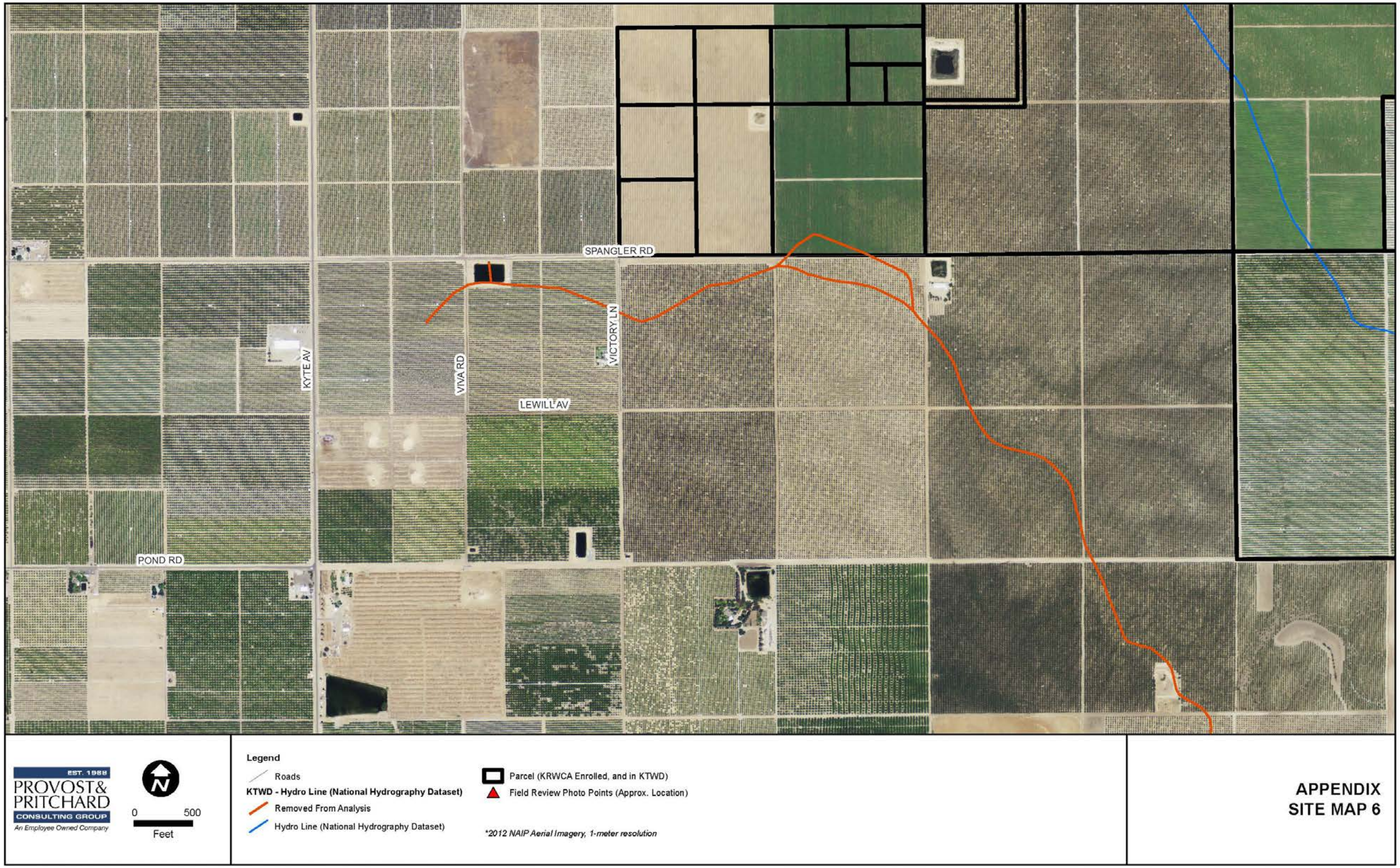
Roads
KTWD - Hydro Line (National Hydrography Dataset)
Removed From Analysis
Hydro Line (National Hydrography Dataset)
Parcel (KRWCA Enrolled, and in KTWD)
Field Review Photo Points (Approx. Location)
*2012 NAIP Aerial Imagery, 1-meter resolution
APPENDIX
SITE MAP 5

Site Map – 5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KYTE AV
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POND RD
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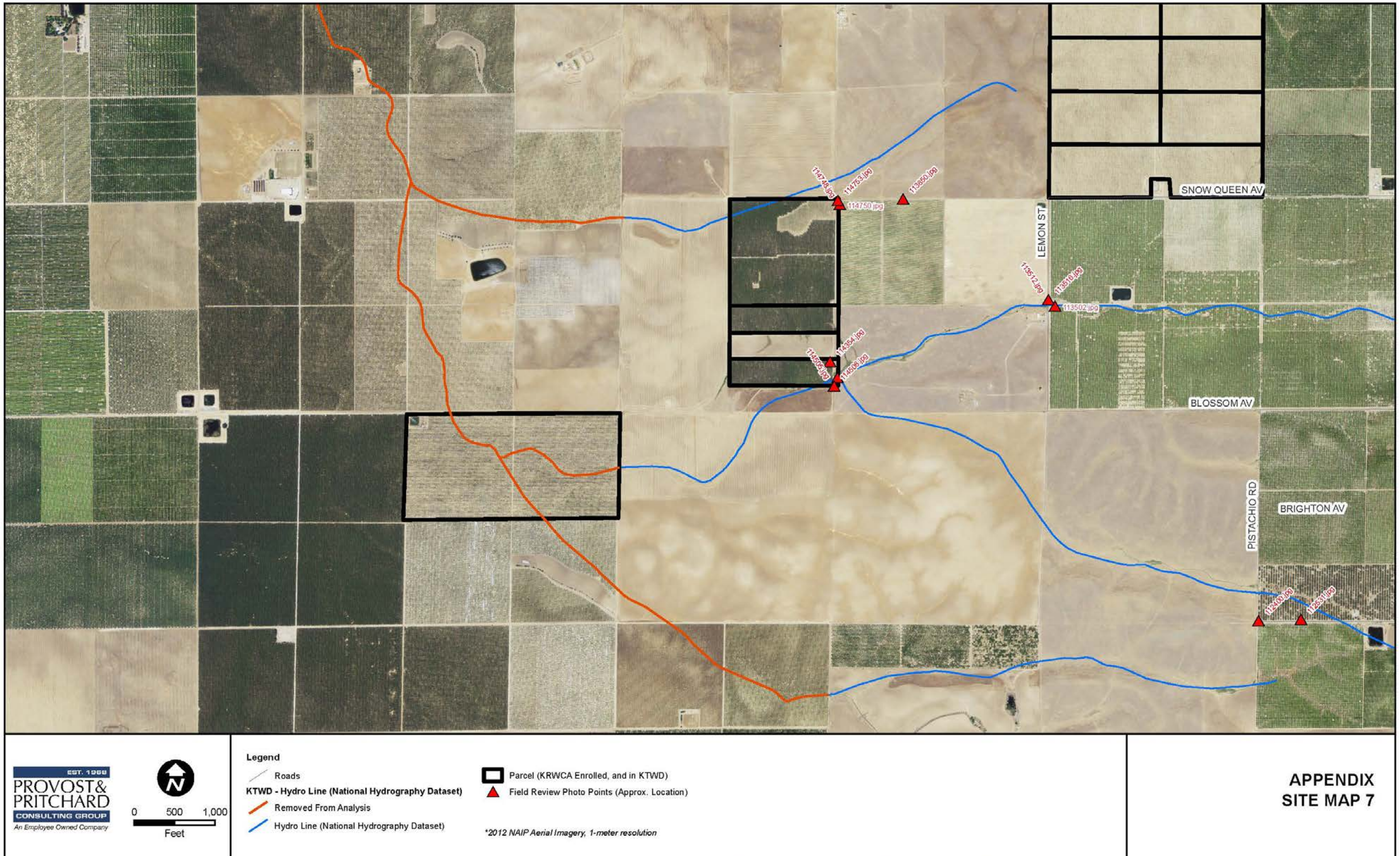
KTWD - Hydro Line (National Hydrography Dataset)
Removed From Analysis
Hydro Line (National Hydrography Dataset)
Parcel (KRWCA Enrolled, and in KTWD)
Field Review Photo Points (Approx. Location)
*2012 NAIP Aerial Imagery, 1-meter resolution
APPENDIX
SITE MAP 6

Site Map – 6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LEMON ST
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114750.jpg
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EST. 1968
PROVOST&
PRITCHARD
CONSULTING GROUP
An Employee Owned Company
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Feet
Legend
Roads
KTWD - Hydro Line (National Hydrography Dataset)
Removed From Analysis
Hydro Line (National Hydrography Dataset)
Parcel (KRWCA Enrolled, and in KTWD)
Field Review Photo Points (Approx. Location)
*2012 NAIP Aerial Imagery, 1-meter resolution
APPENDIX
SITE MAP 7

Site Map – 7

Site Photo 105145

Site Photo 105150

Site Photo 105215

Site Photo 105325

Site Photo 105429

Site Photo 112400

Site Photo 112531

Site Photo 113502

Site Photo 113512

Site Photo 113516

Site Photo 113850

Site Photo 114354

Site Photo 114505

Site Photo 114508

Site Photo 114748

Site Photo 114753

Site Photo 121917

Site Photo 121923

Site Photo 122058

Site Photo 122113

Site Photo 122232

Site Photo 122234

Site Photo 124441

Site Photo 124444

Site Photo 131501

Site Photo 131529

Site Photo 131540

Site Photo 131814

Site Photo 131819

Site Photo 131945

Site Photo 132247

Site Photo 132510

Site Photo 132546

Site Photo 132902

Site Photo 132942

Site Photo 133231

Site Photo 133708

Site Photo 133720

Site Photo 134658

Site Photo 134754

Site Photo 134845

Site Photo 135436

Site Photo 140057

Site Photo 140201

Site Photo 140348

Site Photo 140423

Site Photo 140801

Site Photo 140806

Site Photo 141059

Site Photo 141104

Site Photo 141355

Site Photo 141658

Site Photo 141845

Site Photo 141856

Site Photo 141900

Site Photo 143751

Site Photo 143817

Site Photo 144045

Site Photo 144053

Site Photo 144238

Site Photo 144247

Site Photo 144417

Site Photo 144458

Site Photo 144506

Site Photo 145304

Kern River Watershed Coalition Authority

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