Appendix E

Comment Letters and Reclamation's Response to Comments
Set 3 of 5 (pages 65-79)

EST. 1968
PROVOST & PRITCHARD
CONSULTING GROUP
An Employee Owned Company

WATER & WASTEWATER
MUNICIPAL INFRASTRUCTURE
LAND DEVELOPMENT
AGRICULTURE SERVICES
DAIRY SERVICES
LAND SURVEYING & GIS
PLANNING & ENVIRONMENTAL
DISTRICT MANAGEMENT

FRESNO • CLOVIS • VISALIA • BAKERSFIELD • OAKDALE

130 N. Garden St.
Visalia, CA 93291
(559) 636-1166 • FAX (559) 636-1177
www.ppeng.com

MEMORANDUM

To: Mr. Steve Sloan

From: Richard M. Moss, P.E.

Subject: Hydrogeologic Conditions Associated with the 4S and Smith Ranches Merced County, California and Proposed Course of Future Study

Date: July 11, 2012 revised August 1, 2012

Introduction

You have asked that Provost &Pritchard Consulting Group review and describe the hydrogeologic conditions associated with the groundwater underneath the 4S and Smith Ranches (Ranches). This information will be used to support environmental review documents in support of a pilot program of groundwater pumping and delivery to the neighboring federal wildlife refuges under a contract with the U.S. Department of Interior (DOI).

Our review mainly consists of summarizing the work of others in the description of the hydrogeologic conditions. The 4S Ranch was the subject of a specific study by Nigel Quinn under contract with the U.S. Bureau of Reclamation in 2006. You have had other engineering and hydrogeologists review the groundwater conditions underneath this property as well. This and other materials were reviewed and may be referred to in this document. References to all of the materials reviewed are to be found in the reference section at the end of this memorandum.

In addition, you have asked that we outline a program of monitoring and well testing that would attempt to answer unknown characteristics and conditions of the aquifers beneath the Ranches so that you and the DOI could enter into longer term arrangements of the sale or exchange of groundwater from the Ranches.

Description of Ranches, Region and Hydrology

Location

The 4-S Ranch (5,401 acres) and Smith (1,348 acres) properties are located within western Merced County approximately 6 miles due east of the intersection of Highway 165 and Highway 140 (see Figure 1).

The 4-S property is bounded by the Eastside Canal on its northern and eastern boundaries. The Mariposa Bypass forms much of the southern boundary of the property. Bear Creek and the Eastside Bypass run through the property.

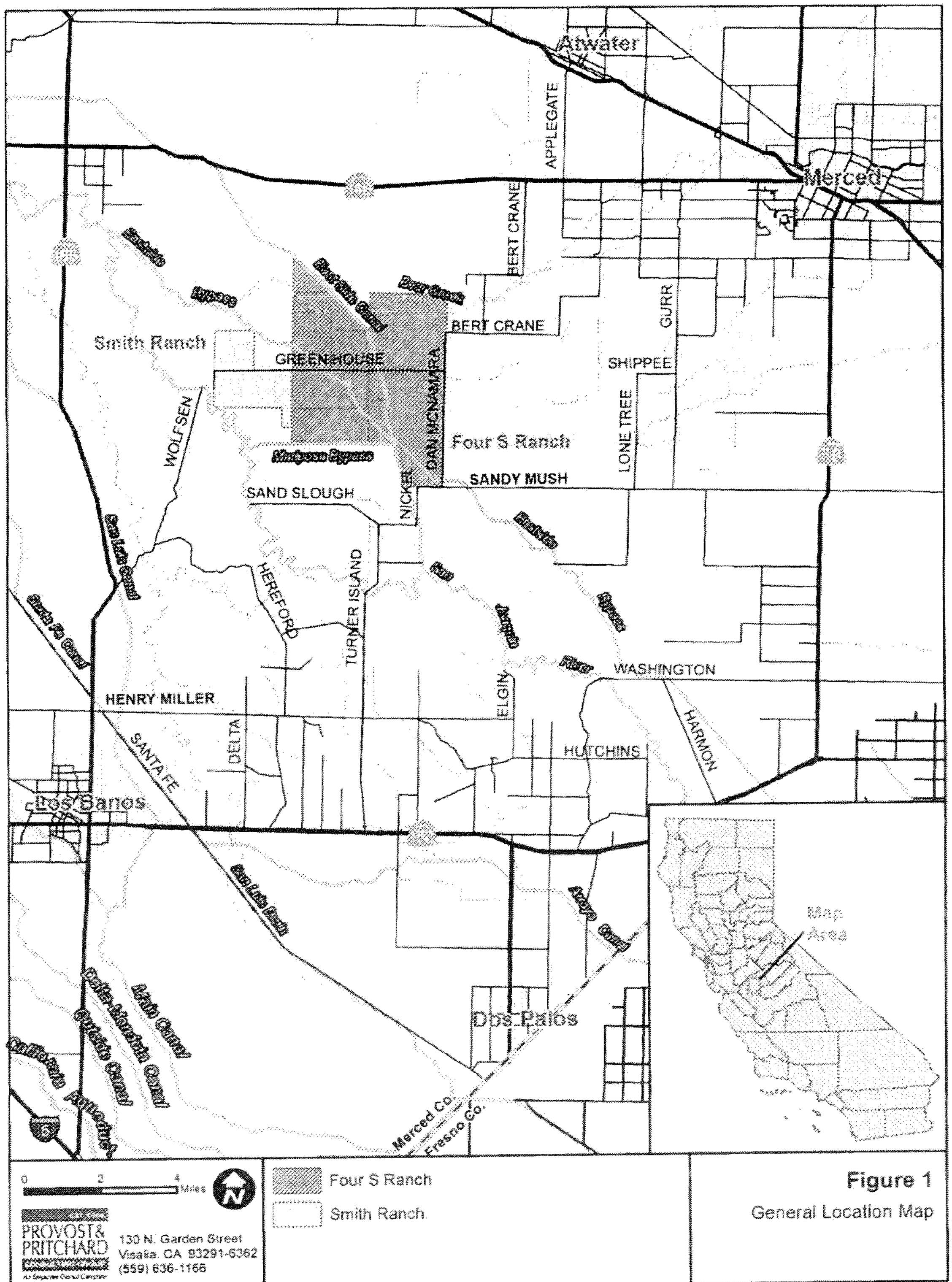


Figure 1
General Location Map

The Smith Ranch has the San Joaquin River as part of its southern and western boundary and the Eastside Bypass pass along the eastern and northern edges of the property.

The noted surface water conveyances typically carry high quality water from sources in the Sierra Nevada Mountain range. The Eastside Canal provides water deliveries from the Merced River and Bear Creek. The Eastside and Mariposa Bypasses typically carry high flow and flood water from the upper main-stem of the San Joaquin River, Fresno River and the Chowchilla River. The San Joaquin River at this point in its passage has a number of different potential tributaries including the upper main-stem of the San Joaquin River, the Fresno and Chowchilla rivers, water imported via the Delta Mendota Canal, runoff from local streams and local drainage waters.

The properties are currently in pasture land, most of which is irrigated pasture used for cattle ranching using approximately 20,000 acre-feet of water per year pumped from the Ranches' well field (Sloan pers. com.). Surface soils within the Ranches boundaries are predominantly classified as Merced silt-loam (USDA, 2012). Surrounding land uses include native uplands and wetlands and irrigated row crop, grain and hay fields.

Basin Description

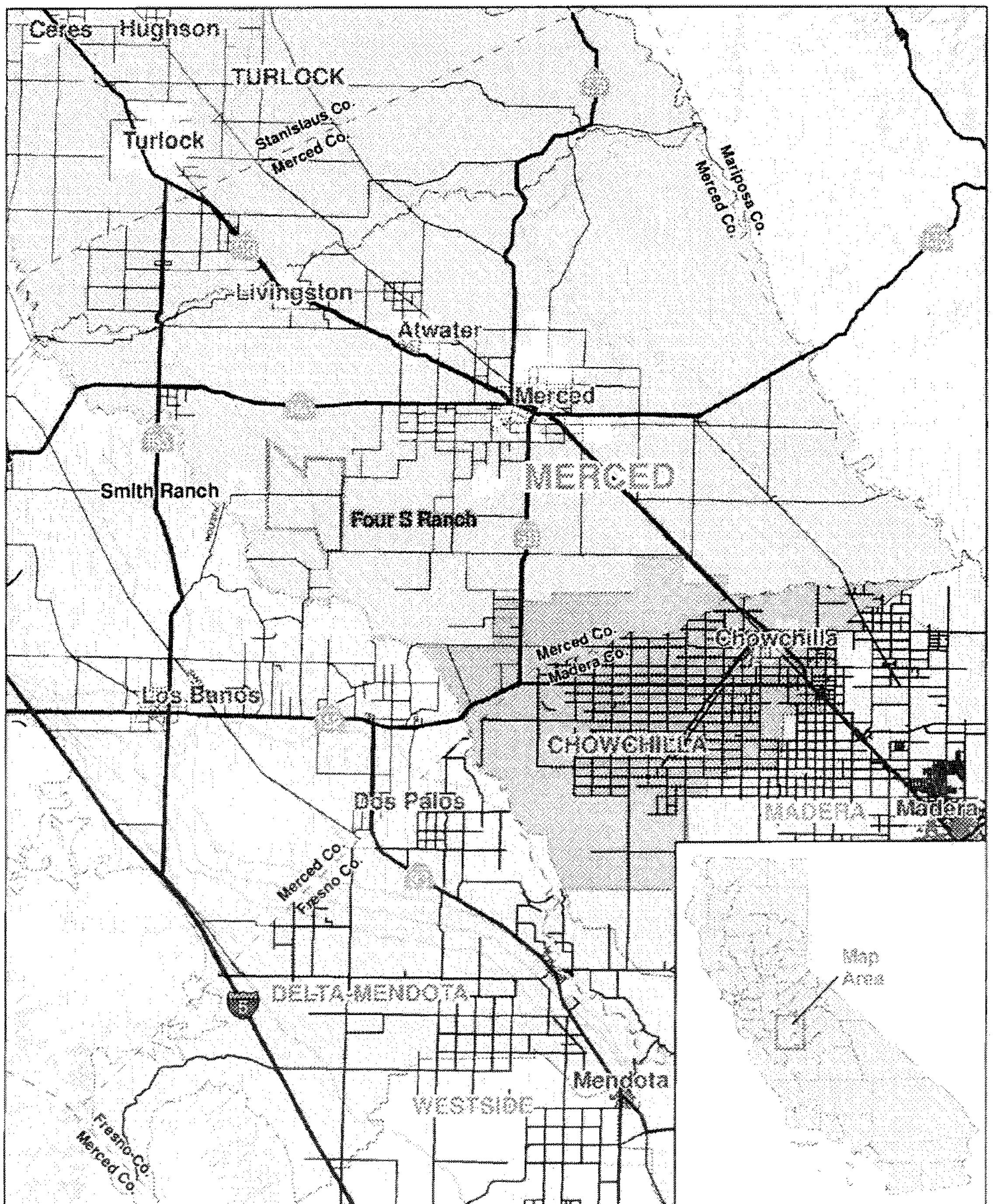
The Ranches lie within the Merced Groundwater Subbasin within western Merced County, due west of the City of Merced and just east of the San Joaquin River. Figure 2 shows the geographic extent of the Merced Groundwater Subbasin. The Merced Groundwater Subbasin is bounded by the Merced River on the north, the San Joaquin River to the west, the Chowchilla River on the south and the crystalline basement rock of the Sierra Nevada foothills on the east (DWR, 2004).

There are three aquifer types in the area. The geology supporting these aquifers is described in more detail below. The shallowest aquifer is an unconfined aquifer (and in places in the southern and western parts of the Basin, a semi-confined aquifer) that occurs in the unconsolidated deposits above the Corcoran Clay. This clay unit underlies the western half of the subbasin at depths between 50 and 200 feet. Below the Corcoran Clay is the confined aquifer that consists of unconsolidated materials (mostly sand and clay) and extends to the bottom of the fresh water column. Below the semi-confined aquifer is the deepest water body that consists of consolidated rocks. Groundwater flow is primarily to the southwest, following the regional dip of basement rock and sedimentary units (DWR, 2004).

Wells in the groundwater basin have been reported as having capacities ranging from 100 to 4,450 gallons per minute. The total storage capacity of this subbasin was estimated to be 21,100,000 acre-feet to a depth of 300 feet and 47,600,000 acre-feet to the base of fresh groundwater in 1995 (DWR, 2004).

Regional Geology

The San Joaquin River Basin is a large structural trough filled with approximately 16,000 feet of eroded sediments from the granitic Sierra Nevada and the marine shales and siltstones of the Coast Range. These sediments derived from alluvial fans, rivers and shallow lakes that formed complex layered beds of various geologic materials that were later folded by land forming stresses in the earth's mantle. Generalized regional



0 4 8 Miles

PROVOST & PRITCHARD
130 N. Garden Street
Visalia, CA 93291-6362
(559) 636-1166

Groundwater Sub-Basins

- MERCED
- MADERA
- TURLOCK
- DELTA MENDOTA
- WESTSIDE
- CHOWCHILLA

Figure 2
Merced Groundwater Sub-Basin

geology has been derived from various reports in the past by Bookman-Edmonston (2003), Ken Schmidt and Associates (Schmidt, 2005) and earlier US Geological Survey investigations (USGS, 1971,1973). According to these reports it is generally understood that the upper 1,500 feet of sediments is comprised of both young and old alluvium, continental deposits and the Mehrten Formation. The Younger Alluvium consists of narrow bands of fines, sand and gravel with little or no hardpan and typically is found along river courses. This alluvial material ranges in thickness from 0 to100 feet. This structural unit comprises interbedded sand, silt, clay and gravel with some hardpan at shallower depths, and ranges in thickness from 400 to 700 feet below the land surface. The bottom of the Older Alluvium is typically between 400 feet and 600 feet below sea level and is apparent in drillers logs as a transition from coarse grained to fine grained sediments (Quinn, 2006).

Embedded within the Older Alluvium are a number of continuous lacustrine deposits of gray and blue silts, silty clays and clays that display low permeability and act as impermeable barriers to vertical groundwater movement. The most significant of these deposits is the Corcoran "E" Clay which is regionally extensive in the Valley trough between Tracy and Kern County. In western Merced County the Corcoran Clay extends to Merced and Atwater and hence underlies the extent of the Ranches. The Continental Deposits are to be found beneath the Older Alluvium – the base of the Deposits extend to between 400 feet and 800 feet below sea level. Beneath the Continental Deposits lies the Mehrten Formation which is comprised of deposits of sandstone, tuff, siltstone, breccia, claystone and conglomerate often referred to by local drillers as "black sand and gravel". Although the depth of this formation is generally unknown in the vicinity of the Ranches (because no wells have been sunk this deep, largely on account of abundant shallow water resources) it is an important aquifer in the San Joaquin Valley and has permitted well production between 1,500 and 3,500 gallons per minute (Quinn, 2006).

Local Hydrology and Nearby Water Conveyance

As partially described earlier, the location of the Ranches is in the Valley trough at a point where there is regularly water flow in nearby water courses both in the course of providing regular irrigation water deliveries and soon to be fishery flows and in the form of high flows, which at times are controlled and at times uncontrolled flood flows. The known hydrology of the more significant water course on or near the Ranches is discussed below.

Eastside Canal - The Eastside Canal generally serves as the eastern boundary of the combined Ranches. The Eastside Canal is owned by the Eastside Canal & Irrigation Company (Company). The Company's surface water supply includes pre-1914 appropriative and state-issued rights to the Merced and San Joaquin rivers and streams intersecting the Eastside Canal such as Bear Creek, Owens Creek, and Duck Creek. The Company is located in Merced County at the confluence of the Merced and San Joaquin rivers and delivers over 33,000 AF of surface water to approximately 13,000 acres of farmlands on an annual basis. The majority of the water delivered by the Company is supplied through the Merced Irrigation District (MID). The water is released by MID at the western boundary of MID into various streams among which are Bear and Owens creeks. In addition the Company receives natural flow and foreign water in named streams which originate in the Sierra Nevada foothills (Bear Creek, Owens Creek, Duck Slough, and Deadman Creek) pursuant to appropriative licenses. Deep percolation of applied water within the Company's service area from these sources is

Kelly FOIA 000101

greater than average annual extractions from the underlying groundwater basin. As a result, in wet years, a high water table is observed in the southern portion of the Company service area (USBR, 2011). The Eastside Canal is believed to have been built around 1890.

The Eastside Canal & Irrigation Company has entered into at least two agreements for the sale of water over the past several years. Both of these agreements call for the movement of water over a period of time (5 and 10 years) in the Eastside Canal to points of delivery south of the Company service area. This has lead to water being regularly in the Eastside Canal, now in fulfillment of the transfer obligations as well as for delivery of irrigation water to the Company service area (USBR 2009, 2011).

Bear Creek – Bear Creek has some flood control features to limit the potential for damages as it makes its way through the City of Merced, but is largely uncontrolled. Flood flows that are not diverted make their water to the San Joaquin River at a point just north of the Ranches. There are water rights associated with Bear Creek with diversions at various points including the Eastside Canal, but much of the flow in the lower reaches of Bear Creek are as a result of releases of Merced River water into Bear Creek as operational spills or for subsequent diversion by downstream water users.

Lower San Joaquin River Flood Control Project - The Flood Control Project was authorized by Congress and the California legislature in 1946 and constructed from 1959 to 1966. The Flood Control Project consists of a network of bypasses, levees, and structures that provide flood protection from Gravelly Ford to the Merced River confluence. Flood Control Project facilities near to the Ranches include:

- San Joaquin River Channel;
- Eastside Bypass - The Eastside Bypass extends from the confluence of the Fresno River and the Chowchilla Bypass to its confluence with the San Joaquin River. The Eastside Bypass carries flood flows from the San Joaquin River (at the Chowchilla Bifurcation Structure) and the eastside tributaries to the main stem San Joaquin River upstream of the Merced River confluence;
- Mariposa Bypass - The Mariposa Bypass conveys flows from the Eastside Bypass to the San Joaquin River. The operating rule for the Mariposa Bypass is to divert all flows through the Mariposa Bypass to the San Joaquin River when flows in the Eastside Bypass are less than 8,500 cfs. Any flows above 8,500 cfs remain in the Eastside Bypass and are eventually discharged into the San Joaquin River;
- Project levees that extend along the Eastside Bypass, Mariposa Bypass, and the San Joaquin River;
- Flood water control structures (weirs and control structures to control water into/out of various project features) (USBR SJRRP, 2011).

The Lower San Joaquin River Levee District was created in 1955 by a special act of the Legislature to operate, maintain and repair levees, bypasses and other facilities built for the Flood Control Project. DWR designed the Flood Control Project levees on the San Joaquin River channels and the bypass channels to provide protection from the 50-year flood event, according to the definition of the event at the time of design in the 1950s (USBR SJRRP, 2011).

San Joaquin River – What is known as Reach 4B of the San Joaquin River stretches from the Sand Slough Control Structure and ending where the Eastside Bypass rejoins the San Joaquin River. Up until relatively recent times, this reach of the San Joaquin River channel did not receive river flows; water in this reach was from high groundwater levels, agricultural tailwater, and seepage from canals, and is often pumped and reused for irrigation. Alternatives for restoration of this reach of the San Joaquin River are currently being reviewed with the intention of increasing its capacity from the current estimate of 1,500 cfs up to 4,500 cfs to support an anadromous fishery (salmon) (USBR SJRRP, 2011).

Flows from 1950 to 2007 in this reach of the San Joaquin River and the Eastside and Mariposa bypasses are summarized below (USBR SJRRP, 2011).

Table 1. Local Channel Flows from 1950 to 2007

Location	Gage Location	Average Streamflow (cfs)	Maximum Daily Average Streamflow (cfs)	Period of Record
San Joaquin River Reach 4B	Sand Slough	705	3700	1939-1949[1]
Mariposa Bypass	Mariposa Bypass near Crane Ranch	456	9960	1980-1994
Eastside Bypass	Below Mariposa Bypass	257	11400	1980-2007

Source: USGS 2009

[1] Period of Record predates completion of Friant Dam

Restoration flow releases from Friant Dam are beginning and are expected to increase over time. These will be regular flows to support the migration of anadromous fisheries (salmon). As noted earlier, restoration alternatives for this reach of the San Joaquin are currently under consideration. Even if restoration of this reach were not to occur, fishery flows are still forecast to run through the Eastside and Mariposa bypasses as a minimum ("no action") alternative. Minimum fishery flows in this reach are expected to be 475 cfs and maximum flows of 4,500 cfs (USBR SJRRP, 2011).

4S and Smith Ranch Aquifer and Well Field Characteristics

The existing well field within the 4-S Ranch was most likely developed in the 1960's or early 1970's - these wells have capacities ranging from 866 to 2,071 gallons per minute (see Table 2). There are 14 wells on the 4-S Ranch, most of which are located along either the Eastside Canal or Bear Creek. The existing well field within the Smith Ranch consists of three wells. These wells have combined capacities of approximately 3,458 gallons per minute (see Table 2).

Kelly FOIA 000103

Figure 3
Well Field Map

Table 2. 4S and Smith Ranches - Most Recent Pump Test Results Summary								
			Pump Test Reports June/July 2010 October 2004 March & August 2009					
Pump No.	Approx Location (Datum NAD83) Lat	Long	Total Pump Lift (ft)	Measured flow rate (gpm)	Standing water level (ft)	Water table drawdown (ft)	Specific capacity of well (gpm/ft of drawdown)
4S Ranch							
1	37.26539	-120.73363	69	1560	43.5	18	89.1
2	37.26196	-120.73582	90	1403	66	16	87.7
3	37.25475	-120.72102	Not Available				
4	37.25374	-120.71872	62	1436	35	24	61.1
5	37.25115	-120.71534	68	1840	14	49	38
6	37.24894	-120.71263	66	2071	13	43	48
7	37.24683	-120.70997	74	1749	21	47	37
8	37.24528	-120.70925	106	1584	12	85	19
9	37.23690	-120.70657	87	1180	43	41	28.8
10	37.22955	-120.70193	69	1667	48.5	17	98.1
11	37.22878	-120.71708	147	866	84	60	14.4
12	37.24428	-120.72459	67	1386	35.5	27	51.3
13	37.25460	-120.73807	98	1055	66	28	37.7
New	37.25804	-120.73907	65	1605	39	23	69.8
Smith Ranch							
1			68	1461	25	37	39.5
2			80	2092	21	52	40
4S-Smith			84	1997	39	40	49.9

Average Lift (ft)	81.3
Total Capacity (GPM)	24,952
Average Capacity (GPM)	1,560
Total Capacity (CFS)	55.4
Average Capacity (CFS)	3.5
Total Annual Production (AF)	40,144
Avg Ann Well Production (AF)	2,509
Average Standing Water (ft)	37.8
Average Drawdown (ft)	37.9
Average Specific Capacity (GPM/ft)	48.0

The Ranches' wells are finished in the upper portion of the unconfined and semi-confined aquifer above the Corcoran Clay. The alluvium deposits vary in thickness and are estimated to be about 200 feet thick to the top of the Corcoran Clay in the area of the well field. Reports from a geophysical survey conducted by StrataTEK in 2009 along Bear Creek states that there are course sediments between 10 and 250 feet below ground surface. It also showed that the course material is generally discontinuous and intrusion of the lower clay is common until around 180 feet where the formation becomes more consistent.

Recharge to this portion of this aquifer comes from rainfall on overlying lands, seepage from neighboring water courses, deep percolation from overlying irrigated lands, the application of water to nearby wetland areas and irrigated lands and resulting seepage losses from these lands (part of subsurface inflow) and subsurface inflow from up-gradient areas towards the trough of the Valley. Well recovery has shown to be quite rapid for several of the wells tested. Other studies (Quinn, 2006) have attributed most of the recharge as occurring from the local water courses. While this is certainly an expected source of significant recharge, the volume of recharge as sub-surface inflow from adjacent areas coming into the well field beyond the boundaries of the Ranches must also be significant given the rapid recovery of the wells. Additional pumping of the well field will incur additional movement of groundwater into aquifer underlying the Ranches. The relative proportion of the volume of water coming from each source of recharge will change with the volume of water pumped; the more water pumped, the greater the inducement to have more water cross the boundaries of the Ranches into the pumped aquifer. Recharge from rainfall and direct deep percolation losses on the land of the Ranches will remain unchanged. Recharge from natural streams and older channels are generally a function of streambed infiltration limitations and not conditions related to the transmissivity of the aquifer. Quinn describes this same issue noting that,

> "...some newer man-made channels which cut through sandy formations within the shallow groundwater aquifer and may experience high rates of seepage – older natural channels may seal over time as fine grained materials plug the interstices between sand grains and hence experience low rates of seepage. In the latter case the rate of seepage is dictated by the permeability of the streambed rather than the permeability of the shallow aquifer" (Quinn, 2006).

Subsurface inflows from neighboring areas are a function of aquifer conditions and characteristics. Subsurface inflows will vary with increased pumping and higher groundwater gradients toward the well field. Stream flow seepage on the other hand can be predicted to stay relatively constant as a function of streambed permeability given that neighboring channels are either natural waterways or were constructed many years ago.

The aquifers that the Ranches' well field pumps from are not believed to be in overdraft as water levels in the area have remained relative constant over many years (Sloan pers. com.). Increases in pumping could change that depending upon the volumes of water pumped and the changing hydrologic sources of recharge both as a result of increased pumping and as a result of changes in local stream flows. The fact that the neighboring San Joaquin River and/or the Eastside and Mariposa Bypasses will soon have regular flows in the form of fishery restoration flows will certainly increase the volume of water recharging the aquifers beneath the Ranches.

Kelly FOIA 000106

Pilot Project

The Department of Interior (DOI) including the Bureau of Reclamation and the U.S. Fish and Wildlife Service on behalf of the San Luis National Wildlife Refuge Complex (Refuge) and yourself are proposing a pilot program of at least one-year in length and likely two years in length to explore the creation of a partnership between the parties that will (i) increase the DOI's overall Refuge water supplies, (ii) determine the efficacy of utilizing local groundwater produced from the Ranches on the Refuges and (iii) determine the long-term production capacity of groundwater from the Ranches for use on the Refuge. The goal of the pilot project will be to provide DOI with an initial annual supply of 20,000 acre-feet per year for use on the Refuge. This amount will be in addition to the volume of water pumped by the Ranches to meet their irrigated pasture needs.

Water from the Ranches' well field will be piped to three points of discharge into Bear Creek. It will flow in Bear Creek to the East Bear Creek Pumping Plant where it will be picked up and discharged into the Refuge water distribution system (see Figure 4). The water to be used on the Refuge will be as determined by the DOI and will be provided on a schedule reasonably acceptable to the parties.

A program of testing and monitoring will be part of the pilot project with the anticipated scope of the investigation to be similar in nature and extent to that described in a following section.

Likely Effects to Groundwater of Pilot Project Pumping

There is no long term effect on groundwater likely given the sources of recharge, anticipated aquifer recovery, the program of monitoring and short-term nature of the pilot project. There is more to be learned about the effects of producing more water on an annual basis from the aquifers underlying the Ranches. There is a general belief among all of the scientists, geologist and engineers that have look at the Ranches' well field that additional water can be pumped and that more information is needed to be able to effectively estimate the safe long-term production of the well field, with the most valuable data to be derived from a longer-term program of pumping, testing and monitoring such as that being proposed by this pilot project.

Short-term effects may include increased depth to groundwater on the Ranches but these effects are likely to be lesser or not existent outside of Ranches given the distance between the Ranches and known neighboring wells. A well canvas of neighboring wells is proposed as part of the Pilot Project. The program of monitoring should be set up to be analyzing on an on-going basis such potential effects and the pilot project managed in a way to minimize any adverse effects outside of the Ranches (if any) should they occur. Short-term effects are not likely to include any increase in the amount of seepage from nearby water courses given that seepage is likely being controlled by streambed permeability and not subject to change as a result of increased depth to nearby groundwater. Flows of subsurface groundwater toward the San Joaquin River from areas up-gradient of the Ranches could be intercepted by increased pumping of the Ranches' well field. To the extent such flow adds to the flow in the San Joaquin River, there could be some resulting reduction from increased pumping at the Ranches. Any such reductions would likely be offset, in whole or in part, by increased subsurface flows from the westside of the San Joaquin River opposite the Ranches. The flows to the San Joaquin River are also likely to be augmented by the increase in

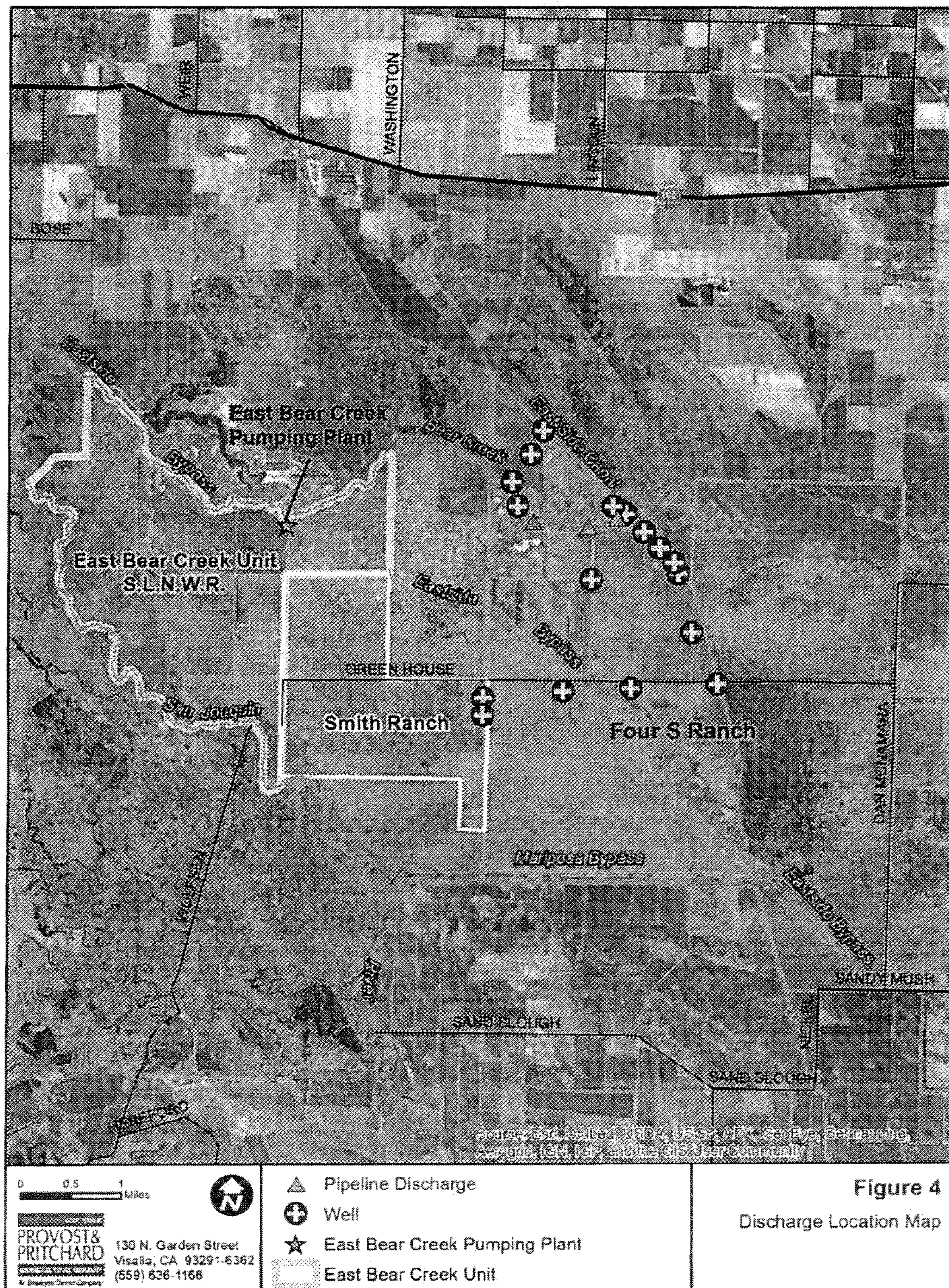


Figure 4

Discharge Location Map

G:\Clients\Sloan_Steve-3509\350912V1-Well Field Investigation\GIS\Map\2012-0618 Discharge Points10.mxd water available to the neighboring Refuge where the groundwater pumped from the Ranches is being applied. Again, a well designed program of monitoring as part of the pilot project can go a long ways toward a definitive understanding of these issues and insuring that any effects are addressed as part of a long-term program.

Suggested Course of Study and Monitoring

An outline for a suggested course of study and monitoring follows. Again, the intent of the monitoring program is consistent with the purpose of the pilot project, especially the last point which is to determine the long-term production capacity of groundwater from the Ranches for use on the Refuge. The monitoring program will also be used to track any effects on groundwater levels associated with increased pumping of the Ranches' aquifers to interests outside of the Ranches so that pumping can be appropriately managed within the context of the purpose of the pilot project.

Initial Study

I. Regional Hydrology, Hydro Geology and Groundwater Stratigraphy:

   a. There has been a significant amount of related work done in the area. Compile and catalog all known sources of information that may be of value in understanding the existing groundwater conditions and any impacts related to the potential of maximizing extractions from aquifers available for pumping at the Ranches;

   b. Local water resources and groundwater conditions/characteristics that potentially could affect the availability and the quality of water to be available from the Ranch should be described. This should include the development of a conceptual model of the well field and the aquifers that support it;

   c. Develop a more detailed description of the stratigraphy of the Ranches' aquifers;

   d. Investigate further the history of water levels in the region and the contour of groundwater surface elevations over time.

II. Well Field Yield

   a. Aquifer sustainability:

      i. Define/estimate aquifer boundaries and likely inflows and outflows (consistent with the conceptual model described above) using existing data;

      ii. Review existing and nearby well hydrographs and anticipated changes to the aquifers' hydrology to estimate future conditions under a maximized extraction regime on the Ranch including the anticipated restoration of flows in the San Joaquin River.

   b. Prepare an estimate of current and future water balances for the aquifers to be impacted by the maximized pumping regime and that the aquifers will not be in an overdraft condition if maximized pumping on the Ranches were to occur.

Kelly FOIA 000109

c. Map other existing users of water from the potentially affected aquifers and to the extent possible provide a history of their pumping and the use of the pumped groundwater.

III. Well Field Production Capacity

a. Obtain records of past and present well field production capacity;

b. Review all existing information from nearby wells and known data describing the aquifer characteristics (both shallow and deep) to estimate potential well field production capacity under maximized yield conditions.

c. Suggest potential density of wells to be located on the Ranch to maximize sustainable yield for a 90 day, 180 day and 360 day annual pumping period.

IV. Well Field Water Quality

a. Confirm existing understanding of water quality from the Ranches wells.

b. Estimate the likely water quality of future well field extractions under anticipated hydrology including the maximized pumping conditions for the Ranches' well field.

Pump Tests and Monitoring
This effort will be informed by the results of the Initial Study but is anticipated to begin early in order to take advantage of full course of the pilot project. You should anticipate that in-field testing is in order. The installation of some monitoring wells may also be needed.

I. Well Field Yield

a. Validate well field production and future water development potential. Perform well test(s) with monitoring wells (using existing wells unless insufficient to assure the required data) sufficient to determine/confirm aquifer characteristics such as specific yield, specific capacity and transmissivity of both the unconfined and semi-confined aquifers;

b. Further refine estimates of aquifer sustainability:

i. Monitor water levels in the well field and neighboring areas through the course of the pilot project.

ii. Refine conceptual model assumptions and results given information generated by the well tests, and long-term monitoring;

iii. Refine estimates of current and future water balance for the aquifer and the conditions under which the aquifers potentially become over-drafted.

II. Well Field Production Capacity – Refine estimates of maximum extraction capacity needed for the contemplated annual extraction periods and resulting necessary well densities from data obtain from the well tests.

III. Well Field Water Quality

a. Perform additional water quality testing in conjunction with the well tests (and the test well construction, if any) to secure the understanding of the well field's likely water quality under a condition of maximum extractions. Analytical tests will consist of those necessary to ensure usability within the wildlife refuges as may be required by the DOI;

b. Monitor quality over the course of pilot project pumping to ensure that quality doesn't change significantly with increased extractions.

Confined Aquifer Deep Wells

Currently all of your wells are completed within the unconfined and semi-confined aquifers that underlay the properties. There is a deep aquifer that is an important water source of water for much of the Valley and could potentially be developed for use. An additional course of study could include development of test wells that pull from this confined aquifer with associated testing and monitoring to also better define the long-term usability of this water source should it be developed.

References

(USDA, 2012) United States Department of Agriculture, Natural Resource Conservation Service, Soils Maps, http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

(DWR, 2004) California Department of Water Resources. 2004. Bulletin 118: San Joaquin Valley Groundwater Basin Merced Subbasin

(Quinn, 2006) Nigel W.T. Quinn, Berkeley National Laboratory, Hydrogeologic Assessment of the 4-S Land and Cattle Company Ranch, April 10, 2006

(USBR, 2011) Bureau of Reclamation, 2011. Draft Environmental Assessment, Water Acquisition from East Side Canal & Irrigation Company for East Bear Creek Unit of San Luis National Wildlife Refuge (2011-2016)

(USBR, 2009) Bureau of Reclamation, 2009. Draft Environmental Assessment, Merced Falls Ranch Refuge Water Supplement and Exchange Pilot Project, Western Merced County

(USBR SJRRP, 2011) San Joaquin River Restoration Program, Research 4B, Eastside Bypass and Mariposa Bypass, Channel and Structural Improvements Project, Initial Alternatives Technical Memorandum, October 2011

(StrataTEK, 2009). MT4 Geophysical Groundwater Aquifier-Imaging Survey for Sloan Enterprises Bear Creek Project. StrataTEK, Groundwater Imaging. April 2009.

Kelly FOIA 000111