Appendix E

Comment Letters and Reclamation's Response to Comments
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May 13, 2014

Via Electronic Mail: remerson@usbr.gov

Rain Emerson
United States Bureau of Reclamation
1243 N Street
Fresno, CA 93721

Re: Warren Act Contract for Conveyance and Storage of Groundwater from 4-S Ranch and SHS Ranch to Del Puerto Water District

Dear Ms. Emerson:

This firm acts as special counsel to the Stevinson Water District (District). The District has extensive pre-1914 and other appropriative water rights to water from Bear Creek and other local creeks. The District also has a historic Agreement with the Merced Irrigation District (MID) that provides the District the rights to *all* operational spill and other water released by MID into these local streams. *All* of the water conveyed in the East Side Canal belongs to the District. The East Side Canal is the District's primary water supply conveyance facility.

SWD-1

The District is very concerned about the Warren Act Contract for Conveyance and Storage of Groundwater from 4-S Ranch and SHS Ranch to Del Puerto Water District (Project) and it's likely impact on the District's water supplies, local agriculture, and the environment. In addition to supplying water for local agricultural use, the District delivers water which ultimately provides needed water supplies for local wetlands.

The Project proposes to extract tens of thousands of acre-feet of water from wells located adjacent to the East Side Canal. This Project appears to be a variation of a project recently abandoned by the United States Bureau of Reclamation (USBR) and the project proponent in late 2013. That project was called the 4-S/Smith Ranch Refuge Water Supply Pilot Exchange Project for the East Bear Creek Unit of the San Luis National Wildlife Refuge. When that project was proposed, the District expressed concern regarding the connectivity between the groundwater wells identified for use as part of the project and the East Side Canal. Indeed, the records of the USBR confirmed connectivity and recognized that the wells, located adjacent to the East Side Canal, would pump canal water. The District obtained numerous documents pursuant to a Freedom of Information

Act request, including well records, reports, and other studies documenting the link between the groundwater wells and local surface watercourses.

The District objects to this Project for the same reasons it objected to the prior project. The only difference between the two projects is the buyer of the water. The District has the following concerns with the Project:

SWD-1 cont.

- The Draft Environmental Assessment's (EA) discussion of Bear Creek and of the East Side Canal is inadequate and misleading. The rights of the District are well documented and extend to *all* the water in the East Side Canal and to *all* waters released by MID into the various watercourses discussed in the EA. (See *Stevinson Water Dist. v. Roduner* (1950) 36 Cal.2d 264 [discussing the District's water rights and judgment/agreement with Merced Irrigation District]; *Crane v. Stevinson* (1936) 5 Cal.2d 387 [discussing the District's extensive water rights and claim to waters in the watercourses discussed in the EA].)

SWD-2

- A Hydrologic Assessment of the 4-S Land and Cattle Company Ranch, dated April 10, 2006 was prepared for the USBR. That Assessment recognizes that the wells on the 4-S Ranch are recharged from Bear Creek and the East Side Canal. (Assessment at p. 3.) Indeed, the Assessment confirmed that "a majority of the wells [on the 4-S Ranch] are . . . greatly influenced by seepage from this conveyance facility." (Assessment at p. 15.) The Assessment went on to opine that the high quality of water in the groundwater wells was due to the high water quality in the canal. Tests conducted as part of the Assessment confirmed that seepage from the East Side Canal provides water to support the proposed Project. (Assessment at p. 19.) A copy of the Assessment is attached hereto.

SWD-3

- A Memorandum prepared by Provost & Prichard Consulting Group, dated 2012, prepared for the project proponent, confirms the location of the groundwater wells on the 4-S Ranch and confirms that they draw from local watercourses. (Memorandum at pp. 7-10.) In fact, that Memorandum goes so far as to conclude additional water will be available for pumping once San Joaquin River restoration flows appear in local watercourses. (Memorandum at p. 10.) A copy of the Provost & Prichard Memorandum is attached hereto.

SWD-4

- USBR staff expressed concern over the availability of water and seepage from the East Side Canal, especially during "consecutive dry years when less surface water is available in the [canal] to recharge the aquifer system." (Memorandum, From Stanley E. "Chip" Parrott to Linda Colella, dated January 18, 2013.) A copy of the USBR Memorandum is attached hereto.

SWD-5

- A U.S. Geological Survey Report, Streamflow Depletion By Wells (Circular 1376), suggests that a well located within 250 feet of a stream will contain approximately 80% depletion from the stream. A copy of the title page and Figure B-2 are attached hereto for your reference.

SWD-6

- The use of wells located along the East Side Canal and otherwise drawing water from the East Side Canal, Bear Creek, or other water courses, violates DWR's Water Transfer Guidelines.

SWD-7

The USBR is aware that this project will draw water from the East Side Canal and from Bear Creek, among other watercourses. The Project proponent does not have rights to water in any of these watercourses and cannot be permitted, through the use of Central Valley Project facilities, to trespass to the rights of the District by pumping the District's water and selling it to third parties. Moreover, and because this Project will draw water from these watercourses, the USBR must study and disclose the impacts of the Project from the unlawful appropriation of the District's water as it relates to the current uses of that water, including agricultural production in an around the District and environmental uses of that water.

The District is concerned and troubled that the USBR would continue to consider this Project with the knowledge that the groundwater wells at issue are adjacent to the East Side Canal and are pumping Canal water. The District will take any and all appropriate actions to vigorously defend its water rights and supply. If you have any questions or require additional information, please do not hesitate to contact me.

Sincerely,

Daniel Kelly

DK:yd

Enclosure(s)

cc: Robert D. Kelley, Jr. (*Via E-mail* wildcatkel@stevinsoncorp.com)
Del Puerto Water District (*Via E-Mail)* wharrison@delpuertowd.org)
Ernest Conant, Esq. (*Via E-Mail)* econant@youngwooldridge.com)

BUREAU OF RECLAMATION
Mid-Pacific Region Geology Branch
Sacramento, California

MEMORANDUM

Date: January 18, 2013

To: Linda Colella (MP-400)

From: Stanley E. "Chip" Parrott, P.G. (MP-230)

Subject: General Hydrogeologic Questions to be Addressed for the Proposed 4S Ranch Pilot Study, Merced County, California

The purpose of this memorandum is to provide a listing of the most important questions regarding hydrogeologic conditions at the 4S Ranch that Reclamation believes need to be addressed by the proposed Pilot Study. As stated in our review comments on the Memorandum titled, *Hydrogeologic Conditions Associated with the 4S and Smith Ranches Merced County, California and Proposed Course of Future Study*, revised August 1, 2012, Reclamation generally agrees with the "Suggested Course of Study and Monitoring," outlined in that document. We believe that the "Initial Study" and "Pump Tests and Monitoring," as outlined are an appropriate approach for addressing the objectives of this Pilot Study.

The questions below are not intended to be an all-inclusive list as other significant hydrogeologic issues may arise during the course of this study. Nevertheless, Reclamation believes addressing these basic issues is essential to the successful completion of this Pilot Study.

1) Estimate the volume of induced seepage derived from surface water conveyances on the 4S Ranch (e.g., the Eastside Canal) during both current and proposed additional pumping conditions. How can this volume be expected to change during consecutive dry years when less surface water is available in the conveyances to recharge the aquifer system?

2) What is the sustainability of the aquifer system for producing the desired additional yield without leading to overdraft conditions?

3) What is the potential impact of the proposed additional pumping on, a) neighboring well owners, b) hydraulically downgradient surface water features – primarily the San Joaquin River, and c) downstream surface water users?

4) What is the groundwater quality on the 4S Ranch under existing pumping conditions and how can this be expected to change with the proposed additional pumping?

5) Will the proposed additional pumping cause land subsidence in the vicinity of the 4S Ranch?

To proceed with this Pilot Study, Reclamation believes it would be appropriate for Merced Falls Ranch, LLC to submit a draft work plan further describing the "Suggested Course of Study and Monitoring" for Reclamation's review. After our review and concurrence on this draft work plan, we anticipate including a final work plan in the Environmental Assessment document.

Hydrogeologic Assessment of the 4-S Land and Cattle Company Ranch

Prepared for : US Bureau of Reclamation

Nigel W.T. Quinn
Berkeley National Laboratory
1 Cyclotron Road, Bld,. 70A-3317H
Berkeley, CA 94720

April 10, 2006

This work was supported by the U.S. Bureau of Reclamation under US Department of Interior Interagency Agreement No. 3-AA-20-10970 through U.S. Department of Energy Contract No. DE-AC03-76SF00098

ACKNOWLEDGEMENTS

This report was prepared for the US Bureau of Reclamation to assist the agency make planning decisions with respect to potential acquisition of additional lands to secure water supply to Grasslands Basin wetlands. The author gratefully acknowledges the financial support provided by Dan Meier, MP-410 who also set the project in motion by arranging initial contacts with the Ranch Foreman, Mr August Oertzen. Mr Oertzen's knowledge of the Ranch and willingness to participate in the project was material to the project's success and was much appreciated. Dr Grace Su and Paul Cook of Berkeley Bational Laboratory assisted with the field monitoring and both individuals contributed to the development of improved water quality logging technology, the write-up of which has been accepted for publication in the technical journal Groundwater. Dr Chin-Fu Tsang and Dr Chris Doughty, also of Berkeley National Laboratory provided early assistance as we were learning the theoretical basis of the well logging technique, which we subsequently adapted to our needs. Dr Kenneth Schmidt provided invaluable access to reports and data, as well as advice, based on his many years of groundwater quality consulting in the San Joaquin Valley. Will Shipp, now in Reclamation Headquarters in Washington DC, provided financial support for the technology development aspect of the project and has been a strong advocate of the use of advanced geophysical monitoring techniques within Reclamation.

I also would like to thank the following for their helpful review comments including Will Shipp, Dan Meier and Michael Heaton with the US Bureau of Reclamation; Dr Kenneth Schmidt of Kenneth D. Schmidt and Associates; and both Dr Terry Hazen and Dr Grace Su at Berkeley National Laboratory.

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1. EXECUTIVE SUMMARY

Hydrogeological assessment of the 4-S Land and Cattle Company (4-S Ranch) was conducted using a combination of field investigations and a survey of available literature from nearby agricultural water districts and other entities. The 4-S Ranch has been able to meet most of its own water needs providing irrigated pasture for beef cattle by an active program of shallow groundwater pumping in the semiconfined aquifer above the Corcoran Clay. Comparison of groundwater pumping on the 4-S Ranch property with groundwater pumping in the adjacent Merquin and Stevinson Water Districts shows great similarity in the well screened depths and the quality of the groundwater produced by the well fields. The pump yield for the eight active production wells on the 4-S property are comparable to the production and drainage wells in the adjacent water districts. Like these Districts the 4-S Ranch lies close to the Valley trough in a historic discharge area. The 4-S Ranch is unique in that it is bounded and bisected by several major water conveyance facilities including Bear Creek. Although the large number of potential recharge structures would suggest significant groundwater conjunctive use potential – the major well field development has occurred along the length of the Eastside Canal. The Eastside Canal is known to be leaky above the "A" Clay – the Canal passes through sandy areas and experiences significant groundwater seepage. This seepage can be intercepted by adjacent groundwater wells. Pumping adjacent to, and along the alignment of the Canal, may induce higher rates of seepage from the Eastside Canal. Groundwater quality below and adjacent to the Eastside Canal is very good, reflecting the origin of this diverted water from the Merced River. Most of the pumpage occurs in a depth interval between 30 ft and 130ft. Safe yield estimates made using the available data show that the 4-S Ranch has sufficient resources to meet its own needs. Further exploitation of the groundwater will be limited if the leakage from the Eastside Bypass, Mariposa Bypass and Bear Creek are insufficient to replace the pumped water on an average annual basis. Should any future lining of the Eastside Canal occur, it would have a significant impact on the groundwater resource potential of the 4-S Ranch and impair the overall quality of the available water supply.

2. HYDROGEOLOGICAL ASSESSMENT

2.1 Introduction

The goal of this hydrogeological report is to provide an assessment of the groundwater resource conditions below the 4-S Ranch in western Merced County. The US Department of Interior is considering the purchase of the property from the landowner for the purpose of meeting wildlife habitat needs. One of the potential assets of the property would be the groundwater supply that could be used for on-site management of the property as a wildlife refuge and/or the export of this groundwater to be used on managed wetlands in the vicinity of the 4-S Ranch.

2.2 Location

The 5,401 acre 4-S Ranch property is located within western Merced County approximately 6 miles due east of the intersection of Highway 165 and Highway 140 (Figure 1). The property is bounded by the Eastside Canal on its northern boundary, follows the boundary between section 2 and 3 of Township T8S-R11E due south for a little over 5 miles on its western boundary including a section of the Mariposa Bypass. Two miles of the levee that runs along the southern bank of the Mariposa Bypass forms the southern boundary of the property. The eastern boundary of the property follows the boundary of sections 13 and 18 in adjacent townships starting at the north-east corner of section 13 in township T8S-R11E but jogs to the east one mile south of this intersection along Green House Road for 1/3 mile to enclose a 2/3 mile long reach of Owens Creek downstream of the Green House Road bridge. The west bank of the Eastside Canal forms a 3/4 mile boundary for the property to the intersection of Owens Creek and the Eastside Canal, which is the most easterly point of the property. South of this point the property

ASSESSOR'S PARCEL MAP

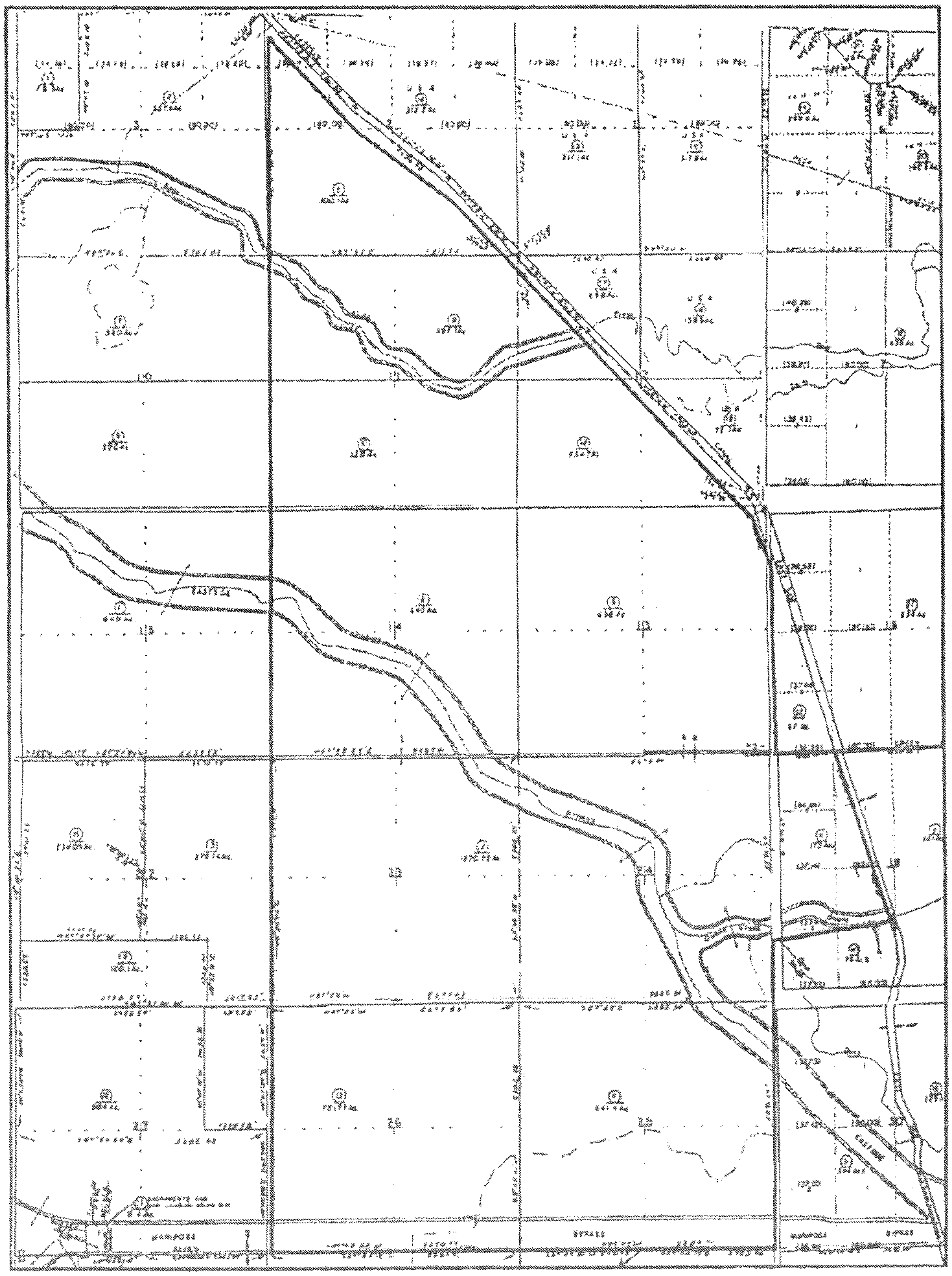

Figure 1. Map of the boundary of the 4-S Ranch in Merced County - Township R12E T8S.

boundary jogs back to the original property line bisecting sections 19 and 24, 25 and 30 in adjacent townships to the south bank of the Mariposa Bypass.

Bear Creek and the Eastside Bypass run through the property. Approximately 1.5 miles of Bear Creek run through the north western corner of the property and a little over 3 miles of the Eastside Bypass runs through the center and south-eastern quadrant of the property. It is apparent from the configuration of the property that the landowners have attempted to maximize the availability of stream-aquifer recharge from large water conveyance facilities along three of the four property boundaries. These surface water conveyances typically carry high quality water from sources in the Sierra Nevada Mountain range. The proximity to the Eastside Canal also provides the landowner with easy access for direct diversions from the Eastside Canal or Bear Creek should the need arise and if contractually permissible. It appears that the landowners have sought to maximize use of the groundwater resource potential of the property, given the recharge potential from the surface water conveyance facilities on three sides of the property.

2.3 Basin description

The 4-S Ranch lies within the Merced Groundwater Basin within western Merced County almost due west of the City of Merced and to the east of the San Joaquin River. Figure 2 shows the geographic extent of the Merced Groundwater Basin. The Merced Groundwater Basin is bounded by the Merced River on the north, the San Joaquin River to the west and the Chowchilla River on the south and contains over a great number of municipal, industrial, agricultural and domestic wells (Schmidt, 2005). Wells in the groundwater basin have been reported as having capacities ranging from 100 to 4,500 gallons per minute (DWR, 2003). 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 434 to 1,946 gallons per minute.

2.4 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 landforming stresses in the earth's mantle. A generalized regional San Joaquin Valley cross-section is provided in Figure 3, derived from an hydrogeological assessment report by Bookman-Edmonston (2003) for the Stevinson and Merquin Water Districts. This report shows that only the upper 400 – 800 ft of the sedimentary material contains groundwater suitable for agricultural, domestic and industrial use and for managed wetlands. The regional geology of the groundwater system beneath the 4-S Ranch is largely derived from this report and by a more recent report by Ken Schmidt and Associates (Schmidt, 2005). An earlier US Geological Survey report by Gary Balding and Ron Page (USGS, 1971) of aquifer and well water quality data within the Modesto and Merced area provides some of the background geology upon which these later reports are based.

The upper 1,500 ft of sediments is comprised of both young and old alluvium, continental deposits and the Mehrten Formation (USGS, 1973). The Younger Alluvium consists of narrow bands of fine sand, sand and gravel with little or no hardpan and typically is found along river courses. This alluvial material ranges in thickness from 0 – 100 feet (USGS, 1973). The Older Alluvium is the more pervasive exposed structural unit in the vicinity of the 4-S Ranch and below the Stevinson and Merquin Water Districts, located less than 5 miles to the north-west. This structural unit comprises interbedded sand, silt, clay and gravel with some hardpan at shallower depths, and ranges in thickness from 400 to 700 ft below the land surface (Bookman-Edmonston, 2003). The bottom of the Older Alluvium is typically between 400 ft and 600 ft below sea level and is apparent in drillers logs as a transition from coarse grained to fine grained sediments (USGS, 1971, 1973).

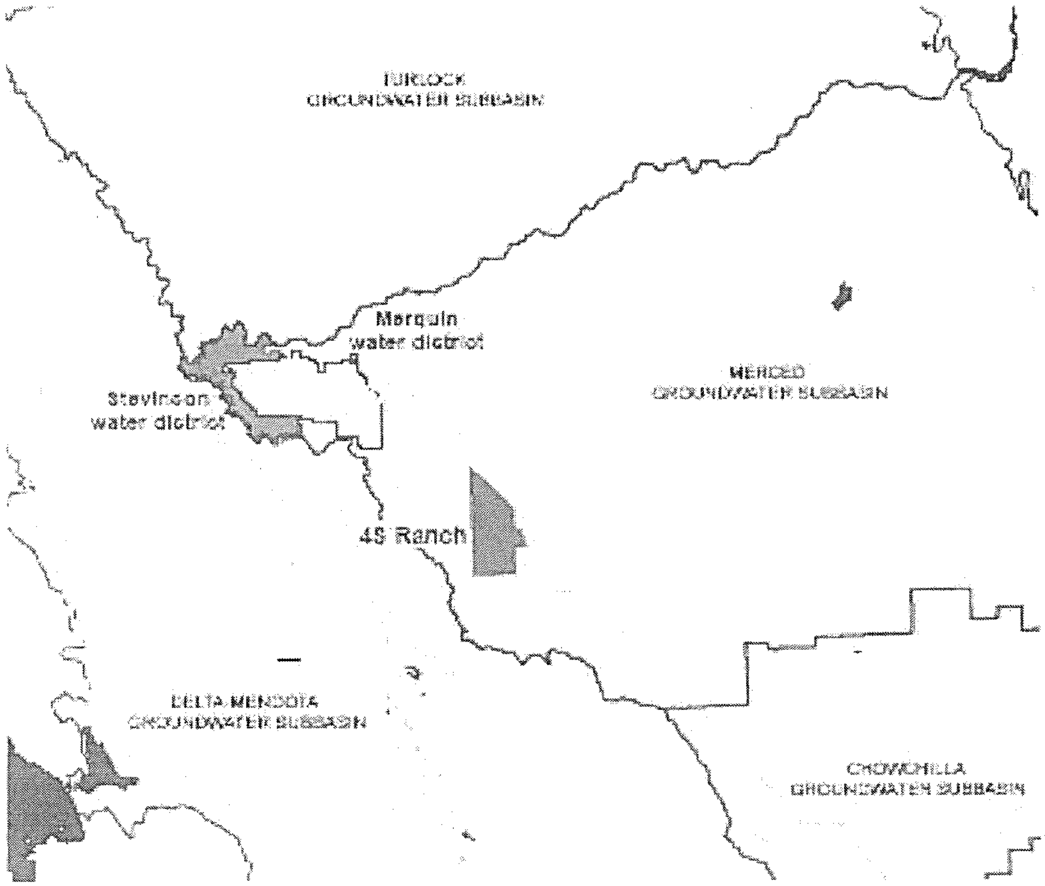

Figure 2. Merced Groundwater Basin showing location of Stevinson and Merquin Water Districts located north-west of the 4-S Ranch (Source : Bookman-Edmonston, 2003).

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 and which pinches out close to the alignment of Highway 99 in the eastern San Joaquin Valley, north of Chowchilla and in the vicinity of Highway I-5 in the western San Joaquin Valley. In western Merced County the Corcoran Clay extends to Merced and Atwater and hence underlies the extent of the 4-S ranch. The Corcoran Clay is at its thickest in the Valley trough reaching thicknesses of 80-100 ft (Bookman-Edmonston, 2003). It is approximately 60 ft thick in the vicinity of the 4-S Ranch.

The Continental Deposits are to be found beneath the Older Alluvium – the base of the Deposits extend to between 400 ft and 800 ft below sea level (Bookman-Edmonston, 2003). Water quality in the upper sections of the Continental Deposits is acceptable for many uses with an average electrical conductivity (EC) below 3,000 umhos/cm. The "base" of this fresh water – typically defined as the interface between water with an EC below 3000 uS/cm and poorer quality water – is not well defined and has been mapped by the USGS to be approximately 500 ft below mean 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 and "black sand and gravel" (Bookman-Edmonston, 2003;

USGS, 1973). Although the depth of this formation is generally unknown because no wells have been sunk this deep, largely on account of abundant shallow water resources, it is an important aquifer in both the Sacramento and San Joaquin Valleys and has permitted well production between 1,500 and 3,500 gpm (Bookman-Edmonston, 2003).

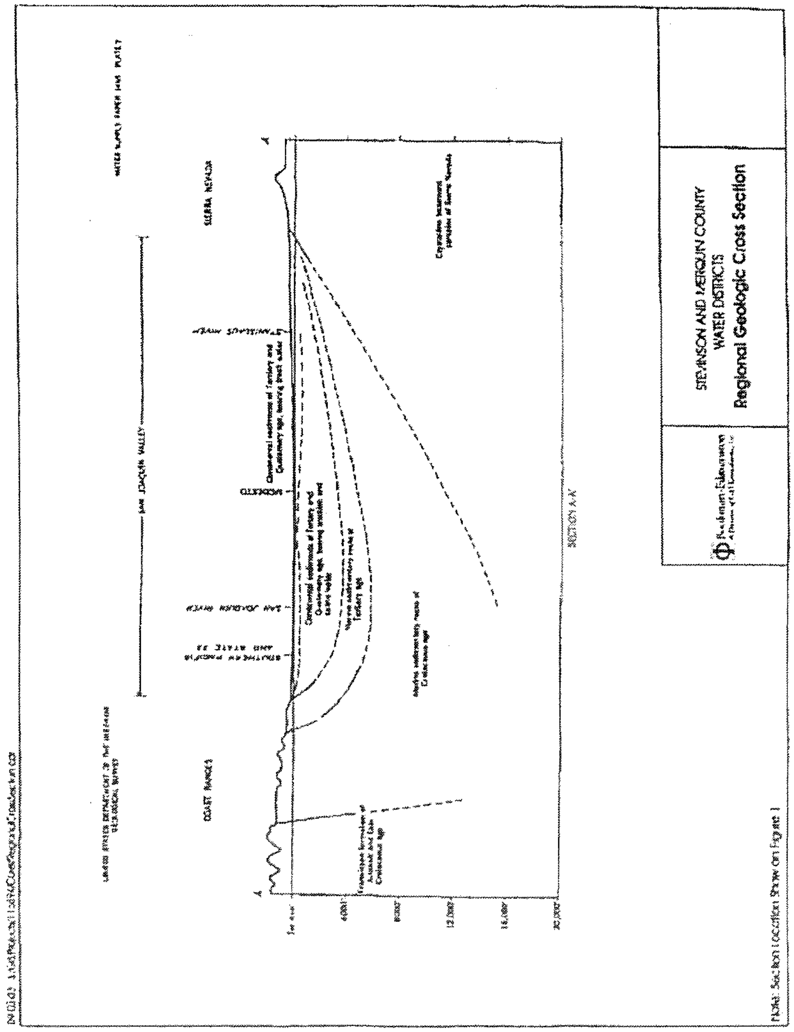

Figure 3. Generalized cross-section of the San Joaquin River Basin in proximity to the 4-S Ranch. (Source : Bookman-Edmonston, 2003).

2.5 Local hydrogeology

The local geology dictates the nature of the local groundwater system and can be derived from well driller's reports, geophysical logs, consultant reports and agency hydrogeological studies in the vicinity of the 4-S Ranch. Figure 4 is a generalized schematic of the aquifer system beneath the Stevinson and Merquin Water Districts, located approximately 3 miles north-west of the 4-S Ranch (Bookman-Edmonston, 2003). This same structural profile of the local geology can be applied to the 4-S Ranch, given the similar location of both the 4-S Ranch and the Stevinson and Merquin Water Districts, which lie in the discharge area close to the San Joaquin Valley trough, east and adjacent to the San Joaquin River. The distal end of the sedimentary deposits between major alluvial fans are characterized by having finer sediment texture and are often discharge zones where water originating from higher elevations on the east side of the San Joaquin Valley is forced under pressure upward through the near surface formations to discharge into sloughs and other surface drainages into the San Joaquin River. Past drainage problems in the Stevinson and Merquin Water Districts are well documented due to a heavy reliance on surface water for irrigation water supply.

Figure 4 shows a depth profile of the major subsurface geologic units that are likely common to the 4-S Ranch property. Figure 5 is a generalized soils map for the study area obtained from the Natural Resource Conservation Service. Surface soils within the 4-S Ranch boundary are predominantly classified as Merced silt-loam. Both figures shows a shallow water table aquifer comprising of sandy-silt to silty sand sediments of Younger Alluvium that ranges between 50 and 100 ft in thickness and that is interfingered by a sequence of clay lenses that is sometimes referred to as the "A" clay. The "A" Clay in this vicinity occurs typically at depths of between 15 and 50 ft and may be up to 25 ft thick. This inter-fingering of deposits is typical of alluvial fans where meandering streams have changed course and clay beds have been eroded and replaced with sand. Beneath the shallow water table aquifer is a better defined series of discontinuous clay lenses that makes up the Older Alluvium. The "C" Clay is a layer within the Older Alluvium. This sequence of interbedded clay and sand layers is typically from 10 – 60 ft thick.

2.6 Cone penetrometer (CPT) logging

Cone Penetrometer Logging (CPT) was conducted at 4-S Ranch to develop a better understanding of the sedimentary geology of the semiconfined groundwater . During the CPT logging experiments, a conical-shaped probe instrumented with sensors was pushed into the ground up to depths of around 100 ft. The cone penetrometer used at 4-S Ranch contained sensors that continuously measured the friction sleeve, tip resistance, and electrical conductivity. A calibration curve was developed to convert bulk soil salinity measurements made with the CPT sensor to an equivalent soil solution salinity. Both Myron Inc. and YSI Inc. soil salinity sensors were used to develop this calibration curve. During the experiments it was noted that saturation occurred in the CPT electrode at bulk salinity concentrations above 600 mS/m – above this threshold the relationship between bulk salinity and EC became highly non-linear. Since the groundwater underlying much of the managed wetland area in the San Joaquin Valley has an EC below 9000 uS/cm – the non-linear portion of the calibration curve was eliminated and a best fit least squares calibration curve fitted (Figure 6).

The best-fit equation was shown to be :

EC (uS/cm) = 13.567 * bulk salinity (mS/m)

This equation has a regression coefficient of 0.9983 (mg/l)

Plots of the sensor data with depth and the subsequent soil types determined from this data are shown in Figures 7 through 9 for three locations on the 4-S Ranch. These locations correspond to the locations of three wells that were logged for water quality. The maximum depths of the CPT logs ranged from about 70 to 85 ft in the three locations. The general soil profile from the CPT logs is consistent with the upper half of the profile shown in Figure 4. We observed a clay and sand layer, followed by a sand layer, a clayey sequence and a sand layer.

In Figure 7, the sand layers are found at about 22 ft below the surface and extend down to about 65 ft in this deep abandoned well. The highest permeability sand layer occurs in a depth interval of 24 ft to 38 ft below the surface. A second clay layer shows up between 66 ft and 71 ft below the surface. Provided the sand layer is reasonably continuous this provides a reasonably extensive shallow aquifer for

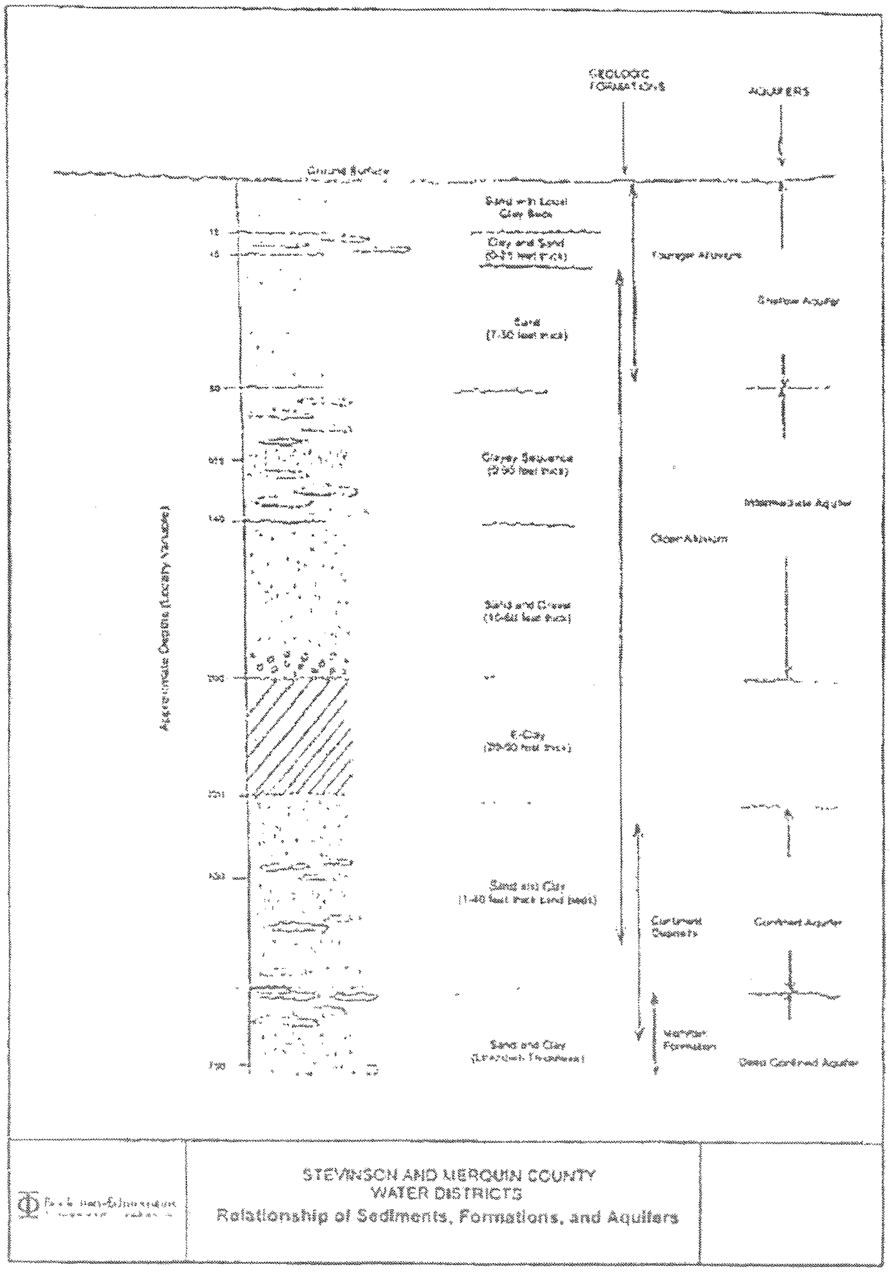

Figure 4. Generalized structural profile of sedimentary deposits and groundwater aquifers in the vicinity of the 4-S Ranch. (Source : Bookman-Edmonston, 2003).

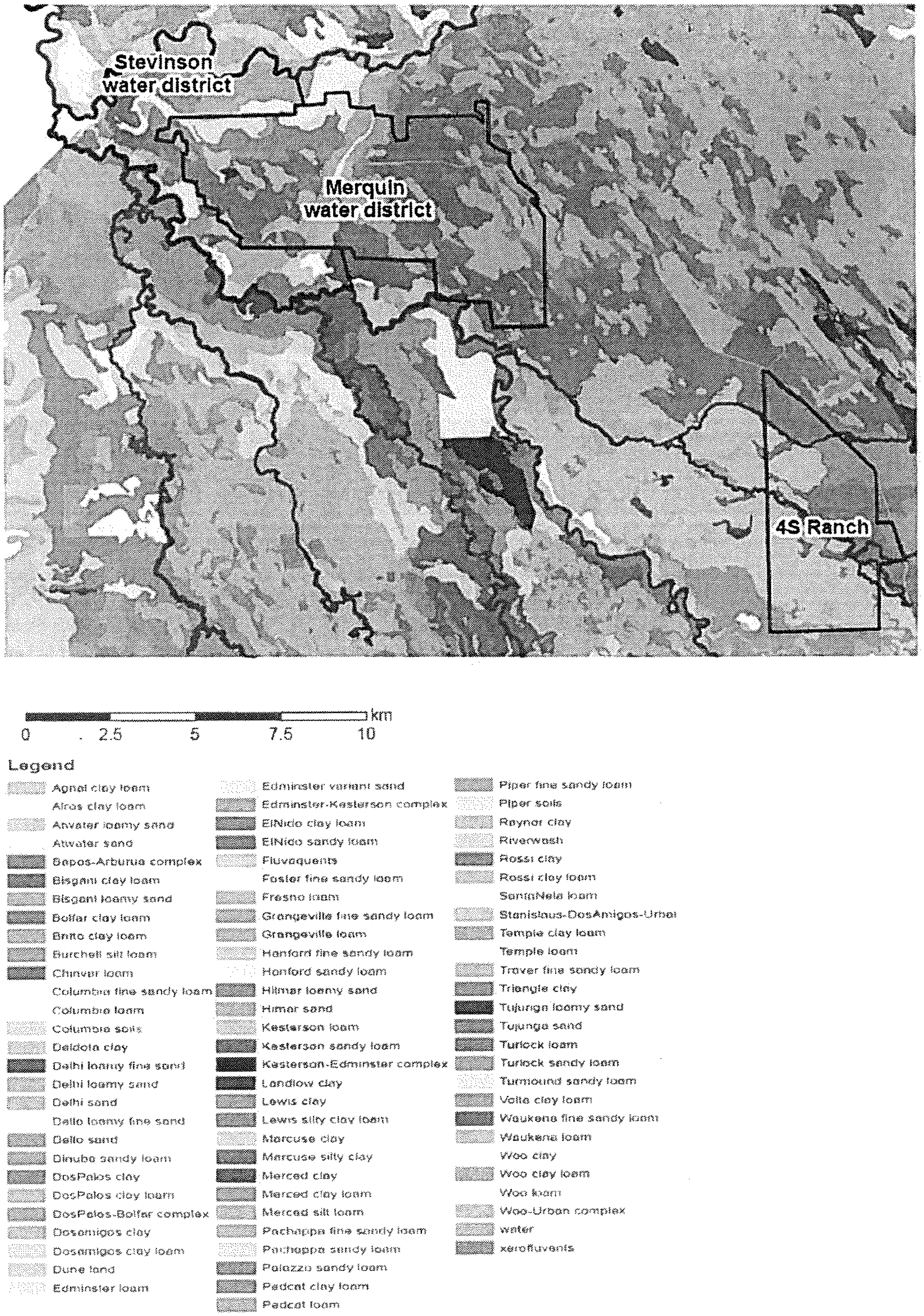

Figure 5. Soils map of the study area showing the 4-S Ranch and adjacent water districts.

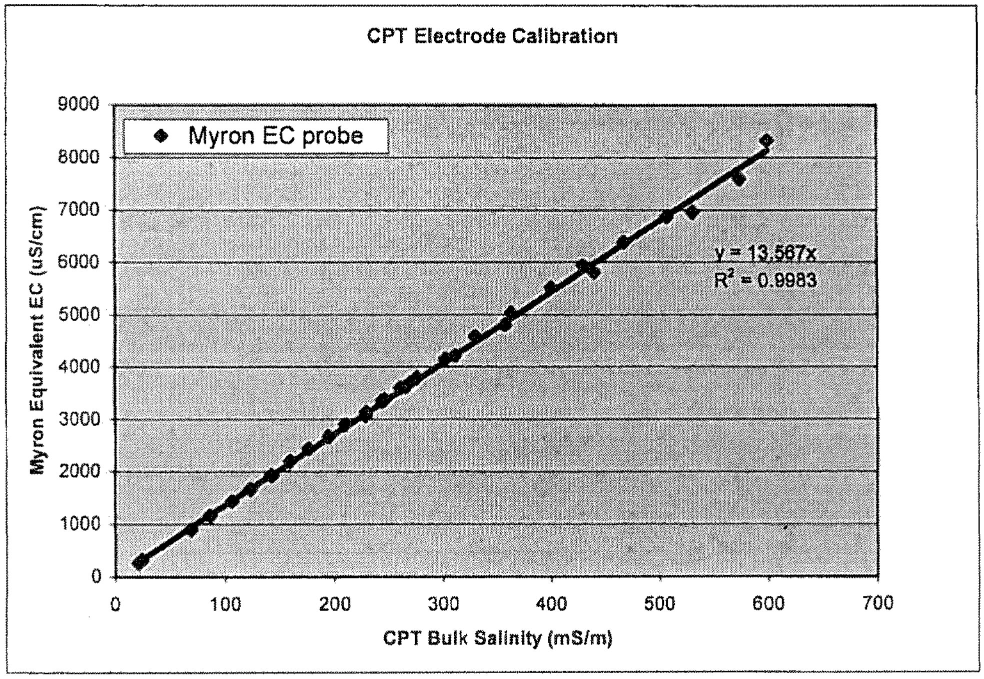

Figure 6. Calibration curve for converting CPT bulk salinity measurements (mS/m) to an equivalent groundwater EC (uS/cm).

exploitation. Bulk pore water salinity is elevated at the near surface (vadose zone) and diminishes to a concentration of about 50 mS/m (680 uS/cm) below a depth of 18 ft. Water quality remains at this level until the probe reached a depth of 75 ft whereupon it increased to 150 mS/m (2,035 uS/cm).

In Figure 8, where the CPT log was taken adjacent to production well 7, a similar stratigraphy is observed to the abandoned well, although these observations were more than 1 mile apart. The CPT log shows a larger fraction of finer grade material. Silty sands and intermediate sand-silty sands predominate over an aquifer that lies between 22 ft and 63 ft below the surface. The porosity and the specific yield of these aquifer materials are lower than that of sand. A clay aquitard, probably the "C" Clay, that is approximately 15 ft thick, lies immediately below the sand-silty sand aquifer. The water quality profile near production well 7 is similar to that at the abandoned well. Bulk salinity concentrations are high in the vadose zone but diminishes to under 50 mS/m (680 uS/cm) until a depth of 62 ft below where the concentration increases to 150 mS/m (2,035 uS/cm).

The stratigraphy of the domestic well that was logged is shown in Figure 9. This well is on the north-west corner of the property and shows a significant layer of highly permeable sand at a depth below 30ft. There is no distinct "A" clay at this location. The aquifer that sits above the "C" Clay is found at a depth range of 24ft to 67ft below the ground surface and is the most extensive and highest in average permeability of the three sites tested using the CPT logging technique. A very thin C clay aquitard is shown in the depth range of 67 to 69 ft below the surface – the CPT couldn't penetrate any deeper than 72 ft at this location and it is possible that the "C" clay is more extensive than shown. The water quality profile shows a poor water quality zone averaging 150 mS/m (2,000 uS/cm) between 5 ft and 23 ft below the surface with a peak concentration of 300 mS/m (4,060 uS/cm) at a depth of approximately 23 ft. Below this level water quality improves in the groundwater averaging 50 mS/m (680 uS/cm) with a small increase to 100 mS/cm (1,350 uS/cm) within 3 ft of the bottom of the CPT logging profile.

2.7 Groundwater quality logging

Flowing fluid electric conductivity (FEC) logging was conducted in an open, abandoned well on the 4-S Ranch property. Measurements of the ambient electrical conductivity (EC) with depth of two other wells on 4-S were also logged. As described by Tsang and Doughty (2003), the flowing FEC logging method involves first replacing the well bore water by de-ionized water or water of a constant salinity distinctly different from that of the formation water. This is done by injecting de-ionized water down a tube to the bottom of the well, while simultaneously pumping from the top of the well, until the EC of the water pumped out of the well stabilizes at a low value. Next, the pumps are turned off and the well is pumped only from the top at a constant low flow rate, while an electrical conductivity probe is lowered into the borehole to record the EC as a function of depth and time.

2.7.1 Open, Abandoned Well

The FEC logging conducted in the open, abandoned irrigation well on 4-S Ranch which was perforated from a depth of 121 ft below ground surface to the bottom of the well. The well depth was estimated to be approximately 223 ft (Figure 10). The water in this well was around 26 ft below ground surface. Deionizing filters were used to reduce the salinity of the well water that was extracted. The extracted water was run through the filters and then the de-ionized water was injected into the well. The water was extracted/injected at a rate of 3.6 gal/min over a period of 5 hours.

After the 5 hour period of replacing the well bore water, the injection pump was shut off and only the extraction pump was on at a rate of 5 gal/min, and the EC profile in the well was logged for the next 3 hours. The initial EC profile in the well before water was extracted/injected and the subsequent hourly EC profiles after the water replacement had ceased and water was only extracted are presented in Figure 10. Over the screened interval, the initial EC profile is nearly uniform at 1350 uS/cm (or 1.35 mS/cm) except for a peak near the top of the well screen between 121 ft to 131 ft. After injecting the deionized water, the EC decreases to around 600 uS/cm between 164 and 220 ft and then increases to 950 uS/cm between 141 and 164 ft. The peak present in the initial profile was still present after the de-ionized water was injected, indicating that flow into the well at that particular location is higher than in the rest of the well. The increase in EC in the interval 141 to 164 ft is because of vertical mixing of the higher EC water with the lower EC water below. The higher EC water entering the well around 121 ft propagated up the well bore over time, whereas the higher EC water entering around 141 ft propagated downward over time most likely because of vertical head gradients.

2.7.2 Ambient EC Profiles

Ambient EC profiles with depth were logged in two other wells on 4-S Ranch: an irrigation well (Well 7) that is still actively used and a domestic well. FEC logging was not conducted in these wells. The plots are shown in Figures 11 and 12. The borehole camera was not available when these wells were logged so we were not able to get the screened intervals. Well 7 had multiple screened intervals according to the caretaker of the 4-S Ranch property. The abrupt changes in the EC with depth are probably because of these multiple screens. The EC in this well is fairly low, ranging between 0.5 to 0.6 mS/cm. The EC in the domestic well increases nearly linearly from the top to the bottom from around 0.8 mS/cm to nearly 1.2 mS/cm. The linear change in EC indicates that this well may be screened only at the bottom of the well casing.

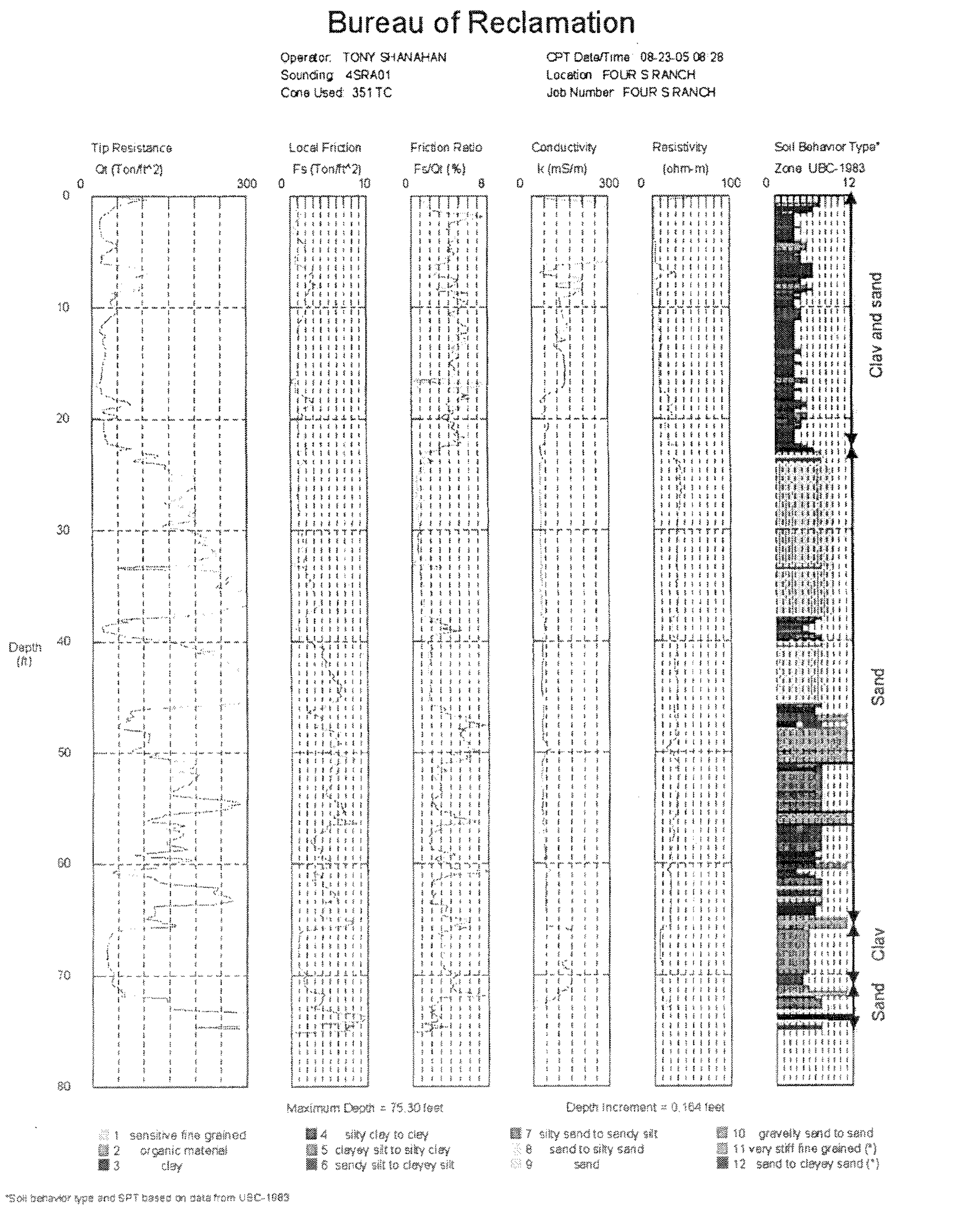

Figure 7. CPT log for the abandoned well near Owens Creek on the 4-S Ranch.

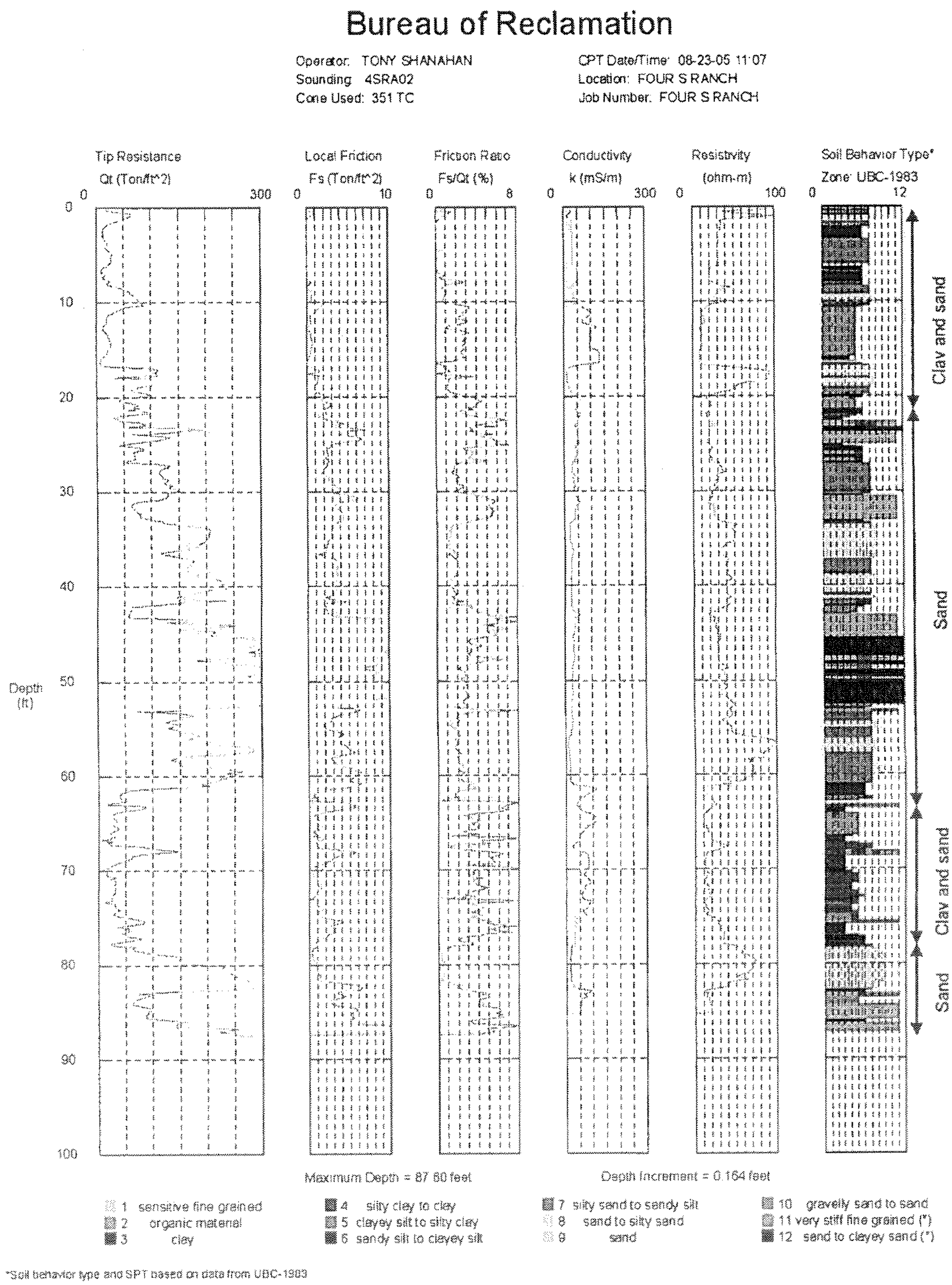

Figure 8. CPT log for production well no. 7 on the 4-S Ranch.

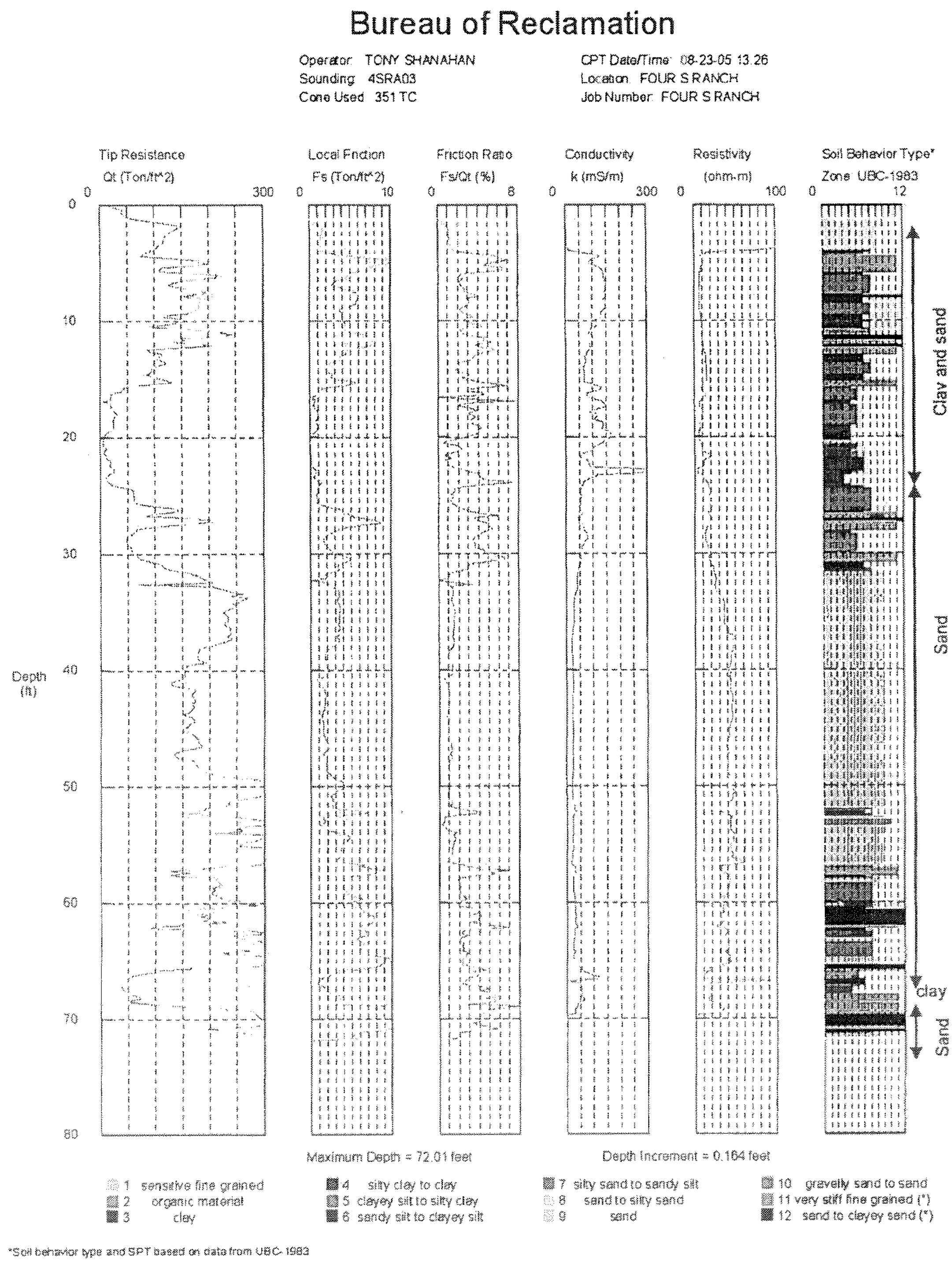

Figure 9. CPT log for the domestic well in north-west corner of the 4-S Ranch.

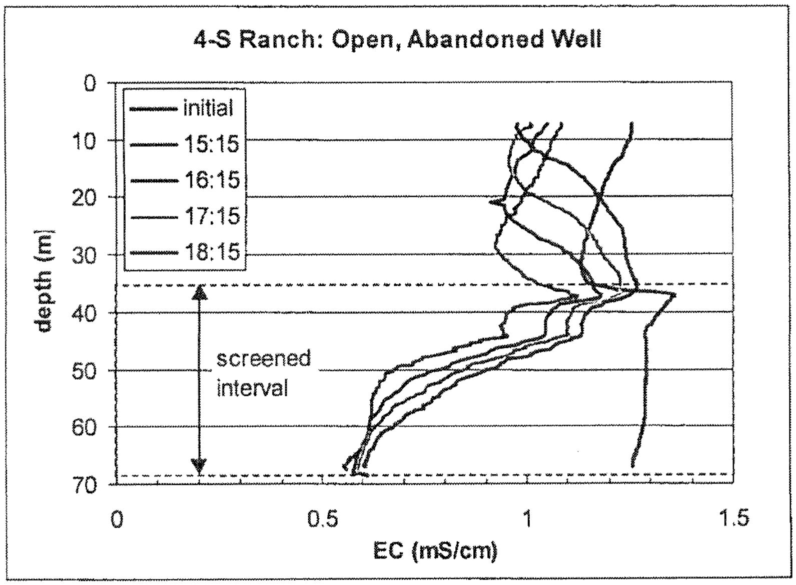

Figure 10. FEC logging profiles at different times at the open abandoned well at 4-S Ranch. The times during which the logging took place are indicated in the legend. The water level in this well was initially at 26 ft below the ground surface.

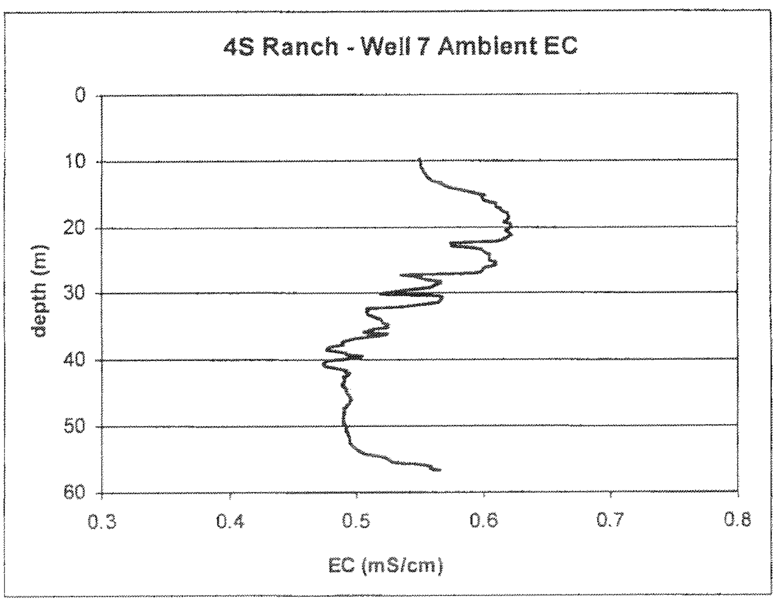

Figure 11. Ambient EC log of Well 7 on 4-S Ranch. Water quality logging was not possible owing to lack of an access port of sufficient diameter though which to pass the probe.

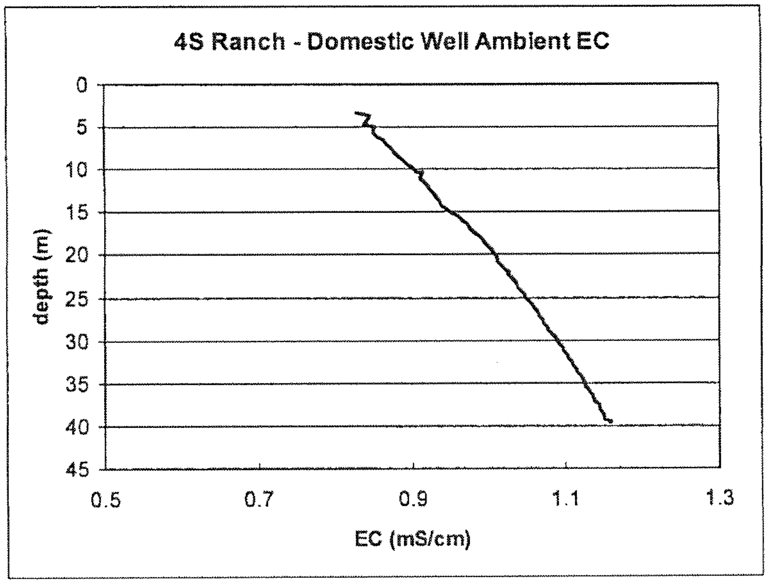

Figure 12. Ambient EC log of the domestic well on 4-S Ranch.

2.8 Subregional groundwater quality

Regional groundwater quality has been described as highly variable in studies by Bookman-Edmonston (2003, 2005) and Schmidt (2005). Water quality in the above- Corcoran semi-confined aquifer is affected by the regional flow system that is influenced by recharge from local streams and surface water conveyances and drainage into the San Joaquin River to the west. Whereas 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. Figure 13 illustrates three different hydrogeological scenarios that occur within the groundwater basin – some of which may change seasonally, that can have a significant impact on the depth distribution of salts and other contaminants within the semiconfined aquifer.

The majority of the wells that are installed within the 4-S Ranch are located along the alignment of the Eastside Canal and are greatly influenced by seepage from this conveyance facility. The salinity of the groundwater pumpage is therefore moderate to low – represented by the ambient water quality of Well 7, depicted in Figure 11 – typically in the range of 500 – 600 uS/cm. Wells such as the domestic well and the open, abandoned well, shown in Figures 10 and 12, show maximum EC's in the range of 1,100 uS/cm to 1,500 uS/cm. The quality of the groundwater pumped by these wells is affected mostly by the quality of the surface water applied to the pasture as irrigation, residual salts that might be dissolved from the aquifer materials through which this percolating water infiltrates and by concentration by the process of evapotranspiration while in the vadose zone. Since the 4-S Ranch is located at the distal margins of the Eastside alluvial fans formed from eroded Sierra Nevada sediments, groundwater quality is expected to be comparable to that measured within the Stevinson and Merquin Water Districts.

Bookman-Edmonston (2003) conducted EC measurements for most of the production wells in both Districts during 2002 and 2003. These data are presented in Table 1. The table shows that all wells are developed within the semiconfined aquifer above the Corcoran (E-Clay) Clay. Many wells in the Merquin Water District, which is located in a similar juxtaposition to the San Joaquin River as the 4-S Ranch, are screened between 30 and 200 ft. to maximize well yield by tapping high yielding sand formations and to exploit regional groundwater flows towards the San Joaquin River from the Merced Irrigation District to the east. The best quality water in the semi-confined aquifer is usually to be found immediately above the Corcoran Clay. The mean EC of these wells is 924 uS/cm (Table 1). This is similar to the ambient EC of the domestic well on the 4-S Ranch (Figure 12).

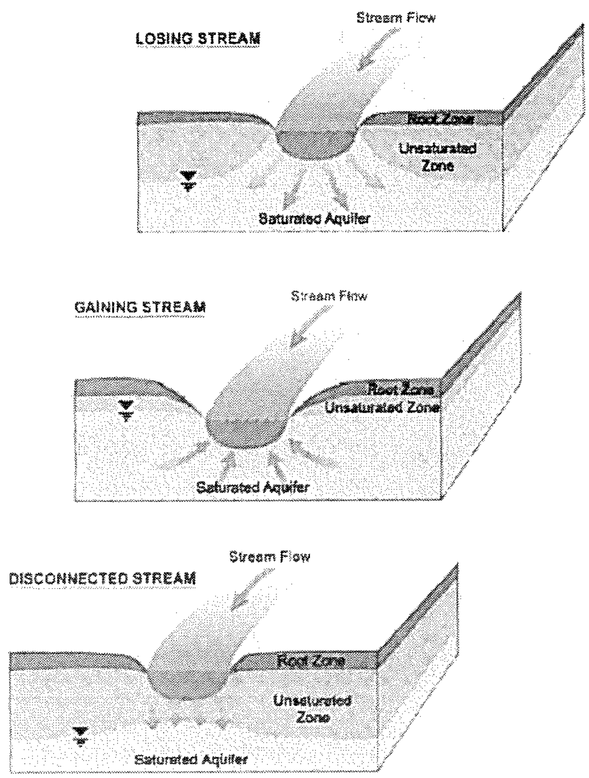

Figure 13. Illustration of canal and river seepage scenarios relevant to 4-S Ranch.

2.9 Groundwater Pumping

Groundwater pumpage rates for the 4-S Ranch are obtained from the Pump Test Reports prepared by the Anderson Pump Company, which tested and rehabilitated several of the wells on the property in October 2004 (Appendix A). These test reports also provide information on the specific capacity of the wells, the maximum drawdown of the water level during pumping, the total pump lift, measured flow rate and cost of groundwater pumping based on the cost of power in October 2004 (Table 2). The pumping rates shown in Table 2 are higher than the average pumping rates for the Merquin Water District (700 – 1,500 gpm) and comparable to the rates for the Stevinson Water District (800 – 4,200 gpm) (Schmidt, 2005) which is located closer to the trough of the San Joaquin Basin and in coarser grained surface sediments (Figure 4).

WELL ID	Well diameter (inches)	Total depth (feet)	Perforated interval (feet)	Gravel pack interval (feet)	Pumpage EC umhos/cm (2001-2002)	* Pump capacity (gpm)	** Pump capacity (Ac-ft/yr)
MERQUIN WATER DISTRICT (11,270 acres)							
M1	16	170	60-160	0-160	1160	845	336
M2	16	180	30-174	0-180	1520	718	286
M3	16	133	30-130	0-130	1490	856	340
M4	16	184	30-174	0-184	510	982	391
M5	16	190	30-180	0-190	500	716	285
M6	16	180	30-170	0-180	500	833	331
M7	16	172	30-160	0-172	760		
M8	16	158	30-160	0-168	720	949	377
M9	16	158	30-150	0-158	1420	804	320
M10	16	196	30-186	0-196		1023	407
M11	16	180	60-170	0-180	750	1502	597
M12					1160	755	300
M13	16	187	60-180	0-187	890	1061	422
M14	16	135	30-130	0-135	890	885	352
M15	16	245	90-230	0-245	770	1667	663
M16	16	205	60-200	0-205	1110	1279	509
M17	16	127	20-120	0-127	790	1111	442
M18	16	190	80-165	50-265	750	975	388
M19	16	220	60-120	0-220	750	1155	459
M20	16	220	90-120	0-220	1240	1527	607
M21	16	160	30-156	0-160		583	232
M22	16	220	80-195	50-195	800	413	164
						Total	**8,209**
STEVINSON WATER DISTRICT (7,560 acres)							
S2	18	180	90-180	50-180			1153
S3	18	144	60-140	0-150	638	1450	577
S4	18	144	60-144	0-153	1581	2300	915
S5					1660	1732	689
S6	18	250	90-250	20-250	1654	3500	1392
S7	18	186	90-186	0-186	1520	2300	915
S8	18	168	54-168	0-220	824	1500	597
SD20	8	120	100-120	84-120		40	
S10	18	198	80-198	50-198	888	2000	796
S11	12	170	95-170	75-170		1349	537
S12	18	240	120-240	0-253	624	4200	1671
S13	18	192	78-106 / 134-162	50-192		3980	
S14	16	162	72-162	0-169		1100	438
S15	16	162	72-162	0-165		2034	809
S16	12	160	50-160	40-160	2160	800	318
S17	18	164	84-164	50-164		1257	500
S18	16	205	65-205	50-205	1009	1800	716
S19	8	135	105-135	75-135		60	
						Total	**12,021**

Table 1. Well construction information and ambient EC in wells located in the Stevinson and Merquin Water Districts during 2002 and 2003.

Pump No.	Total Pump Lift (ft)	Measured flow rate (gpm)	Standing water level (ft)	Water table drawdown (ft)	Specific capacity of well (gpm/ft of drawdown)	Cost/acre-ft (2004 power costs per Kwh)
1	39	1870	9	17	110	$ 10.30
2	73	2504	13	47	70	$ 8.49
4	70	2310	29	33	70	$11.04
5	68	1840	14	49	38	$ 11.59
6	66	2071	13	43	48	$10.21
7	74	1749	21	47	37	$ 13.13
8	106	1584	12	85	19	$16.04
9	59	1402	13	40	35	$12.33
10	42	2343	14	22	107	$ 8.34
11	119	1171	13	98	12	$ 22.27

Table 2. Pump Test Reports completed in October 2004 for existing production wells on the 4-S Ranch.

Analysis of the test data in Table 2 provides another example of the wide spread in well specific capacity. Specific capacity in the existing production wells vary from a low of 12 gpm/ft of drawdown to a high of 107 gpm/ft of drawdown. The general conclusion drawn from the pump tests is that seepage from the Eastside Canal is likely sufficient to allow sustainable pumping at the rated discharge of the installed production wells. It is unlikely that the same pumping rates can be achieved from newly installed wells in locations other than along the alignment of the Eastside Canal, given that the Canal contains water mostly year-around, unlike Bear Creek and the Mariposa Bypass which convey seasonal flows.

Aquifer	Area (acres)	Average estimated aquifer thickness (ft)	Estimated specific yield (percent)	Average groundwater in storage (acre-ft)
Shallow aquifer Merquin WD	5400	70	10.9	41,000
Deep semi-confined aquifer	5400	100	11.3	61,000

Table 3. Estimated groundwater volume in storage beneath the 4-S Ranch using aquifer parameter values derived from the Merquin and Stevinson geohydrologic studies.

2.10 Groundwater Resource Evaluation

The volume of groundwater in storage can be estimated using the average estimated aquifer thickness and the estimated specific yield of the aquifer. Well logs were not available for the 4-S property nor were any of the wells tested deep enough to penetrate the entire above-Corcoran Clay aquifer. In the case of the CPT logging experiments – the cone truck can only typically achieve depths of 70 – 100 ft before the truck starts lifting owing to the high sliding friction on the cone penetrometer. Exceeding the applied load can cause a rod to stick or if the cone truck is pushed out of alignment can cause bent or damaged rods. Since well data was not available for the 4-S Ranch the estimated aquifer thickness and estimated aquifer specific yield are taken from data for the Merquin Water District.

Table 3 suggests that there is approximately 100,000 acre-ft of groundwater in storage beneath the 4-S Ranch. Sustainable exploitation of this groundwater resource depends on the rate of groundwater recharge derived from deep percolation of irrigated water and seepage from canals and conveyance structures that border the 4-S Ranch (Bear Creek and the Eastside Bypass) that cut through the central and northern ends of the 4-S Ranch. Fallowing of the 4-S Ranch to provide water supply to adjacent refuges will remove a significant component of annual groundwater recharge.

2.11 Groundwater levels and aquifer safe yield

Groundwater level data has not been routinely collected for the 4-S Ranch hence there are no hydrographs to show trends in groundwater levels over time. Hydrographs obtained for the Merquin Water District show that water levels have remained reasonably constant over time. This implies, at least for Merquin Water District, that the combination of regional groundwater inflow from the Merced Irrigation District upslope, deep percolation of irrigation application and deep percolation of winter rainfall is sufficient to restore the aquifer to its original state. Total recharge from deep percolation and canal seepage to Merquin and Stevinson Water Districts has been estimated to be about 16,400 acre-ft/yr or about 0.9 acre-ft/acre-yr (Schmidt, 2005). The maximum rate of aquifer groundwater pumping that does not exceed the recharge is known as the safe yield.

In the case of the 4-S Ranch the current rate of pumping from wells No. 1-11 (10 wells - no well no. 3) located on the alignment of the Eastside Canal does not appear to exceed the aquifer safe yield. Well recovery was shown to be quite rapid for several of the wells tested because of groundwater inflow from the east. There is not enough data to determine the safe yield for any new pumping that might occur within the property boundary of the 4-S Ranch. Recharge rates to the aquifer are a combination of effective rainfall, deep percolation of surface irrigation water and groundwater inflow that might cross into the 4-S Ranch en-route to the San Joaquin River. If the figure of 0.9 acre-ft/acre-yr is applied to the entire 4-S Ranch property that would amount to a pumpable groundwater yield of 4860 acre-ft/yr. If an assumption is made that irrigation wells pump on average 50% of the time during the irrigation season between April and September each year (approximately 90 days – same assumption made by Bookman-Edmonston, 2003) – then using the pumpage rates from the test reports in Appendix A yields an average annual pumpage of 7,000 acre-ft/yr from the ten active production wells located along the property boundary and the alignment of the Eastside Canal.

3. FINDINGS AND RECOMMENDATION

Hydrogeological assessment of the 4-S Ranch was conducted using a combination of field investigations and a survey of available literature from nearby agricultural water districts. Pump records and pump performance data were obtained from the Anderson Pump Company. However the company that originally drilled and developed the various production wells on the 4-S Ranch is no longer in business and well logs could not be obtained. The 4-S Ranch has been able to meet most of its own water needs providing irrigated pasture for beef cattle by an active program of shallow groundwater pumping in the semiconfined aquifer above the Corcoran Clay. Comparison of groundwater pumping on the 4-S Ranch property with groundwater pumping in the adjacent Merquin and Stevinson Water Districts shows great similarity in the well screened depths and the quality of the groundwater produced by the well fields. The pump yield for the ten active production wells on the 4-S property are comparable to the production and drainage wells in the adjacent Districts. Like these Districts the 4-S Ranch lies close to the San Joaquin Valley trough in a historic discharge area. Groundwater pumping in the adjacent water districts has become necessary for shallow water table control.

The 4-S Ranch is bounded and bisected by several major water conveyance facilities including Bear Creek. The Eastside Canal runs along the north-eastern and eastern boundaries of the Ranch and the Mariposa Bypass forms the southern border. The Eastside Bypass and Bear Creek run through the Ranch in a south-east to north-west orientation. Although the large number of potential recharge facilities would suggest significant groundwater conjunctive use potential – the major well field development has occurred along the length of the Eastside Canal. The Eastside Canal is known to be leaky and passes through sandy areas which allow significant groundwater seepage which can be intercepted by adjacent groundwater wells. This pumping may induce higher levels of seepage below certain reaches of the Canal. Water quality below and adjacent to the Canal (most of the pumpage occurs in a depth interval between 30 ft and 130 ft) is very good, reflecting the origin of this diverted water from the Merced River. The few wells that are close to the Eastside Bypass, Bear Creek and Owens Creek appear to tap groundwater deeper in the semi-confined aquifer which is poorer in water quality.

Safe yield estimates made using the available data show that the 4-S Ranch has sufficient groundwater resources to meet its own existing needs. If an assumption is made that the existing irrigation wells pump on average 50% of the time during the irrigation season between April and September each year (approximately 90 days) – then using the pumpage rates for the test reports in Appendix A yields an average annual pumpage of 7,000 acre-ft/year from the ten production wells located along the property boundary and the alignment of the Eastside Canal. Should any future lining of the Eastside Canal occur, it would very likely significantly impact the existing groundwater yield of the 4-S Ranch and impair the overall quality of the available water supply.

There is not enough data to determine the safe yield for any new pumping that might occur within the property boundary of the 4-S Ranch. Further exploitation of the groundwater will be limited if the leakage from the Eastside Bypass, Mariposa Bypass and Bear Creek are insufficient to replace the pumped water on an average annual basis.

Other factors for consideration are that the existing wells were likely installed in 1960's or 1970's and are at least 30 years old. Also, several of the wells were observed to be producing sand. August Oertzen mentioned that sand was being added through the casing access tube to replace the sand being removed from the pump bowl. This sand causes wear to pump parts. It is possible that several of the production wells would need to be replaced if maximum well field yield was to be sustained.

4. REFERENCES

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APPENDIX A. PUMP TESTS CONDUCTED BY ANDERSON PUMP COMPANY IN OCTOBER 2004

ANDERSON PUMP COMPANY
(559) 665-4477
Pump Test Report
v.3 5 10/04/04

Customer and Facility Data

Plant/Location: PUMP 1/1.5 ML. NW OF EASTSIDE CANAL AND BEAR CREE **HP:** 50 **Utility:** PG & E
GPS Coord.: Long 37 N 15.923 Lat 120 W 44.021 **Pump Make:** Layne & Bowler
Motor Make: Newman **Type** Turbine **Meter Number:** 43339R
Customer Addr: 4S LAND AND CATTLE **Serial Number:** S1243805
8441 SE 68TH- PMB 196
MERCER ISLAND, WA 980405235 **Voltage:** 480 **Amps:** 59
Contact: AUGUST OERTZEN **State Well #:** 017-00937
Phone: **Fax:** **Cell:** (209) 668-0680
PUC **Acreage:** 2560+ **Farm Type:** Livestock

Test Results

Test Date: 5/9/2005
Tester: ROBERT PARRISH

Run Number:	1
1. Standing Water Level (Ft):	9
2. Pumping Water Level (Ft):	30
3. Draw Down (Ft):	17
4. Recovered Water Level (Ft):	13
5. Discharge Pressure at Gauge (PSI):	4
6. Total Lift (Ft):	39
7. Flow Velocity (Ft/Sec):	7 3
8. Measured Flow Rate (GPM):	1,870
9. Customer Flow Rate (GPM):	0
10. Specific Capacity (GPM/Ft draw):	110.0
11. Acre Feet per 24 Hr:	8 3
12. Cubic Feet per Second (CFS):	4.2
13. Horsepower Input to Motor:	50
14. Percent of Rated Motor Load (%)	90
15. Kilowatt Input to Motor:	37
16. Kilowatt Hours per Acre Foot:	108
17. Cost to Pump an Acre Foot:	$10.30
18. Energy Cost ($/Hour)	$3.55
19. Base Cost per Kwh:	$0.095
20. NamePlate RPM:	1,770
21. RPM at GearHead:	0
22. Overall Plant Efficiency (%):	37

If a Flow Velocity (line 7) is less than 1 ft/second, the accuracy of the test is suspect.

Note any major difference between the "Measured" flow rate and the "Customer's" (lines 8,9).

Remarks

All results are based on conditions during the time of the test. If these conditions vary from the normal operation of your pump, the results shown may not describe the pump's normal performance.

ANDERSON PUMP COMPANY
(559) 665-4477
Pump Test Report

v 3.5 10/04/04

Customer and Facility Data

Plant/Location:	PUMP-2/SOUTHERN PUMP IN NORTHERN MOST FIELD			**HP:**	50	**Utility:**	PG & E
GPS Coord.:	**Long** 37	**N** 15.662 **Lat** 120	**W** 44.018	**Pump Make:**	Johnston		
Motor Make:	U.S.	**Type** Turbine		**Meter Number:**	43348R		
Customer Addr:	4S LAND AND CATTLE			**Serial Number:**	025448419		
	8441 SE 68TH- PMB 196			**Voltage:**	480	**Amps:**	62
	MERCER ISLAND, WA 980405235						
Contact:	AUGUST OERTZEN			**State Well #:**	17-00920		
Phone:		**Fax:**	**Cell:** (209) 668-0680				
PUC		**Acreage:** 2560+		**Farm Type:**	Livestock		

Test Results

Run Number:	1
1. Standing Water Level (Ft):	13
2. Pumping Water Level (Ft):	60
3. Draw Down (Ft):	47
4. Recovered Water Level (Ft):	13
5. Discharge Pressure at Gauge (PSI):	5.5
6. Total Lift (Ft):	73
7. Flow Velocity (Ft/Sec):	9.6
8. Measured Flow Rate (GPM):	**2,504**
9. Customer Flow Rate (GPM):	0
10. Specific Capacity (GPM/Ft draw):	53.3
11. Acre Feet per 24 Hr:	11.1
12. Cubic Feet per Second (CFS):	5.6
13. Horsepower Input to Motor:	55
14. Percent of Rated Motor Load (%)	100
15. Kilowatt Input to Motor:	41
16. Kilowatt Hours per Acre Foot:	89
17. Cost to Pump an Acre Foot:	$8.49
18. Energy Cost ($/Hour)	$3.91
19. Base Cost per Kwh:	$0.095
20. NamePlate RPM:	1,800
21. RPM at GearHead:	0
22. Overall Plant Efficiency (%):	**83**

Test Date: 5/3/2005

Tester: ADAM SHASKY

If a Flow Velocity (line 7) is less than 1 ft/second, the accuracy of the test is suspect.

Note any major difference between the "Measured" flow rate and the "Customer's" (lines 8,9).

Remarks

All results are based on conditions during the time of the test. If these conditions vary from the normal operation of your pump, the results shown may not describe the pump's normal performance.

ANDERSON PUMP COMPANY
(559) 665-4477
Pump Test Report

v 3 5 10/04/04

Customer and Facility Data

Plant/Location: PUMP 4/S/SIDE OF INT. OF BEAR CREEK & EAST SIDE CAN **HP:** 50 **Utility:** PG & E

GPS Coord.: **Long** 37 **N** 15.230 **Lat** 120 **W** 43.124 **Pump Make:** Peerless

Motor Make: Newman **Type** Turbine **Meter Number:** 60R702

Customer Addr: 4S LAND AND CATTLE **Serial Number:** 51219404
8441 SE 68TH- PMB 196
MERCER ISLAND, WA 980405235 **Voltage:** 480 **Amps:** 59

Contact: AUGUST OERTZEN **State Well #:** 17-00921

Phone: **Fax:** **Cell:** (209) 668-0680

PUC **Acreage:** 2560+ **Farm Type:** Livestock

Test Results

Run Number:	1
1. Standing Water Level (Ft):	29
2. Pumping Water Level (Ft):	62
3. Draw Down (Ft):	33
4. Recovered Water Level (Ft):	29
5. Discharge Pressure at Gauge (PSI):	3.5
6. Total Lift (Ft):	70
7. Flow Velocity (Ft/Sec):	9.0
8. Measured Flow Rate (GPM):	**2,310**
9. Customer Flow Rate (GPM):	0
10. Specific Capacity (GPM/Ft draw):	70.0
11. Acre Feet per 24 Hr:	10.2
12. Cubic Feet per Second (CFS):	5.2
13. Horsepower Input to Motor:	66
14. Percent of Rated Motor Load (%)	120
15. Kilowatt Input to Motor:	49
16. Kilowatt Hours per Acre Foot:	116
17. Cost to Pump an Acre Foot:	$11.04
18. Energy Cost ($/Hour)	$4.70
19. Base Cost per Kwh:	$0.095
20. NamePlate RPM:	1,770
21. RPM at GearHead:	0
22. Overall Plant Efficiency (%):	62

Test Date: 5/2/2005

Tester: ADAM SHASKY

If a Flow Velocity (line 7) is less than 1 ft/second, the accuracy of the test is suspect.

Note any major difference between the "Measured" flow rate and the "Customer's" (lines 8,9)

Remarks

All results are based on conditions during the time of the test. If these conditions vary from the normal operation of your pump, the results shown may not describe the pump's normal performance.

ANDERSON PUMP COMPANY
(559) 665-4477
Pump Test Report

v 3.5 10/04/04

Customer and Facility Data

Plant/Location: PUMP 5/S.W./SIDE OF EASTSIDE CANAL 1/4 M. S OF BEAR **HP:** 50 **Utility:** PG & E

GPS Coord.: Long 37 N 15.070 Lat 120 W 42.923 **Pump Make:** Peerless

Motor Make: Newman **Type** Turbine **Meter Number:** 91683R

Customer Addr: 45 LAND AND CATTLE
8441 SE 68TH- PMB 196
MERCER ISLAND, WA 980405235

Serial Number: 51243806

Voltage: 480 **Amps:** 59

Contact: AUGUST OERTZEN **State Well #:** 17-00922

Phone: **Fax:** **Cell:** (209) 668-0680

PUC **Acreage:** 2560+ **Farm Type:** Livestock

Test Results

Test Date: 5/3/2005

Tester: ADAM SHASKY

Run Number:	1
1. Standing Water Level (Ft):	14
2. Pumping Water Level (Ft):	66
3. Draw Down (Ft):	49
4. Recovered Water Level (Ft):	17
5. Discharge Pressure at Gauge (PSI):	1
6. Total Lift (Ft):	68
7. Flow Velocity (Ft/Sec):	7.2
8. Measured Flow Rate (GPM):	1,840
9. Customer Flow Rate (GPM):	0
10. Specific Capacity (GPM/Ft draw):	37.6
11. Acre Feet per 24 Hr:	8.1
12. Cubic Feet per Second (CFS):	4.1
13. Horsepower Input to Motor:	55
14. Percent of Rated Motor Load (%)	100
15. Kilowatt Input to Motor:	41
16. Kilowatt Hours per Acre Foot:	122
17. Cost to Pump an Acre Foot:	$11.59
18. Energy Cost ($/Hour)	$3.93
19. Base Cost per Kwh:	$0.095
20. NamePlate RPM:	1,770
21. RPM at GearHead:	0
22. Overall Plant Efficiency (%):	57

If a Flow Velocity (line 7) i. less than 1 ft/second, the accuracy of the test is suspect.

Note any major difference between the "Measured" flow rate and the "Customer's" (lines 8,9).

Remarks

All results are based on conditions during the time of the test. If these conditions vary from the normal operation of your pump, the results shown may not describe the pump's normal performance.

ANDERSON PUMP COMPANY
(559) 665-4477
Pump Test Report

v 3.5 10/04/04

Customer and Facility Data

Plant/Location: PUMP 6/THIRD PUMP S. OF BEAR CK. & EASTSIDE CANAL **HP:** 50 **Utility:** PG & E
GPS Coord.: **Long** 37 **N** 14.936 **Lat** 120 **W** 42.754 **Pump Make:** Peerless
Motor Make: Newman **Type** Turbine **Meter Number:** 43379B
Customer Addr: 45 LAND AND CATTLE **Serial Number:** 51243702
8441 SE 68TH- PMB 196
MERCER ISLAND, WA 980405235 **Voltage:** 480 **Amps:** 59
Contact: AUGUST OERTZEN **State Well #:** 17-00923
Phone: **Fax:** **Cell:** (209) 668-0680
PUC **Acreage:** 2560+ **Farm Type:** Livestock

Test Results

Test Date: 5/3/2005

Tester: ROBERT PARRISH

Run Number:	1
1. Standing Water Level (Ft):	13
2. Pumping Water Level (Ft):	59
3. Draw Down (Ft):	43
4. Recovered Water Level (Ft):	16
5. Discharge Pressure at Gauge (PSI):	3
6. Total Lift (Ft):	66
7. Flow Velocity (Ft/Sec):	8.1
8. Measured Flow Rate (GPM):	**2,071**
9. Customer Flow Rate (GPM):	0
10. Specific Capacity (GPM/Ft draw):	48.2
11. Acre Feet per 24 Hr:	9.2
12. Cubic Feet per Second (CFS):	4.6
13. Horsepower Input to Motor:	55
14. Percent of Rated Motor Load (%)	99
15. Kilowatt Input to Motor:	41
16. Kilowatt Hours per Acre Foot:	108
17. Cost to Pump an Acre Foot:	$10.21
18. Energy Cost ($/Hour)	$3.89
19. Base Cost per Kwh:	$0.095
20. NamePlate RPM:	1,770
21. RPM at GearHead:	0
22. Overall Plant Efficiency (%):	**63**

If a Flow Velocity (line 7) is less than 1 ft/second, the accuracy of the test is suspect.

Note any major difference between the "Measured" flow rate and the "Customer's" (lines 8,9).

Remarks

All results are based on conditions during the time of the test. If these conditions vary from the normal operation of your pump, the results shown may not describe the pump's normal performance.

ANDERSON PUMP COMPANY
(559) 665-4477
Pump Test Report

v 3.5 10/04/04

Customer and Facility Data

Plant/Location: OLD PUMP 7-(SOON TO BE PUMP 12)/1/4 M. W/OF & 1/2 **HP:** 50 **Utility:** PG & E

GPS Coord.: **Long** 37 **N** 14.655 **Lat** 120 **W** 43.472 **Pump Make:** U.S.

Motor Make: U.S. **Type** Turbine **Meter Number:** 43001R

Customer Addr: 4S LAND AND CATTLE **Serial Number:** R623204223
8441 SE 68TH- PMB 196
MERCER ISLAND, WA 980405235 **Voltage:** 480 **Amps:** 62

Contact: AUGUST OERTZEN **State Well #:** 17-00924

Phone: **Fax:** **Cell:** (209) 668-0680

PUC **Acreage:** 2560+ **Farm Type:** Livestock

Test Results

Test Date: 5/2/2005

Tester: ADAM SHASKY

Run Number:	1
1. Standing Water Level (Ft):	21
2. Pumping Water Level (Ft):	72
3. Draw Down (Ft):	47
4. Recovered Water Level (Ft):	25
5. Discharge Pressure at Gauge (PSI):	0.9
6. Total Lift (Ft):	74
7. Flow Velocity (Ft/Sec):	6.8
8. Measured Flow Rate (GPM):	**1,749**
9. Customer Flow Rate (GPM):	0
10. Specific Capacity (GPM/Ft draw):	37.2
11. Acre Feet per 24 Hr:	7.7
12. Cubic Feet per Second (CFS):	3.9
13. Horsepower Input to Motor:	60
14. Percent of Rated Motor Load (%)	108
15. Kilowatt Input to Motor:	45
16. Kilowatt Hours per Acre Foot:	138
17. Cost to Pump an Acre Foot:	$13.13
18. Energy Cost ($/Hour)	$4.23
19. Base Cost per Kwh:	$0.095
20. NamePlate RPM:	1,765
21. RPM at GearHead:	0
22. Overall Plant Efficiency (%):	55

If a Flow Velocity (line 7) is less than 1 ft/second, the accuracy of the test is suspect.

Note any major difference between the "Measured" flow rate and the "Customer's" (lines 8,9).

Remarks

All results are based on conditions during the time of the test. If these conditions vary from the normal operation of your pump, the results shown may not describe the pump's normal performance

ANDERSON PUMP COMPANY
(559) 665-4477
Pump Test Report

v 3 5 10/04/04

Customer and Facility Data

Plant/Location: PUMP 8/SEE MAP		**HP:** 50	**Utility:** PG & E
GPS Coord.: **Long** 37 **N** 14.532 **Lat** 120 **W** 42.391		**Pump Make:**	Peerless
Motor Make: Newman	**Type** Turbine	**Meter Number:**	91690R
Customer Addr: 4S LAND AND CATTLE 8441 SE 68TH- PMB 196 MERCER ISLAND, WA 980405235		**Serial Number:**	S1242505
		Voltage: 480	**Amps:** 59
Contact: AUGUST OERTZEN		**State Well #:**	17-00926
Phone:	**Fax:**	**Cell:** (209) 668-0680	
PUC	**Acreage:** 2560+	**Farm Type:**	Livestock

Test Results

Test Date: 5/3/2005

Tester: ADAM SHASKY

Run Number:	1
1. Standing Water Level (Ft):	12
2. Pumping Water Level (Ft):	104
3. Draw Down (Ft):	85
4. Recovered Water Level (Ft):	19
5. Discharge Pressure at Gauge (PSI):	1
6. Total Lift (Ft):	106
7. Flow Velocity (Ft/Sec):	6.2
8. Measured Flow Rate (GPM):	**1,584**
9. Customer Flow Rate (GPM):	0
10. Specific Capacity (GPM/Ft draw):	18 6
11. Acre Feet per 24 Hr:	7.0
12. Cubic Feet per Second (CFS):	3.5
13. Horsepower Input to Motor:	66
14. Percent of Rated Motor Load (%)	119
15. Kilowatt Input to Motor:	49
16. Kilowatt Hours per Acre Foot:	169
17. Cost to Pump an Acre Foot:	$16.04
18. Energy Cost ($/Hour)	$4.68
19. Base Cost per Kwh:	$0.095
20. NamePlate RPM:	1,770
21. RPM at GearHead:	0
22. Overall Plant Efficiency (%):	**64**

If a Flow Velocity (line 7) i less than 1 ft/second, the accuracy of the test is suspect.

Note any major difference between the "Measured" flow rate and the "Customer's" (lines 8,9).

Remarks

All results are based on conditions during the time of the test. If these conditions vary from the normal operation of your pump, the results shown may not describe the pump's normal performance

ANDERSON PUMP COMPANY
(559) 665-4477
Pump Test Report

v 3.5 10/04/04

Customer and Facility Data

Plant/Location: PUMP-9/FIRST PUMP NORTH OF GREEN HOUSE ROAD **HP:** 40 **Utility:** PG & E

GPS Coord.: **Long** 37 **N** 14.213 **Lat** 120 **W** 42.395 **Pump Make:** Peerless

Motor Make: Newman **Type** Turbine **Meter Number:** 43359R

Customer Addr: 4S LAND AND CATTLE **Serial Number:** S1240701
8441 SE 68TH- PMB 196
MERCER ISLAND, WA 980405235 **Voltage:** 480 **Amps:** 50

Contact: AUGUST OERTZEN **State Well #:** 17-00927

Phone: **Fax:** **Cell:** (209) 668-0680

PUC **Acreage:** 2560+ **Farm Type:** Livestock

Test Results

Test Date: 5/3/2005

Tester: ROBERT PARRISH

Run Number:	1
1. Standing Water Level (Ft):	13
2. Pumping Water Level (Ft):	58
3. Draw Down (Ft):	40
4. Recovered Water Level (Ft):	18
5. Discharge Pressure at Gauge (PSI):	0.45
6. Total Lift (Ft):	59
7. Flow Velocity (Ft/Sec):	5.5
8. Measured Flow Rate (GPM):	**1,402**
9. Customer Flow Rate (GPM):	0
10. Specific Capacity (GPM/Ft draw):	35.0
11. Acre Feet per 24 Hr:	6.2
12. Cubic Feet per Second (CFS):	3.1
13. Horsepower Input to Motor:	45
14. Percent of Rated Motor Load (%)	101
15. Kilowatt Input to Motor:	33
16. Kilowatt Hours per Acre Foot:	130
17. Cost to Pump an Acre Foot:	$12.33
18. Energy Cost ($/Hour)	$3.18
19. Base Cost per Kwh:	$0.095
20. NamePlate RPM:	1,775
21. RPM at GearHead:	0
22. Overall Plant Efficiency (%):	**47**

If a Flow Velocity (line 7) is less than 1 ft/second, the accuracy of the test is suspect.

Note any major difference between the "Measured" flow rate and the "Customer's" (lines 8,9).

Remarks

All results are based on conditions during the time of the test. If these conditions vary from the normal operation of your pump, the results shown may not describe the pump's normal performance.

Pump Test Report

Customer and Facility Data

Plant/Location:	PUMP - 10/S.W. OF GREENHOUSE RD. & EASTSIDE CANAL	**HP:**	50	**Utility:**	PG & E
GPS Coord.:	**Long** 120 **N** 42.119 **Lat** 37 **W** 13.774	**Pump Make:**	Peerless		
Motor Make:	U.S. **Type** Turbine	**Meter Number:**	32422R		
Customer Addr:	4S LAND AND CATTLE 8441 SE 68TH- PMB 196 MERCER ISLAND, WA 980405235	**Serial Number:**	025479919		
		Voltage:	480	**Amps:**	62
Contact:	AUGUST OERTZEN	**State Well #:**	17-00928		
Phone:	**Fax:**	**Cell:**	(209) 668-0680		
PUC	**Acreage:** 2560+	**Farm Type:**	Livestock		

Test Results

Test Date: 5/3/2005

Tester: ROBERT PARRISI

Run Number:	1
1. Standing Water Level (Ft):	14.2
2. Pumping Water Level (Ft):	40.2
3. Draw Down (Ft):	22
4. Recovered Water Level (Ft):	18.2
5. Discharge Pressure at Gauge (PSI):	0.9
6. Total Lift (Ft):	42
7. Flow Velocity (Ft/Sec):	9.1
8. Measured Flow Rate (GPM):	2,343
9. Customer Flow Rate (GPM):	0
10. Specific Capacity (GPM/Ft draw):	106.5
11. Acre Feet per 24 Hr:	10.4
12. Cubic Feet per Second (CFS):	5.2
13. Horsepower Input to Motor:	51
14. Percent of Rated Motor Load (%)	92
15. Kilowatt Input to Motor:	38
16. Kilowatt Hours per Acre Foot:	88
17. Cost to Pump an Acre Foot:	$8.34
18. Energy Cost ($/Hour)	$3.60
19. Base Cost per Kwh:	$0.095
20. NamePlate RPM:	1,800
21. RPM at GearHead:	0
22. Overall Plant Efficiency (%):	49

If a Flow Velocity (line 7) less than 1 ft/second, the accuracy of the test is suspect.

Note any major difference between the "Measured" flow rate and the "Customer's" (lines 8,9).

Remarks

All results are based on conditions during the time of the test. If these conditions vary from the normal operation of your pump, the results shown may not describe the pump's normal performance.

ANDERSON PUMP COMPANY

(559) 665-4477

Pump Test Report

v.3.5 10/04/04

Customer and Facility Data

Plant/Location: PUMP- 11/S/S GREENHOUSE RD, 3/4 ML. W/OF EASTSIDE **HP:** 50 **Utility:** PG & E

GPS Coord.: Long 120 N 42.930 Lat 37 W 13.776 **Pump Make:** Johnston

Motor Make: U.S. **Type** Turbine **Meter Number:** 0M719D

Customer Addr: 4S LAND AND CATTLE
8441 SE 68TH- PMB 196
MERCER ISLAND, WA 980405235

Serial Number: H05052BLG

Voltage: 480 **Amps:** 64

Contact: AUGUST OERTZEN **State Well #:** 17-00939

Phone: **Fax:** **Cell:** (209) 668-0680

PUC **Acreage:** 2560+ **Farm Type:** Livestock

Test Results

Test Date: 5/3/2005

Tester: ROBERT PARRISH

Run Number:	1
1. Standing Water Level (Ft):	13
2. Pumping Water Level (Ft):	118
3. Draw Down (Ft):	98
4. Recovered Water Level (Ft):	20
5. Discharge Pressure at Gauge (PSI):	0.5
6. Total Lift (Ft):	119
7. Flow Velocity (Ft/Sec):	4.6
8. Measured Flow Rate (GPM):	**1,171**
9. Customer Flow Rate (GPM):	0
10. Specific Capacity (GPM/Ft draw):	11.9
11. Acre Feet per 24 Hr:	5.2
12. Cubic Feet per Second (CFS):	2.6
13. Horsepower Input to Motor:	68
14. Percent of Rated Motor Load (%)	122
15. Kilowatt Input to Motor:	51
16. Kilowatt Hours per Acre Foot:	234
17. Cost to Pump an Acre Foot:	$22.27
18. Energy Cost ($/Hour)	$4.80
19. Base Cost per Kwh:	$0.095
20. NamePlate RPM:	1,775
21. RPM at GearHead:	0
22. Overall Plant Efficiency (%):	52

If a Flow Velocity (line 7) is less than 1 ft/second, the accuracy of the test is suspect

Note any major difference between the "Measured" flow rate and the "Customer's" (lines 8,9).

Remarks

All results are based on conditions during the time of the test. If these conditions vary from the normal operation of your pump, the results shown may not describe the pump's normal performance.