APPENDIX A

POTENTIAL ADVERSE IMPACT OF PROPOSED OPERATION
EXPANSION PROJECT, ARROYO GRANDE, SAN LUIS OBISPO COUNTY

SUMMARY

Questions have been raised concerning potential adverse impact of proposed operations on fresh water aquifers in and down-gradient of the Arroyo Grande oil field in the Pismo Creek Valley. The fresh water aquifer that could potentially be impacted by operations in the Arroyo Grande oil field is limited to a narrow veneer of alluvium along Pismo Creek.

It is unlikely that the oil would migrate vertically from the oil-bearing rock to the aquifer near the surface due to depth and intervening low permeability strata. The cap rock near the top of the structure has been breached at shallow depths as is evidenced by the natural surface oil seeps on Section 31. It is possible that oil from these natural seeps could enter the stream and find their way into the aquifer.

The tar sands that form the seal on the reservoir are self-healing and historically have not shown evidence of fracturing. Well construction practices in the past have been effective in stopping oil form migrating up a well annulus. Future completions will also adhere to the effective construction requirements the Division of Oil Gas and Geothermal Resources.

The steam injection operations will most likely result in the formation of a steam chest or desaturated zone at the top of the reservoir. Oil movement will predominantly be horizontal or downward as it moves toward lower pressure around producing wells and is drawn downward by gravity. Historically much more fluid has been removed from the reservoir than has been injected, and future operations do not include over injecting to reverse that condition.

INTRODUCTION

Questions have been raised concerning potential adverse impact of proposed operations on fresh water aquifers in and down-gradient of the Arroyo Grande oil field in the Pismo Creek Valley. The questions have related to the stratigraphic and areal relationship between the local aquifer and the planned operations in the field. Questions have been asked about possible migration routes through fractures or up the annulus of a well bore.

Additional concern has been expressed about the potential for steam injection operations to impact fresh water aquifers. These concerns have included questions about the mechanics of steam injection and the potential for oil to be pushed toward the surface.

This brief report is intended to address these questions and to show evidence that supports its conclusions. This report begins with a discussion of the general geology and the groundwater aquifer in the area. It is critical to identify all fresh water aquifers before any potential impact can be assessed.

The data used in preparation of this report includes data supplied by the Client, data already in the possession of Pacific Geotechnical Associates, Inc., data obtained from government agencies and personal communications with the Client's employees and others.

For the purpose of this report reference to the "Project area" refers to the Phase IV development outline labeled "Approximate Project Area" on Map 1.

DISCUSSION

Local Geology

As mapped by Hall (1973) the surface outcrops in the region are composed of hard sandstones, pebbly sands and conglomerates of the Edna Member and the brown clays and silts of the Meguelito Member of the Pismo formation (Map 2). The environment of deposition is described as an inner neritic (shallow marine) shelf (Stanley, K.O. and Surdam, R.C., 1984). This interpretation is based on mega and trace fossils and sedimentary structures.

The local structure is formed by a northwest-southeast trending syncline which is paralleled to the north by a related anticline (see Map 2 and Cross Section A-A'). The oil-bearing sands of the Edna Member dip below the alluvial valley to the southwest of the project area.

Fresh Water Aquifer

The area of investigation is located in the Pismo Creek Valley Subbasin of the Pismo Hydrologic Subarea. Groundwater in the subbasin is restricted to surface alluvium and has been deemed by California Department of Water Resources (2002) to be of poor quality due "faults and mineralized zones, residual saline deposits, and local sea water intrusion." See Appendix 1 for a discussion of groundwater in the area.

The fresh water aquifer that could potentially be impacted by operations in the Arroyo Grande oil field is limited to a narrow veneer of alluvium along Pismo Creek (see Map 3). Wells drilled outside of the alluvial fill encounter marine rocks from the surface and because of the natural salinity of the marine sediments have little chance of encountering fresh water aquifers. Analysis of the SP log in "Titan" 68 just outside of the alluvial fill indicates total dissolved solids (TDS) of 3,000 ppm from the shallowest readings which are about 60 feet below the surface. (see Log Illustration 1 and Appendix 2).

Water wells within the alluvial valley are located along Price Canyon Road (see Map 3). The nearest water well, Well 1, is more than one-half mile from the southern limit of the

Project area. The well is reported to be less than 100 feet deep and is developed in the alluvium. The well has tested poor quality water (high total dissolved solids), but the sample was not tested for petroleum hydrocarbons (Tim Cleath, 2005, per. comm.).

POTENTIAL IMPACT ON FRESH WATER AQUIFERS

Location of Water Wells and Stratigraphy
The oil-bearing rocks of the Pismo formation are projected to be seven to eight hundred feet below the surface in the area of the water wells on Section 6. Driller's logs and cores in wells in the northern half of Section 6 describe many tens to hundreds of feet of shale, silt and shell (low permeable rock) above the oil-bearing sands. Any naturally migrating oil in the area would migrate through the sands toward the top of the structure to the north on Section 31. It is unlikely that the oil would migrate vertically from the oil-bearing rock to the aquifer near the surface.

The cap rock near the top of the structure has been breached at shallow depths as is evidenced by the natural surface oil seeps on Section 31. It is possible that oil from these natural seeps could enter the stream and find their way into the aquifer.

Possible Migration Paths – Fractures, Well Annulus
Tar sands form the seal that trap the oil accumulation in the underlying sands. Tar sands are pliable and are self-healing when disturbed by structural deformation and are not likely to fracture. The tar in the pore space forms a sealing surface even if the sedimentary units are offset. Examples of analogous oil fields that have similar geologic conditions and tar seal traps and which are also being steam injected are Kern River and Cymric oil fields located in the San Joaquin Valley, California.

Standard industry and California Division of Oil Gas and Geothermal Resources approved practices for well design, tubular goods, and cementing the casing serve to prevent the upward escape of down-hole fluids. Injection pressures are closely monitored to keep them well below the fracture gradient of the rock. Thirty years of successful steam injection and producing operations in the Arroyo Grande oil field demonstrate the integrity and safety of the engineering practices and ongoing operations (Graph 1).

To the authors knowledge there have been no reported new seeps or increased seep activity in the thirty years of thermal operations in the field.

POTENTIAL FOR STEAM INJECTION IMPACT

Mechanics of Steam Operations
Steam supplies heat which lowers the viscosity of oil allowing it to flow more readily toward the well bore. In a mature reservoir such as the oil-bearing rocks of the Pismo

formation (locally known as the Dollie Sand) more steam is required to maintain heat in the reservoir and to reach parts of the reservoir that have not been heated before.

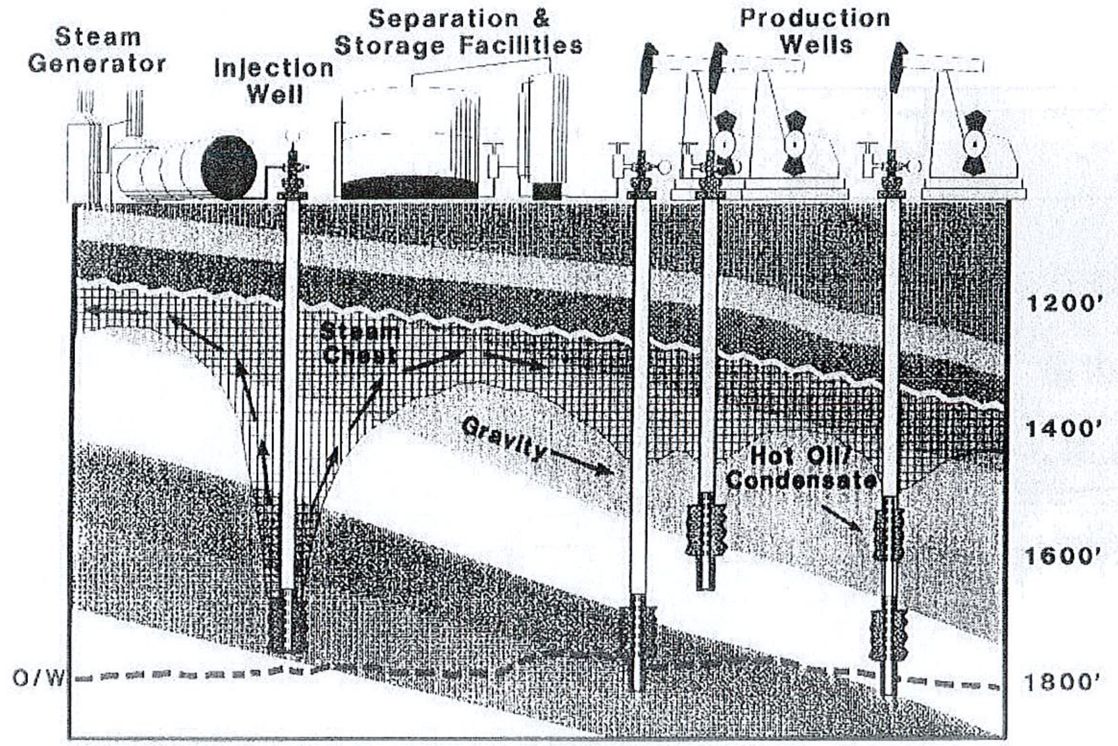


Figure 1. Diagramatic illustration of steaming operation. Steam from injectors and cyclic steamed producers finds its way upward in the reservoir toward the steam chest (gas rises over fluid). Water vapor condenses as the steam cools and heat from the steam lowers the viscosity of the oil. Gravity and lower pressure around the well bore motives the oil toward the producing wells. Picture from "Fieldtrip Guide: from the Sierras to the Sea." April 1992. Bob Timmer and Mike Wracher, editors.

As steam is injected a "steam chest" forms (see Figure 1). This is a part of the reservoir that has been drained of most of its fluid. Initially these pockets are thin and localized. As the oil flows downward toward producing wells the steam chest grows at the top of the sand.

Eventually the steam chest will expand to engulf the entire reservoir, usually from the top down. Evidence of local desaturation is found in wireline logs in the main part of the field in the center of Section 31. (see Cross Section B-B').

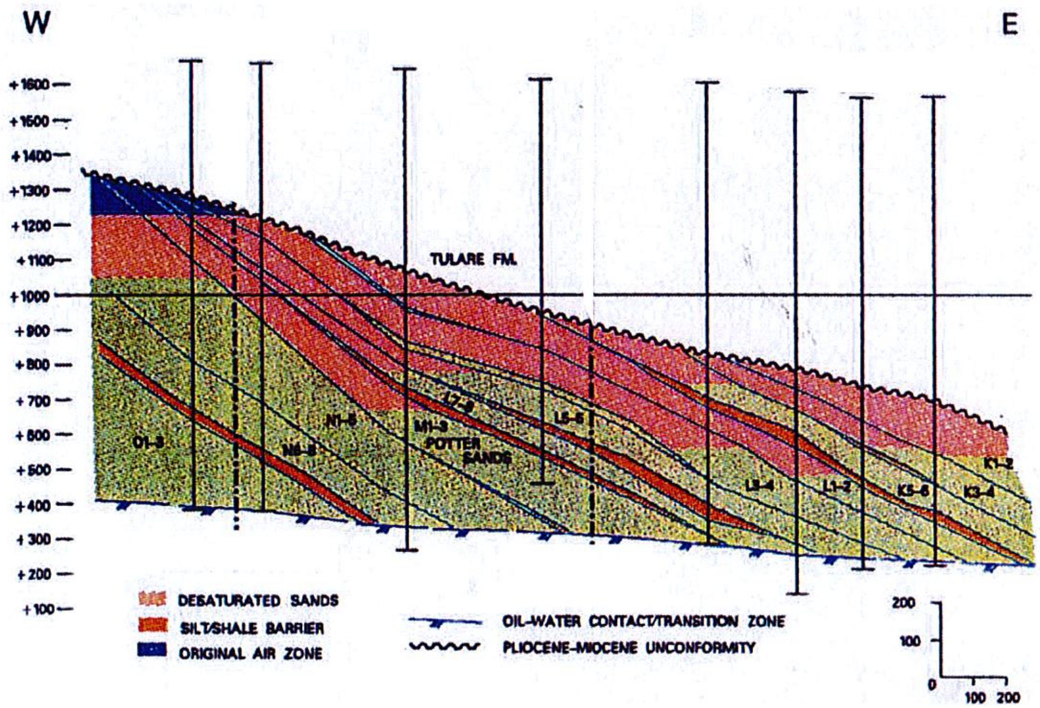


Figure 2. Example of a mature oil reservoir with multiple steam chests (pink areas) at the top of the oil reservoir. Green indicates areas of remaining oil saturation.

Potential for Oil to Be Pushed Toward the Surface

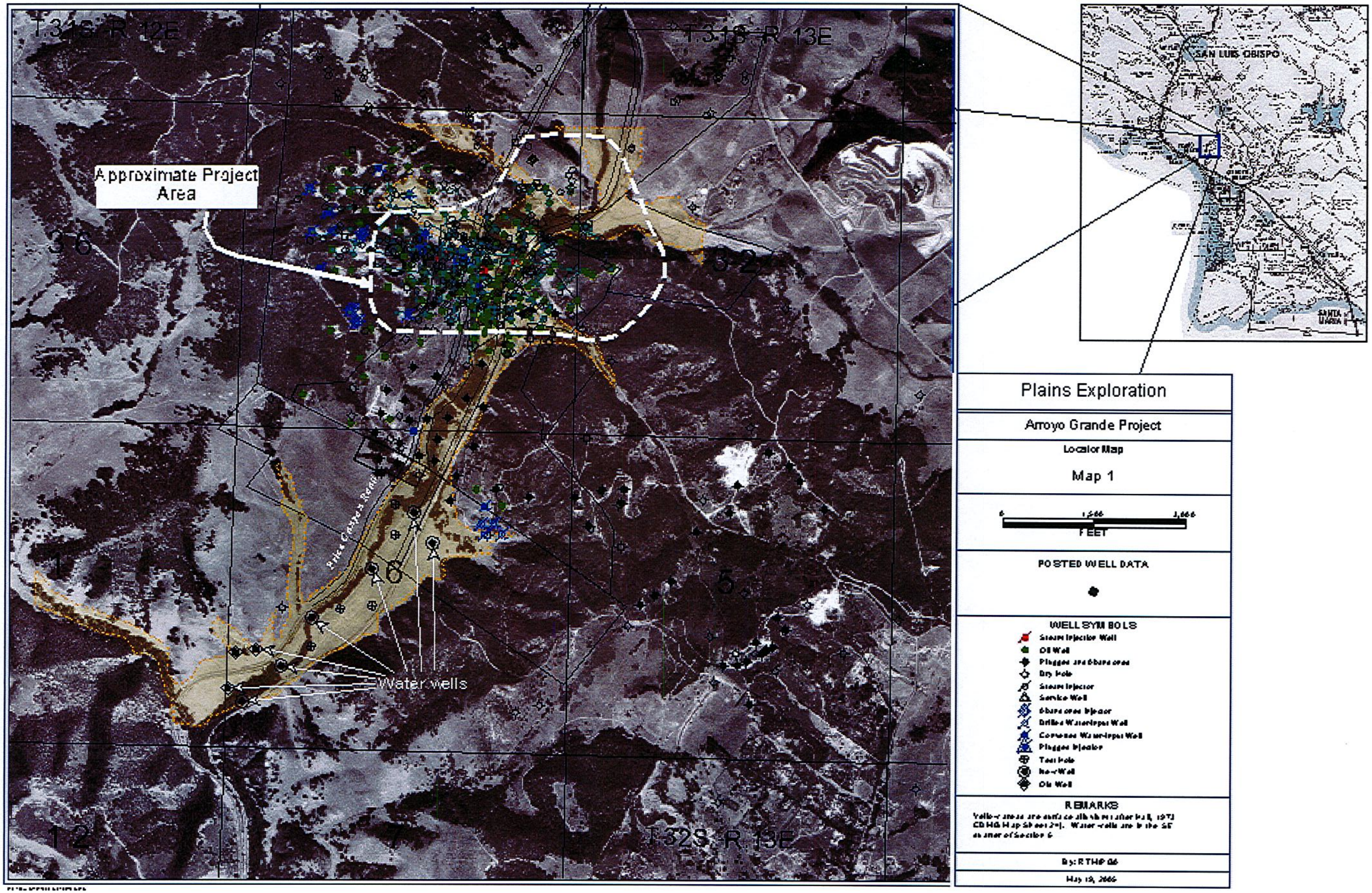
With the formation of a steam chest it is unlikely that any oil will travel upward toward the aquifer. Producing wells are constantly drawing down the pressure in the reservoir, and historically much more fluid has been taken out than has been put in. Graph 2 illustrates the amount of fluid that has been taken out versus the amount that has been injected, and it shows that the planned operations do not include reversing that condition.

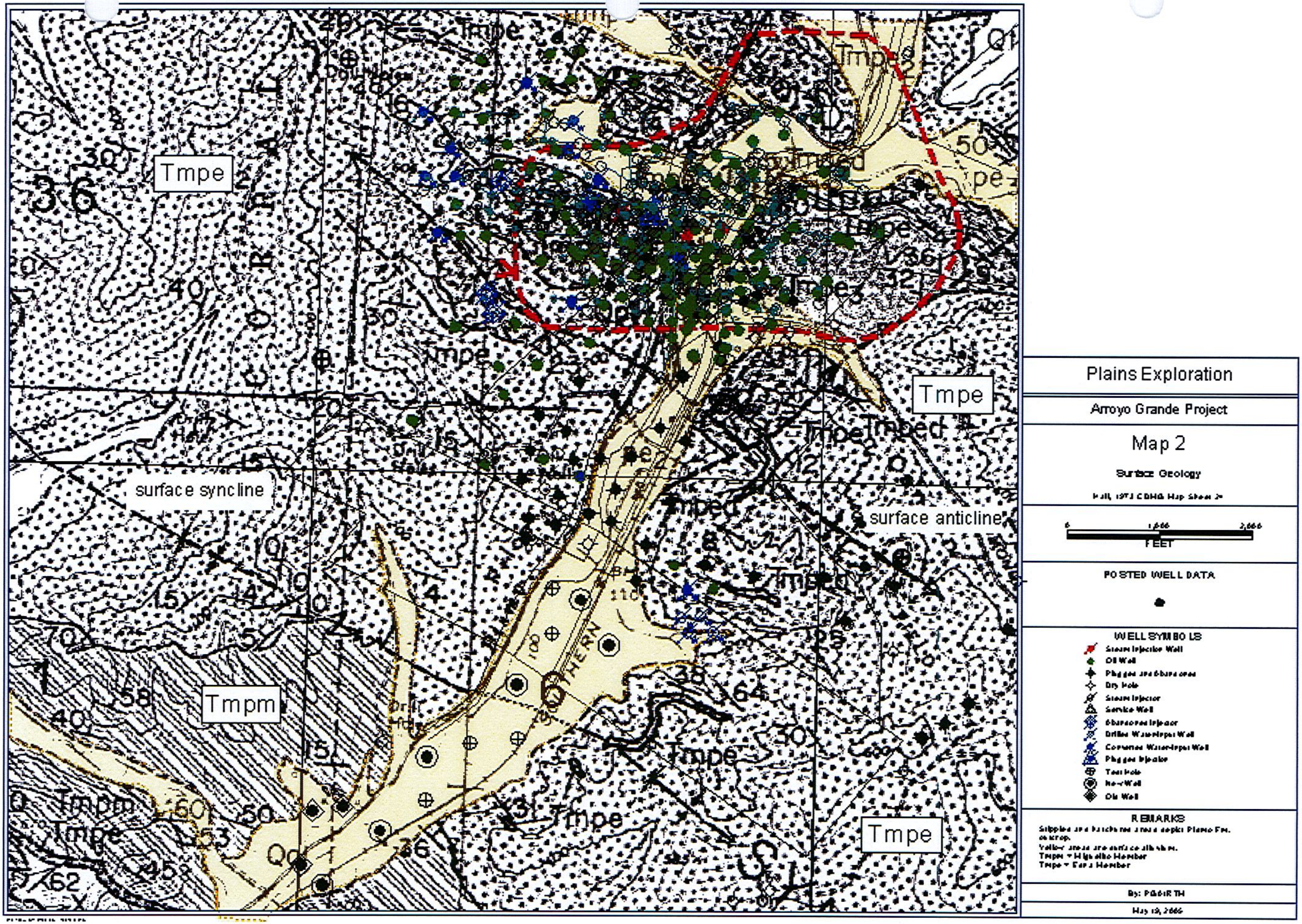
Closing

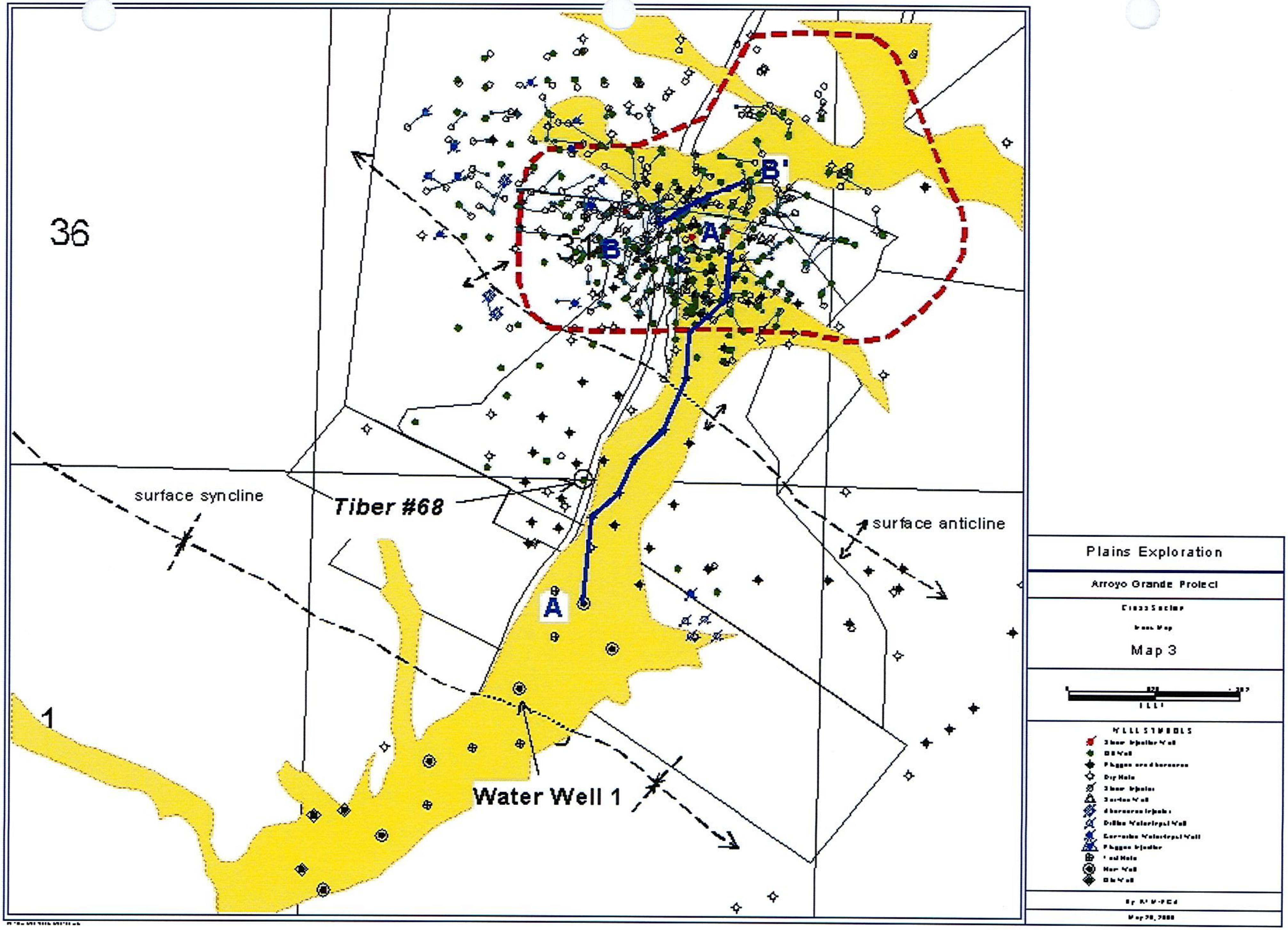
The findings and recommendations listed above are based on a brief review of data obtained from sources named above and PGA's experience in the Arroyo Grande area. It is by no means a comprehensive study and the facts and conclusions are subject to revision as more data are analyzed. The preparer does not warrant the accuracy of the results or predictions contained herein.

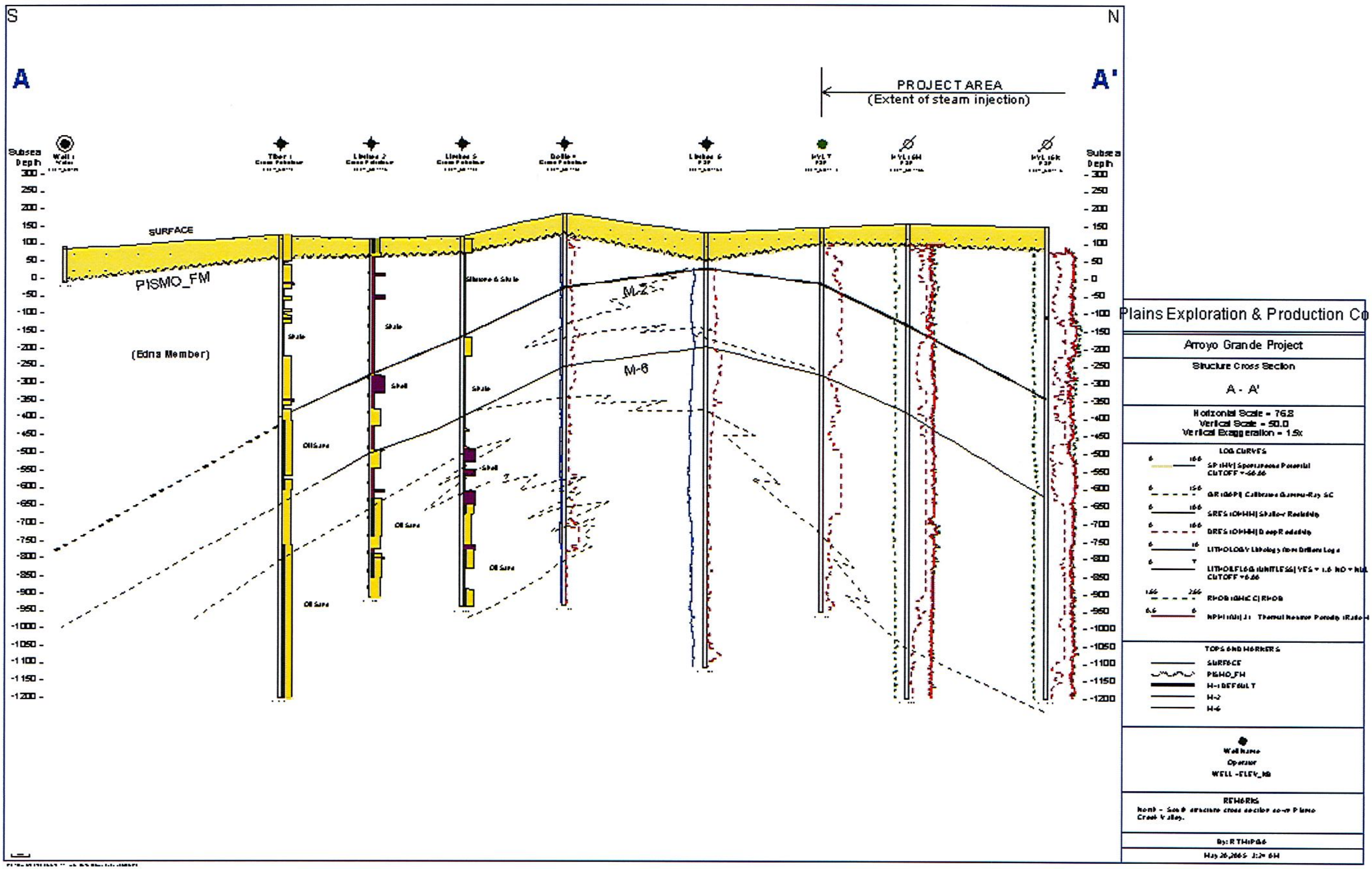
This report is proprietary and confidential, to be delivered to, and intended for the exclusive use of, the above named client only. The preparer assumes no responsibility or liability for the reliance herein or use hereof by anyone other than the above named client.

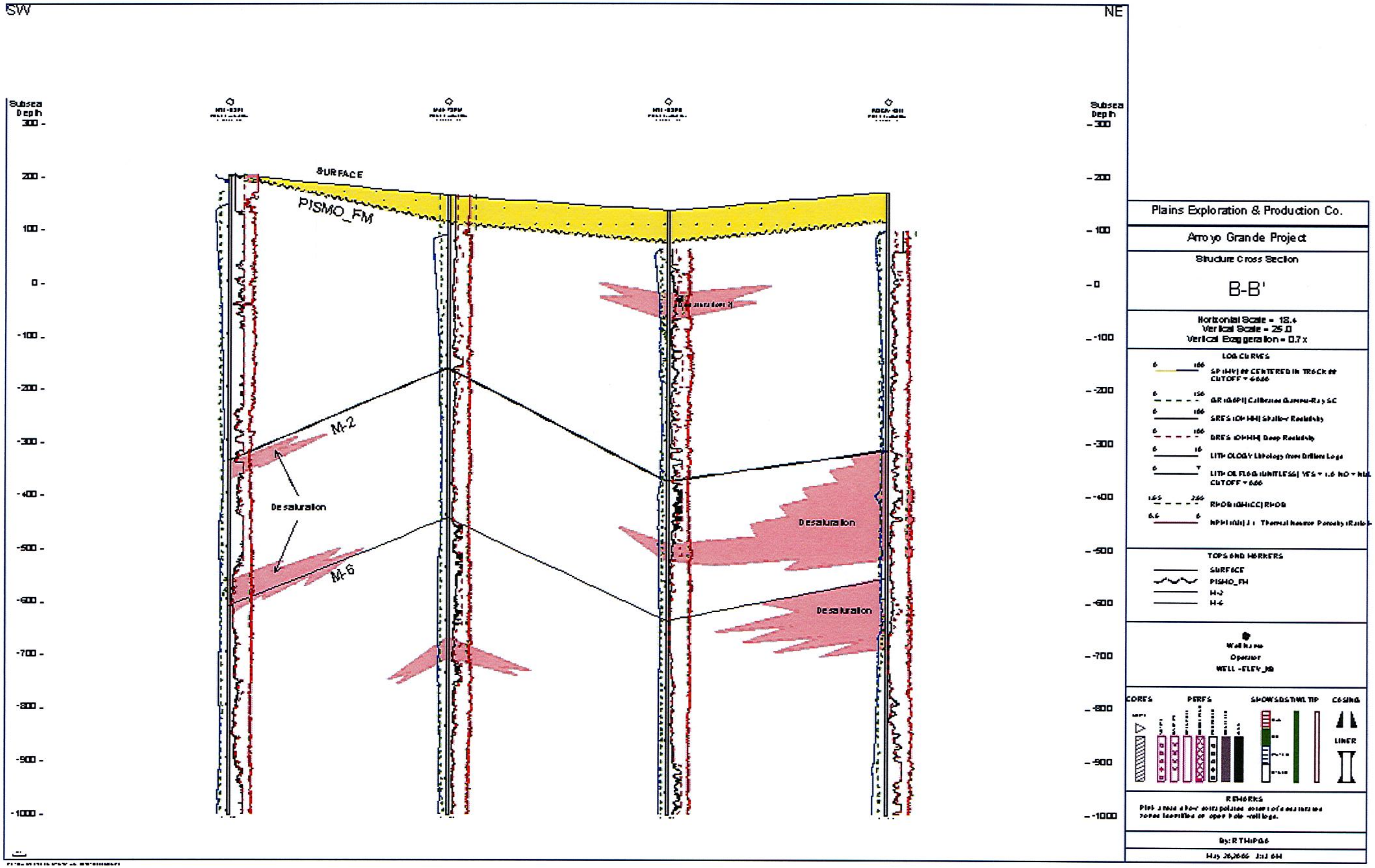
Randall T. Metz R.G.
President


T.31S R.12E
T.31S R.13E
T.32S R.13E
Approximate Project
Area
Water wells
16
1
12
7
6
5
SAN LUIS OBISPO
SANTA MARIA
Plains Exploration
Arroyo Grande Project
Locator Map
Map 1
FEET
POSTED WELL DATA
WELL SYMBOLS
Oil Well
Dry Hole
Steam Injector
Service Well
Test Hole
REMARKS


Plains Exploration
Arroyo Grande Project
Map 2
Surface Geology
FEET
POSTED WELL DATA
WELL SYMBOLS
Oil Well
Dry Hole
Service Well
Test Hole
REMARKS
By:
Tmpe
Tmpm
Tmped
surface syncline
surface anticline


36
31
1
B'
A'
B
A
surface syncline
Tiber #68
surface anticline
Water Well 1
Plains Exploration
Arroyo Grande Project
Map 3


S
N
A
A'
PROJECT AREA
(Extent of steam injection)
Subsea Depth
SURFACE
PISMO_FM
(Edna Member)
M-2
M-6
Shale
Shell
Oil Sand
Siltstone & Shale
Plains Exploration & Production Co
Arroyo Grande Project
Structure Cross Section
A - A'
Horizontal Scale = 76.8
Vertical Scale = 50.0
Vertical Exaggeration = 1.5x
LOG CURVES
TOPS AND MARKERS
REMARKS


SW
NE
Subsea Depth
300
200
100
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1000
SURFACE
PISMO_FM
M-2
M-6
Desaturation
Desaturation
Desaturation
Plains Exploration & Production Co.
Arroyo Grande Project
Structure Cross Section
B-B'
Horizontal Scale = 18.4
Vertical Scale = 25.0
Vertical Exaggeration = 0.7 x
LOG CURVES
TOPS AND MARKERS
SURFACE
CORES
PERFS
CASING
LINER
REMARKS

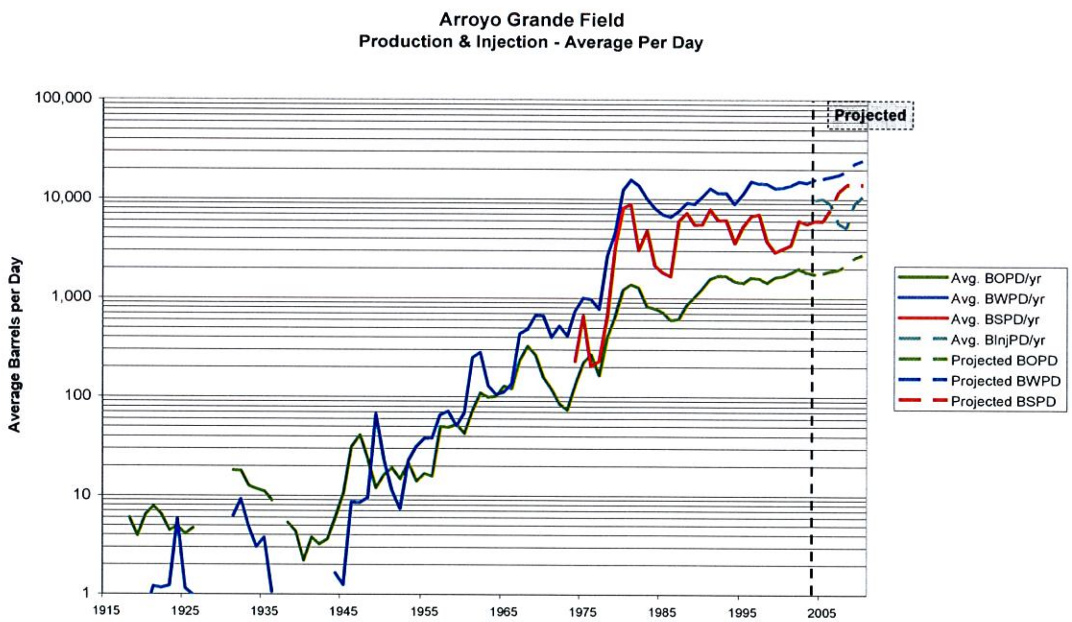
Map 1. Locator map.

Map 2. Surface geology map.

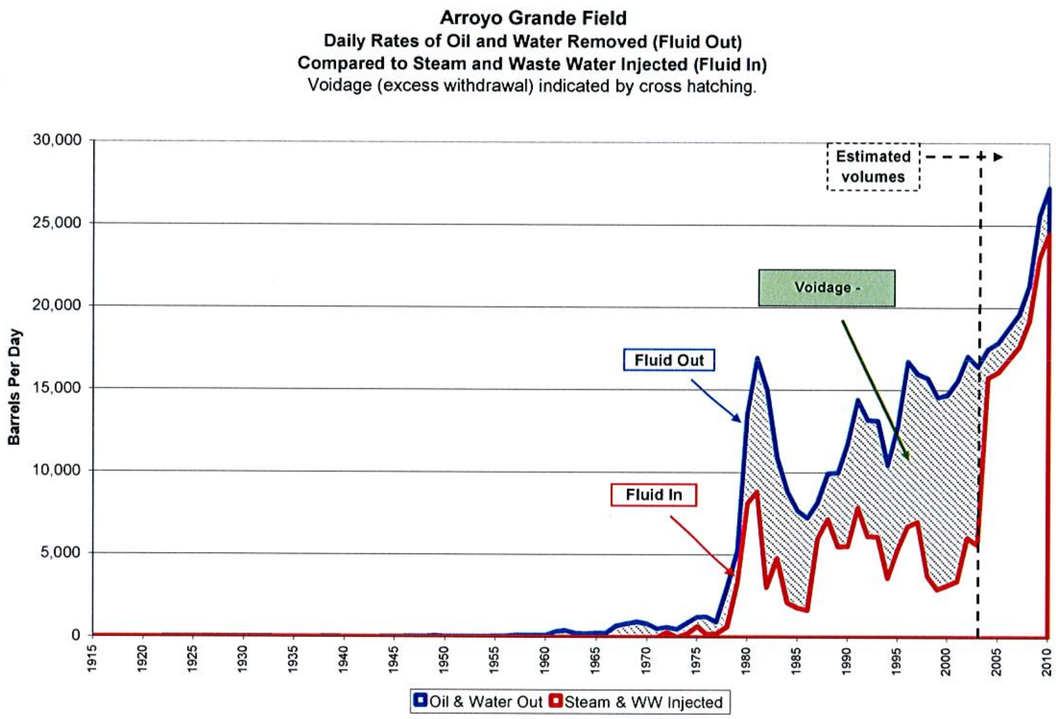
Map 3. Cross section and referenced well locator map.

Structure Cross Section A-A'.

Structure Cross Section B-B'.



Graph 1. Historical oil and water production and steam injection (solid lines) and projected volumes (broken lines).



Graph 2. Historical fluid withdrawal and fluid injection along with projected volumes (right of the vertical dashed line).

REFERENCES

California Department of Water Resources, 2005, http://well.water.ca.gov/

California Department of Water Resources, Division of Planning and Local Assistance, Southern District, "Water Resources of the Arroyo Grande – Nipomo Mesa, 2002", http://wwwdpla.water.ca.gov/sd/water_quality/arroyo_grande/arroyo_grande-nipomo_mesa.html

California Environmental Protection Agency, State Water Resources Control Board, 2005, http://www.waterboards.ca.gov/centralcoast/images/reg3map_001.jpg

"Fieldtrip Guide: from the Sierras to the Sea." April 1992. Bob Timmer and Mike Wracher, editors

Hall, C.A., 1973, Geology of the Arroyo Grande 15' Quadrangel, San Luis Obispo County, California: Calif. Div. Mines and Geology Arroyo Grande 15' quadrangle map sheet 24.

Stanley, K.O. and Surdam, R.C., 1984, The Role of Wrench Fault Techtonics and Relative Changes of Sea Level on Deposition of Upper Miocene – Pliocene Pismo

Formation, Pismo Syncline, California *in* A Guidebook to the Stratigraphic Tectonic, Thermal, and Diagenetic Histories of the Monterey Formation, Pismo and Huasna Basin, California: SEPM Guidebook No. 2, p.21-37.

APPENDIX 1

Groundwater in the Pismo Creek Valley Subbasin

The following are agencies with jurisdiction in the Project area. Included are conclusions regarding the region from the respective agencies.

CRWQCB
The Arroyo Grande oil field lies with the Pismo Creek Valley Subbasin of the Estero Bay hydrologic unit within the Central Coast Region of the California Regional Water Quality Control Board (Figure Appendix-1).

CDWR
The California Department of Water Resources authored a report describing basins and watershed in 2002 in a document titled "Water Resources of the Arroyo Grande – Nipomo Area." The areal extent is shown in Figure Appendix-2 from the map presented as Plate I. The aquifer descriptions from this report are cursory and brief.

> "Groundwater flows southwesterly in Arroyo Grande Valley and Nipomo Valley Subbasins."[9]
>
> [9] Groundwater levels in wells in the Pismo Creek Valley Subbasin are not monitored by the county; therefore, no data were available to determine groundwater elevations. (Executive Summary, p. 7)
>
> "Pismo Creek Valley Subbasins. Groundwater occurs in the alluvium. Thickness of the alluvium ranges from negligible to about 60 feet near the southern boundary. Groundwater is unconfined.

> In some parts of the subbasins, the alluvium may be saturated only during rainfall." (Chapter V, Hydrogeology, p. 55)
>
> "No recent groundwater quality data were available for Pismo Creek Valley Subbasin. The historical data consist of analyses from seven wells sampled in the 1950s and 1960s. Given the data limitations, no trend analysis or box plots were developed for this part of the basin. The data indicate that groundwater quality in Pismo Creek Valley Subbasin generally did not meet Drinking Water Standards for sulfate, chloride, and TDS. Concentrations of sulfate ranged from 740 to 1 mg/L; chloride, from 766 to 49 mg/L; and TDS, from 2,390 to 790 mg/L. Nitrate concentrations in two wells exceeded the MCL. The dominant ions were sodium and chloride-bicarbonate or sulfate-chloride. A study by the Department in 1965 concluded that the poor quality of groundwater in lower Pismo Creek resulted from the presence of faults and mineralized zones, residual saline deposits, and local sea water intrusion. Sampled well depths ranged from 30 to 102 feet." (Chapter VI, Water Quality, p. 122)

The California Department of Water Resources maintains a website (http://well.water.ca.gov/) that shows water elevations for one well in section 19, T31S, R13E (H001), approximately two miles north of the Arroyo Grand oil field and one well four miles to the south in 19, T32S, R13E (Q002). Both of these wells are too far removed from the project area to provide useful data for constructing a local water elevation and aquifer model.

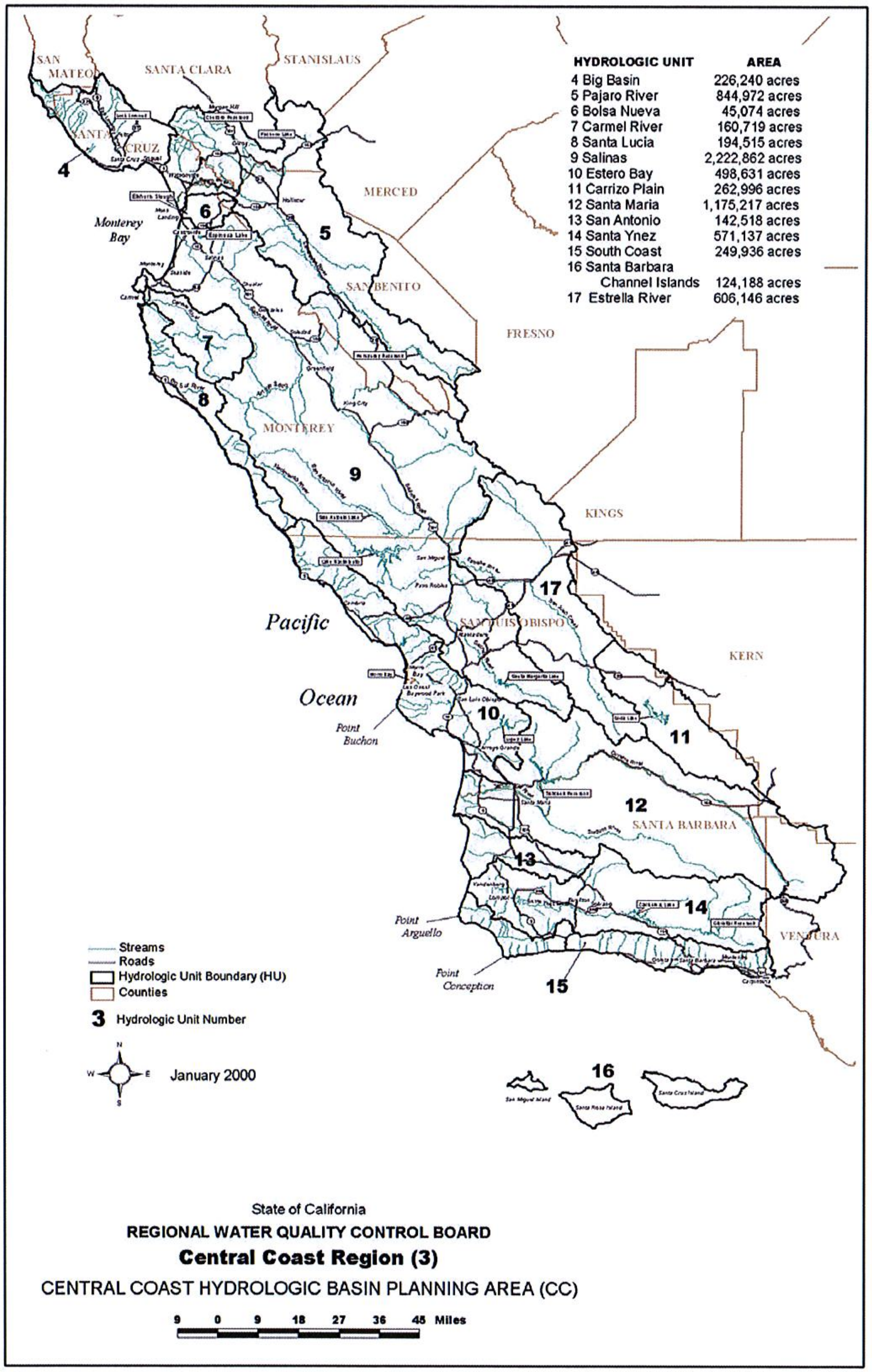
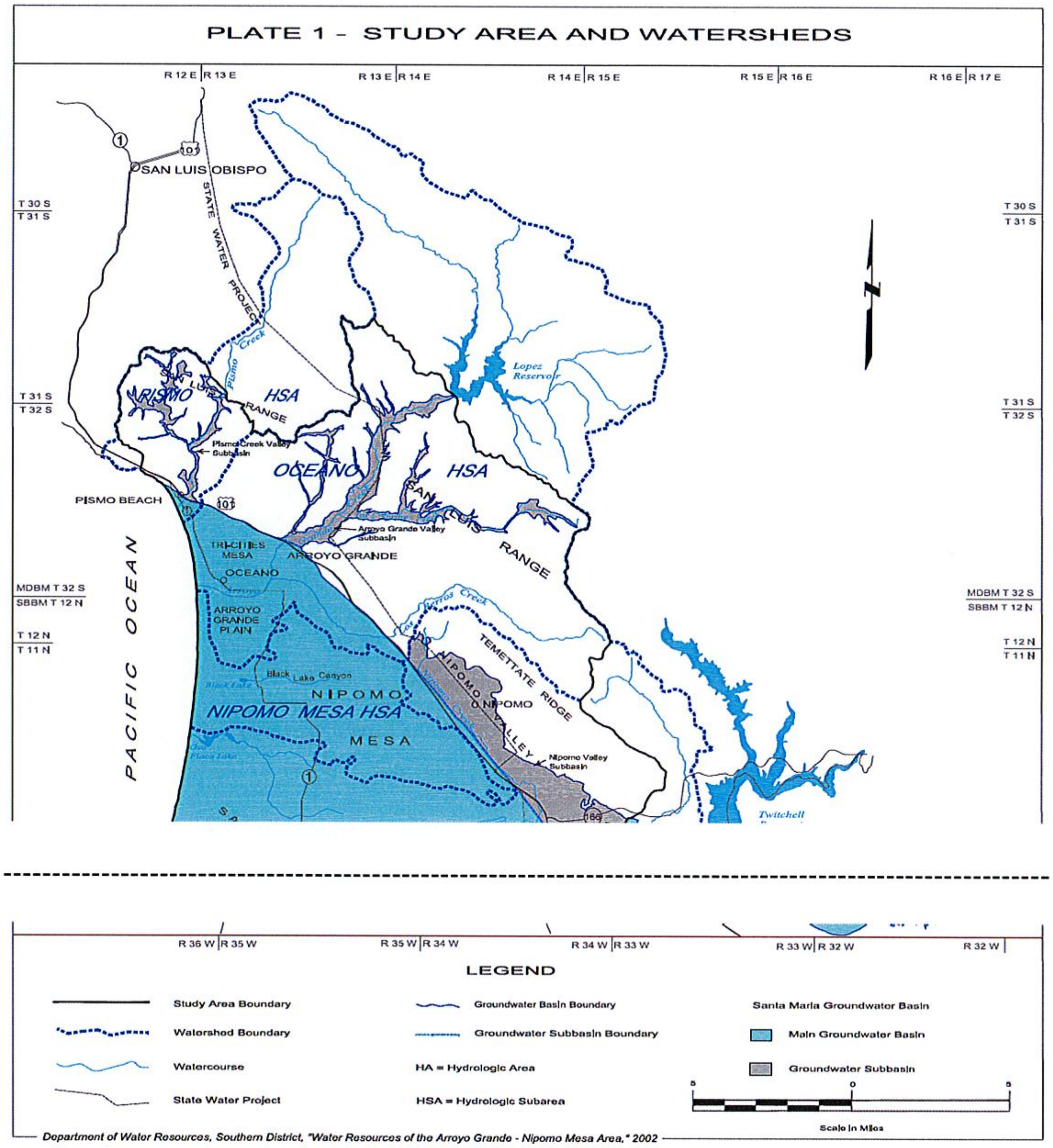


Figure Appendix 1-1



North half of Plate I, "Water Resources of the Arroyo Grande – Nipomo Area", 2002 by the Department of Water Resources, Southern District.

Figure Appendix 1-2

APPENDIX 2

Determination of Ground Water Salinity from SP Log

Groundwater salinity in Plains Exploration *Tiber* # 86, Section 6, T.32S.-R.13E, was determined from the Spontaneous Potential (SP) log and mud filtrate as recorded on the log header. Track 6 of the attached illustration shows a calculated Total Dissolved Solids (TDS) or 3,000 Part Per Million (ppm) or greater from approximately 75 from surface to a depth of 1100 feet below grade. Salinities of almost 8,000 ppm are indicated for the oil bearing sands at about 800 feet.

The equations used to calculate salinities are in WELENCO, 1995, "Water and Environmental Geophysical Well Logs" Vol I., Technical Information and Data, 7th edition, p. 12.

The variables used in this calculation include:

Surface Temperature:	65 °F, log header, log header
Mud Filtrate Resistivity:	2.43 ohm-m @ 65 °F, log header
Bottom Hole Temperature:	125 °F, log header
Total Depth:	2478 ft.
SP:	Log

An SP Baseline (SSP_B) and a VShale (shale volume) calculation were used as discriminators to eliminate non-sand intervals.

These formulae are used to obtain water salinity:

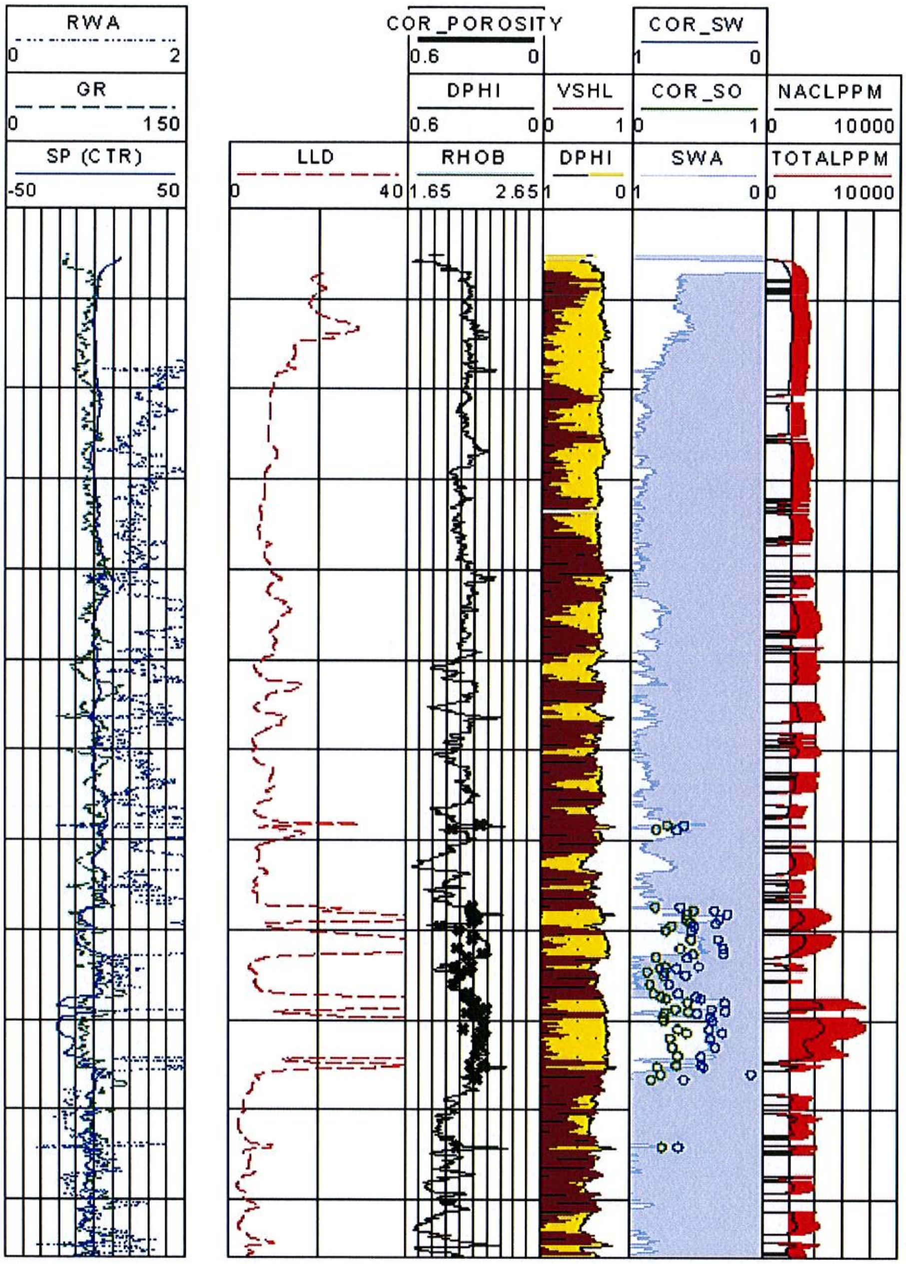
1. $R_{mf}^{corr} = [R_{mf}^{@meas\ tem}(Temp + 6.77)/81.770]$
2. $R_{we} = R_{mf}^{corr}/10^{(sp/-70.7)}$
3. $Rw^{NaCl} = (R_{we}^{1.227})0.825$
4. NaCl ppm = $5300/Rw^{NaCl}$
5. TDS ppm = 1.65 NaCl ppm

Log Illustration 1. Plains Exploration *Tiber* # 86, Section 6, T.32S.-R.13E

Tiber 68

Plains Exploration

ELEV_KB : 165



TD : 2,490

Plains Exploration & Production Co.

Arroyo Grande Project

Composite Log IDS

Log Illustration 1