APPENDIX C
ENTRIX DOCUMENTS

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SUPPLEMENTAL INFORMATION TO LAND USE APPLICATION

Plains Exploration and Production Company
Arroyo Grande Produced Water Reclamation Facility

Prepared for:

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Project # 3086103

May 18, 2006

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Plains Exploration and Production Company (PXP) proposes to install a water reclamation facility to treat produced water from its Arroyo Grande Oil Field in San Luis Obispo County, California (Figure 1, Vicinity Map). Purified water would be used to displace existing groundwater use on the oil field, be made available to potential future partners for additional beneficial reuse, and the remainder would be discharged to Pismo Creek according to the terms of a National Pollutant Discharge Elimination System (NPDES) permit. The NPDES application will be submitted in July at the completion of the *Hydrology and Water Quality Study*. Reject water, created by cleaning the reverse osmosis treatment system (RO System), will be re-injected into the oil-bearing formation. A map depicting the Project area and infrastructure in provided as Figure 2 (Site Plan/Layout).

The Arroyo Grande Oil Field is located in Price Canyon approximately 3 miles northeast of the City of Pismo Beach. The Project lies entirely within the 320-acre field, which is within the larger 1,480 acres Price Canyon Unit as defined by the California Division of Oil, Gas & Geothermal Resources. The *Final Plains Exploration and Production Phase IV Development Plan Environmental Impact Report* (Phase IV EIR) (SLO County and Padre Associates, September 2005) contains substantial information regarding the history of operations at the field, current and proposed operations, and environmental information. The Arroyo Grande Produced Water Reclamation Facility (Project) will be almost entirely on property analyzed in that EIR, and as such, the information contained in that document and supporting exhibits are incorporated by reference in to this supplemental information.

This document provides supplemental information to the County's Land Use Permit form. The information is organized as follows:

- Section 2 provides a description of the purpose and need for the Arroyo Grande Oil Field Produced Water Reclamation Facility;
- Section 3 provides a Project description;
- Section 4 provides an options analysis, summarizing the options considered by PXP for disposal, discharge, and reuse of the produced water in the development of this Project;
- Section 5 provides a California Environmental Quality Act (CEQA) environmental checklist, developed using relevant information from the recently certified EIR for the Arroyo Grande Phase IV development Project, supplemented with new environmental information where appropriate.

The Phase IV EIR contains a complete description of Arroyo Grande Oil Field operations, and is incorporated by reference in this supplemental information. Currently, co-mingled oil, water and gas are pumped (produced) from subsurface oil-bearing formations and then separated by surface facilities on the oil field. The oil is sold, the gas is purified and utilized onsite and the produced water is re-injected into the oil producing reservoir. The oil field uses enhanced oil recovery techniques, including injection of steam into the subsurface formation to reduce oil viscosity and more efficiently extract the oil. For approximately 25 years, the Arroyo Grande Oil Field has been using up to 20 percent of produced water for steam production and injection into the producing zone. The remaining 80 percent of excess produced water is also injected into the producing zone, which interferes with the steam injection and therefore lowers the overall efficiency of the thermal recovery process. If the excess produced water could be introduced to a location (below ground or above ground) that does not interfere with the steam injection zone, then the recovery of oil would be greatly enhanced.

Therefore, the primary purpose of the Project is to enhance the recovery of oil reserves by treatment and reuse of excess produced water. Inherent to this enhanced recovery is dewatering the oil-bearing formation by reducing return water flows from the existing oil/water separation process.

The excess produced water will be discharged to Pismo Creek or beneficially reused for irrigation. The anticipated volume of treated water to be discharged is ~20,000 bbl per day (~2.5 acre-feet per day or ~940 acre-feet per year or ~0.84 million gallons per day). The actual volume of treated water will keep pace with oil production at the field.

840,000 gallons/day

As demonstrated in Section 5, the Project will be constructed and operated with no significant impacts, and no public controversy is anticipated. As such, a Mitigated Negative Declaration would be an appropriate level of environmental review under CEQA, and an alternatives analysis is not required. However, consultation with the CRWQCB-CC has indicated a requirement to evaluate a full range of options for water reuse prior to recommending discharge to Pismo Creek. PXP has been actively pursuing such options for approximately 10 years, since 1997. These options are in three general categories:

1. Underground injection of produced water into oil-bearing formations but outside the zone of influence of the steam injection:

   - Injection into the oil-bearing formation onsite, outside the zone of steam influence
   - Injection into the oil-bearing formation offsite, outside the zone of steam influence.

2. Moderate treatment of produced water (oil and gas separation, filtration) followed by discharge to various sources:

   - Water for dust control at landfill, water transported via pipeline
   - Onsite surface discharge into evaporation/percolation ponds
   - Discharge to the City of Pismo Beach waste water treatment plant
   - Blending of produced water with discharge from the City's treatment plant, discharge of the mixture through City's ocean outfall.

3. High degrees of water treatment (reverse osmosis) followed by reuse or discharge to various sources:

   - Displacement of existing groundwater use on the oil field
   - Surface application
   - Surface irrigation or groundwater recharge for edible agricultural use
   - Surface irrigation or groundwater recharge for non-edible agricultural use
   - Discharge to Arroyo Grande Creek (different watershed from the location of the Arroyo Grande Oil Field)

- Discharge to Pismo Creek (same watershed as the location of the Arroyo Grande Oil Field).

The options analyzed within each of these categories are described in the following subsections, including a feasibility assessment.

The results of the options analysis indicate that high degrees of treatment of the produced water are required if the objective of increasing the efficiency of steam-enhanced oil recovery is to be achieved. The current feasible uses for the water are displacement of groundwater use on the oil field, and discharge to Pismo Creek. The system will also be configured for further, future beneficial reuse of the treated water if willing partners are available.

4.1 UNDERGROUND INJECTION OF EXCESS PRODUCED WATER

Injection into the oil-bearing formation, either within the surface footprint of the oil field or offsite, were considered in detail. The objective was to identify a zone or zones within the oil-bearing formation that could accept the anticipated volume of water without significant interference with the steam injection. Onsite injection was the most feasible, since offsite injection would require the acquisition of easements and other entitlements. Geologists were contracted to identify the best areas for re-injection while PXP engineers determined the feasibility of drilling locations and inquired about the necessary permits.

Reason for Elimination

Results from geologic investigations identified some suitable underground formations capable of accommodating additional water, but these locations were offsite and infeasible to buy or lease. Onsite geology primarily consisted of formations not capable of accepting the additional water without interfering with the steam injection. Several test injection programs confirmed that injection was not feasible (small reservoir/pressured increase). Therefore, these alternatives were eliminated from further evaluation since they did not meet the Project objective of enhancing the steam-enhanced oil recovery.

4.2 MODERATE TREATMENT OF PRODUCED WATER AND SURFACE DISPOSAL

This category of options utilizes the existing water treatment technology on the oil field to separate oil and gas from water, and to filter solids from the water. The resulting produced water contains low levels of petroleum hydrocarbons and other compounds. The following options for surface disposal of this water were considered.

4.2.1 USE OF WATER FOR DUST CONTROL AT COLD CANYON LANDFILL

This option would entail construction of a new pipeline, and delivery of water to Cold Canyon Landfill for use as a dust suppressant during the summer. The landfill owners and operators were contacted and the option was discussed. The landfill has limited needs for water, and the cost and impact of a new pipeline were not justified.

Reason for Elimination

This alternative was eliminated based on the limited water needs of the landfill and impacts of a new pipeline.

4.2.2 Onsite Disposal via Evaporation/Percolation Ponds

This option consists of disposal of the moderately treated produced water to on-site ponds, and either evaporation or percolation of the water. Such are in use in some portions of the San Joaquin Valley.

Reason for Elimination

Percolation tests site soil's infiltration capacity indicated that very low percentages of the produced water would percolate. As a result, very large areas would be required for evaporation, rendering the option infeasible.

4.2.3 City of Pismo Beach Waste Water Treatment Plant

Disposing produced water from the Arroyo Grande Oil Field into the Pismo Beach Wastewater Treatment Facility (WWTF) was considered, and a series of communications with the City defined the feasibility of this alternative.

PXP's proposal to the City included sending approximately 840,000 gallons per day of moderately treated produced water in a new pipeline to the WWTF, and paying a fee for treatment costs.

Reason for Elimination

This alternative was primarily eliminated due to capacity constraints at the City's facility. Discussions with the City of Pismo Beach regarding use of their water treatment plant and/or transmission main to the South County Sanitation District outfall were also unsuccessful because City policy prohibits accepting wastewater from outside the City limits.

4.2.4 City of Pismo Beach Ocean Outfall

This alternative consisted of blending the produced water with the discharge from the WWTF, with the mixture discharged to the ocean through the City's outfall.

Reason for Elimination

This alternative was eliminated due to capacity constraints at the City's facility, prohibition on accepting wastewater from outside the City limits, and potential effects to the City's National Pollutant Discharge Elimination System (NPDES) permit for the outfall. This option was also discussed with the City over several years.

4.3 HIGH DEGREES OF WATER TREATMENT AND SURFACE REUSE/DISCHARGE

PXP considered the option of treating the excess produced water by reverse osmosis. This technique is used for water desalination, and can be designed to remove compounds to levels that would render the water harmless to human health and the environment. This treatment requires a substantial capital outlay, and as such the other two categories of water disposal or use (underground injection, disposal of moderately treated produced water) were carefully analyzed to ensure that they did not provide any viable options.

Once the determination of infeasibility of these two categories of options was made, the use of reverse osmosis was considered the most viable technology for producing highly-treated water suitable for reuse. The options described in this section were evaluated carefully, in particular as they may provide some revenue to offset the capital and operational cost of the treatment system.

PXP proceeded with a pilot plant of the proposed treatment components to demonstrate treatability and verify processes needed to meet water quality requirements for both creek discharge and crop irrigation. The pilot plant operated from mid-2005 to April 2006, successfully demonstrating compliance with water quality goals.

4.3.1 DISPLACEMENT OF EXISTING GROUNDWATER USE AT THE OIL FIELD

Currently, groundwater is used for landscaping, non-potable water use, and in rare cases as makeup water for steam production. This reuse option involves reducing or eliminating these uses of groundwater on the oil field, and replacing the groundwater with the highly-treated produced water.

This option was determined to be a viable beneficial reuse of the water.

4.3.2 ONSITE DISPOSAL BY LAND APPLICATION

In February of 2001, PXP retained ENTRIX to determine the area of land required to absorb the water produced at the field, present an application plan and identify key issues which need to be addressed prior to implementation. In March of 2001, a site visit was conducted and two 95-acre parcels of land were identified as being potentially available for land application of produced water.

The USDA Soil Survey for the area was used to identify the type of soil present and the general properties (including infiltration capacity, thickness and permeability) of the soils. Soil properties were then used to determine absorption area required for the treated water produced at the field on a daily basis.

Results indicated that the infiltration capacity of the soil was the limiting factor. Using the USDA data, up to 170,000 gallons of water could be applied per day at a rate of 0.02 ft/hr. The analysis recommended rotating application areas frequently to avoid surface ponding. The technique could not be used during periods of rainfall.

A corollary of this option involved placing percolation ponds in an arrangement to slow seawater intrusion towards the Edna Valley, east of the oil field.

Reason for Elimination

PXP employed Fugro West, Inc in April of 2006 to further investigate the feasibility of surface discharge of treated produced water, focusing on obtaining site-specific measures of infiltration capacity with percolation tests. Results from soil characterization indicate that the land was of low permeability and had been affected by recent faulting, creating barriers to both ground and surface water flow. Further, groundwater was encountered at relatively shallow (15-20 feet below ground surface) depths.

The shallow bedrock underlying the field coupled with minimal Pismo Creek alluvial deposits would result in surface flows to Pismo Creek. Spray disposal would require more irrigable acreage than is available on PXP property. The conclusion was that discharge to Pismo Creek would occur, in any case, especially during portions of the year when irrigation demands were at a minimum.

These factors led to the conclusion that infiltration in this area was marginally suitable, either for disposal or for slowing seawater intrusion, and thus this option was eliminated from consideration.

4.3.3 Beneficial Reuse for Non-Potable Water or Non-Edible Crops

This alternative included the potential for using the highly treated water for landscape irrigation or other non-potable, non-edible material. The water would require transport by pipeline to the proposed locations. The water would either be applied directly to crops, or used for groundwater recharge in areas of existing use. This alternative had the potential to recoup a portion of treatment costs while also serving as a beneficial reuse.

Reason for Elimination

PXP recognized early in Project development that the reclaimed water resulting from the proposed Project has value as a non-potable, dependable water supply source. Dialogue with nearby irrigators was initiated in 1997, including the Edna Valley east of the oil field. None of the parties contacted made firm commitments for water deliveries in some cases, water delivery distances by pipeline made the option unacceptable to many landowners. In addition, the water needs for these uses are episodic, and could not take the continuous volume of water contemplated. Therefore, some creek discharge would still occur.

PXP will design the facility so that, should a willing partner come forward in the future, they could be provided with water for this beneficial use. Although arrangements with specific irrigators have yet to be put in place, PXP fully anticipates seasonal deliveries of reclaimed water for irrigation.

4.3.4 Beneficial Reuse for Potable Water or Edible Crops

Several parcels of land were researched in the areas adjacent to Price Canyon Road in the Edna Valley and Pismo Creek for irrigation. Land owners were contacted and soil borings taken to identify soil characteristics in the area. The water would either be applied directly to crops, or used for groundwater recharge in areas of existing use.

Reason for Elimination

Water for irrigation of edible crops or for potable use would require transport by pipeline to the proposed locations. The water would either be applied directly to crops, or used for groundwater recharge in areas of existing use. PXP does not represent that reclaimed water from the oil field is appropriate for potable purposes nor for application on edible crops. In the interest of perceived public health, no such proposals are under consideration, and as such this option was eliminated.

4.3.5 Surface Water Discharge in Arroyo Grande Creek

PXP entered into dialogue with San Luis Obispo County Flood Control & Water Conservation District Zone 3 for potential beneficial reuse in Arroyo Grande Creek. A conceptual delivery system was laid out, hydrogeologic studies were conducted for introduction into the creek, right-of-way acquisition was researched, and outlines of delivery contracts were discussed.

Reason for Elimination

Arroyo Grande Creek discharge was the original favorable option between the two creek discharge options. San Luis Obispo County discharges water from Lopez Lake to Arroyo Grande Creek to provide water for downstream agriculture users and aquatic habitat. These discharges thereby reduce the amount of water the County can receive from Lopez Lake for potable use. This agreement would allow the County to purchase treated water from PXP for potable use. The County entered into an agreement, Memorandum of Understanding (MOU), in September 2004 with PXP to purchase the pipeline from PXP over an extended period of time. One year later, estimates of operating costs were substantially higher that those under discussion. This option was eliminated owing to high capital costs, high operating costs, and insufficient land to percolate the required 20,000 bwpd.

Furthermore, this option is substantially similar to surface discharge in Pismo Creek, but carries the burdens of much greater cost, and the adverse environmental impacts of new pipeline construction.

4.3.6 Surface Water Discharge in Pismo Creek

As a result of examining the reach of Pismo Creek in the vicinity of the Arroyo Grande field, the preferred discharge location depicted in Figure 2 was selected. PXP's research into the existing setting of Pismo Creek revealed that the reach downstream of the Arroyo

Grande oil field is largely a conveyance for runoff to the ocean and neither the creek nor its alluvium supports municipal or significant irrigation supplies. The primary beneficial use is aquatic habitat.

PXP sought to gauge the relative flow impact of the proposed creek discharge, however, no stream flow records along Pismo Creek were found (i.e., this is an un-gauged creek, likely due to its limited role as a water supply source and lack of flood control facilities). A hydrologic study is underway to measure flows in Pismo Creek from February through June 2006, to use actual flows to calibrate a standard model (HEC-RAS), and to compare to a comparable watershed (Toro Creek north of Morro Bay). Results will characterize baseline conditions and allow analysis of relative flow of the discharge. These data will also characterize the potential changes to instream habitat available as a result of augmented flows in the creek. A workplan is provided in Appendix C.

With regard to surface water quality in Pismo Creek, little published water quality data exists. PXP initiated a sampling program at three locations (upstream, downstream and near the proposed discharge area). The results of that sampling program will help characterize baseline conditions, especially dissolved oxygen and temperature ranges.

This option was determined to be a viable use of the water.

4.4 PROPOSED FEASIBLE OPTIONS

Three feasible uses of the highly treated water were identified in the options analysis, as follows:

- Displacement of groundwater use on the oil field with highly-treated produced water
- Designing the system to allow for further beneficial reuse for non-potable and non-edible uses, should a willing partner be available in the future
- Discharge of highly-treated produced water to Pismo Creek.

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Reasonable Potential Analysis and Options Analysis

Plains Exploration & Production Company

Produced Water Reclamation Facility

1821 Price Canyon Road, San Luis Obispo

March 16, 2007

Prepared for:

Plains Exploration and Production Company

San Luis Obispo, California

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Reasonable Potential Analysis and Options Analysis
Plains Exploration & Production Company
Produced Water Reclamation Facility
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March 16, 2007

APPENDICES

Attachment A: Results of Produced Water Sampling
Attachment B: Laboratory Reports

TABLES

Table 1: Summary of Attributes of Beneficial Use Options in Addition to Augmenting Flow in Pismo Creek

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Response to Request

This response provides additional information in response to your letter of October 6, 2006 regarding Plains Exploration & Production Company's Report of Waste Discharge for its proposed Produced Water Reclamation Facility on the Arroyo Grande Oilfield in San Luis Obispo County, California. ENTRIX has been retained by PXP to assist with permitting, and this response is submitted on behalf of PXP. ENTRIX submitted responses to your letter on October 27, 2006. We met with you on October 31, 2006 to better define the data needs, and received guidance on additional data needs for Items 4 (Reasonable Potential Analysis) and 5 (Options Analysis). This response presents the requested information for these two items as well as items 2 and 3. We believe that the information provided will be sufficient to allow you to deem our application complete. The request is presented in italics, followed by the response.

NPDES Application

2. *Please submit owner's name and mailing address for each property adjacent to the discharge location.*

As we discussed, the Regional Board considers "adjacent" to be within 300 feet of the discharge location. PXP is the only landowner within 300 feet of the discharge location.

3. *An application fee equal to the first annual fee must be submitted, and will be billed annually thereafter as long as the discharge continues. The fee is based upon the facility complexity and potential threat to water quality (1A in the State Water Board rating system). Additional information regarding these fees is available online at http://www.swrcb.ca.gov/fees/docs/adoptedfeeschedule.html#flowlessthan100. Please submit your application fee of $18,871. Make check payable to the State Water Resources Control Board.*

The fee will come under separate cover, for delivery to the Regional Board on March 20, 2007.

4. *In the report Revised Hydrologic, Water Quality, and Biological Characterization of Pismo Creek, prepared by ENTRIX, Appendix D incorrectly summarizes applicable water quality criteria. Provided as Attachment 1 to this response is a summary of water quality criteria applicable to Pismo Creek, which we will use to evaluate compliance. Please use the criteria provided to evaluate potential for the proposed discharge to violate water quality standards. This "reasonable potential analysis," as it is termed in the State Implementation Policy, will be used as the basis for effluent limitations appearing in your permit. The steps used to prepare the reasonable potential analysis are summarized in Attachment 2 (excerpts from the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California). The Policy in its entirety is available online at: http://www.waterboards.ca.gov/iswp/docs/final.pdf. Alternatively, Water Board staff can complete the reasonable potential analysis. However, your submittal does not make clear which constituent data reflects treated effluent and telephone conversation with your agent, Dan Tormey, indicates that no*

effluent data is included. Therefore, if you prefer that Water Board staff complete the analysis, please submit effluent data and corresponding compliance with appropriate water quality criteria specified in Attachment 1.

More Detailed Process Description.

In our meeting of October 31, 2006, you requested further information regarding the operation of the water reclamation facility. This section provides a more detailed process description, and a brief summary of the pilot testing that was conducted to validate the manufacturer's warranties for the system.

PXP, in anticipation of developing a Produced Water Treatment Plant at its Arroyo Grande Field has conducted extensive pilot testing during a seven month period between 2005 and 2006. The pilot testing was used to validate the design concept of the water treatment plant as well as demonstrate consistent performance results. The final phase of the pilot testing operated the system without the lime-softening pretreatment for a 30-day period to demonstrate that the system would continue to maintain removal efficiencies even under difficult operating conditions. The results of the pilot test data validated the manufacturer's predications, giving PXP confidence that the treatment plant will meet discharge requirements.

The water plant can be divided into two parts. The first part will consist of pretreatment to soften, filter and cool the produced water. The second part of the process will consist of reverse osmosis (RO) and air stripping to remove the regulated constituents prior to discharge. The following describes the treatment plant, the removal of constituents of concern, process predictability and process reliability.

Process Description

The water plant will consist of a series of processes starting with warm-lime softening, deep-bed filtration, strong-acid cation softening (ion exchange) and cooling. The warm-lime softener will remove most of the scale-forming minerals in the produced water, i.e. calcium, magnesium, alkalinity, silica, etc. The deep-bed filters will remove residual particulate matter from the water. Each of the filters will contain three feet of fine garnet and will be operated at a flow rate to optimize particulate removal. The cation softeners will remove residual hardness. At this point in the process, the water is of a quality to be used for high-pressure steam generation, i.e. free of hardness and highly filtered. The water will then be cooled to 80 °F to 90 °F prior to the introduction into the membrane processes.

Pretreated water will then pass through microfilters to remove any residual/fine particulate matter. Microfiltration is a membrane process (similar to RO), and in the AG plant, it will be used to protect the RO from fouling. Microfilters will remove sub-micron particulate matter a hundredfold smaller than the deep-bed filters are capable of (or other types of media filtration, e.g. sand filters or carbonized zeolite filters). After the microfilters, the water will pass through another set of strong-acid cation softeners. These are considered guard softeners and will capture any trace levels of hardness that might pass in pretreatment. At this point in the process the water is ready to be introduced into the RO system, i.e. highly filtered and free of mineral-scale constituents.

The remainder of the treatment system will consist of two stages of RO and air stripping, i.e. 1st Pass RO followed by air stripping followed by a 2nd Pass RO. These processes will treat the water to meet the discharge criteria for Pismo Creek. Target parameters and constituents of

concern are turbidity, pH, temperature, dissolved oxygen, sodium, chloride, sulfate, boron, non-ionic ammonia, acetone and 2-butanone. Occasionally, there are also trace levels of BTEX.

To meet discharge requirements, the plant will be designed with a two-pass RO system. The 1st Pass RO will be operated at high pH (11.5) and will remove soluble species of minerals salts, e.g. sodium, chloride, sulfate and boron. Reject (wastewater) from the 1st Pass RO will be injected back into the oil-producing formation. Permeate (treated water) from the 1st Pass RO will be sent to air strippers. The air strippers will remove some non-ionic ammonia and most of the acetone and 2-butanone. At high pH, 99.5% of the ammonia is in the non-ionic form and is easily stripped. Occasional levels of BTEX will be easily removed to non-detectable levels, because the air strippers are sized to remove acetone and 2-butanone (which are significantly less volatile than BTEX). Additionally, the strippers will cool the water and completely oxygenate it.

The pH of the water from the strippers will be lowered to neutral and fed to the 2nd Pass RO. At neutral pH, 99.0% of the ammonia (not removed by the stripper) will be converted to ionic ammonia. The 2nd Pass RO will readily remove ionic ammonia as well as further reduce the levels of sodium, chloride, sulfate and boron. The permeate from the 2nd Pass RO will have no measurable turbidity. Reject from the 2nd Pass RO will be recycled for other uses in the plant. 2nd Pass RO permeate will be discharged to Pismo Creek.

All of the processes described above were part of the pilot testing conducted at AG.

Process Predictability

During pilot testing, a significant amount of data was collected to monitor constituent removal. These data were routinely compared to well established RO and air stripping models which predict performance.

RO is a mature technology and has been commercially available for over 30 years. As such, RO membrane manufacturers have developed models that are used to predict permeate quality for a range of waters from low-TDS tap water to brackish water to seawater. Prior to pilot testing, several membrane manufacturers were consulted and predictions were developed for the RO components of the treatment plant. These were used to develop the proof-of-concept testing parameters.

Likewise, air stripping is a very common treatment technology used throughout the US to treat groundwater containing volatile constituents. Air stripper packing manufacturers were consulted to determine the operating requirements for the strippers which were tested in the field.

Pilot test data was validated by manufacturer predictions of performance. The percent removals of the key ionic constituents, listed in the "Process Description" above, are never more than three percent below manufacturer predictions, and in some cases the removals are much greater than these predictions. Pilot test results for the air stripper predict the same removal efficiencies for the volatile compounds.

Process Reliability

Several advantages of the process at AG are constant produced water chemistry and feedwater flow. Water treatment plants are more reliable if the feedwater chemistry remains constant. Variable feedwater chemistry requires constant adjustments to operation which usually lead to operating problems. Likewise, constant flow provides for stable operation.

During our meeting on October 31, 2006, you asked that we compare our treatment system to that installed at the Greka Asphalt Plant in Santa Maria. The two plants are fundamentally different, and we do not expect to face the same challenges at Arroyo Grande. The principal differences are as follows:

- The water supply at Arroyo Grande will have constant chemistry and temperature (slight variation year to year) and will be fed to the water treating system at a constant rate. Keeping these parameters uniform is critical to the successful operation of any water treatment system. At Greka, there are a number of water sources – each with a very different chemistry, flow and temperature. Several of the sources have high mineral content and significant levels of petroleum byproducts – both of which create a high fouling potential for any RO system.

- The Greka plant is designed for two levels of filtration – filters for particulate removal and a carbonized-zeolite filter for organic removal (and some particulate removal). These types of filtration can be useful in protecting RO equipment if the stream chemistry and flow is constant. They treat a number of different streams being treated at Greka – boiler blowdown, occasional brine streams (from boiler feedwater softeners), cooling tower blowdown (which can have very high levels of particulate matter and bacteria) and crude tank residues. As configured, the Greka RO system is exposed to mineral-forming scale (there appears to be no hardness removal process) and particulate and petroleum fouling.

PXP is confident that the treatment plant will meet discharge requirements.

Determination of Constituents for Monitoring/Reasonable Potential Analysis

This section provides a specific answer to the question cited above. To determine what constituents from the produced water should be monitored to ensure protection of the aquatic resources identified in the Basin Plan and to meet the requirements of a Reasonable Potential Analysis (RPA), PXP conducted 3 separate water quality analysis of the produced water prior to treatment on January 4, 18, and 25, 2007. The collected water was analyzed for the Priority Toxic Pollutants as specified in the attachment to the letter of October 27, 2006 from the Central Coast Regional Water Quality Control Board and the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California.*

As we discussed, we used the following approach in determining which compounds should be included in the monitoring and reporting program. First, we analyzed samples of produced water prior to treatment. If the compound is not detected in the untreated water, then it will not occur in the treated water. Second, if the compound is detected in untreated water, but at levels below the applicable standard, then it will not occur in the treated water at levels that exceed the standard. Third, if the compound is detected at levels that exceed the applicable standard, then it is recommended that the compound be monitored during operation of the system. As we discussed, and as is common practice, if the method detection limit exceeds the regulatory standard, then a result of "not detected" is considered to mean the regulatory standard is met. Finally, we do not propose to conduct a Reasonable Potential Analysis to allow discharge of compounds at levels that exceed the applicable standard. Although several compounds in Pismo Creek exceed the standards provided in your letter of October 27, 2006, we do not propose to

allow the proposed Facility to discharge water with constituent concentrations above the standards.

The results of the sampling and analysis of produced water (Attachment A, full laboratory reports are provided in Attachment B) indicate that two of the Priority Toxic Pollutants Effluent Limits were exceeded, Benzene and Phenol. Benzene in the produced water prior to treatment exceed the recommended effluent criteria during the January 4 and 18, 2007 sampling and Phenol from the produced water prior to treatment exceeded the recommended criteria during all three water sampling events. All other results were either not detected, or detected below the effluent limits for the Priority Toxic Pollutants.

Based on the water quality sampling results, PXP recommends implementing a water quality monitoring program that would monitor the effluent from the produced water treatment plant for Benzene and Phenol at a frequency that is consistent with the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California.* Water samples will be collected in a manner that is consistent with EPA Methods 624 and 625 pursuant to 40 CFR 136.4 (a)-(c) and 40 CFR 136.5 (a)-(d) at the point of discharge. All water samples will be analyzed at a laboratory that is certified by the Department of Health Services, in accordance with the provision of Water Code Section 13176 and will be accompanied by the laboratory QA/QC reports. The results from the water sampled will be submitted to the Regional Board with the required analytical reporting limits and method detection limits at a frequency determined by the Regional Board.

Based on the results of the Produced Water Treatment Plant pilot test, the results of the water quality analysis on the produced water prior to treatment, and the implementation of a water quality monitoring program for the constituents identified during the RPA, PXP believes the aquatic resources identified in the Basin Plan will be adequately protected.

5. *In describing alternatives to the proposed creek discharge, your submittal refers to the infeasibility to buy injection sites (p.4-2); limited amount that could be reused (p.4-2 & 4-4); limited land disposal opportunities on- or off-site (p.4-3 & 4-4); and irrigation reuse opportunities. Please expand upon this information to address potential combinations of alternatives that could reduce or eliminate the need for creek discharge. If cost is the limiting factor in such evaluations, then specific details of associated costs should be included.*

The response first presents greater detail on individual options, followed by consideration of combinations of alternatives.

Greater Detail on Other Options. The following provides more detail on particular options evaluated.

Onsite Injection

PXP evaluated numerous potential areas to inject produced water into the subsurface without adversely impacting the steam drive. Several areas in the Monterey Formation were evaluated, but increases in zone pressure indicated the injection could not be sustained in compliance with Division of Oil, Gas, and Geothermal Resources (DOGGR) requirements. A sand zone (M-12) and a diatomite zone were investigated, but found to be connected to the producing zones, and therefore would adversely affect the steam drive. The Oak Park area, southeast of the oilfield,

was evaluated, but the area is currently undergoing residential development. The cost of conversion of a portion of this property to injection use was deemed prohibitive based on current real estate values in the area, although a specific appraisal was not conducted. Furthermore the Oak Park area was drilled and tested, and found to not be an open-ended reservoir, suggesting that injection could lead to the sorts of pressure increases observed in the Monterey Formation. The design calls for injection of the reject water produced by the treatment process into the producing zones. Further injection would undermine the project purpose of the facility.

Surface Discharge

PXP evaluated surface discharge on the oilfield. Percolation tests were conducted, and determined limited recharge potential. A total of 16 soil borings were installed by Fugro West in 2005-2006, logged for strata encountered, and analyzed for grain size variation. The data indicted a high percentage of silt and clay, and an average permeability for the area was determined to be approximately 0.5 gallons per day per square foot. Thus, an area of one acre could percolate 20,000 gallons per day (0.06 acre-feet per day). The report further concluded that any water that could be percolated would quickly encounter shallow bedrock and remerge as surface flow in Pismo Creek. The area is also subject to landslides, and further loading by infiltration could increase the incidence of this form of mass movement. As such, the amount of reclaimed water that could be accommodated would be small, and have the potential for adverse impacts. This alternative could only be applied in the dry season, since during the wet season the soils are already at their infiltration capacity.

Irrigation of Edible Crops

PXP communicated with wineries in the Edna Valley and with growers in the area regarding use of the reclaimed water for irrigation of edible crops. As the crops are edible, the California Department of Health Services places limitations on the use of reclaimed water, including additional treatment by oxidation, chlorination, coagulation, clarification, and filtration. Furthermore, boron levels in the water are relatively high and may affect the crops. Some growers considered blending the water with State Water Project supplies prior to application. Ultimately, no users were willing to undertake the additional treatment of the water, and did not negotiate further. This alternative could only be applied in the growing season, when there is an irrigation demand.

Irrigation of non-edible crops

A local landowner has expressed interest in using the reclaimed water for irrigation for non-potable uses. The landowner was only interested in a long-term commitment from PXP for guarantied supplies. PXP cannot make such a commitment, and certainly not beyond the life of the oilfield. PXP believes that providing access to the reclaimed water may induce this landowner as well as others to take advantage of the offer in some fashion, but this is not certain. This alternative could only be applied in the growing season, when there is an irrigation demand. Table 1 summarizes these factors, as well as those for use of the treated water for non-potable use on the Arroyo Grande Oilfield, and use of the treated water for dust control at the nearby landfill.

Table 1: Summary of Attributes of Beneficial Use Options in Addition to Augmenting Flow in Pismo Creek

Alternative	Volume of Water	Further Treatment Required Beyond Proposal?	Can Accommodate Continuous Supply?	Feasible?
Non-potable water supply at PXP Oil Field	Up to approximately 1,000 gallons per day	No	Yes	Yes, will be implemented
Surface Discharge on Oil Field	20,000 to 50,000 gallons per day based on infiltration capacity, still flows to Creek	No	No, cannot discharge during wet season	No: Inadequate infiltration area, drains to Pismo Creek
Irrigation for Edible Crops	Not determined	Yes, oxidation, chlorination, coagulation, clarification, filtration. Boron reduction was a concern.	No, only demand during spring and summer	No, do not have willing recipient for water and upgrades to treatment
Irrigation for non-potable crops	Not determined	No	No, only demand during growing season	No, do not have willing recipient
Landfill Dust Control	Not determined, but likely in the range of 100,000 gallons per day	No	No, only demand during dry season	No, landfill not willing to support pipeline from oilfield

Combinations of Alternatives. The evaluation of options also included the potential to combine them in order to reduce creek discharge. As summarized in Table 1, the currently feasible combination of alternatives is augmenting flow in Pismo Creek with the discharge from the facility, and use of a portion of the treated water for non-potable uses on the Arroyo Grande Oilfield. This non-potable use will reduce the amount of groundwater pumped from the water basin. PXP believes that once the reclaimed water is made available, area landowners may take advantage of its use for other non-potable uses. However, after approximately 10 years of consultation, there are no feasible uses at this time, and these other non-potable uses cannot be guarantied.

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